Using Geo-Information Technologies to Increase the Effectiveness of Fire Brigade Services in Turkey

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ABSTRACT

The coordinated response of fire has become a priority need for effective participation of actors. Within this scope, Geo-Information Technologies (GIT) will help to reduce of catastrophic results of disaster and protect lives and resources, with dynamic use of geo-data in fire disaster management. Interoperable geo-data is urgent need for fire disaster management. With assigned tasks, fire brigade is the most effective actor for the fire disaster management at different phases. In this study, actors that could act in a GIT based fire disaster management are defined. Activities in management phases of the possible fire disaster and geo-data needs to manage these activities were determined. According to this background, case activities such as producing fire risk map, optimizing locations of response teams, and the like were developed by using GIT. This approach can be a preliminary work to trigger effective and collaborate use of geo-data in fire brigade services.

Keywords

Fire brigade, geo-information technology, disaster management.

INTRODUCTION

Frequency of disasters and loss of life and property caused by disasters are rising constantly because of increase in human population, destruction of nature, unconscious urbanization and technological developments (Aydinoglu and Demir, 2010). Because of geological, topographical, and meteorological features, Turkey encounters with disaster events frequently. Fire takes first rank among all other disasters in terms of frequency of occurrence. For instance, an average 20.000 to 25.000 fires occurs annually in Turkey (Istanbul Fire Brigade, 2010). Because they occur in a limited area, fire damages are less than damages caused by other types of disasters. However, fire disaster causes the extent effect in view of the total annual losses. In this scope, there is a need of developing multi-actor and effective approach for fire disaster management.

Healthy and proper geo-data, used by actors performing the tasks of disaster activities, is important requirement for the effective management of fire event. Applying Geographic Information System (GIS) functionality provides a powerful decision support in fire disaster management and the basis to integrate policies directed to actors like citizens, business, and governments. In parallel with the technological development, the concept of Geo-Information Infrastructure (GII) which provides interoperability of geo-data through communication networks has emerged. In this context, many countries in the world have been developing GII to manage geo-data effectively (Aydinoglu et al, 2009).

When the fire occurs, it is required to react accurately, fast and effectively. Various actors from different sectors such as police, fire brigade, and ambulance services are involved in fire disaster management. Coordinate and effective work of institutions and organizations must be provided by defining work-flow of activities performing by different actors in mitigation, preparation, response and recovery phases of fire disaster management according to national statutes and directives (Aydinoglu and Demir, 2010). The activities that are performed in different phases must be managed as integrated processes and the tasks of these activities must be developed in order to use with open service architecture on the web. In this scope, each activity is defined with sub-tasks as map services which are used by the actors to perform the activities, independent from their locations.

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In this paper, the use of geo-information technologies was examined for emergency services. The current situation and laws were explained for fire disaster management. Some case studies with the example of fire risk map were produced to manage the activities and sub-tasks with geo-data. Section 5 discusses the geo-data use of defined actors in the activities.

GEO-INFORMATION TECHNOLOGIES IN EMERGENCY SERVICES

Disaster management is a complex and very wide discipline that includes various actors and needs large amount of information. The most important base for an effective fire disaster management is the healthy and accurate maps. Geo-data which is obtained from various data sources is extensively used in different phases of fire disaster management. GIS support decision making and facilitate optimum solutions for complex problems. (Yomralioglu, 2000; Hitz et al, 2010). However, the expectations is now increasingly shifting towards sharing required geo-data in disaster management activities. Beyond GIS, Geo-Information or Spatial Data Infrastructure (GII/SDI) approach enables the effective collection, management, and access of geo-data by reducing duplication and facilitating integration at different administrative levels (Longley et al, 2001; Masser, 2005; Aydınoğlu et al, 2009). Through interoperable systems, GII provides information from different sources for effective delivery of government services (Harrison et al., 2006). By this way, GII is increasingly considered a critical aspect of decision-making in disaster management.

Service Oriented Architecture (SOA), which facilitates the exchange between different systems that may not have communicated with one another, enables geo-data services to share within a much broader community. Now with the development and application of geo-data services and web GIS, a new model characterized by sharing services ushered in a service-oriented geo-information sharing. Similar to a GII vision, geo-data services as web services encapsulates all the GIS functionalities by applying service-oriented software engineering methods, which realizes the crossplatform, cross-network and cross-language interaction (Yang et al, 2007; Li and Wang, 2008).

