HISTORICAL CADASTRAL MAPS OF CLUJ-NAPOCA

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ABSTRACT
Cadastral maps are usually the highest scale ones of a piece of land. Cities have the highest terrain element density among almost all of the terrain types. The quick changes in the built environment can be analyzed by using the repeated cadastral surveys, if they were carried out and are available for the research. Nevertheless, the availability of the maps is just the first step; they have to be fitted to each other and to modern cartographic coordinates to make quantitative analyses. Here we present the map sheets of two different cadastral systems of Cluj-Napoca (from 1912 and 1940) with the coordinate system definitions and the method to find out the coordinates of the sheets in this system. The cadastral maps of the Cluj-Napoca external parts of 1912 and the inner parts of 1940 can be fitted to the modern maps and spatial databases with an error no more than 3 meters, which can be corrected by a simple manual horizontal shift.

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1. INTRODUCTION

Cadastral maps, usually the highest scale ones of a piece of land, are made for land reG.I.Stry to complete the database of the land ownership information. Their accuracy defines the real preciosity of the ownership signals on the terrain. Besides, to provide help for set up the local signals in reality, they contain almost all terrain elements in their ground-plan form.

The research of the former ownership systems is sometimes interesting. The knowledge of the former state of the natural and build environment, however, is of broader interest in the environmental geosciences. High-scale cadastral maps with their precise representation of terrain elements have the maximum potential for this kind of analyses. The only hindrance of their usage is just because their high scales: for a research concerning a large area the number of cadastral sheets can be very – and sometimes uncontrollably – high. Projects for limited or moderate-extent territories, such as research and representation of the historical topography of a unique city are almost the limit of the cadastral map usage at the present state of the geographic information systems.

Cities have the highest terrain element density among almost all of the terrain types. The quick changes in the built environment can be analyzed by using the repeated cadastral surveys, if they were carried out and are available for the research. Nevertheless, the availability of the maps is just the first step; they have to be fitted to each other and to modern cartographic coordinates to make quantitative analyses. Finding identical points (ground control points; GCPs) is a tiresome work when the study area extends to several map sheets. If applicable, it is easier to find a system that defines the coordinates of distinct points, e.g. the corners of the sheets in a pre-defined coordinate system. Fortunately, the city of Cluj-Napoca has all of these requirements. Here we present the map sheets of two different cadastral systems (from 1912 and 1940) with the coordinate system definitions and the method to find out the coordinates of the sheets in this system.

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2. THE CADASTRAL SYSTEM OF THE HABSBURG EMPIRE AND HISTORICAL HUNGARY

The cadastral maps in the 19th century, prior to the introduction of the metric system, in these territories were using the Viennese fathom as a length unit (1 fathom equals to 1.89648384 meters (Kretschmer et al., 2004) – this accuracy is really needed for the transformation in country-wide applications; Varga, 2002). In Transylvania, the ’Marosvásárhely system’ (centered at Dealul Câstei, west of Târgu Mureş) was used for cadastral purposes after 1890 (Raum, 1986). Sheet units are organized in rows and columns from the projection center. Columns are indicated by Roman numbers, and the rows by Arabic ones (Fig. 1), starting with ’I’ and ’1’ from the center. Directions were indicated first by German then by Hungarian abbreviations: NW as É.N., NE as É.K., SW as D.N. and SE as D.K., respectively (e.g. the sheet group having the projection center at its southeastern corner has the ID of É.N.I.1). Each column and row have the width of 4000 fathoms.

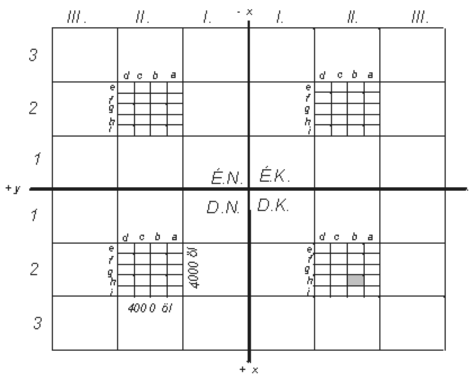

Fig. 1 ***Sheet numbering of the Viennese fathom system of cadastre in the ’Marosvásárhely’ system (Varga, 2002).***

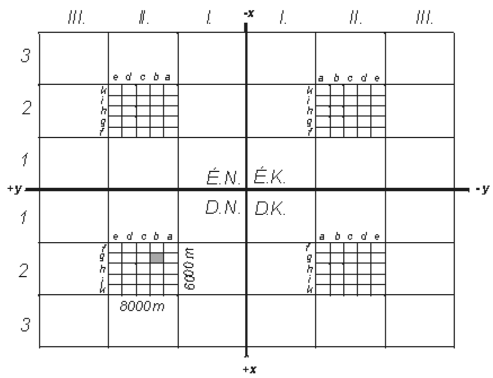

Fig. 2 ***Sheet numbering of the metric system of cadastre (Varga, 2002).***

Sheet groups consist of individual sheets with a width of 1000 fathoms and a height of 800 fathoms, so inside a sheet group there are four sub-columns (labeled by d, c, b, a from west to east) and five sub-rows (labeled by e, f, g, h and i from north to south). Therefore e.g. the southwestern sheet of the abovementioned sheet column has the ID as. „É.N. I. 1. d. i”. Labeling system is the same throughout the mapped area, not depending on the position from the projection center (Bácsatyai, 1993; Varga, 2002). This identification method was used also in other cadastral zones of the historical Hungary and the Habsburg Monarchy but with different column numbers at the projection centers (Buffoni et al., 2003; Brůna & Křováková, 2004; Maślanka, without date).

After introducing the metric system, the extents of the sheet groups, as well as the width and height of the sub-columns and sub-rows, were changed. A sheet group is then 8000 by 6000 meters, divided into five sub-rows and five sub columns, so the individual sheets are 1600 by 1200 meters (Bácsatyai, 1993; Varga, 2002; see Fig. 2). The sub-column identifiers are a, b, c, d, and e, while the sub-rows are indicated by f, g, h, i and k (note that there is no ’j’ sub-row). In local systems, the size of the individual sheets can be different (Timár & Biszak, 2007), and definitely this was the case during the so-called

’Transylvanian quick survey’ carried out by the Hungarian authorities after the Vienna draw of 1940.

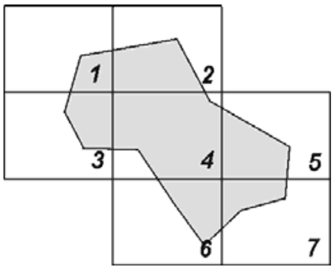

Fig. 3 ***Numbering of the cadastral sheets belonging to a settlement (Varga, 2002).***

The sheet numbering for a settlement was based on the abovementioned sheet systems but the involved sheets has been numbered from the northwestern corner in rows (Fig. 3, 4 & 5.). The built-in ’inner parts’ and the other ‘external parts’ of the settlements were mapped differently and usually in different scales.

The ’Marosvásárhely’ system have Stereographic projection (similarly to the Budapest system; Timár et al., 2004) both in metric and Viennese systems, while the other earlier systems in the Monarchy have ’projectionless’ (Cassini-Soldner-type) coordinates (Marek, 1875; Hofstätter, 1989). The Molodensky-type projection parameters of the Bessel 1841 ellipsoid for the ’Marosvásárhely’ system are the followings (Timár et al., 2004; 2007):

dX= +604 meters;

dY= -143 meters;

dZ= +528 meters,

while the projection center in the Bessel 1841 ellipsoid has the coordinates of:

Φ=46 33’ 8.85”; Λ= 24° 23’ 34.935” (from Greenwich).

The projection center in the maps is at: X=Y=600,000 m.

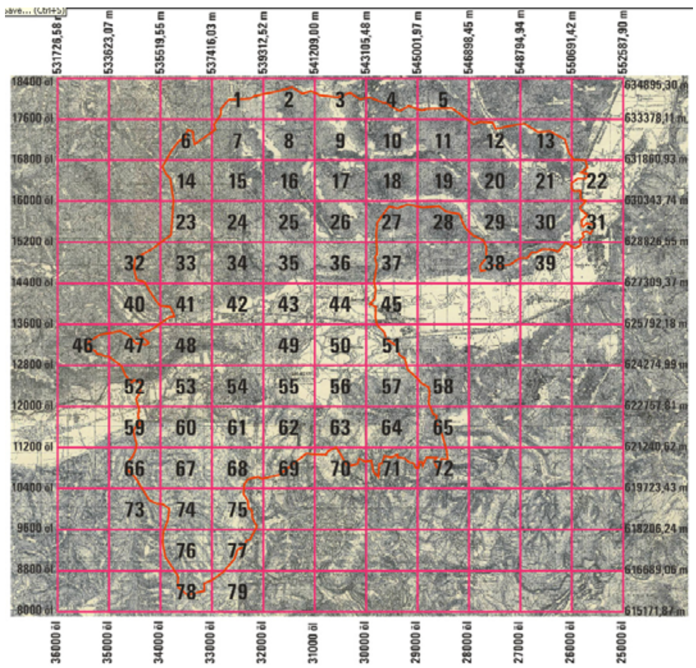

Fig. 4 ***The fathom system cadastral sheet numbers of Cluj (outskirts) in the 1912 series.***

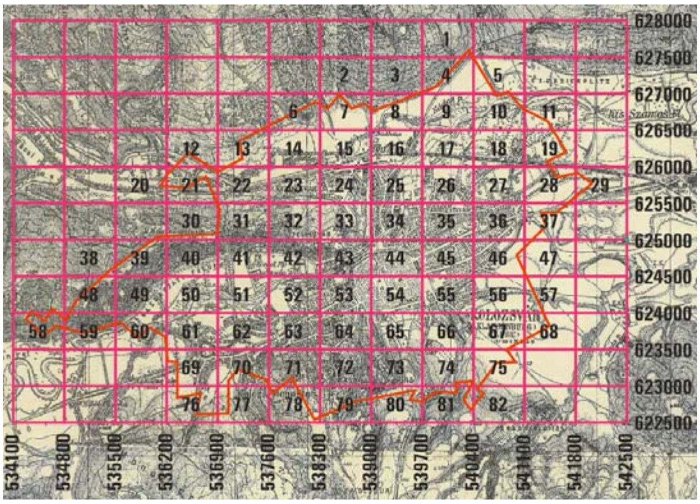

Fig. 5 ***The metric cadastral sheet number of Cluj downtown in the 1940 series***

3. APPLICATION OF THE COORDINATE SYSTEMS TO THE CADASTRAL SHEETS OF CLUJ-NAPOCA

In our analysis, the 1912 cadastral sheets of the external parts and the 1940 sheets of the inner parts of Cluj-Napoca are used. The overview of the sheet numbering is shown in Figs. 4 & 5. It is seen that the metric sheets have irregular size of 700*500 meters. Using these overview maps, the corner coordinates of all sheets can be easily computed for using the four corners as the only CGPs for rectifying the sheets in a G.I.S system. Using the initial coordinate system of the 'Marosvásárhely' system, the sheets can be reprojected to a modern projection or can even be used in a GPS (Timár, 2007).

Fig. 6 ***The fit of the 1940 downtown cadastre to a modern ortophoto (Old Castle District and Citadel sample area)***

An example is shown in Fig. 6, along the Someşul Mic River flowing through the city. The maximum error of fitting the sheets to a modern ortophoto is about three meters. Consider that comparing with ortophotoes, only the basement shape of the building has to be fit to the cadastral sheet. The main source of the error is the unknown orientation of the 'Marosvásárhely' system and can be corrected by a simple horizontal shift using just one GCP in the analyzed area.

Some example conclusions of virtual reconstruction of the old city; the case study of the Old Castle District & Citadel (fig. 6.) and Benedictine Abbey (fig. 7) areas

The Fig. 6. represents the downtown of Cluj-Napoca: in background is the modern ortophoto, in foreground the black lines are the elements of the cadastral map from 1940.

On the southeast side of the River Someşul Mic is situated the Old Castle District, in it the house where the king Mathias Corvin was born in 1443. In this area weren't changes since the Middle Ages, so the old cadastral map and the modern ortophoto show almost the same content. So here we can see the accuracy of the fitting of the old cadastral map sheet on modern coordinates.

We can attract your attention of some differences linked with the River Someşul Mic: we can see where the old bridge was and how wide was that one.

The changes are more spectacular on the northwest side of the River Someşul Mic. Here is situated the hill of the Citadel. On the old cadastral map we can see the bastions and the buildings of the Citadel built in the 18th century. In the 1970s in place of the Citadel was built a hotel, this one we can see on the modern ortophoto. We can see other changes at the foot of the hill: on the old cadastral map we can identify the little building plots of a slum which was demolished, and in place of the old narrow streets now are five blocks which we are represented on ortophoto.

Fig. 7 ***The fit of the 1912 external area map and of the 1940 inner area map to a modern ortophoto (Benedictine Abbey sample area)***

On the Fig. 7. we can see an external part of Cluj. In the first decades of the 20th century half of this area was part of the outer areas of the city so the black lines in foreground are composed by two cadastral maps. In the western part we can see the lines of the map from 1912 map which represents the external area of the city; in the eastern part we can see the lines of the cadastral map from 1941 which represents the inner area of the city. The area now is completely part of the city. The background of the picture is the modern ortophoto.

Comparing the two old cadastral maps we can see that the two maps are fitted very exactly to each other. We can observe which plots were re-classed from external area to inner area between 1912 and 1940.

Comparing the contents of the cadastral map to the modern ortophoto we can see that the area was built up in the last century. Practically only the church of the Benedictine Abbey is the single identical point. Looking at the picture closely we can recognize that some other buildings and fragments of streets are also common elements. But the biggest part of the houses was demolished and in place of them now here are blocks.

4. CONCLUSIONS

The cadastral maps of the Cluj-Napoca 'external areas' of 1912 and the inner areas of 1940 can be fitted to the modern maps and spatial databases with an error no more than 3 meters, which can be corrected by a simple manual horizontal shift. The fit of the two cadastral systems is almost flawless at the boundary of the downtown (Old Castle District sample area). Huge changes in the built environment are detected in Citadel and in Benedictine Abbey sample areas showing only a few remaining buildings in these districts.

Acknowledgements. The authors are grateful to Dr. József Varga (Budapest University of Technology and Economics) for his advises and help during completing this work, and also for his figures used here as Figs. 1 to 3.

REFERENCES

Bácsatyai L. (1993), *Magyarországi vetületek*. Mezőgazdasági Szaktudás Kiadó, Budapest, 193 o.

Brůna, V., Křováková, K. (2004), Analýza *změn krajinné struktury s využitím map Stabilního katastru*. In: Historické mapy. Zborník z vedeckej konferencie, Bratislava 2005 (Kartografická spoločnosť Slovenskej republiky), 27-34, ISBN 80-968365-7-9, ISSN 1336-6262

Buffoni, D., Leoni, D., Bortolamedi, R. (2003), *L'eredita' cartografica catastale degli asburgo in formato digitale*. E.geography: G.I.S e Società - 6° Conferenza Italiana Utenti ESRI, 9-10 Aprile 2003.

(URL:http://www.esriitalia.it/conferenza2003cd/content/documenti/9aprile/buffoni.doc)

Hofstätter, E. (1989), *Beiträge zur Geschichte der österreichischen Landesaufnahmen*, I. Teil, Bundesamt für Eich- und Vermessungwesen, Wien, 196 p.

Kretschmer, I., Dörflinger, J., Wawrik, F. (2004): Österreichische Kartographie. Wiener Schiften zur Geographie und Kartographie – Band 15. Institut für Geographie und Regionalforschung der Universität Wien, Wien, 318 p.

Marek, J. (1875), *Technische Anleitung zur Ausführung der trigonometrischen Operationen des Katasters*, Budapest, 397 o.

Maślanka, J. (without date): *Kataster austriacky*. Manuscript with Internet availability.
(URL: http://gps.put.mielec.pl/new_page_1.htm)

Raum F. (1986), *A magyar kataszteri felmérés szervezetének kialakulása*. *Geodézia és Kartográfia* **38**(1): 46-51.

Timár G. (2007), *GPS-navigáció történeti topográfiai és kataszteri térképeken*. *Geodézia és Kartográfia* **59**(5): 22-26.

Timár G., Biszak S. Budapest 1938 előtti nagyméretarányú térképeinek georeferálása. *Geodézia és Kartográfia* **59**(8-9): 47-51.

Timár G., Molnár G., Păunescu C., Pendea F. (2004), *A második és harmadik katonai felmérés erdélyi szelvényeinek vetületi és dátumparaméterei*. *Geodézia és Kartográfia* **56**(5): 12-16.

Timár, G., Molnár, G., Imecs, Z., Păunescu, C. (2007), *Datum and projection parameters for the Transylvanian sheets of the 2nd and 3rd Military Surveys*. *Geographia Technica* **2**(1): 83-88.

Varga J. (2005), *Kataszteri térképrendszerek. Manuscript with Internet availability*, Dept of Geodesy and Surveying, Budapest University of Technology and Economics (URL: http://www.agt.bme.hu/staff_h/varga/katrend/katrend.html)

THE LAND USE ANALYSIS IN NICOLINA CATCHMENT'S AREA USING G.I.S TECHNIQUES

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ABSTRACT
Land use, as a part of the geo-economic system has important structural variations over a short period of time. The Nicolina hydrographic basin is intensely modified by the urban pressure of nearby city of Iaşi. This pressure has become more and more intense in the last decade as a result of growing constructed area towards the "green" margins of the city, due to a real exodus of the population in an environment less polluted. The analysis of the land use changes is made using the G.I.S techniques. The methodology consists in vectorising the land use structures from cartographic maps DTM (1:25000) and also by remote sensing on satellite images from year 2000 (LANDSAT ETM). We compared online the ANCPI aerial-photos by accessing the site www.ancpi.ro from our area of interest. In our classification we have been analyzing the polygon with a minimum of 100 m2; this limit was related to the resolution satellite images. Our final purpose is to evidence the major changes of land use after 1989 and to correlate this with geomorphological and anthropical factors. By that, we intend to show the real problems regarding land use in the Nicolina catchment's area caused principally by the growing of the urban area.

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1. INTRODUCTION

Land use as a consequence of the anthropic factor is essential to demographic and spatial growth of human society. The meeting point of natural and human structures is a joint result of general and individual interests. The variety of land use is a common expression of relief, climate, soil and human factors. Land use analysis became more popular once the satellites were launched to observe the surface of the Earth (first satellite launched on October 4th 1957). The first satellite built for the purpose of imaging Earth' surface (Explorer 6) was launched on 14th of August 1959 by the United States. At the base of spatial analysis on Earth lie the LANDSAT images. The European programme Corine Land Cover (CLC) started in 1990 and finalized with the European land use map. The project also included Romania. Further on, new editions of the maps appeared in 2000 and 2006. The project relies on a high level of generalization (minimum distinct surface/polygon of 25 ha). A study for Corine Land Cover nomenclature in Romania was realized by Ursu et. colab., 2006.

For the catchment area of the Nicolina River we used as a starting point the CLC map from 2000. Using the online images on ANCPI server a more detailed analysis was performed on minimum surfaces of 100 m2.

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2. DATA

The Nicolina catchment area lies in the North-East of Romania and is included in the geographic unit of Moldavian Plateau. More precisely this area lies at the contact of the south part of the region known in the literature as the Moldavian Plain, *Băcăuanu V.* (1968), with the Central Moldavian Plateau. (fig.1)

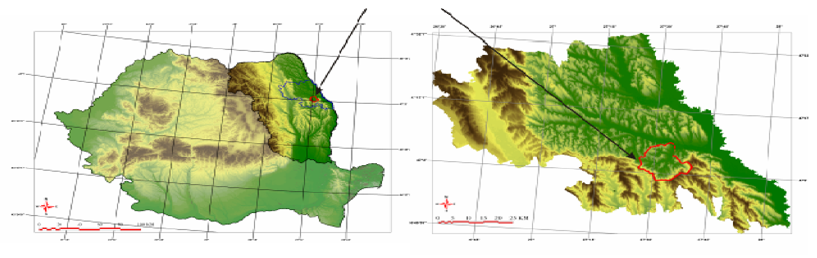

Fig. 1 ***The placement of the Nicolina catchment area***

Our G.I.S project uses as support LANDSAT TM satellite images from the year 2000, some aerial photos taken from the spring of 2004 and also data acquired during our terrain expedition.

The data from the land use spatial analysis in the Nicolina catchment area were processed into the TNT Mips, which is G.I.S soft. The steps we have been following during our analysis were the editing of the elevation lines from topographic maps (1:25.000 DTM, 1986) into a vector layer. After data interpolation a (Digital Terrain Model) DTM of the region. Based on DTM several primary maps were obtained (slope, aspect, elevation), that were processed and classified.

The land use map is the result of identification of the structures with similar spectral reply followed by interpretation on the aerial photos.

The method we have been using consists in the on-screen vectorisation. The land use classified vector contains 14 classes. The criteria we followed were:

-for the urban constructed areas the minimum surface of 100 m^2. This class includes buildings, outbuildings and houses. For Iaşi city the level of generalization was increased because of a higher density of constructed structures than our scale of analysis.

-the communication network from the city boundaries and from the outside the city boundaries was totally extracted as polygons resulting area occupied by this class. We didn't classify the communication network after its quality and purpose.

-the agricultural complex class is specific for those agriculture areas to small too be self identified and includes small cultivated areas with vineyards, fruit trees but also gardens and pastures.

The data were also obtained using an extraction method which consisted in intersecting each class with the primary maps (slope, aspect, elevation) and updating raster histogram of the information. The data were later exported for processing and statistical analysis and we present them Table 1, 2, 3.

The frequency of land use classes related to elevation

Table 1

Land use (%)	Elevation classes (meters)											
	<50	50-75	75-100	100-125	125-150	150-175	175-200	200-225	225-250	250-300	300-350	>350
agriculture	0.0	3.4	25.6	35.7	25.1	9.6	0.5	0.0	0.2	0.0	0.0	0.0
agricultural complex	0.0	4.5	16.1	27.9	24.0	12.8	5.7	3.3	3.1	2.5	0.1	0.2
deforestations	0.0	16.4	17.9	32.6	18.1	5.2	3.6	3.7	1.5	0.2	0.0	1.0
constructions	14.3	29.8	21.2	13.2	12.7	6.0	1.5	0.5	0.4	0.4	0.0	0.0
roads	0.3	10.7	27.2	27.6	17.4	7.5	3.1	2.2	1.7	2.2	0.2	0.0
lakes	0.0	93.8	5.8	0.4	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
fruit trees	0.0	0.7	9.2	43.2	39.9	6.9	0.1	0.0	0.0	0.0	0.0	0.0
pastures	0.0	15.5	28.8	18.9	11.5	7.1	4.9	4.4	3.8	4.0	1.1	0.0
forests	0.1	2.3	8.1	10.9	12.8	8.0	8.8	8.9	8.8	15.0	10.4	5.8
vineyards	0.0	0.0	1.4	7.8	41.1	42.9	6.7	0.0	0.0	0.0	0.0	0.0

The frequency of land use classes related to slope

Table 2

Land use (%)	Elevation (degrees)						
	<2	2-5	5-10	10-15	15-20	20-30	>30
agriculture	41.90	32.88	25.10	0.12	0.00	0.00	0.00
agricultural complex	18.58	30.66	43.85	6.55	0.34	0.02	0.00
deforestations	13.80	17.73	45.34	21.86	1.18	0.08	0.00
constructions	47.43	29.24	20.07	3.08	0.17	0.01	0.00
roads	31.22	27.54	33.57	7.05	0.56	0.05	0.00
mineral extraction sites	26.32	8.33	28.33	15.00	8.51	13.51	0.00
fruit trees	35.04	36.74	25.31	2.78	0.13	0.00	0.00
pastures	25.79	16.60	41.44	14.47	1.54	0.15	0.00
forests	10.30	15.36	45.62	23.35	4.44	0.91	0.03
vineyards	16.20	31.23	48.37	4.15	0.06	0.00	0.00

The frequency of land use classes related to aspect

Table 3

Land use (%)	Aspect							
	N	NE	E	SE	S	SV	V	NV
agriculture	11.6	16.5	16.9	9.9	7.6	10.5	15.8	11.1
agricultural complex	10.6	19.1	17.1	9.7	5.9	12.9	15.9	8.9
deforestations	20.6	24.8	10.7	3.6	2.1	2.7	18.2	17.2
constructions	5.8	19.4	24.2	15.8	10.6	10.5	8.1	5.5
roads	11.5	16.2	18.9	11.6	7.9	9.4	14.7	9.9
fruit trees	3.8	13.6	29.3	21.9	11.5	7.2	10.9	1.7
pastures	14.5	18.1	16.0	7.3	5.3	9.0	17.3	12.5
forests	15.5	15.5	9.4	3.6	2.5	9.2	26.0	18.3
vineyards	12.1	11.8	16.7	20.6	4.8	14.1	12.0	7.8

3. RESULTS

By analysing the informations we obtained during the statistical processing and photo interpretation of the satellite images and aerial photos we observed a spatial dynamic of the agricultural, construction and

Data statistical analysis and interpretation of the satellite images and aerial photos showed the growth of constructed areas on behalf of agricultural and natural-like (mostly pastures) areas. The dynamics of land use categories follow a pattern related to several parameters: altitude, slope gradient and exposition. Altitude related pattern (fig. 2) shows a decrease of agricultural land use with the increase of elevation. Agriculture land in the studied area is widely spread between the altitudes of 50 to 150 m because of its placement at the contact of 2 geographical subunits, the Moldavian Plain (elevation up to 250 m) and the Central Moldavian Plateau (elevation higher then 250 m). The altitudes lower then 50 m are included in the urban area of the city of Iaşi and its proximity and correspond with the junction between Nicolina and Bahlui Rivers. Between the altitudes of 50-175 m most of cuesta's scarps are affected by actual geomorphologic processes and function as pastures. The forests between 50-250 m are plantations for slope protection and those higher then 250 m belong to the natural vegetation of the Central Moldavian Plateau (*Carpinus* spp. and *Fagus* spp.)

In the city's proximity between the altitudes of 50-100 m the presence of man made reservoirs is due to economic (pisciculture) and protection reasons (to prevent flooding). Lately these reservoirs have been also largely used for leisure activities. The vineyards and orchards are specifically placed on highly degraded terrains making thus possible their use as agricultural lands. Most of them are situated in the contact area between the plain and plateau units.

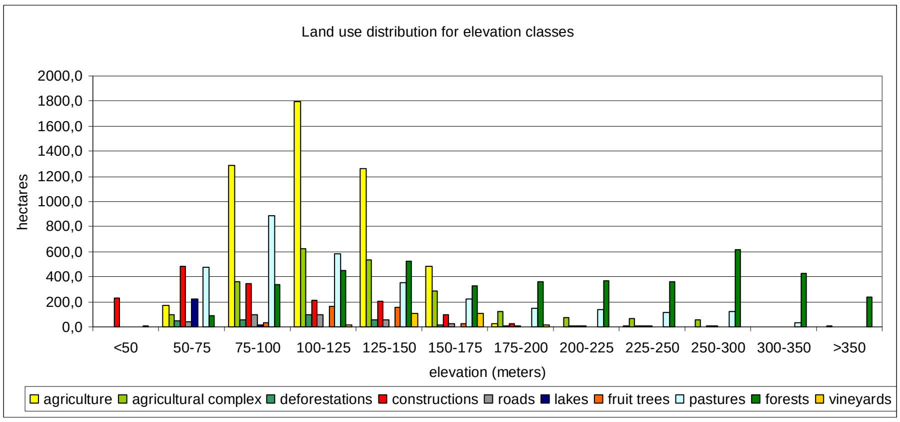

Fig. 2 ***Land use distribution for elevation classes***

Fig. 3 shows the land use distribution for slope classes. The maximum slope gradient for agricultural land use and constructed areas is 10 degrees. Pastures and forests lie on slopes with higher gradients (over 15 degrees) that can not be proper for other uses.

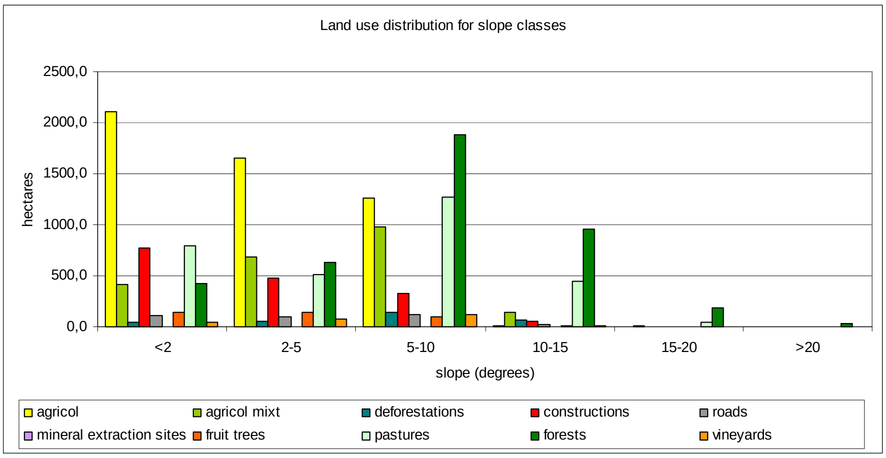

Fig. 3 ***Land use distribution for slope classes***

Fig. 4 shows the correlation between land use and slope exposition. The distribution of most land use categories on the main slope expositions is similar to the general distribution of the same categories in the whole catchment's area. The situation is slightly different for forests which prefer V and NV expositions that are mostly cuesta's scarps formed by the regressive evolution of the Nicolina River.

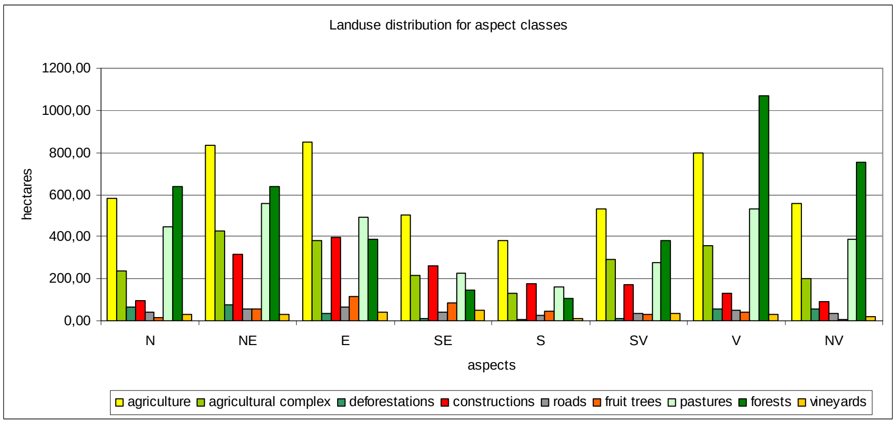

Fig. 4 ***Land use distribution for aspect classes***

Fig. 4 shows the correlation between land use and slope exposition. The distribution of most land use categories on the main slope expositions is similar to the general distribution of the same categories in the whole catchment's area. The situation is slightly different for forests which prefer V and NV expositions that are mostly cuesta's scarps formed by the regressive evolution of the Nicolina River.

