DEVELOPMENT AND EVALUATION OF GEOGRAPHIC INFORMATION SYSTEM (GIS) BASED DISASTER INFORMATION SYSTEM IN ISTANBUL

D. Kepekci[1]

[1] *Engineer, National Earthquake Monitoring Center, Kandilli Observatory and Earthquake Research Institute, Bogazici University, Istanbul, Turkey*
Email: dilek.kepekci@boun.edu.tr

ABSTRACT :

Nowadays, integrated disaster management includes the phases (Mitigation, Preparedness, Response and Recovery) of disaster management that all are called risk management (before disaster) and crisis management (after the disaster) studies. Legal framework (the body of current law) of disaster management phases, mentioned above, in Turkey includes only "Response and Recovery" phase (or crisis management) of the disaster plan. A Geographical Information Systems (GIS) approach has been designed to crisis management that is applicable because of legal framework of Turkey. When we consider disaster caused by the hazard of the possible/expected earthquakes on Marmara Region, GIS based computer model has been designed by aims for fast first and emergency aid to victims and to organize fast and correctly to the groups that charged after the disaster, into disaster sites.

KEYWORDS: Disaster Management, Crisis Management, Earthquake, Istanbul, Kandilli, GIS

1. INTRODUCTION

Principles of plan to crisis management must be for fast first and emergency aid to victims and to oriented fast and correctly to the groups, that charged after the disaster, into disaster sites, and provide the normalization of life style in city. In the context of this principle, it was noticed that the fast reaching of needed city information was important. GIS provide fast reaching of all information as a integrated form. In this study, it will be presented the first works of GIS design that formed for crisis management for Istanbul city, and will be evaluated the present state.

With accumulation of knowledge and the experiences that we obtained from the physical world, disaster and crisis management have been changed and their coverage have been developed. Because of the losses due to the natural disasters, development of disaster management and technology in the World, to use new technologies and scientific approaches for disaster studies of Turkey is unavoidable. Nowadays, system that we defined as Integrated Disaster Management or Modern Disaster Management is same in principle with the disaster cycle that prepared in 1998 year. For this reason, it is necessary to use the new technologies in implementation stage of the phases (Mitigation, Preparedness, Response and Recovery) in the disaster cycle (Figure 1.). % 93 Of lands of Turkey is under the earthquake hazard and % 98 of population of Turkey lives in that earthquake hazard area. In Turkey, it must be taken the serious precautions because of social and economical loses due to the earthquakes (Earthquake Conference in Istanbul, 2004). From these results, earthquake risk is one of the most important risks for Turkey.

Risk triggered by hazards has been increased In Turkey, because urban settlements are formed and designed without taking into consideration the disasters. Occurrence time and location of 17 August 1999 Earthquake were precisely not known, But, before the this earthquake there are many special reports, scientific studies, media interviews about the long term seismicity and location of possible Marmara earthquake (Ambrasays and Finkel, 1992; Ansal and Gunel 1990; Barka, 1997; Barka, 1983; Barka et al, 1998; Eyidogan, 1991; Gundogdu et al., 1991; Gundogdu et al., 1995; Gundogdu et al., 1989; Ucer et al., 1997). But for this region, urban settlements were planned, designed and formed without considering the earthquake hazard (Eyidogan, 1989; Komut, 1999). Probable destructive effects of possible Marmara earthquake were put forward in before 1999 earthquake in the Symposia and Congress (Earthquake Prognostics World Forum On Seismic Safety Of Big

Cities, 1998; Istanbul and Earthquake Symposium 1991; 3trd Earthquake Engineering Conference of Turkey, 1995). As a striking example, before the Kocaeli earthquake a symposium titled “Is Kocaeli in preparation against to the earthquake hazard?” that organized by Chamber of Geophysical Engineers of Turkey.

