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Publication financed ½ from participation taxes
Publication financed ½ from Grant of Romanian Governmnet CNCSIS/1739 (2003-2005) GIS-based *development of algorythms for spatial analysisof geographic resources*(Director: Ionel Haidu)

THE VALUATION OF MAXIMUM RUN OFF ON INTERBASINAL AREAS , ASSISTED BY GIS

ŞT. BILAŞCO[1] I. HAIDU[1]

ABSTRACT – The valuation of maximum run off on interbasinal areas, assisted by GIS
The major floods are those resulted from pouring rain, and they exceed through their volume the floods resulted from the melting snow and even those resulted from pouring rains and melted snow combined. According to hydrological specialized literature, it is emphasized the fact that the summer pouring rains generate floods which get over those already existent, regrdless of their genesis. The determination of maximum run off is usually realized on small basin areas, without taking into consideration the interbasinal areas. The interbasinal areas are characterized by great water contribution coming from pouring rains. The determination of this kind of areas represent the object of the study below.

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The determination of the maximum run off on interbasinal areas assisted by SIG needs to go through some mandatory stages. The logical sequence of these stages is: finding the interbasinal areas; choosing the points, as evaluation sections on the main river flow on which cascading interbasinal areas can be determined; getting the forecast on the maximum intensities; the determination of the maximum discharge. All these stages will be realized by geoinformatical softwares and their specific extensions, except the determination and the rainfall forecasts.

1. THE DETERMINATION OF THE CASCADING INTERBASINAL AREAS

1.1 The determination of the interbasinal areas

In order to make our point, we decided to analize Somesul Mic superior hydrographic basin. The determination of interbasinal areas starts with the removal of the small, 2nd range Horton – Strahler interbasinal areas. All these areas were automatically acquired using specific functions and extensions of the ArcInfo software.

The interbasinal areas are automatically realized having the DEM of the hidrographical basin area as an initial data base. The DEM is a polygon type shapefile that contains the second range basinal areas and uses the extension *Grid Tools* of ArcView 3.2 software.

Grid Tools

Some procedures can be realized through extensions: analyzing, editing, visualising, cutting or combining the grids. (Fig. 1).

The *clip grid* procedure gives the user the possibility to cut off a grid in many ways: cutting the grid using a polygon type theme or cutting the grid that is displayed. The grid can also be cut off inside or outside the polygon or the object.(Fig. 2)

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Considering the fact that the graphical database where we determined the interbasinal areas is grid type and the hydrographical basins are polygonal type, the clip grid procedure will be used in the delimitation process.

Fig. 1 Grid Tools extension menu

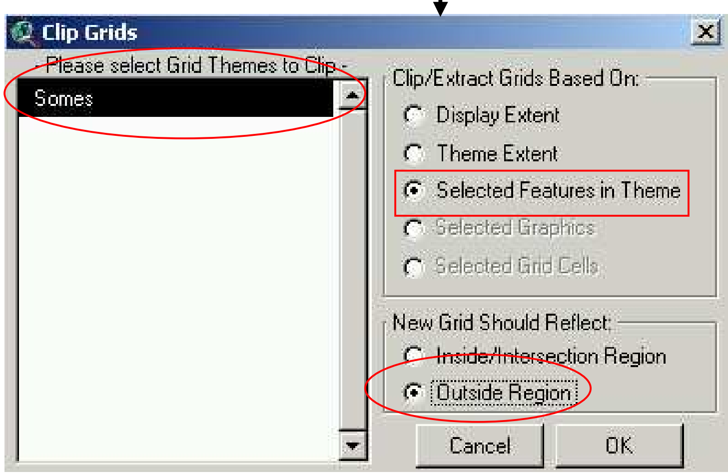

Fig..2 Cutting off the DEM

Another grid appeared after cutting off the initial one. It resulted as a database having the features of the initial grid excluding the surfaces that have been erased.

The structure of the newly formed database will represent all the interbasinal areas adherent to the analized hidrographical basins.

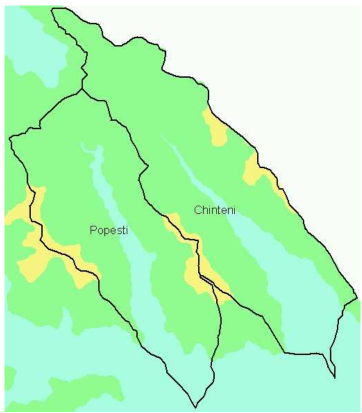

Fig.3 Basinal areas

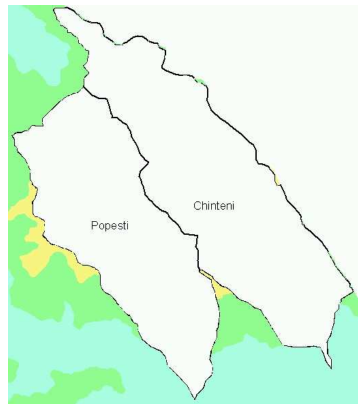

Fig. 4 Interbasinal areas

1.2 Chosing the points on the main river flow, as determination sections, where cascading intrbasinal areas can be determined.

Once all the interbasinals areas were determined one can identify their points and determine the sections of the maximum debits. Three points were identified on the main river flow for calculus. Hidrographical basins tributary to these points are automatically realized using the function *Bach Watershed Deliniation* of the extension Arc Hydro for the Arc Gis software. (Fig. 5,6,7).

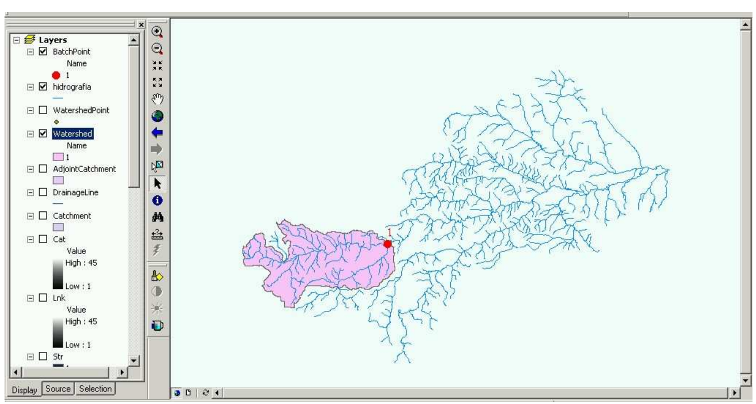

Fig. 5 The first point and interbasinal area

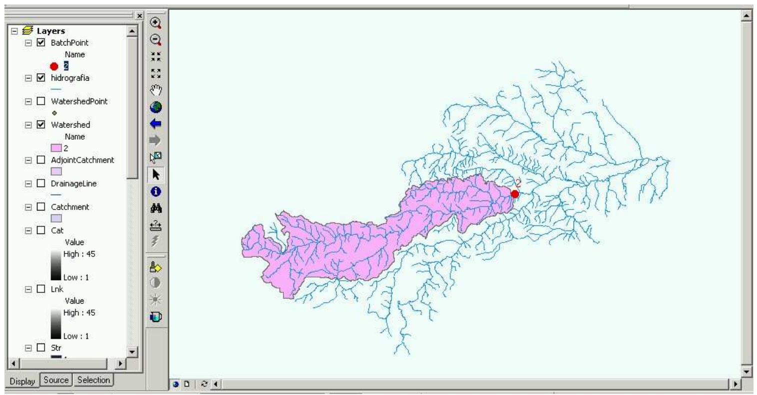

Fig. 6 The second point and interbasinal area

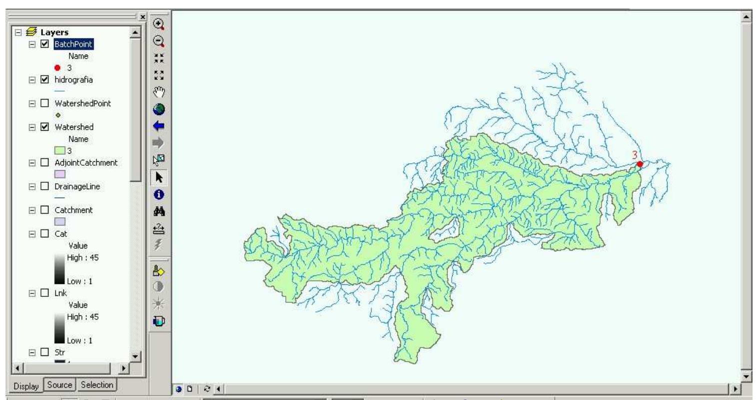

Fig. 7 The third point and interbasinal area

As you can see from the figures above, the hidrographical basins, tributary to each of the 3 points, expand only on interbasinal areas. The surfaces consisting of a hidrographical basin were removed. This can be easily observed in figure Nr. 7 , where the second range hidrographical basin called Lesu was rejected from the hidrographical basin of point no. 3.

2. THE DETERMINATION OF THE MAXIMUM DEBIT AFTER POURING RAINS

In order to determinate the maximum discharge it is necessary to know the physico – geographical and geomorphological conditions of the hidrographical basins and also the rainfalls of maximum intensities from the hidrographical basin.

2.1 Rainfall forecast

The high technology meteorological stations can forecast the pouring rains. One of the ultimate technologies analyses RADAR echoes in order to find the rainfall centre and the places where the rain can create a maximum intensity rainfall situation.

The forecast should contain: the amount of precipitation in mm/min, the duration of precipitation per second or minute and the medium intensity of the rain. For this determination , a 20l/sqm controlled rain has been used during a time span of 5 minutes

2.2 The determination of maximum disccharge

The determination of maximum discharge resulted from pouring rains, that generates the maximum flow, was first used to determine the necessary discharge for dimmensioning the evacuation of water gathered on railroads and railway working sites.

There is more than one way to determine the maximum discharge , the most frequently used being the Kestlin's formula, published in the „Austrian Engineer and Architects Society" magazine in 1868

$$Q = K * i * \alpha * F \quad m^3/s \tag{1}$$

where:

Q – maximum discharge în m^3/s
K – shifting factor in metric system16,67
i – rainfall intensity în mm/min
F- hidrographical basin surface in km^2
α – adimensional factor

$$\alpha = \alpha_1 * \alpha_2 \tag{2}$$

where:

α_1 – flow factor of 0,50, recommended 0,57 for rocky fields

α_2 – unconformity factor of concentrating and spreading the water in its bed. The factor varies according to the water bed's lenght and can vary from 1 to 1/8

All the ways in which a discharge is determined must take into consideration some mandatory ellements: the medium intensity of the precipitation, the amount of precipitation, time time and the surface of the hidrographical basin

Utilizând formula 1 şi datele referitoare la bazinele hidrografice, extrase automat, odată cu realizarea cumpenelor de apă specifice suprafețelor interbazinale, respectuv punclelor reprezentând secțiunile de calcul, s-au obținut următoarele valori ale debitelor maxime la ploi torențiale (Tabelul 1):

Using the 1st formula and the data reffering to the hidrographical basins, automatically extracted with the identification of the basin watersheds specific for interbasinal areas, namely the points for the sections we obtained the following estimates of the maximum discharge caused by pouring rain.

Maximum discharge determination results on interbasinal areas

Tabelul 1

Calculus area	Surface Km2	Q (m^3/s)	Q ($l/s/km^2$)
Interbasinal area Nr. 1	237,62	14,85	62,51
Interbasinal area Nr 2	402,03	25,13	62,51
Interbasinal area Nr 3	948,44	59,28	62,51

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ASPECTS OF USING GIS IN THE COMPLEX ANALYSIS OF THE THERMICAL ANOMALIES AND OF THE TYPE OF ATMOSPHERICAL CIRCULATION

TATIANA CONSTANTINOV[1], MARIA NEDEALCOV[1], IRINA BORTĂ[2]

ABSTRACT - Some aspects of GIS using in thermal anomalies' and types of atmospheric circulation's complex analysis. The optimal instrument to identify links that characterizes inter-secular climatic fluctuations according to Vanghenghem-Ghirs type of circulation can be Informational Systems. This instrument allows operative access to databases in Access, Excel and Statgrphics Plus programs where data is stocked and processed statistically as well as interpolation of thermal anomalies in regualar cartographic network in Surfer, MapInfo, ArcView programs and others. Investigations results obtained through informational Systems allow claiming that thermal regime variability is in close connection with changes in thermal anomaly "warm-cold" frequency correlation and circulation's type transfer from one period to another.

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1. INTRODUCTION

Synoptic or dynamic climatology studies climate as a result of the processes in the general circuit of the atmosphere and estimates the climatic conditions which correspond to certain types of circulation. At present, different types (classifications) of the synoptic processes are known and are taken into consideration when elaborating methods for forecasting meteorological phenomena. At the same time, their effective use become possible along with GIS elaboration, with whose support, databases can operatively, veridical and qualitatively be used and cartographic models elaborated. We would mention in this context, the use of the programs Statgraphics Plus and ArcView.

2. MAIN RESULTS AND DISCUTIONS

The Territory of the Republic of Moldavia, according to Vanghengheim [1] classification, belongs to the Atlantic-Eurasian sector, 60^0 west longitude and 120^0 east longitude. According to this classification, the peculiarities of the circulation which predominates over a long period of time and which is characterized by the development of a homogenous synoptic process are to be analyzed. These Vanghengheim periods are attributed to three forms of atmospheric circulation: one type of areal displacement and two types of meridional displacement dependent on the situation of altitude crests. The areal displacement (*W*-western type) is characterizes by quasi-*areal fluxes of low frequency waves*, which move from west to east. Meridional forms of circulation include the meridional type **C** (central) and *E* (eastern). The central type of meridional circulation is generated by the localization of the crests of altitude over the Eastern Atlantic and of the depression high over the Eastern Europe during the winter season. The eastern type (E) of the meridional circulation is characterized by localizing the crests of altitude in the eastern

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Europe and by forming two depressions of height over the Atlantic and over the West Siberia.

One should mention that similar to this classification, Ghirs previously proposed analogical forms for the atmospheric circulation of the Pacific-American sector. By using the same principles of typifying as Vanghengheim, Ghirs proposed 3 types of atmospheric circulation: western Z and two meridional (M_1 and M_2), with the localization of the crests of altitude over the Pacific Ocean – M_1, and over the western seacoast of the North America – M_2.

Due to the fact that atmosphere represents the most dynamic component of the geographical crusts, evaluating atmospheric circulation requires to be effectuated at global scale; there exists a significant concordance between the two classifications, as confirmed by fig. 1.

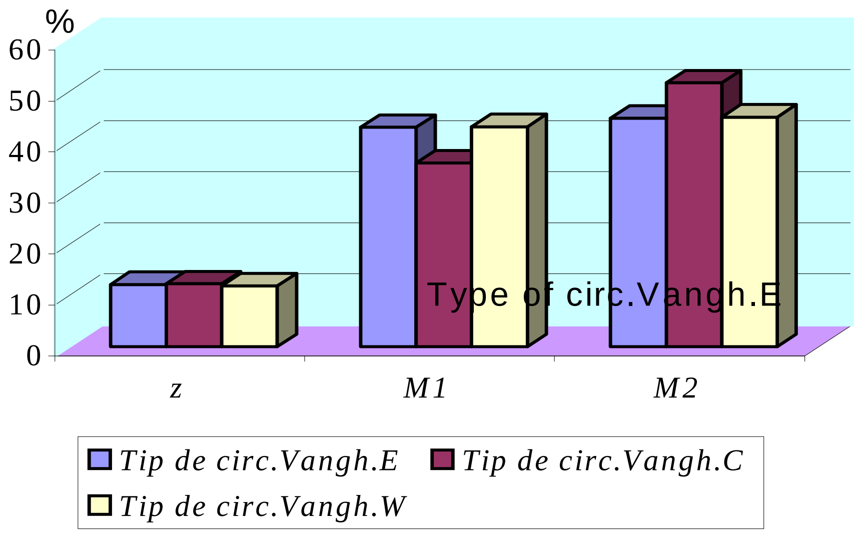


Fig.1. The degree of concordance (%) between the types of circulation Vanghengheim and Ghirs (1973-1993, winter season)

The monthly registries of Vanghengheim – Ghirs type are drawn up for the period 1900-2005 (table 1). The analysis of this registry, indicates that the shift of the epochs (areal-meridional, meridional-areal) takes place each 70 years. The study of the repeating areal type of circulation (during winter months) demonstrates that the stable character of the areal circulation characterizes the end of this epoch (1925-1928). At present, starting with the year 2000, during the winter months, the areal type of atmospheric circulation predominates. The fact that the meridional stable type registered a period of influence much longer (1952-1976) is very interesting. The period of predominance of one or another type of atmospheric circulation has a significant influence over the regional climatic system.

To date, long time-series data are gathered, which allow performing research in connection to the climate variability and to the types of circulation for other seasons too.

A fragment of the registry of the types of atmospheric circulation (winter months) according to Vanghengheim – Ghirs classifications

Table 1

TYPE OF CIR-CULATION	PE-RIOUD	Period phase	XII	I	II
AREAL (W)	W	1900-1902	Cz+м2		
		1903-1907	Wz+м1		
		1908-1911	(E+C)z+м1		
		1912-1915	Wм2		
		1916-1920	Eм2		
		1921-1924	(W+C)м1	Ez	
		1925-1928	**(W+C)z+м2**	**Wz+м2**	
MERIDIONAL (E+C)	E	1929-1933	Ez+м2		Cм1+м2
		1934-1937	Eм2		
		1938-1939	Eм2		(C+W)м2
	C	1940-1942	Cz+м1	Cм2	
		1943-1944	Eм2	(W+C)м2+м1	
		1945-1948	(C+E)м2+м1		
	E+C	1949-1951	(C+W)м1		(E+W)м1
		1952-1956	**Eм1+z**		**(E+C)м1+z**
		1957-1960	**(C+E)z**		
		1961-1968	**Cм1+z**		
		1969-1971	**(E+C)м1**		**Ez**
	E	**1972-1976**	**Ez+м1**		
		1977-1980	(W+C)z	Ez	
		1981-1984	Wz	(E+C)z	
		1985-1987	Cz		
		1988-1995	C+W	W	
AREAL (W)	W	1996-1999	W+C		
		2000-2003	**W**	**W+C**	
		2004-2005	**W**	**W**	**C**

Taking into account that in the last years (table 1) the areal atmospheric circulation predominates and from [1,2], it results that the given type is characterized by close correlative relations with the thermal regime as well as with thermal anomalies (fig. 2).

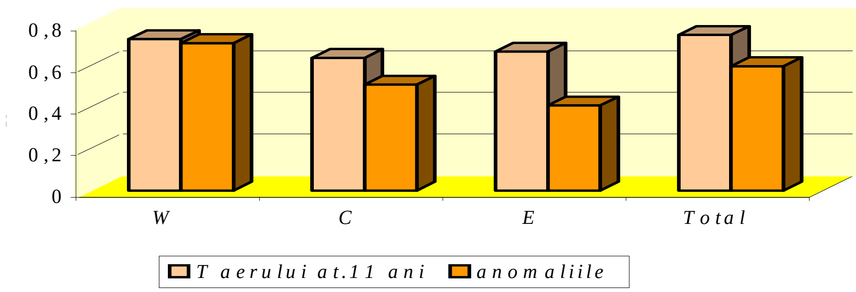
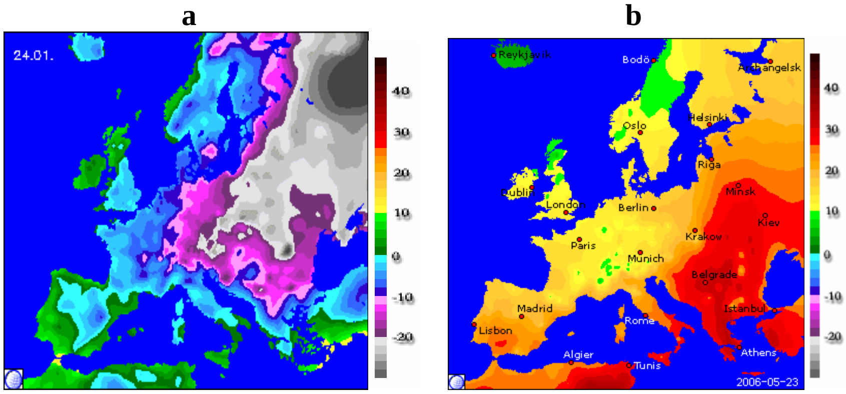


Fig. 2. The significance of the correlation between the longevity of a certain type of atmospheric circulation (after Vanghengheim) with gliding air temperature (11 years) and thermal anomalies for the period 1950-1993

As a confirmation of the related facts, at regional level we could use the significant thermal anomalies, registered in different seasons of the year 2006 and generated by the quasi-areal fluxes with low frequency waves (fig.3).

a **b**



c

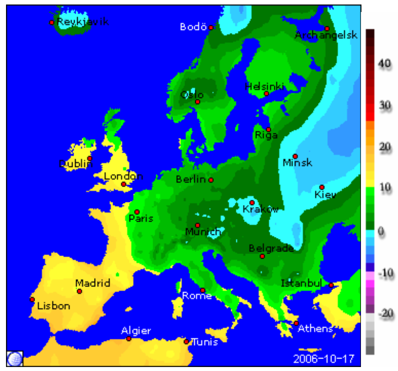


Fig. 3. Thermal anomalies and the type of areal atmospheric circulation (extreme temperatures from: a-January, b-May, c-October, 2006)

The geo-morphological conditions of the territory of the Republic of Moldavia, especially in the cold perioud of the year, „diversify" the distribution of the extreme temperature at spatial aspect. Using regional GIS, it became possible to outline te re-distribution of the extreme temperatures dependent on the local factors (fig. 4),

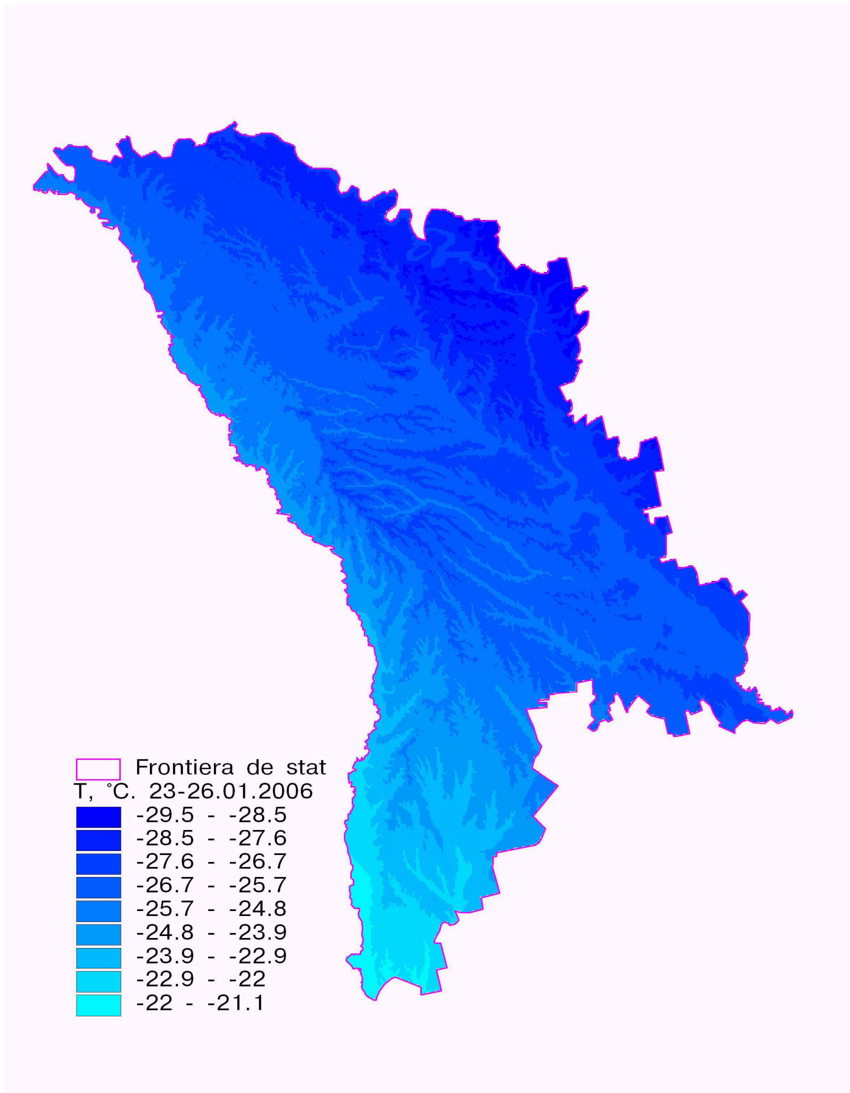


Fig. 4 Redistributing extreme temperatures in the perioud 23.01-26.01.2006 on the territory of the Republic of Moldavia

Leaving aside the warming tendency of winters, the thermal extremes mentioned above are catalogued climate risks [3]. The South of Moldavia registered in the winter of the year 2006 the most extreme thermal anomalies, surpassing even the absolute minimum of the coldest winter of the century – that of the year 1963 (fig.5).

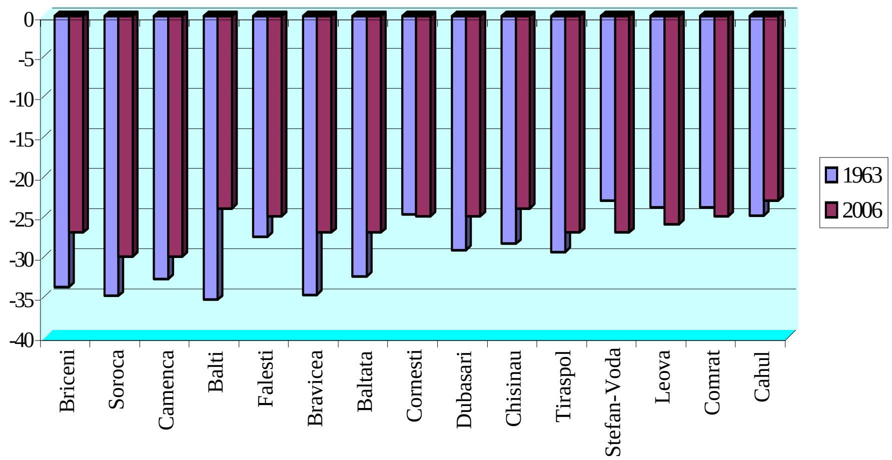


Fig. 5. Thermal anomalies (years 1963 and 2006) on the territory of Rep. of Moldavia

In the end, it can be mentioned that with the transition from the period of the meridional atmospheric circulation to the areal one, the frequency of negative anomalies in the cold period of the year will increase. The increase of the frequency of thermal anomalies conditioned in great part by the types of circulation opens new possibilities in conceiving methods for elaborating forecasts of meteorological extreme phenomena.

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 Geographia Technica, No. 2, 2006, 14 - 19

ON-LINE SUPPORT SYSTEM FOR NUTRIENT POLLUTION IN BISTRITA BASIN

V. CRACIUNESCU[1], ARGENTINA NERTAN[1], CRISTINA TRIFU[2], ADA PANDELE[2]

ABSTRACT. – On-Line Support System for Nutrient Pollution in Bistrita Basin. An important objective of the DIMINISH Project is the development of a dedicated on-line system based on GIS technology, in order to improve the water quality management and implementation of mitigation programs, in the mentioned area. The DIMINISH on-line system is web-based with a distributed architecture and consists in a core server, which handles the interactions between the various modules, the end-users management, the display and manipulation of data

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1. INTRODUCTION

This paper is the presentation of the Diminish Project (LIFE03 ENV/ RO/000539) on-line managemnt system, accomplished in the framework of the Life Environment Program. The project aims to develop an integrated system for water basin environmental management for managing the water quality in relation with water resources, using socio-economical analysis, at the scale of the Bistrita drainage basin. Based on modeling approache the developed decisional system allows to combat the nutrients pollution and to predict which strategy will lead to the reduction of nutrient concentrations within the Bistrita basin and respectively to the reduction of nutrient loads transported by the Siret River into the Danube. The implementation of the Water Framework Directive demands a good knowledge of the many complex interactions between natural processes and human activities and the accomplishment of a sustainable and integrated management of waters.

2. STUDY AREA

Bistrita River (283 km length) had proven to be specifically sensitive to human activities and it is one of the main tributaries of the Siret River, which is the second affluent of the Danube River in terms of discharge and basin surface. The Bistrita River Basin has an area of 7039 km2 and its contribution to the Siret discharge represents more than 30% (Qmean = 65 m3/s). The mean altitude of the basin is 919 m. Besides pollution, the Bistrita basin is influenced by hydraulic management. Residence time in the hydraulic system represents hydrological constraint, influencing biological processes and water quality. Within the basin there are eight reservoirs and three hydraulic channels with role for the sustenance of low summer flow during summer time and for reducing flood intensity along Bistrita River. The investigated area is covered by 9 hydrogeological stations, formed by 4-8 observations wells located normal on the river direction. The permeability ranging between 50 and 500 m/day and the specific debits are above 10l/s/m. The aquifer recharge is due mainly to the infiltration from precipitation. According to the results of the chemical

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analyses, the groundwater water quality is not good in the middle and the south area of the basin, were was lined out overflow for concentrations of ammonium, nitrates, CCOMn , phosphates. The surface water quality monitoring of Bistrita River is accomplished by twenty control stations concerning monthly measurements.

3. GIS DATABASE

The Diminish project allowed the accomplishment of a complex database developed in the GIS environment and provided the possibility to bring together in the same reference system different type of information. The structure of the dedicated GIS database has been planned for the study, evaluation and management of information (related to water quality management), as well as for the assessment of damages inflicted by pollution effects. In this regard the database represented by the spatial geo-referential information ensemble (satellite images, thematic maps, series of the meteorological and hydrological parameters, other exogenous data) is structured as a set of file-distributed quantitative and qualitative data focused on the relational structure between the info-layers. It has been decided to develop a GIS database for the whole study area of the Bistrita basin using different cartographic documents at the scales 1: 25 000, 1: 50 000, 1:200 000. Most of the thematic layers have been extracted from this classical mapping support. Due to the fact that, in most of the cases, the information on the maps is old-fashioned, it is imposed to update it on the basis of the recent satellite images (e.g. the hydrographic network, land cover/land use) or by field measurements (it was necessary to organize several measurements campaigns and to use the GPS technology). One of the purposes of the “Data collection and surveying” task was the improving and updating of the existing database concerning water quality. Besides experimental investigations set up the points-sources and wells location, several campaigns for validation have been carried out 6 months in 2005 year, specially for phytoplankton biomass and silica concentrations at the outlet of the main sub-basins, within the reservoirs and in control sections from the main axis.

The GIS database contains the following info-layers (Figure 1):

- sub-basin and basin limits;
- land topography (15 meters cell size DEM);
- hydrographic network and canals network;
- communication ways network (roads, railways);
- localities;
- administrative boundaries;
- weather stations network, hydrometric stations network ;
- different point of interest (pollution sources, water quality control sections etc.)
- land cover/land use, updated from satellite images.

