Designing a Harmonized Geo-Data Model for Disaster Management

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ABSTRACT

There are problems for managing and sharing geo-data effectively in Turkey. The key to resolving these problems is to develop a harmonized geo-data model. General features of this model are based on ISO/TC211 standards, INSPIRE Data Specifications, and expectations of Turkey National GIS actions. The generic conceptual model components were defined to harmonize geo-data and to produce data specifications. In order to enable semantic interoperability, application schemas were designed for data themes such as administrative unit, address, cadastre/building, hydrographic, topography, geodesy, transportation, and land cover/use. The model, as base and the domain geo-data model, is a starting point to create sector models in different thematic areas. Disaster Management Geo-data Model model was developed as an extension of base geo-data model to manage geo-data collaborate on disaster management activities. This model includes existing geo-data special for disaster management activities and dynamic data collecting during disaster.

Keywords

GIS, geo-data model, standards.

INTRODUCTION

Geographic ("Geo-" prefix) information provides significant benefits within the environmental, social and economic context for sustainable management of urban and rural areas. The integration of geo-information through interoperable systems is the central role of Geo-Information Infrastructure (GII) that provides information from different sources for effective delivery of government services. GII also plays a crucial role in e-government which supports the information flow between government, citizens and the private sector (Aydinoglu and Yomralioglu, 2010; Molen, 2005, Longley, et al, 2001).

A central component of GII is the actual geo-data (ANZLIC, 1996; DHS, 2006). According to The SDI Cookbook of the Global Spatial Data Infrastructure Association (Nebert, 2004), the development of consistent reusable geo-data themes is recognized as a common ingredient and initial phase in the building of GII. Epecially, the Open Geospatial Consortium (OGC) and the International Standardization Organization (ISO/TC211) GI/Geomatics have developed a variety of standards in this area.

Decision making is a very complicated process in disaster management and helps to control damage, to save lives and resources, and to reduce consequences of a crisis. Up-to-date and interoperable geo-data is becoming a key issue in the achievement of these targets and is widely used in the disaster management phases.

In this paper, existing geo-data standards, projects, and regulations are examined. A harmonized geo-data model of Turkey GII (TURKVA:UVDM) that was designed to make the data enabled for multiple uses is explained as a preliminary work to build GII. Emergency Management Geo-Database Model, abbreviated as TURKVA:ADYS, is produced as an extension and sector model of TURKVA:UVDM.

DISASTER MANAGEMENT ISSUES IN TURKEY

Legistations and Actors

Organizational structure and tasks of Disaster Management is described in the 5902 numbered law, put into practice in 2009. While some legistations and regulations are directly related with disaster management, some of

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them are indirect. Actors with their tasks were defined not only in disaster management legislation but also in other related legislations.

When defining tasks of municipality in case of disaster in municipal laws, tasks of interior ministry and actors of subunits is defined in 3152 numbered law, related tasks about disaster management is emphasized in 5302 numbered special provincial administration law and 5188 numbered private security services law. Activities for forest fire and flood disasters are defined in 442 numbered village law while some activities for forest fire disaster are defined in 6831 numbered forest law. Actors and their responsibilities for mitigation and recovery phase in disaster and emergency management are defined in 3194 numbered construction law and 5403 numbered soil conservation and land use law. Besides, 75 legistations defines actors and their tasks for disaster management. Existing regulations pointed out that there is a need of detail research on determination of actors and activities of disaster management in accordance with statute.

According to legistations, there are plenty of actors involved in different levels to act on for mitigation, preparation, response and recovery phases of disaster management. In this regard, there are 17 actors determined on governmental level. There are 187 actors in national level with central, permanent, related, and in-charge organizations And, together with 102 actors on Provincial level, the actors in charge at disaster management are determined as 306 in totals. It is expected that active duties of every single actor from local to national level should be predetermined. In summary, Disaster and Emergency Management Presidency, under responsibility of Prime Ministry, has role for management and coordination. The main strategy is to give active roles and responsibilities to provincial and local actors.

