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Disaster Recovery And Relief - Current & Future Approaches

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WELCOME FROM THE 2007 CONFERENCE HOST

I am greatly honoured to welcome all of you attending the 14th TIEMS Annual Conference in Trogir and know that, once again, the great part of the world has gathered here to try, in unified front, to fight the common enemy – disaster in all its forms. Different countries have different systems and means for fighting against adversity, some of them rich and some of them not, but we all, through gatherings like this, are trying to share our achievements, knowledge and practical solutions, with the aim of enhancing and improving collective benefit.

Throughout its history, this great world of ours has been faced with many catastrophes and disasters, which has intensified over the past decade. We've been witnessing natural, manmade and social disasters as well as new threats in a form of terrorist attacks or pandemic disease threats. The truth is that we have produced better means for fighting against and dealing with disasters, but it is also important to keep in mind that contemporary society, in spite of all its facilities and achievements, is still vulnerable. In some cases it may prove to be even more vulnerable. For example, in a case when a disaster hits densely populated areas. Recent disasters have sent a message that there is still much work to be done. It is also very important to emphasize that natural disasters have become more frequent and more severe because of the human influence on the environment. These are global problems and we must find global remedies - We must think in terms of the world and the future and act now.

In general, Croatia is investing great efforts to achieve the standards of the modern world and specifically the EU, with the objective of not being among the weakest links in the chain of defence against disasters. The high auspices of the Croatian Government and Ministry of Science, Education and Sports, and Ministry of Internal Affairs confirm this.

The Regional Centre for Assistance and Disaster Relief, as the host of this conference, and at the same time a governmental institution engaged in previously mentioned matters, is hoping that the proceedings of this gathering will indicate new, clearer and more efficient guidelines in finding solutions for predictable and unforeseen adversities in the future.

This year's TIEMS Conference on "Disaster Recovery and Relief: Current and Future Approaches" will address and cover vital issues to be considered through interdisciplinary approach using different methods. I hope that it will result with beneficial solutions, which will help all of us to be more prepared and efficient in dealing with all kinds of disasters.

Every contribution is welcome, every idea worth considering and every solution precious. This Book of Proceedings will surely be a document worth revisiting in time to come for all participants of this conference.

I wish you a pleasant and memorable stay in our country in the following days and I am sure that you will find some time to enjoy the beauty of this exquisite part of our world. I hope that you will keep the warmth of our sun and hospitality of our people in your hearts for a long time.

Ranko Britvić
RCADR Director
and Conference host

FORWORD FROM THE PRESIDENT OF THE INTERNATIONAL EMERGENCY MANAGEMENT SOCIETY

TIEMS has for the past year been continuing its global focus, and the society has made measurable developments towards its goals and will continue with the help of its members and supporters to create stronger links and networks for information sharing on emergency management worldwide.

Our annual conference in Trogir, Croatia is TIEMS 14th annual conference, and it is a pleasure to be in this historic city and beautiful area. The program is the best ever with ninety two presentations from all over the world, and it is with our great pleasure to welcome the Prime Minister of Croatia to open the TIEMS 14th annual conference.

The number of participants is expected to be around two hundred representing around thirty different countries, and demonstrates the international foundation for TIEMS, and that the program is of interest far beyond the authors themselves. The participants and sponsors of the conference are all engaged in these important and far-reaching subjects of emergency management. We feel that open international gatherings like TIEMS, gives an excellent opportunity for exchange of ideas and discussions on ways and means to make the world a safer place. We are confident that this and other events also lead to increased international cooperation in this highly challenging area, which is not limited by borders.

The published papers in the proceedings give a broad international view of emergency management with an international perspective, and with these proceedings TIEMS like to stimulate a continuous ongoing international dialogue and debate on emergency management. Many thanks go to Alan Jones for his excellent job as Chairman of the Paper Review Committee, and all his team in reviewing of the papers for conference. I trust that the presenters at TIEMS 2007 appreciate this quality improvement of the event.

TIEMS is an international, non political and not for profit society, which has limited financial resources. TIEMS 2007 in Croatia would not have been possible in the form it is presented without the financial support and help of TIEMS 2007 participants and sponsors and TIEMS is thankful to all of you for your support.

Boja Ostojic has taken the initiative together with local TIEMS supporters to establish a Croatian Chapter of TIEMS, and many thanks go to her for giving TIEMS a permanent presence in Croatia. Special thanks also go to Giedo Van pellicom and Charles Kelly, who have been instrumental in the planning process and the financing of the conference. Giedo Van Pellicom in cooperation with Ulrich Raape have also, in cooperation with many of TIEMS directors, got the TIEMS web-site back on track after an unfortunate interruption during the most critical phase of the planning process of the conference, and we will be pleased to make full use of our new site in making the proceedings from TIEMS 2007 available from our web-site, www.tiems.org after the conference.

Finally thanks go to RCADR and specifically Ranko Britvic and Stiven Vlaislavic and their staff who have supported the conference and formed a local organising committee, preparing all practical details of the arrangement and all social events.

Organising of the conference has been hectic at times, but seeing the fruitful result of the work, is very satisfying, and we hope you will all enjoy the event.

K. Harald Drager
TIEMS President

FORWORD TO THE PROCEEDINGS FROM THE EDITOR AND CONFERENCE PROGRAMME CHAIRMAN

Every emergency in every part of the world, however similar to those that have gone before them seem to pose new challenges for the emergency management community. And with each new challenge it is vital, if we are to improve our overall responses to learn the lessons from these events, and ensure measures are put in place to mitigate and if possible prevent these incidents occurring.

This peer-reviewed collection of papers provides a review of many of the emergencies that have faced the world in recent years and also the threats, which we may all face in future such as pandemic flu and climate change. Most importantly however they address developments, which have been made to manage them, and rather than simply expressing heroic tales, provide a forum for critical evaluation of responses and reporting of new approaches to encourage debate and further develop the profession of emergency management.

One key feature, which appears to underpin, perhaps unsurprisingly, many of papers, is the importance of effective information and communication management. This has long been a challenge for those dealing with emergencies, being raised in many post incident reports and inquiries and it is hoped the papers and the presentations will spark debate amongst you all on the best ways to improve this. TIEMS is actively supporting the improvement of communications practices in the field of emergency management through a range of initiatives, which will also be presented during the course of the conference.

The papers as always convey what has become a hallmark of the TIEMS conference over the years, to provide an interchange between theory and practice with papers from practitioners, researchers, industry and policy makers, which we hope will provide the reader with a balanced and objective view.

Considerable steps have been taken to improve the standard of the papers for the conference over the past year, through the implementation of a new and comprehensive review process. This has however only been possible though the significant efforts and support of the review team, to whom I would like to express my thanks, and hope you will all recognise the improvements realised through this process.

Finally I would like to take this opportunity to thank all of the authors who have spent time and effort to share their experiences, and hope you will all benefits from these, and that these proceedings will form a useful reference document to you in future.

Alan Jones
TIEMS Director
Editor

Academic & Professional Practice

Peer Reviewed Articles

EMERGENCY INFORMATION MANAGEMENT

UNDERSTANDING THE BARRIERS TO THE INTEROPERABILITY OF DISASTER AND EMERGENCY MANAGEMENT INFORMATION SYSTEMS

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KEY WORDS: Disaster and Emergency Operations, Information Systems, User Requirements, Situational Awareness, Interoperability, Information Communication Technology (ICT), Information Exchange, Common Data Formats

ABSTRACT:

Emergency and disaster operations require a multi-agency approach to civil protection. However, agencies such as the police, the fire services, the health services and relevant non-governmental organisations display major differences in the way they handle information. This may be attributable to security rules, operational procedures, or even the culture that characterises each organisation. Situational awareness in a multi-agency operation is a key factor for the effectiveness of disaster and emergency response. Its enhancement is based on the building of a reliable Common Operational Picture, made up of information shared by the different teams of responders working together.

Interoperability describes the ability of systems to connect and exchange information so that they operate effectively together. This has been a long-standing requirement in the military domain, largely due to the demands of joint-service missions but also those of combined multinational operations. However, unlike the military, the civil protection sector is fragmented. Solutions for improving interoperability encounter difficulties in the face of such disjointed "markets". The civil protection "market" does not provide clear directions for the Information Communication Technology (ICT) industry to meet the demand of commonly agreed data formats for exchange of information.

The efforts required for developing common data formats and driving them through lengthy standardisation processes may be seen as inefficient. This is particularly relevant to the fast moving ICT world where the risk of being outdated is high.

The paper suggests that in this context, the achievement of various local, regional or even national ICT strategies could be described as sub-optimal and that there is a pressing need for various stakeholders, and the user community in particular to agree on a common vision for interoperability.

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INTRODUCTION

This paper addresses the issue of information sharing during response operations to disaster and emergencies. It focuses on the case of civil protection organisations that encounter multi-agency dealings every day. By and large, information is shared during the response to emergencies and disasters between organisations that have varied purposes and use differing processes. These exchanges are frequently described as key to the success of operations. Nevertheless, the sharing practices may be difficult as technology, procedures or even trust are not always in place to support them.

THESIS

This paper will not only examine information exchanges in their strictest technical aspects. It will examine the issue further then the dictionary definition[2] which characterizes interoperability as the ability of computer systems or software to operate in conjunction by considering the wider context of information sharing.

Firstly, this paper underlines what is at stake when sharing information by looking into some of the lessons learnt from the response to Hurricane Katrina. It shows that a common situational picture can only be created and is only useful when a structure of coordination mechanisms exist.

The background of the requirement for improved interoperability is explored in the second part of the discussion. Indeed, the EU's evolving strategy for Global Security will ultimately bring about more cases for inter-agency operations for which interoperability is critical.

A model offering a characterisation of the levels of interoperability is proposed in the third part of the discussion. The model describes each level by a form of output corresponding to a range of building blocks.

This paper then looks into the need for standardisation and the proposed solution of a Common Data Format by the EU FP6 funded project called Oasis.

SOURCES OF INFORMATION

The sources of information for this paper are mainly bibliographical and are also drawn from the authors' own experience in taking part in the conception and development of a Disaster and Emergency Management System. The bibliographical references used feature as footnotes throughout the paper.

[2] *The Concise Oxford English Dictionary*, Eleventh edition revised . Ed. Catherine Soanes and Angus Stevenson. Oxford University Press, 2006. *Oxford Reference Online*. Oxford University Press. Cranfield University. 28 Feb. 07 http://www.oxfordreference.com/views/ENTRY.html?subview=Main&entry=t23.e29008

FINDINGS AND DISCUSSIONS

The importance of building situation awareness through the sharing of information – the case of Hurricane Katrina

A striking example of the importance of information sharing can be found in a report[3] to the US House of Representatives on the response to Hurricane Katrina. Although this Transatlantic account may seem distant and possibly irrelevant, some of the issues it raises are generic.

Following the 9/11 incidents, the US government had enhanced its framework for disaster and emergency response by creating the Department of Homeland Security (DHS) and developing the National Response Plan (NRP). During the response to Hurricane Katrina, although most emergency support functions were activated as prescribed in the NRP, it is reported that there was a major lack of situational awareness and disjointed decision making. "Too often, because everybody was in charge, nobody was in charge" as a consequence, valuable situational information was not provided to the White House and some of it was wrongly discounted (when actually accurate). The report believes that "earlier presidential involvement might have resulted in a more effective response".
A number of coordination problems have their origins in the preparation for disasters and it is disturbing to read that top officials in the U.S. Department of Health and Human Services and in the National Disaster Medical System did not share a common understanding of responsibilities and controls.
In effect, it appears that deficient situational awareness was not present solely at the top of organizations nor on the ground, but featured right through the response apparatus. For instance, the Federal Emergency Management Agency (FEMA) lacked knowledge of requirements and resources in the supply chain.
The military provided a key part of the response, but again the lack of coordination caused delays in the Department of Defence response. The report emphasizes that there was a deficiency in adequate information sharing protocols that would have enhanced joint situational awareness. It also outlined that a lack of communication equipment and interoperability contributed to poor ground coordination in the joint military, Coast Guard and National Guard response
Furthermore, failures in communications had a profound impact on the overall response by restricting Command and Control, constraining situational awareness, creating delays in the delivery of relief supplies and limiting officials' ability to address unsubstantiated media reports.

The description of the response to Hurricane Katrina illustrates the difficulty in building reliable situational awareness in the midst of a crisis. It also shows that common awareness must be backed up by effective coordination mechanisms.

The evolving context – the EU's recent approach to Global Security

For the EU, security is increasingly at the forefront of policies, although in the post Cold War era the EU has become less of a "consumer" and more of a "provider" in terms of security[4]. The EU has shown it is keen to preserve peace and security in its area of direct interest, but the difficulties in differentiating between internal and external policies are becoming more apparent.

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[3] Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina, Tom Davis, Chairman. A Failure of Initiative - The Final Report of the Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina.(2006)
[4] International Crisis Group. EU CRISIS RESPONSE CAPABILITY REVISITED.(2005). Europe Report N°160, .

European Security and Defence Policy (ESDP) is moving from concepts[5] to reality. Whereas traditionally its focus has been on the enhancement of military capabilities, recent, developments in capabilities have seen a shift to rapidly deployable, technologically capable and intelligence based forces structured and equipped to perform a wide range of tasks. The focal point of the EU approach now revolves around military capability shortfall, in order to obtain a level of readiness geared to prevent conflicts or assist stabilisation in post-conflict situations.

The EU civilian toolbox has not benefited from as much attention. Paradoxically, the development of civilian capabilities is crucial as civilian missions are increasingly more likely then "high-end military" ones. Several aspects of ESDP are described as non-military. These civilian crisis management capabilities are: policing; the administration of justice (rule of law); civilian administration; and civil protection. Their purpose is to allow the EU to provide the full range of assistance to countries in crisis and a number of organizations and bodies have been set up by the EU to address this issue. The Committee for Civilian Aspects of Crisis Management was established in 2000 to ensure coherence and completeness in the delivery of an EU response to crises and is assisted by Crisis Response Coordination Teams. Since 2001, the Conflict Prevention and Crisis Management Unit has acted as a focal point within the European Commission to look at the civilian aspects of Crisis Management. A joint Situation Centre has also been established (in 2003) to combine the military and the civilian instruments and to provide an operational point of contact at EU level within the Council. In addition, the provision of civilian capabilities were defined in 2000 and Member States pledged to provide 5000 police officers that could be deployed in 30 days as well as 200 experts in the fields of rule of law, civilian administration and civil protection.
The EU recently assessed its collective civilian capabilities[6] for crisis management and began to articulate how these should be expanded, both in scope and quality. The subsequent agreement of a Civilian Headline Goal launched in December 2004 sets out a number of ambitions for the development of ESDP.
This initiative[7] called for the development of capacities in order to allow the EU to:

- Deploy integrated civilian crisis management packages. The definition of these 'packages' and their tasks are derived from the specific needs on the ground and exploit the full range of EU crisis management capabilities.
- Conduct concurrent civilian missions at different levels of engagement. The EU should be equipped to conduct several missions concurrently, including at least one large civilian follow-on mission at short notice in a non-benign environment. These should be sustainable over a longer period of time
- Deploy at short notice. The EU should be able to take a decision to launch a mission within 5 days of the approval of the mission concept and certain capabilities should be deployable within 30 days of the decision to launch.
- Work with the military. The EU missions can be deployed autonomously or in close co-operation with the military. In the latter case, a coherent coordination of civilian and military means in response to crises should exist in order to allow the smooth transition from ESDP operations to long-term EC programmes. This requires a clear functional division of responsibilities and close co-operation in planning of ESDP efforts and exit strategies.
- Respond to requests from other international organisations, notably the UN.

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[5] International Crisis Group. EU CRISIS RESPONSE CAPABILITY REVISITED.(2005). Europe Report N°160, .
[6] Isis. European Security Review, Number 25, EU Civilian Crisis Management : preparing for flexible and rapid response (March 2005)
[7] EU security and defence.(2005). *Chaillot Paper no. 75, Core Documents 2004, Volume V.*

It appears that the conduct of multinational security operations will increasingly have a multi-agency aspect to it. There seems to be a trend in associating military and civilian means in tasks such as conflict prevention, peacekeeping and tasks of combat forces in crisis management. Hence, the capability shortfalls within the EU should not just be assessed in terms of quantity or quality, but also very importantly, interoperability.

<u>Defining levels of interoperability - the military benchmark</u>

Interoperability is key to success in multinational operations. Military forces are aware of this fact due to their long experience of combined coalition operations. Much of the early research for greater interoperability has been conducted by the military. Recently, there has been a new focus to define the various levels of interoperability,[8] which aims to bridge the gap between coalition partners' differences in doctrine, organization, concepts of operation and culture.

<u>Levels of interoperability</u>

LEVELS	**OUTPUTS**	**BUILDING BLOCKS**
Cultural level of interoperability	**WORK EXCHANGE** Synchronisation Unity of Effort	**Common pool of resources** **Common resolution strategy** **Common target set**
Cognitive level of interoperability	**KNOWLEDGE EXCHANGE** Shared Understanding	**Common perception of the problem** **Common knowledge of capabilities** **Shared understanding of intentions**
Technical level of interoperability	**DATA EXCHANGE** Common Operational Picture	**Completeness of picture** **Accuracy of picture** **Timeliness of picture**

Model adapted from U.S.-CREST, RUSI,FRS, SWP. Coalition Military Operations - The Way Ahead Through Co-operability (2000)

This model suggests that there are various levels at which exchanges can be achieved when organisations work together. The basic exchange of data can be described as a technical level of interoperability. It aims at building a common operational picture in a timely, accurate and complete manner. An augmented exchange of knowledge will allow shared understanding of the situation. This can be described as a cognitive level of interoperability where information

[8] U.S.-CREST (Center for Research & Education on Strategy & Technology), RUSI (Royal United Services Institute for Defence Studies), FRS (Fondation pour la Recherche Stratégique) & SWP (Stiftung Wissenschaft und Politik). Coalition Military Operations - The Way Ahead Through Cooperability - Report of a French-German-UK-U.S. Working Group.(2000).

exchanges are not purely descriptive. They are accompanied by a common perception of problems, knowledge of what tasks are being carried out to solve them and a comprehension of how this might have an effect on the situation. Further amplified is the work exchange, whereby the cooperating organisations work not just alongside each other, but actually share some of their tasks and synchronise their efforts. This improved level of interoperability can be referred to as cultural or doctrinal. It suggests that at a high level in the Command and Control chain there will be common definition of strategies and associated targets and a common pooling of resources.

The boundaries between these levels of interoperability are not clear-cut. Nevertheless, many examples illustrate that there are indeed a range of various levels of interoperability or information exchange.

This can be observed for instance through the confirmed interest of the US Department of Defence into effects-based approaches. An effects-based approach[9] seeks to establish the "why" of a mission rather than just the "how". Such an approach encourages a holistic approach where "all of the sources of power and influence that can be applied" and orchestrated so that the synergies that result in effects are greater than those that are additive. In his book, Smith (2006) highlights that "even though the info-structure has improved, being able to conduct effects-based operations has proved challenging" This is generally attributed to a lack of commonly defined "organizational processes, trained individuals, and appropriate tools." Again this suggests that the issues of interoperability need to be tackled at each of the various levels and not just at the strategic or tactical level.

In the same way, a recent RUSI Paper[10] suggests that the exchange of information is not necessarily impeded by technical constraints and that it must find its roots in organisational culture. In fact, an interoperability agreement drawn up in the UK between the emergency services illustrates just how this will change the culture from the top.
In recent legislation[11] to develop an integrated emergency management system, the British Government recognized that a fine balance must be found between making decisions based upon comprehensive and fit for purpose information and acting on that information as swiftly as possible. It underlines that "establishing systematic information management systems and embedding them within multi-agency emergency management arrangements will enable the right balance to be struck". It also goes on to state that "terms and definitions should, wherever possible, come from national standards and publications rather than local initiative…. Otherwise, there is a risk that parochial usage may interfere with interoperability and co-operation with local partners and neighbouring areas and hinder co-ordination at the regional and national levels. The same applies to concepts of operation, doctrine and structures."

The call for standards – the Tactical Situation Object as a proposed solution

It is a fact that interoperability relies on standardisation. In itself, the concept of standardisation is not highly controversial, but implementing it may prove difficult to achieve. Implementation requires political will to organise coherent procurement programs. More importantly it requires the resolve to update capacity, which equates to committing financial resources in the long term.

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[9] SMITH, E.A. Complexity, networking, & effects-based approaches to operations. Anonymous Library of Congress Cataloging-in-Publication Data (2006).
[10] Bell, S. & Cox R. (2006). Communications Inter-operability in a Crisis. *Whitehall Report - RUSIt*.
[11] HM Government. Emergency Response and Recovery , Non-Statutory Guidance to Complement Emergency Preparedness.(2005). , Chapter 2 - Principles of effective response and recovery.

The sources of standards in Europe[12] are varied and can be categorised as follows:

- single-company *de facto* standards;
- multi-company commercial standards, developed by trade associations or ad-hoc standards organizations, often leading to a patent pool;
- formal commercial standards bodies with mixed membership;
- government standards

For private companies, in the first two instances, it is easily understandable that there may be natural tension between two objectives[13]: on the one hand, protecting market share and establishing proprietary positions; and, on the other hand, opening markets through industry-wide acceptance for new technologies, particularly by having the technology accepted as standard. In the fast moving field of electronics and computing it is particularly important to plan technical developments so as to create a balanced portfolio of essential and non essential rights framed around a business strategy. Consequently, the selection of technologies to go through a lengthy and heavy standardisation process is a tricky issue which requires a thorough awareness of future markets. This possibly means that drivers are too weak and wrongly focused rather than barriers too great.

The ability to share information in a timely and secure manner is often critical to the conduct of operations. In order to enhance situation awareness and facilitate information exchanges, the definition of a "standard instrument" which carries the description of the tactical situation between systems is necessary. The OASIS project funded by the European Commission under the FP6 Information Society Technologies program has done significant work of this issue[14]. Its strategy has expanded to include the new CEN (European Committee for Standardisation) workshop to prepare specifications for the interoperability of information systems and further consultation on its work on the Tactical Situation Object" (TSO).

This interface is derived from a NATO standard and more details are available on the project web site. The TSO is able to vehicle the following type of information:

- Identification of the information: the identifier of this TSO, the originator of the information and the date of creation of the TSO,
- Description of the event: the type of the event, its extent, the number of casualties, the consequences on the environment, its criticality,
- Description of the resources: which resources are already used, which resources are available,
- Description of the missions: the tasks that are on going, their status, the teams and resources that are engaged for them and their planning.

Ultimately, this standardisation process should provide the market with the tools required for the operation of advanced systems deployed in disaster and emergency management and is expected to feed into the ISO - International Organisation for Standardisation (Technical Committee for Societal Security -ISO/TC 223) as a contribution to the international work plan for Societal Security standardisation (ISO/TC223).

Concluding remarks

[12] Dolmans M. STANDARDS FOR STANDARDS (2002).
[13] Watts, J.J.S. & D.R. Baigent. Intellectual property, standards and competition law: navigating a minefield.(2002). Volume 2, Page(s):837 - 841 vol.2, .

[14] See the OASIS project website: www.oasis-fp6.org

It is noteworthy that, in essence, the difficulty in understanding the markets of Crisis and Emergency Management Systems is inherent in the fact that these markets are fragmented. The division does not reside only in the lack of coherent acquisition contracts – a major barrier is that the various organisations involved in disaster and emergency operations do not adopt the same perspective when providing a response. Ultimately, their common purpose is about saving lives and recovering from crises, but as the police might need to focus on investigative aspects or the protection/restoration of a scene, the fire service will conduct search and rescue or fight fires and the ambulance service will attend to the health of casualties, sometimes with little consideration of other agencies' requirements. A joint response must offer a united vision of the 'why' and what is the overall strategy to all parties involved.

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Edith Wilkinson currently works for the Resilience Centre of Cranfield University on various EU-funded projects. The OASIS project aims to design and develop an open, modular and generic Crisis Management System in order to improve the effectiveness of the information sharing and interoperability of all agencies involved in disaster emergency response. The MARIUS project aims at developing a pre-operational autonomous initial tactical Command Post that can be deployed very quickly. Its set up and activation are aimed to support operations large-scale disaster or when existing arrangements are incapacitated.

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TOWARDS A FRAMEWORK FOR CRISIS INFORMATION MANAGEMENT SYSTEMS (CIMS)

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Keywords

Crisis Information Management Systems, Frameworks and Architectures, Interoperability, Standards, Emergency Management Systems, Incident Management Systems

Abstract

After a number of recent major natural disasters (eg Boxing Day Tsunami, Hurricane Katrina, and Cyclone Larry) the sector stakeholders are moving towards efforts to define and exploit greater ICT utilisation during the response and recovery phases of major incidents. The focus has moved from just improving voice-data-network-level technologies for communication into harnessing new information-level technologies to cover all phases of crisis management. This includes information infrastructure for incident message routing and standard languages for conveying the semantics of emergency warnings and resource and task management. In this paper we review some of the emerging requirements for Crisis Information Management Systems (CIMS) and look at the current and future technologies that will need to address these requirements. A CIMS needs to also address the sharing of information across emergency agencies and any stakeholders involved in the response and recovery. A CIMS will also be required to follow any number of emergency response models and provide technologies to match and support the policies and rules that govern these human-oriented models. Also, based on our own CIMS demonstrator, we propose a starting framework to support CIMS functionality and identify the key interoperability opportunities.

Introduction

With the recent impact of natural and other disasters, the emergency management community has focussed energy on defining greater requirements for ICT support during and post these incidents. There has also been an expectation that ICT should be providing such support. However, emergency management is not a discipline that follows well behaved rules nor allows itself to be modelled sufficiently well that all contingencies can be catered for a priori. In essence, emergency management is still in its infancy when utilising ICT solutions.

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Crisis Information Management Systems (CIMS) is a new concept now entering the vocabulary of the emergency and disaster sector. Its aim is to provide a complete suite of ICT functions addressing the many requirements from the emergency management community. There are other terms, such as Disaster Management Interoperability System, and Critical Incident Management System, but CIMS is emerging as the preferred term for major crisis needs across multiple agencies and across multiple jurisdictions, where there is a need to exchange information for coordinated action and capability sharing.

Recent work on frameworks for CIMS has shown a broad scope in findings. Kim *et al* (2006) define 12 underlying factors that need to be supported, such as information sharing, resource allocation, secure and reliable communications, coordination with national resources, integrating information, and privacy issues. Dwarkanath & Daconta (2006) outline an "enterprise framework" for CIMS and argue that no single entity can be responsible for the entire management of a crisis which a shared services platform across many enterprises could support.

Ryoo & Choi (2006) argue that modularity is critical for CIMS to maintain their flexibility in adapting to disasters of different magnitude. They also present a classification framework that includes high level functions of: collection, distribution, presentation, and processing for CIMS frameworks. Wang & Belardo (2005) present a crisis management framework where the information management strategies differ depending on the state and type of the disaster.

The Institute for Security Technology Studies (2004) found many challenges facing the CIMS community, including:

- Supporting a wide range of functional areas,
- Supporting the Critical Infrastructure community,
- Supporting a broadly accepted vocabulary of technical terms, and
- Promoting the interoperability of CIMS.

We propose that a CIMS Framework needs to capture and categorise the functions and services of CIMS to enable a common terminology to evolve with shared meanings. Additionally, the interoperability between CIMS must be based on open information standards developed by the community to enable flexibility in the systems architectures and deployment of CIMS.

This paper is organised into three sections covering the aims and scope of CIMS (as shown in Figure 1).

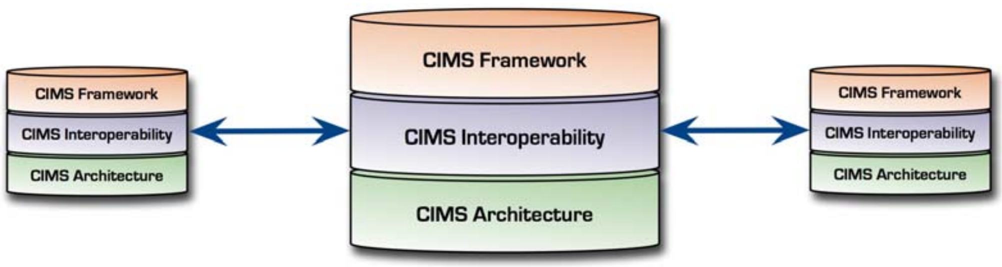

Figure 1 – CIMS Scope

Firstly, the CIMS Framework will be presented that covers the high-level functionality and services provided by CIMS systems. Secondly, CIMS Interoperability covers the sharing of information between CIMS systems in a consistent and standardised manner. This will focus on current information standards related to emergency management. And thirdly, the CIMS

Architecture will cover some of the underlying technical issues for deploying CIMS systems, and will be based in a demonstrator CIMS system.

CIMS Framework

The functionality of a CIMS will vary greatly. This will be reflected in the both the needs of the crisis team using the CIMS and the level of expertise and reporting structures. Figure 2 presents some of the core functionality for CIMS services across three horizontal layers. Layer one functions include functions that provide direct crisis control and management. Layer two provides support functions to layer one services, and Layer three provides core system-wide services.

Figure 2 – CIMS Framework

The Operational Methodology Management function is one of the critical functions of a CIMS and operates across all layers. This supports the processes used in crisis coordination centres which are governed by Incident Management Systems (IMS), which vary across jurisdictions, but fundamentally provide a structured and hierarchical "command and control" framework. For example, in Australia the common IMS is the Australian Inter-service Incident Management System (AIIMS), which governs the roles and relationships between the local, district, and state level disaster coordination centres, and disaster management groups. The Operational Methodology Management would provide overall concepts that would need to be supported across all the other layers and functions, based on the terms, structures, and semantics defined in the IMS.

The layer one Incident Management supports the high-level recording of individual incidents. Since a CIMS will be used for multiple incidents over time, there is need to manage a crisis as a single event. All other layer one and two functions would be related to one or more incidents. People Management supports the management of defined roles, teams, tasks and duties of individuals and organisations.

Resource Management supports the management of resources during a crisis. This involves all stages (discovery, commitment, deployment, return, extension, etc) for resources involved in the recovery and response phases of a crisis.

Notification Management supports the management of outgoing and incoming information messages. This includes broadcast messages to large groups, even community wide, and routing of messages to the right people who need to be informed of the content.

Situational Awareness Management supports development of a "picture-of-operation" that encapsulates the current crisis, based on all the information currently held or made available to the CIMS. Typically, this would be aggregated situational reports or geo-spatial images with multiple layers showing current status of the incident and allowing planning operations.

The layer two Document Management supports the effective categorisation of the documents created and deposited into the CIMS. Report Management supports the automated creation of incident reports, based on the CIMS repository of information, such as status reports etc.

Financial Management supports budgets, expenditures, and reconciliation of financial transactions. Assessment Modeling Management supports planning and modelling functions of the incident, such as damage assessment, or storm-tide surge modelling.

The layer three Authentication and Authorisation Services support users to gain access and be authorised to perform secure functions in the CIMS. Directory Services supports a single view of users across the CIMS including federated identity services. Geospatial Services support mapping of incident data to various map sources, such as road networks or satellite maps.

The aim of this framework is not to present an extensive functional map of CIMS services, but to focus on the core functions, and their interoperability challenges across CIMS.

CIMS Interoperability

When designing CIMS, it should not be assumed that they will operate in isolation. Although some systems have been designed in this way in the past - including a variety of standalone Web-based and client/server solutions, such as WebEOC (ESi, 2007) and L-3 CRISIS (Ship Analytics, 2007) - the requirement for all parties involved in crisis management to use a single (and often centralised) system has hindered their uptake. Crisis management is typically a complex activity involving distributed teams of people from a variety of organisations; therefore, requiring everyone to adopt and log on to a single system is extremely challenging in terms of conflicting organisational policies and procedures (e.g., security policies), differing IT setups and system scalability. In order to be successful, interoperation based on common standards should be supported, both between different implementations of CIMS, as well as between CIMS and other types of software used by the emergency management community. As discussed earlier, many countries have standardised their terminology, principles and command structures for crisis management by developing their own IMS (such as AIIMS in Australia); however, there has been limited adoption of standard formats for information sharing between information systems such as CIMS. Despite this, some work on the standardisation of information formats has begun – particularly in the US, driven by problems highlighted by recent disasters such as Hurricane Katrina and 911.

The most relevant standards for CIMS are being developed by the OASIS consortium's Emergency Management Technical Committee (OASIS Emergency Management TC, 2007). The Common Alerting Protocol (CAP) (OASIS Emergency Management TC, 2005) was the first standard to be sanctioned by this group. CAP defines an XML format for interoperability in alerting and public warning systems. The intention is to promote consistency in the information produced by all kinds of sensor and alerting systems, thereby reducing confusion and helping to get crucial warning information to the public faster. CAP messages carry message identifiers; information about the sender and the time sent; message status, type and scope; and the event category, urgency, severity and certainty. In addition, the messages can carry other optional information, such as instructions for the recipients and a description of the target area. CAP has had good early uptake in the US – e.g., in the Department of Homeland Security and the National Weather Service (Botterell, 2006) – and is emerging as the common information standard for general incident messages.

The next generation of information standards are being developed as part of the Emergency Data Exchange Language (EDXL) family of standards. This family includes one completed standard – the EDXL Distribution Element (OASIS Emergency Management TC, 2006) – and two further specifications that are nearing completion – EDXL Resource Messaging (OASIS

Emergency Management TC, 2007b) and the EDXL Hospital AVailability Exchange Language (OASIS Emergency Management TC, 2006b).

The EDXL Distribution Element (EDXL-DE) captures information required to enable routing of XML (and other) payloads, in order to facilitate information exchange between the various organisations involved in emergency management and response. This routing information includes elements such as the target area for a message (in order to support location-based message delivery); information about the sender; the target address for the message, if applicable; keywords describing the message content; and the type and "actionability" of the message (actual, exercise, test, etc.). The Distribution Element can be used as an envelope/container to support dissemination of other EDXL components, such as resource messages, hospital availability information, or CAP payloads. It can underpin all forms of information exchange in CIMS (including interoperability with other software), as it is designed to carry any form of emergency-related data, and can serve as one of the standards underpinning the Notification Management function of the CIMS framework described in the previous section.

The Hospital AVailability Exchange Language (EDXL-HAVE) enables hospitals to exchange information about their bed availability, status, services and capacity. EDXL-HAVE can partially support the Situational Awareness function outlined previously – that is, it can be used to support emergency logistics and resource-related decisions, but requesting specific hospital resources is outside its scope. This is covered by EDXL Resource Messaging (EDXL-RM), which aims to provide a comprehensive set of message formats for resource management across all areas of the emergency sector. EDXL-RM provides a set of 16 message types for purposes such as requesting resources and responding to resource requests; requisitioning and committing resources; offering unsolicited resources; requesting and reporting resource deployment status; and releasing resources. Although the standard is reasonably complex, it is comprehensive and will provide a good basis for the Resource Management functionality of CIMS. Both EDXL-HAVE and EDXL-RM are expected to be approved as OASIS standards in the first half of 2007.

Figure 3 shows the relationship between the EDXL and other interoperability standards in terms of their roles for underlying communications, routing infrastructure, and incident-specific information messages.

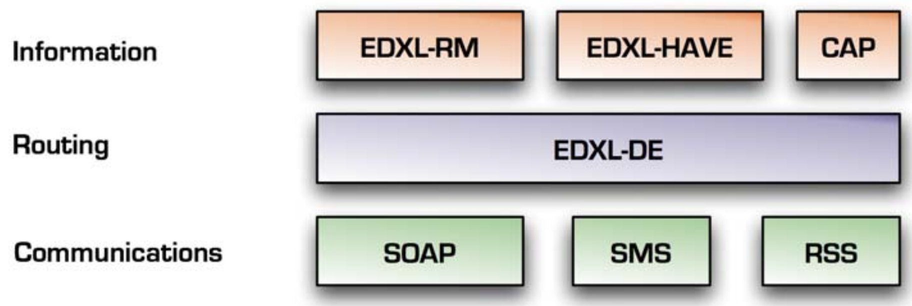

Figure 3 – CIMS Interoperability Layers

These current and emerging standards are a good step in the right direction for interoperability, but are far from covering the full scope of CIMS functionality. Further standardisation efforts will be required to close the gaps. In addition to participating in the development of OASIS specifications such as EDXL-RM, we have been developing information models and XML formats for cyclone/hurricane warnings, tsunami warnings and situation reports. Some of this work is described in our earlier publications (Iannella, 2006; Iannella and Robinson, 2006; Sun *et al.*, 2006).

CAIRNS: A CIMS Architecture

Because CIMS systems come under heaviest load when a disaster occurs, they have to operate in challenging external conditions. Network connections might be intermittent, network nodes have to be able to join and disconnect at will, and information has to be accessible to end user terminals with limited resources, such as PDAs and mobile phones.

CAIRNS (Cooperative Alert Information and Resource Notification System) is a demonstrator of technologies that can be used to construct a resilient, fault-tolerant CIMS architecture. Currently, CAIRNS is focussed towards an interoperable architecture for incident notification.

On the most basic level, CAIRNS is a collection of independent nodes that can join and drop out of the network at will (see Figure 4). Messages between nodes are passed using peer-to-peer (P2P) technologies similar to those used in file sharing networks. There is no central node, which means there is no single point of failure that would bring the whole system down. Each node caches the messages it receives and is able to forward them even if the original sender can no longer be reached. A message is purged from the cache when an update arrives or its expiration time is reached.

Interoperability with other systems is achieved by using a standards-based message format. CAIRNS message traffic is based on SOAP, a standard protocol for exchanging XML-based messages over networks. Each node acts both as a SOAP server and a SOAP client, so that any node can initiate the message transfer without the need to poll. Routing information is attached to the message using EDXL-DE.

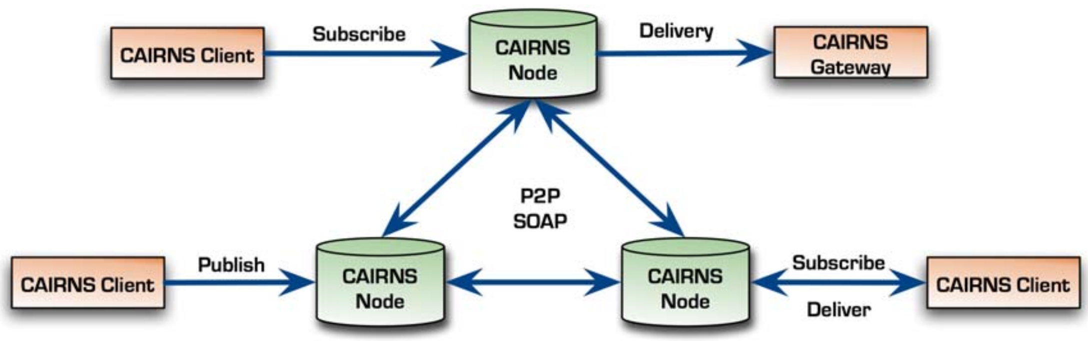

Figure 4 – CAIRNS Architecture

End users can connect to a CAIRNS node with a standalone client or through a Web interface. Each user registers their interest in a particular type of message by specifying subscriptions containing rules such as type of incident, geospatial area affected, sender role, severity and so on. Whenever a new message matching the subscription arrives, the user will get a notification by appropriate gateways to delivery mechanisms (eg SMS, email, SOAP) which can be selected according to rules such as "if it's past 5pm, I want a brief summary by SMS, otherwise send the full message by email". The messages can contain information about the intended recipient roles, so that fire incidents will be relayed to all users with the "fire chief" role specified in their profile even without a matching subscription. By specifying roles instead of specific email addresses, the messages will reach the appropriate persons regardless of their actual identities.

All the information available through CAIRNS is provided by Publishers. At the most basic level, their role is to receive information through other channels (for instance, an ocean buoy that transmits sea level data) and transform it into CAIRNS messages. In practice, a Publisher amalgamates information from different external sources and publishes conclusions based on this data (eg a Tsunami warning). Subscribers are directly connected to the CAIRNS network and can access information either by subscribing or through direct queries. Consumers receive CAIRNS information through one-way gateways that transform CAIRNS messages to a format more suited to the distribution channel. An example of a Consumer could be a member of the general public who receives a tsunami warning as an SMS cell broadcast to his or her mobile phone, or an Emergency Manager responsible for evacuating people.

The next phase of CAIRNS is to extend the architecture to support Resource Management functions from the CIMS Framework utilising the EDXL-RM standard for interoperability. This will also test a number of the related CIMS Framework functions, such as Notification (for routing message) and Situational Awareness (show me the current locations of my resources).

Conclusion

We have presented findings on evaluating the functional requirements for CIMS and developed an initial framework. This has highlighted the key requirement of interoperability for CIMS to enable collaborative sharing of critical information. Our CAIRNS demonstrator is the first step in realising this CIMS framework and technical interoperability architectures.

There is no doubt that information is critical during catastrophic disasters. The emergency sector is now moving towards common CIMS solutions as a result of recent major disasters that have highlighted ongoing challenges across the community. As the community works towards addressing these challenges with CIMS, we need common tools, frameworks, and terminologies for consistency and interoperability.

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Renato Iannella is Principal Scientist at the National ICT Australia (NICTA) and leads the Smart Applications For Emergencies (SAFE) project. His research covers policy-aware information architectures and standards in trusted information and rights management. Renato has extensive experience in the development of Internet, Web, and Mobile technologies and standards and was a former member of the World Wide Web Consortium (W3C) Advisory Board. Renato also is an Adjunct Associate Professor at the University of Queensland, Visiting Associate Professor at the University of Hong Kong and was previously the Chief Scientist at LiveEvents Wireless, IPR Systems and Principal Research Scientist at the Distributed Systems Technology Centre (DSTC).

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Olli-Pekka Rinta-Koski is a Research Engineer in the SAFE project at National ICT Australia (NICTA). His work is focused on incident management ICT infrastructure design, with an emphasis on standards and interoperability. He has previously worked on software development in the fields of derivative trading, mobile communication and bioinformatics. He holds a MSc (Tech) in Computer Science from the Helsinki University of Technology.

EMERGENCY INFORMATION MANAGEMENT SYSTEM ARCHITECTURE

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Keywords

Emergency information management, incident response, real-time information retrieving, information presentation

Abstract

The life cycle of an emergency incident consists of three stages: before, during and after the incident. Therefore, incident response may well differ during these three stages. Generally, actions required before incidents are related to preparation and prevention; actions required during incidents are to do with responding to the incident; actions required after incidents are to do with recovering from the incident and analyzing what has happened. However, to achieve quick responses, communication and information management is crucial throughout these three stages. This paper explores how an Emergency Information Management System can facilitate response to natural or man-made disasters before, during, and after incidents. An overview requirement analysis will be described. Information required by the first responders will be analyzed to find out what types of data the Emergency Information Management System should manage to assist first responders, what actions the system should take to process the data, and how the system should present information to end-users before, during, and after incidents. The findings demonstrated that the system should run regular diagnostics before incidents, monitoring real-time hazard conditions during incidents, and add incident record after it for future references. Subsequently, an Emergency Information Management System model is proposed as a possible solution to meet the previous requirement analysis, in which the necessary functional components of the system and their relationship between each other will be discussed. The particular benefits and possible tradeoffs in system design of the proposed Emergency Information Management System are discussed. Future work is highlighted in the conclusions.

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1. Introduction

In the modern world, successful emergency response not only demands effective management and command, coordination and cooperation from different responding crews, but also requires substantial support from technologies. Effective management and command is essential for all types of emergencies - it could lead to better usage of available resources, more immediate response and less loss of life or property. Coordination and communication is particularly important for large-scale incidents. For example, a single building fire may only require response from the local fire fighting crew, whereas a fire with increased scale and duration demands the coordinated efforts of search & rescue, medical and transportation teams throughout a region. Emergency response has received particular attention from researchers worldwide in the recent years, and a number of advanced technologies such as remote sensing, GIS, incident modelling and simulation, fuzzy logic and reasoning, and fusion theories have been applied to assist emergency responses.

Researchers have developed new ways of responding to emergencies using computer and communications technologies to support the emergency response management team, e.g. cascading web map services and GIS web services for Emergency Response Management (ERM)(Vasardani and Flewelling 2005), and remote sensing (Hutton and Melihen 2006). An architectural proposal for Future Wireless Emergency Response Networks with Broadband Services has also been suggested (Hinton, 2005). However, they showed little consideration of the different actions the system should take at different incident stages. The life cycle of an incident consists of three stages: before, during and after an incident. Therefore, a successful emergency response management must take this into account and enable different actions to be taken at different incident stages. “Successful emergency management requires comprehensive emergency planning and preparedness before an effective response to the inevitable disaster can be implemented”(Tufekci and Wallace 1998). During the incident, effective response means: (1) immediate warnings generated at the early stage, following by (2) quick actions taken to control the development of the incident. ERM does not end when the incident ends, post-event analysis and recovery is important as well. As Cutter said, “An emergency response cycle includes rescue and relief actions immediately following an event, and long-term stages of recovery and preparedness for the next unexpected event”(Cutter 2003).

Irrespective of pre-event planning or on-event response or post-event analysis, data and information are important throughout all the 3 incident stages. “In the absence of data and information, emergency response is simply well-intended guesswork that will most likely result in significant loss of human life”(Erickson, 1999). Therefore, good information management can facilitate effective emergency response. A typical emergency response system contains 3 layers: information source layer, Emergency Information Management System (EIMS) layer, and a command and control system layer. Kyng stated one of the challenges in Designing Interactive Systems for Emergency Response is “system changes with every situation and even with specific situations unfold” (Kyng, 2006). Therefore, without quick and reliable real-time data retrieval, and a large amount of historical data collection, the decisions made by the ERM team are likely to be not timely or optimum. Based on all the available data, the EIMS could analyze the situation, generate risk assessments, and provide decision support to the ERM team. Finally, an efficient command and control system is required to execute the response plans. This paper mainly focuses on the requirements and design of EIMS in the middle layer – that which sits between the information source layer, and the command and control layer.

The paper is structured as follows. Section 2 introduces the user-centred design approach that we adopted, particularly the goal-driven method and incident-stages-focused method that lie behind our design process. Section 3 describes the requirement analysis in detail and summarizes the findings from it. Our proposed EIMS architecture is presented in Section 4.

Section 5 analyzes the benefits and potential drawbacks of this proposed system. Section 6 concludes by discussing current findings and future work.

2. User-centred design approach

Our work is based on a User-centred Design approach, including fieldwork, scenario mock-ups and architecture prototype design. A goal-driven method is adopted during the requirement analysis process and we focus particularly on scenarios at each different incident stage.

Domain review

The following were undertaken to better understand emergency response:

- literature review on emergency response domain, technology-facilitated emergency response methods or systems in particular
- study of real examples of incident command systems
- review of completed and on-going projects relevant to emergency response

Fieldworks

In addition, a number of field visits were carried out with different emergency response teams to study:

- features and common issues with emergency response
- similarities among different emergency response teams
- technologies used in current emergency response systems and relevant issues
- user needs and possibilities for improvements from the emergency response professionals' point of view

Requirement Analysis

To understand and specify the end user's requirements is the first step of a user-centred design approach.

A goal-driven method was adopted to break down the major operational goals of incident commanders into sub goals, which require different decisions to be made. These decisions require certain information which in turn requires data to be collected and processed. Starting from the incident commander's goals, this method of analysis gave us better understanding of what data the EIMS is required to manage.

An incident-stages-focused method was also used to carry out our requirement analysis. Different actions that the EIMS is required to take before, during and after incidents are addressed. These hierarchical breakdowns are discussed in detail in Section 3.

Scenario and prototype

On the basis of what data is required to be managed and what actions the system should take before, during and after incidents, we developed a prototype architecture of EIMS. Components that constitute the system and their relationships between each other are described in Section 4.

3. Requirement analysis

The most crucial requirement of an Emergency Information Management System is to provide the right information in the right format at the right time. This would typically mean providing this capability to the emergency commander since they would be in overall command of the incident. Typical goals of the emergency commander (in approximate priority) would be to: save life; prevent escalation of the disaster; relieve suffering; safeguard the environment; protect property; facilitate investigation/inquiry; and restore normality as soon as possible (Hill and Long, 2001). We use a goal-driven method to analyze what information and actions are needed before, during and after an incident.

Before incident

The main goal before incident is to prepare for incidents and as far as possible to prevent them occurring. The major goal can be broken into sub-goals, for example, in order to predict potential incidents, which needs information about any abnormalities that can be monitored – this therefore requires EIMS to generate reports on faulty parts and abnormal phenomena detected during diagnosis. The full hierarchical breakdown of the requirement analysis before incident is shown in Figure 1.

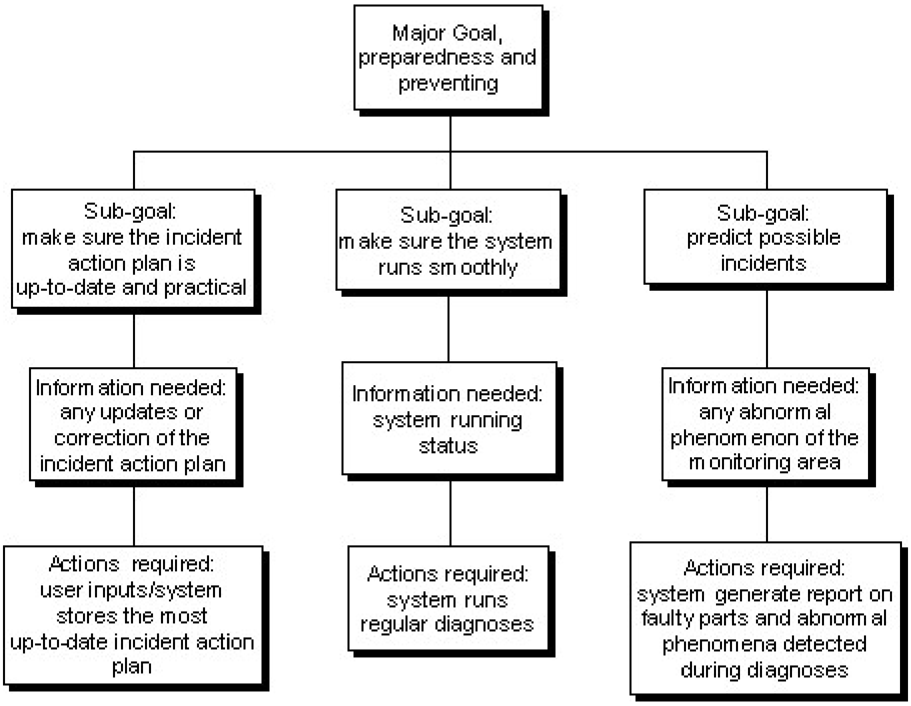

Figure 1. Requirements breakdown before an incident.

During incident

The major goal during an incident is a quick and effective response, including situation assessment and efficient use of the available resources. Situation assessment can be further broken down into incident identification and forward projection, which requires different decisions to be made. For example the incident commander will have to identify the nature of the incident, which demands information about incident occurrence and spread, and in turn requires data such as temperature, smoke, etc at specific location and also requirements about data accuracy and collecting frequency. As a result, actions that the system should take consist of alarm generation, real-time monitoring of the incident, and making historical trend diagram available on request. The full breakdown is shown in Figure 2.

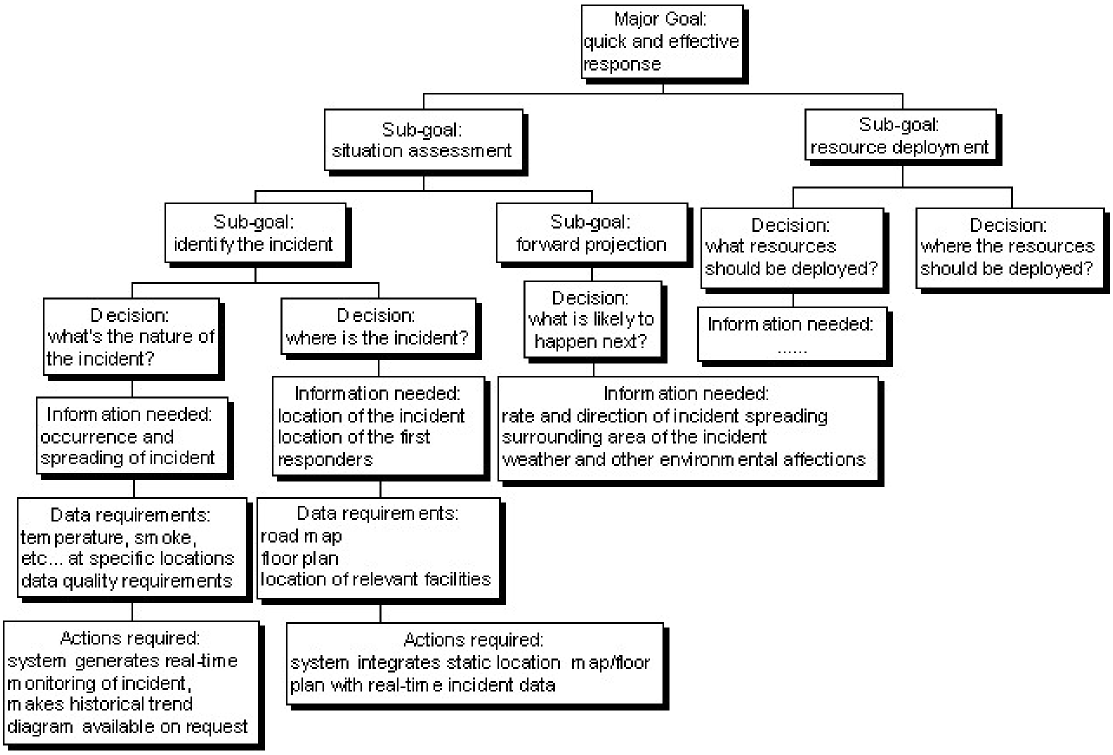

Figure 2. Requirements breakdown during an incident.

After incident

The major goal after an incident is to collate and deliver statistical information on the incident. Post-incident recovery may require long-term work and the involvement of multiple agencies. However, only the goal of analysis and post-event data is discussed here as shown in Figure 3 due to the focus on the goals and requirements relevant to an EIMS.

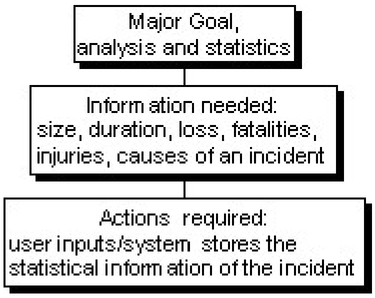

Figure 3. Requirements breakdown after an incident.

In summary, the requirement analysis demonstrated that:

- In order to prepare for emergency incidents, the system should run regular diagnostics to ensure the system works normally.
- To prevent incidents, the system should attempt to predict possible incidents through running regular diagnostics.
- To assist response to incidents that are occurring, the system should monitor real-time hazard conditions and track responder location during incidents.
- To help post-event analysis, the system should record the incident's nature, size, duration, loss, fatalities, injuries, causes, after incidents for future reference and response optimisation.

4. System Architecture

As a result of the requirements analysis, we present our architecture design of EIMS in this section.

Overall System Architecture

The structure of the EIMS is shown in Figure 4. The system consists of four main components:

- Data receiving & processing

The bridge between the lower layer of information source network such as Wireless Sensor Network and the middle layer of information management system.

- Data analysis

The core of the system, load and process the real-time data, integrate the result with pre-stored data such as road map, floor plan to generate interactive incident monitoring or pre-defined incident action plans to provide decision support.

- Data storage

Consisting of two types of databases, one is for dynamic real-time incident data, the other contains a pre-planned knowledge base.

- Data presentation

The interface between users and the system. This displays the required information in the right format at the appropriate level of detail.

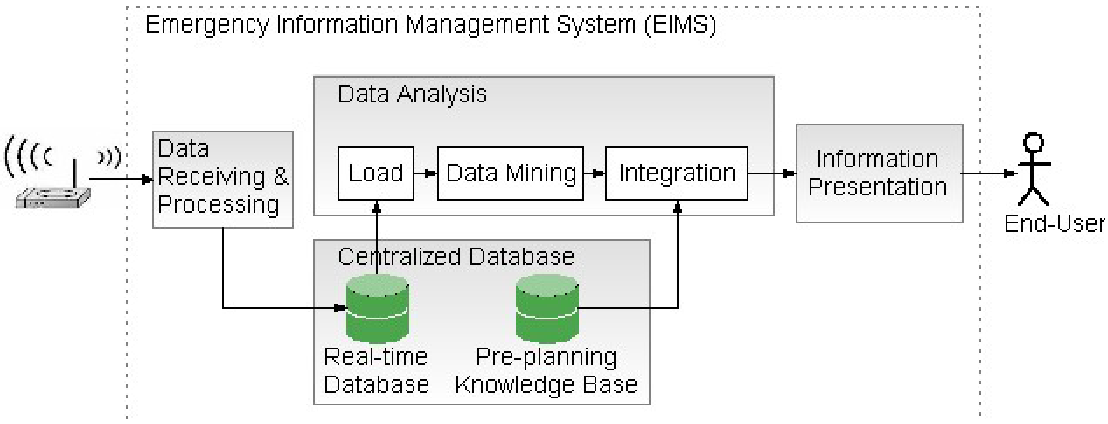

Figure 4. Diagram of Emergency Information System Architecture.

Before incident - System Diagnoses

There are two types of diagnoses, one is the self-diagnosis of the EIMS, the other is diagnosis of the EIMS together with data source collecting equipment. The self-diagnosis of EIMS uses a set of sample data as input, whilst the synthesized diagnosis receives actual data from data collecting nodes as input. In both cases, the actual system output is checked against the expected output to identify any abnormal situations. Further actions - either ignoring, checking or response - can be decided by the incident commander based on the system report. The flowchart is shown in Figure 5.

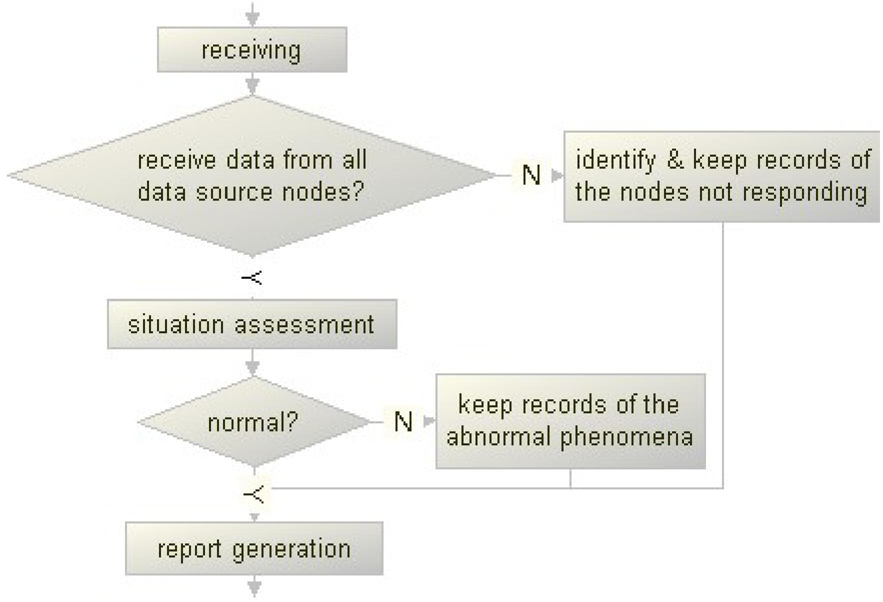

Figure 5. System diagnoses flowchart.

<u>During incident - Monitoring the incident</u>

In the case of an incident, the sensors will wake up and start sending data out. The system receives the current data and stores it in the real-time databases. The data analysis module loads the data and processes it in different ways according to different purposes.

Take real time incident monitoring as an example, the data process module will behave as an alarm filter, decide if it's a false alarm based on rule system or fuzzy logic, generate an alarm if it's a real one, and generate a report if it's likely to be a false one. It should allow the user (e.g. a supervisor) to assess the detailed situation to double check the judgement if they want. This may involved cross-checking alarm data with CCTV images or similar. The data mining and integration module carries out a situation assessment, integrates the results with the floor plan and facilities location, and makes it accessible from the monitoring interface, as shown in Figure 6.

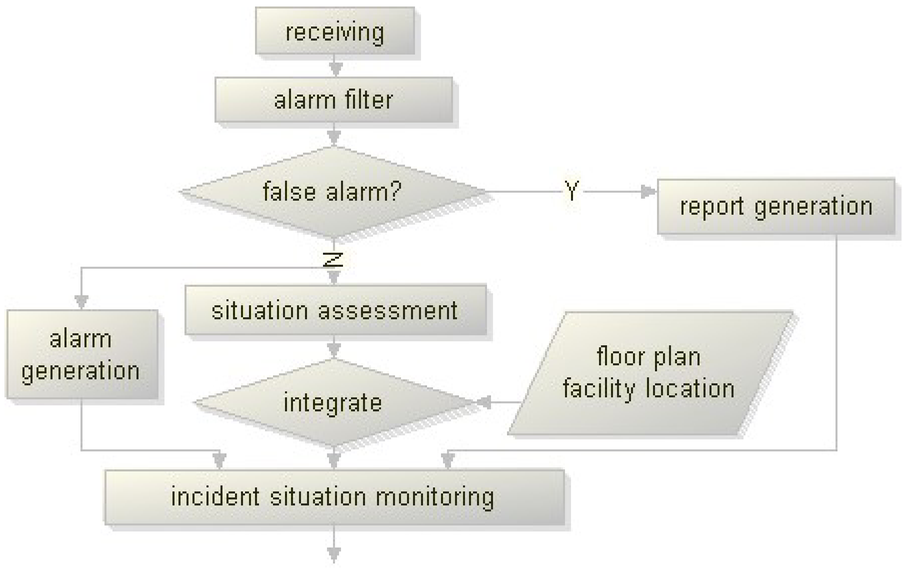

Figure 6. Real-time data monitoring flowchart.

If the system aims to provide risk assessment for the emergency commander, in this case, the data process module will assess the data collected, integrate the results with pre-defined risk levels, and output the location and levels of risks.

If the system is to provide decision support for the emergency commander, it will report all aspects of information that is associated with the decision making, including situation assessment, real-time incident monitoring, location tracking, risk assessment, predefined response levels and associated incident action plans, etc.

After incident – add incident record

The task of EIMS in this stage is a simple but important database interaction with incident commanders. The incident commander fills in a post-event analysis form after an incident has been dealt with. The content should include the following information: Extent, Duration, Loss, Fatalities, Injuries, Causes, Emergency level, Actions taken, and any suggestions on amending the existing emergency plan. Some information such as duration of the incident could be filled in automatically by the system, whilst the rest has to be entered manually. This information will be added to the knowledge base for future statistics and integration purposes.

Figure 7. Add post-event record flowchart.

5. Discussion

Benefits

- Quicker Emergency Response

A nature of Emergency response is that there is often very limited and lack of information during the early stage of the incident. Traditional way of getting information is by communicating with personnel on the incident ground, however, the situation seen and felt is not reliable. The EIMS facilitates emergency response at different incident stages. A lot of technologies lie behind the abstract structure of the system, e. g. data mining technology to analyze the large amount of raw data, fuzzy logic and technology to reduce false alarms, interactive design technology to design user interface with better usability.

- Flexible application

The architecture is at a relatively abstract level, but it can be flexibly applied to different applications. Base on this architecture, depending on different further break down of data processing and data mining according to the context, we can develop risk assessment systems, decision support systems, historical statistics or an integrated multi-purposes emergency response support system. Depending on different contexts of use, it could be an integrated multi-purpose information management system located in an emergency control centre with more resources available, or a compact and efficient single purpose application installed on site, or a web-based service which allow access from mobile devices.

Trade-offs

There are some trade-offs which should be taken into consideration when designing such an EIMS.

- Diagnoses frequency/system cost trade-off

Our research has demonstrated that the system should run regular diagnostics before the incident, but running diagnostics too often could be a waste of time and system resources. In the case of running synthesized diagnoses with a wireless sensor network as bottom layer, too frequent diagnostics might cause the sensors to run out of battery power, thus causing them to be inoperative.

- Quicker response/reducing false alarms trade-off

The EIMS aims to facilitate quicker response to emergencies; however, higher sensitivity may cause a higher rate of false alarms. The quicker way is to generate alarm on receiving of any data out of normal expectation without filtering, but these alarms might not be a symbol of real incident. To filter and reduce the false alarms requires extra time and system resources consumption, for example the activation of two separate sensors before an alarm condition is notified. This is a trade-off to be taken into account during the early stage of an incident.

- Historical trend/running cost trade-off

Another consideration is that during an incident, a historical trend diagram showing the situation from the beginning of an incident could help operators to understand the incident situation and predict what happen next. However, if the incident situation changes rapidly over time, to maintain a trend diagram could result in enormous amount of data storage space and data analysis time.

- Automatic suggestion/manual decision trade-off

Computer-assisted risk analysis and decision support based on reliable data sources and efficient data mining could help the incident commander to judge the situation and quickly issue the control commands. As described by Danielsson (1998), the key to incident command is the quick implementation of a fast strategic response. However, the suggestions made by the system may not be appropriate to the specific situation. Therefore, such a system should not over-automatic their response: the original information that is used to generate risk analysis/decision support results should be available to enable the incident commanders to make their own decisions if they wish so.

6. Conclusions

The idea presented in this paper is general but could be applied to any emergency, whether natural or man-made disaster. The system could be tailored for different purposes, from a simple monitoring system to a complex decision support system.

In this paper, we have proposed an EIMS architecture which facilitates emergency response before, during and after an incident. Requirements analysis and overall system structure design have been discussed, potential benefits and design trade-offs of the system have been highlighted. The findings demonstrated that: (1) in order to prepare for emergency incidents, the system should run regular diagnoses to ensure the system works normally; (2) to prevent incidents, the system should attempt to predict possible incidents through running regular diagnostic checks (3) to assist responses to incidents that are occurring, the system should monitor real-time hazard conditions and track responder location during incidents; (4) to help post-event analysis, the system should record the incident's nature, extent, duration, damage, fatalities, injuries, and causes after incidents for future reference.

On the basis of the work done so far, future research can be carried out to review different technological possibilities and undertake detailed design and implementation of the EIMS. This can lead to small-scale demonstration and experiments to prove the idea, followed by research on specific issues and trade-offs, and investigation of security and robustness.

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Academic & Professional Practice

Peer Reviewed Articles

PANDEMIC INFLUENZA

AVIAN INFLUENZA - THE THREAT OF PANDEMIC IS REAL, IF NOT INEVITABLE WHO WILL PROTECT THE SECURITY/ARMED FORCES IN THE CASE OF PANDEMIC?

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Key words:

Avian influenza, pandemic, bio-terrorism, security/armed forces, education

Abstract

Since 1997 Avian Influenza (AI) infections in poultry have taken on new significance with increasing numbers of cases involving bird-to-human transmission. Do increasing number of human casualties who died due to confirmed infection with H5N1 HPAI viruses impose the suspicion that the potential re-assortment of AI virus genes and the emergence of the new pandemic AI virus generations in humans have already began? Is there some withdrawn "minority report"? We are about to face the serious emergency to which no definitive remedy has been offered yet. The next pandemic could put in questions the entire global security system not to mention the mass casualties, chaos, and political, economic, and cultural integrity, while simultaneously producing high psychological impact and government instabilities. AI has also shed light on a very different danger: that of bio-terrorism and organized crime.

By critical discussion regarding different possible ways to become infected with HPAI viruses, we can't ignore the view that immune system of the human population is hypothetically completely incompetent; nevertheless, the members of Security/Armed Forces we count on substantially in the case of pandemic are human beings.

The established Military educational programs were carefully analysed and we believe that existing ones regarding biological agents and possible biological warfare should be upgraded. There is undoubtedly no advantage in putting too much emphasis on the possibility of accidental/intentional introduction of the communicable diseases, nor from highlighting vulnerabilities. Although, there is a need if not necessity for authorities to do more to educate the Military and Police Forces through extra-specialized programs at the university as well as at the postgraduate level regarding CBRN- defence. Such educational policy is immensely important for Security/Armed Forces to be fully capable to predict and to protect themselves prior to course of action. Track telling are infections diseases being reason for 65-80 % of soldier's hospitalisation in recent wars and military conflicts. Finally, there are also direct international benefits if the government is providing accurate education and timely respond to the threat that AI and other biological agents posed to the global community.

Introduction

1.1 Avian Influenza

By now, the threat of Avian Influenza (AI) has partially receded from the headlines. But the danger posed by the disease remains very real and experts agree that if human-to-human transitions occur, millions of people will die and global economy could dip into recession. It is well known that occasionally devastating pandemic occur in human. Relevant literature data reports that in 20th Century the sudden emergence of antigenically different strains transmissible in humans, termed antigenic shift, has occurred on four occasions, 1918 (H1N1), 1957 (H2N2), 1968 (H3N2) and 1976 (H1N1), each time resulting in a pandemic (1). Since first outbreak in Hong Kong in 1997, AI infections, so called "Bird Flu", in poultry have taken on new significance with increasing number of cases involving bird-to-human transmission and the resulting clinically severe and fatal human infections. The presence of endemic infections by H5N1 (highly-pathogenic-HP) viruses in poultry in several countries indicates that these viruses will continue to contaminate the environment and will be an exposure risk with human transmission and infection. However, the subsequent risk for generating pandemic human strain is still unknown (2). In the light of reasonable threat and the fact that the World Health Organization (WHO) pronounced that world is now closer to another Influenza pandemic than at any time since 1968 pandemic (3), it must be remembered that the true Influenza pandemics are unmistakable and may have catastrophic consequences. Pandemics are the reality of time; the Influenza virus has segmented genome, which undergoes continuous mutations and genetic re-assortments. Minor point mutation causing smaller changes (antigenic drifts) enable viruses to evade immune recognition resulting in repeated Influenza outbreaks during Inter-pandemic years. These pandemics are caused by the most common subtypes of circulating viruses, in the community at that time. Currently, circulating avian subtype H5N1 has high fatality rate and has spread to poultry animals in number of countries. Any virus can cause pandemic if, (a) it has an ability to infect human beings, (b) there is a vulnerable population without innate immunity and, (c) rapid efficient person-to-person transmission occurs. H5N1 has fulfilled the first two criteria and, any genetic change in H5N1 enabling human-to-human transmission will lead to the pandemic of Human Influenza. Human Influenza occurs all over the world with annual global attack rate of 5 – 15% in adults and 20 – 30% in children. It is a self-limiting illness, lasting about a week, characterized by mainly upper respiratory tract illness with symptoms like fever, myalgia and headache. In chronically ill people infection sometimes causes death. Global burden of Inter-pandemic Influenza is estimated around one billion episodes with 3,000,000 – 5,000,000 death annually (3). In the mean time the AI has reached the cross-species transmission and there is a reasonable threat of sudden synergy of AI with seasonal Inter-pandemic Influenza. For the human population as whole the main danger of direct infection with AI appears to be if people infected with an 'avian virus' are infected simultaneously with 'human influenza virus'. In such circumstances re-assortment could occur with the potential emergence of a virus fully capable of spread in the human population. Presumably this represents a very rare coincidence, but one which could result in a true Influenza pandemic (1).

The complete eradication of the disease is absolutely impossible because the natural reservoirs (aquatic birds and shorebirds, originally found in ducks) of the AI viruses are constantly present. In the case of illness in wild birds especially in wild ducks the mild clinical course is mostly expected, although fatal outcome is not a rarity. In opposite almost 100 % mortality in 24 hours after infection with AI viruses is expected in domestic and commercial poultry (1,2,4). In between the AI exceeded the national boundaries and became a trans-national and global threat where natural reservoirs are no longer the major problem. Thousands of people must have been directly exposed to poultry infected with the Asian H5N1 viruses, relatively few become clinically ill and died (1). Do recent human casualties where all the members of the families died due to confirmed infection with H5N1 HPAI viruses pose the very new and threat-full suspicion that the potential re-assortment of AI virus genes and the emergence of the new pandemic AI virus generations in humans has already began? Is there some withdrawn “minority report”?

We are facing serious threat to which no effective remedy has been offered yet. Symptoms of infection are: increased body temperature, cough, laryngeal pain and breathing difficulties. The incubation period takes 7 - 10 days. The manifestation of mentioned clinical signs and symptoms in this period of time requires immediate clinical intervention. In many patients obvious clinical symptoms of AI are detectable after much shorter incubation period (1 - 3 days) (4,5). Mild form has various time of duration where body temperature decreases in a week, and cough in several weeks. The fatal form of AI results mainly in pneumonia characterized by fatal outcome in a few hours (4,5).

The active members of Security/Armed Forces we count on substantially in the case of future pandemic are human beings. Possible future pandemic could completely paralyse the global society. Such incidence could put in question the entire global intelligence and security system not to mention the mass casualties, chaos, and political, economic and cultural integrity. The human resources could be seriously reduced and we can’t exclude the potential losses in the Security/Armed Forces as well.

Nevertheless, the health of livestock today is probably the best it has ever been, so as we learn to better manage that health, we must not lose our skills in managing disease in a world where mistakes are ever more costly (6). Therefore, it is of great importance for government services to evolve the potential nature of the threat and vulnerabilities associated with biological disasters with animal origin and demonstrate its capacity to manage this type of “normal” (accidental) event (7). When developing and performing the successful defence strategies in “normal” (accidental) outbreak of the disease, public will have increased confidence that they will also be able to handle the “abnormal” (intentional) event.

Theory

<u>2.1 Avian Influenza: a boon for terrorists and organized crime?</u>

At the 28th World Veterinary Congress in 2006 eloquent fears and warnings has been expressed regarding the intentional introduction of biological agents (5). It is no longer a puzzle that AI represents a substantial fear regarding the intentional introduction by bio-terrorists. Using the available scientific facts about the disease and simultaneously conducting the virtual scenario of possible biological warfare, it is very obvious that AI has ambiguous character. Meaning, there is a thin line between accidental and possible intentional introduction of the disease among commercial poultry and human population.

We believe that AI has some intimidating properties which disaster/emergency management should take into a serious consideration. Since 1997, the fatal disease has “silently” exceeded the national boundaries and became a global threat. We presume that devastating consequences caused by potentially pandemic AI are comparable to those caused by the phenomenon of terrorism. Though, even if we fortunately manage to avoid a human pandemic in 2007, the lack of coordination in response to this global threat should be the reason for serious concern. Without good government planning and proper oversight pandemic disease like AI could become a boon for terrorists and organized crime syndicates alike. In fact, the upsurge in organized crime experienced by Southeast Europe last year was directly attributable mostly to the region’s failure to a coordinated policy for Tamiflu. Many people considered the drug as a remedy so demand has increased exponentially as soon as the AI scare engulfed Europe. But the availability of the drug and its price, remained unregulated on the pan-European level. And with high demand low and uncontrolled supply, the opportunity to make extra cash by smuggling the drug across borders was soon seized upon by trans-Balkan criminal networks. The outcomes were predictable; available on the Belgrade market for 45 Euro apiece, the drug came to be sold in Italy and other EU members for over 100 Euro per unit. The AI has also turned out to be a boon to the counterfeiting business. With demand for Tamiflu outpacing production, counterfeits-called “Tamiflu candies”- have flooded regional markets. This is much more than just a criminal nuisance; it is also a serious impediment to governmental response at the pan-European level. As countries begin to formulate defences against the AI, they will be forced to grapple with counterfeit “medicine” sold at cut-price and, worse still, with false sense of security among those who have already purchased what they believe to be the cure.

In order to wed out the organized crime and terrorism from this field, governments should make some changes to their approach. First, people need to be better acquainted with the Tamiflu drug, particularly with the fact that it may not be one-stop remedy. Second, there is a need to better regulate the drug’s availability and pricing. As long as the alert for AI remains high, each government should coordinate to keep price of Tamiflu and other remedial drugs more or less the same. By eliminating price differences between national markets of close proximity and having strategic stockpiling control over Tamiflu, it is possible to decrease the incentives for criminal and terrorists group to trade Tamiflu on the back market. Third, this could be the right moment to consider making a generic version of Tamiflu. This might be a move that would knock down the price of the drug and make it widely available, particularly in regions classified as high risk.

Not least, there is a high need to better guard against terrorists using the type A virus against commercial targets. Because AI is typically found in birds, commercial poultry is particularly vulnerable. Poultry consumption has already dropped drastically and this is just a foretaste of what is to come if terrorists exploit this makeshift bio-weapon.

There is another critical point governments should be aware of. Changes in trade and travel mean that unless a new model is developed for disease prevention, there is a real possibility that trans-boundary animal diseases, including AI, will become increasingly difficult to control. The traditional government approach of dealing almost exclusively with the commercial sector of the livestock industry is no longer sufficient (8). All groups (stakeholders), including “Grey husbandry” must be involved in decision-making and disease control. Namely, the “Grey husbandry” possesses the involvements with animals that could range from the legal to the unsanctioned and/or illegal. The importance of these “grey areas” increased in recent outbreak of AI among commercial poultry in the United Kingdom (UK) and Hungary. Synopsis of main recommendation intended for use in the UK and elsewhere in the event that the WHO declares that AI pandemic has started (9) are highly precise and “living documents”. Without mutual transparency in reporting of cases and high-level global political leadership we can loose control over disease we currently believe that we actually have.

Moreover, there is another dilemma; are we actually competent to control the possible pathways of the disease regarding daily international migration from/to those regions classified as high risk? Who can predict possible number of the infected passengers without any clinical signs of the disease (incubation period)? Who can predict and prevent such incidence and recommend quarantine regime without violating the human rights of potentially infected persons within the incubation period although human-to-human transmission remains question mark? There are so many additional issues i.e. *In Vivo re-assortment experiments (reverse genetics etc.),* we have to think about and the only certainty is that there are no certainties, and time is running out.

Finally, even if science fails there are reasonable chances that we can control the spread of AI if there is a strategy in place that allows us increased surveillance over civilian air travel, livestock trade, and gives us the means to better protect key economic sector from terrorists attack.

2.2 Avian Influenza: awareness and education

The recent literature data reveal that the scientific expertise among terror groups is very variable, although some members have backgrounds in medicine, microbiology, chemistry up to and including the PhD level. A high degree of education in terror groups aligned with Global Salafi Jihad movement led by Al-Qaeda is perceived. Namely, over 60% of membership had at least some university education (7). Furthermore, what terrorists can't obtain by formal and traditional educational programs can too often be obtained through online educational services or through national and international conferences!? It is obvious that we are facing well educated "holly warriors". Do we possess well- educated "cavalry" to fight against?

The importance of survivability and Force Protection (FP) is an essential operating capability. It is a fundamental military principle that all military units must be able to protect themselves. FP is, therefore, a basic duty of all NATO military personnel (10). Joint operation requires an attitude of mind, a culture, by which servicemen and women at all levels are encouraged to develop a sense of interdependence, mutual respect and trust. This is enhanced through increased knowledge and appreciation of each service's capabilities, requirements and sensitivities (11). In order to accomplish such course of action, we believe that knowledge alone is not good enough, though; the knowledge is a starting point from which the education processes begin. The combination of a lot of knowledge and a lot of one-sidedness has proved to tend to be very dangerous. Interdisciplinary and intra-disciplinary cooperation is necessity in order to avoid simplification and changing the values tend to be definitive and of significant or even vital importance.

Chemical, Biological, Radiological and Nuclear defence (CBRN) is advanced guard for ultimate FP. Throughout history; infections diseases contracted naturally have had a significant impact on military operations. The intentional dissemination of disease adds a new dimension to threats that are posed by infectious and toxic agents traditionally transmitted only by natural routes. Biological weapons (BW) are unique in their potential ability to inflict large number of casualties over a wide area with minimal logistical requirements and by means that can be virtually untraceable (12). The global community remains highly vulnerable to the strategic, tactical, and terrorist use of BW. BW is priority call because the full impact of BW attack may take days or weeks to develop. We can only presume how vulnerable stationed and especially deployed Security/Armed Forces actually are. AI and other biological agents can proclaim biological warfare as an inevitable, unavoidable pending catastrophe. In the light of such philosophy, the established Military educational programs were carefully analysed and we strongly believe that existing education regarding biological agents and possible biological warfare should be upgraded. We are talking about special knowledge and specialized educational programs that could provide better introduction and understanding of the threat posed by AI (and other biological agents) to each member of the Security/Armed Forces including Police Forces where no such established educational program can be found. There is a strong need for advanced education among Security/Armed Forces in order to increase and to maintain their operational capability in the case of pandemic and other biological disaster of animal origin.

Discussion

For now the AI receded from the headlines. But pandemics are the reality of time. The vast majority of the problem remains the fast spreading of the disease among commercial poultry world wide and increasing number of human casualties along with notoriety of the virus for highly frequent genetic re-assortment, which might empower H5N1 to initiate the next human pandemic. The human Influenza caused by H5N1 subtype of the virus has high case fatality of 54 % (3). AI already daily affects pre- and post-harvests both carrying the risk of economic devastation and thus social and political repercussions locally, regionally, nationally and trans-nationally. This could be expected due to globalisation and vertical integration of many industries where any direct interruption in just one part will have immediate impacts on many others. After all, by holistic observation of possible next human pandemic we can't ignore the nowadays nearly catastrophic climate changes tend to bring more and more uncertainties. It is well known that the devastating circle of the different communicable diseases usually finds its closure in the natural disasters. Dangerous communicable diseases (including AI) are frequent or may even become the inevitable side effects of the havocs. In addition the recent literature data report: "During recent wars and military conflicts soldiers were hospitalized because of:

- Battle injuries: 5 - 25 %
- Non-battle injuries: 5 – 10 %
- Infectious diseases: 65 – 80 %" (13).

Once again, the members of the Security/Armed forces we count on substantially in the case of pandemic are human beings. So our topic question: "Who will protect the Security/Armed Forces in the case of pandemic?" is no longer groundless concern. There is undoubtedly no advantage in putting too much emphasis on the possibility of accidental/intentional introduction of the communicable diseases (i.e. AI), nor from highlighting vulnerabilities. However, in our experience the possible weak point of Security/Armed Force is its limitation in a certain level of educational process. Careful revision of the established Military educational programmes regarding CBRN/E- defence calls for an immediate superstructure. Indeed, where is the synergy between the threat of the next human pandemic or other biological disasters and the Military educational programmes? The answer is importance of survivability. In order to carry out this essential duty, we have to start with definition of knowledge-based Security/Armed Forces. Such definition is eloquently supported by NATO Standards for Proficiency for CBRN- defence (14) and The Strategic Vision: The Military Challenge by NATO's Strategic Commanders, which both requires a highly educated and trained Force as essential to operate in complex environments (15). The targeted education regarding CBRN- defence is crucial in order to possess the national Security/Armed forces as a "cavalry" in the situation of crisis (pandemic).

There is a strong need if not necessity for authorities to do much more to educate the Military and Police Forces through extra specialized programs at the university as well as at the postgraduate level regarding CBRN-defence. Such educational policy is immensely important for Security/Armed Forces to be fully capable to predict and to protect themselves prior to course of action, where affected, terrified, and panicked civilian population needs the ultimate protection. We competently presume that advanced specialized education is the most reliable sentinel and counterterrorism tool for Security/Armed Forces in order to maintain its capability and be able to accomplish its mission in the case of pandemic or/and other disasters. Lack of knowledge and negligence to educational impact is the highest jeopardy to establish and especially to maintain the sustainable Force protection. There are also direct international benefits if the government is providing accurate education and timely respond to the threat that AI and other biological agents posed to the global community.

To summarize our approach to possible AI pandemic by highlighting Military education, we would rather delegate this sensitive and delicate issue to the highest authorities in covering field's i.e. civilian universities, to present this dilemma to wider audience in a brighter way.

Can we possibly imagine what pictures of us our opponents on political and religious filed actually do have? Shall they continue their education while we are still discussing about….

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THE ROLE OF ANTIVIRAL AGENT STOCKPILING IN BUSINESS SURVIVAL AND RECOVERY FROM PANDEMIC INFLUENZA

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Abstract

Survival and recovery of businesses from Pandemic Influenza will depend primarily on their planning efforts and ability to continue operations during the disaster. One suggested method of optimizing employee wellness and continued participation at work is through use of Tamiflu and other antivirals to maintain the workforce.

In recent months, there has been an increased emphasis by businesses to stockpile certain pharmaceutical items and personal protective equipment (PPE). One of the most contentious areas of stockpiling is the specter, and growing reality, of hoarding Tamiflu. Many large international corporations have spent millions of dollars stockpiling antiviral agents in the hope of maintaining their workforce and aiding in recovery following Pandemic Influenza. Preliminary data has indicated that over 40% of larger corporations are stockpiling Tamiflu for their employees. This raises issues of antiviral effectiveness, availability (and ethics of prescription patterns), cost, misuse, safety, and product liability.

Our paper will address three areas of concern: Potential effect of antiviral stockpiling on survival and recovery of the business sector, ethical issues in stockpiling of drugs by various sectors, and the potential effectiveness of antiviral agents as compared to social distancing procedures. Concrete suggestions and guidelines will be provided in how to best address the issues of stockpiling in the face of an Influenza Pandemic.

Introduction

The specter of Pandemic Influenza continues to place all sectors of our society in confusion as related to issues of stockpiling potentially needed supplies, and how to handle rationing of care and medicines/vaccines should the worst materialize. Visions of the 1918-1919 pandemic that wiped out hundreds of thousands of Americans, and millions of our young and vigorous populations worldwide haunt us. These decisions directly impact the ability of businesses to recover following a major disaster of this type. All those in Emergency Management are being forced to face these issues, along with shortages in workforce, continuity of operations planning, quarantine and isolation, protection of our medical facilities and other critical infrastructure issues. It is estimated that 20% of companies will suffer fire,

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flood, power failures, terrorism, or hardware/software disasters. Of businesses suffering a disaster, 43% will never recover sufficiently to reopen their business, and of those that do open, only 29% are still open 2 years later (Deloitte Center for Health Solutions, 2006). This is, in large part, because of their lack of planning and preparation. This purpose of this paper is to specifically address the issues surrounding potential stockpiling of antiviral agents by the business sector as a mechanism of maintaining business continuity and minimizing recovery time following Pandemic Influenza.

Background and Thesis

Great controversy still rages concerning the appropriate steps to be taken by businesses in preparation for the dreaded Pandemic Influenza. Avian Influenza is continuing its march across the globe, although it has yet to be definitively identified as reaching the United States. Great effort and extensive resources have been spent in preparing ourselves for this likelihood. Much has been learned from observing how other nations, especially the United Kingdom, have dealt with this reality in recent weeks (Grey, 2007; Revill, 2007; Shaikh, 2007; Elliott, 2007). Whether or not the H5N1 strain transforms into the pandemic form remains to be seen. However, as long as this particular virus continues to infect hundreds of thousands of domestic birds, as well as the wild bird populations, potential for pandemic still exists and continues to grow.

We have all been inundated by health education and mailings from public health professionals in our nation focusing on the need to become prepared for Pandemic Influenza. The amount of information pertaining to how to prepare ourselves has been overwhelming until many residents are no longer interested in listening. Home preparedness kits are marketed and sold, and bogus remedies continue to be sold over the internet as we try to become better prepared. We are all becoming more aware of what types of actions may be necessary to help our families and loved ones survive. We look to the government and our employers to provide guidance, education, protection, and a safe workplace in which to thrive.

There has been great emphasis on our governmental and public health structures to stockpile antiviral agents, specifically Tamiflu, in order to treat members of our critical infrastructure and first responders should the pandemic occur. Their interest is in the continuation of our critical services in order to provide viability of our medical system and the security necessary should the socials underpinnings of our society be disturbed. Stockpiling of antivirals for protection of our residents is, in fact, government's responsibility and would seem to be an appropriate use of funds. However, it must be noted that these stockpiles are only for treatment, not prophylaxis or protection of others who are uninfected.

Prevention is a separate, and much more daunting, consideration. Antiviral agents are not vaccines, any more than antibiotics are. Antiviral medications can theoretically help prevent one from acquiring the infection, but only for the duration of time that the medicine is actually taken. One course of Tamiflu is 5 days long, a very short period indeed when one considers that each wave of Pandemic Influenza would likely be months in duration, and that there may be many waves. Some more recent recommendations call for prophylaxis for up to eight weeks.

The Dark Side of Pandemic Influenza for Businesses

It is anticipated that Pandemic Influenza would hit in several waves of from 2 – 12 weeks in duration. The peak of each wave could last for 4 weeks, with up to 50% absenteeism of employees at all levels. Both supply chains and customers would also be affected, disrupting the entire business operation. Existence of a Continuity of Operations Plan is essential for survival, and must identify succession of operational leadership, business critical staff, business critical suppliers, and detailed recovery instructions.

Both the World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) continue to closely monitor the movement of H5N1 Avian Influenza, as well as the human cases and corresponding threat of an influenza pandemic. Numbers released from the WHO indicated that there have now been 274 cases of Influenza A/(H5N1) reported and a total of 167 deaths. This corresponds to mortality rate of 61%. Recent events in the United Kingdom have demonstrated the continued movement of avian influenza, where bird flu was reported February 3, 2007 at the Bernard Matthews turkey farm and plant in Suffolk (Shaikh, 2007). Ultimately, over 160,000 turkeys were destroyed (Smith, 2007). The social disruption such an event is capable of causing is immense. Since the infection was identified, there have been issues of "virus cover-ups", hygiene lapses at the turkey farm, possible prosecution of the owner of the turkey plant, connections to bird flu discovered at a goose farm in the eastern Csongrad region of Hungary in January, concern over the response of Department for Environment, Food, and Rural Affairs (DEFRA), and concerns over preparedness of the nation, including stockpiling of antivirals and vaccines. Although it would be easy to say that such situations could never happen in the United States, the stark reality is that they can, and have in the past with other infectious agents.

It is apparent that although avian influenza and the potential for pandemic influenza have moved to the back pages in the popular press, those in public health and emergency response continue their relentless preparation for this and other potential infectious disease menaces.

Sources of Information and Findings

<u>Effectiveness of Stockpiling Tamiflu in Survival and Recovery of Businesses to Pandemic Influenza.</u>

Obviously there is no "correct" answer to this question, since we have never faced this situation in the past. Issues of societal preparedness continue to be subjects of discussion and disagreement. One area of controversy has been the place of antiviral agents in our regimen of weapons against the potential devastation of pandemic influenza. There are those who believe that with massive, rapid administration of antivirals to local areas with Pan Flu outbreaks, the Pandemic could be averted, or at least significantly diminished (Germann et al., 2006). Longini et al (2004) used a modeling system to demonstrate that if 80% of exposed persons maintained prophylaxis for 8 weeks, the epidemic could be maintained. One has to keep in mind that the normal dose pack of Tamiflu covers only a five day time period, although some regimens exist calling for up to 8 weeks of antiviral use. Others believe that this is too optimistic and that pandemics of this sort cannot be stopped, only slowed (Mackenzie, 2005). Of the basic four antiviral agents for use in this disease, there is significant resistance to two, leaving only Relenza and Tamiflu as antiviral candidates. At present, only Tamiflu is produced in tablet form. In 2005, the FDA extended its prophylaxis protocol for Tamiflu to include children between 1 and 12 years of age. It should be noted that there is no information concerning how effective this agent might be as a preventive agent, and some early information indicates that large doses might be necessary for treatment of the H5N1 strain. Antiviral agents are one of a number of measures that must be included in any business continuity of operations plan. No one aspect of the plan will guarantee business survival. It is logical to believe that with an effective prophylactic antiviral agent that is effective against the particular infecting virus, and available to all in a short period of time, there would be significant reduction in mortality, and less business disruption. However, there are many issues to be considered when deciding what is the right course of action for any business. This is the classis risk vs benefit ratio when considering any course of action. As with any treatment or preventive therapy, decisions regarding use must be made on an individual risk versus benefit ratio, as well as placement of this modality in contrast to all of the measures being taken as part of your Continuity of Operations plan. Potential benefits and risks are:

Potential Benefits

- Protection of the workforce, or at least those identified as business critical, so that business can continue (and survive) during a pandemic
- Creation of a caring community where staff will be safe when coming to work
- Access to the drug if needed
- Perception of safety in the work environment

Potential Issues/Problems

- Distribution – who would you give it to and when?
- Cost and availability – social equality issues?
- Hoarding of supplies when there may be ill people who need treatment.
- Who has the authority to actually dispense the medications
- Would all employees (and family members) receive the medication or only those selected by a Continuity of Operations Plan as critical staff?
- Who would create a prioritization scheme for who gets the medication and how would they do it?
- Reports of possible serious mental health side effects involving children.
- What is the shelf live of the drug? How often would you have to rotate stock and who would have that responsibility?
- Protection only for the 5 days the drug is taken.
- How would you protect your supplies?
- Does anyone have the right to commandeer business stockpiles in the face of a national emergency?
- Would it be used for those infected, or as a prophylactic measure?

Much emphasis has been placed on corporate preparedness in recent months as avian influenza continues its movement toward the United States, and attitudes are changing. In the 2006 Deloitte Center for Health Solutions survey of large U.S. companies (Deloitte, 2006), 73% of those responding believed that pandemic flu represented a significant threat, up from 59% the year before. In 2006, 68% said they were very concerned, in contrast to the former 43%. Even though 73% had identified pandemic flu as a real threat, only 52% said they believed they had adequately planned. That 52 % was a significant increase from the 14% who had formerly said they had adequately planned ways to protect themselves in 2005. Other experiences, however, still indicate the need for more serious interactions between Emergency Management, Public Health, and the Business sector in order to optimize interactions that will need to take place in the event of an outbreak. This relationship remains critical throughout the recovery phase as businesses seek to regain their stability, staff and customers.

There is great controversy as to the usefulness and wisdom of Tamiflu stockpiling in the United States. There is no doubt that most major agencies, including WHO and CDC, consider Tamiflu to be an important component of Pandemic Influenza Readiness. However, the WHO and the Food and Agriculture Organization of the United Nations (FAO) recommend against using Tamiflu prophylactically because of potential loss of its effectiveness due to resistance. In June of 2006, the Deputy Assistant for Critical Infrastructure Protection and Compliance Policy for the U.S. Department the Treasury testified before the Financial Services Subcommittee on Oversight and Investigations that businesses needed to have contingency plans that including stockpiling of such items as masks, gloves, and antiviral agents (Parsons, 2006). The Hong Kong Center for Health Protection (2006a, 2006b) has urged Hong Kong businesses to stockpile antivirals, primarily because the public healthcare system will be overwhelmed. Certainly, the manufacturer of antiviral agents has also voiced strong support for stockpiling as a mechanism for businesses to survive such a devastating pandemic. Advertising campaigns and an online Pandemic Toolkit have been created surrounding this concept.

There is some evidence that large businesses have begun stockpiling of antiviral agents, although specifics are difficult to obtain. In reality, use of antivirals is but one piece of a much larger puzzle that businesses must assemble to be appropriately prepared for a Pandemic of Influenza H5N1. There are many locations, including www. PandemicFlu.com and www.who.int that can assist businesses in their efforts to become better prepared. Continuity of Operations plans must be created, with special attention paid to the Continuity of Human Capital, Customer Continuity, Supply Continuity, and IT Continuity (Deloitte Center for Health Solutions, 2006).

Ethical Issues of Stockpiling Tamiflu

One of the risks in encouraging stockpiling of an antiviral agent, whether by businesses, organizations, or individuals, is that this changes from good preparedness into a situation of hoarding a limited supply of life saving medications. Roche has been criticized (Russell, 2006; CIDRAP News, 2006). for marketing their Tamiflu to businesses, with some calling it socially irresponsible. In fact, Roche has created an online Toolkit to help businesses decide how many doses to order. Although the Department of Heath and Human Services has not specifically addressed this issue with corporations, they do advise against any personal stockpiling. Some states, including California have advised their physicians not to prescribe prophylactic antiviral agents for their patients. This is, again, based on the fear that there would not be enough of the drug if needed.

Some believe that since the practice is employment based, that the unemployed or those unable to pay would be unfairly punished. Dr. Howard Markel, a medical historian at the University of Michigan, correlates the existence of a crisis with not only stockpiling, but hoarding, black marketing, and other inappropriate behaviors (Franklin, 2005). In considering the issue of stockpiling, Proctor and Gamble Corporation addressed the ethical considerations of such a move (Prystay et al., 2006). If a limited stockpile is acquired, who gets it and on what basis? If others you know you have a stockpile, do you not become a potential target? Swire Pacific Ltd.'s Cathays Pacific Airways, Ltd. has some type of stockpile, but no specific priority order. Virgin Atlantic Airlines purchased 10,000 doses for their employees (Wolk, 2005). When it's gone, it's gone. Much of the drive to acquire Tamiflu is based on anxiety levels among the population, according to Ira Cohen, an education consultant in Beijing. Myles Druckman, an employee of International SOS who advises companies about Pandemic Flu preparedness, is working on programs to mange anxiety in the work force. The irony of the stockpiling is that the virus may ultimately be resistant to the drug, making high doses necessary, or the drug ineffective. People forget that this is not an antibiotic. It is only protective for the short period it is taken, and they are again vulnerable. How good will a few days of protection be for a pandemic that could go on for months or years, or in many waves?

Comparison of Tamiflu Use to Social Distancing

There has been much discussion of the issues surrounding the concepts of isolation and quarantine. Legal questions, concerns over level of force allowed to maintain quarantine, keeping quarantined populations supplied with basic necessities, and the infringement on individual right are all being debated. Using the new *Community Strategy for Pandemic Influenza Mitigation in the United States* (CDC, 2007) and its Pandemic Influenza Severity Guide with its five levels of severity, a level five would project over 1.8 million lives lost, with a case fatality rate of 2%. Levels four and five would recommend that such things as school closure, cancellation of movies, sports events and other public gatherings, voluntary isolation and quarantine, and use of teleworking strategies be used for months at a time (McNeil, 2007). However, it is anticipated that with the level of illness and death present at that point, the public would be so fearful of large groups that these recommendations would occur naturally. These events would greatly reduce levels of exposure and the potential need for use of Tamiflu.

Findings and Discussion

As the discussion concerning Avian Influenza and the potential for Pandemic Influenza has evolved and matured, much of the hysteria and many of the reactionary positions have been tempered. Regardless of the decision made, each business should at least ask the question of whether stockpiling is a logical and ethical, as well as financially feasible given their specific circumstances. As a guideline, we suggest that you ask the following questions:

1. Have you created a Continuity of Operations Plan (COOP) to guide you in your decision-making process?
2. Have you given appropriate education to your staff and their families concerning how to best prepare for disasters such as pandemic influenza?
2. Are you in a business deemed to be "critical infrastructure" so that governmental plans may already provide various types of assistance, including antiviral agents?
3. If you decide that stockpiling is an appropriate choice for you organization, have you considered the potential issues/problems listed above?

The majority of businesses do not survive after major disasters. The decision as to whether or not to stockpile antiviral agents must be made based after consideration of the many factors presented in this paper, and is just one component of the preparedness equation. The key to the survival of your business will be on taking concrete action based on the plans you have created.

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Dr. Hagen is a graduate of Michigan State University and obtained his M.S. from the University of Montana. He was trained as a research microbiologist at Loyola University Medical Center, where he earned a Ph.D. He also holds an M.P.H. from Benedictine University, and an M.B.A. from Saint Xavier University.

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Ms. Parota has been employed by the DuPage County Health Department for more than twenty years, also having supervised health promotion, community education and information, vital records, web development, media information, graphic design, and dental services. Her programs and efforts have received national acclaim. Twice she was awarded the Secretary's Award for Excellence from the United States Department of Health and Human Services. In addition she received the County Achievement Award from National Association of City and County Health Officers, awards from the American Dental Association and other agencies.

Ms. Parota is a graduate of Loyola University of Chicago. She earned a Master of Education, in Adult Instruction and Management, from Loyola University of Chicago and a Master of Business Administration from the University of Notre Dame.

COMMUNICATING PANDEMIC INFLUENZA RISK TO INDIVIDUALS, FAMILIES, AND COMMUNITIES

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Abstract

All nations understand the need to communicate essential information to help people plan, prepare, and ultimately cope with pandemic influenza and its impacts. Further, they understand the need to align – to the extent possible – their communication plans with others and to coordinate communication in an open, timely, and transparent manner.

Using open-source information and direct work experience, this paper explores best practices in communicating risk associated with low probability/high impact potential threats such as pandemic influenza. It summarizes the current communication strategies employed on a global scale to address risks associated with pandemic influenza to the public and private sector and will identify any shortfalls and gaps by comparing these approaches to best practices. Finally, the paper recommends measures for improving individual, family, and community preparedness through risk communication.

Introduction

<u>What is Pandemic Influenza?</u>

According to the U.S. Centers for Disease Control and Prevention (CDC), a pandemic is a global disease outbreak. An influenza pandemic occurs when a new influenza A virus emerges for which there is little or no immunity in the human population, begins to cause serious illness and then spreads easily person-to-person worldwide. Once international spread begins, pandemics are considered unstoppable, as they are caused by a virus that spreads very rapidly by coughing or sneezing. The severity of disease and the number of deaths caused by a pandemic virus vary greatly, and cannot be known prior to the emergence of the virus.

The CDC says a pandemic can occur when three conditions are met: (1) a new influenza virus subtype emerges; (2) it infects humans, causing serious illness; and (3) it spreads easily and sustainably among humans.

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The risk of a pandemic is serious. Pandemic influenza occurred three times in the last century, with tens of millions dying from the 1918 influenza pandemic (or "Spanish Flu"). Health experts from the World Health Organization (WHO) and CDC suggest there is a potential for another influenza outbreak and a resultant pandemic, especially from H5N1 (or "bird flu"). With the H5N1 virus spreading in poultry from Asia to Europe and Africa and confirmed human cases in twelve countries, the risk continues to escalate. Each additional human case gives the H5N1 virus an opportunity to improve its transmissibility in humans and develop into a pandemic strain. While neither the timing nor the severity of the next pandemic can be predicted, the probability that a pandemic will occur has increased.

<u>What is Risk Communication?</u>

> *"We may be at almost the last stage before the pandemic virus may emerge. Whether the avian influenza pandemic will occur, that is not the question any more, [it is] when the pandemic will occur."* – Dr. Jai Narain, director of WHO communicable diseases department

Risk is an intricate part of our lives. The air we breathe, the water we drink, the food we eat, the cars we drive, are all full of hidden threats and pose some risk to our health and safety. How we choose to deal with all these risks depends upon our perception of them, including how those risks are communicated to us. Baruch Fischoff, an expert in risk communication, found that people's perception of risk is influenced by many factors (see Figure 1).

Figure 1 – Factors Influencing Risk Perception (adapted from Fischoff et al. 1981)

- Risks perceived to be voluntary are more accepted than risks perceived to be imposed.
- Risks perceived to be under an individual's control are more accepted than risks perceived to be controlled by others.
- Risks perceived to be have clear benefits are more accepted than risks perceived to have little or no benefit.
- Risks perceived to be fairly distributed are more accepted than risks perceived to be unfairly distributed.
- Risks perceived to be natural are more accepted than risks perceived to be manmade.
- Risks perceived to be statistical are more accepted than risks perceived to be catastrophic.
- Risks perceived to be generated by a trusted source are more accepted than risks perceived to be generated by an untrusted source.
- Risks perceived to be familiar are more accepted than risks perceived to be exotic.
- Risks perceived to affect adults are more accepted than risks perceived to affect children.

In the United States, the National Research Council defines risk communication as "an interactive process of exchange of information and opinion among individuals, groups, and institutions" (Stern and Fineberg 1996). Risk communication, according to this definition, is a dialogue-focused process which involves discussion between the communicator and the audience on the nature of risk and about methods for managing risks. Through this interaction, the audience is better positioned to decide whether they perceive the risk and/or willing to accept it because of their belief that potential benefits far outweigh the risk.

The term "risk communication" is widely used to refer to the communications established by experts putting forth their technical recommendations. For example, the public tends to trust officials who establish standards for issues in public safety. However, if the level of trust is compromised, the public's perception of risk changes dramatically. Therefore, it is important that risk communication accounts for both risk and public perception of such risk. Dr. Peter Sandman defines risk in this manner – as "risk = hazard x outrage."

In public health, officials use risk communication to educate citizens and to engage them in the decision-making process. For example, citizens are asked to provide input on the location and operation of new facilities, such as manufacturing plants and waste disposal sites. Disease outbreaks, especially exotic ones such HIV/AIDS, Severe Acute Respiratory Syndrome (SARS), and bird flu, cause strong public reaction and heightened perception of risk, making risk communication critically important. For example, the 2004 outbreak of SARS virus in China caused worldwide alarm mainly because of the uncertainty associated with the emergence of this new coronavirus. Yet, comparatively speaking, SARS only caused 55 deaths, while seasonal influenza (or “the flu”) causes 500,000-1,000,000 deaths each year. However, the public does not generally perceive the risk of the flu as in important issue.

> “…This is perhaps the only time since 1968, which was the last pandemic, that we are getting signs, symptoms and warnings from nature….More and more birds are dying and different parts of the world – this is the kind of signals and early warnings that we are referring to.” – *Dr. Margaret Chan, WHO director for Pandemic Flu Preparedness*

Every crisis, no matter how bewildering, comes with a warning – that warning is risk. In recent years, there were increasing numbers of bird flu cases in many different countries and a threat of a future pandemic with a novel influenza virus is considered a real risk. An influenza pandemic will cause very serious consequences on all of us – as individuals, family members, neighbors, friends, and co-workers. The likely rapid transmission of the disease across this highly interconnected society makes it imperative for governments around the world to effectively and successfully communicate pandemic influenza risk to the public. Communicating risks associated with an uncertain disease outbreak is an especially difficult and complex task. Based on lessons learned, it is clear that the consequences of facing a severe pandemic unprepared will far exceed all levels of tolerance.

Thesis

Protect Your Community – Protect Your Family – Protect Yourself

According to experts, the next influenza pandemic will touch the lives of every individual, every family, and every community around the globe. Although we cannot predict the severity of the next influenza pandemic, how well we prepare today will directly influence the potential consequences. With history as our guide, our preparedness must reach across the planet and into every community and every home. Assuming simultaneous outbreaks occurring over large geographic areas, hospitals will be overwhelmed, antiviral medications, if efficacious, will be in short supply, and critical infrastructure – such as transportation, energy, and public safety – will be in disarray. The world will not really achieve global preparedness until all 193 country and the thousands of related local plans are developed, tested, and integrated. Communities around the world must, therefore, rely upon local resources and establish mechanisms to communicate and manage the risks of pandemic influenza now. Well-planned and well-executed pandemic influenza risk communication at the community level is the crucial first step for ensuring that available resources are efficiently routed and delivered where needed. The main question then is: Are our communities prepared to handle an influenza pandemic? They must – because our lives depend upon it.

> *"Pandemics are global in nature, but their impact is local. When the next pandemic strikes, as it surely will, it is likely to touch the lives of every individual, family, and community. Our task is to make sure that when this happens, we will be a Nation prepared." –* Michael O. Leavitt, Secretary of the U.S. Department of Health and Human Services

Effective risk communication guides the public in understanding preparedness and response activities, adhering to and implementing recommended public health measures, and responding effectively to pandemic outbreaks. Community pandemic influenza preparedness strategies should, therefore, provide basic tools and resources to enable every individual within a community to understand the risks associated with pandemic influenza and be prepared to deal with a major influenza outbreak by:

1. **Informing** them about the risks associated with pandemic influenza to increase public awareness.
2. **Educating** them about what has been done and can be done to decrease the spread of illness through personal and local preparedness and ensuring they receive consistent

and current information on the status of the pandemic, the government efforts, and the responsibility of individuals and families.

3. Encouraging them **to take action** before an influenza pandemic outbreak and providing specific guidance for decision making to protect individual and family health.

Improving individual, family and community preparedness based on an approach of – ***inform, educate, and act*** – to reduce risk by saving lives and minimizing damage by preparing individuals and families to plan for and respond appropriately for an influenza pandemic.

Sources of Information

Current Pandemic Influenza Risk Communications Strategies

Since an influenza pandemic would affect every aspect of society, every person must take actions now to prepare. Risk communication strategies serve as an integral component of pandemic influenza plans across all segments of every society – with a clear purpose of turning ideas into actions. At the present, there is no neither generic nor universal risk communication strategy for the global audience. Governments across the world are developing, improving, and testing their own plans for an influenza pandemic and, in most cases, these plans place heavy emphasis preparing for the threat of pandemic influenza. However, in most cases, these planning efforts do not include comprehensive and detailed information on what to communicate, how to do communicate it, to whom and by whom actions must be planned for all pandemic phases and for all audiences.

WHO Global Influenza Preparedness Plan – According to the WHO, there are two main reasons to actively promote pandemic influenza preparedness on the global level:

1. To mitigate the direct medical and economic effects of a pandemic, by ensuring that adequate measures will be taken and implemented before the pandemic occurs.
2. To provide benefits now, as improvements in infrastructure can create immediate and lasting improvements, and can also mitigate the effect of other epidemics or infectious disease threats (WHO, 2007).

Accordingly, WHO developed a global influenza preparedness plan, which outlines the roles and responsibilities of WHO and national authorities and recommends measures on national and international levels that should be implemented before and during an influenza pandemic (WHO, 2005). Recommended actions aim to improve global preparedness, reduce opportunities for a pandemic virus to spread across the globe, and accelerate vaccine development. In addition, WHO provides tools and training to assist in the development of national pandemic preparedness plans (WHO, 2007). The WHO phases provide succinct guidance about the global risk for a pandemic and provide benchmarks against which to measure global response capabilities. Measures on the international level include border controls for persons entering or exiting country (provide information to travellers about outbreaks and recommend travel deferral to affected areas and administering entry/exit screening and medical surveillance). Measures at the national level fall into the following categories:

- Public health information (communications).
- Information for public on risk and risk avoidance (tailored to target population).
- Measures to reduce risk that cases transmit infection (confinement, face masks).
- Measures to reduce risk that contacts transmit infections (tracing and follow up of contacts, voluntary quarantine).
- Disinfection measures (hand washing, air disinfection) (WHO, 2005).

European Union – Most European Union (EU) countries have had pandemic plans for years. On March 26, 2004, the European Commission of the European Communities published a report titled, "Community Influenza Pandemic Preparedness and Response Planning," which outlines the roles of the Commission and the Member States in pandemic preparedness planning and defines key actions for all pandemic phases in the areas of coordination, surveillance, prevention, mitigation and response, communication, civil protection and research. In November 2005, the European Commission published another important communication on pandemic influenza preparedness and response planning in the European Community, as a revision of a previous EU pandemic influenza preparedness and response plan, urging Member States to not only have plans in place but continuously update strategies for pandemic influenza planning and coordination.

The European Centre for Disease Prevention and Control (ECDC) was established in May 2005 to help strengthen EU's defenses against infectious diseases, such as influenza, SARS and HIV/AIDS. In January 2007, ECDC issued the report titled, "Pandemic Influenza Preparedness in EU," which summarizes the results of the first preparedness review of 27 countries (25 EU Member States, plus Iceland and Norway) (ECDC, 2007). This first report is based on many sources including country assessment visits, the simulation exercise "Common Ground," workshops summaries and questionnaires assessing the level of preparedness. Although the report states that substantial progress has been on the preparedness front, at the same time, it emphasizes the need for continuous improvement in a number of different areas, such as health service response, antivirals for public health purposes, communications, and interoperability between countries. At EU level some of the recommended measures to enhance the communication of risks to the public include – developing/updating pre-agreed pandemic messages within countries and between countries where possible, develop/updating educational materials (e.g., leaflets, posters, media advertisements) that can be used in a pandemic. Member states are urged to consider how to reach minorities and address language barriers. A second status report will be published following completion of the assessment of all EU countries later in 2007 (ECDC, 2007).

United States – The U.S. Homeland Security Council published the "National Strategy for Pandemic Influenza," which outlines roles to be played by all levels of government, private industry, international partners, and individual citizens during all pandemic phases (NSPI, 2005). The National Strategy highlights the need for communities to ensure that all necessary and reasonable measures are being taken to limit the spread of an outbreak within their borders by establishing comprehensive and credible preparedness and response plans that are exercised on a regular basis. It also emphasizes the need for clear, effective, and coordinated risk communications to ensure that people, domestically and internationally, understand the actions required to prepare for and respond to a pandemic. This includes "identifying credible spokespersons at all levels of government to effectively coordinate and communicate helpful, informative messages in a timely manner, providing guidance to individuals on infection control behaviors they should adopt pre-pandemic, and the specific actions they will need to take during a severe influenza season or pandemic, such as self-isolation and protection of others if they themselves contract influenza."

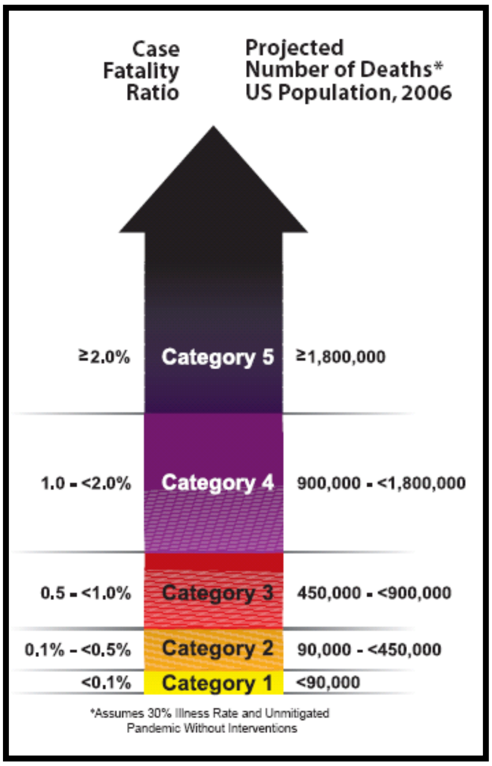
The National Strategy also calls for "integrating non-health entities in the planning for a pandemic, including law enforcement, utilities, city services and political leadership", identifying key spokespersons for the community, ensuring that they are educated in risk communication and have coordinated crisis communications plans is another important local response. Heavy emphasis was also placed on educating the population, which should: (1) begin before a pandemic; (2) be provided by all levels of government and the private sector; and (3) focus on preventing the transmission of any infection, such as the annual influenza or the common cold. Responsibilities of the individual and families include taking precautions to prevent the spread of infection to others if an individual or a family member has symptoms of influenza, being prepared to follow public health guidance that may include limitation of attendance at public gatherings for days or weeks, and keeping supplies of materials at home.

Augmenting the National Strategy, in February 2007, CDC released a draft document titled, "Interim Pre-Pandemic Planning Guidance – Community Strategy for Pandemic Influenza Mitigation in the United States," to help prepare communities in the United States deal effectively with an influenza pandemic. The strategy is based on employing the "non-pharmaceutical interventions" to combat an influenza virus, such as social distancing during the first six- to eight-weeks following the outbreak.

> *"In addition, developing and delivering effective risk communications in advance of and during a pandemic to guide the public in following official recommendations and to minimize fear and panic will be crucial to maintaining public trust."* – CDC's Community Strategy for Pandemic Influenza Mitigation

In an effort to inform and educate the public about the actual and perceived risks associated with pandemic influenza, CDC's strategy established the Pandemic Severity Index (PSI) – as shown in Figure 2 – which comprises five indices for grading pandemic severity. A similar index is used for hurricanes – the Saffir-Simpson Hurricane Scale (NASA, 2007). For pandemic, CDC uses case fatality ratio as a key risk parameter – defined as the fraction of sick individuals that die during the outbreak. According to CDC, the PSI is designed to enable better prediction of the impact of a pandemic and to provide local decision-makers with recommendations that are matched to the severity of future influenza pandemics. In the 1918 pandemic at least 50 million people worldwide died, and the case fatality ratio in the United States was 2.2 percent. Subsequent pandemics in 1957 and 1968 had lower ratios of less than 0.5 percent. If the 1918 influenza pandemic were to occur today, CDC estimates that 1.8 million individuals would die in the United States, which is equivalent to a PSI of Category 5 (CDC, 2007).

Figure 2 – Pandemic Severity Index (CDC)



Case Studies in Risk Communications

Two case studies were selected from areas of public health emergency – SARS and the 2004 Indian Ocean Tsunami – to evaluate lessons learned related to risk communication strategies. As the lessons learned from this case study suggest, it is safe to assume that all the warnings and information in the world will not do much if the public is not sufficiently informed, educated and ready to act.

SARS – The first new severe disease of the 21st Century, SARS emerged in February 2003 and immediately received worldwide media coverage. SARS was a wake up call for public officials across the globe as it revealed how much the world has changed in terms of the impact that epidemics of this sort can have in a highly mobile and closely interconnected world. Caused by a highly contagious new coronavirus, unknown at the time, it was initially diagnosed as an atypical pneumonia. The first outbreak occurred in China, but it was not long before the disease spread quickly across Asia and North America with reported cases in a total of 32 countries. The SARS virus travelled quickly via international air travel routes and by August 2003, causing 916 deaths and infecting more than 8,400 individuals around the world (1,725 of which were healthcare workers) (WHO, 2003). The SARS experience was remarkable in at least three ways:

1. It showed that decisive national and international action, taking full advantage of state of the art information technology and communication tools, was the most effective approach to stop the virus from further spread thus saving thousands of lives.
2. It highlighted the role of public health sector as leader in the coordination efforts across all segments of society to ensure implementation of prevention measures to combat the virus.
3. Public anxiety translated into a desire to take personal action, and information shaped this action in a positive way.

In Hong Kong and Singapore, containment measures were a priority at the government level and used to restore the confidence of tourists and trade partners as economies in those areas were hard hit (Finley, 2005). As information was considered the best way to ensure public participation, efforts were made to issue official reports on the outbreak in frank, open, and continuous manner. This was a critical success factor in getting people to mitigate risks as communities were receptive to messages about their role in outbreak containment and therefore were willing to fully comply with recommended measures (i.e., personal hygiene, frequent temperature checks, hand washing, the urging of hospitals to separate patients with SARS symptoms, restrictions on visiting sick patients in hospitals, etc.) (Lau et al. 2004).

Other measures, such as quarantine, truly depended on community camaraderie which was reflected in a collective need and a shared responsibility to do everything possible to enable communities to return to normal conditions. Wearing protective masks was perceived as both personal protection and public courtesy (i.e., "respiratory etiquette") in both Hong Kong and Singapore (Lau et al. 2004). In just a few months, SARS virus reached Canada, killing 44 and infecting more 350 individuals in Ontario alone (SARS Commission Report, 2006). Thousands of people were placed into quarantine and the health system in the Greater Toronto Area was severely impacted. In the SARS Commission's final report the importance of implementing infection control measures was especially highlighted, however, a number of other key issues that relate to poor community preparedness were reported: (1) poor communication with families; (2) lack of clear and consistent visitation rules; (3) inability to have a traditional funeral, and (4) stigma of being associated with SARS (SARS Commission Report, 2006).

2004 Indian Ocean Tsunami – On December 26, 2004, an earthquake measuring about 9.0 magnitude struck near the west coast of Sumatra, Indonesia, triggering several tsunamis across the Indian Ocean. Despite the distances involved, with the tsunamis taking from between fifteen minutes to seven hours to reach coastlines from Asia to South Africa, they caused catastrophic damage in multiple countries – killing 275,000 people, leaving tens of thousands homeless, and severely damaging the environment. The severity and the scope of the devastation resulted in worldwide humanitarian response, with more than $7 billion U.S. dollars in aid.

In the United Nations' report on the 2004 Indian Ocean Tsunami response efforts offered the following the lessons learned and best practices that relate to the community preparedness and perception of risk associated with tsunami (UN Report, 2005):

- **The extraordinary scale of the disaster** caused difficulties during the initial response in the affected communities as they were not prepared for a catastrophe of such scope.
- **Risk awareness among the population was very low** which helps explain the high death toll. In some areas of Indonesia and Thailand however, certain communities relied on the knowledge of their ancestors passed from generation to generation which enabled them to get to the higher grounds as soon as they feel the first tremors. This illustrates the effectiveness of risk awareness in saving lives.

- **The affected communities themselves were at the front lines in the early relief efforts.** However, efforts were not coordinated on the state level and their involvement in needs assessments, planning and implementation of emergency assistance programs was not addressed.

It is critical that individuals in those areas are educated before tsunami strikes because lessons learned showed ultimately it is up to each individual to take appropriate actions to protect oneself (i.e., moving inland and to higher ground). Figure 3 offers an example of how informing and educating the public leads to action that saves lives and reduces risk.

There are several educational programs in place to educate the public about the risks associated with tsunamis so that they can take appropriate actions in timely manner. The purpose of one such program, the "TsunamiReady Program," is to educate and remind the public about tsunami safety precautions. The program emphasizes risk awareness by educating key decision makers, emergency managers and the public about the nature (physical processes) and threat (frequency of occurrence, impact) of tsunamis, as well risk mitigation steps that could be taken before a tsunami strikes to reduce the risk associated with a loss of life and property.

Figure 3 – The Value of Inform, Educate and Act

A 10-year-old British schoolgirl who was vacationing with her family on the Thai island of Phuket saved the lives of hundreds of people in Phuket by warning them a tsunami was about to strike.

She was taught by her geography teacher that there was about 10 minutes from the moment the ocean draws out until the tsunami strikes.

This single piece of information was enough to initiate and prompt the evacuation of Phuket's Maikhao beach and a neighboring hotel before tsunami hit, saving hundreds of people from death and injury.

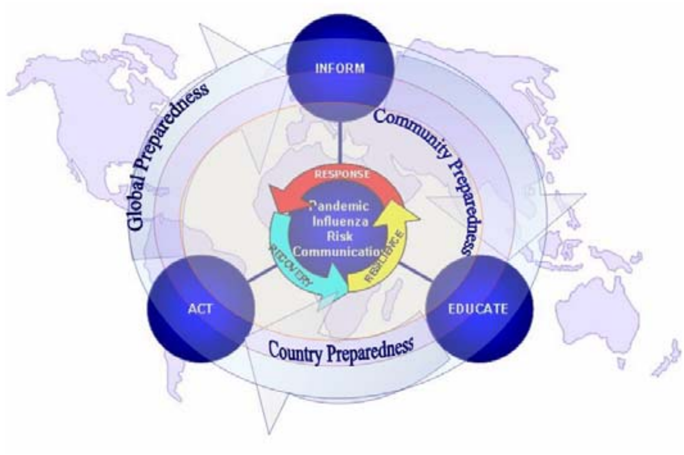
Findings and Discussion

Pandemic influenza is a unique public health emergency that will have wide ranging effects on individuals, families, and communities around the world. Community preparedness can be enhanced by improving public understanding of the risks associated with the dangers of pandemic influenza and the benefits of implementation of community-wide control practices. Public health campaigns based on the ***inform-educate-act*** approach should explain how individual action (e.g., good personal hygiene, staying home when showing symptoms) and community efforts (e.g., implementation of snow days and wearing masks) can help reduce the risk of spreading the virus and consequently save lives.

Data presented in the case studies suggest if pandemic were imminent today, the two primary goals of containment efforts before and during an outbreak would be to delay the spread of disease early after it enters the country or a region and to limit the number of individuals that become infected in community outbreaks throughout the pandemic period. Figure 4 illustrates how inform, educate, and act is applicable to improving risk communications for pandemic influenza.

Inform – Successful decision making starts with the following three words: Inform. Inform. Inform. Individuals within communities must understand that factors relating to society, the environment, and increasing global interconnectedness increase the risk of disease emergence and spread. In addition, the key messages targeting local communities should be translated and modified as required to address the cultural and linguistic needs of that community. While respiratory etiquette has been recommended as the best control measure to combat influenza in the SARS case study, it is difficult to convey that information to the unprepared communities considering the information overload, distractions associated with stressful situation, and the impact of unforeseen problems. Risk awareness and community-based disaster preparedness courses should be introduced in school curricula and in the formal training provided in the workplace settings, healthcare facilities, police and fire personnel and other relevant civil servants.

Figure 4 – Improving Pandemic Influenza Risk Communications



Educate – Knowledge is power. Communities can and should prepare for an influenza pandemic now. Therefore it is of utmost importance to acquire vital information about the magnitude of what can happen during a pandemic outbreak and what has been already done to reduce the impacts on the community (e.g., what the government is doing to prepare for pandemic influenza). Educational campaigns should contain the criteria, justification, role, and methodology that will be utilized during the implementation of the recommended containment measures and description of social, medical, and psychological ways in which individuals and families will be supported before and during a pandemic outbreak. Quarantine – temporary restriction of personal movement to/from an affected area that may be imposed by the governing authority – should be explained to public as a collective action implemented for the common good to promote a sense of solidarity within a community.

Act – Improving preparedness, especially of individuals, families, and communities, will help to lessen the risk of pandemic influenza. To accomplish this, the main question is then what actions an individual can take to help lessen the impact of an influenza pandemic on them and their families. These should be commonsense actions one can take now to prepare for a potential pandemic. For example, the U.S. government established a website (www.pandemicflu.gov) that contains a planning checklist for individuals and families, among others, to help reduce transmission of the pandemic virus if/ when it emerges.

The continuing efforts to identify and contain SARS disease is a constant reminder that communities must be ready today for the unexpected threat of tomorrow. Although it will be difficult to be fully prepared to face every potential health threat, communities can do a lot today to better protect themselves against future threats. Certainly, the experience with SARS and the 2004 Indian Ocean Tsunami reinforces the need for improved global collaboration and mega-community (from local to global) preparedness. It all starts with an informed, well educated individual within a community whose actions can make a difference and save lives.

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Academic & Professional Practice

Peer Reviewed Articles

HUMANITARIAN EMERGENCIES & RESPONSE

A GOVERNMENTAL VISION ON PUBLIC SAFETY GROUP CALLS AND OBJECT TRACING

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Keywords

Emergency Services, Group Call, User localisation, Telecommunication

Abstract

This work has been done within the EU integrated project u-2010 [13]. One goal of the u-2010 project is to provide interoperability over existing communication technologies for emergency and crisis situations. A concrete requirement related to this has been introduced by the National Committee on Telecommunications of Luxembourg (CONATEL) [3]: Objective is to provide push-to-talk group calls between users of different telecommunication systems, like PSTN, GSM, VoIP or radio. Further on, the system should be capable to attach specific users to a group call from a central point. Members of such group calls are mainly first responders of emergency situations, like police forces or fire brigades. Additionally, the system needs some possibility to locate these actors to be able to select the right people being able to respond as fast as possible to an emergency. The resulting application allows enhancing the communication between the different rescue entities. Using the localisation feature permits to contact users in range of the emergency and helps to improve the overall response time in case of an emergency situation.

1 Introduction

This work has been done within the EU integrated project u-2010 [13]. One goal of the u-2010 project is to provide interoperability over existing communication technologies for emergency and crisis situations. A concrete requirement related to this has been introduced by

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the National Committee on Telecommunications of Luxembourg (CONATEL) [3]: Objective is to provide push-to-talk group calls between users of different telecommunication systems, like PSTN, GSM, VoIP or radio. Further on, the system should be capable to attach specific users to a group call from a central point. Members of such group calls are mainly fist responders of emergency situations, like police forces or fire brigades. Additionally, the system needs some possibility to locate these actors to be able to select the right people being able to respond as fast as possible to an emergency. The resulting application allows enhancing the communication between the different rescue entities. Using the localisation feature permits to contact users in range of the emergency and helps to improve the overall response time in case of an emergency situation.

Like for many real time applications, one challenge is to deal with latency caused by the transition from one network technology to another. An acceptable Quality of Service (QoS) needs to be guaranteed. Beside the technical part, there will probably be different political or legal issues, especially for the localisation.

The core of the application relies on a centralized call manger which is directly connected to a database called SPHERE (Single Physical Heterogeneous Emergency Response Environment). It contains up-to-date user information which is periodically retrieved from different external databases (Fire brigade, Police, etc), like contact information, the availability and optionally the location of the first responders to be contacted in case of an emergency situation. The group calls are initiated and managed from the head quarter. Push-to-Talk over IP is used to provide interoperable group calls as it allows voice communication over IP based networks.

For the localisation feature several conceivable techniques exist. The Global Positioning System (GPS) is the most common method. However, an additional communication channel is needed in order to transfer the position to the SPHERE database. As only few devices are equipped with a GPS receiver, other, less accurate techniques need to be considered, as well. This includes GSM cell localisation and localisation of a fixed phone jack. The object tracing feature is included in the front end to provide a high level tracing interface.

2 Group Call Architecture

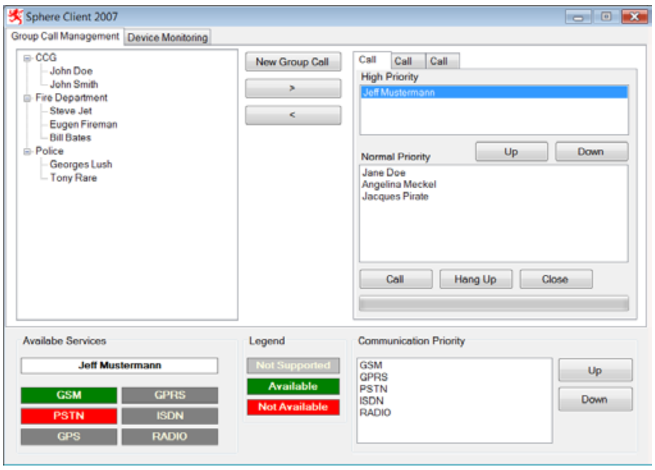

Figure 1. Call Center Application

A major requirement of the National Committee on Telecommunications of Luxembourg is the possibility to setup group calls between users, whatever communication possibilities they currently have, like PSTN, GSM, Internet access or police radio. The scenario is the following. Due to an incident detected by an entity like a 911 call service, first responders need to be contacted in such way that they are able to synchronize their working tasks. If necessary, the call service selects supplemental users to be contacted and establishes a group call architecture among them.

Which users to be involved in a group call depends on the tasks to fulfil and in case of emergencies mainly their position to achieve a fast response to the event. The application depicted in Figure 1 is the front end being used by the call centre to launch the group call. A tree of users is presented on the left side. This tree and their availability are obtained by the SPHERE database. A new group call can be initiated by pressing the "New Group Call" button. Afterwards a new tab will appear on the right side of the window. There it is possible to insert the users, who will join the group call. Two kind of group call members may exist defined by the priority the user have during the group call. Normal Priority users are provided with a Push-To-Talk like communication channel, which allows only one to talk at a time. High Priority Users are provided with a bidirectional communication channel allowing them to interrupt Normal Priority Users.

Active group calls are managed from the central service. Some of them belong to the daily operation and therefore exist permanently. It will be possible to dynamically add new users to the an ongoing call. The term user in this work does not necessarily refer to a physical person. A user may also represent an entity like a police car providing communication facilities capable to participate in several group calls.

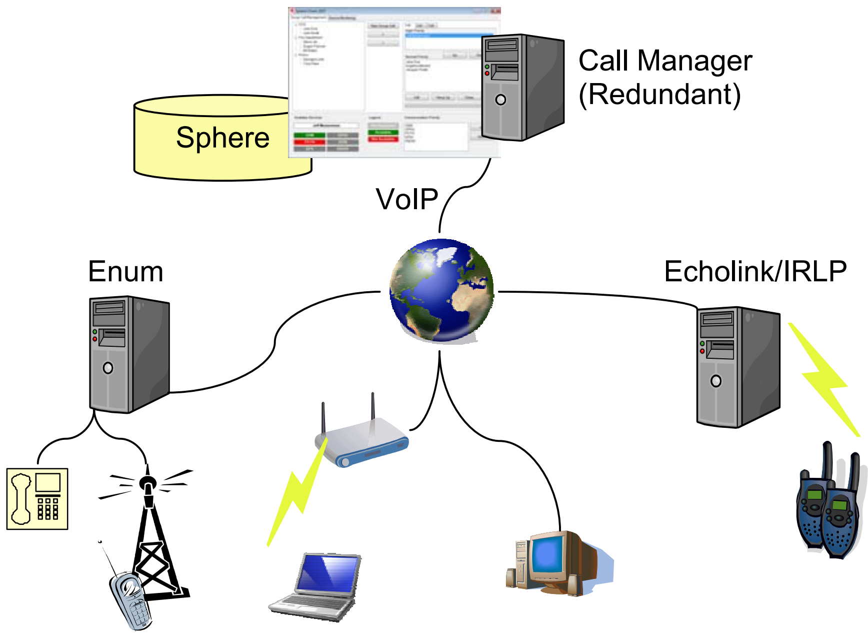

Figure 2. Group Call Architecture

The communication technology is mainly provided by Voice-over-IP (VoIP) as it allows the interoperability between the voice communication technologies. Enum server [5] allows the translation of PSTN phone numbers. Echolink [4] allows interoperability between amateur radio and VoIP but may also be used for police radio. In its easiest version it receives the radio signals via an audio-in of a sound card and translates it afterwards to VoIP.

The group call architecture is shown in Figure 2. The group call is managed from a server denoted in Figure 2 as Call Manager. It establishes the VoIP streams to the various users and relays the voice information between them. Such servers do already exist, like [1], but usually they are designed in such way to only provide the conference call platform. User may join a conference call after it has been checked whether they are authorized. So, people call the system to join. Here it is also possible to centrally call and add users to the group call. If existing conference call systems are used the users is called from the call manager. Afterwards, the call is handed over to the conference call system.

The call manager needs to relay incoming voice streams to all group call participants. For doing this it needs to consider the sender's priority sending the stream. In case it is a normal priority user, the stream is only forwarded if no other stream is currently processed. Only streams originated by high priority users are forwarded in any case.

3 User Localisation

To be able to enhance the response time of emergency services, it is important to know the location of the rescuers registered to the system. Having this information enables to create task forces of people in range of an incident. Upon the task forces, group calls can be launched in order to let the different people organize their actions.

SPHERE keeps track of the units which might be on the move. This allows taking preventive actions like for instance calculate the approximate arriving time of an ambulance at the hospital. The headquarter can this way monitor in real time the different units and take additional initiatives.

Figure 2 illustrates the different localisation possibilities used by SPHERE. Following subsections will briefly explain the basic mode of operation of each technology and how it fits in the context of the application.

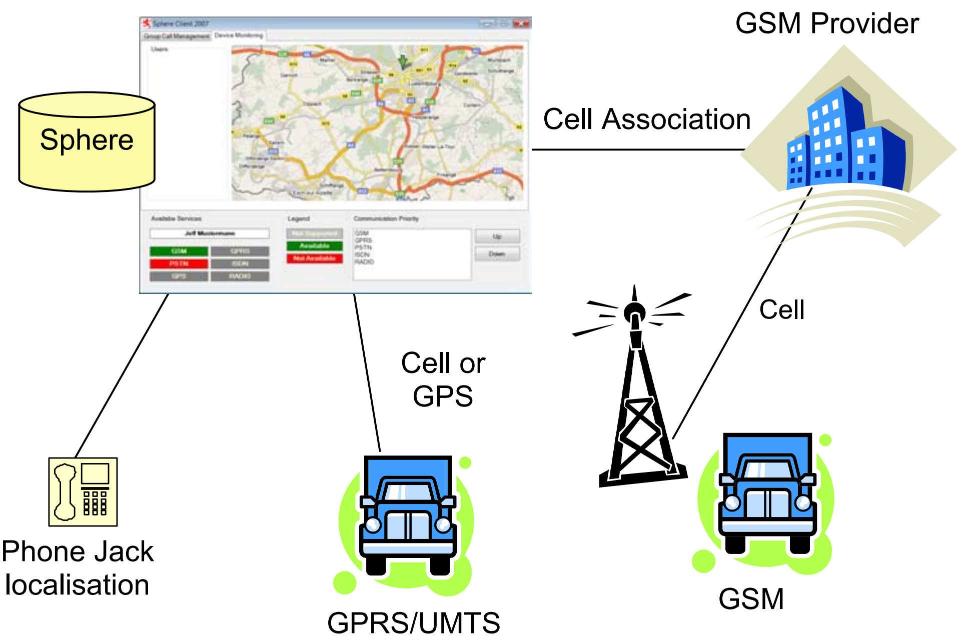

Figure 3. Object localisation architecture

3.1 Using Mobile Phone to Determine the Location

There are multiple possibilities to determine the location of mobile phones. The easiest and most common method is the Cell Identification [7]. Knowing on which cell the mobile phone is registered gives localisation accuracy from a few hundred meters in urban areas to several kilometres in rural areas. However it remains a very useful technique as it is often only necessary to know approximately in which area a certain user is located.

Another method called Time-Advance or Time of Arrival [7] gives more precise location information. It is based on the round-trip delay that can be used to measure the distance between the mobile device and the base station.

Triangulation [7] is another advanced method to determine the exact location of a mobile device using at least three base stations. The round-trip times to the different cells are compared in order to determine the location. The disadvantage is that the telecommunication providers need to install additional systems in order to provide such a service. The triangulation method is cumbersome and pretty probably limited to only localize victims.

A major advantage of mobile phone localisation is that there is no need to have a dedicated communication channel to transfer the location information back to the headquarter. However a close co-operation needs to be setup with the telecommunication provider in order to retrieve the needed data from their data repository.

3.2 Using the Global Positioning System (GPS) to Determine the Location

The most commonly used localisation system is GPS [6]. Many mobile devices are equipped with GPS receivers allowing them to determine the position with an accuracy of approximately 15 meters.

The disadvantage of GPS is that the location coordinates need to be transferred back to the headquarter in order to be evaluated. This is only possible if there is a networking technology available (GPRS/UMTS). Additional software needs to be developed and installed on the concerned mobile devices in order to perform this step automatically. Basic XML messages can be used as an envelope to periodically transfer the coordinates together with a timestamp to centralized server. It is likely that in the near future this kind of localisation technique is the prevalent one. In case no packet switched technology is available, the coordinates can be send to SPHERE via SMS or similar.

4 SPHERE

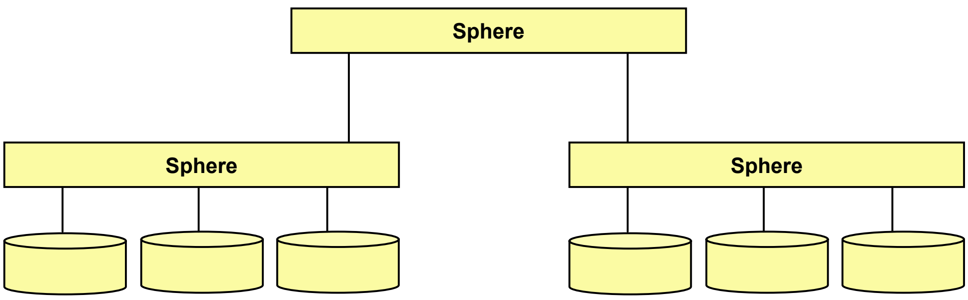

Figure 4: SPHERE Architecture

The purpose of SPHERE is to provide up to date contact information of users playing an active role in case of an emergency. The contact information includes the personal information such as name, address, affiliated rescue service, as well as additional information on individual skills, which might be important in given emergencies. The most important information is the different contact possibilities that the user might have. For instance a fire-fighter might have following communication possibilities: Fixed analogue phone, private mobile phone, radio device. This information can be seen as the static data which is not frequently changed. The dynamic part of the data gives information about the availability/reachability of the different communication possibilities at a concrete point in time. This can be achieved by evaluating information as working plans and location of a certain rescuer.

Such a data repository can only be created if it is continuously feed with up to date information. This information usually exists in the databases of the different institutions that take part in rescue operations.

To be able to use these sources for the group call and localisation technique introduced before the data needs to be transformed from the corporate data structures into a common language in such way that the group call and localisation functionality can be used across public safety institutions. Hence, SPHERE can be considered as a middleware providing a generic access to the existing databases.

Especially in case of emergency situations on the border between different administrative areas, it might become necessary to achieve interoperability across SPHERE systems. So, it is possible to provide group calls across county or country borders and to achieve a better organization of task forces. The target architecture is shown in Figure 4. SPHERE provides an interface to existing data sources on the one side but is also able to interconnect different SPHERE Systems in a hierarchical or non-hierarchical manner.

5 Future Work

Accessing external databases is one of the issues that need to be solved next. It can be seen as a political or legal problem rather then as a technical challenge. Strong security mechanisms need to be included in order to provide an architecture, which is conceivable to operate across institutional boundaries..

Another concern is the single point of failure (SPoF) which occurs when the SPHERE database fails or becomes unreachable. Hence, a certain amount of redundancy needs to be provided. This redundancy can be further utilized to better protect the system against unauthorized insight by disseminating the information in such way that the information is partly distributed among redundant parts. This can be achieved by using threshold cryptography. Using a *(k, n)* scheme [11] allows dividing SPHERE in *n* different shares. To reconstruct the data *k* of *n* shares are needed. The difficult relies in dynamically updating the shares. Additionally such a procedure would create a tremendous management overhead. Nevertheless, the concept behind secret sharing distributed databases looks promising [8].

Considering possible terrestrial network failures, satellite links will be used to provide backup connectivity. This redundancy solution will become the main link for out of area operations, like rescue operations after an earthquake in a foreign country. Users will enjoy the full services of SPHERE in any remote area.

A generic middleware can be used on top of the security protocols in order to interface the different external data source. Projects like Oasis [9] and Orchestra [10] are working on solutions that could directly be incorporated in the application. As a first step, their will be an implementation of a demonstrator using Web services, which manage the data exchange between the different actors.

6 Related Work

In case of an emergency application a good balance need to be found between security and performance. Web Services will be used as a first step to build a “Prove of Concept” demonstrator. There are related projects like OASIS [9] which provide extended web services that can be used for that purpose. It is an XML based Simple Object Access Protocol (SOAP) [12] which provides a basic messaging framework.

More advanced interfaces can be realized using middleware adapters. Orchestra [10] is one of the major projects in this research area. It provides an platform independent open architecture for spatial data infrastructures. It was specifically designed for risk management applications. The integration of the middleware component is planned as a next step in the implementation process.

To be able to directly communicate with the on site rescue units, a mobile router can be used. Cisco Systems [2] is currently testing a prototype named “Mobile Access Router” (MAR) which allows interconnecting different networking technologies in order to achieve transparent communications. It is conceivable to relay the radio transmission of the rescue units using such a device as gateway.

7 Conclusion

Communication is one of the major issues in case of an emergency situation. Improvements need to be made in this area in order to enhance the cooperation of the different rescue units.

The application presented in this work provides a powerful communication and localisation tool that can be used for that purpose. The group call feature allows a better organisation of the different emergency services. The localisation and tracing feature allows contacting relevant units near the incident and monitoring their actions. The response time could be significantly improved which might save lives.

Such an application can be implemented relatively fast. The difficulty is to find an agreement with the different organisation that need to provide access to their databases in order make it work.

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AN ANALYSIS OF ASSISTANCE NEEDS DURING THE STORM GUDRUN

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Keywords

Emergency management, emergency response, preparedness, assistance needs, risk and vulnerability analysis

Abstract

We take as our starting point the view that one of the main objectives of an emergency response operation is to meet the assistance needs that arise in the affected population during an emergency. In Sweden, like in most of the world, there has been a substantial increase in societal emergency preparedness activities during the last few years. At the local level, municipalities are required by legislation to make preparations for the management of emergencies and crises that could affect the area. Furthermore, it is required that such preparations be based on thorough risk and vulnerability analysis. We argue that identifying and describing the potential assistance needs that may arise in different emergencies should be a key ingredient in such risk and vulnerability analysis work. One important source of information regarding this matter is the study of past emergencies.

On the 8th of January 2005 the south of Sweden was hit by a major storm, Gudrun, with long lasting gusts of hurricane strength. Trees corresponding to more than 75,000,000 cubic meters of wood were blown down, and a total of 341,000 homes lost power during the storm. In the municipality of Ljungby, the effects were severe in terms of loss of utilities such as electricity and telecommunications, infrastructure breakdowns that lasted for several weeks after the storm. This situation gave rise to a variety of assistance needs among the affected population. The objective of this paper is to evaluate a constructed categorisation of assistance needs against empirical findings from the response to the storm Gudrun in the municipality of Ljungby and discuss some implications for societal preparedness activities. The work is based on an analysis of interviews

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with mainly municipal actors of central importance during the response and of written documents describing experiences during and after the storm.

Introduction

During the last few years there has been a substantial increase in societal emergency preparedness activities. In Sweden, new legislation has been issued within this field. A guiding principle in Sweden is that emergencies should be handled at the lowest possible administrational level, a notion that is also common in the crisis management literature, see for instance Boin et al. (2003), Perry and Lindell (2003) and Alexander (2005). Thus, municipalities have a wide responsibility during an emergency, generating a need for each municipality to establish an emergency management system. The need for municipalities to improve preparedness for emergency response has lead to a development of new approaches for emergency preparedness. These approaches are often based on risk and vulnerability analysis. One important source of information is studying past emergencies. In this paper, the study of one such event, with focus on generated assistance needs, is presented.

On the 8th of January 2005 the south of Sweden was hit by a storm called Gudrun. During a few hours trees corresponding to more than 75 million cubic meters of wood were blown down resulting in several difficult problems for the area (SEMA, 2005). The municipality of Ljungby was the municipality most affected by this storm. For several weeks, extensive parts of the municipality lacked utilities such as electricity and telecommunications. The larger roads in the municipality were passable a couple of days after the storm and after a week most of the roads were functioning. This situation gave rise to a variety of assistance needs among the affected population.

We take as a starting point the view that one of the main objectives of an emergency response operation is to meet the assistance needs that arise in the affected population during an emergency. It is thus interesting to develop an approach for generating input to emergency preparedness that is based on an analysis of such potential needs. As a first step towards such an approach, a categorisation of assistance needs has been established by the authors. The purpose is that this categorisation can be of help during preparedness activities (see for instance Abrahansson et al., Submitted to TIEMS 2007). The objective of this article is to evaluate the categorisation against empirical findings from the response to the storm Gudrun in Ljungby.

Theory and Method

Theory

Several authors argue that preparedness is an important part of emergency and crisis management and essential for emergency response (e.g. McEntire and Myers, 2004). At the same time planning is a very difficult task due to the complexity of any emergency situation. McConnell and Drennan (2006) raise the question whether planning and preparing are achievable tasks. They point out that at the same time as emergencies may have a high impact they are low probability events, making it difficult to motivate planning and preparedness activities. An additional problem is the competition over resources with other areas such as health and education. Another problem is the tension between a need for a coordinated planning and the reality with institutional and organisational fragmentation. McConnell and Drennan (2006) conclude that preparedness is not impossible but very difficult to accomplish.

In our point of view, shared by many emergency and crisis management scholars, emergencies are in essence about people. For instance, Enander (2007 forthcoming) argues that a significant part of the emergency response operation is to assist the affected individuals to cope with their own situation. Buckle (1998) means that planning, instead of being based on an administrative perspective of which services that can be provided, should be driven by the populations needs. Similar thoughts, i.e. that the need for assistance in the affected population should be the basis during the response of an emergency are presented in Fredholm (2007 forthcoming). According to this view, one major goal of emergency management is to provide service to meet these needs during an emergency. An important part of emergency preparedness and response is therefore to identify the most adequate way to meet these needs (Buckle, 1998) and which services that are required to achieve this (Buckle et al., 2000). Due to the often complex situation it is not always possible to meet all needs that may arise in an emergency. Furthermore, it is not always society's task or responsibility to do so. The affected individuals also have a responsibility in this work. The response organisations have to find ways to prioritize between the different needs that arise in the population (Fredholm, 2007 forthcoming).

Fredholm (2007 forthcoming) has made a general categorisation of what he refers to as assistance needs into five need domains: "protection of life and health", "protection of property", "protection of the environment", "life and function support" and "recovery". This categorisation is based on a focus on accidents. In Fredholm (2003), with a broader scope in terms of emergencies considered, an additional domain is used, namely "protection of democratic values".

A new categorisation of assistance needs including six need domains has been made, heavily influenced by the two publications by Fredholm mentioned above. In this categorisation an additional domain, "psychosocial support"[4], has been introduced due to the focus on such issues in past emergencies such as the discotheque fire in Göteborg in 1998 (Nieminen Kristofersson, 2002) and the Indian Ocean tsunami in 2004 (Nieminen Kristofersson, forthcoming). Furthermore the need domains "protection of property" and "the environment" have been merged. The six domains of assistance needs used in this study are:

- Protection of life and health
- Psychosocial support
- Life and function support
- Protection of the environment and property
- Protection of democratic values
- Recovery

Method

A study of what kind of assistance needs emerged among the affected population during the storm Gudrun was carried out in the municipality of Ljungby. This was carried out using the categorisation of assistance needs described above.

Actors of central importance during the response to Gudrun in the municipality of Ljungby were interviewed using semi-structured queries. The fire chief, who took a leading role in the response, assisted in selecting the interviewees. This led to a selection of representatives from each administrative unit of the municipality that was considered central during the response i.e. social services, environmental services, technical services and the municipal administration. In addition one actor, a police officer, from outside the municipal organisation was selected for interview.

The interviews were transcripted and the interviewees had the possibility to read and comment on the material before use. In addition to the interviews, written documents describing and evaluating the response were also collected and analysed. The information obtained consisted mainly of descriptions of different measures taken to manage the situation, and not explicitly of what kinds of assistance need that emerged. Therefore, an effort was made to interpret which assistance needs the identified management strategies corresponded to. The identified assistance needs were then categorised in accordance with the six need domains described above.

[4] In the two publications by Fredholm referred to above, "psychosocial support" was included in the category "life and function support".

Results

In this section a description of the results, in terms of identified actions and management strategies, the interpretation into corresponding assistance needs and categorisation in accordance with the different domains of assistance needs described above, is given. The presentation follows the structure of the categorisation.

Protection of life and health

During an emergency there is a need to protect life and health of the threatened population both in relation to the physical course of the event and the consequences of it. Since there are, for obvious reasons, very little one can do to reduce the strength of a storm, the focus during and after Gudrun was on handling the consequences.

One consequence of the event was that due to all fallen trees a lot of people outside the city were trapped at home. The loss of utilities such as usable roads and telephones made it impossible to reach those affected. Neither relatives nor authority could get in contact with them to see if they were unharmed. Due to the uncertainty regarding whether people were hurt, the municipality initially focused on the clearing of roads. In addition, motorcycles were used to make passage easier. An interpretation of these actions is that they were carried out in order to be able to gain information on whether people were unharmed, and further to make sure that emergency transports were possible if needed. This need can be categorised as “protection of life and health”, at least in the first phase of the aftermath of the storm. The actions taken could also be interpreted to meet the citizens’ need for passable roads, which could be categorised under “life and function support”.

An additional identified task, mainly for the police, was to search for missing people in the forests. The fallen and uprooted trees made the woods a dangerous place to be. It was also easy to get lost because of the changes in the landscape due to all fallen trees. This task can be seen as a strategy to meet the need for search and rescue which can be categorised as “protection of life and health”.

As a result of the storm many people had no possibility to heat their houses due to the loss of electric power. Due to this problem the municipality established a readiness to evacuate all these people if the temperature should reach the freezing point. An interpretation of this readiness to evacuate is that it was done to meet the affected populations’ need of a warm place to live which can be categorised as “protection of life and health”. I could be argued that the issue of not being able to heat ones house is not necessarily a question of life and health, even in cold temperatures. Thus the readiness to evacuate could also correspond to a need that could be categorised under “life and function support”.

The loss of communication utilities made it difficult or even impossible to get in contact with e.g. fire brigade or the medical service in case of emergency. To facilitate the inhabitants’ possibility to get help when needed, people were positioned out with communication radios in cars at a number of strategic places. The loss of telecommunications also affected the emergency alarm many elderly had installed in their homes. These alarms are connected to and thus dependent on the wired telephone network. Therefore, as soon as the mobile net became operational the municipality started to lend out mobile telephones to elderly to use in case of emergency. These actions taken to make it possible for the affected population to get help when needed can be categorised as “protection of life and health”. They can also be seen as a way to meet the need of the population to feel secure, which could categorised as “psychosocial support”.

Psychosocial support

The falling of trees corresponding to millions of cubic meters of wood resulted in high economic losses for the forest owners. Over night many people lost most of their life's work. The additional loss of electric power also led to problems for farmers with large animal stands. To support these people the municipality made arrangements so that the military’s emergency teams could be used.

These teams visited both farmers and elderly that were assessed to be in greatest need of such support. The municipality also arranged for an emergency team to be available at the fire station, and for a team of social workers at the social welfare office. Furthermore, the church established a telephone number for psychological support. To always be contactable they used a mobile telephone that circulated between different clergymen. An interpretation of the use of the emergency teems, social workers and the possibility to get in contact with representatives from the church was that this was done to meet the need for support related to both grief over losses and anxiety for the future. This can be categorised as "psychosocial support".

Life and function support

As a result of the consequences of the storm the municipality evacuated some elderly that did not manage to live at home to municipal homes for the elderly and also, because of shortage of room, to empty hospital beds. Elderly that were considered to be able to stay at home were assisted in getting food, water and wood etc. Other people in need were given the possibility to temporarily stay in for instance schools with functioning utilities. Furthermore, financial aid was arranged for people with strained economy that had been affected by the consequences of the storm. These actions can be seen as a way to meet basic needs such as food, water and warmth and can be categorised as "life and function support".

Most of the technical infrastructures such as roads, water distribution system, sewer system, telephones, mobile telephones and the electric power grid, were severely affected by the storm. Both municipal and other actors responsible for different infrastructures were engaged in restoring these utilities, often using temporary solutions. This work is interpreted as a way to meet the need to support the inhabitants' daily life and can be categorised as "life and function support".

As mentioned above, the loss of electric power gave rise to problems for many people, for instance regarding the heating of houses. Another example is that farmers were experiencing problems since this loss affected for instance the equipment used to milk cows and to provide the animals with water. The municipality therefore arranged for the distribution of hundreds of mobile power generators and heaters to people in need. This arrangement can be seen as a way to meet the need for electric power and can be categorised as "life and function support".

The effects of the storm also resulted in problems regarding fresh water distribution. Many households, especially in the countryside, used electric water pumps which did not work during the electric blackout. The municipality therefore provided drinking water by placing water tanks in strategic places. In addition, washing and shower possibilities were arranged for. By contacting different apartment buildings in the town, where utilities such as electric power, heating etc. were functional, and different sports clubs the municipality managed to arrange for laundry rooms for the public to use. Furthermore, the municipality's indoor swimming pool was held open free of charge. These actions can be seen as an attempt from the municipality to meet the need for fresh water and hygienic facilities and can be categorised as "life and function support".

The effects of the storm also affected important societal functions such as the fire brigade, the police, home care and the schools. For instance, to ensure that the fire brigade would manage to handle incidents not related to the storm, they always had a backup team ready. To be able to pursue school activities, even though the normal classrooms in some cases were unusable, the municipality arranged alternative classrooms with functioning utilities in the town three days after the storm when most of the big roads were open again. Children that lived in the countryside, approximately 600 people, were picked up by buss and driven to the alternative school accommodations. This can be seen as different handling strategies to meet the inhabitants' need for important societal functions and can be categorised as "life and function support".

Attempts to inform the public on important matters regarding the handling of the consequences of the storm were made by sending out information with the postal services, in newspapers, leaflets and radio (as these communication routes became functional). Another approach was the arrangement of about fifty information meetings to inform about what was being done and to ask for the citizens' opinions. This was done twice a week during five weeks. The meetings were held in different villages in the municipality. At every occasion one politician and one official from the municipal organisation participated. At some of the meetings also other actors such as representatives from the electric power company participated. An interpretation of these actions is that they were directed towards the need for information and can be categorised under "life and function support". The information meetings could be interpreted also as a way to meet the need for information in order to alleviate anxiety and could thus also be categorised under "psychosocial support".

Protection of the environment and property

Since several people had to temporarily move from their houses there were worries that this would increase the risk of burglary. To increase the level of security the police therefore called in extra staff to help guarding the municipality. One important task for the police was to be visible and thus increase the inhabitants feeling of security. This can be seen as a way to meet the affected populations need for protection of property and can be classified as "protection of the environment and property".

Protection of democratic values

The information meetings that the municipality arranged can also be seen as a way to meet the need for democracy and thus also be categorised as "protection of democratic values"

Recovery

The effects of the storm included severe damage to many important technical infrastructures. As mentioned above, many of these were temporarily repaired using alternative solutions in order to be able to provide at least part of the normal function. Restoring these infrastructures to their normal status is a work that is still ongoing. This can be seen as a way to meet the affected populations need for technical utilities and can be categorised as "recovery".

Furthermore, the storm Gudrun destroyed a lot of people's life's work. For some, this resulted in a need for long-term psychological support. This need can be categorised as "recovery".

Discussion

In summary, the storm Gudrun gave rise to a wide range of assistance needs in the affected population in the municipality of Ljungby, and various measures were taken by the municipality and other actors in order to meet these needs. In this section, the approach to generating input to emergency preparedness planning, based on identification and categorisation of assistance needs described in this paper, is discussed.

One objective of this study was to evaluate the usability of the theoretically derived categorisation of assistance needs through analysing emerged assistance needs in a real life event. The empirical results suggest that the categorisation provides a suitable platform for classifying assistance needs even though further developments may be needed. For instance, the approach would have to be applied to studies of various kinds of emergency and crisis situations in order to make statements regarding general applicability possible. In addition, the interviewees were deliberately mainly municipal officials, i.e. actors in different ways responsible for the management of unwanted events. Complementing studies on how the affected population experienced their assistance needs should be undertaken in order to be able to evaluate the general usability of the categorisation, and further to investigate potential discrepancies between information obtained from emergency management actors and that obtained from affected individuals. Such discrepancies have been shown in the literature, e.g. Nieminen Kristofersson (2002). Furthermore, the identified actions and management strategies could sometimes be interpreted to meet several different needs which in turn could be categorised in more than one category. In our point of view this is not a major problem since our aim was to categorise the assistance needs and not the actions taken. However, in future studies it might be wise to try to identify the assistance needs directly, and not interpreted through the actions taken.

The changes in the categorisation of assistance needs in relation to the ones given by Fredholm (2003; 2007 forthcoming), seems to have worked out well, at least for this specific type of event. The major change was the introduction of the additional domain "psychosocial support", which was included in "life and function support" in the references by Fredholm above. As in the case of past emergencies such as the discotheque fire in Göteborg 1998 referred to above, the need for psychosocial support in the aftermath of the storm Gudrun was substantial, which motivates treating "psychosocial support" as a domain of its own. Furthermore, we found that this sort of need was to large extent handled by another organisation than other needs classified under "life and function support".

We argue that despite the need for further developments, the suggested categorisation of assistance needs could serve as a checklist both in emergency preparedness planning, see for instance (Abrahamsson et al, submitted to TIEMS 2007), and in the actual management of an ongoing event. This means for instance that in preparedness activities it is possible to make preparations for management strategies that correspond to the broad spectrum of assistance needs implicated by the categories. During the management of an ongoing emergency the categories could be used as "food for thought" in order not to neglect any important assistance needs.

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Academic & Professional Practice

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BUSINESS CONTINUITY MANAGEMENT

POTENTIAL FOR INTERNATIONAL ADAPTATION OF BEST PRACTICES OF POST-9/11 CORPORATE STRATEGIC PREPAREDNESS PLANNING

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Abstract

This paper presents selected outcomes of a medium-term research effort previously conducted on the strategic affect of the 9/11 terrorist attacks on US corporate disaster planning and management for large publicly held corporations. It outlines key parameters, lessons learned and best practices frameworks analyzed previously, with a view to proposing opportunities for follow-on research, notably as concerns institutions outside of the United States, and particularly in developing regions constituting emerging markets which pose the challenge of strategic risk management planning, for multinational corporations (both US-based and others) and any other significant international investment ventures. The paper and presentation allude more specifically to possible avenues for exploring risk management issues in the region of the Middle-East & North Africa (MENA) and the Gulf sub-region in particular, in view of the current regional economic boom coupled with relatively high risks induced by geo-political instability and the challenging context of institutional governance. This preliminary overview of Middle-East corporate strategic planning preparedness relies on initial exploratory investigations and empirical observations in the field.

Introduction

This paper is a best practices paper, however it builds heavily on past, recent and ongoing research components led by the authors, including a number of empirical research findings carried out in 2006 and early 2007, with a specific view to starting an exploratory research program into international dimensions of the mostly US-based previous research efforts. This is directly linked to an ongoing effort by the authors to mobilize support from international institutional partners, in both Governments and the private sector, to carry-out extensive follow-on research which would allow the development of comprehensive research-based frameworks for corporate best practices in strategic planning for crisis preparedness and response, disaster and contingency management, business continuity and recovery.

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As such, a certain amount of direct observation-based empirical research was carried out, particularly in the Middle-East, with specific focus on the Arabian Gulf in the context of field assignments to the United Arab Emirates, Kuwait, and Saudi Arabia, other interactions in the Levant (Jordan), and off-site meetings with institutional partners from Algeria.

The main objective of this effort is to explore the most appropriate ways in which public authorities, quasi-Government institutions and the private sector could be engaged in appropriate research and action frameworks on strategic institutional and corporate crisis planning and management, by presenting some of the previous US corporate and academic findings and initiating preliminary dialogue on how this emerging knowledge could best be harnessed to benefit both international and local institutions active in a region such as the Middle-East, considered to be at once a potently emerging market and a region characterized by a high degree of risk generated by periodic geo-political instability.

Thesis

Our thesis, in view of its direct reliance on preliminary and ongoing research programs, as well as the fact that it is being studied in view of projected follow-on research, will include some elements traditionally specific to research papers, such as an overview of underlying theory and prospective methodological choices rooted in related research endeavors carried out by the authors.

Our thesis is that, with globalization bringing into play greater interactivity for an increasing number of corporations and institutions (no longer limited to the large often publicly held multinational corporations, with small to medium enterprises / SMEs having greater access to global markets), corporations and institutions are required to adapt considerably in order to remain competitive: on the one hand, national markets are "invaded" by international products and services providers. In first world markets, low cost providers from developing countries make their appearance, and they are challenged by strong regulatory and quality control frameworks, in some cases these being the last boundary of masked protectionism on behalf of industrialized countries' authorities (the case of Dubai Ports World is now notorious in this respect). One of the areas where these corporations need to increasingly adjust their compliance, is on matters related to various aspects of security management. In other cases, first world corporations, in order to remain competitive, must embark on the conquest of emerging markets so as to ensure growth, as their domestic markets saturate. More often than not, these corporations need to be prepared to engage in local partnerships, while upholding their own best practices standards in order to protect both their bottom-line and manage the inevitable "reputational" risk which could stem from these international operations. The "reputational" risk is compounded these days by the need to appease past perceptions of transnational corporations' wrongdoing and exploitation in developing countries, thus leading these corporations to adopt uniform standards of safety across the regions they operate in. On the receiving end, newly emerging markets are attempting to attract more foreign investment, which leads them to researching ways in which to improve their governance standards as well as portray their geographic location as safe and able to protect the business community from any acute crisis of whatever sort (natural hazards, civil unrest, armed conflict, technological / infrastructural disasters, terrorism, etc.). In turn, these emerging markets locations allow industrialized countries' international corporations to produce at competitive rates, while uplifting the state of well-being of local populations in ways that make these emerging markets increasingly attractive as production-bases.

Hence, all sections of the international business community, whether international corporations, host authorities or local institutions and corporations have a stake in improving the real and perceived levels of security, stability, preparedness and the related quality of their governance frameworks. In regions where political risk and geopolitical instability are a potent reality, such as the Middle-East, the case for researching ways in which international best practices can be adapted and adopted for strategic institutional and corporate planning for crisis management, is particularly strong.

Sources of Information

The main sources of information have been, as concerns the conceptual premise of the thesis, research conducted in the context of an NSF-funded research program by the George Washington University's Institute for Crisis, Disaster & Risk Management, within the Department of Engineering Management and Systems Engineering of the School of Engineering and Applied Sciences (Washington DC), on the effect of 9/11 on US corporate strategic planning for risk, crisis and disaster management, and business continuity and recovery. The research effort led to the production of a series of reports and three Doctoral dissertations (the last one in final stage at the time of drafting the present paper), one of which focused particularly on issues such as best practices frameworks for strategic planning.

The main source of information for the prospective follow-on, constitutes in itself a challenge: indeed, even during the large US research program, the sensitivity of issues pertaining to 9/11 and the corporate governance, responsibilities and performance aspects of the research, led to a research protocol which ensured confidentiality for the participating corporations.

As concerns efforts led in context of the present prospective research focusing on the Middle-East poses similar but stronger challenges, both past, present and future. Indeed, at the time of drafting of this preliminary paper, the only way to access information freely has been to do so confidentially and on an ad hoc empirical observation basis which involved informal discussions with key actors, and institutional and corporate decision-makers. This is expected to form a great part of the initial groundwork into the future, but it should be augmented by formal approaches for support from Government authorities as well as private sector entities and individual experts.

This issue of information sources will be a key factor in designing appropriate research outlines which would support any review of the prevailing situation, with a view to developing best practices frameworks. As such, the issue merits in itself a quick overview of challenges concerning information sources in the Middle-East in general and the Gulf in particular, even if situations vary from country to country and often from region to region and from one institution to another within each country. The main challenges identified are:

- The lack of transparency of most governance systems in place across the region, and a prevalent feeling from civil servants, managers and employees, that they jeopardize their careers by speaking candidly of sensitive issues directly relating to the appropriateness of governance systems in place.

- The suspicion of many institutional interlocutors at motives behind such research endeavors, sometimes augmented by hostile perceptions of "western dealings" (and particularly those of the US) in the Middle-East

- The simple inexistence of accurate record-keeping and / or difficulty accessing what records are effectively kept. To be fair and consistent with a fairly bureaucratic reputation of the region, this usual hamper to simple institutional liaison could be turned into an asset, if access to government records is granted, seeing that these are often substantial, even if of uneven quality.

- Some challenges may simply be very similar to those encountered in the USA, ranging from excessive prudence due to the sensitivity of the subject (enhanced by the real issues of potential regional instability which create an added layer of pressure), coupled with the fact that the most "empowered" and informed interlocutors are, by definition, very busy (even more so in institutional settings where they have poor system support) and the hen and egg problem of the relatively low priority that these subjects have for them (in many cases, there is also a deliberate ignorance of these within a culture where it is seen as being negative to speak of disasters and any major potential problems).

Of course, whenever possible, documentation has been a source of information, but mostly as concerns the US-based components of best practices and research into strategic corporate crisis planning. This will continue being the case.

At an appropriate stage it is envisaged to have sets of interviews with key decision-makers and operational individuals, perhaps using confidentiality-bound research protocols (although in the Middle-East, because of prevailing lack of institutional trust, managers tend to not believe that any such confidentiality may be implemented; also, the institutional landscape being much smaller, there is a concern that even generic descriptions of an institution will make it easily identifiable, and in institutions where power and access to information are extremely concentrated, often into a single pair of hands, that the interlocutors would also be just as easily identifiable if any significant information was shared).

At the present stage, while discussions have been initiated for proper informational sourcing with a half dozen institutions, deeper informal discussions on strategic corporate crisis planning and management have only taken place with a couple of these institutions.

In order not to jeopardize future potential for engagement and in view of prevailing gentlemen's agreements, this paper does not divulge which institutions and their leaders accepted to engage in these preliminary investigations, except to say that we were able to speak to a significant cross-section of interlocutors ranging from national high-level and working-level practitioners as well as international partners ranging from small services corporations to large multinationals. Also, internal documents shown could not be cited, hence a references and bibliography section mostly relevant to the US research components against which our approach is tailored.

Methodological choices concerning sample and project design

In view of the prevalent institutional landscape, the authors have prioritized Gulf 'quasi-Government institutions as the first and most relevant category of informational sourcing and participating partners for the projected efforts. Indeed, the rationale for that is the following:

- In the MENA (Middle-East and North Africa) region, even the private sector is driven by Government investments and spending through various forms of re-distribution of the natural resources wealth (mainly petrodollars).

- Governments have built-up large quasi-Government institutions in order to maintain a degree of control over resources while giving these institutions the role of catalysts of private sector development (most private sector firms are contracted by these Quasi-Government institutions to execute projects in all areas of endeavor.

- These quasi-Government institutions, because of their dual interface with Government and private enterprise, and their centrality in national economies and the political landscape, have the best access to information.

- Also, they tend to attract the best pools of managers in light of the fact that they are well-resourced and they have the most chance of being interested in our topics as well as to have the ability to carry forward future implementation imperatives with their outreach capacity towards both Government and private enterprise (best practices dissemination).

- These quasi-Government bodies also have interactions both at the national and international levels (they are the most potent local partners to international firms and they themselves have substantial international investments).

Moving forward, we anticipate the continuation of the use of a certain number of basic investigative tools to create a framework for possible follow-on research based on:

- Operational research partnerships with Government authorities, quasi-Government institutions and private sector enterprises (with a particular focus on the large family business units which constitute an increasingly significant portion of MENA countries' GDPs).

- Structured interviews with practitioners at various levels of responsibility

- If possible, a quantitative review of key crisis preparedness parameters

- A highly qualitative analytical exercise about the prevailing situation – this could be done on the basis of technical audits of the governance systems of participating institutions as they relate to crisis preparedness.

- Data collection and analysis which, while multi-layered, would at least partly use case study methodology, in an effort to build-up a sufficient qualitative critical mass of knowledge on all aspects of strategic crisis and contingency planning, disaster management, business continuity planning and recovery imperatives.

- Much empirical observation is expected, supported by many "off-the-record" interactions, as has been the case until now.

Findings (including description of ad hoc modus operandi)

The present approach to the issues at hand was prompted by an evident need to investigate any international dimensions of a previous research effort aimed at studying the evolution of US strategic corporate planning for preparedness, response, mitigation and management of disasters (particularly those constituting extreme events) as well as the business continuity and recovery aspects of these imperatives.