Comparing the CLC methodology with the one used by us we can see the following aspects:

-the construction class that we used is included in the urban constructions, rural constructions and industrial constructions classes from CLC, because our analysis takes all the constructed areas into one class;

-in the CLC methodology includes two classes for the class we named agricultural complex. We separated the natural vegetation from agricultural complex with natural vegetation, and distributed those structures as pasture, forests and deforestations;

-because of a lower image resolution used in the CLC analyses the coniferous and mixed forests weren't separated into distinctive classes, as we did in our case by using terrain observations and aerial photography;

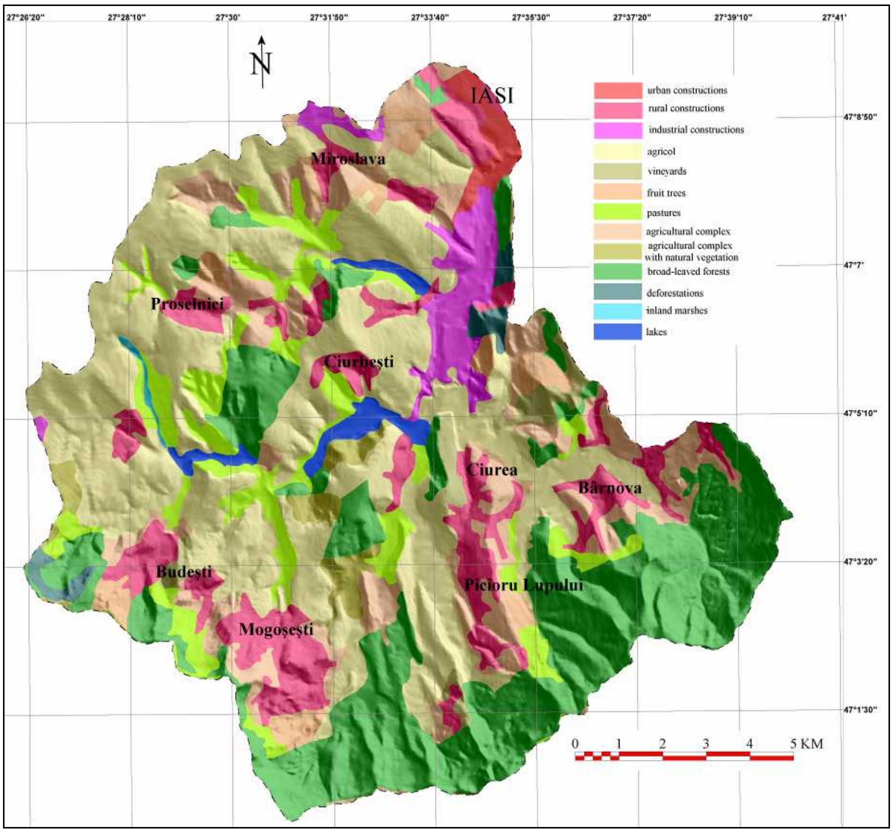

Fig. 5 ***Land use for Nicolina basin (CLC methodology, 1990)***

We can observe from the map regarding the land use in 1990 (fig. 5) created using the CLC methodology that the structures were more compact, and more homogeny. The Nicolina catchment area was occupied in a large proportion by the agriculture areas (aprox.11130 ha which includes the agricultural complex, vineyards and fruit trees classes) and constructed areas witch includes urban constructions, rural constructions, and industrial constructions (aprox. 2837 ha), as a consequence to the communist doctrine. We also can notice a clear limit between the Iaşi urban boundaries and proximate rural areas.

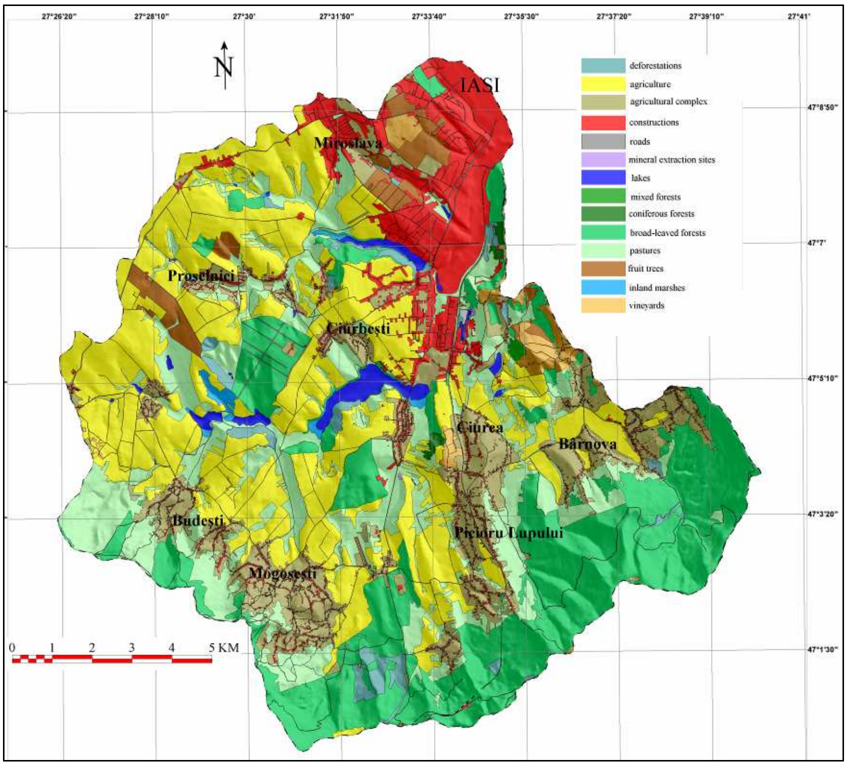

Fig. 6 ***Land use for Nicolina basin***

The change from the planned communist regime to the one which began in 1990 brought some dramatic transformations on the land use. The agricultural areas due to the 18/1991, low suffered an intense fragmentation and change in the way of exploitation. The predominant classes in this case are the construction (1997 ha), agriculture (7910 ha), forest (4114 ha), and pastures (3077 ha).

In the analysis of the land use evolution between 1990 - 2008 we applied the merging of the classes high affected by human activity, like roads and mineral extraction sites and also the merging of the urban constructions, rural constructions and industrial constructions in one class.

In a period of 18 years the classes suffered several changes:

-the growing off the agricultural complex and pastures classes;

-the decrease of the agriculture forest, vineyard and fruit trees areas;

A particular case is the on represented by the construction class. As we can see the land use evolution chart (fig.7) indicates a decreasing trend which is different by the real situation. The improvements of the economic factor after 2000, rouse the immobile market causing a growth in the construction activity who led to the appearance of the metropolitan area of Iaşi. The anomaly of the chart is explainable to the fact that we applied a different methodology which takes into consideration a minimum surface of 100 m^2. The minimum surface area taken in consideration in CLC methodology is of 25 ha.

The coordinates of our area, which is situated at the contact of the nemoral with the forest steppe couldn't indicate a growing of the inland marshes class because off the low quantities of precipitations. The reality is in stead different, due to a possible clogging of the lakes followed by the invasion of hygrophilous vegetation.

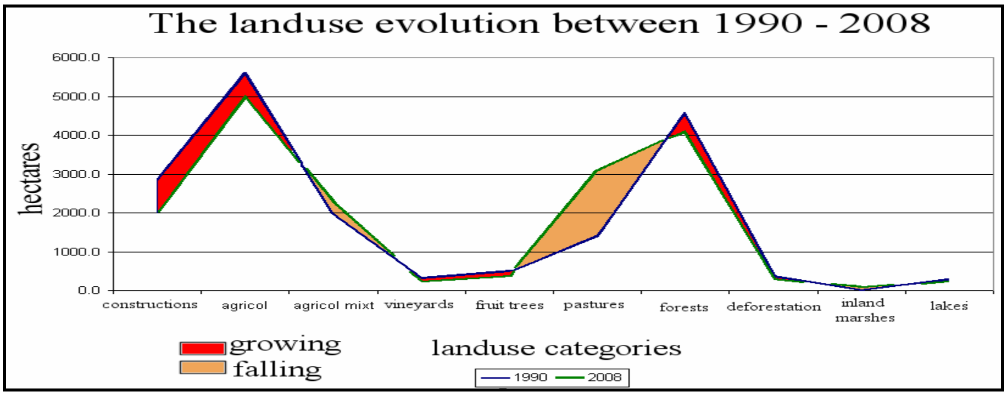

Fig. 7 ***The landuse evolution between 1990-2008***

4. CONCLUSIONS

The use of G.I.S. methods for land use analysis brings more accurate and precise information. The CLC methodology has a more global character with a high level of generalization, not applicable for detailed analysis of relatively small areas like the Nicolina catchment area. The correlations identified in the present study are based on more detailed analysis as compared to CLC methodology. For small areas with diverse structures and complex functions there is a clear need of reducing the minimum surface considered to at least 100m^2, or even more.

REFERENCES

Băcăuanu V., (1968) – *Câmpia Moldovei - studiu geomorfologic*, Edit. Academiei, R.S.R., Bucureşti.

Cismaru C., Niţescu, M., Năstase, V., Gîlcă, V., (1986) – *Studiul procesului de colmatare a unor lacuri de acumulare din bazinul hidrografic Bahlui*, Cercetări. Agronom. în Moldova, 4, 6-7, Iaşi.

Condorachi D., (2004) – *Utilizarea Sig în analiza morfometrică a bazinelor hidrografice de ordinul IV (sistem Horton –Strahler)*, Lucrările Seminarului Geografic „Dimitrie Cantemir", nr.23-24, 2002-2003, Iași.pag.35-48.

Ioniță I., (2000) – *Relieful de cueste din Podişul Moldovei*, Editura Corson, Iaşi.

Patriche C. V., (2005) – *Podişul Central Moldovenesc dintre râurile Vaslui şi Stavnic – studiu de geografie fizică*, Ed. Terra Nostra, Iaşi

Ursu, A., Stoleriu C., Sfîcă, L., Roşca B., (2006) Adaptarea nomenclaturii Corine Land Cover la specificul utilizării terenului în România, „Geographia Technica, no.1, 2006, ISSN 1842-5135, p.193-199, Cluj-Napoca

http://ro.wikipedia.org/wiki/Sputnik

http://en.wikipedia.org/wiki/Satellite_image#cite_note-0

http://www.ancpi.ro

DEVELOPING AN OPEN ROMANIAN GEOPORTAL USING FREE AND OPEN SOURCE SOFTWARE

V. Crăciunescu[1], Şt. Constantinescu[2], I. Ovejeanu[2]

ABSTRACT
The article explore the world of free and open source geospatial (FOSSG.I.S) software with the aim of proving that is possible to design and deploy web based Enterprise Geographic Information Systems only with FOSSG.I.S programs.

*

1. THE OPEN SOURCE CONCEPT

The idea of free/libre open source software is not something new, it has been around for almost as long as software has been developed. In 1983, Richard Stallman defined the concept of Free Software in form of four freedoms:

0. freedom: The freedom to run the program, for any purpose.
1. freedom: The freedom to study how the program works, and adapt it to your needs.
2. freedom: The freedom to redistribute copies.
3. freedom: The freedom to improve the program, and release your improvements to the public, so that the whole community benefits.

In the same year Stallman started the GNU-Project, followed shortly (1985) by the "Free Software Foundation", a legal established body to support the Free Software concept. The GNU General Public License (GPL), developed within the GNU Project, not only grants the four freedoms described above, but it also protects them. Today a myriad of different open source software licenses were derived from GPL and the "Open Source Initiative" (http://www.opensource.org/) has the role of general arbiter of license correctness.

2. OPEN SOURCE G.I.S

The Open Source G.I.S space includes products to fill every level of the OpenG.I.S spatial data infrastructure stack (Ramsey, 2007, Zavante et. colab., 2006, Crăciunescu V., 2007). A great advantage brought by geospatial FOSS (free and open source software) applications, beside the classical open source advantages presented above, is the compliance with existing ISO/OGC standards. At this moment, the majority of the open source G.I.S applications are designed in respect for these standards. This is possible due to the high rate of code reuse. Basically there are some strong core libraries (e. g. GDAL,

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OGR, PROJ), already standard compliant, that are further use by the majority of software applications.

An important moment in FOSSG.I.S history was represented by the birth, in 2006, of the Open Source Geospatial Foundation (OSGeo), a not-for-profit organization whose mission is to support and promote the collaborative development of open geospatial technologies and data. The foundation provides financial, organizational and legal support to the broader open source geospatial community. It also serves as an independent legal entity to which community members can contribute code, funding and other resources, secure in the knowledge that their contributions will be maintained for public benefit. OSGeo organize an annual OSGeo Conference, called FOSS4G, which gather together the people who create, use, and support open spatial software.

3. DEVELOPING AN OPEN ROMANIAN GEOSPATIAL PORTAL

A geospatial portal is a human interface to a collection of online geospatial information resources, including data sets and services (OGC, 2004). Geo-spatial.org is a collaborative effort by and for the Romanian community to facilitate the sharing of geospatial knowledge and the discovery and publishing of free geographic datasets and maps. It was created by a small team of young scientists as an attempt to overcome the Romanian specific geospatial dysfunctions.

Anyone can make a contribution by submitting articles or datasets for publication, adding comments to the existing articles, join the discussion on the mailing list or users forum.

Portal structure

geo-spatial.org was developed following a distributed architecture (Fig. 1). The content is managed by Textpattern, a powerful and flexible, open source content management (CMS) application. For supplementary, specific functionality, custom modules were built. Other free applications are providing server-side functionality: MySQL (relational database management system), PHP, Python, Java (server-side scripting languages), Apache (webserver), Tomcat (servlet container), phpMyAdmin, phpPgAdmin (web clients for database management).

For geospatial data management, top open source applications were also integrated in the website.

UMN Mapserver is a internet map server, a server-side piece of software which renders G.I.S data sources into cartographic map products. Mapserver is one of the most successful open source G.I.S project to date.

PostG.I.S is an extension for the PostgreSQL enterprise relational database. PostG.I.S is certified as "Simple Features for SQL" compliant by the Open Geospatial Consortium. First released in 2001, PostG.I.S is now used around the world as a high-performance server for spatial objects. The spatially-enabled query planner, highly concurrent R-Tree spatial index, and hundreds of spatial analysis and processing functions allow for G.I.S-style data analysis right inside the database.

Mapbender is a software and portal site for geodata management of OGC OWS architectures. The software provides web technology for managing spatial data services implemented in PHP, JavaScript and XML. It provides a data model and interfaces for displaying, navigating and querying OGC compliant map services. The Mapbender framework furthermore provides authentication and authorization services, OWS proxy functionality, management interfaces for user, group and service administration in geoportal projects.

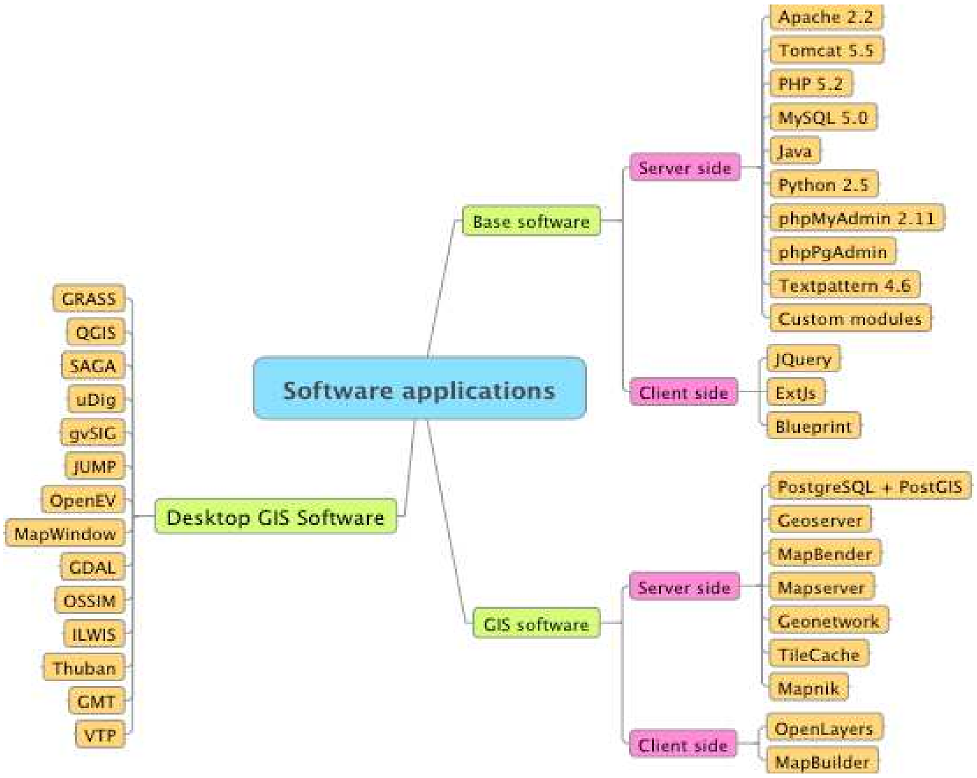

Fig.1 ***Portal software architecture.***

GeoNetwork Opensource is a standards based, catalog application to manage spatially referenced resources through the web. It provides powerful metadata editing and search functions as well as an embedded interactive web map viewer.

Geoserver is a standard compliant geospatial server, allowing the users to publish and edit data. The information is made available in a large variety of formats as maps/images or actual geospatial data. GeoServer's transactional capabilities offer robust support for shared editing. GeoServer's focus is ease of use and support for standards, in order to serve as 'glue' for the geospatial web, connecting from legacy databases to many diverse clients.

OpenLayers is a pure JavaScript library for displaying map data in most modern web browsers, with no server-side dependencies. OpenLayers implements a JavaScript API for building rich web-based geographic applications, similar to the Google Maps and MSN Virtual Earth APIs.

TileCache provides a Python-based WMS/TMS server, with pluggable caching mechanisms and rendering backends. In the simplest use case, TileCache requires only write access to a disk, the ability to run Python CGI scripts, and a WMS you want to be cached. With these resources, a user can create local disk-based cache of any WMS server, and use the result in any WMS-C supporting client.

The information flow between the various server side application and the front end graphical interface in determined by the interaction with the portal users and their requests (Figure 2).

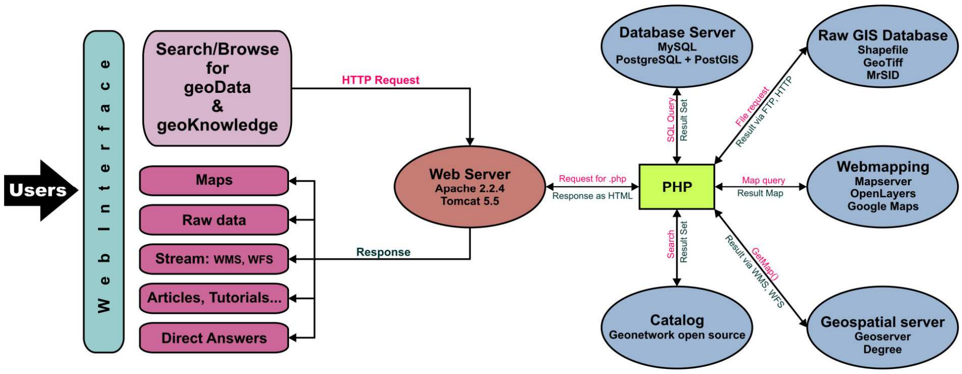

Fig.2 ***Portal information flow***

An entire stack of desktop G.I.S open source tools were and will be further used to prepare the geospatial data published on geo-spatial.org and for technical demonstrations in tutorials. The most important roles were played by:

GRASS (Geographical Resources Analysis Support System). The oldest FOSSG.I.S application. GRASS is a raster/vector G.I.S combined with integrated image processing and data visualization subsystems. It includes more than 350 modules for management, processing, analysis and visualization of georeferenced data. GRASS is currently used in academic and commercial settings around the world, as well as by many governmental agencies and environmental consulting companies.

QG.I.S (QuantumG.I.S) is a user friendly G.I.S applications that runs on Linux, Unix, Mac OSX, and Windows. QG.I.S supports vector, raster, and database formats. Comes with a plugin that provides access to GRASS from within QG.I.S. This includes the ability to view, edit, and create data, as well as perform analysis using the GRASS geoprocessing modules.

VTP (Virtual Terrain Project). Is a complex suite of applications that allow the users to create and real-time explore 3D environments. VTP offer support for realistic implementation of vegetation, sky, buildings, vehicles, roads and any other 3D object.

Portal interface

The website is divided in several functional sections (Figure 3). In each section, the information is placed in predefined categories and sub-categories. Most of the sections contains written materials:

- Articles - theoretical essays on geospatial topics;

- Tutorials - materials indented to teach the user, in a step by step manner, how to work with certain datasets, software, technique etc;

- Reviews - reviews for geospatial datasets, cartographic products, software, articles, books;

- Links - collections of references to other online resources;
- Blog - a non conventional section for publishing thoughts, ideas, findings etc.

The content of these sections can be accessed quickly via RSS and ATOM feeds.

The Download section contains categories for all kind of geospatial data (digital elevation models, processed satellite images, vector data: communication networks, localities, hydrographical networks, contour lines, points of interest etc.) at different scales and spatial extend. Other categories contain documents (PhD thesis, scanned books & articles), old maps, software.

The website interface was carefully designed, respecting the existing W3C (World Wide Web Consortium) standards and separating the structure from the presentation by using strict XHTML markup and CSS (Cascade Style Sheets). New web technologies, like AJAX (Asynchronous JavaScript and XML), were also used to increase the interactivity. The goal was to obtain a simple, friendly and accessible environment for geospatial data and knowledge publication.

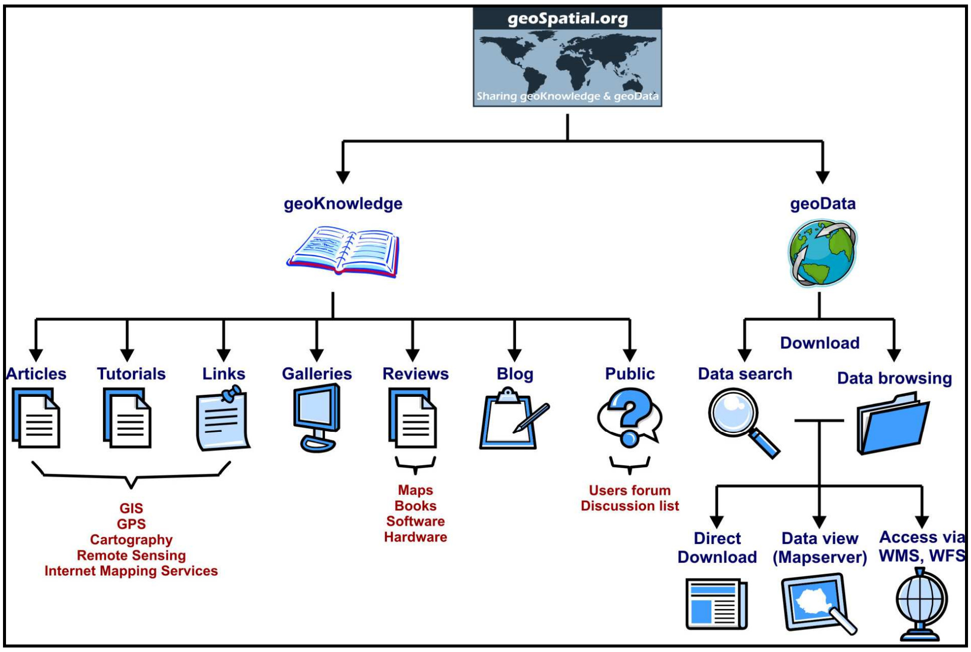

Fig.3 ***Portal interface***

<u>Portal services</u>

Orientated to the users, they provide the single point access to the geospatial information on the portal. Are designed according with OGC (Open Geospatial Consortium) specifications. The user can access the services using a local client (thick client) like common G.I.S applications (E.g. JUMP, gvSIG, uDig) or via a web client (thin client) like webmapping applications (E.g. OpenLayers, Mapserver, MapBuilder).

- Catalog services: provide a mechanism to classify, reG.I.Ster, describe, search, maintain and access information about resources available on the portal. The Catalog functionality is supplied by Geonetwork open source.

- Portrayal services: provide specialized capabilities supporting visualization of geospatial information. The service integrates OGC WMS (Web Map Server Specification) protocol witch allow the user to query the capabilities (getCapabilities) of the mapserver and retrieve maps rendered in a graphical file format (E.g. GIF, PNG, JPEG). The Portrayal functionality is supplied by Geoserver.

- Data services: provide access the geospatial database content. The service integrates OGC WFS (Web Feature Service Specification) protocol. WFS deliver, on demand, geospatial data in GML (Geography Markup Language) format. This service functionality was obtained also by using Geoserver.

4. CONCLUSIONS

The domain of free and open source geospatial applications is growing fast and provide reliable solutions for all the stages of geodata management. The FOSSG.I.S plays an important role in adaptation of G.I.S technology by stimulating new experimental approaches and by providing access to G.I.S for the users who cannot or do not want to use proprietary products.

REFERENCES

Crăciunescu, V., Stăncălie., Ghe., Constantinescu Şt., Ovejeanu, I., (2007), *Web-based geo-information system for transboundary flood management*, „Geographia Technica, no.2, 2007, ISSN 1842-5135, p.20-33, Cluj-Napoca.

Davis, S. (2007). G.I.S for Web Developers: Adding 'Where' to your Web Applications. Pragmatic Programmers.

Neteler, M and Mitasova, H (2008). Open Source G.I.S: A GRASS G.I.S Approach. Third Edition. Springer.

Ramsey, P. (2007). The State of Open Source G.I.S, Refractions Research Inc report.

Raymond, E (2001). The Cathedral & the Bazaar, O'Reilly.

Zavate, L. F., Imboane, Al., M., (2006), *Accesarea datelor geografice pe internet*, „Geographia Technica, no.1, 2006, ISSN 1842-5135, p.203-207, Cluj-Napoca.

STATISTIC ANALYSIS – RESEARCH METHOD IN MODERN GEOGRAPHY

Case study**: *Social impact of the gad phenomenon on human communities in Rovinari coalfield***

Roxana. Cuculici[1], Ines Grigorescu[1]

ABSTRACT
Through the transformations specific to its evolution, society has become a very important environmental modifier and thus, human-environment relationship. By developing a case study on the social impact of the gad phenomenon on human communities in Rovinari coalfield, we will be able to point out within this article the fact that in modern geography, the statistic analysis has become a practical research method and an environmental interdisciplinary evaluation method.
Key words: *Statistic analysis, social impact, interdisciplinary evaluation, coalfield*

*

1. INTRODUCTION

The diversification in the categories of anthropic impact on the environment reflects the dynamic and dimension of human-environment relations, which have a crucial role in the determination of environmental global changes that have presently become a priority of scientific research at international level.

The determinism of the ambivalent character of human-environment relations is defined by interpolating the comprising relations. Thus, what it is considered to be a factor of impact may become the effect of another factor and the environment can influence social development as the anthropic processes act as factors on its components (fig. 1). This ambivalent relation may be subscribed to the specific of human communities or to the features of the environment in a certain area. Haidu I., Crăciun A. I., 2006 was realised a study of industrial impact of the maximum runoff in Motru Charcoal Basin.

The research of the social impact of human-environment interaction effects may be performed, from the systemic perspective, both by geographers and by socioloG.I.Sts, bioloG.I.Sts, landscape architects, town planners etc., for the purpose of an interdisciplinary approach of the concept.

Statistic analysis is the most efficient sociologic method used in the evaluation of the social impact within the areas of a critical environment.

The environment in Rovinari coalfiel has suffered a series of changes, which have led to irreversible transformations. The recognition of this coalfield as an area with a critical environment is determined both by the mining type and by the characteristics of the local environment exposed to anthropic impact.

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The main aspects related to the socio-economic impact of the mining activities in Rovinari basin (fig. 2) is visible under the form of the changes in land use, and particularly by the gadding of private households and other objectives.

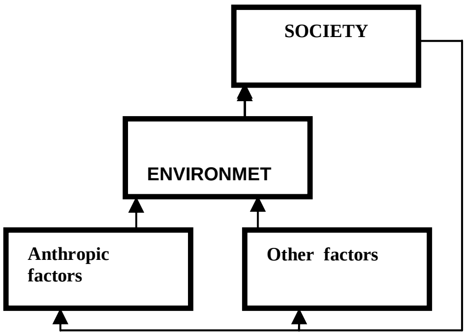

Fig. 1 ***Human (society) –environment relation***

Fig. 2 ***Rovinari Quarry***

During the development of the quarry, several private households were gadded from Ceauru, Roşia, Poiana, Vârţ, and Fărcăşeşti – Moşneni localities to Vărsături, Vart Nou, Ceauru Nou, Corneştii Noi and Cojmăneşti coomunes.

2. PSYCHOSOCIAL RESEARCH

The impact that the landscape structural and functional change has upon some psychological (psychosocial) components emphasizes the ambivalent character of human-environment relations, which can be corroborated with other elements and causalities (fig. 3).

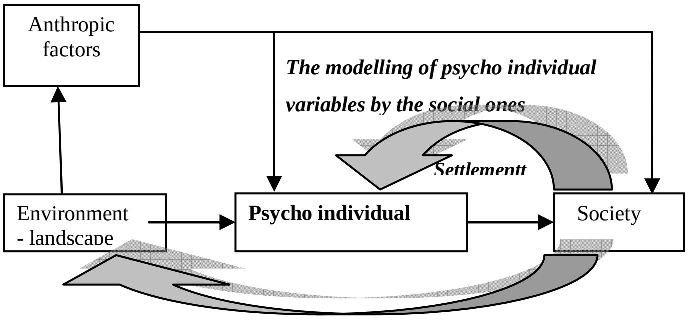

Fig. 3 ***The psychosocial impact of the anthropic changes***

These changes show that not only the environment components affect the society (the structuring of global needs and the social decision to use them into a certain project), but certain psycho individual changeable factors intervene between the environment and the society which can influence environmental (landscape) perception**.**

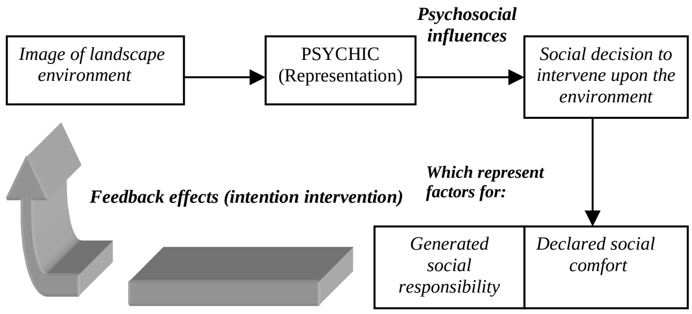

Fig. 4 ***Relation between the environment (anthropicized) and the psychosocial factors***

In order to estimate the social impact which gadding phenomenon has on the human communities in Rovinari coalfield, from the environmental changes perspective, the ***observation method*** has been applied as research method, supported by the ***questionnaire method***. The latter stands for the main tool of work in applying the social investigation, as a method of statistic evaluation of the environment criticalness.

