USING GEOSPATIAL DATA CORPORATELY FOR DISASTER MANAGEMENT SUPPORT

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ABSTRACT:

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. It is a complex issue in the entire cycle of emergency management requiring full and fast cooperation between different actors working in different sectors. Applying Geographic Information Systems (GIS) functionality provides a powerful decision support for emergency management activities. The focus is changing toward integrating these functions to find optimal solutions to complex problems with Geospatial Data Infrastructure (GDI). Finding available information and easy access to required information is crucial for disaster management. That consists of existing information such as buildings, road and dynamic information collected during disasters such as incident, casualty, and like these. Geospatial Data Sharing Model for Turkey as a new approach enables using the data corporately and effectively. General features of this model are object-oriented model, based on ISO/TC211 and Infrastructure for Spatial Information in Europe (INSPIRE) standards, describing nationwide unique object identifiers, and defining a mechanism to manage object changes through time. The model is fully described with Unified Modeling Language (UML) class diagram. This can be a starting point for geospatial data providers in Turkey to create sector models. Disaster Management Data Model as a sector model can provide the most appropriate data to many "Actors" that behave as disaster response organizations such as fire and medical departments. Actors work in "Sectors" such as fire department and urban security. Each sector is responsible for "Activities" such as traffic control, fighting fire, emission, and so on. "Tasks" such as registering incident, fire response, and evacuating area are performed by actors and are part of an activity. These tasks produce/require geospatial data for Disaster Management Data Model and require data based on the Geospatial Data Sharing Model. In this way, Disaster Management Data Model with "Actor-Sector-Activity-Task" classes was designed and discussed as an extension of Geospatial Data Sharing Model with some cases from Turkey.

1. INTRODUCTION

Decision making is a very complicated process in disaster events. When disaster occurs, it is required to react accurately, fast and effectively. Various actors from different sectors such as police and municipality are involved in emergency management. Building a good collaboration mechanism and cross-sector services have critical importance to manage disaster or emerngecy tasks that are rather different than their daily work routines (Scholten et al, 2008). 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 and more efficient, ensuring citizens to get high quality care and information (Zlatanova et al, 2006).

Geo-Information (GI) is becoming a key issue in the achievement of these targets and is widely used in the emergency management phases. Various geo-data sets are needed on emergency response and management. These geo-data can be explained with two categories, existing data and dynamic data (Dilo and Zlatanova 2006, Diehl et al, 2006).

Existing data were produced by different organizations on heterogeneous environment. These geo-data includes topographic maps, administrative units, infrastructure data, risk objects, vulnerable objects, and etc. These data can be base for various geo-data related disaster applications and generally managed by local governments or public institutions.

Dynamic data is collected during the disaster from the activities of emergency management. For example, incident data includes location, nature, and scale. Effects of disasters should be determined with real time data including damaged objects, buildings, and infrastructures, affected and threatened areas. Casualties as a possible result of disasters include wounded and trapped people. The location of emergency response teams are needed as a moving object for giving the route to incident location. By this way, dynamic data produced on real time can support controlling emergency response activities together with the use of existing data.

Beyond Geo-Information Systems (GIS) and a special case of Information Infrastructure (II), the integration of geo-information through interoperable systems is the central role of Geo-data Infrastructure (GDI). By this way, GDI is increasingly considered a critical aspect of decision-making in disaster management. Most countries of developing world are in the process of building GII at different administrative levels for effective geo-data management (Aydınoğlu et al, 2009, Georgiadau, 2003, Masser, 2005, Harrison et al., 2006)

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This paper is organized as follows. Section 2 presents geospatial data sharing model for Turkey that is designed to meet base and existing data needs. Section 4 describes disaster management model as an extension of geospatial data sharing model with some cases. Section 5 closes the paper with conclusions and expectations.