The research project, after an initial study of the economic impacts of 9/11 on directly and indirectly impacted publicly held corporations, which yielded a counter-intuitive result showing that these corporations, in spite of massive initial losses, did manage to absorb the 9/11 shock (many going on to thrive thereafter), focused on analyzing specific sets of parameters allowing to understand how their strategic corporate crisis planning approaches evolved subsequently.

The research project, focused on a single case study methodology applied to four major confidentially participating corporations each constituting a unit of analysis, was thoroughly researched and designed against previous existing (though rare) data and was augmented by the participation of input from some of America's most respected experts from both Government and the private sector (all participating within the confidentiality clauses of the research protocol so as to ensure optimal openness in their assessments and input, in view of their very high profiles in both the policy, institutional and economic spheres of influence).

A set of common observations and best practices recommendations, even if probably needing future validation as the state of the art evolves, was developed and can be summarized as follows: most major US publicly held corporations directly impacted in the World Trade Center attacks of September 11th 2001, had significant crisis preparedness frameworks in place. However, most of these were insufficient to deal with an extreme event which was considered not to be the most likely crisis scenario pre-9/11. The September 11th response demonstrated that some of the existing measures in place were helpful in mitigating the disaster while others existed and were inadequate either through their design, implementation or both, and yet other measures were simply altogether inexistent. In view of the magnitude of the event, it was found that improvisation combined with pre-existing measures allowed a certain level of success in mitigating the disaster. Other parameters were difficult to analyze such as the impact of the prevailing world economic downturn at the time of the attacks.

A certain number of recommendations based on best practices observations were inferred in the findings and conclusions of the research effort and notably:

- The importance of raising crisis preparedness awareness at every level of the corporation, in ways which make strategic disaster planning an integral part of corporate and institutional culture across business lines horizontally and vertically, from the Boardroom to the most grounded technical levels of operation and to include all related contractors associated with operational imperatives.

- The importance of having a dedicated professional team which is appropriately resourced in order to stay abreast of best practices and have active stewardship of all crisis management imperatives, with the mandate of mainstreaming these. It is important that the seniority of the managers involved be sufficient to reflect the priority of crisis management given by the corporate leadership. The top leadership must be directly involved in these stewardship efforts.

- The importance of mainstreaming crisis management imperatives in ways that reciprocally leverage the corporation's own operational strengths towards crisis mitigation while designing preparedness frameworks that enhance the quality of mainstream business line governance in ways that improve business operations and their related outputs and results.

- The convergence of managing crisis-related risks and "reputational" risks, which are closely linked (a crisis can produce "reputational" risk exposure and inversely a "reputational" issue [such as a mainstream business fiduciary governance scandal for instance] can constitute a serious crisis with bottom-line implications).

- The importance of strengthening in-house capacity at crisis management in order to increase a corporation's independence towards other entities while at the same time this strengthens the corporation's capacity at managing necessary external cooperation imperatives.

- The importance of solid contracting, vending, sub-contracting and outsourcing arrangements in order to complement the corporation's own in-house capacity.

- The importance of maintaining strong relationships with authorities in order to leverage the substantial tax-payer dollars invested in government-supported safety and crisis preparedness schemes, including those aimed at protecting corporations, especially those viewed essential to the national economy, and hence of national security interest.

- The importance of information and communications management, both internally for operational response, continuity and recovery needs and externally for these same needs as well as managing stakeholder communications (with employees and their families, Boardroom, shareholders, authorities, contractors, partners, the media, etc.) in ways that optimize the protection, deployment and integration of assets (human, technological, financial, infrastructural, situational, virtual, etc.).

- The importance of well-designed and appropriately located and maintained off-site redundancy sites for critical infrastructural, informational, communications and technological assets.

- The importance of combining flexibility with discipline in order to optimize chances of success of inevitable improvisations.

As concerns the approaches made in the MENA region, the most significant was made in a Gulf country, and other less advanced engagements elsewhere have partially validated both some of the information we have presented above in the Information Sources section (which were findings unto themselves because this informational component is so important to the topic at hand) as well as others that we broach here, some of which merit repetition because of their apparently strong relevance to the challenges of promoting formal frameworks of best practice in the region.

We shall hence present these preliminary findings in reference to most of the observations which we feel to be pertinent at this still preliminary stage, while we focus mainly on that single Gulf country as a representative sample of the region, even with the cautionary principle that each situation is unique. Hence, our discussion flows directly from this approach.

Discussion & Conclusions

The most significant engagement was with a quasi-Government holding which operates a number of large institutional entities with varying approaches to strategic crisis planning ranging from total ignorance of the subject to reports of detailed planning. The entity which has been most interested in collaborating is one that was in the process of approaching professional institutions to design a framework for strategic contingency planning with a view to developing an operational disaster management program and generalizing it to the mother-holding across all entities and proposing further expansion at the level of at least the concerned emirate and perhaps at the national federal level in order to subsequently engage the GCC (Gulf Cooperation Council which groups all of the Gulf's monarchies and operates as a single open market). An international firm engaged in various areas of strategic advisory services and with which one of the authors was associated in areas of technical assistance, afforded access to other institutional partners both local and international, involved in advising that country's Government in its security preparedness imperatives. Some of these experts were involved in advising about strategic corporate governance issues (relating to financial security, due diligence and business integrity), others were there on a major assignment to design a national security institutional framework and yet others were designing an upgraded security system for the country's strategic oil, gas and petrochemicals installations in light of mounting concerns about sub-regional geo-political tensions. Other professionals were simply advising on basic security due diligence at various institutional levels of multiple Governments.

The growing amount of activity in these fields, as per our interactions with all involved, demonstrated both the pre-existing void as well as the combination of increased spending capacity and growing regional instability fed by the chaos in neighboring Iraq, the US-Iran stand-off on nuclear armament and regional influence, and the continuing tensions related to the core Middle-East conflict between Israel and Palestine worsened by the tensions in Lebanon following the significant bombing campaign of Summer 2006.

However, it was regularly remarked that in view of the challenges and the fact that much of the pre-existing infrastructure (including the very recent one erected with proceeds of the continuing oil-boom) did not integrate any significant strategic crisis preparedness planning. It was observed, for instance that all of the country's considerable number of power generation facilities were all concentrated in one site which could be destroyed by a single missile strike.

Other important issues characterizing the region are those which we will not repeat here in any great detail, as they were highlighted in the Sources of Information section: indeed, informational access and integrity is a key challenge, and would be of the key issues to address in any future effort to enhance preparedness frameworks.

Related to this, is the very unequal state of awareness of this issue at the very highest levels of Government, with a few exceptions seeming to confirm the rule.

Also, those who are conscious of the issues seem powerless to act as decision-making is strongly concentrated. Also, institutional culture puts anything to do with security as somewhat of a taboo domain reserved to the ultimate political leadership and its armed forces and specialized security and intelligence services so there is no incentive for institutional entities to get into that area of concern, and quite to the contrary in actual fact. Inversely, the security establishment while happy to consider all security to be under its aegis, also seems to believe that as long as defense and basic governmental security are ensured, there is no particular role to be played at other levels such as economic infrastructural security.

Even high-ranking (expatriate) employees of major international franchises said that their sophisticated multinational subsidiaries tended to reflect the local environment more than their otherwise high standards of management in other mainstream areas of endeavor. One high-ranking such manager explained that the Business Continuity Plan existed because it was an administrative requirement as well as the fact that it was required by their insurer but that it was kept in a manager's drawer, was not updated and was ignored by the great majority of employees.

Another entity CEO of the host quasi-Government entity which was the most forthcoming with information, ascertained that a crisis contingency plan existed across the whole holding, but could not refer us to anything tangible even as he said that the management team was reviewing these plans. He was in fact contradicted by the CEO of another larger sister-entity who was the former Managing Director of one of the world's leading technology franchises in the country, who admitted to there not being any such plan that he knew of.

However, under advisement from one of the US-linked local contractors, he engaged in discussions with a services firm and his own management team in order to develop a framework which was shared with us verbally and which encompassed the most critical aspects of strategic crisis planning, including those found to be relevant in the US research project cited above. At time of drafting this article, a pre-proposal for an action framework was being prepared but no follow-up had yet been given to that initial effort, according to the CEO of the service provider involved.

Overall, the combination of the evident need for such strategic planning and best practices frameworks, the resources at hand and the fact that these countries are developing substantial domestic infrastructure investments, cry out for the proposed research and our preliminary investigations have thus far validated this thesis for both the local business community and the international business community operating in the Gulf and the wider MENA region as well as other emerging markets with greater susceptibility to high risk situations developing. Even if the case of the international financial institutional franchise with a neglected BCP was extreme in view of the fact that most franchises have at least some well-prepared evacuation plans for their expatriates (and often only that), there is clearly still the perception that crisis preparedness is a cost and an imposition at a time when all are competing to reap the profits of the current boom.

While one of the authors was present during a recent field assignment, there was a major disaster leading to loss of life in one of the major office tower complexes under construction. While many such incidents had been until then only the object of private reports, this time, the mainstream national press was encouraged to expose it by the authorities in an effort to put pressure on contractors to properly fund safety preparedness imperatives. That particular incident also demonstrated stated incompetence in the emergency services and the fact that this was also reported in media associated with the authorities may pre-figure a new willingness to achieve better governance of crisis preparedness systems.

While the whole context of our investigation and the many limiting factors do impose the utmost prudence, it does seem that it would be appropriate to pursue international, local, public and private partnership opportunities towards a research program which would increase the very meager body of knowledge relative to a region such as the Middle-East as concerns the challenges and imperatives for strategic institutional and corporate contingency planning for disaster preparedness, and business continuity and recovery, in all areas of potential risks, threats and vulnerabilities whether these been human (conflict, terrorism, technology failures) induced or natural.

We have reason to believe that an appropriate research group could have significant success in partnering with regional Gulf institutions as a first step, notably in the quasi-Government sector in order to conduct an operational strategic and applied research project which would adaptively analyze comprehensively the needs of these institutions in order to develop appropriate framework of actions for future strategic corporate planning needs in key areas such as crisis preparedness and response and business continuity and recovery.

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SEVEN MINUTES TO CHAOS: INTEGRATING THE ACTIONS OF GOVERNMENT AND INDUSTRY

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Keywords

Crisis Continuity Planning Hazard Vulnerability

Abstract

This presentation is designed to facilitate a greater understanding of the business continuity issues that private and public sector planners face today. Each entity (government and business) view risks, threats, hazards, vulnerabilities and their consequences differently. The expansion of terrorism worldwide has caused this perception gap to grow, not to shrink. Solutions and strategies will be discussed in an interactive format that provides insight for government and business leaders and responders at all levels, when interfacing with each other prior to, during and after an event. Are you prepared to address each other's concerns....?

✓Complex Threat Issues - chemical, biological, radiological
✓Threat Dynamics/Attack Dynamics
✓Health and Human Capital Issues
✓Integrating government and business continuity planning
✓Addressing complex planning issues
✓Coordination of Non-Aligned Entities

Introduction

Crisis! The mere mention of the word evokes visions of unspeakable affliction and suffering. The management teams of Government and Business, at all levels, are never put more strongly to the test than during a "crisis." The objectives are immediate and so are the results. Today, individuals responsible for the management of businesses and public agencies must learn to deal effectively with increasingly complex threats, risks, hazards, vulnerabilities and the consequences associated with them.

Do we really need coordination between Government and Business?

There are several reasons for establishing an integrated government/business crisis management team before a crisis event.

First: Government and business have a legal obligation to their stakeholders.

Second: in order to be effective, the crisis management team needs to participate in the necessary steps for developing an effective crisis management program.

Third, crises move faster than the debate. Having a plan in place is crucial for survival.

What is a Crisis?

What do we really know or truly understand about crisis? Several of my colleagues in the industry have identified various aspects of a crisis:

- ❑ Surprise
- ❑ Escalating Flow of Events
- ❑ Loss of Control
- ❑ Intense Scrutiny
- ❑ Human Factors
- ❑ Top Management Attitude
- ❑ Technology
- ❑ Public Perception
- ❑ Sudden Market Shift
- ❑ Product Failure
- ❑ Hostile Takeover

For the purposes of this paper, I offer the following definition: ***Crisis***, "*A disruptive event that is amplified, elevated and magnified*."

Phases of a Crisis

There are distinct phases that delineate the progression of a crisis.

Incipient Phase

The first phase or ***incipient phase*** is characterized by warning signs of pending doom or crisis waiting to happen. The warning signs are clear for the observant to see. Unsafe operating practices, failure to address known hazards, threats and risks, inadequate reporting mechanisms, are but a few of the indicators that government and business need to be aware of.

Unfolding Crisis

This is the phase where the damage actually begins. At this point, the organization becomes aware that there is an unfolding crisis.

During this phase, the organization has to eventually acknowledge that a crisis exists – this includes internal as well as public notification.

Speed at which a crisis travels

Three sub-elements within this phase contribute to the speed that the unfolding crisis develops. The first is "Time Critical," the second is "Time Sensitive," the third is "Time Dependent."

Transition to Recovery

This phase is characterized by a re-establishing of operations and information and a return to "operations as usual." During this phase, government and business need to coordinate attempts to recover and resynchronize operations.

Post-Crisis

The final and most desirable stage of a crisis is the ***post-crisis phase***. During this phase, the crisis has been rectified and the organization has fully returned to relatively normal operations.

Phases of Crisis Management

Phase I - Analysis

Before you can make a decision in a crisis situation, you have to reduce uncertainty. In order to reduce uncertainty, data must become useful information (*Intelligence*).

Phase II - Documentation

The next phase of crisis management is to develop the documentation that supports the "Analysis" phase. This generally consists of policy, plan and supporting documents.

Phase III - Training

The next phase of crisis management is training. A trained and educated workforce can do more to protect you than you can imagine. Training of personnel is a critical component of the "Integrated" approach to continuity planning and preparedness essential.

Phase IV - Maintenance

Maintenance programs assure that the crisis management program works when it is needed. Audits of all areas of preparedness need to be accomplished and this information shared between government and business.

Phase V - Execution

Coordination between government and business leaders can play a significant role in these key areas: management (decision-making), planning (strategic, tactical), operations (affected, non-affected), logistics (resources), finance (tracking/expediting), administration (compliance), external relations (stakeholders, etc.) and infrastructure (internal/external).

Ten actions to take now

Action # 1 Make Your Enterprise an Unattractive Target
Action # 2 Revise Employee Screening Processes
Action # 3 Validate Business, Community and Government Contacts
Action # 4 Assess Business Continuity Plans
Action # 5 Train and Educate Your Workforce
Action # 6 Equip Your Workforce
Action # 7 Review leases and contracts for risk exposure
Action # 8 Assess value-chain exposure to supply disruptions
Action # 9 Review insurance policies, conduct cost/benefit analysis
Action # 10 Communicate Commitment

Conclusion: Seize the Initiative - It Makes Sense

Every crisis carries two elements, danger and opportunity. No matter the difficulty of the circumstances, no matter how dangerous the situation… at the heart of each crisis is a tremendous opportunity.

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THE MITIGATION MODEL FOR MINIMIZATION OF IT OPERATIONAL RISKS

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Keywords

Mitigation Model, IT Operational Risk, Influence Diagram, Incident Prevention Guidemap

Abstract

Organizations and customers lose if business activities are discontinued by an incident of information systems under the current business environment because they pursue real time enterprise and on demand enterprise. The loss includes the intangible decline in brand image, customer separation, and the tangible loss such as decrease in business profits. Thus, it is necessary to have preparedness in advance and mitigation for minimization of a loss due to the business discontinuity and IT operational risks.

Introduction

Business operations are deeply dependent on Information Technology infrastructure regardless of scale and activities of private sectors as well as public sectors. The advanced technology for performance and improvement of IT tends to be continuously applied to the business operations in organizations.

Although the new technology provides some improved results to the business, problems are exposed in response capabilities of IT operational risks which accumulate through operational experience in long term. Therefore, a strategy concerning IT operational risks has been currently focusing on the emergency response after a crisis occurred. As a result, most organizations have operated disaster recovery systems. However, papers show that a mitigation activity is the best alternative to other methods.

In order to solve the problem, this paper suggests a mitigation model that is able to prevent IT operational risks. The model will be represented by a network model which is composed of the three items as following:

1. Causes, attributes, indicators of an operational risk.
2. A periodic time through an analysis of historical data.
3. An index or a regulation related to the examination of causes of an operational risk.

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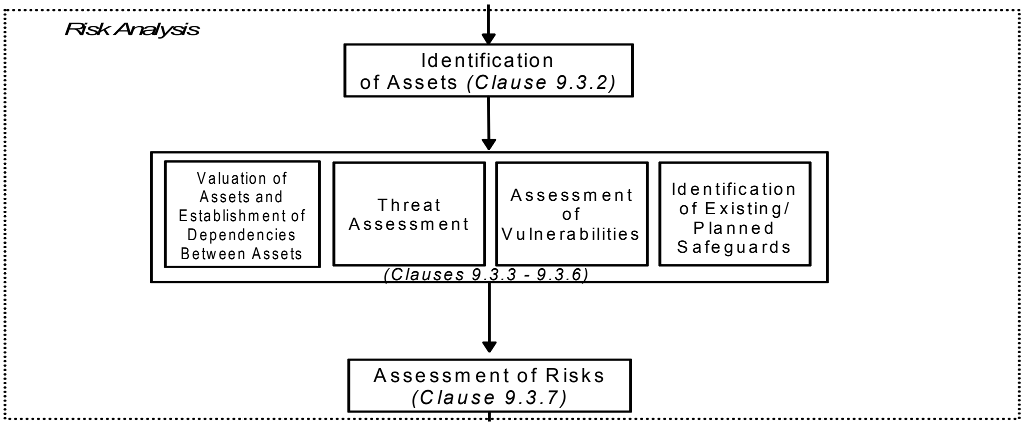
Literature Review

The mitigation model is designed on the basis of IT risks assessment. The process of risk analysis and evaluation refers to ISO/IEC TR 13335-3, Guidelines for the Management of IT Security (GMITS): Part 3 - Techniques for the Management of IT Security [1] as showed in [Fig. 1].



[Fig. 1] Process of Risk Analysis and Evaluation in GMITS

- Identification of Assets: the following assets to be protected are selected and listed below
  - information/data (e.g. files containing payment details, product information)
  - hardware (e.g. computer, printer)
  - software, including applications (e.g. text processing programs, programs developed for special purposes)
  - communications equipment (e.g. telephones, copper cable, fibre),
  - firmware (e.g. floppy discs, CD Read Only Memories)
  - documents (e.g. contracts)
  - funds (e.g. in Automatic Teller Machines)
  - manufactured goods
  - services (e.g. information services, computing resources)
  - confidence and trust in services (e.g. payment services)
  - environmental equipment
  - personnel
  - mage of the organization
- Valuation of Assets and Establish of Dependencies Between Assets
- Threat Assessment: factors such as errors, omissions, fraud, theft, employee sabotage, loss of physical and infrastructure support, malicious hacking, malicious code, and industrial espionage are identified. And the following items are measured in terms of the factors.
  - the threat frequency (how often it might occur, according to experience, statistics, etc.), if statistics etc. can be applied,

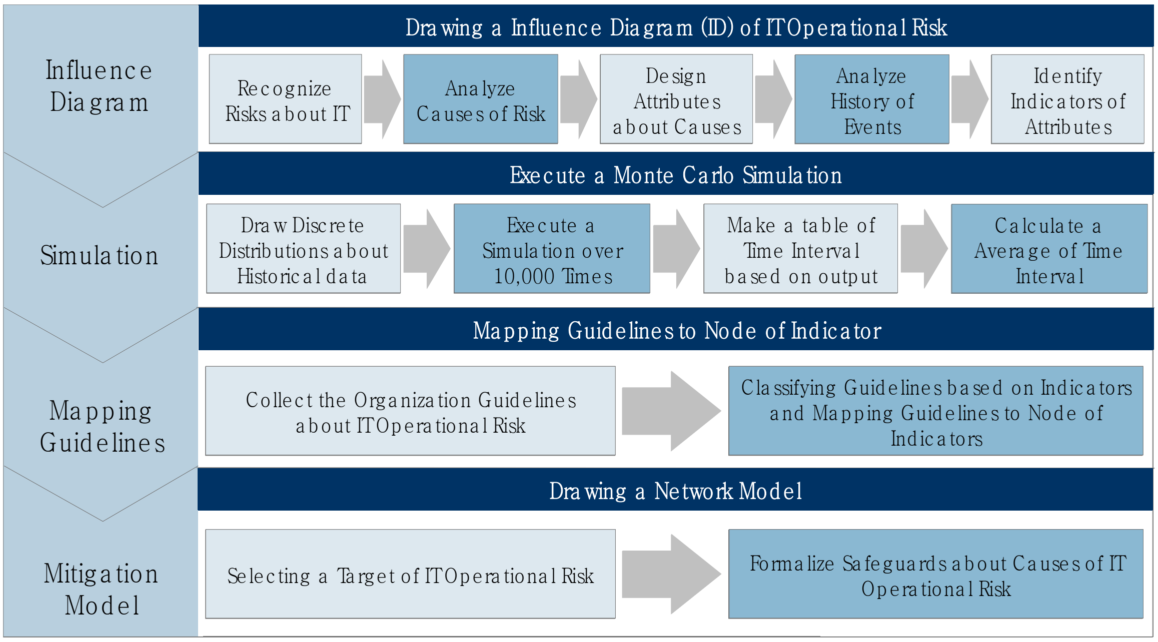
- the motivation, the perceived and necessary capabilities, resources available to possible attackers, and the perception of attractiveness and vulnerability of the IT system assets for the possible attacker to deliberate threat sources
- geographical factors such as proximity to chemical or petroleum factories, in areas where extreme weather conditions are possible, and factors that influence human errors and equipment malfunction that create accidental threat sources

- Assessment of Vulnerabilities: the weak points that exist in the physical environment, the organization, the procedures, the personnel, the management, the administration, the hardware, the software, and the communications equipment are identified and evaluated. The following are examples:
  - unprotected connections (for example: to the Internet)
  - untrained users
  - wrong selection and use of passwords
  - no proper access control (logical and/or physical)
  - no back-up copies of information or software
  - location in an area susceptible to flooding
- Identification of Existing/Planned Safeguard
- Assessment of Risks: the result of this step should be a list of measured risks for the impact of disclosure, modification, non-availability, and destruction for each of the assets of the considered IT system.

The Mitigation Model

The mitigation model is developed using 4 steps as shown in [Fig. 2]. In step 1, the causes of IT operational risks are first identified. Also, the indicators which are significant among the causes are found through analyzing the historical events of organizations. Step 2 produces a time interval which indicates the time to monitor the purpose of risk prevention using a simulation technique. Step 3 explains how the organizational guidelines and regulations map the causes and indicators. Finally, step 4 formalizes the causes, the time interval, and the guidelines through a network model. The model is called the mitigation model of IT operational risks.

This model development can be derived from the process of risk analysis and evaluation of GMTIS. However, a special feature of the model focuses on hazards related to business operations rather than ones related to assets in risk analysis. The model is necessary for business continuity.



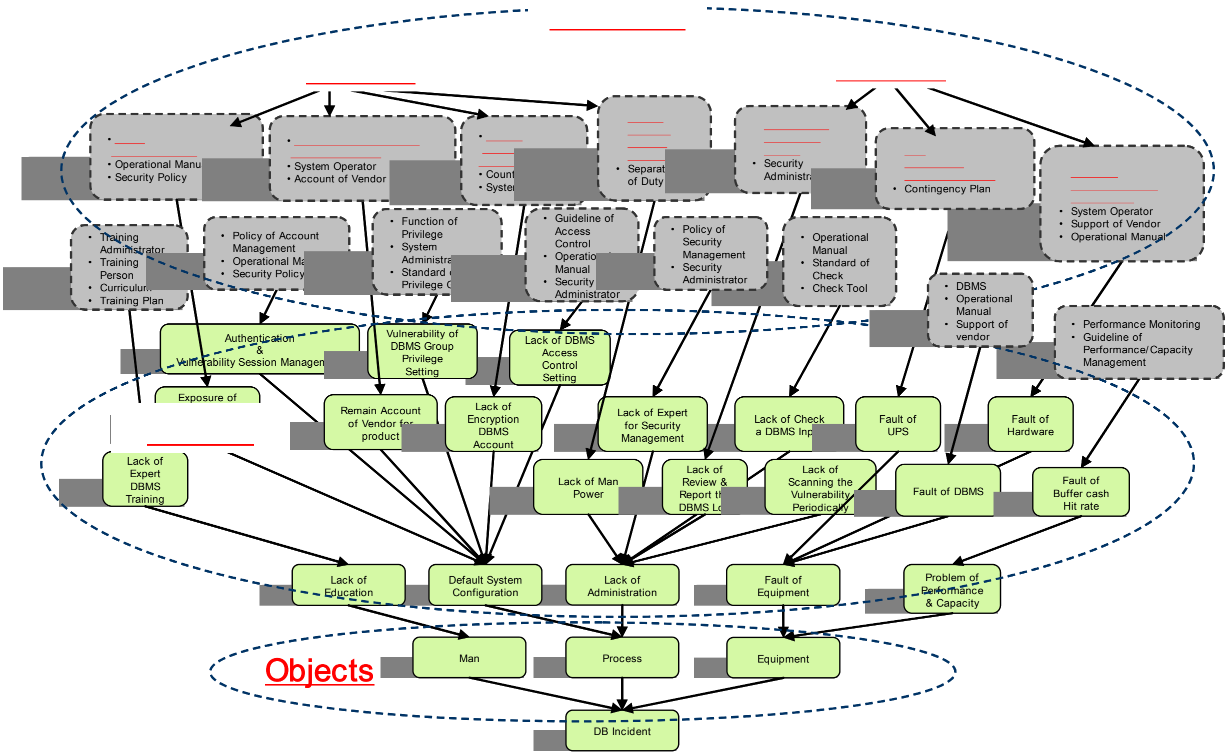
[Fig. 2] The Process of Mitigation Model Development

1. Hierarchical Structure of Incident Analysis

IT operational risks are caused by interruption of business operations. Objects, causes, and attributes of a risk are sequentially identified. Relations among those elements are represented by an influence diagram [2]. [Fig. 3] shows a diagram which displays the objects, the causes, and the attributes with regard to a database incident.

First, objects related to an incident are identified and represented by a tree structure. Second, the objects are classified into many causes and sub-causes in order. Third, the final sub-causes include a few attributes. Finally, one or two indicators which are significant among the attributes are selected by analyzing the organizational historical data of a risk.

This diagram which displays relations among attributes, causes, and objects provides some information to mitigate a risk. For instance, this diagram shows what the operation manager monitor prioritizes to prevent a risk.



[Fig. 3] An Example to Show a Relation of Objects, Causes, and Attributes about a Database Incident

2. Incident Prevention Guide map

Incident prevention guide map (mitigation model) is represented by a network model [3] shown in [Fig. 4]. This guide map includes a time interval and guideline as well as causes about an incident.

First of all, the time interval is a periodic time to check paths (where the model is composed of each path) in order to prevent an incident. The time interval calculates based on the historical records of a specific risk in the organization. If there is not enough data, the Monte Carlo simulation [4] (with discrete distribution made by some records) can be used to produce the time interval.

Secondly, the organization develops policy, regulations, index, and guidelines to inspect some incidents which will occur in the future. However, the problem is when and how those indexes will be used appropriately. The guide map solves the problem.

Finally, the influence diagram shows a hierarchy structure which illustrates indicators, attributes, causes, and objects about an incident. By analyzing the diagram, safeguards (to mitigate according to the causes) are designed. A cause formalizes a path which gathers the safeguard, the guideline and the periodic time together. Thus, an operation manager checks this path to prevent an incident. If an incident occurs, the path will be investigated. Also, the data will be stored according to the diagram's hierarchy structure.

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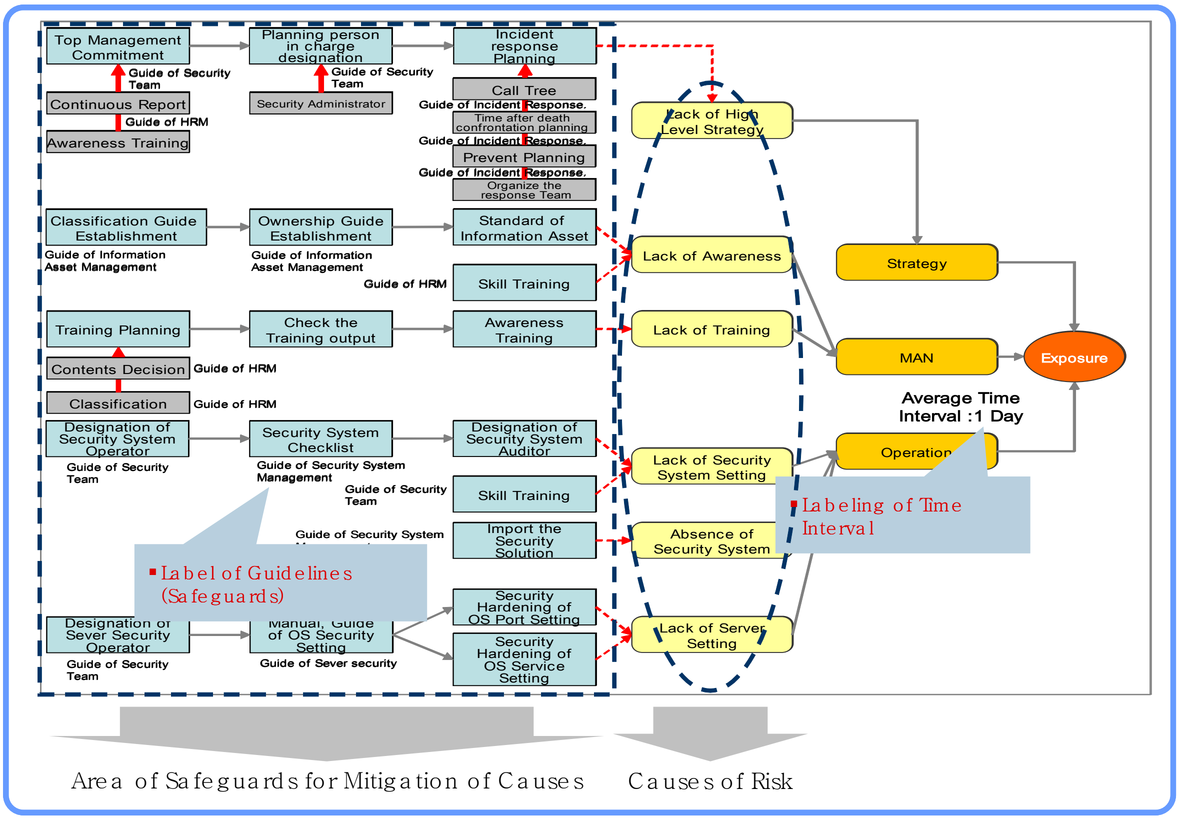

[Fig. 4] An Example of Incident Prevention Guide map

Results – Expecting Effect

The following are expected effects if the model is developed:

1. Minimization of loss through an inspection in advance.

The incident prevention guide map should be contributed to mitigate an incident of IT operation by showing a procedure of examination periodically. That is, the manager figures out which attributes and safeguards should be checked upon on a time based on a cause related to an incident.

2. Record accident data in specific detail.

Most organizations tend to be negligent to record any accident data. There would be no effectiveness in accumulation because accident data in IT operations may be poor. If an operational risk occurs, objects, causes, attributes, and other aspects will be documented according to the structure of the influence diagram and the incident prevention guide map. The records will be used to calculate a periodic time and to produce a living incident prevention guide map.

The paper leads to conclude that organizations can mitigate IT operational risks if a hierarchy structure of risk analysis and an incident prevention guide map will develop according to a category such as IT security, Server, Network, and Application etc.

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Academic & Professional Practice

Peer Reviewed Articles

DECISION SUPPORT TOOLS

USAGE OF PROFESSIONAL ICT TOOLS IN OPERATIONAL RISK MANAGEMENT

PROVEN SUPPORTING SOLUTIONS

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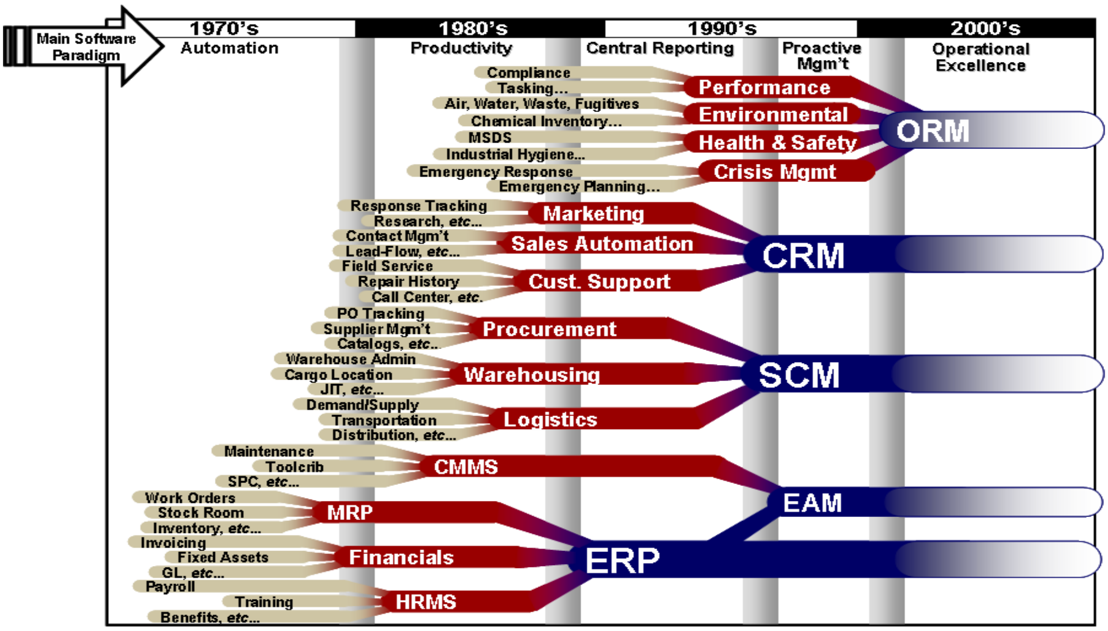
Keywords
Communication, Information, Coordination

Abstract
Operational Risk Management (ORM) is a key issue in business and society continuity. A lot of information and communication technology tools are used in the ORM environment. All these tools are helping the emergency managers, but did we standardize, did we do quality checks, did we test performances, did we prove everything in disaster circumstances? A view.

Introduction
The use of information and communication technology in the emergency management environment looks still after so many years in a start up phase. The main difficulty for the introduction of ICT as supporting tool in emergency management is the uncertainty of de politic and governmental leaders. They do not know what the best organization model is for their 100% prepared and response emergency management. Emergency management is not adolescent and that is why ICT is not introduced as process supporting tool, because the processes are not ready. The only ICT which is used are small tools to manage or to automate some minor issues. The most used software in emergency management are the Microsoft explorer, outlook and office tools. These Microsoft products are a part of the crisis management suite. An emergency manager needs more, he needs tools to get a common operational picture to support him to make decisions in objectives, strategy and tactics.

ICT history
Information and communication technology has changed over the last decades.

Crisis management has changed to not only responding but also prevention and preparation. The complete management to secure for the four risk factors: Nature, Technique, Procedures and people is named Operational Risk Management (ORM). With ORM we try to get optimization of society and business continuity. ORM handles event-, incident- and emergency management. Placing emergency management as a part of the complete ORM, the strategy should be to make a combined tool from all the small supporting tools. After ERP, SCM, CRM it is now time for ORM. See the graphic below:

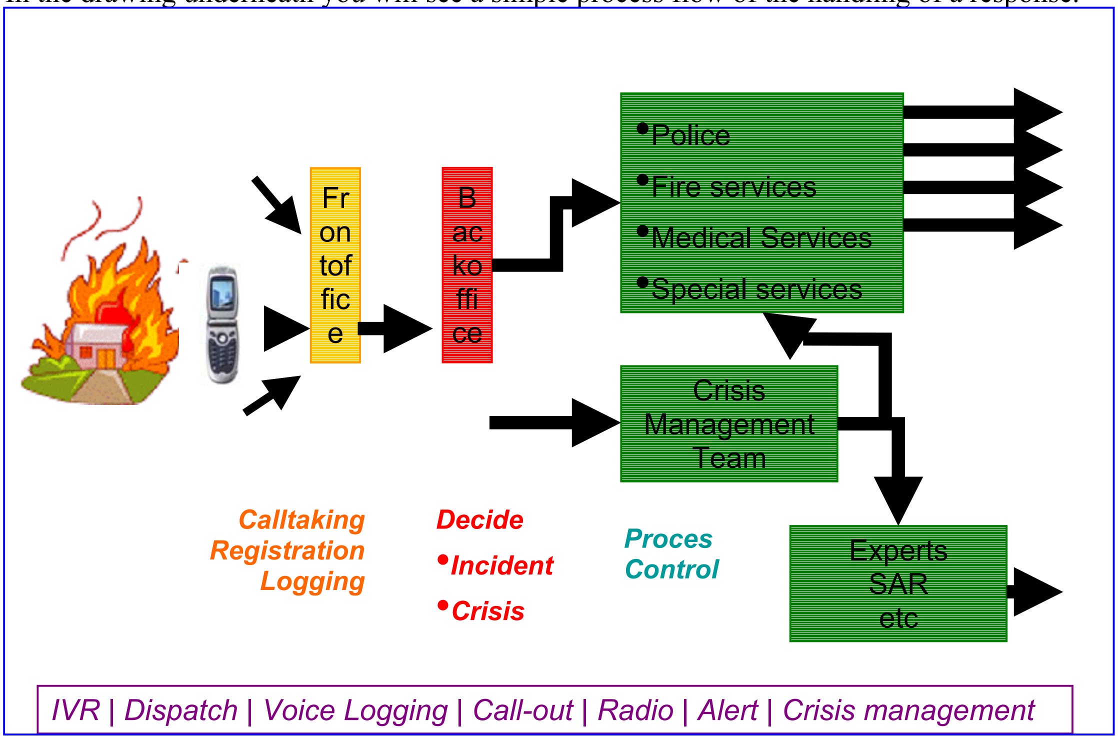


ICT evolution in the past 30 years

Emergency management and ICT

From the moment someone calls the Alarm centre lot of ICT will be used. At that moment the need is created to optimize communication, information and coordination. Everything ought to perform at a higher level. Daily used working habits has to stress to 100% concentration. The fault tolerance must be zero. Decisions has to be made to equip people in their response and recovery. This all is unthinkable without using sophisticated information and communication technology.

In the drawing underneath you will see a simple process flow of the handling of a response.



Incident workflow in a dispatch centre

Communication

To start up crisis response the most important part is communication. Call handling, voice logging, mobilization, notification and radio contact are very sensitive issues.

- Call Intake. In case of a small incident the dispatch centre receives normally one call and will decide the way of response. In case of a big incident the centralists at the dispatch centre will be occupied by handling phone calls and the chance of mistakes will increase. In the first "golden" 15 minutes the possibility of making mistakes are on the highest level. Making a mistake in this first part can give a domino effect on the whole response. ICT can be used for call-handling.
    - Interactive Voice Response system can give the centralist an overview at the intension of callers and probably also where they call from. (If there is a geographic layer in the IVR system.) The centralist will get the ability to get his calls parallel then serial, which will give him a better picture of what is going on.
    - Voice Logging. Constant logging all voice communication is not only crucial for registration and archiving, but also to have a small look back in the decision process. Voice logging systems are more and more advanced.
    - Radio it.
- Call-out systems: Activate communication plan, alert staff, mobilize forces, warn risk objects, notify media, start sirens, manage cell broadcast and many other alerting tools have to be initiated at a proper way as described in a standard operational procedure (SOP). This all is not possible anymore with manual call trees. Call-out systems like Communicator are common and used in nearly every dispatch centre.
- Radio communication. The operational rescue people need to have contact with the control centre and with each other. New techniques have brought us Tetra and Tetrapol which can work over more than one frequency. Some countries have implemented these systems and the progress is remarkable. In many countries the different agencies are working on different frequency and they can not work with one radio kit, this is not helping multi agency operations.

In the response phase during a crisis the service and support of all connections and networks are crucial for keeping communication in optima forma. All kinds of communication should be possible phone, radio, paging, fax, e-mail, chat, radio, internet, data.

Information

Strategic information delivery is the most used sentence in crisis management. Taking care of the 3 R's: Right place, Right time, Right information. The reason of the 3R's is the struggle to receive "a common operational picture". Knowing that information should be and is available, but getting this from the right sources to the right person is the main responsibility for every IT specialist. Organised Information Providing is one of the most difficult parts of emergency management. In the evaluation after a big crisis the most described sentence is: "… should have known …" The questions are: 1. What information do I need to do my job 100% and 2. What information can I provide to let other do their job 100%.

Crisis management software is software that takes care of information processes. It is the process that picks up and delivers information to bring the aid service in the position to make a good and adequate decision. It is software full of processes and sub processes. Getting the right maps and pictures to receive an overall view. Getting information from other agencies how far they are. Getting information about the intension of the disaster. Getting information about availability of resources. Getting a view of the risk objects.

In the past the information technology to support emergency management was focused on the in- and output. The new generation is of Operational Risk Management software is focused on daily use and processing.

- ORM software. This software handles all not daily events and incidents. It helps you to optimize the continuity of your society and business. It is the shell above a lot of specific information packages, which are not often used. Most used software in the world is the Essential Suite. This software is build on/with Microsoft platforms as MS Sharepoint, MS Groove, MS Virtual Earth, MS Bizztalk. This software is also configured around ICS (Incident Command System) and uses multi-agent systems.
- Calculation software. The intensity of an explosion or a leak has to be calculated. Universities and companies have made a great spectrum of many calculation tools: Hazardous material sheets, Gas dispersion models, Intelligence software and Calculation of explosions, oil spill and radiation.
- Crisis communication software. To beware of getting a crisis in a crisis the communication and information exchange to the media has to be done on careful and disciplined way. The CNN-ization of the society can make a small incident to a disaster. Special pressbureau software and Call –out systems are often used.

Coordination

Organizing strategic and tactical synergy in emergency management is one of the most non discussed issues. Coordination starts before communication and information and in many countries good ICT to support emergency management stand stills because of the organizational coordination issue. A lot of money is flowing to consultants which have to advice to questions as: "Who is responsible for what?". The technical issues are the most easiest. The functionality and responsibility issues are constantly under politic and jurisdiction discussion. In many countries it starts at the strategic level with the politic and law responsibly of the mayor, the governor and the departments. At the tactical level the questions are more about command and control: "Who is in charge?". Describing a security matrix will give a view at strategic and tactical synergy through all organizations will help to find the rules in coordination.

Author Biography

Jan Otten (1956) is a Dutch pioneer in ICT to support emergency management. He is founder and director of Respond BV. He studied mathematics, chemistry, physics, theology and informatics. Since 1993 he specialized in crisis management. Jan is travelling around the world to advice and support decision makers in their aim to coop with crises.
Jan is a speaker with an enormous drive. He is a qualified NATO speaker.

SEVESEO
INDUSTRIAL DISASTER MANAGEMENT FROM SPACE

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Keywords

Remote Sensing, Pollutant Dispersion Modelling, Industrial Emergency Management

Abstract

The ESA-funded SEVESEO project aims at developing a decision-making tool that integrates environmental parameters derived from satellite imagery with pollutant transport models in order to support the risk management at Seveso-II industries. The development of the SEVESEO Information System (IS) implies the integration of contaminant transport models that aim at determining the environmental impact of a Seveso type accident, by modeling transport of pollutants around the site. A complete assessment of a simulation of an accident involving hazardous chemicals or an actual emergency response to an accident requires a system that rapidly and accurately models the source term and the subsequent transport of the chemical of concern trough different media. This information enables operators to define risk zones and perimeters. By integrating this information with local geographic information a valuable GIS tool will be provided. This GIS tool will be able to support decision making during technological accidents and to access the impact of the accident on the local environment.

Introduction

In 1976, an important industrial accident happened at a chemical plant in Seveso, Italy, manufacturing pesticides and herbicides. A dense vapor cloud containing tetrachlorodibenzo-paradioxin (TCDD) was released from a reactor. Commonly known as dioxin, this was a poisonous and carcinogenic by-product of an uncontrolled exothermic reaction. Although no immediate fatalities were reported, large quantities of the substance, lethal to man even in micrograms doses, were dispersed in the environment which resulted in an immediate contamination of some ten square miles of land and vegetation. More than 600 people had to be evacuated from their homes and as many as 2.000 were treated for dioxin poisoning. More recently, disastrous industrial accidents took place in Toulouse, Baia Mare and Enschede with many deadly casualties involved.

In Europe, the Seveso accident lead to the adoption of legislation aimed at the prevention and control of such accidents. In 1982, the first EU Directive 82/501/EEC – so-called Seveso Directive – was adopted. On 9 December 1996, the Seveso Directive was replaced by Council

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Directive 96/82/EC, so-called Seveso-II Directive. This directive was extended by the Directive 2003/105/EC. The aim of the Seveso-II Directive is two-fold. Firstly, the Directive aims at the prevention of major-accident hazards involving dangerous substances. Secondly, as accidents do continue to occur, the Directive aims at the limitation of the consequences of such accidents not only for man (safety and health aspects) but also for the environment (environmental aspect). All operators of establishments coming under the scope of the Directive need to send a notification to the competent authority and to establish a Major-Accident Prevention Policy. In addition, operators of upper tier establishments (i.e. having quantities of dangerous substances above the upper threshold contained in the Directive) need to establish a Safety Report, a Safety Management System and an Emergency Plan. Internal Emergency Plans for response measures to be taken inside establishments have to be supplied to the local authorities to enable them to draw up External Emergency Plans. Emergency Plans have to be reviewed, revised and updated, where necessary. Important new elements require operators to consult with their personnel on Internal Emergency Plans and on the local authorities to consult with the public on External Emergency Plans. The Seveso II Directive contains an obligation to regularly test in practice the Internal and External Emergency Plans.

Although it would be unrealistic to expect that men can fully control the industrial and technological risks with which they or their companies are faced, an appropriate management of the risk can be a decisive factor in leaving the least possible room to hazard. Public authorities and private industrial executives, faced with an industrial or a technological risk, are required to have a firm control of all the parameters involved. In that perspective, decision-making instruments are essential tools to help all stakeholders concerned by an industrial accident with the means to make the right decisions likely to anticipate catastrophic events and to plan the best actions to mitigate their impact. The prevention actions must be organized for short and long term risk since an appropriate prevention policy should assess the primary but also the secondary effects of an industrial exploitation / incident involving hazardous products. Past events have shown that environmental or health complications can persist far beyond the date of a technological accident or of the industrial exploitation. The management of these secondary effects generally mobilizes considerable resources.

Hence the need for decision-making tools for the analysis of these short and long term risks that can affect the local population, their property and the surrounding environment. These analysis are to be assessed before, during and after the accident. It is essential to be aware of the environment in which the highest risks are to be expected. Such awareness is derived from the type of SEVESO product concerned, and from an assessment of specialized industries producing those materials, processing them, handling them and transporting them. The different types of incidents and scenarios that might occur should also be taken into account.

In the SEVESEO project, a user tailored information system will be developed that allows an easy manipulation of pre-calculated dispersion scenario's. This includes the search, modification and extraction of the needed information as well as the manipulation of dispersion models that are connected to the SEVESEO IS. Different environmental compartments are considered, including air, soil, surface waters. A specificity of the system is the integrated use of satellite remote sensing for site specification during the preventive phase as well for visual aid during the response phase.

In this paper, the proejct will be briefly described and some considerations about remote sensing, dispersion modelling and information technology will be given.

Theory and Method

Within the SEVESEO project funded by ESA, focus will be on the development of a decision-making tool that integrates environmental parameters, pollutant dispersion modelling and safety strategies in the context of the industrial exploitation of SEVESO II companies and in the occurrence of technological accidents. The SEVESEO decision-making tool - also called SEVESEO information system (SEVESEO IS) shall base the observations and interpretations of the environmental parameters principally on satellite imageries.

The SEVESEO consortium consists of 6 partners from 4 different European countries:

1. Agence Prévention & Sécurité (APS), Belgium
2. Department "Industrial & External Safety", TNO, Netherlands
3. Departement "Direction des Risques Accidentels", INERIS, France
4. PRO DV, Germany
5. Créaction, Belgium

The project also includes five public organizations that participate to the SEVESEO project as end-users. These core user organizations represent 5 countries of the European Union: Belgium, the Netherlands, France, Luxembourg and Germany:

1. Belgium: Centre de Crise du Gouvernement Belge
2. Netherlands: Province of Zeeland
3. France: Chambre de commerce et d'Industrie des Ardennes
4. Luxembourg: Direction de la Protection Civile
5. Germany: Euro Info Centre, Trier

The main role of the user organizations consists of:

- Communication of the minimal requirements regarding the specifications of the SEVESEO IS with respect to the role of the organization in the regulatory framework of the SEVESEO Directive and the national and regional safety legislations;
- Access to input data that is available at the user organization for the execution of the service cases;
- Support to the consortium in the quality assessment of the SEVESEO IS and output products;
- Promoting the results of the projects in their community and in particular within the local organizations that fall under their responsibility.

A particular point of the SEVESEO project is the integrated use of remotely sensed information, modelling tools and advanced IT technology.

- Remotely sensing information has the possibility to offer a global view of the site environment and depending on the platform used (airborne, satellite or UAV), remote sensing can provide frequently updated information. Remote sensing can be used to obtain visual information, surface characteristics (land cover/use, state and abundance of vegetation, topography) as well as atmospheric composition. The phase of a disaster in which the use of remote sensing proves to be the most interesting depends on the platform:

- Airborne (airplane or helicopter) remote sensing can result in very high resolution imagery because of the low altitude compared to satellite imagery and depending on the autonomy also high temporal information for a certain time period (few hours) can be delivered.

- Satellite-based imagery has other advantages. The ground resolution is less compared to airborne sensors but on the other hand, once the sensor is operational in space, it allows to have long term regularly updated information. Minor points are the unavailability of visual information during cloudy conditions. It remains a challenge to further upgraded sensors with increased horizontal and temporal resolution.

- UAV (Unmanned Airborne Vehicle) technology is under development (see for example, **http://www.pegasus4europe.com**) but has the potential to combine the strong points of both airborne and satellite remote sensing). UAV's can fly at low altitude and in case of long endurance versions, continuous monitoring can be performed.

- Numerically modelling the fate of pollutants in the environment has evolved rapidly parallel with computer technology. Nowadays powerful modelling tools exists and are further being developed. With respect to industrial disasters there exist models for:

  - Modelling of the source term, i.e. the calculation of the amount and the characteristics of the accidentally released material from a container, tank, pipeline, etc. There are many possible release ways: explosion, continuous outflow, gas release, BLEVE (boiling liquid expanding vapor explosion), ...

  - Modelling of the dispersion of gaseous, liquid or solid toxic pollutant in the various compartments of the environment (atmosphere, soil, ground and surface water, biosphere, humans and animals). Depending on the required accuracy and the availability of input data, different models can be used. The range of models starts with simple analytical rapid models and goes until complex 3-dimensional grid models that require a lot of input data and are highly computationally expensive.

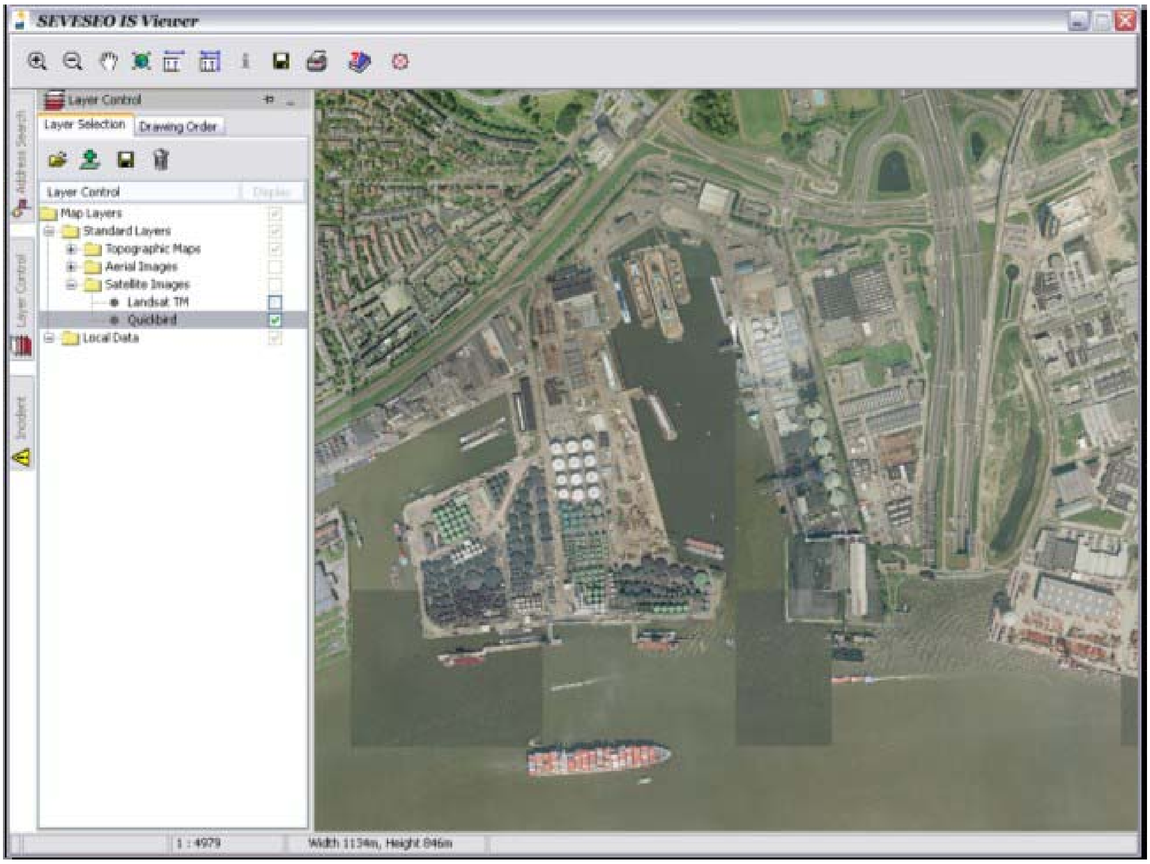
  - Modelling of the impact on ecosystems and human beings individually and on larger groups of the population. .

- Information technology evolves rapidly. Since the existence of personal computers, anybody has access to computing power. The development of the internet further increases the use of computers and has accelerated the use of central databases and the rapid exchange of digital information all over the globe. Current IT technology provides innovative ways of delivering modelled and remotely sensed information to the field actors actively in disaster management. A point of attention is the operability of the service in case of internet shutdown.

Conclusion

The development of the SEVESEO Information System is on its way (Figure 1). Its development is based on many user interactions. The testing of the SEVESEO IS will be done on real cases situated in Belgium, Luxemburg, France and the Netherlands and the results will be confronted with the users in order to further refine the system. The use of remote sensing will in a first step be limited to the use of visual Quickbird satellite images for site viewing and classified SPOT images for land use/cover determination. The latter will also be used for the determination of the surface roughness parameter of any site. This parameter plays an important role in the atmospheric modelling of pollutants around the accident. For the atmospheric modelling, the TNO EFFECTS model will be linked by means of web service technology.

Figure 1: Screenshot of the SEVESEO IS for a test area in Holland (harbor of Rotterdam).



Acknowledgements

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Author Biography

Dr. Filip Lefebre graduated as a physicist from the University of Ghent (1996). During his studies he has been abroad in France for 1 year at the University of Toulouse where he specialized in Atmospheric Sciences. From 1997 until 2001, he has been doing a PhD at the University catholique de Louvain-la-Neuve in atmospheric modelling on the determination of the Greenland surface mass balance. Since 2001, he is working at VITO, first as a researcher and presently as a project manager within the department “Integrated Environmental Studies”. He has been working on the modelling of atmospheric air pollution at the local, urban and regional scale. He has been project leader for a number of national and international projects and is co-responsible for the research group “modelling of atmospheric processes” that has more than 30 years of experience in the modelling of air pollution. Since 2006, he is working on industrial disaster information systems in collaboration with the remote sensing department of VITO.

INFORMATION-ANALYTICAL RESOURCES INTEGRATION IN ENVIRONMENTAL EMERGENCY MANAGEMENT

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Keywords

Decision support systems, environmental, intelligence technologies, resources integration**,** GRID-technology

Abstract

One of the important part of effective emergency management is intelligence decision support systems (DSS). One of such approach is the method of information and analytical resources integration in distributed computing systems. The problems of the dataware of efficiency increasing in the applied studies of safety sciences for information support of decision making systems development have caused need in intelligence methods of decision support.
One of the problems is an information resources increasing. For efficiency of information-analytical resources is necessary usage of all possibilities new information technologies. First of all it is using the modern IT direction of the distributed resources - GRID-technology, intended for ensuring in on-line operation with distributed database and computing resources.

In the paper is considered heterogeneous dynamic distributed information analytical architecture, tracing main trends and principles of the information space update with provision for information flow dynamic.

The results of the studies have found using in investigations on the fundamental studies program of the Russian Academy of Sciences (Electronic Earth: scientific information resources and information-communication technologies) and in studies on Russian Federation program "World ocean".

The important direction of information support efficiency increasing is an intellectual analysis technology use "Data Mining". Possibility of this technology usage intellectual analysis given is researched in the report on example of meteorological information.
Input information are meteorological data, presenting from different regions of the planet/country, in which is kept the summery about type of the phenomena (the wind, storm, etc.), place, where this phenomena existed and organizations, given this information.

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Introduction

The emergency management essential element is fundamental support of decision making at moment or in process of the emergency situations prevention. For this it is necessary integration of all necessary information and analytical resources and use of modern information technology :Web, GIS and Greed technologies.

The important part of effective emergency management is intelligence decision support systems (DSS) (Britkov and Gelovani, 2004). One of such approach is the method of information and analytical resources integration in distributed computing systems. The problems of the dataware of efficiency increasing in the applied studies of safety sciences for information support of decision making systems development have caused need in intelligence methods of decision support.

One of the problems is an information resources increasing (Britkov, 2003).. For efficiency of information-analytical resources is necessary usage of all possibilities new information technologies. First of all it is using the modern IT direction of the distributed resources - GRID-technology, intended for ensuring in on-line operation with distributed database and computing resources.

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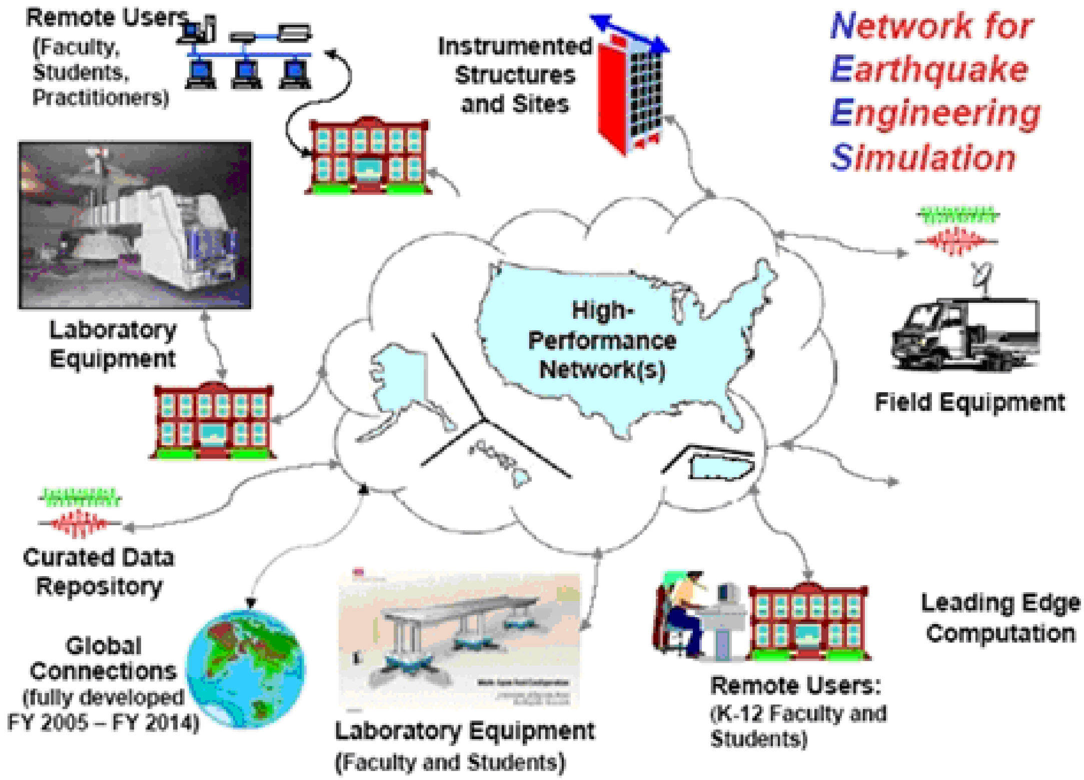
Grid Concept in Earthquake Engineering Simulation

The Grid Concept presents the approach on the construction of distributed computing environment and the Grid software toolkit (IARnet) being developed on basis of this approach. The goal of IARnet is to provide Grid users and developers with standard and easy-to-use distributed application development tools, supporting dynamic discovery, remote access and coordination of heterogeneous resources in global networks, connected with Earthquake Engineering Simulation, as an example (Figure1).

Another example of the Grid Concept is the Web-portal of Unified system of information for state in World Ocean (ESIMO, http://www.oceaninfo.ru/) include the enormous amount of information resources, metadata, scientifically - technical, normatively - methodological, legal, socioeconomic, technical documentations. Operation to maintenance ESIMO web portal, with the help of which can be obtained data on marine environment for the acceptance of best decisions making is new stage in the matter of the information servicing of marine activity. In development portal are utilized modern approaches as to the initiation of data systems - dynamical information representation on portal, the use of data-bases and GIS techniques.

Figure 1. Network for Earthquake Engineering Simulation Grid Concept



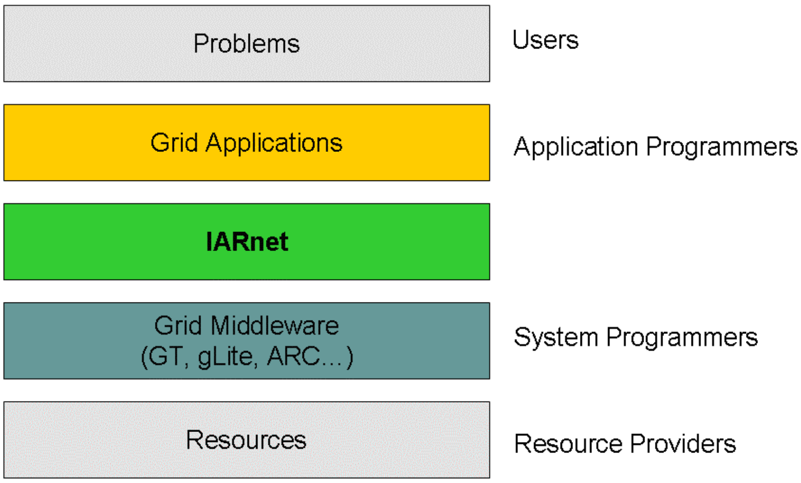
IARnet architecture

The today version IARnet toolbox presents itself set of the libraries, containing facility to resources integration in portioned ambience (the server part, Java and C++ languages) and development of portioned exhibits (client part, Java language), as well as realization several services of the general purpose (Velikhov, 2005).

In base of the architecture IARnet lies the notion information-analytical resource (IAR) as abstractions, allowing describe the general model of the use resource portioned computing ambience for decision of the broad class of the applied problems. If under primary resource to understand any resource, which supports the program access to its functional capacity and can be used for decision of the applied problems then under information-analytical resource shall understand the abstract resource with clearly described functional capacity and program interface of the remote access to this functional capacity, hiding for itself one or several primary resources.

The main principles of the IARnet approach are possible to see in Figure 2.

Figure 2. The main principles of the IARnet approach.



Virtual Data Concept

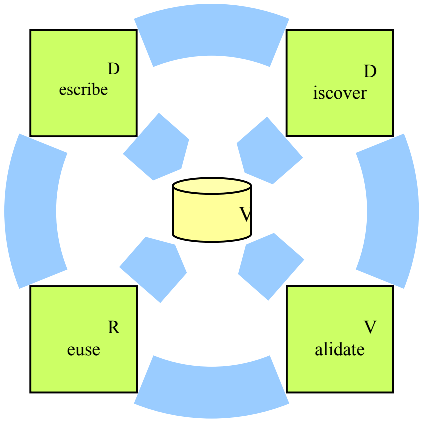
The virtual data concept is motivated by next generation data-intensive applications in which scientists distributed worldwide need to extract scientific information from large collections of data, and would like to share both data products and the resources needed to produce and store them. Virtual data mechanisms seek to enable the declarative specification of the recipes used to derive data, so that requests for data products can be mapped into computation and/or data access across multiple locations. The information recorded to support this reuse of computational results can also be used for other purposes, such as explaining provenance and managing workflows.

The virtual data system implements such virtual data mechanisms. Definition and query operations are expressed in a virtual data language (VDL), and information about data and computation procedures are stored in a virtual data catalog (VDC). We illustrate in Figure3 the lifecycle of virtual data within the virtual data system.

The lifecycle begins when a virtual data definition, described in VDL, is entered in the VDC. This definition can then be discovered by virtual data query operations, and the scientific analysis procedures associated with it can be executed and validated. New algorithms and procedures can be derived from the knowledge gathered, and another round of the lifecycle starts when the derived virtual data is published into the VDC or recorded by the virtual data system.

This approach has been applied to a variety of data-intensive applications, such as the information servicing for marine activity on basis of the web – technologies. However, while command-line interfaces may be appropriate for experts, end users need an interactive environment within which they can easily discover and share virtual data products, compose workflows, and monitor workflow executions across multiple grid sites. Ideally, they should also be able to integrate virtual data capabilities into their specific user communities and science applications, and obtain help with the nontrivial tasks of setting up and configuring the virtual data system and its associated grid compute and storage resources.

Figure 3. Lifecycle of Virtual Data



These considerations have led us to develop, apply, and evaluate, "Grid portal" designed to allow for convenient interaction with the virtual data system. The virtual data portal is an integrated environment that provides a single access point to virtual data and grid resources.
One of the very important problems for emergency management is to increase the capacity by building an enlarged set of risk-management decision support tools and procedures for standardized evaluation and mitigation of the consequences (Britkov, 2002).. The first point is emphasize:
1) the use of a Geographic Information System (GIS) to create a notional port city with air, rail and marine transportation facilities and demonstrate the notional relative proximity of critical infrastructure;
2) identification of hazard simulation and modeling tools to both superpose damage footprints across critical infrastructure and demonstrate potential consequences to the community;
3) demonstration and econometric model evaluation of alternative mitigation and causal chain intervention strategies that are proposed by various economies (Gelovani and Britkov, 2003).
To facilitate collaboration among a maximal number of economies, high bandwidth video teleconferencing with streaming video will be used to minimize transportation costs of participants and mutually demonstrate web-accessible mapping, simulation and modeling techniques currently used by various economies (Britkov, 2001).

The task is to assemble a web-accessible toolbox of hazard models and decision support simulations with using of GIS notional port communities with critical infrastructure and cross-linked hazards. It is very important to develop econometric models that can be used as decision-support tools in evaluating the relative merit of alternative strategies of mitigation, response and recovery from various types of terrorist attacks.

Next feature for this case study is collaboration over a high-bandwidth video-teleconference system. As an overall objective, analysis tools and procedures would be exportable and adaptable for mutual use by any individual economy in assessing their own economy's vulnerabilities, conducting their own terrorist attack consequence mitigation program and increasing the abilities of their own communities to survive and recover from terrorist attack. A list would also be compiled of sources for GIS hazard mapping products and video-telecommunication sites among the various economies, encouraging mutual assistance and continued collaboration (Britkov, 2002).

Intelligence Approach in Emergency Management

One of the main factor in emergency management is an operative taking the efficient decisions. Practically, the database execute the function to memories, access of the user to vault data provides only extraction of the small part from preliminary stored information in response to clearly assigned questions. But, when we have an enormous flow to information, we will get up the task greatly reasonable to use this information to extract hidden in data knowledge for the reason optimize control a process emergency management. This task can be not solved only power of the person on the strength of gigantic volume of given economic inefficacy of such decision. Besides, not always got analyst results are objective since people follow some considerations, a priori beliefs about under study subject that is reflected on objectivity got result (Britkov, 2003).

The methods “data mining” allow reducing the quip of the problem. Using promoted analytical methods in the field of mining the knowledge from source, "damp", data, many organizations enlarge profit, raise power, shorten the expenses and enlarge complacency a client. They already are actively used at analysis market, marketing, forecast of the stock quoting and other business-applications. But in the first place these methods today must interest the commercial enterprises, unfolding projects on base information vault given (Data Warehousing).

The correlations of the volume and speeds to memories and define possible use the artificial intelligence, systems KDD (Knowledge Discovery in Databases) - a systems of the extraction of the knowledge from database.

Using the systems KDD requires the known art of the director of the exploratory tasks since their decision finally must match with logic his intuitive analysis. The Key to successful using the methods KDD serves not simply choice one or several algorithms KDD, but skill of the analyst. Data Mining does not exclude need of the knowledge of specifics of the application domain and understanding themselves data or analytical methods.

Knowledge discovery in databases is an analytical process of the study of the person of the big volume to information with attraction of the facilities of the automatic study given for the reason finding hidden in structure data or dependencies. It is expected full or partial absence of the a priori beliefs about nature of the hidden structures and dependencies. KDD includes the preliminary comprehension and incomplete wording of the task (in term target variable), transformation given to available to automated analysis format and their preprocessing, finding facility automatic study given (data mining) hidden structures or dependencies, approbation of the discovered models on new, not used for building of the models data and interpreting the person of the discovered models.

Data mining - a study and finding "machine" (algorithm, facility of the artificial intelligence) in damp given hidden structures or dependencies, which earlier were not known, not trivial, practically useful, available to interpreting the person (Arseniev, 1997).

As a whole technology data mining it is enough exactly defines as a process of the finding in damp given earlier unknown, nontrivial, practically useful and available interpreting the knowledge required for decision making in different sphere of emergency management Any cognition presents itself modeling of emergency situations. The Model - artificially created system, in which is reflected resemblance of the structure and functions with system-original. Exist two types of the models: prediction and descriptive. The First use one set given with the known result for building of the models, which obviously predict the results for the other set data, but the second describe the dependencies in existing data. The revealed model will not be able to pretend on absolute knowledge, but will give the analyst certain advantage already fact of the finding itself to alternative statistical significant model.

The task of the models building it is possible to divide into two important sub ranges. First, this tasks to categorizations - a referring the new object to some class from their ensemble on base already available given about the other object of these classes. The other sub range form the tasks of the forecast of some unceasing numeric parameter.

One of the key issues of information modeling approach is system integration of all possible relevant tools and systems, including GDIN (The Global Disaster Information Network) is a public-private partnership with the primary objective of getting the *Right Information, to the Right People, On Time* in order to make the Right Decision, so as to help mitigate and effectively respond to the toll of natural and man-made disasters around the world.

Conclusion

The development of the modern information technology tools (Grid and Web approaches) of the analysis environmental information and use geographic information intellectual systems is bound with expansion of the spectrum of the taken into account problems in the first place, comprising of the first queue need forecasting of the development technical and software programs, which can be used for analysis environmental situations. For this necessary use the extended possibilities managerial system data, facilities of the analysis and presentations to information, cut-in in systems of the programs of the statistical analysis, categorization and recognitions, methods of the artificial intelligence for analysis and interpretation result processing. There is basis to expect that the most further development will come of one sides by spreading universal tools and Internet , but on the other hand use the knowledge-based tools for the processing and analysis of environmental data.

The basic accent in researches is done on creation of integration tools is information analytical resources. Integration is considered in following directions: a program-technological level which allows to obtain spatially distributed data; semantic integration with use of means of the artificial intellect, allowing in common to analyze and process the heterogeneous data received with use various methodologies.

To creation of system integration of heterogeneous processes of processing and the analysis of the information approaches have been developed for support of acceptance of operative decisions in extreme situations. One of stages is development of means of access to bases of metadata, to data on the information production represented on Web sites and portals, the integrated database - uniting various types of data (numerical, text, spatial, graphic, etc.).

Have been carried out researches on intellectualization of methods of support of decision-making as by one of the basic directions of increase of efficiency of application of modern information technologies. In particular approaches methods of integration of information and analytical resources in the distributed computing environment were used are.

Realization of technology of integration of information-analytical resources (in the form of the heterogeneous information space) has been carried out.

For an effective utilization of the distributed information resources use of various opportunities and first of all new a field of information technologies - the GRID-technologies intended for maintenance in a mode on-line of work with distributed databases and computing resources has been considered.

It is considered heterogeneous dynamic distributed it is information - the analytical environment tracing the basic directions and principles of updating of environment in view of dynamics of information streams.

The results of the studies have found using in investigations on the fundamental studies program of the Russian Academy of Sciences (Electronic Earth: scientific information resources and information-communication technologies) and in studies on Russian Federation program "World ocean".

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PSYCHOLOGICAL ASPECTS OF EMERGENCIES

EMERGENCY DISASTER PREPAREDNESS FOLLOWING THE KATRINA/RITA HURRICANE DISASTER: A SURVEY OF COMMUNITY MENTAL HEALTH FACILITIES IN FIVE SOUTHERN STATES OF THE U.S.A.

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Key Words

Disaster Response, Mental Health, Hurricane, Emergency Preparedness

Abstract

Hurricanes remain a threat to the health and safety of residents of the coastal areas of the United States. Community mental health agencies have a critical role to play in preparing for and responding to large-scale disasters like hurricanes Katrina and Rita of the 2005 storm season. The timely provision of mental health services to disaster victims has long been recognized as an important component of effective emergency management.

This paper will present the findings of a retrospective descriptive study designed to assess the status of emergency disaster preparedness and client service capacity at community mental health facilities prior to and following the Katrina/Rita disaster in the southern United States. This study was conducted one year after the Katrina/Rita hurricanes. Community mental health facilities in the states of Florida, Georgia, Mississippi and Texas were included in this study. The study revealed that there was no significant increase in the number of emergency exercises or drills by community mental health facilities during the year following the Katrina/Rita disaster. This conclusion is consistent with previously published studies by Compton, Mahoney et al., McHugh, et al, and Sweeney et al. These studies also found that no

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automatic increase in community preparedness exercises and drills occurs following a disaster event. The study also indicated that a greater number of community mental health facilities located in disaster declared areas reported exceeding the facilities capacity for referral services during the evacuation and relocation period than community mental health facilities in un-declared areas.

Introduction

This retrospective descriptive study assessed the status of emergency disaster preparedness and client service capacity at community mental health facilities prior to and following the Katrina/Rita disaster in the southern United States. In times of disaster community mental health resources can be challenged. (Elrod, 2006) (Siegal, 2004) There have been few previously published studies to assess the emergency preparedness and service capacity of community mental health facilities before, during and after disaster events. The research findings presented were self- reported by administrators of community mental health facilities located in five selected southern states. A 27-item questionnaire was created, piloted tested and distributed one year after the Katrina/Rita hurricane event to the 168 administrators at community mental health facilities in Louisiana, Mississippi, Texas, Georgia and Florida. The study questionnaire focused on two major themes: emergency preparedness of each community mental health facility before and after Katrina/Rita and the client service capacity of the mental health facility before, during and after the Katrina/Rita disaster event. Responses were received from 85 (51%) of 168 facilities initially requested to participate in this study.

Purpose

The purpose of this retrospective descriptive study was to assess the status of emergency disaster preparedness and client service capacity of community mental health facilities prior to and following the Katrina/Rita disaster in the United States. Responses were reported by facility administrators. This study was conducted one year after the Katrina/Rita disaster.

Theory and Method

Study Population/Sample

Following a review of the related literature, this retrospective study was implemented. A 27-item questionnaire was created, tested for reliability, piloted and distributed to the 168 administrators of community mental health facilities in five selected southern states in the United States. Responses were received from 85 (51%) of the 168 facility administrators asked to participate in this study. The participating facilities were located in the states of Louisiana, Mississippi, Texas, Georgia and Florida. (Balinsky, 2006)

Questionnaire Design/Content

Prior to distribution of the questionnaire to study respondents the following procedures were conducted: 1) submitted questions were reviewed for content accuracy by a four person expert panel 2) the revised questionnaire was pilot tested with 30 mental health professionals in the southern states of North Carolina, Kentucky and Tennessee and 3) and a test-retest procedure was completed with a different group of 35 mental health professionals located in the southern states of South Carolina and Tennessee.

Researchers designed the questionnaire to focus on two major themes: emergency preparedness of each community mental health facility before and after Katrina/Rita and the client service capacity of the mental health facility before, during and after the Katrina/Rita disaster event. Questions under the emergency preparedness section included whether each facility 1) reported an emergency plan before Katrina/Rita 2) conducted an emergency exercise or drill before or after Katrina/Rita 3) modified an existing emergency plan follow Katrina/Rita and 4) conducted debriefing services for emergency responders to mitigate post traumatic stress disorder. The questions relating to client mental health service capacity before, during and after Katrina included: 1) adequacy of counselors and 2) the ability of facilities to refer clients for addition services such as inpatient mental health, emergency or patient health care, medications, substance abuse, food/shelter, reuniting families, vocational and care/sheltering of companion animals/horses/livestock.(Krisber, 2003), (Elrod, 2006).

Statistical Procedures

Returned questionnaires were code into a data file and analyzed using the Statistical Program for the Social Sciences (SPSS) Version 14. Demographic information (county/parish location, state, zip code and location in an urban/suburban or rural area) was characterized using descriptive analysis (frequencies and percentages). This analysis was completed for the entire 85 responding facilities from the five selected southern states. The responses were also grouped according to whether the location of the community mental health facility's county/parish fell within a Federal Emergency Management Agency (FEMA) Disaster Declared Area immediately following the Katrina/Rita disaster in the fall of 2005. This designation is made by the Federal Emergency Management Agency following the disaster situation in order to provide needed federal emergency services and funding for response and recovery.

Nonparametric tests performed included the Pearson Chi-square and the McNemar analyses. The level of significance chosen for the study was $p = 0.05$. Significant differences in responses associated with emergency preparedness actions and service capacity before, during and after Katrina/Rita were measured. Facility responses were organized into two groups. The first group included facilities located in federal disaster declared areas following Katrina/Rita and the second group included facilities located in the same five selected southern states from area in non-declared disaster locations.

Study Results

Study responses were identified as significantly different when a p value of 0.05 or less was found. An analysis of emergency preparedness responses from all participants was completed for the following questions 1) reporting of an emergency plan before Katrina/Rita; 2) conducting an emergency exercise or drill before or after Katrina/Rita; 3) modifying an existing emergency plan following Katrina/Rita; and 4) providing debriefing services for emergency responders to mitigate post traumatic stress disorder. Selected questions under the questionnaire section of client mental health service capacity before, during and after Katrina included: 1) adequacy of counselors and 2) the ability of facilities to refer clients for addition services such as inpatient treatment, food/shelter, reuniting families and medication. Following the Katrina/Rita disaster 49 (57%) of the community mental health administrators responding reported modifying an existing plan. However, no significant difference was found in the number of administrators reporting plan modification from facilities located in disaster declared areas and those located in non-disaster declared areas.

All 85 community mental health administrators responding to the questionnaire indicated that their facility had an emergency preparedness plan prior to the Katrina/Rita disaster.
The responses of administrators concerning whether their facility conducted an emergency exercise or drill excluding a fire drill before and/or during the year following the Katrina/Rita disaster were compared. No significant increase in the number of facilities responding that they conducted an emergency exercise or drill was found. Both before and after Katrina/Rita

one third of the administrators of community mental health facilities reported that no emergency exercise or drill was conducted.

Debriefing services for emergency responders to mitigate post traumatic stress disorders were reported by 30 of the 85 reporting facilities. Only 22 (44%) of the 50 responds from, facilities located in declared disaster areas reported providing these services. Only 8 (25%) of the 33 responses from facilities located in non-declared areas reported conducting debriefing services for responders. No significant difference in response was found based on the location of a facility within or outside of a disaster declaration area.

Responses to questions concerning client mental health service capacity were analyzed according to the location of the facility within a disaster declared county/parish or outside the disaster declared areas. Questions concerning whether a facility had an adequate number of counselors before/during and after the Katrina/Rita disaster were analyzed using the McNemar test. The results of the analysis indicate that during the disaster period there was a significant difference between the self-reported ability of community mental health facilities in disaster declared areas to provide an adequate number of counselors from the ability of facilities located in non-declared areas.

A significantly greater number of community mental health facilities located in disaster declared areas in the study reported exceeding the facilities capacity for referral services during the evacuation and relocation period than community mental health facilities in un-declared areas. Twenty four of the 51 community mental health facility administrators located in a disaster declared area responded that capacity for referral was exceeded. Eight of the 34 community mental health facilities administrators located in a non-disaster declared area reported that capacity for referral services was exceeded. Table I: Frequency of Referral Services Exceeded by Community Mental Health Facilities During a Disaster in Five Selected Southern States in the United States. Table I. provides a list of the top seven referral service reported by community mental health facility administrators to have been exceeded during the Katrina/Rita disaster.

Table: Frequency of Referral Services Exceeded by Community Mental Health Facilities During a Disaster in Five Selected Southern States in the United States

Disaster Declared Counties/Parishes		Non-Disaster Declared Counties/Parishes	
Referral Services Exceeded	Number	Referral Services Exceeded	Number
1. Food/shelter	17	1. Medications	5
2. Inpatient mental health	16	2. Food/shelter	4
3. Medications	14	3.Emergency inpatient	2
4.Substance abuse	13	4. Inpatient mental health	1
5. Reuniting families	12	5. Substance abuse	1
6. Emergency inpatient	10	6. Reuniting families	1
7. Care/sheltering of companion animals/horses/livestock	8	7. Vocational	1

Conclusions

Following the Katrina/Rita disaster a majority of responding community mental health facilities (57%), in five selected Southern States in the U.S.A. modified their facilities emergency preparedness plans regardless of whether the facility was located in a disaster declared area or not. The number of community mental health facilities in five selected Southern States self-reporting conducting emergency exercises or drills except for a fire drill before and after the Katrina/Rita disaster did not significantly increase. This conclusion is consistent with previously published studies by Compton, Mahoney et al., McHugh, et al, and Sweeney et al. These studies also found that no automatic increase in community preparedness exercises and drills occurs following a disaster event.

The results of this study indicate that disaster declared areas are more likely to experience an inadequate number of community mental health counselors to meet demand during the disaster response period when compared to community mental health facilities located in non-declared disaster areas. Katrina/Rita declared disaster areas reported exceeding their capacity to provide referral services at a significantly higher level than those community mental health facilities located in non-disaster declared areas in five selected Southern States of the U.S.A.

Recommendations

- Federal/State governments should expand proactive incentives for community mental health facilities to increase emergency drills/exercises in the five selected Southern States in the U.S.A.

- Mental health facilities must prepare for an emergency anticipating that during a disaster situation the facility will be required to bring in additional counseling resources to meet demand during the actual disaster response period.

- Community mental health facilities in the five selected southern states in the U.S.A. should include a detailed, specific provision within the facility's emergency preparedness plan to address access and expansion of referral services for clients during a disaster. See Table I for a specific list referral services.

- Future studies should evaluate whether there is a need for community mental health facilities in five selected Southern States in the U.S.A. to provide additional debriefing services for emergency responders to mitigate post traumatic stress disorder following a disaster or whether other agencies unrelated to community mental health facilities are adequately supplementing the service.

Summary

This research study of emergency disaster preparedness and client service capacity at community mental health facilities in five southern states prior to and following the Katrina/Rita disaster indicates that community mental health resources in communities that have been declared disaster areas are more likely to experience demands that exceed their capacity to respond than those facilities that are outside the declared area. This study has helped identify areas of critical need. These include the need for mental health facilities in disaster areas to plan to bring in additional counseling resources to meet increased demand during the disaster response period and to address access and expansion of referral services during a disaster. Additionally, mental health debriefing services for responders to mitigate post traumatic stress disorder should be further evaluated to determine whether additional support services are needed. All community emergency plans should include a major section on community mental health response that is developed in collaboration with local community mental health facilities.

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DISASTER VIEWPOINTS: ADULT'S AND CHILDREN'S EXPERIENCES OF DISASTER, RECOVERY, AND LESSONS FOR MITIGATION

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Keywords:

Hazard education, recovery, community awareness & recovery

Abstract

Post disaster studies ascertain community levels of preparation, warnings, behaviour and experience. The disaster experience of the community informs knowledge that may contribute to the enhancement of mitigation, education and awareness. Research indicates that recovery from disaster is at least partially contingent upon pre disaster levels of preparation, awareness and previous disaster experience. Community mitigation, response and recovery operates at the level of the household. Most commonly the core of the household is a nuclear family in which children are active partners along with their parents in preparation, experience and the post event clear up and recovery. This paper will particularly examine the experiences of adults at children during and after category 5 Cyclone Larry, that devastated parts of North Queensland (Australia) in March 2006. Recovery issues in a rural community that enhance the mitigation of future hazard events are identified.

Introduction

Disaster mitigation requires community education and awareness. Communities are primarily seen by emergency managers as the adult population of a geographical location. Without going into an extensive discussion of the meaning and definition of community, it is obvious that the most immediate subgroup of any community is its children. The Centre for Disaster Studies recognised children as a separate community group when analysing vulnerability to cyclones in the northern beaches suburbs of Cairns, in North Queensland, and developed educational materials in the form of a CD Rom game, Stormwatchers, aimed at primary school children (Anderson-Berry 2003). At the broader international level the significance of children's involvement in disasters has long been recognised by the United Nations as part of children's rights (Pupavac 2001). Widespread throughout the world hazard education modules form part of formal school curricula. The importance of hazard education for children received further impetus after so many children died in the Indian Ocean tsunami, and was addressed in the Hyogo Declaration (UN 2005).

Subsequently researchers have begun to share findings of projects aimed at children's experiences in disaster and the importance of educating children a hazard awareness (Finnis et al 2004, Izadkhah & Hosseini 2005, Dengler 2005, Balaban 2006, Dunbar 2006, Chen & Wu 2006). After Cyclone Larry devastated small communities to the south of Cairns in North

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Queensland in March 2006, a group of school teachers and mothers gathered children's stories of the cyclone and their survival as a means of aiding the recovery of the children by encouraging communication and the sharing of experiences. Cyclone Larry crossed the Coral Sea in mid-March 2006, developing into a severe category five as it approached the coast south of Cairns. The eye of Larry crossed the coast between 6.20 and 7.20 am on Monday 20th March (Bureau of Meteorology 2006), devastating the small towns of Innisfail and Babinda and surrounding small rural settlements. Rebuilding and recovery has been a long process, that a year later still continues.

The Centre for Disaster Studies carried out a rapid post disaster assessment within a week of the event. This household questionnaire survey was open-ended and generated a large number of comments and observations from the more than 200 adults who participated in 147 households (King et al 2006). The questionnaire was structured in relation to the chronology of the cyclone, from earliest preparations and warnings through the event to the impact, clear up and reflection. Six months later the children's accounts were published by Mitchell et al (2006). The most striking and immediate impression of these accounts was the mirroring of the experience of the adults and the very clear involvement and participation of the children in the disaster alongside their parents and other members of the community. This paper therefore has taken some of the stages of the cyclone in order to examine the shared experiences and viewpoints of the adults covered by the household survey and the children who contributed to the Cyclone Larry Tales of Survival. The comments of the adults were transcribed by the researchers amidst the wreckage of the towns and the ongoing rain. Thus they have been abbreviated into phrases. The children on the other hand wrote their accounts more fully in school. However, both sets of comments and stories present a vivid picture of the experience of a severe cyclone, and illustrate the shared experience of the children. For reasons of confidentiality the names of the adults who participated in the survey were not recorded, whereas the children are named as authors in the publication.

Preparations

People were aware of the approach of Larry before Saturday the 18th (many people were watching it develop from a tropical low long before it was classified as a cyclone). A cyclone warning existed throughout Sunday 19th March, which prompted people to take further activities ranging through family actions, to the yard clear up and purchase of supplies.
Adults:

> Cut near trees, opened manhole, informed neighbours, packed up family ready to leave. Female aged 31
>
> Packed photos, kept preparing, priming kids. Female aged 38
>
> Cleared yard, secured all, put trampoline away, and mobile basketball hoop and clothesline packed in shed. Female aged 43
>
> Froze water, bought generator. Male aged 69

Generally people gave one or two responses rather than indicating that they had prepared on a range of actions. As a community they covered all the activities, but as individual households they were more selective in terms of the actions they took.

Table 1. Further Purchases and Preparations Made During the Warning Period

Purchases & Preparations during warning period	Count	Col %
Batteries	4	2.7%
Tinned Food	3	2.0%
Fresh food	2	1.4%
Fuel	3	2.0%
Check or buy generator	2	1.4%

All of batteries, candles, food, fuel	42	28.6%
Nothing	37	25.2%
Batten down/clear yard	28	19.0%
Store water	2	1.4%
Store water & clear up	9	6.1%
batteries & candles	1	.7%
Food purchased and stored	7	4.8%
Secure, clear & shop	6	4.1%
Secure personal belongings	1	.7%
Total	147	100.0%

Source: CDS household survey

Within families the children were involved in preparation activities with their parents. Most children used the word "we" and described the family discussions and tracking the approach of the cyclone. Some families were told to evacuate from storm surge prone areas and the children add accounts of taking their pets. Common preparatory activities included cutting down old trees, clearing up loose tin, boarding and taping windows and of the parents moving cars and heavy equipment close to the house.
Children:

> … we had heard on the news that a cyclone was coming. My family and I were at my grandparents at Innisfail for dinner, we all talked about it. Elizabeth Glinster (Mitchell et al 2006 page 40)
>
> We had been listening to cyclone warnings for days, hoping it would go away. In preparation we taped windows, cleaned up the backyard, found cages for the birds, found batteries for torches, bought food for the animals and food for ourselves. Alexandra Jones (Mitchell et al 2006 page 42)
>
> … as most other people did, we started taking precautions. First we removed all tin and other objects that could cause damage. Then last of all we boarded up the windows and tied things down. Jim O'Sullivan (Mitchell et al 2006 page 10)
>
> As cyclone Larry came closer it intensified and my family and I started to clean up the yard on Sunday afternoon. We taped the windows, cleaned up everything and put the bulldozer next to the house hoping the wind would come in that direction and it would block us from it. We also parked the ute close by in case we had to evacuate. Danielle Silvestro (Mitchell et al 2006 page 26)

The children's accounts capture some of the nervousness of the adults, the long queues in the shops, some parents praying, and an expectation or hope that the cyclone would pass by. Household respondents also identified many of the things that they did not do well enough, although most felt that they had prepared as well as they could.
Adults:

> Panic buying of food. Left everything to the very last minute. Male aged 39
>
> OK. Could do better – needed extra food and gas for barbeque. Female aged 30
>
> Didn't get dog food or gas. Female aged 34

Most single parents were in rented accommodation so their preparatory activities were different from those of nuclear families, being dominated by clearing up the yard and securing personal belongings.

Family and Communication

Households were asked about special needs and disability issues. Mostly it was elderly households that were affected, but some families identified babies and toddlers as a special need and were more vulnerable in consequence. Families saw the impact on children as traumatic, while the children's accounts give a strong picture of family unity and shared experience.

Adults:

One child on crutches had to be carried, and, with the high humidity, one child with croupe. Male aged 40

Children are disrupted. The young ones still upset. When they heard that Innisfail was being demolished, they cried for 2 hours. Male aged 38

Grandmother (90) worsened, and we had to put her in a home. Male aged 40

Stress. Kids traumatised – they sleep lightly, and wake up at the smallest noises. Female.

Contact with other relatives and with neighbours both before and during the Cyclone was very high. Additionally a number of households had invited their neighbours in or had gone and spent the cyclone with neighbours or other relatives. The same is generally true for those households which were defined as more vulnerable. Contact with other relatives was very high, although contact with neighbours was significantly lower for these groups, possibly because of a strong involvement with family and relatives.

Adults:

Phone landlines in South Johnstone stayed on until Monday night. Female aged 69

We are not particularly close to our neighbours but because it was such a horrible experience, we kept checking out how each household was doing and kept swapping one generator between two households. We buried any negative feelings because the community has got to work together. Male aged 37

Phones out Tues. am. Mobile out Monday. Phones back Thursday. Female.

Children:

I was running over to my friend's house to tell them that the cyclone had increased to a category four. As I told them this scary news I didn't know whether to scream or cry. Well I didn't do either because I knew I had to support my family and friends during the rough times. Mikaylah Obah (Mitchell et al 2006 page 34)

We called friends, they called us. Gurpreeth Singh (Mitchell et al 2006 page 8)

The day after Cyclone Larry we rang up friends on the satellite phone. They had all survived but had wonderful stories. Annie Turner (Mitchell et al 2006 page 18)

My sister Jasmine, who lives in Cairns kept calling to see if we were all right and my auntie on the Sunshine Coast was watching the news and rang to ask how we were and what was happening. Emmalene Krause (Mitchell et al 2006 page 22)

During the cyclone we had many phone calls and text messages, some from Tully friends who forgot to get batteries for the radio and others from the relations and friends in places like Sydney, Brisbane, Moranbah and even America checking up on us. Danielle Silvestro (Mitchell et al 2006 page 26)

Shelter and Pets

Two separate questions were asked concerning where people sheltered in the house and what actions they took in protecting themselves and sheltering during the passage of the Cyclone. The impression from the survey questionnaires was that people chose stronger rooms, centrally located rooms, or rooms that were on the lee side of the house. Thus some people moved about from room to room, but others clearly relocated as the wind shifted. Many older Queensland houses have a hallway or passageway in a central part of the house, while newer houses tend to be much more open plan in the main living areas. Therefore the diversity of responses reflected individual household decisions in relation to position as well as internal architecture. Many older high set houses are built of flimsier materials on the main floor while subsequent closing in of the area under the house is frequently done with blocks. In such cases the under house room may be the strongest room in the dwelling.

Table 2. Place and Actions in Sheltering During Cyclone Larry's Passage

Actions to shelter	Count	Col %
Evacuate	17	11.6%
Shelter in central room	31	21.2%
Under mattresses	13	8.9%
Under table	2	1.4%
Shelter in bathroom/laundry	16	11.0%
Lounge	14	9.6%
Shelter in bedroom	8	5.5%
Kitchen	2	1.4%
In room under house	12	8.2%
Anywhere/moved about	28	19.2%
In car/garage	3	2.1%
Total	146	100.0%

Source: CDS Household survey

Adults:

In concrete bunker under house. Female aged 58
In our underground garage. Male aged 39
Friends flat – in the stair well, then in the downstairs 'bunker', but the roller door blew in. Male aged 40
Went to units. Female aged 56
(family including 3 week old baby). Went to Police Station. Male aged 31
Put quilts on windows in bedroom. Female aged 65
The rattles and tree crashes caused us to come out and look. Male aged 75
Went across road and a palm tree smashed the house next door. Went home. Male aged 78

Some children mentioned going to Dad's place of work, but shelters they identified were mostly safe rooms, windowless bedrooms, bathrooms and toilets, concrete utility rooms and garages under the house, hallways and the middle of the house and even the pantry and inside wardrobes. Some evacuated or went to friends and neighbours and there is frequent reference to hiding under beds, tables and mattresses. The well-being of pets was always important, with families sharing their limited space with a bizarre range of pets and domestic animals and birds, including snakes and horses.

Children:

I hid under the table. We covered it with mattresses. All the water came in the windows. Samuel (Mitchell et al 2006 page 12)
I hid in the wardrobe and dad stayed in the house. Mum stayed in the wardrobe with me and Brodie. Riley (Mitchell et al 2006 page 16)
When it was little and it started we went in the bedroom. When it was big we went in the hallway. Emma (Mitchell et al 2006 page 23)
What I vividly remember is that when my family was sitting in a little group down in the laundry under a mattress I was wondering if our roof was going to come off. Jack Dorney (Mitchell et al 2006 page 24)
My horses had to come inside the laundry when the cyclone came so they didn't blow away. Natasja Crowley (Mitchell et al 2006 page 41)

Pets are a significant issue, especially when people are confronted with the need to evacuate. Almost all pet owners are not willing to abandon these household members so that it is not surprising that 66% of all pets spent the cyclone with their owners. The small number that were "out during the cyclone" mostly escaped and bolted and appear to have survived. This included chickens whose cages were blown away, along with accounts from children of rounding them up, with parents, during the storm. Those that did not spend the time in the same room as their owners were generally secured in an outside shed or the room under the house, but many had lost their cages, including birds and snakes.

During the Eye of the Storm

A number of respondents reported having contact with their neighbours during the passage of the eye of the Cyclone. The eye did not pass over all of the communities that were covered in the survey, or the children's stories -- this was primarily an Innisfail experience. It was daylight by the time the eye passed, so that some went outside out of curiosity, while others helped neighbours and cleared wreckage. This was risky behaviour and both children and adults reported the wind returning while they were still outside.

Adults:

Went out in the eye to help move neighbour's roof truss. Female aged 64
During the eye – helped move iron. Male aged 53
All out in the yard before and after. Male aged 37
Regularly out of doors in the eye of the storm. Male aged 37

Children:

We had two turkeys outside in the same cage. So Dad, Ben and I all went out in the middle of the cyclone, I grabbed the chooks and Ben grabbed the turkeys while Dad held down the cage…Emmalene Krause (Mitchell et al 2006 page 22)

During the eye of the cyclone, when it was quieter, the four of us went outside to survey the damage to our property. We nailed up damaged doors and windows and picked up bits of tin. Jack Dorney (Mitchell et al 2006 page 24)

During the eye of the storm, Mum urged us to get on the couch where we played with toys and games to distract us from the destruction outside. Bianca Snodgrass (Mitchell et al 2006 page 27)

Feelings Towards the Cyclone

People's perceptions, responses, feelings and reactions are very important in gauging actions and behaviour. The expectation of the impact of the cyclone is equally significant in driving right behaviour and appropriate preparedness. In asking people how they felt on hearing the cyclone warning, no feelings were suggested by the interviewers or the question, so the 50% of respondents who expressed emotions of fear, being scared or worried were very direct and honest. Very few people failed to take the cyclone warning seriously. Most of the rest expressed an emotion that aided them in being prepared - an acceptance and readiness.

The most common response to the Cyclone warning has been summarised as "increased preparations and activity", although this was expressed in various ways including phrases like "get on with it". Those who took no action largely felt that they were prepared and there wasn't much more to do. Many of those who expressed a state of staying calm were parents who relate to this action to being concerned for their children.

Table 3. How People Acted on Their Feelings Following the Cyclone Warning

Acted on Feeling	Count	Col %
Increased preparations & activity	73	50.3%
No action	29	20.0%
Stay calm/don't scare others	29	20.0%
Confused	3	2.1%
Evacuated	6	4.1%

Listen to warnings	2	1.4%
Upset	3	2.1%
Total	145	100.0%

Source: CDS Household Survey

Adults:

Shocked. Feel sad at loss of others. – houses, banana farms. Daughter is scared, son is happy. There were a few reports of children who remained 'disturbed' a few days after impact. Female aged 41 from Babinda.
Community spirit good, close knit community, a lot of new comers. Male aged 86 at Flying Fish Point
Strong – mother needed to care for others. Female aged 61
Thought they were joking. Female aged 65
Wasn't really believing it. Male aged 37
Stopped functioning – petrified. Female aged 56
Need for urgent response. Male aged 50
Deciding where to go. Scared and apprehensive. Male aged 60
Knew we would be in for it. Serious. Female aged 38
Windows would smash, worried about flying debris and car damage. Male aged 30
Daughter had panic attack, had to comfort her. Thought we were all going to die. Male aged 30
Expected extreme damage - more than there was. Expected house to go but it didn't. Male aged 57
Devastation, like Titanic. Female aged 38
No idea, not from area. When I knew it was a cat 5, I knew it would be bad. Female aged 34
Thought we would lose house. Stressed out Sunday 7 pm when upgraded to a category 5. female aged 39
Not much. The weather was so calm, so you hope it will not hit. The ABC radio said that the calm was deceptive. Male aged 86
Terrified, but thankful. Female aged 30
A bit stunned. A bit slow to react. A bit shocked. Fortunate. Male aged 61
Gave me a chance to do good service to the community. Male aged 40
Buy a generator, extra costs and costs of fuel supply.. We were very frightened, so moved to the police station (a worker there). The home was basically undamaged, but we were grateful to have somewhere strong to go to, and are more philosophical about our fear now. Male aged 31

Virtually all of these feelings and fears are replicated by the children's accounts. The adults in the survey were speaking just days after the event whereas the children wrote their stories some weeks later and are more reflective and philosophical as well as extremely honest. From all of their stories there are a number of impressions that are repeated. These are feelings of anger, scared, excitement, nervousness, terror, bravery and noise as something linked to the fear. They also expressed a feeling of timelessness, sadness, awe, understanding how people lived in the past, wanting and expecting a new life afterwards, and luck and fortune at having survived. Themes of sticking together, being happy in the company of the family, and good feelings towards friends and neighbours are expressed frequently, as well as people yelling, parents and relatives crying and upset, and being calmed by parents. In particular the children personified Larry – he was bad, naughty and cruel etc. The loss of their schools is noted by many children and their strong desire to get back with their friends and restore some normality.

Children:

When I saw the high school in a big heap I felt angry with Larry. Gurpreeth Singh (Mitchell et al 2006 page 8)
I felt saddened, then thought how long it would take for all of us to recover? After all, we survived. Maybe anything is possible if we stuck together. Gurpreeth Singh (Mitchell et al 2006 page 8)
We walked down the street checking on all our neighbours. The damage was awesome, I felt relieved nobody was hurt but sad about the destruction. Chantelle Boase (Mitchell et al 2006 page 14)
The trees fell down everywhere. It made me feel happy because I don't like trees. Kate (Mitchell et al 2006 page 15)
We were all in Cairns when we heard about the cyclone. I felt nervous but excited as we headed for home. In the morning it hit, and I was scared. I came down from the top bunk and sat with my dog, Whiz, because she went a bit crazy. Ian Clegg (Mitchell et al 2006 page 20)
I was scared because I was looking out the window and we saw a shed go down the street. Declan (Mitchell et al 2006 page 23)
(We) … saw our cousins dressed in their school clothes. We asked why they were in their school clothes and they said school was on. I was so excited I couldn't wait to go to school. Sheryl Vue (Mitchell et al 2006 page 36)
Dad is unhappy his bananas have gone, but he is happy as he spends more time with us. Jordan McAvoy (Mitchell et al 2006 page 50)

Community and Personal Impact

Table 4 records personal impacts and lessons learned from this Cyclone. Responses have been broken down by previous Cyclone experience (Winifred destroyed Innisfail almost exactly 20 years earlier). Having gone through an earlier Cyclone was the reality for 81% of the population. The major responses of "shaken" or "distressed/stressed" were stated by 42% of respondents. The random nature of impact and of households' personal situation meant that primary impacts varied considerably. However when questioned about lessons learned there was a 90% response of be prepared, be ready etc, and take it seriously which implied a similar preparatory attitude.

Table 4. Personal Impacts of Cyclone Larry by Previous Experience

	Previously experienced a cyclone			**Total**	
Personal effect	**Winifred**	**Other Cyclone**	**No previous experience**	**Number**	**Table %**
	Number	Number	Number		
Additional costs	1	1	1	3	2.1%
Shaken	18	7	8	33	22.9%
Disoriented	6	1	1	8	5.6%
Lucky/ good community spirit	8	1	1	10	6.9%
Distressed or stressed	18	4	5	27	18.8%
Frustrated	1	1		2	1.4%
Loss of business/work	11	3	2	16	11.1%
Inconvenienced	8	2	3	13	9.0%
No effect	7	1	2	10	6.9%
Worried	9		4	13	9.0%
Loss of belongings	6	1	1	8	5.6%
Guilty	1			1	.7%
Total %	65.3%	15.3%	19.4%	144	100.0%
Lessons learned					
Be prepared	77	10	20	107	75.9%

Take it seriously	12	4	4	20	14.2%
Keep up morale	2	1	1	4	2.8%
Stay in contact with family & neighbours		1		1	.7%
Unpredictability of impact	1			1	.7%
Evacuate	3	4		7	5.0%
Keep out sightseers		1		1	.7%
Total %	67.4%	14.9%	17.7%	141	100.0%

Source: CDS Household Survey

Adults:

Lost everything. Financial trauma. Kids are quiet. Male aged 43

Job uncertainty, no security, homeless. Male aged 50

Loss of income and closer to neighbours. Male aged 30

Sugar cane crop – lost 50%; loss on harvesting. Male aged 53

Everything lost – in the rain for 4 days. Male aged 50

All stress and heartache. High school is gone. Male aged53

No ATMs, no bank, no money for baby's formula. Chemist would give no credit. This was most distressing. Very difficult with young kids. Eventually got some from SES evacuation centre – queued for hours. Female aged 31

Pretty pleased with the way resources were used. It was a marvellous job, the authorities seemed prepared. Male aged 40

Roof missing off own business, along with structural damage. Business did not have business interruption loss insurance. Male aged 47

Male aged 38 Children are disrupted. The young ones still upset.. When they heard that Innisfail was being demolished, they cried for 2 hours.

Female aged 41 Shocked. Feel sad at loss of others. – houses, bananas, farms.

Male aged 43 Lost everything. Financial trauma. Kids are quiet.

Many of the children observed the impacts on their parents and the community in the same manner as those of the adults. Commonly repeated impacts were the loss of jobs, especially their own parents, people being upset at the losses, including the children's own losses, the lack of power and pollution issues, including the problem of asbestos.

Children:

People lost their jobs because the fields were wrecked. Mum lost a few weeks of work. Ian Clegg (Mitchell et al 2006 page 20)

Mum started crying because we had photos and lots of things that were being destroyed by the wind and the rain. Lauren Brennan (Mitchell et al 2006 page 25)

It was frightening. It was noisy. We can't go back to our school because the cyclone has wrecked my school. They're going to pull it down. Tomorrow I have to go to the Good Samaritan Hall with a rug to sit on. Aaron Snell (Mitchell et al 2006 page 43)

I … walked over to the window. I was shocked! I didn't think it was this bad. There was pink insulation everywhere! It looked like pink snow. I looked out further into one of the paddocks. There was our roof! The loud ripping noise was our roof ripping off. Louise Russell (Mitchell et al 2006 page 28)

Most rooms were flooded but mine was the worst. I was so upset. Everything was destroyed, nearly all the things in my room got wet, books, posters, my CD player and my bed. Louise Russell (Mitchell et al 2006 page 28)

There was holes in our roof and all the water came in and we were scared and we were crying. Mum said "don't be scared, be brave". Daniella (Mitchell et al 2006 page 29)

… So we came to Pop's house. When finally we got there we were surprised that he didn't get hurt and neither was his cat or dog. His house was very badly damaged and was not able to be repaired. Now he lives with us until he can build a new house. Elizabeth Glinster (Mitchell et al 2006 page 40)

Our house only lost a few windows and a bit of guttering, but Grandma had lost her business. Kylie De Courcey (Mitchell et al 2006 page 51)
There was a tremendous bang as the roof was wrenched from our house and Mum and Dad joined us under the bed. I peered out from under the mattress to see the ceilings lift and the eerie grey sky above. ….Cyclone Larry changed my life forever. Everything that my family owned was destroyed in a few short hours. Megan Smith (Mitchell et al 2006 page 53)

Clear up, Lessons and Recovery

Most houses are fairly old with a mean of 46 years. Cyclone resistant building codes came in during the mid-1970s so that those dwellings that are less than 30 years old are more likely to have greater Cyclone resistance in their structures. Roof loss occurred almost entirely to houses over 30 years old, as is also the case with wall damage. It was estimated by the interview team that approximately 1 in 20 or 5% of houses had been severely damaged or destroyed. Most of these places were consequently unoccupied, with their former residents not being interviewed in the survey. However, 11 houses that had lost their roofs were occupied and their occupants interviewed at the time of the survey.

Table 5. Damage observed in Household Survey

Damage – nearly all properties had some minor damage. Almost all had major vegetation damage	**Number**	**Percent (of 147 households)**
None	5	3.4
Vegetation and minor damage	36	24.4
Damage to guttering and other minor	12	8.1
Basically fully uninhabitable	12	8.1
Roof loss or damage	16	10.8
Loss or damage to some walls	10	6.8
Water damage	11	7.4
Windows smashed	17	11.6
Doors damaged	7	4.7
Loss or major damage to shed or garage	12	8.1
Awning damage	34	23.1
Fence damage	13	8.8
	185	125.3

Source: CDS Household Survey. Percent > 100 because some properties sustained multiple damage

People began the clear up of damaged structures and vegetation as early as the eye of the cyclone, and were out as soon as the winds had abated. Initial clear up focussed on securing dangerous items and gaining access. Vegetation damage was widespread, and in a rural rainforest environment vast numbers of enormous trees blocked roads, driveways and backyards. Mutual cooperation appears to have occurred immediately and continued alongside the formal intervention.
Adults:

Boss is being good – all staff being paid and even getting generators and fuel. Happy with the government response – the army came by on Tuesday [21 March] with rations. Male aged 49
Concern over leptospirosis. Male aged 27
Neighbours helped out – brought bread and extra supplies. Felt isolated from authorities because English is a problem. Female aged 81

Many of the children's accounts refer to their involvement in the clear up and they mention

the hard unpleasant work that this involved over an extended period of time. Some of the children clearly lived on farms and were accustomed to involvement in farm-work. Throughout the passages the children use the pronoun "we", in the clear up as much as in the preparation. It was a family and community effort in which they were fully involved.
Children:

> Dad and we kids had to clear the driveway of trees and branches after the cyclone so that we could get out. Jim O'Sullivan (Mitchell et al 2006 page 10)
>
> We cleaned up the paddock and fixed up the fences then I had to go home and dry off the chooks, they were badly traumatised. The next day I helped clean up the rubbish. Selena McMurray (Mitchell et al 2006 page 17)
>
> I helped remove branches by dragging them on the four wheeler to the burning pile we had made. Jack Dorney (Mitchell et al 2006 page 24)
>
> Chainsaw in hand, standing shoulder to shoulder with our neighbours, we surveyed the damage. Then we set to work. Elise Lawrence (Mitchell et al 2006 page 46)
>
> We had so much to do it took us a month to repair most of Larry's destruction. Conor Johnson (Mitchell et al 2006 page 71)

Conclusion: Patterns of Shared Experience

There is a recurrent pattern of phases to each cyclone. The precursor to many cyclones is the development of the monsoon trough and of tropical low pressure systems, frequently bringing rain before the low develops. Once the low pressure system develops people begin watching and once the cyclone forms and is named, the watch intensifies (the official term of cyclone watch is applied to the period 24 to 48 hours before expected landfall. During this period of increasing tension people make preparations, clear up rubbish and carry on life as normal. The household survey addressed this period of pre impact for the importance of understanding preparatory behaviour and receipt of warning information. The children's accounts begin with the same period and both mirror and participate in the tension, discussions, actions and preparations of the adults. Both the survey and the children's accounts recorded where and how people sheltered and protected themselves as well as aspects of the damage, but the children described the experience of the cyclone's passage particularly vividly. The eye of the cyclone was a stage in the process, where many people left the safety of their houses, attempted some clear up and even rescues of neighbours and animals, but it was also the point of wind reversal and a separate destructive experience. The final stages in the process of the storm were the initial clear up, contact with others and then the long haul of recovery that ran into most of the rest of the year for most people and an ongoing slow recovery for some.

The feelings of both children and adults shifted from the fearful or tense expectation as the cyclone came closer, through the horror, noise and awesome destruction of the event, with its accompanying emotion of excitement, into the shock, sadness and anger after the storm had passed. Both adults and children reflected on their fortune in surviving as well as the trauma of their losses. They expressed philosophical acceptance and many drew attention to the community spirit, the cooperation and the support and efforts of the many groups of relief and recovery workers.

Cyclones bring significant amounts of the rain that falls in northern Australia's wet season. They are a regular and predictable part of the pattern of the seasons. They configure the experience of life in the north. All are destructive, all are local historical markers, and all cyclones can be prepared for through protective behaviour and mitigation actions. Some cyclones, such as Larry, are severely destructive events, and yet most people who live in the north can expect to go through such an experience every two or three decades. Most of the adults interviewed in Innisfail and the surrounding townships had experienced a previous cyclone and most had been through a severe storm. Most of the children whose stories were recorded by Mitchell et al can expect to go through this experience again in their lifetimes.

The same is true for most of the rest of the children of the north, almost all of whom have so far been spared the practical experience of the Larry survivors.

Education is then of crucial importance in maintaining the safety of all of the people who live in cyclone prone areas. Although it is the primary responsibility of the adult members of the community to make preparations and practise sheltering behaviour that mitigates the impact of the cyclone impact, and thus it is this general community that is primarily targeted in cyclone educational and awareness campaigns, it is clear that the children are equally involved, not simply as passive receivers and potential victims, but as active participants involved with all of their families' activities and engaged with the preparations and recovery of friends and neighbours. Hazard education takes place in school lessons, serving to reinforce the broader community awareness advice. However, the lessons learned by children go further. School lessons are active, requiring activity and involvement of children, whereas community awareness campaigns are primarily passive, placed before people but requiring no action unless heeded. Children are also in an active learning phase of their lives, generally wanting to learn, even if some pretend otherwise. The hazard education they learn as children, however partial or fragmented it may be, stays with them for life. Even more significantly children share their school learning and projects with their families, acting as reinforcers of the more passive community safety and mitigation messages. All members of the community share the hazard experience and consequent natural disaster. All of the community, adults and children, participate in each of the stages of a disaster. All are likely to be traumatised to some extent, so that the more education prepares people, especially children, the better prepared the community will be in future events, thereby enhancing resilience and mitigation.

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PERCEPTION OF THE NEW SETTLEMENT AFTER DISASTER

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This study examines the psychological impact of the disaster on the memory of the affected community. The perceptive process of the individuals are determined according to the memory and place attachment concepts and issues. A case study was conducted in a disaster affected area in Turkey. Duzce city was heavily damaged by the earthquakes in 1999. Comparisons between the new and old settlements were made on the basis to the representations of mind and through images of the new and old settlement with the focus to community reconstruction process of the victims. Cognitive maps of the victims primarily are tried to be determined by the description of the formation of the new/old environs. The state of memory and cognitive schemata is carried out from the view point of syntactic and semantic realms of the environment. The representative performance of the new settlement from the view point of victim is determined as well. The results of the comparison of the new and old settlement determine what the extent the community was psychologically effected from the relocation after the disaster.

Key words: Cognitive Mapping, Place Attachment, Community Reconstruction

INTRODUCTION

Natural disasters are of many types and have diverse characteristics. They caused intensive disruptions and losses to the affected communities. The impacts could vary according to the disaster type and they had physical, social, economical and psychological aspects (Disaster Mental Health Response Handbook, 2000). Individuals and communities are affected in ways which prevent their normal functioning. All appropriate actions after the disaster are taken to enable individuals and their communities to return to their normal life as soon as possible both physically, socially and psychologically (EMA, 1996). The pre disaster environments and places are the part of the physical and social millieu which disaster victims had relations and also different kinds of positive or negative bonds. These bonds also are represented in the human minds as cognitive maps. So by definining the cognitive maps of the victims we could find out the cues of the important part of the pre and post disaster environments.

This paper explores how to evolve places as ever-shifting points of meaning that had relations during unexpected and sudden changes in people's lifes and the response of peoples to variety of influences especially in a disaster affected site. The relation between the human and environment after such a traumatic event is tried to be determined from the point view of the victim's psycho-social experience as well.

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THEORETICAL BACKGROUND

Cognitive maps are mental models of the relative locations and attributes of phenomena in spatial environments. Understanding how people form cognitive maps of their environments is vital for effective post disaster environment design where the users are in a traumatic case. We form cognitive maps to deal with and process the contained in the surrounding environment (Billinghurst and Weghorst 1995). Cognitive mapping is formally defined as;

".. a process composed of a series of psychological transformations by which an individual acquires, codes, stores, recalls and decodes information about the relative locations and attributes of phenomena in their everyday spatial environment" (Stea and Downs, 1973).

An individual's cognitive map is an active information seeking structure of which spatial imagery is but one aspect (Neisser, 1976). Cognitive maps are also made up of memories of objects and kinesthetic, visual and auditory cues (Henry, 1973). The perception of the environment itself is always guided by some sort of cognitive map, so an inaccurate or incomplete cognitive map leads to disorientation and confusion (Neisser, 1976). Designing post disaster environments through which subjects can navigate and orientate themselves successfully requires an understanding of cognitive map formation in such traumatic conditions.

Mac Eachrean and Kraak (1997) articulate a fundamental shift to a new emphasis on map which shows the difference between exploring unknowns and communicating with known with maps. Cognitive maps are important in understanding the representation of the environment in human’s mind. But this term determines the human relationships only by means of mental processes that can not be sufficient to understand the deeper sensational human-environment interactions. Thus, cognitive cartography needs to be strengthened by phenomenological studies which explore the sensational aspects of the human environment interaction.

We know from our everyday experiences that we, across time, evolve bonds towards certain places, e.g. where we were born and brought up, where we live and work. Thus, we make and gain emotional and cognitive conceptions of physical environments that are related to us as individual agents and as members of social groups. This indicates that a place is an extensive concept (Canter, 1977). A variety of theoretical positions and frameworks have been advanced to account for how places become ‘‘places’’—in other words, how places become meaningful. Most existing frameworks share the idea that a place is a complex concept, given life by people attaching meaning to a physical setting in a variety of ways (Smaldonea et. all., 2005). Place attachment in this sense can be used as a tool to understand the level of sensational relations between the human and environment.

Place attachments are profoundly disrupted when environments change rapidly, such as when floods, earthquakes or other environmental disasters strike (Brown and Perkins, 1992). Place attachments are often related to, but not determined by, changing housing and neighborhood conditions. Yet attachments also change as indiviuduals and house holds develop, environments age, or the processes supported by settings alter (Brown B. et all, 2003). As the disasters strike and change the social, physical and psychological environments the new environment which would be constructed could meet the requirement of the victims including all these factors. But the traumatic case added more environmental stresses to the victims more than their daily routine.

Cognitive theories of posttraumatic stress are developed relatively more than biological, psychodynamic, and learning theories. Moreover, cognitive theories have the greatest explanatory and predictive power about the posttraumatic reactions. According to the cognitive theories, before the traumatic experience, people have preexisting beliefs and models of the world. Traumatic experience provides new information which is incompatible with the preexisting beliefs. The kind of posttraumatic reactions depends on the success of the effort to integrate new information into preexisting beliefs. If the person can integrate the new information into the preexisting beliefs, successful information processing occurs. However, if the new information can not be assimilated with the preexisting beliefs, pathological posttraumatic reactions occur (Brewin, Dalgleish, Joseph, 1996). PTSD (Post Traumatic Stress Disorder) occured after the disaster can lead to extremes of retention and forgetting; terrifying experiences may be remembered with extreme vividness, or totally resist integration (Bessel and Kolk, 1998). So, the trauma may cause mental changes that cognitive maps could be impacted. Such changes had a crucial role in the representations of the victims mind and their perception of the disrupted environment. The new environment which will be reconstructed could at least meet the minimum mental and psycho-social needs of the victims such as the important or over valued images of the disrupted old environment. So that this could give the victims to adapt easily and maintain their daily life as soon as possible.

TURKEY-DUZCE AS CASE STUDY

Duzce province is located on the North Anatolian fault line in Duzce plain (Figure 1). As a result of the rapid industrialization between1980-1998, the migration to the city from the rural areas increased. The housing demand rapidly increased as well. The total area of the city is 2593 km². The population is 307.056 according to 1997 census, the density of 108 people/ km² and is more than Turkey's 83 people per km² average. Rapid migration caused unplanned constructions in the city (see Figure 2). Nevertheless, constructors add more floors to the old buildings which were constructed on the weak soil and were over the limits of the municipality laws. New buildings were constructed rapidly with inconvenient labor and material. On the other hand, there were no reliable construction control systems for the building construction processes in Turkey (Duzce Municipality Chairmanship 2000).

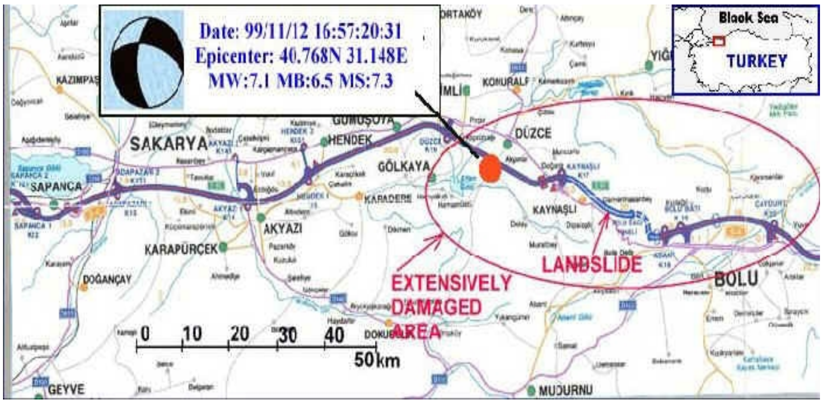

Figure 1 North Anatolian Fault Line and Impact of the Earthquake to Duzce (DMC, 2000).

Figure 2 The Duzce Cıty Center Before the Disaster

In 12 November 1999 the devastating earthquake with 7, 2 magnitudes occurred in Duzce province. Approximately 43000 buildings were damaged (see Figure 3). Generally 84 % of to the houses and % 16 of the work places were damages. Also 980 people died and 38939e peopl were injured (Duzce Governorship 2002).

Figure 3 Duzce City Center after the Earthquake

8004 housing units were constructed in Duzce by Ministry of Public Works and primarily the ministry gave a grant to the house owners who are willing to buy houses or willing to construct houses in their own properties (see Figure 4). New permanent housing sites were constructed by the Public Works after the occupancy of the temporary houses.

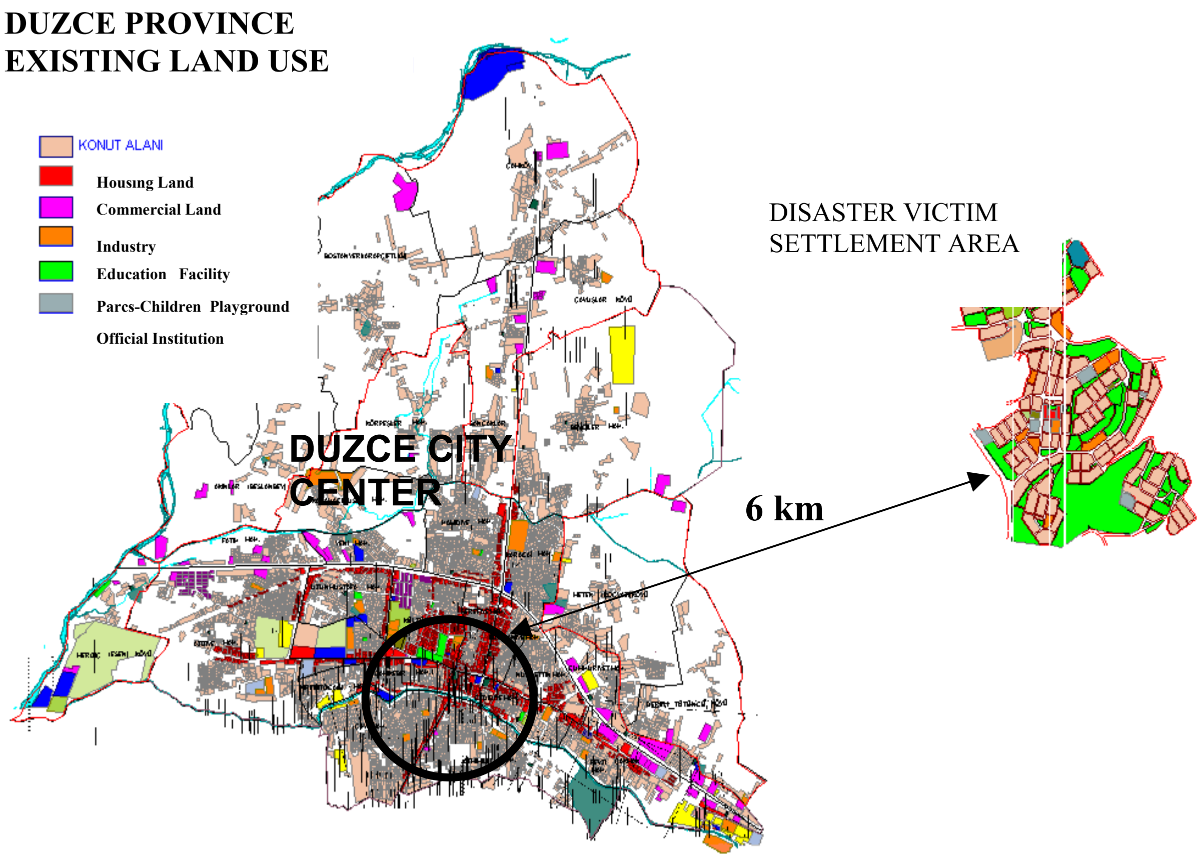

Figure 4 Duzce Province Post Disaster Land Use

The new settlement was located in the northeast of Duzce between Kazıkoglu, Sallar and Nalbantoglu villages (Ministry of Public Works, 2000). The permanent housing site was located outskirts of the Duzce Municipality boundaries and its size is approximately 350 hectares. The disaster victims relocated and begin to live in the new environment which was 6 km far away from the city center.

METHODOLOGY

Two different methodoligies were used in order to find out the cognitive changes and place attachments levels of the victims to the old and new city center. Before the implementation to the focus group, the important landmarks of the new and old settlements were determined by the help of the municipality officials in order to found out the exact place of the old (see Figure 4) and new city landmarks (see Figure 5). This study presents the results of Duzce case study which was conducted among the selected sample of a total of 30 disaster victims between 18–60 ages.

The case study was implemented in two stages. In the primary stage, the new and old city center maps were determined in order to find out the cognitive maps of the victims. We asked them to mark or/and draw buildings, recreational parc areas, landmarks, etc. of the old city (Figure 4) and new city based on three phases corresponding time intervals. The disater victims marked the old city buildings respectively in 1, 3 and 5 minutes. In order to distinguish the durations they were asked to use red pencil in first 60 seconds, blue pencil in the next 120 seconds and green pencil at the last 120 seconds. During the marking or/and drawing process, verbal or written explanations were avoided and victims drew or marked the images which they remembered firstly from the old city center, secondarily from the new city center.

In the second stage, "a fill in questionnaire" was designed in order to determine the characteristics e.g. gender, age, vocation, education, duration of residence in the city, etc. , attachment to the old city and environment, adaptation level, the impact of the new city environment and the relocation period of the focus group.

The variables in the case study were selected in relation to the subject-object orientation. On the subjective side, the variables were gender, age, education, vocation, life period in the city, life period in the house, tenure ownership, disaster loss and relocation. The objective characteristic were selected generally spatial characteristics of the new and old environment such as number of landmarks, locality, quality of the landmarks and images, perception of the new environment and adaptation level of the victims.

During the data analysis, marks and drawings were analyzed according to quality, type and number of landmarks and time durations. These characteristic define the percepiton of the new and old city and the impact of the disaster on the cognitive maps of the victims. The concept of "locality" is related to the landmarks in the circle with the radius of 100 m from the city center point. At the end of the marking and drawing sessions, the results were organized at different time leves for the new and old environment. Our observations were not only oriented to the number of landmarks, but also to what type of landmarks are common, what is the extend the victims mark the landmarks and which landmarks were missed, or remembered or caused to confusion. The sum of marks and drawings with reference to selected qualities in each level and duration was converted to tabulations. The data was analyzed due to statistical programmes and pearson chi-square was implemented to evaluate significant association between variables.

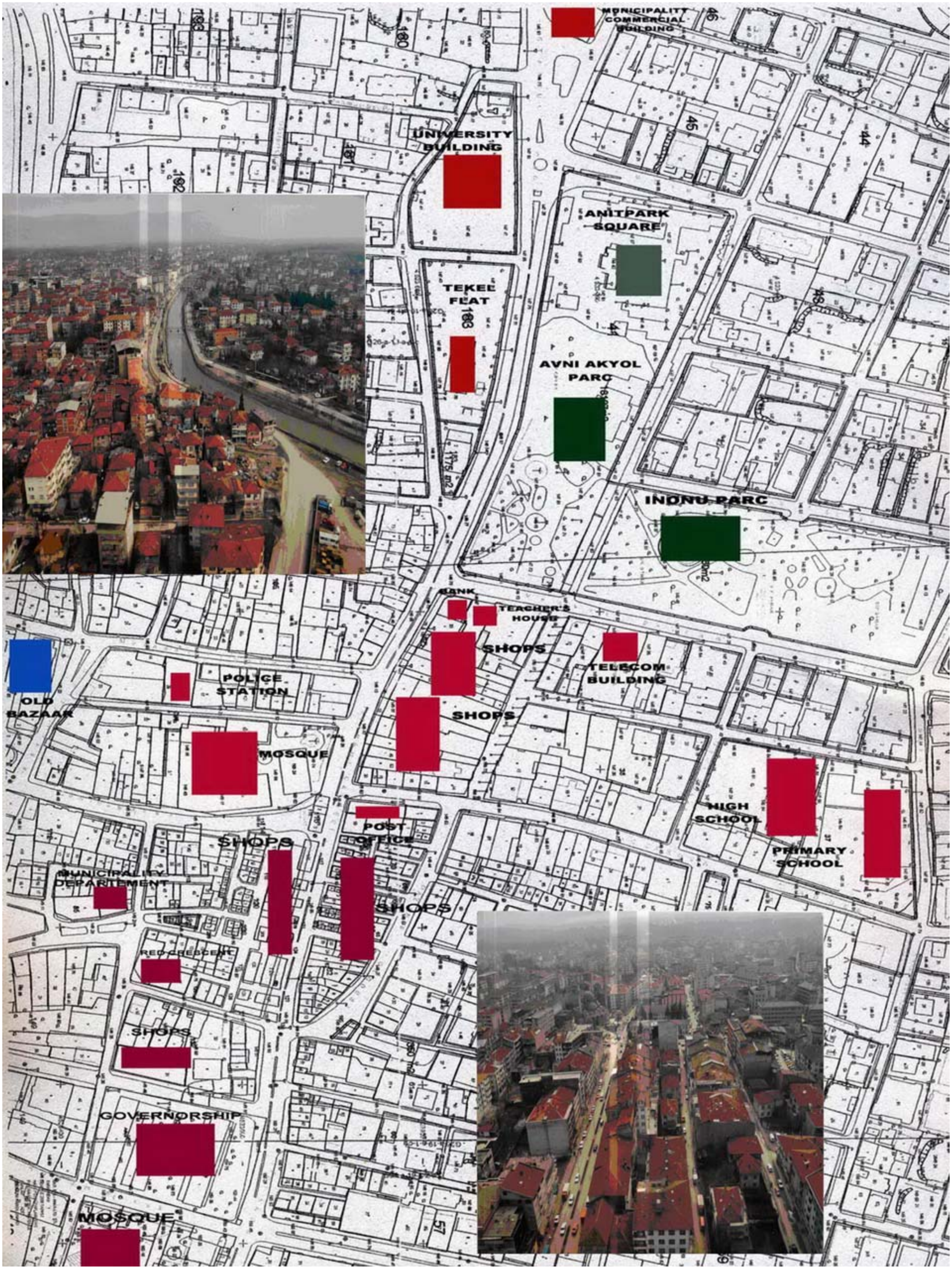

Figure 4 The Old City Center and Important Buildings

Figure 5 The New City Center

DISCUSSION

If we examine the data, it states that 63,3 % of victims live in a new environment after the disaster. The 63,4 % of the victims live more than 20 years in the city so that they had much experiences in the old city environment. Nearly, 50 % of the sample had losses after the disaster so that the disaster had caused high stress to these victims. Hence, the adaptation problems were less than 18,2 % which may show the strong social ties and support of the other community members.

The post office building in the old city center is highly significant to the victims that nearly 70 % of the sample marked or drew it in their maps. This is an important fact that the post office seen as place of meeting. The most marked old official institution is the municipality and governorship buildings with nearly 27 % of the sample. Despite bulky appearance of the municipality commerce center it is missed in cognitive mapping that could not be remembered by the victims.

The important buildings which were marked and drew in the new city center were respectively 39,8 % the Mosque, 39,8 % recreational areas, 26,5 % the municipality and 23,2 % the university building whereas 6,6 % hospital and 3,3 % governorship buildings were marked or drew. The mosque is important because of residences' religious bonds and the selection of recreational areas show the high need of socialization of the victims after the disaster's trauma. The perception of the victim about the official institutions in the new city had negative impacts on them because the buildings are scattered and can not be perceived easily. Also the social facilities were evaluated as insufficient by the victims and they had negative impacts on social reconstruction process.

The first finding is people having more losses during the disaster marked and drew more images compare to people having of no losses in the disaster, this finding is determined in 120 seconds of the mapping process. This shows that, the attachment of these victims to the city is significantly high and they had strong bonds with the old environment in spite of the disaster situation. These people are relocated from their old environment and easily adapted to their new environment and neighboors (x^2=8,3, df=1, p=.04). In gender-marked image relation 70 % of the woman marked or drew more images when compared to the 30 % of the men in the new environment and old environment. These results show that the woman had more experiences in the city and they construct more linkages with the city.

The second finding is 25 % of the residents over 20 years passed the average number of total images of the old city comparatively to 3,3 % of the residents of 10–20 year and to 10 % of residents between 0–10 year. The images determined in the new city center gives closer results compared to the old ones; 40 % of the residents over 20 years marked or drew over the total images of the new city comparatively to 10 % of the 0–20 year residents. This shows that long time residents over 20 years had very strong bonds and attachments either about the old or the new city center.

The third finding is 3 % the victims between 46–65 years age could only remember over the average number of total images and they had a tendency to forget the images of the old city center comparatively to 36,3 % of the 18–45 years age. The image determined in the new city give closer results compared to the olds ones; 6,6 % of the 46–65 years age drew or marked images over the average of the total images comparatively to 36,6 % of the 18–45 years age. This shows the elderly people over 46 had a tendency to forget some of the images of the old and new city center. The impact of the trauma on elderly victims' cognitive schemata is higher than the others and the elderly victims more attached to the city from certain and/or general images that had small ratio (approxiametely 10 %) of the total number of images.

The last finding is that 27 % of the relocated people determine over the average number of total images in the old city center comparatively 10 % to the others. Also the findings in the new city center support this. The 35 % relocated victim determine over the average number of total images in the new city comparatively 10 % of the others. In spite of the traumatic conditions victims had create more sensitive bonds compare to the people having no losses in the disaster and this situation pushes their attachment to the high levels.

RESULTS

This case study presents that there is an impact of the disaster on cognitive maps of the victims. Altough there is tremendeous changes in the city forms, but the construction of the new buildings; the old and new city images in the cognitive maps of the victims are represented in high levels. This is possibly derived from the victims' long time duration of residence, relatively limited change in the old city roads and the small size of the city center. The most of the old buildings (mosques, municipality) were constructed in its previous location so this might be another cause for rememberance.

The perception of the new city and environment shows that the physical reconstruction needs should be strengthened with social reconstruction process during the post disaster situation. Because the people need socialization and more social places in their daily routines. Women's images are generally focused on shops and large stores, so they evaluate the new city from their perspective. However, they mostly evaluate the shopping facilities in the new city insufficient because of shopping is vital form of socialization, and it may overcome the social trauma.

The results of the study clearly show that the impact of disaster on human being especially in visual carteography and cognitive mappings. The residences try to reduce their stresses by means of socialization (boosting social bonds, following traditional occasions, etc.). So, The physical environment should be planned and designed in this point of view to reduce the environmental stress and to boost the reconstruction activities overcoming existing trauma.

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Academic & Professional Practice

Peer Reviewed Articles

TRAINING, EXERCISING AND SIMULATION

DECISION SUPPORT FOR CRISIS MANAGEMENT BY LARGE-SCALE EXERCISES

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Crisis Management Exercise, Power Blackout, Decision Support System, Multi-Criteria Analysis, Case-Based-Reasoning

Abstract

Natural disasters with a subsequent power blackout can cause serious damages in complex economic nets (such as water supply infrastructure or food supply networks) as well as in social systems (e.g. medical care structures). In the event of such large scale emergencies, a coherent and effective emergency management involving complex decisions and fast realisation of appropriate countermeasures is necessary. The aim of this study is to develop a decision support system (DSS) for crisis management in the event of large area blackouts. Multi-Criteria Decision Analysis (MCDA) can help to involve the different parties (e.g. all relevant administrative levels) in the decision making process in a transparent way and to bring together the knowledge from diverse disciplines. In Order to support and speed up the problem structuring process within MCDA, it is proposed to use Case-based reasoning (CBR). CBR is a methodology from the field of artificial intelligence, in which new problems can be solved by adapting solutions that were successful in previous problems.

In this study we present an approach for combining MCDA and CBR in a decision support system for crisis management. The application and creation of a case base is described in the context of a case study which is based on data from the first cross-national emergency management exercise LÜKEX ("Länderübergreifende Katastrophenschutz Exercise"), which was conducted by the Federal Office of Civil Protection and Disaster Assistance in four Federal States of Germany.

1 Introduction

Emergency situations can differ in many ways, for instance, according to their causes and the dimension of their impact. Yet, emergency situations share the characteristic of sudden onset and the necessity for a coherent and effective emergency management involving complex decisions under time pressure and the need for prompt and efficient reactions from the responsible persons (Geldermann et al., 2007). Often, effects of man-made or natural hazards are propagated through complex economic nets (e.g. supply chains such as electricity supply networks or food supply chains) or

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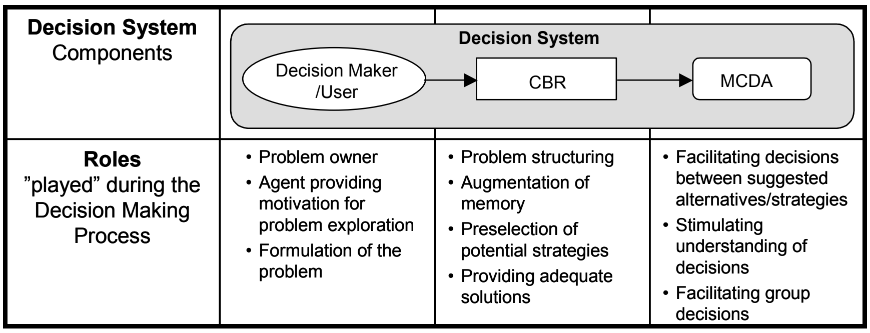
social systems (e.g. medical care structures). For instance, in the event of a large area power blackout, the subsequent impacts and the extent of damages to society and economy as a whole can be severe but predictions are afflicted with uncertainties.
To asses these impacts, the first cross-national crisis management exercise LÜKEX was conducted in 2004 by the Federal Office of Civil Protection and Disaster Assistance in four Federal States of Germany (approx. 29 million inhabitants, area of 120.000 km^2). During this three day exercise, a scenario involving a large area blackout in the south of Germany due to thunderstorms and heavy snowfall was assumed (Bundesamt für Bevölkerungsschutz und Katastrophenhilfe, 2004).
In order to facilitate the complex decision processes in the event of such a large area blackout, decision support is needed. The aim of the study presented in this paper is to develop a decision support system (DSS) for power outages resulting from bad weather conditions, based on the data obtained from the LÜKEX exercise as well as on expert knowledge.
The resolution of complex decision situations in crisis and emergency management following a man-made or natural emergency usually requires input from different disciplines and fields of expertise. Since this involves resolving many conflicting objectives, setting priorities, and perhaps most importantly, bringing the various perspectives of the many stakeholder groups into some form of consensus, multi-criteria decision analysis (MCDA) can help to bring together existing knowledge and to ensure transparency during the decision making process (Geldermann, 2006; Belton and Stewart, 2002; French, 2000; Hämäläinen et al., 2000).
Since the consequences in large scale crises are relatively unpredictable, a structuring and preselection of alternative emergency countermeasures tailored to the actual situation are necessary. For that purpose and to provide richer support for decision making, case-based reasoning methods (CBR) from the field of artificial intelligence can be integrated in DSSs (Dutta et al., 1997; Kolodner, 1993). In CBR systems, new problems are solved by adapting solutions that were used to solve previous problems (Aamodt and Plaza, 1994). For example, experiences and data from the conducted crisis management exercise can be used for decision support in case of an emergency. A possible combination of CBR and MCDA is shown in Figure 1. The implementation of CBR helps the decision makers to structure the knowledge about potential alternative emergency strategies and countermeasures. Thus, it acts to augment the decision makers memory about alternatives and helps to provide potential problem solutions for the person to consider that he or she might not be aware of (Kolodner, 1993).

Figure 1: Decision System integrating CBR (adapted from Angehrn and Dutta, 1992)

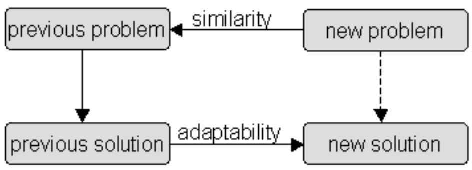


In this paper, the possibility of integrating CBR methods as an approach for problem structuring and preselection in DSSs for crisis management is examined. In Section 2 the foundations of conventional CBR are explained, while Section 3 describes a possible combination of CBR and MCDA as well as parallels between the two methods in a DSS. In Section 4, the structuring of data reported from the LÜKEX exercise as well as the subsequent implementation of a CBR system are presented. The last section concludes the paper by highlighting the contributions of this paper and describing challenges for further research.

2 CBR methodology

Case-based reasoning is a methodology from the field of artificial intelligence. As opposed to rule-based reasoning, where rule chains are given as explanations, CBR uses specific encapsulated prior experiences as a basis for reasoning about new situations (Watson, 1997). In CBR, new problems are solved by adapting solutions that were used to solve previous problems (Kolodner, 1993; Riesbeck and Schank, 1989) (cf. Figure 2). The methodology of CBR has its roots in the field of cognitive sciences. It is adapted from humans` intelligence as people in their daily life often revert back to solutions of previous problems in order to manage new situations. (Ross, 1989; Ross, 1986) for example has shown that people, when learning to solve problems, often refer back to previous problems in order to find suitable solutions in their memories. Also experts seem to have a preference for using cases in problem solving or decision making (Kinley, 2001), but they do not always remember the right ones (Gentner, 1989). This problem is alleviated and memories of experts are augmented by using computers as a retrieval tool (Kolodner, 1993).

Figure 2: Problem solving with CBR (Minor, 2006)



In CBR-Systems, previous cases are stored in a case library (CL). A case typically is a record comprising a problem description (state of the world when the case occurred) and the description of the corresponding solution (Watson, 1997). CBR applications are implemented for different domains and task types. The domain can for example be mechanical engineering, medicine, business administration or crisis management. Different task types in CBR for example are diagnosis, configuration or planning (Richter, 1998). The size of the CL highly depends on the domain and task types being addressed. In some CBR systems, only a few cases are required for an appropriate performance while in others hundreds or even thousands of cases need to be stored in the CL (Leake, 1996).
A fundamental issue in building a CBR-System is choosing the appropriate representation of cases in the CL (Aamodt and Plaza, 1994). The case representation is highly influenced by the domain and the task type of a CBR-System. The main data structures that occur in CBR are the traditional data structures also used in database technology (Richter and Aamodt, 2006). In literature, several different approaches to case representation and, related to that, different techniques for case-based reasoning can be found:

- textual CBR (cases are represented in free text form) (Minor, 2006)
- conversational CBR (cases are lists of questions and answers) (Johnson, 2000)
- structural CBR (cases are stored according to preselected measurable attributes (e.g. names, values like cost and temperature) (Price and Pegler, 1995).

Since attributes of cases are often costly to determine or sometimes simply unavailable, the possibility to match cases on partial information within CBR is essential (Bogaerts and Leake, 2004). The classical CBR process on a conceptual level is represented by the CBR cycle. The main phases of the CBR action are the steps *retrieve, reuse, revise* and *retain* (Aamodt and Plaza, 1994).
During the *retrieval*, the most similar case or a set of similar cases for an actual problem in the CL are determined. The retrieval is based on a measure of similarity between the current situation and the stored case (Wilson, 2001). The process of remembering relevant cases relies heavily upon the used similarity metric. A typically used method for the similarity assessment in CBR is the method of nearest neighbour (Richter, 1998; Watson, 1997; Watson

and Marir, 1994). In this approach, the similarity between two cases is based on matching a weighted sum of features/attributes where the weight expresses the relative importance of a feature. The determination of weights is often one of the biggest problems in similarity assessment. A typical *evaluation function* (also called global similarity function) often used for nearest neighbour matching is given by (Kolodner, 1993):

(1)
$$\frac{\sum_{i=1}^{n} w_i * sim\left(a_i^I, a_i^R\right)}{\sum_{i=1}^{n} w_i}$$

with:

w_i Weight (importance) of attribute I; $\in [0,1]$
sim Similarity function; $\in R^2 \to [0,1]$
a_i^I Value of attribute a_i of input case; $\in$ R
a_i^R Value of attribute a_i of retrieved case; $\in$ R

Both *weights* and dimension of the *local similarity function*, $sim(f_i^I, f_i^R)$ are represented as values between 0 and 1. Closer matches have values close to 1, poorer matches closer to 0. After a case has been retrieved successfully, the next step is to *reuse* and apply the matched case to the new problem. The simplest way of reuse is to transfer the unchanged solution of the old problem to the actual problem. However, in many applications (e.g. planning) this is not possible and even small differences may require significant modification (case adaptation). The case adaptation is performed in the *revision* step. The flexibility of problem solving of CBR systems highly depends on the ability of the system to adapt retrieved cases to new circumstances and on the ability to repair solutions which failed (Leake, 1996). As case adaptation requires additional background knowledge, it is usually performed by user intervention or static rules. In order to overcome the difficulties in case adaptation and to automate this process, (Leake et al., 1997) and (Kinley, 2001) developed a CBR system whose components themselves use CBR for case adaptation.

The adapted cases are stored in the CL in the *retain* step. This provides the mechanism for the system to augment its knowledge and to learn from the problems that have been solved. However, it must be kept in mind that a large CL must be well organised in order to avoid elongation of retrieval time.

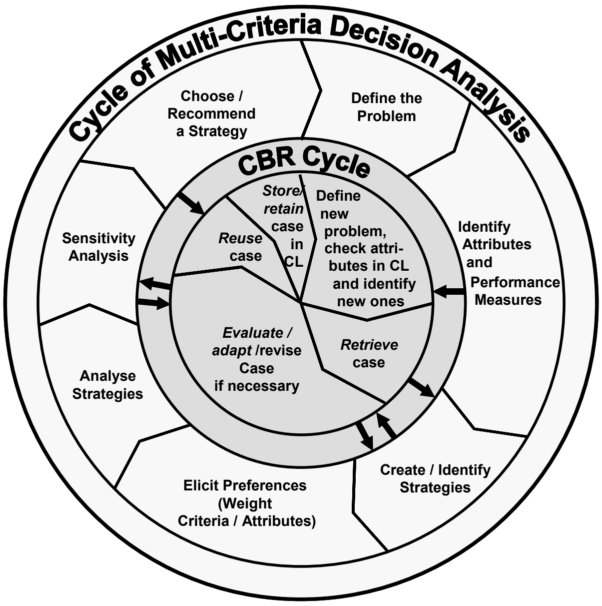
CBR systems have been implemented successfully in the last two decades for several domains and tasks: for diagnosis (Bareiss, 1989), help desks (Lenz et al., 2007), electronic commerce (Stolpmann and Wess, 1998) as well as process design (Price and Pegler, 1995). Furthermore, CBR is used for planning issues. In the late eighties (Goodman, 1989) implemented a CBR system for strategic war planning. In DIAL, a textual CBR system for disaster response planning, the components themselves use CBR for both similarity assessment during a plan retrieval and the adaptation of the retrieved plans (Kinley, 2001; Leake et al., 1997). Other CBR applications in the field of disaster response planning are e.g. the decision support system called CHARADE which is used for forest fire management in Italy (Avesani et al., 2000) and the Interactive Crisis Assistant (INCA) applied to the domain of handling hazardous materials (Gervasio et al., 1998).

In most of the systems using CBR, the user/expert is actively involved in the decision process. Thus, CBR-Systems enable the active participation of experts in complex decisions instead of trying to automate solution finding which was the original intention of knowledge based systems (Wess, 1996). The facilitation and further support of decision processes by means of problem structuring and preselection of potential solutions was the intention of the integration of CBR methods in a DSS using MCDA. In the next section, the combination and parallels of these two methods are explained in more detail.

3 Combining CBR and MCDA

Decisions in the context of emergency management involve many parties who usually have different views, responsibilities and interests (Geldermann et al., 2007; French and Geldermann, 2005). Multi-Criteria Decision Analysis (MCDA), as one method within the field of operations research, can help to involve the different parties in the decision making process in a transparent way and to bring together their knowledge from diverse disciplines. One field of research within MCDA, which has proven suitable for application in the scope of emergency management (see Geldermann et al., 2007; Hämäläinen et al., 2000; French, 1996), is multi-attribute value theory (MAVT). This theory provides methods to structure and analyse decision problems by means of attribute trees and to elicit the relative importance of criteria in such a tree. In short, the essential interactive steps of a MAVT analysis are problem structuring, preference elicitation, aggregation, sensitivity analysis and finally the decision (or a recommendation), each of which is often done in a moderated/facilitated discussion. Problem structuring is a very important part within MAVT which is concerned with appropriately formulating rather than solving a problem (Belton and Stewart, 2002). It gives a better understanding of both, the problem and the values affecting a decision and also serves as a basis for further analyses and as a common language for communication (Shaw et al., 2004; Rosenhead and Mingers, 2001).
However, in large-scale emergencies, problem structuring can become a very challenging task and usual problem structuring approaches might possibly fail. Thus, it is proposed to support and speed up the problem structuring process by using CBR methods for a "preselection" of potential strategies based on past experiences and knowledge. In addition, such an amalgamation of CBR and MCDA could contribute to interactive learning which is often not supported by common DSSs. In this context, learning should be understood in a symbiotic, bidirectional way: users can learn from a DSS about (stored) prior problem solutions and the DSS can learn from users by observing their problem solving behaviours (Angehrn and Dutta, 1992). Figure 3 shows the parallels between the cycles of MCDA and CBR and how CBR could be integrated into the MCDA cycle. Both methods are mutually beneficial.

Figure 3: Cycles of MCDA and CBR



In order to harmonise the terminologies of CBR and MCDA, the wording in the depicted CBR Cycle deviates in a few points from the classical CBR cycle described in the previous section. Since in combination with MCDA, the CBR methods are used for structuring and preselection of possible solutions, we introduced an evaluation step. Here, all proposed cases are evaluated if they are adequate solutions and if they qualify as suitable strategies.

Furthermore, we think that it is useful in the context of decision making in crisis management to set the reuse step behind the evaluation and adaptation process (the revise step in the classical CBR cycle) because CBR methods are only used for a preselection of possible strategies and a modification before application would be necessary in most cases.
Besides finding the most applicable countermeasure strategies in different situations, MCDA can help to enhance public confidence and understanding as well as transparency and traceability in relation to emergency management. Without such trust building components, decisions might not be accepted by the public and the potential benefit of a decision might double back to negative results. It should be emphasised that any multi-criteria decision support system is not intended to substitute but to assist decision makers in resolving complex decision situations (see e.g. Bertsch et al., 2006) and that MCDA as well as CBR – especially in the adaptation/revision phase – necessitate input of the persons in charge and thus actively strive to involve them in the decision making process.

4 Implementation of CBR in a DSS for crisis management

The first national crisis management exercise in Germany, LÜKEX, was conducted by the Federal Office of Civil Protection and Disaster Assistance in four Federal States in 2004. During this exercise, 6000 participants from administration, police and industry practiced how to deal with arising threats caused by natural hazards and the consequential damages. Besides the four Federal States (Bavaria, Baden-Wuerttemberg, Berlin and Schleswig-Holstein) and eight Federal Ministries, 100 external actors, such as, for example, power producers, meteorological service, telecommunication companies, discounters and German Railway were involved in the exercise. During the three day exercise, a scenario was assumed involving a large area blackout in the south of Germany due to thunderstorms and heavy snowfall. The main aim of this simulation exercise was to examine the reactivity to a trans-sectoral crisis in a large area.
The scenario and the course of the exercise was distributed to the participating departments in the form of screenplays, which had been elaborated in more than 100 workshops in preparation for the exercise. The responding operations and consequences of a blackout as well as the proposed reactions of the different departments have been documented in a protocol data base. The exercise has already been analysed in terms of strategic and administrative aspects (Bundesamt für Bevölkerungsschutz und Katastrophenhilfe, 2004). The aim of this study now, is a further evaluation of the LÜKEX exercise considering consequential arising threats and the development of a decision support system for large area blackouts. Since large scale exercises like LÜKEX are conducted in order to be prepared for arising future crises, the gained knowledge should be available for future decisions. Thus, in order to use these experiences for decision support in crisis management, a CBR system based on the protocol data is implemented and integrated in a DSS. In the domain of crisis management, CBR should be preferred to rule-based reasoning, because consequences of disasters are often unpredictable, reported data (e.g. from exercises or previous disasters) can be incomplete and no algorithms for evaluation might be available (Kolodner, 1993). Another major advantage of CBR systems is the fact that they allow the decision maker to propose problems and corresponding solutions very quickly, eliminating the time necessary to develop them from scratch. This time saving aspect is essential in crisis management as, in the event of a crisis, complex decision making often takes place under time pressure. In CBR, problems and solutions which failed can also be integrated, this can be a useful warning, helping the decision maker to take actions to avoid repeating past or potential mistakes. Altogether, CBR seems to be a promising method which is suited for implementation in the decision process in crisis management. It facilitates the preselection of potential emergency countermeasures and problem solutions, because it helps to focus on important parts of a problem by pointing out the important attributes. In building an efficient CBR system, it is essential to find an appropriate representation of cases in the CL (Aamodt and Plaza, 1994). Therefore, relevant, discriminating and measurable features/attributes of the problems and the related solutions must be determined (Watson, 1997).

From the received protocol data, it can be seen that direct damages to critical infrastructures like power supply chains can lead to serious consequential problems in various sectors. Some selected sectors typically affected by long-time power blackouts are listed in Table 1.
Since in the protocol database, all arising problems are stored together, a structuring of the protocol data is necessary before building a case base. The reported data in the protocol data base are classified according to the affected sector (also called domain) and provided with a domain specific key. In total, 18 different domains were identified from the data base. In this section, the data structuring and case base (CL) creation for the health care sector are exemplarily described.

Table 1: Sectors affected by long-time power outages

Domain - Affected Sector	Entity
Direct electricity use	- Industry - Households
Agriculture and food supply	- Milk industry - Livestock farming - Slaughterhouses - Food industries
Medical care	- Hospitals - Nursing homes
Water Supply/waste management/environment	- Water supply - Waste disposal - Handling hazardous materials
Communication and information systems	- Telephone - Internet - Data processing
Transport	- Rail/air/road - Long-distance transport - Local traffic
Emergency and crisis management	- Emergency medical services - Public safety - Administration

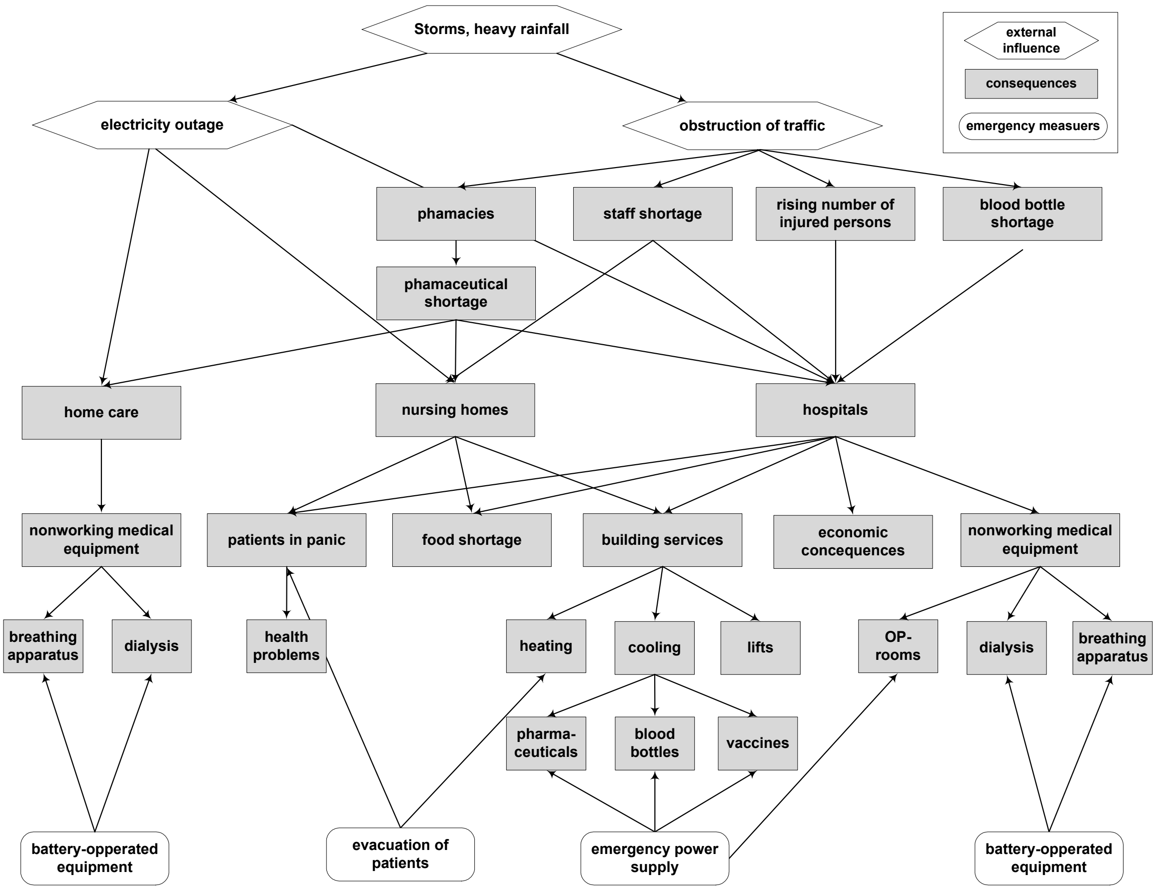
For the structuring of data within each domain, the consequences of a power blackout in combination with bad weather conditions are described (see Figure 4). From this selection, typical representative cases of the domain are identified.
As already mentioned above one of the major challenges in building a case base is the appropriate selection of relevant and measurable attributes for the case representation. For the domain of health care the following attributes/features could be identified:

- duration of blackout
- number of affected persons
- number of affected persons seriously injured
- distance to the next hospital not affected
- range of emergency power supply
- number of missing staff
- range of pharmaceuticals
- amount of missing pharmaceuticals
- number of blood bottles available
- economic losses

Because of the high heterogeneity of the different affected domains, it is impossible to find a case representation with uniform attributes which is appropriate for cases from all domains. Therefore, we suggest to create 18 different case bases, one for each domain. These case bases in the end can be linked again in the DSS. (Leake and Sooriamurthi, 2001) pointed out that in the case of different case representations, retaining multiple case-bases can benefit both performance and maintenance of CLs. However, in order to achieve those benefits it is

inevitable to develop methods for case-dispatching (deciding which case-base to select) and for cross-case adaptation (revising proposed solutions to apply them in another context).
At this point it has to be mentioned that the data in the protocol database of the LÜKEX exercise is not sufficient for the development of a complete CL for a decision support system for large area blackouts. For a more detailed and complete case representation, additional information is necessary, thus experts need to be interviewed and future exercises need to be conducted. But at least it helps to evaluate the immense data already available, to structure it and to document it in a reasonable way. Reuse for future exercises is also possible.

Figure 4: Consequences of a power blackout in the health care sector



5 Discussion and Conclusion

In the event of large scale emergencies like natural disasters with a subsequent power blackout, a coherent and effective emergency management involving complex decisions and fast realisation of appropriate countermeasures is necessary. The selection of efficient countermeasures and reaction strategies usually requires knowledge and input from different disciplines and fields of expertise. In this paper we presented a conceptual approach for decision support in the field of crisis management which combines methodologies from MCDA and CBR: Here the CBR helps the user to structure the knowledge about possible solutions to planning problems and acts to augment the decision makers memory about appropriate strategies in the event of crises. It should be pointed out that any DSS is not intended to automate the decision process nor to substitute the user. Rather it can fasten and facilitate the decision process by assisting the decision makers in resolving complex decisions and finding appropriate solutions.
Protocol data which are reported in a cross-national emergency exercise provide a basis for building a CBR system for decision support in crisis management, especially for a crises

involving large scale power blackouts. Since direct damages in critical infrastructures like power supply networks can lead to serious consequential problems in various sectors, a data structuring in order to identify affected domains and representative cases is necessary before building a case base (CL). A fundamental issue in building a case base is the appropriate selection and representation of cases in the CL. Therefore, adequate features (attributes which are measurable, differentiating and relevant) of the cases must be identified. Because of the high heterogeneity of the domains affected by a large scale power outage, further work needs to focus on the selection of relevant attributes. Thus, in order to develop an operationally applicable decision support system with integrated methods from CBR, further emergency exercises with an appropriate data documentation and expert interviews should be conducted in future. In this regard, experiences and results from the evaluation of LÜKEX 2004 can also be used in advance for an efficient planning of forthcoming large scale exercises in crisis management.

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LEARNING TO EVALUATE MULTIDISCIPLINARY CRISIS-MANAGEMENT TEAM EXERCISES

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Keywords

Training, exercises, crisis management, evaluation, best practice, multidisciplinary teams

Abstract

Training of multidisciplinary crisis management teams is becoming more common practice. Nevertheless, the value of these trainings and exercises is questionable. Scenarios are quite often realistic and challenging to the trainees: the team members are heavily engaged in doing their jobs in a multidisciplinary context. But the degree to which they can really learn from these experiences depends on more than just the realism. The training situation may be too complex or hectic to get a good understanding of the team's performance. A solid evaluation afterwards is therefore of utmost importance. However, an effective evaluation requires expert-evaluators. In many cases evaluators are themselves experts in the field of crisis management. But that does not automatically guarantee them to be expert-evaluators. They need to be able to not only observe and diagnose the team's performance (with respect to taskwork and teamwork), but also to give feedback in an effective and structured way, and to guide the team in their evaluation process. Improving the competencies of evaluators is therefore conditional for increasing the effectiveness of multidisciplinary exercises from a

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learning perspective. Supported by the Dutch Home Office, we developed a six-day course combining practical experience and results of scientific research. In three blocks of two days, the trainees learn more about observing multidisciplinary team performance, conducting an evaluation with the team, and writing an evaluation report. Hands-on experience is combined with short theoretical reflections. Afterwards, the trainees follow an interactive examination during which their performance is assessed by two independent examiners. Up to now, three courses have been conducted. Every course is evaluated based on which the next course is improved. Trainees come from first responder organizations, the military and other organizations (e.g. municipality). In the paper we will describe the structure and contents of both the course and the examination, and share our experiences.

Introduction

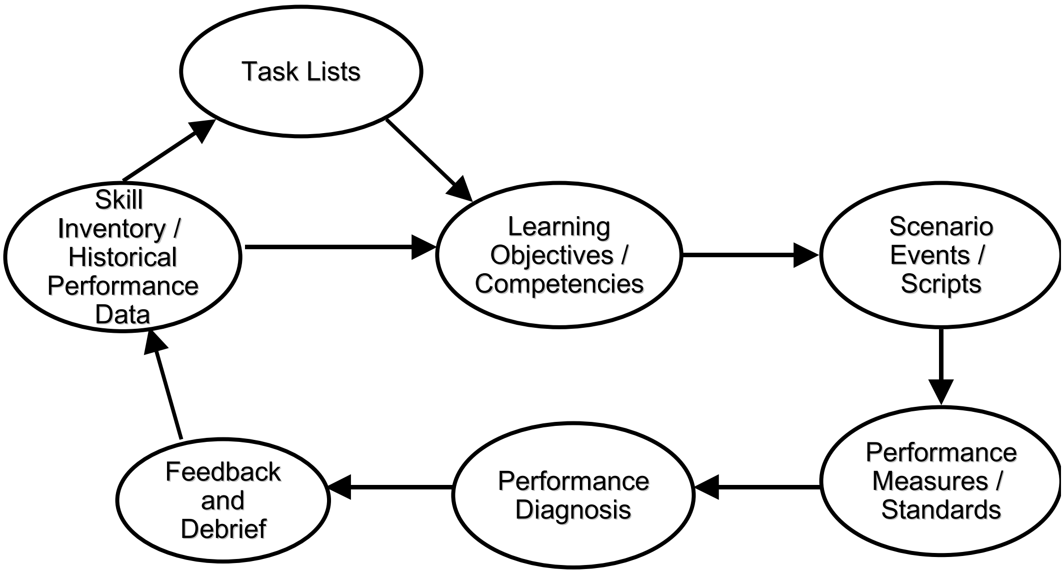
Technological developments have resulted in more sophisticated and complex systems in which humans have to operate. These systems are characterized by a highly dynamic and sometimes hostile environment, the variation of (often conflicting) goals, the incompleteness, uncertainty and ambiguity of information, and the involvement of teams of officers with members having different roles and responsibilities (Rouse, Cannon-Bowers & Salas, 1992). In these situations, many tasks are conducted by multidisciplinary teams. Crisis management teams are characterized by these descriptions. Because crisis management teams have to operate in critical situations affecting the life and well-being of many citizens, it is important that these teams can perform their tasks in a competent way. Team performance is affected by many different variables, both within the team itself and in the organizational and operational context. Therefore, training cannot be the sole contributor to enhance team effectiveness. But carefully identifying and analyzing the variables affecting team performance, and taking into account these factors in the process of instructional systems design, will probably positively impact the effectiveness of the team training (Van Berlo, 2005).

Training of multidisciplinary crisis management teams is becoming more common practice. Nevertheless, the value of these trainings and exercises is questionable. Scenarios are quite often realistic and challenging to the trainees: the team members are heavily engaged in doing their jobs in a multidisciplinary context. But the degree to which they can really learn from these experiences depends on more than just the realism: the training situation may be too complex or hectic to get a good understanding of the team's performance. A solid evaluation afterwards is therefore of utmost importance. However, an effective evaluation requires expert-evaluators. In many cases evaluators are themselves experts in the field of crisis management. But that does not automatically guarantee them to be expert-evaluators. They need to be able to not only observe and diagnose the team's performance (with respect to taskwork and teamwork), but also to give feedback in an effective and structured way, and to guide the team in their evaluation process. Improving the competencies of evaluators is therefore conditional for increasing the effectiveness of multidisciplinary exercises from a learning perspective. Supported by the Dutch Home Office, we developed a six-day course and an interactive exam combining practical experience and results of scientific research. In this paper we will describe the structure and contents of both the course and the examination, and our experience so far. Firstly, the theory behind multidisciplinary team training is briefly explained. In the following two sections we describe the structure and contents of both the course and the exam. Next the findings so far are described and we conclude with a discussion.

Theory and method

It becomes increasingly clear that just putting together a team of individual experts does not make an expert team (Salas, Cannon-Bowers, & Johnston, 1997). In recent years, it has been shown that a good approach to training teams with complex training technology is linking training goals to events in training scenarios in a controlled fashion. This is called the 'event-based approach to training' (EBAT: see Figure 1) (Hall, Dwyer, Cannon-Bowers, Salas & Volpe, 1993; Cannon-Bowers, Burns, Salas & Pruitt, 1998).

Figure 1. The EBAT framework (cf. Cannon-Bowers, Burns, Salas & Pruitt, 1998, p. 366).



The EBAT framework starts at the top left hand side with the tasks to be performed by the team. The basic assumption is that training should provide opportunities for practice, enabling a team to develop critical competencies to conduct their mission, or, to manage an emergency. The team and individual behavior indicating these competencies is explicitly described in the learning objectives. Based on these learning objectives, the training scenario is developed. A training scenario consists of several events that are specifically designed to trigger the team members' behavior as described in the learning objectives. Events are critical incidents that can occur during the course of the emergency and on which the team is supposed to react. For every event, the observers know what behavior the team should demonstrate, and which prototypical mistakes could be made. This facilitates a systematic observation of the team members' behavior. Based on these measurements the training staff is able to make a valid diagnosis of the performance and to assess to what extent the learning objectives have been achieved. During the debrief, feedback is provided to the team and, together with the team, the lessons learned are formulated. The strength of EBAT is the systematic linkage among these components. Without this linkage it is impossible to ensure that team members will have learned anything from the training.

Performance measurement, diagnosis and providing feedback are essential elements to support the learning process the team needs to be engaged in. Although technology can be supportive in this respect, the competence of the human evaluator is critical. Guided by the instructor the team members reflect on the team's performance, discuss which actions have been conducted, why certain choices and decisions have been made and which improvements can be made. In this way, a critical function in the team's learning process can be realized: reflecting on the own behavior in order to gain a deeper understanding of the characteristics of effective team performance. The reflection is primarily aimed at the instructional objectives and the execution of the training scenario (Van Berlo, 2005).

