GEOMATICS – POSSIBLE SOLLUTION FOR AN EFFICIENT MANAGEMENT OF ENVIRONMENTAL PROBLEMS

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Abstract: *Nowadays, the economic interest for mountain regions is increasing. In this context, the management of these territories is of growing significance and therefore has become also the target of topographic and geodetic monitoring. More and more, decisions concerning mountain areas are taken by authorities located far away from the areas of interest. Therefore, reliable extensive information is required to recommend or to adopt realistic and sustainable measures. Management of spatial data by means of Geographic Information System (GIS) plays an essential role based on the latest achievements in Geomatics domain. Geomatics offers the possibility to share, compare, and exchange data between researcher and users in unambiguous and accessible ways for map production and user-friendly technologies for results communication. The main purpose of this research is to create an adequate and complete Geographic Information System which will act as a base for the speleological research carried out in the Semenic – Caraş Gorges National Park which includes part of the largest karstic area in Romania. This research theme was chosen because surveyors possess an important experience in maintaining huge spatial databases at a very high level of reliability. The study points out over 600 speleological cavities in the National Park of Semenic, taking also into consideration the surface features. Seeing that speleology is a multidisciplinary science, we aim to compile a large number of data from different fields (karstology, topography, hydrology), thus creating a comprehensive database, accessible through the software interface which can be used in a large number of scenarios (the development of thematic trails, natural resources management, cave conservation etc.). The proposed Geographic Information System is, first of all, a tool for scientific research carried out in the karstic environment in the National Park, but can also become a powerful aid of the National Park Administration guiding to an efficient land management. Moreover, by means of interrogating the database, the results obtained will facilitate the optimization of regional development programs concerning natural parks.*

Key words**:** *geomatics, surveying, environmental engineering, GIS, speleology, karstic area*

INTRODUCTION

Geomatics involves the integrated acquisition, modeling, analysis, presentation and management of spatially referenced data to support decision making. [1]

Looking for faster and more suitable procedures for mapping, application of geomatics can help to share, compare, and exchange data between researcher and users in unambigous and accessible ways, possibly following codified standards for map production and user-friendly technologies for results communication. [2]

The term "collaborative geomatics" was originally used [3] to refer to an unpublished report [4] where it is defined by seven key requirements: file management, communications, group discussion, calendaring and scheduling, viewing, administration and security issues. D. D.P. McCarthy and others define collaborative geomatics as a participatory approach to both the development and use of online, distributed-authority, geomatics applications.

Collaborative geomatics has the potential to support the following: the development of community-based land use plans; the community-based management of resource development;

the capture and use of traditional environmental knowledge (TEK) in a structured but culturally-sensitive manner. Collaborative geomatics enables communities to collect, display, share and analyze information, as well as collaborate with other communities, relevant agencies and private corporations. This represents a substantial advance in current practices, as the collaborative geomatics system under development for this region is relatively inexpensive to apply and deploy, and user friendly thus minimizing the need for technical expertise and programming (once the system is in place). [5]

MATERIAL AND METHODS

The GIS software GeoMedia Professional had been chosen to provide the framework technology for this study as it offers capabilities to manage all spatial and non-spatial data.

The Intergraph GeoMedia program packet is the right choice because of the fact that it supports establishment of dynamic and hierarchic connections between layers, which means that the change on any layer of lower hierarchic level can cause the change on all layers of upper levels with which they are connected, but also the possibility to overlap the layers with contents located in different geographical coordinative systems. [6]

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 huge amounts of data and infuse the world with intelligence to make processes and infrastructures better, safer, and smarter [7].

GeoMedia's unique ability to access geospatial data in almost any form and bring an integrate geospatial vision, together with a set of analytical functions and editing, allows users from different industries to understand and effectively manage their investments in geospatial assets[7].

