Designing Provincial level Emergency and Disaster Management System for Turkey

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Key words: Geoinformation/GI, Risk management, Emergency/disaster management

SUMMARY

Human life and property losses caused by natural and manmade disasters have been increasing as time goes by. Especially, planning faults in parallel with population increase cause important losses as a result of the disasters such as earthquake, flood, fire, etc. The actors such as fire brigade, ambulance etc. should involve in disasters and emergency management in an effective way. Accurate geo-information is an urgent need in disaster and emergency management activities such as preparation for and loss prevention in disasters, risk management, safe access to disaster regions, monitoring rescue operations, organizing related logistics services, and etc. Applying Geographical Information Systems (GIS) functionality provides a powerful decision support in disaster and emergency management and the basis to integrate policies directed to citizens, business, and governments. In this study, Emergency and Disaster Management System was designed for the Center of Disaster and Emergency which are supposed to be established in each province of Turkey. This model includes components such as Sector-Actor-Activity-Task-Data. In the field work stage, Actors" that behave as emergency response organizations such as fire and medical departments were determined. Actors work in "Sectors" such as fire department and urban security. Actors are responsible for “Activities” in the processes of loss prevention, preparation, intervention and redevelopment. "Tasks" performed by actors were defined as a sub-part of activity, such as fire response and traffic control. These tasks require base data and produce dynamic data for emergency response. In this way, geographic data models in compliance with ISO/TC 211 Geographic Information standards were designed and discussed with some emergency activities.

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1. INTRODUCTION

Emergency and Disaster Management is to conduct preparedness, mitigation, response, and recovery activities in a cycle to save human lives, reduce material damages on natural and human-made disasters (ORCHESTRA, 2008). According to FEMA (2009), the types of these disasters can be considered as chemical emergencies, dam failure, earthquake, fire and wild fire, flood, hazardous material, heat, hurricane, landslide, nuclear power plant emergency, terrorism, thunderstorm, tornado, tsunami, volcano, wildfire, and winter storm.

When disaster occurs, it is required to react accurately, fast and effectively. Various actors from different sectors such as police, fire brigade, and municipality are involved in emergency management. By this way, good decision making and information management help to control damage, to save lives and resources, and to reduce consequences of a crisis. The number of casualties is reduced by making the emergency services work safer (Scholten et al, 2008). Geographic ("geo-" prefix) Information is becoming a key issue in the achievement of these targets and is widely used in the emergency management phases. These geo-data can be explained with two categories, existing data and dynamic data (Dilo and Zlatanova 2006, Diehl et al, 2006). Existing data produced by different organizations includes topographic maps, administrative units, risk objects, vulnerable objects like schools, government building, hospitals, and etc. These data can be base for various geo-data related emergency applications. Dynamic data is collected during the disaster from the activities of emergency management and supports controlling emergency response activities together with the use of existing data such as incident data, affected and threatened areas, casualties and meteorological data.

While Geo-Information Systems (GIS) provides a powerful decision support to serve specific projects, Geo-Information Infrastructure (GII) enables effective collection, management of geo-data to stimulate better governance and to support corporate decision making (Longley, et al, 2001, Georgiadau, 2003, Aydınoğlu et al, 2009) in disaster and emergency management. The development of consistent reusable geo-data themes is recognized as beginning phase in the building of GII (Nebert, 2009). Emergency activities should be defined with common definitions and concepts in view of the geo-data. In this way, various techniques have been developed for semantic interoperability of highly heterogeneous programming and data models.

Open Geospatial Consortium (OGC) and ISO/TC211 Geographic Information/Geomatics committee have developed a variety of standards in this area. In respect of these standards, while Infrastructure for Spatial Information in Europe (INSPIRE) Directive (INSPIRE, 2007) are triggering to produce harmonized geo-data for the countries of the European Union (EU),

ORCHESTRA project is designing and implementing the specifications for a service oriented GII providing interoperability among risk management authorities in Europe. In addition, US Department of Homeland Security (DHS) Geospatial Data Model covers quite a broad number of data themes like these (Scarponcini et al, 2008). A great diversity of standard implementations are required for access and exchange of geo-data. These include OGC Web Services, GML, etc. (OGC, 2008). For example, as a standardized object modeling language with well defined semantics, Unified Modeling Language (UML) was developed for the purpose of domain modeling, application system design, database design, business modeling, and so on.

