POSSIBILITIES OF MONITORING THE AREAS AFFECTED BY NATURAL CALAMITIES USING INTERGRAPH TECHNOLOGY

Carmen GRECEA, Assoc. Prof. Ph.D. eng., University "Politehnica" of Timişoara, carmen.grecea@ct.upt.ro
Clara – Beatrice VÎLCEANU, Ph.D. Student at the University "Politehnica" of Timişoara, beatrice.vilceanu@yahoo.com

Abstract: *During the last decade, the visualization and analysis of the GIS data in real time have become growingly significant, especially in those activity domains in which, the operating process involves a direct connexion to the spatial data. Thus, whether it is about different networks such as line system, pipage, railway system, road network, land management or publicity, the people will need rapid access to this data.*
Moreover, disasters, regardless of their type (natural or anthropic) will continue to appear, this leading to the need for different users in the disaster management sector to share and access the information.
This paper, aside from its educational purpose, aims at highlighting the importance of the GeoMedia product suite in obtaining the final work that consists of digital high resolution georeferenced representations, which can be useful for analyzing and taking the best decisions in specific control and command centres.
An eloquent example is represented by the possibility of creating digital risk maps for certain territories prone to disasters like earthquakes and landslides by means of Intergraph technology. In order to create this kind of applications which are useful for long term monitoring of the affected areas, the skills and the management capabilities of a geodetic engineer regarding spatial data are a "must" because he can organize the GIS program so that it comprises information from different fields such as topography, geodesy, cartography, soil mechanics, geology, accentuating the multidisciplinary approach needed in the study of natural calamities.

Keywords: *GIS, spatial data, geodesy, calamity, risk map, geospatial.*

1. Aims and Background

During recent years remote sensing and geospatial information tools and technique, including numerical modeling, have advanced considerably. These tools offer a greater understanding of the Earth as a complex system of geophysical phenomena, including where and when hazards may occur, and what impact they may have on the natural and built environment, and society itself. The information obtained from such systems is beginning to be operational to decision makers for management in case of emergencies. [1]

In addition to this, GIS programs have improved quite a lot their cartographic capabilities. Within GIS environment a map is not a static image which requires its own production, as it happens with CAD programs, but one of the multiple views of our model. A map window can also be explained like a dynamic camera view of the contents of the distinct databases. Another interesting feature is the dynamic updating of maps and queries which make user always see the real contents of the databases regardless whether the values have been changed. The symbolization based on attributes is another remarkable aspect. So, it is a

pretty straightforward approach to produce a collection of maps by accessing many local geospatial databases or others databases accessible through Intranet or Internet. All these computer or technical concepts can be integrated with cartographic theory to produce all sort of qualitative maps, choropleth maps and symbol proportional maps that show multiple distributions, locations, patterns, inter-relations, and all the relevant aspects of the phenomena or problem under study or research [2].

Several fields in the geosciences can take advantage of recent developments in the availability of digital maps in GIS environment. For example, in order to administrate the land more responsibly, one has to analyze the risks involved by the occurrence of natural accidents such as earthquakes and landslides. This analysis should be conducted using GIS software.

Both landslides and earthquakes are major geological hazards that threaten human life and affect infrastructures and land use all over the world [3].

1.1. The importance of landslides' study

Landslide inventory maps are important sources of information for landslide susceptibility, hazard and risk assessment [4]. Landslide event inventory maps are particularly significant because – if properly prepared – they are nearly complete, i.e., they show all the landslides produced by an individual landslide trigger (e.g., a rainstorm, an earthquake, a rapid snowmelt event). [5]

Landslide engineering-geology mapping is made to identify the affected areas and to study measures to stabilize. Traditional maps have different scales and in Romania the most usual scales are 1:25000 and 1:10000, but having digital maps that could be available on Internet or Intranet represents a great advancement.

An important aspect of the problem of landslide occurrence is the slope macro (Fig.1) and micro zoning, in terms of landslide risk and continuous monitoring of landslides. [6]

