Spatio Temporal Hazard Mitigation Modeling using GIS and Geospatial Data mining Techniques

[1]ABDUL FATTAH CHANDIO, [2]PROF LIU YU SHU, [3]PROF CHENG CHENG, [4]ATTAULLAH KHAWAJA
[123]Dept of Computer Sciences [4]Department of Electronics Engineering Beijing Institute of Technology, Beijing, 5 Nandajie, Zhongguancun, Haidian District, Beijing, P.R. China 100081, China

Abstract

This research demonstrates the development of temporal GIS and its applicability to support spatio-temporal hazard mitigation modeling. Many GIS data models have been proposed to incorporate temporal information into spatial databases. Thematic characteristics are represented as attributes of spatial objects. Temporal information is either associated with time-s tamped individual layers, such as the Snapshot Model, or individual spatial objects, such as the Space-Time Composite Model. On our earth lots of events occurs everyday continually. If the effect of these events is negative on human life called natural hazards. If these hazards severely destroy human lives and properties called natural disasters. Earthquake, landslides, floods and tornadoes are the example of mostly occurring natural disasters all over the world. We can not eliminate these hazards but we can minimize the risk of these hazards, the minimization of risk is called hazard mitigation. For prevention and mitigation of these hazards a geospatial based system can be realized. The main aim of this paper is to present a geospatial based hazard management system that can predict, asses and mange the hazards in order to help minimizing destruction. In this paper we presented Spatio Temporal Hazard Mitigation Modeling using GIS and Geospatial Data mining Techniques.

Key-Words: Hazard mitigation, GIS, Spatio temporal data, Spatial Data mining

1 Introduction

Spatio-temporal data mining is an emerging research area dedicated to the development and application of novel computational techniques for the analysis of very large, spatio-temporal databases [1]. Spatio-temporal applications have been rapidly gaining momentum in the last few years. In spatio-temporal applications, each object is related to another object in a complex manner. The availability of spatio-temporal databases introduces the possibility of mining a new class of rules that capture changes and movements.

Data mining techniques are typically inductive, as opposed to deductive, in that they are not used to prove or disprove pre-existing hypotheses but rather to identify patterns embedded within data, and thereby support hypothesis generation. Spatiotemporal data mining presents a number of challenges due to the complexity of geographic domains, the mapping of all data values into a spatial and temporal framework, and the spatial and temporal autocorrelation exhibited in most spatio-temporal data sets A temporal GIS aims to process, manage, and analyze spatio-temporal data. However, the capabilities of any information system largely rely on the design of its data models. Data models present the conceptual core of an information system; they define data object types, relationships, operations, and rules to maintain database integrity. A rigorous data model must anticipate spatiotemporal queries and analytical methods to be performed in the temporal GIS. Information about temporal constructs must be represented by data objects defined in data models to be stored or retrieved for analysis in a GIS. If a temporal GIS does not have a good data model, its support for temporal queries and temporal analysis of phenomena will be ineffectual. Spatial data mining, i.e., mining knowledge from large amounts of spatial data, is a highly demanding field because huge amounts of spatial data have been collected in various applications, ranging from remote sensing, to geographical information systems (GIS),

computer cartography, environmental assessment and planning, etc. The collected data far exceeded human's ability to analyze. Advances in database technologies and data collection techniques including barcode reading, remote sensing, satellite telemetry, etc., have collected huge amounts of data in large databases. This explosively growing data creates the necessity of knowledge/information discovery from data, which leads to a promising emerging field, called data mining or knowledge discovery in databases . Knowledge discovery in databases can be defined as the *discovery of interestin*g, implicit, and previously unknown knowledge from large databases. Data mining represents the integration of several fields, including machine learning, database systems, data visualization, statistics, and information theory. In this paper we present a model of hazard mitigation based on spatio temporal data mining technique association rule mining. The primary objective of modeling hazards is the prediction of hazard prone areas in space and/or time [2].

