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INFORMATION SYSTEM INFRASTRUCTURE FOR A NATIONAL-SCALE EMERGENCY MANAGEMENT CENTER

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Abstract

During the last decade of the 20th century, Turkey was shocked with numerous disasters. As a result, many efforts have been started to establish emergency management centers at various scales. This paper presents our views on the required information infrastructure of a national-scale emergency management center and the characteristics of a decision-support software required in such a center. The major responsibility of such a center will be to predict, track and minimize the effects of disasters, and manage the governmental resources in any part of the country.

Introduction

A disaster is a sudden, low-probability catastrophic event concentrated in time and space in which a society or a relatively self-sufficient subdivision of a society, undergoes severe danger and incurs such losses to its members and physical appurtenances that the social structure is disrupted and the fulfillment of all or some of the essential functions of the society is prevented [1].

Throughout time societies have dealt with natural and/or man-made disasters. For example, the Greco–Roman cities of Pompeii, Herculaneum and Stabiae were covered with and instantly preserved by volcanic ash up to 65 feet deep that resulted from the eruption of Mount Vesuvius in AD 79 [2]. The great fire of London in 1666 destroyed a large part of the city over 4 days including most of the civic buildings, a cathedral, 87 parish churches and about 13,000 homes [3].

Natural disasters kill an estimated 1 million people every decade and leave millions more homeless according to recent UN-IDNDR data. The economic damage from natural disasters has tripled in the last 30 years [4]. These make emergency management a crucial response mechanism against disasters. Emergency management is the discipline and profession of applying science, technology, planning, and management to deal with extreme events that can injure or kill large numbers of people, do extensive damage to property, and disrupt community life [5].

Establishing emergency management centers has been proved to be effective in all countries. The Carter Administration in USA pulled together various disaster response/emergency management programs and personnel previously scattered throughout the federal bureaucracy and created the Federal Emergency Management Agency (FEMA) in 1979 for comprehensive emergency

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management [8]. The Unified State System for Emergency Prevention and Elimination (USEPE) of Russian Federation provides communities' and the nation's prevention of, preparedness and response to and recovery from emergencies and disasters. [8].

During the last decade of the 20th century, Turkey was also shocked with numerous disasters. A series of major earthquakes in which the most severe one was the 7.4-richters Izmit earthquake (17th of August 1999, at 03.05 a.m.) that resulted in 15 thousand casualties in the largest industrial region of Turkey; floods in several major cities in south, west and north coasts that occurred after a rainfall of 600kg/m2 within a week in the region; mud flood in Isparta and Bartin cities are among the striking examples. After so many recent disasters, there has been subsequent development of state and local emergency management programs and centers along similar lines with international efforts.

This paper presents our views on the required information system infrastructure for establishing a national-scale emergency management center. We focus on the required software for providing decision support to the center personnel.

A National Center for Emergency Management

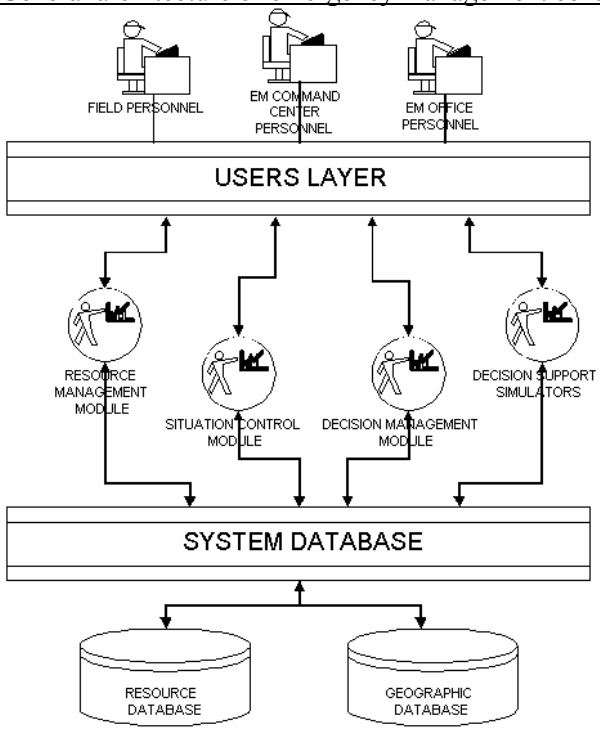
The proposed center consists of one emergency management command and control center, an emergency management office in each major governmental organization, such as ministries and general directorates, and several mobile emergency management offices that can quickly move to the crisis region to gather information and react to changing situations at real-time.