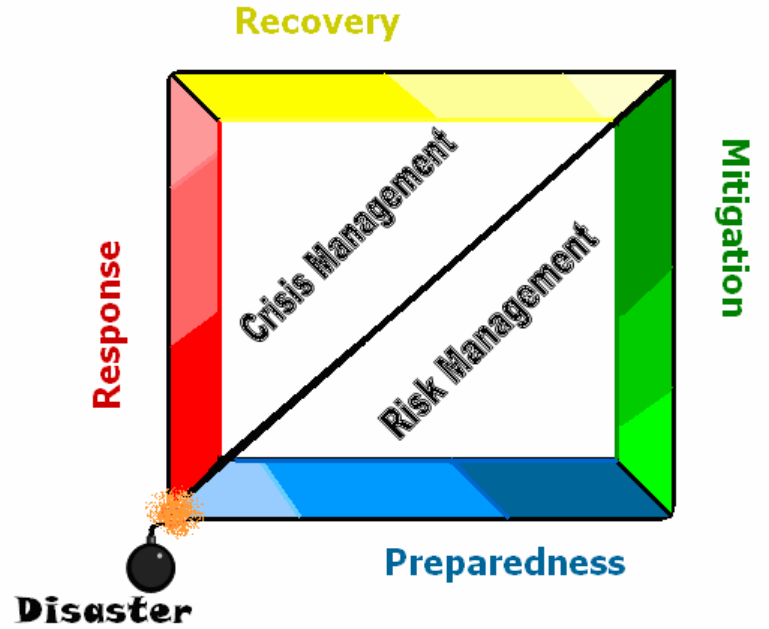

Figure 1 Integrated Disaster Management System

Before Kocaeli earthquake disaster, the possible problems were well defined for Marmara Region. In the context of Turkish legal framework, when it was planned the studies against to the disasters in 1998, this studies was in coverage of crisis management. Crisis management is, in principle, needs fast and efficient system. For these needs, the using of GIS was designed/planned to use in the crisis management and to accelerate the obtaining of the knowledge/information by the query.

As important input, it were considered that database of city were firstly formed in system in the planning of an organization of a mega city, as Istanbul, during the disaster. In this context, “disaster information system” based “city information system” was designed. Furthermore these studies were thought to be served in to different fields. Works that used in the several phases in the Integrated Disaster Management by GIS technology are described and defined by several researchers (Yalciner, 2002; Nuraliyev, 1999; Kim and Levine, 1996; Unlu, 2005; Bener, 2005; Nishikawa, 2002; Istanbul Earthquake Master Plan, 2003). Addition to this, a work sheet/plan should clearly be defined and described how all operations and process related to GIS will be implemented. This could be called “usage plan” in the response phase.

2. GIS PRINCIPLE IN THE CRISIS MANAGEMENT

Geographic Information System (GIS) is a computer based system for capturing, storing, analyzing and managing all kind of data and associated attributes which are spatially referenced to the earth. In the formation of GIS, a computer hardware, application program modules and well organized data-base are in harmonious. When we consider the scientific approach before 1999 year, in the crisis management after the disaster, aim was fast response of government forces to disaster site. By doing this, it was provided efficient aid to citizens who effected in disaster. In other words, in the crisis management it was aimed the formation of system that includes fast and efficient arrival of disaster site by the aims of efficient and correct decision.

GIS is used in several study areas from city planning to election analysis, form city management to the effective

action of transportation, from economic analysis to historical maps (Daihani, 2001; Ipek et al., 1997; Pratt, 2002).

When it was considered the size and dimension of Istanbul city, it was needed digital mapping system that analysis and synthesis by fast way. For this aim, formation of GIS system was planned and designed. By the Geographic Information System, it was planned and designed for analyzing and query of a lot of digital data (Esri, 1996a; Esri, 1996b; MapInfo, 2005).

Public and logistic institutions were evaluated in a system. Later, when we need new operations, it could be written and programmed the new interfaces/scripts.

We can give an example for aims of use of GIS. In the great disasters, local people are exposed to disaster; they could not have a role in crisis management. Disaster teams and group are generally formed by foreigners to disaster sites. By using the GIS, these teams and group can easily work in the disaster sites. In principle, GIS is formed by the aim of supporting of the acceleration of response phase of crisis management. By GIS it could be used from the teams/groups who is unfamiliar in to disaster area. In addition to this, GIS can also be used in different areas and problems related to the disaster.

3. STUDIES ON DATABASE DESIGN FOR ISTANBUL DISASTER/CITY INFORMATION SYSTEM

Disaster/City information system was designed to use for several aims. In the study that produced for Istanbul, it was firstly designed to provide harmonious of the computer hardware, of application modulus and of well organized database. For this work, after hardware, operating system and GIS software (ArcView GIS 3.0a and AutoCad) are bought, it were begin to obtain the data in the determined formats. Main aim was to upload into system of some numeric and descriptive data. By formation of the purposes of City/Disaster information system, it were collected and prepared the following information.

For Istanbul city database designs, that used in the GIS application for planning aims and usage aims during a possible disaster, based on "geographic information", "Building/Structure information", "Site/Area Information", "Boundary Information", "Transportation Information", "Energy Transportation Lines Information" and "Drinking and Usage Water Institution"

Geographic information was classified as "earthquake regions and settlement units", "1894 Earthquake Damage Distribution Map", "Potential Landslide Regions", "Istanbul Geology Map", "Lakes/Lagoons" and "Rivers/Streams" and these data were used in the database design.