2. GEOSPATIAL DATA SHARING MODEL

A geospatial data sharing model of Turkey titled as TURKVA:UVDM was designed to make the data enabled for multiple uses. UVDM includes the data that needs to be shared among the users. The design of UVDM follows user requirements. This base and domain geospatial data model is a starting point to create sector models such as Disaster Management Information System (ADYS) as seen on Figure 1. The sectors can produce their models based on the rules of UVDM compliant with ISO/TC 211 and OGC standards, Turkey National GIS actions, and the expectations of INSPIRE data specifications that European countries follow to utilize in their country towards building European SDI.

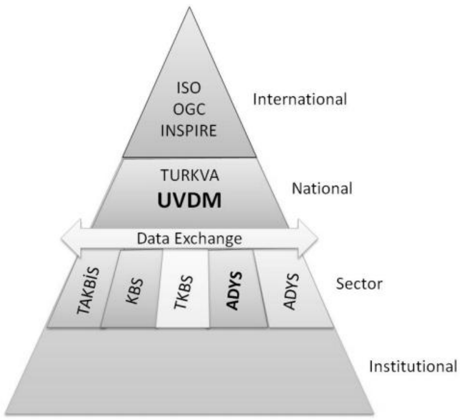

Figure 1. Base and sector geospatial data models

UVDM is an object-oriented geo-data model that enables the users to store objects and their associated attribute data in a single system. UVDM is a semantic model because harmonized model provides common domain of interaction and the related information. That is, a variety of different kinds of organizations can operate in the same geo-information and exchange the data technically. For this, UVDM is designed with UML class diagrams. UVDM Generic Conceptual Model specifies the components to determine application schemas of geo-data themes and to harmonize geo-data.

UVDM geo-data themes are Administrative Unit (IB), Address (AD), Land Ownership / Building (MB), Hydrography (HI), Topography (TO), Geodesy (JD), Transportation (UL), Land Cover / Use (AR). Application schemas of UVDM data themes were described with documentation, feature catalogues, and UML application schemas.

If we summarize the use of some UVDM data themes on disaster management activities;

- Address (AD) data theme provides a simple data structure for geocoding and address matching on controlling incident location and emergency actors.
- Transportation (UL) data theme is to capture basic infrastructure information for water, air, road, transit and rail networks and can be used with AD information. Transport Junction enables to mark connection points between multiple transportation modes. Also included is an Activity class to document transportation agency and other public events that will affect travel.
- Land Cover/Use (AR) data theme includes classes that relate to environmental monitoring and response. Most of these are oriented more towards natural disasters and recovery efforts rather than environmental monitoring for Homeland Security purposes. Land Use and Land Cover features can be used to assess damage after an event.
- Ownership/ Building (MB) data theme includes classes of buildings and parcels. It is related to address information. Detailed building information provides enough detail for emergency management personnel to effectively respond to local emergencies.

3. DESIGNING GEOSPATIAL DATA MODEL FOR DISASTER MANAGEMENT

Disaster Management is a complex and very wide discipline that includes many actors and needs large amount of information. Therefore, effective data management mechanism should be provided as a critical aspect of disaster management.

Actors of disaster management sectors need base existing geospatial data that was maintained by local government and public institutions. On this scope, TURKVA:UVDM can be accepted as a base model of disaster management activities because it was supposed that UVDM includes the date shared by all geospatial data users at local level. By this way, Disaster Management Information System, abbreviated as TURKVA:ADYS, can be produced as an extension and sector model of TURKVA:UVDM. As explained before, TURKVA:ADYS has existing data special for disaster management sectors and dynamic data collecting during disaster.

According to general conceptual approach of TURKVA:ADYS; Actor, Sector, and Task are the most important concepts between Activity and Information. Therefore they form the top-level classes. Figure 2 shows the overview of the classes and the most important relations in the model.

- 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.