Projects and Geo-data standards

In Turkey, data dictionaries and large-scale map production regulation (BOHHBUY) includes information for presenting the data on the maps and does not include information for using in various thematic applications. The urban GIS applications of local governments were developed in accordance with the GIS software companies. Therefore, since public institutions use a different conceptual model and feature catalogues, the geo-data are not interoperable (LRCD, 2006; Emem and Batuk, 2007).

Various GIS projects were developed for disaster management, especially for earthquake. Some of them are Disaster Information System Project (ABIS), and Disaster Inventory Information System, JICA, TABIS, İSMEP BİMTAŞ, HAZTURK, RABİS. However, there is not data standard or GII strategy that put into practice for effective disaster management.

Turkey Disaster Information System project (TABIS) aims to use GIS-based information and other data gathering systems especially for emergency planning, the implentation of disasters, can be used disaster management and damage estimation. The system can be utilized as a decision support system for the central and provincial administration. The other objective of the sytem is to improve standards to provide a basis for countrywide application. TABIS Object Catalogue (TABIS-OK) was generated within TABİS project, prevent uncontrolled growth of data and management of same data by different institutions, by interdisciplinary work increase efficiency and provide basis to standards regarding data exchange.

DEVELOPING A HARMONIZED GEO-DATA MODEL

This model, Geo-data Exchange Model of Turkey GII (TURKVA:UVDM), can be accepted as a new approach on geo-information management in Turkey. UVDM is a geo-database model that is developed in view of user requirements, defines specifications of geo-data themes, and enables data management independent from any particular software or hardware.

UVDM is complying with ISO/TC 211, INSPIRE data specifications that European countries follow in order to work towards building European GII, and Turkey National GIS vision. UVDM is an object-relational data model that enables users to store objects and their associated attribute data in a single geo-database system. UVDM is a semantic model because a harmonised model provides a common domain of interaction and the related information. UVDM is designed with Unified Modelling Language (UML).

Conceptual Model

UVDM generic conceptual model specifies the components to determine the application schemas of geo-data themes and to harmonise geo-data. These components were defined and divided into two sections, scope/application area and technical components (Aydinoglu and Yomralioglu, 2009; Aydinoglu, et al., 2010)

- Scope and Application Area Components include; Standard Hierarchy, Scale-resolution, Generalization Approach, Building Province Level GII
- Technical Components include; Principles, Terminology, Reference Model, Application Schema Rules, Spatial and Temporal Aspects, General Feature Model, Identifier and Versioning Management, Registers and Registries, Portrayal, and Multiple Representation.

Design of UVDM follows the requirements of the application algorithms. This model is focused on the application and use of information, rather than a specific workflow for an organization. The base principle is that if a geo-database is modeled for a province, it could then be a model from local to national level.

Geo-data should be maintained at a level where the data are managed effectively. The only way to have consistent and current national datasets is to have transactional updates performed by local datasets. These data can be combined, transformed and integrated into the national datasets. The spatial hierarchy approach enables the collection of data at province level, larger than 1:5000 scale and 50 cm resolution, and then generalizes to different levels.

Base application schema of UVDM:

- High level and base class of UVDM is *UVDM_CografiNesne* accepted as common and compulsory class.
- All feature classes defined on data themes are sub-class and specialization of *UVDM_CografiNesne*. •
- All geo-objects in feature classes have geometry and/or topology in a position.
- All geo-objects are referenced on a Geography Coordinate System named as CografiReferans.
- NesneTanımlayıcı defines all geo-objects with unique identification.
- NesneVersiyonu defines and controls changes of the objects through time with attributes.
- KullanımHakkı defines data accession permission and sources with attributes.
- Metaveri defines information about all geo-objects at data set level of feature classes.