The following two observations are important in determining the responsibilities of the center and the functions it has to support. First, it has been argued that disasters are in fact local events. The local governmental body has traditionally had the first line of official public responsibility for first response to a disaster [11]. But municipal bodies tend to get much less exposure and have much less availability of resources compared with the central government. A national-scale emergency management center's basic responsibility should be to assist the local governmental bodies in all aspects of disaster response and recovery [12].

Second, if one looks across the range of threats we face, from earthquakes, to floods, to war, one will find there are common preparedness measures that we deal with in trying to prepare for those threats. These measures include evacuation, shelter, communications, direction and control, continuity of government, resource management, and law and order. It is the establishment of these measures that then becomes a foundation for all threats in addition to the unique preparedness aspects relevant to each individual threat. Thus, many emergency management capabilities are now operationally based on these functions, which are appropriate to a range of hazards [6]. The emergency management center software to be used in the center should be able to support the above-mentioned functions of the center.

The center also needs to have a sufficient number of qualified personnel to operate the existing emergency management center software. Each individual in the center should have a specialized function, abilities and responsibilities to manage. The actors can be classified as data collecting/entry personnel, decision makers, technical analyst experts, public relation experts and communication specialists.

Figure 1: General architecture of emergency management center software.



Emergency Management Center Software

Decent computers, large displays, scanners, fast printing equipment with high-volume capability as well as color printers and plotters will constitute the hardware infrastructure of the center. The center has connection with the local and mobile offices with telephone lines, dedicated communication lines, and/or the Internet. Satellite data communication means should also be considered for data exchange between the crisis region and command and control center.

Recent experience has demonstrated that investment in information technology may significantly increase the capacity to respond to disasters in a regional, national, or even international level. Computer-based decision support software to handle the disaster preparedness and response programs [9] have become an essential part of the emergency management centers. Such software help to coordinate, monitor, organize and distribute the required information in a timely and efficient manner appears to make it an ideal tool for strategic crisis management [10].

The general architecture of the software is shown in Figure 1. The emergency management center software should be composed of at least the following modules:

a. Resource Management Module

A resource is defined as anything that is owned by the central government and that may need to be moved to the crisis region or made available to the needy during the crisis time. Such resources may include, for example, fire-brigades, ambulances, doctors, medicine, food, etc. The goal of this module is to manage available resources in an efficient and effective manner. It provides a means for entering all kinds of resources under the authority of different governmental organizations into a central database. Thus it keeps an inventory of available resources with their actual geographical locations.

During and after a crisis, this module is used to display the current status of the resources on digital maps. The status may include the affected resources because of the crisis, needed resources in the

crisis region as well as the distance of the resources from the crisis region and their amounts . It also provides various facilities to make spatial queries like "Calculate the number of ambulances in a neighborhood of 100 km of the affected region.", "Where can I find the required 1000 tents from the nearest locations within 24 hours?" Therefore it eases allocation of required resources and tracking of the allocated resources.

b. Situation Control Module

This module is used to store and serve the data related with the crisis and to view the up-to-date situation on digital maps after a crisis. It supplies the users in the command and control center with the information about the type, location, and the amount of damage in terms of effected regions and number of people.

The Resource Management and Situatıon Control modules use GIS system to help tracking the operation within the field and the allocation of the resources over digital maps.

c. Decision Support Simulators

A number of simulators for highly probable crisis and disaster situations like flood, earthquake, fire and wildfire and chemical material spills are also part of the system. They help to predict the possible effects of a certain disaster and the potentially risky regions around the affected region. These will be developed by experts by exploiting proven theories and made available to the experts in the command center. The analyst experts in the center will have the necessary skills to use the appropriate type of simulator and experiment with the parameters effecting the simulator and try out different scenarios. They will try to estimate the effects and results of the disasters such as possible threatened regions and the population.

A sample screen snapshot from a flood simulator is given in Figure 2.

d. Decision and Order Archiving and Tracking Module

This module will be used to store all the decisions made and orders given by the managers in the center and any information regarding the fulfillment status of them. All the decisions and orders and whether they have been carried out or not can be queried at once by using this module. An example of such an order would be "Send the below listed resources to the crisis region in 6 hours" and this order's status would be whether the corresponding office has yet taken an action or not. We assume that the receiver of the orders is responsible for reporting the status related to the given order.

