33rd Asian Conference on Remote Sensing 2012 (ACRS 2012)
26-30 November 2012, Pattaya, Thailand

# DEVELOPMENT OF DISASTER MANAGEMENT DATABASE OF MONGOLIA

V.Batsaikhan*[1], G.Bulgan[2], D.Amarsaikhan[2] and D. Bayarbaatar[2]

*[1]Disaster Research Institute, National Emergency Management Agency of Mongolia*
*Partizany gudamj-6, Ulaanbaatar, Mongolia; Tel/Fax: 976-11-262846*

*[2]Institute of Informatics, Mongolian Academy of Sciences*
*av.Enkhtaivan-54B, Ulaanbaatar-51, Mongolia; Tel: 976-11-453660, Fax: 976-11-458090*

**KEY WORDS**: Disaster database, Geographical information systems (GIS), UML

**ABSTRACT:** At present, the need for a global access to decentralized management of geographical information is driving the researchers to reorganize a system design and architecture that enable interoperability of data models and services. The aim of this study is to describe the conceptual framework and preliminary work related to the disaster management database of Mongolia using a unified modelling language (UML) for model-specification and usage of XML and streaming for data exchange. Also, within the framework of the study, a possible update of the developed database by the processing of remote sensing (RS) data sets with different spectral and spatial resolutions is proposed.

## 1. INTRODUCTION

In accordance with the directive of the Disaster Research Institute "periodically implementing a policy on the preventing and saving from disaster, providing timely readiness for emergency, reducing disaster threat and elimination of its consequences, improving national capacity building, utilizing scientific and technological achievements, and supplying with the modern advanced techniques and technologies as well as the capacity strengthening for disaster combating by developing geoinformation and integrated disaster information database (that can fulfill) fulfilling the requirements of all level users of the emergency authority, mapping of the dangerous phenomena and disaster areas and related processing of the necessary data sets, interpreting aerospace images, and implementing database for terrain illustration and modeling" reflected on the Government activity program (2008-2012), a joint project of the National Emergency Management Agency, Mongolian Academy of Sciences and National University of Mongolia entitled "Web-based disaster geoinformation database of the National Emergency Agency" has started its activities in 2012 (Bulgan et al. 2011).

At present, the need for a global access to decentralized management of geographical information is driving the researchers to reorganize a system design and architecture that enable interoperability of data models and services. Within the framework of the above mentioned project, team of National Emergency Management Agency, Mongolian Academy of Sciences and National University of Mongolia is working toward the development of integrated and complex database that contains geoinformation and attribute characteristics of different entities to be used for the emergency cases as well as disaster monitoring at the Emergency Agency. After the implementation, disaster geoinformation database will be located on a website and serve different users from different organizations (Bulgan et al. 2011).

In general, disaster management system refers to the ability of digital systems to freely exchange all kinds of spatial information about the disaster and about the objects and locations, and also cooperatively, over networks, run software capable of manipulating such information. The power of GIS-based information processing has long been correlated with a high level of difficulty. Of the many challenges, one of the most pressing one is to build an infrastructure that can mold data and withstand intricate analysis from an easy-to-use, readily accessible distributive environment. It is known that sophisticated GIS processing is faced with difficulties in tracking/ describing various datasets, processing procedures, parameters, and assumptions; managing the different data sets involved in the analysis; building several nested layers of analysis that make it easier to understand the problem, and automating and documenting the process for iteration or reproduction. The aim of this study is to describe the conceptual framework of disaster management database and its applications.

***Conceptual model***

Conceptual model describes a conceptual framework for the abstraction, simplification and classification of the phenomena and their relationships as viewed by the user community of the database. At this stage, a logical structure which specifies the logical data content of the database should be defined. For proper conceptual database design one should clearly define different data sets and differentiate all possible entities and their attributes. At this stage, classification and grouping of classes of objects, the reduction of redundancies or duplications have to be thoroughly investigated. The database should consist of two types of data sets, namely, spatial and attribute. For the representation of spatial data sets a layer based approach can be used as it can easily separate different themes and store them as logically and physically independent data sets. For proper database design and implementation different issues related to the themes (e.g., how many, symbols and annotation, relationships and identifiers) and their attributes (identifiers, relationships) should be considered. For the attribute database design, data flow diagrams, flow charts and UML might be used and the physical implementation can be carried out using relational and object-oriented structures. Here, the entities must be uniquely identified by their ID numbers and different foreign keys should be defined on the basis of determining the relationships among the entities. In the present study, the disaster management includes the following sets of objects, and their conceptual modeling can be carried out as shown in Figure 1.