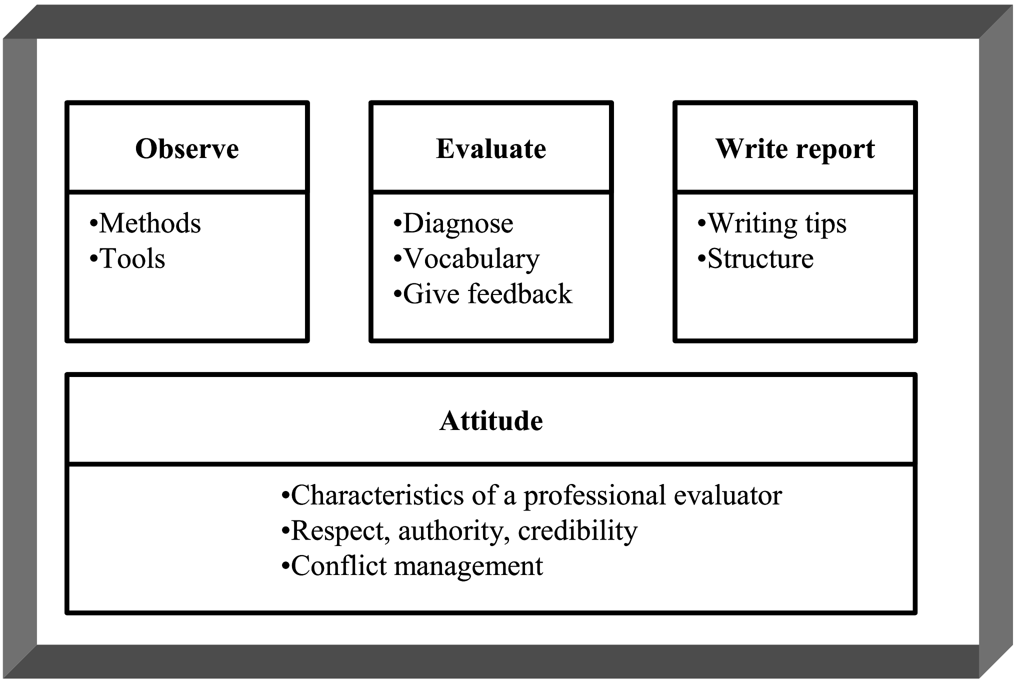
The partners in our project team have various backgrounds, covering the fields of operational crisis management, instructional design, organizing and evaluating exercises, and research on real-life crises and team training. Based on our practical and theoretical experience, we defined the competencies expert evaluators need to have in our view. As a prerequisite, they need to have basic knowledge of the structures and processes within multidisciplinary crisis management organizations. They also need to be able to observe multidisciplinary teams, and diagnose their processes and performance. Based on the observations and diagnosis, they should give feedback to the group in two ways: a) directly to the team during a guided discussion, and b) afterwards in a written report. The evaluator must be able to handle resistance from the team and give the feedback in a respectful matter. In the following sections we will describe the structure and contents of both the course and the exam.

Structure and contents of the course

Supported by the Dutch Home Office, and with the Dutch Police academy as project manager, we developed a six-day course. In three blocks of two days, including an evening program, the trainees learn more about observing multidisciplinary team performance, conducting an evaluation with the team, and writing an evaluation report. Hands-on experience is combined with short theoretical reflections. One or two core instructors are responsible for most of the lectures and exercises; guest-instructors and role-players are scheduled on more specialized topics.

The four building blocks, upon which the course is based, are 'observe', 'evaluate', 'write evaluation report' and 'attitude' (see Figure 2). These are the four pillars that we believe form the base that good evaluators need. All the competencies or knowledge that we want the trainees to acquire, are placed within one of these blocks.

Figure 2. Structure of the course on learning to evaluate multidisciplinary teams.



In the block 'Observe', we treat the theoretical topics of human biases in observations, as well as non-verbal communication and group dynamics, e.g. team roles (Belbin, 1996), and influence techniques (Forsyth, 2006). We share tips and tricks in making observation notes and practice frequently with observing different situations. In the block 'Evaluate' trainees learn the basic rules of giving and receiving feedback, and human interaction processes (Remmerswaal, 2003; van Dijk, 2000). We pay attention to personal styles and how to handle conflicts with(in) teams. The trainees practice frequently with different feedback situations. In the block 'Write report' we focus on writing an evaluation report: what is a good way to describe the entire performance of a multidisciplinary crisis management team in a report and how does this relate to the training objectives? And how do you come to a conclusion in a logical and understandable manner? The so-called OAOA-method (a Dutch acronym for Observe-Analyze-Judge-Recommend) has found to be helpful in this respect. The blocks described so far reflect three key competencies of an evaluator. A prerequisite however, is a professional attitude of the multidisciplinary evaluator. This relates to the way the evaluator sees his own role in the whole process of improving the performance of crisis management teams during training and exercises. The multidisciplinary factor requires them to gain knowledge about all relevant organizations. And last but certainly not least, we stress the importance of respect, authority and credibility.

In the course, we integrate these four blocks by combining theoretical blocks with frequent practices. For instance, at the start of the course trainees practice their observation and writing skills based on DVD-recorded team actions. Trainees engage in role-playing situations (both with fellow trainees and professional role players) and practice feedback skills. At the end of the course, trainees observe a real-life exercise of the Dutch police force or the military, giving them an opportunity to practice in a realistic operational setting.

Trainees bring in a variety of operational expertise, cultural differences, and training experiences. For instance, the police evaluates real-life large-scale operations with specific evaluation teams, but gives the feedback only to the overall commander. The fire brigade particularly has experience in evaluating training and exercises. The military has, in general, a more formalized way of conducting evaluations mainly focused on procedures. In order to promote gaining knowledge about other disciplines in the crisis-management organizations, several group activities and an evening program are included in the course. This gives trainees (also informal) opportunities to exchange knowledge and expertise, learn from each other's difficulties, and get a better understanding of each roles and positions. Combined with the fact that the core-instructors guide and coach the trainees, a safe learning environment is established.

Structure and contents of the exam

After the course a competence test takes place. A competence test is an instrument with which trainees can demonstrate the acquired competencies and is a standard way of concluding a course at the Dutch Police academy. Proven competence results in a formal qualification. The trainee has to perform successfully during his assignment in order to be qualified in his day-to-day practice. Competence tests are developed and determined by a development group, consisting of faculty teachers, operational experts and specialists, and a developer of competence tests from the Examination Board of the Police Academy. This development group determines the content and form of the test. A competence test contains one (or more) assignment(s), which is (are) described and provided with assessment forms (checklist) and explanatory notes.

According to the Examination Board, a valid competence test must be competence-based and as realistic as possible. That is why the development group often chooses a work sample test to assess the competences of the student. In this case, however, this was not possible because the expert-evaluators can only do their activities when qualified. Therefore, we developed a simulation in order to assess the trainees. A competence test must also be reliable. This means the assignment needs to be standardized. For this purpose, we used several scripted scenarios for the simulation. These scenarios describe the interaction within a multidisciplinary crisis management team and were played by professional role players. The performance of this team is recorded on DVD. During the exam, the trainee watches the DVD, observes the team (as if he was present at the exercise) and prepares for the feedback session. He is then taken to a separate room in which the particular team members (the same role-players as on the DVD) are ready for the actual feedback session. In this 20 minutes interactive session, the trainee gives the feedback to the team members who play their scripted roles. Finally, the trainee writes the evaluation report.

Two independent assessors observe and assess the trainee's performance. The assessors are observation and evaluation specialists, do not teach during the course, and are trained in assessing trainees following the regulations of the Examination Board. They use a standardized assessment form with several criteria (see table 1). The trainee passes the competence test when he scores positively on all four crucial criteria and at least two of the non-crucial.

Table 1. Format of the assessment form.

1.	**Conducting the evaluation**	
1.1	Give effective and constructive feedback	Crucial
1.2	Reflect on contents of teams' performance	Crucial
1.3	Actively involve the team in the evaluation	Crucial
1.4	Authority	
1.5	Credibility	
1.6	Respect	
2.	**Writing the evaluation report**	
2.1	Content	Crucial
2.2	Structure	

The quality of 'conducting the evaluation' is assessed immediately after the trainee has finished the feedback session. The assessors consult the role-players to get a better understanding of how they have perceived the students' performance. On a later moment, the same assessors evaluate the report. When the student passes his assignment, he receives his certificate from the Examination Board of the Police-academy.

Findings

Empirical validation of training interventions is an essential step. Empirical research is needed in order to formulate theoretically sound and validated design specifications. Because of the practical nature of Instructional Design research, this research should have ecological validity (Elen, 1995). This ecological validity is achieved, as much as possible, in a naturalistic environment and by conducting design experiments. A design experiment focuses on engineering innovative educational environments and simultaneously conducting experimental studies of those innovations (Brown, 1992). It is an empirical study in which instructional support is designed, implemented, validated and revised in an iterative, recurrent way (Brown, 1992; De Corte, 2000). And that is what we have done during the cycle of three courses so far.

After every block of two days, there was plenty of opportunity for trainees and teachers to reflect on contents and structure of the course. After the last day, they all engaged in an interactive evaluation discussion. The topics of the course, the relations between the topics, the intensity of the course, the quality of the teachers, the homework, the exercises and role plays: everything has been discussed in an open atmosphere with the intention to improve the course's quality. After all exams of a course, the assessors and role-players have a good picture of the extent to which the trainees master the competencies. These experiences are fed back to the core instructors who determine, together with the teachers, how these experiences relate to the objectives and contents of the course. In this way we continuously checked how we could better help the trainees in achieving the training objectives and improve the quality of the course while at the same time maintaining the high quality standards of the exam.

All trainees indicated the course as 'very intense'. An explanation is that the focus of the course is not only the topic 'evaluation' or the roles of other disciplines, but also the attitude of the trainee. Conducting many practical exercises, receiving and giving personal feedback, has been perceived of as useful learning moments. A safe learning environment is therefore of paramount importance. Making mistakes was accepted, discussions were respectful, and everybody was keen on helping the others in improving their competencies. In the periods between the course blocks, trainees indicated that they practice what they have learned. This was not only related to their tasks as evaluators during exercises, but also to other tasks like for instance evaluating real-life incidents and personnel management. The exam, with professional role-players, is perceived of as realistic, dynamic and difficult. Trainees have the experience of giving feedback to a real team and that you really have to earn the certificate. That is reflected in percentage of trainees that eventually pass the exam: during this pilot phase, about 30% of the trainees does not pass.

Finally, everyone appreciated the various disciplinary backgrounds of the trainees. This stimulated a multidisciplinary view on crisis management and that is of course essential for evaluating multidisciplinary teams.

Discussion

In this paper we have described the structure and contents of both the course and the examination, and shared our experiences. Up to now, the course has been conducted three times. Every time the course is evaluated based on which the next course is improved. It is, at least in The Netherlands, one of the first courses specifically aimed at learning to evaluate multidisciplinary crisis-management teams. Besides, the target group itself has a multidisciplinary background as well: trainees come from first responder organizations, the military and other organizations like for instance the municipality.

Conducting evaluations is a profession in its own. The Dutch Home Office has to intention to form a pool of crisis evaluators at a national level. The course alone is just one step in creating a more professional community of evaluators. We are now beginning to form a pool of professional evaluators that can and will be assigned to several (large-scale) multidisciplinary crisis-management exercises. More and more crisis management organizations are getting convinced that these certified evaluators really have an added value: we already received over one hundred calls for participation to the course. In this way it would be possible to have several evaluators in every single newly formed safety regions in The Netherlands. Having a national pool of professional evaluators can also stimulate the regions and its organizations to organize and conduct multidisciplinary trainings and exercises. It is a guarantee that you will have a solid evaluation afterwards, increasing the degree to which teams can really learn from these exercises. Several former trainees are currently also part of an evaluation team engaged in two big infra-structural projects, assessing the newly formed crisis-management organization structure in a series of exercises.

Expanding the knowledge base and increasing the competency level of the evaluators is a continuous effort. This can be facilitated by practical experiences as evaluators, but also by critically reflecting upon your own behavior as an evaluator, together with peers. We are now in the process of organizing these group reflection sessions, and also to integrate the evaluators' experiences into the next courses. This course gives a good and firm basis for evaluating multidisciplinary teams in the crisis management organization. Nevertheless, the crisis management system in The Netherlands is still a complex system, consisting of many different organizations at various levels: operational, tactical and strategic, as well as local, regional, national and international. Besides the more general competencies as trained in this course, other competencies may be required for conducting evaluations at specific (combinations of) levels. One example could be setting up and leading a large, multidisciplinary evaluation team. Together with the Dutch Home Office, we will define these competencies and determine if these need to be integrated within the existing course or that additional courses need to be developed.

Large crisis management exercises often involve many teams that are distributed in the area. As the teams and team members are not physically on the same location, performance measurement and providing feedback can be problematic. In order to give adequate feedback, it is essential that observers, who are distributed them-selves as well, can quickly compare and integrate their observations. In this way, the time needed to prepare the evaluation session can be reduced to a minimum. The sooner the results of an exercise can be evaluated, the better it is. For this reason, a group of former trainees has experimented with a mobile performance measurement and evaluation tool, specifically developed for distributed team training (Van Berlo, Hiemstra & Hoekstra, 2003). This tool on a tablet-pc (MOPED) helps the evaluators in observing team performance and in quickly generating, sending and receiving data to support the evaluation. Given the rapid technological developments, we expect that during crisis management training and exercises, evaluators will use these tools and support more and more. It is therefore important to get a clear picture of how the training staff should be supported in doing this, how this affects the competencies of evaluators and how they can best be prepared for this.

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Marcel van Berlo holds a PhD in Instructional Psychology and Technology and is researcher on training and instruction. He has experience in the design, execution, and management of research projects in the field of military training, crisis management, instructional design, team performance measurement and feedback, and designing innovative team training environments. Within TNO he is also business developer on human factors related to public safety and security.

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FURTHER ENCOURAGEMENT FOR THE BEST USE OF SIMULATIONS

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Keywords:

Simulator, simulation methods, engine room simulator

ABSTRACT

Although over the last decade the world Merchant Fleet has become highly sophisticated and technically improved, economical, safe and reliable, human errors and accidents still happen. To minimize human and material losses in navigation, simulators (engine and navigation) are being increasingly applied, in the training of students as well as in the training of seamen. By simulator training the knowledge, experience and safety during work have been obtained, since this method enables simulation of certain failures and conditions without human or material losses.

In the 21st century maritime education and training are faced with both opportunities and challenges. STCW Convention requires institutions to adopt new approaches or make reforms in all the aspects concerned [1]. For an effective and high-quality education and training, the staff of maritime education and training instructors should establish further exchange and cooperation, joining hands in order to meet the required standards. *(The results presented in the paper have been derived from the scientific research project "Marine Power Plants Control in Faulty and Failure Conditions supported by the Ministry of Science, Education and Sports of the Republic of Croatia)*.

INTRODUCTION

Between theoretical-analytical approach to training for professional work, and real efficient professional work, there is an educational area that in modern education belongs to models and stimulations. Today, models and simulations are applied in industry, science and educations, as research or as educational techniques that reproduce actual events and processes under test conditions. Exactly this is happening in maritime technologies, where the object is to educate/prepare seamen, students and professors for complex working conditions. The whole range of simulators and methods of simulation already exist in this area and it's continuously developing. These way users can, in the real way, overcome vital objects/devices/equipment; but without adverse consequences of theirs possibly wrong decisions. There is a problem that occurs during models installations, and that is – their construction is never concluded; model's installation is a never-ending process. Models are constantly remodelled and replenished with new and fresh information. Researches in simulation's educational effects have shown that the more realistic replica is (of real tasks in real working

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environment), the more effective are simulations in passing the knowledge. Technological development brings in focus the managing of complex technological plants, and this managing demands expert, but mostly practical knowledge and skills.

How to efficiently educate young people, so they can become good and skilled maritime managers and ship masters - not only in maritime profession, but broader? There are growing demands for efficiency, and education is getting more expensive – does it offer a really good education for people who are getting ready for complex tasks? If we want that seamen, nautical engineers or marine engineers, are doing well in managing the ship, than they have to learn how to do it. This is accomplished by passing to them appropriate theoretical knowledge and possibility of work on range of simulators.

Power supply system planning, especially for a ship, is a very complex process that is constantly developing and upgrading. Complexity of the system is mirrored in colligation of production, distribution and consumption of electrical power on relatively “small” space (meaning the size) that is completely autonomous. In ship’s power supply system, the generator is operating on its own transmission network. That means that with change of loading there is change of tension on terminals, generator, change in frequency, that is, change of rotor’s rotation speed. Those parameters must be kept within given limits. So, it’s necessary to continuously regulate terminal tension of synchronous generator by changing excitation current, and to regulate speed of rotation to keep it synchronous. This way we maintain constant frequency of induce tension. For those reasons, the subject of research is:

- How to regulate the load in ship’s power electrical systems, to optimize the costs: The solution for this problem is formation of complex optimizing system for distribution of electrical power between consumers, according to sequence of electrical power sources (priority), to achieve the maximum effect;
- How to regulate the operation of synchronous propulsion engine and turbine;
- How to optimize the operation of synchronous generator;
- How to optimize the fuel consumption.

Different behaviours were analyzed on marine engineering simulator. Operation’s analysis significantly influenced the input parameters of simulations models.

SHIP ’S POWER ELECTROENERGETIC SYSTEM

Ship electrical power system is considered to be a dynamic and complex system, because the power can’t be stored. Simultaneously with production, there is a process of electrical power consumption. Parameter’s quality is easily disturbed, and the measurements for power supply quality are:

- Frequency – constant, deviations are within strictly given limits. Basically, the frequency is 50 or 60 Hz. Frequency regulation is connected to the mechanical number of rotations of generator shaft, and in colligation with regulation of operating power;
- Tension (voltage) – it’s not possible to maintain constant value of voltage in every part of electrical network. Electro-energetic system must be close to nominal value. This is accomplished with different devices and through correct dimensioning of electro-energetic system. Elevated voltage puts stress on isolation, and decreases the time-limit for system’s components. Decreased voltage is causing larger power supply losses in the system;
- Availability- the electric power system must be design so that the consumers, in any given moment, can take the necessary amount of power - by quantity and by power. The aim for dimensioning of electro-energetic system is to achieve the optimal solution for higher level of safety supply, with minimum costs.

Above mentioned parameters for electrical power quality must be satisfied in range of possible propulsion states, and when some of elements are out of order because of failure or maintenance. Today, mainly the alternating current (AC) is used in ship’s electro-energetic systems. Comparing AC to DC – AC has the bigger amount of available power, bigger production, distribution and exploitation rate of electrical power. But, there are also bigger losses in transmission because of reactive power transmission (because of limited lengths present in ship’s electro-energetic systems, the losses are smaller compare to similar conditions on land). Larger losses are causing the skin effect; and there is a possibility of static and dynamic stability disturbances; with bigger power installation there is the increase in short circuit's power value, which is mirrored in equipment design, and so on.

Tendency is to manage the ship's power electro-energetic system like any other system. It isn't always possible to describe it with mathematical model like differential equations, so we try the intelligent managing structures and techniques that have significant success in managing of highly complex systems, as well as alterable systems. Intelligent systems are capable to perform some of the following functions: planning of operation on different levels; learning based on previous experiences; and identification of changes that are endangering the system's configuration, such as breakdowns. Based on mentioned functions, there was a development of different planning areas, expert systems, non-prominent systems, neuron grids, learning systems, failures diagnostic, hybrid systems, genetic algorithms, Petrie net's. This way, many systems could be made as highly resistant and tolerant to breakdowns, because there is an increase of reliability and availability of individual system and the ship's whole power supply. Namely, the aim of processes intelligent management is based on integration of existing knowledge and experience in management systems to achieve improvement of system's performances.

Electric generating plant's operation stability in great deal depends on loading size, propulsion conditions, system's technical-technological characteristics, and on the whole range of other conditions. During operation of ship's electric generating plant, there is a need for parallel generator operation on its own grid; so at the moment of big power consumers' connection, the maintenance of operation stability represents a significant problem. With growing level of automation of ship's power systems and demand for quick solution of problems; there is a tendency to improve the quality and safety power supply. It's difficult to learn during real events, so there are observances of appropriate mathematical models. This is much simpler and without adverse consequences on power plant. Research of ship's propulsion system dynamics as the only representative for complex, dynamic and technical systems is demanding application of the most effective modelling methods. In this work we used modelling with MATLAB-SIMULINK (power System Blockset).

The object of this work is to apply specified intelligent management system (genetic algorithm) to loading distribution, and to achieve the dimensioning of electrical safety equipment in high voltage electro energetic systems, that will ensure tolerance of breakdowns during operation.

Which elements to install, what size and type – to achieve the optimal effect – that is a very difficult optimization problem. The difficulty of finding the solution lays also in the fact that this is a combined optimization problem, where every one from a large number of combinations is made from a series of parameters in system operation. Along with that, the system is faced with a range of operational restrains. When solving the problem, we can achieve some good results from *adoptive research of solution sphere* technique. Genetic algorithm is especially efficient. During many generations the natural evolution is evolving in accordance to principles of natural selection, and by mimicking that process, the genetic algorithm is capable to "evolve" the problem solution.

Genetic algorithm is providing the independence in form of object functions. It is applicable to continuous or combined optimizations, and it's providing for stochastic approach in searching for optimum. This is totally in accordance with loading distribution optimization and optimization for electrical safety element location.

SIMULATION'S MODELS

Different methods were analyzed in this work, with the object to achieve the optimum activity, motivation, interest and efficiency in students' work. Two groups of students (12 students in each group) were testing the change of loading in ship's power system [2]. With the help from instructor/ professor, students were trying to change the load (kW) in electro energetic system (power system). They were observing what is happening with generators in ship's power grid. One part of each group was trying to optimize the fuel consumption of diesel generator units, analyzing the ship's power grid when faced with short circuits in a part of power grid. The other section of student's group was trying to regulate the steam in turbine operations, and so on. Each group had different parameters for change; students were working on a simulator for a period of time – trying to reach the best solution for observed system. They were comparing and presenting results. Those results they considered as the best, students were submitting as input parameters for further mathematical modelling. This way we've achieved better motivation, team work and – the most important – logical thinking that is attributing to problem solving.

WORK CONDITIONS ON THE ENGINE ROOM SIMULATOR

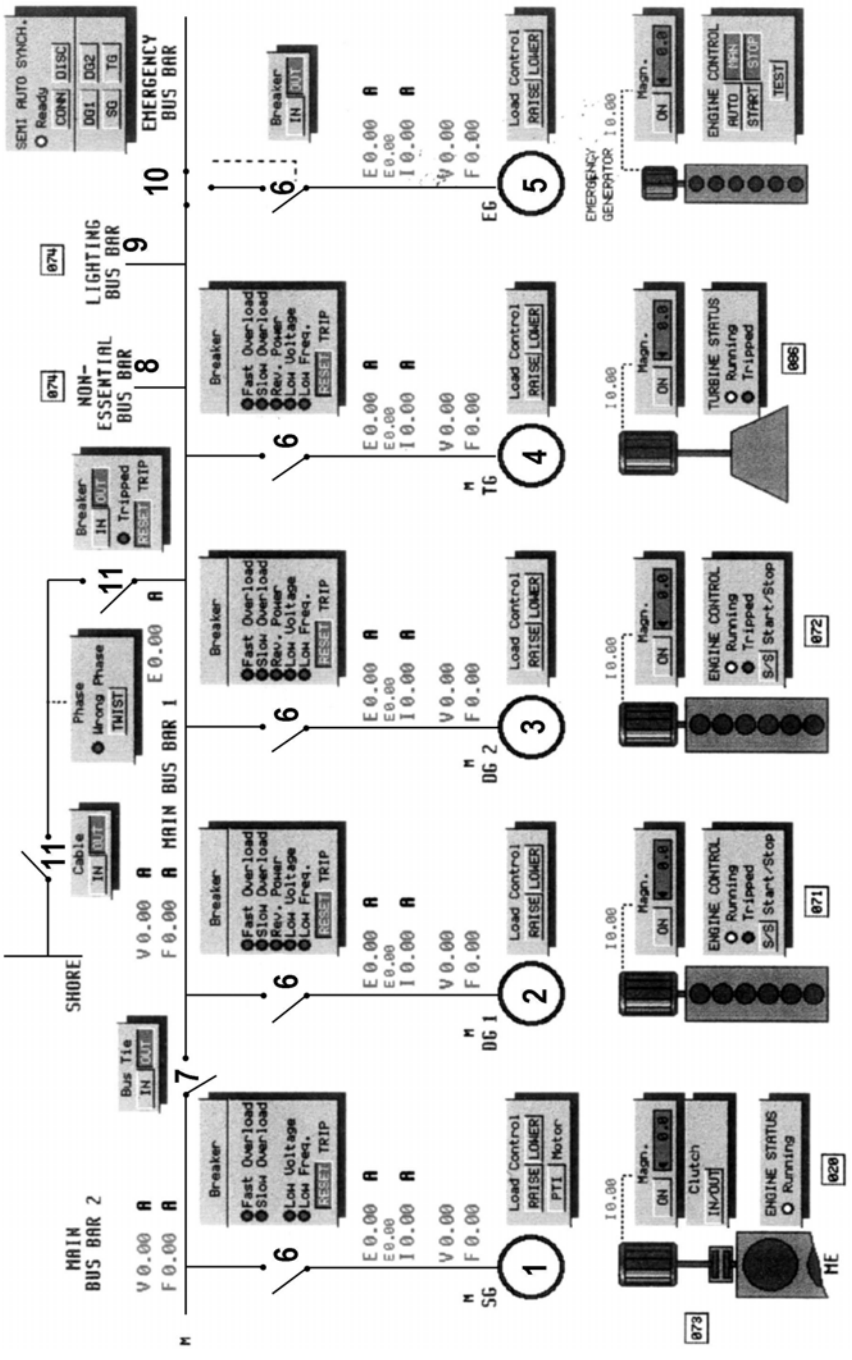


Figure 1: Electric power system scheme [3]

The works of the generator under equally distributed loading as well as condition which occur during stabilization of generator work are shown. Stopping of main engine (fuel oil supply cut off) and also the changing loading due reduced steam supply have been simulated (Figure 1.) The diagram (Figure 2.) shows the difference between an optimum and equal mode of loading. Within determined period (initial phase) the system works under an optimum mode of loading, where the priority on DG 1 takes over a greater part of loading, while DG 2 takes over the remaining loading. The optimum loading means the optimum operation regarding the fuel oil consumption, ship/s speed regarding generator characteristics. During subsequent period, Figure 2., the total electrical loading shall be divided into two equal parts (equally loaded generators). When simulating these processes, the values of voltage and main bus bar (1) frequency has not changed (slight deviations are shown by small oscillation). All parameters point at the system stability. It proves that the simulation of the system operation shall be necessary as to identify possible failures. In this way future marine engineers shall be trained for their jobs in the engine room and accordingly the crew shall be additionally educated, which all will contribute to the safety of navigation.
All simulations will be performed in Matlab and the model has been built with blocks [3] from the Power System Blackest. In this paper we didn't show the blocks from Power system Blackest but the results of the simulation are on the Figure 3.

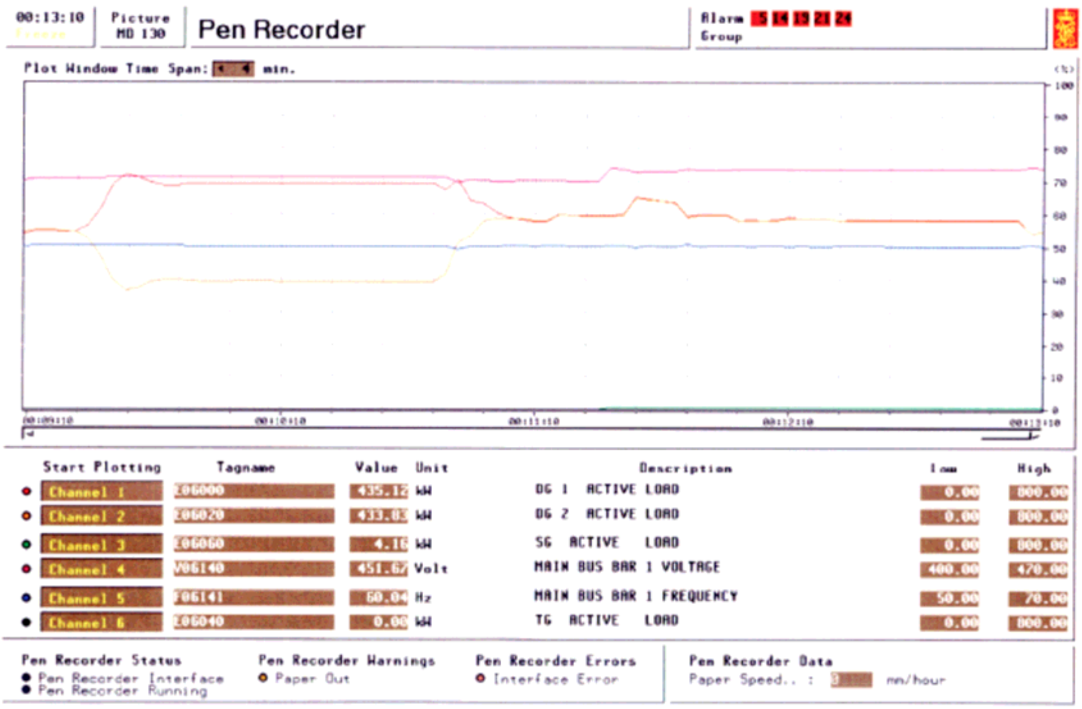


Figure 2: Diagram of loading of electrical energy generator – pass over from optimum to equal loading

MATLAB
Whatever the objective of our work-an algorithm, analysis, graph, report, or software simulation-MATLAB has quality tools. The flexible, interactive MATLAB language and companion toolboxes provide engineers, scientists, mathematicians, and educators with an environment for technical computing applications.

Simulink is a program package developed in Matlab surrounding, that is allowing modelling, simulation and analysis of system's different dynamic conditions. It supports linear and non-linear systems; modelled in continuous, but also in discreet time.

The characteristic of this simulation is use of graphical interface and "click-and-drag" operations with a mouse, to draw models in form of a block diagram. Simulink contains a rich library of input data generators, output variables' displays, linear and non-linear system's components and connectors.
After the modelling of a system, there could be different types of simulations. (Simulink-menu, or with commands that are entered in Matlab's command mode). By using the oscilloscope or other blocks for display of variables, the system's variables could be visible even during the simulation. Also, simulation's parameters could be changed (duration, source frequency...) with simultaneously monitoring of the results. Simulation's results could be stored for subsequently processing and visualization.

After the complete displayed of a block, and after all characteristics have been adjusted to mach the appropriate system, it's time for simulation performance. Firstly, duration time for simulation is selected. It begins with selection of Start function. During the simulation it's preferable to hold open the oscilloscope's display, to monitor the output variable. After the simulation's end, some of the output variables that were generated by the system could be additionally analyzed, processed and graphically displayed [5].

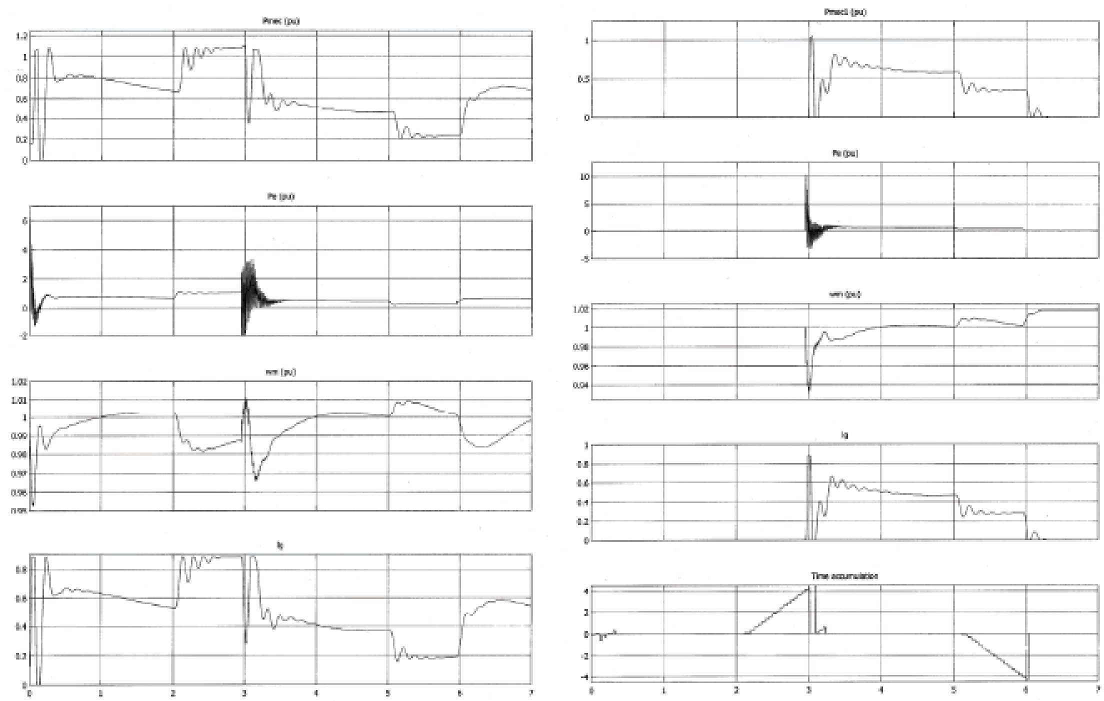


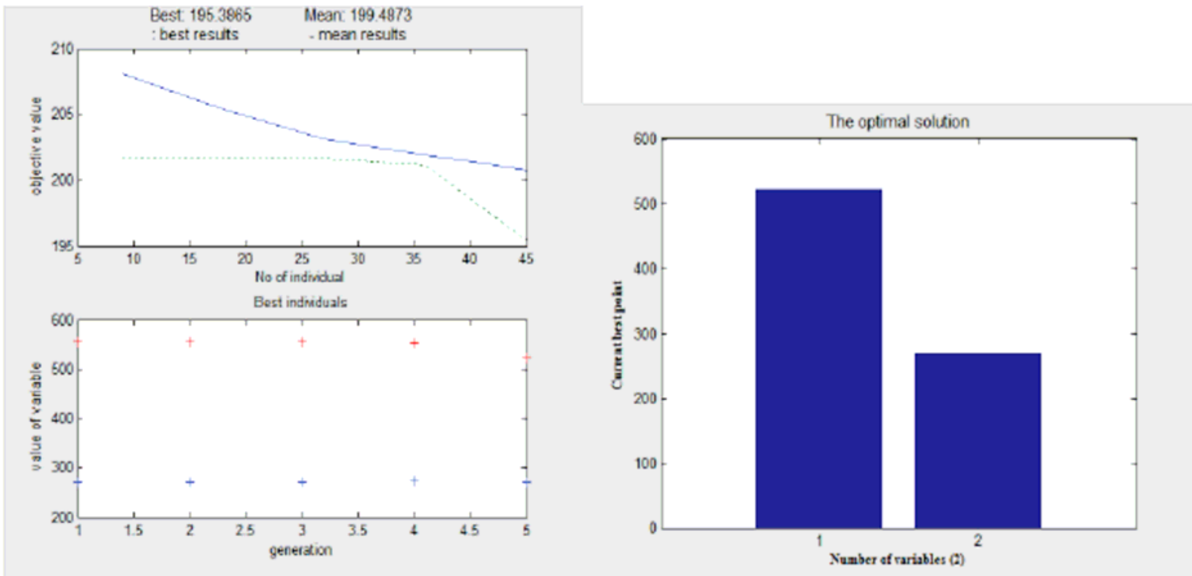
Figure 3: Simulation model in Simulink – results are graphically shown on a) SG1 b) SG2
a) Mechanical power b) Electric power c) Number of rotations d) Fuel valve e) Time of loading accumulation

GENETIC ALGORITHM

The genetic algorithm is a heuristic method of optimization, which is based on mimicking the natural evolution with search for the best individual, which is best adjusted to environment conditions [6]. Through the natural selection, the individuals are singled out – those who'll survive and create an offspring. This way, the population is advancing and adjusting itself to the environment. Genetic algorithms are imitating the natural evolution, in a way that the optimizing process represents the living environment for individuals (units) – process's input data. Each unit represents a combination of input parameters that are suitably coded. Through the selection in genetic algorithm, the units are picked up according to its genetic material: units with quality genes remain, namely –they are showing better results. The population is advancing through the genetic algorithm; it's offering better solutions for optimizing problem. Process of selection, reproduction and manipulation of genes materials is constantly repeating - until it reaches the condition for stopping the genetic algorithm. Initial population of units is created at the time of initiating the genetic algorithm. Genetic algorithm is executed until the condition for stopping is met. Condition for stopping depends on the problem and on conditions in which the problem is solving. When implementing the genetic algorithm, the main problem is correct choice of chromosome's representing and means of decoding to obtain the input data for function "good", and also the setting of this function.

GA is standard suitable for simulations of unanticipated processes, where few units (representing different types of competitors), are fighting for survival.

Functions "good" are used when developing GA – fitness function is representing quality price for individual unit. In the simplest form, the "good" function is equivalent to function f, which it optimizes. Higher quality means better chances of survival, creating the offspring through crossbreeding – so the "good" function doesn't represent any restrains (it can mean the selection in practice). The most difficult step is the definition of "good" function, because this function must truly mirror the problem it represents. During the genetic algorithm there is a selection process. It consists of preserving and passing of good attributes to the new population. Crossbreeding brings the exchange of genetic material between two units. Mutation is influencing one unit, and it is a random change of one or more genes. Genetic algorithm performs a large amount of operations, so it's possible to extract individual parts that could be executed independently. Specific equations for system's determination have been set, and entered parameters are based on simulations performed on Northcontrol simulator. On an example of three electric power sources (synchronous generators) and a certain group of consumer's genetic algorithms have been implemented through several calculation cycles. Figure 4: presents an optimal solution of our problem (optimization of expenses) where we discussed and analysed the problem of load regulation and regulation of generators work within the ship's electric power system.



a) b)

Figure 4: Simulation results GA: a) The result of each generation b) Optimal solution

CONTROL OF THE ELECTRICAL POWER SYSTEM

For safe control of ship's power system, it is necessary to understand the dynamic. The controlling system must be based on the following:

- Effectiveness – deliver power supply to all customers with minimum production costs and losses;
- Quality - ensuring the constant tension, frequency and wave form;

- Safety – this factor is variable in time, and it depends on power system resistance to disturbances;
- Reliability – probability of satisfactory performance during the set period (not depending on time).

Power system plant could be described with five propulsion states (Figure 5.)
Object of control safety contra-measures is the maintenance of normal propulsion state. The worsening of propulsion system brings reducing of control problem.

Power system stability is a capacity to maintain the balanced state - with original parameters, and after exposure to disturbances; and with variables of system state within the limits that ensure system's integrity.

System integrity is practically preserved if the rest of the system is complete (integral), without further failings of production units or consumers; with exclusion of the disconnected elements in the grid; and with object to achieve isolation or deliberate disconnection of elements to preserve propulsion for the remaining part of the system.

Power system is a multi-variable and non-linear regulation system, with constant changing of propulsion state. The consumption and machinery participation is also constantly changing, and that brings about the change in network's parameters. When the power system is exposed to disturbances, the stability of system depends on initial propulsion state and on the nature of that disturbance.

When analyzing the power system's stability, we emphasize the sudden and significant changes – short circuits, and also the smaller and common changes, like the change of loading (connection and disconnection of major consumers, or changes of referent quantities in regulation systems).

That is the reason why is distant simulation learning technology – on board and ashore - is one of the three components of a strategy for better located maritime education and training in the work processes on board. The other two are: experiential learning on board and teaching (training) in the classroom or on the simulators.

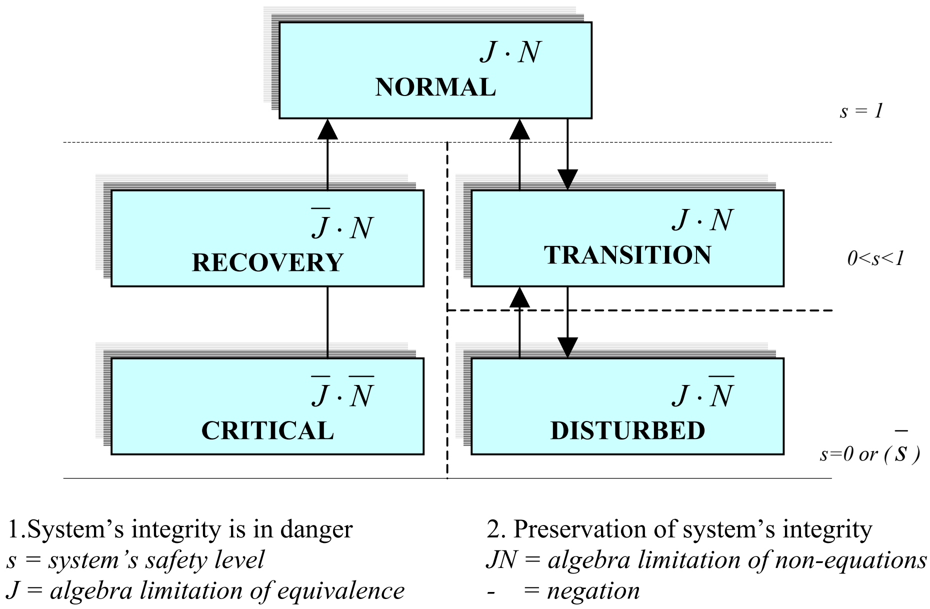


Figure 5: The propulsion states

CONCLUSION

With simulators, specific behaviours in certain situations can be taught much better than on „real" ships. High safety standards of ship operation require appropriate crew training and competence assessment for subsequent certification. This is the reason of simulating certain damages effects by computers and by means of a simulator. The introduction of the simulator as a teaching aid to was very successful according to feedback from both the students and the instructors. The provision of this educational tool, in conjunction with the optimisation techniques, will help to accelerate the understanding of engines, engine room, propulsion plant and another part of system through an interactive learning process.

Today, we try to go a step further with simulation models, that is – we try to create the Interactive simulation system (VR-i3D or 3D/VR). Those systems are representing the combination of sets and program support, for creation of different applications that are enabling the consumer to interact with virtual environment. *Scol* components of VR system are receiving input signals from the user's operated device, and through multiple sensor outputs, the illusion of virtual word is created. This way we created the image of virtual ship with simulation of dynamic behaviour of ship's power supply system. The objective is to train personnel and verify characteristic of prevised devices and equipment.

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BIOGRAPHY

Maja Krčum was born in Split, Croatia (on March 1958.). She graduates from the Faculty of Electrical, Mechanical Engineering and Naval Architecture, University of Split on March 1981. She received a graduate degree (M Sc.) at the Faculty of Electrical Engineering, University of Zagreb in 1996. Her master's thesis was entitled "Simulation on Model of Shipboard Electrical System". In 1997. she was appointed Head of Department, also working as a tutor and counsellor. Now, she is quality manager at the Faculty. She was participated in a number of both national and international conferences where her papers and lectures were generally acknowledged as an active and valuable contribution towards the development of her profession. Her primary interest lies in the field of shipboard propulsion systems, with a special emphasis on electrical propulsion and its numerous applications (simulation methods). She is also a member of several national and international societies (e.g. IEEE, ELMAR, KOREMA…)

Anita Gudelj was born in Split, Croatia (1970). She received her B.S. degree in mathematics and computer science (1993) from University of Split, Faculty of Mathematics. Since 1995 she is a lecture at the Maritime Faculty University of Split. Also, she received the M.Sc degree in information science from Faculty of Organization and Informatics, Varaždin, Croatia (2000). Her postgraduate research was "Design and Implementation of Temporal Database". Now, her primary research interest is database design. But, together with some other staff member of Faculty, she currently works with Matlab and simulator. Her research work also includes simulations, genetic algorithm and their implementations on ships.

Predrag Krčum was born in Mostar, Bosna and Hercegovina (1953.). He graduates from the Faculty of Electrical, Mechanical Engineering and Naval Architecture, University of Split (1982.). He worked as expert assistant in PTT – Split, as director of manufactory “Obuća” –Split, and since 2005. He is a lecture at the University Centre for Polytechnic Study – Split. His primary research interest lies in the field of automatic control of hydraulics and pneumatics propulsion and also in some system for education students.

Academic & Professional Practice

Peer Reviewed Articles

CRITICAL INFRASTRUCTURE PROTECTION

UNDERSTANDING COMPLEX SYSTEMS INSTABILITIES TO PREVENT CRISIS OF CRITICAL INFRASTRUCTURES

Claudio Balducelli
ENEA[1]

Keywords

Systems instability, Critical Infrastructures, Inter-dependency, Cyber-vulnerabilities, Socio-technical systems

Abstract

"Instability" is a an undesired phenomena that occurs when a system responds to external stimuli in a way the makes it less controllable. An instable state of a system is a condition in which very low variations of the state parameters may produce a system behaviour that, in some cases, could also generate the system collapse.
From experiences and analyses, that will be illustrated in this work, is possible to discover that physical systems instabilities are today in most cases well known and can be better understood considering past accident scenarios.
But new type of instabilities, coming from the cyber and organisational layers must be well analysed in the next future. These researches have to address the problem of making risk and dependability analysis applicable not only to physical systems but also to socio-technical systems. More in particular this new type of risk analysis had to deal with the interdependencies problem typical of the "complex systems". It is necessary a better understanding about how some vulnerabilities or attacks inside the cyber and organisational layers of the critical infrastructures, could generate or amplify instabilities in the physical layer. At the same time is necessary to know how much stable a physical system must be for not collapsing in presence with new instabilities coming from cyber and organisational layers.

Introduction

Every type of physical system can work in a more o less stable working condition; to avoid the collapse is important to know what configuration of the state parameters generates an increasing or a reduction of the system stability level. In this paper the instabilities of the physical systems are analysed, considering different types of plants and infrastructures for which non only the physical layer but also the cyber and organisational parts could be critical. In the nuclear reactor field, boiling water reactors cores are considered instable when they work at low power and low water flow: the phenomena of high mode power oscillations in the core is illustrated as one of the principal effect of instability of these type of reactors. A specific scenario including regional power oscillations was observed in october 1993 during the special tests conducted by ENEA-AMN at Caorso nuclear power station to test core instability level of this plant. This type of physical instability is described in section 1.

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For an electrical transmission network the frequency, the voltage profiles and their associated stability margins are considered and analysed; their deviation from normal state could made the network more instable and vulnerable. The specific emergency scenarios occurred during the Italy-Swiss black-out, happened on September 2003, the black-outs in Canada-United States on August 2003 and the last event in Germany in November 2006 were also determined by some intrinsic instability of the networks that was augmented by human and organisational errors. The importance of the available recovery time during the crisis is also considered; the time available for recovery actions depends on the degree of network instability, and it could allow the execution of emergency operator procedures. The main factors that that make more instable the energy transmission network are analysed in section 2.

Some lessons learned about the causes and the conditions that generate systems instability are elicited from the previous specific cases and from other similar cases, occurred in the past.

Starting from common considerations about these instability cases, some general features that characterise the systems instabilities are evidenced and illustrated in section 3 as potentially applicable to every type of systems or networks.

When we consider Critical Infrastructures, we have to take in account that they are not simply physical plants but contains also a cyber and an organisational layer including the information/control system components and the human organisations supporting and controlling the normal operation of the whole infrastructures.

Cyber and organisational layer supervise and control the physical layer, and must first of all take under control the potential instabilities of the physical system. The globalisation of the markets generates computer based system, technical solutions and human organisations more instable now than in the past. These new aspects of the system instability problem are analysed also in section 3

Finally, in section 4 some key recommendations are indicated to try to mitigate the Critical Infrastructures instabilities.

Physical instabilities: lessons learned from nuclear power plants

The local power generation in the core of a nuclear reactor is directly related to the neutron flux, which itself is a function of the reactivity. In BWRs, the reactivity depends strongly on the core void fraction. Thus when a void fraction oscillation is established in a BWR, the power oscillates according to the neutronic feedback. This feedback mechanism which is shown in Figure 1 in a simplified manner may under certain conditions lead to poorly damped or even limit-cycle *power oscillations*.

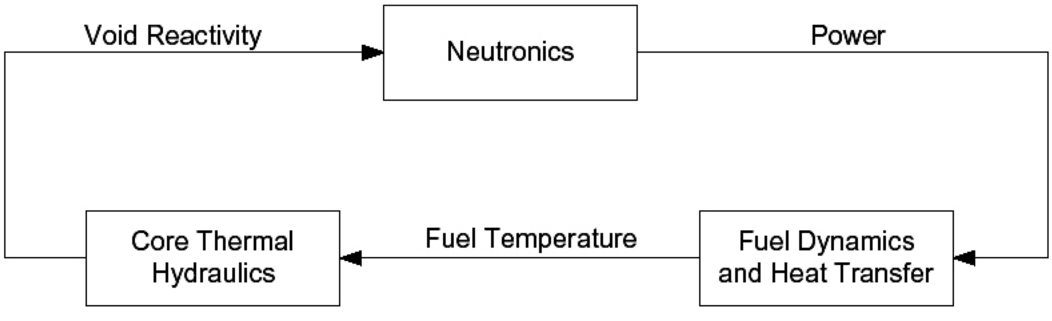

Fig 1 – Feedback mechanism of the void reactivity

Their frequency lies around 0.5 Hz, that is about twice the transport time of the coolant through the core (T = 1/0.5 = 2 sec). Amplitudes from nearly 0% to more than 100% in power have been observed. The oscillations, in different parts of the reactor core, are mostly global, i.e. they are "in-phase".

Higher mode power oscillations are also possible; these divide the core into two regions oscillating in opposite directions at constant overall power. These regional oscillations are cumbersome for the operators since their detection is not directly possible with standard instruments that display only core-average data. Even more complex modes of instability have also been observed.

During the early years of BWR technology, there was considerable concern about the possible effect of coupled neutronic/thermal-hydraulic instabilities. However, after various in depth experiments and analyses, it became clear that BWRs could be designed such that instabilities would not occur under normal operating conditions. In fact the normal reactor operating point, characterised by the Core flow and the Thermal power, is *far from the operating conditions in which instabilities may occur*. This situation is visible in fig 2 in which it is recognised that instability of the reactor core may happen only in operating points where Core Flow is less than 50% and Thermal Power less than 70% and more then 35%.

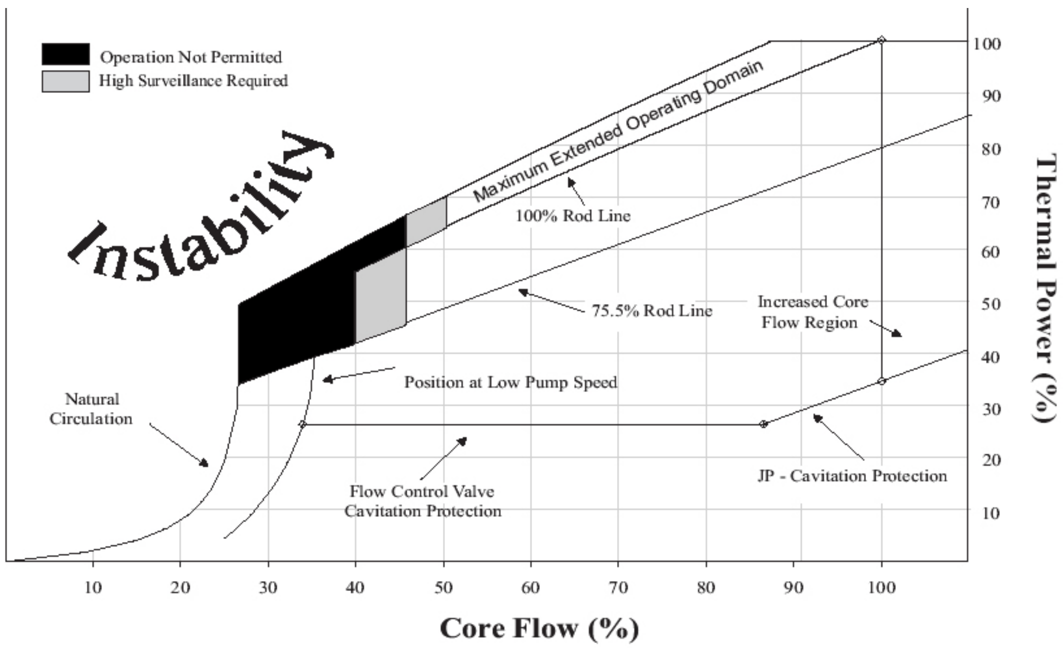

Fig. 2 – Operative map of a Boiling Water reactor core

Several nuclear reactor plants experienced power-void oscillations, during special tests, similar to the test conducted by AMN-ENEA on Caorso Power Plant the first of october 1983 in which the instability regions was reached under operative controlled procedures. From these experiences the nuclear reactor operators recognised the possibility to arrive, in safe conditions, near the instability points.

Lesson learned from this experiences was that, to have a more complete control of the plant, is necessary to know in advance in what part of the reactor core map (Core Flow versus Thermal Power) the instability phenomena occur. This knowledge may be acquired with special controlled tests and also with system simulation analysis (Ginestar D. *et al*, 2002). In other words is necessary to know not only what may be the "normal" working condition of the physical system, but also what are the working conditions to be avoided for preventing instability phenomena.

Critical Infrastructures instability

In the last years it was recognized that Critical Infrastructures (Rinaldi S.M *et al*, 2001), suffer of major instability problem today respect to the past.

This problem has today a greater impact on the emergency management community, and its significance has increased since governments and citizens became aware that services furnished by power distribution networks, telecommunication networks, transport infrastructures and other key resources are actually more critical than in the past. To maintain their style of living, modern societies are more dependent on their critical infrastructures; but, ironically, critical infrastructures seem to be less stable than in the past. Some new types of vulnerabilities are candidates to having a strong impact in the future emergency management practices and social security strategies.

The need for protecting critical infrastructures becomes more important also as a consequence of the so-called 'cascading effect', caused by the mutual 'interdependencies' (Rinaldi S.M, 2001), of the networks. There are different causes and external conditions that contribute to augmenting such type of interdependency. When we consider critical infrastructures, we have to take into account that they are not simply 'physical' plants and networks. In fact, they contain not only a physical layer, but are also made of 'cyber' components and systems, and include human organisations to manage and supervise the daily operations of the infrastructure.

Anyway if we look only at physical layer, as the example of fig 3 for an electricity network, it is possible to discover a lot of similarity of their potential instability with the instability of the nuclear reactor core described in the previous section.

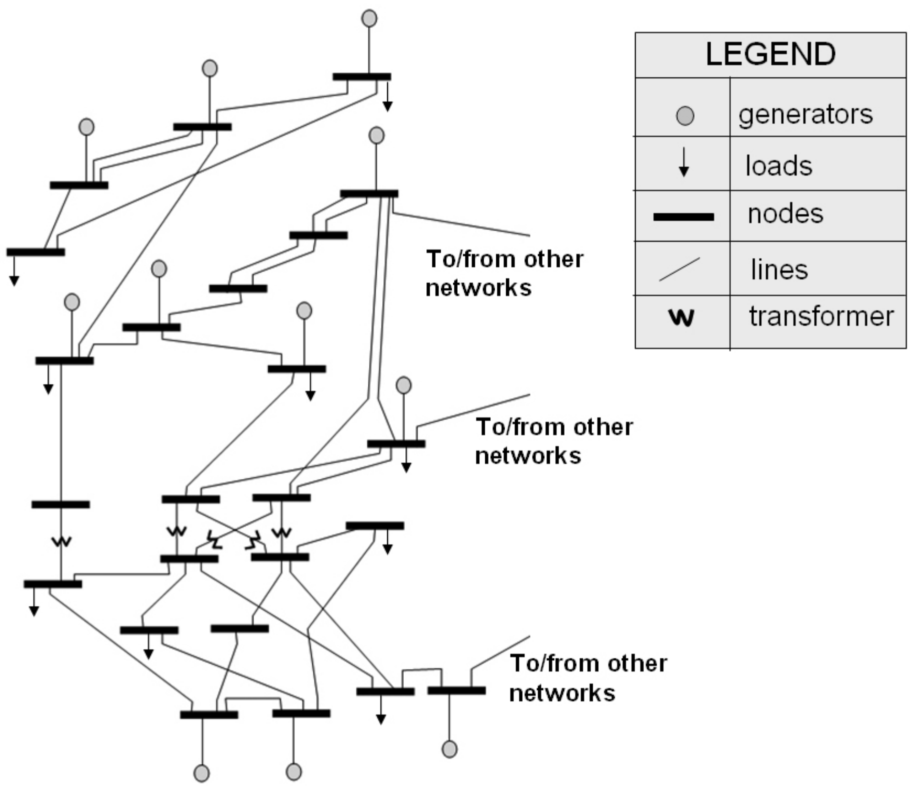

Fig. 3 – A simple electrical transport network

In fig. 3 is shown a simple electrical transport network, as it is described in the IEEE Transaction paper (1999). The basic elements in the network are:

- the "generators", that are different types of power production plants (Oil/Steam, Coal/Steam, Hydro, Nuclear etc.) and represent the points in which energy is produced,
- the "loads" that represent the points in which power is consumed (by a city distribution network, by an industry or by a railway energy substation),
- the "nodes" that represent the buses where generators and loads are connected,
- the "lines" that represent the electrical cables in which power flow from the generators to the loads or toward other networks, as the foreign network.

Different portions of the network generally work at different voltage levels, and are interfaced with "transformers".

The stable working condition of such system may be explained in the same way as could be explained the stability of a tandem bike on which more cyclists are pedalling (Soder L., 2002).

Every cyclists have to pedal at the same frequency since all sprockets are connected with same chain. Also in the electrical network all the generators (turbines) have to rotate at the same frequency to maintain constant (50 hertz) the electrical power frequency.

If some cyclists are simply sitting on the bike and do not pedal they could be compared to the loads of the electrical network; in fact they are points in which the energy produced by the other cyclists is consumed. To keep constant the speed of the bike the total force of the active cyclists (total generation) has to be the same as the total power absorbed by the passive cyclists (total loads). It could be noted that the chain between the cyclists may be slightly elastic; it means that an angle difference may exist between the pedals positions of the different cyclists. The same phenomena happens in the electrical network when a "phase angle" exists between active and reactive generated power, and all the generators have to work in such way to reduce as much as possible these phase angles differences. For the bike system a great angle difference indicates that some cyclist pedal too slowly and some other too fast. In the electrical transmission network the angle difference indicates also an insufficient power production in some part of the network and a surplus of production in some other parts. In such situation, for the bike and for the network system as well, some instability conditions could arise.

It interesting to note that, in the previous condition, the instability level of the tandem bike system increases much if the bike speed is low (bike oscillations can arise), and, on the contrary, decreases when the speed of the bike increases.

In the same way, also the electrical network system results more vulnerable, due to such instability problem, when the electrical production and consumption is low. The Italian electrical black-out of September 2003, mainly determined by a too high energy flow from foreign countries, happened during the night, the period in which the energy production and consumption are low; the Italian energy operator (GRTN) said in such occasion that the same black out may be avoided during the day, when production and consumption are higher.

If we look again at the nuclear core operative map of fig 2, we could note that, also for this system, the instability condition is higher when the core flow is low (30-35% of the nominal flow).

From the above considerations we can learn the following lesson: to work in a safe condition, whatever the considered system is, the system operator have to maintain its parameters near the nominal working states. System shutdowns or start-up must be executed with attention, because during the execution of such procedures may be possible to pass through zones where the system instability is higher, and a collapse event may occurs.

Causes that determine the physical instability of the networks

The globalisation of the markets makes more difficult for the networks operators to manage the systems in a safe working status, far from the instability zones.

Generally the electrical system operator of a certain nation have to decides or plans the day before what generators (production plants) will be used the day after to satisfy the internal energy consumption and the external requests. This is imposed by the fact that it is not possible to execute rapid start-ups or shut-downs of the production plants. Depending on the plant typologies these procedures may require long times (hours) for the execution.

In the energy field new possibilities were recently introduced for distributed generation of renewable energy like solar energy or wind. But the power transmission networks and their control and supervisory systems are not ready to manage these new autonomous energy producers that introduce additional instability inside the electrical system. In fact is not always possible to forecast with sufficient accuracy where and when the weather conditions requested by the renewable energy production plants will be available. This types of plants have a “degree of autonomy” that is not always compatible with the need to maintain the whole system in a safe condition (far from the instability zones).

The consequence of the serious incident, which originated in the North German electrical grid during the night of 6 November 2006, was simply the European grid separation in three large islands, but, on this occasion, Europe risked a very large blackout, involving a lot of countries. One of the reasons of this incident was also attributed to voltage instabilities caused by the wind energy production plants, installed in the North of Germany by autonomous energy providers.

The free energy market imposes today also the necessity to sell and acquire energy from different countries during some time periods that are determined by economical reasons, but that do not take in account the systems instability constraints.

One of the main reasons of the electrical network instability, which in September 2003 generated the collapse of the Italian grid, came from the large amount of energy imported by Italy from France. The cost of this energy is lower if transferred in the night period. This determines a higher amount of power flow coming from France to Italy during the night. But in such condition, when fewer generators are in operation, the total voltage stability margin is narrow, and the network has less degrees of freedom to manage potential instabilities caused by the high cross-border power flow.

Cyber and organisational instabilities

When we speak about Critical Infrastructure instabilities we have consider not only the faults arising in the physical layer of the infrastructure but also what happens on the cyber and the organisational layer (Balducelli C. *et al*, 2005).

This situation is well described in the table of fig 4, extracted from the Joint United States-Canada Power Outage Task Force report, that shows the sequences of events happened on august 14 2003, four hours before the collapse of the US-Canada power grid.

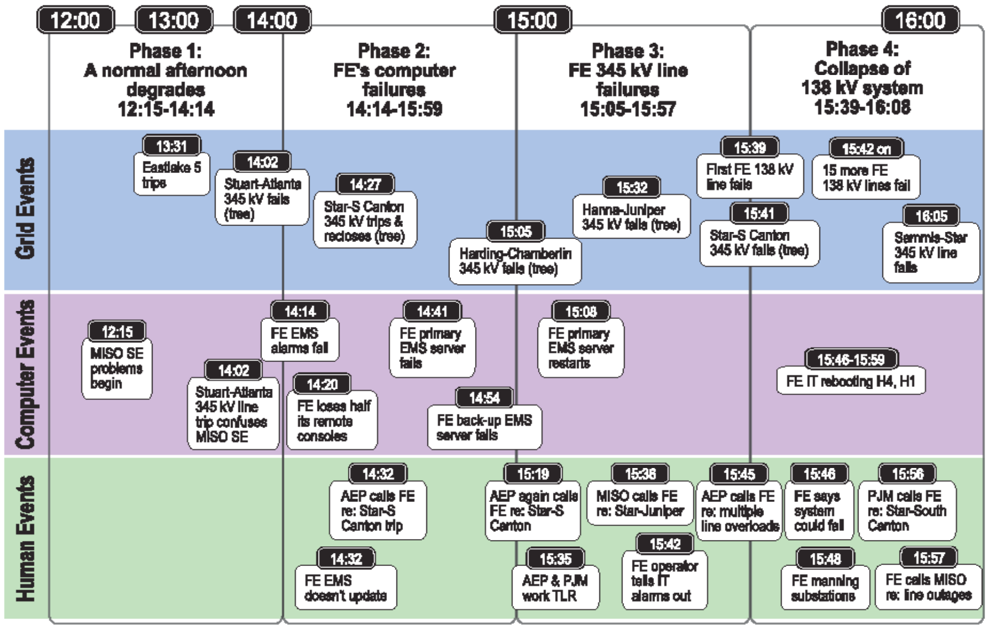

Fig 4 - Timeline of the U.S- Canada Power System outage

In the table the events are classified as physical (grid) events, computer (cyber faults) event and human events (operator errors), and at every event the relative time label is associated.

From the figure is possible to evidence that in this case the first events of the chain was caused by some computer faults: the program MISO SE (the State Estimator tool) utilised by the electrical operators to evaluate the status (stability level) of the physical network gave some wrong indications. For such reason after 12:15 the electrical operators were not completely aware about the real state of the network.

They were not alerted about some instabilities that started inside the network; without the proper corrections, the instability levels increased, and many other physical faults arose like several lines disconnections. As it is visible in the bottom part of the figure, also many wrong types of operations ware executed as the operators didn't understand the causes of the alarms that arrived in certain sequences at control rooms.

This situation describes well as a cyber infrastructure, that is designed to allow the operators to maintain the physical network far from well known instability zones, contains some intrinsic vulnerabilities that may cause itself some not foreseen instabilities.

Other vulnerability points of the cyber infrastructure depend on the cyber-attack possibilities that increased in the last years. Some time cyber attackers may exploit also the same automation mechanisms designed to increase the cyber-infrastructure efficiency.

New instabilities appeared also in the human organisations managing infrastructures. In the global world this is generated by the necessity to reduce the organisational and industrial costs, that for a company are determined by the competition with other companies.

The globalisation of the markets and the competition make both computer systems and human organisations more vulnerable and exposed to external threats.

Sources of instabilities in the cyber layers are also caused by loss of employers or industry operators with critical skills. The introduction of a new generation of information/control systems often requires more knowledge/expertise about these new technologies. But frequently, the companies are afraid about the introduction of new technologies, and at the same time, the oldest ones are not competitive anymore.

To reduce personnel cost, many energy distribution companies promote the utilisation of 'remote' maintenance of devices and cyber components utilising the internet connectivity. But this new type of connectivity can be used also by malicious users or cyber-terrorists to damage the network functionality.

Some key recommendations to reduce complex systems instability

The physical layer of the system have some "intra-dependency" with the software components dedicated to monitoring and controlling the internal functions. For the most important and critical infrastructures these components belong to a cyber layer that is called SCADA[2] system.

Regarding SCADA system many misconceptions exist, and, in particular one of these is the idea that "SCADA system resides on a physically separate, standalone network". In effect most SCADA systems were originally built before and often separate from other corporate networks. As a result, IT managers typically operate on the assumption that these systems cannot be accessed through corporate networks or from remote access points. Unfortunately, this belief is usually fallacious. In reality, SCADA networks and corporate IT systems are often bridged as a result of two key changes in information management practices. First, the demand for remote access computing has encouraged many utilities to establish connections to the SCADA system that enable SCADA engineers to monitor and control the system from points on the corporate network. Second, many utilities have added connections between corporate networks and SCADA networks in order to allow corporate decision makers to obtain instant access to critical data about the status of their operational systems. Often, these connections are implemented without a full understanding of the corresponding security risks. In fact, the security strategy for utility corporate network infrastructures rarely accounts for the fact that access to these systems might allow unauthorized access and control of SCADA systems.

For these reasons SCADA systems have been protected as their internal failure, eventually caused by attacks, may contribute to produce physical instability phenomena.

Another important issue that may be considered to reduce the physical systems instabilities is the need of *more coordination* between the different organisations managing critical networks and infrastructures.

It is well known that inside every infrastructure many procedures, tools and resources are available for the operators to prevent and manage crisis or instability events. Anyway every infrastructure operator normally looks inside his own infrastructure and has the primary goal to protect it against failures and disruptions. Anyway actually the infrastructures are more and more interconnected; they produce services and materials that are utilised by other infrastructures; the lack of a certain service inside a local infrastructure may produce failure inside remote one that, if consequently fails, could produce additional damage inside the local one. This is the so called "interdependency" phenomena (Rinaldi S.M, et al, 2001) that, for more coupled infrastructures, seem to be a new and emerging instability problem.

While for the instability problems encountered inside single plants, the local operators are generally trained to maintain the system inside the operative zones, far from well known

[2] Supervisory Control And Data Acquisition system

instability regions, interdependency is a new instability phenomena, affecting sets of coupled infrastructure, for which the operators have not sufficient information and knowledge.

To front this new type of instability is necessary to co-operate and to exchange information between different infrastructure owners about the status of critical services that are essential for the survival of some other coupled infrastructure.

In this type of communication there are two main types of information that have to be exchanged to mitigate the possible instabilities arising from interdependency problems:

Info about quality of services

The infrastructure that acts as service provider informs the service consumer about the quality of the service delivery. Information can not only be related to actual service delivery but also to "future service delivery". Information related to future service delivery may be accompanied with a probability of occurrence. One purpose is that the service provider can inform the service consumer of possible future problems to give the service consumer sufficient time to take mitigation measures. In the case of incidents, it might be important for the service consumer to know that the problems are not within its own infrastructure but are related to a failure of a consumed service.

Negotiation info

In this case the service provider and the service consumer negotiate the terms of possible service degradations. One party sends a proposal to the other one. Proposals contain suggestions concerning the minimum quality of service levels for certain services, time spans and locations. The other partner can then accept or reject each proposal. Negotiation messages are always exchanged in both ways. There are different possibilities how negotiation can start. For example, an electricity distributor has to disconnect a certain area for some time but he is flexible with the exact time. He can suggest possible times for the disconnection and a telecommunication provider can choose one of the options. Another possibility is that a service consumer sends, as a reaction to an information about quality of certain services for the next future, a preference list with the most important services. These preferences can be considered during recovery crisis and recovery phases.

Conclusions

We described how instabilities are a sort of intrinsic phenomena for every types physical systems. Every complex systems like energy plants, energy distribution or telecommunication networks have some cyber and operational layers dedicated to monitor and control the system instabilities.

Actually complex networked systems are the core of many critical infrastructures, that are coupled together and that exchange critical services each other. Instabilities of a specific physical system are often well known by the systems operators and they have sufficient knowledge to avoid intra-system cascading failures.

But, when the interdependency problem between more infrastructures arises, the operators are not sufficiently prepared and a not usual co-ordination strategy is needed.

EU IRRIIS integrated project (IRRIIS, 2006), started one year ago, with the objective to produce a set of software components (based on MIT – Middleware Improved Technology) to be installed as mutual co-ordination support for the different infrastructures operators. We hope that the results of this project will be available as soon as possible to address and solve, almost in part, the increasing instability of critical infrastructures.

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Author Biography

Claudio Balducelli is a senior scientist working at ENEA as project manager since 1983 in the field of AI technologies applied to operator decision support systems for emergency industrial accidents. His interests include operator models, knowledge formalization, planning, computerized procedures, plant diagnosis, case based reasoning, learning and fuzzy algorithms. He co-ordinated also the prototypical implementation of various site applications like a cooperative training system for the Genoa Oil Port managers (MUSTER project) and an emergency operator support system for major Oil Deposits and Pipelines in Italy. He is team leader inside SAFEGUARD FP5 project (Safeguarding Critical Infrastructures), and IRRIIS (Integrated Risk Reduction of Information-based Infrastructure Systems) FP6 project.

THE PROBLEM OF POWER INTERRUPTION:
LOSS ASSESSMENT AND INSURANCE

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Keywords
Power interruption, loss assessment, insurance, liability limits, insurance tariff assessment

Abstract
Analysis of power supply interruption for different category of consumers has been done. The method of the insurance tariff estimation of the risk of power interruption was designed. Estimations of the insurance tariff with reference to power supply interruption of the middle size town population has been executed.

Consequences of power supply interruption
In the general structure of losses caused by emergencies the significant place is occupied with the damages connected to outage of power supply of consumers. In accordance with data of Electric Power Research Institute (EPRI), about 2 million companies in the USA lose 46 billion dollars a year because of loss of production in connection with power interruption and 6,7 billion dollars a year – because of decrease in quality of the delivered electric power (direct damage) [1].

Consequences and the sizes of damages connected with power interruption are most in detail investigated in the case of large scale outages caused by system failures. The list and the brief description of the largest failures of power supply interruptions in the world are resulted in the Table 1.

Table 1. Some examples of large scale power interruption

1965	January, 28 submission of the electric power in territory of several states **of Northwest USA** has stopped. More than 2 million people have remained without the electric power for 2,5 hours.
1977	Well-known «Night of Fear» in **New York**. Because of hit of a lightning in electric transmission line New York city has been stay without power for two day, the damage for the sum over $300 million has been caused.
2003	August, 14 in a number of the largest cities of east **coast USA and Canada** there were industrial disasters. Switching-off of the electric power have taken place on the area more than 24 thousand sq. km. This event have been impacted more than 50 million in the USA and Canada and has led to a shutting-down over 100 power stations, including 22 nuclear reactors. The

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	financial losses has made about $6 billion.
2003	August, 18 because of emergency switching-off of a power supply system **of Georgia** submission of an electricity on all country, including objects of life-support has been stopped. Tens thousand passengers have got stuck in cars of trains of the underground and at stations of the Tbilisi underground. In the majority of cities of Georgia water supply was interrupted.
2003	August, 28 failure in power supply has impacted the central and southeast areas **of London**. There were stopped trains on the central lines of the London underground, passengers were evacuated from lifts stopped between floors. Local trains movement has been broken.
2003	Because of storming wind there was a short circuit on power transmission 380 кV in the Swiss Alps. In different areas **of Italy** the electric power supply was interrupted from 5 till 16 hours.
2005	July, 25 there was a system failure in **Moscow**, in result the electricity supply in the most part of areas of Russian capital and a number of cities of Moscow suburbs was disconnected. Transport network, many enterprises and commercial structures have stopped, shops were closed. 72 % of Moscow people have suffered from failure in electricity supply.
2006	November, 4 at exit in the sea on the river Ejms **(Germany)** passenger liner *Norwegian Pearl* scheduled switching-off 380 kV transmission lines for pass liner under the line was carried out. However at redistribution of the electric power flows the system of automatic protection of one of the next lines has caused a wave of switching-off in Germany, the countries of Benelux, France, Spain, Portugal, Italy, Morocco, Austria and Croatia.

As a rule, power interruptions lead to a wide spectrum of consequences in various areas of human activity. For example, consequences of the system's failure which have occurred in Moscow in May, 2005 have mentioned the following sectors of economy and an infrastructure: banks, authorities, stock exchanges, the industrial enterprises, communication, trade, transport, public health services, municipal services. The total losses from the accident was estimated in 1 billion 708 million 400 thousand Roubles (Moscow), and in the Moscow area — in 503 million 940 thousand Roubles. Other example of infrastructural consequences are faults in work of system of water supply owing to switching-off of the electric power in the USA and Canada in 2003.

Failures in power systems lead to development of emergencies of various scale: sub-local, local, territorial, regional, federal and transboundary. In Table 2 statistics of corresponding emergencies in Russia for the period with 2001 on 2005 is resulted.

Table 2. Statistics of emergencies in the Russian Federations caused by failures at electric power systems

Year	Total emergencies	Sub-Local	Local	Territorial	Regional
2001	16	5	10	1	0
2002	15	6	7	2	0
2003	12	5	4	3	0
2004	8	4	2	1	1
2005	13	12	1	1	0

The analysis of failures in power systems reveals their general laws and completely confirms the system nature of occurrence such emergencies [2]:

- The majority part of power supply systems was created at the end of 50th years of XX century counting upon mutual aid of operators in emergency. Modes in which these systems work now, are beyond, stipulated at their designing, mainly in connection with liberalization of the market.

- Even the most insignificant event (for example, the overload of a line or breakage of wires by the tumbled down tree) can cause weight of problems for the loaded system of power supply of the big extent.
- Failures in work of the emergency equipment and accident protection devices (frequently because of bad servicing) can not prevent with such situations; the existing system of automatic control frequently appears unable to prevent emergency.
- Except for only technical factors, in all cases of occurrence and development of system failures the considerable role is played with human, economic and situational factors, including the common lack of information on places of potentially possible failures and unavailability of the personnel quickly to react to an emergency.

Estimation of insurance tariffs and liability limits

As shows experience of developed countries, one of the most perspective mechanisms of management of considered risk is insurance. Calculation of insurance tariffs and liability limits is essentially possible if dependence between frequency of events and consequences as economic damage (distribution "frequency - losses") is known. If the estimation of the distribution is executed for events, which can be identified as insurance events within the framework of the contract of insurance power interruption there are problems of definition of acceptable liability limits, franchises, the insurance tariff and other characteristics of the insurance policies.

Insurance of the damage caused by electric power interruption, can be carried out within the framework of contracts of property or liability insurance. In case of liability insurance, the tariff of insurance reflects the size of a payment of the insurant (the power companies) to the insurer (the insurance companies), the liability carried out within the framework of established limits.

At calculation of the net - rate “the principle of a standard deviation” which declares equality of size of the payments collected for full term of insurance, to the expected size (i.e. to average value) claims, combined with “the risk charge”, proportional to a standard deviation from average value more often is used. Using of the risk charge is dictated by necessity of maintenance of stability of activity of the insurer, i.e. reduction of ruin probability [3].

The size of the of insurance rate is defined for the integrated categories of consumers (the population, industrial consumers, services) in view of the reasons caused by power outage. Settlement formulas are below resulted by the example of the population.

The size of damage caused by power interruption essentially depends on duration of switching-off of consumers. The average damage from outages of the population supply, caused *δ-th* the reason (equipment failure , natural disaster, actions of the third parties, etc.), on all intervals of duration of power interruption is estimated according to expression:

$$\overline{Y}^{(pop,\delta)} = \frac{\sum_{\tau} Y_{\tau}^{(pop,\delta)} q_{\tau}^{(pop,\delta)}}{\sum_{\tau} q_{\tau}^{(pop,\delta)}} \quad (1)$$

where $Y_{\tau}^{(pop,\delta)}$ - damage in population customers, caused by power interruption with duration τ, initiated by δ-th reason, Rouble/year; $q_{\tau}^{(pop,\delta)}$ - frequency of power interruption with duration τ, initiated by δ-th reason, event/year.

The estimation of frequency of power interruption n $q_{\tau}^{(pop,\delta)}$ can be carried out on the basis of an index of system reliability of power supply *SAIFI* (System Average Interruption Frequency Index), reflecting an average of breaks in power supply in a year on one consumer. In case the number of contracts of insurance of the consumers caused by the reason *δ,* coincides with number of consumers it is possible to count that $q^{(pop,\delta)}$ is equal $SAIFI^{(pop,\delta)}$.

The liability limit of power company for interruption in electricity supply the population caused *δ-th* by the reason on one event, is established with use of value of the maximal duration of a outage τ^{max} and estimated on the basis of the formula:

$$L^{(pop,\delta)} = R_{\delta} y_{\tau^{\max}}^{(pop)} N^{(pop)} \omega_{\tau^{\max}}^{(pop)}, \qquad (2)$$

where $y_{\tau^{\max}}^{(pop)}$ - average specific damage at one consumer at one outage by duration τ_{max}, Rouble/year/event; $N^{(pop)}$ - a population consumers of the electric power, people.; $\omega_{\tau^{\max}}^{(pop)}$ - the share of the population injured of a interruption by duration τ_{max}.

The liability limit of power company for electricity interruption supply the population caused by set of the reasons (insurance risks), is estimated on the basis of the formula:

$$L^{(pop)} = \mu^{(pop)} \sum_{\delta} L^{(pop,\delta)}, \qquad (3)$$

where $\mu^{(pop)}$ – factor of a variation of insurance compensation of damage to the population. If the standard deviation of size of the damage caused by power interruption in supply of the population on *δ-th* reason is known, factor of variation μ is assessed by the formula:

$$\mu^{(pop)} = \frac{\sqrt{\sum_{\delta} \left[\left(\overline{Y}^{(pop,\delta)} \right)^2 N^{(pop)} q^{(pop,\delta)} \left(1 - q^{(pop,\delta)} \right) + \left(R^{(pop,\delta)} \right)^2 N^{(pop)} q^{(pop,\delta)} \right]}}{\sum_{\delta} \overline{Y}^{(pop,\delta)} N^{(pop)} q^{(pop,\delta)}} \qquad (4)$$

If the standard deviation of size of the damage caused by electricity supply of the population on *δ-th* reason is not known, value of factor of a variation μ*,* is evaluated by the formula:

$$\mu^{(pop)} = 1{,}2 \frac{\sqrt{\sum_{\delta} \left[\left(\overline{Y}^{(pop,\delta)} \right)^2 N^{(pop)} q^{(pop,\delta)} \left(1 - q^{(pop,\delta)} \right) \right]}}{\sum_{\delta} \overline{Y}^{(pop,\delta)} N^{(pop)} q^{(pop,\delta)}} \qquad (5)$$

Base value of the net - rate of the tariff of liability insurance of power interruption in supply the population caused by the reason *δ,* is defined under the formula:

$$a_0^{(pop,\delta)} = \frac{\overline{Y}^{(pop,\delta)}}{L^{(pop,\delta)}} q^{(pop,\delta)} \qquad (6)$$

where $\overline{Y}^{(pop,\delta)}$ - average value of damage caused by interruption in supply of the population caused by the reason *δ*, Roubles; $L^{(pop,\delta)}$ - a liability limit for damage caused by power interruption by the reason *δ*, Rouble; $q^{(pop,\delta)}$ – frequency of outage caused by the reason *δ*, event/year.

In case the standard deviation of size of damage of the population caused by interruption in power supply on *δ-th* reason is known the estimation of risk charge is carried out under the formula:

$$\Delta a^{(pop,\delta)} = a_0^{(pop,\delta)} \alpha(\gamma) \sqrt{\left[1 - q^{(pop,\delta)} + \left(\frac{R^{(pop,\delta)}}{\overline{Y}^{(pop,\delta)}}\right)^2\right] \frac{1}{N^{(pop)} q^{(pop,\delta)}}} \quad , \qquad (7)$$

where $\alpha(\gamma)$ - factor which values are determined depending on a required level of solvency of the insurance company γ; $R^{(pop,\delta)}$ - a standard deviation of damage of the population caused by power supply interruption by *δ-th* reason, Rouble; $N^{(pop)}$ - a population.

In case the standard deviation of size of damage at the population caused by electricity supply interruption, is not known, the estimation of the risk charge is carried out under the formula:

$$\Delta a^{(pop,\delta)} = 1{,}2 a_0^{(pop,\delta)} \alpha(\gamma) \sqrt{\frac{1 - q^{(pop,\delta)}}{N^{(pop)} q^{(pop,\delta)}}} \qquad (8)$$

Example of calculation of tariffs of insurance of damage caused by interruption in power supply of the population.

By the technique stated above calculation of tariffs of insurance is executed. At calculations it is supposed, that insurance of consumers is made irrespective of the reason of the outages (all calculations are made for the generalized reason of electricity supply interruption).

Calculation of tariffs is executed for town Kaluga (Russia). The population of Kaluga with suburbs – 500 thousand persons. Frequency of power interruption for the given settlement supposed $q^{(pop)} = SAIFI^{(pop)} = 1{,}3$ (event/year on 1 consumer).

Distribution of frequencies of power interruption of the population by duration factor of a variation τ (event/year on 1 consumer), received on the basis of the analysis of the statistical data for the countries of Northern America and the Western Europe, is resulted in Table 3 [4].

Table 3. Distribution of power interruption frequencies for population

Outage duration	Power interruption frequency, event/year on 1 consumer ($*10^{-2}$)
From 1 to 20 min	10,01
from 20 min to 1 hour	11,44
From 1 to 2 hours	30,03
From 2 до 4 hours	32,89
From 4 to 6 hours	21,45
From 6 hours to 1 day	14,3
More than 1 day	2,86
Not defined	7,15

Distribution of specific damages from power supply interruption by duration τ (Rouble/year on 1 consumer), is resulted in Table 4.

Table 4. Distribution of loss caused by power supply interruption of the population

Outage duration	Losses, Rouble/year on 1 consumer ($*10^2$)
From 1 to 20 min	0,12
from 20 min to 1 hour	0,65
From 1 to 2 hours	9,01
From 2 до 4 hours	9,47
From 4 to 6 hours	12,61
From 6 hours to 1 day	30,24
More than 1 day	13,04
Not defined	8,47

The rating of average damage caused by power supply interruption of the population, on all duration intervals, designed under the formula (1), makes 1069,5 roubles on one consumer.

Also the rating of liability limit of the power company for power interruption of the population is executed. Calculations are made for the generalized reason of power interruption, index R_δ=1 used in the formula (2) (a share of outages caused by the reason δ). The option value $\omega_{\tau_{\max}}^{(pop)}$ of a share of the population injured of outage by duration $\tau_{\tau max.}$, is appreciated by results of the statistical data and equals 57,5 %.

Let amount of insurance policies corresponds with the population $N^{(pop)}$ - 500 thousand. Then, the liability limit of the power company assessed by the formula (2) will make 54,6 million roubles.

As a liability limit of the power company value of the maximal damage which has arisen as a result of power interruption at all insured consumers is accepted. Net - rate of the tariff of liability insurance for the population, assessed by the formula (6) makes 0,63 %.

As it is not enough accessible statistical data for calculation of size of a standard deviation of size of damage a rating of the risk charge it is feasible under the formula (8). Let the insurance company with solvency probability γ = 0,95, then factor $\alpha(\gamma)$ = 1,645; and value of the risk charge will make 0,12 %. Accordingly, value of the net - rate of the insurance tariff will make 0,75 %.

Fig. 1 shows dependence of the net - rate of the insurance tariff on amount of insurance policies. Analyzing the received dependence, it is possible to see, that at increase in amount of insurance policies, predictably, the insurance tariff is reduced.

Fig. 2 shows the behavior of the net - rate of the insurance tariff at change of index SAIFI - an average power interruption in a year on one consumer.

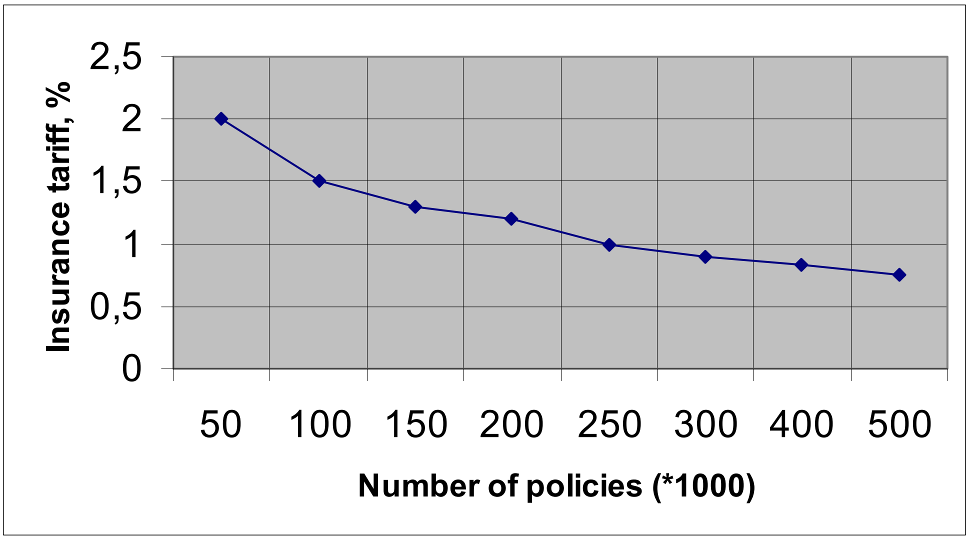

Fig. 1. Dependence of the net - rate of the insurance tariff on amount of insurance policies

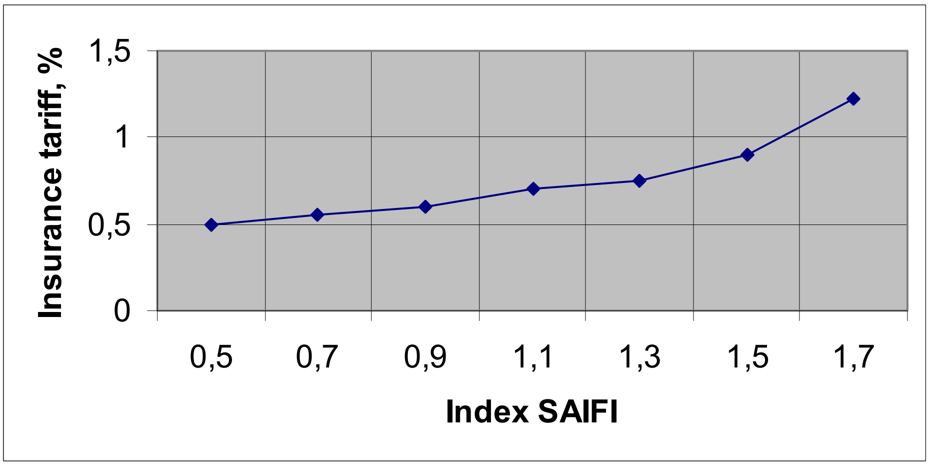

Fig. 2. **Dependence of the rate of the insurance tariff for the population from change of index SAIFI**

Analyzing the received dependence, it is clear, that at increase in index SAIFI, i.e. at increase in an average of power interruption in a year on one consumer value of the insurance tariff increases. Basically, it means, that increase of reliability of power supply leads to reduction in insurance tariffs.

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GLOBALIZATION OF POWER BUSINESS - THREAT OF BLACKOUTS?

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Keywords

Critical infrastructure protection, blackout, public private partnership

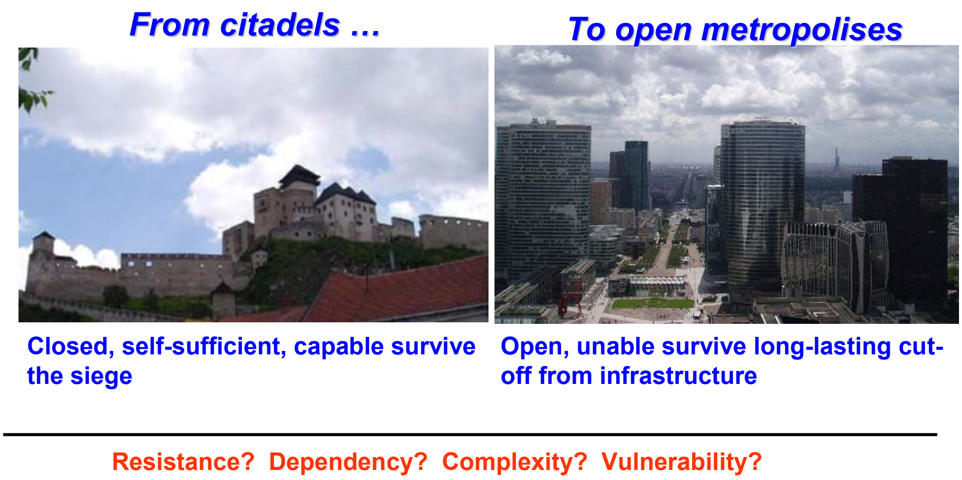
Abstract

The Czech Republic has well developed national transmission grid. Nevertheless five emergency situations occurred this year (2006). The last one leaved about 2 millions people without electricity for several hours. The serious discussion between public and private sector, that has started already two years ago, was accelerated. Ministry of Interior, Ministry of Regional Development and three Regional Governments sponsored several studies and research projects how to improve population protection as well as critical infrastructure protection. We find out discrepancy between crisis legislation and energy ones.

Emergency situation according to crisis legislation activates measures to ensure emergency delivery of goods and services (for population protection). In the opposite, the emergency situation according to energy legislation activates measures to restrict or shut off the energy supply without penalty (for energy equipment protection). It creates gap between public responsibility (to ensure human safety) and private responsibility (to make profit).

Introduction

Human settlements have changed. Hundreds years ago the settlements were closed, self-sufficient and capable survive the siege. Today's cities are open and they can be hurt by attack on its infrastructure. We should understand well theirs resistance, dependency, complexity and vulnerability (Fig.1). City can be hurt by attack on its infrastructure.



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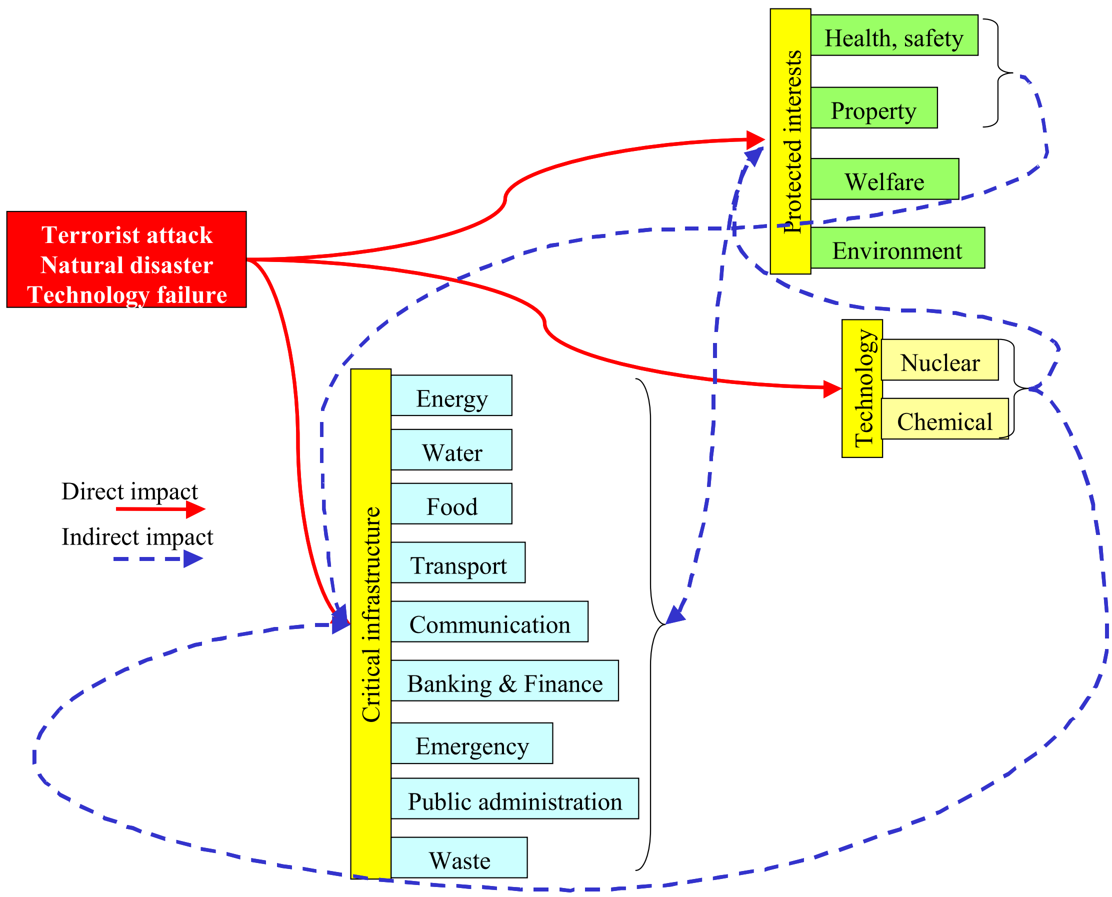

Fig. 1

Exposure to hazard comes from complexity and interdependency of critical infrastructure. Like a small fire can develop to firestorm in a similar way the trivial failure can develop to crisis situation through domino and cascade effect (Fig.2).

Protected interests can be hurt not only directly but also insidiously through critical infrastructure demotion (attack on the power grid, communication, water system, etc.). As well as attack against population can result into critical infrastructure demotion due to lack of personnel.

Problem arisen from globalization

Human safety is government's task. But once the infrastructures were privatized (energy, transportation, telecommunication, water supply, …) we can recognize the differences between private and public approach to the risk.

Whereas government takes care about sectoral and inter-sectoral availability, the private owner understands rather the project risk management, incident management plan and business continuity planning. It brings several problems. Private CI companies in the same sector are in the competitive position. Trouble of one company is a welcome opportunity for another. Therefore the sectoral cooperation is problematic. Private owner is shifting CI operation to their technical limits to be competitive enough. It can lead to lower safety, especially if supply interruption is free of penalty (i.e. exercise "force majeure" privilege).

Multiple terrorist attacks on critical infrastructure can cause crisis situation that exceeds capacity of rescue services. Significant hazard to human health and life as well as significant property loses can lead to activation of radicals and disintegration of democracy system (Fig.3).

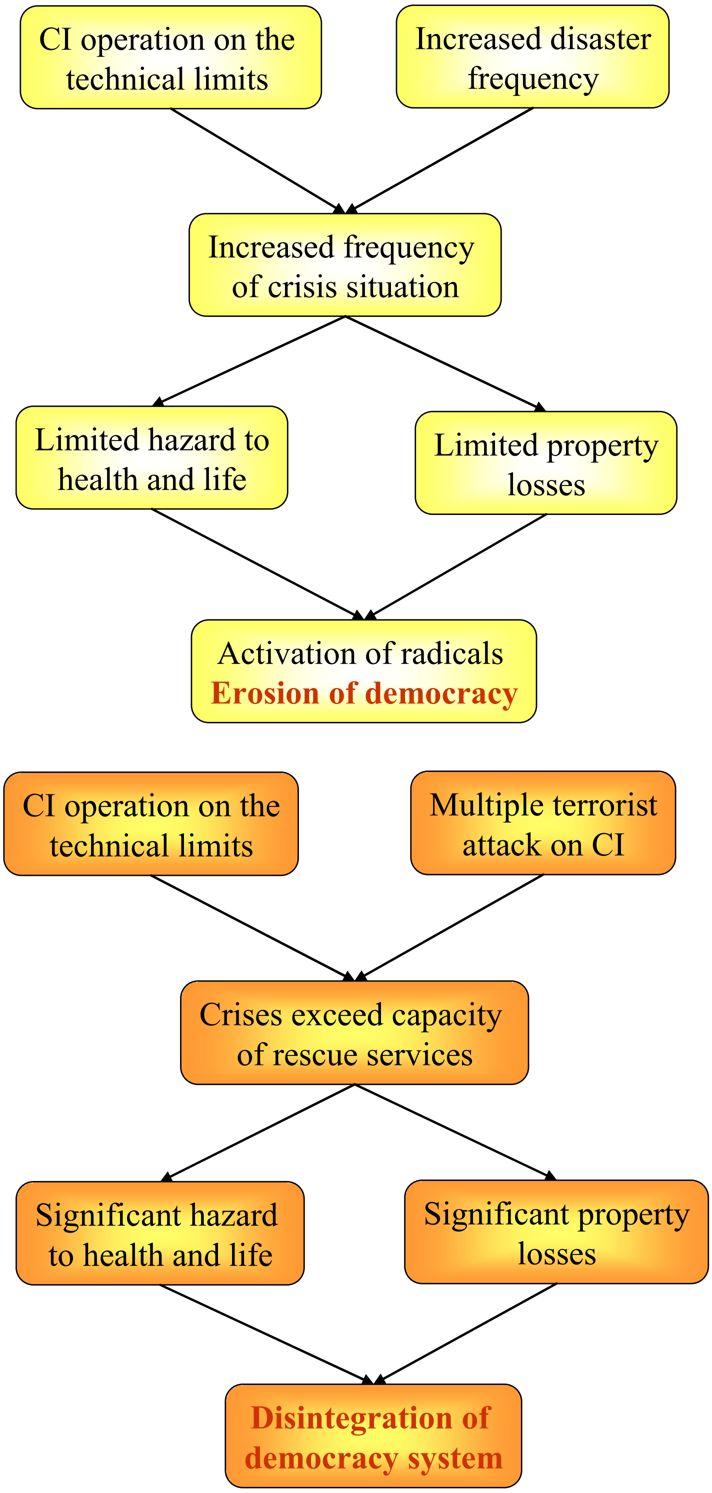

Fig. 2

Once in a while are some villages without electricity due the extreme weather conditions. Cost cutting leads to slim the faulty crews and so the local blackouts (longer then 24 hours) are more frequent. The 2 or 3 weeks blackout can result into chaos and it is jeopardy for democracy.

Conflict between safety management and market value oriented management is obviously seen in perception of emergency. Emergency status in crisis legislation is oriented on provision of necessary supply of goods and services on behalf of population protection. Emergency status in energy legislation is oriented on supply restriction or cut without penalty on behalf of energy facility protection. Bigger gap asks for higher capacity of Integrated Rescue Services (Fig.4). The gap can be overcome by legislation (symbolized by arrow).

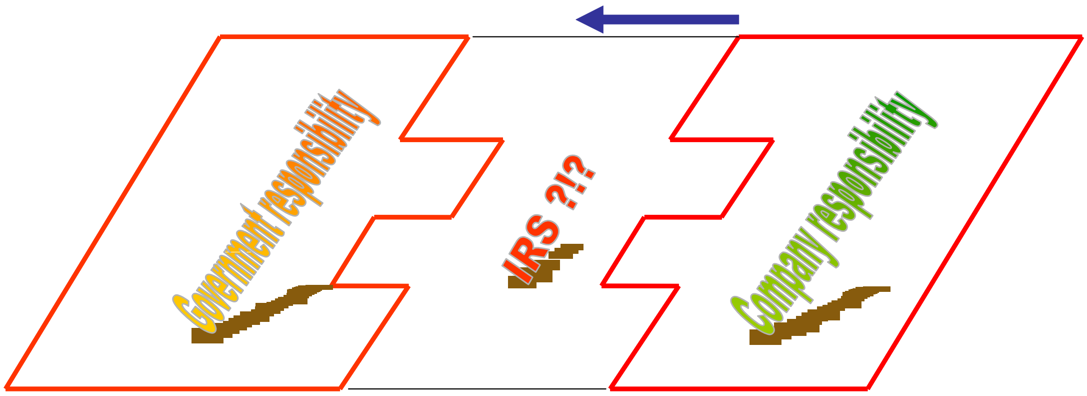

Fig. 3

Many energy infrastructure companies have well developed emergency response plans. Although these plans focus on responding to natural disaster and man-made errors, they still provide a solid basis for responding to the harms inflicted by a potential terrorist attack. However, far fewer companies have approached the issue of proactive security in a considered, comprehensive and proactive manner.

From the security point of view a strategic security plan should look at far more than fences, lights and guards. These plans should look at the broad range of business, public affairs, legal and regulatory issues that impact security, such as:

- How do we integrate our security planning into our business continuity planning?
- What informations are we providing publicly that we shouldn't and how do we change this? Why is this information being made public?
- What liabilities do we have and how can we limit them? What is our standard of due care in the wake of these attacks and are we meeting that standard?
- What legal and regulatory impediments are there to building redundancies and how can we overcome them?
- How do we communicate our security planning to stakeholders without compromising security in the process - both before a crisis and after?
- How do we plan on working with the authorities in handling these security issues - both before a crisis and after?
- How does the changing national security environment as a whole impact our business plans and models?

In an open democracy reliant upon a free market economy, security is necessarily imperfect. Further, in dealing with an industrial sector as extensive in scope and geography as the energy sector, it is impractical to suggest that this entire infrastructure could or should be rendered perfectly invulnerable to terrorist attacks.

Threat of blackouts

According to vulnerability analysis and risk scoring done in the project "Population protection and its dependency on energy critical infrastructure" (Institute of Population Protection, CITYPLAN, ViP, 2004-2005) the national grid (transmission system 400kV and 220 kV) is the most critical part of energy infrastructure (Fig.5). X-axis represents relative expression of the risk scoring.

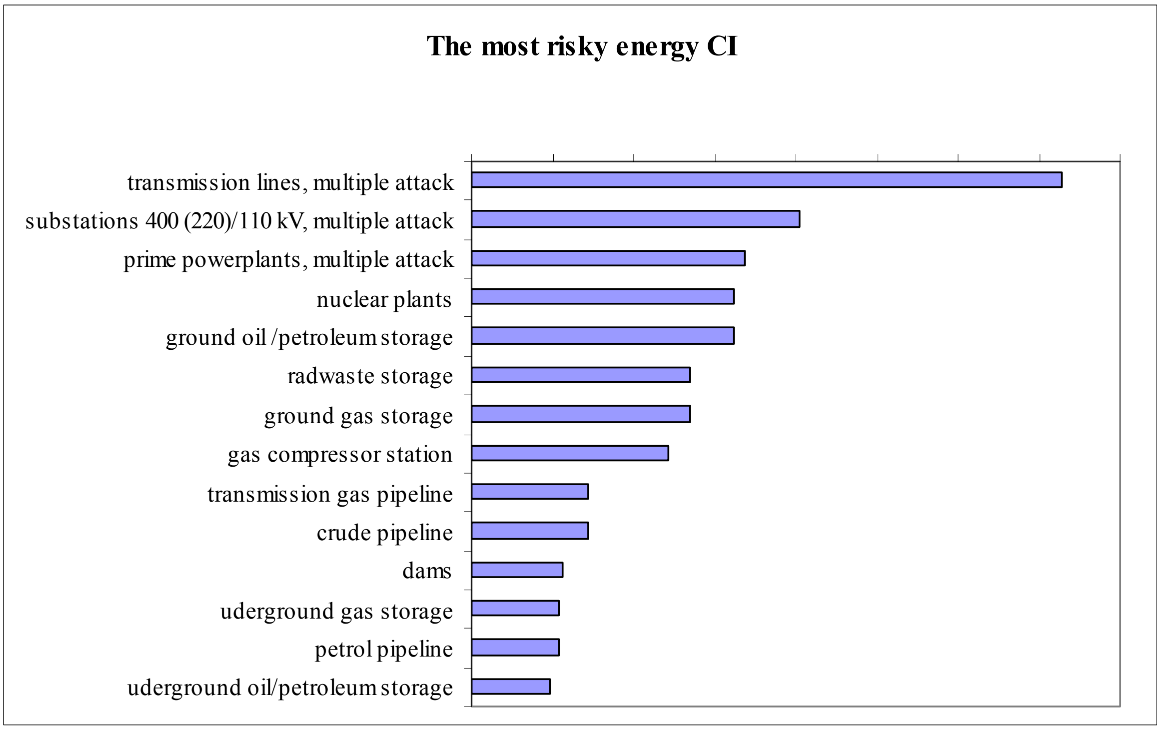

Fig. 4

After 9-11 attack in USA, as well as attacks in Madrid and London show, that N-1 rule is not sufficient enough to ensure protection against blackouts. On 14 August 2003 a large section of national grid failed leaving 50 million people in the US and Canada without power. And not just without power; in Cleveland pumping stations shut down leaving people without water; in Toronto subways were out of action for several days. Then it happened in Europe. In quick succession major power outages occurred in Southern Sweden and in Italy. It can happen also in the Czech Republic, because the Czech national grid operation is also under pressure of power traders.

Critical infrastructure should be equipped with the immune system. Time is the key factor that determines extent of losses. Our critical infrastructure structures are almost as ingenious as skeleton. Our critical infrastructure piping is almost as ingenious as bloodstream. Our critical infrastructure control systems are almost as ingenious as nervous system. But we are missing something what is ensured by lymphatic system. We need to be prepared not just for single event, but much more.

Immune system knows to treat hundreds attacks of viruses and bacilli a year and most of them is able eliminate automatically without our brain and without doctor. This is big challenge for research, development and innovation that should lead to self-healing critical infrastructure systems. Public Private Partnership can facilitate this effort if the sustainable development will be based on the safety management and business continuity planning.

RESPO Project

Last year RESPO (RESilient Power) project has started. Project is granted by Czech Ministry of Trade and Industry. Project will solve the resilience of power distribution against the national grid blackout. About 38% power generation in the Czech Republic comes from power plants and district heating plants connected to the distribution grids. Because ancillary services are provided by the national grid, during power outage of national grid today's distribution grids are not able to balance local power generation and load.

RESPO project will solve the crisis demand side management that enables to regulate and provide necessary power to customer and critical infrastructure facilities. Project team is constituted from five research companies led by the CITYPLAN.

Project should contribute to enhance current European electricity networks to be sufficient to meet challenges and policy imperatives of the 21st century, especially from the human safety point of view. RESPO project is in the line of the SmartGrids European Technology Platform for Electricity Networks of the Future (Fig. 6).

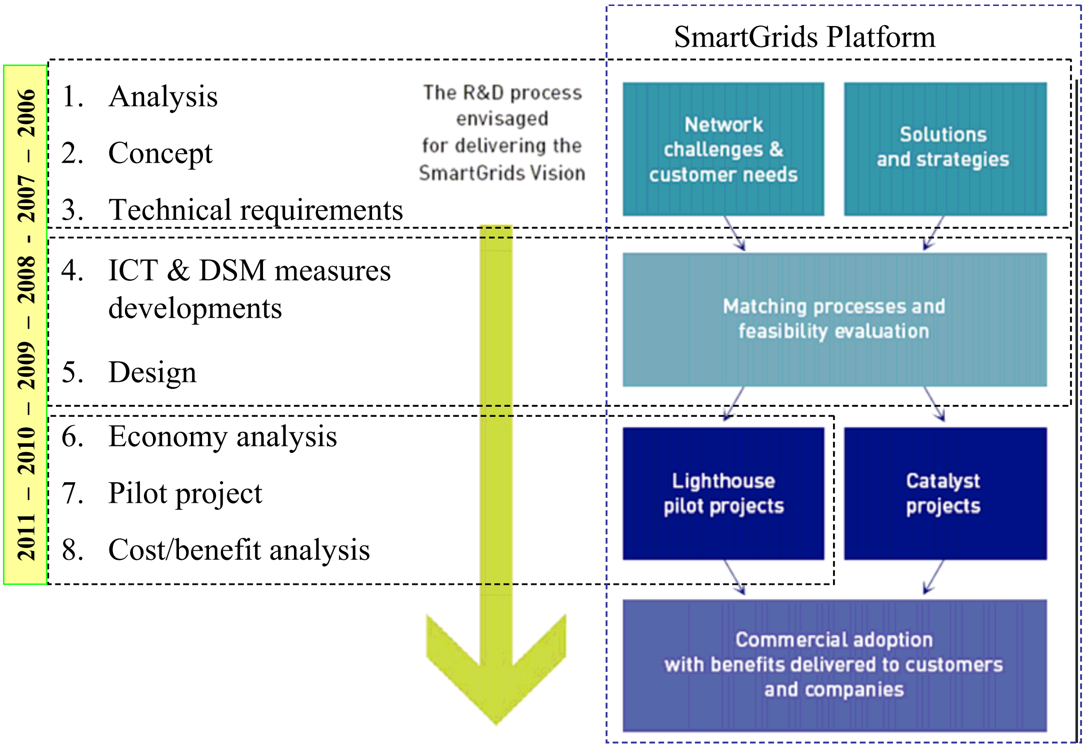

Fig. 5

The figures show, that RESPO project fits well the SmartGrids platform.

Results

Critical infrastructure protection is no imaginable without Public Private Partnership. In the Czech Republic this problem is solved on three levels (Fig.7).

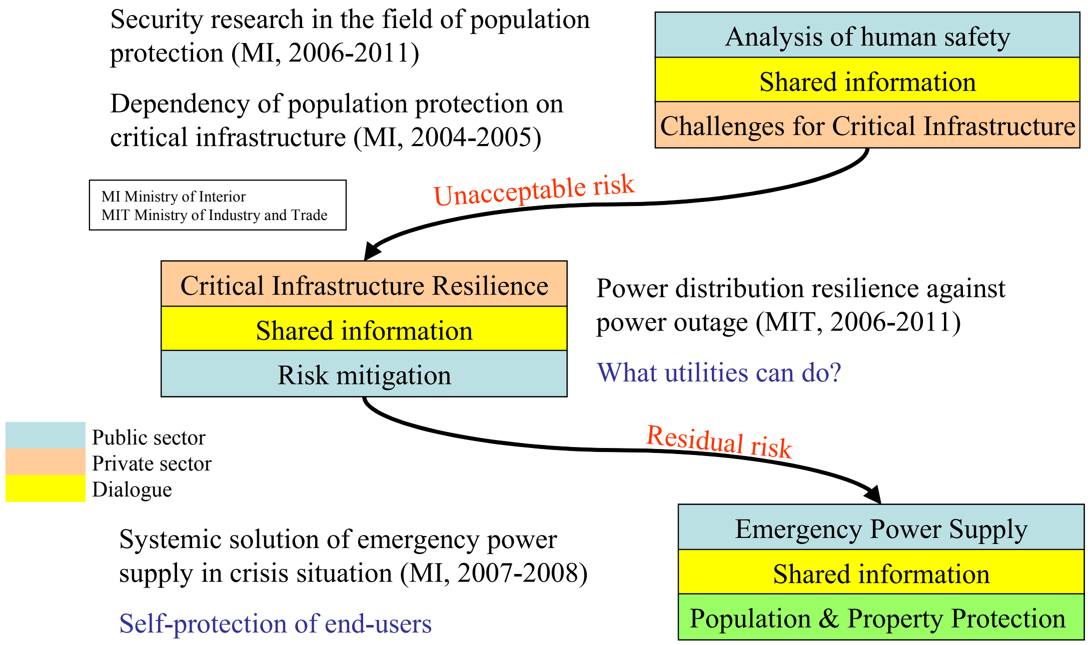

Fig. 6

On the national level the public sector provides analysis from the holistic view on the human safety. We provide vulnerability analysis, impact analysis and risk assessment. The results address the challenges towards private sector to mitigate unacceptable risk.

On the second level the owners and managers should look for measures to provide resilience, protection and defence of critical infrastructure facilities and technology. The good praxis to improve security and service continuity is the Business Continuity Management and Incident Management Planning.

The residual risk is then shifted on the end-users. If measures implemented by utilities will not be sufficient, the residual risk will be higher and it should be overcome by end-use measures. On this third level population should be advised to provide self-protection as well as the commercial sector should be advised to provide business continuity planning.

Discussion

It will be challenging task to the future to harmonise understanding of what a certain security level means (terms of level of protection, organisation, procedures, etc.) between different private, public and (inter)national bodies and different languages, and organisational and legal systems.

This requires also development of ontology to support effective communication between (inter)dependent critical infrastructures across national borders.

Author's Biography

Mr. Benes is general manager of CITYPLAN - engineering and research company. He has more than 35 years of experience in the engineering, economy and management. His areas of particular expertise include critical infrastructure protection, business continuity planning, energy engineering and economy analysis.

Academic & Professional Practice

Peer Reviewed Articles

CLIMATE CHANGE AND ENVIRONMENTAL PROTECTION

OMS – AN END-TO-END COASTAL AND OCEAN MONITORING SYSTEM

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Keywords

Marine monitoring, Ocean observing, Marine surveillance, Maritime security, Information and warning system

Abstract

OMS stands for *Ocean Monitoring System* with an innovative, integrative approach to coastal and marine observation and hazard prediction. Its development is driven by increasing needs for coastal and marine surveillance and requirements for coastal states to monitor their Exclusive Economic Zones (EEZ), to enhance maritime security and to manage sustainable coastal zones (refer to e.g. the United Nations Convention on the Law of the Sea, UN (1982) and International Convention for the Safety of Life at Sea, IMO (1974). Coastal regions are inhabited by more than 50% of the world's population and particularly endangered by impacts of climate change and environmental stresses. These facts and a series of international conventions and initiatives like GOOS (cf. e.g. WMO & IOC (2004)) but also recent disasters like the 2004 tsunami catastrophe in the Indian Ocean call for significant enlargements of observational forecasting and warning capacities and capabilities.

Because of ever shrinking public budgets integrated and low-cost surveillance systems composed of well-proven and commercially off-the-shelf available components and sub-systems are required. The OMS matches these challenges with an open and highly flexible modular system design, integration and management scheme. The project is industry driven and enjoys strong backing by scientific institutions and governmental agencies. The OMS is an end-to-end system with the following main components: (1) sensing and information production with in-situ sensors, buoys, piles, aerial remote sensing and surveillance systems like X-Band radar and HF-SWR, (2) operational now- and forecasting, (3) system/sub-system integration, control and management, (4) information processing and tailoring and (5) dissemination including rapid warning facilities capable to reach large people communities in hazard threatened areas.

The OMS is presently developed as a pilot system covering the Southern North Sea including major parts of Germany's territorial waters and EEZ. Primarily the system will deliver reliable data and information and additionally serves as a demonstration and reference system for interested parties and users.

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Introduction

Throughout the last decade an increasing demand for coastal and ocean surveillance systems can be observed worldwide. This is fostered by a variety of requirements in governance, management, exploitation, utilisation and protection of coastal and marine regions and their resources. More than 50% of a still increasing world population already live in coastal regions. Migration towards attractive, rapidly developing and resourceful coastal areas is still ongoing on the global scale. This leads to increasing pressure on these areas. For instance, most fish stocks in coastal waters, shelf seas and nowadays increasingly in open oceans are overused, coastal waters are frequently nutrified and many areas are overpopulated or polluted. Also wetlands, mangroves and coral reefs are degrading in terms of extension, quality and biodiversity. Offshore oil and gas resources are to a major extent exploited on the continental shelf forcing exploration and production to move towards deep and ultra-deep waters or very sensible environments like the polar seas. Renewable energy resources are increasingly developed in the marine space with offshore wind energy generation as a pioneer technology and wave, tidal and ocean thermal energy have future potential. Methane hydrates are a huge ocean energy resource which in amount might increase all on- and offshore located conventional hydrocarbon resources by a factor of two. For the decades to come, it can be expected that methane hydrates from larger reservoirs will be extracted. Following a decline in research and exploration in the 1980s, nowadays also ocean mineral resources like deep-sea located manganese nodules and ore-muds become of interest again. Utilisation of coastal space for food production has increased tremendously and strong environmental impacts are already observable. This tendency is ongoing and even increasing due to enhanced food demands but also by presently exploited perspectives to use ocean resources in biotechnology and pharmacy. Moreover, the major part of global trade and a large part of recreation and leisure activities take place in marine areas which can be clearly seen in the tremendous increase of ship and fleet sizes with corresponding cargo and passenger capacities.

In addition to associated pressures and stresses on coastal zones and offshore regions climate change impacts like sea level rise, stronger and more frequent extreme weather conditions and warming of the seas have to be seriously considered. Moreover, maritime security and safety is a strong driver and concern as already small disturbances and interrupts in marine trade and shipping can seriously affect the world's economies which crucially depend on in-time delivery of goods and raw materials. Marine and coastal areas are also very vulnerable to disasters of which the impacts of the 2004 tsunami throughout the Indian Ocean and the severe destruction of the City of New Orleans in consequence of a hurricane are only two prominent examples which happened in the past couple of years.

All these and other issues and associated socio-economic processes call for improved governance and management of marine and ocean space and resources. A series of initiatives, policies and instruments are presently developed and implemented. This includes for instance the step-wise realisation of the Global Ocean Observing System (GOOS) or developments of integrated management schemes and tools (e.g. ICZM) with incorporation of coastal and offshore areas in spatial planning. Further, the Law of Sea and the ongoing refined determination of Exclusive Economic Zones (EEZ) demand from coastal states to monitor and manage their marine areas. All this requires profound knowledge on marine environments and eco-systems with associated physical, chemical and biological processes including their temporal and spatial variability. Accordingly appropriate decision-making, reaction, response and mitigation measures need rapid and in many cases real-time information and reliable forecasts on several system and state variables. It is also obvious that matching of such demands requires multi-source and multi-tasked coastal, marine and ocean observing and monitoring systems with increased capacities for real-time surveillance, hazard prediction and early warning. Whereas such systems are implemented and further developed for long in higher industrialised countries they are entirely lacking or significantly underdeveloped in other regions and countries.

However, even "rich" countries have clearly identified large gaps between demands and needs in marine surveillance and monitoring on the one hand and available financial resources and observational capacities on the other hand. This calls for innovative approaches on all levels. This includes sharing of costs, infrastructure and resources and development of cost-efficient, highly automated, less maintenance intensive and more robust technologies. The needs for integrated approaches requires also that "classical" demarcations between for instance marine monitoring, maritime surveillance and security, management of sea and land transport, disaster response and mitigation or exploration of living and non-living resources are vanishing as all these activities depend on and share common information sources and knowledge bases.

Motivation for and Objectives of the OMS

Based on the above depicted facts and trends but also strongly stimulated by the 2004 Indian Ocean tsunami catastrophe considerations were made among a group of companies together with scientific institutions loosely associated in the so called Maritime Cluster of Schleswig Holstein on bringing together individual experiences, technologies, knowledge and capacities and to join forces to develop an innovative approach towards coastal and ocean observing, monitoring and surveillance. Besides integration observation capabilities for a series of key parameters and processes of relevance the system should also include operational forecasting and simulation, task specific and cross-sector evaluation as well as end-user tailored dissemination of acquired data and information. Moreover, as the "last mile" the system shall demonstrate the capability to quickly issue and broadly distribute public warnings in case of danger or foreseeable hazards or catastrophes.

Figure 1: Illustration of the main OMS components and its end-to-end approach.

Such a system has to be built modularly and flexible in order to be tailored to regional specifics and application intentions as well as for matching individual demands of users and customers. It must be also possible to integrate the system as a whole or only some of its subsystems or even individual components into already existing applications. Contrary to existing monitoring and surveillance systems which usually have a long design, development and implementation history in governmental agencies the OMS shall be entirely composed of commercially available off-the-shelf components which are intelligently integrated, interfaced, controlled and managed within a highly modularised and accordingly very flexible system.

Moreover, the OMS shall be an end-to-end system spanning from sensing, data acquisition and information generation side ("the first mile") on the one end to the warning and information transmission ("the last mile") on the other end.

By this approaches the costs and efforts for development of the pilot system as well as for subsequent tailoring and implementation of other systems are significantly reduced but the system remains still open for new developments as well as for integration of new subsystems, supplementary modules and components. In addition linkage with or incorporating data and information from already existing monitoring systems has to be ensured. Consequently the project and system development is industry driven but enjoys strong support by public agencies and is strongly backed by scientific institutes. All therefore needed technologies, components, products, services and experiences are available within the formed group of companies together with the associated public institutions which form the so called "OMS Team".

As to our knowledge such an approach to develop and functionally demonstrate a multi-source and multi-task coastal and ocean observing system was never conducted elsewhere before. The objective of the OMS pilot project is also to establish, test and operate an in-front-of-the-door pilot implementation to demonstrate the system and its components to interesting parties as well as to provide supplementary data and information to regional authorities, institutions, users and to the general public. As application area the North German coast with the adjacent world-wide unique Wadden Sea and parts of the German Bight was selected. This was strongly motivated by the rough environment of the Southern North Sea, the storm surge endangered North Frisian isles and coastal areas and the regional managerial and protection needs. The system is installed at the West Coast Research Centre based in the town of Büsum which provides infrastructure and logistic support. Also the centre contributes with already existing components and also has a strong interest in its future use.

Description of the OMS North Sea Pilot System

Basically the OMS consists of four main compartments or blocks: (1) subsystems and sensors for in-situ observation, remote sensing and surveillance acquiring data and information of key parameters and processes like water levels, waves, currents, other state parameters and information such as ship traffic, (2) operational simulation models utilising data and information from the system for short-term forecasts of e. g. tide, surge, wave and current fields and which are also usable for hind- and nowcasts as well as for rapid scenario simulations (e.g. spills), (3) system control and data management including the overall system control and maintenance functionalities and interfaces. It controls all subsystems, modules as well as sensing devices and it displays, validates and stores data and information. It is also openly designed for later integration of components for enhanced information processing, data evaluation, generation of higher level data and information (data products), and (4) the warning and dissemination part which can issue and spread rapid public warnings and routinely provides dissemination services for end-users and the general public.

In the following sections and paragraphs we provide a brief overview on these main system components which, however, can be illustrative only within the scope of this paper (for more details one is referred to the OMS website (OMS, 2007) which will be successively supplemented with Internet based information services, actual information and data.

<u>Sensing, Surveillance and Data Acquisition Subsystems and Devices</u>

It is one of the intentions of the OMS development to demonstrate that different data and information collecting subsystems with a representative cross-cut of devices and sensors typically applied in ocean monitoring and marine surveillance can be effectively integrated and jointly function in a combined system. In the present pilot application these are the following subsystems:

Fixed Monitoring Stations on various platforms which are classically used in marine monitoring. Typically the platforms are buoys, light vessels, offshore piles or platforms and coastal or harbour stations which hoist a variety of sensors.

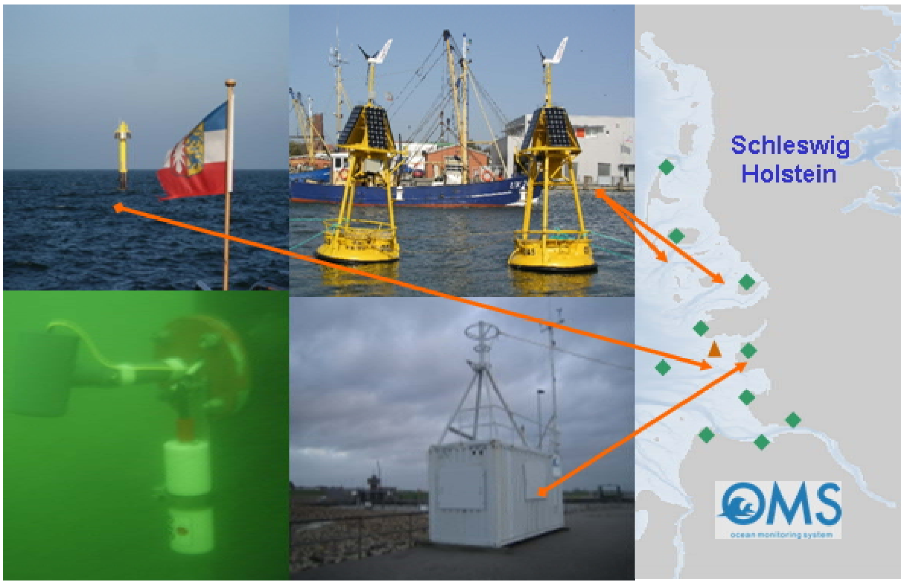
The OMS pilot system presently integrates

(a) three multi-sensor buoys (1 existing research and 2 new commercial ones with an innovative anti-fowling system) on which e.g. water temperature, salinity (conductivity), turbidity and currents through interlinked bottom-deployed acoustic Doppler current profilers are measured,

(b) a newly established measurement pile which in addition to the parameters listed for the buoys includes a meteorological station, an acoustic water level and wave gauge and an underwater mounted high-frequency pressure gauge. This pile also serves as a test site for new sensors and developments. For instance one OMS science partner plans to interface newly developed bottom-mounted seismic detectors, and

(c) a containerised coastal station situated at the port mole head of Büsum equipped with a high-frequency acoustic tide and wave gauge and a meteorological station.

Figure 2: Deployment positions and photos of the fixed monitoring stations of the OMS. The photos on the left show the measurement pile and a thereon mounted pressure sensor, the upper right one the 2 new ODAS buoys during test deployment in the port of Büsum and the photo below the measurement container in Büsum with the meteorological sensors. The black triangle depicts the location of a third buoy, the squares the locations of some tide gauges all operated by third parties. Photos courtesy of -4H- JENA Eng. GmbH and FTZ – West Coast Research & Techn. Centre.



Coastal X-Band Radars with Integrated Wave and Current Monitoring at 2 locations. In surveillance mode the radars monitor ship traffic ranging approximately 50 km offshore. When switched to wave/current acquisition mode the built-in monitoring system acquires wave and surface current fields and produces derived wave state parameters as maximum and mean wave height, wave direction and spectra with approx. 20 km range.

HF-SWR Radars installed at 2 locations measuring surface currents and wave conditions in a typical range of 80 to 100 km. They are also capable to detect disturbances in the water surface conditions up to 200 km (well beyond the visual and radar horizons). Evaluation of the back-scattered signals allow also the detection of targets with lacking electro-magnetic signature or low radar-cross-section (e.g. wood or plastic boats, possibly also radar-stealth constructed vessels) as these cause typical disturbances on the water surface. Such targets are not detectable by classical surveillance radars. Specialised evaluations allow also detection of disturbances on the water surface as they are typical for tsunami wave trains in deeper water. By this a tsunami can be detected before the waves enter shallower nearshore and coastal waters where they may pile up disastrously. By this detection, response and warning times for approaching tsunami wave trains can be significantly enlarged.

Figure 3: Locations and illustrations of the X-Band and HF-SWR Radar systems of the OMS. The two photos on the left show the site of the X-Band and wave monitoring radar installation at the port lock building of Büsum. The photo on the right shows the HF-SWR radar antennas installed in Büsum. Photos courtesy of Raytheon Anschütz GmbH and Helzel Messtechnik GmbH.

External Data and Information Sources

A series of external sources feeds the OMS with supplementary data and information. This includes several tide gauges operated by the German Federal waterway authorities and/or the regional environmental agency, a weather station operated by a private meteorology company and a research station on the island of Helgoland. This also demonstrates the capabilities of the system to include and handle almost any monitoring and surveillance data from arbitrary other sources, like existing monitoring networks or other surveillance systems.

<u>Operational Fore- and Nowcasting</u>

The OMS incorporates an operational numerical modelling system (see e.g. Duwe and Nöhren (2000), Nöhren et. al. (2003), Pfeiffer and Mahnke (2006)) which provides in routine operation modes short-term forecasts of currents and water levels (optional other parameters like water temperature and salinity). The OMS three-day forecasts are produced routinely and automatically every day after the receipt of automatically transmitted information to compile boundary and forcing conditions (wind conditions, air pressure, water levels and river runoff) from a larger scaled North Sea / Baltic Sea forecast model operated by the German Maritime and Hydrographic Agency (BSH). The set-up and initialising information also includes results from the routine weather forecast of the German Weather Service (DWD) and actual run-off measurements of the River Elbe and other larger rivers entering the Southern North Sea.

The OMS model system consists of three main components:

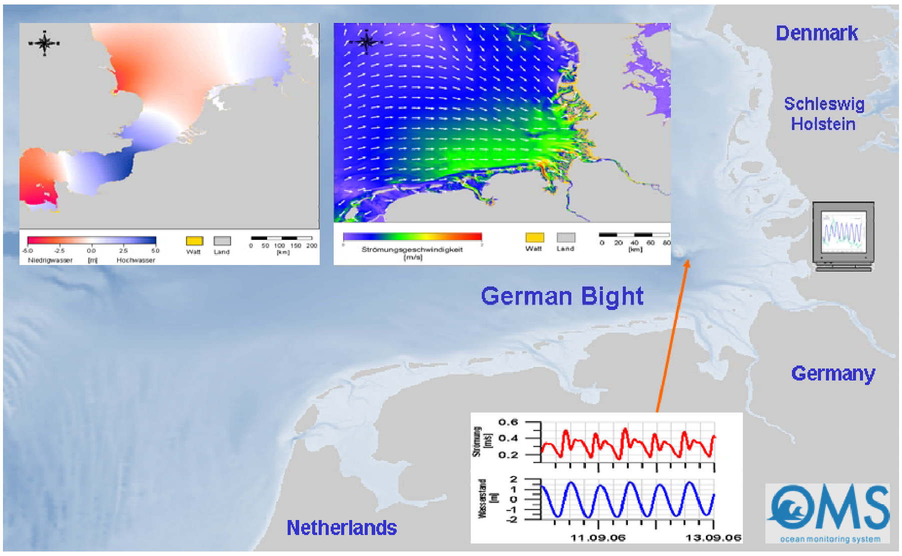
(1) the **Southern North Sea OMS Model** – a larger-scale model with about 600 metres horizontal resolution which covers the southern North Sea between the entrance of the Channel between near Trèguier (Brittany) in France and Salcombe (Devon) in the UK in the west to its northern boundary which is located approximately between the Danish town of Esbjerg and Newcastle-upon-Tyne in the UK,

(2) the **German Wadden Sea OMS Model** which is an embedded higher resolution model (about 150 metres) covering the Schleswig-Holstein and parts of the Danish North Sea coastal areas and Wadden Sea towards approximately 30 kilometres offshore. It also includes in more detail the main shipping approaches in the area and into the River

Elbe to the Kiel Canal as well as the entire tidal part of the River Elbe up to the town of Geesthacht east of the City of Hamburg, and

(3) a **Lagrangean Tracer Module** (usually kept in stand-by mode) which can use results from both models for prognosis of for instance oil and chemicals spills or drifting objects on demand.

Figure 4: Illustration of simulation and forecasting results overlaid on a part of the North Sea model and bathymetry. The upper left panel displays a snapshot of the water level distribution in the entire model domain, the upper right one a scope of the current field (shaded for current speeds with a subset of displayed current vectors) in the German Bight. The time series illustrates simulated tidal conditions at a position near the island of Helgoland. The computer screen depicts the location of the OMS control centre in Büsum. Courtesy of HYDROMOD GbR.



Besides operational forecasting the model can also produce nowcasts when updating boundary and forecasting conditions obtained from forecasts with assimilated actually measured data. In the same way hindcasts are possible to conduct when historic data and information are used. When operated in case-study-mode the model system can be fed with scenario dependant boundary and forecast conditions and thereby it can also be utilised for simulation of planning scenarios. For instance it can forecast and access changes and impacts in case of configuration changes (e.g. dredging of shipping lanes, construction of ports or marinas, manmade and natural coastline changes). Another application of the model system is for rapid response and decision support by "playing through" various feasible or highly probable scenarios. For the North Sea this is of particular importance to assess the possibility of storm surges. Usually weather forecasts reveal a certain uncertainty in wind direction and speed. Even smaller directional changes may result in significant alterations of local surge heights and local distributions and, correspondingly, to different situations of danger or threats.

The model system produces a series of data / information products such as time series at relevant or interesting positions or snapshots of distributions which can be also compiled to animated graphs or short video scenes.

<u>OMS System Control and Data Management</u>

The control and data management system of the OMS (OMS-DMS) controls, manages and integrates all components and subsystems on the corresponding levels. It further quality-controls, pre-processes and displays the data and information and finally archives them for subsequent access and further use.

Each OMS subsystem (i.e. a measurement station, an ODAS buoy or a radar system) has its own data management, control and data transmission system which is intelligently interfaced with overall system control and management. The same applies – one or two levels deeper respectively – to instruments and/or sensors which are part of an OMS Subsystem. For this and in order to guarantee system flexibility, modularity and efficiency all components are integrated by intelligently designed interfaces usually on software levels. This is of utmost importance as one cannot force a manufacturer of a sensor, instrument or subsystem to adjust their specific hard- or software to the OMS but, vice-versa the OMS has to accommodate the manufacturer specifications entirely by (a) transferring the produced or acquired data and information in a OMS conform and consistent manner and (b) ensuring that possible functionalities to control and command the components are appropriately integrated into the OMS control unit.

The two main elements of the OMS control and management subsystem are (1) the **OMS Control Centre (OMS-CCU)** which includes display, watch-dog and system control consoles of all subsystems and also integrates system-specific consoles and processing devices of larger or stand-alone subsystems like the radars, and (2) the **OMS Data Base System (OMS-DBS)** which receives the incoming data and/or produced information (including system information), conducts further consistency and quality checks of incoming data and files them in the systems' central data base and data archives. The data base has a generic design, a comprehensive meta-data repository and parameter lexicon which generally support almost all types of arbitrary time and geo-referenced data.

Information Processing and Tailoring

Information and data can be specifically tailored to various end-user needs and requirements. This is done with a series of embedded evaluation and data product generation tools which are either part of the subsystems themselves or are embedded in the OMS data processing and evaluation part. Typical examples in the pilot system are the generation of animated graphs and video scenes of current distributions from HF radar surveillance or simulation models, the generation of video scenes from X-Band radar images or production of time series from historic data.

Generally the various end-users specify the individual implementation of a monitoring and surveillance system and area specific requirements determine what kind of data products are matching best user-needs and application desires. Hence data products and the kind of information extracted from such a system as well as the way how such information is produced inside a system vary considerably. For instance, real- or near-real-time applications need sound and rapid evaluation of multi-source data and fast transfer to the warning system which is usually achievable at cost of data accuracy and quality control measures. On the other end use of the data for long-term assessment of e.g. environmental and climatological changes requires reference sampling, precise calibration against laboratory measurements or water samples and validation with sophisticated statistical tools which is usually conducted on a larger time frame. Accordingly, a module is foreseen inside the OMS which can easily accommodate specific and additional evaluation and information processing routines.

The database model and design allows incorporation of multi-level data products. Furthermore, the value of the system increases along with its continuous operation. Accordingly the data base is consecutively filled with acquired data and produced information.

This facilitates the system to act as a resource for long-term monitoring objectives as well as for enhanced evaluations and statistics. Hence the system will be a versatile inventory of historic data and it will also provide important baseline information for a variety of applications ranging from scientific objectives to support of operational and managerial needs.

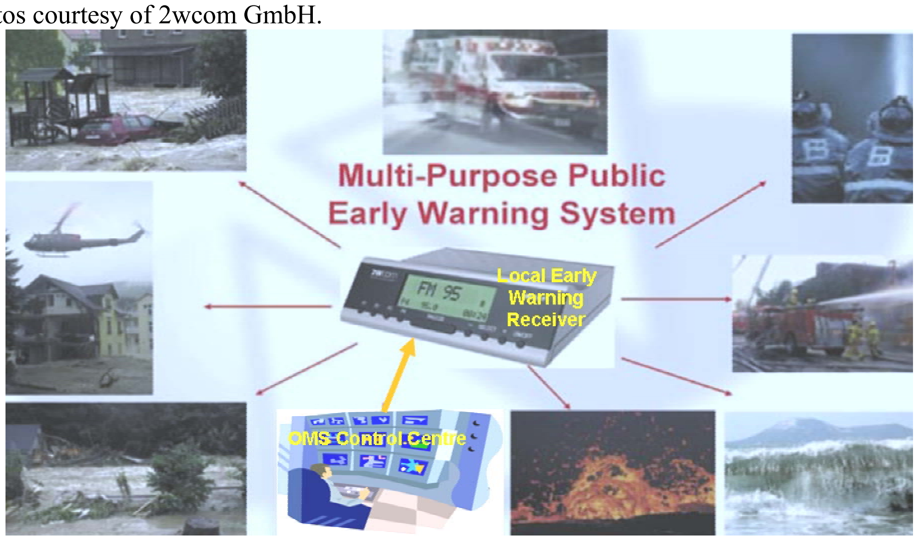
System Maintenance

Maintenance of the OMS as a whole as well as of its subsystems is supported by wide area access through web and Internet services and protocols. By this control and maintenance of the system is eased and its operators can be remotely supported by individual specialists (e.g. from the manufacturers of subsystems) which reduces operation and maintenance costs considerably. However, it must be kept in mind that in-situ sensors and especially offshore deployed components need regular maintenance, periodic replacement of sensors and also from time to time reference sampling for calibration. This can only be done by technical staff on site and requires regular transfer of personnel and equipment to the sampling locations.

Hazard Prediction and Early Warning

As said above, the OMS is an end-to-end monitoring and surveillance system and thus incorporates also the so called "last mile". This is realised by a robust, autonomous and rugged computer controlled radio transmittal system integrated into the control centre. Through this the operator can broadcast warnings which are either distributed through public information services or to a network of low-cost receivers and display units with the size of a radio clock. The receivers give audio alarms and also display short alarm messages visually. Such alarm units can be deployed in public places, agencies, administration, police stations but also in hotels and other tourist facilities.

Figure 5: Illustration of the "last mile" of the OMS with the early warning receiver in the centre. Photos courtesy of 2wcom GmbH.



This subsystem is well proven and for instance installed in large numbers in Sweden to transmit alarms in case of nuclear power plant failures across wide, remote and low-dense populated areas to a large community of people. It was also most recently installed on the island of Bali in Indonesia for transmission of tsunami warnings and other hazards to the population.

Dissemination and Distribution of Data and Information

Data and information produced by the OMS is distributed and disseminated on three levels. First and system-internally, data are rapidly transmitted to the control centre and there displayed on a series of monitors together with other system information, performance and housekeeping data. This enables the system operators to control the system and, if necessary, invoke corrective actions or react to site-specific conditions. Typical examples of the latter are changes in data acquisition speeds of specific sensors if an interesting or dangerous situation is identified or switching the acquisition mode of the X-Band radars to wave monitoring in case of storms with associated dangers for shipping.

Secondly, hazardous situations could also be identified by the system itself and the operator receives a high-priority threat or warning notification to support response and mitigation actions and associated decisions.

The operator can then rapidly decide to whom and in which way such warnings are transmitted further and what kind of warnings have to be broadcasted. Practically such warnings can be also issued automatically but in almost all cases a "human interface" takes the related decisions and actions.

Further, routinely data and information is also transmitted to end-users and the general public which is done through the OMS web server and web site, OMS (2006). The level of access to information and data and the use of related web-based information services are distinguished among the community of users. Some information and data are routinely displayed on the public web site whereas other services require access permission of authorised users or user-groups. In this conjunction it is important to point out that the OMS pilot system demonstrates a series of such information processing and tailoring measures but that finally the customers and end-users specify which services and routines are integrated into a specific system implementation.

Preliminary Results, Discussion and Perspectives

Presently the OMS pilot and reference system for the German North Sea is in advanced stage of implementation. Most platforms and sensors are already installed and in test-operation and the remaining ones will be installed within spring 2007. The system overall integration and the adaptation of management and information processing routines is also proceeding well. According to the project plan the system will enter into test operations in late summer/early autumn 2007 and will from thereon deliver data and information to the end users. By then it will also facilitate as a demonstrator and reference system and can be presented to interested parties.

Innovation Aspects

The OMS incorporates a series of innovations which are also considered to have certain implications on future applications and also on the raising market for marine monitoring and surveillance systems and technologies. Firstly, the described end-to-end approach "from sensing to warning" is integrated in such a system for the first time. Secondly the OMS combines aspects and objectives of environmental monitoring with marine surveillance and security as well as with hazard prediction and early warning. By this the possibilities of application are considerably enhanced and the community of end-users is greatly widened.

Furthermore, the modular and flexible design of the OMS allows integration of almost arbitrary subsystems for sensing and generation of data and information including interfacing with existing systems. It is also not only limited to marine applications but can also be transferred to purposes of land- or inland water monitoring. Last but not least the OMS development is industry driven and composed of proven and commercially available modules (products and services). Combined with the broadened user community this should significantly reduce cost and efforts of monitoring and surveillance and this will also ensure that its further development matches with market potentials and end-user requirements.

Challenges for Future Applications

However, with the introduction of the OMS also a series of new approaches and procedures emerge which are presently rather vaguely adopted at parties and especially stakeholders concerned. In most countries the thematic areas and objectives covered by the OMS are vertically structured and in many cases cross-sector cooperation and horizontal collaboration among therefore responsible agencies and administrations is underdeveloped. Accordingly topics of joint use of a system like the OMS which necessarily includes sharing of responsibilities, budgets and other resources among the end-user community have to be resolved.

This likely requires difficult and longer-lasting decision-taking and organisational processes and, correspondingly, large efforts along with the definition and initialisation of an OMS implementation project and for its organisational and financial engineering.

Moreover, there is also still a large gap between user needs and expectations to such systems and the ability to adequately contribute to system operation and maintenance costs which has been proved by a series of activity and surveys within operational oceanography communities throughout Europe.

Another challenge is the public-private cooperation in marine surveillance and monitoring which are considered as predominantly public services and activities conducted by agencies and partly also by research institutions on their behalf. In this more traditional approach industry is still considered as a smaller-scale provider of hardware components or specific services rather than in the role of a system provider and partner in its operation.

A major challenge for the near future will be ensuring the sustainability and continuous operation of the OMS. The developing companies can certainly contribute by own resources and vice-versa gain commercial benefits and advantageous market position. However, contributions of the user communities are also needed to ensure proper operation of the system and continuous functioning of infrastructure and subsystems including shared coverage of costs and efforts for maintenance and in day-to-day operation.

Conclusions and Outlook

We expect that with the availability and operation of the OMS pilot, reference and demonstrator implementation for the German North Sea area the interest at communities, stakeholders and countries will raise considerably. This applies for both, the system and its end-to-end approach as a whole as well as for certain components and subsystems. The pilot project also proves the functioning of the cooperation between different industries ranging from very small enterprises to large companies with system integration capacity as well as collaboration between industry, science and governmental agencies. In mind of the maritime markets and the administrative and industrial structures in the area of marine monitoring and surveillance such partnerships are vital for successful applications and future implementations of the OMS. Moreover, this constellation gives excellent possibilities for further marketing and qualification of the system.

The OMS is expected to attract other institutions and administrations to feed the OMS with data and information from other networks or from single stations. Also voluntary ship of opportunity observations (Ferrybox systems) as presently test-wise applied in several countries can be integrated. Besides from being a functional and operational reference, the OMS pilot system will facilitate as test site for new developments. By this it will also provide possibilities for developers and users to test and qualify specific components, sensors and services as well as for exploitation and future use of data and information. As such the system also comprises a sound infrastructure for follow-up projects as well as for operational use to match the upcoming requirements and challenges in the area of marine monitoring and surveillance.

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THE CLIMATE CHANGE IMPACT ON THERMOKARST IN WEST-SIBERIAN TERRITORY AND GEOECOLOGICAL RISKS IN GAS INDUSTRY

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Geo-ecological risk, gas industry, permafrost, thermokarst, global warming, remote sensing

Abstract

The basic expected consequences of climatic change in the territory of Russia are systematized. It is shown, that changes of climate can lead to an increase in number and scales of emergencies at the gas industry objects. Examples of monitoring of changes of individual components of the environment in the territory of Western Siberia with use of remote sensing of the Earth surface are given.

Climatic change and emergencies in gas industry.

The global climate change is the generally acknowledged fact, and expected consequences of climatic changes may affect many branches of economy and social sphere of the majority countries in the world [1]. The researches executed by organizations of the Russian Academy of Sciences and the Ministry of Emergencies of Russia have allowed to allocate and range about 40 factors of strategic risks in the basic spheres of the vital activity of the state. These factors have been integrated into five basic spheres of the vital activity of the state: economic, political, social, natural-industrial and R&D. The study has shown, that one of the important factors of strategic risks are consequences of the global climatic change [2].

The given problem is directly connected with the problem of energy security, the maintenance of which substantially depends on the sustainable operation and development of the gas industry of Russia at large and the Gazprom's industrial complex in the first place. Negative consequences of global change of climate are one of threats to reliable gas supply to internal consumers and to performance of obligations on export contracts. As scales and intensity of climatic changes have stochastic nature, it is expedient to carry out the assessment of corresponding impact with use of the risk concept [3]. As applied to the considered processes of interaction of natural and technological factors it is expedient to use the concept of geoecological risk. Geoecological risks include both the risks caused by cumulative negative influence of natural and technological factors on the environment and population's health in zones of industrial objects of the gas industry operation (techno-natural risks), and the risks caused by the influence of natural factors on the gas industry development (natural-technological risks). The special urgency of researches on identification and assessment of the geoecological risks related to climatic changes, is caused by the necessity of accelerated development of natural gas and liquid hydrocarbons fields in the territory of the Yamal peninsula and of the Barents Sea shelf.

The materials of the Third National Report of the Russian Federation concerning the global climate change show that with a high degree of probability climatic changes can be expected in the territory of Russia [4]. It is marked, that consequences of the climate changes can be different for various regions and fields of activity. The basic trend of the climate change is the warming accompanied by increased aridity. Most intensively the process of warming will show up to the east of Ural while near to the Black Sea the cold snap is possible. But this is only one side of process. The other side, of no less importance, lies in the strengthening of nonuniformity of the natural phenomena and the growth of the frequency of extreme statuses.

According to experts, the greatest changes of climate and scales of consequences can be expected in northern regions of the country. An increase of the average temperature of air by 4 ^{0}C will entail irreversible changes in permafrost regions. Already now in Western Siberia intensive thawing of frozen breeds (up to 0,04 m /year) is marked. Within 20-25 years it is expected, that the border of thermokarst in Western Siberia will move 30-80 km to the north, and on islands – up to 200 km. By 2050 the zone of permafrost will move up to 150-200 km. According to model assessment by the end of the summer season the top layer of ground can thaw to the depth of 0.1-0.2 m in the Extreme North and almost to 2 m near the southern border of permafrost. Because of warming by the middle of the 21st century the thickness of active layer of ground may increase by 0,6 m in the southern zone of permafrost [5]. The warming of climate will lead to irreversible natural processes that will have negative consequences for settlements and explored territories. Thawing of permafrost will lead to the growth of technological emergencies due to collapse of buildings and constructions and damage of communications.

Already at present in Western Siberia the annual number of failures and accidents at oil and gas pipelines, with the total length in Russia about 350 thousand km, accounts for about 35 thousand. About 21percent of failures are connected with mechanical impacts, including those with loss of stability of the bases and deformation of support. There are numerous examples of infringement of integrity and destruction of houses and industrial buildings, ruptures of pipelines due to permafrost degradation. It is expected, that with the increase of average annual temperature of air by 2 degrees the carrying ability of the bases will decrease by 50 percent [1].

The threat to integrity of the infrastructure objects is especially great where the frozen ground contains plenty of ice. Such areas include a significant part of the valley of the Lena river, the West Siberian plain, Chukotka and the most part of island territories of the north of the European part of the country. In the listed regions there are large oil and gas complexes, power transmission lines, Bilibinsk nuclear power station.

One of the climatic change consequences may become an increase of frequency of such short-term extreme weather conditions as strong snowfalls, hail, storms, late frosts, abnormally low or high temperature of air. The trends of change of dangers and threats connected with the climate change are shown in Table 1 [6].

Table 1. Trends of change of dangers and threats by Federal Districts of Russia

Federal District	Trends of dangers changes				
	Flooding	Forest fires	Degradation of permafrost	Initiated technological emergencies	Bio-social emergencies
North-Western	-	-	↑	↑	↑
Central	-	-	-	-	-
Southern	-	-	-	-	-
Volga-Ural	↑	↑	↑	↑	↑
Siberian	↑	↑	↑	↑	↑
Far Eastern	-	↑	↑	↑	↑

↑ - increase of danger;
- no changes.

Since the majority of gas fields and significant number of gas pipelines are in the territory of northern areas in the zone of distribution of permafrost, as the analysis of Table 1 shows, the climate change will probably lead to the growth of geoecological and other risks.

The possible forms and scales of geoecological risks manifestation, as applied to underwater crossings and linear sections of operating main gas pipelines on the territories of Western Siberia, are studied in detail in [7]. The processes initiated by the climate change, will render significant influence on the system of main gas pipelines in the territory of Yamal peninsula, where significant part of linear sections may be found in bogs or at the bottom of lakes, which will lead to the growth of frequency of emergencies.

Monitoring of climate change consequences on the basis of remote sensing data

The prospects of gas production in Russia are connected with the development of the north territory, which requires the pipeline system expansion and building of other objects of the gas and oil industry in permafrost. Due to the global warming, started in 1970-ies, the increasing of geocryologic processes in permafrost is expected. The accident rate in the gas and oil pipeline systems and other objects of oil and gas industry in West Siberia is going to grow that will lead to increasing of geoecological risk and significant financial damage. So the study of changes of the bog landscape cryogenic conditions in West- Siberian permafrost is relevant problem. It cannot be solved without using of the Earth surface remote sensing data. Due to the progress in the information-space technology development, the spatial resolution of space images has considerably increased, that gives an opportunity to study changes of cryogenic conditions of the bog landscape using high-resolution space images under impact of climatic changes.

Among indicators of cryogenic conditions the most important ones are geomorphologic indicators. The main of them in permafrost conditions are thermokarst, polygonal relief and antinodes.[8,9]. The analysis of remote sensing data in geocryological researches has shown that thermakarst lakes can be used as the most prospective indicator of cryogenic landscape changes.

The territory of the Sredne-Hulymskoye oil field has been selected for studying changes of permafrost rocks state using space images. The test area for researches is situated between the upper streams of Levaya Khetta and Hugeyaha, which are big left tributaries of the river Nadym. The thermokarst lakes, formed as a result of undersurface ice melting, are the objects for researches. Geocryological processes caused by the global warming lead to declining durability of permafrost rocks. It results in thermokarst lakes' area reduction and their full disappearance.

Research of dynamics of cryogenic objects changes on the test area was carried out using five space images taken at different time. They are:

Landsat - 1 (scanner MSS), 10.08.1973.
Landsat - 5 (scanner MSS), 26.06.1988.
Resurs - F2 (scanner MK 4), 14.06.1993.
Landsat - 7 (scanner ETM), 03.07.2002.
Spot - 5 (scanner HRV), 20.07.2005.

Fig. 1 represents a fragment of the test area space image (1973) where 11 thermokarst lakes are indicated with numbers. Changes of the lakes water surface areas were measured with use of the software ERDAS Imagine using space images taken in different times for the study of dynamics of the thermokarst lakes' state.

Fig. 2 represents fragments of space images taken at different time, showing consecutive stages of decreasing area of thermokarst lake 9, isplayed according to numbering in Fig 1.

Measurements of water surface area of lake 9 carried out in different years have shown that the water surface area of lake 9 in 1993 (Fig. 2-b) declined down to 60 percent of the initial area, measured in 1973 (Fig. 2-a). The process of area declining is still continued. It is confirmed by space images taken in 2002 and 2005 (Fig. 2-c and Fig. 2-d accordingly). During more than 30-year period the lake's area has decreased to 40 percent of initial size.

The analysis of dynamics of the area changes for all 11 lakes (Fig. 1) has shown that some lakes had disappeared at all or had been transformed in disappearing lakes. An example of disappearing lake is given below. Measurements of areas of all 11 lakes made with space images are presented in Fig. 3 as a family of graphs that show dependence of the lake area on time.

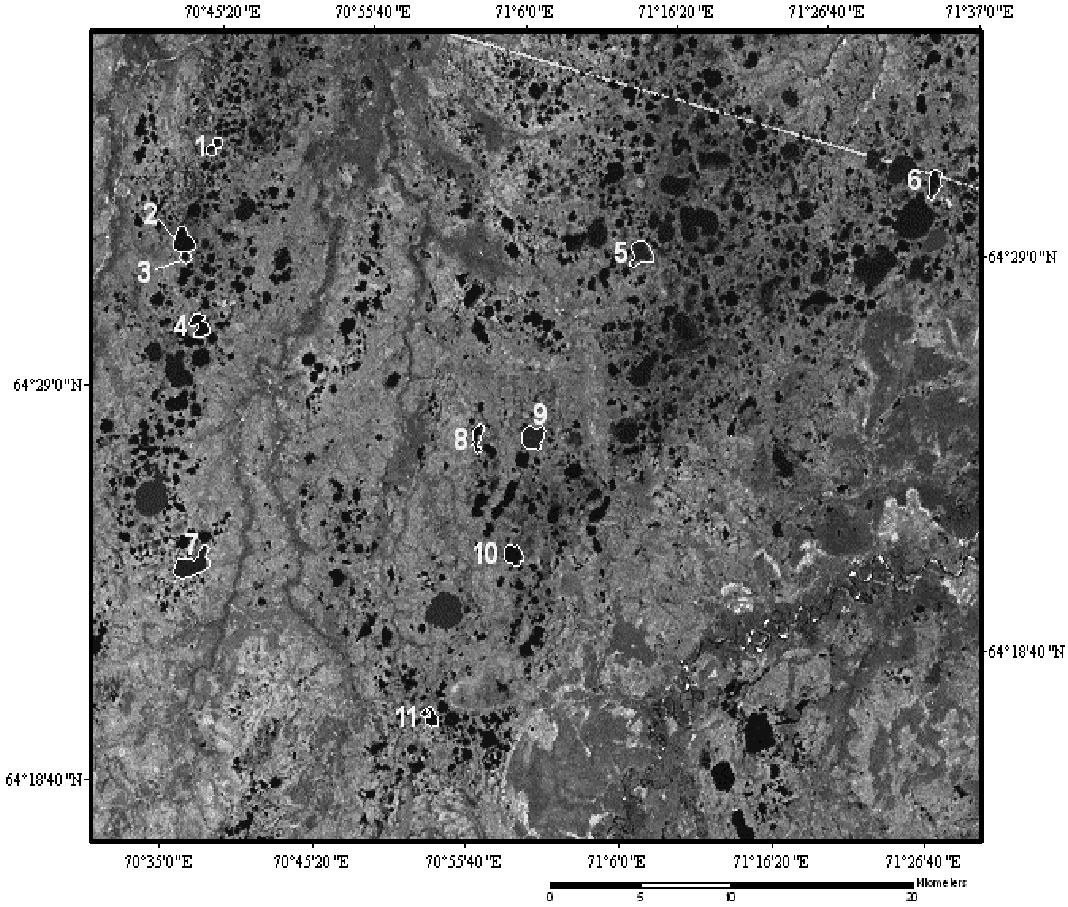

Fig. 1. Fragment of space images Landsat-1 (10.08.1973г.)
with indicated thermokarst lakes

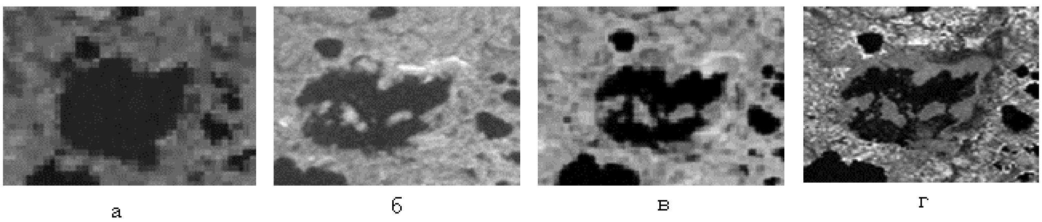

Fig. 2. Space images fragments of consequent stages of thermokarst lake 9 decrease. Designation: a-Landsat-1 (1973), b-Resurs -F2 (1993),

c- Landsat-7 (2002), d- Spot-5 (2005)

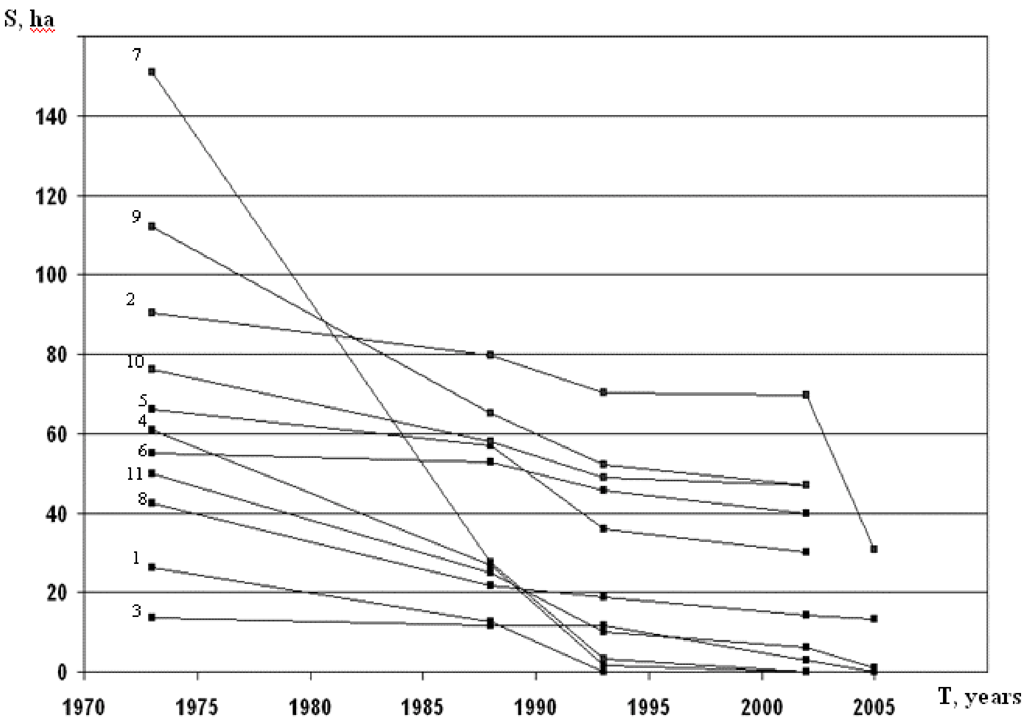

Fig. 3. Changes of thermokarst lakes' areas in time

Fig. 3 represents disappeared lakes indicated with numbers 1, 3, 4, 7, 11. The other 6 lakes have reduced their areas. It allows to make conclusion about swift degradation of frozen rocks under the influence of global warming. This conclusion is confirmed by results of researches of American scientists [10], who on the basis of analysis of space images of West- Siberian permafrost territory determined that during the period from early 1970-ies till the end of 1990-ies the amount of big lakes (with area exceeding 40 ha) had declined from 10,882 to 9,712 and 125 big lakes had disappeared completely.

Conclusion

As the executed analysis shows, the consequences of the global climate change for the gas industry objects are not only probable, but also might be large-scale events.

Expected consequences of climatic changes require a system of engineering adaptative measures. Such measures can include a complex of actions aimed at the preservation of the soil temperature, technical and biological rehabilitation and a complex of antierosion actions. Monitoring of the soil thermal condition should play an important role.

It is known that the north territory of Russia warms up considerably faster than others regions of the world. For the last century an average annual temperature (according to existing data [11]) has increased by more than 3°C. Bog landscapes spreading in the permafrost area are most sensitive to temperature alterations because of permafrost melting [12]. Thermokarst lakes are the most convenient object for distant monitoring of the global warming influence on the permafrost rocks state and the study of bog landscape dynamics on the basis of space images taken at different times.

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THE SYSTEM FOR MONITORING OF UNDERWATER POTENTIALLY DANGEROUS OBJECTS AND INTEGRATED INFORMATION CONTROL SYSTEM WITH USING OF AUTONOMOUS DEVICES

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Keywords: underwater, autonomous, radioactivity, toxicity, seatechrim

Abstract

The present project suggests the system of on-line monitoring of underwater potentially dangerous objects. The system provides on-line notification in case if radioactivity and toxicity at the objects being under control of autonomous vehicles exceed safe for environment levels.

The system consists of the set of specially developed autonomous devices which monitor the level of radioactivity and toxicity of underwater potentially dangerous objects. The devices are being deployed on the bottom for the period up to 1 year. The underwater devices are equipped with specially developed spectrometric sensors for radioactivity control and potentiometric ion-selective sensors for chemical control of underwater environment for the depth up to 300m.

In case when the level of radioactivity or toxicity exceeds safe for environment levels the autonomous control devices come up to the surface and transmit the data about the level of radioactivity or composition and levels of toxic substance concentration through the satellite communication system.

The integrated information system for control of the condition of underwater dangerous objects provides registration of such objects at the territory of Russian Federation and receiving of satellite signals from recovered underwater autonomous equipment. The data from the autonomous devices is being processed and analyzed and the results are being transmitted to the corresponding bodies of the Ministry of Emergency of Russia.

The system of monitoring and information control system are being developed for using in the main aquatories of Russian Federation – Black and Baltic Sea, Barents Sea, a number of areas at the Far East.

Introduction

One of the most significant problems of environmental safety of Russian Federation is a problem of long-term monitoring of underwater potentially dangerous objects (UPDO) containing radioactive, chemical toxic components and explosives.

Russian company Seatechrim Ltd. conjointly with a number of companies and Scientific Institutes have been designing and manufacturing components and subsystems for monitoring of such objects for the last three years. The project allows to provide data on pollution rate for the Monitoring Center located in the Ministry of Emergency of Russian Federation.

The integrated information system controlling the condition of underwater potentially dangerous objects being under development includes but is not limited to the monitoring of the following objects:

- the sources of radiation pollution;
- the sources of chemical pollution including submerged chemical weapon;
- objects with explosives;
- other potentially dangerous objects (pipelines, oil wells, sunken vessels, etc.).

The sources of potential pollution have different origin (Vialyshev A.I. *et al*, 2006).

The allies in WW II (USSR, USA and Great Britain) made a decision to liquidate captured chemical weapon and poisons by submerging on great depths in Atlantic ocean after the Second World War has finished. However many vessels were towed and submerged in Skagerrak and Kattegat connecting Baltic and North seas on depth from 200 to 680m. The total amount of submerged vessels according to different sources varies from 42 to 60.

Shells, bombs and containers with poison substance were submerged loose 70 miles to the south-west from Liepaya (5000t) and in the area of Bornholm Island (30000t) at the depth of 100-105m. The thickness of their jackets varies from 2 to 6, rarely to 10-12mm. The average corrosion rate of steal constructions in Baltic sea comes to 0,1-0,15 mm per year depending on the environment and rate of electrochemical corrosion. Furthermore, the possibility of mass (so-called “volley”) emission of poison substance exists in the areas of tight burial of chemical weapon. Corroded jackets of underlying ammunition can be damaged by upper layers and the poison substance can come out to the environment.

The process of depressurization of the containers with poison substance lying loose on the bottom can be extended for tens and hundreds years. The jacket fouled with sea shells can’t be destroyed in a moment, the process of poison leakage takes time and sea water can hydrolyze much of it.

Negligibly small amount of poison substance got into a human organism through food chain has not only strong toxic but also mutagenic action.

Chemical mutagens cause changes in body and gametal cells of a human as well as radiation does. Moreover, stable compounds of poison substances and their toxic by-products got into human organism cause more dangerous consequences than radiation exposure.

The main conclusion of both Russian and foreign specialists comes to the following:

1) Ammunition and containers with poison substance submerged loose don't pose much hazard provided that safety requirements are followed (that is dangerous areas should be closed for fishing, shotfiring etc.)

2) Ammunition in the bilges of submerged vessels pose much more threat. All the bombs and shells are in similar conditions, the corrosion rate is almost the same. It means that thinning of their jackets to some breaking point can lead to immediate destruction of the ammunition under the action of the upper shells as it was mentioned above.
The other potential source of pollution requiring control and monitoring is submerged radioactive waste.

13 areas in the North region of USSR (Abrossimov Bay, Stepovoy Bay, Tsivolka Bay, Sedoy Bay etc.) and 10 areas in Far-East region (including Japan sea, east shore of Kamchatka) were chosen for submergence of radioactive waste.

Submergence of containers with radioactive waste is not always followed by leakage of radioactive nuclides. Only the damage of the container jacket (3-5mm thickness steal) and damage of the inner volume filling of the container (concrete, asphalt or furfural) can cause the leakage (Vialyshev A.I. and Lissovskiy I.V., 2006).

Methods

Till recently the monitoring of UPDO was based on occasional sea expeditions. The research vessel with special measuring equipment could come close to the supposed place of UPDO location and carry out necessary measurements. One of the advantages of such monitoring method is the possibility to achieve high accuracy measurements of any required parameters because such method allows to use any types of deployed underwater measuring equipment.

However, disadvantages of this approach are obvious. First of all, the cost of carrying out of sea works is extremely high if it is necessary to make measurements in a large number of places where UPDO are located. It is caused by high cost of the survey vessels and underwater operations itself.

Such approach is selective and doesn't allow to carry out long-term monitoring.

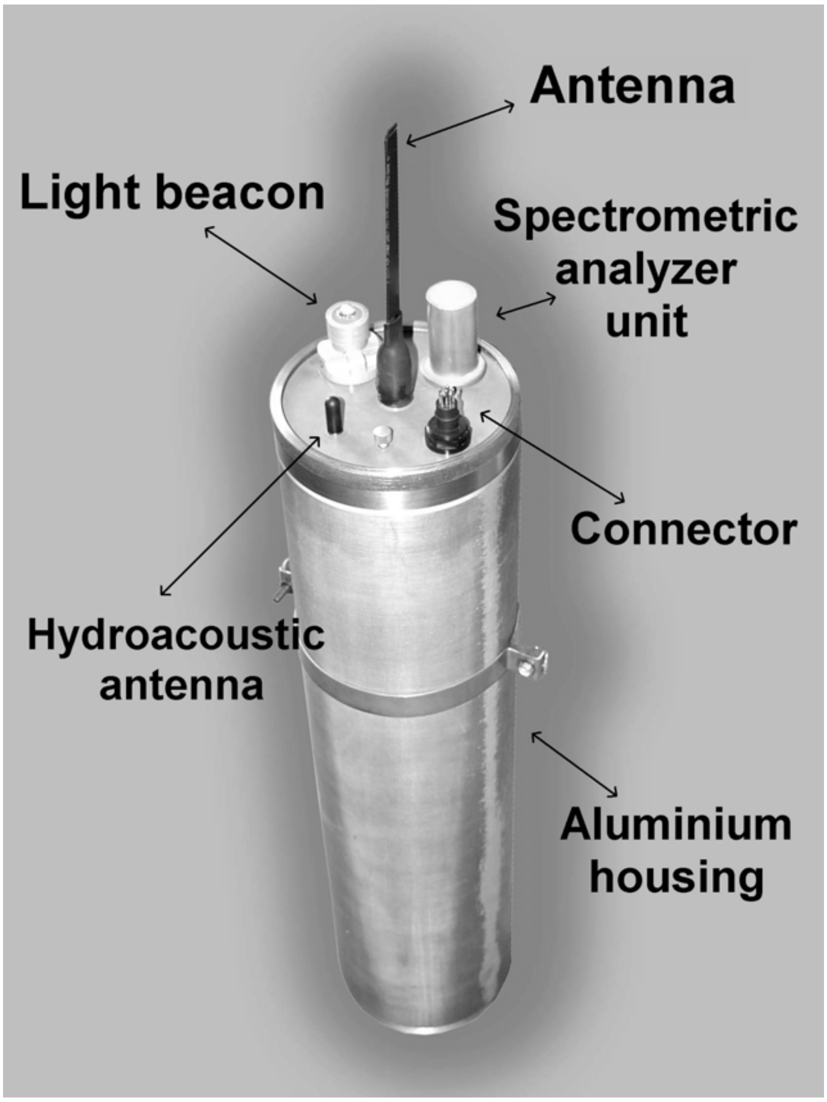
The monitoring of UPDO with using of vessels is impossible because of the large amount of UPDO and variety of their types. Therefore the development of some types of autonomous monitoring devices is necessary.

This problem can be solved through development and manufacturing of the autonomous devices for periodical measurements and spectrometric analysis of radiation background in the places where UPDO are located. Such devices would also control toxicity of sea water in the places of UPDO location and transmit the message in case of exceeding the determined level through a satellite communication system after recovery.

The operation principle of the system for radiation monitoring (SRM) is the following:

The SRM is being deployed on the bottom at the area where the UPDO is supposed to be located. The system includes radiation spectrometer, radio beacon, electronic microprocessor-based control system, electromechanical anchor release, ~~hydroacoustic antenna~~, power supply, flashing beacon (Picture 1) .

