#### BULETINUL INSTITUTULUI POLITEHNIC DIN IAȘI Publicat de Universitatea Tehnică "Gheorghe Asachi" din Iași Tomul LVI (LX), Fasc. 3, 2010 Secția CONSTRUCȚII. ĂRHITECTURĂ

# UNSING GEOGRAPHIC INFORMATION SYSTEM VISUALISATION FOR THE SEISMIC RISK ASSESMENT OF THE ROMANIAN INFRASTRUCTURE

### ΒY

### **ANA-MARIA TOMA**

Abstract. All over the world, the seismic risk assessment is becoming the problem of the century. Scientists from the interdisciplinary field of informatics have been trying to develop software to help societies to improve their management of situations, in case of earthquakes.

At present, Romania does not have any complex software to monitor the vulnerability and the seismic risk using Geographic Information System (GIS). NetSET product is the first version of this specific software which permits further developments in the seismic risk assessment. In the following years it is meant to become a very powerful complex tool, in order to help the society in case of disasters. With its help, in Romania, scenarios will be designed, and as a result a better time response and management of situations in case of disasters will be provided.

Key words: GIS; Iași, Romania; NetSET.

## 1. Introduction

GIS (Geographic Information System) represents the system which joints two data bases. One data base operates with geometrical spatial objects and the second data base with the attributes of the information contained in the first one [1]. The main purpose of this system is to analyse and to study the information, after introducing, storing and editing it, having as result complex decisions making.

GIS offers the possibility of associating information with the graphical elements of a map. The system integrates and analyses data from different sources, like topographic plans, demographic data, meteorological maps, and so on.

## 2. The Basic Principles of a GIS

GIS can combine different types of maps and can display them in tridimensional, realistic images, which presents the information much more efficient and to a larger group of people than the traditional, bidimensional maps (Fig. 1). Being an information system, GIS has to satisfy a certain set of conditions, as: system efficiency, economics, security, data protection and respecting the law.



Fig. 1 – GIS types of maps, NW of Sicily, ground susceptible to slides in case of floods.

## 3. Performing a GIS Based Project

Generally, a project based on GIS visualisation can be organized in a series of logical steps, each step being built on the one before.

#### 3.1 Main Features of a GIS Software

The first step in designing an application based on GIS is to discuss with the potential users to verify if the necessary data were taken into

32

consideration. After defining the objectives, the design step could proceed. In the end, a "pilot project" will identify any missing elements from the formed data base and will permit correcting the data before designing the entire project data base [1].

Designing the Data Base represents the most critical part of the project. The complexity and the accuracy of the data base determine the quality of the analysis and of the results. The steps in designing the data base are the followings: identifying the geographic objects, designing the layers, determining the objects attributes and defining each attribute.

The analysis is usually the most time consuming step in a project. Sometimes this is impossible to be done manually, so GIS is used to improve efficiency. Different scenarios can be tested, in the end being possible to change some data and even adding new layers.

The results are displayed graphically in form of a map and through a description, in form of a report.

## 3.2 Some Examples of Using GIS Based Products

### a) *HAZUS*

A classical example of a GIS, used to implement the national methodology of assessing the seismic risk is HAZUS (HAZards United States). This software package is used in the computational design of different disaster scenarios like earthquakes, floods and tornados. As the result of these computer



Fig. 2 – The economic losses produced by the earthquake in Hayward.

		The second secon	
Δna_N	laria	Loma	
111a-1v	iaiia	ronna	

simulations, there could be obtained useful information regarding planning strategies to reduce the effects of earthquakes, improving the emergency time response, estimating the number of people requiring medical help, and other information that could be helpful (Fig. 2).

#### b) Alquist – Priolo

This software has the starting point in the law called "Alquist – Priolo State Special Studies Zone Act", from California. The main objective of this law is to diminish the effects that the earthquake surface faults have on buildings (Fig. 3).



Fig. 3 – Earthquake fault zone map in California (http://ceres.ca.gov/planning/pzd/2000/pzd2000\_web/pzd2000\_misc19.html).

The Alquist – Priolo software has been developed in order to help the civil engineering companies and the people to find the closest earthquake fault to houses and construction sites.

#### c) *RADIUS*

RADIUS software (Risk Assessment tool for Diagnosis of Urban areas against Seismic disasters) was developed by the International Decade for Natural Disaster Reduction committee in order to help the local administration organisations in determining the seismic risk. The software is presented as an Excel page having also tools from ESRI ArcExplorer. It tries to promote activities which could help to reduce the earthquake effects on urban areas in the entire world, especially in the third world countries (Fig. 4).



Fig. 4 – Calculus using RADIUS.

## d) ASPELEA

The only international project developed in Europe concerning disaster management and earthquake assessment is ASPELEA project (Assessment of Seismic Potential in European Large Earthquake Areas). The aim of this project is the seismic risk assessment using GIS, being used in countries like Greece, Italy, Albania, Bulgaria and Romania (http://cordis.europa.eu/inco/fp4/ index en.html).