The questionnaire consists of 13 (17) items concerning pollution issues, living conditions, economic status of the region, gadding process, land use, etc. and it has been applied to 25 individuals (representative sampling) from the subject area.

Therefore, this study identifies the social representation of environmental changes caused by the gadding phenomenon, creating a factor pattern of causes and effects. The main stages of the performed sociological investigation consist in the following:

Stage I (pilot) aimed at identifying factor variables and at selecting landscape factors, which affected the psychosocial and psychological factors studied based on the conceived causal schemes (fig. 3, 4).

Stage II (research) represents the phase in which the investigated subjects select at least three and maximum five out of the elements of the landscape changes representation. During this phase, the **causal-factor variables** are being identified and measured, as well as the determination of the sense and the value of the relation between them and the **effect-variables**.

Stage III aims to identify the phenomena transformed into social problems, which are afterwards described onto a section of hypotheses consisting of:

Hypothesis 1. Context (landscape) factors that influence ***the declared motivation and affectivity*** corresponding to the population in the habited area;

Hypothesis 2. Context (landscape) factors that influence the ***desirable behaviour***, specific to the population in the habited area;

Stage IV. These hypotheses have been verified using the ***questionnaire*** that was structured in three chapters of response.

Stage V aims at identifying the causal relations, at determining their value and at drawing the conclusions of this research.

3. STATISTIC ANALYSIS

During the first stage, the processing will resume to the quantification, on each representative element, of the positive frequencies specific to the selected statistic population (ex. how many subjects have selected factor 1, how many have selected factor 2 etc.), as well as the one obtained during the grouping, analysing the most probable elements of the representation.

Following these operations, the variables' values have been processed (within the module) and mediated among the subject group and it has been selected the one with a greater value as independent variable to verify its influence in the dependent psychosocial variables (verification of the statistic hypotheses). Subsequently, a variance test was applied to this series of indexes and another multifactor test, specific to several independent variables (after we noticed their connection), was applied in order to complete the statistic chart.

I. Descriptive analysis. The causal variables (environmental): *F1-pollution, F2-gadding, F3- development of mining activities; F4- localities development, F5- roads condition*, whose statistic parameters and dependent variables are (tab. 1, tab. 2):

The parameters of the statistic series

Table 1

		f1	f2	f3	f4	f5
N	Valid	25	25	25	25	25
	Missing	0	0	0	0	0
media		3.1200	3.1600	3.5200	3.0400	3.3600
abaterea standard		1.42361	1.21381	1.29486	1.20692	1.03602
varianta		2.027	1.473	1.677	1.457	1.073
Minimum		1.00	1.00	1.00	1.00	1.00
Maximum		5.00	5.00	5.00	5.00	5.00

Dependent variables

Table 2

		responsab	expectanta	confort	intentie
N	Valid	25	25	25	25
	Missing	0	0	0	0
media		3.7600	3.0800	3.0800	3.9200
abaterea standard		1.30000	1.15181	1.32035	1.11505
varianta		1.690	1.327	1.743	1.243
Minimum		1.00	1.00	1.00	1.00
Maximum		5.00	5.00	5.00	5.00

II. Variance analysis. We can see that F1, F2, F3, F5 variables are connected between them, thus we explain them being selected. A research may be run in order to find out whether these variables have connected effects when they influence other variables.

If separately analysed, **F1** (pollution) influences responsibility and intention, **F2** (gadding) influences the intention to change, **F3** (development of mining activities) influences, **F4** (localities development) influences declared responsibility, while **F5** (roads condition) influences the expectations regarding the impact of landscape transformation.

4. CONCLUSIONS

During our investigation process, when we used variance tests, we noticed that the context factors (landscape) influence the ***declared motivation and affectivity*** specific to the population in the area under study. The statistic research indicates that the independent factors have an influence on the dependent variables, which is emphasized by the results of *One way Anova* test – the values are bellow the admissible safety thresholds. This fact confirms the hypotheses of our research:

The greater the landscape transformation, the greater the psychological impact – *expectancies related to the impact of landscape transformation*.

The greater the negative changes of the landscape, the less significant the psychological impact –*declared social impact compared to environmental conditions*.

When using the variance tests, the context (landscape) factors show their influence on ***the desirable behaviour***, specific to the population in the area under study

Taking into account that the analysed situation is critical and that the psychic reacts differently in common situations, this kind of study may be completed and even reconsidered from other points of view, from different theoretic or research levels, by using other methods, tools or terms, combining other phenomena or case variables, psycho individual, psychosocial or/and socio-cultural variables. Therefore, the evaluation of these elements determines psycho individual processing, affected by the psychosocial element corresponding to the situation, respectively the collective perception on the gadding and placement of the subjects interviewed on the matter of the present environment situation, which makes *the gadding phenomenon a real social problem*.

BIBLIOGRAPHY

Bălteanu D., Şerban Mihaela, (2005), *Modificările globale ale mediului*, Editura Universitară, Bucureşti.

Cândea Melinda, Erdeli G., Guran Liliana, (1993), *Influenţa exploatărilor miniere asupra mediului geografic în bazinul carbonifer Motru*, Ed. Universitară, Bucureşti.

Chelcea S., (2001), *Metodologia cercetării sociologice*, Editura Economică, Bucureşti.

Grigorescu Ines, Cuculici Roxana, (2007) *Evaluarea impactului social al hazardelor hidrologice. Studiu de caz: inundaţiile din aprilie-mai 2006, comuna Mânăstirea, judeţul Călăraşi*, Geo Valachica, Vol II, Editura Transversal, Târgovişte.

Haidu, I., Crăciun A.I., (2006), *Utilizarea S.I.G în vederea estimării scurgerii maxime înainte şi după decopertarea terenului dintr-o carieră de cărbune*, „Geographia Technica, no.1, 2006, ISSN 1842-5135, p.91-97, Cluj-Napoca.

RESEARCH CONCERNING THE STATE OF ENVIRONMENT AFTER SHUT DOWN OF ARAD FERTILIZER PLANT

F. Dumescu[1], L. Klein[1]

ABSTRACT
The former Chemical Fertilizer Plant Fertilizer situated at about 15 far from Arad was shut down in 1990 and since that time dismantling of equipment was carried out, but concrete buildings and environment affecting heritage remained on the site. The paper deals with the state of pollution on the site and with the possibilities to liquidate buildings so for reuse of the area and also for correcting the landscape. Demolishing by controlled explosions is a solution that can be so effective as producing no significant pollution.

*

1. INTRODUCTION

The platform of the former Arad Chemical Fertilizer Plant is situated at about 15-km eastward from Arad and about 2-km far from the closest inhabited area.

The plant was set up in 1971 when construction begun and the first part was started up in 1977. This first part produced NPK type complex fertilizer and had a capacity of 100,000 t P_2O_5 per year. As a secondary product ammonium nitrate or nitro-chalk containing 75,250 t N/year resulted.

The basic adopted technology, an imported one, consisted in attack of phosphate ore with nitric acid. So it was necessary to build and start up at the same time ammonia and a nitric acid producing plants. Also suitable deposits and storage places for raw material intermediate products and final products had to be constructed. The necessary utilities such as industrial water, steam (resulting in an electric-power plant), and industrial air were produced and sewage for different type of used water was necessary as well.

In 1976 the construction of a new part of the plant began, this time the urea being the final product. This meant a new 300,000-t/year ammonia plant, similar to the first one, and a. 420,000-t/year urea plant, a new electric-power plant and the suitable deposits. These capacities were stared up in 1983.

In 1990 the plant was shut down because of reasons that are not object of this study and it was never started up again. Afterwards all technologic, electric and automation equipment and the steel constructions was demolished and sold. The technological equipment is dismantled and valorized partly in other plants and mainly as scrap iron. Such way on the platform only concrete and brick constructions and small amounts of unused raw materials such as phosphate and diatomite remained. A surface of 343,482 m^2 is involved.

Now only a small part of the plant is occupied by small enterprises that deal with storage and distribution of petroleum derivatives and of chemical fertilizers (produced by others). The remaining area is not used in any way and is occupied by not usable constructions. A proposal for demolishing the existing buildings and industrial reuse of the area was forwarded, but until now the technical solutions were not established and no financing was found.

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However, a general demolishing project and also a special demolition project by detonation were set up. Environment protection authority imposed an assessment that had to contain results of chemical analyses concerning soil pollution and its radioactive contamination, data concerning contamination of underground water and also analyses of concrete to be demolished.

Demolishing concerns buildings of the former complex NPK fertilizer plant, one of the ammonia plants, the urea plant, deposits and the attached scaffolds. These constructions can be classified in two groups, namely one suitable to be demolished “piece by piece” and another that can be demolished either “piece by piece”, or with explosives. During demolishing environment affecting pollutants are expected to be noise, dust, the resulting waste, including dangerous ones (asbestos, phosphorite waste).

2. ACTUAL STATE OF ENVIRONMENT ON THE PLANT AREA

a. Water Quality

The actual state of water quality in the area of the former plant is illustrated by the results of analyses carried out by laboratories of specialized water authorities or in laboratories certified by those authorities.

Underground water quality was controlled on samples from wells existing inside and around the plant. Results of one of the latest sampling and analyses are given in table No. 1. ISO standard methods were used.

Underground water quality

Table 1

Characteristics	Well number							
	F4	F6	F7	F8	F11	F12	F13	F14
pH	7.85	6.5	7.08	6.62	7.06	5.49	7.71	7.40
Ammonia, mg/l	0.37	1.43	1.27	2.88	0.74	3.10	3.56	0.63
Nitrites mg/l	0.14	0.03	0.01	0.05	0.02	0.04	0.26	0.60
Nitrates mg/l	195.2	45.70	199.0	189.0	10.0	48.1	285.0	204.5
Phosphates mg/l	0.22	0.15	0.13	4.60	0.16	1.46	0.13	0.10

However the analyses results are improved compared to previous periods, they generally are worse than the provisions of the drink water quality standard (e.g. pH 6.5 – 9.5, ammonia 0.5 mg/l, nitrates 50 mg/l)

Radioactivity data for water collected in wells are reproduced in table 2 and it can be seen that values do not reach warning limits.

Radioactivity data for underground water

Table 2

Characteristics	Well number							
	F4	F6	F7	F8	F1	F12	F13	F14
Immediate activity Bq/m^3	312.8	233.3	119.0	122.7	229.7	266.3	915.6	268.8
Activity after 5 days Bq/m^3	219.4	108.4	96.2	82.3	82.3	81.6	855.6	123.8

Evens taking into account errors of about ±50 Bq/m3 the values are inside the warning value.

The characteristics of water discharged into the river Mures are controlled by the laboratory of the specialized authority. Figures for the latest sample are given in table 3.

Waste water discharge into river Mures

Table 3

Characteristics	Max. admitted value	ReG.I.Stered value
pH		7.68
Suspended matter	35	123.00
Fixed residuals	2,000	655.00
Ammonia		71.00
Nitrites		0.01
Nitrates		16.00
Phosphates / phosphorus		23.2/7.56
Phenols		0.03
Extractables	20	23.60

However in some respects not inside the admitted values, the characteristics of wastewater prove that now household type activities are developed on the site and, at least in this respect, there is no heritage with environmental meaning.

Air Quality

During its activity the plant had a polluting influence on atmosphere mainly due to the nitric oxide emissions, but also to ammonia and dust. After shutting down of plant, all this type of pollution was eliminated.

A possible discharge of pollutants to the atmosphere can appear during the future demolishing the concrete buildings, by crashing and transport operations. Classic way of demolishing produces solid particles, but if detonation will be the chosen method further CO_2, N_2, nitrogen oxides, and carbon monoxide, the latest of high toxicity, can appear.

Quality of Soil

Data regarding chemical characteristics of soil ale reproduced in table 4.

Results of soil analyses

Table 4

Sampling place	pH	Ammonia	Nitrates	Phosphorus	Kalium
Nitro-chalk plant	7.7	20.0	6.10	135.8	825
Ureea plant	7.9	0.48	0.70	139.7	450
Packing installation	7.5	0.60	0.80	432,0	1150
Nitric acid plant	8..0	2.18	0.83	103.5	151
Ammonia plant	8.1	1.08	2.14	25.11	265
NPK conditioning	7.2	0.42	0.25	84.00	850
Nitrochalk prilling	8.1	0.64	5.90	85.60	675
NPK plant	7.8	12.4	0.72	80.80	127
NPK pilling	7.8	2.16	13.8	84.00	1920
KCl drying	8.1	2.08	0.82	93.20	1000

The gray marked values are above the maximum admitted.

Radioactivity data are as follows (β global activity, Bq/kg):

- Phosphate ore storage area: 1149.2 ± 85.2,
- Ground level: 1454.3 ± 99.5,
- +7m level: 1776.5 ± 114.8,
- Soil inside the plant: 631.4 ± 51.9.

Comparison and criteria value is annual average radioactivity of non-used soil in Arad: 478.7 Bq/kg.

b. Pollutant content of concrete

As a possibility to solve the pollution remained after the plant shut down is demolishing the existing concrete buildings, the pollutant content of that concrete can be important. There for analyses of specific pollutants contained in building concrete were carried out. Some of the main results are reproduced in table 5. The analyses produced the highest fluoride content of about 7 – 8mgF/Kg inside the south NPK prilling tower and inside the NPK processing building.

Pollutant content in concrete of buildings

Table 5

Sampling place	Nitrate mg N/Kg	Ammonia mg N/Kg	Phosphates mg N/Kg
South NPK prilling tower, outside	8	<4	<4
South NPK prilling tower, inside	240	68	62
North NPK prilling tower, outside	6	<4	8
North NPK prilling tower, inside	280	87	72
NPK processing building, outside	21	7	25
NPK processing building, inside	320	140	56
Nitrochalk prilling tower, outside	17	<4	-
Nitrochalk prilling tower, inside	64	14	-
Nitrochalk building, inside	82	22	-
NPK building, inside	104	63	35

The following comments are given to the analyses of pollutant contents of concrete:

- results for a layer of 0 – 10 mm of concrete was analyzed as deeper ones did not present any of the specific pollutants;
- on the concrete surface mainly calcium nitrate is present because of reaction with calcium carbonate, there for presence of ammonia nitrogen is lower;
- urea could not be found as it suffers a hydrolysis during the time;
- the low fluoride content is due to the low presence of fluorine in fertilizers.

3. DEMOLISHING AS A SOLUTION TO AVOID FURTHER POLLUTION AND TO PERMIT REUSE OF LAND

As the area of the former fertilizer plant is so positioned that it can become a flourishing industrial area and some new activities already started there, but the existing old buildings can be a danger for them.

A project for demolishing was set up by the same institution that designed the plant and it has the approval of the local council.

During demolishing the existing water supply network, the existing sewage, the law voltage electric network and the access road network will be used. It is important that specialized people emptied the electrical transformer stations, so these stations contain neither transformers, nor the oil. Such way pollution with them is prevented and not any leakage of oil was found.

During demolishing the main equipment to be used is a concrete breaker, two bucket track excavators, a frontal feeder a bulldozer.

The main technology proposed for demolition is that using explosives. In a previous work the authors referred to that technology (Dumescu, Klein, 2007), conclusion being that this technology is suitable and not dangerous so regarding safety as regarding environment protection. Biali, G. et. colab., 2006, was studied G.I.S techniques for agricultural lands altered by pollution.

As the concrete is not really polluted, the waste resulting in demolition by explosion is not dangerous and can easily be reused as filling material.

4. CONCLUSION

Demolishing of the buildings that belonged to the former Arad Fertilizer Plant is not only possible but also a necessity as they are highly degraded, they represent a danger and risk for other objectives on the platform and for the persons working there. Demolishing is a polluting activity but its polluting power is not very high and can be limited by suitable steps on the site.

Reuse of most of the area of the former Arad Fertilizer Plant is possible only by demolishing the very specific buildings. The demolishing is a condition of ecologic, economic and scenery reconstruction of the area.

BIBLIOGRAPHY

Biali, G., Popovici, N., Morozan, N., (2006), Folosirea tehnicii G.I.S în acțiunea de bonitare a unui teren agricol afectat de poluare cu metale grele, „Geographia Technica, no.1, 2006, ISSN 1842-5135, p.19-25, Cluj-Napoca;

Dumescu F., Klein L., 1994, ,, Studia Universitatis V. Goldis” Arad, 84 - 88;

Dumescu F., Klein L.,1996, ,, Studia Universitatis V. Goldis” Arad, 115 – 122;

Dumescu F., Klein L., 2003, *„Kitekintés-Perspective”*, International Vysegrad Fund, 201- 204, Békéscsaba, Hungary;

Dumescu F., Klein L., 2007, *Contributions to the Study of Diminishing Environmental Heritage of a Chemical Plant*, XI International Eco-Conference, – Environmental Protection of Urban and Suburban Settlements I, Proceedings, Novi Sad, Serbia, 247 – 254.

CHANGEMENT CLIMATIQUE EN ISLANDE : 1830-1999

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ABSTRACT
The climatic evolution (1830-1999) of Iceland (Stykkishólmur) is approached by a method combining 3 numerical classifications (air temperature, sea temperature, sea ice). The Log Laplace distribution is used to characterize the shape of air temperature. This work is done on 5 trended sub series determined by the non parametric Mann-Kendall-Sneyers test. Furthermore, the existence of Icelandic "Little Ice Age" is discussed. Finally a Dimension build on information theory is proposed to describe spatial and temporal sea ice evolution around Iceland.

RESUME
On étudie l'évolution du climat de l'Islande à partir des températures de Stykkishólmur (65°05' Nord et 22°4' Ouest) de 1830 à 1999. Les données ont été organisées en 5 sous séries. La première (1837 à 1847) est chaude (Tmoy : 3,60°C), la seconde (1847 à 1869) est plus fraîche (Tmoy : 2,92°C), la troisième correspond à une phase de stabilisation ainsi qu'à une légère décroissance des températures moyennes (1870 à 1920, Tmoy 3,03°C), la quatrième (1920 à 1964) est en forte croissance (Tmoy : 3,72°C) et enfin la dernière (1924 à 1999) est plus stable voire en relative décroissance (Tmoy : 3,58°C). L'utilisation de la loi Log Laplace tronquée a mis en évidence la présence de deux populations (Tmin et Tmax) jouant sur les températures de la série de manières différentes. Une série de classifications ascendantes hiérarchiques (CAH) ont été réalisées sur les températures de l'air, de la mer et la glace de mer. Une discussion est esquissée sur l'existence du petit âge glaciaire en Islande. Pour terminer, un indice de dimension construit sur la théorie de l'information est proposé pour représenter l'évolution spatiale et temporelle de la glace de mer autour de l'Islande.

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1. INTRODUCTION

L'Islande comprise à des latitudes septentrionales équivalentes à celles de la Sibérie (63°23' et 66°32' Nord) et entre les longitudes 13°30' et 24°32' Ouest, est un point de convergence entre des courants maritimes atlantiques de signatures différentes (Gulf stream et courant Est groenlandais). D'autre part elle est positionnée sur le parcours des dépressions anticycloniques, à mi-chemin entre les hautes pressions atmosphériques des Açores et du Groenland. Celles-ci la traversent régulièrement du sud ouest vers le nord est, charriant des précipitations (solide et/ou liquide) sur la façade sud et sud-est de l'île et associée à des vents violents.

En outre sa proximité du pôle et de l'inlandsis Arctique est à l'origine de la présence des glaces de mer dérivant le long de ses côtes. La débâcle de ces glaces de mer ainsi que les évènements climatiques sont signalés par les chroniques littéraires depuis l'an 900. On constate que ces débâcles semblent de plus en plus rares depuis les années 1965-1971. Ces dernières, coïncident avec la reprise du dernier réchauffement climatique en Islande (Ogilvie et Jónsson, 2001). Ces auteurs ont partitionné le XIXe siècle en périodes chaudes

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ou froides, et constaté que : « les années considérées comme étant les plus froides avaient été caractérisées par une grande présence de glace de mer vers la fin de l'hiver et celle-ci perdurait pendant le printemps et l'été » ; il conviendrait de s'interroger sur le rôle joué par les glaces de mer dans la perturbation du système climatique.

Par la longueur de la chronique littéraire, nous détenons la possibilité de corroborer et d'interpréter les observations tirées de la longue série instrumentale de Stykkishólmur ainsi que de qualifier les changements climatiques actuels par une typologie pouvant être étendue aux temps historiques du peuplement. Toutefois un certain recul mérite d'être observé tant les descriptions météorologiques islandaises sont empreintes de références climatiques établies à l'échelle d'une vie humaine.

2. DONNEES

Nous disposons de trois séries de températures ainsi que de données portant sur la fréquence d'observation des glaces de mer.

- Les températures mensuelles de l'air à Stykkishólmur de 1830 à 1999 ;
- Les températures mensuelles de l'air à Teigarhorn de 1873 à 2000 ;
- Les températures mensuelles océaniques de 1867 à 1985 à Stykkishólmur.
- La fréquence d'observation des glaces de mer en nombre de jour d'apparition intégré par mois de 1964 à 2001 sur neuf secteurs maritimes dont la limite supérieure est définie par 12 miles nautiques (19,3 km des côtes).

Les températures de l'air

La série de Stykkisholmur (65° 4' 1.90" N et 22°44' 1. 43" O) est la plus longue. La qualité ainsi que les métadonnées concernant cette série ont été discutées par Jónsson et Garðarsson (2001). Cet exposé ne fait référence qu'aux données de Stykkishólmur, qui suit les mêmes tendances climatiques que Teigarhorn (64°40' 51.56"N et 14° 20' 58.88" O).

L'évolution des températures mensuelles de l'air à Stykkishólmur (1830-1999) fait apparaître plusieurs particularités du climat islandais. Les 2040 mois ont des Tmin comprises entre -12.2°C et 7.5 °C, des Tmax comprises entre 3,40 °C et 12,30 °C. La moyenne des températures mensuelles de l'air varie de -1,66°C (février) et 10,04°C (Juillet). La variance des Tmin (7,194) est le double de la variance des Tmax (3,207). Le climat islandais est tamponné, il a une faible amplitude thermique et est relativement stable durant 170 ans.

Les températures océaniques

Les Tmin océaniques sont comprises entre -1,8°C et 8,5°C, les températures moyennes mensuelles entre 0,56°C (février) et 10,53°C (août) tandis que les Tmax varient entre 3,3°C et 13,3°C. Les températures océaniques sont très pondérées, en effet, les écart-types des Tmin (3.77°C) et Tmax (3.31°C) sont très proches ainsi que les températures moyennes, mais sont sensiblement différentes de ceux de l'air.

La régulation des températures maximales et minimales s'effectue mieux dans le cadre des températures océaniques. Nous avions remarqué que les températures maximales de l'air sont mieux régularisées que les températures minimales. Et les températures de l'eau de mer montrent que l'océan n'est pas la cause de la variabilité des températures minimales de l'air.

La glace de mer

Les glaces de mer sont présentes en continu aux hautes latitudes (70°N) et ont leurs origines soit dans la mer de Barents, soit dans l'océan Arctique ou encore au Groenland. En effet, cette terminologie regroupe les glaces allochtones (démantèlement de la banquise, vêlage de l'inlandsis groenlandais) et les glaces autochtones (gel de l'eau de mer). Cette glace est alors charriée vers l'Islande par le courant Est groenlandais ou encore par le courant Est islandais selon son origine et est aperçue en Islande le plus fréquemment au cours des mois de mars à avril.

La glace de mer est mesurée (observée) depuis le sol, elle peut être comptabilisée plusieurs fois sur un même secteur induisant un biais dans la mesure. Outre ce biais, la glace de mer tourne autour de l'île dans le sens horaire ce qui perturbe le climat. En effet, la glace de mer peut jouer le rôle d'isolant thermique en protégeant le réservoir de chaleur qu'est l'océan et en limitant le réchauffement de la basse atmosphère, en créant un écran à fort albédo entre l'océan et l'atmosphère. Qualifier et quantifier sur une échelle temporelle et spatiale leur rôle apparaît comme une clé pour la compréhension des régimes climatiques successifs qu'a connu l'Islande. Ainsi en prenant en compte le comportement de la glace de mer on pourrait confronter les périodes de changements climatiques globaux connus sur le pourtour de l'Atlantique Nord, à celles observées en Islande.

La régulation des températures maximales de l'air se fait mieux (et plus vite ?) que la régulation des températures minimales. Quels sont l'origine et le contrôle de ce double processus ? S'agit-il de la circulation atmosphérique ou de la circulation océanique ? Quel est le rôle de l'océan et de la glace de mer dans le climat de l'Islande ?

3. OUTILS ET METHODE

Le dégagement des tendances : ILTA

Nous utilisons la méthodologie numérique Iterative Linear Trend Analysis (ILTA) développée par Mercier et Haidu (2003). Cette procédure a déjà fait l'objet d'application variée (Ananichieva et al. 2003 ; Haidu et Mercier 2003). Pour cela, le test de Man-Kendal-Sneyers (MKS) est utilisé dans sa version physique (one way). Ce test nous permet de segmenter la série initiale en sous séries de tendances homogènes.

Les tests de la segmentation

La qualité de la segmentation est mesurée par une batterie de tests. Le test de Wilcoxon sur la moyenne de deux sous-séries successives, le test de Kendall-Stuart sur la monotonie et le signe des tendances, le test d'indépendance de Wald-Wolfowittz et le test non paramétrique de Sen. La conclusion des tests nous amène à affirmer que les tendances dégagées sont bel et bien différentes (moyennes différentes, tendances différentes).

Les distributions : la loi Log Laplace tronquée

Après vérification des tendances, plusieurs processus climatiques étant en jeu, nous avons cherché à les identifier en utilisant des lois différentes de la loi normale. Nous avons appliqué successivement trois distributions différentes : la loi Log normale à deux paramètres, la loi Log hyperbolique (Bagnold 1937, Barndorff-Nielsen et al. 1982) à quatre paramètres ainsi que la loi Log Laplace tronquée à trois paramètres mise proposée par Fieller et al. 1984. Ces deux dernières étant caractérisées par le traitement particulier des extrémités des courbes et par la non symétrie de la fonction de distribution. La double loi Log Laplace tronquée à six paramètres permettant la recherche des mélanges de deux distributions (4 processus) a été aussi utilisée.

Classification ascendante hiérarchique métrique euclidienne et regroupement par la méthode de Ward

Plusieurs classifications ascendantes ont été réalisées, elles ont permis une typologie de l'abondance de la glace de mer, une typologie de la répartition temporelle de la glace de mer, une classification mensuelle des températures de l'océan.

4. RESULTATS ET PERSPECTIVES

Les températures de l'air

• Les tendances des températures de l'air :

Le processus ILTA a dégagé cinq tendances résumées au tableau 1.

Présentation des cinq tendances (1830-1999)

Tableau 1

	S1 1837-1847	**S2 1847-1869**	**S3 1869-1920**	**S4 1920-1964**	**S5 1964-1999**
Durée (mois)	123	270	606	530	427
Tendance	Croissante	Décroissante	Stable à faible croissance	Forte croissance	Stable à faible décroissance
Tmin °C	-6.0	-9.7	-12.2	-4.9	-4.6
Tmoy °C	3.60	2.92	3.03	4.11	3.58
Tmax °C	12.0	11.9	12.3	12.2	11.8

La succession de ces tendances est globalement conforme à celle proposée par Ogilvie et Jonsson (2001) bien que les limites ne soient pas les mêmes. En effet ces auteurs ainsi que (Hanna, Jónsson, Box, 2004) utilisent une régression linéaire et des moyennes mobiles afin de dégager les tendances. Contrairement à ILTA ces deux méthodes opèrent un lissage sur la hauteur des pics de température ainsi que sur leur position dans le temps, il n'est guère surprenant de constater alors une divergence entre les limites des tendances que nous proposons et les leurs.

- Tendances sur les températures minimales et maximales de l'air

Mélange de deux populations (Tmin et Tmax) sur les six séries de Stykkishólmur

Tableau 2

	$\alpha 1$	$\beta 1$	µ °C	p1	$\alpha 2$	$\beta 2$	µ °C	p2
1847 - 1869	**0.2766**	**0.2948**	**0.54**	**0.662**	*0.1598*	*1.991 e-02*	*9.76*	*0.338*
1869 - 1888	*0.1286*	*8.610 e-02*	*-0.43*	*0.281*	**0.3555**	**4.863 e-02**	**9.55**	**0.718**
1888 - 1925	**0.1491**	**0.3493**	**-0.92**	**0.726**	*0.0966*	*2.938 e-02*	*9.44*	*0.274*
1926 - 1951	**0.1679**	**0.1134**	**1.39**	**0.517**	*0.1779*	*2.850 e-02*	*10.66*	*0.482*
1951 - 1966	**0.1620**	**0.8567**	**0.195**	**0.90**	*0.0418*	*2.489 e-03*	*9.81*	*0.10*
1966 - 2000	**0.1587**	**0.2205**	**-0.223**	**0.511**	*0.2606*	*1.123 e-03*	*10.95*	*0.49*

Appliqué aux Tmin et Tmax, l'outil ILTA a permis de dégager six tendances auxquelles on a appliqué la double loi Laplace tronquée. Pour les deux populations Tmin et Tmax, les paramètres $\alpha < \mu$ et $\beta > \mu$ sont les pentes, p1 et p2 sont les proportions de mélange des deux populations. Les deux populations sont contrôlées par deux processus distincts.

La glace de mer

- Abondance de la glace de mer (A, B, C)

La glace de mer est abondante et présente de nombreux mois :

Durée de la présence de glace de mer (1801-1900)

Tableau 3

Durée en mois	< 3	3 +	4 +	5 +	6 +	7 +	> 8
Nb années	12	35	25	15	10	3	0

La classification montre trois ensembles A, B, C, en fonction de la durée de présence de la glace de mer : A >171 jours ; 135>B>33 jours ; 0>C>37 jours de glace de mer.

- Répartition géographique de la glace de mer

On constate que dans le Nord et le Nord-Ouest, ainsi qu'au Nord-Est et à l'Est la glace de mer est fortement présente dans tous les types (A, B, C). La classe A est fortement présente de 1964 à 1970 alors que la tendance des températures de l'air fait apparaître une série stable voire faiblement décroissante. Par la suite on n'observe plus qu'une alternance des classes B et C. La glace de mer se fait plus rare sur les côtes islandaises.