3.1. ADYS as an Extension of UVDM

ADYS geo-database model can be produced as an extension or sector model of UVDM that has generic conceptual model components and existing data needed for emergency management. In this way, ADYS has the same application schema rules as UVDM. ADYS has existing and dynamic data to use during emergency events. For example; Incident, Casualty, DisasterArea, and RiskArea are continuously changing data during disaster events as seen on Figure 3. Incident manages information about incident time, type, and like these. Casualty stores trapped, wounded, missing as a result of an incident. While DisasterArea stores the spread of disaster, RiskArea controls possible risk zones if disaster continues. EmergencyBuildings includes buildings that need to get special attention during disasters such as schools, shopping areas, governmental buildings, etc. Emergency Buildings can be related to Building (YAPI), Address (ADRE) via YAPI, and other feature types in UVDM. Incident can be related to ADRE and Road (YOLH) to get the location and route information.

- After getting an urgent call, AKOM performs the task ‘registering the incident’. This requires road (YOLH) and numbering (NUMA) data on UVDM geo-database. This task produces the location of incident (Incident) which is dynamic data on ADYS geo-database.
- AKOM performs the tasks “determining risk zones and threatening landmarks” requiring NUMA, YOLH, and building (YAPI) data. This task produces “risk map” on UVDM geo-database.
- AKOM together with MOBESE performs the task “determining team locations and routes” requiring “incident, YOLH, Teams” data to produce “Traffic Access Map” on ADYS geo-database
- Beside these, geo-data is required and produced to execute other tasks of this emergency response.

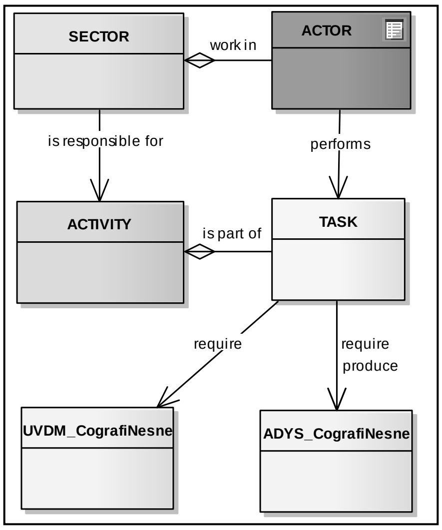

Figure 2. UVDM:ADYS Class Hierarchy

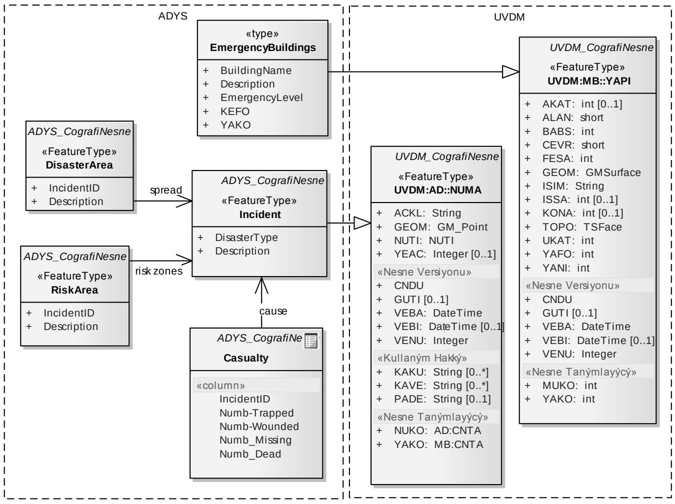

Figure 3. A Profile of UVDM and ADYS geo-database

3.2. ADYS Classses with the activity “Controlling Emission”

Disaster response scenarios can be determined to manage disaster activities with UVDM:ADYS Class approach. For example, explosion of gas station as the activity “Controlling Emission” has the Actor-Activity-Sector-Task-Information classes as seen on Figure 4;

- 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”.

4. CONCLUSION

Geo-information has key importance for disaster management activities. It should be possible to exchange information between different partners at different administrative levels as a multi-disciplinary activity. UVDM was developed to solve application-driven geospatial data needs at local level with base model approach and supports decision making activities with common semantics. This can also solve the existing and base data needs of disaster management activities. ADYS can be developed to be used corporately with UVDM. By this way, disaster management strategies should be developed at local level. Activities with Tasks should be formalized sequentially while required data for each task should be defined to manage disaster events within GII mechanism.