Description of research area

The Semenic – Caraş Gorges National Park is situated in the south-western part of Romania, in the central part of Caraş-Severin County (Fig.1). It covers a surface of 36,364.8 ha, includes 10 reservations and is the 6th largest National Park in Romania. The first initiative to transform the area - occupied by the park today - into a protected area was initiated in 1955 when the Caraş Gorges Mixed Reservation was declared. In 1990 the site appears under the title of National Park, for the first time.

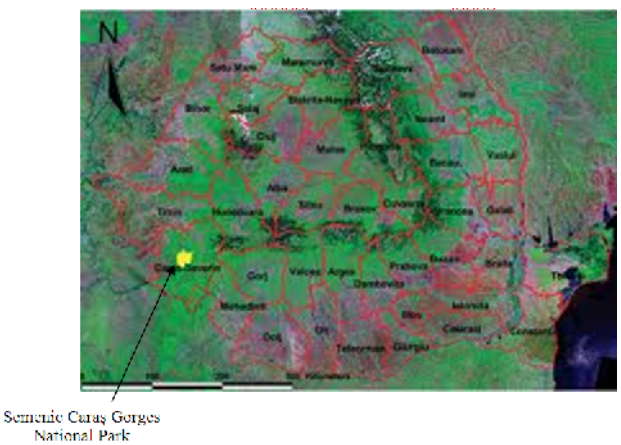

Figure 1. Localization of the research area

From a geographic point of view (Fig.2), the Semenic – Caraș Gorges is part of the Western Romanian Carpathians unit, the Banat Mountains group. Two sub-groups of these mountains cross the park: the Semenic Mountains and the Anina Mountains.

The area includes many natural resources which require protection: a wild beech forest, rare biota, a sinkhole valley and major karst systems, established by important water inputs and discharged by springs with high flow rates. There are 37 cavities discovered until now, very densely distributed (caves, such as Țolosu, Subcetate, Liliecilor etc. and potholes). [8]

Figure 2. Geographical location of the research area [9]

Data acquisition

The graphical data support consists of raster images of topographical maps in ***.tif*** format. In order to represent the National Park we have used four maps with a nominal scale of 1:50.000 (L 34 104 B, L 34 104 D, L 34 105 A, L 34 105 C). The projection system of these maps is Gauss-Krüger. Also used for the purpose of digitization the elements of interest, is a map of the National Park in ***.jpg*** format.

The attributive data has been collected either directly from the field by experts or volunteers or extracted from existing databases provided by the "Explorers Speleological Association".

Speleological cavities are the main focus of the research, thus the majority of the attributive data will refer to them. The following type of information is contained by the database: identification data (cave name, speleological basin number, numeric identifier within basin), administrative data (the territorial administrative unit that contains the site), morphologic data (type of site, name of mountain unit, subunit, name of the hallow), speleometrical data (total length, dislevelment), hydrological type, discovery (name of discoverer, date of discovery), important features (speleothems, archaeology, paleontology), fauna (bats, coleoptera).

Cave names, basin and identification numbers have been taken from forms submitted to the "Emil Racoviță Institute of Speleology". The speleometric data was taken from existing topographical measurements or from measurements provided by the "Explorers Speleological Association". Historical data came out from existing archives or recordings of new discoveries. The important data features were taken either from existing databases or, directly from the field. Information on fauna was extracted from research papers and catalogues- or, provided directly by experts.

Developing the application

Several reference points with known geographical coordinates were inserted into the program to serve as a base for georeferencing the raster images (Fig.3), using the correspondence between the vector elements represented in the program and their position on the raster images.