- Répartition temporelle de la glace de mer (Z, Y2, Y1, X, W)

Une classification a réparti dans l'année la fréquence de la glace de mer en cinq classes :

W, années sans glace de mer. **X**, faible présence de glace de mer dans l'année et temps de résidence des glaces de mer de janvier à novembre avec un maxima de mai à novembre (μ =3,95et σ =2,72). **Y1**, durant l'été, l'automne et le début de l'hiver la glace de mer est fortement présente près des côtes.) μ = 30,57 et σ = 19,26. **Y2**, Forte présence de la glace de mer de février à juillet (56 à 219 jours) μ =53,50 et σ = 17,03. **Z**, Forte présence des glaces de mer de mars à juin (80 à 638 jours) avec μ =113,21 et σ = 32,23.

En croisant les deux classifications précédentes (cf. Tableau 5) on obtient une typologie des glaces de mer annuelles en fonction de leur temps de résidence. Exemple : 88,8 signifie que la glace de mer a été vue de 1964 à 2001, 88,8 fois entre mars et juin durant des années froides. On utilisera étendra cette codification dans le passé en se fondant sur les chroniques historiques.

Types saisonniers des glaces de mer dans chaque classe A, B, C

Tableau 5

	Z	Y2	Y1	X	W
A	88.8 ± 20.1	26.9 ± 11.3	6.9 ± 6.6	0.8 ± 1.1	0 ± 0
B	21.4 ± 18.3	25.2 ± 22.6	14.9 ± 12.6	1.6 ± 1.6	0 ± 0
C	3 ± 3.7	3.3 ± 3.7	8 ± 11.6	1.5 ± 2.3	0 ± 0

Les températures océaniques

- Les classifications annuelles des températures de l'eau :

Typologie des températures de l'eau

Tableau 6

	M1	M2	M3	M4
Tmoy °C	4.22	5.11	5.22	5.35
Fréquence	0.195	0.355	0.262	0.186

La classification reprend quatre groupes : M1 regroupe 23 années dont la moyenne a les valeurs les plus basses (4,22 °C) ; M2 regroupe les 42 années dont les moyennes est de 5,10°C, M3 a une moyenne de 5,22°C et compte 31 années et M4 regroupe les années dont les températures sont les plus élevées (5,35°C).

- Un océan plus chaud que le continent

Pour les 118 années disponibles, les températures océaniques sont toujours supérieures à la température annuelle de l'air. L'écart de température entre ces deux milieux n'est pas régulièrement réparti au cours du temps (cf. Tableau 7).

Ecart entre les températures de la mer et de l'air pour les 4 séries 1847-1999

Tableau 7

	S2 1847-1869	S3 1869-1920	S4 1920-1964	S5 1964-1999
δTmax	2.5	3.5	1.7	2.2
δTmoy	2.1	1.8	1.1	1.5
δTmin	1.7	0.8	0.5	0.9
Variance	0.1	0.3	0.1	0.1

Types de glace de mer et écart des températures mer-air

Tableau 8

	Glace de mer A	glace de mer B	glace de mer C
δTmax	2.5	3.5	2.7
δTmoy	1.9	0.9	0.5
δTmin	1.5	1.9	1.3
δTσ	0.3	0.6	0.4

Synthèse de la qualification des périodes (absence de données pour S1 et S2)

Tableau 9

	Température eau de mer				Glace de mer		
Classes	M1 = 4,22°C	M2 = 5,10°C	M3 = 5,22°C	M4 = 5,35°C	A fort	B moyen	C faible
S3	**31,4**	**35,3**	17,6	15,7	14,0	**58,0**	28,0
S4	4,5	**34,1**	**34,1**	27,3	0	6,8	**93,2**
S5	15	**40**	**35**	10	17,1	**40,0**	**42,9**

Les données océaniques ne sont pas disponibles pour la série S1 et ne le sont que partiellement pour la série S2. Pour S2 qui connaît un refroidissement l'écart moyen est de 2,1°C. Pour S3 et S4 à tendance croissante, l'écart est plus faible, entre 1°C et 2°C. La série 5, a un écart de 1.5 °C. En confrontant les écarts δT (mer-air), on constate que :

- Lorsque la glace de mer est fortement présente (**A**), l'écart est le plus élevé.
- Lorsqu'il n'y a aucune glace de mer (**C**), l'écart est quatre fois plus faible : l'océan réchauffe par conduction l'atmosphère. On a ainsi mis en évidence le rôle isolant des glaces de mer.

Caractériser l'évolution spatiale et temporelle de la glace de mer

Le déplacement dans l'espace et dans le temps de la glace de mer a été approché au niveau annuel par un indice construit sur la théorie de l'information. La dimension d'entropie est définie par Feder (1988) comme une mesure multifractale d'un processus binomial multiplicatif. Martin et Taguas (1998) ont défini un système de processus itératifs qui génère une distribution de longueurs. Cette dimension d'entropie D_E s'écrit :

$$D_E = \sum p_i \ln p_i / \sum p_i \ln s_i$$

Avec : p_i, la fraction de glace présente au cours de l'année dans une région comprise entre un intervalle (r_i, r_{i+1}) ; c'est une fréquence temporelle. Et s_i, un indice de similarité qui prend en compte l'espace car $s_i = (r_{i+1} - r_i) / (r_{max} - r_{min})$ r_i est la longueur du secteur étudié et r_{min} et r_{max}, les valeurs extrêmes. Le numérateur s'appuie sur la fonction H de Shannon et fonctionne comme elle : H prend une valeur maximale H_{max} à l'équiprobabilité lorsque les i secteurs ou classes sont occupées par les mêmes pi et dont la somme est égale à 1.

4. CONCLUSION

Nous avons caractérisé les séries suivantes :

S1 : 05/1837-07/1847 ; série climatique pondérée, la variabilité annuelle est caractérisée par des hivers courts et froids une série estivale précoce et constante avec des « chocs thermiques » en juillet.

S2 : 07/1847-12/1869 ; série à étés froids, maxima faibles, des hivers froids, variances hivernales les plus fortes et printemps avec une forte variabilité.

S3 : 01/1870-05/1920 ; longue série, faiblesse de ses minima étés comme hiver, rares maxima estivaux. Le petit âge glaciaire thermique islandais ne s'achève qu'avec cette période.

S4 : 06/1920-06/1964 ; tous ses minima, ses moyennes et ses maxima sont supérieurs à ceux de la série de référence. Le réchauffement est sensible en hiver et au début du printemps. Absence de glace de mer à 93%.

S5 : 07/1964-1999 ; minima élevés, des hivers doux, des étés chauds. La variabilité hivernale est faible. Cette période est moins chaude que la précédente. La fréquence des glaces de mer est inférieure à 50%, et M1 présente une grande variabilité.

Pour notre part, la série **S2** entre parfaitement dans le petit âge glaciaire, par contre, un réchauffement qui débuterait en 1869 rallongerait d'une quinzaine d'années la durée du petit âge glaciaire. Sont aussi problématiques, les deux phases postérieures (1870-1920) et (1920-1964) ; la seconde étant réellement une phase de réchauffement ; et d'autre part la phase « chaude » antérieure 1837-1847. Plusieurs constats peuvent être émis : La glace de mer isole et protège un océan "chaud"; les vents ne sont pas réchauffés par l'océan. Au printemps, les vents refroidissent le continent ; au printemps, la glace de mer abondante refroidit localement le continent; la variabilité de l'atmosphère est la cause des températures minimales de l'air; la température moyenne de l'île est inférieure de 2°C à celle de l'océan. L'Islande est une île froide entourée par un océan chaud. Il conviendrait d'étendre cette classification jusqu'à l'âge du peuplement de l'Islande, investigation qui est toujours en cours actuellement. Un indice de Dimension est proposé pour décrire l'évolution spatiale et temporelle de la glace de mer.

REFERENCES

Anachieva M.D., Davidovich N.V., Mercier J.-L., (2003), *Climate change in North-Western Siberia in the last hundred years and glaciers recession in Suntar-Khayata*, Data of glaciological studies, pub.94, Moscow, Russian Academy of Sciences, Glaciological Association, pp. 216-224.

Bentsen M., Drange H., Furevik T., Zhou T.,(2004), *Simulated variability of the Atlantic meridional overturning circulation*, 20 p.

Bjornsson H., Jónsson T, (2004), *Spatial and temporal mapping of temperature variability in Iceland since the 1870's*, 5 p.

Box G.E.P, Jenkins G.M., (1976), *Time series analysis : forecasting and control*, Holden day, San Fransisco ed., 575 p.

Broecker W.S., (1994) *Massive iceberg discharge as triggers for global climate change*, Nature N°372, pp. 421-424.

Dansgaard W., White J.W.C, Johnsen S.J., (1989), *The abrupt termination of the Younger Dryas climate event*, Nature N°339, pp.532-534.

Fieller N.R.J., Gilbertson D.D., Olbricht W., (1984), nature, 311, p 648.

Guðmundsson A.T., (1986), *Íslandsedar, eldvirkni á Íslandi í 10.000 ár*, Vaka-Helgafell, Reykjavík, 168 p.

Hanna E., Jonsson T., Box J.E., (2004), An analysis of icelandic climate since the nineteenth century. Int. J. Of Climatology. 24, pp 1193-1210.

Haidu I., Mercier J.-L., (2004), *Stochastic way for climate predictability*, International Conference on Geography, Glasgow 15-20 august 2004.

Haidu I., Mercier J.-L., (2003), *Deux états statistiques caractérisent-ils le climat du dernier millénaire?*, Colloque Assoc. Intern. Climatologie, Varsovie 10-13 Septembre 2003, Les relations Climat - Hommes, pp. 157-160.

Haidu I., Mercier J.-L., (2003), *Alternation between two statistical states in the climate of the last millenium*, Intern. Conf. On Earth System Modeling, Hamburg 15-19 september 2003, pp.154-157.

Humlum O., (2004) A climatic perspective on observed Arctic Permafrost change, 3 p.

Jakobsson T., (1995), *Um hafís fyrir Suðurlandi-frá landnámi til Þessa dags*, Errindi á Oddastefnu í Þykkvabæ laugardaginn, 20 maí 1995, site : www. verdur.is

Jakobsson Þ., (2002), *Hafís við strendur Íslands, Stefnumótunarfundur í Þoskeldi, haldinn í Reykholti í Borgaafirðir***,** 17-18 október 2002, Veðurstofa Íslands, site : www. verdur.is

Jóhannesson T., Adalgeirsdottir G., Bjornsson H., Palisson F., Sigurdosson O., (2004), Response of glaciers in Iceland to climate change, 4p.

Jónsson T., Hilmarsson G., (2001), *Early Instrumental Meteorological Observations in Iceland*, International Journal of Climatology, Climatic change N°48, pp. 169-187.

Jónsson T., Jóhannesson T., (1994), *Veðurhorfur á næstu öld*, Veðurfarsbreytingar og gróðuhúsaáhrif, Náttúrufræðingurinn, 64 árg. 1 hefti, pp. 13-29.

Kendall M.G., Ord J.K., (1990), *Time series*, Edward Arnold.

Kendall M.G., Stuart A., (1979), *The advance theory of statistics*, Mc Graw-Hill New-York.

Oglivie A.E.J., Jónsson T., (2001), *“Little Ice Age” Research : a perspective from Iceland*, Climatic change N°48, pp. 9-52.

Mercier J.-L., Haidu I., (2003), *Reconsidering the mediterranean rainfall : the case of the distance between the monthly extremes and monthly totals*, Intern. Conf. “Hydrology of the Mediterranean and Semi-arid regions”-Montpellier, April 1-4, Montpellier CD.

Morales-Maqueda M.A., Willmott A.J., Darby M.S., (1999), A numerical model for interdecadal variability of sea ice cover in the Greenland-Iceland-Norwegian sea, 25p.

Ólafsdóttir R., (2001), *Land Degradation and Climate in Iceland : a spatial and temporal assessment*, Lund University, Departement of Physical Geography, Sweden, 215 p.

Sneyers R., (1975), *Sur l'analyse statistiques des séries d'observations*, Note technique N°143, OMM N°415, Genève, 192 p.

Thorodssen Þ., (1916), Árferði *á Íslandi í Þúsund ár, Hið Íslenska fræðifélag*, Kaupmannahöfn, 432 p.

Thorodssen Þ., (1924), *Fjórar ritgerðir, Safn Fræðifelagsins um Ísland og Íslendinga III, Hið Íslenska fræðifélagi í Kaupmannahöfn*, Kaupmannahöfn, 130 p.

Yevjevich V., Obeysekera J.T.B., (1985), *Effects of incorrectly removed periodicity in parameters on stochastic dependence*, Water Resources Research 21, Volume 5, pp. 685-690.

Unkown (Þorgilson A.), (1986), *Landnámabók, Islendingabók Landnáma*, hið Íslenska Fornbókafélag, Reykjavík, 38p.

TOURIST TRAILS ANALYSIS AT ST. ANA LAKE REGION USING G.I.S METHODOLOGY

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ABSTRACT
Tourist trails analysis at St. Ana Lake region using G.I.S methodology. Most of the tourist routes in Romania were marked in the first decades of the past century. Now days these routes are remarked, and represents an important segment of touristic offer. Are research are concentrated on verifying some of the routes characteristics such as length, time. For this we developed a G.I.S system, which calculates these values, based on region DEM and tourist routes positions. The developed system has a friendly interface developed in Borland Delphi and a powerful G.I.S background using IDRISI modules. The results obtained from the system is quite surprising, values of the walk time differs very much in some cases from those specified in route descriptions. After verifying the base data and calculation methods we concluded, that historical route description holds some errors and our analysis system can be a valuable tool in tourist route analysis.

*

1. INTRODUCTION

Almost all tourist trails are a result of the 1920's and 1930's. These trails are reconditioned by NGO's and by ecologic associations to promote tourism.

Although today's tourism and services within tourism are much different from those in the last century, the material aspect of tourism got reevaluated and recalculated, tourist trails are a new way of discovering the beauties of the wilderness thus acquiring new knowledge. It's needless at this day to mention that covering some tourist trails is not just healthy but also relaxing and helps maintaining a healthy lifestyle.

The today's tourist demands much more information that is precise and plentiful than its predecessor in the last century, even though he or she can't use to a good extent all the received information. Starting from this necessity of the travel agencies, of the agents and holiday makers this precise and vast database can be a considerable help.

The description of tourist trails can be classified into two categories. The first part of the description is short and precise, that offers data like: the type of the marking in use, the estimated time one needs to cover it, total length, the biggest elevation level, etc. The description continues with the presentation of the important sights and elements of the trail just as we would cover the trail led by a virtual guide. In this description we will have info regarding the landscape and sights, flora, fauna, existence of springs, shelters, etc. Outlining the differences between the two descriptions is very important because they are stored and processed differently on PC and furthermore search for data in these information databases is done differently.

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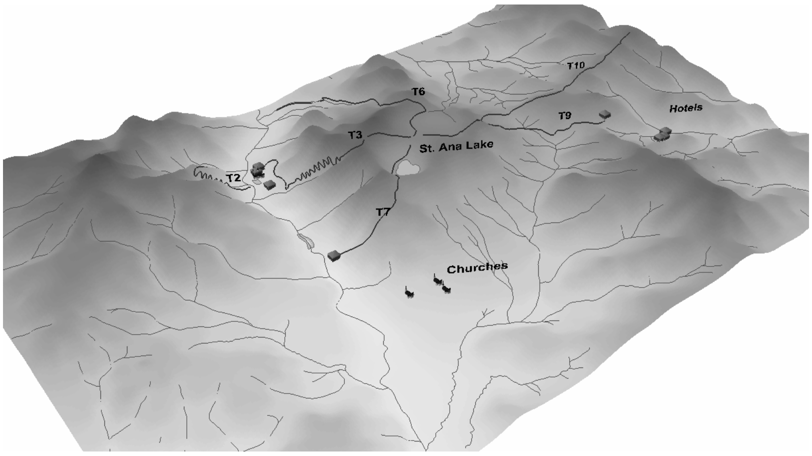

Fig. 1 ***The St. Ana Lake region with the analyzed tourist trails***

2. USAGE OF G.I.S IN THE ANALYSIS OF TOURIST TRAILS

The purpose of our research was to create an analysis system with which we can determine some of the characteristics of the tourist trail. Some of these characteristics one can find in the description of the trail, as a conclusion they are meant to be compared and verified others are new information.

As a principle the fallowing calculations can be performed with G.I.S analysis that can offer new information:

- determining the angle of the slopes to different parts of the trail
- determining the quantity of energy necessary to cover the trail's length
- longitudinal profile of the whole trail

At the same time some figures can be determined just as in the description, like:

- maximum elevation
- time needed to cover it
- distances

To be able to assess such a database we used as a starting point the digital elevation model and the exact position of the trail. Based on the topographic map of the region at scale 1:50000, combined with the touristic map the basic data structures were created. This includes the digital elevation model interpolated from the digitized contour lines and the position of tourist trails in vector files. The digital elevation model had to be converted in IDRISI raster format at 5m resolution, while the tourist trails should to be in SHP files, every trail in separate file.

The majority of G.I.S programs are made for specialists and not for any user with limited knowledge of the software. A disadvantage could be that the average user can use this software only after some specialized training.

G.I.S software offer a wide variety of calculus that refer to the angle of the slopes, exposition, visibility, profiles, but could present problems if a travel agency's agent needs to analyze it on the spot and answer to questions like: what is the average elevation along a single slope? What is the quantity off energy that one requires to cover that part of the trail? Etc. The element missing from G.I.S software is that of offering the possibility of controlled supervision that could be accomplish according to some predefined algorithms. This could lead to the results accomplished by the user, without the user knowing the calculating methods and the steps of the analysis, but through the existence of some predetermined variables it could be personalized. So there is a need to some predefines software for G.I.S, specialized in some specific areas of research.

3. THE DEVELOPED SYSTEM AND ITS RESULTS

To develop such products we need two things: the first step is the creation of the base of the system, or to integrate some of the existing G.I.S algorithms into our own. The first method is not popular because it's not cost-effective; the second one would be accepted if we can combine multiple elements from different parent software's.

In previous research analysis software were developed for Lacu Rosu region, where the selected 6 tourist trails were hard coded in the software. In this case we modified this software giving the possibility to the user to select any desired trail to be analyzed.

To assemble the system of analysis there were used:

- programming environment Borland Delphi 7, to create the user's interface and as a frame of development for applications
- IDIRISI Andes Edition, it can be easily adapted and integrated into Delphi
- InovaG.I.S, a visualization library for many types of file.

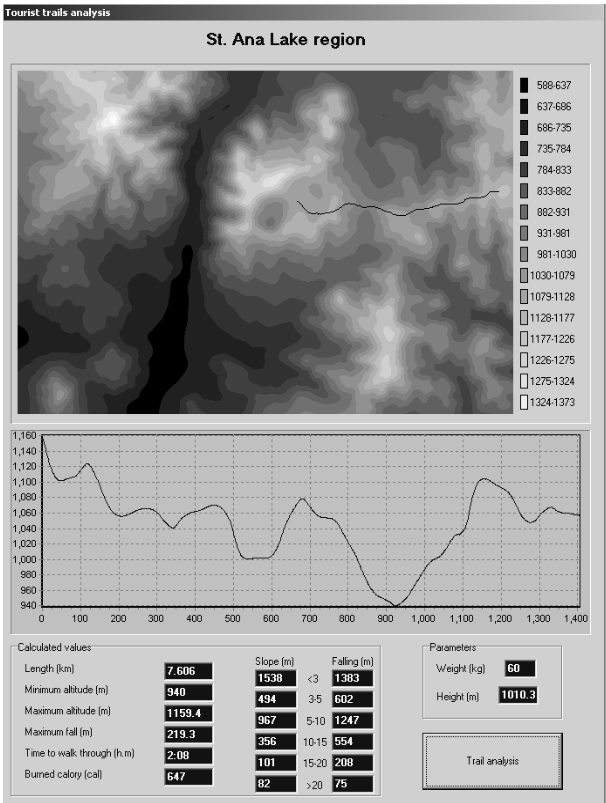

Fig. 2 ***The interface of the developed system***

This newly developed system requires from any host PC the prior installation of IDIRISI and of inovaG.I.S softwares.

The modifiable parameters of the application are: the tourist trail, the weight of the person.

By the selection of one of the trails this data is generated:

- the length of the trail, taking into consideration the elevation corrections as well
- the maximum and minimum points of the trail and the biggest elevation
- the total length of ascends and descends on different categories of slopes
- the necessary time to cover it taking the inequalities of the trail into consideration
- the calories burnt by one individual if one meal is taken into consideration

For this research 6 trails were chosen from the 10 existing one in the vicinity of the St. Ana Lake. The table bellow shows the major characteristics of these trails. In the even rows of the table there are marked the fallowing: type of marking, time to cover it, length, maximum elevation, trail's difficulty.

The characteristics of the trails around St. Ana Lake based on tourist maps

Table 1

T2. Tusnad Spa – Ciucas Lake – Howkrock				
Red triangle	11/2 hour	2,5 km	189 m	hard trail
T3. Tusnad Spa – St. Ana resort				
Red cross, blue triangle	3 hour	6 km	554 m	medium trail
T6. Varghis river – Mohos sheer – St. Ana resort				
Yellow triangle	2 hour	5,5 km	420 m	easy trail
T7. Unio motel – St. Ana resort				
Blue cross	1 hour	3,75 km	430 m	easy trail
T9. St. Ana resort – Carpati resort				
Yellow cross	2 hour	7 km	245 m	easy trail
T10. St. Ana resort – Tetelea peak				
Blue cross	4 hour	9 km	105 m	medium trail

Using the developed analysis system the following results were obtained, comparing to the given ones.

The calculated characteristics of the tourist trails near St. Ana Lake

Table 2

	T2	T3	T6	T7	T9	T10
L	3	6.7	5.9	4.1	4.9	7.6
minH	665	691	702	627	891	940
maxH	986	1213	1130	1061	1104	1159
dH	321	522	428	433	214	219
T	1:02	2.27	1:45	1:23	1:22	2:08
E	406	945	543	492	402	647

The abbreviations used in the table are:
- L - length in Km
- minH – the lowest point (meters)
- maxH – the highest point (meters)
- dH – maximum fall (meters)
- T – estimated time to cover the trail (hour, minute)
- E – the amount of calories burnt (kcal) for a person averaging 70 kg

The values used in the database and the chart are taken from the specific literature.

3. CONCLUSIONS

Comparing the resulted values we can observe that except trail T2 and T10, the others have acceptable values for maximum fall. Based on the topographic map it could be observed that the maximum fall is higher than 200m.

Regarding the length of the trails T9 and T10 have much shorter calculated values then on the touristic map. Because of the other correct values we could not stipulate that there were any problems during the analysis. The most feasible explanation is that on tourist map some frequent but relative small deviations could not be represented.

We also tried to characterize the trails based on the calculated values. As it's observable from figure 3, the most stressing trail is T2, based on the length of segments with slopes over 15 degrees. Trail 3 is classified as medium probably even if have the higher length with slopes over 20 degrees. But it also have approximately 30% with slopes under 5 degrees. Trail 7 is classified easy because of its shortness, while trail 10 is medium mostly because it's relative long length.

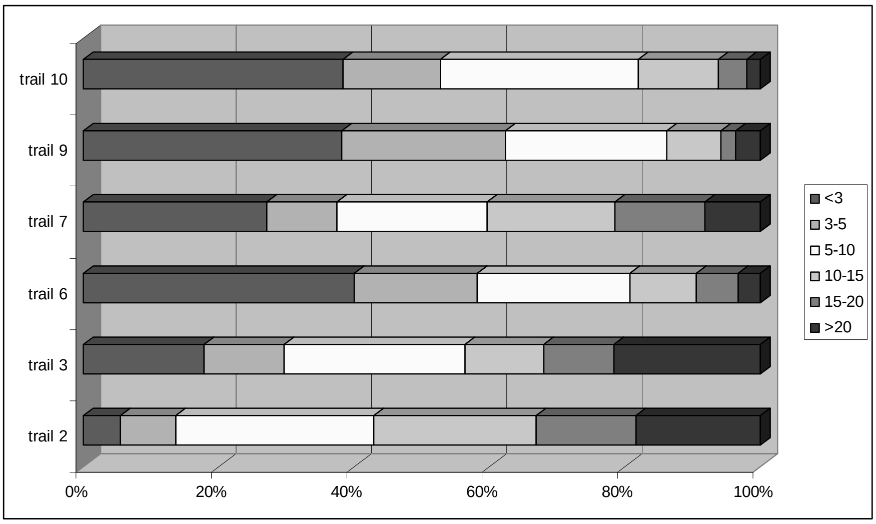

Fig. 3 ***Slope category distribution along the trails relative to their length***

The hardness of a trail can be evaluated based on the burned calories relative to unit length. From figure 4 we can observe the relative accuracy of trail hardness classification from the touristic map: trails 2, 3 and 7 are classified hard or medium, having a calories/unit length value over 100. It's also observable that maximum fall along the trail could not be considered as a representative measure of trail hardness.

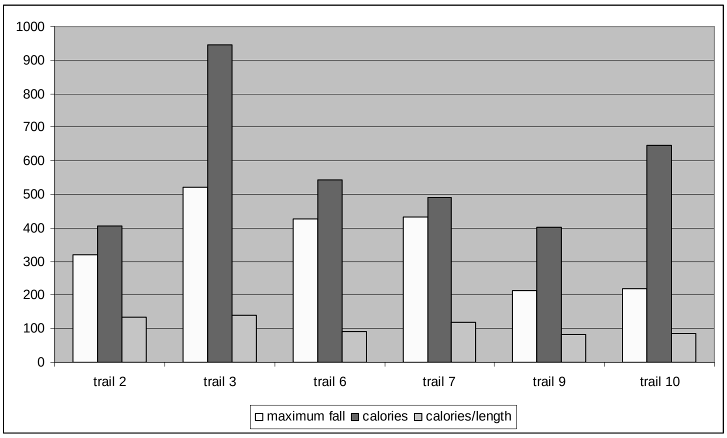

Fig. 4 ***The interface of the developed system***

Our final conclusion is that the majority of the trails – at least those in the study region – present estimated numbers and values, and were not reG.I.Stered as a result of a rigorous field study. Although with the perfecting of the existing analytic program, we consider that these inexactitudes can be corrected obtaining accurate and useful data and information for the tourists and for the organizations and agencies as well.

REFERENCES

Dombay I., Magyari-Sáska Zs. (2006), *Hegyvidéki túrautak jellemzése G.I.S rendszerek segítségével*, Volumul celei de a III. Conferințe Internaționale de Geografie,

Magyari S. Zs, Haidu I. (2006), *Posibilități de modelare spațială în mediu programat*, Editura Universității „Al.I. Cuza”, Iași

Pándi G., Magyari-Sáska Zs. (2007), *Turismul la lacul Sfânta Ana*, Geografia în contextul dezvoltării contemporane, Presa Universitară Clujeană, Cluj-Napoca

*** (2001), *A Szent Anna-tó és környéke*, Hartă turistică, Dinmap,

http://www.cchr.ro/jud/turism/

THE BUILDINGS' MANAGEMENT IN THE SANITARY PUBLIC SYSTEM OF BIHOR DISTRICT - DETAILED RESEARCH

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ABSTRACT

For the last twenty years the use of the buildings based on a technology that provides the management of the information streams, from the different points of view (services, administrative, financial), had a successful evolution.

Nowadays the modern building is supplied by an infrastructure which improvement of comfort conditions and increase in a level of persons' safety allows to adapt and correspond constantly to the changes of conditions as the result of the effective utilization of resources.

Owing to the use of the management in buildings, in present clauses it is underlined that the important part in this measure is the improvement of the consumers` comfort, reflected in the increase of the service contentment degree of the hospitalized patients and the qualitiy of the provided medical services. From this point of view, the Geographical Information System is presented as the necessary operational tool of the sanitary management's establishments which provides the authenticity, the accuracy of the information and the objectivity of the basic estimations, the formulation and the introduction of the strategic development policy, the decisions and the control of sanitary establishments.

Keywords: Management, building, database, Information Geographical System, medical services, patients.

1. INTRODUCTION

THE IMPORTANCE

The present report emphasizes the importance of the effective management of the buildings in the improvement of delivery and increase in the reference to services of health and, in particular, in the organization and work of sanitary establishments with beds.

The hospitals are organized depending on specificity of a pathology in the general hospitals or hospitals with a single specialisation and have in their structure separate sections for treatment and providing special care of patients with acute and chronical diseases.

The sanitary establishments with the beds (hospitals, institutes, the centers of health and medicine) provide special medical services: preventive, curative, urgent, recovery and palliative, and also before, during and after the birthgiving, participating in an integrated system with primary and out-patient special health services, with the purpose of the population`s health maintenance.

The Geographical Information System provides the management of informational streams, in frame of the buildings` management of a sanitary area.

THE PURPOSE

The purpose of the buildings management in the sanitary system is to perform the quality of service and to provide efficiency of access to the medical services, rendered by

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sanitary establishments with beds, for all categories of persons, from urban and rural territories; to adults, children, workers, unemployed, socially poor persons and persons with small incomes or without them.

2. RESEARCH METHODS

Choice of research methods, processing of information

The applied way of research of this report is the way of monitoring consisting in supervision over processes of the phenomena and the subsequent dynamic analysis or comparison of several phenomena, finishing synthesis of the basic characteristics. This way of research methods by grouping under the basic characteristics are applied, grouping obtained data under personal characteristics (the served population, structure of the buildings, quality indicators of rendered services and so on), spatial (local placement – space arrangement) and under time characteristics. Also, the way of supervision was carried out also by interrogations in occasion concerning the contentment degree of the hospitalized patients. The present work is an observant, retrospective and descriptive research.

3. RESULTS AND DISCUSSIONS

The consumers` satisfaction of medical services makes a complex combination of necessary needs, expectations about nursery and the experience concerning nursery services received by them.

The territorial site, the aspect, the structure, the useful area and the level of deterioration of the sanitary establishment makes the important criterion when the consumer searches for medical services of high quality.

The proper utilization and service of the buildings and of the belonging equipment are necessary for achievement of efficiency, according to qualitative design parameters.

There is a number of the important characteristics which need to be accomplished by the medical services. For the present report have been considered the following:

- availability
- adequacy
- reference
- acceptability
- professional competence
- physical safety

AVAILABILITY

The first requirement to any medical service consists in disponibility and accessibility to those who require it. It is very clearly that if in any society necessary medical services does not exist or are not available, or exists and are available but are not easy to obtain, the quality of medical services descreases.

Availability is refered to the consumers' oportunity to receive medical service at the right place and at the right time, depending on their needs. It assumes interdictions' absence of the following order: geographical, economical, financial, social, cultural, organizational or a linguistic barrier.