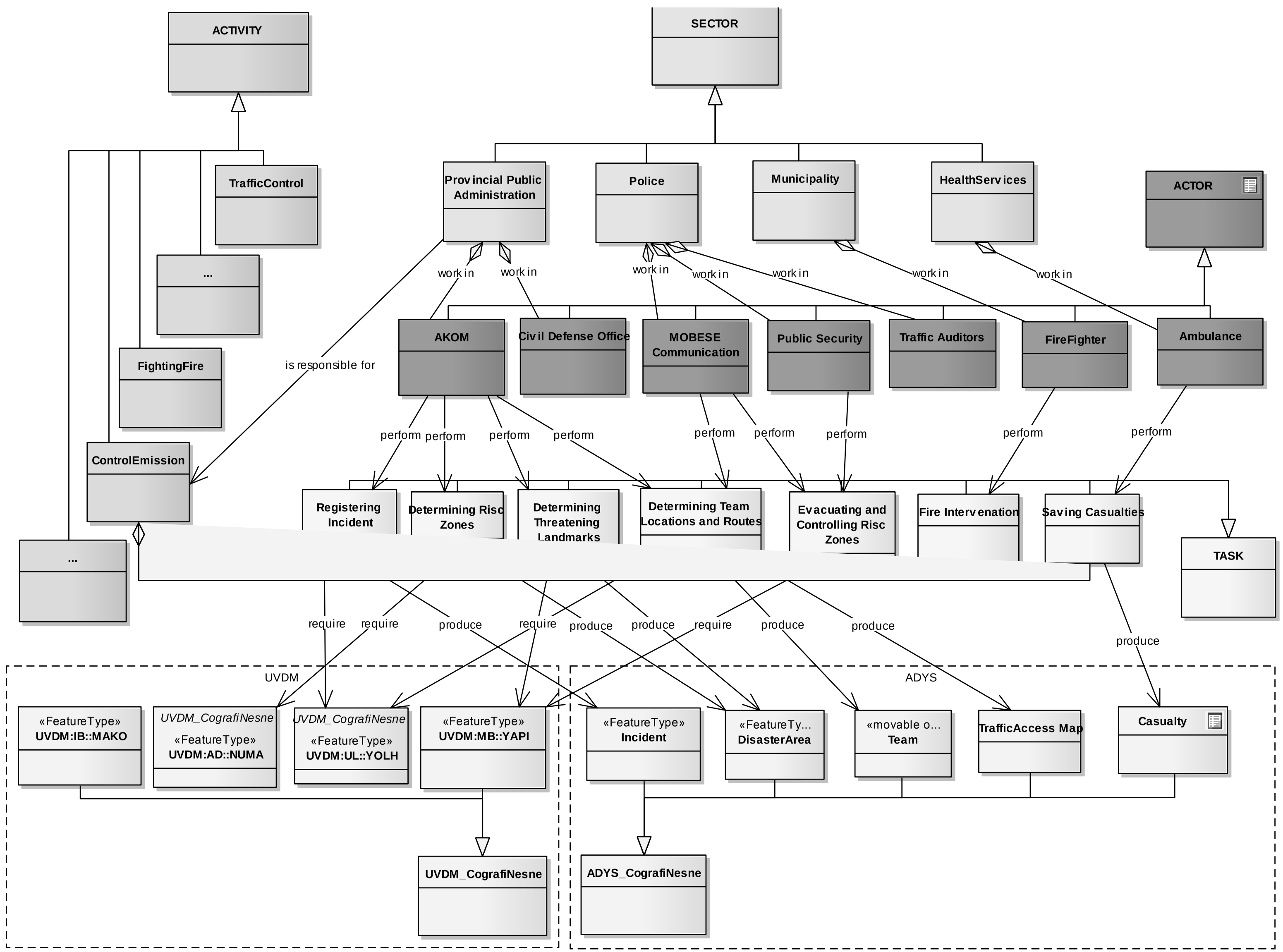

Figure 4. UML class diagram for the process “Controlling Emission”

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