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Welcome from the Host of the 2006 TIEMS Conference

I sincerely welcome every participant, attending the 13th TIEMS Annual Conference in Seoul from 25 countries and hope each can share in the professional knowledge of TIEMS participants, who are not only from far located countries as Africa but also China, Japan, Nepal, Pakistan, India, Sri Lanka, and many more. In addition, I would like to express my thanks to the keynote speakers, who play major roles in their fields of emergency management.

My thanks are also given to the Korean co-hosts for the Conference, such as the Korea BCP Association and Electronic Times, with the governmental support of the National Emergency Management Agency (NEMA) of Korea. Furthermore, I appreciate the authorities of business enterprises, including IT and construction business, who by exhibiting advanced technologies and other products and supporting the event financially, have helped to ensure the successful progress of the Conference.

Over the past few years, we have seen a series of disasters in all corners of the world. These have included both natural disasters such as the South East Asian Tsunami, Indian Earthquake, Hurricane Katrina, and several major flooding and wildfire events. There have also been a number of man-made disasters including the London Bombings, and the accidental release of chemicals from a factory in China leaving millions without the most basic commodity of drinking water. These disasters as well as the continued threat of terrorism and the new, evolving and growing threats to our safety such as bird flu and climate change to name but a few also remind us all of the need for a globally co-ordinated and integrated approach to emergency management.

Transport, communications and power supply networks have also demonstrated their criticality and vulnerability and fighting the consequences of such vulnerability requires pre-planned resource allocation on a large scale, based on robust emergency management strategies. With respect to the global consequences of these and many other new threats, a global approach to the understanding, mitigation and response is required. New and existing technological advances are capable of helping, but may also be a cause of risks themselves.

This conference on the advances in the global emergency management and the support they offer, it is hoped will encourage beneficial discussion to shape the future of emergency management, and ensure that the world is prepared for these threats and resilience is developed in the following areas:

- Global approach to new threats, such as contagious diseases, terrorism and critical infrastructures. These threats have to be identified, their transmission mechanisms have to be modelled and defence strategies developed and prepared

- Developing new methods, knowledge and organisations in order to better understand their nature by scientific research and major event investigation. Training needs in order to enhance skills and practices for professionals and volunteers are identified, improving the resilience after major events

- Cooperation and communication across scientific disciplines and practitioners in order to effectively deal with these threats in practice. This challenge covers engineering design and social sciences, various world regions, stakeholders participation before, during and after major events on a collaborative and knowledge based approach

- Application of technologies to support knowledge management, monitoring, notification and decision support in emergencies.

With this in mind, I re-emphasize that international experts from all over the world will gather together, discuss a variety of issues, and share their own experience and knowledge with others.

I strongly hope that each delegate of the conference will enjoy the wide and varied programme that has been put together including the several tours of Korea and welcoming reception, the Korean ceremony of the National Disaster Prevention Day and much more, and thus, will remember this event as an unforgettable one.

Dr. Young jai Lee,
TIEMS Vice President and Conference host
yjlee@dgu.edu
8th May 2006 – South Korea

Foreword from the TIEMS President

The power of Mother Nature and the damage that it can cause has been demonstrated to us again in the last year with hurricane Katrina, and the earthquake in Pakistan. And it is these catastrophes along with other terrorist atrocities of the past years that unfortunately serve to illustrate the importance and increased need for global cooperation in emergency management. TIEMS are therefore continuing our global focus, and the society has made measurable developments in the last year towards our goals and will continue with the help of our members and supporters to create stronger links and networks for information sharing on emergency management worldwide.

Our annual conference in Seoul, Korea, is such an opportunity to create these links and is more important than ever with nearly 60 international papers for presentation at the conference, (the ones published in these proceedings, those delivered in due time for printing). Overall the papers, it is felt give a broad international view of emergency management in an international perspective, and with these proceedings TIEMS like to stimulate a continuous international dialogue and debate on the many varied elements of the profession and its practice.

The number of participants this year is expected to be close to 600 from more than 20 countries, and representing a variety of emergency management areas, clearly illustrating a good international foundation for TIEMS, and that the program is of wide interest. We feel that such open international gatherings like this, give an excellent opportunity for exchange of ideas and discussions on ways and means to make the world safer, and hope will lead to increased international cooperation in this highly non-border problem area.

TIEMS is an international non political and not for profit society and subsequently has limited financial resources. TIEMS 2006 would therefore not have been possible in the form it is presented without the financial support and help of the participants and sponsors and we are thankful to you all.

Special thanks go to Young-Jai Lee, Kyoo-Man Ha and Alan Jones, who have all worked closely with the proceedings and all details of the arrangements and Ulrich Raape, who has been responsible for the TIEMS WEB-site, and many elements to improve our services to participants of the conference. Following the conference the proceedings will also be published on the TIEMS web site, www.tiems.org

Finally special thanks go to Korean NEMA, Korea Business Continuity Planning Association and the TIEMS Korean Chapter, who have all supported the conference forming a local organising committee, preparing all the practical arrangements. HANATOUR Service Inc. has also assisted by arranging travel and accommodation for participants and tour events during the conference, which they have made an excellent job of making the conference a professional event.

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

K. Harald Drager
TIEMS President
khdrager@online.no
30th April 2006 – Oslo

Editors Introduction to the Conference Proceedings

With each year that goes by, we face new challenges and emergencies, which seem to push the boundaries of which we work one step further, and demand new solutions to ensure they are dealt with as quickly and efficiently as possible. This peer-reviewed collection of papers provides details of many of the emergencies that have faced the world in the past year and also those developments, which have been made to manage them. Rather than simply expressing heroic tales they provide a forum for critical evaluation of responses and reporting of new approaches to encourage debate and further develop the profession of emergency management.

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.

One important element underpinning many of the papers is that of the importance of disaster prevention, which is particularly pertinent as this year's conference coincides with the Korean National Disaster Prevention Day. Many of the papers appear to express strong opinion for increased focus on prevention, and although it is recognised that we will almost certainly never be able to prevent all emergencies occurring by building more resilient communities we will endeavour to reduce the critical impacts.

A further key theme which seem to be brought to the fore in many of the papers is that of the importance of disaster prediction, an important lesson which the world learnt from the Tsunami of 2004. Many go on to discuss new developments in this area and others examining the best ways of conveying this information to populations likely to be impacted.

Finally I would like to take this opportunity to thank the paper review committee for their time and support in reviewing the papers for these proceeding, though I am sure they will all agree with me that it has been a pleasure and has provided an insight into many new and developing areas.

Alan Jones
TIEMS International Councillor
Chair of Paper Review Committee
Alan.Jones@tiems.org
10th May 2006 – United Kingdom

Academic and Professional Practice

Peer Reviewed Articles

Community Resilience & Vulnerabilities

DAMAGE DUE TO TSUNAMI AND DISASTER RESILIENT HOUSE CONSTRUCTION ACTIVITIES IN SRI LANKA

M.S. Sri Gowri Sanker[1]
Graduate School of Economics, Kobe University, Japan

W.M.G.B.Giragama[2]
H.K. Agrarian Research and Training Institute, Sri Lanka

Keywords: Tsunami and Disaster Management, Developing Countries, Low-Cost Housing technology, Rat-Trap Bond, Disaster Tolerance and Environment Friendly

Abstract

The tsunami erupted by the underwater earthquake in Sumatra on the 26th December 2004 caused a huge damage in seashore areas of Sri Lanka. It destroyed the lives of many people and brought hardship to the survivors too. The social impacts include more than 31,000 deaths and 15,000 injuries, nearly 150,000 houses destroyed or damaged, representing about 13% of the housing stock in the affected areas and 450,000 people displaced. The damage estimation indicated housing damage loss of US$ million 344 and total need assessment is US$ million 487. Fourteen districts of the coastal belt were severely affected by this tsunami. Total number of fishing houses affected by tsunami is 69,320 and that is 55% of the total fishing houses. Out of total 131,000 fishing households 72,372 (55%) affected by tsunami. Within 100m limits from sea coast 20,604 houses damaged, between 100- 300m range 19,226 houses and over 300m limit 29,490 houses damaged due to tsunami. Since the family is the basic social unit and the house is the basic special unit where the act of dwelling takes place, permanent house construction started with several designs. A holistic approach to house design should essentially be people centered and custom-made and the architect has to work within these two considerations in designing house. Low cost house construction technology is used in these districts based on those considerations. Also this technology is more environmental friendly and the dwellers comfort because it used less timber, cement quantity. In this technology house wall preparation was done as *Rat trap* bond. Hence it has more tolerance for seismic vibrations as well as due to air column in wall reduced heat conductivity. The low cost concrete roof prevent from cyclones. More than 700 houses were constructed using the above technology in tsunami-affected areas of Sri Lanka. This housing technology is considered as a critical measure disaster reduction and more environmental friendly. This paper analyses this housing construction system in detail.

Introduction

[1] Graduate School of Economics, Kobe University, Japan, 2-1 Rokkodai-cho, Nada-ku, Kobe-city, Japan 657-850, Visiting Researcher & Research Economist, Asian Disaster Reduction Center, Kobe, Japan; E-mail: sgsanker@econ.kobe-u.ac.jp
[2] Irrigation Water Management and Agrarian Relation Division, H.K. Agrarian Research and Training Institute, P. O. Box 1522, Colombo 7, Sri Lanka.
E-mail: *hartiiar@sltnet.lk*, *gbgiragama@yahoo.com*

Sri Lanka a tropical country, lies between 60 and 100 N latitude and between 800 and 820 E longitude has an area extent of about 65,610 square kilometers. On 26th December 2004 an undersea earthquake registering 9.0 on the Richter scale, later upgraded to 9.3, struck in the Indian Ocean off the western coast of Sumatra, Indonesia at 6.59 am Sri Lanka time (National Disaster Management Center 2004). This tsunami tidal wave of up to 15m in height traveling a speed of more than 500 km/hour caused devastation along the coastline of Sri Lanka was affected after about two hours (Central Bank of Sri Lanka 2005). Not even 1 per cent of coconut trees were affected (Gunaratne 2005).

Total coastal line is about 1585 km in length and affected nearly 1200km in southwestern, southern, southeastern, eastern and northeastern cost of Sri Lanka (Fig 1). This tidal wave destroyed not only human lives but also houses and our economy. The houses were severely affected by the tsunamis.

The total damage is estimated is estimated to be around US dollars 1 billion (4.9 per cent of the GDP) and the reconstruction, is estimated to cost around US dollars 1.8 billion (Central Bank of Sri Lanka 2005). Economic growth in 2005 has been revised downward by about 0.5 – 1.0 per cent from the original estimated value mainly due to disruption to the fisheries sector.

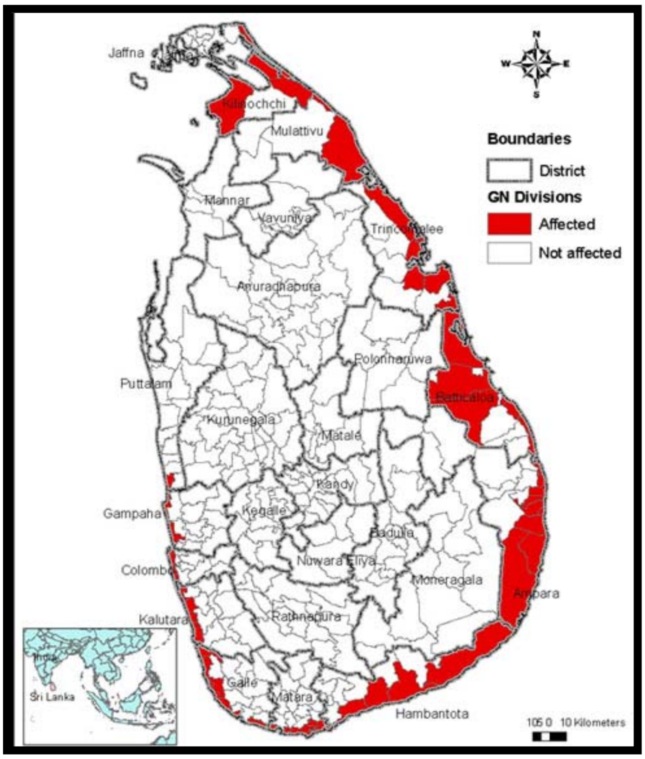


Fig 1: Tsunami affected areas in Sri Lanka

Shanmugarathnam (2005) stated "A fundamental concern shared by all the displaced groups I interacted with was that relocation could not be seen in isolation from livelihood security, which implied people's ability to achieve decent states of being. Housing is an integral part of a household's livelihood system". This shows the essential requirement of house construction for tsunami-affected areas.

While emphasizing the need for decentralization and local participation it is also important to recognize some of the immediate action priorities at al locations (Philips 2005). These priorities are identified as follows:

- Temporary housing and facilities
- Clearing and disposing of tsunami debris
- Clean-up of wells and agricultural lands
- Coastal land use planning through community participation and strategic environmental assessment
- Resettlement planning through community participation

The housing facilities became the priority area.

According to Department of Censes and Statistics (2001) Sri Lanka had 5.4 million housing units and required more than 500,000 houses due to civil war in the north east and other houseless families. Low cost housing technology was introduced by Intermediate Technology Development Group (ITDG- now Practical Action) to Kenya, Peru and India.

As a national level research and training institute HK. Agrarian Research and Training Institute conducted 52 training programmes for village leaders on Disaster Management and Low Cost House Construction Technology with financial assistance from ITDG-Practical Action. Those programmes conducted from Trincomalee, Ampara, Hambantota, Matara, Galle, Kalutara, Colombo, Gampaha, Nigambo and Puttlam where tsunami affected areas except Northern Province. The author was resource person in this training programmes and got understanding and experience on house construction. Based on the experience this paper developed.

Permanent resettlement of the victims followed tsunami disaster, hundreds of thousands of permanent houses may have to build and the process kook time more than fourteen months. In between the stage of immediate helter and permanent shelter, there comes the stage of temporary shelter, which stretches for more than one year until the completion of the construction of permanent houses.

<u>Semi –permanent house for temporary shelter</u>

The basic concept of this housing is the use of cement fiber sheets for the external walls, internal partitions, roof doors and windows. The idea of that once the permanent house is built to the level of the roof structure, the temporary house can be dismantled and the cement fiber sheets can be used for roof of permanent house. Four people can erect this temporary house, in fact semi-permanent, house in one day (Jayawardana 2005). Once all the sheets are connected in monolithic fashion, the wind resistance can be enhanced burying the sheets by about 150 mm with a soil fill. This soil fill can be compacted and rendered so that even in a rainy day this house gives a dry space for the occupants. This will also enhance the cyclone resistance of this house. After seeing this house completion in one day at the University of Moratuwa premises, Prof MTR Jayasinghe of the Department of Civil Engineering has suggested that this model can assist the post disaster reconstruction in any situation, not only tsunami reconstruction.

This semi-permanent house out of cement fiber sheets comprises four spaces; Living room, kitchen and two bedrooms. Its doors and windows are also from cement fiber sheets (Jayawardana2005). They should be constructed separately.

For the construction of this house, the following materials are required

- 25 Nos 8 –feet cement fibers
- Nos 10 –feet cement fibers
- 20 Nos angle iron connection measuring 25x25x3 mm

The following precaution should be taken when fixing the sheets as well of the semi-permanent houses. The cement fiber sheet has two sides. The side is recommended to face the sky when used in roof, should be arranged facing indoors when fixed as well of the semi permanent houses. Those are on semi-permanent house constructions used in Sri Lanka this paper emphasizing the permanent house construction.

Abayakoon (1996, 1998) initiated the seismic risk analysis in Sri Lanka and demonstrated that Colombo is more vulnerable to seismic events than any other part of country. Dissanayake and Mohadevan (2005) stated an earthquake make ground motion in all directions, shake buildings and lead to collapse or cause components to fall, either of which can be life threatening. This shows the risk of seismic events and Sri Lanka should improve housing technology to tolerate seismic events.

Methodology

This paper is to study the impact and nature of damage to houses especially in the fisheries sector. The basic data collected based on secondary data of houses and damages to houses of fishermen. This paper analyses this housing construction systems in detail.

The secondary data used in this study were from the Department of Census and Statistics, and other papers. Based on the secondary data house damaged due to tsunami at each district are analyzed. Also the percentages of house damage based on distance from sea cost are analyzed. Also temporary house and permanent house construction methods indicated.

Compared house construction traditional technology with ITDG –Practical Action technology based on construction cost, disaster tolerance and environment friendly characteristics. Main emphasis was given to new house construction method suitable for fisheries families. Because fishers are prefer to live close to seacoast. Those areas are under high wind prevailing and houses should strong enough to tolerate them. Also tsunami and earthquake may be affecting them more than inland people.

Island wide house damage

The social impacts include more than 31,000 deaths and 15,000 injuries, nearly 150,000 houses destroyed or damaged, representing about 13% of the housing stock in the affected areas and 450,000 people displaced. The damage estimation indicated housing damage loss of US$ million 344 and total need assessment is US$ million 487 (Philips 2005). Nationally, there are an estimated 4.6 million dwelling units, 29% of which are considered temporary (built with non-durable materials). It is reasonable to estimate that Sri Lanka requires over 200,000 new housing units. Total number of fishing houses affected by tsunami is 69,320 and that is 55% of the total fishing houses. Out of total 131,000 fishing households 72,372 (55%) affected by tsunami. These figures show the important of new low cost housing technology.

Temporary housing with amenities therefore became a priority at initial stage but now permanent hosing is important. The planning and development of permanent settlements to proceed in orderly, consultative and participatory manner is important.

Results

District level fishery house damage

The highest number of completely damaged houses in Batticaloa (3,705), Jaffna (2,227), Trincomalee (2,156), and Ampara (2,148) districts. The highest number of partially damaged houses in Batticaloa (2,830), Jaffna (1,242), Trincomalee (1,751), and Ampara (1,378) districts.

Island wide fishery house damage based on distance from sea coast

Within 100m limits from seacoast 20,604 houses damaged, between 100- 300m range 19,226 houses and over 300m limit 29,490 houses damaged due to tsunami. This distances as well as elevation should consider on damage cause factor.

District level fishery house damage based on distance from seacoast

Within 100m limit the highest number of fisher house damaged in Trincomalee District (3,586) the second and third highest number of fisher house damaged districts is Jaffna District (2,381) and Matara District (2,292) respectively. The least number of fisher house damaged districts are in Batticaloa (802) and Hambantota (884) districts. This is special situation because those districts face tsunami directly as they are in the eastern side of the country. Mangroves and other tree cover on the sea coast and less number of houses prevailed within this limit may be the cause. The damaged of fishery houses between 100-300m horizontal distance from sea coast are indicated in Fig 3. The maximum number of houses damage within this range is in Batticaloa District (2,779). The least number of fisher house damaged districts are in Kalutara (836) and Colombo (465) districts. This may be due to high elevation of housing lands and Mangroves and other tree cover on the seacoast. But for most of the districts less number of houses damaged comparing with other two ranges.

The highest number of fishery houses damaged over 300m horizontal distance from sea coast is in Batticaloa District (6,773). This is very high number comparing with other districts. Number of houses damage in Gampaha (3,443) and Hambantota (3,400) districts are in second and third in order. Least damage took place in Colombo (128) and Kalutara (883) districts.

Percentages of destroyed houses due to tsunami indicated in the following Figure 2. It depicts that the districts on the east and southeast areas are Batticaloa, Trincomalee and Ampara.

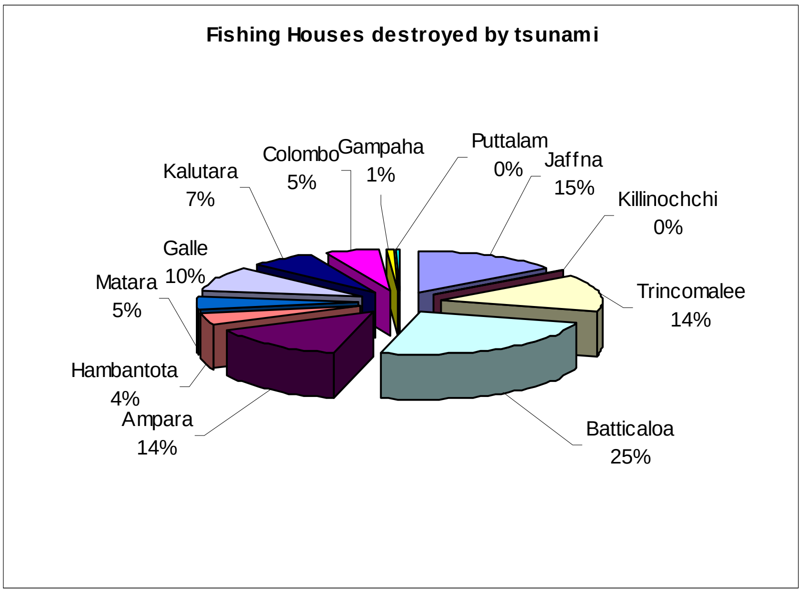


Fig 2: Percentage of destroyed fishery houses based on districts

Figure 3 depicts that the highest percentages of completely damaged houses in Jaffna, Batticaloa, Ampara and Matara districts. The lowest damaged houses in Puttalam and Gampaha districts. The highest partly damaged houses in Kalutara, Colombo and Batticaloa districts. The lowest partly damaged houses in Puttalam and Gampaha districts.

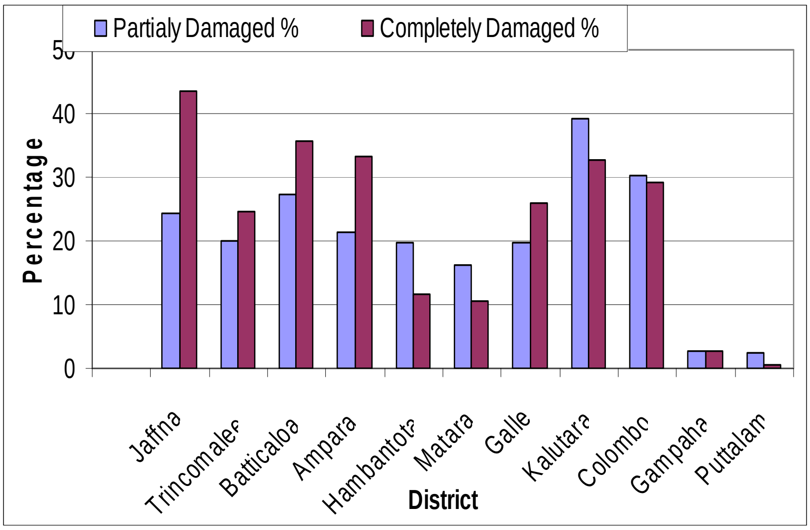


Fig 3: Percentage of partly and completely damaged fishery houses

Based on distance from seacoast percentages of damaged houses are given in the Figure 4. Within 0 -100 meter range the highest damage took place in Colombo and the lowest in Batticaloa. From 100m to 300m range the highest damage took place in Kilinochchi and the lowest in Colombo. More than 300 m from coast the highest damage took place in Batticaloa and the lowest in Colombo.

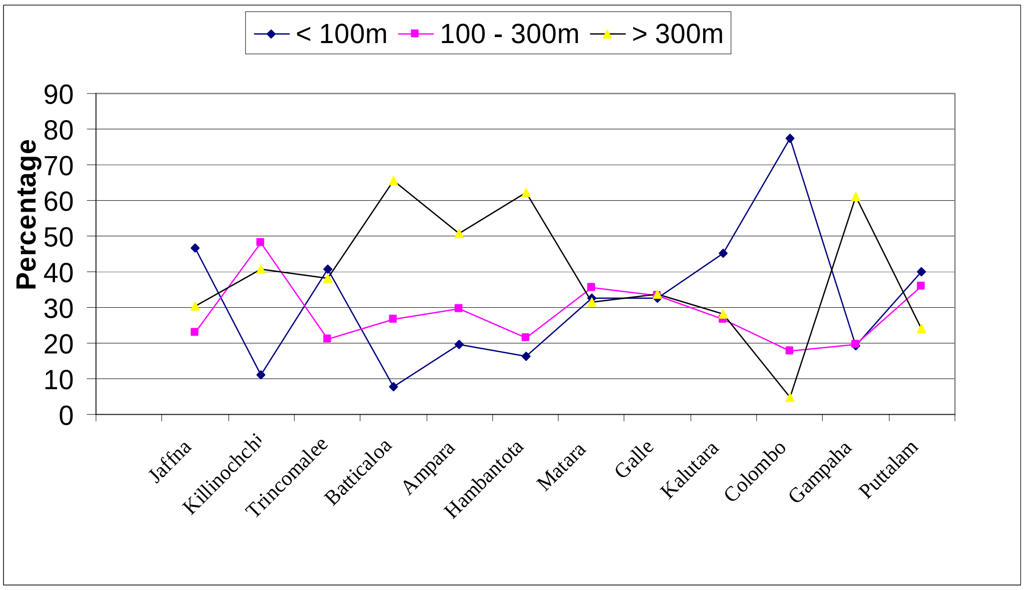


Fig 4: Percentage house damage by district based on distance from seacoast

House construction

Government policies initially prohibit new construction within 100 meters of the mean sea level (in some areas 200 meters). The re-building process has been painfully slow with almost no new homes yet constructed in the most severely affected areas. An important process of community mapping has taken place in eastern and southern coastal areas, led by NGOs, but the local authorities are reluctant to accept such bottom up initiatives.

In Sri Lanka, hundreds of thousands survivors continue to live in temporary shelters or tents some six months after the disaster (Leckie 2005). Reports indicate that the government has planned to build new housing four to five kilometers from traditional coastal villages. This may have an impact on people's livelihoods, especially fishing families dependent on the sea and immediate access to it. When one visits temporary resettlement sites in Sri Lanka, it is not difficult to get the feeling that tsunami survivors are going to waiting for many years before all of the housing that is needed is actually in place.

Throughout the tsunami-affected countries, reconstruction efforts have generally been top down initiatives, excluding many affected communities from decision making.

Harris, (2005) stated livelihood in Sri Lanka have been affected not only by initial devastation of the tsunami but also by the policies and practices of government and the humanitarian aid communities post disaster response. Initially displaced people lived in tents and then transfer to transitional shelters and finally permanent houses.

Low cost house construction

Low cost house construction consists with three steps at wall construction, roof preparation and concrete roof finishing.

Wall construction

Rat trap type wall construction using normal bricks (2, 4, 9). This method saves 20% of bricks than normal 9-inch traditional wall construction method (Fig 5). This method is control heat transfer in and surrounding environment due to air column in the wall. This will improve human comfort of the dwellers of these houses. Good finish on both side of the wall need not plaster. Hence by using this method we are able to serve expenditure for plastering.

Fig 5: Wall construction in progress

Arches are common features in house today. It is a technology, which has been in use for hundreds of years and has withstood the test of time as evidenced by the numerous arches seen in ancient buildings and old houses in Sri Lanka. Practical Action has trained masons on the technology and the practical use of several types of arches, some of which were constructed at Practical action pilot project sites. Arches can be used not only to beautify buildings but also to minimize cost by reducing the use of steel and concrete. Arches can be used to make doors and windows look attractive from the exterior. Walls are decorated by introducing arches in Fig 6. This will improve internal air circulation of the house. Also it gives attractive inside look. Top of the walls cover air cavities (rat trap) by bricks and then roof construction done (Fig 7). Construction cost of 100 sq. feet is reducing from 8759 to 6454Rs. by this method. This wall has sufficient strength to construct two stair houses without concrete piles.

Fig 6: Arch preparation

Fig 7: Completed walls

<u>Roof preparation</u>

Due to high price of planks timber roof preparation is much expensive in house construction. This technology introduce substitute for 2x 4 inch plank prepared by three 1x2 inch flanks with similar strength. This ITDG technology on one way reduces cost for planks. On the other hand if we need ceiling, these constructed flanks have allowed doing it easily without extra expenses. The distance form one plank to next should be change based on roofing material tile or asbestos sheet or aluminum sheet.

Fig 8: Completed roof

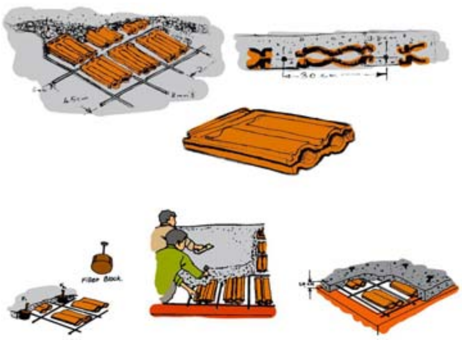


Fig 9: Concrete roof construction

<u>Concrete roof preparation</u>

Concrete roof preparation is better for high wind prevailing areas like mountain peaks. Initial steal wire bars laid 45cm x 30cm spacing. As figure indicated to reduce amount of concrete mixture, two (grade 3) roofing tiles put with design on the slant shattering. Then concrete mixture in the concrete at lower edge On the other hand these tiles control heat conductivity through concrete roof to inside.

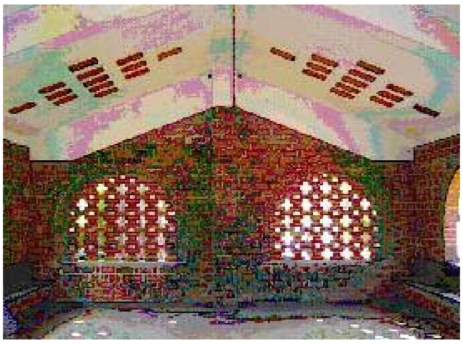


Fig 10: Completed concrete roof

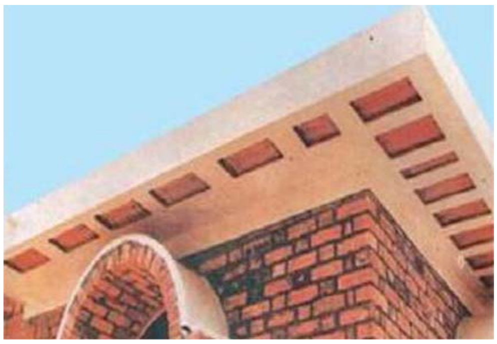


Fig 11: Completed filler slab and sunshade

<u>Filler slab and sunshade construction</u>

The normal slab preparation high cost gone for concrete mixture. Similar to concrete roof preparation steal wire bars laid 45cm x 30cm spacing and two grade 3 roofing tiles place on the flat shattering and fill concrete (Fig.11, 12).
Sunshade can be turned out at a very low cost for covering doors and windows. They can be made very attractive and can be made by using only Ferro cement planks and bricks (Fig. 11, 13). This bricks that are used for construction should be between 2" –2.5" thick.

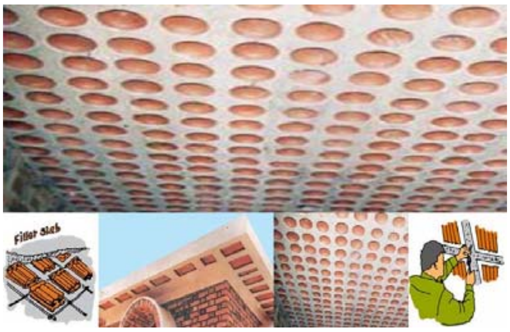
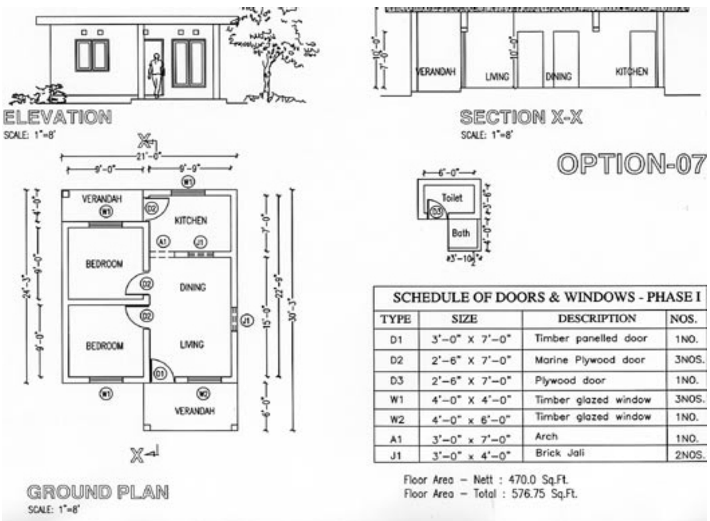


Fig 12: Concrete filler slab using empty curd pot (clay)

Fig 13: Completed flat concrete roof and sunsheds

Completed two houses based on ITDG (Practical Action) technology indicated in Figure 14.

Fig 14: Completed Houses



SCHEDULE OF DOORS & WINDOWS - PHASE I			
TYPE	SIZE	DESCRIPTION	NOS.
D1	3'–0" X 7'–0"	Timber panelled door	1NO.
D2	2'–6" X 7'–0"	Marine Plywood door	3NOS.
D3	2'–6" X 7'–0"	Plywood door	1NO.
W1	4'–0" X 4'–0"	Timber glazed window	3NOS.
W2	4'–0" x 6'–0"	Timber glazed window	1NO.
A1	3'–0" x 7'–0"	Arch	1NO.
J1	3'–0" x 4'–0"	Brick Jali	2NOS.

Fig 15. Plan of 470 square feet net floor area house

Construction cost

By using this technology the construction cost per one squire foot is Rs.510 (5 US$) and for 350 sq. foot house with verandah, toilet, bedroom and kitchen Rs. 175,000 (1750 US$). Fig 15 shows a plan of 470 square feet net floor area house. This house includes two rooms, living room with dining space and two verandahs. Table 1 shows the total construction cost of proposed method reduced cost by 27%

Table 1 Estimated cost for 500sq feet house construction

Item	**Unit**	**Traditional method cost Rs**	**ITDG method cost Rs.**	**Profit %**
Foundation	Cu. Ft 325	34,125	30,875	10
Wall	Sq. ft 1200	117,600	80,400	32
Roof	Sq. ft 690	113,850	91,770	19
Beam, lintel		42,755	33,025	23
Door, Window frame	Ft. 141	23,970	10,716	55
Item	**Unit**	**Traditional method cost Rs**	**ITDG method cost Rs.**	**Profit %**
Doors	Sq. ft 56	12,320	12320	0
Windows	Sq. ft 64	25,600	25,600	0
Floor	Sq. ft 435	28,275	28,275	0
Finishing		77,250	34,000	56
Total		475,745	346,981	27%

Advantages of this technology

The advantages of this technology are utilization of available resource and based on peoples request construction plan able to change suitable way. Also based on the disaster in the area construction method can change. E.g. Cyclone prone of high wind prevailing area concrete roof house can construct with comparatively low cost. Flood prevailing areas flat concrete roof is appropriate. There are more than 700 houses were constructed using the above technology in tsunami affected areas of Sri Lanka. This is environmental friendly technology.

Conclusion

Based on this estimate the construction cost reduced by 27% and this new technology environment friendly. Hence new construction of about 200,000 houses will save high amount of money. That is highly important to developing county like Sri Lanka. Also Sri Lanka faces many disasters (floods, cyclones, and tsunami) within last few decades and damage and destroy large number of houses. The house constructed using this technology has more tolerance to seismic vibration than traditionally constructed house.

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Author Biography

Dr. M. S. SriGowri Sanker is currently working as COE Researcher of the Graduate School of Economics, Kobe University, Kobe, Japan and he is also the Visiting Researcher and the Resource Economist of the Asian Disaster Reduction Center, Kobe, Japan. He is the Sri Lankan citizen and has wide experience is disaster impact evaluation and disaster economics and development. He is the specialist of Economics of Disaster and development and one of the promoters of mainstreaming disaster reduction into development initiatives. He authored many books and papers in the fields of economic policy, disaster economics and globalization. He participated in the missions to evaluate the disaster impact in many parts of the world. He is the member of TIEMS.

Dr. W. M. G. B. Giragama is the head of the department of Agrarian Relations and Irrigation Watershed Management of the Agrarian Research and Training Institute of the Ministry of Agriculture, Government of Sri Lanka, Colombo, Sri Lanka. He is the Climate Geographer and Disaster Impact Evaluation Specialist. He participated in the many disaster impact evaluation missions in Sri Lanka and continuous contributor to the cause of disaster reduction and sustainable agrarian development issues. He is the professional trainer in disaster reduction and management. He authored many papers and participated in many conferences abroad and in Sri Lanka. He is the citizen of Sri Lanka.

DISASTER MANAGEMENT IN INDIA
TIME TO FOCUS ON PREVENTING THE NEXT DISASTER

Ms.Kajal Singh[1]
Rajarshi School of Management & Technology

Abstract

Over the past fifty years, there has been a significant evolution in thinking about disasters among aid workers, economic development specialists, policymakers, community planners, academics and other involved in the disaster field. The debate has shifted from the narrow concept of providing quick disaster "relief" based on a charitable impulse to a broader concept of disaster "management" that encompasses community involvement in prevention and preparedness, mitigation, emergency relief, rehabilitation as well as long-term development that incorporates both prevention and preparedness.

At 6.29 am, on the morning of December 26, 2004 an undersea earthquake erupts in Sumatra, triggering off tidal waves called tsunami. A minute later, the India Meteorological Department (IMD) gets the news, in 15 minutes; IMD tracks the tsunami to the Indonesian coastline. At 7.50 am, the tsunami hits Car Nicobar, The Island is almost wiped out. Then the tidal wavers head for the southern coast of India. At 8.50 am, Tamil Nadu is hit. (Table.1.1, Tsunami damage in India).

Following the unparallel tragedy that has killed over 150,000 across the world, particularly in Indonesia and Sri Lanka, tsunami is the new word on the world'smind. But something worse could happen. What is the state of our disaster preparedness? Do we need to be part of a global combat network? With 22 states and union territories on the official list of disaster-prone areas, who's next? India cannot afford to take any more chances. We must be ready now. (Refer Table 1.2, Global list of Some Historical Tsunami Deaths, & Table 1.3 List of Tsunami that Affected India).

Disaster Mitigation Initiates

The phrase disaster management means a continuous and integrated process of planning, organizing, coordinating and implementing measures which are necessary or expedient for the following (i) prevention of danger or threat of any disaster; (ii) mitigation or reduction of risk of any disaster or its severity or consequences; (iii) capacity-building; (iv) preparedness to deal with any disaster; (v) prompt response to any threatening disaster situation or disaster; (vi) assessing

the severity or magnitude of effects of any disaster; (vii) evacuation, rescue and relief; and (viii) rehabilitation and reconstruction.

[1] Lecturer, Udai Pratap College Campus, Varanasi-221002, Uttar Pradesh (U.P), INDIA, E-mail: Kajal20@gmail.com

Thus, mitigation means measures aimed at reducing the risk, impact or effects of a disaster or threatening disaster situation Preparedness refers to the state of readiness to deal with a threatening disaster situation or disaster and the effects thereof. Reconstruction means repair or construction of any property after a disaster. And resources include manpower services, materials and provisions. The Bill states that the phrase capacity- building includes (i) identification of existing resources and resources to be acquired or created. (ii) Acquiring or creating resources identified under sub-clause (i) and (iii) organization and training of personnel and coordination of such training for effective management of disasters.

The Government of India has adopted mitigation and prevention as essential components of their development strategy. The Tenth Five Year Plan document has a detailed chapter on Disaster Management. The plan emphasizes the fact that development cannot be sustainable without mitigation being built into developmental process. Each State is supposed to prepare a plan scheme for disaster mitigation in accordance with the approach outlined in the plan. In brief. Mitigation is being institutionalized into developmental planning.

Disasters can have devastating effect on the economy; they cause huge human and economic losses, and can significantly set back development efforts of a region or a State. Two recent disasters, the Orissa Cyclone and the Gujarat Earthquake, are cases in point. With the kind of economic losses and developmental setbacks that the country has been suffering year after year, the development process needs to be sensitive towards disaster prevention and mitigation aspects. There is thus needed to look at disasters from a development perspective as well.

Further, although disaster management is not generally associated with plan financing, there are in fact a number of plan schemes in operation, such as for drought proofing, afford station, drinking water, etc. which deal with the prevention and mitigation of the impact of natural disasters, External assistance for post-disaster reconstruction and streamlining of management structures also is a part of the Plan. A specific, centrally sponsored scheme on disaster management also exists. The plan thus already has a defined role in dealing with the subject.

Recently, expert bodies have dwelt on the role of the Planning Commission and the use of plan funds in the context of disaster management, Suggestions have been made in this regard by the Eleventh Finance Commission, and also the High Powered Committee on Disaster Management. An approach on planning for safe development needs to be set out in the light of these suggestions.

But a basic lesson that all disaster situations have taught us is that without the involvement of the local people and the affected community, the implementation of any plan is not possible, it rues "The Disaster Management Bill 2005 leaves 70 million disabled people endangered," announces http://vl.dpi.org,citing www.dnis.org.

Although our country has been subjected to natural disasters from time to time, these have never been adequately factored into our planning process, "laments India Economic Road Map: The Next Five years 2002-2007" on http://planningcommission.nic.in. "By and large, we have taken the approach that these events are transient in nature and, therefore, can be addressed as and when they arise.

"Between 1988 and 1997 disasters killed 5, 1116 people and affected 24.79 million very year," says http://www.undpquakerehab.org/ about Indian statistics, in a document titled, 'Natural Disaster Risk Management Programme'. "In 1988, 11.2 per cent of total land area was flood prone, but in 1998 floods inundated 37 per cent geographical area". Indian subcontinent is among the world's most disaster prone areas, states Building Materials and Technology Promotion Council (www.bmtpc.org). The numbers it gives are: 54 per cent of land vulnerable to earthquakes; 8 per cent of land vulnerable to cyclones, and 5 per cent of land vulnerable to floods. “In 21 cyclones in Bay of Bengal 1.25 million lives have been lost in India and Bangladesh”, informs a page titled ‘Disaster Mitigation & Vulnerability Atlas of India’.

India is spending huge amounts on disaster relief measures. Why not spend it on disaster management instead?

“We must set the stage for the efforts in the longer term, as we move from saving lives to recovery and reconstruction”.
-Kofi Annan, UN Secretary- General

What? Why? Our disaster preparedness

Disasters are not predictable. They follow no standard operating procedures. Disaster preparedness in about managing the unknown, not a science but a social behavior that’s responsive, predictive and imaginative. Effective disaster management depends on four factors:

- Preparedness: knowing where and when disaster will hit.
- Mitigation: through measures like coastal zone regulation, building earthquake-resistant buildings, before the event.
- Relief: effective action, like moving supplies quickly
- Rehabilitation: building lives again.

(Orissa, 1999. Bhuj, 2001)

The Orissa super-cyclone and the earthquake in Bhuj, Gujarat exposed serious limitations in India’s preparedness system:

- India has no national disaster management policy
- During a crisis, the state administration is in charge; the Central government only offers financial and material help
- Disasters are nobody’s job. Different ministries-home, agriculture, science-take turns when disasters strike. This creates an administrative crisis during the calamity
- Disasters are treated as a one time crisis
- Disaster management is non-plan expenditure

To deal with the aftermath of the situation in Orissa, the national cyclone mitigation project and a core group on cyclone mitigation were announced. Due to lack of funds and direction, these are yet to take off. The death toll reported so far, as well as the number of persons who are missing or have been displaced, is given in the Table.

Table: Number of deaths, injuries and missing and displaced persons due to tsunami in India

No. of deaths	**No. of injured persons**	**No. of missing persons**	**No. of displaced persons**	**No. of affected districts/islands**
10,872	Tamil Nadu (3432 as on 3-2- 2005)	5,764 persons are reported to be missing in A&NIslands and are feared to be dead	647,556	41
	Andaman & Nicobar (1514 as on 3-3-2005)			

	Pondicherry (561 as on 12-01-2005)			
	Kerala (1707 as on 10-01-2005)			

Note: Figures from Andhra Pradesh not available.

Earthquakes don't kill, buildings do

Bhuj showed that science could be used to track earthquake prone areas and specific earthquake monitoring and micro zoning would help in this. Policy's role was to make sure that building codes on earthquake proofing were enforced in vulnerable areas to minimize deaths.

An environmentalist wrote: earthquakes do not kill. Buildings do. Therefore, once we understand the vulnerability of seismic areas, we have to use this knowledge to ensure that structures that come up are earthquake resistance. But this is precisely where we fail. Even after the devastating Bhuj earthquake contractors are merrily abusing the building requirements for earthquake-prone regions, whether Assam or Delhi.

Of the 11 national programmes announced after Bhuj, the first was the earthquake risk mitigation programme to enable engineers in quake-resistant buildings to accelerate the process of vulnerability- reduction. The government also committed to enforce earthquake-resistant building codes in seismic zones.

We do not need new science to teach us this. But what we need is to ensure government agencies strictly regulate, so ensuring structures are built taking into account building codes.

Island Ecology

"About 10persent of tsunami impact could have been absorbed by the now non-existent mangrooves, and sea beaches," says Sameer Acharya, secretary, Society for Andaman & Nicobar Ecology, a non-governmental organization (NGO) based in Port Blair. After Tsunami, an international research team discovered just how important mangroves were in a dramatic way. In a recent paper published in Oct.8 issue of the Journal Science, they showed how three villages shielded by the Pichavam mangrove forests in Cuddalore district escaped without a single death. The Science paper confirmed earlier laboratory experiments, which showed that 30 trees per 100 square meters could reduce the intensity of a tsunami by more than 90 per cent. The same went for coral reefs. A report published in National Geographic showed that settlements behind a bank of intact coral reefs in the Maldives similarly escaped the worst effects of the Tsunami. The importance of mangroves & coral reefs can be underlined by these facts.

The Supreme Court has revised its ban on tree felling in forest areas and allowed the administration to use timber for rehabilitation work. The government subsidizes this distruction. Between 1991 and 2001; total subsidies to industry have grown from Rs208.57 lakh to Rs 411.23 lakh in 2000-01.Many relief workers in tsunami- affected areas now report that areas with mangroves or any other natural barriers, like Pondicherry, have incurred less loss in life & property than Nagapattinam and Cuddalore, where the Tsunami waves went through the low lying areas that were occupied by settlements instead of forests. "There should be some kind of a planned development; there should be some kind of law enforcement in terms of what region to be occupied even in the coastal region," says V Rajamani, a seismological scientist based in Chennai.

India needs centralized ocean management

In the US, a single body, the National Oceanic and Atmospheric Administration, coordinates all oceanographic and atmospheric studies, but in India, there is a multiplicity of organizations involved in oceanographic studies, under various ministries, and this causes an information whirlpool. To name a few:

- Department of Ocean Development: funds for oceanographic studies
- Survey of India: maintains tidal gauges; managed by local port trusts.
- IMD: entrusted with disaster warnings, including those from the sea.
- Geological Survey of India: for marine geological studies, including undersea earthquakes.

Why, with all these organization, do we still lack proper data? Research on India's strategic areas (defense, nuclear and space) gets prioritized, while modernized tide gauge systems to provide real-time data on wave behavior gets sidelined, even if the amount involved is as tiny as Rs. 10 crore, Along our 5,700 km-long coastline, there are only 10-12 tide gauges, and they, too, are operated manually. Survey of India (soi) had in fact mooted a proposal to have an array of digital tide gauges to transmit real time data by satellite to a 24-hour centre at the soi headquarters, Dehradun.

Learning from the Tsunami: Mitigating Crises in the Future

Now tsunami have struck here, India is also considering being part of a global tsunami warning system, besides developing an indigenous one that will be built at a cost of Rs.125 crore, DOD will be the nodal agency. Disaster management demands, frstly, scientific knowledge to understand the map our vulnerability.

But science needs now to go beyond mere technology and to start thinking of the people they're for instead of the infrastructure they're with. The scientific establishment, in its ivory tower, cannot respond to disasters unless they know what's needed on the ground and who to share information with. So ocean science, like the others, needs to be part of a wider vision where technology, people, administration all comes together to combat disaster impact.

What we must understand is that we can never have an effective disaster surveillance syatem, without strong, capable and accountable scientific institutions and people to head them.

Secondly, understand that instrumentation-however important, however sophisticated-will not save lives. Science can merely help us predict natural disasters; only warn us about our vulnerability. The challenge is to use this scientific knowledge for policy and implementation.

Let me repeat what an environmentalist, said "If we do not change our governance system, we will only end up shedding crocodile tears after every disaster."

One year later-What the UN is doing: Over the past 12 months the UN has:

- Built over 200 health care centers;
- Rebuilt over 25,340 permanent shelters;
- Fed over 2 million people;
- Provided over 561.000 children with school-in-a-box kits while their schools are built.

These figures are just an attempt to show that ensuring transparency and accountability in the recovery process is essential to "build back better".

Communities are the first responders to a disaster. The current status of formulation of village disaster management plans and their training in India is given on table 1.3.

Role Of Corporate Sector In Disaster Management

While disaster reduction is a collective responsibility of the entire society, the corporate sector can contribute very significantly. What task is nobler than rehabilitating the lives shattered in a disaster and rebuilding their future through effective mitigation? The corporate world should reinvent their mission and vision and redefine their priorities in the enlightened context of social responsibility. Conferences, Seminars and Discussions should be held. Aim should be to build a culture of prevention towards a disaster free society. The involvement of the corporate sector in disaster management & mitigation is the most pressing need of the hour. As there will be no end to these calamities, its time to lay down new & bold approaches in terms of preparedness, connectivity among communities, corporate & governments.

How And Why Is The Corporate Sector Involved In Mitigating Disasters?

To illustrate the private sector motivation and role in the disaster response and recovery, a research was conducted on corporate responses to the Gujarat Earthquake in India. The analysis produced findings based on in-depth interviews with national and multinational companies, which responded to the Gujarat Earthquake. These indicated that corporations are motivated to become involved in disaster response and recovery based on five organizational factors:

1. Social Values
2. Disaster Sensitivity
3. Internal Organization
4. External Pressures
5. Perceived Benefits

These dimensions expands the understanding of corporate motivations that focuses primarily on organizational benefits and stakeholder expectations, and introduces the critical influences of social values, commitment to philanthropy, and resource availability and relevancy. The corporate sector has, till now, focused primarily on providing immediate relief. This succor comes in the form of providing large amounts of case to substantiate the relief efforts of the government, providing medical and food aid to the needy, and in some cases, helping affected communities in their rehabilitation process in the wake of a calamity.

Towards disaster-resistant societies

A number of lessons emerge from various studies and assessments of the numerous disaster occurrences in India. The key lesson felt by many researchers, organizations, & the government is the need for a gradual shift of focus from the "immediate measures" to the 'long -term efforts' of disaster management. We can't stop or change the nature of disasters. What we can change, certainly control, is the scale that a disaster wreaks. This is what disaster preparedness. Disasters can retail death only when the response to it is lazy, i.e unplanned. Therefore, disasters have to be planned for, actively encountered, not only at the level of policy (of which India is seen enough already, in the last five years) but also, and specifically, at where it hits hardest: people affected. Affected because they were not informed, affected because machinery busily whirring to only reproduces itself day after administered day never factored them in its positivist mathesis.

It's not usual to point out that the real victim of the recent disaster is Indian Science, and to the extent that the State controls research, actually the Indian State. Its time to change. However, there is a need to revisit an infuse pragmatism in the process to truly communicate to the masses that India may soon become disaster resistant. It would be apt to

Conclude by reminding us that "Everyone sits down to a banquet of consequences at one point of time"-Leo Tolstoy.

India is spending huge amounts on disaster relief measures. Why not spend it on disaster management instead? 'Link Disaster Management with Welfare', is the need of the hour. We are passing through times when countries are grappling with disasters and struggling to cope with their aftermath as we have seen in the recent past- the Tsunami, the Mumbai floods, Hurricane Katrina, followed by Rita. The pressing need of the hour is to build a culture of prevention towards a disaster free society, and lay down new and bold approaches in terms of preparedness, connectivity among communities, corporates and governments.

Let us wish that such calamities never happen again. But if they do then we must be prepared.

Table 1.1 - Tsunami damage in India

Factor	**Andra Pradesh**	**Kerla**	**Tamil Nadu**	**Pondichery**	**Total**
Population affected	211,000	691,000	2,470,000	43,000	3,415,000
Area affected (km^2)	7.9	Unknown	24.87	7.9	40.67
Length of coast affected (km)	985	250	1,000	25	2,260
Extent of penetration (km)	0.5 – 2.0	1 - 2	1 – 1.5	0.30 – 3.0	
Reported height of tsunami (m)	5	3 – 5	7 – 10	10	
Villages affected	301	187	362	26	876
Dwelling Units	1,557	11,832	91,037	6,403	110,829
Cattle lost	195	Unknown	5,476	3,445	9,116

Table –1.2 Global Lists of Some Historical Tsunami Deaths

Year	**Place**	**Number of Lives lost**
1692	Port Royal Jamaica	3000
1703	Tsunamis in Honshu, Japan following a large earthquake	5000
1707	38 foot Tsunami, Japan	30,000
1741	Following Volcanic eruptions 30 feet wave in Japan	1400
1753	Combine effect of an earthquake and Tsunami in Lisbon, Portugal	50,000
1868	Tsunami Chile and Hawaii	More than 25000
1883	Krakatoa Volcanic explosion and Tsunami Indonesia	36,000
1896	Tsunami Sanrika, Japan	27,000
1933	Tsunami, Sanrika Japan	3000
1946	32 foot high waves in Hilo,Hawaii	159
22May,1960	Along the coast of Chille	Approx.2000 (+3000

		person missing).
1964	195 foot waves engulf Kodiak, Alaska after the Good Friday Earthquake	131
17Aug.1976	Philippines	8000
19Aug.1977	Indonesia	189
18July.1979	Indonesia	540
12Sept.1979	New Guinea	100
12Dec.1979	Columbia	500
26May 1983	Sea of Japan	500
1998	Papua New Guinea	Approx.100

Source: Prevention/Protection and Mitigation from Risk of Tsunami, a modified document (strategy paper), 2005, Ministry of Home Affairs Government of India.

Table1.3 List of Tsunami that Affected India

Date	**Remarks**
12April,1762	Earthquake in Bay of Bengal. Tsunami wave of 1.8m at Bangladesh Coast
19thAug.1868	Earthquake Mag.7.5 in Bay of Bengal. Tsunami run-up 4.0m at Port Blair
31stDec.1881	Earthquake of Mag.7.9 in Bay of Bengal reported tsunami run –up level of 0.76m at Car Nicobar,0.3m at Nagapattinam,1.22m at Port Blair
27thAug.1883	Karakatoa,1.5m Tsunami at Madras,0.6m at Nagapattainam,0.2m at Arden
1884	Earthquake in the western part of Bay of Bengal Tsunami at Port Blair, Doublet(Mouth of Hoogly River)
26thJune 1941	8.1 quake in the Andaman Sea at 12.9 N,92.5E Tsunami on the east coast of India with amplitudes from 0.75 to 1.25m.Some damage from East Coast was reported.
27th Nov.1945	Mekran Earthquake (Magnitude 8.1).12 to15mwaveht.inOrmara in Pasi(Mekran coast).Considerable damage in Mekran coast. In Gulf of Cambay of Gujrat wave heights of 11-11.5m was estimated.
26thDecember 2004	Earthquake of magnitude 9.3 off north Sumatra coast generated devastating Tsunami waves affecting several countries in South East Asia.

Source: Prevention/Protection and Mitigation from Risk of Tsunami, a modified document (strategy paper), 2005, Ministry of Home Affairs Government of India.

Table 1.4: The current status of formulation of village disaster management plans and their training are as follows: Table 1.3

Phase	**Programme State**	**Village DM Plans**	**DMC members trained**	**First Aid**	**Search & Rescue**
I (Oct 2002 onwards)	Bihar	858	12390	2717	3876
	Gujarat	1340	15833	5821	1056
	Orissa	9170	110016	1769	1788
II (June 2003	Arunachal Pradesh	0	0	0	0
	Assam	40	200	160	160
	Delhi	50	180	30	0
	Maharashtra	0	0	0	0
	Manipur	0	0	0	0
	Meghalaya	0	173	0	0

onwards)	Mizoram	0	0	0	0
	Nagaland	0	0	0	0
	Sikkim	80	0	903	0
	Tamil Nadu	161	78	18	25
	Tripura	0	0	0	0
	Uttaranchal	75	562	40	7
	Uttar Pradesh	0	0	0	0
	West Bengal	0	0	0	0
	Total	**11774**	**139432**	**11458**	**6912**

Source: 3rd Meeting of the Project Management Board (PMB), GOI-UNDP Disaster Risk Management Programme (2002-2007).

Table 1.1 - Tsunami damage in India

Factor	**Andra Pradesh**	**Kerla**	**Tamil Nadu**	**Pondicher y**	**Total**
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Villages affected	301	187	362	26	876
Dwelling Units	1,557	11,832	91,037	6,403	110,829
Cattle lost	195	Unknown	5,476	3,445	9,116

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Academic and Professional Practice

Peer Reviewed Articles

GIS in Emergency Management

DEVELOPING A MANAGEMENT MODEL AND DATA COLLECTION FOR EMERGENCY INCIDENTS USING MOBIL-GIS.

Mehmet Zeki Coşkun and H. Can Ünen
Istanbul Technical University[1]

Keywords: GIS, Location Based Services, Emergency, Management, Hand PC.

Abstract

Recent days the new market fields come into existence related with the new services by development and adoptation of mobile technologies. All the reasons of incrasing of use of the services are enormous developing internet and its technologies, coming out the potential employment behind of this developing and successful application into the real life these employment, inceasing of wireless networks and getting powerfull of e-commerce technology and its structure. The target of mobile GIS is to find the location themselves, define the target that they want to go and reach to the target by taken GIS data form the net, mobile devices and GPS technology.

This study is part of the project funded by BAP-ITU (Science and Research Projects - Technical University of Istanbul) in order to develope a management model and realizing data collection for after and before disasters using Mobil-GIS. Istanbul, which is located in Western side of Turkey, has been selected for this study. As Istanbul has over 15 million population, more than one million houses in 384 km square and is located near to the Anatolian fault zone it is a realy good sample for all kind of emergency applications.

In this study, a main points of a management model are defined and the model is formed. The application fields of mobile GIS in Turkey and World, systems requirements, the problems in practice and data security are exeamined and a software are developed to collect and transmit data using handy computers. After an test application is executed in Istanbul.

Introductıon

Location a basic factor for a person to perceive and understand the globe he lives on. The frustrating speed of development on technology also affects the daily rhythm in the same way. In this sense, people are always in need of accessing spatial information anywhere, or anytime today. Cellular phones, pocket PCs, digital cameras, GPS receivers and Geographic Information System (GIS) applications that permanently entered our daily lives have made this need come true (Flick and Bell 2000; Yomralıoglu, 2000).

It is obvious that our futures will be shaped by the rules that will be decided according to technological conditions. As a matter of fact, many rules regarding to mobile and spatial information, like the necessity for more than %67 of the 911 emergency calls to contain the

[1] Istanbul Technical University, Civil Engineering Faculty, Department of Geodesy and Photogrammetry Engineering, 34469 / Maslak / Istanbul / Turkey.

positional information with at most 125 meters of error, have been set in United States and Europe (Erden 2000).
Specialy, in case of imergency incients, mobile technology will help us to collect date and organize all equipments and personnel. Because all data can be collected and transmitted online instantly and the organization of emergency helpes can be realized instanly data.

Data Collection With Mobile GIS

Today, new services on development and adaptation of mobile technologies and markets for these applications are being developed. The frustrating development rate of the internet technologies, the understanding and application of the job opportunities behind this development, the growth of wireless mobile networks and the improvement of the e-commerce structure and technologies, have been the causes for the increase of the mobile technology use. 454 GSM operators in 182 countries were serving 730 million users by the end of 2002. In 2002, 75% of the new mobile clients started to use the GSM networking services. The number of the mobile network users has exceeded 1 billion for voice and data transfer these days. (http://www.infotech.com; Yomralıoglu, 2000).

Mobile GIS consists of more than one technology working together:

- Mobile hardware
- Computer
- GPS
- Wireless communication network

The aim of mobile GIS is: making users easily reach their objectives with the GPS technology and the GIS data they bought on the internet by determining their location and the target point. Although this system seems to be mainly used for touristic purposes, it can also be used in other projects by courier companies, infrastructural services, police, army, and administrative units like the Ministry of Finance, fire department, emergency services or taxi drivers (Derekenaris et al. 2001; Korol 2004; Virrantus at all 2001).

Data is the most important component of Location Based Services (LBS). In today's life, where there is a huge amount of data, the collection and the transfer of these data is a major problem. This problem increases when every individual and association collect data specifying their own different standards. Services can be used for different projects mainly by touristic affairs, courier companies, infrastructural services, police, army, and administrative units like the Ministry of Finance, fire department, emergency services or taxi drivers.

Mobile Hardware and Operating Systems

Radical changes are seen in operating systems as the hardware performance of the mobile device increases. This situation has also effects on software development tools. The development of mobile GIS technologies gained acceleration with the development of pocket PCs that use various operating systems. The most common operating systems are: PALM OS and WINDOWS. The operating systems on Pocket PC (PPC), Pocket PC Phone Edition (PPC PE) and SmartPhone (SP) (table 1) are Windows CE based. The Pocket PC operating system, with its 2003 version, had a commercial-purposed name change as Windows Mobile 2003. Its second version that is named Windows Mobile 2003 SE supports horizontal mode – LandScape (Casademont at all 2004; Korol 2004; http://www.microsoft.com).

Software for Mobile Hardware

Mobile software development tools and their platforms are given in Table 2. Here, light and dark shaded boxes tell that the software developed with the given tool will work on the corresponding platform, and the white boxes tell that it won't work. The difference between the light and dark shade is: Connecting to the device and performing processes like publishing or debugging are possible for the dark shaded boxes, whereas for light shaded boxes it is not possible. "R" indicates that the runtime libraries should be installed on the device (http://www.microsoft.com).

Table 1. Mobile Devices and Software Platforms

Software Development Environment	eVC 3 (C++)	eVC 3 (C++)	VC 3 (C++), eVC 4 (C++)	VS Whidbey (C#, VB.NET, C++)
Equipments				
Operation System	PPC 2000	PPC + PE 2002	PPC +PE 2003	PPC + PE v Next VGA Landscape Square Standart SP v Next QVGA Standart
APIs	Win32 POOM	MFC Network Administrator	.NET Compact Framework Bluetooth SMS	.NET CF Whidbey New Engines New Class Library DirectX
CE OS	3.0	3.0	4.2	5.0 (Macallan)

Table 2. Software Development Tools and Environment for Mobile PCs.

.NET Compact Framework	SP 2002	SP 2003	SP 5.0	PPC 2002	PPC 2003	PPC 5.0
1.0 – VS 2003				R		
1.0 – VS 2005				R		
2.0 – VS 2005			R		R	R
Native						
eCV 3						
eVC 4						
Other						
EVB 3					R	

A "Visual Basic .NET" software development platform, Microsoft DevelopmentEnvironment 2003 v.7.1.1.3088 and Microsoft .NET Framework Software Development Kit v.1.1 were used for this study. Microsoft .NET Framework v.1.1 is a necessary Windows component for developing XML Web Services and new generation software applications. The key components of the ".NET Framework" are the .NET Framework libraries that include ADO.NET, ASP.NET, Windows forms and common runtime environments. ".NET Framework" programs provide easy integration with other programing languages and easy

modification and improvement on the execution environment. ".NET" also provides platform independence.
".NET Software Development Kit" (SDK) is equipped with examples, compiler and the tools to help developing new applications and services based on ".NET Framework" technology. Any software developed by "Visual Basic .NET – SDK" is fully compatible with all pocket PCs working with Windows CE operating system. Testing should be done on a pocket PC during the development process. The test procedures are carried out by the on-line connection between the mobile device and the PC that the software is being developed. This process can also be done on PC using an emulator provided by the SDK. Microsoft ActiveSync software is used for the on-line connection between the PC and the mobile device.

ActiveSync synchronizes the PC and the pocket PC via cable, infrared or bluetooth connections. ActiveSync also enables connection of the device between other sources. To obtain a connection between the device and the PC, ActiveSync software must be installed beforehand. Remote access is not possible except from these connections. (http://www.asus.com, 2005; http://www.esri.com/software/arcgis/arcpad, 2005; http://www.trimble.com/mgis_mobilegis; http://www.hp.com, 2005).

Software has been tested with MS ActiveSync 4.0 and the data has been transferred to the pocket PC. The data used in the software is a reduced version of the standard data because of the limitations due to limited memory, storage and microprocessor. ASUS MyPal 620 and HP iPAQ hw6515 have been used as pocket PCs. Picture and data transfer, coordinate measurements may or may not be integrated depending on the hardware (Picture 4.2 a, b). ASUS MyPal 620 doesn't have GPS, GSM and camera properties integrated on it. These deficiencies are removed by the addition of GSM and GPS Compact Flash Cards to the device. GPS, GSM and camera properties are present in HP iPAQ hw6515 as default.

It is hard to handle out mobile GIS tasks with disintegrated pocket PCs. There are 3 Compact Flash additions that are necessary but there is one extra slot present in the device. This slot can be extended to two at most and one of the extra hardware must have BlueTooth compatibility. Also, software development is much more easier in integrated systems than others (Figure 1).

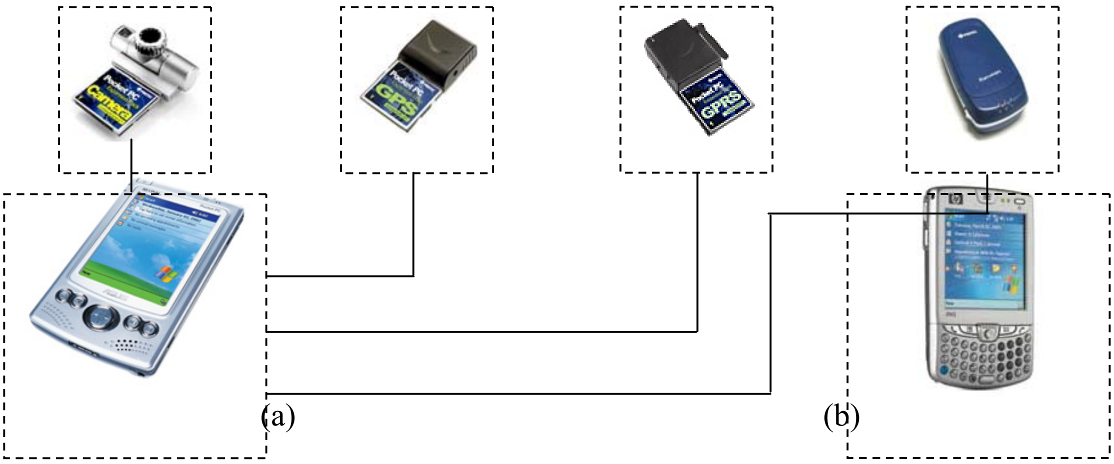

Figure 1. a) GPRS, GPS and camera disintegrated pocket PC,
b) GPRS, GPS and camera integrated pocket PC

Since the expansion slots will be occupied by other hardware on disintegrated devices, it will only be possible to use the devices internal storage, which will cause problems on data storage and processing. The processor-speed problems of the current generation integrated devices also prevents mobile GIS applications ineffective for the time being.

Management and Data Collection

As mentioned before, a wireless communicastion network is necessary in mobile GIS applications. This communication can either be done by GSM or a radio communication system to be built in the working area. Generally, this is possible in metropolitan areas of developed countries. Because of this, communication by GPRS, which is the most common way, is used. Other wireless technologies like intranet, bluetooth (nearly next future), radio-set network can also be used instead of GSM.

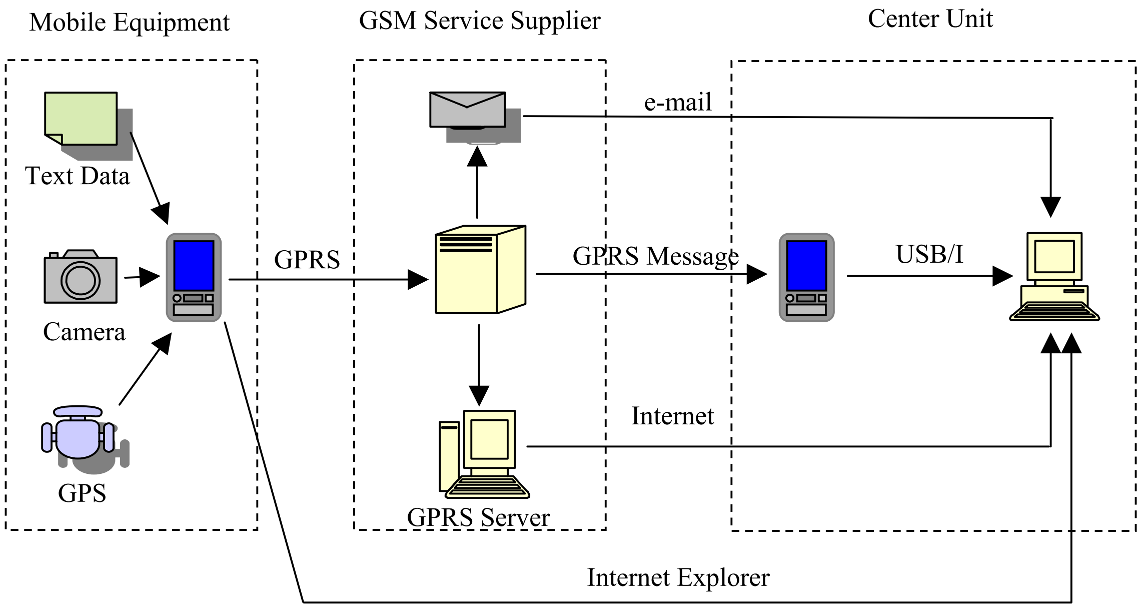

Figure 2. Mobile GIS Process Model

In this study, a model related to emergency management was tried to be built, which is one of the possible applications in mobile GIS. The aim in this study is to manage the emergency support teams and equipments effectively during an emergency situation. The working principles of this system are as stated below:

The mobile equipments all should meet the required specifications (camera, GPS receiver, GSM). Mobile devices are used to determine the damaged structures in the hazard area. First, the teams locate the damaged building and determine the coordinates of it with the GPS receiver. Location can be viewed in the program by using the software in the device and attributes of the structure (building type, current state, number of casualties, presence of emergency aid, access status etc.) can be defined and sent to the main unit. Data coming from all mobile devices are collected in the main unit and optimal distribution of the necessary help teams and equipments is made according to the collected data (Figure 2).

A software that work on pocket PCs have been developed for the mobile GIS application in emergency management. The amount of data the software can process is as much as the available storage in the device. For this reason, the data is transferred to the mobile devices after reducing the amount of graphic or non-graphic data as much as possible. For example, most of the properties (colour, type, thickness) of the road data were not used in the mobile GIS environment. Moreover, the unnecessary attributes were also sorted out from the transferred system.

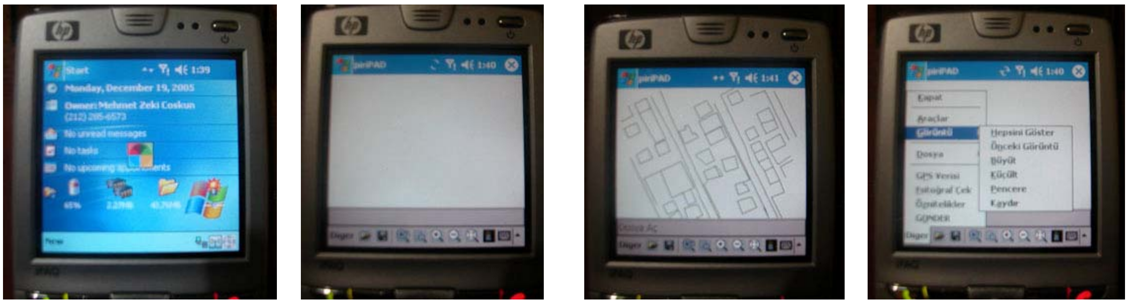

Figure 3. Display of sorted out data and Menu

The flow in the program is as stated above. On the developed mobile software, the position is found either from the map or from GPS coordinates (Picture 3).

GPS coordinates are taken using the program menu of the mobile device, the picture of the building is taken or a previous picture is added to the system. After entering the necessary attributes and explanations, data is sent using “Send” menu via GPRS or internet (Picture 4). Security in mobile GIS systems is very important because it is impossible to block the incoming spam messages. However, it is a controllable situation. In case of transferring the data via e-mails, spam e-mails can be manually sorted or this control can be carried out by putting a simple password to the e-mails.

In GPRS transfer, control can be done by adding the sender’s GPRS number or a simple password to the messages.

Data sent through internet via GPRS of an internet browser can also be similarly controlled.

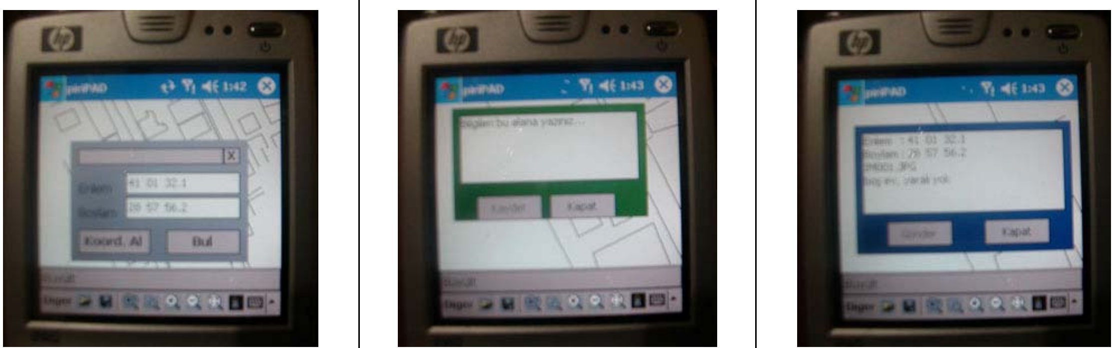

Figure 4. Data Collection and Data Transfer screens

Conclusion

When Istanbul is taken into account, it is necessary to collect data like roads, population, building structure or topography in electronic format. Direct data transfer from the servers will be prohibited due to security reasons. Instead, data will first be transferred to another computer. The hardware to be bought, a PC, GIS software and a GPS receiver will be used for the transfer process.

The hardware profiles of the PC and the mobile devices, the necessary connections, the GIS software to be used, the interface designs and the database to be used for the practical applications stated above is determined in this study.

In an emergency, i.e. eartquake or strom, all kind of data such as image and attrubutes of damaged buildings with their locations, number of injured and dead people or more information can be collected faster and online and sent to the center of emergency manegement office. Thus, these information are used to dispatch staff, equipments and medical supplies or etc to where the damages occur.

Next generation wireless technology specialy bleutooth can also be used as a wrieless technology. It was possible few meters between devices but now, it is much more than few meters depending on device class (class 1 or 2 or 3 radios class 1 have a range 100 meters). Ofcourse it is not necessary for this system drafted but this technology is developing enermously.

Mobile equipments and APIs (Application Programming Interfaces) has been still developing. Following topics have to be taken in to the account when a wriless technology and mobile applications is developed:

- Band with
- The process time in mobile and server
- Minimal programing codes
- Memory
- Minimal use of Recursive functions
- Design for small and less resolution
- Controlling OS for power saving

The main disadvantages of the mobile GIS devices can be stated as: A slower processor and lesser memory compared to the standard PC, a smaller screen with a lower resolution and the difficulty of software development. The processor speed is lower especially in integrated systems than disintegrated systems. However, these limitations do not significantly affect the use of these devices in emergency management.

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Author Biography:

Mehmet Zeki Coşkun was born in Malatya in 1964. He is graduated from ITU-Geodesy and Photogrammetry Engineering Department, then took his MsC degree in 1992, and took PhD degree in 1998. He has been an assistant professor in Surveying Tecniques Division since 2000. He is interested in GPS, GIS, Mobile GIS, Emergency Planning, and software development.

Hüseyin Can Unen, Res. Asst. was born in Ankara in 1982. He is a research assistant in Istanbul Technical University (ITU), Geodesy & Photogrammetry Department, Surveying Techniques Division since November 2005. He graduated from Middle East Technical University (METU), Civil Engineering Department in June 2004 and currently carrying out his Ms.D study in ITU Informatics Institute, Satellite Communications & Remote Sensing Program since 2004. His area of study is GIS applications in emergency management.

MONITORING OF LARGE STRUCTURES FOR SAFETY ISSUES USING BRILLOUIN DISTRIBUTED SENSING

***L. Thévenaz*[1]**
EPFL Swiss Federal Institute of Technology

KT. Chang[2]
Kumoh National Institute of Technology

M. Niklès[3]
Omnisens

T.R. Seok[4]
Kumi Waterworks & Sewerage Affairs Bureau

Keywords: Optical fibre, Brillouin-based techniques, distributed sensing, temperature monitoring, reinforcing pipes, tunnel deformation, leakage detection.

Abstract

Brillouin time-domain analysis in optical fibres is a novel technique making possible a distributed measurement of temperature and strain over long distance and will deeply modify our view about monitoring large structures, such as dams, bridges, tunnels and pipelines. Optical fibre sensing will certainly be a decisive tool for securing dangerous installations and detecting environmental and industrial threats.

Introduction

Developed societies require more and more information for their safety and for their economic development. Recent disasters due to landslides, fires in tunnels and collapses of bridges are a source of serious concern on the part of the public, which seeks, for more safety and for an efficient prevention of these frequent recurrences of dangers.

Sensing in adverse environment and extreme conditions requires dedicated techniques. Quite recent technologies like fibre optics may offer novel valuable solutions and give rise to a strenuous research effort. Optical technologies are an essential actor owing to their tremendous capability to transmit and process a high density of information. Optical fibres are a key component for these technologies and their potential for optical processing and for collecting information as sensing probe is still widely unexplored. The

[1] EPFL Swiss Federal Institute of Technology, Laboratory of Nanophotonics & Metrology, STI-NAM Station 11, 1015 Lausanne, Switzerland, Email: Luc.Thevenaz@epfl.ch
[2] Kumoh National Institute of Technology, 1 Yangho-dong, Gumi, Gyungbuk 730-701, Korea, Email: ktchang@kumoh.ac.kr
[3] Omnisens, PSE, CH-1015 Lausanne, Switzerland, Email: Marc.Nikles@omnisens.ch
[4] Kumi Waterworks & Sewerage Affairs Bureau, 50 Songjeong-dong, Gumi, Gyungbuk 730-717, Korea

development and the popularity of telecommunications have entirely screened the fact that optical fibres may be efficiently used for sensing purposes.

In this paper we present applications of a novel technique using optical fibres to monitor large structures for safety purpose. The fibre is used as sensing element and can provide distributed measurements of quantities like temperature or strain. In other words a value of temperature and/or strain can be obtained for any point along the fibre. This is made possible by using a nonlinear optical effect in the fibre called Stimulated Brillouin Scattering (SBS).

Principle and physical aspects

Optical fibre sensors based on stimulated Brillouin scattering have now clearly demonstrated their excellent capability for long-range distributed strain and temperature measurements [1]. The Brillouin interaction causes the coupling between optical and acoustic waves when a resonance condition is fulfilled. It turns out that this resonance condition is strain and temperature-dependent, so that determining the resonance frequency directly provides a measure of temperature or strain.

The resonance frequency is an intrinsic property of the material that may be observed in any silica fibre. This is very attractive since the bare fibre itself acts as sensing element without any special fibre processing or preparation. Standard optical cables may thus be used, resulting in a low-cost sensing element that may be left in the structure. Since the optical effect only depends on the fibre material, it is absolutely stable in time and independent of the instrument. Different measurements performed over a long-term period are thus fully comparable.

Brillouin scattering results from the scattering of light by sound waves, as depicted in Fig. 1. Thermally excited acoustic waves (acoustic phonons) produce a periodic modulation of the refractive index. Brillouin scattering occurs when light is diffracted backward on this moving grating, giving rise to frequency shifted Stokes and anti-Stokes components. This process can be stimulated when the interference of the laser light and the Stokes wave reinforces the acoustic wave through electrostriction. Since the scattered light undergoes a Doppler frequency shift, the frequency difference, called Brillouin shift $_B$, depends on the acoustic velocity and is given by

$$\nu_B = \frac{2\, n V_a}{\lambda_o} \qquad (1)$$

where V_a is the acoustic velocity within the fibre, n is the refractive index and $_o$ the vacuum wavelength of the incident lightwave. The Brillouin shift is observed in the 12-13 GHz range around a 1300 nm wavelength and in the 10-11 GHz range at 1550 nm, mostly depending on the core doping concentration. This Brillouin shift is therefore fibre-dependent and may be seen as a fingerprint of the fibre.

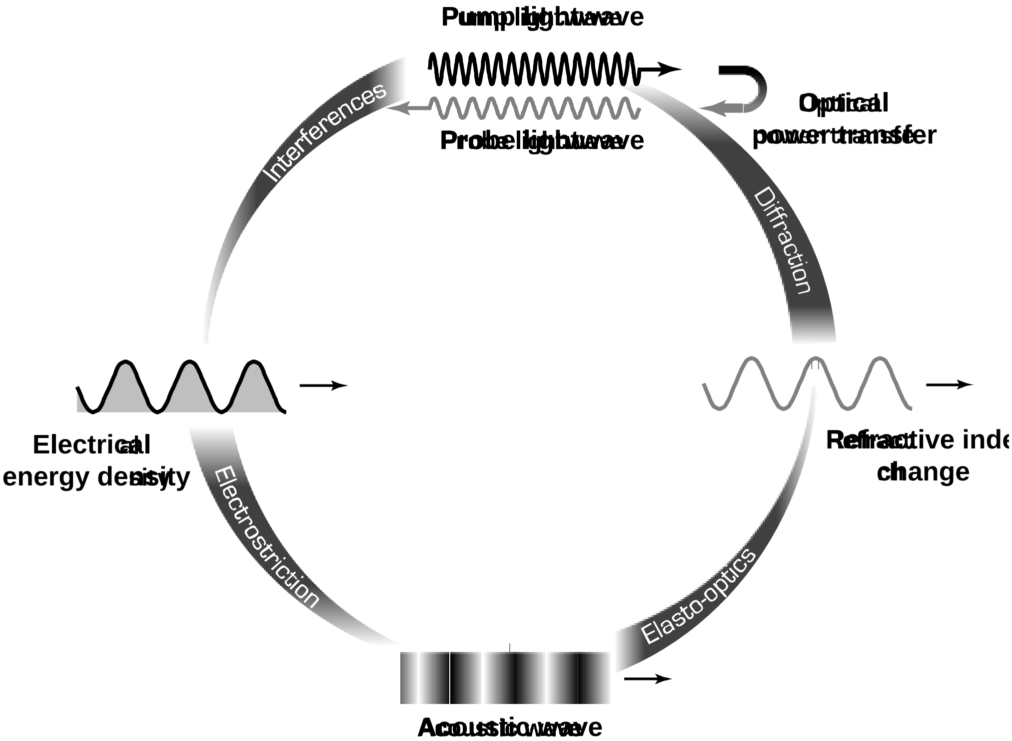


Fig. 1 Description of the stimulated Brillouin scattering. This resonant interaction involves 2 optical waves propagating in opposite directions and 1 acoustic wave and results in a power transfer from one lightwave to the other thanks to 4 different processes.

For sensing purpose the effect of stimulated Brillouin scattering is observed somehow differently: two lightwaves, propagating in opposite directions within a single mode fibre and showing an optical frequency difference equal to the Brillouin shift ν_B will also similarly generate an acoustic wave through electrostriction. The moving grating sustained by this acoustic wave will diffract light from the upper frequency lightwave, called pump, to the lower frequency lightwave, called probe. This power transfer is equivalent to an amplification process from the probe point of view, and the net gain experienced by the probe reads:

$$I_S = I_o \, e^{g_B(\nu) I_P L} \qquad (2)$$

Where the intensities are I_o for the incident probe, I_S for the probe after amplification and I_P for the pump, respectively, and $g_B(\nu)$ is an equivalent gain coefficient called Brillouin gain spectrum and L the interaction length. The actual amplification experienced by the probe only depends on the pump intensity, so that the strongest effect is obtained using intense pump light, the probe power being maintained as low as possible to avoid significant pump depletion.

The strong attenuation of sound waves in silica determines the shape of the Brillouin gain spectrum. Actually, the exponential decay of the acoustic waves results in a gain $g_B(\nu)$ presenting a Lorentzian spectral profile:

$$g_B(\nu) = g_o \frac{\left(\Delta\nu_B/2\right)^2}{\left(\nu - \nu_B\right)^2 + \left(\Delta\nu_B/2\right)^2} \qquad (3)$$

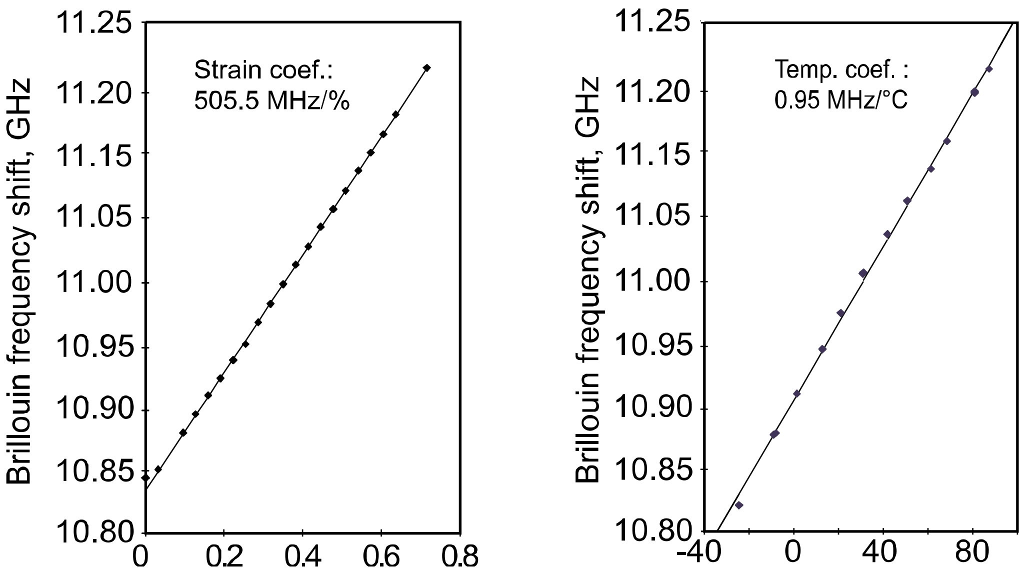
where $_B$ is the full width at half maximum. This FWHM width ranges from 35 MHz at 1300 nm to 25 MHz at 1550 nm in standard single mode fibres, these figures being significantly increased for more special fibres.

The Brillouin gain spectrum peaks at the Brillouin frequency shift $_B$, and the peak value is given by the Brillouin gain coefficient g_o:

$$g_B(\nu_B) = g_o = \frac{2\pi\, n^7\, p_{12}^2}{c_o\, \lambda_P^2\, \rho_o\, V_a\, \Delta\nu_B} \qquad (4)$$

where p_{12} is the longitudinal elasto-optic coefficient, $_o$ is the density, $_p$ is the pump wavelength and c_O is the vacuum velocity of light. In most fibres the peak gain value g_o lies in the $2-3\times10^{-11}\ \frac{\text{m}}{\text{W}}$ range.

The acoustic velocity is directly related to the medium density which is temperature and strain dependent. As a result the so-called Brillouin frequency shift carries the information about the local temperature and strain of the fibre as shown in Fig. 2 [2].



Brillouin-based techniques bring the following advantages over other distributed techniques:

- The technique makes use of standard low-loss single-mode optical fibre offering several tens of kilometres of distance range and a compatibility with telecommunication components.
- It is a ***frequency-based technique*** as opposed to Raman-based techniques which are intensity based. Brillouin based techniques are consequently inherently more accurate and more stable on the long term, since intensity-based techniques suffer from a higher sensitivity to drifts.
- Brillouin scattering can be optically ***stimulated*** leading to a much greater intensity of the scattering mechanism and consequently a more acceptable signal-to-noise ratio.

The frequency difference between pulse and probe can be scanned for precise and global mapping of the Brillouin shift along the sensing fibre. At every location, the maximum of the Brillouin gain is computed and the information transformed to temperature or strain using the calibration coefficients of Fig.2. The probe signal intensity can be adjusted to acceptable levels for low-noise fast acquisition whatever the measurement conditions and fibre layout, thus solving the main problem, which is generally associated with, distributed sensing based on spontaneous light scattering.

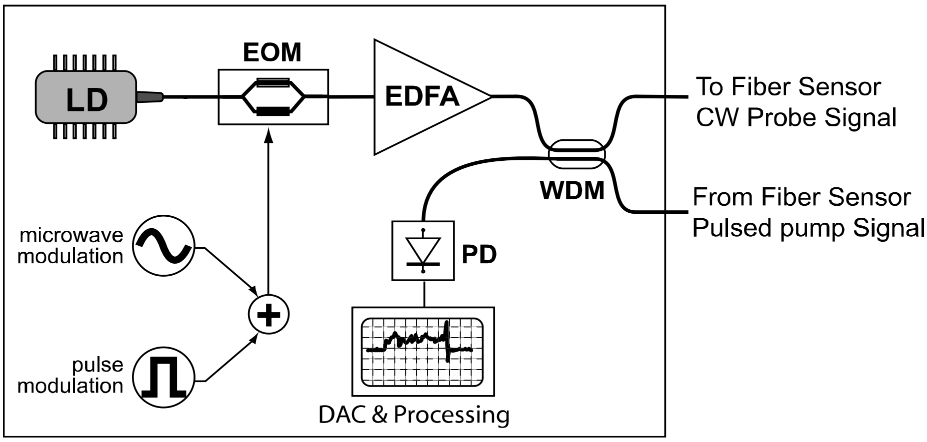


Fig. 3: Schematic setup of the DiTeSt instrument developed for the measurement of Brillouin frequency shift in optical fibres. The monitoring configuration requires a so-called double-ended configuration where both fibre ends are connected to the instrument.

The localization of the temperature or strain information along the fibre is possible by using a pulsed pump signal. The interaction of the probe with the pump is recorded as a function of time and the time information can be converted into distance. An actual temperature profile of the fibre can be computed by using calibration curves (Fig. 2). Thanks to the high speed of light, fibre lengths of several kilometres can be scanned within a fraction of second, yielding several thousands of measurement points. The spatial resolution is set by the pump pulse width or the equivalent distance occupied by half of optical pulse within the fibre (for instance a 10ns pulse yields a 1 metre spatial resolution along the fibre).

The spatial resolution obtained with this technique is 1 meter for a 30 km range. The physical limit for spatial resolution is just below 1 meter and results from the acoustic properties of silica. This configuration of the sensor is thus definitely dedicated for long range measurements with meter resolution and is not suitable for centimeter resolution. It must be pointed out that a novel and very inventive configuration was recently reported by K.Hotate *et al*, based on a correlation technique, that achieved measurements with a 1 cm spatial resolution, but the range is also reduced to less than 1 km, accordingly.

The accuracy on the determination of the Brillouin shift $_B$ depends on the amplification contrast and the probe signal intensity. In standard fibres an accuracy of 0.5 MHz is observed. This approximately corresponds to a 0.5 K temperature resolution and to a 1 10^{-5} strain resolution. The Brillouin shift accuracy can be improved to 200 kHz, corresponding to a 0.2 degC temperature and 4 10^{-6} strain resolutions, respectively, at the expense of either a worse spatial resolution or a longer measurement time.

An innovative instrumental configuration has been developed for temperature/strain monitoring based on the measurement Brillouin frequency profiles of optical fibre [3]. The company Omnisens in Switzerland has integrated this technique into commercially available instruments called DiTeSt. The used schematic configuration of the optics is shown in Fig. 3.

Advanced modulation techniques and wavelength-demultiplexing components developed for telecommunication applications offer ideal solutions for the generation and the control of both pump and probe signals. The operation wavelength was selected to match the lowest attenuation (typically around 0.2 dB/km at a 1.55 micron wavelength) of standard singlemode telecommunication fibres. The system main original feature is the presence of a single laser source (LD) that is modulated through a Mach-Zehnder electro-optic modulator (EOM). This electro-optic modulator is used on the one hand for pulsing the CW light forming the pump signal and on the other hand for the generation and frequency tuning of the probe signal through the modulation of the laser light. A dedicated Er3+ doped optical amplifier (EDFA) is used to boost the optical signal intensities and wavelength-demultiplexing components are used to route the signals in the sensing fibre. When the probe signal returns from the sensing fibre its intensity as a function of time is recorded with a fast photodetector (PD) and digital acquisition card.

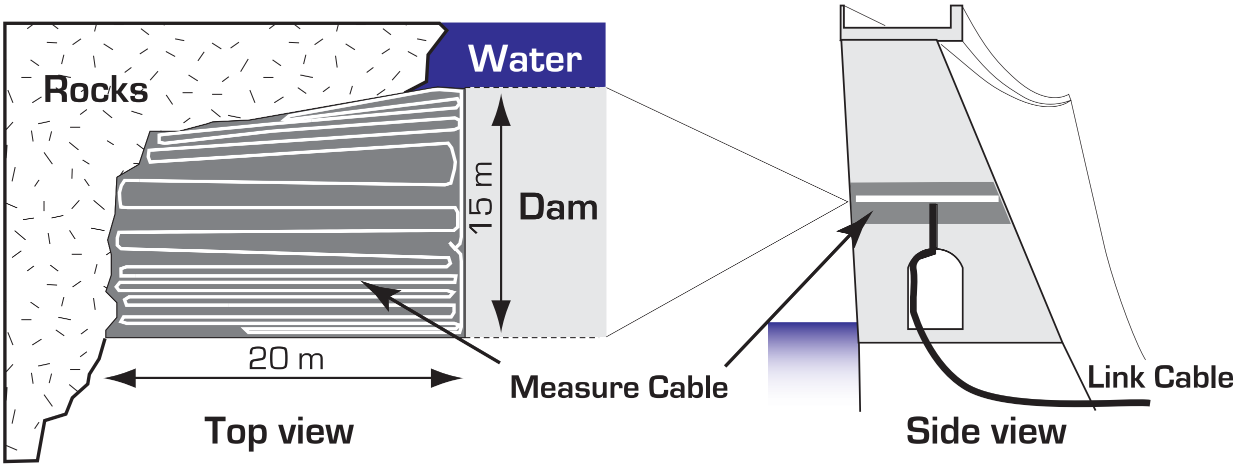


Fig 4 View of the concrete slab and of the mat-like installation of the measuring cable for concreting temperature monitoring, during the raising of Luzzone dam in the Swiss Alps

The Brillouin time-domain analysis was first developed to detect local strains in telecommunication cables, which may cause early failure due to fibre breaking. It turned out that this application has gained little interest, the manufacturing quality of telecom cables making the optical fibre to show practically no strain.

But the special threadlike geometry of the optical fibre makes it an excellent candidate for monitoring large structures and installations. This property clearly opens new opportunities for a better control of the natural or built environment. The distributed nature of the sensing element offers the possibility to densely control a structure over its entire length, surface or volume, which would be impossible using point sensors.

We had the opportunity these past few years to perform many measurements on different sites. In all cases the sensor demonstrated its capability to perform the required measurements, in few cases at the expense of a special installation or packaging of the fibre.

Concrete temperature monitoring in a dam

The first application reported here was performed in 1997 in a real environment and uses the optical fibre as a temperature probe. The equipment was used to monitor the concrete setting temperature in large structures.

This monitoring is of prime importance in critical works, since the density and the importance of microcracks are directly related to the maximum temperature experienced by the concrete during the setting chemical process.

Zone in the Swiss Alps was recently raised to increase the power capability of the associated hydroelectric plant. This raising was actually achieved by gradually stacking new concrete slabs of 15 m x 10 m average size for a 3 m thickness, as shown in Fig. 4. A small optical telecommunication cable was installed during the concreting over the central layer of the largest slab, so that the embedded cable makes a dense horizontal mat, necessary to obtain a two-dimensional temperature distribution of the whole slab area. Fig. 5 shows the temperature distribution over the slab 30 days after concreting. It can be clearly seen that the temperature rises up to 50 degC in the central area. Periodic measurements showed it took about 6 months to cool down this region. The outer areas of the slab rapidly stabilize at the ambient temperature, so that an observer is totally unaware that the concrete is still fairly hot in the central region of the dam.

Secure tunnelling using smart reinforcing pipes

Construction of tunnels in unstable soils may lead to severe safety issues. Numerous tragedies during the construction process were reported in the past. This issue is particularly present in Eastern Asia and techniques based on the installation of reinforcing bars are now commonly used.

The possibility to use the reinforcing tools as sensing elements turned out to be very attractive, since it offers the opportunity to inform on the soil movements during the construction in real time. Brillouin local analysis of strain turns out to be very convenient for this application, since the fibre may be installed to replace many points sensors and thus to fully inform on the deformations experienced by the reinforcing pipes. In addition the fibres from different pipes may be serially connected, so that the entire site may be controlled in a single measurement process.

The fibre was placed longitudinally along the pipe and at each cardinal point on the section, as shown in Fig. 6. In case of moving unstable soils the pipe is subject to flexure and fibres placed on opposite sides of the pipe experience symmetric and opposite strains (elongation-compression). This makes possible to subtract any offset due to temperature and residual strains resulting from the installation.

The fibre optic sensor system was tested in the Ulsan-Kangdong tunnel in South Korea, that is a section of a national road under construction. The system is used to predict the behaviour of the tunnel section during and after excavation.

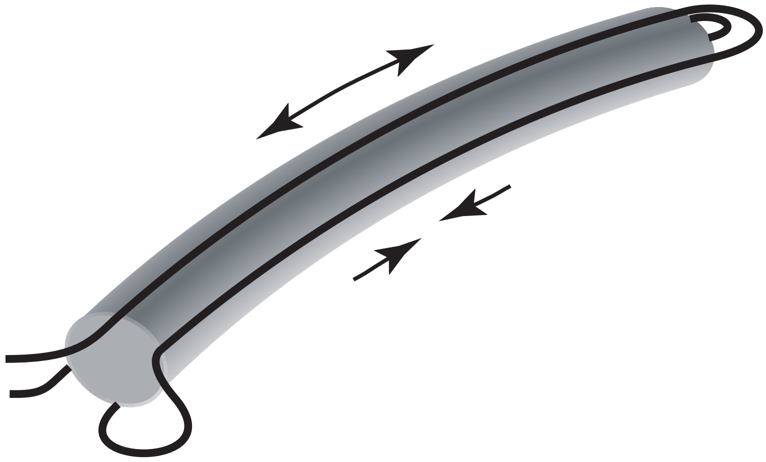


Fig 6 Schematic view of the smart reinforcing pipe used for strengthening the soil during excavation. The fibre is placed at the four cardinal points of the pipe section and experiences strain whatever the direction the pipe is deformed by soil movements.

During tunnelling, most of the tunnel deformation is observed within 1 day after tunnel excavation. The smart pipe thus offers a key advantage with respect to conventional techniques as far as safety is concerned, since it informs immediately after installation.

As a result of the fibre placement the response to strain of the smart reinforcing pipe is symmetric with respect to the centre line. This is clearly shown in Fig 7, which is a typical measurement of the response of a smart reinforcing pipe during excavation in the Ulsan-Kangdong tunnel.

From these strain data, the stress and displacement of the reinforcing pipe are calculated, giving important information to predict issues about the tunnel safety. As shown in Fig 7, large variations of the pipe deformation occurred just after tunnel excavation, within 2 days. Then the strain response remains steady, meaning that the tunnel deformation has stopped and the tunnel may be considered as safe.

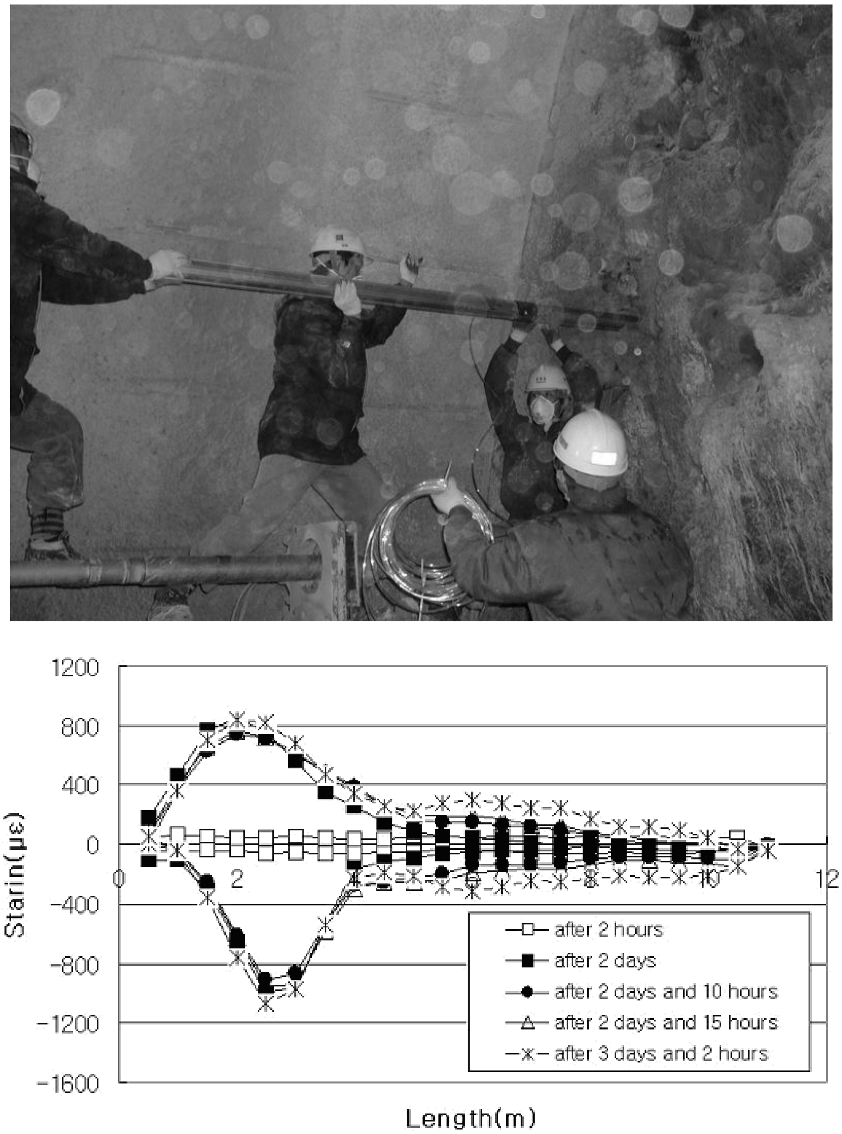


Fig 7 Top: Installation of a reinforcing pipe containing fibres as strain sensor in the Ulsan-Kangdong tunnel Bottom: Distribution of strain along the smart reinforcing pipe for 2 fibres placed on opposite sides, showing a symmetric deformation. The deformation process stops after 2 days and remains steady.