CURRENT SITUATION OF FIRE BRIGADE SERVICES BASED ON REGULATIONS IN TURKEY

There are 72 statutes about disaster management in Turkey which are complicated and deficient for multi-actor disaster management. Explanations show us there is a need of detail research on determination of actors and activities for fire disaster management in accordance with statute. Despite the fact that detail definitions and descriptions are made, there is no a disaster management plan that provide integrated task and coordination among the actors. The main reason of this deficiency is scattered presence of content in statute.

In this way, actors that have responsibilites on disaster management were determined by examining legacy applications, statute, and the law on Disaster and Emergency Management Department Organization and Functions numbered 5902. The actors which take part in disaster management activities are leveled as governmental, national, regional, provincial and local accordingly to their hierarchical relation. In this regard, there are 17 actors determined on governmental level. There are 187 actors in national level and 102 actors on regional and provincial level, the actors in charge at DEM are determined as 306 in totals.

Mitigation, preparation, response and recovery phases performed by varios actors for fire disaster were determined, based on legacy applications and directives. Furthermore, required work-flows that several different actors are responsible, were examined. Fire disaster management actors are direct users of geo-data. Fire Brigade is the most important actor for the fire disaster. The establishment, duties, authorization, and responsibilities of Fire Brigades in Turkey were defined in the Regulation on Municipilaty Fire Brigade. The activities and sub-tasks of these activities performed by the Fire Brigades has been defined in view of various regulations,especially Regulation on Protection of Buildings from Fire.

CASE STUDY: MANAGING ACTIVITIES OF FIRE DISASTER

In this study general conceptual approach of fire disaster management can be defined with Sector-Actor-Activity-Task-Data upper classes (Figure 1).

- “Actor” expresses units like fire department, ambulance, police, municipal police, search and rescue teams, etc. that take in charge in fire disaster management.
- Every actor work in different “Sector”; like security, municipal, health etc.
- “Activity” expresses geo-data used in required situations during loss mitigation, preparation, response and recovery phases of fire disaster managemet.

- Every activity are formed by “Tasks” in specific phases.
- Actor needs geo-data and can produce new geo-data during the task performing. Hereby, the task needs existing data or dynamic data in database. Furthermore, it produce dynamic data during emergency response.

Integrated fire disaster management can be possible with the using of actor-sector-activity-task approach. In the scope of the study, various activities performed by different actors using geo-data have been defined for urban-fire event:

Mitigation phase of the fire event is composed of activities as “creation of planning base maps” and “mitigation plans” within the sphere of many different actors. Preparation phase of fire event is composed of activities as “determination of response unit locations”, “determination of fire-fighting resource locations”, “evacuation planning” and “determination of aid materials warehouse locations”. Response phase of fire event is composed of activities as “determination of response area”, “response planning”, “evacuation planning” and “aid planning”. Coordinated work of actor agencies carries great importance in terms of effective performance of activities at the response phase of the fire event. Recovery phase of fire event is composed of activities as “determination of structural damage”, “determination of settlement” and “land use”.

For fire disaster, 77 sub-activities have been defined in view of activities explained above. Every activity has varios tasks respectively that need geo-data to perform these activies. These data can be used by different actors. Relationships of actor-sector-activity-task-data have been determined for each sub-activity.

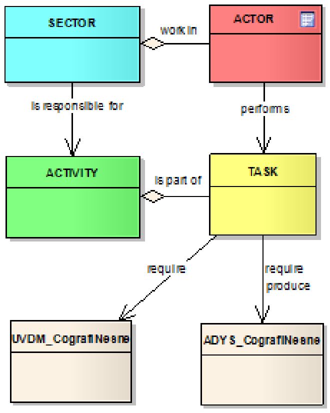

Figure 1:Actor-Sector-Activity-Task-Data Model

Producing Fire Risk Map as a sub-activity

The first activity of the mitigation phase is the creation of planning base maps that covers production of current situation map, production of fire risk map, technical and social infrastructure planning, and as sub-activities seen on Table 1.