In this paper, Section 2 explains current law and organizational structure for emergency management. Section 3 gives case studies about developing Emergency Management Geo-data Model as a sector model of Geo-data Exchange Model at provincial level that was produced from a research project. Section 4 discusses the use of this geo-data model on emergency management activities.

2. PRESIDENCY and PROVINCIAL DIRECTORATE for DISASTER and EMERGENCY MANAGEMENT

In Turkey, disaster management was governed by three actors until 2009. These are General Directorate of Disaster Affairs under Ministry of Public Works and Settlement, General Directorate of Civil Defense under Ministry of Interior, and General Directorate of Turkey Emergency Management under Prime Ministry. With the law N.5902 issued in 2009, the activities of those three departments were ended and the Disaster and Emergency Management Presidency has become operative since 17 December 2009. The Law N.5902 defines the central and provincial level structure of this new unit. According to this law there are six departments at central levels. Service groups or actors defined by Disaster and Emergency Management Presidency are (Official Gazette, 2009);

- Planning and Mitigation Department
- Response Department
- Recovery Department
- Civil Defense Department
- Earthquake Department
- Department of Administrative Affairs

In addition to these departments there are three high levels.

- Higher Committee for Disaster and Emergency Management
- Co-ordination Committee for Disaster and Emergency Management
- Earthquake Advisory Board.

Provincial Directorate for Disaster and Emergency Management should be built in each province, which is directly attached to the governor of the city. Determination of the disaster and emergency risk of the city, constitution and application of response plans for the cities, and managing the logistic services at the time of disaster and emergency are the roles of Provincial Directorate for Disaster and Emergency Management. Loss and damage

assessment, preparation and application of civil defence plans are the authorization of this directorate. They also manages Management Center for Disaster and Emergency.

Management Center for Disaster and Emergency, a center working 24 hours, coordinates the response in disaster and emergency. The center is appointed with secure data processing and communication emergency services. In this study, a geo-data model was designed for Management Center for Disaster and Emergency to manage provincial level disaster and emergency management activities.

3. DESIGNING A PROVINCIAL GEO-DATA MODEL

Disaster and Emergency Management is a complex and very wide discipline that includes many actors and needs large amount of information. Effective data management mechanism for building GII should be provided at provincial level. Turkey GII:Geo-data Exchange Model, abbreviated as TURKVA:UVDM, can be accepted as a base model of emergency management activities because it was supposed that UVDM includes the date shared by all geo-data users at provincial level (Aydinoglu and Yomralioglu, 2010). UVDM can be a starting point to produce sector models for Emergency Management. By this way, Emergency Management Geo-Database Model, abbreviated as TURKVA:ADYS, can be produced as a sector model of TURKVA:UVDM.

UVDM Conceptual Model specifies the components to harmonize geo-data and to determine application schemas of geo-data themes. UVDM geo-data model meets application-driven geo-data needs, is a semantic model including a common domain of information, and an object-relational data model. UVDM is compliant with ISO190XX and INSPIRE data specifications, and following Turkey National GIS Actions. UVDM includes 16 data themes such as Address (AD), Land Ownership/Cadastre (MB), Administrative Unit (IB), Transportation (UL), Hydrography (HI), Land Surface (AR), Topography (TO), Geodetic (JD), and the like that can be used in emergency management as base data. Feature types in these data themes were defined with geometry, attributes, cardinality, relationships, topology rules, and the like.

TURKVA:ADYS provides the most appropriate data to each actor which is involved in emergency management. According to general conceptual approach of TURKVA:ADYS; Actor, Sector, and Task (AST) are the most important concepts between Activity and Information. Therefore they form the top-level classes. Figure 3 shows the overview of the classes and the most important relations in the model (Aydinoglu, et.al., 2009).

- Each *actor* such as fire fighter, ambulance, public security team, and etc. *work in* a *sector* such as police, municipality, and health services.
- Each *sector* is *responsible for* some *activities* such as traffic control, fighting fire, emission, and so on.
- Each *task* such as registering incident, fire response, and evacuating area *is part of activity*. In other words, Emergency activities comprise tasks respectively.
- *Actor performs task*. For Example; firefighter as an actor performs fire response.

- *Task requires and produces information* during emergency event. That is, each actor needs data to perform its task, but the actor can also deliver data to the system. Usually a task requires some *existing data* from *UVDM* geo-database and also some *existing and/or dynamic data* from *ADYS* geo-database. And, this task produces some *dynamic data* on *ADYS* geo-database during disaster.
- Each of the five top-level classes has its *subclass*, which is modeled as *isA* relation.