Pipeline leakage detection

The next application is based on distributed temperature sensing using Brillouin analysis and demonstrates that the long range capability of this technique may lead to a very efficient and cost-effective solution.

In 2002 the construction of a natural gas storage facility some 1500m under the ground surface was started in the area of Berlin in Germany. Using mining technology the building of underground caverns for gas storage in large rock-salt formation requires hot water and produces large quantities of water saturated with salt, the so-called brine. In most cases the brine cannot be processed on-site and must be transported by a pipeline to the location where it can either be used for chemical processes, or injected back safely into the ground. Because the brine can be harmful for the environment, it was a mandatory request that the pipeline is monitored by a leakage detection system.

In the Berlin project a 55km pipeline was built and a Brillouin-based optical fibre sensor was selected as a leakage detection system [4]. In order to cover the whole pipeline distance, it was decided to use two DiTeSt analyzers although one instrument would have been theoretically able to cover the whole distance with its two channels. However the installation of the fibre cable required some 60 splices (that correspond to a additional loss of up to3 dB) which reduces the distance range of the instrument accordingly and justified the use of two instruments. The selected sensing cable is a customized version of a standard armoured telecommunication fibre optics cable for underground applications. The cable includes the optical fibres used for temperature monitoring as well as fibres for data communication between the instruments and the control room and additional spare fibres.

During the construction phase the fibre cable was first placed in the trench and buried in the sand some 10 cm underneath the pipeline. The position of the cable with respect to the pipeline is important in order to guarantee that all leakages are detected. The position of the sensing cable is a trade-off between the maximum contrast in the case of a leakage and the assurance to detect leakages occurring from every point of the tube circumference.

The overall pipeline configuration together with the temperature monitoring system configuration is schematically depicted in Fig.8. Both DiTeSt instruments are installed in dedicated buildings (gate II and gate V respectively). Each instrument is responsible for the monitoring of half of the total distance and an optical switch is used to select the section to be monitored, so that the longest fibre section is 16,85 km. The central computer located in the control room can communicate with the instrument through an optical LAN using spare fibres in the sensing cable. The temperature profiles measured by both DiTeSt instruments are transferred every 30 minutes to the central PC and further processed for leakage detection.

A dedicated software runs continuously on the central PC and controls the complete monitoring system. It performs the leakage detection through a comparison between recorded temperature profiles, looking at abnormal temperature evolutions and generates alarm in the case of the detection of leakage. The system is able to automatically transmit alarms, generate reports, periodically reset and restart measurements, and requires virtually no maintenance.

The brine is pumped out from the underground caverns and is injected into the pipeline at a temperature of about 35°C. At normal flow rate the temperature gradient along the whole pipeline length is about 8°C. Since the pipeline is buried in the ground at a depth of approximately 2 to 3 meters, the seasonal temperature

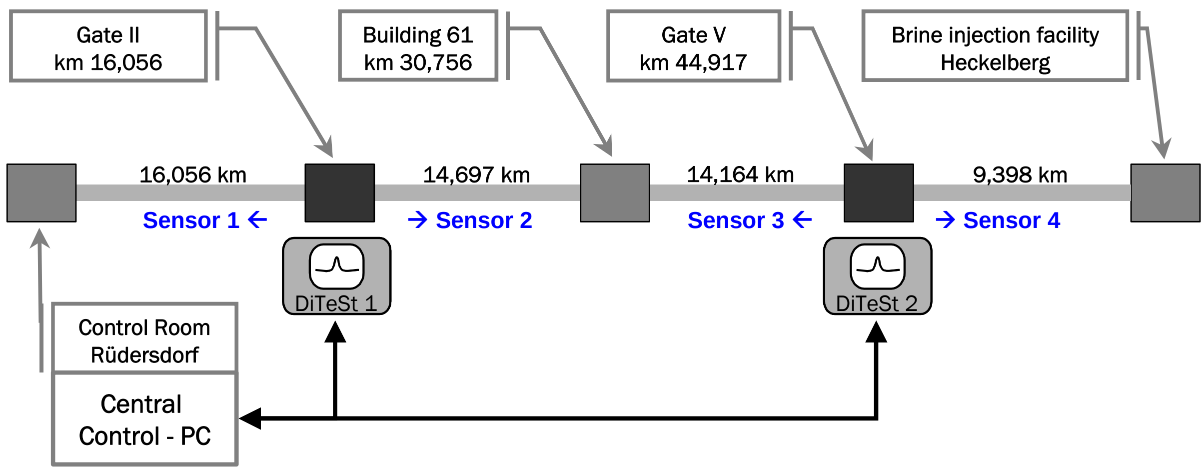


Fig. 8 : Schematic representation of the brine pipeline built to evacuate the brine from Rüdersdorf and transport it to Heckelberg where the brine in injected back into the ground. Both DiTeSt instruments have two measurement channels, respectively called sensor 1 to 4. The sensors temperature profiles are periodically transferred to the central PC for further processing and alarm generation.

variations are quite small and the soil temperature was measured to be around 5°C. As a result a substantial temperature increase is associated to every leakage even in the case of low leak rates.

The pipeline construction phase was completed in November 2002 and the pipeline was fully operating in January 2003. In July 2003, a first leakage was detected by the monitoring system. It was later found that the leakage was accidentally caused by excavation work in the vicinity of the pipeline. Fig. 9 shows the occurrence of the leakage and its effect on the temperature profiles as they were displayed on the central PC in the control room. The graphs in Fig. 9 correspond to measured raw data, i.e. Brillouin frequency shifts, as a function of distance. By using the 0.927 MHz/deg temperature coefficient, the local temperature increase due to the leakage is measured to be 8°C. This corresponds to a leak rate as low as 50ml/min. An alarm was immediately and automatically triggered and the flow was eventually stopped.

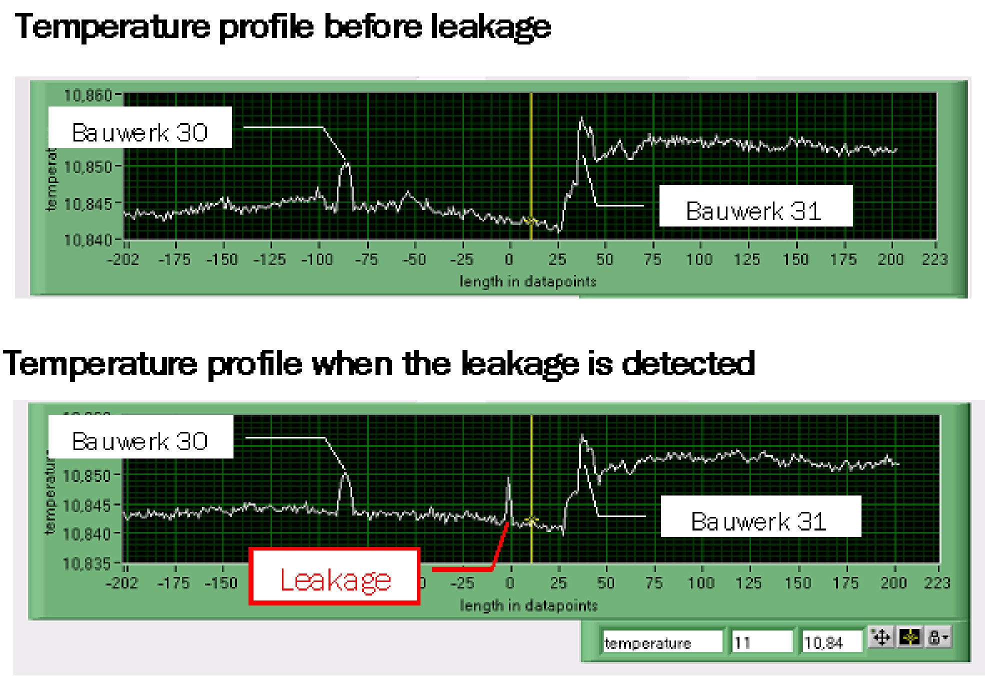
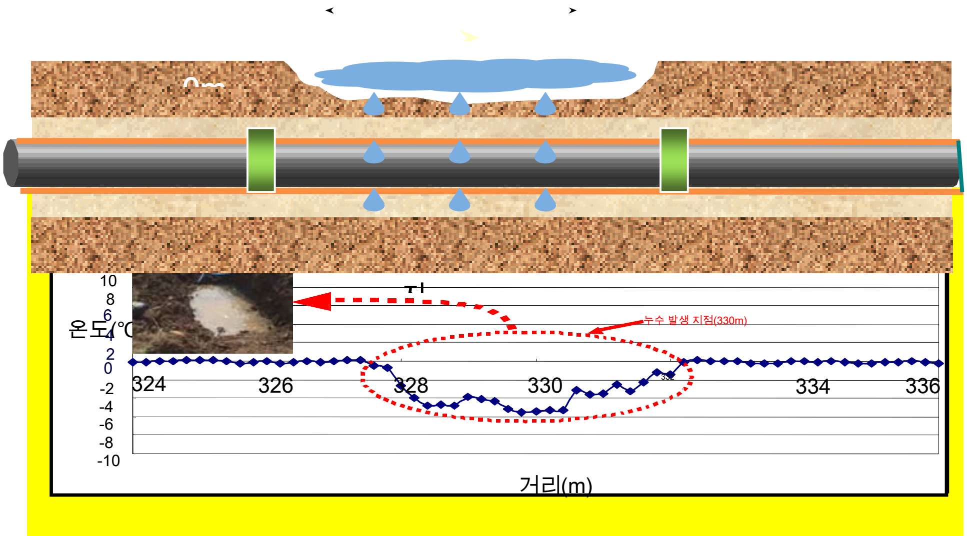


Fig. 9 Measured profiles before and after the leakage occurred at distance 17’970 meter from the pumping station, as displayed on the central PC in the control room. The vertical scale corresponds to raw Brillouin frequency shift given in GHz. The observed local temperature increase associated to the leakage was measured to be of around 8°C.

Taking into account the application requirements in terms of distance range and measurement time, neither Raman nor spontaneous Brillouin scattering techniques were applicable and only a stimulated-Brillouin-based system could perform an accurate temperature monitoring in the available time (monitoring of 55km with 1°C accuracy in less than 10 minutes). To-date the leakage detection system has been in operation for two years and two leakages were successfully detected.

On the other hand, leakage detection for water mains is ongoing at Noksan, Pusan, Korea. This project was initiated in June this year 2005 by Pusan Metropolitan city and 4.4km length of pipeline of which diameter is 900mm has been under construction. The local government worried about the leakage problem that might be stemmed from the ground subsidence because the territory Noksam is a reclaimed land from the sea to develop a big industrial complex.

Unlike the brine case, where the temperature of the liquid inside keeps relatively high so that the fibre underneath easily picks up the temperature difference in case it leaks, water detection by temperature is not easy due to the lower margin of the temperature difference between in and outside of pipe. It was successfully achieved, however, with specially developed sensor cable which was incorporated with heating wire. As of August 11, 2005, validation test has already been finished. As the figure 10 shows the results of measurement profiles, it is very clear that the water seepage deprived the temperature that had been warmed up by heating wire before water permeated and consequently spot out the location of seepage or leakage.



Conclusions

Fibre optics distributed temperature sensing techniques have opened new possibilities in temperature and strain monitoring and gradually have found applications in various domains such as the oil and water mains, tunnel deformation, dam monitoring, etc. Their ability to precisely measure temperature and strain evolution over several tens of kilometres and localize the information with a meter spatial resolution makes them very attractive for safety monitoring applications. Among today's available sensing techniques, Brillouin-based techniques have demonstrated the best performances in terms of distance range, accuracy and detection time.

Furthermore, new configurations have been demonstrated to extend the distance range beyond 100km while maintaining a spatial resolution in the meter range.

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SEARCHING THE NEW LOCATIONS AND DETERMINING THE LATEST STATUS OF FIRE STATIONS WITH GIS IN ISTANBUL

Turan Erden and Mehmet Zeki Coşkun
Istanbul Technical University[1]

Key words: *GIS, location-allocation problem, fire stations, point locations, arc-node data model.*

Abstract

Coverage problems find applications in the location of emergency facilities, such as fire stations, where it is desirable that every possible emergency must be covered within a fixed number of minutes of response times, or when the objective is to minimize the worst-case response time, to the furthest possible point. These problems are referred to as *location-allocation* problems, because two types of decisions: where to locate, and how to allocate demand for service to the central facilities. This typical location-allocation problem might involve the selection of location for fire stations. Here GIS can be used to find locations for fire stations that result in better response times to emergencies.

The main mission of fire department of Istanbul is to reach to the disaster point within less than five minutes. Fire department execute its mission with 59 fire stations, 2724 personnel, and 310 vehicles now. The fire stations are too insufficient by thinking of the city of Istanbul with the population of the 15 million people over. It has to be searched new locations for the fire stations in Istanbul. Exploring the appropriate locations (i.e. fire stations) is the problem of finding appropriate point location.

In this study, firstly, the map of Istanbul which is 1/5000 scale is arranged in point of our analyzing. Secondly, data are prepared for a GIS program by leaving the unnecassary data. Road information (highways, main roads, emergency road) and existing fire stations will be pointed out on a digital map on the computer. Arc-node topology on ArcGIS software will be constructed with above mentioned data. This is an obligatory for making the network analysis.

In the scope of this study, moreover, a survey which is called *fire service survey form* is being conducted. The existing fire stations in Istanbul in the point of existing status of view are being investigated with this survey. Data of survey are stored in the ArcGIS software. This survey is very important because of giving the latest status of fire stations for emergency management activities of Istanbul.

Finally, in the selected part of İstanbul city, new locations of fire stations are investigated for giving the best service to the domination area. Moreover, the latest status of fire department

[1] Istanbul Technical University, Civil Engineering Faculty, Geodesy and Photogrammetry Engineering Department, 34469 Maslak-ISTANBUL-TURKEY

of Istanbul is being determined. This is an inevitable for emergency planning activities in the point of view of city of Istanbul.

Introduction

The effective use of information is getting importance because our age is information age. The information in our environment are increasing very rapidly. Due to the size and intensity of information, they become excessive and complex. These information must be managed by organizing carefully. The consept of Information System appear as the result of this need. A kind of Information Systems which have wide area applications is Geographic Information System. It is provided for the best product from information by Geographic Information System (GIS) (Davis, 1996; Star and Estes, 1990).

Healhty, culture, environment, life, and security procedures which everybody can meet can be performed by GIS. For instance, at the fire cases, reaching by an fire brigade to fire case area at the shortest time and making the first aid depend on a lot of parameters. To reach fire case area, precautions which take into consideration for transportation network, road information, the traffic intensity, the location of the hospital, and life safety must be organised efficiently. The more important thing than the above information is to best evaluate the 'time' information. GIS can help gathering these types of information. (Yomralıoglu, 2006).

Fire risks in urban areas have undoubtedly increased over the years and the rising cost of fire losses would seem to indicate that they are increasing at a greate rate. With the cities growing in size and complexity day by day need to be managed more and more efficiently. The above intances require for decision making rapidly and vigorously (Erden, 2001).

In this study, with over 15 billion inhabitans, the city of Istanbul is taken into consideration (Figure 1).

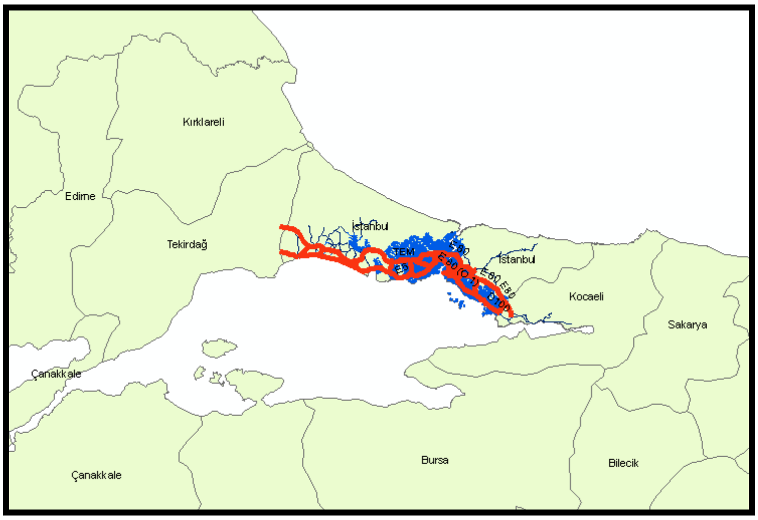


Figure 1. Study Area

The Information of Fire Cases in Istanbul

From 1994 to 2005 the number of fire cases is increased very rapidly in Istanbul (Table 1). Especially it is unavoidable with expanding the settlement area of it. This requires becoming well-prepared against fire cases in Istanbul (Fire Statistics, 2005).

Table 1. The Fire Cases in Istanbul

Years	The Number of Fire Cases
1994	12769
1995	14788
1996	15308
1997	15940
1998	19210
1999	19567
2000	20608
2001	20647
2002	18108
2003	21697
2004	22386
2005	22176

The Latest Status of Fire Brigade of Istanbul

The Information About Fire Brigade of Istanbul

Fire brigade of Istanbul was founded in 1774 based on the valuntary organization. In 1997, fire brigade was changed into fire brigade department of Istanbul. The fire brigade of Istanbul is one of the five oldest fire brigades in the world based on founded dates.

Istanbul fire brigade has the diffuculties because of the fact that Istanbul is the trade, industry and tourism center; it has transportation diffuculties and narrow streets, because of the strategical location of Boshphorus, and excessive immigration. Istanbul fire brigade makes an effort to reach the number of personel in the world standards. The Department of Fire Brigade of Istanbul is divided into five directorate, which is named are:

- Center Brigade
- The District of Istanbul Brigade
- The District of Anatolian Brigade
- The District of Bosphorus Brigade
- The Disaster Coordination Center of Istanbul

The main mission of fire department of Istanbul is to reach to the disaster point within less than five minutes. Fire department execute its mission with 59 fire stations, 2724 personnel, and 322 vehicles now (Table 2, 3, and 4). The fire stations are too insufficient by thinking of the city of Istanbul with the population of the 15 million people over (Fire Statistics, 2005).

Table 2. The Personnel Information of Fire Brigade

Directorate	**Official**	**Worker**	**Temporary Worker**	**Contr Pers.**	**Repr. official**	**Duty service**	**Overall**
Center Brigade	127	52		5	2	17	203
The District of Istanbul	532	602	170			180	1484
The District of Anatolian	404	354	81			134	973
The Disaster Coordination Center	6	1				57	64
Overall	1069	1009	251	5	2	388	2724

Table 3. The Vehicle Information of Fire Brigade

	Official Stock Vehicles																
Directorate	Shaft	Otomobile	Multi-purpose	Emergency vehicle	Mobile tube vehicle	Mobile lubrication vehicle	Van	Rescue Truck	Ladder	Minibus	Forest Vehicle	Water Tank	Truck with crane	Foam tower	Vehicle with air-bag	Live-broadcast vehicle	Total
Center Brigade		10				1	3			6							20
The District of Istanbul	23	2	17	6	1		7	4	20	2	4	70	1	1	2		160
The District of Anatolian	12	2	13	4			5	2	13	3	10	32	1	1			98
The Disaster Coordination Center		1														1	
Overall	35	15	30	10	1	1	15	6	33	11	14	102	2	2	2	1	280

Table 4. The Vehicle Information of Fire Brigade (cont.)

	Hired Vehicles					
Directorate	Otomobile	Van	Minibus	Water Tank	Total	Overall
Center Brigade	3	4	3		10	30
The District of Istanbul	6	11	1	4	22	182
The District of Anatolian	3	4	1	1	9	107
The Disaster		1				

Coordination Center						
Overall	12	20	5	5	42	322

In this study, 39 fire stations are taken into consideration and all analysis performed based on this information (Figure 2).

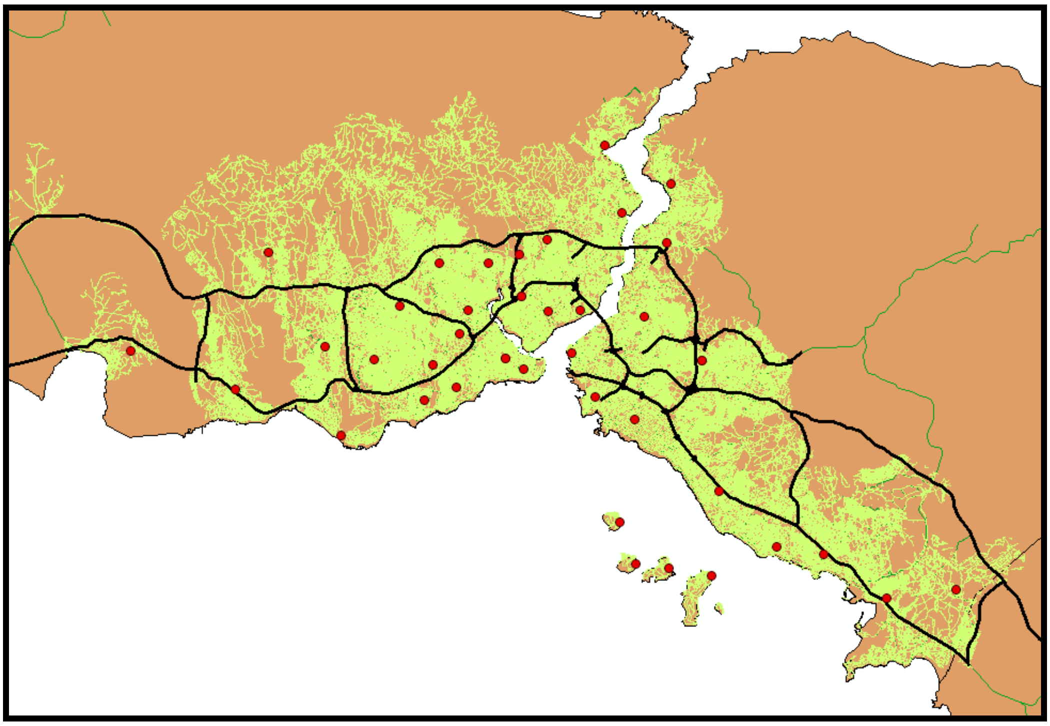


Figure 2. Fire Brigades in Study Area

Point Location Finding

Coverage problems find applications in the location of emergency facilities, such as fire stations, where it is desirable that every possible emergency must be covered within a fixed number of minutes of response times, or when the objective is to minimize the worst-case response time, to the furthest possible point. These problems are referred to as *location-allocation* problems, because two types of decisions: where to locate, and how to allocate demand for service to the central facilities. This typical location-allocation problem might involve the selection of location for fire stations. Here GIS can be used to find locations for fire stations that result in better response times to emergencies (Longley et al, 2001)

Preparing Road Data for Analysis

In this study, firstly, the map of Istanbul which is 1/5000 scale is arranged in point of our analyzing. Secondly, data are prepared for a GIS program by leaving the unnecassary data. Road information (local roads, main roads, highways) and existing fire stations will be pointed out on a digital map on the computer. Arc-node topology on ArcGIS software will be constructed with above mentioned data. This is an obligatory for making the network analysis.

Road data are constituted as vertex and edge data for performing network analysis correctly. Especially polylines are divided into vertices from one node to another node. Arc-Node data model is formed by performing it.

Analysis data are formed as personel geodatabase with the name of fire brigade analysis. And under this there is a personel geodatabase feature dataset with feature classes for using this analysis (Figure 3).

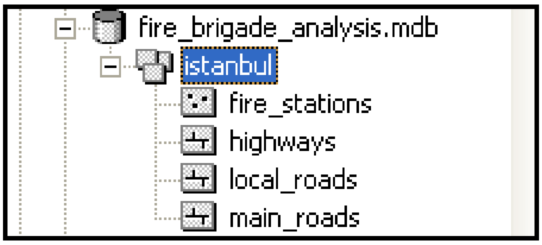


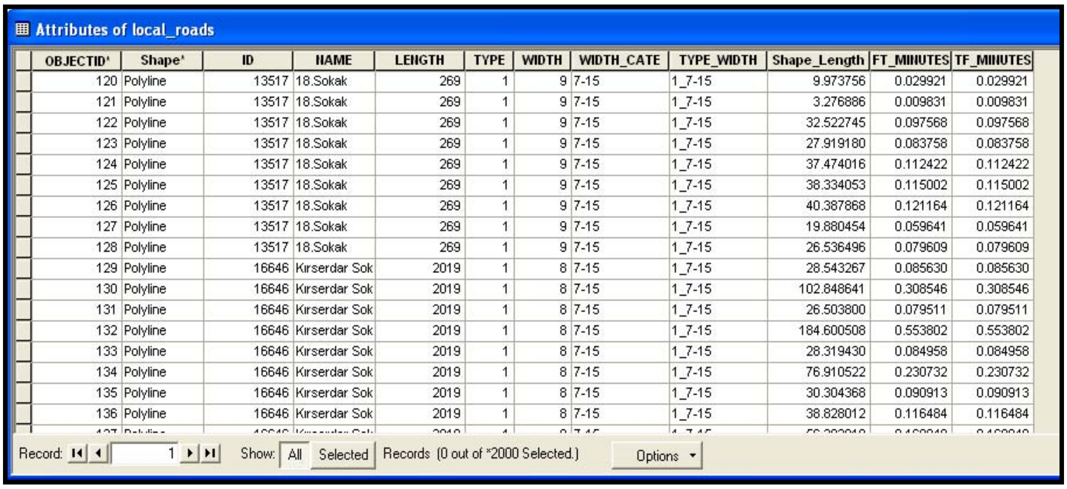
Figure 3. Geodatabase structure

Road types are categorized with three groups: local roads, main roads and highways. After that; road data are assigned to certain speed values in order to obtain the realistic results (Table 5). The road speeds of 20, 40 and 80 km/h are assigned to local roads, main roads and highways respectively.

Table 5. The Relation Between Road Types and Their Speeds

Road Types	**Road Speeds (km/h)**
Local Roads	20
Main Roads	40
Highways	80

In addition to road types and their speeds data, roads also have information with ID, Name, Shape Length, Width, FT_Minutes and TF_Minutes (Figure 4).


Attributes of local_roads

OBJECTID*	Shape*	ID	NAME	LENGTH	TYPE	WIDTH	WIDTH_CATE	TYPE_WIDTH	Shape_Length	FT_MINUTES	TF_MINUTES
120	Polyline	13517	18.Sokak	269	1	9	7-15	1_7-15	9.973756	0.029921	0.029921
121	Polyline	13517	18.Sokak	269	1	9	7-15	1_7-15	3.276886	0.009831	0.009831
122	Polyline	13517	18.Sokak	269	1	9	7-15	1_7-15	32.522745	0.097568	0.097568
123	Polyline	13517	18.Sokak	269	1	9	7-15	1_7-15	27.919180	0.083758	0.083758
124	Polyline	13517	18.Sokak	269	1	9	7-15	1_7-15	37.474016	0.112422	0.112422
125	Polyline	13517	18.Sokak	269	1	9	7-15	1_7-15	38.334053	0.115002	0.115002
126	Polyline	13517	18.Sokak	269	1	9	7-15	1_7-15	40.387868	0.121164	0.121164
127	Polyline	13517	18.Sokak	269	1	9	7-15	1_7-15	19.880454	0.059641	0.059641
128	Polyline	13517	18.Sokak	269	1	9	7-15	1_7-15	26.536496	0.079609	0.079609
129	Polyline	16646	Kırserdar Sok	2019	1	8	7-15	1_7-15	28.543267	0.085630	0.085630
130	Polyline	16646	Kırserdar Sok	2019	1	8	7-15	1_7-15	102.848641	0.308546	0.308546
131	Polyline	16646	Kırserdar Sok	2019	1	8	7-15	1_7-15	26.503800	0.079511	0.079511
132	Polyline	16646	Kırserdar Sok	2019	1	8	7-15	1_7-15	184.600508	0.553802	0.553802
133	Polyline	16646	Kırserdar Sok	2019	1	8	7-15	1_7-15	28.319430	0.084958	0.084958
134	Polyline	16646	Kırserdar Sok	2019	1	8	7-15	1_7-15	76.910522	0.230732	0.230732
135	Polyline	16646	Kırserdar Sok	2019	1	8	7-15	1_7-15	30.304368	0.090913	0.090913
136	Polyline	16646	Kırserdar Sok	2019	1	8	7-15	1_7-15	38.828012	0.116484	0.116484

Record: 1 Show: All Selected Records (0 out of *2000 Selected.) Options

Figure 4. Attributes of local_roads

Constituting Network Dataset Based on Road Data

A network is a set of features that participate in a linear system such as a utility network, stream network or road network. Network are well-suited for tracing analysis (Zeiler, 1999). Constituting the Network Dataset is necessary for analysing network issues.

Local roads, main roads and highways are chosen for constituting the Network Dataset in ArcGIS environment. End-point connectivity are used in analysis procedure. Global turns are taken into consideration for turn data. Drivetime is used for impedance for the Network Dataset according to FT_Minutes and TF_Minutes which are determined for every road types. Drivetime impedances are specified the attributes for the Network Dataset. In this study, road directions are not taken into account.

Performing Analysis

With ArcGIS Network Analyst, service areas which are required are found around any location on a network. A network service area is a region that encompasses all accessible streets (that is, streets that are within a specified impedance). For instance, the 7.5-minute service area for a point includes all the streets that can be reached within 7.5 minutes from that point (ArcGIS Help, 2006).

Service areas created by Network Analyst also help evaluate accessibility. Concentric service areas show how accessibility varies with impedance. Once built, service areas can be used to identify how many people, land, or anything else is within the neighborhood.

In this study, Service areas are determined for 39 fire stations. Service area regions are obtained for every fire station with 2.5, 5 and 7.5-minute drive times respectively. All road networks, settlement area of city, the locations of fire stations are taken into consideration in analysis (Figure 5)

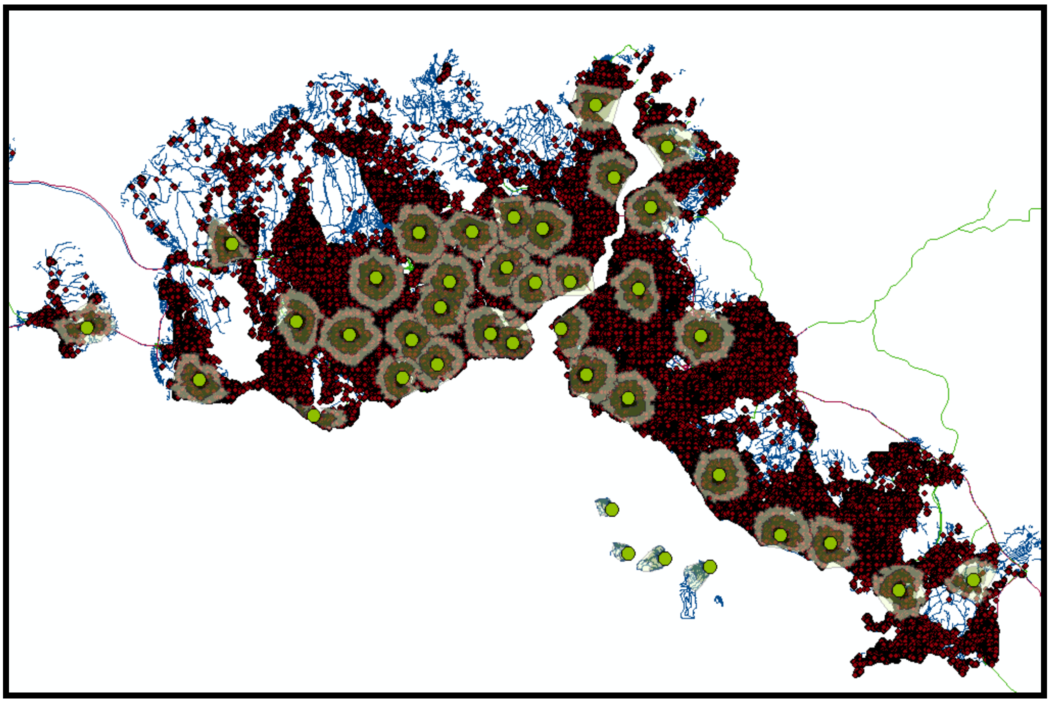


Figure 5. Service Area Determination for Existing Fire Stations

It is showed that fire stations is insufficient according to settlement area of the city. Searching new locations for fire stations are unavoidable. For this purpose, according to 2.5, 5 and 7.5-minute drive times, new locations of fire stations are located based on existing locations of fire stations (Figure 6). In this study, the domination areas of new locations of fire stations are determined by making total drive times minimum.

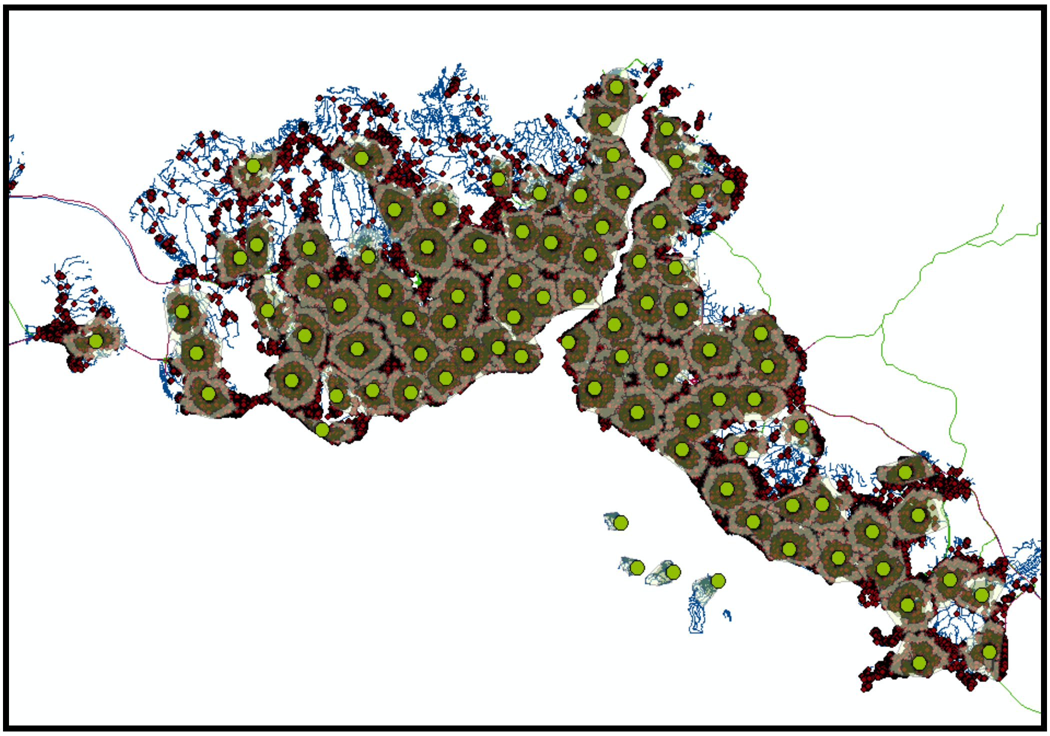


Figure 6. Domination Areas of Old and New Locations of Fire Stations

Conclusion

In this study, firstly, the latest information about fire birigades are given. In addition to this, rapid increasing in fire cases from 1994 to 2005 shows the seriousness of the situation. Moreover, expanding the settlement area of Istanbul year by year show the necessity of determining the new locations of fire stations. In this study new locations of fire stations are investigated for giving the best service to the domination area in settlement area of Istanbul. It is clear that the number of fire stations is too insufficient. It is seen that the necessity of adding 39 new fire station to existing 39 fire stations. This is an inevitable for emergency planning activities in the point of view of city of Istanbul.

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Author Biography

Turan Erden was born in Tekirdağ in 1977. He is graduated from ITU-Geodesy and Photogrammetry Engineering in 1998, then took the MsC degree in 2001. He has been working as a research assistant in Surveying Techniques Division in Geodesy and Photogrammetry Engineering Department since 1999. He is a doctorate student now. He is interested in GIS, Emergency Planning and related subjects.

Mehmet Zeki Coşkun was born in Malatya in 1964. He is graduated from ITU-Geodesy and Photogrammetry Engineering Department, then took his MsC degree in 1992, and took PhD degree in 1998. He has been an assistant professor in Surveying Tecniques Division since 2000. He is interested in GPS, GIS, Mobile GIS, Emergency Planning, and software development.

INTELLIGENT GIS BASED EMERGENCY VEHICLE MANAGEMENT

Meead Saberi Kalaee[1], Dr. Hamid Reza Kalani
Civil Engineering Department of Ferdowsi University of Mashad, Iran
Communications Administratory of Mashad Emergency Center, Iran

Keywords: GIS, Graphs Theory, Emergency Vehicle Management, Intelligent System, Notification & Response, Navigator System, Satellite Positioning

Abstract

GIS provide critical support for decision makers during emergencies. Emergency management is a collaborative effort requiring coordination among specialists in planning, logistics, operations and etc [5]. The research reported in this paper attemps to reduce emergency projecting response times by an intelligent GPS-GIS based analyctical system. This system designed to choose the best path depending on different daily traffic conditions for emergency vehicles in order to pass them in the minimum time length. The system has two main components: 1) GIS base map and planning specific layers; 2) Graphical traffic analysis. This system provides for easy production of maps, reports, and analyses to develop and revise emergency response plans. The use of a GIS to support emergency management, both in response and planning, has become easier.

Introduction

Geographic Information Systems (GIS) are computer-based software programs that store geographic data and allow users to conduct spatial assessments for analytical and decisionmaking purposes. Geographic Information Systems are designed to collect, store, and provide data where geographic location is important [2].

The use of GIS by industry and governments, which includes collecting, and displaying spatial information for planning and functional analysis, has increased significantly over the last five years. This is mainly due to the greater computing power available to users at a much lower cost. New systems, both hardware and software have been developed that allow for the convenience and flexibility of use on laptop computers [2].

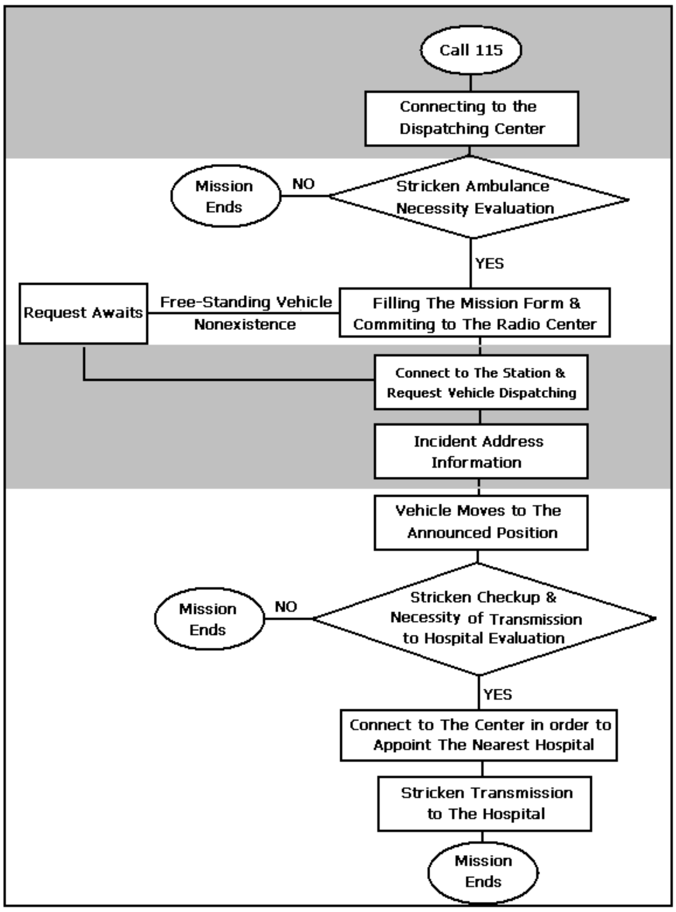
GIS is a very useful and progressive tool that provides a wide range of capabilities across various user groups. When responding to an incident, first responders can use GIS to identify the various resources required – police, ambulances, fire fighters, tow trucks, cranes, chemicals such as dispersants in order to help respond to an emergency in a timely and efficient manner [2].

1 meead.saberi@gmail.com
Mailing Address: Apt. #8, Golriz Street, Sajjad Blvd, 91866-54795, Mashad, Iran

Emergency Operations Algorithm

Emergency operations chart operated by Iran emergency centers from incident occurrence and calling 115 untill stricken/traveler transmission to a hospital and emergency vehicle return to the center commonly likes Figure 1.

Figure 1. Emergency Operations Algorithm



Emergency Operations Algorithm Timely Evaluation

This chart can be devided into four sections.

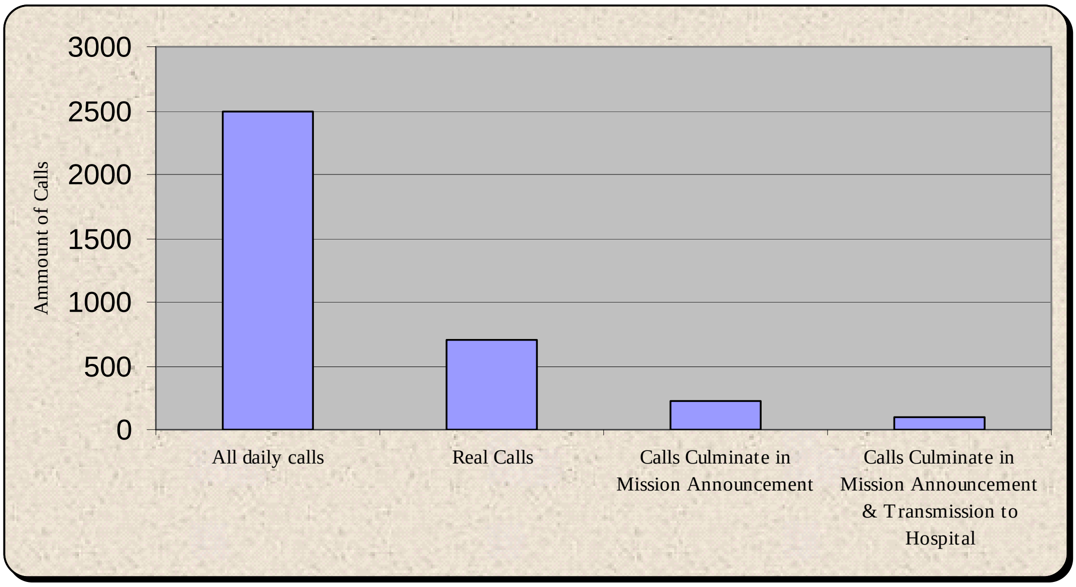
Section One: Notification

It is the time needed to establish a connection to the emergency center. Mashad Emergency Center has 6 phone lines and 4 dispatchers to answer calls. When all 4 operators are busy answering calls, there are still 2 other free lines. Therefore this system can answer 4 calls together and await 2 other calls. Thus the seventh call will be failed. Table 1 shows the moderate amount & variety of answered calls by Mashad Emergency Center in a day.

Table 1. Amount & variety of answered calls by Mashad Emergency Center

Type of Call	Ammount
All Daily Calls	2400-2500
Real Calls	600-700
Calls Culminate in Mission Announcement	200-230

Chart 1. Amount & variety of answered calls by Mashad Emergency Center



Only %40-43 of all calls culminate in mission announcement will conduce to transmission to hospital. Furthermore 9:00-11:00 A.M and 18:00-20:00 P.M are answering rush hours for Mashad Emergency Center.

Through more study on Mashad citizens' behavior after an incident happens and on their calls to 115, we understood that in the first five minutes after the incident occurrence no one calls 115 because of the accident shock. Multiplicity of similar parallel calls connects to the emergency center in the second five minutes. In order to track the emergency vehicle position large ammount of similar calls to 115 again are made to the emergency center in the third five minutes. However according to the existing statistics the emergency mission procedure in Iran big cities from start untill the "Vehicle Moves to The Announced Position" takes 8 to 10 minutes. Therefore there are so many unnecessary calls to emergency in the second and mostly the third five minutes after the accident. This people behavior makes emergency free connection lines busy inessentially. Overall this section takes atleast 10 seconds to atmost 4 minutes to answering a call.

Section Two: Dispatching

It is the time that dispatcher needs to evaluate the called situation that culminate in stricken ambulance necessity or unnecessity. This section mostly depends on dispatchers' skills and experience which takes atleast 1 minute to atmost 4 minutes.

Section Three: Positioning

It is one of the most important emergency operations steps. It starts with dispatching decision and continues untill "The Vehicle Moves to The Announced Position". In this section after making decision to dispatch an ambulance, filled mission form will be delivered to the Radio Center. This center connects to the nearest Emergency Stations and request an ambulance.

Through intelligent transportation systems the time of accurate positioning of the emergency vehicles during missions or in returning to the stations can reduce eminently. Employment of a satellite positioning system and a computerized mapping database in emergency vehicles afford an accurate (X, Y) coordinates positioning which greatly reduce positioning time versus traditional positioning systems [3].

Satellite Positioning System & Mapping Database

Today in Iran Emergency Centers, after the notification the Emergency Radio Center establishes radio connections to the emergency vehicles in the notified region in order to notices their position and mission's situation. They refer to a papery city map set on the wall to find out the nearest emergency vehicle and hospital. Installing a Satellite Positioning System (GPS) in each vehicle and a Control Center automated with a GIS Based mapping database beside the Radio Center allows emergency managers to locate all the emergency vehicles and proper hospitals in the region with no delay [1].

This system provides the following Benefits:

1. No need to establish a radio connection to each vehicle to locate its position
2. Easily select the nearest free emergency vehicle and a proper hospital to perform the mission
3. Reduce the positioning time
4. Relief emergency management

Section four: Transportation

It is the most important and most susceptible part of an emergency mission. It includes right path selection in order to pass to get to the incident location in the minmum time length. In Iran's current emergency systems this decision is made by the emergency vehicle driver and the dispatcher who is unaware of the urban traffic hourly conditions. With the following suggested designed software the best path can be chosen in a very short time.

Intelligent GIS Based Navigator System

Today GIS usage perquisites in transportation systems have been made clear to all the planners and managers. Through GIS based analysis many of the transportation problems have been solved. The "intelligent GIS based navigator system" which is designed and suggested in this paper is established on two main bases: 1) a GIS base map 2) Graphs Theory.

Because of the absence of a wide network traffic control system able to report the city main streets traffic condition momently in Iran cities, exploitation of an on-line system is effectively impossible. Therefore hourly traffic condition statistics can help mostly. Different traffic conditions can be partitioned into three cases: 1) Low 2) Moderate 3) Heavy. These hourly conditions will be defined as several layers on the city GIS based map. This system can draw all possible graphs which bridge the home and destination by determination of their coordinates. These graphs pass all the possible streets which lead to the destination. The total distance of each graph can be measured simply with eqn (1).

$$L = \sqrt{x^2 + y^2} \qquad (1)$$

Above-mentioned hourly traffic conditions includes traffic volume and journey speed for each street. The time needed to pass each street can be measured easily by dividing the distance on its journey speed. A factor of safety dependent on different parameters such as street width, pedestrian traffic, number of traffic lights in a path and generally any speed reducer element can be multiplied by the measured time. By adding the streets pass time length in a path, the total time needed to get to the announced destination can be calculated. The Intelligent GIS Based Navigator System will choose the path with the minimum time length between all the drawn graphs in only a few seconds. To employ this system the objects below are essential:

1. Hourly traffic conditions informations

2. An on-line connection among the Emergency Center and the Traffic Control Center in order to control traffic points such as traffic lights.
3. Informations about traffic limitted streets because of constructions, repairments, etc.
4. A GIS base map and planning specific layers, including point locations for persons and facilities, hospitals, emergency stations, traffic signals, traffic control cameras and etc.

In addition other geographically referenced information about populations, potential events, resources, infrastructures can be advanageous too.

Results and Conclusions

These are the advatanges of using this system briefly:

1. No needs to set up a radio connection among the emergency vehicle and the Emergency Control Center in order to consult about the best path.
2. Accurate destination pinpoint.
3. Select the path with minimum time length
4. Reduce notification and response time and increase emergency management efficiency

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Author Biography

My full name is Meead Saberi Kalaee. I was born in January 1985 in Tehran, Iran. I have started my academic studies and researches since September 2003. Now I am a student in Civil Engineering Department at Ferdowsi University of Mashad, Iran.

Academic and Professional Practice

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Web Technologies in Emergency Management

THE KEY RISK INDICATORS OF WEB SITE SECURITY

Lee, SungJoong[1]
Lotte Data Communication Company

Lee, YoungJai[2]
Dongguk University

Keywords: KRI, Risk, Web, Hacking

Abstract

This research is based on IT Security risk assessment on Web Site. It is carried out from 16th JAN 2006 to 24th MAR 2006. The research showed the how much Vulnerability is there through Web Site.To analyze and reduce IT security risks on Web Site, this research used Security Risk on WEB Site by OWASP's TOP 10 Vulnerability.

According to Risk Classification by OWASP's TOP 10 Vulnerability and Tiger Team's[3] own Methodology, the target web sites are selected by a group of web diagnostic specialists. For each web site, the mock diagnosis is implemented for the risk items, and Root causes are analyzed.

Throughout the analysis, we could analyze the vulnerability exist on Web site, find out root causes and classify them, and finally we could find out Key Risk Indicator (KRIs) which needed to make the Risk Assessment Model for the Web sites.

Introduction

It is now a trend that the number of Domestic/International Web sites is continually increasing. Also, the number of corporate business purpose Web sites are also increasing and the amount of information data is exponentially increasing as well.

The following table is the statistics of Web site vulnerability which announced by www.scientechsecurity.com (Author: Robert Lemus). It defines the trend that the figures are rapidly increasing.

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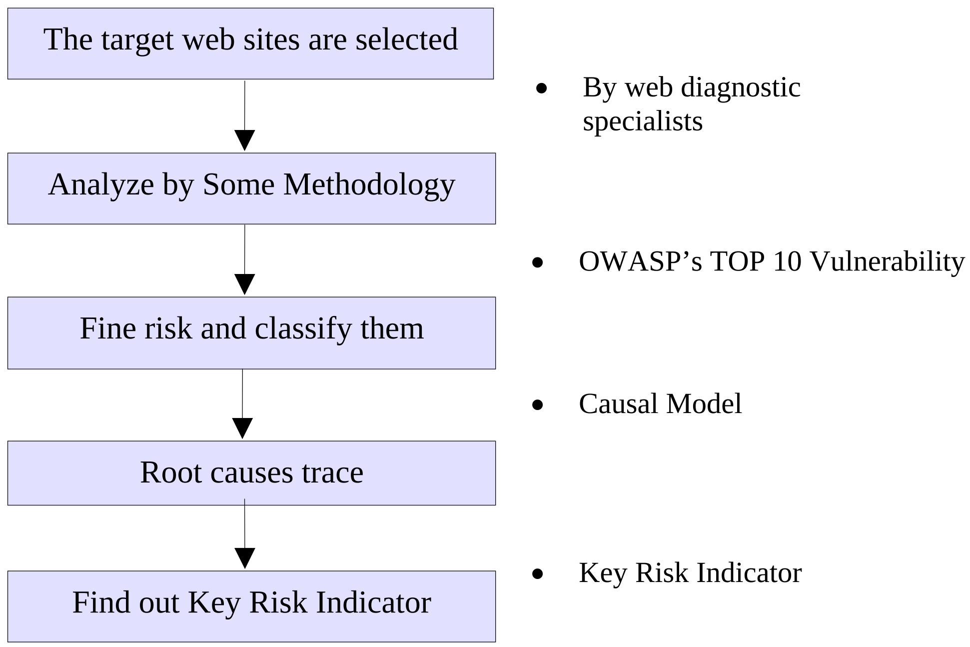
[1] IT Security Team Manager, Lotte Data Communication Company
Doctoral student of MIS, Graduate School of Dongguk University
Off) 82-2-2102-1021, Cell) 82-11-240-4800, Email: tagging@empal.com
[2] Chairman of TIEMS KOREA Chapter / Chairman of KOREA Business Continuity Plan Associative, 26-3-ga Pil-Dong, Chung-gu, Dongguk University, Seoul, Korea 100-715
Off) 82-2-2260-3297, Cell) 82-18-339-6386, Email: yjlee@dgu.edu
[3] The derivation of the "Tiger Team" is originally come from the military. A Tiger-Team performs a simulated attack on a web site and evaluates their security measures such as web vulnerability.

	2005	2004	2003	2003	2002
CERT/CC	5,990	3,780	3,784	4,129	2,437
NVD	4,584	2,340	1,248	1,943	1,672
OSVDB	7,187	4,629	2,632	2,184	1,656
Symantec	3,766	2,691	2,676	2,604	1,472

[Table 1. Increase of WEB SITE Vulnerability]

However, in this research, with priority given to research and analysis of vulnerability on Web site development, the Key Risk Indicator (KRIs) about building and designing a safe Web Site is studied.



<Picture 1> Research and Analysis Model

This Study of Security Risk on Web Site took a part of the project about Information security and cognition raise for a particular corporate. The whole project was implemented as following steps.

The specialist group examined with the Delphi Technique, and selected the preferential observing sites to perform the penetration test, so that the mock hacking and vulnerability analysis are implemented. Finally, the deduced risks are classified, and the root causes are found at last.

It took Two and a half months to analyze a numbers of sample sites' mock hacking and vulnerability analysis, and the scope of this research was limited for a particular corporate Web Site operation.

The Research purpose

Korea is the country that has a various environments for many different Web sites developed, so that on-line commercial transaction and internet information communion culture is highly developed.

Along with such Web site development, the cyber contrary function become a deepen issue. The various types of vulnerability such as degeneration of language, violence, porn and virus diffusion, infringement of copyright, outflow of digital assets and hacking are spreading.

The result that focused on mock hacking and vulnerability analysis is examined as for the basic data to compute KPI and to make propriety Web Site risk avoidance model.

The purpose were to minimize the risk during Web Site and operation, to deduce the risk factors that need to be preferentially managed, and to defined the priority ranks, then deduce Key Risk Indicator, and finally to educate web developers with the guide in future.

Such KRI minimize the risk that caused by the error in designing and developing Web Site and materialize the analysis model for vulnerability with implementing Web Site Development guideline.

Also, the education and examination would be done so that the risk on designing and coding could be minimized, and the ratio of risk and improvement of vulnerability could be measured in the long term of period.

Data Analysis

The risk assessment is examined according to OWASP's TOP 10 Vulnerability (Open Web Application Security Project) Standards and the Tiger Team's self inspection checklist. Security specialists set up the tiger-team, and examined the major sample Sites by mock hacking through the penetrate test.

Also, the risk analysis computed the examination checklist with using OWASP's Top 10 most critical Web application security flaws as a base model.

1. Non-validated input
2. Broken access control
3. Broken authentication and session management
4. Cross site scripting
5. Buffer overflows
6. Injection flaws
7. Improper error handling
8. Insecure storage
9. Denial of service
10. Insecure configuration management

These can be summarized as below 21 items if reclassified with examination actual checklist.

1. XSS (Cross Site Scripting) attack
2. Attack using Vulnerable PC configuration
3. Information outflow by malicious program like key logger
4. Information outflow by vulnerable browser (lack of patch)
5. URL interpretation (vector variable fabrication)
6. Directory Indexing vulnerability attach
7. Absolute path extraction by induction of error
8. Exploiting URL parsing attack
9. XSS (Cross Site Scripting) attack
10. SSL Man-in-middle-Attack
11. Servelet, EJB, Applet vulnerability attack
12. CLASS files decompiling attack
13. Parameter Tampering attack

14. File Upload/Download vulnerability attack
15. SQL Injection attack
16. Path Traversal attack
17. SQL Poisoning attack
18. Outflow of DB Schema
19. System O/S Authorization acquisition through DB
20. Web Command Prompt
21. System/Administrator root account acquisition

We performed the real examination with the experts using the checklist above. And Data is summarized in Table 2 as shown below.

File Upload	File Download	SQL Injection	XSS	Authentication & Session Management	Weak Access Control	Unnecessary Files	Error in O/S environment	Weak error control
19	14	21	23	20	36	34	30	14

[Table 2] The risk of Web Sites Unit = No of count

These vulnerabilities are reclassified to the business impact assessment by classification procedures in different kinds of business impact assessment tables

<table>
<tr><th colspan="3">Business Impact Assessment Table</th></tr>
<tr><td rowspan="2">Information outflow</td><td>Customer</td><td>Many registered customer information (Name, Resident number, ID/Password, Address etc.)</td></tr>
<tr><td>Internal</td><td>Many internal employees' information (Name, ID number, Password, Resident number, Address etc.)</td></tr>
<tr><td rowspan="3">System destruction</td><td colspan="2">Possible to delete system files by uploading web shell</td></tr>
<tr><td colspan="2">Possible to delete DB, Table by accessing DBMS through weak access control to DBMS</td></tr>
<tr><td colspan="2">Possible to delete system file by accessing through Telnet/FTP</td></tr>
<tr><td rowspan="8">System information acquisition</td><td rowspan="3">Source Information</td><td>Possible to download Source code through file download vulnerability</td></tr>
<tr><td>In case of existence of Source backup file</td></tr>
<tr><td>In case of uploading web shell</td></tr>
<tr><td rowspan="5">Simple Information</td><td>Possible to obtain information by exposing system configuration files</td></tr>
<tr><td>In case that ID/Password in cookie are obtained by snipping and XSS</td></tr>
<tr><td>In case that Web service sample file is exist</td></tr>
<tr><td>Possible to expose important information by directory listing vulnerability</td></tr>
<tr><td>In case that source backup file is exist</td></tr>
<tr><td rowspan="5">Information fabrication</td><td rowspan="2">Money fabrication</td><td>In case that money related fabrication is possible through accessing DBMS (bid, estimate, sales price etc.)</td></tr>
<tr><td>In case that buying price in internet shopping mall can be fabricated</td></tr>
<tr><td rowspan="3">Genuine fabrication</td><td>In case of Homepage alteration is possible</td></tr>
<tr><td>SQL Injection / Replay Attack, Log-in information snipping can fabricate so that the other user's information can be exposed</td></tr>
<tr><td>In case that DBMS data can be altered.</td></tr>
</table>

		In case that writing can be done on administrator only bulletin(notice) board
		Possible to alter and delete the other person's writings

[Table 4] Business Impact Assessment of Web Site Vulnerability

Such results of business impact analysis which based on assessment table above are requested to fix according to Quick_Fix Management procedure. 44 Information outflows, 22 System destruction errors, 66 system information acquisitions, 39 Information fabrications are summarized and fixed.

Unit = No of count

Execution result	Information outflow		System destruction error	System information acquisition error		Information fabrication error	
Company & SITE	Customer	Internal		Source information	Simple Information	Money fabrication	Genuine fabrication
TOTAL	19	24	22	22	44	6	33

[Table 4] Results of business impact assessment on Web site vulnerability.

According to [Table 5] The RISK and Vulnerability Causal Model, the causes of such risks can be defined as below.

1. Absence of education for developers (Web hacking/Safe coding style training)
2. Absence of Developer training (Web hacking/Safe coding style training) and Source code examination solution
3. Absence of Network operator targeted training
4. Absence of System operator targeted training/periodic examination on configuration file
5. Absence of Periodic examination on source file backup
6. Absence of DBMS access control solution and Network segmentation

Level 1	Level 2	Cause	a reform measure
Information spillage	Customer's Information	developers coding style problems	Absence of Developer training (Web hacking/Safe coding style training) and Source code examination solution
		developers configuration problems	Absence of DBMS access control solution and Network segmentation
	Private Information	developers coding style problems	Absence of education for developers (Web hacking/Safe coding style training)
		developers configuration problems	Absence of DBMS access control solution and Network segmentation
System demonstration	OS,DBMS	developers coding style problems	Absence of education for developers (Web hacking/Safe coding style training) and Source code examination solution
		developers configuration problems	Absence of DBMS access control solution and Network segmentation
		firewall rule configuration problems	Absence of Network operator targeted training
System Information	Source Code	developers coding style problems	Absence of education for developers (Web hacking/Safe coding style training) and Source code examination solution
		developers configuration problems	Absence of Periodic examination on source file backup

	Simple System Information	developers configuration problems	Absence of System operator targeted training and Periodic examination on source file backup
		developers coding style problems	Absence of education for developers (Web hacking/Safe coding style training) and Source code examination solution
Information falsification	Money falsification	developers configuration problems	Absence of DBMS access control solution and Network segmentation
		developers coding style problems	Absence of education for developers (Web hacking/Safe coding style training) and Source code examination solution
	Data falsification	coding style and configuration problems	Absence of education for developers (Web hacking/Safe coding style training) and Source code examination solution
		developers coding style problems	Absence of education for developers (Web hacking/Safe coding style training) and Source code examination solution
		developers configuration problems	DBMS access control solution and Network segmentation
		developers coding style problems	Absence of education for developers (Web hacking/Safe coding style training) and Source code examination solution
		developers coding style problems	Absence of education for developers (Web hacking/Safe coding style training) and Source code examination solution

[Table 5] The RISK and Vulnerability Causal Model

Summary and Conclusion

This research has eagerly watching results in two main focuses. Firstly, Web-business is rapidly growing in Korea at present, Web site risk analysis is tried comparatively in practice, and throughout the Key Risk Indicator (KRIs) analysis, Web site security risks are defined as indicators even though they were restrictive.

Secondly, the basic indication to bring up the training on developers and management objects could be found by analysis on web site risk, defining and classifying root causes and defining priority ranks for KRI.

However, suggestion for future research to complement and improve is, to be able to minimize the risk efficiently, the Risk Avoidance Model regarding on the Key Risk Indicator which measured in this research is needed to be studied and verified research model.

Also, the priority rank for measured KRI is needed to be done, Training on developers and management object are needed to be indicated, and finally, the results from them are needed to be indexed for the future.

Throughout such research, Web site security GUIDE which is based on Risk Avoidance Model can be established, so that it can be set up and apply to the developers who are participated on the particular projects.

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DISTANT WIRELESS TRANSMISSION OF PICTURE AND SOUND - NEW AID IN CRISIS MANAGEMENT

HERETIK, J, URBANEK, J.F, PESKOVA, K, BARTA, J
Department of Civil Protection at the Faculty of Economics and Management the University of defence[*]

Keywords: Interoperable Terrain Videoconference System of Civil Protection, Wi-Fi technology, Global positioning system (GPS), Distant wireless transmission.

Abstract

At the beginning of 2005 the activities concerning the development of a new "device" for distant wireless transmission of picture and sound were taken up at the University of Defence in Brno (in the Czech Republic). The device, having a working title "Interoperable Terrain Videoconference System of Civil Protection", is applicable in the sphere of crisis management and civil protection.

The primary aim of the project is to transfer the activities from the site of an extraordinary event (area of interest) near to the directing staff (directing workplace).

On-line visual information from the place of extraordinary event origin has a much higher predicative ability than a spoken word.

Our endeavour was to develop a system that is cost-effective and is built-up from commercially available equipment that is off-shelf in any salesroom specialized in wireless components.

Introduction

At the beginning of 2005 work on the development of a new "tool" for distant wireless transmission of picture and sound applicable in the field of crisis management and civil protection was started. The project called "Interoperable terrain videoconference system of civil protection" is begin developed by a team under the direction of Asoc. Prof. Jiri Frisons Urbanek, PhD.

Interoperable Terrain Videoconference System of Civil Protection

The main impulsion for opening this project was idea of approximation of activities from the place of extreme event to the operative workplace. Video informations on-line directly from the place of extreme event have much higher predicative ability than speaking.

To assemble the system of "Interoperable terrain videoconference system of civil protection" The effortwas used technology of Wi-fi (simplified diagram of data transmission is shown on figure).

[*] Kounicova 65, 612 00 Brno, Czech Republic

Effort of the problem-solving team is to develop the system which is undemanding for finance and can be set up from the commercially available equipment which you can buy in each specialized shop with Wi-fi components.

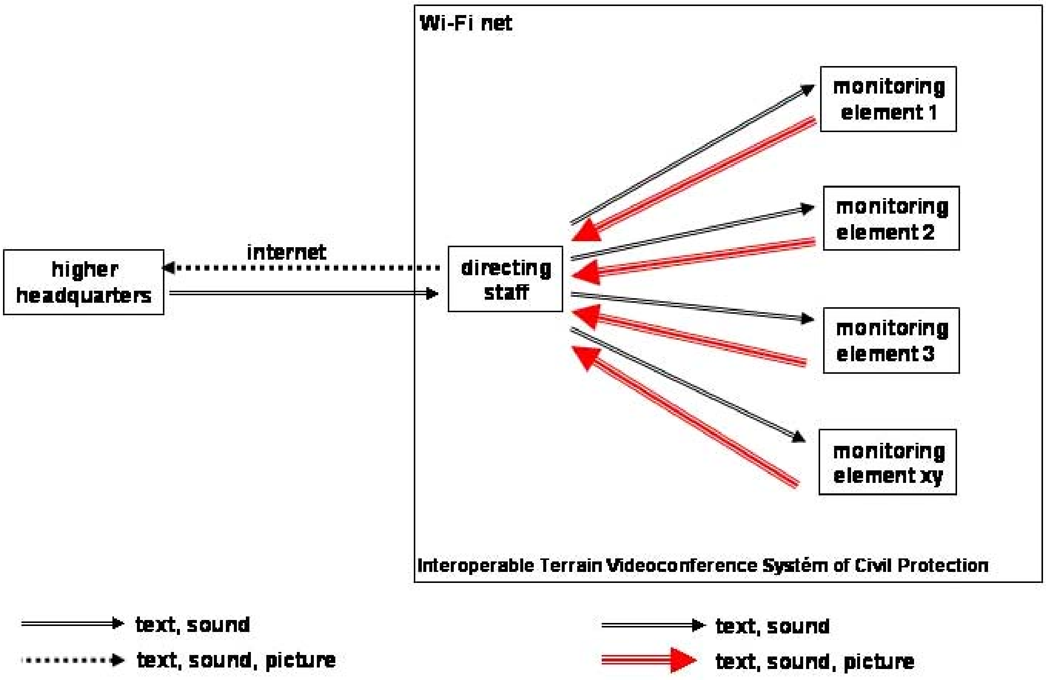

Figure: Fimplified diagram of data transmission

In specialing the output in similarity full-functional program unit of Interoperable terrain videoconference system of civil protection, solving team came out from the following ideas:

- sensing of tight spot (position) of monitoring item via GPS and display it in map (including providing the further information, for example speed of movement, altitude, etc.),
- possibility of archiving of all data transferred on-line from area to interes to directing workplace and their further process and upgrade,
- posibility of fixation Wi-Fi kamera on the arbitrary carrier (e.g. car, aircraft prototype, person, etc.),
- except of verbal communication is posibility of transit suggestion to monitoring item by alternative method (e.g. formation of necessary standard operating procedure for particular option of monitoring and their activation via Wi-Fi net, short message system, etc.),
- directness of system i. e. possibility of dissemination and adding of other items.

Current version of „Interoperable terrain videoconference system of civil protection“ operate as „extension**“** of software product of Emergency Office (EMOFF). EMOFF was developed by czech company T-SOFT s.r.o. based in Prague. It is implementation of module „Mobile workplace“ to the current version of EMOFF.

We can find that starting plan of solving team was realized. Developed system uses (as a basic component) personal digital assistant (PDA) where is installed EMOFF software (corrected version for PDA). PDA is equipped with GPS for scannig of tight spot. Monitoring item is equipped with Wi-Fi camera for video transmission from interest place to the operative workplace. Operative workplace has a notebook with installed EMOFF software. Part of EMOFF are standard operational procedure for monitoring. Specific standard operational procedure is assigned to monitoring subject through the directing notebook. Monitoring subject does appropriate activities in agreement with standard operational procedure. Monitoring subject (after activation of standard operational procedure) starts his activities according to steps which are defined exactly. He has to confirm beginning and ending of his activities with every step. It is subsequently displayed on directing notebook. Operative workplace has perfect overview about specific activity of monitoring subject.

Conclusion

"Interoperable terrain videoconference system of civil protection" is still developed and innovated by the problem-solving team. The system is entirely independent on stationary source of electrical energy (it has his own source of electrical energy). It is possible to use this system on almost any place (it is fully mobile and it is possible to create you own Wi-Fi net at least 25 square kilometres).

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WEBSERVICE INTEROPERABILITY FOR EMERGENCY MANAGEMENT DECISION SUPPORT

Ulrich Raape[†], Florian Marquardt, Patrick Kautz[*], Thomas Schulze[‡]
ResilientDecisions; Fraunhofer IFF; O.-v.-Guericke University Magdeburg

Keywords: Interoperability, Webservices, Decision Support

Abstract

The Distributed Spatiotemporal Interoperability (DALI) approach addresses the issue of Interoperability between the separate domains of geoinformation (GI) and modeling & simulation (M&S) technology. While interoperability is often limited to a specific domain, DALI tries to exploit the synergies of coupling OGC-compliant services and HLA-based simulations in a standardized manner. The paper describes the status of the evolving DALI concept in its current third development stage and takes a closer look at the latest advances in addressing open questions of cross-domain interoperability based on the OGC and HLA specifications.

Introduction

While the geographic information (GI) and the modeling and simulation (M&S) domain both offer a wealth of systems, services and concepts or architectures for interoperability, the access to services outside the "own domain" still results in proprietary solutions, leaving the need for cross-domain interoperability unaddressed.

But often processes in both the spatial and temporal dimensions need to be modeled, forecasted, analyzed for decision support and other tasks; Environmental and Emergency Management (EM) are just two example application areas [Raa+05]. The Spatiotemporal Interoperability approach (DALI) uses the Open Geospatial Consortium (OGC) specifications and the High Level Architecture for Modeling and Simulation (HLA) as domain-specific state-of-the-art interoperability technologies and strives to make the synergies of coupling OGC-compliant services and HLA-based simulations usable in a standardized manner. This paper describes the third implementation stage of DALI and some of the advances that have been made in areas that previous stages left unaddressed.

The remainder of this paper is structured as follows: Section 2 points out different forms of interoperability in the Gesospatial and M&S domain. Next, the DALI-Architecture as an approach for spatiotemporal interoperability is discussed. The different stages in the DALI development process are described in this section. Sections 4 and 5 focus on the advances of spatiotemporal interoperability in the current third development stage. The Web-Service oriented structure of the new architecture and topics like Web-based HLA-Access, using geography markup language (GML) data as federate input and the visualization of simulation

† ResilientDecisions, D-39122 Magdeburg, Germany
* Fraunhofer Institut für Fabrikbetrieb und –automatisierung IFF, D-39106 Magdeburg, Germany
‡ Fakultät für Informatik, Institut für Simulation und Graphik, D-39016 Magdeburg, Germany

results based on styled layer descriptions (SLD) are presented in theses sections. Lastly, an outlook concludes the paper.

Interoperability

In general, Interoperability is defined as "the ability of two or more systems or components to exchange information and to use the information that has been exchanged" [IEEE90]. In the M&S domain it is defined as "the ability of a […] simulation to provide services to, and accept services from, other […] simulations, and to use the services so exchanged to enable them to operate effectively together" [Dep. Of Defence 1994].

The complex topic of Interoperability needs to be structured in more detail and is subject to current research and development.

General Interoperability Architectures

Service Oriented Architectures (SOA) are an example of general (non domain specific) interoperability approaches and can be described as collection of services providing an ability, for example, to exchange information [Barry 2005]. Some of the first service oriented architectures were based on CORBA or DCOM technologies. Today SOA based on Webservice and XML/SOAP technology is in focus for civilian enterprise integration. Services are defined using a Webservice Definition Language (WSDL) and published in directories based on the Universal Description, Discovery and Integration (UDDI) meta-service. One of the main advantages is that Webservices are supported by a wide range of operating systems and development/deployment environments. Elements and standards used by SOAs are also commonly used by domain specific architectures and approaches, such as the Extensible Modeling and Simulation Framework XMSF, GI Services and HLA Evolved [Raape et.al. 2005].

Interoperability in the Geospatial Domain

Interoperability of the geospatial domain is currently mainly provided through the standardization bodies ISO and OGC. ISO specification series 191xx provides a rather high level view on geospatial data and processes, while OGC specifications address both the abstract as well as the implementation level. One of the most promising approaches to foster interoperability within the geospatial community is provided by the OGC, an international non-profit industry consortium.

The standardization work of the OGC is currently state of the art within the geospatial domain. Based on the ISO/IEC Reference Model for Open Distributed Processing (RM-ODP), it has produced mature specifications that provide a high level of interoperability. The OGC Webservices Framework provides a common set of interfaces and encodings that span the functional parts of the enterprise.

While all current implementation specifications provided by OGC focus on static, non temporal dynamic geospatial data, it is up to the Sensor Web Enablement (SWE) initiative to address the integration of live sensors and simulation models [Simonis et.al. 2003]. Simulation model integration can be interpreted as a special way of sensor device integration: Models predict, estimate, or simulate features by analogy with Web Feature Services (WFS) that produce features from conventional data stores. Features produced by models are commonly observations which reflect the complexity of the acquisition process and provide information about how the data was collected, where, with what kind of a sensor, when and so on. The Observation and Measurement (O&M) specification provides general models and XML encodings for observations and measurements made using sensors and became mostly part of the Geographic Markup Language (GML) [Cox et.al. 2004]. The GML observation model understands an observation as the process of observing some phenomenon. It is not a simple object with a value, time stamp and location identifier, but a complete model that gives additional information about what and how the process was performed. The Sensor Model Language (SensorML) provides models and XML Schema for describing sensor systems and observation process models [Botts 2004]. To access the spatiotemporal data, a highly specific subtype of a WFS, the Sensor Observation Service (SOS) was developed. Although a lot of integration and harmonization work with other standardization communities will have to be performed, OGC SWE is currently the most promising approach to handle dynamic geospatial information in a standardized way.

Interoperability in the Modeling & Simulation Domain

In the past decades simulations often have been specialized, monolithic applications not prepared to communicate or interoperate with other systems. It was in the military domain where the standards Aggregate Level Simulation Protocol (ALSP) and Distributed Interactive Simulation (DIS) have been developed and deployed widely to standardize synchronization among similar simulations. Based on the ALSP / DIS experiences and the requirements derived from the need to build interoperable, modular, cost-effective and flexible simulations focus shifted to Interoperability and Reusability. As a result, the US Department of Defense (DoD) triggered the development of the High Level Architecture for Modeling and Simulation (HLA) currently being the state-of-the-art architecture for distributed simulation systems.

The HLA is a software architecture and infrastructure technology for distributed simulation systems (called *Federations*) consisting of heterogeneous, distributed and dislocated subsystems (called *Federates*). HLA offers flexible communication and synchronization services to allow federates and federations to operate under a wide range of different time regimes, which also led to the participation ("HLA-enabling") of non-simulation systems like databases, sensors, etc. HLA is the prescribed DoD and NATO standard for military simulation interoperability and was adopted as open international standard IEEE 1516.

The HLA consists of three major building blocks: the *HLA Rules*, the *HLA Object Model Template (OMT)* and the *HLA Interface Specification (IfSpec)*. The Rules, OMT and IfSpec define how federations and federates shall behave, communicate and how their object models have to be described. The HLA rules describe the basic behavior of federations (rules 1-5) and federates (rules 6-10). The Object Model Template (OMT) provides a common framework for the communication between HLA simulations and consists of the Federation Object Model (FOM) which describes the shared objects, attributes and interactions for the whole federation and the Simulation Object Model (SOM) which describes the shared object, attributes and interactions used for a single federate. The Interface Specification is object oriented (with some exceptions) and divided into six service groups. The Time Management services allow the transparent management of federates under different time regimes (e.g. real time, time stepped, event driven, continuous) which is a major breakthrough compared to previous technologies. A so-called Runtime Infrastructure (RTI) is provided which offers the necessary services needed to implement the HLA.

DALI Spatiotemporal Interoperability Architecture

Often applications in Environmental and Emergency Management require dynamic information, delivered by sensor networks, simulations or archives. Sometimes different scenarios must be analysed and compared. E.g. in an emergency response application, a decision maker needs not only to have actual (if not realtime) information; in addition, to be able to forecast the spatio-temporal consequences of decision alternatives would be very helpful. On the other hand simulations often require spatial information, e.g. road networks, terrain information, infrastructures etc.

The interoperability architectures described in the previous section are limited to their respective domain. The handling of dynamic information in OGC environments is only beginning to be addressed, and the management of geospatial information in HLA environments is nearly undefined.

This section describes the DALI approach which tries to achieve interoperability also between OGC and HLA "services".

Approach

The OGC Specifications and the HLA provide a solid foundation for an spatiotemporal interoperability architecture; the key feature comparison shown in table 1 shows that in terms of the capability to model and support spatiotemporal processes in a modular and standardized way both technologies are complementary.

Criteria	HLA	OpenGIS
Domain	Time	Space
Applications	Simulation	GIS
Approach	Distributed Heterogeneous Simulation-based Systems	Interoperable Geo-enabled Web-Services
Standardization	DoD, NATO, IEEE	OGC
Temporal Awareness	Yes	No
Time Management	Yes	No
Spatial Awareness	No	Yes
Availability of Services	During Federation Runtime	Permanent
Web-based Services	No	Yes
Communication Style	Stateful	Stateless

Table 1: HLA/OpenGIS Key Feature Comparison

An integration of both standardization approaches would offer features and services accessible to both basic architectures. Table 1 also indicates what bridges need to be built between both technologies. In general, the DALI approach can be structured as follows:

- making OGC services available to HLA federates,
- making federations available to OGC services.

As a minimum, the following points have to be addressed:

- Federations must be permanently available as OGC webservice (by creating appropriate wrapper interfaces / services);
- Provisions must be made to create, start, control and terminate Federation Executions remotely (e.g. using suitable management services);
- Geographic objects must be made interchangeable. This results in a GI Reference FOM on the HLA side which has to follow the OGC Open Geodata Model as closely as possible. Achievement of semantic interoperability on the HLA side is an open research issue very important to the DALI approach.
- Specialized federates have to be created that façade selected OGC services to ensure HLA compliancy. Using HLA declaration and object management services, they will listen to GI requests within federations and will transparently collect responses from appropriate OGC services.

DALI Architecture

The DALI approach cannot cover every potential application scenario equally, and for some specific cases other (proprietary?) protocols or architectures will be a better choice. However, typical scenarios have to be defined before going into implementation details. Typical scenarios with different interactivity and synchronization requirements are [Raape 2005]:

- „Just the Results“: The system or service requesting simulation services is only interested in the results of the simulation.
- “Keep me informed”: The simulation service requester wants to be informed about the progress of the simulation run and/or about certain events (triggered by update frequencies or conditions previously defined). The communication requirements will range from the “Just the Results” level up to a level where the application of specific protocols or architectures starts to be indicated.
- “Online Visualization”: The requester wants to “see” what happens on the simulation side. Depending on the visualization requirements, this scenario might range from a static picture being refreshed every n seconds up to smooth (but non-interactive) animations.
- “Interactive online Animation”: interactive visualization requires the visualization client to be in the causality loop of distributed time management. This scenario requires the visualization and animation to be a HLA-federate participating in the federation to be monitored.

The development of specialized GI/OGC federates that mirror OGC service functionality transparently into HLA federations and the development of OGC SensorWeb services that transparently map HLA-based simulation services as “virtual sensors”, are not described in detail here. Different approaches have been evaluated to achieve permanent availability and remote control of federations.

Using the DALI architecture, much flexibility can be gained when an application can be orchestrated with specific modules / services and simulations dynamically be initialized at runtime (shift from pre-configured, sometimes hardwired initialization to on-the-fly initialization). A further DALI design principle uses the black-box feature where a simulation federate or service hides the implementation details; thus, using the same interface, the same object model can be served by a database, simulation or sensor network federate. These DALI concepts can be used to create (decision support) systems that are able to be applied in different usage scenarios ranging from analysis and planning, training and real-time decision support [Klein / Wytzisk 2001].

DALI Development Process

The DALI approach is being developed iteratively: at each stage of development, a set of open issues are addressed conceptually and prototypically as well as current developments in neighboring technology and standard areas are evaluated. Depending on the results of previous stages and current status of the projects where DALI work is embedded in, the next stage is planned. This section describes stages 1 and 2 of the DALI approach shortly before a closer look at the advancements of stage 3 is taken.
Stage 1: First implementation of DALI

A first Emergency Management prototype based on the DALI concept has been developed and implemented during a German R&D project and presented in [Schulze et.al. 2002] and [Wytzisk 2003]. The chosen scenario was to monitor and forecast spatially distributed runoff in a given area of Germany using a complex distributed hydrological simulation system. In addition to a set of static spatial input data provided by OGC Webservices, the simulation is parameterized by extremely up-to-date rainfall data, provided by on-line measuring points which are integrated by appropriate Geofederates. Current runoff measurements are incorporated to continuously calibrate the model during runtime integrating water level measurement points. Interoperable sub-models can be integrated to forecast high water hazards and flood damage to supply suitable information for operative emergency management. The first prototype was developed to demonstrate the basic concepts described above and to serve as the platform for additional federates and spatiotemporal services. A case study region in Germany has been chosen that allows access to a (nearly) real-time sensor network in reservoirs and rain gauges.

Stage 2: the European MEDSI Prototype

A second and updated prototype of the DALI approach has been implemented as part of the European R&D project "Management Decision Support for Critical Infrastructures (MEDSI)". The objective of MEDSI project has been to develop a web-based integrated set of software services as a tool to enhance the capabilities of crisis planners and crisis managers in both private and governmental organizations. MEDSI enables them to utilize various information sources for better monitoring and reduction of potential and actual risks and for more effective response in case of threats imposed especially to the subjects of the critical infrastructure [MEDSI 2005].
One of the MEDSI test scenarios deals with a flooding situation in the city of Magdeburg. As part of the Magdeburg prototype implementation, a generic evacuation simulation has been developed which operates in a lightweight prototype version of the DALI architecture. The application scenario describes the evacuation of 20.-30.000 people from risk-prone areas into evacuation areas and is based on the historic flood situation in the city of Magdeburg in 2002. The scenario includes a decision support system prototype to support the crisis management group of the region of Magdeburg. Modules provide the necessary geographical and non-geographical base data, and the generic evacuation simulation model was used to forecast and evaluate different evacuation scenarios under varying conditions as well as to identify potential bottlenecks during the evacuation process and the identification of critical success factors [Raape/Petjoch 2004]. According to the individual scenarios the system has already run or is currently running, an online or post-mortem visualization is possible using OGC webservices or animation software (see figure 1).

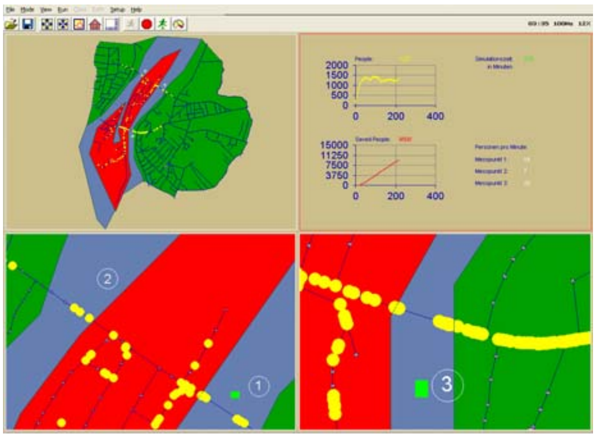

Figure 1: Animation of a single evacuation scenario

At runtime, the street network is requested from an OGC service and is made available to the HLA-based generic evacuation model. This results in ad-hoc configuration and initialization capability needed in the EM domain.

The rest of the paper describes the current stage 3 of the DALI implementation sequence, the progress made and the next steps to be taken on the way to OGC/HLA based cross-domain interoperability.

Current Stage: Web-based implementation of DALI

Overview and Prototype Architecture

Based on the experiences made, the third implementation phase described in the following uses the webservice approach to implement new capabilities and address certain shortcomings of previous stages. In order to allow the user to send a DALI parameter set (which defines the spatial or simulation services involved as well as their initial configurations and the definition of the output parameters) and receive the (simulation) results according to the request-response-pattern, a type of service chain was to be implemented.

Figure 2 shows the components of the architecture. The client (top left) communicates with a webservice façade of the GeoSim-Management-Webservice which itself provides permanent access to the HLA-based simulation functionality (one of the major requirements stated above). This central webservice is able to activate the required federates for a specific simulation as requested by the client. In order to start the required federates and get them joined into a common federation execution, the GeoSim-Management-Webservice issues requests to the webservice interfaces of the federates. Every federate therefore needs to have a webservice wrapper which provices permanent accessibility.

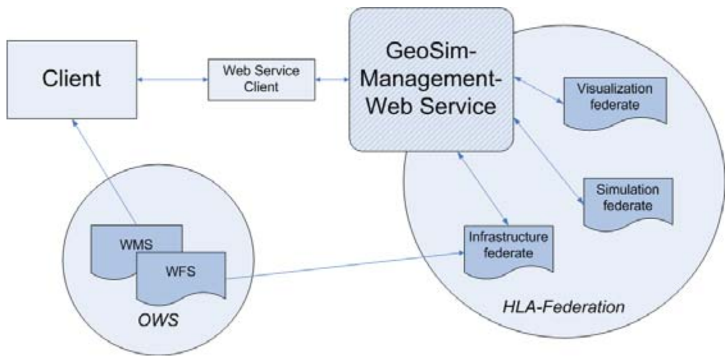

Figure 2: Structure of the architecture

The GeoSim-Management-Federate is responsible for the startup, control and shutdown of the federation and the required federates. OGC Web Map and Web Feature services (bottom left) provide the basic spatial data (in our case information about the traffic network, see below). The spatial data within the user specified rectangle (bounding box) is processed and fed into the HLA federation execution by the geofederate which is implemented as infrastructure federate in our specific prototype scenario. During the federation execution the visualization federate collects the required data to generate the results after the run.

Further details of the stage 3 concept and prototype and an additional sequence diagram can be found below. At this stage OGC SWE services have been evaluated but not been used due to the lack of available SWE implementations. In addition, the prototype uses a proprietary object model; the challenging area of generic OGC/HLA object model mapping (GML/O&M/SensorML vs. OMT, GI reference FOM) will be considered in the next development stages.

The prototype implementation uses a traffic scenario: different types of vehicles, optionally following different traffic patterns (e.g. rush-hour / transit / event-induced or evacuation traffic), are modelled by one or more traffic simulations (federates). The road network is provided by an infrastructure federate which uses OGC services to access the spatial data of the network. Additional simulations can join to model dynamic processes which may interact with the traffic and/or the infrastructure, such as weather (online weather data or weather simulations describing fog, toxic clouds, etc.) and flooding simulations which may result in impassable roads.

Depending on the usage scenario (see section 3.2), the results are published by the visualization federate during simulation runtime or after simulation completion in the user defined manner. The whole simulation process is managed by the GeoSim management webservice. It is the sole interface between simulation and client.

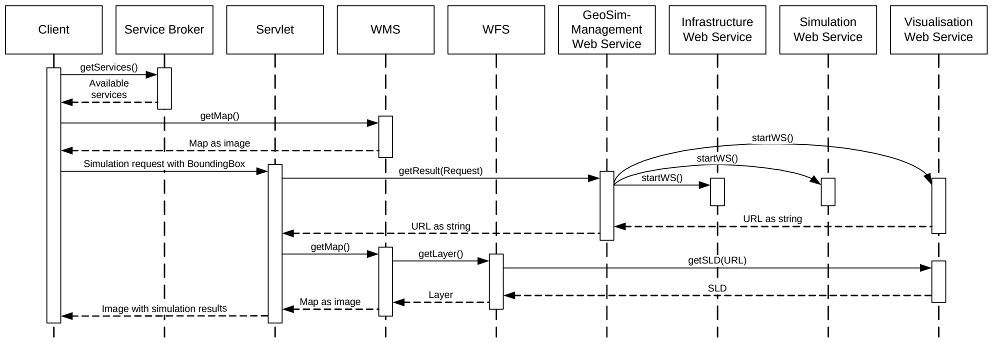

Figure 3: Sequence Diagram

Figure 3 contains an functional overview of the complete web-based implementation of stage 3 of DALI. At first the user requests a list of available WMS, WFS and GeoSim-Management-webservices. Out of this list the sources for the geodata are chosen, and the user can specify the geographic area which should be used for the simulation and other simulation parameters. Then the simulation is started by the user, and the client sends a request to the selected GeoSim-Management webservice that contains all the parameters. The GeoSim-Management webservice creates a new federation and starts the GeoSim Management federate. After the federate joined the federation successfully the GeoSim management webservice starts the other federates by sending requests to their webservic façades which in turn get their federates started and joined. When all federates joined the federation, the simulation begins and runs until the abort criterion is reached or the simulation ends. Now the visualization webservice processes the simulation results, generates a SLD file and sends back its URL. At the end a new getMap-request is send and the generated SLD affects the map so the results can be portrayed by the WMS.

Wherever possible open source software has been used. For several reasons the DMSO RTI 1.3NG software has been used which is not available for free anymore. Future work will focus on the forthcoming HLA specification (IEEE1516-2006, also known as “HLA Evolved”).

Summary and Outlook

The Distributed Spatiotemporal Interoperability Architecture (DALI) presented in this paper describes an approach to exploit the synergies of coupling OGC-compliant services and HLA-based simulations in a standardized manner. In its current third development stage, central issues like remote control of HLA components and OGC compliant visualization of results are addressed using a generic webservice based approach and by rethinking methods developed in previous development stages. The DALI architecture is under ongoing development, and still lots of issues and open questions need to be solved and answered. However, recent developments and standardization initiatives in related areas (e.g. HLA Evolved [Möller 2005], OGC OWS-3 Testbed [OGC 2005]) are encouraging if not utilizable for the overall aim of spatiotemporal interoperability.

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INTERNET PUTS EMERGENCY PREPAREDNESS WITHIN REACH OF SCHOOLS

Christopher D. Hekimian, Dr. Sc. SE, MSEE
DXDT Engineering and Research, LLC[1]

Keywords: Emergency Preparedness, Emergency Planning, Emergency Response, Schools

Abstract

There are over 90,000 public schools in the United States. Together, they are responsible for the education and safety of over 47 million students. In a time when natural and man-made catastrophes as well as life threatening emergencies can occur at any time, School districts and administrators of individual schools are obligated to take meaningful emergency planning. As is often the case with emergency preparedness measures, the need for resources is not always well appreciated until after an emergency or catastrophic event has occurred. Particularly with respect to schools, many other priorities seem to take precedence over sound emergency planning. Aggravating the matter is the apparent reluctance of education officials to bring local school natural disaster or terror attack response issues to the forefront of discussion with parents and the community. Consequently, many schools either do not have any viable emergency response plan; their plan is out of date; or the existence of the plan and its use not well understood by those charged with its implementation.

The U.S. Department of Homeland Security and the U.S. Department of Education have worked together to provide basic emergency planning guidelines to the education community. The private sector has also developed some Internet-based tools that employ technology in order to define and communicate emergency response information, and to educate stakeholders in emergency plan implementation.

This paper will analyze the U.S. government and private sector solutions to the emergency planning void affecting schools. It will examine the common ground existing between the two approaches and set forth ways that they can be employed together in order to enhance the safety of children in the United States and globally.

Introduction

The United States has over 90,000 public schools that are responsible for the education and safety of over 47 million students (NCES Common Core of Data, 2002). School administrators are obligated to take meaningful emergency planning steps in a time when natural and man-made catastrophes as well as life threatening emergencies can occur at any time, without warning. The need for emergency planning is not always well-appreciated until after an emergency or catastrophic event has occurred. Particularly with respect to schools, many other priorities seem to take precedence over sound emergency planning. Education officials are sometimes complacent or otherwise reluctant to bring local school natural

[1] 20140 Scholar Dr. TIC 213, Hagerstown, MD 21742, tel:301 520-1575, chrishekimian@cs.com

disaster or terror attack response issues to the forefront of discussion with parents and the community. There is concern over appearing alarmist, or political, or being the bearer of "bad news". Consequently, many schools either do not have any viable emergency response plan; their plan is out of date; or the existence of the plan and its use not well understood by those charged with its implementation.

The U.S. Department of Homeland Security and the U.S. Department of Education have worked together to provide basic emergency planning guidelines to the education community. Internet and software-based tools, developed by the private sector assist in the development, communication, maintenance and evaluation of emergency response information and plans. Some of the tools go far to educate stakeholders in the implementation of the emergency plan.

This paper will analyze the U.S. government and private sector solutions to the emergency planning void affecting schools. It will examine the common ground existing between the two approaches and set forth ways that they can be employed together in order to enhance the safety of children in the United States and globally.

Sources of Information

Joint DHS-DoEd Emergency Planning Handbook for Schools

The joint DHS- Department of Education initiative is intended to provide school officials with a "one-stop-shop to help officials plan for any emergency, including natural disasters, violent incidents and acts". A handbook that provides general guidance for developing a comprehensive emergency response plan for schools is available online at URL: http://www.ed.gov/admins/lead/safety/emergencyplan/index.html. Although by its own assessment the handbook acknowledges that little evidence exists to form a basis for quantification of best practices for crisis planning for schools, it would appear that the handbook goes far to meet that need. Also, no cost "Crisis Planning for Schools Training" seminars are currently being offered in select cities as part of the initiative.

US Life Safety, Inc. Emergency Preparedness for Commercial Buildings (website)

The primary source for information on software and internet solutions that address emergency preparedness, planning and response for schools was the website of US Life Safety, Inc., of Pittsburgh, PA.

Findings

DHS-DoEd Handbook Recommendations

The handbook provides guidelines for developing and understanding an emergency and crisis plan that reflects the needs, resources and culture of the school and local community. What constitutes a crisis and the types of crises that schools may experience from weather related phenomena to acts of terror are introduced in the first chapter of the handbook and are discussed in greater detail in the last chapter of the handbook. The handbook comprises five sections and addresses the principles of crisis planning; mitigation/prevention, preparedness, response, and recovery. Action checklists providing specific proactive and reactive measures are provided in each chapter in the handbook. Case studies describing successful initiatives from other schools are presented and detailed aspects of crisis management are elaborated on in the final chapter.

An appendix is provided to assist school crisis planners in getting started on their emergency response plan, including resources for information. It is suggested that crisis plans for other agencies in the community be investigated for ideas and information that might be useful for the school's plan. However, the reader is also warned against formulating an emergency response plan solely by cutting and pasting from other plans. The emergency and crisis response plans from the local or neighboring school district's are identified as potential resources to be drawn upon for developing plans for individual schools. Information about how other agencies interface with responder agencies can be useful for developing the schools approach.

The handbooks treatment of preparedness emphasizes the importance of assessing and addressing the safety and integrity of building facilities (window seals, HVAC system, and structure) and school physical security. The handbook indicates that;

> "mitigating emergencies is also important from a legal standpoint. If a school, district, or state does not take all necessary actions in good faith to create safe schools, it could be vulnerable to a suit for negligence. It is important to make certain that the physical plant is up to local as well as federal and state laws."

The statement underscores the importance of faithfully engaging in the emergency planning process and maintaining a continual awareness and commitment to sound mitigation and preparedness principles. How administrators can use policy and curricula to influence changes in school culture that are conducive to a climate of emergency preparedness and the importance of identifying and involving stakeholders are discussed.

The importance of defining roles and assigning responsibilities before a crisis is addressed and the reader is provided with a list of several key roles that must be filled. The roles of school commander, liaison to emergency responders, student caregivers, security officers, medical staff and spokesperson are suggested. A graphical decision support tool that would assist administrators in making decisions regarding school lockdown, evacuation or relocation is presented. The development and use of decision support tools during the mitigation or preparation stages is important in that it allows important decisions to be made in advance and reduces the possibility that argument, debate or decision deadlock will occur during the response phase when teamwork is needed the most. The handbook suggests that no matter what degree of effort and foresight that goes into an emergency response plan, events unfolding in the wake of a crisis will almost undoubtedly occur with an element of surprise.

Recommendations include that maps of the school and information about the facilities be collected, stored and made available. During a crisis, responders need to know the location of utility shut-offs and shut-off procedures, first aid resources and facilities such as kitchens and other building facilities. Site maps should include information about classrooms, hallways, and stairwells. Potential staging sites should be identified on the maps as well. The handbook provides a more comprehensive list to serve as a general guideline. The ability to provide easy accessibility and multiple copies of the materials are important.

The development and roles of school and district level crisis intervention teams for the recovery phase of a crisis are discussed. The importance of establishing clear lines of communication between the state, the district, the school, and community groups and responder agencies is emphasized. The potential for utilizing resources (materiel and volunteer) within the community is addressed in the handbook. The concept of the Incident Command System is introduced in the handbook.

The final chapter in the DHS-DoED Emergency Planning Handbook for Schools emphasizes the importance of collaborating with community emergency responders during emergency response plan development. Web-accessible resources provided by FEMA for emergency and crisis mitigation are listed. Information resources for volunteer organizations such as Freedom Corps are provided.

Some of the more important aspects of emergency response that are elaborated on in some detail are: Considerations for students and staff with special needs; Recommendations for communicating with families about crisis prevention; Models of crisis intervention for students and; Suggestions on how to work with the media before, during and after a crisis. Descriptive examples of successful emergency planning initiatives that have been implemented by schools and school districts are discussed in the final chapter of the handbook.

Software Automated Preparedness and Response Tools

Many of the criteria suggested in the handbook are supported by software and internet-enabled tools that are currently available. Tools can be obtained that provide a verifiable means of training to the plan, evaluating the plan, communicating the plan and providing plan related details in an efficient manner. Current products conform to DoEd and DHS recommendations by providing access to school specific data such as building floor plans; locations of fire alarm switches, exits, fire extinguishers, evacuation routes and rally points.

Software and web-based or web-enabled emergency preparedness management systems are designed in part to help schools comply with OSHA and local codes through enabling the easy accessibility, distribution and maintenance of Emergency Preparedness Plans, Disaster Recovery/Contingency Plans and general safety guidelines and personnel rosters. Information including points of contact, daily attendance, schedule and roster information can be made accessible through a network enabled system. Information about students and staff with special needs should be supported.

Web-based systems have the potential to go beyond what non-web solutions can provide by supporting direct access by emergency responder personnel. Emergency responders can use the system to plan for various kinds of emergencies that could impact the school and to obtain the most current response-related information. Such systems support a dialogue between the schools and the responder agencies and enable responders to comment upon and contribute to a school's emergency response plan, in conformance with DHS/DoEd recommendations.

Depending on the resources of the responder agencies, they may either be able to access critical building information directly from their vehicles or they can maintain a printout or notebook of the critical information and keep it on hand in case a response is necessary.

For schools that do not already have an up-to-date emergency response plan, providers of automated emergency preparedness/response systems will often be able to provide a template that will make developing one, conformal to the main, technical DHS/DoEd recommendations a straight forward process. Some tool providers will be able to arrange more specific guidance at an additional cost. The aspects of the DHS/DoEd recommendations that involve the outreach to the community and cooperation with responders will need to be coordinated by the school, although guidance on those tasks is likely to also be available from the vendor.

Of course, no automated tool to support emergency preparedness or response will be effective if enough people do not know of it's availability or how to use it. It is advantageous to have a system that can automatically administer training material and tabulate training related statistics for each school employee as required. Some of the more advanced systems support training in both slideshow and streaming video formats. The system should be able to flag any individuals that are not current in their training schedule and, if the system is web-based or web-enabled, it can send out reminders [2].

[2] US Life Safety Inc.,Life-Counts®, 2006, URL: http://www.uslifesafety.com/

The capacity for an emergency preparedness/response system to self-verify training is one indicator of a premium system and a capability that is not matched by non-automated systems. Systems that support self-evaluation of the emergency response plan that they support can automatically identify which parts of the plan users have difficulty understanding (through missed test questions) so the plan can be improved. The capability would tend to have excellent implications in terms of risk reduction and reducing underwriting costs and liability protection. Parents of students would also be likely to appreciate the comprehensive approach to school emergency preparedness.

The web-based services provide for offsite data storage at multiple sites and with frequent back-ups, which is consistent with NFPA 1600 standards and DHS guidelines for business continuity planning. They are also more supportive of access from multiple sites than web-enabled systems that might reside on a company's intranet and are subject to more restrictive remote access controls. Flexibility in configurations can support hybrid deployment of web-based systems where some of the schools data would remain on the school's server while some data would remain on the remote host server.

The cost of the automated systems varies depending upon the deployment options and the many features that can be supported. The web-based systems are associated with one time installation and licensing costs as well as a recurring monthly cost similar to the cost of a basic cable TV account. Depending on the data mirroring and back-up services that are provided, the recurring fee may represent a significant bargain. The good news about the systems are that often times special prices are available to schools and school districts are often offered volume discounts when they purchase a system. Referral programs may also be offered.

Discussion

The current political climate is one of awareness of the threat of domestic and international terrorists. Recent events such as the terrorist attack in Beslan, Russia reinforce the fact that schools are not immune from specific targeting by terrorists. The aftermath of poor emergency preparedness and response in the wake of the storm Katrina further underscored the importance of diligent planning. Public administrators are essentially "on notice" in that lack of due diligence is not likely to be so easily excused in the future. Lists of grant recipients are long and it is apparent that currently the government is willing to help school administrators in implementing the means to better protect students and staff and better support cooperation and communication between schools and responder agencies.

School or school district administrators should be aware of grant programs that have been offered on a consistent basis by DHS and DoEd, and other federal, state and local agencies in order to improve safety and emergency communications for schools (and hospitals and local government agencies). Many school administrators are adopting low-risk strategies to try to secure top-shelf automated systems. Volunteer grant writers, or grant writers that will work on a contingency or low-cost basis are being retained in order to plan project implementation and pursue grants. General information on two U.S. government grant programs are provided below.

