SEISMIC HAZARD MAPS OF THE BUILDINGS WITH 3D MODELLING IN GIS APPLICATION

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Abstract*: The issue of 3D modelling is very important nowadays in technical domains and has particular application in general cadastre. In the process of modelling there is a number of software that can create 3D project. The earthquake risk assessment map has been created with programs like Google SketchUp, Autodesk Autocad and ArcMap. In this paper we created a 3D model of an urban area located on Bahlui River Bank Right Street of Iasi. The result of the research is represented by a series of thematic maps for the buildings in the area. The obtained map indicates the presence of second-class seismic mapping for the study area. This assessment requires a technical expertise for the development of risk and the implementation of some limit work that limit the effects of the earthquake.*

Keywords*: 3D modelling, data base, GIS, thematic map, buildings, seismic risk.*

1. Introduction

The issue of cadastre in villages is diversified to answer at some complex requirements. A special cadastre of the buildings allows creating database for a specific domain. The database can be used to assess the behaviour of buildings, such as the seismic risk. In this purpose we can make a monitoring maps and seismic maps of buildings.

The database preparation and process for the purpose of achieving specialized maps, requires the use of modern analytic models. The issue of 3D modelling is important in technical domains and has particular applications in general cadastre. The use of modelling is facilitated by making a large number of software. The modelling can be 2D and 3D depending on the user needs. The programs used in the 3D modelling are Google Sketchup, Autodesk Autocad and ArcMap. The 3D model is accessible for every user and represents an easy and interactive way to visualize the buildings dates and details.

The analysis of the current status of the buildings may be needed in certain situations and the realization of technical expertise for risk assessment. Based on the obtained data by applying the expertise, it results the need of some work to limit the effects of the quake. All together, the data from the technical expertise improves the database from the cadastral evaluation of the studied areas.

2. Research Methodology

The research is created in several stages in the field and in the office. The research is continuing and it is enhanced by taking data from other types of studies (construction, hydro, transport networks etc.).

A first step from the research is represented by topographic measurements for raising details in the purposed analysis that is delimitation of the buildings outline from the ground, for roads that delimitate the zone, side access routes and green spaces. The recorded data were

transferred in computers memory to achieve in automatic system a graphical representation of the measured terrain surface and processed using Autocad and Topo LT software.

For the study zone the delimitation procedure was georeferencing the cadastral plans, adapting them to zone corresponding orthophotomap this way we combined the graphical representation trough digitalization of contours and cadastral measurements. The importance of data in any GIS application is primary and any resulted product depends on the existence, accuracy and homogeneity of this. The figure below represents the flow of data input into GIS.
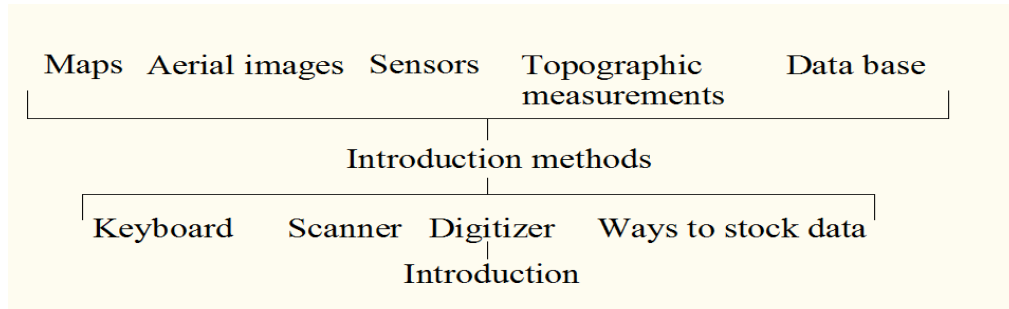

Fig. 1. The collection and data entry (Badea A., Badea Ghe., 2013)

In general the data have references that involves geographical localization, this offers the possibility of using different GIS applications, enabling their use by various institutions, organizations, utility companies and various users.

With GIS application help, advanced query and analysis can be created, this way, we can exploit not only dates and geospatial information but dates, technical information and economic data and information through interrogation with other existing platforms in an institution. Together with GIS, 3D simulations of special data are more and more accentuated.