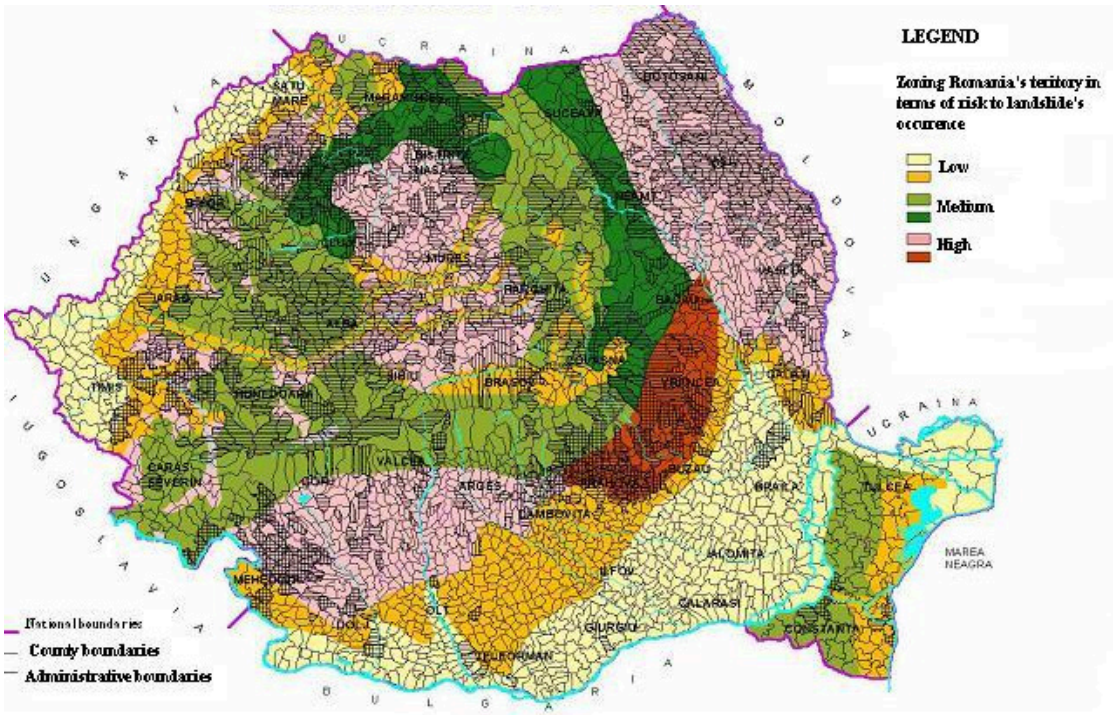

Figure 1. Zoning Romania's territory into large areas prone to landslides

Classifying landslides (Fig.2) has always been an important issue for researchers in this field of activity. It is useful for anticipating the evolution of future processes of land sliding and for adopting the correct strategy regarding the elaboration of stabilization measures.

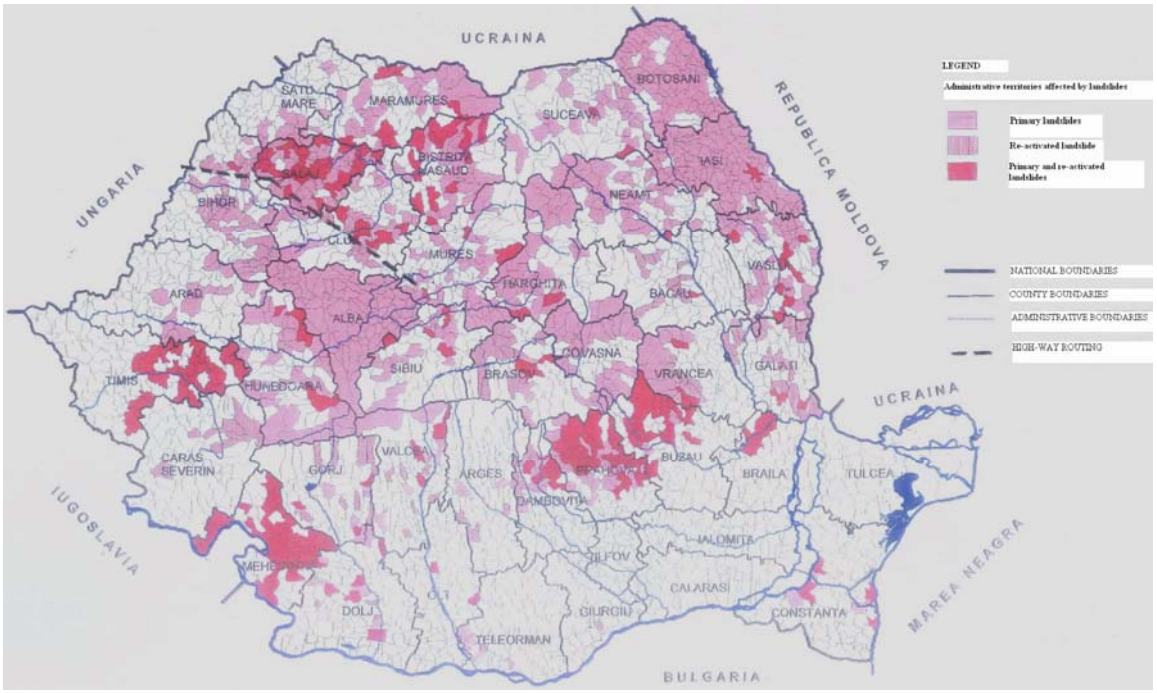

Figure 2. Type of landslides that affected Romania in time

1.2. The importance of seismicity study

Earthquakes strike violently and without warning. Identifying potential hazards ahead of time, and advance planning and preparedness of the population can reduce the dangers of serious injury or loss of life from an earthquake. Furthermore, social awareness and education on natural hazards is a crucial factor leading to enhanced public safety and reduced losses [7].