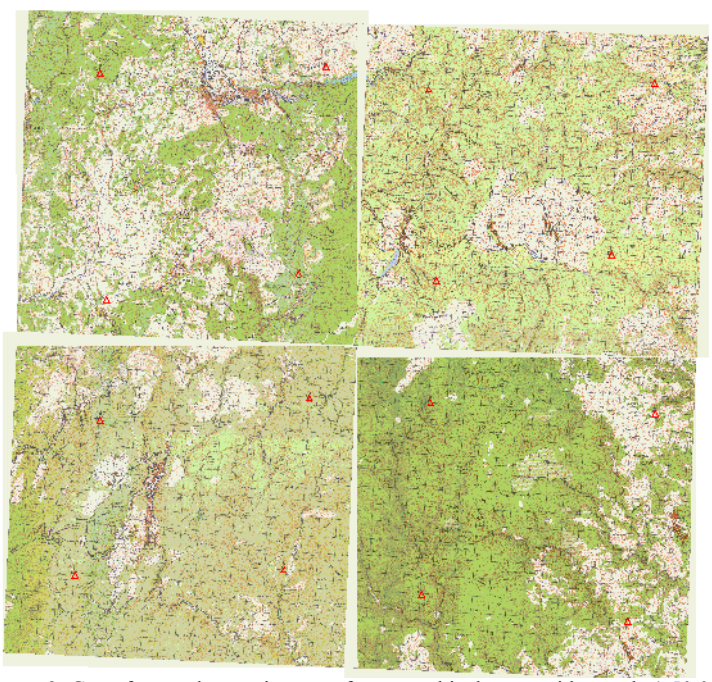

Figure 3. Georeferenced raster images of topographical maps with a scale 1:50.000

An existing map of the Semenic – Caraş Gorges National Park was inserted for the vectorization (Fig.4) of the park limits (green dashed line), park trails (red dashed line) and access roads (red solid line). It is registered using common points with the topographical maps.