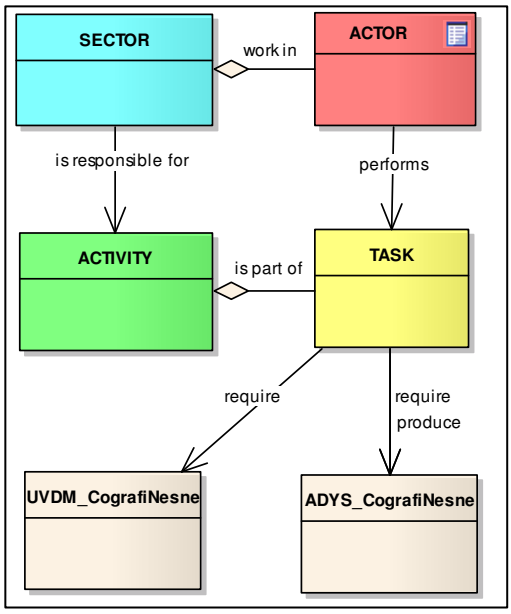

Figure 1. Classes and Relationships for Emergency Management

ADYS geo-data model, a sector model of UVDM, has the same application schema rules as UVDM. ADYS are in development phase based on geo-data needs of emergence tasks and includes existing and dynamic data to use during emergency activities. For example; *Incident, Casualty, DisasterArea,* and *RiskArea* are continuously changing data during emergency events. While *DisasterArea* stores the spread of disaster, *RiskArea* controls possible risk zones if disaster continues. *EmergencyBuildings* that need to get special attention can be related to Building (*YAPI*), Address (*ADRE*) via *YAPI* in UVDM geo-data model. *Incident* that manages information about incident time and type can be related to ADRE and Road (*YOLH*) to get the location and route information.

For example, explosion of gas station as the activity “Controlling Emission” has the Actor-Activity-Sector-Task-Information classes as seen on Figure 6;

- Various sectors such as “Police, Municipality, Provincial Public Administration (PPA), and Health Services” have responsibilities on Emergency Management.
- The activity “Explosion” is one of the activities for which “PPA” is responsible out of municipality area.
- “Disaster Coordination Center (AKOM) and Civil Defense Officer” represent the responding actors working in Sector “PPA”. Firefighter is a responding actor working in

Sector “Municipality”. “MOBESE and Public Security teams” represent the responding actors working in Sector “Police”.

- The tasks such as “registering incident, determining risk zones and threatening landmarks, determining team location and routes, evacuating and controlling risk zones, fire intervention, and saving casualties” are parts of the activity “explosion”.
- After getting an urgent call, geo-data are managed as below consecutively;

i. AKOM performs the task ‘registering the incident’. This requires road (*YOLH*) and numbering (*NUMA*) data on UVDM geo-data model. This task produces the location of incident (*Incident*) which is dynamic data on ADYS geo-database (Figure 2-a).

ii. AKOM performs the tasks “determining risk zones and threatening landmarks” requiring NUMA, YOLH, and building (YAPI) data in UVDM geo-data model. This task produces ”*RiskArea*” and ”*DisasterArea*” data in ADYS geo-data model. As a case study, possible explosion of LPG station were examined and the risk map including threatening building were determined (Figure 2-a).

iii. AKOM together with MOBESE performs the task “determining team locations and routes” requiring “*incident, YOLH, Teams*” data to produce “*TrafficAccess*” in ADYS geo-database. As a case study, produced map give optimum routes to fire fighters and ambulances to reach the location of incident (Figure 2-b).

iv. Beside these, geo-data is required and produced to execute other tasks of this emergency response.