Earthquakes' impact on everyday life, on the economic and social activity, is amplified by the psychological effects that create anxiety and fears and have a devastating effect on the environment and on unpredictable areas with increasingly widespread, especially if no monitoring, analysis and decision system for optimal reduction and annihilation effects of disasters and calamities generated by these phenomena, exists. [8]

In Romania there are several significant areas of seismicity with earthquakes at normal depths (less than 60 km). The most active zones are in the western part of Romania near the city of Timisoara (Banat and Danube Seismogenic Zones), in the central part near Sibiu (FC) and in the north western part at Baia Mare. [9]

Strong ground-shaking mapping soon after a moderate-to-large earthquake is crucial to recognize the areas that have suffered the largest damage and losses. These maps have a fundamental role for emergency services, loss estimation and planning of emergency actions by the Civil Protection Authorities [10].

This is particularly important for areas with seismic risk levels, such as Banat region in south-western Romania (Fig.3).

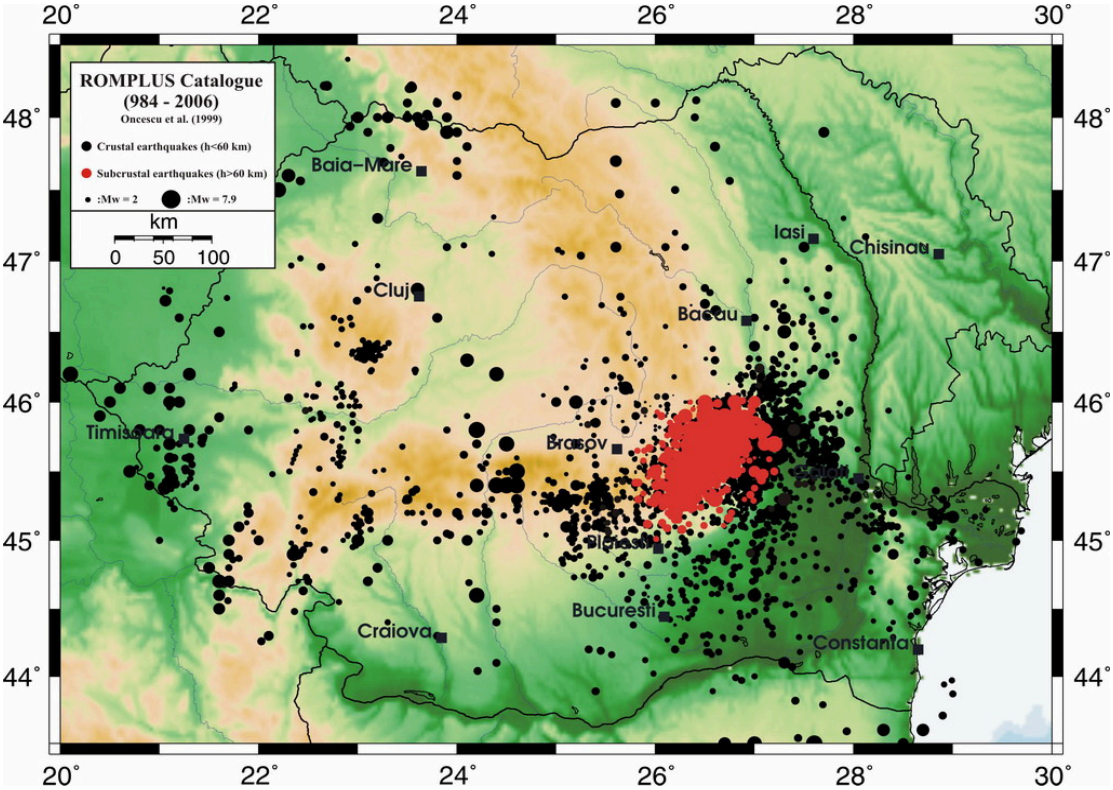

Figure 3. Map with seismicity in Romania [11]

As a consequence, in the last decade, a significant number of countries started drawing up and updating the maps of the areas prone to natural hazards, mainly earthquakes and landslides. Such maps can only be prepared by an expert team (geologists, geo-technicians, geodesists), accentuating the multidisciplinary approach needed in the study of natural calamities. Also, they imply a thorough work, starting with field observation, field measurements up to the analysis level and modern solutions, like Intergraph technology.

2. Material and Methods

2.1. Intergraph technology

According to their Corporation, *Intergraph* is the leading global provider of engineering and geospatial software that enables customers to visualize complex data. Businesses and governments in more than 60 countries rely on Intergraph's industry-specific software to organize vast amounts of data into understandable visual representations and actionable intelligence. Intergraph's software and services empower customers to build and operate more efficient plants and ships, create intelligent maps, and protect critical infrastructure and millions of people around the world.