Picture 1. System for radiation monitoring (SRM)



The radiation rate is being measured with specified frequency according to a determined schedule. The SRM recovers from bottom to the surface and transmits encoded ~~radio~~ signal if the radiation rate exceeds a determined level set before deployment. The signal is being received by a satellite system and transmitted to the Center of radiation monitoring for recording and analyzing.

The system selectively measures gamma-rays in the specified energy bands. Since gamma-rays consist of gamma-ray quantum with one or several energies and form discrete spectrum the system can uniquely determine radioactive nuclide.

The spectrometric (radiation) analysis unit is based on the scintillation gamma-ray detector with CsJ(Tl) crystal ∅19×45mm which is optically coupled with photodiode. The unit includes amplifier of the detector signals, multichannel analyzer of pulse amplitude and data storage and processing device.

The autonomous system for control of sea water toxicity uses ion selective electrodes. It is known that inorganic compounds are the products of poison substance hydrolyze. Hydrochloric acid is a product for yperit and phosgene, hydrofluoric acid is a product for sarin and soman, hydrocyanic acid is a product for tabun. Thus the methods based on the detection of secondary compounds of poison substances (hydrochloric acid and hydrofluoric acid) can be used for detection and control of leakage of poison substance into the sea water (Stepanets O.V. *et al*, 2001).

Therefore the increased concentration of the products of poison hydrolyze is one of the evidences that poison substance is present in sea water environment.

Ion selective electrodes of device deployed on the bottom allow to detect presence of the products of poison substance hydrolyze, then the monitoring device recovers to the surface and transmits encoded radio signal via satellite .

Such devices are the main part of the integrated information control system (IICS); they can be deployed for a period of 1 year to the bottom on the depth up to 600m.

The integrated information control system (IICS) of the condition of underwater potentially dangerous objects (UPDO) carries out a number of functions. (Picture 2.)

1. It receives the signals from recovered autonomous systems of control of UPDO condition; processes and analyzes the received data and informs the corresponding services of the results of data processing.
2. The system uses acquired and analyzed data for providing updated list of existing UPDO.
3. Forms the system of long-term monitoring of underwater potentially dangerous objects which provides immediate warning if the determined rate of radioactivity or toxicity of the objects is exceeded.

Results

The main differences between the integrated information control system (IICS) of the condition of underwater potentially dangerous objects (UPDO) and other environment monitoring systems are the following:

1. The IICS is being developed specially for monitoring of UPDO according to specific requirements.

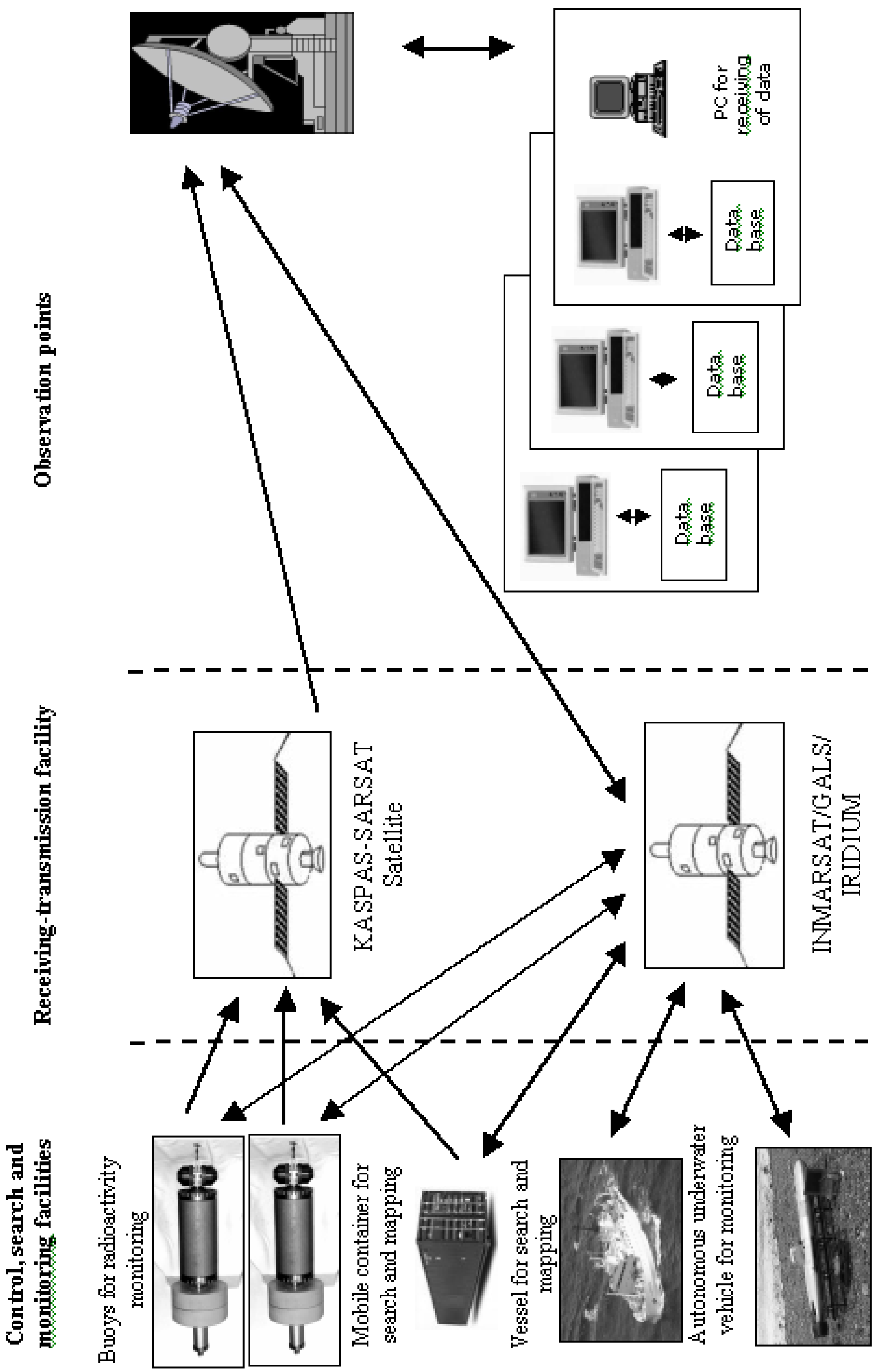
2. Reliability and quality of the measured underwater data related to observed objects are more important than speed of acquisition of information about the emergency with UPDO in the process of monitoring.

3. The IICS supposes deployment of monitoring devices in immediate proximity to UPDO which requires carrying out of some survey and mapping operation.

4. All the devices for monitoring, their design, manufacturing, and deployment are subject to the characteristics of the specific observed UPDO and its location.

Thus taking into consideration the specific character of the territory of Russian Federation, specificity of observed objects, variety of UPDO types we can conclude that the integrated information system controlling the condition of the underwater potentially dangerous objects suggested for development is of great importance for monitoring systems applied in Russian waters and doesn't have any analogues.

Picture 2. Scheme of information interchange



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GIS IN EMERGENCY MANAGEMENT

SUPPORTING MOUNTAIN RESCUE OPERATIONS WITH IPV6, MOBILE ROUTING AND MIDDLEWARE

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Keywords

Mountain Rescue, IPv6, Network Mobility, Mobile Routing, Middleware.

Abstract

The domain of Mountain Rescue poses many challenges for providing on-location communications for multiple roaming rescuers in areas that have little or no fixed network coverage. Furthermore, controllers at HQ are often unable to efficiently manage and monitor search operations. In this paper we describe how these challenges can be solved using a combination of new IPv6 networking protocols, mobile routers and appropriate middleware. We use the operations of the Cockermouth Mountain Rescue Team (CMRT) in Cumbria, UK as the basis for our testbed. However, the solutions we provide are also applicable to many mobile search and rescue scenarios in harsh communication environments (e.g. earthquakes, floods, tsunamis and major terrorist events).

In rural locations, available network infrastructure is limited if not entirely absent. Deploying mobile routers in rescue vehicles and in rescuer's backpacks allows us to bring the networks to the location. Furthermore, mobile routers can utilise any existing networking infrastructure available on location. Using IPv6-based protocols, the mobile routers automatically detect available networks and configure themselves appropriately. This includes networks projected by rescue vehicles, other mobile routers and any available fixed networks (e.g. GSM, GPRS, UMTS and TETRA). Rescuer's mobile devices configure themselves in a similar manner and rescuers can talk hands-free, in full-duplex mode with one-to-one, one-to-many, or open broadcasts. Middleware deployed throughout the system provides constant real-time monitoring of search operations. All operations can be monitored and managed via 2D and 3D visual displays at the HQ. Rescue vehicles, search groups and rescuers can be tracked, monitored and ordered to move to different locations. Controllers are able to consult knowledge databases concerned with rescue personnel, geographical information, previous incidents and radio coverage. In addition, intelligent search algorithms in the middleware can be cross-referenced with the knowledge databases to help controllers manage and monitor search operations more efficiently.

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Introduction

It is our central research hypothesis that innovation in mobile networking and middleware can greatly benefit search and rescue operations in emergency and crisis situations. Being able to move entire networks (as well as single user devices) in a seamless manner in response to specific areas of need is of critical importance. The new Internet Protocol, IPv6, plus related network mobility protocols can help us achieve this. In addition, the ability for a command and control centre to monitor and manage rescue personnel and other resources in real-time can significantly increase operational efficiency. The ability to support mobile search and rescue teams in such fashion is the focus of Lancaster University's involvement in the u-2010 project (http://www.u-2010.eu). Our testbed concentrates on Mountain Rescue in the English Lake District, Cumbria, UK. The domain of Mountain Rescue services is an ideal candidate with which to test out the u-2010 paradigm. Typical Mountain Rescue missions consist of one or more mobile teams that need to communicate in areas where there is little or no communications infrastructure. However, the underlying principles of our research will apply to any mobile search and rescue operations such as in the aftermath of tsunamis, hurricanes, floods, earthquakes and major terrorist events. Initially, the users of the system we are deploying are the Cockermouth Mountain Rescue Team (CMRT). The user base will most likely be expanded to include other mountain rescue teams within the Cumbria region. In addition, a secondary deployment in Slovenia will see the Slovenian Mountain Rescue Association (SMRA) as the main users.

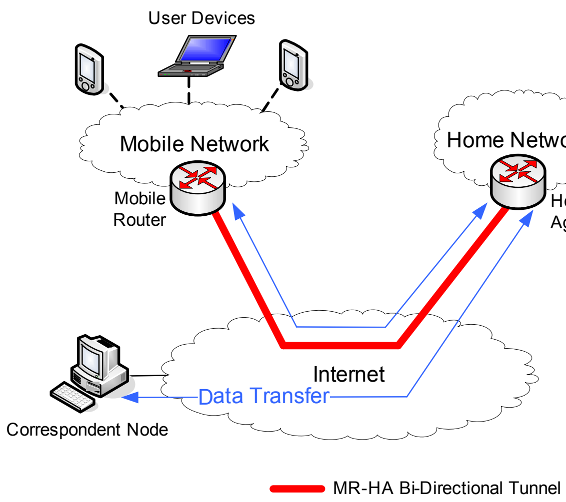
IP version 6

The Internet Protocol version 6 (IPv6) (Deering, 98) is the new generation of the basic protocol of the Internet. IP is the common language of the Internet, every device connected to the Internet must support it. The legacy version of IP (IPv4) has several shortcomings which complicate, and in some cases present a barrier to, the further development of the Internet. The coming IPv6 revolution will remove these barriers and provide a feature-rich environment for the future of global networking. The new addressing format in IPv6 is large enough to allow even the most seemingly insignificant electronic devices to have a globally reachable presence on the Internet. This will spearhead the new drive towards ubiquitous computing and leverages new networking models such as Personal Area Networks (PANs) and sensor networks. The hierarchical addressing format in IPv6 also eliminates inefficient routing tables inside core Internet routers. IPv6 also includes a feature called 'Neighbour Discovery' which means that hosts can automatically detect an IPv6 network and configure their host addresses accordingly (Narten, 98). Not only does this remove a large burden for network administrators, it is extremely beneficial for mobile hosts that can move from network to network. This is exploited by the mobile flavour of IPv6, Mobile IPv6 (Johnson, 98), which allows any host to roam and attach to different networks whilst hiding mobility from users and applications thus providing seamless user experience. A more in-depth description of IPv6 is out of scope for this paper. However, the reader is referred to (Johnson, 98) and (Dunmore, 05b), the latter containing a thorough deployment guide in addition to describing the main features of the protocol.

Network Mobility

While the idea of network mobility may seem a novel idea or even an extravagance to some, for first responders in crisis situations and especially mobile search and rescue teams, it makes perfect sense. Network mobility provides the capability for distinct local networks to move and attach to different points of other networks while still retaining mobile transparency to the users and applications inside the local network. Thus, teams of rescuers and emergency responders will be able to keep their usual network identities and configurations while they are moving around and attaching to different provider networks as they become available. This allows the rescue and emergency workers to concentrate on their tasks in hand rather than have to re-configure user devices to use whichever provider network is available at that precise time and location. The Internet Engineering Task Force (IETF) has long concentrated on individual host mobility in IPv6 via the Mobile IPv6 standard. In 2001 a new IETF working group known as Network Mobility (NEMO) was started with the aim of facilitating the mobility of entire networks. The work was motivated by the intent to support network mobility models such as Personal Area Networks (PANs), networks of in-vehicle devices and access networks in public transportation (e.g. buses, airplanes and trains). To fulfil these requirements, the NEMO Working Group developed the NEMO Basic Support Protocol (Devarapalli, 05). Every mobile network contains a Mobile Router (MR) which is responsible for connecting to new networks but also hiding the mobility from nodes inside its own network. Every mobile network also has a Home Agent (HA) located on its home network which is used as a relay whenever the mobile network is away from home.

Figure 1 NEMO Basic Support



The design of the NEMO Basic Support Protocol is heavily based on the Mobile IPv6 standard. The protocol relies specifically on a bi-directional tunnel that is instantiated between a mobile network's MR and its HA located in its home network. It is via this so-called MR-HA bi-directional tunnel that all traffic destined for the mobile network must travel whenever the mobile network is away from its home network. Referring to Figure 1, the Mobile Network is away from home and a bi-directional tunnel is been established between its MR and its HA. Any packets being exchanged between the user devices on the mobile network and nodes elsewhere on the Internet, will be relayed (or 'tunnelled') via the HA. An example path taken by packets to/from a correspondent node is shown.

Middleware

At present, the control room at CMRT headquarters (HQ) hosts a database that logs calls and basic details of search and rescue operations. However, the limited communications infrastructure prevents any real-time (or even quasi real-time) monitoring and management of search operations in progress. This often results in resources (rescue workers, vehicles, dogs etc.) being deployed in a sub optimal manner. In general, the rescuer workers rely on their knowledge of the terrain and experience of past operations to conduct their searches. For simple search operations, this usually suffices. However, for complex multi-team searches, the limitations of the communications infrastructure coupled with the lack of real-time monitoring and management tools, means that teams operate in an inefficient manner. This potentially increases the time taken to locate and rescue casualties. Middleware deployed throughout our new system will provide constant real-time monitoring of search operations. All operations can be monitored and managed via 2D and 3D visual displays at the HQ. Rescue vehicles, search groups and rescuers can be tracked, monitored and ordered to move to different locations. Controllers are able to consult knowledge databases concerned with rescue personnel, geographical information, previous incidents and radio coverage. In addition, intelligent search algorithms in the middleware can be cross-referenced with the knowledge databases to help controllers manage and monitor search operations more efficiently.

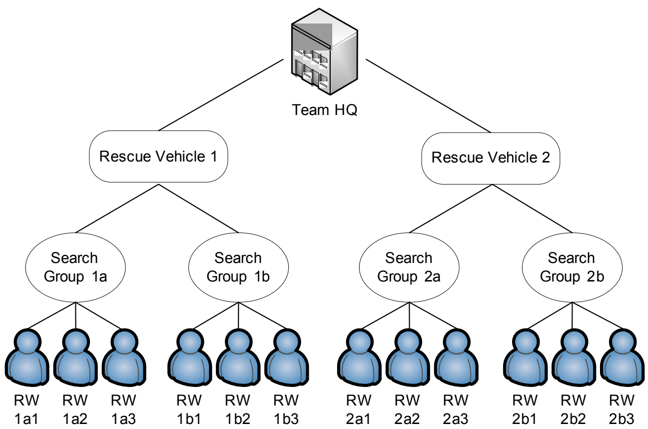
The rest of this paper is structured as follows. The following section looks at the general envisaged networking model for Mountain Rescue services, how the mobile routers are deployed and how the IPv6 network mobility protocols are used. It also describes how the monitoring and management middleware functions. After this we briefly list our sources of information. Finally, we present and discuss our findings from running the system on our mobile testbed at Lancaster University.

Thesis

The General Network Model

Lancaster University is on the border of the English Lake District, which is extremely popular with hikers, fell runners and mountain climbers. In cooperation with the CMRT, Lancaster University is deploying IPv6 mobile routers to provide them with an on-mountain data networking solution. Lancaster University is also responsible for network connectivity of all the schools and colleges in the Lancaster and Cumbria counties via the CLEO (Cumbria and Lancashire Education Online - http://www.cleo.net.uk) initiative, which uses CANLMAN (Cumbria And North Lancashire Metropolitan Area Network – http://www.canlman.net.uk). The importance of this is that we can provide the backhaul network access that the Mountain Rescue service's mobile networks can rely on.

Figure 2 Mountain Rescue Hierarchy



In a typical Mountain Rescue operation, each Mountain Rescue Team (e.g. CMRT) will have several search groups which will be assigned to a base vehicle and, in turn each individual rescue worker will be assigned to a search group. This leads to an obvious hierarchical relationship as depicted in Figure 2. However, these relationships are loose in that rescue vehicles, search groups, and individual rescue workers may sometimes change their 'points of attachment' as a search operation evolves. Referring to Figure 2, we determine that each search group represents one distinct local network, with its rescue workers being nodes on that network. Since each search group can change location, the search group network becomes mobile. In a similar fashion, the rescue vehicles are their own distinct mobile networks, only the Team HQ remains static. To further complicate things, any rescue worker can move in such a fashion that they can attach to a network of a different search group or even a different rescue vehicle. How all this confusion can be organised using IPv6 and network mobility is discussed in the next section.

Providing sufficient network connectivity in such remote rural locations is very challenging. The choice of network infrastructure is limited as wired connectivity is restricted to major towns. In addition, fixed public networks such as GSM, GPRS and UMTS have patchy or non-existent coverage in some areas. However, any connectivity we can provide on

CANLMAN plus any public wireless networks, plus possible satellite connectivity (provided by u-2010) can all be exploited by IPv6 mobile routers. Furthermore, we can build coverage 'on-demand' by locating portable 802.11, 802.16 or GSM/GPRS base stations with the mobile routers.

Figure 3 General Network Model

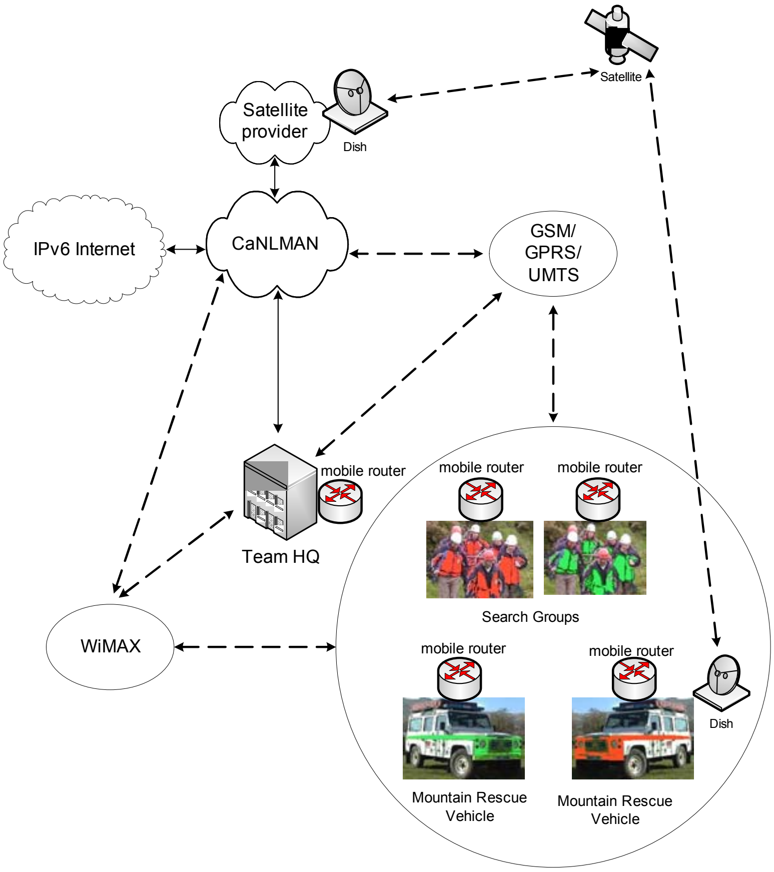


Figure 3 illustrates an example network infrastructure for the Mountain Rescue deployment. Mobile routers are located with the rescue vehicles. Using high gain directional antennae, we can project a hotspot of connectivity across an area being covered by the search groups assigned to that vehicle. Network technologies such as 802.11 and/or 802.16/WiMAX can be used to achieve this connectivity. The vehicle mobile routers can use GSM/GPRS/UMTS connectivity as the uplink to the Team HQ. Other options are to support point-to-point or point-to-multipoint WiMAX links or bi-directional satellite links via appropriate antenna and transceiver assemblies on the rescue vehicles connected to the mobile routers. Small form factor mobile routers are integrated into backpacks of designated rescue workers thus providing connectivity for each search group. In general, each search group will have its own 802.11 hotspot that rescue workers can connect to. Thus, rescue workers are not only connected to others in the same search group, but also with Team HQ via their rescue vehicle and also with rescue workers from other search groups via the wireless networks of different search groups and the search vehicles. If a rescue worker has connectivity to any of search group's wireless network then they have connectivity to the overall network. Since the mobile routers can also bridge different wireless networks, the effective coverage area can be expanded.

Yet it is IPv6 and network mobility that truly facilitates this capability. Using IPv6 neighbour discovery a rescue worker's device will automatically detect the network of a different search group and attach to it without any user involvement (assuming the usual network has been lost). Any existing applications would normally be broken at this point. However, using

NEMO, the applications can go on using the old IPv6 addresses and do not even realise the device has moved.

IPv6 Network Mobility and Mobile Routers

At first glance the Mountain Rescue network model appears to be a swarm of mobile nodes that move randomly and therefore the best networking model to apply might seem to be a Mobile Ad-Hoc Network (MANET) model. However, as previously mentioned our Mountain Rescue Team has a distinct command and control hierarchy that needs to be reflected in the network model. While not as strict a hierarchy as a military organisation, nevertheless consultation with members of the actual team revealed that the hierarchy is important. Therefore, mobility patterns tend to verge towards distinct clusters of individuals that move randomly in relation to other clusters but in relatively similar directions in relation to individuals in the same cluster. Thus a network mobility model is more appropriate as the routing model reflects the natural hierarchy as opposed to the flat routing architecture in MANET protocols.

Referring back to Figures 2 and 3, our network mobility solution defines each search group as a mobile network. In addition, each rescue vehicle is also a distinct mobile network. The home network of both rescue vehicles is the Team HQ, where a Home Agent is located. Similarly the home network of a search group is the rescue vehicle to which it belongs. The mobile routers located at the rescue vehicles also act as a HA for the search groups that belong to it. Each search group has a mobile router (in the backpack of a designated rescue workers) which connects to other networks as the search groups move. In their usual 'home' topology all traffic proceeds as with normal routing. However, if search group 1b (Figure 2) moves away from rescue vehicle 1 and automatically picks up (using IPv6 neighbour discovery) rescue vehicle 2, the NEMO Basic Support Protocol is activated. A bi-directional tunnel is established between the MR of search group 1b and the HA located at rescue vehicle 1. Traffic is now tunnelled to/from search group 1b via the HA at rescue vehicle 1. In this way, all the user devices attached to search group 1b do not have to change their IPv6 addresses and existing application sessions are not broken due to the movement.

NEMO also supports nested network mobility. After search group 1b has moved, search group 2b could move out of range of all other networks except that of search group 1 and attach at that point. Thus, search group 2b is now connected to the overall network via search group 1b. We now have nested mobile networks as search group 2b is away from home, connected to search group 1b, which is also away from home. This introduces 2 levels of tunnelling. In general *n* levels of mobility introduces *n* tunnels and associated tunnel overhead and latency. Further details of applying NEMO to Mountain Rescue services can be found in our previous papers (McCarthy, 05), (McCarthy, 06a). Thus, whilst the bi-directional tunnel approach in NEMO BS provides a good short term solution for supporting mobile networks, it does impose a sub-optimal routing model (known as triangular, pinball or dog-leg routing). In order to overcome the problems generated by triangular routing, a technique termed Route Optimisation (RO) was developed in Mobile IPv6 which allowed the mobile node to update the correspondent node with its new address after moving. However, in the case of NEMO, there are more complex issues to consider. To mirror the Mobile IPv6 RO would mean updating *all* correspondent nodes for *every* local host attached to the mobile network; an unacceptable level of overhead. Route Optimisation in NEMO is an on-going topic which has not been definitively solved as of yet. One RO technique for NEMO is to use a 'Reverse Routing Header' (RRH) which is an IPv6 routing header extension for NEMO BS that tries to 'record' the optimum path across mobile networks (Thubert, 07). In tests across our testbed, we found this to be a slight improvement over NEMO BS (McCarthy, 06a).

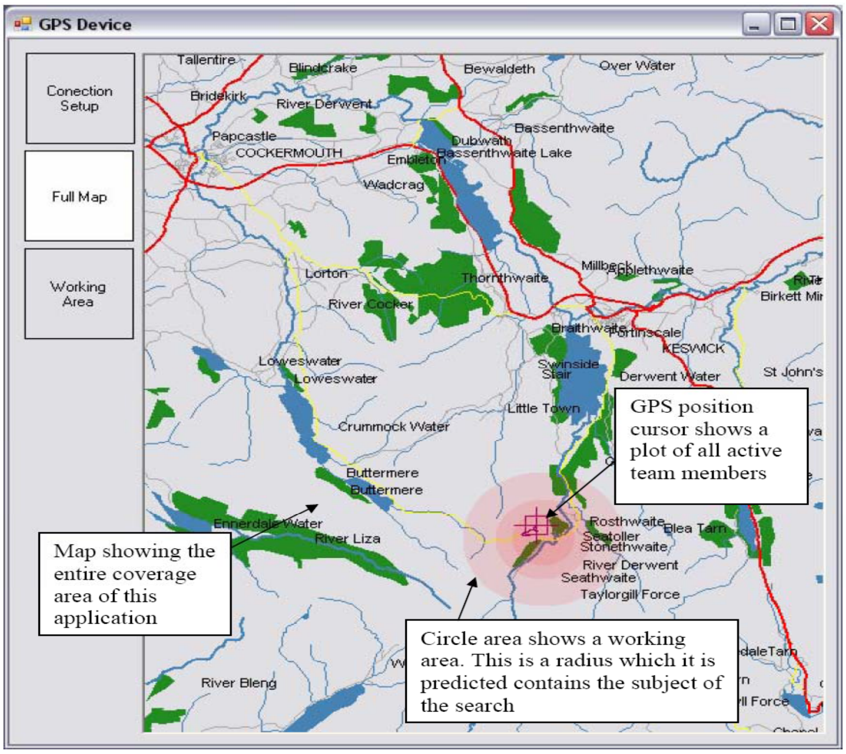
Monitoring and Management Middleware

To complement our network mobility solution for Mountain Rescue, we are developing middleware that allows the Mountain Rescue Team to monitor and manage search operations in real-time. The middleware is present at the Team HQ, and at the rescue vehicles, and utilises several knowledge databases in addition to providing real-time location updates of rescue personnel and vehicles. The knowledge databases consist of: Rescue Personnel, Geographical Information System, Previous Incidents, Communications and Search Theory.

The rescue personnel database contains detailed information on the Mountain Rescue personnel. This information includes any specialist skills (e.g. medical, dog handling, climbing), their contact details and work patterns (rescue workers are volunteers), current location and availability. When an emergency call is received at the Team HQ, the middleware automatically searches the database and displays which Team members are available and the set of skills that are covered.

The Geographical Information System (GIS) contains all the geographical data relevant to the Mountain Rescue Team's jurisdiction. This includes detailed terrain maps, roads, land features, car parks, hotels, campsites etc. It also has a dynamic element so that events such as rockfalls, landslides, severe weather, livestock movements, road blockages and traffic conditions can be overlayed onto the static geographical information. The middleware can query this database to gain geographical information for any area with the region. It is used primarily for displaying locations of personnel and vehicles during a search operation.

Figure 4 Predicting Locations



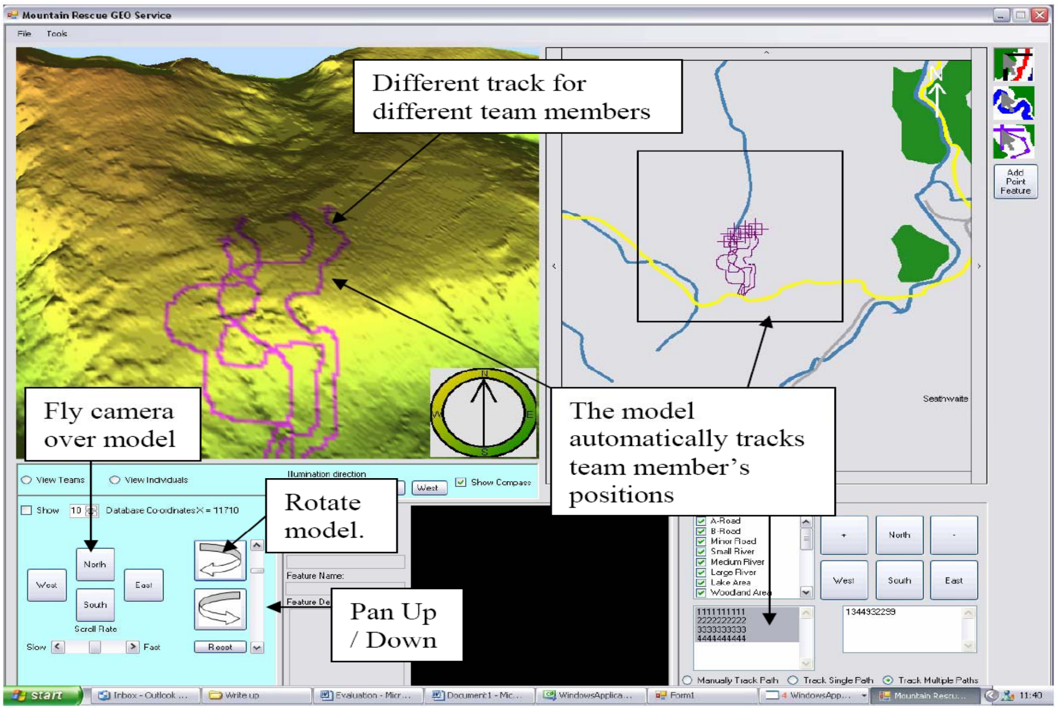
Details of all previous call-out incidents are stored on the Previous Incidents database. This includes the locations of the casualties, their injuries, the nature of the accident, the weather conditions, time of year etc. All this helps the middleware use statistical techniques to extrapolate likely locations for missing casualties when their locations cannot be ascertained from the emergency call. The most likely problem areas where the casualty might be located can be displayed in the control room (Figure 4) and relayed to the devices of the rescue workers.

The Communications database holds 'maps' of coverage areas for several wireless networking technologies such as GSM/GPRS, Tetra and 802.11 as projected from vehicles in certain locations. The purpose of this is so that the Mountain Rescue Team know in advance where there are black holes in connectivity so they can adapt accordingly. For example, cross-referencing with the GIS also allows controllers at HQ to analyse terrain and reception data and then inform rescue vehicles of the optimum locations to park in order to provide temporary connectivity to the search groups on the mountainside.

We also have a Search Theory database embedded in the middleware. This can suggest search patterns for the search groups to take based on the information obtained from the emergency call and the cross-referencing of the other databases.

The main feature of the middleware is the real-time tracking and monitoring of rescue personnel, search dogs and vehicles. Using the mobile networks and wireless infrastructure provided, GPS devices in the vehicles or worn by rescue workers/search dogs continuously update the server part of the middleware with their locations. The locations of Team members and vehicles are displayed in the Team HQ and at terminals in the rescue vehicles overlayed onto 2D or 3D maps of the search area (see Figure 5).

Figure 5 Screenshot of the middleware



Users of the middleware can add/remove details from the display such as contours, roads, land features, rescue workers, search groups etc. The routes taken by rescue workers can be displayed as 'snail trails'. All movements are logged so that missions can be played back later to evaluate efficiency.

Sources of Information

Our main sources of information for this paper are the Cockermouth Mountain Rescue Team, the Slovenia Mountain Rescue Association and various RFCs, Internet Drafts from the Internet Engineering Task Force as well as mailing list discussions. In liaison with the aforementioned Mountain Rescue personnel we identified a set of requirements, both user-orientated and technical, which acted as the criteria by which our system was designed. Space constraints prevent us from discussing these requirements in detail here. The interested reader is referred to (U-2010, 07).

Findings and Discussion

In this section we discuss some of the findings we lessons we have learnt from running the system on our mobile testbed at Lancaster University. For the mobile routers we are using 5 Cisco 3200 Mobile Access Routers (MARs). We also use standard PCs and laptops running

Linux and NEPL (NEMO Platform for Linux) to act as mobile routers. The current mobile router devices that we use are fine for deploying in the rescue vehicles. However, we have found them too bulky and heavy to be easily carried by individual rescue workers in their backpacks. Additionally, since the 3200 is intended to be powered via the vehicle's battery, we found it extremely difficult to replicate this using a battery light and small enough to be carried. We are thus developing prototype devices running embedded Linux that will serve as personal mobile routers.

The NEMO BS Protocol can be used to produce a working solution to our Mountain Rescue scenario. However, NEMO BS capability is not efficient enough to support real-time or time-sensitive applications such as VoIP or video streaming. However, for 'elastic' applications such as the location updates for our monitoring middleware, it is sufficient. We also considered the NEMO Route Optimisation technique RRH's ability to improve the overall performance. We found that the RRH technique could provide some performance improvements yet it is still inadequate to support the real-time applications that we want. We have mentioned how Mobile IPv6 RO is not suitable for NEMO. However, even if we could have a NEMO RO technique similar to that of Mobile IPv6, it would still be someway short of supporting real-time applications such as VoIP due to handover latencies in the order of seconds, as demonstrated in the 6NET project (Dunmore, 05a). Thus, we need better RO techniques to be able to support VoIP and real-time streaming. This is why we are investigating the idea of using MANET protocols together with NEMO to provide route optimisation for mobile networks that are close together physically although not topologically. For more details on this, please see (McCarthy, 06b).

In our middleware tests we have found that to avoid location update storms to the server (when rescue workers turn on devices at roughly the same time), we configure location updates to be slightly randomised within a given time period +/- 20%. Thus, if we configure a location update period of 30 seconds, the actual period will be pseudo-random between 27 and 36 seconds. In addition, location updates are set according to the entity being located. A rescue worker will move more slowly than a vehicle or a search dog. In general the faster the movement, the more frequent the location updates need to be. Many simulated operations (from GPS logs of actual missions) have revealed where resources could have been deployed more efficiently and search time reduced. We are still improving the system and aim to be using it on real missions in late 2007 or early 2008.

In summary, the system to date is very promising despite a number of challenges that need to be overcome. While the system can clearly provide mountain rescue teams with automatic, mobile ad-hoc communication, it does not yet have the ability to support real-time applications. Similarly, while mobile router devices can be carried in backpacks, they are not yet small, light and durable enough for live deployment. To conclude the answer to our central research hypothesis, our experience with the system indicates that this will be a very promising tool for Mountain Rescue services. However, because we have yet to deploy the system in the field, we cannot at this time make any concrete conclusions as to the effectiveness of the tool in real missions. This will, of course, be for future study.

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Author Biography

Martin Dunmore is a Research Associate in the Computing Department at Lancaster University. He received a BSc (Hons) in Computer Science in 1997 and a Ph.D. in Distributed Computing in 2001, both from Lancaster University. His research interests include IPv6, wireless and mobile computing, ad hoc networking, QoS, traffic engineering, and intelligent network systems. Some of the previous European projects he has worked on include Eurescom P702, PETERPAN and 6NET. In P702, he developed an IPv6 MPEG video service that utilised the IPv6 flow label field for marking its relevant traffic streams in a coordinated fashion with RSVP. In PETERPAN he designed a "Hybrid Edge Device" that interfaced between the IP access and ATM core network boundary, which integrated the QoS paradigms of IETF Integrated Services and the ATM ITU-T/ATM-F QoS classes. In 6NET he was leader of the workpackage that investigated and deployed IPv6 solutions for Mobility, WLANs, VPNs, QoS and Site Multihoming. Martin has also been involved in numerous other research efforts such as the LANDMARC project, BERMUDA (which enabled IPv6 service between the Universities of Lancaster, Southampton and UCL) and collaboration with DERA (now Qinetiq) on the use of QoS, mobility and IPv6 in military contexts. During his time in 6NET he helped to launch the UKERNA Wireless Advisory Group which aims to provide advice to all UK Universities and Colleges on matters concerning wireless and mobile networking.

ISTANBUL DISASTER INFORMATION SYSTEM

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Keywords: Disaster information systems, TABIS, GIS, Emergency Management, Mitigation

Abstract

Natural hazards, especially earthquakes have been threatening Turkey, and will continue to threaten in the future. The 1999 earthquakes in Turkey caused 20,000 casualties, injuries, 30,000 building damages. According to the results of many earth science researches, Istanbul is waiting for her earthquake in the near future. Thus, Turkish Ministry of Internal Affairs and Istanbul Technical University initiated a project on May 2001, called Turkey Disaster Information System (TABIS) Standards, to prepare GIS standards based on disaster management and these standards are declared to the central and local governors by the Turkish Ministry of Internal Affairs.

Aim of the study is to apply the proposed GIS-based information and management support system standards model for a selected pilot region in Istanbul in order to set an example for the succeeding applications in the country to be implemented in the future. The system, using modern satellite technologies and information systems, will be used especially for planning and applying emergency preparations, disaster management and loss assessment activities in case of a disaster and will also function as a decision support system for central or local authorities (ministries, governorships, municipalities, etc.) at other times. As a result of the study, an information system model is planned to be built that will support the authorities on their decisions by assisting the harmony and coordination in disaster planning between Istanbul, local municipalities and neighboring cities and by improving the TABIS standards.

So far, data source organizations for the collection of data are determined and preliminary design of the system is done in the project. After the inspection and integration of the data gathered from different sources, the emergency management tools to be used in the system will be determined.

With the establishment of the system, the impact to the national economy of Turkey will be minimized because of a disaster and the recovery operations after the disaster that will take place in a metropolitan city like Istanbul.

INTRODUCTION

If we look at Turkey in general or Istanbul in particular, Geographic Information Systems (GIS) have started being widely used as a popular technology for urban administration and planning purposes. However, a system with a data structure and standardization that would completely provide any need of a city has never been perfected yet. This study is an example for a disaster management system, which its likes have not yet been established for Turkey. And the project is supported by Turkish Prime Ministry State Planning Organization and Istanbul Metropolitan Municipality.

Aim of the study is to apply the proposed GIS-based information and management support system standards model for a selected pilot region in Istanbul in order to set an example for the succeeding applications in the country to be implemented in the future. The system, using modern satellite technologies and information systems, will be used especially for planning and applying emergency preparations, disaster management and loss assessment activities in case of a disaster and will also function as a decision support system for central or local authorities (ministries, governorships, municipalities, etc.) at other times. As a result of the study, an information system model is planned to be built that will support the authorities on their decisions by assisting the harmony and coordination in disaster planning between Istanbul, local municipalities and neighboring cities and by improving the TABIS standards.

Turkey Disaster Information System (TABiS) was developed in the scope of "Development of a National Database Using Geographical Information Systems (GIS) and Remote Sensing System and Standards for a Disaster Management Decision Support System" in the Istanbul Technical University (Karaman H., et al, 2002).

For Turkey and especially for Istanbul there are no GIS which have standardization and the data structure that provides all the required processes for a city even though the popular technology of GIS is used widely for the city management and planning (Şahin et.al., 2006).

SYSTEM FEATURES

System will provide planning and preparedness for disasters and will help to orientate the response and logistic support faster and more accurate than before. After a disaster, system will act as a decision support unit for the mitigation efforts. The system will inform the decision makers about:

- What kind of and how much help is needed from where,
- From where can this help be provided in the shortest time,
- Which specifications are needed for the staff to be charged.

Optimization and planning of the response will reduce the disaster loss and response and recovery costs. Thus, the system will minimize the economic catastrophe likely to follow the disaster for Istanbul. Also, announcement of the emergency plans to public will minimize the panic state during and after the disaster. This will also enable the participation with public. The system will provide current, correct, standardized and consistent data for its users and prevent the complexity of transmitting of unnecessary information.

Steps proposed at starting phases related to the study were: Configuration of the spatial and non-spatial data related to emergency management, formation of the principles of the institutional structure to keep the system up-to-date, formation of the system and determination of the hardware and software to be used, acquisition of different types of data according to the prescribed scales, determination of the integration of the data coming from different sources, determination of the presentation formats, formation of access and distribution of the data. As can be seen, the study requires a multi-dimensional expertise, generating solutions for the tasks in multiple phases (Şahin et.al, 2006).

All actions in the scope of the study are carried out with cooperation between Istanbul Metropolitan Municipality (IMM) and Istanbul Technical University (ITU).

ESTABLISHED TASKS

- Project budget was arranged in order to fulfill long-term requests and purchasing of equipments and services for the year 2006 have been made and documented.
- Determination of spatial data and data sources was made. Data formats and spatial references were also determined.

- A detailed draft of tasks to be done during the project was prepared. Main features of this draft are: carrying out system analysis, obtaining necessary equipments, obtaining necessary basic software, carrying out system design work, data transformations, data production, development of application software, testing of the system and putting into practice.
- Project headquarters were formed in a room assigned by the Deanship of the Faculty of Civil Engineering in accordance with the academic committee of the Department of Geodesy and Photogrammetry Engineering (Figure 1).

Figure 1: Project Headquarters.

- Acquisition of a portion of the data from IMM or other relevant organizations is established. Gathered data can be listed as follows:

    - 1/5000 scaled base maps produced in 2005.
    - 1/1000 scaled digital maps from 1996.
    - Satellite imagery covering Istanbul.
    - Digital geometric data related to transportation.
    - Spatial topographic data and attributes being served in Istanbul Guide on the IMM website.

DATABASE DESIGN PROCESS

The primary objective while bringing TABIS to life, is the database design. The design process involves logical and physical design respectively. In the logical design phase, data types for the physical design phase and the spatial representation of the data (point, line, polygon) are determined along with their attributes. In the physical design phase, data sets, feature classes and tables to store the data defined in the logical design phase are built and relations between relevant data are defined. TABIS Object Catalogue (TABIS-OC), which is a standard data model for a GIS based management information system, is specified for the planning of preparations and rapid loss assessment in case of a disaster. This catalogue defines the features to be evaluated in the system.

TABIS-OC ,an object oriented database model, and IMM-DB (Istanbul Metropolitan Municipality Database), a relational database of IMM implemented for test purposes are compared in detail. IMM-DB is currently being used especially in applications that local governments need and contains data models used in projects in national scale and is developed by the integration of several private sector projects. It is decided that these two database models will be compared for the enrichment of the system to ensure that the system will be used easily by the local government.

MODELS USED FOR THE DATABASE DESIGN PHASE

With the establishment of the project for setting the standards of a remote sensing and GIS based, disaster management focused decision support system, it is aimed to define the mandatory data to be present in an information system and how these data should be structured. TABIS-OC has a basic geodatabase structure oriented to all specialties. Object models, object definitions, attribute definitions and attributes that the catalogue contains is similar to a structure of a topographic map. Digital maps can be prepared from the database by applying some generalizations on the data. TABIS-OC consists of two main components built parallel to the digital spatial and the hazard models (Figure 2). First component, Basic Topographic Object Areas, covers the modeling of actual objects characterizing the geometry of the related region. The second component, Disaster Management Object Areas, contains discretely referenced object models to be included in a geographical information system for disaster management purposes.

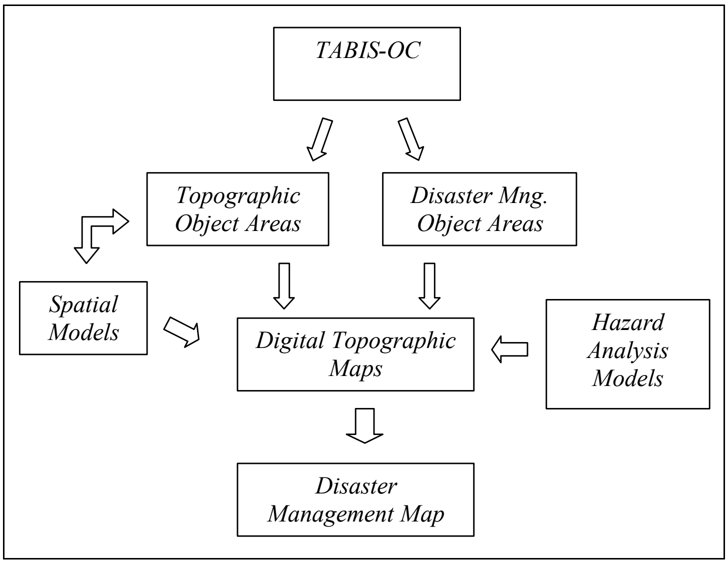

Figure 2: TABIS-OC

IMM-DB, is in a geodatabase structure, where geodatabase is a data model providing data storage and management on standard relational database tables. Two different architectures can be present in geodatabases: personal geodatabases or multi user databases. Multi user geodatabases are large and dynamic databases allowing more than one user to work simultaneously. A geodatabase stores spatial data in components as conceptual models determined by their similarities in utilization. These components are classified as feature dataset, feature class and table (Figure 3). Table is the component storing attributes related to a vector data. Feature classes store vector data in relevant geometries in a layer structure. These layers can be stored in a feature dataset or directly in the geodatabase. A feature dataset contains feature classes that can be presented together due to topology or content of the subject.

IMM-DB contains initially unused feature datasets, but this situation reduces the need to update the conceptual model in the future. In other words, the necessity of the geographic information system built in the scope of a project does not diminish after the completion of a project.

IMM-DB is in a structure that it can meet any content expansion due to integration of several projects, along with the datasets developed during the projects that it was used. Thus, the model consists of administrative area, ownership, residential area, urban service, infrastructure, transportation, numeracy, vegetation cover, recreational area, hydrography, topography, geology, geophysics, geodesy, project area, protection zone and zoning datasets.

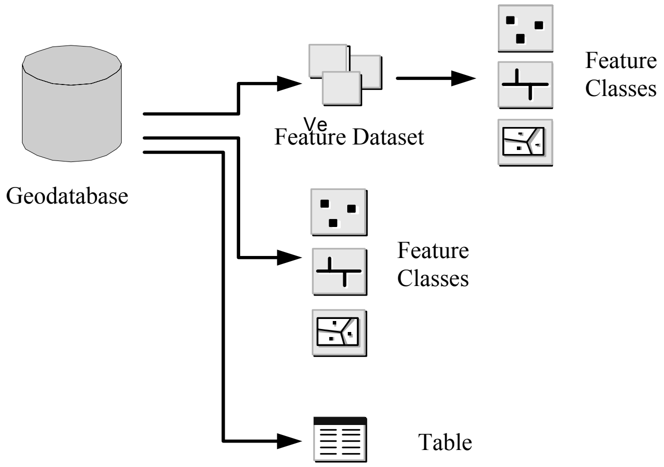

Figure 3: IMM-DB

ANALYSIS AND COMPARISON OF DATABASE MODELS

The database to be developed in the scope of the project will be built on TABIS-OC containing all of the objects needed in the system. The object models, object definitions and attributes included in this structure completely fulfills the needs of a topographic information system. Object areas are divided into two as basic topographic object areas and disaster management object areas. The components of the object catalogue are resolved during the logical design phase of the database.

While displaying the structure of TABIS-OC, object areas were classified along with their sub-groups and arranged in a more understandable form. Also, all object types are arranged in this form in order to be organized during the database development.

The database model to be used in the project, will be developed by the contribution of IMM-DB on adding models needed by the local authorities and on obtaining compatibility. As mentioned, IMM-DB database structure consists of a data model that divides the spatial data into components according to their usage patterns. Feature datasets that are designed and updated throughout multiple projects enriches the database structure. At the first phase of the study carried out, IMM-DB has been discussed on every aspect and its conceptual model was revealed up to its attribute data. While working on IMM-DB, compilation of the data classes contained were shaped into a more understandable figure.

At the second phase of the study after considering the data models of TABIS-OC and IMM-DB, these structures were compared in detail and the features that exist in TABIS-OC but not in IMM-DB were listed. So, the match-table prepared this way would lead to a complete model at the database design phase. TABIS-OC and IMM-DB, although looking similar due to their contents, have structural differences. For example, in TABIS-OC, each spatial object is defined as different objects. Whereas in geodatabase structure they are defined as subtypes of the feature classes they belong to.

CONCLUSION

From the study, advantages and disadvantages of each carefully examined database structures according to each other have been stated. In further stages, a stronger database structure is foreseen to be established based on the gatherings from this study.

By the completion of the project, every kind of national information system studies will be constituted according to defined standards and will be able to relate the national information systems to the system that is planned to be developed. The aim is to unite all independent studies and to enable the exchange and management of the valuable data for disaster management.

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Academic & Professional Practice

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EMERGENCY PREPAREDNESS

COORDINATION OF INTERNATIONAL ASSISTANCE FOR DISASTERS: THE MPAT PROGRAM

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Keywords:

Humanitarian Assistance, Military, Coordination, Multinational, Tsunami

Abstract

There is great need in the world today to do whatever necessary to enhance our ability to respond to catastrophic disaster in a multinational fashion. In late 1999/early 2000, the Commander of the U.S. Pacific Command initiated an innovative process to bring together the Chiefs of Defense of many Asia-Pacific region militaries. In this fashion, the Multinational Planning Augmentation Team (MPAT) Program originated. It grew from 5 nations in 2000 to 33 nations in 2005. The basic concept was to enable the rapid establishment of a Multinational Force Headquarters (MNF HQ) to allow multilevel interoperability at the operational level.

A key component is this international relationship is the development of concepts and procedures without formal policy constraints that can impede multinational interoperability. The four operational objectives of MPAT are:

1. Increase speed of initial crisis response by a Coalition Task Force (CTF) in the Asia-Pacific region.
2. Improve the interoperability of coalition or combined forces
3. Improve overall MNF HQ mission effectiveness.
4. Build Unity of Effort.

The brilliance of the MPAT achievement is routinely bringing together a small group of planners from throughout the region so they get to know each other and become proficient in common crisis response planning procedures. Thereby, improved speed and effectiveness are accomplished.

The purpose of this presentation is to examine the current structure and efforts of MPAT, as well as its recent activities and successes. This is especially true in relationship between MPAT and the Joint Task Force (JTF) 536, which was renamed as the Combined Support Force (CSF) 536 subsequently, to respond to the South Asian Tsunami of 2004.

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Introduction and Thesis

Throughout history, nations have suffered disasters that have gone well beyond their capabilities
and resources to respond and recover. Whatever the society or culture, whether through circumstance or decision, survival requires acceptance of risk. This may come through living on one of the great fault lines (such as on the west coast of the United States), on the slopes of dormant volcanoes, in a swath of land aptly named "tornado alley, in a city below sea level that is constantly threatened by hurricane winds and flooding, where devastating snowstorms are common, or in cities with their risks of crimes and terrorist activity. It should surprise no one when some of these risks yield their bitter fruit.

Most developed nations, have advanced significantly in their disaster preparedness activates, focusing on the areas of preparedness (vulnerability analysis, surveillance and early detection), response, and (to a lesser degree) activities related to recovery. However, it is only in recent years that issues surrounding coordinated international aid to assist those nations undergoing a major disaster have been addressed. Not surprising to those within the disaster management environment, the greatest difficulties arise in the areas of communication and coordination. Our ability to respond to these issues was severely tested in the South Asian Tsunami of 2004 (Morrow, 2006).

Sources of Information

History of Humanitarian Responses

In the United States, research into the natural history and societal response to disasters began in the early 1950's, through the National Research Council's Disaster Committee. Periods defined were: warning, threat, impact, inventory, rescue, remedy, and recovery. Except for the notable absence of the preparedness phase, more recent attempts to analyze the process also follow these steps. It is important to note that early research considered the psychological and societal effects of a disaster to be temporary and short term. There had been controversy concerning whether there has been a decreased ability to physically and psychologically cope with crisis and change, or whether these needs were just overlooked and denied in our earlier society's perspective of self-sufficiency. It is now understood that there is a greater need for crisis intervention and mental health programs during and following disasters than was believed previously (National Mental Health Information Center, 2007).

In our new lexicon, disasters have taken on a meaning having greater depth and scope. There have always been man-made disasters, whether from fires in chemical plants, reactor meltdowns, accidents involving all forms of transportation, tanker spills of oil, or accidental release of chemicals. To that mix, we now must add the fearful specter of weapons of mass destruction being unleashed on broad populations. It has also been suggested that the horrors of civil war and genocide be added to our list of disasters to address.

What are the reasons that other nations become involved in assisting in international response and recovery efforts in a disaster? This paper deals with international involvement in a humanitarian response, a response mounted to assist individuals and countries that can no longer handle the situation and have asked for help. As defined, these are humanitarian efforts because they "improve the lives of mankind and reduce suffering" and "promote fraternity among nations". There is truly no one definition of humanitarian, except that it deals with the value of man. By our definition, a humanitarial effort must be non-coercive and selfless, it must be of no benefit to any except those we seek to assist, and it must be based on action, not talk. Even more difficult is that to be truly humanitarian, such actions must be devoid of political self-interest, military motives, profit, and promotion of any one form of government or ideology.

Historically, a multinational response to disaster involves at least four major groups (Schoenhaus, 2002): governmental organizations, non-governmental organizatinos (NGOs), military, and international civilian police (CIVPOL) who are sponsored by organizations such as the United Nations (UN), the Organization for Security and Cooperation in Europe (OSCE) and regional security organizations around the world.

It is important to recognize the levels of actions that might be taken by the international participants in a humanitarian response. These phases mirror the sequence of events found in any action plan. First, there need to be policies created regarding what needs to be done or activated. Second, there must be a concerted effort at the operational level to create and coordinate plans based on those policies,and third, those plans must be executed in an organized and effective manner.

Multinational humanitarian responses would be appropriate if the disaster is internal to national borders, but beyond the capabilities of that nation to handel, if the disaster itself is multinational in scope, or if a nation is intensely affected by events that occur outside of their borders. The most recent multinational disaster, and the largest in scope, was the Indian Ocean tsunami of December 2004.

<u>History of MPAT</u>

The Commander of the US Pacific Command recognized in the late 1990s that there needed to be better cooperation and coordination between the militaries of that area (Weidie, 2006). He called together the Chiefs of Defense to discuss several issues, one of which was to look for improvement in the area of Military Operations Other Than War (MOOTW). One major outcome of this work was the creation of the Multinational Planning Augentation Team (MPAT), to strengthen relationships between planning staffs (Griffard, et al, 2006), and to enhance cooperation and coordination (U.S. Pacific Command, 2006) at the operational level during disasters.

One unique, and critical feature of this group of militaty leaders is that it is based on cencensus, not on formal agreements or formal oversight. Lack of bureaurocratic requirements leads to quicker decision making processes and implementation. Early meetings indicated the immediate need for Standard Operating Procedures (MPAT Portal, 2007) based on the foundation of three basic principles.

1. There needed to be operational starting points to enhance speed and effectiveness of the operation.
2. The need to agree or “agree to disagree: based on information available and frames of reference.
3. There needed to be a Command Task Force (CTF) planning structure to assure that plans were carried through the execution phase. Detail can be found in the Standard Operating Procedures (SOPs) and five starting points.

The MPAT is comprised of experienced military planners who are adept at facilitating the rapid and effective establishment and/or augmentationn of Multinational Coalition Task Force Headquarters (CTF HQ) Standard Opetrating Procedures. There were five operational starting points of importance.

1. Common terminology.
2. The lead nation concept of who will be in charge of coordinating the multinational response.

3. Nations agree in principle for the need for a common command and control relationship framework.
4. Creation of a CTF headquarters template of positions and people as a starting point.
5. Creation of a CTF common process for general planning and military decision-making.

<u>Use of the Conceptual Framework in the Indian Ocean Tsunami</u>

There was an oportunity to utlilize some of the MPAT concepts in the multinational response to the Indian Ocean tsunami in 2004-5. It is in the coordination of US forces with other countries participating in humanitatian assistance/disaster relief (HA/DR) efforts that MPAT exerts its influence. This type of cooperation is essential to keep in perspective the fact that the military should always be in a supporting role to the host nation. An existing bi/multinatinoal security relationship can enahnce and accelerate needed response activities. MPAT, as well as the Asia-Pacific Area Network World Wide Web portal (APAN) were integral in the multinational response to the Asian Pacific tsunami.

<u>Findings: Use of MPAT in the 2004 Indian Ocean Tsunami</u>

The MPAT program was first tested in response to the Indian Ocean tsunami of 2004 (Weidie, 2006: Weidie, 2007; Wolfowitz, 2005). MPAT contributed to the creation of the Combined Coordination Centers (CCCs) that held a "seat at the table" for all military and interagency liaison officers during Operation Unified Assistance, the name given to the US military response to the 2004 tsunami. General Gary North, Director of Operations for the United States Pacific Command (USPACOM) during the tsunami, called MPAT a "huge success because we were able to put together planners who had worked together in peace time in a non-stressful organization and environment; they were able to start talking to each other irrrespective of what country you came from, or what uniform you were wearing or what language you spoke (Lerooux, 2005). An orchestration of cooperative efforts resulted. MPAT was a key element in coordinating rapid military support among the 13 nations involved. Some of those involved in the civil-military operations were representatives from the Office for the Coordination of Humanitarian Affairs, the World Food Programme, UN Joint Logistics Center, and the World Health Organization. It was a safe venue in which to address common concerns without overt US or military leadership.

An MPAT Secretariat, representing all MPAT nations, had been created to develop and implement the program. The Secretariat deployed a cadre of planners to a lead position, initially designated Joint Task Force 536 (JTF 536). Upon orders from the National Command Authority, the commander of the U.S. Pacific Command had ordered the standing up of Joint Task Force 536 on December 28, 2004. This was 48 hours after the earthquake, with a magnitude of 9.0 on the Richter scale, devastated northwestern Indonesia, Thailand, Sri Lanka, India, Maldives, and several nations in the area of responsibility. Between December 29 and December 30, initial relief supplies were transported in country with disaster relief (DR) assessment teams. The forward element of Joint Task Force 536 arrived at the Royal Thai Navy Air Base in Utaphao, Thailand. The command element of III Marine Expeditionary Force arrived from Okinawa, Japan, and was designated as Combined Support Force (CSF) 536 on January 3, 2005. MPAT was focused on improving multinational interoperability at the operational level of command.

What was apparent to all at the outset was that the needs of the three most-affected nations were unique and did not share much commonality. The United Nations, the International Red Cross, and other IOs and NGOs were not mature in a coordinated or economic sense. Medical assets from the deployed USS Abraham Lincoln made early visits to Indonesia and provided preliminary reports and assessments by their medical team. It was apparent early on that hundreds of thousands were killed outright by the tsunami. Interestingly and quite fortunately, only a small fraction of all affected were seriously injured. More were homeless, separated from family members, or unable to travel to their homes because of impassibility of the roads.

CSF 536 was organized to respond effectively to the uniqueness of support needed by the three different countries. This was performed by assigning each of the three major countries (Indonesia, Thailand, and Sri Lanka) its own team, or combined support group (CSG). Each CSG was tailored for that particular nation's unique needs.

The CSGs were on the ground in their respective countries and had close tactical relationships with local U.N. representatives, NGOs, and foreign military assets already in place. The CSGs also interacted closely with the host nation's political and local infrastructure and with that country's U.S. embassy. A most important liaison made early on was with the U.S. embassy of the affected nation. Within each embassy is a group of specialists who facilitate U.S. support activities at nearly all levels. These are called "country teams."

A command coordination center (CCC) was located at CSF 536 headquarters in Utaphao, Thailand (Cossa, 2005). This organization became the center of coordination and a vetting body when responding to and addressing the hundreds of requests for support from the tactical levels.
One delightful observation was made during this large and unprecedented combined HA/DR response. A coherent symbiotic relationship with strong leadership can work well when the differences are seen as strengths and not weaknesses. One major point that was obvious to all in CSF 536 from the outset was that the United Nations, the WHO, the World Food Program, IOs, and most NGOs are positively superb in their field of responding to devastated populations of people during a disaster.

Findings and Discussion

Where the military, the U.S. military in particular, made its most significant impact was in its ability to respond in a timely manner at all levels. The civilian organizations cannot do this effectively. CSF 536 provided hands-on leadership and coordination of efforts immediately. The term "fog of relief" describes the uncoordinated massive duplication of efforts and redundancy in HA/DR. It nearly stopped logistical relief efforts in Indonesia by blocking airlift movement at one Banda Aceh airport. Thousands of tons of supplies were accumulated because of uncoordinated incoming lifts from many countries coupled with an embryonic outgoing distribution capability. It is in this arena that CSF 536 military participation was valuable. CSF 536 provided logistical expertise and support at all levels, communications, and early medical forensics support. Advanced surgical teams from the 3rd Medical Battalion were offshore if that need was requested. More than 2,200 helicopter lifts and 1,300 C-130 sorties were flown to deliver appropriate relief supplies or needed personnel. The 9th Engineering Support Battalion from 3d Force Services Support Group opened critical roads and restored public health infrastructure in Sri Lanka. This allowed that country to return to its baseline level much more quickly.

One valuable piece of CSF 536 support that greatly benefited HA/DR efforts was the practical design and use of the "request for assistance" (RFA) process. This process streamlined the request procedures and allowed for each country's needs to be addressed at the appropriate level in the most timely fashion. The "fog of relief was minimized by use of the RFA process. Simply put, it allowed for supportive needs to be met at the lowest level that could address those requests. Appropriately vetted needs for higher-level support were routed rapidly to the next level. This approach streamlined resource allocation and economically allowed for maximal attention to be directed where it was needed most. It also promoted constant surveillance of assets and capabilities, because each RFA went through singular analysis and vetting by subject matter experts at each particular level.

We live in a world of increasing disasters, both natural and man-made. Any effort that reduces human suffering through humanitartian means must be utilized and optimized. This is even more important if those efforts transcend national ideologies and borders for the common good. In dealing with disasters in the most effective, efficient, and expedient manner, we are faced with a paradox. The governments and military machines of nations are created to protect the land and welfare of the people they serve. The wide and varied NGO's and humanitarian agencies propose to provide goods and services to those in need. Humanitatian responses are fraught with the difficulties of lack of coordination, resource deployment issues, interagency communication, security, exploitation by others, and many other problems they are not trained to address. The paradox exists in the fact that it is within the military structure and training that we best find the ability to cope with these issues. The MPAT concept provides a framework for the intersection of these realities. Its effectiveness is obvious and has been demonstrated. From the very first workshop in Manila in 2000 (Duncan, 2000) to the Emerald Express 06-1 gathering (2006), MPAT continually increases its insight and understanding of HA/DR. We we look forward to its future as an integral component of the humanitarian response and recovery efforts so needed by our world in responding and recovering from the disasters it will face.

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Author Biographies

Dr. James Hagen is Professor and Director of the Public and Non-Profit Management Program at the Graham School of Management, Saint Xavier University in Chicago. He is also Director of the Disaster Preparedness and Management Certificate Program that provides education and training for those responsible for helping their organizations prepare, respond, and recover from both manmade and natural disasters. Dr. Hagen is a Professor of Public Health and Epidemiology, and served as Deputy Executive Director of the DuPage County Health Department from 1999 to 2005. Dr. Hagen is a licensed Nursing Home Administrator, and works to prepare long term care organizations for the special needs of vulnerable populations. He is a certified Emergency Response Coordinator, a Certified Public Health Administrator, and is certified by the Department of Homeland Security as a Master Exercise Planner.

During the federal TOPOFF 2 full-scale exercise in the Chicago area during 2000, Dr. Hagen served as a public health Incident Commander. He was a presenter for the TOPOFF 3 National Biological Seminar, moderator of Advanced Distance Learning Exercise panels, and a mentor for the New Jersey Venue. He works to train hospitals in several emergency preparedness areas, including communication, isolation and quarantine, and SNS issues. In 2005, Dr. Hagen worked as consultant during the Alaska Shield/Northern Edge Military Exercise in Alaska. He also worked in post-Chernobyl, post-Soviet Union Ukraine with the health ministry to study recovery issues and to assess public health needs.

Dr. Hagen is a graduate of Michigan State University and obtained his M.S. from the University of Montana. He was trained as a research microbiologist at Loyola University Medical Center, where he earned a Ph.D. He also holds a Master's Degree in Public Health from Benedictine University, and a Master's Degree in Business Administration from Saint Xavier University.

Brigadier General RS Ahluwalia (Retd), an alumnus of the 1970 National Defence Academy batch, is a graduate of the Army Aviation Course, the Long Gunnery Staff Course and the Defence Services Staff College. He has been an instructor at the School of Artillery, The Junior and Senior Command Wings of The Army War College. He retired as the Deputy Assistant Chief of Integrated Defence Staff at New Delhi, in September 2006. He headed the Directorate of Operational Logistics. The Directorate is the nodal agency to coordinate Armed Forces Assistance for Disaster Relief operations.

He has handled the Armed Forces assistance for Tsunami, the floods in central India, aid for Katrina victims in USA, the J & K earthquake in 2005, the aid to Philippines in Feb 06, assistance to Indonesia in May 06 and to Lebanon in Aug 06.

He represented India at the Disaster Management Seminar at Chang Mai, Thailand in May 05. In Aug 05 he was part of the international team at Honolulu, Hawaii, US PACOM to evolve the Multi National (MPAT) SOP for Disaster Management for the Asia and Pacific Region. He hosted the International Seminar on Disaster Management- "Emerging Challenges for the Armed Forces" at New Delhi in Dec 05. Thirty participants from overseas participated in addition to 300 Indian delegates. He has attended the United Nations Civil Military Coordination Course for Humanitarian Assistance at Manila, Philippines in Feb 06 and the United Nations Civil Military Coordination Staff Training Course at Geneva, Switzerland in Mar 06. He is a member of the core group constituted by NDMA to evolve the National Concept and Policy for Nuclear Disasters

He has presented papers at a number of National and International seminars/conferences. He has also delivered lectures at the Benedictine University in Lisle, USA, the Inderprasta University in Delhi and the National Institute of Disaster Management. Presently, he is on an assignment with The United Nations OCHA as a consultant for disaster management and is a visiting professor with the Inderprasth university, Delhi, India.

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RISK MANAGEMENT

RISK ASSESSMENT OF THE EMERGENCY PLAN APPLICATION

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Keywords: Safety management, risk assessment, emergency plan, recovery measures.

Abstract: As common practice in safety management procedure, risk assessment is performed as part of establishing procedure of safety management system. Potential risks are identified, assessed and proper preventative measures established. After the occurrence of accidental event, emergency plans offer relief and recovery measures based on risks assessed prior to accidental event. Further risk assessment of emergency plan application has to be done on site due to changed circumstances and availability of assets and manpower.
In cases of serious hazards to people and environment established risk assessment matrix is to be viewed from different standpoint making some risks acceptable in extreme situations.
It is the intention of this paper to explain on site risk assessment and selection of applicable emergency plan sections to reduce level of risk and the scale od damage while performing recovery procedure.

Introduction

After the occurrence of accidental event which can cause damage to human life, assets, environment and affect company's reputation and continuity of business, recovery measures have to be undertaken according to already prepared emergency plan or emergency plan created in real time on site.

Emergency plans are based on possible scenarios emerging from the occurrence of accidental event and the post accident state of the affected system. Unfortunately it is known that most accidents do not happen according to ideal scenarios and in the majority of cases there is a discrepancy between real on site situation and the emergency plan which should provide applicable procedures for the recovery of system after the occurrence of the accidental event.

Depending on the nature of accident and the dynamics of consequences development it is necessary to approach accidents more carefully and studiously. Using bow tie diagram as a timeline describing the development of accidental event and emerging consequences it is possible to determine the moment in which risk assessment of available recovery measures can be performed. Risk of the emergency plan application can be assessed using well known techniques which are to be selected depending on the available resources.

1. Assessing the risk of the emergency plan application

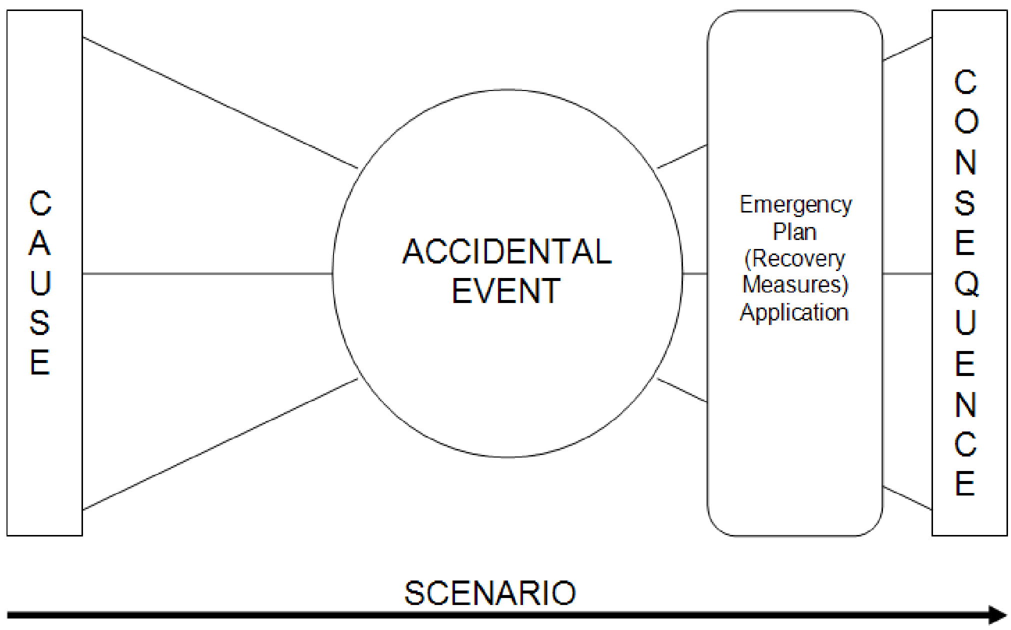
First step after the occurrence of accidental event is assessing the condition of the system. As system is an integrated set of constituent pieces that are combined in an operational or support environment to accomplish a defined objective (U.S. Department of Transportation Federal

Aviation Administration Air Traffic Organization, Safety Services, 2006), each affected system component has to be inspected and assessed as well as its influence on system as a whole.

Analysis of the system in post accident condition depends on sustainability of the system in immediate post accident period, nature of accident and the rate of development of consequences. If the accident was expected and its probability established in the initial risk assessment then there should exist an emergency plan consisting of recovery procedures which aim to prevent accident consequences using predetermined resources. In case there is available time for analysis and evaluation of recovery measures proposed by the emergency plan, risk assessment of the application of those measures and their alternatives should be performed on site. Otherwise, recovery and relief measures proposed by the plan are to be applied in consecutive order as suggested in the plan taking into account decision makers knowledge, experience and logic.

Risk assessment of the emergency plan application must include data on post accident system condition with emphasis on system components essential for the execution of recovery measures, available means for performing recovery measures (assets, manpower, availability of external assistance etc.) and time frame set for their application.

Figure 1. Bow Tie diagram



Emergency plan risk assessment should include all sections of the emergency plan applicable to the situation caused by the accidental event. Usually emergency plans propose different measures to deal with different aspects of the system: human life, environment, assets and business continuity. It is a very rare situation, except in very isolated cases, that measures proposed by various sections of emergency plan deal with the recovery of all aspects of the system so it is obvious that some sacrifices have to be made according to predefined priorities.

When assessing the risk of recovery measures application proposed by the emergency plan special attention should be given to the choice of a suitable risk assessment method. In any case, risk assessment is supposed to provide clear results in qualitative or quantitative form in order to support decision making.

2. Suitable risk assessment methods

According to majority of authors risk is a combination of the probability of the danger occurrence and the damages it could cause while the level of safety is complementary to the level of risk.

Any risk study involves three major elements: risk analysis, risk assessment and risk management. Risk analysis deals with the identification of dangers, estimation of their frequencies and their consequences, without explaining their explicit significance. Risk assessment procedure is based on previously completed risk analysis aiming at deciding whether the tolerable risk has been reached. Risk management is a procedure of selecting the appropriate measures to reduce the risk to a tolerable level and integrate them in the management procedure of regular activities (Trbojevic, 2001).

Selection of the risk assessment approach has to be carefully done and significant factors that can help choose this approach are to be considered. The quantity and quality of the used information determines the degree of the approach flexibility. Low level of information limits the choice to rough and poor approaches. Use of traditional methods is undesirable at a certain level, particularly if the potential of a major danger is significant. In general, the danger identification is qualitative and based on an expert judgment. It should be creative, structured, well defined, and benefit from the experience of accidents.

Different types of approaches can be used to assess the risk: they can be qualitative, semi - quantitative or quantitative. Generally, the qualitative approaches are easier to apply. They require fewer resources and fewer skills. However, they provide less meaningful results. On the other hand, the quantitative approaches require more resources and skills, but provide more detailed and comprehensive results. Semi-quantitative approaches are situated between both of these extremes. Choice of the suitable risk assessment method depends on the complexity of the system and dynamics of events caused by the accident. In emergency circumstances it is preferable to avoid complex methods and aim at simplification and clarity but still preserve certain level of thoroughness.

Most commonly used qualitative risk assessment methods are AMDEC and Risk Matrix method.
The AMDEC (Analyse des Modes de Défaillance, de Leurs Effets et de Leur Criticité (French for FMECA- Failure Mode and Effect Analysis)) is a risk analysis method operating on the whole system. It is static, based on an inductive reasoning (causes-consequences) to study the causes, the effects of failures and their criticality. It consists in determining the significance of every failure mode according to its influence on the system behavior, enabling to assess the impact of the failures on the reliability of the system safety (EURAMP, 2006). Despite its simplicity it is not adapted to real time processes and it is more suitable as a method for preliminary risk assessment of the system that can be used to build safety management system.

The approach of the risk matrices seems to be the most commonly used technique to assess the risk because of its simplicity and almost universal applicability. Several types of matrices are used and the most common matrix is the one with categories of probabilities and very simply interpretable consequences. It uses four types of consequences (damages) concerning the human life, the goods, the environment and the reputation. The difficulty of dealing with new dangers and heterogeneous dangers limits the use of this method.

The dangers are identified; their frequencies and their consequences are assessed. The frequencies and the severity of the consequences are distributed on a scale, typically with 3 to 6 levels. The frequencies can be: very improbable, improbable, probable and frequent. The severity can be: negligible, little significant, significant and catastrophic. The risk is assessed according to a matrix of type shown in figure 2, the level of which can be distributed on a scale with 2 to 6 levels, and the title of these levels can be different (e.g. acceptable or tolerable) according to the used standard. But there should be at least one level called unacceptable or intolerable, that is incompatible with the safety concept and the system operation (EURAMP, 2006).

Figure 2. Risk Assessment Matrix (Zuijderduijn , 1999)

Degree	Event consequences				Occurrence Probability →				
	On people	On the assets	On the environment	On the reputation	Not probable	Slightly probable	Probable	Very probable	Extremely probable
0	No injuries	No damage	No effect	No significance					
1	Light injuries	Minimal damage	Minimal effect	Minimal significance					
2	Minor injuries	Minor damage	Minor effect	Minor significance					
3	Major injuries	Local damage	Local effect	Limited significance					
4	Single casualty	Severe damage	Serious effect	National significance					
5	Multiple casualties	Total loss	Massive effect	International significance					

Acceptable risk   Non desirable risk   Unacceptable risk

The risk matrix methods show some weakness points:

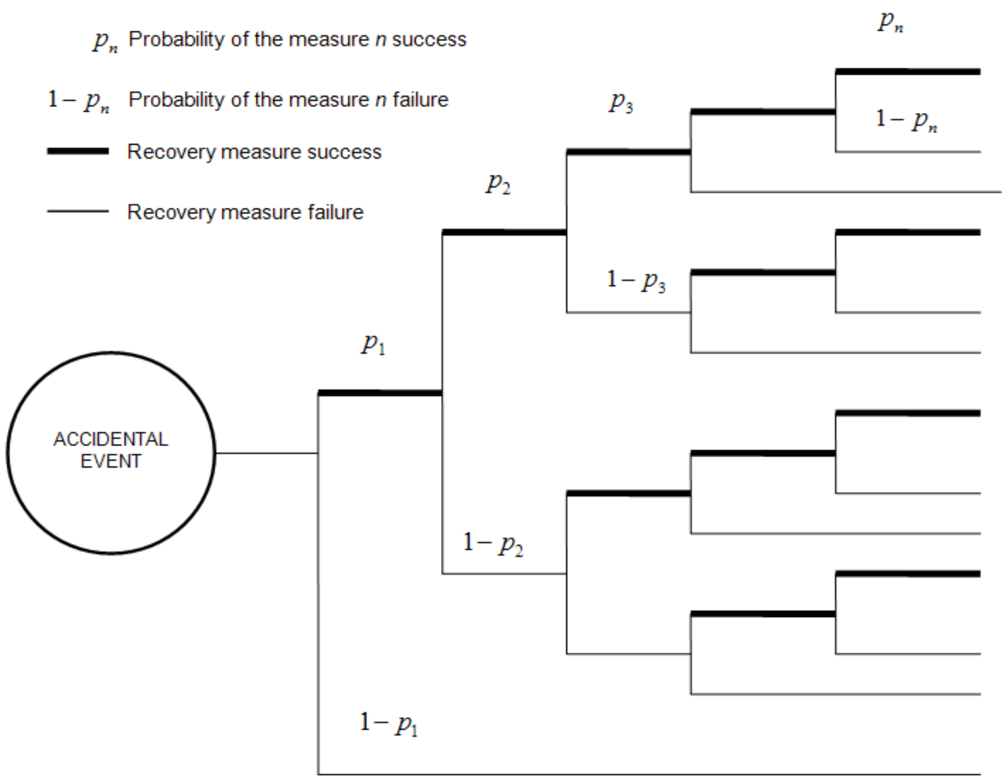
1. Several coherent judgments are necessary to estimate the accident probability and their consequences. It is sometimes difficult to choose the correct consequence for a risk category.
2. The risk matrix addresses only one danger at a time and tends to underestimate the total risk on which the decision should be based concerning the risk.
3. The lack of standardization can lead to confusion.
4. The difficulty to process new dangers.
5. Some matrixes use quantified definitions of the frequencies and consequences. The risk can be obtained adding the values of its frequency and of its consequences. It doesn't constitute quantification and the method remains qualitative (EURAMP, 2006).

Semi-quantitative methods are more accurate than risk matrices. They use quantitative techniques of risk analysis without giving quantified results. The most well known methods are Fault Tree Analysis, Event Tree Analysis and Bow Tie Analysis. Since Bow Tie Analysis is an arborescent type method composed of an event tree and a failure tree where the connecting point of the bow tie represents accidental event, in case of emergency plan application it is not suitable for an in-depth risk analysis and assessment, but provides efficient timeline presentation. Fault Tree Analysis starts from the undesirable final event and through a tree constructed by combinations of intermediate events leads to initial event that caused or could cause accidental event.

On the other hand, Event Tree Analysis covers the part of timeline after the occurrence of accidental event that triggers emergency plan application. It aims at determining the resulting events from an initiator event and provides the estimation of the system drift. The general approach consists in:

1. defining an initial event (accidental event)
2. defining all of the corresponding safety measures (applicable recovery measures)
3. building the tree
4. describing the sequence of the events (EURAMP, 2006)

Figure 3. Event Tree Analysis adapted to recovery measures application risk assessment



In case of recovery measures risk assessment the tree is constructed on the basis of the accidental event. The quantitative operation of the event three method aims at estimating the occurrence probability of the final consequence from the intermediary events generated by the accidental event where recovery measures considered for application are represented as intermediary events included in the tree. It enables to quantify the risk, attributing a level of probability to every included event (recovery measure). This approach enables to rank the various possible scenarios to focus the effort on the most probable one. However, it is complicated and difficult to apply on large systems (EURAMP, 2006), but remains a very powerful method suitable for assessing risk of recovery measures application.

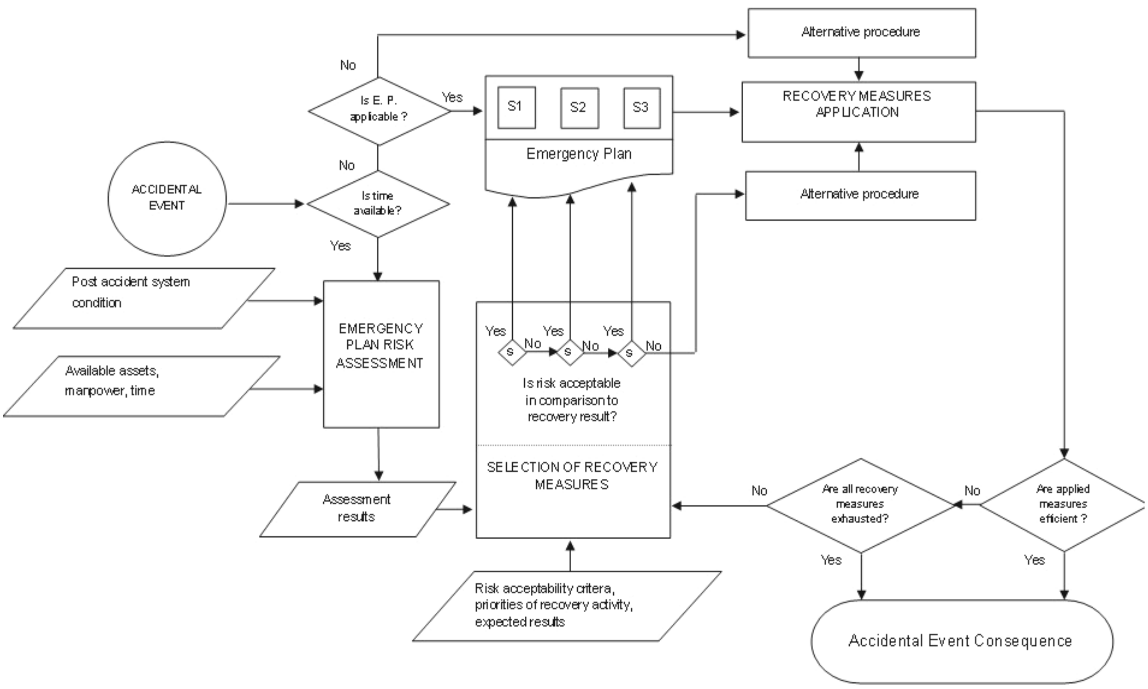
The quantitative risk analysis (QRA) is one of the most sophisticated techniques of risk assessment. It provides an explicit understanding of all the hypotheses and factors contributing to the accident. In general, these methods use techniques based on statistical analyses of the background data in order to estimate the failure cases. These methods are known as analysis methods of frequencies. The estimation of the frequencies are performed with techniques such as: frequencies analysis of the accident backgrounds, Fault tree quantitative analysis, Event tree quantitative analysis, Bayesian analysis, Consequences methods, Human reliability analysis etc. Application of these methods in emergency circumstances is limited by the resources and the available time. However, it is possible to use already existing models adapted to systems post accident condition to perform analysis by simulation in order to predict the effect of applied recovery measures (Faber, 2001).

In cases of frequent and non significant risks or in cases where there are no other means, it would be more appropriate to perform an estimation of the frequency based on a personal experience using assessment through judgment.

3. Selection of recovery measures

Risk assessment process must provide comparable results of risk levels attached to each applicable recovery measure proposed by the plan or created ad hoc. Those results are to be compared with predefined risk matrix to establish risk acceptability.
Before selecting recovery measures it is essential to determine the aim of recovery activities and establish an order in which it will be possible to apply selected recovery measures taking into account post accident condition of the system.
Recovery measures which can be applied with acceptable risk have to be compared against the cost of their execution and the expected recovery result. It is obvious that those recovery measures that satisfy defined priorities with acceptable risk of execution and favourable input/output ratio will have priority in the selection order (process).

Figure 4. Flowchart of emergency plan risk assessment process triggered by the accidental event



It is understandable that priorities of recovery activities will be preservation of human life, environment, assets and protecting business continuity. In some cases business continuity will be ranked higher on the list of priorities to be achieved according to the policy and aims of the affected system.

After the appropriate measures have been selected on the basis of assessed risk and defined priorities, they should be executed according to the procedure described in relevant emergency plan section, or in case all recovery measures proposed by the plan were rejected, according to the alternative procedure created on site.

Execution of recovery measures has to be monitored and managed in real time until achieveing satisfying the level of safety. In case undertaken measures are not effective, additional recovery measures have to be activated until all measures selected during assessment process are exhausted. If circumstances in which recovery measures are being executed are changing rapidly, new assessment of system condition has to be performed.

If applied measures are efficient and the condition of the system is satisfying, recovery process is terminated. Accidental event will still leave its consequences on the system, but at an acceptable level (spent assets, time loss etc.).

Conclusions

Risk of the emergency plan application can be assessed by testing recovery measures probability of success and failure using the technique of Event Tree Analysis. The using of this method is limited by its quantitative component and availiability of resources. Risk Assessment Matrix can be used to define acceptability of risk and in some cases to assess risk, but it depends on the personal experience of the assessor.

Selection of recovery measures to be applied is influenced by aimed condition of the system, ratio of engaged assets and the expected result of application and established level of involved risk. It is obvious that those measures which can be applied with acceptable risk and can provide maximal recovery result with minimal use of assets will be selected in recovery procedure.

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ERMA - ELECTRONIC RISK MANAGEMENT ARCHITECTURE FOR SMALL AND MEDIUM-SIZED COMMUNITIES

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Risk management, decision support, crisis management, workflow, indicators

Abstract

Project ERMA (Electronic Risk Management Architecture) strives to support risk management processes in small to medium-sized communities in case of natural or man-made disaster. The supported life cycle of risk episodes ranges from key indicator-based monitoring services, via process-oriented guidance for prevention and relieve, up-to public alerting services that are accompanied by citizen relationship management components to advise the public and gather information from the public. A pivotal element in this life cycle is know-how about processes. Process know-how enables effective support of rescue forces on the one hand, but also furnishes an invaluable resource for knowledge transfer and reuse. This paper presents ERMA's approach on the structuring of risk management processes along a process management stance. It reports on ERMA's components with a particular emphasis on its process management services.

Introduction

Any risk episode can be characterised by its unfolding flow of information. Starting with single indicators of an emerging or existing hazard, an avalanche of data overwhelms risk managers once the risk episode has proven to be a serious disaster. The question arises of how to deploy key indicators to assess risks and how to evaluate sensor data according to key indicator knowledge. Based on this assessment, certain decisions have to be drawn. Following these decisions, specific actions have to be taken–i.e. start of processes–and rescue forces as well as the citizen have to be advised–i.e. instantiation of workflows and information delivery in the spirit of citizen relationship management (CiRM). Here it is where process management is essential (Mak et al., 1999). Moreover, CiRM is not only instrumental for the advise of citizens, but also for the capture of information from the citizen–i.e. the citizen acts as an additional sensor network–which for instance can be used for the gathering of information about blocked roads in the case of a snow-related break of woods.

The operational backbone for each risk management episode is located in command centres of local or regional authorities. The level and scope of information technology (IT) support varies significantly, since not standard software solution has been established until now. The vast majority of IT services in command centres is custom made for each organisation. No reference processes or other means of standardisation have gained ground so far as in many other domains.

Yet, some activities typical for command centres are already supported by IT tools, e.g. resource management applications or mapping tools for the display of and interaction with graphical maps comprising tactical symbols and information layers. However, process management is not really supported although its vantages are proven (Mak et al., 1999). Similarly, key indicator systems are also rarely found although they allow for an efficient and effective monitoring of evolving and potentially hazardous situations. This lack is further compounded by the fact that sensor networks are increasing at tremendous speed but they are not used for disaster identification and surveillance. This lack might be due to their high complexity, an inappropriate economics of scale for small to medium-sized communities, or merely people are conservative when introducing new techniques and processes.

The ERMA platform intends to support the entire life cycle of a risk management episode that starts with the identification of a hazardous episode and its assessment. Following a decision on actions to be taken, suitable instructions are given that are accompanied and supported by certain processes. Then, a set of communication and collaboration services are employed to support the communication among rescue and communication with the citizen to give them advise. ERMA provides a set of tools to underpin this life cycle:

- a key indicator-based decision support system combined with a process management component,
- an early warning system to alarm emergency staff and concerned citizens,
- citizen relationship management as well as team collaboration software to support the communication to the citizen and among rescue organisations and other authorities.

The decision support system will derive specific counter actions by assessing the measurement data of sensors and monitoring tools, while corresponding tasks are managed by the process management component. Hence, ERMA will combine the advantages of these tools to a customisable bouquet of a risk management system that is in particular scalable to smaller communities.

ERMA's implementation is based upon SOA (Service Oriented Architecture) in order to link all its components and to allow connections to other external risk management architectures and platforms like ORCHESTRA and OASIS. In this manner ERMA is flexible and extensible and such easy to customise to special requirements of end-users.

The ERMA project started in September 2006 with a two year runtime, and will provide a first prototype to be tested in two user sites in 2007. Final results are expected end of 2008. This paper will present background, state-of-the-art and requirements of ERMA with a first outlook on the derived ERMA system architecture.

Risk preparation and response

The ERMA project focuses on the specific needs of small and medium-sized communities. Hence, an analysis of their risk patterns is required. Information revolving around the preservation of the environment's quality and safety is geographically and administratively dispersed: they include municipalities, fire departments, police, disaster relief organisations, various company types, and many other public and private bodies. Thus, any information gathering process needs a coordination of these different stakeholders. However, initiatives for coordination at the local level are sparse. Hence, instead of a homogenised, co-ordinated, and interoperable process, different information collection processes during major or minor natural, industrial accidents or environmental pollutions are in place.

Hazards threatening small end medium-sized communities can be classified in three categories:

a) Natural risks (earthquakes, landslides, floods, hurricanes and tornadoes, snow falls, tsunamis, volcanoes).

b) Technological risks, associated to the sudden release of large amounts of energy or dangerous substances (fires, explosions, toxic clouds, toxic spills to water, radioactive releases). Usually associated to the existence of industrial sites, sea-ports, and transportation of hazardous materials (by road or rail).

c) Man-made risks related to the activity and the existence of people (forest fires, abnormal conditions in the basic supplies to the population).

Although they have some common features, they are essentially different from the point of view of surface covered (usually a larger scale in natural risks), probability in a given zone, occurrence dynamics, etc., and emergencies should be treated in different ways. However, a common aspect is the convenience of warning the population in time.

From the point of view of emergency management and population warning, these hazards can have completely different features. Thus, a flood, a snow fall, or a volcanic eruption can be often foreseen within a certain time, which gives a safety margin to inform and alert the population. Instead, a toxic release from an industry implies a very short time (alert to population should be performed massively over a given zone and very quickly), and an explosion will probably occur without warning at all.

An essential aspect of emergency plans is, under certain circumstances, alerting the population about the existence of a hazard and giving people sufficient lead time, along with adequate instructions on what they must do (these instructions should also have been supplied in advance). This information must be given only to the population affected by the emergency; otherwise it would create unnecessary fear among other people. This means that a methodology has to be applied -often "a priori"- to define the zone covered by the given hazard. As possibly the dangerous event (as usually happens with technological risks) will take place in or near dense populated zones, or the area covered will be significant (as happens with natural risks), the amount of people to be contacted can be relatively large.

Furthermore, in certain emergency situations the time elapsed between the start of the emergency and the moment in which the effects reach the people can be rather short. Suppose, as an example, a release of toxic gas from a process plant. If the atmosphere is stable, a toxic cloud can be localised; this cloud will move at the velocity of the wind and in a short time can reach an urban zone. If a previous risk analysis has established what to do (zone affected according to the meteorological conditions, instructions to be given to the population for that specific event), quick and massive information to the population affected will reduce drastically the consequences.

Although most large towns have analyzed this problem and have emergency plans ready and alerting systems available (for example, a sirens net), many small or medium-sized communities do not. In these cases, an alerting system such as that proposed in ERMA can be a good solution: a rapid and complete sending of an alerting/instructing message, which could eventually be completed with more specific actions in strategic places (hospitals, schools, isolated buildings, etc.).

Process support

Know-how about processes furnishes an invaluable source of knowledge about tasks to be conducted in order to respond to specific events. The question arises of how to capture this know-how. Recently, major coordination projects have been started to standardise rescue operation. For instance, the treatment of mass casualties, i.e. more than 100 injured people, requires resources from several organisations since only very few cities have the capacities to treat this large amount of injured people with their own forces. Hence, treatment, service and logistic procedures have to be agreed upon as reference processes. These reference procedures have to consider different types of equipment used by various organisations. Even not every fire-fighting vehicle of the same class comes with identical equipment. Also resource limitations apply for the provision of identical services, e.g. space required for the equipment.

The question arises of (1) how to design this processes in light of the various requirements, and (2) how to formally represent them in terms of a process modelling framework.

Know-how about processes is only available in terms of manuals for the most part, i.e. major fire brigades have specified their response patterns by so-called standard tactics. Each tactic describes certain patterns of actions to be taken depending on the event at hand. As such, predefined processes collect experience, organisational and administrative knowledge about how specific actions are to be undertaken, like e.g. evacuations, securing of installations, mounting of flooding dams. Ad-hoc processes allow one to plan end execute not yet modelled series of actions in specific occasions in order to customize pre-defined patterns to event-specific requirements. Once defined and completed, they can be adapted, stored, and reused later for similar situations. Until today, action plans of emergency situations like flooding are collected in large manuals with small or no IT support at all. Such manuals do not support tracing of actions, graphical overviews, showing of interdependencies, logging, or ad-hoc changes by nature.

A formal representation of such processes is required in order to embark for process guidance and analysis. Moreover, the use of workflow engines will ease the definition of complex scenarios, so that each step and respective information exchange can be modelled. In the case of an emergency, involved staff can concentrate on extreme and unusual events while routine jobs are guided by quality-assured workflow procedures.

In a formal stance, a process is a set of temporally or logically ordered activities intended to reach a goal involving resources (Curtis at al., 1992, Rupprecht et al., 2000). A process can be regarded as a system where the elements are activities and resources and the relations are the sequential or logical dependencies between those elements. The set of relations describes the process structure. An original process does not necessarily have to be a “real” process that has occurred in the past or is observed in the present, but it can also be a potential solution of how things could be done in the future. Thus, we define a process model as a mental or explicit representation of original processes such as risk management processes for the medical care of mass casualties.

Process models can be decomposed into different sub-processes, which again can be made up of other sub-processes. Sub-processes on the lowest level of decomposition are called activities. The decomposition of processes results in an aggregation hierarchy. Depending on the intended goal of the representation form, other elements of interest besides activities and logical dependencies can be represented in a process model. Those most frequently mentioned are (Curtis et al., 1992):

- *Agent* – an actor (human or machine) who performs an activity, e.g. a paramedic;
- *Role* – a coherent set of activities assigned to an agent as a unit of functional responsibility, e.g. dispatcher;
- *Artefact* – inputs and outputs of an activity. Artefacts provide important means for process synchronisation in major development projects, while in risk management application they merely address documentation purposes.
- *Resource* – resources represent the capabilities and tools required for the execution of an activity, e.g. motor-driven ladder.

Process modelling serves various intentions. Its major objectives can be classified into five basic categories (Rupprecht et al., 2000) applied to the crises management domain:

- *Enable mutual understanding and communication* – process transparency is enabled du e to a formal representation of the processes and it helps emergency teams to exchange their views on the work to be done and to understand what part they play in the operation.
- *Support process improvement* – the analysis of process models allows the identification of potential bottlenecks, missing synchronisations among activities or missing activities at

all. The analysis can be done by the use of formal reasoners (e.g. static or dynamic analyses) or visual animation.

- *Support process management* – a process model builds the basis for detailed scheduling, planning, easier monitoring, and co-ordination of an actual rescue activity.
- *Automate process guidance* – the documentation of processes support the reuse of process know-how. Thus, process models offer guidance and reference material to facilitate human decision process performance for specific situations.
- *Design process execution support* – once process models are formally capture, specific IT environments can be designed that are tailored to these specific processes, i.e. supporting the enactment of processes.

In first place, ERMA is providing an environment for the engineering of reference processes. This environment is build upon the metaphor of a drawing board for the graphical design of process structures (Rose 1998). Process structures will be designed by rescue workers in an intuitive fashion and formally checked for certain structural properties, such as appropriate synchronisation points or compliance of resource limitations. The graphical support goes beyond prevailing tools, such as he ones for Event-driven Process Chains (Scheer et al., 2002). Specific emphasis will be put on the specific requirements of rescue forces. These requirements include the consideration of resource limitations, compliance with command lines, heterogeneity of equipment, etc. The result of this endeavour will be a process engineering workbench for the design of reference processes. The workbench will build upon experience in the automotive (Fünffinger et al., 2002) as well as medical domain (Sedmayr, 2007). Both sectors can also be characterised by their complexity and flexibility of processes.

In second place, ERMA is going to employ a process engine, which supports emergency staff with predefined and ad-hoc process description. As such, predefined process models collect experience, organisational and administrative knowledge about how specific actions are to be undertaken, like e.g. evacuations, securing of installations, mounting of flooding dams. Ad-hoc workflows allow one to plan end execute not yet modelled series of actions in specific occasions in order to customise pre-defined patterns to event-specific requirements. Once defined and completed, they can be adapted, stored, and reused later for similar situations.

This unique feature of the ERMA system is not available on the market. In science, individual modules have been tested in the domain of emergency management. Examples include the simulation of events with training purposes (Pollak et al., 2004), the support of information dispatching (Van Someren et al., 2005), or collaboration processes (Georgakopoulos, 1999). Rescue organisations are reluctant to employ new IT technology in their daily operations, be it because their application is too time consuming or because the systems require a change of long trained and proven procedures. Systems supporting these procedures, easing their execution, and supporting exchange of experience are still missing.

Implementation

The ERMA project will develop a comprehensive risk management platform which is based on a SOA orchestration of relevant systems. Interfaces to other systems will augment the ERMA service portfolio where needed.

The following figure shows the planned architecture of ERMA with different modules to be integrated and the respective information flow. Optional components (presented in light grey) will be linked by SOA (Service Oriented Architecture) to establish loosely coupled and interoperable services, which can be integrated or deselected for individual requirements. The decision support system (DSS) serves as core component integrating the application logic and scheduling other functions when demanded.

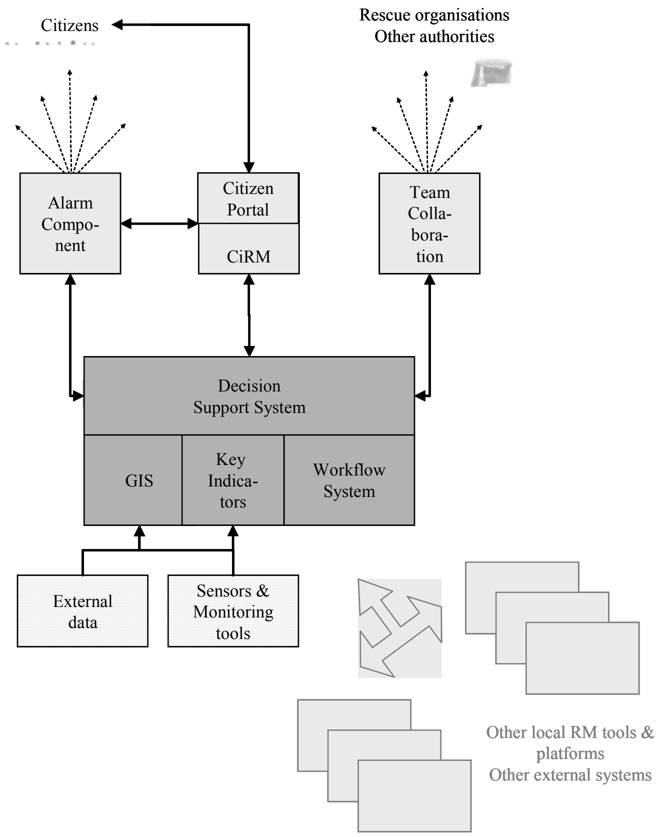

Figure 1. ERMA SOA Architecture

The DSS of ERMA will perform the following tasks:

- collection of sensor data,
- assessment by key indicators,
- derivation of states and actions,
- visualisation of measurement data in specific region, deduced state and actions, and finally,
- display of workflows for corresponding tasks, and
- editing and processing of workflows.

The workflow system will detail the proposed key indicator actions and guide users in executing the necessary steps. These steps in turn have been documented before and the target community has the possibility to adapt existing process models to its own needs in advance or directly in the crisis situation (ad-hoc processes). The exchange and adaptation of workflow models and instances will be possible, which allows the re-use of process models across different organisations.

Each reference process describes certain patterns of actions to be taken depending on the event at hand. As such, predefined workflows collect experience, organisational and administrative knowledge about how specific actions are to be undertaken, like e.g. evacuations, securing of installations, mounting of flooding dams. Ad-hoc workflows allow one to plan and execute not yet modelled processes in specific occasions in order to customize pre-defined patterns to event-specific requirements. Once defined and completed, they can be adapted, stored, and reused later for similar situations. Moreover, the use of the process workbench will ease the definition of complex scenarios, so that each step and respective information exchange can be modelled. In the case of an emergency, involved staff can concentrate on extreme and unusual events while routine jobs are guided by quality-assured workflow procedures.

The ERMA user interface will be designed as a cockpit. The DSS will give indication on what happened and what do to in which order, while additional modules will support communication to and from the citizen and between rescue organisations and involved authorities:

- The alarm component allows one to warn and inform the public by transmitting vocal or textual messages to stationary or mobile phones in a specific region. Feedback tracing collects the response of the public and gives an indication on reachability and such on further measures and scope.
- Additionally, a citizen information portal will be established. It is connected to a citizen relationship management module (CiRM), which furthers communication with the public and also channels citizen feedback and calls to the responsible position.
- Team collaboration software allows sharing of short textual information, forms, movies and images, documents and the like between rescue organisations and/or authorities. Additional features like chat functions, notifications on changes and upload, calendars, address and contact lists supports information exchange between all concerned parties.
- Via SOA external systems can be linked and their information displayed or processed. For example, weather information from a commercial or state provider will be integrated in the key indicator system to support the decision process.

Application

The ERMA system could be used in small and medium-sized municipalities, and would be operated in command centres of disaster management authorities or organisations like fire brigades. A possible scenario is that ERMA supports a city with a river nearby which from time to time bursts its banks.

Its water level is permanently monitored by a sensor system sending data at regular intervals to the decision support system of ERMA. The key indicator system module assesses the current situation on the basis of threshold values and possible threats for the municipality. It also informs via the internet-based citizen portal the public about the current water level, with background information about potential risks, impacts, and guidelines what to do when.

When the sensors report the exceedance of alarm threshold due to a rising water level, the key indicator system checks the incoming values, integrates weather prediction values, and proposes counter actions, which are predefined crises management processes. The flow of activities will be presented by a workflow system. The responsible staff can change and adapt these workflows to the current situation. The workflows show activities, roles and actors, related input- and output documents (like forms), as well as rules and conditions related to activities. Risk managers can coordinate their command chain according this task flow. Setting the state of each activity according the real life state of activities allows one to monitor and "walk" through processes. Real life changes of the process can be transferred to the model as well as to the instance and saved for later reuse.

Additionally, the system stores the current information (instances of the process: time, decisions, involved persons/organisations in activities, etc.) for tracing, logging and after-action debriefing and analysis.

One the key indicator systems signals the passing of a threshold, it activates the corresponding reaction procedure, e.g., the evacuation of jeopardised areas near the river. The risk manager invokes now the attached alarm module to send a multi-channel warning to citizens in danger, for instance, by calling mobile phones or by sending SMS directly to the region at risk. Transfer of information to the citizen portal (i.e. maps) allows one to inform the public about the upcoming evacuation, about blocked streets, and about next steps to do. In addition, citizens can feed the portal with their own observations about the situation, which in turn helps the rescue organisations. The CiRM catches and collects this incoming information, but also provides address and contact data about citizens, logs information exchanges like incoming phone calls, and offers additional information about specific citizens or organisations or facilities like kindergartens (special equipment, special handicaps, etc.).

With the team collaboration software the rescue organisations exchange legal forms, written evacuation plans, and moreover maps of the regions, images and photos taken, or information about past events and crises situations in this location (i.e., what happened last year).

Last but not least, the connection to other risk management systems facilitates the access and pushing of information from and to other systems and institutions. Referring to the scenario written above, a municipality located downstream can be informed about the current water level, the activities of other rescue organisations, or can request or offer shelter for evacuated citizens.

Outlook

ERMA is going to provide a process-oriented workbench for the support of rescue operation in small and medium-sized communities. A specific focus will be placed on risk identification and assessment on the basis of key indicator system, a process workbench for the support of coordinated rescue operations, and a citizen communication component for alerting as well as for gathering feedback. From a process-oriented point of view, ERMA focuses on the design of processes as well as the execution of processes. In the course of process definition, ERMA will build upon the city network of SETRIC (Security and Trust in Cities), which so far produced a significant number of best practice reports, will be used for elaborating the requirements, transfer best practices in workflow models, and disseminating the results.

Due to the employment of service-oriented architectures, ERMA is going to adapt and build upon existing components for alarming, geographical visualisation, collaboration, and citizen relationship management. It will promote a process-oriented stance for supporting emergency management operations. Specific components will be developed for indicator-based risk assessment as well as dedicated process support for risk management. ERMA will combine best-of-class components and best practices on risk management. Its innovative power is due to the combination of services and their customisation features.

The ERMA project started in September 2006 with a two-year perspective. It will provide a first prototype to be tested at two user sites in 2007. Final findings about the performance of the platform and its customisation prospects are expected by the end of 2008.

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Gertraud Peinel received her MS in Business Computing (Applied Mathematics and Economy) from the University of Ulm in 1993. She was working on projects in the domain of electronic trade networks, multi-channel e-Government services and risk management in heterogeneous system environments. She was project manager for several projects for the EC (like APNEE-TU, Env-e-City, USE-ME.Gov and ERMA) as well as national funded projects. Her domain of expertise includes Internet technologies, system architectures, business models, and process management.

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WIN: A NEW SERVICE ORIENTED ARCHITECTURE FOR RISK MANAGEMENT

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Keywords

Risk management, service oriented architecture

Abstract

The Wide Information Network (WIN) Integrated Project (EU FP6 Call 2 DG IST) has started in September 2004 and will end by end of 2007.

The project integrates existing reference results and initiatives to contribute to the design, the development, and the validation of a scalable solution contributing to the future Single Information Space for Environment and risk management in Europe (SISEE), Information space where environmental institutions and services providers, irrespective of size or location, can do business or simply collaborate with no technical restraints

The solution proposed by WIN is based on a Service Oriented Architecture (SOA), the strong advantage of this kind of architecture is to allow to build information systems enabling the creation of applications by combining loosely coupled and interoperable services without the knowledge of the underlying systems.

A maximal interoperability is guaranteed by WIN compliance with main current and emerging standards.

The solution includes a set of generic services, standard data modelling components which facilitate the deployment on various thematic cases.

The project has successfully passed the second annual review, focused on the service oriented architecture.

The last year of WIN project will be focused on validation, experimentation, evaluation and preparation of the deployment of the solution, in several thematic.

Sections

<u>Introduction</u>

The general requirements put in priority in the design of WIN architecture are fully in line with DG INFSO main guidelines on future architecture of systems:

- Maximal interoperability to inter-operate data, services, and environment or risk management actors;
- Easy access to various sources of data, connection with existing data sources to reuse existing information spaces;

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- No constraint on the localization of the data themselves, data being hosted at the favourite location in line with the applicable practices and rules;
- Generic solution and potential deployment for environmental or risk management applications;
- Reuse of standards ensuring the compatibility with other developments and enabling an easy integration with existing systems;
- Modularity of the solution which can be deployed on one or several computing nodes;
- Low cost solution and very light Client configuration offering an easy-to-use access for both SMEs and institutions;
- Support of business processes to model and execute real world business processes and enable service chaining.

WIN project covers in particular the following issues:

- The definition of a data/information model valid for risk management issues relevant to Europe and in line with European geo-information standards (INSPIRE);
- The design of the Info-structure optimised in terms of use of state-of-the-art information technologies and high capability to inter-operate data, services, and risk management actors;
- The development of a basic set of generic core services that can be deployed to cover major needs of various actors, whatever the specific thematic field;
- The investigation of multiple stakeholder business and organisational models;
- The evaluation of WIN added value through real life experimentation scenarios;
- The definition of the info-structure deployment roadmap.

Theory and method

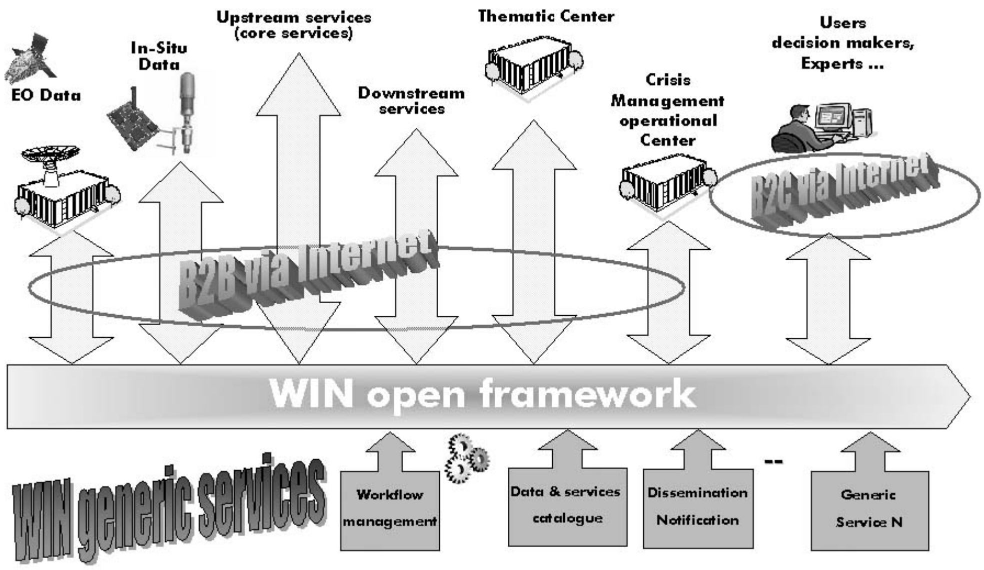
Interoperability is considered as the main driver of WIN solution. Indeed, WIN high interoperability directly results from the compliance of WIN architecture with existing and emerging standards (ISO, OASIS, W3C, OGC,…) and the collaboration established with several other projects like :

- DG INFSO other projects on risk management , in particular ORCHESTRA project;
- DG ENTREPRISE support actions on Data harmonization (RISE…);
- DG ENV INSPIRE initiative;
- European Space Agency (ESA) GMES Services Elements and HMA (Heterogeneous Mission Access) projects for what concerns interfaces with GMES services and interfaces with Space systems Ground Segments.

This high interoperability allows building a variety of powerful solutions based on cooperative systems for environment or risks management, using WIN as a core of the solution.

The hereafter figure 1 illustrates the use of WIN as a federating infrastructure which allows building a powerful overall solution by loosely coupling of cooperative systems or components, in an environmental or risk management domain.

Figure 1 : WIN, a federating infrastructure



The user requirements have been collected and analysed in relation with actors of two risk management communities: actors involved in oil spill process and Civil protection managing forest fires.

The inputs collected from these actors have been merged with the ones coming from lessons learned on past events or coming from previous projects on same thematic fields.

The whole risk cycle has been addressed, from risk assessment to capitalization and every type of actors has been considered:

- The policy & decision makers (European, National, local levels)
- The scientists and experts
- The on fields operators
- The data & service providers

The collected users' requirements, classified, characterised with the thematic and technical attributes and arranged into a data base, have been the basis for further data modelling and design activities.

Using user requirements specifications, the data modelling work has produced a data model specification and developed consistent and generic risk data models. Special attention has been put on the interoperability with data models produced by complementary projects - such as ESA HMA (Heterogeneous Missions Accessibility); EC ORCHESTRA and EC MOTIIVE/RISE – via the use of standards from standard bodies notably W3C, ISO, OGC and OASIS.

Main objectives of WIN data modelling have been :

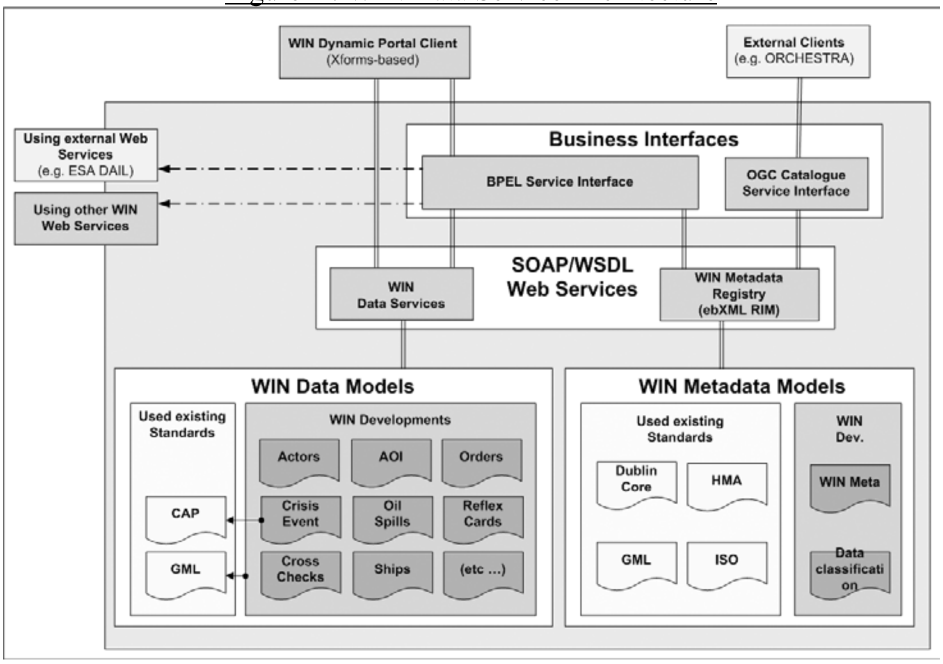
- To assure interoperability of the created data models;
- To use standards wherever possible and to limit developments to strict specific features;
- To deal with complexity of data models;
- To combine generic and specific elements of the data model;
- To produce data models that allows easy exchange of datasets.

To achieve these objectives, the most appropriate support technologies have been selected:

- W3C standards to develop the WIN data models: XML as format to exchange data and XMLSchemas to model XML. Selecting XMLSchemas has allowed integrating easily existing standards (like. GML, CAP, ISO, SensorML, CIQ, etc…) which are also expressed in XMLSchema.
- OASIS standard ebRIM (electronic business Registry Information Model) to design the Registry Model. Note : On January 5, 2007 - The Open Geospatial Consortium, Inc.®(OGC) selected the OASIS standard ebRIM (electronic business Registry Information Model) as the preferred cataloguing metamodel foundation for future application profiles of the OpenGIS® Catalogue Service Web (CS-W) specification.

Results are depicted in the figure 2:

Figure 2 : WIN Data Service Architecture



The WIN Data Models cover management of important objects that play a role in Crisis / Risk management – like identification of all types of Actors, Ordering of data and services, performing Cross Checks, managing crisis alerts, follow-up particular crisis events (like oil spill or fire) and description of particularities of a type of disaster (like oil spill or fire).

The WIN Metadata Model is based by large on existing standards (such as Dublin Core, GML and ISO19115) - and includes some additional specifications for WIN. All this metadata is managed in the same way by using the ebRIM standard, which can express any type of metadata and – on top of that – make valuable associations between metadata. This allows very powerful querying and managing of metadata.

The WIN Data models are implemented via the Data Web Service component, the metadata via a ebXML Registry tool. Both components/tools are using SOAP/WSDL type of Web Services, which is the standard. This allows standard-based connections to other tools like for Workflow management –based on BPEL standard.

WIN functional architecture is based on user requirements. Basically, the user requirements underline the need of an information system providing:

- Easy access to reference data managed by the different actors at European, National and Local level;
- Easy access to historical data collected during past disasters to benefit of lessons learned;
- Supports to establish the relationships between users and providers;

- Interfaces with service providers acting in domains of interest such as oil spill monitoring, detection, drift forecast services, rapid mapping services, etc … ;
- Tools to facilitate information exchange between actors including dissemination means, collaborative applications, multi-linguality to overcome the language barrier etc…;
- Tools for efficient decision process;
- Communication means with scaleable QoS according to the risk phase;
- Support and training.

According to these needs, WIN has been designed as a backbone data infrastructure offering a set of generic services and interfacing Services & Products providers, Data providers, End users and other stakeholders for risk management purpose.

In short, WIN generic services can be classified into 4 functional groups :

- User management (registration, profile information, authentication & authorisation);
- Data/Products/Service access (registration, catalogue, ordering, exploration of external standardized catalogues);
- Support tools (Object viewers & GIS, Multi-lingual glossary, Alert Services, Crisis Event follow-up, Reflex cards, Directory of contact, Collaborative working tool);
- Administration (data handling & dissemination, workflow management, system monitoring, data storage, backup, traceability, help desk).

All these generic services are accessible to the users through a Web Portal.

Regarding the data, there are several kinds of issues :

- Technical issues mainly related to interoperability : WIN supports various formats (raster, vectors, documents, etc) and complies with interoperability standards, in particular OGC CS-W (Catalogue Service Web) specification. As a consequence, WIN can be "connected" to various sources of data, either directly when WIN and external system share common standards (OGC,…), or through specific connectors when alignment of legacy system is required. A demonstration of WIN multi-catalogue capability in relation ESA HMA (Heterogeneous Mission Access) has been performed during ESA-EC interoperability workshop (in Frascati on April 3rd 2007),
- Organisational/Business issues related to data access rights and pricing policy : WIN solution is generic, it allows to manage different types of business / organisational models, but it requires a prior agreement between the parties.

A particular attention has been put on the characterisation of the actors communities (groups of end users and providers sharing a same theme or mission).

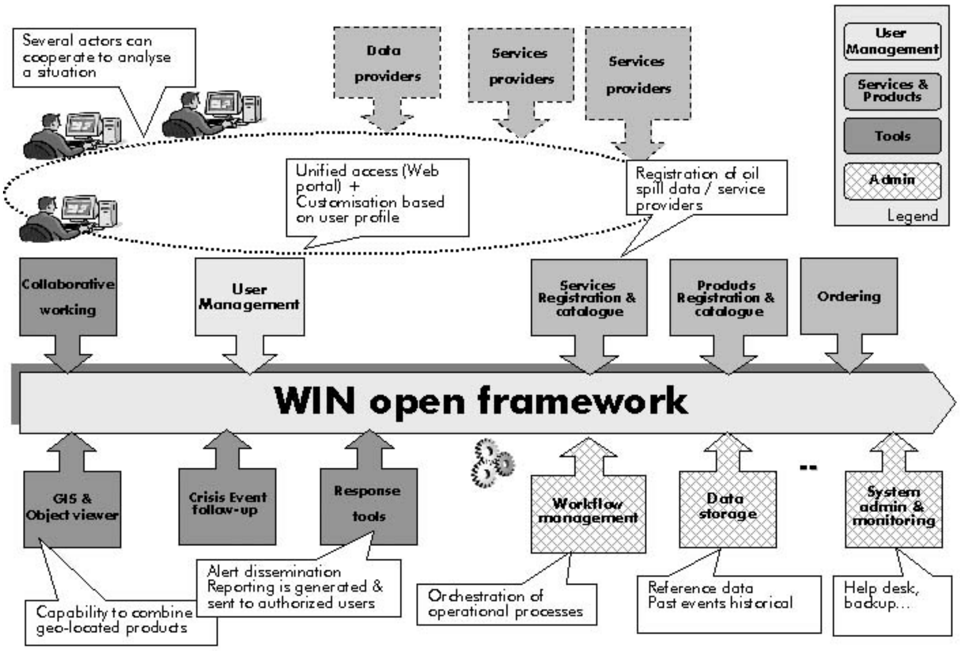
In the Risk and Environment Management (*) framework, a community may group users and providers according to various criteria such as : Geographical areas (European, trans national, national, local and also sub-local); risk thematic (Oil Spill, Fire, Flood); risk phase (pre-crisis, crisis, post-crisis).

In WIN system, the community characterisation is based on charters concept (business, mission, quality, interoperability charters) and results in enhanced user profile management and cataloguing services.

This allows to provide a so called "profile based system" where users access to relevant information according to their needs and rights (figure 3).

(*) Note : Risk management and Environment management share most of needs in term of architecture, even if Risk management requires specific capabilities (like forces management) to manage the crisis. These specific capabilities for crisis management are provided by other complementary projects (like OASIS CM), while generic capabilities for the whole risk management cycle (from prevention to damage assessment) are provided by WIN architecture and services. WIN, which is being validated on Risk management cases, can also support as well other environmental thematic fields, provided the data models are enriched as needed.

Figure 3



Results

Since the WIN infrastructure is to interoperate in a context of cooperative systems, the Service Oriented Architecture (SOA) is most appropriate type of design methodology to be followed.

SOA represents a style of architecture, primarily for application development, that is typically multi-tier and based on the principle of dividing business processes into a series of subunits or services.

The services can then be assembled and linked together to perform a desired application.

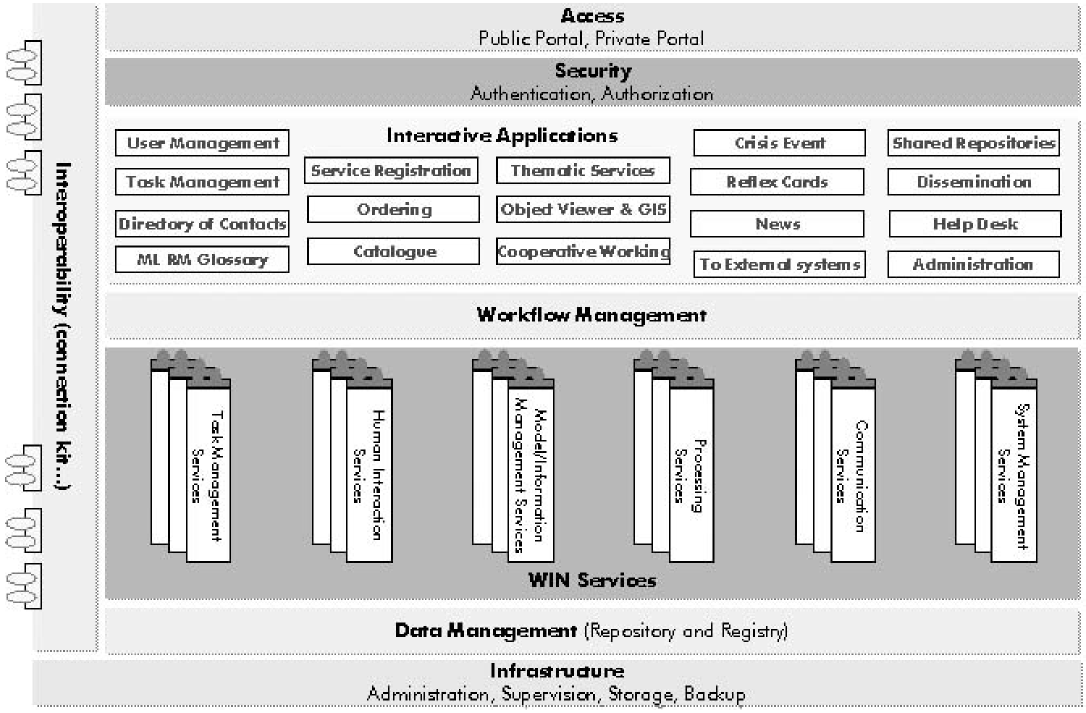
The services are defined at a level above that of the traditional view of components.

As a consequence, this approach allows the definition of system architectures having the following characteristics:

- Stateless services, ensuring re-usability, since they are designed to be used in any context,
- Interoperable services, ensuring, of course, interoperability, since they are defined and realized according to market standards (XML, XSDL, WSDL, SOAP…) in order to interact in a ‘plug and play’ mode, both internally and externally,
- Loosely coupled services, enabling an optimum flexibility.

The figure 4 shows a high level vision of the WIN architecture from a SOA standpoint, illustrating the component structure approach.

Figure 4 : WIN SOA Model



Then, in line with this SOA model, the logical architecture schema is based on 3 layers:

- The presentation layer;
- The service layer;
- The data/information layer.

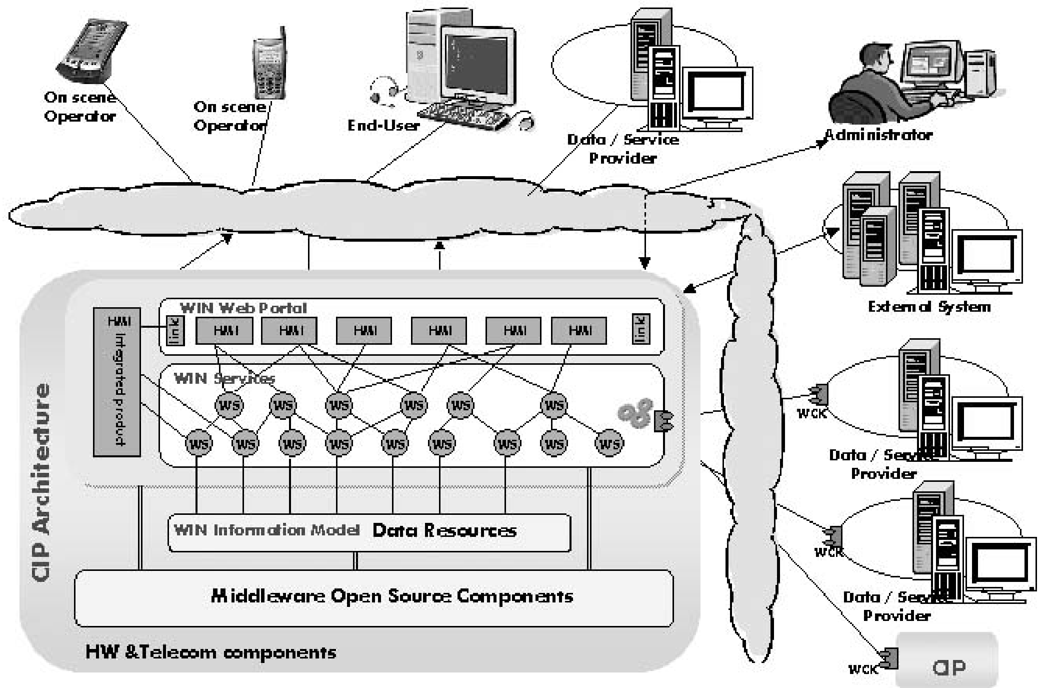
Through the presentation layer, the user can connect the WIN portal and, after authentication, accesses to WIN services.

The services layer offers a panel of elementary services that can be combined and chained into workflows. The richness of the model comes from the fact that WIN services, external services, and human tasks can be orchestrated to support automation of operational practises.

The data information layer, including data models and metadata model, is fully based on standards; this increases the overall interoperability, allowing to share data/information with other cooperative systems.

The figure 5 illustrates the layered approach.

Figure 5 : WIN layered architecture overview



CIP : WIN Common Integration Point. The CIP is an instantiation of the WIN system for a given community of actors
WCK : WIN Connection Kit
WS : WIN Web Services
HMI : Human Machine Interface

To sum up, WIN solution includes in particular:

- An open architecture and info-structure based on ISO, OGC, OASIS, W3C standards;
- A set of generic services like catalogue of data and services and GIS allowing an easy access and powerful combination of various sources of information;
- A generic registration capability which provides a very efficient way to extend the information system by “plug and play” of various external services in relation with the thematic domains;
- A work flow management, allowing to support domain practises by design and execution of most frequently activities work flow;
- A set of data/information models corresponding to generic and specific requirements for WIN experimentations (generic, oil spill, fires and floods models) , this set being easily extendable in relation with new target application.

Apart from its high interoperability, other advantages of this solution are:

- A cost-effective deployment consequence of the maximal use of open source components in the infrastructure implementation and, basically, no specific needs on client side;
- The architecture can be deployed at several levels (geographical levels or thematic domains), and a level can be considered as a data/service provider for another level.

Development of an open architecture like WIN is guided by the compliance with the standards of the domain (OGC, W3C, OASIS and INSPIRE recommendations) in order to provide highly interoperable systems and to ensure sustainability. And besides this high level requirement, is the need of using new information technologies.

Implementation of WIN software components is fully based on these principles. Most of the developments are realised in JAVA within a J2EE light architecture (JBoss, Tomcat). The WIN services are provided as Web Services using SOAP-formatted XML envelopes and having their interfaces described by WSDL. BPEL is used to manage the workflows.

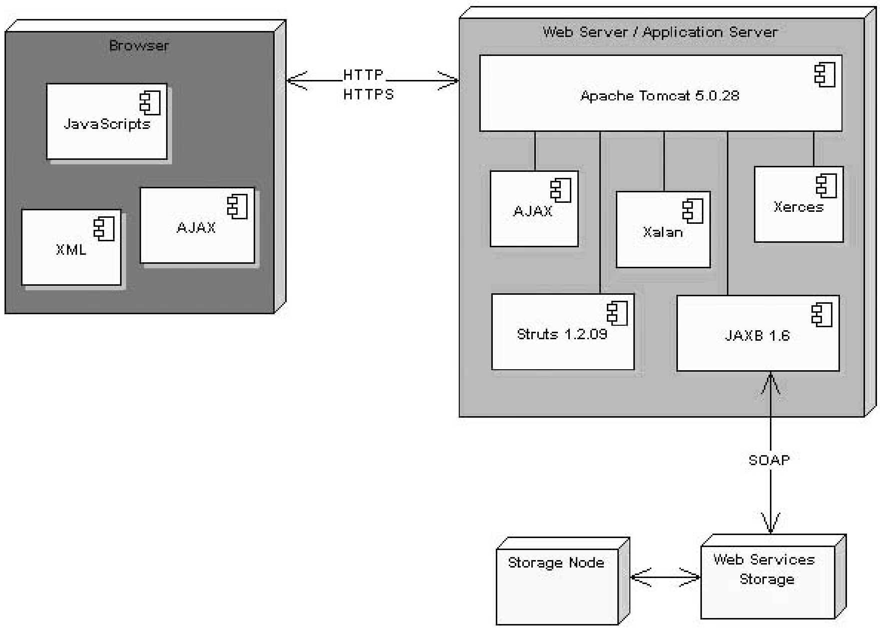
The WIN web-application respects the VMC (View Model Controller) model. The selected implementation of VMC is Apache Struts. The view part of the VMC is realized by JSPs and XSLT Transformations running by Apache Xalan. Further more, in order to propose advanced Man Machine Interactions, the AJAX technology is used to interact with the server side of the web-application.

On the server side, the web-application resources are protected by the JAAS standard coupled to an LDAP resource.

We can also mention ATOM as technology used for syndication.

The figure 6 provides an overview of the WIN Web Application Software Components (almost all of them are Open Source):

Figure 6 : WIN Web Application Software Components



WIN software is developed by several partners of the WIN consortium across Europe. This implies many exchanges of information (documents, emails, brainstorming…) and increases the complexity of integration and testing tasks.

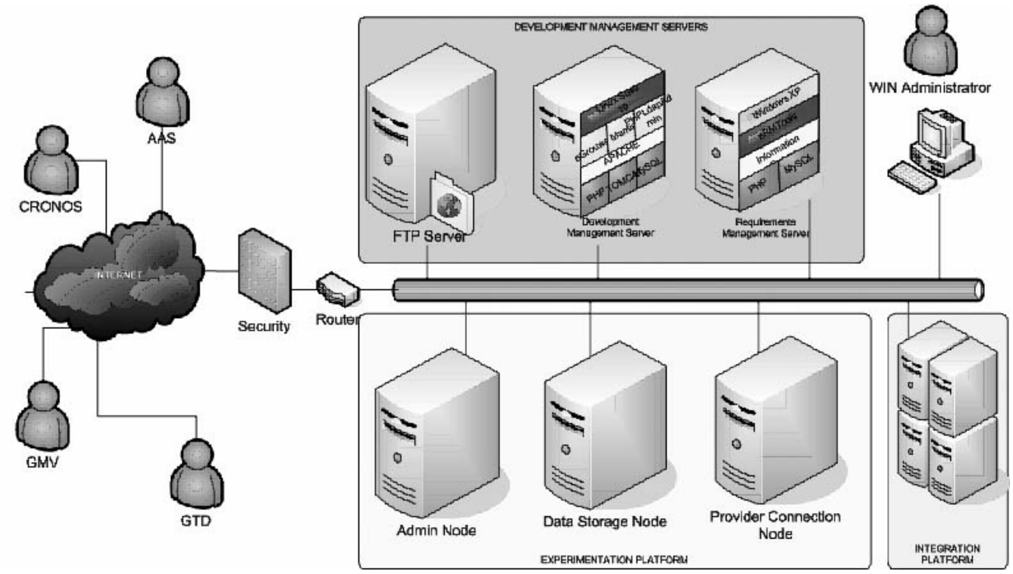
To ease these exchanges and to prevent integration problems, the different companies have agreed to work with a common development methodology.

According to this methodology, a collaborative platform (see figure below) has been set up in order to provide over internet:

- A management environment including :
  - Configuration management and version control tool (Subversion)
  - Bug tracking (Mantis)
  - Content management system including forums, wiki, etc … (eGroupware)
- A integration environment (for integration and validation testing)

- A experimentation environment (for end-to-end validation and experimentation)

Figure 7 : WIN Integration & Experimentation platform



Two domains of experimentations are defined:

- Marine and Coastal domain with experimentations related to oil-spill monitoring and response process, in relation with Marcoast GSE project and several users and service providers in France, Spain, Italy, and Greece,
- Land risk management domain, with experimentations on fire and floods disaster management in relation with French and other countries Civil protections.

Planned experimentations will allow evaluating benefits of WIN and in particular:

- The capability of WIN to support end-to-end oil spill monitoring and response process, orchestrating the required data information models, interfaces with dedicated services, information dissemination to relevant users, including notification and alert in case of crisis;
- The capability of WIN to improve risk management for what concerns fire and floods, through the advantages resulting from GIS capabilities (combination of different sources of information, like Earth Observation data and in-situ or cadastral data), the management of on-demand data ordering in case of disaster, and several facilities (collaborative working, …) contributing to a more efficient disaster management process.

WIN benefits have been widely disseminated and positive appreciated in user forums like the European Group of experts in satellite monitoring and assessment of sea based oil pollution (EGEMP) and the Gestion des Risques and Vulnérabilités des Territoires (GERI) forum.

Discussion

WIN deployment roadmap includes many opportunities at European and regional level, on several thematic like shoreline monitoring, land-based risks management and environment management domains. According to the needs, various deployment of WIN can be performed.

Two typical models are presented hereafter:

- WIN can be deployed using a “Internet-based” model where all actors involved on a given thematic field can find easily the relevant data and information they need, the WIN infrastructure acting like a “broker” between the providers and the users (data and services consumers), helping the users to perform their activity in various phases of risk management cycle, and providing data/service providers with a wider "audience",

- WIN can also be deployed on a "case-by case" model, after a customisation phase helping to adjust the model to specific practises; in particular the customisation allows to design the different work flows to support specific processes, to extend the data/information models needed in a given thematic domain, or to integrate complementary tools or services like decision-support or response management services.

WIN project has defined an open architecture to support risk management process and more generally environment management processes. A first implementation has been performed through a core set of generic services.

The solution, based on Web services, is generic and modular, and as such, it can be adjusted to any context of environment management or risk management:

- Cooperation with other systems compliant with the standards can be easily performed,
- New thematic domains can be modelled,
- New data/services services can be registered,
- New work-flows can be designed.

The compliance with current and emerging standards is the guarantee of the sustainability of the solution, and of its interoperability with other standard-compliant systems.

WIN utility value is its contribution to the build of efficient and secure systems of systems for environment or risk management ; in particular :

- WIN facilitates user access to several data sources, masking the complexity related to the variety and heterogeneousness of sources,
- WIN facilitates collaborative working between actors,
- WIN supports operational practises through automated work flows,
- WIN facilitates the set-up of links between users and data/ service providers
- WIN supports tracability of events, actions, exchanges,…

The added value of the solution is being demonstrated in relation with several kind of actors on two thematic (oil spill, fires).

WIN results constitute a major contribution to the future Single Information Space for Environment in Europe.

Author Biography

Christian ALEGRE (Thales Alenia Space) : Engineer from SUPELEC (French Electronic & Computer sciences high school) has developed a strong experience in technical and project management in a European context in remote sensing and software domains. After various programs as SW developer, he was responsible of a SW department for five years before to take the responsibility of the Integration for the ENVISAT Ground segment in Italy and then to be in charge of the project management. He has developed the know-how to work with European partners coming from various countries: Spain, Italy, Germany, United Kingdom, Sweden, for both technical and contractual matters. Christian Alegre is the WIN Project & Technical coordinator since September 2004, the beginning of the project.

Cecile MONFORT (Thales Alenia Space) : Computer Science Engineer from Ecole Nationale Supérieure d'Electronique, Electrotechnique, Informatique et Hydraulique de Toulouse (ENSEEIHT) . She has acquired her skill in computer sciences through various projects in many domains notably image processing, ground segments, information system. In 2001, she has joined Thales Alenia Space to take the technical responsibility of the IQGSE (Image Quality Ground Support Equipment), a software suite for the MSG (Meteosat Second Generation) commissioning. Since April 2005, Cecile Monfort is the WIN technical manager and brings her support to the System Design and Development WP.

Academic & Professional Practice

Peer Reviewed Articles

COMMUNICATIONS TECHNOLOGIES & TECHNIQUES

RADIO COMMUNICATION FOR PUBLIC SAFETY IN EUROPE, AND THE ROLE IN DISASTER RELIEF

Hans Borgonjen
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Keywords:

Radio communication, Public Safety, cross border communication, Role in disaster relief, Tetra standard.

Abstract

Schengen has done a lot of work to realize cross border radio communication. The goal was to have a harmonized frequency band and a common technology. The frequencies were realized by the CEPT (European frequency body) decision on the 380-400 MHz band. This realisation was a unique result; for the first time there was harmonization in Europe for all Public Safety organisations.

Common technology was reached through ETSI (European Telecommunication Standardisation Institute). With participation from Public Safety organisations and industry the TETRA standard was developped. This standard is based on the Schengen requirements and is ”tailor made” for the command and control type of radio communication within Public Safety. A special target was to prove that it was possible to have a better operational cooperation between Public Safety organisations from different countries. This was done in the Schengen 3-country pilot some years ago.

At this moment many European countries have national Public Safety radio networks (almost) finished or in the project phase. Most are based on the TETRA standard. An other technology that is used, e.g. in France, is Tetrapol. The 3-country pilot now also includes France, making it a 4-country initiative, to achieve (beside interoperability between TETRA networks) possibilities for cross border cooperation between a country with a TETRA network and a country with Tetrapol.

Disaster relief is not a national problem. Many disasters involve more countries. For coöperation between the different Public Safety organisations good radio communication is a vital instrument in such circumstances. The work done by Schengen, the experiences from the 3-4 country pilot, and the fact that there is a high level of standardisation between the European Public Safety organisations, can help solving disaster relief.

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References

This paper is referring to the Schengen developments, in particular to Schengen Telecom.
My experience is that some people want to know the original background. The most relevant official Schengen documents are mentioned in the reference list.

Why a standard?

Schengen:
The European Schengen Agreement in 1985 had many different objectives, not least that of opening borders and abolishing of systematic border controls. One of the aspects that this involves, is that of cross border co-operation between public safety organisations - Article 44 of the Schengen Agreement states that cross-border communication between control centres, etc must be made possible. *(Ref 1)*

To work this out in more detail and to come with proposals, a special group was created: 'Schengen Telecom', with in a later stage a subgroup 'crypto', chaired by the Netherlands. The chairmanship of Schengen Telecom changed each half year in conjunction with the country which was the chair of Schengen. *(Ref 2)*

This was the basis on which, already some years ago, a lot of work has been done within Schengen Telecom to realize cross border radio communication. The mandate was to realize a 'short term solution' and a 'long term solution'. *(Ref 3)*

Short term solution: For the short term solution there has been a workshop in Helsinki in September 1999. Goal was to decide on practical solutions in a situation where there is no common solution in 2 neighbouring countries. *(Ref 4)*

Long term solution:
Main focus was the long term solution. This should be based on digital radio technology and not the old analogue.
The big question was: "how to realize cross border radio communication". A European wide radio network was not realistic, so the approach was to have an agreement on those aspects which are necessary for making it possible to come to cross border radio communication.

The goal was to have a harmonized frequency band and a common technology; with these two strategic focus points, it is possible to have radio projects in the different countries which are so common in the fundamental technical approach that they can work together. Important advantage of this approach is, that the different countries can have their own individual planning. If e.g. in the Netherlands there is a need for replacing the old analogue radio networks, a digital radio project can be started (based on the 2 criteria!) and when Germany starts some years later (but also based on the same 2 criteria!) the common technique and frequencies are making it possible to have cross border radio communication.

Frequencies
The first goal was to have the same solution for the frequencies. Frequencies are like the fundaments under a house. Without a harmonized frequency band it is impossible to realise radio networks which can communicate among each other. A lot of work has been done to make frequency plans, calculations on sharing models (most frequencies are used for different purposes; some can be shared, most are creating problems) and political lobby to make clear that Public Safety in Europe needs a harmonized frequency band.

The frequencies were realized by a CEPT (the European frequency body) decision in 1995 where in the 380-400 MHz band, 2x3 MHz was allocated for Public Safety with an expansion to 2x5 MHz. This was a unique result, because for the first time there was harmonization European-wide for all Public Safety organisations.
At the moment all European countries that have been implementing a digital radio network, or are starting radio projects, are using this 2x5 MHz.

Technology
The second goal: common technology was also very complex. One of the ideas within Schengen Telecom was to develop a specific technology for Public Safety by them self. Because the ‘core business' of Public Safety is not ‘making standards', and while there is an official body in Europe, this idea was left and Schengen Telecom approached ETSI (the European Telecommunication Standardisation Institute).
ETSI is recognized by the European countries and has e.g. developed the GSM standard.

Schengen Telecom created functional requirement documents for the radio infrastructure, the terminals and security aspects. Those documents have been used within the ETSI process, where a special Technical Committee (RES-6, later TC-TETRA) was created to develop a new standard. This standard was optimized for professional users; not only Public Safety, but also transport, utilities, airports etc. Advantage of this approach is that the market is bigger than only Public Safety, which causes lower prices, more functionalities and a bigger selection of terminals.
In 1995 Schengen Telecom asked ETSI to evaluate, how close the TETRA standard meets the Schengen requirements (Ref 5). The answer was almost 100% positive.

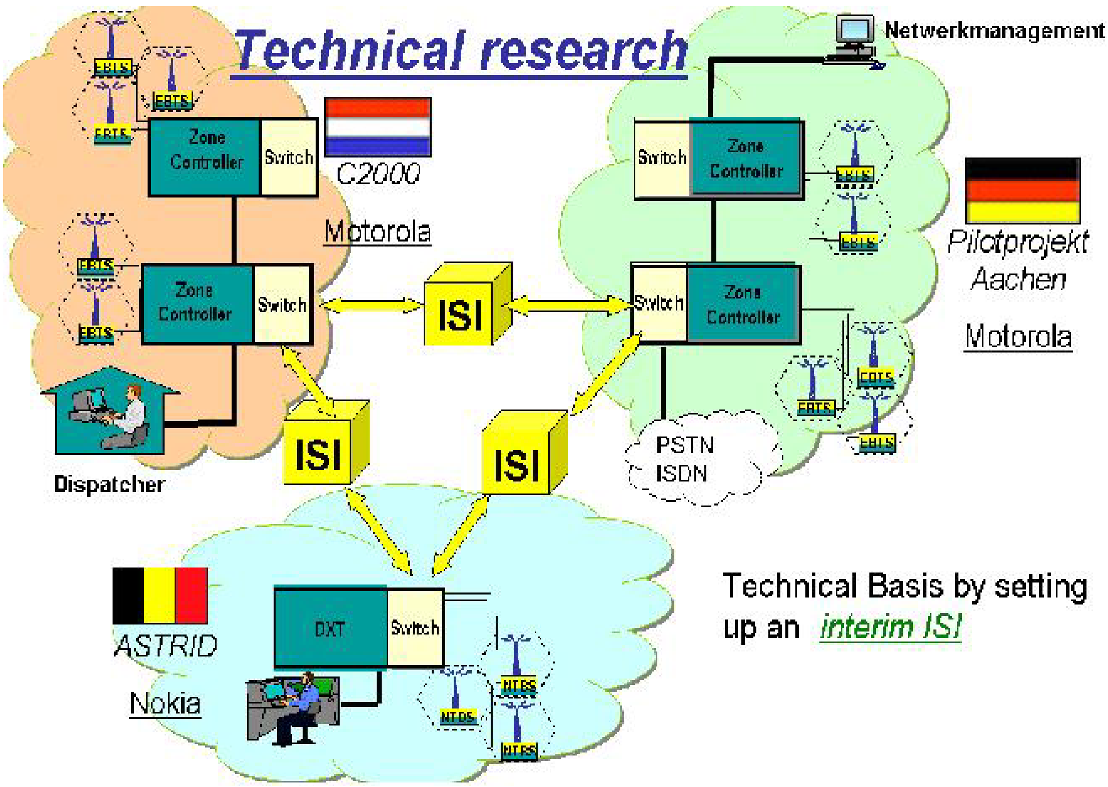
Some Schengen countries directly participated in the ETSI working groups. Finland, Belgium, UK and the Netherlands were the most active Public Safety representatives in this process. The director of ETSI once said in a presentation that is was the first time that an ETSI standard was developed with such a strong participation from the potential users.
In this way in the second half of the 90ties the TETRA standard was developed with participation from Public Safety organisations, industry and administrations. The standard is based on the Schengen requirements and is ”tailor made” for the command and control type of radio communication within Public Safety. Specific functionalities, which are e.g. not available in GSM are group communication (reaching 20 police and fire cars within half a second is impossible with GSM), Direct Mode (terminal to terminal communication without using the infrastructure) and several security functionalities (air interface encryption, end-to-end encryption).

Police Cooperation
In 1999 the mandate was formally included in the Schengen Acquis by decision of the Central Council of Schengen and taken over by the European Union with the coming into force of the Treaty of Amsterdam. *(Ref 6)*
The responsible body was, and still is, the working group Police Co-operation (third pillar from the EU).
The most relevant decisions from Schengen were adopted in the so called ‘Schengen Acquis documents'. *(Ref 7)*

3-country pilot

A complexity for the acceptation of the outcome of Schengen Telecom by all countries was that the proposed solution was not yet implemented, and the standard was even still in development. A special target within the Schengen Telecom mandate was therefore to prove that with the proposal from the harmonized frequencies and a common technology, it was indeed possible to have an improvement of the operational cooperation between Public Safety organisations from different countries. Germany, Belgium and the Netherlands volunteered to organize these tests. *(Ref 8)*. This was called 'the Schengen 3-country pilot' which was done some years ago.

The picture below shows how the 3 TETRA networks (ASTRID in Belgium, Pilot system in Aachen Germany and C2000 in the Netherlands) were connected.
The ISI (Inter System Interface) was during the pilot 'an interim ISI'. ETSI has already finished the standard for the complete ISI.



The 3-country pilot is now also including France , making it a 4-country initiative, to get beside interoperability between TETRA networks also possibilities for cross border cooperation between a country with a TETRA network and a country with Tetrapol.
This is tested between Belgium and France.

Situation at the moment

This section describes the TETRA market today and the situation within Public Safety in Europe. As already mentioned in section 1, the TETRA standard is not only for Public Safety, but also for other professional users like public transport, utilities, military etc. 10 years ago the TETRA MOU was founded. It is an organisation which has as a goal to make TETRA a world wide success. Industries, users, operators, agencies, consultants etc are members. Beginning 2007 the MOU had a good 140 members in about 80 countries.

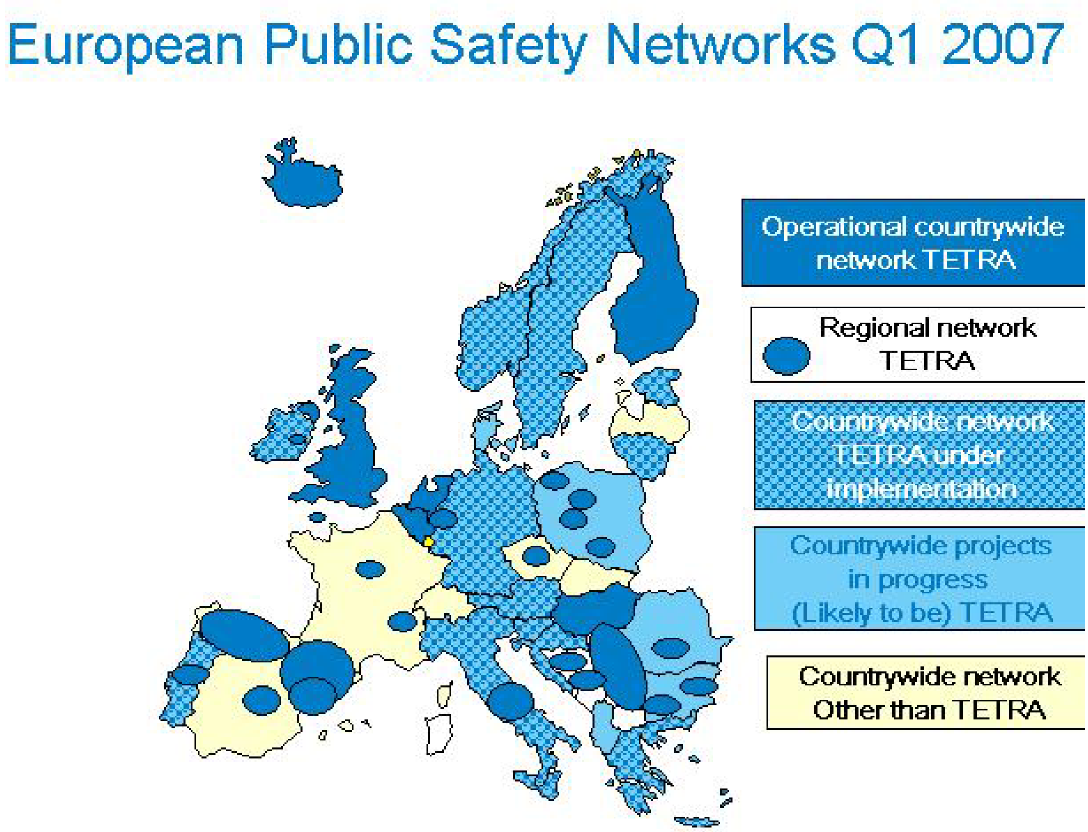
Main task, besides organizing marketing events like the TETRA World Congress, is to keep TETRA a 'multi vendor' market. There is a complete 'Inter Operability Process' (IOP) in place, where an Italian governmental test body checks if e.g. a TETRA terminal from EADS is 100% working on a Motorola TETRA infrastructure. If so, a certificate is published, so potential buyers can be sure that every thing works as they expect.

The 'pie diagram' below, shows how the different markets are divided. Public Safety is the biggest by far.

<u>Public Safety radio in Europe: the 'PSS Europe map'</u>

At the moment many European countries have national Public Safety radio networks (almost) finished or in the project phase. Most are based on the TETRA standard. In Finland (the Virve network), UK (Airwave), Belgium (ASTRID) and the Netherlands (C2000) the networks are fully operational. In Sweden (RAKEL), Italy and a lot of countries in Eastern Europe, networks are being built. In Norway, Denmark, Ireland and Germany there has been, after a technical neutral tender procedure, a decision for TETRA. The projects are preparing the roll-out. An other technology what is used, e.g. in France, is Tetrapol.

In the map below you can see which countries already have a TETRA network fully operational (dark blue), regional TETRA networks, Countrywide networks under implementation (dotted blue) and where it is expected to implement TETRA (light blue)
Other technologies like Tetrapol (light cream). Status is Q1 2007.



Role of radio communication in disaster relief

Disaster relief is not a national problem. Many disasters involve neighbouring or even more countries. Good cooperation between the different Public Safety organisations at such a moment is essential. Good radio communication is a vital instrument under such circumstances. A similar role is to be expected in the future for 'broadband data communication'; besides a technical solution, the frequency aspect has to be solved, like in the past for TETRA.

The work done by Schengen, the experiences from the 3-country pilot and the recent 4-country initiative, and other lessons learned from the new digital radio networks, can help solving disaster relief. As described in section 2, there is a high level of standardisation between the European Public Safety organisations. For cross border disaster relief, this is essential for the coordination between the involved Public Safety units.

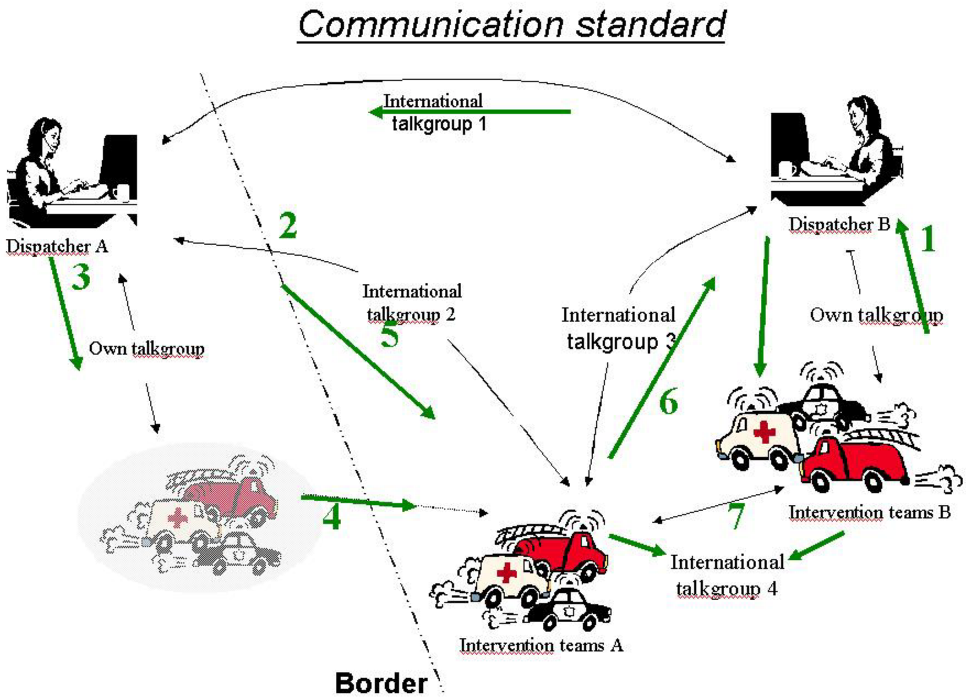
<u>Lessons learned from the 3-country pilot</u>
If cross border communication is so important during disaster relief, how is this done?
The experiences from the 3-country pilot are very useful in this respective. The different operational tests were completed with a 'multi agency, multi country' disaster scenario, where police, fire, ambulance services from Belgium, Germany and the Netherlands were working together.

Lessons learned are:

- Cross border cooperation should always be coordinated by the control rooms from the different countries. Reason is that at the start it is important that the involved control rooms in the different countries coordinate amongst each other what actions to take and by whom.

- During the dispatch of the disaster event, óne control room should be in charge, also of 'the visiting units'.This is for keeping an overall view, short decision lines, sending extra other units etc.
- Radio backup to the 'own national control room' is still necessary, e.g. for asking advise regarding legal issues if jurisdiction is different in the countries.
- For international pursuit the situation is different: this is mostly done by 'self supporting teams'. Status messages are useful.
- There are many 'talkgroups' involved. Those talkgroups have to be (partly) programmed in advance. Careful considerations are necessary on how the operational communications lines and procedures have to be, in situations of international cooperation (see diagram below). 'International fleetmaps' with international groups are necessary.
- Beside group communication, individual call and phone call is also desirable.
- Language misunderstandings are a problem (can be improved by using NATO alphabet and status messages). International 'communication terms' are important.
- Use of DMO (Direct Mode Operations: radio communication without using the radio infrastructure) has to be coordinated in advance (there is an 'international DMO model' adopted by most West European countries)
- International training (dispatching units from the control rooms as well as 'field units' are very important).
- Emergency call handling and Automatic Vehicle Location in foreign countries are important functionalities to realize in future.
- Terminal equipment recommendations are: display has to show active network in roaming conditions, preferential network to be selectable by units themselves, and identification of group members.
- A 'full ISI' (Inter system Interface) is necessary to enable the radio networks to have all the above-mentioned functionalities.

The diagram below shows the different talkgroups during the above mentioned 'multi agency, multi country' disaster test scenario. Detailed information at www.3countrypilot.com.



Biography

Hans Borgonjen, is from vts Police Netherlands, a governmental organisation responsible for all information technology for Public Safety in the Netherlands including the C2000 network. He is responsible for international standardisation, knowledge exchange etc.

He is also Director and Board member of the TETRA MOU and one of the founders of the Tetra standard (also as result of my Schengen Telecom activities). Chairs the PSRG (Public Safety Radiocommunication Group) an informal platform of governmental people responsible for a national radio project.

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DISTRIBUTION OF MARITIME SAFETY INFORMATION – RADIO NOTICES IN THE PERIOD 2001 – 2005

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ABSTRACT

The full implementation of GMDSS requires also a detailed understanding of the concept of maritime safety information. The concept of national coordinator for maritime safety information has also been described, including the analysis of these.

The analysis comprised the original data relating to the distribution of radio notices in Croatia in the period 2001 – 2005, referring in particular to: COASTAL/NAVAREA, COASTAL/NAVTEX and LOCAL.

This paper also indicates the crucial importance of high level of reliability of maritime safety information in automated technical/technological processes and of acquiring satisfactory equipment of the services, which participate in the distribution of maritime safety information. The analysed issues indicate the need to conduct further scientific research.

INTRODUCTION

The Ministry of maritime affairs, traffic and communications has, pursuant to the main document of the world service of navigational notices IHO/IMO (WWNWS No. 53) – 1996 (1 WWNWS No 53 – 1996 is a joint IHO/IMO/WMO Manual about maritime safety information. It contains recommendations about providing such notices by dividing them to subsystems. It also includes recommendations about producing radio notices and communicational needs of coordinators.
), Clause 2.1.8., 6.5. and 6.6., and the IHO/IMO/WMO Maritime safety information manual, Clause 2.6.4., of 19th April 1996, appointed the national coordinator for navigational notices and informed about it the International Hydrographic Organisation and the International

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Maritime Organisation. National coordinator is a national organisation responsible for classification and publication of notices and information relating to the safety of navigation.

The concept of national coordinator assumes the use of appropriate technological tools and the work of expert personnel during the 24-hour navigational safety service, aimed at collecting, producing and distributing radio notices. National coordinator must have accurate information available.

MARITIME SAFETY INFORMATION

In general, maritime safety information is defined as navigational and meteorological reports and other messages, referring to safety, which are of vital significance for all ships in the sea.

The analysis of IHO/IMO/WMO maritime safety includes the following elements:

- navigational warnings,
- meteorological warnings,
- reports about ice,
- information related to search and rescue,
- weather forecasts,
- messages relating to pilot services (except the USA),
- updating messages relating to electronic navigational systems.

The service of maritime safety information is an internationally harmonised network of broadcasting maritime safety information collected from various sources, most significant being the following:

- National hydrographic bureaus (navigational warnings and updates of electronic charts);
- National meteorological bureaus (meteorological warnings and weather forecasts);
- Centres for coordinating search and rescue (distress signals coast – ship and other urgent information);
- International patrols for watching ice in North Atlantic (ice related hazards).

The exclusive authorised sources of maritime safety information approved by IMO or WMO are authorised to dispatch maritime safety information.

According to the IHO/IMO Manual (WWNWS No.53.), all navigational safety notices are classified as:

- NAVIGATIONAL WARNINGS,
- METEOROLOGICAL INFORMATION, and
- SEARCH AND RESCUE.

WWNWS and COMSAR/CIRC 4 determine providing radio notices in such manner that the competent organisations maintain the sections of the IMO/IHO/WMO Manual referring to each of them.

Thus the following refers to each category of radio notices:

- Navigational warnings must be published in accordance with the WWNWS No 53 standards, organisation and procedures, in accordance with IHO official guidelines through its Committee for dispatching radio navigational warnings (COMSAR/CIRC 4 Annex, Clause 2.5.1.), (Performed by Croatian Hydrographic Institute - NO).

- Meteorological information must be published in accordance with technical regulations and recommendations of the World Meteorological Organisation (Performed by Maritime Meteorological Centre – PMC).
- Distress alarms must be given by various administrative bodies (COMSAR/CIRC 4, Clause 2.5.3.) responsible for the coordination of search and rescue operations, according to the standards determined by IMO (at present performed by LK, ORPs, Croatian Navy (HRM), and by Coast guard in the future).

2.1. Distribution of radio notices for the area of Croatia in the period 2001 – 2005, and the analysis of the types COASTAL/NAVAREA, COASTAL/NAVTEX and LOCAL
NAVIGATIONAL WARNINGS
Navigational warnings are divided to:
- COASTAL/NAVAREA,
- COASTAL/NAVTEX,
- LOCAL.

NAVAREA notices contain data about the safety of navigation for open seas and along main navigational routes, and are sufficient to ships navigation in the open sea. They are broadcasted in English and Spanish language.

COASTAL notices contain data about a particular coastal area and often supplement NAVAREA notices. They are dispatched in the English language and in the language of the country which distributes them. They are broadcasted through NAVTEX programme and telephone.

LOCAL notices refer to ports and areas close to the coast and supplement coastal notices. They are broadcasted in the language of the country which distributes them. Urgent notices are also distributed, after being announced in Channel 16. The announced urgent notices are later broadcasted through the channels of coastal radio stations.

The analysis and the sources of navigational warnings are the basis of the table presentation of radio notices distribution in Croatia in the period 2001 – 2005.

TABLE 2.1.1 Navigational warnings 2001

SOURCE/KIND	PA PU.	PA RI.	PA SEN.	PA ZAD.	PA ŠIB.	PA SPL.	PA PLO.	PA DUB.	PLOV-PUT	HYDR.INST.	MMTPR
COASTAL/ NAVAREA	4	4	-	3	2	3	-	2	-	-	-
COASTAL/ NAVTEX	19	19	-	13	21	21	-	5	1	1	-
LOCAL	19	32	2	22	46	68	2	17	-	-	-
TOTAL	42	55	2	38	69	92	2	24	1	1	-
TOTAL	326										

Source: prepared by the authors according to original NO-HHI data.

TABLE 2.1.2 Navigational warnings 2002

SOURC E/KIND	PA PU.	PA RI.	PA SEN.	PA ZAD.	PA ŠIB.	PA SPL.	PA PLO.	PA DUB.	PLOV-PUT	HYDR.IN ST.	MMTPR
COASTAL/ NAVAREA	4	3	1	-	1	-	-	5	-	3	-
COASTAL / NAVTEX	10	11	2	18	9	27	1	15	-	4	1
LOCAL	5	22	1	28	26	55	4	11	4	-	-
TOTAL	19	36	4	46	36	82	5	31	4	7	1
TOTAL	271										

Source: prepared by the authors according to original NO-HHI data

TABLE 2.1.3 Navigational warnings 2003

SOURC E/KIND	PA PU.	PA RI.	PA SEN.	PA ZAD.	PA ŠIB.	PA SPL.	PA PLO.	PA DUB.	PLOV-PUT	HYDR.IN ST.	MMTPR
COASTAL/ NAVAREA	2	1	-	-	3	2	-	4	2	1	-
COASTAL / NAVTEX	6	4	1	4	5	20	-	5	-	-	-
LOCAL	8	24	2	33	19	70	9	27	-	-	-
TOTAL	16	29	3	37	27	92	9	36	2	1	-
TOTAL	252										

Source: prepared by the authors according to original NO-HHI data

TABLE 2.1.4 Navigational warnings 2004

SOURC E/KIND	PA PU.	PA RI.	PA SEN.	PA ZAD.	PA ŠIB.	PA SPL.	PA PLO.	PA DUB.	PLOV-PUT	HYDR.IN ST.	MMTPR
COASTAL/ NAVAREA	1	1	-	2	2	3	1	1	-	-	-
COASTAL / NAVTEX	2	2	2	3	3	10	-	-	-	2	-
LOCAL	13	31	3	56	54	72	7	14	4	2	-
TOTAL	16	34	5	61	59	85	8	15	4	4	-
TOTAL	291										

Source: prepared by the authors according to original NO-HHI data

TABLE 2.1.5 Navigational warnings 2005

SOURC E/KIND	PA PU.	PA RI.	PA SEN.	PA ZAD.	PA ŠIB.	PA SPL.	PA PLO.	PA DUB.	PLOV-PUT	HYDR.IN ST.	MMTPR
COASTAL/ NAVAREA	-	1	1	4	-	2	-	2	2	-	-
COASTAL / NAVTEX	7	5	1	5	7	5	1	2	3	-	-
LOCAL	19	24	2	42	49	32	2	12	7	14	-
TOTAL	26	30	4	51	56	39	3	16	12	14	-
TOTAL	251										

Source: prepared by the authors according to original NO-HHI data

2.2. Port authorities

In order to identify the characteristics of distribution it is necessary to investigate the results of the statistical analysis of distributed radio notices in the period of five years, presented in graphic form and classified according to the source and to the analysis of radio notices taken separately and as a whole. Port authorities are organised in their geographical order in Croatia, from the north (N) to the south (S).

Pula Port Authority

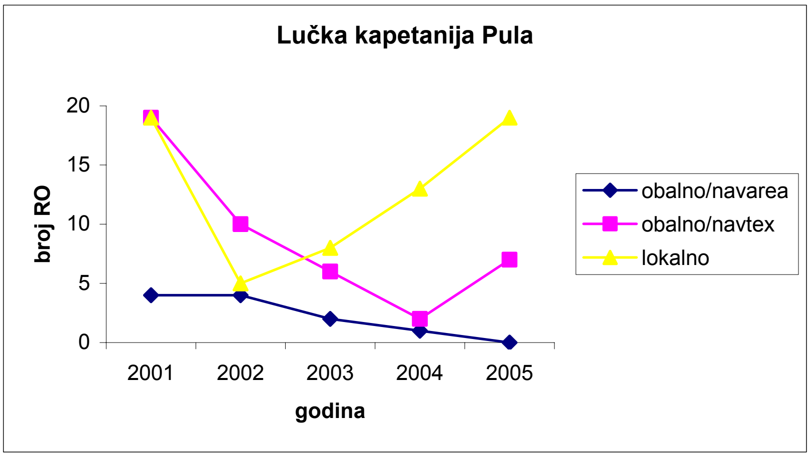


Figure 2.2.1 Distribution of radio notices in Pula

In Pula Port Authority a continuous growth of radio notices of the category LOCAL has been registered in the period from 2002 to 2005. Radio notices COASTAL / NAVTEX oscillate, with a decline from 2001 to 2004, and increase in 2005. Radio notices COASTAL / NAVAREA are in a decline.

Rijeka Port Authority

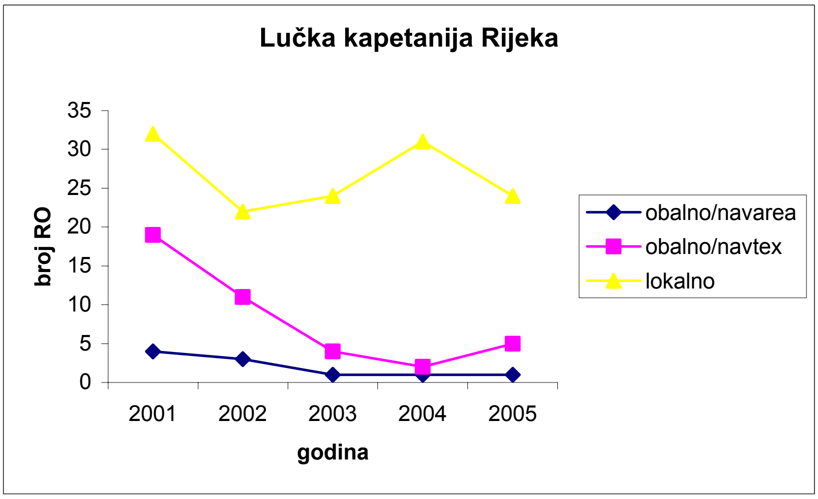


Figure 2.2.2 Distribution of radio notices in Rijeka

In Rijeka Port Authority there is an increase of radio notices of the type LOCAL in period from 2002 to 2004, after that decrease in 2005. Radio notices COASTAL/NAVTEX were decreasing until 2004, then increasing in 2005. Radio notices COASTAL/NAVAREA are in a constant and slight decrease until 2003, after that there are constant.