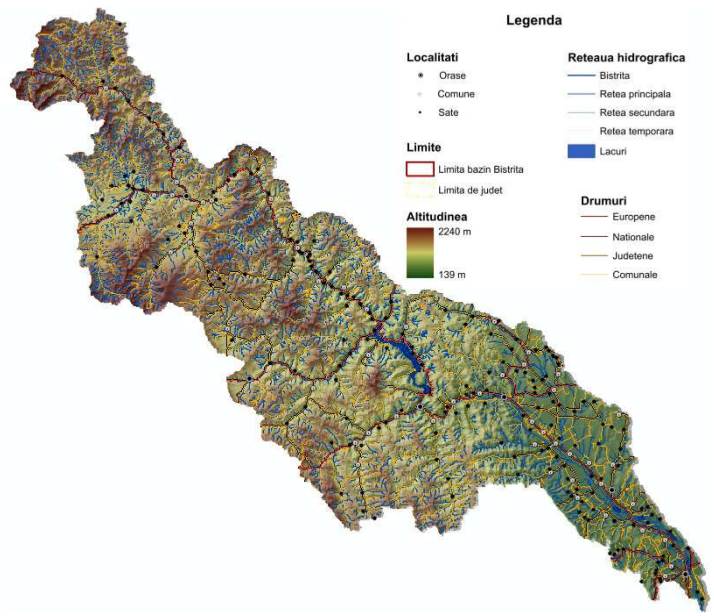

Fig. 1. GIS info-layers for the Bistrita basin.

4. MODELLING APPROACH

The developed basin management system integrates in GIS environment, by using an open WEB-based interrogation and analysis informatics tool, the identification of sources pollution (e.g. agriculture, industry, waste water disposal), the monitoring data and mathematical modeling tools that are enabling to analyze the impact of human activities due to their complexity and due to the fact that they are developed to specific purposes. The ecological model for surface water was developed for studying eutrophication problems in large rivers (namely the Seine River). The model consists in coupling a hydrological model (Hydrostrahler) with an ecological model (Rive). The surface water model takes into account the whole drainage network according to the concept of stream order and calculates the seasonal and geographical variations of the main water variables for the entire network, taking into consideration the constrains related to the morphology, hydro-meteorology and point and non point pollutions. Together with the GIS environment the modeling approach facilitate the identification and quantification of the effect of possible measures for achieving the environmental objectives. These will be used to analyze for instance the effect of change in land use, water abstraction or point and diffuse pollution, measures linked on the functionality of the wastewater treatment plants or the use of the chemical fertilizers.

The mathematical models are easy to use by the local authority due to the developed web interface, which is able to connect in an automated mode the input originating from the users of the system, to interactively extract data and requests from the users. Due to the designed visualization interface several actions such as the display of the GIS information or the selection of the zoom display of the data will be performed by the user before sending the request to the system.

4. DIMINISH ON-LINE SYSTEM

An important objective of the DIMINISH Project is the development of a dedicated on-line system based on GIS technology, in order to improve the water quality management and implementation of mitigation programs, in the mentioned area. The DIMINISH on-line system is web-based with a distributed architecture and consists in a core server, which handles the interactions between the various modules, the end-users management, the display and manipulation of data. The main functions of the on-line system are the following: acquisition, storage, analysis, management and exchange of raster and vector graphic information and related attribute data for the water quality management activities, as well as updating the information, data restoring, elaboration of thematic documents and generation of value-added information. The distribution of the spatial and tabular attribute data over an Internet Web-based network represents a powerful and effective communication method that overcomes the disadvantages of the classical approach. All the partners and end-users are able to access the system using a simple web browser (like Internet Explorer or Mozilla Firefox) to store, display, query, analyze and retrieve information's. The system flow-chart is presented in Figure 2.

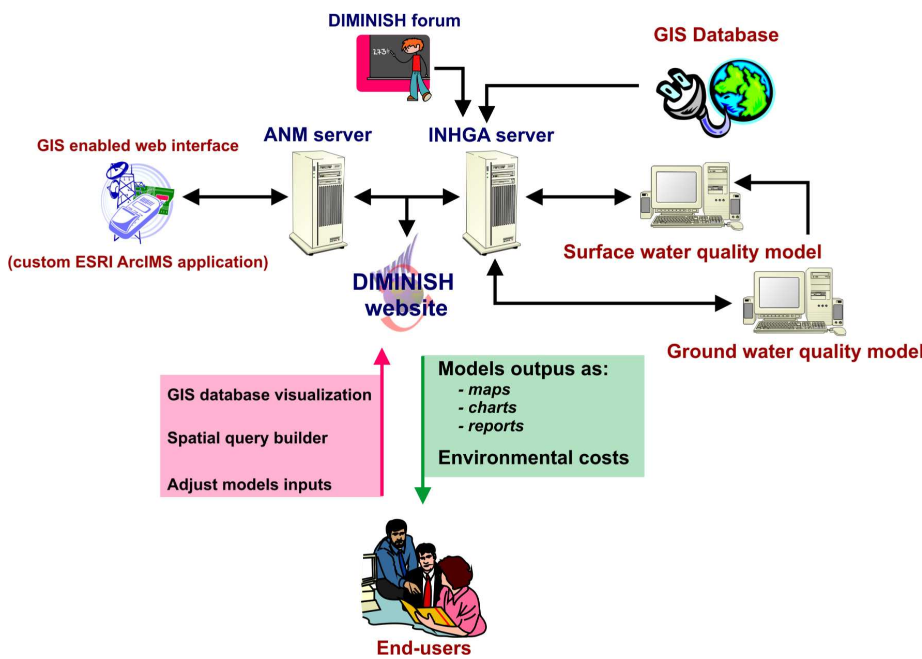

Fig. 2. DIMINISH on-line system flow-chart.

Viewing GIS data on the Web, generally involves a three-tiered architecture:

- a spatial server that can efficiently communicate with a Web server and is capable of sending and receiving requests for different types of data from a Web browser environment;
- a mapping file format that can be embedded into a Web page;
- a Web-based application in which maps can be viewed, download and queried by an end-user/client via a Web browser.

Publishing the data on the Web (webmapping) using this approach would not change the existing data workflow– how the data are created, maintained, and used by desktop applications. This means that the mapserver dynamically generates maps from the files stored in a certain folder every time a user sends a request, without changing the initial data files.

Users with appropriate privileges can access the DIMINISH through the web browser and perform queries, and retrieve different products useful in order to:

- process these data for specific computations;
- change the inputs for the mathematical models;
- browse the mathematical models outputs in a GIS environment;
- integrate the multi-source processed information in Decision-Analysis-Matrixes in order to better understand the impact of the pollution on humans and environment; upgrade the result in a Decision-Analysis common access space of the GIS Server;
- provide the right, both short and long term, decisions.

ESRI ArcIMS was chosen as core software for webmapping. ArcIMS is on of the most important application in the field. The native formats can include those used by different commercial vendors. Other nonproprietary formats can be used as well, including the OGC standards for Geography Markup Language (GML), Web Map Server (WMS), Web Feature Server (WFS) and relational databases. The ability to have simultaneous access to diverse data formats on the fly without conversion makes ArcIMS one of the top applications available. The use of ArcIMS as webmapping platform ensured the compatibility between all the DIMINISH participants as they all use ESRI products for GIS activities. The basic structure of ArcIMS is presented in Figure 3.

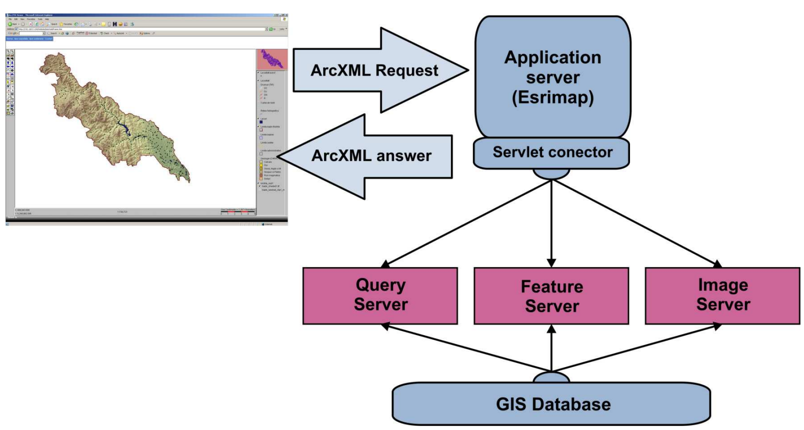

Fig. 3. ArcIMS structure

The web interface was designed according with end-users needs. The goal is to obtain a simple and friendly environment for spatial data management and scenario creation. A screenshot from the main page of the web interface is presented in Figure 4.

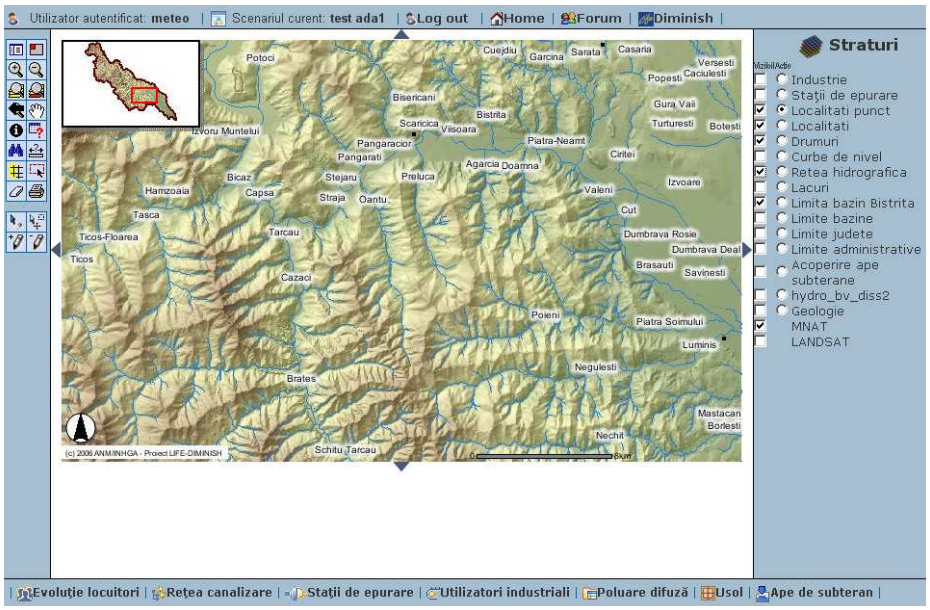

Fig. 4. Web interface structure

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 Geographia Technica, No. 2, 2006, 20 - 26

THE ASSESSMMENT OF NITRATES FLUX TO THE GROUNDWATER, USING GIS, AT A CATCHMENT AND NUTS4 SCALE

SORINA DUMITRU[1], IOANA NILCA[1], VICTORIA MOCANU[1], VALENTINA COTET[1], C. SIMOTA[1]

Abstract

The presence of the high nitrogen concentrations in soils is a high potential risk for the groundwater and, implicitly, for human and animal health , because the ground water is the main source of the drinking water in many areas abroad. One of the main risk factor for nitrates pollution is the agricultural activity.

The aim of the paper is to describe the nitrates pollution evaluation procedures at the scale of a catchment and at NUTS4 level, using data from the Geographic Information System SIGSTAR – ICPA, available weather data from statistical yearbooks, as well the pedotransfer functions from the methodes and models database. In order to compute the nitrates flux to the groundwater, a simulation model ROIMPEL, developed in the frame of an international cooperation, is used. The computed values are compared with the maximum nitrates flux that can be removed out by the groundwater and translated in the terms of maximum number of the livestock without affecting the groundwater.

La presence dans le sol de concentration elevée de nitrates c’est un risque potential pour l’eau souterraine et pour santé humaine et animal, parce que l’eau souterraine est la principale source d’eau potable dans beaucoup des regions. Un factor de risque de certain importance pour la nitrate pollution c’est l’activité agricole.

L’objectif de cette papier est cel de présenter le methode d’estimer la pollution avec nitrates a l’échelle de bassin versant et a NUTS4 niveau, en utilisent des données de System d’Information Geographique SIGSTAR – ICPA, des données climatiques disponibles de l’Annuaries Statistiques, et aussi des functions de pedotransfer provenant de la base de données de methodes et modeles. Pour calculer le flux de nitrates dans l’eau souterraine, on a utilisé un model de simulation ROIMPEL developée dans un projet international. Les valeurs obtenues sont comparé avel le maximum flux de nitrates quel a été lavé dans l’eau souterraine et traduit en terms de nombre maximum des animaux sans affecté l’eau souterraine.

Key words: Geographic Information System, nitrates pollution, nitrates flux, animal units.

INTRODUCERE

The presence of the high nitrogen concentrations, exceeding the admissible maxim limits, may have a negative impact on the environment through the possible losses in the ground and surface waters and/or atmosphere. Generally, the nitrogen behaviour is determined by a lot of physical, chemical and environmental factors, such as: climate, relief, soil type and its properties. It is the main constituent of the leaf chlorophyle, of all amino-acides and other essential components for crop growing and development, but besides these, inadequate nitrogen quantities affect negatively the main environmental resources.

The agricultural activities are the main nitrogen supply in soil, through application of the mineral and organic fertilizers doses, sometimes in inadequate fertilizers rates determining

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the accumulation of high quantities of nitrogen in soil. In the last decades, worldwide there was an increasing tendency of for using nitrogen based fertilizers, because the nitrogen represents an essential nutrient for conservation and/or amelioration the soil fertility state and for agricultural production, which has to satisfy the needs of increasing population. The intensive agriculture applied a long time, the uncontrolled organic and mineral fertilizers application in inappropriate moments are some of the elements that determined important nitrogen quantities accumulation, which represented a major source of nitrates in the ground and surface waters from urban and rural zones. The organic and mineral fertilizers use determines surface water eutrophication and nitrates accumulation in the drinking water. The nitrates ground water pollution determines potential adverse effects for human and animal health, the groundwater being the main source of the drinking water in many areas. This is why it is necessary to apply suitable practices according to an agricultural system that should optimize the crop production in order to avoid the environmental contamination with nitrates. As a consequence, the Nitrates Directive became a basic component of communitary agricultural policies and a condition for the EU candidates.

In order to promote a sustainable agriculture based on suitable agricultural practices application for environmental protection, in our country a Code of Good Practices was elaborated (Dumitru et al., 2003). This represents a group of technical and scientific knowledge available for agricultural farmers in order to be implemented in practise. The Code has to be harmonized with the European Nitrates Directive regulations regarding to water protection against the nitrates pollution from agricultural activities and consists of specific recommendations for our country. The scientific Romanian community tried through different studies and succeeded successfully to elaborate some information systems, which evaluated and monitored the potential vulnerable zones to nitrates, using pre-established indicators. An important objective is to create an interface between the outputs of these systems and the stakeholders, especially that's are located in vulnerable zones to nitrates pollution, in order to self-evaluate and monitoring the risk of environmental deterioration and to implement agricultural technological plans for protection and/or amelioration of the environment.

The aim of this paper is to develop an easy-to-use system for characterising the potential vulnerability to nitrates pollution of a vulnerable area to nitrate pollution.

Data sources

The available databases are: the soil map of Romania (at the scale 1:1 000 000), the soil map at the subtype level (1:200 000), the soil profile database (PROFISOL), the spatial distribution (at NUTS4 level) of the average value of cumulated precipitation deficit (Potential Evapotranspiration– Precipitation), the catchments boundaries, the surface water network, the main groundwater bodies, the land cover using the main landuse classes.

Database structure

The database is organised as a workbook, each spreadsheet describing a component of the full database. The main component is the existing hydrological registry, transpus într-o aplicație de tip workbook într-o structură de butoane active, astfel:

- In a spreadsheet, each surface water body (river sector, natural or artificial reservoir) delimited in the cadastre is represented by an active button, transffering, by pressing, the information application control to a particular spreadsheet storing the data for that water body (fig. 1);

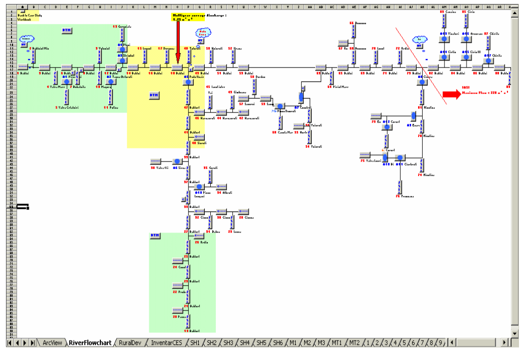


Fig. 1. The Bahlui river structure

- The particular spreadsheet for each water body store the hydrological information for that water body (fig. 2): for rivers; catchments; lakes, technical characteristics for dams and draining systems of the water body.

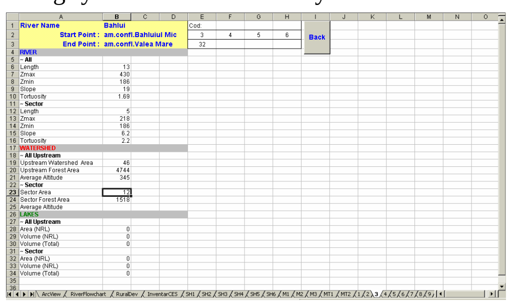


Fig. 2. The hydrological information stored for a segment of Bahlui river.

The weather (climate) data from the meteorological station of the area are stored in specific spreadsheets, that could be loaded from the spreadsheet describing the hydrological cadastre: the monthly average temperatures, precipitations and radiation on the basis of the climate time series for 1896-1955 (monography: Clima RPR), daily values for temperature, precipitation and sunshine interval, as well as monthly average values for another climatic parameters needed by the crop growing simulation models on the basis of 1960-1990 series.

Information on rural development of the Bahlui catchment are stored in special spreadsheets al NUTS4 level.

The Digital Terrain Model (obtained through SIG prelucration of topographic maps at a scale 1:200 000) for different areas of hidrographical catchment (fig. 3) is loaded from the central spreadsheet of the catchment (the DTM buttons from fig. 1). Inside the DTM included in the aplication, the main geographical elements (water arms, water bodies) of the region are specified.

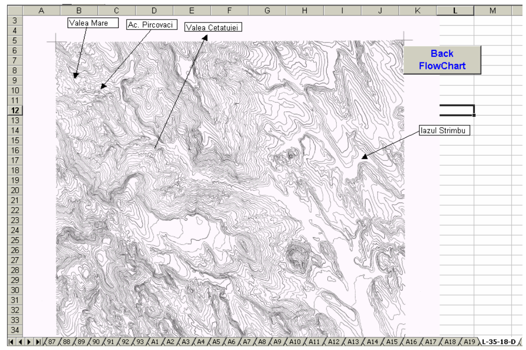


Fig. 3. The countur lines for an area of Bahlui catchment, the basis of the Digital Terrain Modelling (DTM).

The image provided by CORINE Landcover for the area of interest with the landuse types is completed with active buttons which, by pressing, transfer the control to the spreadsheets containing characteristic information for specific location (fig. 4)

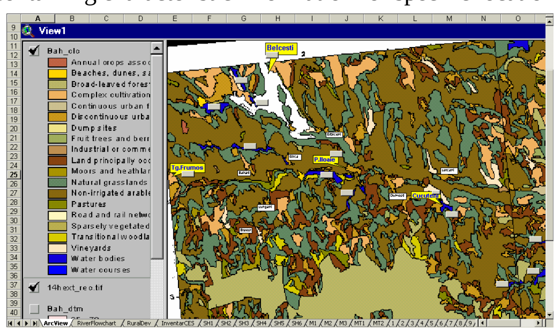


Fig. 4. Landuse in an area of Bahlui catchment.

Metholodology

To evaluate the nitrates fluxes to the groundwater the agro-climatic simulation model ROIMPEL was used, developed in the frame of an international colaboration, the IMPEL project (Rounsevell, 1998).

The model simulates the crop yields and the water and nitrogen balances in a specific area, like in a catchment, and for various systems of agriculture, based on long-time-series of recorded climate data. The output of the ROIMPEL model serves in a next step for assessing economic parameters, using the energy equivalent of the main activities (soil tillage, mineral fertilisation, and weed control by pesticides) in each of the specified agricultural systems. ROIMPEL is a site-specific, modular mechanistic simulation model of crop yields limited by soil water and nitrogen availability, using limited easy-to-map soil and weather data. Therefore, ROIMPEL is appropriate for GIS based regional and sub-regional land use projects.

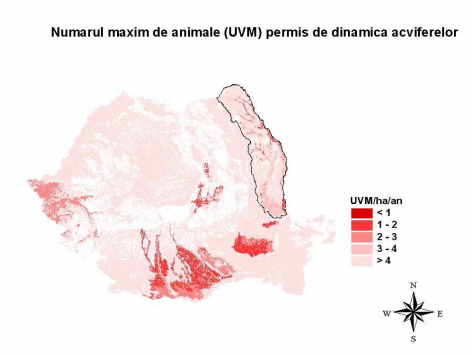
The minimum requirements for soil data are the soil texture and organic matter classes. With them, additionally soil parameters could be derived, using pedotransfer functions

(Voltz at al., 1997; Daroussin & King, 1997). The Maximum Available Soil Water Content to the root front depth was the key soil parameter used for spatial extrapolation of the site specific simulation output. This soil parameter was computed using a standard methodology from soil water parameters (soil water retention curve, field capacity, wilting point), soil mechanical parameters (soil resistance to penetration, defining root elongation rate) and a climate index characterising the cumulated atmospheric water deficit during the vegetation period. The minimum weather data are monthly values of the average daily temperature and the month cumulated rainfall.

Various practices for nitrogen and water management could be very easily considered specifying some easy to derive parameters through external files, and the nitrate concentrations, which are potentially hazardous for groundwater contamination, are optionally derived.

The flow chart

1. The selection of the catchment, as well as the available layers from the database for this catchment (the soil, surface water bodies, groundwater, and landuse coverages, the Digital Terrain Model).
2. The selection of the climate data characterizing this catchment, from the available weather database.
3. The evaluation of some parameters needed by the model and that are not available directly from the database.
4. The evaluation of some parameters from PROFISOL database, characterizing soil profiles (point database), using pedotransfer functions, and the extrapolation of the results to the whole area of the catchment.
5. Running ROIMPEL in order to evaluate the average nitrates flux leached below the root front depth considering homogeneous al the soil-terrain units, and for different scenarios:
   - various autumn and spring crops (maize, winter wheat, grass)
   - different manure amount applied on the field (0, 2, 4 animal unit /ha/year)
6. The evaluation of quadratic regressions between the leached nitrates flux (expressed as kg NO_3/year) and applied manure amount (expressed by animal units/ha) for each homogeneous soil-terrain unit, using simulation model output.
7. The evaluation using these regressions of maximum livestock (animal units/ha) in order not to exceed the maximum nitrates flux allowed by the aquifer dinamics (the drained nitrates flux has to be lower than that allowed by the aquifer dinamics) (fig. 5).



Fg. 5. The maximum number of animal units ha^{-1} for the whole country.

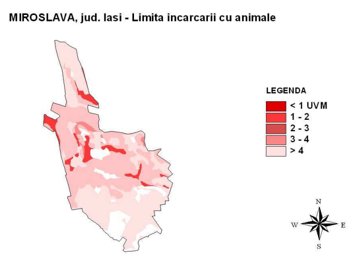


Fig. 6 . An example for a “comuna” (NUTS4 level) from Bahlui catchment with the maximum animal units (com. Miroslava, county Iaşi).

8. In the case of soil-terrain units draining not in an open aquifer, the maximum livestock is designed by the Code of Good Agicultural Practice.
9. Data aggregation at the „comuna” level (NUTS4 level) (fig. 6)

Conclusions

- Running the simulation model for water and nitrates dinamics in soil ROIMPEL in order to evaluate the average nitrates flux leached under the roots depth allow:
  - The evaluation of the quadratic regressions between the leached nitrates flux (kg NO_3 $year^{-1}$) and the manure applied in the field (expressed through the number of animal units ha^{-1}), for each homogeneous soil-terrain unit (using model output)
  - The evaluation using these regressions of the maximum number of animals (animal units/ha) in order not to exceed the maximum nitrates flux allowed by the aquifer dinamics.
- The results could be aggregated at the NUTS4 level, “comuna”, obtaining a characterization of the “comuna”:
  - The evaluation of the potential livestock for a “comuna” (following the Nitrates Directive requirements)

- The comparasion with the real livestock of the "comuna" allow the evaluation of potential development at NUTS4 level.

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SPECIFIC APPLICATIONS AND GIS DATABASES FOR LOCAL ADMINISTRATION CASE STUDY: FLOREŞTI COMMUNE, CLUJ COUNTY

C. HAIDU[1], V. ZOTIC[2], V. SURD[2]

ABSTRACT. – Specific Applications and GIS Databases for Local Administration. Case Study Floreşti Commune, Cluj County. The implementation of GIS technologies in the public administration domain comes from the very need for a fast analysis, objective and interdisciplinary instrument, as a support for optimal decision at the administration unit level. Based on the study case of the city of Floresti, we developed an efficient model of GIS technologies integration into the information system of a city hall - AEDILIS.

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The current public local administration in Romania is undergoing an extensive process of reorganization, dictated by the prolonged transition from one political system to another. This reorganization is materialized by the transposition of the administrative act on new legal coordinates, restructuring the beaurocratic system, remodeling the patterns of management of the administrative territory, changing priorities in the sense of increasing the productivity of the budgetary resources etc. All these processes of reorganization have been carried out, and continue to be carried out, through obsolete patterns of data and information management. As a result, one can ascertain that the trend of restructuring the local administration has not included the aspect of managing data and information, a fact which has caused great damage to the quality of the administrative act. These damages affect the fairness of the undertaking of measures, because of the incomplete information regarding the population, built base, status of the plots and the owners, shortcomings in the accurate evaluation and the collection of taxes, impossibility to define an explicit direction of development etc. The perpetuation of this status in many of the local administrations, for lack of funds or reticence to innovation and technology, will inevitably lead to the amplification of the state of uncertainty, incapability and unconcern towards the administrative act.

On the other hand, the large volume of data and information which needs to be managed within an administration, their pronounced dynamics, the perishable character of the data, as well as the high number of statistic reports which the local administration, through its services, is required to transfer to the statistics department or the county council, further complicates the administrative act in its classic version.

What direction should be followed in order to modernize the aspect of data and information management? Of course there are numerous solutions, but it is also interesting to see their costs and ability to adapt to the specific needs of the administrative system. The IT systems of the GIS category are one of the most effective solutions for the assumption of the task of managing data and cartographic, alphanumeric or other types of information from the local administration.

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The IT systems from the local administration must combine the following characteristics: to offer fast and controlled access to data, to offer accurate information in real time, to allow the control of management, to include mechanisms of registration and to facilitate exchange of information with other organizations. The suggested system, Aedilis, has been projected and designed to this purpose, and is a modern tool of recording and processing both graphic and attribute data.

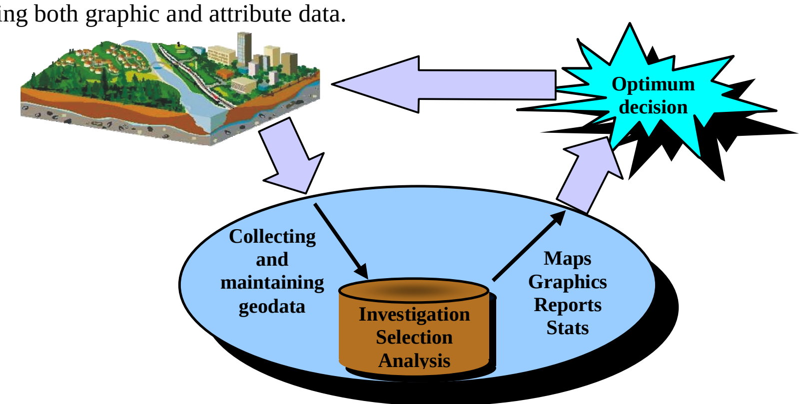

Fig.1. The flow of geo-information in the context of the decision-making act

The starting point is the idea that geographical data such as information regarding plots and the occupancy and use of the plots are crucial to the practical activities of all fields connected to public administration: urbanism, tax administration, agriculture, environmental protection, civic protection etc. Also, there are attribute data which show up as information in different contexts, such as the identification data of the owners.

The AEDILIS system contains a unique database which is used jointly by the particular applications. The principles which regulate the functioning of the whole system are rendered as restrictions and recommendations of design and development, grouped by their field of application: on the database and the applications, respectively. These principles are valid for any implementation with the same purpose.

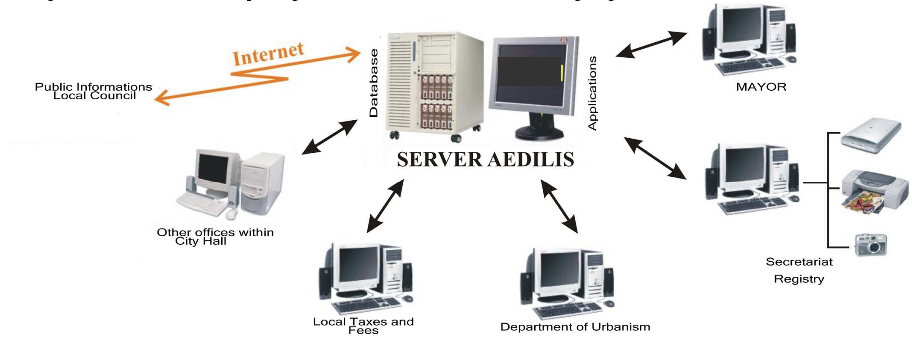

Fig.2. The central position of the AEDILIS system inside the mayoralty's information system.

The model of the application was built and tested using graphic data taken from the General Urbanism Plan (PUG) of Floresti commune verified and updated on the field. The extensive development of the commune over the last few years has created the need, within the Floresti mayoralty, to implement a specialized information system, based on GIS technology, modular and easy to use. The following potential applications have been considered: records of building authorizations, records of constructions and real estate in general, records of the agricultural fields and other records connected to the agricultural roster, records of population, administration of the public domain, records related to the tax base, digital PUG, functional mapping and releasing urbanism licenses, real estate advertising, miscellaneous statistics and balance sheets.

From a technical point of view, AEDILIS is an original software system created through sequential developments of applications which include GIS-type procedures and functions implemented in the context of using intranet and internet environments. The database engine used is MySQL, and the assembly languages in which the programs were written are PHP and Javascript. The Aedilis applications work like normal web pages, are launched from a web browser such as Internet Explorer, from which they contact the Apache web server which contains the database and the applications.

1. CHARACTERISTICS OF THE GIS – AEDILIS DATABASE

The AEDILIS database contains both the graphic data as well as the attributes. The digital map is built by interpreting and reproducing in the application window the tables which store graphic objects and metadata with their drawing characteristics. The link between the graphical objects and the attributes is ensured through a code, the cardinal of the link being 1:1. The attributes are organized in related tables, an example of which can be analyzed in the figure 3.

The most important requirements which have to be met by a GIS database for use in the local administration are:

- respecting uniqueness – a single database, without redundant information;
- simple mechanisms of interconnectedness based on codes with comprehensible meaning – for example a simple and efficient link key can be formed from the address by collating the street name and house number, as can be seen in the following picture;
- independence of the data from the frame – in order to avoid incompatibilities of frames one must use data conversion programs from different sources towards a simple representation, in the Aedilis case, all the information from the database are of text type;
- maintaining the historical character – all modified data must first be saved in an archive, together with the time stamp, the user who made the change and the reason;
- using Romanian letters – it is the only way to obtain properly ordered reports;
- specifying, according to each relation between tables, of the type of behavior – aggregation or composition between data, for example the relation between the attributed of a plot and its owner behave as an aggregation of data – accordingly, if he sells the land this does not mean that he is deleted from the database, because he can own another plot, however, the relation between a graphic object and its attributes is in most cases of composite type, since deletion of the graphic part dictates the deletion of the corresponding attributes and vice-versa.