Intergraph operates through two divisions: Process, Power & Marine (PP&M) and Security, Government & Infrastructure (SG&I). Intergraph PP&M provides enterprise engineering software for the design, construction, and operation of plants, ships, and offshore facilities. Intergraph SG&I provides geospatially powered solutions to the defence and intelligence, public safety and security, government, transportation, photogrammetry, utilities, and communications industries.

The *GeoMedia*® product suite is a set of well-integrated applications that provide you with the full breadth of geospatial processing capabilities needed by industries, such as

governments and transportation agencies for map production, infrastructure management, and land management. Utility and telecommunications companies, as well as defence and intelligence organizations, also rely on this product suite for data analysis, data sharing and map production.

GeoMedia's unique ability to access geospatial data in almost any form and bring an integrated geospatial view together, along with a broad set of powerful analytic and editing tools, enables customers in several industries to efficiently manage and understand their investments in geospatial assets:

- local, state, and national governments for emergency response and planning;
- government and state transportation departments for network planning and management, railway and roadway asset management, and map production;
- national and state government agencies for the exchange of geospatial data, metadata, and services between other departments, countries, and agencies;
- defence agencies for military planning and map production;
- utility and telecommunications companies for planning, environmental standards analysis, and land management;
- local governments for parcel management, utility asset management, public distribution of data and information;
- almost any agency or industry that can benefit from a geospatial view of its business and assets.

In the following list, the most important customer benefits are presented:

- *universal data access* (GeoMedia's data server architecture provides you with access to all common geospatial forms, most computer-aided design formats, and even simple forms such as text documents. The data server architecture makes it possible to integrate both visually and for interrogation a broad range of mostly disparate forms, thus bringing to one view all the data needed to make sound business decisions.);
- *standards-based approach to enterprise and public data exchange* (the GeoMedia suite provides a strong set of interfaces for data and metadata exchange that fully align with global spatial data infrastructure standards such as those specified by OGC and the INSPIRE Directive);
- *easy integration with Geospatial browsers* – (GeoMedia WebMap provides simple methods for integrating local data and services with the most popular geospatial browsers, such as Microsoft's Bing Maps and Google Maps);
- *high level of productivity (*GeoMedia products are engineered for production systems. All commands are scrutinized with regards to user input and workflows. Minimizing mouse movements, button clicks, along with a well-organized graphical user interface, improves productivity, saving hours of labor in production environments.);
- *state-of-the-art map composition* (the GeoMedia suite provides an easy-to-use, yet sophisticated map layout environment that supports workflows – from quick simple generation of workprints to complex detailed national mapping products);
- *rich geospatial analysis* (the GeoMedia suite provides all the analytic and presentation tools required to enable businesses and agencies to combine their business questions with geospatial data to provide key insights for planning and efficient asset management);
- *expansive customization environment using standard development tools* (the GeoMedia suite is designed to be extensible, using standard software development environments for the unique requirements of a particular customer workflow. The same development environment provided to customers is used to construct the products themselves, thus guaranteeing a rich and stable development platform.) [12].

2.2. Methodology

For producing the risk maps using the GeoMedia program from Intergraph, spatial data was used, namely digital plans having a scale of 1:100.000 and raster images of Mehedinți and Timiş Counties (Fig.4, Fig.5) with the affected areas, as well as primary alphanumeric attributes.

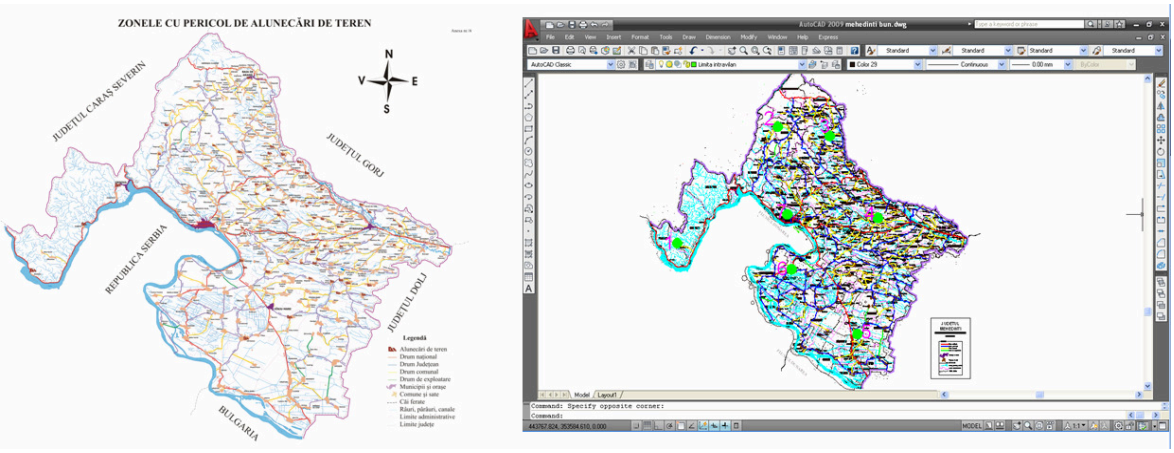

Figure 4. Raster image and digital plan of Mehedinți County at a scale of 1:100.000