In Bihor district, the total number of the population and territorial distribution are specified in table I and figures 1,2,3.

Total number of the population of Bihor district and on territories, in 1992,1998, 2004

Table 1

TERRITORY	**THE POPULATION**		
	1992	**1998**	**2004**
Oradea	326980	326077	312633
Alesd	52310	51815	50128
Beius	102098	101433	95191
Marghita	83106	83560	80044
Salonta	61102	61272	58965
Total in Bihor	625596	624157	596961

From the applied table it is noticeable the reduction of the population by 4,5 % at a level of district Bihor in a 13 year period (1992-2004). This tendency of reduction is also kept on territories, for example, in the territory of Beius city it is ascertained the most significant reduction of the population (6,8 %). The explanation comes with the migration of the young population to the most accessible territories from the social and economical point of view, especially geographical, as the territory of Beius city is in a mountain-hilly zone, with scattered villages where roads on wintertime are remote.

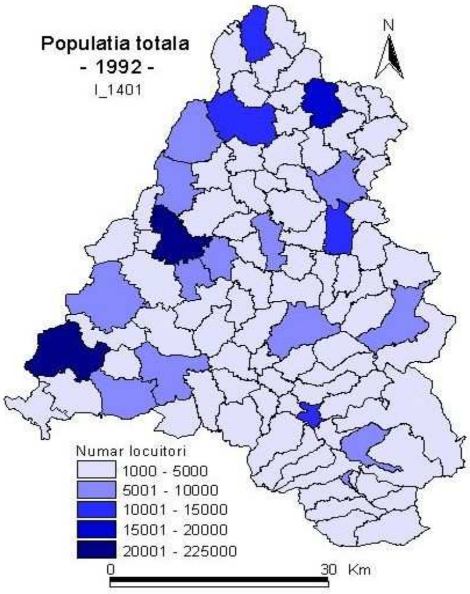
Another prominent aspect, observed in a long time, was the population distribution on districts (cities and villages) and the quantitative evolution of the population in frame of the examined territory. For research of the phenomenon in dynamics, have been composed maps (map 1, map 2, map 3) where cities and villages have been shaded depending on the quantity of the territory`s inhabitants (the quantity of the population is represented by different color tones, from light to dark; the light color tones correspond to a number of inhabitants around 1000 and 5000, and to the most dark color there correspond 21001-210000 inhabitants).

Analyzing the maps it is possible to notice the concentration of the population in the cities: Oradea, Salonta, Marghita, Beius, Alesd- the average population in field zones and the population with small quantity of inhabitants in mountain zones.

The quantitative evolution in time of the inhabitants on territories has no greater changes, except the reduction of inhabitants` number in Salonta city and Buntesti village from Beius area (the change has occurred on a single rank- 5000 inhabitants).

From the graphical representation, it is possible to notice:

- The concentration of the population in the city zones that has led to the increase of pressure for the medical services in these zones,
- The small quantity of inhabitants from remote zones, the access improvement to these zones by means of municipal roads, the clearness of the First Aid District Service has led to the reduction of negative pressure on the buildings of sanitary system.



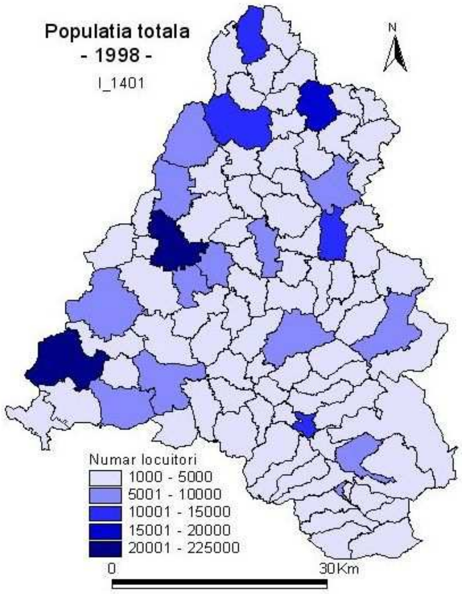


Fig. 1 ***The population of Bihor district in 1992*** **Fig. 2** ***The population of Bihor district in 1998***

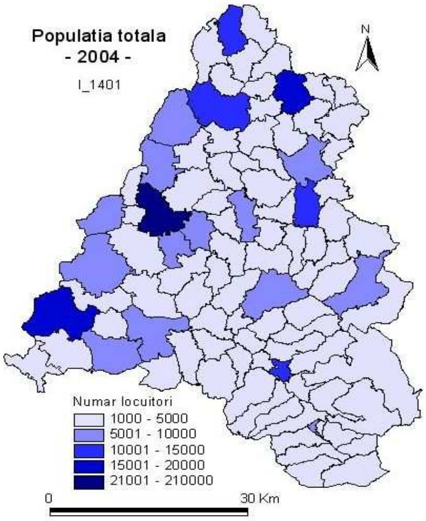
The change of the leG.I.Slation in this time interval has not strongly affected the construction or the disappearance of hospitals. It has affected only the Centers of Health.

We apply distribution maps of four categories of sanitary establishments with beds, achieved on the base of their topographical data.

On the map[1] 4 it is possible to notice the counterbalanced distribution of hospitals to territories with which the respective availability of the population to services of hospitals are provided.

Owing to the complex character of the buildings' management, in our research were analyzed five hospitals selected in accord with the territorial arrangement and the rendered medical services (the general hospitals):

- The Clinical Hospital District Oradea
- The Municipal Hospital „Ep. N. Popovici" Beiuş
- The Municipal Hospital „Dr. Pop Mircea" Marghita
- The Municipal Hospital Salonta
- City Hospital Aleşd



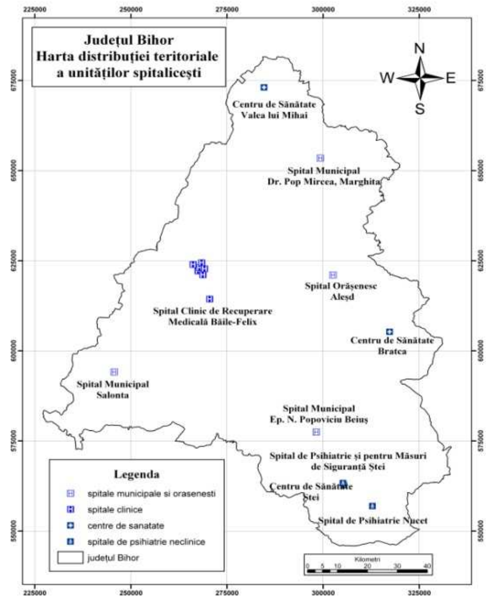


Fig. 3 ***The population of Bihor district in 2004*** **Fig. 4** ***Hospitals of Bihor district***

Each sanitary establishment provides special health services for the population of Oradea city and to the next localities: Beius, Marghita, Salonta, Alesd and the population from the next villages, serving a large percent of cases from district, owing to branches in hospitals. The arrangement of each establishment on the main street of the city provides an easy access to the population and to the first aid service.

The task of each hospital is to maintain a qualitative medical activity, at the high professional level, observing for increase in incomes according to the prices, receiving the maximum contentment concerning the rendered activity, both from the personnel and patients.

THE ADEQUACY

The concept of adequacy is closely connected with attempts of reduction concerning the used resources in order to supervise the prices in the health system. Particularly, we mean that if the services received by the patient correspond to his health requirements, he will be satisfied, regardless of the location or duration of the medical service.

From this point of view was traced the structure of branches with a number of beds, their time evolution (1992, 1998, 2004) in the analyzed hospitals. The obtained data are specified in table IV and on maps 6-7.

In the majority of the hospitals and in their branches it is possible to notice a reduction of the beds' number. The diabetes and gastroenterology`s branches make an exception. The number of the beds has been reduced up to 25, therefore there are no significant changes on the maps concerning the beds' number in hospitals.

The most complex hospital considering from the variety of the branches is Oradea District Hospital, the main territorial hospital, which in 1992 had 1243 beds, and in 2004 a reduction of 14 % is observed. There were not formed or disbanded any of the branches.

During the observable period, at The Beius Hospital, we observe the formation of 2 branches in 2004: Orthopedy, traumatology and Neurology.

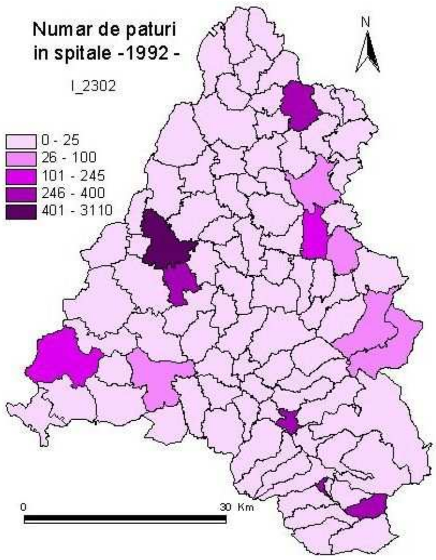


Fig. 5 ***The numbers of the beds in hospitals in 1992***

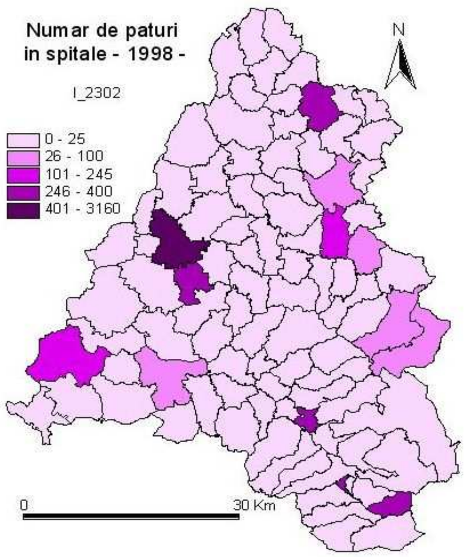


Fig. 6 ***The number of the beds in hospitals in 1998***

THE REFERENCE

The activity of a hospital is displayed by the number of the patients that apply to the hospital`s services.

The result of the activity is reflected by a number of parameters:

- parameters of volume and intensity of the activity;
- parameters of the services` type;
- parameters of the surgical activity;
- parameters of the functional research;
- parameters of the radiological research;
- parameters of the activity’s complexity;
- parameters of the hospitalization`s conditions;
- parameters of the death rate;
- other parameters (nosocomial infections, repeatedly hospitalized patients and so on)

It should be mentioned that these parameters have to be observed at a national level, in order to get a comparative analysis.

The IOH (International Organization of Health) reports also assume the comparative analysis with other countries in order to define strategies on average terms, considering the integration with the EU.

THE PROFESSIONAL COMPETENCE

Even though it is based on technology, the medical service remains, basically, a process in which people are in mutual relation with other people. In order to satisfy the human needs in an efficient way it is necessary to provide the medical services by an optimum number of experts with the corresponding and competent preparation.

In the applied maps (maps ¹ 8 - 14) are represented in evolution (1992, 1998 and 2004) the number of the doctors from the public sectors, the average sanitary personnel and the average number of workers in health activity and social service.

There are no significant changes observed during the time considering the number of the employed medical personnel.

The professional competence starts with the existence of the high quality clinical achievements, expressed in duly maintenance of the preventive educational service, diagnostically and effective therapeutically services in order to define and satisfy the patient's needs.

In a simple way, the medical care of the patient includes a few stages:

- the inspection of the patient
- identification of the problems, definition of the diagnosis
- the treatment
- continuous supervision

The distribution of all knowledge and skills of an individual expert, the credibility, the decency, the confidentiality, the seriousness and the reputation of the personnel proved by the previous preparation and achievements are very important for successful reception.

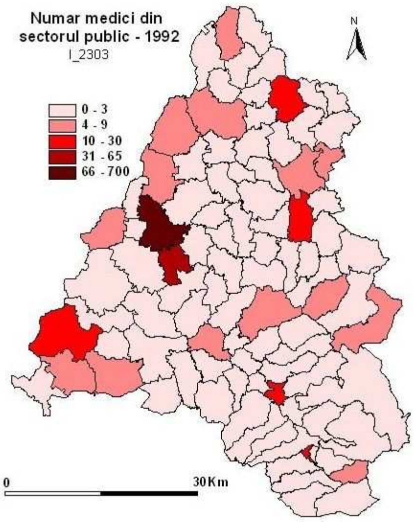


Fig. 7 ***The number of the doctors in the public sector, 1992. A card ¹ 9 Average sanitary personnel,***

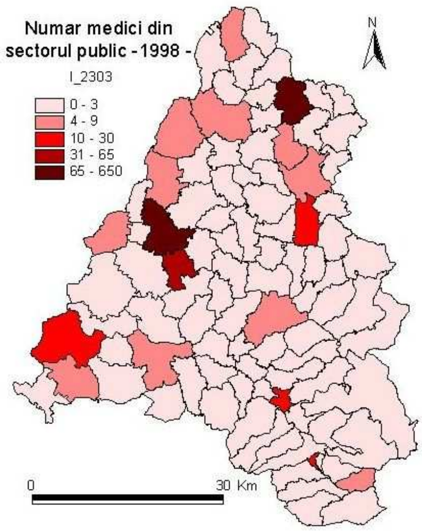


Fig. 8 ***The number of the doctors in the public sector, 1998***

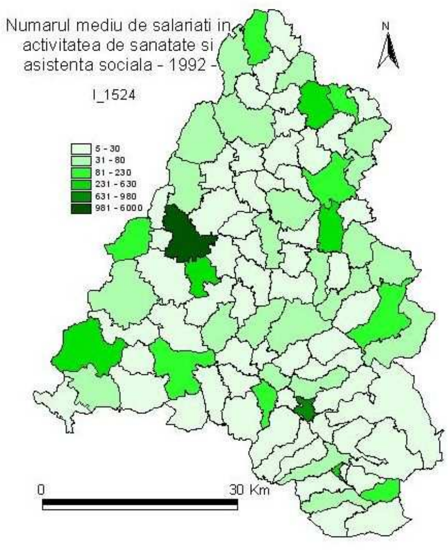


Fig. 9 ***The average number of the workers in health act. and soc. service, 1992***

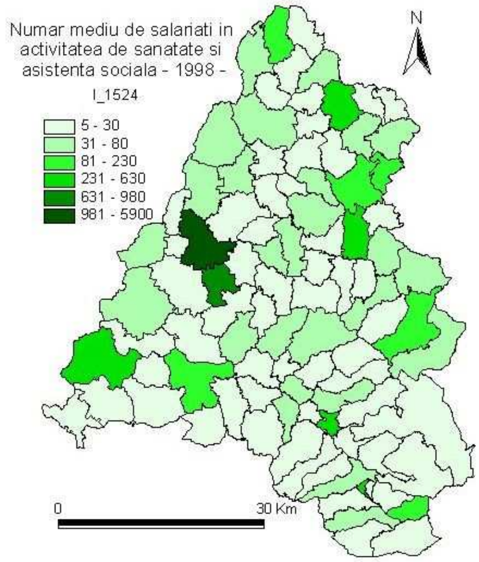


Fig. 10 ***The average number of the workers in health act. and soc. service,***

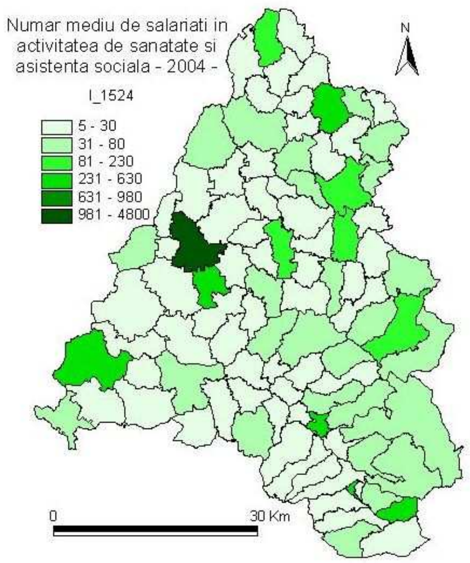


Fig. 11 ***T he average number of workers in health and social activity service, 2004***

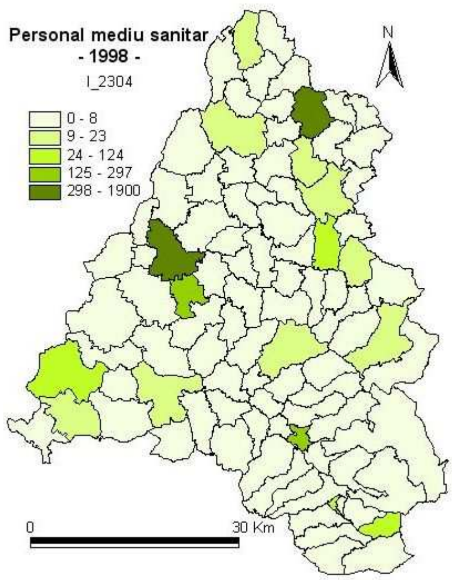


Fig. 12 ***The average sanitary personnel 1998***

The importance of the expert`s competence is asociated with a competent management neccesity. The managers should be able to maintain the required norms and positions that are being in a rapid evolution and the economical pressures which demand a high competition of health establishments.

4. CONCLUSIONS

The maintenance of an effective buildings' management of a sanitary site is an absolute need, a corresponding operation and service of buildings and the belonging equipment according to the design parameters of quality, being the first requirement in quality assurance.

For the management of the buildings it is necessary to pass the following steps:

- the definition of its condition - inspections, examinations, to estimate the existing situation and to establish the general and local objective
- the definition of the charges
- the corresponding service - the introduction of the action plan
- the information and comprehension of the patients

The *advantages* of an effective management are:

- the essential reduction of the prices
- the opportunities to manage and control
- the improvement of the consumers' comfort (both for the patients and personnel)
- the raised ability to prevent the different components dysfunction
- the centralized control of the operational systems

Availability is refered to the consumers' oportunity to receive medical service at the right place and at the right time, depending on their needs. In Bihor district the concentration of the population in city zones leads to the increase of pressure in the sanitary services of these zones and the reduced number of the inhabitants from the remote zones, the access improvement of these zones by means of municipal roads, the clearness of the First Aid District Service`s work has led to the reduction of the negative pressure on the buildings from the sanitary system.

The change of the leG.I.Slation in this time interval has not strongly affected the construction or the disappearance of hospitals. It has affected only the Centers of Health.

Each sanitary establishment provides special health services for the urban population and to the next localities. The arrangement of each establishment on the main street of the city provides an easy access to the population and to the first aid service.

The patients change the hospital or the doctor owing to their discontent concerning the received medical services in hospitals from the quality points of view. This attitude makes a stimulant competition and improves quality in medical area of hospitals.

The concept of adequacy is closely connected with attempts of reduction concerning the used resources in order to supervise the prices in the health system In the majority of hospitals and in their branches, it is possible to notice a reduction of the beds' number, except the diabetes and the gastroenterology branches.

Reducing the average duration of hospitalization, the number of the patients has increased leading to a high pressure on the building. Also, the lack of the beds' number has increased in all hospitals.

The conveniency (for example, disposed hours of consultations), the comunication and comfort can affect the final result of the medical services. When the patient and his family are well informed and calm they will be able to understand the therapeutical options, to make the right decisions, to take part during the medical treatment and to be realistic concerning the results of the medical care.

The satisfaction of the patients taken on research consist in 59 %; patients were mostly dissatisfied with the accomodation, food and medicines then with the received health services. This is why the satisfaction of the hospitalized patients depends on the buildings' conditions that has an influence upon the patients, because the hospital rooms are too large, the toillets and bathrooms are mixed and the furniture is too old and so on.

The professional competence starts with the existence of the high quality clinical achievements, expressed in duly maintenance of the preventive educational service, diagnostically and effective therapeutically services in order to define and satisfy the patient's needs.

The importance of the expert`s competence is asociated with a competent management neccesity. The managers should be able to maintain the required norms and positions that are being in a rapid evolution and the economical pressures which demand a high competition of health establishments.

The introduction of a high technology equipment in the medical practice has led to the decrease of the medical personnel`s pressure during the para-clinical investigation by a significant reduction of the investigation time and also by an effective increase of the results` accuracy.

BIBLIOGRAPHY

Armean P. and collaborators, (2004), *Sanitary management: basic concepts of public health*, Publishing house Coresi, Bucharest.

Băduț M**.** , (1998), Informatics for managers, Publishing house Teora, Bucharest.

Daina Lucia**,** (2007), *Textbook of sanitary management*, Publishing house University of Oradea city.

Dana Galieta Mincă, Marcu M.G. and collab., (2004), *Public health and sanitary management*, University publishing house „Carol Davila", Bucharest.

Haidu I., Haidu C., (1999), *S.I.G. – The territorial analysis*, Publishing house *H*G*A*, Bucharest.

Imbroane Al.M., Moore D., (1999), *Introduction in G.I.S. And Detecting on Distance*, The printing press of the Cluj University.

Longley P.A., Goodchild M.F., Maguire D.J., Rhind D.W., (2001), *Geographic Information – Systems and Science*, Wiley.

Mureșan F., Tirt, D.P., Haiudu, I., Specific features of database for hospital management. An example for Bihor County, „Geographia Technica",no.1, 2006, ISSN 1842-5135, p.133-139, Cluj-Napoca

Săvulescu C., Sârguință R., Abdulamit A., Bugnariu T., Turcu L., Barbu C.**,** (2000), *Bases G.I.S.*, Publishing house H*G*A*, Bucharest.

Stăncioiu I., Militaru G., (1999), *Management- Basic elements*, Publishing house Teora, Bucharest.

Tellier Y., Daniela Rovența-Frumușani, *Human resources and organizational development*, Publishing house Cavallioti.

Tirt, D.P., (2006), *Aplicarea SIG la nivel județean în noul program national de diabet zaharat*, „Geographia Technica, no.1, 2006, ISSN 1842-5135, p.199-203, Cluj-Napoca.

Vlădescu C., (2000), *Management of Health Services*, Publishing house Expert, Bucharest.

Zaharie D., (2001), *Informative systems for a decision-making*, Publishing house Dual Tech.

***** Law number 95/2006, concerning the reform in the sanitary public area

STATISTIC METHODS AND QUALITATIVE INDICATORS IN HUMAN GEOGRAPHY.

CASE STUDY: CITY IMAGE MAPPING

M. C. Neacşu[1]

ABSTRACT
Dans l'esprit d'une philosophie de la gestion urbaine, au fond d'une compétitivité augmentée entre les villes, générée par le processus de la mondialisation, les études de géographie urbaine approfondissent des nouveaux concepts dans l'essai de trouver un bon instrument pour organiser l'espace urbain. Ainsi, à coté du *design urbain*, du *marketing* et du *branding urbain*, on trouve aussi l'image urbaine, qui peut cartographier les principales malfonctions ainsi qu'elles sont perçues par les résidents et pas seulement. Cet étude se concentre sur l'identification des habitats d'attractivité et de répulsivité du municipe Ploieşti, la carte mentale pouvant devenir un instrument opérationnel pour un futur modelè d'organiser l'espace urbain.

*

1. INTRODUCTION

Both statistical methods, as well as qualitative indicators have entered human geography at the middle of last year, on the context of *positivism*, thought current which emerged as a reaction to descriptive geography present until the '50s when there was an acute need for laws to explain spatial models and configurations of geographical phenomena and processes.

As a philosophical current, *positivism* indices scientific rigor in the analysis of the urban space, as it is expressed as method, specific to natural, physical sciences and predominantly in social problems. Although the method of observation is a classic one, another approach of it is suggested: the collection of objective data sets and their statistical processing, the suggestion of work hypothesis and their test, the formulation of theories.

Several forms of the positivist current individualised, out of which the most used are: *logical positivism* and *critical positivism*, through which social behaviour can be expressed mathematically and explained using investigation methods used by natural sciences (such as

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observation, as stated above). R. Johnston (1983) synthesised *logical positivism* in six postulates:

1. The events which take place within a society or which involve human decision have a determined cause, which can be identified and measured;
2. Taking a decision is the result of operating a set of rules, to which each individual adheres;
3. There is an objective reality which comprises individual behaviour and its consequences, which may be observed and stored in an objective manner according to universal criteria;
4. The researcher is a neutral (objective) observer;
5. As in the case of studying physical world, there is a structure of human society (which makes it function as an organic whole) which changes in a determined manner, according to observable laws;
6. Applying the laws and theories in the spirit of *positivism* in the analysis of social behaviour can be done without changing the law that operates in a particular situation or the change of the context in which the law will be applied.

Critical rationalism emerges as a response to *logical positivism*, focusing on verifying the applicability of a law and identifying its exceptions.

The beginning of the ‘60s is marked by the so-called „quantitative revolution” in geography, which allows the use of statistical methods. It is the moment of proliferation of multifactor classifications of cities, hierarchies according to rank, modelling of urban settlements and the analysis of dynamics of territorial fluxes within the city, between cities, between the city and the adjacent space.

Also, urban space and its internal structure is analysed according to new approaches. Statistical approaches reveal the fact that the distribution and configuration of residential areas or processes such as segregation are not exclusive results of ecological factors, which means that taking the individual decision is not influenced by natural laws, but by economic ones - maximisation of utilities (access to urban services) and profit, in the context of diminishing costs. The studies insist on spatial configurations of processes which take place in the urban space.

The 70s bring even more critics to *positivism*, among which the most obvious was related to the object of analysis of urban geography studies. Some of the geographers of the moment brought to discussion the fact that, if spatial forms are social constructions and results of social manifestations and forces, then researches on urban space should focus more on social relations, rather than on spatial ones.

In this spirit, a new phase of epistemological approach is entered, aside from the fact that it is object of series of statistical data and mathematical processing, becomes the object of perceived interpretative knowledge. It is the time of a new philosophical current, *behaviouralism*. Quantitative indicators are completed now by qualitative variables. The plan of the city is doubled by the mental map, and cognitive maps are used in order to map residential mobility, consumer behaviour, the degree of attraction or repulsiveness towards certain urban areas (perception on neighbourhoods), city image.

What is new in the behaviourist approach? The translation of the gravity centre from the space form of social processes and behaviours towards the process itself (S. Gale and G. Olsson, 1979). Spatial characteristics of human behaviour are now approached, through elements related to perception, attitude etc. And the data is collected through polls, questionnaires, qualitative interviews etc.

According to Reginald Golledge (1979), the behaviourist approach in geography researches takes into account the following premises:

- Each individual places himself and others in the external world, in the objective reality;
- Elements of the same objective, exterior reality exist and will continue too exist even after individual interaction will cease;
- Elements of external reality will continue to exist as part of the external environment, independently from the degree of awareness of the individual;â
- Knowing the existence of places and their spatial characteristics remains in the memory of the individual after the cease of physical interaction with the respective place.

The adoption of these premises allows the portrait of the nature of objective reality as it is perceived by the individual. Also, it allows for the collection of information and data on objective reality and their representation so that each individual could understand and communicate the characteristics of the objective reality. Moreover, for Lee (1973), objective reality is all that can be perceived, or understood by the individual and human community.

The behaviouralist movement allows the introduction of new concepts in urban geography and human geography in general, such as mental maps or cognitive maps, used also by Kevin Lynch (1960) in The image of the city, which implied methodological reconsiderations.

2. CITY IMAGE MAPPING

Theoretical aspects. In 1960, year that marks the start of an especially scientifically fertile decade, because of the new concepts that arose from the academic debates and the university scientific groups, on the background of the modernist trend that used to dominate the society, and researchers' opponent opinions related to its consequences (the depersonalisation of cities, and of urban life, the attempt to understand the city, and the way it works, as an engine, as a system, the human community remaining a simple quantitative component in this whole gearing; the exaggerating of geographic determinism and the models' monopole in the scientific approach of cities), the American citizen, Kevin Lynch launches the concept of *city image*, as an idea and as an expression, in the pages of his work, whose promoter he was, along with Jane Jacobs, Christopher Alexander and others.

Therefore, urban elements and forms create certain connexions and meanings in the mind of the urban actors. The physical part of the city is doubled by the mental one (the mental map, the urban image). The mental city outlines, or at least should indicate the lacks in functionality in the physical city. People are no longer prisoners of a predefined urban model, determined in its whole, but now like or have a repulsive attitude towards certain elements or forms that appear in the urban landscape. The inhabitants, therefore, become an active element in the reconfiguration and resize of the urban architecture. For Lynch, the city is a "text" that is deciphered, decrypted by the inhabitants, or by the simple bystanders of that particular urban life. Therefore, the city must be "readable". If it is "readable", then it is decoded and correctly perceived by people, that is it has meanings. If the elements and the urban forms are loaded with significances, then, the city has an identity.

For any city there is a *collective image*, a mental product of the human community that populates and represents it, but also, *individual images* of the urban actors, unique images, mental representations of the city, of its neighbourhoods, of its streets, through some physical directly perceptible landmarks, which sometimes become animated, more or less, by different social meanings of some objectives, areas, by their history or name.

Lynch's idea resides in the isolation of some urban elements and the diagnosis of the inhabitants' view of them, searching for the meanings that they have on a mental level. As such, some distinctive elements are aimed:

• *The paths*. They are ways of access along which the observer (a simple inhabitant of the city or a visitor) passes by, occasionally or potentially, with the purpose of reaching certain objectives, either by foot (and it is interesting here to observe the quality of the sidewalks and of the pedestrian crossings), either by a vehicle (case in which the dominant of the perception is given by the quality of the traffic road). For most of the inhabitants, the streets are the predominant elements of the city image. People observe the city when they pass through it and some elements of the urban landscape are allotted in space and spotted in terms of their localisation along a street, a boulevard, etc.

• *The nodes*. These are "strategic" places or points, penetrable by an observer, from and towards his destination. Some of these "nodes" represent the nucleon of those districts or neighbourhoods, that constitute themselves as symbols for that particular area and around which they clearly show their influence. Well marked in the urban landscape, through squares, and roundabouts, the nodes are signalled by Kevin Lynch as being genuine "breaches" in communication, where the rhythm or direction is sensibly changed.

• *Landmarks*. They are another type of reference elements for the city image, with a particular typology; they are external, impenetrable by the observer. This category is constituted from reference elements that have a certain local utility, when they can't be "seen" except from certain places or from certain angles. This is the case of certain road posts, shop windows, some institutions or churches, different elements or other details of the urban landscape that "fill" the inhabitants' image.

• *The Neighbourhoods*. They are fundamental "cells" of the urban social space, with a remarkable internal cohesion through which that urban community perceives the whole city. Therefore, in most cases, the district image is reflected on the general qualitative image of the city, taking into account the time spent inside that particular neighbourhood. Also, the district may set a certain social behaviour to its inhabitants. The neighbourhood is acknowledged through a certain characteristic (texture, space, forms, details, symbols, type and colour of buildings, social significances with a certain emotional meaning, type of activity, functions, inhabitants, degree of maintenance/usage, topography, etc.), which allows the observer to identify it, if he is inside it (endogenous perception), characteristic that transforms itself into a basic reference, if the subject is outside it (exogenous perception). As such, the districts are relatively wide areas of the city, which may be mentally identified by the observer, and that have certain own internal quality. Practically, at a perceptive level, each district is unique, impressing a certain belonging spirit to its inhabitants, which may sometimes be identified as a strong urban community held in a tight internal cohesion.