<u>DoEd OSDFS Grants</u>

The U.S. Department of Education Office of Safe and Drug-free Schools (OSDFS) has initiated the Emergency Response and Crisis Management Grant Program, which is specifically directed towards local education agencies. $24M has been allocated to this program for 2006 and OSDFS expects to award about 105 new grants. The range of awards is between $100k and $500k with an average award anticipated to be about $230k. The grant program is designed to provide funds to local education agencies so they may strengthen and improve their emergency response and crisis plans. Crisis prevention, mitigation, preparedness, response and recovery must be addressed in the grant proposal. Partnerships within the community are also required.

Implementation of automated emergency preparedness and response tools by a school or school district would appear to be a viable basis an application for the OSDFS grant program. Detailed information about the grant program, and related grant materials can be obtained by visiting the Department of Education Grants website: http://www.ed.gov/fund and browsing the education programs by topic.

DHS Assistance to Firefighters (AFG) Fire Prevention and Safety Grants

For 2006, the U.S. Department of Homeland Security (DHS) has set aside $32.5M for its Fire Prevention & Safety Grants. This grant program is not limited to schools but emphasizes support to local fire responder agencies. Some grants to schools and to school districts have been made under this grant program. The aspect of automated emergency preparedness and response systems that allows for before the fact access of school floor plans and other data, by firefighters for their own planning purposes would tend provide a nexus between a school seeking to implement an automated system and the Fire Prevention and Safety Grant. More information on the Assistance to Firefighters, Fire Prevention & Safety Grants can be found on the Assistance to Firefighters Grant Program website:
http://www.firegrantsupport.com/fp_about.aspx.

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Author Biography

Christopher D. Hekimian received a Masters of Science degree in electrical engineering from the California Polytechnic University in Pomona in 1995, and received his Doctor of Science in Systems Engineering and Engineering Management from the George Washington University in Washington, DC, in 2004. As a software engineer and policy analyst, Dr. Hekimian has co-Authored 3 papers related to emergency management or homeland security. Dr. Hekimian founded DXDT Engineering and Research, LLC, a company that performs research consulting, patent development, and engineering, in 2003

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RESPONDING TO BIO-TERRORISM WITH THE AID OF HAZARD MODELLING

Alan Jones [1]
Warwickshire County Council – Emergency Planning Unit
Coventry University – Centre For Disaster Management

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Abstract

Terrorism has for many years been a phenomenon which has shocked the public and challenged the emergency management community. The atrocities of recent years have further astounded everyone with an era of suicide bombers, and the threat of weapons of mass destruction, particularly biological weapons. Although this threat of bio-terrorism is not new, and attacks with conventional weapons are thought likely to predominate, the threat cannot be ignored.

Tackling this almost unthinkable threat is however made more difficult, as there are few historic incidents as a point of reference for risk assessment and planning. In an attempt to bridge this gap, capabilities have been developed known as hazard prediction modelling, which enable the simulation of incidents and their associated impacts.

This paper presents the results from research intended to make an assessment of such capabilities and the improvements offered by their use to emergency management professionals in planning for and responding to bio-terrorism. The paper first examines the nature of the threat before going on to examine current methods of impact assessment / prediction, and the requirements of core responders of hazard modelling, which may be used to inform the future development and enhancement of such capabilities.

Introduction

The number of terrorist incidents has decreased considerably since the 1980's. Yet with attacks like that of September 11 in New York and Washington and the recent London bombs of July 2005, it is clear that this phenomenon is not waiving, and the threat of terrorism remains. In fact despite the number of incidents having halved, the lethality of the remaining incidents has dramatically increased resulting in fifty percent more fatalities (Karmon, 2002) (Barnaby, 2001:17). A further change to the threat is the indiscriminate nature of recent attacks demonstrating an unashamed willingness of terrorists to maim and kill innocent civilians on a mass scale, with almost no consideration for their own lives (Gearson, 2002).

The use of conventional weapons (i.e. explosives), have undoubtedly predominated in recent years with incidents link the Bali, Madrid and London bombings and it is recognised that this trend will likely continue in future. There is however evidence to suggests that terrorists seek

[1] Tel: +44 7712582409
Email: alanbjones@hotmail.com or alanbjones@warwickshire.gov.uk

ever more extravagant and devastating means of terrorism using weapons of mass destruction, which through just their very mention cause anxiety and gain media and subsequently public attention to the objectives of the terrorists, suggested by some to be a keen aim of many terrorist groups (Deshowitz, 2002).

A clear demonstration of the use of such weapons came in March 1995 when the Aum Shinrikyo cult mounted attacks using Sarin on the Tokyo subway (Combs, 2003), which was considered to have "broken the taboo in the use of weapons of mass destruction" (Karmon, 2002:122). Despite the attacks causing wide scale disruption and panic they were considered largely futile due to the primitive and ineffective method of dissemination, demonstrating the difficulties faced by terrorists in the use of weapons of this kind (Dhawan et al, 2001). It is disputed however that with a change from the independent terrorist groups of the 70's and 80's to co-ordinated networks of disparate groups with similar aims such as Al-Qaida, who are able to pool knowledge and resources, initiating such attacks successfully is within closer reach of terrorists.

Biological weapons (defined as "any organism or toxin found in nature that can be used to incapacitate, kill, or otherwise impede an adversary" (Richards CF et al, 1999:184)) have become a increasing focus of international terrorists and dictators over the past 30 years who have been seen to be making continued efforts to obtain and produce them (Hoge, Rose, 2001). The reasons for their appeal being that biological weapons are low cost (in comparison to other weapons), are the hardest to detect and trace, can cause widespread panic and disruption without killing many or any people, and are the most complex to mitigate against and many have the possibility of secondary transmission (Simon, 1997, Karmon, 2002, Granot, 2000). Some suggest (Richards, et al, 1999) that there are however disadvantages to the terrorist from the use of biological weapons including the dangers in producing and handling the agents, though as cited earlier (Gearson, 2002) and demonstrated by many recent attacks including the London Bombings, terrorists have demonstrated that they often have no consideration for their own lives.

The threat from biological weapons was further compounded by the anthrax attacks in 2001 (Curr & Cole, 2002) and several public statements by terrorists since indicating an ongoing interest in the development of improvised biological weapons. This re-enforces the fact that biological weapons are no longer a hypothetical concern confined to fictional thrillers and rare policy discussions (Brusstar, 2002) but that plans and capabilities must be in place to ensure the world is ready to respond.

It is considered the most likely means of distribution by the terrorists utilising biological weapons is the release of the agent into the air as a biological aerosol ("a stable cloud of suspended microscopic droplets of bacteria or virus particles", Simon, 1997:429). Distribution via explosive processes is undesirable because of the likelihood that the organisms will be destroyed during the explosion, and distribution via water supplies is seen to be a less appealing due to the large amount of biological agent which is required mainly because of dilution factors and water purification procedures which extract bacteria (*ibid.*1997). Dissemination of biological agents using aerosols is however not without its problems and in order to be effective the agent particles would need to be refined to 2µm which is a complex procedure requiring specialist knowledge and equipment. Despite this, aerosolisation is considered the most effective means of distribution and depending on the atmospheric conditions could result in clouds of infectious materials carried over hundreds of kilometres.

It is believed that estimation of the dispersal of the material will be a critical element in preparing for and responding to such attacks, though unlike estimations of the impacts of plane crashes which can be made based on passenger and crew manifests, estimating the plume of hazardous materials is much more complex. Such hazardous areas can be defined however using a concept of Crisis Prediction (hazard modelling), which has gained appreciable momentum in recent years and which enables the identification of hazardous areas such as those created following a biological release (Swiatek & Kaul, 1999).

Hazard models are tools, which enable probabilistic prediction of hazards, represented on a rectangular grid (X, Y) (Hunting Engineering, 2000). In order to create such models input files are required which describe the circumstances of the hazard i.e. what, where and when. Through the use of complex particulate transport equations it is then possible to produce hazard files, which define the hazard 'footprint' or 'template' (Hunting Engineering, 2000, & Science Applications International Corporation, 2002a/b). This output can then be manipulated in conjunction with other grid format files (databases) to analyse the hazard further.

Hazard modelling is predominantly used as a decision aid for consequence management following the immediate onset of disasters. It also has the capacity however, to be used in other practical applications in emergency management including contingency planning, validation of emergency response plans, training, exercising, and post incident evaluation.

This paper presents the results from research, which seeks to evaluate these models and to identify how they may be utilised to assess the risks and the impacts of a biological attack on an unprotected civilian population. Conclusions will then be drawn on how these models may improve the effectiveness and safety of response should such a threat become reality.

Theory and Method

Research began with an extensive literature review to identify the vast arsenal of biological weapons, which are obtainable, their most probable forms of dissemination and their impacts on unprotected populations. This literature review also sought to review existing hazard modelling environments which are being developed or which are in current use, and any studies relating to their offered improvements to disasters involving biological weapons.

Secondly a number of questionnaires were distributed to core responders identified as having a role in preparing for and responding to a CBRN incident in the UK, according to strategic national guidance. This element of the research sought to identify current adoption and awareness of hazard modelling, alternative / current means of impact assessment and desired user requirements and attitudes towards hazard modelling.

Finally using the information gathered during the literature review it was possible to generate a number of probable scenarios, which could be simulated using hazard modelling to evaluate the benefits and performance of current capabilities, and potential uses of their output. This was also important in corroborating the responses from the questionnaires.

The model chosen for this experimentation was based upon its applicability to model a bio-terrorist incident in the United Kingdom, its reputation and positive reputation of verification and validation. The final consideration and one, which was considered to have significant influence for the end user, was finance.

Based on this information one such model was identified, the Defence Threat Reduction Agencies, Hazard Prediction and Assessment Capability (HPAC). A forward deployable, Nuclear Biological and Chemical (NBC) hazard prediction capability, which is stated to accurately predict the effects of a hazardous material release into the atmosphere and evaluate the subsequent collateral impacts on the civilian and military populations.

The software uses integrated source terms, and an array of terrain, land-use and meteorological data (i.e. climatology, high resolution weather forecasts and real-time observations), and particulate transport algorithms to model hazard areas and human collateral effects in minutes. Its use is designed for both operational users (i.e. those users responding to actual or expected events) and analytical users (i.e. those involved in research and development). (Science Applications International Corporation, 2002a).

Results

The literature review identified up to seventeen hazard modelling capabilities able to simulate the dispersion of biological agents used as weapons. Despite such capabilities being available and widely used in the United States however, adoption in the UK was limited to just one quarter of those involved in the questionnaire. Furthermore current means of consequence assessment were considered largely inadequate with respondents to the questionnaire citing either blind estimation or reliance on others with no obvious pattern or justification for their response. This is considered to largely be the result of a misunderstanding of the roles and responsibilities of those authorities resulting from confusing and sometimes conflicting guidance.

Despite limited adoption and even awareness of hazard prediction modelling significant interest was expressed as to its potential to assist in planning and responding to incidents of bio-terrorism, though its use as identified during the research has both advantages and disadvantages.

<u>Advantages of Hazard Modelling</u>

The advantages were many and varied throughout the disaster cycle, identified below:

1) Preparedness Planning
The importance of risk assessment and the need for planning, which is soundly based upon it is vital if the authorities are to ensure the adequacy of plans and capabilities to respond. Though with little known experience of bio-terrorism, it is difficult to assess the risk or plan logistics for such an eventuality if it is not possible to estimate the likely consequences. With the advent of hazard prediction modelling though it is possible to develop worst-case scenarios on which to assess vulnerability and assess potential response requirements, including decontamination and adequate stockpiles of antibodies for treatment.

2) Training and Exercising
In addition to having sound plans in place for a bio-terrorist attack, implementation and monitoring of these is essential and is achieved through training and exercising. Though again visualising this almost unthinkable threat can be difficult.

Hazard modelling provides trainers and those preparing exercises with a platform on which they have the ability to create illustrative scenarios, with tangible materials for those involved creating a greater sense of realism, increasing the chances that those involved will gain an accurate understanding of the challenges faced. Furthermore hazard modelling enables numerous scenarios to be created developing broader thinking of those being trained of the likely responses required and more comprehensive testing of procedures under various scenarios.

3) Response
Once a biological attack is suspected it is important that steps are taken to determine exposure risk, and the potential effect[s] to define the needs from both local and national resources. Identified in the research as the phase in which questionnaire respondents would find hazard modelling most useful, during the response phase there are numerous benefits of the use of hazard modelling perhaps most crucially the protection of life and to do this it is vital to

provide adequate warning and advice to members of the public. By using hazard modelling it is possible to estimate the likely spread of the agent in the atmosphere and from this develop strategies for evacuation or shelter, and determining areas where responders would need to use personal protective equipment.

Early assessment of the impact will allow specific, targeted and prompt treatment, and provide a greater window of opportunity during which prophylaxis by response agencies and the public will be more effective and thus save lives (Simon, 1997). It is commonly recognised there is a need for better strategies for mobilising and co-ordinating the vast resources which would be required to respond to a bio-terror attack, increasingly important as extensive pressures are likely to be placed on these.

Hazard modelling will enable rapid forecasting of contaminated areas and determination of where these would be most appropriately and effectively deployed, for instance those most likely to benefit from medical intervention, or those who require immediate isolation if any secondary contamination is to be contained. By using these estimations it will also be possible to identify potential number of casualties so as to identify appropriate hospital space, and mortalities so that appropriate mortuary arrangements can be put in place.

Using the output from the model it may also be possible, with interrogation of underlying Geographic information, to identify and evaluate the secondary hazards of the release. For instance if the bio-plume crosses a freshwater reservoir which serves the local population with drinking water then it may be necessary to restrict this source until it is tested for contamination.

Finally in the longer term mitigation of the impacts hazard modelling can assist by providing damage and loss assessments, such as those areas, buildings and critical facilities, which will likely be inaccessible due to contamination, and also be used to inform the longer term economic consequence assessment.

4) Post Incident

The importance of isomorphic learning (Toft & Reynolds, 1997) cannot be underestimated if future improvements are to be made to response tactics, and be better prepared for such disruptive events as a bio-terror attack. Hazard modelling assist in this endeavour by allowing the incident to be re-created allowing decisions to be evaluated and lessons learnt.

<u>Disadvantages of Hazard Modelling</u>

Despite the many benefits of hazard modelling there are also a number of uncertainties, some significant to suggest that current technologies are not adequate to support such rapid and dynamic response.

1) Reliability and availability of data
Firstly the output created from such models is clearly only as good as the input data used for their calculation. The research revealed that the reliability and availability of input data required for such modelling is questionable. Foremost is that by its very nature terrorism is unpredictable and with a biological attack likely being covert, may go unrecognised for hours or even days, and with hazard modelling reliant on real time information this immediately negates its use. The only way it is thought such information and intelligence could be obtained is through use of air sampling devises, though these would be dependant upon their strategic placement, and would also be extremely expensive.

As well as the user input information the reliability of the incorporated data of such models was found to have inconsistencies when compared with other data sources. Firstly in the case of population data there appeared to be no consideration for variables such as night and day population migration known to illustrate significant differential in major cities, furthermore at a national level, population numbers varied between data sets compared by up to two million, though comparability at a sub national level was much more accurate.

Location inconsistencies where also identified as a problem as numerous co-ordinate systems are being used across the world, some seeing the world as spherical, some flat and some based on one continent alone. The result is that the co-ordinates of a location may not match in each case. Scalar differences of these inconsistencies ranged from 0.7 km to 11.4 km.

2) Reliability of Models and Output
Despite this, general option of those involved in the research revealed the considered reliability of such models was good. In fact such models as that used in the research have undergone extensive validation and review with the developers claiming they are more than ninety percent accurate. The experiments carried out also supported this with close comparability with other estimates, though the question remains as to the accuracy of any such prediction until there is a measurable CBRN event occurs and such predictions remain speculative.

The reliability of the output from such models is also questioned as many of the models base consequence / impact assessments i.e. casualties / mortalities, on the likely collateral affects on fit military males. Considering the normal composition of the average society including elderly, infirm and the young the resulting consequences could be worse than estimated.

In addition those models identified during the research appeared to have no consideration of the likely impacts of population dynamics, particularly important where the agent released has the potential for secondary 'person to person' transmission.

3) Resource Demands
In addition to the disadvantages noted already a particular reason why hazard modelling may not be widely adopted in the UK as cited by questionnaire respondents is the demand they place on resources both financial and physical (i.e. workforce).

Firstly the cost of procuring such models is considered to be high, and with the exception of HPAC used in this research and available free of charge, with a government sponsor, many of those models found to be available cost several thousand pounds.

It is also considered that a great deal of expertise is required to operate such models requiring significant training time for staff. The research revealed that extensive training materials where available to enable in house training saving time, though to attain an adequate level of proficiency level to operate and understand the output took considerable time.

4) Model appropriate risks
The final key disadvantage of current hazard modelling capabilities considered their ability to model appropriate and current threats.

Firstly all models evaluated as part of the research had only the ability to predict the consequences of a malicious release of a biological substance into the open air. Conversely it is as likely that terrorists will initiate such attacks within buildings or enclosed environments such as the London Underground, demonstrated by the attacks on 7th July as a target of terrorists. It is known however that such capabilities are being developed for the future.

Secondly although it is recognised that the threat of bio-terrorism remains, it must be understood that the targets and consequences may not always be humans, and may in fact be crops and livestock i.e. agro-terrorism, which could create scenes similar to the foot and moth outbreak of 2001. Current hazard models found during the research do not have the capability to model such impacts, which should be considered.

Specification for the Future

The research has established that hazard modelling may aid the response to a bio terrorism incident though there are also many difficulties faced through its adoption, and areas in which improvements are required. Those involved in the research identified the following abilities of future hazard prediction modelling capabilities, which were desirable:

1. Hazard area display Incl. measure of uncertainty
2. Ability to predict likely casualty rates
3. Ability to predict likely mortality rates
4. Ability to evaluate various counter measures e.g. evacuation / shelter
5. Ability to determine personal protective equipment requirements
6. Consideration of the effects of population movements on any possible spread
7. Ability to evaluate long term impacts (e.g. environmental, economic & social)
8. Ability to model the impacts of releases in confined / enclosed spaces

Conclusions & Recommendations

Adoption of hazard prediction modelling is low in the UK and current methods of prediction / consequence assessment largely inconsistent. Strategic national guidance of CBRN response does not however clearly establish with whom responsibility for such assessments will rest, and this results in an inconsistent and inadequate response. It is therefore recommended that there is a need to:

- Clarify roles and responsibilities and promote a co-ordinated approach to initiatives relating to hazard modelling following CBRN incidents.

The research found that despite the uncertainty of responsibilities there were a number of planning and operational requirements, which could not be met with those assessment techniques currently used, particularly the ability to estimate the physiological effects of a bio-terror attack. Though despite this understanding of the need for information of this kind adoption of hazard modelling in the UK is limited, perhaps as identified during the research because of a lack of awareness and understanding of hazard modelling. Furthermore the vast array of seemingly competitive modelling capabilities, makes any choice difficult unless people are aware and understand their strengths and limitations. It is therefore recommended:

- Training and awareness be developed and delivered to highlight the strengths and weaknesses of hazard modelling capabilities

- A central point be established where emergency managers may receive impartial information and comparison of the available modelling capabilities.

Comparison of user requirements with current capabilities however identified various needs which were unsatisfied illustrating a need for further research and development. It is realised that the development of a 'perfect' hazard prediction capability may be some way off though it is felt with greater co-ordination of developments, this will be made easier. In fact it is understood that research continues regarding the development of capabilities for use in the UK, by government and the military, though much of this is appears to be done in isolation and without fully considering end user requirements. It is therefore recommended that:

- Both national and international working groups on consequence / hazard modelling be set up to united researchers and developers from the public and private sectors, academics, emergency management and response professionals and other relevant experts to co-ordinate the future developments in a comprehensive and co-ordinated manner.

In addition to the models themselves it has been identified that a number of uncertainties exist relating to the supporting data for such capabilities. As with the hazard models themselves however users are faced with a confusing array of sources for the data to support such calculations. It is recommended therefore that:

- A comprehensive study of data capabilities and limitations is undertaken by an independent body to ensure that those using them can be assured of their accuracy and appropriateness, and where there are deficiencies these be addressed.

The uncertainty involved in modelling biological releases is clearly evident in relation to the data used but the underlying methodology and algorithms are also an important consideration. Full analysis of these was neither within the remit nor capabilities of this research as they concern detailed mathematical models, however the information, which informs them, has been highlighted by the research as a cause for concern.

Atmospheric dispersion clearly is not an exact science and as, illustrated earlier in the paper a number of external factors influence the behaviour of any plume. When considering the likely impacts of a biological release however there are added uncertainties. Firstly with little know experiences and data available in relation to such terrorist incidents in the past there is little opportunity to evaluate the resulting outputs. Furthermore impact assessments in many of the models available appear to be based upon the effects on young health military males (Defence Threat Reduction Agency, 2002). This clearly does not illustrate the demographics of the average UK community, and thus the impacts experienced could be significantly different. Based on this it is felt important to recommend that:

- Clear information be given to emergency responders and managers to ensure they have a realistic understanding of the uncertainties involved in modelling predictions and the variability to be considered.

In relation to this uncertainty factor is the ability of existing hazard modelling capabilities to consider the current threats posed by terrorist, and thus meet the requirements of the emergency community. For instance all of the models evaluated as part of this research were found to have a limited range of biological agents to choose from, including those known to have been considered by terrorist groups. Furthermore the ability of the models to accurately predict releases in areas, which are thought to be, and suggested by terrorists as targets such as urban and enclosed (e.g. buildings, underground transport system) environments is limited.

Urban environments particularly have complex local topography, which lead to local wind patterns carrying the contaminant in unexpected directions. Many of the hazard modelling capabilities are known to based on a 30m building canopy which clearly does not represent major cities in the UK or the rest of the world, and therefore pay little consideration to such meteorological phenomenon, which could lead to inaccurate assessments (Beriwal & Merkle, 2001). Secondly in relation to the considered release of biological releases within enclosed environments such as underground transport networks as was demonstrated by the 1995 Sarin attacks in Tokyo (Fountain, 2002), very few capabilities exist and little research is known to have been conducted in relation to the airflow patterns in such environments. It is therefore finally recommended that:

- Consideration should be given to developing profiles within existing models for an extended list of agents, including those which are naturally occurring but which could be adopted as weapons (i.e.influenza).

- Further research to characterise the local wind flow patterns in urban areas, and enclosed environments to inform the development of appropriate modelling capabilities.

It is important of course to tackle the causes of terrorism at the root, but terrorism is an ever-evolving phenomenon and one, which it may not be possible to eradicate. It is though also impossible to estimate the precise likelihood of a terrorist attack involving biological weapons, though clearly the threat cannot be underestimated. Consideration must be given therefore to whether full use is being made of science and technology to counter these threats, technologies like hazard modelling.

"It is a significant challenge to prepare for an unknown event" (McFee, 2002), but it is the unknown to which the world is most vulnerable. Hazard modelling, is one way in which this unknown can be simulated and through this enable the preparation of more robust plans and response strategies. Clearly the capabilities developed to date have some way still to go though, as previous studies have shown a favourable interest exists in hazard modelling amongst the emergency planning community (Amat & Athwal, 2001). Despite this however efforts to provide such capabilities for the emergency management community in the UK, have been thwarted by lack of funding and restructuring of services. It is now vital that partnerships be built and a co-ordinated and consistent approach taken to ensure preparations are put in place to for asymmetric attacks such as those involving biological weapons, to address the resource and information gap, which exists.

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Author Biography

Alan is currently an Emergency Planning Officer, for Warwickshire County Council in the UK, where he is responsible for various aspects of emergency management ranging from risk assessment, business continuity, mass fatality planning, and the development & use of GIS across the work area.

Alan has a Bachelor of Science (BSc Hons) in Development and Health in Disaster Management (2002) and has recently completed his Masters degree (MSc) in Disaster Management at Coventry University – Centre for Disaster Management, researching the use of hazard prediction modelling to improve planning and response to bio-terrorism in UK.

In addition to Alan's current role he has also worked in Emergency Management across all levels of government in the UK. Firstly central government (Home Office – Emergency Planning Division) where he worked as part of the scientific research group developing hazard modelling, and other areas in support of EPD objectives. The findings of which were ultimately disseminated and used in the development of effective national arrangements for integrated emergency management. Alan has also worked for the Government Office for the West Midlands where he was seconded to assist in the development of the largest live CBRN exercise to be held to date in the UK.

A PRELIMINARY STUDY ON QUICK ESTIMATING MODEL OF EARTHQUAKE CATASTROPHE -AN EXAMPLE OF PAKISTAN EARTHQUAKE

QU Guosheng[1], LI Yigang, LI Yanfeng, NING Baokun
National Earthquake Response Support Service

HUANG Jianfa
China Earthquake Administration

Key Words: Earthquake catastrophe, Disaster Situation, Quick Estimation Models

Abstract

This paper discusses the mainly affected factors of earthquake catastrophe estimation, including the earthquake parameters (time, magnitude, epicenter, depth), properties and strike of the earthquake fault, the density of population and distribution of economic values, the ability of anti-earthquake level of buildings, the sites and topography conditions, etc.. By the systematical analysis of some recent global strong earthquakes cases and the affected factors for quick estimating of catastrophe, four types of models are suggested, that are, the mountain collision of Himalaya-Tethys, the subduction zone of oceanic plates subducting to continents and islands, normal faults and continent rifts, and transform faults under the ocean floor. The comprehensive mechanisms of catastrophe formation and the possible catastrophe areas or belts are suggested.

Introduction

Since 1994, the projects on urban seismic hazard and losses assessment near 30 cities have been done in China, and also each provincial center on emergency management and decision-making have been established (Chen, 1995, Qu, 1996, 1999, 2003, Feng, 2004). Many developments on risk assessment, emergency management and emergency responses have achieved in the world in recent years (Walker, 2005).The problem for emergency response is how to make quick prediction of potential disaster after the large earthquake occurred, if the large earthquake will result in the catastrophe, especially for rural area. By the systematical analysis of some recent global strong earthquakes cases and the affected factors for quick estimating of catastrophe, four types of models are suggested in this paper.

The Definition of Earthquake Catastrophe and analysis of related factors

The Definition of Earthquake Catastrophe

The mean of earthquake catastrophe is not sure at present. Gao (1997) suggests that the mean of earthquake catastrophe is determined when the casualty is more than 10000, and direct economic losses is more than 10 billions RMB in one case. In each case that has been aids by international city search and rescue teams, the death number is more than 2000 in recent

[1] Email: Qgsh@263.net

years, for example, in Jiji earthquake of Taiwan with magnitude 7.3 in 1999, the death is 2412, and direct economic losses are 10 billion US dollars, Gujarat earthquake in India with magnitude 7.6 in 2001, the death is more than 40000, and direct economic losses are 2.1 billion US dollars, Algeria earthquake with magnitude 6.8 in 2003, the death is 2273, and direct economic losses are 0.5 billion US dollars, Bam earthquake in Iran with magnitude 6.3 in 2003, the death is more than 31000; Gujarat earthquake in India with magnitude 7.6 in 2001(Qu, 2001), the death is more than 40000, and direct economic losses are 2.1 billion US dollars; India ocean earthquake and tsunami with magnitude 9.0 in 2004, the death is more than 30,0000, and direct economic losses are 100 billion US dollars; Pakistan (or South Asia) earthquake with magnitude 7.8 in 2005, the death is more than 8,7000, and direct economic losses are 10 billion US dollars. Based on the cases above, the mean of earthquake catastrophe are: the death people will be over 1000, the direct economic losses will be over 10 billion US dollars.

The Main Affected Factors of Earthquake Catastrophe

The main affected factors of earthquake catastrophe include parameters of earthquake (such as the time of earthquake, magnitude, epicenter, depth of epicenter), and the seismotectonics background and their spatial distribution (normal fault, thrust fault, strike-slip fault or both kinds of faults), the abilities of anti earthquake of buildings, site conditions and social (population) and economic distribution and their density.

Case analysis of recent global strong earthquake

Fast estimating the degree of earthquake damage and giving the decision and advice is very important to emergency relief action startup after a Ms>7.0 earthquake. Quick disaster damage adjustment is affected by lots of factors from the following recent strong earthquake cases.

Magnitude 7.5 – Northern Peru

According to this event details (Talbe1), the inferred results are as followings: Its magnitude is 7.5 and the epicenter is located in the front of eastern Andes foothill where there are several cities with high population, so the earthquake may cause great damage and casualties. The depth released by the United States Geological Survey (USGS) immediately after this earthquake is about 85.4km, which belongs to middle-deep type and may cause a few casualities.But the epicenter is loacated on the east of Andes about 400km from the western coast of the South America (Fig.1), and based on the studies, the Pacific ocean plate underthrusts toward the Puru segment of Andes by the angle of between 20 and 30, we can estimate that its depth is about 150km and will cause less damages in this event. One day after the earthquake, the recaculated depth is 132.3km and two people killed by news report form Puru government.The estimaiton of local depth is crucial to this event which is based on the caculated depth by global seismic stations and local tectonic background.

Magnitude 7.6 - Pakistan

According to this event details (Talbe1), the inferred results are as followings: Its magnitude is 7.8 and the epicenter is located in the front of Himalaya foothills. The depth is about 10-15km. We can infer that this earthquake occur on the main boundary thrusts (MBT) where the historical earthquakes had caused great damages and casualties (Fig.2). Additionally, the earthquake happened in the scenic spots of northern Pakistan where lots of cities and villages are distributed with dense population, so this event can cause huge damages; Disaster news from Internet and Media come more from Islamabad and surrounding area where the tremble is felt obviously. But there is little news about extensive damage after 3 hours, the north Pakistan has little report after 2 hours which may be due to traffic and communication interruption, forming the "blind stage" of devastated earthquake. Based on the above analysis, we give the great disaster relief advice after 2.5 hours.

Table 1 Case analysis of recent global strong earthquake and fast related disaster assessments

Region	Date-time Local	Magnitude Ms	Location		Depth km	Fault type	population	damage
			latitude	Longitude				
Northern Peru	05, 09,26,18:55	7.6	5.657°S	76.4 W	132.3	subducted zone	more	light
Pakistan	05, 10, 08, 08:50	7.8	34.4N	73.6W	10-15	Thrust fault	more	catastrophe
Congo-Tanzani	05,12, 05, 14:19	7.0	6.1S	29.7E	10	Rift-normal fault	more	light
East of the south Sandwich islands	06, 1, 2, 7:10	7.5	60.8S	21.4W	Not clear	Transform fault	no	no
Mozambique	006 2, 23, 0:29	7.5	21.1S	33.2E	10	Rift-normal fault	less	light

Fig.1 Plate tectonic map of Peru 7.6 earthquake

Fig.2 Disaster information map of Pakistan Earthquake Real line involved: part damaged area, dotted line involved: no disaster reported area

Because the earthquake mechanic fault is in the front of Himalaya front thrust belt with north-west verging hanging wall and 20-40°angle of dip. According to the past damage distribution of the earthquake induced by thrust faults, the macro-epicenter and micro-epicenter are different, so we infer that the macro-epicenter should lie in north-west of micro-epicenter. The inferred results are approved by relief action and disaster evaluation after this event.

2.3 Magnitude 6.8 – Lake Tanganyika region, Congo-Tanzania

According to this event details (Talbe1), the inferred results are as followings: Its magnitude is 7.0 and the epicenter is located in the Lake Tanganyika region. The depth of epicenter is about 10km and shallow earthquake affecting Congo, Tanzania, Kenya, Zambia and Burundi, so this event may cause great disaster. The earthquake occurred in the East African rift system with a serious of normal faults. The earthquake generated faults may be on the east normal faults of the rift dipping to the west. The west Lake Tanganyika region and nearby cities may be the heavy disaster area. Because the Kalemie city is 50km away from the epicenter, the inferred intensity is near VII VIII (pic.3) (based on the estimation of intensity) and will have some loss. On the basis of analyzing the building earthquake resist, the casualties may be little. We concluded that there were no great losses and this conclusion was verified by local newspaper after 2 days, only 7 persons were killed by this earthquake in the Kalemie city.

<u>Magnitude 7.4 –East of the South Sandwich Islands</u>

According to this event details (Talbe1), the inferred results are as followings: The earthquake occurred on the east of the south Sandwich island of south Atlantic Ocean which is the transform faults affected region under the Atlantic and Pacific Ocean floor. The earthquake generating tectonic should be large scale transform faults forming the arcade islands such as

Bird island and Edward Prince island (Fig.4). Although the sea water is deep, the transform faults have strike slip characters and little vertical rupture displacement, so the hazard of tsunami is little. Because the surrounding islands are far away from the epicenter (about 300-500km), we infer that there should be little losses from this earthquake.

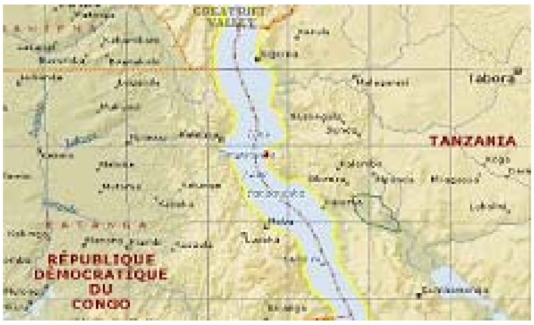

Fig.3 Map of earthquake epicenter of Democratic Republic affected of the Congo and Tanzania area

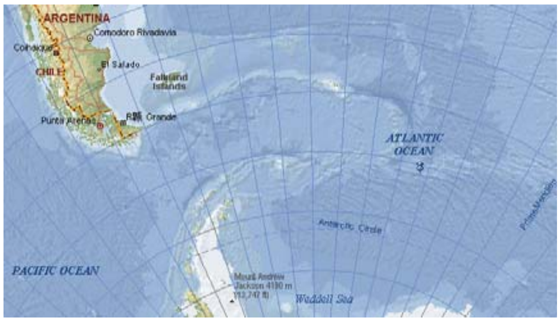

Fig.4 Sea floor topographic map of earthquake

Preliminary establishment of quick estimating model of earthquake catastrophe

From the above analysis of strong earthquake cases, the different disaster damages can be caused by the same magnitude earthquake with different depth, epicenter, time and social economic situations. Such as the Ms 7.6 earthquake which caused great loss in the North Pakistan but little damage in the Peru and South Atlantic ocean area. On the conditions of close magnitude and depth, different epicenter and fault type cause different losses such as the great losses in the Pakistan while little losses in the Kago-Tanzania. On the same conditions of seafloor earthquakes, the tsunami occurred in the Indian Ocean and caused great casualties while less loss in the South Atlantic Ocean. On the basis of the above analysis, quick estimating models of earthquake catastrophe are classified as followings:

<u>Mountain collision type of Himalaya-Tethys</u>

This type is thrusting or continental strike-slip faults as earthquake generating structure which runs cross Pyrenean, Alps, Atlas, Mediterranean Sea, Zagros and Pamir-Himalaya earthquake belts from west to east. Most earthquakes belong to shallow earthquake except the middle depth earthquake in the Pamir and occur in the mountain ranges or its front where lots of developing countries have poor earthquake resist buildings and dense population. The micro-epicenter and macro-epicenter have different locations. When the magnitude is more than 7.0 and depth is between 5 and 30km with dense population, the great losses are along the fault strike or hanging wall such as 1999 Turkey Ismit earthquake, 2003 Algeria earthquake, 2003 Iran Bam earthquake and 2005 South Asian earthquake.

<u>Subduction zone type of oceanic plates subducting to continents and islands</u>

This type is mainly include the earthquake generated subduction zones surrounding Pacific and India Oceans, include subduction seismic zones surrounding Pacific (Andes, Cordillera mountains, Alaska, Aleutian island, Japan-Nansei Shoto, Taiwan, Philippine, Papua-New Guinea, Tonga and New Zealand et al) and Indonesia, Banda Sea Arc, many times earthquake generated tsunamis occurred in history. Due to the subducting angles are different in different parts of Pacific and India Oceans, so to determined the depth of epicenter depends on the subducting angles is very important, and then to consider if the epicenter located in the high dense population area. Historical records show that Japan, Alaska, and North American countries will has less damage when the earthquake magnitude near or less 7.5 occurred, but the Indonesia, Philippine, Papua-New Guinea, Tonga and South American countries will have huge damages in the same conditions (earthquake magnitude near or less 7.5).

Normal faults and continent rifts

The seismic structure is normal faults, normal slip faults and rift in areas of this type, such as the East Africa Rift and the North China Rift Valley. Because the source depth is usually shallower than 20Km in such plain area and cities distributed with high dense population. Strong earthquake can cause catastrophe, such as the Tangshan earthquake Disaster that happened in China in 1976.

Transform faults under the ocean floor

Seismic structure in areas of this type is large scale transform faults. Ordinarily, earthquake occurring in such area will not induce catastrophe, such as the Richter magnitude 7.5 earthquake that occurred in the South Atlantic Ocean. A Richter magnitude 8.7 earthquake that occurred in the Northwest Atlantic Ocean induced a tsunami that caused more than 50,000 fatalities in Portugal and Spain in 1755.

Comprehensive analyses of affected factors for quick estimating of catastrophe

Above analysis results following relationship between the affected factors and the catastrophe intensity:

Disaster Degree = Magnitude * Depth * Fault type
Disaster losses = Disaster degree * Population density * Vulnerability

In generally, catastrophe will quite likely occur in the land area if the earthquake magnitude is larger than 7.0, the source depth is shallower than 30Km, and the epicenter is in urban area, and the disaster happens in developing country or territory.

If the earthquake magnitude is larger than 7.0, the source depth is shallower than 30Km, the depth of the water in the epicenter area is deeper than 4000m, a tsunami will quite likely happen and induce a catastrophe in the sea area. Otherwise, if not all the factors meet above condition, a catastrophe probably will not happen.

Conclusion

This paper discusses the mainly affected factors of earthquake catastrophe estimation, including the earthquake parameters (time, magnitude, epicenter, depth), properties and strike of the earthquake fault, the density of population and distribution of economic values, the ability of anti-earthquake level of buildings, the sites and topography conditions, etc.

By the systematical analysis of some recent global strong earthquakes cases and the affected factors for quick estimating of catastrophe, four types of models are suggested, that is, the mountain collision of Himalaya-Tethys, the subduction zone of oceanic plates subducting to continents and islands, normal faults and continent rifts, and transform faults under the ocean floor.

The comprehensive mechanisms of catastrophe formation and the possible catastrophe areas or belts are suggested.

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Author's Biographies

Dr. QU Guosheng, Prof. and Chief Engineering, National Earthquake Response Support Service, China Earthquake Administration. He has applied his research achievements to the prevention and mitigation of seismic hazards in China and achieved breakthrough progress in such fields as urban disaster emergency management, the application of geographical information systems (GIS) and remote sensing (RS), three-dimensional underground structure modeling for urban areas, exploration of active tectonics, regional seismotectonics and petroleum structural geology. Qu is also an instructor of doctorate candidates in the Institute of Geology, CEA.In 2005, he participate the South Asia Earthquake search and rescue action in Pakistan as a team member of CISAR.

Dr Li Yigang, currently associate professor of national earthquake response support service, China earthquake administration. Research interests include earthquake disaster prediction, emergency management, GIS&RS application and 3D Structure modeling.

DEVELOPING AN EARTHQUAKE LOSS ESTIMATION PROGRAM FOR TURKEY

Muhammed Şahin[1] and Himmet Karaman[1]
Istanbul Technical University

Keywords: Disaster, risk assessment tool,preparedness,mitigation, response, recovery.

Abstract

To protect the Turkish society, business sector, buildings and lifelines from the earthquake, Turkey and United States, aim to develop a risk assessment tool. This tool will be based on HAZUS (Hazards US) system which was prepared by FEMA to assess multi hazards. HAZUS is used nationwide to mitigate the long term effects of the natural disasters on human life at social and economic areas. The product of this project will be named as HAZTURK (Hazards Turkey). The designing HAZTURK program will help on natural risk management, program development, development of the current lifelines of Turkey according to the seismic hazards, and designing more stable economy in addition to development and testing of methods for hazard characterization.

The proposed tool will support;

- Decision support for disaster mitigation: the evaluation of alternative scenarios for land use changes, building upgrades, and infrastructure improvements.
- Response, recovery and redeployment following disasters: determining which areas need help more and which areas are the most efficient the help.
- Planning for response and recovery efforts before disasters strike: fire, rescue, and health care needs, resources and lifelines.
- Finding new research areas: characterizing earthquakes, defining building fragilities, and improving data sets.

First of all a demonstration project will completed on a selected municipality of Istanbul to check if the results are consistent. This will help to develop more coherent loss estimation analysis and risk assessment. The aim of this demonstration project is to;

- Provide cost effective and reliable computer and GIS based risk assessment tool that supports risk management.
- Support mitigation efforts at disasters by evaluating alternative land use changes, development of building codes, building upgrades and substructure improvements
- Develop the earthquake knowledge of the community at the regional, provincial, and national levels.

[1] Istanbul Technical University, Civil Engineering Faculty, Geodesy and Photogrammetry Engineering Department, 34469 Maslak-ISTANBUL-TURKEY

Introduction

To support reduction of loss from earthquake hazards affecting millions of people and billions of dollars of infrastructure in Turkey, study the means for creating HAZTURK, a Turkish version of HAZUS, the methodology and software that estimates potential earthquake damage and loss in the U.S. The key objectives for a new Turkish version of HAZUS are to:

- Develop an earthquake hazard characterization model for Turkey based on HAZUS.
- Create a comprehensive Turkish inventory database for loss estimation.
- Develop vulnerability functions for infrastructure at risk to supplement those in HAZUS.
- Develop parameters for casualties, shelter needs and economic loss that reflect conditions in Turkey.
- Provide improved near real time loss assessment capability based on Turkish information resources.
- Provide software that takes full advantage of state-of-the-art GIS platforms and internet capability.
- Provide user-friendly computer interface and support materials suitable for a wide variety of users in Turkey including emergency managers, scientific investigators and decision makers.

To realize these objectives, a feasibility study is required to determine the steps to developing loss estimation methods and software applicable Turkey, the potential for technology sharing with HAZUS, and approaches to potential distribution. The feasibility study is intended to be used to seek funding for HAZTURK development from sources such as the World Bank, the United Nations and others (Sahin and Karaman, 2005).

Local officials and planners will use these tools to assess national and local risks, and prioritize loss reduction activities. The new tools will pinpoint vulnerable areas that would benefit from special land-use provisions or building codes, or compare damage and loss assessments of buildings, key facilities, and infrastructure before and after applying different prevention or intervention options.

The project will begin with an assessment of the models, tools, research and data that is available in Turkey and for Turkey. The first step in the project is to identify a proposed area of study based on needs, vulnerabilities, local interest, willingness to participate and the availability of data and other resources. Input will be sought from government officials, regional and local emergency managers to assist with conducting the demonstration, university personnel to assist with conducting the demonstration, collecting data and developing demonstration methods.

Once a study area is selected, a group of users will be identified to participate in the project. Turkish risk management resources will be assessed including identifying and assessing local and regional emergency management capability, participants and stakeholders.

Data Storage

The necessary data will be described and a plan prepared for gathering it. This includes boundary maps, geological surveys, seismic risk studies, census and other data, building data, building types unique to Turkey, and applicable building codes. Where gaps in the data exist, a number of international databases have been identified that can be potentially used to build the default database including but not limited to:

- LandScan population data

- World Agency of Planetary Monitoring and Earthquake Risk Reduction's building inventory data derived from satellite imagery
- National Center for Earth Resources Observation and Science data
- UN Department of Economic and Social Affairs (DESA) Development Policy and Planning Office data
- UN Environmental Programme Division of Early Warning and Assessment Global Resource Information Database

Following data collection, a database model will be designed, populated and tested (Sahin and Karaman, 2005).

Methodology and Software Development Process

A prototype tool for assessing residential building damage will be developed including modules and damage functions for unique Turkish buildings. The prototype damage and loss model will include the database, a building classification system based on local and regional building stock and construction practices, the methods suited for hazard characterization and damage and loss calculations for use in the study area.

In addition, a prototype software tool for mitigation analysis for residential building will be developed.

The prototype software will be used to conduct a sample analysis in the demonstration study area. This will include a building damage and loss assessment, and a sample mitigation analysis. The new methodology will be testing and validated with local data.

Architecture of HAZUS

The HAZUS software consists of a three-tier system architecture that utilizes a relational database management system for storing and retrieving inventory data, model parameters and analysis results. This configuration provides HAZUS with the means to utilize data interchangeably from a variety of sources, to communicate with other emergency management tools. The user interface, GIS functionality and report generation is packaged in the *Presentation Layer.* The study region management module and engineering analysis (hazard characterization, damage and loss) modules are packaged into the *Application Logic Layer*. Data access is implemented in the *Data Access Layer*. MSDE (Microsoft Database Engine) serves as the database engine in this layer. The three-tiered approach for HAZUS allows for changes to be made to a single layer without having to modify the other layers. The inter-communication between the different layers is done via interfaces (in simple terms, these are protocols of communication), and as long as the interfaces remain the same, the internal workings can be modified without affecting the rest of the system. (NIBS, 2005)

HAZUS Hazard Characterization

The methodology generates estimates of the consequences to a city or region of a "scenario earthquake" -- that is, an earthquake with a specified magnitude and location. For these events, the probabilistic ground motion data is provided by USGS. Earthquake faults are developed from data supplied by the U.S. Geological Survey in Golden, CO with enhancements by the state agencies of California and Nevada. Historical earthquake epicenters are compiled from several catalog and databases: the ANSS Worldwide Earthquake Catalog, the National Earthquake Information Center (NEIC) database, and the Earthquake Seismicity Catalog Volume 1 (NOAA/USGS). Also, USGS shakemaps, that describe shaking immediately following an earthquake in California, can be imported in geodatabase format. As an example, for estimating the building damage due to ground shaking, GBS data is combined with the following damage functions: (1) fragility curves that describe the probability of reaching or exceeding different states of damage given peak building response, and (2) building capacity (push-over) curves that are used (with damping-modified demand spectra) to determine peak building response. The extent and severity of damage to structural and nonstructural components of a building is described by one of five damage states: None, Slight, Moderate, Extensive, and Complete. (Schneider and Schauer, 2005)

HAZUS Analysis Procedures

A HAZUS analysis consists of three basic steps:

a. Study region creation
b. Hazard characterization
c. Damage and loss analysis

HAZUS results can be mapped and are displayed in detailed browser tables, summary reports, a global summary report that provides a 19 page document on a scenario earthquake for a region, and a quick assessment report for use in response and recovery situations according to the HAZUS Earthquake Model (Figure 1). (Schneider and Schauer, 2005)

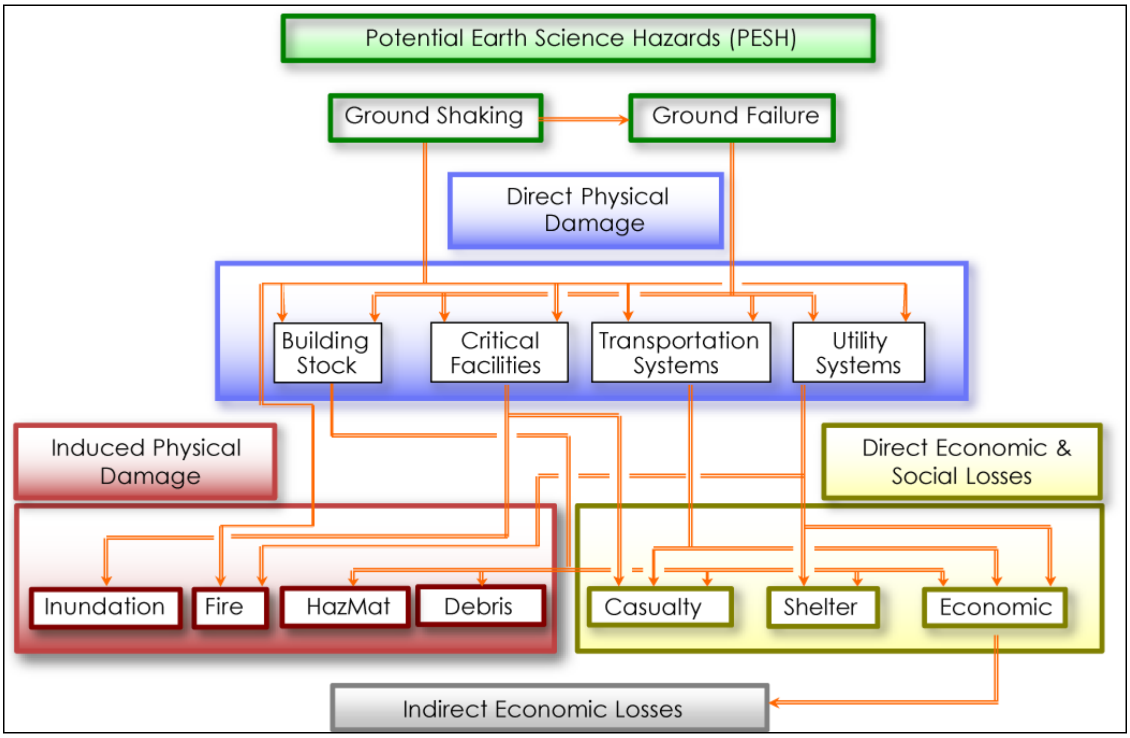

Figure 1. HAZUS Earthquake Model Components

Conclusion

This study is a start of a project that will conduct the disaster management and hazard mitigation works firstly for a region of the city of Istanbul and then the Istanbul city and finally the whole Country of Turkish Republic. The reason for not using the HAZUS program for Turkey as itself is not readily transferable for use in Turkey. National and provincial boundaries, characterization of the earthquake hazard, data used in HAZUS and its method of storage are applicable only in the U.S. That is why the loss estimation program of HAZTURK must be build from the beginning. For the U.S. it has taken approximately 7 years to have a fully usable and nationally applicable loss estimation program. For Turkey, we hope to shorten this period with the experience and the help of the team that desing and develop

HAZUS for the U.S. This work as itself has some deficiencies, like has no other disaster types other then earthquakes, but as in the HAZUS example, those missing parts will be added after the first working version of HAZTURK hasbeen released. Firstly, it is important to have a working software for loss estimation of earthquakes. Then the improvements on the earthquake model will be done, and then the other disaster models will be added to the system. Like, flood.

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Author Biography

Muhammed Şahin is a professor of Surveying in the Faculty of Civil Engineering, Istanbul Technical University. He has been the head of Surveying Technique Division since September 2004. He was born in Pazar, a town of Rize where he finished his primary, secondary and high schools. He graduated from the Department of Geodesy & Photogrammetry, Istanbul Technical University in 1987. He received MSc & PhD from University College London and University of Newcastle Upon Tyne, UK, respectively. He become an assistant professor in 1994, an associate professor in 1996 and professor in 2002. His research interests include satellite positioning techniques, monitoring of earth crust using GPS, emergency management, disaster information systems, GIS based on emergency management.

Himmet Karaman is a geodesy and photogrammetry engineer and has his Master of Science degree on 2003 from ITU Science and Technology Institute on database systems on disaster management. He is a PhD candidate since 2004. He is a research assistant in Istanbul Technical University, Civil Engineering Faculty, Surveying Technique Division, since 2001.

Academic and Professional Practice

Peer Reviewed Articles

Fire Fighting & Safety

TEST AND EVALUATION ON THE FIRE EXTINGUISHING USING THE REINFORCED EXTINGUISHING AGENCY

Dr. Lee, Tae Shik [1], Dr. Cho, Woncheol [2], & Dr. Ha, Kyoo-Man [3]
Yonsei University

Key words: fire, reinforced fire-extinguishing agency, damages

Abstract

The purpose of this study is to test and evaluate the performance of the newly invented reinforced fire-extinguishing agency. There are three findings to pay attention to. First, when using the reinforced extinguishing agency, fire fighting distance will be expanded from 4 meters to 8 meters. Second, thanks to the reinforced extinguishing agency, citizens will be willing to help putting out the fire based on their cooperation. Third, the reinforced fire extinguisher will play a key role in minimizing the fatality of human life and property damages in the Korean society.

Introduction

In Korea, there are 561 casualties per year due to fire, and each individual risk is 1.2 x 10-5/yr. There were 2,089 casualties in 2003, and each individual risk was 4.1 x 10-5/yr. Total casualties' risk was 5.3 x 10-5/yr in the same year. As a reference, each individual risk was 1.92 x 10-4/yr in 2003 resulting from traffic accident (Lee, 2004b).

In Korea, the risk level of fire is one half of that of traffic accident. Each individual risk resulting from the fire in Korea is two times bigger than that of U.S. The number of fire accident is increasing every year by 4.2%. In 2003, the number of fire was 31,372 to include 8,474 of house fire, 3,416 of factory fire, 6,049 of car fire, 1,698 of shopping center fire, 2,056 of restaurant fire, 457 of business area fire, 675 of storage facility fire, 106 of school fire, etc. In short, there were 86 fires per day in 2003. Their damages were officially recorded as 150 million dollar. Yet, substantial damages would be much bigger than that, considering that many people's important memories were also burned out during the fire (Kim, 2004).

There are several significant steps to blow out the fire. First, when trying to quickly extinguish the fire, we should keep remaining flameproof for environmental reason in particular the moment toxic black smoke disappears. Second, when people are burned with the fire, it is important for us to cool their burned part of body and thus their burnings will be minimized. Third, when the fire is beyond control, we should rely on the fire extinguisher to rapidly control medium or large sized fire especially without directly approaching the fire. With the above reasons, many in the international community have tried to develop reinforced extinguishing agency particularly for the purpose of easily approaching the center of fire.

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[1] Part time Professor, E-mail: synectix@yonsei.ac.kr
[2] Professor
[3] Research advisor

When producing the fire extinguisher, It is required that the product should be no problem to use against every three kind of fire such as general fire, oil fire, and electric fire. However, many worried that reinforced extinguishing agency could not be applied to electric fire, because it came to add water to electric fire when used. After 30 years of research and experiment, however, it is very sure that the reinforced extinguishing agency can be applied to electric fire, if considering that the product requires only 100 milli liter solvent to extinguish the 20 liter petroleum fire.

In Japan, developing the liquid extinguishing agency has been strongly encouraged and supported, while each house is required to equip with extinguishing-tool fire extinguisher, which is a sort of liquid extinguisher (Lee, 1999). In the U.S., fire extinguishing chemicals, being liquid, are very popular in special factories and offices. In Korea, the Korea Fire Equipment Inspection Corporation (KFEIC) initially approved 3.5 liter fire extinguisher, being liquid, at the end of 2004 and thus liquid fire extinguisher came to be introduced in the Korean market.

Basic information

Characteristics of reinforced extinguishing agency

1) The speed of extinguishing fire

The reinforced extinguishing agency plays a role in swiftly extinguishing large and medium sized fire and then recovers environment by equipping with the system of no electricity source.

2) The ability of defending blaze

Both children and the aged can easily use the reinforced extinguishing agency. In addition, 100 liter reinforced extinguishing agency can extinguish the fire within 50 meter. In case of using the reinforced extinguishing agency before the fire spreads, it has a flameproof effect.

3) Merits of reinforced extinguishing agency

(1) The reinforced extinguishing agency straightly infiltrates to the ignited place of fire.
(2) The reinforced extinguishing agency prevents oxygen from ignitable material.
(3) The reinforced extinguishing agency swiftly cools down the part of outbreaking fire.
(4) The reinforced extinguishing agency has a flameproof effect.
(5) The reinforced extinguishing agency is friendly to environment, because of its neutral character.

4) Merits during the use of reinforced extinguishing agency

(1) To the men, the reinforced extinguishing agency minimizes physical burnings and stimulus, prevents toxic gas, allows taking breath, and others.
(2) To the property, the reinforced extinguishing agency minimizes damages, protects fortunes, and produces no another burnings except ignited place of fire.

5) Merits during the management of reinforced extinguishing agency
The quality of reinforced extinguishing agency is perfectly steady before fire outbreak, so the reinforced extinguishing agency is always ready for fire. Even 20 degree below zero, it works well. After fire, people can go back to their normal life thanks to the reinforced extinguishing agency.

6) Merits during the misuse of reinforced extinguishing agency

(1) To the men, the reinforced extinguishing agency is fewer stimuli oriented. Without fire, the reinforced extinguishing agency does not produce chemical action.

(2) To the property, the reinforced extinguishing agency is like spreading water during its misuse. So, we can use rag to get rid of it.

Characteristics of reinforced fire extinguisher

The reinforced fire extinguisher can spray its material up to 11 meter. Regardless of powder or gas, the reinforced fire extinguisher has several merits like below.

First, the reinforced fire extinguisher has easy access to the fire place. In the case of fire breaking, it is never easy for anyone to access to the fire place. In particular, it is much more difficult to access within 10 meter around the fire, because of heat in airtight space. In this situation, the reinforced fire extinguisher can spray its extinguishing material from the distance and thus cools down the fire without closely approaching the fire. By decreasing the distance from the fire, the reinforced fire extinguisher finally puts out the fire.

Second, the reinforced fire extinguisher has its potential ability to put out the fire. In case of fire, floor, wall, and ceiling are suddenly surrounded by fire. In the meantime, the reinforced extinguishing agency has solubility in water. After being sprayed, the reinforced agency makes a membrane of blocking oxygen, sticking to floor, wall and ceiling. At the same time, the reinforced agency cools down the indoor temperature into normal one by cooling effect. As imperfectly-burned toxic gas decreases, the black gas turns into white vapor. One minute after starting fire extinguishing by the reinforced agency, it is very evident that the fire will not recur, when considering that smoke around fire place disappears.

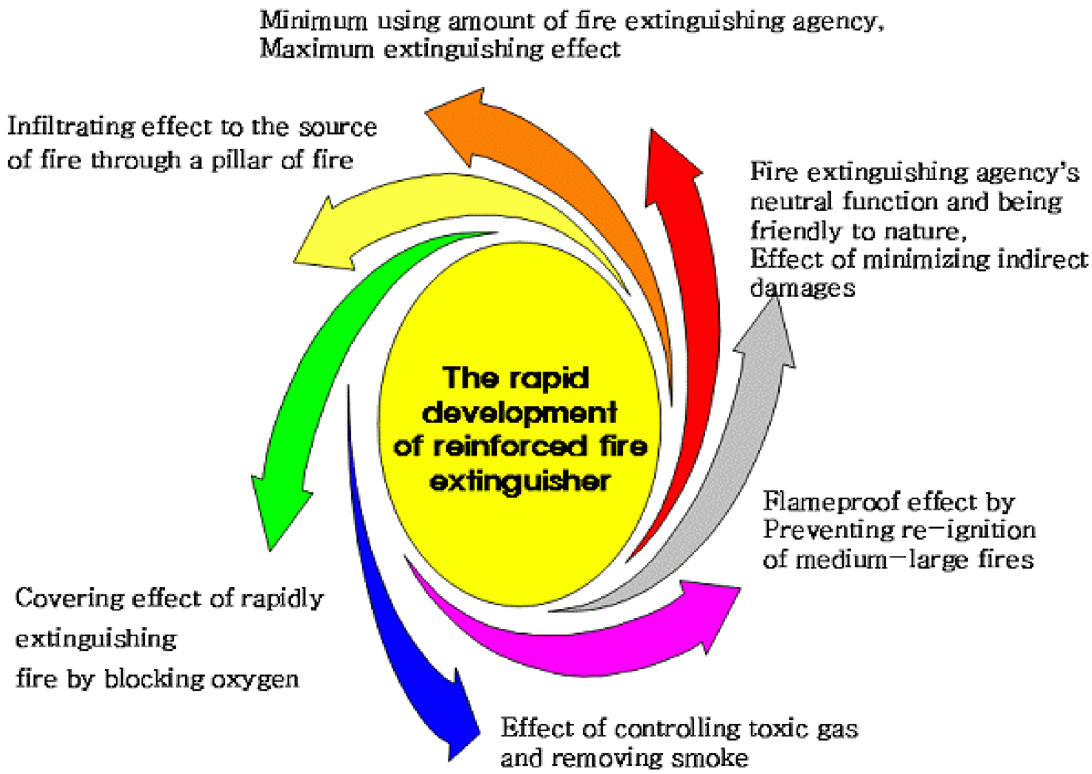

Figure 1. The rapid development of reinforced fire extinguisher

Third, the reinforced fire extinguisher discourages the outbreak of toxic gas and then changes it into vapor. Before facing the fire, the reinforced fire extinguisher smells ammonia. Because of this, the reinforced fire extinguisher can maximize the effect of cooling down. When it is injected through the fire, it will have chemical action and then disappears.

Fourth, the reinforced fire extinguisher is friendly to nature, and its extinguishing agency has neutral characteristics in terms of component. In addition, because the reinforced extinguishing agency is friendly to nature, it will have fewer damages to the fire place, when it is used as fire extinguisher. Just after using the reinforced fire extinguisher, office workers will not have much difficulty to work for their office again, and the environment around fire will be improved by spraying water. In short, office workers continue to work for their office even after putting out the fire, when using the reinforced fire extinguisher.

Characteristics of extinguishing-tool-style fire extinguisher

Fire is outbroken around kitchen, living room, and bedroom in house or apartment. In this case, fire extinguisher, which is light weight, should be promptly accessed by children and the aged.

It is extinguishing-tool-style fire extinguisher that children and the aged most need in this emergency situation. In Japan, the U.S., and some European countries, this kind of fire extinguisher is available in home. Those countries believe that extinguishing-tool-style fire extinguisher is most effective one to put out the fire of early stage. The weight of extinguishing-tool-style fire extinguisher is 450 gram, containing 320 millimeter liquid. By using these components, extinguishing-tool-style fire extinguisher can extinguish the fire around 5 meters within 11 seconds.

Extinguishing-tool-style fire extinguisher can blow out many kinds of fire such as cushing fire, curtain fire, garbage can fire, frying pan fire, gas stove fire, etc. at home. In particular, when considering that extinguishing-tool-style fire extinguisher plays a role in putting out the fire from big gas stove in living room, the small fire extinguisher should have most excellent function to put out the fire.

Fire extinguishing test and its evaluation

This paper had a demonstration to officially test the reinforced extinguishing agency on track and field in Yonsei University on November 17, 2004. Many attendees watched it such as the President of Yonsei University, many professionals in fire studies, other college authorities, and guests of honor from outside.

The demonstration had 12 kinds of experiment. The examples are followings; A demonstration on automatic extinguishing system of subway vehicle as the first time in the world, a demonstration on extinguishing of flame-radiator-style fire-extinguisher, a demonstration on extinguishing of cooling-electrical machinery-style fire extinguisher, a demonstration of extinguishing of newly-developed-office-style fire extinguisher, a demonstration by home-sprayer-style fire extinguisher, a demonstration by kitchen-specialized fire extinguisher, a demonstration on checking out complete extinction from the toxic of tire fire, a demonstration on checking out flameproof to prevent mountain fire, a demonstration on 100 liter fire extinguishing equipment, a demonstration on mannequin (clothes) fire, a demonstration on had extinguishing system of subway vehicle, a demonstration on no-electric-power fire extinguishing by using 300 liter water, etc. (Lee, 2004a).

The first test - a demonstration on fire extinguishing by attaching automatic fire extinguishing system to top of subway electric train

One quarter of the same size model of real subway electric train was sprayed by four liter gasoline. When indoor temperature became 65 degree, a temperature sensor detected it and thus automatic fire extinguishing system could operate. Within 3 seconds, the fire on subway electric train came to be automatically extinct, since 2 liter of reinforced extinguishing agency fell down from the ceiling of subway electric train.

a. Maximizing fire in subway electric train
b. One second after automatic fire extinguishing
c. Three seconds after automatic fire extinguishing

Figure 2. A demonstration on automatic fire extinguishing of subway electric train

The evaluation on the first test

1) The reinforced extinguishing agency, being 2 liter, is proven to blow out the fire and prevent oxygen within 3 seconds after automatically sensing the fire.
2) The reinforced extinguishing agency can suppress toxic gas produced by the fire and thus save human life especially by avoiding suffocation.
3) White smoke, produced during the process of extinguishing the fire, is vapor. The vapor is harmless to human life and rather cools down the inside of fire place. The fact that the vapor disappears in 30 seconds means that cooling down the fire place is done completely.
4) The reinforced extinguishing agency plays a role in cooling down the fire place by promptly turning the temperature of fire place into normal one.

The second test - Checking out if remaining smoke produced during the period of extinguishing used tire is toxic

a. The moment of maximizing the fire
b. In the process of extinguishing the fire by 3.5 liter fire extinguisher
c. Immediately checking out remaining fire after putting out the fire

Figure 3. Checking out if remaining smoke produced during the period of extinguishing used tire is toxic

It was testified that produced smoke within 10 seconds after using 1 liter reinforced extinguishing agency is harmless to the humans, particularly after maximizing the toxic gas from 7 burning used-tires with gasoline.

<u>The evaluation on the second test</u>

1) It was very sure that because toxic gas becomes vapor after extinguishing the fire, the humans have no problem to take breath the air.
2) It was certified that 1 liter extinguishing agency can put out the fire and minimizes indirect effect of fire through cooling down, preventing oxygen supply, and flameproof.
3) It was proven that extinguishing liquid does not contain toxic in particular after completely putting out the fire but is friendly to natural environment.

<u>The third test - Extinguishing big fire</u>

Each set of wood is 1m■1m■2m cubic and four sets were displayed. Under each set of wood, there was 2 liter gasoline. Gasoline fire was set out. The test was to put out the most maximizing fire from gasoline and wood by using the reinforced extinguishing agency containing the pressure of nitrogen without a source of electricity. The most maximizing fire was up to 10 meter, while the reinforced extinguishing agency was thin stream water.

The length of hose was 25 meter, and nitrogen added pressure was 9.8(Kgf/cm2) during its spraying. The water stream was 6 milli meter nozzle in its diameter, which reaches up to 15 meters. It was shown that the fire was extinguished within 20 seconds and black smoke during the fire turned into white vapor.

The spending amount of reinforced extinguishing agency was about 20 liters, which can put out the 4m■4m■8m fire. Putting out this sizable fire has been approved by the Korea Fire Equipment Inspection Corporation as A class (for timber) fire extinguisher's ability.

a. The moment of maximizing the fire
b. In the process of extinguishing the fire by 100 liter fire extinguisher
c. Immediately touching out remaining fire after putting out the fire

Figure 4. Test on A class fire extinguisher's ability of putting out 4m■4m■8m fire

<u>The evaluation on the third test</u>

1) It was testified that any place touched by the reinforced extinguishing agency cannot be easily refired any more thanks to its flameproof characteristic.
2) The fact that heat was not felt from burned fire after completely extinguishing means the reinforced extinguishing agency's excellent effect of cooling down
3) It was verified that just 20 liter liquid of 100 liter fire extinguisher, which was used for 4m■4m■8m fire, can completely control the flame
4) It was shown that the moment the reinforced extinguishing agency touched down the fire, the fire was absolutely put out. In short, the reinforced extinguishing agency could straightly infiltrate into the source of fire and then produced oxygen blockade.

Conclusion

The reinforced extinguishing agency or its fire extinguisher will have a huge impact on our Korean society like followings.

First, when using the reinforced extinguishing agency, fire extinguishing distance will be expanded from 4 meters to 8 meters. Whereas vapor-style fire extinguisher or powder-style fire extinguisher puts out the fire around 4 meters, the reinforced fire extinguisher blow outs the fire around 11 meters. If considering that the fire on the first floor or second floor in the buildings is usually within 11 meters, the reinforced fire extinguisher can effectively protect human life and reduce property damages from the fire.

Second, thanks to the reinforced extinguishing agency, citizens will be willing to help extinguishing the fire based on their cooperation. By using fire extinguisher used by many now, it is very hard for citizens to attempt to put out the fire, because it cannot easily access to the fire. However, citizens can attempt to put out the fire from the distance of more than 10 meters, when using the reinforced fire extinguisher. Thus, citizens will be more cooperative to fight against fire, in particular by relying on the positive function of the reinforced fire extinguisher.

Third, the reinforced fire extinguisher will play a key role in minimizing the fatality of human life and property damages caused by the fire in the Korean society. As an example, the fatality of human life and property damages by the fire in Japan has been much decreased, after encouraging each home to equip with liquid-style fire extinguisher. So, the reinforced fire extinguisher will be contributed to the improvement of fire loss in terms of human life and property damages very much in Korea in the near future.

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INSTANTANEOUS LIQUID RELEASE FROM RAILTANKER:

THE INFLUENCE OF NOISE SHIELDS ON POOL SHAPE AND POOL SURFACE

Nils Rosmuller
Nibra[1]

Key words: freight railway, safety, noise shield, instantaneous release, pool shape, fire fighting

Abstract

Introduction

In the Netherlands, the Betuweline, a dedicated freight railway, will among other things, be used for transportation of all kind of hazardous materials from the Port of Rotterdam to the German Hinterland and vice versa. The line is about 150 kilometers long. Alongside the line, over more than 100 kilometers noise shields have been constructed. The question is how and to what extent this noise shield will affect the pool shape and surface of an instantaneous release of a flammable liquid, such as LPG.

Theory and method

In case of an instantaneous releases of a rail tanker ($50m^3$) both risk analysts and emergency responders reckon with a circle like pool shape of about $600m^2$ This shape and surface is based upon a full scale test without a noise shield or any other barrier nearby the rail tanker.

To asses the influence of the noise shield, a full scale test was conducted on an already constructed part of the Betuweline. A $50m^3$ rail tanker was filled with a red-colored liquid. The liquid was instantaneous released. Three camera's and three observers recorded the consequences.

Results

A very peculiar pool shape results due to the noise shield. A zone between the rails and the noise shield (2 meters wide and 90 meters long) is within 2 to 3 minutes filled with 15 centimeters liquid. The total pool surface was about $750m^2$. Both shape and surface deviate substantially from the traditional figures. These insights are both relevant to emergency responders for disaster abatement purposes and to risk analysts for effect modeling purposes. The ministry of Transport is examining the possibilities to deal with these results.

[1] Netherlands Institute for Fire Service and Disaster Management (Nibra), PO Box 7010, 6801 HA Arnhem, Netherlands: n.rosmuller@nibra.nl

Discussion

The results are based upon one single instantaneous release test. In addition, it is interesting to find out what the pool shape and surface would be in case of a continuous release from the rail tanker near a noise shield.

Introduction

In the Netherlands, the Betuweline, a dedicated freight railway, will among other things, be used for transportation of all kind of hazardous materials from the Port of Rotterdam to the German Hinterland and vice versa. The line is about 150 kilometers long. The railway is aligned closely to multiple cities and villages. Because of that, noise shields were designed to protect the inhabitants for too high noise levels of passing trains. Alongside the line, over more than 100 kilometers noise shields have been constructed. Legal criteria are absent in the Netherlands for designing noise shields along railways. Still, two main aspects are taken into account in designing such noise shields including the noise reduction and the way the noise shield fits in the environment. However, the effect of noise shields on hazardous material releases is not a part of the deliberations so far. One of the possible accident scenarios on the Betuweline is the instantaneous release of a rail tanker, for example filled with a flammable liquid (Werkgroep Betuweroute Regionale Brandweren, 1994). The question is how and to what extent this noise shield will affect the pool shape and surface of an instantaneous release of a flammable liquid, such as LPG.

Theory

In case of an instantaneous releases of a rail tanker ($50m^3$) both risk analysts and emergency responders reckon with a circle-like pool shape of about $600m^2$ (CPR, 2000). This shape and surface is based upon a full scale test without a noise shield or any other barrier nearby the rail tanker. The fluid could flow in all directions without being hindered by any barrier at all. The liquid flows through the permeable ballast of the railway and forms a circle-like pool. The depth of this pool is relatively small, about several centimeters. Large amounts of the liquid descend into the earth. In case of a fire, the pool surface in combination with its depth determines the heat release rate and the time the pool is on fire. Both surface and depth have repercussions on the fire fighting possibilities for example how much foam should be used for repression or how to access the emergency. In 1994 and for the Betuweline, fire brigades guaranteed that they would be able to repress a $600m^2$ pool fire. At that moment, they did not reckon for noise shield alongside the track. That is why it is important to find out if designed noise shields influence the pool shape and surface, and to what extent.

The instantaneous release test

To asses the influence of the noise shield, a full scale test was conducted on an already constructed part of the Betuweline (Nibra, 2005). A $50m^3$ rail tanker was filled with a red-colored liquid from the nearby ditch. We used water instead of a flammable liquid for safety reasons, environmental aspects and costs. At 20 degrees Celsius, water has almost the same viscosity as flammable liquids[2]. This viscosity is important because it determines the flow pattern of the liquid. The table below shows some design aspects of the rail tanker that was used in the full scale test.

[2] The nominal viscosity of water is 1,0mm2/sec and is in the range of viscosity numbers of flammable liquids like gasoline (Verkerk, 1986).

Table 1: Design characteristics of the rail tanker.

Aspect	Specification
Type:	Tanoos 896
Maximum volume:	75 m^3
Release jaws (2):	80 cm x 20 cm
Height release jaw - rail:	40 cm

The test was hold near the villages of Leerdam and Vuren very close to highway 15, hectometer 34,5. The test location was relatively horizontal (hardly any elevation). This flat location prevents the liquid for flowing in one dominant direction (the lowest point). On one side of the rail tanker, a noise shield, including a door in the shield is apparent. The shield is dug in a small sand dike of 60 centimeters high. The door is important because its frame and sill is not dug in a small sand dike. During the test, the door is closed. At the test location, markers were positioned and connected with red-white striped ribbon. This ribbon is used as an iso-distance line and assists observers in making their observations of the pool size. The mutual distance between the ribbons is 5 meters, and starts from the centre of the rail tanker.

The picture below shows the test location, including the rail tanker, the noise shield, the door in the shield and the ribbons.

Figure 1: Test site photograph.

The test was realized with the cooperation of many stakeholders: ProRail (providing the rail track), fire region Zuid-Holland Zuid (preparation and logistics), fire brigades of Lingewaal/Lingewaal Zuid, Sliedrecht, Lingewaal/ Asperen en Papendrecht (filling the rail tanker), NedTrain (providing the rail tanker), the national police ((KLPD) for photography and video observations), Ministry of Transport (traffic management at highway 15) and the dike reeve Vierstromengebied (ditches).

The liquid (50m^3) was instantaneous released. The results were observed in two ways:

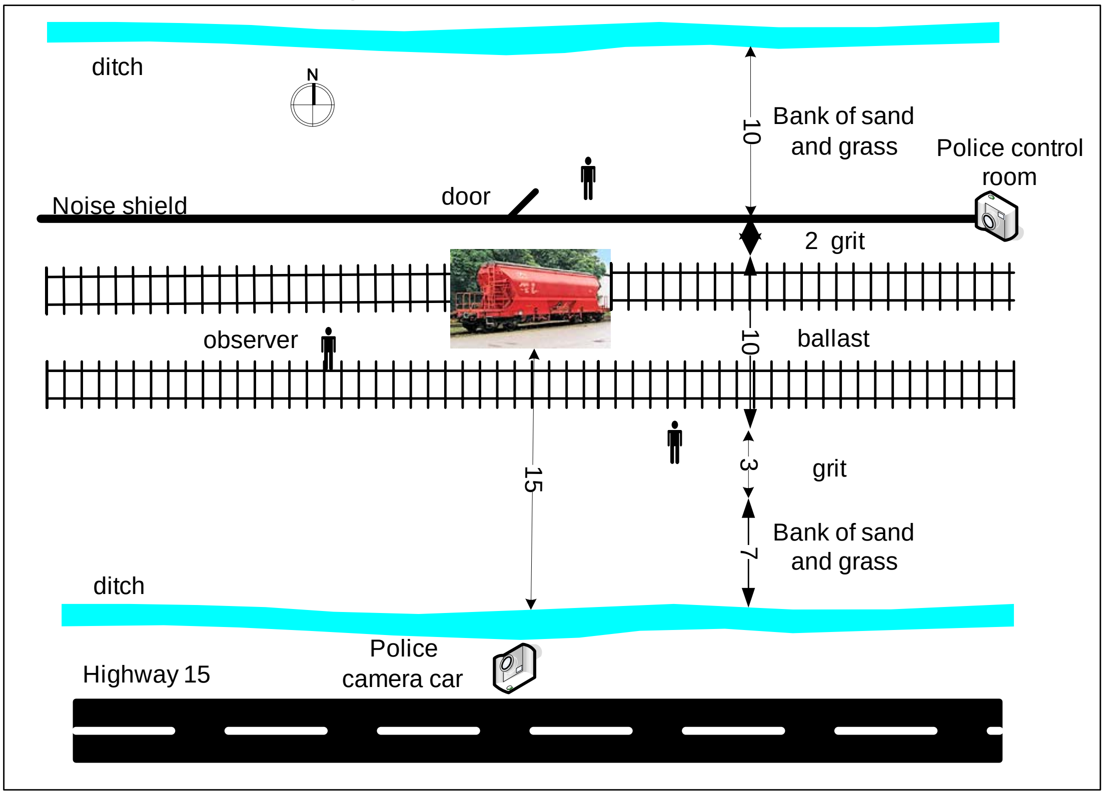
- Three police camera's (1 helicopter, and 2 police cars)
- Three observers (2 at each side of the rail tanker, and 1 behind the noise shield)

An observation protocol was developed. The three police cameras were coordinated by the police control room near the test site. One liaison of the test team was apparent in the police control room. The test leader was in contact with the liaison and the observers. The observers were in contact using the Dutch new emergency response communications system C2000. The test leader coordinated the observations by indicating the start of the release. Using C2000, the test leader requested the observers to indicate the pool shape at the below specified moments.

Each of the observers had his own observation map. The observers were asked to indicate the pool size on the papers by marking the size on a pre specified raster. Four observations were made by each observer: after 2 minutes 30 seconds, 5 minutes, 7 minutes 30 seconds and after 20 minutes.

Both observers and policemen were instructed before the test. This instruction was meant to clarify the goal of the test and the aspects the observers should take notice of. The figure below shows the test arrangement.

Figure 2: Test site schematic overview.



The table below shows the relevant test data.

Table 2: Test site data.

Aspect	Specification
Date and time	24 June 2005, 11.00 am
Temperature	30 degrees Celsius
Weather conditions during test	Dry and sunny, hardly any wind
Weather conditions 1 week before test	Heat wave: 5 days, 30 degrees Celsius
Location ditch (north) behind noise shield	10 meters from noise shield
Ground conditions noise shield-ditch	Sandy and covered by grass, dry

Ditch (north) behind noise shield	Cleaned 1 week before test, 1-side dammed, hardly any current
Width ditch (north) behind noise shield	3 meters
Location noise shield	4,75 meters from the centre of the rail track
Location noise shield	2 meters from ballast
noise shield	60 cm earth dike outside the noise shield, except for the doors
Width door in noise shield	1 meter
Width ballast rail track 1	5 meter
Width ballast 2 tracks	10 meter
Width grit along side tracks	3 meter
Width grit-ditch (south)	7 meter
Ground conditions grit- noise shield (south)	Sandy and covered by grass, dry
Location ditch (south)	15 meters from rail tanker
Ditch (south)	Not cleaned, connected to open water, hardly any current
Width ditch (south)	3 meter

Results

The pool shape and surface did not develop significantly different between 2 minutes 30 seconds, 5 minutes, and 7 minutes 30 seconds from the release moment. After 20 minutes, the liquid still flew underneath the ballast and grit. The latter could only be observed by observers at the test location. Cameras did not record this liquid flow. The mechanism causing this delayed liquid flow is that the liquid initially is stored in the ballast and grit. Later, when the ballast and grit are saturated, the liquid is 'released' from the ballast and grit and flows to the lower points. Figure 3 and 4 show the pool shape after 7 minutes 30 seconds respectively 20 minutes from the release moment. As can be seen from figure 3 and 4, the total pool is consists of several characteristic sub parts of the pool.

Figure 3: Pool size after 7 minutes and 30 seconds (is the same for 2 minutes and 30 seconds and 5 minutes).

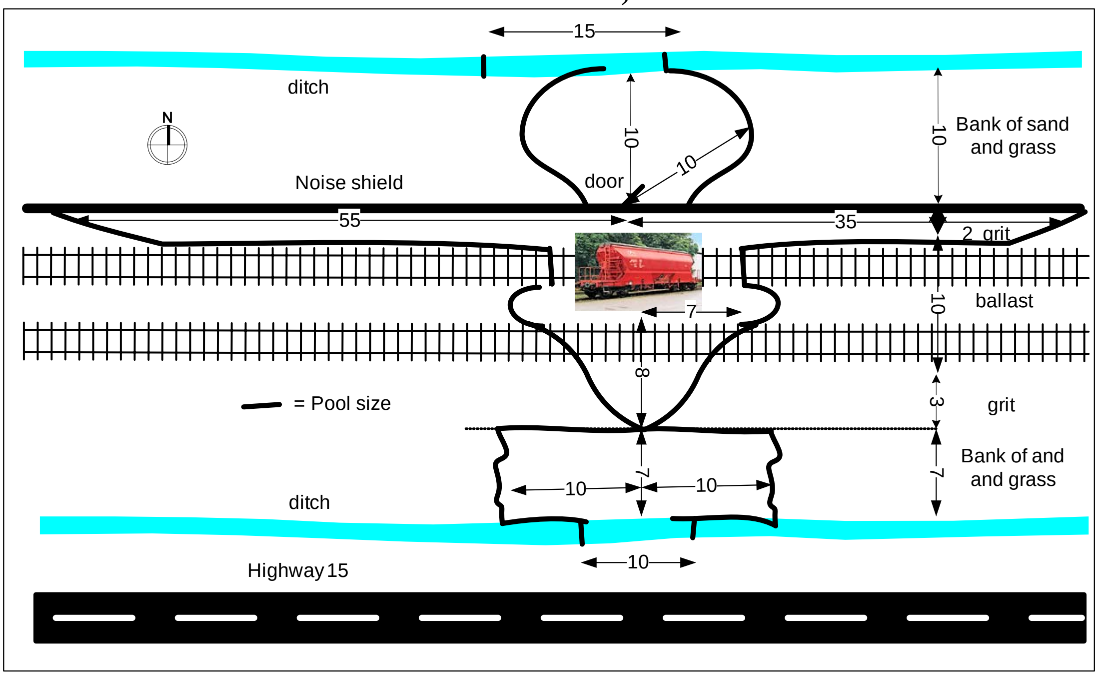
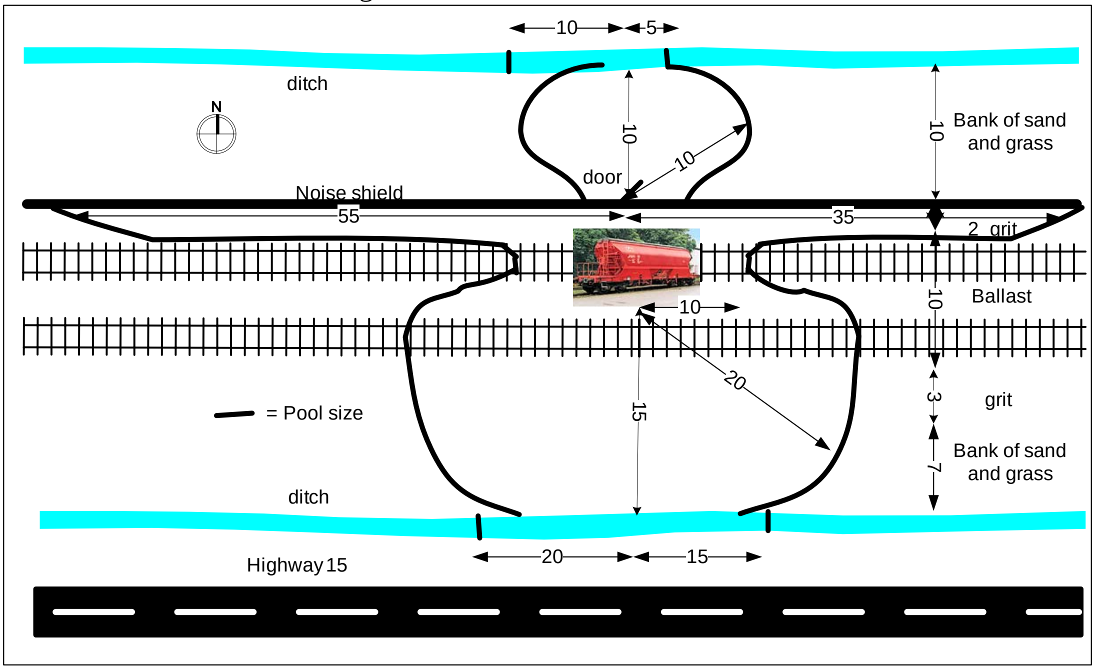


Figure 4: Pool size after 20 minutes.



The table below summarizes the observations as made by observers and cameras. In this table, the characteristic pool parts are presented in the most left column (in sequence from north to south). The upper 2 rows indicate the moment at which the pool shape is observed. The cells that originate are filled with test results. For the pool surface, the cells contain square meters. For the dispersion of the liquid in the ditch, the cells indicate the length in meters over which liquid spots appeared.

Table 3: Results instantaneous release.

	Observation after ... minutes					
Characteristic part of the pool	Pool shape (7,5)	2,5	5	7,5	Pool shape (20)	20
Behind noise shield	Half circle	160 m^2	160 m^2	160 m^2	Half circle	160 m^2
Grit along noise shield (west)	Ditch	110 m^2	110 m^2	110 m^2	Ditch	110 m^2
Grit along noise shield (east)	Ditch	70 m^2	70 m^2	70 m^2	Ditch	70 m^2
Ballast rail track	Rectangle	15 m^2	15 m^2	15 m^2	Rectangle	20 m^2
Ballast between 2 tracks	Ditch	20 m^2	20 m^2	20 m^2	Ditch	40 m^2
Ballast and grit	Triangle	55 m^2	55 m^2	55 m^2	Rectangle	150 m^2
Pool south (A15)	Rectangle	140 m^2	140 m^2	140 m^2	Rectangle	210 m^2
Total surface	-	570 m^2	570 m^2	570 m^2	-	760 m^2
Ditch behind noise shield (north)	Spots	15 m	15 m	15 m	Spots	15 m
Ditch (south)	Spots	10 m	10 m	10 m	Spots	35 m

The difference between the observations after 7 minutes 30 seconds and 20 minutes is about 200 square meters (about 550 respectively 750). The liquid buffer in the ballast and grit causes this delayed increase after 20 minutes. At that moment liquid flows underneath the ballast and grit. This delayed flow also influences the pool shape in the ballast and grit zone: after 7 minutes 30 seconds the pool was like a triangle where it is a rectangle after 20 minutes.

A very peculiar pool shape results due to the noise shield. A ditch is created between the rail track and the noise shield (2 meters wide and 90 meters long) is within 2 to 3 minutes filled with 15 centimeters of liquid. The total pool surface was about 750m^2. Due to the noise shield, both pool shape and surface deviate substantially from the traditional figures.

In addition, the following aspects were observed during the test:

- The developed ditch (15 centimeters deep) between rail track and noise shield stretches in western direction (about 55 meters) a bit more that eastwards (35 meters) due to a small elevation
- The remaining parts of the pool are at maximum several centimeters deep
- Already during filling activities small leakages caused liquid to flow under the rail tanker and under the door frame
- The pool stretches about 10 meters on the rail track in the transport direction, meaning that the liquid only flows under the 2 direct adjacent other rail cars.
- The earth below the door frame is completely washed out
- The dispersion in the ditch behind the noise shield is hampered by vegetation in the ditch and therefore spots originate instead of a continuous surface
- Five railway sleepers were washed out involving a hole of 75 centimeters deep
- The ballast stones were launched over a distance of 5 meters from the rail tanker

The insights regarding pool size and pool shape are both relevant to emergency responders for disaster abatement purposes and to risk analysts for effect modeling purposes. For emergency responders because it determines:

- The amount of foam to repress the emergency
- The accessibility of the emergency scene
- Heat radiation to other rail cars and hence possible domino effects

For risk analysts because it determines:

- Heat release rate
- Possible evaporation
- Heat radiation to other rail cars and hence possible domino effects

Conclusions and recommendations

The following conclusions are drawn:

1. The pool surface is about 550 square meters after 7 minutes 30 seconds and about 750 square meters after 20 minutes
2. Along the noise shield, over 90 meters a 2 meter wide ditch originates, being about 15 centimeters deep
3. The noise shield blocks the liquid flows in lateral direction, except for the door in the noise shield
4. The released liquid reaches the parallel ditches relatively fast (within 2 to 3 minutes)
5. Underneath the ballast and grit, liquid flows, without being clearly visible from above

The following recommendations were made:

1. Develop a pool fire repression strategy, thereby reckoning for the pool shape and surface as a result of the noise shield. In addition, take care of the length of the ditch parallel to the noise shield and the liquid flow underneath the ballast and grit.
2. Reconsider the door frame construction
3. Reconsider the primary direction for repression activities with respect to the noise shield presence
4. Calculate the burning time of the resulting pool and the effect of the noise shield on the heat release rate
5. Assess the influence of noise shields on both sides of the track.

Discussion

The results are based upon one single instantaneous release test. Still, we argue that similar tests would result in similar pool shapes and surfaces. The reason therefore is that most important variables were controlled and that unexpected variables, such as weather conditions, hardly affect the outcomes.

Opposite an instantaneous release, most of the railway leakages are continuous. In general, continuous releases have a smaller release volume but last longer. Therefore, it is interesting to find out what the pool shape and surface would be in case of a continuous release from the rail tanker near a noise shield, for example 100 liters per minute.

The rail tanker was positioned before a (closed) door in the noise shield. Substantial amounts of liquid flew underneath the door frame. It is interesting to find out what the pool shape en surface would be when locating the rail tanker not for a door but only for the noise shield. In addition, it is interesting to find out if in that situation, the liquid will also wash out the earth underneath the door frame.

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Author Biography

Nils Rosmuller has a PhD in transport safety at Delft University of Technology. Since 2001, he is working at the Netherlands Institute for Fire Service and Disaster Management, at the research department. His main fields of interests are transport safety, tunnel safety and the safety of fire fighters.

COOLING A RAILTANKER BEHIND A NOISE SHIELD

Nils Rosmuller
Nibra[1]

Key words: freight railway safety, noise shield, cooling, rail tanker, fire fighting

Abstract

Introduction

In the Netherlands, the Betuweline, a dedicated freight railway, will among other things, be used for transportation of all kind of hazardous materials from the Port of Rotterdam to the German Hinterland and vice versa. The line is about 150 kilometers long. Alongside the line, over more than 100 kilometers noise shields are apparent. The question is to what extent this noise shield hinders the cooling of a rail tanker, carrying for example a flammable liquid, such as LPG?

Theory and method

To answer this question, a full scale test was conducted on an already constructed part of the Betuweline. Two railcars and a rail tanker were placed behind a three meters high noise shield. First, it was tested whether firemen or water canon be used to squirt the water. The water canons prevailed. Next, four positions of the water canons to cool the rail tanker were tested. Three camera's and three observers recorded the spots and the extent of water that hit the rail tanker.

Results

The results indicate that the noise shield to large extent prevents the water from hitting, and therefore cooling, the rail tanker. The upper parts of the rail tanker were hardly hit by the water canons and the small amount of water flowing down the rail tanker did not reach the lower parts of it because of the armatures at the rail tanker. Also the amount of water in the ditches to be used for cooling was too small. The ditch nearby ran empty. These insights are both relevant to emergency responders for disaster abatement purposes and to water management organizations. The ministry of Transport is examining the possibilities to deal with these results.

Discussion

The results are based upon one single full scale test near a three meter high noise shield. In addition, it is interesting to find out what the influence would be in case of other heights of the noise shields.

[1] Netherlands Institute for Fire Service and Disaster Management (Nibra), PO Box 7010, 6801 HA Arnhem, Netherlands: n.rosmuller@nibra.nl

Introduction

In the Netherlands, the Betuweline, a dedicated freight railway, will among other things, be used for transportation of all kind of hazardous materials from the Port of Rotterdam to the German Hinterland and vice versa. The line is about 150 kilometers long. The railway is aligned closely to multiple cities and villages. Because of that, noise shields were designed to protect the inhabitants for too high noise levels of passing trains. Alongside the line, over more than 100 kilometers noise shields have been constructed, varying in height from 1 tot 4 meters. Legal criteria are absent in the Netherlands for designing noise shields along railways. Two main aspects are taken into account in designing such noise shields including the noise reduction and the way the noise shield fits in the environment. However, the effect of noise shields on emergency response activities is not a part of the deliberations so far. One of the possible accident scenarios on the Betuweline is a pool fire radiating a rail tanker filled with a flammable liquid (Werkgroep Betuweroute Regionale Brandweren, 1994). To prevent the heated rail tanker for exploding, it has to be cooled. The cooling can be performed by squirting large amounts of water on the rail tanker. The question is to what extent this noise shield hinders the cooling of a rail tanker, carrying for example a flammable liquid?

Theory

In theory, 10,2 liters of water per minute per square meter of the rail tanker is sufficient to cool a rail tanker. Cooling prevents the pressure increase in the rail tanker: the temperature increase of for example a flammable liquid is limited. 'Sufficient cooling' means that the pressure in the rail tanker does not reach a peak that causes a Boiling Liquid Expanded Vapor Explosion (BLEVE). To this end, the rail tanker should be cooled over its total surface, so 360 degrees (NVBR, 2005). For a typical rail tanker on the Betuweline, the 10,2 liters water per minute per square meter implies 6000 liters per minute. In addition, this amount of water should be applied during at least 4 hours (Werkgroep Betuweroute Regionale Brandweren, 1994). When formulating these cooling requirements, noise shields were not incorporated in the design and therefore not reckoned for in the cooling strategy. However, now that the noise shields appear along the Betuweline, fire brigades are aware of the reduced possibilities to get the water on the rail tanker. In case of too small volumes of water reaching/hitting the rail tanker, heat radiation might cause pressure increasing in the rail tanker and in the end an explosion endangering inhabitants along the line and emergency responders. In addition, fires might expand to adjacent rail cars causing domino effects such as releases of hazardous materials or additional explosions. To protect both inhabitants and emergency responders, it is important to find out if and to what extent the noise shields influence the cooling opportunities for fire brigades.

The rail tanker cooling test

To answer this question, full scale tests were conducted on an already constructed part of the Betuweline (Nibra, 2005). Two railcars and a rail tanker were placed behind a three meters high noise shield. Because of safety and financial reasons, we did not position the rail tanker above a real life pool fire. Hence, the test was developed to hit the rail tanker with the water canons and to observe the water volumes that reached the rail tanker. We made use of one rail tanker and two railcars. The rail tanker is position in between the two railcars. The table below presents the specifications of both types of containers.

Table 1: Rail tanker and railcar specifications.

Aspect	Rail tanker	Railcar
Type	Demonstration car	Rijmms 660
Height from rail (WH)	4,00 meter	4,28 meter
Height rail to car (FH)	1,25 meter	1,23 meter

Width (B)	2,50 meter	2,70 meter
Length (L)	14,00 meter	14,20 meter

Both types of containers are visualized below.

Figure 1: dimensions of Rijmms 660.

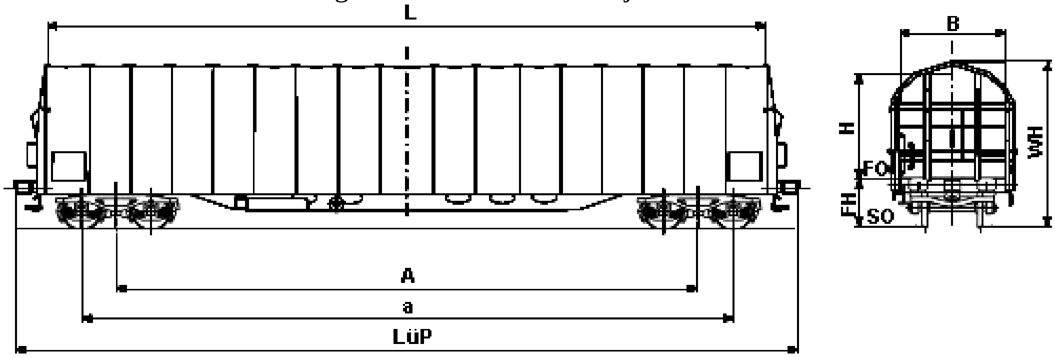
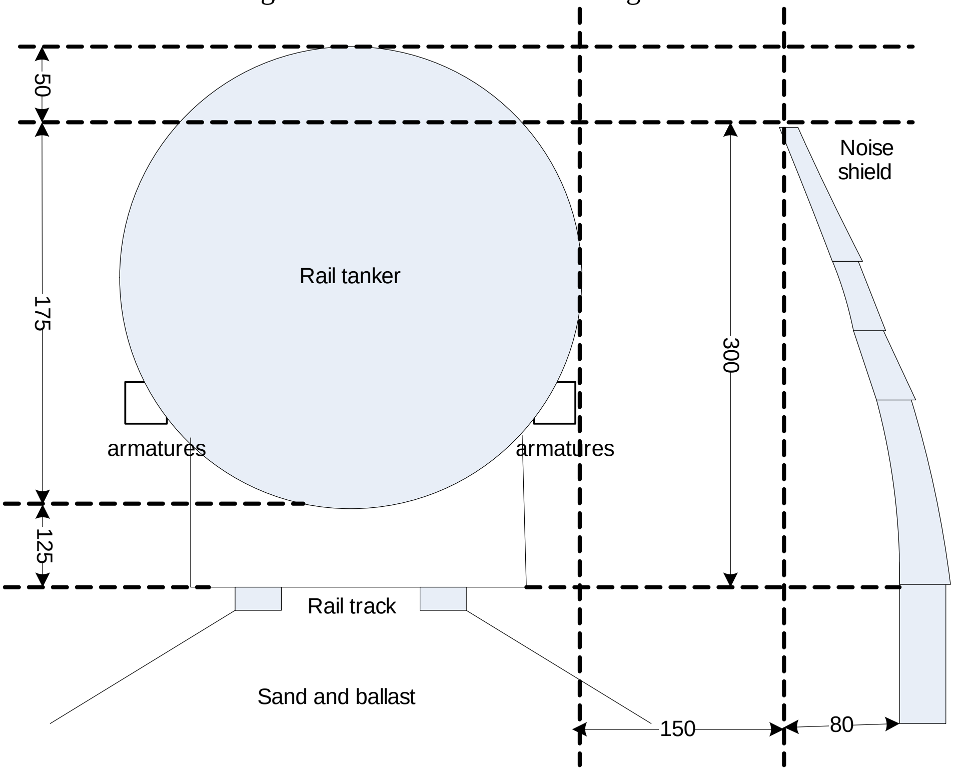


Figure 2: Photograph of rail tanker.

The Betuweline noise shield varies in height from 1 to 4 meters. We selected a test location where a 3-meter high noise shield has already been realized on one side. The test was held near the villages of Leerdam and Vuren very close to highway 15, hectometer 34,7.

Figure 3 presents a front view of the test arrangement.

Figure 3: Front view of test arrangement.



The tests were realized with the cooperation of many stakeholders: ProRail (providing the rail track), fire region Zuid-Holland Zuid (preparation and logistics), fire brigades of Lingewaal/Lingewaal Zuid, Sliedrecht, Lingewaal/ Asperen en Papendrecht (operating the water canons and hoses), NedTrain (providing the rail tanker), the national police ((KLPD) for photography and video observations), Ministry of Transport (traffic management at highway 15) and the dike reeve Vierstromengebied (ditches).

The test results were observed in two ways:

- Three police camera's (1 helicopter, and 2 police cars)
- Three observers (2 at each side of the rail tanker, and 1 behind the noise shield)

An observation protocol was developed. The three police cameras were coordinated by the police control room near the test site. One liaison of the test team was apparent in the police control room. The test leader was in contact with the liaison and the observers. The observers were in contact using the Dutch new emergency response communications system C2000. The test leader coordinated the observations by indicating the start and the end of the cooling activities. UsingC2000, the test leader requested the observers to indicate the place where the rail tanker was directly hit by the water and the amount of water that flew of from the rail tanker. Each of the observers had his own observation map. The observers were asked to indicate those parts of the rail tanker that where directly hit (high/low and left/right) on the papers by marking these parts on a pre specified raster on the rail tanker. The amount of water hitting the rail tanker was qualified in terms of a lot or scarce and in terms of continuous or incidental.

Both observers and policemen were instructed before the test. This instruction was meant to clarify the goal of the test and the aspects the observers should take notice of.

In particular, the rail tanker should be hit with the water canons. Four different water canon positions were tested:

a) 1-sided: 2 water canons behind the noise shield and rectangular (about 90 degrees) on the rail tanker
b) 2-sided: 2 water canons behind the noise shield and 2 water canons from the south without a noise shield in between, both positioned rectangular (about 90 degrees) on the rail tanker
c) 2-sided: 2 water canons behind the noise shield and 2 water canons from the south without a noise shield in between, both positioned in angle (about 45 degrees) on the railcar
d) 2-sided: 2 water canons inside the noise shield (angle about 5 to 10 degrees) and 2 water canons from the south without a noise shield in between, the latter positioned in angle (about 45 degrees) on the railcar

The table below summarizes the test data. The positions of the water canons are number 1, 2, 3 and 4 (most left column). The type of water canon is specified in the one but most left column. The upper row presents the various tests a), b), c) and d). The cells contain the water canon positions per test regarding the centre of the rail tanker. The water canon locations are labeled using the direction from the rail tanker (north, east, south and west). The distances are measured in meters from the centre of the rail tanker. The cells contain information about the direction and distance per canon per test.

Table 2: Test site data: arrangements of water canons a) to d).

nr	Type water-canon	a) 2 canons, 90 degrees and behind noise shield	b) 4 canons, 90 degrees and 2 behind noise shield	c) 4 canons, 45 degrees and 2 behind noise shield	d) 4 canons, 2 canons inside noise shield (5-10 degrees) and 2 canons 45 degrees
1	Street water-canon: 5 to 6 bar	North: 25 m. East: 10 m.	North: 25 m. East: 10 m.	North: 15 m. East: 20 m.	North: 1,5 m. East: 20 m.
2	Oscillating: 8 to 10 bar	North: 25 m. West: 10 m.	North: 25 m. West: 10 m.	North: 15 m. West: 30 m.	North: 1,5 m. West: 30 m.
3	Oscillating: 8 to 10 bar	-	South: 25 m. East: 10 m.	South: 25 m. East: 30 m.	South: 25 m. East: 30 m.
4	Oscillating: 8 to 10 bar	-	South: 25 m. West: 10 m.	South: 25 m. West: 30 m.	South: 25 m. West: 30 m.