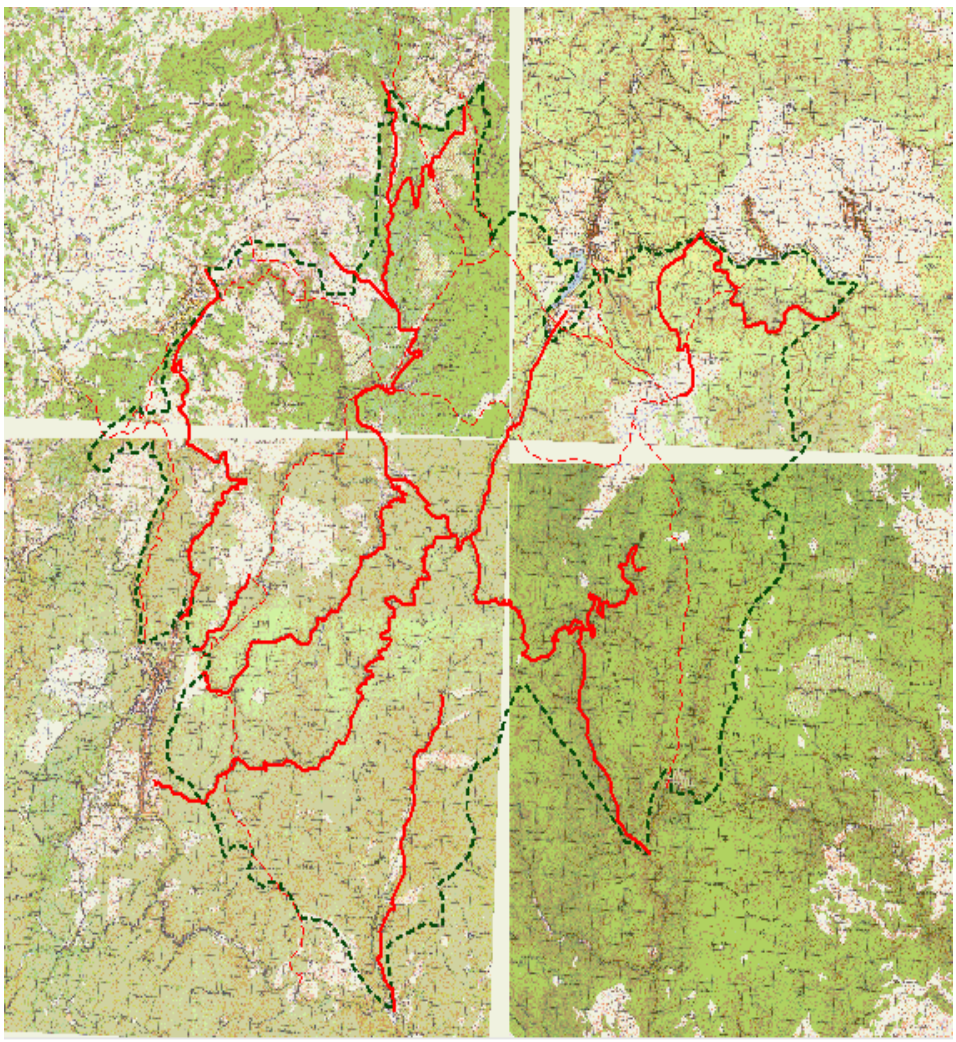

Figure 4. Vectorization of National Park's limit (green) and access roads (red)

After the vectorization of infrastructure elements which help establish access routes to focus sites, the characteristics of speleological cavities were introduced. As stated above, speleological cavities are a distinct feature class and the vast majority of attributive data (Fig.5) refers to them. Using the geographic coordinates of the caves determined through GPS measurements they are inserted in the GeoMedia file.

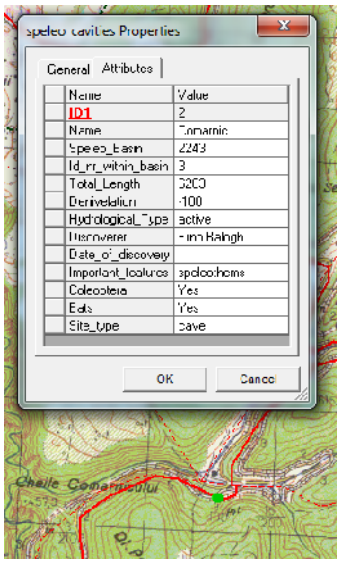

Figure 5. Attributive data for the speleological cavities

RESULTS AND DISCUSSIONS

An important advantage of this application is represented by rapid access to information facilitating the management and research activities. The interrogation of the database provides both tabular reports and maps, thus every query created by a user will be visible in the map window (Fig.6) and in the data window (Fig.7).

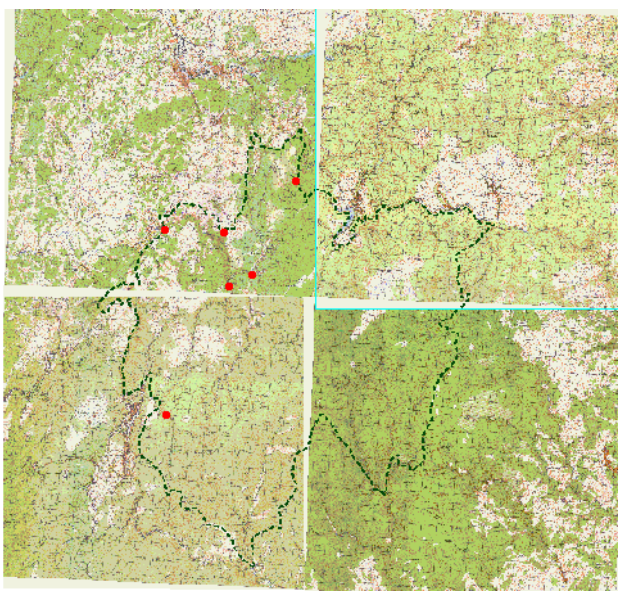

Figure 6. Interrogation of the attributive database - speleological cavities having a spread area over 1000 m – map window