Fire.Mit.01: Creation of Planning Basemaps			
Sub-Activities			
Fire.Mit.01.01	Production of Current Situation Map	Fire.Mit.01.06	Sensitive Area Planning
Fire.Mit.01.02	Production of Fire Risk Map	Fire.Mit.01.07	Regulation of Land Use Plan
Fire.Mit.01.03	Technical Infrustructure Planning	Fire.Mit.01.08	Regulation of Zoning Plan
Fire.Mit.01.04	Social Infrustructure Planning	Fire.Mit.01.09	Regulation of Environmental Plan
Fire.Mit.01.05	Power Plants Planning	Fire.Mit.01.10	Regulating Region Plan

Table 1: Sub-Activities of Planning Basemaps Activity.

In this study, as a sub-acitivity, the process of fire risk map poduction was shown with the use-case description that is referred to as standard operating procedure. Fire-risk map information and tools help communities develop informed mitigation plans that will reduce losses from fire events. The map allows to visualize risks in relation to each other, gauge their extent, and plan what type of controls should be implemented to mitigate the risks. Fire risk differs from a society to another society according to social structure and urban infrastructure. In this study, Regulation on Protection of Buildings from Fire for Tukey, the fire risk research of Istanbul Fire Brigade and the statistics formed by Istanbul Fire Briagde have been used to specify the risk criterias for Istanbul province and the fire-risk map for Besiktas district of Istanbul was produced (USG, 2010; Audit, n.d.).

The fire risk research of Istanbul Fire Brigade has evaluated the fire events occurred for ten years, industrial plants, other workplaces and narrow streets on the basis of quarter within the scope of research. In this scope, risk levels of buildings has been determined. For example:

- Explosive substances, filling facilities, industrial plants, factories, museums and palaces have been determined as first level risk group.
- Buildings, shopping centers, hotels and manufacturing plants have been determined as second and third level risk group.

Regulation on Protection of Buildings from Fire has been used in classification of the buildings according to the fire risk. Once the risk criterias are specified, rate each risk with 4 being the most significant and 1 being the least significant.

Fire Brigades are in charge of production of the fire-risk map in the provinces of Turkey. To produce the fire risk-map, Standard Operating Procedures (SOP) for performing activity with tasks were formed with using use-case description for Fire Brigades in Turkey. Use case description with the tasks of fire-risk map producing sub-activity defines the methodology of the fire risk map production (Table 2).

Use Case Description: YAN.O.01.02	
Name	Production of Fire-Risk Map
Priority	High
Description	The user specifies the fire risk zones for jurisdiction area with using GIS.
Pre-condition	Analyzing Fire Events sub-activity coded YAN.O.01.01
Work-flow	
Task.1	**Import “Building” Feature Class:** Import “Building” polygon feature class from UVDM geo-database.
Task.2	**Add “risk” Attribute:** Add “risk” attribute column for “Building” feature class.
Task.3	**Determining Risk Groups of Buildings According to “use type”:** “use type” attribute of “Building” includes the use types of the buildings. Risk value of historical buildings, filling facilities and industrial plants are equal to 4. Risk values of comminal life places like health facilities, educational institutions, public buildings and shopping centers are equal to 3. Risk values of apartment buildings are equal to 2. Risk values of detached houses and ruin buildings are equal to 1. Risk values of empty houses are equal to 0.
Task.4	**Determining Risk Groups of Buildings According to “structure type”:** “structure type” attribute of “Building” includes the structure types of the buildings. Each structure type has different resistance time as defined in regulation. Risk value of structure coded F30 is equal to 4. Risk value of structure coded F60 is equal to 3. Risk value of structure coded F90 is equal to 2. Risk value of structure coded F120 is equal to 1. Risk value of structure coded F180 is equal to 0.
Task.5	**Determining Fire Risk Levels of Buildings:** Determine the “risk” values of the buildings taking account of the determined risk groups according to use type and structure type.
Task.6	**Import “LandUse” Feature Class:** Import “LandCover” polygon feature class from UVDM geo-database.
Task.7	**Determining Risk Areas in “LandUse” Feature Class:** Determine the area featured fire risk and the fire risk values of these araes. “land use type” attribute of “LandUse” includes use type, flora and vegetation cover.
Task.8	**Determining Risk Objects:** Merge “Building” polygon feature class and “LandUse” polygon feature class. Composed “RiskObject”polygon feature class has “risk” attribute that defines the fire risks of the objects.
Task.9	**Import “Transportation” Feature Class:** Import “Transportation” line feature class from UVDM.
Task.10	**Determinig Risk Values of Risk Objects:** Adjecency of the risk objects must be taken as a parameter while determining the risk values of the risk objects.
Task.11	**Convert “RiskObject” to Point Feature Class:** “RiskObject” polygon feautue class should be converted to point feature class.
Task.12	**Determining Fire-Risk Zones:** Inverse Distance Weighted (IDW) interpolation method is implemented to specify the fire-risk levels for the region.
Data source: UVDM-Conformant Data Set Provided by Focal Point	
Description	Turkish GII: Geo-data Exchange Model (TURKVA: UVDM)
Geographic scope	Turkey wide, although a smaller area may be selected
Thematic scope	TURKVA:ADYS
Documentation	TURKVA:UVDM