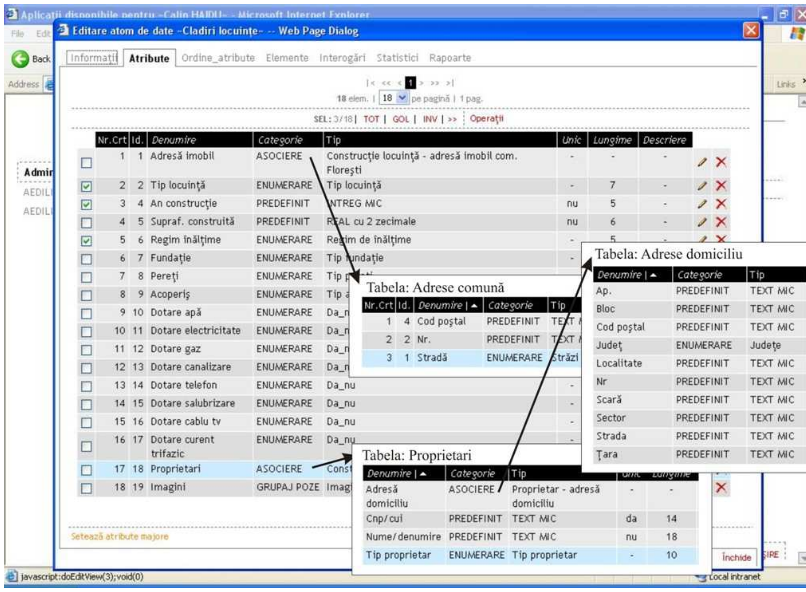

Fig. 3. Defining attributes through metadata, example for residential buildings.

An important specific problem related to the GIS databases from the local administration is related to the precision of the data. Special applications can be created to manage data in course of correction. For instance, the progressive land registrar, we believe that the local officials shouldn't wait for the completion of the land measurements in order to begin building the GIS database of its administrative territory, but can adopt a system of self-correcting starting from the current urbanism plan, doubled by corrections on the field and the assumption of correct coordinates as measurements advance.

In the specific case of the three villages of the Florești commune, the option of progressive land registrar was chosen. To this purpose, the following layers were vectored: functional areas, restricted areas, parcels separated into yards and gardens, green plots, empty plots, industrial plots, constructions separated into houses, apartment buildings, garages and dependencies, institutions, commercial plots, street network, alleys, main road, hydrographic, fountains and hydrants, main electric networks, interest points. Concerning the attributes, the data from the agricultural registrar, the population records registrar, the owners' registrar and the tax statements are being inserted.

2. SPECIFIC GIS APPLICATIONS IN THE LOCAL ADMINISTRATION-AEDILIS

AEDILIS is an open, modular system. It consists of applications which are specific to solving specific problems and, as new problems are identified, we can elaborate new applications to be integrated in this system.

Access of users to the applications is hierarchized and secured. A user from the urbanism department will have full rights in the application which manages the construction authorizations, for example, but he will only be able to view information regarding population records. Practically, each official from the mayoralty will have modifying rights only over the date of which he is in charge, on the basis of the job description.

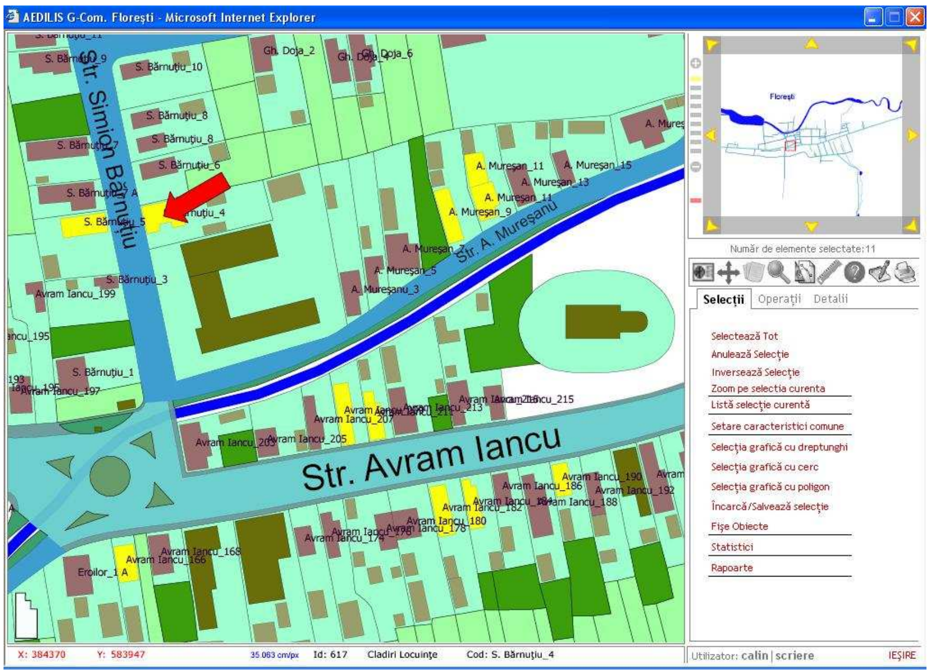

Fig. 4. Using the combined code „streetname_number".

The interface of any GIS application, in the usage of the public administration must be simple and accurately specific for the problems which might arise. To support and effective use, there are procedural rules and mechanisms such as: validation of the data upon introduction, simulation of the uniqueness for the automatic code fields, usage of the predefined enumerations and work with lists and fast searches.

A major principle which must be abided by is concurrent access. Respectively, for the possibility to work operatively, one must solve the problems of expectancy in the concurrent work both from the point of view of access to multiple sessions of a data application as well as in case different applications access the same data. For example, the data of a land owner can be used at the same time by several applications, such as: records of the construction authorizations – if we assume that the owner asks for such an authorization at that time, population records as head of the household where he lives, in case of a statistic/report also performed at the present time, and at the local tax department, where he has to make a statement of acquiring, for instance, a new real estate asset. It is obvious that this owner's personal data must be stored in a single place, and also from a single application will be performed any possible changes of his address, in that should be the case.

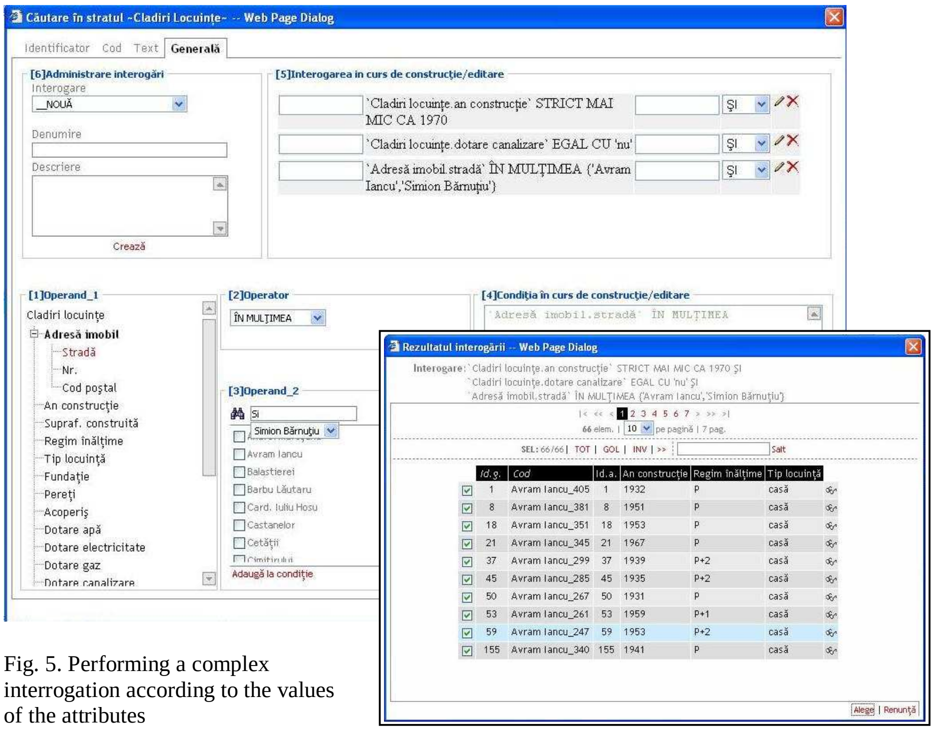

Fig. 5. Performing a complex interrogation according to the values of the attributes

In a general diagram of functions which a specific GIS application must perform we can mention:

- establishing, in accordance with the problem which needs to be solved, of the active layer and the chain of relations of the tables of attributes involved;
- mechanisms of localization, search and interrogation according to the values of all the attributes;
- mechanisms of selection and logical operation with selections of objects;
- operations of editing: adding, deleting, modifying with restrictions imposed by the particularity of the problem;
- possible complex specific operations in which information from other layers interact, for instance for automatically releasing an urbanism certificate;
- the possibility of carrying out reports and statistics on objects from the active layer;
- printing the map at different sizes.

3. PERSPECTIVES

Despite the fact that the standards of application of GIS in public administration are poor, the AEDILIS system has proven (Zotic and Haidu, 2006) and continues to prove through this paper that this shortcoming can be overcome by a flexibility in the organization of the database which is capable of serving multiple applications: records of constructions, records of construction authorizations, records of population and others. The next phase of development of the AEDILIS system intends to implement new functions particular to the *statistic analysis* and the *spatial analysis* dedicated to applications from the field of local administration.

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Geographia Technica, No. 2, 2006, 34 - 39

USING GEOGRAPHICAL INFORMATION SYSTEMS IN THE MANAGEMENT OF PROTECTED NATURAL AREAS

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ABSTRACT. – Aspects of the use of Geographical Information Systems in management of the natural protected area. In Romania, biodiversity conservation concerns has lasted since the beginning of the 21 century, so as nowadays are using some methods, techniques and new instruments as a good management support. GIS are instruments that helps the specialists to analyse and identify natural protected areas from the environment point of view. Mapping database and a vector dataset achievement, which represents natural protected areas boundaries, are the support for a better management of the territory, but also as a basis for some normative documents on the biodiversity conservation management.

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The equilibrium reached in time between natural and socio-human systems is a prerequisite for the normal evolution and progress of society. However, 20th century man used to tamper with the natural systems, often in a brutal manner, and the impact of his unfriendly behavior to nature has increased with the advance of society and civilization. Technology and human intelligence have joined hands in inducing global environmental change whose future effects are hardly predictable. We have a good knowledge of the constructive and destructive power of technology, but sketchy insights into the number of species making up the Planet's biodiversity. Only 10% of the approximately 1,400,000 animal species and 400, 000 plant species are well-known to and analyzed by science.

Man's impact on the natural systems has made very many plant and animal species lose their habitat and living conditions, becoming extinct long before their genetic potential and usefulness could be assessed. The result of human intervention in the landscape has often led to the fragmentation or destruction of some valuable ecosystems and implicitly of the species constituting them, thus depriving the natural heritage of much of its value.

In time, the study of biodiversity covered several stages: the 1960s featured only local studies with highlight on endangered, endemic or rare species (Red List), materializing in a Convention on the International Trade with Endangered Species (CITES); in the 1980s studies focused on the regional level; in the 1990s, a global perspective on biodiversity emerged finalized with the establishment of the UN Global Environmental Fund and the convening of the Rio de Janeiro Summit in 1992.

A special interest for biodiversity conservation, promoted and sustained by various specialist, has been manifest also in Romania, where a national network of various categories of areas has been put in place.

As early as 1928, at the first National Congress of Natural Scientists in Romania debates focused on the issue of nature protection and the enactment of a law for the creation of nature reserves, monuments of nature and national parks (the first being "Retezat" Natural Park, 100 km^2, set up in 1935).

However, there are lots of other problems beside biodiversity, in such fields as spelaeology, karst phenomena, geology and geomorphology, fossiliferous sites and landscape ensembles which ought to be addressed and areas protected from the negative anthropic impact. So, responsible action at all and every level is necessary in order to

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identify, study and put forward alternatives and solutions for sustainable development, including nature protection in the equation, to the benefit of ourselves and of future generations.

Although the need for environmental protection had been acknowledged in the 1930s (when the first bill for the protection of the monuments of nature was passed into law and the Commission for the Monuments of Nature was set up), yet no significant progress was recorded. Important steps forward were made in the 1990s when Environment Laws were enacted in 1995 (No.137) and 2000 (No. 5) sanctioning the 827 protected natural areas (134 lying inside parks and the Danube Delta Biosphere Reserve). Though imperfect, Law No. 5/2000 represented a landmark in environmental protection efforts. Thus, in 2003, a number of 17 natural and national parks (627121 ha) minus the Danube Delta Biosphere Reserve had already been in place (under Annex 1, Law No. 5/2000), subsequently nine new parks and 152 nature reserved were legiferated.

Natural and National Parks - 2006

Nr. crt.	Numele parcului	Tip	Suprafața (ha)
1	DELTA DUNĂRII	rezervația biosferei	580.000,00
2	DOMOGLED-VALEA CERNEI	național	60100,00
3	RETEZAT	național	38.047,00
4	PORȚILE DE FIER	natural	115.655,80
5	CHEILE NEREI-BEUȘNIȚA	național	37.100,00
6	MUNȚII APUSENI	natural	75.784,00
7	MUNȚII RODNEI	național	46.399,00
8	BUCEGI	natural	32.663,00
9	CHEILE BICAZULUI-HĂȘMAȘ	național	6.575,00
10	CEAHLĂU	național	8.396,00
11	CĂLIMANI	național	24.041,00
12	COZIA	național	17.100,00
13	PIATRA CRAIULUI	național	14.800,00
14	GRĂDIȘTEA MUNCELULUI-CIOCLOVINA	natural	10.000,00
15	SEMENIC-CHEILE CARAȘULUI	național	36.664,80
16	MUNȚII MĂCINULUI	național	11.321,00
17	BALTA MICĂ A BRĂILEI	natural	17.529,00
18	VÂNĂTORI NEAMȚ	natural	3.018,00
19	LUNCA MUREȘULUI	natural	17.166,00
20	LUNCA JOASĂ A PRUTULUI INFERIOR	natural	8.247,00
21	COMANA	natural	24.963,00
22	GEOPARCUL DINOZAURILOR ȚARA HAȚEGULUI	natural	102.392,00
23	MUNȚII MARAMUREȘULUI	natural	148.850,00
24	GEOPARCUL PLATOUL MEHEDINȚI	natural	106.000,00
25	PUTNA – VRANCEA	natural	38.204,00
26	BUILA – VÂNTURARIȚA	național	4.186,00
TOTAL			1.585.201,60

Our research falls in line with the preoccupations of the Ministry of Environment and Water Management to localize and trace the boundaries of protected natural areas in order to improve their management. The succession of research stages had to observe also the international conventions Romania is a party to and harmonize nature protection issues to profile developments mainly in Europe. Our aim was to work out a Cadastre of Protected Natural Areas as reference tool for the complex management of these areas. This task was partly attained by the following steps:

- the elaboration of the methodology outlining protected natural areas in terms of a unique corresponding system of codes assigned in the data-base;
- the creation of a standard descriptive geographical model of the boundaries of protected natural areas (parks and reserves);
- the opening of training sessions with county agency inspectors to familiarize them with the use of GPS equipment and the basics of GPS knowledge;
- the elaboration of a map on the scale of 1:25 000 for all the communes having protected natural areas on their territory. In this way the bounds of protected natural areas can be mapped out in conformity with the documentation received from county inspectorates, the Institute of Spelaeology, Romsilva Company, from other specialists, etc.

By means of GIS-based data processing using the above-mentioned methodology, a number of 772 protected natural areas were delimited and described (under Annex 1, Law No. 5/2000). The boundaries of the remaining areas (up to 827) could not be established either for lack of identification acts or the depreciation of the site (usually by human activity) or again for having been listed in the high-protection category (special areas within parks or the Danube Delta Biosphere Reserve).

In order to facilitate identification, the coordinates of the polygon center of each reserve, as well as its surface-area would be calculated and, in the event of a reserve having several bodies, calculations would include the coordinates of each body center so as to obtain greater location accuracy.

All the drafts of these reserves (STEREO 70 projection) were appended to each county, their electronic variant (http://www.mmediu.ro/dep_mediu/biodiversitate.htm) being available now for the public at large.

Apart from the documentation received from County Environmental Protection Agencies, the elaboration of the Cadastre resorted also to the information and data published in various works or periodicals which in many cases (particularly of caves), completed existing information. Whenever necessary, the documentation received from county agencies was supplemented with aerophotogrammes and remote sensing pictures in order to assess boundaries or trace them more accurately.

A data-base of management and/or cadastral units for each protected area was worked out, with mention of the respective production units and forest ranges, also associating the data to GIS-related information levels.

The results thus obtained focus on some essential aspects such as:

- Concordance between the topographic survey and the methodology of tracing the geographical bounds on specific landforms (summit, hill, over thrust, watershed, etc.);
- Accurate presentation of the draft of topographic elements, with mention of synonyms and elimination of landmarks liable to generate confusion;
- Verification of forest management and/or cadastral units with protected areas.

Planimetric elements and the information on forest management and cadastral units were accepted in order to facilitate orientation and overall localization. The data were confronted with forest management lists provided by Romsilva Company.

The elaboration of this project was based on the following cartographic documents provided by the Ministry of Environment and Water Management and our partner institutions:

- Topographic maps on the scale of 1:5 000, 1:10 000, 1:25 000 and 1:50 000;
- Landsat 7 TM and Landsat 7P images;
- Forest maps on the scale of 1:20 000;
- Cadastral maps supplied by Environmental Protection Agencies;
- Geological maps, cave maps, etc.

Since the 1:50 000 topographic maps have few elements of detail and are not accurate enough to allow correct assessment of digitized areas, the solution was to start from the eight-color topographic maps on the scale of 1:25 000 issued over 1979 – 1982.

Analyzing the documentation and the respective data-base pointed out some particularities in the distribution of protected natural areas in Romania and of surfaces occupied or listed under Annex 1, Law No. 5/2000.

Protected natural areas in this country cover 232,188 hectares. Distribution is uneven and unbalanced in terms of territorial administrative units, big relief steps and representative ecosystems. Looking at the distribution at county level it appears that most protected areas (83) are in Alba County next in line standing Bihor (60), Caras-Severin (47) and Hunedoara (42), followed by a group of 13 counties with 36 – 21 reserves, and a similarly large group with 18 – 11 reserves. Another 10 counties register fewer than 10 reserves, while two counties (Ialomița and Teleorman) have none.

The spatial distribution shows that the counties situated in the west of Romania have more areas protected than those located in the east and south of the territory (Olt 6, Giurgiu 4, Brăila 2 and Călăraşi 1), whereas some counties have no protected areas of national importance at all.

In terms of the summated area of reserves by county, the situation looks altogether different. For example, if Tulcea County with its Danube Delta Biosphere Reserves is not taken into the equation, then Caraş Severin with its 32,100 hectares of protected natural areas ranks first. Next come Neamț (24,600 ha), Sibiu (18,700 ha), Argeş (17,000 ha), Mureş (14,100 ha) and Constanța (12,700 ha). There are 17 counties with small protected area (6,500 – 1,000 ha), 12 counties with between 1,000 and 100 hectares protected and three counties with under 100 hectares of protected areas. There are cases when, despite the great number of protected areas, their overall surface is pretty small, e.g. Alba County, which ranks first in terms of number of reserves, liss on position 25 in regard of overall area (782 ha) given that 32 of its protected areas have under one hectare each. In other counties, updating the documentation and digitizing the information revealed protected areas to be larger than reported in Law No. 5/2000. For example, boundary digitization of the 18 reserves in Vrancea County added 2,634 hectares to the previously reported 2,877, raising their surface to 5,511 hectares.

The protected area of the Vâlcea County reserves listed in the law with 614 hectares reached more than twice that figure (1,458 ha) after boundary processing. A similar situation has Braşov County (from 5,400 ha to 8,476 ha) and other counties, too. It follows that this approach has substantially enlarged protected natural areas by making a new delimitation and harmonizing the documentation received from the Environmental Protection Agencies, County Forest Direction, Local Bodies and Research Institutes.

In the big relief units – mountains, hills and plains, the highest proportion of protected areas (both in respect of number and surface) is found primarily in the mountainous region, next in hills and plateaus, and very little in the plains. A drawbach in securing true protection and development for protected species, irrespective of territorial biodiversity is the fact that numerous protected areas (20% of the total) are very small (under one hectare), 244 cover between 1 – 10 hectares and only 155 are larger than 155 hectares. Creating buffer zones around these small areas would be a good idea. Looking at spatial distribution it appears that the southern and south-eastern parts of the Romanian Plain have few or no reserves at all (two counties).

There is little, if any, interest in biogeographically important zones such as the steppe and the sylvo-steppe known for their ecosystems of great scientific value, ecosystems in which the natural vegetation has been almost completely replaced by human action. Therefore, the duty of research is to identify and make proposals for the delimitation of areas representative for these types of ecosystem, while the Ministry of Environment has the task to protect them.

The Ministry's initiative to increase the number of protected natural areas and natural and national parks is welcome, indeed, moreover so as it is in these very areas that areal protection to representative ecosystems can be ensured by adequate management. As known, biodiversity is best maintained and developed in large enough spaces.

The exchange of data and information with the other groups of specialists involved in the Biodiversity Information Management System (BIMS) has largely been facilitated by the Ministry of Environment and Water Management with a view to bringing together the facilities held by each partner. The thematic workshops and the course in using GIS and remote sensing techniques to manage biodiversity information enabled the exchange of information with county-based Environmental Protection Agencies.

The various stages of the project provided basic information for the elaboration of a series of normative acts among which we would recall the following:

The Government Decision No. 230/2003 for the delimitation of the biosphere reserve, of national and natural parks and the setting up of their administration (Official Monitor No. 190/26.03.2003) contains GIS-produced color maps of protected areas (Fig. 1).

The Minister's Order No. 552/2003 approving inside zoning of natural and national parks for the conservation of biological diversity (Official Monitor No. 648/11.09.2003) contains black and white maps of inside zoning.

The Government Decision No. 2151/2004 institutes a protected natural area regime for new zones (Official Monitor No. 38/12.01.2005).

The Government Decision No. 1581/2005 institutes a protected natural area regime for new zones (Official Monitor No. 38/12.01.2005).

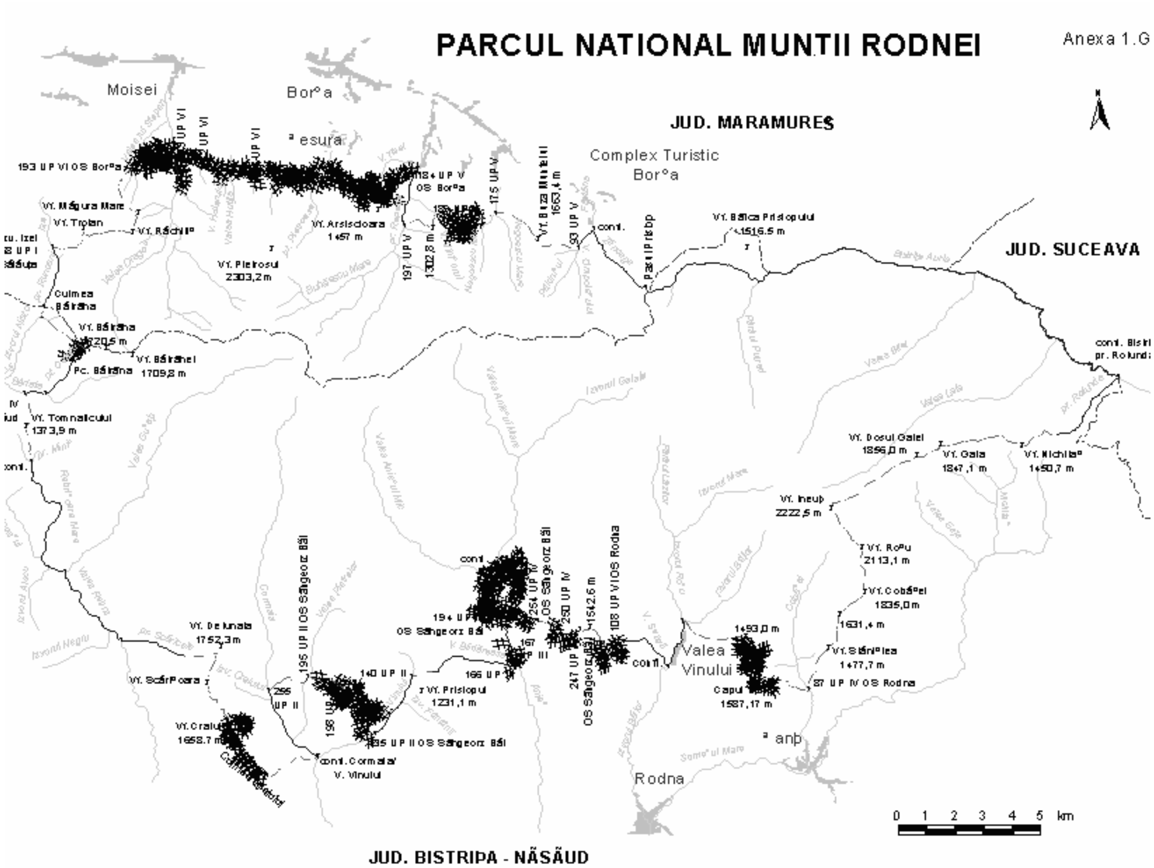

Fig. 1. ***The boundaries of ˝Munții Rodnei˝ National Park.***

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Geographia Technica, No. 2, 2006, 40 - 50

UP-TO-DATE ASPECTS CONCERNING THE IMPLEMENTING OF THE GIS TECHNOLOGIES IN THE MANAGEMENT OF THE AGRICULTURAL TERRITORIES IN THE REPUBLIC OF MOLDAVIA

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ABSTRACT. – Actual aspects of GIS technologies' implementation for agricultural lands management in the Republic of Moldova. The subject of this paper is to present information about GIS education in the Republic of Moldova and discuss related problems. Among more then 40 Moldavian universities, only 3 answered the inquiry that they teach GIS or subjects with GIS contents. They are the State Agrarian University of Moldova, the Technical University of Moldova and the State University from Tiraspol. In all departments courses of GIS or with GIS content are a part of undergraduate study. The students in these courses are introduced to data acquisition, data storage and management as well as data analysis and visualization. GIS teaching at the postgraduate level is not organized. The most important problems in teaching GIS at Moldavian universities are: the lack of appropriate academic and scientific staff; the absence of GIS literature in the Romanian language; the acquisition costs for geodetic equipment (especially GPS receivers) and for some graphical and attribute data; the shortage of teaching time and lack of understanding methods of spatial analysis. There need to implement and to promote GIS and LIS teaching and training to other specialties and postgraduate study programs.

1. GENERAL ISSUES

During the 90´s, while implementing the reform of the agriculture in the Republic of Moldavia, about 2 milion hectares of land had become private, which means about 60% of the country's territory. The average size of a farm, divided in 2-7 plots situated at a considerable distance between them and on which fitotechnical production (horticulture and wine growing) takes place does not overpass 1.5 ha. Besides, 1.245.000 families had received in property plots belonging to houses and gardens. All the project working, including subsequent plotting, preparing and release of Titles for autoidentification of the land owners' rights, have been effectuated by engeneers-specialists in the field of cadastre and territory organization, based on GIS Lcad and MapInfo software.

The Republic of Moldavia prepares at present the introduction of a new geodesic network, five geodesical points being already measured and connected to EUREF; there were effectuated geodezical elevations in order to re-establish the geodesical nework of 1st category. Works to create a new levelment network and new cadastral maps are being held; there are also some steps in the field of editing new tematic maps of the cities, of the whole country. Many geodesists, topographists, fotogrammetrists, cartographists and other specialists are involved and trained in this activity, using traditional methodes as well as the most modern equipement, including GIS software.

This aim can not be reached without the support of a lot of well trained specialists, keen users of GIS techniques, capable to provide rapidly the nececery information to the decision factors.

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As a conclusion to the exposed data:

1. The present problems of the management of the agricultural lands can be solved only by qualified specialists from different fields of the national economy.
2. All these specialists should be able to fulfield the tasks at the level of modern requirements, only by applying the adequate technologies, methodes and performant equipements, including those in the field of GIS.
3. Reaching the enumerated aims, implies the endowment of the specific teams of executors with the proper GIS hardware and software.

2. THE PRESENT SITUATION OF THE TRAINING IN GIS FOR APPLICATIONS IN THE MANAGEMENT OF THE AGRICULTURAL FIELDS

Only in three Universities (*State Agrarian University of Moldova, Technical University of Moldavia and Pedagogical University of Tiraspol*) among the 40 in the Republic of Moldavia, GIS discipline is tought, along wih other disciplines containing GIS elements in the curricula. All these studies are held only at the diplomate universitary level, where students learn the general theory of GIS, the methodes for acquisition, hoarding and management of data, their validation and processing, elements of modelising and spatial analysis. No University has curricula ellaborated and implementated at the level of Master.

The Faculty of Cadastre and Law - State Agrarian University of Moldova has three specialties - Cadastre and territory organization, Evaluation of Buildings and Environment Engineering - where students can get familiar with the GIS basis, at the level of simple user. GIS disciplines have the greatest weight in the first specialty. Here, besides GIS discipline (6 credits), other disciplines in connection with GIS technique are taught: Automation of cadastre works (4.5 credits), Project and organization of territory (5.5 credits), Remote electronic measurements (2.5 credits), Geodesy (8 credits), Topography (8 credits), Cartography (7 credits), Photogrammetry and remote sensing (6 credits), Spatial geodesic technologies (2 credits). These disciplines deal with well-known software as Idrisi, MapInfo, Arc/Info, Arc/View, InventGrad, AotoCad, AotoDesk as well as the with the smaller LCad and LegalCad.

In the frames of the First Project of Cadastre, UASM - State Agrarian University of Moldova and UTM - Technical University of Moldavia had received generous donations of hardware and software modern equipment up to hundreds of thousands of dollars, for topo-geodesic measurements. UTM managed to obtain and implement a Project TEMPUS-TACIS "Graduate education in the field of GIS"

There is to notice also the acute lack of teachers; of didactic-methodic literature in Romanian; the huge cost of topo-geodesic equipment (especially GPS) and of the tool needed in the acquisition and management of the data of the type attribute and spatial; the small number of lectures in spatial analysis. The majority of the specialists, scientists, teachers and decisional factors from other fields in the country does not hold a clear vision on the necessity and importance of the study and implementation in their activity of GIS technologies. The majority of the specialists in economy does not have basic knowledge in the field of GIS, in contradiction with the Decision of the Government of the Republic of Moldavia concerning the Geographical Informational National System, adopted in 2003.

Thus, an important issue arises: that of preparing teachers in the field of projecting GIS technologies and applying them in different fields of the social-economical life, among which, of great importance is the field of the management of the agricultural lands.

In order to achieve this Program, teachers and specialists from different fields are needed; their preparation could be organized at the level of master and post-graduate studies, at the level of user or specialist in implementing GIS in the following specialties:

- Geo-informational technologies applied in agriculture (for agricultural and biology specialties graduates)
- Geo-informational technologies applied in the environment engineering (for monitoring and improving the environment specialties graduates)
- Geo-informational technologies applied in cadastre and territory organization
- Geo-informational technologies applied in the management of natural resources
- Geo-informational technologies applied in the evaluation of buildings etc.