A second step is represented by 3D modelling. This designates a technique for rendering real objects with the use of certain media that enable the specification of required points program running graphical controls by the three coordinates X, Y, Z. This represents the basis for building three-dimensional model. The program used is Google SketchUp. This is model software for three-dimensional modelling used in different domains: architecture, civil engineering, mechanical engineering, cinema, game design etc. The resulted projects can be made available to general public by placing them on Google's 3D Warehouse. This is a virtual repository that allows the geographical location of projects carried out by interacting with Google Earth. The projects can be viewed in real time using Google Earth or through online Google Maps interface.

In this current project a file with the .dwg extension was imported in Google Sketchup medium, process which made possible building, road and green space modelling, also, to create the model as accurate as possible some requirements are imposed from the beginning of the process. This way we specify the desired measurement unit, in our case it is set to meters. A very important step in a 3D modelling project is to order it within layers. When a model becomes very complex with more models and parts, the user can encounter difficulties in case of wanting to select specific parts for editing. Working with layers makes the designer's work much easier, it is important for layer 0 to be activated during the entire modelling process, importing textures and photos, makes the model to look very similar to the studied zone.

The third step involves creating a *geodatabase* in ArcMap software that encompasses the spatial data. Data entries may have certain features to achieve a thematic map. Such a feature can be seismic risk class of the building. In this case thematic maps with various classes of seismic risk for buildings will be obtained. The seismic risk class of a building will assign the risk class of the living zone.

3. The results-Case Study

The study area is located in Iasi and according to Norm P 100-92 and 100-1/2013 shows a peak ground acceleration for projection Ag = 0.20g design and corner period -Tc = 0.7 sec. The study zone is bounded by Ţuţora Avenue, Primăverii Avenue and Bahlui River Bank Right. In this territory are estimated a number of 40 buildings with different levels between 4 and 10. Most of the buildings are medium type (4 floors and the heights about 15 meters).
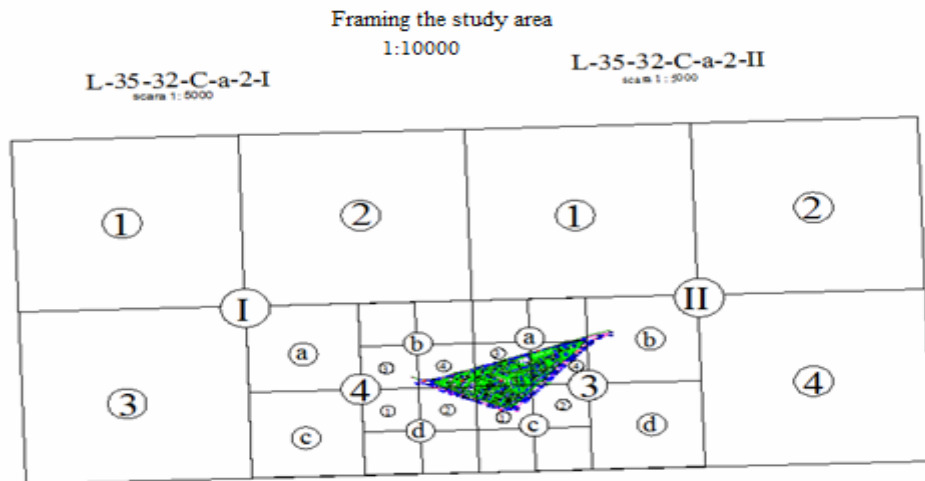
Fig. 2. Delimitation of the study area, Iaşi

We need to see the buildings classes of seismic risk because the average age is between 38-53 years and the buildings have not benefited of repairs and consolidation work and the number of the earthquakes in our country has increased.

3D city modelling is representing a domain that evolved rapidly in the last years and is seen like a promising way for support and expands the capabilities of spatial and environmental planning, analysis, specialized research and not least promoting cities.