The photograph below shows the beginnings of the test where water canons behind the noise shield are installed. From this photograph it is clear that the rail tanker is only slightly higher than the noise shield, and therefore difficult to hit with the water canon.

The water canons were tuned. Tests made clear that water canons should squirt converged water beams instead of diverged beam. A diverged beam flights away even when there is hardly any wind. To hit the rail tanker, a converged water beam is used. The converged water beams could be aimed at the rail tanker by varying the pressure of the pumps and the sprout angle.

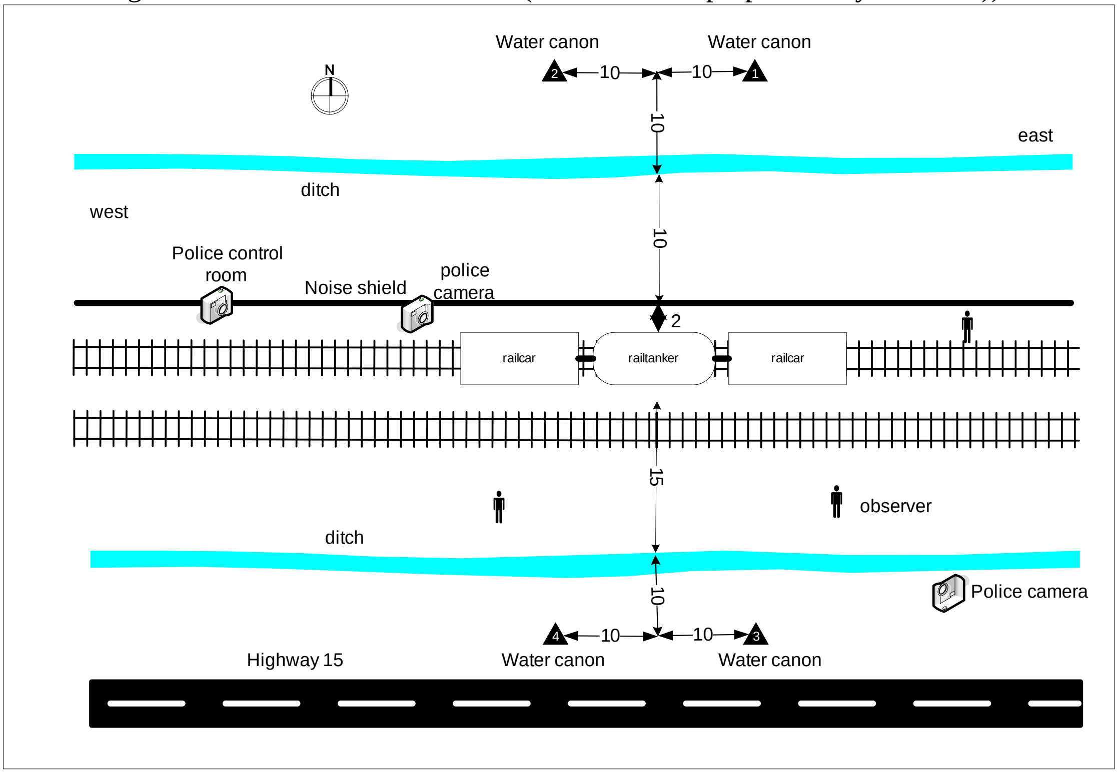
Figure 4: Tuning water canons for the test.

Table 2: Test site data.

Aspect	Specification
Date and time	24 June 2005, 1.00 pm
Temperature	30 degrees Celsius
Weather conditions during test	Dry and sunny, hardly any wind
Weather conditions 1 week before test	Heat wave: 5 days, 30 degrees Celsius
Height railcar (Rijmms 660)	4,20 meter
Height rail tanker (demo car) armatures included	4,00 meter
Height noise shield	3,00 meter
Distance between lower part noise shield and rail tanker	2,30 meter
Distance between noise shield and rail tanker at 3 meters high	2,00 meter
Type pump application	HSP-19B
capacity pump	Covers 15 meter height with 2400 liters/min including 1 bar dynamic pressure

The figure below shows the test arrangement (for illustrations purposes, only for test b).

Figure 5: Overview of test location (for illustrative purposes only for test b)).



Results

We did not observe any differences in hitting the railcar left from the rail tanker or the railcar at the right. This is understandable because neither the containers nor the arrangement of the water canons differed. There was no problem hitting the rail tanker from the side where there was not noise shield.

The table below shows the test results for the rail tanker and railcar squirting converged water beams. The water canons were operated by firemen. The most left column presents the container (rail tanker or railcar). The one but most left column presents the position at the container that is hit. The upper row presents the four different tests. The cells contain the qualifications by the observers. The qualifications are based upon the camera images, filled out observer formats and interviews with the observers. We emphasize that in this table, the amount of water hitting the south side of the containers is not presented: this side was fully hit.

Table 3: Test results cooling.

		a)	b)	c)	d)
railcar: noise shield side (north)	Height (2,75-4 meter from rail)	-/+	-/+	-	+
	Height (1-2,75 meter from rail)	--	--	--	-/+
Rail tanker: noise shield side (north)	Height (2,75-4 meter from rail)	-/+	-/+	-	+
	Height (1-2,75 meter from rail)	--	--	--	-/+

-- = no hit; - = hardly any hit; -/+ = partial hit; += moderate hit; ++ = fully hit

The results indicate that the noise shield to large an extent prevents the water from hitting, and therefore cooling, the rail tanker. The upper parts of the rail tanker were hardly hit by the water canons and the small amount of water flowing down the rail tanker did not reach the lower parts of it because of the armatures at the rail tanker. Also the amount of water in the ditches to be used for cooling was too small. The ditch nearby ran empty.

In addition, the following aspects were observed during the test:

- After a period of squirting water, a pool originates between the track and the noise shield
- Water runs of the rail tanker, however, does not reach the lowest point of the rail tanker because of its armatures
- Water canons inside the noise shield pretty much hit the upper side of the rail tanker
- Canons operated by firemen better hit the rail tanker than oscillating water canons
- Water levels is ditches decreased rapidly causing capacity problems
- Developing new test arrangements took about 10 to 15 minutes (included tuning the water canons)

These insights regarding the possibilities to hit the rail tanker and the limited volumes are both relevant to emergency responders for disaster abatement purposes and to water management organizations. For emergency responders because it determines:

- The lack cooling capacity and hence the risk of explosions
- The primary direction for repressing accidents

For emergency responders and water management organizations because the water canons require large amounts of water that cause ditch to run empty. This shortage disables the cooling opportunities.

Conclusions and recommendations

The following conclusions are drawn:

1. A converged water beam better hits the rail tanker than a diverged water beam
2. Firemen operating the water canons better hit the rail tanker than oscillating water canons
3. There is hardly any difference in effectiveness when water canons are arranged rectangular or 45 degrees regarding the rail tanker
4. The 3-meter high noise shield causes that the upper parts of the rail tanker are hardly hit
5. The 3-meter high noise shields cause that the lower parts of the rail tanker are not hit at all
6. Water runs down the rail tanker, however it does not reach the lowest points
7. In absence of the noise shield, water canons fully hit the rail tanker
8. A water pool develops between the noise shield and the track

The following recommendations were made:

1. Take noise shields into account when preparing for incident management at the Betuweline
2. When preparing for incident management, take into account the development of a pool between the noise shield and the track, due to the squirted water volumes
3. If water canons are necessary for squirting water, then it should be tuned into a converged beam and positioned rectangular regarding the rail tanker
4. Assess the cooling capacity of the water running down the rail tanker
5. Invest the opportunities for replacing/relocating armatures on the rail tanker
6. Reconsider the primary direction for repression activities with respect to the noise shield presence

7. Asses the influence of a 2 meters high noise shield
8. Consider various extinguish strategies for cooling a rail tanker behind a noise shield

Discussion

The results are based upon one single full scale test near a three meter high noise shield. Still, we argue that similar tests would result in similar cooling results. The reason therefore is that variables were controlled and that unexpected variables, such as weather conditions, hardly improve the results. More wind actually would further deteriorate the effectiveness.

In addition, it is interesting to find out what the influence would be in case of other heights of the noise shields. In particular heights in the range of 1,5 and 2,5 meters.

In addition, other types of incident management might be necessary, such as providing a foam blanket. Such strategies have not been tested, but might be useful to give an idea of the opportunities when noise shields are present.

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Author Biography

Nils Rosmuller has a PhD in transport safety at Delft University of Technology. Since 2001, he is working at the Netherlands Institute for Fire Service and Disaster Management, at the research department. His main fields of interests are transport safety, tunnel safety and the safety of fire fighters.

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Information & Communications

COMPARISON OF EMERGENCY SCENARIOS FOR FUTURE PUBLIC SAFETY COMMUNICATIONS

Delia Berrouard, Krisztina Cziner, Adrian Boukalov
Helsinki University of Technology (HUT)

Keywords: user requirements, emergency response communication, information flow, hierarchical structure

Abstract

Development of emergency response communications technologies cannot be done effectively without taking into consideration the user requirements. Therefore several international user interviews were carried out during the Wireless Deployable Network System European IST project (WIDENS). Our paper discusses the information flow and spatial distribution of different European emergency response organizations. The main result of the study that, even several similarities were found in the organizational structures and hierarchical arrangements, still every nation react and handle emergency situations somehow differently. Main difficulties of emergency communications are lie in the efficient information transmission and the interoperability problems of the systems.

Introduction

WIDENS (Wireless Deployable Network System) is a system developed by the "Information Society Technologies" group of the European Commission, intended to provide rapid set-up voice and data communication for disaster response, using ad hoc networking technologies. This network will provide support for a number of applications such as transmission of real time video, high-resolution still images and large data files. The network is targeting to meet the user requirements for a robust, mission critical network for public safety, similar to existing infrastructure based networks such as the TETRA system. The paper focuses on description of the results of public safety user studies carried out within the project, following work previously conducted through WIDENS. It presents an international perspective of three different fire fighting scenarios, and information about the strengths or limitations in present emergency management for different user groups in different countries. The main goal is the identification of information flow, spatial distribution and certain operational details within and between organizations. All of these factors can have impacts on the design of effective telecommunications technologies related to features, functionality and required information.

Literature Review and Methods

<u>Issue of Concern</u>

The development of telecommunications technologies for use in the sector of emergency response is advancing quickly and discussion of the needs and potential uses for the users of this technology should be considered. This is of importance both in validating and rendering practical the work of advancing technologies as well as in order to reach the goals of efficiency in emergency response, which directly translates into reduced injury, loss of property and life. Attention to the needs of users in technology is not new as can be seen in the industrial sector, which caters to the demands of their customers, followed by in-depth marketing studies. However, in the domain of public safety technologies, which is directed by somewhat different elements including public funding and political decisions, studies of user considerations are somewhat behind the advancement of technology. Negligence of user consideration is not isolated to this domain. In the diverse domain of public safety and emergency response there is a great need for efficiency in the work that is carried out and continuous improvements in effective response. Technology may support public safety and rescue services through a number of means:

1. providing communications,
2. taking measurements of critical variables,
3. monitoring,
4. allowing access to relevant stored information(maps, medical records etc.)

Literature Review

Emergency response and public safety telecommunications is widely discussed in literature, but the user's involvement into to research process in rarely discussed. It seems that the majority of research tends to be focused only on the technological development itself. Usually the user requirements are mapped on basic level, and most of the feedback from the user's side is coming just on the testing phases. This may be from user interface discussions to the development of new features, programs or tools . Other bodies look to the integration of different information sources, so as to be accessible to the right people at the right time in order to effectively prevent emergencies, and if needed subsequently coordinate response efforts e.g. (Ilmavirta, 1995). (Pintér, 1999). A great deal of this may be addressed through the extension of modeling or monitoring programs e.g. (Heino, (1998); Anogianakis, (1998); Ikeda,(1998); Luque, (2001)). Comparatively, literature addressing the needs of users directly, or acting to understand the organizational, information flow and tactical approaches of public safety personnel in the context of application to telecommunication is not great (Zografos, 2000).

Methodology

Through the involvement of various actors in public safety and emergency response, the methods of this research held the intentions of bringing forward the voice of the users for application and use in the development of telecommunications technologies. This included participation from decision-makers and policy writers to in-field personnel. The methods included the interviews, preparation of user questioners, participation of the researcher in relevant workshops and simulated scenarios. The key issues addressed in the study are:

- identification of large-scale scenarios relevant to Europe
- identification of specific reference scenarios as seen from different organizational and national perspectives
- identification of the organizational functions, importance of cooperation between organizations and actual activities during a scenario including communication flows

Development of potential scenarios and operations of organizations was the main focus of the study. The publication presents three user case studies, each from different national perspectives.

Scenarios, Case Studies

The following three fire related scenarios act to give an understanding of the organization and arrangement of emergency responses from different national and organizational perspectives:

1. Urban fires: Finnish example in Helsinki
2. Urban fires: Danish example in Copenhagen
3. Forest fires/later potential cause of Urban fires: Southern Europe (Greece, Italy, Portugal, Spain)

<u>Urban Fires: Finnish example in Helsinki</u>
Urban rescue services are prepared to cope with a wide range of emergency scenarios. An emergency does not need to be very large to trigger several different organizational sectors, such as the fire brigade and medical services and police. In the situation of a large-scale fire, the fire brigade, rescue services and medical services are all involved. The fire brigade copes with the fire and manages all things concerning the fire. The rescue team is specifically trained to rescue and remove victims from the fire risk area. The medical services give first aid care and then transfer the victims to appropriate locations for additional treatment, such as hospitals.

Communication between organizations and individuals happens at the lowest level of hierarchy to coordinate activities on-site. Members of a team have their own talk group, and one leader monitors the team group as well as the groups of any additional teams. If information from another team is important, this leader will forward it to their team members. If there is a special case, for example the presence of explosives, and the teams are separated, the communication goes through higher leaders and is passed back down to the team members on-site. Radio communications are used, with pre-defined talk groups for discussion. Management of these talk groups is done from a mobile command and control center if it is necessary.

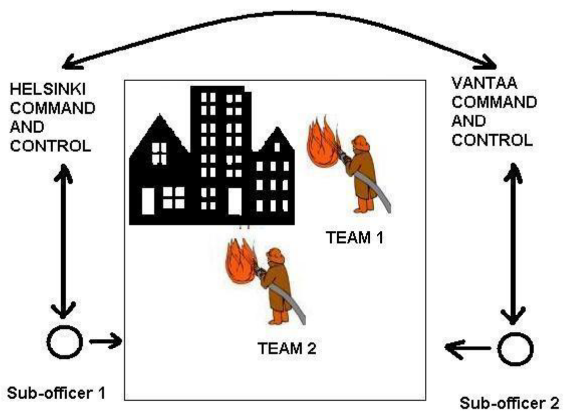

Figure 1. Urban Fire Scenario: Helsinki, Finland

When the fire has been put out and the responsibilities of the fire brigade are all met, the fire brigade will leave the scene and the police will take over management of the scenario. In this way we see that if an organizational sector isn't needed for a scenario, it is dropped out and other sectors take responsibility. All aspects of emergency management are highly pre-established at some level. Actions and decisions are often automatic and part of procedure, based on experience and careful planning.

<u>Urban Fires: Danish example in Copenhagen</u>
Denmark's emergency response units are well prepared for handling urban fire emergencies. Activities within and between different organizations are closely planned, including fire brigade, police and ambulance services. Cooperative agreements are existing between all of the Nordic countries. The emergency calls are usually handled by the police, but in Copenhagen, the country's largest city containing nearly one third of the total population, the fire brigade is the authority responsible for handling this calls. The advantage of this is that the fire brigade has the ability to dispatch police cars and ambulances in addition to fire trucks.

The first organization to arrive on scene is the one responsible for making the decisions for scene management and calling in additional help if needed. In the case of an urban fire generally the fire brigade is first to arrive. Fire scenarios of any size are identified by four categories, and the responsibilities of different organizations are given spatial limits within these category boundaries. The central location of the event where the fire is burning is the Red Zone. This area is absolutely controlled by the fire brigade. The area just outside of the Red Zone within which the fire brigade is operating is the Yellow Zone. This area contains the fire trucks, all equipment. Beyond is an area identified as the Green Zone. Here any necessary ambulance personnel and hospital equipment is located and operating. The police secure the boundary from access to the public. The final White Zone identifies any area outside of the scene management.

Medical assistance may be asked to enter the Yellow Zone, for example in order to remove victims who have been brought out of the Red Zone through to the Green Zone for treatment or removal to a hospital. During the scenario, one on-site mobile command post is established to maintain contact with all of the organizations present. The fire brigade coordinates its own operations within the Red Zone. The medical services coordinate their activities together with the needs of the fire brigade and the services of the hospitals. The police coordinate their own activities, and are guided by the areas of operation established by the fire brigade and medical services. Together, the organizational structure acts to efficiently and effectively cope with the emergency scenarios an urban fire might pose.

<u>Forest Fires: Experiences in Southern Europe</u>

In southern European countries where forest fires are a particular problem due to hot, dry summers such as Greece, Italy, Portugal and Spain, plans in place to mitigate the specific risks of forest fire smoke are limited. Forest fires are a risk not only to the timber and natural ecosystems that they engulf, but also to homes, infrastructure and human lives. In a virtual fire scenario of a large forest fire incident, the general public or police are typically the first to notice. Through citizens or the police, the fire brigade is notified. Depending on the seriousness of the fire, the first attack is made by plane if available, or by ground. Generally this takes place within the first one to two hours of identification of the fire. An area of 100km squared, could be considered typical for the fire site. Planes flying over the burn area observing the smoke plume and its movements can see smoke but are not able to judge the severity of risk the smoke poses.

Depending on the legal system of the country in question, generally the fire brigade is the organization taking charge of such a scenario. Flow of information during a scenario for control of a fire goes upwards through the ranks to the fire brigade center of operation, sometimes with involvement of the local authority such as the mayor or local prefect. The police act as “local sensors” on the ground, coping with all community related issues concerning the forest fire. Operational fire fighting decisions are made by the fire brigade, but larger decisions such as evacuation of a town are made by the Ministry of the Interior / Civil Protection. The actual evacuation is carried out by the police.

The main responsibilities of fire fighters during a forest fire are to prevent further advancement of the fire and protect property and infrastructure. By containing a fire, it is allowed to burn itself out. Containment is done by using anti-fire barriers such as lines cut into standing forest or use of fire retardant to delay the flames or growth of the fire. The wind direction determines the different orientation of these anti-fire lines. Often a multi-fractured polygon may be cut around the fire.Most European cities monitor air quality to cope with general pollution, and some indications of forest fire smoke risk may be taken from these stations. Smoke impact management is non-existent. No alert plan exists for high-risk air particle status. Most authorities do not have specific larger-scale plans for smoke inhalation risks to populations, and evacuation is based on past experiences of the decision-makers, with no real procedures in place. Considering the potential widespread and long-term impacts of the public at large, there are strong grounds for the implementation of technology. This can be considered in terms of air quality and smoke monitoring capabilities, communicating this information to the appropriate authorities at the right time, and smoke risk planning and procedures for forest fires.

Discussion

The bulk of work in emergency response that considers standards development and discussion with users seems to come from the USA. This seems to help fill some of the void until one considers the inherent problems to be addressed in this research as identified earlier, considerations such as language barriers, incompatible technologies and accessibility, not to mention sensitive political perspectives and investments in technology. With a uniquely North American perspective, challenges may have been more standard to begin with at the very least by means of similar language and cultural approaches to emergency response. There is left a definite need to address the issues of users from a European perspective if efforts towards National, European and Global harmonization are to be optimized.

Differences and similarities of operational systems

There appears to exist some similarities and differences in the operational systems and arrangements of organizations during an emergency response Table I. This can be observed between organizations and nations, and is recognized both through the communication flow.

	Urban Fire Helsinki, Finland	**Urban Fire Copenhagen, Denmark**	**Forest fire Italy , Spain, Portugal, Greece**
Organization receiving the emergency call	Fire Brigade or Police	Fire brigade	Fire brigade
Responsible Organization	Fire brigade	Fire Brigade (but first who arrives is leading the operations)	Fire brigade
Hierarchical structure of the network	Decision-making kept on-site as much as possible –each organization coordinates themselves -inter-coordination with between group leaders	Decision-making kept on-site as much as possible – each organization coordinates themselves, and inter-coordinates with each other between group leaders	High level decision making High level coordination is needed.
Network Topology	Teams of 2-4 depending on organization/activity type	Teams of 2-4 depending on organization/activity type (smoke diver, firefighter, ambulance, etc.)	Big teams 10-1000 people
Estimation of inter users distances/area	Usually close distance tens of meters, 1-4km squared.	May be tens of meters, 1-4km squared.	Hugh distances, 1000km squared
Users mobility	Communication and movement is organization-specific, but inter-related at a lower hierarchical level.	Communication and movement is organization-specific, but inter-related at a lower hierarchical level.	Communication and movement is organization specific
Service availability vs. hierarchy/topology	Within organizations. Voice information, some GIS information; value for more accessible databases, GIS, sensors information in the future.	Within organizations. Voice information; value for accessible databases, GIS, sensors information in the future.	Voice communications, access is required for data bases, maps, Fire sensors etc.

TABLE I. DIFFERENCES AND SIMILARITIES BETWEEN THE SCENARIOS

Examining three scenarios all dealing with different aspects of fire fighting reveals a great deal of similarity between arrangements. We can see that in all three fire examples the fire brigade takes control of the scenario. This is to be expected considering their expertise in fire management. What is interesting is the fact that in all three examples, control of a scene or scenario is layered, and different layers of the scene may have different sectors in control of management. As mentioned earlier, a scenario does not need to be very large in order to involve several different organizations.

Hierarchy of Organizations
Organizations act independently with head members coordinating any cooperative efforts between them. In the Danish example, the head officer of the fire brigade determines how many medical members will enter the Yellow Zone for removal of victims. This message is given directly to the head officer of the medical team, who then arranges their personnel. In the southern European and Finnish examples, organizations similarly hold very specific roles and interaction between those roles is passed through higher personnel. Although communication between organizations is limited, that which does take place occurs through the lines of strict hierarchy. Information works its way up and then back down the chain of command from one organization to the next. That chain of command can be much longer than in the other cases, where on-site management is more likely and shortens the chain of command.

A high level of hierarchy seems to be consistent in all cases. As just indicated, this hierarchy can limit the efficiency of passing information from one organization to another. Hierarchy is important for control of a scenario and seems to be effective when fewer groups are coordinated together, the larger the scenario, the more complex communication becomes. Note that in a few cases such as the Finnish and Danish examples, decision making is kept on-site as much as possible, reducing the levels of hierarchy needed to pass through before taking actions.

Specific access to information and data can be critical in decision making. This can be seen in the case of risk from forest fire smoke. Specially designed monitoring tailored for forest fires, and distribution to the right officials can go a long way in reducing civilian and firefighter risks. In Such scenario-specific technologies can be valuable for each scenario described.

Results

It is important to understand the operations of organizations during an emergency scenario. A greater understanding of the underlying procedures, organizational and spatial arrangements of rescue services can go a long way to supporting the development of future technologies and enhancing the efforts of public safety activities. Figure 2 is a general flow-chart diagram indicating information flow in a general multigroup management scenario. Information from the scenarios demonstrated in this paper can be elaborated and built upon through future user studies in Europe. Further development of such diagrams can be done by elaboration and additional content from future studies. These, together with the case study content, serve as a valuable basis for user requirement mapping and system studies. The main focus in the case studies to get to know the organization hierarchy better and type and form of communication used inside and between the organizations, and what kind of information is required in certain emergency situations. Try to identify the strengths and limitations of the recently used systems, examine their efficiency, availability and response time. To find better technical solutions for the interoperability of the equipments used by different organizations is the key issue of the further studies.

The spatial arrangement of operations varies from scenario to scenario. Teams within organizations tend to be working spatially close together – from a matter of meters, to tens of meters. The distances between different teams of an organization will be slightly greater, and the distances between teams of different organizations can vary greatly. Two teams from different organizations may be working in close proximity, or they may be at a further distance, depending on the zones of operation of each organization. This brings us to a question in terms of the range over which equipment for telecommunications need to be able to function (Table II). These distances described for specific organizations may be much smaller, e.g. meters or tens of meters, than they might be for communication between organizations, e.g. meters to kilometers. Specifications should take into consideration the needs, immediate or potential, for communication between all members for any given scenario.

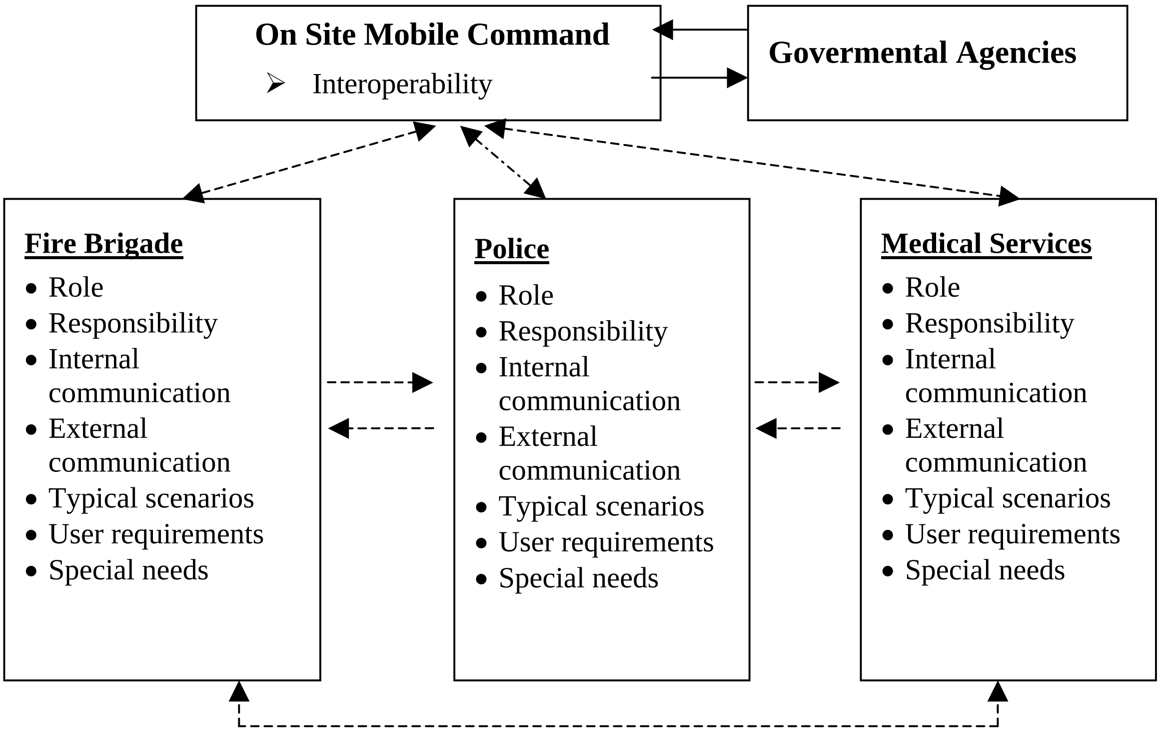

Figure 2. Multi group emergency management

Typical type of communication	**Data exchange between organizations**	
Voice and low bit (e.g. GIS)	Governmental Agencies, Public Works, and Water Management	National Police, Fire Brigade, and Medical Services Headquarters
low bit (e.g. GIS)	Municipal heads	Municipal heads
voice	Municipal heads	Team leaders
voice	Team leader/team member	Team leader/team member

TABLE II. DATA EXCHANGE BETWEEN ORGANIZATIONS

Conclusions

In Europe the public safety communication system is differ from country to country, and sometimes even from region to region or city to city within the same country. These differences can act to create barriers to successful cooperation between organizations, particularly in the event of international cooperation. Adding to the problems of variation in languages, standards for procedures or collecting and storing of available information, instruments for basic communication may quite simply be incompatible. This may further aggravate the complications of an emergency response in the case of loss of basic infrastructure.

It is clear that technology continues to advance in leaps and bounds, including within the domain of telecommunications and information systems. The problem seems to be access to the multiple and diverse existing technologies rather than further development of new ideas, although the latter is certainly an area of keen interest and value. An additional challenge to simply making technology accessible to the users in terms of availability and affordability is the difficulty of making complex, intensely informative technologies practical to the working environment of individuals involved in emergency response. Information and access to that information needs to be understandable, readily available, and practical to use in often difficult environmental conditions such as high heat, low visibility or awkward protective clothing.

Key results revealed that similarities exist in so far as organizational roles are concerned, holding specific responsibilities in terms of location and task. Hierarchical arrangements and information flow may also be similar. However, difficulties lie in the efficient transmission of information due to slow information flow. Spatial distribution of personnel varies for scenarios, which is very relevant for the functioning of communication systems. Future European studies are recommended for the advancement of our understanding of these newly addressed issues in public safety user technologies and the needs of users in Europe, the results of which hold great value to the effective development of technology and their subsequent use in public safety.

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Biographies

Delia Berrouard is a Researcher at Helsinki University of Technology, Department of Electrical Engineering, Communications Laboratory.

Krisztina Cziner is a Research Scientist at Helsinki University of Technology, Department of Chemical Technology, in the same time holding a part time research position in the

Communications Laboratory. Before joining Helsinki University of Technology in 2001, she studied Chemical Engineering at University of Veszprem, Hungary. She has published several articles on process integration and process evaluation. At the moment she is finishing her doctoral thesis.

Adrian Boukalov received his M.S degree in radio engineering from Leningrad Electrotechnical institute (LETI) Radio System Department, St. Petersburg, Russia, in 1984. Next 5 years he spent in industry being involved in several R&D projects. Later he has been a managing director of private company that has been active in the area of software development and communications. Since 1998 he has been with Communications Laboratory of HUT. His research interests include system aspects of smart antennas, resource allocation, network planning and simulation. He is responsible for the research activity of a small group of engineers and students working in this area. In 2002 Adrian became an elected chairman of the Technical Specification Group System (TSG SYS) of the transatlantic project MESA. His management responsibilities in MESA include the co-ordination of MESA work on system concept and technology development, co-ordination of different international research initiatives related to MESA. Adrian is the WP manager in WIDENS (www.widens.org) and CELTIC project DeHiGate. Since 2005 he is Vice Chairman of OCG EMTEL /ETSI.

EUROPEAN HARMONIZATION IN PUBLIC SAFETY COMMUNICATION AND INFORMATION SYSTEMS - THE NARTUS PROJECT

Adrian Boukalov[1] & K. Harald Drager[2]
Helsinki University of Technology, Finland &
The International Emergency Management Society

Abstract

The NARTUS project is focused on creating a European platform and roadmap for future public safety communication and will help to facilitate European integration in the area of Public Safety with particular focus on public safety communications and information systems.

The tools used by NARTUS for creating such platform and roadmap, have been identified in Forum Conferences. Through Forum Conferences NARTUS will launch consultations and build consensus organizing, developing and following up discussions between operational and technological stakeholders involved in Public Safety Communication and Information systems.

The diversity of technologies used by different European member states and user groups creates serious interoperability problems at different levels, starting from the level of equipment and going to the level of applications and user/system requirements. The interoperability problem dramatically reduces the efficiency of emergency response, especially in complex situations and /or requiring coordinated international efforts.

The increasing costs of new technologies and limited state budgets require careful evaluation of new systems at the tendering phase of new contracts' negotiations. At the same time the small size of the public safety market makes it more difficult for manufactures and service providers to reduce their level of costs.

The only solution to this multidimensional problem is to internationally harmonize requirements, systems and applications. Harmonization will be a complex process that requires the involvement of different key players at the international level and could continue for long periods of time. The key element of harmonization will be the creation of an internationally accepted roadmap that will facilitate discussions between major stakeholders and will provide a vision and key milestones for this work.

With the main goal of continuously improving the harmonization of technologies, the NARTUS project will establish links and regular discussions between Public Safety (PS) communications systems users, policy makers, industry, research organizations and standardization bodies.

[1] adrianboukalov@hotmail.com
[2] TIEMS President, Norway, khdrager@online.no

Background

The main objective of the project is to create a pan European (including non European Union nations) consultative network for public safety users, applications and system providers and operators that utilizes vehicles such as conferences, meetings, electronic media etc to create a discussion platform that will facilitate European convergence in the area of public safety communications and information management systems.

The need for such a convergence stems from a series of obstacles that hinders communication and the exchange of update to date and accurate data in emergency settings, thus jeopardizing the effectiveness of public safety operations. Currently there are a large number of diverse technology systems that either cannot inter operate, or, if they can, the interoperability is very limited in scope. In the interests of effective and consistent levels of service delivery across Europe, the communication within authorities, from authorities to citizens and from citizens to authorities needs to be internationally harmonized.

Among the obstacles presently hindering the building of an internationally integrated system are, for example multi languages and the difficulty of localization of emergency calls. Also, the networks enabling the communication between the authorities and from authorities to the citizens are difficult to implement as harmonized systems due to different structures, cultures and policies of the various authorities.

The diversity of technologies used by different European member states and user groups creates serious interoperability problems at different levels, starting from the level of equipment and going to the level of applications and user/system requirements. The interoperability problem dramatically reduces the efficiency of emergency response, especially in complex situations and /or in situations requiring coordinated international efforts.

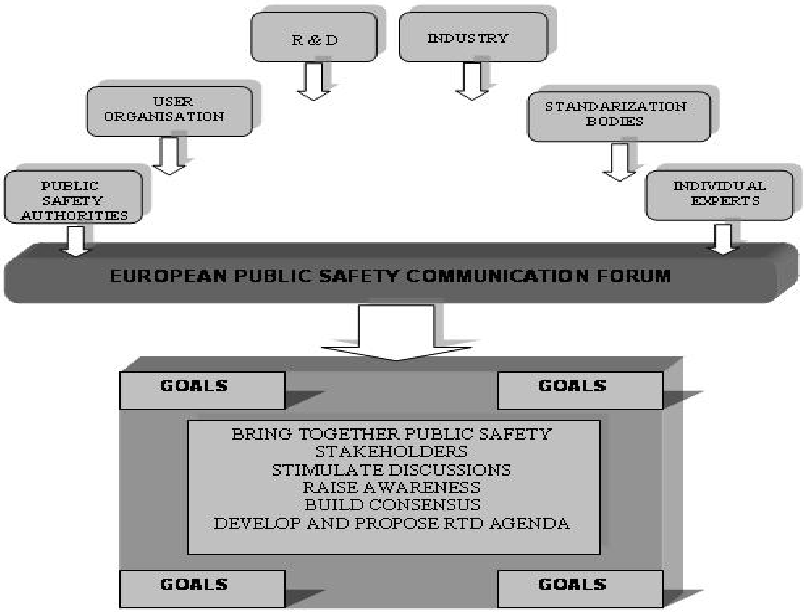
The increasing costs of new technologies and limited state budgets require careful evaluation of new systems at the tendering phase of new contracts' negotiations. As a result a large number of diverse systems are used, but they cannot talk with each other efficiently. At the same time the small size of the public safety market makes it more difficult for manufactures and service providers to reduce their level of costs. The communication between authorities, from authorities to citizens and from citizens to authorities needs to be internationally harmonized.

The only solution to this multidimensional problem is to internationally harmonize user requirements, systems and applications.

Harmonization will be a complex process that requires the involvement of different key players at the international level and could continue for long periods of time. The key element of convergence will be the creation of an internationally accepted roadmap that will contain a vision of future requirements, identify areas for further research, identify methods and technologies that will integrate legacy systems and identify emerging technologies that could be used in civil protection/public safety service delivery and that can be used to influence policy makers, regulators and standardization making bodies.

This is where NARTUS comes into play: NARTUS will establish and drive a European Public Safety Communication Forum that will produce a roadmap based on international consensus and convergence and which will be focused achieving future interoperability based on the harmonization of user requirements

Figure 1: Main project contributors and results



European Public Safety Stakeholders Forum

NARTUS convergence efforts will be pursued through the establishment of a European Public Safety Stakeholders Forum. Within such a process, a series of activities will provide educational and interactive media to enable the development of an internationally harmonized roadmap.

The European Public Safety Stakeholders Forum will be the central vehicle for launching a dialogue and building consensus, through a cycle of 5 conferences in the three years project period, discussions, workshops, electronic forum etc, which will bring together all Public Safety stakeholders.

The Conferences will be the showcases for the Project and will be the main platform for the final dissemination of the outcomes and deliverables from the Project. They will be a means to educate all public safety stakeholders, including political, authority, users, industry (including manufacturers and service providers), regulators and standardization making organizations. This platform will also help to validate, update and consolidate existing public safety user requirements, discuss a structure for security communication, and study system solutions. It will promote and facilitate the exchange of best practice, information, ideas, and experiences.

NARTUS Forum activities will represent the exchange platform for public safety political, technological and user stakeholders that will:

- Help to consolidate and validate existing common public safety user requirements
- Discuss a structure for security communication, and study system solutions
- Promote and facilitate the exchange of information, ideas, and experiences
- Provide advice and inputs to policy makers, regulators and standardization making bodies

The public safety user requirements to be established in the project will integrate user input from previous studies and relevant projects, both existing and in the future, and will help to produce a consolidated high level Public Safety User Functional Specification for communications and information management systems for the future.

The European Public Safety Stakholders Forum will represent member states' interests at the European and international levels and provide coordinated European input and advices on matters related to public safety communications and information systems issues.

Input To European Standardization Activities

Standardization aspects will be addressed in the project with particular focus on communication with standardization making and regulatory bodies to influence the development of international standards.

The project will establish links with ETSI[3], ITU[4], OMG[5] and other relevant standardization organizations that have interests in the areas relevant to public safety communications and information management systems. It will facilitate the flow of information between relevant IST research projects and industrial organizations in order to contribute to standardization and to influence international standardization development activities. The particular focus will be on projects EMTEL[6], MESA[7] and OASIS[8]. The input into standardization organizations will facilitate the convergence efforts and help to shape the future market in this area.

Political Harmonization And Consensus Building

The vital part of the harmonization process is the participation and consensus building at the level of national authorities. Public safety communications and information management and communication systems have always been considered as an important part of the domain of national security, where the idea of establishing an international cooperation has been treated with a large degree of skepticism. The NARTUS project will facilitate the dialog between European national public safety agencies to achieve consensus on common user requirements and technologies in public safety communication and information management systems. These discussions could help to develop international legislation and standards required for introduction of European harmonized public safety communication and information systems management and emergency response protocols and provide more cost effective solutions.

Dissemination Activities

Making information available and accessible is a contribution to the consensus building process. Main focus will be given to the form in which information will be provided as well as to the tools to put at disposal. Main targets will be stakeholders, which will be consulted during the Forum process.

A communication and dissemination plan will be adopted, laying down the policy on which and how documents will be sent and to whom. Activities to disseminate the project inputs and outputs of the Forum will include the five conferences, electronic forums linked to the project

[3] ETSI: European Telecommunications Standards Institute
[4] ITU: International Telecommunication Union
[5] OMG: Object Management Group
[6] EMTEL: Special Committee (SC) on Emergency Communications
[7] MESA: is an international partnership project initially created by ETSI and (Telecommunication Industry Association) TIA who have agreed to co-operate for the production of mobile broadband specifications for Public Safety aimed at the Public Safety markets.
[8] OASIS: On-line access to services and support from the Irish Government

website, the editing and issuing of a project leaflet, of regular news and of a newsletter to be posted on the website as well as all other documents of interest (conference reports, results of studies but also list of meetings reflecting the project progress).

NARTUS will enable the fluent communication between the users (citizens/authorities), regulatory bodies and industry and allow this exchange to be continuously available to the system developers and standardization bodies.

Decision-makers will be the final target. Dissemination will need to address them with clear messages outgoing from the work carried out by the experts. Media support will be a useful further support to spread out the projects results. To this end, specific media events might be organized together with the first conference to launch the project and at the end of the project.

Integration Of Emergency Telecommunication Systems

The project will facilitate the integration of different technologies in the area of public safety by supporting regular discussions between stakeholders and technology providers and by providing relevant inputs to standardisation organisations, regulators and other research projects. The political harmonisation in the project will provide a platform for harmonisation and integration of different technologies and data structures.

Public Safety Technologies Assessment And Road Mapping

Technology assessment and road mapping of public safety technology will be another key objective of the project. The introduction of new (and the optimizations of existing) public safety Communications and Information management systems is a very costly and complex process. The increasing complexity level of public safety communication and information management systems technology will require large investments. Those investments will be mainly supported by the budgets of European states and have to be carefully evaluated and justified.

This work will facilitate the development of the open architecture required for public safety information and communication systems thereby enabling the provision of better value for money systems.

Roadmap For Future Public Safety Communication

The support action will help to establish an internationally harmonized road map in Public Safety Communications and Information Management Systems. It will help to facilitate European integration in the area of Public Safety with particular focus on public safety communications and information management systems.

The roadmap will define the key technology focus areas where the efforts in R&D, industrial organizations, standardization organizations and business units have to be brought together. The key milestones and links between key players will be defined. The road map will help to define the new market areas, and these will be brought to the attention of industrial players.

Development Of Strategic Research Agenda For IST FP7[9]

Another goal of the project will be the identification of research and development challenges and objectives for the next 3-/5-/10- years. The project will define the vision and the strategic research agenda for the technology platform for the future IST FP7 research program. The

[9] IST FP7: Information Society Technologies, Framework Program 7

potential of the market in public safety communication and information systems will be evaluated. The project will explore the needs and gaps in public safety with respect to state-of-the-art and will identify actors for all relevant stages and determine the critical mass. The European competitive position and potential will be assessed in NARTUS.

Cooperation With IST Projects

It is an objective of NARTUS to facilitate the exchange of ideas and information between industrial and research organizations in the areas of technology, user requirements and standardization. The NARTUS project will identify and establish links with relevant IST research projects and will help to define the structure and scope of the IST and industrial projects that will be established in the future.

The NARTUS project will establish a regular exchange of information links with other IST projects such as CHORIST[10], u2010[11] and others.

Market Study

The market study and business models developed in the project will identify the relevant market areas and provide business models for the industrial organizations and SME's (Small and Medium sized Enterprises) interested in this area. The public safety communication and information management systems market is much smaller compared to the consumer market of public communication systems and requires careful evaluation to attract industrial investment.

Project Organization And Funding

The NARTUS project is a SSA (Special Support Action) under the sixth EU framework program within ICT for Environmental Risk Management. The project is fully financed by the EU Commission.

The following partners form the NARTUS Project Consortium is shown in the following table:

Role	**Participant name**	**Participant short name**	**Country**
Coordinator	Helsinki University of Technology	HUT	Finland
WP 1 leader	British Association of Public Safety Communications Officers	BAPCO	UK
WP 2 leader	Thales	Thales	France
Participant	EADS Secured Networks SAS	EADS	France
WP 3 leader	The International Emergency management Society	TIEMS	Internat.

[10] CHORIST: IST Project - Integrating Communications for enhanced environmental risk management and citizens safety
[11] u2010: IST Project - Ubiquitous IP-centric Government & Enterprise Next Generation Networks Vision 2010

WP 4 leader	SQUARIS Consultants	SQUARIS	Belgium
Participant	National Technical University of Athens	NTUA	Greece
Participant	Martel	Martel	Switzerland
Participant	Universidad Politécnica, Madrid	UPM	Spain

The interrelation between the work packages and their content is shown in Fig 2.

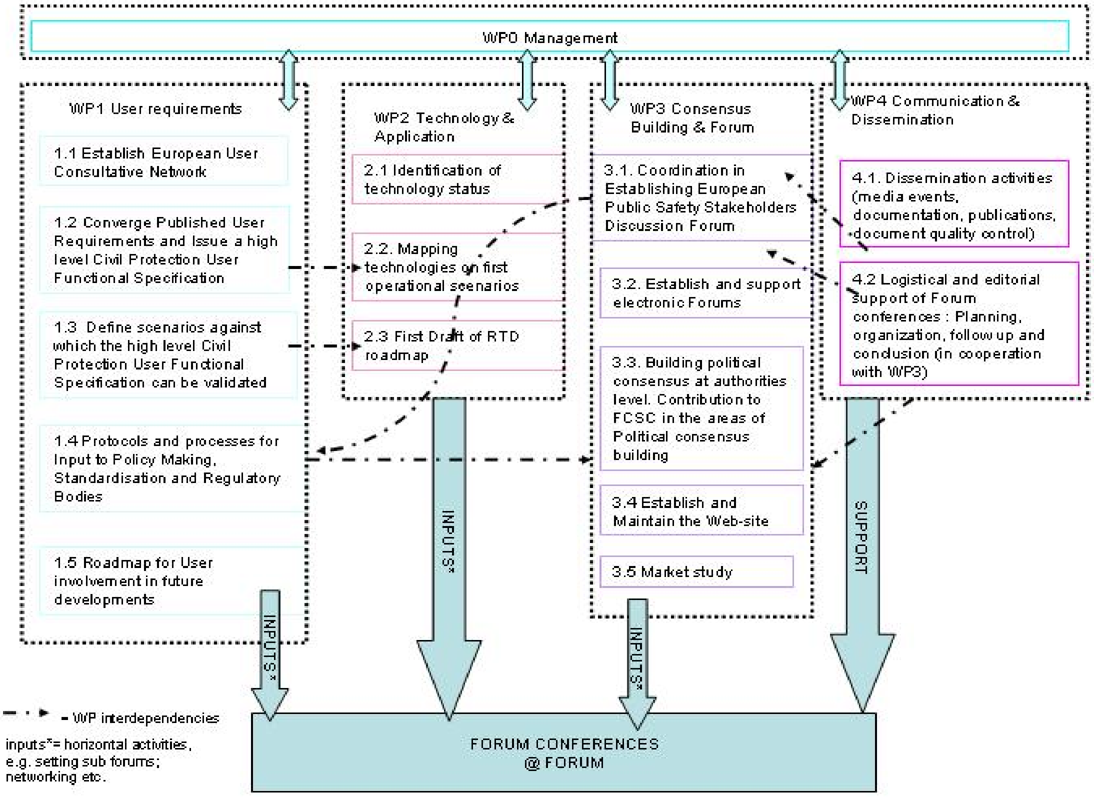


Fig 2: The different work packages and their interrelation and content

NARTUS Project Time Schedule

The project will start 1st of June 2006, and will last three years. The first European Public Safety Stakeholders Forum is planned to take place in Helsinki, Finland, when the Finnish Government take over the chairmanship in EU late November 2006.

Conclusions

The NARTUS project is a EU Commission initiative aiming at harmonization and a common platform for public safety communication in Europe, with further global implications.

The key element of harmonization will be the creation of an internationally accepted roadmap that will facilitate discussions between major stakeholders and will provide a vision and key milestones for this work.

With the main goal of continuously improving the harmonization of technologies, the NARTUS project will establish links and regular discussions between Public Safety communications systems users, policy makers, industry, research organizations and standardization bodies, which is intended to continue after the project's lifetime.

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Adrian Boukalov received his M.S degree in radio engineering from Leningrad Electrotechnical institute (LETI) Radio System department, St. Petersburg, Russia, in 1984. Next 5 years he spent in industry being involved in several R&D projects. Later he has been a managing director of private company that has been active in the area of software development and communications. Since 1998 he has been with Communications Laboratory of HUT. His research interests include system aspects of smart antennas, resource allocation, network planning and simulation. He is responsible for the research activity of a small group of engineers and students working in this area. In 2000-2001 he had been a principal investigator of the international co-operation project between HUT and Stanford University (USA) and had been a visiting scientist with at Smart Antennas Research Group (SARG) at Stanford University. In 2002 Adrian became an elected chairman of the Technical Specification Group System (TSG SYS) of the transatlantic project MESA (www.projectmesa.org). His management responsibilities in MESA include the co-ordination of MESA work on system concept and technology development, co-ordination of different international research initiatives related to MESA. Adrian is the WP manager in WIDENS (www.widens.org) and CELTIC project DeHiGate. Since 2005 is Vice Chairman of OCG EMTEL /ETSI.

K. Harald Drager received his M.Sc., in Electrical Engineering/Control System Engineering from the Norwegian,Technical University in 1966, and his M.Sc. in Industrial Engineering from Purdue University (USA) in 1973.

He is the President of TIEMS, Chairman and Managing Director of QUASAR Invest AS and Chairman and Managing Directorof A/S QUASAR Consultants

He is specialized in International Business Development, Strategic and Tactic Analysis and Implementation, Emergency and Risk Management, Hazard Communications and Project Management. He is founder and currently President of the International Emergency Management Society (TIEMS) since 2002 and has been a consultant to NATO, World Bank/IFC, Safetec and a board member of Det Norske Veritas (DNV). He has been involved in numerous national and international projects, e.g. EUREKA Project MEMbrain (1993-1995), British/Norwegian R & D Collaboration Project (1995), French – Norwegian Research Project (1990 – 1993), SIRTAKI (EU), and MEPDesign (EU). He has published 81 papers in international publications.

Academic and Professional Practice

Peer Reviewed Articles

Natural Disasters
Impacts & Responses

THE PRELIMINARY DESIGN AND IMPLEMENTATION OF A GLOBAL EARTHQUAKE DISASTER ALERT SYSTEM

LI Yigang[1], QU Guosheng, DU Xiaoxia, SHANG Hong
National Earthquake Response Support Service

HUANG Jianfa (2)
China Earthquake Administration

Key Words: Global Earthquake Disaster, Alert System

Abstract

This paper describes the preliminary design and Implementation of a global earthquake disaster alert system (GEDAS), including the framework, the database, the computing models and the software modules. The framework of this system is introduced first, including the location of alert in the whole earthquake disaster response process and mainly components of GEDAS. The global scale data used by the system, such as VMAP0, GeoCover and Landscan, is introduced in detail. The core compute models, including scenario earthquake model, economic loss estimation model, casualty estimation model and alert assessment model, are described and analyzed in detail. As to the software, the whole workflow and the function of each model are introduced briefly.

Introduction

Earthquake and earthquake induced disasters, such as the Indian Ocean tsunami in 2004 and the heavily damaged South Asia earthquake in 2005, caused huge economic loss and casualty. Earthquake disasters are becoming the mainly part of catastrophes recently. Although earthquake can not be predicted exactly until now, we can get the magnitude and location for a certain earthquake event quickly after it happened based on the earthquake monitoring network. An earthquake disaster alert system can give a quick estimation of the probable impact and trigger a reasonable emergency response based on the earthquake information and local data and quick response for a disaster event can effectively reduce casualty and economic loss. GDAS Global Disaster Alert System and PAGER (Prompt Assessment of Global Earthquakes for Response) are such alert systems (Martin,2004,2005;USGS,2005). GDAS already gave alert assessment and rich local information to ECHO and UN since 2003 yet PAGER is still in construction.

CISAR (China International Search and Rescue Team), an international disaster aid team, was established in 2001. CISAR took part in the Algeria, Iran and Pakistan earthquake rescue deployments after it was established. From the three deployments, an information support and alert software system is found to be important for quick and effective rescue. In 2005, we started to develop a Global Earthquake Disaster Alert System (GEDAS) for CISAR and the international relief affairs. GEDAS is some kind of GDAS software, such as the base data and alert model used in these systems are same. But earthquake is the only disaster event managed

[1] Email: Liyig@263.net

in GEDAS and GEDAS give more map making and analysis tools. This paper describes the design and Implementation of GEDAS, including the framework, the base data, the computing models and the software modules.

The Framework of GEDAS

Alert is the first step in the whole disaster information support process. A success alert needs to give economic loss and casualty estimation, disaster trend analysis and emergency response advices after the disaster event as soon as possible. Fig.1 is the picture of the whole information cycle of earthquake emergency response process. The alert must be given in one hour or shorter after the earthquake event to unfold a timely emergency response.

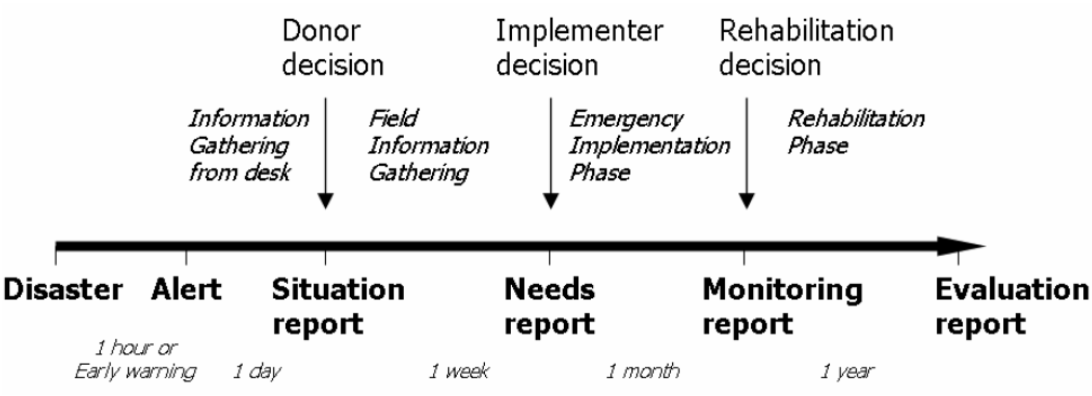

Fig.1 Information cycle of earthquake emergency response process (IPSC, 2005)

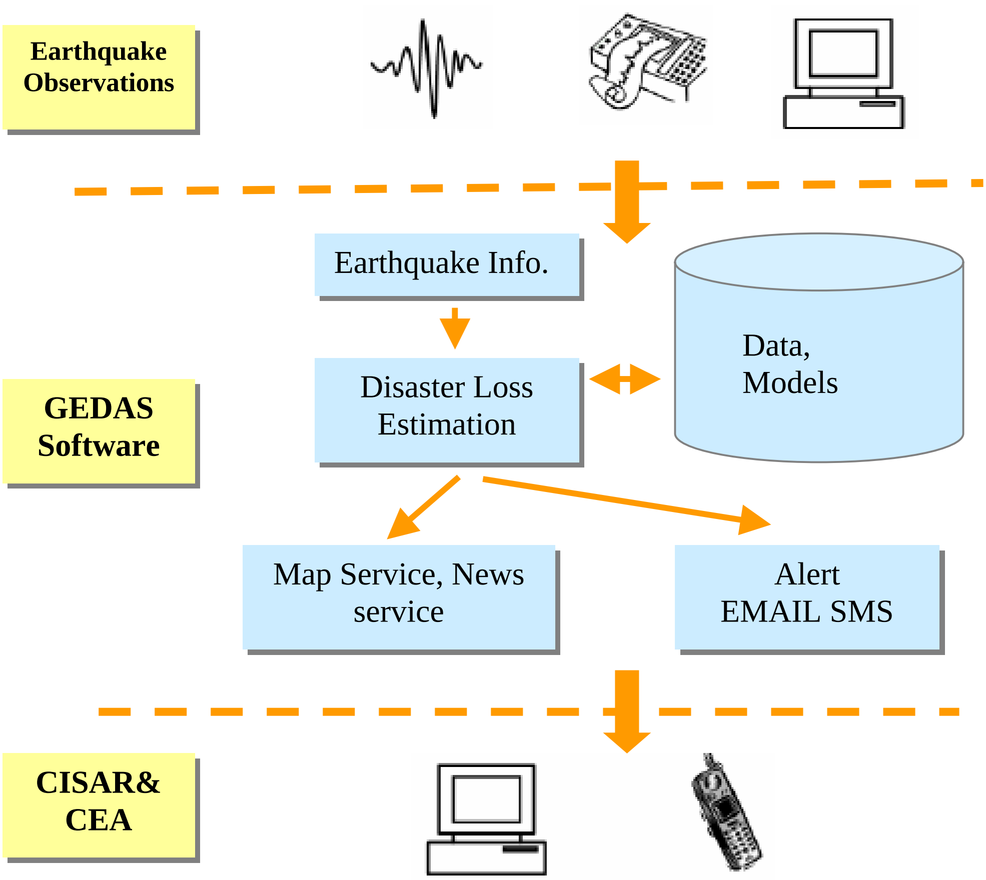

Fig.2 Framework of the global earthquake disaster alert system (GEDAS)

GEDAS composes of three parts, information acquiring, loss estimation and information releasing (Fig.2). Earthquake information can be got directly from monitoring stations and NEIC'S global earthquake list service (Finger). The information processing and loss estimation part is the core of GEDAS. Based on the global database and compute models, GEDAS can give a quick economic loss and casualty estimation and also maps around the epicenter. The alert information is sent to CISAR, NERSS and other related organizations by website, email and SMS.

The GEDAS Database

<u>The Fundamental Geographic Data</u>

1.VMAP0 & VMAP1

Vector Map Level 0 (VMap0) is an updated and improved version of the National Imagery and Mapping Agency's (NIMA) Digital Chart of the World (DCW). VMap0 database provides worldwide coverage of vector-based geospatial data which can be viewed at 1:1,000,000 scale. It consists of geographic, attribute, and textual data. VMap0 includes major road and rail networks, hydrologic drainage systems, utility networks (cross-country pipelines and communication lines), major airports, elevation contours, coastlines, international boundaries and populated places. VMap0 is divided into four parts (Fig.3).

Vector Map Level 1 (VMap1) is based on 1:250,000 map scale source, and is 4 times the resolution of VMAP0. The VMAP1 data is divided into a rather complex global mosaic of 234 geographic zones. However at the present time, NIMA are only releasing 55 selected areas of the VMAP1 dataset. Some of the excuses given include the protection of cartographic monopolies of its overseas partners, such as that it is not ready for the public to see it, that their security office has not approved it, and that NIMA is afraid the public might "misuse" it.

VMAP0 & VMAP1 are read directly into ArcGIS from VPF format and used as the background for loss estimation and map making in GEDAS.

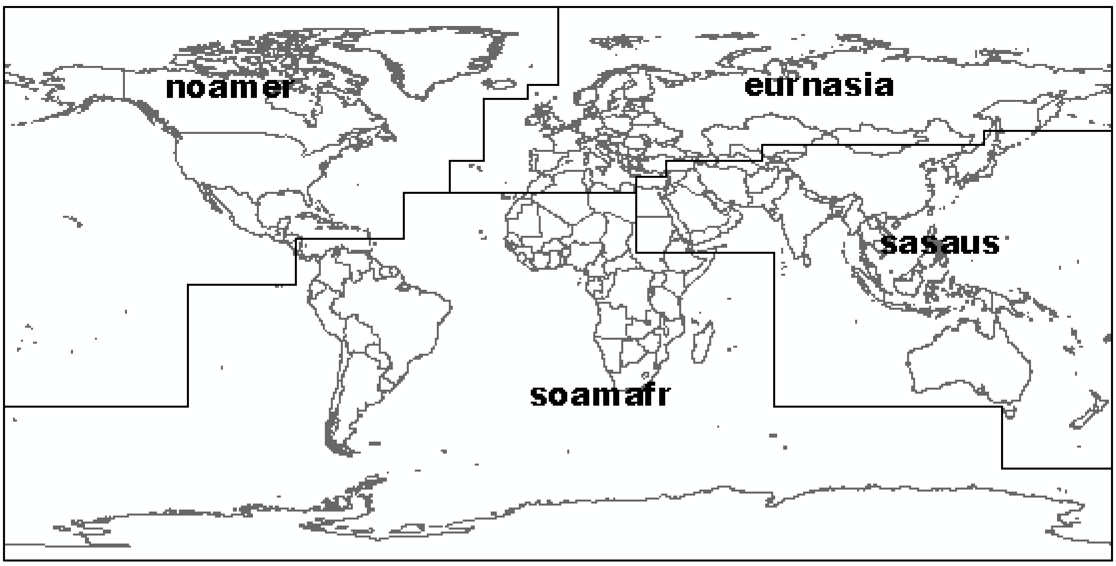

Fig.3 The Tiled Sheets of VMAP0 data

2.GeoCover 2000 Mosaics

The Landsat GeoCover dataset is a collection of high resolution satellite imagery provided in a standardized, orthorectified format, covering the entire land surface of the world (except Antarctica). This is an invaluable record of land cover and land cover change, provided in a consistent manner that allows for use in a wide range of activities including environmental assessment, emergency planning, land management, resource stewardship and many Earth science related research.

The GeoCover 2000 mosaics are segmented into tiles of approximately 250,000 square kilometers. Each tile covers five degrees of latitude in a UTM zone, which is 6 degrees of longitude (Fig.4). The scenes are UTM zone and minimum latitude of the tile and Several tiles of approximately 100-260 MB. These mosaic images are in MrSid format and can be directly opened using ArcView, ArcGIS, ERDAS Imagine, ENVI, PCI or the free MrSid Viewer available from LizardTech.

In GEDAS, GeoCover data are managed by using an index vector layer and used as background for loss estimation and also for map making and 3D visualization.

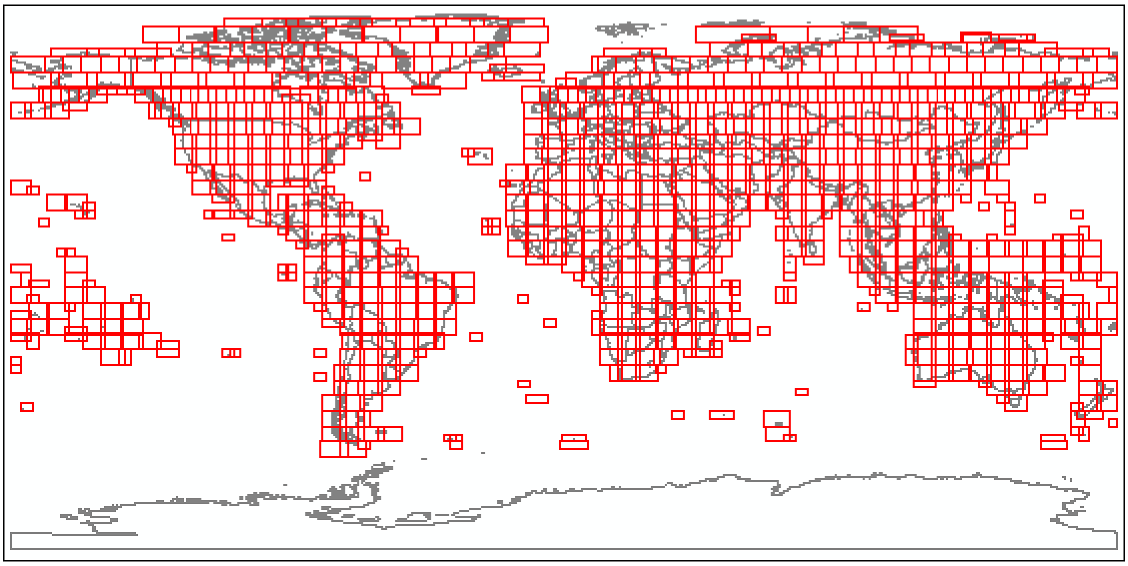

Fig.4 Global distribution of Geocover2000 data

The Population Data

Oak Ridge National Laboratory(ORNL)'s Global Population Project, part of a larger global database effort called LandScan (Fig.5), collects best available census counts (usually at province level) for each country, calculates a probability coefficient for each cell, and applies the coefficients to the census counts which are employed as control totals for appropriate areas (usually provinces).The probability coefficient is based on slope, proximity to roads, land cover, nighttime lights, and an urban density factor. GIS is essential for conflation of diverse input variables, computation of probability coefficients, and allocation of population to cells, and reconciliation of cell totals with aggregate (usually province) control totals. Remote sensing is an essential source of two input variables-land cover and nighttime lights-and one ancillary database-high-resolution panchromatic imagery-used in verification and validation (V&V) of the population model and resulting LandScan database.

Until now, Lanscan is the best population database for disaster estimation. In GEDAS, Landscan is a core database and used as base input for casualty and economic loss estimation.

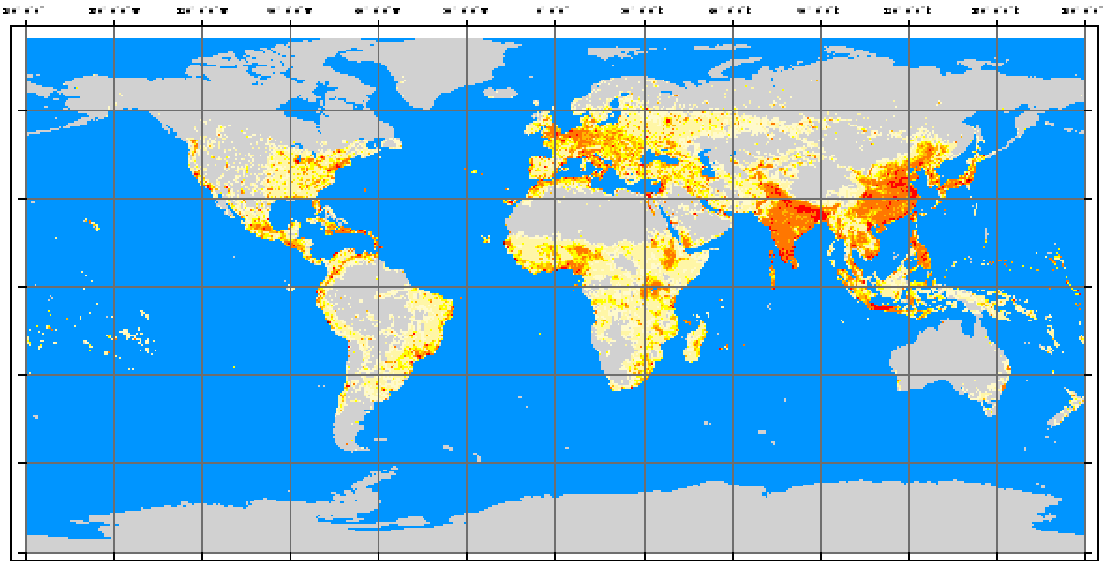

Fig.5 Landscan global population data

<u>Other Data</u>

Other data, Such as SRTM DEM data, GDP data, historical earthquake data, nuclear power station data, are also parts of the GEDAS database, used mainly for 3D Visualization and disaster loss estimation.

Disaster estimation and alert assessment model

<u>Scenario earthquake model</u>

GDAS uses circles which radiuses are 5Km, 25Km, 50Km and 100Km as statistic and analysis region. This method is universal and easy for data summarizing but do not think about the relationship of earthquake intensity and the disaster impact. When we compute the economic loss and casualty, we must know at least a rough intensity for a certain region. We use an empirical relationship to estimate the scenario intensity for an earthquake event. Following is the empirical formula we use in GEDAS which derived from the empirical formula used in Western USA (Anderson, 1978; Howell, 1975; Gupta, 1976; Liu Jie, 1999; Gutenberg, 1956).

$$I = I_0 + 3.2 - 0.00106\, r - 2.7 \lg r$$
$$M = 2/3 * I_0 + 1$$

I_0 is the intensity in the epicenter M is the Richter Magnitude r is the radius I is intensity for a certain distance from the epicenter

In some areas, such as in China, we use more detail empirical intensity relationship to compute earthquake scene.

Economic loss estimation model

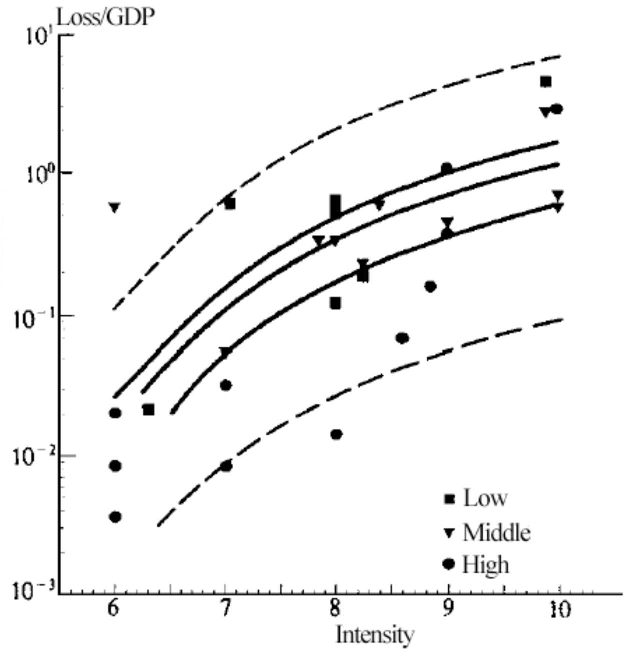

Fig.6 Relationship of earthquake intensity and economic loss (Chen etc., 1997)

We use a method that estimate earthquake losses based on several macroeconomic indices such as the Gross Domestic Product (GDP) and population (Chen Yong, 1995; Chen QF, 1999). This method does not require a detailed inventory database of the structures and facilities in the impact region and can get quick loss estimation.

Fig.6 give us the relationship between intensity and the ratio of economic loss by GDP for Low, middle and high income countries separately. Based on this relationship, we can get the economic loss by using following formula:

$$E_P = \sum_{I_i} P_T(I_i) \cdot f(I_i, \ GDP) \cdot GDP$$

E_P is the economic loss, fI $_i$, GDPis the ratio of intensity I by GDP, I $_I$ is earthquake intensity, GDP is Gross Domestic Product. P $_T$I $_I$ is the risk of impact of intensity in T years. For a certain earthquake, P $_T$I $_I$ is always 1.

Casualty estimation model

Table.1 Matrix of mortality rate and injury rate (Chen Yong, 1995)

Intensity / Loss	**Mortality**	**Injury rate**
VI	$0.2 * 10^{-4}$	$0.36 * 10^{-4}$
VII	$3.2 * 10^{-4}$	$3.1 * 10^{-4}$
VIII	$4.0 * 10^{-4}$	$260 * 10^{-4}$
IX	$480 * 10^{-4}$	$2200 * 10^{-4}$

Compare to economic loss estimation, casualty estimation is more difficult. A reasonable relationship between earthquake intensity and casualty must think about the structure parameters. Because we have not a detail structure database until now, a simple relationship for casualty estimation is used in GEDAS (Table 1).

Alert assessment model

Referring to the GDAS alert model, we adopt following alert grade assessment formula:

$$A \quad \max(M - 4.5 \quad 0)^{0.5} \quad \log(\max(P / 80000 \quad 0)) \quad \max(V \quad 0.5)^{1.5} / 3$$

A is the alert score, M is the magnitude, P is the total population in the area where intensity is lager than six, V is the venerability index and can be got from the ECHO global need assessment report every year.

The alert rank can be divided into three kinds, green, yellow and red. When the score value is smaller than 1, green alert will be released; when the score value is between 1 and 2, yellow alert will be released; when the score value is lager than 2, red alert will be released. The international relief organization should concern and prepare for deployment when the red alert is released.

The GDEAS Software

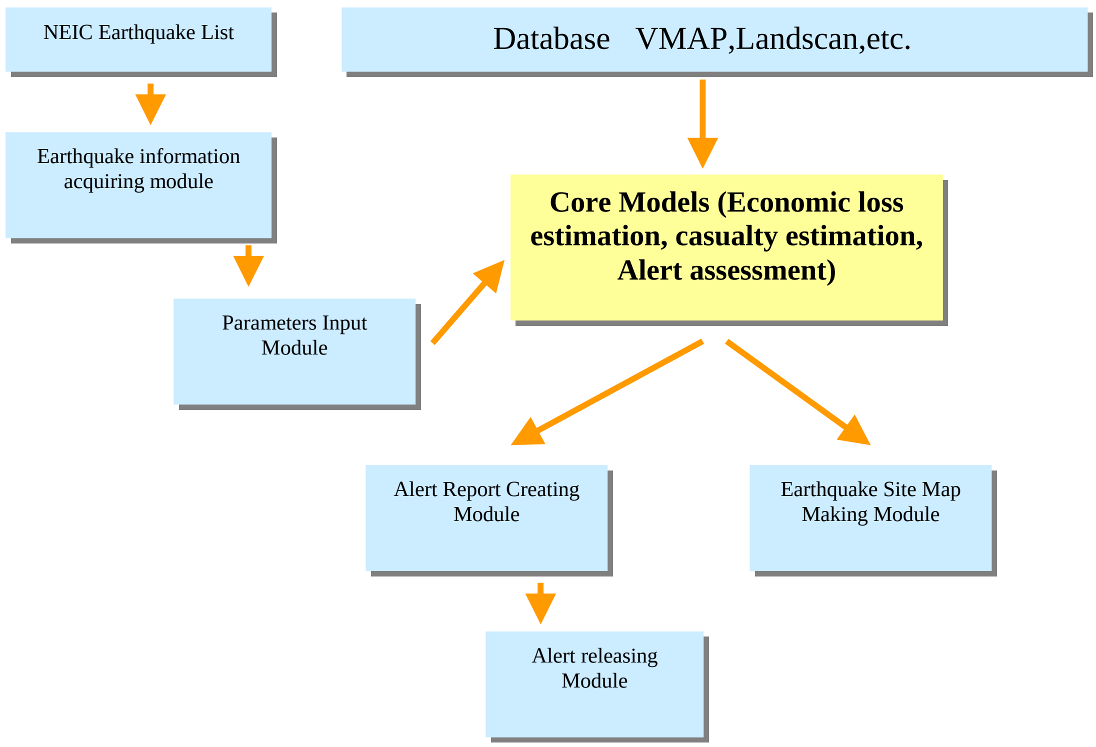

Fig.7 Modules of the global earthquake disaster alert software

The GEDAS software is developed on ArcGIS platform. Fig.7 is the sketch of the modules and the workflow. The software modules includes parameters input module, loss estimation and alert assessment model, alert report creating model, alert releasing module and map making module.

The earthquake information can be got automated or by hand from the NEIC website. The core computing models will compute the earthquake affected field, the economic loss, the casualty and the alert score. The software can create an alert report based on the computed result automatically, including the earthquake parameters, the disaster impact, the trend analysis and the deployment advices. The local maps can also be created for field works (Fig.8).

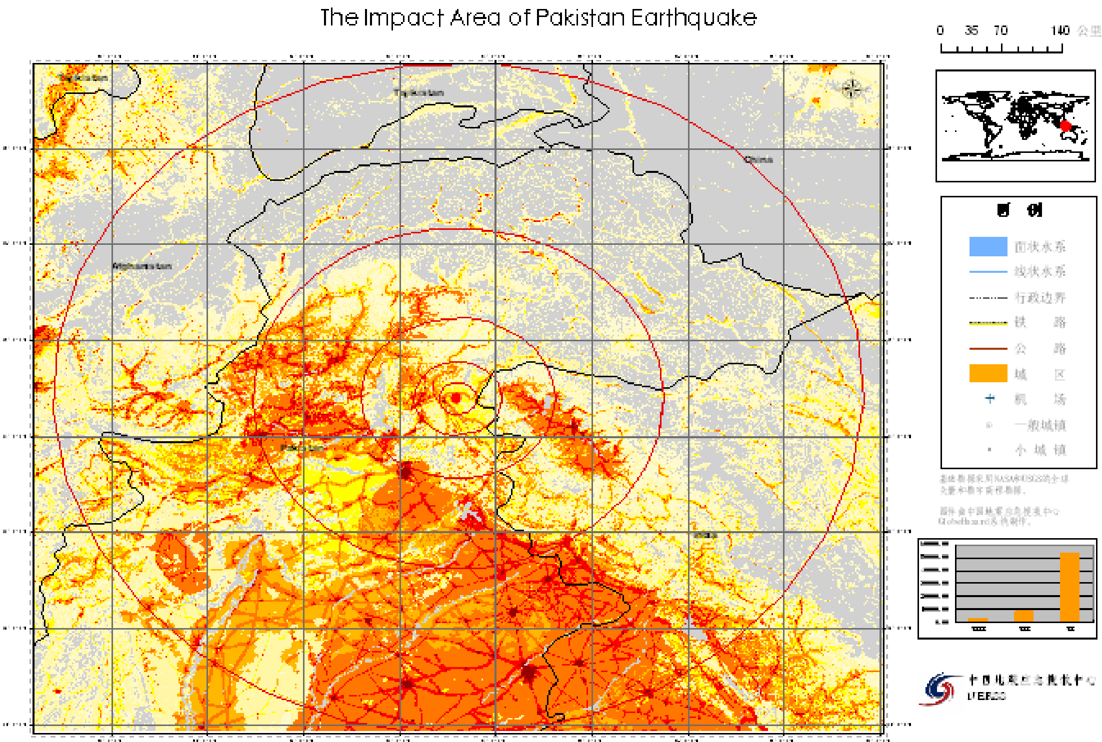

Fig.8 An example of earthquake emergency decision aid map

Conclusion

This paper described the preliminary design of a global earthquake disaster alert system, including the framework, database, computing models and software modules. This software system already supply information and decision support in CISAR's international rescue work. It can also supply information to the international relief community in the future.

The GEDAS software is still in developing, and it can only supply rough economic loss and casualty estimation and simple map making function now. More works, such as the detail assessment models and alert release module are still need to be accomplished.

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Author's Biographies

Dr Li Yigang, currently associate professor of national earthquake response support service, China earthquake administration. Research interests include earthquake disaster prediction, emergency management, GIS&RS application and 3D Structure modeling.

Dr. QU Guosheng, Prof. and Chief Engineering, National Earthquake Response Support Service, China Earthquake Administration. He has applied his research achievements to the prevention and mitigation of seismic hazards in China and achieved breakthrough progress in such fields as urban disaster emergency management, the application of geographical information systems (GIS) and remote sensing (RS), three-dimensional underground structure modeling for urban areas, exploration of active tectonics, regional seismotectonics and petroleum structural geology. Qu is also an instructor of doctorate candidates in the Institute of Geology, CEA.In 2005, he participate the South Asia Earthquake search and rescue action in Pakistan as a team member of CISAR.

TURKEY DISASTER INFORMATION SYSTEM: A CASE STUDY FOR ISTANBUL

**Muhammed Şahin, Himmet Karaman, Ergin Tarı,
Hakan Yavaşoğlu, H. Can Ünen**

Istanbul Technical University[1]

Keywords: Disaster Information System, TABIS, GIS, Emergency Management, Mitigation.

Abstract

1999 Marmara Earthquakes caused 20000 casualties, many injuries, more then 30000 building damages, according to the official records. Especially the earthquakes and the other natural disasters still threaten the Turkey. Ministry of Interior of Republic of Turkey and Istanbul Technical University initiated project on May 2001, called Turkey Disaster Information System (TABIS). In TABIS project, GIS standards based on disaster management were created on December 2002 and announced to the central and local governors by the Ministry of Interior. The results of the many earth sciences research declare that Istanbul is waiting for her earthquake in the near future.

The aim of this study is to create and conduct a GIS based information and management system for Istanbul, which uses satellite technologies and information systems for planning emergency preparation and application, disaster management and loss estimation in a natural disaster situation and for the ordinary times a decision support system for the central and local governments.

In this study, the southern costs of the Istanbul City will be taken into consideration because of the scientific reports which were published on this matter. All the scientific reports announce that the most risky areas of Istanbul are the southern costs of the metropolitan city.

The main processes that will take most of the attention on this study are;

- Studies for modeling the space
- Configuring the data (whether spatially referenced or not) related to disaster management
- Creating the principles for institutional structuring to keep the system up to date
- Installing the system and determining the software and hardware for service
- Acquiring the different characteristic data (geometric, attribute, meta) for different scale
- Determining the integration way of data which were acquired from different sources
- Determining the presentation standard of data (cartographic of text document)

Creating the communication and distribution ways of data.

Introduction

[1] Istanbul Technical University, Civil Engineering Faculty, Geodesy and Photogrammetry Engineering Department, 34469 Maslak-ISTANBUL-TURKEY

The aim of the project is to create an information system which has the capability to help the decision makers, ministries, governments and municipalities to conduct the planning, mitigation, response and recovery phases of the emergency management, by using modern satellite techniques and information systems, before, during and after the disaster occurs. This project will be an application for the city of Istanbul for an example to GIS based information and management system standard for the whole similar applications in Turkey.

By this way it is planned to constitute a management and information system that settles the coordination between the administrative districts of Istanbul and the other cities on disaster planning and management standard of Istanbul.

This system will be supported by the current satellite technologies like GPS and remote sensing and public improvement, cadastre, infrastructure, ground and superstructure and population data. Those data will have very detailed attributes for the reliable use in analysis, planning, decision support and response operations.

Thus, during a potential disaster, the first aim of the emergency and disaster management and also the mentioned system, reducing the number of the casualties will be provided, and after that the loss of goods and loss of the country's economy will be minimized.

For the Turkey and especially for the 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.

Background of the Project

1. Training on Emergency Management
2. Just after the catastrophic disasters in 1999 there have been an aggrement between FEMA (Federal Emergency Management Agency) and ITU (Istanbul Technical University) in 2000.
3. Development of Turkish Fire Brigades
4. Development of Emergency Management System
5. GIS standards based on Emergency Management (TABIS)
6. To develop GIS standards for emergency planning & administration, disaster management & damage estimation, and as a decision support system for central & local authorities (ministries and local administrative units) at other times.

The outputs of the fouth project are;

- Workshop with local authorities in Turkey, April 2002
- Workshop with private sector in Turkey, June 2002
- International Symposium on GIS, September 2002

Final Report was submitted to the Ministry in November 2002 as;

- Guidlines for Managers
- Fundamentals of TABIS
- TABIS Object Catalogue.

What is TABIS

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)

The heart of the Turkey Disaster Information System is the spatial database. The reference model of the TABiS system constitutes of two vector components.

These components are named as;

- Digital Spatial Model (SMM), and
- Digital Disaster Model (SAFM).

Both digital models constitute the space on a basis based on the object by separating the place one by one to its components. (Karaman and Sahin, 2004)

TABIS Object Catalogue

Both digital models form the space by separating it to its components based on object oriented basis. This process is called as atomizing of the space in the database modeling. The atomized data of the both digital models prepared as an object catalog. These catalogs are;

- TABiS-Basic Topographic-Spatial Object Domains Catalog (TABiS-TOK)
- TABiS-Disaster Management Object Domains Catalog (TABiS-AOK)

The aim of the TABiS-TOK is the modeling of the concrete objects which are the characteristic parts of the topography of the region where the system will be constructed. Parallel to this aim, the components of the TABiS-TOK are named as "Basic Topographic-Spatial Object Domains". TABiS-TOK is also has the quality of being a data standard for the country wide public and private institutions who want to set up a detailed spatial information system for their own purposes. Because of the object modeling, object definitions, attribute definitions, data types for the attributes and attribute values can be matched with analog topographic map contents, a disaster management based GIS which is constituted convenient to the TABiS-TOK model can work totally harmoniously with the other GISs of the same region. Even if the aims of the systems are different. (Karaman and Sahin, 2005)

A virtual map which was modeled according to the TABiS-TOK is named as "Digital Spatial Model" (SMM), and a virtual map which was modeled according to the TABiS-AOK is named as "Digital Disaster Model" (SAFM). (Karaman and Sahin, 2005)

Proposed System Features

The system will have a plan and preparedness for every kind of disaster and this will help to orientate the response and logistic support works faster than before and as accurate as it can be. The response centers and support stokes can be located to the places that the system offers. These offers will be the results of the analysis of the system according to the transportation to the emergency region and amount of the loss. After the disaster occurs, the system will be decision support unit for the mitigation efforts in determination of the temporary settlements and gathering places and distribution places for the aid and support, determination of the amount and the possessor of the aid for the citizens and institutions.

It will be able to seen from the system that;

- What kind of and how much help is needed from which disaster region and
- From where can this help be there in the shortest time?
- Which kind of specifications needed for the staff that will be charged?

Optimizing and planning the response, help and logistic support will reduce the loss of disaster and response and recovery costs. This will minimize the economic catastrophe that follows the disaster at the city of Istanbul. Announcing the publicity the emergency plans and

these kinds of studies are exists will minimize the panic that could happen during and after the disaster. This will also help to apply the plans in order with the participation of the public. The system will provide current, correct, standardized and consistent data for its users. The system will prevent the complexity of transmitting of the unnecessary information.
Parameters to be applied in the proposed study are: studies related to the spatial reference of the geographic information system, 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 prescibred 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 it can be understood from the listing, the subject requires a multi-dimensional expertise. It can't be possible to generate solutions to the listed tasks at a single phase.

In the determination of the data related to either emergency management or physical world or in the organization and interrelation of these data, land use plans are very important data resources. When the urbanization rates are taken into account for our country, it can be seen that even the most recent land use plans have insufficient data to show the real state. New land use, land cover and water classes will be formed by using remotely sensed data carrying relevant inforation gathered from observation satellites. By this method which provides homogeneous evaluation possibility, datasets that are economical to update will be formed. High resolution satellite imagery will be used in the study for obtaining up-to-date data. The study, which is out of scope of the classical data gathering methods, will be presented as a sample study of satellite remote sensing, GPS and integrated GIS. The study, designed with this scope, is hoped to make great contributions to emergency management studies in Turkey.

All actions in the scope of the study will be carried out with cooperation between Istanbul Metropolitan Municipality and Istanbul Technical University. The relevant paper by Istanbul Metropolitan Municipality is presented as an attachment.

Standards regarding the staff that will work in the emergency management focusing GIS center during and after the study are determined. Responsibilities and working areas of the staff in the system are defined by making the job definitions.

Different Studies for Istanbul Disaster Information System

There are four different institutes with the four indepentent studies for Istanbul:

a. State Planning Department of Turkey
b. Istanbul Governorship (ISMEP)
c. Istanbul Metropolitan Municipality
d. Turkish Emergency Management Agency (TEMA)

State Planning Department of Turkey

This project will unite those studies and the system will be conduct from one hand. The aim of the Istanbul Disaster Information System is to establish a GIS based information system for;

- emergency planning & administration
- disaster management & damage estimation, and
- as a decision support system for central & local authorities (ministries and local administrative units) at other times.

Istanbul Seismic Risk Mitigation & Emergency Preparedness Project (ISMEP)

The proposed project will initiate a process that aims at transforming Istanbul in the next 10-20 years into a city resilient to major earthquake. The overall goal of the proposed project is to save lives and reduce the social, economic and financial impacts in the event of future earthquakes.
The specific objective of the project is to improve the city of Istanbul's preparedness for a potential earthquake through enhancing the institutional and technical capacity for disaster management and emergency response, strengthening critical public facilities for earthquake resistance, and supporting measures for better enforcement of building codes and land use plans. (Sahin, 2006)

Components of ISMEP

<u>Component A: Enhancing Emergency Preparedness</u>
This component will enhance the effectiveness and capacity of the provincial and municipal public safety organizations in Istanbul to prepare for, respond to and recover from significant emergencies, especially those arising from earthquakes.

<u>Component B: Seismic Risk Mitigation for Public Facilities</u>
This component will reduce the risk of future earthquake damage to critical facilities in order to save lives and ensure their continued functioning in the event of an earthquake, through retrofitting of hospitals, schools and other priority public facilities.

<u>Component C: Enforcement of Building Codes</u>
This component will support innovative approaches to better enforcement of building code and compliance with land use plans.

<u>Component D: Project Management</u>
This component will support the Istanbul Provincial Administration to implement the project in efficient and transparent manner, and build the institutional capacity to sustain the implementation of Seismic Risk Mitigation and Preparedness program beyond the life of the project.

Feasibility studies were initiated last year.

- Emergency Communication systems
- Disaster Management Information Systems
- Improvement of Emergency Response Capability
- Pilot Project for Strengthening Public Buildings (39 schools, 12 University Hospitals, 1 Student Dormitory, 2 Search & Rescue Buildings)
- Bakırköy Province Pilot Project for Strengthening Residences (350 buildings)
- Social Tendency Survey for Residence Strengthening. (Sahin, 2006)

Main Projects for Istanbul

- JICA Report, 2003
- Istanbul Earthquake Master Plan, 2004
- ISMEP, 2005
- Turkish Emergency Management Agency
- ITU

How to Use GIS in Disaster Mitigation

Using GIS for disaster management is the easiest and the quickest way for these days. While the technology is developing for the information systems it is getting faster to use more complicated systems. (Karaman and Sahin, 2005) Disaster decision support tools, frequently including GIS, remote sensing and GPS, necessitate the inclusion of elements that give disaster managers relevant information for mitigation and preparedness planning without burdening them with the mathematical equations and models that produce damage, death, and injury calculations based on hazard event parameters. GIS-based technologies are essential for conducting place-based hazard & vulnerability assessments. (Thomas, 2005)

Conclusion

After completing the project, every kind of national information system studies will be constituted according to a standard and it will be able to relate those national information system studies to the system that will be created with this project. The project will unite all independent studies and will help to exchange and manage the valuable data for disaster management of Istanbul.

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Author Biography:

Muhammed Şahin is a professor of Surveying in the Faculty of Civil Engineering, Istanbul Technical University. He has been the head of Surveying Technique Division since September 2004. He was born in Pazar, a town of Rize where he finished his primary, secondary and high schools. He graduated from the Department of Geodesy & Photogrammetry, Istanbul Technical University in 1987. He received MSc & PhD from University College London and University of Newcastle Upon Tyne, UK, respectively. He become an assistant professor in 1994, an associate professor in 1996 and professor in 2002. His research interests include satellite positioning techniques, monitoring of earth crust using GPS, emergency management, disaster information systems, GIS based on emergency management.

Himmet Karaman is a geodesy and photogrammetry engineer and has his Master of Science degree on 2003 from ITU Science and Technology Institute on database systems on disaster management. He is a PhD candidate since 2004. He is a research assistant in Istanbul Technical University, Civil Engineering Faculty, Surveying Technique Division, since 2001.

Ergin Tari is an associate professor in the Faculty of Civil Engineering, Istanbul Technical University. He graduated from the Department of Geodesy & Photogrammetry, Istanbul Technical University in 1988. He received MSc & PhD from Istanbul Technical University. Between 1998 and 1999, he was a Visiting Scientist at Department of Earth, Atmospheric and Planetary Sciences of Massachusetts Institute of Technology with GPS and Geodynamics Group in Earth Resource Laboratory. He become an assistant professor in 1998, an associate professor in 2000. His research interests include engineering surveys, deformation measurements, surveying, GPS measurement, planning, evaluation and deformation, GIS based on disaster management.

Hakan Yavasoglu is a geodesy and photogrammetry engineer and has his Master of Science degree on 2003 from ITU Science and Technology Institute on monitoring of earth crust using GPS. He is a PhD candidate since 2005. He is a research assistant in Istanbul Technical University, Civil Engineering Faculty, Surveying Technique Division, since 2001.

Hüseyin Can Ünen is a research assistant in Istanbul Technical University (ITU), Geodesy & Photogrammetry Department, Surveying Techniques Division since November 2005. He graduated from Middle East Technical University (METU), Civil Engineering Department in June 2004 and have been carrying out his Ms.D study in ITU Informatics Institute, Satellite Communications & Remote Sensing Program since 2004. His area of study is GIS applications in emergency management

RAPID ASSESSMENT OF THE DELIVERY OF MENTAL HEALTH SERVICES TO HEALTHY SURVIVORS OF THE EARTHQUAKE IN BAM, IRAN

A Mowla[1]
Shiraz University of Medical Sciences

MD; A.S.Forouzan[2]
University of Social Welfare and Rehabilitation Sciences

MD; H. Malek Afzali[3]
Tehran University of Medical Sciences

MD, PhD; F.Bahreini[4]
Ministry of Health and Medical Education

MS; M.T. Yasamy MD.[5]
Shahid Beheshti University of Medical Sciences

Keywords: Rescuers, Bam earthquake, Mental Health Services Delivery, Evaluation.

Abstract

Background

Natural disasters cause millions of deaths, disabilities, and huge financial losses worldwide every year. The major concern of our health system has been to reduce physical mortality and morbidity, but we must also recognize that such events are a source of considerable stress for the survivors, causing in many serious and long-lasting psychiatric complications. The purpose of this study has been to assess the function of rescuers in the delivery of mental health services to survivors of the earthquake in Bam, Iran, over the first 2 weeks after the event.

Methods

For our purposes, 2 groups of survivors were selected: the first group included healthy survivors of ≥15 years of age living in Bam after the earthquake. The second group is comprised of healthy survivors of <15 years of age living in Bam after the earthquake.

[1] Office of Vice-Chancellor for Research, Shiraz University of Medical Sciences, Shiraz, Iran
[2] Ameneh Setareh Forouzan**,** MD, Department of Social Welfare Management, University of Social Welfare and Rehabilitation Sciences, Tehran ,Iran, Email: asf@hbi.ir
[3] Department of Epidemiology and Biostatistics, Tehran University of Medical Sciences, Tehran,Iran
[4] Office of Vice-Chancellor for Research and Technology, Ministry of Health and Medical Education,Tehran ,Iran
[5] Department of Psychiatry, Shahid Beheshti University of Medical Sciences, Tehran, Iran

According to the settling of healthy survivors in 13 different regions of Bam during the 2 weeks after the earthquake, 6 individuals of ≥15 years and 6 survivors of <15 years were selected from each of these regions, using random sampling procedures. Two weeks after the earthquake, a questionnaire, including questions about demographic data, functions of the rescuers in rescuing and emergency procedures, information for the survivors of their relatives' conditions, and quality of condolence for the survivors was prepared. It also included questions on the existence of facilities for tension relief for the children, to be filled out for each case by trained assessors with a standardized method. The data were analyzed using SPSS software.

Results

In both groups, >85% of the cases who needed help from the load of the earthquake were rescued by their relatives, and rescuers from the Red Crescent Society. Help from other governmental organizations accounted for only a small portion (5%) in this field. Only 25% of cases who needed help and rescuing from the load of the earthquake were rescued within the first hour. Only 40% of the cases received sympathy from their rescuers. About 60% of the cases claimed to have had enough information about their relatives. About 40% of the cases were consoled and prevented from crying by rescuers. Only 30% of the cases said that they knew drug-addicted individuals who were not given alternative materials. 23% of the children were playing again during the 2 weeks that followed the earthquake, and 32% of them had some facilities for playing.

Conclusion

Regarding the rescue activities for both groups, primary care had been provided by relatives and domestic people. Therefore general training and organizing of CBOs (Community Based Organizations) for the provision of services in disasters, especially in regions of high risk to earthquake, would certainly help reduce suffering and injuries. According to our research, rescuers are seriously in need of training in mental health provision, and major areas of education needed include, e.g. use of counseling techniques, providing the right kind of information for the survivors, and stress management procedures.

Introduction

A disaster is defined as a disruption of human ecology that exceeds capacity of a community to function normally.1 A substantial amount of research pertinent to understanding the effects of disasters has been published over the past 20 years.2 Specific psychological problems, such as anxiety and depression, and most notably post-traumatic stress disorder (PTSD) were found most often, followed by non-specific psychological distress with varying health problems and concerns. 2-4

Reviewing calamitous earthquakes over the last century in Iran, beginning with the quake in Silakhor in 1909 (magnitude 7.4), reveals that the Iranian plateau is one of the world's most seismically active areas; earthquakes are frequent, destructive, and cause heavy loss of life. 5

The magnitude of 6.6 for the Bam earthquake struck at 5:26 a.m. local time on December 26, 2003, while most people were asleep in their homes. It destroyed much of the city. The human and physical devastation was staggering, with 41 000 people presumed to be dead, tens of thousands injured, and nearly all survivors among the original 100 000 inhabitants left homeless. Large numbers of injured people were evacuated to hospitals throughout Iran, especially in Tehran and the provincial capital, Kerman, because all major hospital facilities in Bam had been destroyed, and many of their doctors and nurses injured or killed. 6

This report provides a brief review on the delivery of mental health services to healthy survivors of Bam earthquake living in Bam during the 2 weeks following the earthquake. Two age groups were assessed in this study: i) adults and ii) children (those <15 years of age) who are more prone to psychological issues after a disaster. 7-9

Methods and Participants

In a descriptive-analytic study, we tried to assess the function of rescuers about delivery of mental health services to the healthy survivors of the earthquake over the 2 weeks immediately after the earthquake. According to the settling of healthy survivors in 13 different regions of Bam during 2 weeks after the earthquake, 6 individuals of ≥15 years and 6 survivors of <15 years were selected from each region using random sampling procedures. Two individuals in each group refused to participate in the study due to severe anxiety and depression. A questionnaire including the following questions was prepared, which was filled out for each case by the trained assessors with a standardized method:

1) Demographic data, including age, sex, marital status, place of living (urban or rural area) before the earthquake, education.
2) Quality of rescuing and emergency services delivery, including questions about the interval between the earthquake and the time of rescue, who were the rescuers, and how the rescuers encountered and consoled them.
3) Quality of information services delivery to the survivors, including questions about receiving correct information about the situation of their first degree relatives, the interval between the earthquake and the time of receiving the mentioned information.
4) Quality of condolence and mental security created by the rescuers, including questions about quantity of condolence by the rescuers, ability of the survivors to open out their hearts.
5) For children, existence of facilities for playing and tension relief.

After data collection, their answers were analyzed using SPSS software.

Results

Group A. Adult healthy survivors (≥15 years old)

The mean age of the 76 individuals in this group was 41.5±25.3 (Range:15-65 years). 42(55.2%) were male and 30(39%0)of them were married. 38(50%)of individuals in this group were living in rural areas before the earthquake. Only 15(19.5%)had academic(university)degrees. 45 (59.2%) needed rescuing from the load, of which 42 (93.3%) were rescued by their relatives or friends. Also 12 of these 42 individuals (26.6%) said that other natives had a role in their rescue. Table 1 shows the role of the different rescuer groups in rescuing these individuals. Table 2 shows that >50% of the individuals of this group which needed rescuing from the load, were rescued in the first 2 hours after the earthquake.

Twenty two (49%) individuals who needed rescuing from the load believed that rescuers consoled them in a good manner. 19 (42%) of them said that rescuers had talked to them about their inconvenience and they were able to open out their hearts. 37 (82%) said that rescuers had not let them cry; in other words, >80% of them were prevented from tension relief (Table 3). Table 3 also shows that 95.5% of them believed that they have been given unreasonable hope.

Twenty-seven (35.5%) individuals in group A said that rescuers had affronted them during delivery of the emergency services. 16 (21%) individuals in this group remained unaware of their first relatives' situation. Only 28 (37%) individuals in this group said that their place for rest overnight were sufficiently quiet. 25 (32%) individuals in this group said that they knew ones who were addicts, but who did not receive narcotics or alternative materials.

Group B. Healthy survivors under 15 years old

In this group (n=76), the mean age was 9.5±4.6 (Range: 5-15). The male to female ratio was 2/1.43 (57%) needed rescuing from the load. Of them 30 (70%) were rescued by their relatives or friends, and 7 (16%) were rescued by other natives (Table 1). 55 (72%) of them believed that no one has been concerned about their situation. 4 (5%) of the individuals said that someone had treated them badly or abused them. Only 32 (42.1%) of the children had facilities for playing.

Discussion

Disasters traumatically expose normal populations to severe threats to life, deaths of relatives, and massive environmental destruction. Survivors experience a state similar to that seen in the aftermath of other traumatic experiences, such as rape, kidnapping, automotive and industrial accidents, crime, combat, and internment in concentration camps or as prisoners of war.

This state is characterized by intrusive images, impaired concentration, sleep disturbances, disturbing dreams, trigger anxiety, phobias, anxiety, depression, and rage. 10

A meta-analysis of 52 studies11 showed that the rate of psychopathology was 17% higher in groups that had experienced a disaster than in the same groups before the disaster or in control groups. Higher impairment rates were found for groups that had experienced naturally caused disasters.

In studies from developing countries, psychiatric morbidity has been reported in 75% of victims of a cyclone in Sri Lanka 12, 55% of victims of a volcanic eruption in Colombia 13, and 40% of people attending primary health care clinics following an earthquake in Ecuador. 14

Youth exhibited additional problems unique to their age groups, such as behavioral problems, hyperactivity, and delinquency, but like adults, they were also vulnerable to PTSD, depression, somatic complaints, and ongoing stress. The high rate of psychiatric disorders found in the survivors of natural disasters, especially earthquakes, indicates the need for provision of mental health services for disaster survivors.2

The residents of the ancient city of Bam in south east Iran slept as 26 December 2003 began. By 5:26 a.m. the city lay in ruins, shattered by an earthquake that lasted just 10s and measured 6.5 on the Richter scale, devastating more than 90% of the city center and historic buildings. The human statistics make chilling reading - over 35 000 people killed, another 23 620 injured (8 028 of them seriously) and almost 20 000 homes destroyed.

Essential services, including water supply, power, telephone, healthcare services, main roads and the city's only airport were crippled. The major tourist attraction in the area, the 2 400-year-old citadel Arg-e-Bam, the world's largest dried clay structure and a world heritage site, was totally destroyed. 15

This study demonstrates the function of rescuers in the delivery of mental health services to survivors (living in Bam after earthquake) during the first 2 weeks after earthquake. Table 1 shows that >85% of those needed rescuing from the load were rescued by their relatives or friends and also other natives, and only 5% were rescued by rescue workers of the Red Crescent Society or other governmental organizations. This point leads us to call for more and better education about confronting disasters for inhabitants in such vulnerable areas. Also, creating non-governmental organizations for partnership of general population in helping injured individuals in disasters will be most effective. This may decrease the extent of the damage.

According to the contents of Table 2, ~25% of individuals in group A who needed rescuing from the load were brought out in the first hour after the earthquake, which shows that planning for facing to crisis and first aid should be undertaken more seriously. In a similar study, immediate rescuing and rapid hospitalization were shown to be effective in reducing mortality and morbidity in disasters. 16

In group A, about 40% of the individuals who needed rescuing from the load said that rescuers have talked to them about their inconvenience and had consoled them which 78.9% of these rescuers were their relatives or friends and only ~20% were rescue workers. Also, in previous earthquakes in Iran, survivors have believed that rescue workers were not concerned about their feelings.17 Planning educational programs for changing the attitude therefore seems to be essential, as well as increasing the knowledge of rescue workers of the health system, Red Crescent Society and police and military forces about the importance of delivering mental health services to the survivors of natural disasters.