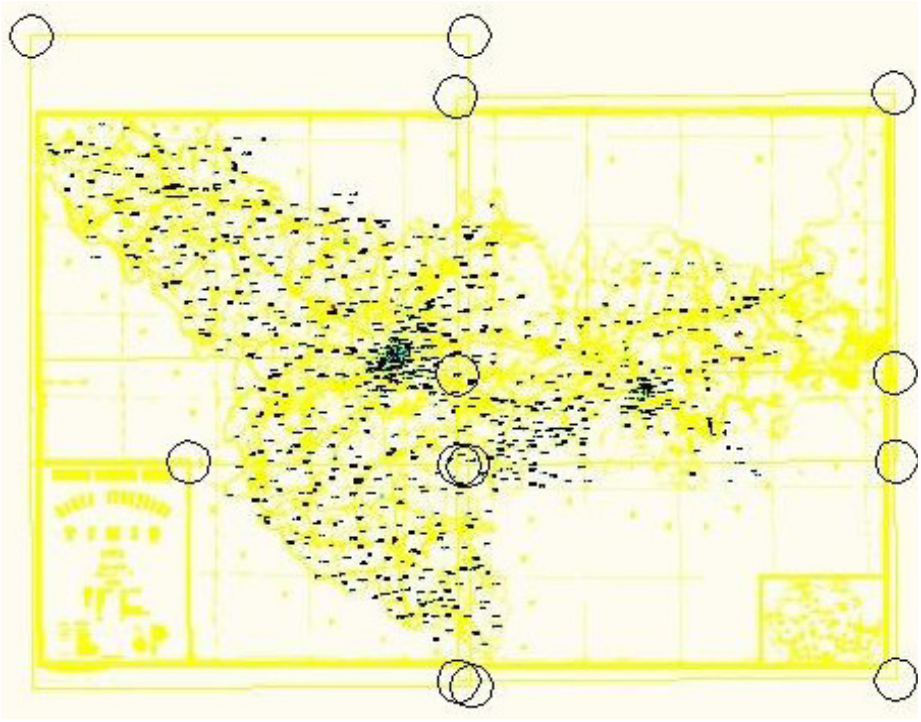

Figure 5. Raster image of Timiş County

The first step consisted in transforming the rectangular Three-Step Stereographic coordinates that were necessary for inserting the raster image, into geographical coordinates (longitude and latitude) with the aid of the TransDat program.

In GeoMedia, after a new connexion to an existing database, Romania.mdb, has been created, new feature classes were defined: for the landslide project – Reference Points, Georeferenced Image, Mehedinți County Boundaries, Roads affected by landslides, Areas

affected by landslides – and for the earthquake project – 8 seismic main faults, 2 important epicentres of the county, Roads affected by earthquakes, – Reference Points, Georeferenced Image, Localities affected by earthquakes, County localities. Then the reference points were inserted into the map windows to serve as known points for the raster images. After the images have been inserted into the map windows, they were georeferenced. Afterwards, all the graphic elements were vectorised (Fig.6, Fig.7) and their primary alphanumeric attributes were introduced.

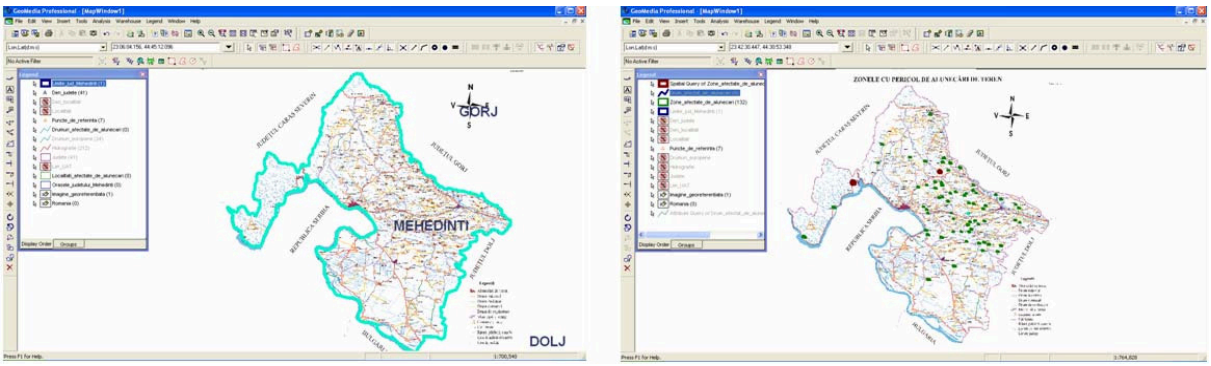

Figure 6. Vectorisation of "Mehedinți County Boundaries" and "Areas affected by landslides" feature classes