Depending on the needs and requirements of the user the modelling in Google Sketchup has five ways to view the data: X-ray, Wireframe, Hidden line, Shaded, Shaded with textures, Monochrome.
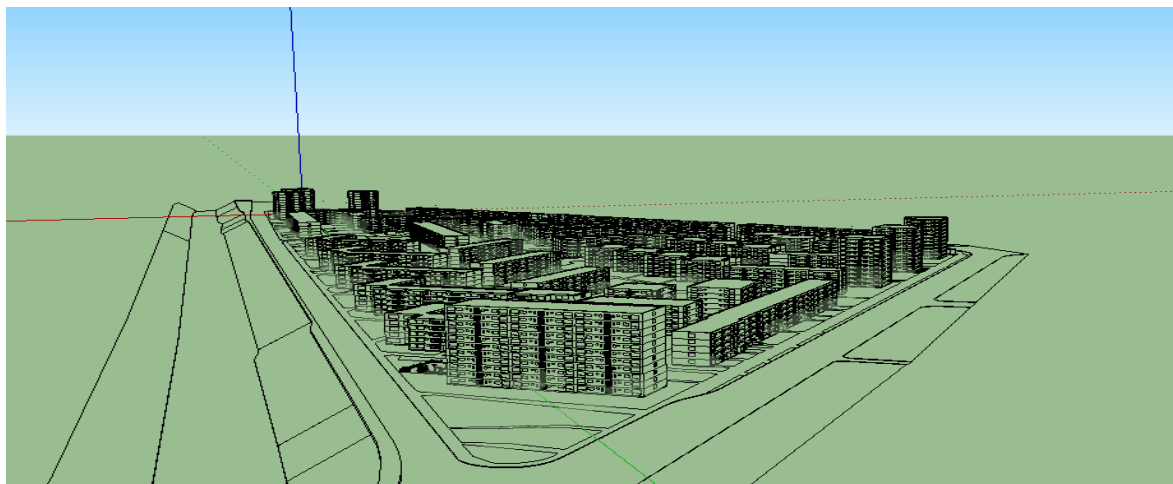
Fig. 3. *Hidden Line* view mode

From the analysed data presented in fig. 3 we can see that *Hidden Line* mode offers the possibility of viewing perspective line, some lines can't be seen because different objects are obstructing their examination. This mode is indicated to be used by users of the various consultancies company.

Fig. 4. *Shaded with textures* view mode

Analysing the data presented in fig. 4 we can see that *Shaded with Textures* mode shows the reality on the ground, this is possible because of different textures imported in the model that we created and from the auxiliary elements attached to the project. Interactive and realistic this mode of observation provides for user the benefit for an easy manipulation of the model and a detailed study of development possibilities.

Fig. 5. Model 3D on foggy day

From the analysed data presented in fig. 5 we can observe that the 3D model can also benefits from a few useful settings for an analysis of meteorological phenomena, as we can see in the picture shown above the fog phenomenon appears simulated in 25th may, 2015 at 8:32 PM. In this context, meteorological phenomena are observable for the study area.
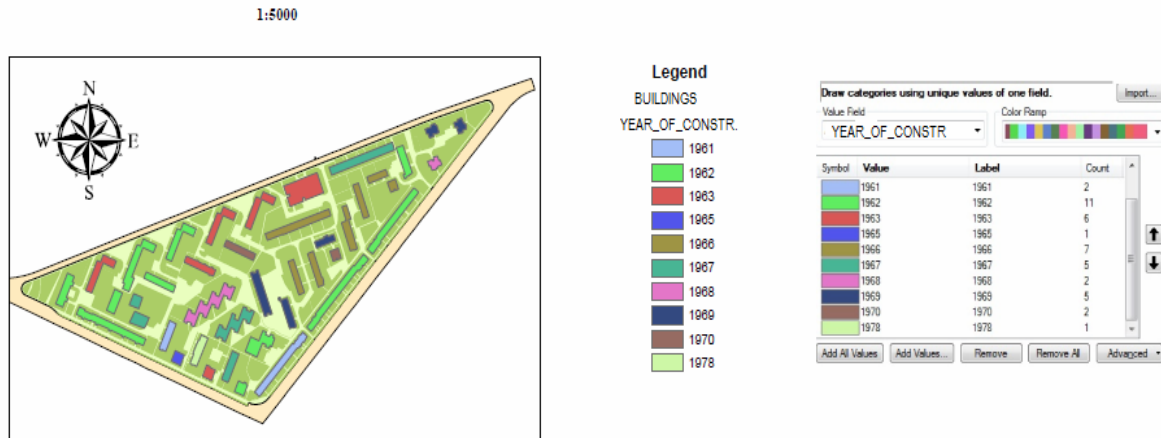
Fig. 6. The symbolisation of construction with the years