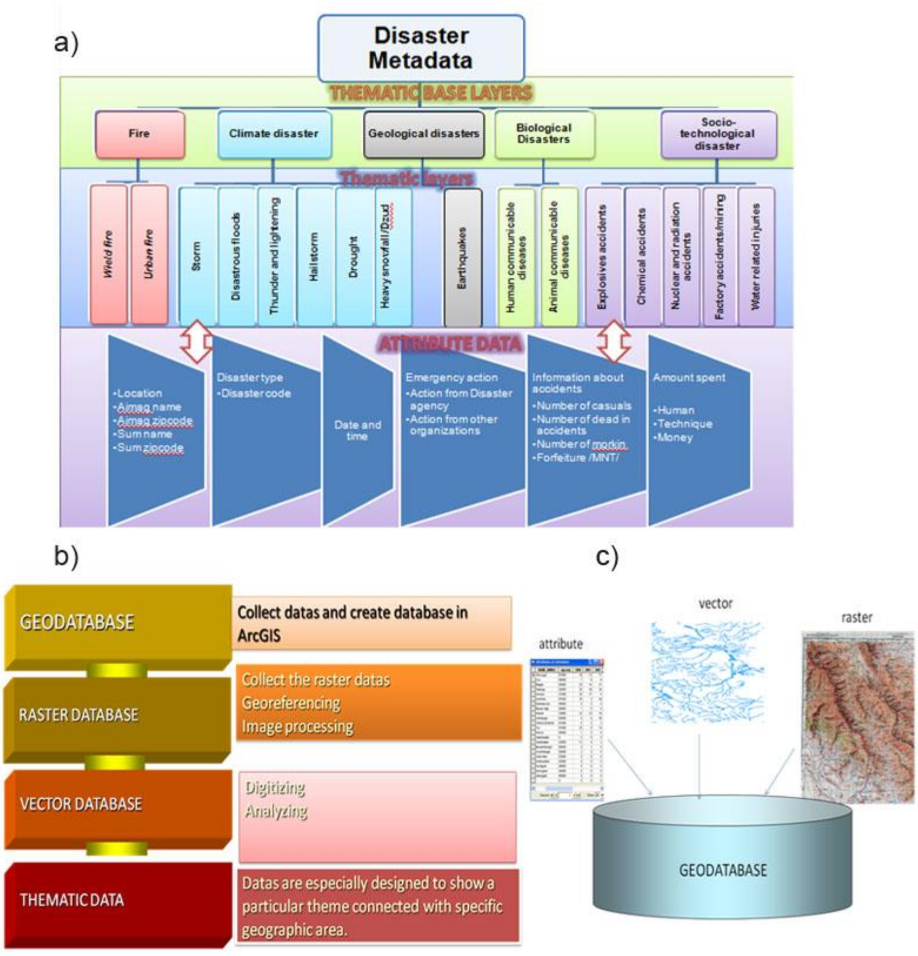


Figure 1: Scheme of disaster metadata (a), Geodatabase design (b,c).

In the present study, the disaster management includes the following sets of objects, and their conceptual modeling can be carried out as shown in Figure 1.

1. Fire
- Wild fire
- Urban fire
2. Climate disaster
- Storm

- Disastrous floods
- Thunder and lightening
- Hailstorm
- Drought
- Heavy snowfall/Dzud

3. Geological disasters

- Earthquakes

4. Biological Disasters

- Human communicable diseases
- Animal communicable diseases

5. Socio-technological disasters

- Explosives accidents
- Chemical accidents
- Nuclear and radiation accidents
- Factory accident/mining
- Water related Injuries

After the conceptual schema, a logical data model that defines a logical structure of the database should be defined. It can be illustrated as shown in Figure 2.

***Physical model***

Physical model transfers the specified logical data to the internal data structure (Amarsaikhan, 2000). In our study, as we decided to develop topologically structured database, for the physical implementation of the integrated database, all necessary data sets had to be converted into a digital format using ArcGIS system.