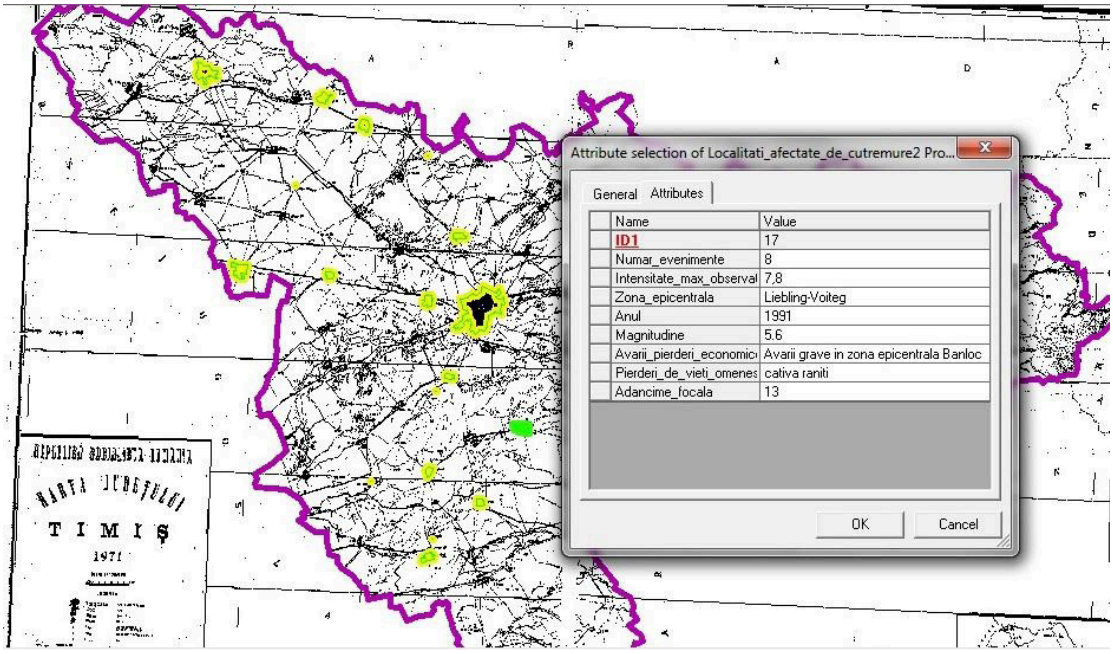

Figure 7. Vectorisation of "Timiş County Boundaries", "Roads affected by earthquakes" feature classes and input of attributive data

3. Results and Discussions

The landslide and earthquake risk maps created allow analysis and interrogation of the data from the associated database through attribute and spatial queries and buffer zones thus enabling the authorities to obtain a complete, updated and professional picture of the real situation. The first two pictures (Fig.8, Fig.9) present analysis of Mehedinți County.