• *The edges* (discontinuities). These are linear elements with a precise identity for the observer, diametrically opposed to the access ways. These are frontiers between two types of precincts.

The above presented elements constitute the "rough material" that lies at the basis of drawing up a city image. These do not appear as singularities, but are put into a scheme; they receive value and significances through the relations among them. This is why the perception scale (the "geographical resolution") is essential for the general outlining of a city image. As such, a landmark means nothing unless the resolution is increased (the perception scale is reduced), if it is not inserted into a scheme on the street, in a crossroads, in a neighbourhood, in a part of the city, city reflected by a number of mental individual images, number proportional with the number of inhabitants.

Case study and methodological aspects. This study has been carried out using two questionnaires that were conducted in 2001 and 2004 in Ploieşti city, on two experimental focus groups (250, respectively 200 inhabitants).

Firstly, between the two although quantitatively similar samples, some clear differences have outlined, as a result of the way of "selecting" the respondents: in 2001, *street questionnaire, random selection*, whereas in 2004, *Internet questionnaire* (hosted by different sites of Ploieşti city, with all the advantages and disadvantages that incur from this)

Therefore, some differences have been outlined:

- A population segment, aging between 18 and 25, with 20% larger than in the case of the street questionnaire, difference that is perfectly reflected in the age segment of over 55 (23% in 2001, as opposed to 3% in 2004);
- The two sexes are represented almost equilibrate in 2001 (42% masculine and 58% feminine), whereas in the second poll, it seems to highlight mostly the masculine perception (67%);
- It seems that, at least at the level of 2004, the Internet has been accessed by people owning a university degree (approximately 70%), as opposed to a third in the classical poll;
- Regarding the type of residence (one level house or block of flats), the differences are insignificant; in both cases predominate the owners living in blocks of flats;
- The perception of the inhabitants regarding the city image of Ploieşti is relevant through the large percentage (approximately 70%) of the ones living in this city for over 15 years.

The questions were closed, semi-open that offered the opportunity of attaching personal details (following the model of something else/what?) and open, especially the ones aiming "deficiencies", "solutions" or "prognoses" (for ex: How would you see Ploieşti city in twenty years' time?)

Objectives:

a) the perception on urban habitat and the inside perception on city image;

b) the links that may be established between the perception on the city and different independent variables, selected in the heading of the questionnaire - sex, age, education, the length of time spent living in that district, etc (the hi square significance test);

c) the identification of causal relations between the perception on different life and urban living conditions (the urban habitat) and the perceived quality of the city image;

d) the outline of some territorial disparities and of some opinion regions (perception maps).

3. RESULTS

The perception from micro-scale to macro-scale. It is obvious within the two sequences of the study, the differentiated perception from the micro-scale (residence level) to the macro-scale (neighbourhood and city), the percentage of the people who appreciate the quality of their own residence as being good and very good (86% in 2001 and 65% in 2004) knowing a significant decrease as regards to the appreciation of the street, the neighbourhood, or the city, case in which there is a growth in the percentage of the undecided ("I can't tell", respond, with regards to the neighbourhood between 14 and 35% of the people interviewed). The results highlight an absolutely natural thing, considering that each man knows its own residence better than the street or the neighbourhood he inhabits.

Correlation between variables and the acuity of perception. Applying the hi-square test (the test of the null hypothesis), it has resulted that the perception is distorted inversely proportional to the own income. As such, in the case of the people with low income, the acuity of the perception as regards to the living conditions increases.

City image. Although there is an entire segment in the questionnaire that aims the living conditions, the last part of the poll is interesting with regards to identifying the perception on city image. As such, according to the results of the questionnaire, it seems that the city of Ploieşti is not an attractive place from the point of view of the business opportunities, as at the statement "The city offers many employment possibilities and business opportunities", 77% have stated that they "disagree" or that they "partially agree". The negative perception is enhanced by the high percentage (over 65%) of the ones who respond in the same manner in the case of the statement "Ploieşti is an extraordinary place for me to live in along with my family". In return, over 40% perfectly agree with the statement "It is a city with a working aspect (series of grey blocks) which has not preserved its historical past."

Also, the inhabitants of Ploieşti name precisely the first three things they dislike most in their city, as the analysis of the responses for the afferent question outlines predominantly the sector of public services (street cleaning, illumination, and public security, but no lastly, the behavioural hazard), a small percentage of the people interviewed indicating also the architectural aspect.

The question "Which are the first three things that you like most within our city?" also highlights some interesting aspects:

- Firstly, the diffusion of the perception in a very wide spectre: from concrete elements (The Chestnut Boulevard, which in 2004 has the highest percentage, the Palace of Culture), and diverse social aspects or elements related to the urban services.

- A significant percentage (17% from the 2004 questionnaire) does not respond to this question, although they have given answers to the former one.

- 55 % of the people interviewed in 2001 and a similar percentage in 2004 are not satisfied with the ensemble image of the city of Ploieşti.

„Which do you consider to be the symbol that represents the city of Ploieşti?" is the edifying question form the questionnaire, with regards to the perception on the city image or identity. And the study has showed that over a third of the inhabitants who were interviewed indicates as symbol or associates the city image to the petroleum or the connected elements (oil distilleries, The University of Petroleum and Gas or the Museum of the Petroleum).

Mental maps. The results of the study have allowed the identification and outlining of some attractive and repulsive areas in Ploieşti, highlighting, in the first case, the central part and the axe of the boulevards that go across the city from North to South, and in the second case, the peripheral neighbourhoods.

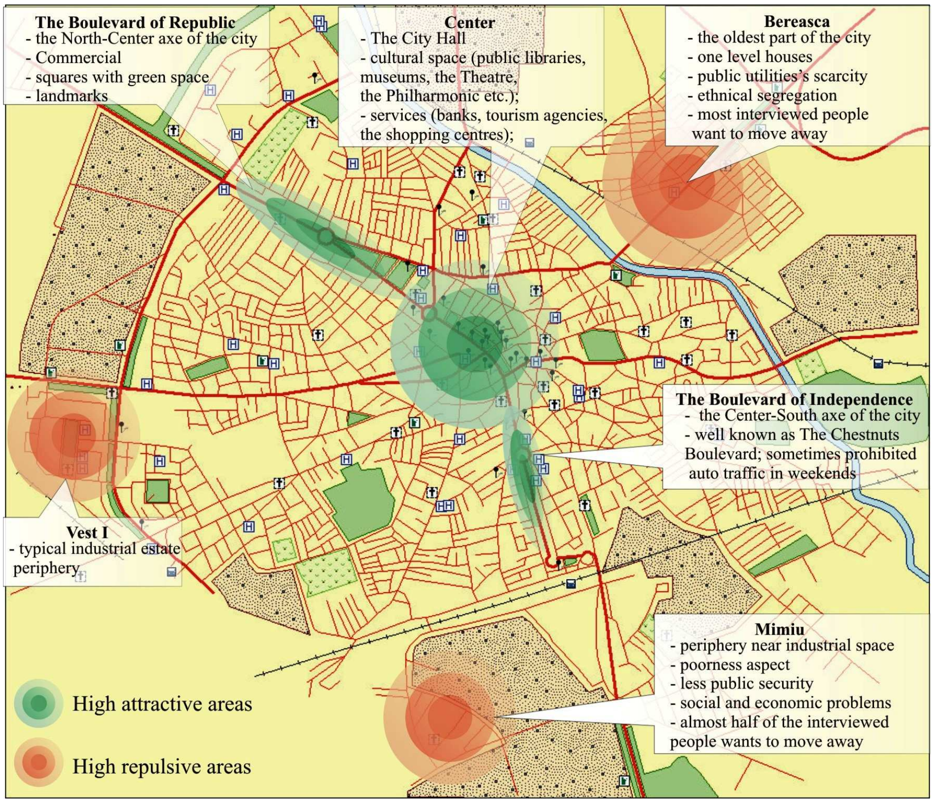

Fig. 1 ***The Mental Map of Ploieşti City***

4. CONCLUSIONS

Romania, and in general, the countries from the former communist block constitute a “fertile” ground for complex studies of urban and social geography, which are very attractive to the researchers in the area, as we are in the phase of crystallising some work models.

Although the city image is an especially attractive concept to the geographers, it requires an interdisciplinary approach and the understanding of the way in which the concept may be fully operable in the following urban planning studies.

There are no clear perception differences between the two opinion polls made in Ploiesti (2001 and respectively, 2004), especially regarding the attractive and repulsive areas of the city, although the samples from the people interviewed have been sensibly different regarding the structure. However, on the basis of this primary perception, repeated polls must be made, with a more and more profound degree of detail and specificity.

The results of this study have shown that the social status and the quality of life distort the acuity of people’s perception of the city they live in, regarding the aspects related to identity, symbols, etc.

The mental maps and the situation of the perceptions have outlined an attractive area on the North-South axe of the city, crossing the central part, with a complex functionality, while a general totally negative perception is represented by the neighbourhoods situated outside the area of the "city body", beyond the discontinuities (railway, river etc.) at the periphery of the city, in the proximity of the industrial platforms. It seems to be a typical situation for the forced industrialised cities that are going through functional and why not, identity reconsideration times.

REFERENCES

Golledge, Reginald, (2006), *Philosophical bases of behavioral research in geography*, în vol. Approaches in Human Geography (Aitken S., Valentine, G.), SAGE, pp. 75-85

Kitchin, R., (2006), *Positivistic geographies and spatial science, in vol*. Approaches in Human Geography (Aitken S., Valentine, G.), SAGE, pp. 20-41

Lynch, K., (1960), *Image of the city*, MIT Press, Cambridge (Massachusettes)

Neacşu, M. C., (2005), *City image*. The dynamic of inside perception between 2001 and 2004. Case study: Ploiesti, The Economic Journal, VIII, No. 16, pp. 57-71, ISSN 1454-4296

Pacione, M., (2001), *Urban Geography: A Global Perspective (2nd edition)*, Routledge, London

Tversky, Barbara, (1993), *Cognitive maps, cognitive collages, and spatial mental models*, in vol. Spatial Information Theory: A Theoretical Basis for G.I.S, Proceedings of the COSIT '93. Lecture notes in Computers Science, Springer-Verlag, Berlin, pp. 14-24

LA TEMPÊTE DE SABLE DU 19 AU 22 FÉVRIER 2004 EN ALGÉRIE : CONDITIONS MÉTÉOROLOGIQUES ET CARACTÉRISTIQUES

Z. Nouaceur [1]

ABSTRACT

The Sirocco wind represents in Algeria a hot and dry wind that blows from the Sahara, towards the coastal regions. At the time of the occurrence of this type of phenomenon, the uprising of dust and sand by the winds strongly reduce the visibility. In the same time, we can observe a spectacular and unusual rise of the temperatures in the regions of the north of the country. The situation that prevailed from February 19 to 22 2004 represents an extreme case of the types of Sirocco weather. The aerological and climatic analysis of this event tends to show that the types of weather associated with the Siroco wind represent a phenomenon the impact of which on the economic activity, the health of the populations and the evolution of the global and regional climate is incontestable.

Key-words: climate, sand-winds, Sirocco, lithométéore

*

1. INTRODUCTION

En période hivernale, L'accentuation du déficit thermique dans l'Arctique impose une circulation atmosphérique généralement zonale dans l'hémisphère Nord. Sur l'Afrique du Nord, durant cette période, les anticyclones des Açores et de Libye sont soudés ou séparés par un seuil peu profond. Les perturbations polaires qui circulent au nord de ce système, sont rejetées sur la Méditerranée et l'Europe occidentale. Lorsque ces deux centres d'action sont séparés par un thalweg, la circulation devient méridienne et permet ainsi à l'air polaire de se glisser le long de la face orientale de l'anticyclone des Açores et d'atteindre les basses latitudes. L'air chaud équatorial prend le chemin inverse et remonte vers le nord sur l'autre face du thalweg, le long de la cellule libyenne. Ces mouvements ondulatoires et divergents de la circulation atmosphérique, sont appelés des ondes de Rossby,. Dans sa progression, la coulée froide est liée à une configuration aérologique spécifique, qui se résume en un couloir dépressionnaire en surface, positionné à l'avant de la cellule anticyclonique et un thalweg d'air froid, puis parfois une goutte froide en altitude. Cette situation est souvent accompagnée d'un vent fort de secteur sud-ouest. Ce courant d'accélération, axé sud-ouest / nord-est, matérialise le Jet subtropical sur le flanc oriental de l'onde. L'advection d'air froid sur les régions tropicales peut être à l'origine de la genèse de perturbation active d'altitude, lorsque des advections tropicales ou équatoriales se produisent simultanément. Ces cellules se déplacent en général d'ouest en est. Des perturbations convectives mobiles peuvent aussi prendre naissance dans le flux d'est des couches inférieures (Dhonneur, 1978). Ces incursions froides dans le domaine tropical favorisent ainsi une accélération des flux d'air nécessaire à la prise en charge du matériel fin. La dynamique éolienne devient très active dans ces régions aride et semi –aride où la masse de poussière mobilisable par le vent est considérable. Au Sahara et sur ces marges occidentales, cette quantité varie de 60 à 200

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millions de tonnes. Coudé–Gaussen & al. (1994), Moulin & al**.**, (1997) estiment que près d'un million de tonnes de particules et d'aérosols se retrouvent chaque année en suspension dans l'atmosphère. Ce matériel est ensuite transporté dans le sillage des vents dominants au large des côtes africaines, vers l'Europe du Sud (Dragana & al 2004) et même vers l'Europe du Nord (Franzen & al 1995). On a même signalé des poussières éoliennes africaines sur des régions aussi éloignées que l'île de la Barbade (Shinn & al. 2000) et l'Est asiatique (Taichu & al 2006). Les vents de sable sont des phénomènes météorologiques à part entière, il font partie des types temps connus sous le nom de « lithométéore » (Nouaceur, 1999, 2004). Ces manifestations aérologiques sont définies par le mode de transport, la concentration et la durée de suspension des particules de poussières et de sables dans l'atmosphère. Les tempêtes de sable, constituent un volet non négligeable de cette nomenclature (WMO, 1996). Le Sirocco est un vent de sable qui souffle depuis le sud en Algérie, il est aussi appelé « *Chhili* ». Durant les journées de Sirocco, une hausse inhabituelle des températures et une accentuation de la sécheresse de l'air sont observées, notamment sur les plaines littorales. Dans le même temps, un important transport des poussières s'opère depuis le centre du Sahara, vers l'Europe.

2. METHODOLOGIE

La méthode de travail utilisée pour cette analyse est basée sur une étude fine des situations synoptiques et climatiques qui ont engendré cet épisode de poussière. Cette investigation est faite à partir de données climatiques, de cartes isobares du niveau de la mer et de cartes des surfaces isobariques (500 et 850 hPa). Ces cartes sont publiées quotidiennement et archivées sur le site http://www.wetterzentrale.de.

Les données météorologiques (vitesse et direction du vent, température, humidité relative et type de temps) ont été collectées sur le site http://www .weather.uwyo., elles proviennent du réseau météorologique algérien et concernent 24 stations (figure 1).

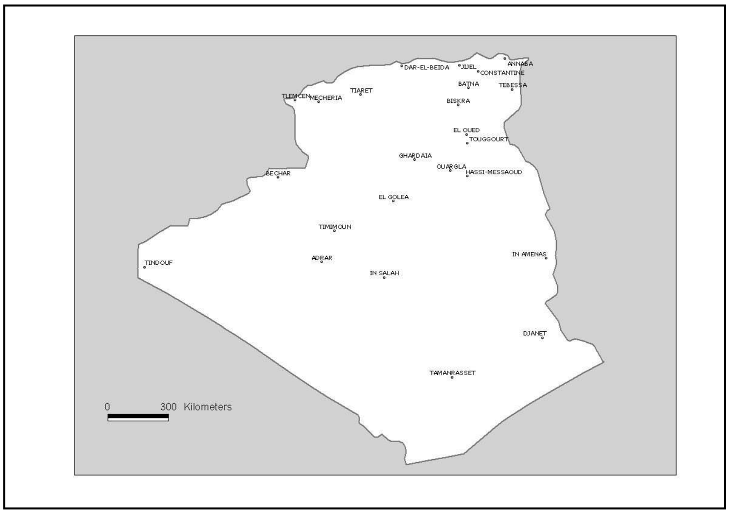

Fig. 1 ***Carte du réseau météorologique***

3. ANALYSE DE LA SITUATION METEOROLOGIQUE

La situation observée entre le 19 et le 22 février 2004 est conforme au schéma de l'advection polaire. L'air froid pénètre en altitude le domaine saharien, il entraîne ainsi la remontée d'air tropical chaud et humide vers le nord –est de l'Afrique septentrionale. Cette dynamique a favorisé le creusement d'une dépression (986 hPa) positionnée initialement sur les îles Canaries et dont l'activité cyclonique a provoqué l'aspiration des poussières éoliennes sahariennes vers le nord. Ces transferts sont confirmés par les taux de particules « PM10, particule de diamètre inférieur à 10 µ » enreG.I.Strés par le réseau de surveillance de la qualité de l'air Airmarais (Réseau de surveillance de la qualité de l'air de l'Est des Bouches – du – Rhône, du Var et du Vaucluse en France). Cinq stations marseillaises affichent le 21 février, les taux journaliers les plus élevés de l'année 2004 (plus de 100 µg par m ^{3}) (Airmarais, 2004). A Avignon, la situation est similaire, les deux stations de mesure des poussières, enreG.I.Strent le même jour (106 µg à la Mairie et 96 µg sur Le Pontet).

L'analyse des conditions en altitude (500 hPa) est plus appropriée pour dévoiler le cheminement de l'air froid qui s'engouffre dans les couches moyennes de l'atmosphère, vers le sud. La progression dans le méandre décrit par le thalweg commence dès le 19 février, la limite méridionale de tout ce système correspond au 40e parallèle nord (figure 2). Son axe principal est orienté nord - est / sud - ouest selon une trajectoire qui va de la France jusqu'en Sibérie. Au 20 février, la progression vers le sud – ouest continue, l'onde cyclonique qui s'est constituée sur ce parcours s'étend jusqu'au 20e parallèle. Le 21, une goutte froide se détache sur la péninsule Ibérique, elle concerne aussi l'ouest de la France, le Maroc Occidental ainsi que le Sud des Îles Britanniques. Les cartes des températures enreG.I.Strées à 850 hPa (environ 2500 m) montrent bien la descente de l'air froid polaire en direction des tropiques (figure 3). L'isotherme 0 °C atteint ainsi une la latitude 40° N entre le 19 et le 20 février. Ces cartes montrent aussi la forte poussée d'air chaud axée sud-sud-ouest / nord-nord-est sur l'Algérie orientale et la Tunisie. Le schéma qui est décrit plus tôt semble relayé par la dynamique actuelle, progression de l'air froid vers les latitudes méridionales et compensation par une advection chaude vers les latitudes septentrionales.

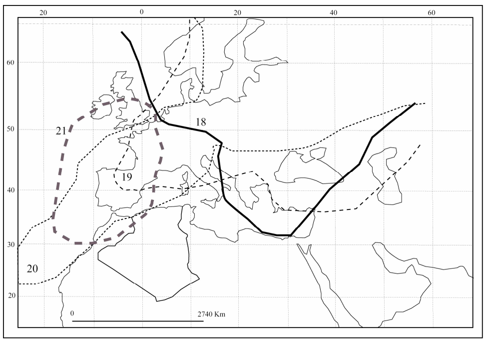

Figure 2. ***Évolution de l'isohypse 556 dam entre le 19 et le 21 février 2004. Synthèse obtenue à partir des cartes du géopotentiel du niveau 500 hPa publiées sur le site :*** http://www.wetterzentrale.de

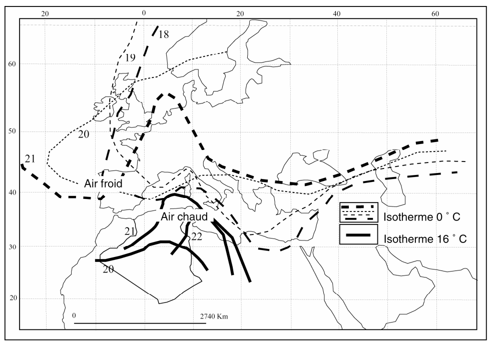

Figure 3. ***Évolution des isothermes 0 et 16 ° C entre le 19 et le 20 février 2004. Synthèse obtenue à partir des cartes de température du niveau 850 hPa, publiées sur le site :*** http://www.wetterzentrale.de **.**

En surface, la dynamique s'articule autour d'un creusement d'une dépression en relation avec la situation d'altitude. La position initiale de cette cellule cyclonique est notée sur le littoral du Sahara occidental, dès les premières heures (2 h 29 min) de la journée du 20 février (figure 4). Tout ce système évolue vers l'est, la perturbation est bien formée à 15 h 14 min et son front froid touche les côtes mauritaniennes et remonte vers le moyen Atlas marocain. Une circulation tourbillonnaire s'établit sur toute la région et dans le secteur chaud de la perturbation, une importante accélération des vents liée à l'aspiration de l'air chaud saharien est notée. Le 21 février, la perturbation et son front froid progressent vers le nord-est, l'axe de ce système est positionné à 15 h 14 min selon un arc qui va de l'Erg *Echech* au sud, jusqu'au centre du littoral algérien (figure 4). Le vortex est centré sur l'Espagne et la dépression tend à se combler puisque son noyau atteint 993 hPa. La perturbation continue sa progression en spirale vers le nord-est le 22 février. Le front froid se décale encore vers l'est algérien. Sur la méditerranée, le système s'incurve pour atteindre le sud de la France. La perturbation perd encore de son activité et la pression au niveau du vortex est de 1003 hPa. Le 23 février, elle se comble progressivement en poursuivant son périple vers l'est.

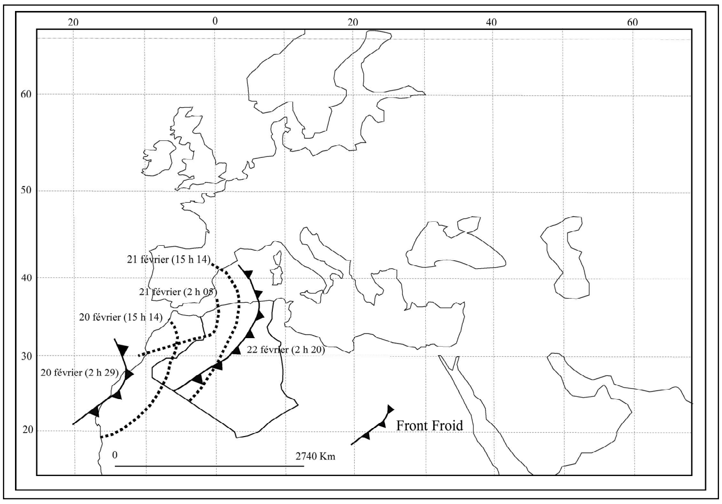

Fig. 4 ***Évolution du front froid entre le 20 et le 22 février 2004.***
Synthèse obtenue à partir des cartes publiées sur le site :
http://www .weather.uwyo**.**

4. ÉVOLUTION DU TEMPS

4. 1. ACCÉLÉRATION DES VENTS ET BAISSE DE LA VISIBILITÉ

Les vents qui soufflent sur tout le territoire algérien, entre le 19 février à 12 h et jusqu'au 22 février à la même heure, présentent des directions du quadrant sud (secteurs 180 à 240°)
(tableau 1).

Observations horaires des directions (case en gris) des vents du quadrant sud (120° - 240°)

(Données du 19, 20, 21 et 22 février 2004) **Tableau 1**

Date	19	20				21				22		
Heure	12 H	12 H	14 H	16 H	18 H	12 H	14 H	16 H	18 H	12 H	14 H	18 H
DAR-EL-BEIDA		■		■	■	■	■					
DJANET					■	■	■	■	■			■
TAMANRASSET		■					■	■	■			
JIJEL		■			■	■	■	■	■			
MECHERIA		■	■	■	■			■				
ANNABA	■					■	■	■			■	■
CONSTANTINE	■	■	■	■	■	■	■	■	■			
TEBESSA	■	■	■		■	■	■	■	■	■		
BATNA	■	■	■	■	■	■	■	■	■	■	■	
TIARET		■	■	■	■	■			■			
TINDOUF			■	■								
TLEMCEN				■								
BECHAR		■	■	■	■	■	■	■	■	■	■	
ADRAR	■	■		■	■	■	■	■	■			
BISKRA		■	■	■	■		■	■				
EL GOLEA		■							■			
GHARDAIA		■	■	■		■						
HASSI-MESSAOUD	■	■	■	■	■				■			
IN SALAH	■	■	■	■	■	■						
TOUGGOURT	■	■	■	■	■	■						
EL OUED	■					■	■	■	■			
TIMIMOUN												
OUARGLA	■	■	■	■	■	■	■	■	■			
IN AMENAS	■	■				■	■	■	■	■		

Dès le 19 février, les observations au sol mettent en évidence sur les Hauts plateaux, un axe d'accélération des vents « ouest – est ». Les vitesses atteignent, dans ce secteur 15 m / s à Mécheria où l'on note les premières observations de tempête. A Tiaret et à Batna, les anémomètres enreG.I.Strent des vents avec des vitesses de l'ordre de 14 m / s pour la première station et 13 m/ s pour la seconde.

Le 20 février, un deuxième foyer d'accélération concerne le sud – ouest et le centre du Sahara. Les directions des vents affichent une orientation sud – sud - est (160°) à sud – sud - ouest (220°) dans plusieurs stations. Dans le même temps, les vitesses augmentent dans l'axe du front froid de la perturbation. Les plus fortes valeurs sont enreG.I.Strées à El Goléa, Adrar et In Salah avec respectivement 21 m / s, 19 m / s et 15 m / s. Les visibilités au sol sont fortement réduites par le soulèvement et la mise en suspension des sables et des poussières sahariens.

Le 21 février, dès les premières heures de la journée, la situation évolue. Une grande partie du pays observe une réduction sévère de la visibilité (figure 5). Un seuil de moins

500 m est noté à 12 h dans neuf stations. L'observation de brume de poussière est généralisée sur le pays. De la brume sèche est notée aussi dans certaines stations du littoral et du centre du Sahara.

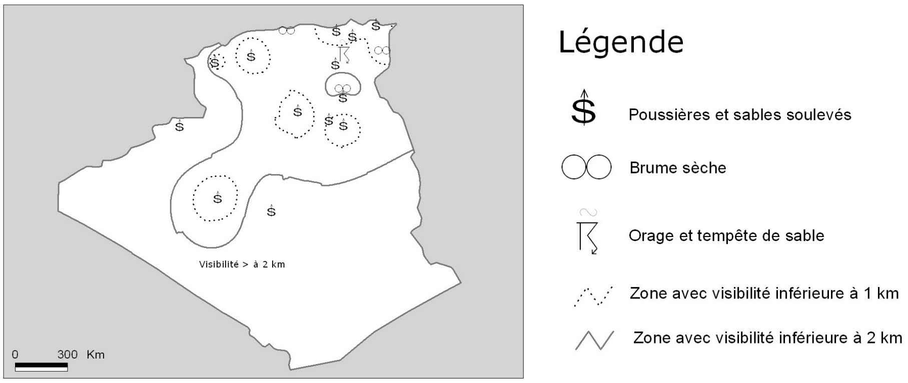

Figure 5 . ***Types de temps et visibilité le 21 février 2004 à 12 h. D'après les données collectées sur le site : [http://www .weather.uwyo](http://www.weather.uwyo).***

A Batna, station située sur les Hauts plateaux, les vents soufflent avec des vitesses évaluées à 16 m / s à 02 h, 06 h et 11 h du matin (figure 6). La baisse de la visibilité occasionnée par les poussières sahariennes est très importante, l'observation de 16 h indique une réduction de 0,750 m (figure 6). De violents orages éclatent l'après-midi et des pluies de boue rougeâtre tombent sur cette localité.

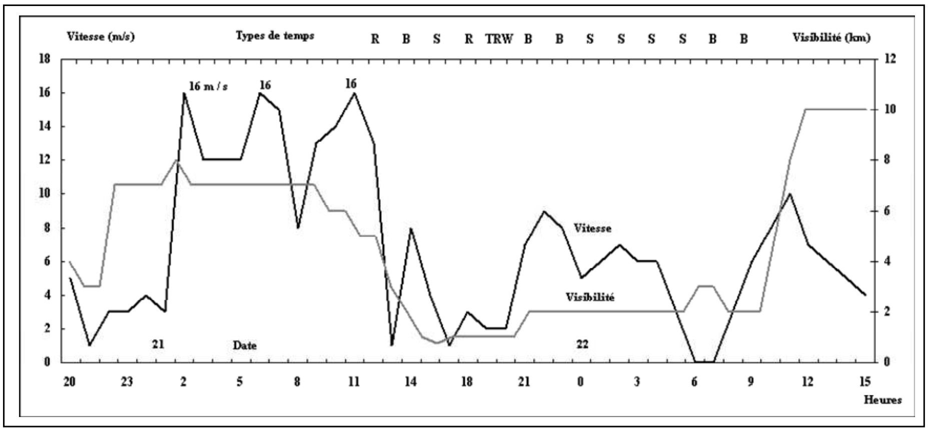

Fig. 6 ***Types de temps, vitesse du vent et visibilité enreG.I.Strés entre le 20 et le 22 février 2004 à Batna. R = pluie, B = brume de poussière, S = tempête de sable, TRW = Orage. D'après les données collectées sur le site : [http://www .weather.uwyo](http://www.weather.uwyo).***

Dans plusieurs régions, du nord du Sahara aux plaines littorales du centre et de l'est, le ciel s'assombrit et prend une couleur ocre, témoignant ainsi de l'importance de la prise en charge de la poussière et des sables par les vents. En fin d'après-midi, vers 18 h, des pointes de vitesses élevées sont toujours notées dans quelques stations sahariennes, 25 m / s et 20 m / s respectivement à Hassi Messaoud et El Goléa. Durant la nuit, la situation évolue, les vitesses du vent diminuent et les visibilités s'améliorent progressivement. Le 22 février au matin, des averses de pluie sont notées à Annaba, Tébessa, Ouargla, Hassi – Messaoud et El

Goléa. Dans ces trois dernières stations sahariennes, les pluies sont imprégnées de poussières éoliennes. En fin d'après-midi, la situation redevient normale

4. 2. SÉCHERESSE DE L'AIR ET HAUSSE DES TEMPÉRATURES, UN TYPE DE TEMPS CARACTÉRISTIQUE DES JOURNÉES DE SIROCCO

Le Sirocco est un vent qui charrie des masses d'air chaud et sec du centre du Sahara vers les plaines littorales. Dans sa progression vers le nord, il traverse tous les ensembles morpho - structuraux du pays. Il commence son périple par la traversée de l'Atlas saharien qui dépasse les 2000 m d'altitude. Il aborde ensuite les Hauts plateaux où l'altitude est légèrement supérieure à 1000 m. Après ce relief, une nouvelle fois, le Sirocco franchit une chaîne de montagne élevée « la chaîne Tellienne » et atteint enfin les plaines littorales. Lors de ce dernier mouvement, les masses d'air saharien se compriment adiabatiquement. Ce mouvement assèche encore plus l'air et favorise l'augmentation des températures. La situation observée lors de cet épisode de poussière est marquée par cette particularité du Sirocco. Les températures enreG.I.Strées ont été exceptionnellement élevées pour la saison sur les régions nord du pays.