A common framework is determined for the unique identification of geo-objects. This means that all geo-objects carry a unique identifier property called the geo-object identifier (CNTA). These identifiers can be used to ensure interoperability among databases under national systems. A temporal feature class is produced for each feature class to manage the data through time temporally and to control changes. This class defines attributes such as CNTA, versioning number (VENU), version starting and finishing date (VEBA and VEBI).

For example; currently, there is no unique administrative unit code (IDBK) differentiating national to local level; therefore, the administrative unit definitions used in public institutions were combined in respect of Turkey's administrative hierarchy. In the administrative unit data theme (IB), an IDBK was created to access the databases of administrative units. Geo-data sets can be related to each other with CNTA attributes (Figure 1). The CNTAs of objects; road data sets (YOLH) in UL, numbering data sets (NUMA) in AD , and building data sets (YAPI) in MB were determined hierarchically based on the lowest level administrative units of IB data themes, district/village (MAKO). This enables data sharing as in a real-world interaction.

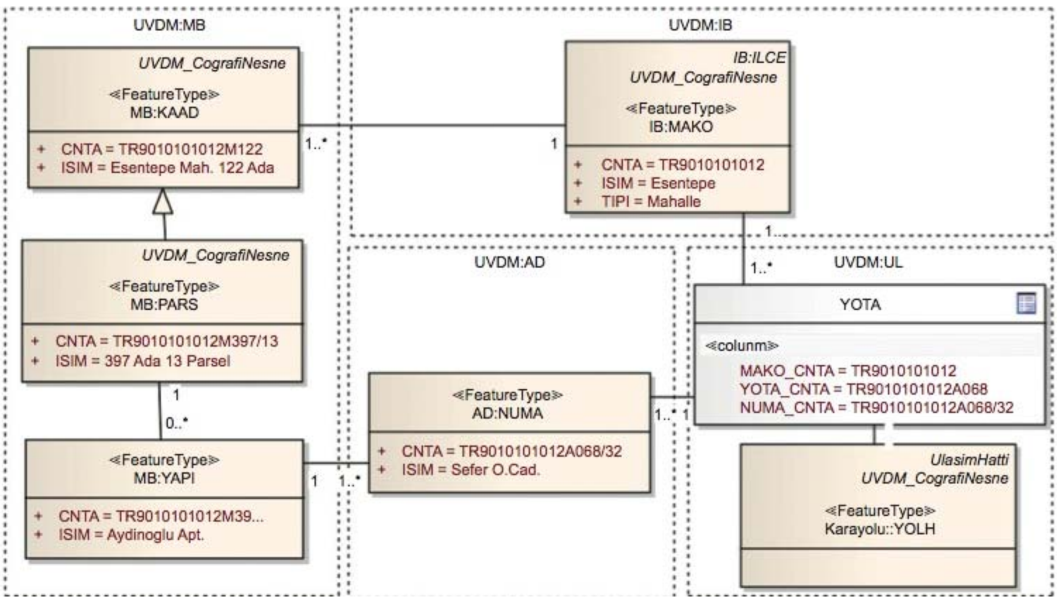

Figure 1. Managing geo-data in the sharable environment of IB, UL, AD and MB data themes

Geo-data Themes

The UVDM geo-data themes are Administrative Unit (IB), Address (AD), Land Ownership/ Building (MB), Hydrography (HI), Topography (TO), Transportation (UL), Land Cover/Use (AR), and Geodesy (JD). These data themes were selected because they were determined the most needed by geo-data users and are also accepted as INSPIRE data themes. Application schemas of UVDM data themes were described with documentation, feature catalogues, and UML application schemas. Feature types in data themes are defined with definition, geometry, attributes, attribute values, relationships, topology, and constraints.

If the use of UVDM data themes on disaster management is emphasized:

- IB data theme can be effective on the coordination of disaster management activities.
- AD data theme provides a simple data structure for address matching and controlling locations of actors and emergency structures.
- 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.
- HI data theme includes data about rivers and lakes that can be used on controlling floods.
- TO data theme includes elevation and surface data that can be used on determining landslide and flood risks.
- UL data theme is to capture basic infrastructure information for water, air, road, transit and rail networks. This can be effective on logistics and navigating emergency actors.
- 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.