Building/Structure that evaluated in the system, was classified according to "type" and "function". Standard building information in the disaster information system includes "building name", "district", "quarter", "street", "type", "function", "store number", "site", "building type", "shelter capacity", "heating type", "temporary settling state" and "telephone-fax". Classifications according to "building type" based on official education buildings, private education buildings, health buildings, security buildings, religious buildings, administrative provinces, ministry representatives, governmental buildings, communication buildings, fire brigade buildings, municipality buildings, Law buildings, foreign representatives, sport buildings, other official buildings and guesthouses. These buildings classifications were detailed according to their functions.

Official education buildings and private education buildings were classified as primary schools, high schools, universities and hostels. Database design of all education buildings, addition to standard building information, were formed as "student number", "personnel number", "garden area", "heating type". For hostels, these were formed bed capacity, numbers of rooms, number of students and garden area. For education buildings for temporary settling aims, database design was formed for "ownership state", "building type", "store area", "number of store", "total store area", "accommodated people number", " kitchen possibility", "dinning hall

possibility", toilet-shower area", "tent area" information.

Health buildings were classified as public (state, university and ministry hospitals) and private hospitals, village clinics/dispensaries and blood centers. Database design of all Health buildings, addition to standard building information, was formed as "building name", "address", "ownership", "bed capacity", "number of doctor", " number of nurse", "health civil servant", "operating room", "morgue capacity", "number of cars", "blood stocking quantity", "laboratory possibilities".

Security buildings were evaluated as police station and administrative buildings of police and gendarme forces and classified as district security directorate and police stations and gendarme stations. Database design of all security buildings, addition to standard building information, was formed as "address", "number of policeman", "number of officer", "number of noncommissioned officer", "number of soldier", "number of cars", "number of motorcycles", "number of amour-plated vehicle", "number of bus and midi bus", " number of minibus" , ""number of field vehicle".

Religious buildings were evaluated as mosques, churches, synagogues and patriarch buildings.
Buildings of administrative provinces were evaluated and database design of these buildings, addition to standard building information, was formed as "personnel information", "instruments and equipments information".

Ministry representatives were evaluated as regional and general directorates. Database design of these buildings, addition to standard building information, was formed as "personnel information", "instruments and equipments information". For governmental building, database design of these buildings was formed as standard building information.

Communication Buildings were evaluated as "powerhouse" and "building information" and were classified as Telekom's powerhouse buildings, radio management centers. Database design of all these buildings, addition to standard building information, was formed as "address information", "instruments and equipments information", "powerhouse capacities", "powerhouse buildings distribution areas".

Fire brigade buildings were evaluated as "central" and "local" sites. Database design of these buildings, addition to standard building information, was formed as "personnel information", "instruments and equipments information".

Municipality buildings were evaluated as "general directorate" and "local directorate". Database design of all these buildings, addition to standard building information, was formed as "personnel information", "instruments and equipments information", "powerhouse capacities", "powerhouse buildings distribution areas".

Law buildings were evaluated as "law buildings" and "prisons". Database design of all these buildings was formed according to the standard building information.

Foreign representatives, sport buildings, other official buildings were evaluated and database design of all these buildings was formed according to the standard building information.

Guesthouses were evaluated as "Guesthouses" and "holiday camp" Database design of all these buildings, addition to standard building information, was formed as "address information", "number of room", "bed capacity", "kitchen possibility", "dinning room possibility", "number of personnel", "garden area".

Area Information that evaluated in the system was classified according to "residence areas", "green areas", "forest areas", "industrial areas", "military areas", "prohibited areas for building", "graveyard areas", "temporary settling areas". These areas were showed as closed areas in GIS.

For “residence areas”, “green areas”, “forest areas”, “industrial areas”, “military areas”, “prohibited areas for building”, database design of all these buildings was formed as “name information”, “district”, “area information”, “capacity”, “personal number”.

Boundary information that evaluated in the system was classified as administrative and municipality boundaries. District boundaries and village boundaries were formed boundaries and were defined as closed areas. Database design of all these information were formed as “name”, “area”, “demography”, "number of building”, "village number”, “house number”. For municipality boundaries, database design was formed as “name”, “area”.

Transportation information that evaluated in the system was classified as “main roads/highways”, “railway system”, “harbor / seaports, shipyards, airports, coach stations”.

Main roads/highways were divided first and second order artery, street information. Main roads/highways were defined as linear lines. Furthermore, database design of all these information was formed as “name”, “type”. All streets in Istanbul were added in database system. For railway system information as described a linear lines, database design were formed.