Obtaining correct information about the situation of first-degree relatives may play an important role in the reduction of anxiety following natural disasters.18 In the first group of our study, only 57% were aware of their relatives' situation in the first 2 week after earthquake, whereas 85% had no information about their childrens' situation. 40% of individuals of both groups said that rescuers had not let them to cry. Also, in another similar study of earthquakes in Iran, survivors had been prevented from tension relief.17

Attendance in mourning (lamentation) ceremonies for relatives is an important factor which facilitates tension relief and has a role in the reconstruction of family relationships. 17 Only 50% of individuals in group A had some possibility to attend such ceremonies. 32% of individuals in group A said that they knew someone who was an addict, but had not received any alternative treatment. Hence educating rescuers about symptoms of withdrawal syndrome and treatment with narcotics should be a concern.

Five percent of individuals in group B said that they had behaved in a bad manner or been abused in the first 2 weeks after the earthquake. This group was more prone to psychological issues after a disaster because of their age.7-9 It seems that greater attention should be paid to this particularly vulnerable group in future. Only 23% of children had played during these 2 weeks, while 32% said that they did not have any facilities for playing. Previous studies demonstrated that children have had a positive reaction after receiving toys in disasters and these facilities reduces the prevalence of PTSD and other psychological problems. 17

Conclusion

In conclusion regarding groups, rescue activities and primary care had largely been provided by relatives and domestic people; therefore general training and organizing CBO (Community Based Organization) for providing services in disasters especially in regions which are at high risk of earthquake will be useful for reducing the injuries. According to this research, rescuers are in serious need of training in mental health services and that the major areas of education needed include in particular counseling techniques, access to and provision of the necessary information for survivors, and stress management techniques.

Tables & Figures

Table 1: The role of different rescuer groups in rescuing survivors who needed rescuing from the load

Rescuer Group \ Group	Group A		Group B	
	Absolute frequency	**Relative frequency**	**Absolute frequency**	**Relative frequency**
Relatives and friends	42	93.3	30	69.7
Other natives	12	26.6	7	16.2
Rescuers of Red Crescent Society	2	4.4	2	4.6
Police and military forces	-	-	2	4.6
Health workers	-	-	-	-
Foreign rescuers	-	-	-	-
Others	2	4.4	5	11.6

Table 2: Absolute and relative frequency of individuals of group A who were rescued from the load
(In different intervals between the earthquake and the time of rescuing from the load).

Time	**Absolute frequency**	**Relative frequency**
$1 \geq t$	13	28.9
$2 \leq t \leq 3$	16	35.5
$4 \leq t \leq 12$	7	15.4
$12 \leq t \leq 24$	4	8.9
$24 \leq t \leq 48$	4	8.9
$48 \leq t \leq 72$	1	2.2
$72 < t$	-	-
Total	45	100

Table 3: Absolute and relative frequency of positive responses of individuals in group A who were rescued from the load to the following questions.

Questions	Rescuing step		First aid step	
	Absolute frequency	Relative frequency	Absolute frequency	Relative frequency
Did rescuers talked with you about your inconvenience?	19	42.2	25	55.5
Did rescuers listen to you carefully and considerately?	22	48.8	33	73.3
Did rescuers ask you not to cry?	33	73.3	34	82.2
Did rescuers give you unreasonable hope?	22	48.9	43	95.5

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WEATHER AND ITS CONSEQUENCES TO EMERGENCIES

Ivan Obrusnik[1]
Czech Hydrometeorological Institute

Keywords: Early warning, forecast, multi-hazard, disasters, meteorology

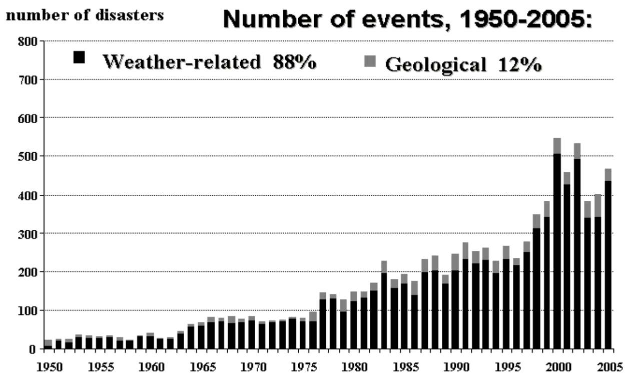
Abstract

Weather is rather important factor in many disasters and practically almost 90% of natural disasters taking place every year are connected with weather, climate or and water. Main weather related disasters are floods, tropical cyclones, tornadoes, severe weather and many others. Some of the disasters are connected with variability of climate. Most of weather - related events are fast and need appropriate and quick early warning (EW). National Meteorological and Hydrological Services (NMHSs), which should be an integral part of state emergency systems usually, issue such warnings. They utilize all available modern technology for observations including satellites and radars, numerical weather or hydrological modeling and data and information dissemination. All warnings should be accurate, timely and should reach responsible authorities, communities and finally the public. Activities of NMHSs have been supported and coordinated on international scale by the World Meteorological organization (WMO). Examples of early warning for natural hazards like tropical cyclone, flood, and drought, environmental hazards like forest fires as well as man made hazards provided by NMHSs connected to emergency systems are shown. Finally, a multi-hazard approach to early warning and disaster reduction is introduced.

Natural disasters of meteorological or hydrological origin

The number of natural disasters as well as their impact has been showing increasing tendency last 10 or 15 years. Most of these disasters, almost 90%, are weather-, climate- and water-related events (CRED, 2006).

Fig 1: Number of disasters in the last 50 years

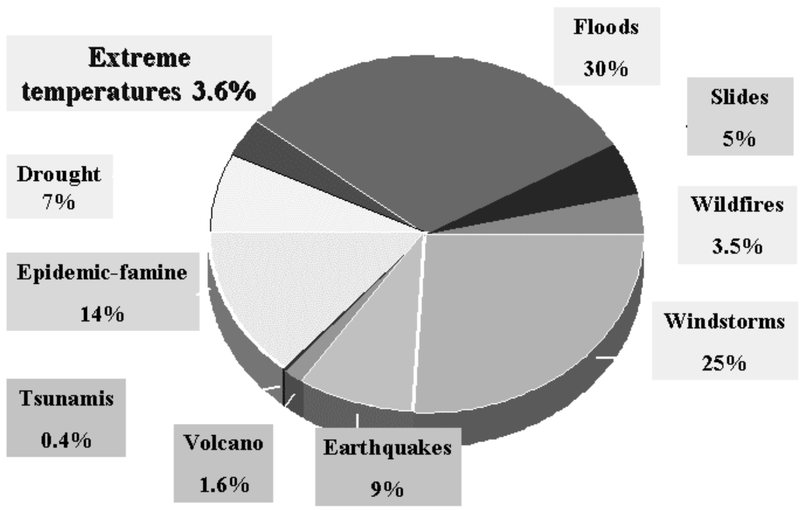


[1] Na Sabatce 17, 143 06 Prague 4, Czech Republic

It is a reason why both *National Meteorological and Hydrological Services (NMHSs*) on national and the World Meteorological organization (WMO) on international levels have been more and more involved in disaster reduction nowadays. Disaster reduction in general should always strongly involve activities of NMHSs and WMO especially in its early warning part. Last decade has shown many examples of well functioning NMHSs as well as some drawbacks in activities of NMHSs before and during disasters. NMHSs play an important role in weather-related disasters, which can be both very fast like tornado but also relatively slow like drought.

A distribution of weather-related and other types of hazards is shown in Fig 2.

Fig 2: Types of hazards leading to disasters



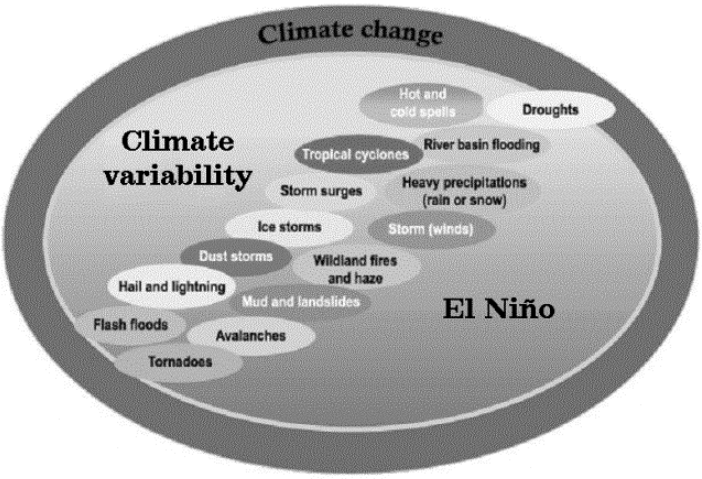
Early warning (EW) for such hazards covers a wide time span – from the shortest lead time for warning in the case of tornadoes, flash floods, hails and lightning (minutes or tens of minutes) up to relatively long lead time in the case of spells of hot and cold air or droughts (months). In recent years, climate variability and possible climate change can have a strong influence on number and range of weather extremes and consequent disasters (see Fig. 3). Each of the above-mentioned types of hazards needs a special approach to prepare an accurate and timely warning. NMHSs responsible for warnings have to utilize all data and information available and create forecasts and warnings tailored for emergency systems as well as for direct communication of warnings to the public by means of media, the Internet or mobile phones.

Role of the World Meteorological Organization in disaster reduction

The World Meteorological Organization coordinates observations, data processing and other activities of NMHSs towards reduction of life and property from natural and human induced disasters. Space and land-based hydrometeorological observations provide data and information needed for the forecasts and early warnings enabling preparedness for emergency relief and response. To affect relief efforts in humanitarian crises, the WMO-24-hour national operational contacts offer services including general briefings on the emergency's environmental conditions, weather advisories and seasonal outlooks.
Observing systems on platforms ranging from satellites, weather radars to buoys measure a variety of data. More than 10 000 manned and automatic surface weather stations, 1 000 upper- air stations, some 7 000 ships, 100 moored and over 1 000 drifting buoys and

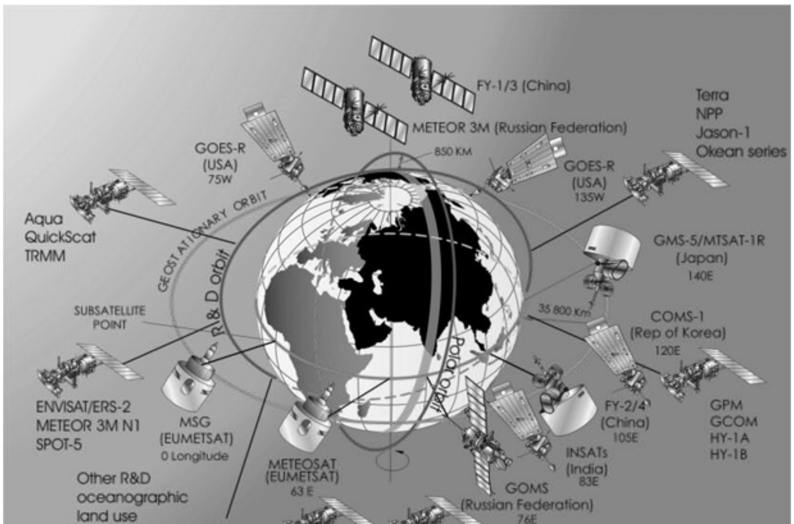
hundreds of weather radars measure every day key parameters of the atmosphere, land and ocean surface. In addition, over 3 000 commercial aircraft provide more than 150 000 observations daily.

Fig. 3: Weather-, climate- and water- related hazards (Jarraud, 2006)



The Environmental Observation Satellite network included five operational near-polar-orbiting satellites and six operational geostationary environmental observation satellites as well as several Research and Development satellites.

Fig 4: Network of meteorological satellites (WMO, 2004)



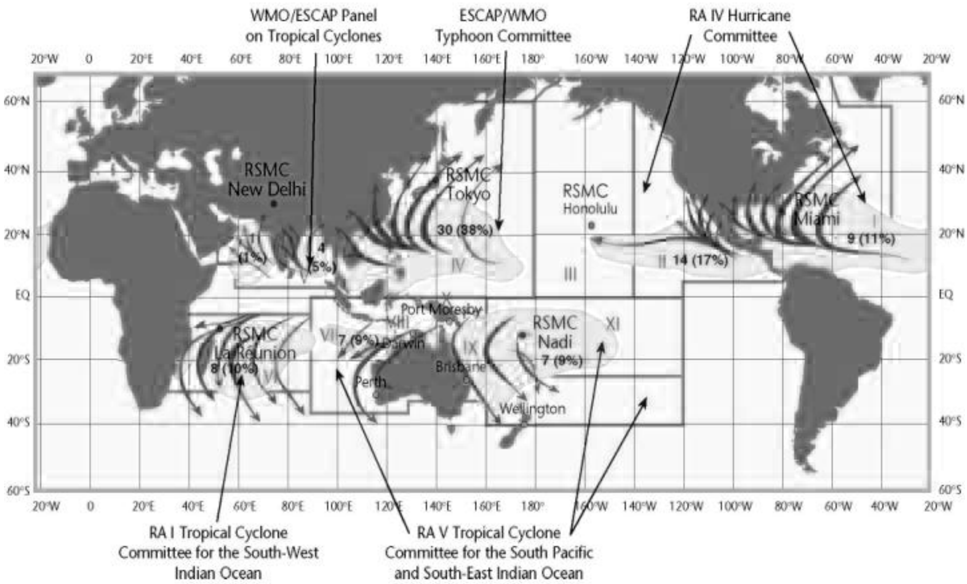
Polar orbiting and geostationary satellites are normally equipped with visible and infrared imagers and sounders, from which one can derive many meteorological parameters. Geostationary satellites can be used to measure wind velocity in the tropics by tracking clouds and water vapor. Satellite sensors, communications and data assimilation techniques are evolving steadily so that better use is being made of the vast amount of satellite data. Improvements in numerical modeling in particular, have made it possible to develop increasingly sophisticated methods of deriving the temperature and humidity information directly from the satellite radiances. Research and Development (R&D) satellites comprise the newest constellation in the space-based component of the Global Observing System (GOS).

The Global Telecommunication System (GTS) internationally exchanges the resulting data and information from observations, as well as the forecasts and warnings generated. Specialized weather and climate modeling centers process data and make model outputs and products available for use by all the nations. Some centers produce weather analyses, forecasts, advisories and warnings. Others produce monthly, seasonal and inter-annual analysis and forecast products, and also specialized products. Moreover, many NMHSs compute daily regional weather models with higher resolution giving more precise forecasts but for shorter lead-time than global models from the specialized modeling centers. For over 50 years, WMO has facilitated worldwide cooperation in establishing observation networks and has promoted the provision of meteorological and related services.

Tropical Cyclones

Tropical cyclones (Bulletin, 2006) are one of the most devastating of all natural phenomena. They form over all tropical oceans. In the western North Pacific, mature tropical cyclones are known as *typhoons*, in the western hemisphere are called *hurricanes* and *tropical cyclones* in other areas. The potential for creating destruction caused by their violent winds, torrential rains and their size, severity, and frequency of occurrence and vulnerability of the vast areas they affect compound associated storm surge.

Fig 5: Regional Specialized Meteorological Centers for tropical cyclone warning



Thanks to international cooperation and coordination by WMO, and with the aid of meteorology and modern technology, such as satellites, weather radars and computers, all tropical cyclones around the globe are now being monitored from their early stages and throughout their lifetime by relevant centers of NMHSs and by six Regional Specialized Meteorological Centers (RSMCs) located in Honolulu, Miami, Nadi (Fiji), New Delhi, Tokyo and La Réunion. Most of the damage inflicted by tropical cyclones is usually caused by storm surge and flooding. A typical example could be hurricane Katrina, which caused severe damage and losses in Louisiana and New Orleans especially by flooding despite a well-predicted trajectory and strengths of the hurricane itself.

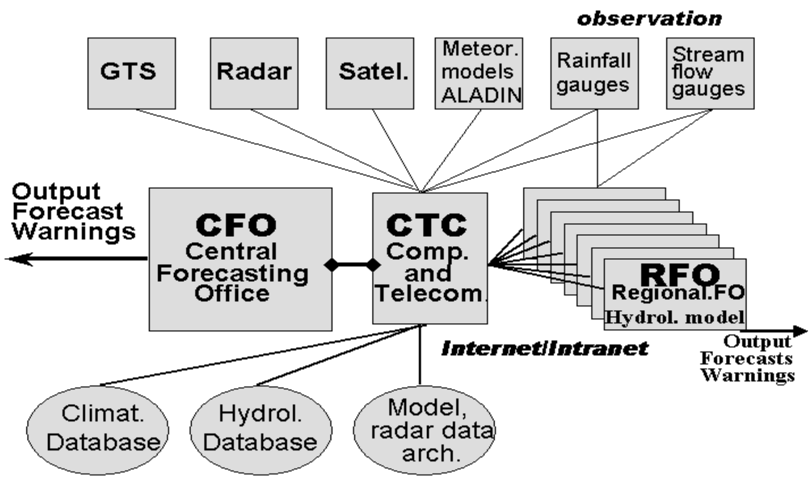
Similarly, NMHSs with the help of coordination and methodological support from WMO have been issuing forecasts and warnings for many other types of disasters of hydrometeorological origin like various types of storms including snowstorms, tornadoes and hails, torrential rains, heat and frost waves and also droughts, etc. However, the most frequent hazards causing enormous damages all over the world are floods.

Forecasting and warning system for floods

Flood forecasting and warning is relatively difficult task, which needs a close cooperation between meteorologists and hydrologists and good cooperation with other parts of emergency systems. In general, an accurate and timely forecast of forthcoming flood, its progress in time as well as forecasting the end of such event is a good, even though rather difficult example of involvement of NMHSs in early warning.

One example of a fully integrated approach to flood forecast and warning could be found in the Czech Republic, which passed through three big floods during last decade (in 1997, 2002 and 2006 years). During this decade an early warning system for floods had to be improved from both the point of view of an application of recent scientific and technological tools and by the use of rather advanced and efficient organization of Forecasting and Warning Service (FWS). Organization of such a system is shown in Fig. 6.

Fig 6: Simplified scheme of Forecasting and Warning System for floods

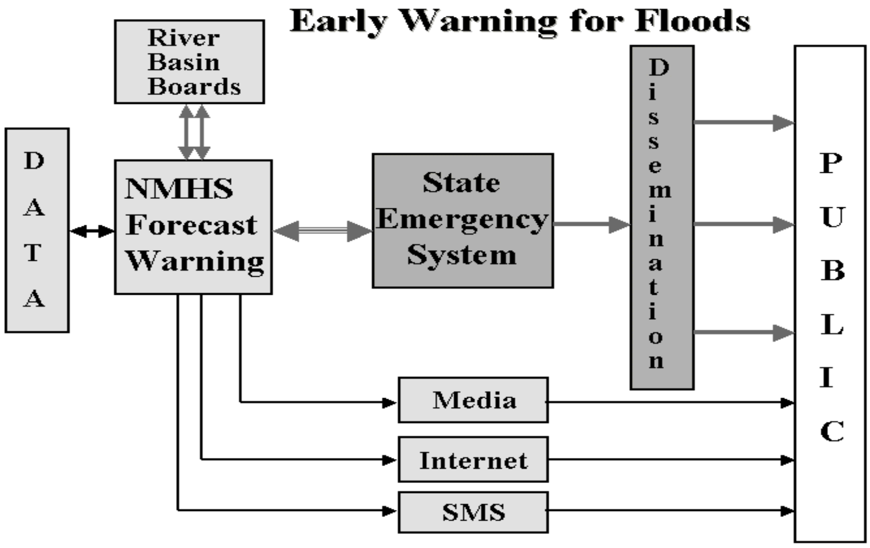


This FWS system involves the Central Forecasting Office (CFO) and six Regional Forecasting Offices (RFOs) and is based on *a multi-sensor observation input* (precipitation, river flow, and data from the WMO Global Telecommunication System (GTS)).

The system is based on *modern remote sensing systems like weather radars and satellites* (especially for nowcasting). Moreover, the system also routinely uses data from *numerical weather models* for heavy precipitation forecast and permits flood forecasts with a longer lead-time. The system uses also hydrologists both at CFO and RFOs equipped with *hydrological models* producing forecasts of water levels and discharges in river profiles. Potentially, GIS images of flooded zones would be added. The development of the hydrological part of the system, especially the models and river gage networks, together with information about reservoirs has been coordinated with River Basin Authorities.

However, FWS run by NMHS should be cooperating with *River Basin Boards* (there are five of them in the country) and connected with the state emergency system. Fig. 7 shows the warnings are disseminated to lower levels of the system like regions, districts, communities, and finally, to the public by this system with the help of the *Main Office of Fire and Rescue Service.*

Fig 7: Integration of Forecasting and Warning Service of NMHS in a state emergency system



All activities should be in accordance with flood mitigation plans and under a direct supervision of the *Flood Authorities*. When the flood reaches a disastrous level, then *crisis management staffs* would take over command and lead instead of the flood authorities. The minister of interior has the command and responsibility for the Central Crisis Management Staff in all non-military emergencies and disasters in the country. Fig.7 also shows that in many urgent cases an additional dissemination of warnings directly via media; the Internet and SMS messages via GSM should efficiently be used.

Climate

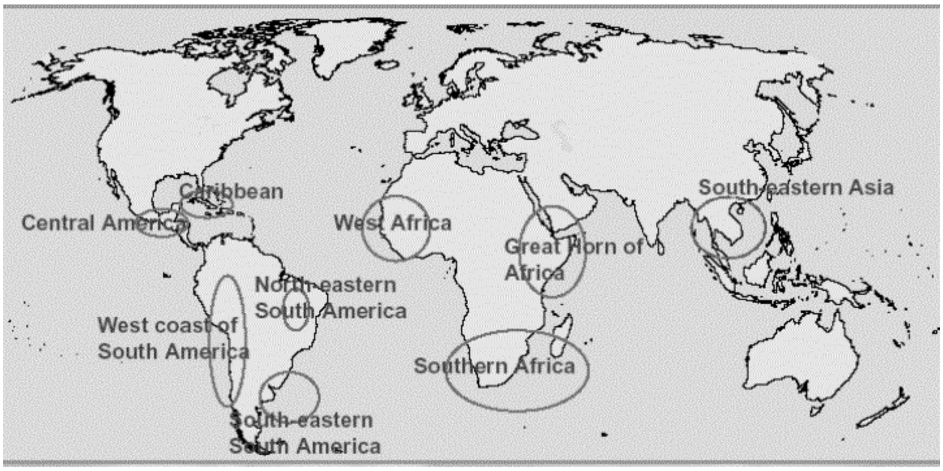
Climate variations at all timescales can have major impacts on numerous human activities. Prediction of such variations and events bring about major humanitarian and economic benefits. The need for systematic climate observations for the understanding and prediction of climate trends and variability, for the detection and attribution of climate change, and for providing guidance on mitigation and adaptation measures is now widely recognized. WMO and NMHSs contribute to fulfilling this need, and especially to meeting the requirements of the United Nations Framework Convention on Climate Change (UNFCCC) for climate information. Early warning for climate extremes allows sufficient lead-time for authorities and the public to act and to reduce losses on property and lives. NMHSs provide such forecasts and warnings in a timely manner by application of climatological and hydrological knowledge and in cooperation with emergency and relief agencies.

a) El Niňo
One rather dramatic phenomenon among Earth's climatic variations is the El Niño/Southern Oscillation (ENSO). An *El Niño* strikes every three to seven years, when trade winds in the tropical parts of the Pacific Ocean weaken or reverse their usual route. The winds then blow surface water warmed by the tropical Sun to the eastern Pacific Ocean and the equatorial west coast of South America. Rain follows the current, and eastern South America may then experience flooding, while Australia, southern Africa and Indonesia may have drought. A La Niña event is the opposite, with warmer waters in the western Pacific and cooler waters off the west coast of South America.

The prediction of El Niño/La Niña events up to several months ahead based on a careful monitoring of the sea-surface temperatures of the Pacific Ocean is a top priority for NMHSs around the world enabling to diminish impacts of this climatic phenomenon.

Regional Climate Outlook Forums (RCOFs) established in some areas (see Fig. 8) prior the 1997-1998 El Niňo event could provide advance information on the likely climate features of the upcoming season. RCOFS stimulate the development of climate capacity in NMHSs of the area, and can be helping to generate decisions and activities towards mitigation of adverse impacts of climate and climate variability.

Fig. 8: Regional Climate Outlook Forums in the world (CLIPS, 2006)



b) Heat waves
Heat waves, higher maximum temperatures and an increase in the number of hot days are already happening. The risks are significant: some heatwaves are associated with pollution; they kill or affect more people than tornadoes, earthquakes or hurricanes. Cities are hardest hit because even small increases in global temperatures can be amplified via the "heat island" effect. In the urban environment, concrete, tarmac and tall buildings absorb solar radiation and release it to the air, while the relative lack of vegetation means there is less cooling by evaporation. Deaths from heatstroke in large cities could become much higher. An example is a high level of human losses in France during a heat wave in summer 2003. Away from the cities, livestock and wildlife can suffer from heat stress, crops fail, and tourism may decline.

c) Droughts
Drought could be the most devastating climate extreme. Without proper management droughts can trigger other human-made tragedies such as famine, widespread displacement and death especially in developing countries. Drought predictions dependent on monitoring observed patterns of monthly and seasonal rainfall, streamflow, groundwater levels, snow cover and other parameters. Some NMHSs have developed drought EW systems capable of integrating reports and data from various sources and of identifying the start of drought period. Droughts in many countries have been linked to El Niňo. However, in some parts of the world like Europe without so strong phenomena like E Niňo seasonal forecasts from modeling and drought warnings have been more difficult.

d) Forest fires
Forest Fires are uncontrolled fires occurring in vegetation more than 1.8 m in height, which have become rather frequent in the past decade in many parts of the world. When combined with lightning strikes and human actions drought conditions produce thousands of forest or wildland fires. The use of models to simulate duration, spread and intensity of fire is an effective tool for fire management and some NMHSs produce warnings and forecasts for

such fires. A modern approach is the use of satellite remote sensing for wildfire monitoring and fire danger assessment.

e) Locusts
Locusts in large numbers can devastate large areas and cause big losses in agriculture especially in some developing countries. Accurate meteorological information is crucial for understanding locust outbreaks, upsurges and plaques and for eventual control operations. NMHSs in locusts affected areas of Africa, the Middle East and Asia provide necessary information and forecasts when required. At international level the Desert Locusts Information Service of FAO maintains a global overview and prepares medium- to long-term forecasts for all countries within the distribution areas of the desert locust.

Environmental emergency

WMO assists NMHSs and other national and international authorities to respond effectively to environmental emergencies involving the large-scale dispersion of airborne hazardous substances, caused, in particular, by nuclear and radiological incidents. Preparedness programs are of particular importance for rapid and effective meteorological support required to mitigate the disastrous consequences of a nuclear emergency.

The International Atomic Energy Agency/WMO Joint Radiation Emergency Management Plan commenced for an international nuclear exercise to test the full operation of the emergency information-exchange procedures with the help of WMO's Regional Specialized Meteorological Centers, Regional Telecommunication Hubs and NMHSs at national levels.

NMHSs and WMO have also been supporting emergency response to the dispersion of smoke from large fires, ash and other emissions from volcanic eruptions and chemical releases from industrial accidents. Some of NMHSs are responsible also for smog forecasting and warning.

Another important problem where meteorology plays a key role is *ozone depletion*. The stratospheric ozone layer protects plants, marine life, animals and people against harmful effects of solar ultraviolet B (UV-B) radiation. In the mid-1980s, the discovery of a "hole" in the stratospheric ozone layer over the Antarctic lead to intensive research of the chemistry and transport of ozone in the atmosphere. Increased UV radiation harms DNA in animals, inhibits photosynthesis in plants and damages the plankton forming the base of the marine food chain.

The subsequent finding, based on monitoring, that chlorofluorocarbons from industrial and cooling processes, along with other anthropogenic chemicals, were responsible for this catastrophic thinning of ozone prompted the drawing up of the 1985 Vienna Convention on the Protection of the Ozone Layer and the 1987 Montreal Protocol on Substances that Deplete the Ozone layer and its subsequent Amendments. Both NMHSs and WMO have been involved in these activities and issuing warnings and forecasts of dangerous levels of the ozone layer and solar UV-B radiation.

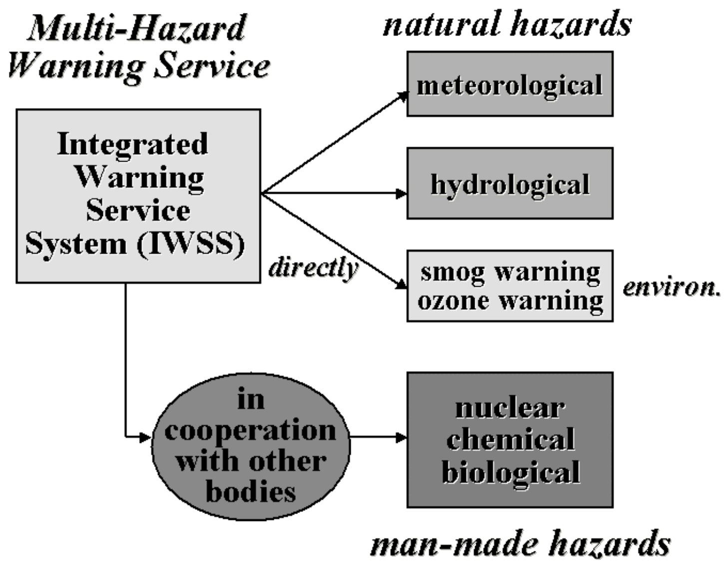
Role of NMHSs and WMO in Multi-hazard early warning

Many disasters in the last decade have shown an urgent need for early warning for a wider range of hazards both natural and man-made. This multi-hazard approach cn efficiently utilized infrastructures of NMHSs, WMO and other agencies on international, regional and national scales. A system established in the Czech Republic shown schematically in Fig. 8 can serve as an example of such approach.

This system produces early warning for meteorological, hydrological, environmental and man-made hazards and cooperates closely with other parts of the state emergency system. The very close cooperation of the Czech NMHS with crisis management authorities has lead step by step to acknowledgement of CHMI as official authority (single voice) for issuing meteorological, hydrological and air pollution warnings and information. At the same time, CHMI has become a standard part of the state emergency system.

Similarly, global early warning systems, including national alert-and-response mechanisms based on a multi-hazard approach, could avert disasters like the Indian Ocean tsunami of December 2004.

Fig. 9: Multi-hazard warning service used by NMHS in the Czech Republic (Obrusnik, 2001)



WMO's Global Telecommunication System (GTS) provides end-to-end capabilities for data collection and the development and dissemination of early warnings internationally. The GTS is already used by the Pacific Tsunami Early Warning System, which is coordinated by the International Coordination Group for the Tsunami Warning System in the Pacific of the Intergovernmental Oceanographic Commission (UNESCO), and has proved to be highly effective. The Pacific Tsunami Warning Center, operated by NMHSs from USA and Japan, will use the GTS for issuing tsunami early warnings to the Indian Ocean Rim countries, while the Indian Ocean Tsunami Early Warning and Mitigation System is being developed. The GTS will serve as a critical telecommunication mechanism for the exchange of tsunami related data and warnings in the longer term. WMO is taking action to ensure that the GTS will be fully operational for tsunami and seismic applications in the Indian Ocean and other areas at risk. It is building on the telecommunication and staffing infrastructure, which is already in place for tropical cyclone and storm-surge warnings.

Conclusions

Meteorology and hydrology play an important role in decreasing losses of human life, destruction of social and economic infrastructure and degradation of already fragile ecosystems caused by various kinds of natural and man-made disasters. WMO and the National Meteorological and Hydrological Services contribute significantly, at international and national levels, in the identification, assessment and monitoring of disaster risks and the provision of early warnings. They need to cooperate with national emergency systems and authorities, scientific communities, intergovernmental and non-governmental organizations, the private sector, the media and the public to be aware of the role of NMHSs and WMO and ensure that they have the capacity to contribute to the mitigation of disasters.

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Critical Infrastructures
Crisis / Emergency Management

A TOOL TO FORMALISE AND TEST ATTACK SCENARIOS OF SOFTWARE INTENSIVE CRITICAL INFRASTRUCTURES

Claudio Balducelli & Giordano Vicoli
ENEA (Italian Agency for New Technologies, Energy and Environment)[1]

Keywords: intrusion detection, attack trees, attack patterns, critical infrastructures, attack modelling

Abstract

Modelling and simulation of attacks scenarios could help to discover the hidden vulnerability points inside software intensive critical infrastructures, like energy distribution networks, railway networks etc. that are controlled and supervised by SCADA (System Control And Data Acquisition) systems.

To define the possible attack scenarios is necessary to analyse the attackers characteristics and the resources and the opportunities that could be available for the attackers.

In this paper the formalism of “attack trees” is proposed as usefull modeling technique for attacks: more attack sequences are generated from a single tree configured and “edited” using ATP (Attack Tool Platform). ATP provides users with a set of instruments useful for building (editing) attack actions profiles, a tree of this profiles, tree instances (named attack scenarios) and then for running simulation sessions using these instances.

The same attack action can be associated to different action profiles having different levels of difficulty. In this way an attach tree could include different attack paths with different associated attack difficulty levels.

The utilization of attack trees realizes a formal representation of the attack sequences to be tested. In such way this formalisation represents also a formal strategy to elicit knowledge and information about potential vulnerabilities of the infrastructures.

ATP tool was used in SAFEGUARD[2] project to test attack scenarios against an electrical transmission network controlled by a SCADA system. The laboratory testing environment and the results are also described.

Introduction

This paper is a follow-up of a work already proposed in [1] where a sort of reference language to model and implement intrusions and faults scenarios was proposed. In that work a proposal was done to formalize the required paths of attacks or system faults through the definition of

[1] Via Anguillarese 301, 00060 Rome, Italy
[2] A multi-agent system to safeguard Large Complex Critical Infrastructures developed inside EU FP5 program

attack trees. The root of an attach tree represent an event that could significantly harm the infrastructure's mission.

Every path in the attack tree represents a unique type of attack (or a unique type of fault propagation) for the infrastructure.

Different types of nodes and links can be utilized during the design phase of an attack tree: AND node, OR node or XOR node. Such a model allows also the insertion of a certain degree of certainty inside the different paths.

Attack trees are in some way similar to fault trees that was extensively used in nuclear applications [2]. The main difficulties to apply fault trees depends on the difficulty to asses the failure rates of the different nodes of an information system and to evaluate the interdependencies between the different components failures [3].

The utilization of such attack trees realizes also a formal representation of the attacks. This formalism could help the attack analyst to classify attack knowledge and to realize a more efficient method to elicit attackers expertise and behaviour.

The attacks may be planned by unintentional or malicious attackers, they may be single persons, communities or organisations. Single intruders generally have limited resources to conduct the attack activity. Organisations, and especially terrorist organisations, may have a lot of resources available. They could be generally able to conduct "distributed attacks" composed by sets of efficient sequences of single attacks in different points of the layered infrastructures.

Studies and the analyses of the "intruders' behaviour", in relation to the intrusion typologies and the types of knowledge and preferences of the involved actors, are necessary to support the generation of realistic attack scenarios and with an higher level of occurrence.

To make more effective such analyses, in this work an Attacks Test Platform (ATP) tool is proposed, based on the previous defined attack trees, that can be used for modelling and simulating attack scenarios. This tool is a suite of applications provided to test the robustness of an information intensive critical infrastructure against malicious attacks. The ATP components are instruments with which users may configure a set of attack sequences against a SCADA system or a generic information intensive system. The tool was developed in the framework of "SAFEGUARD", an European research project having the objective to realise a "Multi-agent System to safeguard Large Complex Critical Infrastructures".

To develop an attack sequence knowledge and expertise of potential attackers are required. The formalism of the "attack trees" is used to generate more attack sequences from a single tree that is configured and "edited" using the ATP tool. The tool provides users with a set of instruments that they can use for building (editing) attack actions profiles, a tree of this profiles, tree instances (named attack scenarios) and then for running simulation sessions using these instances.

The same attack action can be associated to different action profiles having different levels of difficulty. In this way an attach tree could include different attack paths with different associated attack difficulty levels.

Attack Test Platform generality

The three principal functionalities of the Attack Test Platform (ATP), as described in the following, are:

- attack trees editing
- scenarios generation from a tree
- scenarios running

Attack tree editing

An attack tree is composed by two type of nodes: logical node and action node.

The logical is the node that represents a point of decision, it is a step that has the property to define several sub-set of the tree. In simpler words the logical step provides a combinatory logic node for having several solution of attacks at that point of the tree.

The action is the node that represents the effective attack, the wicked action on attacked system.

The initial logical node of the attack tree represents the final objectives of the attacks; The terminal leafs (action nodes) of the tree represent the actions that must be executed for reaching the objectives. We can have three types of logical nodes:

· <AND> node (all children nodes must be executed)
· <XOR> node (only one of the children nodes must be executed)
· <OR> node (any combination of the children nodes must be executed)

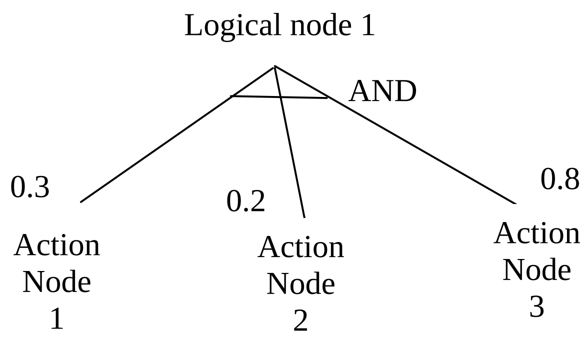

Fig 1 – graphical representation on a node

As visualised in fig 1 to the action nodes is possible to associate a certainty factor as a real value between 0.0 and 1.0. This number represents the probability (a score) that the action will have success; this probability normally depends about the degree of difficulty associated of the action. Here 0.0 is associated to infinite difficulty level and 1.0 to absence of difficulty. The visualised three generates only one scenario composed by all the three actions with a difficulty global factor of:

0.3 x 0.2 x 0.8 = 0,048 probability of success

In the figure is visualised the graphical interface, Attack Tree Editor (ATE) used to edit and visualise an attack tree.

The tree formalisation use “steps” to represent the nodes.

Here it is possible to visualize the Logical Steps (L) and the Action Steps (A). Every children steps are included inside a "children folder" that can be open and closed to see the children steps. Every steps has attributes like the "NAME", the "OPERATOR" for the logical steps or the "SCORE" for the action steps.

ATE graphical interface is the first program that must be used to begin the attack formalisation activity. ATE allows the user to open a TREE initial model for building a new TREE attack structure. It is also possible to open an old TREE model to add or modify parts of the tree.

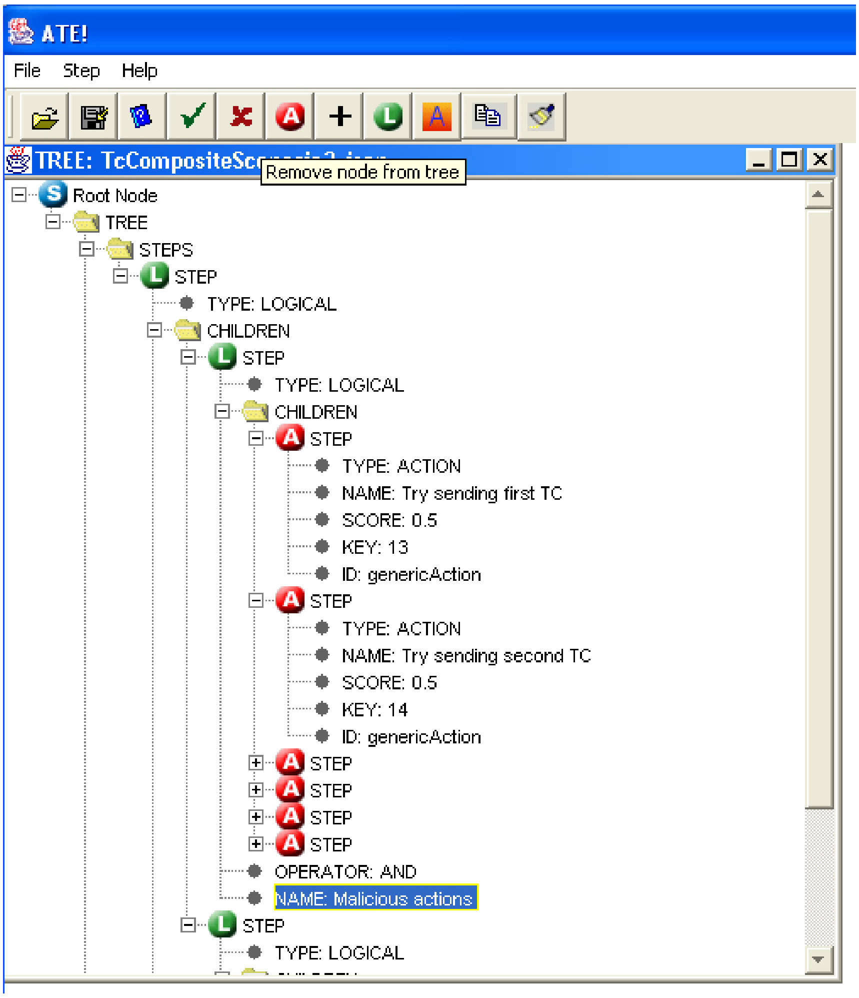

Fig 2 – ATE graphical interface

Actions that you may do on a existing TREE are:

- add (or remove) a Logical step or an Action step;
- add (or remove) an attribute (it's not a node, but a couple key-value that represents an attribute for the parent node).
- change the node structure;
- copy and paste a sub-tree from a tree toward another tree;
- save all;
- open and change an old tree.

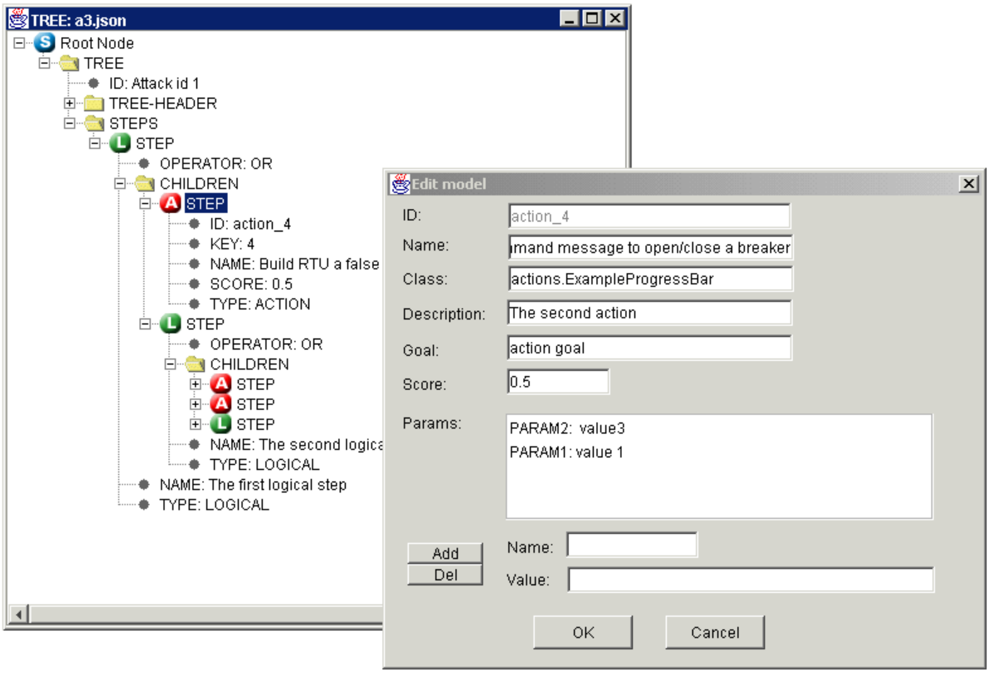

Fig 3 – the meta-descriptor dialog for the selected action on tree.

ATE allows also to edit a meta-description of the actions defined inside the tree, as it is visualised in fig 3. In the meta-description is possible associate a class for the action and also some action parameters. This information will be necessary to run the action inside a testing environment as it will be described in the following. Action class indicate the name of the program that will execute the action in the testing environment and the parameters are the relative program parameters like values for program running time, program running options etc.

Scenarios generation from a tree

ASE (Attack Scenario Editor) application let the operator to build a set of scenarios from a given tree. A single scenario represents a sequence of actions the test environment has to perform on the target network. From a given tree more scenarios are generated, and this mainly depends about the total number of <OR> or <XOR> operators that are defined inside the tree.

User can open a tree like the one showed in picture 2 and he can generate every possible scenario with an automatic mechanism. ASE explores the tree structure and for each logical node it observes the "OPERATION" attribute.

If a logical node has three branches and if the attribute value is "AND" the procedure exports every children node inside a single new scenario; if the attribute is "XOR" the procedure export only single children nodes inside three different new scenarios; if the attribute is "OR" the procedure export any combination of the children nodes inside seven different new scenarios.

Examples

As an example we have formalised an attack tree (see Table 1) containing the general procedure for an attack toward some user workstations of a local area network of a society.

TABLE 1 – Example of a simple attack tree against a workstation of a local area network

---

Goal: Stealing information, blocking services, modify data to/from a target machine
Precondition: The attacker is a user of a local area network

AND 1. (0.9) Identify the subnet where reside a PC with the information
2. Enter in the subnet
XOR 2.1 (0.9) The subnet is physically linked to the main network. Possibility to enter in any node (PC) of the local network
2.2 (0.2) The subnet is not physically linked to the main network. Possibility to enter only in a node (PC) belonging to the subnet
3. (0.95) Identify the IP address of the gateway machine
4. (0.95) Identify the IP address of the target machine
5. Build a message reading clone machine for the target machine
AND 5.1 (0.9) Get the MAC address for the gateway machine
5.2 (0.9) Get the MAC address for the target machine
6. Start malicious activity
XOR 6.1 (0.9) Start sniffing and stealing information
6.2 Blocking some services furnished by the server
XOR 6.2.1 (0.3) The attacker machine is connected to his own network plug-in
6.2.2 (0.6) The attacker machine is connected to a public network plug-in
6.3 (0.2) Modify user information exchanged with a server

Postcondition: The attacker must have time to acquire, analyse the information, and work on the attacker machine

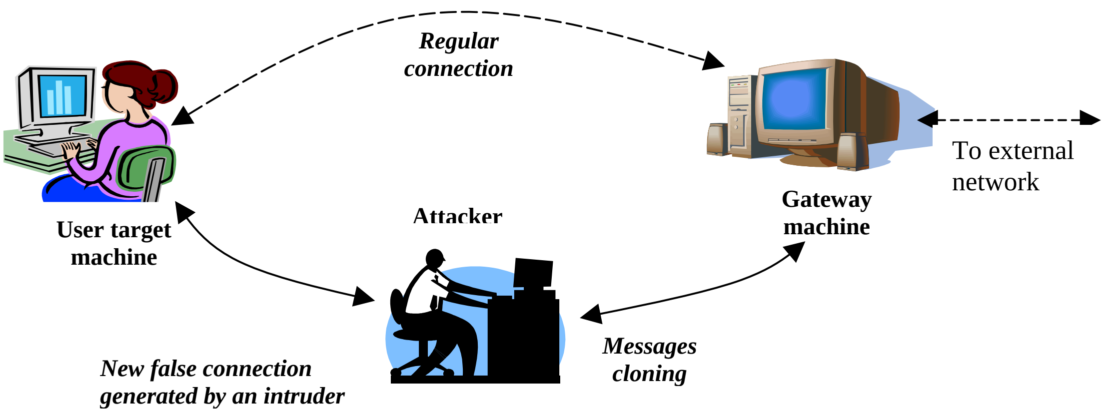

Fig 4 – Attacker intrusion inside a local area network

In the previous example fig. 4 shows how an attacker coud enter inside a subnet of local area network remotely or locally as defined by the logical step n. 2.

The attacker has to front different difficulties, that are dependent about the type of subnet where the target machine resides: if the subnet is physically connected to the main network the attacker may work from any other machine of the main network (step 2.1), otherwise he have to enter in some way to work on a workstation physically connected to the target subnet (step 2.2).

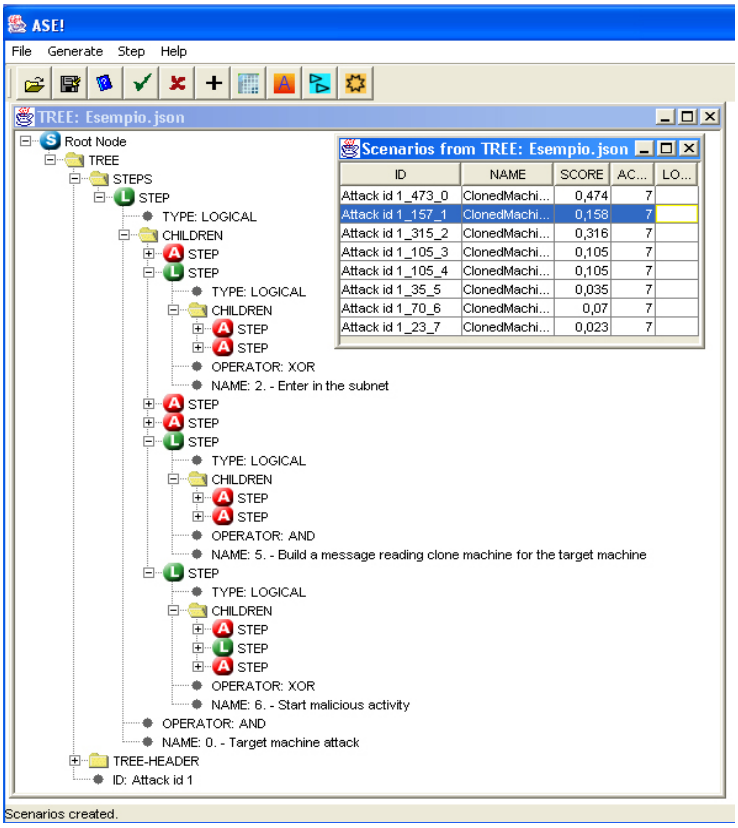

Fig.5. – ASE interface and scenario generation from a single tree

In both cases firstly he identifies the MACs (Media Access Control address) of the target machine and of the machine functioning as gateway as well (step 5.1, 5.2). Then he will set-up in the target machine the MAC address of his machine as a false address of the gateway machine. The same false setting is done for the gateway machine. In such way all the messages that the target machine will send/receive from the gateway will flow trough the intruder machine. The final objectives of the attacker may be of three type with different difficulties:

- Sniffing and stealing information from the target machine (Step 6.1). This is the most easy task and it is difficult for the network administrator to find out the intruder.
- Blocking some of the services offered to the target machine by the central server(step 6.2). This task is easy to do but is also easy find out the intruder especially if he work from his room and use his own plug-in for the machine.
- Modify the information exchanged with the server.

The last task is more difficult as it is necessary to know the content of the exchanged information (step 6.3).

In fig 5 is visualised ASE application interface where the previous tree is implemented.

Using "Generate" menu is possible to launch an automatic mechanism for creating from the tree every possible scenarios. The application, when this operation is completed, shows a table with scenarios generated. In this table is showed the scenario "SCORE" that represents the successful difficulty of the a scenario calculated composing the difficulties of every single action.

Table 2 show the structure of the seven generated scenarios corresponding to seven different paths inside the attack tree. Then user may open, modify and save all the generated scenarios.

Table 2 – Generated scenario table

Scenario	0	<1., 2.1, 3., 4., 5.1, 5.2, 6.1 > with 0,474 of difficulty
Scenario	1	<1., 2.1, 3., 4., 5.1, 5.2, 6.2.1> with 0.158 of difficulty
Scenario	2	<1., 2.1, 3., 4., 5.1, 5.2, 6.2.2> with 0,316 of difficulty
Scenario	3	<1., 2.1, 3., 4., 5.1, 5.2, 6.3 > with 0.105 of difficulty
Scenario	4	<1., 2.2, 3., 4., 5.1, 5.2, 6.1 > with 0.105 of difficulty
Scenario	5	<1., 2.2, 3., 4., 5.1, 5.2, 6.2.1> with 0.035 of difficulty
Scenario	6	<1., 2.2, 3., 4., 5.1, 5.2, 6.2.2> with 0.070 of difficulty
Scenario	7	<1., 2.2, 3., 4., 5.1, 5.2, 6.3 > with 0.023 of difficulty

Attack tree reusing

A specific attack tree can be reused inside another tree. For example the attack tree generated in the previous paragraph, that model an attacker working inside a local area network, can be reused inside another tree containing the working procedure of attackers working on machines installed on the external network, using an internet connection.

TABLE 2 – Example of a simple attack tree with attacker working on the external network

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Goal: Stealing information, blocking services, modify data to/from a target machine
Precondition: The attacker works on an external network and use the "buffer-overflow" mechanism to obtain the super-user rights in the attacked system.

AND 1. Find the weakness of a personal Web site
XOR 1.1 (0.5) Find a known software bug
1.2 (0.2) Decide to make more attempt
2. Operate on the Web site interface
AND 2.1 (0.7) Find a function for which super-user rights are required
2.2 (0.2) Use the buffer overflow technique to inject malicious software
2.3 Enter and start working inside the local area network of the user

Postcondition: The attacker must have time to acquire, analyse the information, and work on the attacker machine

The previous table shows the attack tree relative to an attacker working from an external network. In this case the attacker must find the "weakness" of the software used to implement a personal Web site of a user or a society. He can decide to find a known software bug of a specific version of the software that allows to exploit the "buffer overflow" process; otherwise he can also to execute more attempts, but with minor probability of success. Buffer overflow is the process that an intruder can utilises to inject inside a victim system a software code able to make malicious activity, as for example to obtain to work with super-user rights and privileges. Despite many buffer overflow protection mechanisms were analyzed and implemented[4], buffer overflow remains a valid method to exploit the vulnerability of software systems.

In the attack tree of Tab. 2 the function of step 2.1, if executed, gives for a certain time the super-user rights to the external user. If, in the mean time, the attacker is able to inject a malicious software, he could acquire the super-user rights and the possibility to work as a privileged user in the sub-net where the workstation of the victim resides.

In this way the attacker has the possibility to work inside the local sub-net. Executing step 2.3, is equivalent to "reusing" the tree described before, that includes the attack procedure against a user belonging to a local area network.

ATP allows to substitute a logical step of a tree with an already defined tree. In such way the complete tree of fig. 6 is generated.

If we ask ASE to generate all possible scenarios we obtain a list of 16 scenarios, 9 more respect to the previous tree. The obtained difficulties to execute these scenarios are variable from 0.033 to 0.001. It means that for an external attacker the overall difficulty to conduct the attack is 10 times higher respect to an internal attacker: this appears as reasonable result.

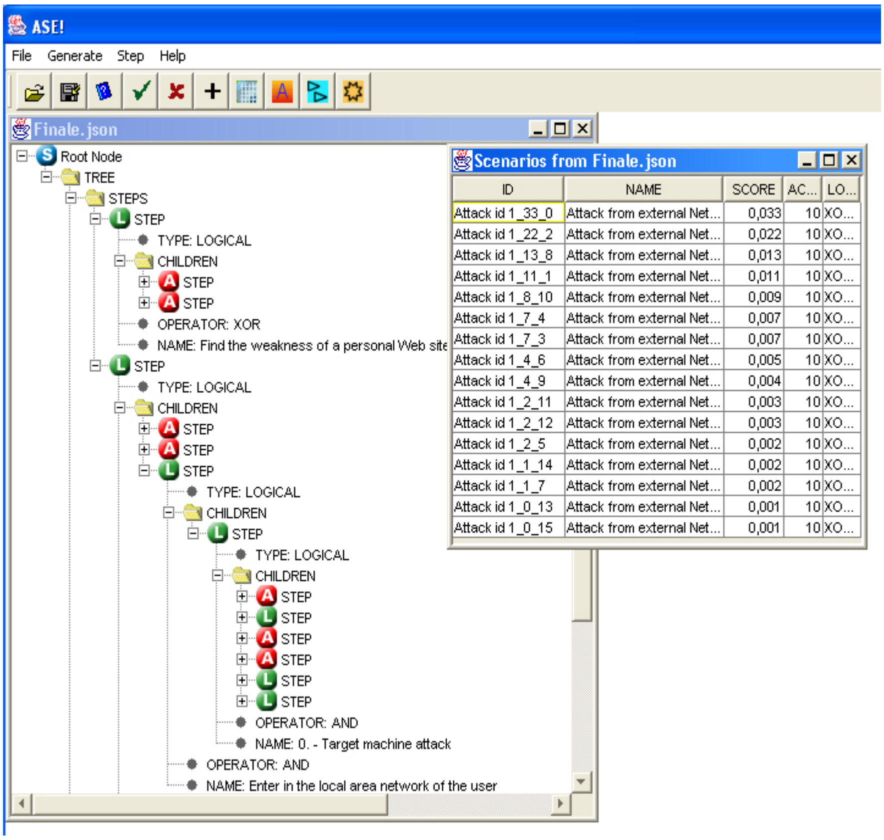

Fig. 6 – Attack tree relative to an external network attack

Attack scenarios running

Attack scenarios are the sequence of action steps that an attacker must execute to obtain the attack goal. ATP allows to "execute" the action steps of an attack scenarios in a simulated environment. The action steps of a scenario could be customized and made more specific, adding new features to actions previously defined in the tree that generated such scenario.
More in particular at every action must be associated to the "time" on which it will be executed. In such way a certain action could fire after or before other actions. The same action can be also repeated more times during a certain time length. This is the typical behaviour of an attacker that try more time to sniff or corrupt data inside transferred data packets buffers.
The actions can be also linked to the piece of malicious code realising the attack and a set of parameters, eventually required by the code, can be defined.

Experiments about attacks on SCADA systems

ATP was used to run simulated attacks scenarios against the SCADA software environment used as testing environment for SAFEGUARD agents[5]. The situation is illustrated in fig 7. An attacker is able to enter inside the Wide Area Network on which are connected the workstations of the Control Centre[3] (CC) of an electrical transmission network. These workstations are part of the Supervisory and Control System used by the electrical operators to monitor and control data coming from Remote Terminal Units[4] (RTU). Fig 7 shows how the attacker can sniff the messages exchanged between a CC and an RTU and how, with sufficient skill, he may also modify information stored inside tele-commands packets, producing in such way “false commands”, aimed to generate unexpected remote operations, like an unexpected disconnection of an electrical line. Also in this case, as in the example described previously, the intruder could be “internal” (an employer/associate of the electrical company), or “external”, if the Wide Area Network make available some services that require the internet connection; the availability of these services may be used as a weakness for attacks that make use of the buffer-overflow mechanism.

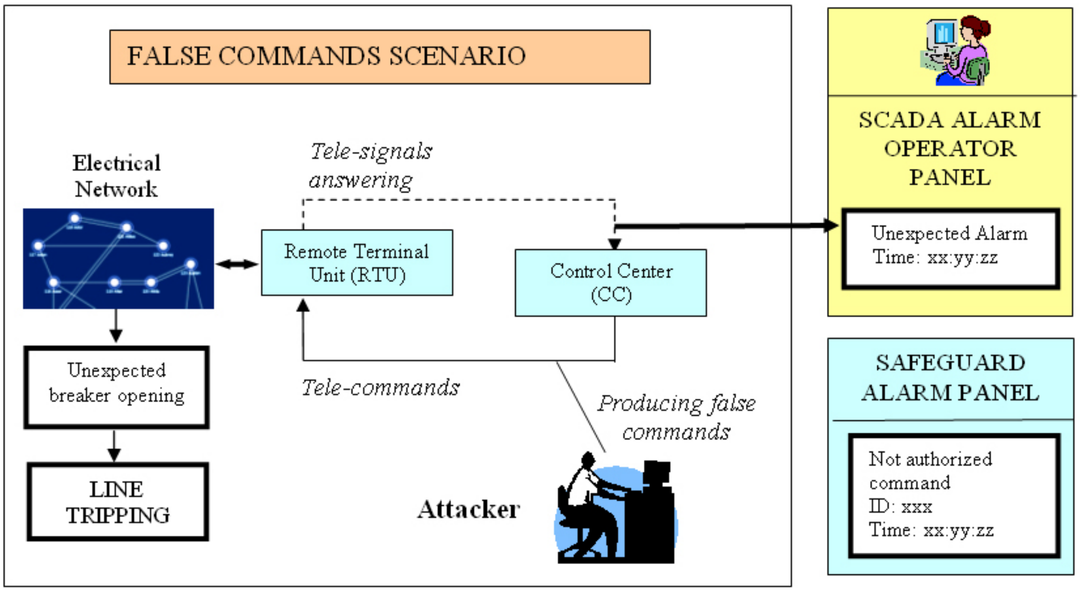

Fig 7. – Intrusion against a SCADA software environment

Fig 8 shows the ATP interface utilised to run the false command attack scenario. The complete attack sequence is composed by 7 action steps visible on the attack panel. The times on which every action is fired, is visible on the TIME column, where time increases from the bottom to the top. Certain actions relative to sending false tele-commands are repeated more times (100 times every 5 second in this case). Repeating more time these actions the attacker try to find the right command ID of a certain tele-command.

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[3] A Control Center is the place in which the electrical network operators could monitor the status of the network, receive alarms and send remote commands from/to the peripheral electrical devices (breakers, transformer, generators etc)

[4] Remote Terminal Units are computerized devices acting as data monitoring front-ends of the Control Centers, normally located inside the electrical sub-stations and connected to Control Centers with a Wide Area Network.

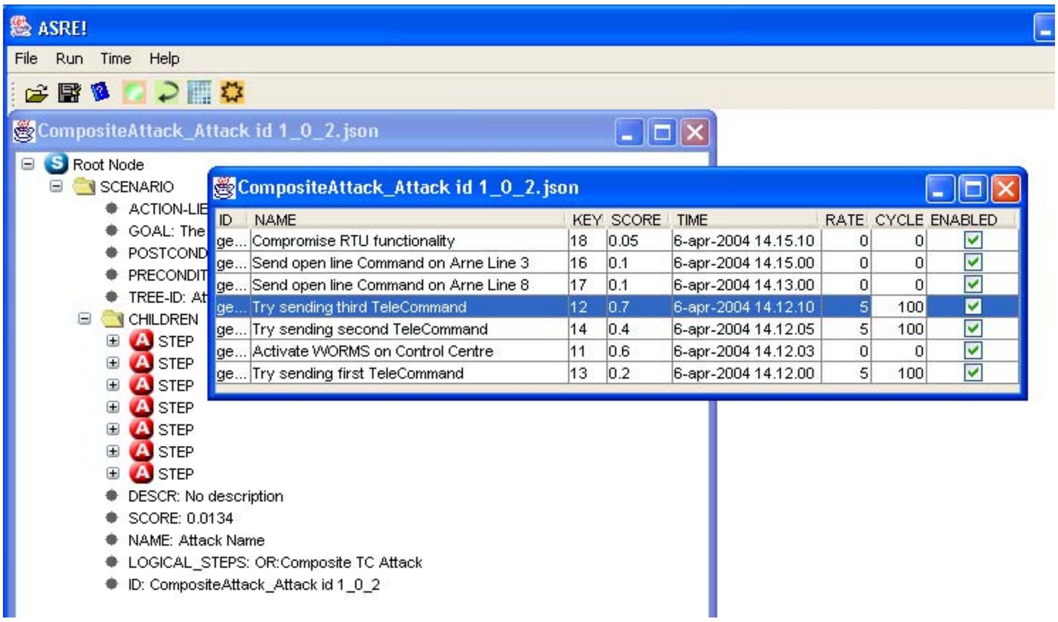

Fig 8 – The ATP interface to run false command attack scenarios

If a true command ID is found, it may be possible also to generate commands able to disconnect electrical lines, load shedding, change transformer tap positions ect.

Conclusions

Using ATP many different attack scenarios was configured and executed inside the Safeguard test bed. In particular the following scenarios was tested:

- False command scenario inside an electrical network
- Loss commands scenario inside and electrical network
- Perturbations inside SCADA communication packets
- Worms generation inside electrical Control Centres
- Data corruptions scenario inside electrical Data Base
- Malicious scan of Tele-communication packets
- Various types of buffer overflow attacks

More attack trees was configured including or a single type of the previous attacks or more than one, generating in such way a “composite” type of attacks.

Test was executed on the emulated SCADA environment to analyse the anomaly detection capability of the Safeguard agents.

All the most important functionalities of ATP are tested and the results suggest the introduction of some additional improvements. For example, it seem useful the introduction of a new type of actions like the “manual executed actions”. These actions will be used to wait the execution of manual action by the attacker. This allows to suspend temporary the attack sequence if it is necessary to wait for the execution of a manual activity (login into a server, browsing a data base, searching etc.) whose duration cannot be “a priori” determined.
Despite these new needed capabilities, the Attack Tool Platform is already now a useful software platform that support definition and archiving in a formal way knowledge and expertise about attacks and malicious activity.

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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.

Giordano Vicoli from 1988 to 1992 took part in research projects in the field of design and development of expert systems for diagnosis and control of industrial plants. From 1993 he has been working in the field of design and development of decision support systems and training applied in emergency management of high risk industrial plants. His interests was in the development of distributed application with J2EE and CORBA technologies. He works at the SAFEGUARD project work-packages developing the emulated SCADA test environment and furnishing the expertise necessary to formalize the attack scenarios. He is actually team leader in IRRIIS (Integrated Risk Reduction of Information-based Infrastructure Systems) FP6 project.

A STEP FORWARD IN THE MODERN EUROPEAN CRISIS MANAGEMENT SUPPORT [1]

Martin Endig [2]
Fraunhofer Institute for Factory Operation and Automation[3]

Jaroslav Pejcoch [2]
T-SOFT - Top Solutions for Tomorrow s.r.o.[4]

Abstract

Due to the complexity of the current living environment of the western world one of the top priorities in the European countries is the protection of the critical infrastructures considering an advancing the field of crisis management. The main concern when responding to a crisis is how to facilitate the integration of information from various sources through different media in a meaningful practical way. This challenge has been considered in the European project "*Management Decision Support for Critical Infrastructure*" (MEDSI) which finished at the end of October 2005. The main objective of this project was the development of a first step in a new European crisis management support considering the information aspects. This paper focuses on a summary of the MEDSI project considering mainly the project results based on specified user scenarios. In special, the different research areas like interoperable geographical information services from the crisis management perspective, ontology as well as symbology for crisis management will be presented.

Introduction

Nowadays accessing existing, up-to-date information is one important precondition for a modern decision support for critical infrastructure. This requires a new approach considering modern available IT technologies as one essential basis. Against the European background one step forward in a modern European crisis management support has been considered in the frame of a STREP European Research & Development Project called "Management Decision Support for Critical Infrastructure" (MEDSI) which was finalized by a consortium of 11 partners from 8 countries at the end of October 2005. The main objective of this project was the development of a web-based integrated set of software services used as a tool for enhancing the capabilities of crisis planners or/and managers from the IT technology side. MEDSI enables to utilize various existing information sources for better monitoring and reduction of potential and current risks and for more effective response in case of threats imposed espe-

[1] This works is co-funded by the European Commission in the MEDSI project IST-2002-506991.

[2] Martin Endig and Jaroslav Pejcoch are members of the MEDSI consortium. Various authors from this consortium contributed to this paper. For a description of the MEDSI consortium and further information to the project refer to www.medsi.org.

[3] Director Prof. Michael Schenk, Sandtorstrasse 22, D-39106 Magdeburg, Germany, E-mail: martin.endig@iff.fraunhofer.de

[4] Novodvorská 1010/ 14, CZ-14201 Praha 4-Lhotka, Czech Republic, E-mail: pejcoch@tsoft.cz

cially to the subjects of the critical infrastructure. For it, a data fusion of geospace, organizational and other territorial and operational area is realized in a standardized IT environment. The standardization and openness brings the possibility to further grow this seed in national and international levels and to assure the interoperability with other systems. The resulting system environment should be used by users from general security areas as well as environmental protection, utilities management, airports and seaports, healthcare, transports, roads, energy plants, borders control etc. MEDSI considered only the first step in the right direction against the European background. The focus of this paper is the presentation of the general MEDSI approach, architecture and various selected research areas based on different specified user scenarios.

MEDSI Approach

The underlying objective of MEDSI is to make the process of crisis management more efficient, in an innovative framework, in order to give an effective answer to a crisis and reduce the likelihood of damage to people and critical infrastructures. From the specified real user scenarios, it is known that most of these processes are done by hand. MEDSI has innovated through the basis of a system oriented to solve the stated problems that are detailed in the scenarios, that is, a system that helps crisis managers take decisions for the solution of crisis situations.

Since there are many different scenarios in which this kind of systems are applicable, the system should be flexible enough to adapt to every situation, especially from the point of view of the acquisition of local data (information, maps, etc.) and the customisation of the standard procedures.

Besides, the granularity of crisis centres and their jurisdiction is varied, and so do their interdependencies, and as a result MEDSI envisages a deployment based on independent cells, adaptable to any organization. It is able to work in different situations at different geographical places with only changes in the data sets of the organizations and their jurisdictions. The communication among *MEDSI cells* and the fostering of interoperability with non MEDSI systems are other important objectives. Therefore, MEDSI is conceived as an organized structure (likely hierarchical) of interconnected cells, in which the usage and fostering of standards will assure the interoperability between cells and with external systems.

On the other hand, the current technologies provide higher levels of interoperability between loosely coupled systems and platforms. One of these technologies is Web Services and MEDSI uses these technologies to tackle different aspects of a crisis management system, in order to assess its feasibility. It enables to cover both geographic and non-geographic information exchange.

Regarding the functionality of such a system, it should include the whole lifecycle of the crisis management processes. Mainly, it should cover the risk assessment, the identification of information needs, the collection of data, the analysis of all the available information, the planning of responses, the dissemination of information to action forces and media, the response action monitoring etc. This functionality is clearly explained in the defined use cases. In order to assure that it will be possible to cover both current and future needs, the system envisaged a layered component-based architecture.

One of the MEDSI project objectives is to find a new way of supporting decisions in the area of crisis management against the European or international background. As a result of this challenge a general approach considering two main aspects is required:

- In each country different command or organisation structures exist to deal with crisis situations. These structure varieties must be accepted in a possible future solution meaning the concrete solution must be integrated in the existing local social, organizational and system environments.

- The whole system must be shown as a network of crisis management solutions. In this network information and decisions must be exchanged. As a result, not only a local solution is required but also a wider concept for the international emergency management.

To deal with these challenges in the scope of MEDSI it was required to introduce a flexible approach. For that it has been introduced the idea of *MEDSI cell* and *network*. The *MEDSI cell* is the concept for supporting the local decision maker in the crisis management, and the *MEDSI network* is the concept for the interoperability of MEDSI cells against the national and international emergency management support. This concept can be defined in detail as follows:

- A MEDSI Cell is a specific implementation/instance of a MEDSI system and consists of the system functionality and specific data and data sources covering a certain geographical area (usually corresponding to the jurisdiction of a specific crisis management organization).
- A MEDSI cell communicates with other MEDSI cells (according to the hierarchical structure of the crisis management organizations)
- A MEDSI cell communicates with the existing systems used by the crisis management organizations and providers of data on critical infrastructures. These information providers may be shared by several cells from the same or different hierarchical level, in case of territorial overlap, general information providers (i.e.: maps providers) or common resources.
- A MEDSI cell is an autonomous entity. This means it is able to work independently irrespective of whether it is connected to others cells; i.e. each MEDSI cell has capacity to support decisions in crisis situations within its pre-defined area.
- A MEDSI cell is not a new/different organization or organizational structure for dealing with crises.
- The MEDSI network is a number of MEDSI cells that basically follow the existing hierarchical structure/network of crisis management organizations.

Based on these considerations the MEDSI project can be arranged on the cell level as first step in the modern European crisis management support.

MEDSI Cell Architecture

The general system architecture for a MEDSI cell is shown in figure 1. The MEDSI system is composed on of nine different system components with following objectives:

- *Administration*: This component provides all required functions for the management of user, user groups, and privileges for the groups and the logging of user interactions.
- *Planning*: This component provides functions for the dynamic content of plans meaning provision of content to this point in time, when the plan is needed.
- *Reports*: This component focuses on the creation of specific report types in order to gather the Analysis, the Planning and the Symbology needs.
- *Symbology*: One of the main concerns of Geographical Information Systems is how to facilitate the integration of information from various sources through different media in a meaningful way. Here, the crucial task is how to obtain timely and accurate geospatial information to quickly visualize and understand the context of emergency situations. This component provides all required functions for it.

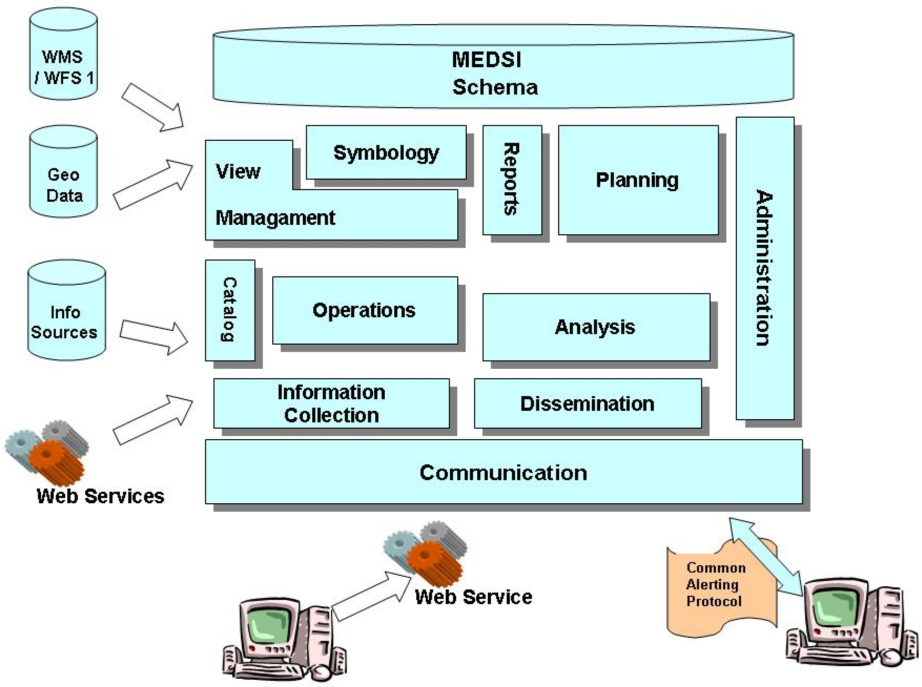

Figure1: Architecture Overview Diagram of a MEDSI Cell

- *View Management*: The immediate access and use of geospatial information and applications are essential for effective management of all types of critical infrastructure systems. The ability to rapidly share and apply geospatial information is important because emergency and disaster management in these domains require cooperation among a broad range of organizations operating across many jurisdictions providing by this component.
- *Operation*: This component includes functionalities which enables the crisis management in real time.
- *Analysis and SOP*: The key innovation lies in the definition of the common crisis management ontology, which enables procedural interoperability of various regional, national and international agencies, private subjects etc. in favour to share the "Common operation picture" of the situation. Based on this ontology, the large-scale co-ordination of the crisis management activities is facilitated. This component provides all required functions for its.
- *Dissemination*: This component provides a message oriented middleware that is used to enable message exchange between users in a MEDSI Cell, among MEDSI Cells, between MEDSI cells and other systems.
- *Information Collection*: This component provides all required functions for interoperability among European data sources for crisis management based on the standardization of the acquisition of data from heterogeneous sources through web technologies.

In the frame of the project all components has been implemented prototypically and integrated in a useful way as validation of MEDSI concepts and ideas in a running prototype.

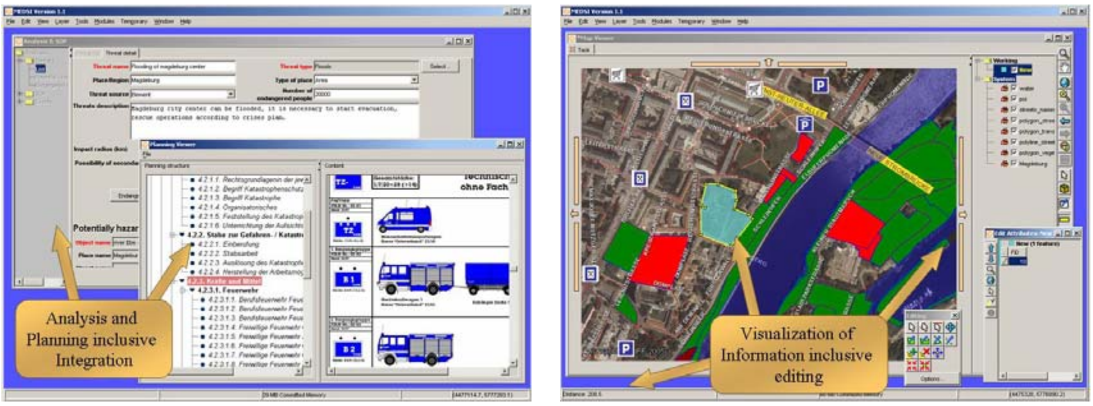

Figure2: Selected Screenshots from the MEDSI Prototype Instance for the Magdeburg Scenario

User Scenarios

Defining all user requirements is a mandatory first step in the process of developing a new approach in the European crisis management within the framework of the MEDSI project. For this purpose two different specific user scenarios in Holon (Israel) and Magdeburg (Germany) were specified. Two different crisis situations are considered in these scenarios:

- flooding along the river Elbe and
- a chemical fire event in city Holon.

Both scenarios are based on reality and consider past events. The scenarios served as the basis for the specification of all user requirements. The main objective of these scenarios was to provide a clear idea about the basic requirements of crisis management, being in this way an important precondition in the process of MEDSI system requirements definition. To reach this goal, the following aspects were considered in the user scenario specification:

- Specification of two main crisis scenarios
- Specification of a domain model, identifying entities, organisations, environments, and events that play a significant role during the crisis management process
- Specification of a general process for crisis management which should be considered in the MEDSI system
- Specification of actors that participate in the crisis management
- Specification of a set of high level generalized uses cases showing the basic activities in the crisis management process, in order to derive all relevant components and processes
- Specification of selected required non-functional requirements for the proper operation of the system

All these tasks contributed to the specification and development of a system that considers the real user requirements in the area of crisis management.

Innovation Areas

For the provision of an innovative framework for a step forward in the modern European crisis management support, the following selected innovation areas were considered in the frame of MEDSI project:

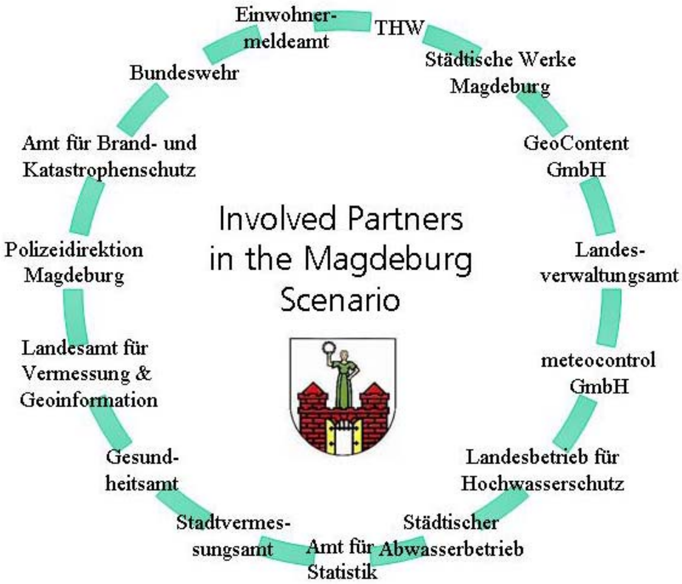

Figure3: Overview about the involved local Partners in the Magdeburg Scenario

- *Innovation in Data base schema*: As part of its research effort, MEDSI comes up with a definition of a generic database model that covers the needs of crisis management agencies in terms of providing the needed information. Starting from domain model (conceptual schema generally expressed in terms of entities and relationships) it was created the logical model with its entities and descriptive attributes and finally it is obtained a data model, specifying the data structures in the database which will be used by several application components. MEDSI works in heterogeneous information environment of distributed geographical information and not geographical information sources, which means not only need for using common ways of accessing data (e.g. WFS, WMS, XDI), but we face also the problem of maintaining coherent contents/semantic metadata descriptions through mechanisms such as ontology's.
- *Innovation in Architecture*: In the emergency management area a lot of different heterogeneous information sources exit which are required for supporting the decision making process. For latter, special generalized components are needed, like for analysing or planning. Furthermore, in each European country different preconditions exist considering the available information sources. In fact, for the realization of MEDSI approach, a more general approach is needed. For the technological side the Web-Service based architecture promises one possible solution. As a result, the architecture of MEDSI is a three tiers architecture based on a web service approach for accessing heterogeneous information sources and existing software component providing special functions like analysis or simulation functions, in general. For accessing information and functions a Catalogue Service based on ontology approach was developed inside the architecture.
- *Innovation in Symbology*: Symbols, built from basic icons, will be augmented with dynamic information. For example, a hospital can publish the number of free beds, and this information can be incorporated in the symbol representing the hospital. Research outcome in MEDSI is a proof of concept implementation of the framework for displaying of dynamic attributes. Use of web services to provide values of symbol attributes. The values of the dynamic symbol attributes will be received by the MEDSI system via web services, thus establishing a standardised and technologically up-to-date way for various entities (e.g. hospitals) to provide additional information. Research outcome of MEDSI is a proof of concept implementation of acquiring the values of symbol attributes via web services. Use of the SLD standard for conveying symbol information. Styled Layer Descriptor (SLD) is a language, defined by OGC, which can be used to customize the output of WMS and WFS on the client side. Instead of information about

the symbol in internal format, the symbology package will build an SLD file, which will be placed as a parameter in the WMS request.

- *Innovation in Geographical Information System*: Enabling Collaboration over a distributed and interoperable GI Framework has been made available to MEDSI in a framework capable of accessing Geographic Information in an interoperable fashion over a distributed environment (the Internet). For that, an OpenSource client (JUMP) has been abstracted, merged with MEDSI framework and extended to support specific functionalities of other business specific modules. Aside from this, other geographical information specific functionalities have been created or improved because of their importance in providing a proof of concept of the system applicability. Examples are improved GML support and development of WFS support. As a result, MEDSI is now able to have distributed access to interoperable geographic data sources in two types of standard requests:
    - Web Map Service (WMS) for portrayal services (maps rendered as images)
    - Web Feature Service (WFS) for querying GI data

  Available geographic data sources (WMS or WFS) are found by means of a catalogue service also put in place. Because of the increasing complexity of MEDSI prototype, and in order to improve integration while maintaining low coupling between modules, it has been developed a plug-in mechanism for module integration based on reflection.
- *Innovation in interoperability of data sources*: One of the key issues of innovation for interoperability among European data sources for crisis management is the standardization of the acquisition of data from heterogeneous sources through web technologies. In order to assure the compatibility between crisis management systems and sources of information, it is basic to provide the proper mechanisms to exchange data based on a common ontology. The basic technology to implement this functionality for non geo-spatial data through the web is Web Services. However, this is a technology focused on remote invocation of methods, and not on data exchange, and it does not cover basic needs for distributed data sharing: data transactions, caching and synchronization, security policies, etc. On the other hand, it does not provide an abstract mechanism to locate data resources and data types. These needs are common to different domains, and the OASIS consortium, has launched an initiative to solve this problems through web services: the initiatives XRI (eXtensible Resource Identifier) and XDI (XRI Data Interchange). The objective of XDI is to enable data from any data source to be identified, exchanged, linked and synchronized into a machine-readable dataweb using XML documents and XRI, a URI-compatible abstract identifier scheme. MEDSI will prove this emerging technology before its final specification and will provide feedback from the crisis management domain. By the end of the project, MEDSI will be able to make a technical recommendation about the usage of XRI/XDI for critical infrastructures protection.
- *Innovation in interoperability*: In the current situation, there are lots of separate systems working on their specialized domain, like crisis information systems, public warning systems, modelling and simulation tools. One of the biggest problems is: the systems are not able to operate with each other and act as a single body. The most feasible way to make these separate systems interoperable is through message oriented middleware and a set of standardized messages specifically developed for this purpose. It has been developed the message oriented middleware that is used to enable message exchange between MEDSI Cells; between MEDSI cells and other systems. This middleware processes messages that make use of data structures developed specifically for MEDSI and the Common Alerting Protocol (CAP). CAP is a standard data interchange format being worked on by Organization for the Advancement of Structured Information Standards (OASIS) consisting of XML messages. Main purpose of CAP is to enable exchange of warnings, alerts, reports and information between parties in this domain. This standard is in the development stage and the OASIS community announced that they are expecting feedback from projects using this message set. The feedback will be used in shaping the next releases of CAP Standard. It has been adopted and being used by

organizations such as International Telecommunication Union of United Nations, Department of Homeland Security of United States. The consortium has already identified several shortcomings of CAP. It has been implemented other messages to exchange information between components among MEDSI Cells for sending attachments. Besides these, based on the results of the next analysis stage the consortium will also implement new messages that are needed for exchange of information among MEDSI Cells. In order to prove interoperability between other modelling tools and MEDSI. Using the modelling tool it will be developed a message structure that will enable information exchange between the modelling tool and MEDSI.

- *Innovation in Ontology*: The key innovation lies in the definition of the common crisis management ontology, which enables procedural interoperability of various regional, national and international agencies, private subjects etc. in favour to share the "Common operation picture" of the situation. Based on this ontology, the large-scale coordination of the crisis management activities is facilitated. The current situation shows the heterogeneous and distributed important information resources, which make the effective collaboration very difficult, both in the crisis planning and the response. The common ontology, linked to the proposed standards of Symbology and messaging, will increase the possibility to view and understand the situation, have a better control upon the resources and be fast and more accurate in the decisions. This will happen not only at the regional level, but will bring the possibility for better co-operation at the multinational scene, as the critical infrastructure is interlinked across the borders and the same behaves the crisis situations. The ontology and its manifestation in the proposals to the standardisation bodies would be a new tool to support the European activities in the critical infrastructure protection and will enable the nations to co-operate more effectively.

Conclusion

In this paper a new approach to handling the complexity of the living environment of the western world has been presented as one step forward in the modern European crisis management support. This approach was developed in a European project which finished at the end of October 2005. The general outcome of this project was development based on defined real user scenarios resulting in the MEDSI cell and network concept as one of the main project output. Latter they can be used in Europe as basis to consider the different preconditions in all European countries. To solve the technological problems on the cell level the application of existing IT technologies is possible although extensions of several technologies are required in order to deal with special user requirements in the crisis management area. The MEDSI project contributed especially on this level. Further, MEDSI could only make a first step in the right direction. Further research tasks depend on the achieved results and the clarification of different political questions will also be required in the future aiming to create the political preconditions for an overlapping European crisis management.

Acknowledgments

This work is based on the joint effort of the partners of the MEDSI consortium. Various authors from the MEDSI consortium contributed to this paper. The MEDSI project and consortium is described at http://www.medsi.org.

SECURITY OF NON-CONVENTION SHIPS AND NAUTICAL TOURISM PORTS

Josip Kasum, Sc. D[1], Eli Marušić, M.S.[2]
Faculty of Maritime Studies

Zvonko Gržetić, Sc. D.[3]
Hydrographic Institute of the Republic of Croatia

Keywords: Convention ships, Non-Convention ships, Security, Safety

Abstract

According to the Convention about Safety of Life at Sea – SOLAS [5], ships may be classified in two categories:

- Convention ships, and
- Non-Convention ships.

Convention ships are ships which have been determined by the SOLAS Convention. Security of these ships has been stipulated by the *International Ship and Port Facility Security Code – ISPS Code* [5]. The Code refers to the security of national merchant ships and ports open to international travel, obligations of government authorities, companies, port authorities and concessionaires in special purpose ports, and other physical and legal persons responsible for the security, measures for providing security of ships and ports, control of the implemented measures, and sea violations [1].

Non-Convention ships are all other ships, like fishing boats, warships, sports and recreational boats, etc. For such ships and also for nautical tourism ports there are no systematic and generally accepted international regulations regarding security or they are inadequate. It has to be noted, though, that the number of non-Convention ships, especially recreational boats in nautical tourism ports, is constantly increasing. Consequently, the density of the traffic is also increasing in countries with strong nautical tourism [2].

In this paper the authors studied the risks of non-Convention ships and nautical tourism ports. Further scientific investigation has been proposed, as well as possible solutions for security protection of non-Convention ships and nautical tourism ports [3].

Introduction

At the present level of technological development ISPS code provides a certain level of security protection of Convention ships. Despite the detailed legal regulations and their application, there is still a risk of any form of distress for Convention ships.

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[1] Assistant Professor
[2] Lecturer
[3] Director

For non-Convention ships the situation is worrying. It is necessary to point out that, despite their number and continuous increase, adequate, sufficient, comprehensive and obligatory legal regulations do not exist yet, nor the standardised practice in protection from various risks. In this paper the authors inform about the risks concerning security of non-Convention ships. [4]. It is assumed to be possible to develop and offer to international community the proposal about organised security protection of non-Convention ships. Also, the authors propose the possible method of development of organised security protection.

The authors propose the working title of the code of security for non-Convention ships and nautical tourism ports: (*International Non-Convention Ship and Nautical Tourism Port Facility Security Code – InSNTPS Code*).

Theory and Method

ISPS rules are applied to new and existing ships in international voyages, and refer to:

- Passenger ships,
- Fast passenger vessels,
- Cargo ships and fast vessels of 500 GT and above,
- Movable drilling objects, and
- Passenger ships in national navigation to the distances over 20 NM from the land or distant islands.

The rules are not applied to war ships, military and other ships owned or managed by a country, which signed the SOLAS Convention referring to security.

The basic definitions of International security code refer to:

- Estimation of the security of the ship,
- Plan of the security of the ship,
- Security system,
- Security officer of the ship,
- Security officer of the company,
- Incident relating to security,
- Level of security,
- Errors,
- Verifications,
- Recognised organisation for security,
- System of alarms,
- Automatic system for identification,
- Permanent summarised record,
- Company
- Confrontation ship/port,
- Port,
- Activity ship/ship,
- Responsible body,
- Declaration about security, and
- Administration.

It is evident that the rules refer to the essential elements:

- Ship,
- Company,
- Port, and
- Other supporting elements (interactions, rules, etc.).

It is assumed that the above declaration as method is comprehensive, and, at the present level of technical and technological development, it is utterly reliable and applicable.

Results

Non-Convention ships are mostly used at sea, but also at rivers and lakes. In the development of the security system, besides sea-going ships, ships at rivers and lakes have to be taken into consideration.

The whole group participates in potential safety risks. When estimating risks the starting point may be the basic information about comparing the number of non-Convention ships in countries with strong nautical tourism with the number of Convention ships of the same country [8] (Table 1.).

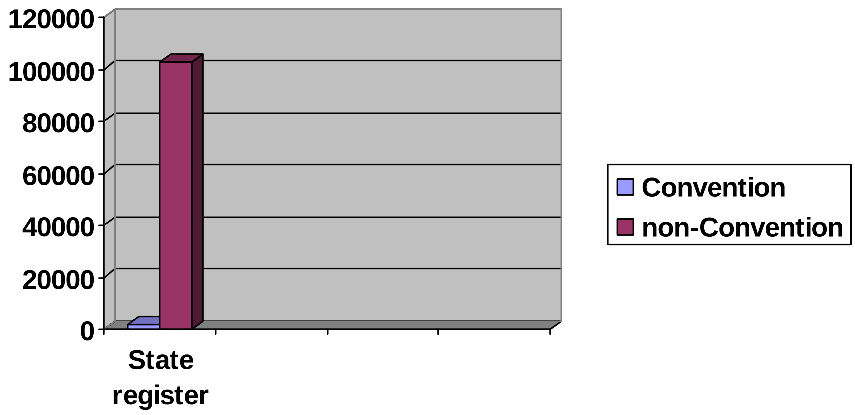

Table 1 Comparison of the number of Convention and non-Convention ships in the Croatian Register of Shipping in 2006

Source: www.mppv.hr, Public debate about measures for improving the status of Croatian mariners, Mali Lošinj, 1st March 2006

It is assumed that in most cases the number of non-Convention ships in relation to Convention ships is higher or increasing. The risks are various and predictable. Some examples of risks are:

- Terrorist attack,
- Environment pollution,
- Biological pollution, and,
- Human trafficking, illegal trade etc.

It is evident that a relatively big group of non-Convention ships is in the area for which there is no suited form of ISPS code.

Therefore the appropriate security code for non-Convention ships and nautical tourism ports has to be developed: (*International Non-Convention Ship and Nautical Tourism Port Facility Security Code – InSNTPS Code*).

Discussion

When creating the InSNTPS code for non-Convention ships it is proposed to start from the basic elements (levels one to four):

1) non-convention ship,
2) organisation,
3) nautical tourism port, and
4) other supporting elements.

The first level refers to non-Convention ships. It is proposed to analyse recreational boats, fishing and other ships. It is assumed that military and police ships are adequately protected by the corresponding legal regulations. Recreational and fishing ships in various countries are steered by individuals with various unequal and non-standardised skills and licences. Differences are in acquired skills, authority and formal licences. Therefore, it is proposed to standardise at international level officer's qualifications, education programme and official form of various licences. Special education programmes relating to security need to be developed and implemented in the existing programmes for obtaining licences.

At the second level organisation forms need to be recognised or developed. Non-Convention ships, except fishing boats, mostly refer to recreational boats. The characteristic of these ships is individual, i.e. free or personal engagement of owners or users in navigation and other procedures relating to ships. Therefore any form of organising them is, to put it mildly, undesirable. However, this category of ships may be classified in various forms of organisations. Organisation is a from of trade, sports or similar association, for instance, charter agency, user of the ship, owner of the ship, sports club, diving club, etc. It is proposed to develop programmes of organised educational courses and issuing permits relating security.

The third level relates to the proposed general term, nautical tourism port. It is assumed that such a port is an organised coastal infrastructure for organised berthing and guarding of ships. Nautical tourism port needs to be considered as the basic element of coastal part for which appropriate security procedures and permits have to be developed.

The fourth level includes other ancillary supporting which are expected to be partially included in the model. These are port authorities, information and flows of information [7], various verification procedures, etc. [8]. In some countries, for instance in the Republic of Croatia, there are organised voluntary guards of non-Convention recreational boats [9]. They have to be appropriately included in the system. It is certain that adequate area needs to be discussed and co-ordinated at international level. Therefore, it is proposed that the development of the security system of non-Convention ships is implemented through an international organisation, like *United Nations-UN* or *International Maritime Organization-IMO*.

The procedure of creating appropriate security system of non-Convention ships is very complex and comprehensive. Therefore it is proposed to develop an outline of the security system of non-Convention ships according to the proposed algorithm (Figure 1). Complex dynamic systems, to which the security of non-Convention ships may be categorised, is not easily developed and structured without suitable programme support. The method of dynamic modelling may be functional in understanding behaviour of dynamic systems. Therefore, after developing the model it needs to be dynamically modelled and future effects need to be simulated.

Figure 1 General algorithm of the development of InSNTPS

Conclusion

In general, ships navigating world seas, rivers and lakes may be divided to Convention and non-Convention ships. The world community developed a system of rules ISPS code for the security of Convention ships and ports.

Non-Convention ships may be found in all world seas, rivers and lakes. They use nautical tourism ports. In this paper the authors notify about the existing and realistic risk to the security on non-Convention ships and nautical tourism ports, and about the lack of uniformity of the necessary licences at the world level.

The proposal is to develop a unique data base about collisions of Convention ships with non-Convention ships.

It is also proposed, according to the general algorithm, to develop at an international organisation level the security system of non-Convention ships. The development of such system should start from the proposed basic elements, and should apply methods of general system theory and dynamic modelling.

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Study Of Effective Factors in Performance Of Urban Transportation Network During Emergency Condition

Givehchi S[1], Mehrdadi N[2], Nazariha M[3],
Baghvand A[4], Saffarzadeh M[5], Ardestani M[6]

Keywords: Disaster, Emergency condition, performance, Transportation network

Abstract

Urban network transportation can have an important role in natural disaster management. This role can be influenced by three parameters such as: specification of disasters, specification of network and environmental conditions. Each of three characteristics can have special impact in improving or decline of management during emergency condition. The problem appears when demand of using increases while probably transportation network is damaged or influenced by incorrect human behavior, which arises from disaster or its result.

This research is trying to identify the most important factors that impact on the above mentioned parameters (1) to classify damages on the urban network by disasters (2) to study methods of combination these parameters for increasing the capacity of urban transportation network and improving performance in emergency conditions. Therefore part of Tehran transportation network will be studied to recognized portion of these parameters and its factors in emergency management after an unusual condition.

Introduction

Recent earthquakes have presented us important lesson of the role of transportation network in managing critical condition. After Bam earthquake (2003) and Kerman region earthquake in Iran, The role of accessibility of transportation network was considered more than before. Study of the transportation network should perform in two topics, one the urban transportation and second roads. (1)

In this research we studied the role of optimum performance of urban transportation network in modifying emergency management. However two components of network (urban and road transportation) have complementary role in transportation service presentation. (2) In Bam earthquake In Kerman region In Iran because of the form of urban and structural specifies of it, function of road transportation was more important than urban transportation. Hours after disaster in this region the original route of Bam was closed because of crowd travelers who wanted to enter the damage city. (3) This traffic flow did not permit to other travelers who wanted to leave the city and the road performance of network was stopped hours after

[1] Graduate student of natural disaster management – Tehran University Iran
[2] Associate professor faculty of environment - Tehran University Iran
[3] Assistant professor faculty of natural disaster management –Tehran University Iran
[4] Assistant professor faculty of natural disaster management –Tehran University Iran
[5] Associate professor faculty of Transportation – Tarbiat Modaress University Iran
Email address: Saeed_givehchi@yahoo.com
[6] Assistant professor faculty of natural disaster management –Tehran University Iran

disaster. The cause of this condition was not physical damage of earthquake but these conditions occurred because of at least two factors that have not physical origin. (4) Most of studies that did until now have concentrated on physical condition and factors but physical factor of transportation network is one of parameter that can be impact on managing transportation network in emergency condition. (5) In Bam earthquake two important factors which impact on road emergency rescue and relief were crowed flow of travelers who wanted enter the city and using the opposite line of road. This problem led to two consequences:

One – in spite of the fact that urban network had an agreeable performance the total function of earth network was unarguable.

Two - formation long line of vehicle, which blocked the road. This problem led to formation blocking condition in route.

Material And Methods

The objectives of this research are:

1) To classify damages on urban network transportation

2) To study the methods of combination three parameters, Specification of disasters, specification of network and environmental condition to identify manners for reinforcement of emergency response. After an unusual conditions - unusual condition describe on under status:

1) Catastrophic disaster, which impact on all lifelines of cities such as earthquake or flood. After an earthquake collection of reasons may cause on urban transportation network these reasons classify into two groups that are physical reasons and social parameters. (6)

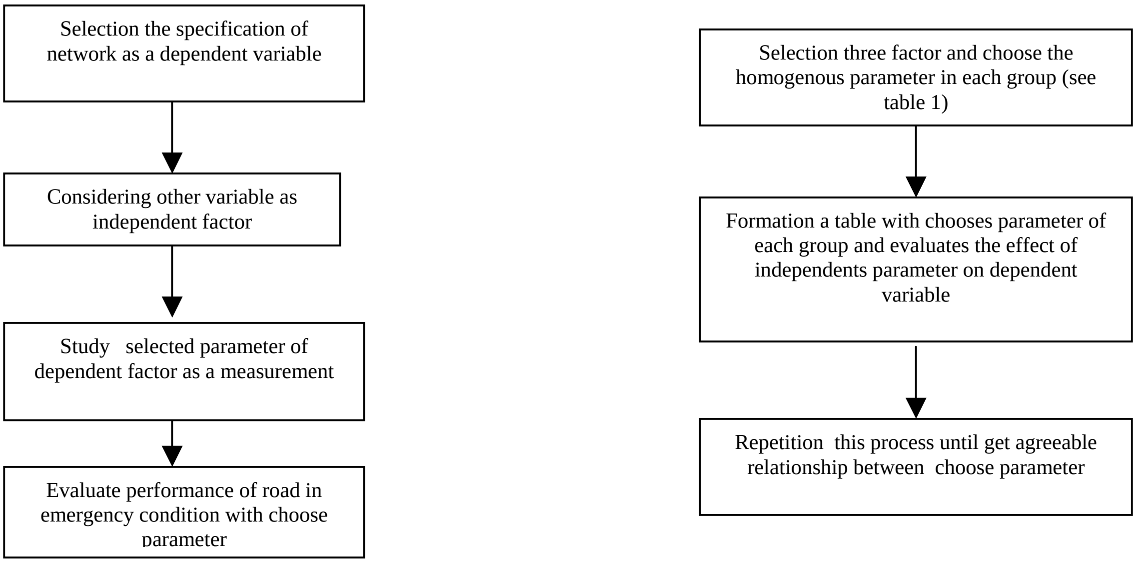
2) Unusual conditions that result from an unexpected factor, which can influence on regulation travel in the network such as car accident. This branch of unusual conditions is more commonly compare of one group and have slight impact on traffic flow. Because of repetition of this group of unusual condition we can study on them and extend our research on the other unusual conditions. (7)

Researches have been until now were concentrated on physical specification of transportation network and have tried to explain the performance of network by physical measurements. (8) These indexes or measurements can measure the performance of transportation network by means of physical characteristics of road such as accessibility, open length of route, time of travel and other parameters. The result of using these measures concludes to inexact evaluation of performance of transportation network.

Zone of study was part of east section of transportation in Tehran city. This part of transportation network was studied by analyzing in two manners:

First: by using two suitable scenarios, which based on defined environmental conditions and distinguish kind of disaster, in this approach concentrated on second factors (Specification of network) the result of this part of study illustrated in figure 1 -a.

Second: with considering three factors and by method of changing one of them, analyzed the impact of varying one of them in value of others. The result of this approach illustrated in figure 1-b.



a b

Figure 1- Method of execution of two approaches of analyzing performance of transportation network.