Senj Port Authority

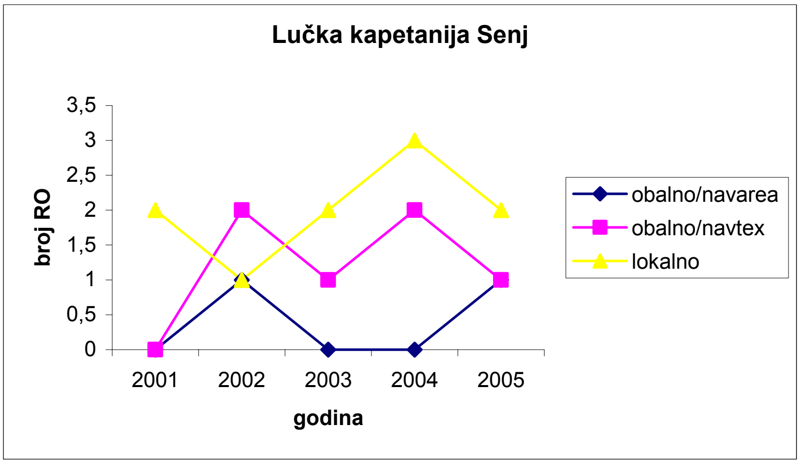


Figure 2.2.3 Distribution of radio notices in Senj

In Senj Port Authority there was an increase of radio notices COASTAL/NAVTEX in 2001/2002, decrease in 2003, a growth again in 2004, and a fall in 2005, but still higher than in 2001. Radio notices LOCAL are decreasing in 2002, after that increasing till 2004, and fall in 2005. Radio notices COASTAL/NAVAREA increased in the period 2001-2002, decreased in 2003, decreased again in 2004 and retained the same level in 2004, after grow in 2005.

Zadar Port Authority

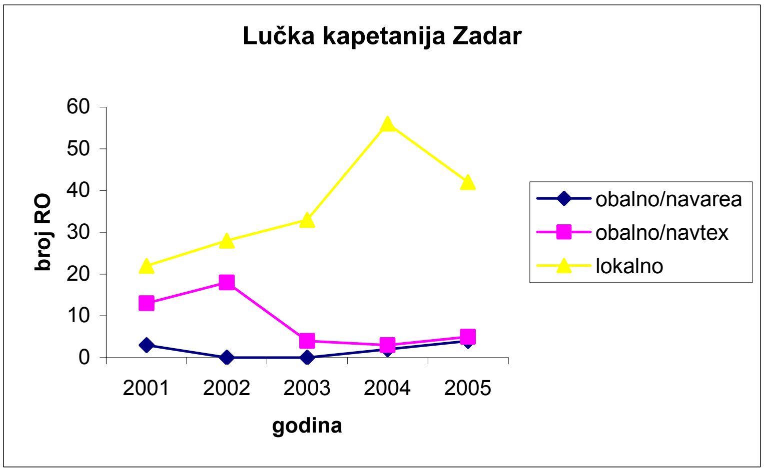


Figure 2.2.4 Distribution of radio notices in Zadar

In Zadar Port Authority there was first an increase of radio notices of the category LOCAL until 2004, to be followed by a decrease. Radio notices COASTAL/NAVTEX are increasing in 2004, to decrease after. Radio notices COASTAL/NAVAREA were decreasing until 2003, to increase in 2004/2005.

Šibenik Port Authority

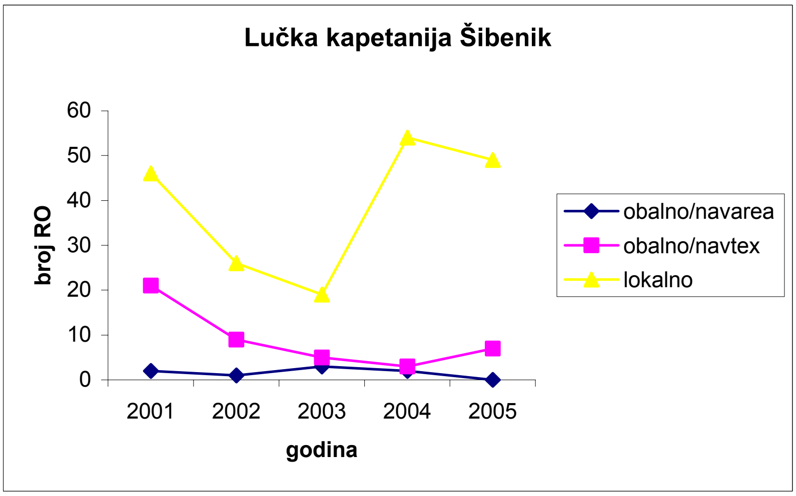


Figure 2.2.5 Distribution of radio notices in Šibenik

In Šibenik Port Authority radio notices of LOCAL categoty was decrease to 2003, and then an increase in 2004. Radio notices COASTAL/NAVAREA were slightly increasing until 2003, followed by an decrease in 2004 and a decrease in 2005. Radio notices COASTAL/NAVTEX were followed by a decrease from 2001 to 2004, to increase in 2005.

Split Port Authority

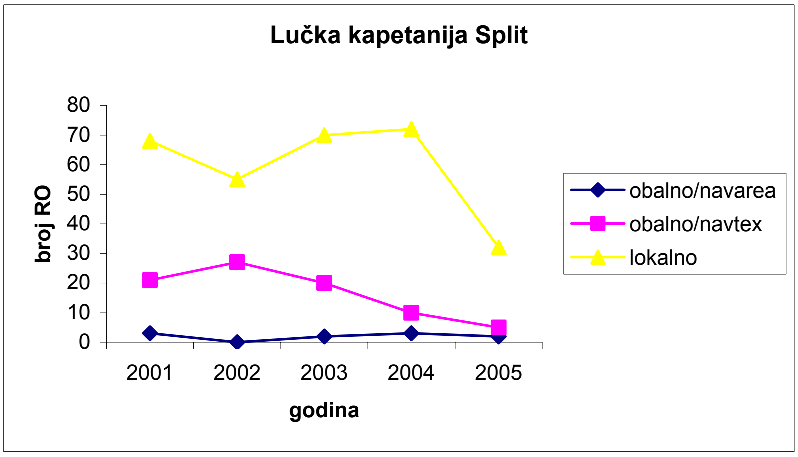


Figure 2.2.6 Distribution of radio notices in Split

In Split Port Authority there is a decrease of radio notices COASTAL/NAVTEX in 2002-2005. Radio notices of the category LOCAL a decrease in the period 2001/2002, to be followed by an increase in 2002 – 2004 and decrease in 2005. COASTAL/NAVAREA radio notices mainly remained at the same level, slightly increasing in 2004 and decreasing back to the same level in 2005.

Ploče Port Authority

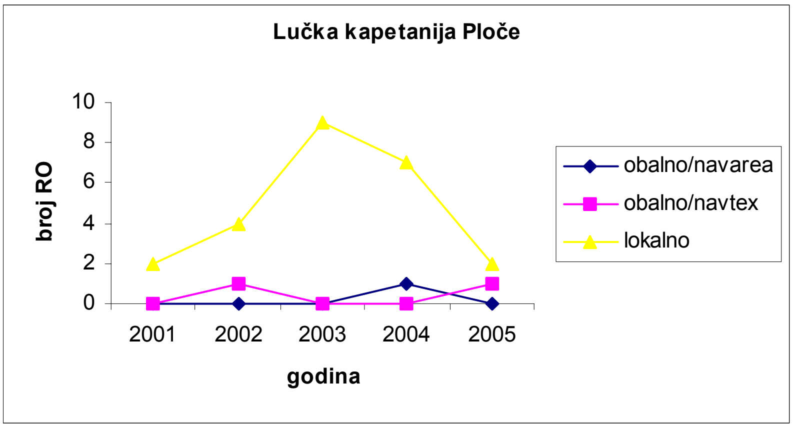


Figure 2.2.7 Distribution of radio notices in Ploče

In Ploče Port Authority there was an increase in the number of radio notices LOCAL till 2003 followed by a decrease in 2003-2005. Radio notices COASTAL/NAVAREA and COASTAL/NAVTEX slightly oscillated in observed period.

Dubrovnik Port Authority

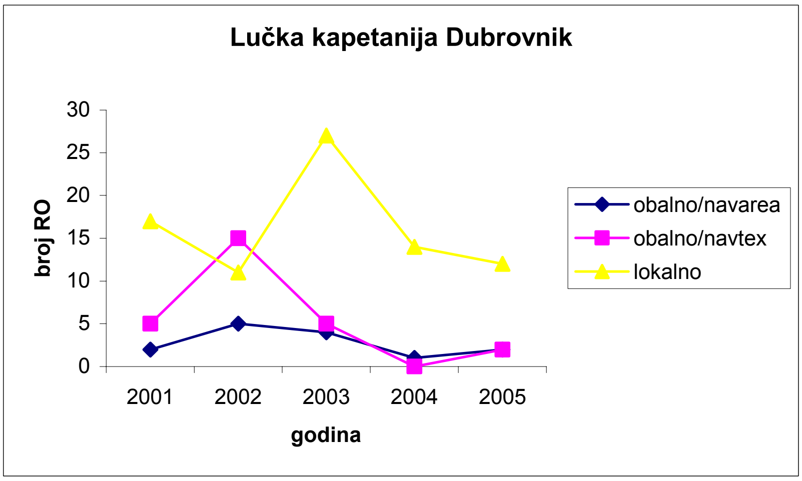


Figure 2.2.8 Distribution of radio notices in Dubrovnik

In Dubrovnik Port Authority there is a increase of radio notices COASTAL/NAVTEX in 2003, following a decreasing till 2004, and after increase in 2005. COASTAL/NAVAREA slightly oscillated and LOCAL were decreasing in 2001/2002, increased in 2003 and decreasing again in 2004, 2005.

Other sources
Other sources of radio notices are:
- Institution for maintaining navigational routes PLOVPUT, Split,
- Croatian Hydrographic Institute, Split
- Ministry of the sea, tourism, traffic and development, Zagreb, and
- Others.

Institution for maintaining navigational routes PLOVPUT

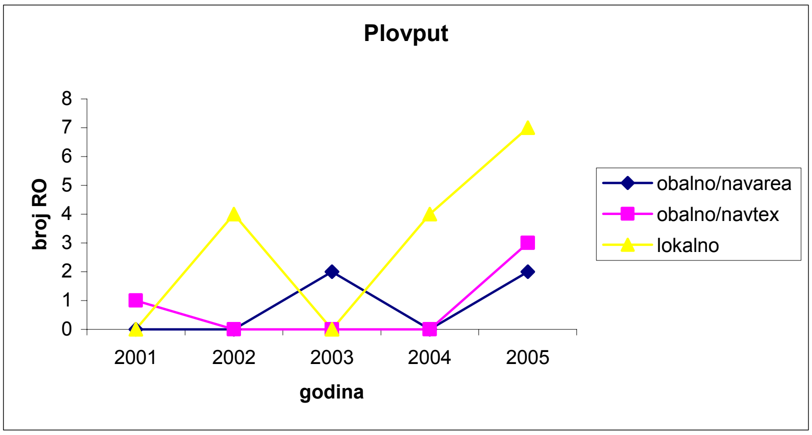


Figure 2.3.1 Distribution of radio notices by Plovput

The total number of radio notices broadcasted by Plovput is oscillated, and at the end of observed period are increasing.

Croatian Hydrographic Institute

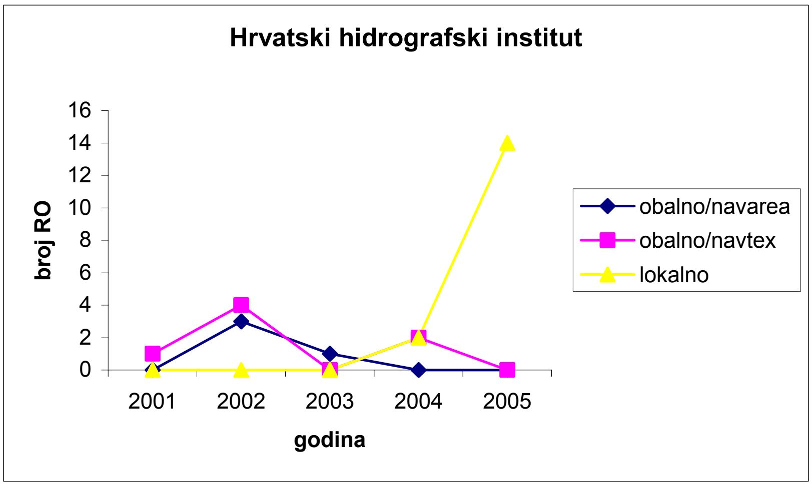


Figure 2.3.2 Distribution of radio notices by the Croatian Hydrographic Institute

The increase of radio noteces LOCAL especially in 2004 to 2005. Other category oscilate.

Ministry of the sea, tourism, traffic and development (MMTPR)

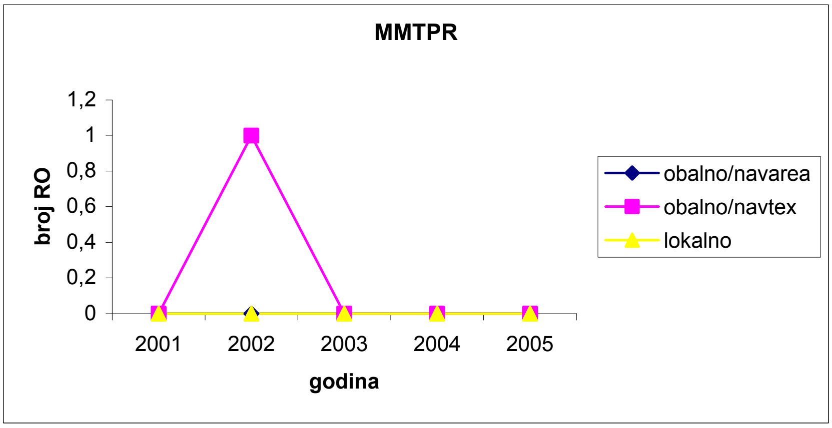


Figure 2.3.3 Distribution of radio notices by the MMTPR

Ministry of the sea, tourism, traffic and development has the right to broadcast radio notices in special circumstances (e.g. when the occurrence refers to the whole territorial sea of Croatia), which explains the low number of radio notices by the Ministry of the sea, tourism, traffic and development in the observed period.

2.4. Distribution of radio notices in Croatia, for all factors, according to the analysis, for the period 2001 – 2005

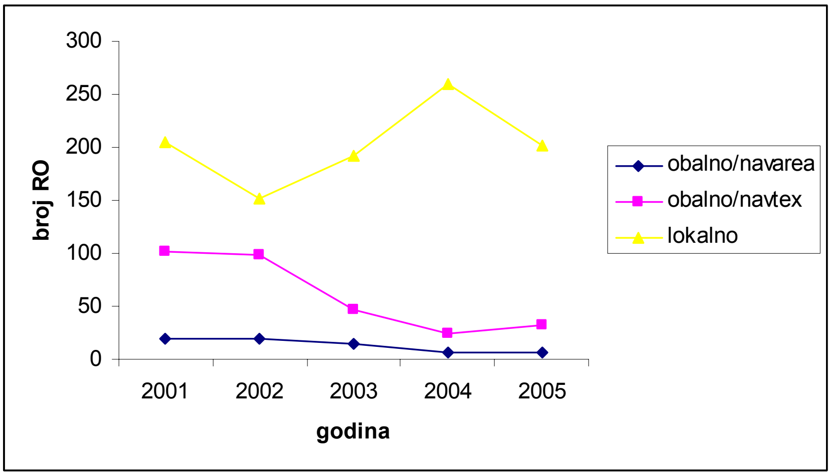
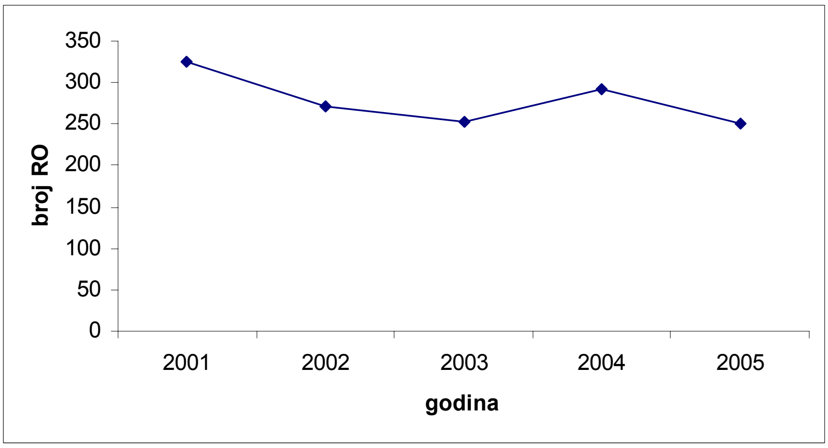


Figure 2.4.1 Distribution of all radio notices, according to the analysis

The number of LOCAL radio notices are decreasing in 2001/2002. followed by increase till 2004., after they decrease again. COASTAL/NAVTEX decreased in 2002-2004, slightly increased in 2005. The number of COASTAL/NAVAREA radio notices slightly decrease till 2005.



Total number of distributed radio notices for the period 2001 – 2005 in Croatia shows the oscillation in 2002 and an increase in 2004/2005. The growth can be explained by extended works at navigational safety objects: lights, jetties, coast etc., hydrographic and other researches, and by increased traffic in the Adriatic.

TABLE 2.4. Radio notices - average

YEAR	AVERAGE
2001	0.89315
2002	0.74247
2003	0.69041
2004	0.79726
2005	0,68767

The presentation of the average distribution of radio notices in Croatia in the observed five-year period indicates the fact that on average a minimum of one radio notice is broadcasted in two days, while in some of the years the average shows almost one radio notice a day. The number of consultations of the national coordinator personnel provided by means of telephone or telefax cannot be precisely defined, but it can be asserted that they are provided on daily basis. Consultations may become the basis for a radio notice to be broadcasted or not. The purpose of the study of the radio notices distribution average is to point to commercialisation trends, which may refer to ORPs as well (existence or not). On the basis of an insight into the radio notices distribution average, previous analysis of radio notices distribution and an insight into hazards for human lives at sea, it becomes obvious that the services for supplying maritime safety information to mariners is indispensable. These segments need to be separated from general trends, respecting the principle that everything that serves to the safety of human life at sea should not be commercialised2.

Further researches

The previous analysis of the original data allowed understanding of the issue of distribution of maritime safety information. It opened space to further scientific researches which relate to the analysis of the data, the analysis of the content of radio notices, understanding of the number of the of particular categories of radio notices, the speed needed for eliminating failures within the navigational area of port authorities, the frequency of certain hazards, the estimation of safety of navigation in navigational areas based on the distribution according to the time of occurrence and/or season.

2 The premise that someone might charge all telecommunication services (distress and general communication) prompted IMO to pass the Resolution A.707. (17) which defines which communication forms must be provided free of charge.

CONCLUSION

Human life is jeopardised to the greatest extent in maritime traffic means. In automated technological processes (increasingly in use for conducting ships) the reliability of information has crucial importance for the lives of people included in the process. Maritime safety information needs to be sufficiently reliable in order to obtain the satisfactory level of the ship from information aspect. The analysis of distribution of radio notices based on original data in Croatia, and the analysis of the categories of LOCAL, COASTAL/NAVAREA and COASTAL/NAVTEX for the observed period of five years undoubtedly proves the extreme importance of services which provide such information. It is necessary that the services included in the distribution of safety information, in accordance with the technology and GMDSS requirements, are brought to the level of reliability required by automatic processes. It is also necessary to conduct further researches indicated in this paper. The researches will provide understanding about the estimation of safety of navigation along the navigational areas based on the distribution of radio notices analysed in terms of port authorities, seasons and months, with the presentation of frequency of broadcasting about particular kinds of hazards and the speed of eliminating them or of their termination.

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EARLY WARNING
& ALERT SYSTEMS

ADVANCE EMERGENCY MANAGEMENT IN GAS PIPELINES INCIDENTS

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Keywords: Emergency Management, Gas Pipelines, Prevention Management, Mobile Mesh Networking Technology, Pipeline Integrity Management, ATLAS, AVL/GPS

Abstract

Advance Emergency Management applies well-established technologies in communications, control, electronics, and computer hardware and software. Advance Emergency Management in gas pipelines is intended to reduce notification and response time and mitigate the environmental impacts of gas pipelines incidents. The research reported in this paper attempts to reduce emergency projecting response times by usage of several modern technologies such as ILI, GIS, ATLAS, AVL/GPS and etc. [1]

Introduction

Natural gas is a nontoxic, colorless fuel, about one third lighter than air and has no smell in its natural state. Natural gas has a limited flammability range and a high ignition point. When mixed with air in the right proportion and ignited by a spark or flame, natural gas will burn or explode.
Natural gas is usually distributed in both coated steel and plastic pipelines. Steel natural gas lines may have pressures from 35 pounds per square inch to over 500 pounds per square inch and can be up to 24 inches in diameter. Plastic natural gas lines may have pressures up to 60 pounds per square inch (Intermediate High-Pressure) and can be up to 8 inches in diameter. Plastic natural gas lines will have a coated copper wire running parallel to the natural gas line. This wire is for locating purposes. [2]

Most distribution natural gas lines are not marked, except for temporary markings after someone contacts the one-call system. Pipeline markers indicate the approximate location of the high pressure pipelines and some larger Intermediate High-Pressure lines in rural locations. Pipeline markers bear the company name and emergency telephone number.

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Distribution natural gas mains are buried underground with service laterals installed for industrial, commercial and residential customers.
Natural gas has an excellent safety record and gas emergencies are not common. However, we believe people should know how to recognize and respond to a natural gas emergency if one should occur. [2]

A gas emergency is any gas-related event that: threatens the safety of any person or property; that causes damage to any part of the gas supply chain; that threatens the ability of the gas delivery system to meet customer demand; or that has the potential to do any of these. In many emergencies several of these events may be combined.
Most jurisdictions currently have a classification of gas incidents and emergencies, which provides for different levels of incident/emergency severity. The levels escalate from minor incidents such as a gas service pipe rupture affecting a small number of customers, to loss of gas supply jeopardizing the integrity of the gas supply network. [5]

Major Causes of Gas Pipelines Incidents

Damage to gas pipelines in Iran occurs most often because of these major causes:

- Earthquake
- Flood and river bank situations
- Mountainous regions
- Old age pipelines
- High populated regions close to pipelines
- Land sliding

Possible Signs of a Gas Pipeline Leak

Pipelines can be accidentally hit, dented, scraped or gouged. Sometimes, there may not be any apparent damage to the pipeline. When a pipeline is damaged, the supply of natural gas to homes and businesses could be interrupted. A damaged pipeline can leak natural gas – possibly causing fires, explosions or asphyxiation. Possible signs of a gas pipeline leak are usually: [6]

1. A blowing or hissing sound
2. Dust blowing from a hole in the ground
3. Continuous bubbling in wet or flooded areas
4. An odor similar to the smell of rotten eggs
5. Dead or discolored vegetation in an otherwise green area
6. Abnormally dry or hardened soil
7. Flames, if a leak has ignited

Prevention Management

<u>Pipeline Safety</u>
According to Federal Program and Reauthorization Issues, DOT statistics indicate that excavation damage, by such third parties as construction companies and highway crews, is the major cause of pipeline accidents for natural gas transmission and distribution pipelines. Excavation damage is the second leading cause of accidents for hazardous liquid pipelines, after corrosion, according to DOT. Other major causes of pipeline releases include material defects and pipeline operator errors. Significant releases from pipelines happen infrequently; however, when they occur, they attract much attention. [8]

In order to reach high preparedness during gas pipelines incidents, four emergency exercises and four leak inspection emissions are being held annually in Iran.

Pipeline Integrity Management

Pipeline management requires a delicate balance of many factors, including technical and managerial skills, financial resources, and environmental compliance. As pipeline infrastructures age, inspection and maintenance programs are needed to maintain integrity, promote longevity and incidents reduction. However, the selection of appropriate, yet cost-effective, methods is still widely considered to be more of an art than science. There are numerous factors to consider in pipeline management: design, construction, operation, protection, inspection, maintenance, repair and rehabilitation.

A key management tool involves qualitative and quantitative or probabilistic risk assessment (including both hazard identification and evaluation), as well as risk control and reduction. Performance monitoring and evaluation through periodic reviews of the management system also are important. The goal of such programs is to use inspection, monitoring and maintenance to prevent structural integrity problems, especially those that jeopardize public safety or the environment.

There are three aspects to consider in dealing with pipeline integrity: prevention of loss, detection of loss, and response in the event of loss. To prevent loss of integrity, pipeline inspections are a fist-line defense.
Furthermore a GIS map with several important layers such as populations, earthquake zones, flood vulnerable regions and etc can be a valuable help. [7]

In-line Inspection Technology to Detecting Mechanical Damage

Mechanical damage is the most common cause of pipeline incidents for both gas and hazardous liquid pipelines. Many of the incidents are in areas previously located in sparsely populated regions, but as construction and populations have expanded, are now located within and adjacent to significant population centers. Pipeline operators, in addition to everyday operations, must now take into account the activities on and near pipeline right-of-ways that occur as municipalities and industrial centers expand.

Accurately determining areas that have been subjected to mechanical damage has become one of the priorities facing pipeline operators today. As in-line inspection (ILI) tools become more sophisticated, the expectations of accuracy in identifying certain features are considerably higher than was the case as few as ten years ago. Operators are being encouraged to make greater utilization of the inspection technology and tools available; and with the additional information provided from these tools and other methods, maintain or improve upon an already exemplary safety record.

The need for a safe, reliable, and efficient pipeline system becomes more crucial as energy consumption continues to increase. To that end, helping to provide a safer and more efficient delivery system may be one of the benefits of the second quadrant magnetic flux leakage (MFL) technique.

Advance Emergency Management

Applications and Technologies

Several applications and technologies can be deployed and integrated to support gas emergency response work: [1]

- ATLAS – Automated mapping (AM), Facilities Management (FM) and geographic information system (GIS). The automated mapping component captures gas and electric distribution maps, and detail plates along with other graphical layers used to design new gas and electric facilities. The FM component interfaces to existing corporate gas and electric business databases that store "facility" information (such as service pedigree and location) to the graphical images to provide intelligence to the network model. A landbase, which includes aerial photography (in the background) , includes vector features, road centerlines and edges and other features used to develop a spatially accurate depiction of gas and electric facilities. ATLAS interfaces with the Mobile Dispatch System to provide the geographical location of all gas work orders, and provides the landbase information and the vector information. It is also the basis for the Mobile Maps application.

- A geographic grid system, which was traditionally used to key gas and electric distribution maps and records and locate equipment into some grids.
- The Mobile Dispatch System provides real-time work order dispatching from the office to field crews. It runs on desktop computers and "hardened" laptops mounted in service vehicles. It allows any field personnel to obtain job information on their in-vehicle computers and to provide job status and completion information using the same device. Communication is done over public and private wireless networks.
- The SkyView application uses the ATLAS landbase and in-vehicle Automated Vehicle Location (AVL/GPS) to provide job location and a view of the crew's location relative to the service territory for the crew, dispatchers and supervisors.
- Mobile Maps provide crews with gas and electric drawings for the service territory. It is updated electronically when someone enters one of the wireless network access points (typically at a service center).

Figure1. Advance emergency management integrates the technologies in the left hand and results the benefits in the right.

Integrating technologies has led to numerous benefits: [1]

1. Team well being – field employees are able to locate and complete work more efficiently.
2. System updating directly – gas emergency information is updated more quickly and is immediately available to the dispatcher.
3. Safety – dispatchers use SkyView to pinpoint crew's location if there is a problem.
4. Effectiveness – wireless communication allows faster dispatch, a quieter control/dispatch room, and reduced dispatcher/field crew radio time. MDS coupled with AVL through SkyView provides a graphical representation of the work and the resources available, which help the dispatcher more readily identify the closest resource to reduce drive time.
5. Emergency response – because the dispatcher has the SkyView application, he is able to see his position relative the assigned job to determine the best route.
6. Cost savings – as a result of more efficient scheduling, the number of full-time employees has been reduced and over time reductions have occurred.

<u>Mobile Mesh Networking Technology</u>

New wireless technologies being developed may dramatically improve communications for defense among federal, state and local officials. Staying in touch by wireless e-mail has become essential during a national disaster such as a gas pipeline huge incident, just as it is during routine operations. E-mail has become the most used communications technology in organizations, even more than the phone.[4] But mobile communications can go down during a disaster. One way to keep the networks online being pushed by some technology developers is mobile mesh networking technology, which is based on a combination of mobile technologies and can be deployed very quickly when conventional mobile lines go down. One of these emergency-response new technologies is Iridium-based mobile telephones, which can help government and business set up emergency "command centers" after a disaster.

Response to Pipeline Incidents

In the event of a suspected natural gas emergency: [4]

1. Isolate the area and restrict entry to trained emergency response personnel.
2. Establish isolation zones based upon measurements from combustible gas indicator instruments. Gas odor or lack of gas odor is not sufficient to establish safe zones.
3. Avoid creating sparks. Potential ignition sources for natural gas include electrical motors, firearms, static electricity, non-explosion-proof flashlights or tools, and any open flame or spark. Do not light a match, start an engine, use a telephone, switch lights on or off, or do anything that may create a spark.
4. Immediately make the operator aware of the situation. Check the posted right of way or station signs to find out what company operates the pipeline and how to contact the operator.
5. Let the escaping gas burn if it is on fire. Attempting to extinguish a natural gas fire may result in a secondary explosion. If necessary, provide cooling for nearby exposures that are threatened by the fire.
6. Avoid forced ventilation of structures and excavations. Forced ventilation can actually increase the possibility of a flammable atmosphere.

If gas escaping from broken/leaking line: [2]

1. Turn off machinery and prevent other sources of ignition such as open flames, vehicle engines and the operation of electrical switches or cellular phones.
2. Evacuate everyone from the endangered area and prevent vehicles and bystanders from entering the area.
3. Do not attempt to make any repairs or operate natural gas valves unless instructed to do so by professional personnel.

If escaping gas catches fire: [2]

1. Evacuate the area and prevent others from entering.
2. Do not attempt to put out flames. Putting out a gas fire without stopping the supply of gas could cause a more serious danger.

If a fine is pulled, jarred, or if coating or locating wire is damaged: [2]

1. Stop all work and check for the sound and other signs of escaping gas in the area.
2. Do not attempt repairs or backfill until the related Gas Company has repaired any damage. Unrepaired damage to a gas line or coating will eventually cause a failure to occur. Unrepaired damage to a locating wire will cause difficulty in properly locating a plastic gas line in the future.

[4] Marty Hollander, vice president for marketing at Cemaphore Systems Inc.

Results and Conclusions

Since implementing the Advance Emergency Management, the number of emergency and potential emergency calls responded to in 60 minutes or less by four percent has been increased. The average response time for all jobs has also been reduced by more than five minutes – an improvement greater than twenty percent. Deploying AVL technology with the MDS rollout can be very suspicious. Emergency employees and dispatcher who use the system see first-hand the convenience of being able to immediately view where they are with respect to the job and view the best route to get to the job. Employees no longer need to waste time looking for directions on paper maps. They also appreciate the added measure of safety they feel because the dispatcher can see them, knows where they are, and is able to provide assistance should they need it. [1]

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HAZARDOUS – FLOOD EARLY WARNING SYSTEM

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Keywords

Urban flash flood, Early warning system, system integration, ontologies, GIS, SCADA

Abstract

This paper shows the preliminary results of Hazardous research program, still in progress and supported by "POR Sicilia 2000-2006 Misura 3.14". The coordinator of the project is Proteo S.p.A., an Italian SME specialized in developing environmental ICT solutions; the partners are:_the University of Palermo, the Civil Protection of Catania and Palermo towns, the Campania Region Fire Department, Sicily Hydrographic Office. The main aim of Hazardous is the design of an urban flash flood early warning system. In particular this paper describes the approach used to integrate the GIS component with the heterogeneous remote sensing system and with the real time applied model. This target has been achieved by providing a sharable knowledge base, based on ontological development and integration, to satisfy the need to master and integrate all the software system components that are SCADA (Supervisory Control and Acquisition Systems) / GIS (Geographical Information Systems) / DSS (Decision Support Systems). Two prototypes of the Hazardous system will be implemented and located in Catania and Palermo: the two biggest towns of Sicily.

Introduction

In order to successfully manage natural hazards, the need is to identify, assess and control various factors that contribute to harm in the supervised area. These factors depend on a large set of heterogeneous information, which is often owned by different entities, and which ranges from sensor data, communication vectors, demographic data, land use data, available transportation etc.. All this information needs to be integrated to allow seamless use and consistent management, and then they need to be processed and reliably-and quickly communicated. In order to achieve this goal the challenge is to move from traditional centralized control systems to a distributed heterogeneous array of devices, with complex logical and physical interactions (Murray et al., 2003). The side effect of such a novel approach is the growing need of tools, which are able to guarantee the coherence and consistency of data and services distributed among the remote locations. Commercial Supervisory Systems provide monitoring and automatic protection functions, but they are not usually able to provide early warning detection, and in-depth warning diagnosis. A key issue in safety critical systems (EC, 2000) is warning diagnostics, as they are early warning systems of natural hazards. Therefore advanced supervision methods are necessary in order to overcome the supervision methods based on the classical limit value (Isermann, 2004). Several different innovative approaches and methods for supervision, early warning, fault detection and diagnosis have been recently developed (Isermann, 1997). Each method is specialized to solve a specific kind of problem, and it is based on different knowledge bases of the supervised system. As a consequence, in order to cover the needs of a safety critical application, the optimal strategy is based on a framework of integrated use of different

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methods (Ploix et. al., 2003). Furthermore the role of decision making in the field of widespread systems control is becoming an increasingly key item. This decision making includes high levels of abstract reasoning based on soft computing and Artificial Intelligence (AI) (Murray et al., 2003). Since each of these different approaches and methods is based on its own knowledge base, the main problem to overcome is to provide a holistic and consistent conceptual model of the supervised system.

The conceptual model would represent the result of the integration among all the different knowledge bases used to carry out the supervisory system. The main goal of the integration process is to develop a conceptual model that supports an interdisciplinary approach for the management of the whole flash flood early warning system. Experts from different disciplines involved in the flash flood management, as well as the different components of the distributed supervisory system as software agents and application systems, as SCADA, GIS, software simulation models, DSS, require access to the same data, but for different purposes. As a consequence, they can overlap different kind of structures, meanings and relations to the same data. Ontologies have been developed in AI to facilitate knowledge sharing and reuse. In general ontologies provide a common understanding of a domain and an explicit conceptualization that describes the semantics of the data (Gruber, 1993). Moreover ontologies are defined as a formal specification of a shared conceptualization, generally based on first order logic (Artale et al., 2004), that must be machine readable (Studer, 1998). Hazardous deals with the design of a Rule Based Expert System (RBES) able to provide on line early warning of flash flood consequences, fault detection and diagnosis of the early warning system, contributing a machine readable integrated conceptual model of the whole system.

In this research programme techniques are being developed for the automation of data analysis and interpretation, so that the potential of data sources is fully realised. These tools will maximize the benefit of available data for informing early warning systems, since the capability to get, in real time, knowledge from data is essential for the efficient and effective management of flash floods to protect public health. This goal will be achieved through the development and application of a novel artificial neural network named Cellular Neural Network (CNN) (Chua, 1988) that is able to provide real time modelling of physical phenomena represented by Partial Differential Equations (PDE).

The CNN paradigm can be used to compute the transience of PDE after spatial discretization. The solution of these equations requires spatial discretization with an appropriate numerical integration method to reduce the PDE to a set of Ordinary Differential Equations (ODE). This set of ODEs can be mapped in a CNN array and its transience gives the solution (Szolgay, 1993). By using CNN, faster computation of PDE can be achieved; this huge computing power may be useful when real time solutions of PDEs are required. This work will investigate a CNN architecture able to map the 2D spatial numerical integration schema for preserving the qualitative properties of PDEs.

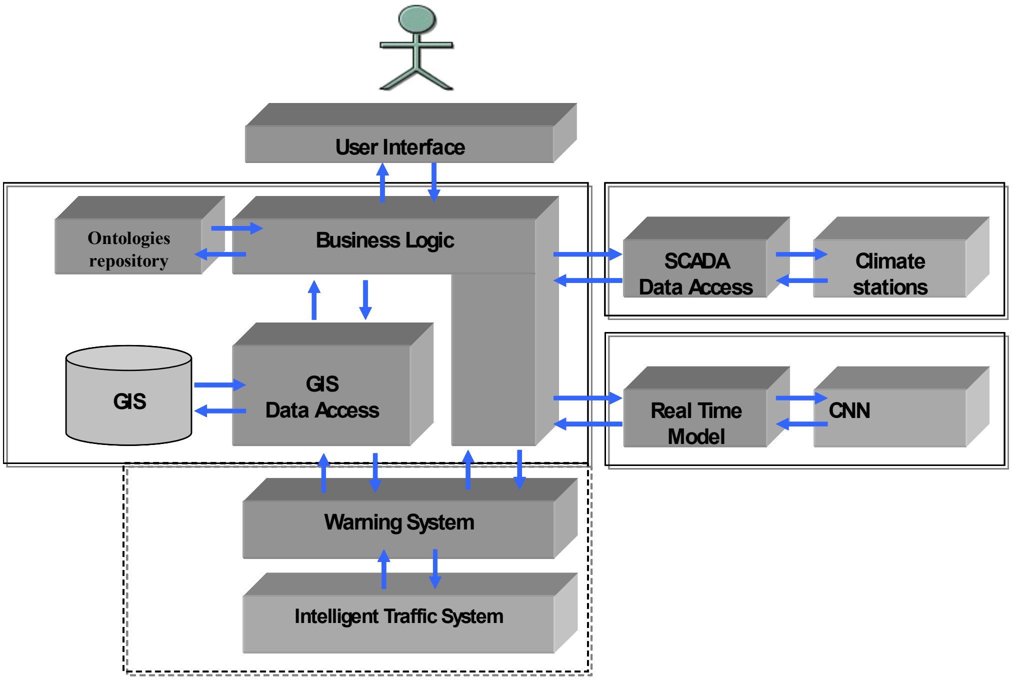
Hazardous architecture

The main goal of Hazardous platform is urban flash flood nowcasting and warning. After the hazard has been recognized, because of the short time frame available to forward the warning, Hazardous exchanges information directly with the people affected by the flood. The main communication channel, chosen by Hazardous to warn the people in danger, is a network of electronic signs suitably distributed in the urban area.

Hazardous platform masters and integrates an heterogeneous system of climatic and hydrometric sensor networks, owned by independent meteorological services. The real time processing of rain and flow level gauge data allows Hazardous system first to track the storms and thus to nowcast flash floods, and then to provide an early warning about the imminent hazard.

Main Hazardous components are: the GIS, the Warning System integrated with the Intelligent Traffic System (ITS), the distributed SCADA, which manages the Remote Sensing Systems, the Cellular Neural Network module (CNN), and the User Interface module (UI). All the components are loosely coupled via Web Services, by using a middleware architecture that in the following figure is represented by the Business Logic layer.

Fig 1 – Hazardous architecture

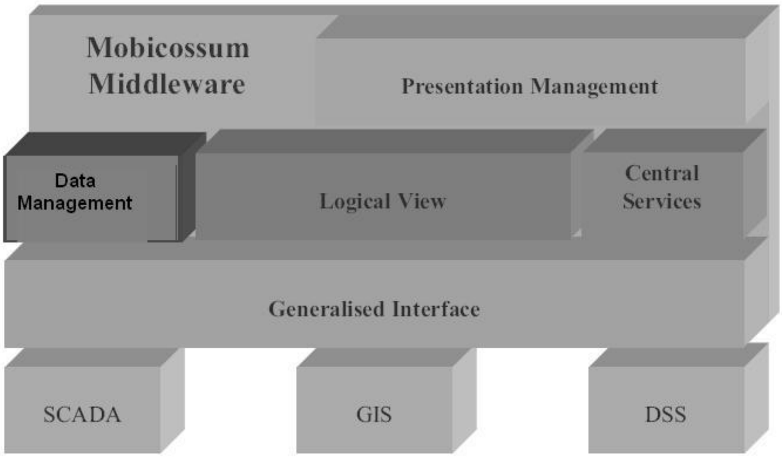


Web Services are simply software applications that can be integrated one to each other, by using open Internet standards, HTTP and XML. Web Services offer an infrastructure to easily integrate multi platform distributed application, because they are URL (Universal Resource Locator) addressable resources that return information to clients who want to use it. One important Web Services feature is the fact that the Web Services represent black-box functionality that can be reused whatever service is implemented. Web Services provide well-defined interfaces, called contracts, which describe the services provided. Developers can assemble distributed applications using a combination of remote services, local services, as well as custom code.

The middleware architecture used to integrate the Hazardous components is based on a previous research project named Mobicossum (Advance Mobile Computing Software System for Utilities Management) (Cavalieri et al, 2004a). Mobicossum platform offers high level services to support the interaction between mobile operators and a pervasive system of distributed elaboration sources as an array of heterogeneous SCADA Systems, Geographical Information Systems, and Decision Support Systems.

As shown in figure 2, the Generalized Interface (GI) (Cavalieri et al, 2004b) is placed at the lowest level in order to provide basic access to the SCADA, GIS and DSS applications. The GI offers a unique set of services, internally mapped to the real services offered by each set of SCADA, GIS and DSS applications. The set of services made available by the GI can be directly handed by a user, or may be accessed by the other components of Mobicossum Middleware. For this reason, the other components are placed at a higher level. The client (mobile user) interface is represented by the Presentation Management, placed at the top of the Architecture.

Fig 2 – Mobicossum architecture



The following section briefly explains how Mobicossum platform has been extended to include semantic integration capabilities in order to ensure flash flood management.

Semantic integration of Hazardous software components via ontologies.

A key role in the Mobiccossum architecture is the Data Management (DM) component (figure 2). In fact DM ensures the cooperation among heterogeneous information systems. Successful integration among heterogeneous information systems needs more than physical connectivity; firstly it needs to know what information is needed to be accessed, determining where they are and how they can be acquired, and secondly it needs to interpret that information within the appropriate context. Mobicossum DM answers the first requirements, the DM derives from the need of data brokerage inside Mobicossum. Mobicossum users could have no idea about the location of information they need and about the application that maintains the information. For this reason data brokerage is aimed to identify real applications containing data requested by the user and to identify real tag (ID) of these data inside each real application, in order to read/write each datum. According to the internal architecture of Mobicossum, DM has the task to perform data brokering, as explained in the following. The real application (SCADA, GIS, DSS) exports its methods by using Web Services. Each application may have one or more Web Services, because each application's Web Service is able to perform specific operations. An Application Identifier (ApplicationID) is assigned to each real application. In Mobicossum environment this parameter must be unique and it is assigned to the real application, in the moment of the integration of the real application into Mobicossum. DM supports reliable data brokering providing high level services as the following functions:

- GetApplicationIDbyModelName
- GetApplicationIDbyPlant
- GetApplicationIDbyUserCoordinate
- GetVarsIDbyDeviceType
- GetVarsIDbyUserCoordinate

In the Hazardous project DM capabilities have been extended to ensure semantic interpretation of heterogeneous software services and data, and to ensure their reconciliation in case of semantic conflict. The designed ontology is able to manage several kinds of relations among the spatial entities and the spatial process models, used to simulate dynamic urban floods.

In Hazardous spatial process models are used in order to track the storm motion and to simulate the evolution of shallow flows. For these two different kind of spatial process models both Eulerian and Lagrangian conceptual views have been used. Storm movement has been described as a Lagrangian motion on an urban area; on the contrary water runoff caused by the storm has been modelled as an Eulerian change over the time.

Four main kind of relations, among spatial entities, and spatial process models, have been taken into account (Brown, 2004):

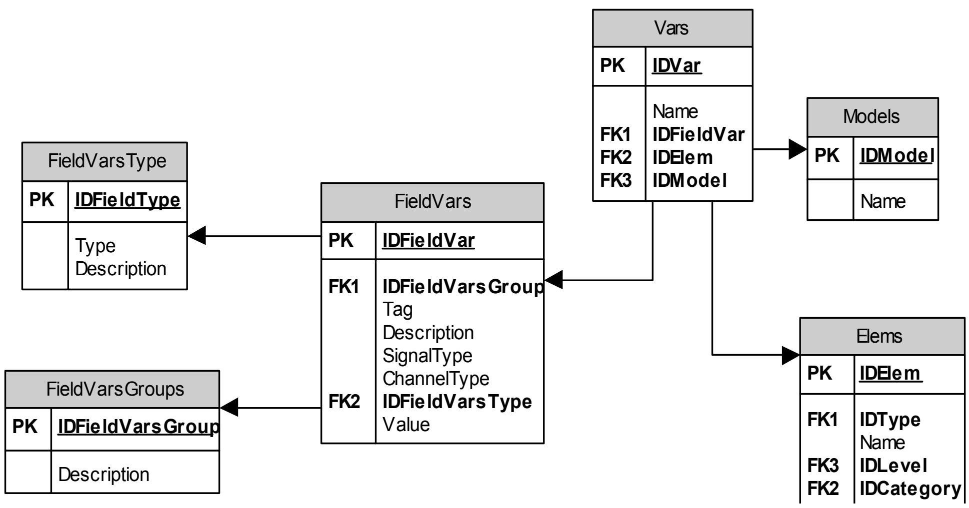
- *Identity relationships*: a spatial features associated with agents, which are used to simulate a spatial process over the time, can move or change, and attributes of features associated with agents can change.
- *Causal relationships*: agents have the ability to take actions that affect spatial features and/or their attributes, even if there is no identity association between the agent and the spatial features it is acting on
- *Temporal relationships*: the actions of the agents and the updating of attributes or locations of features can be handled using synchronous or asynchronous approaches.
- *Topological relationships*: movement of spatial features can require basic information about the physical world or spatial relationships between features.

The ontology has been designed modelling the relation among four main kinds of concepts:

- *Models*: set of spatial process models used in the system.
- *Elements*: set of objects represented in the system. Each element belongs to one or more models.
- *Vars*: set of time varying attributes. For instance, SCADA variables are represented in this class. Each Var is ever linked with an element and a model, but not vice versa.
- *Events*: set of events which can happen; each event impacts on one or more elements, and an element can trigger events.

The following figure shows the Vars ontology, and its relations with other entities as Models and Elements.

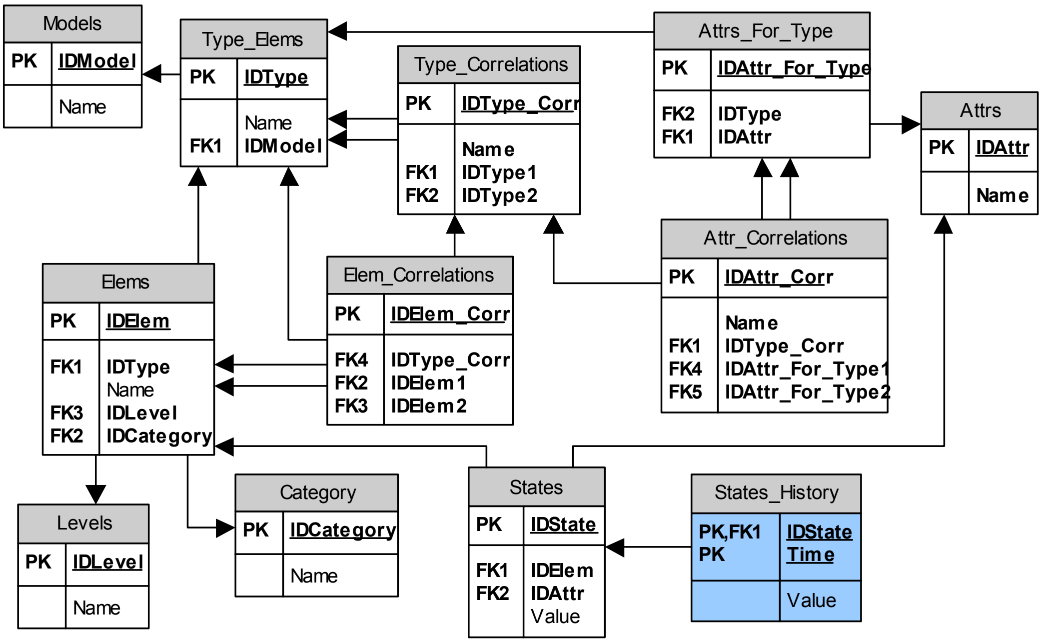
Fig 3 – Ontology of SCADA variables



In the following figure (figure 4) the relationship between Elements and Models is explained. It is of interest to note that the same object could be represented, inside different kinds of models, by different elements, and that these distinct elements could share some attributes.

For instance a street could be represented in a traffic model as a transportation means, used by road haulage or by pedestrian traffic; the same street, during a flood, could be represented as an escape route or alternatively an open channel in which the water level and/or its velocity is temporarily too high.

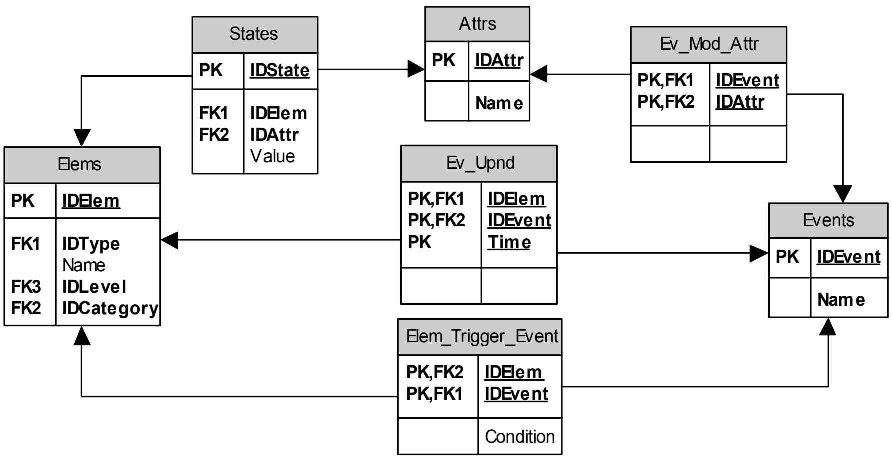
Fig 4 – Relationship between Models and Elements



The States History table (figure 4) permits to manage states that change over the time and to simulate scenarios in extended time.

Finally the last designed relationship is between Elements and Events. In this case it has been modelled how an element can trigger an event, or alternatively an event can change the status of an element. The relationship between Elements and Events has been shown in the following figure (figure 5).

Fig 5 – Relationship between Elements and Events



The conceptual model, briefly described above, has been implemented by using OWL (Ontology Web Language) and embedded in the Mobicossum DM.

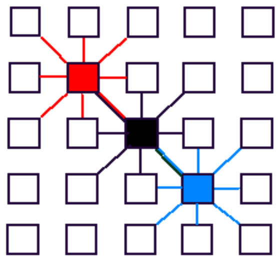
By this way Hazardous Business Logic (figure 1) is able to automatically check, by using in real time a RBES as reasonor, the reliability of the processed data and the consistency of the knowledge derived from these data.

Modelling flash flood by CNN

The hydraulic simulations, based on novel real time simplified numerical models, allow on-line early analysis of risks related to flash flood events, based on the real time SCADA database. By this way the simulation results, as well as the input GIS and SCADA data, are used by the Decision Support System in order to provide the emergency manager and the operations staff data necessary to identify an event, locate the extent and the potential danger, and prepared to react in a proper and timely way. For this purpose, in Hazardous project, Cellular Neural Networks are used to model in real time urban flash floods.

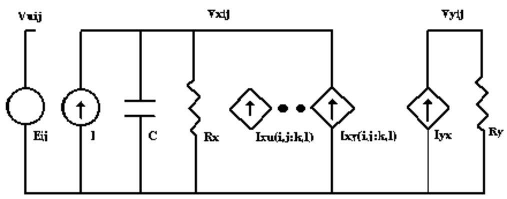
CNN is a natural and flexible framework for describing locally interconnected, simple, dynamic systems that have a lattice-like structure (figure 6). They consist of arrays of essentially simple, nonlinearly coupled dynamic circuits containing linear and non-linear elements able to process in real time large amounts of information.

Fig 6 – Lattice-like structure of a CNN



The main advantage of this novel architecture (Fortuna et al, 2001) is that it is easily suitable for analog implementation (figure 7). Their structure, tailor made for VLSI (Very Large Scale Integration) realization, has led to the production of some chip prototypes that, once embedded in a computational infrastructure, produced the first analog cellular computers. This new architecture is able to perform time-consuming tasks, such as image processing and PDE solution.

Fig 7 – VLSI implementation of a CNN



The equation that regulates the behaviour of a CNN structure, is:

$$\dot{x}_{i,j}(t) = -x_{i,j}(t) + A * y_{ij}(t) + B * u_{ij}(t) + I$$

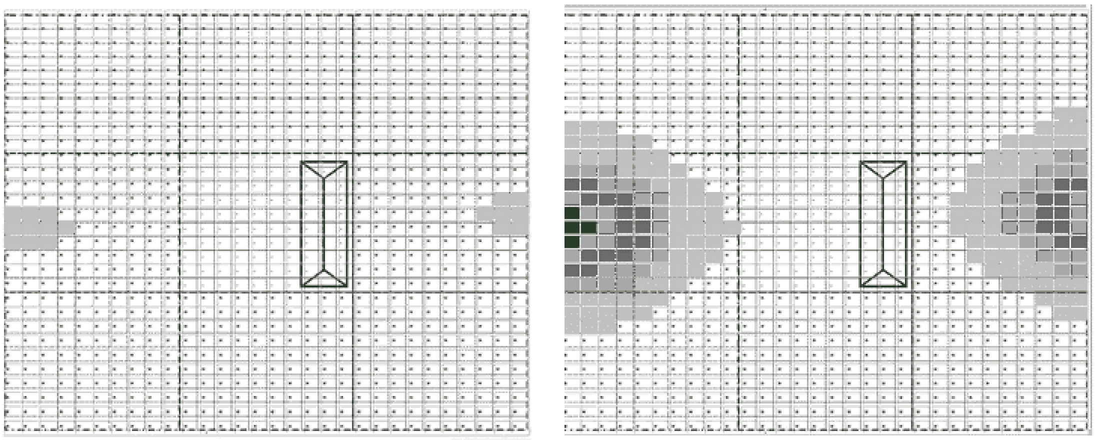
where *u(t)* is the input of the cell, *x(t)* represents the state variable, *y(t)* is the output of the cell, and *A* and *B* are, respectively, the feedback template coefficients and the control template coefficients. The feedback and control template represent the coupling coefficients of the cells and they completely define the behaviour of the network with a given input and initial condition. *I* represents the Bias term used to model the watershed topography.

It is shown (Chua et al., 1995) as a paradigm for several spatio-temporal phenomena occurring in reaction diffusion PDEs. In particular PDEs and CNNs share the property that their dynamic behaviour depends only on their local interactions. Recently CNN has been used as solver of PDE for several complex tasks as lava flow modelling (Del Negro et. al, 2005). Therefore in this project CNNs have been used to solve the Navier-Stokes equation of fluid motion.

Results

Hazardous platform is still under implementation. Two prototypes climatic and hydrometric stations are going to be installed. In particular in the urban area of Catania 6 rain gauges and 5 hydrometric gauges, able to measure the water level in the urban drainage network, are being located. In the urban area of Palermo 2 rain gauges and 2 hydrometric gauges, are being located as well. Hazardous platform will supervise all the climatic and hydrometric stations by using a wireless network (GPRS). Hazardous will integrate these data with the existing climate network owned by the Hydrographic Office of Sicily. The CNN simulator is actually under implementation. The following figure shows some preliminary results of a flood propagation in a test scenario, provided by the CNN simulator.

Fig 8 – Modelling water flood by CNN



Conclusion

In this paper the preliminary results of Hazardous research program, actually in progress, has been described. In particular this paper shows the approach used to integrate the GIS component with the heterogeneous remote sensing system and with the real time model used. A novel supervisory platform has been designed, in which data brokerage services have been extended to ensure semantic interpretation of heterogeneous software services and data, and to ensure their reconciliation in case of semantic conflict. An ontology has been designed, which is able to manage several kind of relations among spatial entities, and spatial process models. A CNN framework has been used to design a real time simulator which is used to simulate in real time urban flash flood.

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GLOBAL DISASTER ALERT AND COORDINATION SYSTEM

MORE EFFECTIVE AND EFFICIENT HUMANITARIAN RESPONSE

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Keywords

Disaster alerts, Humanitarian aid, GIS, Web technology, Consequence modelling

Abstract

The Global Disaster Alert and Coordination System, jointly developed in 2005 by the European Commission and the United Nations, combines existing web-based disaster information management systems with the aim to alert the international community in case of major sudden-onset disasters and to facilitate the coordination of international response during the relief phase of the disaster. The disaster alerts are based on automatic hazard information retrieval and real-time GIS-based consequence analysis. This paper shows how information systems in general and GDACS in particular can improve efficiency and effectiveness of humanitarian response.

Introduction

All major donors of humanitarian aid agreed in 1995 in the Madrid Declaration[2] that international response to disasters should be independent and impartial or, in other words, needs-driven. In a recent report of the United Nations Office for the Coordination of Humanitarian Affairs (OCHA, 2006) on the effectiveness and efficiency of humanitarian aid, emphasis is put on accurate assessment of the humanitarian needs, partially to be achieved by improving the information exchange between humanitarian responders. The United Nations have organized response in 9 "clusters" (OCHA, 2006). These clusters (Table 1) represent broad categories of needs during a relief operation and can be divided in relief needs for the affected population (e.g. how much emergency shelter is needed) and information needs for responders (e.g. how can we organize logistics in order to get emergency shelter to the affected population).

Table 1. Need clusters used by the United Nations.

Information needs for responders
• Camp Coordination and Camp Management
• Logistics
• Early Recovery
• Emergency Telecommunications

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2 http://ec.europa.eu/echo/pdf_files/madrid_declaration_en.pdf

Relief needs for affected population
• Emergency Shelter
• Health
• Nutrition
• Protection
• Water, Sanitation and Hygiene

While it is essential to qualify and quantify these needs for each particular disaster in order to target an effective response, there are other information needs that are as important to set up an efficient response. Firstly, the international humanitarian community must be made aware of the disaster through early warning (before the disaster strikes) or alert (immediately after it occurred). Secondly, an understanding of the size and characteristics of the disaster is essential for good response. In particular in a complex and heterogeneous community like the international humanitarian community, efficient response can only be planned if it is coordinated. Coordination of response requires a clear situational awareness by the whole community.

Table 2 shows the list of information needs for an efficient and effective response. Typically, the main sources for such information are:

- The local government, with its local emergency management authority (LEMA): this is the main source for official information on the scale of the disaster.
- The Office for Coordination of Humanitarian Affairs (OCHA): with the mandate to coordinate humanitarian response, OCHA is the central hub for relief and response information. OCHA sends disaster assessment and coordination (UNDAC) teams to the affected area to collect information, sends search and rescue teams (through the INSARAG network) to rescue affected people, sets up an On Site Operations Coordination Centre (OSOCC) and/or humanitarian information centres (HIC) and disseminates all information through a website (ReliefWeb). However, many of these mechanisms are only deployed if needed. This decision requires information from other sources.
- The international media is a rich source of information. However, not all that is reported in the media is true. Automatic collection and analysis of news (e.g. European Media Monitor, Best, Van Der Goot and De Paola, 2005) has the advantage of quantity: many news sources can be processed. Manual collection and analysis of news (e.g. ReliefWeb) has the advantage of quality: resulting information is more reliable.
- Automated consequence analysis is an alternative source of information: after collecting global datasets of sufficient detail on population, vulnerability, key assets and critical infrastructure, transportation lines and populated places, these datasets can be analysed and relevant information can be extracted.
- Early warning and alert systems: timely knowledge about the occurrence of a natural hazard is critical and can be provided by geophysical, meteorological or other measurement systems, optionally combined with a humanitarian impact assessment.

Table 2. Information needs and providers in humanitarian response. X indicates areas where information is available for a particular need. Shaded cells indicate areas that are at least partially covered by GDACS.

Task	Information needs	Hazard alert or early warning	Automated consequence analysis	Media	Operations Coordination Centre	Local Emergency Management Authorities
Early warning and alert	Assess need for international intervention	X		X		X
	Determine affected area	X	X	X		X
Situation awareness	Assess incident	X	X	X	X	X
	Assess affected population		X	X	X	X
	Assess damage		X	X	X	X
	Assess Critical Infrastructure and Key Assets		X		X	X
	Assess indirect or secondary effects		X		X	X
Provide efficient response	Camp Coordination and Camp Management		X		X	
	Logistics		X		X	
	Early Recovery		X		X	
	Emergency Telecommunications					
Provide relief to affected population	Health (death, injured, need for medical care)		X		X	
	Emergency Shelter		X		X	
	Nutrition		X		X	
	Protection				X	
	Water, Sanitation and Hygiene				X	

Information systems play an increasing role in all these information sources. The latter two (automated consequence analysis and early warning and alert) are fully automatic and, therefore, produce information in near-real time. Media analysis can be automated to a certain extent. But also information that traditionally has been exchanged through telephone, telex or fax can now be shared through web-based platforms. OCHA has developed such tools.

This paper shows how information systems can improve efficiency and effectiveness of humanitarian response. The Global Disaster Alert and Coordination System is one such system that has a proven track record and is currently used widely in the humanitarian community.

Theory and Method

Early Warning and Alert for Humanitarian Impact

While the ultimate assessment of needs is done through the local government or through international assessment teams (e.g. UNDAC), geographical information systems (GIS) can contribute to estimate such needs on a near real-time basis. This is possible because consequences of natural hazards are mostly determined by local factors, which can be stored and processed in GIS. For instance, absence of human population and infrastructure will determine if a hazard event is of relevance to the humanitarian community. A typical entry strategy for an international organisation always requires a certain number of casualties or affected people (ECHO, 2004). Therefore, one straightforward way to eliminate irrelevant hazard events is by comparing the affected area with local population density.

When there is population, the disaster will only require international intervention if the local community cannot cope. Coping capacity is an essential element to consider in the context of humanitarian aid. Coping capacity (Schneiderbauer and Ehrlich, 2005) includes local population vulnerability (e.g. quality of housing, income, insurance policies and family structure) but also resilience built in the society (e.g. civil protection authorities, strong and functioning government and presence of Red Cross).

A disaster affects population through direct damage (e.g. destroyed shelter), indirect damage (through secondary effects such as landslides after earthquakes or inundation after tropical cyclones), direct socio-economic losses (loss of family or job) and indirect socio-economic losses. In most cases modelling of damage and losses requires detailed information on census, building stocks and local business and industry which is becoming available on continental scale (for instance in the HAZUS MH system for North America, FEMA, 2006), but not yet on global scale.

However, knowledge of exact consequences of a disaster is not necessary to estimate the overall humanitarian impact. Humanitarian needs for earthquakes – but also for other disasters – are mostly proportional to the population (Gutierrez *et al.*, 2005). The denser the population is, the more shelter and transportation infrastructure there is. Statistical models using the event magnitude, the affected population and the vulnerability of the population are able to predict the level of expected humanitarian needs (De Groeve and Eriksson, 2005; De Groeve *et al.*, 2006).

Table 3. Information related to humanitarian needs provided by GDACS by disaster type. Data is shown in italic, models in plain font. (1) See http://www.gdacs.org/sources.asp for a full list of data sources. (2) Physical flood monitoring based on remote sensing (De Groeve et al., 2007) or an international network of gauging stations (Fekete et al., 1999) is in development, but not available yet on global basis.

	Earthquake	Cyclone	Volcano	Tsunami	Flood
Hazard occurrence	*Seismological networks (1)*	*World Meteorological Organization Regional Specialized Meteorological Centres (1)*	*Media monitoring; volcano observatories (1)*	Earthquakes of magnitude 7 and higher occurring under water	*Media monitoring (1) (2)*

Determine affected area	Fixed radius of 100km around epicentre Alternative: intensity modelling (e.g. Wald *et al.*, 1999)	Fixed radius of 200km around track points Alternative: satellite measurements (NOAA), wind field modelling (e.g. Holland, 1980)	Fixed radius around volcano Alternative: Eruption modelling	Wave propagation and height modelling (Annunziato, 2006)	*Media monitoring* *Satellite observations (interpretation of near real-time MODIS images)*
Determine affected population	*Global population dataset* (Bhaduri *et al.*, 2002)	*Global population dataset* (Bhaduri *et al.*, 2002)	*Global population dataset* (Bhaduri *et al.*, 2002)	Urban population of affected coastal cities	*Media monitoring*
Determine vulnerability of population	*Sub-national vulnerability index* (Vernaccini *et al.*, 2006)				
Determine need for intervention (De Groeve *et al.*, 2006)	Function of magnitude, depth, population and vulnerability	Function of cyclone wind speed and population	Function of volcano eruption status and population	Function of earthquake magnitude	Function of flood magnitude and population affected

Table 3 shows an overview of the data and models used currently in the Global Disaster Alert and Coordination System. The principle of GDACS is to use the best open source information that is available on global scale and apply models to create missing information. The models used in GDACS are currently humanitarian impact models (for all disasters) and a tsunami wave propagation and height model (Annunziato, 2006). The impact models for earthquakes, tropical cyclones and volcanoes have been calibrated with historical disaster impact data (De Groeve *et al.*, 2006).

When GDACS detects a new event with potential humanitarian impact, the system generates email, SMS and fax alerts to inform humanitarian responders about the disaster and, simultaneously, starts consequence analysis routines and other information processing tasks described below.

<u>Consequence analysis and secondary effects</u>

With the currently available global datasets, it is not possible to have a detailed and accurate assessment of disaster consequences and humanitarian needs, as it is possible on national scale in certain countries (FEMA, 2006). However, global geographical databases are becoming available at increasingly larger scale, provided by research organisations, government organisations or international organisations. With every new global dataset, new aspects of consequence models can be implemented.

In spite of this strong data dependence, relevant information can be extracted from the currently available global datasets (Peduzzi *et al.*, 2005). Even if information on potential consequences can have low confidence (such as the probability of a dam burst after an earthquake), information on the absence of consequences can have high confidence (no dam burst because there are no dams in the affected area). Knowledge about potential factors that can complicate intervention is very relevant for planning response.

Table 4. Consequence analysis in GDACS.

	Earthquake	Cyclone	Volcano, Tsunami, Flood
Assess Critical Infrastructure and Key Assets	Neighbourhood analysis of global datasets *Datasets available on nuclear plants, hydro-dams, airports, ports, etc.*		
Assess indirect and secondary effects	Tsunamis (see tsunami) Landslides: report on slopes in affected area (from *digital elevation models*, e.g. SRTM, Werner, 2001)	Damage to agriculture by flooding: report on land use in affected area (from *global land cover*, e.g. GLC2000, Bartholomé *et al.*, 2005)	–
Provide information for logistics	Neighbourhood analysis of transport related global datasets *Datasets available on roads, airports, ports*		

Table 4 shows the current consequence analyses provided by GDACS. A geographical analysis of the affected area (which is either obtained from a data source or modelled) can offer valuable information for (1) evaluating potential damage to critical infrastructure and key assets and (2) logistics through the transportation network.

Moreover, the likelihood of disaster specific secondary effects can be assessed based on the presence or absence of critical conditions. For instance, landslides cannot occur without slopes and tsunamis cannot occur above water. Indirect socio-economic effects of the disaster can also be estimated to a certain extent through a geographical analysis: for example, floods can only cause crop loss in areas with significant agricultural area.

It must be clear that the information that can be provided by automated consequence analysis will rapidly gain in importance in the coming years. New technology (such as new satellite sensors) and software (such as Google Earth) allow the collection of more and more detailed datasets either through direct measurement or as a community effort (e.g. Open Street Map[3]).

Media and open source monitoring

A third source of information in the immediate aftermath of a disaster is the international media. This can be seen in the large sense including any information that is published relevant to the disaster, including scientific data and expert reports. Information systems, such as GDACS, can be automatically configured to collect such information from the Internet.

When a new disaster is detected by GDACS, the system starts a targeted collection of media report using a direct interface with the European Media Monitor (Best *et al.*, 2005), an on-line newspaper scanning system developed at JRC. This information is dynamically published in on the GDACS website and in GDACS reports. In addition, GDACS collects specialized

[3] http://wiki.openstreetmap.org

humanitarian information sources from partner organisations, including ReliefWeb news and situation reports and UNOSAT maps.

Depending on the disaster type, different organisations provide scientific data or expert information that is of use for response planning. Automated collection of this information and dissemination through a single website increases the efficiency response. Examples of such information collected by the GDACS system includes earthquake intensity maps (ShakeMaps) from the United States Geological Survey, near-real time flood extent maps from the Dartmouth Flood Observatory, earthquake mortality estimates from the World Agency for Planetary Monitoring and Earthquake Risk Reduction.

In particular for scientific information and expert reports it is important to present only information that is relevant to a given disaster. Even if the definition of "disaster" various widely in different professional disciplines, there is currently a de facto standard for identification of disasters that is used in GDACS and by GDACS partners to relate information. This standard is the GLIDE number, a globally common Unique ID code for disasters (Tschoegl *et al.*, 2006).

Operations Coordination Centre

Computer systems cannot predict the detailed consequences of a disaster. The most important information on the situation must come from observations on the affected area. Since OCHA has the mandate to coordinate international relief, it is the information hub between the many organisations involved in a response (including aid donors, international NGOs, local relief workers and the local emergency management authorities). In response to a growing need for structured information exchange between first responders in an international humanitarian disaster, OCHA developed the Virtual On-Site Operations Coordination Centre (Virtual OSOCC). The Virtual OSOCC is an on-line information exchange and coordination tool for disaster managers and international response organisations. It is used by responders during major disasters to exchange information in order to facilitate their decision-making for international assistance. Since 2006, the Virtual OSOCC has been integrated in the Global Disaster Alert and Coordination System.

By combining both automatically collected and modelled information (available before or immediately after a disaster strikes) with field-based information from responders (typically available hours after the disaster), GDACS is able to fill the critical information gap at the onset of the disaster before an On-Site Operations Coordination Centre (OSOCC) has been set up in the affected area.

However, also after the establishment of an OSOCC, the professional response community continues to use GDACS as a private platform to exchange unofficial information, making it an excellent source of information for needs assessment and response planning. Ultimately, though, other OCHA tools become the main source of information, including ReliefWeb (dissemination OCHA Situation Reports) or, for large disasters, a Humanitarian Information Centre in the affected area.

Local emergency management authorities

Last but not least there are the local emergency management authorities (LEMA). Unless the disaster has disrupted the local chain of information, the LEMA has the means to obtain the most reliable information on disaster consequences and relief needs. Thanks to a targeted promotion and training by OCHA, LEMA are increasingly being included in GDACS. This is extremely important for an efficient and effective response from the international community. Not only can LEMA provide critical information to the international community, but they can also be aware of what relief is available and is being deployed.

Results

A scientific evaluation of a change in effectiveness and efficiency of humanitarian response due to the use of information systems such as GDACS is hardly feasible. Even if, in a review of humanitarian response (OCHA, 2005), the United Nations recommended the establishment of benchmarks to measure progress, such benchmarks are unlikely to be sensitive enough to detect the contribution of a single factor (i.e. use of information systems) to the overall improvement of humanitarian response. Moreover, it is unlikely that information systems alone would improve response a lot: changes in effectiveness and efficiency cannot be seen separately from the general changing culture of accountability in humanitarian aid.

However, there are indirect ways to assess the impact of information systems on effectiveness and efficiency of response. Firstly, a historical analysis of the accuracy of GDACS alerts and consequence analysis information can determine how trustworthy the information is. Users are likely to use trustworthy information, while they will quickly abandon systems that provide more false information than correct information. Secondly, an analysis of the use of GDACS can show if the objectives are met.

Needs assessment: alerts and consequence analysis

An analysis of the accuracy of GDACS earthquake alerts has been published before (De Groeve *et al.*, 2005). However, that analysis was based on the assumption that the number of casualties was representative for humanitarian needs. This assumption does not always hold (Eriksson, 2006). A better measure for humanitarian needs is the monetary value of humanitarian response.

Table 5 shows the accuracy of GDACS alerts compared to humanitarian response in the past 2 years. For earthquakes, tsunamis, tropical cyclones and volcanoes, very few disasters were missed, and only because of particular circumstances. Of those, only Hurricane Stan – or more precisely, the landslides caused by the heavy rain accompanying hurricane Stan – required significant humanitarian aid (3 million US$). There are slightly more false alerts, in particular for tsunamis and volcanoes: more work is needed to improve results.

Table 5. GDACS alerts compared to humanitarian response. Financial data is from OCHA's Financial Tracking System (FTS) and ECHO's HOPE database.

<table>
<tr><td>Period of observation: January 2005 to November 2006</td><td>Number of events</td><td>Correctly alerted</td><td>False alert</td><td>Missed alert</td></tr>
<tr><td rowspan="2">Earthquakes (magnitude > 5) and tsunamis (magnitude > 7)</td><td>2141</td><td>7</td><td>8</td><td>2</td></tr>
<tr><td colspan="4">Total funds: 1.2 billion US$
Total funds for missed alerts: 275,000US$
False alerts: 6 where false tsunami alerts; 1 caused 200 deaths but did not trigger international response
Missed alerts: 1 in sparsely populated area, 1 was a series of low magnitude events.</td></tr>
<tr><td>Tropical Cyclones</td><td>141</td><td>12</td><td>3</td><td>2</td></tr>
</table>

	Total funds: 5.8 million US$ Total funds for missed alerts: 3 million US$ Missed alerts: Gamma (Honduras, 2005) never reached hurricane strength; Stan (Mexico and Guatemala, 2005): most damage because of landslides and heavy rain. False alerts: Shanshan (China, 2006), Saomai (China, 2006), Nabi (Japan, 2005); it is possible that humanitarian response was provided for Shanshan and Saomai, without this being reflected in the FTS.			
Volcanoes	35	8	27	0
	Total funds: 22.3 million US$			

Use of GDACS in the humanitarian community

Another measure of success is in the use of the GDACS system. The assumption is that if the GDACS information does not contribute to more efficient and effective response, the system would not be used. The number of users of the GDACS system (the combination of the alert system, the consequence analysis system and the Virtual OSOCC) reaches 4000.

Most GDACS users are from the international response community, the search and rescue (including UNDAC) teams, international and national NGO's, including the Red Cross and Red Crescent organisations. Together, this group – which is the primary focus of the system – represent 65% of users. However, GDACS is being promoted in disaster prone countries. This is done through annual stakeholder conferences and by including GDACS in the regular and established OCHA training and simulation exercise sessions organised by OCHA/FCSS in disaster prone countries. As a result, already 90 users from local emergency management agencies (representing 5% of users) are registered in the GDACS system. In addition, individual people from disaster prone regions are subscribing and represent 6% of the users.

Discussion

With ever increasing availability of global geospatial information and real-time measurements of natural hazards, information systems can play a significant role in making humanitarian aid more effective and efficient. While currently only simple consequence analyses can be performed due to data restrictions, such analyses will become more detailed and complex, ultimately producing very detailed forecasts or now-casts of the disaster situation and humanitarian needs as is the case now in countries like the United States.

The Global Disaster Alert and Coordination System is one of the first multi-hazard information systems to provide such functionality. It not only produces alerts and consequence analysis reports, but it also collects open source information in a targeted way and provides a closed forum for professional responders to coordinate their response.

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Author Biography

Tom De Groeve is a research scientist at the Joint Research Centre of the European Commission, located in Ispra, Italy. Since 2001, he is responsible for research and development of GIS based applications in crisis management, including large spatial data infrastructures and modelling activities. Previously, Dr. De Groeve worked for the Canadian Network for Centres of Excellence in Geomatics (GEOIDE) in Quebec City, Canada, where he also completed his Ph.D. studies on spatial uncertainty in forest type maps in 1999. Dr. De Groeve is born in Belgium and has an engineering degree in Geophysics and Mining Engineering from Leuven University.

Academic & Professional Practice

Peer Reviewed Articles

MEDICAL MANAGEMENT & RESPONSE

APPLICATION OF COMPUTER VISION IN SECURITY AND EMERGENCY ACTIONS

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Keywords

Computer vision, teleoperation, disaster control, search and rescue, telemedicine, mobile robot.

Abstract

There is a wide area of possible emergencies, from intentional to accidental. Mobile robots can be used in lot of them. To use mobile robots, we must have both reliable and high quality computer vision. This paper deals with different aspects of robot/computer vision applications in emergencies. Since there are a lot of difficulties in outdoor applications of robots, human expertise, human experience and human reactions can be non-replaceable. The best way to overcome problems is to implement the system with human operator in the command loop. It is called teleoperation. When medical task have to be performed, teleoperation is the only choice for now, because of complexity of actions. If the medical operation (surgery) need to be performed, then it is called telesurgery. To help doctors to be more sensitive of the distant scene, virtual reality can be used and development of tactile sensors can be vital. In the paper, a novel edge detector is presented. It is the intention to use it in mobile robots constructed for emergencies. Depending on which standard algorithm is used the performance of edge detector is improved by 10.41% to 53.36%. This is only a small step in image processing necessary for reactions in emergency situations. Edge detection is used to form matrix of distances between edges in image and robot. The use is in force feedback by visual input. Another possible application is in face recognition. If edges are better recognized, characteristic lines are to be better identified and, finally, face recognition more successful. Face recognition is very important in safety applications, but also in human-robot interaction. The last subject included in the paper is wavelet prediction of the motions in the robot teleoperation.

Introduction

In the world of increasing interconnectivity and great dependences, any misuse of high tech or new materials can result in catastrophe. Usual emergency situations are: traffic accidents, fires, terrorism, environment pollution, war, earthquakes, volcano eruptions, flood, dryness, etc. Usually taken actions are: medical intervention, fire distinguishing (or control), ruins management, search and rescue in ruins, fire locations, marine accidents' locations, traffic accidents' locations, etc. Causes of disasters can be natural, but also the product of human

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actions (i.e. terrorism or negligence). These disasters can be monitored over telemonitoring or surveillance systems. Of course, that implies some sort of computer vision (Arsenio, 2003).

Computer vision applications can be used in teleoperation (Şendur and Guleryuz, 2004) over communication media (cable, wireless, etc.). It is very interesting when people cannot be in contaminated area (i.e. radiation, biological or chemical agents). Robots can be deployed in that area and human operator can command over visual tele-control (Seelinger, 2002; Slawinski, 2006). Robots can be programmed to distinguish fires, to search for survivors, to monitor contamination, etc.

This paper presents vision application in robot control for emergencies based on Internet and wireless link. Visual control loop is explained. Various image processing algorithms can be applied. Vital importance of edge detection in measurements is pointed out. It is a step toward advanced algorithms, such as motion estimation, intention recognition, decision making, object recognition, etc.

Edge detection can be used also in face recognition. It is interesting in security (i.e. to recognize authorized personal). Edge detection is vital in obstacle avoidance and object recognition. If robot recognizes humanoid shape, it can begin rescuing operations. Well recognized edges are also preferred for input to virtual reality controls.

The National Science Foundation (NSF) is an independent federal agency that supports fundamental research and education across all fields of science and engineering, with an annual budget of nearly $5.3 billion. Some of the project financed is development of search and rescue robots, such as in Figure 1.

Figure 1: *Example of search and rescue robot (NSF PR 03-91, downloaded from http://www.nsf.gov/od/lpa/news/03/pr0391.htm)*

Figure 2 shows some of robots practical for experiments for all aspects of robot vision except stereo vision and telemedicine.

Figure 2: *Some of available robots for presented research*

Figure 3 shows an example of tactile sensors for teleoperation (Genta and Antoniette, 2005; Çavuşoğlu et al., 2001). This can be used in telesurgery as in the other applications, including many sorts of virtual reality. Idea of telesurgery is illustrated in Figure 4.

Figure 3: *Example of tactile device for telesurgery*

Although many people form medical profession opposes the idea of replacing a real human doctor with any kind of robotic or telemedicine system, telesurgery is the matter of presence and close future.

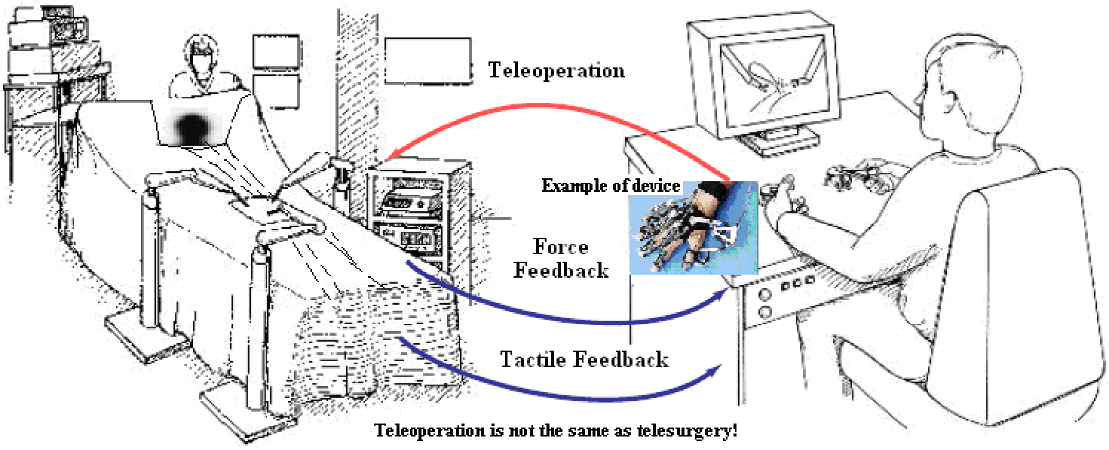
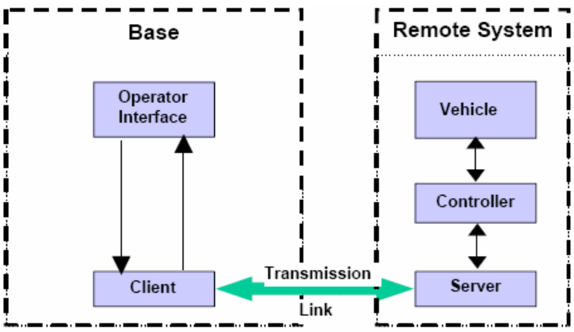


Figure 4: *Telesurgery*

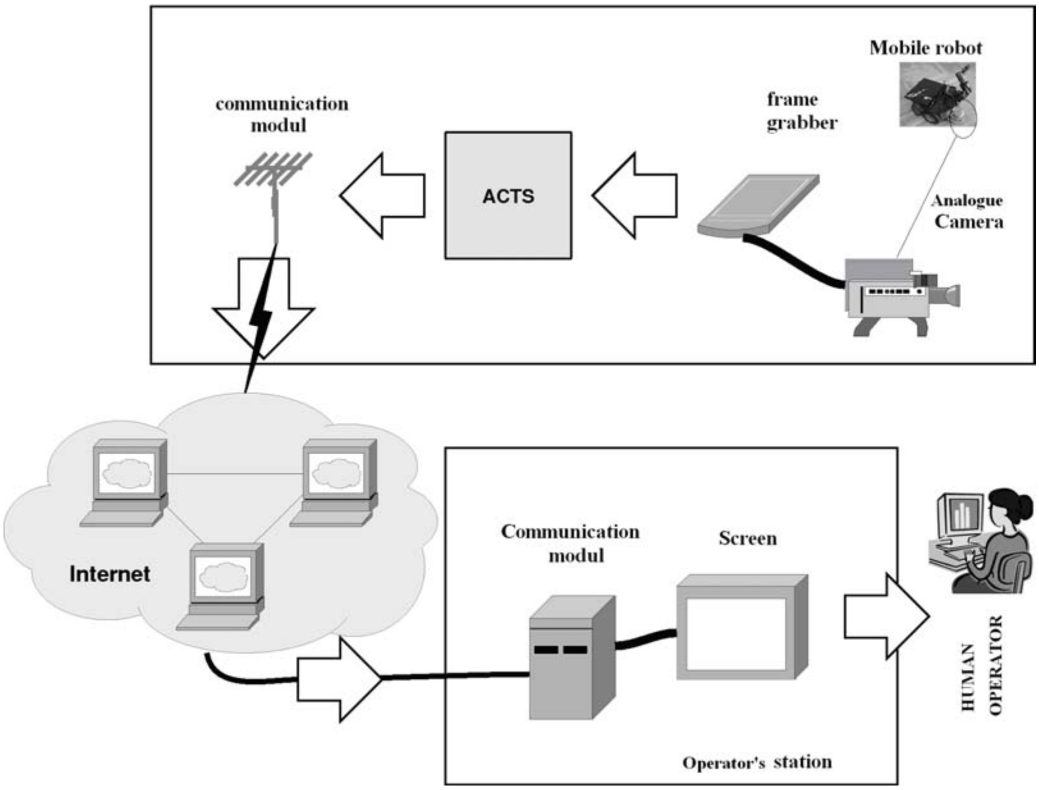
Theory and Method

Edge detection is a common low level step of image processing (Nixon and Aguado, 2002) for robot vision applications. An edge in an image is a contour across which the brightness of the image changes abruptly. It is often interpreted as singularities. Singularities can be characterized easily as discontinuities where the gradient approaches infinity. In discrete signal analysis edges are the local maxima of the gradient.

Figure 5.a illustrates basic structure of the teleoperation of robot. Place of the teleoperator is in the base, on safety, while the robot is in the dangerous environment. The modifications for improvement of robot's vision system are placed in the client's side of the system. As a matter of fact, this presents a simulation of a real situation and therefore it is experimental information flow.



a)



b)

Figure 5: *a) Basic structure of teleoperation, b) experimental setup*

Figure 5.b shows experimental setup from previous works, i.e. in (Budišić, 2006). Part which deals with the aim of this article is between communication and screen modules in client's application (operator's station).

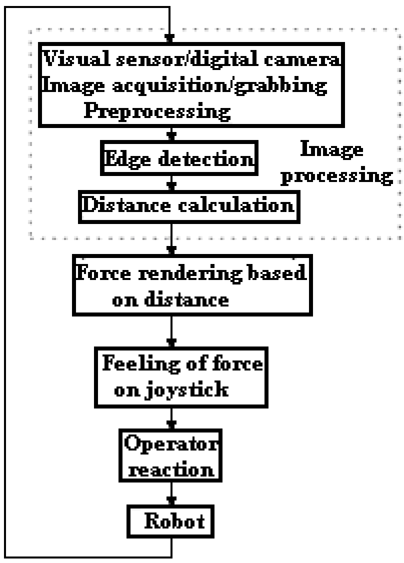


Figure 6: *Visual force feedback robot control*

Figure 6 shows a role of edge detection in force rendering in teleoperation. Based on distances from the edges, force is produces. The goal is that operator feels the force in proportion with the distance: if the robot is closer to the edge, the force that operator feels is higher. Feel of force is on the joystick, which operator uses for control of distant robot. For analogue cameras, installation of frame grabber is necessary to enable A/D conversation.

Most of the nowadays digital cameras do not need frame grabber. Figure 7 shows the role of edge detection in computer vision system for face recognition.

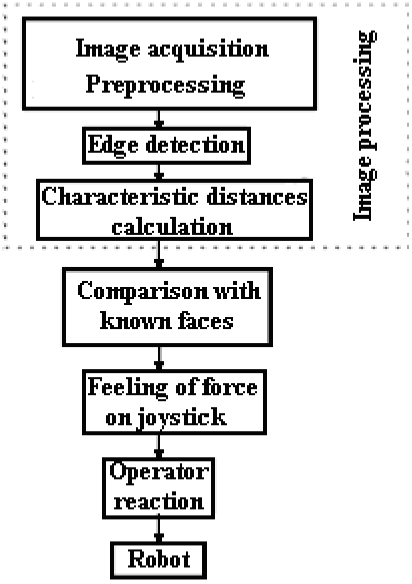


Figure 7: *Edge detection's role in face recognition*

Teleoperation has a lot of badly solved or un-solved problems and therefore teleoperation system needs improvements to be completely reliable. One of the problems is the problem of lost pockets of data. In force feedback based on visual data, the lost pockets of data are frames or parts of frames. Figure 8 is schematic explanation of the solution for the problem. Wavelet estimator estimates the value of pixels in the next frame based on wavelet regression (values of pixels in previous frames). If the next frame (time t + sampling interval, which is new present frame) does not come to the client side of communication channel on time, estimated frame is visible on the operator's screen. If the next frame comes on time, predicted frame is just overwritten with true frame (Casavola et al., 2006).

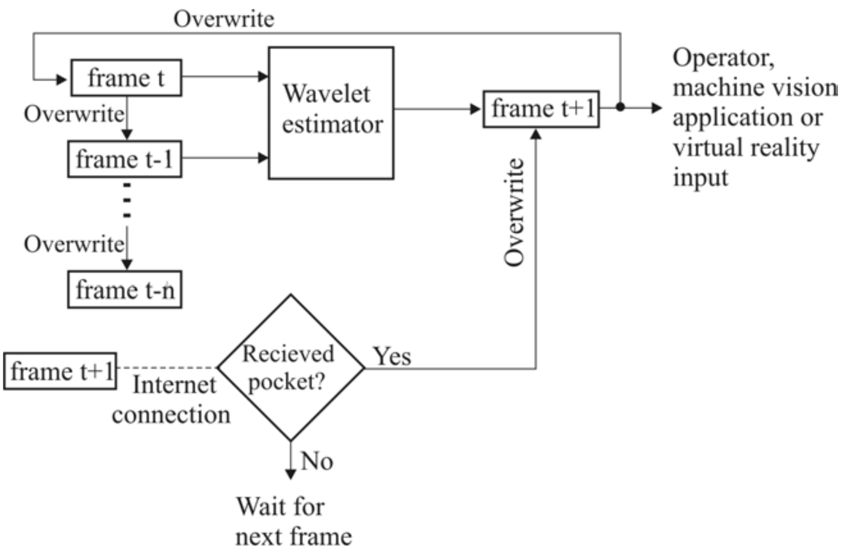


Figure 8: *Wavelet prediction in teleoperation*

We will now concentrate on necessary theory for these applications. Let us consider an image sequence $I(p_i, t)$ with $p_i = (x_i, y_i) \in \Omega$ the location of each pixel in the image. The brightness constancy assumption states that the image brightness $I(p_i, t+1)$ is a simple deformation of the image at time t:

$$I(p_i, t) = I(p_i + v(p_i), t + 1) \quad (1)$$

where $v(p_i, t) = (u, v)$ is the optical flow between $I(p_i, t)$ and $I(p_i, t+1)$. This velocity field can be globally modeled as a coarse-to-fine 2D wavelet series expansion from scale L to l (Bruno and Pellerin, 2002):

$$V_\theta(p_i) = \sum_{k_1,k_2=0}^{2^L-1} c_{L,k_1,k_2} \Phi_{L,k_1,k_2}(p_i) + \\ + \sum_{j \geq L}^{l} \sum_{k_1,k_2=0}^{2^j-1} \left[d^H_{n,k_1,k_2} \Psi^H_{j,k_1,k_2}(p_i) + d^V_{n,k_1,k_2} \Psi^V_{j,k_1,k_2}(p_i) + d^D_{n,k_1,k_2} \Psi^D_{j,k_1,k_2}(p_i) \right] \quad (2)$$

where Φ_{L,k_1,k_2} (p_i) is the 2D scaling function at scale L and Ψ^H_{j,k_1,k_2}, Ψ^V_{j,k_1,k_2}, Ψ^D_{j,k_1,k_2} are wavelet functions which represent horizontal, diagonal and vertical directions. These functions are dilated by 2^j and shifted by k_1 and k_2. The solution can be found by usage of chosen error function and minimization, e.g. (Bruno and Pellerin, 2002; Bruno and Pellerin, 2001):

$$E = \sum_{p_i \in \Omega} \rho\big(I(p_i + V(p_i, t), t+1) - I(p_i, t), \sigma\big) = \sum_{p_i \in \Omega} \rho\big(r(p_i + V), \sigma\big) \quad (3)$$

and the motion wavelet coefficient vector, θ, is calculated by:

$$\theta = \arg\min_\theta (E) \quad (4)$$

Once motion wavelet coefficients have been estimated for each frame f_i of a sequence S containing M frames, anyone can obtain a feature space spanned by the motion feature vectors θ_i, $i = 1, \ldots M$. To temporally segment the feature spaces Ω_{seg} (spanned by θ_{seg}), in (Bruno and Pellerin, 2002) a hierarchical classification with a temporal connexity constraint is considered.

Edge detection and wavelet prediction are based on above theory and well-known wavelet theory (Sweldens, 1998; Jansen and Oonincx, 2005; Mallat, 1999; Mertins, 1999). Motion between neighboring wavelet coefficients in all directions is used to find edges. Motion field in aproximation coefficients is used for prediction.

Results

Experiment is performed at NEC notebook with mobile AMD Athlon XP-M 2600+ processor working at 1.67 [GHz]. The system has 480 [MB] RAM and the operating system is MS Windows XP with service pack 2. Application for programming and execution was Matlab 7.0. Edge detector code is programmed as Matlab m-script. Norton Antivirus is in the background (which slows down the computer).

Table 1 shows time of operation for above mentioned experimental setup. Different setup or different computer configuration can result in faster or slower execution of the algorithm, which we proposed. As it can be seen from the Table 2, execution time is improved even between the first and the second generation wavelets for 11,65% (Haar wavelet) to 17,8% (Daubechies wavelet of the second order). Table 3 shows execution time for Perwitt method. If measurement no.1 is excluded (it is not close to other results probably due to activation of hard disk at the moment of experiment) we obtain more realistic average (the last row in the table).

Table 1: *Execution time of various edge detectors.*

Edge detector	Time of execution
sobel	0.5 [s]
canny	0.922 [s]
perwit	0.48 [s]
zerocross	0,544 [s]
Roberts	0.51 [s]
proposed with LWT lazzy	0,43 [s]

Table 2: *Execution time of various wavelets in filter and lifting implementation.*

Proposed edge detector	Time of execution
DWT haar	0,635 [s]
LWT haar	0,561 [s]
LWT lazzy	0,43 [s]
DWT db2	0,657 [s]
LWT db2	0,54 [s]

Table 3: *Replicability of the experiment on m-scripts (un-optimized code) for Perwitt method*

No.	Time of execution
1	1.582 [s]
2	0.46 [s]
3	0.52 [s]
4	0.451 [s]
5	0.45 [s]
average	0.6926 [s]
average without extreme	0.47025 [s]

Table 4: *Replicability of the experiment on m-scripts (un-optimized code) for Canny method*

No.	Time of execution
1	0.931 [s]
2	1.542 [s]
3	0.881 [s]
4	0.922 [s]
5	0.871 [s]
6	0.881 [s]
7	0.911 [s]
8	0.871 [s]
average	0.97625 [s]
average without extreme	0.895 [s]

Table 4 shows the same for Canny edge detector, table 5 for zerocross method, Table 6 for Roberts edge detector. Tables 7 and 8 shows results of the proposed wavelet edge detector based with lifting realization of wavelet transform. As it can be seen from the all presented tables, depending on which standard algorithm is used the performance of edge detector is improved by 10.41% to 53.36%.

Table 5: *Replicability of the experiment on m-scripts (un-optimized code) for zerocross method*

No.	Time of execution
1	0.681 [s]
2	0.531 [s]
3	0.531 [s]
4	0.521 [s]
5	0.531 [s]
6	0.531 [s]
average	0.544 [s]
average without extreme	0.529 [s]

Table 6: *Replicability of the experiment on m-scripts (un-optimized code) for Roberts method*

No.	Time of execution
1	0.441 [s]
2	0.431 [s]
3	0.441 [s]
4	0.441 [s]
5	0.451 [s]
6	0.45 [s]
7	0.451 [s]
8	0.451 [s]
average	0.444 [s]

Table 7: *Replicability of the experiment on m-scripts (un-optimized code) for proposed wavelet method with lifted wavelet transform of lazzy wavelet*

No.	Time of execution
1	0.431 [s]
2	0.451 [s]
3	0.45 [s]
4	0.451 [s]
5	0.451 [s]
average	0.4468 [s]

Table 8: *Replicability of the experiment on m-scripts (un-optimized code) for proposed wavelet method with lifted wavelet transform of Haar wavelet*

No.	Time of execution
1	0.681 [s]
2	0.521 [s]
3	0.521 [s]
4	0.521 [s]
average	0.561 [s]

Table 9: *Replicability of the experiment for proposed method with LWT of db2 wavelet*

No.	Time of execution
1	0.541 [s]
2	0.541 [s]
3	0.54 [s]
4	0.531 [s]
average	0.53825 [s]

***Table 10:** Replicability of the experiment on m-scripts (un-optimized code) for proposed wavelet method with discrete wavelet transform (FGW setting) of Haar wavelet*

No.	Time of execution
1	1.172 [s]
2	0.641 [s]
3	0.631 [s]
4	0.641 [s]
5	0.631[s]
6	0.631[s]
average	0.7245 [s]
average without extreme	0.635 [s]

***Table 11:** Replicability of the experiment on m-scripts (un-optimized code) for proposed wavelet method with discrete wavelet transform (FGW setting) of db2 wavelet*

No.	Time of execution
1	0.651 [s]
2	0.651 [s]
3	0.661 [s]
4	0.661 [s]
5	0.661[s]
6	0.661[s]
average	0.657 [s]

Tables show how stable times of executions are for different algorithms. If the range between minimum and maximum time of execution is smaller, the algorithm is more stable.

Discussion

As it can be seen from the results section, WT algorithm has smaller deviation from the average. Further improvement can be achieved by optimization of the code. The main goal in further research should be obtaining as short as possible time of operation. It is important in order to obtain more fps (frames per second). The goal can be reached by programming in C programming language.

It is also important to point out that the proposed algorithm works with gray scales, while standard algorithm works only with black and white output. This could be advantage in more sophisticated applications, such as groping of lines with same colours into objects.

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HURRICANE KATRINA: NATURE'S "WEAPON OF MASS DISRUPTION"

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Keywords
Crisis Katrina Cooperation Hazard Vulnerability

Abstract

In the aftermath of Hurricane Katrina, New Orleans was reduced to a devastated shell of its former self. In spite of significant warnings ahead of time, the city, the State of Louisiana and the Federal Government were overwhelmed by the impact of the category 4 hurricane, and thus were unable to effectively allocate resources and respond in a timely manner. For several days the city was left to manage the consequences of Hurricane Katrina alone. Can we learn some significant and valuable lessons from this event and apply them to what might be the possible aftermath if a "dirty bomb" was detonated in a city?

As you read this, you may be asking: "Why are you worried about a manmade "dirty bomb"?" Well, many individuals may not be aware of this, but a manmade "dirty bomb" scenario is actually one of the foremost concerns in terrorism activity at this time in the US.

A "dirty bomb" does not have to be manmade. Nature provides us with many potential "dirty bombs", these may come in the form of readily recognized natural disasters such as, hurricanes, tornadoes and earthquakes; or as a pandemic.

Introduction

In the aftermath of Hurricane Katrina, New Orleans has been reduced to a devastated shell of its former self. Despite significant warnings, the city, the State of Louisiana and the Federal Government were overwhelmed by the impact of the category 4 hurricane.

Preparedness Responsibility

In today's fast paced environment waiting can be deadly. It was revealed that the Director of FEMA waited almost four hours before contacting Homeland Security regarding the situation in New Orleans. This "wait and see" approach was disastrous. Would a similar delay occur if a manmade "dirty bomb" were detonated in a similar sized city?

Let's analyze just a few examples from the Katrina aftermath. Without question, New Orleans, the fourth largest port in the world, is vital and strategically important and in fact is the gateway to the Mississippi River. The port ships 50% of the grain exported by the U.S. The port accounts for 25% of the coffee imported and 25% of the seafood that comes into the

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U.S. The Louisiana Offshore Oil Port (LOOP) is located near the city. The LOOP carries about 10% of the U.S.'s oil imports. The LOOP is the nation's only deepwater tanker terminal, typically receiving almost a million barrels of foreign crude oil daily.
The port facility is located in 110 feet of water about 20 miles south of Grand Isle, La., an area severely hit by Hurricane Katrina.

Sabine Pipe Line LLC owns and operates the Henry Hub, which is the centralized point for natural gas futures trading in the U. S. The Henry Hub interconnects with nine interstate and four intrastate pipelines. Henry Hub is the pricing point for natural gas futures contracts traded in the New York Mercantile Exchange, or NYMEX.

No Warning

Hurricane Katrina gave us plenty of warning. With a manmade "dirty bomb" there will be no warning. *Let's repeat this vital fact – with a manmade "dirty bomb" – either nuclear, chemical or biological – there will be no warning.*

In the aftermath of Katrina, chaos, confusion and blame seem to be the order of the day. *Yet, we knew it was coming.* We had ample time to do something about the event. With no warning, albeit less destructive force, what would the potential reaction to a manmade "dirty bomb" be? Are we prepared?

Observations: Hurricane Katrina Response – Are you on your own?

Reflecting on the current state of response to the hurricane and projecting forward to the possible response to a manmade "dirty bomb" what conclusions might we draw?

Hurricane Katrina devastated the infrastructure of the Gulf Coast states. Electric Power Supplies, Gas and Oil, Telecommunications, Banking and Finance, Transportation, Water Supply Systems, Emergency Services, Continuity of Government.

A dirty bomb by any other name

Business and government must increase their efforts in the area of preparedness. The threat of a "dirty bomb" being detonated is growing not lessening. Add to that the threat of an influenza pandemic that could sideline up to 40% of the workforce, shut down foreign trade, and degrade public services and you have a recipe for calamity.

Complexity – Criticality

In the recent past we have seen twenty of the world's biggest economies in some phase of recession. These economies account for 60% of the world's output. World trade growth, which held up throughout both the world recessions of the early 1980's and 1990's, fell twelve percentage points in 2001.

A "dirty bomb" detonation could easily overshadow the devastation (in human lives and impact to businesses) from the combined hurricanes of 2005, events in Iraq, the impact of oil prices, concerns about corporate governance, problems in the IT industry and current account imbalances that have led to falls in investment around the world.

Can I afford not to be Personally Prepared?

Government and business leaders have a responsibility to protect their organizations by facilitating continuity planning and preparedness efforts. Using their status as "leaders," senior officials, senior management and board members can and must deliver the message that survivability depends on being able to find the opportunity within the crisis. Today we cannot merely think about the plannable or plan for the unthinkable, but we must learn to think about the unplannable.

Concluding Thoughts

Should you depend on government (at any level) for your personal well being in the event of a manmade "dirty bomb" incident? The aftermath of Katrina indicates that there is much to be done regarding the ability of government to respond effectively.

Should you depend on your employer for your personal well being in the event of a manmade "dirty bomb" incident? Market research indicates that only a small portion (5%) of businesses today have a viable plan, but virtually 100% now realize they are at risk.

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ICT IN EMERGENCY MANAGEMENT

AN OPERATIONAL DEFINITION OF EMERGENCY RESPONSE CAPABILITIES

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Keywords

Emergency response capabilities, operational definition, analytic framework.

Abstract

Well developed emergency response capabilities are crucial in order to keep the risk in a community at low levels. Analysing these capabilities before an emergency occurs is important since it can identify weaknesses and possibilities for improvements. To start off from an operational definition is a possible point of departure in such an analysis. In this paper, therefore, we develop an operational definition of emergency response capabilities, which builds on systems theory and an operational definition of risk. The definition includes three essential elements; the task to which the capability is related, measures of how well that task can be performed and a description of the context affecting the performance of that particular task. The definition makes clear that the context might have large effects on how well a task can be performed and that there are uncertainties both regarding the context and how well a task can be performed given a context. Furthermore, we argue that it should be possible to make judgements about any statements that are made in the analysis regarding their validity and therefore the tasks and performance measures must be defined accordingly. The conclusion is that the operational definition provides an analytic structure which can help actors to gain knowledge about their emergency response capabilities and limits thereof.

Introduction

In the ideal world all hazards facing a community can be prevented and kept from materialising. Preventive risk reductions are indeed often effective in mitigating hazards; unfortunately perfect prevention is virtually impossible. Actually, it might be counter-effective to excessively focus on preventive measures since this often leads to an increased level of community vulnerability (McEntire, 2001), which is also known as the vulnerability paradox (Boin, 2004). In addition, many hazards are beyond the human ability to prevent (Gundel, 2005; McEntire, 2005) or beyond the authority of specific organisations to influence. Furthermore, prevention and mitigation measures might be known but impracticable because they are associated with too high costs, require technology that has not yet been developed or are otherwise not feasible. Another issue is that some hazards are extremely hard to predict and therefore impossible to prevent (Gundel, 2005). Because of these inherent insufficiencies of preventive strategies, it is sensible to complement preventive measures with mitigation and preparation efforts in order to increase

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response capabilities and reduce vulnerabilities in communities, so that the consequences are kept at low levels once a hazard materialises. Achieving a balance between prevention and resilience (developing a capacity to absorb, respond to and recover from events) is thus a rational strategy in managing the risk in a community.

When a hazard materialises it exposes people, organisations and infrastructure in the community to strains and stresses of various magnitude, which put demands on their capabilities to resist, cope with and recover from the potentially harmful events. In such situations needs arise because fundamental values, such as human values, are threatened. These needs have to be met in a timely manner in order to minimise the negative consequences. However, in crises and emergencies, affected persons and groups may lack the capabilities (such as lacking the resources, knowledge or skills) that are required for meeting some of these needs, thus causing needs for external assistance to emerge. Meeting these needs then become the task for emergency management organisations (Fire and Emergency Services, NGOs etc.), which thus put demands on their emergency response capabilities. An important step in order to attain good emergency response capabilities is to work proactively with emergency planning and preparedness (Coles and Buckle, 2004). In the proactive work it is important to analyse and evaluate the existing emergency response capabilities in the organisation in order to highlight weaknesses and possibilities for improvements. Furthermore, conducting regular assessments are crucial since organisations and the environment in which they operate, constantly undergo change, which means that organisations have to adjust and adapt their current activities and strategies to even maintain their existing emergency response capability.

Suggestions of methods and frameworks for assessing capabilities have been made previously in the research literature and in various guidelines, e.g. Anderson and Woodrow (1991), UNDP (1998), IFRC (1999), Kuban and MacKenzie-Carey (2001). Some of these methods focus on organisational capabilities while other focus on the capabilities of the affected population to self-protect. An issue in applying these methods, however, is that there is no general consensus of how the relevant concepts are to be interpreted (Buckle and Mars, 2000; Weichelsgartner, 2001), which is exacerbated by the general lack of operational definitions. Furthermore, these frameworks generally provide a limited guidance of how to analyse capabilities in order to ensure the validity of the analysis. The aim of this paper is therefore to operationally define emergency response capability and the intention is that the operational definition should provide a framework for analysis as well. Here, an operational definition of emergency response capability is considered to be a definition that provides an operation or procedure, which can be used to determine what is required to comply with the definition. The definition builds on systems theory and an existing operational definition of risk. Therefore, we first review the definition of risk and also extend it to include the concept of vulnerability, which is tightly coupled to capability.

Risk framework

The concept of risk is used across many scientific disciplines and is also extensively used in practice. However, there is no general consensus regarding the definition of risk (Fischhoff, Watson et al, 1984). According to Renn all definitions of risk have in common that they make a distinction between reality and possibility and he proposes to define risk as "the possibility that human actions or events lead to consequences that affect aspects of what human values" (Renn, 1998). According to the standpoint on risk that is adopted in this paper, the risk in a system depends on two essential components; the likelihood of harmful events and the consequences of them. However, this view is by no means accepted universally. In some disciplinary areas related to emergency management, risk is given a different meaning, which is also pointed out by Dilley and Boudreau (2001) who argues that risk is sometimes used only referring to external events and hazards, not the consequences for the system in question. Cutter and colleagues, for example, relate risk only to the external hazard agent, where it is seen as "an objective measure of the likelihood of a hazard event" (Cutter, Boruff et al, 2003). References to the consequences of the hazards are thus not made in this definition. McEntire argues that "risk is a result of proximity or exposure to triggering agents, which increase the probability of disaster"(McEntire, 2001). This definition clearly expands on the one proposed by Cutter and colleagues. In our view proximity to triggering agents contributes to the risk; however it is not the only factor that determines which consequences that arise. The approach to risk chosen in this paper leads to the conclusion that the purpose of all emergency management efforts, whether it is in the form of prevention, preparedness, response or recovery, is to reduce the risks, by reducing the likelihood of harmful event, the consequences of them or a combination of both.

A quantitative, operational definition of risk is proposed by Kaplan and colleagues (Kaplan and Garrick, 1981; Kaplan, 1997; Kaplan, Haimes et al, 2001) and is used extensively in risk research. The definition is based on systems theory and it is assumed that one has defined a system for which the risk is to be estimated. A system is perceived as a collection of state variables that can be used to describe the world. It is important to note that the system and the real world is not the same thing. Since "…every material object contains no less than an infinity of variables and therefore of possible systems" (Ashby, 1957) one has to define the system with the objective to achieve a good enough, for the purpose of the analysis, representation of the real world. The state variables can be lumped together into elements that consist of one or a collection of such variables and constitute some kind of meaningful unit in the context of interest. Here, for example, an element can be the Fire and Emergency Services which can be described by several state variables of which one could be the number of fire fighters that are engaged in an emergency response operation. One could employ a more detailed system definition, for example using individual fire fighters as elements in the system, but in the present context it is sufficient to use emergency response organisations as the elements of interest.

The assessment of emergency response organisations' capabilities has similarities with the problem of risk assessment. Both types of assessments are concerned with potential events that can happen in the future and therefore the development of an operational definition of emergency response capabilities can benefit from using the definition of risk as a point of departure. Of central importance in the definition of risk referred to above is the notion of scenarios, which is defined as "a trajectory in the state space of the system" (Kaplan, 1997). A scenario can thus be seen as the progression of the system over time. In determining the risk in a system one has to identify all (at least the most important ones) scenarios that deviate from the "success scenario", S_0. S_0 denotes a scenario where everything in the system behaves as intended and scenarios that deviate from S_0 are called risk scenarios. After estimating the probability and consequence of each scenario, one ends up with a set of risk scenarios (S_i) and their corresponding probabilities (L_i) and consequences (X_i). This set, called the "set of triplets", *is* the risk in the system. Therefore, when determining the risk in a system one really has to find the answer to the three questions: "What can go wrong?", "How likely is it?", "What are the consequences?" (Kaplan, 1997). Based on the set of triplets several risk metrics and measures can be expressed in order to facilitate risk presentations and decision making.

Obviously, an important issue resides in deciding which negative consequences to include in the definition of risk. Ashby uses the term essential variable to refer to a state variable that is related to a consequence dimension, i.e. the variables that are important to protect (Ashby, 1957). Consequences can be said to arise when these essential variables take on values outside some predefined range. However, there is no general answer to which state variables that should be seen as essential, since the consequences of interest depend on the values that the analysis is based on. The consequences to consider are thus contingent on the context of the particular analysis, such as its purpose. In addition, at which point in time the consequences should be estimated is also contingent on the particular context. Traditional application of the quantitative definition of risk, in what is frequently called "technical risk analyses", has been claimed to be too narrow in only focusing on a single consequence dimension (Renn, 1998), and only focusing on immediate impacts after a hazardous event (Einarsson and Rausand, 1998). However, we argue that there are no preconditions of which consequence dimensions to use when employing the quantitative definition of risk. The criticism thus addresses the traditional *application* of risk analysis, not the *definition* of risk per se. Therefore, we believe that the quantitative definition of risk provides a suitable platform in an emergency management context as well.

Incorporating vulnerability into the risk framework

Research over the last couple of decades has recognised the limitations of the previously predominant view, in which the hazards where seen as the main concern for emergency and risk management. Since then there has been a shift in focus to a view that also account for the vulnerability of the exposed systems, e.g. persons, groups, organisations, communities (Weischelsgartner, 2001; Wisner, Blaikie et al, 2004). However, there is no general consensus as to how vulnerability is to be conceptualised, and some definitions are even contradictory (Cutter, Mitchell et al, 2000; Dilley and Boudreau, 2001; Haimes, 2006).

According to the view adopted in this paper the overall risk in a system is a result of the interactions between the characteristics of the various hazardous events that might affect the system and a range of "vulnerability inducing" factors (e.g. physical, economical, institutional and societal) that characterises the system (Salter, 1997; Dilley and Boudreau, 2001; Sarewitz, Pielke Jr. et al, 2003). These factors either aggravate or alleviate the effects of various hazardous events, but those "factors that make a system vulnerable to a hazard will depend on the nature of the system and the type of hazard in question" (Brooks, Adger et al, 2005). Therefore, vulnerability is context-dependent and has to be related to a specific hazardous event to be meaningful (Dilley and Boudreau, 2001). A corollary of this is that a system that is vulnerable to a certain hazardous events is not necessarily vulnerable to other, although there often exist generic factors that altersthe system's vulnerability to many hazards (Brooks, Adger et al, 2005). In this paper we use vulnerability to represent an emergent system property[4] that determines the effect a specific hazardous event has on the essential variables of the system.

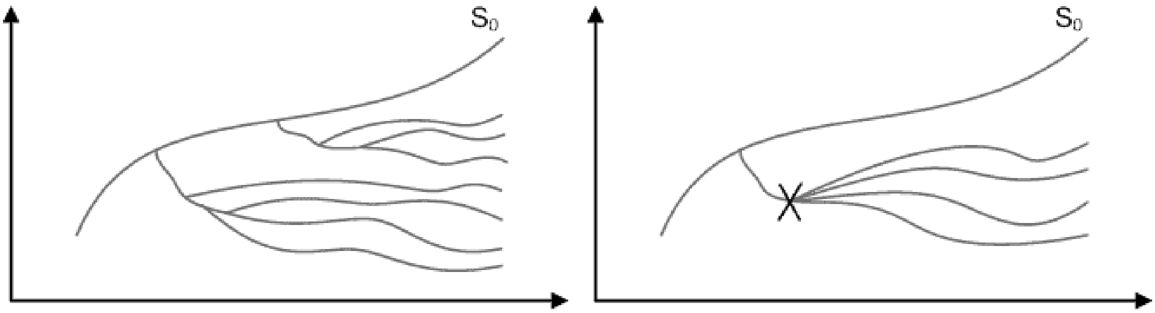
The framework provided by the quantitative definition of risk, referred to above, can also be utilized to define vulnerability in that the vulnerability of a system can be expressed as a "set of triplets". An imperative difference from the definition of risk, however, follows from the fact that vulnerability must be related to a specific hazardous event. The risk scenarios, i.e. the trajectories in the state space, described by the set of triplets are thus contingent on that the specific hazard has materialised and exposed the system. Thus, the vulnerability in a system is the answer to the three questions; "What can happen?", "How likely is it?" and "What are the consequences", where the answers are contingent upon that a specific hazardous event affects the system. In Figure 1 the difference between the definition of risk and vulnerability is illustrated using a state space representation.

To illustrate the use of the triplet assume that a community's vulnerability to a release of chlorine gas due to train derailment close to the city is to be analysed. The purpose of the analysis, such as whether the physical consequences (e.g. death and injuries), the consequences to the community's future prosperity, both these factors, or other factors are of interest, can have large effects on which the relevant scenarios are and which consequence dimensions to consider. Assume that we in this example are interested in the direct physical consequences. Next, one has to identify what can happen given that there is a chlorine gas release. One factor that affects the consequences of the gas release is the wind direction. If it blows away from the city negative consequences do not arise. If it blows towards the city the extent to which populated areas are exposed to the gas depends on for example wind speed, atmospheric stability class, and land exploitation proximate to the railway track. Furthermore, the extent to which the population in the affected areas are

[4] A closely related definition of vulnerability does not regard vulnerability as a system property, e.g. a "property of the whole". Instead vulnerability refers to the system's states or the conditions that "can be exploited to adversely affect (cause harm or damage to) that system" (Haimes 2006). Furtermore, Einarsson and Rausand suggest that vulnerability should be used to describe the *properties* of a system that "may weaken its ability to survive and perform its mission in the presence of threats" (Einarsson and Rausand 1998).

exposed to toxic gas concentrations for example depend on whether warning systems are in function and alert the community inhabitants, whether the ventilation can be shut down, either automatically or manually etc. From these varying conditions a number of scenarios can be defined and consequences and probabilities of each scenario can be estimated. The resulting set of triplets then represents the vulnerability of the community to the specified hazardous event.

Figure 1. The difference between risk and vulnerability using state space representations.*



* The definition of risk is illustrated to the left and the definition of vulnerability is illustrated to the right. The main difference can be seen in the right part of the figure where the scenarios in the definition of vulnerability are contingent on that a particular hazardous event has occurred and affected the system. This event is marked by a cross in the right figure. In a risk analysis, on the other hand, one is interested in all scenarios that deviate from the "success scenario", S_0.

It is important to note that the specification of the hazardous event and the purpose of the analysis can have large effects on the description and analysis of vulnerability. Assume for example that in addition to the specification of the hazardous event made above, the wind blows towards the city. The community is clearly more vulnerable to this event since the possibility of the wind blowing in a "harmless" direction is dismissed. However, no characteristics of the community has been altered, only the specification of the hazardous event. Therefore, we argue that it is important to clearly state the event that the vulnerability is related to. Regarding the purpose of the analysis, assume that instead of analysing the vulnerability of the community we are interested in the vulnerability of the responsible railway company to a chlorine gas release. The consequence dimensions of interest will be different than above, since the interest resides in how the company is affected. Damages to goodwill and costs due to damage liabilities are examples of consequence dimensions of interest. The physical consequences to the population certainly might have an effect on how the railway company is affected, but it is not necessarily in the central interest of the analysis. This example shows that changing the purpose of the analysis might also lead to a change in system definition. Thus, when analysing vulnerability it is important to clearly state the purpose of the analysis along with system definition and system boundaries.

Emergency response capabilities

The use of the term vulnerability has suffered some criticism since its main focus is on the negative characteristics of systems, i.e. their inabilities. The criticism has especially addressed those instances when vulnerability is applied to individuals or social groups since it might lead to a view that "treat them as passive victims" (Cannon, Twigg et al, 2003). Instead, the argument goes, one should focus on the capabilities of systems to resist, cope with and recover from hazardous events. In this paper we are interested in applying the concepts to emergency response organisations. However, this focus is not to be interpreted that we are depreciating the importance of the capabilities of the affected population. Both these types of capabilities are crucial for the overall vulnerability of a community. We agree with Coles and Buckle who state that "governments are rarely able to meet all needs of affected people" (Coles and Buckle, 2004), therefore it is important that the affected population are empowered and encouraged to take proper actions.

As described in the introduction, emergencies and crises are often characterised by the fact that the affected population is not self-sufficient. Thus, needs of external assistance emerge, which if unmet will lead to negative consequences. The extent and character of the assistance needs is determined by factors such as the nature of the hazardous events, its severity and the capabilities of the affected to resist, respond to, and recover from the events. Relieving these needs and preventing additional needs to arise becomes the overarching goal for the emergency response organisations in a community, e.g. Fire and Emergency Services, NGOs etc. Perry and Lindell argues that it is important that emergency planning aims at identifying "the demands that a disaster would impose upon emergency response organisations and the resources (personnel, facilities, equipment and materials) that are needed by those organisations to meet the emergency demands" (Perry and Lindell, 2003). However, it is not only the demands directly imposed by the hazard agent upon the emergency response organisations that they have to deal with. Other demands arise due to the fact that a response is initiated. As such, two fundamentally different types of demands can be distinguished; *agent generated demands* – those stemming directly from the hazardous event, such as demand for meeting assistance needs and demands for hazard containment, and *response generated demands* – those emerging from the response to the emergency, such as information distribution and coordination (Dynes, 1994). What ultimately determines the success of an overall emergency response is to which extent the agent generated demands are met, since these are related to the essential variables of the system. The extent to which the response generated demands are met have an indirect effect in that it facilitates or impedes the possibilities to meet the agent generated demands.

An operational definition of emergency response capabilities

Whether emergency response organisations are able to meet the demands that are put on them in a crisis depends on their *emergency response capabilities*. The operational definition of emergency response capabilities that is proposed in this paper acknowledges that analysing capabilities and evaluating them are distinct processes. Evaluating capabilities, i.e. deciding whether a capability is acceptable or not, is a process that is intrinsically value-laden and subjective. The proposed definition aims at facilitating an *analysis* of capabilities and does not address issues of evaluation. The definition includes three essential elements: the *task* to which the capability is related, *measures* of how well that task can be performed and a description of the *context* affecting the performance of that particular task. However, given a specific context there might still be uncertainties about how well the task can be performed, which can be expressed as a set of scenarios similar to the quantitative definition of risk. In the following sections these elements are explored further.

A capability should be related to the performance of a specific task or function when being analysed, i.e. capability to do what?, not just capability in general. For instance, in the case of train derailment mentioned above examples of tasks for the actor Fire and Emergency Service might be "to stop the release" and "to issue warnings". In being specific about the particular task, capabilities are related to the actual course of events, which enables the analyst to be concrete about whether that particular task can be performed or not and providing support for or against it. We argue that in an analysis of capabilities one should strive towards defining tasks such that it is possible to determine if they can be performed or not (or to which degree they can be performed).

It is important to be clear about how to measure how well a task can be performed. Performance measures might vary for different tasks but important dimensions often include effectiveness (the extent to which the response actually satisfy the need that correspond to the demand) and efficiency (whether the task can be performed in a timely manner and within reasonable resource limits). Some performance measures might be directly related to the essential variables of the system as a whole while others might have a more indirect relation, depending on the nature of the task. Since the performance measures determine how well a specific task can be performed they need to be possible to derive, given a specific scenario. This means that they cannot be, for example, of the type "how good the release was managed", unless a clear definition of "good" is provided. Returning to the example above a suitable performance measure related to the task "to stop the release" might be "time from alarm until the release is stopped".

Variation in context, such as conditions in the environment and effects of the hazardous event, will have an affect on how well the tasks can be performed in an emergency situation. Emergency response capabilities are thus context dependent and this must be accounted for in an analysis. In the example above, a description of the context may include, for instance, whether the scene of the accident is accessible by road and whether the actor has access to certain resources. The capabilities that organisations possess during "optimal" conditions might thus be reduced if the context is different.

Given a specific context there might be uncertainties regarding how well a task can be performed. The emergency response capability can thus be seen as a set of triplets, similar to the quantitative definition of risk, corresponding to the three questions:

- "What can happen when an actor is performing a specific task, given a specific context?"
- "How likely is it?"
- "What are the consequences, for the performance measures defined for that particular task?"

An actor can in this case be seen as a part of an organisation, an organisation, or several organisations, thus the definition is flexible regarding the scope. From the scenarios it is possible to extract measures and metrics very much similar to what is done in a quantitative risk analysis, for example curves equivalent to risk curves or expected values. However, the details of how to do this in practice are outside the scope of this paper.

The relation between the definition of emergency response capabilities and the definition of vulnerability, proposed in a previous section is quite straightforward. In a system, for example a geographic region, there might be several actors that possess different emergency response capabilities. The actors and their capabilities will affect the unfolding of the scenarios, i.e. the trajectories in the state space of the system, given that the system is affected by a hazardous event. Thus, the emergency response capabilities will affect the vulnerability of the system as a whole. Some capabilities will certainly have a larger influence on the overall system vulnerability than others, which is important to consider in a comprehensive vulnerability analysis.

Discussion

The use of the definition of emergency response capabilities might be perceived as being demanding, in the sense that it can be time-consuming to carry out a comprehensive analysis. However, the definition should be seen as an ideal operationalisation and be used as a guidance for how a systematic analysis can be structured. The definition acknowledges that there are uncertainties about future events, both regarding the context in which the task are to be performed and regarding how well the task can be performed given a specific context. Furthermore, it should be possible to make judgements about the validity of any statements that are made about capabilities.

We argue that the main purpose of adopting the definition to analyse emergency response capabilities is to introduce a proactive mode of thinking into emergency response organisations. The definition provides an analytic structure that can encourage actors to be systematic when anticipating future events, the demands that are put on them in these events and whether these demands can be met. In the analysis it is possible to identify weaknesses in the emergency response capabilities of actors and alternatives regarding improvements can be suggested. In addition, such an analysis might have the potential of creating a mental awareness of the actors' capabilities and the limits thereof. The limits of the capabilities can then be communicated to other organisations and people and thereby increasing the awareness of the society as a whole. Furthermore, in analysing capabilities the organisations are forced to be concrete about how well the tasks can be performed and to express the capability in measurable quantities.

If the analysis is carried out as a coordinated exercise between many emergency response organisations, there might be additional benefits of analysing emergency response capabilities. First, there is a possibility that adoption of a common perspective on emergencies and a common language can be encouraged. This would for example facilitate communication and cooperation during an emergency and thereby improve the emergency response. By making an analysis of emergency response capabilities into a coordinated exercise between many organisations in a community it is also easier to gain knowledge about the emergency response capabilities of the community as a whole.

In the proposed definition, capabilities are analysed in a concrete manner where tasks are directly related to the actual course of events in the emergency. Another approach could be to analyse higher level abstractions, such as flexibility or capacity to improvise. However, since these are hard to relate to the actual course of events in an emergency it is hard to gain knowledge about the effect these abstractions have on the emergency response and evaluating the validity about statements addressing higher level abstractions might be difficult. In addition, these higher level abstractions are often effects of having a set of concrete capabilities. An example is flexibility, which is often an effect of the ability to perform tasks in different contexts and conditions, for example being able to perform a task even though the regular personnel are disabled. Higher level abstractions can thus often be extracted from the more concrete capabilities.

In analysing emergency response capabilities one will encounter the same problem as one does when applying the quantitative definition of risk, namely choosing an appropriate level of detail in the description of scenarios and context. In theory, there is an infinite set of scenarios and an infinite number of possible contexts, since a description always can be made more detailed. However, very detailed descriptions are often unpractical in real world applications since there is a trade-off between for example the level of detail and the time required to complete the analysis. An important task when analysing emergency response capabilities is therefore to choose an appropriate level of detail. Choosing a too fine level of detail will lead to that too much effort is committed to details that will not affect, or have very limited effect on, the overall analysis. Choosing a too coarse level of detail, on the other hand, could result in that important aspects are overlooked. An example is how to define a task. At the most general level regarding the example with the derailed train, the task might be "to manage the situation". This could be divided into a number of more detailed tasks, e.g. "stopping the release", "issue warning" etc., which in turn could be further divided into tasks of even higher level of detail. The level of detail will in turn affect the number and character of the performance measures that are used to capture what is to constitute a well performed task. The level of detail that is ultimately chosen need to depend on the aim of the specific analysis.

There are several areas for further research. Firstly, there is a need to apply the definition of emergency response capabilities in a comprehensive case study with the purpose of testing the applicability of the framework. Choosing an appropriate level of detail in the analysis is one issue that needs to be addressed. Secondly, the problem of synthesis should be addressed. Using the proposed definition capabilities are *analysed*, i.e. the overall emergency response is broken down into separate tasks, but it is sometimes not straightforward how to synthesise these capabilities into an overall assessment of the capabilities of for example a community.

Conclusions

In this paper we have proposed an operational definition of emergency response capabilities that includes three essential elements. The task to which the capability is related, measures of how well that task can be performed and a description of the context affecting the performance of that particular task. The definition makes clear that there are uncertainties about how well a particular task can be performed given a specific context and that this must be taken into account in an analysis. We conclude that the definition provides a framework for analysing emergency response capabilities which can help actors to gain knowledge about their capabilities and limits thereof. Such an analysis can also serve as a basis for a subsequent evaluation and suggestions for capability improvements.

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SATELLITE BACKHAULING OF WIRELESS TECHNOLOGIES FOR EMERGENCY COMMUNICATIONS

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Keywords

Emergency Communications, Satellite, backhauling, GSM, UMTS, WLAN, WiMAX, TETRA.

Abstract

This paper presents the overall architecture of the WISECOM system, which can quickly re-establish and provide telecommunication services after a disaster. The architecture is explained and it is described together with a role model, which adapts to the system. The work tries to map the existing complex interactions taking place nowadays in an emergency situation to a sensible architecture, which can accommodate all needed actors and roles, and which can exploit, at the same time, the newest wireless technologies. The core element of the architecture, the WISECOM Access Terminal, is then described in details. The targeted infrastructure covers bi-directional communication needs for voice and data and will be scalable, covering the needs for a few persons to larger groups. It comprises equipment that is easy to carry by a person, ideally as a carry-on cargo on planes. The infrastructure covers the immediate needs in the first hours and days following an emergency. Furthermore, the system integrates location-based services assisting Search and Rescue (S&R) operations for emergency scenarios. A secondary objective is to provide an easily deployable infrastructure meant for medium to longer term needs, useful during the recovery and rebuilding phase following an emergency. The infrastructures allow the integration of alert systems, communication to and from the citizens or rescue teams, and rapidly deployable emergency telecommunication systems.

Introduction

Several recent global disasters have resulted in high losses of lives and massive damage. Both early warning systems and rescue operations would have benefited from improved communications systems providing global disaster proof coverage. Katrina wiped out 3

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million telephone lines, took out 38 emergency 911-call centres, and impaired more than 1,000 cellular transceiver towers. There were major gaps in communication between different entities operating in the disaster recovery, which resulted in a series of logistical errors and led to a chaotic situation that required massive aid to control. The EU Commission states: "Recent large catastrophes and crises like Tsunami the Katrina hurricane dramatically showed the importance of communication to prevent the deaths of thousands of people." And the UN Office for Coordination of Humanitarian Affairs says "A Global Disaster Relief System is desperately needed". Satellite communications offer a required robustness, global coverage and enables infrastructures to be in place in shorter time then any other technology. Awareness of communication needs in times of disasters is now at a high level worldwide, and satellites can play a key role in creating temporary ad-hoc infrastructures suitable for both rescue workers and victims during disasters. In order to address this issues, the European Commission is supporting a project called WISECOM [1]; an acronym for Wireless Infrastructure over Satellite for Emergency Communications.

This paper presents the WISECOM project, and discusses the potential impact WISECOM may have by use of satellites in disaster recovery, outlining global requirements for emergency communications in light of initiatives by the UN, EU, ETSI and others.

WISECOM studies, develops, and validates by live trials the candidate rapidly deployable lightweight communications infrastructures for emergency conditions. The infrastructures will integrate several terrestrial mobile radio networks - GSM, UMTS, WiFi, and optionally WIMAX and TETRA - with satellite systems. The hardware shall be both lightweight and rapidly deployable, and thus suitable for public safety communication. Satellite systems, due to their very wide area coverage and the possibility of readily transportable terminals, intrinsically allow for a rapid deployment of a telecommunication infrastructure when and where a terrestrial infrastructure is not available (e.g. after a natural or industrial hazard). The connection to the public networks (PSTN, ISDN, Internet) is directly provided at the satellite gateway, depending on the offered service. The satellite segment of the WISECOM project will be based on both Inmarsat BGAN and DVB-RCS, the former for worldwide basic services and the latter providing larger bandwidth support. The hardware will be tested in real trials at the end of 2007 with emergency simulations under stress.

The paper is organized as follows. In the next section the overall concept of the WISECOM system architecture is presented together with the business model which maps to it, and which describes which role is played by the different and many actors involved. The following section describes in details the key element of this architecture, which is the WISECOM Access Terminals, WAT. The final discussion is given in the "Conclusion" section.

WISECOM Architecture

The WISECOM system represents the technical answer to telecommunication needs for people involved in a post-disaster emergency situation. The reference architecture of this WISECOM system, illustrated in Fig. 1, is based on a modular approach. A WISECOM Client guarantees the interworking between the various access and satellite solutions, providing additional functionalities. Despite the multitude of technical solutions that could be used to realise the WISECOM system, several distinct logical blocks can be distinguished. It is the aim of this section to define these logical blocks, so that a common high-level WISECOM reference architecture and terminology can be adopted.

The WISECOM system enables the communication between the disaster end-users (victims, rescue teams or any other kind of involved people) located inside or outside the disaster area using different kinds of communication devices; the transmission occurs across a number of network elements, which compose the WISECOM communication chain. The white boxes in each different domain represent possible groups of network elements with complementary or close characteristics, or supporting the same type of technology. Inside a network element group there might be several network elements involved in the communication. The physical implementation of the domain in the WISECOM system may include at the same time technologies belonging to one or several network element groups, but the communication chain will always flow across one of group of network entities per domain at a time.

Two main segments are defined in WISECOM:

- the On-Disaster Site Segment,
- the Disaster-Safe Segment.

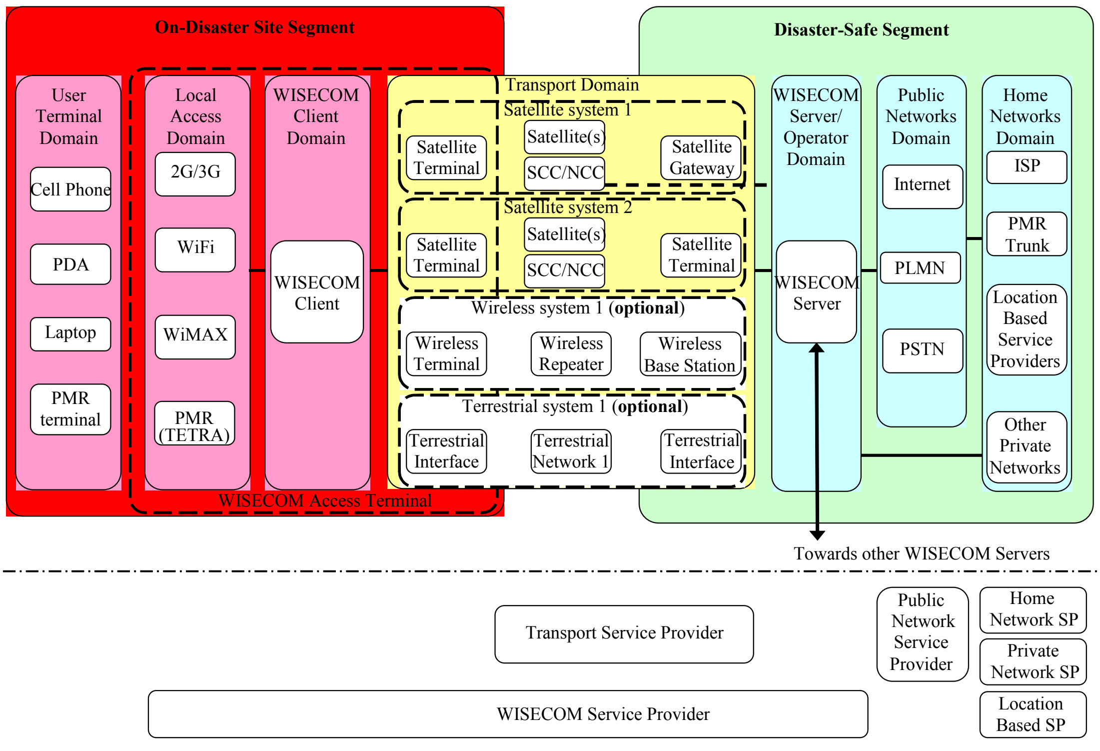
The former consists of the User-terminal Domain, the Local Access Domain, the WISECOM Client Domain and the group of network elements responsible for the access to the transport domain from the disaster area (satellite terminals, terrestrial wireless terminals, etc…).

The latter comprises the group of network elements responsible for the access and control of the transport domain, the WISECOM Server / Operator Domain, the Public Networks Domain and the Home Networks Domain.

The interface between the two segments is provided by the Transport Domain; where one part is located in the On-Disaster Site Segment and the other in the Disaster-Safe Segment.

In Fig. 1, the full lines between the WISECOM Server / Operator Domain and the Home Networks Domain are used to represent possible direct high security connections between a WISECOM server and some special networks or servers dedicated to emergency situations. Of course, these connections can also be achieved via public networks.

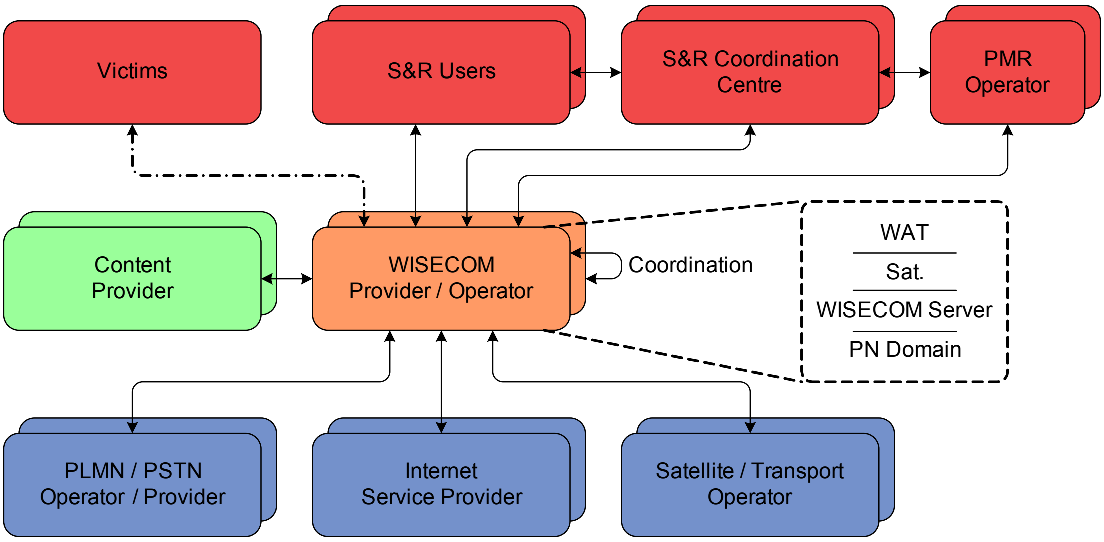
Figure 1 – WISECOM Functional Architecture.



The technical architecture shown in Fig. 1 is part of a more or less complex set of relations among different operators and service providers involved in the provision of services for the WISECOM system(s). In any case beyond the various business relations among the different players involved, the solution is technically simple and for this reason reliable.

These relationships are clarified in the role model presented in the following Fig. 2. The definition of roles in the WISECOM communication system has to closely follow the typical organisational structures in handling of global, regional or national disasters, whereby current practice but also ongoing efforts and future plans for an improved (re)organisation of disaster relief operations must be taken into account. It is still to be studied and evaluated in the framework of this project, in how far the role model and system architecture of the WISECOM communication system can in turn have an active influence on these future organisational structures.

Figure 2 – WISECOM Role Model.



The following roles can be identified: WISECOM operator or service provider, victims, S&R (Search and Rescue) users, S&R coordination centres, PMR (Professional Mobile Radio) operators, content providers, satellite transport service operator/provider, Internet Service Provider, PLMN/PSTN (Public Land Mobile Network / Public Switched Telephone Network) operator/provider, Mobile Network Operator (MNO).

The WISECOM operator or service provider plays the central role in the considered system, interfacing all of the following roles, as illustrated in Fig. 2; usually, each WISECOM operator owns one WISECOM server to which one or several WISECOM clients (or WISECOM Access Terminals, WAT) are connected; the WISECOM operator acts as a kind of "concentrator" for a complete and tailored service provisioning – in terms of communications services, content, and infrastructure – to the system users, and is their main/single direct interface.

The victims come in as passive or active end users from a communications system point of view via their standard equipment (mainly mobile phones), which may be used both in active and passive modes (active calling or sending SMS or being located within a certain cell).

S&R users include both early phase (immediate search & rescue) and response phase (rescue, transport and medical treatment etc.) forces; here the main relation is provisioning of services (communications, LBS, and content) via WISECOM Access Terminals available to the rescue organisations. S&R coordination centres mainly coordinate and command the field rescue forces throughout all disaster phases.

PMR operators, like national/regional TETRA operators, have an established operator/provider relationship with the users and obviously must be interfaced also in the more general WISECOM role model and architecture.

Content providers can for instance be providers of Geographic Information Systems (GIS), of maps, image services or of other kind of data. In general, the WISECOM service provider should be the central entity responsible for the integrity of all content provided to end-users; for instance the WISECOM service provider would buy and regularly update static reliable GIS map information from various respective content providers and take care of central provisioning to all end-users; for dynamic real-time data, on the other hand, he would preferably secure via agreements reliable and permanent on-line access to content hosted by those providers, for the sake of efficiency and timeliness.

The satellite transport service operator/provider provides the key backhauling link from the disaster areas to the disaster-safe segment; here the relation between the WISECOM operator and the satellite operator should be preferably simple and direct, i.e., the WISECOM service provider would ideally be or become a service provider of the satellite backhauling capacity at the same time; in the case of one global satellite system like Inmarsat, one could think of one truly global WISECOM provider which could be a key advantage in support of streamlining global coordination of disaster management.

The last three players take care of the connections to the core terrestrial public networks: Internet Service Provider, providing access to the Internet, PLMN/PSTN operator/provider, providing voice/data communication and connection to the fixed and mobile legacy networks, mobile positioning and messaging; an MNO, for the local access domain. An MNO – potentially the same as the previously mentioned PLMN operator/provider – may come in as a specific player if the WISECOM operator/provider does not act at the same time as a (virtual) MNO itself; here the main relation would be a tailored contract for provisioning of vendor-specific SIM cards, specific roaming agreements and use of its licensed frequencies; note that in such a case one unique provider per considered WISECOM service area would be preferable, to keep the number of involved partners low and thus the complexity of contractual, technical, and service level frameworks;

Finally, a general and long-term (maybe only indirect or implicit) relation exists between WISECOM operators /providers and regulatory and licensing bodies; the related issues are the whole licensing process for dedicated reserved emergency frequency bands (both terrestrial wireless and satellite) or potential pre-emption usage of general frequencies only in emergency situations etc; this role and relationship has its own complexity and is thus not addressed in this paper.

When one looks at the various levels of size (geographical extent) of disasters (local, national, regional, large-area [2]) and of the organisational structures in performing disaster relief operations (local, single or multi-rescue-organisations, national extent, international extent), apparently the WISECOM communication system should be generic in a sense that it could be used in all cases. A multi-national or global approach can only be met by properly adapted structures in cooperation and command, and some level of hierarchy can be expected, but in any cases a distributed-cooperative approach will be required. Consequently a respective WISECOM system would certainly mirror such structures to some degree. However, looking at the current reality, global harmonization and setting up such structures seem to have just started with still quite visionary goals. In many cases, national structures dominate the scenario, and also many of the smaller to medium disasters are typically of regional or national extent.

In any case the WISECOM architecture is general and flexible enough and to accommodate both an organized and hierarchical solution and the fully distributed-cooperative model. This is one of the most important benefits of the WISECOM technical approach.

WAT and WISECOM Client

The WISECOM Access Terminal (WAT) is the key equipment of the WISECOM system, it is the physical device which is brought to the place of the disaster by the i.e. rescue teams, it includes all logical and physical modules which enable the connection of standard mobile phones (GSM, UMTS, TETRA) and wireless data transmitters (WiFi, WiMAX) to the public networks (Internet, PSTN/PLMN).

As it was already explained, the WAT spans over three domains: the Local Access Domain (LAD), the WISECOM Client Domain (WCD), and the Transport Domain (TD). For this reason it can be thought as a combination of three modules: one interacting with the LAD technologies, one providing the operations needed for the satellite transmission and reception, and one module in the middle interfacing these two worlds with more or less intelligence. The functionalities located in the two external modules are specified by the characteristics of the related technologies (terrestrial or satellite), and thus they are well defined.

The core interfacing functionalities of the WAT lay in the middle module, the WISECOM client, for this reason it represents the main subject of the present section.

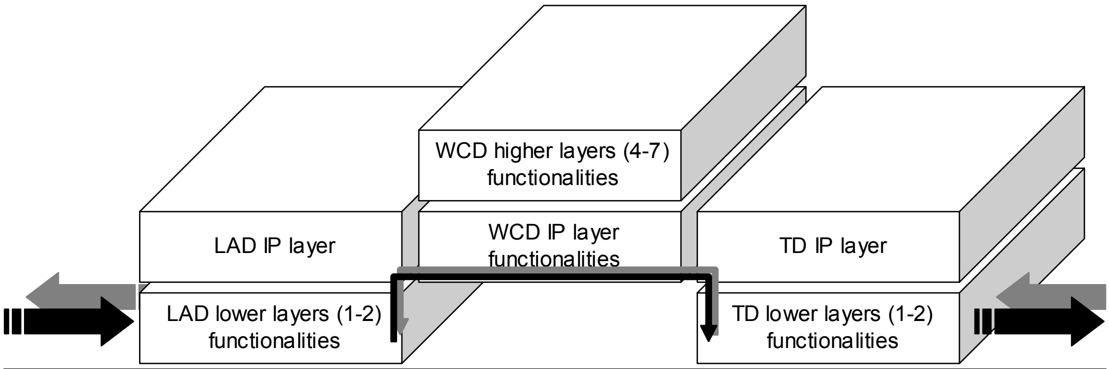
The functionalities to be found in the WAT can be classified according to the three domains (LAD, WCD, TD) and to the layers of the ISO/OSI (International Standard Organization's Open System Interconnect) protocol stack. For this analysis we can divide the seven layers of the ISO/OSI into the three following groups:

- Lower layers (physical and link layer, layers 1 and 2);
- IP layer (network layer, layer 3);
- Higher layers (transport layer and above, layer 4-7).

This is done, as we will see that the IP layer plays a fundamental role, and all transitions and interfacing operations can be performed going through the IP layer; this makes the operations easier, on one hand, and, on the other hand, it allows the system to be handled in a unique way independently of the technologies which are used on the two sides of the LAD and of the TD.

The resulting WAT functional block architecture is shown in the following figure.

Figure 3 - WISECOM Access Terminal (WAT) functional block architecture.



In real implementations the three domains of the WAT, and the six logical modules, may be located on the same physical device or on physically different devices. In the former case the WAT will look like one single "box" which integrates the satellite modem and the base station(s) for the LAD (e.g. a GSM base station, or a WiFi access point). Nevertheless satellite modems and wireless base stations (GSM picocells or WiFi access points) are commercial off-the-shelf and standalone equipments, so the latter case seems to be more likely. In this latter case the WAT will be composed of several physical elements: at least one element for every LAD (one GSM picocell, one WiFi access point, etc…), one (or more) element(s) for the WCD (e.g. a LINUX computer), and one element (and only one for each WAT) for the satellite TD. It is assumed that the connections among the elements (across the three domains) will be performed over IP by means of Ethernet cables, for this reason the IP layer remains a core one. In this case the WCD will also have modules implementing Ethernet functionalities at layer 1 and 2, but this is not considered relevant and can be neglected for the present analysis, and thus it is not depicted in Fig. 3.

The LAD modules in the WAT contain all functionalities characteristics of the particular wireless technology used in the local terrestrial loop: GSM, UMTS, WiFi, WiMAX, and TETRA. The modules should allow the operation of standard user terminals (mobile phones, PDAs or laptops, etc…), this implies that the air interface provided on the LAD should comply the given standards. On the other side a transition to IP should be already performed in this domain for all standards which natively do not run over IP, i.e. GSM, UMTS, and TETRA. So the two LAD modules take care respectively of these two tasks, the needed functionalities are summarized in the following:

- LAD lower layers (1-2):
  - Physical and link layer functionalities (e.g. modulation, power control, MAC, etc…).
- LAD IP layer:
  - Data format conversion to IP: e.g. encapsulation of GSM signalling (e.g. the A-bis interface between the BTS and the BSC) into IP, codec conversion, encapsulation of TETRA signalling into IP, etc… It should be noted that in this module only simple operations of signalling adaptation to IP should be performed, more complex functionalities, such as protocol or signalling conversion, should be performed in the WISECOM client (WCD).

The WISECOM client logically operates only at IP layer and above. It is a transition module for all the traffic in the middle of the WAT, it may be the destination of some higher layer signalling, such as authentication or LBS. The WCD may also intercept (or spoof) some signalling which is destined to higher layers counterparts beyond the TD. For both these two reasons the WCD contains functionalities at layers higher than IP. The needed functionalities are summarized in the following:

- WCD IP layer:
  - All IP QoS functionalities (it is foreseen to adopt DiffServ approach): data flow classification, packet marking, traffic policing (filtering), traffic shaping, queuing and scheduling (priority aware scheduling should be used together with smart buffer management and dropping policies, e.g. RED, Random Early Detection), connection admission control and congestion control (optional in DiffServ).
  - All conventional IP functionalities, such as IP routing and addressing, if NAT (Network Address Translation) is needed, it should not be used here but in the TD module.
  - IP add-on functionalities: e.g. IP sec may be implemented here, if needed; it is not foreseen to use Mobile IP.
- WCD higher layers (4-7) terminated at the WCD:
  - LBS functionalities.
  - Authentication, authorization: specific GSM/UMTS functionalities may be implemented in this module, in order to save signalling over the satellite (e.g. Visitor Location Register, VLR), a RADIUS (or DIAMETER) authentication server may be also implemented in this module, acting as an authentication proxy.
  - Billing.
- WCD higher layers (4-7) "intercepted" at the WCD:
  - Caching: e.g. Performance Enhancement Proxy for TCP.
  - IP signalling adaptation to satellite: this kind of operations are particularly important for non-native IP traffic, such as GSM/UMTS, protocol conversion/adaptation may deserve an own software unit and may run on dedicated computers: e.g. GSM connection control may be translated into SIP, timers may be adapted to the longer satellite delays.

The TD is the last stage of the WAT processing the outgoing traffic before it is sent over the satellite and it is the first stage for the incoming traffic. This module performs the very final operations needed for the satellite transmission (or the very preliminary ones for incoming traffic); all operations requiring more complex processing should be located in the WCD.

- TD IP layer:
  - IP queue management: taking into account that most of the QoS IP management is performed in the WCD, and that packets are already marked with the appropriate DSCP (DiffServ Code Point) according to their (DiffServ) service class, the IP management in the TD results to be very easy; nevertheless a set of DiffServ queues has to be foreseen, packets are classified according to their DSCP and mapped to the related queue. All other operations (traffic policing, traffic shaping, buffer management and dropping policies, admission control and congestion control) can be neglected as they are already performed in the WCD module.
  - IP encapsulation and segmentation
- TD lower layers (1-2):
  - Satellite L2 management: address resolution, L2 security, L2 scheduling and resource management: This latter operation is very important, as it is responsible of gathering the needed physical resources (satellite capacity) to transmit the traffic, and of mapping the IP queues to appropriate L2 classes. The operations performed in the real systems (BGAN and DVB-RCS) may differ, but this is normally transparent to IP layers and to the other modules (WCD), so it can be neglected in the present analysis.
  - Satellite physical layer operations.

As it was already explained the connection of the WCD and of the LAD modules should occur at IP layer. The following technologies should be considered for the interfacing of the WCD with the LAD: GSM, UMTS, TETRA, Wi-Fi, WiMAX..

The latter two can be considered native IP bearers, so they do not pose particular problems when they have to be interfaced with IP. The former three technologies are voice-based and in conventional architectures they do not run originally over IP, at least at this stage, i.e. immediately behind the base station. In any case since the LAD-to-WCD interfacing should occur over IP, it is recommended to make a simple encapsulation of these conventional signalling (GSM, UMTS and TETRA) over IP. This type of traffic should be then forwarded to the WCD. More complex protocol translations or conversions deserve particular attention and for this reason they should be left to dedicated processing units, i.e. to the WCD.

The technologies foreseen for the transport domain are: Inmarsat BGAN, and DVB-RCS. The equipment needed to implement the WCD-to-TD interface is a commercial off-the-shelf satellite terminal. These types of terminals normally include the lower layers implementation (the TD lower layer module) and the related IP layer one (the TD IP layer module). Normally it is possible to connect a computer to this type of terminals over Ethernet, so the interfacing occurs over IP, as already anticipated and shown in Fig. 3. The operations performed in the TD IP module are just the ones strictly needed by the satellite transmission, they are normally in any case performed by conventional satellite terminals; all more advanced operations and all WISECOM-specific functionalities have to be performed in the WCD module, as already explained in this section.

It is worth mentioning that the interface between the TD IP module and the TD lower layer one, may optionally comply with the ETSI Broadband Satellite Multimedia Working Group (BSM) model [3]. This model separates the protocol and procedures in a satellite system into two parts: The upper part provides IP-based interworking using a set of common satellite independent (SI) functions that are applicable to many satellite systems. The lower part provides the satellite dependent (SD) functions. ETSI/BSM air Interface specifications define a mapping of the SD functions to the mechanisms used by specific types of satellite system. This framework allows protocols at the SI layer can develop without impacting the design of satellite technology, enabling satellite systems at the SD layer to evolve in parallel. The BSM reference model has a logical interface between the SI and SD layers provided by the Satellite-Independent Service Access Point (SI-SAP). This suggests the existence of the SI-SAP as an internal standard interface within a satellite terminal. If this is the case the TD IP module may be able to interoperate with different underlying TD lower-layer modules, and this is considered highly advantageous for the WISECOM system.

Conclusion

Disasters are often combined with the destruction of the local telecommunication infrastructure, causing severe problems to the rescue operations. In these cases the only possible way to guarantee communication services is to use satellites to provide a backhaul connection to the intact network infrastructure. In fact the existing solution today to overcome the communication problems is to use satellite phones in the first hours after the disaster. With the help of more complex and bulky technologies [4,5] it is also possible to rebuild and deploy a wireless telecommunication infrastructure to transmit both voice and data over the satellite, e.g. providing connection for standard GSM/UMTS, WLAN, WiMAX, TETRA, etc. to the public networks. So in addition to supporting search and rescue operations, these solutions restore local 3G/4G infrastructures allowing normal mobile phones and terminals (e.g. laptops) to be used by the victims of the disaster. Anyway the latter solutions require many hours to several days to be brought to the place of the disaster.

This paper has presented the approach proposed by the WISECOM project [1], which aims at developing a complete telecommunication solution that can be rapidly deployed immediately after the disaster, within the first 24 hours, replacing the traditional use of satellite phones or heavy and cumbersome devices. WISECOM restores local GSM or 3G infrastructures, allowing normal mobile phones to be used, and enables wireless standard data access (e.g. WiFi or WiMAX). The paper also presented technical details of the key system modules.

Looking at the current reality of emergency communications it is easy to conclude that satellites are a fundamental element which has to be considered in this area, but their integration with terrestrial technologies is needed. Unfortunately it seems that there is no global harmonization and no widely accepted way of organizing the re-establishment of a telecommunication infrastructure in a post-disaster situation. For this reason the WISECOM project proposes a model which includes the existing state of the art, which is easily to be upgraded with new upcoming technologies, and which, at the same time, is general enough to accommodate the complex interactions between rescue teams and different service providers, in both a hierarchical and distributed fashion. This should be considered in future standardization activities.

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Dr. Matteo Berioli (M.Sc. '01, Ph.D. '04) is with the German Aerospace Center (DLR) since 2002. His expertise covers many fields in the area of Internet communications over satellite. His project experience includes several national and international projects at European level, in the framework of ESA, EU-IST and COST, experiments and trials over satellite, development of prototypes and demonstrators, measurement campaigns, where he has often covered leading roles (e.g. he coordinated all demonstration and trials activities of the WirelessCabin project). He has also experience in running industrially funded projects, as well as more theoretical works: He is author/co-author of several papers, which appeared in international journals and conference proceedings. He has been reviewer for technical international journals and for many international conferences (IEEE and non-IEEE). He has worked as an ETSI (European Telecommunications Standards Institute) expert in broadband multimedia satellite communications. He is currently coordinating the WISECOM project, and the satellite working group in the PSC Forum (Public Safety Communication Forum).

Dr. Harald Skinnemoen (M.Sc. '85, Ph.D. '94), managing director of AnsuR, joined Nera in 1987, and has been working with aeronautical, mobile and broadband satellite systems, covering most technical aspects from the physical layers to the system concept. He has participated in a number of international studies and published a number of conference papers. He also worked as Nera SatCom R&D Product Manager. Since 1998 he has served as an expert to ETSI in broadband multimedia satellite communications, and as the first and founding Chairman of the corresponding ETSI SES BSM workgroup. He has been deeply involved in global satellite standardization and regulatory work in cooperation with ESA, ITU, TIA, the DVB Project, IETF and others. He also serves as an expert reviewer to the EU Commission and as a lecturer to TopTech's international Master of Space Engineering program in Holland. Dr. Skinnemoen is a Senior IEEE Member.

Sindre Kopland-Hansen (M.Sc. '93) technical director of AnsuR, hired by Nera Satcom 00-06 for DVB-RCS terminal work and later the Nera World Pro 1010 Inmarsat BGAN terminal development project working from pre studies to responsible for the non access stratum - access stratum interworking protocol stack. Ericsson '93-00 working with IN services for 2 years , GSM data interworking for 2 years and H.323 IP telephony Gatekeeper development for 2 years. These total 13 years has all been in heavy research and development projects incorporating pre studies, standardization work, modeling, implementation and testing. Before this Mr. Kopland did his main Thesis on Tracking of Remote Sensing LEO Satellites at the Norwegian Defence Research Establishment/University of Oslo. Mr. Kopland is hired by the University of Oslo as external examiner for final M.Sc. level exams.

Dr. Markus Werner (M.Sc. '91, Ph.D. '02) has been with the Institute of Communications and Navigation of the German Aerospace Center (DLR), Oberpfaffenhofen, Germany, between 1991 and 2005, where he worked as a research scientist, project manager and group leader. He has been a managing partner of TriaGnoSys GmbH since 2002. His project experience includes several national and ESA studies and various projects in the framework of European ACTS, IST, COST 227, and COST 252 and COST 272 programs. He has been the project manager of the EC FP6 Network of Excellence in Satellite Communications (SatNEx). He lectured on mobile satellite communications at Ilmenau Technical University from 1995-96. He is also a Lecturer at the Carl-Cranz-Gesellschaft (CCG), Oberpfaffenhofen, Germany, teaching satellite communications courses for telecommunications professionals. He is co-author of more than 80 scientific publications and of the textbook 'Satellite Systems for Personal and Broadband Communications' (Berlin, Germany: Springer-Verlag, 2000). Dr. Werner is a Senior Member of IEEE, and a member of VDE/ITG.

Academic & Professional Practice

Peer Reviewed Articles

MARITIME SAFETY & SECURITY

SOLVING THE PROBLEM OF CHEMICAL SPILLS AT SEA

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Keywords:

Toxic chemicals, spills at sea, decision making, solving the problem, monitoring.

Abstract

Nowdays, there are many toxic chemicals, which is transported by sea and incidence of accident which results with chemical spills are very often. Many techniques of solving the consequences of chemical spills are developed. But in many cases, it is more desirable to not act and to leave chemicals to disperse in sea column or in the air. Most of chemicals which is transported by sea are not persistent in sea environment and will totally desappear after some time. It is posible to avoid hazards to emergency team (risk of fire, explosion and poisonong) and many problems connected with treatiment, transpotration and storing of toxic waste by making the decision *not to act*. It is also money saving action. In coastal zones, where it is necessary to remove toxic chemicals, the selection of proper method depends on the characteristics of chemicals, environment and available devices.

Introduction

Chemical spills are serious economical and ecological problem especially near the coast. Usually the damage is temporal and it depends on the range of spill. Sea environment is very sensitive and action againts chemical spill have to be efficient and immediate. In the action we would to take care of circumstancens of the accident and sometimes the best solution is to apply more than one tecnique of solving damages of the spill. But first we have to ask ourselves: Is it posible to respond to the situation? and Should we act at all?

Thesis

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Most of chemicals which are transported by the sea are not persistent in sea environment and will totally desappear after some time. In many cases, it is more desirable to not act and to leave the chemicals to disperse in sea column or in the air. It is posible to avoid hazards to emergency team (risk of fire, explosion and poisonong) and many problems connected with treatiment, transpotration and storing of toxic waste by making the decision *not to act*. It is also money saving action. In coastal zones, where it is necessary to remove toxic chemicals, the selection of proper method depends on the characteristics of chemicals, environment and available devices.

Sources of information

Situations in Which Action against Chemical Spills Is Not Possible

In some cases it is not possible to take actions against chemical spills. It depends on:

- Time needed to act. Before we start the operation it takes at least 24 hours for making decision how to act; searching for and locating the spill; preparing and transporting the equipment from the storage which is usually at land to the site of chemical spill in good conditions. If we add time needed for the operation which is at least 12 hours to the time needed to start the operation, we get the time needed to act of total 36 hours (Kantin, 1996).
- The characteristics of chemicals. The characteristics of chemicals determine persistency of the chemicals and consequently possibility of action. The characteristics of cemicals which determine the possibilty of action are: colour, density, solubility, evaporation rate, viscosity, spread coefficient, chemical reaction between chemicals and equipment.The period of 36 hours is too long for successfully completion of the operation, if the chemical is not persistent. The chemical will spread in sea water and it will be unpossible to act.

When chemical spills happen in the sea port or near the coast, the time needed to start the operation is relatively short and it is easy to confine the location of chemical spill. Due to short time needed for starting the action, it is possible take operations against larger number of chemicals than offshore. It usually takes 2 to 3 hours to remove harmful effects of chemical spills if the chemical is spilt in the port and 6 to 12 hours if it is spilt along the coast (depends on the accessibility of the site), (Bićanić, 2003). Therefore, action against harmful effects of chemical spills is possible if the chemical is persistent at least 24 hours in coastal area, and at least 12 hours in ports. The persistency of chemicals depends on coefficient of solubility, volatility, spread and temperature of the environment.

Situations in Which Decision *Not To Act* Is Made

Chemical spills can be harmful due to the risk of fire, explosion, air and water toxicity or bioaccumulation...The decision *not to act* is made:

- when life of members of the team are endangered due to risk of fire or explosion, or due to risk of poisoning by touch or respiration;
- when action would cause heavier pollution;
- When spilled chemical is not known. In the case of bulk chemical the name can be found more easily then in the case when chemical is packed.

Preventive measures have to be taken in order to protect people and environment when decision *not to act* is made. It is necessary to provide evacuation for local population, crew members and members of the team which are in contact with chemical spill. It is also necessary to protect the vessels passing near polluted area and to route them out of endangered zone. It is necessary to monitor the spill, the quality of water, as well as sediment and air.

Situations in Which Decision *to Act* Is Made

The decision *to act* is made when following conditions occur:

- if the persistency of chemical in the water leaves enough time to partially remove the chemical,
- when the chemical is naturally confined (in ports or along the coast) the decision has to be made quickly,
- if the risk to the members of the team is not too big,
- if all necessary equipment is available and compatible to spilt chemical and if it is possible to use it properly,
- if polarized chemical is disposed on shore or in case of floating containers, the decision to act is also made.

Findings

It is rarely possible to remove spilt chemical from sea. In sea transport, many of the chemicals are not persistent and it will totally disappear from the environment after some time. Therefore, in many cases, it is more desirable to leave the pollutant to disperse in water column or in the air. The decision *not to act* enables to avoid many risks to members of the team (risk of fire, explosion, poisoning by respiration…) and many problems connected with treatment, transport and storage of toxic waste. It is necessary to take certain preventive measures, when is not possible to act and remove the pollutant from sea environment:

- to estimate risks to the people (members of the team, crew members, locals) and the environment. It is necessary to collect all the information available of transported chemical and meteorological conditions of polluted area,
- to establish monitoring of polluted area, especially in fishing zones, hatcheries, fish or shell farms,
- to sample the organisms, the pollutants…

In some areas, it is desirable to confine pollutant prior to removing and to remove pollutant from the environment (especially from the ports and coastal zones). It is possible to remove spilt chemical, if it floats on the surface, is unvolatile, coloured, unsoluble in the water, and of relatively high viscosity. The selection of proper method of pollutant removing depends on the characteristics of chemicals, effects of the environment and available devices.

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IMPORTANCE OF THE SAFETY OF NAVIGATION AND SAFETY PROTECTION TO NAUTICAL TOURISM

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KEY WORDS:

Nautical tourism, ports of nautical tourism, safety of navigation system, safety protection, protection of the sea and marine environment, improvement measures

SUMMARY

The paper presents the results of research into the state of safety of navigation and safety protection in the ports of nautical tourism, as well as the condition of protection of the sea and marine environment in the Croatian part of the Adriatic.

The authors evaluate the attained level of the development of nautical tourism, the capacities of ports of nautical tourism and their technical-technological limitations, primarily in the light of expecting greater acceptance of bigger vessels and yachts. The paper defines improvement measures for the safety of navigation, safety protection, measures for the protection of the sea and coastal area, pointing to the importance of training in order to avoid maritime accidents. The authors emphasize the importance of establishing the internal structure of the safety of navigation and safety protection in accordance with expected changes.

INTRODUCTION

The term of nautical tourism has been available in the scientific and technical literature for a long time, but its complete and widely accepted definition is still lacking. The definition in the Act on Tourism Activity[4] considers nautical tourism to be the sailing and stay of tourists-boaters on vessels, as well as their stay in ports of nautical tourism for leisure and recreation. Nautical tourism is also considered as different forms of tourist traffic taking place in the maritime domain and in the ports of nautical tourism, by means of vessels of different sizes

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[4] Official Gazette 8/96.

and different kinds. In this process, the boater being the sailing subject must have all the navigation documents, while his vessel must have all the certificates required for safe navigation. However, the definition of nautical tourism is not complete in its qualification of tourism as a kind or form, and there are no unique views in this respect. Most of authors consider nautical tourism to be a kind of tourism, or a special form of tourism, some rate it among selective kinds of tourism, others not, and it can also be found within these groups in different classifications according to different criteria. The development of nautical tourism in Croatia is limited by the capacity and technical-technological characteristics of the existing ports of nautical tourism. Increased number of vessels and large yachts in the Adriatic requires changes in the infrastructure and organisation of nautical ports, and sets specific requirements regarding the safety of navigation, safety protection, and protection of the sea and coastal area.

CONDITION OF THE SAFETY OF NAVIGATION AND PORTS OF NAUTICAL TOURISM

The system of the safety at sea[5] is defined by three basic determinants [6]: authorised personnel, material resources, and organised set of measures, procedures and rules. The active aim of the system is to ensure the safe navigation of ships, yachts and boats, and the protection of marine environment, that is to prevent accidents and other dangers from ships, yachts and boats. The system of the safety of navigation in Croatia is based upon a number of regulations of different legal power, and on the systematic implementation of the provisions of international conventions and agreements relating to the safety of navigation and the protection of marine environment, already adopted by the Republic of Croatia or to be adopted in the near future. Even though the basic activity of the system is chiefly oriented towards ships, the measures and procedures equally refer to nautical tourism vessels, primarily to yachts and boats. The differences in the implementation arise from inability to implement consistently certain principles, which is usually due to technical or technological limitations of vessels. Basic law which regulates the safety of navigation in the Republic of Croatia is the Maritime Code[6]. Besides normative requirements, of particular importance for boaters are also different facilities for the safety of navigation, first of all lighthouses, which have even become popular holiday destinations among boaters, as well as different pilots and other nautical handbooks. They help in defining the most convenient route in an area, in choosing the most adequate port, shelter or anchorage, and in other activities naturally connected with navigation.

The knowledge and skills necessary for the safe navigation are obtained through theoretical and practical learning, and by getting certificates of different kinds and categories. The basic knowledge and skills necessary for steering the vessel of nautical tourism are proved by the certificates of competence.[7]

Many authors deal with the safety of ports of nautical tourism, particularly marinas, investigating the planning, designing and building of marinas by using new technical-technological solutions. Through the use of modern materials and technologies, for example in the pontoon port of nautical tourism, with relatively small interventions it is possible to keep the natural appearance of the shore and ensure the protection of the sea and coastal area. In this process, all technological standards must be observed [7], in order to provide complete safety to vessels and their owners, boaters.

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[5] The term of the safety of navigation system, unless otherwise stated, besides the safety of people and ships, also implies measures for safety protection and protection of the sea and coastal area from pollution.
[6] Official Gazette 181/04.
[7] Ordinance on Boats and Yachts, Articles 49 – 68, Official Gazette 27/05, with amendments.

The safety condition in the ports of nautical tourism, according to categories as defined by the Croatian regulations [1], is as follows:

Anchorages provide satisfying level of safety in the summer period. Throughout the rest of the year when the probability of occurrence of bad weather is increased, the safety of ships at anchorage is questionable. For that reason, anchorages should be considered as adequate destinations only in the summer period, while in other parts of the year the traffic there is very low or missing.

Berths are characterized by different levels of safety provided to vessels lying at berth. The berths which are situated in protected bays or within the protected parts of public or other ports ensure a high level of safety, particularly if used by vessels of proper size, and if adequate mooring equipment is used. Such berths provide safe accommodation for vessels throughout the year including wintering.

Marinas offer the highest level of safety to vessels at berth both in the summer when vessels frequently enter and leave port, and in the winter when most of vessels do not have a permanent crew. For the protection of environment, every marina (except 3rd category marinas) must have adequate boats or equipment for efficient elimination of smaller pollution incidents. The marinas built in an area which is not naturally protected from the action of the sea may include parts where berthing is not safe under certain circumstances. In such marinas the impact of waves can be reduced by constructing breakwaters, but when a marina is fully occupied the vessels moored near its entrance may be exposed to damaging effects of the sea.

Leisure ports are mostly used by local inhabitants who are well acquainted with navigational conditions in the port area, so that in terms of safety they are considered to be free from danger.

EXPECTED LINES OF DEVELOPMENT

In the years to come, essential characteristics of nautical tourism are bound to change. The reasons for change are based on the development of technology, the development of economy, and on the change in social circumstances. The influence of new technologies or of the improvement of existing ones should be expected in several areas, particularly in terms of:

- advancement of the technology of construction and maintenance of vessels,
- advancement of the technological support for acceptance of vessels and for providing services in ports or during navigation,
- advancement in the technological areas which are not directly connected with navigation but have a great influence on it (e.g. changes in the construction technology).