Scientifical research in the view of applying GIS technologies along with organising the educational process will be held in the following directions:

- creating the support for spatial data at national and international level;
- applying GIS at the level of State Administration;
- applying GIS in agriculture;
- applying GIS in the field of cadastre and territory organisation;
- applying GIS in the field of building evaluation;
- applying GIS in the field of environement protection, the use and management of natural resources;
- applying GIS in ecological monitoring;
- applying GIS for editing maps with different purposes, automatisation of cartographic works;
- applying GIS in remote electronical measurement in different GIS projects;
- applying GIS in physical and human Geography
- creating and distributing data obtained with the help of GIS technologies, with free access for public

3. THE CONCEPT OF TRAINING

During its short history, GIS followed an evolution from the beginning of the 70ies in some Universities and Scientific Institutions to the first applications in the military and public administration fields in the 80ies and continuing to business and others fields of the social-economical life in the 90ies. In the contemporary informational society, GIS technologies along with energy and telecomunication became the main developing force of business. Related to the above mentioned fact and in concordance with the existing tendencies in the universitary education, a education strategy in the field of GIS should be established. Developing universitary curricula and methodes of training will be prior to practical applications of the programme and implementation in different real projects. At present, the majority of the Universities use in the educational process, predominantly standard packages of some known software and less their own. We evaluate that the following forms of education would be possible:

- graduate studies (classical education on different specialties either at diploma level or master; many universities in the world give priority to the last one in the field of applied science);
- politehcnical universitary studies (with more practical than theoretical studies in the field of Geomatics of Informatics with GIS application)
- life-long studies (different forms of self-training, especially in the fields of technics, calculating and ellaborating of advanced programms)
- perfectioning in the frame of international projects;
- post-universitary studies (stage courses, professional „recycling”, an efficient and quite cheap solution);
- low frequency studies (less expensive educational form practiced in many countries);
- remote studies (developped especially in the last few years, but requires an attentive preparing)

After answering at the question: „How should education be?” – another one rises – „What should be studied?”

The last definitions of GIS treat it as a complex and technic informational system (networks, hardware, software, data, people, technological processes) and bring us close to the questions above. In modern science and practice, two directions appeard in science and education: ellaborating and implementing GIS systems on one side and applying them in the view of modeling spatial data on the other side. These two directions are presented by two categories of specialists: a) GIS ellaborators, represented by engineers, information engineers, geodesists and b) GIS users – geographers, cadastre-engineers, land architects, geologists and many others who apply GIS technologies as a tool for analysis and spatial modelations.

Engineers who deal with ellaborating and implementing GIS systems create the specialized informational system for the processing of geographical data. Besides analytical geometry, structure and typology of spatial data, management of geographical data, these specialists need advanced knoledge in the field of ellaborating software, compatibility and inter-operability of the the distributive data processing systems, of the architecture of modern softs and proceedings for their ellaboration. The management and control of the huge volume of spatial data requires the application of new techniques and methodes for implementation of spatial modelling, based on the knoledge of selecting and storing methodes, and simultaneous processing of data and spatial information

Besides specific professional knoledge, geographers and other specialists in GIS, need to know the GIS techniques, the graphic analysis functions, the operations of GIS analysis, spatial statistics, mathematical and statistical modellations, methodes for integrating the existing models with the available data sources and means of visualisation.

3. THE DEVELOPEMENT OF THE CURRICULA

The key-problem in the development of curricula is education. As mentioned above, four categories of specialists who require adequate training in GIS field could be identified:

- GIS users who apply GIS techniques in their day-to-day professional activity, even for simple purposes, without problematical situations and who do not require the knowledge of the informational system in detail;

- specialists in GIS development who have basic knowledge about GIS as a informational system as well as about modeling, projecting and implementing processes of GIS applications, GIS analysis, general principles for different solutions. They should be able to activate as project manager, as members of the teams for spatial modulation, but they do not know good enough all the technical solutions;

- GIS engineers who project and implement GIS applications from the technical point of view, being specialized on data management, programming and spatial analysis, and visualization with the help of software. They have the obligation to know in detail the new technologies for elaborating GIS software;

- GIS analysts who are very familiar with spatial modeling as well as with the mathematical methods of solving the exposed problems.

After identifying these four professional profiles it becomes easier to establish the content of the curricula. Thus:

a) GIS user:

- **aptitudes**: to be able to use GIS as a procedure in his day-to-day activity;

- **abilities**: to have general knoledge in computer use, GIS architecture, digitization procedures and peripherical equipment, GPS, specific GIS software, SGBD, numerical modelations, theory basis, GIS concepts and terminology.

b) GIS development specialist

- **aptitudes**: to be able to apply GIS technologies and possibilities in new circumstances; activate as project manager in ellaborating or developping GIS;

- **abilities**: to know the principles of the GIS projecting process: fesability study, GIS definition, costs and benefits of GIS, the possibilities of data management, the knoledge of the principles of spatial modelling and of the solutions for the spatial problems; the knoledge of the support disciplines: geodesy, topography, cartography, fotogrammetry, remote electronical measurement etc.

c) GIS engineer

- **aptitudes**: to be able to develop and trade new GIS technologies and their appllications;

- **abilities**: to know the entire process of ellaborating the software, from conceptualization of the problem to its implementation: fesability study, technical solution, new product marketing, special problems in managing the database and inter-operability, testing; interface projecting, management, hardware and GIS networks, telecomunication.

d) GIS analist

- **aptitudes**: to be able to effectuate analysis and spatial modelletions;

- **abilities**: to know mathematical modelation, numerical and simulating methodes; to accumulate knoledge from different aplicative fields: physical processes, ecological, natural, socio-human etc.; processes decision making, technologies to ellaborate GIS software; existing data sources and their quality.

CONCLUSIONS

We notice, in the development of the concept of education and of curricula in the field of GIS, their interdisciplinary and multidisciplinary nature, which does not allow, in our opinion, to concentrate the teaching to a separate, distinctive and only one speciality. GIS can not exist independently, without the theoretical foundation assured by some support disciplines as: applied mathematics, statistics, geography, geomatics, nature sciences and engineering, informatics, informational technologies etc. GIS universitary lectures should become a didactical discipline for the majority of the specialists envolved in the management of the agricultural territory, it should have a central place in their curricula. Up-to-date, in the frame of the existing curricula, this course should be compulsory for some specialities (geography, cadastre and territory organisation, geomatic, environement engineering, building evaluation, ecology etc.) at the level of user, developper or GIS analist, - maybe with some modifications –, and also for master post-universitary or other studies. At the level of GIS engineer, the facilities offered by existing specialities are useful – Informatics and Informational technologies.

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TRENDS IN 3D TOURIST MAPPING

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ABSTRACT. – Trends in 3D tourist mapping. 3D representations are much more effective and more precise. Today's tourism is still based on analogical products, presented in travel guides and brochures. Today's tourism is still based on analogical products, presented in travel guides and brochures. The result is the necessity of 3D representations that may convince the operators of the effectiveness of a tourist map, its role in advertising and promotion.

1. CHALLENGES

Today's tourism is still based on analogical products, presented in travel guides and brochures, without using the technical support offered by digital cartography and the new ways of disseminating cartographic products.

Digital support of 3D representations is much more effective and more precise, but the companies using the latest generation products are those affected by a strong concurrency (in the Alps area) and are willing to improve their image and economic performances. In the travel and tourist industries it is important that potential customers can quickly find all the information they need.

The tourist boards are increasingly looking for new ways of presenting their main assets drawing on the full range of analogue and digital media. (Almer, A & Stelzl, H. , 2000) Tourist companies and organizations take an increasing interest in the development of a Travel, Leisure and Tourism Information Service.

Travel, Leisure and Tourism Information Service **(TLTIS)**

- Tends to be an innovative system which offers information on a specific resort, region, entertainment, businesses;
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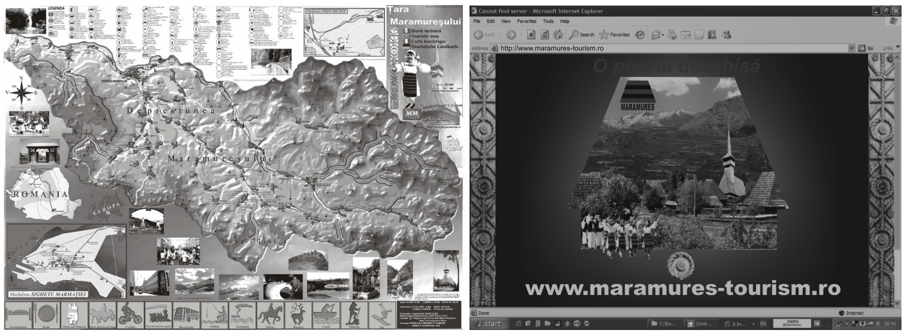

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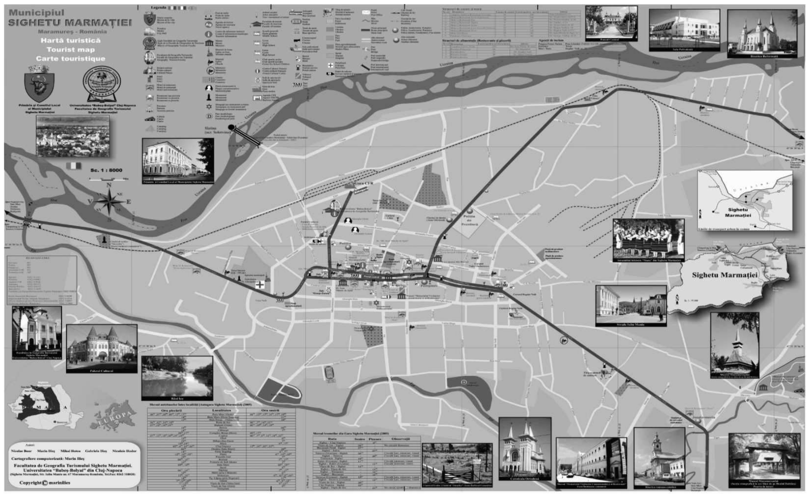

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CONCLUSIONS

The great challenge of 3D mappers its o produce a perfect map, functional as well as aesthetic. Elaborated and well refined products will be the only ones that may convince the operators of the effectiveness of a tourist map, its role in advertising and promotion.

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TRENDS IN 3D TOURIST MAPPING

GABRIELA ILIEŞ[1], M. ILIEŞ[1]

ABSTRACT. – Trends in 3D tourist mapping. 3D representations are much more effective and more precise. Today's tourism is still based on analogical products, presented in travel guides and brochures. Today's tourism is still based on analogical products, presented in travel guides and brochures. The result is the necessity of 3D representations that may convince the operators of the effectiveness of a tourist map, its role in advertising and promotion.

1. CHALLENGES

Today's tourism is still based on analogical products, presented in travel guides and brochures, without using the technical support offered by digital cartography and the new ways of disseminating cartographic products.

Digital support of 3D representations is much more effective and more precise, but the companies using the latest generation products are those affected by a strong concurrency (in the Alps area) and are willing to improve their image and economic performances. In the travel and tourist industries it is important that potential customers can quickly find all the information they need.

The tourist boards are increasingly looking for new ways of presenting their main assets drawing on the full range of analogue and digital media. (Almer, A & Stelzl, H. , 2000) Tourist companies and organizations take an increasing interest in the development of a Travel, Leisure and Tourism Information Service.

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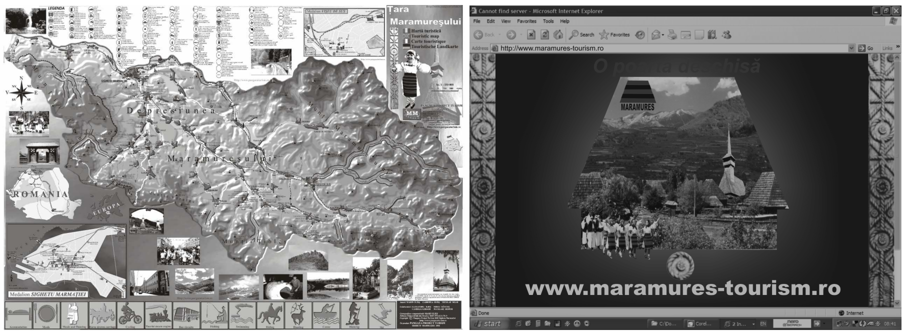

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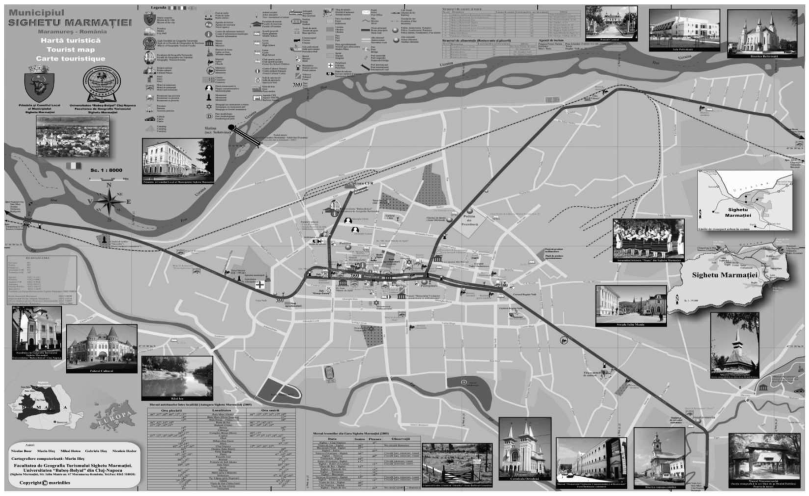

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BURNT AREA STATISTICS 3D GIS TOOL FOR POST-FIRE ASSESSMENT

M. MATEESCU[1]

ABSTRACT - The apparent lack of a robust tool to produce 3D rendering and animation of burnt areas lead to the development of the BAS2 (Burnt Area Statistics 2) utility. As the post-fire burn assessment is becoming more and more important in developed countries (USA, EU), systems to rapidly evaluate a post-fire situation are being set in place. The reporting phase being the crux of this process, a tool to create accurate, beautiful and customizable 3D scenes is a welcome guest in the GIS world. Released under an *open source* license, this utility can be extended by interested actors.

Keywords: GIS, post-fire assessment, 3D rendering, 3D graphics

1. INTRODUCTION

This paper presents the BAS2 (Burnt Area Statistics 2) reporting software, intended to support the reporting stage after a forest fire.

A wildfire, also known as a forest fire or vegetation fire is an uncontrolled fire often occurring in wild land areas, but which can also consume houses or agricultural resources. The most common cause is human carelessness; other causes include lightning, arson, volcano eruption as well as meteorites.

Forest fire management includes three stages:

- *Pre-fire* : prevention, risk assessment,
- *During fire* : combat tactics, mitigation, intervention policy,
- *Post-fire* : damage assessment, rehabilitation policy.

Post-Fire Burn Assessment is an increasingly important subject in affected countries or regions. The U.S. National Parks Service is implementing various post-fire burn assessment methods since the '70s. Closer, the European Union considers wildfires as one of the top priorities in its environmental agenda; thus, the Joint Research Center maintains the "*EU Fire Database*" - in force of the (EC) No 2152/2003 directive-, comprising a temporal and spatial history of forest fires in 14 Member States of the Union and Romania. As the JRC recognizes, the reporting of forest fires is mostly on a summary basis, lacking the mapping and assessment of occurring fires.

In order to submit clear and comprehensive status reports to decision factors so they can take sound decisions, we have developed a software tool to create accurate surface counts and nice 3D maps of burnt scars.

The program presented is not a GIS extension but a fully standalone, open source application. It is intended to be a replacement of the ArcScene product from the ArcGIS family, the ArcScene being unable to process even fair to medium datasets.

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2. ACTUAL STATUS

Several procedures were developed to manage the post-fire burn assessment, from the economic as well as ecologic point of view. They differ by aim, domain and of course by given / available inputs. A method based on remote sensing using Landsat-TM images and introducing indices to measure burn severity -similar to NDVI- was developed for the US National Park Service (Key & Benson 2003). From the ecological perspective, the assessment of vegetation regeneration/recovery after forest fires was conducted using Landsat-TM images through classification techniques using Normalized Difference Vegetation Index (NDVI) and Normalized Difference Moisture Index (NDMI) by a team of researchers from the U.S. Yosemite Park Administration (Syfert & al, 2005). A post-fire watershed assessment study in order to identify sensitive erosion prone spots in order to implement emergency rehabilitation of burnt areas, using a hydrologic modeling tool was conducted by (Goodrich & al, 2005). Abstract statistical methods such as Principal Components Analysis (PCA) of multi-temporal multi-band images taken before and after forest fires were successfully ran and documented (Chuvieco 1999), pointing out that local variance (due to fires) appears in low-order components(Siljeström & Moreno, 1995).

To outline the importance of post-fire assessment, one can check the policy of two of the most powerful blocks in the world *vis-à-vis* of forest fires:

- Regarding EU fire management, it is stated that *"the information on areas burned by fire at the European level is normally aggregated at administrative level and ignores the exact spatial location and extent of fires"* (JRC 2006). The EFFIS program, set up to respond rapidly to occurring fires, implements a rapid damage assessment system by continuously analyzing MODIS as well as TERRA and AQUA multi-band satellite imagery. Its aim is to establish a system of rapid post-fire damage assessment, so quick intervention can be triggered to prevent further damage by soil erosion or increased fire risk.
- On the U.S. Level, NASA has set up a near real-time hazards monitoring system (that includes forest fires), that mainly relies on MODIS imagery (which the Europeans are taking over as well).

The above-mentioned systems are web-based , their reporting ability being somehow limited, and their main importance being the delivery of near real-time data for further processing.

In the particular field of burnt area reporting, as mentioned, the ESRI ArcScene extension is not doing an amazing job. This extension is very costly both financially and computationally. From the computational point of view, ArcScene does not use any hardware graphical acceleration, thus being very slow and even crashing on complex graphics scenes.

Since the beginning of personal computing, at least 25% of the IT market shares were games, and the vast majority being video games. In time, graphic acceleration cards were supplied and today any computer possesses such a card that allows it to render extravagant

3D graphics without glitch. Special software libraries/interfaces were designed to provide a means to control vendor-specific hardware; the most popular being OpenGL and DirectX.

The BAS2 software utility (Burnt Area Statistics 2) is the heir of BAS (1) created in 1999 by I.Gitas, as an ArcInfo/Workstation batch utility. Today it includes very basic GIS functions (intersection and merging) and 3D mapping and rendering using OpenGL hardware acceleration, being able to spin a scene in real-time at an amazing speed.

3. OBJECTIVE

The BAS2 software is intended to cover the existing gap in the GIS world in 3D. Using as inputs the land cover map, a given fire perimeter polygon and an elevation map, BAS2 will output a fully customizable 3D scene of the burnt perimeter. This scene would be colored and viewed at will.

A secondary output of BAS2 is a cumulative report of "real" burnt areas (so, 3D surfaces). Usually land cover maps expand over hills and valleys, and the 2D area is considerably smaller than the real surface (that includes slopes – the 3D one).

4. UTILITY. POTENTIAL CONTRIBUTIONS

Being *open source*, BAS2 is not only totally free but also available for modification/customization/extension by others. That said, the targeted users are those users that cannot afford the 3D extension of ArcGIS as well as people using other cheaper or even free GIS products. We assume that the users of this utility would be forest service engineers or related jobs, and the audience – decision factors / authorities.

By its ease in use (wizard-like interface), we assume BAS2 will be used at international scale. It will contribute to the foresters community with accurate, beautiful and quickly produced reports.

5. IMPLEMENTATION

The product was developed as a Windows executable, using the Borland Delphi development environment. Several parts of it are developed by thirds using open licensing (GPL/LGPL or free for non-commercial use), such as:

- GPC – General Polygon Clipper by Alan Murta , 1999
- TDBF – freeware DBF component for Delphi
- OpenGL12 – from Project JEDI (LGPL), parts copyrighted by Microsoft, Silicon Graphics Incorporated, NVidia , Brian Paul ,Mike Lischke, John O'Harrow,Eric Grange,Olivier Chatelain,Tom Nuydens,Matthias Thoma,Sven Bobrowski.

The Sahpefile format reader and all other modules were developed from scratch.

The workflow of BAS2 is easily guessed from its interface (Fig. 1), as follws:

1. *Definition of inputs*
   a) Fire Perimeter - as ESRI Shapefile (SHP+SHX+DBF)
   b) Land Cover Map - as ESRI Shapefile (SHP+SHX+DBF)
      - specification of database field containing category identifier
   c) Elevation Data (TIN) - as ESRI Shapefile (TIN, obtained either from DEM or from contour lines)
2. *Intersection*
   a) Land Cover layer is intersected with the Fire Perimeter polygon
   b) The TIN is also intersected with the Fire perimeter (to ease the following computation)
   c) results of previous operations are intersected.
      - *Note:* instead of executing only two intersections: $LC \cap FP$, then $\cap\ TIN$, BAS2 executes three, but limits the number of features to be intersected by „clipping" the land cover and the TIN with the Fire Perimeter polygon. Ex: Land Cover has 500 features, the TIN – 700 triangles, the „straight" way would be : $500 \cap 1 \cap 700$ resulting to -say- Q features, after 35000 operations. By clipping with the fire perimeter, we may have $500 \cap 1 \Rightarrow A$ (say A=*200)*, $700 \cap 1 \Rightarrow B$ (say B=*100*) and $A \cap B \Rightarrow Q$ features, after 500 + 700 + A*B = 21200 operations (33% faster).
3. *Display*
   a) Summary of real burnt areas by categories (ex.: vegetation type)
   b) Definition of the color table (1 color per category) and of visible categories
   c) Graphical 3D rendering of the scene. (possibility to take screenshots)

<u>Resources:</u>

- Any computer „younger" than 1999 should be able to run BAS2 perfectly.
- the more RAM , the better (256 MB a recommended minimum)

<u>Future foreseen development:</u>

- a Lazarus port : Lazarus is a free, open source RAD IDE like Delphi, a port to Lazarus will allow BAS2 to run on Linux, other Unixes and Mac OS X
- A DEM to TIN and a „Contour Lines Shapefile" to TIN module (now the TIN has to be created using a separate GIS product)

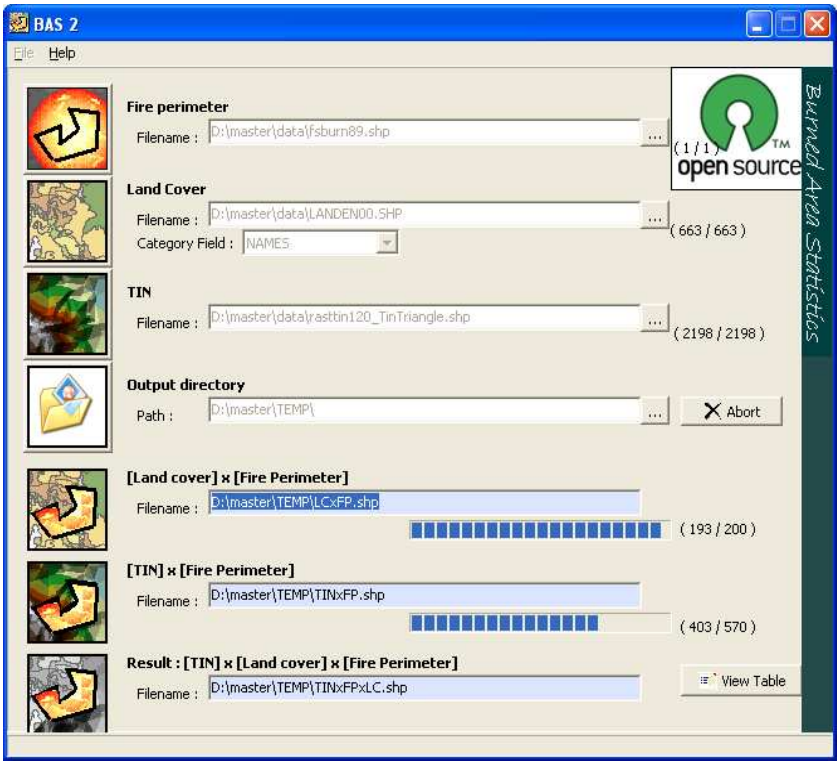


Fig 1. BAS2 screenshot. Interface is wizard-like (very intuitive usage)

6. CASE STUDY: THE 1989 FOREST FIRE IN THE ISLAND OF THASSOS

The island of Thassos is situated in the north-east of Greece (Fig. 2), and was formerly known as “the Green Island”.

Fig. 2 Island of Thassos

Incidence of forest fires increasing as tourism did, a series of fires swept the island in the 80's, from south to north in 1984, 1985 and 1989 burning most of the island as depicted in Fig.3.

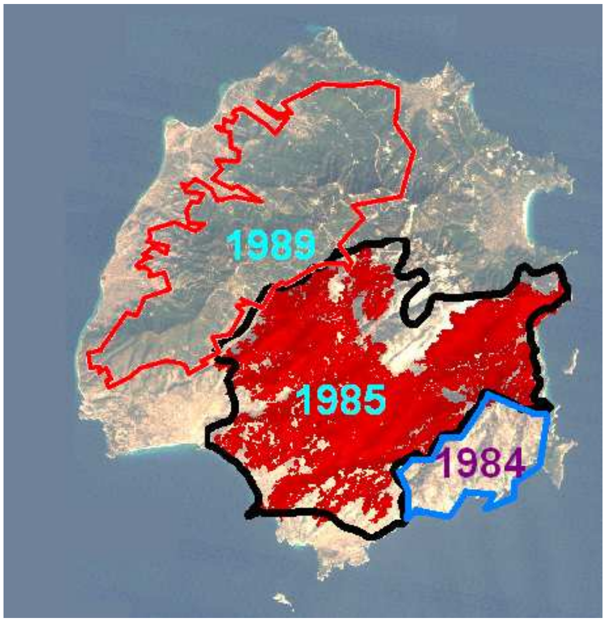


Fig. 3: Forest fires of 1984,1985 and 1989 in Thassos

For the present case study, we analyze the 1989 forest fire. The inputs are three ESRI Shapes (.SHP+.SHX+.DBF) and consist of the Fire Perimeter as measured by the Thassos Fire Brigade, a land cover map (from the CORINE database) as drawn in Fig. 4:

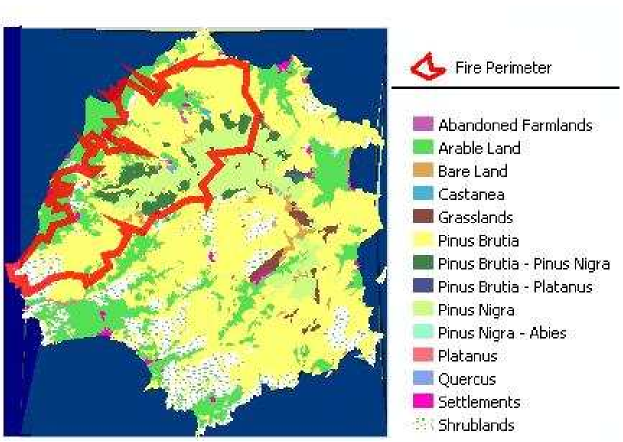


Fig: 4. Fire Perimeter and Land Cover Map (ArcGIS preview)

The elevation data (required for the third dimension data) is fetched as a TIN (triangular irregular network) layer, obtained from a 30m/pixel DEM. The input TIN is presented in Fig. 5:

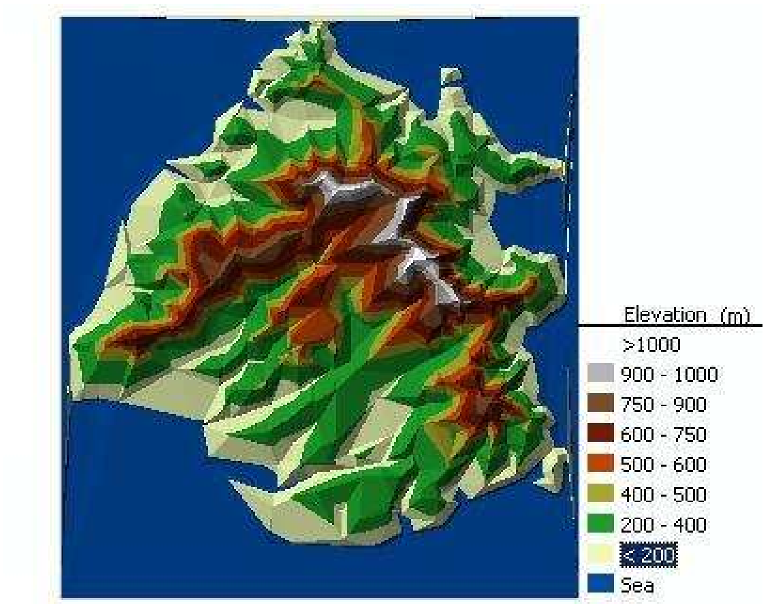
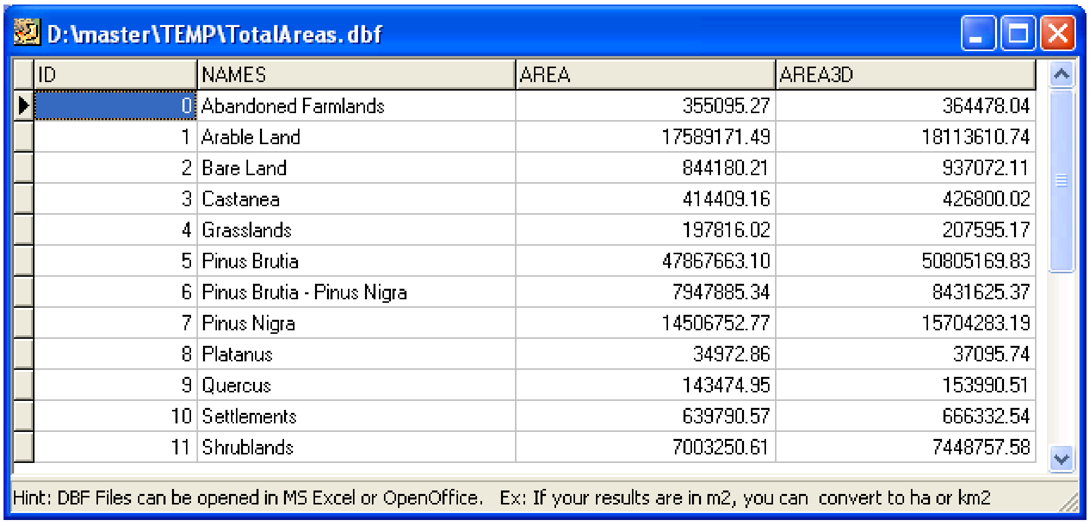


Fig.5: Elevation data as TIN – (ArcGIS preview)

Once the inputs were set up, the intersection process may start (after pressing the COMPUTE button). All temporary files are stored in the "Output Directory"; So the user may save this project from File/Save As... and reload it later, without needing to restart the time-consuming intersection process.

As soon as the intersection is ready, the user receives the report of total burnt areas (2D as well as 3D, real surface) (Fig. 6). This output is also stored in the output directory as file **TotalAreas.dbf**, which can be later opened in spreadsheet tools such as MS Excel or OpenOffice Calc for further processing.