Collection of Factors	Parameters in each groups of factors
Specification of disaster	1. Kind of disasters (earthquake, flood, fire , accident,…) 2. Intensity of each disasters (this parameter can describe quantities or qualities) 3. Time of happening 4. Location of occurrence
Specification of network	1. kind of road (urban route or road) 2. Class of road 3. Geometrical specific of road (length, width, slope, hazardous locations)
Environmental conditions	1. Parameters that return to structure around road such as (height of structure around road, age of structure, limit of road and method of land use around route 2. Human behavior after disaster 3. Distribution of SOS in space 4. Geological condition (existence of fault, …)

Table 1- Collection of three groups of factors and sample parameters in each groups.

Collection of factor	Selected parameter for evaluation group one	Selected parameter for evaluation group two
Specification of disaster	Intensity of earthquake (M)	Date of happened (C_X) Class 1of time (00-06) Class 2 of time (06-12) Class 3 of time (12-18) Class 4 of time (18-00)
Specification of network	Open width of urban road (W)	Number of cross sections (N)
Environmental conditions	Open distance between road and first structure around (L)	Portion height of highest structure with width of road (p)

Table 2- Selected parameter in each group of factors. (We choose the first column of parameter for study)

	M	W	L
M	1.00	-0.6 3	-0.43
W	-0.6 3	1.00	0.76
L	-0.43	0.76	1.00

Table 3- co relationship coefficient between three-selected parameter in three groups in one scenario of earthquake. (Scenario with better condition)

	M	W	L
M	1.00	-0.68	-0.45
W	-0.68	1.00	0.81
L	-0.45	0.81	1.00

Table 4- co relationship coefficient matrix between three selected parameter in each group in second scenario of earthquake.

Findings

The result of this research presented in tables 1 to 4.

Result And Discussion

In our research to distinction parameters that can control the performance of transportation network in emergency condition, developed three groups of parameters. Considered factors are:

1- Specification of disaster
2- Specification of network
3- Environmental conditions.

Last index can classify in second group of factors. Second group of factors most concentrated on planning of road.

Study of spesification of disasters

Most disasters such as earthquake, flood, faire, road accident, storms…can impact on transportation network. Mechanism of impression of each disaster will return into three parameters, the kind of disaster, and the intensity of it and other specific of disaster that indicate interaction between disaster and around environment. Such as the time of happen that impact on injuries and behavior of people in critical conditions. The last parameter will discuss about interference between environmental condition (which will be explain later) and two characteristics, which were mentioned above. Remembering the kind of disaster, probable disaster, which influences on transportation network is earthquake. Research showed that road system is vulnerable lifeline in essential equipment in urban areas. All part of transportation network is vulnerable again earthquake but urban rail transportation and road are more sensitive again earthquake. In zone of study (part of urban route of transportation network in Tehran) we described two scenario of earthquake disaster. One scenario presented better condition compression with second scenario. With considering this two scenario and simulation the second unusual condition (mentioned above) with data of table 1 the parameter intensity of earthquake choose as suitable parameter in collection of disaster and the coefficient of correlation ship of this parameter in two scenario is illustrated in table 3 and 4. These two scenarios were based on two critical conditions that may occur. One scenario is related the earthquake with magnitude under M= 6, and second scenario indicate occurrence earthquake with M value more than 6.

Study of specification of network

Transportation network divide to four essential manner of use, which are air transportation, road, rail and marine transportation systems. This research concentrated on urban transportation network consists of urban roads. Urban road can divide into two groups of routes, Avenue and street. The definition of each component relation with kind of using. In this research we assumed that the deference between two components is clear. Our study was emphasizing on second component (avenue) because of more than 70% of rescue and relief travel in Tehran should doing in this component of network. For evaluated the performance of the urban transportation network in parameter in second collection in table 1, the open width of road after unusual condition choose as suitable parameter that can be measured. In 20 samples of points this parameter is measured under two scenario of earthquake and the result of correlation factor of this parameter is showed in table 3 and 4.

Study of environmental conditions

In the zone of study environmental conditions were most important factor, which can influence in performance of transportation network. These factors commonly forget because of difficulty method to quantification of them. Environmental conditions are un homogenous parameters that can divide to:

1- humanistic parameter: behavior of human can study qualifiedly and quantitative but presentation a model for predicting human behavior is more difficult. This problem originates from the act that human behavior in unusual condition is commonly do not following a especial pattern. In this situation people show difference behavior that classifying of kind of this patterns is more difficult.

For example car accident in this situation is most probable because of in concentration of drivers. The result of happening these problem is violence the conditions. (9)

2- environmental physical parameter: these factors related to around environment. These parameters can describe in exceeded group of variable that originate from around a road. Common parameters are the height of building around the route. The coefficient of height of highest building to width of road and the other parameter that listed in table 1. We choose the minimum distance between first buildings from route as a essential parameter. This parameter can evaluate by basis of meter and showed it by index (L) in table 3 and 4 illustrated the co relationship coefficient.

In emergency condition the most important factor is the Time. Time have an important role in decreasing injuries of disaster but decreasing time of response related on difference parameters such as accessibility of transportation network. Without existence of safety transportation network most of trying is vain. In emergency condition accessibility into damaged region fulfillment serious task. Performance of transportation network in unusual condition can measured by means of opened length or opened width of the road. However by means of these instruments, measuring the work of network is possible but influence of environmental condition and type of each disaster can change all of predictions, which do by considering physical measurement. Attention to only physical condition for planning in critical condition may lead unexpected situation. High correlation coefficient between the free open width of road and magnitude of earthquake and (L) index demonstrate attention to three groups of factors in planning of transportation network in emergency condition.

Conclusion

The result of this research demonstrates that the co relationship coefficient between choosing parameter in each group of factor is acceptable. So dividing essential factor of performance of network into three groups of factor can help in simplicity of study performance of transportation network in unusual condition. This method helps us to select only one parameter in each group to study the impact of it in performance of network. This approach showed that environmental parameter that commonly forgot has an important role in physical factor and total in performance of network. The relationship between open widths of road after earthquake is most correlated into the environmental factor and type of disaster.

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Academic and Professional Practice

Peer Reviewed Articles

Business Continuity & Organisational Safety

The Role of Government to Support Private Sector's Pre-Disaster Activities in Korea: Natural Disaster Mitigation and Preparedness

Kum-Sook We, Youn-Hee Kim, Sung-Ye Hong, Eun-Kyoung Lee
Crisis Management Institute

Keywords: Government role, private sector, natural disaster preparation, disaster mitigation, business continuity plan

Abstract

This paper is a summary of National Emergency Management Agency (NEMA) funded project "A study on the survey of the mitigation and prepare activities for the private sectors and the suggestion to make a regulation" in 2005. NEMA is the central agency that deals with disaster mitigation, preparation, response and recovery activities in Korea. This paper discusses about the role of government to support emergency preparedness and business continuity against natural disasters for Korea's private sector. The survey was conducted to investigate the types of disasters that private sector have been facing in Korea. The 77 companies participated in this survey. The survey results indicate that private sector encounters natural disaster incidents in day-to-day business activities more frequently than any type of disasters. According to the survey, there are many supporting tools such as insurance programs and tax reduction premium for private sector's mitigation and preparedness activities in the area of man-made disasters. However, the results show that the current supporting tools for private sector's activities to ensure or minimize the private sector's loss during the natural disaster is very limited. This paper also covers the recent government's law and regulations to support the private sector's emergency preparedness and business continuity in Korea. In the light of government role to support the private sector's emergency preparedness, similar laws and regulations in the United States are investigated and summarized. The policies on disaster management steps: disaster preparedness, mitigation, were investigated and compared between the United States and Korea. The figure shows the difference focus on disaster management between Korean and US. Disaster management policies in Korea concentrated in post disaster activities. Unlike Korea, Disaster and emergency management policies in US focus on pre disaster activities including mitigation and preparedness. NFIP or other polices conducted by FEMA are good examples.
Finally, recommendations and suggestions have been made to the Korea Government. The research results have been applied to the process to legislate an act; the tentative title of the act is "Pre-disaster Mitigation Supporting Act for Business".

Introduction

Over the past years, natural disaster has especially been a great challenge to business. Whether the business is large or small, the consequences of natural disasters were severe enough to devastate daily business activities. Natural disasters such as flood, Typhoon, blizzard and drought often occur in Korea. The status of preparedness of natural disaster inadequate despite the fact natural disasters happens frequently in Korea. In addition, this paper also examines how to encourage private sector to prepare for natural disaster proactively so as to minimize loss.

In 2005, National Emergency Management Agency (NEMA) funded a project titled "A study on the survey of the mitigation and prepare activities for the private sectors and the suggestion to make regulation". NEMA is the central agency that deals with disaster mitigation, preparation, response and recovery activities in Korea. The objectives of this project are 1) to investigate the current natural disaster status and its damage 2) to understand current insurance law so as to compensate natural disaster damage and loss to business. 3) Compare the law and its supporting disaster stage 4) to make recommendation(s) on the formulation of policies, regulations that supports proactive preparedness and mitigation activities for private sector.

Research Method

The survey was conducted to investigate the types of disasters that private sector have been facing frequently in Korea. Two surveys were conducted with different focus group. First survey was targeted to large companies, which ranked within 100 companies in Korea. The second was targeted at small businesses, which were registered with small business bureau in Korea.

The questionnaire is designed to assess the current disaster management preparedness situation in private sector.

The first survey was conducted in July 2005. The target group was the companies that revenue-ranked within 100 large companies in Korea. Table 1 shows the number of target companies return ratio. The first survey included the multiplex commercial buildings and companies doing business in the field of emergency management. There are lots of multiplex commercial buildings in Korea and these are known to be vulnerable to disasters and hazards due to lack of preparedness. Therefore, it is essential that this research includes a broad range of multiplex commercial building so as to determine the current status of preparedness for natural disaster.

Table 1 Distribution and return from large companies

Target group	Initial distribution	Return ratio
100 ranked large business	97	54(55.7%)
Multiplex commercial buildings	37	16(43.2%)
Emergency management companies	47	8 (17%)

Table 2 shows the initial distribution and return ratio that distribute to small business in October, 2005. A large number being returned due to the wrong mailing address causes the low return ratio. In addition to that, small business are not familiar with the disaster preparedness and mitigation concept, hence, there is no replicable person to participate answering the questionnaire.

Table 2 Distribution and return from small business

Target group	Initial distribution	Return ratio
100 small business	200	23(11.5%)

Research Results

<u>Disaster type that private sector frequently experienced in Korea</u>

The most frequently faced disaster in daily business activities was asked in the questionnaire. Figure 1 and 2 shows the disaster type that first and second target group answered.

Figure 1 shows the result of the most frequently faced disaster in the first focus group which contained large companies and multiplex commercial buildings in private sector. As indicated, natural disaster such as hurricane and flood, were ranked as the first disaster type.

Natural disaster is also ranked at the first disaster type in second target group as shown in the figure 2.

The survey results indicate that private sector encounters natural disaster incidents in day-to-day business activities more frequently than any type of disasters. Although large corporations replied that they are recognized the importance of the readiness of disaster however, they do not have enough resources to prepare natural disaster sufficiently.

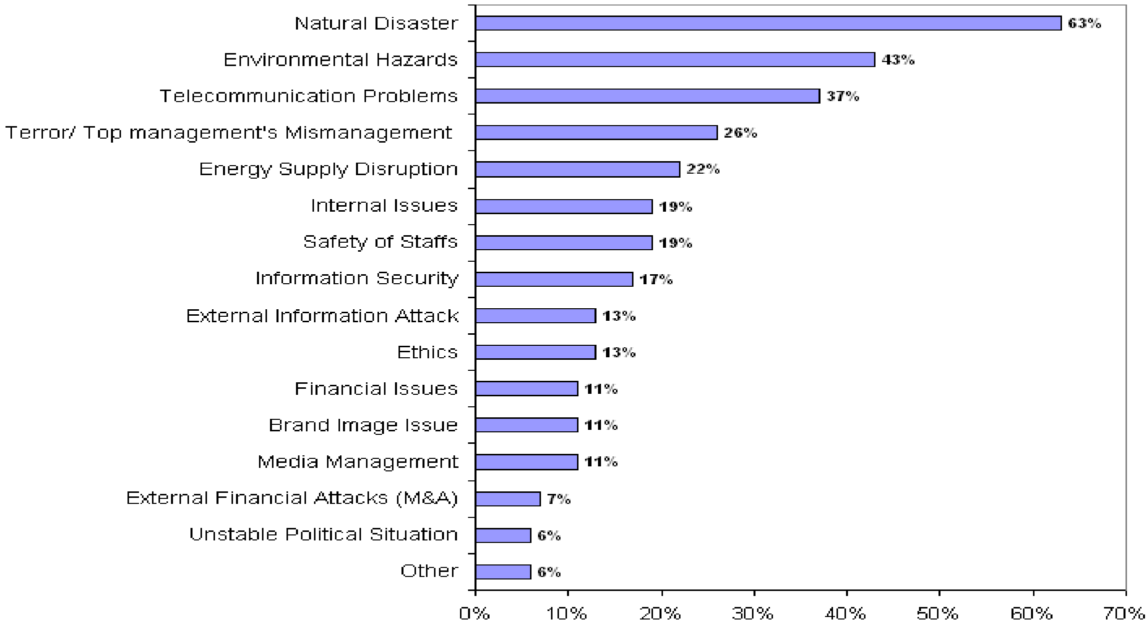

Figure 1 Type of Disaster for Large Business

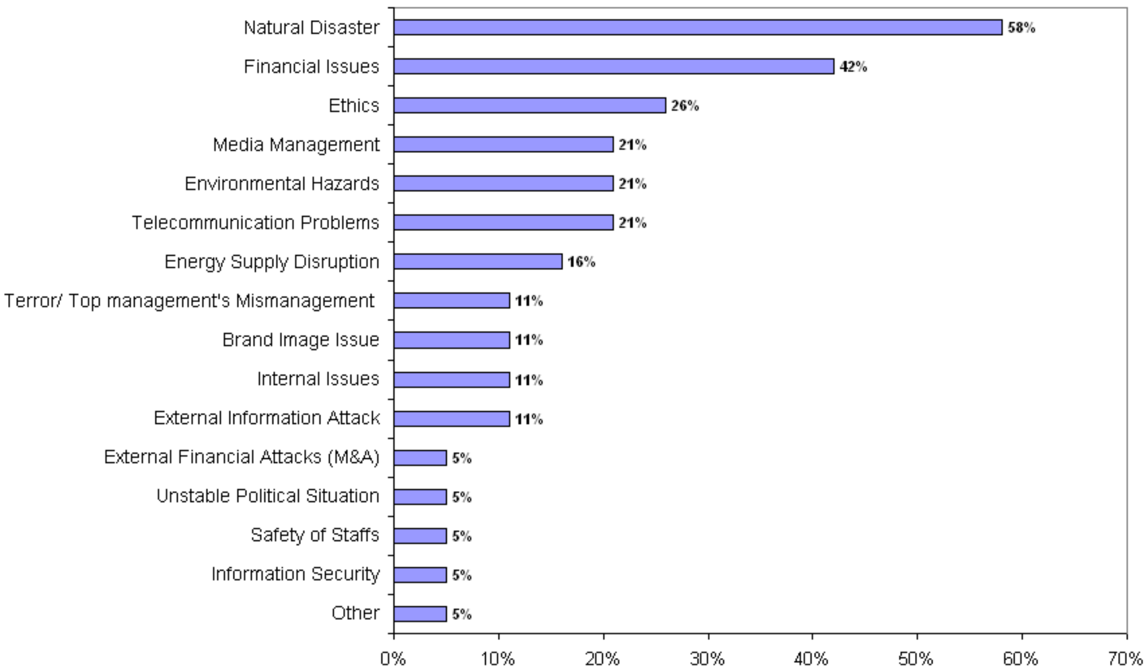

Figure 2 Type of Disasters for Small Business

Private sector's requests to government to prepare disaster readiness

One of the questions in questionnaire was "What type of policies and laws should be in place from government to ensure and encourage for private sector's disaster readiness?"

The survey result shows that private sector wants to have a policy and regulation that provides monetary support. For example, the expenses that are invested to the disaster preparedness and mitigation should be recognized as a tax deduction. Table 3 shows the summary of the request from private sector.

The Private sector also demands a lower premium rate if the company has a disaster mitigation plan or policies on disaster preparedness.

Last but not least, the private sector also wants to have low interest rate loans that are readily available to pay for the cost for disaster preparedness plan or consulting.

Table 3 Private sector's request to government regarding disaster preparedness

Request from private sector	Large business	Small business
Corporation tax deduction and Accepting pecuniary loss in balance sheet	45%	45%
Decrease insurance premium	21%	23%
Low interest loan to pay for disaster preparedness cost	14%	18%

Issues were summarized for private sector to corporate with local/central government to solve the issue and problem in disaster mitigation and preparedness. Table 4 shows the summary of the issues. Communication and coordination was ranked at first.

87% of Small business answered that the importance of disaster management are recognized in the company and 79% of them has started to prepare disaster management and business continuity plan within the last two years.

Table 4 Issues of corporation between private sector and government

Issues with government	Large business	Small business
Communication and coordination	38%	26%
Unified/systematic approach	20%	31%
Lack of understanding of each sector	18%	17%
No feed backs systems from lessons and learned	3%	4%

Current status of disaster preparedness condition in private sector

There are only few studies that show the disaster preparedness status in private sector. One of the researches conducted by Korean Fire Protection Association (KFPA) in 2004 showed that factory and plantation in private sector was not well prepared for flood and inundation hazard (KFPA, 2004). Interestingly, the hardware and equipment preparedness status for natural disaster is relatively well prepared in contrast to the software aspects of the disaster preparedness. For example, in the case of inundation, training for employee, documentation for previous natural disaster statistics or building response plan and recovery plan are not well documented or missing. However, hardware or physical preparedness such as sandbags and wrapping of the exposed pipeline to prevent loss in wintertime are adequately prepared.

Figure 3 shows the summary of disaster readiness status of plant and factories in private sector.

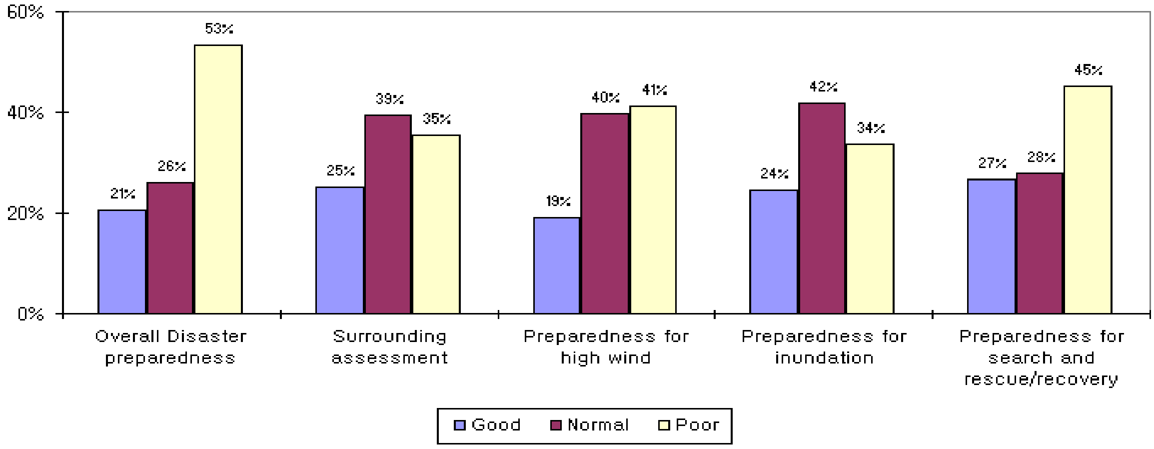

Figure 3 Disaster preparedness status of plant and factories in private sector

Current disaster preparedness support policy for private sector in Korea

The research also examined current laws and policies that contain any supporting or compensation of natural and man-made disaster loss in Korea. There are only 6 laws, acts and policies to support loss from natural disaster support. In the mean time, 23 laws, acts and policies are found to support the loss from man made disaster in Korea.

This research defined disaster management staged as mitigation, preparedness, response and recovery. We categorized all supporting laws, acts and policies to disaster management 4 stages as previously discussed. Figure 4 shows the pre/post disaster support ratio.

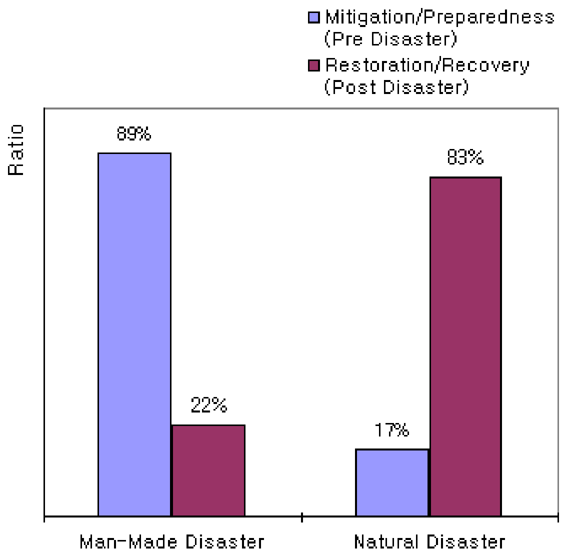

Figure 4 Pre/post disaster support ratio in law and regulation in Korea

Although supporting disaster laws and regulations try to address how to help and assist all disaster management stages such as mitigation, preparedness and recovery; however none of them specifically mentioned about private sector's disaster preparedness.

In the United States, most disaster support laws and regulations are heavily concentrated on supporting mitigation and preparedness stage. Figure 5 shows that law, acts and polices heavily support post disaster activities while law, acts and regulations in US are support mostly pre disaster activities. For example, disaster mitigation act, flood disaster protection act, Stafford act, hazard mitigation and election assistance act, and natural flood insurance reform act in the United States and mostly operated by FEMA are mostly supporting mitigation and preparedness activities (Robrt P.Hartwig, 2004, David Simpson, 2004).

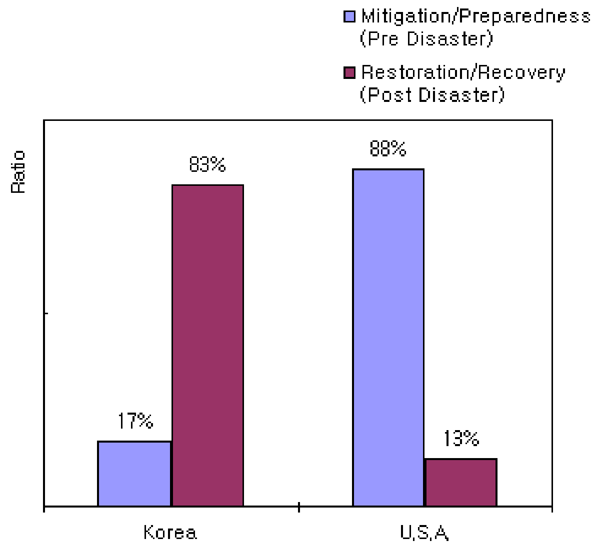

Figure 5 Pre/post disaster support ration in laws and regulations between Korea and USA

Discussion

Based on the survey results, suggestions and recommendations were made to Korean Government through NEMA. The emphases are;

- Central/local government should be the driving force to set the standard and provide guidelines to private sector for preparing the emergency disaster management
- Central/local government should encourage private sector to participate the disaster preparedness certification program and give tax incentive to the companies that possess the certifications.
- Central/local government should set law to support and encourage private sector by providing the cost of investment in disaster preparedness, building business continuity plan, exercise, drills as company's intangible assets. This is the same concept as environmental accounting (environmental accounting report, 2001) in environmental hazards which is been a common practices in western countries.
- Central/local government should fund more on research activities for disaster mitigation technology and cost effective analysis that is associated with it.
- It is hard to expect for private sector to prepare proactively to prepare disaster preparedness and mitigation due to the cost and uncertainty of the visible results. Hence, government should place supporting framework such as tax incentive or insurance premium incentives.
- Currently natural flood insurance is in place however, private sector is not eligible to buy this insurance. Government should adjust the eligibility of the current flood insurance, so that private sector can buy this insurance.
- Investigate the best practice for cost saving by investing money to disaster preparedness and mitigation for disaster recovery

The research results have been applied to the process to legislate an act; The tentative title of the act is "Pre-Disaster Mitigation Supporting Act for Business".

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Author Biography

Kum-Sook We is a CEO at Crisis Management Institute and a professor in the department of Information Industry of the Dongguk University, Korea. She worked for Korean Government in the area of e-Government for 6 years after receiving a doctoral degree in the Dongguk University, Seoul, Korea, majored in Computer Software Engineering. She was a visiting scholar at the ICDRM, George Washington University, Washington D.C. USA in 2003 to 2004 academic year. She has been participating various consulting and research projects in emergency management and business continuity for Korea Government and private sector.

Youn Hee Kim received a doctoral degree in the George Washington University, Washington D.C. USA, majored in engineering management and systems engineering. She has been participating various consulting and research projects in emergency management and risk assessment area including Design for Safety for NASA and National Science Foundation funded project, impacts of 9/11 to corporate America. Her interests are business continuity and risk assessment in Information Technology, work process improvement using Information Technology, and data management.

Sung-Ye Hong received two master degrees in the DongGuk University, Seoul, Korea, majored in Electronic Information Processing and Hawaii Pacific University, Honolulu, D.C. USA, majored in Master of Science in Information Systems. She has done various Information Technology related projects including Electronic Banking System over 13 years with the National Livestock Cooperation Federation, Seoul, Korea. In addition, she has been participating various system development audits as a CISA (Certified Information System Auditor). Her interests are crisis management (including business continuity) and work process improvement using Information Technology in business.

Eun Kyeng Lee received a bachelor of Science in Civil Engineering, Kyung-Hee University, in Korea. She has received a master of Science Degree in Civil engineering in Kyung Hee University in Korea. She worked for e-Government project at the Ministry of Planning and Budget in Korean Government. She is currently working as a researcher at the Crisis Management Institute in Korea. She is a certified Business Continuity Specialist by the Korea BCP Association.

MONITORING AND INFLUENCING SAFETY THROUGH SAFETY CULTURE

Eriksson, Kerstin [1,3] & Borell, Jonas [2,3]
Lund University

Keywords: safety culture, safety climate, safety, safety management, learning

Abstract

Organizations need to make sure that their level of safety is acceptable. Therefore it is important to know which factors contribute to the level of safety and how to monitor and improve these factors. One method used today to evaluate the level of safety in organizations is safety culture measurements. In different contexts, different models of safety culture are used. Safety culture is often considered an antecedent or an indicator of safety. It is also common to consider systematic organizational learning, often including incident reporting systems, important for continuous safety improvements. To efficiently monitor and influence the level of safety through safety culture and learning activities there is a need for a model for the relationship between safety culture and safety. It is also desirable to identify more factors, beside safety culture, that contribute to the level of safety in organizations. In this paper we propose a tentative model for the relationship between safety culture and safety, focusing on cause-effect relations, with learning as a mediating factor between safety culture and safety. We also discuss the need for additional factors contributing to safety in organizations. Our present research aims to develop methods suitable for continuous safety improvements in the field of medical service organizations.

Introduction

In the field of safety management, monitoring the level of safety in organizations is of general interest. Organizations want to make sure that their level of safety is acceptable. Often it is also desirable to achieve continuous improvements of safety in order to raise the safety level. Therefore it is interesting to investigate which factors contribute to the level of safety in organizations, and how to monitor and influence these factors. One concept often used to evaluate and influence the level of safety is safety culture. Different forms of safety culture measurements have been used to measure the level of safety in for example aviation (e.g. Gill & Shergill, 2004), shipping (e.g. Ek & Akselsson, 2005) and the nuclear power industry (e.g. Reiman, Oedewald and Rollenhagen, 2005).

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[1] Department of Fire Safety Engineering, Lund University, P.O. Box 118, SE-221 00 Lund, Sweden, kerstin.eriksson@brand.lth.se

[2] Department of Design Sciences, Division of Ergonomics and Aerosol Technology, Lund University, P.O. Box 118, SE-221 00 Lund, Sweden, jonas.borell@design.lth.se

[3] LUCRAM (Lund University Centre for Risk Analysis and Management), http://www.lucram.lu.se/.

Within the field of medical services the importance of an improved safety culture has recently attracted much attention. For a long time there has been a culture of punishing people who make mistakes through different disciplinary actions. Reason (1997) points out that it is often the system rather than the person that ought to be blamed for an accident. Reason distinguishes between active failures and latent conditions. Active failures are unsafe acts committed by an individual person. They are difficult to foresee and prevent. Latent conditions are circumstances that are built into the system. They are results from decisions made by e.g. designers or management. Studies have shown that errors made by health care personnel are frequently the result of latent conditions in which the errors have often occurred earlier (Ternov & Akselsson, 2005). If the goal is to prevent new mistakes from occurring it is important to highlight these latent conditions to make it possible to learn from those mistakes. This can be done by e.g. a near-miss and incident reporting system. Improving the safety culture in an organization increases the confidence that the organization uses the reports to improve safety and not to blame individual persons. An improved safety culture also increases the willingness of and commitment for the employees to report.

Within medical service organizations there is a faith that improving safety culture also improves the safety in organizations. However, there is no clearly established model for the relationship between safety culture and safety (e.g. Hale, 2003). Practical work with safety improvements benefits from validated models for the relationships between influential concepts within the safety domain. Such a model would be useful for strategic decisions on where interventions should be directed. Furthermore, it is also desirable to identify more factors, beside safety culture, that contribute to the level of safety in organizations. We are presently studying safety management in the medical service of a Swedish Region. One aim of that project is to investigate the usefulness of safety culture measurements as an instrument for safety improvements in their organizations. In our present research, we aim to develop a model over causal relationships between antecedents of safety and safety, suitable for generating hypotheses of complementary factors of safety that can be influenced. In the end, we want practical methods for safety development.

Theory and Method

Safety culture and safety climate

In different contexts, different definitions of safety culture and safety climate are used. Neither of the concepts is well defined, which leads to a confusion over the use of the terms (Guldenmund, 2000; Hale, 2000). In the literature there are several different definitions of the two concepts. Some of these definitions overlap. Cox and Cox (1991) define safety culture as something that "…reflects the attitudes, beliefs, perceptions, and values that employees share in relation to safety". Brown and Holmes (1986) instead use the term safety climate and express it as "…a set of perceptions or beliefs held by an individual and/or group about a particular entity (p. 455)". Hale (2000) describes culture as something more than a collection of attitudes and values of some casual group. About attitudes and values in relation to safety Hale claims that "…to be labelled as a culture they have to go beyond the sum of the individuals (p. 7)".

Guldenmund (2000) proposes a framework where the concepts safety culture and safety climate fuse. Guldenmund conceptualizes safety culture as having three layers. These are basic assumption, espoused values and artefacts. The core of the culture resides in the basic assumptions. These assumptions permeate the whole organization and are unconscious and relatively unspecific. In the middle layer we find the attitudes. This layer can be equated with safety climate. At the outermost layer we find the particular manifestations, i.e. the artefacts, Guldenmund (2000) pointed out the need for safety research to explicitly focus on causal relationships among concepts considered related to safety.

Safety culture (or climate) is often considered a subgroup of organizational culture (or climate) (DeJoy, Gershon & Schaffer, 2004). The organizational culture comprises both general dimensions and specific dimensions. Communication and leadership are examples of general dimensions and safety culture is an example of a specific dimension (Neal, Griffin & Hart, 2000). Since the expression safety culture indicates something separate from organizations culture, which it is not, Hale (2000) instead proposes the use of the expression cultural influences on safety. Since the expression safety culture is so commonly used we also choose to use it, although Hale makes a good point.

<u>Measuring safety culture and safety climate</u>

There is no consensus regarding which dimensions, factors or aspects safety culture or safety climate consist of, and how to measure them. Several different instruments have been designed for this purpose with a variation in what is measured (Glendon & Stanton, 2000). According to Hale (2000) attitudinal measuring tools like questionnaires only measure at most safety climate. To determine safety culture there is a need to study more factors than attitudes (i.e. safety climate), sometimes referred to as using a triangulation approach.

When measuring safety climate it is common to use questionnaires. To do this there is a need to understand safety climate's main dimensions (DeJoy, Gershon & Schaffer, 2004). Different authors use different dimensions. It is common to use dimensions as management, safety systems, risk, competence, and work pressure (Flin, Mearns, O´Connor & Bryden, 2000). Instead of using already developed questionnaires and scales most researchers develop their own. Consequently there are no questionnaires or scales that are fully validated (Hale, 2000).

Ek and Akselsson (2005) described an operational definition of safety culture, consisting of nine aspects of safety culture. They have used the operational definition in several studies. Building on Reason (1997), Ek and Akselsson stress learning as a crucial part in the development of safety. Their work aims to find methods for improving safety culture, and thereby safety. Their method developed for measuring safety culture "…is intended to collect valid data that characterize the safety culture in such a manner that the results can support changes towards more efficient safety management (Ek & Akselsson, 2005, p.174)". The models nine aspects of safety culture, which were theoretically derived, are interrelated with each other, and have shown correlations when measured. The aspects were chosen to provide a good coverage of the spectrum of factors currently thought to be relevant for accomplishing continuous improvements in safety.

The first four aspects in Eks and Akselssons (2005) operational definition are borrowed from Reason (1997). The first aspect is *learning*. It is hypothesized that monitoring operations and trying to collect relevant information, analyze it, and feed back the proper conclusions in order to improve safety is central for proactive safety. The second aspect, *reporting culture*, is considered vital for efficiency of the learning processes. This, in turn, is depending on the third aspect, which is (the need for a) *just culture*, without excessive blame-placing that obstructs proper reporting. The fourth aspect is *flexibility*, i.e. the ability of the organization to transform itself when necessary (for safety reasons). The fifth aspect is *communication*, how everyday communication influences safety. *Safety-related behavior* is the sixth aspect. *Attitudes towards safety* is the seventh, (the perceived) *working situation* the eighth, and *risk perception* the ninth aspect in the model.

The nine-part operational definition of safety culture has been used and applied at different levels within the organizations studied. Ek and Akselssons method for data collection was observation of operative work, inspection of documents relating to the safety organization and the reporting systems for anomalies and incidents, semi-structured interviews with a small sample, and questionnaire assessments of safety culture and organizational climate among a large sample. The method can be characterized as utilizing a triangulation approach (Hale, 2000). Ek and Akselsson measured safety culture with a standardized questionnaire, developed by Ek, comprising the nine aspects of safety culture described above. The questionnaire contained 97 items, of which a majority was answered using a 5-point scale. Using Guldenmunds (2000) definition of safety culture, it might be more appropriate to say that the questionnaire measured safety climate rather than safety culture.

Reporting systems and learning

To achieve a successful learning system many organizations believe it is enough to develop an incident and accident reporting system (Hale, 2000). If managed successfully, a reporting system can help to develop a learning organization (Koorneef, 2000). Pidgeon (2000) placed reporting systems as a key to a good safety culture. For an effective reporting system there is a need for the organization to structure and limit blame for not reducing the reporting frequency and learning.

Koorneef (2000) described in detail how a system for organized learning from small-scale incidents can be set up. Building on the work by Argyris and Schön (e.g. Argyris and Schön, 1996), Koorneef described how organizational learning should be organized in order to function properly. The main idea is to make organizations better at efficient proactive safety management, where occurred and possible “unwanted events” are used as motivational and meaningful input to organizational learning processes aiming for continuous safety improvements. Koorneefs model evolves around the idea that operational surprises need to be detected and reported. An operational surprise occurs when unanticipated operational conditions arise. Organizational learning is seen as when individuals within an organization experience operational surprises and start inquiry processes about them. Koorneef believes that it is necessary with a designated learning agency, i.e. an organizational unit responsible for gathering reports on organizational surprises and analyzing them, followed by the sending back of lessons learned to appropriate receivers within the organization.

Koorneef (2000) described how safety culture was considered important during implementation projects of the learning process model developed. Koorneef concluded that there is a need for further investigations into which barriers to successful implementation of good organizational learning for safety that might stem from (safety) culture within different organizations. “The cultures in different organisations obviously had their impact on the success of projects. Some were and are highly defensive. The key premise remains that an organisation must want to learn from its operational surprises or it will not do so, no matter what effort is invested by researchers, consultants or even the staff in a given part of the organisation (Koorneef, 2000, p. 159)”.

Safety performance metrics is a complicated issue. Some writers call for safety research to address the connection between safety and factors thought to lead to or influence safety (e.g. Guldenmund, 2000). Other scholars propose other approaches, avoiding a need to directly measure safety. There are different reasons for such ideas. Reason (1997), for an example, concludes that when a certain level of safety is reached by an organization, the frequencies of negative outcomes are so low that they are no longer suitable as measures of safety performance. Instead, Reason argues, one can turn to monitoring processes aiming for safety improvements. That means to turn from studying output to studying process. A similar approach is described by Weick and Sutcliffe (2001), proposing that safety is a “dynamic non-event”, that continuously has to be re-established. As different learning processes seem necessary for the maintaining and development of safety it is interesting to monitor and manage such learning processes. We also believe that a positive safety culture is necessary for the possibility to initiate and run such learning processes successfully. Therefore it is also of interest to monitor and try to influence safety culture.

Studying safety culture in medical services

For measuring safety climate in Swedish medical service organizations we use Ek and Akselssons (2005) operational definition of safety culture, and an edited (shortened) version of their questionnaire, with slight adaptations of some items to the studied medical services context. We test how their operational definition can be used in medical service organizations (i.e. hospital clinics). In that context, we are examining the relationships between the safety-related concepts of safety culture and learning. The questionnaire assessments are complemented with interviews and studies of the formal safety management systems. The practical aim of the project is to develop methods for measuring and communicating safety culture, so that it can be addressed by improvement processes.

We plan to use incident reports as indicators of activities in the field of learning (for safety). We are collecting data on the frequencies of incident reports filed and analysed in the organizations studied, and plan to systematise the analysis based on Koorneefs (2000) model for organizational learning for safety improvement. In the research we will compare safety climate data with frequencies of incident reports produced, analyzed and acted upon. This will be done twice, with approximately 12 months between the measurements. We aim to establish statistical relations between the nine aspects of safety culture we measure with the questionnaires, and the level of learning activities around incident reports.

Results

Our starting point is a simple model over causal relationships between safety culture, learning and safety. Findings from literature studies and research contacts with different medical service organizations in Sweden indicate that a causal chain from safety culture to safety might be illustrated as in Figure 1.

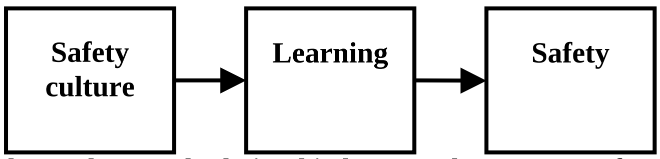

Figure 1. A model over the causal relationship between the concepts safety culture and safety.

The above model proposes that safety culture can either facilitate or obstruct learning activities, which in turn can influence the level of safety. This is in line with e.g. Reason (1997), who places great emphasis on learning and factors influencing learning as important for (the development of) safety in organizations. The model above concerns causal relationships between concepts that might be seen as different aspects of a coherent whole. The parts of the model should not be seen as separate entities that interact with each other, but rather as different aspects of efficient safety improving activities.

In accordance with Guldenmund (2000), we look at safety climate as a manifestation partly formed by an underlying safety culture. Considering safety climate as one indicator of safety culture means that safety climate measurements are indirect measurements of safety culture. In combination (triangulation) with measurements of other concepts that are hypothesised to be influenced by safety culture, and hence possible indicators of the safety culture, we try to capture the safety culture.

We believe that the frequencies of filed and analysed incident reports are possible measurements of activities concerning organizational learning for safety. We are trying to capture connections between safety culture indicators and such reporting statistics. This will be used to refine our model.

Discussion

In this paper we describe a tentative model for the relationship between safety culture and safety. The model only coarsely illustrates one causal chain. To improve safety, there is a need for more detailed models. We aim to develop our model by further analyzing the causal relationship between safety culture, learning and safety. It is also desirable to identify more factors, beside safety culture, that contribute to improvements of safety in organizations. This is what we are presently working with, using data from studies of safety culture and learning processes in medical service organizations.

Since frequencies of reports passing different stages in a system for organised learning is a rather coarse measure of learning activities, we try to find complementary sources of information as well. We use interviews and observations, and are looking for more ways of capturing learning in the organizations we study.

To be able to capture the level of safety it is essential that we don't miss the main factors. Examples of possible factors that seem promising for closer examinations are knowledge, skills and motivation (e.g. Neal, Griffin & Hart, 2000). We are currently designing a study where we will investigate the relationship between safety-related knowledge and attitudes to safety. This work is planned to further enhance the model and make it more suitable for monitoring and influencing improvements of safety through safety culture and better at capturing ways to improve safety.

We believe that the chain metaphor is highly appropriate. It might be the case that the whole system is no stronger than its weakest link. It is possible that some links in the causal chain are crucial for success, e.g. attitudes towards incident reporting might more or less hinder actual organizational learning and safety improvements. There has been awareness of the possibility of such dependencies for a long time, but we believe there still is no sufficiently developed and validated model for the issue.

So far we are only concerned with causal relationships in one direction. However, we believe there might be influences going in the other direction as well, given the definitions we use, but we do not focus on that in our present research.

It is important to improve the level of safety to prevent accidents and emergencies from occurring, but it is impossible to prevent everything. Therefore it's necessary to study both safety and emergency management. Solitary focus on either is unfavourable. In future research we are interested in studying how safety culture, learning and other factors that influence safety affect the ability of an organization to prepare for and handle an emergency. We will also study if there are other important factors, beside those thought to influence safety, that influence emergency management.

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Author Biographies

Jonas Borell is a PhD student at the Department of Design Sciences at Lund University. Jonas has a MSc in Psychology. Main research area is proactive safety management. Jonas participates in FRIVA, a framework research program funded by the Swedish Emergency Management Agency.

Kerstin Eriksson is a PhD student at the Department of Fire Safety Engineering at Lund University. Kerstin has a MSc in Risk Management and Safety Engineering. Main research area is risk and vulnerability analysis and crisis management. Kerstin participates in FRIVA, a framework research program funded by the Swedish Emergency Management Agency.

Academic and Professional Practice

Peer Reviewed Articles

Tsunami 2004
Improving Emergency Management

EFFECT OF M 9.0 26/12 ON SRI LANKA: SOCIO-ECONOMIC IMPACT EVALUATION OF SRI LANKA'S TSUNAMI DISASTER AND CRITICAL REVIEW OF THE NEEDED COUNTERMEASURES.

M.S. Sri Gowri Sanker[1]
Graduate School of Economics, Kobe University, Japan

W.M.G.B.Giragama[2]
H.K. Agrarian Research and Training Institute, Sri Lanka

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Abstract

Severe earthquake at the coastal areas of Sumatra island of Indonesia at the magnitude of 9.0 and the consequent Tsunami not only created the historic human and economic damage but also raised questions of hi-tech early warning systems and the risk communication in the region as well as in the country. Though it made severe impact in the Indian Ocean countries, in this paper we evaluate the situation of Sri Lanka which is the second worst affected country in the region. Accordingly more than 40,000 people died, more than 800,000 people have been affected and about 70% of the country's coastal area of the country has been damaged. Severe damage has also been caused to the internal infrastructure of the country affecting the speedy recovery and rehabilitation activities. This is further aggravated by the post-disaster epidemic of diseases. Though there is an influx of foreign aid, improper supply management considerably negates the efforts to bring back normalcy. Colossal loss to the economy in various forms also further hurdles the post disaster development efforts as development and disasters are horizontally and vertically related under the macro economic framework. Hence this paper critically evaluates the post tsunami scenario in Sri Lanka with special reference to the economic and social impact and also the necessary and sufficient countermeasures needed in the future to reduce such impacts through regional integration. In addition, future disaster management strategy to the country through the regional perspective is also discussed.

Preamble

So far natural disasters in Sri Lanka are mainly hydro-meteorological phenomenal events such as flood, landslides, cyclones, and droughts and these natural disasters have caused extensive damage to the people and property year after year, disrupting social and economic

[1] Graduate School of Economics, Kobe University, Japan, 2-1 Rokkodai-cho, Nada-ku, Kobe-city, Japan 657-850, Visiting Researcher & Research Economist, Asian Disaster Reduction Center, Kobe, Japan; E-mail: sgsanker@econ.kobe-u.ac.jp
[2] Irrigation Water Management and Agrarian Relation Division, H.K. Agrarian Research and Training Institute, P. O. Box 1522, Colombo 7, Sri Lanka.
E-mail: *hartiiar@sltnet.lk*, *gbgiragama@yahoo.com*

development endeavors, triggering tremendous damage people and their livelihood and to expose substantial economic losses to the economy. But the 2004 December 26th Tsunami disaster was something Sri Lanka has never experienced for more than 100 years. According to the available records, Sri Lanka first experienced Tsunami in 1883 after *Krakatoa* volcanic eruption (*Indonesia*) on 26th August (CRED, 2005). The scale at which 2004 Indian Ocean Tsunami struck the entire region is unimaginable and paradoxically, 2004 Tsunami was also on the same 26th day!!!.

On Sunday, December 26th morning, two hours after the first earthquake occurred, tsunamis triggered by massive earthquakes in the *Sumatra* and *Nicobar* regions, plunged Sri Lanka into crisis. These waves initially lashed the Eastern coast and subsequently hit many areas of the Southern and Western coasts of Sri Lanka, causing extensive damage to life and property. These Tsunami waves struck about 70 percent of the coastline of Sri Lanka (more than 1,200 km). The waves penetrated inland areas even up to 400-500 meters in many places, leaving behind few intact structures. It has even struck a heavily packed passenger train bound for southern coastal town *Galle* and killed more than 1,500 people. Thirteen districts along the coastal line, out of a total of 25 districts in the country, have been affected. This Tsunami disaster left more than 35,000 people dead, second highest dead toll in the region behind badly affected Indonesia, and another 8,000 missing. According to the Government figures, about one million people are affected, which is almost 5 percent of the total population. More than 120,000 houses were also damaged. The damage caused by this Tsunami is being estimated now and expected to be over 100Million US$.

The strip of coastline hit by the waves was generally dominated by poor squatter households and fishing villages engaged in minor economic activity. Fishermen communities have been particularly devastated by the Tsunami. Agricultural production and markets have also been affected by the Tsunami. The worst devastations however happened in the poorer areas of Sri Lanka in the South and the conflict-affected North and East. The South-Western coastal areas, which are the main tourist destinations, account for roughly 40 percent of the affected people, mostly Sinhalese. The conflict affected zone in the Northern and Eastern part of the country comprises six of the affected 12 districts. Four of them – *Jaffna, Mullaitivu, Batticaloa* and *Ampara* - have been badly hit by the Tsunami, comprising more than 50 percent of the affected people. These conflict affected zones are predominantly inhabited by Tamils.

Post Tsunami survey results indicate that more than half of the affected people have lost their livelihoods. Two thirds of those who lost their income are fishermen; the second largest group is retail traders, followed by people engaged in agriculture and manufacturing. Almost all of them depend now mainly on welfare and charity. Whilst district authorities and local and international communities responded spontaneously, they were soon overwhelmed by the magnitude of the disaster. The Government immediately declared a state of national disaster and requested international assistance. The international community was quick to respond by pledging financial assistance and commissioned needs assessment missions. Given the magnitude of the catastrophe and the over-pouring support from a huge number of sources the need for effective coordination has become a major predicament.

Socio-Economic Situation of Sri Lanka when Tsunami Struck

It was obvious that the tsunami struck at a time when the Sri Lankan macro economy was already under pressure on several fronts, creating fears of a economic decline into the kind of crisis that was seen in 2001 when the economy contracted by 1.5 per cent. Some of the same problems that produced the 2001 crisis were re-emerging. The 2001 crisis was driven primarily by a rapidly deteriorating domestic policy and political environment in the context of accumulated macroeconomic imbalances, aggravated by lower exports due to depressed global economic conditions and lower agricultural output due to adverse weather. The situation was turned around then by a series of political and economic policy initiatives. The international efforts and domestic initiatives which brought a ceasefire agreement (CFA) with the Liberation Tigers of Tamil Eelam (LTTE) was seen as a first step towards solving the country's long standing ethnic conflict. The prospect of peace and a substantive set of economic reforms – including the floating of the currency – succeeded to some extent in gaining donor support and renewing investor confidence. GDP growth resumed at an annual rate of 6 % in 2003, fiscal consolidation efforts saw the budget deficit reduced progressively to 8 % from 10.8 % in 2001 while inflation moderated to 6.3 per cent from 14.2 per cent in 2003.

There was considerable unease within the business and investor community about the direction of policy under the new government elected in April 2004. Economic growth began to slow from the second quarter of 2004 and ended the year with a growth rate of 5.4 per cent. Some policy weaknesses and the slow pace of reforms contributed to the lower performance. The most visible, and potentially the most destabilizing manifestation of weakening macroeconomic management in 2004 was a persistent build up of inflationary pressure from mid-year onwards. A ballooning oil import bill saw the current account deficit on the balance of payments (BOP) widening to over 3.3 % of GDP from 0.4 % in 2003. This was accompanied by a deceleration of capital inflows, with long-term inflows to the government (consisting primarily of foreign concessional loans) declining by US$ 130 million in 2004. Foreign borrowings by the commercial banking sector increased significantly in 2004 raising the country's foreign private debt exposure. The currency depreciated by 8.5 per cent against the US dollar despite efforts to bolster the exchange rate which contributed to the decline in Sri Lanka's gross official reserves from US$ 2.3 billion at the beginning of 2004 to US$ 1.9 billion by November.

These domestic and external developments led to an acceleration of inflation from mid-2004, and real interest rates turned negative. Symptoms of a bubble economy began to emerge: a sharp increase in credit growth to the private sector in excess of 20 per cent, with an estimated 40 per cent of the increase for consumption spending; and a boom in the Colombo stock market unsupported by major indicators of economic fundamentals. The peace process appeared to have stalled, and with privatization initiatives shelved concerns over the government's ability to reduce the fiscal deficit began to increase. Markets started to get jittery with the growing realization that fundamental imbalances in the economy were intensifying. Though the external payments situation improved marginally in December 2004 the rupee depreciation again gathered pace. On 17 December 2004 the currency fell to a historical low of Rs.105 against the US dollar. Thus, the tsunami came at a time of bleak economic news. If there was no effective policy response, a slide into crisis became a serious possibility. The tsunami diverted attention away from these imbalances but did not eliminate them. As we look at the post-tsunami recovery issues and the policy scenarios, it is important to emphasize that the successful post-tsunami recovery is inextricably tied to the resolution of these fundamental structural imbalances (Jayasuriya.S., Steele.P., Weerakoon.D).

Due to the peace process that halted the violence contributed to the productive livelihood of the people at various levels. New ventures and various other productive sectors re-emerged which provided the much needed support to the people. Inter community understanding and cohesiveness was at the highest level and contributed to the development.

Tsunami Impact: Socio-Economic Phenomenon

The Tsunami struck the country when the country started its way into development. The immediate damage and impact was not known but now a days it is estimated to be second highest in the region after Indonesia. Following tables and figures show the situation in detail.

Table 1

Province	District	Affected Families	Displaced Families	Displaced Persons			Deaths	Injured	Missing	Damaged Houses		No. of Camps
				In Welfare Centers	With Relatives and Friends	Total				Completely	Partially	
Northern	Jaffna	13,485	10,640	11,360	28,760	**40,120**	2,640	1,647	540	6,084	1,114	19**
	Killinochchi	2,295	318	305	1,298	**1,603**	560	670	1	1,250	4,250	2
	Mullaitivu	n.a.	6,007	11,993	10,564	**22,557**	3,000	2,590	552	3,400	600	23
Eastern	Trincomalee	30,102	27,746	19,515	62,084	**81,599**	1,078		337	5,974	10,394	42
	Batticaloa	63,717	12,494	26,889	35,957	**62,846**	2,840	2,375	1,033	15,939	5,665	48
	Ampara	38,624	n.a.	73,324	*	**73,324**	10,436	120	876	29,199		74
Southern	Hambantota	16,994	3,334	574	17,168	**17,742**	4,500	361	963	2,303	1,744	5
	Matara	20,675	2,904	3,202	8,996	**12,198**	1,342	6,652	613	2,362	5,659	29
	Galle	23,174	1,472	4,507	123,247	**127,754**	4,218	313	554	5,525	5,966	38
Western	Kalutara	6,905	6,905	3,261	24,452	**27,713**	256	400	155	2,780	3,116	16
	Colombo	9,647	5,290	5,812	25,885	**31,697**	79	64	12	3,398	2,210	28
	Gampaha	6,827	308	876	573	**1,449**	6	3	5	292	307	2
North Wester	Puttlam	232	18	66		**66**	4	1	3	23	72	2

Source: National Disaster Management Center, 2005 Sri Lanka Department of Census and Statistics, Government of Sri Lanka, 2005.

Figure 1: Death Toll

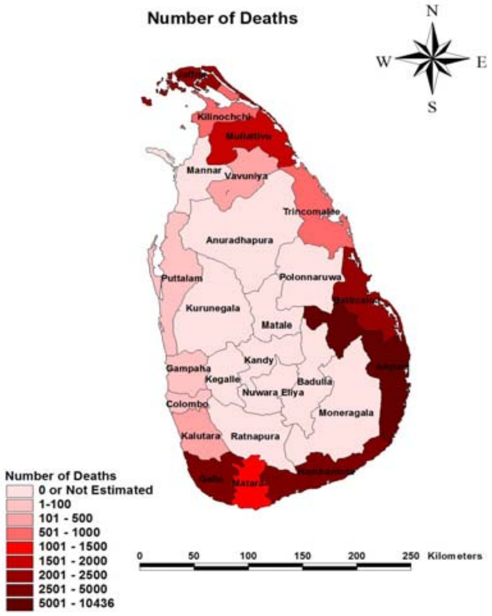
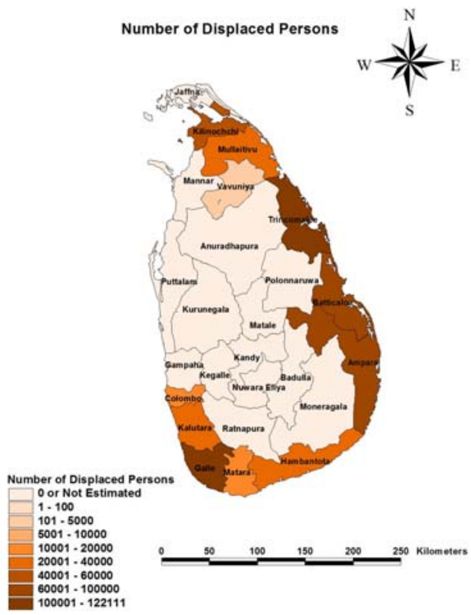


Figure 2: Displaced People



Source : National Disaster Management center, 2005, Sri Lanka

The death toll is now well above 40,000 people and majority of the victims were women and children. More than 800,000 thousand people were displaced. it can be said that in terms of death and missing numbers, Sri Lanka is second to the Indonesia and greater than other affected countries in the region such as India, Thailand and Maldives. Among thousands of damaged houses, majority were the poor fishing communities' houses. In addition to this, the economically important damage was the tourist resort hotels in the southern area of Sri Lanka. It can also been seen that more than 300 schools were completely damaged or sustained major damages. Many lifeline spots and public infrastructure facilities were also damaged.

Figure 3: Affected Families

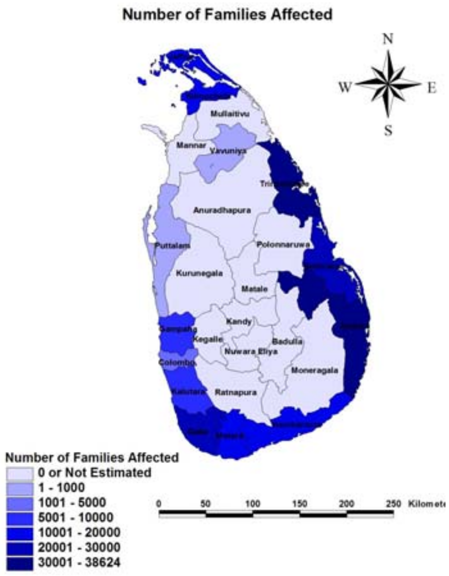
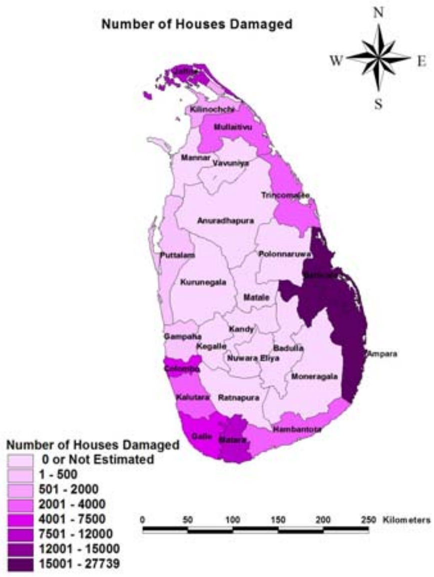


Figure 4: Damaged Houses



Source : National Disaster Management center, 2005, Sri Lanka

Though the damage and the geographic impact of the tsunami were uneven, the majority of the human damage was from the coastal belt from the conflict affected north and eastern areas. The severity of the tsunami disaster in the northern and eastern provinces compounded problems arising from the three decades long internal conflict. The majority of the internally displaced people live in these two provinces. The worst hit industry was the fisheries industry and the tourism industry. Further marginal damage was also experienced by the agriculture industry as the tsunami affected areas are predominantly fisheries and agriculture areas. Hence the damaged caused to these industries are severe in terms of the people's livelihood.

Tsunami Impact Evaluation

The ADB-JBIC-WB assessment estimated that Sri Lanka had suffered asset damages of around US$ 1 billion (4.5 per cent of GDP), and estimated that the medium-term financing needs (including immediate relief) would be around at US$ 1.5-1.6 billion (7.5 per cent of GDP. The largest financing needs were in the housing sector. The destruction of private assets was substantial ($ 700 million), in addition to public infrastructure and other assets. Loss of current output in the fisheries and tourism sectors – which were severely affected – were estimated at $ 200 million and $ 130 million, respectively. Key industrial, agricultural and metropolitan centers were relatively unaffected and the damage to capital assets was primarily to tourism and fisheries sectors, each of which contributes only around 1.5-2 per cent of GDP. These aggregate figure for financing needs were quite close to the government‘s own estimate of US$ 1.8 billion presented in February 2005 though there were some important differences at the sector level damage estimates (GOSL, 2005a). The government of Sri Lanka (GOSL) subsequently (May 2005) firmed up the country's total investment needs to be US$ 2 billion (GOSL, 2005b) (Table 2). The differences between these estimates reflect the government's more ambitious longer-term plans while the donor assessment was largely geared to restoring the pre-tsunami situation.

Table 2: Damage Estimation and Needs Assessment on Reconstruction and Rebuilding. (US$ Million)

Sector	ADB/JBIC/WB*		GOSL**
	Losses	Needs	
Housing	306-341	437-487	400
Roads	60	200	210
Water and Sanitation	42	117	190
Railways	15	130	77
Education	26	45	90
Health	60	84	100
Agriculture	3	4	10
Fishery	97	118	250
Tourism	250	130	58
Power	10	67-77	-
Environment	10	18	30
Social Welfare	-	30	20
Excluded Items	90	150	
Telecommunication (Fishing and rural)	-	-	60
Port Development	-	-	32
Industrial Development	-	-	34
Enterprise Development	-	-	55
Regulatory and Admin Infrastructure	-	-	38
Microfinance/SME credit	-	-	150
Total	**970-1000**	**1500-1600**	**1769**

Source: *ADB, JBIC, World Bank (2005) and **Govt. of Sri Lanka (2005)

Impact and Response

The immediate impact on the economy was measured by the disaster impact on the GDP and it is estimated to be fairly limited, about 1 to 2%. This is bit surprising figure if we consider the extent of the human losses and damage to other facilities. The reason could be that a smaller part of the active economic engine is damaged. But according to the 2005 economic figures it looks so small but in the long term when the economy gets benefit from the current resources the damage will be much more as the cumulative loss to the future economy will be incurred from the current assets which were damaged. Hence the Government and the donor agencies should plan their reconstruction and rehabilitation plan based on this. In other words, it can be said that the overall impact on the national income over time will depend on how quickly asset replacement or the reconstruction will occur.

The household spending has also changed since tsunami. The savings are also affected and the consumption decreased. But the families affected are now receiving certain support from the government and the much more supplementary support came from abroad. Though this would have mitigated the domestic spending for a short term the long term impact will definitely arise from the future economic imbalances which would arise from prolong delay in reconstruction. A larger disaster like tsunami of course destroys the consumer durables and assets thus creating a blockade for the spending and savings which would lower the future income flows. This will ultimately affect the economic performance in the long run and the societal set up at least in the sort run. Further community support in reconstruction process is invaluable and that is the vital element for the sustainable recovery too.

Since the international response was quick and huge, the affected people saw some bright future and that raised their working sprits too. The promised relief assistance by the international agencies and governments in terms of aid flow and debt relief raised the hope of quicker recovery and early resumption of active economic growth. Now it is very much imperative to the government and other recovery partners to use these responses in a coordinated and responsible manner for quicker recovery. Aid coordination with the international agencies and NGOs are of paramount importance. The promised external assistance by bilateral donors, multilateral agencies, NGO/Private Sectors is almost 2230 Million US Dollars and this is much above to the government requested or estimated damage assessment of 1769 Million US Dollars. Hence now it would a huge task for the authorities to effectively mange the funds and accelerate the recovery and growth. Hence a proper coordination and relief distribution in terms of sustainable recovery is the most needed strategy now.

Needed Disaster Countermeasures and Sustainable Recovery

Since not only Sri Lanka, but also the Indian Ocean region experienced such a massive disaster, it is now imperative to establish necessary and sufficient countermeasures in the countries, which include establishment of early warning system for various natural disasters including tsunami awareness centers in the Indian Ocean rim, enhancement of national and regional emergency information dissemination and supply management systems, building Infrastructures for disaster prevention and mitigation, and promotion of school education and community awareness on disaster reduction. These are most needed activities at the moment to prevent the occurrence of such large scale damage by disaster in Sri Lanka and other vulnerable countries in the region.

It is sad to say that the progress is recovery is very slow and almost 5 to 10 % of the damaged houses are rebuilt. Hence the authorities must accelerate the recovery efforts with available and promised funds rather than lobbying for further funds. Further coordination among the domestic and external agencies is found to be a serious problem. This has to be rectified to ensure the equal opportunities for the affected people and this should assure their return to the normal economic run as quick as possible.

As we have seen in this paper when tsunami hit the country had serious macroeconomic imbalances. This is further aggravated due to the absence of policy alternatives and mismanagement. The authorities should not be overwhelmed by the short term recoveries in the currency pressure due to the economic phenomenon that would follow a major disaster and the huge subsequent assistance. Hence pragmatic macroeconomic policies should be drawn to divert the ad-hoc manner of the recovery stimulated growth in the proper path that leads to the sustainable development.

The most important aspect is to pursue the ongoing Cease Fire Agreement and Cessation of Hostilities in the conflict and disaster affected areas of Sri Lanka. The future growth of the economy in the long run after the disaster depends much on the peaceful and development conducive situation of the country. If another conflict erupts then that will destroy the already affected nation beyond recoverable terms. Hence proper domestic coordination with the authorities in the war affected areas is much needed (SriGowri Sanker, M. S., 2006).

In addition school education about disaster prevention and mitigation, community based disaster mitigation activities, proper early warning system and methods to disseminate these early warning s effectively to the public, public awareness programmes, information dissemination and coordination among stakeholders are much needed as disaster countermeasures in Sri Lanka in the view of preventing further disaster damages (ADRC, 2005).

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Author Biography

Dr. M. S. SriGowri Sanker is currently working as COE Researcher of the Graduate School of Economics, Kobe University, Kobe, Japan and he is also the Visiting Researcher and the Resource Economist of the Asian Disaster Reduction Center, Kobe, Japan. He is the Sri Lankan citizen and has wide experience is disaster impact evaluation and disaster economics and development. He is the specialist of Economics of Disaster and development and one of the promoters of mainstreaming disaster reduction into development initiatives. He authored many books and papers in the fields of economic policy, disaster economics and globalization. He participated in the missions to evaluate the disaster impact in many parts of the world. He is the member of TIEMS.

Dr. W. M. G. B. Giragama is the head of the department of Agrarian Relations and Irrigation Watershed Management of the Agrarian Research and Training Institute of the Ministry of Agriculture, Government of Sri Lanka, Colombo, Sri Lanka. He is the Climate Geographer and Disaster Impact Evaluation Specialist. He participated in the many disaster impact evaluation missions in Sri Lanka and continuous contributor to the cause of disaster reduction and sustainable agrarian development issues. He is the professional trainer in disaster reduction and management. He authored many papers and participated in many conferences abroad and in Sri Lanka. He is the citizen of Sri Lanka.

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Improving Emergency Management Practice

THEORETICAL APPROACHES TO EMERGENCY RESPONSE MANAGEMENT

Christian Uhr and Lars Fredholm

Lund University, Swedish Rescue Services Agency

Keywords: emergency management, disaster management, crisis management, command and control

Abstract

The concept of Command and Control has until today been a central starting point in many theoretical discussions concerning efficient emergency response management. Different system architectures in civil contexts seem to correspond to military traditions and the hierarchical principles of Command and Control. In an emergency or crisis situation the responding actors are likely to be described as components of a system based on administrative delimitations like geographical and organizational boundaries. However, empirical studies indicate that a complex, dynamical and unpredictable course of event sometimes causes the emergence of new management constellations, the neglect of predetermined decision domains and other phenomena that could conflict with the Command and Control concept. Researchers like Quarantelli (1998), Comfort (1999) and Drabek (2003) among others have with different approaches earlier highlighted this discrepancy and several scientific publications are available. Nevertheless there appears to be a lack of discussions on complimentary theoretical approaches to emergency response management in the existing discourse. In order to get a survey of theoretical discussions on the concept of Command and Control and its usefulness for emergency response management, a review of literature has been done. Our result is that the approaches can be structured in three categories, which we define as *a detailed* approach, *a mission* approach and *a sceptical* approach.

Even though emergency management research could be regarded as an interdisciplinary research field we argue that a further integrated academic approach should be established to develop the theoretical discussions and enhance the capability of generating an efficient response when future crises occur.

Introduction

Emergency and crisis management has during the recent years been given a lot of attention in both media and in the academic world. Different types of educational programs in the subject area are at a rapid pace established at universities and other institutions offering methods for practitioners and administrators to better deal with the next terrorist attack, pandemic, fire or hazardous waste. It seems probable that this development will continue as our consciousness of risks for various reasons increases, simultaneously with public demands for efficient response management. One example of this development is the criticism conveyed by survivors, media, the public, experts and a commission on how the Swedish government responded to the Tsunami disaster 2004 (SOU 2005:104) which in its turn has given rise to a lively political discussion on responsibility conditions and the need for development of the management process on nation level. Inquiries following severe catastrophes, e.g. the one mentioned above, often draw attention to problems of inefficient co-ordination and indistinct authority structure within the responding systems.

One way to visualize one or several responding organizations is to present a hierarchical structure of various decision makers. This seems suitable for describing jurisdictional relations. Who is in charge over whom? Who has responsibility for what? Problems could easily be associated to certain functions or predetermined information ways. It is reasonable to assume that our model or mental picture of how a responding system is constituted and behaves is greatly influenced by these models or administrative figures. But, are we aware of the real conditions that create the operational context in which the emergency management process exists? Are our models of the crisis response system marred by shortcomings depending on simplifications originated from a traditional military perspective? These questions arose on the basis of empirical findings alongside with a literature review.

In 2004 a research project funded by the Swedish Rescue Services Agency and the Swedish Emergency Management Agency began, with a very exploratory approach, to study the response processes following several major accidents in Sweden with focus on management functions on higher decision levels. During interviews with experienced officers among others, new phenomena came to light, phenomena that were not always considered in the preparedness process but had, according to the interviewees, a great impact on how the situation was handled. Administrative structures were neglected in order to better cope with the unique situations. Friendship and personal contacts seemed to have an effect on how different collaboration constellations were formed and authority centres arose outside the formal management structure. These findings led to a growing interest in how the theoretical reasoning in the subject has developed. In the literature various theoretical approaches have been used to understand, structure and analyze what could be regarded as the emergency response system. The concept of Command and Control seems to have influenced much of this descriptive and normative modelling. At the same time critical views on Command and Control as a theoretical base for emergency management have developed, mostly from sociologists like Qurantelli (1998), but also from representatives from other “schools of thought”, like disaster researcher Comfort (1999). This criticism has together with empirical findings lead to the following questions at issue:

How do researchers interpret the concept of command and control?

Is there a need for a further theoretical development in the discourse of emergency management?

In order to find answers to these questions the concept of Command and Control will be analyzed. Furthermore, we present some of the critical views aimed at the Command and Control concept and relate the discussion to empirical findings.

Three approaches to Command and Control

The concept of Command and Control is difficult to catch. The idea has been developed and it now exists in many versions and applies in various areas. C^2 became C^3 (The additional C meaning communication) which in its turn has expanded to amalgams like C4ISR (Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance.) In this paper we stay with C^2 as a concept of principle.

It is clear that Command and Control unquestionably is an organizational phenomenon (Kronenberg, 1988). In the military context Command and Control appears to have been a theoretical starting point when designing organizational structures. The idea of predetermined authority centres in a defined system comes into view as a governing thought when examining different approaches to the concept. The following definition of Command and Control comes from the Department of Defence Dictionary of Military and Associated Terms (2002).

“The exercise of authority and direction by a properly designated commander over assigned forces in the accomplishment of the mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities and procedures which are employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission.”

No doubt, there has been a military influence on how the society should prepare and respond to different kinds of civil crises. A threat must in one way or other be taken care of irrespective of the matter being a hostile state or a natural disaster. Some theorists do not make a distinction between civilian and military Command and Control. In "Command and Control in Civil Emergencies" (Edit, 2003) the editor writes that civil Command and Control is virtually the same as the military version. The same elements are present. However, differences between civil and military contexts can without doubt be found –Military forces can actively take the initiative. In civil emergencies actors are "reactive". A uniform understanding of what the concept of Command and Control really means does not seem to exist, neither among theorists nor practitioners. The theory of Command and Control is changing with the emergence of new adversaries challenging the system and new technologies supporting it (Rosen, Grigg, *et al* 2002), although one can observe a common denominator in all interpretations of the concept. The basis of all Command and Control is the authority vested in a commander over subordinates (MCDP 6, 1996).

When reviewing emergency management literature and listening to the academic discussions three different approaches to Command and Control seem to emerge. We have chosen to categorize these approaches as the *detailed* approach, the *mission* approach and the *sceptical* approach.

The Detailed Approach

The detailed approach involves the military "Anglo-Saxon application" of Command and Control when a central authority through a mechanistic control structure commands and controls the units in a lower hierarchical level in a unidirectional way. Commanders are in control of their subordinates and subordinates are under control of their commanders. In the traditional approach the top-down perspective is consistent through the whole system.

This approach can be observed in some military contexts but also in civilian ones. Before the Great Depression of the 1930s the bureaucratic structure was dominant, greatly influenced by Weber's idea of bureaucracy, where power is ascribed to positions rather to the individuals holding those positions. When examining emergency response organisations the detailed approach to Command and Control appears to have an effect on certain administrative structures and constitutes a cultural phenomenon within organizations. An example of when this interpretation of Command and Control is present is when a commander in detail exercises Command and Control over a handful of firemen trying to rescue someone inside a burning house. The commander decides what actions to take and which priorities to make. He or she gathers information from the fire-fighters and the fire-fighters will be given detailed orders to realize in order to achieve a predetermined goal.

In MCDP 6 (1996) the term detailed control is used when a commander controls with "tight-reins". Command and Control in this approach is centralized and orders and plans are explicit. According to this text the detailed control emphasizes a vertical information flow, with information flowing up the chain of command and orders flowing down. This type of control is, according to the authors, the preferred method when time is not a critical factor, when procedures must be closely adhered to for safety reasons, or when restrictive rules of engagement demand close monitoring and extensive reporting of events.

The Mission Approach

This approach is well captured by the Marine Corps Doctrine Publications (1996). In chapter 1 they discuss the behaviour of a complex system, characterized by reciprocal action and feedback. This view of command and control has several important features which distinguish it from typical Command and Control. In the text they focus on the military context. Nevertheless the argument seems to be applicable in civil emergency management as well. They see the military organization as an open system, interacting with its surroundings, rather than as a closed system focused on internal efficiency. The feedback loop makes Command and Controls a continuous, cyclic process and not a sequence of discrete actions. The action-feedback loop also makes Command and Control a dynamic, interactive process of cooperation. Finally, the most important characteristic of this approach, this view does not see the commander as being above the system, exerting Command and Control from the outside –like a chess player moving the chess pieces – but as being in integral part of this complex web of reciprocal influence. The author ends the section saying: "It is unreasonable to expect Command and Control to provide a precise, predictable, and mechanistic order to a complex undertaking as war."

Rosen, Grigg *et al*. (2002) describes detailed and mission Command and Control as extremes along a spectrum of command structures. The mission Command and Control can be related to "Auftragstaktik", a German concept which dates back to the 19th century. Anglo-Americans use the term "mission-type orders" for Auftragstaktik. (Hoffman, 1994). The link to mission Command and Control becomes clear when analyzing the concept. The essence of Auftragstaktik is to give the subordinate commander a general mission. (Hoffman, 1994) Mission Command and Control decentralizes decision-making authority and grants subordinates significant freedom of action. (Rosen, Grigg *et al*. 2002)

In "Systems theory and the science of military Command and Control" (Skyttner, 2005) Skyttner introduces the living-system approach (inspired by Miller, 1978). A living system is a physical phenomenon existing in space and time containing a hierarchy with gradually increasing complexity. In the living-system theory the boundaries of the system are more conceptual than physical in higher system levels. This way of looking at the concept of Command and Control incorporates much of the ideas presented above. Skyttner means that the most important component in a system of Command and Control is the human being, a fact that could be interpreted as a non-mechanistic conceptual view.

A brief review on teaching literature on Command, Control and Coordination for international rescue and relief operations (Nato/PfP course 2004) and discussions with course participants indicate that the interpretation of the concept varies also in this field. Mission Command and Control is described in the teaching literature and the concept of co-ordination is given a lot of attention, but the understandings of Command and Control in these international connections sometimes also seem to be associated with a traditional military culture. The Swedish Rescue Services Agency, who is an international actor and a training institution, partly conveys a mission approach to Command and Control. International relief organizations operate in very complex environments where the administrative hierarchies aren't comprehensive and where the order mandate is not always very clear. Many different organizations, e.g. voluntary, military, local, governmental and international ones, operate both jointly and independently in contextual dependent environments which demand freedom of action, possibilities to ad-hoc solutions and incorporate administratively power neutral co-ordination functions. These circumstances appear to have influenced the actual application of Command and Control.

The Sceptical Approach

Some disaster researchers and organization theorists show a negative attitude to the Command and Control concept as a basis for disaster management or as a basis for management in general.

Comfort (1999) relates the concept of Command and Control to mechanistic models of systems in operation developed in physical sciences and engineering. Furthermore, she interprets the basic assumption underlying the models as if the problem is well defined and systems can be closed to outside interference and disturbance, they can function without error. According to Comfort the principle of Command and Control is clear specification of the authority relationships among subunits in order to increase control over performance of the whole organization. The Command and Control organizational design has proven functional and robust in well structured, routine conditions but is weak in uncertain, dynamic conditions (Comfort, 1999). She also writes that first response services such as the police, fire service and emergency medical services operate primarily with a Command and Control orientation and describes the efforts that have been made to adapt the strength of Command and Control principles to disaster environments, where common training and skills enable multiple units to work readily in co-ordinated action, but flexibility is needed for rapid response.

Quarantelli (1998) shows a clear negative attitude towards the concept of Command and Control as a basis for disaster management. He means that in many countries there is a strong tendency to assume that the best model for disaster organizational preparedness and managing is what has been called a "command-and-control" model. The notion taken from the military area that a top down, rigidly controlled, and highly structured social organization model ought to be developed for disaster purposes, is questioned. According to Quarantelli direct studies in the disaster area have not only shown that Command and Control models seldom are organizationally viable, but more important, would be poor models for disaster planning even if they could be implemented in the real world. He gives prominence to what he calls an *emergent resource coordination model* instead of a Command and Control model. Rather than attempting to centralize authority, it is far more appropriate to develop an emergent resource coordination model. The problem is one of coordination, not control. Quarantelli implies that disasters have implications on many different segments of social life and the community, each with their own pre-existing patterns of authority and each with the necessity for simultaneous action and autonomous decision-making. This makes it impossible to create a centralized authority system. Quarantelli writes that we ought to leave aside the fact that the command and control model is more fiction than fact even in the military area. It is not the way armies, navies or air forces actually operate, especially in conflict situations; stereotypes and group mythologies to the contrary.

Recently Drabek and McEntire (2003) conducted a review of literature on disaster sociology. They state that their collection of literature is representative of the significant debates, which have taken place in the sociology of disaster over the last 15 years. In their review they observe that recent research illustrates considerable tension between two models that seek to explain emergent phenomena and provide policy recommendations for emergency managers. Drabek and McEntire say that some scholars and most practitioners advocate Command and Control structures for disaster events while many sociologists recognize the spontaneous emergence of personnel and resources after disaster. Others favour a more complex perspective, and suggest the need for standard operating procedures in certain circumstances and altered bureaucratic structures and processes in other situations. Drabek's and McEntire's analysis of the literature results in a criticism of what they call the bureaucratic approach in which they include Command and Control structures. In their review they conclude that the Command and Control model is based on inadequate theory, incomplete evidence and a weak methodology. In relation to this conclusion they say that the assumptions of the Command and Control approach to emergency management are predominantly faulty. Drabek and McEntire conclude that their review of the literature shows the limitations of the Command and Control managerial model for disaster response.

Seddon presents in his book "Freedom from Command and Control" his thoughts on command and control thinking and what he describes as systems thinking (Seddon, 2005). He describes systems thinking as an alternative to Command and Control in service organizations and emphasizes among other things the need for individual freedom. Command and control designs stifle freedom. (Seddon, 2005). Furthermore he proposes an outside-in perspective instead of a top-down hierarchy. Seddon's main interest is, as said before, focused on service organizations, but his reasoning seems to be applicable to emergency response activities, as they reasonably can be regarded as a service function of the society.

In the Leader to Leader Institute Wheatley (1997) discusses living systems and self-organization, but unlike Rosen, Grigg et.al (2002) she uses these concepts as an alternative approach, i.e. not as a part of a developed Command and Control concept. Even though Wheatley has a broad approach and does not specifically mention emergency management, her reflection is interesting. She means that patterns of relationships form into efficient systems of organization and that organization is a naturally occurring phenomenon. As a living system self-organizes, it develops shared understanding of what is important, what is acceptable behaviour, what actions are required, and how these actions will be performed. Furthermore, she writes that as the system develops, new capacities emerge from living and working together. Wheatley is critical to the view of organizations as machines.

Discussion

Our interest in the discussion on Command and Control depends on our conclusions from analyses of emergency response management in three disasters in Sweden. In the summer of 2004 there were extensive floods in the south of Sweden and high water levels hit many communities. In January 2005 a great storm struck the southern part of the country. (Krisberedskapsmyndigheten, 2005). Forests were destroyed, people were isolated, serious electricity distribution problems occurred and some areas had to wait several weeks for the service to be resumed. In February 2005 a large emission of sulphuric acid in the city of Helsingborg occurred (Helsingborgs stad Brandförsvaret, 2005). 16 000 tons of sulphuric acid leaked out in an industry close to a residential area. The rescue operation continued for three days and the situation was uncertain. Many inhabitants had to stay indoors for several hours and measures were taken to cordon off large areas.

The structures of decision-making in these disasters did not emerge in accordance with the concept of detailed Command and Control in the whole operational context. Central in the concept of detailed Command and Control is the top down perspective. The authority comes from the commander at the top of the organization or the operational context and there is a more or less hierarchical organizational structure aimed to execute this authority downwards.

The empirical behaviour of decision-making in the analyzed disasters seemed, to a considerable extent to function in a bottom up perspective. Local decision makers were the first decision makers engaged in the dynamic courses of events. They were also "closest" the emergency and had to make decisions from their interpreting of the situation long before knowledge of the situation reached higher levels of management. An important function of higher levels then was more to co-ordinate these local decision makers than to exercise overall authority.

Our hypothesis, based on our analyses of the structures of the emergency response management in the three disasters, is that the central response management problem is to bring about a functional balance between a bottom up perspective and a top down perspective instead of exercising an authority from the top of the operational context. The formation of this balance depends on the dynamics in the course of events and different conditions in the operational context. In some phases of the course of events the top-down perspective is predominant and in other phases the bottom up perspective is predominant.

The three identified approaches to the concept of Command and Control can be discussed in relation to the problem of balance between top down and bottom up perspectives. The *detailed* approach of Command and Control neglects the problem of balance. The strict detailed chain of command from a central authority does not pay attention to the dynamic surroundings and is perhaps valid in a static surrounding. The *mission* approach is still related to the idea of a central authority in the system but can handle the balance problem through decentralized authority in accordance with the centralized authority. The decentralized authority gives possibilities to cope with dynamic surroundings. Researchers with a *sceptical* approach deny the possibility to create a centralized authority system and mean that disasters have implications for many different segments of social life and the community. Each such segment has its own pre-existing patterns of authority and the necessity for simultaneous and autonomous decision-making (Quarantelli, 1998). Quarantelli says that rather than attempting to centralize authority, it is far more appropriate to develop an emergent resource co-ordination model. The problem is one of co-ordination, not control. This approach denies that the dynamics and the great number of interests make it possible to create a central authority. The problem of balance in the management is solved by co-ordination.

According to research there is a clear tendency towards informal co-operation forms. Even normal organizations become more network-like. The development is from hierarchies to network and network demands trust. (Arwidsson, 1991) These statements are interesting as they seem to correspond to our empirical findings. The detailed approach to Command and Control does not take this development into consideration. In MCDP 6 (1996) the authors write that detailed control does not normally work well in a rapidly changing situation; nor does it function well when the vertical flow of information is disrupted. Therefore, it is not the preferred method of control under conditions of great uncertainty and time constraints.

Conclusions

The concept of Command and Control is interpreted and used differently depending on research discipline and practical circumstances. To avoid misunderstandings in the existing discourse there is a need for clarification in theoretical as well as in practical connections.

The criticism in the sceptical approach to Command and Control seems to a great extent to be focused on the detailed approach to the concept. In the Marine Corps Doctrine Publications (1996) Command and Control is described with words like co-ordination, dynamics and context depending which neutralizes some of the criticism broadly aimed at command and control from Quarantelli (1998), Drabek and McIntire, (2003), Comfort (1999) among others. Instead of seeing co-ordination as an alternative to Command and Control it sometimes is incorporated in the concept.

Our conclusion from the study of literature and from our analyses of the three disasters is that the central problem in emergency response management is to make balance between top down and bottom up perspectives in a dynamic surrounding instead of exercising a central authority downwards. We mean that there is a need for a theoretical development from that point of view.

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Author Biographies

Christian Uhr is employed by the Swedish Rescue Services Agency and is a PhD Student at the Lund University Faculty of Engineering, Department of Fire Safety Engineering. He works together with Prof. Lars Fredholm in the research project, “Improving Emergency and Crisis Management”. The work is focused on trying to identify conditions for rapid establishment and adaptation capability in important management functions.

Lars Fredholm is employed as a researcher at the Swedish Rescue Services Agency and adjunct professor at Lund University Faculty of Engineering, Department of Fire Safety Engineering. He is a project manager for a research project named “Improving Emergency and Crisis Management”.

THE LESSONS LEARNED FROM THE EVALUATION OF EMERGENCY MANAGEMENT FOR LOCAL GOVERNMENTS IN KOREA

Kisung Bang [1]
Korea NEMA

Youngjai Lee [2]
Dongguk University

Keywords: lessons, evaluation, emergency management, local government

Abstract

The Korean NEMA has evaluated the emergency management of the local government to intensify the capabilities of emergency preparedness. The three components are involved in the evaluation: organizational capability, four phases of comprehensive emergency management, and the elected official's interest. 250 local governments took part in the evaluation process.

The main point was to move organizational programs from efforts toward post-disaster to efforts toward pre-disaster, via a route that poses strategies, policies, and budget, etc. However, the lack of experience of emergency management for the local government was that the integrated emergency management system was not organized elaborately. The evaluation showed that every community needs to develop its own emergency preparedness program, which permits effective response, although vulnerability and threats vary.

Introduction

Korea NEMA (national emergency management agency) had managed prevention, mitigation, preparedness, response, and recovery of natural disaster since being established in 2004. And NEMA had set up its organizational structure over local governments and operated local emergency management teams last year. For the teams' operations, NEMA built up national laws, regulations, policies, programs, and liabilities, etc in terms of local emergency management.

NEMA had the necessity to evaluate how well the emergency management department of the local government follows the rules about emergency preparedness, and in conducting its emergency response and recovery. In addition, the law required evaluation yearly. Accordingly, this paper introduces the evaluation of the emergency management practice (activities) for the local government and it also addresses the lessons learned from it.

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[1] Director of Natural Disasters, Korea NEMA, bks5231@nema.go.kr
[2] Professor, University of Dongguk, KOREA, yjlee@dgu.edu

Evaluation Indicator

The purpose of the evaluation of the local government activities was to intensify its capabilities, teach about past activities, prepare more detailed evaluation methods objectively, and to drive interest of top official such as the mayor. Evaluation indicators were first developed to achieve these goals. The indicators' scheme was composed of a hierarchical structure. The first level of this structure was as the following components: organizational capability, four phases of comprehensive emergency management, and the elected official's interest. These components were divided into a more detailed hierarchy.

Organizational capability meant emergency management team organization, emergency management plan feasibility, emergency operation center essentials, emergency management funds preparation, special policy development with innovative activities, and committee organization. This first component included six criteria, and each criterion had its own two or three sub-criteria. These sub-criteria were composed of several elements which get a score on the basis of written documents described by the local government [table 1].

[Table 1] An example of evaluation indicator scheme

Criteria	Sub-criteria	Grading basis element	Evaluation standard	Referred documents
1010 Emergency management team	1011 EMT Organization & Consolidation	1011-1. EMT propriety 1 section 2 charge (A) 2charge (B) 1 charge (C) Others (D)	·Organizational Structure	·Regulation of EMT ·Organizational Chart & human resource
		1011-2. Manpower Increase 8 above (A), 6 above (B), 4 above(C), below (D)	·Human formation	
		1011-3. Ratio (present staff/full staff)*100 90%(A), 80%(B), 70%(C), below (D)	Organization Consolidation	

The second component (four phases of comprehensive emergency management) referred to prevention including mitigation, preparedness, response, and recovery. Prevention phase included 10 activities that mainly focus on public safety. Preparedness phase consisted in six criteria that explained exercise and emergency preparation according to the types of disaster. The response phase had four elements that primarily showed emergency action and relief. In the last phase, the recovery step was evaluated by the physical restoration of the community and detailed recovery plans from disasters.

The third component (the elected official's interest) was an essential indicator. The total budget, reserve funds, and the organization structure depended on high-ranking officials' interest and support. These high-ranking officials included the provincial governor, the mayor, the county headman, and the mayor of a borough. The third level was concerned with how much they make an effort to manage the local disasters.

Evaluation Method

[Table 2] shows that mark allot to the first level (components) of the evaluation indicator's scheme. The total mark of the megalopolis and the province was different from the city, the county, and the borough, in which their activities were centered in the actual field.

[Table 2] Allotting of Mark Table

<table>
<tr><th colspan="2" rowspan="2">Component</th><th colspan="2">Megalopolis, Province</th><th colspan="2">City, County, Borough</th></tr>
<tr><th>mark</th><th>Subtotal</th><th>mark</th><th>subtotal</th></tr>
<tr><td colspan="2">Organization Capability</td><td>250</td><td>250</td><td>250</td><td>250</td></tr>
<tr><td rowspan="4">4 Phases of Emergency Management</td><td>Prevention</td><td>240</td><td rowspan="4">500</td><td>350</td><td rowspan="4">700</td></tr>
<tr><td>Preparedness</td><td>90</td><td>150</td></tr>
<tr><td>Response</td><td>70</td><td>100</td></tr>
<tr><td>Recovery</td><td>100</td><td>100</td></tr>
<tr><td colspan="2">Official Interest</td><td>50</td><td>50</td><td>50</td><td>50</td></tr>
<tr><td colspan="2">Total</td><td>800</td><td>800</td><td>1,000</td><td>1,000</td></tr>
</table>

Nine megalopolises, seven provinces, and 234 cities/counties/boroughs took part in the evaluation process. First, the emergency management team of the megalopolis and the province evaluated their jurisdictional cities, countries, and borough with grading standard that symbols A (A+, Ao), B (B+, Bo), C (C+, Co), and D. As a result, the team selected a high-ranking 20% and a low-ranking 20% among their jurisdictional ones and reported the consequences to NEMA.

The central evaluation team consisted of NEMA officials, university professors, and consultants of private sectors. They visited the office of the local governments, and reviewed written documents, and interviewed officials in terms of their selected high-ranking city, county, and/or borough including the megalopolis and the province. They also interviewed the provincial governor, the mayor, the county headman, and the mayor of the borough about their efforts, interests, and their participation in the local emergency management.

Evaluation Result

Of course, the central team chose excellent local governments, in which the team praised and rewarded them. The overall viewpoint was to transfer organizational programs from efforts toward post-disaster (response and recovery phases) to efforts toward pre-disaster (mitigation and preparedness), via a route that poses strategies, plans, goals, policies, regulations, and budget, etc.

However, the integrated emergency management system was not organized elaborately because of the lack of practice and experience of emergency management for the local government. The evaluation showed that every community needs to develop its own prevention and emergency preparedness which permits effective response, although vulnerability and threats may vary. The evaluation also helped assess the personal and organizational vulnerability, and recognize the importance of the top leader's supporting structure.

Another objective of this evaluation was to find out a good model case from each phase of the emergency management. NEMA expects that the local government reflects lessons learned from the suggested models to manage local disasters with other disasters.

Learned Lessons

The main issue from the evaluation was necessary to elaborate the emergency management system and the institution for the community's confidence. Here are the lessons learned from the local emergency activities.

Intensify Vulnerability/Risk Assessment Process

First, the vulnerability and risk assessment will have to be conducted if the plan of effective local safety management, preparations of local prevention foundation, specific character of locality, and a particular program can be designed and operated successfully. For instance, some models were like as the following:

- Research project for disaster prevention and hazard mitigation about disaster vulnerable areas
- Evacuation manual by developing a map of expected flood districts.
- Response plan about oil spill accidents of private sectors located in a district.
- Awareness survey of officials and civil monitors in terms of emergency management

Second, the local government will have to be induced so that it can do risk assessments using disaster funds because of limitation about regular safety inspection of local facilities. Also, so it can monitor vulnerable areas simply for the prevention and the mitigation.

In conclusion, the local vulnerability/risk assessment was essential to increase local prevention capabilities as well as being projected programs of the emergency management suitable to local characteristics.

Strengthen Field Response Functions

First, the coordination plan between EMT, government agencies, and civil organizations will have to be specific to mobilize and allocate human and physical resources efficiently.

Second, it requires an effort to make public media coordinate during disasters to participate in proactive and reactive disasters such as training and exercise, public information, damage assessment, and the restoration from disasters.

Third, it requires the identification of the role of EMT of megalopolis and province that guides and advises some activities related to emergency management of its jurisdictional organizations in order to intensify the team's authority and capability. The following systems for guidance and advice are included: funds support, evaluation institution, pamphlet publication for community etc.

Reinforce Lesson Learning Process

First, the Lesson and Learning process has to be reinforced to improve programs related to the prevention and the emergency preparedness through education, training, exercising, disaster recoveries, and through the official's knowledge etc. A good model in a county was illustrated where inhabitants lightened candle-lights or smoked using straws to rise temperature in vinyl houses during snow storm.

Second, the evaluation system needs to be mainly concerned with improving somewhat and reflecting somewhat to the system rather than simply evaluating institutions and programs of emergency management. The following elements will be suggested as evaluation process:

- Accumulate vital records and knowledge with experience for emergency management learning.
- Gather why cases become successful and unsuccessful.
- Examine whether the emergency action plan were activated and the response procedures were undertaken well.

Need High-ranking Officials' Interest, Participation, and Support

First, it needs policy and institution for top official to be more interested in protecting life and property of residents rather than a demonstration effect about facilities and administration

- Participate in education and exercising.
- Observe vulnerable and dangerous districts regularly.

Second, a good model of top official's prevention needs to be found out as following:

- Have a meeting with the top leaders of each organizations monthly to discuss some issues related to a county.
- Set up organizations newly to support human power for damage recovery.
- Inspect and Improve their living facilities by improving power, gas, and boilers etc, for poor residents and the back village that lacks the ability to do it themselves
- Apply a patent about development of prevention product.
- Operate local self-control organization of prevention that inhabitants join.

Require Information Support System

First, it is necessary to use information support system or data retrieval system after developing it. For increasing officials' productivity, resources such as human, physical data including vital records, manuals, and private organizations can be retrieved and modified efficiently. Thus, these resources must be managed systematically.

Second, information technology can be applied to emergency management after business processes are rearranged. A good case in a city showed that the mayor interviewed through the conference call system because he was in another megalopolis.

Conclusion

The lessons learned from this regular evaluation helped improve disaster prevention performance and made emergency preparedness more comprehensive and realistic. The evaluation activity was ultimately helpful in finding oversights and deficiencies, and guiding how well the emergency management was being managed.

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Author Biography

Mr. Kisung Bang
- General Director, Headquarters of Recovery Support and Relief, Korea NEMA
- Business Activity: Strategy and Policy in Natural Disaster Management
- E-mail: bks5231@nema.go.kr

Dr. Young-Jai Lee
- Professor, MIS Department, Dongguk University
- Chairman, Korea BCP Association
- Vice-President, TIEMS
- Research Area: Risk-Based Decision Making, Information Management
- E-mail: yjlee@dgu.edu

INTEGRATION OF UBUNTU WITH THE DESIGN AND PRACTICE OF EMERGENCY MANAGEMENT TRAINING PRINCIPLES

James C. Hagen, Ph.D., M.B.A., M.P.H.[1]
Saint Xavier University

Keywords: Ubuntu, Disaster, Emergency, Tabletop, Full-Scale

Abstract

There is an assumption of the universality of management approaches that allows, or becomes an imperative to, direct utilization of Western teaching methods and techniques in the unique environment of developing southern African nations. What needs to be acknowledged and addressed is that emergency training methodologies must be operationalized not only within the governmental, economic, and political realities of the nations involved, but also within unique social, familial, and cultural constructs. It is the purpose of this paper to look at potential modifications of existing emergency training methods.

Currently, there is specific training being provided to those who wish to become experts in exercise design and Master Exercise Practitioners (MEPs) in the United States. Identified design steps and procedures for exercise conduct are taught as models for exercise development. Although these procedures have been demonstrated to be highly effective in Western Culture to train those involved in Emergency Management, such training practices are not directly compatible with the ubuntu reality. Decision-making, communication, and perception of time are three critical areas of ubuntu philosophy when considering their impact on emergency preparedness and response. Similar considerations have been made when working with the Alaskan and American Indian native cultures as well.

This presentation will serve to demonstrate how the ubuntu concept of "humanness" might be integrated into the western training methodologies of tabletops, drills and exercises. It is truly through appropriate cross-cultural training principles and practices that confident, competent emergency managers and leaders will emerge.

Introduction

Within recent years, the importance of, and reliance on, the use of drills, tabletops, and exercises in training for disaster management has increased significantly.

There are three well know teaching techniques: lecture, guided discussion, and demonstration/ performance. It is demonstration and performance that are most important in teaching skills and expected behaviors. In disaster situations, pre-arranged actions need to be taken in a short period of time for the most effective response. The cornerstone of this type of training is application of knowledge through actual performance (and repetition) of skills and procedures.

[1] Director, Public and Non-Profit Management Program, Graham School of Management, Saint Xavier University, 18230 Orland Parkway, Orland Park, IL 60467, hagen@sxu.edu

In the United States, there are certain Fundamentals of Instruction familiar to all those who teach. This is especially true for those who teach skills requiring application of knowledge in the practical and measurable world of disaster management. New material is taught in four steps:

1. Preparation – to clearly create a lesson plan, with objectives, goals, and necessary materials detailed.
2. Presentation – to identify and define the best methods of presentation suited not only to the material to be presented, but to the audience to whom the material is being presented.
3. Demonstration/Application – to allow the students to physically apply the knowledge gained as early and as often as possible.
4. Review and Evaluation – to evaluate how much knowledge has been conveyed with respect to goals and objectives, and then provide corrective measures appropriate to the individual and culture involved.

Lecture and guided discussion, although vital to the successful disaster management training, must be followed by demonstration and performance. It is through repeated application of skills that actual learning takes place. This concept holds true, regardless of the culture in which the training takes place. However, method of delivery of instruction must be carefully considered in light of cultural realities if the ultimate goal of information transfer is to be attained. This is especially true concerning the ubuntu philosophy of southern Africa. Basic concepts of ubuntu should be related to the demonstration/application method of teaching disaster management. To be truly successful, African leaders must borrow ideas and practices from the rest of the world, while anchoring themselves in their own cultural roots (Mbigi, 2005). Leaders in disaster management in the Western world should do the same. Ubuntu within southern Africa offers not only challenges, but opportunities for those who manage and respond to disasters.

Ubuntu as a Cultural Cornerstone

Ubuntu is not a new concept within African management literature (Karsten and Illa , 2005; Lascaris and Lipkin, 1993; Mbigi and Maree, 1995). As a philosophical thought system, ubuntu is commonly used as a measure of good and bad, right and wrong, just and unjust (Mangaliso and Manzo, 2001). Broodryk (2005) defines ubuntu as humanness, and states that the basis for this humanness is found in the slogan "umuntu ngumuntu ngabantu" which means "I am a person through other human beings".

A critical concept when considering ubuntu and language is the difference between language as used to transfer information, and conversation. More traditional approaches focus on information transfer, whereas ubuntu, as a philosophy and way of life, focuses on conversation. Lervik and Lunnan (2004) conceive transmission of management concepts as more efficiently taking place through transmission processes like conversation.

Mbigi (1997) states that "Traditional African life is characterised by grass-roots, participatory, and consensus democracy….Traditional African education is both a social and intellectual journey". Mbigi goes on to stress that current training programs are too intellectually dry and analytic. They need to more intentionally include "creative design", and "social and ritualistic aspects of learning in designing training and development programs". Ubuntu teaches that life is an indivisible whole and that we experience life through others. It emphasizes our interconnectedness and responsibility to each other (Nussbaum, 2003). We must use this participatory and social form of culture in creating learning experiences that best convey disaster management principles. In doing so, we seek to combine rather than divide, include rather than exclude, and work within a whole life construct rather than to subdivide and compartmentalize. Those thoughts are antithetical to much of Western teaching that seeks to transfer information through breaking it down into manageable pieces and compartments.

Tabletops and Exercises in Emergency Management Training

The United States Federal Emergency Management Agency (FEMA) defines an exercise as "a focused practice activity that places the participants in a simulated situation requiring them to function in the capacity that would be expected of them in a real event." Real-world emergencies and disasters have proven time and again the vital importance of exercises to a rapid and effective response. In an emergency situation, people tend to respond in the manner they are familiar with, the manner in which they are trained. In 1989, United Airlines Flight 232 crashed in Sioux City, Iowa. Of the 295 on board, 186 passengers survived the failed emergency landing attempt. The high level of training and readiness of the community was apparent in this event. Two years prior to the crash, a full-scale exercise had been held, revealing many issues and problems that were corrected prior to the actual crash.

Two months before the Loma Prieta earthquake struck Northern California, FEMA had coordinated a full-scale response exercise that was credited with improving the disaster response to that event. In 2000, the Urban Search and Rescue (US&R) Task Forces participated in exercises (a building collapse scenario and an earthquake based scenario) that gave them experience to search for victims when they were sent to New York City after the collapse of the World Trade Center towers.

The purpose of exercises is to provide competence in emergency functions. The two main benefits of such training are individual training, providing experience at practicing one's own role and system improvement, allowing a broader perspective of how a system responds to an emergency. In most cases, it is the systemic training that uncovers the worst deficiencies in response capabilities. Finding and correcting these deficiencies before an actual disaster is always the goal.

The ideal comprehensive exercise plan will be of progressive complexity (Emergency Management Institute, 2006). From the outset, departments, organizations, and agencies interact, with each exercise building on the former. One difficulty in this nation has been the interaction of different entities in a community response. Each sector (such as the hospital, police, transportation, volunteer agencies) may have highly specific drills, such as within a hospital to test evacuation procedures, or to see if a fire department or brigade can successfully put out a fire. However, it is the entire community integrated response that is tested in an exercise. Ubuntu already values the community as one entity, and will greatly enhance the ability of southern Africans to respond on a local level. Exercises begin as discussions around a table, or tabletops

In an ideal situation, the first step in the comprehensive exercise program would be to gather the different sectors together in a very low stress environment to discuss how best to prepare for emergencies or disasters. In reality, this step is often neglected because of short time frames, limited time for meetings, or the perception that it is not necessary. The next step is for each sector to hold drills to make sure they know what is needed within their area in response to a disaster.

The next exercise in complexity and stress would be the functional exercise. Although actual resources (people or things) do not actually move, this exercise more realistically tests several functions, and the ability of the community to work together to effect a successful response. The Players sit around a table, as in the tabletop exercise, but simulators in another area communicate by phone, fax, radio, or other methods of communication, simulating the unfolding of an actual event. This type of exercise is critical prior to a full-scale exercise to identify and correct problems that might cause fatal flaws in the execution of full-scale exercises. The full-scale exercise then follows, where a real event is simulated as closely as possible. A simulated event causes responders and their equipment to move, and involves actors or simulated victims that are handled as they would be in a real event. Law enforcement, volunteer organizations, businesses, and all potentially affected parties can be involved. And the exercise may involve governmental officials as high as desired. The larger national events may also exercise international relationships.