In the following years, economic development in Croatia and in the neighbouring Adriatic countries will have a direct influence on the changes in nautical tourism, in the safety of navigation and in the protection of marine environment. Overall economic development will bring about an increased number of domestic and foreign users of the services of nautical tourism, which will result in a higher demand for these services and an expansion of the number and kind of secondary services. On the basis of trends in the last two decades, significant changes in social circumstances can be expected. In this respect, it should be pointed out that an increasing awareness of the need for preservation of natural environment is evident, and consequently the changes in the system of values. Regarding its influence on the nautical tourism, this means that the highly protected areas (such as the eastern coast of the Adriatic) will become much more attractive, and at the same time users of particular areas will change their attitudes towards measures for preservation of natural environment. Market trends for the vessels of nautical tourism show a gradual but evident rise in size and the level of equipment. Increase in the number of vessels will basically influence the required capacities of ports of nautical tourism, and will result in the further growth of the number of ports of nautical tourism or expansion of the existing ones. In this respect, two kinds of vessels are distinguished:

- vessels using the services of nautical tourism,
- vessels used near the place of residence.

Increase in the number of smaller vessels regularly using the services of the ports of nautical tourism is certain, being nearly equal for motor vessels and sailboats. Even though there are no clear indicators, it is likely that there is a little greater increase in the part of motor vessels. On the other hand, even a small increase in the number of large yachts (for which very modest reception capacities are currently available in the existing ports of nautical tourism) will bring about significant changes in the arrangement and characteristics of berthing places. From a technological point of view, such vessels require the conditions that are usually met by the ports accepting smaller vessels. Two very different manners of use should be distinguished:

- permanent berth of large yachts for accommodation or custody, and
- chiefly navigation along the coast.

Increase in the number of large yachts on permanent berth in the Adriatic marinas and ports will require adequate environment having the characteristics of a fashionable place (luxury hotels and restaurants, casinos, efficient traffic connections, satisfying level of safety protection, etc.), followed by the infrastructure capable of receiving and providing services to such vessels. From the point of the safety of navigation and environmental protection, it should be emphasized that big yachts are operated by skilled and qualified crew sufficient in number, so that their safety level is very high. That is the reason why they contaminate the environment comparatively less than smaller vessels. However, the greater the size of the vessel the lower is their safety level in the existing ports of nautical tourism. The attempts to accommodate the same number of vessels as in earlier times may lead to inappropriate berthing of vessels at places which are not adequate for the particular size of the vessel. This can also apply to the ports under construction or those planned in which it will be necessary to harmonize the former standards with the new ones, particularly regarding the widths of vessels and their classifications. In addition to the above mentioned, other changes are also expected, requiring modifications of the technological organisation of ports of nautical tourism, as follows:

- gradual enlargement of the port resources as expected by its users, particularly regarding maintenance,
- change in the distribution of ownership of the vessels using the port, and
- change in the structure, education and needs of the vessel users.

IMPROVEMENT MEASURES

On the basis of the conducted analysis, it can be concluded that the existing system of the safety of navigation fully meets current as well as expected needs in the forthcoming short-term period. The conditions of the safety of navigation laid down in the valid regulations provide a satisfying level of safety in the ports of nautical tourism, so that no substantial amendments are expected in this respect.

Therefore, further improvement measures for the safety of navigation and protection of the sea and marine environment should be based on the development of new services, first of all through improved maintenance of vessels, providing additional information to boaters, as well as providing complementary services (e.g. towing, repairs, etc.). These measures may be implemented either on a commercial or non-commercial basis. Special attention should be given to the measures which reduce the influence of human error, since such influence is the main cause of maritime accidents of vessels in nautical tourism. In this respect, special attention should be paid to (informal) training measures.

Improvement measures for the safety of navigation

As the condition of the safety of navigation depends in the first place on the number of vessels, and on the sailing area, the period of stay, places to be visited, etc., with the increase of arrivals one should expect a greater number of events in which vessels at sea will ask assistance. The places in which such events are expected to occur are naturally related with the areas of stay, in the first place with famous destinations, and those offering additional services or providing shelter in bad weather. Unfavourable impacts of an increased traffic may be reduced by a number of measures, as follows:

- improvement, monitoring, informing and reporting on weather prospects, and additional informing on local conditions,
- improvements in reporting on local navigational conditions, procedures in case of emergencies, ports of refuge, etc.
- building of the network of service providers,
- modernizing of the communication and information support to vessels at open seas,
- better coverage of waterways and destinations with the vessels of the competent ministry,
- improvement of the search and rescue at sea,
- better medical assistance, especially to divers, and
- greater promptness in the implementation of regulations, according to the level as established in the European Union.

Even though some of these activities are in part the common services provided by the ports of nautical tourism, most of them come within the competence of ministries, and the establishing of the Vessel Traffic Management and Information System (VTMIS)[8] is certainly significant support for improvement of the safety of navigation of smaller vessels. The monitoring system for boaters during navigation, and during departures or arrivals, including the communication in navigation, is part of the established maritime communication system.

[8] Implying the system in accordance with the requirements of EU Directive 2002/59.

Improvement measures for the safety protection

The importance of the safety protection is particularly emphasized by the fact that the satisfying level is critical to the economic efficiency. Leisure and recreation are possible only under the conditions of high safety protection, and therefore the above mentioned issues may have adverse effects on overall efficiency of the nautical tourism in the Adriatic. Assuming that in all ports of entry the safety protection system is in accordance with the international requirements [2], the measures for the safety protection improvement in the ports of nautical tourism should be organised on the same bases, taking into account that conspicuous control or excessive surveillance may cause opposite effect. Because of that, it is very important to establish internal structure of the safety protection (safety levels or methods of communication with appropriate services) in a way comparable to the system established in public ports, as provided in the international conventions and related national regulations.

It is therefore proposed to establish and improve:

- the internal structure of the safety protection in a way comparable to the system established in public ports, in accordance with regulations [5],
- technological support for the safety control of people and vessels,
- knowledge of protection measures and education of users of nautical tourism ports in terms of safety protection,
- cooperation with appropriate services in order to practice operations in predictable circumstances.

Most of these activities, like in the case of improvement measures for the safety of navigation, cannot be conducted as commercial activities. Some of them can be conducted in that way with the support of the state and the local government, so that such approach should be taken into account wherever possible. With an increase in the number of vessels, particularly of large high-speed vessels and large yachts, increased volume of jobs should be expected in order to preserve the desired level of safety protection. As most of the users use several ports of nautical tourism during their stay in the Republic of Croatia, considerable improvement can be made by means of uniform implementation of measures and procedures on national level or even on regional level.

Improvement measures for the protection of the sea and marine environment

Measures for the pollution prevention should be based upon increasing the awareness of the need for preservation of environment and systematic implementation of measures by persons providing services to the vessels of nautical tourism. In this respect, we can distinguish the measures for the newly constructed ports or facilities, and the measures appropriate for the existing ports.

In case of the construction of new ports of nautical tourism, the measures for the protection of environment are manifested through the protection of area and the protection of environment from the consequences of the conduct of planned activities. The protection of area requires the compliance with two basic principles: the principle of the least possible encroachment in the area, and the principle of an acceptable impact on the environment.

The principle of the least possible encroachment in the area means that just the area necessary for the conduct of a certain activity is taken. *The principle of an acceptable impact on the environment* implies that no activity at sea shall, in any way, significantly affect the living world in its close vicinity or change essential properties of the marine environment.

The prevention of pollution of the sea and coastal area in the first place refers to the pollution resulting from the release of black and grey water from vessels and waste. In principle, the pollution prevention in ports comes within the competence of who manages the port. The measures which are equally suitable to the new ports of nautical tourism as well as to the existing ones are as follows:

- promotional actions for the growth of awareness of the need for environmental preservation,
- placing of sufficient number of containers for oily water and waste, especially near attractive destinations,
- more frequent control of anchorages by the boats of harbour master's offices,
- imposing a ban on the release of oily water and faecal discharges in certain areas and marking it with relevant notices,
- issuing concessions for the collection of waste in unmonitored bays and anchorages.

Improvement measures for the training of boaters

The information on maritime accidents in the last years leads to a conclusion that the main cause of maritime accidents of boaters in the Adriatic is mostly inadequate training or insufficient experience. For that reason and because of the fact that training is the main factor which helps to reduce the consequences of human error, it is proposed that training of all participants, particularly boaters, is improved through:

- systematic informing,
- encouraging of professional upgrading,
- encouraging of the activities of boaters' associations and promoting the principles of the safety of navigation and environmental protection through helping such associations,
- promoting of competitions,
- promoting the knowledge of structure and work of services which participate in rendering assistance and performing the tasks of pollution prevention.

Some of the above mentioned activities may be managed independently and successfully on a commercial basis, while some of them may be closely connected with promotional activities at the state level.

CONCLUSION

The safety of navigation and the safety in ports of nautical tourism in the Adriatic are regulated by numerous regulations which are largely based on international laws and systems, and can be considerably harmonised at regional level as well. Implementation of these regulations requires a well organised system of maritime administration or of all other subjects responsible for the safety of boaters in navigation and during their stay in ports of nautical tourism, either on a commercial or voluntary basis. Particular attention should be paid to the safety protection, which in large part indirectly influences the management efficiency of the ports of nautical tourism.

In this respect, technological support to the control of the safety of people and vessels must be constantly improved, in the first place through informing the users of nautical tourism ports about the protection measures, and through a better cooperation with the appropriate services, particularly regarding the practise of actions to be taken in case of safety threats.

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BIOGRAPHY

Damir Zec, born in 1959, obtained his Master Mariner certificate in 1985, MSc degree in 1992, and a PhD in 1994. He joined the Faculty of Maritime Studies, University of Rijeka, in 1986. Now he is a full professor, teaching subjects mainly related to safety of navigation, security and pollution prevention. He has been actively involved as external advisor to the Croatian Ministry responsible for safety of navigation, maritime security and pollution prevention as well as an expert on behalf of IMO and EC in the same fields. He has actively participated as lecturer at numerous international venues as well as a guest lecturer at several academic institutions, mainly in Europe.

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Srećko Favro, born in Split, graduated as an engineer of the naval traffic – maritime management. He completed postgraduate study „Geographic basis for lateralization of Croatia". He is an adviser for nautical tourism at Hydrographic institute of Republic of Croatia. Also is Sworn court marine expert and assessor and member of International institute of marine surveying. Consultant – Lead auditor QMS ISO 9001:2000. He is author of many scientific and technical papers in nautical tourism. Executive director of the project „Study of Nautical Tourism Development in Croatia" by Government of the Republic of Croatia. He is passionate sailor with oceanic experience.

PLACE OF REFUGE AS A NEW ELEMENT OF THE PROTECTION OF CROATIAN MARINE ENVIRONMENT

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Key words: places of refuge, IMO guidelines, Erika packages, Directive 2002/59/EC,

Abstract

The place of refuge is one of the latest acts in a long process of creation of international rules for the protection of the marine environment. In November 2003, the IMO Assembly adopted two resolutions addressing the issue of places of refuge for ships in distress. Resolution A.949 (23) Guidelines on places of refuge for ships in need of assistance, is intended for use when a ship is in need of assistance but the safety of life is not involved. The guidelines recognize that, when a ship has suffered an incident, the best way of preventing damage or pollution from its progressive deterioration is to transfer its cargo and bunkers, and to repair the causality. Such an operation is best carried out in place of refuge. A second resolution, A.950 (23) Maritime Assistance services (MAS), recommends that all coastal States should establish a maritime assistance service (MAS). By adoption of the Maritime Code in 2004, the Republic of Croatia pledged to determine the places of refuge by the end of 2007.

Introduction

Since the second half of the XX century the danger of sea disasters has increased significantly with the consequence of greater marine environment pollution due to oil spills. The main reason for this has been the building of giant vessels for the transport of oil. This was not a matter of greater concern until 1954 when the first international Convention on prevention of marine environment oil pollution was brought. Previously it was thought that little leakage could do no great harm to the vast ocean area and there was no awareness of serious damage that could be caused by oil pollution.

Unfortunately, it was soon discovered that the accident of one large tanker can cause environmental disaster (such as Torrey Canion, Amoco Cadiz or Exxon Valdez). Therefore many actions have been taken in the recent history to prevent accidents that cause pollution of the environment. One of the recent actions in endeavours to protect and preserve the maritime environment is concerned with the subject of places of refuge.

Many maritime law experts have been involved in various activities over the years trying to solve the problem of Places of refuge. The problem needs to be resolved in a satisfactory

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manner as soon as possible. The issue concerns the acceptance of obligation by the Coastal States to designate one or several places where the vessels in distress may be brought. It is about avoiding environmental disasters when accidents happen at sea. Therefore, it is important that a ship can get rapid and effective assistance allowing the easier prevention of environment pollution. It is general opinion that maritime accidents of the scope of Erica and Prestige would never have happened if the coastal states had designated the ports of refuge.

By adoption of the Maritime Code in 2004, and in accordance with IMO the Republic of Croatia stipulated the liability to designate places of refuge. Article 17, paragraph (3) of the Maritime Code states that "the Minister shall designate places of refuge; prescribe the requirements that the places have to satisfy and prescribe the conditions and methods in which the places shall be used." According to the Article 1021, paragraph (1) "the Minister is obliged to bring in the legislation on places of refuge within the period of three years from the enforcement of the Code" (Pomorski zakonik Republike Hrvatske, 2004).

However, the issue of Places of refuge involves many aspects. The first is decision making regarding the appropriate place, another one is the problem of financial security, as well as the problem of liability in case of environment pollution. And of course, it is very important to define the role of the salvor regarding Places of refuge. This matter is in close relation to the modern right to salvage as the salvors are the ones who are the first to face the problem when coastal states decline to allow the place of refuge to the vessel they are trying to salve. On the other hand, salvors should be fully engaged in places of refuge once they are determined

The Background Issues of Places of Refuge

By the end of the twentieth century protection of the marine environment became essential and designation of places of refuge is one of the most important aspects of better protection. The idea first appeared in the 1989 Salvage Convention and its Article 11.

During the debate on places of refuge, the legal issues surrounding this concept were analysed and the question was asked whether a coastal state is under an obligation, or at least is not precluded, under international law, from providing a place of refuge (where a ship can be taken when it is disabled, damaged or otherwise in distress and is posing a serious risk of pollution), in order to remove the ship from the threat of danger and undertake repairs or otherwise deal with the solution.

The article 98 of UNCLOS is also about the obligation of seafarers to assist the vessel in distress. Articles 17 and 18 of UNCLOS provide that ships of all States have a right of innocent passage through the territorial sea. Article 18 requires such passage to be "continuous and expeditious" but it does include stopping and anchoring if incidental to ordinary navigation or "are rendered necessary by force majeure or distress or for the purpose of rendering assistance to persons, ships or aircraft in danger or distress".

The right of the coastal State to take action to protect its coastline from marine pollution is well established in international law, relevant provisions include: UNCLOS, Articles 194, 195, 198, 199, 211, 221, 225; Salvage Convention, Article 9; and Facilitation Convention, Article V (2).

These provisions do not state that ships in distress have a right of entry to a place of refuge, nor do they explicitly refer to the question of a Costal State's obligation to establish places of refuge. On the other hand, neither do they preclude such a principle.

The recent incidents which have diverted the attention on the issue of places of refuge were the Erika, Prestige and Castor accidents. The single-hull tankers Erika and Prestige leaked around 22.000 and 20.000 tonnes of oil into the sea, causing huge damage to the environment, fisheries and tourism.

In December 1999, the Maltese tanker Erika, carrying 31,000 tonnes of heavy fuel, sailing from Dunkerque (France) to Livorno (Italy) in very rough weather, broke up in two off the Bay of Biscay near the Southern Brittany. French Navy saved the crew by helicopters. About 20,000 tonnes of heavy fuel washed the coast polluting about 400 kilometres of the French Atlantic coast including many tourist resorts. After the wreck of the Erika in 1999, the European Union considerably reinforced its legislation to give Europe better protection against the risks of accidental oil spills (Ozcayir, 2004).

At the beginning of 2001, The Castor, a tanker of 30,068 tons deadweight with a full cargo of gasoline developed a severe crack off the coast of Morocco while en route from Constanta, Romania to Lagos, Nigeria. She was taken in tow when near the coast of Spain. The damage to the hull was serious and the salvors tried to find a safe place to lighten the cargo. Requests were made to the authorities of several countries to allow the vessel to be brought to a place of refuge for the lightening operations. The salvors were unable to find a sheltered place to effect cargo transfer for 35 days. In the end they had to perform a ship to ship transfer when the casualty was towed off the coast of Tunisia. Fortunately her cargo was safely unloaded (Ozcayir, 2004).

The incident caused a great deal of concern and rose the awareness of the necessity to provide the refuge for vessels in distress and impelled the decision by IMO's Maritime Safety Committee (MSC) at its 74th session in May 2001 to look at the problem of places of refuge.

In November 2002, the Prestige, 26-year-old tanker carrying 77 000 tonnes of heavy fuel oil, developed a starboard list off the coast of Galicia. It eventually broke and sank 270 km off the Spanish coast. Thousands of tonnes of heavy fuel oil spilled into the sea, polluting the Galician coastline. The pollution then spread to the shores of Asturias, Cantabria and the Spanish Basque country. By the end of 2002, it reached the French coast and about 200 km of Atlantic coastline from the Spanish border to L'Ile d'Yeu were affected. Apart from the damage to the environment, the oil spill from the Prestige has had a disastrous effect on fishing and tourism (Ozcayir, 2004)

IMO Work on Places of Refuge

Places of refuge were first discussed in IMO during discussions regarding the 1989 Salvage Convention. Even then the subject was controversial. The Legal Committee approved article 11 of the Salvage Convention which is as follows:
"Co-operation
A State Party shall, whenever regulating or deciding upon matters relating to salvage operations such as admittance to ports of vessels in distress or the provision of facilities to salvors, take into account the need for co-operation between salvors, other interested parties and public authorities in order to ensure the efficient and successful performance of salvage operations for the purpose of saving life or property in danger as well as preventing damage to the environment in general." However the research in 2002 showed that the States that ratified the Salvage Convention never expressly accepted by their national law legal effects of its Article 11.

In May 2002, the Maritime Safety Committee (MSC) at its 75th session approved, in principle, the proposed general framework concerning future work on places of refuge developed by the Sub-Committee on Safety of Navigation (NAV). That work placed high priority on the safety of all involved in any operation concerning the provision of places of refuge, with due attention to all environmental aspects associated with these operations. This included the preparation of guidelines for: a. actions a master of a ship should take when in need of a place of refuge (including actions on board and actions required in seeking assistance from other ships in the vicinity, salvage operators, flag State and coastal States); b. the evaluation of risks, including the methodology involved, associated with the provision of places of refuge and relevant operations in both a general and a case by case basis; and c. actions expected of coastal States for the identification, designation and provision of such suitable places together with any relevant facilities.

Guidelines on places of refuge for ships in need of assistance were adopted at the 23rd Assembly in 2003. The IMO Assembly has developed Guidelines on places of refuge for ships in need of assistance (Assembly Resolution A.949(23). The guidelines are intended for use when a ship is in need of assistance but safety of life is not involved. Where the safety of life is involved, the provisions of the SAR Convention should be followed.

The guidelines recognize that, when a ship has suffered an incident, the best way of preventing damage or pollution from its progressive deterioration is to transfer its cargo and bunkers, and to repair the casualty. Such an operation is best carried out in a place of refuge. However, to bring such a ship into a place of refuge near a coast may endanger the coastal State, both economically and from the environmental point of view, and local authorities and populations may strongly object to the operation.

Therefore, granting access to a place of refuge could involve a political decision which can only be taken on a case-by-case basis. In so doing, consideration would need to be given to balancing the interests of the affected ship with those of the environment.

A second resolution, Maritime Assistance Service (MAS), recommends that all coastal States should establish a maritime assistance service (MAS). The principal purposes would be to receive the various reports, consultations and notifications required in a number of IMO instruments; monitoring a ship's situation if such a report indicates that an incident may give rise to a situation whereby the ship may be in need of assistance; serving as the point of contact if the ship's situation is not a distress situation but nevertheless requires exchanges of information between the ship and the coastal State, and for serving as the point of contact between those involved in a marine salvage operation undertaken by private facilities if the coastal State considers that it should monitor all phases of the operation.

The role of the Legal Committee was to consider the extent to which provisions of international law either place an obligation on or facilitate the development of rules requiring coastal States to provide a place where a ship can be taken when it is disabled, damaged or otherwise in distress and is posing a serious risk of pollution in order to remove the ship from the threat of danger, and undertake repairs or otherwise deal with the emergency situation.

Debate in the Legal Committee from that time on focused on the specific issue of liability and compensation arising from a decision by the coastal State whether or not to grant a ship in distress a place of refuge and it was at this point in the debate that the CMI became actively involved. (Balkin, 2006).

The role of CMI on places of refuge

As has been the case in other subjects considered by the Legal Committee over the years, the research undertaken by the CMI proved to be of invaluable assistance to the Legal Committee in its deliberations. This was so even though the Legal Committee ultimately did not agree with CMI's view on the need to develop a new convention on the subject of liability and compensation in relation to places of refuge. (CMI, Yearbook 2003)

The detailed submissions put to the Legal Committee by the CMI over many sessions helped to ensure that all members of the Legal Committee were fully aware of the various ramifications of the problem.

There were two main CMI documents. The first reported on discussions at the 38th CMI Conference in Vancouver (June 2004) while the latter provided an analysis of existing international law instruments on liability and compensation and their possible application to places of refuge.

These forcefully expressed CMI's views that the present international regime is confused and unsatisfactory and that, while many of the provisions require States to act reasonably (for example the Intervention Convention) when confronted by potential pollution threats, nonetheless they do not contain clear guidelines identifying the duties and obligations that shipowners, States and others who may be involved are under when making a request for a place of refuge or when receiving such a request. Consequently, they do not sufficiently encourage States to grant places of refuge to distressed vessels.

The Legal Committee was also fully apprized of CMI's views as to the deficiencies in coverage contained in the four principal international conventions dealing with liability arising from pollution damage (the 1992 Civil Liability Convention, the 1992 Fund Convention, the 1996 Hazardous and Noxious Substances Convention and the 2001 Bunkers Convention).

Despite these arguments, the Legal Committee decided that, at least at present, there was no need to recommend the development of a new convention since the existing liability and compensation regime worked reasonably well. And once the HNS and the Bunkers Conventions enter into force, the regime would work even better. (Balkin, 2006).

Activities on places of refuge at EU

Following the accidents that devastated European coasts in the past decade, the risks related to maritime shipping became obvious and the EU was pressed to adopt a series of preventive measures, known as the Erika I and II packages. The packages were introduced to reduce the risks of accidental pollution by ships. The Commission also established a European Maritime Safety Agency (EMSA) responsible for improving drafting and enforcement of EU rules on maritime safety.

<u>The Erika I package (March 2000) and Erika II package (December 2000)</u>

These packages had two objectives: firstly, to tighten existing legislation (on port State control and monitoring of classification societies) and, secondly, to propose new measures to speed up the phasing-out of single hull oil tankers, improve controls on shipping in European waters, establish a European Maritime Safety Agency and create a supplementary fund for compensation for oil pollution damage. Except for the proposal on compensating victims of oil spills, where the Member States preferred to pass the dossier to the relevant international body (the IMO), all the other measures have been adopted by the European Parliament and the Council.

The Erika I package addressed the most serious gaps in the EU maritime safety legislation revealed by the December 1999 oil spill: Firstly, it strengthened the existing Directive on port State control. Secondly, it strengthened the existing Directive on classification societies and thirdly, it set a timetable for phasing out single hull oil tankers worldwide. Double hull tankers offer better protection for the environment in the event of accidents. The IMO had accordingly decided that only double hull oil tankers should be built as from 1996. However, the gradual replacement of single hulls by double hulls was spread over a very long period, ending in 2026. The EU pushed for a speedier phase-out and succeeded in winning international acceptance for its position: in keeping with the new international and Community standards, the last single hull tankers will be banned from EU waters by 2015.

However, the Commission regrets that the timetable it originally proposed was not accepted, as it could have prevented the Prestige accident. Under the Regulation finally adopted by the European Parliament and the Council, the Prestige was to have ceased operating by 15 March 2005 at the latest. Had the timetable proposed by the Commission been upheld, the Prestige would have had to be taken out of service on 1 September 2002.

Directive 2002/59/EC

Within EC it has been decided that Member States no later than 5. July 2004 shall establish plans to the identification of places of refuge for ships in distress, Article 20 of Directive 2002/59/EC (establishing a Community vessel traffic monitoring and information system).

Following the Prestige accident, the European Council, in December 2002 called for an accelerated implementation of this Directive by July 2003. Member States were urged to establish as early as possible, and no later than by 1 July 2003 plans to the identification of places of refuge for ships in distress. The Parliament, in its Resolution of September 2003, also insisted on the importance to implement these provisions as early as possible.

Member States need in particular to comply with article 20 of the Directive.
"Article 20 - Places of refuge
Member States, having consulted the parties concerned, shall draw up, taking into account relevant guidelines by IMO, plans to accommodate, in the waters under their jurisdiction, ships in distress. Such plans shall contain the necessary arrangements and procedures taking into account operational and environmental constraints, to ensure that ships in distress may immediately go to a place of refuge subject to authorisation by the competent authority. Where the Member State considers it necessary and feasible, the plans must contain arrangements for the provision of adequate means and facilities for assistance, salvage and pollution response. Plans for accommodating ships in distress shall be made available upon demand. Member States shall inform the Commission by 5 February 2004 of the measures taken in application of the first paragraph.

National plans for identification of places of refuge for ships in distress must contain the following elements: procedural aspects: the competent authorities need a clear framework to assess the requests of ships in distress; and geographical element: designation of places (not necessarily ports) of refuge. Regional cooperation is an essential part of the Directive. It will be facilitated by EMSA

Although many EU countries have experienced difficulty in implementing the relevant parts of an important ship reporting and monitoring directive (2002/59/EC), which includes plans to accommodate vessels in distress, most contracting parties already notified their places of refuge to the Commission. Some even made these places known to the public, although member states are not obliged to do so.

Third Maritime Safety Package (Erika III package)

Although the number of accidents was reduced the Commission decided to adopt a third package in 2005 to supplement and improve existing rules. Over the last ten years the EU, has introduced legislation aimed at improving the level of maritime safety and the prevention of accidental pollution by ships. The positive results obtained so far are due to a large extent to the establishment in the EU of a line of defence against substandard ships, and in particular through controls of ships in European ports. These defensive arrangements represent a considerable cost for the port and coastal state administrations, even though the main responsibility for applying the security rules rests with the shipowners and flag states. Similarly, the shipowners who practice a high-quality policy suffer the consequences of the persistence of substandard shipping, which confronts them with unfair competition, repeated port controls and an overall undermining of the image of the maritime transport sector. Moreover, despite the reduction in the number of maritime accidents, the threats relating to failure to comply with safety standards remain. The pressure on flags of convenience and more generally any defect in the maritime transport chain must therefore be maintained and even accentuated.

The seven proposals contained in the package are therefore intended to supplement the European rules concerning maritime safety and improve the efficiency of the existing measures. They take account of the experience acquired in implementing the Community legislation on maritime safety (the Erika-I and II packages and the measures adopted following the Prestige accident), and the concerns expressed on several occasions by the European Parliament, the European Council and the ministers of transport. The seven proposals contained in the package are as follows: 1. A proposal for a Directive on the conformity requirements of flag states; 2. Amendment of the Directive on classification societies; 3. Amendment of the Port State Control Directive; 4. An amendment of the Traffic Monitoring Directive; 5. A proposal for a directive on accidental investigations; 6. A Regulation on liability and compensation for damage of passengers in the event of maritime accidents; 7. A Directive on the extra-contractual liability of shipowners (Memo/05/438 *Third Maritime Safety package*, Brussels, EU).

An amendment of the Traffic Monitoring Directive establishing a clear and precise legal framework for places of refuge is the main objective of the proposal to amend the Directive on the Community maritime traffic information and monitoring system. This legal framework provides that the Member States designate independent authorities responsible for designating the most appropriate place of refuge. These authorities will have the information they need to take their decisions, including a precise inventory of potential places of refuge along the coasts. The proposal also provides for the widespread use of the SafeSeaNet data exchange network. This system, developed by the Commission and operated by the European Maritime Safety Agency will enable the maritime authorities to have precise information about movements or ships and their cargos

Recent developments relating to places of refuge at EU level since the CMI's Vancouver conference in June 2004 have been as follows: Under Article 20 of the existing EU Traffic Monitoring Directive, EU Member States are obliged to draw up plans to accommodate ships in distress. Such plans must contain the necessary arrangements and procedures taking into account operational and environmental constraints, to ensure that ships in distress may immediately go to a place of refuge subject to authorisation by the competent authority. In implementing these provisions, some EU Member States encountered difficulties. In November 2005, the European Commission proposed amendments to the Traffic Monitoring Directive. These amendments first of all envisage the replacement of Article 20 by a new text pursuant to which Member States shall ensure that, subject to the results of the assessment of the situation, ships in distress are admitted to a place of refuge which will make it possible to limit the threat posed by their situation. The accommodation of a ship in distress in a place of refuge shall be the subject of a prior assessment of the situation and a decision taken by an independent competent authority designated by the Member State. These authorities shall meet regularly to exchange their expertise and improve the measures taken pursuant to the new Article.

Next, the Commission proposed to insert a new Article 20a into the Directive, which would deal with plans for the accommodation of ships in distress. Under this provision, Member States would be under an obligation i.a. to draw up plans for responding to threats presented by ships in distress in the waters under their jurisdiction. These plans would have to take into account the relevant IMO guidelines, and shall contain a number of mandatory items, including an inventory of potential places of refuge and the financial guarantee and liability procedures in place for ships accommodated in a place of refuge.

Thirdly, a new Article 20b would be inserted on financial guarantees. Under the proposed provision, Member States would be entitled, prior to accommodating a ship in distress in a place of refuge, to request the ship's operator, agent or master to present an insurance certificate or a financial guarantee.

Places of refuge – a new element of protection of Croatian maritime environment

After a decade of application of the1994 Maritime Code, a new Code was enacted on 8 December 2004. The content of the new Maritime Code is based on the solutions of the 1994 Maritime Code. However, a considerable number of new provisions resulted from aspirations to bring Croatian Maritime code in accord with international unification instruments which have been ratified by the Republic of Croatia after the1994 Maritime Code entered into force. Apart from many international contracts these are 1989 Salvage Convention, 1992 Civil Liability Convention and 1992 Fund Convention as well as many amendments and additions to SOLAS and MARPOL 73/78.

Many new provisions of the Maritime Code resulted from adjustment of the text with current conventions which have not entered into force but which offer more advanced solutions or are intended for even better environment protection such as 2001 International Convention on the Control of Harmful Anti-fouling System on Ships. Certain provisions have been amended in accordance with recommendations and guidelines of IMO, CMI, such as IMO Guidelines on places of refuge or the International Safety Management Code.

Considerable amount of amending relating to the safety of navigation resulted from the fact that Croatia is the signatory party to Paris Memorandum of Understanding on Port State Control. The main objective of the Memorandum is to have the foreign cargo vessels, which enter the ports of signatory States, checked to establish weather they comply with the standards of most significant treaties relating to the safety of navigation.

Passing the new Maritime Code enabled the complete amendment of the maritime legislation in compliance with the EU legal practise. Therefore, it could be said that the Maritime Code of the Republic of Croatia is among most advanced codes in the world (Petrinović, 2005).

The decision on the commencement of talks regarding Croatia's full EU membership was made on 3 October 2005 in Luxemburg. Maritime strategy of the Republic of Croatia in accordance with the EU system is based on absolute application of highest standards on safety at sea and marine environment protection. Although the Republic of Croatia is the signatory of many international conventions and our legislation complies with international-law regulations on safety at sea, maritime policy of EU often prescribes even higher standards than the ones brought by the IMO. The EU sometimes presses IMO to enact stricter regulations regarding the safety at sea and marine environment protection. The examples of this practice are previously discussed packages Erika I, II and III.

The Republic of Croatia, in compliance with the IMO Guidelines and EU Directive 2002/59/E pledged that the Minister in charge of maritime affairs should designate places of refuge within the three years, as well as set the terms and methods in which these places could be used. Croatia has thus showed a high level of awareness relating to the protection of marine environment. The experience of states that allow vessels in distress to enter places of refuge such as Netherlands showed that localised pollution can facilitate the combat and prevention of damage contrary to the larger scale uncontrolled pollution which can follow the decision to send the vessel to high seas as it was the case with Erika and Prestige.

The Croatian Hydrographic Institute was delegated the duty to conduct the study on places of refuge by the Ministry. The project group consisting of experts was formed with the task to perform this complex and delicate duty with a scientific approach. The dilemma remains weather to have fixed places like Denmark, or to have at disposal all available places for vessel acceptance, as in the Sailing Directions. The latter example follows the model of the United Kingdom and Norway. Regardless of the model Croatia accepts in the end, it is necessary to decide on the procedure and to perform the detailed study of various models in case a vessel needs a place of refuge. By the end of the year Ministry needs to enact the Regulations on places of refuge, the requirements that these places must fulfil as well as the terms and methods of the use of places of refuge, and the Croatian Hydrographic Institute is obliged to complete the study on places of refuge.

Conclusion

The issue of places of refuge is just one of the problems in relation to protection of marine environment which needs to be considered by the Coastal States within their rights and interests, in order to assist vessels which are damaged or disabled or otherwise in distress at sea. The places of refuge are envisaged as geographical areas, designated in advance, which could if necessary be provided with facilities, services and other requirements suitable for investigation and repair of damage, and for urgent repairs of vessels, especially laden tankers, as well as for the transhipment of their cargo.

The experience with pollution incidents so far has shown that the problem of marine environment protection by the private law, such as Salvage Convention**,** cannot be solved in a satisfactory manner. Therefore more involvement of most coastal states' administration is required. The coastal states according to IMO guidelines designate places of refuge for vessels (especially tankers) in need of assistance, and which are far away from their flag states. However, appropriate contingency plans need to be prepared to avoid the risk of making wrong decisions when unprepared and under pressure by groups that represent different interests.

The International Maritime Organisation by issuing a resolution establishing guidelines on places of refuge has tried to influence the Coastal States to designate places of refuge in their territorial waters. EU by its directive (2002/59/EC) requires the member states to make detailed plans in cases when a vessel requires assistance, and to submit the list of places of refuge in which the vessels in distress could be salved and pollution prevented. The member states are obliged to fulfil these requirements by the end of this year, and that is also the deadline in Article 1021, subparagraph (1) of Maritime Code. This makes the Guidelines of IMO Resolution A. 949.(23) on places of refuge obligatory. This measure should be welcomed as it is surely going to enhance the level of safety whenever there is any threat of pollution.

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COMMUNITY RESILIENCE

SOCIAL ASPECTS OF NATURAL DISASTER

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Keywords: hurricane Katrina, physical / social vulnerability, disaster response

Abstract

Although the hurricane Katrina is not the greatest natural disaster that has struck the US, there is no doubt that it was without a precedent among recent natural disasters. Disaster consequences mostly depend on society development, as well as on its ability to absorb disasters and provide disaster relief. As this case seems to involve a rich country with highly developed disaster management system, an effective response was naturally expected.

Why did Katrina happen at all? Katrina can be regarded as an example of how one particular disaster turns into another, of much greater proportions. Therefore, the main thesis of this paper is that Katrina embraces three disasters: natural, technological and social. In addition, three factors causing a disaster are given: physical vulnerability, social vulnerability, and disaster response. Furthermore, the focus is on city abandoning and an increase in crime and violence being the main aspects of social disaster during and in Katrina's wake. Accordingly, Katrina seems to be the "worst case" although an optional explanation is given as well. In conclusion Katrina is considered in social, community and civilizational terms.

Introduction

In short, the consequences of Katrina are: 1820 people lost their lives; over a million of the homeless and refugees; 80 % of New Orleans flooded; cca. 80 trillion US dollars of material damage; 352 000 houses, 160 000 of that number in New Orleans, have been destroyed in the Gulf Coast area (TIME, 2006).

The consequences shouldn't have been of such proportions. The scientists had been warning that a strong hurricane would strike that area. They had been giving out advices on how to reduce the impact of a possible disaster. Weather agencies had predicted one of the most active hurricane seasons. Information on wind force, weather details and possible effects had allowed enough time to prepare and evacuate the residents[2]. Management and SAR systems were expected to be

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[2] N*ational Weather Service bulletin for New Orleans region:* 10:11 a.m., august 28, 2005. special warning: *urgent - weather message: ...devastating damage expected...hurricane Katrina...a most powerful hurricane with unprecedented strength...rivaling the intensity of hurricane Camille of 1969. Most of the area will be uninhabitable for weeks...perhaps longer. At least one half of well constructed homes will have roof and wall failure. All gabled roofs will fail...leaving those homes severely damaged or destroyed. The majority of industrial buildings will become non functional. Partial to complete wall and roof failure is expected. All wood framed low rising apartment buildings will be destroyed. Concrete block low rise apartments will sustain major Damage...including some wall and roof failure. High rise office and apartment buildings will*

prepared for a disaster. However, in spite of all, one of the most developed countries in the world hasn't succeeded in protecting its citizens.

Our starting point is that Katrina represents a streak of three disasters. First was a hurricane which, as a natural disaster, was inevitable. In consistence with the trend of hurricanes in modern times, its consequences should have been brought down to material damages and a low number of casualties. The real disaster occurred when some of poorly maintained levees broke which could be labeled as technological disaster, and flooding of the city followed as a result. As a third, a social disaster occurred including numerous casualties, sufferings, anarchy, asocial behavior, an increase in crime and violence. Social disaster originated from the previous two, it culminated after the city flooding and it continued during the recovery period. In distinction from hurricane, flooding as well as a social disaster could have been prevented.

Katrina turns out to be a complex disastrous event. Many factors and aspects should be taken into consideration in the analysis of this disaster. Focusing attention to the most severely affected city of New Orleans, this paper offers the sociological approach. The first part of the paper supports the thesis that physical vulnerability, social picture of the city and disaster response are crucial for disaster proportions. The second part focuses on two problems, the first one being the fact that large number of residents had decided not to leave the city, and the second one being an outbreak of crime and violence.

Physical vulnerability

New Orleans was founded in 1718 as a jeans trading centre. Having been founded at the crossroads of three navigable water bodies, Lake Pontchartrain, the Gulf of Mexico and the Mississippi river, the city of New Orleans evolved into one of the most important ports. The city location that ensured its development throughout the years has become an ever growing threat. The city has always been subject to flooding due to its position at the crossroads of three waterways but also because the major part of the city is below water level.

In order to reduce flooding risks, the levee able to resist Category 3 hurricanes[3] was designed in 1960. But by building levees, natural, protective wetlands south and east of the city have been destroyed. Taking into consideration the fact that many city parts are below sea level, even heavy rains would lead to flooding. It was well-known that if a heavy rainstorm, Category 4 or 5, stroke the city, the majority of its territory would have found itself under water 20 ft (6m) in height (Westerink, Luettich, 2003).

The problem of physical vulnerability was recognized a long ago. Scientists have foreseen possible disasters suggesting measures and activities in order to reduce risks. For instance, M. Fischetti (2001) in his article *Drowning New Orleans* warns that New Orleans is a disaster waiting to happen. The author points out that the human activities along the Mississippi river have

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sway dangerously...a few to the point of total collapse. All windows will blow out. Airborne debris will be widespread...and may include heavy items such as household appliances and even light vehicles. Sport utility vehicles and light trucks will be moved. The blown debris will create additional destruction. Persons...pets...and livestock exposed to the winds will face certain death if struck. Power outages will last for weeks...as most power poles will be down and transformers destroyed. Water shortages will make human suffering incredible by modern standards. The vast majority of native trees will be snapped or uprooted. Only the heartiest will remain standing...but be totally defoliated. Few crops will remain. Livestock left exposed to the winds will be killed. An inland hurricane wind warning is issued when sustained winds near hurricane force...or frequent gusts at or above hurricane force...are certain within the next 12 to 24 hours. Once tropical storm and hurricane force winds onset...do not venture outside! (http://en.wikipedia.org/wiki/national_weather_service_bulletin_for_new_orleans_region).

3 More about Saffir Simpson scale: http://www.nhc.noaa.gov/aboutsshs.shtml.

dramatically increased risks and only massive re-engineering of the area would be able to save the city from flooding.

Shortly after the disaster, New Orleans reports were perfectly clear: a real disaster took place not because of the hurricane, but because of the levees breaking and city flooding. Hence, there was every reason for making complaints against the authorities that wouldn't provide money for the levee maintenance. They turned a deaf ear to the warnings about incapability of the levee to resist a hurricane of such a force (Flaherty, 2005).

Social vulnerability

According to S. Cutter and C. T. Emrich (2006:103) social vulnerability is the product of social inequalities. It is defined as the susceptibility of social groups to the impacts of hazards, as well as their resiliency, or ability to adequately recover from them. This susceptibility is not only a function of the demographic characteristic of the population (age, gender, wealth, etc.), but also more complex constructs such as health care provision, social capital, and access to lifelines (emergency response, personnel, goods, services).

Despite general prosperity of the US, the differences among the rich and the poor are maintaining the upward trend and are evident among states, regions as well as city quarters. The hurricane struck the poorest states of the US. According to the Census Bureau data for 2004, Mississippi State had the highest state poverty rate in the nation - 21, 6% and Louisiana State had the second position with 19, 4% while Alabama State had the eight highest rate at 16. 1%. The income of the median household in these states is well below the national average of 44,684$ and are among the lowest in the nation; in the State of Mississippi average household income is 31,642$, and in Louisiana it amounts 35,110$. The city of New Orleans is also marked by a high rate of poverty. While 10, 9% of US inhabitants live below poverty limit, the Census data indicate that more than one in four - 28% - of the city's residents were living in poverty before the hurricane stroke the city. Of the 245 large cities in the nation (population of 100 000 or more), New Orleans tied for the sixth poorest in the 2000 Census. Those who were poor in New Orleans commonly lacked their own means of transportation. Calculations based on Census data show that more than half of the poor households in New Orleans, 54%, didn't have a car, truck or van in 2000. Among the elderly, proportion was even higher; 65% of poor elderly households in New Orleans did not have a vehicle (Sherman, Shapiro, 2005). Poverty is followed by downward social mobility and poorly developed social networks: the birth-rate in Louisiana comes up to 77, 4% while the US average is 60%. A high poverty rate is also accompanied by a higher rate of the disabled and handicapped which in New Orleans surpasses the US average; in a 5-20 age group, there are 10,3% of the above-mentioned (US average 8,1%), in a 21-64 age group, there are 23,6% (US average 19,2%) and in a group gathering those of 65 and above there are 50,1% (US average 41,9%) of the disabled and handicapped.

Afore-mentioned data helps to explain why relief efforts were so important to Katrina victims. In disaster as Katrina was, many groups defined themselves as vulnerable: the elderly, children, the handicapped, the ill, minorities, tourists, the homeless, prisoners, etc. However, the class can be considered as basic factor that helps explain the social vulnerability. In general, wealthier were in better position before the disaster as they are after it. On the other hand, the poor, mostly African-American population that makes up the majority of New Orleans' residents has proved to be the most vulnerable group. They were not provided with material goods on disposal, transport nor social networks that could have helped them in leaving the affected city and getting by in a disaster.

Disaster response

In response to Katrina, the emergency management system defined itself as non-functional and in collapse. There is no doubt that an organizational breakdown happened, which was also confirmed in a Senate Committee report named *A Nation Still Unprepared*. An official investigation concluded about system failures at all levels, as well as about mistakes of the officials in charge: *...the failure of government at all levels to plan, prepare for and respond aggressively to the storm. These failures were not just conspicuous; they were pervasive. Among the many factors that contributed to these failures, the Committee found that there were four overarching ones: 1) long-term warnings went unheeded and government officials neglected their duties to prepare for a forewarned catastrophe; 2) government officials took insufficient actions or made poor decisions in the days immediately before and after landfall; 3) systems on which officials relied on to support their response efforts failed, and 4) government officials at all levels failed to provide effective leadership* (Senate Committee, 2006).

The authors are looking for the reasons of the organizational breakdown in long-term trends and bureaucracy. According K. Tierney (2005) the massive governmental reorganization that accompanied the creation of the Department of Homeland Security[4], sealed the fate of disaster management in US. Federal Emergency Management Agency was incorporated into a 180 000 employee bureaucracy dominated by military, security, and law enforcement agencies. Many experienced officials had already left the agency in the aftermath of 9-11. DHS politics and programs jeopardized, in this author's opinion, two basic principles of the emergency management: all hazards approach and comprehensive emergency management. In other words by entering into such an organization, FEMA lost its independence, it was more engaged in internal reorganization and terrorism and it started neglecting natural disasters.

City abandoning

The question why thousands of, mainly poor, residents at the same time African Americans, in spite of warnings, didn't leave New Orleans can partly be answered by looking into the social picture of the city. Namely, as it was said before, a decision about leaving the city was conditioned by the socio-economic resources: income, private transport availability, age, health condition, disposable social networks outside the city, etc. The same factors will define how the affected population will recover after disaster.

In accordance with the afore-said, E. Fussell (2005) makes a distinction between two dominating evacuation strategies which were stratified by income. The evacuation strategies of most upper and middle-income residents were quite straightforward: make a hotel reservation or arrange a visit with out-of-town friends and family, board the house windows, pack the car, get some cash and leave town. These residents most often evacuated during the voluntary or mandatory evacuation period in the 24 to 48 hours before the storm was predicted to hit. For this group, the costs of leaving on Saturday were lower with respect to missing work or school since the storm was projected to arrive on Monday. They were likely to have been informed by television, radio, internet, e-mail, or telephone of the hurricane's projected path long before it arrived.

The situation was quite different for low-income inhabitants who had fewer choices with respect to how to prepare for the imminent arrival of Katrina. Since the storm was at the end of the month and many low-income residents of New Orleans live from paycheck to paycheck, economic resources for evacuating were particularly scarce. Furthermore, low-income New Orleanians are those who are least likely to own vehicles, making voluntary evacuation more costly and

[4] DHS was founded in 2002 as a response to terrorist attacks of 11th September 2001. Such an organization was believed to provide better coordination and monitoring.

logistically more difficult. These residents were also more likely to depend upon television and radio for news of the storm, and alarm from these channels only became heightened in the last 48 hours before the storm arrived. Many of them remained in their home. Some of them took refuge in the city emergency shelters *Superdome* or *Convention Centre* in belief that they would get protection and care until the storm had passed out. Although evacuation strategies were stratified by income, elderly people and those with chronic health conditions or disabilities within each social stratum were less likely to evacuate than those in good health.

Thousands of people who didn't abandon the city were socially vulnerable structures. Because of the situation they found themselves in, these residents needed protection and care from the system. Major omission was made when the mandatory evacuation of the city wasn't proclaimed and organized. On the contrary, the fact that public shelters were given at disposal tells that those who wouldn't or couldn't leave, were, in fact, given the possibility to stay. The very fact that these groups had stayed behind in the city, in which help and care were not provided for, couldn't lead but to a social disaster.

Social and situational context of crime and violence

A social disaster was marked by an extraordinary increase in crime and violence. As such behaviors are not registered as characteristic of the period following disastrous events, this phenomenon will be viewed in a situational context in which it has happened: social picture of the city in distress in which an adequate help wasn't provided for.

New Orleans is generally marked by a high rate of crime. According to the AreaConnect and FBI Crime Reports data for 2004, New Orleans far exceeds the US average in criminal activities. On 100 000 New Orleans residents annually occur 56 murders (US 5,5), 40,1 rapes (US 32,2), 389,8 robberies (US 136,7), 462,4 aggravated assaults (US 291,1), 1112 burglaries (US 729,9), 2662,9 thefts (US 2365,9), 1387,1 car stealing (US 421,3).

Many studies emphasize social causes of crime and violence. Such behaviors are encouraged by continuous poverty and unperspectivness of the social groups as well as by conditions deriving from living in poverty. S. Kaufman's (2005) research, conducted among violent criminals in New Orleans, showed that American social institutions produce criminal behavior. This author isolated co-factors that interact to produce violence: growing up without enough food, often competing with multiple siblings; being taught to steal to help with their parents' rent; a chronic childhood illness that was not resolved because there was no money for doctors: ear aches, hernias, etc.; pitiful schooling, where avoiding violence supplanted learning; juvenile imprisonment, and being forced to defend oneself against guards and other inmates; untreated symptoms of depression, mania, psychosis, and other mental disabilities; a lack of employment outside the drug trade. Previous factors are frequent among the African-American residents in New Orleans and are concentrated in certain city quarters.

There is no doubt about increase of crime during and in Katrina's aftermath, but a part of such activities, particularly thefts, can be explained by peoples' need for basic provisions (food, water, clothing, toiletries, etc) in a situation in which disaster relief, aid and rescue weren't provided for. As there was no organized assistance in providing adequate supplies to the threatened population and as supermarket owners shut down their stores and left the city, people were breaking in as to assure their own survival.

We get to know a lot from a report by Lorrie Beth Slonsky and Larry Bradshaw (2005), two paramedics who happened to find themselves in New Orleans when the disaster occurred: ... *It was now 48 hours without electricity, running water, plumbing. The milk, yogurt, and cheeses were beginning to spoil in the 90-degree heat. The owners and managers had locked up the food,* *water, pampers, and prescriptions and fled the City. Outside Walgreen's windows, residents and tourists grew increasingly thirsty and hungry. The much-promised federal, state and local aid never materialized and the windows at Walgreen's gave way to the looters. There was an alternative. The cops could have broken one small window and distributed the nuts, fruit juices, and bottle water in an organized and systematic manner. But they did not. Instead they spent hours playing cat and mouse, temporarily chasing away the looters. ... When individuals had to fight to find food or water, it meant looking out for yourself only. You had to do whatever it took to find water for your kids or food for your parents. When these basic needs were met, people began to look out for each other, working together and constructing a community…If the relief organizations had saturated the City with food and water in the first 2 or 3 days, the desperation, the frustration and the ugliness would not have set in…*[5]

J. Scanlon (2005) emphasize that it is important to examine the context of various acts which seem to have occurred in New Orleans. Persons for example were reported to have broken into stores to "steal" water, food, or other necessities, but they were making every effort to help themselves. This behavior is just as appropriate as if someone using an axe to chop through a roof. The stores were closed. No arrangements had been made for food, water and clothing to be provided. People took the only recourse they had for survival. The unacceptable behaviors, which are being sanctioned in normal circumstances, are being tolerated in a state of emergency. The social norms have changed.

The store break-ins aimed at satisfying basic needs could have been prevented by providing aid and relief to those in need of help. In the same manner by ensuring and maintaining law and order as well as by timely provision of additional forces, real acts of crime, violence and delinquency could have also been prevented. However, restoring order and calm in the city that had already been taken over by chaos was additionally aggravated because the police was going through its own crisis. Many policemen, traumatized by the ongoing events, found themselves in the situation of being forced to choose between duties and help that their families were in need of. Part of them, therefore, gave up and left their posts.[6]

Why did Katrina happen?

L. Clarke (2005) has labeled Katrina as the worst case, considering this disaster as an event that goes beyond imagination: *Events that we call worst cases are beyond the imagination, overwhelming it with images, data, noise, disorder, and sometimes violence and despair. Since the disaster, I've been grappling with the social, political, and physical dimensions of Katrina, trying to figure out what I think about it all. It is stretching my imagination, and that is one way I know it really is a worst case.*

Under our previous analysis resembling conclusion emerges: Katrina was worst case as a series of unbelievable and unfortunate circumstances: the hurricane struck physically vulnerable area and socially vulnerable population. The situation was made worse by an organizational breakdown and a failure of organizations and forces to mitigate or control the situation. Major omission was made at the point when city flooding hadn't been predicted and mandatory evacuation proclaimed. The city put public shelters at disposal of those who were left behind, but there was no plan of how to cope with their needs and safety. Social picture of the city and the general

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[5] Bradshaw and Slonsky are paramedics from California that were attending the EMS conference in New Orleans. Their shocking report tells us about a group of people attempting to leave the city and about all the misfortunes they came across on their way.

[6] More than 200 New Orleans officers have been under investigation by the police department for leaving their posts during the hurricane crisis. Furthermore, among police rank there were cases of theft and two suicides on records (Johnson, 2006).

collapse of aid systems and public mechanisms could not have resulted but in such a sequence of events.

Following this line of reasoning about Katrina, as a series of unbelievable and unfortunate circumstances, or as a case that goes beyond imagination, one cannot help doubting that just everything will go wrong in a rich and powerful country as this one, and that one disaster will grow into another, even greater one, accompanied by a collapse of all systems for providing mitigation and assistance. This opens the way to another interpretation of Katrina. However, we will not confirm it but it will be given consideration only as a possibility. So, can a disaster be a way of solving social or other problems? Is a disaster involved in social and ethnic cleansing? Will the black, the poor and others of the marginal status in society be welcomed as returnees to New Orleans? Will the city be reconstructed as the cleansed imitation of the previous one? Once it has been reconstructed, will the African Americans, make up 2/3 of the population? In addition some arguments could be mentioned.

As it was mentioned before, prior Katrina New Orleans was a city loaded with social, economic and other problems the authorities had a hard time coping with. To illustrate once again: the city had a population of just over 500,000 and was expecting 300 murders per year, most of them centered on a few, overwhelmingly black, neighborhoods. The statement made by Illinois senator, Mr. Barack Obama, is very illustrative: *I hope we realize that the people of New Orleans weren't just abandoned during the Hurricane. They were abandoned long ago - to murder and mayhem in their streets; to substandard schools; to dilapidated housing; to inadequate health care; to a pervasive sense of hopelessness.*[7] Furthermore, Louisiana congressman, Mr. Richard Baker, suggests that a natural disaster solved a problem that asked for great investment and effort by the authorities: *We finally cleaned up public housing in New Orleans. We couldn't do it, but God did* (Quingley, 2005). Furthermore, the statement made by *New York Times* editorialist David Brooks that people who lack middle-class skills should not be allowed to resettle the city: *If we just put up new buildings and allow the same people to move back into their old neighborhoods, then urban New Orleans will become just as run down as before* (Smith, 2005). The US President promised reconstruction of the city on several occasions: *There is no way to imagine America without New Orleans, and this great city will rise again.*[8]

The fact is that coping with the effects of such a great disaster is not easy, but it is well known that city reconstruction is not progressing. Data indicate that the situation in New Orleans a year after disaster is far away from one that we could describe as good: it is estimated that a year after the impact approx. 171 000 – 250 000 people have returned out of 465 000 inhabitants that New Orleans had before it. The unemployment rate is in increase: before Katrina, it was 5, 8% and a year after 7, 2%. On the other hand, labor contingent is in decrease: it was 633 759 before and 444 153 a year after. Number of homes for sale is rising while average home sale price is in decrease. During the first four months after the disaster, a number of suicides in the city increased for 300%. A number of murders in June 2006 were approximate to the level before Katrina although just a half of the previous number of inhabitants was living in the city at that moment. 49% of roads are in function and 17% of vehicle owners are using them. There are 60% of electric energy consumers, 41% of gas consumers, 29% of schools are open, 23% centers for child care, 62% of libraries, and 50% of hospitals (TIME, 2006).

In addition there's one more question. Why did the organizational breakdown happen at all since FEMA had conducted an exercise Hurricane Pam in July 2004, involving different emergency

[7] http://www.obama.senate.gov/statement/050906-statement_of_senator_barack_obama_on_hurricane_katrina_relief_efforts/
[8] http://www.msnbc.msn.com/id/9345270/

services, army and state and federal agencies. The exercise simulated a Category 3 hurricane and it comprised 13 districts in Louisiana. Furthermore, FEMA Regional Director, Mr. Ron Castleman, evaluated it as an important improvement in preparedness: *We made great progress this week in our preparedness efforts. Disaster response teams developed action plans in critical areas such as search and rescue, medical care, sheltering, temporary housing, school restoration and debris management. These plans are essential for quick response to a hurricane but will also help in other emergencies.* (FEMA, 2004).

Conclusion

To obtain a complete picture of natural disasters in modern society it is required to observe their causes and consequences in a broad civilization and narrow social context. The civilizational context of Katrina would be that hurricanes are becoming stronger and more frequent. That trend confirms already acknowledged influence of modern civilization on hurricanes as natural disasters. Highly developed countries are placing the economic prosperity and profit on the primary position and they consider themselves free from participating in global ecological actions.

Secondly, a social dimension of natural disasters is recognizable in their consequences which largely depend on the society and its social, economic, political, and other issues. Katrina confirmed that even in highly developed societies there are certain segments of population that are more vulnerable to disasters than the others. Their vulnerability is a direct outcome of inequalities within society and it is already present at the time of disaster outbreak. Perspectives of such groups in disasters mostly depend on their being recognized by the society itself and being offered assistance and relief. If the system is not ready or if it fails in its efforts for any reason, there’s a possibility that a disaster evolve into a greater one.

It is not easy to manage disasters which are striking large cities and the situation gets worse if the affected area happens to be marked by concentrated poverty and all that it takes along. Major omission in Katrina was, in our opinion, oversight to declare and organize mandatory evacuation. Let’s imagine Katrina if all the residents were evacuated from the city. Consequently, this disaster would be just one in a series to prove the rule that hurricanes in modern society could cause increasingly serious material damages but also take less and less victims. If an option of remaining in the city was left open in the first place, it should have been considered that the people who stayed behind would belong to the socially vulnerable structures that would be in need of immediate help and relief. Having in mind the social picture of the New Orleans, additional forces for restoring order in the city were needed as well.

With regard to the previous report we can point out one more level which can be discussed. Katrina was in many ways exceptional disaster but it reaffirmed sociological findings according to which, in spite of a complete destruction and lack of organization, the community affected by a disaster could help itself to a certain extent. Spontaneous, self-organized and cooperative activities and behaviors were not isolated cases in Katrina. Just to mention once again the paramedics’ report that says: *...Our little encampment began to blossom. Someone stole a water delivery truck and brought it up to us. Let's hear it for looting! A mile or so down the freeway, an army truck lost a couple of pallets of C-rations on a tight turn. We ferried the food back to our camp in shopping carts. Now secure with the two necessities, food and water; cooperation, community, and creativity flowered. We organized a clean up and hung garbage bags from the rebar poles. We made beds from wood pallets and cardboard. We designated a storm drain as the bathroom and the kids built an elaborate enclosure for privacy out of plastic, broken umbrellas, and other scraps…*

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EXPLORING FOREST-FIRE EVENTS ON WEBSITES - VIEWPOINTS OF PEOPLE OF DIVERSE CULTURAL BACKGROUNDS

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Keywords:

Forestfires, bushfires, internet, websites, newspapers, residents, risk communication, preparedness.

Abstract:

From 2004 to 2006, my project "*Potential of the internet for enhancing residents' bushfire preparedness*" [PIB] was conducted. Focus: Analyzing the capability and the utility of information sources provided by authorities for the public via the Internet and especially the WorldWideWeb (WWW). Crucial research questions were: How well are these new risk communication means utilized by residents, and why or why not? How likely are they to significantly advance problem awareness, preparedness and coping with actual fires? How can the usability and effectiveness of these tools for individual risk management be improved?

Conceptually, this Australian project is based on the author's socio-psychological Risk Communication Model. The investigation comprises six studies, which combine several approaches, including focus groups, experiments, surveys and expert panels.

Last year, sub-study PIB-E "*Surveying bushfire events on websites - experience of people from different cultural backgrounds*" was carried out. The participants had to survey: How the then present fire situation in Australia was covered in pertinent websites; which bushfire preparedness advice they offer; how internet information compares to reports in newspapers, and what the strengths and deficiencies are. An assessment questionnaire was developed for this. Partakers were 6 experienced students; 2 Australians, 2 Asians, 2 Europeans.

The survey was focussed on websites of fire authorities in the states of South Australia (CFS), Victoria (CFA), and New South Wales (RSF). All were found to be generally helpful and informative. Some examples of quality ratings on a 1-to-5 scale: "Understandibility" 4.3/4.4/3.7; "Own info need met" 4.0/4.0/3.8; "Motivating for fire preparation" 3.8/3.7/3.0; "Better than brochures" 3.6/4.0/2.8; "Clarity of fire safety actions" 4.2/4.6/3.3. Regarding media, the websites are appraised as far more comprehensive in scope, yet newspapers are easier to obtain, usually less demanding and likely to be more explicit and emotive.

The respondents also identified shortcomings, in both content and presentation of fire preparedness information for residents, and stated limitations of addressing cultural variety. Obviously there is considerable potential for the improvement of websites. Pertinent suggestions are outlined and resultant research needs discussed.

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Introduction: Problem area

Websites as information source pertaining to forest fires

In countries such as Australia, large areas inhabited by many people are regularly exposed to the risk of fires in the environment (called wildfires, forestfires or bushfires). Consequently, emergency management is a permanent task. Risk information/communication/education about bushfires near residential settings are crucial components. Residents need to be properly informed about relevant hazard characteristics, preventative measures and appropriate behaviours during the onset of an emergency situation and after the event. Information campaigns for enhancing disaster preparedness make use of media activities (television, radio, internet) meetings with residents, and a variety of visual communication means, such as information leaflets and brochures and video-tapes. Internet-based information provision, especially websites run by authorities have been commonly established within the last decade. They are widely available and accepted as essential and increasingly indispensable information source for both experts and residents; however, they are not yet 'mainstream' procedures.

Research on the value of fire websites.

Given the increasing relevance of fire authority websites, the capability and utility of information sources provided via the Internet became a significant issue. In order to get empirical data, from 2004 to 2006, my project "*Potential of the internet for enhancing residents' bushfire preparedness*" [PIB] was conducted. Conceptually, this Australian project is based on the author's socio-psychological Risk Communication Model. The investigation comprises six studies, which combine several approaches, including focus groups, experiments, surveys and expert panels. Last year, sub-study PIB-E "*Surveying bushfire events on websites - experience of people from different cultural backgrounds*" was carried out. The research questions to be clarified are summarized below in table 1.

Table 1:

Project PIB -- Sub-study PIB-E -- 2005 *Surveying bushfire events on websites - experience of people from different cultural backgrounds* Research issues
Focus: How are events, i.e., current bushfires in an area, represented and explicated on websites of pertinent fire authorities. *Crucial research questions*: ◊ How well are new risk communication means using the InterNet utilized by residents, and why or why not? ◊ How is information provided in websites perceived in comparison to reports in local newspapers? ◊ To what degree does website information advance problem awareness, preparedness and coping with actual fires? ◊ How can the usability and effectiveness of these tools for individual risk management be improved? *Critical perspective:* Explorations and expectations of residents (rather than fire experts), and differences between people from diverse cultural backgrounds.

The focus of this study are experiences of residents, both local ones and those from a different linguistic and cultural background.

Research method

Study design

The research plan was to focus on a current bushfire during the 'fire season', to choose the most relevant websites of the pertinent governmental fire authorities, to ask experienced people for a continuous appraisal of these internet information sources, to examine newspaper reports during the same time period, and to incorporate people from different cultural backgrounds into the study. Details are listed in table 2.

In January 2006, the largest bushfire happened in South Australia, claiming 9 lives and destroying 83000 hectares of farmland.

Website assessment

The websites listed above were regularly inspected by the participants and finally assessed using the author's "Questionnaires for the Appraisal of Website Utility for Residents".

Table 2:

Project PIB -- Sub-study PIB-E -- 2005 *Surveying bushfire events on websites - experiences of people from different cultural backgrounds* Project design:
Information sources: Monitoring and assessing of three websites: ◊ CFS = South Australia's Country Fire Service (Adelaide; responsible for the area which had disastrous fires in Jan 2005) =>> http//www.cfs.org.au/ ◊ CFA = Country Fire Authority of Victoria (Headquarter in Melbourne; a large institution; in parts progressive) =>> http//www.cfa.vic.gov.au/ ◊ RFS = New South Wales (NSW) Rural Fire Service (located in Sydney; is the world's largest fire service) =>> http//www.bushfire.nsw.gov.au/ *Newspapers:* The Age; Herald-Sun (both from Melbourne).
Participant sampling: Sampling of six people who are knowledgeable about bushfire issues from a residents' point of view, familiar with InterNet and website features, and are from different national and cultural backgrounds: South Australia & Victoria (i.e., Australia), HongKong & China (i.e., Asia), Germany & Netherlands (i.e., Europe).
Timing: Regular website observation for 1 month, mid-Jan to mid-Feb 2005; during the same time, checking for newspaper articles about bushfires.

Furthermore, an agenda for describing and comparing reports in Melbourne newspapers was developed.

Empirical findings

Only selected results can be presented here, regarding the appearance of the websites of fire authorities, their usefulness for residents' hazard preparedness, and the eminence of internet-based information in relation to newspapers.

Appraisal of the 'face' of the websites

As the results in table 3 (next page) demonstrate, the governmental websites of interest were generally rated positively, including their navigation features. However, basic requirements, such as an organisation's name and contact provisions, are not always transparent.

Assessment of information regarding "fire preparedness"

In table 4 (next page), the main results regarding the convenience and utility of information for residents are presented, focussing on preparedness for fire hazards. The observed websites were found to be generally helpful and informative. Positive evaluations include: "Understandibility", "Clarity of fire safety actions" and "Motivating for fire preparation"; they are seen as "Meeting own information need" and "Better than brochures".

Relevance of linguistic and cultural background

The ratings of the participants from a European or Asian background tended to be slightly less positive - they are less familiar with the English language (which dominates in websites) and the significance of forestfires for Australians.

Table 3:

Project PIB -- Sub-study PIB-E -- 2005
Surveying bushfire events on websites - experience of people from different cultural backgrounds
Mean responses compared for websites of CFS (S.A.), CFA (Victoria), RFS (N.S.W.)
A: Assessment of the overview & introductory page of the website

Facet	*Variable content*	*Response scale*	CFS	CFA	RFS
A1	Name of authorisation stated	% "yes"	100%	50%	83%
A2	Contact details provided	% "yes"	100%	67%	83%
A3	Organisation of home page	1= very poor to 5= excellent	4.5	3.7	3.7
A4	Ease of navigation	1= not at all to 5= very	4.5	3.7	4.0
A5	Ease of locating relevant information	1= not at all to 5= very	4.2	4.5	4.0
A*	Ratings as favourite site	1= most, 3= least favourite	1.7	1.7	2.7

Table 4:

Project PIB -- Sub-study PIB-E -- 2005
Surveying bushfire events on websites - experience of people from different cultural backgrounds
Mean responses compared for websites of CFS (S.A.), CFA (Victoria), RFS (N.S.W.)
B: Evaluation of information regarding "Fire preparedness"

Facet	*Variable content*	*Response scale*	CFS	CFA	RFS
B1	Interesting to look at	1= not at all to 5= very much so	3.8	3.7	2.7
B2	Understandability	1= not at all to 5= very much so	4.3	4.4	3.7
B4	Visual appeal	1= not at all to 5= very much so	4.0	4.0	2.2
B5	Helpfulness of pictures/illustrations	1= not at all to 5= very much so	3.2	3.7	2.4
B7	Comprehensiveness	1= not at all to 5= very much so	4.5	4.3	3.7
B9	Length of section safety/preparedness	1= far too short to 5= far too long	3.3	3.0	2.7
B10	Keypoints & summaries provided	% "yes"	100	83	100
B11	Good examples given	1= not at all to 5= very much so	4.2	4.2	3.5
B12	Clarity of fire safety actions	1= not at all to 5= very much so	4.2	4.6	3.3
B13	Own info need is met	1= not at all to 5= very much so	4.0	4.0	3.8
B15	Extent of motivating fire preparation	1= not at all to 5= very much so	3.8	3.7	3.0

B16	Difficulty remembering information	1= not at all to 5= very much so	1.8	2.5	2.7
B17	Seen as reliable source of information	1= not at all to 5= very much so	4.2	4.3	3.7
B18	Clarity of where to get assistance	% "yes"	100	100	83
B19	Better than brochures	1= much poorer to 5= much better	3.6	4.0	2.8
B22	To be recommended to lay people	1= not at all to 5= very much so	4.0	4.0	2.8

Evaluation of newspapers in relation to websites

Regarding alternative media, the websites were appraised as far more comprehensive in scope, yet the respondents emphasized that newspapers are easier to obtain, usually less demanding and likely to be more explicit and emotive. This judgment is stricter for websites which deal with principal bushfire matters rather than current events.

Discussion and outlook

Evaluation of websites' strengths and weaknesses

All study participants identified shortcomings, either regarding the content or the presentation of bushfire impacts and proposed procedures to enhance preparedness for hazardous events; see the list in table 5. Information complexity and comprehensibility for non-australian citizens are core issues, i.e., limitations of addressing cultural variety were stated.

Table 5:

Project PIB -- Sub-study PIB-E -- 2005

Surveying bushfire events on websites - experience of people from different cultural backgrounds

Appraisal of websites – criticisms and suggestions

Perceived shortcomings:

◊ Some information and instructions too 'texty',
◊ information about present bushfires not as current as newspaper or TV reports,
◊ some parts difficult to understand for people with a 'non-english' linguistic and cultural background,
◊ some summaries of key points too complex,
◊ explanation of technical terms occasionally hard to find and/or to understand,
◊ inconvenient if information comes in 'pdf" format and needs a printer.

Suggested improvements:

◊ Reflecting the (restricted) awareness and knowledge of residents,
◊ using more maps, pictures, diagrams, charts to convey information,
◊ providing downloadable videos for demonstrating fire risks and enhancing preparedness,
◊ including facilities for those with not-so-good eyesight,
◊ adding information aimed at children,
◊ placing up-to-date information about current bushfires on prominent frontpage position,
◊ making core information usable for all website users, including those who have restricted download capabilities, no flash player and can't print website texts,
◊ enhancing accessibility for the wider Australian audience, by providing information in languages other than English.

Clearly there is considerable potential for improving websites (cf. part 2 of table 5). When working on website enrichments, some audiences deserve particular attendance, e.g., children, elderly people, and residents with an non-australian background.

Considerations for further research

Improving the potential utility and actual utilization of a website has better chances if based on empirical research about residents' responses to the content and appearance of forestfire information. In table 6, a set of pertinent research topics are suggested. These issues refer to the presentation mode (e.g., the role of pictures), the links to other media (e.g., radio), the fire situation (before versus during versus after an event), linguistic and cross-cultural problems (e.g., non-australian residents), and website requirements regarding specific groups (e.g., children).
Research projects about the soundness and efficiency of internet-based fire information should be conducted both before and after re-designing a website.

Table 6:

Project PIB -- Sub-study PIB-E -- 2005 *Surveying bushfire events on websites - experience of people from different cultural backgrounds* Research suggestions
◊ Comparing the communication efficiency of pictures versus diagrams versus charts versus videos as visual enrichments of text information, ◊ critically analyzing the options for providing multi-language bushfire information and preparedness advice, ◊ exploring differences in website utilization across people of high or low familiarity with internet & web-browser procedures, ◊ website utilization regarding specific information needs 'before' versus 'during' versus 'after' bushfire events/disasters, ◊ empirically investigating the links between website features and the real behavior when preparing for or coping with actual fires, ◊ testing the linkage and potential mutual enrichment of information provided by various media, such as websites, newspapers, television and meetings of community groups such as 'fireguard', ◊ investigating necessary features in case children and/or the elderly are to be addressed in websites.

Final considerations

It appears almost certain that 'electronic' information channels will become as commonplace in disaster preparedness as in many other fields of public information, communication and education. In fact, WWW-based risk communication has considerable advantages: Information can be updated regularly and quickly, users can bookmark and store relevant hazard info, access is fast and blockage unlikely (unlike telephone contacts).
The results from the current study, "*Surveying bushfire events on websites - experience of people from different cultural backgrounds*", will help to better identify (1) why and how residents seek and utilize information regarding forestfire preparedness, (2) whether current websites of fire authorities meet the reading style and information needs of residents, and (3) which features of websites are essential and deserve substantial improvement in order to maximize their potential for enhancing residents' preparedness.

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Biography:

Scientific education in Germany. Various positions as social scientist and lecturer at research institutions and universities. Then director of a social-scientific consultancy team and visiting lecturer in Austria, Switzerland, Australia and New Zealand. Since 1993 with the University of Melbourne. Main areas include: applied social research, environmental psychology, and research methodology. Special substantive interests: risk perception/ communication/ management; impacts of environmental stressors (eg, noise, fires); hazard appraisal and disaster preparedness; residential choice and satisfaction; decision processes and decision-aiding technologies; teaching quality. Methodological interests: response scales, survey methodology, evaluation research, and structural models. Conducted numerous empirical investigations; strong emphasis on interdisciplinary approaches and applicability of findings. Also worked as consultant with governmental agencies, courts and companies. Publication of about 100 articles/reports/chapters/books.

CIVIL RESPONSE AFTER DISASTERS

THE USE OF CIVIL ENGAGEMENT IN DISASTER ABATEMENT

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Keywords

Civil engagement, volunteers, civil emergency response, myths, government.

Abstract

The Netherlands Institute for Safety (NIFV) conducted an international literature review to investigate the behavior of citizens participating in response to disasters. The results of the literature review are compared to studies of four Dutch disasters: airplane crash in 1993 (cargo plane crashed into an apartment building in Amsterdam), the flooding of several rivers in the province of Gelderland in 1995, the fireworks disaster in Enschede in 2000 and the pub fire in Volendam in 2001.

In the literature review it is shown that (internationally) citizens massively respond to disasters, participating in rescue activities. This is confirmed for the Dutch situation in the four Dutch disaster studies. It is also shown that (internationally and in the Dutch situation) professional emergency responders do not know how to deal with this large number of volunteers who show up and want to help at the disaster scene. Myths of panic, looting and apathy appear to dominate the attitude of professional disaster responders towards civilians. Disaster preparedness plans do not take into account the use of civilians and are more focussed on measures to keep them away from the disaster scene. Training and education programs in the Netherlands are still based on the previously mentioned myths. Recommendations are made to improve these matters.

Introduction

For the last decades the responsibility for safety in the Netherlands has increasingly become a governmental one. Emergency response has become more and more the concern of professionals and the use of volunteers in emergency response seems to be decreasing. In the Netherlands it has become difficult to recruit civilians who want to join the volunteer fire brigade (Haverkamp, 2006). On the other hand there are initiatives of people wanting to participate in creating a safe neighborhood (Nieborg and Ter Woerds, 2004). Lately there has been some discussion about this responsibility for safety in the Netherlands. Citizens should be aware of the fact that the government cannot guarantee permanent and complete safety and that they have their own responsibility for their safety. Therefore there is an increasing appeal from the government to civilians to take their own responsibility. At the moment there is a campaign in the Netherlands, called 'Think ahead', which encourages people to prepare themselves to different kinds of disaster. Also there are some initiatives in the city of Amsterdam to stimulate civilians to participate in response to disasters, such as a communication campaign and the use of cell broadcasting to inform people what to do and how they can help in case of disaster (Van der Most, 2007).

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The question is whether engagement of citizens in disaster response is advisable. If so, is it necessary to encourage citizens to participate in disaster response? What is the attitude of professionals and government towards civil engagement in disaster response? And if engagement is advisable and citizens need to be encouraged to participate in disaster response, how can this be achieved? In what way can the government stimulate engagement of civilians in disaster response?

These questions have been leading for a review of the literature, conducted by the Netherlands Institute for Safety *Nibra* (NIFV) in 2006. After this literature review, the NIFV conducted four case studies, in order to compare facts from the international literature to the Dutch situation. The question was whether findings from international literature also apply to the Netherlands.

Aim of the investigation and sources of information

The aim of the literature review was to investigate whether engagement of citizens in disaster response is desirable, and, if so, whether stimulation of this engagement is necessary. In order to gain an insight into the *advisability* of involving citizens in disaster abatement, the literature search focused on the pros and cons of engagement of citizens in response to disasters.

In order to gain an understanding of the possibilities to *stimulate* citizens to participate in response to disasters, the literature search focused on distinctive characteristics and conditions which determine whether and to what extent people will participate in the response to disasters. Also information was searched about the way the government can influence characteristics and conditions which determine the participative behavior of citizens.

Finally we searched for information about the *attitude* of government and emergency services towards participation of civilians in response to disasters. This attitude can play an important role in deciding if and how participation of citizens should be stimulated.

The aim of the case studies was to establish whether the findings in the international literature also apply to citizen response to disasters in the Netherlands. For the case studies evaluation reports of the cargo plane crash in Amsterdam in 1993, the flooding of several rivers in the province of Gelderland in 1995, the fireworks disaster in Enschede in 2000 and the pub fire in Volendam in 2001 were used.

Findings of the literature review

Is engagement of citizens in response to disasters advisable?

Previous research from different scholars (Barton (1969), Ye and Okada (1976), Quarantelli (1989), Tierney and Goltz (1995), Auf der Heide (2004) and Petal et al. (2004) shows, that in case of disaster, the majority of victims saves itself or is rescued by other civilians. Less than a quarter of the victims are rescued by professional emergency services. Emergency services simply have not got the capacity to rescue all the persons involved. This leads to the conclusion that engagement of civilians is not only desirable, but also necessary to save lives in case of disaster. The fact that citizens are instantly present at the disaster scene and can immediately start their rescuing activities is the most mentioned advantage of civil engagement in response to disasters. In addition to this, the following advantages are also mentioned:

- Citizens generally have a better knowledge of the stricken area and know the daily routines of their family, friends and neighbors. This implicates that they can help in localizing possible victims (Aguirre et al. 1993, Barton 1969);
- Engagement of citizens helps the community in the psychological recovery after disasters (Lowe and Fothergill 2003).

Besides advantages, the following disadvantages can be found in the literature:

- Individual participation by civilians is difficult to coordinate which makes it difficult to make adequate use of their capacities and skills (Drabek and McEntire 2003);
- The mass assault of volunteers wanting to help and the convergence of people and materials can cause logistic problems. (Barton 1969, Dynes 1994, Perry and Lindell 2003);
- Volunteer rescuers trying to help can become a casualty themselves (Petal et al. 2004).

Taking all the advantages and disadvantages into consideration, it is not easy to draw an unambiguous conclusion. One could argue that the disadvantages prove to be minor as compared to the major advantage of immediate and mass civil response to disasters. However there is very little quantitative information about the disadvantages of civil participation: how many people died or became injured as a consequence of civil participation? For instance because of the logistic problems they caused, due to which professional help arrived too late. Or because they got injured themselves. Or because they helped someone inadequately, enlarging his or her problem rather than helping this person. Since in the literature there are no answers found to these questions, only indicative conclusions can be drawn. At this moment it is my opinion, that civil response to disasters is advisable, since there is no evidence of the disadvantages being larger than the advantages. The fact that so little has been written about it, may indicate that it is not such a big issue. Further research at this point is necessary however, to prove this statement right or wrong.

Must citizens be stimulated to respond to disasters?

If we take into consideration the convergence of people and goods, we see that a part of this question has already been answered. Lots of people simply do respond to disasters and do not have to be stimulated to help other people. On the other hand there are also people who do not come and offer their help, so there is some extra potential of citizens, which might be worthwhile attracting. The question is whether the government should put an effort in attracting more people to come and help, given the fact that all this help causes logistic problems and coordination of all this help is difficult. The handling of this convergence seems to be a problem which must be solved first, before extra volunteers are stimulated to go and help at the disaster scene. Then there is the problem of the volunteer rescuers becoming injured at the disaster scene, or injuring other people in their attempts to rescue them. In order to overcome these problems it may be necessary to inform people about the best way to respond to disasters and to offer their help.

Considering all this, we think that at this moment citizen response itself does not need to be stimulated by the government. What needs to be stimulated is the proper way in which this help is offered. In this way the disadvantages of civil response can be minimized.

Can citizens be stimulated to respond (differently) to disasters?

As mentioned earlier, the literature search also focused on distinctive characteristics and conditions which determine whether and to what extent people will respond to disasters, as well as the possibilities of the government to affect these characteristics and conditions in order to stimulate citizen participation.

Literature shows a somewhat scattered pattern of characteristics and conditions that determine people's response to disasters. With respect to the characteristics it seems that especially white, young (18-29 years), males from the social mid-class actively respond to disasters (Wenger and James 1994, Drabek 1986, Barton 1969). When it comes to preparing to disasters, several studies show that women play a more important role in preparing for disasters than men (Mileti 1999, Ruitenberg and Helsloot 2004). Regarding age it appears that younger people (21-40 years) take warnings from the government more seriously and prepare themselves better for disasters than older people (Drabek 1986).

Regarding ethnicity an important note is made by Drabek (1986), who infers that not ethnicity determines the reaction to disasters, but the extent to which people have access to official information. If people are badly informed about what is going on and what actions they can take, it is not surprising they do not know what to do in order to prepare and respond to disasters.

The extent to which people are informed about the disaster therefore is one of the conditions which determine the way people respond to disasters. Being part of a social network also plays a role. Women often appear to be better informed about possible threats, either via the media, or via their social networks (Mileti 1999, Ruitenberg and Helsloot 2004).

Another condition is having previous experience with similar disasters. The influence of previous experiences with disasters is ambiguous. There is some evidence that people with previous experiences are better prepared for the disaster they have already experienced (Miller Canzler 2004). Other studies show that people with previous experience with a disaster are more negligent if they did not suffer any damage from this previous disaster (Miller Canzler 2004).

Considering the fact that there are several characteristics and conditions that determine whether or not people participate in disaster response, we may conclude that, when we want to change the way people participate in response to disasters, the government should aim at the young males from the social mid class. The question is however how this change of response can be achieved. One should think that this is best achieved by informing people what to do in case of disaster before the disaster has taken place. Literature has shown however, that it is difficult to engage people in preparing to disasters. People do not tend to prepare themselves for accidents that have a little chance of occurrence (Drabek 1986, Buckle et al. 2003, Godschalk et al. 2003, Ruitenberg and Helsloot 2004). They do on the other hand prepare themselves for accidents which are easier to imagine, such as accidents in and around the house. Therefore it is better to educate and inform people about what to do in everyday accidents: if people know how to act in these situations, they may also effectively use this knowledge in disaster situations (Ruitenberg and Helsloot 2004). Recommendations of studies in the field of bystander response support these findings. They also conclude that it is desirable to train as many people as possible in first aid (Pelinka et al. 2004, Thierbach et al. 2004, Herlitz 2005).

What is the attitude of government and emergency services towards citizen response?

In our literature search concerning the attitude of government and emergency services towards participation of civilians in response to disasters, it appeared that the attitude differs. There are examples of disasters where professional emergency responders worked together with civil responders (Aguirre et. al 1993). Examples of disasters where there was not much cooperation between civil and professional responders are however also present (Tierney and Goltz 1998).

When it comes to preparedness, then the official emergency services appear not to take civil response into account. Disaster preparedness plans and trainings are based on myths of panic, disorder and dependency/passivity and not on actual behavior of citizens (Auf der Heide, 2004). In 1954 Quarantelli already pointed out that people do not panic in case of disaster. Also Auf der Heide (2004) states that 'The issue of panic in disasters is frequently clouded by a lack of understanding what the term means. The word is often very loosely and incorrectly used to describe virtually any type of fear, flight or uncoordinated activity.' He describes panic as: 'irrational, groundless or hysterical flight that is carried out with complete disregard for others.' Research shows that several conditions must be present simultaneously to trigger panic (Auf der Heide, 2004):

- the victim perceives an immediate threat of entrapment in a confined space.
- escape routes seem to be rapidly closing

- flight seems to be the only way to survive
- no one is available to help.

There are a lot more studies which support Quarantelli's and Auf der Heide's findings, amongst others Drabek (1986), Quarantelli (1989), Perry and Lindell (2003), Dwyer and Flynn (2005).

Also the expectation of dependency of the emergency services has been proved wrong by many studies (Barton 1969, Drabek 1986, Quarantelli 1989, Ruitenberg and Helsloot 2004, Auf der Heide 2006). The same holds for the misconception of disorder and looting (Drabek 1986, Quarantelli 1989, Quarantelli 1994, Auf der Heide 2004, Jong and Helsloot 2005, Barsky et al. 2006).

As preparedness plans are based on the previous mentioned myths, emergency services have not prepared themselves for the fact that people massively respond to disasters and want to help. This means that the massive flow of people and goods is not accounted for and becomes a problem for the emergency services, rather than an expansion of means (Quarantelli 1997, Drabek and McEntire 2003, Auf der Heide 2004 and 2006).

Recommendations from the literature review

The literature review shows, that civil response to disasters always occurs and that civilians rescue most people. Civil response to disasters therefore is a desirable and inevitable phenomenon, which does not need to be stimulated, but should be cherished. Emergency services therefore should take this civil response into account when they prepare themselves for emergencies. Until now, disaster preparedness plans are based on myths of panic, social disorder and apathy, which are clearly misconceptions. Emergency services appear to have different attitudes towards civil response, when disaster strikes. There are examples, where emergency services do not know how to handle this massive response. However there are also examples where emergency services and volunteers cooperate very well.

It is not a surprise that recommendations from the literature mainly aim at emergency services and how they can better prepare themselves to handle civil response in case of disasters. Recommendations found are:

- Take, in the disaster preparedness plans, into account that civilians will massively respond to disasters and that large flows of people and materiel can be involved (Quarantelli 1997, Drabek and McEntire 2003, Auf der Heide 2004 and 2006);
- ensure a good information provision service when disaster has stricken (Barton 1969);
- establish a communication center as soon as possible, in order to coordinate help from whoever offers help (Barton 1969);
- appoint a leader for coordination of civilians wanting to help and designate groups of civilians to certain areas (Barton 1969, Quarantelli 1997, Auf der Heide 2004);
- try to activate civilians as much as possible to join already organized groups of responding citizens, rather than acting on their own (Quarantelli 1997);
- provide the public with first aid and disaster skills (Barton 1969, Pelinka et al. 2004, Thierbach 2004, Herlitz 2005, Auf der Heide 2006).

Findings of the Dutch case studies

In order to compare the findings in the international literature to the Dutch situation, four Dutch cases have been analyzed for the following aspects:

- characteristics and conditions of citizens responding to disasters;
- behavior of citizens responding to disasters:
  - panic;
  - public disorder;
  - dependency/passivity;
- cooperation between volunteers and professional emergency services in response to disasters;
- preparedness of professional emergency services regarding citizen response to disasters.

The cases which have been analyzed are: the plane crash in Amsterdam in 1993, the flooding of several rivers in the province of Gelderland in 1995, the fireworks disaster in Enschede in 2000 and the pub fire in Volendam in 2001.

A brief description of the disasters is included hereafter. In table 1 the various forms of civil response in the four cases are shown. In table 2 the findings of the case studies are presented.

Plane crash 1993

At October 4 1993 a cargo plane from EL-Al crashed into an apartment building in Amsterdam, Bijlmermeer. 43 people were killed, amongst whom four members of the plane crew. Two people suffered severe burns and about 45 people had minor injuries.

Flooding rivers 1995

At January 30 1995 the emergency management team of the region Nijmegen decided to evacuate an area which was endangered of flooding from several rivers. Other regions followed. All together, within five days 250.000 people were evacuated, of whom 12.500 persons were taken care of by the government

Fireworks disaster 2000

At May 25 2000 a storage of fireworks exploded in Enschede. More than 10.000 people were made homeless, 22 people were killed and 947 wounded persons were registered. The first day 700 people were taken care of in accommodations provided by the government. Of these people, 380 stayed only one night, 184 people stayed two nights and 97 people stayed three nights.

Pub fire 2001

Shortly after midnight at January 1 2001 a short but severe and intense fire occurred in a pub in Volendam. The pub was located at the attic of the premises. About 350 people, mainly youngsters, were present at that time. The capacity of the emergency exits was not enough to get the people out quick enough. 14 people were killed and 245 people were injured, of who 182 were taken into hospital (112 of these 182 were taken into intensive care). The other victims were taken care of by their own families and/ or friends.

Table 1 Types of civil response in four Dutch disasters.

Civil response	Plane crash 1993	Flooding rivers 1995	Fireworks 2000	Pub fire 2001
Alert	+	-	+	+
Search and rescue	+	-	+	+
Give first aid	+	-	+	+
Give psycho sociological care	+	+	+	+
Transport victims to hospital	+	-	+	+
Help evacuate	not applicable	+	-	not applicable
Give shelter at own home	+	+	+	+
Organize and equip shelters	+	-	+	+
Take care of people in shelter	unknown	+	+	+
Donate money and goods	-	-	+	+
Reaccommodate	+	+	+	-

Table 2 Four Dutch disasters compared to findings from international literature review

	Plane crash 1993	Flooding rivers 1995	Fireworks 2000	Pub fire 2001
Citizen characteristics	Lower social class; ethnic minorities, illegal immigrants	Various	Working class	In pub: youngsters outside pub: youngsters, family and friends
Panic	None	None	None	In the pub people panicked. Outside no panic.
Public disorder	One report of looting	None	None	None
Dependency/ passivity	More than 100 people rescued themselves/ were rescued by volunteers. 8 persons (appr. 10 %) were rescued by emergency services. On the other hand, reports of hundreds of people walking around in a shattered way. These people were taken care of by emergency services.	Many initiatives to help from the entire community. No numbers known of people who rescued themselves/ were rescued by the emergency services. 95% of the people arranged their own evacuation and place to stay. 5% was taken care of by the government.	Many initiatives to help from the entire community. No numbers known of people who rescued themselves/ were rescued by the emergency services. After the disaster over 93% of the people arranged their own place to stay. Less than 7% was taken care of by the government.	Many initiatives to help from the entire community. No numbers known of people who rescued themselves/ were rescued by the emergency services. After the disaster all people were taken care of by volunteers in their own community of Volendam.
Cooperation volunteers and professionals	Some volunteers acted aggressively towards professionals, urging them to	No cooperation between volunteers and professionals; volunteers went their own way.	Some kind of cooperation existed in shelters, where professionals coordinated the	Volunteers were very opposed to professional emergency services. In psychosocial

	Plane crash 1993	**Flooding rivers 1995**	**Fireworks 2000**	**Pub fire 2001**
	hurry up		actions of volunteers	aftercare professionals and volunteers cooperated within 'Support project'.
Preparedness for citizen response	None	The government and emergency services prepared transport and shelter for 25% of the people. In reality only 5% used the arranged transport and shelter.	Emergency services were overwhelmed by the large number of people and goods emerging at the disaster scene (in order to help). This was not accounted for in disaster plans.	Emergency services were not prepared for the hostile attitude towards professional emergency care.

Discussion and recommendations

Comparing the results from the Dutch case studies to the results of the literature review, the following can be concluded.

Concerning the characteristics of people who respond to disasters, we do not have enough information to make a sound pronouncement. However, in all four analyzed disasters in the Netherlands we see a massive civil response to disasters. Also it is shown that in these cases, the emergency services were not prepared for this massive response. In disaster preparedness plans especially the number of people who can take care of themselves was underestimated. In Volendam (a community with a strong sense of solidarity) emergency services were not prepared to the hostile attitude towards professional emergency care.

Apathy proved in all four cases clearly to be (no more than) a myth. In the Bijlmer disaster there was one report of looting, so looting cannot completely be ruled out for being a myth. The myth of panic can indeed in all four cases be called a myth. Only in Volendam, youngsters present in the pub panicked. As there were to little emergency exits for all the persons present and there was a direct and life-threatening fire and nobody from outside was able to help the people in the burning attic, these circumstances fit the category of conditions when people panic as described by Auf der Heide earlier in this article.

Finally, with respect to the cooperation between volunteers and emergency service professionals it can be concluded that in most of the cases this cooperation was not shown. All together it can be concluded that the facts found in the four cases in the Netherlands support the findings in the literature survey. Therefore the recommendations made in the literature review also seem to be applicable to the Dutch situation. More specifically, for the Netherlands the following recommendations can be made for preparedness and response to disasters:

When it comes to preparedness:

- Massive response to disasters from civilians must be accounted for in preparedness plans:
  - The expected percentage of people needing help with transport to or finding accommodation can be downsized from 25% to 10% and possibly even to 5%. Further research is needed to confirm these figures.
  - Plans to spread injured people over several hospitals should take into account that most of the injured people will be transported by own means to the

nearest hospital. As a result of this, hospitals in the vicinity of the disaster will quickly become overcrowded.

- This means that it should be considered not to send ambulances to the nearest hospitals, but to always let them drive to hospitals in other regions, or even abroad.
- Another possibility to deal with this problem is to find solutions to quickly enlarge the capacity of the nearest hospital, such as mobile units, like the in The Netherlands used so-called SIGMA-teams (teams for quick medical assist).

- In order to deal with the large amount of people coming to the disaster scene to donate goods, it is advised that emergency agencies should enter into an agreement with a distribution firm, preferably having several distribution centers at its disposal. People can be asked to deliver their goods to a distribution center away from the disaster scene. In this way people bringing goods will not disturb search and rescue activities at the disaster scene.

- Behavior of panic and apathy should not be part of training material and exercises. Further research is needed for the aspect of looting, in order to confirm or refute this behavior in case of disaster.
- In order to effectively coordinate the response of people in times of disaster, it is advised that the government should try to activate civilians as much as possible to participate in associations in their community, especially in their own neighborhood. In this way, in case of disaster, people can be coordinated via their leaders.

When it comes to response it is essential that people wanting to offer their help, can do this in such a way that it contributes to fighting the disaster:

- In order to use all the help that is offered, let civilians as much as possible carry on with their helping behavior and try to facilitate this. Do not take over tasks from civilians that are carried out in a proper way.
- In order to make sure civilians know how their help can be offered in an effective way, they should shortly after the disaster has stricken be informed about what has happened, what the government is doing, what help from civilians is needed and where civilians can report themselves to offer their help.
- establish a communication center as soon as possible, in order to coordinate help from whoever offers help;
- appoint a leader for coordination of civilians wanting to help and designate groups of civilians to certain areas.

In the Netherlands, the Netherlands Institute for Safety will incorporate these recommendations in education and training material for the Dutch emergency services.

The NIFV is currently working on further research, investigating what specific responding behavior civilians express in different parts of The Netherlands and in different types of disaster. Also the attitude of the emergency services in different parts of The Netherlands towards civil response will be investigated.

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NATURAL HAZARDS MANAGEMENT

ANALYTICAL INPUT TO EMERGENCY PREPAREDNESS PLANNING AT THE MUNICIPAL LEVEL – A CASE STUDY

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Keywords: emergency preparedness, risk analysis, vulnerability analysis, assistance needs

Abstract

In this paper an approach for employing risk and vulnerability analyses as the basis for emergency preparedness planning is discussed and exemplified using a case study. The study consisted of three connected parts: a broad scope hazard identification and analysis, an assessment of potential assistance needs should any of the hazards materialise and finally a mapping of actors and dependencies. The case study was conducted as a series of workshops, involving key actors from the studied municipality. Some thirty hazard scenarios, originating from five different categories; accidents, epidemics, infrastructure/utilities breakdown/interruption, criminal activity and socially induced scenarios were identified, described and initially evaluated in terms of possible consequences over a range of predefined attributes. In the next step, an analysis of potential assistance needs that may evolve during the identified scenarios was undertaken. Furthermore, an effort was made to identify municipal actors of central importance in the management of potential emergency scenarios, their respective tasks, resources and dependence on service from various technical infrastructures, other actors etc. Examples from the resulting overview of potential emergency scenarios, generated assistance needs and emergency management actors, tasks, resources and dependencies are presented and discussed, alongside with some implications for societal preparedness activities.

Introduction

The importance of planning and preparing for emergency and crisis has been increasingly evident over the last decades. In Sweden, this development is reflected in various ways, e.g. in the issuing of new legislation, requiring public authorities at all levels to perform risk and vulnerability analysis within their respective sector or area of responsibility, and furthermore to develop plans and make preparations for the management of potential forthcoming unwanted events (SFS, 2003, 2006a, b).

The challenges related to planning and preparedness activities have been extensively debated in the literature. For instance, the balance between preventive measures and preparedness activities have been discussed (McEntire, 2005; Pelfrey, 2005), and several suggestions on what could be called “sound principles” of emergency and crisis preparedness have been put forward (Perry and Lindell, 2003; Alexander, 2005). In these concepts, knowledge about the hazards and potential unwanted events facing a community is of importance when making

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preparations for the management of future potential emergencies and crises. However, several authors have argued that, particularly when discussing the concept of crisis in a complex system like a human society where the inherent level of uncertainty is vast, the possibility of anticipation is limited (Boin and Lagadec, 2000; Boin, 2004; French and Niculae, 2005; Gundel, 2005) thus generating a need for strategies of resilience, which is often referred to as developing a capacity to absorb, respond to and recover from harmful events[4]. Another interesting discussion on this topic, although more directed to risk evaluation and management is presented by Klinke and Renn (2002). Furthermore, McConnell and Drennan (2006) contribute with an excellent discussion on various "tensions" between the "ideals" of crisis preparedness and the realities of a crisis. Despite the fact that it is difficult to anticipate harmful scenarios in complex systems, we take the position that knowledge about the potential hazards a community is facing, in conjunction with a notion on what values one wants to protect from harm should to the extent possible be sought and used as input to emergency and crisis planning and preparedness.

The overall objective of the work which this paper is based on is to gain knowledge about how input from risk and vulnerability analysis work can come to better use in planning, preparing for and managing unwanted events in society. The final aim is to develop a framework for analytical input to the emergency preparedness process at the local, municipal level. It is a common notion in the crisis and emergency management literature that crisis management is predominately a local affair (Boin et al., 2003; Perry and Lindell, 2003; Alexander, 2005). For instance, according to Boin et al (2003) the trend in designing emergency management structures is to build them from the bottom up: local authorities begin to deal with disaster, regional and national authorities offer assistance. In this paper, the objective is to present some approaches we have used in practice in a Swedish municipality and some results and conclusions drawn from this work.

The case study

In 2006 a case study was carried out in a Swedish municipality with approximately 23 000 inhabitants (for full project report in Swedish, see Abrahamsson and Johansson (2007). A series of workshops and interviews with representatives from various actors in the municipality were conducted during the study, which consisted of three connected parts; a broad scope hazard identification and analysis, an assessment of potential assistance needs should any of the hazards materialise and finally a mapping of important actors and dependencies. The three parts of the study are presented in more detail in the following sections.

Broad scope hazard identification and analysis

As mentioned above, knowledge about the hazards and potential unwanted events facing a community is of importance when trying to prepare for future emergencies and crises (Perry and Lindell, 2003; Alexander, 2005). In this part of the study, our aim was to be able to make a structured, comprehensive identification of potential risk scenarios facing the municipality, and in this endeavour we found the framework provided by Kaplan and colleagues in the form of an operational definition of risk based on systems theory very useful (Kaplan and Garrick, 1981; Kaplan, 1997; Kaplan et al., 2001). In this framework, when the system under analysis behaves as intended, it follows the "success scenario" S_0. To determine the risk in the system one needs to find all the scenarios (or at least the important ones) that deviate from S_0 and leads to unwanted consequences (of significance), i.e. the risk scenarios, S_i, and further to estimate their respective probabilities (L_i) and consequences (X_i). Another way to put this is that one needs to find the answers to the questions: "What can go wrong?", "How likely is it?" and "What are the consequences?" (Kaplan, 1997). In order to make use of the

[4] Wider conceptions of the term resilience, including anticipation and prevention of harmful events, have been presented; see for instance Leveson et al. (2006).

framework one needs to generate an understanding of what constitutes S_0 in the system of interest. This in turn requires a notion of what is included in the system and of its boundaries, something that is well known to have major influence on the results of an analysis.

In this study, the system of interest was the whole municipality with its inhabitants, technical infrastructure, industry, administrative functions, etc. To make an explicit, detailed description of what constitutes S_0 in such a complex system is a task of monumental proportions. In this particular study, our approach was to define S_0 as any scenario that does not generate negative consequences (above a specified level) in any of a number of predefined consequence categories[5]:

- Life and health
- Environment
- Economy
- Living- and functioning conditions
- Democratic and legal values

The category "Life and health" has to do with whether a risk scenario may result in fatalities, people being severely injured or ill, people in need of health care etc. The category "Environment" encompasses the environmental impacts a risk scenario could bring about in geographical and temporal sense, the possibilities of recovery etc. The economic impact refer to short term as well as long term effects on the whole "system" i.e. effects for the municipality's inhabitants, industry and trade and societal functions are considered. Further, the category "Living- and functioning conditions" has to do with the proportion of inhabitants and/or trade and industry that have their living conditions and/or prerequisites to function in a normal fashion considerably complicated or ruined. Finally, the category "Democratic and legal values" refers to the extent to which an unwanted event could result in defiance against democratic principles, society's laws and regulations etc. A starting point for the identification and analysis was that the focus should be on unwanted events with consequences of severe magnitude, i.e. only scenarios resulting in significant consequences in any or several of the above categories were assessed explicitly, while identified scenarios scoring low in all consequence categories were omitted. This will be further discussed in relation to issues of completeness below.

For every consequence category a five level scale was constructed in order to enable rough estimates of potential consequence levels in the different categories that a risk scenario might generate. For each level a short description of the corresponding consequences was made. An example regarding the consequence category "Life and health" is presented in table 1 below.

Table 1. Example of consequence scale for the attribute "Life and health"

	Life and health – consequence scale
1	Single fatalities and/or several severely injured and/or some ten in need of medical care
2	Several fatalities and/or some ten of severely injured and/or hundreds in need of medical care
3	Some ten fatalities and/or hundreds of severely injured and/or thousands in need of medical care
4	Hundreds of fatalities and/or thousands of severely injured and/or tenths of thousands in need of medical care
5	More than a thousand fatalities and/or tenths of thousands severely injured and even more in need of medical care

In a similar manner a five level scale regarding the expected frequency with which the different potential emergency scenarios may occur, ranging from "less than once in ten

[5] In this part of the study, a number of "basic values" important to protect from harm were defined, leading to the consequence categories given above. A sixth category, not originating from "basic values" was used in the analysis: "demand on societal resources" having to do with to what extent societal resources will be needed to deal with the effects of a specific risk scenario and whether resources from outside the municipality will be needed.

thousand years" for level 1 to "more than once in ten years" for level 5, was constructed to help evaluation of the identified scenarios.

In order to facilitate identification of potential unwanted events (i.e. the risk scenarios) the municipality might face, extensive check-lists were constructed containing support for generating risk scenarios in five different categories;

- accidents (both in socio-technological systems and materialised natural hazards),
- spread of disease,
- infrastructure/utilities breakdown/interruption,
- criminal activity (including terrorism), and
- socially induced scenarios.

During the workshops, some thirty risk scenarios (or rather "sets" of risk scenarios, see below) were identified, described and initially evaluated in terms of likelihoods and possible consequences in the categories described above. In addition to the checklists mentioned above, existing risk assessments, for instance regarding the petrochemical industry, were used as input to the identification and evaluation process. To illustrate the range of scenarios considered, some examples are given: "a large release of chlorine gas from industrial facility", "a large release of hydrocarbons from industrial facility – vapour cloud explosion", "a severe storm", "a severe epidemic", "many people are falling sick, the reason unknown", "a long-lasting (more than one week) disruption of freshwater distribution", "a long-lasting (more than one week) loss of electric power", "a long-lasting (more than one week) disruption of district heating system", "virus attacks on municipal IT-systems", and "a credible threat regarding attack on petrochemical industrial facility". For each of the identified scenarios, an appraisal of the likelihood and consequence in the predefined consequence categories (using predefined, 5-level consequence- and likelihood scales like the one in table 4 above) was made. This part of the study resulted in a comprehensive overview of the kind of events that may affect the municipality alongside with an indication of what consequences these may implicate.

Here, some comments related to the framework provided by Kaplan and colleagues mentioned above should be made. In the general definition of risk given by Kaplan et al. (2001), the set of potential scenarios in a system is by nature infinite and non-denumerable. However, for practical purposes, if one is interested in determining the (approximate) risk in a system the set of scenarios should be finite, complete, and disjoint. The first requirement can be met by "partitioning" the infinite set of scenarios, S_A, into a finite set of scenarios, S_i, where each scenario, S_i, represents an infinite subset of more detailed scenarios, S_α (Kaplan et al. 2001). For instance, in this study, the scenario "Long lasting (more than one week) loss of electric power[6]", comprises all scenarios matching that description, e.g. blackouts lasting two weeks, or three weeks, blackouts occurring during the warm summer, or during cold winter months etc., which could all lead to different consequences (and have different likelihoods). The "scoring" in the evaluation of the scenarios in the study was based on *one* representation of that scenario (or set of scenarios). The level of detail in the partitioning of the scenario space, S_A, will affect how well the approximate measure of the risk, gained though the analysis, corresponds to the "real" risk in the system.

In this study, the set of scenarios evaluated were finite (by letting an infinite set of scenarios, S_α, be represented by one scenario, S_i, as described above). The completeness requirement means that the set of risk scenarios, S_i, should in aggregate cover the scenario space, S_A. In this study, completeness was achieved, in a rather technical sense, by adding the scenario (or set of scenarios) "all scenarios not explicitly treated" to the set of risk scenarios. The reason for this was twofold. Firstly, it is an acknowledgement that all potentially important risk

[6] This scenario could in turn be seen as a subset of the scenario "Loss of power" (disruptions lasting less than a week not being explicitly included in the assessment).

scenarios in S_A (S_A being defined by the five categories of risk scenarios given above[7]) may not have been identified and evaluated yet and that future assessments should strive to identify more scenarios in the different categories. Secondly, a deliberate choice was made not to include risk scenarios with "minor" effects on the municipality in terms of consequences in the different consequence categories. For instance, power disruptions lasting less than a week were not explicitly considered in the evaluation. The third requirement; that all scenarios be disjointed, i.e. that there is no "overlap" between the scenarios cannot be said to be fulfilled in the study. For instance, there may be an overlap between the scenarios "Severe storm" and "Long-lasting (more than one week) loss of power" in the sense that the first may well lead to the other. However, since the objective is not to generate a "measure" of the overall risk in the system (municipality), but rather an extensive overview of potential risk scenarios and a rough understanding of their related consequences, this is of little importance. In the next section, this overview is used to identify and describe potential assistance needs that may evolve in the different scenarios.

Assessment of assistance needs

One starting point in this work is that the assistance needs that may arise in the affected population over time and space in an emergency situation should be a cornerstone in societal emergency preparedness, a point of view inspired by for instance the work of Buckle and Fredholm (Buckle, 1998; Buckle et al., 2000; Fredholm, forthcoming).

Based on the identification and description of emergency scenarios that was made in the previous stage, an attempt was to identify and characterise the potential assistance needs that may arise in such events. To facilitate this identification and characterisation a model was constructed based on the following categorisation of need domains: "protection of life and health", "psychosocial needs", "life and function support", "protection of property and the environment", "protection of democratic values", and "recovery", which were derived from the categorisation given by Fredholm (forthcoming).

Two workshops with representatives from various functions in the municipality were held where the emergency scenarios identified in the previous part of the study were considered in order to identify and categorise potential assistance needs in the affected population. It should be noted that discussions on for instance whose responsibility it might be to prepare for and act in order to meet a specific need were deliberately not held during the workshops. The intention was rather to generate a comprehensive overview of needs on all levels to be used as input to discussions on such matters. Some examples of results are given below:

- Protection of life and health:
  - Need for information (what happens, how to act etc?), Need to distance oneself from exposure (e.g. evacuation, vaccination, isolation of infected), Need for caretaking of injured and ill, Need for caretaking of diseased etc.
- Psychosocial needs:
  - Need for acute support for anxiety and grief, Need for information (e.g. what happens, is the dangerous situation over, how long will it continue?) etc.
- Life and function support:
  - Basic needs like food, water, lodging etc. Need for alternative societal services in case of disruptions (fresh water distribution, electric power, communications etc).
- Protection of property and the environment:
  - Need for restoration of damaged property, trade and industry facilities etc. Need for protection/restoration of environmental values etc.

[7] Potential scenarios that can not be related to any of the five categories described above falls, should they exist, "outside" of this definition completeness.

- Protection of democratic values:
  - Need for protection of equal rights of citizens in times of chaos etc.
- Recovery:
  - Need for restoration of functions of societal importance, both administrative and physical (e.g. technical infrastructures). Need for long term psychosocial support etc.

Risk scenarios and the potential needs and consequences they may result in, put demands on the capability of various municipal actors to respond to and manage such events. In the following section, a mapping of important municipal actors and their dependence on various resources etc in order to perform certain tasks related to the management or prevention of such events is presented.

Mapping of central actors and dependencies

In order to facilitate an analysis of the municipality's emergency management capabilities, an effort was made to identify *actors* (i.e. an organisation or part of an organisation) of central importance in potential emergency scenarios. Furthermore, the respective *tasks* of critical importance that each actor might perform were identified and described alongside with the necessary *resources*, in terms of for instance personnel and artefacts required to perform a certain task. Finally the actors' dependence on service from various *technical infrastructures*, other *actors* etc in order to be able to perform a certain task was mapped out. Thus the following kinds of elements were considered in the survey:

- *Actors*, e.g. Health care and Rescue services.
- *Tasks,* e.g. to fight fires or to operate the district heating system.
- *Resources* (in addition to technical infrastructures), e.g. vehicles and population directories.
- *Technical infrastructures*, e.g. roads, power distribution system, sewer system.

The objective of this part of the study was to assess the dependencies between an actors' capability to perform a certain task and the access to resources, technical infrastructures and other actors performing certain tasks that might influence this capability. This was done using two measures of dependence relationships: the *occurrence* of dependence, i.e. how often does the dependence occur, and the *strength* of dependence, i.e. how severely is the actors capability to perform a certain task affected when for instance a certain resource, ”normally” used to perform this task, is unavailable. The approach is presented in more detail below.

Occurrence of dependence

Sometimes, in order to be able to establish whether dependence as described above exists, a relatively detailed description of the tasks is necessary. Assume, for instance, that one task for the rescue services is "*to fight fires"*. To be able to perform this task, one can imagine that the resource "*ladder truck*" is needed for some, but not all types of fire. This could be handled in (at least) two ways. One way is to divide the task "*to fight fires"* into a number of sub-tasks of higher level of detail, e.g. *"to fight fires in high-rise buildings"* (where this dependence is likely to occur), *"to fight forest fires"* (where this dependence is not likely to occur) and so on. However, it is not always necessary to describe the tasks in more detail. Instead, one could indicate how often one estimates that the dependence occurs, which allows tasks of more general character to be assessed. This was done by using a three-level categorisation as described in table 2.

Table 2. Occurrence of dependence

	When an actor is to perform a certain task, how often is there a dependence of a certain : technical infrastructure/resource/ other actor performing a certain task
1	The dependence is always present
2	The dependence is often present (2/3 of the times)
3	The dependence is sometimes present (1/3 of the times)

Strength of dependence

All dependencies are not of equal importance for an actors' capability to perform a certain task. For example, the loss of one resource may reduce the efficiency with which a specific actor will be able to perform a certain task while the loss of another resource prevents the actor to perform the task at all. In order to achieve a rough understanding of the level of importance of the different dependencies that were identified for an actors' capability to perform a certain task a measure of strength of dependence was introduced, see table 3.

Table 3. Strength of dependence

	Effect on an actors capability to perform a certain task in case of: technical infrastructure disruption/resource unavailability/other actor not performing a certain task
A	The task is not possible to perform
B	The task is possible to perform but with severely reduced efficiency (1/3 of normal efficiency)
C	The task is possible to perform but with somewhat reduced efficiency (2/3 of normal efficiency)

To exemplify the approach let us look at the actor *fire and rescue services*. Among the tasks that were identified for the fire and rescue services were:

- Managing fires in buildings, which involves everything the emergency services does when handling fires in buildings, e.g. search and rescue and limit the spread of fire.

To be able to perform this task the actor *fire and rescue services* has resources in terms of personnel, vehicles and other equipment etcetera. The dependence on such resources alongside with dependence on technical infrastructures and tasks performed by other actors, were mapped out for each of the tasks identified for the rescue services using the measures of occurrence and strength of the dependence described above. One example of the resulting information is presented in table 4.

Table 4. Example of a task with corresponding dependencies[8].

Tasks	Resources	Technical infrastructure	Tasks performed by other actors
Managing fires in buildings – industrial buildings	Personnel, max 17 2 regular fire engines (1,A) 1 industrial fire engine (1,A) 1 Ladder truck (3,A) Foam system (1,A) 2 Hook loaders (1,A) 2 Management vehicles (1,A)	Roads (1,A) Fire hydrants (1,A) Radio communication (2, A) Mobile telecommunication (3,A) Public warning system (3,B)	Reinforcement from neighbouring municipality (1,A)

This kind of mapping was performed for municipal actors identified to have tasks important to emergency management, providing an overview of the structure of actors and resources (and dependencies) available within the municipality to meet the needs and demands arising in potential emergency scenarios. Some examples of actors included in the study were: the

[8] Numbers and letters within parenthesis represent an assessment of the occurrence and strength of the dependence; see tables 2 and 3 above.

rescue services, health- and geriatric care, the office of energy and the environment, the municipal district heating company and municipal schools.

Discussion

The objective of this study was to apply an approach to generate analytical input to emergency preparedness planning in a case study at the local, municipal level. The approach is based on a systematic and comprehensive identification of the broad range of potential hazards and risks facing the municipality. This feature of the approach, i.e. the objective to identify and analyse risk scenarios originating from a very broad spectrum of risk and hazards sources, a process facilitated in the approach by predefined categories and checklists, is one of the major points. We find that in many existing practical approaches to analytical input to preparedness activities, the focus is mainly on one or a few types of hazard, sometimes to a large extent based on previous experience. We claim that in adopting a broad scope in terms of hazard and risk scenarios considered in an analysis, the municipality has a better platform for comprehensive preparedness planning activities. One could argue that there are two sides to that coin, in that it is a time and resource (in terms of personnel) consuming activity. The response from the municipality under study indicates however, that the advantages were considered to be worth the extra effort, in that the participants gained a better knowledge of the total spectrum of risks facing the municipality, and that they were able to identify and discuss potential unwanted events that they had no experience of beforehand. The second major point of the approach used is the explicit, structured identification and description of potential assistance needs that may arise given a specific risk scenario, a process facilitated in the approach by a model based on a number of predefined domains of assistance needs. On a general level, the information obtained from these two parts of the study could be used by municipality officials, planners and politicians as one input to reasoning about for instance the distribution of responsibility to meet identified needs, identification of areas in needs of improvement, identification of education and training needs, resource allocation issues etc.

The third part of the study was more focused on the structure available for meeting potential consequences and needs, in terms of important actors and their dependencies on various resources, technical infrastructures and coordination with other actors. The information obtained from this kind of work could also be used by the municipality as input to the assessment of the capabilities of the different actors to meet the needs generated by various risk scenarios. The issue of being able to describe and evaluate such capabilities in a structured manner is discussed by Jönsson et al. (2007), where an operational definition of the term emergency response capability is given.

All parts of the study are tightly connected in the sense that information generated in one stage can be (and were) used as input to the others. To exemplify, information from the mapping of actors and dependencies can be used as input to the assessment of potential consequences that may arise in identified emergency scenarios (which will be dependent on the capabilities of the actors to meet the needs and demands generated by the event). The other way around, the identification of potential emergency scenarios and the related assistance needs may generate input regarding “new” tasks that need being managed by one or several actors. In this sense, the approach with the three interconnected parts can be seen as a circle of feedback and feed forward loops of information.

It may also be a point that the kind of inter-organisational workshops that were conducted during the study, with representatives from many different administrative units within the municipality, could assist in building professional networks. Such networks have proved to be of importance in the management of emergencies and crises, see for instance Uhr and Johansson (2007).

Conclusions

We have demonstrated an approach that can be used to focus the emergency preparedness efforts undertaken in a municipality on the various needs that may arise should any of the hazards facing the municipality materialise. The approach consists of three parts; starting with an identification effort where the potential hazard scenarios that the municipality is facing are mapped out. The next part of the approach focuses on the identification and description of different needs that may arise if any of the hazard scenarios identified should materialise. In the third part the actors responsible for meeting those needs are identified, and furthermore an analysis of what the different actors are dependent on, in terms of resources, technical infrastructures etc.., in order to be able to meet the needs is conducted. We argue that in using the suggested approach one creates a suitable foundation for emergency preparedness planning which is based on the spectrum of hazards relevant to the specific municipality in question and on the range of specific needs that may arise in that municipality as a consequence of any of the hazards materialising.

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SIMULATION-BASED INFORMATION SYSTEMS FOR MULTI-HAZARD RISK ASSESSMENT AND NEAR REAL TIME LOSS ESTIMATIONS DUE TO STRONG EARTHQUAKES

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Multi-hazard risk assessment, earthquakes loss estimations in "emergency" mode

Abstract

The paper addresses the questions most frequently raised by risk managers: what is the likely outcome (consequences) of future natural and technological disasters, as well a strong earthquake just occurred. It suggests simulation models and procedures for estimating the potential impact of negative events in terms of life and property losses. The paper is providing the results of multi-hazard and seismic individual risk assessment and mapping for the territories of the Russian Federation at national and regional levels with Extremum family systems' application, as well as near real time damage and loss assessment due to strong earthquakes at global scale.

Introduction

Natural and technological disasters are becoming more frequent and devastating. Social and economic losses due to negative events increase annually, which is definitely dealt with evolution of society. In order to save lives and protect property against future events the urgent measures should be taken. Disasters' preparedness of population and Civil Defense professionals, development of preventive measures plans, as well as rapid response systems should be improved. Assessment of loss due to earthquakes and other hazardous processes of natural and technological character are of primary importance in evaluating potential scope of the disaster just occurred as well as in estimating and mapping multi-hazard risk at different levels. The paper addresses the simulation models for shaking intensity distribution, damage to buildings and structures, number of fatalities and injuries, which are used in Extremum family systems assigned for these purposes, as well as procedures for multi-hazards risk assessment. It analyses the influence of uncertainties, as well as that of intrinsic methods applied, on the reliability of estimations obtained with the systems' application.

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Simulation Models' description

The section describes the models for seismic hazard, vulnerability, damage and casualties estimates. All simulation models bring in their own uncertainties and propagate the uncertainties of the previous steps of the estimation procedure. Actually, the problems of accuracy are considerably more complex than it is suggested in the previous sentence; in addition, to the classical behavior of uncertain input data through each step of the procedure, the simulation models introduce biases of which influence on the final results is not easy to assess; this cannot be thoroughly discussed here.

Estimation of shaking field

Data about event source parameters are input for computation of probable shaking field, in terms of "intensity". Authors understand that the previous sentence could be very much misleading; by definition, intensity describes formally an observed state of a set of artifacts which have undergone damage caused by an earthquake; it cannot, *a priori*, be "computed"; furthermore, it takes conventional values in the form of integers (it is "scale"), a decimal value being meaningless (at the most, an observer can hesitate between two integer values to assign, what is sometimes rendered as a half-grade. The "intensity" referred to here is of somewhat different nature: it stems from a regression analysis between "true intensity" and measured acceleration (when available, which is not often the case); in a way, it can be considered as an interpolated value of acceleration between two consecutive "true intensities" empirically converted into accelerations. Authors follow the traditional way of expressing the shaking; no doubt that progresses are badly needed to improve the situation and think in terms of true acceleration responsible for the damage observed.

The formula used is taken from Shebalin (1968).

$$I = bM - \nu\, lg \sqrt{\Delta^2 + h^2} + c \tag{1}$$

where Δ - epicentral distance (km); h - source depth (km); M - magnitude.

Coefficients in the formula are estimated taking into account empirical data. They are estimated by Shebalin and given for the former USSR regions in (New…, 1977).

More general generalization of attenuation law parameters for Europe are given by the report (Earthquake..., 1998). The coefficients proposed for the Southern and Northern parts of the Central and Southern Europe are listed in Table 1.

Table 1. Macroseismic field coefficients for the Central and Southern Europe by (Earthquake …, 1998)

Region	***b***	***ν***	***c***
Southern part $\varphi \leq 47^\circ$ N	1.5	4.0	3.8
Northern part $\varphi > 47^\circ$ N	1.5	3.5	3.6

For other territories, these coefficients may be derived from statistical analysis of available data sets; one could alternatively use the average values: 1,5; 3,5; 3 proposed by Shebalin.

Vulnerability functions for buildings/ Fragility laws

In the present situation both concepts of fragility and vulnerability are used by authors. Vulnerability may be estimated through physical and economical domains. Physical vulnerability is an index, which characterizes the loss of functional properties of the considered structure. It may be estimated as a ratio between the expected number of damaged buildings of a certain type due to earthquakes with intensity *I* and total number of buildings belonging to this type. Economic vulnerability for buildings of different types is characterized by ratio between the cost of repair and the initial cost of construction (Larionov et al., 2003a, 2003b, 2006).

In the Extremum family systems the fragility laws are used for different building types classified according to MMSK-86 scale:

- buildings' types A1, A2 (from local materials);
- buildings' types Б, Б1, Б2 (brick, hewn stone or concrete blocks);
- buildings' types В, В1, В2 (reinforced concrete, frame, large panel and wooden);
- buildings' types C7, C8, C9 (designed and constructed to withstand the earthquakes with intensity 7, 8, 9)

The fragility laws are understood as the dependence-ships between the probability of buildings belonging to different types to be damaged and the intensity of shaking in grades of seismic scales. The laws are usually constructed on the basis of statistical analysis of strong earthquakes engineering consequences.

There are two types of laws: the probability P_{Ai} (I) of damage state not less than given value and probability P_{Bi} (I) of definite damage state. The normal law is used for construction the curve approximating the probability P_{Ai} (I). The hypothesis about the normal law was checked with application of Kolmogorov-Smirnov criterion.

When constructing the fragility law, it is taken into account that buildings may suffer after earthquake any damage state (from d = 1 up to d =5), namely a building after earthquake may prove to be undamaged (event *B0*), to experience slight damage (event *B1*), moderate damage (event *B2*), heavy damage (event *B3*), to be partially destroyed (event *B4*), to be completely collapsed (*B5*). In order to estimate the parameters of the normal laws the representative statistical data set, which includes events occurred in the second part of XX – beginning of XXI centuries in Russia, Uzbekistan, Turkmenistan, Romania, Moldova, Armenia, Georgia and other countries, was used. The values of mathematical expectation M of earthquake intensity in grades of MMSK-86 intensity scale, which result in building damage state not less than given value, are given in Table 2. The values of mean square deviations of intensity vary from 0.4 up to 0.5.

Table 2. Averaged expected intensity of earthquakes in grades of MMSK-86 scale, which will result in different damage states of buildings

***Buildings types according to* MMSK-86**	***Buildings damage states d***				
	Light d=1	***Moderate d=2***	***Heavy d=3***	***Partially destroyed d=4***	***Completely collapsed d=5***
A1, *A2*	6.0	6.5	7.0	7.5	8.0
Б1, *Б2*	6.5	7.0	7.5	8.0	8.5
B1, *B2*	7.0	7.5	8.0	8.5	9.0
C7	7.5	8.0	8.5	9.0	9.5
C8	8.0	8.5	9.0	9.5	10.0
C9	8.5	9.0	9.5	10.0	10.5

When determining the probability P_{Bi} (I) of definite damage state the theorem about the total group of events is taken into account

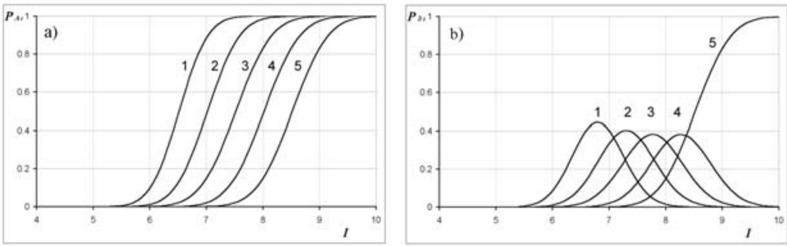
$$\sum_{i=0}^{5} P_{Bi}(I) = 1 \qquad (2)$$

The probability P_{Bi} (I) of definite damage state of buildings is estimated by the relationship

$$P_{Bi}(I) = P_{Ai}(I) - P_{Ai+1}(I) \qquad (3)$$

where P_{Ai} (I) - probability that buildings will suffer the damage state not less than state i; P_{Ai+1} (I) - probability that buildings will suffer the damage state not less than state i+1. The fragility laws for the buildings of *B* type, constructed with taking into account the characteristic normal laws parameters given in Table 2 and σ = 0.4 – 0.5 are shown in figure 1.

Fig. 1. Fragility laws for *B* type buildings (MMSK-86)
a – probability of damage state not less than given value; b – probability of definite damage state; 1, 2, 3, 4, 5 – buildings damage states



Building stock from earthquake prone area to another one is so varied (material, mode of construction) that one can wander about the validity of any averaged fragility laws (vulnerability functions). And, in principle, it is desirable to rely on regional data sets when constructing the fragility laws (vulnerability functions), but relevant data are not available for all earthquake prone areas either because engineering data on consequences of strong earthquakes are not accessible or simply do not exist.

In Table 3 the example of regional fragility law is given. The parameters of normal laws for the region around the lake Baikal, Siberia were estimated on the basis of data available in the Regional Scale of Seismic Intensity for this area (РШСИ-2000). The value of mean square deviations of intensity for all types of buildings is equal to 0.5.

Table 3. Averaged expected intensity of earthquakes in grades of MMSK-86 scale, which will result in different damage states of buildings

Buildings types according to РШСИ-2000	***Buildings damage states d***				
	Light d=1	***Moderate d=2***	***Heavy d=3***	***Partially destroyed d=4***	***Completely collapsed d=5***
A, *C5*	6.2	7.0	7.8	8.6	9.4
Б, *C6*	6.4	7.4	8.4	9.4	10.4
B, *C7*	6.7	8.0	9.1	10.1	11.0
C8	7.3	8.7	9.8	10.7	11.3
C9	8.3	9.5	10.4	11.2	11.5

Besides fragility laws (vulnerability functions) Extremum system simulation models allow to construct damage probability matrices for different buildings types also based on empirical data. The information about earthquake engineering consequences gained after separate events, as well as statistical data of international and regional seismic intensity scales may be used for estimating the probability of definite damage state. These matrices also should be of regional type in order to take into account the peculiarities of existing building stock for the country under consideration. The Table 4 shows the probabilities of damage states equal to 5, 4 and 3 estimated with different empirical data sets: extended statistical data about strong earthquakes consequences in CIS and other countries; empirical data in EMS-92 and information about the behavior of 32,548 buildings of 15 structural types gathered in 41 towns after the 1980 Irpinia earthquake (Chavez et al., 1998).

The probabilities of damage state *d*=5 estimated with usage of EMS-92 scale and data set in Chavez et al. (1998) are less in comparison with the values based on extended data set for the events occurred in CIS and other countries. This fact gives evidence about more vulnerable building stock in the latter countries. The maximum deviation in probabilities to survive damage states *d*=5, 4 and 3 providing the same intensity reaches 40 %. Moreover the building stock is evolving (ageing, maintenance): monitoring is needed. In practice this is barely taken into account in computing the averages.

Table 4. Probabilities of definite damage states in the case of the event intensity *I*=8

***Buildings types according to* MMSK-86**	***Source of information about damage to buildings***								
	Reports and publications about events consequences in CIS and other countries			***EMS-92***			***Chavez et al., 1998***		
	***d*=5**	***d*=4**	***d*=3**	***d*=5**	***d*=4**	***d*=3**	***d*=5**	***d*=4**	***d*=3**
A	0.50	0.34	0.09	0.11	0.45	0.14	0.10	0.34	0.35
Б	0.20	0.37	0.30	0.00	0.10	0.32	0.01	0.34	0.20
B	0.02	0.14	0.34	0.01	0.05	0.14	0.00	0.13	0.13
C7	0.01	0.02	0.14	0.00	0.01	0.06	0.00	0.02	0.03
C8	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.01	0.00
C9	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Vulnerability of population/ Laws of earthquake impact

Vulnerability of population to seismic action of a given intensity is understood here as the ratio between the expected fatalities and the total number of persons living in a certain type of buildings. In order to estimate the mathematical expectation of fatalities and injuries within the built environment the laws of earthquake impact on population are used. They are understood as the dependence-ship between the probability to be killed or/and injured and the intensity of shaking in grades of seismic intensity scales.

The parametric laws of earthquake impact on people inside buildings are constructed on the basis of analysis of empirical data about social losses during past strong earthquakes with taking into account the theorem about the total group of events. When computing the laws, it is assumed that the event C_k (total number of social losses, irrevocable and sanitary losses) may occur providing that the building survived one of the damage states (at one of the hypothesis B_i forming the total group of incompatible events).

Fatalities and missing are referred to irrevocable losses. Sanitary losses include all people who need medical treatment. The sum of sanitary losses and irrevocable ones are called total losses. The structure of sanitary losses takes into account three level of impact: extremely heavy injured, heavy injured and slightly injured. Social losses are computed according to

$$P_{Ck}(I) = \sum_{i=1}^{5} P_{Bi}(I) \cdot P(C_k | B_i) \tag{4}$$

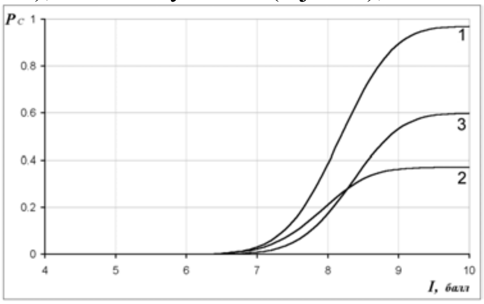
where $P_{Ck}(I)$ — probability of people to be impacted during the earthquake with intensity I; $P_{Bi}(I)$ — probability of definite i damage state of buildings providing the given value of earthquake intensity; $P(C_k|B_i)$ — probability of people to survive k level of impact under the condition that the building survived the damage state i. The values of $P(C_k|B_i)$ are obtained on the basis of processing of empirical data about social losses due to past events in the CIS and other countries during the last about 50 years (table 5).

Table 5. Probability of population to be affected for different damage states *d* of buildings

Social losses C_k	***Probability of population to be affected at damage states of buildings***				
	Light d=1	***Moderate d=2***	***Heavy d=3***	***Partially destroyed d=4***	***Completely collapsed d=5***
Total	0	0.01	0.11	0.6	0.97
Irrevocable	0	0	0.02	0.23	0.6
Sanitary	0	0.01	0.09	0.37	0.37

The laws of earthquake impact on population inside buildings of *B* type, which are constructed with use of Table 6, are shown in fig. 2.

Fig.2. Laws of earthquake impact on people inside *B* type buildings: 1-total social losses (total number of casualties); 2- sanitary losses (injuries); 3- irrevocable losses (fatalities)



In Table 6 the probabilities of population to be affected against the seismic intensity *I*, which are obtained with usage of the equation (4) and Table 5, are shown.

While computing expected social losses the empirical data about the population migration during day time, as well seasonal variations should be taken into account.

Table 6. Probabilities $P_{Ck}(I)$ of population to be affected inside buildings of different types against seismic intensity

Buildings types according to **MMSK-86**	***Social losses***	***Intensity in grades of MMSK-86 scale***						
		6	**7**	**8**	**9**	**10**	**11**	**12**
A	Total losses	0.004	0.14	0.70	0.96	0.97	0.97	0.97
	Irrevocable losses	0	0.05	0.38	0.59	0.6	0.6	0.6
Б	Total losses	0	0.03	0.39	0.90	0.97	0.97	0.97
	Irrevocable losses	0	0.01	0.18	0.53	0.6	0.6	0.6
B	Total losses	0	0	0.14	0.70	0.96	0.97	0.97
	Irrevocable losses	0	0	0.05	0.38	0.59	0.6	0.6
C7	Total losses	0	0	0.03	0.39	0.90	0.97	0.97
	Irrevocable losses	0	0	0.01	0.18	0.53	0.6	0.6
C8	Total losses	0	0	0.004	0.14	0.70	0.96	0.97
	Irrevocable losses	0	0	0	0.05	0.38	0.59	0.6
C9	Total losses	0	0	0	0.03	0.39	0.90	0.97
	Irrevocable losses	0	0	0	0.01	0.18	0.53	0.6

Individual risk assessment and mapping at different levels

The above described simulation models are used within the framework of the Extremum family systems for estimating the individual seismic risk R_s or the probability of death (or injuries) due to possible earthquake within one year in a given territory. Seismic risk may be determined through mathematical expectation of social losses $M(N_j)$ with taking into account the number of inhabitants *N* in the considered settlement and probability of seismic event *H*

$$R_s = H \cdot V_s\left(I\right) = H \cdot M(N\ )/N \tag{5}$$

where $V_s(I)$ – vulnerability of population for the considered settlement; *H* – probability of seismic event per one year; *N* – the number of inhabitants in the considered settlement.

The mathematical expectation of social losses *M*(*Nj*) for the considered settlement taking into account inhabitant migration in the buildings of *j* type during the day and night is determined by equation

$$M(N_j) = \sum_{j=1}^{n} \iint_{S_c} \int_0^{24} \int_{I_{\min}}^{I_{\max}} P_{Cj}(I) \cdot f(x,y,I) \cdot \Psi_j(x,y) \cdot f(t) dIdtdxdy \tag{6}$$

where I_{min} и I_{max} – maximum and minimum possible earthquake intensity; S_c – settlement area; n – number of considered building types according to MMSK-86 scale; $P_{Cj}(I)$ – probability of fatalities and injuries under the condition of damage to buildings of j type due to earthquake with intensity I; $\psi_j(x,y)$ – density of population distribution within the considered area in buildings of j-type; $f(x,y,I)$ – density function of earthquakes' intensity probabilities within the unit area with coordinates x , y; $f(t)$ – function obtained on the basis of statistical analysis of data on population migration during 24 hours.

The multi-hazard individual risk R_e may be estimates as

$$R_e = 1 - \prod_{i=1}^{n} (1 - R_{ei}) \tag{7}$$

where n — number of considered emergency situations of natural and technological origin; R_{ei} — individual risk due to i-th emergency situation.The individual risk computations with simulation models' application may be carried before and just after the event in near real time. The reliability of loss and risk estimations strongly depends on different issues, but the most important ones are the databases on population and building stock distribution, as well as regional vulnerability functions of various elements at risk and regional shaking intensity attenuation laws (Bonnin et al., 2002a, 2002b, 2004; Chen Yong et al., 2001; Frolova et al., 2006). When computations are done at different levels: facility level, urban, regional, country or global one, the proper databases should be developed taking into account the end user requirements about the details of expected results.

Examples of seismic and integrated risk assessment and mapping at national and regional levels with System Extremum application are shown on fig. 3 and 4. In order to make computations of individual seismic risk for the whole Russian Federation territory and the Krasnodar area a lot of data about population distribution and existing building stock was compiled and analyzed. Table 7 presents the general information about existing building stock in the Krasnodar area.

Table 7. Averaged characteristics of existing building stock for the Krasnodar area

Building type (MMSK-86)	***City model***		***Town model***		***Village model***	
	Portion	***Height, m***	***Portion***	***Height, m***	***Portion***	***Height, m***
A	0.33	6	0.43	4	0.58	4
Б	0.45	15	0.48	6	0.39	6
B	0.14	21	0.08	9	0.02	7
C7	0.08	16	0.01	12	0.01	10

Class and location of settlements were taken from Russian topographic maps of scale 1: 200 000 published by MTS, 1970-1999, and verified according to the administrative maps of Russian Federation of scale 1:500 000…1:3000 000. On the whole the information about 250 000 cities/ towns and villages were used for risk computations at national level.

The information about seismic hazard was taken from the review maps of seismic zonation of the Russian Federation territory OSR-97A, B, C. The maps show the seismic intensity I which may occur in a given area within the time interval equal to 50 years with probability of exceedence equal to 10% (OSR-97A), 5% (OSR-97B) and 1% (OSR-97C).

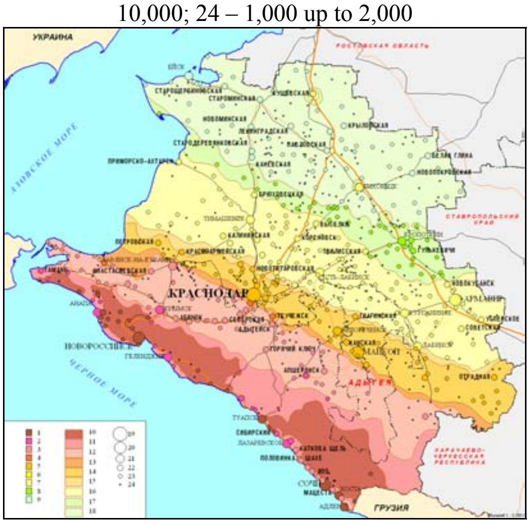
The obtained values of individual multi-hazard risk for the Russian Federation (fig. 3) vary from negligible ones up to $50.0 \bullet 10^{-5}$ and higher.

Fig. 3. Zonation of the Russian Federation territory according to the level of multi-hazard risk;
risk R_e , 10^{-5} 1/year categories: 1- more than 50; 2 – 20 up to 50; 3 – 5 up to 20; 4 – 1 up to 5; 5 – 0.5 up to 1; 6- 0.2 up to 0.5; 7 - 0.1 up to 0.2; 8 –less than 0.1. Values of risk for the cities with population more that 50 000 people, R_e , 10^{-5} 1/year: 9 – more than 50; 10 – 20 up to 50; 11 – 10 up to 20; 12– 5 up to 10; 1 up to 5; 13 – 1 up to 5; 14 – 0,5 up to 1; 15 - less than 0,5. Number of inhabitants: 16 –1,000,000 and more; 17 - 500,000 up to 1,000,000; 18 – 200,000 up to 500,000; 19 – less than 200,000

The following risk R_e , 10^{-5} 1/year categories are identified: extremely high (> 50); rather high (20-50); high (10 – 20); average (5 – 10);- moderate (1 – 5); insignificant (0,5 –1); low (< 0,5). The highest values of risk are typical for settlements in Sakhalin, Kuril Islands, Kamchatka, near Lake Baikal, Altai-Sayan region and Northern Caucasus. In these regions the main contribution to risk value is made by natural disasters. The highest values of risk due to technological accidents are typical for cities: Bratsk, Novokuzketsk, Yurga, Kemerovo, Norilsk, Dzerzhinsk, Orsk, Tol’yati, Nizhnij Tagil, Pervouralsk, Magnitogorsk, Chelyabinsk. In these regions the special measures should be implemented to reduce the risk level.

The results of seismic risk computations for the Krasnodar region are presented in fig.4 by signs (circles of different size and color) for cities and by hypsometric layers for small settlements with number of inhabitants less that 1,000 people.

Fig. 4. Zonation of the Krasnodar area according to the level of individual seismic risk taking into account secondary technological accidents;
risk R_e , 10^{-5} 1/year categories: 1- more than 30; 2 – 25 up to 30; 3 – 20 up to 25; 4 – 15 up to 20; 5 – 10 up to 15; 6- 5 up to 10; 7 - 1 up to 5; 8 – 0.5 up to 1; 9 - less than 0.5. Values of risk for the cities with population more that 50 000 people, R_e , 10^{-5} 1/year: 10 – more than 30; 11 – 25 up to 30; 12 – 20 up to 25; 13– 15 up to 20; 14 – 10 up to 15; 15 - 5 up to 10; 16 - 1 up to 5; 17 – 0,5 up to 1; 18 - less than 0,5. Number of inhabitants: 19 – more than 500,000; 20 - 100,000 up to 500,000; 21 – 50,000 up to 100,000; 22 – 10,000 up to 50,000; 23 – 2,000 up to 10,000; 24 – 1,000 up to 2,000



Obtained values of seismic risk for the Krasnodar area (fig. 4) vary from negligible values up to rather high ones equal to $40.2 \cdot 10^{-5}$. The high values of risk are obtained for the Novorossijsk city, Tuapse and Lazarevskoe towns, as well as for Krasnodar city, Sochi and Adler towns. On the whole for more that 40 % of the Krasnodar region territory the value of seismic risk computed taking into account the secondary technological processes exceeds value equal to $1.0 \cdot 10^{-5}$.

Earthquake loss estimations in “emergency mode” at global scale

Different Extremum family systems are used for expected loss assessment due to strong earthquake at global scale. Since August, 2000 the system version is used in order to provide quick information on damage and casualties assessment of strong earthquakes all over the world within the framework of EUR-OPA Major Hazards Agreement Program EDRIM (Electronic Discussion for RIsk Management).

Procedure of expected damage and loss assessment in “emergency mode” includes:

1. The information about the earthquake parameters (origin time, epicenter coordinates, depth, magnitude) is received by e-mail messages or taken automatically from Web sites of Seismological Surveys: Geophysical Survey of Russian Academy of Sciences (GS RAS), European Mediterranean Seismological Center (EMSC), National Earthquake Information Center of USGS (NEIC), and occasionally national agencies, such as Kandilli Observatory and Earthquake Research Institute (KOERI), Japan Meteorological Agency (JMA), Japan Weather Association (JWA) and others;

2. Computations of expected damage extent, social and economic losses due to earthquakes and identification of the effective response measures;

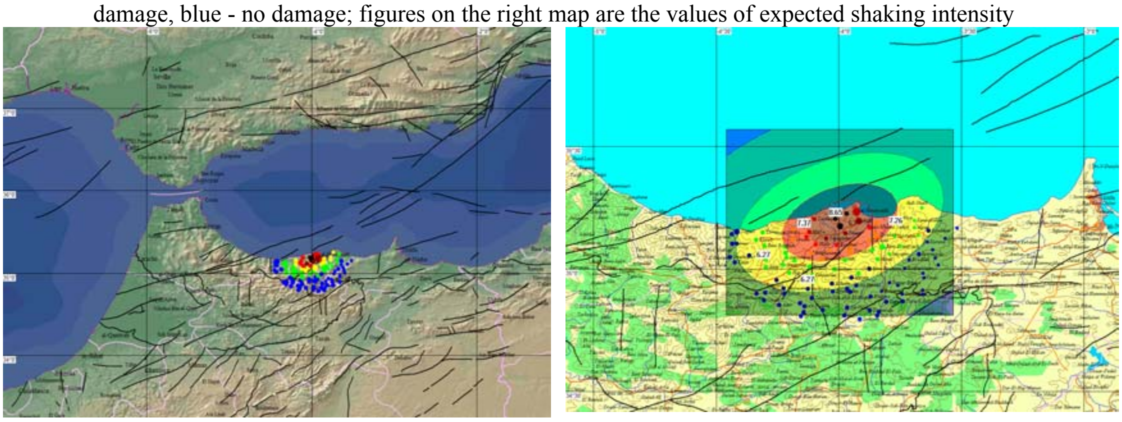
3. Expert estimation of the obtained results with the knowledgebase about past events application;

4. Taking a decision about expected consequences estimation;

5. Dissemination of messages about expected damage and losses.

The results of computations are usually presented as maps and tables, where estimations of expected number of fatalities, injuries and homeless are given for the whole stricken area and for each settlement. Figure 5 shows maps with the results of expected damage and loss computation for the earthquake occurred on February 24, 2003 in Morocco with Extremum System application. By dots of different size and color are shown the settlements in the stricken area; the dot size stands for the number of inhabitants, the dot color stands for the average damage state of the buildings. In the given example the computations were made for the following event parameters: Latitude - 35,190N; Longitude - 3,996W; Depth - 2 km; Magnitude - 6,1 (Taj-Eddine Cherkaoui et al., 2004).

Fig. 5. Results of possible losses assessment due to February 24, 2004 earthquake in Morocco in different scales; dots are settlements in the stricken area; colour of dots stands for the average damage state of building stock: black -total collapse, brown - partial collapse, red - heavy, yellow -moderate, green - slight damage, blue - no damage; figures on the right map are the values of expected shaking intensity



The results of expected damage and loss estimations strongly depend on the input event parameters determined by Seismological Surveys in "emergency" mode. Figures 6a, b show the patterns of expected damage distribution in the case of the Bam earthquake occurred in Iran on December 26, 2003, which were obtained with the using NEIC data (fig. 6a) and IIEES data (fig. 6b). Underestimation of expected damage was related mainly with unreliable depth determination (it was given as 33 km by GS RAS and NEIC and revised on December 27, 2003) and with scatter in event location (Table 8). According to the information published on July 22, 2004 at the ***ReliefWeb*** site the Iranian authorities revised the number of dead from December 26 quake, which Bam officials had earlier said killed 43,000. The event location made by IIEES (assumed to be the most accurate) and focal depth estimation by Reconnaissance Team (Eshghi et al., 2003) allowed to obtain the estimation of expected number of casualties close to reported one (Table 8).

Table 8. Expected consequences due to the Bam earthquake on December 26, 2003

Survey	***Coordinates***	***M***	***h, km***	***Expected fatalities***	***Expected injuries***
NEIC	58.27 N; 29.01 E	6.7	33	18-221	110-1,008
NEIC, Significant Earthquakes	58.311 N; 28.995E	6.6	10	5,538-22,337	14,933-40,904
EMSC	58.34 N; 29.05 E	6.8	30	1,201-6,939	2,751-18,661
GS RAS	58.38 N; 29.24 E	6.8	33	417-3,168	1,247-10,776
IIEES	58.38 N; 29.08 E	6.5	13.2	6,795-25,035	19,085-38,122
IIEES	58.38 N; 29.08 E	6.5	8$^{*)}$	11,022-35,394	33,067-40,831

$^{*)}$ (Eshghi. et al., 2003)

Fig. 6a. Results of possible losses assessment due to December 26, 2003 earthquake in Iran with usage of NEIC event parameters

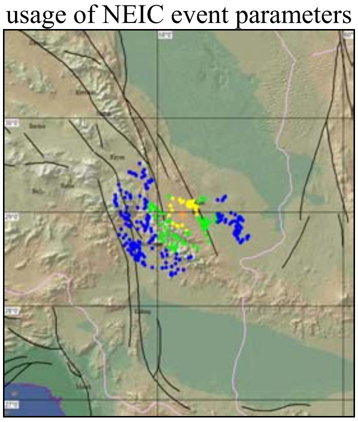
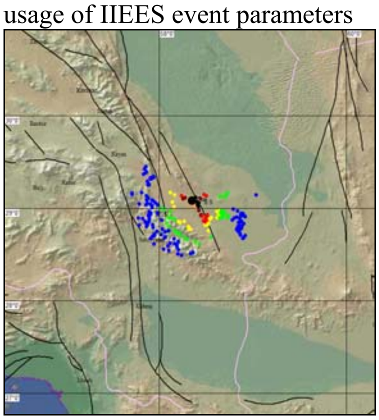


Fig. 6b. Results of possible losses assessment due to December 26, 2003 earthquake in Iran with usage of IIEES event parameters



Taking into account the scatter in expected number of casualties obtained with using different event parameters determined by Seismological Surveys in "emergency" mode, the role of experts should be mentioned. Expert knowledge and/or knowledgebase about past events in the stricken area may help to make a proper choice between the estimations on expected damage and loss obtained with the Extremum System application.

The analysis of results of computation on expected damage and loss by expert team definitely allows to increase the reliability of estimations, which will be transferred to decision makers. But it will take additional time and may result in about one hour delay.

Besides the errors in event parameters determinations by Seismological Surveys, there are other factors which influence on reliability of expected damage and loss assessment in "emergency" mode with the Extremum System application. Between them the main factors are the following:
• completeness and reliability of databases on elements at risk (population and built environment) and hazard sources;
• reliability of vulnerability functions for different elements at risk due to earthquakes and other secondary hazards;
• lack of access to confidential sources of information. damage and casualties to be estimated with the error, which does not exceed 60%.

Some of these factors may be taken into account at the expense of the System calibration with usage of knowledgebase about well documented past strong earthquakes mentioned before (Frolova et al., 2003a, 2003b; 2006) and high-resolution space images application in order to verify the data on buildings' inventory in earthquake prone areas. The only factor, which can't be compensated by the system calibration, is the influence of the discrepancies of events location by different Alert Seismological Surveys. More than six years experience of the Extremum family Systems' operation showed that in practice one of the Surveys provides the input data, which allows expected damage and casualties to be estimated with the error, which does not exceed 60%.

Conclusions

The present paper gives the description of simulation models for shaking intensity distribution, seismic vulnerability of different elements at risk, as well as methodological procedures for seismic and multi-hazard risk assessment with application of the Extremum family systems.

The examples of the System application for different purposes: near real time damage and loss assessment at global scale, as well as multi-hazard risk assessment for the Russian Federation territory and seismic risk estimation for the Krasnodar region taking into account technological accidents triggered by strong earthquakes are given.

On the whole, application of Extremum family systems for expected loss and risk assessment at different levels showed good and less good things for many reasons. In future many refinements should be introduced in order to avoid existing limitations in simulation models and databases on population and built environment distribution.

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Dr. Valery Larionov is a Vice General Director of Extreme Situations Research Center. He has contributed to research on emergency response since 1972. He is an expert in assessment and management of natural and technological risk; organization of management and response to emergency situations; industrial safety, assessment and management of seismic risk. At present he has conducted researches on expected losses assessment due to natural and technological hazards and emergency management with GIS technology application. The Russian Federation government awarded Dr. Valeri Larionov, along with others, the prizes in 1999 and 2001 for the work on development of the Russian Federal system for monitoring and forecast of emergency situations.

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DEVELOPING AN EARTHQUAKE LOSS ESTIMATION TOOL – HAZTURK - FOR TURKEY

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Keywords

HAZTURK, MAEviz, Consequence Based Risk Management, Earthquake, Loss Estimation

Abstract

The increasing interest in computer-based seismic risk and loss assessment systems imposes new research requirements on the earthquake engineering community. Such systems are being used for the important purposes of disaster response planning and formulating risk reduction policies. Their accuracy and reliability are therefore fundamental to the success of these mitigation measures. The ingredients of seismic loss assessment are hazard (exposure), vulnerability or fragility (sensitivity), inventory (value) and integrated visualization (losses). This paper describes the components of seismic loss assessment developed, implemented and assembled for the city of Istanbul.

To reach the maximum reliability on the loss assessment results the input data should also have the maximum quality, since the results of the loss assessment based on the inputs. To get the most reliable results from the software for a new region, the best available data are required. The best available data for the city of Istanbul is the data of the Zeytinburnu District. This selection provides the best results for the loss estimation of the buildings with respect to the accuracy of the building attributes.

Before starting the loss assessment process for the region first, the previous works or studies were reviewed. The main topics for those previous studies are determined as hazard, fragility and inventory. For the hazard part available attenuation relations for Turkey, are investigated and compared based on the available earthquake scenarios for the city of Istanbul. At the fragility part, a new method named as parametrized fragility method (PFM) which is proposed by (Jeong and Elnashai, 2006), is used for deriving the fragility relationships for Istanbul buildings. At the inventory part, data for the study area Zeytinburnu -a district of Istanbul- are collected, processed and refined.

Introduction

Increasing possibility of the Istanbul Earthquake also increase the needs of a seismic loss assessment for the city of Istanbul. This project aims to accomplish a seismic loss assessment for the buildings of the Istanbul. Leading seismic loss assessment software around the world are only capable of use for the country that they were developed for. To be able to use this kind of software for another country with different administrative units, different ground motions, different vulnerabilities, and different inventories requires a huge effort, and the results may not be as good as needed. The deficiencies are based on the different geographic systems and datum used in different countries. These differences lead to big errors of distance, area, and angle calculations. For example, if we take into consideration the attenuation relationships to calculate the accelerations on the study area, the inputs are the magnitude of the expected earthquake, the soil types, and the shortest distance from source to the site. The error on the distance cause enormous errors on acceleration values at the site, which causes big differences on loss estimation and mitigation process. The use of HAZTURK software for Istanbul case includes the use of Turkish datum, administrative units, regional attenuations and strong motions.

Thesis

The approach for the study is CRM also known as Consequence Based Risk Management, which is developed by the Mid-America Earthquake (MAE) Center. "CRM paradigm provides a philosophical as well as a practical framework for the assessment of the dynamic inter-disciplinary relationship between causes, effects and effectmitigation, response and recovery features of major event or disaster management, and links seamlessly with new Major Incident Management (MIM) approaches being developed and applied in other fields. Social Sciences and Information Technology are also major components of the CRM Framework, as well as the Engineering Engines. These three components define the hazard and the consequences as seen in Figure 2. In Figure 1, the 'Consequences' are all effects of earthquakes (or indeed any other form of natural or manmade hazard - incidents) on society, including engineering, social and economic impact. 'Consequence-Mitigation' refers to all measures of reducing the consequences of hazard events. The latter includes conventional measures of retrofitting of engineered systems, as well as network hardening, social impact reduction measures and land-use management alternatives. The MAE Center approach couples 'Decision-Making' and 'Visualization' so as to provide the decision- and policy-maker with a vivid environment for informed decisions. This approach provides an exceptionally effective framework for loss assessment in the service of mitigation, response and recovery. It is also suitable for planning research, education and outreach in a systematic and transparent fashion." (UIUC MAEC, 2006)

Figure 1

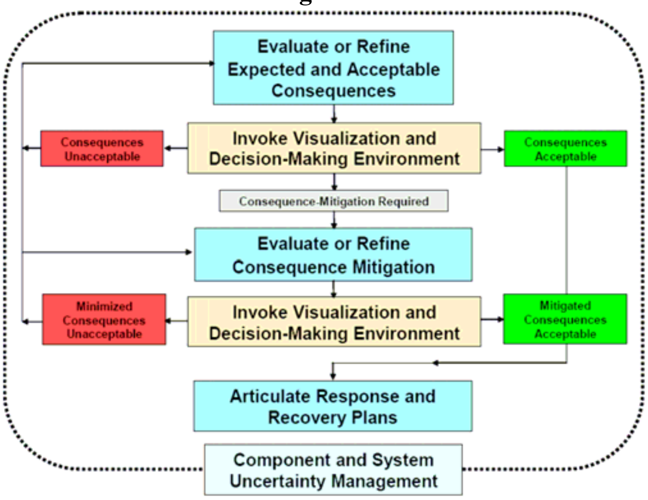
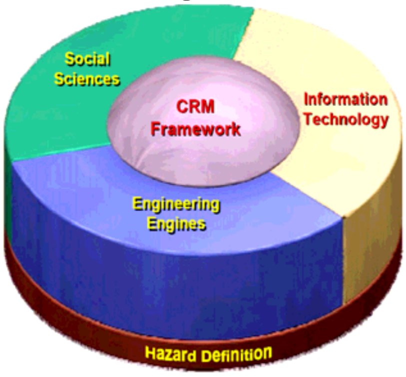


Figure 2



Based on the CRM approach the seismic loss assessment study is divided into three parts. Based on these parts the outline of the study will be explained except the fragility part.

<u>Hazard</u>

The loss estimation depends on the acceleration of the ground motion with respect to magnitude, distance, soil conditions and topography. There are two type of approaches for the attenuation relations for Turkey. The first one is to adopt the attenuation relations of the Northwest America because of the similarity on the faultlines of the San Andreas and North Anatolia. The second one is to create new attenuation relations for Turkey by using only Turkish strong motion records or both strong motion records around the world and Turkey. There are six attenuation relations given in Table 1 which can be used for the loss estimation process of Istanbul.

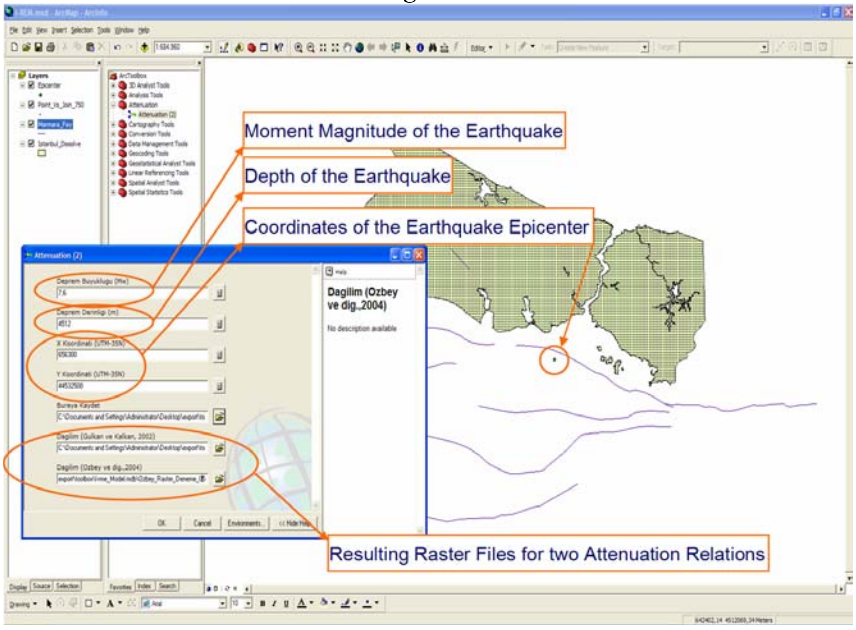
Table 1

Attenuation Model	Ground Motion Parameter	Distance Type	Site Conditions
Kalkan & Gülkan (2004)	PGA & PSA	Horizontal Dist. To Rupture	Rock, Soil, Soft Soil
Özbey et al., (2004)	PGA & SA	Horizontal Dist. To Rupture	Hard Rock, Rock, Dense Soil, Stiff Soil
Ulusay et al., (2004)	PGA	Dist. To Epicenter	Rock, Soil, Soft Soil
Boore et al., (1997)	PGA & SA	Horizontal Dist. To Rupture	$V_{S,30}$
Fukushima et al., (2003)	PGA & SA	Site to Fault Plane Dist.	Rock, Soil
Sadigh et al., (1997)	PGA & SA	Horizontal Dist. To Rupture	Rock, Deep Soil

The attenuation relations which are used within the first approach are, (Boore et al., 1997), (Sadigh et al., 1997), (Fukushima et al., 2003). These models, excluding the Fukushima et al., 2003, which were derived both using both North American, Japanese, Turkish and Western Eurasian records, are derived by using the North American strong motion records, including some other records around the world and Turkey. The second approach is used by; (Kalkan and Gülkan, 2004), (Özbey et al., 2004), (Ulusay et al., 2004), is mainly using the Turkish strong motion records. But, because of the lack of enough data, those models include the records around the world.

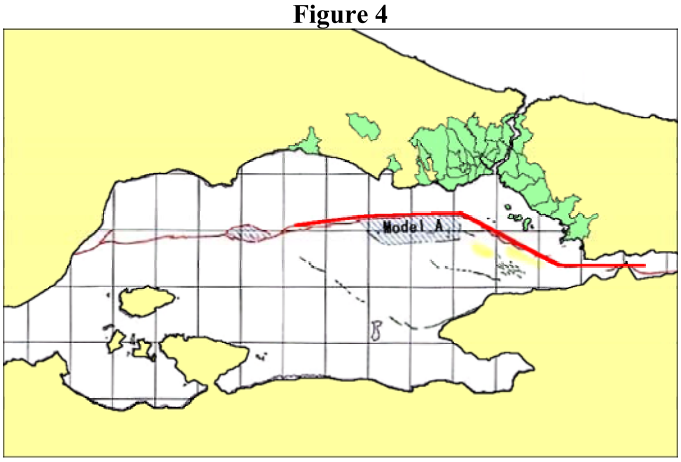
A deterministic approach is followed in selection of the attenuation relations. The most possible earthquake scenario is applied to all attenuation relations using the ArcGIS 9.1 Geographic Information System software. A model created by (Unen, 2006) is used to evaluate and compare the candidate attenuation relations. The model was built to generate the acceleration values for Istanbul based on the (Kalkan and Gulkan, 2002) and (Ozbey et al., 2004) attenuation relations for each point in every 750 meters. See Figure 3. The model is edited and improved to include different distances and different soil types, which are used to derive the accelerations.

Figure 3



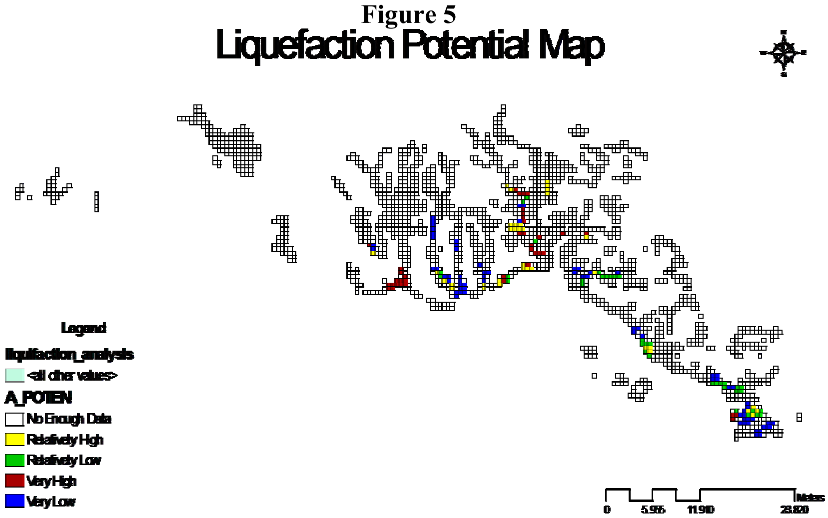
There are four different earthquake scenarios for the expected earthquake in Istanbul, which were constituted by the JICA study team and published in 2002 as a report (JICA, 2002). The most possible one is named as Model A. "Model A is break on the eastern section of the fault line. This section is about 120 km long from west of 1999 Izmit earthquake fault to Silivri" as shown in the Figure 4. This model is the most probable model of these four scenario earthquakes because the seismic activity is progressing to the west. The moment magnitude (Mw) is assumed 7.5" (JICA, 2002).

Figure 4



Another hazard parameter for earthquake is the liquefaction. "Excessive hydrostatic pore water pressure during earthquakes leads to the loss of stiffness and strength of soils. They behave, therefore, as viscous fluids rather than as solids. Liquefaction takes place generally in loose saturated sand deposits. Its effects on structures are devastating. The liquefied material initiates lateral-spread slides or leads to loss of bearing capacity under foundations. This depends on the depth and thickness of the liquefied zone and local topography. Excessive pore water pressures cause sand boils on the ground." (Elnashai and Di Sarno, 2007) Liquefaction susceptibility is also taken into account for the study. However, the data for liquefaction is not enough for the whole city of Istanbul as it can be seen in Figure 5, the white cells indicate the areas with no data available.

Figure 5



The effect of the topography on ground motions in earthquakes is also considered in the study. The city of Istanbul has many hills (see Figure 6) and this may amplify the ground motions during the earthquake. As it can be seen from the previous earthquakes, hills and mountains amplificate the ground motion drastically (Table 2). However, the effect of the pure topography couldn't represented good enough. The studies on the effect of topography generally underestimates the amplification at the top of the mountains and hills (Geli L., et al., 1988). There are also no design codes availables except the Eurocode-8 Part-5, which take into consideration the effect of the topography (Paolucci R., 2002). That is why, the (Eurocode 8, 1994) and (Paolucci R., 2002) are taken into account for this study.

Figure 6

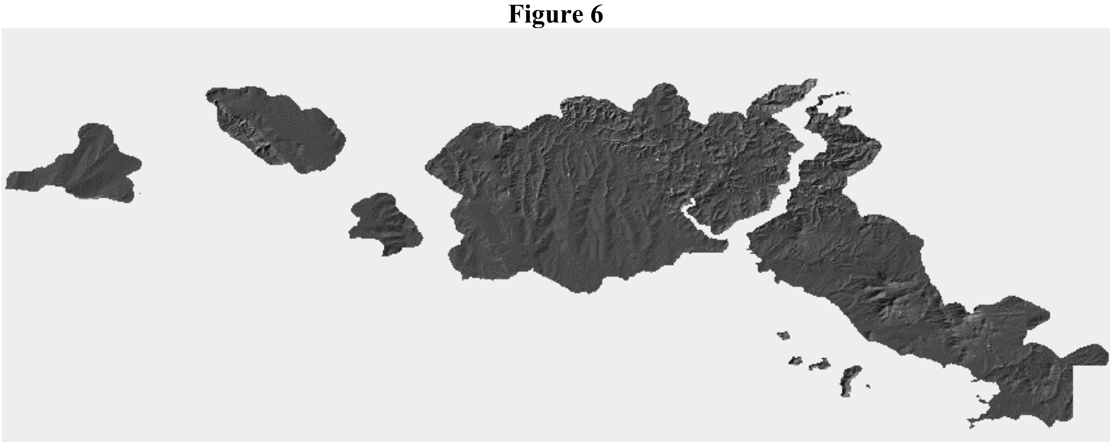


Table 2 (Paolucci, 2002)

Earthquake	Date	Type of Observation
Lambesc (France)	1909	Macroseismic
Friuli (Italy)	1976	Macroseismic
Irpinia (Italy)	1980	Macroseismic
Chile	1985	Macroseismic/Instrumental
Northridge (California)	1994	Instrumental
Umbria-Marche (Italy)	1997	Macroseismic/Instrumental
Egion (Greece)	1995	Macroseismic

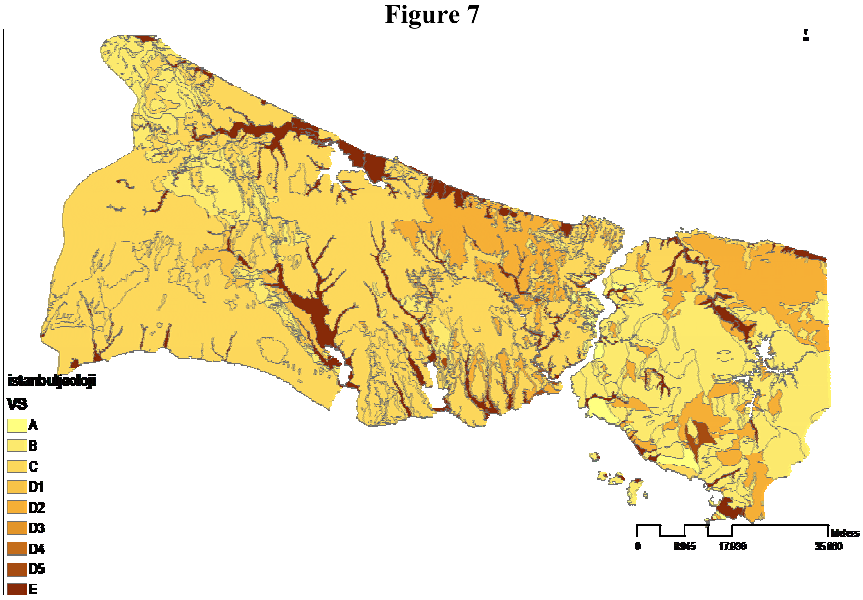
Athens (Greece)	1999	Macroseismic

Most of the attenuation relations uses NEHRP ground classifications (Table 3), which is based on the shear wave velocity values of the site. For this study the NEHRP site classes were used to create a ground classification map of Istanbul in Figure 7. The ground classification map is used for creation of the acceleration maps of Istanbul for the candidate attenuation relationships.

Table 3

Site Class	Average S Wave Velocity Over Upper 30m
A	>1500m/sec
B – B0	760 - 1500m/sec
C – C0	360 - 760m/sec
D – D0	180 - 360m/sec
D1	300 - 360m/sec
D2	250 - 300m/sec
D3	220 - 250m/sec
D4	200 - 220m/sec
D5	180 - 200m/sec
E	<180m/sec

Figure 7



With respect to those attenuation relations mentioned above at the hazard section, the hazard maps of peak ground acceleration, spectral acceleration at a number of key periods were created. All the attenuation relations were run for a M_W=7.5 earthquake with a 10 km depth, and the PGA values were compared for each earthquake.

Inventory

The building data for Zeytinburnu District is being used for the study. The data is derived from the Istanbul Metropolitan Municipality. The attributes are important for the loss assessment process of the buildings. The attributes of the building data must include the features listed in Table 4. The more the attribute we have about the study area inventory, the more accuracy we get on the assessment.

The data classification and format is another big issue in the process. A unique set of records must be ingested as the inputs and a unique set of data must be the outputs. According to this approach the data classification and format for the study and the software is generated and given in Table 5.