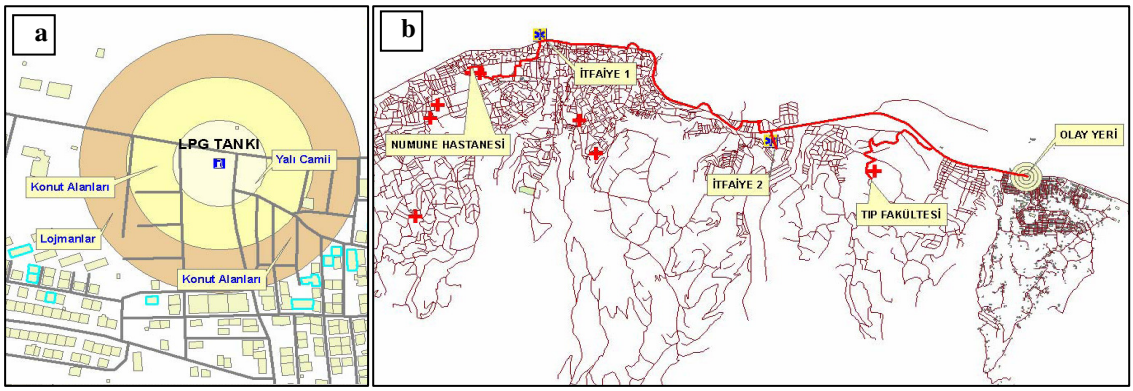

Figure 2. a) Risk Map for the Explosion of LPG Station b) Traffic Access Map

4. CONCLUSION

Geo-data has great importance at different phases of disaster management; preparedness, mitigation, response, and recovery. As emergency management is a multi-disciplinary activity, the most fundamental asset is the data itself that needs to be shared or to be integrated between different partners. GII provides the tools giving easy access to distributed databases for emergency management actors who need geo-data for their own decision making and emergency tasks. Similar to the case study, Actor-Sector-Activity-Task-Data classes have been designing for emergency management activities. Processes with Tasks were being formalized sequentially while required data for each task were defining to manage

emergency events within GII mechanism. In this way, ADYS, developed as sector model of UVDM, can solve application-driven geo-data needs of The Management Center for Emergency and Disaster built in provinces of Turkey. When web based user interface developed with Service Oriented Architecture (SOA) is configured on the web and data servers, it will be possible to manage and to use geo-data on electronic communication networks.

REFERENCES

Aydinoglu, A.C., Quak, W., Yomralioglu, T., 2009. Some Spatial Data Management Issues towards Building SDI. In International Workshop on Spatial Information for Sustainable Management of Urban Areas, FIG Commission 3 Workshop, Mainz, Germany.

Aydinoglu, A.C., Yomralıoğlu, T., 2010. A Harmonized Geo-Information Model for Urban Governance, ICE- Municipal Engineer, 2010 (*in press)*

Diehl, S., Neuvel, J., Zlatanova, S., Scholten, H., 2006. Investigation of user requirements in the emergency response sector: the Dutch case, In Second Symposium on Gi4DM, Goa, India.

Dilo, A., Zlatanova, S., 2008. Spatiotemporal data modeling for disaster management in the Netherlands, In Bartel van de Walle, Yan Song, Siyka Zlatanova, and Jonathan Li, editors, Information Systems for Crisis Response and Management, pages 517–528. Harbin Engineering University.

FEMA- Federal Emergency Management Authority, 2009. Types of Disasters, available on: www.fema.org (01.02.2010)

Georgiadau, Y. (2003). Access to information infrastructures: the rainbow metaphor. In Proceedings of the NSDI III workshop: Empowering people through geospatial data, Agra, India.

INSPIRE (2007). A Directive Of The European Parliament and of The Council Establishing An Infrastructure For Spatial Information in The Community INSPIRE). EC JRC, Brussels.

Longley, P.A., Goodchild, M.F., Maguire, D.J., Rhind, D.W., 2001. Geographic Information Systems and Science. Wiley Pub., USA.

Nebert, D.D., 2009. The SDI Cookbook: Developing Spatial Data Infrastructures V.3. Global Spatial Data Infrastructure Association.

OGC- Open Geospatial Concortium (2008). Topic 1,5,8,10. http://www.opengeospatial.org/ standards/as (available:01.01.2009)

Official Gazette, 2009. The Law About Structure And Tasks Of The Presidency For Disaster And Emergency Management, No.5902, 29.5.2009.

ORCHESTRA Cons., 2008. Orchestra book: An Open Service Architecture for risk management, EU.

Scarponcini, P., Camateros, S., Custers, O., Zlatanova, S., Oosterom, P.V., 2008. Introduction. In P.V.Oosterom, S.Zlatanova (Eds.). Creating Spatial Information Infrastructures towards the spatial semantic web, Taylor&Francis Book.

Scholten, H., Fruijter, S., Dilo, A., and van Borkulo, E., 2008. Spatial Data Infrastructure for emergency response in Netherlands. In Nayak, Zlatanova (Eds.). Remote Sensing and GIS technology for monitoring and prediction of disaster, 177-195, Springer-Verlag.

BIOGRAPHICAL NOTES

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