D:\master\TEMP\TotalAreas.dbf

ID	NAMES	AREA	AREA3D
0	Abandoned Farmlands	355095.27	364478.04
1	Arable Land	17589171.49	18113610.74
2	Bare Land	844180.21	937072.11
3	Castanea	414409.16	426800.02
4	Grasslands	197816.02	207595.17
5	Pinus Brutia	47867663.10	50805169.83
6	Pinus Brutia - Pinus Nigra	7947885.34	8431625.37
7	Pinus Nigra	14506752.77	15704283.19
8	Platanus	34972.86	37095.74
9	Quercus	143474.95	153990.51
10	Settlements	639790.57	666332.54
11	Shrublands	7003250.61	7448757.58

Hint: DBF Files can be opened in MS Excel or OpenOffice. Ex: If your results are in m2, you can convert to ha or km2

Fig.6: The report of cumulative areas per burnt category

This completed, the user is prompted to define a color table of elements to be rendered in 3D. A default color table is suggested. All elements are selected as “showable” by default. After this color table is defined, the software is ready to render the 3D graphics of the burnt scene (Fig. 7):

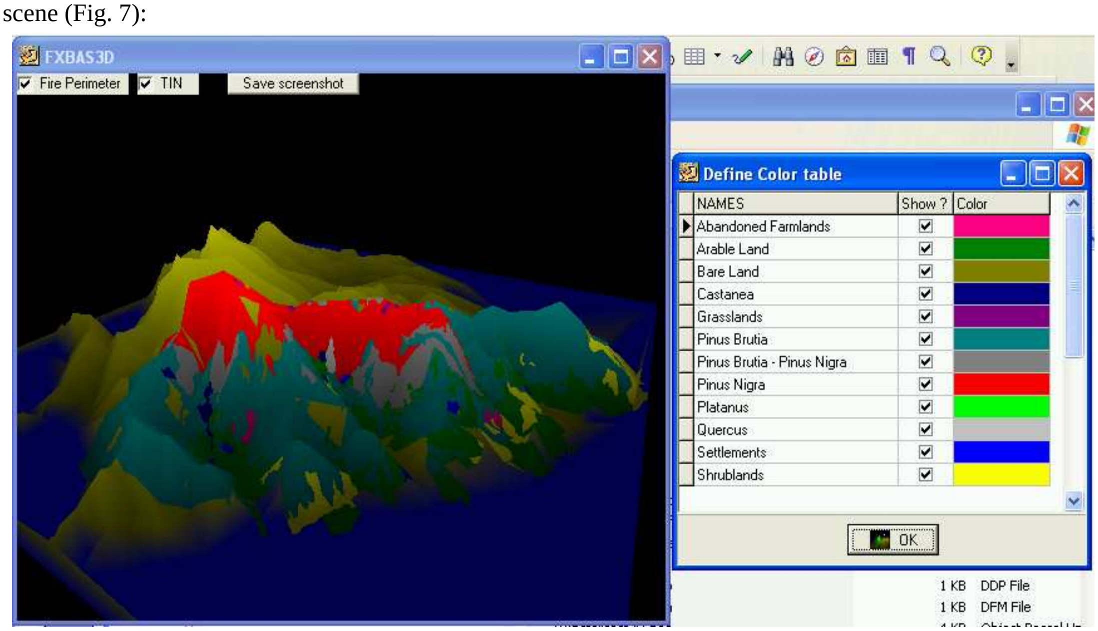


Fig.7 : default rendering of the burnt scene(all categories displayed)

The user may rotate the scene using the mouse (much like a 3D game) and zoom in/out using the mouse wheel. Different perspectives may be achieved (Fig.8):

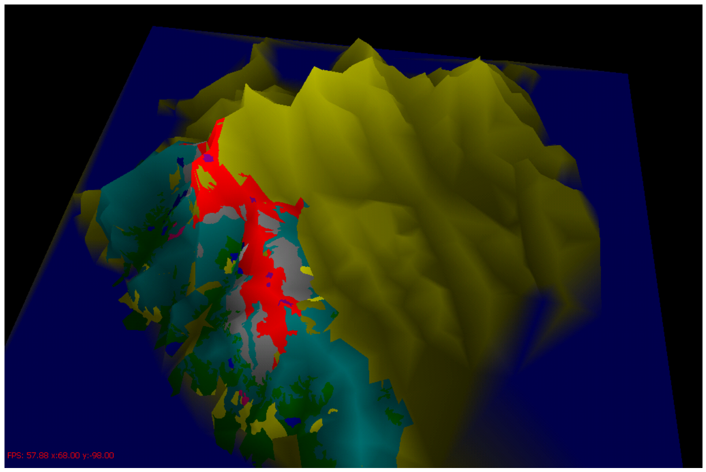


Fig.8: Different perspective of the same scene. Screenshot took using the built-in function.

It is on the user's latitude to choose all or just some of the elements to be rendered. In the following scene, only *Pinus Brutia* species are to be drawn (Fig.9):

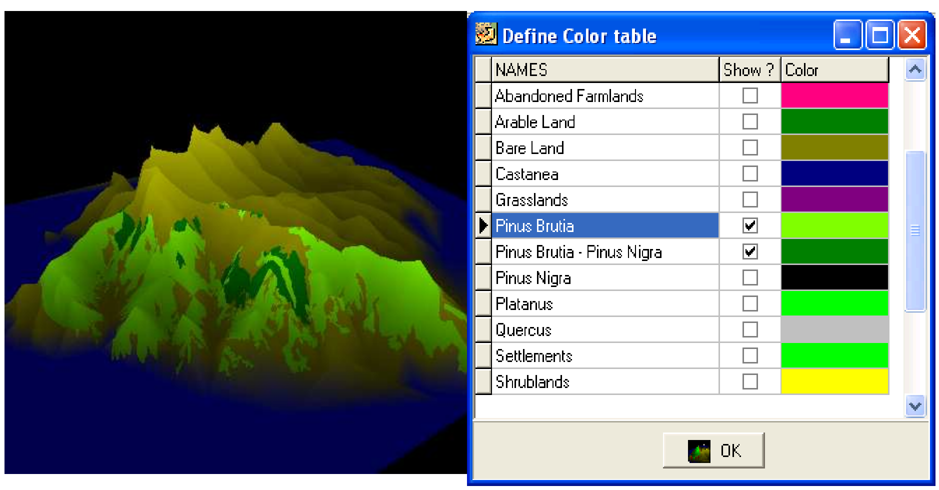


Fig.9: Rendering of Pinus Brutia and Pinus Brutia-Pinus Nigra categories

During rendering, heights below sea level are drawn in blue (“navy”) and the 3D surface is drawn in shades of yellow. The user may wish to see only the 3D decorum, only the burnt surfaces or both (default). A “Take Screenshot” function is also provided.

7. CONCLUSION

The BAS2 utility is a robust and useful tool to produce accurate and comprehensive three-dimensional scenes to be used in post-fire assessment reports. Quantitative results (areas) are also provided. Usage of hardware 3D acceleration (OpenGL) makes BAS2 a faster utility than other alternates on the market. In extenso, BAS2 can be used for general 3D mapping of land covers, the segmentation of vegetation layers on altitude, for example, being very intuitively seen in such a 3D scene.

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ADVANTAGES IN USING *GIS* FOR THE MANAGEMENT OF WASTE *IT&Tc* EQUIPMENT

MICHAELA DORA MIHAILESCU[1], L. DASCALESCU[2], AL. IUGA[3], R. BELECA[3]

ABSTRACT. – Avantages de l'utilisation des *SIG* pour la gestion des déchets d'équipements informatiques et de télécommunication. Le papier analyse les perspectives d'utilisation des systèmes d'informations géographiques pour faciliter la gestion des déchets d'équipements électriques et électroniques, notamment de ceux provenant des produits informatiques ou de télécommunication. Ce travail a été stimulé par les efforts législatifs faits par l'Union Européenne et par la Roumanie afin de contrôler et de réduire les quantités des déchets ultimes, ayant comme but la protection de l'environnement. La surveillance des sources de déchets, la distribution géographique des producteurs et des centres de collecte, le routage des moyens de transport des déchets, la gestion des matériaux obtenu après recyclage ne sont qu'une partie des points d'intérêt de la mise en place des *SIG* dans ce domaine. Le papier discute dans cette perspective les avantages multiples de la démarche *SIG*.

*

Selective collection of waste electric and electronic equipment (*WEEE*) is a main goal of the European and national legislative organisms, aiming to eliminate the hazardous materials, as well as to collect and recover the recyclable materials, in view of environment protection. The main responsibilities are to be charged to the producers of electric and electronic equipment (*EEE*) and the local administrations. The use of geographic information systems (*GIS*) is approached from the perspective of its application to *WEEE* management, particularly for the waste resulted from information technology and telecommunication equipment (*IT&Tc*).

1. COLLECTING AND PROCESSING *WEEE*

Recent studies in *WEEE* domain [1,2] approach the theme from the perspective of the terms imposed on European and national level with respect to the responsibilities and the methods to apply for the waste recovery and recycling.

The European Parliament and the European Council issued directive no.2002/96/EC with the following objectives [3]: (*i*) reduce waste arising from *EEE*; (*ii*) encourage separate collection and subsequent treatment, reuse, recovery, recycling and safe environmental disposal of *EEE*; (*iii*) improve the environment performances of all operators involved in the life cycle of *EEE* (producers, distributors and end-users) and specially the economic agents directly involved in the processing of *WEEE*. Directive 2002/95/EC adds severe restrictions on the concentration of certain hazardous substances in new products [4].

The above-mentioned directives are transposed into Romanian legislation, as governmental orders [5,6]. At the same time, the Ministry of Water and Environment, as

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well as the Ministry of Economy and Commerce have subsequently issued special orders to rule the way these decisions are put into practice [7,8].

Thus, according to the requirements of HG 448/2005, *EEE* Romanian producers are obliged to support the establishment of at least one collection center in each county, and at least one collection point in each town with over 100.000 inhabitants. Until the end of year 2006, one collection center must be established in each town with over 20.000 inhabitants. The local administrations should set up locations for the collection centers and have direct responsibilities in collecting *WEEE* from household end-users. The final goal is an average waste collection rate of at least 4 kg/inhabitant/year, until the end of year 2008.

Taking into account the direct responsibilities of the producers, they have been registered at the National Agency for Environment Protection, getting unique identifier numbers that give them the right to trade *EEE*. Thus, the origin of a product is controlled in view of managing it after the end of its use period, when it becomes a *WEEE*.

2. MANAGEMENT OF WASTE *IT&Tc* EQUIPMENT

According to HG 448/2005 [5], *WEEE* are composed of various electric and electronic equipment: large and small household appliances, *IT&Tc equipment*, consumer equipment, audiovisual and lighting equipment, electric and electronic tools, toys, sport and leisure equipment, medical devices, monitoring and control instruments, automatic dispensers.

Waste *IT&Tc equipment* represents about 10% of the total *WEEE*. In *IT* category, the main waste occur from central computer units, minicomputers, printers, personal computers (including monitors, keyboards, mice), laptop and notebook computers, actually any product or equipment for collecting, storing, processing, display and communication of data by electronic means. In *Tc* category, the main waste occur from used fax machines, telex machines, telephones of all types, answer machines, actually any product or equipment for sound or images or any other information transmission.

Waste from „grey products”, as *IT&Tc* product are often called, contain metals, plastics, glass, electronic boards, hazardous materials (batteries, accumulators). Recover and recycling technologies for these materials must process them in view of reaching the recovery percentage imposed by 2002/96/EC directive (75% of the average weight and 65% of the product value).

The authors of the present paper got interested in these waste *IT&Tc* equipment due to a research program CEEX on the recovery of recyclable materials [9,10], financed by the Ministry of Education. The project objective is the set-up of a pilot-center near Bucharest for the recovery of waste *IT&Tc* equipment, one of the main phases in the *WEEE* processing (fig.1). Analyzing the flow chart presented in fig.1 from the *GIS* applicability point of view, spatial distributed entities can be identified, associated with huge descriptive databases (*EEE* producers, distributors, household end users, industrial end users, collection centers, treatment stations, etc.) that justify the authors' preoccupation for revealing the advantages of this particular approach.

The first issue in starting even the planning of a GIS implementation must be the establishment of the real goals of the project and identification of useful output data for the eventual beneficiaries, two requests without which such an attempt may fail [11].

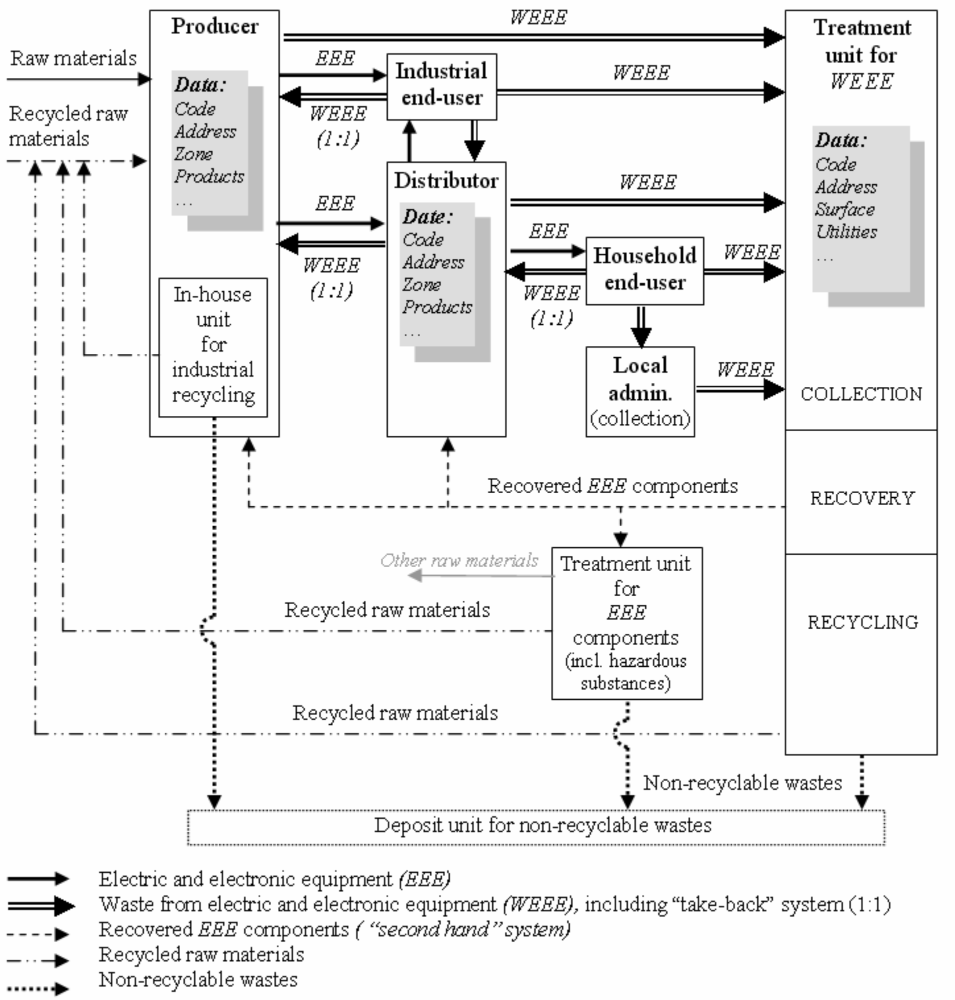

Fig.1. Schematic flow diagram of the electric and electronic equipment (*EEE*) and the correspondent waste (*WEEE*).

3. *GIS* FOR THE MANAGEMENT OF WASTE *IT&Tc* EQUIPMENT

GIS applications for *WEEE* management, particularly the management of waste *IT&Tc* equipment, can be ranged as "infrastructure" type. Previous studies on the *GIS* applicability in public administration [12], a domain specific for infrastructure *GIS* projects, synthetically underlines both the goals to be followed, as well as the advantages arising from implementing this *GIS* type applications.

In the particular case of the CEEX project mentioned before, the development of *GIS* applications for the management of *IT&Tc* waste is proposed. The initial goal is the facilitation of the running activities in the complex process of waste collecting and recycling. At the end, new digital information products are expected to be used in the decision process.

In order to implement a *GIS*, several steps should be carried out: analyze of the hardware and software technical specifications for each involved entity, data model design (define layers, graphical symbols, attached descriptive database structure definition, etc.), getting the input data from all available sources (local administrations, environment agencies, corporate organizations of *IT&Tc* producers, etc.), filling databases records, data validation according to field measurements. Examples presented in fig.2 and fig.3 display in graphical format the information supplied by the Ministry of Water and Environment [1], suggesting an eventual approach of the theme from a *GIS* perspective.

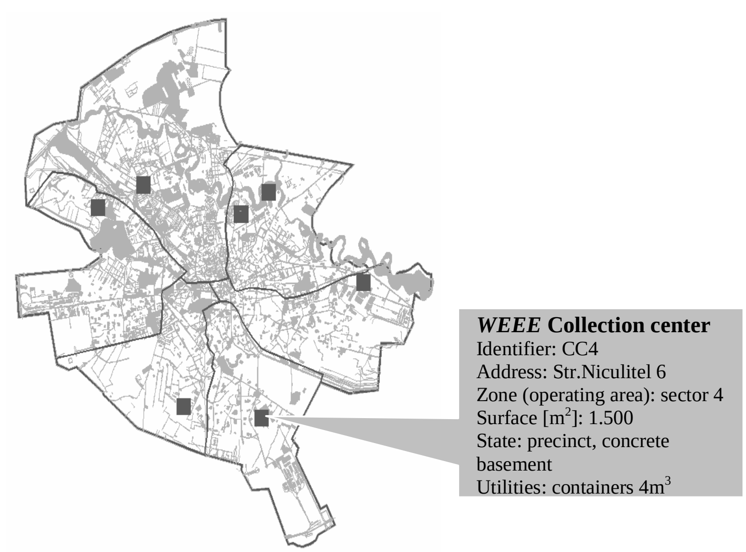

Fig.2. *WEEE* collection centers and the operating areas, geographically located (Bucharest municipality).

The final phase offers the possibility to get reports, analyses, thematic maps, etc., as a useful support for the management level (ex: tracing collected *WEEE* from an *EEE* producer to the nearest *WEEE* collection center – fig.3).

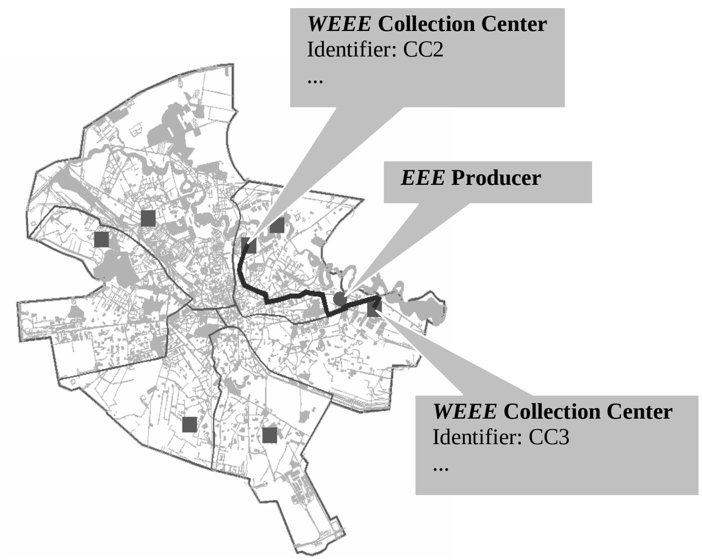

Fig.3. Tracing *WEEE* from the producer to the nearest collection center.

The advantages in using *GIS* may be „quantified" by means of the increased efficiency recorded by the beneficiaries, both from technical point of view, as well as under financial aspects, with respect to the present management of waste *IT&Tc* equipment.

From the technical point of view, the advantages are common to most *GIS* applications, such as:

- reliability and confidence in operation
- scalability (an important advantage from the point of view of managing more numerous collection centers and waste recycling infrastructure)
- interoperability (facile data exchange between different software platforms)
- quick and intuitive access to databases
- high speed decision process
- flexibility (adaptability to changes)
- unification of data models
- increased degree of conformity between the digital data and the actual in field situations
- complex query facilities on databases, using spatial and attributive criteria, etc.

From the financial point of view, the advantages of using *GIS* are difficult to estimate without a preliminary pilot project, developed on a narrow geographical area, aiming to record in detail the costs involved in this process. Therefore, the financial aspects will become part of a further approach.

4. CONCLUSIONS

The present paper approaches *WEEE* management, in particular that of waste *IT&Tc* equipment, from the perspective of the facilities offered by *GIS*, following the typology of other "infrastructure" type applications. The idea of using *GIS* in this particular domain is a consequence of identifying geographical distributed entities, with spatial and descriptive attributes, in the data flow of the complex material recycling system.

Using *GIS* in the recovery and recycling flow of waste *IT&Tc* equipment brings benefits, due both to the efficiency and suggestiveness of spatial analyses, as well as to the accuracy, accessibility and scalability of the specific databases (graphical and descriptive).

The use of *GIS* is suggested to the *IT&Tc* producers as an alternative for superior management of their own *WEEE*. At the local administrations level, the already implemented *GIS* can be enriched with special *WEEE* modules. Spatial location of waste sources, collection routing, studying the geographical allotment of main producers and processors, tracing the recovered products post recycling are but a few of the *GIS* applicability areas identified by the authors as having certain advantages for the *WEEE* management.

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ASPECTS REGARDING SOIL EROSION SPATIAL MODELING USING THE USLE / RUSLE WITHIN GIS

C. V. PATRICHE[1], V. CĂPĂȚÂNĂ[2], D. L. STOICA[2]

ABSTARCT – The present study refers to soil surface erosion and applies the Universal Soil Loss Equation within GIS in order to test certain methods of quantification for the control factors, as the USLE / RUSLE imply. The models' testing implies the comparison of estimated values with the ones measured for 2 small hydrographic basins placed in the Curvature Sub-Carpathians, tributary to the Zăbala River. At the same time the scientific paper includes the application of USLE model for the sterile terrigenous masses situated in the former sulphur quarry up in the volcanic Mountains of Calimani.

1. INTRODUCTION

The scientific approach regarding the problematic of soil erosion began in the thirties at the initiative of the American specialists in the field of pedology and agronomy. The research focused on the identification and quantification of the erosional processes control factors, resulting in the elaboration of the universal erosion equation (USLE) (*Wischmeier W. H., Smith D. D.,* 1978). The great majority of subsequent studies dealt with the calibration of the parameters intervening in this equation, in order to quantify real erosion and reproduce trusty measurements for concrete terrain parcels, characterized by particular combinations of the physical-geographic and human induced elements. Consequently, in Romania, such calibrations were carried out by *Moțoc M. et al.* (1975), resulting in one equation to be considered proper for the specific conditions of the Romanian territory, equation implemented by the *ICPA* (1987) in the methodology used for the elaboration of pedologic studies.

Beside these calibrations, the researchers' effort concentrated also on the revising of the universal erosion equation. In this respect, *Williams J. R.* (1975), proposes a modified equation (MUSLE) for the quantification of the alluvium resulting from erosion following each rain, and a collective of American researchers (*Renard R. G., Foster G. R., Weesies G. A., Porter J. P.,* 1991) proposes a revised, computerized and more complex equation (RUSLE).

2. POSSIBLE QUANTIFICATIONS OF THE USLE / RUSLE FACTORS.

The present study regards the soil surface spatial modelling through the application of the universal soil loss equation inside the GIS in order to test different quantification methods of the control factors, according to the USLE (*Wischmeier & Smith,* 1978), adapted by *Moțoc et al.*, 1975), or RUSLE (*Renard et al*., 1997).

The models testing was accomplished through estimative values comparison with the ones measured (*Gaspar, Cristescu,* 1987) in the perimeter designated by the two small hydrographic basins (tributary to the Zăbala River) situated in the Curvature Sub-Carpathians. The input parameters are represented by the digital elevation model, generated at a resolution

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of 10m (*Capaţână V.*, PhD student, „Al. I. Cuza" Univ. of Iaşi), the soil map at 1:200.000, the land use according to CORINE land cover 2000 and the 3 (red) and 4 (infrared) spectral bands of the LANDSAT image from 18.06.2003. The spatial information was computed with the TNT mips 6.4 software.

Regarding the equation adopted by *Moţoc et al.* (1975) for the pedo-climatic conditions characterizing the Romanian territory, the factors intervening in the USLE (R, K, LS) differ substantially, as far as the their conception and quantification are concerned, compared with the corresponding factors to be found in other USLE / RUSLE equations applied at the international level. Consequently, these factors cannot be used in combination.

USLE and RUSLE have the same mathematical expression:

$$E = R \cdot K \cdot L \cdot S \cdot C \cdot P$$

where:

- E: is the average annual erosion rate (t/ha an);
- R: is the rainfall erosivity;
- K: is the soil erodibility;
- L: is the slope length influence;
- S: is the slope steepness influence;
- C: is the correction coefficient for the effect of vegetation;
- P: is the correction coefficient for the effect of erosion control measurements.

The difference resides in the factors' quantification manner. For instance, in RUSLE, the evaluation of rainfall erosivity factor was revised in order to account for the precipitations falling on cvasi-horizontal surfaces, the calculating algorithm used for LS factor was changed, a time dimension was added to the erodibility factor etc.

Rainfall erosivity (R)

Rainfall erosivity (R) represents the annual sum of the products between the energy of the erosive rainfalls (E) and their maximum 30 minutes intensities (I_{30}):

$$e = 0.29\ [1 - 0.72\ e^{(-0.05i)}]$$ (*Brown & Foster*, 1987)

where:

- e – is the rainfall's kinetic energy per unit of precipitation (MJ/ha mm);
- i – is the rainfall's intensity (mm/h)

$$R = \sum EI_{30}$$

where:

- R – is the annual rainfall erosivity (MJ mm / ha h an).
- E – is the rain's kinetic energy (MJ/ha);
- I_{30} – is the maximum 30 minutes intensity (mm/h).

Due to the difficulty of direct calculation of rainfall erosivty, as the rainfalls intensity is not currently recorded at the meteorological stations, indirect estimative models were elaborated on the basis of statistical relations between the erosivity and other parameters, easier to calculate: average annual precipitations, warm season average precipitations, maximum daily and hourly precipitations etc. (*Rogler & Schwertmann*, 1981, *Diodato*, 2004, *Renard & Freimund*, 1994 etc.). Although numerous, these relations cannot be applied for the Romanian territory because they are applicable for the areas they were elaborated for. For Romania, the rainfall erosivity is expressed differently, representing the average annual soil loss for the rainfall erosivity unit. The values of this parameter oscillate between 0,064 in the Western Plain and 0,207 in the Meridional Carpathians and, partially, the Getic and Curvature Sub-Carpathians (*ICPA*, 1987).

In the present study, we used the both the R factor zoned for the Romanian territory and the value of 450 present in the study of soil erosion at European level (*Van der Knijff et al.*, 2000).

Soil erodibility (K)

Soil erodibility, respectively soil's erosion susceptibility, can be determined on the basis of nomograms or calculating relations (*Wischmeier*, 1971, 1978), taking into consideration the granular-metric fractions of 0,002 – 0,1 mm, 0,1 – 2 mm, the organic matter content and the soil's structure and permeability. A more simple calculating relation was proposed by *Römkens et al.* (1986) and revised by *Renard et al.* (1997).

$$K = 0.0034 + 0.0405 \cdot \exp[-0.5(\frac{\log D_g + 1.659}{0.7101})^2]$$

where:

- K: is the soil erodability (t ha h / ha MJ mm);
- D_g: is the geometric mean weight diameter of the primary soil particles (mm):

$$D_g = \exp(\sum f_i \cdot \ln(\frac{d_i + d_{i-1}}{2}))$$

where: d_i, respectively d_{i-1} are the maximum and minimum diameters of the particle size class i, and f_i is the sub-unitary percentage of the particle size class i.

The present study uses the erodibility valus as specified by the *ICPA* standards (1987) and the derivate values form the above stated relation.

The C factor (the vegetation effect)

The C factor expresses the influence of vegetation upon soil erosion, and displays values between 0,02, in the forested areas and 1 for the uncovered soils. These values can be taken over from the standards elaborated by *Motoc et al.* (1975), or can be derived from satellite imagery, through calculation relations, depending on the normalised difference vegetation index (NDVI) (*De Jong et al.*, 1998):

$$C = 0.431 - 0.805\ NDVI$$

The main inconvenient in the use of satellite imagery is the fact that the derived values for NDVI and C are momentarily values, corresponding to the moment of image acquisition. Consequently, derivation of the C factor or other parameters should be based on a mosaic of images taken at different moments throughout the year.

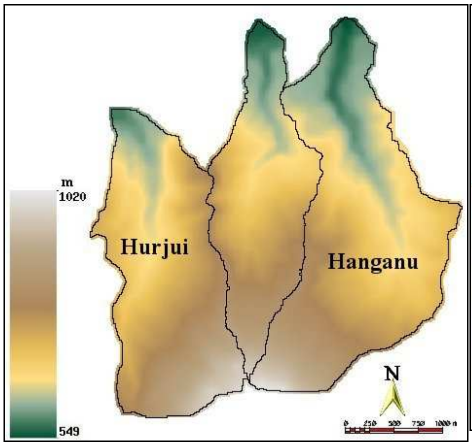

Fig. 1. The digital elevation model and the positioning of the studied hydrographic basins

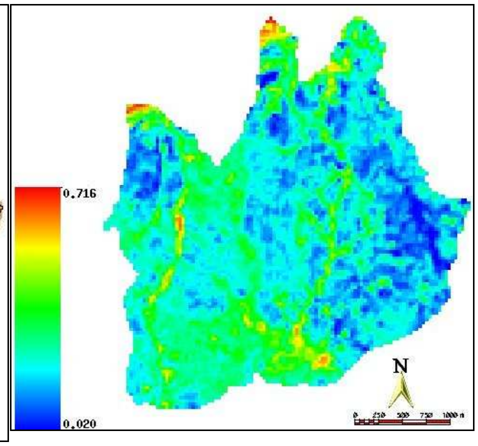

Fig. 2. The C factor generated on the basis of NVDI, using LANDSAT imagery, conform to *De Jong et al.* relation (1998)

The LS factor (slope length and steepness factor)

Among all the factors, the slope length is probably the most difficult to compute when the soil erosion spatiality, within GIS, is to be considered. The slope length represents the plan projection of the distance between the onset of runoff and the point where runoff enters a channel larger than a rill or deposition occurs.

Inside USLE, the L factor is quantified using the standardized slope length (slope segment) raised to an exponent that takes values between 0,2 and 0,6:

$$L = (\lambda/22.13)^m$$

The USLE version adopted in Romania (*Moţoc et al.*, 1975), the L factor is represented by the slope length raised at 0,3.

For RUSLE, the m exponent is determined with the following relation:

$$m = \beta / (1 + \beta)$$ (*Foster et al.*, 1997)

$$\beta = (\sin \theta / 0.0896) / [3 (\sin \theta)^{0.8} + 0.56]$$ (*McCool et al.*, 1989)

where θ is the slope angle.