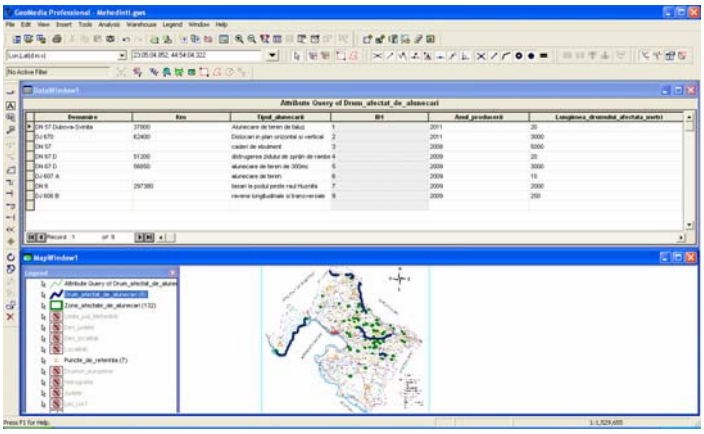

Figure 8. Highlighting the roads affected by landslides

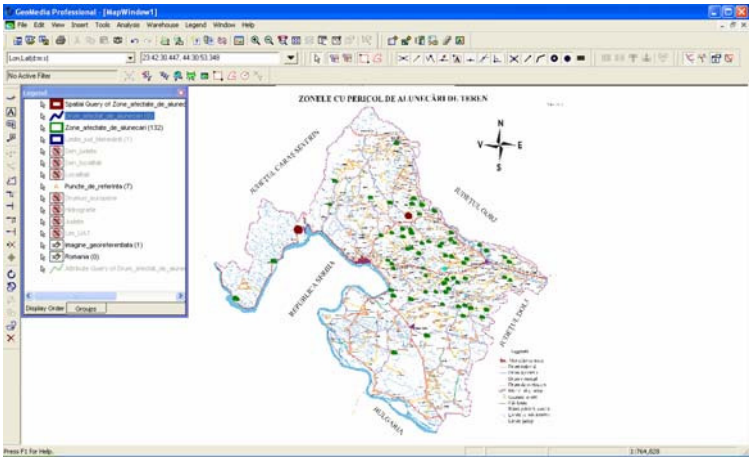

Figure 9. Placing buffer zones around the localities in which areas affected by landslides are bigger than 1000 m^2

In the following pictures (Fig.10, Fig.11) analysis of digital representation for Timiş County is illustrated.

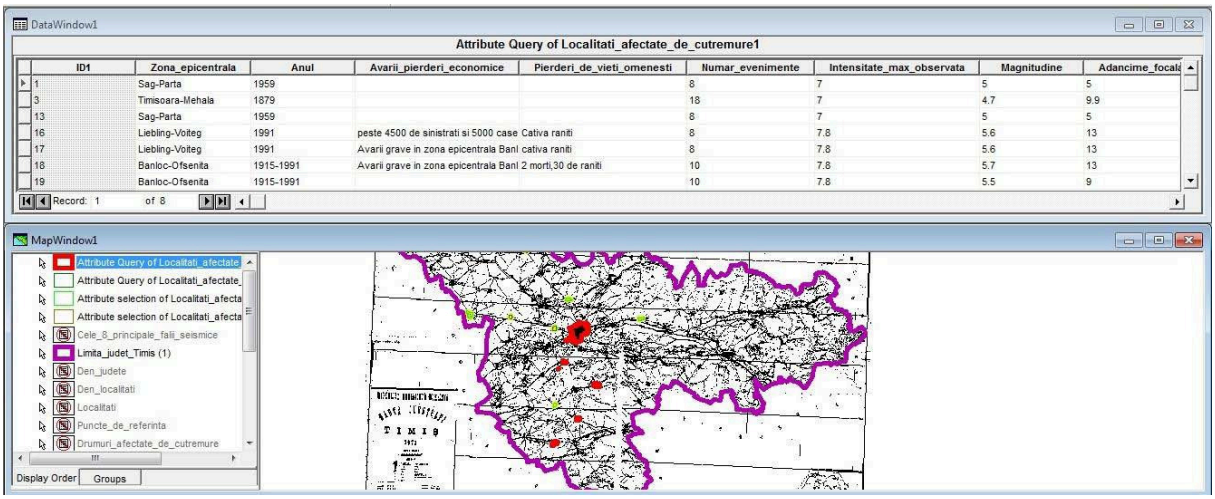

Figure 10. Localities in which the number of events is bigger or equal to 7

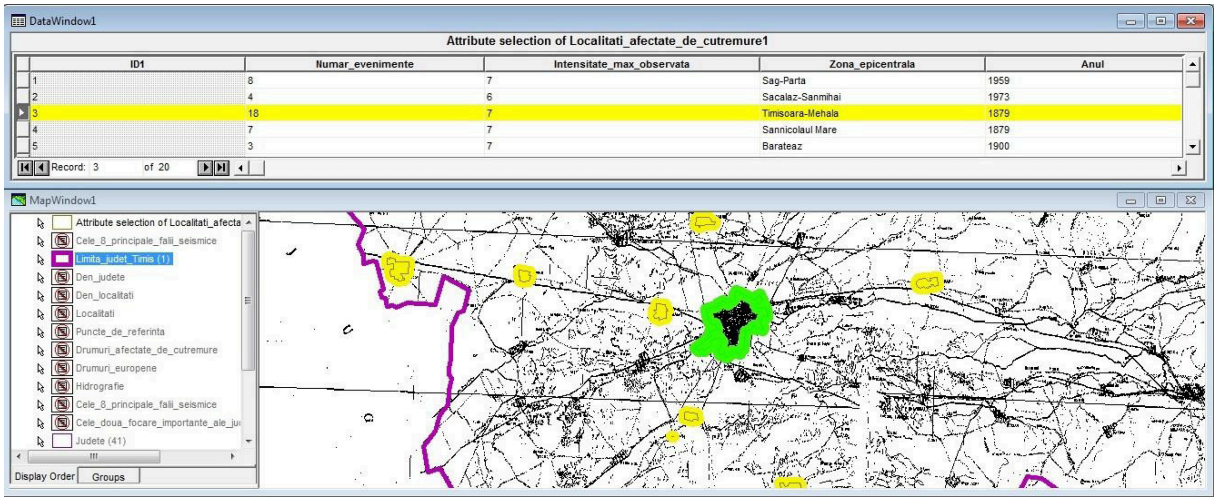

Figure 11. Connection between the attributive and graphic data

Having as a management tool the interpretation of a risk area map, adequate measures can be adopted by the local authorities in order to prevent high landslide and earthquake hazards. The measures consist in: allot funds for landslide and earthquake risk prevention, monitor landslides, create early warning landslide systems, draw-up emergency plans in case of occurrence of the mentioned natural calamities, and set up programs to insure people and goods in the event of landslides and earthquakes. Last but not least to restrict or even prohibit the construction of buildings in the affected area and the changing of the land category.