## 4. Presentation of NetSET and its Specific Application for Iași, Romania

NetSET (**Net**work **Spatial Editing Tool**) is a software package designed by the Romanian company Data Invest, from Iași [2]. This module developed a GIS application designed to solve important problems from the local public administration and economic agencies (www.datainvest.ro).

NetSET software is considered to be an open system, having a very friendly user interface and a flexible set of predefined functions for the spatial analysis which help the managerial decision making.

From the functional point of view, NetSET software can create and actualize different types of maps, import any types of GIS files, (*e.g.* \*.dxf, .dwg), perform a spatial analysis and simulate events (Fig. 5).

Ana-Maria Toma



Fig. 5 - Iași, NetSET 3D model [3].

## 5. Evaluation of Seismic Risk in Iaşi Using NetSET Map

In order to evaluate the seismic risk in a certain region, one has to have data about the existing buildings, the earthquakes that have been registered in that area and the paths that firemen and medical teams take in case of disaster [3].

In case of a city like Iaşi, building data came from expert's reports or computer simulations [4]. Inserting all this data in NetSET, one can get a very clear image of the seismic risk in that area. The buildings can then be classified into four groups, depending on their degree of risk in case of an earthquake: emergency: degree 1 (U1), degree 2 (U2), degree 3 (U3) and unknown degree of emergency [5].

In the Table 1 there are presented three buildings from Iaşi, as their data were inserted in NetSET [6].

Structural type	Soil type	Building type	Year of construction	Altitude	Emergency degree		
Precast panels	Clay	Block of flats	Unknown	P+4	U1		
Masonry	Clay	Block of flats	1965	P+4	U3		
Frames	Clay	Block of flats	Unknown	P+10	U3		

Table 1NetSET data

With the help of this software one can visualise the path that firemen or medical teams could take in case of an emergency situation, only by introducing the address of the place in need (Fig. 6).



Fig. 6 – The access route of the firemen team, located in Lascar Catargi Street, No. 59, NetSET Map.

Using NetSET, one can also compute the distance from two different locations, *e.g.* the distance from Gheorghe Asachi Street and Nicolina Street, 3.715 km (Fig. 7) [6].



Fig. 7 – Computing the distance between two locations, NetSET Map.

#### 6. Conclusions

Seismic risk assessment is a problem that the science men are thinking about and trying to solve, all over the world.

In the case of Romania there isn't any complex software to monitor the vulnerability and the seismic risk using GIS. NetSET is the first attempt to come close to such software, but it is still in its design state. In the following years it is meant to become a very powerful complex tool, in order to help the society in case of disasters. With its help, in Romania, scenarios will be designed, and as a result a better time response and management of situations in case of disasters will be provided.

Received, March 14, 2010

"Gheorghe Asachi" Technical University of Iaşi, Department of Descriptive Geometry and Drawing e-mail: anamtoma@ce.tuiasi.ro

### $R \mathrel{E} F \mathrel{E} R \mathrel{E} N \mathrel{C} \mathrel{E} S$

- 1. Dimitriu G., Sisteme informatice geografice GIS. Edit. Albastră, Cluj-Napoca, 2001.
- Ciobanu A., Lefter C., Ocheşel A., Gâlea D., in *Monitorizarea GIS a riscului seismic urban*, by Atanasiu G.M., Gâlea D. (Eds.), Edit. Politehnium, Iaşi, cap. 2, 2005.
- 3. Atanasiu G.M., Gâlea D. (Eds.), *Monitorizarea GIS a riscului seismic urban*. Ed. IIa, Edit. Politehnium, Iași, 2008.
- 4. Atanasiu G.M., Brătianu C., Leon F., Decision Based Risk Assessment Model for Existing Damaged Infrastructure, Application to Iași City. Eur. Sci. Found., 2008.
- Niculiță I., Ocheșel A., Gavriluț G., Ciobanu A., Bejinariu S., in *Managementul* riscului seismic urban utilizând IIS, by Atanasiu G.M., Gâlea D. (Eds.), Edit. Politehnium, Iași, cap. 2, 2009.
- 6. Toma A.-M., *Elemente fundamentale privind folosirea tehnologiilor GIS*. Ph. D. Res. Report, "Gheorghe Asachi" Techn. Univ., Jassy, 2008.

### MONITORIZAREA RISCULUI SEISMIC DIN ROMÂNIA CU AJUTORUL TEHNOLOGIILOR GIS

### (Rezumat)

Managementul riscului seismic este considerat pretutindeni a fi problema secolului. Oamenii de știință din domenii informatice încearcă să dezvolte programe de calcul și vizualizare a riscului seismic pentru a putea veni în ajutorul societății.

În momentul actual, în România nu există un sistem informatic geografic suficient de complex care să ajute la monitorizarea vulnerabilității fondului construit în caz de seism. NetSET este un program românesc, special realizat pentru managementul riscului seismic. Acest produs este în curs de dezvoltare, urmând ca pe viitor să ajute societatea în caz de dezastru atât din punctul de vedere al timpului de răspuns cât și al reducerii efectelor acestuia.