2 Spatio-temporal databases

Various spatial and spatially referenced data are needed during different phases of disaster. Data about spatial, environmental and hydrological characteristics, social and economic life around Strait, registered fire and accidents caused by navigating ships and tankers are needed for complete and accurate decision making. [3]

Spatio-temporal database is a database that embodies spatial, temporal, and spatiotemporal database concepts, and captures spatial and temporal aspects of data. Spatio-Temporal Database is a special temporal database and it has all the features of temporal databases. If we look at any timestamp only, it is almost the same as the conventional spatial database The importance of incorporating time in modeling data is widely recognized by many researches, but most of the intentions mentioned are focused around the non-spatial domain. Particularly, temporality has been studied in banking, administrative and other commercial databases. Although the underlying concept of time handling is the same, the great difference between spatio-temporal and a spatial database is what they refer to. Since spatial data are spatially referenced, the spatial topology has to be maintained in the updating process. This maintenance of topology becomes more critical when different version of an object have to be accessible, for each given of time slices, and where correctness of topology is required. A common question in risk analysis is “How are events related in time?” In a risk management application where a time is a factor, it is important to study the relationships of the parameters that occur together [4]. Validity is one of the main concepts in spatial databases. Logically, no decision can be made when there is no valid data. If only the most recent data are kept, and out-dated ones are deleted, one can have the static database which is a snapshot of the real world (just like taking a photograph of a dynamic object). On the other hand, many spatial analysis applications do need to travel through the history of data and retain an impression about its old status. In this case, it can be seen that deleting data, even if it is non-valid, may be disastrous. In addition, many applications require estimation about the future. In this respect, one concludes that considering time as an independent dimension, which allows traveling alone the time line, is necessary. Keeping an active time domain in a spatial database, gives rise to the term spatio-temporal databases. relationships are also operational. Spatio-temporal objects are limited to a given temporal validity. When new information is assigned, the database has to be changed, in order to add the new data. In such a case the database may have to rebuild completely for storing the new state, which causes a great amount of redundancy. Alternatively the database might be time stamped in order to indicate the temporal validity of its objects.

The ability of versioning a database is essential for all spatio-temporal applications, where knowledge of the real world is uncertain or changing through time.

2-1 Spatiotemporal Database Management Systems (STDBMSs)

Spatiotemporal Database Management Systems (STDBMSs) manage data whose geometry changes over time. There are many applications that create such data, including global change (as in climate or land cover changes), transportation (traffic surveillance data, intelligent transportation systems), social (demographic, health, etc.), and multimedia (animated movies) applications. For this research we consider the spatial temporal data that relates with hazards. The modular structure of spatio temporal database management system is shown in figure 1

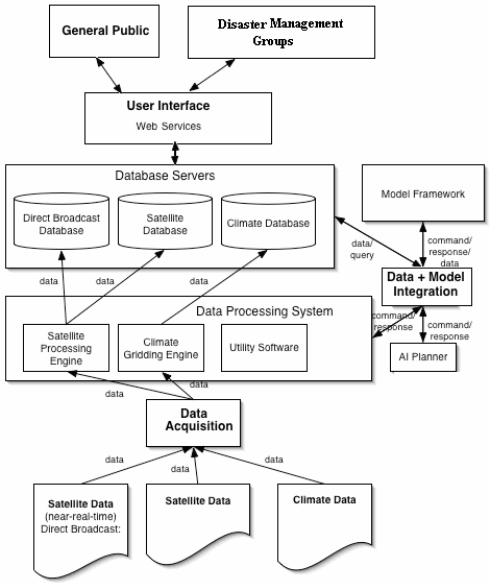

Fig -1 Spatio temporal database management system

3 Integrating time in Geographic Information Systems

A spatio-temporal GIS extends a customary two or three dimensional spatial GIS on the time axis. A space-time path is defined by the changes of locations over time. In a spatio-temporal framework space and time are equivalent features of an event or a process. Furthermore each entity which physically exists in the real world is defined in a spatio-temporal context which can be conceptualized using spatial, temporal and attribute information.