4. Conclusions

Earthquakes and landslides expose the society to risks, such as material damages or casualties, but they can be greatly reduced by better planning, construction, and mitigation practices before these natural hazards happen, and providing critical and timely information to improve responses after they occur. An important measure that should be adopted is represented by the drawing up or updating the risk maps for areas exposed to danger.

Both earthquake and landslide risk and the associated investigations conducted so far have become more and more complex and have to comply with vast amounts of spatial data as well as subsequent analytic results.

By means of GIS technology, after analyzing the maps created, rapid decisions can be made that can become the object of some valuable projects regarding the development of micro and macro region.

The landslide and earthquake digital risk maps created with the aid of GeoMedia programme have the following advantages:

- administration of large amounts of data;
- constitute a very useful information source to improve the existing topographic and mapping data base;
- necessary to be able to monitor the behaviour of slopes and earthquake events in time;
- possibility of performing a series of analyses and interrogations of the spatial data;
- creating thematic maps;
- buffer zones and spatial filters;
- connection to CAD data.

The main problems encountered in conducting this research are:

- relatively low precision due to the fact that the raster image of the Mehedinți County has different administrative boundaries than the digital plan;
- adding attributive data to the data base and vectorizing the graphic elements are time consuming phases.

5. Acknowledgment

"This work was partially supported by the strategic grant POSDRU 107/1.5/S/77265 (2010) of the Ministry of Labour, Family and Social Protection, Romania, co-financed by the European Social Fund – Investing in people."

6. References

1. Zoran M. – "Geospatial and geophysical information for earthquake hazard assessment in Vrancea area, Romania", EGU General Assembly 2010, held 2-7 May, 2010 in Vienna, Austria, p.6808.
2. Pérez Gómez R. – "Web based GIS supporting the assessment of earthquake-triggered landslides projects", Proceedings of XXIII International Cartographic Conference, 4-10 August, Moscow, 2007, Russia.
3. Prokešová R., Kardoš M., Medveďová A. – "Landslide dynamics from high-resolution aerial photographs: A case study from the Western Carpathians, Slovakia", Geomorphology Journal, ISSN 0169-555X, Vol. 115 (2010), pp. 90 – 101.
4. Galli, M., Ardizzone, F., Cardinali, M., Guzzetti, F., and Reichenbach, P. – "Comparison of landslide inventory maps", Geomorphology Journal, Vol. 94, pp. 268 – 289, Published by Elsevier, 2007.
5. F. Ardizzone, M. Cardinali, M. Galli, F. Guzzetti, and P. Reichenbach – "Identification and mapping of recent rainfall-induced landslides using elevation data collected by airborne Lidar", Natural Hazards and Earth System Science, no.7, pp. 637 – 650, 2007.
6. Vîlceanu B. – "Master Thesis: Using Intergraph technology for the study of the areas affected by landslides in Mehedinți County", Timişoara, 2011.
7. Zouros N., Pavlides S., Soulakellis N., Chatzipetros A., Vasileiadou K., Valiakos I., Mpentana K. – "Using Active Fault Studies for Raising Public Awareness and Sensitisation on Seismic Hazard: A Case Study from Lesvos Petrified Forest Geopark, NE Aegean Sea, Greece", Geoheritage Journal, DOI 10.1007/s12371-011-0044-y, ISSN: 1867-2485, Published by Springer-Verlag, 2011.
8. Stoian (Amza) C.B., Moscovici A.M., Stoian I – "Modern technologies for monitoring landslide", Research Journal of Agricultural Science, ISSN 2066-1843, Vol. 42 (3), pp. 862 – 869, 2010.
9. Grecea C. – "Geodetic engineering – important tool for Romania seismicity study", Proceedings of the 11th WSEAS Conference on Sustainability in Science Engineering (SSE'09), ISSN: 1790-2769, pp. 102 – 107, Timişoara, Romania, 2009.
10. Convertito V., De Matteis R., Cantore L., Zollo A., Iannaccone G., Caccavale M.– "Rapid estimation of ground-shaking maps for seismic emergency management in the Campania Region of southern Italy", Natural Hazards Journal, ISSN: 1573-0840, DOI 10.1007/s11069-009-9359-2, Published by Springer Science+Business Media, 2009.
11. www.infp.ro
12. www.intergraph.com