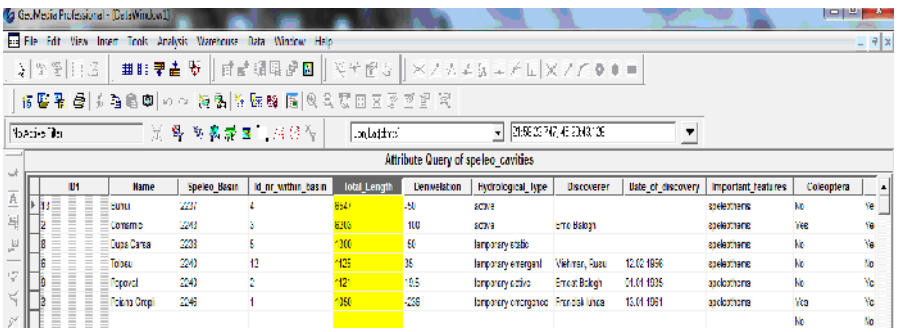

Figure 7. Data window representing the interrogation results sorted descending

Spatial analysis which involves intersecting several classes of elements can also be performed (Fig.8).

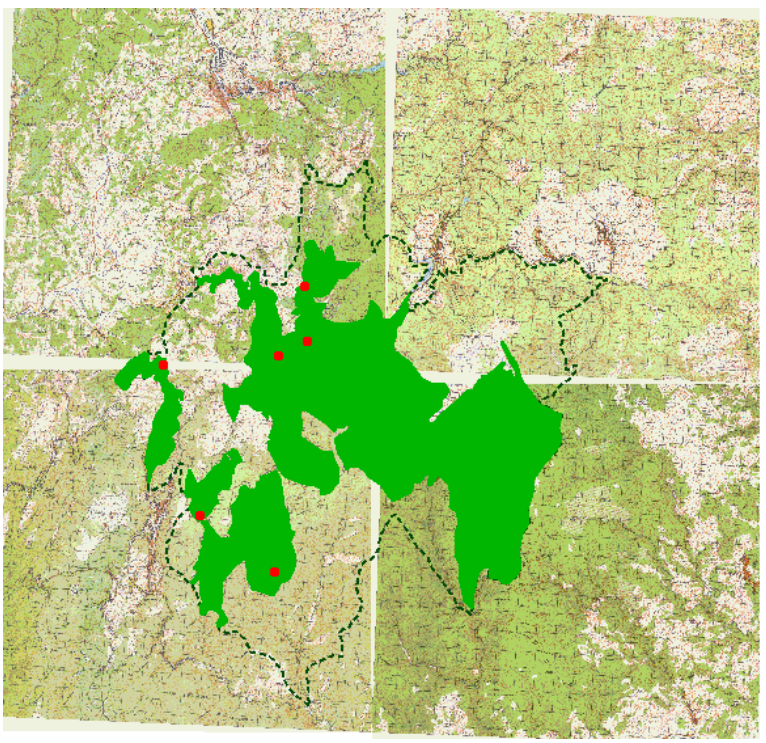

Figure 8. Map showing bat caves situated in restricted areas

CONCLUSIONS

Updating this GIS can be easily performed if new information will be available leading to the extension of the existing database. Relating to this, several disadvantages have to be mentioned: the complexity of the relief may obstruct the study of certain objectives situated

in difficult areas, or GPS technology may not always be possible to be used, leading in this case to the necessity of classical land surveying.

The implementation of the GIS concerning the speleological cavities in the "Semenic – Caraş Gorges" National Park proved to be a real help in the centralization of the data from multiple studies carried out on the park's caves. With the aid of relevant queries through the GIS interface more pertinent management decisions concerning caves in the park can be made. Also, the coordination of exploration activities undertaken by speleologists has been simplified. To sum up, the GIS has improved the management, coordination and data centralization for all of the different studies carried out on the speleological cavities in the National Park.

More than that, by updating and monitoring the database for dedicated GIS solutions, one can control the evolution and development of speleological resources and also, could prevent major risks according to Environmental Engineering requirements.

Starting with the developed system, using GeoMedia WebMap, a WebGIS could be designed, thereby allowing access to ordinary users, who will be able to access questions in a simple language, without knowledge of database interrogation.

ACKNOWLEDGMENT

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