After crisis, data collected using this module could be analyzed and evaluated in the sense of developing effective crisis management methods for different crisis types. The data entry personnel in the center organizes the incoming and outgoing data and updates the central databases when required.

e. Raw Data Archiving Module

It is also used to archive all the raw reports coming from various sources. This may be formal or informal reports and other types of correspondence. For example, this module is used to record a mobile office's request to get some critical resources and their amount in the disaster region. All incoming raw data should be archived in some manner, and then be filtered, validated, and correlated (e.g., geographic and non-geographic data) by the data analyst personnel before updating the corresponding databases.

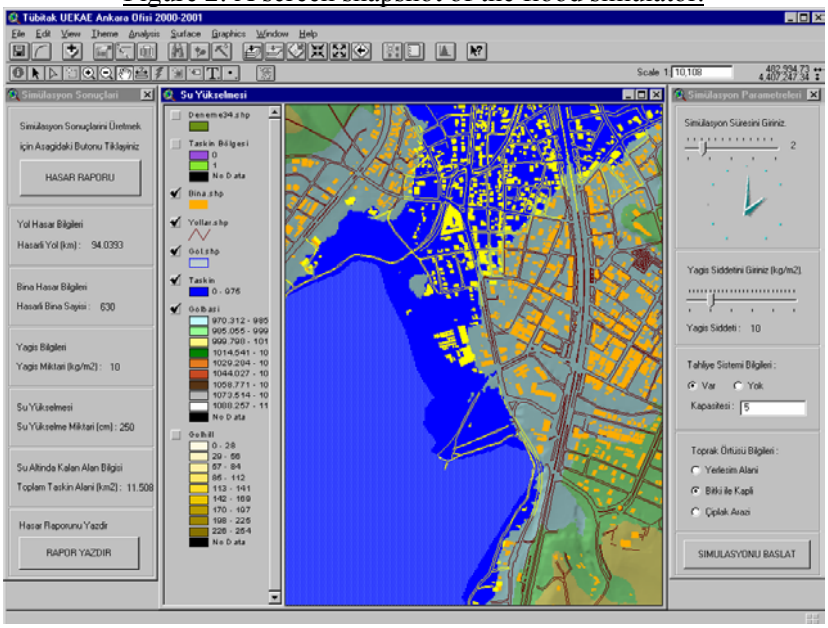
Database Support

As shown in Figure 1, a central data storage containing both geographical and non-geographical data lies underneath the information system. The geographic database will contain both large and

small-scale administrative borders and units, transportation, topographic and cadastral digital maps of the country. The non-geographic database will contain any binary formatted data such as information about resources, correspondence, decisions, and orders and all the available demographic characteristics information about the country.

Data from various sources are fed into the center by various means; e-mail, fax, telephone, magnetic media, or other ways. They may contain formatted and unformatted text messages, database export files, Word or Excel files, voice and video files. The orthophoto images or commercial satellite images to obtain up-to-date information about the situation and to assess the damage will also be sent to the center from the field.

Figure 2: A screen snapshot of the flood simulator.



All offices whether permanent or mobile should be able to access remotely the databases in the center according to their authorization level. This will supply up-to-date data to the offices and also provide distributed updating of the central database. We have some concerns about the structure and initial population of the database. It is certain that each office organizes their data in a different way, keeps them in different formats, or uses different databases. Sometimes a similar resource is represented in completely different ways in different government offices. To match the central database design with the offices would make the database structure as well as the correlations of data among different offices complicated. On the other hand, defining a single common database structure to accommodate all the requirements from different offices is also inherently difficult. Using a different database structure than that of the offices will also require transferring and converting data using special adapters in order to update the central database.

Since sensible data will be exchanged with the offices, ensuring of the security and reliability of the communication media – whether Internet, dedicated network, telephone lines or satellites – is crucial. Furthermore, as excessive delays could negate the usefulness of the system, response time of the system should be kept minimal by choosing the appropriate server hardware and the network configuration.

Conclusion

Natural disasters cannot be prevented and will continue to strike. Due to increasing population and land development activities, the amount of property damage and cost of recovery after each disaster will continue to increase [13]. This paper addressed the establishment of a national-scale emergency management center with specialized software that will increase the efficiency of preparedness and response operations in natural and man-made disasters.

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