Two phrases come to mind when considering the intersection of emergency management and ubuntu. The first is the often used phase “All disasters are local.” The second is the African proverb “It takes a village to raise a child.” In disasters, the community must rise up as a single response entity. It is the community that should be responsible for protecting our most vulnerable populations, especially in an emergency or disaster situation.

Ubuntu Principles Critical to Emergency Management

Decision-making, communication, and perception of time are three critical areas of ubuntu that must be taken into consideration to determine their impact on emergency management training principles (Mangaliso and Mzamo, 2001)**.** Similar considerations have been made when working with the Alaskan and Hawaiian native cultures as well.

One critical issue when considering ubuntu in the context of emergency management is in the area of decision-making. As emergency managers, we often must decide between alternative courses of action and make rapid unilateral decisions. These decisions must often be made in very short periods of time with limited information during crisis situations. Under ubuntu, this linear process becomes a circular one, with time needed for serious considerations of many alterations, as well as their permutations. The need for speed in crisis situations must be taken into account, while respecting the ubuntu perspective of consensus. Americans decide as individuals in a command and control structure, and value the opinion of experts, whereas Africans decide by consensus and value the opinions of everyone (Broodryk, 2005). Unity resulting from consensus is the goal in ubuntu, while quick action and decision-making, a linear process, is the emergency management response. In realizing the importance of this type of decision-making process, it is ever more vital that these types of considerations take place prior to crisis oriented events. Not only does this result in a more unified, consensus-based decision, but greatly enhances the long term commitment to goals and smoothness of implementation should the need arise.

Another aspect of ubuntu that must be given serious consideration is the heightened importance of oral tradition in language and communication. Traditionally, stories transmitted from generation to generation served as the foundation for their beliefs, heritage, and wisdom (Ahiauzu, 1986). It is interesting that white South Africans are now learning Zulu as a means of better understanding the patterns of interaction (Crowe, 1995) that occur in their culture. In carrying on oral tradition, African youth grow to listen more closely, to focus on context, and to place much more importance on the spoken word. Wisdom and cultural values, and a sense of belonging comes from oral tradition and the social context in which it occurs. Conversation and social interaction are critical to the understanding of, and ultimately taking appropriate action during, a crisis.

The perception of time, its importance, and its role in accomplishing goals has always been a major cross-cultural issue. Time is not perceived in African cultures as measured in discrete units in traditional Africa, but rather as a continuum, to be experienced and shared (Mangaliso and Mzamo, (2001). It values events and relationships, and is used to treasure the past and the future. Broodryk (2005) calls this African time, or tolerance time, and correlates the stress resulting from being so time conscious to serious health issues in Europeans. He also notes that the Japanese have a similar culture of communalism, and retain their traditional concept of time that is similar to African time. However, when dealing with the Western world, the Western concept of punctuality is honored. There is a fundamental difference of perception of time. It is said that "God gave the African time, and the Westerner a watch" (Fadiman, J.A., 2000). This can be a most difficult to align with ubuntu, as time in emergency management often translates into lives lost or destroyed.

Emergency Management is a unique perspective when examining and integrating ubuntu perspectives and perceptions into disaster scenarios. Because of its time sensitive nature, and the effect it can have in life and death situations, there must be special considerations made when planning and conducting tabletops, drills, and exercises with decision-makers, managers and the public. Lessons learned can then be extrapolated more generally to the application of management and leadership theory.

Conclusions

It is the contention of this paper that both cultures have much to gain from an incorporation of ubuntu philosophical concepts into comprehensive exercise planning. By enhancing and taking advantage of the African concept of community, the "Orientation Seminar" in the Comprehensive Exercise Plan becomes an even more critical component of a successful exercise program. In Africa, one must work with the existing community structure in consensus building concerning activities surrounding potential disasters. In the United States, where one often moves straight to tabletops and exercise without community building activities, much more emphasis must be placed on building community infrastructure prior to, or in concert with, the orientation.

In Africa, the exercises should incorporate story telling in the oral tradition with existing written methods of communication. The social context and conversation become critical to the community working together in the response activities. From tabletop to full-scale exercises, participatory learning is the key to translation of knowledge and ultimately to demonstration and application of the skills necessary during a response. Kotze and Holloway (1996) have provided an excellent resource for reducing risk and consideration of disaster mitigation in Southern Africa. Activities are provided, drawing on hazards and vulnerabilities specific to that area. It is critical that risk reduction efforts be linked to community-based services, and that active partnerships exist between emergency response community and the communities-at-risk. Often neglected is the fact that "the greatest impact of recurrent threats falls on women" In Africa, although women are the ones who maintain family under the worst conditions, as well as provide goods and services, they are often considered the most vulnerable. They are limited in education, political opportunity, and access to information. The number of households headed by women increases, as does the poverty level of this group. If there is to be a successful response, those most involved with family and community life must be intimately involved in exercise activities.

Exercises must be specific to the southern African realities. Southern Africa has been subject to severe drought, seasonal flooding, deadly endemic diseases, periodic epidemics, and decades of civil unrest. It is in working together that communities strive to survive. One must take advantage of this strength when planning for disasters. Dealing with the fundamental difficulty in different perceptions of time is one of the most difficult issues. Although pre-planning has always been a fundamental concept, it is even more important that advantage be taken of existing community infrastructure, or the infrastructure reinforced before further actions are taken. As much consensus as possible must be reached on vital questions pertaining to response so that valuable time is not lost in obtaining optimal cooperation and community response. Much work has yet to be done in integrating and incorporating ubuntu into management training practices. The first step needs to be an identification of the fundamental differences so that the best of both worlds may ultimately be utilized.

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Risk Assessment & Professional Practice

QUANTITATIVE HAZARD ANALYSIS OF INFORMATION SYSTEMS USING PROBABILISTIC RISK ANALYSIS METHOD

Dr. Young-jai Lee[1], Taeho Kim[2]
Dongguk University

Keywords: hazard analysis, probabilistic risk analysis, activity based costing, business process, information systems

Abstract

Hazard analysis identifies probability to hazard occurrence and its potential impact on business processes operated in organizations. This paper illustrates a quantitative approach of hazard analysis of information systems by measuring the degree of hazard to information systems using PRA and activity based costing (ABC) technique. Specifically the research model projects probability of occurrence by PRA and economic loss by ABC under each identified hazard. To verify the model, each computerized subsystem which is called a business process and hazards occurred on information systems are gathered through one private organization. The loss impact of a hazard occurrence is produced by multiplying probability by the economic loss.

Introduction

Organizations have demanded hazard analysis and emergency preparedness about all hazards such as computer and communication breakdowns, and cyber terror as business activities dependency on information systems increased continuously. Hazard analysis identifies probability to hazard occurrence and its potential impact on business processes operated in organizations. This paper is focused on how hazard analysis manages quantitatively.

Crisis management and quantitative/qualitative hazard analysis about information systems were investigated. In addition, several case studies by the probabilistic risk analysis (PRA) method described other subjects such as nuclear, intelligent traffic system, and industrial engineering, etc. These subjects have involved in this research.

This paper illustrates a quantitative approach of hazard analysis of information systems using a case study.

Research Model

The research model is represented as following:

$$f(R_i)=\sum P_i \times L_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

[1] Professor, University of Dongguk, KOREA
yjlee@dgu.edu
[2] Graduate Student
kimclub1@empal.com

- f(Ri): The sum of risk loss impact from the beginning to "i"th event-path
- Pi: The probability of hazard occurrence of "i"th event-path
- Li: Loss amount of "i"th event-path

<u>Probability of hazard occurrence (Pi)</u>

The Probabilistic Risk Analysis (PRA) is used to measure probability of the hazard occurrence (Pi) in this research. Specifically among the PRA methods, the Event Tree technique takes as modeling of the hazard analysis and the MCS (Monte Carlo Simulation) as a probabilistic analysis technique.

PRA means a model that allows the uncertainty of the business to be quantitative through the probability distribution of the resulted variables. Also, it is the accumulated probability distribution as taking the assumption that the probability distribution of the hazard variables is related to the business uncertainty [(US.DOT, 1996)].

The formula to produce Pi refers to Cho's model (2000) and makes it by using the Event Tree technique as following.

$$Pi=P(Cn)(Ci...k)=P(Ti)P(E1)P(E2)......P(Ek) \qquad .... \qquad (2)$$

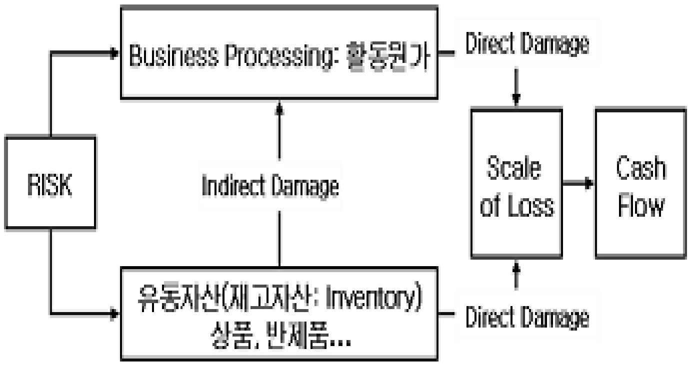
In this model, ***P(Cn)*** indicates the probability of an event to be the possible stirring (***Ti***). ***P(Ci...k)*** means that the probability of each event can be possibly occurred from ***P(E1)*** to ***P(E11)*** on an event-path. In other words, an event that can be possibly occurred is caused by a stirring event. ***Pi*** produces a result by multiplying ***P(Cn)*** by ***P(Ci...k)***.

The procedure to measure ***Pi*** is as followings:
i) The classification between a stirring event and an event occurrence
ii) Build up the event tree scheme
iii) The calculation of probability of the event occurrence is related to each event-path using MCS

<u>Loss Amount (Li)</u>

The measurement of the loss impact is based on the Activity Based Costing (ABC) method. Fig. 1 shows the ABC model. If a crisis strikes an organization, business processes, assets, property, or a business image, they are damaged. Those elements affect the decrease of sales volume of the organization directly and indirectly, which produces bad cash flow as a result. The major concern is how business processes and inventories that are damaged by a business crisis, measure quantitatively in terms of information systems.

<u><Fig. 1> ABC Model for Economic Loss Measurement</u>



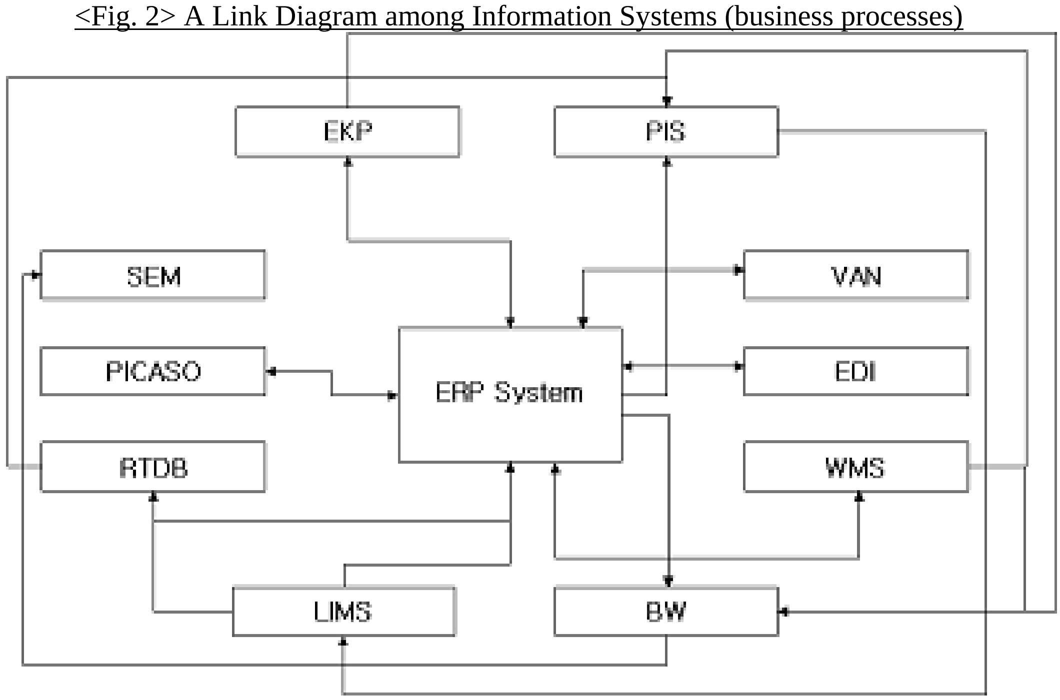
Research Model Analysis

The research model is verified through a case study that illustrates a big chemical engineering company being composed of the headquarter and a factory in the local area. It assumes that the hazard strikes the information systems in the organization.

Analysis of Information System Asset

The information system includes ERP and 13 legacy systems, in which each system is consisted in detailed business processes. Fig. 2 shows a link among each system, which means that a linked system is affected if one system breaks down because the systems share the data. PICASO, RTDB, LIMS, PIS, and WMS subsystem supports the manufacturing process. SEM provides executive management based on data which are produced by the BW subsystem. EKP operated by a groupware system is a kind of knowledge management system.

<Fig. 2> A Link Diagram among Information Systems (business processes)



The expenses element with the amount gathered as the following: IT expense ($1,919,629), IT property ($1,919,629), Salary ($47,009,496), department expense used by employees ($24,263,771), external project ($322,099), and business profit ($162,685,177).

Hazard Analysis of Information Systems

The Incident/Accident history with the interview to the system director is gathered to analyze the hazards related to the information systems.

Table 1 shows hazards that were controlled orderly within a specific time period during one year (2003). This research is focused on the technological hazards such as human error, and equipment failure (except natural hazards and civil hazards). The organization was faced with cyber terror, and the virus had the highest rate among the hazards.

<Table 1> Accidents that occurred on Computer & Information Systems

Category	Accident	number	Rate(%)	Acc. No.
Operation Defect	Virus	9	30.0	T1
	Data deletion on PC	1	3.3	T2
	Operator error on Servers	1	3.3	T3
	Lack of DB management	1	3.3	T4
	Defect of computer devices	1	3.3	T5
Operation Defect / System Defect	Server breakdown	2	6.7	T6
System Defect	Network down & defect	3	10.0	T7
	Defect of Web service	1	3.3	T8
	Data transmission delay	1	3.3	T9
	Server disk error	2	6.7	T10
	DB defect	1	3.3	T11
Infrastructure Defect	Air conditioner trouble	4	13.3	T12
	UPS defect & trouble	3	10.0	T13
Total		30	100.0	

Scenario Development of Hazard Analysis

1. Event on Hazard Analysis
The PRA measures probability of the event occurrence with the event tree model, which is developed by a predefined scenario. There are two kinds of scenarios. One is for stirring event and the other is for the event that can possibly occur. The stirring event promotes an event that is possible to occurrence, which may be a series of events. The accident that shows in Table 1 indicates a stirring accident. A breakdown of business process (such as ERP system that shows in Fig. 2) is affected by a stirring event, which refers to an event that is possible to occur.

Accordingly, we called that the process breakdown of ERP, EKP, BW, SEM, PICASO, LIMS, RTDB, WMS, VAN, EDI, PIS into E1, E2, E3, E4, E5, E6, E7, E8, E9, E10, E11 sequentially.

2. Scenario Development of Accident Occurrence
The purpose to develop the scenario related to the accident occurrence is due to the lack of historical data in the organization. The scenario was created based upon a few historical data.

Table 2 shows the total number and the rate of each stirring event that explains accident occurrence, which is derived from a scenario during two years. Virus (29%) is the most and DB defect is the least (2%) among the stirring events.

<Table 2> Stirring Events by Scenario

분류	세부사건	사고번호	기간																								총사고수	사고비율
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		
운영장애	바이러스	T1	0	0	1	1	0	1	1	0	0	1	1	1	0	0	2	1	0	0	1	0	0	1	1	0	13	0.29
	PC안 정보삭제	T2	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0.04
	운영자의 서버장비조작실수	T3	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0.04
	DB관리미숙	T4	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0.04
	전산주변장비장애	T5	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0.04
시스템장애	서버다운	T6	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	3	0.07
	네트워크다운 및 장애	T7	0	1	0	0	0	1	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	4	0.09
	웹서비스장애	T8	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0.04
	데이터전송망딜레이	T9	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	2	0.04
	서버디스크에러	T10	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	3	0.07
	데이터베이스 장애	T11	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0.02
기반시설장애	서버에어컨고장	T12	1	0	0	1	0	0	0	1	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	1	5	0.11
	UPS장애 및 고장	T13	1	0	0	0	1	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	4	0.09
총계																											45	1.00

Table 3 refers to the total number and the rate of breakdown of each business process that indicates an event occurrence, which is derived from a scenario during two years.
ERP breakdown (24%) is the most among event occurrences.

<Table 3> Events Occurrence by Scenario

Process명	사건번호	기간																								SUM	사건발생비율
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		
ERP	E1	1	0	0	1	0	0	1	0	0	1	1	0	1	0	1	1	0	1	1	0	1	0	0	0	11	0.24
EKP	E2	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	1	6	0.13
BW	E3	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0.07
SEM	E4	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0.04
PICASO	E5	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	5	0.11
LIMS	E6	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0.07
RTDB	E7	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	4	0.09
WMS	E8	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0.07
VAN	E9	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	3	0.07
EDI	E10	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	3	0.07
PIS	E11	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0.04
총계																										45	1.00

3. Scenario Development of Event-Path
An event-path scenario that is shown in Table 4 develops on the basis of the link among the business processes like Fig. 2.

<Table 4> Event Path Scenario of ERP Business Process

Scenario No	T	P1	P2	P3	P4	P5	P6	P7
1	T1	E1	E2	E3	E4			
2	T1	E1	E5					
3	T1	E1	E6	E7	E11			
4	T1	E1	E6	E7	E8	E11		
5	T1	E1	E6	E7	E8	E3	E4	
6	T1	E1	E6	E11				
7	T1	E1	E11	E6	E7	E8	E3	E4
8	T1	E1	E9					
9	T1	E1	E10					
10	T1	E1	E8	E11	E6	E7		
11	T1	E1	E3	E4				

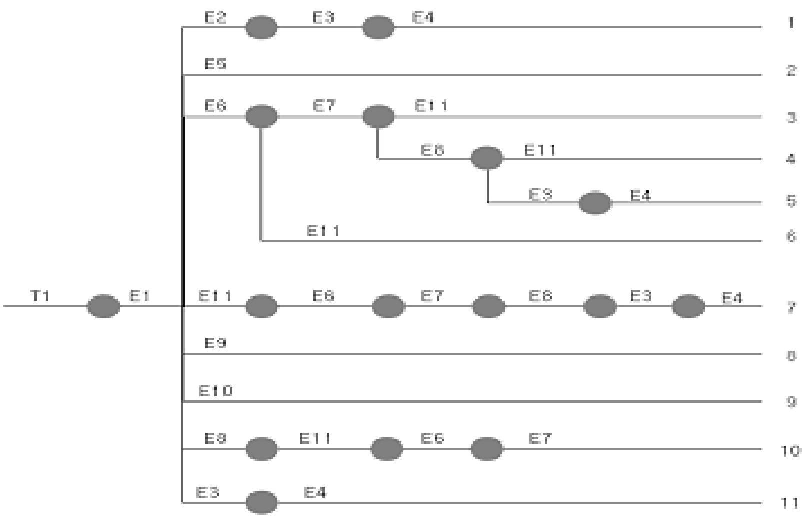
T: stirring event, P: business process

In the case of scenario number 1, for example, T1 (stirring event, virus) affects E1 (event occurrence, ERP) breakdown. E1 induces E2 (EKP) breakdown, and E2 brings about E3 (BW) breakdown, and E3 causes E4 (SEM) breakdown. Scenario 1 refers to an event-path. Table 4 includes 11 event paths stirred by a virus accident (T1). Accordingly, event paths can be created by each stirring event, that is, overall accidents in the organization.

Event Tree Modeling

The event-paths can be transformed to an event tree that represents the relationship between a stirring event and event occurrences. The Event Tree that comes from the event paths in Table 4 shows a causal relation between E1 (ERP) and the other Legacy system, induced by T1 (virus stirring event)[Fig. 3]

<Fig. 3> Event Tree Induced by a Stirring Event T1



<u>Monte Carlo Simulation</u>

@RISK 4.5.2 simulation software for the Monte Carlo simulation selects a P method among several probabilistic distributions. P distribution requires the average and standard deviation of each stirring event that shows in Table 5, and the average and standard deviation of each event occurrence that shows in Table 6. Table 5 and Table 6 make on the basis of Table 2 and Table 3.

<Table 5> Average & Standard Dev. of Stirring Events

분류	세부사건	사건번호	평균 사건발생수	표준편차
운영장애	바이러스	T1	0.541666667	0.588229966
	PC안 정보삭제	T2	0.083333333	0.282329851
	운영자의 서버장비조작 실수	T3	0.125000000	0.337831962
	DB관리미숙	T4	0.083333333	0.282329851
	전산주변장비장애	T5	0.125000000	0.337831962
시스템장애	서버다운	T6	0.166666667	0.380693494
	네트워크다운 및 장애	T7	0.250000000	0.442325868
	웹서비스 장애	T8	0.083333333	0.282329851
	데이터전송망딜레이	T9	0.083333333	0.282329851
	서버디스크 에러	T10	0.166666667	0.380693494
	데이터베이스 장애	T11	0.083333333	0.282329851
기반시설장애	서버에어컨 고장	T12	0.291666667	0.464305621
	UPS장애 및 고장	T13	0.208333333	0.414851117

<Table 6> > Average & Standard Dev. of Events Occurrence

Process	No	Average No.	St. Dev.
ERP	E1	0.458333333	0.508977378
EKP	E2	0.25	0.442325868
BW	E3	0.125	0.337831962
SEM	E4	0.083333333	0.282329851
PICASO	E5	0.208333333	0.414851117
LIMS	E6	0.125	0.337831962
RTDB	E7	0.166666667	0.481543412
WMS	E8	0.125	0.337831962
VAN	E9	0.125	0.337831962
EDI	E10	0.125	0.337831962
PIS	E11	0.083333333	0.282329851

Each result that is operated by 10000 simulations shows in Table 7 and in Table 8.

<Table 7> Simulation Result of Stirring Event

분류	Accident	No	Result
운영장애	바이러스	T1	0.5417
	PC안 정보삭제	T2	0.0833
	운영자의 서버장비조작실수	T3	0.1251
	DB관리미숙	T4	0.0834
	전산주변장비장애	T5	0.125
시스템장애	서버다운	T6	0.1665
	네트워크다운 및 장애	T7	0.2502
	웹서비스 장애	T8	0.0833
	데이터전송망딜레이	T9	0.0833
	서버디스크 에러	T10	0.1667
	데이터베이스 장애	T11	0.0832
기반시설장애	서버에어컨 고장	T12	0.2915
	UPS장애 및 고장	T13	0.2083

<Table 8> Simulation Result of Event Occurrence

Process	No	Result
ERP	E1	0.4583
EKP	E2	0.2499
BW	E3	0.125
SEM	E4	0.0834
PICASO	E5	0.0833
LIMS	E6	0.125
RTDB	E7	0.1667
WMS	E8	0.125
VAN	E9	0.125
EDI	E10	0.125
PIS	E11	0.0833

Economic Loss Measurement by ABC

The Economic value of each process includes the following elements: salary, department expense, IT expense, IT property, external project, and business profit. Salary is divided by activity volumes (business hours) of employees that are involved in business process. The department expense, external project expense, and the IT expense are divided into the business process according to a rate of salary allocated to the business process. The IT property is divided by the power of influence of the business process. Activity volumes of the employee and the influencing power are investigated through interviews and survey in the organization. As a result, Fig. 9 shows economic value of each business process.

<Table 9> Expense of Each Business Process

process	process expense	monthly expense
ERP	211,670,158,636	17,639,179,886
RTDB	5,769,834,780	480,819,565
PIS	1,396,831,319	116,402,610
PICASO	4,221,155,247	351,762,937
EKPEKP	2,132,444,341	177,703,695
SEM	2,634,597,246	219,549,771
BW	28,470,304	2,372,525
EDI	239,414,097	19,951,175
VAN	119,358,195	9,946,516
LIMS	15,181,420,053	1,265,118,338
WMS	10,080,703,923	840,058,660
Total	253,474,388,141	21,122,865,678

Result

In order to verify the proposed research model, probability of the event occurrence and economic loss are produced according to each event path. Table 10 refers to probability of event occurrence on each event path.

<Table 10> Probability of Event Occurrence on Each Event-Path

No	T	P1	P2	P3	P4	P5	P6	P7
1	T1 0.5417	E1	E2	E3	E4			
		0.4583	0.2499	0.125	0.0834			
2		E1	E5					
		0.4583	0.0833					
3		E1	E6	E7	E11			
		0.4583	0.125	0.1667	0.0833			
4		E1	E6	E7	E8	E11		
		0.4583	0.125	0.1667	0.125	0.0833		
5		E1	E6	E7	E8	E3	E4	
		0.4583	0.125	0.1667	0.125	0.125	0.0834	
6		E1	E6	E11				
		0.4583	0.125	0.0833				
7		E1	E11	E6	E7	E8	E3	E4
		0.4583	0.0833	0.125	0.1667	0.125	0.125	0.0834
8		E1	E9					
		0.4583	0.125					
9		E1	E10					
		0.4583	0.125					
10		E1	E8	E11	E6	E7		
		0.4583	0.125	0.083	0.125	0.1667		
11		E1	E3	E4				
		0.4583	0.125	0.0834				

By Formula (2) of the research model, for instance, probability of event path 1 is 0.5%, which means 0.005 frequencies during one month happened. Also, the probability of event path 2 makes 2% although the other paths have very low frequencies.

The economic loss of each event path sums up the loss of each business process on the event path. For example, in the case of event path 1, the total economic loss adds up loss of E1, E2, E3, and E4. The total amount of event path 1 becomes the value of $18,588.00 that is shown in Table 11. Thus, the risked amount of event path 1 has a result ($96,178) by multiplying the occurrence probability by the loss amount. Table 11 shows the risked amount of each event path affected by the event occurrence (E1, ERP) and the stirring event (T1, virus).

<Table 11> Risk Amount of Each Event-Path

Event path	Occurrence Prob.	Loss amount ($)	Risk amount($)
1	0.005174174	18,588,164	96,178
2	0.02068015	17,816,883	368,455
3	0.000430923	18,701,160	8,058
4	5.38653E-05	18,721,112	1,008
5	6.74125E-06	18,349,218	123
6	0.002585019	18,698,788	48,336
7	2.69488E-05	19,189,277	517
8	0.031032639	17,649,126	547,698
9	0.031032639	18,904,298	586,650
10	5.36713E-05	18,721,112	1,004
11	0.002588122	18,107,345	46,864
Average Amount			$165,803

Cho (2001) researched that the average value (economic loss) of the total event paths per a stirring event refers to the level of a hazard. Therefore, the average of 11 event paths tells $165,803.00, which indicates that the economic value of the ERP process can be affected by the virus hazard in this case study.

Summary and Conclusion

This paper illustrates a quantitative approach of hazard analysis of information systems through a case study. The research model projects probability of occurrence by probabilistic risk analysis (PRA) and economic loss by activity based costing (ABC) under each identified hazard.

To verify the model, first, each computerized subsystem which is called a business process and hazards occurred on information systems are gathered through one private organization. Second, scenarios of an event-path, which means a relationship among business processes, are developed on the basis of gathered data. The probability of hazard occurrence and the probability of business process breakdown are extracted from the scenarios. Third, event-paths, which are affected by a hazard, are represented by an event tree technique. The operation of the event tree was conducted by Monte Carlo simulation using the @RISK4.5.2 simulation program. Fourth, economic loss of a business process is measured by the ABC method, in which the cost includes salary, direct and indirect expenses, IT property value, business profit, etc. Finally, the loss impact of an event-path is produced by multiplying probability by the economic loss. The quantitative degree of a hazard occurrence results in average economic loss impact of all event-paths.

It concludes that the possibility to measure the level of hazard quantitatively can show in spite of the limitation to the simulation operation and the scenario development process. The quantified level of the identified hazard is provided (can be helped) so that the senior management can make his decision effectively about hazard mitigation implementation.

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Author Biography

Dr. Young-Jai Lee

- Professor, MIS Department, Dongguk University
- Chairman, Korea BCP Association
- Vice-President, TIEMS
- Research Area: Risk-Based Decision Making, Information Management
- E-mail: yjlee@dgu.edu

Mr. Taeho Kim

- Graduate student, MIS Department, Dongguk University
- Research Area: Decision-Making, E-business
- E-mail: kimclub1@empal.com

COAL MINE RISKS MANAGEMENT SYSTEM PATTERNS

Prof. Valery D. Ayurov,
Assoc. Professor Alexey L. Puchkov, Dr. Olga G. Shashkova,
Moscow State Mining University, Russia[*]

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Abstract

The article defines a coal mine and associated stopes, panels and levels as an integral complex of hierarchically organized interdependent production facilities and physically heterogeneous material flows of coal, waste rock, water, and methane generated. The arguments follow that an efficient risk management should be based on the mine arrangement system patterns, as well as on the patterns of maintenance of safe conditions. It is important to represent the mine as a model, giving an integral notion both of these both patterns. The authors argue that because coal mining processes are interdependent in space and time, there is an interrelation between mining processes of adjacent stopes when the same panel is being mined, between mining processes of adjacent stopes when neighboring panels are being mined, and between mining processes of stopes of panels of neighboring levels. It is recommended to implement expenditure optimization mechanisms at the coal mine risk management systems in two stages: first an efficient structure of preventive and compensative costs of particular risks management at coal mine production facilities to be determined, and then an efficient amount of total expenditure on risk management at coal mine production facilities to be assessed.

Introduction

A coal mine is an integral complex of interrelated and interdependent artificial and natural production facilities of variable scale, involved by man in his purposeful activities aimed to safely excavate and produce the mineral. Such facilities can be categorized as the following upgrade sequence: stopes, panels, levels, underground mine operations, and, finally, the mine as a whole.

A stope, as the principal production unit of a coal mine, is an integral complex of interrelated and interconnected mining elements. These mining elements include the mined out space, mine workings confining this space, the coal seam face, the immediate and main roof and sole host rocks, stoping system, face support, and conveyor.

A panel, as the next in scale order coal mine production facility, incorporates an ordered assembly of sequentially mined out stopes combined by a common system of technical

[*] 119991 Leninsky Prospekt, 6, GSP-1
Moscow, RUSSIA
Tel: +7 495 236 9753
Fax: +7 495 230 7606
e-mail: apuchkov@rambler.ru
www.msmu.ru

arrangement solutions. This system of technical arrangement solutions ensures safe and efficient mining operations within the panel. It serves as a system shell aggregating the stopes of the panel and ensuring the homeostasis of the panel as a system [2].

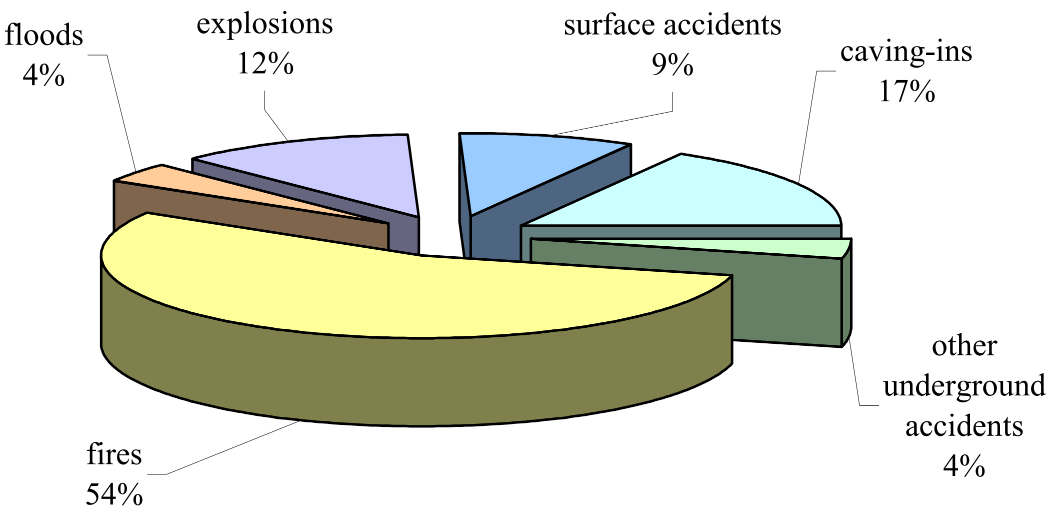
A level, being the next large in the scale sequence mine production facility, is composed of an ordered assembly of sequentially mined out panels, also combined by a common system of technical arrangement solutions. This system of technical arrangement solutions ensures safe and efficient mining operations within the level. It serves as a system shell aggregating the panels of the level and ensuring the homeostasis of the level as a system.

Similarly, the totality of coal mine levels is aggregated by the system shell of common technical arrangement solutions into the underground mine operations, being then aggregated into the mine a whole by the system shell of the mine general technical arrangement solutions.

Via this hierarchically arrayed system of coal mine production facilities, coal mining processes are being implemented. These mining processes produce physically heterogeneous material flows of coal, waste rock, water, dust, and methane. The intensity of the above flows is subject to the mine geological and mining conditions, and the intensity of mining processes initiating these flows.

All the mining processes in a mine are subject to the geological and mining conditions of implementation thereof. The coal mining conditions are subject to change, the same as the properties of mining elements of the principal coal mine production facility, the stope, and the interconformity these properties, with a consequential mismatching of mining processes. As a consequence, the intensity of the mine material flows produced by the mining processes is continuously subject to change.

Fig. 1. The structure of Russian coal mine accidents



The continuous change of the mine material flows and the low predictability of these flow are the reasons of coal mining liability to accidents. The structure of accidents at Russian coal mine is shown in Fig. 1.

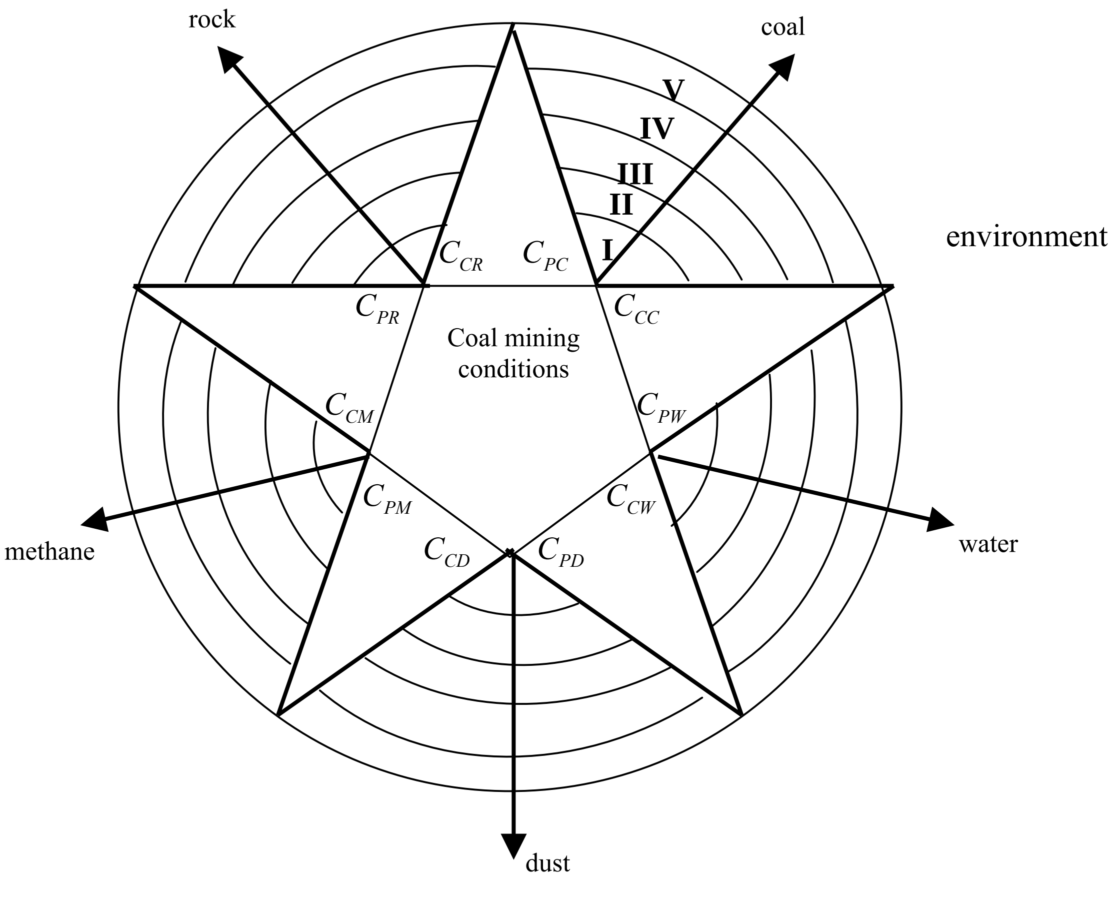
As it obvious from the above structure, fires are the predominant type of coal mine accidents. It is quite natural, as coal production is production of a principal energy carrier. Next in sequence are caving-ins, due to the energy carrier being produced from a rock massif composed of various rocks. The considerable percentage of explosions is due release in the process of coal mining of substantial quantities of methane occluded in coal and contained in coal dust. Methane and dust produce an explosive mix in contact with air oxygen. Floods and other accidents to which the underground mine operations are liable, are due to coal mining operations affecting aquifers and involving a high concentration of machines and mechanisms.

Theory

An effective management of the risks accompanying coal mining activities is subject to the systematic principles of a mine organization as a hierarchically arranged system of production facilities. Therefore, it is important to represent the mine as a model, giving to a person an integral notion both of the patterns of mine composition of production facilities and of the patterns of maintaining its safety.

Mine production facilities are based on the geological and mining conditions of the mineral production, and are organized in hierarchical levels.[1] Mine production processes generate material flows of coal, waste rock, water, dust, and methane toward the environment. These flows are formed according to the hierarchy levels of mine production facilities. Therefore, in order to find system patterns of mine risks management procedure, it is convenient to represent a coal mine structural model as the scheme shown in Fig. 2.

Fig. 2. A structural model of coal mine flows generation



Where I, II, III, IV, V – hierarchical levels of coal mine production facilities: I – stope; II – panel; III – level; IV – underground mining operations; V – mine as a whole;

C_{PC}, C_{CC}, C_{PW}, C_{CW}, C_{PR}, C_{CR}, C_{PM}, C_{CM}, C_{PD}, C_{CD} - the cost of preventive (P) and compensative (C) measures of mine safety ensuring for the respective flows generated.

All the mine safe operation measures can be subdivided into measures to mitigate risks inside and outside the mine[2]. The mine inside risk mitigation measures are related to occupational safety measures. The mine outside risk mitigation measures are related to the environment protection measures. Both the former and latter ones can be either preventive or compensative in character.

The preventive measures are aimed to decrease accident probability, while the compensative ones are aimed to mitigate accident consequences. Both category measures are to be implemented in advance of any actual accident. The preventive measures are to decrease the probability of simultaneous emergence of accident factors. The compensative arrangements are to influence the space and time incidence of emergency progress conditions, mitigating probable damages.

Implementation of preventive and compensative measures always involves costs. These costs are represented in Fig. 2 as the five-point star beams, being subject to the coal mining conditions. The five-point star beams cross all the hierarchical levels of coal mine production facilities. This means that preventive and compensative mine operation safety arrangements are to be implemented on each hierarchical level of its production facilities.

The accident prevention and consequences mitigation process at a coal mine is subject to a certain pattern. All the mine safe operation measures are to be designed and implemented pursuant to a certain procedure: from the maximum hierarchical level of coal mine production facilities, to the minimum hierarchical level thereof.[2] All accidents shall be suppress in the opposite sequence: from the minimum hierarchical level of coal mine production facilities, to the maximum hierarchical level thereof.

Method

Coal mining processes are interdependent in space and time. There is a close interrelation between mining processes of adjacent stopes when the same panel is being mined, between mining processes of adjacent stopes when neighboring panels are being mined, and between mining processes of stopes of panels of neighboring levels.

Therefore, implementation of mining processes safety measures in one stope, will inevitably affect the mining processes safety in another stope. Therefore, the costs of preventive and compensative measures for different coal mine production facilities are interrelated both within their mutual hierarchical level, and between themselves. Consequently, there is always available an efficient option of ensuring the necessary mine operation safety level due to selecting an optimal cost structure of the measures.

A coal mine risk management total expenditure making up model can be represented as follows:

$$E_i = p_i y_i + (1 - p_i) \cdot (C_{Pi} + C_{yi}), \qquad (1)$$

Where

p_i - The probability of an accident due to the i-th mine flow implementation;

y_i - Assessment of consequences of an accident due to the i-th mine flow implementation;

C_{Pi} - preventive costs of decrease of the probability of an accident due to the i-th mine

Flow implementation;

C_{yi} - compensative costs of advance decrease of consequences of an accident due to the i-th mine flow implementation.

According to this model, the costs of coal mine risks management involve the costs of preventive and compensative measures and the risk assessment. The risk assessment in its turn involves the costs of accident control and consequences mitigation. The accident control procedure shall be implemented at the mine pursuant to the emergency control plan. The types and scales of likely accidents shall be determined in advance on the basis of previous experience of mining operations in similar mining and geological conditions, and using available statistical data.

An example of preventive costs of water environment protection are the costs of drainage and impervious screens arrangement, drill-holes grouting and waterproof bulkheads construction, fuel and greasing materials accounting and control system implementation; environmental instruction and personnel training expenditures.

An example of compensative costs of water environment protection are the costs of sewage treatment, sludge treatment and utilization, treatment works renovation and maintenance, and costs of other similar arrangements, including payments for third parties' sewage water treatment and hazardous waste utilization services.

An example of occupational safety preventive costs are the costs of advance degassing of the deposit in order to decrease gas ingress into mine workings and prevent gas blowouts; the costs of improvement of drill-and-blast operations procedure; of personnel training and professional examination; of occupational and industrial safety standards implementation; and of routine auditing of mine production processes.

An example of occupational safety compensative costs are the costs of concomitant degassing of mined coal seams and host rocks; costs of mine ventilation system improvement; costs of explosion-proof equipment application in mine workings of gaseous mines or extra costs involved due to the need to use pneumatic power.

The coal mine risk management costs optimization process shall be implemented in two stages. At Stage I, an efficient structure of particular risks management preventive and compensative costs shall be determined. At Stage II, an efficient amount of total risk management expenditure shall be assessed.

An efficient structure of preventive and compensative costs of particular risks management shall be determined upon the condition of risk minimization at a production facility of the examined hierarchical level, provided the preventive and compensative costs are invariable. A mathematical model of assessment of an efficient structure of these costs, is the following:

- Costs structure assessment criterion:

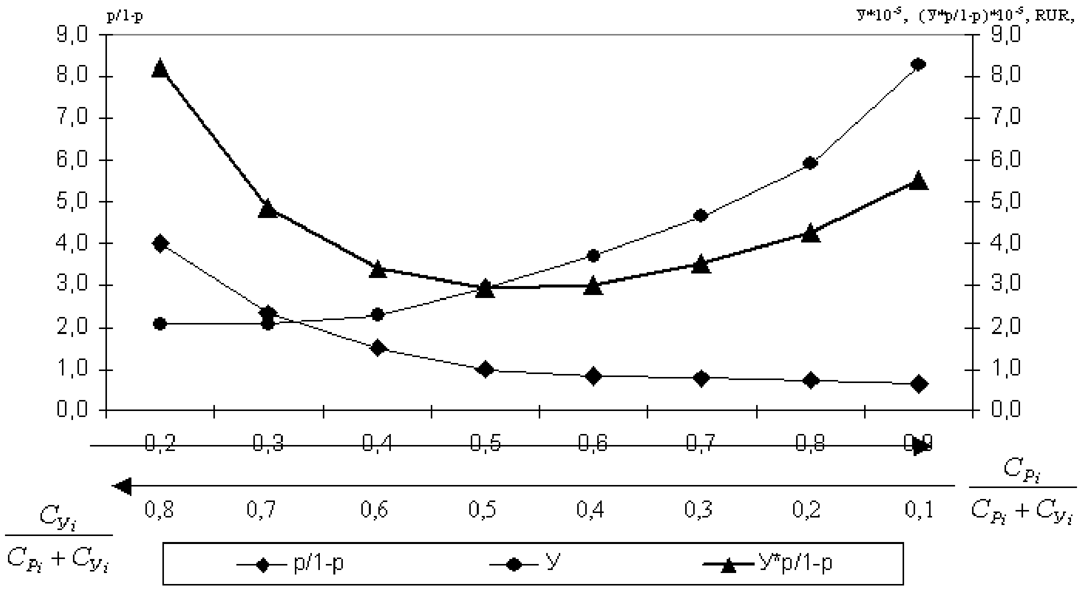
$$\frac{p_i}{1-p_i}\cdot Y_i \rightarrow \min \quad , \qquad (2)$$

- Limitation:

$$C_{P\,i} + C_{Y\,i} = const \quad . \qquad (3)$$

Fig. 3. shows the process of formation of an efficient structure of risk management preventive and compensative costs.

Fig. 3. Formation of an efficient structure of coal mine risk management costs



As it is obvious from the above diagram, in case of a particular preventive and compensative cost structure, specific for each type of risk inherent to coal mine production facilities, a minimum risk is ensured.

An efficient amount of coal mine risk management expenses is determined upon the condition of minimization thereof, provided the structure of preventive and compensative costs is invariable. A mathematical model of assessment of an efficient amount of risk management costs is the following:

- expenses assessment criterion:

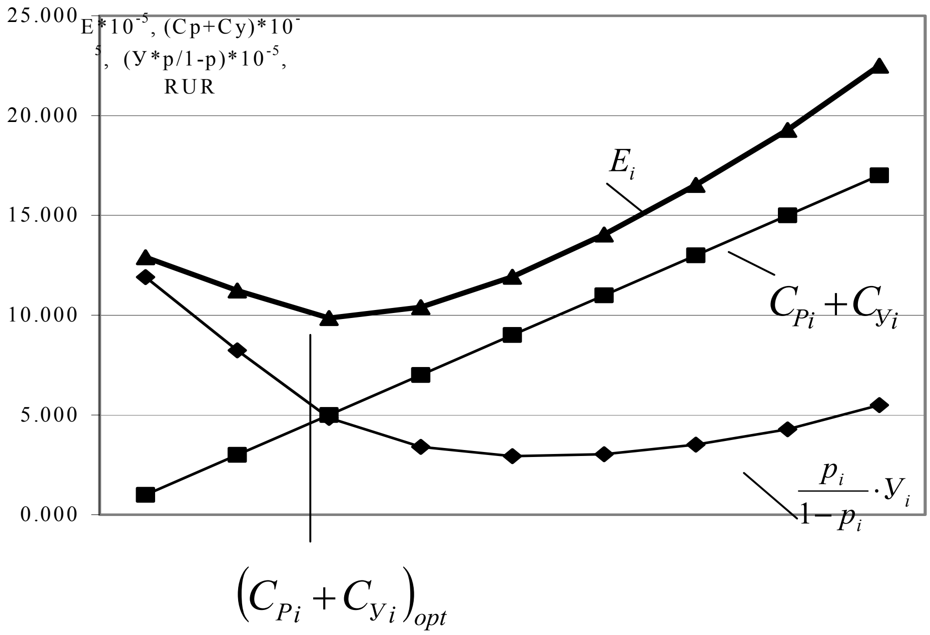
$$E_i = \frac{p_i}{1-p_i}\cdot Y_i + \left(C_{P\,i} + C_{Y\,i}\right) \rightarrow \min \quad , \qquad (4)$$

· limitation:

$$\frac{C_{P\,i}}{C_{У\,i}} = const \quad (5)$$

Fig. 4 shows the process of formation of an efficient amount of coal mine risk management expenses.

Fig. 4. Formation of an efficient amount of coal mine risk management expenses



As it is obvious from the above diagram, in case of a certain ratio of preventive and compensative costs to assessed risk, a minimum amount of the total expenditure on risk management at production facilities of the all the coal mine hierarchical levels is achieved.

Results

1. A coal mine is an integral complex of hierarchically organized interdependent production facilities, where mining processes are being implemented, and physically heterogeneous material flows of coal, waste rock, water, and methane are generated.
2. Mismatching of coal mining processes causes a continuous variation of intensity of material flows generated by these processes, and creates risks of accidents at the coal mine production facilities.
3. An efficient risk management at coal mine production facilities shall be based on the mine arrangement system patterns, and on the patterns of maintenance of safe conditions at these facilities.
4. Maintenance of safe conditions at coal mine production facilities is implemented via preventive and compensative measures. The costs of these measures are interrelated within each hierarchical levels of mine production facilities. Employment of this interrelation allows to minimize coal mine risk management expenses, provided an acceptable level of mine operation safety is maintained.
5. It is advisable to implement the coal mine risk management expenditure optimization procedure in two stages. At Stage I, an efficient structure of preventive and compensative costs of particular risks management at coal mine production facilities is to be

determined. At Stage II, an efficient amount of total expenditure on risk management at coal mine production facilities is to be assessed.

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Authors Biography

Professor Valery Ayurov, Technical Sciences, works at the Department for Environment Economy at Moscow State Mining University, Russia. He leads on strategic research work in mining industry in Russia and provides best practice on economy system patterns.

Dr. Alexey Puchkov gained his PhD degree in Economic Sciences from Moscow State Mining University, Russia, and is currently an Associate Professor at the University's Department of Economy and Mining Industry Planning. He carries out tasks on strategic research in mining industries and presently is working on his Dissertation devoted to development of incremental methodology for environment and economic assessment of the activities carried out under degasification of mining arrays.

Dr. Olga Shashkova gained her PhD degree in Economic Sciences from Moscow State Mining University, Russia. She works at the Department for Environment Economy in the University and deals with strategic research issues on efficient resource management. She is currently working on her Dissertation by developing methodology to increase efficiency of mineral resource management at enterprises.

DOMIN*after* PROJECT

Rudolf URBAN and Jiri F. URBANEK*

University of Defence, Czech Republic

Keywords: European crisis / emergency management integration; Operation management interoperability.

Abstract

The „DOMINafter“ acronym means: "the Development of Operation Management Interoperability Needful for the Agents of First Toxicosis / Emergency Response". It is known about unsatisfactory interoperability, that it depresses total operability of emergency, rescue and liquidating services at regional and over-border multinational territories. The preparing of continuously international operable professional crisis / emergency management must be able next activities: effective concurrence, collaboration, cooperation and interaction at incident or disaster areas of trans-national extent. They must be able of these activities without predefined scenarios even. A necessity of a creation of a Base is outlined for setup and co-education of crisis / emergency management agents of all European countries. DOMINafter Base creation is our vision. Regional agents of top crisis / emergency managements from whole Europe should have periodically passed through this Base. Important contribution of the Base will be face-to-face contacts, which are founded at the integration and operation procedure tuning of European Integrated Rescue Systems. They would be made at over-border extraordinary events & disasters and subsequent integrated intervention of rescue and liquidating services. Our readiness is discussed and presented for above problem solution in this paper. The „Interoperable outdoor videoconference system, especially for crisis management of civil protection®„ is improved for application in DOMINafter project. The importance of this system other modules named "esTou®" and "NETour" is emphasized for future operation.

Introduction – a Vision Analysis

The project „DOMIN*after*“ is an outline of our vision of future educational / training Base, which will be responsible for the integration of European first responders management. Future realization of this vision is needful for European security research specification also. The educational and research abilities of Czech University of Defence and its three faculties: economy & management, technological and military health sciences they are fully convenient to this vision. It is ranked among the best qualified and competent universities for security research in Europe. A sense of individual acronym letters is analysed further in the connection to word connotation.

D O M I N*after*

Total operability of emergency, rescue and liquidating services is depressed by unsatisfactory interoperability at regional and national territories. The interoperability of crisis / emergency

* Kounicova 65, 612 00 BRNO, Czech Republic

operations is evaluated as the critical process of crisis / emergency operations. Poorly prepared and insufficient interoperability may be the restriction at protecting against terrorism. International impacted extraordinary incidents and disasters ask that multinational responders must operate integral even without previous co-training. Successfully solved interoperability brings synergic effects in operational cooperation and collaboration of operation entities. It acts integrally in multidisciplinary environments at multi purpose tasks.

DO M I N *after*

International operable professional crisis / emergency response managements are needful for continuous & competent preparation and effective response without national restrictions at the European territory. This management must be able to make effective cooperation, collaboration and interaction at disaster areas of trans-national extent and even without predefined scenarios. Modern crisis is hard to predict and plan. All unexpected is possible. This intuition brings an improving of situation awareness in Europe, because technological readiness may or may not be sufficient for all possible situations. But the readiness of crisis / emergency response management is possible, namely in information exchange and sharing of pan-European E-governmental services.

DOMIN *a* *fter*

The readiness, cooperation and co-education of crisis / emergency management agents of all European countries converge to the Base creation. Top and operation crisis / emergency management regional agents from whole Europe should pass through this Base periodically. They will meet mutually here. They will acquaint with contemporary levels of pan-European crisis / emergency management interoperability. They will have a possibility to assert its reminders and suggestions in a mirror of all-European conceptions and programmes forming crisis / emergency operability. They will have the possibility of a tutorial with research & development agents of European security research & engineering and with European industrial I S / IT providers.

DOMIN*a* *f* *te* *r*

European First Responders Management must be future management of European Integrated Rescue Systems. The managers in future Base will found European security integration and procedure tuning for cross-border extraordinary events & disasters. They will be able to manage subsequent integrated intervention and effective rescue & liquidating services. It will be important contribution of the Base.

D OMIN*after*

A DYVELOP© (the DYnamical VEctor LOgistic of Processes) [© J.F.Urbanek. 1998 - 2002, ISBN 80-7204-232-7] is our methodology for DOMINafter project solution and for technologies development. It uses the Blazons© as special flowcharts for process productivity & entity's relationships expressions.

Project Indicia and Methods

Czech University of Defence has rich experiences with above problems solutions, because it solves more like these projects at national level. Our University offers DOMIN*after* project to the utilizing in the frame of the EU security research.

WiFi (Wireless Fidelity) Pilot Technology of DOMINafter project will be well contributed for Value Added in European economy and for the reinforcement of the competitiveness of European industry. The great potential for exploitation of this project is centred to end users at the PPP principle (Public Private Partnerships). Scientific and/or technological excellence is in the implementation of COTS principle (Commercial – off - the Shelf) in the created systems and technologies.

The contributions to tangible and demonstrable improvements in the security of our DOMINafter project are in previous patent protecting results. They are centred to interoperability increasing in civil / police / military / fire-brigade / rescue / humanitarian organizations managements. It is on behalf of high operability & efficiency. It brings quality improvement, steadiness consolidation and system & process integrity and harmonizing of civil protection in the context with economic and environmental sustainable development. It all will be made in the environments of democratic establishment & organizations in the modern threats. The project builds effective partnerships among end users (i.e. State, Public and Local Authorities & Integrated Rescue System's Components), among industrial producers and among research & development agents.

Our project team is potentially able to carry out its activities successfully and to ensure its efficient management, including protection of classified information and intellectual properties. It is because, the project team is composed from experienced and skill managers and scientists of various organizations and from civil / military management persons proofed and tested in various situations. DOMINafter project is mission oriented and has close relevance to the proposals of Programme of Work of the EC PASR (Preparatory Action for Security Research) and it respects all its five priority missions:

- Optimising security and protection of networked systems;
- Protecting against terrorism;
- Enhancing crisis management;
- Achieving interoperability and integration of systems for information and communication;
- Improving situation awareness.

PASR priority directions of security research are included automatically, because our project has ability to prevent, to protect, to prepare and to investigate against the terrorism and consequently it create the presumptions for damage minimisation.

External man-powering of DOMINafter project is not necessary. Our financial requirements are dependent at overall PASR project budget and at the frame of whole EC project consortium. Our real potential in security research projects is very high.

Top technologies for DOMINafter Project

Three problems will be especially solved within this project:

a) Toxicosis prevention via antidotes
b) Virtual modelling and simulation via 3D + CAD
c) WiFi Pilot Technology

a) Toxicosis prevention via antidotes

Czech University of Defence has unique research facility of highly toxicosis substances (real or potential chemical warfare agents using in terrorism threats). It is capable for performing a comprehensive analysis and evaluation of biological, humanitarian, anthroposophy and environmental effects. New original antidotes against nerve agents have been developed and produced here. Our University has many experts for consultative activities and expertises on environmental problems, chemical disasters and management of mass casualties of the CBRN, which act at international cooperation with NATO countries even. Recent research activities at the field of the toxicosis are next:

- Improvement of the effectiveness of antidote pre-treatment of nerve agent acute poisonings by the development of new type of pharmacological pre-treatment of nerve agent poisoning with the help of enzyme scavengers (butyrylcholinesterase) and hydrolysing enzymes (paraoxonase);

- Improvement of the effectiveness of antidote treatment of nerve agent acute poisonings by the development of new reactivators of acetylcholinesterase inhibited with nerve agents (especially against tabun, cyclosarin and soman);
- More precise diagnosis of nerve agent exposure including the standardization of cholinesterase activity determination;
- The development of new, more efficacious decontamination means (foams, emulsions) to protect exposed soldiers against percutaneous poisonings;
- More precise diagnosis of sulphur mustard exposure using the method for the detection of DNA cross links and breaks (comet assay).

b) Virtual modelling and simulation via 3D + CAD

Digital terrain modeling and visualizations are our contemporary applications. They are directed into the area of 3D (three dimensional) visualization, digital terrain modeling, geographical analyses and optimization processed in real time. Other features are in development process, like remote sensors control, net management, informational sharing and management and other.

Main targeting application is cybernetic operation system of reconnaissance planning, control and management, which is parametric by real time, by virtual terrain (3D + ortho-photo maps) and by optimization functions.

Situation overview and awareness act fully in 3D environments. They bring the features and abilities of management decision making support, which is achieved by specific system of the analyses and optimizations.

Virtual modelling and simulation need more possibilities in detail expression of the entities in closed objects. It brings CAD (Computer Aided Design) modelling.

Main solved items within DOMINafter project:

- 3D visualization of the areas (contemporary whole Czech Republic);
- 2D and 3D map modeling, including cover variability;
- tactical situation modeling and it’s interactive modification;
- 3D model creation, the motion and deployment;
- visibility analyses;
- observation point hospitalization;
- terrain altitude modification and visual scheme variability;
- path calculation;
- interactive navigation;
- flight simulation;
- 3D + CAD cycles.

c) WiFi Pilot Technology + esTou® +NETour + avaxTour

Research & development project of Czech University of Defence “WiFi Pilot Technology” was created, developed and evolved of the interoperable communication and technologies as industrial products. Special product of this paper authors is „The Interoperable Outdoor Videoconference System, Especially for Crisis Management of Civil Protection®„. This WiFi information & communication system and technology are our intellectual property as the technology developer. The application of this cybernetic system and further development of its WiFi Pilot Technology are our real contribution for the enhancing of European crisis management. They contribute to the interoperability qualitative increasing and to system's integration of information and communication security and information sharing. It fully implements the COTS principle for security optimising and protection of information networked systems in EC PASR and future 7th EC framework programme.

Starting restrictive conditions of WiFi Pilot Technology consist in a necessity to give the technology for an involving of final and end users "on key", which will be sufficiently secure and reliable, outdoor – mobile, compatible and purpose-built with using hardware / software and telecommunication resources. This Technology is setting up at commercial and globally approachable hardware and next components. It is investment modest, enough resistant to violators, user's friendly working in low-cost operation and environmentally friendly. This Technology derives a benefit from international reputable software for crisis/emergency management (e.g. Emergency OFFICE = „EMOFF"). Competitive advantages of this Technology and its relevant hardware & software consist in the fact that they are operating on the system's, process´, arrangement's and network's environments, which are currently and without special secrecy commercially and freely approachable (COTS).

The Processes and them relevant Process Systems (PrSs) acting in specific Environments (ENVs) and their Productivities (PRs) are possible to model at the Blazon© in the Figure. It is a part of descriptive, analytic and evaluative phases of the production and next innovation of the WiFi Pilot Technology. It is instrumented via dynamic - process – value – vector expression of informatics'-logistical relations of the technology and others objective entities.

The Conclusion

The developments of the a) and b) items are dependent at DOMINafter project realization. The development of the c) item is fully in the management of this paper authors. The impact of WiFi Pilot Technology allows qualitative and efficient information & technological support of crisis / emergency managements. It makes possible for first responders management and other agents to operate in "Mission Area ENV" in the frame of the „Crisis Operation PrS" – see Blazon© at the Figure. The Blazon© identifies two critical interoperable interfaces: The "EVENT Mngmnt" and "SECURITY".

The "EVENT Mngmnt" is the most important interface for information logistics. Interpreted monitoring, reporting, revising and controlling information go through this interface. The "SECURITY" is the most important interface for information security. The interoperability improvements at the both interfaces bring a new implementation of on-line / off-line duplex broadcasting among mobile nodes of special local wireless network "NETour" (WLAN, WiFi). Tranzit (booster) NETour nodes are equipped by separate battery-powered Access-Points (APs) and directional synchronizing Antenna System (AS). These ASs are stationary or mobile. Quite new component of WiFi Pilot Technology is booster flying means - "avaxTour" (Aerial Vehicle Axial Telecommunication Outdoor Unmanned (Registered)). Beside a retranslation, it has several further functions, important for crisis EVENT management. They make from the avaxTour, NETour and WiFi Pilot Technology necessary modules for future European crisis / emergency management's integrity. WiFi will be replaced by DVB (Data Video Broadcasting) technologies in the future.

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Authors Biographies

Brigade general, professor, Rudolf Urban, PhD. – University of Defence Rector, Chief of Civil Protection Department. E-mail: rudolf.urban@unob.cz.

Associate professor, Jiří F. Urbánek, PhD. – University of Defence Professor, Civil Protection Department. E-mail: jiri.urbanek@unob.cz.

Academic and Professional Practice

Peer Reviewed Articles

Disaster Prediction / Estimation

EFFORTS OF EARTHQUAKE DISASTER MITIGATION USING INFORMATION BEFORE S-WAVE ARRIVAL

Yukio Fujinawa
Real-time Earthquake information Consortium[1]

Keywords: earthquake, mitigation, early warning, safety network, consumer systems

Abstract

In Japan extensive seismic networks have been constructed nationwide composed of high sensitivity seismographic network (Hi-net), broadband network (F-net) and strong motion network (K-NET). All these data from NIED and those from JMA and universities have been collected and distributed through NIED to scientists and engineers through the Internet under the coordination of the National Seismic Research Committee of MEXT. As a practical application of those data MEXT, JMA and NGOs are cooperating to develop an earthquake early warning system (EEW) for the purpose of providing seismic parameters to any users concerned with seismic risk reduction. A content of information officially issued from JMA is seismic focal parameters, which are sent several seconds after detections of seismic signal at the nearest site at present.

Once earthquakes occur those focal parameters are calculated as soon as enough number of observation sites sense seismic waves, and are revised successively as seismic signals are received at larger number of sites in time, with the result that more accurate information is obtained. The transmitted parameters are used by application systems at sites to estimate specific information for particular users at particular site in order for triggering various disaster mitigation countermeasures including automated and/or half-automated responses.

Many of applications have been developed by consortium of concerned organizations as the Real- time Earthquake Information Consortium (REIC) and several companies. At present we are in the testing stage of the whole system consisting of official information issue from JMA, information transmitting using variety of media by several service organizations and testing of developed application instruments for several fields. From this summer on practical usage will start at least for the prescribed users. Full adoption of the system is expected to reduce a large portion of damages induced by major disastrous earthquakes amounting several tens percents.

Introduction

Two representative ways to reduce earthquake disasters is earthquake prediction and the construction of buildings capable of withstanding earthquake ground movements. In addition to this, various other reduction measures should also be employed, such as urban planning less vulnerable to natural disasters, speedy recovery and restoration systems, and mutual

[1] Real-time Earthquake information Consortium (REIC),
Tel: +81-3-5366-2720, E-mail: fujinawa@real-time.jp

economical assistance in the form of insurance, etc. Comprehensive set of measures needs to be adopted in order to build a safe and secure society.

This paper will outline a new method for mitigating the damage caused by earthquakes, which involves the use of early warning information sent out immediately after sensing seismic waves at nearest sites to hypocenter. Although there may typically be a mere 1 to 10 seconds before the earthquake ground motion, it is thought that this brief lead time can be used not only for safety of lives, but also in a range of other ways for protection of property.

In Japan a R&D efforts aimed at developing practical applications for such systems are being carried out though collaboration between industry, academia and the government, as part of the Leading Project conducted by the Ministry of Education, Culture, Sports, Science and Technology (MEXT). Here, we will provide an outline of this project to develop the early warning technology into effective utilization all over the country.

Previous real-time earthquake information for public use has focused on time ranging from several tens of minutes up to 24 hours immediately after earthquake hits, with the aim of providing information for emergency management products which helps local governments and enterprises to carry out disaster prevention activities. These R&D efforts came to the fore in the 1990s, and having learned lessons from the Kobe Earthquake. Those systems that are available work primarily for loss estimation using data obtained by strong-motion seismographs after large earthquakes begin.

On the other hands, after the Tokaido Shin-kansen sustained damage caused by earthquake activity, the Railway Technical Research Institute (RTRI) set about developing technology for detecting seismic occurrence and for using short lead time to secure only the safety of railway carriages in operation (Nakamura, S., 1996). After that, the UrEDAS (Urgent Earthquake Detection and Alert System), which would detect P-waves, predict the magnitude and epicentral position of the earthquake using single site data and then issue warnings, came into use. The Japan Meteorological Agency (JMA) and RTRI conducted research into making this system more advanced making use of real-time seismic data from the extensive network, i.e. NowCast Information System.

Then, from FY2001, NIED began another R&D of real-time earthquake information with the aim of using data collected from the high sensitive seismic observation network (High-Net) to issue earthquake EEW, not just to limited companies, but also to any organization and person in the whole country that would require it. This concept of general use with possibility of various customisations with cooperation of government and NGO (Figure 1) is different from similar previous efforts (e.g. http://www.seismolab.caltech.edu/early.html). After achieving several positive results, the system was introduced FY2002 for testing and trial by Fujisawa City of Kanagawa Prefecture in local governments.

The service needs an extensive seismic network covering the area. At present, there are several earthquake observation networks that have been set up by the Japan Meteorological Agency (JMA) and some that have been set by Headquarters for Earthquake Research Promotion (HERP). The JMA operates observation networks that aim to provide information to help citizens and disaster prevention organizations in charge of earthquake and tsunami disaster prevention. The digital strong-motion waveform observation network is made up of around 600 monitoring and observation stations. Tsunami and earthquake early detection network stations (of which there are 200) are used to install seismometer enabling UrEDAS type notification of earthquake parameters. Of the basic observation networks set up by HERP, currently it is only the high-sensitivity seismograph network (Hi-Net) transmitting data in real-time, enabling use for emergency management.

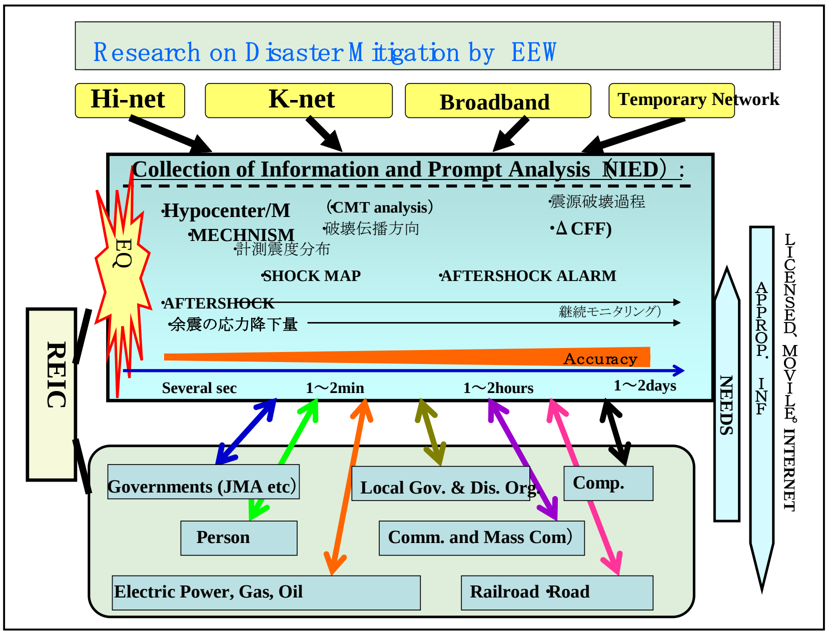

Fig. 1 Liaison system for the development project of EEW in Japan.

Earthquake Early Warning

In FY2003 the Research Project for the “Practical Use of Real-time Earthquake Information Networks” was launched as a five-year plan with the aim of integrating NIED's real-time earthquake information, with a view to developing practical applications for this information and putting it into practical use. The emergence and dissemination of a new disaster prevention system comes with high hopes, not only for the improvement of disaster prevention capabilities, but also in terms of the economic benefits it may yield. The project is expected to run for five years, with a planned budget of around 1 9 billion yen.

The structure of the project is outlined below (Hayama, 2005).
1) Research into processing of earthquake data

(1) Earthquake detecting system for Early Warning:
The aim here is to use earthquake waveform data to promptly analyse and provide information on the location of the seismic source occurrence time, and the magnitude of the earthquake.

(2) Development of Early Warning Information Generating System:
A system uses two kinds of algorithms of NIED (Horiuchi et al, 2005) and of JMA (Tsukada, 2005). The latter depends on the UrEDAS and territory method, the former arrival data as well as quasi-data that seismic waves have not yet arrived at residual sites.

(3) Transmitting system:
A system is developed enabling the speedy and highly reliable distribution of earthquake data for work operations. Use is made of dedicated line and satellite wireless communication system, as well as IP-VPN, local wireless, and mobile telephone network.

2) Development of basic data system for receiving side
A database is for underground (sedimentary) situation by using boring data collected by government and private companies in the past. The database is used in order to more accurately estimate site amplification factor of seismic waves to predict ground motion.

3) Tests and studies into practical use

(1) More than ten types of prototype systems have been developed and tested by REIC that is designed to support automated and semi-automated disaster-prevention responses using lead ones-several tens seconds before earthquake hits.

(2) Studies into impact of earthquake information
Studies and analyses are carried out into the effect on society of real time earthquake information when false alarm is sent.

EEW Systems

1) Methods for immediate seismic source determination
Earthquakes are the result of fault movements, and seismic waves spread outwards from the time when that fault movement is initiated (Fig 1) Ordinarily, if those waves reach three or more earthquake observation stations, seismological methods can be used to ascertain the location of the earthquake, the time of the quake and the magnitude of the quake. In the Earthquake Early Warning (EEW), uses are made of two types of seismic waves the primary (or longitudinal wave) called the P-wave that travels at around 6 km per second, and the transverse wave called the S-wave that travels at around 3.5 km per second. It is the S-wave that causes large horizontal ground movement referred to as the principal shock, which brings about earthquake damage. The S-wave is several times larger in magnitude compared with the P-wave If we are able to quickly estimate the location of the seismic source, occurrence time and the magnitude of the earthquake as soon as the P-wave reaches necessary number of observation stations and send that information out, then this may enable personal evacuation measures to be taken or protection activity to be shutdown prior to the offset of major ground motion.

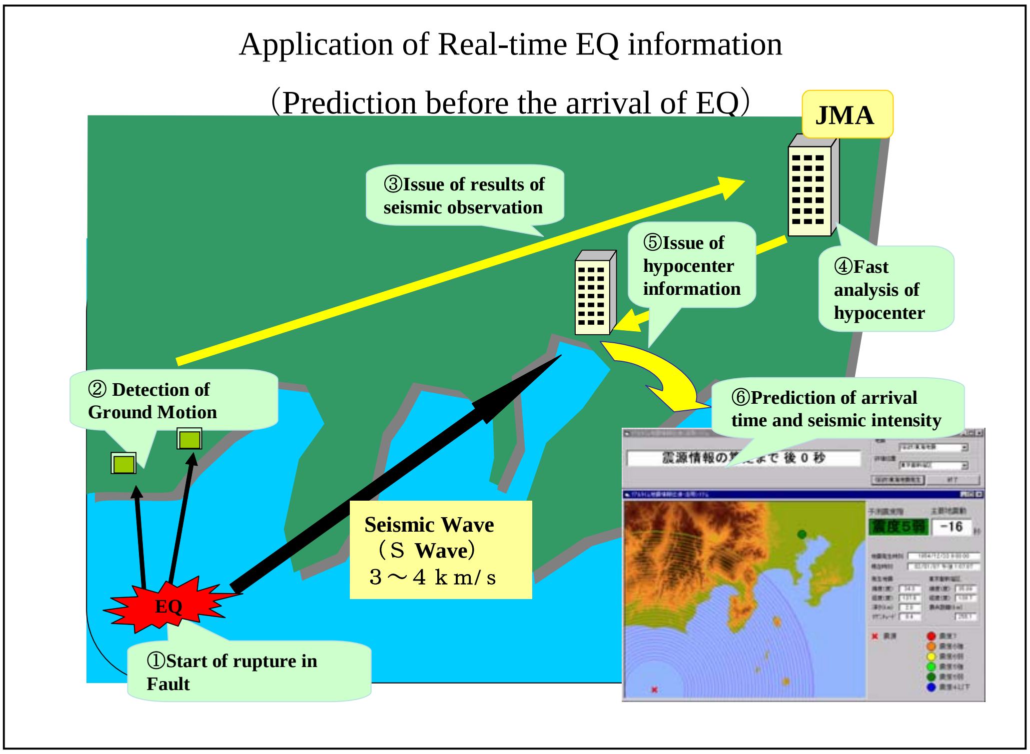

Fig. 2 Scheme of EEW in Japan and application image at any place of usage.

NIED's new seismic source determination system allows focal parameters to be estimated when P-waves are detected at the first two observation stations. The parameters of the seismic source are determined to a reasonably high level of accuracy (Horiuchi et at, 2005). The close spacing of observation stations at around 20-km intervals enables the algorithm effective. Seismic arrival data at some stations are used in conjunction with information that the earthquake has not yet hit other nearby stations (Arrival/non-arrival method). As time goes on, more observational data can be obtained, which can be used to recalculate the seismic source of more reliability. Once the estimation has been considered to be convergent the analyses finalized. The use of this method makes it possible to calculate in just a few seconds in most of cases, several tens times faster than ordinary method.

JMA uses a method to estimate the seismic source based on the envelope shape of the P-wave at one observation station (UrEDAS method). They also use the results of another predictions to estimate the location of the seismic source (Territory method). A combination of these two methods is used when the seismic wave has only arrived at one or two observation stations. Then, once the seismic wave reaches a third observation station, they can look for the seismic source using a 0.1-degree scale grid search to ascertain the horizontal position of the source. (Tsukada; 2005). Seismic source estimates using this method are continued until the seismic wave has arrived at five observation stations, after which seismic source predictions for EEW are complete.

NIED and JMA are now engaged in joint R&D as part of National Leading Project aiming at practical use of the information to various kinds of users by integrating these two methods. In this R&D the two are looking into ways to preside cross-references between the two methods, and at how to and speed up these methods. By FY2005, results based on two methods are compared and prioritised on the basis of evaluation results, and from FY2006 the plan is to integrate the algorithms themselves.

2) Determination accuracy and reliability
In current observation networks, its takes around two seconds firstly to determine the seismic source from when the seismic wave is detected at the first observation station. As time passes, the seismic wave reaches more and more observation stations, enabling the seismic source are successively recalculated providing more confident estimation. Figure 2 illustrates the immediate source determination of an earthquake (M 5.3) that hit Tottori Prefecture on

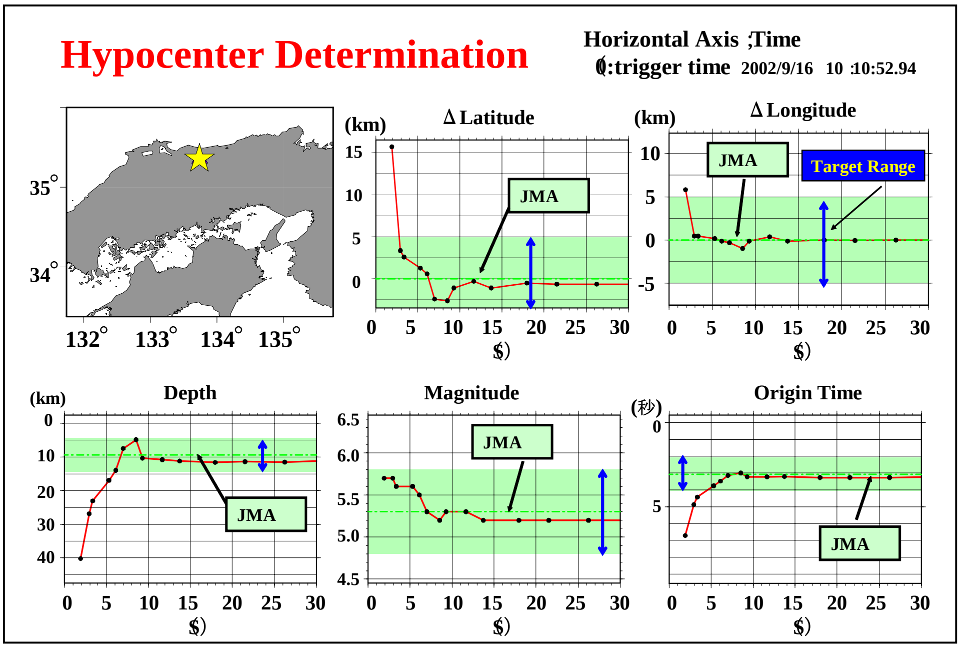

Fig.2 Example of seismic source determination as analysed by real-time systems for the Tottori Prefecture Earthquake (September 16, 2002). In the Figure dot denote EEW result, and "JMA" means the off-line official result reported by JMA ordinary after several days later.

September 16, 2002. Arrival time at the first observation station is taken as the starting point. In this example, seismic source determination begins 2.5 seconds, which is many times faster than in conventional methods.

Seismic sources were determined with around 95% accuracy in FY2003. This meant that of all noticeable tremors, erroneous information was sent out only for a few percent of cases. With subsequent R&D outcomes, the current success rate stands at around 99%, sufficiently reliable to be used in most of the situations. Through tests using the integrated data and the evaluation of contents of EEW, data is progressively being collected that can answer questions about how reliably automated control would be done, and how we can make the warning products more reliable.

These statistics are based on real-time information data prior to the integration of the two independent methods, and include statistics for small earthquakes as well. Since the integration of the two information systems, EEW is limited for earthquakes of magnitude of 4 or higher and estimated JMA seismic intensity of 3 or higher. If we look only at the statistics for information sent out for earthquakes with maximum intensity of 4 or higher, then we find that in the period from June to October 2005, there were zero cases of erroneous information being sent out (Sekita, 2005). Now many are of the opinion that this information has enough ability to put to use for at least to authorized users. However existence of small possibility of error causes JMA to deliberately consider how to use generally in country.

4) Distribution systems
On March 25, 2004, the JMA, which is in charge of the issue of information, began verification tests for EEW. The JMA and NIED are continuing to compare and investigate the various methods available and is continuing to work on integrating data processing methods to make the information more comprehensive, more reliable for the practical uses planned in 2006.

Since June 2005, JMA has been conducting trial distribution of the integrated information. At present, they select better results provided by the two processing methods with the result of establishment of order for priority. There are about 150 organizations receiving the EEW to develop systems for application of their own interests as users or vendors.

From FY2006, they will move on to the next stage, which will involve integrating the methods on the algorithm level to establish a consistent series of process to issue EEW. At this time, they will also look into new processing methods as well. The results of these verification tests are to be used to produce a processing engine for a next-generation Earthquake Early Warning operation system of JMA.

Development of disaster-prevention prototypes

REIC has been taking over the part of the project involving experimental study and research into making effective use of EEW, and is working on the development of earthquake disaster prevention systems tailored to the needs of different users. Their studies and research are field-specific and focus on 14 themes that span typical I I sectors. To achieve their aims, REIC has formed a working group (WG) for each field where systems are to be used that consists of members who are academic experts from universities, research institutes, governmental organizations, and related industries. An overview of the R&D initiatives is outlined below.

1) Database
Compiling research outcomes and technical information are to be shared amongst researchers and developers. It makes research activities more efficient, make effective use of information, and will alleviate problems such as development redundancies, etc.

2) Development of an earthquake disaster-prevention system.
Development efforts are divided up into two areas: earthquake disaster prevention, and data transmission. Research in the former area involves looking into the following 10 themes.

(1) Fire department systems,
(2) Medical systems,
(3) Home electronics system,
(4) School system,
(5) Plant system,
(6) LPG systems,
(7) Outdoor activity systems,
(8) Building maintenance systems,
(9) Elevator systems, and
(10) Dam systems.

For example, in the case of medical systems, the aim is to ensure that EEW is issued as soon as possible, so that the safety of patients, doctors, nurses and other staff is secured, unforeseen circumstances during surgery are prevented, medical testing equipment in operation is stopped. And initial emergency system is established as soon as possible to support mass relief and rescue efforts. The system supports to ensure that the safety of staff can be confirmed and that staff can be mobilized before communications lines become congested.

The design of information appliance of home electronics has involved investigating to what extent earthquake damage to households can be minimized, with survey data on damages incurred during the Kobe Earthquake. Those were used as the basis to identify prerequisites for minimizing such damage. Surveys and reports show that the moment an earthquake hits, people become panicked, and although normally they know that they need to extinguish all flames and open doorways and exits, at that moment all they can do is nothing but get down on the ground.

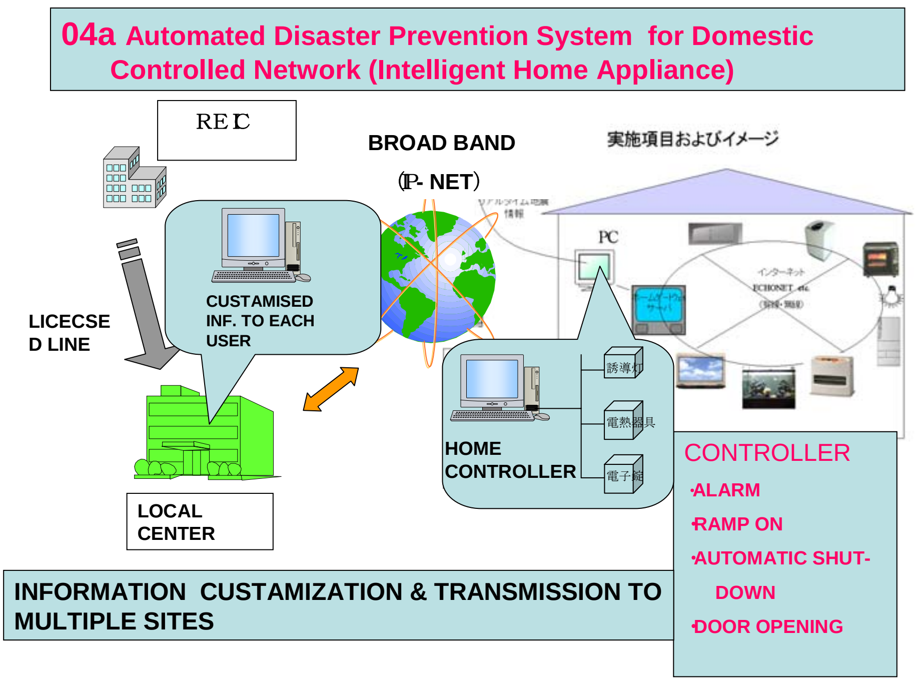

Fig. 3: Overview of automated disaster prevention system for information control appliances for household.

This finding lead to the idea that it is important and effective to automate, as best as possible, measures for cutting off heat sources and securing evacuation routes. During the development of systems, these findings are being incorporated into the design process.

For school systems, the first aim is to save lives of children, and the second aim is to use school education to promote the dissemination and use of EEW, in order to develop, as quickly as possible, a social environment in which emergency earthquake information is able to be used effectively. (Fig. 4) Through training and drills in schools, efforts are being made to mitigate the damage incurred at the time of an earthquake, and to educate around one million citizens a year to promote the use of emergency earthquake information.

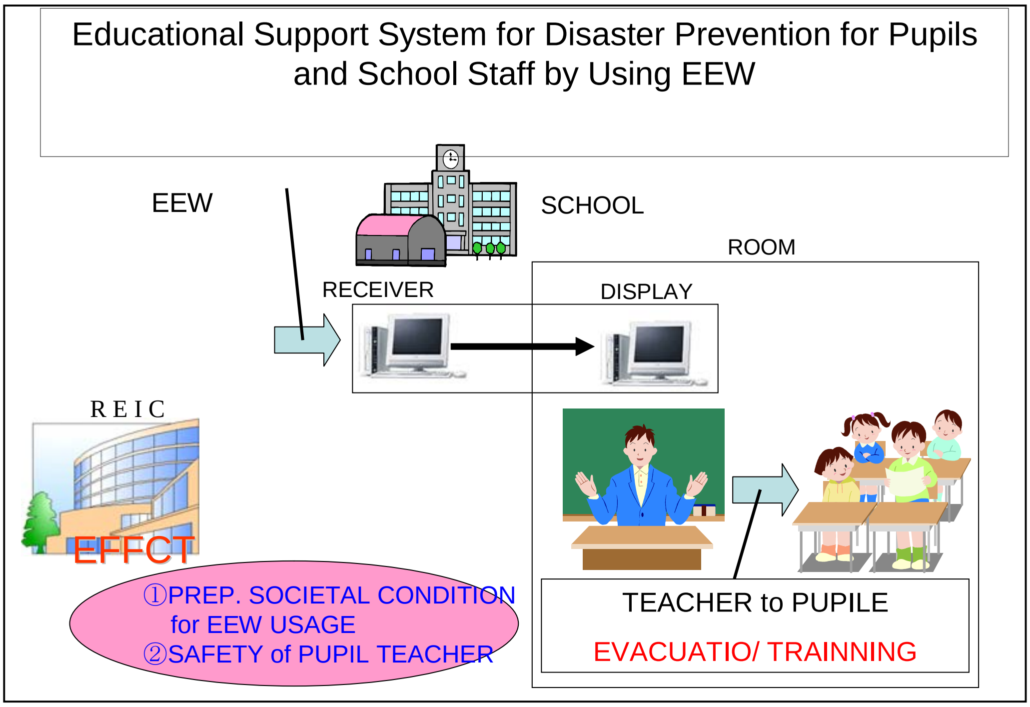

Fig. 4: Overview of disaster-prevention education support system for school students and staff using earthquake early warning (EEW).

3) Development of data transmission methods
The following four themes are being focused on in the development of data transmission methods.

(1) Disaster prevention wireless systems,
(2) IP telephone systems,
(3) Public mobile communications systems, and
(4) FM broadcasting systems.

In the development of these systems, new data transmission systems are not being developed, but rather, for the mean time, development is focused just on finding ways to transmit EEW basically over existing data transmission systems. Enough fund is expected to be prepared by communication companies as the market expands. For FM broadcasting systems, the aim is to distribute information using existing FM broadcasting systems for the transmission of information to a large number of registered users with minimum transmission delay. We expect digitalisation of FM radio will open the road to use of the channel for a transmission of the warning.

Discussion

It is without saying that any of people should be given chance to use the information. As to the EEW, however, the information has intrinsic limitation as possibility of error and false alarm making the general use difficult. So that the practical usage is going to start from registered users postponing the warning by broadcasting a little while. .

The issue to be considered now is how to make such systems (a) cause less confusion, and (b) more helpful. It is highly likely that when information is provided to people in a form that they are not used to, then even if this information does not cause con-fusion, it still may not be very helpful either. For safety managers such as of departments and hotel, to better fulfil their responsibilities, they may simply decide to use such systems just to provide information only to own staff not to public. However, it may be problematic that while warnings can be issued to registered staff within a building, there is no way of warning to those people passing outside the building where the broken window glass is expected to be showered down. There is no doubt that further investigation how to use for passengers or mass at arbitrary "time, place and opportunity" is needed.

Even when earthquake prediction becomes possible, the best choice would probably be to rely on EEW and continue on with certain societal activities after earthquake prediction information has been issued, being aware that the earthquake could hit at any time. This idea involves using earthquake prediction information and EEW together as a pair. Studies into what is needed to make effective use of EEW have shown that there is a high need for earthquake prediction, and that many people want prediction information that will give them several hours or several days warning, as opposed to the 10 or so seconds available to them by using EEW are issued. The earthquake disaster prevention community needs to address these demands in earnest.

Conclusion

With the establishment of intense earthquake observation networks, it is become increasingly possible to predict strong ground movement before earthquakes wave hit, enabling disaster prevention measures to be employed in advance. The development of prototype systems designed to make effective use of EEW through automated or semi-automated operations is also progressing steadily, with practical applications for registered users due to emerge in FY2006. However, issues still remain that need to be resolved before applications for indiscriminate people can be started. These issues must be resolved through collaboration between relevant organizations, and understanding and cooperation on the part of users. Service companies, organizations, and individuals need to get involved in order to find practical applications of EEW so as to minimize the damage that will be caused by large earthquakes to occur at unexpected time.

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PREDICTING THE FAILURE OF SLOPE USING THE TRS SENSOR

K.T. Chang[1], H.S. Han[2]
Kumoh National Institute of Technology

J.H. Ryu[3]
Hanlyo University

Keywords: Slope, Landslide, Polynomial model, Growth model

Abstract

This research is conducted to develop the qualified data analysis system for predicting the behaviour and failure of slopes. The data were acquired from TRS (translation, rotation and settlement) sensors and were transmitted to the control centre using real-time monitoring technology utilizing the CDMA communication system.

The use of appropriate mathematical modelling has been useful in creating a predictive capacity for landslides. Through observation and analysis of a real-time measured time series, a reasonable mathematic model was selected to predict landslide behaviour.

Two theoretical models are suggested; the polynomial function and the growth model. These models are judged to be most suitable for the description and analysis of measured deformation from an active landslide. This paper describes the application of these models to field data extracted from a slope in Nerupjae, South Korea. Analysis of the results confirmed good correlation between measured field data and predictive models.

Introduction

Throughout the years geotechnical engineers have collected considerable amounts of data from monitoring engineering projects that are prone to landslides. Despite the fact that in the civil engineering, practice substantial amounts of data has been accumulated, the effective use of these data to facilitate the prediction of future landslides has not been adequately addressed. The frequent occurrence of catastrophic landslides in recent years in Korea has reiterated the urgent need for geotechnical professionals to forecast, more accurately, the sliding event. A review of current works shows that existing predictive methods for landslides have seldom been based on basic physical principles or concepts. However, observations have confirmed repeatedly that the classical *growth* models simulating the phenomenon of *growth* could be applicable in providing a predictive capacity. For example, the deformation of rock

[1] Kumoh National Institute of Technology, 1 Yangho-dong,, Gumi, Gyungbuk 730-701, Korea. Email ktchang@kumoh.ac.kr
[2] Kumoh National Institute of Technology, 1 Yangho-dong,, Gumi, Gyungbuk 730-701, Korea. Email hsh0372@hotmail.com
[3] Hanlyo University, 199-4, Dokryeri, Kwangyang, Chonnam, 545-704, Korea. Email chryu2@paran.com

avalanche *grows* exponentially or with power function, for certain period. According to a model devised by Verhulst, the deformation of a landslide with the foot of the slope facing a river may follow the logistic distribution. The present paper shows the methodology involved in utilizing two kinds of theoretical models for the description and analysis of monitoring data and how the resulting information can be interpreted to facilitate prediction.

Prerequisites for Prediction Modelling

The selection of an appropriate mathematical model is vital for the accurate prediction of landslides. It would be erroneous to assume that a particular model is suitable the prediction behaviour on the basis of *best fit* to data acquired in the field. It would be equally misleading to assume suitablity if the residual sum of squares is a minimum between the data and the model. It is important to understand fitting and prediction are entirely different concepts. Fitting provides an indication of ability to model past and present behaviour and fitting well suggests good interpolated estimation. It could be groundless to extrapolate such interpolation to the estimation into future behaviour.

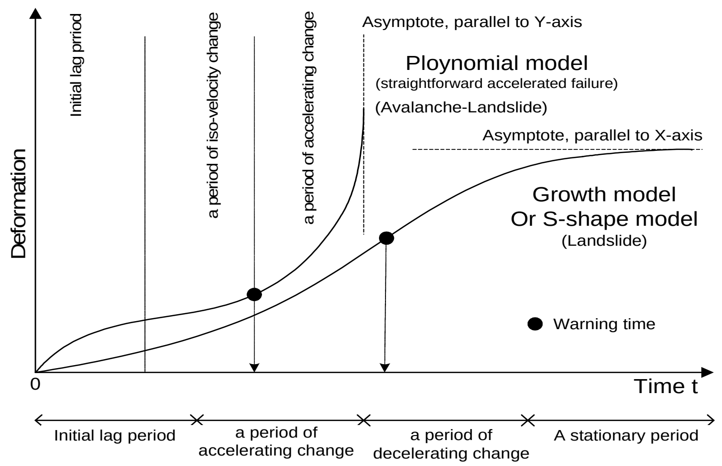
A more reliable way to achieve a more accurate prediction is to acquire a better fundamental understanding of the movement mechanisms and of landslide itself. As an example these can take the form of a linearity tendency, a periodical fluctuation, a season transform, a growing tendency or some form of efficiently proved differential equations. Through the effective use of observation and analysis of a real-time measured time series, it is possible to select a reasonable mathematic model to prediction the behaviour of a landslide. By fitting the suggested model to the raw data and adopting other relevant parameters in the model, the prediction of failure time can be achieved routinely[1, 2].

Two proposed models

From experience, the deformation for a landslide with the characteristics of an avalanche is mainly presented as "straightforward accelerated failure", with little or no inherent or natural constraint. The deformation appears to follow exponential, power or polynomial growth. On the other hand, the deformation of a landslide into a riverbed or subjected to unavoidable inherent or natural constraint shows approximately an S-shaped curve. Both failures have inflection points and maximum curvature points in their respective deformation curves as shown in Fig. 1.

For predicting a landslide based on deformation observed in the early stage, the determination of an appropriate model and its "best-fit" parameters is still a frequently used method. The key is to select a best-fitted model considering both engineering geology survey and minimizing the squared errors between model and data. Two models are proposed; 3-degree polynomial models

Fig.1 Sketch map of slope movement process [3]



For "straightforward accelerated failure" case(polynomial model), we assume the time function of the deformation N as

$N(t) = a_3t^3 + a_2t^2 + a_1t + a_0$ (1)

The coefficients(a_3,a_2,a_1,a_0) could be determined by curve fitting technique by spread sheet. The next step in the analysis is to determine the asymptote and maximum points in this curve. In this case, the asymptote indicates the failure of slope. Since the asymptote is the infinity of the deformation curve of slope, the maximum deformation of slope result in failure. As the profile of the curve approaches the point of rapid gradient change, then it is assumed that landslide will be imminent. To find out the point of curve slope change, Eq. (2) is rearranged,

$dN/dt = 3a_3t^2 + 2a_2t + a_1$ (2)

For "Failure with Inherent" case(growth model), we also assume the time function of the deformation N as

$N(t) = a_7t^3 + a_6t^2 + a_5t + a_4$ (3)

In this case, the value of a^7, has minus value compared to a^3 of the polynomial model. This model has also asymptote, therefore, the next step in the analysis is to determine the asymptote and maximum points in this curve. In this case, the asymptote means also the failure of slope. Because asymptote is the maximum value of deformation curve of slope, it will result in failure. At the point of curve gradient change, landslide warnings should be alerted.

Applied Measuring System

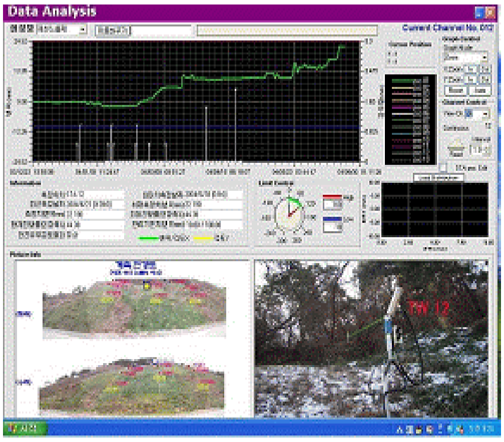
Fig. 2 shows the specially developed measurement transducer called the TRS sensor. It is designed to measure parameters such as displacement(translation), rotation, settlement (hence TRS). By adding the specific measuring sensor for rotation, TRS sensor could forms the 3D vector which facilitates the understanding of slope movement and tendency. This TRS sensor is applied to the Nerupjae case study (Fig. 3).

Fig. 2 TRS sensor

Fig. 3 TRS sensor applied in Nerupjae

16 No. TRS Sensors and a rain gauge were installed to analyze the slope behaviour in Nerupjae, Jaechon, which is the cut-slope adjacent to a national road. The deformation shape versus time of Nerupjae has followed the typical 3-degree polynomial equation. Fig. 4 shows the slope view, sensor and the deformation graph. The data was analyzed, and that of sensor

No. 12 showed the typical failure type. It is 3-degree polynomial having the deformation equation of trend line by time is $y = 1E\text{-}08x^3\text{-}3E\text{-}05x^2 +0.0316x\text{-}0.3472$, and $R^2 = 0.929$. As can be seen in Fig. 5, the trend line of the slope deformation is very close to the asymptote, this suggest that the failure is imminent.



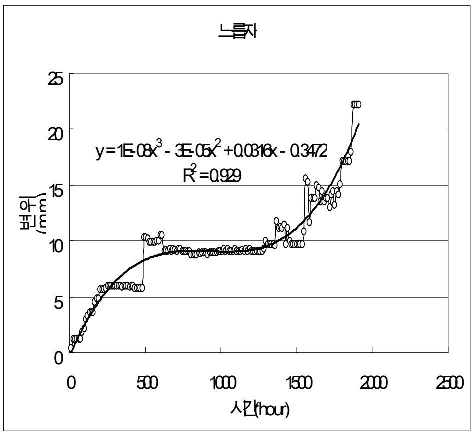


Fig. 4 Computer screen of TRS sensor   Fig. 5 Data analysis of Nerupjae

Summary

Compared with other pure mathematic models, the presented model is a better representation especially, based on polynomial function form, and similarly, it was found that dD/dt and the asymptote in the curve perform key roles in predicting the landslide. Again, compared with other existing models, the suggested models are more generalized and simple since they are 3-degree polynomial functions.

However, there are still influential factors not involved in the presented model, for example, geometric shape, amount of precipitation, etc, On occassions the presented model still shows some instability. This presented model only considers the monitoring data from the tertiary creeping stage not including data from the first and second stages. In addition, the physical meaning of *a* value is not yet clear. Therefore, there are still problems and questions to be investigated in the future.

The equations of the deformation trend line of Nerupjae by time is represented to the 3-degree polynomials ($y=ax^3 + bx^2 + cx + d$).

As you can see in Table 1, the trend line is believable because of high R^2 value.

Table 1. Summary of Nerupjae

field	failure model	trend line	R^2
Nerup	polynomial	$1E\text{-}08x^3\text{-}3E\text{-}05x^2$ +0.0316x-0.3472	0.929

The coefficient 'a' of Nerupjae equation is plus value, therefore, the asymptote of Nerupjae is located at x-axis(time-axis), also the trend line of the field was going to the asymptotes, it is estimated that their failures are very close.

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Academic and Professional Practice

Peer Reviewed Articles

Humanitarian Response To Emergencies

PAKISTAN’s EARTHQUAKE – THE LASTING IMPACT

Khalid Hasnain Qureshi
Pakistan Lions Youth Council

Abstract

Perhaps, Pakistani Nation would never be able to forget the horrible morning of October 8, 2005 when it faced the history’s worst ever earthquake in the form of a great loss of lives, property and business. It was the day when an earthshaking quake with a magnitude of 7.6 on Richter scale jolted a number of cities, towns and villages of North-West Frontier Province (NWFP), Federally Administered Northern Areas (FANA), Azad Jammu Kashmir (AJK), Islamabad and Lahore, leaving hundreds & thousands of people dead and score of human-beings injured on the spot. The official reports have added that the death toll increased up to 73000 people including a major portion of the deaths of children and infants closing chapter of the young generation in quake-hit zone completely. Besides this the quake has left 2.8 million people without shelter.

This paper examines the impact of the recent Pakistan earthquake and the relief and recovery effort that ensued before setting out recommendations for the future improvement of Emergency Management in Pakistan.

Background

The earthquake background informs that Kashmir lies in the area where the Eurasian and Indian tectonic plates are colliding. Out of this collision, the Himalayas began uplifting 50 million years ago, and continue to rise by about 5 mm/year. This geological activity is the cause of the earthquakes in the area.

The United States Geological Survey (USGS) measured its magnitude as 7.6 on the Richter scale with its epicenter at 34 29 35? N, 73 37’ 44? E, and 100 km (65 miles) northeast of Islamabad (Pakistan). The epicenter was located at a depth of 26 km (16.2 miles) below the surface. The earthquake caused a widespread destruction in northern parts of the country besides damagaing some parts of northern India and Afghanistan slightly.

The worst hit areas included country-administered Kashmir, Northwest Frontier Province (NWFP) and western & southern parts of the Kashmir Valley in the Indian-Administered Kashmir. It also affected some parts of the country’s largest province; Punjab while Karachi city in Sindh province experienced a minor aftershock at a magnitude of 4.6. There have been many secondary earthquakes in the region, mainly to the northwest of the original epicenter. A total of 147 aftershocks were registered in the first day after the initial massive quake that hit at 8:52 am, one of which had a magnitude of 6.2 (a tremor of magnitude six is rated as “strong” earthquake). 28 aftershocks occurred with a magnitude greater than five during four days after the principal quake and even eleven after the big one.