L'examen de l'évolution horaire des températures et de l'humidité relative dans les stations de Constantine, Jijel et Annaba, montre clairement la progression de l'air chaud et sec depuis les zones sahariennes vers le nord du pays. Les courbes d'évolution présentent toutes des profils contraires.

A Constantine (station située sur les Hauts plateaux), la hausse des températures est accompagnée d'une baisse sensible de l'humidité relative (figure 7). Le minimum d'humidité (19 %) est enreG.I.Stré le 20 février à 21 h. Les températures horaires nocturnes affichent aussi des valeurs inhabituelles en cette saison. A 00 h, on enreG.I.Stre ainsi 22,4 °C. La tendance des deux courbes ne s'inverse que dès 21 h le 21 février, puisqu'à partir de ce moment, l'humidité relative retrouve des valeurs supérieures à 60 %.

L'évolution des températures et de l'humidité à la station d'Annaba (située sur le littoral) est conforme à la situation observée à Constantine (figure 7). On retrouve ainsi une très forte hausse des températures le 21 février avec un maximum de 27 °C enreG.I.Stré à 12 h. En opposition avec la tendance des températures, les valeurs de l'humidité relative affichent des seuils très bas qui sont inférieurs à 35 % entre 20 h le 20 février et 13 h le lendemain. Le point minimal de 19,8 % est atteint à 23 h, le 20 février. Encore une fois, les températures nocturnes restent élevées pour la saison, elles sont supérieures à 20 °C pour toute la nuit du 20 au 21 février.

Dans la station de Jijel (située aussi sur le littoral), le même phénomène est observé (figure 7). Les températures, qui étaient lors des journées précédentes fraîches et n'excédaient pas 17 °C, sont soumises à une très forte augmentation. Le maximum « 27 ° C » est atteint entre 15 et 17 h le 20 février. Durant la nuit du 20 au 21, les températures nocturnes atteignent des seuils quasi – inhabituels pour un mois de février. On observe ainsi plus de 20 °C toute la nuit et tôt le matin et 26 °C entre 21 et 23 h. Une chute brutale de l'humidité est notée dès 11 h du matin le 20 février. Les valeurs sont inférieures à 10 % à partir de 18 h et jusqu'à 6 h le lendemain.

Les situations observées à Constantine, Annaba et Jijel, illustrent d'une manière flagrante, l'effet caractéristique des vents Sirocco. La descente des masses d'air sur les plaines littorales entraîne une hausse spectaculaire des températures et une sécheresse accrue.

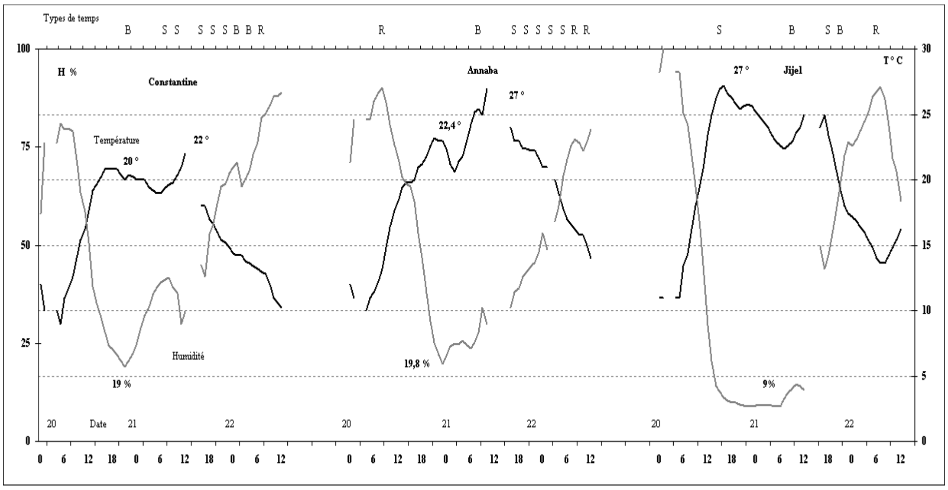

Figure 7. ***Évolution horaire de l'humidité et de la température du 20 au 22 février 2004 dans les stations de Constantine, Annaba et Jijel. R = pluie, B = brume de poussière, S = tempête de sable, TRW = Orage. D'après les données collectées sur le site : [http://www .weather.uwyo](http://www.weather.uwyo)***

Les écarts de températures, évaluées entre les données de la station d'Annaba et quelques stations du Sahara oriental, expriment cette particularité (tableau 2). On constate l'écart négatif du 19 et 20 février. Pour cette dernière date, ce seuil est plus intense et dépasse – 10 °C pour presque toutes les stations (sauf pour El Oued). Cette importante différence est liée à la date d'arrivée de l'air chaud sur les régions sahariennes qui a eu lieu le 20 février. Les températures enreG.I.Strées cette journée ont été encore plus chaudes que celles observées lors du 19 février. L'arrivée de masses d'air saharien à Annaba a eu lieu le 21 février, elle explique le passage à des écarts positifs relevés à 13 h ce même jour. La journée du 21 se détache ainsi clairement par des valeurs positives, qui illustrent la hausse des températures observée dans la station littorale.

Écarts des températures enreG.I.Strés dans la station d'Annaba et dans quelques stations sahariennes (période du 19 au 22 février 2004)

Tableau 2

Date	**Heure**	***El Oued***	***Touggourt***	***Ghardaia***	***Ourgla***	***Hassi - Messaoud***	***In Salah***
19	**12**	-1	-1	-2	-3	-4	-6
20	**14**	-9	-12	-12	-15	-14	-17
21	**13**	**4**	**3**	**4**	**0**	**1**	**3**

5. IMPACT DU SIROCCO SUR L'ACTIVITÉ ÉCONOMIQUE ET SUR LA SANTE

La baisse de visibilité qui accompagne généralement les vents de sable (Nouaceur, 2004), est à l'origine d'importantes perturbations de la navigation aérienne. A Nouakchott, en Mauritanie, une moyenne de plus de 200 jours avec visibilité réduite par les poussières et les sables, est comptabilisée chaque année. Inutile de préciser que les perturbations aériennes sont bien plus qu'occasionnelles sur l'aéroport de la capitale mauritanienne. Lors de la tempête de sable du 21 février 2004, la compagnie Air Algérie a dû subir une situation aérienne exceptionnelle. Plusieurs vols nationaux et internationaux ont été annulés ou détournés sur d'autres aéroports où la visibilité était meilleure. Le coût économique de telles perturbations est considérable pour les compagnies aériennes qui doivent chaque fois prendre en charge tous les frais occasionnés par de telles défaillances. Au niveau de la circulation routière, la baisse de la visibilité a occasionné de nombreux accidents de la route. Sur tout le territoire algérien, les journées du 20 et du 21 février 2004 ont été caractérisées par une augmentation importante des d'accidents de la route (El Moudjahid, 21 et 22 février 2004). Lorsque la vitesse des vents augmente, leur capacité de transport et d'érosion est renforcée. Ceci accentue l'ensablement des grands axes routiers sahariens. Les longs tronçons algériens qui relient Adrar à Bordj Baji Mokthar et In Salah à Tamanrasset, sont régulièrement coupés par des dunes de sable. On constate le même phénomène en Mauritanie sur la Route de l'Espoir (reliant Nouakchott à Boutilimit). Si les signes de l'ensablement sont parfaitement visibles dans le paysage naturel, l'augmentation des poussières éoliennes dans l'atmosphère est difficilement quantifiable. L'appréciation d'une telle charge véhiculée par les vents depuis le centre du Sahara est donnée par l'importance de l'augmentation des observations des brumes de poussière au Sahel (Nouaceur 1999, Ozer 2000). Cette masse de particules qui sédimentent très lentement sur les régions concernées par ce type de phénomène est à l'origine de nombreuses maladies (affections de la sphère ORL) qui affectent les populations locales. Le centre hospitalier universitaire d'Alger a enreG.I.Stré durant cet épisode de Sirocco, l'admission en urgence de plus de 500 malades asthmatiques (El Moudjahid, 2004). Au service des urgences médicales de la wilaya d'Oran, on a noté plus de 200 admissions relevant de la même pathologie. Dans le même temps, à Tiaret, on a compté l'admission à l'hôpital de 25 personnes souffrant de difficultés respiratoires. Ces chiffres, même s'ils ne sont pas importants par rapport à l'ensemble de la population urbaine, montrent cependant les effets extrêmement néfastes sur la santé du type temps lourd, chaud et poussiéreux qui accompagne généralement les vents « Sirocco ».

6. CONCLUSION

La situation météorologique qui a été observée du 19 au 22 février 2004 est à rattacher à une descente d'air froid en altitude, véhiculée par un thalweg. Cette configuration a favorisé l'accélération des flux et la mise en place de vents de sable de secteur sud sur une grande partie du territoire algérien.

L'une des singularités des vents Sirocco est sans aucun doute le changement de temps occasionné par l'arrivée des masses d'air chaud et sec qu'il véhicule depuis le Sahara, vers les plaines littorales. Sur ces dernières régions, une hausse remarquable des températures et une sécheresse accrue des masses d'air sont notées en relation avec la descente provoquée par le relief.

Dans son sillage, ce vent transporte aussi une quantité non négligeable de particules terrigènes qui réduisent la visibilité. Lors de la journée du 21 février, une grande partie du territoire algérien a connu une réduction de visibilité très sévère. Lorsque l'accélération des flux est suffisante, les poussières éoliennes sont expulsées de l'Afrique du Nord vers des régions aussi lointaines que le nord de l'Europe. Le Sahara est d'ailleurs considéré comme la source la plus importante d'aérosols terrigènes à l'échelle mondiale (Javier & al 2002).

Sur le plan économique, les vents Sirocco aG.I.Ssent par la réduction de la visibilité qu'ils occasionnent sur les liaisons routières et aériennes dans toutes les régions concernées par ce type de manifestations. Sur le plan de la santé humaine, nul doute que la pollution terrigène qui accompagne ce type de manifestation entraîne de nombreuses pathologies dermatologiques, respiratoires et oculaires. La recherche dans ce dernier axe reste cependant difficile à faire. Il faut en effet isoler l'action réelle de la poussière éolienne sur la santé humaine, des autres causes liées aux comportements et habitudes des populations locales (tabaG.I.Sme, hygiène, habitudes vestimentaires, etc.). Cette problématique rejoint d'ailleurs d'une manière tout à fait similaire les questionnements des chercheurs dans le domaine de la pollution atmosphérique.

BIBLIOGRAPHIE

Airmarais., 2004, *Résultats annuels de 2004*, 7 p.

Coudé – Gaussen G., Rognon P., Le Coustumer M., 1994, *"Incorporation progressive de poussières sahariennes aux limons des îles orientales du Cap Vert ", Compte Rendu de l'Académie des Sciences de Paris*, T 319, II, pp 1343 - 1349.

Dhonneur G., 1978 : *Traité de météorologie tropicale.* Direction de la Météorologie Nationale, 151 p.

Dragana D., Zorka V., Ivana T., Miroslava U., 2004, "Contribution of dust transport and resuspension to particulate matter in the mediterranean atmosphere", *Atmospheric Environment*, 38, pp 3637 – 3645.

El Moudjahid, 2004, quotidien national algérien, 20, 21 et 22 février 2004.

Franzen L. G., Hjelmroos M., Kallberg P., Rapp A., Mattson J. O., Brorstrom-Lunden E., 1995, *"The Saharan dust episode of south and central Europe, and northen Scandinavia", Weather*, n ° 50, pp 313 – 318.

Javier P M., Octavio L., Leire M., Ma J., Andrès C., 2002, *"Saharan dust storm over the Canary Island during winter 1998 as depicted from advanced very high – resolution radiometer", Deep Sea Research II*, No 49, pp 3465 – 3479.

Moulin C., Lambert C., Dulac F., 1997, "*Control of atmospheric export of dust from north Africa by the North atlantic Oscillation", Nature*, No 387, pp 691-694.

Nouaceur Z., 1999, "*Évolution récente des lithométéores en Mauritanie*" Thèse de doctorat, Université Jean Moulin Lyon III, 503 p.

Nouaceur Z., 2004, "Brume *sèche, Brume de poussière, chasse – sable et tempête de sable : des types de temps spécifiques des régions sèches "*, Norois, n ° 191, pp 121 – 128.

Ozer P., 2000, *Les lithométéores en région sahélienne : un indicateur climatique de la désertification.* Thèse de doctorat en Sciences Géographiques, Université de Liège, 312 p.

Shinn E. A., Smith G. W., Prospero J. M., Betzer P., Hayes M. L., Garrison V., Barber R. T., 2000, *"African dust and demise of Caribbean coral reefs", Geophysical Research Letters*, No 27, pp 3029 – 3032.

Stegmann P. M., Tindale N. W., 1999,*Global distribution of aerosols over the open ocean as derived from the coastal zone color scanner,Global Biogeochemical Cycles*, No 13 (2), pp 383-397.

Taichu Y. T., Masaru Ch., 2006, *"A numerical study of the contributions of dust source regions to the global dust budge"*, Global and Planetary Change, Volume 52, Issues 1-4, July, pp 88-104.

World Meteorological Organization., 1996 "Guide to meteorological instruments and methods of observation", N° 8, Geneva.

Sites Internet

http://www.wetterzentrale.de

http://www .weather.uwyo

SELECTION OF THE DETERMINATES TRUSSU RIVER WATER QUALITY FACTORS USING MULTIVARIABLE ANALYSIS

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Ivam Holanda de Souza[4]

ABSTRACT
Principal component analysis (PCA) was applied to evaluate and interpret a large water quality data set and apportionment of pollution sources factors with a view to get better information about water quality of the Trussu River valley. The investigation was carried out in the part of the valley where several farms with livestock activities and some villages are located. Water quality parameters were sampled from September/2002 to March/2004 at nine stations located along 24 km of the Trussu River for thirteen physical-chemical (2,223 observations). The PCA application resulted in three significant components, explaining 73.78% of the total variance of the data set. The first one, PC_1 (accounting for 48.36% of the variance) was mainly associated with sodium, Electric Conductivity, chloride, magnesium, sulphate and hydrogen-carbonate. It, basically, reflects ionic group of salts (mineralization processes). PC_2 (15.91% of the variance), was dominated by organic contaminations in water (NO_3-N and NH_4-N), suggesting anthropic activities. PC_3 was mainly contributed by pH e PO_4 and than, may be related to the effects caused in the water by non-point sources pollutants, such as agricultural runoff. This study suggests that PCA technique is a useful tool for identification of important surface water quality monitoring parameters.
Key Words: *Water quality. Data reduction. Multivariate analysis*

*

1. INTRODUCTION

World population growth, increased water use by the world population associated with improvements in life quality and absence of policies for a more conservative use associated with the increased man made contamination of water resources has decreased water availability (VEGA et al., 1998). Water plays a vital role in determining life quality of humankind and other living creatures.

In the last decades there has been innumerous studies on agriculture and its role as a nonpoint source pollutant, in water contamination in many countries (LAKE et al., 2003; ELMI et al., 2004). The large number of variables involved in the characterization of the quality of water bodies has prompted to the application of multivariate statistical methods of analysis such as principal components analysis (PCA).

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This technique has been applied to investigate a variety of hydrological, meteorological and chemical processes (HELENA et al., 2000; GANGOPADHYAY et al., 2001; TOLEDO; NICOLELLA, 2002; MENDIGUCHÍA et al., 2004).

PCA main goal is to apply linear techniques to transform a large set of variables into an uncorrelated smaller one containing most of the information stored in the original set (HOTTELING, 1933). Applications of PCA in water quality studies have been reported by several authors, such as Simeonov et al. (2003); Brodnjak-Voncina et al. (2002); Bordalo et al. (2001). The main goal of this paper is to apply PCA to identify the most important variables describing the quality of water at the Trussu River, an originally intermittent stream now regularized by the Trussu dam in Iguatu County, Ceará State, Brazil.

2. MATERIALS AND METHODS

The Trussu River is a tributary of the Jaguaribe River system in Ceará State, Brazil. It originates at an altitude of 580 m and flows eastwards for approximately 42 km before discharging into Jaguaribe River. Weather is identified by hot dry summer days and warm winter nights and classified according to Köopen as type BSh'w'. The average maximum daily temperature in October is around 34 ºC while the colder nights of July can reach 20 ºC. Rainfall distribution is unimodal and strongly concentrated in the autumn months (March to May). As a general rule, more than 80 percent of the annual rain falls during this period. Average annual rainfall is 750 mm year^{-1}. The annual potential evapotranspiration is 2,940 mm, which is about four times the average annual rainfall. In average, there are 2,945 hours of sunshine during a year.

The investigated river run is located approximately between the parallels 6°20'59" S and 6°16'48" S, and meridians 39°27' W and 39°16' W (Figure 1), with mean elevation of 300 m over the sea level. It runs 25 km from the Trussu dam to the mouth of Trussu River. Some small villages are located in the studied area.

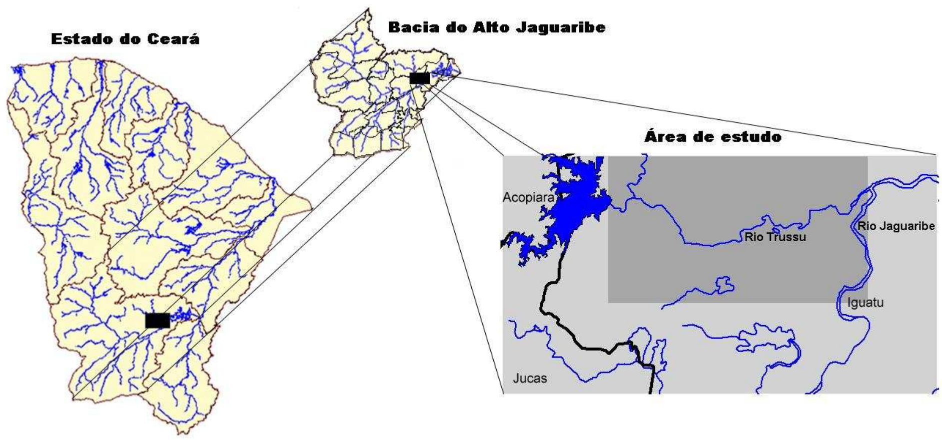

Fig.1 *Location of studied area*

Nine points spread out over the studied area were selected as monitoring stations. They were designated as: EA1, EA2, EA3, EA4, EA5, EA6, EA7, EA8, and EA9. Stations EA1, EA2, EA5, EA6, EA7 were distributed along the river course to monitor surface water, while stations EA3, EA4, EA8, and EA9 are shallow wells designed to monitor ground water (Figure 2). Station EA1 has never received any municipal or agricultural wastewater, and the water quality in this station reflects pollution from overland flow. AE2 (Pedreira farm) receives water from agricultural fields; while AE5 (Santa Clara village) and AE6 (Varjota village) receive water from urban areas. Water quality in station EA7 (Barreira dos Pinheiros village) reflects the effect of contaminants upstream from it. AE3 (Pedreira farm) and AE4 (Varzea da Lama) receives water from agricultural sites; while AE8 (Suassurana village) and AE9 (Varjota village) receive water from human settlements.

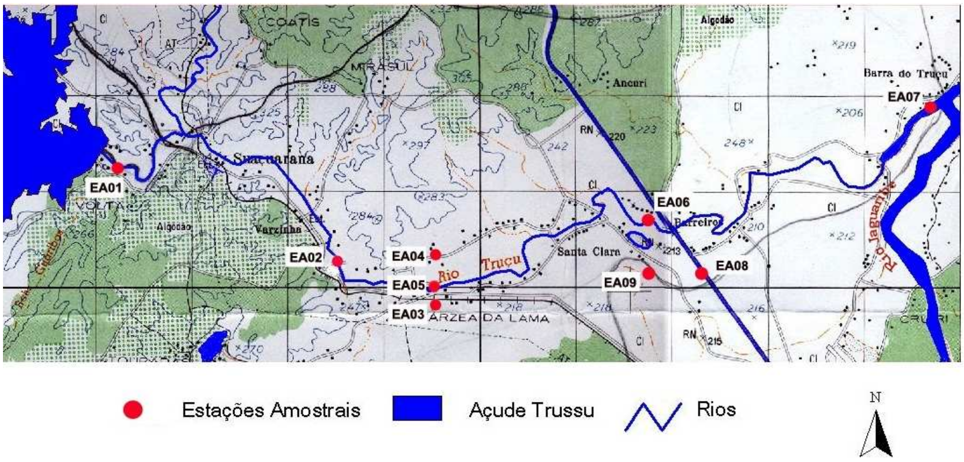

Fig. 2 ***Location of sampling sites***

Samples were collected monthly from September/2002 to March/2004 for thirteen physical-chemical parameters (2,223 observations). Samples were stored in polyethylene bottles provided with an hermetic-locking cap, and immediately transported to the laboratory and stored at 4 ºC before being analyzed to determine water quality variables. Units and methods of analysis of these variables are presented in Table 1.

Multivariate statistical methods, such as Factor Analysis/Principal Component Analysis (FA/PCA) allow the identification of important components or factors that explain most of the variance of a system. In this study, factors were estimated from principal component methods. The number of factors, called principal component (PCs), were defined according to the criterion that only factors that account for variances greater than 1 (eigenvalue-one criterion) should be included. The rationale for this criterion is that any component should account for more variance than any single variable in the standardized test score space. The dataset was standardized through z-scale transformation in order to avoid misclassification due to wide differences in data dimensionality. Standardization reduces the influence of variables variance and eliminates the effect of different units of measurement.

Water quality variables measured during 2002-2004 in Trussu valley, Brazil

Table 1

Variable	Abbreviation	Unit	Analytical method
Ammonical nitrogen	NH_4–N	mg L^{-1}	Spectrophotometric
Calcium	Ca	$mmol_c$ L^{-1}	Flame AAS
Chloride	Cl	$mmol_c$ L^{-1}	Spectrophotometric
Electrical Conductivity	EC	dS m^{-1}	Electrometric
Hydrogen-carbonate	HCO_3	$mmol_c$ L^{-1}	**Richard (1954)**
Magnesium	Mg	$mmol_c$ L^{-1}	Flame AAS
Nitrate nitrogen	NO_3–N	mg L^{-1}	Spectrophotometric
pH	pH	dimensionless	pH-meter
Phosphate	PO_4	$mmol_c$ L^{-1}	Spectrophotometric
Potassium	K	$mmol_c$ L^{-1}	Flame photometer
Sodium adsorption ratio	SAR	dimensionless	Richard (1954)
Sodium	Na	$mmol_c$ L^{-1}	Flame photometer
Sulphate	SO_4	$mmol_c$ L^{-1}	Spectrophotometric

After the correlation matrix definition, the appropriateness of the factor model was evaluated. A measure of sampling adequacy was computed using the Kayser Mayer Olkim (KMO) index, which compares the magnitude of the observed correlation coefficients to the magnitude of the partial correlation coefficients. If variables share common factors, partial correlation coefficients between pairs of variables should be small when the linear effects of the other variables are eliminated. Factor analysis model is acceptable when KMO > 0.5 (Monteiro and Pinheiro, 2004).

Although the factor matrix obtained in the extraction phase indicates the relationship between the factors and the individual variables, it is usually difficult to identify meaningful factors based on this matrix. Interpretation of the matrix may be easier using the rotation procedure. Rotation does not affect goodness of fit of a factor solution. That is, although the factor matrix changes, the communalities and the percentage of total variance explained, does not change. The rotation process in factor analysis allows flexibility by presenting a multiplicity of views of the same data set (Dillon and Goldstein, 1984).

3. RESULTS AND DISCUTIONS

The Pearson correlation matrix for the complete set of variables analyzed (Table 2) shows the most auto-correlated variables are: EC, Ca, Mg, Na, K, HCO_3, Cl, SO_4, SAR, with correlation coefficients (r) larger than 0.5. Several authors dispute the threshold for r. Silveira and Andrade (2003) are less conservative as they adopted a value of 0.3, while Helena et al. (2000) adopted a value of 0.5.

The high correlation found between calcium (Ca), magnesium (Mg), hydrogen-carbonate (HCO_3) and sulphate (SO_4) can be explained by the presence of limestone sediments associated with the geology of the catchment. On the other hand, the correlation between chloride (Cl) and sodium (Na) cannot be attributed to soil origin, since these minerals are not found in the local geology (COTEC, 1989). It is believed that higher concentration of these elements is due to anthropic influences, such as irrigation and sewage conveyed from urban areas. The strong correlation between electrical conductivity

(EC), chloride (Cl), sodium (Na), magnesium (Mg) and sulphate (SO_4) was previously expected because the electrical conductivity expresses salt concentration in water.

Pearson Correlation Matrix for water quality variables for Trussu Rive

Table 2

Variable	pH	EC	Ca	Mg	Na	K	HCO_3	PO_4	Cl	NH_4	NO_3	SO_4	SAR
pH	1.000												
EC	0.069	1.000											
Ca	-0.091	0.710	1.000										
Mg	0.017	0.850	0.647	1.000									
Na	0.099	0.960	0.670	0.814	1.000								
K	0.100	0.562	0.370	0.449	0.543	1.000							
HCO_3	-0.088	0.725	0.595	0.536	0.772	-0.476	1.000						
PO_4	0.257	0.006	0.080	-0.014	0.080	-0.051	0.048	1.000					
Cl	0.097	0.971	0.687	0.888	0.935	-0.511	0.637	0.032	1.000				
NH_4	0.119	-0.025	-0.265	-0.077	-0.016	0.046	0.030	-0.024	0.001	1.000			
NO_3	0.165	-0.024	-0.291	-0.081	-0.013	0.048	-0.002	0.083	0.002	0.877	1.000		
SO_4	0.070	0.841	0.496	0.735	0.816	-0.508	0.641	0.087	0.846	0.029	0.075	1.000	
SAR	0.117	0.932	0.603	0.720	0.982	-0.562	0.797	0.096	0.885	0.010	0.012	0.790	1.000

Total variance (eigenvalue) explained by each factor

Table 3

Component	Eigenvalue	Percentage of variance (%)	Cumulative percentage (%)
1	6,287	48,36	48,360
2	2,068	15,91	64,271
3	1,237	9,51	73,785
4	0,871	6,70	80,489
5	0,641	4,93	85,417
6	0,609	4,69	90,103
7	0,420	3,23	93,334
8	0,246	1,90	95,230
9	0,180	1,39	96,617
10	0,151	1,17	97,782
11	0,136	1,05	98,828
12	0,104	0,80	99,630
13	0,048	0,37	100,000

Eigenvalues for the set of variables are presented on Table 3. One can conclude that PC_1, PC_2 and $PC_{3,}$ with values of eigenvalues large than one, explain most of the variance of the data set. They explain, respectively, 48.36, 15.91 and 9.51% of the total variance of the data, i.e., three dimensions concentrate 73.78% of the information that is contained in thirteen variables. The results are consistent with reports by Mendiguchía et al. (2004), when, in a study of a seven-parameter model for the river Guadalquivir in Spain, have found 79.1% of the total variance concentrated into the first two components.

The values of communalities of the variables presented on Table 4 suggest that the common factors (principal components) explain more than 61% of the variance, exception to potassium. Projections of the original variables on the subspace of the principal components are called loadings and coincide with the correlation between the factors and variables. Loads of PC1, PC2 and PC3 are presented in Table 4. They can be used to identify variables that detain high correlation with each factor.

The first principal component is highly affected by sodium, EC, chloride, magnesium, sulphate and hydrogen-carbonate with loads higher than 0.8. It, basically, reflects ionic group of salts. The second component has strong positive loadings (> 0.92) on NO_3-N and NH_4-N and low positive loadings on Na, EC, Cl, Mg, HCO_3, K and SO_4. It represents the nutrients group of pollutants which points to some source of wastewater and runoff. The third one is mainly contributed by pH and PO_4 and therefore, may be related to agriculture activities.

One can also observe that the variables explained by the first and the second component present values of communalities above 0.9, while the variables explained by the third component presented communalities above 0.61, that is 61% of the variance of the variables PO_4 4 and pH is explained by the three first components of the model. This suggests the model applied is a better indicator of salt and organic naturally available contents than agricultural fertilizers effects on water quality.

Communalities and factor loadings for PC_1, PC_2 and PC_3

Table 4

Variable	Communalitie	Factor loading (λ)		
		1	2	3
Na	0,941	0,968	0,047	0,039
EC	0,877	0,936	0,008	-0,017
Cl	0,817	0,901	0,073	0,001
SO_4	0,763	0,865	0,123	0,011
Mg	0,732	0,852	-0,074	-0,040
HCO_3	0,668	0,808	0,037	-0,116
SAR	0,648	0,781	0,184	0,061
Ca	0,663	0,740	-0,339	0,033
K	0,398	-0,615	0,051	0,132
NO_3-N	0,917	-0,043	0,945	-0,148
NH_4-N	0,917	-0,042	0,922	-0,255
PO_4	0,618	0,077	0,149	0,768
pH	0,644	0,040	0,349	0,721

Varimax rotated factors for the first three principal components

Table 5

Variables	Communalitie	Factor loading (λ)		
		1	2	3
Na	0,941	0,965	-0,009	0,096
EC	0,877	0,936	-0,030	0,030
Cl	0,817	0,901	0,030	0,063
SO_4	0,763	0,866	0,077	0,085
Mg	0,732	0,850	-0,099	-0,017
HCO_3	0,668	0,815	0,029	-0,064
SAR	0,648	0,782	0,126	0,145
Ca	0,663	0,726	-0,369	-0,021
K	0,398	-0,614	0,042	0,112
NO_3-N	0,917	0,002	0,957	-0,007
NH_4-N	0,917	-0,005	0,952	0,103
PH	0,644	0,009	0,148	0,789
PO_4	0,618	0,036	-0,059	0,783

Dillon e Goldstein (1984) showed that, although the load factor matrix obtained in the extraction phase indicates the relationship between each variable, orthogonal rotation of the factors could produce more meaningful interpretations. This produces a set of orthogonal factors, which are independent and uncorrelated. In a study of multivariate structure of evapotranspiration, Andrade et al. (2003) applied the varimax rotation algorithms and obtained a matrix that was easier to interpret. However, as demonstrated on Table 5, this procedure resulted in little improvements for the water quality model of Trussu River for the first three components is still correlated with the same variables as before the varimax was applied.