Analysing the data presented in fig. 6 it results that the study area is dominated by buildings constructed in 1962. The buildings have been designed to seismic risk which no longer corresponds to the seismic risk from our days. In this context, the owners must realize consolidation projects for buildings to follow current seismic standards.
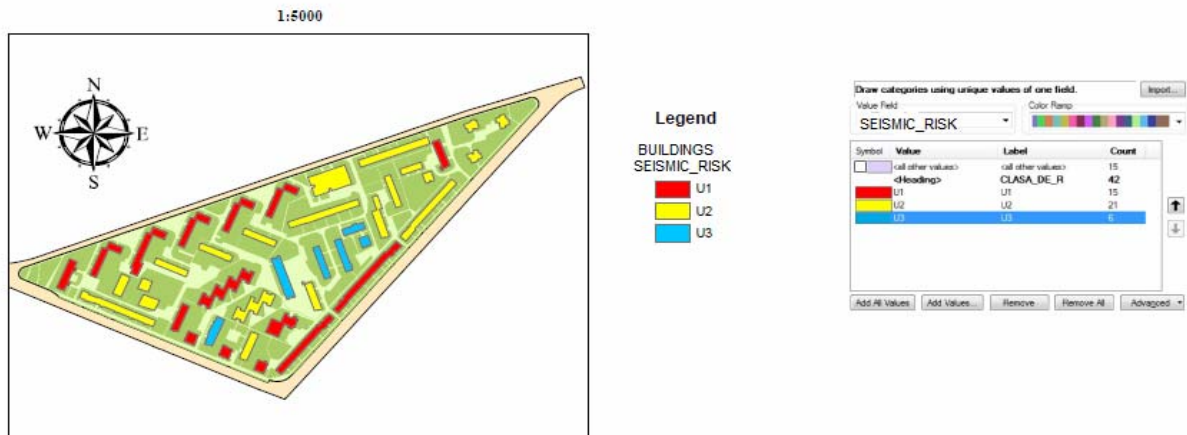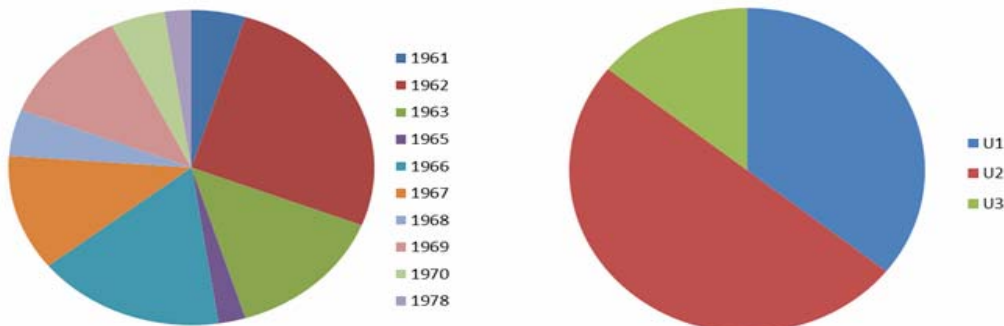

Fig. 7. The symbolization by class of seismic risk

Fig. 8. The results of input data query

Analysing the data presented in fig.7 it results that the buildings that dominate are from second class of seismic risk represented with yellow colour, this type of buildings under the earthquake effects would suffer major degradation. In this context, the buildings should be expertized and begin consolidation work.

In fig. 8 we presented as diagrams the results of input data query based on years of construction buildings and seismic risk classes. In this context, we can observe that the predominant class of seismic risk is influence by the year of buildings construction.

4. Conclusions

From the analysis of data obtained through observations and measurements in the Bahlui River Bank Right area processed with AutoCAD, Google Sketchup, ArcGIS Desktop 10.1 and analyses made we can conclude that:

1. 3D modelling is accessible for all users and is an easy, interactive for data visualization and details of buildings.

2. To realize a complex 3D cadastre the modelling can expand for other buildings like industrial, administrative or residential.

3. The method of research using 3D modelling in Bahlui River Bank Right, Iasi is very useful in various types of analyses that help to better understanding of the risks affecting the area in case of an earthquake.

4. Following the realized seismic risk map we can see that in the studied area the predominant buildings are from second-class seismic mapping, so is required to evaluate the assessment risk by the technical expertise that are designed to reduce the potential impact in case of emergencies.

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