Table 4

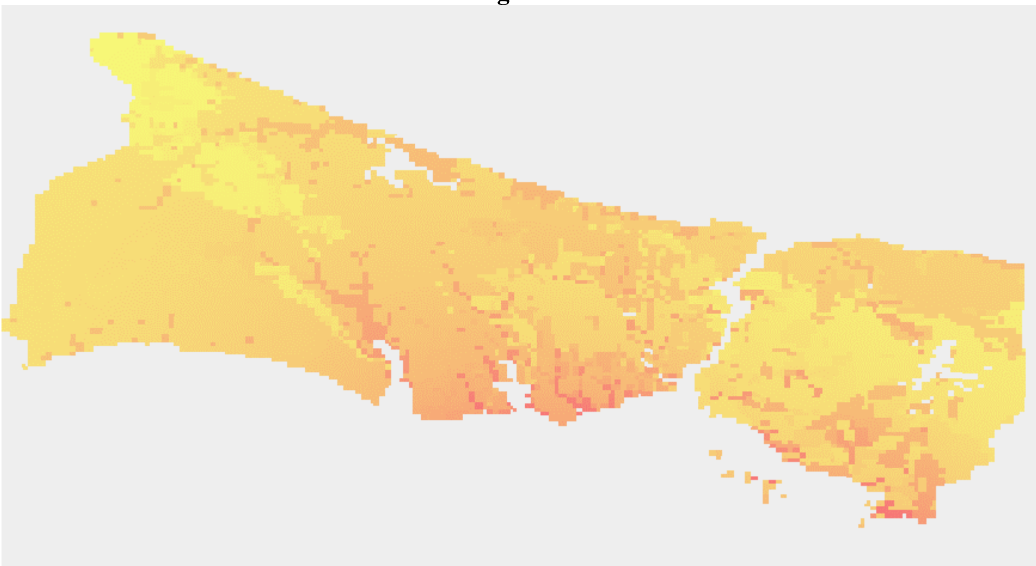
Data Model for Building Inventory										
ID	Structure Type	Number of Storeys	Construction Year	Occupation Type	Essential Facility	Dwelling Number	Square Meter (m2)	Building Value	Content Value	Address
Data Model for Geology Inventory										
ID	Geology	Area	Perimeter							
Data Model for Ground Classification										
ID	Soil Type	Area	Perimeter							
Data Model for Boundary Inventory										
City Boundary										
ID	City_ID	District_ID								
Distrcit Boundary										
ID	City_ID	District_ID	Sub-district_ID							
Sub-distrcit Boundary										
ID	City_ID	District_ID	Sub-district_ID							
Data Model for Attenuation Relations										
Coefficient Table for the Attenuation relations										

Table 5

Dataset	Data Format	Extension	Data Type	Coordinate System	Datum
Hazard	ASCII Raster	*.asc, *.txt	ASCII	GCS*	WGS84
Building	ArcGIS Shape file	*.shp	Nokta	GCS*	WGS84
Geology	ArcGIS Shape file	*.shp	Poligon	GCS*	WGS84
Topography	ASCII Raster	*.asc, *.txt	ASCII	GCS*	WGS84
Boundary	ArcGIS Shape file	*.shp	Poligon	GCS*	WGS84
Attenuation	Tablo	*.csv	Tablo	GCS*	WGS84
Others	ArcGIS Shape file	*.shp	Çizgi, Nokta, Poligon	GCS*	WGS84
Mapping	XML	*.xml	XML	GCS*	WGS84

The tool will have the ability to generate the acceleration values for the study are, based on the characteristics of the regarding attenuation relation. This creates the need for ground classification, geology, topography inventory as an input. The resulting dataset gives the acceleration map in raster format as seen in Figure 8.

Figure 8



Sources of Information

JICA's study on Istanbul (JICA, 2002) is reviewed and the useful data and models are taken into consideration for the study. Four different models were found in the JICA report, which are developed according to the breaks on the fault line at the Sea of Marmara. Those scenarios were named as Model A to Model D. It is also indicated in the JICA study report that the most possible scenario is the Model A. That is why, the model A taken into account as the scenario, while the attenuation relationships were compared.
There are other previously generated models reviewed for loss estimation, which are carried out by two different research teams, named as, Kandilli Observatory and Earthquake Research Institute (KOERI, 2002), and the Earthquake Master Plan for Istanbul prepared by the Bogazici University, Istanbul Technical University, Middle East Technical University and Yıldız Technical University (IMM, 2003), which used the JICA study data and KOERI software.

Findings and Discussion

All the attenuation relations were run for a M_W=7.5 earthquake with a 10.0 km depth, and the PGA values were compared for each relationship. The results are given in the Table 6.

Table 6

Attenuation Model	**Site Categories (m/s)**				**Acceleration Values**			
	Soft Soil	**Soil**	**Rock**		PGA_{min}	PGA_{max}	PGA_{mean}	σ
Kalkan & Gülkan (2002)	V_S=200	V_S=400	V_S=700		0.073	0.542	0.168	0.060
Kalkan & Gülkan (2004)	V_S=200	V_S=400	V_S=700		0.474	1.725	0.823	0.184
Ulusay et al., (2004)	V_S=200	V_S=400	V_S=700		0.079	0.632	0.262	0.092
	Stiff Soil	**Dense Soil & Soft Rock**	**Rock**	**Hard Rock**				
Özbey et al., (2004)	$180 \leq V_S \leq 360$	$360 < V_S \leq 760$	$760 < V_S < 1500$	$V_S \geq 1500$	0.051	1.843	0.196	0.168
	Class C	Class B	Class A					
Boore et al., (1997)	$180 \leq V_{S,30} \leq 360$	$360 < V_{S,30} \leq 750$	$V_{S,30} > 750$		0.059	0.681	0.148	0.076
for Geometric Mean					0.053	0. 599	0.132	0.068
	Rock							
Sadigh et al., (1997)	$V_S \leq 750$				0.048	0.639	0.177	0.099

Fukushima et al., (2003)	**Soft Soil**	**Medium Soil**	**Hard Soil**	**Rock**	1.863	2.636	2.245	0.158

Next Generation Attenuation Models from the Pacific Earthquake Engineering Research Center, are also going to be applied for the loss assessment tool. The developing tool will give the option to choose the attenuation relation to the user. The ongoing work is on the fragility generation for the Turkish building inventory. The fragilities will be derived by using the Parametrized Fragility Method. Idealized systems are analytically subjected to suites of ground motion representing a particular scenario that the loss assessment is to be carried out for. Once stiffness, strength, and ductility are known, analytically-based probabilistic fragility relationships are derived without further simulation. This method is proposed by (Jeong and Elnashai, 2006).

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TRANSPORT SAFETY

OPPORTUNITIES AND CHALLENGES FOR CONFIGURABLE SENSOR NETWORKS FOR ENABLING EFFECTIVE FIRE-IN-TUNNEL RESPONSE

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Networks, emergency response, fire, tunnel, stakeholders, UCD

Abstract

Recent fires and resulting casualties in major road tunnels have highlighted the need for both better safety precautions and the need for a more effective emergency response during an incident. More complete, accurate and relevant information during an incident can increase the effectiveness of the response by the emergency team. Although traditional sensor networks (eg those detecting smoke or fire or enabling data transmission) can help supply information, they may be susceptible to damage and are relatively inflexible. The dynamic reconfiguration of sensor networks provides an opportunity to increase the quality of the information environment at a fire in tunnel (or other disaster) situation. This reconfiguration can include: switching between wired and wireless links to mitigate physical network damage; repurposing of sensor nodes to change what they sense or how quickly they report; introduction of new mobile gateways for self repair of network damage; and the integration of multiple mobile sensor networks (eg personal sensors worn by emergency crew, or those introduced by autonomous robots).

The effectiveness of this reconfiguration is determined by the extent to which it supports the needs of the emergency response team during a fire in tunnel incident. A series of field studies was undertaken to identify both opportunities and challenges in this respect. Particular opportunities for enhancing the information environment were: providing a capability to 'see' through the smoke; accounting for vehicle occupants during an incident; managing hazardous goods; tracking the movement of emergency workers; monitoring of the tunnel infrastructure; and transmitting advance information to fire crews. However, there were also some potential barriers, including: scepticism of emergency teams due to concerns over reliability, cost,

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maintenance and false alarms; the reliance on existing visual information at scene; the needs of a hierarchical and clearly defined command, control and operational structure; and the individual and collective responsibilities during an incident. The implications for network reconfiguration are discussed.

Introduction

Recent disasters, including flooding, fire and explosion, have highlighted potential for loss of life, and the need for an effective emergency response to these disasters. Although in many cases the initial incident may not be preventable, a fast and effective strategic response by the emergency services can minimise loss of life and damage.

Road tunnels are a good example of where safety features can be incorporated to (1) reduce the likelihood of incidents occurring, (2) minimise the likelihood of minor incidents turning into major disasters, and (3) assist the emergency services when responding to an incident. There are several recent examples of fires in road tunnels where there has been loss of life, for example the Mont Blanc road tunnel in 1999 where 39 people died.

There are various operational conditions that are typical stressors on firefighters during an incident such as a fire in tunnel, including ambiguous and incomplete information, particularly during the early phases on an incident (Danielsson, 1998, Danielsson and Ohlsson, 1999). It may not be clear what the nature and extent of a incident is, how many casualties or potential casualties are involved, where potential escape routes are, and what further risks are present.

Embedded sensor networks have the potential to enable a better state of ‘preparedness’ prior to any incident, provide an early and reliable alarm if an incident does occur, and support a more effective response by the emergency services throughout the course of an event. A broad definition of sensors is used to describe the ability to describe or measure absolute and relative properties or attributes of entities within an environment. For a tunnel environment, this would therefore include measurement of physical properties such as heat and smoke levels, the nature and location of dynamic entities such as vehicular traffic and personnel in the tunnel, visual data such as CCTV images (visible or IR spectrum), and data that allows the placement of these entities and attributes on a ‘map’ of the incident.

There is currently much interest in providing real-time information to emergency responders during an incident. For example the FIRE project (http://fire.me.berkeley.edu/about_fire.htm) is applying and designing new technologies such as wireless sensor networks (WSNs) and small head-mounted displays (HMDs) for firefighting in order to compliment existing and proven methods of firefighting.

However, the data that can be supplied to emergency teams is dependent on a robust sensor network. During the course of an incident, there is likely to be damage to networks which can render fixed networks inoperable. Fire in tunnel incidents have demonstrated the catastrophic impact on emergency responders of the technical failure of systems. In addition, since incidents are highly dynamic and often unpredictable, fixed sensor networks may not offer the flexibility needed as an incident develops.

There are a number of implications for sensor networks that are effective within a fire in tunnel (or indeed other) emergency scenario. They should be robust to cope with a demanding environment and adaptable to support dynamic needs. This implies networks that:

- are ‘self healing’ when damage occurs
- can be reconfigured to alter what they measure or how they report data
- can be scaled up or down successfully as sensors leave or join the network
- are able to operate within a highly heterogeneous environment (eg different kinds of fixed, mobile and embedded sensors, different operating systems)

Current constraints to creating these robust, ubiquitous and heterogeneous networks are largely software related. In particular, there is a lack of a consistent, generic programming platform that enables the creation of these networks.

The RUNES project (www.ist-runes.org/) is addressing the issues above. It is a large-scale European technology development project, the aims of which are to provide the software platforms and development tools to enable the creation of reconfigurable networked embedded system.

To demonstrate the potential benefit of advanced sensor networks, a fire in tunnel scenario is being used – it is a challenging environment where dynamic information provision is critical to effective emergency management (ie being in a state of 'preparedness', incident response and 'post mortem'). A key part of the project has been to understand the requirements of the stakeholders involved in emergency management within a fire in tunnel: the technological development within the project is therefore being married to a user-centred design approach. This paper summarises key technological features, and describes opportunities to impact on stakeholders concerned with emergency response.

Technology overview

The RUNES EU funded project is focused on the creation of software tools that will enable the construction of systems which create or utilise existing large heterogeneous networks of computing devices. The devices may range from single function sensors such as temperature or light, up to full multifunction workstations with extensive resources and computational power. The networks may range from large fix wire communication systems to local wireless connectivity such as Bluetooth. More detailed explanation can be found in Coulson et al., (2006).

At a general level, RUNES addresses four key aspects of a heterogeneous, embedded sensor network:

Autoconfiguration: The automatic configuration of devices without manual intervention, without any need for software configuration programs or jumpers. Ideally, auto-configuring devices should just "Plug and Play".

Configuration: The setting of the parameters of a device provided through the device's interface for achieving a desired behaviour in the operational range of the device.

Preconfiguration: The configuration of devices either in advance of their deployment or in advance of a scenario actually developing, using whatever manual intervention is necessary.

Reconfiguration: The ability of a system to change its configuration on the fly; either in response to particular commands given manually, or in a semi- or fully-autonomous manner to achieve a particular mission critical objective - which might vary from reporting information in an accurate or timely way to maintaining connectivity.

Within a specific application context, the network configurations outlined above provide a range of basic capabilities to a stakeholder within a particular environment:

1. Maintaining the integrity of the data within an information environment
2. Providing additional information to the information environment or widening the information environment
3. Changing the purpose of the information environment to suit specific needs
4. Optimising the efficiency and functions of the information environment

From a user's perspective, an advanced sensor network acts to supplement, maintain or enhance an information environment. However, the underlying technology will be relatively transparent to an end user (eg tunnel manager, control room operator, emergency response team or tunnel user).

Theory and method

This article is written from a user-centred design perspective, eg. Preece et al., (2002). Although it discusses potential technologies, the underlying interest is in determining the potential impact of technologies on one or more end users. Effective technologies need to impact positively on user outcomes – ie consistent with a 'realised value' outcome from an information science perspective, as described by Ahituv et al., (1998).

A series of field visits were undertaken to understand opportunities for advanced sensor networks to impact on a fire in tunnel incident. This data collection was based on a review of tunnel fire incidents and safety initiatives (eg UPTUN: Cost-effective, Sustainable and Innovative Upgrading Methods for Fire Safety in Existing Tunnels, http://www.uptun.net/), interviews with stakeholders and field visits to four different road tunnels: the Øresund bridge/tunnel link between Denmark and Sweden; the Mont Blanc tunnel between France and Italy; the Kent (UK) Dartford and Medway tunnels; and the Elbe tunnel in Hamburg.

During these visits, a variety of user needs were discussed with tunnel health and safety managers, operations managers and fire service commanders who had specific responsibility for responding to incidents in those tunnels. The following is a summary of opportunities and challenges that arose from these discussions. 'opportunities' are used to describe where there are relatively unequivocal benefits to stakeholders, 'challenges' describe where there are potential benefits but concomitant challenges to successful introduction.

Results – *opportunities* for advanced sensor networks

Opportunity #1 'Seeing' through the smoke

Problem summary: Smoke in the tunnel is always treated as a major incident as it presents the greatest threat to personnel in a tunnel when there is a fire. However, smoke in the tunnel quickly renders the CCTV that is used by the tunnel Operators useless. Even 'white' smoke from car engines that seldom leads to a fire obscures the CCTV and causes extreme visibility problems for tunnel occupants, tunnel supervisors and emergency workers. In addition to the obscuration due to smoke, it can be difficult to identify the nature of smoke, and track its rate of progress.

Proposed technological solution: The use of networked embedded technologies to distribute and maintain the transmission of data acquired from location sensors during system damaging scenarios; to enhance the information by the integration of more location sensors; enable the incident (including objects) to be sensed or 'seen' when all visual capability is lost through smoke propagation.

Usability (operational) aspect: To impact on operational goals of situation assessment and response, including casualty rescue.

Stakeholder feedback: This capability of 'seeing' in the smoke was suggested by both health and safety fire commander stakeholders and may be their greatest need if there was a serious incident. There are some solutions available (eg infrared helmets that fire fighters can use) but they are expensive, are infrequently needed, and are another piece of equipment that must be carried and maintained.

Opportunity #2 Managing hazardous goods

Problem summary: There is a lack of information on hazardous goods travelling through the tunnel. This has implications for safety management, regulation compliance and emergency response.

Proposed technological solution: The use of electronic tagging of cargos and/or intelligent hazard plates that can be read by sensor networks. The use of networked embedded technologies to distribute and maintain the transmission of data acquired from electronic tags relating to the type and quantity of hazardous goods being carried through the tunnel,. The integration of the cargo sensors into the wider tunnel network.

Usability (operational) aspect: There are three distinct uses for this information – (1) strategic goods transportation risk assessments based on accurate and complete historical data; (2) accurate identification of hazardous goods (conformance) during normal operation; (3) emergency response (preliminary and ongoing situation assessment) during a fire in tunnel or other incident.

Usability (operational) aspect: Impacting on operational goals of risk reduction (pre-incident), preparedness, and situation assessment.

Stakeholder feedback: This issue was particularly pertinent to the individuals with health and safety responsibility. Tunnel management will typically ban the passage of certain hazardous goods, and limit the passage of other hazardous goods to night time when the traffic levels (and hence risk) are lower. A variety of approaches are used, ranging from escorting hazardous goods, limiting their passage, pre-entry vehicle checks and relying on self-compliance with regulations in place. A constant concern is that drivers are either unaware of the nature of their cargoes (especially for mixed loads), are unaware of the restrictions put in place, or even actively flout the restrictions by temporarily removing the hazard plates to allow unrestricted passage. At one tunnel, where hazardous goods passage was restricted to the night time, the tunnel operators discovered 10-20 lorries a month with hazardous cargoes travelling during the daytime. However they were well aware that there were others with plates on that they didn't discover, and others without plates that were deliberately flouting the passage regulations for hazardous goods. More accurate data on the types, frequencies and travel patterns of hazardous cargoes would enable better planning of restrictions for this traffic (eg diversion of hazardous cargoes via the ferry). Automatic identification of hazardous cargoes would also enable better enforcement of the travel restrictions.

From a fire commander perspective, there was also a lack of information on hazardous goods, which could be vital for putting into place an effective response to an incident. The information on the hazard plates is used to determine an appropriate responses (eg some chemicals can explode if water is put on them!). Within tunnels, this information can sometimes be obtained from the tunnel control rook using CCTV, but this depends on the orientation of the lorry in relation to the cameras. Other options on arrival are to ask the driver or passengers, but this depends on effective communication links in the tunnel.

Opportunity #3 Tracking/managing movement of fire fighters

Problem summary: If a fire commander is not at scene, or if the incident is large or smoke obscured, it is difficult for them to direct the fire fighters for fast and effective casualty search. There may be a lack of knowledge of the physical environment (e.g. layout of building interiors), and this can also hinder the direction and movement of the fire fighters.

Proposed technological solution: The use of networked embedded technologies to distribute and maintain the transmission of data acquired from personal location sensors and virtual map of the physical environment during system damaging scenarios.

Usability (operational) aspect: Impacting on operational goals of life preservation (both from a fire fighter and potential victim perspective). Potential for increased operation effectiveness.

Stakeholder feedback: The fire commanders highlighted the need to (either personally or via someone else) control the search for people by being able to direct the movement of the fire fighters. An example would be where there are multiple teams in an incident (each with a team leader) - it is useful to be able to remotely direct them into different rooms/sectors by giving them direct navigation instructions. At the moment, fire fighter locations are determined by reference to fixed locations (eg cross passages in tunnels). The locating of firefighters is particularly problematic in large, complex and/or relatively undifferentiated environments such as cargo ships. A potential drawback is the accompanying need for accurate electronic maps of the incident showing escape routes and fixed and dynamic hazards. The most effective solution would be a sensor network that would enhance electronic maps by identifying/locating all potential victims within an incident. The fire fighters could then be actively directed towards them, whilst taking into account the physical layout of the incident.

Opportunity #4 Accounting for vehicle occupants

Problem summary: It can be difficult for tunnel operators to determine how many occupants are in cars at the scene of an accident, and keep track of them if they start leaving their vehicles. This is particularly the case when smoke obscures CCTV images.

Proposed technological solution: Tagging technologies to identify and track the number of vehicle occupants and determine whether they have remained in the vehicle or have evacuated. The use of networked embedded technologies to distribute and maintain the transmission of data acquired from personal and vehicle location sensors during system damaging scenarios.

Usability (operational) aspect: To impact on early stage situation assessment and casualty search.

Stakeholder feedback: In normal situations, affected tunnels would be evacuated before the fire services arrive. This type of sensing capability would add value in serious situations, but would be of less value during more routine incidents.

Opportunity #5 Monitoring the integrity of the tunnel infrastructure

Problem summary: The lack of real-time information on the structural integrity of the tunnel infrastructure during a fire in tunnel scenario. This could lead to a lack of confidence regarding the safety of those (casualties and rescuers) during a fire.

Proposed technological solution: The use of embedded networked technologies to distribute and maintain the transmission of data acquired from temperature sensors embedded in the tunnel infrastructure during system damaging scenarios.

Usability (operational) aspect: Impacting on operational goals of life preservation (safety of all those within the tunnel) and preservation of property.

Stakeholder feedback: Both the fire commanders and health and safety professionals described the problems associated with monitoring the structural integrity of tunnels, particularly 'iron pipe' tunnels. However, the fire cladding within tunnels will typically ensure resistance to temperatures in excess of 1000° for several hours. A potential concern is the cost and maintenance implications for a technology that may never be used.

Opportunity #6 Transmission of information to the fire crew during approach to an incident

Problem summary: The lack of information by the fire service during the early phase of an incident.

Proposed technological solution: The use of embedded networked technologies to distribute and maintain the transmission of data acquired from multiple sources. This can enhance the information environment by broadening the data distribution to the fire crews as they are approaching the incident.

Usability (operational) aspect: This may enable a quicker and more accurate situation assessment during the early phase of an incident.

Stakeholder feedback: A typical quote from a local fire commander was that on the way to an incident 'often we don't know enough …… we will always like to know more'. In theory, sending information to the fire crews (and in particular the fire commander) is useful, but mobile communications between the multiple agencies involved, and mobile data terminals generally provide sufficient information. The usefulness of this capability also depends on the duration of the journey to the incident – in many cases the local responders are situated less than five minutes away, and this limited time window reduces the potential impact of pre-arrival information.

Results – *challenges* for advanced sensor networks

Challenge #1 Introduction of new sensors into the fire in tunnel scene

Problem summary: There is a lack of information during a fire in tunnel incident. There is a need to supplement the existing information environment with sensor data, when the existing information environment is too scarce to enable situation assessment and effective decision making.

Proposed technological solution: The introduction of new assets such as sensors and sensor gateways to the scene. This could be by manual (eg distribution by hand) or by automatic means (eg self-directed robots who can optimise their position to restore connectivity). These additional assets are then integrated into existing networks.

Usability (operational) aspect: This may impact on the ability to perform a situation assessment when there is scarce information during a fire in tunnel.

Stakeholder feedback: There was a combination of interest and scepticism regarding this concept. One fire commander was highly sceptical about this (and other very technological solutions). There were two main issues. He did not necessarily see a need, as much information can be gained through visual inspection at the scene. However this would depend on the incident, and also the degree to which the commander was operating near to the incident – operational practice varied between countries. There was also concern about the reliability and maintenance costs of for advanced devices based on seeing little return for current technologies that they have available (eg infrared helmets and a rapid response motorbike). In contrast, another fire commander was more positive towards new technological solutions, and could appreciate the potential benefits of introducing new sensors within an incident. There was a general concern over the reliability of new equipment, and the impact of having to carry and deploy additional gear.

The tunnel operators were concerned about the overhead costs of introducing additional sensors within an environment. From the operator's perspective a sensor network to supplement the existing CCTV network increases the likelihood of false alarms and represent a substantial maintenance overhead while providing little perceived added value in terms of incident detection and response. However, when CCTV is rendered inoperable through the presence of smoke, the added value provided by heat and smoke sensors will be far greater.

Challenge #2 Data transmission to/from/between fire fighters

Problem summary: An inability to transfer data to/from/between individual fire fighters at scene.

Proposed technological solution: The use of networking technologies to distribute and maintain the transmission of communications data acquired from multiple sources. System optimisation (eg reduction of sensor data reporting frequency to increase bandwidth available) within an ad hoc and heterogeneous network.

Usability (operational) aspect: This may impact on the operational capability and safety of the fire fighters, by increasing communication between them.

Stakeholder feedback: There was mixed response to this from the fire commanders. The fire fighters are usually focussed on carrying out specific tasks. They are directed by team leaders, who have been set objectives by the fire commander. [As an example of the different roles, the fire commander will make decisions based on strategic goals and use of resources (eg the decision to employ all resources to focus on containment). They will issue commands to the team leaders based on what they want achieved. The team leader will then instruct the fire fighters to carry out the actions to achieve the goals set by the commander.] There is a rigid hierarchical command and control structure, and hence little need to transfer data between individual fire fighters. However the necessity of continual interaction between team members when working in hazardous conditions was emphasised. This communication would be to determine the well being of other team members rather than to communicate commands. At present this communication will be face to face and/or by radio.

Challenge #3 Status monitoring of the fire fighters

Problem summary: Lack of ability to monitor fire fighter health and operational capability during an incident.

Proposed technological solution: The use of networking technologies to distribute and maintain the transmission of mobile and biometric sensor information. This sensor data can include the data used to determine heat stress - eg core body and skin temperature and heart rate (McLellan and Selkirk, 2004) - and reserve capacity within breathing apparatus.

Usability (operational) aspect: This potentially impacts on the operational capability of the fire fighter, but is particularly relevant to the maintenance of the safety of the fire crew.

Stakeholder feedback: The fire commanders were negative towards the health monitoring idea for two reasons. They felt strongly that the individual fire fighters were able to assess their own capability to operate within a given environment – they have personal responsibility for this, and this should not be removed from them. In addition, the operational capability of an individual fire fighter would depend on a number of personal and contextual factors including whether the fire fighter was simply having an 'off day'. A fire fighter can judge how these factors combine to impact on their capability at any point in time ('how they feel'). Embedded sensors (eg heart rate and temperature) would not capture the subtleties, and would result in false negatives and false positives. Automatic registering of fire fighters as they entered a incident, plus a more accurate means of tracking the rate of air usage with breathing apparatus was however welcomed. At present this is usually done using white boards, markers and tags. A robust sensor network could log fire fighters in and out of an incident, and provide a more accurate forward projection of reserve air capacities.

Discussion and conclusion

The above section has described a number of opportunities for advanced sensor networks to impact on a fire in tunnel situation. It has also described concepts which offer theoretical benefit, but in practice pose challenges to successful introduction. In reality, there are opportunities and challenges associated with each of the ideas outlined above.

Taking a user-centred perspective it is clear that advanced sensor networks have considerable potential for enriching a scarce and degrading information environment as would occur in a fire in tunnel incident. New display technologies such as head mounted displays or other portable interfaces rely on a robust underlying network infrastructure that can deliver information as and when needed – the 'right information, at the right time and in the right way' referred to by Hollnagel (1988). [However, as discussed by Flach et. (1998), the fundamental question is actually that of defining 'right' within any given context.]

In some cases, subtle design of proposed technologies can differentiate between potential success and failure. For example, although a proposed 'health monitoring' function may seem to offer theoretical benefit to fire fighters, the concept behind this was incompatible with the self-reliance values of the fire fighters. However, a redesign so it is a 'self help' rather than 'remote monitoring' aid may be more successful.

There are a number of themes which emerge which are pointers to how the technical capabilities described may be harnessed successfully for stakeholder benefit:

- The need to explicitly add value over and above existing safety features (eg the use of CCTV to identify incidents)
- Compatibility with organisational structures (eg the existing hierarchical nature of command and control)
- Consistency with the values of individual stakeholders (eg the self-reliance of fire fighters)
- The trade off of technical constraints (eg bandwidth and battery life)
- Graceful degradation during failure and traceability of data
- Robustness of solutions
- Concepts based on assisting the stakeholder rather than unnecessary automation (Bainbridge, 1987)

The most effective technologies may be those were there are benefits to multiple stakeholders and where technologies can be incorporated into working practices without imposing additional demands on stakeholders.

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AVOIDANCE OF HAZARDOUS TRAFFIC SITUATIONS CAUSED BY REDUCED VISIBILITY IN INCLEMENT WEATHER CONDITIONS

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Keywords

Traffic safety, Enhanced Vision, IR Technology, System Evaluation

Abstract

Every year, numerous accidents happen on European roads due to reduced visibility (fog, darkness, heavy rain). The fact that transport safety is compromised by inclement weather conditions is a concern to the public and to authorities and industry trying to optimise safety by improvements of infrastructure, technologies, and regulations.

A system for enhanced sight effectiveness, SEE[2], aims at demonstrating how technological solutions may improve transport safety. The purpose is to raise human situation awareness in conditions of reduced visibility in the automotive context by the development of an enhanced vision system (EVS). This paper deals with a brief presentation of the system itself, and with the planning and execution of the evaluation of the system. In such a system a sensor operating in a spectral band less obscured by fog and enhancing the visibility at night - as compared with the visible band - produces an image, which is then presented to the driver on a suitable display inside the car.

The introduction of an efficient enhanced vision system in the automotive sector shall bring safety benefits to several applications, e.g. the direct application of EVS would be the augmentation of the visibility range in fog and at night, supporting avoidance of hazards and vulnerable objects (pedestrians and cyclists etc.). Infrared sensors are means that could help drivers to overpass human eyes limitation.

1 Introduction

Using infrared detection, IR, for improving night sight and sight in foggy weather is not a new issue. However, diverging philosophies have been utilised by various carmakers about how the enhanced images should be displayed. Two types of infrared images with different perceptual qualities are typically discussed. The near IR light lies closer to the visible spectrum of light and thus images based on near IR resemble the normal view closely. Images in near IR spectrum have a high level of detail and may appear more familiar to the subject. However, the high detail level may also result in image clutter making the image more difficult to scan, e.g. light from streetlights and oncoming cars is visible in the near IR image. The far IR is characterized by a low level of detail but a very long range and low image clutter. Images based on far IR may be less familiar to the subject which could result in difficulties of interpreting the images. Conversely, the sharp contrast between warm objects

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[2] SEE, Sight Effectiveness Enhancement, was a European project partly funded by EU

and background may enhance object detection, such as pedestrian, wild life, etc; see Knoll (2002) and Rumar (2003). Carmakers have previous chosen between these two alternatives, see Willie D. Jones. The new idea in the SEE system is to combine the advantages of the two systems by having both available and fuse the two presentations into one.

The System

The requirements for the EVS system were the following:

- The sensors shall operate in two selected spectral ranges of SWIR (1.3-2.5 μm) and LWIR (8-13 μm).
- The field of view should cover 36° x 27° (horizontal x vertical), at least 24° x 18°.
- The camera should provide a resolution of 320 x 240 pixels (1/4 VGA) or more.
- Sensor technology: For usage in cars it is necessary to employ un-cooled sensor assemblies.
- The thermal sensitivity of the system should allow resolving temperature differences of $dT \leq 0.1°$.
- The camera should operate correctly across a range of environmental temperatures of –20°C to +60°C.
- The intensity information per pixel should contain 8 bits, if possible 12 bits.
- Video Standard: PAL
- It is considered essential to house the camera in a pod in order to protect the system against moisture, humidity, snow etc.
- The usage of the IR-camera on a car requires a special protection of the optical system from hits by stones and other objects that can mechanically damage the system.

The position of the IR cameras on the car is indicated in figure 1

Statistics

Statistics of accidents in various countries – especially connected with bad visibility due to fog or darkness - have been studied, and various scenarios have been developed in order to identify realistic situations on which we expect the enhanced vision may carry significant safety improvements.

The statistical data have been taken from a couple of European and a US database. Even though the number of accidents in general may differ from one country to another, comparison among databases shows that accidents due to these specific situations of fog or darkness are of nearly the same sequence as compared to the total number of accidents for various countries. Table 1 compares statistical data from three different European countries, Denmark Statistics, German Statistics, and Swedish Statistics, and from USA, the FARS database, related to accidents due to fog or darkness, respectively, as compared with the total number of accidents

Based on this indication, we claim the validity in using detailed results of any of these databases depending on the available access for the specific kind of request.

Examples of various types of accidents related to reduced visibility are given below based on data from Danish traffic accidents in 1999, see Denmark Statistics. The accidents due to dark environments are distributed according to various situations like single accidents, accidents involving two cars, and accidents involving a car and pedestrians.

The relative numbers of accidents are the following:

For single accidents the most frequent are the three situations shown in figure 2.

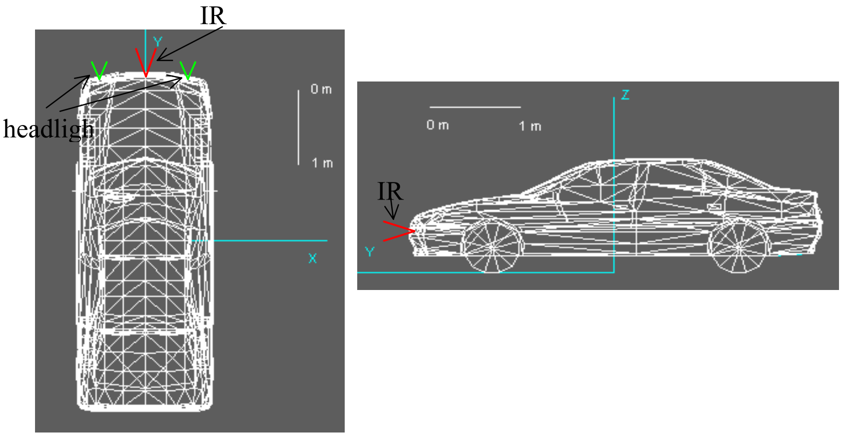
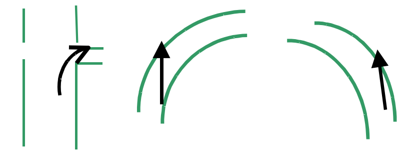


Figure 1, Positions of the SWIR and LWIR cameras

	Accidents due to fog related to total number of accidents	Accidents due to darkness related to total number of accidents
Danish statistical data	1,43%	28,30%
German statistical data	1,34%	23,10%
Swedish statistical data	No information	25,48%
US statistical data	1,45%	28,96%

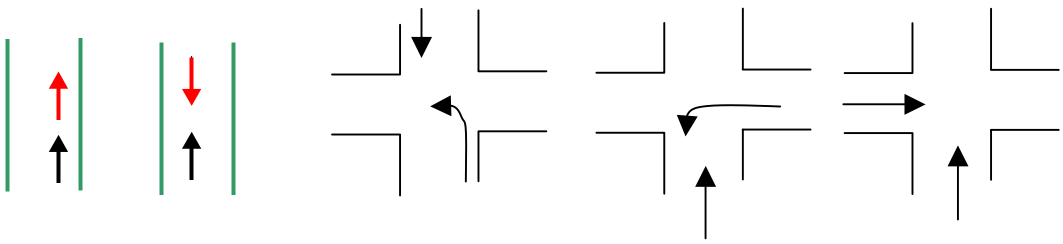
Table 1: Frequency of accidents related to fog or darkness as compared to total number of accidents in a sample of countries



45% (46%) 16% (46%) 21% (45%)

Figure 2: Most frequent single accidents in dark as compared with the total number of single accidents in dark. In brackets the same number of accidents in dark as related to the total number of the same kind of accidents in all kinds of visibility.

For accidents involving two cars a large number of situations are specified, in fact 17



categories, but the most frequent situations are shown in Figure 3.

10% (24%) 13% (27%) 12% (20%) 11% (23%) 14% (19%)

Figure 3: Most frequent accident in dark involving two cars as related to the total number of two cars accidents in dark. In brackets the number of the same accident in dark as related to the total number of the same type of accident for all kinds of visibility.

For accidents involving a car and pedestrians the most frequent are the ones sketched below in Figure 4 with the relative distribution as follows:

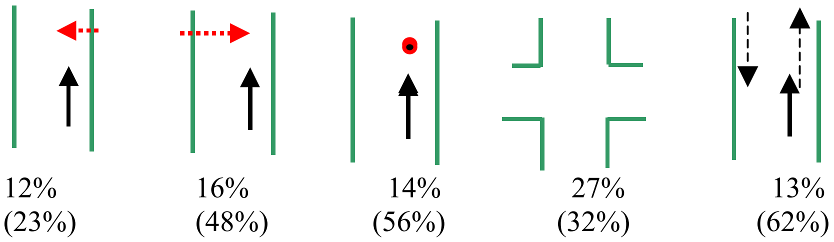


Figure 4: Most frequent accident in dark involving a car and pedestrians as related to the total number of car and pedestrians' accidents in the dark. In brackets the number of the same accident in dark as related to the total number of the same kind of accident for all kinds of visibility.

Similar results are found related to reduced visibility due to fog; see Andersen, V., et al. 2003.

Scenarios & sessions

Based on the statistical survey a number of scenarios were designed for testing the EVS system.

The subjects experienced the scenarios in different kinds of weather conditions and in conditions with or without the SEE enhanced image. The subjects were not all expected to react to all the scenarios, but the expectation was that an adequate number of them would react to the same scenarios allowing analyzing their time of reaction.

The scenarios were implemented in a movie simulating a recorded tour in real environments. The road layout and the surroundings in the simulated movie were realistic and included buildings, trees, open areas and other vehicles. In this way a realistic level of visual workload was achieved. The weather situations simulated were the ones shown in table 2.

Scenario Matrix – Automotive				
SEE Function	**No Fog Day**	**Dense Fog Day**	**No Fog Night**	**Dense Fog Night**
With SEE				
No SEE				

Table 2: Visibility conditions in the automotive evaluation.

However, for daylight in clear weather it was not expected that the SEE enhanced vision would be used, as there was no need for it, and this situation was simulated only without the using the SEE system just for reference.

During the session the subjects were inspecting the movies of different weather conditions in various orders for reducing learning effects. All potential dangerous situations, especially concerning 'soft road-users' such as pedestrians and cyclist ought to be indicated, and all indications were logged with the related time tag in the 'Observer'[3] system.

The velocity of the car in the video was about 60 km/h. During darkness and dense fog it was possible to see and navigate by the road-side and the white-lining on the road. With a reduced visibility of, e.g., 20 meters due to dense fog, the speed allowed the person only 1.2 seconds for responding to unexpected objects ahead.

Technical set-up

As indicated, no real car or real environments were used for evaluating the system. Simulations of various weather situations were provided for avoiding the constraints due to needed but missing real weather conditions. In the experiment the 'Observer' was used for collecting data. Data were extracted from the 'Observer' system and analyzed with the statistical functionality of Microsoft Excel. A 'Concept Board' was used as input device as an alternative to a normal keyboard. When the subject touched anywhere inside a large area of the board a code was sent to the 'Observer' registering the time of the push (minutes, seconds and milliseconds). Figure 5 shows the setup in the experiment room.

The size of the window at which the subject looked was approximately 8 inches in order to correspond to the size of the display expected to be developed for use in a car.

The experimenter controlled the sessions by means of a keyboard. She was in the room during all sessions, seated out of sight of the subject.

Instruction

The instruction included a cover story in order to counterbalance the limited realism and ecological validity of the experiment caused by the lack of a real driving environment, such as a car or a real car simulator. Subjects were introduced to the system as a passenger sitting besides the driver helping to navigate during the bad visibility. The rationale behind the story was that it would be more plausible than instructing the subjects to be the drivers since they had not control over the events in the movie.

Figure 5: Picture of the setup in the test room.

Debriefing

Immediately following the test session the subjects were put through a brief interview concerning their subjective impression of the various versions of the movie. A questionnaire was filled out concerning the general impression of the infrared images per se, and in comparison with the vision without the SEE system. Likewise, the questions were related to

[3] The Observer is a piece of software developed to collect and analyze any kind of behavioural data. About The Observer and other related products go to Noldus Information Technology at: http://www.noldus.com/

perception of objects and obstacles, and perception of terrain features. For comments not covered by the questionnaire there was room for 'Other comment about the infra-red presentations, positive or negative'. The overall satisfaction is shown in figure 6. For the detailed response concerning object identification and manoeuvring, see Andersen, V., et al. 2006.

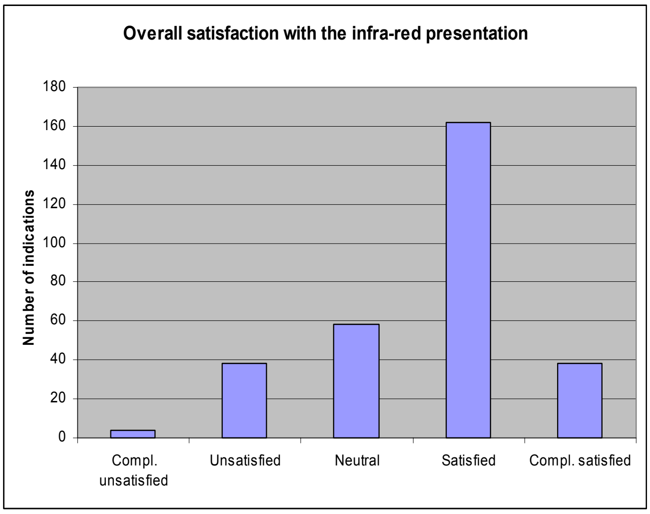


Figure 6: The overall satisfaction with the options offered by the SEE system.

Experimental Design

Based on the loggings, scenarios responded to by nearly all of the subjects were selected.

For each weather-condition a time window was defined. The time window begins at the time at which the situation reacted upon may be spotted and ends when the situation is passed by the test car. The time of reaction for each of the subjects within this time window was recorded, and the time distribution of reactions for each weather situation related to using or not using the SEE system were compared by a 'paired two sample for means t-test' to check the difference in mean-time and the significance of this observation.

Results

For night-time, clear weather condition, the results for all four scenarios showed an advantage in using the SEE system: drivers detected the obstacle earlier with increased opportunity of avoiding dangerous situations. For scenario one and two the subjects' detections using the SEE system was more than 0.5 sec earlier than the detections made without the SEE system. However, even so, the difference was not statistically significant due to the fact that the variance of these observations was rather high as the decision about a safety critical situation was dubious for these scenarios - cyclist along the road - which may be seen as dangerous or just a normal situation. For scenarios 3 and 5, however - a man lying on the road and a cyclist crossing the road - it was obvious to everybody that this was a safety-critical situation. As expected, therefore, all subjects reacted promptly to these situations, and the advantage was significant.

In foggy weather the outcome was very different. In fact, the analysis showed a *disadvantage* in using the SEE system – as summarised in Table 3. However, a detailed analysis of the parameterization of the fog simulation has shown that the lack of sight effectiveness enhancement was due to a non-optimal selection of parameterization issues in the simulations, see below.

Figure 7 shows an example of the same frame: with SEE at the left and without SEE at the right hand side during night.

Scenarios	Day, dense fog	Night, no fog	Night, dense fog
1	disadvantage, significant	advantage not significant	disadvantage significant
2	disadvantage significant	advantage not significant	disadvantage significant
3	advantage not significant	advantage significant	advantage not significant
5	disadvantage significant	advantage significant	advantage significant

Table 3: Detection times with indication of advantage/disadvantage of the SEE system

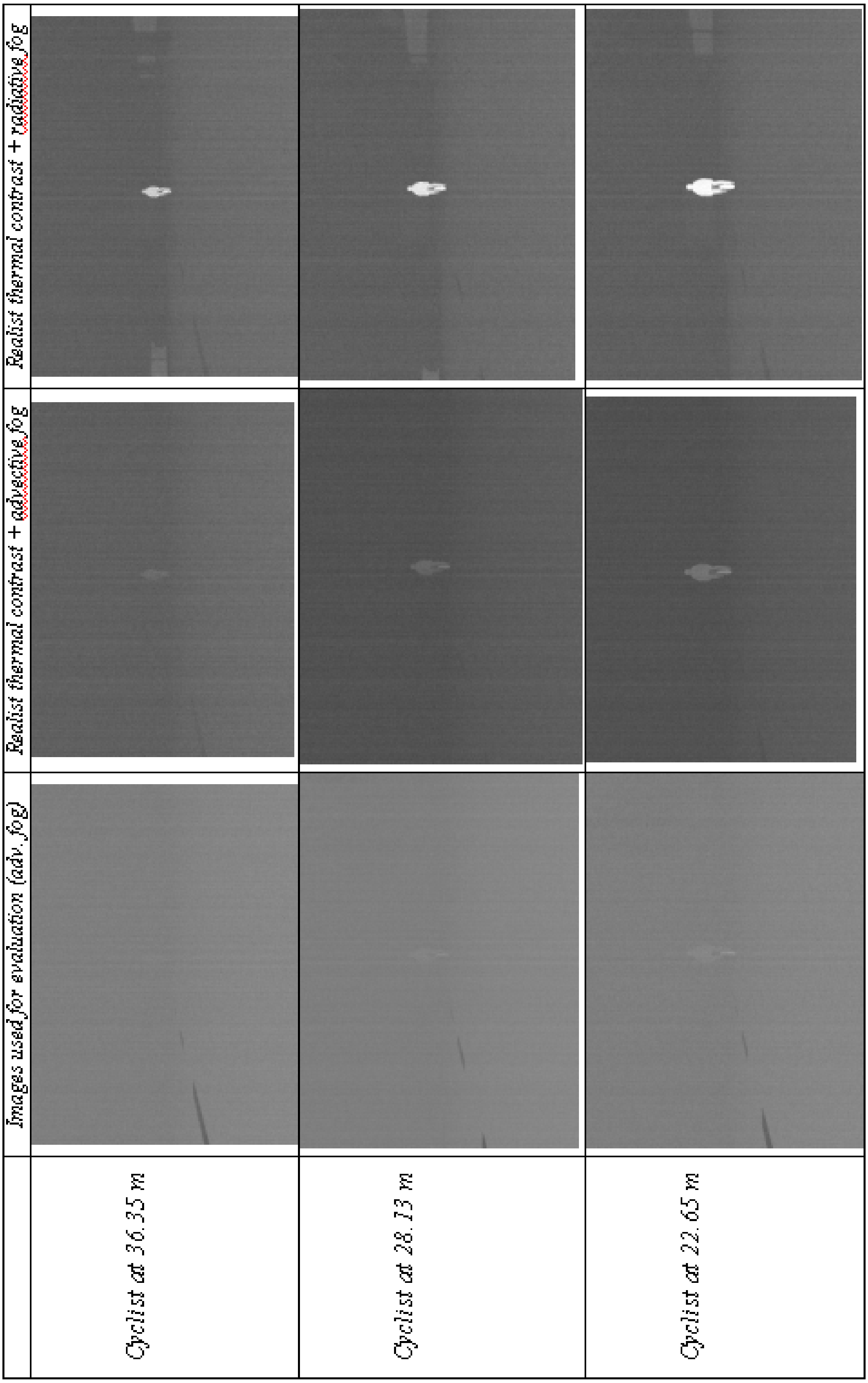
Figure 7: Night, clear weather. Cyclist is completely visible with SEE, but only a back-light is visible without SEE, i.e. missing back light means no sight of the cyclist without the SEE system.

Parameter Selection

As the results from the simulations did not show the improved performance of the system for foggy weather conditions as expected from a real test of a prototype of the SEE system, renewed efforts were made to identify the sources of the difference in performance between the real SEE prototype system and the simulated one. These efforts have identified the reasons why the simulations have been far from optimal with regard to bringing out differences between using the SEE and not using the SEE system during foggy conditions. It turned out that the parameterization selected for the simulations have not been optimal – but have in fact by chance reproduced a type of fog that puts the SEE system at a distinct disadvantage. Moreover, the temperature difference between the simulated, surrounding fog and the simulated objects (cyclists) was too small as compared with real conditions.

New simulations were produced with a more realistic temperature difference between the simulated objects and the environments resulting in improved performance of the system, and furthermore simulations were repeated with radiative type of fog instead of the advective type of fog as for the initial simulations[1]. The result is shown in figure 8 comparing the initial simulations with the new ones for fog during day. The new simulations show a drastic improvement of system performance and conform better to the informal tests with the SEE prototype system.

Figure 8, comparing the initial simulations with the new ones for fog during day



Conclusion

A sight effectiveness system for automotive enhanced vision for decreasing the risk of road traffic accidents was developed and evaluated from a simulation of the system using test subjects.

For night-time, *clear* weather condition, the results for all selected scenarios show a clear advantage in using the SEE system.

In foggy weather the situations was somewhat different. The analysis showed, in some situations, a disadvantage in using the SEE system. Nevertheless, the advantage of the system for night vision came through even under foggy conditions where the SEE system shows a statistically significant advantage for two of the selected scenarios. However, new and more realistic simulations of foggy conditions resulted in a drastic improvement in the performance of the SEE system.

Results from the questionnaire responses by the test subjects show largely positive reactions. A great improvement by using the SEE system for night driving in clear weather is indicated by 95% of the test persons. However, although the objective test showed no positive effect of the SEE system during foggy weather 55% of the test persons agreed that the system improved their vision, see Andersen, V., et al. 2006.

However, we have tested the system only in simulated conditions, not in a natural context with the system installed in a real car. Drawbacks of the real system may be – like for navigation systems – that it may take too much attention, taking the drivers focus away from the road. Furthermore, people have to be acquainted with the system in order make the right interpretation of the image, and elderly people being the ones with the highest need of visual support in bad weather conditions may be the ones most reluctant to use that kind of new system. Moreover, the system itself has a more limited filed of view as compared to the normal sight out the wind screen.

Finally, a general consideration related to all efforts trying to increase safety on the roads, like technical improvements, better roads, or tighten up traffic regulations is that many people are tempted to increase speed until they have the same subjective feeling of being in control.

The SEE system may find use in a number of other domains. Especially it has been evaluated similarly within the domain of aviation, likewise with positive results; see Andersen, H.B., et al. 2006.

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[1] Radiative fog tends to form late at night or in early morning hours. It may also form following precipitation that clears near or after sunset. Considerable variation is likely, especially over open areas or near water sources where fog will tend to be denser. Dense areas may be isolated but can present a hazard to land, air, and sea travel. The Advective fog can form and advect into a region almost any time of day. It shows some tendency to develop in late afternoon or evening hours over coastal areas. It may range from thin to dense, but dense conditions may cover larger area than radiation fogs, and changes in intensity tend to be more gradual than with radiation events.

SPATIAL DECISION SUPPORT SYSTEM: A CONCEPT FOR SUCCESS IN EMERGENCY MANAGEMENT ON THE MOTORWAYS?

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Keywords:

Spatial Decision Support System, GIS, Emergency Management, System Analysis, eCall system

Abstract

This paper will present an approach to the problems of emergency management on motorways with the use of a Spatial Decision Support System (SDSS). The acceptable data management costs by using existing spatial data stored in GIS, like generation of new data with various spatial functions and transparency for all emergency services, give such an approach an advantage in relation to the classical operational methods used. The SDSS uses GIS in conjunction with other decision models and could be a powerful tool for the coordination of all participants in the decision-making process during emergency situations, and to give them a more cooperative surrounding. Therefore, herein, for the purposes of the emergency management on motorways the main idea is to provide support in organisation by combining GIS with decision models to make an operative spatial decision support system concept.

Introduction

The state motorway systems due to the permanent exposure to the risky events i.e. accidents should be especially concerned. For example, Europe has an average of 1.7 million of car accidents per year assisted by emergency services, which includes the medical emergency service. The straight consequences of car accidents are higher costs of health insurance systems, and national economies are burdened with less productivity and bigger range of material goods damage. In order to maximise road safety and efficacy of emergency support, Europe initiated several projects to increase safety on the roads such as E-Merge, eSafety and eCall. Concerning its efficiency eSafety system and eCall could be of the special interest. For example, *e*Safety Support is a European Commission funded project assisting the *e*Safety initiative in its goal of reducing the number of fatal road accidents in Europe (eSafety; 2005). The project's main tasks are to stimulate and monitor the activities, progress and results generated by the *e*Safety initiative. It offers assistance to the *e*Safety Forum and its Working Groups, keeps all stakeholders up-to-date on *e*Safety progress and findings, and promotes the benefits of Intelligent Vehicle Safety Systems to the general public (esafetysupport, 2006).

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The data from the document "European Road Safety Action Programme" (11) point to the fact that the motorway accidents make 5% of the total number of accidents, but the level of mortality in the motorway accidents is over 9% of the total number of injured people including the pedestrians that are unfortunately the most endangered population. The very interesting information is that the motorways in EU are only 0.9% of the total length of the paved roads, but on contrary, in the last years the annual average number of dead persons in the accidents on the motorways in EU is 2.500.
Figure 1 shows lowering trend of the fatalities on the EU roads as well as set objective to reduce a number of the fatalities for 50% by 2010.

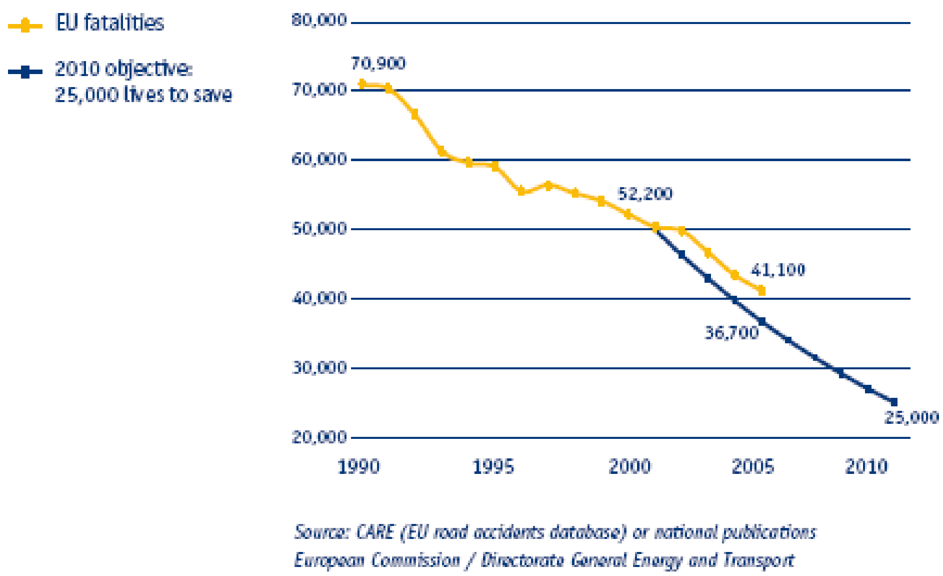

Figure 1: Lowering trend of the fatalities on the EU roads

Acceptance of eCall technology means that European countries have to improve their Public Safety Answering Point (PSAP) by the end of 2007. The whole emergency management system should be also improved with necessary ICT tools that enable quick and reliable response to the car accidents and fully utilize the advantages of eCall technology. Regarding the promotion of eCall at national level the Commission strongly recommends that the Member States set up national platforms for promoting eCall (5). They should have participation from relevant ministries including the authorities responsible for emergency services, as well as private industry and service providers (Buzolic J., Mladineo N., Knezic S.; 2002).

The Commission strongly urges the national and regional governments to act and to invest in the necessary emergency care infrastructure for eCall, with the view to launch the full pan-European service in 2009. Considering the total impact of eCall estimated by the SEiSS study, the annual accident cost savings are estimated to be up to 22 billion € and the annual congestion cost savings up to 4 billion €, which brings the total annual benefits up to 26 billion €. Compared to these benefits, the investments needed are relatively small, 150 € per vehicle and up to 50,000 € to upgrade a PSAP (13). On the basis of this initial investment per PSAP, and adding the costs for training their staff and to ensure adequate language support, it brings the annual total costs up to 4,550 million € in EU 25, including the in-vehicle systems.

Accepting the international agreements and protocols, as well as hosting numerous tourists during summer, Croatia faces the need for establishment unique Enhanced Emergency Call

Services. European citizens in distress situations are able to call the "112" and get through to the emergency services in all Member States. Thus, anyone traveling within the Union has to remember only one number and this guarantees a quicker and more efficient intervention.

In November 2004. Croatian Parliament accepted Protection and Rescue Law. The introduction of the new Law states that: "In accordance with 112 European Convention, Republic of Croatia, like European Union members, will introduce free phone number 112". Until the new Law was accepted, like in the most European countries, emergency services in Croatia were disassembled such as: police (telephone no. 92), fire brigades (telephone no. 93), medical emergency service (telephone no. 94) and National Maritime Search and Rescue Centre (telephone no. 9155). The new law recommends an introduction of the new Centre 112 as Public Safety Answering Points (PSAP) services, which would efficiently pull together and coordinate all emergency services. Organization of "Centers 112" demands very complex intervention within information and telecommunication systems in order to achieve high technological services level, increase efficiency of first aid and, generally, interventions in diverse emergencies and catastrophes. Experiences of the United States and European countries will definitely help the process of system conceptualization in Croatia, even though, the progress in information and telecommunication technology is so fast, that all the countries have the same challenge how to utilize all possibilities of technological progress.

A particular challenge for the rescue system in Croatia is recently built motorway Zagreb-Split (officially marked as A1) a part of which, named "Bosiljevo-Dugopolje", is isolated regarding urban centres (cities), thus making an approach of the emergency services very difficult considering responding time. In order to make emergency services to function properly on the Zagreb-Split motorway, a specific approach for emergency system development on the motorway based on both E112 concept and functional support of "Spatial Decision Support System" (SDSS) is proposed.

Building SDSS for emergency management on motorways

Decision process is a generic process that can be applied on any kind of organized set of activities in order to meet objectives. Generally, there is no unique model of decision process, because it includes numerous variables, different kinds of decisions (strategic, tactical, and operational), as well as different decision makers.

Generally, use of that knowledge and experience in the development of a "Decision Support System" (DSS) for enhanced emergency call services logically leads to the implementation of a system that will support all decision levels (Mladineo, N., Knezic, S., Jajac, N.; 2005). The organization of that system is generally hierarchic; at each level decisions are made in accordance with the authority. Decision character is different at some levels and depends on the system organization; decision range at lower levels is in accordance with previously made strategic decisions.

Conceptualized DSS for tactical and operational level is divided in a number of segments (modules) that will be additionally built in the further phases. Basic module is GIS (Geographical Information System), for all levels of DSS, that comprise information sub-systems about spatial and other data and serves the other modules with data and information. GIS module is divided in several thematic layers with basic information about settlements, road network, topographic data, location about police and fire departments, emergency services and hospitals, etc (Mladineo, N., Knezic, S., 2005).

For "Center 112" level conceptual scheme of DSS is different, because this level supports activities of particular services (police, fire brigades, ambulance, etc.) as can be seen on Figure 2.

For the different emergency situations the simulations have been performed for the following items: availability of the emergency vehicles, velocity of the intervention as well as scope of the intervention in the 20 minutes time outside of urban areas, such as motorway (Mladineo, N., Knezic, S., Jajac, N.; 2006). Functional organization of the 112 Centre is conceptualized taking into account political and administrative borders, such as counties. Each 112 Centre is usually in charge for only one county thus making the coordination difficult during the rescue operation on the motorway A1, because its southern part is situated in five counties.

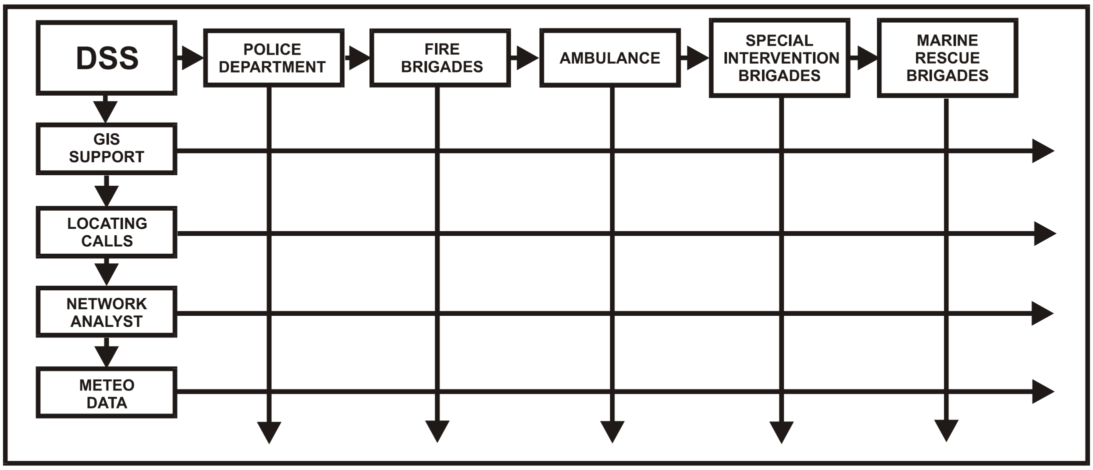

Figure 2: Conceptual framework for DSS development for “Enhanced Emergency Call Services (Centre 112)” level

Aiming at improvement of an efficacy of the rescue operation on the A1, precisely on the segment from Bosiljevo to Dugopolje, an inter-agency model is conceptualised. Therefore, an efficient coordination between counties’ 112 Centres is established. Since the major problem is spatial processing, namely determination of the accident spot, the selection of the nearest available resources for the rescue operation, as well as determination of the fastest intervention pathway "Spatial Decision Support System" (SDSS) concept is used with the dominant role of GIS.

Reviewing the literature it may be found that Jankowski et al. (1997) discuss the involvement of many stakeholders in solving spatial decision problems. They present SDSS for groups called Group Choice. Additionally, Jankowski et al. (2001) present a new prototype of SDSS emphasizing the need for the improvement of the typically limited role of maps as support tool, to move toward the use of maps as a source of structuring in multiple criteria spatial decision-making.

For the solving problems on the motorway, the first step in a development of the SDSS was an establishment of GIS support for a relatively large area (313 km of the motorway) as well as significant number of available emergency services’ units on the motorway (police, emergency medical care, fire brigades, special services) that access the motorway via local roads. Approach to the motorway is limited to the 20 official toll (entrances/exits) distributed equally each 10 to 30 km. Isolation of the motorway from the urban centres and thus from the most important resources for the emergency actions rises a question of meeting the usual responding times. This means that assumptions for the rescue system with the responding time within 20 minutes should be analysed on both whole and part of the motorway A1.Using GIS and other GIS-based tools the scope of the emergency services action is visualised. Centres of the areas are base stations and scope is defined by using 10 to 20 kilometres of the road network.

Since both medical emergency unit and fire brigades have additional stations, the three separate layouts (Figure 3 – police, Figure 4 – medical emergency unit and Figure 5 – fire brigades) were made showing that medical emergency unit has the best mobility. Fire brigades have also good mobility because they have three stations located on the motorway near major tunnels.

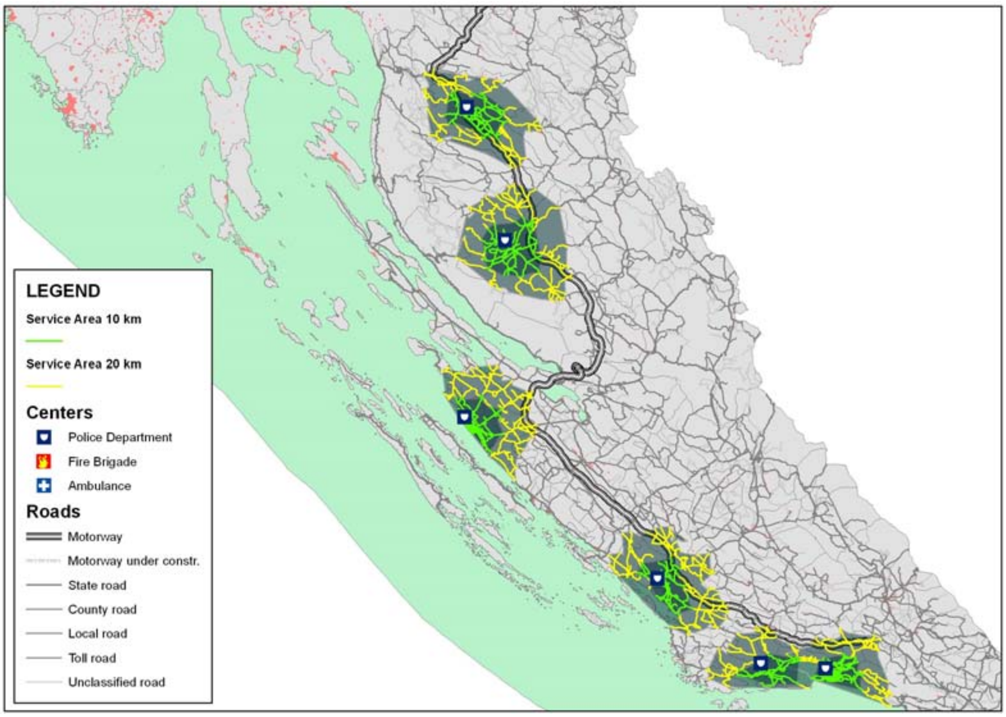

Figure 3: Service area (10 and 20 km) for police vehicles

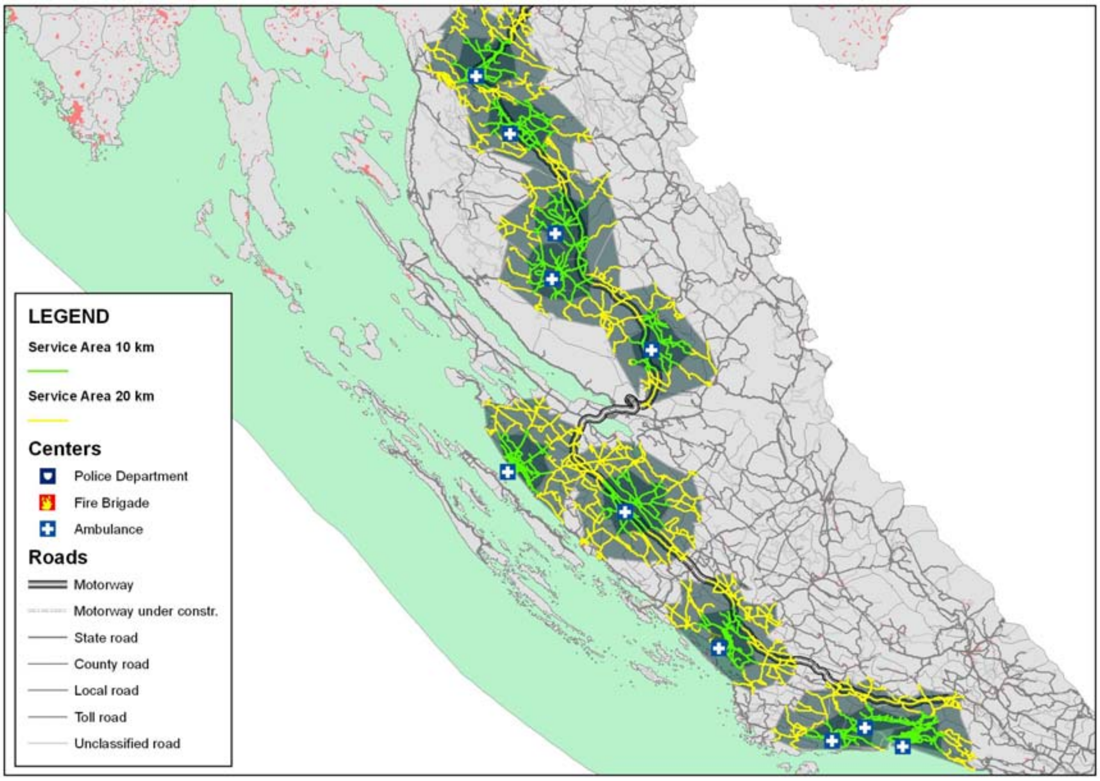

Figure 4: Service area (10 and 20 km) for medical emergency units

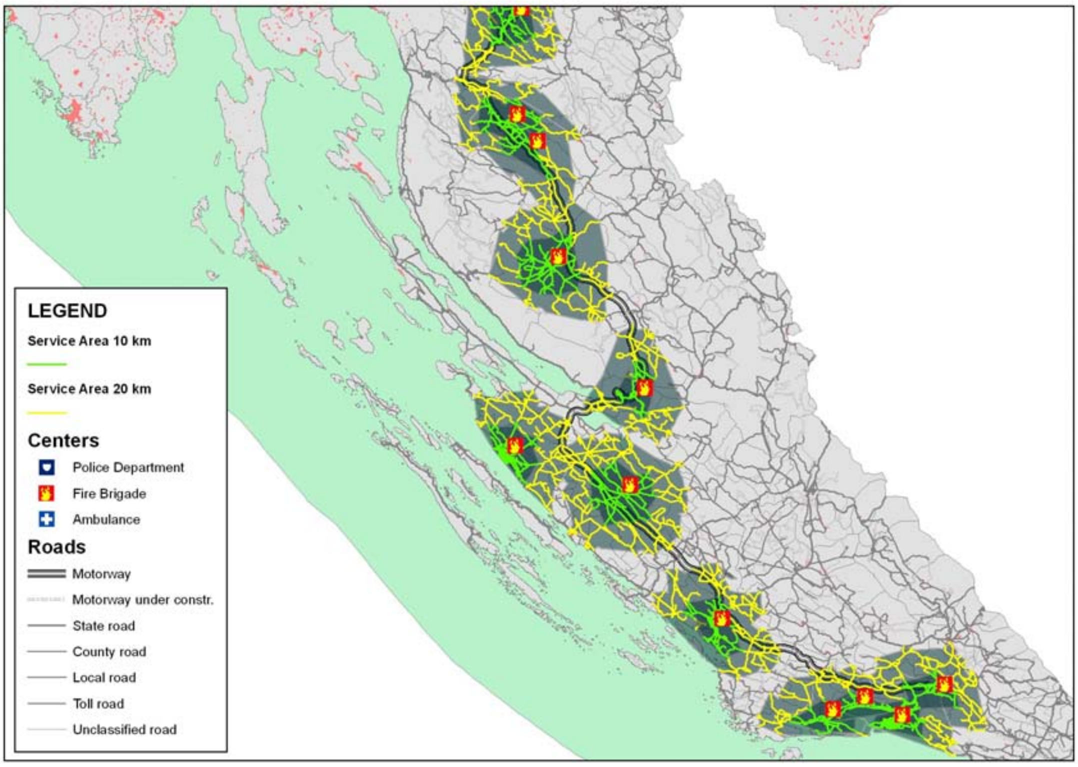

Figure 5: Service area (10 and 20 km) for fire brigades

The next step includes simulation of the vehicles' velocity. The intention was to define real coverage of the motorway within the 10 or 20 minutes. Starting time is an event when vehicle leaves the station (garage), while an average velocity of 60 km per hour on the local roads is estimated based on the experience. For the entrance and travel on the motorway an average speed of 100 km per hour is estimated.

Figure 6 and Table I show the results of the simulation for the part of the motorway from the toll 15 to the toll 19. These data are put into correlation with the real time starting from the emergency call to the time when the vehicle enters the road. Based on the simulated travel time to the accident spot (it is saved in the knowledge base), the dispatcher decides form which stations the units for intervention and rescue should be employed (resources management**)**. From figure 6 we can see how coverage could be poor if police vehicles are situated in the Zadar station, because within 20 minutes they can reach only point ZD-17-Left, ZD-17-Right, ZD-16-Left and ZD-16-Right, thus covering only 8 km of the motorway (Table I). Medical emergency units present better coverage because form the Benkovac station they cover 44 km of the motorway BE-19-Left and Be-19-Right, together with units from Zadar (ZD-17-Left, ZD-17-Right), and 24 km from both entrance of the tunnel St. Rok covered by the medical emergency unit from Lovinac. Regarding the location of the fire brigade in front of the entrance of the St. Rok tunnel, the whole motorway segment from the toll 14 to toll 20 is covered by the fire brigades within 20 minutes.

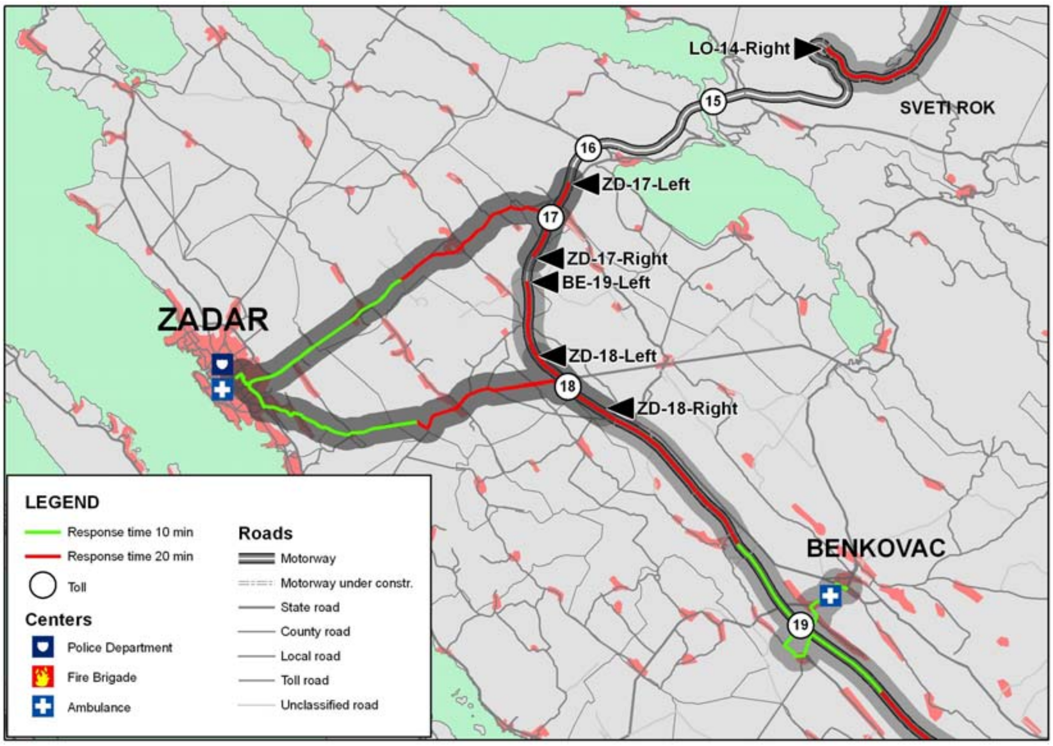

Figure 6: Layout of the coverage of the motorway with response time (10 and 20 min) for the both police and medical emergency vehicles

Poor coverage of the certain segments of the motorway A1 with the medical emergency units demands additional medical emergency teams as well as police during the summer months when there is higher accident risk due to the huge number of tourists. The additional units are located on the motorway and cover the most critical areas evaluated by the simulation in GIS.

Table I

Emergency Station	2	4	6	10 min	12	14	16	20 min	TOTAL
Zadar				**10 km**				**19 km** **21 km**	10 min **10 km** 20 min **21 km**
Benkovac*			**7 km**	**12 km**				**29 km**	10 min **12 km** 20 min **29 km**
Lovinac*			**6 km**	**13 km**				**30 km**	10 min **13 km** 20 min **30 km**

Local Road – Average speed: 60 km/h

Motorway – Average speed: 100 km/h

*** only medical emergency**

A special function of SDSS is supporting of so called «route guidance systems». A problem is that route guidance systems do not always consider the relative risk between different routes. An obvious improvement would be to add to the traditional optimization criteria (the shortest or the fastest route) a new option: the safest route. In theory, this would require a large amount of accident statistics to be added to the digital maps on which the route calculations are based. In practice, however, estimates of the accident risks of certain road types would be a reasonably good approximation (ETSC 1999).

It is also clear that in-car route guidance systems distract the drivers from their normal driving task, but, on the other hand, to a lesser extent than a conventional map (CEC, 1998; Ståhl, Berntman & Petzell,; 1997). Additionally SDSS should support transportation of the injured people to the hospital that could give an adequate treatment. A Swedish physician estimated in 1991 that 50 out of 800 fatalities (6%) could be prohibited with improved emergency service at Swedish hospitals. A part of this can be prohibited by faster transport from the location of the crash, the other part by improved medical treatment. (Bo Brismar, 1991).

Conclusion

Affiliation of Croatia in the unique European system PSAP and establishment of Emergency call Centres 112 initiated conceptualization of DSS for Enhanced Emergency Call Services at operative level.

There is some obstacle s during establishing of the emergency management systems on motorways because the newly built motorway Zagreb – Split (A1) is often situated away from the urban areas and number of vehicles on the motorway has seasonal character because of tourists (discrepancy between summer and winter). Paper proposes introduction of SDSS which helps to establish efficient emergency management using GIS and its spatial analysis tools. After the analysis it should clear where the territories which cannot be reached in reasonable time are situated and what strategy has to be undertaken. Moreover, using statistical data about vehicles on the motorway, operational emergency management plans, for each period of the year, can be precisely evaluated. Improvement of the emergency services that can save lives and reduce injuries caused by the traffic accidents is posed as imperative. The study of an introduction of eCall technology in motorway network and its connection with 112 European emergency system demands an intensive research and application of both organizational methodology and technological possibilities. Achievement of the synergetic effect is possible by intensive application of ICT technology and GIS support.

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Academic & Professional Practice

Peer Reviewed Articles

BUILDING SAFER COMMUNITIES

DISASTER PLANNING AND RESPONSE: CONSIDERING THE SPECIAL NEED OF AGING POPULATIONS

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Keywords

Frail Elderly, Disaster Response, Emergency Preparedness, Disaster Planning, Natural Disasters

Abstract

The world's population is aging and this changing demographic provides a challenge for emergency management professionals. While there is a great deal of diversity among older adults world wide, there are many common health issues that must be taken into consideration when planning for the emergency preparedness and response needs of the frail elderly. When planning emergency interventions, a clear understanding of the aging process and the impact of common chronic diseases processes can facilitate a more successful response.

Introduction

In some countries, frail elderly live in institutional settings such as assisted living facilities, or nursing homes. In an emergency situation, problems can arise in these institutions unless special care is taken to address the emergency preparedness and response needs of the frail elderly. Without special assistance, many of the frail elderly can be severely compromised in their ability to respond to and recover from disasters. The 2005 hurricane season in the United States underscores the importance of recognizing and addressing the vulnerabilities of the

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frail elderly living in independent or assisted living environments. If the special needs of the frail elderly are not incorporated into emergency planning to improve emergency preparedness and response initiatives, their critical needs cannot be met during the disaster. The purpose of this discussion is to outline the special needs of the frail elderly during a disaster and to suggest emergency preparedness strategies for addressing this vulnerable population.

The 2005 hurricane season in the United States underscores the importance of recognizing and addressing the vulnerabilities of special populations such as the frail elderly. In this paper, the term frail elderly refers to adults over the age of 65 suffering from the effects of physical deterioration due to age and chronic disease that severely affect their ability to recognize and respond to a disaster. Chronic disease in combination with advancing age, also increase the risk of complications due to environmental changes during a disaster. Subpopulations of those over 65 years of age and older may also suffer from low economic status and poor social networks that further increase their risks. These characteristics put the frail elderly in danger of increased sickness and death during a disaster. This was evidenced in the United States with Hurricane Katrina. Although only 15% of the residents of New Orleans pre-Katrina were aged 65 and older, 74% of hurricane related deaths were people in that age group, and almost half of those were older than 75 years of age (Hyer, et al., 2006). Emergency management professionals must recognize the importance of developing a special section in disaster plans that address the needs of the frail elderly. Emergency plans must address the needs of elderly living independently or in institutional settings.

Thesis

Emergency managers must consider the special needs of the frail elderly in emergency preparedness planning to minimize the disaster's immediate and long term impacts on this population. During a disaster experience, individuals with special needs such as the frail elderly are at a greater risk for sickness and death (Somasundaram & van de Put, 2006). Communities who do not address the special evacuation needs of the frail elderly increase the risk of illness and death of this group during a disaster event. (Smith, 2005)

Sources of information

This paper was prepared using published research studies focused on special populations that should be addressed during disasters and best practices for successful disaster planning and preparation at the community level.

Findings and Discussion

<u>The Vulnerable Elderly</u>
Factors contributing to the vulnerability of the frail elderly are important considerations for emergency managers to understand. Advanced age alone does not equate to vulnerability and within the elderly population, there is a wide range of individual health and fragility. However, frail elderly have increased risk of death during or following a disaster. Characteristics of frail elderly living independently include:

1) chronic illness
2) limitations in vision, hearing and mobility
3) reliance on outside health care resources
4) low economic status
5) poor social networks

Frail elderly living in institutional settings:

1) Nursing homes

2) Assisted living facilities

The probability of developing chronic illnesses increases with age. Many older adults suffer with chronic diseases such as diabetes, cardiovascular disease, chronic obstructive lung disease, and arthritis (Ferrini & Ferrini, 2008). Chronic illnesses often result in a decreased ability to perform routine activities of daily living (ADLs) such as bathing, dressing, and using the toilet. A recent study reported that one-fourth of the young old (65-74 years of age) and almost one-half of the old-old (75 and older) had at least one limitation in ADLs due to chronic disease (Centers for Disease Control, 2004). Deficits in ADLs require assistive devices and/or physical assistance in performing these activities. Much of this care is provided through informal networks such as family and friends (U.S. Department of Health and Human Services, n.d.). These networks may be lost during a disaster leaving this vulnerable population at risk. During Hurricane Katrina, loss of family and friends left many frail elderly unable to care for themselves or to advocate for their own needs while housed in a public shelter (Dyer et al., n.d.).

Chronic illnesses may also result in physical limitations that impact the ability to respond during a disaster. Visual impairments, hearing impairments, and impaired mobility can present major challenges during disasters. The frail elderly with impaired mobility may not be able to find shelter or quickly evacuate when the onset of a disaster is sudden such as earthquakes and floods. Those with sensory impairments may be unaware of disaster warnings and instructions. Emergency managers must address these limitations when planning sheltering-in-place, evacuation, response and mitigation of disaster events (Fernandez, 2002). The impact of these impairments was documented with elderly Hurricane Katrina evacuees in a public shelter, “Many could not walk to the bathroom or the cafeteria and many were demented and did not know where they were. Some had sensory impairments that prevented them from reading signs indicating where help was located or from hearing the public address system announcements” (Dyer, n.d.).

The frail elderly may also have decreased health status during and after a disaster due to the loss of transportation, medical and communication infrastructures. The frail elderly may be housebound, and reliant on the delivery of medication, medical treatments, or nursing care. These services are provided by volunteers or paid employees and the loss of infrastructure can leave frail elderly without vital services during and after disaster events. The disruption of infrastructure is a particular concern for the frail elderly with chronic conditions or diminished capacity. This problem was demonstrated in the United States during a severe snowstorm in the state of New York in 1987. Hospitals in the state of New York were required to accept frail elderly patients with chronic respiratory conditions which overextended hospital resources. These patients typically managed their respiratory conditions at home. The hospitalizations were required because the homes of these frail elderly lost electric power and they were unable to manage their conditions at home. While the hospital responded to the special need of this vulnerable group, the lack of preplanning for alternate sheltering capacity caused the ability of the hospitals to meet other urgent care needs to be diminished (Fernandez, et al., 2002).

Groups of frail elderly that can be at higher risk during a disaster are those of extreme age or low income. Age in combination with low economic status increases vulnerability during a disaster. Older women, especially women of color, suffer economic and social disadvantages (Ferrini & Ferrini, 2008). Since women live longer than men, they are the larger elderly group in need of services during a disaster. Older women must have special consideration when planning for evacuation, shelter specifications and relocation. In some circumstances, elderly women have the increased burden of care giving responsibilities. Cultural restrictions in some societies that discourage women from seeking disaster aid or medical care further contributes to the vulnerability of elderly women following a disaster (Kumar et al., 2007).

Individuals with low economic status have limited financial resources and may not be able to evacuate before a disaster. During recovery, when members of this group lose a home or possessions, these cannot be restored without outside assistance. The impact of low economic status was found to be a major factor for those seeking shelter following Hurricane Katrina. Six of 10 Katrina evacuees housed in a public shelter had incomes below $20,000 (Brodie, et.al, 2006). Many residents in the higher socio-economic levels in the area affected by Katrina had the means to evacuate to hotels or to shelter with friends or family.

In disaster situations, frail elderly with poor social networks are at increased risk of illness and death. The lack of functional social networks was reported as the primary cause for the large number of elderly men dying in a week long Chicago heat wave in the United States in 1995. Studies of this heat related disaster indicated that older men, particularly men without children and men with substance abuse problems were less likely to maintain crucial parts of social networks which provide support during an emergency. Although research indicates that men are more likely than women to become socially isolated, both elderly men and women are susceptible to the loss of social ties. Those frail elderly who live alone and do not engage in support networks are at increased risk. To reduce this risk, emergency preparedness programs can encourage the building and strengthening of social networks (Klinenberg, 2002).

Frail elderly in institutional environments such as nursing homes and assisted living facilities present significant challenges during a disaster. The frail elderly in group living environments typically have greater mental, physical and mobility limitations in contrast to the elderly in independent living environments. In many cases, the frail elderly in institutional environments require total dependence on others for their care. In order to meet the special needs of the frail elderly living in an institutional environment, such as nursing homes and assisted living facilities, community and state planning for disasters must include representatives from these institutions. These representatives are familiar with the special needs of their residents and this information is vital in the development of appropriate disaster preparation, response, mitigation and recovery plans. The deaths of thirty-four residents in St. Rita's Nursing Home in Louisiana occurred because the residents were not evacuated to safety prior to severe flooding. During Hurricane Katrina, an estimated 36 additional deaths in 12 other nursing homes revealed the terrible consequences of inadequate institutional planning and response to the disaster (Hyer, 2006).

Community Emergency Planning

Planners must consider the frail elderly as a high risk group when developing a risk assessment, the emergency plan, and a geographic assessment of their community. Emergency planners need to understand how the unique social and political patterns of communities can result in heightened risk for specific sub-groups such as the frail elderly. Emergency management planners must go beyond the development of a community natural hazard and risk assessment. Planners must identify and map special groups that are at higher risk than the general public. A community vulnerability map can identify the location of at risk groups such as the frail elderly (Morrow, 1999).

Community Vulnerability Maps

Community Vulnerability Maps assist emergency managers in identifying the magnitude and location of high risk groups. This information on high risk groups is necessary to estimate the manpower, equipment and health care resources needed during the response phase of a disaster to effectively evacuate and shelter disaster victims. Knowledge of the geographic location and total number of the frail elderly living in institutional environments that must be evacuated during a disaster can help avoid problems such as double counting of the same ambulance to evacuate two different nursing homes. This double counting error was found to be one of the causes of death of the frail elderly during the Hurricane Katrina disaster. Nursing home patients were not evacuated prior to flooding because the ambulance service listed in the institution's plan was unavailable because the ambulances were servicing other facilities. (Smith, 2005)

Mapping does not have to be completed in a costly or high-tech manner. Residents of a rural community in the Philippines created a three-dimensional town map on a plywood base. The group used flour and water dough to depict the most vulnerable locations and homes in their community. Local planning projects sponsored by schools and other voluntary organizations can use low tech methods to visually display high risk areas and vulnerable groups within their neighborhoods (Morrow, 1999)

Warning and Evacuation

Emergency managers should consider the unique needs of vulnerable elderly in regards to adequate warning system and transportation issues during evacuations. Visual and audible warning devices and alarms must be maintained to meet the needs of the visually and hearing impaired frail elderly. Individuals with impaired mobility and those who do not have adequate physical or financial resources may not be able to evacuate during a disaster.

The frail elderly who have no transportation or need special transport due to mobility impairments should be identified and alternate transportation plans put in place. Emergency managers should have a strategic plan in place that demonstrates 1) adequate ambulance service will be available to meet the demands of all frail elderly living in institutional environments 2) coverage will be available to frail elderly living independently.

Providing proper medications to the frail elderly in a safe manner during evacuation is important for effective care of the frail elderly. During an evacuation, medication and the equipment needed to administer the medication should be transported in the same vehicle as the victim. If medications are transported separately, health care providers will not be able to administer necessary medications during unanticipated long delays during transport. The proper secure storage of medications must be provided during transport as well. If residents are allowed to carry their own medications during evacuation, the improper consumption and trading of medications may occur (Department of Health and Human Services, 2006)..

Emergency Shelters

Emergency shelters must be provided with the necessary supplies, staff, and equipment to ensure adequate healthcare for those with special needs. Shelters designated for the frail elderly should have wheelchair access and bathroom facilities to meet the needs of mobility limited individuals. When communities identify significant populations of individuals with special need, including the frail elderly, it is recommended that special care emergency shelter centers be established. These special care centers are available to individuals requiring assistance with activities of daily living. Typically, special care centers are equipped with basic medical assistance and monitoring. Lee County, located in the state of Florida in the United States, is an example of one local community with established special care centers. While Lee county special care centers have basic medical assistance and monitoring, they are not equipped with advanced medical equipment, medications, or staff to provide advanced medical care. Lee County requires that each special needs resident be accompanied by a caregiver since volunteer medical staff will be unfamiliar with the resident's special needs. There are limitations to the care provided by special care centers. Notices provided by Lee County concerning their special care centers state the following warnings, 1) "If the volunteers do not report to the shelters there will be no hands on other than your caregiver and a Public Health Unit manager (R.N.) to assist should an emergency arise." 2) "If you need 24 hour skilled nursing care, dialysis 3 or more times a week, or are electricity dependent for life support, your are not a good candidate for Special Care Centers." (Lee County Public Safety, 2001).

Past disasters in the United States have demonstrated that the lack of a centralized medical record tracking system for evacuees in shelters slowed the provision of health services for the frail elderly (Hyer, et al., 2006). Community and state level emergency managers need to create a system that allows for key health information to be portable and available to medical personnel for adequate treatment of disaster victims.

When planning food for shelter disaster victims, emergency managers need to recognize that many of the frail elderly have poor dental health or no teeth and this restricts their diet. Chronic diseases such as hypertension and diabetes may also require dietary restrictions that are difficult to provide in a shelter.

Planning for Nursing Home and Assisted Living Facilities

Nursing homes and assisted living facilities must be required to have very detailed emergency plans which address early evacuation of residents and safe off-site shelter locations. Since rapid onset of some types of emergencies leave institutions such as nursing homes and assisted living facilities little time to evacuate, preplanning is critical. In addition to planning for an evacuation to a separate safe shelter, each institution housing the frail elderly should also maintain adequate supplies of food and medicine and an emergency power generator to allow sheltering-in-place in case no timely warning can be provided to allow evacuation. (Hyer, et al., 2006).

Summary

The world's population is aging and this changing demographic provides a challenge for emergency management professionals. The needs of the frail elderly in the community and institution must be met. There are specific needs in regards to warning, evacuation and sheltering the frail elderly. Addressing these needs can facilitate a more successful emergency response.

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Dr. Smith is an Associate Professor at the University of Tennessee, Coordinator of the Graduate Safety programs and Director of the UT Safety Center. Prior to accepting her current position, Dr. Smith completed a successful 20-year career working with rural communities on the complex issues of disaster mitigation, environmental protection, and community safety. She teaches graduate courses in emergency management, accident prevention and environmental health. Dr. Smith's research areas include emergency evacuation and warning systems for special populations.

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Dr. Tremethick has a broad nursing background having worked and/or taught clinically in Intensive Care/Critical Care, Medical/Surgical, and Physical Rehabilitation nursing. She has also studied aging and has worked with the aged in community and institutional settings. She was appointed to and currently serves on the Marquette County Aging Services Advisory Committee, the Michigan State Advisory Council on Aging, and the Michigan Healthy Aging Initiative Steering Committee. She currently teaches at Northern Michigan University in Community Health Education.

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REGIONAL PLANNING AND CONSTRUCTION CONSULTANCY – MITIGATING DISASTER

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Abstract

Regional planning is a part of the continuum in disaster management and it is one of the important segments in mitigating conseguences.

Regional planning officers, that is to say, the decision makers in regional planning need to keep emphasizing the importance of the relationship between regional planning and protection. Such an issue shouldn't be taken into consideration only after a natural or man-made accident with disasterous consequences had taken place.

This paper will try to describe the importance of the town-planning protection measures in regional planning that would, as bordering parameters in making regional plans, contribute to the enhancement of living conditions and protection of the inhabitants.

GIS systems and IT modelling as a significant support to crisis management provide outstanding possibilities of determining and application of the town-planning measures of protection within the phase of regional-plan making. They provide a background made of seismic maps, maps of the river flooded areas, areas potentially endangered by accidents taking place in tecnical and/or technological processes or traffic, maps of the areas pointing to the subterranean river flows and spring water sources with special protection treatment, etc.

Examples will also show by way of illustration that drawing up plans and object construction can effect an increase or a decrease in disaster conseguences. Studying the afore-mentioned issue should be a continuous process especially in the areas where time span between disasters is long and there is a possibility of disregarding it.

Introduction

A disaster represents an abrupt interruption in functioning of a community caused by a natural or technical / technological event that results in great human and material losses or environmental damages going beyond the capability of the stricken community to solve the problem by using its own resources.

Disasters have always been happening but it seems that they are becoming more and more frequent and more serious. New hazards created by people, on one hand, and, greater area exposures, on the other, (an increased number of inhabitants, that is, greater population density) influence greatly on society's increasing vulnerability.

It would be an illusion to expect that development can be stopped. Therefore, every community has to decide on acceptable risk types. It should also, through its activities, influence a part that might be changed, that is, direct its development toward reducing area vulnerability.

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In this way we are faced with a constant, continuous and interdisciplinary work known as disaster management. Within the framework of disaster management we deal with different mitigating activities aiming at risk reduction, either by reducing hazards or eliminating them, by reducing area vulnerability or by combining both factors.

Through hypothetic situations and measures undertaken, this paper will try to point out the importance of regional planning and civil/construction engineering, which, together with the area's development, might ensure reduction of an area's vulnerability.

Regional planning changes living conditions and protection of people

Old industrial plants

In the few last decades many towns and settlements have grown so certain industrial plants, once having been built at the outskirts of town, found themselves surrounded by apartment blocks. Because of not being informed about the problem or neglecting it, the tenants of such apartment blocks faced a problem of living in the midst of the endangered area, that is, an area prone to possible accidents.

In today's world, each community should put efforts into finding a solution to such a situation.

Each community should, by monitoring the situation in the area and for the sake of the already constructed part of the town or settlement, pinpoint all the potential accident spots, old plants or similar facilities, warehouses holding hazardous and explosive substances. Plants and warehouses that are not necessary for the city functioning should be closed down or moved outside the residential area.

New industrial zones

Through precise town or settlement development plans, industrial zones are becoming separated from the residential zones.

Disadvantages of planning the industrial zone location might be in the fact that in the planning phase the type of plant to be built in that very zone is usually unknown and all that is being identified at that stage refers to some general standards to be satisfied by the future plants. The choice of location also usually depends on the existence of favorable conditions for connection to the already existing infrastructure.

It turns out that the location of the industrial facility is not based on the risk assessment or on the consequences of a possible accident. On the other hand, being pressured by the investors, certain industrial zone standards that were identified previously, later on, during the phase of obtaining building permits for the individual facilities, are often violated or neglected.

Areas that should be exempt from construction

Taking into consideration certain natural conditions or man-made ones and protection of its residents, we come to the conclusion that there are areas that should be exempt from construction. Although, generally speaking, construction is prohibited in the areas where it is not allowed, such areas should be specifically pinpointed and defined.

Areas that do not meet the standards for construction in terms of natural hazards are: fault zones, areas prone to flooding, torrents, avalanches and strong winds.

This includes land-slide sites as well because they are expected to become active under earthquake activity and heavy rain, while a settlement might be constructed above or under the land-slide site. They represent a dangerous zone for the inhabitants of the settlement in both of the above-mentioned cases.

Areas threatened by volcanic eruptions are also considered inappropriate for construction.

Areas for construction considered inappropriate because of the actions of humans are the zones in the vicinity of industrial plants that are identified as dangerous and harmful in cases of an accident. An inappropriate area may also be endangered by the eventual collapse of a hydro-electric dam on rivers.

In all such areas, the already constructed settlements may be kept in its existing framework but should be stopped from spreading by implementing certain measures.

Protection of drinking water reserves

Society's attention has already been directed toward protection of drinking water reserves. Attention should also, in this respect, be paid to the areas that might have an effect on the underground drinking water reserves, that is, on the underground flows supplying river heads with drinking water. Special construction conditions should be provided for such areas. Especially vulnerable parts should be exempt from construction altogether.

Wrong choice of a location for town spreading

People sometimes tame nature and construct by determination where construction is not possible because of the non-existence of favorable conditions. It may turn out to be a bad decision.

New Orleans can serve as the best illustration of the afore-mentioned because its inhabitants went through a true disaster as a direct outcome of one of the bad decisions made in the past.

Geographical features of the area, with the Pontchartrain Lake and the Mississippi River at the coast of the Gulf of Mexico on one hand, and an area known as the origin of many hurricanes on the other, proved that a city of these dimensions, as the present day's New Orleans is, shouldn't have developed in such a location. Even though the first constructors established the settlement on the highest point of the bay, vulnerability was obvious already at the point when apartment blocks started to be built on the lower hills. Seasonal inundation of the Mississippi River and Lake Pontchartrain during the hurricane seasons have been the cause of frequent flooding. River and lake embankments represented a good solution for some time, but it also had a direct negative outcome: the town started spreading over the area that was situated under the level of waters that were surrounding it. The city became dependent on its embankments or levees.

In 2005, hurricane Katrina showed why New Orleans had been thought for decades to be one of the most threatened American cities.

Infrastructural facilities

Facilities being built on roads (bridges, viaducts, tunnels) are at its most vulnerable parts. There should always be alternative roads on one level. Water and electrical power supplies should be brought over from different directions, that is, different sources, which is very important for the big cities.

Protection elements in big cities

Cities, because of a high population density, are particularly vulnerable to possible accidents having disastrous consequences. For this reason, efforts should be made by taking certain measures in order to reduce the vulnerability. The vulnerability in the city area that has already been constructed should be reduced, wherever possible, by an adequate spatial reconstruction, that is, by not allowing an increase of interpolation. The new city parts should be planned bearing in mind the elements that would render the area's vulnerability acceptable.

Some elements reducing vulnerability:
- an interspace among facilities having to do with a demolition zone and fire prevention
- facilities constructed far away from the main city roads so as to leave free passage to emergency services in the case of them being pulled down

- not-constructed areas, out of the demolition zones, in all city quarters, where people might find shelter in a case of an earthquake and where, in a case of major demolitions, camping-sites might be organized for them

If we imagine a major earthquake having disastrous consequences, when, along with facilities' demolition and cracking roads, there are also a number of fires breaking out all at the same time, and when accidents in various plants and warehouses are also likely to happen as a secondary result of the earthquake or the fire, then these safety precautions become more and more acceptable.

Area for light planes landing and a heliport

Settlements, smaller and bigger cities should allocate an area for light planes landing and a heliport, because such an area would eventually render it easier for evacuation or emergency intervention. Such an area is also of a great importance for the zones being struck by frequent forest fires.

Sea

The sea has always been thought of as an infinite area where all the waste of the land life can be discarded. There is a growing consensus on how land and sea are interconnected.

The direct consequences of previous thinking that ignore human impact on the sea are clearly visible today and special attention should, therefore be paid to this problem in particular.

A lot would be done if the sea and coastal space had been treated just as the land space, by organizing zones reserved for certain activities such as: tourist zones, zones for maritime cultures, passages – corridors for passage of tankers and other vessels. The activities should also be well set apart, as on land, in order to reduce the influence of one activity on another one to the maximum or to make it impossible altogether.

Environment pollution can be categorized as belonging to a group of disasters having slow effects, but more questionable ones because its impacts become visible only after a longer period of time when an intervention in trying to improve the current state seems impossible.

For this reason, sea pollution should be paid more attention to and certain precaution measures should be undertaken, e.g.: land waste should be previously purified and treated, municipal services should be organized and included in treatment of all the waste produced by vessels, protection from the sudden sea pollution caused by sea accidents should be provided for.

Conclusion

Regional planning is a part of the continuum in disaster management and it is one of the important segments in mitigating conseguences.

Regional planning officers, that is to say, the decision makers in regional planning need to keep emphasizing the importance of the relationship between regional planning and protection. Such an issue shouldn't be taken into consideration only after a natural or man-made accident with disastrous consequences had taken place.

This paper tried to describe the importance of the town-planning protection measures in regional planning that would, as bordering parameters in making regional plans, contribute to the enhancement of living conditions and protection of the inhabitants.

GIS systems and IT modelling as a significant support to crisis management provide possibilities for determining the application of the town-planning measures for protection within the phase of regional-plan making. They provide a background made of seismic maps, maps of the river flood areas, areas potentially endangered by accidents taking place in tecnical and/or technological processes or traffic, maps of the areas pointing to the subterranean river flows and spring water sources with special protection treatment, etc.

This situation in regional planning must inevitably, be constantly improved. In the communities in which the correlation between regional planning and protection is neglected or which are not aware of the importance of that correlation, it is necessary to initiate primary activities by producing legal regulations and other legal measures of protection in regional planning and by increasing awareness of the community about the correlation between after-effects and construction.

About the Author

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TERRORISM

NATIONAL RESPONSE TO TERRORIST THREATS

A CASE STUDY OF DECISIONS RELATED TO EMERGENCY PREPAREDNESS IN THE NORWEGIAN HEALTH CARE AUTHORITIES

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Keywords

Decontamination, emergency response, emergency preparedness, authority decision, risk and performance analysis

Abstract

The terrorist attacks on the World Trade Centre and Pentagon, September 11th 2001, prompted nations worldwide to start rethinking their emergency preparedness status. In Norway, the threat of weapons of mass destruction became a focus of government attention. Two parallel instructions, to plan and acquire decontamination equipment, were issued, one to the Directorate of Civil Defense and the other to the Norwegian Board of Health. This work had been initiated before the terrorist attacks, but its planning and practical execution were enforced after the September 11 events.

This paper analyzes the planning and execution process, with emphasis on the process carried out within the health authorities. Several issues are considered. Firstly, why did the Norwegian government decide to purchase the decontamination equipment? Secondly, why were the time frames for acquisition and disposition so narrowly set? Thirdly, what level of improvement was expected in the performance of national emergency management? Based on a document study and interviews with involved personnel, the issues are viewed from three different perspectives: governmental communication to the public; relative power among competing governmental bodies; and performance of the emergency response arrangements.

We conclude that, even though the equipment is now in place, the operational environments (fire departments and hospitals) lack scientific evidence on the emergency performance of the equipment. Furthermore, criteria, limitations and prerequisites for the use of the equipment are not clear. Finally, future use and performance of the decontamination equipment are left to the different responders and are not related to any national plans.

Introduction

The Ministry of Health and Social Affairs launched in July 2001 a new act and regulations on health-related and social emergency preparedness, which included the section (2-1) on responsibility: “The subject carrying the responsibility for a service, also carries the responsibility for the necessary emergency preparations as well as for the executive services, including financing, in the case of war and of crisis and disasters in peace time,..”. This means that the different health services are themselves responsible for maintaining their operations during crisis situations. Risk and vulnerability analyses are mandatory as support for the enterprises’ emergency management systems, addressing the emergency response measures and equipment. In the wake of the terrorist attacks on the World Trade Centre and Pentagon,

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September 11th 2001, hereafter denoted the 9/11 attacks, increased government attention was focused on the threat of weapons of mass destruction.

This paper analyzes the planning and decision process involved in providing decontamination units to the Norwegian health care services that was carried out in autumn 2001 and continued into the first part of 2002. The scope was that decontamination of victims exposed to nuclear, chemical or biological substances should be undertaken in mobile units at the accident scene or close to the hospital access. The work was initiated by the Norwegian Board of Health but was handed over to the Directorate for Health and Social Affairs on January 1st 2002. The directorate then coordinated distribution to the health services (mainly hospitals) and follow-up activities.

Theory, methods and data

The 9/11 attack affected global security and as a consequence Norway was also in a crisis situation. Even though no event had occurred on Norwegian territory, the authorities were requested to reconsider their crisis management systems. Rosenthal et al. (1989; 2001) claim that crises represent "a serious threat to the basic structures or the fundamental values and norms of a system, which under time pressure and highly uncertain circumstances necessitates making critical decisions." They postulate that crises are a threshold to one of many alternative futures, inviting intense political activity at different levels. There are politicians and administrators who realize the importance of the aftermath and invest in the improvement of management procedures, techniques and preparations. But how could the involved parties in Norway determine where these efforts should be directed? An important principle of Norwegian emergency management is performance orientation. In order to choose the best options the use of a systematic planning process is assumed (Banfield 1959; ISO 2002), employing different methods of performance assessment.

In this paper we examine the Norwegian authorities' decisions to provide decontamination equipment from the crisis and risk management perspectives. The main research questions were:

Why did the Norwegian government decide to purchase the decontamination equipment?

Why were the time frames for acquisition and disposition so narrowly set?

To what extent was risk and performance assessment part of the decision support?

The study is a combined review of the documents in the case, filed by the Directorate for Health and Social Affairs (DHSA), and of interviews with involved personnel in the planning and decision process. The documents are dated from January 2001 until June 2005. We have only used open sources. We have not had access to any classified documents. However, there are no indications that classified documented assessments had played an important role. The majority of documents were issued in the period August 2001 – March 2003. There are about 150 different documents. Furthermore, 29 newspaper articles are included in the analysis, covering Norwegian emergency preparedness issues against nuclear biological and chemical substances. The articles were published in Norwegian regional and national newspapers during the first year after the 9/11 attacks. The analysis is performed from three different perspectives: governmental communications to the public; the power situation amongst competing governmental bodies; and performance of the emergency response arrangements.

This paper is limited to analysis of decisions and follow-up activities at the strategic level, covering the national professional considerations within the health authorities. Experience at operational and tactical level from the implementation and use of the equipment since 2001 is part of this project. The work is still ongoing and will be published later.

The planning and decision process leading to the distribution of decontamination units

<u>Background and existing work</u>

The Norwegian Board of Health (NBH) initiated a study in 1997 on the status of Norwegian emergency preparedness in relation to equipment and pharmaceuticals in the health sector. In the aftermath of this work another study was launched with the aim of identifying the types and quantities of different equipment needed in case of extraordinary situations. The work concluded that there was weak preparedness against human exposure to chemical substances. The society's ability to respond satisfactorily was poor. The report (NBH 2001) recommended that the health services be upgraded with detection, decontamination and individual protective equipment. Later on, in August 2001, the NBH carried out a survey directed to the 19 counties[2], with the aim of documenting the level of health preparedness against hazardous chemical substances and of mapping what equipment was available and ready for use. The survey revealed that there was very limited or practically no equipment available in 14 of 19 counties. The counties that had some equipment reported that this was insufficient and not dedicated to cleaning contaminated patients. Some health service units in the counties cooperated with the local fire brigade, but the equipment held by the fire brigades was also inadequate. Only 2-3 hospitals of 56 had equipment that could be called approximately sufficient and had facilities for receiving patients in dedicated areas.

Some work on contamination preparedness had also been carried out in the Directorate of Civil Defense (DCD) following a train accident at Lillestrøm station.

<u>The decision process</u>

There had been a process ongoing before the 9/11 attack, which concluded that 10-15 mobile contamination units were required. The NBH had already dedicated approx. 3 mill. NOK to provide 2 or 3 units, to be distributed to the most critical hospitals. Independently from the work described here, the Ministry of Justice and the Police had appointed a specific committee with the aim of developing recommendations for changes in the Norwegian rescue and emergency management sectors. The secretary of this committee contacted the executive officer in the NBH to clarify the status of the decontamination units. At that time the NBH had already developed draft tender specifications, dated September 4, and this information was sent to the committee secretary a few days before 9/11.

Then the 9/11 attack occurred and the agenda was totally changed. The Norwegian government requested the Ministry of Social and Health Affairs to analyze the current emergency preparedness situation. The work needed to be resolved promptly. Then the earlier work on providing decontamination units matched the request very well. The NBH saw an opportunity to complete their preparations. At the same time they also invited the DCD to cooperate in equipping the combating resources on the accident scenes with detection and decontamination measures, as well as the emergency wards at the hospitals. The leader of the emergency management section in the Ministry followed up the work by ensuring that contact with the Minister was made and that preparation of the formal governmental decision support materials was finalized. All the formalities were in place October 5th, less than a month after the 9/11 attacks.

The call for tender was issued by NBH September 25th. The contract was placed October 30th. The NBH then coordinated the purchase with the DCD and agreed jointly on choice of vendor, units, detection equipment, protection suits and subsequent training activities.

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[2] In 2001 the specialized health services incl. hospitals were owned and governed by the regional authorities (counties). This was changed from 2002. The responsibility then was transferred to national (governmental) level. By law, the responsibility for specialized services and the ownership of hospitals etc. were further transferred to five separate regional health enterprises, owned by the government.

There had been an election to the Norwegian parliament September 10th, and the Government in office lost. Neither the outgoing Government (the social democrats) nor the election winners (an alliance of non-socialists) had any objections whatsoever to the plans. A press release was issued October 5th from the Prime Minister's Office supporting the investments.

The same day as the contract was signed with the supplier of the decontamination units, the NBH sent an inquiry to the Norwegian counties asking them to recommend locations within the areas of their respective responsibility as support for the final national distribution.

The response from the 19 counties

As mentioned above, the first questionnaire had already been sent from the NBH June 20th 2001, independent of the 9/11 crisis. However this work was important for the outcome and it consisted of three questions:

1) Which hospital in the county is particularly likely to receive contaminated patients?
2) Which hospitals in the county have dedicated equipment to deal with contaminated patients? What type of equipment is available?
3) Which hospitals in the county ensure their emergency preparedness through agreements with collaborative partners? Who are they, what equipment do they have and what are expected response time?

Only 14 of 19 counties responded, and the tendency was clear: very little equipment was available for decontamination purposes. Some hospitals had sent medical staff to Sweden for special courses in the treatment and decontamination of patients suffering from the results of chemical accidents. Some counties documented their familiarity with the decontamination concept through the hospitals' different roles in the public emergency management plans. In the Oslo area the military forces, three major hospitals, the city council, the county council and the paramedic services in the region organized an expert committee, with the aim of elaborating issues relating to chemical accidents and the operational and technical needs in the area.

After the 9/11 attacks, the NBH sent an inquiry to all the counties in order to map the need for decontamination equipment as support for the final placement of the 16 purchased units and approx. 200 protection suits. Now the response rate increased to 100 % and all counties except one reported specific needs for the equipment. No county had conducted a separate risk and vulnerability analysis as argument for their requirements. One county established a scenario in which 100 persons were assumed to be intoxicated with an unidentified chemical substance. A discussion of available resources to deal with this concluded that there was a general lack of preparedness. Other counties and related hospitals justified their need for contamination units on the basis of population densities and a general description of transport conditions and industrial activities, or simply on the fact that the hospital served a population distant from other hospitals.

Deliveries

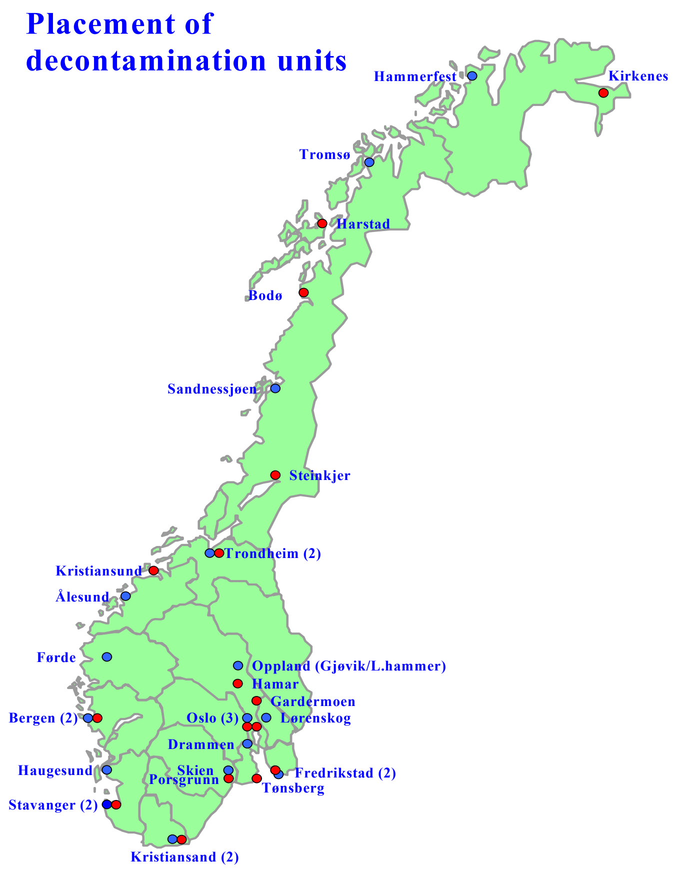
The decontamination unit is simply a washing assembly placed in an area where the victims can be gathered, undressed, washed and prepared for transport to hospital or admitted to hospital, cf. figure 1.

Figure 1, decontamination in a Norwegian unit

The Norwegian units are on trailers, fitted with two tents to make two parallel decontamination lines. A total of 32 units have been provided by the Norwegian authorities, of which 16 are located at selected hospitals and 16 are located at centers of civil defense brigades. The decontamination units are distributed across the country in accordance with a coordinated evaluation by the NBH and the DCD, based partly on assessment of needs and partly on geographical considerations, cf. figure 2. The DCP handed the equipment over to Civil Defense units throughout the country with the aim of supporting the accident scene teams with decontamination units. The hospitals were to protect in-house activities from contaminated patients, by providing the units for the emergency ward.

The materials supplied included mobile contamination units, detection equipment (CAM – chemical agent monitor, nuclear dose rate unit), protection suits and voice amplifiers. The specifications were mainly based on Swedish documentation (Swedish Board of Health and Welfare 1995) but extended to provide facilities for cleaning of patients contaminated by nuclear or biological substances.

<u>Figure 2, Location of the units</u>



The operational requirements for one decontamination unit are 24 persons (recommended crew), approx. 150 m^2 fairly level ground capable of supporting the weight of the trailer (approx. 3 tons), water supply (6-8 barg), and appropriate positioning in relation to wind direction and to other necessary accident scene/hospital operations.

<u>Assessments</u>

The NBH had to make two distinct assessments; 1) which supplier met the specifications most adequately, and 2) how were the needs for the equipment distributed across the country. For both these assessments an overall risk and vulnerability analysis would have been convenient. In the autumn 2001 no overall risk and vulnerability analysis existed, nor was there a list of recommended scenarios or situations of hazards and accidents on which to base any emergency preparedness measures.

The criteria for supplier selection were time and conditions of delivery, documented quality and user friendliness, economy, education and training provided, references and environmental aspects. The chosen vendor had been cooperating with the NBH for a long time, and was chosen mainly for time of delivery. The vendor also supplied thorough documentation, supplemental training and theoretical education, which increased the NBH's confidence in their products. However, the EFTA Surveillance Authority (ESA) questioned the NBH's public procurement, the treatment of the tender documents and the award procedure. The exchange of communication between the parties lasted more than a year before ESA closed the case.

The distribution of the equipment was not supported by any specific performance analysis, for example analyses based on risks and vulnerabilities. The distribution plan was concluded at a meeting November 16th between the DCD, NBHS and a representative from the National Police Directorate. After one county submitted a complaint that it had not received any decontamination units, the DCD responded through a letter in March 2002 that a thorough analysis had been made based on quantities such as population density, geographical location, probabilities for and consequences of mass destruction situations, and accidents involving dangerous goods on road, rail or at sea. However, these analyses are not documented, nor is there any reference to them in the earlier documentation obtained from the open sources.

Follow up activities from the Directorate for Health and Social Affairs

After the Directorate for Health and Social Affairs transferred the equipment to the hospitals, the Regional Health Services became responsible for the nuclear, biological and chemical protection measures, including the maintenance, operation and training of staff in connection with the decontamination units. A minor survey was carried out in 2003 (Grønning, Kvam and Talåsen 2003), and they concluded:

- There are major differences between the hospitals, particularly in relation to the number of personnel who have responsibilities for decontamination and who have received training.
- 14 of 16 hospitals have reported that they have carried out practical drills with the units.
- The majority of hospitals have developed specific operation procedures.

From the documents gathered from the Directorate for Health and Social Affairs in 2007 there were no documents on file containing experience data from the location, maintenance, training of personnel, or operation of the decontamination unit. The interview with the leader of the emergency preparedness section in the DHSA and a search through the DHSA's web pages confirmed this finding.

Ullevål University Hospital, Oslo, is appointed by the national health authorities as a medical competence centre on intoxication by chemical warfare agents and clinical management of these cases. In the material used for this study no specific documents from this organization have been found relating to the nation-wide use of decontamination units.

Discussion and conclusions

Government communications with the public

The decision to purchase decontamination units was announced October 5th by the Minister of Health, stating that general emergency preparedness in the health sector was good but there was a need to strengthen preparedness against weapons of mass destruction. The NBH was in 2001 preparing a major reorganization, segregating surveillance from emergency planning and consulting. Measures providing for decontamination of health care workers were launched before the 9/11 attacks, though not implemented at that time, building on experience from the Tokyo terrorist attack (sarin intoxication of subway), which there led to closure of a hospital.

Just before the 9/11 attack the Office of the Auditor General of Norway released a report, which harshly criticized civil defense preparedness, material and equipment inventory control and the internal control systems in the DCD and the Norwegian Civil Defense. The answer from the Ministry of Justice and Police was given after the 9/11 attacks and it acknowledged completely the criticism and provided measures to improve the situation.

The professional emergency organizations remained rather passive; neither the police nor the fire departments took part in the public discussions. There were no complaints about the emergency preparedness measures as such, and the professional emergency organizations showed no interest in obtaining control over the decontamination equipment.

Neither the media nor the public at large involved themselves in the different issues relating to the procurement and provision of decontamination units. The media seemed satisfied with bringing the weaknesses in the civil defense area to public attention, recognizing that measures were being taken. The debate was not characterized by scrutiny of the measures' performance. The major public discussion was limited to two months after the 9/11 attacks. Within a year the decontamination units were in place and the topic has rarely since been up to public debate.

Competing situations among different actors

Norway had a change of government following the national election, resulting in a new Minister of Justice and Police. Allocating resources to the area of emergency management as a response to the terrorist threat was fully supported by the Norwegian Parliament. Ensuring its reputation could have been important for the retired government and avoiding political controversy important for the winners. The political struggle was more visible in the bureaucracies:

The DCD was in a process where public administration and supervision of safety and emergency preparedness were under scrutiny and major organizational reforms were expected, and uncertainty about the future was therefore large. The traditional tasks involved in providing and maintaining the Norwegian Civil Defense were down-prioritized and had changed over the last 20 years. The decontamination equipment would imply a new area of expertise and entail new operational and maintenance tasks. The situation could be seen as a dynamic force in the process of the legitimization and re-legitimization of the emergency management administrative authority ('t Hart and Boin 2001). The first responders, especially the fire services and their related authorities (the Directorate for Fire and Electric Safety), were kept out of the discussion, and finally contacted when all the decisions about task responsibilities had been made.

In 2001, the health sector was involved in many major change processes as discussed above. A new law on social and health preparedness, segregating supervision from public administration, separating the Ministry of Health and Social Affairs into two ministries, and finally the 9/11 attack all called for clarification reports on the state of preparedness. However, the documents we have perused provide no evidence of internal disputes, nor did the interviews reveal any controversies among the different parties. One respondent commented that the 9/11 attack made the newly enforced law on health preparedness visible, and it has ever since held a central position in the regulations. He emphasized that both the specialized health services and the local public services now show particular interest in emergency preparedness work.

Analyses and assessments of the emergency response performance

There is no documentation showing which scenarios have been determined as dimensioning for the equipment, and supporting the subsequent decisions on location. In Norway a public report was released in 2000, discussing vulnerabilities in society (NoU 2000). The report addressed threats from chemical and biological agents, and the different categories of toxins. The use of decontamination units is only practical for a limited number of chemical gases. Biological substances will not be prevented or dealt with.

If we were to follow standard planning processes, as required by the law on health preparedness, we would expect different types of analyses (Banfield 1959; ISO 2002). For example issues such as: will a decontamination unit be available when it is needed? If yes, what is its performance (effectiveness) in terms of contamination removal capacity and execution time? Will the decontamination unit survive external loads – what are the vulnerabilities?

Decisions have been made without a systematic planning process that includes analyses of risk and performance. These evaluations should have been carried out as part of the implementation process within the operational emergency organizations, or structured experience gathering from practice, tests or real operations should be conducted. Otherwise the authorities run the risk of the rescuers losing confidence in the decontamination units as effective emergency response measures.

<u>Conclusions</u>

Why purchase the decontamination equipment? The 9/11 attacks came in the middle of an ongoing decision process. For the administrative staff working on chemical protection questions in spring and summer 2001, the 9/11 attack was thus a “lucky coincidence”. They had a “nose” for developing their case. Not much documentation was needed at that time to convince the decision makers of the importance of the issue.

Why were the time frames so narrowly set? The September 11th events triggered rethinking of emergency management in Norway. The attack came less than three months after the new act on health-related and social emergency preparedness came into force. The Minister of Justice and Police also needed to show their ability to respond effectively. The directorates were embroiled with internal problems, in the context of which the investment projects were regarded as positive opportunities. Close timing was therefore important for all actors involved on the higher levels. The haste with which the measures were implemented must also be seen in the light of the organizational changes in the health sector and the need for the involved parties to become operational as quickly as possible. There is also a possible explanation related to the ESA complaint, where the only argument for the chosen vendor was delivery time.

What characterized the planning and decision process? The process can be said to be “top-down” in the sense that the users on regional and local level (hospitals, local civil defense units) were not involved in the planning. Neither were risk and performance assessed on the basis of operational judgments. Nobody questioned the performance of the equipment. Neither the media nor the public at large were able to make critical analyses of these processes. They recognized and acknowledged that preparatory actions were made, but the adequacy of these actions was rarely questioned. They seemed to applaud the rapidity of action without questioning the relevance or effectiveness of the equipment. Occasional criticisms from medical staff, experts on infectious substances and first responders have been forwarded to the DHSA, without being followed up. As far as can be judged from the available documentation there have been no instructions, requirements or guidelines given from national health authorities to the operational level in relation to the use of the equipment, maintenance, continuous training of personnel or exercises. The relationship between local organizations, especially the hospitals, and the national intoxication competence centre at Ullevål University Hospital, Oslo, remains unclear.

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PROFILING SUICIDE TERRORISTS

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Key Words:

Terrorism, suicide, sociology, politics, strategy

Abstract

The causal logic of suicide as a tool of terrorism occurs on three levels; the strategic, the social, and the individual level. The strategic level includes political and policy level considerations and includes nationalistic considerations. The strategic desired outcome of the action is to draw attention, or garner support, for a given political goal. The majority of modern suicide incidents (57%) are secular in nature and are not affiliated with religious organizations. At the social level the considerations are also nationalistic and rarely include irrational or fanatic behavior. Individually the motivation for action involves an altruistic social perspective. This indicates that the action party is driven by a high level of social integration and respect for community values.

The misconception of suicide terrorists as religiously oriented fanatics that have underlying mental considerations and low education or social status is no longer accurate. Recent studies have narrowed the profile to identify individuals who are not socially isolated, have emotional and familial ties to their community, and include an increasing number of females. This paper will explore the social constructs of suicide terrorism and attempt to identify characteristics at the organizational and individual level that make profiling suicide terrorists more accurate.

The Ideology of Terrorist Organizations

Options for expression are the foundation of a free society. Without these options, because of coercive government or oppressive ideologies, expression in its peaceful form is stilted. Terrorist organizations often no longer view themselves as part of their societal or governmental structure, nor do they view their enemies as members of governments or civil societies. Terrorist organizations, and members within terrorist organizations, have a subjective interpretation of the world. Their perspective, often narrowly focused on single objectives, give rise to the perception of limited options for action. However, at no point do these organization and members lack logic and the ability to reason. Fanaticism can include moral absolutes to a given agenda, but does

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not mean that irrationality or madness is at the helm. Martha Crenshaw, the seminal terrorist sociologist, writes (1995), "The variable from which their belief systems are formed include their political and social environments, cultural traditions, and the internal dynamics of their clandestine groups. Their convictions may seem irrational or delusional to society in general, but the terrorists may nevertheless act rationally in their commitment to acting on their convictions."

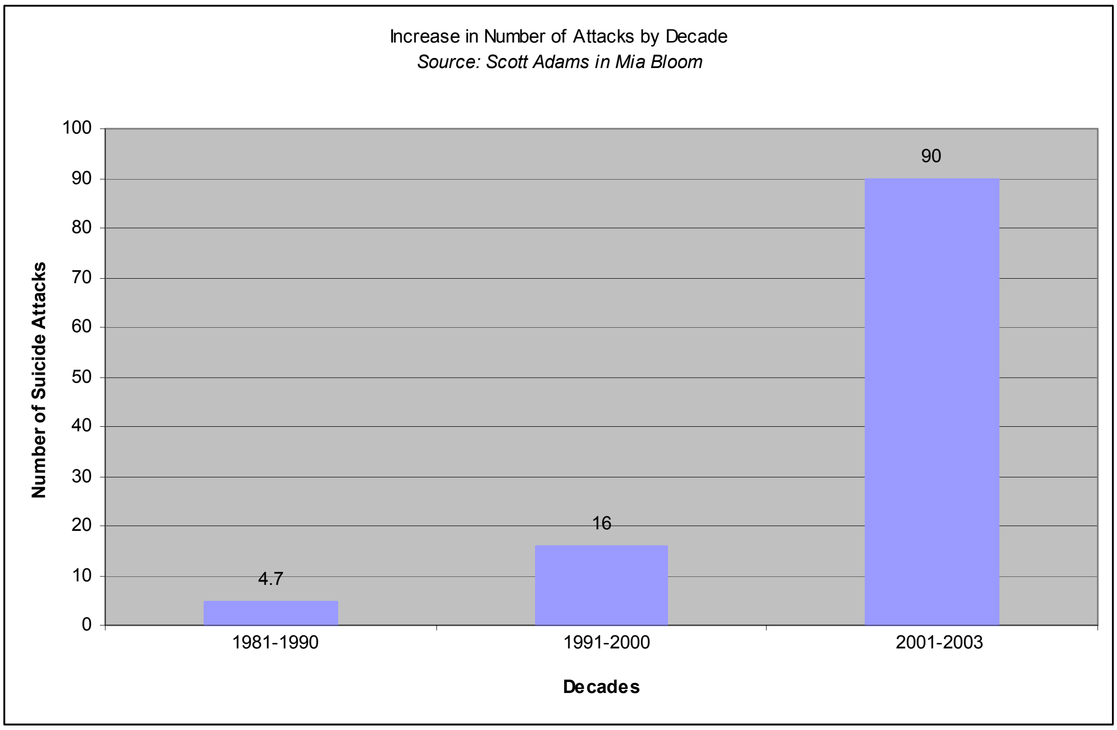
Given this perspective it is fair to acknowledge that terrorists, who use violence in extreme measure and often against innocent and symbolic populations, rarely view themselves as terrorisms. More often, within the narrow lens of their ideology, whether it is anarchism, Islamic fundamentalism, or revolutionary nationalism, these groups regard themselves as liberators, holy soldiers, martyrs and in all cases legitimate fighters for a noble and righteous cause.

Despite these commonalities it is impossible to create a typical or consistent profile of a terrorist, or a terrorist organization. Post (1985) noted that, "Behavioral scientists attempting to understand the psychology of individuals drawn to this violent political behavior have not succeeded in identifying a unique "terrorist mindset". People who have joined terrorist groups have come from a wide range of cultures, nationalities, and ideological causes, all strata of society, and diverse professions." Crucial to an understanding is the concept of perspective – the idea that we all have a view of the world, a view of ourselves, a view of others, and a view of ourselves in relation to others – which are all important to understand focused ideologies such as fundamentalism (Monroe and Kredie, 1997). The key concept is that fundamentalists see themselves not as individuals but rather as symbols.

In 1978 a group of psychoanalytically oriented theorists performed a field study, long before the outbreak of modern suicide bombing, to systematically analyze the approach to terror. The study was based on a series of interviews with Palestinian Arabs living in refugee camps in Gaza, Jordan, Cairo, and Jerusalem. The interview, and the foundational hypothesis was, "real or imagined threat or injury to the nation may be perceived by the individual as a danger or humiliation to the self, and that the individual response to the threat is substantially rooted in the distinctive psychological dynamics of self and its extensions" (GAP, 1978). The core theory used to explain this behavior was Kohut's narcissistic rage phenomenon occurs when the self-object fails to live up to absolute expectations. Although narcissistic rage occurs in some levels in all individuals, in those for whom a sense of absolute control over an archaic environment is indispensable, the narcissistic rage takes on violent forms. (Kohut, 1972)

Historical Trends in Suicide Attacks

The past decades have seen a dramatic increase in the number and scope of targeted suicide bombing attacks. Today, terrorist organizations rely increasingly on suicide attacks to achieve major political objectives, and attacks are growing in both frequency and diversity of location (Pape, 2003). Given the nature of these attacks there is an unmitigated success even in the event that limited damages are done. These attacks, regardless of their eventually kill/injured rate often inspire religious or ideological zeal, which in turn further destabilizes societies (Ganor, 2001). Because an attack with low kill/injury rate can affect public moral, suicide bombing causes not only direct damage to individuals but also severe psychological damage to the population at large. The fear of an attack, which is often greater than the threat itself, is largely the result of its unpredictability (Grimland, et. al, 2006).



Suicidal behavior, especially as a delivery method for a weapon, is not easily definable. Suicide in general can be divided between those who attempt suicide and those who succeed and die by suicide. If the intention of murder, in addition to suicide, is added to the event there is another distinction between those who are ready to die, those who seek to die, and those who are indoctrinated into suicide (Grimland, et. al, 2006). In addition, because the perpetrators death is a precondition for the success of the mission, analyzing perpetrators post event is almost impossible.

The profile of suicide bombers is as reflective of the population at large, as terrorist organizations. Merari's 2004 study of Palestinian terrorists found no differences in socioeconomic or educational factors from the general Palestinian population. One factor of note was the predominance of male suicide bombers but that has changed over the past ten year to include women martyrs. In addition, many martyrs are often unmarried, and many organizations routinely reject candidates who are under 18 years of age (Grimland, et. al, 2006). According to Merari the typical Palestinian suicide terrorist is, "religious, normal, polite and serious. Motivations include the effectiveness of suicide bombings as a military strategy, nationalistic pride, the need to revenge national and personal humiliation, and hatred of Israel and America." Ironically Moghadam's 2003 study reports that Hamas and PIJ (Palestinian Islamic Jihad) recruiters will not select candidates they deem to have suicidal tendencies. One PIJ member quoted in the study said, "In order to be a Martyr bomber, you have to want to live." (Grimland, et. al, 2006).

Women's role in suicide bombing has dramatically increased in the past decade. Often chosen for their innocent appearance (dressing as if pregnant), the reduced likelihood of a full body search because of proximity taboos, and their greater psychological impact.

In addition, Laqueur (1987) noted that female terrorists are more loyal and fanatical than their male counterparts. To date the major terrorist organizations around the world use female suicide bombers including but not limited to; PKK (Kurdistan Workers Party) in Turkey, the LTTE (Liberation Tigers of Tamil Eelam) in Sri Lanka, the SSNP (Syrian Social Nationalist Party) in Lebanon, the PIJ (Palestinian Islamic Jihad) in the Middle East, and Hamas in Sudan, Syria, Iraq, and Lebanon. As reported by Beyler in 2003, female suicide bombers had accounted for:

- 30-40% of suicide bombings by LTTE
- 73% of suicide bombings by PKK
- 41% of the suicide bombings by SSNP

The role for women in these traditionally patriarchical societies affords few freedoms to women. Women are traditional defined in terms of their male family members and are often formally uneducated. In groups such as the PKK women's involvement means both ethnic and gender emancipations. They are given equal status to their male counterparts and often undergo extensive military training. (Grimland, et. al, 2006). Because of their physical limitations in regular military operations, suicide missions offer them an opportunity to prove equality and worth to the organization.

Beyler (2003) studies extensively the role of the female "Birds of Freedom" suicide commandos as part of the Sri Lankan LTTE, who has between 5000-9000 female members. Beyler indicated that these women were considered equal to their male counterparts, given extensive training, and were sometimes even recruited as children. Many of the women were former rape victims and viewed the suicide missions as a way of restoring their self and public esteem (Beyler, 2003).

Of special note is the Chechen organization of "Black Windows" and almost exclusively female terrorist organization committed to the Chechen insurgency. Traditionally the Black Widows are sisters, mother, or wives or Chechen men who have died in battles with federal troops. Also included are women who have been raped, beaten, or otherwise "disgraced" by Russian troop. Their first attack on June 9, 2000 by Hawa Barayev killed 27 Russian Special Forces, a phenomenal success rate for a suicide attack. In 2003 the Black Windows were responsible for over 165 deaths in six suicide attacks (Bloom, 2005).

The role of female suicide bombers has also taken the Middle Eastern terrorist organizations by storm. Of debate is who was first, but Bloom, who has done extensive studies in the Middle East, identifies her as a 17 year –old Lebanese girl who in 1985 blew herself up near an Israeli convoy as part of the secular SSNP, a pro Syrian-Lebanese organization. These women, who are metaphorically and literally dying to participate, have caught both the Israeli Defense Force (IDF) and Palestinian organizations off guard. Originally denouncing women's violent role in Islamic fundamentalist organizations, Palestinian clerics have been forced to issue retrospective religious rulings (*Fatwas*) to now support women's roles.

Mitigation and Prevention of Terrorist Events

Rational choice theory as a tool to mitigate against terrorist organizations is not new (Anderton and Carter, 2005), and (Cornish and Clarke, 1987). Weaknesses to this idea have included social, psychological, and cultural influences. More importantly, rational choice theory does not account for why only a few individuals, among potentially millions in virtually identical situations, become terrorists. Individuals with passion, pride, remorse, and unique social reconstitution pressures, will often trump rationality. When behaviors deviate from the predicted base, understanding the mindset of a terrorist or a suicide bomber, become impossible to understand.

If insanity nor sociopathy nor rational choice can fully account for terrorist behaviors, what explanation is there? Crenshaw attempts to answer this by stating that although terrorists rarely exhibit psychological disorders, they may exhibit identifiable psychological traits and may have been influenced by identifiable social factors. This also raises the question of options, and how a rational person can turn to extremist violence. To be both politically motivated and "reach the point of no return" where violence and suicide is the only option requires a unique set of environmental factors. As noted before, not all suicide violence is religiously oriented, moving a martyr closer to their chose deity. Rather, the predominance of motivations is suicide as a military strategy. While often effective in its kill/injury rate, and effective in stirring up social passion for a cause, suicide terrorism is still an expensive undertaking when the time and labor to prepare a suicide mission is calculated.

Probably the greatest affect of the suicide mission is the continued platitude of the agent themselves. Wafa Idris, the first female suicide bomber is the Palestinian/Israeli conflict, who blew herself up outside a café in 2002, is still revered as one of the great martyrs of her time. Despite her low mission success (she killed herself and an 81 year man) she is the principle reason for *fatwas* allowing women to participate in suicide missions. Posters or her in montage and in portrait are easily available and a movie regarding her life is currently under production. This is particularly relevant where the primary target of a suicide bombing is not the target itself, but the continued recruitment of new volunteers.

The path to violent action is never thought of as the first solution to a new problem. Rational actors are forced to violence by lack of other means to gain attention to their cause. The halt of terrorism can be gained by the presence of options; such as electing opposition via popular vote, providing legitimate voice to an organizations perspective, or reducing the environmental conditions contributing to a sense of oppression through education and political choice.

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A CONTRIBUTION TO THE ENHANCEMENT OF PROTECTION MEASURES AGAINST PIRACY

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KEYWORDS:

Piracy, safety of navigation, protection measures.

ABSTRACT

Piracy describes materially motivated forms of organised acts of piracy perpetrated against a ship, aiming at unrighteous acquisition of material and/or financial assets. In the worst cases piracy results in human casualties. This paper discusses the impact of acts of piracy closely connected to the sailing route selection and the safety of navigation. It presents piracy threatened areas in the world. Comparable areas are subject to comparative analysis. It is expected that before long, seamen will implement new protection measures aiming at obstructing acts of piracy, particularly when transporting special and commercially very valuable cargo. This paper suggests paths for development of protection measures and legal framework for their introduction.

INTRODUCTION

Piracy has been legally defined by the *UNCLOS – United Nations Convention of Law at Sea*. UNCLOS advises to all signatory countries to cooperate to the fullest possible extent aimed at preventing piracy at sea or at any other place which is not under jurisdiction of any country. According to UNCLOS piracy is [1]:

- Any illegal acts of violence or detention, or any act of depredation, committed for private ends by the crew or the passengers of a private ship or a private aircraft, and directed on the high seas, against another ship or aircraft, or against persons or property on board such ship or aircraft against a ship, aircraft, persons or property in a place outside the jurisdiction of any State,

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- Any act of voluntary participation in the operation of a ship or of an aircraft with knowledge of facts making it a pirate ship or aircraft,
- Any act of inciting or of intentionally facilitating an act described in two previous subparagraphs.

On the high seas, or in any other place outside the jurisdiction of any State, every State may seize a pirate ship or aircraft, or a ship or aircraft taken by piracy and under the control of pirates, and arrest the persons and seize the property on board. The seizure may be carried out by ships or aeroplanes of the military or government authorities.

Piracy is also indirectly mentioned in the *International Convention on Safety of Life at Sea – SOLAS* [3], and in the *International Ship and Port Facility Security Code – ISPS Code* [4]. There are no clearly stipulated measures for protection against piracy, which is considered to be the basic disadvantage for a successful protection against piracy attacks.

Due to the increased threat of piracy the *International Chamber of Commence – ICC* founded the *International Maritime Bureau – IMB* whose task is to collect and exchange data about any kind of attacks to ships [4]. In 1992 ICC IMB founded the *Piracy Reporting Centre – PRC* located in Kuala Lumpur. Its role is to collect, process, analyse and forward data about piracy attacks.

THEORY AND METHOD

Piracy acts have adverse effects to navigation. Their effects relate to the selection of navigational route, measures of precaution and protection applied for safe navigation along the piracy threatened areas.

From the point of safety of navigation navigational areas have to be classified to *Piracy Area Navigation – PAN* and *Non-Piracy Area Navigation – NPAN*.

When selecting the navigational route all statistical data about piracy need to be taken into account. If the selected route passes through the piracy threatened area, the route should be changed if possible.

If it is indispensable to navigate along the piracy threatened areas preparatory measures need to be undertaken. Necessary precautions during the navigation of the ship along the piracy threatened areas are realised by increasing the number of anti-piracy watch. Anti-piracy watch is a precondition for early discovery of attempts of piracy attacks to the ship.
Piracy attacks occur more frequently during the night than during he day. It is therefore necessary to navigate particularly carefully and observe the area surrounding the ship.

RESULTS

Areas limited in space like channels, straits, passages and bays, are naturally convenient for piracy attacks to ships. Piracy is more frequent in underdeveloped countries.

I. In south-eastern Asia and Indian Sub-Continent there are several hot spots of piracy activities [5]:

- Indonesian Islands,
- Malacca Strait ,
- Malaysia, and
- Singapore Strait.

In Africa and the Red Sea the hot spots of piracy activities are [5]:

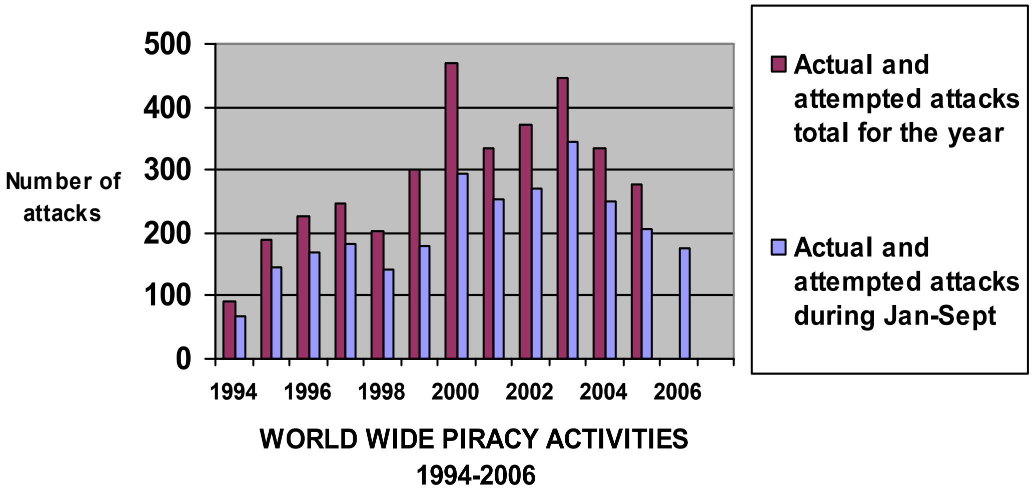
- West Africa (Nigeria),
- Aden Bay and the Red Sea, and
- Somalia waters.

The hot spots of piracy activities in middle and South America are [5]:

- Brazil,
- Jamaica, and
- Peru.

Table 1 World-wide piracy activities 1994-2006

Source: http//www.icc-ccs.org, *Piracy and armed robbery against ships report for the period 1st January – 30th September 2006,* ICC International Maritime Bureau, Kuala Lumpur, 2006.



Statistical analysis of the data for the period of 1994 to 2005 show that annual piracy activities amount to 290.42 attacks a year.
Distribution of piracy activities is not even. The areas of real attacks are illustrated in Figures 1, 2 and 3 [5].

Figure 1 Piracy and Armed robbery – 1st January to 30th September 2006 Attacks in SE Asia, Indian Sub-Continent and Far East
Source: http//www.icc-ccs.org, *Piracy and armed robbery against ships report for the period 1st January – 30th September 2006,* ICC International Maritime Bureau, Kuala Lumpur, 2006.

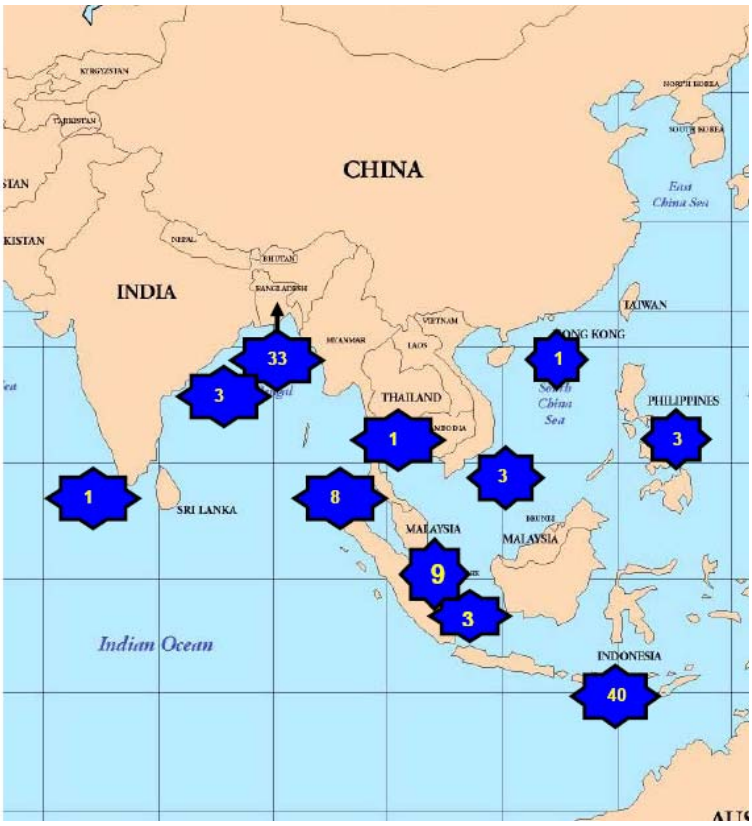


Figure 2 Piracy and Armed robbery – 1st January to 30th September 2006 Attacks in Africa
Source: http//www.icc-ccs.org, *Piracy and armed robbery against ships report for the period 1st January – 30th September 2006,* ICC International Maritime Bureau, Kuala Lumpur, 2006.

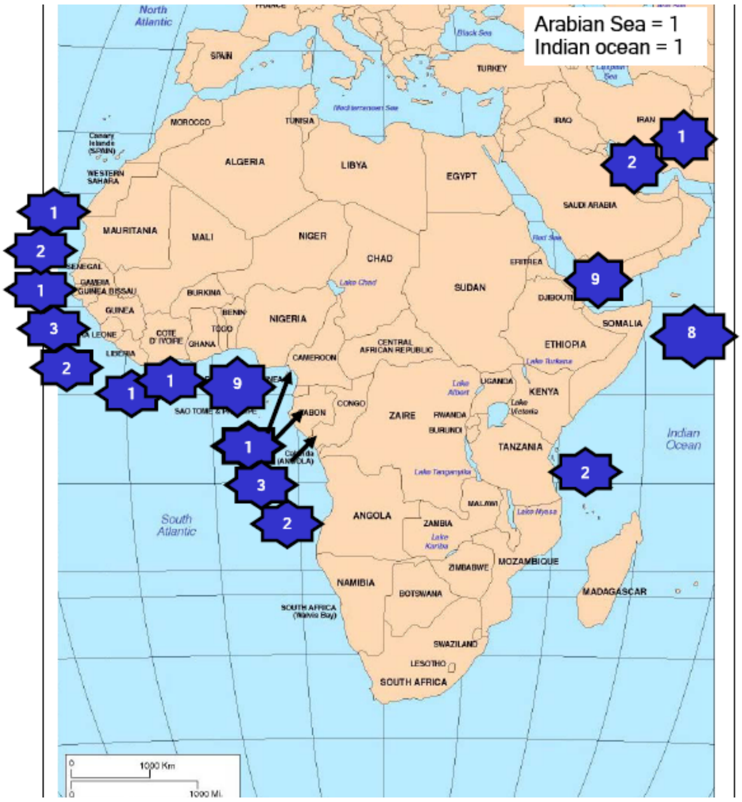
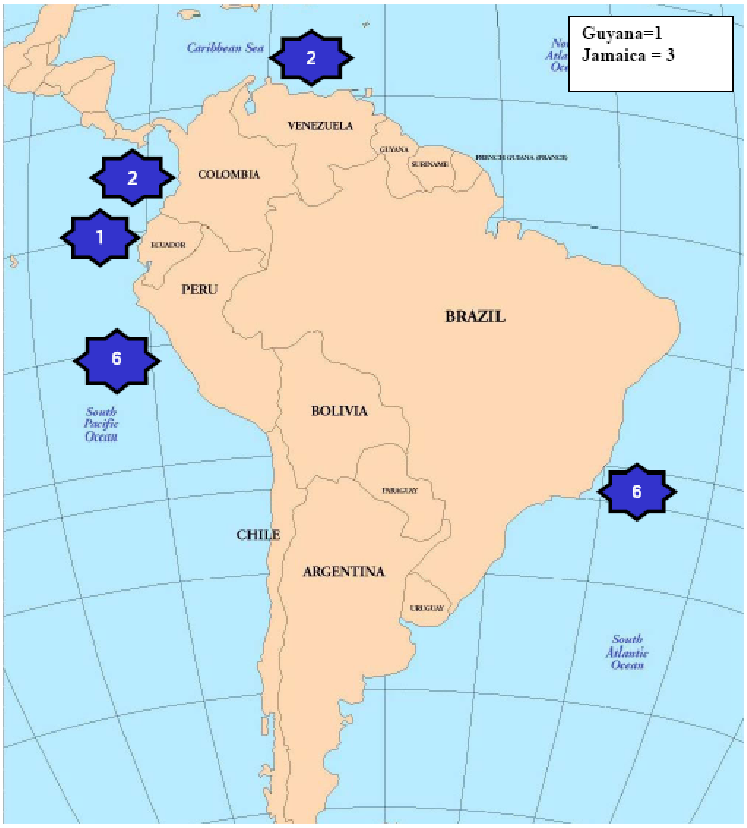


Figure 3 Piracy and Armed robbery – 1st January to 30th September 2006 Attacks in Caribbean, South and Central America
Source: http//www.icc-ccs.org, *Piracy and armed robbery against ships report for the period 1st January – 30th September 2006,* ICC International Maritime Bureau, Kuala Lumpur, 2006.



It is proposed to consider the following areas as key hot spots of piracy activities:

- Bangladesh,
- Malacca Strait,
- Singapore Strait,
- Nigeria,
- Somalia,
- The Red Sea,
- Brazil, and
- Peru.

These areas are considered key hot spots as there the number of attacks is above the average [5]. Evaluation of the existing piracy protection measures can be done analysing the number of attempts of attacks and the total number of successful attacks [2]. The indicator of success shows that the existing piracy protection measures are not sufficient. [2].

DISCUSSION

It is indisputable that piracy the safety protection is a threat for the protection of ships. It is assumed that in the case of piracy attacks the current alarm system of the ISPS Code[4]. The alarm system is installed in the Convention ships, and pursuant to SOLAS requirements, it has to be installed in the Commander Bridge and in another place on the ship. Depending on the kind of performance, the warning after activating the alarm is done by:

- Permanent monitoring of the alarm system (checking signal every six hours),
- Integrating it with the equipment of *Global Maritime, Distress and Safety System – GMDSS*, and
- Changing the spoken and text messages.

However, the alarm system does not contribute significantly to the increased piracy protection measures. Surely, the current measures for protection against piracy are not sufficient, and it is therefore necessary to develop new measures for prevention and protection against piracy. It is assumed that it is possible to use various weapons and other technical and technological devices. Hence, it is necessary to study psychological, military and other aspects of using personal weapons according to determined requirements, and the modern technical and technological protection devices similar to the protection of objects ashore.

The use of weapon would definitely require additional training aimed at obtaining certificate for manipulation. The use of technical and technological devices aimed at increasing the piracy protection measures may relate to:

- Electric protection barriers,
- Dazing system, and
- Deck video surveillance system.

Technical and technological protection devices aimed at increasing protection measures against piracy at ships require adaptation to special conditions of life at sea. Also, during the further study it is necessary to determine the ratio between the number of attacks to ships in navigation, in the anchorage or berth, in order to optimise the adjustment of the selected device for the protection of the ship. One should note the difference between piracy and terrorist attacks, and in future researches attacks aimed at acquiring property or money should be distinguished and studied separately from political and religious attacks. A real contribution to increasing the piracy protection measures is also legal support in designing the proposed protection measures. In case of positive results of the proposed researches,

[4] SOLAS XI-2/6

regulations relating to training authorised personnel for using weapons should be developed. It is expected that the *Standards of Training, Certificating and Watch keeping - STCW* will be adequate legal support to possible use of weapons on the ship. Moreover, it is advised that the storage requirements are defined by the ISPS Code.

It may be concluded that after the research proposed to the *International Maritime Organisation – IMO* amendments to the ISPS Code should be proposed.

CONCLUSION

Piracy is a minor form of organised activities targeted at a ship aimed at illegal acquisition of material and/or financial goods, and it has been legally defined by the UN Convention of Law at Sea. The Convention of Law at Sea advises all signatory countries the highest extent of cooperation aimed at prevention of piracy in the open sea or in any other place which is not under the jurisdiction of any country. According to the Convention piracy is any illegal form of violence, or detention, or any act of depredation, committed for private ends by the crew or the passengers of a private ship or a private aircraft, and directed on the high seas, against another ship or aircraft, or against persons or property on board such ship or aircraft against a ship, aircraft, persons or property in a place outside the jurisdiction of any State, act of voluntary participation in the operation of a ship or of an aircraft with knowledge of facts making it a pirate ship or aircraft, and any act of inciting or of intentionally facilitating a piracy act.

Piracy activities affect the selection of navigational route. When selecting the navigational route all statistical indicators of piracy attacks and the obtained data about the areas of presence of piracy attacks need to be taken into account. If the route which the ship has to select passes through the areas of presence of piracy then it is necessary to change the route.

If possible, the route through presence of piracy should be replaced by a new route through safe area. If it is not possible then actions for preventing the assault of pirates onto the ship should be undertaken.

The analysis of the data about piracy activities indicates that the existing protection measures are not adequate. Therefore a possible implementation of adequate devices aimed at increasing piracy protection measures is proposed. If the suggested researches confirm the proposal, it is further proposed to use weapons and other technical and technological protection devices which are used for protection of objects and equipment ashore. The use of the proposed protection measures requires legal framework which can be realised through the IMO and modifications of the SOLAS Convention, ISPS and STCW Code.

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BIOGRAPHY

Josip Kasum, Sc. D. was born on 6th May 1961, in Zagreb, Croatia. He was employed at computer maintenance of Ei Honeywell Bull. He worked as an independent designer in the electronic department of the company DALMA Split and as a research assistant for technical aspects of telecommunications from 1991 to 1993. He has been employed at Croatian Hydrographic Institute (HHI) since 1993. He actively participates in various scientific and/or expert projects within the HHI, such as ADRIA1/ADRIA2 – optical under-sea cable. He also works as the author and/or editor of publications from the fields of naval electronics, radio service and telecommunications and as the manager of system support and Director's consultant since 2000. He gained navigational experience while working on hydrographic survey on the following vessels: m/v JUNAK – Brodospas, m/v VIHOR – Brodospas, m/v HIDRA – HHI – permanently, m/v PALAGRUZA – HHI and m/v LITTLEHALES–USA NAVAL SHIP in the joint project – Hydrographic survey of the high sea of the Adriatic. He is a member of the Association for electromagnetic compatibility ELMACO from Split and an associate in two technical boards of the Bureau of Standards in Zagreb. He also worked abroad, e.g. in London, Great Britain, where he participated in the work of COMSAR, a subcommittee of IMO, in 1998 and 2003, and in various European countries, in accordance to the requirements of the Council for telecommunications of the Republic of Croatia and of HHI. He is a member of the Royal Institute of Navigation in London. He is a member of System Dynamics Society, University of Albany, USA. He passed the State examination, and also went to through advanced training in Honeywell Bull HW/SW, personal computers HW/SW, computer networking, management etc. He has a skipper licence, GMDSS-GOC radio operator licence, etc. He is a permanent expert witness at the County court and Commercial court in Split. Pursuant to the Decision of the Croatian Parliament he has been a member of the National Council for higher education since 2004. He has been a member of the Scientific Traffic Council at Croatian Academy of Arts and Sciences since 2005 He is registered in the Registry of researchers of the Ministry of science, education and sports of the Republic of Croatia, reg. number 222324. He has published 24 scientific papers in relevant scientific magazines and scientific conferences, and a series of books, researches and studies.

Krešimir Baljak, Graduate engineer was born on 10th January 1979 in Zadar, Croatia. He graduated at the Maritime Faculty in Split with the thesis *Plovidba uz pomoć nebeskih tijela uz strukturu nebeske sfere te povijesno i mitsko značenje* and was awarded the academic title of Graduate engineer of maritime traffic. . He gained navigational experience while working on tankers for crude oil, chemicals and liquefied gas for the shipping companies *CHEMIKALIEN SEETRANSPORT* (Hamburg), *TECTO* (Antwerpen) and *OSG* (London) from 2002 to 2004. He worked in the Secondary maritime School as a teacher of nautical subjects from 2004 to 2005. He started working at the Maritime Faculty of the University of Split in 2005 as an assistant at the Institute for maritime navigation. He is a member of the Maritime Captains Association. He has a deck officer licence for ships over 500 GT, captain licence for yachts up to 500 GT, general radio operator licence GMDSS, qualifications for work with crude oil, liquefied gas, hazardous materials, managing fires, providing first aid assistance and medical care aboard, basic security on tankers and ships, etc. He is registered in the Registry of researchers of the Ministry of science, education and sports of the Republic of Croatia, reg. number 278380. He published several scientific and expert papers, participated in scientific and expert conferences and research workshops. He is doing his post graduate studies at the Traffic Faculty in Zagreb.

Pero Vidan, Graduate engineer was born on 9th September 1076 in Metković, Croatia. He graduated from the Maritime Fcaulty in Split in 2000 and then sailed at various ships for *Splitska plovidba*, *Mediteranska plovidba*, *Armada Swiss*, *Seatrade*. He passed the exam for the Captain of the ships above 3000 GT. Since 1st March 2006 he has worked as an assistant at the Maritime Faculty in Split for the practical courses of Practice and Electronic Navigation. He is a member of the Maritime Captains Association He is registered in the Registry of researchers of the Ministry of science, education and sports of the Republic of Croatia, reg. number 288456. He is doing his post graduate studies at the Traffic Faculty in Zagreb

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FIRE FIGHTING & SAFETY

AGENT BASED FUZZY COGNITIVE MAPS IN FIRE FIGHTING DECISION SUPPORT

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Keywords

Decision support, fire fighting, fuzzy cognitive maps, agent systems, agent based fuzzy cognitive maps

Abstract

Fire fighting process in Croatia is mainly based on the firefighter knowledge. People on the field decide when to include air forces in the extinction, when to call new forces, etc. Modelling such a complex decision process is difficult and only possible with qualitative modeling techniques. This paper presents the developed agent based fuzzy cognitive map containing fire fighter knowledge. The map can be used as a decision support tool to facilitate the decision process in such a stress situations. Agent based fuzzy cognitive map is qualitative modeling and simulation technique built combining fuzzy cognitive maps and multi-agent systems. Fuzzy Cognitive Maps are qualitative modelling and simulation technique that models system like the group of concepts and the cause-effect relations among concepts. A FCM is represented as a weighted, directed graph with the map concepts as graph nodes and the cause-effect relations as a graph directed edges. FCM is a method for representing the knowledge and an inference process that generates conclusion of the dynamic system behaviour. A multi-agent system can be defined as a network of entities working together on solving the problem that is beyond the agent individual solving capabilities and knowledge with properties like no global system control, decentralized data, etc. The Agent Based Fuzzy Cognitive Map is a Fuzzy Cognitive Map based on a multi-agent system with each concept mapped in to the agent. ABFCM enables each concept in the map to use the different inference process and enables the further extension with the introduction of new agents with specific functionality, like assisting the user with the map results interpretation.

Introduction

The main idea of this work is to facilitate a fire fighter manager work. The term fire fighter manager is used for a person or persons that guide a fire fighting process.

One way to do that is to develop decision support system for a fire fighter manager decision-aid in such a stress situation as a fire fighting (Li at al. 1991). The concept of a decision

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support system (DSS) is very broad since decision support system can take many different forms. We can say that a DSS is a information system that supports decision making (Power, 1997).

Decisions concerning such emergency situations like a fire fighting are numerous. Majority of DSS systems in the fire fighting area are built on a fire risk prediction models and fire propagation models (Sung-Do et al., 2003). Those models are mainly GIS (geographical information system) based. We are developing DSS system trying to incorporate fire fighter manager knowledge about fire fighting forces management. The fire fighter manager knowledge is responsible for the decisions like:

- when to call air support,
- when to relocate forces from one fire scene to another,
- if the fire fighting forces are limited in a case of multiple fires which fire has a priority i.e. if there is just one Canadair to which fire scene will it be sent? Etc.

These decisions are, of course, based on the GIS data but we would try to capture general knowledge that would be applicable to different fire locations with diverse geography.

Since this kind of knowledge and inference process made by a human fire fighting manager is very complex it could not be defined quantitatively. One of the solutions is to use a qualitative model. Qualitative model should capture fire fighter manager knowledge and decision making process. It is important to stress out that this kind of fire domain DSS is in no way replacement for the human, just an aid-tool.

There are many qualitative modelling techniques like qualitative reasoning (Travé-Massuyès et al., 2003), system dynamics (Craig, 2001), semantic networks (Fisher et al., 2002) etc. Here we would use technique called Agent Based Fuzzy Cognitive Map. In short it is a technique developed combining Fuzzy Cognitive Maps and Multi-agent systems. Those techniques are explained in detail in next chapters.

FCM

Fuzzy **C**ognitive **M**ap - FCM is qualitative modelling and system dynamic behaviour technique. FCM models system like a group of concepts and cause-effect relations among those concepts and then represents system as a weighted, directed graph (Kosko, 1986). Bart Kosko has defined FCM in 1986. expanding **C**ognitive **M**aps or **C**ausal **M**aps – CM in a manner that concepts and cause-effects values from {-1, 0, 1} assembly are augmented to the [-1, 1] interval (Kosko, 1992).

It can be said that a Fuzzy Cognitive Map is combination of a conceptual map and fuzzy logic providing more realistic and more accurate real word portrait then the conceptual maps binary logic. FCM modelled system is represented as a weighted, directed graph with concepts represented as a graph nodes and cause-effect relationships represented as a graph directed edges.

FCM develop process is similar to the expert system knowledge base development. One or more expert identifies concepts and cause-effect relations among those concepts. Expert job is also to define cause-effect relations intensity. In a FCM each cause-effect relation is described with the linguistic variable which is then described with the membership function (Cox, 1999).

It is implied that a large cause-effect relation weighted factor means a strong cause-effect relation among concepts. Experts describe relations as a strong, week, etc. like in fuzzy logic. But the defuzzification process is done directly by the expert or by the map creator. For example, strong positive effect in the defuzzification process becomes weighted factor 0.8. Medium strong negative effect in the defuzzification process becomes weighted factor -0.48. The positive weighted factor sign indicates that if the concept from which cause-effect relation originates increases than the concept in which cause-effect relation terminates also increases. The negative weighted factor sign indicates that if the concept from which cause-effect relation originates increases than the concept in which cause-effect relation terminates decreases.

In a simplest form of a FCM, weighted factors are limited to the set {-1, 0, 1}, that is, cause-effect relations strength is maximized. This facilitates transfer of an expert knowledge to a FCM. Sometimes experts don't know how to defuzzificate their knowledge, that is, how to quantify impact among concepts. In that case knowledge engineer can use Questionnaire method or Documentary Coding method to extract expert knowledge linguistically and then proceed with the knowledge defuzzification (Kim et al., 1998).

Questionnaire method is implemented via interviews which provide the knowledge to the knowledge engineer who then fills questionnaires capturing expert knowledge. Documentary Coding method is systematic encoding of available documentation that is at the knowledge engineer disposal and contains system information.

Fuzzy cognitive map represents knowledge about a system but also provides inference mechanism based on the expert knowledge expressed in the FCM form. Because of that FCM can be considered artificial intelligence system (Miao et al., 2000). Inference mechanism in the simplest form is manipulation of two matrices - concept vector and adjacency matrix (Taber, 1991). The concept vector contains fuzzy cognitive map concepts values. The adjacency matrix mathematically represents cause-effect relations among map concepts. If the *i*-th node state at the time moment *t* is denoted with A_i^t and if the *i*-th adjacency matrix column is denoted with w_{ji} simple inference process is introduced with the next equation:

$$A_i^t = f(\sum_{\substack{j=1 \\ j \neq i}}^{n} A_j^{t-1} w_{ji})$$

The A_j^{t-1} is *j*-th node state at the time moment *t-1*, *f* is a transformation function and *n* is overall map concepts number. The transformation function normalizes node state to the interval [-1, 1]. Transformation function also incorporates expert knowledge. Transformation function is not limited to any predefined function and depends on the system modelled with the map. Commonly used functions include *tanh* function, *signum* function, etc.

Generating conclusion on the system, represented with the map, behaviour is called fuzzy cognitive map dynamic analysis. Map nodes are set to initial state (based on the state of real concepts represented with the map nodes) and then the map is started. Results obtained with the map are map conclusion about system behaviour. The conclusion can be made only if the map enters fixed-point attractor or limit cycle state. With the map fixed-point attractor the map concepts don't change value any more. With the map limit cycle state the map concepts repeat previously reached value.

Multi-agent system

Multi-agent system is a system composed of several autonomous components or agents (Jennings et al., 1998). Agent is a computer system, situated in an environment, it can receive stimulus from the environment and can flexibly and autonomously act in pursuing its goals (Franklin et al., 1996). In our application it is appropriate to observed multi-agent system as a loosely connected network of entities together solving problems beyond agents' individual capabilities. Multi-agent system characteristics include:

- agents have limited information or problem solving capability,
- there is no central system control,
- data are decentralized,
- multi-agent system is asynchronous.

Agent interaction is the key issue in a multi-agent system (Ferber, 1999). Interaction occurs as a chain of agents actions while agents are in a dynamic connection. Interaction consequences influence the future agent behaviour. Agents can realize interaction either directly, either through environment or through some kind of a mediator agent.

Ontology

An agent application covers a limited domain. It is practically impossible to create general multi-agent system. Agent application domain is defined through one or more ontology. Common ontology is something that is mandatory for a multi-agent system. Without common ontology it is not possible to accomplish sensible and useful communication among agents regardless of the used technology, application area or information infrastructure. It is *conditio sine qua non* for a multi-agent system.

Ontology is explicit specification of the knowledge conceptualization (Gruber, 1993). Formal knowledge representation is based on a knowledge conceptualization. The knowledge conceptualization is definition of concepts, objects, entities that exist in the observed domain and their relations. The conceptualization is abstract, simplified domain representation. Each knowledge based system or agent possessing knowledge is bounded to some kind of a conceptualization. When the domain knowledge is formally described, domain objects are called universe of discourse. The universe of discourse is a set of objects and their relations in the developed dictionary describing the knowledge. Knowledge base and ontology are not the same. Common ontology describes the dictionary that can be used in the "conversation" about a domain while knowledge base includes knowledge necessary for solving a problem or answering a domain question.

ABFCM

Multi-agent system and fuzzy cognitive map technologies synergy has provided theoretical basics to define new method for qualitative modelling called *Agent Based Fuzzy Cognitive Map - ABFCM*. Agent based fuzzy cognitive map is a fuzzy cognitive map in which each concept is mapped into the agent in the multi-agent system. Cause-effect relations among map concepts in the multi-agent system are carried out through agent message communication exchanging information about cause-effect relations. In a classic fuzzy cognitive map all concepts use the same inference process to calculate the node new state. Agent Based Fuzzy Cognitive Map enables each concept modelled with an agent to use different algorithm to calculate new state.

Theoretical ABFCM basics are tested with the specially developed ABFCM prototype which is also used in this paper to provide the fire fighter manager with the decision support system. The prototype has a graphical user interface enabling user to simply draw map and to define map concepts inference process and other characteristics like initial state. More detailed ABFCM explanation is provided in a paper currently submitted to be considered for publication in the Journal of Intelligent and Fuzzy Systems.

ABFCM FIRE FIGHTING DECISION SUPPORT SYSTEM

We are developing a fire fighter manager decision support system based on the ABFCM method. The fire fighter manager decision support is not the only disaster management area for the ABFCM decision support.

A fire fighter manager guiding a fire fighting process needs to make many different decisions. ABFCM decision support system can be made and used quickly. The ABFCM is based on the fire fighter knowledge whiteout quantitative values. It can be obtained at the fire site and then used in a decision support for the observed fire. Example of a decision support encompasses situation when a fire fighter manager has to decide how to distribute land and air fire fighting forces among simultaneous fires. That situation is not uncommon on the Adriatic coast especially in the fire fighting season during the summer. Information (the Split-Dalmatia

County from 20.7.2006. till the 29.7.2006.) from the Croatian National Protection and Rescue Directorate (DZUS, 2007) are shown in the table 1. It is not uncommon to have two fires in the same time. The fire fighter manager has to distribute the fire fighter forces according to the fire priorities.

Table 1. Fire locations from the 20.7.2006. till the 29.7.2006. for the Split-Dalmatia County according to the Croatian National Protection and Rescue Directorate

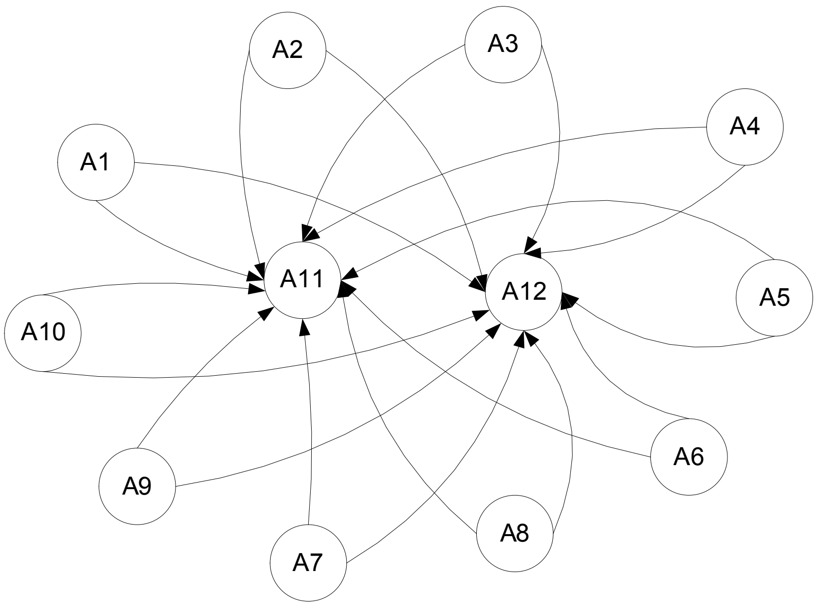
Date	Fires in the Split-Dalmatia County
20.7.2006.	1. Vrgorac
21.7.2006.	1. between Lovreć and Šestanovac (Prpuša) 2. Vrgorac
22.7.2006.	1. between Lovreć and Šestanovac (Prpuša) 2. Sitno Gornje
23.7.2006.	
24.7.2006.	
25.7.2006.	1. Mosor, Debelo Brdo 2. Muć-Ogarje-Karanove Kuće 3. Žrnovnica-Lolići 4. Kaštela
26.7.2006.	1. Vrgorac – Matokit – Sveti Rok 2. Mosor, Debelo Brdo 3. Sadine-Rudine
27.7.2006.	
28.7.2006.	
29.7.2006.	1. Vrgorac – Matokit – Sveti Rok 2. Hvar

Development of the ABFCM map demands extracting the expert knowledge about system concepts and their relations in the modelled system. Knowledge extraction for the obtained map is done by the knowledge engineer using both methods, Documentary Coding and Questionnaire, described in the FCM chapter. Based on the available documentation about fire fighting process, fire fighting management, fire fighting forces (UPVH, 2007) etc. and based on the information provided by the expert the knowledge engineer has identified main concepts. Main identified concepts affecting fire fighter manager decisions on calling and allocating available forces in a fire are:

- possibility of a human loss
- strategic buildings endanger (infrastructure, military objects, …)
- other buildings endanger (houses, business buildings, …)
- proximity of nature monument

- national park or nature park proximity
- fire extension area (an emerging fire is easier to extinguish then the developed one)
- endanger of important traffic routes (like the highway Zagreb-Split) surrounded with mine fields
- the vegetation type caught in a fire
- meteorological factors that influence fire spreading (like the wind)
- the time of day (air forces are neutralized during the night time)

Figure 1. The ABFCM map for the fire fighter decision support



- A1 - possibility of a human loss
- A2 - strategic buildings endanger (infrastructure, military objects, …)
- A3 - other buildings endanger (houses, business buildings, …)
- A4 - proximity of nature monument
- A5 - national park or nature park proximity
- A6 - fire extension area (an emerging fire is easier to extinguish then the developed one)
- A7 -endanger of important traffic routes (like the highway Zagreb-Split) surrounded with mine fields
- A8 – the vegetation type caught in a fire
- A9 - meteorological factors that influence fire spreading (like the wind)
- A10 – the time of day (air forces are neutralized during the night time)
- A11 - land forces
- A12 - air forces

Special provisions at the Adriatic coast refer to the islands and peninsula Pelješac. In a fire case the islands and peninsula Pelješac have precedence over the other regions. This knowledge is not included in the map on figure 1. because the map is limited to a fire fighter manager knowledge fragment for the developed map. Influence of the special provisions can be introduced in the map with the new concept (or concepts) and cause-effect relations. We have restricted the map because this is initial research. The map can incorporate such complex and comprehensive fire fighter knowledge and will be expanded in the future.