Relief work begins

Pakistan's earthquake has reflected an unprecedented relief work done by the government agencies, non-government organizations, political, religious, trade & media organizations, national & international donors and general public. This is the only tragedy of the world where beggars offered petty donations for the quake victims. The relief work was primarily focusing on taking out the dead bodies and rescuing the people lying-down under huge debris of houses, schools, government buildings, seminaries, mosques/worship places, banks, hospitals and other institutions, completely smashed owing to quake. Secondly the relief activities turned to shift the injured persons to the hospitals of those cities where the hospital buildings remained safe.

Role of the Government

The situation, later the massive destruction, forced the government to announce emergency across the country, which hampered all the routine work in government departments, as it only focused to take all necessary steps towards providing maximum relief to the quake survivors. The President of Pakistan, General Pervaiz Musharraf played a most vital role in facing the challenges appeared after the earthquake. He strategically framed out the work and immediately announced to establish President Relief Fund (PRF). The PRF put everyone on the way of an enthusiastic campaign of fundraising for the quake victims. Besides this the federal government immediately allocated billions of Pak rupees (millions of $ US) for the quake-hit areas.

International Donor Conference

The government in the third week of October 2005 announced to hold an international donor conference in Islamabad on November 19, 2005. This conference, which was attended by United Nations Secretary General, Mr. Kofi Annan, remained successful, as the international donors pledged $ 5.8 billions on the eve of this function. The following brief statement reflects contribution of the international donors.

State/Org	Pledges	State/Org	Pledges
Asian Development Bank	$ 1b	Switzerland	$ 40m
World Bank	$ 1b	Norway	$ 35m
Saudi Arabia	$ 573m	Sweden	$ 20m
United States	$ 510m	Finland	$ 06m
IDB	$ 500m	Indonesia	$ 05m
China	$ 326m	Denmark	$ 05m
IMF	$ 275m	Australia	$ 4.5m
Iran	$ 200m	Canada	$ 4.5m
Turkey	$ 150m	Bangladesh	$ 02m
Germany	$ 130m	Azerbaijan	$ 1.5m
France	$ 124m	Malaysia	$ 01m
United Kingdom	$ 120m	Mauritius	$ 01m
Japan	$ 120m	Thailand	$ 0.25m
European Union	$ 110m	Sri Lanka	$ 0.10m
UAE	$ 100m	Afghanistan	$ 0.5m
Kuwait	$ 100m	Singapore	$ 0.4m
Agha Khan Foundation	$ 50m	Bhutan	Rs. 3.2m

Compensation Policy/Guidelines

According to Federal Relief Commission (FRC) the government's compensation policy announced for the earthquake victims narrates as noted below;

- Compensation – Dead

  The compensation for the dead to a household is restricted to Rs. 100,000 (One hundred thousand only / about $ 1700) for the time being, irrespective of the number of dead.

- Compensation – Injured

  Category-1 (Rs. 50,000/ about $ 800)

  i). Permanent disability, which includes amputation of appendages or loss of one or both eyes, paralysis of limbs due to injury or head injury leading to permanent disability.

  Category-II (Rs. 25000 / $ 400)

  i) Fracture of bones
  ii) Amputation of fingers/toes
  iii) Abdominal injuries leading to major surgeries
  iv) Injuries requiring hospitalization for more than two weeks at the time of admission

  Category-III (Rs.15000 / $ 250)

  i) Minor Injuries admission to a hospital for less than two weeks
  ii) Seriously injured cases having visible evidence of injury on the body and exempted from producing hospital discharge slip for payment of compensation
  iii) Other injury cases claiming compensation but having no visible signs of injury on the body subject to verification of the compensation distribution committee.

- Reconstruction Grant

i) Rs. 175,000 per household admissible to all the affected houses including the special grant of Rs. 125,000 announced by the President of Pakistan and Rs. 25,000 as an incentive to those adopting quake resistance standard in house building as laid down by the government.
ii) CGI sheets for construction of transitional shelters were provided free of cost.

The earthquake – Latest Updates as on March 25, 2006

As per official sources following is the brief about the earthquake's victims and relief work / operation.

Casualties

Dead	73,338
Seriously Injured	69,417
Other Injured	58,897

Recuperation and Relief Camps

Facility	Total	Available Space
CC/Hospital	1	36
Relief Camps	11	1407

Medical Assistance

Field Hospitals (International)	43
Medical Teams (International)	48
Field Hospitals (Domestic)	24
Medical Teams	39

Relief Provided

Tents	940,349
Blankets	6,276,167
Rations	73,487 (Tons)
Medicines	1,803 (Tons)
Miscellaneous goods	30,970 (Tons)

Tent Villages / School Established

Area	Villages	Schools
Azad Jammu & Kashmir	74	20
NWFP	531	20
Total	605	40

Infrastructure

Roads Cleared	95 %
Water Supply Restored	75 %
Electric Supply Restored	70 %
Telecom facility restored	96%

Interim Construction

Interim Shelter Construction	372,715 units
CGI Sheets Provided	1,441,102 units

Air Sorties

Air Sorties Generated for Relief operation	29,578

Financial Aid

Amount Pledged	US $ 6,523.103 million
Amount Committed	US $ 3,113.105 million
Amount Disbursed	US $ 1,021.175 million
Domestic Pledges	Rs. 10.799 billion

Compensation Distributed (Million Rs)

Description	AJ & K	NWFP	Total
Dead	3,386.000	1,732.300	5,118.300
Injured	545.122	345.825	890.947
Houses	6,710.300	6,924.725	13,635.025
Total	**10,641.422**	**9,002.850**	**19,644.272**

Volunteers Reported

AJ & K	65
NWFP	0
Total	**65**

NOCs (Non-Objection Certificates) issued for Import: **Total: 2170**

International Assistance

Air flights for relief goods	1630
Relief Workers participated in Relief Operation	11,240
Number of Countries	86

Role of NGOs

In the relief/rehabilitation work, a number of National and International NGOs have performed a remarkable job in the quake-hit zone to date. The International NGOs/Organizations/Donors working for the South Asia Earthquake are:

World Food Programme, Disasters Emergency Committee, Red Cross/Red Crescent, Islamic Relief Worldwide (UK), Islamic Relief Worldwide, Mercy Corps, OXFAM, Tear Fund, American Red Cross, Plan International, Ameri Cares, The British Red Cross, Canadian Red Cross, Catholic Relief Services, Care International, Church World Services, Christian Aid, Concern, Air Serv, Humedica, International Medical Corps, International Rescue Committee, International Rescue Corps, Map international, Medair, Medicins Sans, Frontier Muslim Aid, Northwest Medical Teams, Plan USA, Save The Children USA, UNHCR, United Methodist Committee on Relief, World Vision, Action Aid International, Action against Hunger, ADRA, Episcopal Relief and Development, Operation USA, OXFAM USA, Relief International, UNICEF-USA, World Concern, World Emergency Relief, Mercy-USA, Brother's Brother Foundation, Food for Hungry, International Aid, International Orthodox Christian Charities, International Relief Teams, Lutheran World Relief, American Refugee Committee, Baptist World Aid, Direct Relief international and BBI.

General Public Role in Relief Work

Realistically, the role of Pakistani Nation, in the form of a dedicated participating in relief operation, can never be forgotten at any stage. The people individually as well as in small groups gathered relief goods by moving door-to-door besides depositing donations in the President Relief Fund and other relief accounts. The people after hearing about the tragedy, rushed to the quake-hit areas through various modes of transportation just to help the victims. All employees working in government and private organizations announced to donate their 1-day salary amount in the President Relief Fund besides sending relief goods to the victims through trains, road transport and their personal transport.

Input from Political, Religious, Social, Trade circles in relief activities

The contribution of political, religious, social and trade organization in relief activities continued in quake zone is much admirable. It is pertinent to mention that most of the industrial and pro-government political organizations donated huge amounts for the earthquake victims through PRF while the anti government political parties and most of the religious organizations executed relief works at their own alleging that "the government remained failed to reach the quake zone on time, which resulted into the improper work for rescuing the people". However, such parties performed relief activities by providing a huge quantity of relief goods to the quake-hit areas. Reportedly all these parties established thousands of relief camps across the country for collecting/gathering relief articles for the quake victims. It was unprecedented that the nation performed a vital role in sending the relief items to the most difficult hilly areas of quake zone in severe winter season, started in the country from November, 05 to February 06.

The Earthquake-Aftermath

Reconstruction of Houses and Buildings

According to careful estimates Pakistan will have to bear about $ 3.5 billion for the reconstruction of destroyed houses and building across the quake-hit areas. On March 30, Major General Nadeem Ahmad Khan, Chairman Rehabilitation and Reconstruction section for the earthquake, told a private news channel that the international funding institutions had promised to provide $ 3.5 billion for this purpose out of which half of this major amount has been received to the Pakistani government. He stated that a sum of $ 200 million is expected to be spent on the houses reconstruction in the quake zone while rest of the amount would be spent on the building reconstruction and rehabilitation of infrastructure.

Rehabilitation work continued

The rehabilitation work in all quake-affected areas is still continued, as the efforts have been geared up for the proper execution of rehabilitation tasks. According to United Nations Secretary General, Kofi Anan "Survivors of the Pakistan's earthquake will be engulfed in a "wave of death" unless the international aid effort is stepped up immediately, while the World Health Organization's regional director Hussein A. Gezairy has termed the incident "A bigger catastrophe than the Tsumani in destruction to infrastructure". The World Bank and Asian Development Bank have estimated that the cost of the devastating earthquake will exceed $ 5 billion, which includes estimated cost for relief, reconstruction and livelihood support for the victims. Although the rehabilitation work is continued in the quake-hit zone with the already received half of the amount of $ 3.5 billion, but the remaining portion of the amount must be given to the government to execute the rehabilitation work properly.

US Troops Left Quake Zone

The US troops who had rushed to Pakistan's quake-hit areas NWFP and AJK, have started returning to their homeland from March 31st. According to a private news channel, the process for the complete return of the US troops will be completed by April 15. It may be recalled that before this, the NATO forces who had also reached Pakistan last year to participate in the relief activities have already returned in February, this year. The Pakistani government have severally applauded the services of US troops a NATO force contingents for their dedicated participation in the relief efforts.

Return of quake survivors from Tent Villages

The earthquake-affected people have started returning to their native areas from tent villages run by the government and non-governmental organizations in different parts of the five-affected district of the North-West Frontier Province. The reports from the quake-hit zone in NWFP have confirmed that the people in the camps at various localities were seen packing their belongings and heading towards their native villages/towns in line with the NWFP governments decision of closing all camps by March 31st. The repatriation process will be completed in three phases. Over a hundred families left for their villages located on the hilltops on the first day of starting the process from a government-operated camp in the city of Battagram.

Canada announced immigration for Quake-hit people

In-context with the rehabilitation process, The Canadian government has announced to award immigration status to the quake-affected people. The Canadian High Commission in Islamabad, through its website, has asked the quake survivors to contact Embassy in person or through letter proving their belonging from the quake-hit zone. The High Commission has also asked the affected people that if they have not the resources to visit embassy, they can write a letter containing their complete address. The High Commission has termed this scheme as most beneficial, stating it would help the quake survivors to shift themselves in Canada easily without any condition.

Mobile bank to function in quake hit areas

The Ministry of finance and commercial banks has agreed that the mobile bank teams will operate in the designated earthquake-affected areas so that affectees are ensured speedy disbursement of money, with which they can start reconstruction efforts. No fee charges would be realized from the affected people for opening and operating accounts. The condition of minimum balance will also not apply to the accounts of earthquake affectees in AJK and NWFP.

Landslide Threat Exists in Pakistan

The landslides present a substantial threat to the survivors of the October 8 earthquake in Pakistan and urgent action is needed ahead of summer rains to prevent large-scale loss of life. According to Professor David Petley of the International Center at Britain's University of Durham and Dr. Mark Bulmer of the Landslide Observatory at the University of Maryland in the United States, both visited quake-hit zone in January this year, have said that while the response of Pakistani and international relief agencies to the earthquake had been remarkable, the landslides have posed a substantial threat to the survivors. They said that following the threat there should be necessary arrangements for the quake survivors before start of the summer rains in Pakistan so as they could be saved from this threat as a precautionary measure.

Establishment of Disaster Management Cell-DMC

Feeling a dire need of Disaster Management Cell (DMC), Prime Minister, Shaukat Aziz has accorded approval to establish the DMC at prime minister secretariat, Islamabad. The premier has asked the concerned authorities to equip the DMC with latest technology of earthquake precautions and measures so that such worst incident could be avoided in future. It may be recalled that there were lot of debates on the urgent need of DMC's establishment in the country as soon as the nation faced the earthquake tragedy.

National Volunteers Movement-NVM

The President of Pakistan has asked the department concerned to form a force of volunteers by naming it as National Volunteer Movement in the country. The President has also inaugurated the NVM, urging the authorities concerned to prepare database of the volunteers and build their capacity to participate in the relief activities in quake zone. It is worth mentioning that there was no particular forum existing in the country before the earthquake.

Federal Relief Commission's Task concludes

The Task assigned to FRC regarding rehabilitation of quake-survivors has almost concluded and this temporarily established department has been closed. According to Major General

Farooq Ahmad (Chief of FRC) the FRC has almost completed its assignment, but the departments concerned will do the rest of the work. He admitted that had there been a particular or already established disaster management department in the country, the nation would have not faced this tragic incident.

Economic Impact of the Earthquake

The earthquake is expected to have some adverse impact on Pakistan's overall economy. At least in the short run, it is true that the affected region accounts for a fairly small fraction of the Country's output. According to Mr. Mohsin S.Khan, Director, International Monetary Fund, Pakistan's main economic infrastructure-factories, ports, financial centers-was mostly unaffected. Similarly, Pakistan's main crops-cotton and wheat- are mostly grown in other parts of the country. Still with economic activity having been virtually wiped out in the directly hit Areas, there will be some dampening impact on growth. Together with a somewhat buoyant Harvest of crops like cotton, grother in 2005/6 could be some ½ to 1 percent lower than the 7 Percent projected prior to the earthquake. Eventually, however, as rebuilding activities get underway, growth may strengthen. The Natural disasters destroy assets, and the process of restoring assets results in growth. The relief and reconstruction may result in some price increases. Obviously, the relief and reconstruction efforts will affect the government budget. The relief and reconstruction efforts translate into an average cost of about 1-1 1/2 percent of GDP per year in the next few years. To combat such problems Mr. Mohsin said that the IMF is Ready to provide financial resources through the Emergency Natural Disaster Assistance (ENDA). The ENDA is aimed at meeting the foreign exchange financing needs of a country hit by a natural disaster. It is the quick disbursing and the government only needs to present a statement of the general economic policies they response to follow.

Recommendation

On the eve of such prestigious event, it is recommended the following:

- To Equip Pakistan with latest technologies and methods to avoid at maximum such natural disasters
- To establish a global network of NGOs working on Emergency management.
- To Build Capacity of the government and NGOs on Emergency Management.
- To Establish Office of The International Emergency Management Society (TIEMS) in Pakistan.
- To organize International Conference under aegis of Tiems Management in Pakistan.
- To initiate fundraising campaign for Pakistan's earthquake, starting from this conference.
- To prepare an affective project proposal for the rehabilitation of quake survivors

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Authors Biography

Mr. Khalid Hasnain Qureshi was born in September 1970 in Khanewal District of southern parts of the Punjab, Pakistan. He did graduation (Bachelor of Arts) and Law Graduation (LLB) from Bahauddin Zakria University, Multan, Punjab. He started his professional career in 1994 and served on various important positions in Sambu Construction Company, Daewoo group, Pakistan Lions Youth Council and English Daily "The Post" He also rendered honorary services to Daily "The News" International and Daily "Pakistan". Currently he is working with a UN enrolled prominent NGO, Pakistan Lions Youth Council. His excellent performances during his 12-year professional track include special promotion, award wining and appreciation certificates. He has skills in Human Resource Management, Volunteer management, Administration, Project proposal, Project design and management and Monitoring & Evaluation. He already visited South Korea twice in 1995 and 2002 in-connection with attending 30th International Camp (as delegation head) organized by Korean National Commission for UNESCO in Ichon-Seoul and 1st AVA Asia Pacific regional conference on volunteer management (as country speaker) staged by Federation of Volunteer efforts in Busan respectively.

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"LISTEN TO THE WOMEN" LINKING RELIEF AGENCIES AND LOCAL CAPACITIES IN COMPLEX EMERGENCY OPERATIONS

Kristin S. Scharffscher
The University of Stavanger

Introduction

Complex emergencies are comparable with modern crises, in that there are discrepancies between the realities in the field and how the situation is perceived and dealt with by those who move in to help. Complex emergencies can also be seen as the dire consequences of severe inequities in the global distribution of vulnerability. Scholars have called for new approaches to complex emergency management, in order to make relief more effective and to rebuild local resilience for when the next disaster hits. This has been the formal intention of humanitarian organisations and donors for a while already, but appears difficult to implement in practice – especially for relief agencies.

Systematic consultations with affected women and active use of women's existing contingencies and capacities can not only bring about more effective and sustainable humanitarian relief work that counters the world's vulnerability inequities. It can also support the affected communities in establishing a "self-sustaining peace"[1]. In 2000, United Nations' Security Council (UNSC) adopted Resolution 1325, which requires United Nations (UN) agencies to mainstream a gender perspective into all activities related to the support, restoration and provision of peace and security. While many development agencies over the past few years have improved their routines on consultations with women, emergency relief agencies still tend to operate in a largely pre-designed and conventional crisis management manner. This corresponds with the notion of complex emergencies being perceived as 'crises', the way these are defined by for instance Rosenthal et al (2001). When there is an overwhelming sense of urgency, managers are faced with what they see as a dilemma between keeping control of the tasks at hand or to collect information through (time- and manpower-consuming) consultations.

From the perspective of crisis management theory and with the post-tsunami relief operation in Sri Lanka as a case study, this paper explores the nature of complex emergencies and discusses the operational challenges for the coordinators of humanitarian complex emergency operations in relation to communication with women's local resources and contingencies.

The nature of complex emergencies

A disaster is an event which is commonly perceived as unforeseen and which poses severe threats to life, health, values and structures of the affected community (or communities). Although the terms 'man-made' and 'natural' disasters are still part of the disaster research

[1] Self-sustaining peace can be defined as a community's "capacity to handle conflicts with empathy, creativity and by non-violent means" (Galtung, 1996).

vocabulary, it is no longer possible to distinguish clearly between the two. “Disasters are a complex mix of natural hazards and human action” (Wisner et al, 2004).

The term complex emergency first emerged in Africa in the late 1980s and it defines compound humanitarian disasters that are “of a multilateral nature [and] require a system-wide response” (Duffield, 1994). A complex emergency normally encompasses “extensive violence and loss of life, massive displacements of people, widespread damage to societies and economies, need for large scale, multi-faceted humanitarian assistance, hindrance or prevention of humanitarian assistance by political and military constraints and significant security risks for humanitarian relief workers in some areas”.[2] Complex emergencies are normally declared by the UN in order to mobilise its own agencies as well as the international community (including donors), when a natural disaster or sudden escalation of violence forces massive migration in an area that is already severely affected by weak infrastructure, poverty, food shortages and/or war. The UN’s mandate enables it to mobilise when the national state authorities in the affected area cannot cope and/or explicitly ask for external support.

Complex emergencies have much in common with modern crises, both in terms of characteristics and in how they are perceived and dealt with by those who move in to help. They seem to come as a surprise, there is loss of control, confusion and increasing uncertainty, there is a strong perception of time pressure, too much and too little information at the same time, many actors turn up and very often there is a breakdown of normal decision structures (Rosenthal et al, 2001). Rosenthal et al define a crisis as a “social construction” that should be “explored in terms of multiple realities”. They point to a widening gap between the actual nature of modern crises and conventional crisis management methods, and argue that “new crises require new ways of thinking”. K. Maynard points to a similar phenomenon in relation to complex emergencies: “The operational persistence of the old model of relief has created a fundamental gap between conventional methods of humanitarian assistance and the realities of modern disasters” (Maynard, 1999).

“Complex emergencies have no clear beginning nor end and the return to ‘normalcy’ is lengthy,” states R.H. Green and I.I.Ahmed (1999). In parallel with modern crises, complex emergencies can be regarded as non-confined processes that are part of or manifestations of problems that are global in nature (Huntington, 1996). As members of the modern “world risk society”, U. Beck states that we are becoming cosmopolitan rather that national citizens. The global nature of modern risks and our means of dealing with them are diminishing the role of the nation state (Beck, 2005). This can be interpreted in relation to the notion that modern hazards transgress national borders and that our exposure to them is more closely linked to our individual wealth, power and access to information than to our nationality. It can also be related to the political weakening of third world governments that perpetuates and even deepens third world citizens’ poverty and consequent vulnerability. Looking specifically at complex emergencies, M. Duffield puts a similar notion more explicitly into a political context by stating that “humanitarian aid is the North’s principal means of political crisis management in a now marginal South” (Duffield, 1994). These statements point to the fact that the global distribution of resilience and vulnerability is closely linked to the world’s unequal distribution of power and wealth. B. Wisner et al discusses vulnerability in a political context and states that “people’s exposure to risk differs according to their class, whether they are male or female, what their ethnicity is, what age group they belong to, whether they are disabled or not, their immigration status and so forth” (Wisner et al, 2004).

The theory presented above indicates that complex emergencies should be seen as the ultimate human ‘cost’ of severe inequities in the global distribution of vulnerability. Both Wisner et al and Maynard argue that disasters would not cause the human suffering we are witnessing in complex emergencies, if people hadn’t had their capacities and resilience

[2] http://ocha.unog.ch/fts/exception-docs/AboutFTS/Definitions-Glossary.doc

reduced by social, political or economical factors, as well as by war. Inspired by Beck's writings, Wisner et al argue that "international efforts to 'manage' aspects of the impacts of hurricanes, droughts and volcanoes on behalf of poor, former colonial countries could […] be considered a form of ecological modernisation. However, the fatal flaw in ecological modernisation is that it never deals with the root cause" (Wisner et al, 2004). Like Rosenthal questions the effectiveness of conventional crisis management, Wisner et al reject "those definitions of vulnerability that focus exclusively on the ability of a system to cope with risk or loss" (ibid.). If this is the case then complex emergency operations should aim to restore the affected population's resilience and contribute to the building of a "self-sustaining peace" (Maynard, 1999). "Relief has been, and probably always will be, the only chance for those affected to survive," writes B. Munslow and C. Brown (1999)."The problem is that relief aid has become seen as a policy in its own right, and has become detached from an overall policy to engender peace" (ibid.).

Different agendas, different modes

In most complex emergency operations, relief agencies and development agencies often work side by side, but the challenge seems to be to bridge the differences in their operational focus. Whereas relief agencies work with a short-term timeframe and tremendous pressure to cater for a wide range of needs on a massive scale within a very limited space of time, development agencies tend to focus on long-term, sustainable solutions that are designed in relation to the (often) ongoing conflict and the general cultural context. "Because of the quite different nature of their work," write J. Goodhand and N. Lewer, "there is often tension between relief and development organisations and agencies with more specific human rights and peace-building agendas" (Goodhand and Lewer, 1999). Goodhand and Lewer distinguish between 'development agencies' and 'agencies with more specific human rights and peace-building agendas'. However, many development agencies have adopted a much stronger awareness of the link between human rights, peace-building and development over the seven years that have passed since their article was published, and the distinction may no longer be as striking as the divide between relief- and development agendas and activities. When discussing UN complex emergency operations throughout the 1990s, B. Munslow and C. Brown point to "the lack of a common, coordinated plan and structure of action that involved a transitional bridge between emergency relief work and redevelopment, and a joint control body to oversee the work of both parties" (Munslow and Brown, 1999). K. van Brabant notes that "the real reason why agencies find it so difficult to coordinate is that they want to maintain their independence and individual profile" (van Brabant, 1997).

Scholars working on crisis management theory often emphasize the role that local capacities play in the imminent aftermath of a disaster (among them Quarantelli, Thierney and Stallen). Research conducted in the 1980s revealed that the vast majority of those rescued during the first 48 hours of studied disasters had been helped by fellow citizens and/or the immediate local community. Research has also highlighted that, "contrary to widespread belief, citizens do not panic in disaster situations. […] Citizens often prove to be the most effective kind of emergency personnel" (Helsloot and Ruitenberg, 2004). This is often also the experience of humanitarian relief workers. A study conducted among tsuanami-affected communities in India and Sri Lanka "suggest that it was neighbours and untrained local volunteers who contributed the most in rescue efforts and who provided immediate relief" (Thomas and Ramalingam, 2005).

While warning of the "naïveté" it would be to "cast civil society as composed solely of 'angelic groups'", R.H. Green and I.I. Ahmed stress the importance of civil society involvement in complex emergencies where violent conflict is part of the picture. "Civil society can make important contributions by providing basic essential services at the local and national levels." (Green and Ahmed, 1999). "Even if [the agencies'] role is restricted to the building of wells and latrines," state Goodhand and Lewer (1999), "these activities should be based on a more fine-grained analysis and understanding of community processes and structures and more detailed and nuanced conflict analysis". This may, however, lie at the core of the coordination difficulties. While development agencies focus on local capacities and the involvement of the affected community in rehabilitation and peace-building, this requires knowledge about the culture and the conflict at hand – a 'time consuming' task in the eyes of many relief agencies. 'Time' – to ask, listen, learn, understand, rethink and redesign - seems to be the one asset that will always remain extremely scarce within conventional crisis management and current emergency relief practice.

Women's vulnerability and resilience capacities

Women normally constitute the majority of adult civilians that are affected by violent conflict. 80 per cent of the world's 40 million refugee and IDPs are women and children (UN, 2001). While suffering from the same resilience reduction as men due to the political, social, ethnic and geographical reasons referred to by Wisner et al (2004), women affected by complex emergencies are exposed to additional risks that are specific to their gender. The term gender-based violence (GBV) encompasses violence inflicted on women (or men, although the term is predominantly used to describe violence against women) solely because of their gender and/or perceived status as a sexual object. The term GBV encompasses genital mutilation, rape and other sexual assaults, domestic violence, sexual slavery and sexual favours in trade of food or assistance. In a forced migration setting, humanitarian organisatiosn can almost invariably regard GBV a latent threat to their female beneficiaries (Olsen and Scharffscher, 2004).

On the other hand, women also represent great capacities in terms of restoring community resilience, rehabilitation and peace-building - the way out of complex emergencies. In a report to UNSC in 2002, UN's Secretary-General Kofi Annan stressed how women make "a critical difference in the promotion of peace, particularly in preserving social order and educating for peace." He also pointed to the fact that women "have organized groups, across party and ethnic lines, advocating for peace, and have been active in reconciliation efforts, often with the support of regional and international networks" and noted that "greater attention to the gender norms and customs of a society can […] provide useful insights" (UNSC, 2002).

Resolution 1325, referred to in the introduction of this paper, is one of several UN announcements that over the past few years have pointed to the need for stronger involvement of women in UN's activities including complex emergency operations. It seems evident that the international consensus regarding the involvement of women would now have been implemented by systematic consultations with women in the initial stages of a complex emergency operation. If this is not the case, could the reasons why be linked to the operational environment of complex emergencies as outlined above? And what could be the implications for the effectiveness of relief work if the women affected by a complex emergency are not listened to?

Method

The empirical material for this article is based on fieldwork over a six-month period, from January to July 2005. The author worked for UN's Office for the Coordination of Humanitarian Affairs (OCHA) on the post-tsunami operation in Sri Lanka from January to April 2005. She was based in the capital Colombo and spent some time in affected areas in the eastern part of the country. In addition, she was hired by the UN in connection with a Lessons Learned conference on the tsunami operation, held in Colombo in June 2005. During these periods the author observed and took notes, both on how she conducted her own work and what she saw as constraints and challenges for herself and colleagues, and how she perceived the humanitarian operation in general. Particular attention was paid to gender mainstreaming activities, consultations with women as part of project design and reports/ analyses, as well as agency initiatives that aimed to support affected women's protection and resilience capacities. Between April and July 2005, the author conducted 53 interviews with managers and key personnel (such as gender advisors and special consultants) in all UN agencies with a presence in Sri Lanka and in selected international and national non-government organisations (NGOs). Sri Lankan feminist researchers, civil servants and senior officials representing Sri Lankan authorities were also interviewed. The interviews were semi-structured and lasted from 30 minutes to two hours. All interviews took place in Colombo and in the eastern town of Batticaloa. Document studies, literature searches and unrecorded consultations with other relevant individuals (such as NGO staff, UN staff engaged in other complex emergency operations and Sri Lankans who were indirectly affected by the tsunami) also formed part of the study. The empirical material presented in this paper constitute however the first stage of a larger analytical process and does not reflect the width of the information that has been collected.

Post-tsunami relief coordination in Sri Lanka

Early in the morning on December 26th 2004, the shores of 12 countries in Southeast Asia were struck by a tsunami that killed between 200.000 and 240.000 people.[3] Homes, livelihoods and infrastructure were destroyed in a matter of minutes and across the region approximately five million persons found themselves in need of immediate assistance. Indonesia and Sri Lanka were hardest hit and throughout the first half of 2005 these two countries became recipients of an unprecedented mobilisation of international aid and attention.

At the time of the tsunami Sri Lanka had already for years been in a situation labelled 'complex political emergency' (Goodhand and Lewer, 1999) and 'complex emergency' (OCHA, 2002). Political violence erupted in 1971 and turned into civil war in 1983. A cease-fire between the Government of Sri Lanka (GoSL) and the Liberation Tigers of Tamil Eelam (LTTE) was brokered in February 2002, but at the time of the tsunami the situation was unstable with incidents of random violence and attacks by various political, religious and militant groups. In addition to a considerable Tamil Diaspora across the world today, the violent conflict in Sri Lanka has produced approximately 800.000 internally displaced persons (IDPs) and killed well over 60.000 people (UNDP/UNFPA, 2001).

Three main relief coordination entities emerged in the immediate wake of the tsunami, and they reacted to the situation in seemingly different ways. These were the GoSL, the LTTE (that controls some of the tsunami-affected areas in the North and the Northeast), and the UN. For the purpose of the analysis presented in this paper, the LTTE coordination will not be discussed in much detail while the UN entity will be divided into two sub-entities: The UN presence already established in Sri Lanka to assist in the conflict-related development and rehabilitation process, and the UN presence that was established in Sri Lanka specifically for the post-tsunami relief operation. The term 'presence' is deliberately used as the divide relates to groups of staff rather than agencies. Some agencies function as both development and relief agencies, depending on the mission at hand and the staff who are there to deal with it. The categorisation is relevant in this paper as the two types of UN presence were different in a way that clearly protracted the dilemma of 'control versus knowledge'. The practical approach to the situation by all coordination entities may be linked to their different organisational 'modus operandi', and how managers and staff perceived the 'crisis'.

For the GoSL, functions from Presidential level to public servants in the affected districts were taken by surprise and quite soon the normal decision procedures were replaced by what

[3] Figures still vary greatly. The UN refers to about 200.000 persons confirmed dead while there are indications of a significant number of unreported casualties.

was believed to be more appropriate structures. With support from the UN, the Centre for National Operations (CNO) was set up in lieu of the already existing National Disaster Management Centre (NDMC), reportedly in an attempt to gain a better overview and control over the various aspects of national, local and non-government relief activities as well as to produce information on the nature and extent of loss and damages. Influenced by a strong sense of urgency and the non-routine nature of the tasks at hand, CNO was initially staffed by volunteers and headed by a person handpicked by the President. Desks responsible for the various relief sectors[4] were established, but a couple of weeks passed before these desks were effectively linked up with and staffed by relevant state departments and/or Ministries. Although accustomed to war-related calamities, national contingencies did not seem prepared for a disaster of this magnitude and there were few 'pre-designed' solutions to problems that occurred. Due to the war, the infrastructure and logistical lines to the East and Northeast were already very weak pre-tsunami, which also hampered the relief work and the flow of information. However, more than anything, the hierarchical culture of the state bureaucracy influenced on how information was collected from the affected areas: Government Agents (GAs)[5] were responsible for providing different types of reports to the CNO, but they were poorly resourced and with volunteers receiving and processing information and figures, CNO's reports were repeatedly questioned in terms of accuracy. The information-generating procedures were not changed during the emergency relief period but they were gradually strengthened by more organised staffing of the desks (until the CNO suddenly ceased operations on February 4th) and by international support, both at national and district level (for instance through supplies of IT equipment).

LTTE reacted to the tsunami by activating the logistical network that had been set up for military activities. The network had been designed in a way that involved the civilian population in the provision of logistical supplies, and so it was based on flexibility, local knowledge and informal lines of communication. This made it relatively efficient in terms of providing quick and appropriate relief to affected populations. There were ad hoc solutions but by and large they appeared to be based on local knowledge, and there was a strong involvement (if not dependency) on civilian resilience and capacities. LTTE's challenge was rather the difficulties in receiving international relief supplies due to GoSL restrictions on transport and supplies. This indicated the start of a rapidly growing politicising of the post-tsunami relief and reconstruction in Sri Lanka, which is typical of many complex emergency operations.

The scale of the human suffering after the tsunami prompted President Chandrika Bandaranaike Kumaratunga to ask for international humanitarian assistance. UN declared the post-tsunami situation in Southeast Asia a complex emergency and personnel were mobilised from all corners of the world. Within the UN many staff were transferred from Headquarters or from missions in other complex emergency areas in order to 'kick-start' a large-scale relief operation. UN Disaster Assessment and Coordination (UN-DAC) Teams landed in Colombo less than 48 hours after the tsunami had hit, and a Humanitarian Information Centre (HIC) was set up along with a UN-OCHA office within few days. On January 6th 2005, a so-called Flash Appeal[6] was published indicating the needs and planned relief projects within various relief sectors, according to UN's Flash Appeal template. The Flash Appeal was based on information gathered by teams specifically trained for quick assessment in chaotic circumstances. They were not in-depth and the information was basically intended to indicate

[4] Relief work is traditionally divided into different sectors such as shelter, water/sanitation, nutrition, livelihoods, protection and health, but the range of sectors varies between different emergencies.
[5] The public administration of each district (of which there are 14) is headed by a centrally appointed representative from the Sri Lankan authorities: The Government Agent (GA).
[6] http://ochaonline.un.org/cap2005/webpage.asp?Page=1184

to donors the scale and nature of needs, how the UN and implementing organisations[7] planned to work to meet these needs and what it would cost to do it. Beyond the initial UN-DAC missions, the emergency teams concentrated on the collection, analysis and dissemination of information that was available from trusted sources. These sources were predominantly UN staff and the CNO (to the extent where CNO's figures corresponded with UN estimates). Staff appeared to apply their experience from previous complex emergency missions within a framework of pre-designed routines. Solutions to most of the problems that occurred were either found in a routine manner or through consultations with UN colleagues or Headquarters. Since most were mobilised on short notice many stayed in Sri Lanka only for limited periods of time, such as one month. As far as the author was able to register, no Sri Lankans were hired by the UN for this work except as drivers and secretaries.

The UN's Resident Coordinator in Sri Lanka was the Country manager of the United Nations Development Programme (UNDP), which had an established pre-tsunami presence in Sri Lanka. When the post-tsunami operation was declared a complex emergency, he was appointed Humanitarian Coordinator, which meant that he became in charge of the humanitarian relief operation in addition to the ongoing, conflict-related development and rehabilitation work. The Humanitarian Coordinator appeared intent on placing the relief operation into the context of ongoing political processes, and he seemed sceptical of initiatives or activities that could threaten the reputation and goodwill of the UN within Sri Lanka. So did many of the UN representation that conducted development and rehabilitation work in Sri Lanka prior to the tsunami. 'Pre-tsunami' UN representatives were predominantly concerned with how to conduct the relief operation in a manner that would be politically and culturally appropriate, and in a way that would not harm the ceasefire or general peace-process. Emphasis was put on the involvement and support of UN's existing presence in most of the districts that had been affected. Apart from agency field offices and activities, this presence consisted for instance of networks of locally and internationally recruited UN Volunteers (UNVs). It was often referred to the fact that "Sri Lanka does not have a failed state. So we [the UN] are here to support the Sri Lankan authorities, not to take over what they are supposed to do themselves". There was a significant sense of hesitance and self-censorship in terms of issues that were perceived as 'sensitive', such as human rights and protection. "The easy thing is to be kicked out," commented one UN manager. "The difficult thing is to stay".

The two different approaches within the UN system appeared to create some conflict. On the one hand in relation to the perception of urgency and to what degree the relief work should be of a pre-designed or consultancy-based nature. A UN representative who was part of the 'emergency mode' coordination entity noted that "you have very long-standing group of people here […], you have a country that has been development and conflict focused. […]. So you come in where the pace and method of working, well, it needs to adjust to a disaster, and I think it has pretty slow in doing that." On the other hand in relation to cultural and political sensitivity. Managers and staff who had worked in Sri Lanka for some time kept referring to "the complexity of the situation here" and the fact that "it takes a very long time to get to know this country and perhaps we never will and that's why we should be humble".

It is worth mentioning that the majority of International NGOs that came to Sri Lanka to take part in the post-tsunami operation did not report systematically to or communicate with to any

[7] Organisations that collaborate with the UN to implement a project, usually under a sub-contracting relationship. These can be national government institutions, national or international NGOs, or other organizations such as private sector (source: http://ocha.unog.ch/fts/exception-docs/AboutFTS/Definitions-Glossary.doc).

of the coordination entities described above.[8] The Consortium for Humanitarian Agencies (CHA) had been established prior to the tsunami as a coordination body for the conflict-related activities of National and International NGOs, expanded their presence after the tsunami but had no formal power to coordinate the activities of any of its members. Meetings were however held on a regular basis and information was disseminated gradually in order to encourage voluntary adherence to standards, guidelines and the principles of "Do no harm"[9].

Consultations with women in affected areas

In the eastern town of Batticaloa , as in many affected towns and villages, most of the initial relief work was conducted by members of the local community. Batticaloa is located in an area that is severely affected by the war, and many national and international NGOs were involved in extensive development and rehabilitation activities there at the time of the tsunami. Batticaloa also has several NGOs run by women and working especially for women. Some of these became involved in the initial relief work, and among the post-tsunami initiatives in Batticaloa was a gender watch-list, published at regular intervals. The gender watch-list was intended as a reporting channel for GBV, to make sure incidents received due attention by the humanitarian community.

One local women's organisation started to arrange regular meetings where female representatives from affected communities and IDP camps/groups, NGOs, district authorities and health services were invited. The meetings were held in Tamil with translators present, and while local organisations and some international development agencies would come, international relief agencies were scarcely represented. One of the strengths of these meetings was that the participants often knew each other. They had knowledge of the realism of different solutions to problems that were voiced, in relation to social and religious norms, community structures and the resources that were available. They were also able to quickly identify individuals and families who were particularly vulnerable and discuss what support would be the most appropriate in order to retain the dignity and social situation of those involved.

When international relief organisations and supplies arrived in Batticaloa, few of the resources described above were consulted or involved as information gathering, new coordination structures and meeting schedules were established. Relief was delivered to affected populations parallel with some local relief activities and meetings that were organised by the local civil society often went unnoticed or were ignored by the international relief community. Some of this was corrected as international coordination gradually improved but by that time several of the local initiatives no longer existed. The gender watch-list was never fully acknowledged by the CNO or the UN coordination structures in Colombo, except within UN's 'working groups' on gender and on HIV/AIDS. Early reports of rapes of female tsunami victims promoted calls for confirmed documentation but were later dismissed as unsubstantiated rumours.

At Colombo level, consultations concerning affected women's vulnerability were regarded as a protection issue and thereby 'sensitive' and difficult to deal with in the speedy manner that was the case with for instance food distribution or well cleaning. While many 'emergency mode' coordination entities showed a preference for what was referred to as "first things

[8] Sri Lankan authorities introduced routines for NGO registration and reporting through the establishment of the Centre for Non Governmental Services (CNGS) on March 7th 2005, some time after the initial emergency was declared over.
[9] 'Do No Harm' is a concept developed by M. B. Anderson (1999) and the Collaborative for Development Action, which analyses how aid can support peace or war. One tool within the concept is 'Peace and Conflict Impact Assessment' (PCIA), applied to the Sri Lankan context by a group of partners including CHA: http://www.humanitarian-srilanka.org/PCIA/index.php

first", 'development mode' entities were aware of the issue but found it difficult to deal with in terms of its "sensitivity". There was no unwillingness to "consult and include the women". It just didn't happen in practice in any systematic manner, except by certain dedicated groups and individuals, most of whom had been involved with women's issues and the curbing of GBV prior to the tsunami. A national TV advert campaign to raise awareness about GBV was stopped when the tsunami happened. "Well, other issues suddenly seemed more important," one UN member of staff commented. "We will put it back on later, hopefully in the autumn." When one manager reported to other UN managers that affected women were selling sex in exchange for baby food and vegetables, she met scepticism. "I think there are so many other things they're worrying about, so many priorities. There isn't hard data. And it's sensitive."

Discussion and conclusion

The empirical data presented above indicate clear differences in how the post-tsunami situation was perceived and reacted to by the different relief coordination entities. Whereas the coordination conducted by the national authorities bore the hallmarks of 'conventional crisis management', the UN presence that was already established in Sri Lanka appeared to focus strongly on the UN mandate - which in essence was to support the state in the post-conflict rehabilitation - to the extent of some self-restraint. For entirely distinct reasons, both LTTE and the new UN presence were already on 'high alert' and reacted in a 'routine-like' fashion and with pre-designed solutions. However, UN's 'relief mode' preparedness did not display the "new ways of thinking" that may be needed for "the realities of modern disasters". UN staff who were in a 'relief mode' produced a substantial amount of 'information' and project plans with an almost significant disregard for the knowledge and resources that were available through consultations and local involvement. UN's 'development mode' coordination, on the other hand, encompassed the involvement of local capacities and knowledge networks, but it took some time before these were brought into relief-related decision-making. 'Development mode' hesitance seemed to irritate 'relief mode' staff and the 'relief mode' sense of hurry seemed to worry 'development mode' staff. The conflict between the two operational modes appears to have been solved by sharing tasks along the lines of concerns, priorities and operational mode. Consultations with affected women, however, appeared to be conducted by neither of the two UN relief coordination entities but rather by dedicated groups and individuals. Reports of GBV were questioned by decision-makers in term of validity, which may be linked to the attention given to the political aspect of UN's activities and the fact that 'protection' was seen as 'sensitive' and therefore difficult to handle when things were moving much faster than normal.

In the wake of the tsunami, Sri Lankan women clearly represented resilience capacities that were both efficient and culturally appropriate. There are also indications that women's organisations worked across ethnic divides in a way that supported the peace-building and reconciliation process in their area. The women were however not consulted, their capacities were not supported, nor were they involved in the planning and implementation of UN's relief coordination.

The tsunami-affected women were the ones that lost out. While their national state authorities reacted to the tsunami in a manner that appeared heavily flawed in terms of efficient crisis management, the empirical data in this paper suggest that women's own local relief initiatives were sidelined by international 'relief mode' activities. By the time the culturally more sensitive 'development mode' coordination entities were able to correct the 'sidelining', the harm had already been done.

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HUMANITARIAN EMERGENCY MANAGEMENT: SECTOR CHARACTERISTICS AND THE POTENTIAL FOR COORDINATION

Bjørn Ivar Kruke[1] and Odd Einar Olsen[2]

Keywords: Complex emergency, Coordination, Humanitarian sectors, Emergency management, Network.

Abstract:

The purpose of this paper is to examine the concept of coordination in complex emergencies and to identify humanitarian sector features that may influence on the coordination potentials. The paper is part of a project studying emergency management networks. Relief work and measures to reduce hazards in complex emergencies has to rely on cooperation between independent organisations with different mandates, resources and objectives. Thus, cross-sector coordination calls for alternative strategies because the well-known approach relying on "command, control and communication" has little legitimacy. Coordination problems in complex emergencies are often identified as organisational problems within the coordinating body or the organisations involved. This paper focuses on characteristics within the different humanitarian sectors in order to explain divergence in coordination success.

Empirical data was collected during the spring of 2005 in Kalma IDP Camp in Darfur. Preliminary findings indicate that different humanitarian sector features, such as degree of standardisation and expertise, resource demand and cross-sector dependency, may influence the sectors coordination dispositions. High degree of standardisation and expertise seems, together with resource demand, to make coordination an easier exercise. High degree of standardisation, expert and resource demand seems to make adaptation to emergent changes difficult. Acute emergency situations call for increased intra- and inter-sectoral networking, including information exchange and collective planning in order to utilize existing resources in a resilient manner.

Introduction

A complex emergency may be defined as *"a humanitarian crisis in a country, region or society where there is total or considerable breakdown of authority resulting from internal or external conflict and which requires an international response that goes beyond the mandate or capacity of any single agency and/ or the ongoing United Nations country program"* (IASC 1994). The conflicts referred to in the definition could cause – or has been caused by - problems concerning food insecurity, poor health conditions, a collapse in infrastructure and economic life, environmental problems, violence

[1] Department of Media, Culture and Social Sciences, University of Stavanger, Norway
E-mail: bjorn.i.kruke@uis.no
[2] Department of Media, Culture and Social Sciences, University of Stavanger, Norway
RF-Rogaland Research, Stavanger Norway, E-mail: oddeinar.olsen@uis.no

against humanity, refugees and IDPs[3] trying to escape the conflict areas and harassments from fighting groups. In the worst cases, this could lead to a breakdown in state or local authorities. In order to reduce human suffering and to improve the security situation, the only strategy that has proved any kind of efficiency is interventions from external actors. Most often, the security situation is poor both for the local population and for the humanitarian relief community.

Complex emergencies are by definition very difficult to handle for one single organisation or entity. The massive scale and the complex interdependencies between different problems call for contributions from many different organisations processing different capacities (Kruke and Olsen 2005). According to the humanitarian principles for relief work everybody has the right to receive, but also to give humanitarian aid. Relief work has become big business and the number of international relief organisations has grown significantly (from 900 to about 30.000 since the 1970s). Due to this situation, reliable humanitarian operations in complex emergencies need to be organised in a networking structure (Kruke and Olsen 2005). Thus, coordination of organisations attracted by complex emergencies has appeared at the top of the humanitarian agenda. Based on a review of the literature, Kruke and Olsen (2005) identified the most challenging problems in relief coordination;

- Nobody has got the authority to instruct others,
- Relief organisations have different mandates, agendas and resources,
- The competition among them direct their attention away from collective action and reduce the sharing of information,
- Politics among donors and relief organisations reduce the potential for efficient cooperation between the organisations.

In most complex emergencies, the relief work is organised as sector based clusters of organisations trying to coordinate their efforts. During the last year, the UN has tried to strengthen overall coordination in humanitarian emergencies by launching the cluster approach to coordination (OCHA 2006). Within this strategy, a cluster is a group of specialised organisations with a designated lead agency within 9 defined humanitarian areas[4]. The strategy aims to improve the effectiveness of the humanitarian response capacity and to define roles and responsibilities within future operations. The clusters should be responsible for assessments, capacity building, preparedness, advocacy, resource mobilisation, identify gaps, predictable action, and coordination with other clusters.

Almost all literature has focused on problems concerning organisational structures, politics and competition as main factors hampering coordination. At the same time, different activities seemingly have different potentials for coordination. Thus, it is reasonable to ask if there are any inherent characteristics within humanitarian sectors affecting the coordination potentials? The purpose of this paper is to examine the concept of coordination in complex emergencies and to identify sector characteristics that may influence on the coordination potentials.

[3] Internally Displaced Persons (IDPs): Persons or groups of persons who have been forced or obliged to leave their homes or places of habitual residence, in particular as a result of or in order to avoid the effects of armed conflict, situations of generalized violence, violations of human rights, or other natural or human-made disasters' and who have not crossed an internationally recognized state border (OCHA 1999:6)

[4] The sectors are (lead agency in brackets): Water & sanitation (UNICEF), nutrition (UNICEF), health WHO), emergency shelter (UNHCR, IFRC – and NRC), service provision telecom (OCHA and others), service provision logistics (WFP and others), camp coordination (UNHCR, IOM), early recovery (UNDP), protection (UNHCR and others).

Theoretical framework: Coordination challenges in complex emergencies

Coordination may be defined as *"the systematic use of policy instruments to deliver humanitarian assistance in a cohesive and effective manner. Such instruments include strategic planning, gathering data and managing information, mobilising resources and ensuring accountability, orchestrating a functional division of labour, negotiating and maintaining a serviceable framework with host political authorities and providing leadership"* (Minear et.al. 1992:3). The definition focuses on effectiveness based on rational decisions and participation among many actors. But this might not always be the case. Bernt Bernander, a former Coordinator of UN Humanitarian Assistance, puts it this way: *"Everybody wants to coordinate and nobody wants to be coordinated"* (Minear et.al. 1992:7).

Coordination in complex emergencies has in most cases to build on a mix between resiliency and anticipation (Kruke & Olsen 2005), whereas the success depends on the coordinated response capacity (Adinolfi et.al. 2005). Wildavsky defines resilience as *"the capacity to cope with unanticipated dangers after they have become manifest"* (1991:77) whereas anticipation is defined as "*prediction and prevention of potential dangers before damage is done"* (Wildavsky, 1991:77). Resiliency implies flexibility in organisations and management and diversity in resources and resource bases, whereas anticipation is based on planning and training (Kruke and Olsen 2005).

Even though emergency areas normally have inadequate amount of resources and specific expertise, available diversity in several humanitarian sectors implies the possibility for better utilization of available resources and expertise through increased coordination. Diversity, or several service providers within some sectors, entails multiple coverage, duplication and overlap (redundancy) (Rochlin *et al.*, 1987) and thereby also *resource slack* (Schulman 1993) in personnel and desired resources not yet utilized in ongoing humanitarian projects.

Whenever multiple activities share some limited resources (e.g., money, storage space, or time), a resource allocation process is needed to manage the interdependencies among the different activities and actors (Malone and Crowston 1994). But, *even though most humanitarian organisations share a vague vision about why they are present in the emergency area, no formally accepted superior management or coordinating function normally exists. As a consequence, reliability in management of complex emergencies relies in most cases on coordination between more or less autonomous organisations* (Kruke and Olsen 2005:278).

Effective interagency cooperation and coordination is required to cope with increased systems complexity through anticipation of risk and also to respond in a resilient manner (Comfort et.al. 2001). This can be obtained by forming organisational networks defined as *"any collection of actors (N ≥ 2) that pursue repeated, enduring exchange relations with one another and, at the same time, lack a legitimate organizational authority to arbitrate and resolve disputes that may arise during the exchange* (Podolny and Page 1998:59). These actors often have different philosophies and practical approaches (Anderson and Woodrow 1998), differences that may inhibit a coordinated response and undercut the disposition of field-staff to be flexible (Minear et.al. 1992). These differences are calling for information-exchange to sort out misunderstandings and misconceptions, information exchange and coordination to increase effectiveness of disaster management (Comfort 1993; Comfort et.al. 2001, 2004; Reindorp and Wiles 2001; Minear 1998; Lautze *et al.* 1998; Kruke and Olsen 2005).
With all these constraints, why do the actors see a need to coordinate? The discussion about cross-sectoral coordination has much to do with dependencies between different humanitarian sectors, where one activity produces something that is used by another activity (Malone and Crowston 1994). The emergence of problems with the requirement to inter-organizational and inter-sector collaboration forms some compulsory needs for cooperation (Kapucu, 2003). But coordination is also urgent within a humanitarian sector: *"Humanitarian coordination is based on the foundation of sectoral coordination"* (Reindorp and Wiles 2001:39). Coordination is, in accordance with Malone and

Crowston, *the management of dependencies between activities* (1994:90). In this way, humanitarian action can be broken down into more or less coordinated sector initiatives or a group of activities that are all 'subtasks' for achieving an overall goal (Malone and Crowston 1994) of reliable humanitarian action. Thus, a network structure (Kruke and Olsen 2005), or a system wide response (Duffield, 1994), is preferable for humanitarian relief operations.

Dependencies between different humanitarian sectors may result in a sort of social network or structure between the actors. It is a question of forming a *"pattern or network (or "system") of relationships obtaining between actors in their capacity of playing roles relative to one another"* (Nadel 1957:12). Reindorp and Wiles also mention relationships between emergency managers built over time, a shared technical expertise and the feeling of added value as features calling for coordination (Reindorp and Wiles 2001). *Effective coordination must add value to a humanitarian operation by facilitating better quality and more effective and efficient responses to help those in need than would be done in its absence* (Reindorp and Wiles 2001:15). The contextual rationality of emergencies is calling for increased trust in social networks and thereby, as Stephenson puts it, in ongoing and repeated conversation … conversations *"centred on the aim of securing the most effective use of resources on behalf of those suffering. To the extent that these communications occurred, they would heighten the potential for bottom-up coordination and lead to more effective inter-organisational relationships and thereby to improved coordination among humanitarian organisations and outcomes* (2005:348).

According to the previous arguments, a successful coordination has to rely on communication between different actors. As long as there exist interdependencies between sectors and within sectors, it is easier for 'independent' actors to realise that they will benefit from coordinating their activities. Efficient communication depends on trust and a shared language. This is easier to establish if the counterparts share some technical expertise and a feeling of added value in the form of flexible resource availability. Thus, the degree of interdependency between sectors and the degree of expertise required to operate within a humanitarian sector, should influence on the potentials for coordination. The higher cross-sector dependencies that is present in a sector, the higher need for coordination. The higher degree of expertise required providing a service, the easier the coordination should be.

Comfort states that uncertainty of outcome, a feature of most disasters, entails a requirement for exchange of information (Comfort 1990). Experienced risk, or shared risk, (Comfort et.al. 2001) and security/insecurity (Reindorp and Wiles 2001) are related features calling for cooperation. Due to the connection between coordination and the provision of key services as understood by each major humanitarian organisation, it is paramount to recognise the transitory character of the operating environment and therefore to integrate inter-organisational coordination into the humanitarian organisations core mission (Stephenson 2005). According to these arguments, the need for risk reduction and uncertainty of outcome should stimulate coordination. In humanitarian sectors characterised by a high demand of resources and high cross-sector dependency, the risk is normally higher than in sectors with a low resource demand and few dependencies to other activities. Furthermore, a high degree of standardisation in operations should normally reduce risks and uncertainty about outcome. Thus, sectors with a high degree of standardisation in operations should have a low need for coordination.

In the next sections, different humanitarian sectors will be discussed with regards to the degree of expertise needed, degree of standardisation, resource demands and cross-sector dependencies. This will be compared to the coordination activities observed in Kalma IDP camp.

The context and findings

The complex emergency in Darfur escalated in early 2003 and has so far resulted in the death of 2-300 000 people and displacement of some 2.4 million people. Most of them are internally displaced persons (IDPs) living in settlements, villages, cities and camps within Darfur. Almost ten percent of the IDPs live in Kalma, a camp some 20 kilometres east of Nyala, the state capital of South Darfur. Darfur is of the size of Spain. Kalma is approximately 1300 kilometres from Khartoum, the capital of Sudan, and even further away from the nearest port.

Kalma IDP camp was established in January 2004 and is from the outset self-settled. By March 2005 more than 150.000 IDPs were registered in Kalma. The influx of IDPs is due to the war in the region, but the health service and food distribution in the camp may also be pull-factors.

Kalma is divided in eight geographical areas. Each geographical area is of the size of a "normal" refugee camp. There are several service providers in most humanitarian sectors. There was from the outset no infrastructure. Agencies, local, national and international, have together with the population constructed everything from scratch. Kalma is precisely an example of how a refugee camp should not be (ref Sphere 2004, UNHCR 2000, NRC 2004). The camp layout is not based on an overall strategic planning, shelters have been erected with no focus on flood-areas, there are inadequate number of latrines, inadequate systems for waste disposal, no fire-walls between the sectors, and a very complex water distribution system. These shortcomings in camp construction are only partially handled through a massive effort by all actors. This is not easy in a camp receiving about 30 000 new arrivals only in December 2004 - January 2005. In addition, the security situation in the region is very difficult, with a complex and fast-shifting character of the emergency.

<u>Humanitarian sectors</u>
The humanitarian sectors established in complex emergencies varies based on the context (e.g. Sphere 2004, UNHCR 2000, NRC 2004, de Waal 2005, OCHA 2006, HIC Liberia 2006), and are broadly divided into two groups. The first group consists of the sectors to be found in almost all emergencies, such as Coordination/Management, Food distribution, Non-Food-Item (NFI) distribution, Water, Sanitation, Hygiene, Primary Health Care (PHC), Nutrition, Education, Protection and Community support. The second group consists of more context specific sectors and clusters such as:

- Agriculture, Disarmament Demobilization, Rehabilitation & Reintegration (HIC Liberia 2006),
- Population estimation and registration, Site selection and planning, Shelter, Environmental sanitation, Supplies and Transport (UNHCR, 2000),
- Camp security, Livelihood strategies for self-reliance, youths and recreation (NRC 2004),
- Personnel, Livelihoods and Urban Search and Rescue (Adinolfi et.al. 2005),
- Emergency telecommunications, Logistics and Early recovery (OCHA 2006).

In Kalma IDP Camp, the following sectors are represented: Camp management and Camp coordination (the management sectors), Food distribution, Nutrition, NFI distribution, Water, Sanitation, Hygiene, PHC, Immunization, Epidemic Treatment, Education, and Community work. These sectors vary with regards to sector characteristics (standardisation, expertise and resource demand, and cross-sector dependency) illustrated in table 1.

<u>Degree of standardisation</u>
Standardisation of service and service delivery in humanitarian sectors is a proactive strategy for preplanning of, and transparency in, humanitarian aid and therefore important for reliable humanitarian action. Some humanitarian sectors, such as Food distribution, Nutrition, Water, PHC (including Epidemic treatment, and Immunization) and Education, are more standardized than others. These sectors are based on routine deliveries, standard content, fixed regulations, memorandum of understanding with lead agencies and the government, etc. The health sectors are regulated by

international and domestic standards, standards coordinated with WHO and Ministry of Health (MoH). Education is also a standardised sector. Implementing partners in the different camps construct and organise schools mostly based on local tradition and standards. The curriculum in all schools, except the Quaranic schools, is national.

Other sectors are less standardised and therefore more flexible both in content and in implementation. While Food distribution and Water are very regulated, especially with regards to content, but also implementation, the management sectors, Camp management and Camp coordination, are highly flexible both due to the context and also available resources. Hygiene promotion, Community work, Protection and Sanitation are also to different degrees context specific and based on less standardised approaches.

Table 1: Humanitarian sector characteristics[5]

Sector/features	**Degree of standardisation**		**Degree of expertise**		**Resource demand**		**Cross-sector dependency**	
	High	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**
Camp Management		X		X		X	X	
Camp Coordination		X		X		X	X	
Sanitation		X		X		X		X
Hygiene promotion		X		X		X	X	
Community Work		X		X		X		X
Protection		X		(X)[6]		X	X	
NFI- Distribution		X		X	X			X
Food Distribution	X			X	X			X
Nutrition	X		X		(X)[7]		X	
Water	X		X		X			X
Primary Health Care	X		X		(X)		X	
Epidemic treatment	X		X		(X)		X	
Immunization	X		X		(X)		X	
Education	X		X		X		X	

<u>Degree of expertise</u>

Expertise is a prerequisite for effective humanitarian action in many humanitarian sectors. Expertise can be divided in personal qualifications, general relief aid knowledge and particular professional, technical expertise. Personal qualifications such as stamina, flexibility, diplomatic skills, adaptability and cultural sensitivity are mandatory general qualifications. Relief aid competence, especially through practical experience, is another mandatory qualifications requirement in many humanitarian organisations working in complex emergencies. Some sectors are however also dependent upon specialized skilled staff (Water, Nutrition, PHC (including Epidemic treatment and Immunization) and Education). Medical doctors and nurses perform complicated health services. Action Contre la Faim (ACF), the major nutrition actor in Kalma, run a Therapeutic Feeding centre (TFC) for the severe malnourished children, requiring medical treatment. Water engineers plan, dimension and construct water distribution systems. The planning of a piped water distribution network in Kalma

5 This rough differentiation of the humanitarian sectors are conducted for the purpose of discussing coordination challenges. A more detailed discription of the different sectors is required to differentiate the humanitarian sectors.

6 The narrow, security aspect of protection entails specific expert knowledge, whereas the broad aspect of protection requires a more general knowledge.

7 Nutrition and the health sectors are not as resource demanding as for instance Food- and NFI distribution. These sectors do however require external specific, specialised equipment and resources.

was complex, because of the flat terrain, the need for pumps and pipes, the specification of the diameter of pipes, the amount of pipes from different wells, day reservoirs, water pressure, the amount of local labour requirements, etc. Educationalists, or pedagogues, plan and implement education.

Even though the other sectors do not have the same specific expertise requirement, aspects of Camp coordination, such as site planning, do need specific expertise. The narrow, security aspect of Protection entails in-depth knowledge of UN policy and guidelines pertaining to protection of civilians and in particular the policy and practice of collaborative response.

Resource demand

The humanitarian sectors do also score differently with regards to their degree of resource demand. This has much to do with the context, the emergency itself and to what degree it is possible to purchase resources locally. Purchasing resources locally is cheaper than purchasing externally, easier to coordinate, less resource demanding (than huge logistical operations) and would entail buying items familiar to the displaced population and also serve as a boost for the local economy. The complex emergency in Darfur is however of such a scale that purchasing resources locally is only a limited option. Some resources are also not available locally (e.g. medical items, food, plastic sheeting, soap, water pipes, water pumps).

Food- and NFI distribution, Water and Education are resource-demanding sectors and therefore also fund-intensive. A good donor relationship is therefore important in these sectors. Most of the items required must be transported into the emergency area. The supply lines are 1300-1500 kilometres on bad roads and a fairly inoperative railway (due to the security situation). Education does however buy most of the items locally, with the exception of most of the school material. The Education sector seeks to provide primary school education for some 16 000 school-aged children in Kalma, as specified by UNICEF.

The health sectors and Nutrition are also fairly resource demanding. They bring with them their own external "full package" of specialized equipment and resources.

Less resource demanding sectors, such as Community work, Hygiene promotion and Sanitation are purchasing most of items locally. Some sanitation NFIs (e.g. concrete for latrines and showers, and plastic sheeting) is however transported into the emergency area.

Cross-sector dependency

Some sectors are heavily dependent upon effective service deliveries in other sectors, while other sectors are fairly independent. Especially the management sectors are together with Nutrition, the health sectors, Hygiene promotion, Education and Protection to different degrees dependent upon service deliveries in other sectors. Nutrition is closely linked to food distribution and the health status in the camp. A good hygiene standard is dependent upon effective service delivery in NFI distribution (especially soap[8]), Water, Sanitation, PHC and Education. Poor sanitation standard affects most of the activity in the camp, from the health status, the number of admissions to health clinics, the nutrition level, the mortality level, education, community activity, etc. The health status of the residents is therefore a good indicator of the status in several sectors in the camp. Hygiene promotion campaigns are conducted as joint efforts by actors from many sectors in the camp, such as PHC, Nutrition, Water, Sanitation and Education, and also as unilateral initiatives, such as the *Oxfam Public Health Promotion team* effort. Education is a key sector with regards to dissemination of key survival

[8] The current soap ration in Darfur utilized by WFP and the U.N. Joint Logistics Center (UNJLC) is 250 g. USAID recommends that the minimum soap ration should be no less than the Sphere humanitarian guideline of 450 g (USAID/DART 2005).

messages (INEE 2004:5). Education is at the same time dependent upon deliver of water and sanitation in the schools, and the school-feeding programme coordinated by WFP and UNICEF.

The humanitarian sectors and their coordination dispositions

Effective coordination is about an optimal use of resources and accountability for them (Donini, 1996:14), facilitation of better quality and more effective and efficient responses to help those in need (Reindorp and Wiles 2001:15), and the systematic use of policy instruments to deliver humanitarian assistance in a cohesive and effective manner (Minear et.al. 1992:3). When discussing the humanitarian sector coordination dispositions some criteria's or characteristics are relevant to distinguish between the quality of coordination:

- Gathering data and managing and distributing information is important to reduce risk and uncertainty (Comfort et.al. 2004).
- Collective planning (short to medium term) is another criteria for effective coordination in emergency operations (Minear et.al. 1992).
- Collective action. Management of information and collective planning are then the baseline for collective action through mobilising, sharing and flexible resource allocation aiming in particular to avoid duplication of effort and also gaps in service delivery.

In the following discussion, we use these criteria's to differentiate between humanitarian sectors coordination dispositions. The sectors score differently with regards to extent of information exchange, collective planning and collective action. This is partly because the sectors have different characteristics, but also because some sectors do not have permanent implementing partners/service providers, while other sectors have one or more service providers.

Camp management and Camp coordination, are responsible for overall coordination, especially of cross-sectoral issues. They are "cross-cutting" sectors, sectors with specific relevance for all the other sectors (Sphere 2004, OCHA 2006, NRC 2004, DPPC 2004). The relevance of the management sectors has much to do with information and information exchange. The management sectors must know more than other agencies about what is going on in the camp. Even though data gathering and information management is conducted in most sectors in Kalma, it is only the Camp Coordinator that, through registration of the IDPs, collects data in a structured way, making these data available for the other sectors. Registration is important for most other sectors, and in particular Food- and NFI distribution, PHC, Water and Sanitation, Education and Immunization. In addition to overall registration of all IDPs in Kalma, the Camp Coordinator monitors the service in several sectors (water- and sanitation status monitoring, cooking and hygiene habits surveys and protection monitoring).

All sectors participate in the weekly coordination meeting for information exchange between the humanitarian sectors. A survey through 31 of the minutes indicates that the meeting run on a standard agenda, covering most sectors. The limited information about immunization and epidemic treatment are covered as part of the health sector. Hygiene promotion and the narrow aspect of Protection are only to a small extent discussed. Increased focus on Hygiene promotion March/April 2005 came as a result of the diarrhoea situation in the camp.

There are also sectoral Kalma meetings in the management sectors, and in Water and Sanitation.

The management sectors have, together with Protection, NFI distribution, Nutrition, Epidemic treatment (Outbreak Preparedness & Response), Health, Water/Sanitation and Hygiene promotion (Health Promotion/Hygiene Education), weekly coordination meetings on regional level (South Darfur State level), while Food Distribution and Education have bi-weekly meetings on regional level. The sectors do informal information exchange on an ad-hoc basis, but sectors, such as PHC, Nutrition and Protection, do not include all actors within the sector in these informal talks. World Vision (WVI) is the only service provider for Food distribution in Kalma, while World Food Program (WFP) is responsible for the "food-pipeline". Information-exchange within Food distribution is therefore a matter of communicating the requirement for food between WFP and WVI, while execution of Food distribution is an internal WVI issue. Nutrition is conducted by a variety of organisations, but the main service provider is ACF. ACF did initially periodic blanket food distributions for all children below 5, prior to taking over the Therapeutic- and the Supplementary Feeding centres from MSF-H. Other nutrition initiatives for children, pregnant and lactating women are conducted by a variety of small organisations, of which most of them are local. These are however only unilateral initiatives without structured information exchange. Information exchange is nevertheless necessary to handle the reasons for the nutrition requirement and also to secure nutrition for all vulnerable groups.

Collective planning is conducted both during the weekly inter-sectoral coordination meeting and in planned additional meetings. A constant stream of emergent challenges, calling for rapid response, is mostly addressed in ad-hoc meetings. A Hygiene promotion campaign in April-May 2005 was planned by agencies volunteering to join in based on an open invitation to all agencies in all sectors. The same was the case with the head counting in March 2005.

These initiatives are not based on intra-sectoral collective planning, except in the management sectors, Water, Sanitation and Education. Community Work, Protection, PHC, Epidemic Treatment, Nutrition and Sanitation are based on both unilateral initiatives and planning between some of the actors, but not as collective initiatives comprising the whole sector. Immunization and Protection are planned and executed by many actors, but with no collective planning in Kalma. While the involved actors plan Immunization openly, the narrow scope of Protection is looked upon as too sensitive.

Since there are no permanent service providers in Immunization and NFI distribution in Kalma, agencies volunteer to join in when required. UNICEF, MoH, and a few large PHC organisations in Kalma conduct immunization planning. NFI distribution is planned by a variety of actors from case to case, and not as collective efforts. While Immunization campaigns comprise the whole camp, lack of overall planning for NFI distribution, together with the size of the camp, results in different standards between geographical sectors in the camp. NFI distribution is a sensitive issue in the camp creating tension among the IDPs. Another sensitive sector is Camp management. The Camp management sector is, together with Camp coordination, cross-cutting sectors with a primary goal to bring all the other sectors into information exchange, collective planning and collective action. The Sudanese Camp Manager, Humanitarian Aid Commission (HAC), is facing difficulties in trying to coordinate cross-sectoral issues due to the humanitarian community's' lack of trust in HAC. The discussion is summarized in table 2.

Table 2: Humanitarian sectors and coordination disposition

Sector	**Coordination**		
	Easy	**Intermediate**	**Difficult**
Food Distribution	X		
Immunization	X		
Primary Health Care	X		
Epidemic treatment	X		
Water	X		
Camp Coordination		X	
Hygiene promotion		X	
Education		X	
Community Work		X	
Nutrition		X	

Camp Management			X
NFI- Distribution			X
Sanitation			X
Protection			X

Discussion: Coordination disposition and humanitarian sector features

There seems to be a correlation between high degree of standardisation and easy to coordinate for several sectors. These sectors are based on routine deliveries, standard content, fixed regulations, memorandum of understanding with the government, etc. In Kalma, Water was however difficult to coordinate because the water distribution system was very complex and large. Education is fairly difficult to coordinate, especially due to the political sensitivity and the link to established local education structures. This correlation seems however to be valid especially during routine operations based on anticipated strategies. When faced with emergent situations, a resilient approach may be required, increasing the need for coordination.

Even with standards for amount of food and water (Sphere 2004, UNHCR 2000), the situation in emergencies may force humanitarian actors to deviate from established standards. Shortages of resources are a regular characteristic of emergency areas. Darfur is no exception. The supply lines are 1300-1500 kilometres and the requirement for resources are vast. During the famine in Darfur in 1984/5, the international system was criticised for not being able to deliver food rations in accordance with minimum standards. Alex de Waal stated that *"the food was committed late, delivered late, and failed to reach the right people"* (2005: 213). The situation in Kalma spring 2005 forced the humanitarian community to reduce service delivery both in Water, Food distribution and Education. These are examples of resiliency in action (Wildavsky 1991), but based on inadequate response capacities (Adinolfi et.al. 2005).

The degree of standardisation seems in most sectors also to correspond with the degree of expertise. High degree of standardisation corresponds with high degree of expertise. The health sectors score high on both degree of standardisation and expertise demand. They also score high on cross-sector dependency. Cross-sector dependency is a characteristic shared by most of the humanitarian sectors. The standards of the different sectors do not stand-alone: they are interdependent (Sphere 2004:8). This dependency is mainly latent during routine operations, but increases during emergent, ad-hoc operations, calling for functional division of labour (Minear et.al. 1992), not only in specific sectors, but also between sectors. Some sort of social network or a social structure (Nadel 1957:12) is therefore necessary for reliable humanitarian action in emergency situations.

There also seems to be a correlation between high degree of expertise and easy to coordinate.

The management sectors are split with regards to their ability to coordinate. Both sectors are marked as low on expertise (specific expertise). The Camp manager in Kalma faces lack of trust among the international community, making the coordination role difficult. This may be a general problem in IDP-settings in complex emergencies, because the government often is looked upon as one reason for the emergency. The Camp coordinator is at the same time facing problems because of an overall lack of formalization in the humanitarian community (lack of MOUs, LOUs).

A likely correlation between high resource demand and easy to coordinate is also found. A resource-demanding sector such as Food distribution is easy to coordinate, particularly because of the low number of actors involved. NFI distribution is difficult to coordinate due to lack of implementing partners. Another reason for the difference might be that food is distributed routinely every month, while NFIs are distributed as campaigns a few times a year. The health sectors and nutrition are fairly resource demanding, particularly because of external specialized equipment and resources, making coordination less important. They are also relatively easy to coordinate, because of the standardisation and that they share a common expertise.

The correlation between cross-sector dependency and easy to coordinate is however blurred. Camp management has high cross-sector dependency, but is difficult with regards to coordination. The reason is mainly lack of trust among the international community. The sensitivity in Protection is a likely reason for the difficulty in coordination. Both Food distribution and Water are easy to coordinate and score at the same time low on cross-sector dependency. Food distribution is, as discussed earlier, conducted by one agency. Food distribution is therefore easy to coordinate. Cross-sector coordination of Food distribution has however proven to be challenging, especially due to Food distributions low cross-sector dependency. Water may be characterized in more or less the same way. Water is, as Food distribution, not particularly cross-sector dependent and internal coordination in Water is fairly easy and structured.

Summary and concluding remarks

Both theory and findings point at the need for information exchange, conversations and coordination among involved parties, and thereby more effective intra- and inter-organisational relationships. This is important during routine operations and in particular in emergencies.

The findings and discussion indicate that different humanitarian sector features, such as degree of standardisation and expertise, resource demand and cross-sector dependency, may influence the sectors coordination dispositions. High degree of standardisation and expertise seems, together with resource demand, to make coordination an easier exercise. Low degree of standardisation, expertise and resource demand seems at the same time to complicate coordination.

High degree of standardisation, expert and resource demand seems however to make adaptation to emergent changes difficult. Reliable humanitarian action in the different sectors has primarily two goals; avoid gaps and duplication in service delivery by securing reliable utilisation of available resources in their respective sectors. The emergency itself is calling for humanitarian assistance in a cohesive and effective manner (Minear et.al. 1992) with the aim of securing the most effective use of resources on behalf of those suffering (Stephenson 2005). Information exchange, collective planning and collective action are important characteristics and foundations for effective emergency coordination. Collective planning is important to secure anticipation of possible challenges, (Wildavsky 1991), and necessary prepared capacity (Adinolfi et.al. 2005), such as available resources and expertise. Pre-planned activity can bring the humanitarian community a long way, but not all the way. Resilience (Wildavsky 1991) or response capacity (Adinolfi et.al. 2005) is therefore required to adapt to the shifting conditions of the emergency. This is challenging especially for humanitarian sectors with a high degree of standardisation, expert and resource demand. Effective humanitarian action in these sectors would rely on increased focus on intra- and inter-sectoral networking, including information exchange, and collective planning, to utilize existing resources in a resilient manner and to adapt to the fast changing context of complex emergencies (Kruke and Olsen 2005).

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Academic and Professional Practice

Peer Reviewed Articles

Non Reviewed Papers / Presentations

DEVELOPMENT OF DISASTER WARNING SYSTEM USING DMB (DIGITAL MULTIMEDIA BROADCASTING)

Duke H. Jeong[1] & Geum Y. Min[2]
Department of Management Information, Dongguk University, Korea

Abstract

More than 200,000 people were killed by an earthquake beneath the ocean. It was sent giant waves crashing ashore places as far apart as Indonesia, Thailand, Sri Lanka, and Bangladesh.

It was affected by tsunami in the Southeast Asia in 2004. The tsunami damaged properties and human casualties in Southeast Asia. The necessity of disaster information sharing and disaster warning system implementation have been issued and discussed in U.N and APEC.

This research is to investigate advantages of a DMB (Digital Multimedia Broadcasting) technologies to develop a warning and broadcasting systems for typhoon, earthquake and tsunami disaster information in disaster impacted areas. It is also develop a model the information sharing scheme for disaster information to damaged area.

Research Background and Objective

The disaster damages resulted not only in life and property damages of the individual, but also, could be spreaded situation of national crisis. The systematic control on disasters management such as, Mitigation and Preparedness, Response, Recovery activity is necessary. And state of the art equipment, the structure of quick response, the structure of cooperation between an organization related disaster management and volunteer are required for efficient disaster management.

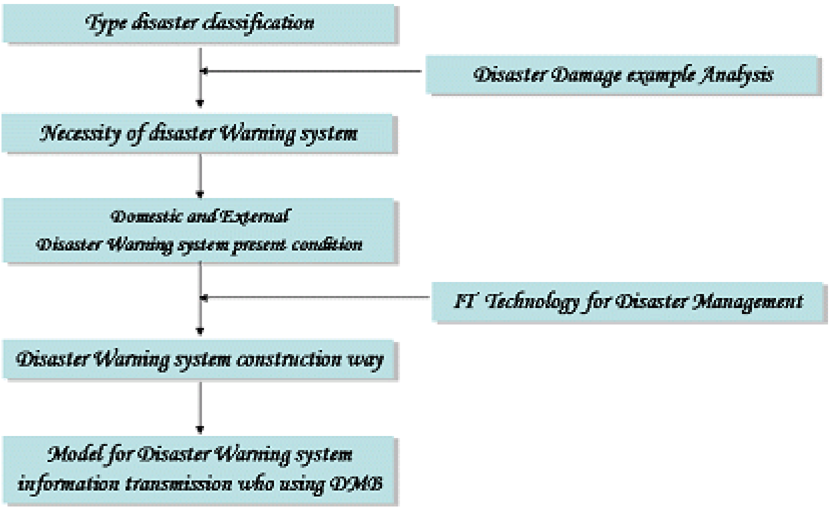
More than 200,000 people were killed by an earthquake beneath the ocean. It sent giant waves crashing ashore places as far apart as Indonesia, Thailand, Sri Lanka, and Bangladesh. Many cuntries in the Southeast Asia were affected by tsunami in 2004. The tsunami damaged properties and human casualties in Southeast Asia. The necessity of disaster information sharing and warning system implementation has been issued and discussed in U.N and APE.
The growing necessity of disaster warning system issused by tsunami's the damage recently. Because of tsunami, the Indian Ocean countries that suffer great damage are quick and correct warning system induction of country dimension.

This research is to investigate advantages of a DMB (Digital Multimedia Broadcasting) technologies to warn broadcasting systems for typhoon, earthquake and tsunami disaster information in disaster area. It is also develop a model for the information sharing scheme in damaged area.

[1] duke@donggguk.edu
[2] goldzero@dongguk.edu

Research Procedure & Scope

This research defines disaster damage types and presents necessity of disaster warning system through damage type example. The disaster warning system development take advantage of IT technology achieve according to study procedure with [Figure 1].

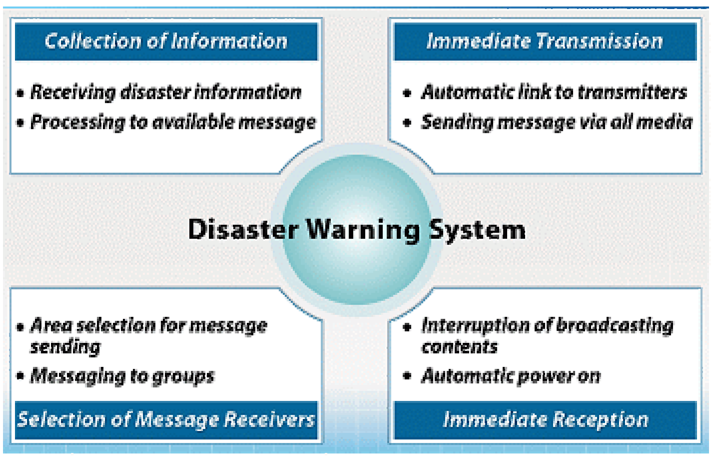


[Figure 1] Research Procedure

It is necessary to define disaster and present necessity of disaster warning system through disaster type statistical analysis. It is to present domestic and external disaster warning system operation state are currently used and developed. At last, the disaster warning system development method are presented to take advantage of IT technologies. The model for information transmission in disaster warning system that apply DMB of IT technology.

Disaster Warning System

Disaster warning system is to warn and inform to population (people) and an organization related disaster management in case disaster occurrence danger is predicted. [Figure 2]1) It presents a function and role for disaster warning system. Disaster warning system manages information for disaster hot spot to database with earthquake hot spot, fire hot spot, damage by a flood hot spot, crash danger facilities. It is included in collecting data using artificial satellite & high technology that is installed in area and inform disaster information using means of communication & broadcasting in case disaster occurrence danger is predicted.

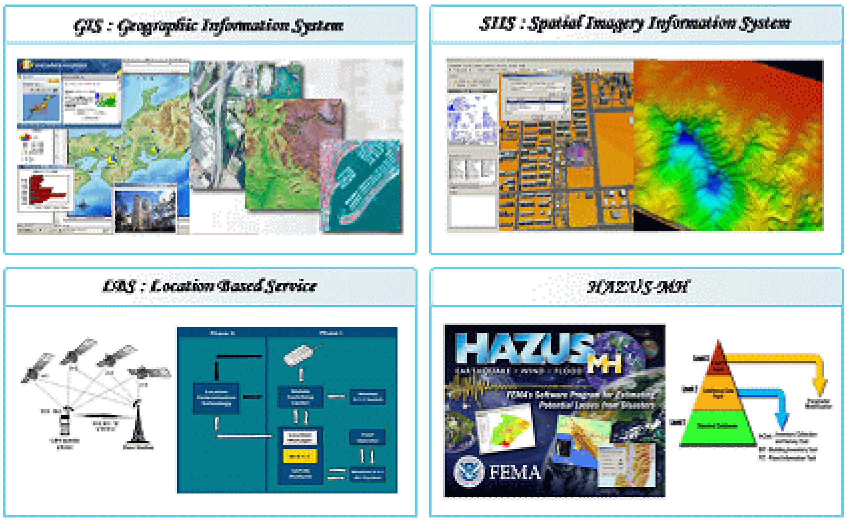


[Figure 2] Disaster warning system function and role

It is difficult to predict in when and what area disaster may happen technologically. However, if a correct disaster information of disaster warning system is transmitted to an organization related disaster management and population (people), life and property damage can be minimized.

IT technology for disaster management such as Mitigation and Preparedness, Response, Recovery activity

The mitigation and preparedness activity steps are analyze disaster types scientifically using GIS(Geographic Information System) and do near training with actuality disaster situation to development of simulation. On Figure 3, it is presented the disaster managemen which take advantages of IT technology at Mitigation and Preparedness activity step



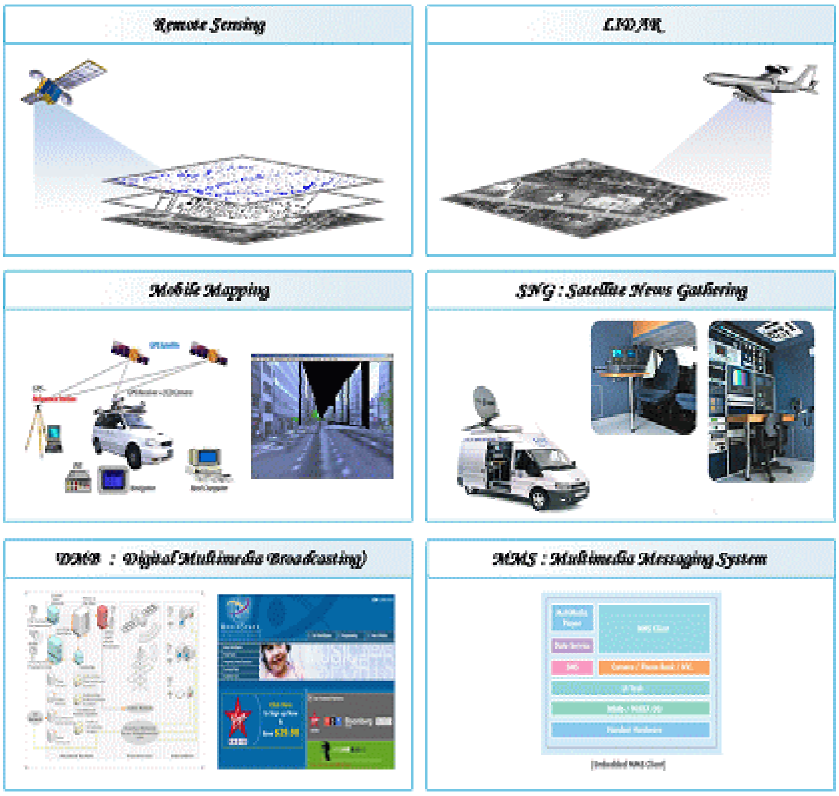
[Figure 3] Disaster Management Mitigation and Preparedness activity connection newest IT technology

On disaster response and recovery activity steps, it utilizes wireless communication network to transfer information quickly, and investigate correct and quick disaster damage situation taking advantage of IT technology. On Figure 4, It is presented disaster management which take advantages of IT technology at response and recovery activity step

Development of disaster warning system

Science of meteorology, physics, earth science etc and ICT(Information and communication Technology) technology are used as complex disaster warning system development. Disaster management warning system is consisted of disaster situation observation, analysis and prediction & judgment, disaster information transmission

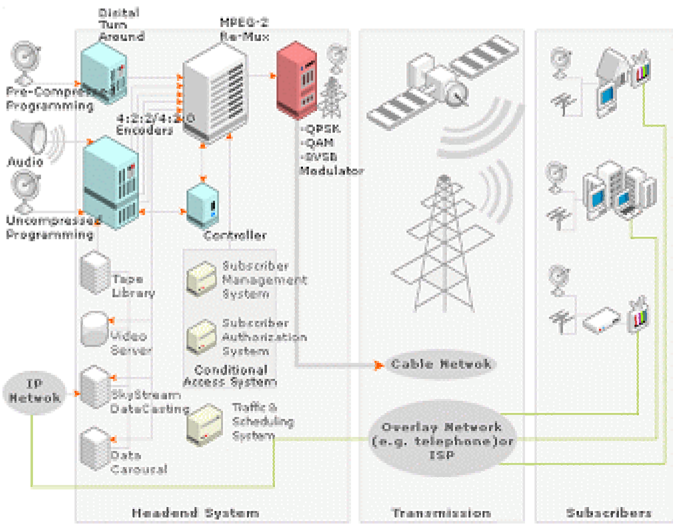
The disaster situation observation is a activity that take advantage of suitable observation mourning in type of disaster and create basis data to prediction & judgment disaster situation. For example, typhoon uses satellite & AWS(Automatic Warning System) and earthquake observes situation about disaster through seismograph.
Second, the disaster situation analysis and prediction & judgment are the activities that collect source data(seismic data, water level data, tsunami data) that is observed and create information that need in decision-making. Processed data are used to make a foundation in disaster management mitigation and preparedness, response, recovery activity. Third, the disaster information transmission is a activity that inform to disaster information organization related disaster management and population(people) since decision making about a disaster warning was finished.



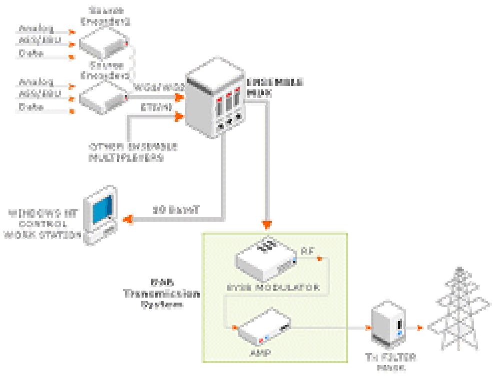
[Figure 4] Disaster management Response and Recovery activity connection newest IT technology

Disaster warning system that applied DMB(Digital Multimedia Broadcasting)

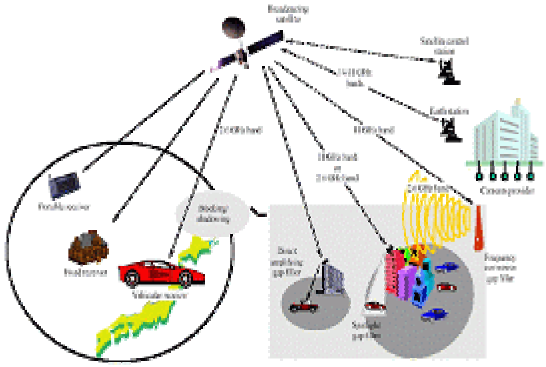
The DMB is to provide high-quality animation, an audio and multimedia broadcast such as data during movements by an abbreviation of digital multimedia broadcast. In the case of ground wave DMB, it is technology observed worldwide because being developed first time in korea. DMB broadcasting is changed to provide high-quality image service while moving the broadcast that watch into living room or domestic fixed form with [Figure 5]



[Figure 5] DMB key map

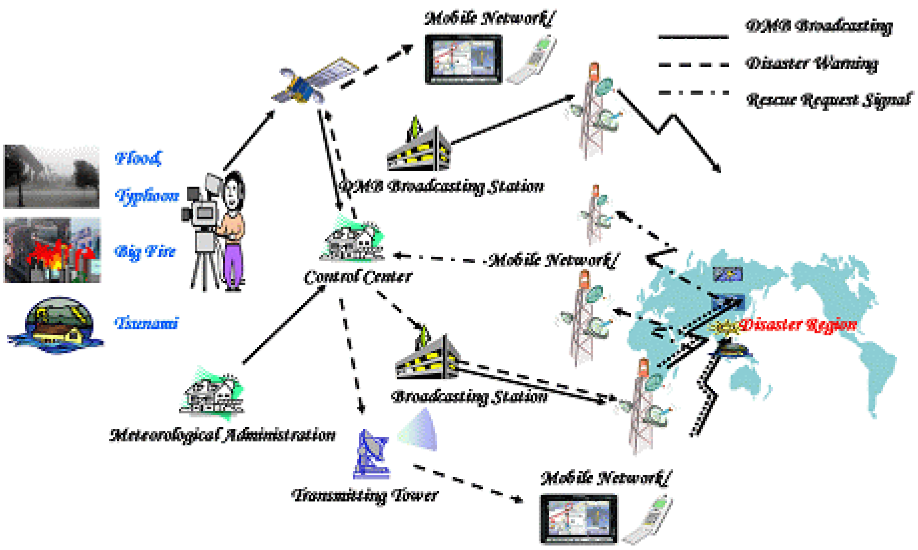


[Figure 6] Ground DMB key map



[Figure 7] Satellite DMB key map

The enough reason of using DMB are evaluated by service of most suitable for disaster broadcasting since it is individual service technology that use carrying along terminal. The DMB has capability of quickness and mobility that can transmit disaster warning and evacuation hand-bell to various data to people when produce disaster. Disaster warning system that use DMB with [Figure 8]. It informs disaster information to disaster area's people through ground wave broadcasting and satellite in case various disasters happened. Peoples' judgment for disaster situation would be through passed disaster information, and transmitted to organization related disaster management guides the nearest shelter through DMB broadcasting to disaster local resident. The DMB terminal owner receives shelter information through voice guidance, image, photography, data and may be respond from disaster.



[Figure 8] Disaster warning that take advantage of DMB

The disaster warning system take advantage of DMB, as moving voice of high quality & image service(TV) can receive in-comming, and can transmit information of high-capacity. However, it would be including engineering problem, economical problem, Terminal diffusion problem etc to the disaster information transmission which take advantage of DMB.

Conclusion

Damage by the earthquake strike Southeast Asia vicinity December, 2004 did to recognize the importance of disaster warning. Early warning center managers who are situated in Djakarta can predict beforehand about earthquake sea wave. However, it presented problems about transmission methods that can inform these disaster information to fishermen or Sri Lanka's candy store master and native people. Disaster information transmission is necessary to minimize life and property damage informing disaster situation to people through all communication mediums that take advantage of IT technologies.

Disaster information transmission that take advantage of ICT is the one of way that can inform disaster information rapidly and correctly to local residents in the country. One of the disaster information transmission technology that take advantage of ICT does to recognize disaster warning being processed by caption on DMB broadcasting reception terminal lower column as soon as urgency warning of typhoon, heavy rain, heavy snow is possibly transmitted. The DMB can be used to help on watching disaster warning broadcasting always. The DMB broadcasting can offer disaster information in isolated situation by disaster because video signal through ground wave and satellite is passed.

Additional, CBS (Cell Broadcasting Service) disaster information transmission can inform disaster information to a moving person when disaster happened. And in dead of night period of time, can communicate disaster information to people through medium of transfer communication in case disaster happens. The disaster information transmission takes advantage of ICT technology can reduce damages since transmit and deliver disaster information rapidly and correctly.

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A RESEARCH ON FOR DISASTER DAMAGE PREDICTION MODEL BY DATA MINING TECHNIQUE

Duke H. Jeong[1], Hyoung S. Shim[2]
Department of Management Information, Dongguk University, Korea

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Abstract

This research is to implement a model for disaster damage Prediction using Data Mining analysis. The case research data were used to analyze the disaster types and damages. The disaster types and damages were used to find factors of typhoon damage type by property of typhoon. The factor analysis and correlation were conducted to analyze relationship between time, location, and size of disaster based on damages .The Data Mining analysis technique were used to find pattern and relationships for typhoon example.

Introduction

Many properties and casualties are damaged by typhoons on summer in Korea. The government and private sectors have been working on mitigating and minimizing damages by typhoons through broadcasting alarm enforcement and forecasting damages in disaster mitigation and preparedness.

This research is to research and implement a model for disaster damage prediction using data mining analysis. The model is to analyze factors of typhoon damage types by properties damages during past 10 years. It has been executed correlation analysis on those data with factor analysis. Finally, it was to implement a model based on the factors of data mining analysis with typhoon sample data. The results are presented a prediction model to mitigate and minimize the disaster damages.

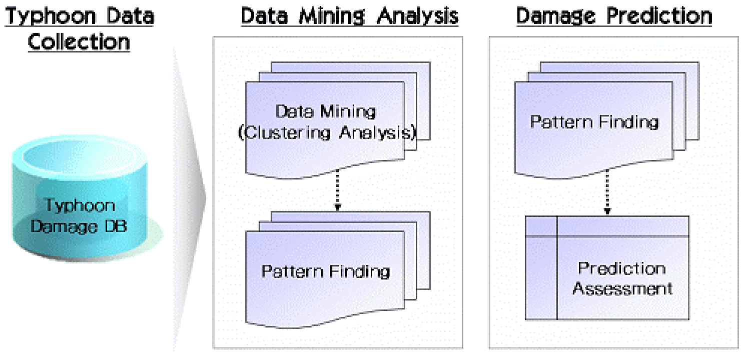
Research Procedure and Scope

In this research, the research is to be limited to the typhoon damages on analysis unit of disaster prediction. The case analysis areas are limited to the regional area in Seoul. The achieve data are presented according to research procedure with [Figure 1].

Firstly, the analysis of typhoon attribute are conducted the typhoon's data during past 10 years (1994 ~ 2003 year). The data are executed correlation analysis to find factors for prediction collecting damage data which happened by occurrence special property of typhoon. Secondly, the application of data mining technique with finding factor and damage prediction model to develop and implement a model are conducted a damage prediction model using Clustering

[1] duke@dongguk.edu
[2] hsshim@dongguk.edu

Analysis of data mining. At last, the model was chosen for typhoon on assessment of a prediction model applied Data mining. Then it compares and evaluates with actuality damages from analysis result applying prediction model.



[Figure 1] Research Procedure

Research Subject

Typhoon Characters

The characters of typhoon factors are divides into different properties of typhoons to analyze special properties and interrelations for damages. Numbers of typhoon origination that happen during past 10 years in Korea with [Table 1] course is about 164, and number of typhoon occurrence that inflict direct damage examined by 32. Typhoon is influencing in Korea yearly mean about 3, and damage about 1 out of 3, like 'Rusa'(2002), 'Maemi'(2003), 'Maegi'(2004)

[Table 1] Typhoon numbers

Year	June	July	August	September	Total
1994	2	7(2)	9(2)	8	16(4)
1995	1	2(1)	6(1)	5(1)	14(3)
1996		5(1)	6(1)	6	17(2)
1997	3(1)	4(1)	6(2)	4(1)	17(5)
1998		1	3	5(1)	9(1)
1999	1	4(1)	6(2)	6(2)	17(5)
2000		5(2)	6(2)	5(1)	16(5)
2001	2	5	6(1)	5	18(1)
2002	3	5(3)	6(1)	4	18(4)
2003	2(1)	2	5(1)	3(1)	12(3)
Total	14(2)	40(11)	59(13)	51(7)	164(32)
Average	1.4(0.2)	4(1.1)	5.9(1.3)	5.1(0.7)	16.4(3.2)

*( ) is Typhoon number of effect Korea

Heo (2003) are presented shapes and transfer paths of course associating according to the type of typhoon since selected 76 types among typhoons that happen between 1960 and 1989 classifies course 8 pattern. Also, Lee(2003) presented that influenced factor of precipitation, Highest Velocity, shortest path etc. In this research, the interrelation of weather element and typhoon damage are presented in [Table 2]

[Table 2] Correlation atmospheric factor & typhoon damage

	Amount of Damage	Inundation Area
Average Temperature	-0.089	-0.074
Highest Temperature	-0.101	-0.179
Precipitation	0.397**	0.520**
Wind Velocity	0.157	0.344**
Highest Velocity	0.260**	0.471**
Relative Humidity	0.130	0.234
Sea-level Pressure	-0.097	0.013
Shortest Path	-0.233**	-0.137

In this research, the special properties of occurrence cause of typhoon with [Table 3], finding property of typhoon with pre-data and post-data of typhoon occurrences.

[Table 3] Typhoon Properties

Property	
Pre-data	- Occurrence Time - Occurrence Area - Typhoon Size
Post-data	- Central Pressure - Typhoon Level - Typhoon Path - Precipitation - Highest Velocity

Typhoon Damages

Damage types with relationships damage division are dividing by casualty and facility damages. Facilities damage divided Public facilities and private facilities and assessment damage sizes. Since the research is limited extent to regionally Seoul City with [Table 4] together, with Seo (2004) research that do Pusan city damage division factor establishing damage factor of typhoon.

[Table 4] Damage Division

Division	Sufferer		Number				Flooding(ha)		
	Households	Number	Death	Disappearance	Injury	Total	Farmland	City	Total
Total									

Division	Facility				Farmland	Crops	
	Washout	Destruction	Flooding	Total			
Total							

Division	Facility Damage ( )				
	Road	River	Waterworks	School	Water supply

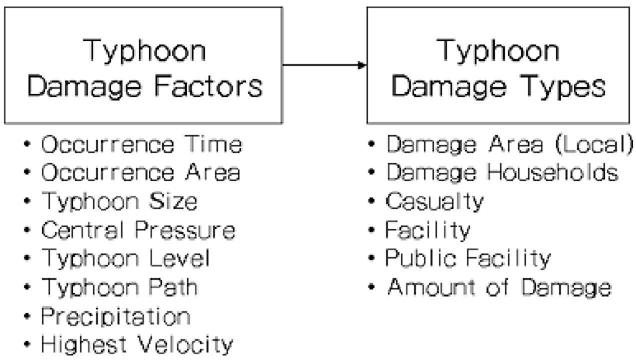
Total					

This research applied factor deduction to value about damage example such as damage number of household according to occurrence area, person's number etc.. for factor for damage by [Table 5].

[Table 5] Factor of Typhoon Properties

Analysis Content	
Occurrence Area	- Damage (Local)
Damage Types	- Damage Households - Facility - Public Facility - Amount of Damage

With [Figure 2], correlation analysis between Properties factor for typhoon and factor for damage by typhoon, finding effecting for damage of typhoon.

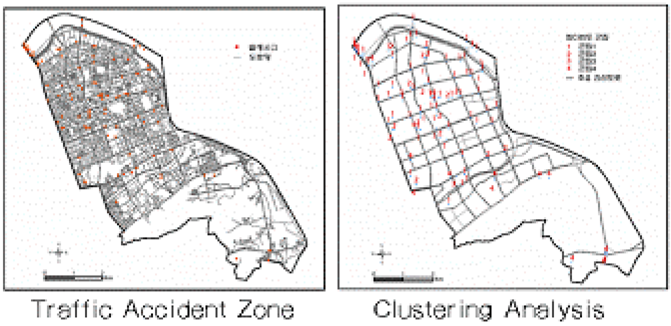


[Figure 2] Typhoon Damage Factor

<u>Data Mining Analysis Technique</u>

Disaster damage prediction Technology is to construct and to research TAPS (Typhoon Analysis & Prediction System) that utilize super-computer for prediction about typhoon, and damage prediction that applied LiDAR technology and a GIS Mapping technology. The damage prediction is needed fast and expensive equipment for correct analysis sequence. However, data mining would support decision-making through analysis - sales forecast, customer inclination etc.- and so on. It is used for deducing pattern by analytical method that achieve to find relevant information or knowledge because analyze data more effectively.

Lee(2003) is done to research a prediction model that applied GIS and data mining for investigated pattern about occurrence in traffic accident. Applied clustering analysis is done to classify a district accident pattern to Seoul city(Gangnam-gu) areas on [Figure 3].

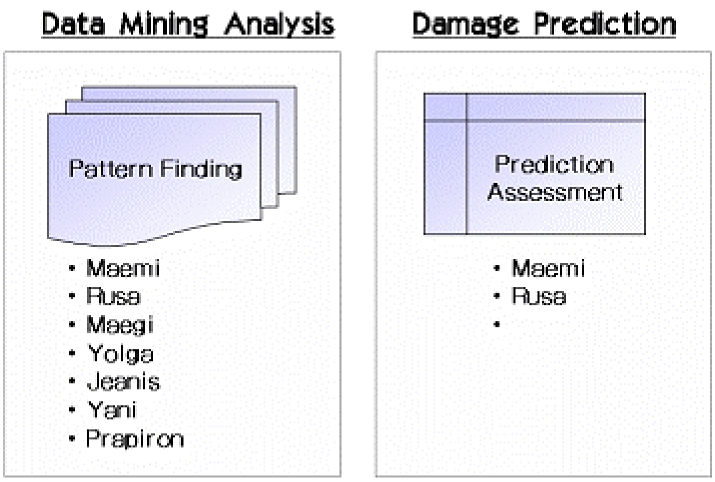


[Figure 3] Data Mining Analysis Result

In this research, one of the advantages of Clustering Analysis technique of data mining and produces typhoon, achieving research technique was to use forecasting information, damage type and scale for damaged district of Seoul area.

Result Testing

In order to test validity assessment of data mining technique, it is applied damage predictions about execution of damages, and it is done a comparative analysis that applies a typhoon example. The results are presented properties in result finding on [Figure 4].



[Figure 4] Data Mining Result Testing

Conclusion

The disaster prediction model is used to achieve disaster damage prevention and mitigate disaster impacts. The disaster management is to minimize damages at disaster occurrence and minimize a loss of lives with disaster prediction. Effectively achieve make certain human and material resources disaster response activity

Quick and correct disaster prediction technologies contribute prediction analysis through analysis on multidimensional analysis takes advantage of new information technology. The damage prediction model was conducted based on data for topographical characteristic and building.

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