Regardless the calculation relation, the problem of slope length spatialisation, within the GIS still remains. Apparently, the fittest approach resides in the substitution of slope's linear length (λ) with the upslope drainage specific area (A_s), that can be determined by multiplying flow accumulation, where a pixel value equals the number of the pixels drained from upslope, with the pixel's side:

$$L = 1.4 (A_s / 22.13)^{0.4}$$ (*Moore et al.*, 1993)

$$L = (\text{Flow Accum} \cdot \text{resolution})^{0.6}$$ (*Desmet & Govers*, 1996)

We notice the different values, for each author, for the multiplication and exponent coefficients. In the first case, the first relation, stated above, applied by *Van der Knijff et al.* (2000) for the spatial modelling of soil erosion at European level, uses the 1,4 value, while *Griffin et al.* (1988) recommends the 1,6 value for the estimation at pixel level. In the second case, the m exponent takes the 0,4 value, while other authors recommend the 0,6 value.

The use of specific upslope drainage area (A_s) does not generate concluding results within the GIS as far as the surface erosion is concerned (fig. 4). This parametrization seems to be more adequate for the concentrated erosion modelling or for sediment transport at the river channel level.

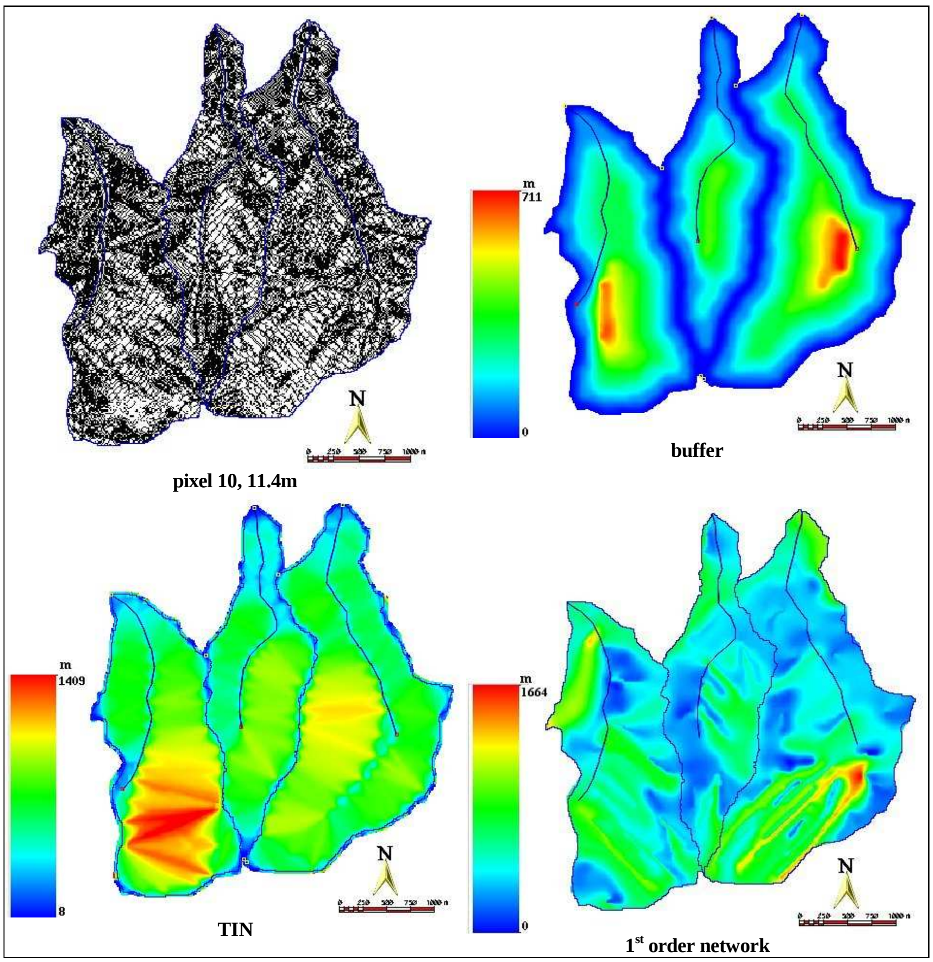

Fig. 3. Alternative possibilities for the quantification of flow length.

The present study also tests other manners of spatial expressions for the slope length factor (fig. 3):

• Using the *pixels' side as flow length*, differentiated on the basis of perpendicular or diagonal flow orientation as it enters the pixel. It is the simplest approach, even if, conceptually, it is less correct. The use of a same value as flow length assumes that the slope is made up by segments of equal dimensions, consequently, having different inclinations, which does not corresponds with reality. Nevertheless, certain studies demonstrate that this approach generates viable results if one uses the proper pixel dimensions.

• *Buffers* generation at successively greater distances starting from the main topographic ridges, followed by their interpolation to obtain a continuous spatial representation of the flow length. The procedure is simple for symmetric basins but it becomes more and more difficult for asymmetric or sinuous basins that require several corrections.

• Generation of a *triangulated irregular network* (TIN) between hydrographic ridges and the main valleys axis and the network's length sides values interpolation. The procedure generates errors along the ridges and, occasionally along the valleys axis, due to the presence of a dense network of small triangles. At the same time, the triangles' sides orientation do not coincide, very well, with the slope's maximum inclination direction. Nonetheless, the most important inconvenient resides in the constant values of the flow length along the triangles' sides, while in reality, these values should increase down-slope.

• Considering the flow length equal with *the length of the 1st order river segments* (or the length of the 1st order hydrographic basins), the approach becomes more *natural* compared with the preceding methods, but this method displays the same inconvenient as the TIN method, respectively the constant values along the river segments.

The spatial modelling of the slope steepness factor is more facile. The calculating relation for the USLE is:

$$S = 65.4 \sin^2 \theta + 4.56 \sin \theta + 0.0654$$

The USLE version, adopted in Romania, uses one of the below stated relations:

$$S = \theta^{1.5}$$
$$S = 1.36 + 0.97\,\theta + 0.138\,\theta^2.$$

where θ is the slope angle, expressed in percents.

In RUSLE, the slope steepness factor is evaluated differently depending on the slope angle (*McCool et al.*, 1987):

$$S = 10.8 \sin \theta + 0.03 \text{ pentru } \theta < 9\%$$
$$S = 16.8 \sin \theta - 0.50 \text{ pentru } \theta \geq 9\%$$

For the erosion resulting from snow melt, on slopes $\geq$ 9%, the second relation is substituted by (*McCool et al.*, 1987, 1993):

$$S = (\sin \theta / 0.0896)^{0.6}$$

A similar relation is proposed by *Moore et al.* (1993) for the quantification of the slope steepness factor regardless the inclination angle:

$S = (\sin \theta / 0.0896)^{1.3}$

This relation is used in combination with the L factor, evaluated on the basis of the specific upslope drainage area, in order to approximate the LS factor from RUSLE. The combination is also known as the Sediment Transport Capacity Index.

This manner of quantification for the LS factor was also tested within the present study, using both L as derivate of the flow accumulation and a fixed value of 50, which is the same as the one used in the erosional risk assessment study at the European level (*Van der Knijff et al.*, 2000). In the same respect, we also tested the calculating relation for Romania: $S = \Theta^{15}$.

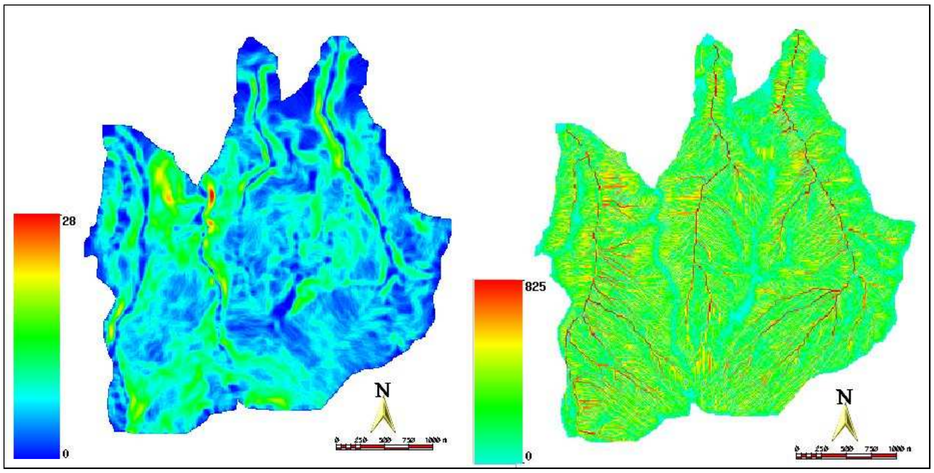

Fig. 4. The quantification of LS factor using the relation proposed by *Moore et al.*, 1993 (left) with a fixed value for L (50) and the specific upslope drainage area (right).

2. SOIL EROSION SPATIAL MODELING

The comparison between estimated average erosional values for the two hydrographic experimental basins (Hanganu and Hurjui) with the values measured by *Gaspar & Cristescu* (1987) emphasize the RUSLE equation as being optimal where the LS factor is quantified conformal with *Moore et al.* (1993) with a fixed value of 50m for the flow length, in which case the average error is minimum (2t/ha an). We also obtained good results by using buffers combined with the soil erodibility at the level of spatial soil unit. The greatest errors are generated by the use of pixels' side length as flow length and the specific upslope drainage area (fig. 5)

One can notice that the spatial distribution of erosion, obtained through different combinations of factors is similar and the most prominent factor is the slope steepness. The exception is given by the model that uses the specific upslope drainage area, which emphasizes most clearly the linear erosion, instead of emphasizing the surface erosion.

The main sources of errors, in the quantification of erosion through the models shown in table 1 are:

- The generalisation of the soil erodability, both by using an unique value at the basin level and by the use of soils map at small scale (1:200.000) for the spatial distribution of this parameter;
- The quantification errors of the flow length. No method, from the one we tested, is avoiding errors.
- The use of C factor generated on the basis of NDVI using a single LANDSAT satellite image, which catches only the momentarily situation of this parameter.

Results regarding the annual average estimated erosion using different quantification methods for the control factors, compared with the annual measured average erosion.

Table 1

Factors	*Hanganu Basin – **measured erosion: 28,8 t/ha an***		*Hurjui Basin– **measured erosion: 38,1 t/ha an***		*Absolute* **average error**
	Estimated erosion	Error	Estimated error	Error	
R=0.207; K=0.6; C-NDVI; $L^{0.3}$ buffer; S = $\theta^{1.5}$	19,1	9.7	30	8.1	8.9
R=0.207; K=0.6; C-NDVI; $L^{0.3}$ unique for the basin; S = $\theta^{1.5}$	27,6	1.2	42,6	-4.5	2.85
R=0.207; K=0,6; C unique for the basin; $L^{0.3}$ unique for the basin; S = $\theta^{1.5}$	36	-7.2	45,6	-7.5	7.35
R=0.207; K=0,6; C-NDVI; $L^{0.3}$ TIN; S = $\theta^{1.5}$	25,5	3.3	42	-3.9	3.6
R=0.207; K soil units; C-NDVI; $L^{0.3}$ buffer; S = $\theta^{1.5}$	27,7	**1.1**	42,4	-4.3	2.7
R=0.207; K=0,6; C-NDVI; $L^{0.3}$ pixel; S = $\theta^{1.5}$	13	15.8	19,6	18.5	17.15
R=0.207; K=0,6; C-NDVI; $L^{0.3}$ network order 1; S = $\theta^{1.5}$	27,2	1.6	41,9	-3.8	2.7
R=450; K=0.0438; C-NDVI; LS Moore et al (1993)	26,7	2.1	40	**-1.9**	**2**
R=450; K=0.0438; C-NDVI; LS with the upslope drained surface;	43,6	-14.8	65,6	-27.5	21.15

Another application regards the Călimani Massif even if, here, we did not dispose of erosion measurements to validate the models. Here, the sterile terrigenous masses left after the quarry abandon, constitute a risk element through its increased sliding and erosional potential. In order to estimate the erosion we used the DEM at a resolution of 5 meters (elaborated by dr. Stoica D.L.). The factors from the USLE equation were quantified according to the standards adopted for Romania (*Moţoc et al.*, 1975, *ICPA*, 1987), mentioning that the L factor was evaluated on the basis of the 1st order network length.

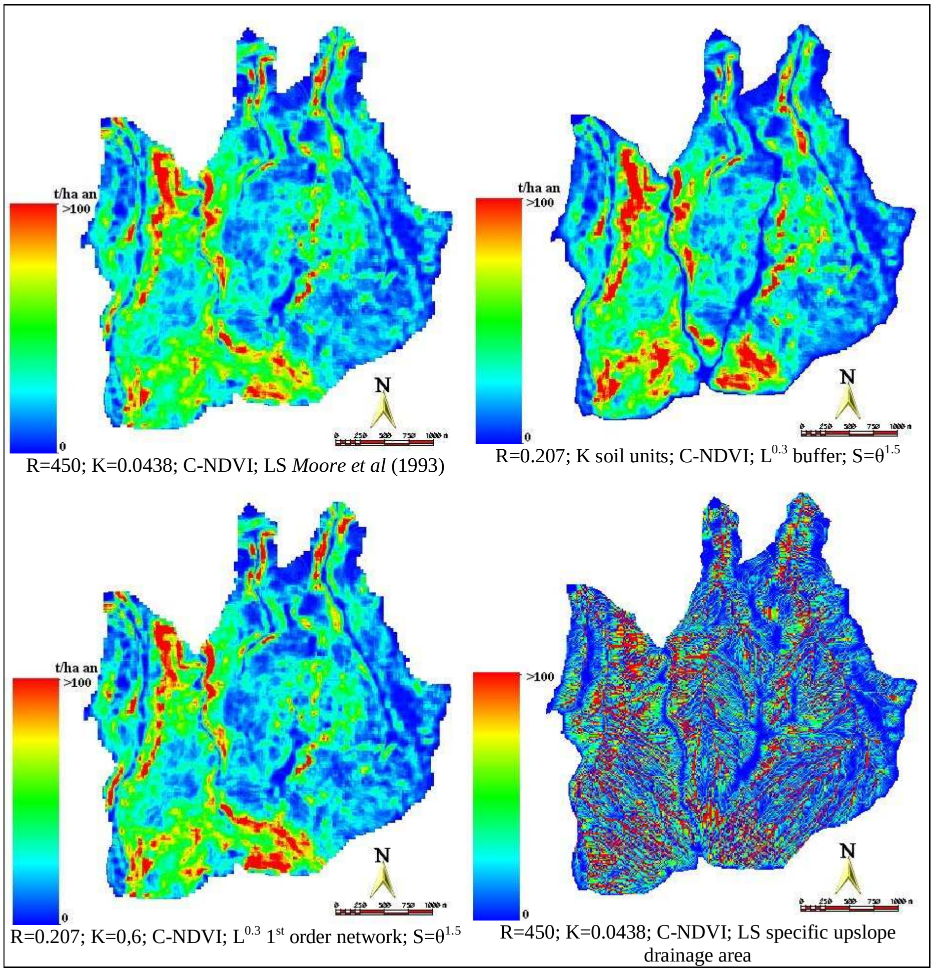

Fig. 5 Examples of spatial models for soil erosion obtained through different quantification methods of the control factors.

The spatial distribution of the estimated erosion (fig. 6) emphasizes, very clearly, the sterile terrigenous masses, the quarry and the degraded terrains surrounding the quarry which are characterized by a much greater erosion rate in comparison with the surrounding un-affected area, which displays values of 70-350 t/ha an, and, frequently, even above 500 t/ha an. These contrasts are also revealed by the chart showing the variation of the erosion rate along a topographic profile intersecting two sterile masses. The main peaks mark the inputs and outputs from the sterile masses, the erosion values suddenly increasing from 2-13 t/ha an to over 140 t/ha an, because of the lack of vegetation and the great erodability of these masses but also, as a result of steep slopes associated to sides of the sterile masses. Inside the sterile terrigenous masses, the erosional values vary greatly from 0 t/ha an to 100 t/ha an.

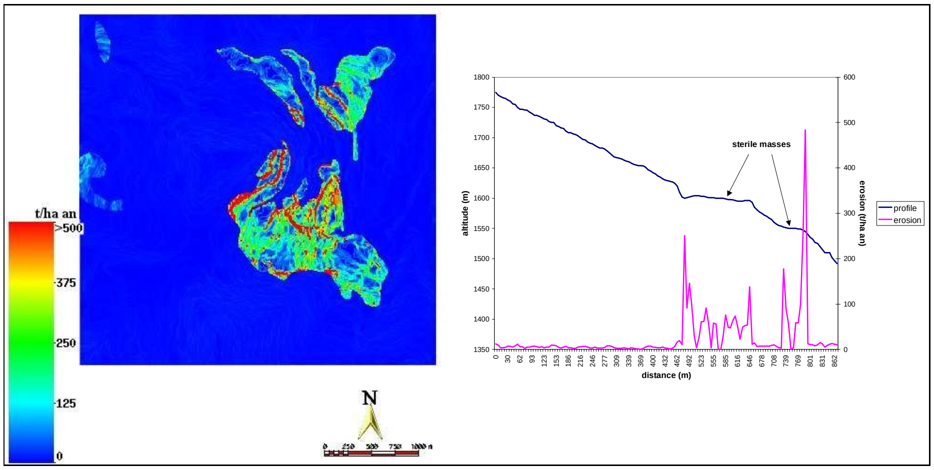

Fig. 6. The spatial model of erosion in the area of Călimani's sterile terrigenous masses (left) and the variation of estimative erosion rates along a topographic profile (right).

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ANALYSIS OF THE HYSTORICAL PRECIPITATION SUMS OF SULINA STATION BY MEANS OF POWER SPECTRA IN RELATION TO SIBIU STATION AND NAO AND SOI INDEXES

P. PAUL[1] B.S. DAVID[2]

Abstract: Precipitation is a very variable climatic element. It is highly variable, both temporally and spatially at different scales (inter-annual and intra-annual). The search for cycles in the climatic records can answer some of the complexities of the atmospheric system. This example uses the Sulina precipitation series (1868-2005) and Sibiu (1851-2005) to illustrate the relations of these two stations with each another as well as the influence of NAO and SOI indexes on them.The annual precipitation series of Sulina and Sibiu were analyzed by means of spectral analysis. The power spectra were calculated using the autocorrelation spectral analysis (ASA) and the maximum entropy spectral analysis (MEM). The cycles revealed were compared to other studies illustrating thus the influence of large scale phenomena such as El-Nino Southern Oscillation and North Atlantic Oscillation.

*

1. Introduction

Many authors have analyzed the precipitation patterns in several parts of Europe. Bràdzil (1992) described fluctuations of precipitation in Europe using series of annual areal precipitation sums; Schönwiese et al (1994) gave a general view of the seasonal behavior of precipitation trends in different European countries during 1961-1990 and 1981-1990. Haidu examined the sequential means of the annual rainfall of Europe in the view of climatic jumps (1996), and discussed the credibility of long term trends of the precipitations (2003). For Romania studies were conducted by numerous authors of whom we acknowledge Boroneant C. and Rambu N. (1992), Busuioc Aristita and Von Storch H (1995) who had studied several Romanian precipitation series identifying change points and revealed the NAO influence on the Romanian stations. As far as power spectrum analysis on climatological data is concerned a useful study is that of Ghil and all (2001) who analyzed by means of power spectra the SOI index. The present study is motivated by the above-mentioned attempts and it must be regarded as the first step in a more extended enterprise.

The annual precipitation series of Sulina station (3m, λ= 45°.15' φ= 29°, 67') and Sibiu (416m λ = 47°80' φ = 24°15') were chosen for the period 1868-2005 and 1851-2005 due to their locations Sulina in the south- east of the country bordering the Black Sea and Sibiu in the middle of the country. The stations have also some of the oldest precipitation records in Romania and the changes they had suffered are well documented.

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The main aim of this paper is to find the detection of significant cycles in the annual and seasonal precipitation series and find out whether there is an influence of the NAO and ENSO phenomena on the Romanian territory.

2. Methods and analysis.

Since the Sibiu station was considered homogenous the double mass curve was used only on Sulina records to test its homogeneity against the Iasi series (100 m, λ= 47°.17' φ= 27°.63'). An arithmetic plot of the accumulated values of observations of the two stations was paired in time. The relationship remained constant, fact indicated by a straight line (the very slight deviations were regarded as insignificant). Thus we concluded that the data presents no inhomogenities

The spectral analysis is used to analyze cycles of precipitation data. The power spectra of annual anomalies were analyzed using the maximum entropy spectral analysis MEM (Burg, 1978) and the autoccorelation method (ASA). The choice of these two methods was motivated by the fact that there is no best spectral estimate (Tosic & Unkasevic 2005) and thus is advisable to apply several independent procedures.

The ASA Blackmann & Tuckey (1958) is similar to the periodogram. Given a time series {X (t): t = 1, ………. N} the power spectrum

$$\overline{S_x}(f) = \sum_{k=-(N-1)}^{N-1} \varphi_x(k) e^{-2\pi fk}$$

The advantage of the method over the perodogram is that it reduces the estimate's variance and bias and attenuates the leakage effects (Ghill et al, 2002).

The MEM method identifies with the Burg algorithm reveals the frequencies more accurately (Padmanabhan, 1991). Still there is some subjectivity in choosing a filter. In the present study we decided upon the criterion suggested by Ross (1975) and quoted by Tosic & Unkasevic (2005) **N/3,** where N is the length of the series. In such an AR spectral procedure, peaks occur exactly at frequencies corresponding to roots in the AR polynomial.

The general formula of MEM can be described as follows (Ghil and al., 2002):

Given a time series {X (t): t = 1, ……….N} that is assumed to be generated by a wide-sense stationary process with zero mean and variance σ^2, M' + 1 estimated autocorrelation coefficients {Qx(j): j = 0, …….., M'} are computed from it:

$$\text{Qx(j): } = \frac{1}{N+1-j} \sum_{t=1}^{N-j} X(t) X(t+j).$$

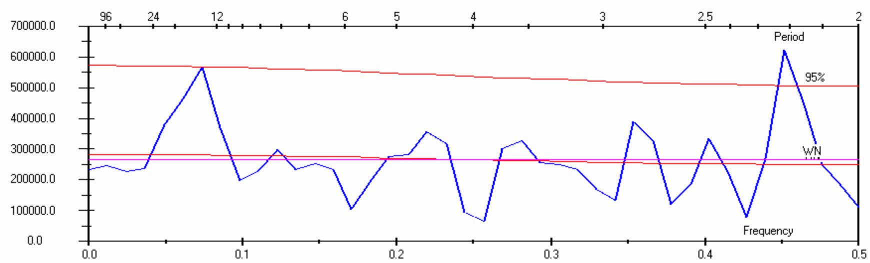
3. Results and discussion

The MEM and ASA have been used on the normalized sums of precipitations, which means that the mean value for the entire interval has been subtracted from each annual value and then the residual divided by the standard deviation.

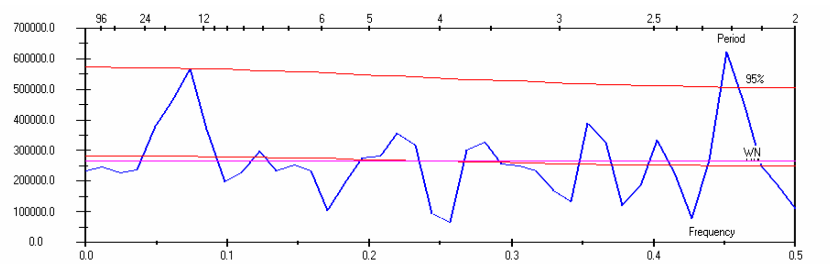
Figures 2 (MEM) and 3 (ASA) show the spectrum of the Sulina and Sibiu series, over 138 and 151 years of records. It can be noticed that there is a general agreement between the two spectral methods. However there are some differences in their spectral resolution and signal detectability. Even so the two methods show nearly identical annual results.

For Sulina two peaks were found: a cycle of 2,2 years at above 95 % level of significance which accounted for up to 5.596 of variance and another one with a periodicity of 13.66 years which explains 4.111 of the variance at. 90% level of significance. Only the cycles revealed by both methods were selected.

For Sibiu ASA method at a level of significance of 95% identified no relevant cycles. Yet at 90 % three were identified: a 2 years cycle (4. 0 variance explained); one of 6- 7 years (4. 1 explained variance) and a 3 years cycle (3.3 variance explained). The MEM method confirmed a cycle of 6, 88 years (9. 6 explained variance) and a biannual one of 2,0 (3.3 explained variance)

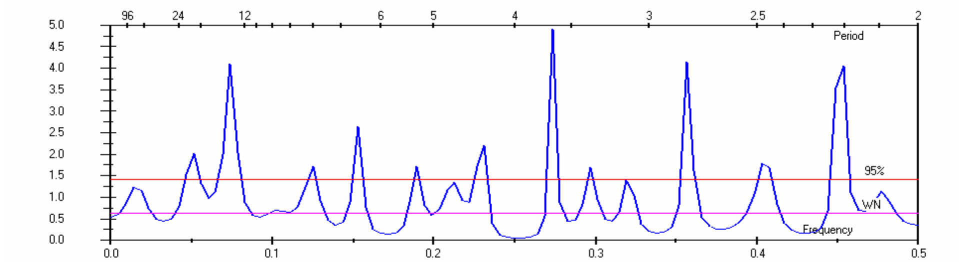


a) Sulina ASA

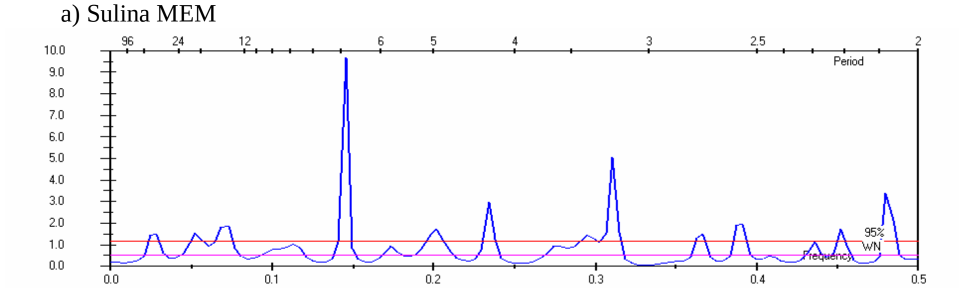


b) Sibiu ASA

Figure 1 The ASA power spectra for the annual sums of Sulina (a) and Sibiu (b)



a) Sulina MEM



c) Sibiu MEM

Figure 2 The MEM power spectra for annual sums of Sulina (a) and Sibiu (b)

Three cycles were identified a Quasi Biannual Oscillation (QBO), a medium –wave oscillation cycle observed at annual with a periodicity of about 14 years and a 6-7 years cycle.

These relevant cycles detected in this study usually agree with results obtained for other studies of Europe. Bràdzil et al. (1985) founded cycles with lengths of 2-5 years and 10 -16 years for the annual precipitation totals over Central Europe. Maheras and Vafianidis (1991) detected the QBO for Sofia (Bulgaria) and Thessaloniki (Greece). Cycles of medium waves were identified for Serbia and Montenegro as dominant in winter the seasonal precipitation over 1951-2002 and a QBO for the third part of the same season by Tosik (2004). For the station of Belgrade the same oscillations were identified by Tosic & Unkasevic (2005).

According to Reed et al (1961) QBO is one of the most important components of short term climate fluctuations, and can be found in the zonal wind and temperature of the tropical stratosphere. Lamb (1972) and Tosic & Unkasevic (2005) noted that QBO is related to the Southern Oscillation, which is the strength of subtropical height belt in both northern and southern hemisphere. Many studies have shown that there may be two fundamental time-scales in the inter-annual variability of the monsoon- ocean – atmosphere system: a QBO cycle associated with the tropical biannual oscillation and a cycle of 4-6 years associated with the ENSO phenomena.

The correlation among Sulina and Sibiu and the NAO and SOI indexes was investigated and 95% significant correlations were found as presented in Table 1:

		SOI	SULINA	SIBIU	NAO
SOI	Pearson Correlation	1	-,127	-,221*	-,156
	Sig. (2-tailed)		,162	,014	,084
	N	123	123	123	123
SULINA	Pearson Correlation	-,127	1	,250**	-,260**
	Sig. (2-tailed)	,162		,005	,004
	N	123	123	123	123
SIBIU	Pearson Correlation	-,221*	,250**	1	-,172
	Sig. (2-tailed)	,014	,005		,058
	N	123	123	123	123
NAO	Pearson Correlation	-,156	-,260**	-,172	1
	Sig. (2-tailed)	,084	,004	,058	
	N	123	123	123	123

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 1 The correlation between Sulina and Sibiu stations and NAO and SOI indexes.

4. Conclusions:

The findings from this paper are consistent with phenomena identified over Europe.

Therefore concluding we can say that three cycles were identified a Quasi Biannual Oscillation (QBO), a medium –wave oscillation cycle observed at annual with a periodicity of about 14 years and a 6-7 years cycle.

They appear to be related somehow to the ENSO and NAO phenomena although their connection is not quite clear. Negative correlations between Sulina and NAO and between Sibiu and SOI have been identified.

Acknowledgement : The data was obtained from the GHCN2 public database and from the Romanian Meteorological Annuary. The indexes were obtained from the following source: http://www.cpc.ncep.noaa.gov/data/indices/

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THE STUDY OF VEGETATION WITH AID OF SATELITE IMAGES IN THE CIRIC HYDROGRAPHIC BASIN (COUNTY OF IAŞI)

C. V. SECU[1], N. ŞTEFAN[2], A. OPREA[2]

ABSTRACT. – The usage of the satellite images Aster and Landsat allow the exact mapping of the vegetation, through the differentiation of the natural ecosystems from the human transformed ones, the separation of the degraded ecosystems, the differentiation of the homogeneous ecosystems from the heterogeneous ones, the individualization of the ecosystems with high humidity values, on the basis of the Landsat images, through the calculation of the vegetation index.

*

The Ciric River, tributary on the left to the larger Bahlui River, develops a small hidrographic basin of 58 sq. km in which the human influence becomes visible through urbanization in the lower compartment that includes water accumulations and agricultural terraces. These agricultural terraces, on the slopes are mainly used for vineyards and orchards. All these modifications changed the natural status of the environment and the results can be traced in the vegetation's composition and structure.

Sharp cartographic materials to reveal the above mentioned aspect are considered a neccessary condition to meet the requirements of a sustainable assemblage pursued by the SEEEC project.

1. INTORDUCTION

The natural factors determining the vegetal associations' spatial distribution in the Ciric hidrographic basin do not display significant variations. The geologic deposits characterizing the altitudes exceeding 150 m consist in ferruginous sands with small gravel fragments that are specific for a seashore environments. The sand deposits are covered by sand stones (burr/hone) and fine sand deposits which support above and dissonant sandy clay deposits (Brânzilă M., 1999). The soils in this area inherit the medium and fine texture from the above mentioned deposits and the soluble salts concentrated in the meadow and slope base areas.

The relief is typical for a hilly field region (the Jijia Hilly Field Region) through its prolonged ridges, the general disposition from NW to SE and the presence of Bahlui's River terraces , in the low compartment. The most representative surfaces in this respect were identifiied by Barbu N. & co. (1987) in the Ward of Tătăraşi (20-25 m relative elevation) and the Ciric Hill (the 60-70 relative elevation terrace). Between 36 m, which represents the altitude of the Ciric-Bahlui junction and 216,7 m, the maximum altitude of Aroneanu Hill, the geomorphologic processes dispaly enough ,,strength" in order to maintain active dynamics on the north and west oriented slopes and to break out landslides.