Concepts are listed according to the importance. For example, possibility of a human loss has greater impact on a decision to call fire forces than a traffic shutdown. The concept significance is encoded in the map thru cause-effect relation weighted factor. Large cause-effect relation weighted factor implies strong cause-effect relation among concepts. The fire fighter manager main decisions are to call land and/or air fire fighter forces. They are introduced in the map thru two concepts:

- land forces
- air forces

It should be stated that decisions concepts are also simplified. Real life situation is much more complex. The fire fighter manager has to decide will he call just local fire fighter forces or extend the call to outer fire fighter forces. Will he call Canadair or helicopter or other air forces?

The complexity of decision making in a fire fighting situation is just partially presented in this paper. This kind of knowledge and decision making process is hard to specify in the paper, let alone to capture and model. But if the ABFCM can provide just a part of the expert knowledge and generate correct conclusions (even limited ones) it could be very useful.

The map with the identified concepts and cause-effect relations is shown in the figure 1. The concept values and cause-effect relations weighted factors depend on the real fire situation. They can easily be adjusted on the scene to display particular situation. If the observed fire is near national park than this cause-effect relation will have a large weighted factor. If the observed fire is not near national park than this cause-effect relation will have a small weighted factor. Example adjacency matrix could in an assumed case look like:

$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.1 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.6 & 0.7 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.7 & 0.7 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.2 & 0.2 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.5 & 0.45 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.6 & -0.4 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.7 & -0.5 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Adjacency matrix contains cause-effect relations weighted factors depending on a real fire situation. In an assumed case, fire is not near nature monument, national park or nature park so fourth and fifth row of the matrix are zero because these concepts do not affect fire fighter manager decision on bringing land or air forces. The assumed fire occurs during the late afternoon approaching night so there is negative effect (-0.5) on concepts of bringing air forces to the fire scene. Similarly assumed other fire conditions resulted in the cause-effect relations weighted factors in the example adjacency matrix.

The map can also quickly be expanded with totally new concepts besides the concepts already identify. That means that the map can be quickly adjusted if the real fire situation introduces new concepts. For example, the fire is approaching chemical factory that could contaminate drinking water source. Is that covered with the concept buildings endanger or with the concept possibility of a human loss? Or this situation requires the new concept? How the expert (fire fighter manager) makes decision in this case?

These ideas should be tested in the real fire fighter situations.

Conclusion

Agent Based Fuzzy Cognitive Map method facilitates knowledge capture. It enables quick and simple coding of an expert knowledge also providing inference process that generates conclusion about the system behaviour.

This method can be used to provide system decision support in different domains. In this paper ABFCM is presented as a decision support system for the fire fighting domain but the ABFCM can also be adopted in others disaster management domains. The map presented in the paper is generated by the knowledge engineer using Document Coding method and Questionnaire method for the ABFCM map development. The expert itself can also deploy the ABFCM method and build the map according to the real life situation.

As already stated this is in no way replacement for the human expert just a support tool. Decision support system can be quickly built and adjusted to a particular situation customizing map concept values and cause-effect relations weighted factors and it can be extremely useful in a disaster management stress situations.

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Tomislav Vuko is a deputy fire commanding officer responsible for Adriatic coast and islands. His experiences in forest fire fighting were irreplaceable for definition of forest fire fighting procedures and forest fire fighting models. He was the main adviser in all our forest fire research and development projects.

SCHIPHOL AIRPORT FIRE SAFETY: A BENCHMARK ON FIRE PREVENTION AND SAFETY MANAGEMENT

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Key words

Fire safety, airport terminal, benchmark, safety management, fire prevention, high reliability organizations

Abstract

Introduction
Schiphol Airport belongs to the four busiest airports in Europe. Over 46 million passengers and 1.5 million ton cargo per year are handled nowadays. The Schiphol airport terminal is the central building of landside and is complex because of its functional interferences and large dimension in volumes and surface. With some airport terminal fires in mind (e.g. Düsseldorf, 1996) fire safety is an important aspect in the safety modernization program of Schiphol. The question is how Schiphol airport Terminal fire safety efforts score compared (benchmarked) to other comparable complex buildings?

Theory and method
To compare several complex buildings on fire safety, an evaluation framework needs to be developed. Subsequently, the benchmark was performed with the multimodal public transportation and transfer terminal in the Dutch city of Utrecht and with the airport terminal of Düsseldorf International airport (Germany).
Each of these three cases (Schiphol, Utrecht and Düsseldorf) was studied on two main aspects: fire prevention and safety management. The benchmark for both fire prevention and safety management was performed in three steps:

1. analyzing relevant documents
2. interviewing key officials
3. observing the building (or plans , Utrecht) and its use

Results
The results indicate that the developed fire prevention framework and safety management framework are very useful for scoring the fire safety of complex buildings.
All three considered cases prioritize safety over security in case of an emergency. In the airport terminals, retail is located in the middle of the halls whereas in Utrecht, retail will be located in the side walls of the building. All three objects have a sprinkler installation and a fire notification system. All three operate an evacuation installation; however Utrecht is not implemented in the safety organization yet (must still be build). In all three object operate a

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smoke-heat distraction system. Regarding safety management, Schiphol and Utrecht developed a dedicated policy aimed at continuous improvement, involving a system for granting permits, monitoring and sanctioning. However, not all aspects of their safety management systems are fully implemented yet.

Conclusion
Analyzing both the safety prevention and organization gives a broad insight in the total of fire safety in a complex building. To this end, the two developed evaluation frameworks for fire prevention and safety management were very useful. The interaction between these aspects still can be developed in a more consistent way.

Discussion
The results are based upon three objects that vary with regard to its history: Düsseldorf has been newly built recently, Utrecht is to be built and the Schiphol airport Terminal exists for decades. Still, the benchmark shows the main fire safety concepts of the three cases, which can be used for themselves as for other complex buildings as well.

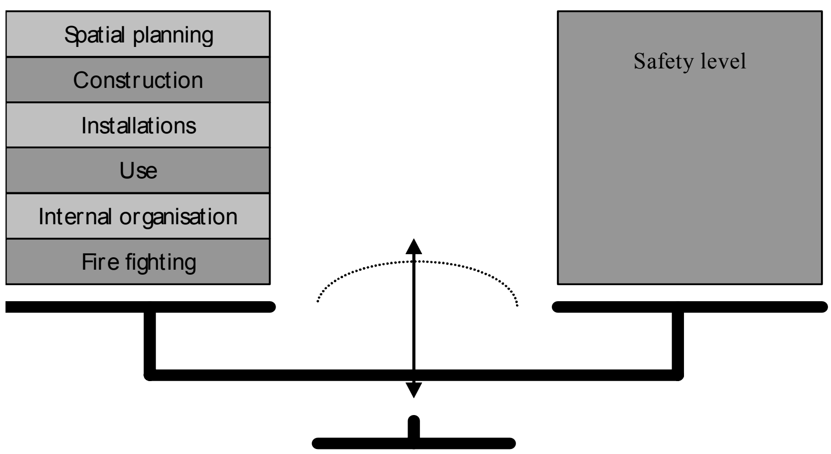
Introduction

For complex buildings such airport terminals, prescriptive fire safety rules are absent in The Netherlands. Instead, a performance-based approach needs to be applied to design and manage safety. In the end, the performance-based approach should result in safety level which is as least as safe as is intended by the pre-scriptive rules.

The problem however with the performance-based approach is that it concerns tailor-made applications. Various such applications are difficult to compare. To compare various performance based approaches, we developed two frameworks regarding fire safety. Fire safety can be realized in the design of the building and in it's management:

- Fire prevention: the building-related fire enhancement to reduce the probability on fire or to minimize the fire consequences
- Safety management: the managerial enhancements to reduce the probability on fire or to minimize the fire consequences

Figure 1: Fire safety



Spatial planning, construction, inventory and use and installations are part of the fire prevention framework. The internal organization, use and fire fighting are incorporated in the safety management framework. Both fire prevention and safety management should add to a minimum required safety level. Various safety enhancements from both frameworks could realize this minimum safety level.

In this paper, we present both safety frameworks and their applications to three complex buildings:

- Schiphol airport terminal (The Netherlands)
- Düsseldorf airport terminal (Germany)
- Public transport transfer facility Utrecht (The Netherlands)

In section 2 the research approach is presented. In section 3, the two fire safety frameworks are developed. In section 4, the fire prevention framework is applied to the three complex buildings. In section 5, to the same three buildings, the safety management framework is applied. In section 6, we draw conclusion regarding the developed frameworks and their application.

Research approach

Two reference documents were developed, one for fire prevention and one for safety management.

2.1 Fire prevention framework
The fire prevention framework was based upon the Dutch building directive 2003 for new buildings (Bouwbesluit) [VROM, 2003]. This building directive inhabits fire safety prescriptive measures. However, these are not applicable to a large and complex building such as an airport terminal. For such types of buildings, article 1.5 and chapter 2.22. in the directive provides a safety performance-based approach. The owner should prove his solution is at least as safe as it is realized following the prescriptive measures. The way the owner full fills the required safety level, is up to him. The reference for assessing the fire prevention of the three benchmark objects consists of the following aspects:

a) Building and it's surroundings: such as fire and smoke compartments, escape routes and possibilities, construction integrity, materials and accessibility and water supplies
b) Installations: such sprinklers, heat smoke distraction and fire alarm ~~and~~ installations.
c) Inventory and use: fire safe materials, activities and interior design

These three main categories were subdivided in 6 benchmark aspects for fire safety. For these 6 aspects including:

- (The restriction of) fire risky situations
- (The restriction of) fire development including fire alarm
- (The restriction of) fire extension (fire compartments)
- Fire resistance of the construction
- Safe escape
- Fire suppression related to the building (such as sprinklers)

A checklist was developed in which these 6 main categories were further detailed in way that we could specify the quality of to these categories belonging components.

The specification/application of the fire prevention framework is done by:

- Studying documents
- Interviewing key actors: the designer of the fire prevention concepts, the designer and the safety manager.
- A site tour

2.2 Safety management framework
The safety management framework is based upon:

- The Dutch directive for chemical industries which is a translation of the EU Seveso guidelines [VROM, 1999]

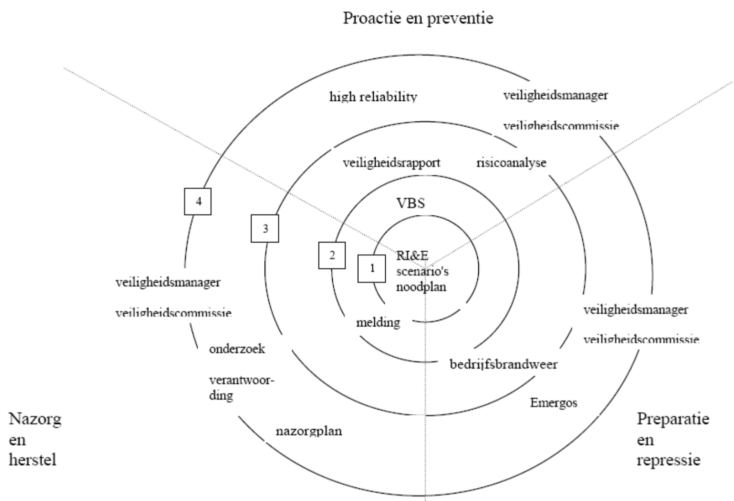
- Emergos: checklist for company emergency organizations [TNO, NIFV and KIWA, 2002]
- Theory of High Reliability Organizations
- The ICAO Safety Management Manual [ICAO, 2006].

The safety management framework is formulated based upon the processes that need to be managed. Four levels are distinguished:

- Level 1: Basic (no Safety management system: only complies with minimum legal safety requirements)
- Level 2: Safety management system: The organization has a safety management system in which the plan-do-check-act loop works. This level is comparable to the level of small chemical industries in The Netherlands.
- Level 3: Safety case: The organization has a safety management system and conducts safety cases to assess safety. This level is comparable to the level of large chemical industries in The Netherlands.
- Level 4: Excellent: the organization has a full-working safety management system and encompasses all the three levels before. This level is comparable to the level of nuclear industries.

Figure 2 below shows the main elements of each of the levels. Still needs to be translated in English)

Figure 2: Safety management framework



These four levels are further detailed in a checklist that was applied in the benchmark. The level of safety management coincides merely with the scores on the following aspects:

- Safety management system
- Risk inventory and assessment
- Accident analysis
- Company's emergency response plans
- ER education and training
- Fire brigade and in-company occupational safety

The application of the safety management framework is done by:

- Studying documents
- Interviewing key actors: the safety and health manager, the chief of (airport) fire brigade and the manager of the company emergency response organization.
- A site tour

These two frameworks were applied to Schiphol and two other complex buildings. To this end, the Schiphol airport Terminal was characterized from a fire safety (prevention and management) point of view.

Based upon this activity, safety experts of AAS and researchers chose 2 benchmark objects: Flughafen Düsseldorf International (Germany) and Public Transport Transfer facility Utrecht (Netherlands) as benchmark objects. The main categories of benchmark criteria were:

Table 1: Benchmark aspects.

Main category	Aspects
Building	1-roof concept, multiple functions, safety versus security, multi modal transportation and multiple exits and entrance, construction activities
Public	Number of visitors,, multiple languages, unfamiliarity, goal of the attendance, various organizations
Risks	Vulnerability, risk assessment, public
Organization	Incident management, high reliability, 24/7 (24 hours, 7 days a week), safety management system

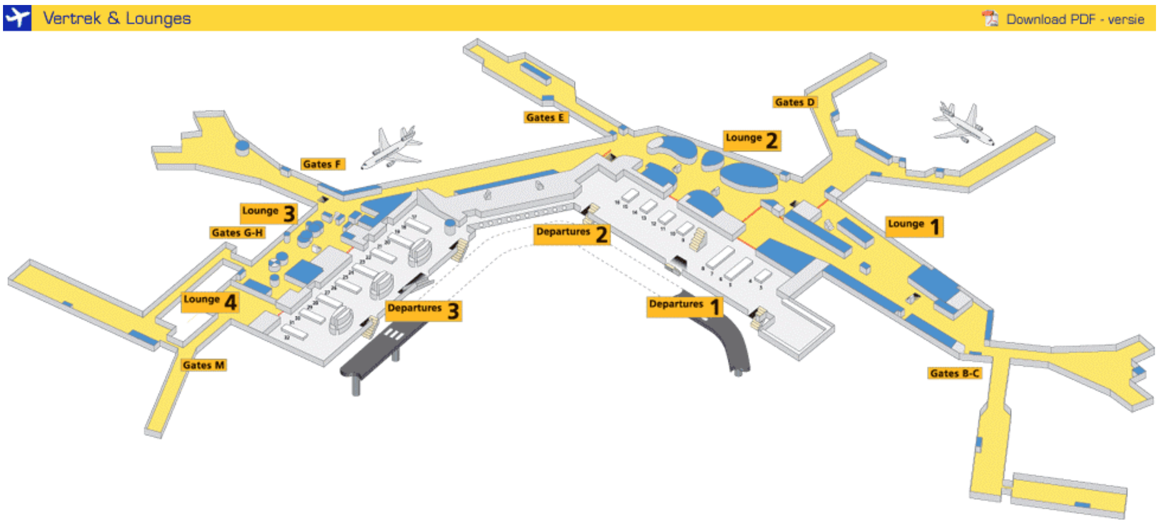
Most characteristics of Düsseldorf and Utrecht are similar to Schiphol. Both Düsseldorf and Utrecht however deviate in 1 aspect from Schiphol. The Düsseldorf airport Terminal is a totally new building, opened in 2003. After the 1996 airport terminal fire in Düsseldorf, from 1997-2003, almost 400 million euro were invested in the new airport terminal. The public transport transfer facility of Utrecht is in its final design stage and does not exist yet. However, because we compare the object in a conceptual manner rather than as part of an audit, both objects are relevant for the benchmark.

For efficiency reasons, the fire prevention and safety management framework were applied in coordination to each of the benchmark objects. This means for example that fire prevention specialists and safety management specialists visited the Düsseldorf airport Terminal together. First, we applied the frameworks to Schiphol, followed by Utrecht and finally to Düsseldorf. This sequence had to do with the availability of the persons in charge of fire safety aspects of the objects.

2.3 Schiphol airport Terminal, Düsseldorf airport Terminal and Transport Terminal Utrecht
In this section, we briefly described the three benchmark objects.

Schiphol airport Terminal
In the Netherlands, Schiphol Airport is main international hub for international and intercontinental flight. In 2006, 46 million passengers about 1.5 million tons of cargo is handled.
For the future Schiphol aims at handling 65 million passengers per year. The main part of the airport for passengers handling is the Schiphol Terminal. The Schiphol Terminal is the responsibility of Amsterdam Airport Schiphol (AAS). The picture below shows the map of the Schiphol Terminal. There are 3 departure halls (1, 2 and 3) and 8 piers (B, C, D, E, F, G, H, and M) and 61 gates which form the connection between the landside and airside. The train station is a tunnel below the Terminal building.

Figure 1: Site map of Schiphol airport Terminal [AAS, 2007].



In such a large and complex building with many (foreign) passengers, many organizations employing a great variety of activities, fire safety is elementary. To this end, Schiphol runs an extended fire safety (re)construction program called Continuity and Fire Safety Program (C&BT-program). This more than 100 million euro program consist of 26 fire safety projects in the Terminal and runs to the year 2010.

Düsseldorf airport Terminal
Nowadays and in the future, Düsseldorf handles about 18 million people year and 97.000 tons cargo. The main part of the airport for passengers handling is the Terminal. The picture below shows the map of the Düsseldorf Terminal. There are 3 departure gates (A, B and C) and 1 hall for arrivals. The train station is in a tunnel below the Terminal building.

Figure 2: site map Flughafen Düsseldorf [Flughafen Düsseldorf International, 2007]

Transport Terminal Utrecht
Terminal Utrecht handles about 13 million passengers in 2020. The terminal is a multi level building over about 16 rail platforms. Trespassers using the terminal from east to west are separated from travelers. On the Terminal several office buildings are developed. Adjacent to the Terminal, a large indoor mall (Hoog Catharijne) and a conference building (Jaarbeurs) are situated.

Figure 3: impression Terminal Utrecht [Gemeente Utrecht, 2007]

Now that we presented the fire prevention and safety management frameworks we will present its application to the three benchmark objects.

Fire prevention

The table below summarizes the relative results on each of the 6 aspects (most left column) for Schiphol, Utrecht and Düsseldorf (upper row) [NIFV and NHL, 2007] (in which for Schiphol the C&BT program is completely realized, hence the future situation). In the cells, the score of Schiphol Airport is presented relative to the Dutch Building directive, multimodal transfer facility Utrecht (still in design) and Düsseldorf International Airport.

Table 2: Benchmark results fire prevention

	Schiphol .... than Building directive 2003	Schiphol ... than	
Reference		Utrecht	Düsseldorf
Restrict fire risky situations	Better	equal	Equal
Restrict fire development including fire alarm	equal	Better	Worse
Restrict fire extension (fire compartments)	better	Equal	Equal
Fire resistance of the construction	better	Better	Better
Safe escape	Equal	Equal	Equal
Fire suppression (building related)	Better	Equal	Equal

Based upon this table, Schiphol scores:

- better than the Dutch minimum fire safety requirements: the main reasons therefore are that the occupancy level is below maximum, the sprinklers installation and 60 minutes fire resistance time of the construction instead of the minimum requirement of 30 minutes and the multiple building related fire suppression equipments.
- a bit better than the to be realized Public transport facility in Utrecht: the reason is that material class in Schiphol is less flammable than is Utrecht and the fire resistance of the construction.
- equal to the airport Terminal of Düsseldorf: Düsseldorf is better than Schiphol because it has an advanced smoke distraction system in the terminal and smoke hoods above retail shops and the overall use of fire resistant materials in the airport terminal Schiphol is better than Düsseldorf because its construction is 30 minutes more fire resistant.

Safety Management
The table below summarizes the results on each of the 6 aspects for Schiphol, Utrecht and Düsseldorf [NIFV and NHL, 2007] (in which for Utrecht the intentions as described are realized and today's situation is continued in the management organization of the terminal):

Table 3: Benchmark results safety management system

	Schiphol on VMS-level	Schiphol ... than	
Reference		Utrecht	Düsseldorf
Safety management system	2	worse	better
Risk inventory and assessment	1	equal/ worse	better
Accident analysis	3	Worse	Unknown
Company's emergency response plans	3-4	Equal	better
ER education and training	3	better	Equal
Fire brigade and in-company occupational safety	3	better	Equal

Based upon this table, we conclude that Schiphol scores

- About level 2 to 3 on the safety management levels: risks are not analyzed using scientific methods such as TRIPOD or the bowtie technique. The safety management system is concept ready, but needs to be implemented
- A bit less than Utrecht: Utrecht uses scientific methods and techniques to assess risk and to analyze accidents
- Better than Düsseldorf. Düsseldorf has no safety management system at all.

Discussion

The two self-developed frameworks for evaluating fire prevention and safety management proved to be very useful for scoring the safety of complex buildings. In addition, the frameworks facilitate a comparison between various complex buildings: comparing Schiphol with a new built Terminal (Düsseldorf) and a to be built public multimodal transfer facility (Utrecht).

We had to deal with a variety of information. For Schiphol, we had access to all relevant documents and we could speak every official we needed for the research. For Utrecht, in particular documents regarding the safety management were not constipated yet. In Düsseldorf, safety management for the terminal did not exist at all.

At Schiphol, we visited the airport Terminal and conducted 6 in-depth interviews. Regarding the Transport Terminal Utrecht, a site visit was of coarse not possible. Still we conducted 6 in-depth interviews as well. For Düsseldorf, we did the site visit, however, we only had two relevant safety documents available for analysis and instead of in-depth interviews we were given two fire safety presentations and discussions afterwards.

Apart from these methodological aspects, we are convinced that the fire prevention and safety management framework are useful tools for developing and evaluating fire safety of complex buildings. To better balance fire safety, hints for more integration between fire prevention and safety management could be useful. Such hints might become available when applying the presented frameworks more often and publishing the results in international journals and conferences on safety.

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FIRE FIGHTING ABILITY VISTAS IN TURKEY AND COMPARISION WITH EUROPAN UNION COUNTRIES

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Key words: *Fire, Turkey, Emergency, Management, EU.*

ABSTRACT

In the twenty-first century, residential, commercial and also rural areas which we live and use are getting larger rapidly because of several reasons. And population growth is also increasing along with these circumstances. Turkey is a developing country in this century and growth of fire fighting abilities are not as much as the growth mentioned. It is obvious that fighting is very important for the developing countries lacking enough development on emergency management. A well-developed response, equipment and personnel will help for the development of fire fighting. This paper is a collected work and discusses the abilities of fire fighting of Turkey for metropolitan cities and shows the differences from European Union Country Cities which are selected as samples.

Introduction

Fire, an indispensible aspect in our lives, can cause losses of lives and property due to several reasons when it goes out of control. And danger increases with developing technology and expanding residential areas. Countries have established agencies and developed models within possibilities, experiences, living standards and degrees of development in order to cope with fire hazards.

When we look at developed countries, firefighting and ambulance services are working together with predefined access routes. And also social securities of firefighters, clothing and equipment needs according to the mission statements, number of personnel, equipment and vehicles are defined with regulations. However, in Turkey, firefighting is not even considered as a particular branch (Kurutuz, 2003). Fire brigades are considered in the planning stages of a city in developed countries, by planning the elimination of the factors causing fire hazards and by prioritizing pre-hazard legislations. Whereas in Turkey, buildings are not mostly used on their purposes (Kurutuz, 2003). Another dramatic aspect is that, there are 1369 streets which are not accessible for the fire brigades in Istanbul, Turkey's largest city (Erden, 2000).

In İstanbul, growth of urban and industrial areas is given figure 1 (Kaya, 2007). It can seen from the Figure 1 and Table 1 that there are %128.45 of growth in European side of Istanbul just in 14 years, population increased to over 15 million but the growth of fire brigades is the same.

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Table 1: Result of Growth

Classes	Area (hectare)		Change (%)
	1987	2001	1987-2001
Urban Area and Industrial Area	13 460	30 750	+128.45

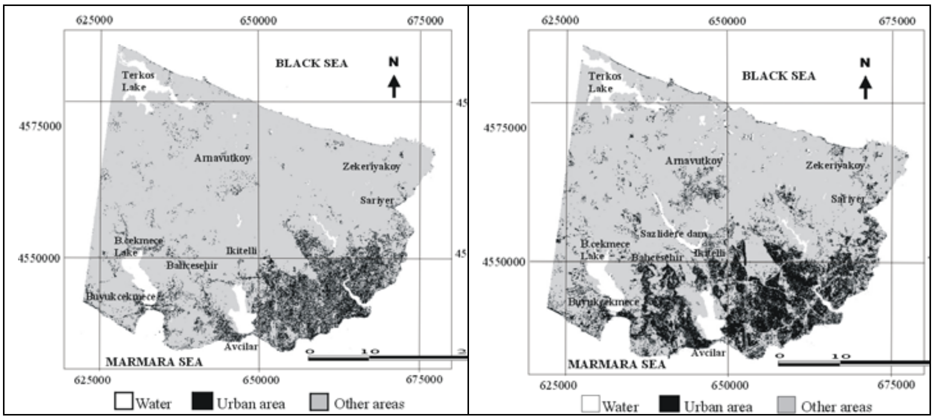

Figure 1: Classified Landsat 7 ETM+ images of 1987 and 2001 (Kaya, 2007).

Structure of Fire Brigades in Turkey and Some Europan Countries

Reliable information about the fire disaster protection in Turkey can not be reached before the second half of the 16th century. First studies started by Ferman (order) of Sultan in 1560. Then, Davit, a french, organized the first fighting team named as “Tulumbacı Takımı”. By the time the numbers of “Tulumbacı Takımı” changed and evaluated and than transformed into military system and they transferred to the manucipilies in 1923. At present, a governmental foundation representing the national fire brigade organization hasn’t yet been established. Fire brigades of every city are bound to their city’s local authority (Yenturk, 2001).

Fire departments which are placed at low-risk areas or containing a limited number of personnel and vehicles are called squads, and departments placed at high-risk areas containing more personnel and vehicles are called groups. Currently there is no operating information system is present for the Fire Department of Istanbul although there has been a study for this purpose previously. There are personnel called “mıntıkacı” (zone master) helping the brigade finding the shortest route in the region they know. “Mıntıkacı” is the member of the squad or group knowing every street of the region. When assigned, “mıntıkacı” is given a training of every road, street, building and door number related to the region (Erden, 2001).

Structures of the fire departments of some European countries are summarized below (Yentürk et al., 2002);

Germany

In this country, a coordination group between ministries is present within the Ministry of Interior. This group is continuously in contact with the local authorities. Local authorities are controlled by mayors having the full responsibility. Also an emergency squad is present within the municipalities. The municipality manages fire and rescue missions in emergencies also with the help of federal army and the police organization.

Austria

"Federal Alarm Centre" is working within the Ministry of Interior in Austria. This centre is the brain of the civilian defense system. Alarm centres focused on city scale are present within this system. City alarm centres are in continuous coordination with the Federal Alarm Centre.

Belgium

Coordination Centre for Crisis Management is formed within the Ministry of Interior. A directorate general for civilian defense, also related with the Ministry of Civilian Defense, is working within the verge of this centre. Governorship informs the directorate general.

Finland

In this country, a directorate of general rescue services is present within the verge of the Rescue Department of the Ministry of interior. This directorate is in touch with the government offices in cities. These offices are in coordination with the emergency control centers and the centers are in coordination with municipalities.

France

In this country, a civilian security department is workin under the Ministry of Interior. This department is the brain and summit of the civilian defence organizations.

Ireland

Interdepartmental advising commitee formed within the central government is the summit of emergency management in Ireland. Almost every ministry is involved in this commitee and this commitee provides support and advice to the local units via three sources.

Spain

Central government manages the general directorate of civilian defence. This directorate also works within the Ministry of Justice and the Ministry of Development and Housing, managing the national emergency plans through the support of state governors.

Sweden

Local administrative board is held responsible by the government for rescue services. If a board is not present for a region, then local authorities are held responsible.

Italy

Emergency management in Italy is organized at two different levels. These are central level and non-central organizations.

Greece

Emergency plans in Greece are made on three different scales. These are emergency plans within central government, within Secreteriat General of Civilian Defence bound to the Ministry of Interior, and within national scale.

Emergency management and civilian defence structures of the EU countries showcase a wide administration span. There is a flexible expansion concept on the introduces organizations. Fire departmenst are generally in contact with local authorities in these expandable models. These organizations also contribute to the core of the emergency management systems. Geography and land area of EU countries highly influence the organization structure of civilian defence organizations. For example, in countries with relatively low populations, hierarchical structure of the central authority is clear and sharp. But in countries showcasing differences in geography and ethnology, fire fighting and civilian defence structures have local characteristics (Yentürk et al., 2002).

Some Data About Fire Fighting for Turkey and Some Europan Countries

There are 420 fire stations, 2100 vehicles, and 26500 firefighers in Turkey's city fire birigades. Those firefighersintervene againist 71600 fires and 15200 technical rescue and the fire stations (as of 2000 data). The avarage of fire vehicles is over 20 and the fire stations need to be improved (Yalın, 2002). The number of fire-fighters by 1000 inhabitants is given in Table 2.

Table 2: Number of fire-fighters by 1000 inhabitants for 8 countries

Countries	fire-fighters by 1000
Turkey	0,4
Austria	36
Switzerland	30
Luxemburg	16
Germany	15
France	4,2
Italy	0,9
Spain	0,3

On the other hand, the annual expenses per person for fire departments in the European countries are given in Table 3. Although there are not any clear statistical records for Turkey, it is guessed that Turkey would be very low-ranked on the mentioned table (Yentürk et al., 2002).

Monetary and personnel inadequcy are not the only reasons for the ineffective fire fighting services in Turkey. Lack of voluntary collaboration is one of the main effects. As can be seen from Table 4, in most countries, the percentage of volunteers dominate the total fire fighting personnel numbers (Yentürk et al., 2002; Atlas of World, 2007).

Table 3. Annual Expenses per Person for Fire Departments (2002)

Countries	Annual expense per person (Euro)
Turkey	?
Finland	65
Norway	55
Sweden	45
Ireland	30
Switzerland	55
Germany	85
Autralia	90
Belgium	45
France	30
Italy	20
Greece	20
Spain	20

Table 4. The Number of Fire-fighters, population and Total Area

Countries	The Number of Volunteer	The Number of Total fire-figther	~ Population x 1,000,000	~ Area km^2
Turkey	0	26,500	85,0	780,000
Finland	10,380	23,360	5,0	337,000
Norway	0	27,900	4,5	324,000
Sweden	4,000	29,500	8,0	450,000
Ireland	0	3,090	4,0	70,000
Switzerland	195,000	210,000	7,0	41,000
Germany	1,139,400	1,210,270	83,0	357,000
Autralia	273,670	285,000	7,5	83,000
Belgium	6,000	6,215	9,0	30,500
France	206,900	243,660	59,0	347,000
Italy	23,500	55,210	57,0	301,000
Greece	0	6,300	10,0	132,000
Spain	10,420	12,980	40,0	504,000

In Figure 2, Percentage of The Total Fire Fighters On The Country's Population is Given in Chart Representation.

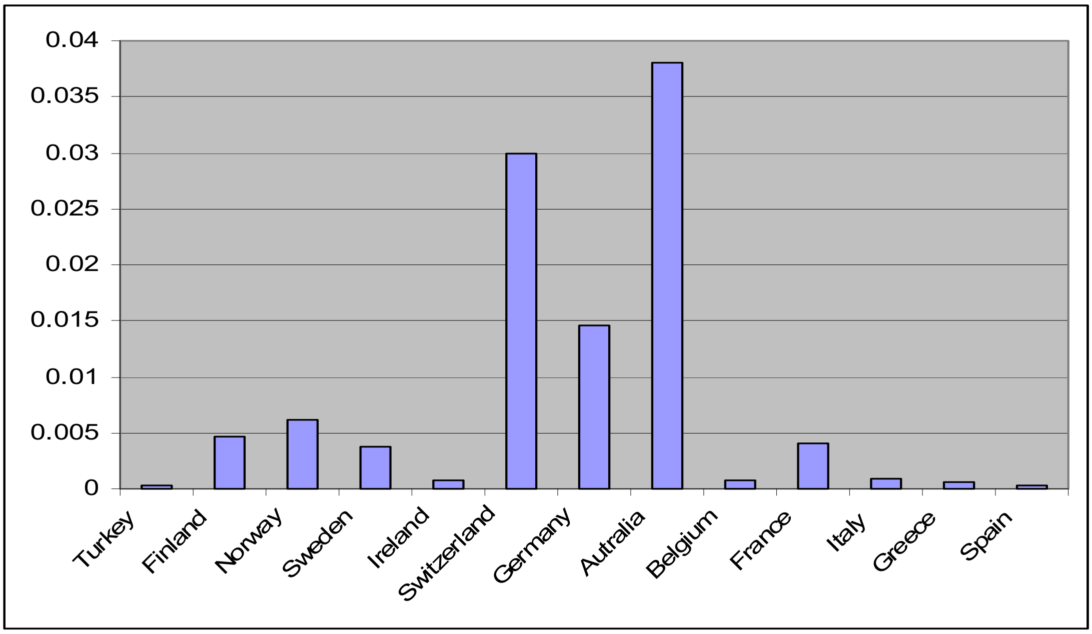

Figure 2. Percentage Of Total Firefighters On Population

Conclusion

The Fire Department of Istanbul of Istanbul Metropolitan Municipality has planned staffing 1250 personnel recently. Currently, Istanbul has 2,000 firefighters within city limits, while world standards show that a fire fighting organization provides one firefighter per one thousand residents. According to this, Istanbul should be employing 12,000 firefighters for its population of 12 million. However, there are ## firefighters employed in Istanbul (Erden, 2000; Kılıç, 2007).

Recent studies shows that the number of fire stations and fire fighters are too insufficient. For example; there is necessity of adding 39 new fire station to existing 39 fire stations in Istanbul (Erden and Coskun, 2006).

As one of the most important problems of developing cities on fire fighting, following can be mentioned: growing population, high frequency of job and city changes, decrease of voluntary fire fighters, decrease of social responsibilities of people, interference of dangers and developing technology on lives. Turkey also cannot make use of its volunteer potential. While rural fire fighting activities in most countries are handled by volunteers, in Turkey there are no fire fighting service for rural areas in that manner. (Yenturk et al., 2002).

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Academic & Professional Practice

Peer Reviewed Articles

EMERGENCY RESPONSE TECHNIQUES

COMPARING THE PERCEIVED PUBLIC PERFORMANCE OF GOVERNMENTAL ACTORS IN RESPONDING TO FOUR MAJOR SEISMIC ACTIVITIES

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Keywords: Earthquake, Government, Performance, Turkey

Abstract

This paper, through collecting data from major Turkish and international newspapers and by using content analysis, examines the responses of Turkish government to 4 seismic events took place in 1999, 2002 and 2003. The paper discusses if and how the responses of public officials and organizations improved. The data collected from the news coverage of these events following the 30 days after the earthquake is coded according to the four stages of disaster management.

The news reports of the government's response to the earthquakes is analyzed at two levels. First, they were evaluated for the overall tone of the report. Then they were reviewed at the statement level. These statements then were examined at three levels. First, statements were coded according to their tone. Next, the statements were coded by 1) the type of organization listed in the account, and if the organization was a governmental organization, 2) its level in the intergovernmental system and 3) the performance of each organization during and following the earthquake. The coding for the type of organization emerged from a review of the organizational types and the clustering of the organizations named into one of several categories. The final coding effort examined the news accounts in terms of their focus on one of four stages of disaster management: i) mitigation, ii) preparedness, iii) response and iv) recovery. The data shows that governmental actors has relatively improved their performance but were not able to completelt build public trust.

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Introduction

Disasters are “calamitous natural or human-caused emergency events that suddenly result in extensive negative economic and social consequences for the populations they effect” (Donahue and Joyce, 2001). They “signal the failure of a society to adapt successfully to certain features of its natural and socially constructed environment in a sustainable fashion” (Oliver and Smith, 1996). Major natural disasters such as earthquakes, while they vary in scale, usually threaten the general welfare of the effected people by generating problems and conditions that are difficult to anticipate and address (Comfort, 1995; 1999 Schneider, 1992; 1995; Donahue and Joyce, 2001). Even though individuals, communities, charity organizations, and private companies try to help, their efforts are often woefully inadequate (Schneider, 1995) to ease the enormous and extraordinary burdens on the people who experience them. As Schneider (1995) states “[w]hen a natural disaster occurs, few people stop to ask if the government *should* intervene. Instead, citizens tend automatically to view the situation as a serious *public* problem requiring immediate *governmental* action”. According to Schneider (1995) four specific characteristics of these cataclysmic events make them critical policy issues that require governmental attention. They are: i) objective dimensions (severity, range, and visibility of disasters); ii) political aspects (riveted public attention and window of opportunities for political action); iii) symbolic aspects (strong metaphors like “disaster”); and finally, iv) absence of market solutions. Therefore, Schneider asserts, governments are expected to intervene because, that is seen as governments’ basic responsibility and failure to do so can cause extraordinarily severe societal problems. Second, disaster situations can become highly politicized issues, and finally, “[g]overnment is the only institution with the resources and the authority to help citizens cope with such cataclysmic events” (1995).

Today, emergency management is defined as a primary responsibility of governments (GDDA, 2002; FEMA, 2002). The entire structure of disaster management emerged as a result of major crises (Clary, 1985; Comfort, 1988; Schneider, 1995). For instance, in the U.S., the evolutionary pattern from the Congress’s first piece of disaster legislation that provided assistance to fire victims in New Hampshire in 1803, to The Disaster Relief Act of 1950, which set the first comprehensive nationwide system of disaster response and relief (Clary, 1985), and finally to the creation of The Federal Emergency Management Agency (FEMA) in 1979 (May, 1985) have progressively increased the role of public service agencies in disaster management.

Modern disaster response has also evolved overtime (Donahue and Joyce, 2001) into an array of activities what we call today Comprehensive Emergency Management (CEM).This approach was developed in 1979 by the National Governors’ association during its study of emergency preparedness (Clary, 1985; Donahue and Joyce, 2001). The CEM approach specifies four phases of modern disaster management (FEMA, 1997; Donahue and Joyce, 2001):

1) *Pre-Disaster mitigation:* Activities undertaken in the long term, before disaster strikes, that are designed to prevent emergencies and reduce the damage that results from those that occur, including modifying the causes of hazards, reducing vulnerability to risk, and diffusing potential losses.
2) *Pre-Disaster Preparedness:* Activities undertaken in the shorter term, before disaster strikes, that enhance the readiness of organizations and communities to respond to disasters effectively.
3) *Disaster response:* Activities undertaken immediately following a disaster to provide emergency assistance to victims and remove further threats.
4) *Post-Disaster Recovery:* Short-and long-term activities undertaken after a disaster that are designed to return the people and property in an affected community to at least their pre-disaster condition of well-being.

Theory and Method

Public agencies have "the legal responsibility for the protection of life and property during a disaster" (Comfort, 1999: 140). Emergency management is a complex policy subsystem which requires, public agencies' collaboration with private and non-profit agencies because of multigovernmental, multisectoral, and multiphased efforts to mitigate, prepare for, respond to, and recover from disasters (Comfort, 1999, 2001; Donahue and Joyce, 2001). Managing these interorganizational/intersectoral collaborations is a major challenge by itself. These challenges increase considerably under the pressures caused by disasters.

Disasters generate problems that are often difficult to anticipate and handle and they impose extraordinary demands on the decision-making and service-delivery systems because: 1) disasters are large-scale, rapid on-set incidents relative to the size and resources of the effected jurisdiction; 2) disasters are uncertain with respect to both their occurrence and their outcome; 3) and finally, disasters occur relatively infrequently (Schneider, 1992; Donahue and Joyce, 2001). Further, the challenge of governmental response to disasters becomes more problematic due to the gap between the emergent norms that guide social interactions and the bureaucratic norms that dominate governmental activities during the disasters (Schneider, 1992: 1995). As a result, "the effectiveness of governmental efforts in this area has been highly variable" (Schneider, 1992).

When systems have been designed to function and have promised for substantial responsibilities during and after major disasters they are subject to higher expectations for effective performance in developing credible public responses to these crisis situations. Failure to perform effectively during major disasters raises serious questions on the trustworthiness and assurance of continuity of such systems (La Porte and Keller, 1996; La Porte and Metlay, 1996; Pearson and Mitroff, 1993).

Despite the increasing popularity of the concept of trust in a wide range of disciplines from sociology to organization and management theory and from public administration to economics, the development of a common conceptual framework has yet to happen. Sources of, mechanisms for examining public trust have lead to the development of different approaches and definitions of what is meant by it (e.g. for a recent review see Adler, 2000). La Porte and Metlay (1996) assert that a serious *analytical shortfall* exist in our understanding of the bases for institutional trustworthiness. One of this paper's goals is to contribute to this understanding. Following La Porte and Metley (1996) we offer the following: *Trust* is the belief that those with whom you interact will take your interests into account, even in situations where you are not in a position to recognize, evaluate, and/or thwart a potentially negative course of action by "those trusted". *Confidence:* exists when the party trusted is able to empathize with (know of) your interests, is competent to act on that knowledge, and will go to considerable lengths to keep its word. *Trustworthiness:* is a combination of trust and confidence.

Shockley-Zalabak et al. (2000) state that high levels of organizational trust is associated with *effective crisis management*. Allen and Caillouet (1994) note that in crisis situations, simultaneous accountability pressures emerge from multiple stakeholders which can challenge the public's perception of the appropriateness of organizational and public leaders' responses to the crisis situation. Ruef & Scott (1998) citing Suchman (1995) define legitimacy as "a generalized perception or assumption that the actions of an entity are desirable, proper or appropriate within some socially constructed system of norms, values, beliefs and definitions". Ruef & Scott (1998) also suggest that the legitimacy of an organization is determined to some degree by the perceptions of key stakeholders who assess its *performance* against some standard or model. Therefore *perceptions of failure to perform effectively* during major disasters bring serious questions on not only the trustworthiness but also the assurance of continuity of public institutions (La Porte and Keller, 1996; La Porte and Metlay, 1996; Pearson and Mitroff, 1993). Using the responses of Turkish public institutions to four earthquakes one of which was one of the largest earthquakes of the 20th century, we examine how governmental performance impacted perceptions of trustworthiness and ultimately legitimacy.

Comparing the Perceived Performance of the Governmental Responses to 4 Earthquakes

In 1999 two major earthquakes struck Turkey. The first one, on August 17, hit Turkey's most populous and industrial region at 3:02 am local time with a 7.4 moment magnitude on the Richter scale (KOERI and GDDA, 2000). It caused extensive damage in the eight provinces of northwestern Turkey. In the provinces of Kocaeli, Istanbul, Yalova, Sakarya, Bolu, Eskisehir, Bursa, and Zonguldak 17, 480 people were killed, 43,953 were injured, and about 600,000 were left homeless (GDDA, 2000) because of the 45-second tremor. The second, magnitude 7.2 on the Richter scale (KOERI, 2000) earthquake, struck mainly northwestern province of Bolu on November 12, 1999, only 89 days after the first disaster and killed 736 people and injured 4,948 and left thousands homeless (GDDA, 2000)[2]. Both earthquakes took place on the North Anatolian Fault line (NAF), one of the most active fault lines of the world. A third one, with a magnitude 6.4 on the Richter scale struck Cay town in the Afyon Province on February 03, 2002, 3 years later the first two, killing 44 people. The fourth one struck the eastern province of Bingol on May 01, 2003, with a magnitude 6.4 on the Richter scale and killed 176 people.

Government's perceived performance plays an important role in the level of trust that people have for public institutions and media plays an important role in shaping perceptions of that performance (Schneider, 1992). LaPorte and Keller (1996) note that after a seismic event, public institutions are challenged to meet the public's expectations of them. They suggest that when public institutions cope with seismic events effectively, public trust is sustained and perhaps increased. On the other hand, failing to respond in an effective manner can have a negative effect on this trust. From an organizational trust standpoint, therefore, disasters are both threats of losses and opportunities for gains.

Hearit (1995) suggests that in order to maintain and achieve legitimacy, an organization must demonstrate *competence*. One element of competence is the provision of a product or service which meets standards of quality and desirability. Individual incompetence is one of the major reasons that organizations can lose trust (Thomas, 1998). Oliver-Smith (1996) states that when disasters happen they tend to affect most aspects of community life.Thus, when they occur, the responses need to be based on local understanding of the social and physical environments, which corresponds to Hearit's (1995) standards of quality and desirability. Disasters provide an opportunity to examine how perceived governmental performance shape and/or changes public trust.

Crises often produce massive audiences for the mass media (Graber, 1989 cited in Loges, 1994). Media Systems Dependency (MSD) theory argues that under certain circumstances, such as when people perceive that they are threatened by their natural and/or social environment information from the mass media becomes more central to the goals of people, groups, or other social systems (Ball-Rokeach , 1985; Ball-Rokeach et al., 1984 cited in Loges, 1994; Hirschburg et al., 1986; Loges, 1994; 2000). Loges (1994) have demonstrated that dependency relations with mass media are more intense the more one perceives one's social and natural environment to be threatening.

Newspapers often shape the perceived trustworthiness of public institutions. "The media lie at the key intersection between public agencies and their publics" (Loges, 2000). For example, when

[2] The data for the first two earthquakes were collected, analyzed and presented by Oztas, N. 2002. "Bitter Lessons from Quakes: Fault Lines of Trust and Legitimacy Aftershocks Response and Recovery by Learning?" at the *ASPA's 63rd National Conference on Featured Panel: Public Trust and Public Service: Influence of Governmental Officials' Responses to National Disasters*. Phoenix, Arizona. March 23-26, 2002.

Washington State's Mount St. Helens volcano exploded in May 1980, the average citizen and official agencies lacked a frame of reference from which to interpret the explosion. As a result, public officials were unable to provide information about what to do and what to expect due to the ambiguities of the disaster Hirschburg et al. (1986)., found that during and following this disaster the media served as the primary information source for people. Similarly, Turner and Paz (1986) showed that the media system as a whole is structurally located to serve as our primary disaster and emergency alert system. They also found that printed words more easily convey new and elaborated information than television and radio. Thus, to analyze the effects of Turkish government's perceived performance and competence in responding to the 1999 disasters data from 4 major newspapers were used.

Data

To analyze and to compare the perceived performance of the governmental responses to the four earthquakes that struck Turkey, news accounts from 3 major international newspapers *The Washington Post, The New York Times,* and *The Guardian* (London) and a national paper *Radikal* was collected to provide a broad perspective. "Turkey" and "Earthquake" were used as key words ın our search of the Lexis-Nexus database to locate the news pieces published in the three international newspapers in the 30 days following immediately after the 4 earthquakes. After the first analysis the news pieces that are not about the four earthquakes that struck Turkey are excluded and the final sample from the international papers consisted of 178 articles. In addition to these three international papers, *Radikal*, one of the biggest national papers of Turkey was used to provide more detailed information on the earthquakes and perceptions of government performance. Because *Radikal* was not available on Lexis-Nexus a day-by-day search on the "Turkiye"(Turkey) section of its online version was conducted. This search uncovered 883 earthquake related news articles published by *Radikal* in the 30 days following the four earthquakes. The combined final sample for the four earthquakes consisted of 1061 news articles of which 883 (83.2%) were from local and 178 (26.8%) were from international sources (Table 1). Quantitative content analysis was employed to analyze the media messages.

Table 1News coverage and tone distribution

Tone Distribution	İzmit 1999*							Düzce 1999**							Afyon 2002***							Bingöl 2003****						
	Positive	%	Neutral	%	Negative	%	Total	Positive	%	Neutral	%	Negative	%	Total	Positive	%	Neutral	%	Negative	%	Total	Positive	%	Neutral	%	Negative	%	Total
Radikal	19	3	416	70	153	26	**588**	22	10	158	75	30	15	**210**	12	43	6	21	10	36	**28**	20	35	25	44	12	21	**57**
The New York Times	0	0	40	61	26	39	**66**	2	29	4	57	1	14	**7**	0	0	0	0	0	0	**0**	0	0	4	67	2	33	**6**
The Washington Post	0	0	17	47	19	53	**36**	3	33	6	67	0	0	**9**	0	0	0	0	1	0	**1**	1	25	2	50	1	25	**4**
The Guardian	0	0	19	50	19	50	**38**	1	25	3	75	0	0	**4**	1	33	2	67	0	0	**3**	2	50	0	0	2	50	**4**
Total	**19**	**2**	**492**	**68**	**217**	**30**	**728**	**28**	**12**	**171**	**74**	**31**	**13**	**230**	**13**	**40**	**8**	**25**	**11**	**35**	**51**	**23**	**33**	**31**	**43**	**17**	**24**	**71**

* İzmit 08/18/1999-09/16/1999 ** Düzce 11/13/1999-12/12/1999 *** Afyon 02/03/2002-03/03/2002 **** Bingöl 05/01/2003-06/01/2003

The news reports of the government's response to the four earthquakes was analyzed at two levels. First, they were evaluated for the overall tone of the report. Then they were reviewed at the statement level. Trust, legitimacy, and disaster management literatures were consulted to develop a coding scheme. In the assessment of tone, an article was coded **positive** in tone if it was 60% or more favorable to the government's efforts. A **negative** tone was assigned to reports that were 60% or more unfavorable to the government's efforts. A **neutral** assignment was made when the article contained no or very little "judgment" of the government's efforts – mainly a factual presentation of what had happened. The articles that were not directly related to four Turkish earthquakes and responses to it were coded as not-relevant and were not included in the analysis.

The second level of analysis examined the statements for every report. A statement was defined as a "sentence or the set of sentences that expresses evaluation of the behavior of public institutions and their leaders" (Allen and Caillouet, 1994). These statements were examined at three levels. *First,* statements were coded according to their tone. *Next,* the statements were coded by 1) the type of organization listed in the account 2) its level in the intergovernmental system and 3) the performance of each organization during and following the earthquake. The coding for the type of organization emerged from a review of the organizational types and the clustering of the organizations named into one of several categories. The *final* coding effort examined the news accounts in terms of their focus on one of four stages of disaster management: i) mitigation, ii) preparedness, iii) response and iv) recovery. Final sample included 3921 statements from 1061 news reports (Table 2).

To test the reliability of the coding assignments, four colleagues, one of whom spoke Turkish, each coded 10 randomly selected statements from the list of coded statements. Each statement was coded by tone and then for the four stages of disaster management. The inter-coder reliability was found to be 86.6% for positive/negative coding and 90% for phases of disaster management coding.

Results

Article Level Findings: The magnitude of the first disaster and the failure of public agencies, particularly the central government has brought harsh criticisms. Of the 728 content analyzed news pieces covering the first earthquake that struck İzmit only 19 (2%) of them had a positive tone and all were published by the local paper *Radikal*. More than approximately 40% of all the coverage in the international papers had a negative tone, demonstrating that public agencies did not have a satisfying performance in responding to the 7.2 scale disaster. When the Düzce earthquake struck only 89 days after the first earthquake the percentage of the positive tone coverage has raised to 12% despite the fact that local paper had a much less positive tone (10%) coverage compared to the international papers (25% and above). After the third earthquake the percentage of the positive tone coverage has dropped down to 13% and negative tone coverage raised to 35%. After the fourth earthquake the coverage was better again.

*Statement Level Findings:*Table 2 highlights the distribution of the positive and negative statements by the phases of disaster management and also of the organizations mentioned during these phases. Overall public institutions (central government, local governments, military, and civil defense army combined) were severely criticized at all stages of the Izmit earthquake. Of the 1,253 negative statements 80.6% (1010) were about the unsatisfactory performance of the public institutions' responses to the disaster. Of these 57.3% (718) were about central government's perceived weak performance .

After the first earthquake, compared to other organizations' performance the central government received the highest number of critical comments at each stage of the disaster except for the mitigation phase. While the responsibility for not adequately preparing for the disaster was shared with the local governments (25.2%) and the Turkish people (7.6%), the central government received the highest number of negative statements (46.6%). At the response (73.5%) and recovery stages (84.6%) the central government also received the majority of the criticism. In the mitigation phase, the percentage of negative statements that criticized the central government (19.3%) was lower than the criticisms directed to local governments (27.4%) and contractors (32.5%). Contractors received the highest number of critical comments; mainly for not following the construction codes and the local governments for not enforcing those codes while the codes themselves received 6 positive but no negative comments. Following the Izmit earthquake, hundreds of lawsuits were filed against the construction companies and many contractors were prosecuted.

In the mitigation and preparedness phases of the Izmit disaster the central government and the local governments together received the largest number of critical comments. The number of the combined positive statements for these two phases was 8 compared to 451 total negative statements. The overall statement level account of the management of the Izmit earthquake shows that the Turkish society as a whole and particularly the public institutions failed to mitigate and prepare for a major but not unexpected disaster. The finding was not different for the response stage. The central government's performance received 551 negative comments, which corresponds to the 44% of all (1,253) the negative statements. Of the total 119 positive statements at the response stage, 63.9% (76) were about the efforts of foreign rescue teams (24.3%), Turkish people (23.6%), and Turkish voluntary organizations (16%). In many instances the efficiency of both foreign rescue teams and Turkish non-governmental rescue teams served as a point of reference for the public to compare public institutions' performance. At the response phase the only public institution with a relatively higher positive evaluation was the Turkish Military (17%).

The press reports indicate that the central government and other public institutions did not meet public expectations in two areas. The first was not responding in a timely fashion to the earthquake. Many complained about not seeing any governmental rescue teams and/or representatives during the most critical first two days of the disaster. Second, while there was no shortage of food, supplies and foreign aid immediately following the Izmit earthquake, there was a problem in their distribution to places most in need. With aid and volunteers pouring in from all over Turkey and from over 50 countries around the world the coordination of these efforts was also lacking. As a result, the people held their government responsible while government leaders defended themselves by "being overwhelmed". The Prime Minister said no government in the world has enough rescue teams to respond to such a major disaster.

It seems clear that the press felt that governmental efforts in responding to the earthquake were not timely and coordination had failed. A majority of the 551 negative sentences about the central government noted these failures. A lack of organized governmental activities, particularly during the first two days of the disaster was revealed in reports describing decomposing food in the streets and unburied bodies under the wreckage was all reported by Turkish and international news sources (cf. *Radikal, The New York Times, The Washington Post*). At the same time, one of the biggest earthquakes of the century that affected more than 15 million people in a big metropolitan area simply overwhelmed the capacity of government to respond. Thirty-two statements from governmental leaders and scientists and international rescue team leaders noted that the government was simply "overwhelmed" during the response stage. The following two excerpts from *The New York Times* (Aug 23, 1999) summarize the unfolding events and their consequences in terms of public trust:

STATEMENTS		Mitigation								Preparedness								Response								Recovery								
		İzmit 1999	%	Düzce 1999	%	Afyon 2002	%	Bingöl 2003	%	İzmit 1999	%	Düzce 1999	%	Afyon 2002	%	Bingöl 2003	%	İzmit 1999	%	Düzce 1999	%	Afyon 2002	%	Bingöl 2003	%	İzmit 1999	%	Düzce 1999	%	Afyon 2002	%	Bingöl 2003	%	TOTAL
Contractors	Positive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Negative	104	32,5	1	33,3	6	37,5	17	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	167
Central Government	Positive	5	33,3	2	50	0		4	67	2	100	9	64	0		3	50	13	10,9	20	32	2	40	4	33	56	60,2	21	78	2	67	1	12,5	725
	Negative	62	19,3	1	33,3	5	31,3	17	39	61	46,6	3	75	2	50	3	50	551	73,5	9	34	4	50	3	60	44	84,6	57	86	2	33	4	45	1350
Military	Positive	0		0	0	0	0	0	0	0	0	2	14	0	0	1	17	21	17,6	11	18	1	20	0	0	8	8,6	0		0	0	2	25	140
	Negative	5	1,6	0	0	0	0	0	0	4	3,1	0	0	0	0	0	0	61	8,1	1	4	0	0	1	20	0	0	3	5	0	0	0	0	104
Turkish People	Positive	0	0	0	0	0	0	0	0	0	0	0	0	1	50	0	0	28	23,6	4	6	0	0	0	0	8	8,6	2	7,5	0	0	0	0	99
	Negative	45	14	1	33,3	2	12,5	2	4,5	10	7,6	0	0	0	0	1	16	22	2,9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	113
Local Government	Positive	1	16,7	1	25	0	0	0	0	0	0	1	8	0	0	0	0	2	1,7	3	5	0	0	0	0	5	5,4	1	3,5	0	0	1	12,5	53
	Negative	87	27,4	0	0	3	18,8	6	13	33	25,2	1	25	2	50	2	34	50	6,7	4	15	2	25	0	0	5	9,6	6	9	4	33	0	0	409
Voluntary Orgs.	Positive	0	0	1	25	0	0	0	0	0	0	0	0	0	0	0	0	19	16	3	5	0	0	2	17	9	9,7	1	3,5	0	0	1	12,5	99
	Negative	0	0	0	0	0	0	0	0	2	1,5	0		0	0	0	0	3	0,4	0	0	1	12,5	0	0	0	0	0	0	0	0	0	0	6
Foreign rescue teams	Positive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	24,3	12	19	0	0	2	17	7	7,5	2	7,5	1	33	1	0	123
	Negative	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Private Business	Positive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	5,1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
	Negative	6	1,8	0	0	0	0	2	4,5	0	0	0	0	0	0	0	0	1	0,1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
Red Crescent and Civil Defense Army	Positive	0	0	0	0	0	0	2	33	0	0	2	14	1	50	2	33	1	0,8	10	15	2	40	4	33	0	0	0	0	0	0	2	25	244
	Negative	1	0,3	0	0	0	0	0	0	7	5,3	0	0	0	0	0	0	36	5	0	0	1	12,5	1	20	3	5,8	0	0	3	25	5	55	162
Other	Positive	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Negative	10	3,1	0	0	0	0	0	0	14	10,7	0	0	0	0	0	0	26	3,5	13	47	1	0	0	0	0	0	0	0	1	0,9	0	0	112
TOTAL	Positive	6		4		0		6		2		14		2		6		132		63		5		12		93		27		3		8		1489
	Negative	320		4		16		44		131		4		4		6		750		23		10		5		52		66		10		9		2432

> "Turkish citizens take lead in recovery efforts in earthquake crisis, highlighting government's inability to respond effectively to disasters. As the scale of this week's disaster sinks in, many people interviewed in downtown Istanbul expressed shame and disgust at their Government's handling of the crisis. They echoed the widespread criticism in the Turkish press about the lack of equipment and of trained personnel in a country that has suffered repeated earthquakes over the last hundred years."
>
> "… in the wake of the overwhelming earthquake disaster on Tuesday, many residents of this giant city [Istanbul] with an estimated population of 12 million are more doubtful than ever that their Government is capable of planning ahead for such a catastrophe. "I don't trust the Government to plan for this," said Ms. Sesahan, a sculptor. "Take what is happening today as a model. The people are being very helpful and supportive of one another, but the Government can't get real help to the people."

An interesting finding was that the number of positive statements was higher than the negative statements in only one phase of the Izmit disaster—that of recovery. There, the Central government's performance received 56 positive statements compared to 44 negative statements. Similarly the military received 8 positive evaluations and no negative evaluations at the recovery stage. It appears that the government put extra effort and resources to regain the trust of people that was lost during the first three phases of the disaster. They provided 113,924 tents in 121 "tent cities" with health clinics, schools, shopping centers, childcare centers…etc (GDDA, 2000). The government also provided low interest housing credits, rent aid, and many other services to the victims including food, clothing, and health services as part of the recovery efforts. What was not revealed during the 30 days covered by this analysis was the government's promise to build more than 30,000 pre-fabricated temporary houses for the coming winter. With minor exceptions, the majority of these were completed by November 30th, 2000. As a result, the perceived performance of the government increased at the recovery stage compared to the earlier three stages.

The perceived improvement of public institutions' efforts in the final stage, recovery, has certainly had a positive effect on government's seriously questioned legitimacy especially during the early days of the disaster. However, the perceived failure of government was so intense during the first three stages that many governmental officials were protested during their visits to the region and even many months after the disaster. Since the North Anatolian Fault Line (NAF) is of the most seismically active faults in the world, aftershocks despite government's trust rebuilding efforts, reminded people of their insecurity as well their government's unreliability during a disaster. The trauma of the Izmit earthquake was so immense that, during the aftershocks many people did not hesitate to jump from the 5th or 6th floors of the apartment buildings rather than staying inside. Given the "disaster psychology" of the victims and the public's intense feeling of "distrust" of the only sector "with the resources to deal with a major disaster" (Schneider, 1992), expecting that the government would be able to rebuild the "lost trust" with successes at one stage of the disaster would be very naïve.

When the second earthquake struck Turkey Only 89 days after the first earthquake, government was much better organized, responded faster and tried to earn public trust by performing better. The content analysis of the news reports show that at all stages of the disaster central government has received much more positive evaluations compared to the first earthquake. Especially at the prepareddness and response stages the number of positive statements were higher than the total number of the negative evaluations. At the recovery stage, however, there were more negative statements due to the fact that the area efffected from the earthquake had harsh winter conditions and the recovery efforts in the first earthquake area were still continuing. There were even a shortage of winter tent supplies in the markets.
In 2002 and 2003 two other earthquakes struck Turkey. These were, compared to first two, in less populated and smaller areas and thus they received less media attention. The content analysis of the

news reports have showed that at the mitigation phase for both the third, Bingöl and fourth, Afyon, earthquakes the central Government, Local Governments, Contractors and Turkish public all have received negative evaluations. The majority of the criticisms were directed to the central government (31.3% and 39% respectively) who funded some of the collapsing public buildings and the contractors (37.5% and 39% respectively) who built them and the local governments (%18.8 and %13 respectively) who did not enforced the building codes properly. Particularly a collapsed boarding public school has received lots of media attention after the Bingöl earhquake. In responding to these two earthquakes central government, military and civil defence army has performed relatively better. The recovery efforts of the governmental organizations has received much better evaluations after the third earthquake but not after the fourth.

Overall despite the fact that central government has tried to improve its performance, the total number statements evaluating its performance were more negative (1350) than positive (725). The ratio of negative statements to positive statements is much worse for local governments (409:53). Red Crescent and Civil Defense Army, despite their low performance in the first earthquake have overall improved their performance and had done a better job (162:244). The Military has also a good record in terms of the overall ratio of negative statements to positive statements (104:140). Foreign rescue teams as well as the local voluntary organizations have done a job that earned the hearts of the public since the first earthquake and were shown as examples of efficiency and effectiveness.

Discussion

These findings indicate that during the Izmit earthquake the people's perception was that public institutions in general and the central government particularly, failed to live up to their expectations in mitigating, preparing for, and responding to the disaster. However, the central government did a much better job in their recovery efforts. Despite the improved performance at the last phase of the disaster, the failures attributed to the public institutions during the first three phases resulted in a "distrust" of government. Forty-six statements the people or journalists stated that people do not "trust" government anymore or have "lost confidence" in it. To rebuild trust, in the last 8 years starting after the İzmit earthquake, government has devoted more resources, time and energy in preparing for the future disasters. As a result, despite the fluctuations central government's performance in the analyzed last 3 earthquakes, has relatively improved. Empirical research is needed to asses if this has resulted in increased levels of public trust.

In a democratic society, legitimacy is the major foundation of any government. When a large number of people in a society perceive that their government is incompetent and cannot meet its expected role obligations the legitimacy of that government is de facto endangered (Blau and Scott, 1962). One important component of legitimacy is public's trust. High levels of organizational trust is associated with effective crisis management (Shockley-Zalabak et al., 2000). Failure to perform effectively during major disasters brings serious questions on the trustworthiness and assurance of continuity of such institutions (La Porte and Keller, 1996; La Porte and Metlay, 1996; Pearson and Mitroff, 1993).

These data suggest that the Turkish government failed to mitigate, prepare for, and respond to the Izmit disaster and that this failure to perform brought forth serious questions about the trustworthiness and legitimacy of the government. The findings about the recovery efforts of the Izmit earthquake and in the following three earthquakes revealed overall a relative improvement in the performance of governmental organizations which appeared to reduce the perceptions of incompetence. Given that high levels of organizational trust is associated with effective crisis management (Shockley-Zalabak et al., 2000), it would be reasonable to conclude that government has restored some of the public trust it has lost with its improved performance.

One important observation is that according the media coverage the public did not compare the performance of the Turkish government to its past performances. Rather, the performance of the international and Turkish non-governmental organizations, especially their efficiency in the search and rescue efforts, served as a reference point for the public to assess their government's performance. This suggest that in a more globalizing world, public expectations are more likely to be set by external and non-governmental referents rather than relative improvements in government's records.

The high percentage of both the negative and positive statements about the public institutions at every stage of the disaster supports Schneider's thesis that "[w]hen a natural disaster occurs, few people stop to ask if the government *should* intervene. Instead, citizens tend automatically to view the situation as a serious *public* problem requiring immediate *governmental* action" (1995). As much as a government is expected to actually get involved at every stage of the disaster, one of the most important roles expected from government is to play a leadership role. Massive disasters such as earthquakes demand involvement by a number of national and international entities. In the Turkish experiences there were no shortage of involvement from the different members of the society. Aid and volunteers poured in from all over Turkey. These findings showed that the non-governmental actors, for instance business organizations, with relatively minor effort, were able to easily receive positive coverage and appreciation in the media and furthered their organizational legitimacy. The expectations from the government, on the other hand, were higher and failure to satisfy them has brought rapid and serious criticisms.

These findings also showed that as much as failure to provide timely help, the failure in the coordination of non-governmental help has received the same attention and negative coverage for the government. The failures of government to collaborate with people not only harmed confidence in it but also discouraged people to collaborate with the public sector and for instance more than 30 NGOs came together to form an alliance and coordinated their own activities after the İzmit earthquake. Similarly, due to observed inefficiencies in governmental coordination and leadership people chose to volunteer for non-governmental rescue teams like AKUT, during the Izmit disaster. The lesson is that, for the government as much as actually doing the job in preparing for, responding to, and recovering from the earthquakes, leading and coordinating the activities of the other members of the society is also particularly important.

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IMPROVING EMERGENCY RESPONSE THROUGH COGNITIVE TASK ANALYSIS

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Abstract

Society has a responsibility to aid its citizens in case of emergency. This calls for planning and preparations. However, societal emergency response activities are not always fully effective. This might be due to suboptimal emergency planning and preparations, with some planned response actions not working as intended. For example, it is possible that some actions show to be 'over-planned' with too much content detail, while other actions show a lack of adequate drill or information support. Each emergency has its own specific characteristics, and good emergency response demands conscious thought processes for guiding the interaction between the response and the dynamic course of events. Yet, some response generated demands almost always arise during emergencies (Quarantelli, 1997), and such demands should preferably be handled automatically. Thus there is a need for a mix of conscious and automatic processes during emergency response. Conscious processing has the ability to adapt to the present situation, but is relatively slow and confined to one thing at a time. Automatic processes are relatively fast and can operate in parallel, but can not be adapted to the situation. The question is which task belongs on which level. Rasmussen (1983) described a model over different cognitive performance levels, linking control mode (automatic vs. conscious) to situation (routine vs. novel problems). We believe that Rasmussen's ideas can be used throughout the emergency planning and response processes to sort tasks in accordance with their probable optimal mental control modes. Based on a study of emergency planning and response activities in the Swedish city of Malmö we propose and discuss an algorithm for guiding the selection of appropriate competence types for different tasks.

Introduction

In case of emergency society has a responsibility to support its citizens. This calls for planning and preparedness at different administrational levels. Due to the possible complexity of emergency situations planning is a very difficult task and may not always be as optimal as it could. Since it is not possible to predict future events in detail, one has to save some capacity for conscious processing of what is going on and 'on-line' problem solving.

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While the responses to a specific emergency situation are unique, there are some functions that are almost always needed in emergency response activities. Quarantelli (1997) discusses the concept of response-generated needs, and arrives at the conclusion that there are some generic needs that response organisations can be almost certain to face when activated. Such things are preferably prepared for in advance in such ways that they can be taken care of practically without any (mental) effort. There is a tendency during emergency planning to forget that some tasks can be executed in a reflex-like manner, while others necessarily have to be attended to with great mental effort. As a result, some actions get 'over-planned' while others get less attention than desirable. This might lead to sub-optimal response performance.

The aim of this paper is to describe a possible method for cognitive task analysis, to be used for improving emergency planning and response. The result is a schematic routine for sorting tasks in accordance with their probable optimal mental control modes. The empirical focus is on the example of manning/staffing in the emergency response organisation of the city of Malmö, but the general principle is what is important.

Emergency management in the city of Malmö during the Lebanon crisis of 2006

In the middle of July 2006 an armed conflict between Lebanon and Israel broke out. This resulted in a decision from the Swedish government to evacuate Swedish citizens from Lebanon. At the time many Swedes descendant from Lebanon were visiting their families during their summer holiday. In addition, many people with permanent residence permit in Sweden have moved back to Lebanon during the last years. A first estimate of the number of people that needed evacuation from Lebanon to Sweden was 3,500, but in the end about 8,000 people had been transported to Sweden and about 1,000 of them to the city of Malmö. The day after the evacuation of Swedish citizens began, Malmö started up a part of their emergency response organisation. Most of the people evacuated to Sweden arrived in Stockholm and was then transported by train or bus to other parts of the country. Busses and trains arrived at Malmö station where a reception committee was arranged. The reception committee provided information, and when needed also helped with places to stay and in some cases even with resources to buy food. Malmö also started up a support centre, primarily for worried relatives. In total, the Malmö response organisation worked for about three weeks.

During Malmö's emergency response activities to the Lebanon crisis the organisation initiated the emergency response activities according to plan, and the manning of the 'front line' (e.g. a psychological and social support centre) worked well. However, some other things did not work quite as well. When the front-line response activities were up and running deficiencies in the advance planning of the relief of personnel were revealed within the central organisation. The central organisation did not plan and prepare for long-term staffing. Because the crisis happened during the period of summer when most people in Sweden are on vacation there was hesitation to bring in more than a minimum of staff. This hesitation was due to cultural norms, and not to legal matters. As a consequence some individuals on duty were overloaded with tasks. The individuals responsible for arranging personnel rostering were occupied with other tasks, continually demanding their attention. After approximately one week, some people were exhausted. Further, they did not know neither whether nor when they were to be relieved. When pointing out fatigue and/or requesting relief, personnel were referred back and forth between managers, due to uncertainty on which mode the organisation was in, and accordingly on who was actually responsible for managing personnel relief in the central organisation. There was no planning and therefore no routines to immediately arrange and ensure a long-term manning. We conclude that the manning of the central organisation did not function properly in a long-term perspective. Put together, there was an obvious threat to the organisation's ability to continue operations. In the event of greater emergencies, perhaps with more acute threats involved, this could result in great negative consequences. These problems call for measures to prevent them from reoccurring.

Before the Lebanon crisis of 2006 occurred, Malmö's response organisation had some preparations related to manning. In their operational plan it was expressed that the need to ensure access to personnel and other resources is the main purpose of a contingency plan. In the plan we found some items interpreted as concerning manning, e.g.:

- During an emergency the support staff decides how many persons are needed for service. According to the plan the support staff shall also "Estimate the need for resources", "Work out a plan for the support staff" and "Plan the emergency response in detail". The plan also mentions "Schedule for relief", without any information on what or how to do. *Our comment: These tasks can be seen as concerning personnel rostering. Because of their vague formulations in the plan these tasks are left to be solved 'on-line'.*
- Each section-leader shall "Be responsible that the members of the section are relieved when needed". *Our comment: No instructions are given on how to interpret 'when needed', and no advance planning in this matter is actively supported in the operational plan.*
- Updated lists with names and telephone numbers for calling people in to duty.

As shown by the list of example items above staffing/manning is mentioned in some places in the operational plan. However, in none of the places any details are given regarding what and how to do. There are no explicit routines for how to manage personnel rostering.

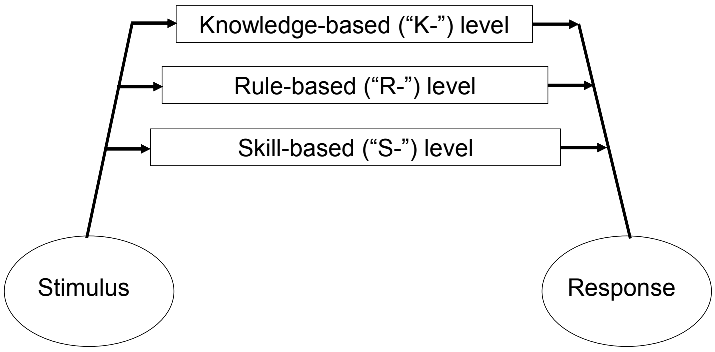
Theory and method

<u>Theory</u>

Human performance varies between routine tasks and unfamiliar tasks, regarding e.g. cognitive functioning and capacity. It is well established that human activity consists of parallel processes occurring with different degrees of conscious control (e.g. Kellogg, 1995). A cognitive approach places consciousness in the short-term memory system (sometimes called working memory) (Baddeley, 1986). Human short-term memory has a limited capacity, literary meaning that one cannot hold more than a few things at a time active in memory (e.g. Miller, 1956; Baddeley, 1986). In each moment, a person can be consciously occupied with only one single thing, sometimes referred to as being in focal awareness (e.g. Marton & Booth, 1997). The same person can at the very same time be engaged in numerous other activities, taking place on other levels within the cognitive domain. In a specific situation the combination of the task at hand and the person determines which activities will take place, and on which cognitive level each activity predominantly will be executed.

Rasmussen (1983) describes a model of human cognitive performance, separating the skill-, rule- and knowledge-based levels. The model (simplified) is illustrated in figure 1. In the model, a certain stimulus is first tested at the S-level. If it is found (maybe falsely) to be familiar enough to be handled without conscious involvement it is responded to on the S-level. Otherwise it is passed on for check at the next higher level, the R-level. There a check is performed whether any prior experiences have established a rule of some kind that seems (maybe falsely) probable to be applicable in the situation. If a rule judged acceptable is found, the stimulus is responded to on the R-level. If no acceptable rule is found, the stimulus is passed on to the highest level (the K-level), where it receives conscious attention and demands precious mental resources.

Figure 1. A sketch of Rasmussen's S-R-K-model.



Performance at the *skill-level* typically takes place without conscious attention or control. In everyday life we usually perform several different tasks simultaneously at this level. Generally, much of human performance can be thought of as a sequence and coordination of building-blocks in the form of skilled acts. Such sequences of skilled acts can be guided by stored rules, describing procedures aggregating separate acts. Such rules belong to the next higher, *rule-based* level of performance. They can be empirically based on the individual's experience, stem from some other person, or be thought out deliberately. The actual performance is characterized by feed-forward control, i.e. the execution of one or several rules with little or no feedback guidance. Rule-guided action demands relatively little conscious mental resources. Conscious monitoring as part of a feedback control activity may be considered a concurrent activity at the highest, *knowledge-based* cognitive level. Note that there is interaction between the different levels, where different aspects of a complex response to a complex situation are taken care of at different levels (Rasmussen, 1983).

In unfamiliar situations, of which a person has no prior experience, there is a need for conscious, symbol-based analysis of the situation and its options for action (Rasmussen, 1983). This demands lots of cognitive resources, and must be done in a time-consuming, serial manner. On this so-called K-level goals are explicitly stated, and action is guided by feedback from mental or physical trials. Obviously, K-level activities are extremely dependent on the available mental model of the situation.

The level on which a certain task is performed may vary. Familiarity with a (type of) task and/or prior experience of similar situations makes it more probable that the task will be performed on a lower cognitive level in the S-R-K-hierarchy. In combination with the significantly more limited capacities at higher levels such a shift downward is highly desirable, since it frees valuable K-level capacity for what may need it more. The tendency of familiar tasks to gradually be performed on lower levels in the hierarchy and to accordingly need less conscious control is what sometimes is referred to as automation (through experience). The downside with automatic processes is that they in themselves cannot adapt to the situation.

Bearing in mind these characteristics of human performance and different levels within the cognitive domain, what can be done in advance in order to increase the likelihood of successful performance? On the K-level, the ability to swiftly construct mental models can be strengthened. Here, e.g. access to previously tested constructs and symbols to use in conscious elaboration can be of great help. This can be addressed by training and education. Competence on the S- and R-levels can be built up through routines and exercises that build up experience.

To optimize emergency response, preparations should aim to free as much as possible of the responders' precious and limited K-level capacity to what needs it the most. Typically, this may be critical thinking and problem solving, used to adjust emergency response to the actual situation.

Method

The aim of this paper is to describe a possible method for cognitive task analysis, to be used for improving emergency planning and response. The method was developed using data from a study of Malmö's handling of the Lebanon crisis of 2006. Found weaknesses in Malmö's response activities were analysed and conceptualized in S-R-K-terms (Rasmussen, 1983). From that conceptualization we formulated an algorithm (a structured process) for checking anticipated emergency response actions against the S-, R- and K-levels, aiming to sort tasks in accordance with their probable optimal mental control modes.

The study of the Malmö handling started with an examination of journal notes from the response organisation's information system and notes and minutes from managerial meetings during the events. Documents such as written preparedness plans and organisational charts were also studied. From analysis of the initial material an interview guide was constructed, and a series of interviews were conducted with people who had participated in the response organisation. In an iterative process additional informants and documents were identified. In recurring meetings with a high-rank representative from Malmö's organisation our tentative understanding of the intended plan as well as of implemented actions during the Lebanon crisis were checked. As an overarching strategy, we aimed at triangulation of facts through the use of several sources of information with partly overlapping scope. This strategy brought a "convergence of evidence" (Yin, 2003, p 100), strengthening our confidence in the reliability of our findings.

Results

Considering which cognitive level would be suitable for different (sub-) tasks might help in forming and elaborating emergency planning and preparations. Such sorting might build upon Rasmussen's S-R-K-model (Rasmussen, 1983). An algorithm for emergency planning encompassing an S-R-K-based optimization might look like this[4]:

1. Identify the probable aim (-s) of a future emergency response.
2. Think out successions of actions that would lead to the fulfillment of the aim (-s) identified. This might be accomplished using e.g. backtracking or task analysis.
3. For each identified action, strive to place things as low as possible in the S-R-K-hierarchy and try to avoid overloading the limited K-level of individuals during actual response activities. Ask the following questions:
    - How could this be done as simply as possible?
    - Could it be done on the S-level? If so, then what is needed?
    - If not, could it be done on the R-level? If so, then what is needed?
    - Is the task probable to (partly) need the K-level? If so, what can be done to create circumstances that facilitate this?
    - Can routines, information or training help to simplify fulfillment of the action?

Demonstrating the algorithm

Malmö's handling of the Lebanon crisis of 2006 revealed a lack of planning and preparation for long-term staffing within the central organisation. Due to this, some individuals were near exhaustion and long-term operability was threatened. Applying the proposed algorithm to a

[4] Steps 1 and 2 in the algorithm are found in practically all emergency preparedness processes.

short, simplified example restricted to the manning problems reported from Malmö might look like this:

1. Aims of response activity: Provide psycho-social support and emergency housing.
2. Necessary actions: To conduct the emergency response activities intended there was a need for personnel. Since people cannot work intensely for more than a short period of time without a significant drop in productivity (and perhaps also in health), sooner or later there is a need for personnel relief. Therefore it is necessary to plan and prepare for prolonged manning. Examples of sub-tasks related to the manning need:
   a) The identification of response tasks needed in the present situation.
   b) The identification of manning needs in relation to the situation. How many persons are needed for each task? When? How long shifts are realistic? Etc.
   c) The identification of persons in the organisation suitable for identified tasks related to the situation.
   d) Communication with staff selected to call in.
3. S-R-K-sorting: The first of the sub-tasks above (*a*) requires K-level attention. The latter three sub-tasks (*b-d*) can all be facilitated by preparations of routines, check-lists etc., that has the possibility to transform them from mentally challenging to more or less effortless automatic activities on the S- and R-levels. If successful, that would free K-level capacity for guiding the interaction with the dynamic course of events.

The brief example above shows that it is possible that the problems concerning manning could have been avoided if the proposed algorithm had been used as a tool when developing Malmö's operational plan.

Discussion

We have shown how making use of knowledge about human cognitive abilities and limitations might help to construct better emergency planning and response. The idea of making S-R-K-analyses as part of emergency planning can be seen as making use of knowledge from the fields of human factors and cognitive psychology in emergency management. The short and simplified example above does not include details, and serves only to give an illustration. In real practice much more detail is needed.

The ideas presented in this paper might seem trivial. Trying to think about what might happen, which actions are probable to be needed, which tasks they imply, and then how these can be prepared for are not new ideas. Yet, the discussion above about the Malmö example has shown that the emergency preparation process might benefit from the aid of theories and models that help structuring the analytical process of foreseeing. We believe that considering which of the S-, R-, and K-levels that would be optimal for different sub-tasks can help in several ways. For example, the concept of different cognitive levels can in itself shed light on otherwise overlooked sub-tasks, e.g. ones that are taken for granted because they usually happen automatically. It is also possible to not fully consider the need for K-level resources associated with certain classes of tasks. Such misses can significantly lower the ability of a response organisation.

S-R-K-analysis of operational planning does not solve all problems, but it might help in avoiding some problems from occurring. It can by no means stand alone. 'The big picture' is needed first – it is necessary to have some grasp of possible scenarios before one can start working out response needs, appropriate tasks, and then probable optimal cognitive levels to put them on. At best, it might contribute as a complement to e.g. different kinds of risk and vulnerability analyses.

Other approaches to tackling the example problems concerning manning discussed in this paper could aim at norms and knowledge within the organisation. A general understanding of the generic response need for persistent long-term manning seems to be a fair goal in that direction. Another example could be a clarification of the responsibilities concerning manning within the organisation. These approaches could be used along with S-R-K-analysis of operational planning. To just put more resources at the problem, e.g. through putting more individuals at the task of manning, would probably be effective but not as efficient as (combining it with) preventive S-R-K-analysis of anticipated manning tasks.

We believe that S-R-K-analysis can be applied to more than manning tasks. Probably it can be used generally in preparedness planning. It would be very interesting to test the proposed S-R-K-analysis algorithm in further contexts, develop more detailed method recommendations and gather more information on its possible merits as a preventive tool.

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THE END OF PROCESS MANAGEMENT?

IS THE PROCESS-DRIVEN APPROACH THE OPTIMAL WAY TO SOLVE CRITICAL SITUATIONS?

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Keywords

Process management, emergent behaviour, emergency management, information support, asymmetric threats, terrorism, critical infrastructure, standards, information management

Abstract

The process management has become an evergreen in each "well kept organization. This paper discusses the relevance of the process management method in emergency situations as has been researched in the T-SOFT Ltd. Company in consequence with the software tools development. The situations where processes are not followed or defined and still proper results are obtained are described. Emergent behaviour in extreme situations can be recognized and the discussion about its general usability for the newly defined approach is introduced. Possible positive influence of the software products for the decision support in emergency situations is indicated.

Introduction – Process management approach

The provocative title does not necessarily mean to quit the process management, but rather it would like to show an alternative way of thinking about the critical situations evolution and management. The process management has become a traditional way of thinking in companies and institutions in recent years. What are the common features for emergency management and traditional or business management of companies?

In the business area the ISO 9001 standard has been implemented for last few years. This standard, after several revisions, accepts the process approach as a base for the management and quality assurance.

This approach has definitely many advantages. It allows finding critical path in processes, tracking redundant steps, checking the responsibility for all of the process phases etc.

This approach is excellent for auditing the system itself. The essential need for the process is to deliver an output required. But many times the audit focuses to the formal check of the inner process itself, result of such might be negative. Even if final effect is adequate to requirements.

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In other words, everything is working well but processes are not being used as they were defined.

The question is: is it wrong or is it ok? The behaviour of people in the systems ensures obviously the proper results at the end – so what method and way of thinking and doing are proper for efficient management? And what might be consequences for the management in critical situations?

The secret of processes

Many people from ISO 9001 certified companies would agree that in many cases the certified processes are not being used. They admit the process definition is required just for the formal certification but things themselves are being done in some other way.

In the emergency management the situation might be similar. Having discussed those issues with people from the ambulance, they also admit that during large incidents etc. they use different procedures than those officially defined.

But in spite of this it works somehow. How it is possible? People simply behave somehow…

Emergent behaviour

When a collection of individuals, each following specific rules are studied, unexpected behaviour of the whole group may pop out of the system. Very simple examples are numerous:

- Crickets tend to sync their mating calls, calling all at once at the same speed
- Birds flying around can create large groups of birds that seem to behave as one
- Robots start to follow walls
- Economic agents all act together in an economy that can rise and fall, and may even crash down.

All of these higher level behaviours cannot be described the same way as their agents themselves.

"**Emergence** is the process of deriving some new and coherent structures, patterns and properties in a complex system. Emergent phenomena occur due to the pattern of interactions between the elements of a system over time. Emergent phenomena are often unexpected, nontrivial results of relatively simple interactions of relatively simple components." (From http://en.wikipedia.org/wiki/Emergence)

Emergence is the process of complex pattern formation from simpler rules.
This can be a dynamic process (spanning over time), such as the evolution of the human body over thousands of successive generations. Or it might be emergence, happening over disparate size scales, such as the interactions between a big number of neurons resulting in a human brain capable of thinking (even though the constituent neurons are not individually capable of thought). The original term was "categorial novum" coined by Nicolai Hartmann. [2]

For a phenomenon to be termed emergent it should generally be unpredictable from a lower level description. But, in the management of the company, for example, we need to predict the behaviour of the whole system from the behaviour of lower level elements. At the very

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[2] Nicolai Hartmann (* February 20, 1882, † October 9, 1950) - German philosopher.

low level, the phenomenon usually does not exist at all or exists only in trace amounts: it is irreducible. Thus, a straightforward phenomenon such as the probability of finding a raisin in a slice of cake growing with the portion-size does not generally require a theory of emergence to explain. It may, however, be profitable to consider the "emergence" of the texture of the cake as a relatively complex result of the baking process and the mixture of ingredients.

But for practical management we need something different. We need to be sure that the description of behaviour will result in the proper outputs of the process, which would be reached by the global process definition.

One of the examples of the emergent behaviour is the problem solved by cellular automata.

What is Cellular Automata?

From the theoretical point of view, *Cellular Automata* (CA) were introduced in the late 1940's by John von Neumann (von Neumann, 1966; Toffoli, 1987) and Stanislaw Ulam. From the more practical point of view it was more less in the late 1960's when John Horton Conway developed the *Game of Life* (Gardner, 1970; Dewdney, 1989; Dewdney, 1990).

CA's are *discrete dynamical systems* and are often described as a counterpart to *partial differential equations*, which have the capability to describe *continuous* dynamical systems. The meaning of *discrete* is that space, time and properties of the automaton can have only a finite, countable number of states. The basic idea is not to try to describe a complex system from "above" - to describe it using difficult equations, but simulating this system by interaction of cells following easy rules. In other words:

Not to describe a *complex* system with *complex* equations, but let the complexity emerge by interaction of *simple* individuals following *simple* rules.

Hence the essential properties of a CA are

- a *regular n-dimensional lattice* (n is in most cases of one or two dimensions), where each *cell* of this lattice has a discrete state,
- a *dynamical behaviour*, described by so called *rules*. These rules describe the state of a cell for the next time step, depending on the states of the cells in the neighbourhood of the cell.

The first system extensively calculated on computers is - as mentioned above - the *Game of Life*. This game became that popular, that a scientific magazine published regularly articles about the "behaviour" of this game. Contests were organized to prove certain problems. In the late 1980's the interest on CA's arose again, as powerful computers became widely available. Today a set of accepted applications in simulation of dynamical systems are available.

Can we reach any kind of compromise?

Is there any possibility how to combine both process and behavioural approaches? Or in other words : Is there even a possibility to describe the behaviour of participants of any process in order to ensure the process results even the participants do not know anything about the process described on the higher level?

The process approach defines the process from the upper level or from outside. This kind of description we need for audit – for checking if the process works properly.

The optimal status we would like to reach is to ensure the participants would acts exactly as it is described on the higher level.

The problem is processes are usually defined for let us say "ideal situation" which can vary in the real life.

In essence we could find following directions for the future thinking and experimenting:

1. define the behaviour of people in order they do in certain situation exactly what is requested by the process definition,
2. implement the simulation system which can help us, based on the experiments with the behaviour of all the participants, to define the process which will be able to cover most of the functionality in the real life,
3. precise the behaviour of participants in such a model backwards based on the simulation on the simulator, which is controlled by the process definition.

There are probably more variants and options in the effort how to combine both approaches. Next essential question should be if the behaviour description is not a process itself on the lowest level.

We believe the basic difference is that the process is usually sequential while the behaviour is rather event driven.

On the level of behaviour we can abstract away from the specific process. The description of some participant behaviour can serve for more processes not only for one.

In the process definition we have usually sequences of steps defined, which are executed step by step.

In the behaviour description we can find also some definitions like following:

4. XZ must be done every time
5. XY must be done each hour
6. This must not be done anytime
7. If AB happens do XY
8. etc.

The very typical historical example of such a description is the Decalogue from the Bible.
The Emergent Behaviour paradigm can serve as a base for development of a new strategy of software for decision support, command and control, alerting and other activities in emergency management. Current Standard Operation Procedures (SOPs) can be complemented by a *rule-based* modules, which would support the emergent behaviour. There is an example in the software tools developed by T-SOFT.

Further development of T-SOFT software emergency tools

The objective of the further research in the area discussed above is to find the way how to support the behaviour of people in order to fulfil the requirements on processes outputs, not being forced to follow the process itself.

Next steps in development of our tools (mainly Emergency Office - **EmOff** and simulation system **ESIM**) are to extend the process definition features the following way:

1. enable to define standard operation procedure using also steps which are not time framed
2. add steps which are to be done every time
3. add definition of activities which must not be done
4. define situations or constellations which are to be excluded
5. add a feature enabling the possibility to monitor and analyse actual behaviour of participants during the an emergency situation solution
6. upgrade the ESIM simulation system in order to have a possibility to change the processes dynamically according to the behaviour of participants

It means to enhance the tools by the rules-based engine, taking into account the real emerging situation, either by monitoring single agents or the "crowd" as a whole. Then we expect an increased performance and exactness of the decision support system.

Conclusion

The most requested conclusion of any work is to answer the questions given in the beginning. If we ask the question according to the header of this paper, i.e. if we can expect the end of the process management, or if the process management will be replaced by the behavioural approach, it is very difficult to give the simple answer.

We can see good possibilities how to enhance the process management approach by some features of emergent behaviour. The goal of this paper is to open this question as a next chapter for possible research and development in the area of management and emergency management information support.

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Since the 1991 he is the stockholder and managing director of T-SOFT Ltd. Company. From the beginning he is responsible for the internal organization of the company, definition of standard processes and quality assurance. He also took part in research projects, mainly in the area of simulation. In the area of simulation systems he obtained the Ph.D. title in 2004. Problems of process management and an emergent behaviour are also the theme of his dissertation MBA work.

NON REFEREED PAPERS

CROATIAN AGENDA: IMPLEMENTATION OF WAR EXPERIENCE TO MEDICAL DISASTER MANAGEMENT

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Key words:

War, disaster preparedness, trauma system

Abstract

At the very start of independence in 1991 Croatia was faced with military and paramilitary agression of former Yugoslavian federal army. Since there was no aid from abroad, we had to lean on our own capabilities to solve increasing health demands among soldiers and civilians. Intially, NATO doctrine has been modified and Mobile Surgical Teams composed of civilian medical staff were supporting army units at the first battleline. Special services were developed for other public health problems and their activities were coordinated by Headquarter for medical crisis. Excellent results were achieved despite adverse political and economical circumstances.
In recent time, there is a growing public interest for disaster preparedness. Our plans for such situations are guided in two directions. First of them is building Croatian trauma system in four steps following recommendations from western countries, especially European Union. This is supposed to be a prompt answer to medical crisis within certain geographical area. Other direction is re-establishing Headquarter for medical crisis at the national level, including all services and potential hierarchy. Our war experience suggests that this is a straightforward and easily changeable model allowing quick adaptation. When too excessive demands are put on local capabilities and resources during the crisis, this might be an excellent back-up solution.

Introduction

In former Yugoslavia military medicine was completely separated from civilian system. Ex federal army developed all segments of health services, including emergency and disaster medicine as well as hospitals of highest rank. Military physicians were privileged in terms of professional training and working conditions. The whole organization was generously financed by the state.

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On May 30th 1990 the Croatian parliament was constituted after first democratic elections in our history. Less than three months later (August 16h 1990) Srbian paramilitary units started to obstruct free transport of people and goods by placing huge wooden obstacles on main roads in the middle part of Croatia. Until May 1991 there were over 200 terrorist attacks with explosive devices and over 100 assaults with fire-weapons, thus resulting in 16 Croatian citizens killed and 56 more wounded. Under protection of federal army Serbian rebels proclaimed secession of the middle part of Croatia on May 22nd 1991. Six days later, on May 28th 1991, first brigades of future Croatian army were recruited from regular police force, though they were practically unarmed at the beginning. Open agression of ex Yugoslavian military forces started on July 3rd 1991 including tank attacks, but European Union declared embargo on export of weapons to whole territory of ex Yugoslavia on July 5th 1991. Until the end of 1991, 45% of Croatian land was under constant attacks of heavy weapons and 95% of targets were civilian. Finally, Croatia was internationally recognized on January 15th 1992 (Croatian memorial documentation center of Patriotic war, 1991; Patriotic war in city of Karlovac , 1991; Ljubičić et al, 2006).

Regarding health care needs, increasing military agression brought huge problems to unarmed Croatia:

- Migration of 500 000 people from occupied territories to Zagreb and other big cities
- Traffic isolation of southern part of Croatia and uncertainty of travelling, including emergency medical service cars
- Considerable loss of health care infrastructure and supplies on occupied territory as well as because of blockade of military medical warehouses on unoccupied territories by ex Yugoslavian army
- Escape of medical professionals abroad and, to much lesser amount, to Serbian rebels
- Constant lack of finances for medical needs. Croatia was completely unarmed in 1991 and all money had to be invested in buying weapons. Because of international embargo we were forced to buy waepons at international black market for triple prices (Ljubičić et al, 2006).

Under such adverse circumstances whole structure of health care in Croatia had to adapt to war conditions.

Group of physicians unofficially met in Zagreb on August 18th 1990, only two days after first action of Serbian paramilitary forces. During the next month they made an inventory of available medical supplies and initiated plans for medical aid to other parts of Croatia (Ljubičić et al, 2006). On December 19th 1990 they were appointed to Headquarter of health care with departments for preventive medical actions, toxicology and re-distribution of medical supplies.

Initial protocols about control and safety of drinking water, control of conserved food as well as about immunization, nourishment and other daily needs for refugees were published on January 24th 1991. Due to increased demands later on Headquarter of health care established additional five departments (for mobile surgical teams, evacuation and treatment of wounded persons, psychiatry and information & investigation) as well as six services (for administration, medical tactics, repair of medical equipment, transport, distribution of drugs and security) (Ljubičić et al, 2006). Very soon, NATO textbook was translated to Croatian languagw (Prodan et al, 1991) and many seminars and courses about first aid (Hebrabg et al, 1991) were made for non-medical and medical providers. All activities were based on the hard work of enthusiastic medical personnel who were “civilians in the military uniform with police symbols” (Ljubičić et al, 2006).

Mobile surgical teams were established on February 4th 1991. Each team consisted of five members: two physicians (surgeon, anestehesiologist), two nurses (surgical and anesthesiological) and a driver (Puntarić and Brkić, 1995). First intervention in the field was on March 31th 1991 when Croatian police officer Josip Jović was killed (Ljubičić et al, 2006). Until the end of the war mobile surgical teams have been always present near the first battle-line supporting professional brigades, i.e. 50 m behind during attack phasis and 100 m behind during retreat phasis.

On January 3rd 1992 first cease-fire was signed between Croatian army and Serbian forces. Meanwhile, Headquarter of health care reorganized treatment of wounded persons at four levels (Vučkov et al, 1998; Marcikić et al, 1998; Ilić et al, 1998; Janković et al, 1998):

- Level I: educated soldiers and medical technicians giving first aid at the battle-line
- Level II: physicians who were located not far off the battle-field. Their responsibility was to make initial triage and to solve medical emergencies
- Level III: civilian ambulance services or war hospitals equipped with surgical teams
- Level IV: hospitals for definitive treatment of injured persons.

Further improvements were introduced in May 1992 when Level I providers were detached from the authority of Headquarter of health care and incorporated in regular army units (Ljubičić et al, 2006).

In 1995 Croatian army performed few decisive operations when most part of Croatia was liberated. Those were: "Flash", "Summer 95" and "Storm". In all of them medical support to combat units was excellent (Petričević et al, 1998; Tonković et al, 1997; Lovrić et al, 1997; Janković et al, 1997) and regular health care for civilians was re-established in a couple of days (Ljubičić et al, 2006).

Finally, during the whole period of war in Croatia there were no tetanus diseases or epidemics (Atias-Nikolov, 1995), including poisoning of food and water (Plavšić et al, 1992). Sporadic infectious diseases were recognized on time and adequatly cured (Ljubičić et al, 2006;Tiljak 1996). Among 25 000 wounded persons, only few of them had gas gangrene and only 800 amputations of extremities were performed (Jovanović et al, 1999; Rukavina, 1998; Maričević and Erceg, 1997; Hančević et al, 1992; Turčić et al, 1995). Dedication and commitment of civilian health care personnel was able to compensate inexperience in war medicine, lack of finances and lack of firm military organization (Puntarić and Brkić, 1995).

Theory and Method

In recent time there is a growing public interest for disaster preparedness in Croatia. Literature suggest that a disaster respond is best provided through an extension of already existing trauma system (American Trauma Society, 2002). Croatia still hasn´t got one, although we are investing some effort to make it. This article is arguing two questions:

- Do we need Croatian trauma system at all?
- If the answer on the first question is positive, one should think over if our war experience should be incorporated?

Crude numbers of deaths per year due to external cause of injury and poisoning (ICD 10: V01-Y89) in Croatia were obtained from Croatian National Institute of Public Health (Croatian National Institute of Public Health, 2006). Because in ex Yugoslavia separate statistics for Croatia and other ex Yugoslavian republics was not reported before 1985, this was the starting year for the purpose of the present study. Latest data for Croatia reached year 2005.

Risks during transport have gained recently great interest in Europe (Consultation Paper On a 3rd Road Safety Action Plan 2002-2010, 2001; Commision of the European Communities , 2001; Commision of the European Communities , 2003). In Croatia police statistics is the only one offering details regarding time of death of transport accidents victims during three periods: on the scene, during transport and in the hospital up to 30 days (Ministry of Internal Affairs, 1995-2006). Data were analyzed and compared with other studies.

On the level of international statistics we operated with European health for all database (WHO Regional Office for Europe, 2007), which provides age-standardized death rate (SDR) from external causes of injury and poisoning (ICD 10: V01-Y89) as well as SDR from motor vehicle accidents (ICD-10: V02-V04, V09, V12-V14, V19-V79, V82-V87, V89). In this database, SDR were calculated using the direct method i.e. they represent what the crude rate would have been if the population of a certain country had the same age distribution as the European standard population. Comparison was made for Croatia, average of European Union (including new members since May 2004) and two European countries with mature trauma systems (the Netherlands and Great Britain).

Results

Crude numbers of deaths per year due to external causes of injury and poisoning (ICD 10: V01-Y89) in Croatia are presented in tables 1, 2 and 3 for three periods: 1985-1990 (before the war), 1991-1995 (during the war) and 1996-2005 (after the war) (Croatian National Institute of Public Health, 2006).

Table 1. Crude number of deaths per year due to external causes of injury and poisoning (ICD 10: V01-Y89) in Croatia for 1985-1990 (Croatian National Institute of Public Health, 2006).

Year	1985	1986	1987	1988	1989	1990
N°	3841	3641	4104	4178	4095	4381

Table 2. Crude number of deaths per year due to external causes of injury and poisoning (ICD 10: V01-Y89) in Croatia for 1990-1995 (Croatian National Institute of Public Health, 2006).

Year	1991	1992	1993	1994	1995
N°	7325	6346	4538	3715	3847

Table 3. Crude number of deaths per year due to external causes of injury and poisoning (ICD 10: V01-Y89) in Croatia for 1996-2005 (Croatian National Institute of Public Health, 2006).

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
N°	3295	3119	3173	2939	2905	2742	2707	2859	2870	2878

In the period 1985-1990 Croatia has lost 24 240 citizens because of injuries. During the war our losses were 25 771 and in eleven years of peace after the war we have lost nearly 30 000 people. All together, during past 21 years Croatia has lost nearly 2% of its population only because of injuries.

Police statistics (Ministry of Internal Affairs, 1995-2006) about mortality in transport accidents in Croatia is presented in table 4. This is a trimodal distribution with death peaks on the scene, during transport and in the hospital up to 30 days.

It is obvious that overall mortality due to transport accidents in Croatia is gradually decreasing. More important are two other facts:

- Share of hospital mortality to overall mortality has not significantly decreased during past 10 years and remained constantly over 25%
- Share of mortality in prehospital setting was between 72-80%.

On the international level we made a comparison between Croatia on one side and average European Union (including new members since May 2004) and two European countries with mature trauma systems (the Netherlands and Great Britain) on the other. Age-standardized death rate (SDR) from external causes of injury and poisoning (chart 1) as well as SDR from motor vehicle accidents (chart 2) were employed.

Chart 1. Age-standardized death rate (SDR) from causes of external injury and poisoning for Croatia, average of EU, the Netherlands and Great Britain (WHO Regional Office for Europe, 2007).

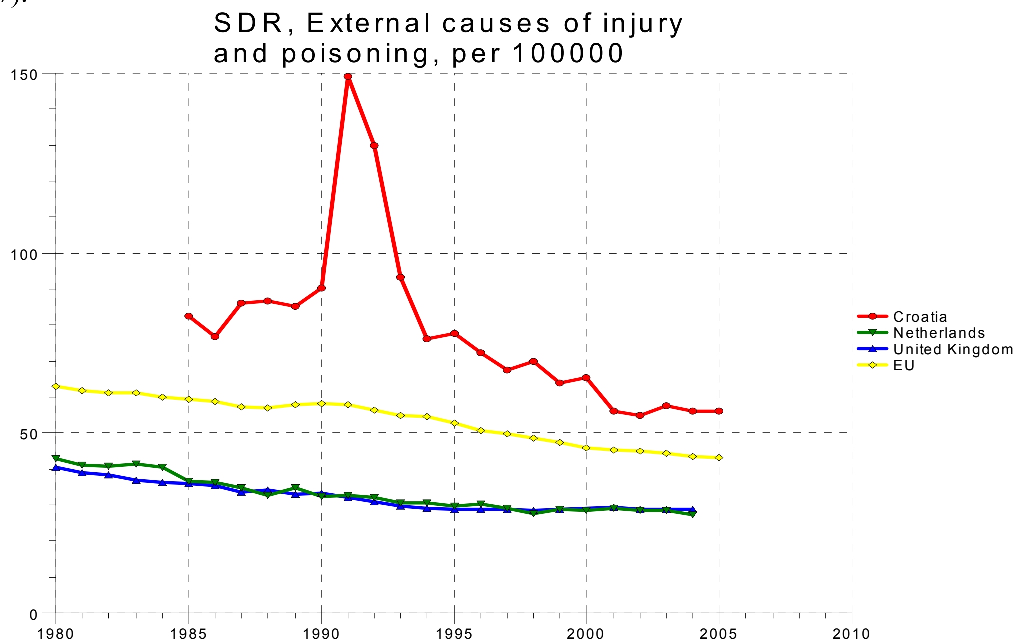
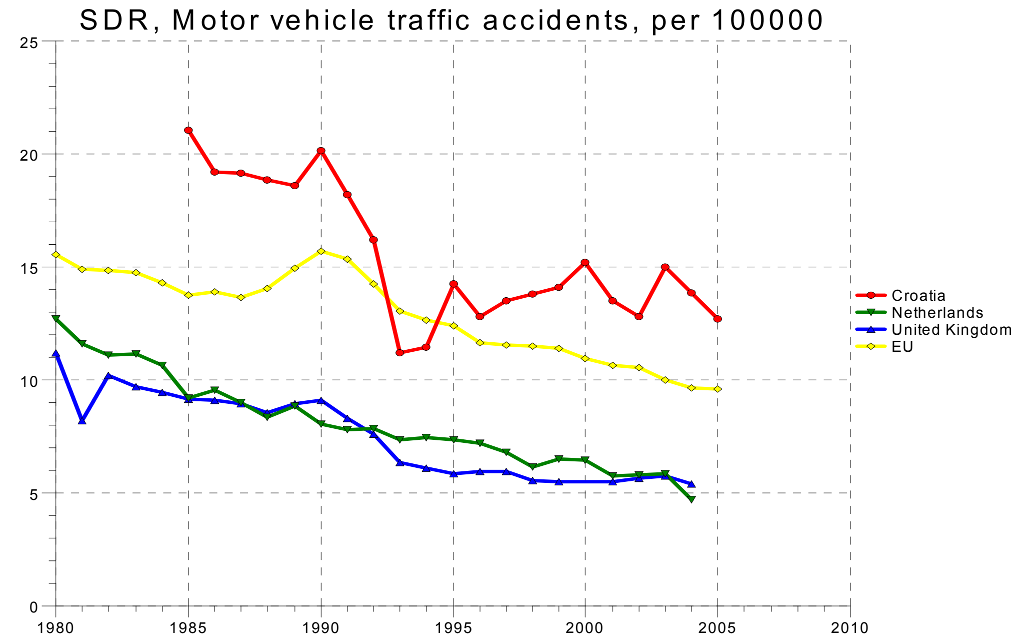


Chart 2. Age-standardized death rate (SDR) from motor vehicle accidents for Croatia, average of EU, the Netherlands and Great Britain (WHO Regional Office for Europe, 2007).



Death rate because of external causes of injury and poisoning is decreasing in EU and countries with a mature trauma system. Croatian statistics demonstrates the same trend with exception of war period. On the other hand, in 2004 risk to die in Croatia because of injury is still 30% higher than in EU and nearly doubly higher than in the Netherlands or Great Britain (chart 1).

Deaths in motor vehicle accidents are more specific than deaths due to all transport accidents. Therefore, trend regarding SDR of motor vehicle victims over last thirteen years in Croatia is completely opposite from trend regarding number of deaths in transport accidents according to police statistics. In 2004 risk to die in a motor vehicle accident in Croatia is 40% higher than in EU and nearly trebly higher than in the Netherlands or Great Britain (chart 2).

Discussion

Trauma care in Croatia is organized according to old German/ Austrian model. Treatment of injured patient in the field is provided by prehospital emergency medicine service which has no communication with hospitals. In majority of hospitals emergency services are fragmented i.e. there are separate departments for internal, neurological, psychiatric diseases etc. So, injured patients are brought to surgical emergency department and treated by surgeons. If vital parameters are critical, patient is transported directly to intensive care unit where anesthesiologist make initial resuscitation (intubation, ventilation, central i.v. lines) and after that surgeons perform operations like thoracis drainage, laparatomy, external fixation etc. Accordingly, emergency medicine in Croatia is not an independent specialty and it is acting only in prehospital setting.

In all acute hospitals surgeons and anesthesiologists are promptly available. We have well organized radiology, laboratory services and blood bank. On the other hand, our clinical hospitals are nominated because of their bond with medical schools and not because of their excellency in treatment of patients at the first place. There are no regulations about responsibilities of district hospitals, so they are developed very individually. Any kind of accreditation of hospitals in Croatia has been never made.

During past 21 years Croatia has lost 79 498 people or nearly 2% of its population only because of injuries. This study demonstrated that risk to die in Croatia because of injury is 30% higher than in EU and nearly doubly higher than in countries with mature trauma system (the Netherlands or Great Britain). Risk to die in a motor vehicle accident in Croatia is 40% higher than in EU and nearly trebly higher than in the Netherlands or Great Britain. Analysis of trimodal death peaks after transport accidents also demonstrated that share of mortality in prehospital setting after transport accidents was constantly between 72-80% during past 15 years. This gives a lots of worry, because such an unefficiency ranks Croatia among countries with unorganized health care. For example, in low-income country (Ghana) there is no formal emergency medical service and prehospital mortality because of injuries amount to 81%. In Mexico, as in many other middle-income countries, there are only basic ambulance services, at least in the urban areas, and the proportion of deaths occuring in the field is 72%(Mock et al, 1998). Finally, share of hospital mortality after transport accidents has not significantly decreased during past 10 years and remained constantly over 25%, despite other improvements in medicine. This may indicate passive attitude of hospital management and surgeons regarding treatment of injured victims (Mitchel et al, 1994; Mitchel and Wolferth 1995).

In "National Health Strategy 2006-2011" Croatian government declared that there is a strong need to improve current way of tretment of injured persons in Croatia (Government of Republic of Croatia, 2006). Main goal in this area is to integrate prehospital, hospital and interhospital segment of trauma care in one system and to develop standards of treatment. Accreditation and categorization of hospitals is stressed out, including the need for nomination of trauma centers as units of trauma system. Special focus was given on better medical treatment of victims in road traffic accidents, but improvements in disaster preparedness are also required (Government of Republic of Croatia, 2006).

On May 22nd Ministry of Health and Social Welfare appointed Committee for Implementation of Croatian Trauma system with broad responsabilities. According to international experiences (American Trauma Society, 2002), the Committee developed basic definition: «A trauma system is an organized, coordinated effort in a defined geographic area that delivers the full range of care to all injured patients and is integrated with the local public health system». The main components of the trauma system are: prehospital care, acute (hospital) care, post-hospital care and injury prevention (American Trauma Society, 2002).

The Committee also adopted the methodology for implementation of Croatian Trauma System:

- Enhancing knowledge of health care professionals
- Organization of trauma units within hospital emergency bays
- Organization of trauma centers
- Organization of trauma system(s).

Since May 22nd 2006 few important tasks have been:

1. Project was presented for the first time at the 4th Congress of Croatian Surgeons in Zadar (May 24th-27th). Opinion of the audience was split.
2. Committee organized the 1st Conference on Croatian Trauma System in Trakošćan (October 15th-17th). There were 70 participants, mainly leaders in traumatology (sub-specialization very similar to trauma orthopaedics with five years of training in general surgery as a prerequisite), but also leaders in anesthesiology and prehospital emergency medicine. The conference resulted in unanimous support to the project from all participants and especially from Croatian Society of Surgeons, Croatian Society of Anesthesiologists, Croatian Society of Emergency Medicine Physicians, Croatian Society of Orthopaedics and Traumatologists, Society of Croatian Patients and Croatian Society of War Veterans.
3. The Committee also established good contact and cooperation with Croatian Red Cross, Croatian Auto Club Organization, Medical Headquarter of Croatian Army and Croatian Mountain Rescue Service.
4. ITLS (BTLS) course was introduced to Croatia in 2004 with capacity of 1-2 courses per year. After ITLS course was incorporated in “Project for Implementation of Croatian Trauma System” we made 10 provider courses, each with 30 students, and two instructor courses. At the moment we have a network of 40 instructors and instructor candidates. Plan for 2007 is to make 14 courses.
5. Croatian Society of Surgeons received written approval from American Society of Surgeons regarding introduction of ATLS course to Croatia. Initial training of course coordinator, course director and educator is in progress
6. Arrangements for Croatian trauma registry are made and full implementation is expected in September 2007.
7. Ministry of Health and Social Welfare also established Committee for reorganization of emergency medical service in Croatia. After analysis of experiences from abroad the Committee made a draft version of curriculum for specialization in emergency medicine.

It is obvious that many efforts have been invested in this project. Our next steps will be to prescribe capacities for trauma bays and to introduce verification and accreditation processes for trauma centers of different categories.

On the other hand, we have some doubts about plans for medical disaster management. There are strong recommendations from USA that “a disaster respond is best provided through extension of existing resources within a trauma system. The best strategy for a community to prepare for disasters is to create a strong trauma system infrastructure that will deal daily with injuries and have the capacity to efficiently expand to respond to the demands of an unconventional or natural disaster" (American Trauma Society, 2002). At this point, few facts more about trauma system should be empasized. Based upon a new organization of preexisting knowledge through Advanced Trauma Life Support Course (ATLS), the entire trauma system is driven by the tenet that severely injured patients should be triaged to the appropriate trauma facility (American College of Surgeons, Committee on Trauma, 1993) because the nearest and most convenient hospital may not be the most appropriate one for the type of care that is needed (European Transport Safety Council, 1999). In this model, nonphysicians, such as emergency medical technicians or paramedics, initiate emergency care in the field and transport critically injured patients to hospital-based emergency departments, where emergency physicians provide definitive emergency care. Finally, the true value of a trauma system is reflected in the seamless transition between each phase of care (American Trauma Society, 2002).

It is well known that disaster puts excessive demands on resources, capabilities and organizational structure on health care institutions (American College of Surgeons, 1997). It seems that trauma system becomes frail when hospitals are damaged or when the external systems supplying hospitals with key services and resources needed for the organization to function are disrupted (Millin et al, 2006; Rodriguez and Aguirre, 2006). The recent lessons from Hurricane Katrina indicate that health professionals still need to do more to protect public in times of national disasters (Kunreuther, 2006;Logue, 2006).

At this moment, we do not believe that physicians should wait in hospitals for patients during disasters. War in Croatia was a man-made disaster of massive proportions. These days Croatia was completely unarmed, unrecognized by international community, traffically spilt into two parts, one third of land was occupied, 500 000 refugees were searching their shelter, medical supplies were either robbed by Serbian paramilitary forces or blocked by ex federal army and there were no finances for medical needs (Ljubičić et al, 2006). Under such huge pressure and without previous experience in military medicine Croatian health care professionals have created firm organization under Headquarter of health care. Despite adverse conditions, there were no tetanus diseases or epidemics (Atias-Nikolov, 1995), including poisoning of food and water (Plavšić et al, 1992), sporadic infectious diseases were recognized on time and adequatly cured (Ljubičić et al, 2006; Tiljak, 1996), among 25 000 wounded persons only few of them had gas gangrene and only 3% amputations of extremities were performed (Jovanović et al, 1999; Rukavina, 1998; Maričević and Erceg, 1997; Hančević et al, 1992; Turčić et al, 1995). In Croatia there was an unique situation when highly educated specialists (surgeons and anesthesiologists) were constantly available at the first battle-line giving medical support to soldiers. They were acting as «civilians in military uniforms and with police symbols» (Ljubičić et al, 2006).

When too excessive demands are put on local capabilities and resources during the crisis, re-establishing of Headquarter of health care might be an excellent back-up solution for Croatia.

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DISASTER PLANNING: PREPARING FOR THE UNEXPECTED

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ABSTRACT

How prepared are you for emergencies that occur at any time in your community or facility- a fire, a bomb threat, a chemical leak that emits toxic fumes, a flood, a hurricane, tsunami or tornado? Following is some practical advice designed to provide direction and procedures for the development and implementation of a comprehensive disaster preparedness program, for either natural or manmade emergencies and disasters.

It is essential to design plans of action in the event of a disaster to ensure the safety and well being of individuals and property. This disaster action plan will provide established procedures and guidelines for the management and staff to follow in the event of a disaster. The plan will assist in the protection of life and property by preparing individuals of the community or facility with a plan of action, reducing the unknown or unexpected, anticipating potential problems, determining possible solutions to disaster related problems, and establishing recommendations that will improve the readiness of the community in the event of a disaster.

INTRODUCTION

How prepared are you for emergencies that occur at any time in your community or facility-a fire, a bomb threat, chemical scare, flood, hurricane, tsunami, etc. The basic need for assistance during and after disasters has been stressed the past thirty years in all nations and this presentation will focus on some of the unique problems of Hurricanes Katrina, Andrew, and the tsunami of Indonesia. Following is some of the practical advice designed to provide direction and procedures for the development and implementation of a comprehensive disaster preparedness program, for either natural or manmade emergencies and disasters.

It is essential to design plans of action in the event of a disaster to insure the safety and well being of individuals and property. This disaster action plan will provide established procedures and guidelines for the management and staff to follow in the event of a disaster related emergency. The plan will assist in the protection of life and property by preparing individuals of the community or facility with a plan of action, reducing the unknown or unexpected, anticipating potential problems, determining possible solutions to disaster related problems, and establishing recommendations that will improve the readiness of the community in the event of a disaster. The good Samaritans, volunteers, bystanders, survivors,

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governmental agencies, and the family should realize that a well-coordinated emergency response plan that fully capitalizes on currently available assets is a very valuable resource.

Disasters both major and minor, occur frequently enough that one can evaluate each occurrence and comparatively analyze the problems. There are victims in all disasters. Most individuals and organizations responding to a disaster have not had prior experience, and since an immediate response to victims' needs is so vital, there is a tendency to see the situation and the response it requires, as unique. Studies show that individuals and teams can be assembled in advance and trained in disaster control and remedial action to aid victims.

While the functions of emergency management have been performed for decades by government and other organizations, it was only recently that the broader ideas about managing emergencies were developed. Consequently, with Hurricane Katrina the objective was to use available resources and capabilities in order to effectively deal with this disorder, but there was very little pre-planning.

Today my primary emphasis is to focus on the social disruption caused by disasters and investigate the role of the various agencies that can play in relief and recovery operation of disasters. This is a particularly useful way of examining disasters, since disaster agents create demands with which a community must cope. Hurricane Katrina was one of the largest disasters to hit the US. Based on the combined casualties, damage, and disruption, Katrina was clearly a catastrophe and the most devastating natural disaster in the history of the United States. There were more than 1,300 fatalities, and the damage covered more than 90,000 square miles, with more than a million people driven from their homes. The financial cost of Hurricane Katrina has been projected at more than 200 billion dollars. Many U.S. federal agencies have been criticized for their slow response and the aftermath that continues even today. As a matter of fact, two recent reports from the GAO (Governmental Accounting Office) have been very different. The report praised the U.S. Coast Guard while FEMA (Federal Emergency Management Agency) was criticized for their slow response. The U. S. Coast Guard, that today is one of the twenty-two agencies under the Department of Homeland Security (DHS) played an exemplary role in the aftermath of Katrina.

VULNERABILITY ANALYSIS

The vulnerability analysis will determine the extent of what is to come and with a particular hazard can provide the basis for developing a practical, workable, emergency operations plan or checklist along with appropriate standing operating procedures. A vulnerability analysis (Hazard Identification) should be a matter of record at all levels of government. In analyzing and assessing the vulnerability of individual facilities, you must consider environmental, indigenous, and economic factors. Valuable information from a historical approach on what emergencies happened in the past twenty or thirty years would provide valuable information about potential emergencies that might take place in your area.

For planning purposes, you must assume that most emergencies likely will arrive with very little warning, have a rapid onset, and have a potential for substantial destruction. The likelihood that some of the emergencies mentioned earlier in this paper would ever strike your area may be very small, but you should have the capability to react, cope with, and recover from any emergency situations that could occur at your location.
It is incumbent to provide direction and procedures for the development and implementation of a comprehensive emergency response program. It is essential to design plans of action in the event of an emergency to insure the safety and well being of individuals and property within your area. A disaster (emergency) is a sudden, calamitous event bringing widespread damage or suffering, loss, or destruction, and great misfortune, often arriving without forewarning.

The emergency action plan will provide established procedures and guidelines for management and staff to follow in the event of an emergency. The following emergency plan will assist in the protection of life and property by preparing workers in the facility with a plan of action, reducing the unknown, anticipating potential problems, determining possible solutions to emergency related problems, and establishing recommendations that will improve the readiness of the people in their communities in the even of an emergency.

IS OUR COMMUNITY READY FOR AN UNEXPECTED EMERGENCY?

The question that you may have to answer is - how well prepared are you for an unexpected emergency situation? This is why we must have an action plan ready to ensure that the plan formulated covers the unexpected situations with this being very difficult to identify and predict.

Any community or facility is vulnerable to some extent. Analysis of vulnerability to a particular disaster can provide basis for development of a practical, workable, emergency operations plan or checklist along with appropriate standard operating procedures (SOP). It is necessary to conduct a thorough vulnerability analysis. This is the basis of what might go wrong within your community, and to know how to address the problem of how to implement the emergency response action plan. There has been considerable effort at the federal and state levels to identify hazards such as earthquakes, hurricanes, and other natural emergencies, and especially manmade emergencies since September 11, 2001 and the shooting of 32 students and professors on the Virginia Tech campus. Once you have completed this exercise it is possible to start developing emergency response policies, procedures, and protocols.

Your community must be ready to survive the worst possible emergency. No matter what your business involves, your emergency response plan should be effective and current. The action plan can't be just a manual to inform your workers on what to do or not to do, but must create a greater awareness of the need for readiness in the event of an emergency or catastrophe. A total response management framework of various activities that can be executed in response to an emergency is a key element. This is the reason to develop your plan with a step-by-step training approach with response actions and staff and worker assignments. Is their training appropriate for current and future changes within the community, developing a list of back-ups for employees on sick leave or vacation. Drills should be held at both opportune and inopportune times to cover any situation. During drills everyone in the community must obey the instructions as posted when the alarm is sounded. This leads to the site emergency response plan to minimize devastating property losses and protect jobs and business profits.

SITE EMERGENCY RESPONSE PLAN

There are many possible incidents that may affect the community or enterprise, both from within the boundaries of the organization and from outside. Some of these incidents may be natural, such as severe thunderstorms, tornadoes, floods, and severe winter weather. Many others may be manmade such as flammables, toxins, reactive gases, fire, power failure, explosion, bomb threat, hazardous materials, and terrorist acts mentioned earlier. In order to be properly prepared to handle such conceivable incidents and to keep them in the realm of emergency rather than disaster, a Site Emergency Response Plan (SERP) with the following nine elements are recommended:

- List of emergency numbers for company team members, fire departments, medical rescue services, and police departments.
- Site evacuation routes and procedures, both primary and secondary.

- Location, type, and availability of both site and community emergency equipment.
- A plot plan of designated hazardous materials at or near the location.
- Material safety data sheets on all hazardous materials at or near the location.
- A crisis communication plan for dealing with the media.
- Plan coordination, recommendation, and contacts of site and community officials and emergency responders.
- Training information, including responsibilities of site personnel.
- Testing dates (drills) and procedures, including site exercise results and recommendations.

This includes drills, tests of various program elements and response capabilities, evaluating response procedures, and corrective actions. Alarm tests, simulated drills, and mock exercises with community groups are several testing approaches. Evaluation results and proposed/actual corrective actions must be documented and incorporated into the plan. Involving community agencies in the testing process enhances community relations and improves the plan. It can also lead to improved training opportunities such as mutual aid. Each type of potential emergencies has a different impact. In deciding on whether your enterprise is adequately prepared for the different types of emergencies, it is a good idea to perform a vulnerability analysis of your facility discussed earlier. This will determine the probability and potential impact of the different types of emergencies. One thing that should be checked out is the emergencies of the past.

In Bhopal India, over 2,500 persons died from the methyl isocyanide leak-the worst industrial disaster ever recorded. The Indianapolis Coliseum explosions resulted in 81 deaths and approximately 400 injuries, even though the physical damage was confined to one part of the building in a very large metropolitan area.

Disasters can be subdivided into manmade (technological) and those situations which are usually called "natural disasters" (floods, hurricanes, volcanic eruptions, tornadoes, blizzards, earthquakes, etc.) A technological disaster might be one such as a structural fire, radiological accidents, and explosions. Frequently there is little advance warning in disasters such as these.

Disasters can be divided into phases or periods: A warning period; a threat period; an impact period; an inventory period; a rescue period; a remedy period; and a restoration period. When looking at these phases it is easy to see that the warning period is the most opportune time for providing community information and possible evacuation. Advance warning does not always occur, and thus we must do as much as possible to offset the lack of warning. Disaster planning is an attempt, prior to the actual occurrence of the crisis, to facilitate recognition of emergency demands and to make the community response more effective. It is an exercise in the anticipation of what might be required for any relevant group or organization.
The primary emphasis here will be upon the social disruption caused by the physical effects of the disaster. This is a particularly useful way of examining disasters, since disaster agents create demands with which the community must cope. Such demands are created at the very time when the community's problem solving ability may be severely damaged by the impact of the disaster.

Disaster agents may and do vary along different dimensions. These dimensions and their variants can be combined in a multitude of ways. Thus, it nearly is impossible to develop a meaningful yet simple typology of disaster agents. Nevertheless, knowledge of how disaster agents may differ along one dimension is still useful for emergency planning. Such knowledge should alert the planner to possible variants that have to be taken into account.

Furthermore, some dimensions are more likely than others to be operative and varying in certain localities.

Disaster agents vary in terms of their predictability. An explosion or an earthquake is considerably less foreseeable than a flood, which is brought about by a series of more precisely measurable factors. In fact, for some of weather phenomena, it is possible to obtain, for specific localities, the gross probabilities of a particular disaster agent striking the given area. For example, the chances of hurricane force winds in given Florida cities in any given year can be calculated, with Hurricane Andrew being one of the most disrupted.

A disaster agent can vary in terms of its frequency. Although natural disasters may be relatively rare happenings, there are certain locales, which can be labeled as disaster prone. To illustrate, some regions in the Ohio Valley are more susceptible to flooding, other areas such as in the Midwest are subject to tornadoes, and the Gulf coast is frequently confronted with the threat or occurrence of hurricanes. Thus, there are geographic, climatic, and other conditions which present the possibility of a particular disaster and represent a sustained threat. Here again, gross figures for frequency can be obtained for some disaster agents. The National Weather Service has not only calculated tornado incidences by month (May being the highest), by state (Texas having the most), by square mile (Oklahoma having the highest), but also in terms of threat when high tornado incidence and dense concentration of population is taken into account.

The following factors all deal with time but should not be confused. Disaster agents differ in their speed of onset. For example, impact is sudden in tornadoes and flash floods, while other floods gradually crest. Also, some types of agents, such as earthquakes, may impact an area repetitively in a matter of hours. Length of forewarning is the period between warning and impact. Tidal waves generated by an earthquake illustrate the distinction between the previous two factors. Length of forewarning of tidal waves may be several hours, but their actual speed of onset, once initiated, is very rapid. Disasters also differ in their duration of impact. A tornado impacts an area for only a few minutes, but a flood's impact may be sustained for several days. The worst time combination from the viewpoint of damage potential is a disaster agent that is rapid in onset, gives no warning, and lasts a long time. An earthquake with strong after-shocks is an example of such a threat.

The final differentiating characteristics of disaster agents are their scope of impact and intensity of impact. Scope of impact is essentially a geographic and social space dimension. A disaster can be concentrated in a small area, affecting few people, or dispersed over wide areas, affecting large numbers. Intensity of impact reflects a disaster's potential to inflict injuries, deaths, and property damage. These two factors should be clearly distinguished. For example, an explosion, though highly destructive, may affect only a limited geographic area, whereas a flood may be of low intensity but affect a broad geographic area and many people. This, of course, has important implications for the degree of disruption of local community affairs. A destructive but focalized disaster, though tragic, may have only minimal consequences for the community at large. Conversely, a diffuse but less destructive disaster may be extremely disruptive to everyday community living.

TRAINING

Training is an essential part of most activities within any community. This is especially true when it comes to emergency response and your action plan. Workers should be trained to handle emergency situations within their area. Proper training in emergency response will prove a valuable asset to the company/ community as well as to the employees should the need arise. Such training may include company team members as well as emergency responders from the community. Training for all employees should include:

- power disconnects

- use of fire extinguishers
- search and rescue techniques
- emergency response policies and procedures
- emergency first aid/ medical treatment

GEOGRAPHIC INFORMATION SYSTEMS (G.I.S.)

Another innovative approach designed to increase response preparedness for disasters that recently has been discussed in public health meetings is the geographic information systems. This approach will enhance the preparedness goals and provide a well-trained workforce that can also be relevant in tabletop exercises simulated drills. The G.I.S. applications would especially be of great help in response to large-scale emergency problems such as natural disasters, terrorism, and accidents.

In future workshops and educational programs increased preparedness with G.I.S. training will enhance the various ways we can realize the importance of G.I.S. software relative to our responsibilities in an emergency response program

EVACUATION, PLANNING AND PROCEDURES (CREATE A WRITTEN PLAN)

On site emergency response evacuation planning is a process where the responsibilities of all facility personnel must understand the emergency action plan and general evacuation procedures for their community or location. Once the emergency alarm sounds, every employee needs to know the following evacuation procedures:

- What evacuation route to take - predetermined routes - primary/secondary
- Assemble and check-in point locations where you meet once you get outside
- All facility personnel must assist visitors, members of the public, and sub contractors from the premises. Visitors will remain with staff
- Don't put your work away
- Don't use elevators
- Don't stop to gather your belongings
- Don't stop to inquire if it's a false alarm
- Departmental emergency coordinator or designee will take a roll call-an organized head count
- The emergency coordinator will report the employees who may still be in the building
- Department searchers will check the building for workers who failed to hear the alarm. Searchers will operate in teams
- Each department will stay assembled until further instructions

In the event that immediate assistance of the community resources is not available, you may need to develop additional resources, acquire additional equipment, conduct more training, and establish mutual-aid agreements with close-by enterprises. Other organizations and agencies that might be willing to assist are:

- the office of emergency management
- utility companies
- medical centers and local hospitals
- municipal, county, and state police
- emergency medical services (EMS)
- insurance carriers
- hazardous incident response teams if available

- contractors

Developing a generic plan is a start, but you need a basic emergency response plan to cover special provisions for the most threatening type of emergencies is required by OSHA for all employers.

ELEMENTS THAT ALL EMPLOYEES LEARN

- How to report an emergency
- How to activate and recognize the alarm or warning system
- Check-in and rescue procedures
- Assigned tasks and responsibilities

CONTINUING ASSESMENT: A virtually constant demand in disaster situations is an overall appraisal of what is happening. If no reliable data is available, assessment will be inadequate and confusions will result. Assessment is crucial because of its direct relationship to organized action. Appropriate actions are determined on the basis of perceived needs at any given time or location during disasters.

MOBILIZATION AND UTILIZATION OF HUMAN AND MATERIAL RESOURCES: Disasters, just as everyday situations, require the utilization of human and material resources. Personnel must be recruited, trained, and mobilized. Necessary resources must be acquired, maintained, and allocated for appropriate activities. Disaster situations present acute problems in the allocation of crucial human and material resources. Equipment may not be located at points where it is most needed. Specially trained personnel may not be immediately available, and there is no time for training. The location of relevant resources in the community may not be known, hence valuable supplies may go untapped. Given these possible contingencies, the central demand is to effectively utilize all valuable resources. Human and material resources must join together in the most useful way to meet disaster demands.

COORDINATION: The need for coordination underlies much of what we have been discussing; it is the essence of good planning. In normal times, overall coordination of the community is generally not critical as various community organizations can carry out their activities in large measure independent of one another. However, during disasters cooperative measures are necessary to allocate the resources of the community so that high priority needs are met. Problems and situations must be assessed and decisions made. Information gaps have to be filled. Resources have to be allocated and distributed. Coordination is therefore the key to planning.

CONTROL AND AUTHORITY: Coordination is impossible without some system of overall control and distribution of authority. There must be people who have responsibilities, who are in charge, and whose authority is legitimate. The lack of overall control will simply not suffice in disasters. A general tendency in disaster situations is for new authority patterns to emerge. An individual's authority may be legitimized by his technical competence, his preparation, or his degree of information about the on-going situation. The role of police departments in disaster coordination is a good example.

In any given disaster situation, the characteristics and consequences of the disaster agent are part of the global picture. However, in the planning process it is necessary to break the whole down into parts so that the situation becomes manageable. Attempting to react to the global picture becomes ineffective and inefficient.

Community consensus in the aftermath of such widely publicized disasters as Chernobyl, Bhopal, and Hurricanes Katrina and Rita, indicates the need for advanced planning through an organized community effort. In any given disaster situation, the characteristics and consequences of the disaster agent are all part of the "larger picture."

Successful coping with disaster agents requires thorough preplanning of the anticipated impact of the disaster and the response to victims' needs; such planning requires the combined efforts of legislative leaders, social agencies, and citizens' groups. This is where Federal Emergency Management Agency (FEMA) ensures its disaster preparedness with a comprehensive response program.

Disaster research studies have identified organized planning as the primary means of successfully aiding disaster victims. Through international communication and cooperation, the existing response framework can be investigated and strengthened in a critical review of the state of the art in victim assistance.

SIMULATED DRILLS, TESTING AND EVALUATING

A key to any successful emergency response plan is to hold drills and evaluate the responses of your employees. Practice before an emergency helps prevent panic and confusion. Drills are the ultimate test for determining emergency preparedness. All drills should be planned with an intended goal and to uncover weaknesses in the plan and to make sure everyone follows it. Drills should cover most situations and clearly establish detailed procedures for carrying out complete and partial evacuations from buildings.

Evaluating drills not only provides a strong emergency response, but also lays the foundation for a successful safety program. Evaluation results and proposed/actual corrective actions must be documented and incorporated into the plan. Involving community agencies in the testing process enhances community relations and improves the plan. It can also lead to improve training opportunities.

SUMMARY

The key to controlling an emergency response situation is a well-conceived and developed program. The major elements that should be included in any emergency response preparedness plan are the following:

- communications
- evacuation procedures
- company assessment
- natural emergencies and disasters
- man-made emergencies
- consideration for emergency operations
- emergency/disaster recovery

ACTION PLANS SHOULD BE DESIGNED TO INSURE THE SAFETY AND WELL-BEING OF INDIVIDUALS AND PROPERTY IN THE EVENT OF AN EMERGENCY OR DISASTER.

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Biography

Tonisav Antoljak, MD, Mr.sci. was born in 1960 in Croatia; is married and I has two children, who has up to now published 40 scientific articles and reviews and attended more than 30 congresses in Croatia and abroad. His is also a co-author of 59 chapters in textbooks of surgery for students of medicine at the School of Medicine in Zagreb and School of Medicine in Osijek. In addition he is one of the editors of two textbooks of surgery used at the Schools of Medicine in Zagreb and Osijek.

Croatian ministery of health and social welfare appointed him as the chairman of Committee for realization of Croatian trauma system in May 22, 2006 and since Jun 2006 I am the chairman of Committee for introducing ATLS to Croatia, appointed by Croatian Society of Surgeons.

He is a member of Croatian Medical Association, Association of Croatian Surgeons, Croatian Association of Traumatologists, Croatian Association for Biomechanics and European Federation of Orthopedics and Traumatologists (EFORT). He is also the member of international association of traumatologists "Gerhard Küntscher Kreis" since 1995. Secretary of this association Mr. Klaus Klemm, MD, invited me personally to join them.

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INTERNATIONAL RESPONSE TO DISASTER
GOVERNMENTS AND MULTI-NATIONALS

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International Disaster and Emergency Resilience Conference (IDER)
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Abstract

One area where disaster management can undoubtedly be improved is in the international response. There are huge benefits to be gained, for instance, by developing co-operative arrangements between governments and multi-national companies to improve the international response to disaster.

One of the initiatives at IDER 2007 this October in London is to develop a multi-national response group. This presentation will look at how this initiative and others are being taken forward.

Governments are best able to provide the diplomatic access to countries suffering a disaster but do not readily have all the resources that may be required. Many multi-nationals, on the other hand, do have the resources such as food, medicine, transport, engineering equipment and communications. A co-operative arrangement for disaster response with governments providing the political authority and impetus and multi-nationals providing the resources would do much to improve international response to disaster and satisfy the prime requirements of relief, rehabilitation and reconstruction.

The government and multi-national arrangements would be most effective if they are entirely voluntary and based on 'Agreements in Principle'. A central register of disaster response arrangements together with a database containing details of the resources that individual companies may make available would best be held by a global and independent organisation such as the UN to ensure a more focused, co-ordinated and appropriate response.

The benefits from such an arrangement are many. The global community would benefit from improved international disaster response, humanitarian assistance and environmental protection. Inter-governmental assistance would benefit international relations. Governments would have ready access to resources but would pay for them only at the time of use. Multi-nationals would support the humanitarian response, fulfil their corporate responsibility, make good use of their available resources, receive government approval and enhance their reputation.

Biography

Simon Langdon is a Director of CEDAR*three* Limited. This year he is also chairman of the International Disaster Emergency Resilience conference (IDER) to be held in the City of London on

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9th and 10th October. IDER, which last year was held in Rome, attracted over 70 organisations from 20 countries.

Simon is an acknowledged authority on crisis management and has worked with a number of major international organisations and multi-nationals. He has conducted crisis management exercises in the UK, Europe and the Middle East. He has experience of anti-terrorist operations. He was presented with the prestigious Business Continuity Institute Consultant of the Year award in 2005.

Recent crisis management projects with which Simon has been involved include the BBC, the Welsh Assembly Government, the Highways Agency, the Financial Services Authority, a major Swiss bank, WestLB, Pfizer Pharmaceuticals and South West Trains. He has previously worked on major crisis management projects with Lloyds TSB, British Airways, the National Air Traffic Services, IATA and the Strategic Rail Authority. He was operationally involved in the Rail Industry response to the Potters Bar rail crash.

Simon has lectured on Crisis Management internationally and most recently in the Middle East and within the Rail Industry, the Aviation Industry and the Financial Services including an international conference at the Bank of England.

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BIOTERRORISM PREVENTION AND RESPONSE: A NEW MODEL FOR BIOLOGICAL THREAT REDUCTION

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Abstract

The deliberate use of biology for harm is a problem that spans many familiar problems, but equates to none, and a diverse set of professional communities—from public health, and scientists to law enforcement, emergency managers and the intelligence community—find themselves on the front lines in dealing with it. However, existing approaches to preventing and protecting against bioterrorism are not well suited to a problem with such a decentralized set of actors or diversity of perceptions, and they do not effectively establish the linkages that can identify and take advantage of synergies among communities that deal with different aspects of the problem.

Over the past three years, CSIS has developed a new approach for biological threat reduction. It is an approach that is comprehensive, international, and interdisciplinary—a framework that aligns with and could be adopted to implement Secretary General Annan's call for a global forum of stakeholders. In this framework, traditional security models—arms control, nonproliferation, and diplomatic approaches—play an important role, but they need to be supplemented by new mechanisms to address changing threats, technologies, and times.

CSIS is an independent, bipartisan, non-governmental, and non-profit research and analysis organization that provides decision-makers with strategic insights and practical policy solutions.

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LOCATION DETERMINATION OF AUTOMATIC FOREST FIRE MONITORING STATIONS BASED ON AHP AND GIS DATA

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Keywords

forest fire, video monitoring, GIS based planning, AHP

Abstract

Forest fires represent a constant threat to ecological systems, infrastructure and human lives. Great affords are therefore made to achieve early forest fire detection, which is traditionally based on human surveillance. A rather more advanced approach to human forest fire surveillance is installation of remotely controlled video cameras on monitoring spots. The next, even more advanced step is automatic surveillance and automatic early forest fire detection. In almost every country which encounters high risk of forest fires at least one such systems was developed, proposed and implemented. In Croatia that is iForesFire developed at University of Split.

Croatia belongs to countries with enhanced summer forest fire risk particularly the Dalmatian coast and islands. Because of that a lot of efforts have been made in forest fire prevention. Split and Dalmatia County is the leader in those efforts. Since 2003 University of Split, Split and Dalmatia County authorities and Fire Brigade Administration for the Coast work together on development and establishment of holistic forest fire prevention approach. Its technical part is based on automatic forest fire monitoring network and advanced information system.

One of quite important tasks in development of the forest fire monitoring network is the monitoring stations location determination. This paper describes the approach applied in Split and Dalmatia County. It was based on Analytic Hierarchy Process (AHP) as multi-criteria decision making procedure and intensive use of GIS data. The final result was the network of 56 monitoring location optimally located according to set of various fire-monitoring, technical and economic criteria.

Introduction

Forest fires represent a constant threat to ecological systems, infrastructure and human lives. According to prognoses, forest fires, including fire clearing in tropical rain forest, will halve the world forest stand by the year 2030. In Europe, up to 10,000 km^2 of vegetation are

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destroyed by fire every year, and up to 100,000 km^2 in North America and Russia. Approximately 20% of CO_2 emission into the atmosphere is caused by forest fires (Kührt et al. 2001) .

Croatia belongs to countries with high forest fire risk. In summer seasons seven coastal counties in Croatia and in particular the Adriatic islands are permanently exposed from high to very high fire risks, due to densely-spaced conifer forests. Only in Split and Dalmatian County in the year of 2003, wildfire occurred as many as 130 times. The total burned area in the year 2003 was 9.700 ha. The direct and indirect damage of the lost woody biomass was assessed at the level of 16 and 60 mil.€, respectively (Hrastnik et al. 2004).

The only effective way to minimize damage caused by forest fires is forest fire early detection and fast reaction, apart from preventive measures. Great efforts are therefore made to achieve early forest fire detection, which is traditionally based on **human surveillance**. Usually the human surveillance is realized by 24 hours observation by human observers located on selected monitoring spots. In Croatia the human forest fires surveillance is mainly organized by Croatian Forests (Hrvatske šume) – the governmental organization responsible for protection and exploitation of forests in state ownership. Human surveillance is usually organized only during summer months. For example in Split and Dalmatia County there are 16 forest fire surveillance stations of Croatian Forests in operation from June 1st to September 15th and few other observation stations organized by local authorities and organizations. Human observers are usually equipped only with standard binoculars and communication equipment and their observation area is the area covered by their sight of view. Croatian official regulations define that the maximal distance between two monitoring spots have to be less than 15 km, but in practice that is hardly achieved.

A rather new, technically more advanced approach to human forest fire surveillance is installation of **remotely controlled video cameras** on selected monitoring spots. Now the human observer is not anymore located on the monitoring spot. His observation station is the monitoring centre equipped with adequate video presentation and video storing devices, wires or wireless connected with distant video cameras located on monitoring spots. The video cameras based human forest fires surveillance has many advantages in comparison to direct human observation on monitoring spots. Let us mention the most important of them:

a) Using video cameras the human observer is capable of monitoring a wider area covered by few video monitoring field units.

b) Cameras are usually equipped with power zoom (optical zoom with at least 20 x magnification) so the observer could easily inspect suspected areas.

c) Such system usually has video storing capabilities, at least for the last couple of days, so stored video data could be quite useful in post-fire analysis.

d) The application of video monitoring stations is not limited only for forest fire prevention tasks. They could be successfully used during fire fighting as distant video presets device.

The next more advanced step in forest fire monitoring is **automatic surveillance and automatic early forest fire detection system**. The research and system development in this area was extended in the last couple of years. There are two main types of automatic forest fire surveillance:

a) terrestrial systems based on monitoring from ground monitoring stations, and

b) satellite systems based on monitoring from satellites.

Satellite systems are suitable for monitoring wide forest areas like Canada or Siberia Sometimes airplane-based systems are used to monitor such areas, but today wide area monitoring is usually only satellite-based. As an example, let us mention Canadian Fire

Monitoring, Mapping, and Modelling (Fire M3) System (Fire M3, 2007), or European FUEGO program (Escoral et al, 2001).

For monitoring areas like the Adriatic coast and islands the satellite monitoring is not appropriate solution. Terrestrial or ground-based systems are much more suitable. In terrestrial systems different kinds of fire detection sensors could be used like:

a) video cameras sensitive in visible spectra – forest fire detection is based on smoke recognition during the day and fire flame recognition during the night,

b) infrared (IR) thermal imaging cameras – forest fire based on detection of heat flux from the fire,

c) IR spectrometers – forest fire detection is based on identification of the spectral characteristics of smoke gases, and

d) light detection and ranging (LIDAR) systems - forest fire detection is based on measuring of laser light backscattered by the smoke particles.

Infrared and laser-based systems are more sensitive and they generate less false alarms, but their price is quite height in comparison to video (CCD) cameras sensitive in visible spectra. For example the price of one typical high quality outdoor pan/tilt CCD camera is 3.000 €, and the price of one typical IR thermal imaging camera is 25.000 €., 8 times more. Additional feature of CCD video cameras which are today on the market is their dual sensitivity. They are color cameras sensitive in visible spectra during the day, and black and white cameras sensitive in near IR spectra during the night.

Figure 1. *Croatian* ***iForestFire*** *monitoring station in experimental work on Marjan hill (Split area) during 2005 and 2006 fire season*

The terrestrial systems based on CCD video cameras sensitive in visible and near IR spectra are today the best and the most effective solution for realizing automatic surveillance and automatic forest fire detection systems. In almost every country which encounters high risk of forest fires at least one such systems was developed and proposed. Some of them are on the market under various commercial names like FireWatch (Germany), FireHawk (South Africa), ForestWatch (Canada), FireVu (England), UraFire (France). In Croatia one such system named **iForestFire** (Stipanicev et al, 2006) (iForestFire, 2007) was developed at University of Split. In all those systems automatic forest fire detection is based on smoke recognition during the day and flame recognition during the night. **Fig.1** shows iForestFire monitoring station during 2005 and 2006 experimental work on Marjan hill in Split area.

Implementation of one forest automatic fire monitoring station is better then no one, but for efficient forest fire monitoring a **network of monitoring stations** have to established. Planning of automatic monitoring stations locations is quite sensitive task because a lot of criteria have to be fulfilled and that is the main topic of this paper.

System approach to location determination of forest fire monitoring stations and determination of priority plans for their realisation

Locations of automatic forest fire monitoring stations could not be arbitrary defined. A lot of different fire-monitoring, technical and economic criteria have to be satisfied. On one side the ideal situation could be to cover all regions with high forest fire degree at least with two monitoring station, but on the other side is reality, particularly the economic reality. Because of that usually the main goal is to maximally satisfy various fire-monitoring criteria with minimal number of monitoring stations and minimal implementation cost.

The first effort to define and optimise the network of forest fire monitoring stations in Split and Dalmatia County appeared in the year 2000. A group of researchers from University of Split Civil Engineering Faculty, Croatian Telecom and UNEP (Mladineo, 2000), (Mladineo and Knezić, 2000) published a pilot study about fire decision support system and suggest the methodology for "optimisation of forest fire sensor network''. Proposed forest fire sensors were monitoring stations equipped with IR cameras having 12 km protecting radius. Their case study was island Brac and PROMETHEE method was used as multi-criteria analysis method based on 6 criteria:

C1 – Land use (urban areas, individual residences, industrial areas, agriculture, woods, maquis)

C2 – Areas around electricity supply high voltage infrastructure (300 m wide)

C3 – Areas around fiber-optic cables (150 m width)

C4 – Protected areas (nature parks)

C5 – Risk areas (waste disposal sites)

C6 – Types of woods (Pinus halepensis, Pinus nigra, Quercus ilex)

Their experiences were valuable for us, but we have further improved the procedure for location selection. The main differences between their approach and our approach were in following items:

a) Monitoring stations in our system are based on networked video cameras sensitive in visible and near IR spectra, connected in IP based VPN (Virtual Private Network).
b) Location selection was divided in two levels
    - determination of all monitoring stations location,
    - determination of priority plans for monitoring station realisation.
c) Another set of criteria was defined, more suitable from fire-monitoring, economic and technical point of view. At each level different criteria were defined.
d) Another type of multiple criteria decision analysis (MCDA) was used, namely the AHP - Analytic Hierarchy Process.

Our final result was the network of 56 forest fire monitoring stations covering all parts of Split and Dalmatia County interesting from the forest fire point of view. Monitoring stations were divided in 10 operative zones and realization was planned in three realization phases. In this paper we will present the first part – location determination using AHP and GIS data.

Location determination of forest fire monitoring stations

Location determination of forest fire monitoring stations is a procedure divided in 5 steps:

a) Criteria definition
b) Determination of all possible locations
c) Evaluation of each location according to defined criteria,
d) Calculation of overall criteria satisfaction degree and
e) Determination of locations list according to overall criteria satisfaction.

Steps c), d) and e) were performed using Analytic Hierarchy Process (AHP) as multi-criteria decision analysis procedure.

Criteria definition

Criteria were divided in two groups: fire – monitoring criteria and techno – economic criteria:

A. Fire – monitoring criteria

A1 Location importance from the fire monitoring point of view

A2 Forest fire danger rating for area covered by monitoring station

A3 Recent and planed protected areas (national parks, nature parks, protected landscapes)

A4 High voltage infrastructure in area covered by monitoring station

A5 Railway in area covered by monitoring station

A6 Risk areas in area covered by monitoring station (waste disposal, places with increase human concentration like sightseeing spots, rest stations and similar)

B Technical and economic criteria

B1 Coverage - percentage of visible area in comparison with maximal potential view area.

B2 Location importance according to other correlated reasons (in area covered by monitoring station there are other important objects like water supplies, waste storage, entrance roads to forest areas etc.)

B3 Not overlapping with another location view area.

B4 Existence of suitable tower where monitoring camera could be mounted like mobile operator towers, TV towers or monitoring towers.

B5 Existence of access road.

B6 Existence of low voltage power supply.

Additionally to those criteria monitoring network communication infrastructure includes some restrictions, too. The communication between stations was planned on maximal use of license free WiFi communication in microwave 2.4 GHz frequency range, and because of that

- monitoring stations have to in each other sight of view and
- distance between monitoring station has to be less than 10 km if we want to be inside EU limits for maximal Effective Isotropic Radiated Power allowed for WiFi communication.

Multi-criteria decision analysis

Multi – criteria decision analysis (MCDA) defined methods and procedures by which multiple and even conflicting criteria could be included in decision process. In our case we have few candidates and few different criteria, and our goal is to find the list of candidates according to their overall criteria satisfaction. There are lot MCDA methods like PROMETHEE (Brans and Vinche, 1985), ELECTRE (Roy, 1991), MAUT (Keeney and Raiffa,1976) or AHP (Saaty, 1980). We have decided to apply AHP because we had previous successful experiences with this method (Mandic et al, 1989), the method is quite simple for use by non-technical people and it has been applied in numerous GIS based decision making situations (Chulmin, 2000).

Analytical Hierarchy process (AHP) is a quantitative method for ranking decision alternatives by developing a numerical score to rank each decision alternative based on how well each alternative meets the decision maker's criteria. The process involves

1) Identifying the decision elements (selection criteria).

2) Recording relative importance of those elements by pairwise comparison.

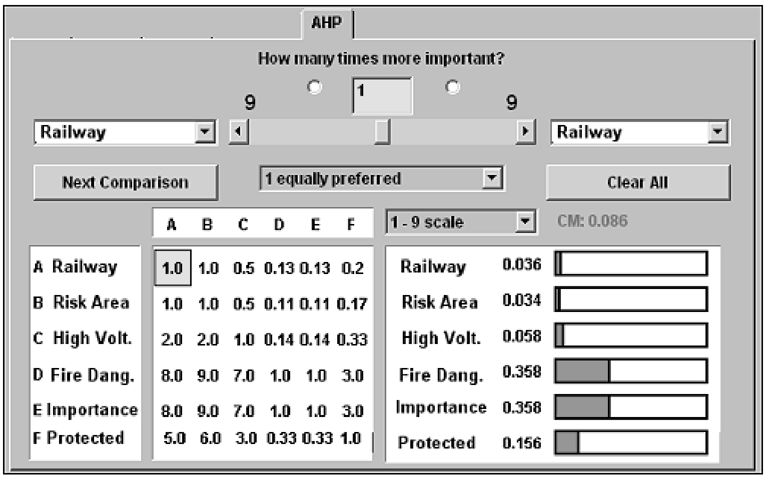
3) Construction of an importance table also by pairwise comparison of alternatives according to each criterion.

4) Final calculation by a simple linear algebra mathematical procedure.

A scale from 1= ''equally important'' through 9 = ''extremely important'' is used to record the relative level of importance for the pairwise combinations of the decision elements. Reciprocal values means opposite level of importance for example 1/9 = ''extremely non important''.

In our case we had two groups of criteria: fire –monitoring and technical-economic and we suppose that each of them is equally important. Pairwise comparison was performed in each group using Web – HIPRE, a Java based multi-criteria decision support engine develop in System Analysis Laboratory at Helsinki University of Technology (Web-HIPRE, 2007). **Fig.2** shows the comparison table for fire - monitoring criteria.

Figure 2. *Pairwise comparison table of fire - monitoring criteria*



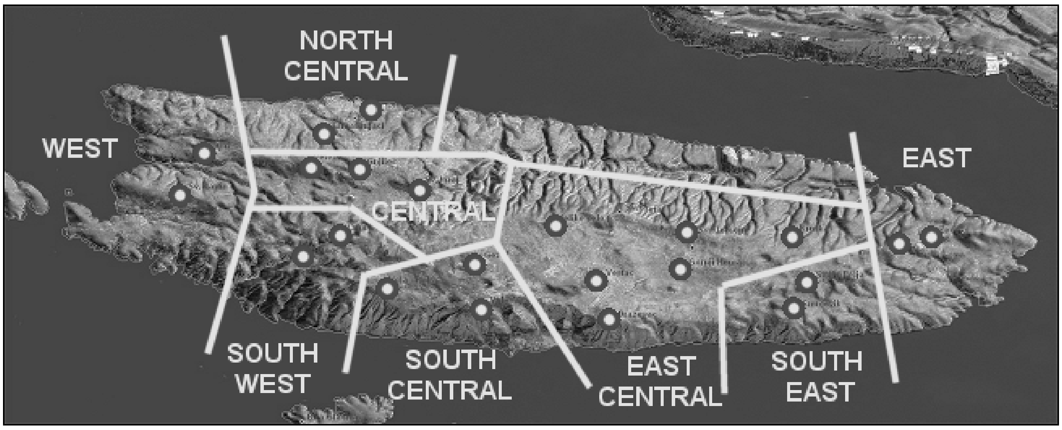
The table also shows the relative importance of criteria obtained as a result of pairwise comparison. Two criteria were on top A1 – '' Location importance'' and A2 – ''Forest fire danger rating'', both of them having relative degree 0.358. Similar table was calculated for techno – economic criteria. In this group the most important one was B1 – '' Percentage of visible area in comparison with maximal view area'' with relative degree 0.457.

In the next step all possible locations in one sub-area were compared in pairs according to each criterion using GIS and non GIS data. As a illustrative case study let us show the procedure for island Brac.

Case study: island Brac

Island Brac has specific geographical characteristics and during the summer time the number of tourist three times overcomes the inhabitants (approx. 40.000 tourists and 14.000 inhabitants). Because of its specific mountain relief island Brac was divided in 8 different sub-areas or zones (East, South East, East Central, South Central, Central, North Central, South West and West). North part of island Brac was monitored from the coast. In each zone at least two potential monitoring spots were defined, all together 22 potential monitoring locations. **Fig. 3**. shows all of them.

Figure 3.*All potential monitoring locations on island Brac*



Monitoring stations in each sub-area are pairwise compared according to all criteria, and the winner was chosen as the most appropriate location for that zone. **Fig 4**. shows the comparison results for sub-area East Cetral where three potential locations were defined: Vidova Gora, Gezul and Vela visoka. Vidova gora was the best choice having overall criteria satisfaction degree 0.515. Vela visoka was second with degree 0.265 and Gezul last with degree 0.220.

Pairwise comparison was based on intensive use of GIS data and GIS analysis. For example **Fig.5**. shows two potential locations in East Central zone – Vidova gora and Vela visoka, their field of view and its overlapping with recent and planned protected areas, and its overlapping with high voltage infrastructure. For those criteria (A3 and A4) GIS analysis gave us numerical data for each potential monitoring location. For some other criteria like A1, where it was not possible to use numerical analysis pairwise comparison was made using expert judgment.

The final result was the network of 56 forest fire monitoring stations divided in 10 operative zones shown on **Fig.6**.

Each operation center would be primarily responsible for monitoring stations located in their area, but all of them are also connected together in VPN (Virtual Private Network), so anyone with appropriate authentification can use monitoring stations located in surrounding zones, too. Typical example is island Brac shown in **Fig. 3**. The north island part is better covered by monitoring stations located on the coast in Omis – Makarska area, so the operator on island Brac would be allowed to use monitoring stations on the coast.

Figure 4. *Final result of location selection using AHP applied for zone South Central of Brac*

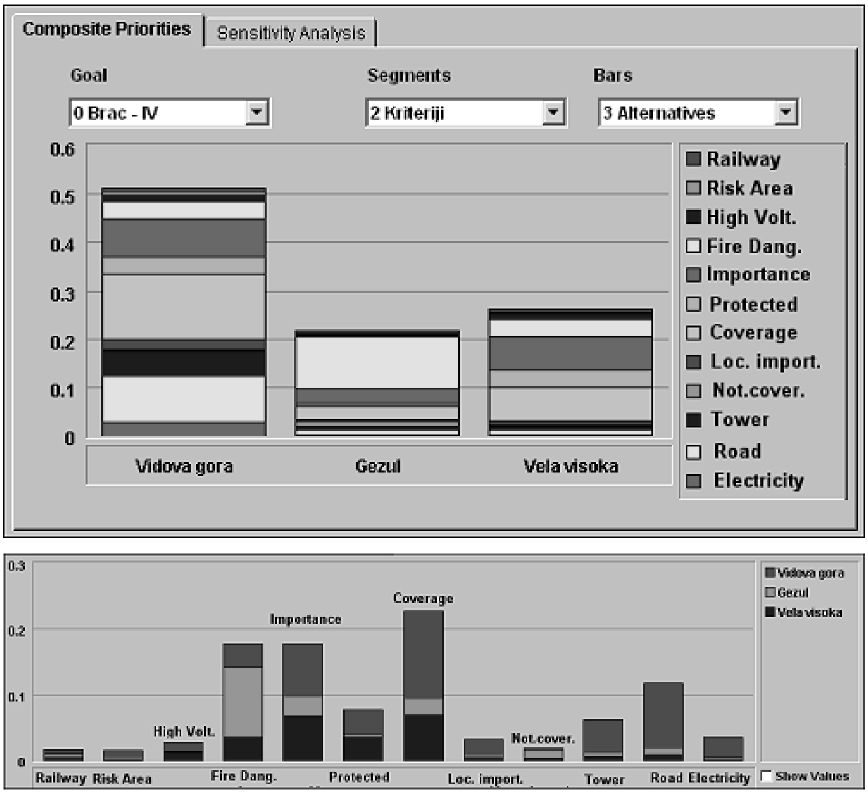


Figure 5.*GIS data used in location selection for zone South Central of island Brac*
1st row - Overlapping of two location field of view and protected areas
2nd row - Overlapping of two location field of view and high voltage infrastructure

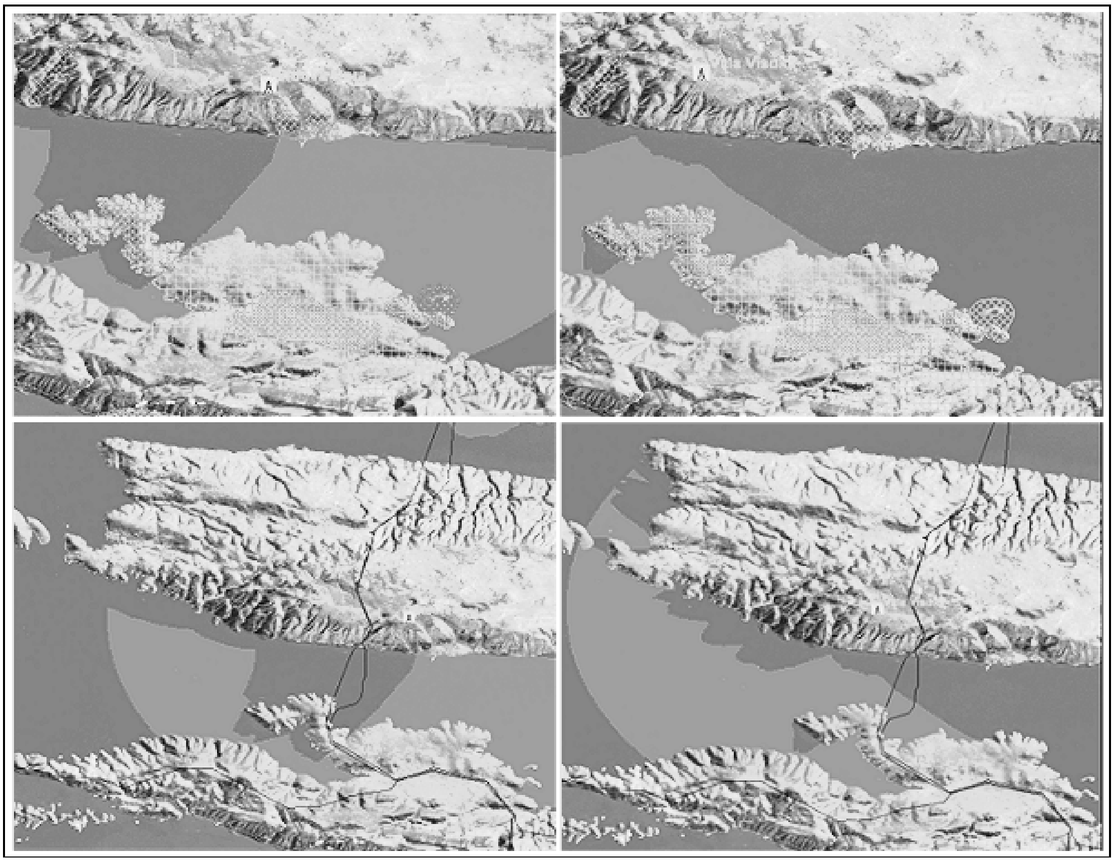
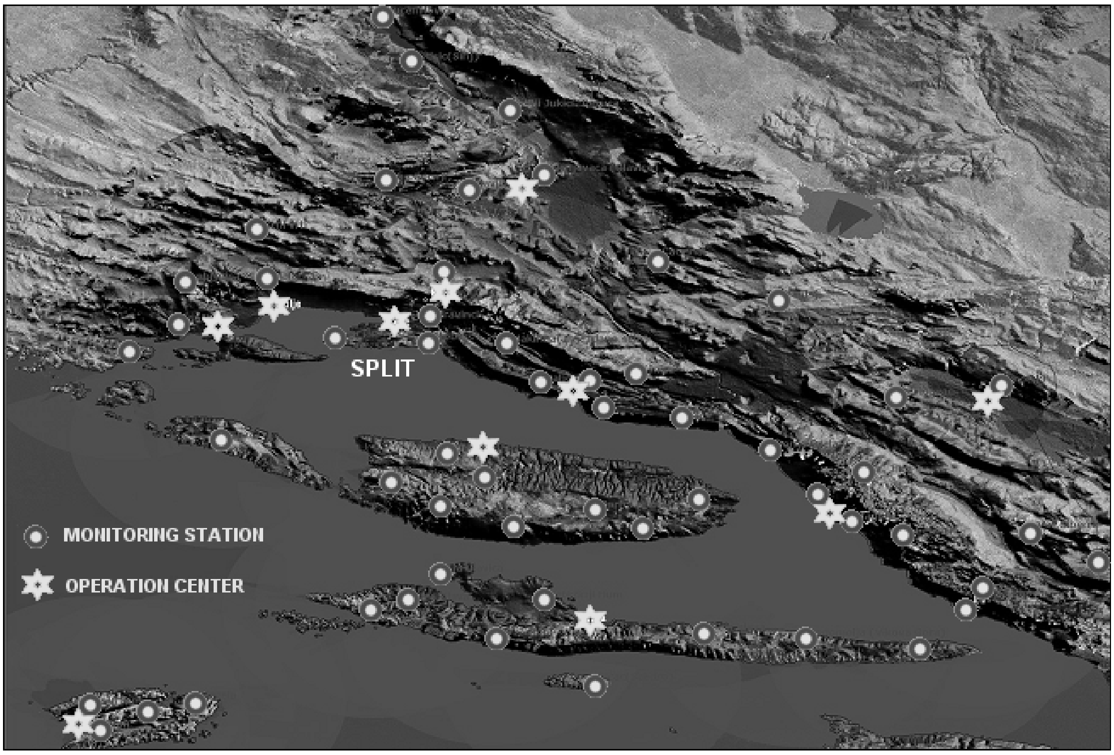


Figure 6. *Split and Dalmatia County future forest fire monitoring network with 56 monitoring stations divided in 10 operating zones*



Similar procedure, also based on AHP and another set of criteria was used in determination of priority plans for monitoring network realization. Three realization phases were defined, each of them having partial operability, but that will be the topic of our next paper.

Conclusion

Today the best cost effective solution for early forest fire detection is automatic forest fire ground based monitoring using cameras in visible spectra. One monitoring station is better then no one, but for efficient forest fire monitoring a **network of monitoring stations** have to established. Planning of automatic monitoring stations locations is quite sensitive task because a lot of criteria have to be fulfilled. Therefore the system approach based on multi-criteria decision analysis and intensive use of GIS data and GIS analyses has to be established. Based on our experiences with experimental tests of Croatian intelligent fire monitoring system – **iForestFire**, we have designed the forest fire monitoring network of Split and Dalmatia County conceived of 56 monitoring stations divided in 10 operating zones. The realisation is planned it three phases and we expect it in the next couple of years.

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Author Biography

Darko Stipanicev is a professor of computer science and electrical engineering, head of Department for modelling and intelligent systems at Fac. of El.Eng., Mech. Eng. and Naval Arch. University of Split. His research interest is complex system modelling and application of intelligent technologies, particularly advanced digital image analysis. Since 2002 he leads a number of research projects connected with forest fires, especially early forest fire detection using video monitoring and development of forest fire integral information system.

Tomislav Vuko is a deputy fire commanding officer responsible for Adriatic coast and islands. His experiences in forest fire fighting were irreplaceable for definition of forest fire monitoring criteria and determination of potential forest fire monitoring locations. He was the main adviser in all our forest fire research and development projects.

LJiljana Bodrožić is a PhD student at Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture University of Split, working as a young scientist on sensory networks, forest fire video monitoring and forest fire integral information system, particularly on integration of GIS and GIS analysis procedures.

FIRE, EVACUATION AND RESCUE PRECAUTIONARY MEASURES

Tonci Jelic
Department for Employees' Health and Safety at Work
Dalmacijacement d.d.

As is already known, saving human lives in case of accidents and rescuing property from fire, is of crucial importance in the first moments when the accident happens or the fire starts.

Therefore, an adequate training of all employees is of immense importance, same as alarm equipment, that is, the rescue and extinguishing. For the most part, all of that is regulated by legal acts, but it is necessary to always take it a step further, looking for the best possible solutions, because we can never say we have done everything that is possible for the protection from fire and the rescuing of employees.

We should always take everything into consideration which you think might cause fire and endanger human lives, including the very estimation of the situation and of the materials which are being used, the greatest number of people that can be present in the buildings in a single moment, combustible materials and all other factors.

Our policy so far and talks with employees show there is always fear at those places where greater quantities of dangerous, harmful and inflammable materials are being stored. However, during the construction of the structures for that purpose, usually a sufficient number of measures have been taken for the reduction of the risk. Due to fear of injuries or damage in such parts of the plant, the employees approach their work very cautiously and with respect and in that way most often reduce the risk of injuries to a minimum with their own conduct.

A great deal of attention should be devoted to those places where the employees are not aware of the danger and where there is a great number of employees. In doing so, one should always be careful not to endanger the lives of employees by setting up stable systems for fire fighting, that is, the employees must be warned timely.

In all premises with electrical systems and cable channels, one should install fire alarms which are connected via fire alarm centers to the telephone network and send the signal of fire or malfunction to the central station. After the signal has been received, the staff who are responsible for a 24–hour watch warn the staff on duty about the reception of the signal and are obligated to check the received signal. In case of a false alarm, fire alarm system is being reset and returned to the original state, while the staff records in writing the type of the alarm, the part of the plant where it was activated and the possible cause. The records are controlled by the staff responsible for the monitoring of fire alert systems. It is important for one to record all false alarms and their causes and on the basis of the causes of alarm activations find solutions for the reduction of the number of false alarms.

If fire starts, an employee should try to put out small fire with a fire extinguisher, so that, in case of such situations, all employees should be introduced with the basics of using fire extinguishers. All fire extinguishers also have to be appropriately serviced and regularly controlled and one should pay close attention to the choice of the extinguisher depending on the type of fire that can break out. If the fires are big, we call our colleagues to help and, if necessary, also fire departments. At the same time, the responsible staff puts out the fire on the parts that are carrying voltage, while the staff in charge of mechanical maintenance check the hydrant networks and connect the hoses for fire fighting. The most important thing to do is to warn the staff at the entrances to the endangered structures and inform them where to direct firemen when they enter the factory.

Besides the measures for the prevention of the spreading of fire, it is extremely important that the evacuation ways are clearly and visibly marked. Apart from the occupational habit and the fear that there is something left that we have not yet undertaken, oversights can be found in many structures and all those oversights can take human lives.

We always appoint people who have enough professional knowledge and we offer specialization in evacuation and rescue though training plans. The staff that participate in the rescue are familiar with possible dangers and if they suspect their own lives might also be in danger, they are obligated to call the services for evacuation and rescue.

Many employees are members of volunteer firefighting organizations and rescue services and those associations are to a large extent familiar with dangers in our areas. There are increasingly less activities in which rescue organizations participate. The hosing down of streets to reduce dusting, assembly and works carried out at great heights are in most cases done by specialized organizations. Through such activities and by becoming familiar with areas and plants, we can significantly contribute to the speed of rescuing and the reduction of risk of accidents.

All activities related to fire extinguishing and rescuing are coordinated from the control center. All participants are obligated to constantly inform the staff responsible for the coordination of all activities, over the phones, installed in all parts of the plant, as well as over mobile devices.

All mentioned activities are of fundamental importance and none of them should not be omitted or taken lightly. One should promote and raise consciousness among the employees about safety at work and protection from fire and broaden their experience through exercises as well as discover faults, which have to be eliminated.