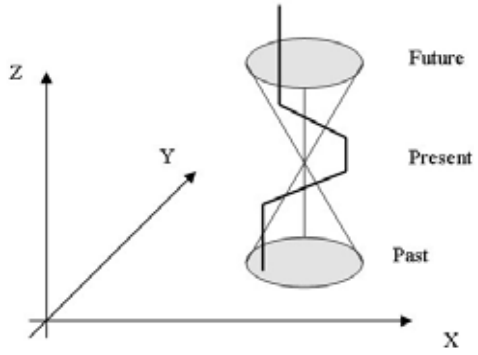

Figure 2. Space and time path

Every spatial object used in a GIS has a temporal validity as well as one or many attribute values. The entity of a spatio-temporal process may change its spatial representation over time as well as its spatial relationship to other entities. In addition, the related attribute information may be subject to changes throughout time. The concept of time implies that changes occur throughout the present, the past and the future of the life span of a real-world phenomenon.

3-1 Temporal Data Modeling in GIS

The development of temporal data modeling in GIS parallels to the progress of temporal data modeling in the computer science (CS). The incorporation of temporal components has been implemented with the relational model and then with the objectoriented data models in CS. The trend of temporal data modeling in GIS is moving from time-stamping layers (similar to relational tables) to time-stamping events or processes (similar to objects). Data semantics is a key issue in data modeling and the fundamental idea is to raise the level of abstraction in the transition from layers/tables to events/objects. .Figure 3 shows the spatio temporal data model for hazard mitigation.

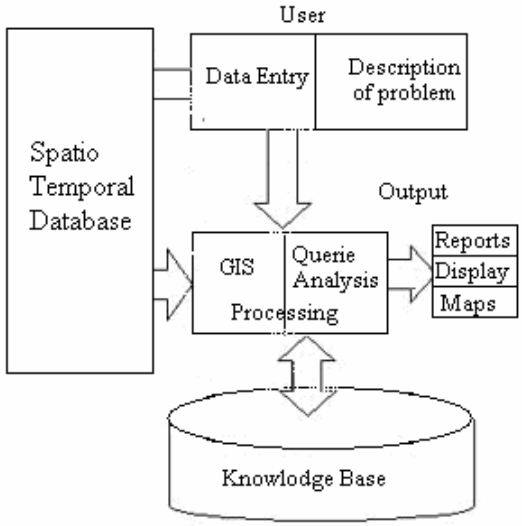

Fig-3 Spatio-temporal data model for hazard mitigation system

Conclusion:

In this study the hazard mitigation is presented based on spatio temporal database management system. This will help to maintain and update the history of disasters in hazard affected regions with time constraint. The development of temporal data models in computer science has shown an influence on the trend of temporal modeling in GIS. However, GIS data modelers need to consider the evolution of spatial objects in addition to retroactive or post active changes and all other issues to be considered in a non-spatial databases, Temporal GIS needs a top-down approach to modeling spatiotemporal information, because behaviors of natural phenomena need to be considered and should be considered prior to available GIS data formats and data structures in constructing temporal GIS representation. The importance of temporal geospatial hazard information system is presented that can be to analyze disasters and minimize the degree of losses and destruction.

References:

[1] Miller, H.J. and Han, J. (2001) Geographic data mining and knowledge discovery: an overview, in H.J. Miller and J. Han (Eds), Geographic Data Mining and Knowledge Discover, 3-32, London: Taylor and Francis.

[2] A. Brenning, "Spatial prediction models for landslide hazards: review, comparison and evaluation", Natural Hazards and Earth System Sciences, 5, 853–862, 2005 SRef-ID: 1684-9981/nhess/2005-5-853 European Geosciences Union

[3] Abdulvahit Torun, Sebnem Düzgün," USING SPATIAL DATA MINING TECHNIQUES TO REVEAL VULNERABILITY OF PEOPLE AND PLACES DUE TO OIL TRANSPORTATION AND ACCIDENTS:A CASE STUDY OF ISTANBUL STRAIT" ISPRS Technical Commission II Symposium, Vienna, 12 – 14 July 2006

[4] Dan Li, Sherri Harms, Steve Goddard, William Waltman, Jitender Deogun, "Time-Series Data Mining in a Geospatial Decision Support System", Department of Computer Science and Engineering, University of Nebraska-Lincoln, Lincoln NE 68588-0115