The climatic condition described by the multi-annual average temperatures of 9,6^{o} C (1973-2004) and precipitaions of 587,9 mm (1964-2004) (Secu C., 2005) ensure 5-6

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t/an/ha biomass production in the forested areas and 2 t/an/ha for the pasture parcels (Doniță N.& co., 1992).

The hidrographic features of Ciric bazin have sufferd radical modifications in the past century as far as the river's meadow is concerned. The topographic maps of 1: 50.000 edited in 1894 reveal few small water accumulations most certainly used as water supply reservoirs for domestic animals and only one bigger accumulation near the Şorogari Commune. Starting with 1960 the complex arrangement measures in the Ciric's meadow include the Doronaț, Ciric I, II and III water accumulations. The hydro-technical arrangements at the level of Ciric's River meadow induce moistening and determine slope slidings which required human interventions for *utility and agricultural* purposes (Ungureanu I., 1977) but have not been stabilized up to the present times.

The territory taken into study is included in the bigger Silva-steppe unit (Doniță N. & co. 1992), respectively the Northern Silva-steppe characterized by the sporadic presence of *peduncular oak* (Quercus robur) and the *tataric maple* (Acer tataricum) within the continental Sillva-steppe pastures.

2. OBJECTIVES

Using the satelite imagery the following features were obtained: the natural (forests and pastures) and hunam induced (perrenial and annual cultures) ecosystems' typology as extracted through cartographic means; the individualization of ecosystems homegenity (homogenous and heterogenous ecosystems); the delimitation of degraded ecosystems and their associated factors (degarded ecosystems as a result of natural and human induced factors); the quatification of vegetation indices using LANDSAT TM imagery.

3. METERIALS AND METHODS

In order to classify the vegetation we used the Aster 2 (RGB, assembled in 2000) and Spot satelite images and the the cartographic techniques were applied with the use of TNT mips 6.9 software. Apart from the basic cartographic support (topographical maps at 1;25.000 and 1:5000) we added a series of models obtained in TNT mips (the elevation model, terrain declivity, slope exposition etc.)

The study of the vegetal association in the field consisted in the realization of plants inventories.

In order to identify the vegetation's characteristics and to correlate them with certain geographic particularities of the territory taken into study we made use of the *visual interpretation.* This method implies a greater subjective degree compared to the automatic classification based on the spectral analysis using pixels. As far as the automatic classification is concerned it is possible that errors occur between to total different surfaces which are *viewed* as identic (e.g. roads, the landslide gliding beds and constructions have the same spectral respose or the same colour).

Forasmuch as the Ciric basin is narrow it becomes accesible and can be easily walked through thus *visual interpretation* of the satelite images is not difficult.

In this context we realized correlations between the colours displayed on the satelite images with the types of vegetation and other characteristics of the studied territory (e.g. landslides, buildings etc.), with the texture and the shape of the studied areals. The

Aster and Spot images reveal the vegetation distribution and other elements in *false colours*.

Using the Landsat imagery and the TNT mips formulae we quatified the vegetation indices. This methods applies for the identification of highly humid ecosystems. In this respect from the 7 Landsat bands we used the 3rd (Red) and the 4th channels (Near infrared) at a resolution of 30 x 30 m. The spectral reflectance differs between vegetation types and between seasons.

4. RESULTS

For the sake of differentiation between natural and human modified ecosystems we considered the colour hues and the shape of the polygons that imply as a real correspondent a relatively homogenous surface as far as the aspect of species combination mode and their functionality is concerned.

Analyzing the Aster image we observed that this reveals close colour hues for the forest and grasslike vegetation but the forested parcels have regular shapes with straight segments implying human intervention and the herbal vegetation displays dendritic development on valleys and extending up the slopes.

The cultivated vegetation is easily identifiable through the shape of each areal, the majority of polygons representing annual cultures display rectangular shapes. The perennial cultures have almost the same shapes as the annual parcels but as far as the vineyards are concerned the texture is given by the roads between parcels. This characteristic texture does not apply for orchards.

When the floristic composition is uniform the colour hues are also uniform. The changes induced by the presence of plantations, sometimes outland for the representative floristic region (e.g. resinous plantations) imprint different colour hues. The herbal vegetation appers most frequently as a mix of colours on the satelite image due to the vegetal pheno-phasis characteristics and the influence of external factors, as soil humidity, terrain degradation processes etc.

The ecosystems heterogenity is determined by the human induced factors, cosequently the heterogenous ecosystems are associated with constructed sites and, on small parcels, with human generated deposits in the lower part of the hidrographic basin. In the rural perimeters the objects revealed by the satelite images have regular shapes and describe a heterogenous mix of vegetation, communication ways and constructuins.

In the cultivated vegetation area the heterogenous aspect of the ecosystems is given by the different spectral reflectance of each vegetation type yet the regular shapes of the polygons confirm that the majority of species are cultivated species.

In order to delimitate the *degraded ecosystems* we considered the human influence along the transportation ways in especially the roads *oscillation* at slopes level and the separation of degraded ecosystems in the landslides areas.

Along the roads, we usually find, ruderal vegetation but the routes modification, in time, on the slopes implied terrain degradation and consequently species degradation. As far as the roads traversing *cuestas* fronts and other slopes with high declivity the change of routes determines deep erosion acceleration. Some of this deep trenches are also of great width (more than 100 m deep trench near the Stanca village, the northern part of the basin) (Fig. 2,1a and 1b).

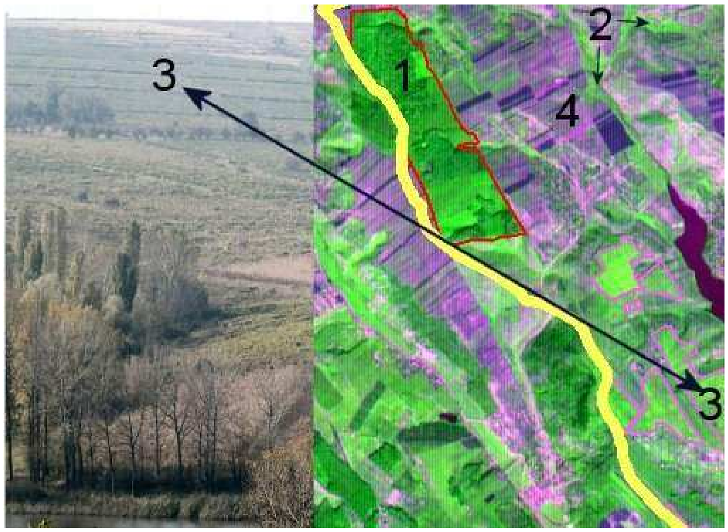

Figure 1. Vegetation types revealed by the Aster image (2005) 1=forest, 2=meadow herbal vegetation; 3=vineyards and 4=cultivated vegetation.

The landslides give a tessalation aspect to the satelite image. Depending on the landslides stability degree these can be classified in *active landslides*, sometimes combined with deep erosion processes where the vegetation is scarce, dispersed and the satelite image reveal the same colours as for the constructed sites or roads (Fig. 2, 2a şi 2b). The stabilized or low development rate landslides reveal a satelite image *textured in fish scales* where the shapes and colours reveal the inclusion of cultivated surfaces.

The map obtained when calculating the vegetation index displays greater values of humidity for the forested (code 1 on the map) and the meadow areas and also an increased humidity for soils (Fig. 3). On the map there can identified cultivated areas (4) resembling, in hue, the forest vegetation. Because a deciduous forest includes a mix of species the texture of the image is not uniform, unlike in the case of cultivated land where there will not be found pixels with different hues. The high humidity characteristic for meadows emphasizes better the distribution of hygro-phil vegetation(Aster image) but the pixels dimension (30 m) blur the exact cartographic actions. The opened colours point out the cultivated vegetation and, in the same time, the reduced humidity values.

The advantage of remote sensing cartography derives from the opportunity of exact measurements for cultivated parcels when using images with small dimension pixels (Aster); the differentiation of natural vegetation types (forests and pastures) from the cultivated ones (perrenial fron annual); delimitation of certain degraded vegetation areas (on landslides); the delimitation of characteristic ecosystems on the basis of their humidity values (meadow vegetal associations).

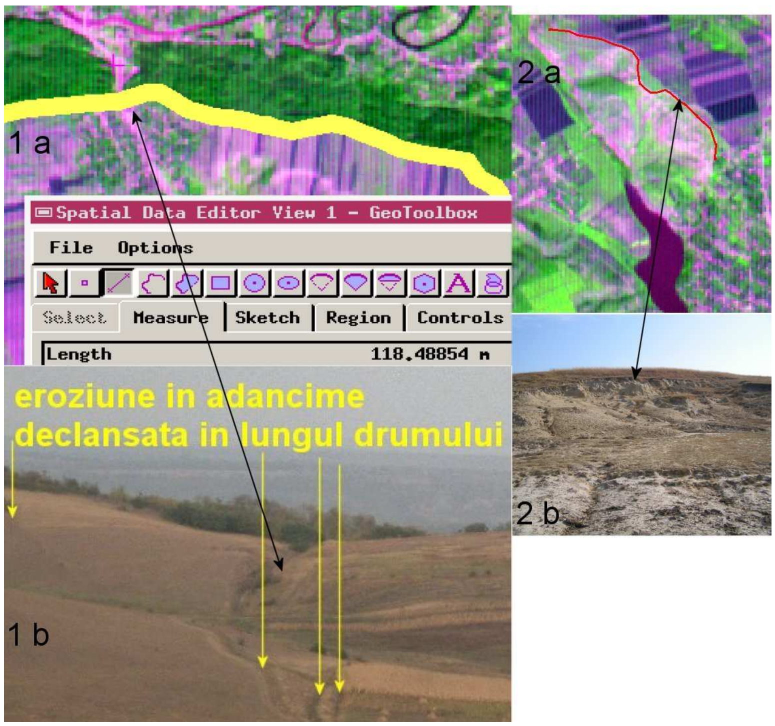

Fig. 2. Vegetation degradation under the influence of deep erosion along roads (1 a and b) and within the landslides perimetres. (2 a and b).

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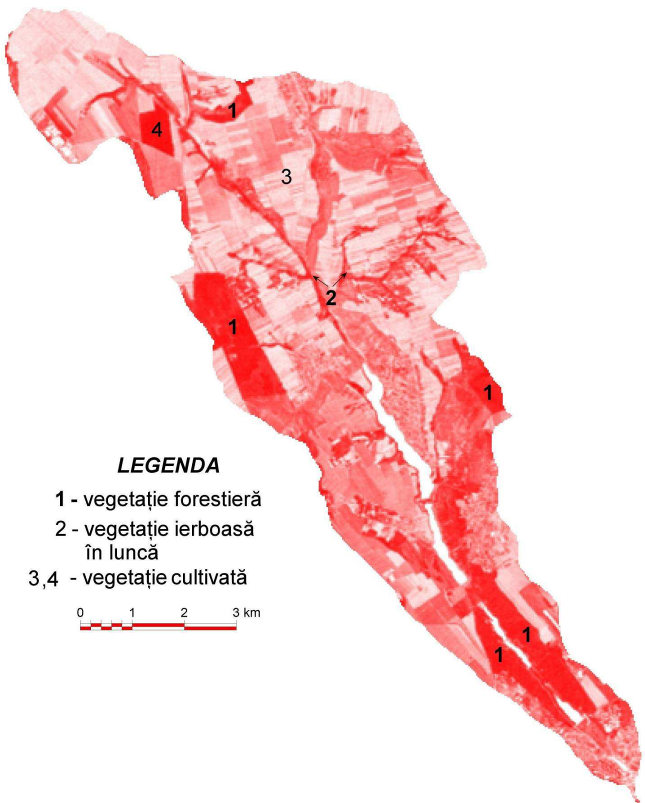

Fig. 3. Ciric Hydrographic Basin, *Vegetation Index Map Interpreted from Landsat Imagery* (2005)

THE USE OF GEOGRAPHIC INFORMATIONAL SYSTEMS IN THE STUDY OF NATURAL HAZARDS

A. Ursu[1]

Abstract - This study presents the results of GIS applications in Natural Hazards studies. We have attempted to evaluate the direct and induced effects of the sudden manifestation of a geomorphologic process upon the communication networks and rural settlements, as well as on the terrain accessibility. Spatial analysis proves very useful in risk assessment and crisis management.

In our modern world there is a paradox between the extraordinary accomplishments from the fields of science and medicine which make life safer and healthier, and the important human and material losses caused by the so called natural hazards. The paradox is complicated due to the fact that science itself isn't hazard-free, situation that leads to the occurrence of recent threats caused by the errors from the technologic systems (Keith Smith-1996).

Thus, human society is now exposed not only to the risks caused by natural phenomena such as earthquakes, floods, tornados, droughts etc., but also to the technologic ones such as explosions, toxic substances seepages, accidents etc.

Risks represent an integrating part of the day by day life, and their elimination is impossible, the only option being that of reducing the losses, departing from the idea that disaster prevention is always cheaper that the aftermath recovery. This may be realized on two ways: through the modification of the natural processes or through the reduction of their impacts on the human society.

The present paper proposes to use a series of GIS techniques with the declared purpose of developing analysis possibilities of the geomorphologic risk processes through simulations and modeling that would be useful in the decision taking in crisis situations, or in a future territorial planning.

Main objectives:

1. The realization of thematic layers with the spatial distribution of the present geomorphologic processes, as well as with the morphometric characterization of the region
2. The realization of the thematic layers of the human properties that may be affected by geomorphologic risk processes
3. The use of the GIS methods in the evaluation of the effects resulting after the manifestation of geomorphologic hazards

The present landscape is subject to permanent modifications because of the actions of the contemporaneous modeling processes, often increased by that of the human factor, directly on the landscape or indirectly through the modification of the other geosystem components.

From the present geomorphologic processes, we have analyzed the rock downfalls, landslides and muddy flows, due to their importance among the risk generating natural processes.

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Also, the modifications caused by the human interventions from the last years such as the deforestation of some surfaces, the slope over-charging with constructions, the modification of the slopes angle, the digging at the slopes base for house or roads constructions, etc have had as effect the activation or reactivation of some geomorphologic processes with possible disastrous effects in the near future.

The Digital Elevation Model has been realized on the basis of the topographic maps and represents the departing point for a whole series of thematic layers: slope, slope exposition, relief fragmentation height, hydrographic basins, discharge direction maps, etc

The realization of the thematic layers of the human properties that may be affected by the geomorphologic risk processes. For the realization of these thematic layers we needed to draw the map of the roads network and that of the land use types. These were realized through on screen digitization, on the basis of the 1:25000 scale topographic maps and of the satellite images, and later through the attachment of attributes in the table database for each road segment, according to its importance, respectively to each polygon according to the terrain use.

The use of GIS methods in the evaluation of the effects resulting from the manifestation of geomorphologic hazards has implied the use of the overlay method, of the simulation of a barrage occurrence, and of the network and multilayer type analyses.

Through the OVERLAY method we have integrated the spatial data referring to downfalls, landslides and muddy flows with the data referring to the land use and the rods network, thus evidencing the areas exposed to the geomorphologic risks.

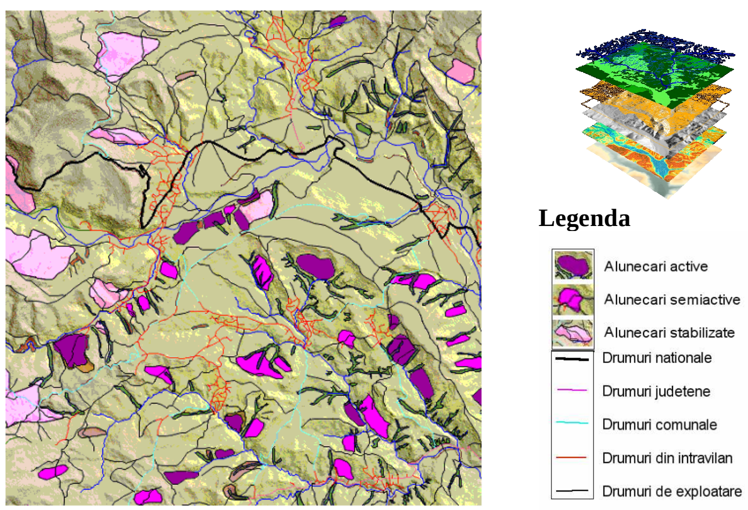

Fig.1 The distribution of the present geomorphologic processes according to the roads network (Legend from top to bottom: active landslides, semi-active landslides, stabilized landslides, national roads, county roads, township roads, outside-town roads, exploitation roads)

For the simulation of the direct and indirect effects that occur as a consequence of the manifestation of the natural hazards we have realized three applications on raster and vector files in some sample areas, mentioned below:

1) For the evidencing of the direct effects we have chosen an area situated near Greşu, which has been strongly affected during the past by landslides, situation confirmed by the local toponymy of „Fugitura" ("The Downfall"), and that presently is highly regarded by the inhabitants of the nearby counties for the construction of residences. This landslide has lately given signs of reactivation on certain sectors.

We have departed from the assumption that an eventual earthquake may destroy the equilibrium position of the landslide body that may thus slide up to the valley blocking the course of Putna River. We have chosen three situations according to the height of the new formed dam: 7, 14 and 20 meters, and have simulated the water accumulation upstream the dam, obtaining in each case the surface occupied by water and the water volume retained by the dam.

Overlaying these layers over that of the properties (constructions, roads) we may observe which of these will be flooded in each of the three cases. Thus we have considered that the areas that are flooded by the water gathered behind the 7 meters dam present a high degree of risk exposure, those flooded by the waters behind the 14 meters dam a medium exposure risk, and those flooded at a 20 meter water height a small exposure degree. The areas that remain un-flooded in the last case are considered as not being exposed to risk. This classification is based on the fact that the probability of the formation and maintenance of a 7 meter dam is higher than that of the occurrence of a 20 meter one.

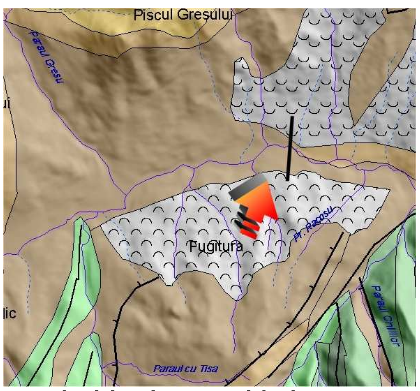

Fig.2 The sliding direction and the dam position

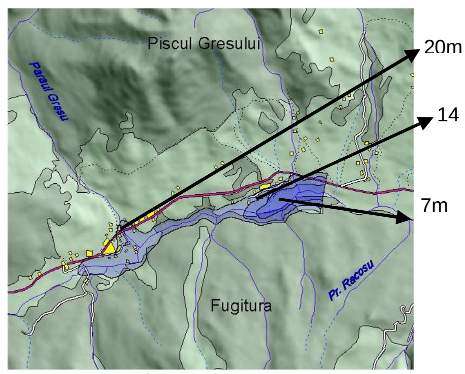

Fig. 3 The areas flooded in the three situations

Legend:

--Properties unexposed to flooding risk,
-- Properties with low risk exposure,
-- Properties with medium risk exposure,
-- Properties with high risk exposure.

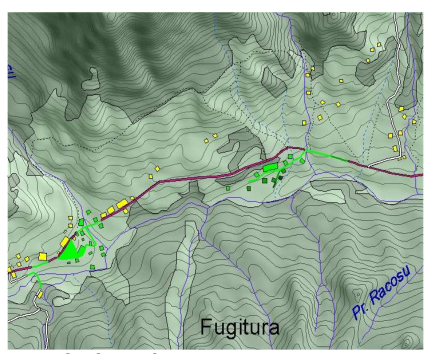

Fig.4 Flooding risk

2) Another application has been developed on the basis of the vector files that have a NETWORK type topology, respectively those of the communication networks.

Thus we have given impedance (friction) values for each road sector and calculated different optimum directions before and after the manifestation of a geomorphologic risk process, in this way being possible the evaluation of the un-functionalities induced to the transportation system.

This application proves to be useful in the optimization of the transportation network, in the finding of optimum routes for arriving in the affected area and in the evaluation of the effects of a road sector blocking on the transportation activities downstream the blockage and the finding of the alternate variants.

As the impedance value attached to the line is higher, the resistance to movement along this will be higher. Along the low impedance lines the movement is produced easier, situation due to which the Network Analysis operation directs the optimum routes along these lines. The impedance value may be directly proportional with the length of the road sector, case in which may be calculated the shorter directions between two points, without taking into account other parameters that influence movement. To reach a model closer to reality, we have to take into account several variables.

Thus the initial impedance value for each sector of the line is of 1.00, this value characterizing sectors of the national roads, on plane surfaces, with asphalt carpet in a good state, situated outside the towns, where the maximum admitted speed limit is of 90km/hour, and that do not have many curvatures. Having as landmark these sectors, the impedance value increases for all the other road sectors with the increase of the slope value, of the "meandering coefficient", the decrease of the road rank, the existence of the speed limitations, the modification in the road carpet type or its degradation.

If the application would have included an urban area, it would have been possible the characterization of the intersection nodes through the limitation of veering on certain directions, the introduction of one-ways etc.

In our study area we have applied this methodology in the Valea Sării-Barsesti sector.

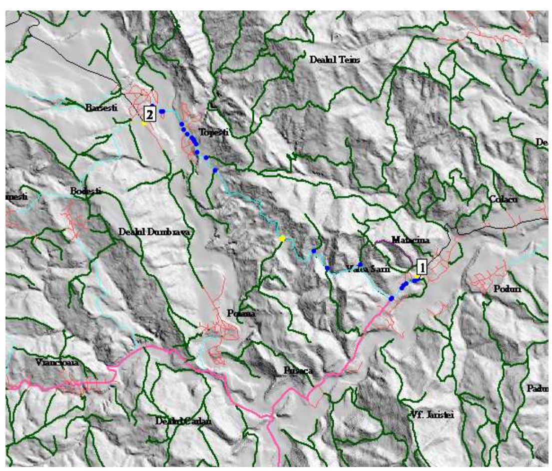

Fig. 5 The optimum route between Valea Sarii-Barsesti in normal conditions-

After the construction of the database that includes the impedance values for each road sector, we have determined the optimum route in normal conditions, as it may be seen from the above picture. Later we have introduced a virtual barrier, corresponding to eventual rock falls, and have recalculated the optimum route, the result being visible in the below image.

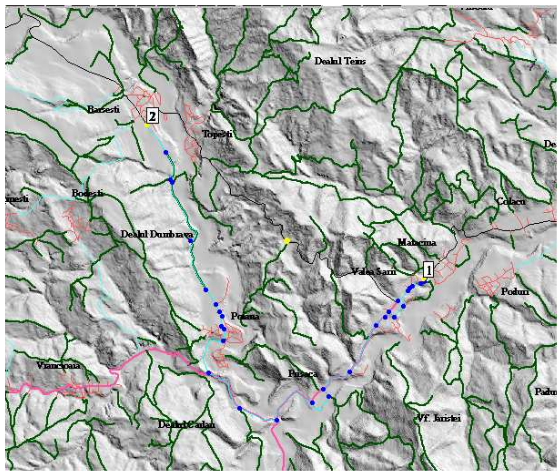

Fig. 6 The bypath route between Valea Sarii-Barsesti
in the case of the DN 20 A road blocking

It may be observed that the second route does not correspond to the shortest one from the traversed distance point of view, because it would have chosen agricultural exploitation roads. Instead it corresponds to the route with the lowest impedance, in this case being obvious the importance of the road type (county, local).

This operation is very useful in the risk management, if we have in view the fact that once the database is realized, the route calculation is conducted in a very short time.

3) If we desire to observe the influence of the geomorphologic processes on the terrain accessibility on the ensemble, and not only on the communication network, it is necessary to integer as many raster and vector files in more costly operations.

For the calculation of the accessibility, it is necessary in the first phase to realize a layer (Friction) that would integrate several factors that influence movement, respectively slope, land use, roads, rivers, bridges, etc.

Each folder will be classified in ten classes, value 1 corresponding to the minimum impedance (low slope, national road), and the value 10 to the maximum one (high slope, forested area etc). The 0 value will correspond to the barriers of the river or escarpment type. These folders will be multiplied one with each other and thus we will obtain the final impedance or friction layer.

On this layer we have conducted the Cost operation, so as to estimate the cost of the movement in all the directions, departing from a central point situated in the centre of Tulnici Township.

Later we have taken into consideration the situation of a landslide reactivated on Putna, and we introduced a barrier in the corresponding impedance raster, and we have led the Cost operation again, thus evidencing the problems induced by the landslide on accessibility.

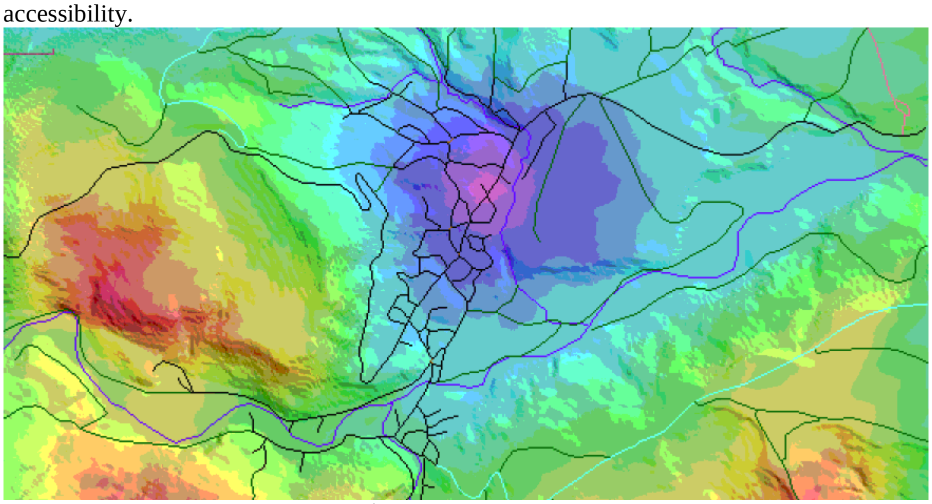

Fig.7 Map of terrain accessibility around Tulnici

In conclusion we consider that the use of GIS in the physical geography studies proves to be advantageous during all the research stages.

Also, for the management of some utilities or communication systems there is the possibility of the simple or multi-criteria analysis of the databases, offering a helping hand in the user decisional activity.

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APPLICATION OF DIGITAL LANDSCAPE MODEL IN CRISIS MANAGEMENT

J. Kolejka[1]

1. Recent dramatic events in landscape are more common than in the past

The complexity of present development of the nature and society give geography unlimited opportunities for public scientific involvement in services for the human community. Our planet is experiencing sharp changes as consequences of climate warming. The course, intensity and frequency of occurence of extreme atmospheric and hydrological phenomena is being changed. Numerous terrain forming processes in the landscape (erosion, land sliding, subsidences etc.) are accelerated. Simultaneously soil cover is slowly being exhausted in intensive agricultural areas while land is abandoned in less suitable regions. Forest stands – especially those planted by humans – suffer not only from direct impacts of meteorological, climatic, hydrological and geomorphological processes but also from intermediated consequences of physical and chemical environment changes. The change of mass and energetic balance of our landscape, regardless if it is caused by natural or human factors, represents a today´s reality and it is necessary to face it efficiently. The economic transformation and deep changes in territorial distribution and manufacturing specialisation heading to the more sophisticated technologies and products are followed with considerable alternation in price maps. Similar consequences are visible in tertiary sphere (in commerce and services) and in human life and behaviour as well. Nature, social and technical sciences are deeply involved in mitigation of running changes are usually being felt as an endangerment. Extreme dangerous processes threatening life, health and properties at the large scales require a complex approach and management. The system procedure developed for these purposes is being called „crisis management".

Present crisis management (CM) represents a set of activities focused on preparatory, operational and mitigating response to processes in the territory threatening human lifes and properties.

The present state of CM is characterised by a set of circumstances:

a. The prevention aspect of natural and human triggered risks is underestimated for longer time, as enough knowledge and suitable technologies are available.

b. Completed and commonly applied „accident plans" (or evacuation plans etc.) are too primitive because of they are based on (it depends on case) separated know how generated by individual technical, nature, economic and social sciences.

c. There is an unhealthy isolation and mutual competition between sciences participating in CM leading to reduced application efficiency of available valuable but mutually not linked knowledge here.

d. There is a very important public order for the highest integrated participation of sciences in future safety assurance.

One of the most important tasks of the CM is the surpassing these circumstances. A large attention is paid to the support of crisis management systems both in governmental and security practice, and also in applied geographical research and GIT development (e.g.

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Brázdil, et al., 2005, Corbley, 2006, Damon, 2006, Dotson, 2006, Fedra, 2006, Hayashi, 2006, Knapp, 2001, Lapšanský, 2000, McLaughlin, 2006, Valenta, Valentová, 1999).

2. Role of geography in crisis management

Due to synthetic approach, geography has an opportunity to integrate in certain territory and/or on general platform the knowledge and data coming from involved nature, social and technical sciences for the purpose of CM. Geography has also enough information necessary for integration. Geography and geographers in persons must be reliable and relevant to enter procedures of CM to participate in an efficient response to dynamic processes threatening lives and properties. Geography offers following abilities and features to fulfil this role:

a) Empirical knowledge base (certified information about the course of processes in the past, about relationships influencing the origin, course and consequences of processes).
b) Geospatial data base (reliable geographical data base representing territorial differentiation of factors important for the set of selected natural and human made hazardous processes to be proceeded in CM).
c) Geoinformation technologies for rapid geodata collection (and monitoring), geodata transmission and storage, data processing and visualising (GIS, DPZ, GPS, computer cartography).
d) Expert systems supporting a qualified assessment of future states of processes and able to document them using a full geodata processing based on powerful processing and visualisation technologies.
e) Explain any critical situation in wide relationships (with regard to the primary-natural, secondary-economic and tertiary-social landscape structure), offer immediate and long-term response, communicate with broad publics using understandable written text, spoken language, graphical models (pictures, graphs, maps, 3D models, animations, etc.).

Crisis management is a very complex procedure (Fig. 1) based on various data and knowledge linking. The final data and knowledge selection respects the hazardous event as well as the form of data multi-criterial processing. CM outputs have sharp territorial character. With regard to geography posses suitable integration abilities and uses the last geoinformation technologies, it is quite clear, if geography seeks wide involvement in CM and offers data, methodological participation and know how for facing real threatening situations. Geographical data for the input into CM has to be first pre-processed to get it in a mutually balanced form. The values of variables of individual thematic (analytic) GIS layers - maps have to to be in similar relationships as well as are real factors in the real territory. The digital landscape model has been developed for these purposes.

3. Digital landscape model and its contribution to CM

The digital landscape model (DLM) represents one example of synthetising abilities of geography useful for geodata integration into a form reflecting maximum objectively the territory of CM application.

A digital landscape model (DLM) is defined as a minimum 3D or 4D computer generated scheme of a chosen segment of global landscape sphere which represents a simplified, yet integrated image of its elementary structural features, optimally also its dynamic features. The model's first three dimensions (spatial coordinates) describe the model's structural aspect, while the fourth dimension registers the time aspect. In other words, the DLM simulates a complex 3D or 4D map of present landscape as a universally integrated geo-database. DLM is thus a product of complete data integration into a limited file of multi-attribute information layers (at least for the primary, secondary and tertiary landscape structure, plus DEM) which facilitates various static and dynamic modelling procedures and presentations representing real relations between the variables in the area (Fig. 2).