Table 2: Use Case Description of Fire-Risk Map

In Figure 2, actor-sector-activity-task-data relations are showed for fire-risk map production. This relation includes the tasks explained in the use case description. Fire brigade use data from geo-database to perform the activity and produce fire-risk map. Fire-risk map for Istanbul-Besiktas district is produced according the tasks defined as in use-case description form and UML class diagram (Figure 3).

According to results of the fire-risk map, there might be a need of change, revision or addition at hand in the present regional plans, zoning plans or in environmental plans and land use plans as a part of mitigation phase or maybe a need for creating localized land use plans. Locations of hydrants, water supply points, etc. as a part of preparation phase are determined according to the results of the fire risk map for provience. Additionally, these integrated prcesses manage the response phase of the fire disaster. All activities of fire disaster are relevant to each other and can manage easily with using open service GIS.

CONCLUSIONS

Geo-data has great importance at different phases of fire 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 fire disaster management actors who need geo-data for their own decision making and emergency tasks. Processes with Tasks were being formalized sequentially while required data for each task were defining to manage emergency events within GII mechanism. When web based user interface developed with Service Oriented Architecture (SOA) is configured on the web and data servers, it is possible to manage and to use dynamic geo-data on electronic communication networks. Related stakeholders could manage and update the data with GII approach at a place where the data is maintained effectively. With this view as explained the fire case examples with standard oriented procedure approach, described data managed in the geo database with GII approach provide actors interoperability in fire disaster management.

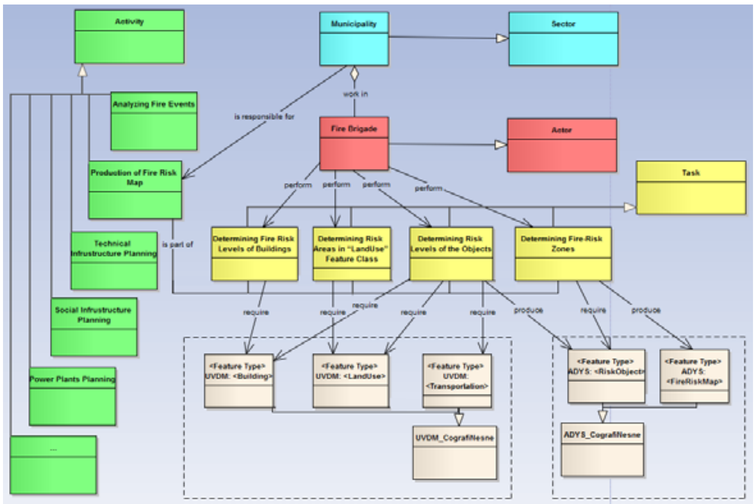

Figure 2: UML Class Diagram for Fire Risk Map

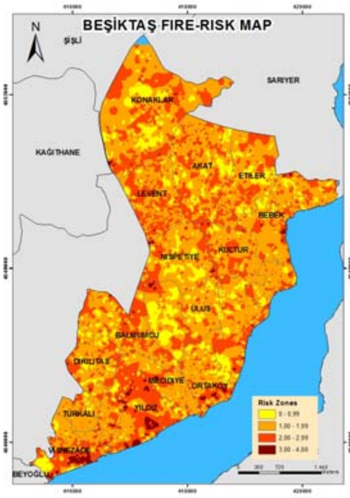

Figure 3: Fire Risk Map of İstanbul-Beşiktaş

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