DESIGNING GEO-DATA MODEL FOR DISASTER MANAGEMENT

UVDM can be accepted as a base and the domain geo-database model. UVDM includes the date shared by all geo-data users at local level. This is a starting point to create sector models in different thematic areas like Disaster Management. Disaster Management Geo-data Model, abbreviated as TURKVA:ADYS, was developed as an extension and sector model of TURKVA:UVDM. This includes existing data special for disaster management sectors and dynamic data collecting during disaster.

Disaster Management is a complex and very wide discipline. While disaster and emergency situation occurs, data should be used effectively to get decision and to control incident/disaster in Turkey. Actors of emergency management sectors need base existing geo-data that was maintained by local government and public institutions.

ADYS has the same conceptual model components as an extension of UVDM. ADYS has existing and dynamic data to use during emergency events. For example; Incident, Casualty, DisasterArea, and RiskArea are continuously changing data during emergency events as seen on Figure 2. Incident manages information about incident time, type, time, 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.

CONCLUSIONS

In Turkey, collecting and sharing geo-data from different sources has some difficulties because there is no standardized data structure. Thus, the harmonized GI model can support various applications from local to national level. TURKVA:UVDM, also called the harmonized geo-data model or feature/object model, can provide an approach on effective geo-data management. Conceptual components support to manage the data in terms of linking, sharing and reusing with unique identifiers.

Disaster management is a multi-disciplinary activity. GII provides the tools giving easy access to distributed databases owned by actors who produce/use geo-data for their own decision making and disaster tasks at different administrative levels. Disaster Management Geo-data Model (ADYS) should be developed and used corporately with UVDM. By this way, disaster management strategies should be devtermined for Turkey at local level. Activities with Tasks should be formalized sequentially. Required geo-data for each task should be defined to manage disaster events within GII mechanism.

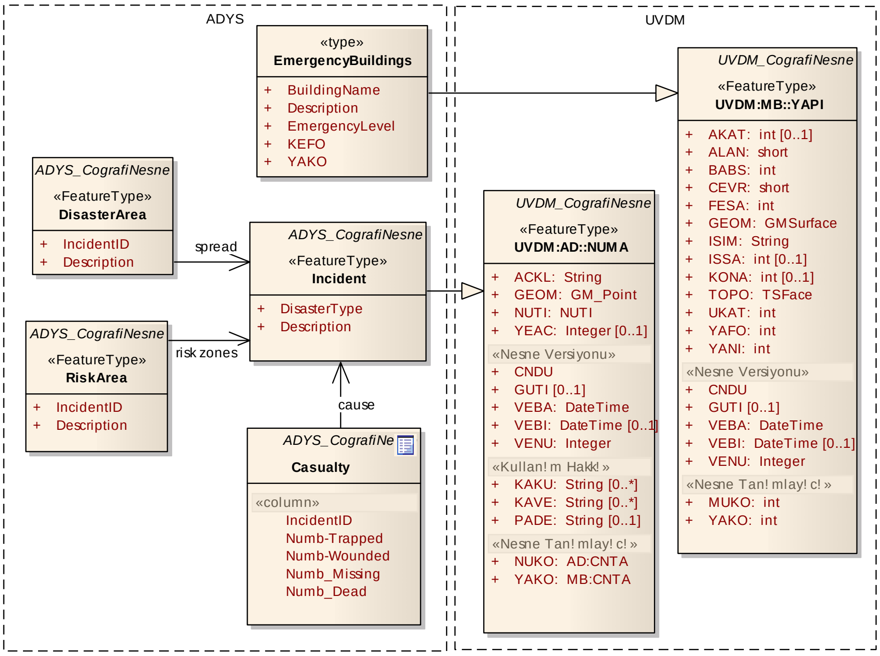

Figure 2. A profile of UVDM and ADYS geo-data model

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