DLM as a special type of fully integrated geodata base in GIS provides CM with following positives:

a. Original analytic data layers are unified in single data format, cartographic projection, co-ordinate system, scale, resolution and all the integrated analytic themes are mutually logically linked as it is in real territory. The reference polygon in the „natural background" integrated layer is represented by the area of the „homogenous natural landscape unit" depicted with a vector. The vector co-ordinates are given by values of parameters of individual natural landscape features involved into geodata integration. If necessary (usually common requirement of various expert system models), additional variables and their values can be inserted into „polygons". It is supposed that homogenous natural landscape units will be likewise homogenous from the viewpoint of the newly added variable. The parcel or sub-parcel with one way of utilising represents a reference polygon in the layer „human impact". Similar situation is typical for the integrated layers „development limits", where a parcel or sub-parcel represents homogenous society or individual interests. Additional variables can be inserted into this type of reference polygons in GIS supposed as homogenous in the area represented by the polygon.

Such homogenous reference areas (polygons in GIS layers) can be applied in various assessment, modelling and simulation procedures as isotrophic spaces for the origin, development, behaviour and consequences of hazardous process.

b. DLM can serve as very suitable geodata source for many specialised software models (moduls) as a whole, or only selected information taken from DLM can enter the consequent data processing. DLM can be disintegrated into relevant analytic layers fully mutually balanced and corrected. This kind of data base can reduce significantly the error level in data processing. A typical example of integrated data processing is CM.

c. DLM is an open data system. It can be currently completed with other variables and/or upgraded and/or improved with more detail and more reliable information. Regardless the borders of reference polygons will be moved, the interior remains homogenous. Similar procedure (addition of new variable) is practically impossible in the database consisting of many independent (not mutually balanced) analytic layers. What layer will play the role of set of reference polygons remains under question.

d. DLM as integrated geodata base can be easily presented and demonstrated over DEM. DEM can serve as carrying surface both for analytic layers from disintegrated DLM as well as for presentation of any from three integrated layers. The mutual compatibility of layers, their visualising and simulation is ensured.

The contribution of geography for an efficient CM is based on the DLM compilation, on the a purpose oriented processing of its content, on the procedure development, formalising and algorithmising providing support for the decision making. It needs an interdisciplinary data and knowledge integration dealing with relevant factors of natural, economic and social aspects of the environment.

Different DLM information and geographical know how are being applied in:

a) CM precautional phase,
b) response planning,
c) real-time decision-making,
d) execution of immediate remediation measures,
e) long-term remediation phase.

DLM and GIS are involved in these activities with fully integrated geodata, cartographic and visualising tools.

4. Present situation in crisis management in Czech Republic

4.1 Geographical data sources for CM

Czech Republic belongs to countries with very complex and at the same time very profound thematic territorial documentation. Thematic maps at various scales and resolution are available for application in CM both in analogue and digital forms. Regardless to the reasons why any survey was completed in the past, the territory of Czech Republic is covered by maps about natural, economic and partly social factors relatively well. Of course, the mapping campaigns will continue in the future. Especially the natural segment of the environment is covered well with analogue and digital maps at scales 1:5000 (agricultural soils), or 1:10 000 (terrain, forest bioclimate and soils) to 1:25 000 (geology) or 1:50 000 (geology, drainage areas). These analytic maps were proceeded by separated field mapping and by related specialists. If these maps were overlaid in GIS many false parameter combination originate. Such faults can be removed by the logical geodata integration in DLM. Similar disharmony is typical for geodata about various human impacts on the environment (land use, biotops, agricultural area, master plans, landscape plans etc.) and about the population. Here is the logical geodata integration also inevitable. Cadastral database (parcel distribution) can be used as a survey support in GIS integration procedures. An important lack of information about society and individual interests in the landscape breaks some CM procedures. The important historical objects, military areas, nature protected areas, utilities protection zones, water sources protection areas and some other are documented quite well. Technical maps are available for many town and cities in Czech Republic. Much worse from this view point is the situation in rural areas.

The most prominent factor of a present landscape is terrain. There are many links between terrain features and other natural landscape ones here. Terrain operates as local differentiation factor of many natural features and human activities. In DLM the DEM is used as an information bearer surface form other geodata layers in DLM as well as for the derivation of various morphometric terrain features (slope, exposition etc.). The most detail and publicly accessed terrain information in CR is represented by contour lines in topographic map at the scale of 1:10 000 and in ZABAGED1 as digital version of this map set. The commercial raster DEM with 10 m pixel size is also available for the whole territory of Czech Republic.

Following can be stated about the situation in Czech Republic:

a) Various geodata bases are available and applicable for CM. The most of them are distant and heterogenous from the view point of the scale, resolution, format, projection, etc. They are suitable for CM. The collection of the most important layers (for CM) runs under the supervision of the regional administration (GIS and CM departments of regional governments – krajské úřady).

b) There are only general conceptions about application of geodata in CM and its transformation for other users.
c) Powerful technologies (and better ones will be developed in the future) are available for CM for geodata and information storage, processing, transmission (wireless, GSM,...), etc.
d) The most scientific, programming and executive capabilities are available for development of CM systems (geodata, technologies, expert knowledge – 2D, 3D and 4D presentation tools, HW and SW).
e) Some relevant geodata and formalised knowledge is still missing. The source of them can be found partially in disposable geodata. It needs careful interpretation. The present narrow scope can be widened using geographic and other expert know how and by the application of more users friendly GITs.

The multicriterial decision making typical for CM has to be supported with all information and technologies available. The geoinformation cannot be exchanged in its original form which is limited in expedience. It needs to be pre-processed in relationship to the present level of knowledge and technological development. There is no other way in CM as the one represented by GIT. DLM represents the geodata unification procedure in this process.

4.2 Administration of crisis management

Activities of CM are liable to the act No. 240/2000, about the crisis management and changes of other acts (crisis act). CM definition says, that „the CM is a set controlling activities involved bodies focused on the analysis and assessment of security risks, on planning, realising and checking activities carried out in a consequence of solution of crisis situation.“ Chapter II of the crisis act defines CM institutions. They are represented with (1) bodies of territorial administration on all the levels, i.e. the government of Czech Republic, regional administration, administration of communities with wider agency, administrations of common communities as the organisation components of CM, and (2) elements of the integrated rescue system (IZS) as realizing tools.

Members of IZS are Fire brigades (HZS), Police and Rapid medical aid. Representatives of territorial administration and of IZS constitute *Security councils* on all levels of governments for need of prevention and planning. Specialists and scientists are usually invited to co-operate with security councils in affected areas.

CM execute phase is coordinated by the *Crisis staff* composed by deputies of administration and integrated rescue system. Crisis staff responds to the hazardous event on given level or scale. The manager of the Security council (SC) and the Crisis staff (CS) is the head the territorial administration at given level. If SC and CS are not able to cope with the event themselves, the SC and CS of the nearest higher level are invited to assist. Organisations responding the event using power form *Strike staff.* It is subordinated to CS on the same level.

5. Examples of DLM application in CM

The practice of the mostly engineering based solutions in CM represents commonly a parade of technically perfect but not correct results: Such faults are usually not unmasked and this way not corrected. A professional geographer posses enough experience from supporting and detail geographic disciplines (regardless to their specialisation) to able to assess combinations of variables participating in hazardous event, to identify key elements and to offer their evaluation for the decision making in CM. The „nature“ of a geographer is an ability to present results in products of modelling, visualising and animation. The main attention is paid to such ways of presentation they can address the widest audience taking part in CM..

5.1 Flood

Many software packages for inundation modelling are available for defined water discharge in Czech Republic. Floods are modelled for Q_5, Q_{20} and Q_{100} usually, and/or for historical or other registered discharge maxima. DLM data are applied: on soils (infiltration ability), geology (infiltration), atmosphere (previous precipitations, catchment area repletion, evaporation), terrain (surface, drainage barriers), land use (surface coarseness, embarrassing objects). Another important role is played by local valuables – about objects with special importance (population meeting places, concentrations of specific population groups – children, elderly people, disable people etc., environmentally important objects – sources of additional threat, historically, architectonically or other important building, key industry or manufacturing areas). Geographical information on all the three landscape structures enters the CM during flooding.

Geographical information is subdued to the special assessment e.g. for the identification of endangered buildings, deployment routes, evacuation areas and evacuation routes etc. Such results (usually maps – see Fig. 3) are immediately transferred to competent elements of CM and to affected publics (usually 3D models – see Fig. 4).

5.2 Road toxic accident

This situation requires special technologies: a moving vehicles is equipped with a GPS instrument for position monitoring (Czech market has variable systems for car monitoring enough), CM dispatcher is operating on-line with the system for the vehicle movement monitoring and visualising in a digital road (and topographic) map. The vehicle accident is announced by special message (by GSM) or as its GPS last position message. The toxic substance fading serves e.g. as a trigger for starting CM activities. The message about the accident reaches the elements of IZS. The evacuation zone is delimited in topographic maps in GIS. Immediately starts the accident environmental impact modelling. Digital maps of involved factors (e.g. geology, soils, vegetation, land use etc.) are taken from the CM central geodata base and using the chemicals catalogue these maps are evaluated from the view point of possible dissemination of pollutants. The area evaluation from the view point of possible ignition is another way of geodata pre-processing (e.g. geology: rock permeability, rock saturation, soils: permeability, humidity, vegetation: age and species composition, terrain: slope and aspect, atmosphere: temperature, humidity, wind direction and velocity). A mobile meteostation provides CM with the present air temperature and humidity, and wind direction and velocity. A synthetic assessment from the view point of pollution spreading of aggrieved area will be get by combining analytic information derived from basic maps in central data base. With regard to the forecast and risks the selection and territorial/time deployment of CM activities starts. Such model of application of geographical data is under testing at the present time.

6. Further perspectives of geographical data, geographical knowledge and GIT application in CM

Geography in connection with GIT represents a powerful analytic and synthetising tool for relevant territorial decision making based on multicriterial processing of large amounts of geodata in real time. A consequent improvement of CM procedures using IT will consist of:

a) improvement of modelling procedures based on GIS for more reliable hazardous processes forecasting to prepare CM staff and society for realising of individual CM steps,
b) improvement of visualising technologies for transmission of all CM outputs in the most synoptic form, it is the area for development of 2D, 3D and 4D cartography,
c) transmission technology improvement for communication in CM (web based and wireless technologies),
d) this development represents a deep motivation further analytic geographical research of hazardous processes in physical, economic and human geography,
e) improvement of geodata collection and mapping technologies focused on risk factors will be also necessary
f) development of principles and technologies for construction of public CM geodata bases including data and information sharing tools will be expected among licensed and other publics.

Such situation is awake to the Czech Ministry of Education, Youth and Sports which supported since 2005 a large research project No. MSM0021622418 „Dynamic geovisualising in crisis management“, focused on development of tools and sources supporting optimal response to phenomena threatening the human society.

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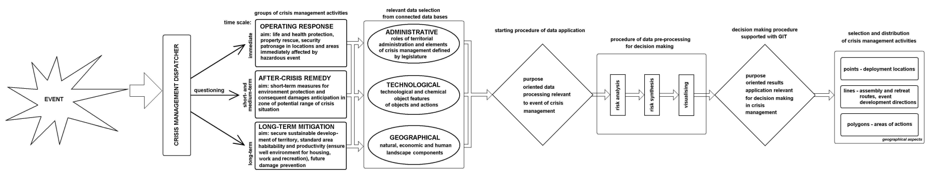

Fig. 1: Crisis management inputs, tasks and outputs

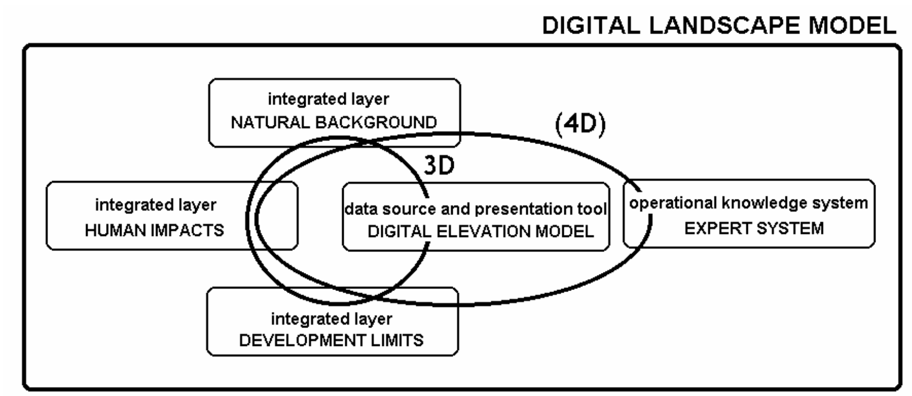

Fig. 2: Structure of digital landscape model

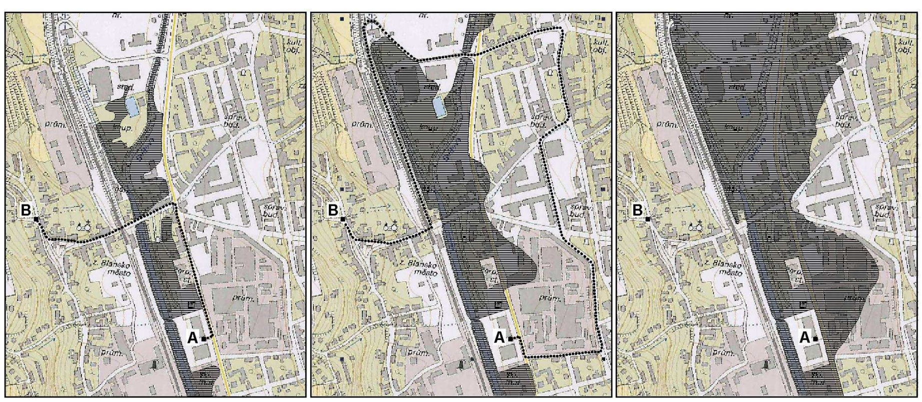

Fig. 3: Escape route derivation for three different levels of flood (Q_5, Q_{20}, Q_{100})

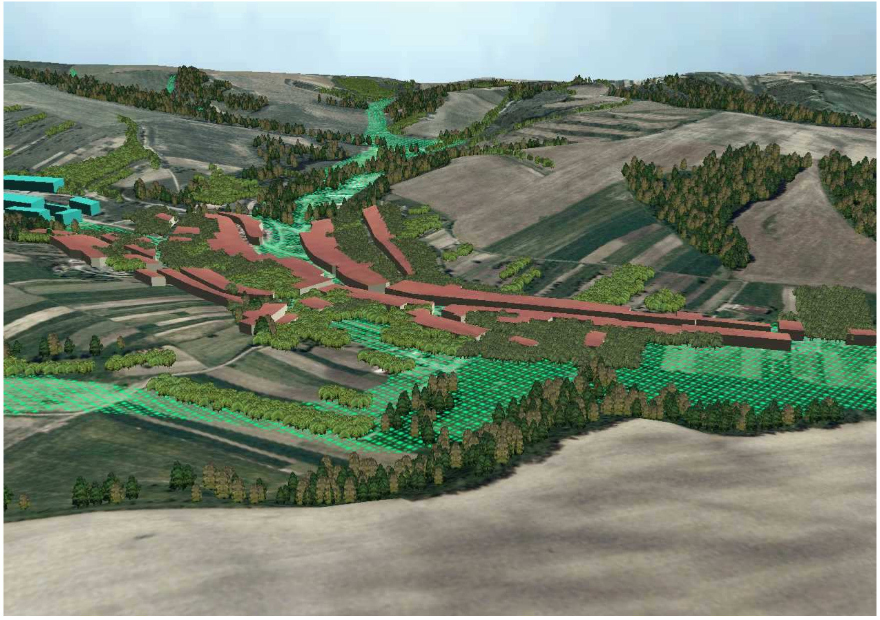

Fig. 4: Example of 3D model of flooded area

Example of 3D model of flooded area

 Geographia Technica, No. 2, 2006, 110 - 116

THE ASSESSMENT OF THE TOURISM POTENTIAL OF CODRILOR REGION

S. GÎRBU[1]

ABSTRACT. – The assessment of the tourism potential of Codrilor Region. Tourism represents an important sector of the global economy. Nowadays it has become a reliable source of income for the budget of many states. Many countries effectively use their own tourism potential, thus contributing to the creation of new jobs and the increase of the welfare of their population. As for the Republic of Moldova, there are views that Codrilor region is the most attractive part, as one can find there all sorts of tourism attractions. However, it is our opinion that the tourism potential of the region is not entirely capitalized because of the lack of a thorough study regarding the natural, human and economic heritage.

The strategy for the development of tourism drawn up by the Ministry of Culture and Tourism foresees a further development of tourism. This fact confirms once again the necessity for the setting up of a thorough study in the given region, which needs special investigations with the purpose of assessing the tourism resources, the drawing up of new routes to include new objects of interests for visitors. In this purpose, field researches have been made in the given region in summer 2006. The result of the performed researches, as well as the study of the scientific literature, have contributed to the completion of knowledge regarding the tourism resources of Codrilor region.

Tourism represents an important sector of the global economy. Nowadays it has become a reliable source of income for the budget of many states. Many countries effectively use their own tourism potential, thus contributing to the creation of new jobs and the increase of the welfare of their population.

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The result of the performed researches, as well as the study of the scientific literature, have contributed to the completion of knowledge regarding the tourism resources of Codrilor region.

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The region includes the most numerous and vast **state protected areas**, such as ***scientific, landscape and natural reserves***. It also concentrates many ***religious architecture monuments***, such as ***monasteries***, and ***some monuments of civil architecture***. They form a very attractive set of valuable objectives, which may contribute to the development of tourism (**Fig. 1**). Analysing the tourism map of Codrilor region, all these objectives may be classified in the following types and forms of tourism:

Itinerary with cultural valences *– historical and cultural monuments, museums to study the local county*

Pilgrimage *– monasteries, stone and wooden churches*

Museums and monuments *– historical and architectural monuments, museums, memorial houses*

National folklore *– local artistic orchestras, folk national architecture, manufacturers*

Rest and balneary treatment *– balneary and climatic resorts and spas, leisure and esthetic objectives of the natural landscape*

Scientific *– scientific reserves*

Rural *– beautiful landscapes.*

Among the reserves, special attention should be given to ***"Codru"* scientific reserve**. It stands out due to its morphological features, with ancient landslides, a mosaic of forest soils and rich vegetation. The main task of the reserve is to keep the natural complex as a "standard" of activity for other natural reserves. Scientific researches in the field of evolution of natural processes are performed. The correlation between the elements of the complex is determined in order to find the means of directing these processes and the methods to re-establish the natural resources as a whole, to ensure the functioning of the ecosystems.

The second **scientific reserve** is ***"Plaiul Fagului"***, located in the North-West of the region. It was created to protect the unique beech trees and other species of trees. The initial regime of the reserve was established due to the botanical, hydrical, soil and geological objectives.

Among the **landscape reserves and monuments** of Codrilor region, one should mention: *Trebujeni, Temeleuți, Valea Mare, Cazimir-Mileşti, Căbăieşti-Pârjolteni, Țigăneşti, Voloca Verbca, Vila Nisporeni, Dolna, Căpriana-Scoreni and Hânceşti Forest, the park from Mileşti, the park from Micleşti and the alley with larch trees and lime tree, the group of coniferous trees from the village Rassvet*, which stand out due to their aspect.
There are fewer **geological and paleontological monuments**. However, the best known are: ***Tofan's Cliffs*** (West of Vălcineț village), ***"În Dos"*** (Sipoteni village), the ***cliffs from Văsieni*** (on the right slope of Botna river valley), ***"La Chetrărie" cliff***, East of Vorniceni village. There is a ***geological afloriment*** to the north of Costeşti commune, ***"Cimitirul Cailor" quarry*** to the north of Pănăşeşti village, a ***pothole*** with well shaped forms at 6 km from Nisporeni town, a ***tectonic fracture*** near Selişte village and a steep slope not far from Sineşti village. On the West edge of Pocşeşti one may find a location for fossilized vertebrates.

Among the **hydrological objectives**, apart from Prut river, several dam lakes are used for leisure and fishing, like those from Mândreşti, Săseni, Năpădeni, Costeşti and Ulmu, Nisporeni. ***The spring near Jeloboc village***, and those from ***Cişmea and Step-Soci***, are also very dear to the locals.

Generally, Codrilor region has very many **planned springs**. Springs with normal water are those of ***Ştefan cel Mare*** near the villages of Săseni and Vălcineţ, with mineral waters – those from Hârjauca, Nişcani (2 springs), Corneşti, Călăraşi and Cioara.

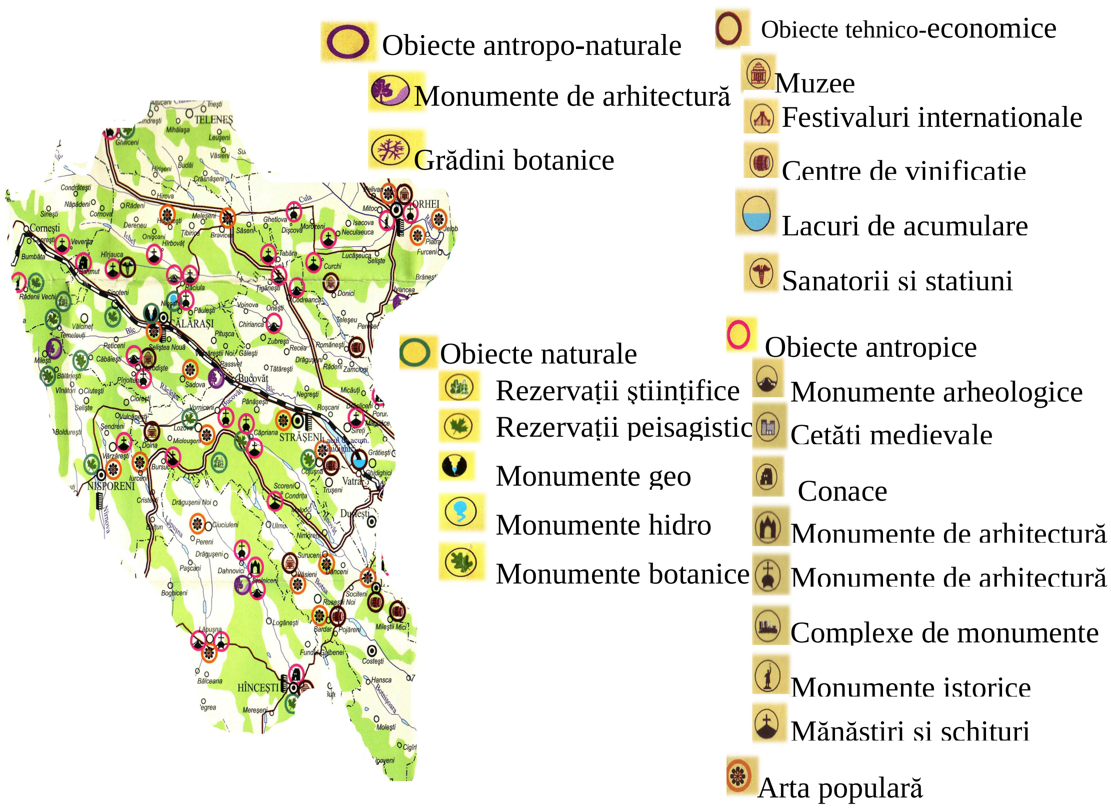


Fig 1: Tourism map of Codrilor region

The mineral water from Hârjauca is used for treatment of many illnesses. The well-known "Codru" spa is located nearby. It functions on the basis of the local curative mineral water, containing hydrocarbonates, sulphurs and sodium, similar to the famous „Essentuki-17", „Jermuc" and „Berezovski" mineral waters, and on the basis of medicinal mud brought here in cisterns from Kuialnic (near Odessa). The hydrocarbonated water of Corneşti, resembling that of "Borjomi" type, may be used in treating hepatitis and cholecystitides. The hydrocarbonated, sulphur and sodium water of Călăraşi (near the railway station and on the territory of the can factory), resembling to the "Jermuc" type, is recommended for the treatment of illnesses concerning the locomotion, gastro-intestinal, nervous system, hepatitis, cholecystitides, metabolic deregulations. The water of Cioara, similar to that of "Borjomi", "Poleana", "Avadhara", may be used in the treatment of heart diseases, gastro-intestinal diseases, hepatitis, cholecystitides, metabolic deregulations.

The ***representative sector with forest vegetation Hârjauca-Sipoteni of Hârjauca Forestry District*** is one of the **botanical monuments** within the analysed region.

Codrilor region includes numerous **natural forest reserves**, like: *Sadova, Boguş, Scăfăreni, Cabac, Zberoaia-Lunca, Condriţa and Voinova, Dancu, Nemteni, Sărata-Galbenă, Sărata Răzeşi, Pogăneşti, Ghiliceni, Teleneşti*.

Within the Codrilor region, there are also a several **reserves**, small in size, with flood plain vegetation (*moor grass, honey balm, oatgrass, hair grass, meadow grass*), located in the flood plains of Cula, Răut and Buda rivers and within the protection area of "Codru" scientific reserve.

Codrilor region is also known for the high number of **ancient trees**, about 120. Most of them are oaks, beech trees and forest pines.

This territory represents also an area of concentration of **human monuments and objectives**. Among the **civil architecture objectives**, one should mention *the manor of Zamfirache Ralli nobleman* of Dolna, *the architectural complex of "Manuc-Bey Manor"* in Hânceşti town, the manor of the family of writer Alexandru Donici from Bezeni, the *manor house of Russo family from Micăuţi*.

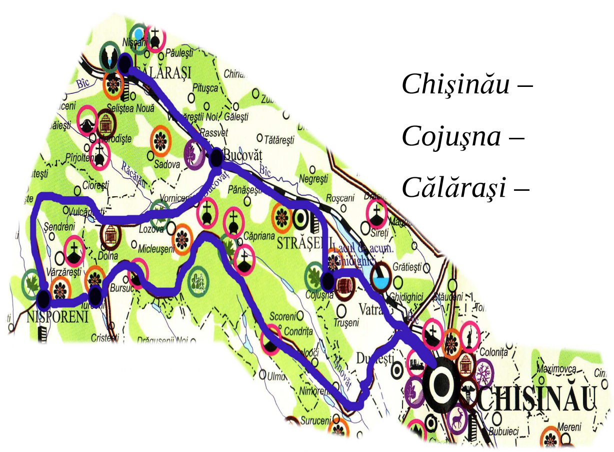
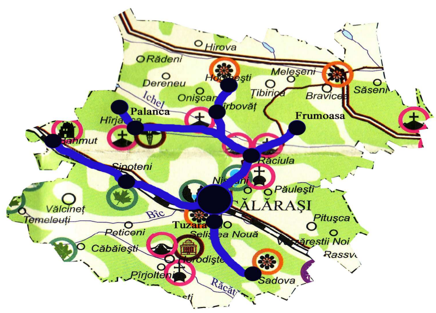


Fig. 2. The tourism route of "Codrii Moldovei" vineyards

Among the **memorial objectives**, one should mention the *birth house* of the poet Grigore Adam, in Bălăneşti, the *museum-house* of Alexandru Donici in Bezeni, with the bust of the writer. In Bezeni one may also find the "Saint George" chapel of Donici family, representing a true architectural masterpiece, built in 1848 using carved stone. In Mășcăuți



1. Călăraşi – Frumoasa – Răciula – Hârjauca – Palanca – Hârbovăț – Hogineşti – Călăraşi

* Călăraşi * Mănăstirea Frumoasa * Mănăstirea Răciula * Casa Mierii şi a Florilor * Muzeul Casa Părintească * Mănăstirea Hârjauca * Mănăstirea Hârbovâț * Centrul meşteşugăresc „Olarii" * Călăraşi

2. Călăraşi – Tuzara – Sadova – Sipoteni – Bahmut – Călăraşi

* Biserica „Sf. Alexandru Nevschi" * Biserica „Acoperământul Maicii Domnului" * Vinoteca Dumitru Tătaru * Rezervația Peisagistică „Sadova" * Rezervația Naturală Silvică „Sadova" * Rezervația Științifică „Plaiul Fagului"

Fig.2 b Traseul turistic recreativ (raionul Călăraşi)

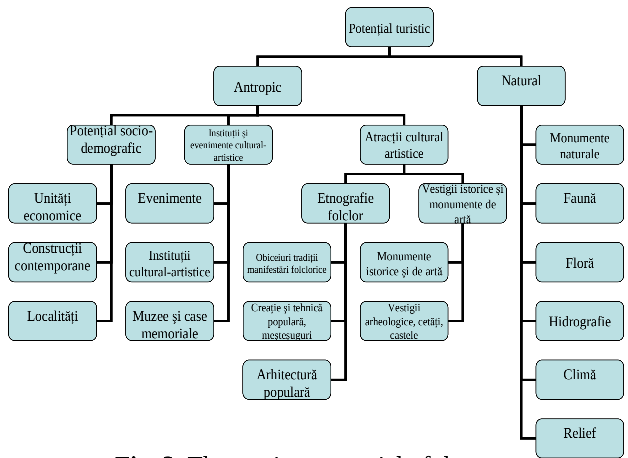


Fig. 3. The tourism potential of the Republic of Moldova

Due to the diversity of the materials collected in the field, the scheme proposed by the above-mentioned Ministry has been completed (**Fig. 4**).

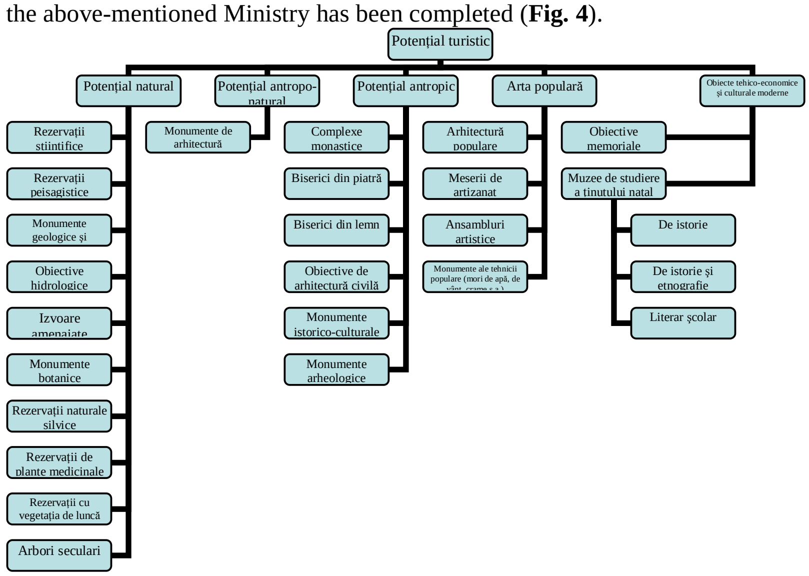


Fig. 4. The tourism potential of Codrilor region

The objectives of the tourism potential of the region consist of: the natural potential, the human and natural potential, the human potential, the technical-economic potential and the modern cultural potential.

At present, the following objectives are used: the human potential (monasteries and monastic complexes, historical and cultural monuments), folk art (cratsmanship, folk architecture), natural potential (landscape reserves, hydrological objectives, ancient trees).

The perspective for the extension and diversification of the tourism potential relies on the detailed research of the tourism attractions, as well as on the introduction of new tourism routes.

The assessment and effective use of the leisure tourism potential of the territory according to the given scheme might contribute a lot to the enlargement of the tourism and recreational basis of the region, both for foreign and domestic visitors.

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