Energy Transportation Lines Information that evaluated in the system was classified according to “high voltage lines”, “natural gas lines and their impact areas”. These lines were defined as linear lines and were wrote their names.
“Drinking and Usage Water Institution that evaluated in the system was classified according to “dams”, “Drinking and Usage Water distribution lines and chlorinating units”.

All dams used as Drinking and Usage Water reservoir were defined as closed area. Database design were formed as “name”, “district”, “structure type”, “max water level”, “ lake volume of max water level”, “reservoir area”, “filling rate”. Drinking and Usage Water distribution lines and chlorinating units were defined as closed area, and database design was formed as “name”, “type”, “capacity”.

For example, when we consider number at a time (23.01.1998) of study, by the aims of formation of query of database, information was collected from 3155 education institutions for the Istanbul city that is exposed expected great earthquake. Like this, all kind of information in the formed database design was collected. The collection of data was provided by Istanbul governorships and personnel efforts. For main aims, to form geographic information system, digital maps (1/1.000 scaled and 1/5.000 scaled photogrammetric maps, 1/5.000 scaled maps and 1/25.000 scaled Istanbul City Guide maps) that produced by Istanbul Municipality were used as a base map. To convert the prepared data to geographic information (location/position of buildings, sites, companies, and other data relations with these data) were made by Akropol Engineering. For these studies, several software and computer programs (ArcInfo, AutoCad, MapObjects, Arcview, Microstation, C and Visual Basic) were used in this period. Governmental and logistic institutions were considered in a system. Study was begun one year before 19 August 1999 Earthquake and was completed four month after 1999 earthquake.

While this system was located in crisis centre of the Istanbul Governorship, it was transported to Disaster Management Center (AYM) of Istanbul Government in 2000. On the formed system, information and boundary about a city, district or quarter could be in detail determined and all structural facilities are in query form. All these facilities are defined as layers. The map layers were based on “district”, “religious buildings”, “communication buildings”, “sport areas”, “lakes/lagoons”, “administrative buildings”, “ health buildings”, “education buildings”, “rivers/steams”, “directorates”, “security buildings”, “fire brigade buildings”, “law buildings”, “swamps”, “hostels”, “railway systems”, “underpass”, “overpass”, “shores”, “airports”, “ramparts”, “municipality buildings”, “bridges”, “energy transportation lines”, “graveyards”, “parks”, “roads”, “building sites”, “quarters”. During the possible earthquake, entered GIS data will be analyzed by query and then these

information will be used correctly orientation of emergency teams to disaster area and for first aid to people at this area. Needed and necessary city information that required in crisis management could be observed and queried in digital form. Now, temporal information in the use of response have been uploaded in to system.

To achieve GIS use, Computer software's and interfaces/scripts should be developed for the moment when used GIS (Daihani, 2001). To do this, "usage plan" should be prepared. When we consider GIS use of the crisis management, Planning of GIS use before disaster has important.

4. RESULTS

In the crisis management, it is determined usage need for response to disaster in short time and efficient form by using possibility and resources of city. For this need, Geographic Information System (GIS) were designed and formed.

Number of institution that used GIS has increased in Istanbul. From now on, a new approach, new understanding and new procedure must be for disaster information system that could be used during and after the disaster (in crisis management).

As a result, if we use the geographic information system (GIS) in crisis management, "usage plan" for disaster information system must implement. This plan in detail must include all stages (for example, what is priority in the solution of problem? Which procedure do GIS use in problems? How are information system used in the problems?) step by step. Furthermore, this work could not easily be achieved. This process is a hard and a serious task, but must be do.

Studies and behaviors before and after 17 August 1999 Kocaeli Earthquake show that it is important to struggle in fast and efficient manner in the crisis management. First of all, people life must transform to safe mode. For example, response for this process do not concentrates/focus at one area. Response do not orientate wrongly. In all same operations, GIS has necessity. Furthermore, if we don't have "usage plan" of GIS during the disaster, it is forgotten that GIS will be idle. For the use of the crisis management, this work will be accelerated the response after the disaster if it is produced "usage plan" of this work.

Furthermore, GIS based works provide useful instruments in the risk management (for example mitigation) studies before the disaster and in the crisis management studies after the disaster. We must not forget that mitigation studies are the most important phase of disaster management and mitigation studies must be considered in integrated form. Shortly, integrated disaster management must be produced/constructed for reduce of disaster risks.

Geographic Information System (GIS) have potential to serve all phases of Disaster Management System.

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