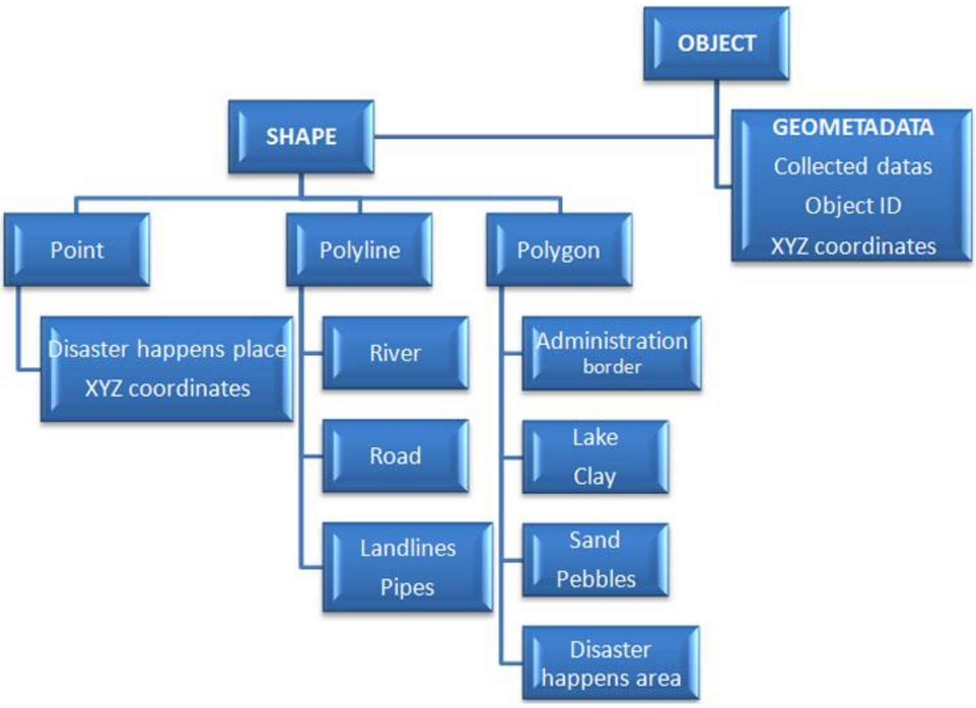


Figure 2: Logical data content

For this purpose, initially, topographic and other thematic maps represented in a raster format, have been georeferenced to a Gauss-Kruger map projection using different number of (mainly, 9-12) ground control points (GCPs). For the transformation, a linear transformation and nearest-neighbor resampling approach were applied and the related root mean square (RMS) errors were always below 0.35 pixel. After the digitization, for each defined entity, the necessary attributes were entered and the entities were uniquely identified by their ID numbers.

**3. DATABASE UPDATE BY RS DATA**

Once the database is developed, it needs to be regularly updated. As database contains a variety of data sets, different types of information will require different approaches for the update. Surely, when update of information is made, the currently existing data should be kept in data archive. For the update by RS data interpretation and automatic methods can be used.

Any visual interpretation using RS data can be considered as an interpretation approach. This is the most widely used method for extracting thematic information or updating various layers of a GIS. For example, land use types can be directly digitized on the RS images thus producing a new map, meanwhile updating a digital database stored within a GIS.

In the automatic method, thematic information should be automatically generated after applying some image processing techniques. In other words, land cover mapping can be performed using RS images from MODIS, Landsat, SPOT and other high resolution satellites. To extract the land cover information from the selected RS data sets, one of the advanced classification methods should be applied. For this aim, at the beginning, all images were thoroughly analyzed in terms of radiometric quality and geometric distortion (Richards and Jia 1999). Then, the RS images should be successively georeferenced to either UTM or Gauss-Kruger map projection using topographic maps of the concerning areas. The GCPs should be selected on well defined cross sections of roads and other clearly delineated sites. In all cases of the georeferencing, RMS errors should be below 0.5pixel.

## 4. CONCLUSIONS

The overall idea of this study was to describe the conceptual framework and preliminary work related to the disaster management database of Mongolia using a UML for model-specification and usage of XML and streaming for data exchange. For the physical implementation of the database, ArcGIS system was used and the data sets were structured as layers of the system. For the update of the thematic layers within the integrated disaster information database, information extraction from RS data was proposed and for the information extraction manual and automatic techniques were considered.

## 5. REFERENCES


1. Amarsaikhan, D., 2000. Information technology and cadastral information systems in developing countries. Technical Report, Institute of Informatics and RS of the Mongolian Academy of Sciences, Ulaanbaatar, Mongolia.
2. Amarsaikhan, D. and Sato, M., 2003. A conceptual framework for development of a cadastral information system linked to an environmental information system in Mongolia, A Paper Published in the ‘Non-Reviewed Papers’ part of Proceedings of the Computers for Urban Planning and Urban Management (CUPUM)’03 International Conference, Sendai, Japan, pp.1-10, May 2003.
3. Amarsaikhan, D., 2010. A conceptual framework for update of urban GIS by RS data. The 4th Annual International Conference on the Application and Development of Geospatial Technologies in Mongolia.
4. Bulgan, G., Amarsaikhan, D., and Tsogzol, G., 2011. Structure of the integrated disaster information database, Scientific reports of the Institute of Informatics, Mongolian Academy of Sciences.
5. Richards, J. A. and Jia, S., 1999. Remote Sensing Digital Image Analysis—An Introduction, 3rd edn (Berlin: Springer-Verlag).