4. CONCLUSIONS

The results of the present study point to the existence of three main independent types of contaminants determining water quality of the Trussu valley. PCA loadings indicate that variables responsible for water quality variations are mainly related to salts/mineralization processes (soil erosion/leaching followed by overland flow process), organic pollution (representing influences from municipal effluents) and nutrient variables (representing influences from non-point sources such as agricultural runoff) Orthogonal rotation on the component axis resulted in no aid in determining other meaningful variables related to water quality in Trussu valley.

Acknowledgement. The authors gratefully acknowledge the financial support by Comissão de Aperfeiçoamento dos Professores de Ensino Superior - CAPES and the Fundação Cearense de Apoio a Pesquisa – FUNCAP.

REFERENCES

Andrade, E. M.; Silveira, S. S., Azevedo B. M., (2003), *Investigação da estrutura multivariada da evapotranspiração na região centro sul do Ceará pela análise de componentes principais*. Revista Brasileira de Recursos Hídricos**,** v. 08, n. 01, p. 39-44.

Bordalo, A. A., Nilsumrachit, W.; Chalermwat, K., (2001), *Water quality and uses of the Bangpalong river (Eastern Thailand)*. Water Research, v. 35, n. 15, p. 3635–3642.

Brodnjak-Vocina, et al., (2002), *Chemometrics characterization of the quality of river water*. Analytica Chimica Acta, v. 462, p. 87–100.

Cotec - Consultoria Técnica Ltda. Barragem Trussu -*Estudo e avaliação dos impactos ambientais*. Tomo I:diagnóstico ambiental, Fortaleza, PRONI-DNOCS. 1989. 118p.

Dillon, W. R.; Goldstein, M., (1984), *Multivariate analysis methods and applications*. New York, John Wiley e Sons. 587p.

Elmi, A. A. et al. , (2004), *Water and fertilizer nitrogen management to minimize nitrate pollution from a cropped soil in southwestern Quebec*, Canada. Water, Air, and Soil Pollution. v. 151, p. 117-134.

Gangopadhyay, S.; Gupta, A.; Nachabe, M. H., (2001), *Evaluation of ground water monitoring network by principal component analysis*. Ground Water, v. 39, n. 2, p. 181-191.

Helena, B. et al. , (2000), *Temporal evolution of groundwater composition in an alluvial aquifer (Pisuerga river, Spain) by principal component analysis*. Water Research v. 34, n. 03, p. 807-816.

Hotteling, H. , (1933), *Analysis of a complex of statistical variables into principal components*. Journal Education Psychology, v. 24, p. 498-520.

Lake, I.R. et al., (2003), *Evaluating factors influencing groundwater vulnerability to nitrate pollution: developing of G.I.S*. Journal of Environmental Management, v. 68, p. 315-328.

Mendiguchia, C. et al., (2004), *Using chemometric tools to assess anthropogenic effects in river water a case study: Guadalquivir river (Spain)*. Analytic Chemical Acta, v. 515, p. 143–149.

Monteiro, V. P.; Pinheiro, J. C. V. , (2004), *Critério para Implantação de Tecnologias de Suprimentos de Água Potável em Municípios Cearenses Afetados pelo Alto Teor de Sal*. Revista de Economia Rural**,** v. 42, n. 02, p. 365-387.

Silveira, S. S; Andrade, E. M., (2002), *Análise de componentes principais na investigação da estrutura multivariada da evapotranspiração*. Engenharia Agrícola, v. 22, n. 02, p. 171-177.

Simeonov, V. et al., (2003), Assessement of the surface water quality in northen Greece. Water Research, v. 37, p. 4119-4124.

Toledo, L. G.; Nicolella, G., (2002), *Índice de qualidade de água em microbacia sob uso agrícola e urbano*. Scientia Agrícola, v. 59, n. 01, p. 181-186.

Vega, M. et al., (1998), *Assessment of seasonal and polluting effects on the quality of river water by exploratory data analysis*. Water Research, v. 32, n.12, p. 3581-3592.

ABOUT THE PROBLEM OF DIGITAL PRECIPITATIONS MAPPING USING (GEO)STATISTICAL METHODS IN GIS

C.V. Patriche[1], L. Sfîcă[2], B. Roşca[3]

ABSTRACT

Our study reveals some problems related to the digital mapping of mean annual precipitations using (geo)statistical methods in GIS environment. The applications are carried out for a 4950 km^2 region situated in Vrancea County, using a sample of 34 rain gauges. We first address the data uncertainty issue looking for georeference errors and data errors. As a result we chose to eliminate 2 rain gauges from our analysis significantly evading the general spatial precipitations pattern probably due to the shorter data recording intervals. We show how easily such outliers can mislead us by inducing a false precipitations – latitude correlation. We then proceed by deriving mean annual precipitation spatial models using classical statistical approaches (ordinary kriging, cokriging) and a more elaborated approach (residual kriging). Comparison of the results proves the superiority of the latter. Still, the uncertainty of the output has to be considered, especially when it comes to the extrapolation of the residual kriging model outside the calibration area.

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1. INTRODUCTION

The atmospheric precipitations constitute a very important climatic element, being the input data for many models of different nature, such as (agro)climatic, hydrological, biological, soil models etc. From all climatic parameters, the precipitations are probably the most difficult to model, due to their main dependency on air masses dynamics. As in the case of other climatic parameters, the space and time scales influence greatly the choice of the spatialisation method, the accuracy of the output etc. (*Patriche C.V.*, 2007). The most difficult to model are the momentarily values (e.g. single rainfall event, daily precipitations) as they do not show an important dependency on the topographic or other quantifiable terrain characteristics. At such scales, simple local interpolators like ordinary kriging, cokriging, IDW, are sufficient for deriving fairly good spatial models. Mean values, such as mean monthly or annual values are generally more predictable. Still, we often find out that, except for the local altitude, other terrain characteristics do not explain much of the precipitations variance.

Many spatialisation methods can be applied for deriving spatial models of precipitations (*Patriche, C.V.*, 2005). A good synthesis about the use of statistical spatialisation methods for meteo-climatic variables is given by *Dobesch, H., Dumolard, P., Dyras, I.* (editors, 2007) and about the use of geostatistical (kriging) methods by *Hengl, T.* (2007). We mentioned already, local interpolators such as ordinary kriging, cokriging, IDW, which are more suitable for momentarily values. In addition, we may mention the

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universal kriging, which computes first a polynomial trend surface, and especially the widely used residual kriging, also known as detrended kriging or regression kriging. The last method uses a combination of regression and ordinary kriging to derive both terrain dependable (regional) precipitations characteristics and local precipitations characteristics.

2. STUDY REGION

Our study focuses on problems related to spatialisation of mean annual precipitation values at regional scale. The study region is situated mainly in Vrancea County and covers a surface of 4950 km^2, comprising a relief of plains, hills and mountains, with altitudes generally increasing westwards, from 4m to 1770m (fig. 1). We used precipitation data from a sample of 34 rain gauges and a Digital Elevation Model with a resolution of 30m.

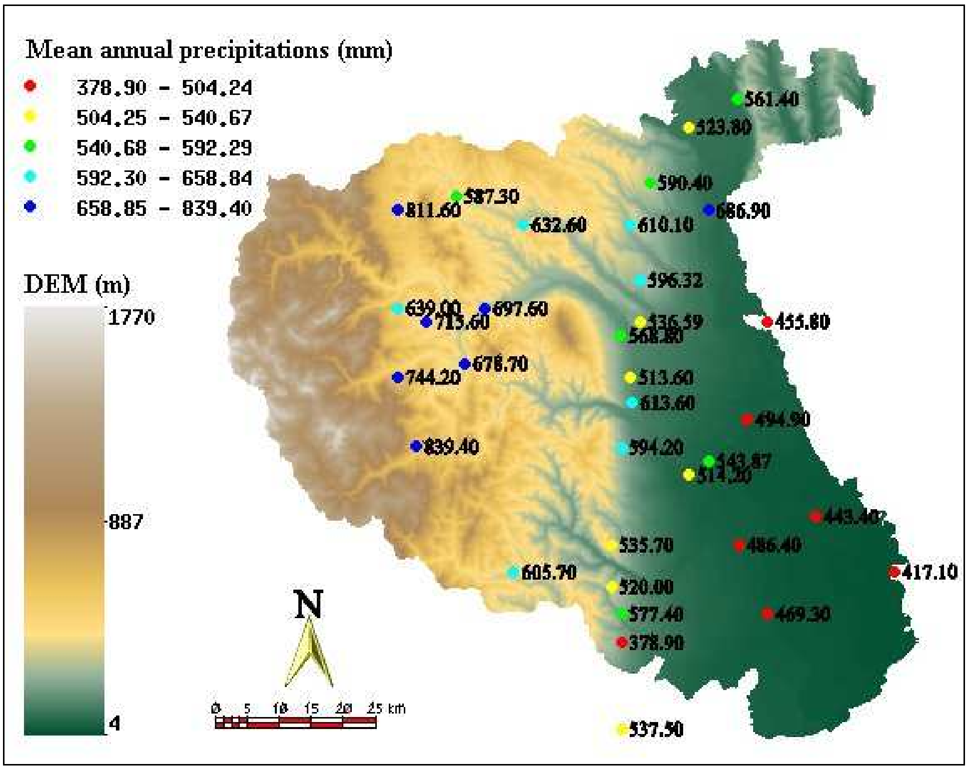


Fig. 1 ***Using the preliminary visualization of point precipitation data to search for possible outliers and precipitations spatial patterns***

3. INPUT DATA UNCERTAINTY ISSUES

Before starting our statistical analysis, a *visual inspection* of mapped rain gauge precipitation data may be useful for identifying possible outliers and precipitations spatial patterns. Figure 1 shows the mapped point precipitation data classified into intervals including an equal number of points. We may easily see the general pattern of precipitations increase from east to west caused by the increase of the altitude in the same direction. We may also notice the *bias* of the rain gauges network caused by its preferential location at lower altitudes, along the valleys and at the contact between plains and hills (piedmont area). The mountainous region, situated in the west, is practically uncovered by rain gauges, meaning that our models will have to be extrapolated here and we shall have to decide if the extrapolation is realistic or not.

The visual inspection of mapped rain gauge precipitation data also points out the presence of 2 possible outliers, Pufesti (686.9mm) and Slobozia Bradului (378.9mm). We shall refer to them later.

Let as first analyze another source of uncertainty, which is often overlooked: *the georeference errors*. Georeference errors refer to errors of the X, Y, Z coordinates. Misplacements of station / rain gauges points on the map may induce significant errors, especially in highly fragmented terrain, when predictors' values are extracted from raster layers or when local interpolators such as kriging are used for spatial modeling. The former will lead to wrong predictors' values and therefore inaccurate regression models, while the latter will generate locally displaced precipitation fields.

Correlation between the stations / rain gauges altitudes and the respective DEM altitudes may be used for identifying possible georeference errors or errors in recording the stations / rain gauges altitudes (fig. 2). The correlation should be very good, although not perfect for several reasons: the DEM generalizes the altitude information according to its resolution; the stations / rain gauges latitude and longitude values are generally given in degrees and minutes. Now supposing that the seconds are rounded up or down to the closest minute, it actually means that we may have a coordinate error of up to 30 seconds, meaning about 900m for latitude and 600m for longitude. These errors double if no coordinate rounding was performed and the seconds were just disregarded.

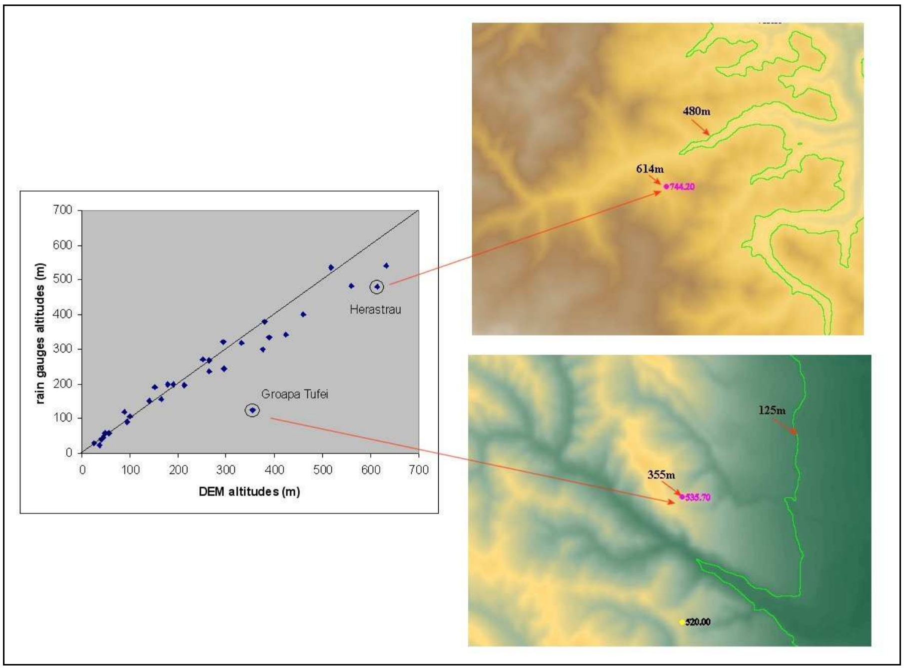


Fig. 2 ***Correlation between the rain gauges altitudes and the respective DEM altitudes as a method to identify possible georeference errors***

In our situation, we notice 2 points situated outside the correlation cloud indicating possible georeference errors: Groapa Tufei and Herastrau (fig. 2). The position error is very obvious for Groapa Tufei, in which case the recorded rain gauge altitude is 125m, while the DEM altitude for this particular location is 355m. We can see how far away is the 125m altitude isoline along which the rain gauge should be located. There are 2 possible explanations for this error: either the horizontal coordinates of Groapa Tufei are wrong, or the recorded altitude is incorrect. What is the potential negative impact of such a georeference error on spatial statistical models of precipitations? If the real altitude of Groapa Tufei is 125m, so the recorded altitude is correct, but the horizontal coordinates are wrong, then this point may be used for regression analysis, provided that the neither the DEM altitude values or other derived predictors' values are used for models computation. In a geostatistical approach (ordinary kriging, residual kriging etc.) it is not advisable to include such misplaced points because they will misplace, in their turn, the precipitation values. Still, if the value of a misplaced point is similar to those of the neighboring points, the error induced by the georeference error may be small enough and the respective point may be kept. This is also the case of our 2 georeference errors displayed in figure 2.

Let us refer now to the possible *data errors*. As we mentioned before, there are 2 points situated significantly outside the altitude – precipitations correlation cloud, namely Pufesti (686.9mm) and Slobozia Bradului (378.9mm), therefore indicating the presence of 2 possible outliers (fig. 3). In the case of Pufesti rain gauge, the mean annual precipitation regime is characterized by a secondary maximum in August. Taking into account that all other rain gauges display a single maximum in June, we are inclined to believe that either the August data is incorrect or the Pufesti data represent a shorter time frame, corresponding to a more humid period. On the other hand, the mean annual value recorded at Slobozia Bradului rain gauge is obviously too small for the climatic conditions of our region. Because the monthly values display a normal annual distribution, we are inclined to believe, as before, that the data correspond to a shorter time frame from a drier period.

But how do these points affect our spatial precipitation model? Is it necessary to remove them from analysis? Figure 3 shows the influence on the altitude regression model. We notice that even though these 2 points are associated with the highest residuals, the difference between the actual and the deleted residuals (jackknife error) is small (fig. 3c), meaning that their removal from analysis does not significantly change the altitude regression model. This is happening because the points are situated on opposite sides as compared to the regression line (fig. 3a) and therefore have opposite effects, balancing the regression line. Their removal increases the correlation coefficient but does not significantly change the direction of the regression line, meaning that the regression equations are very similar with or without these points. This can also be grasped if one notices that the altitude – precipitation correlation coefficient (0.66) is quite similar with the cross-validation correlation coefficient (0,62), meaning that the one by one removal of all sample points does not significantly change the altitude – precipitations relationship.

What about the effects on other predictors? We must mention that, apart from altitude, we also used latitude and longitude as predictors and at first we obtained a good regression model using both altitude and latitude. Looking further into details, we noticed that the latitude – precipitations correlation is a false correlation, induced by the presence of the 2 outliers (fig. 4), one with a higher precipitation value situated in the northern part of our region (Pufesti), the other one with a lower precipitation value situated in the South (Slobozia Bradului). If one eliminates these 2 points, the latitudinal correlation cannot be depicted any more.

For this reason and because of our intention of using also kriging for spatialisation, in which case the great residual values of the 2 suspect points would be represented on the map, we decided to eliminate them from analysis.

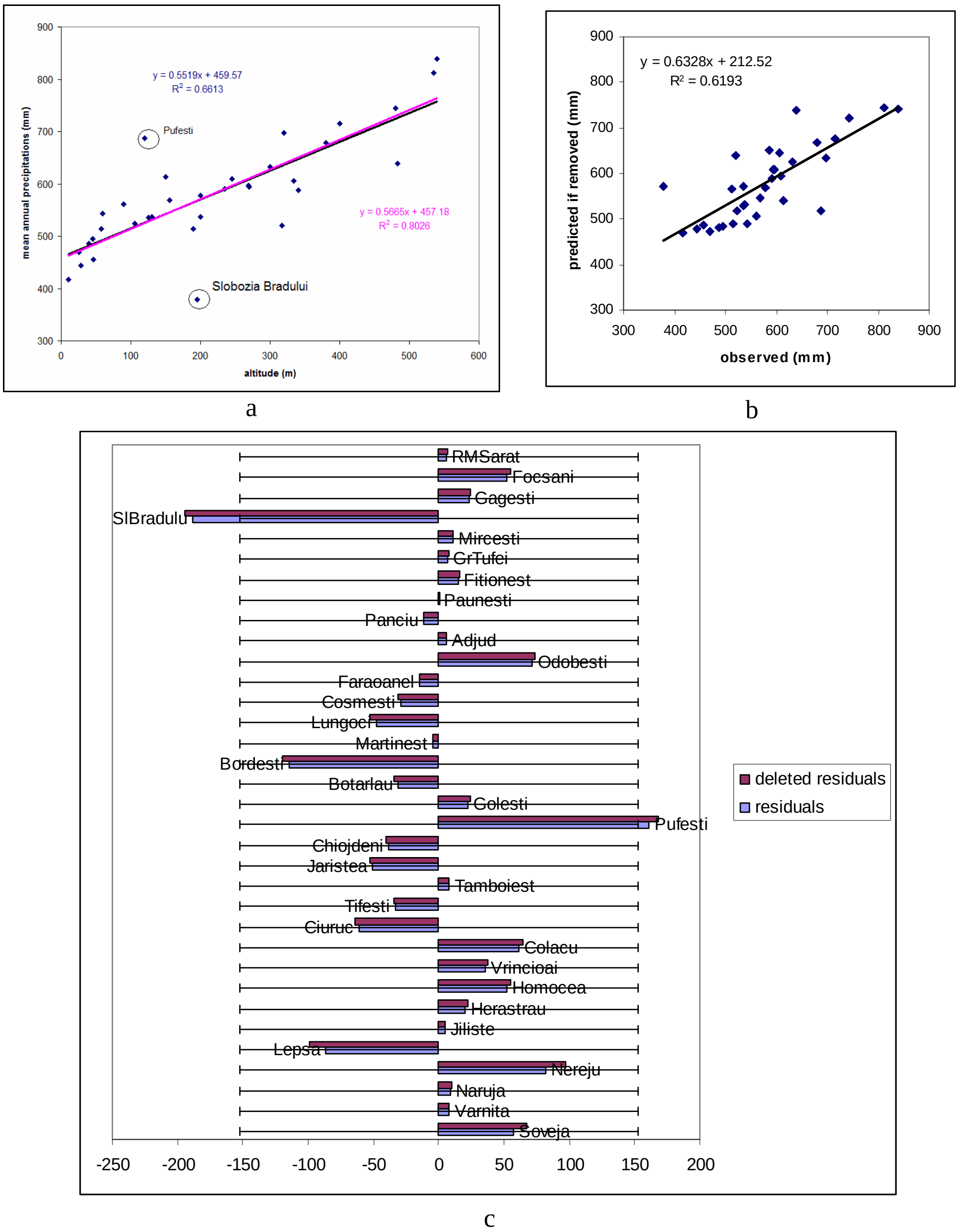


Fig. 3 ***The altitude – mean annual precipitations relationship (a) and comparison between actual and deleted residuals (c) showing the presence of 2 possible outliers; cross-validation of the altitude model using all stations (b)***

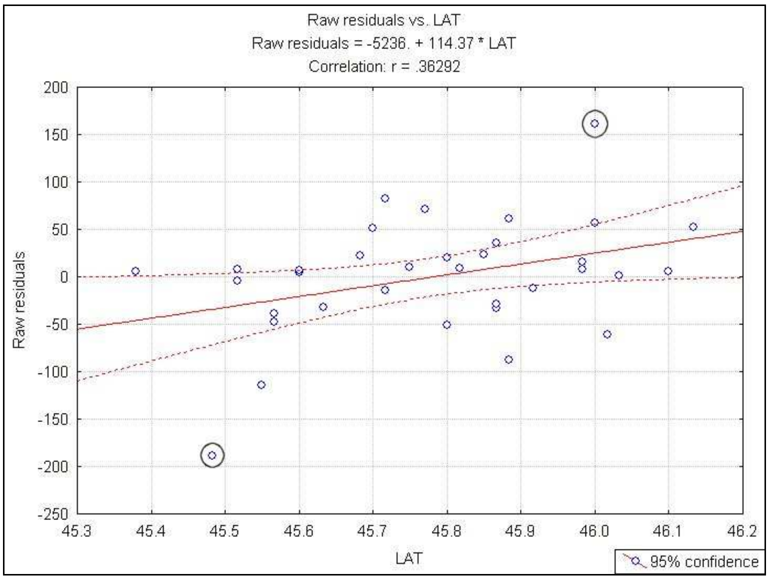


Fig. 4 ***An unwanted effect of outliers: the false correlation precipitations – latitude***

4. SPATIALISATION OF MEAN ANNUAL PRECIPITATIONS. RESIDUAL KRIGING VS. ORDINARY KRIGING (COKRIGING)

Resuming the data uncertainty issues, we recall that we found 2 important georeference errors corresponding to Groapa Tufei and Herastrau rain gauges, but we decided that we may still keep these points because their values are very similar to those of the neighboring points, so the errors induced by their presence are negligible. On the other hand, we found 2 suspect data points (Pufesti and Slobozia Bradului), showing values very different from those of the neighboring points, due either to data errors or, more likely, to shorter precipitation recording intervals. Because their presence may significantly affect a geostatistical model and because they induce a false latitudinal correlation, we have decided to eliminate them from our analysis.

The spatialisation of the mean annual precipitations was carried out by means of 3 different methods, namely ordinary kriging, cokriging and residual kriging, in order to compare their performances. Because the cokriging spatialisation, with altitude as co-variable, proved to be very similar to the ordinary kriging spatialisation, we shall not refer to it as it follows, because the conclusions regarding the ordinary kriging output apply also to the cokriging approach.

Figure 5 shows *the ordinary kriging* spatial model of mean annual precipitations. We may notice the smoothness of the precipitation field with values gradually increasing from east to west, following the general increase of the terrain altitude.

The *residual kriging* approach (fig. 6) combines regression and ordinary kriging methods to produce the final map. Regression analysis is used to link the predictand values to the terrain characteristics, while the ordinary kriging models the regression residuals. Finally, the two spatial models are added up to produce the final map.

In our case, we used the altitude regression model achieved after the elimination of the 2 suspect points referred to previously (fig. 7). The explained variance is 80% and the estimated mean annual precipitation vertical gradient is about 56mm/100m. The regression line of the correlation between the observed and the predicted values is very close to the main diagonal, along which it should be situated in an ideal situation.

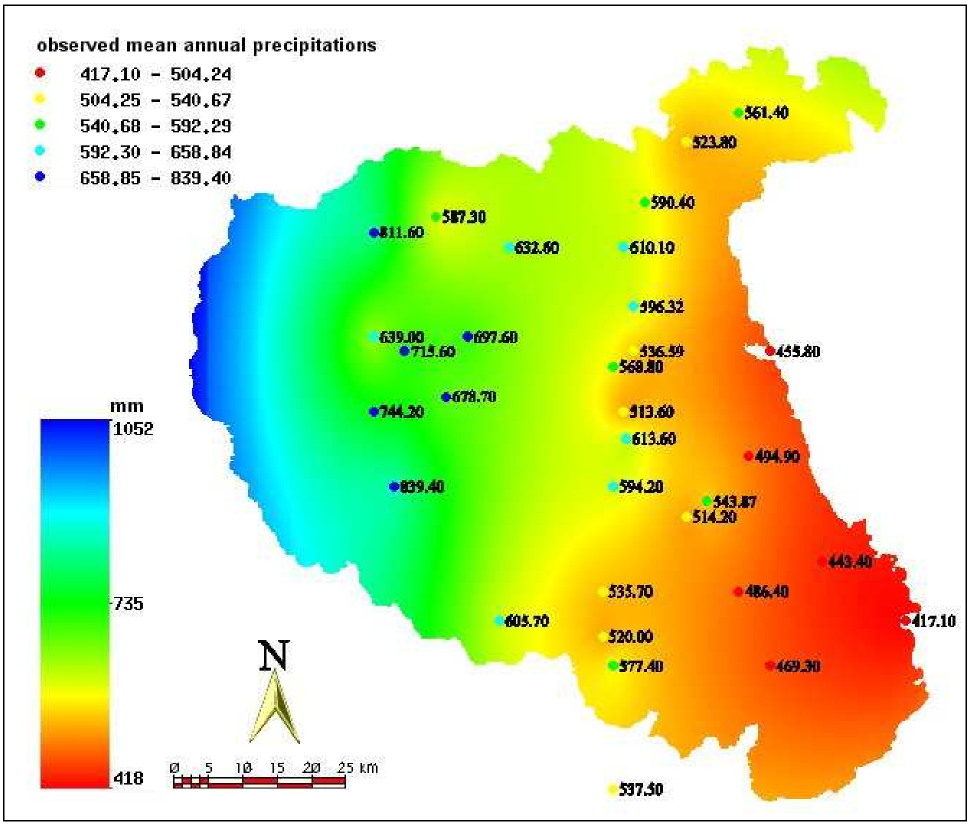


Fig. 5 ***Ordinary kriging of observed data***

One of the problems related to regression models is that of model's *extrapolation*. In our case, the westernmost part of the region is uncovered by rain gauges, meaning that we shall have to extrapolate our regression model there if we want to estimate the mean annual precipitation values for this part as well. Performing the extrapolation up to 1770m of altitude, we estimate precipitation values of up to 1463mm. Such estimated values are, in our opinion, unrealistic. If the extrapolation is unreliable, then we should confine ourselves with the calibration area of our model. Taking into account that the highest rain gauge altitude is 540m, we recommend the study region should not extend over 700m (fig. 6, bottom, the black line). Therefore the entire westernmost part of our region should be excluded the final map because of extrapolation uncertainty.

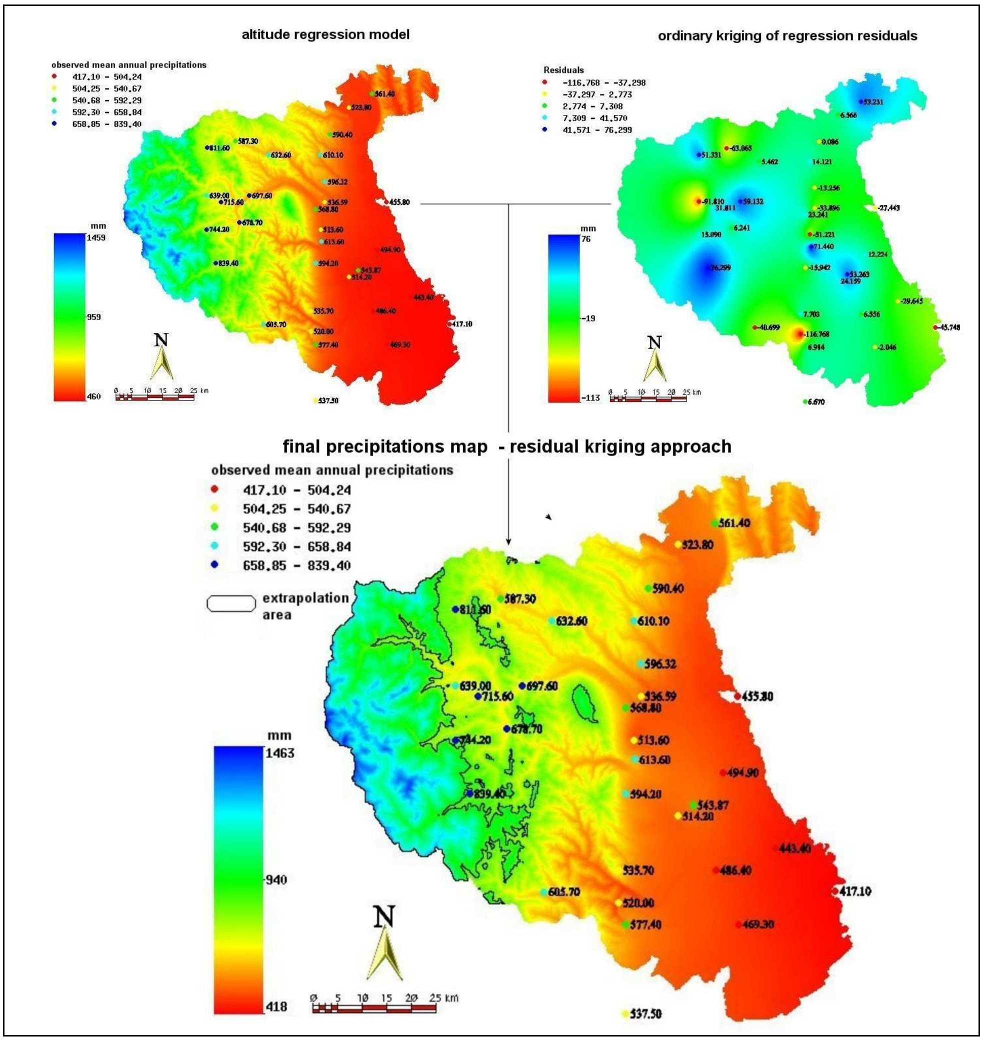
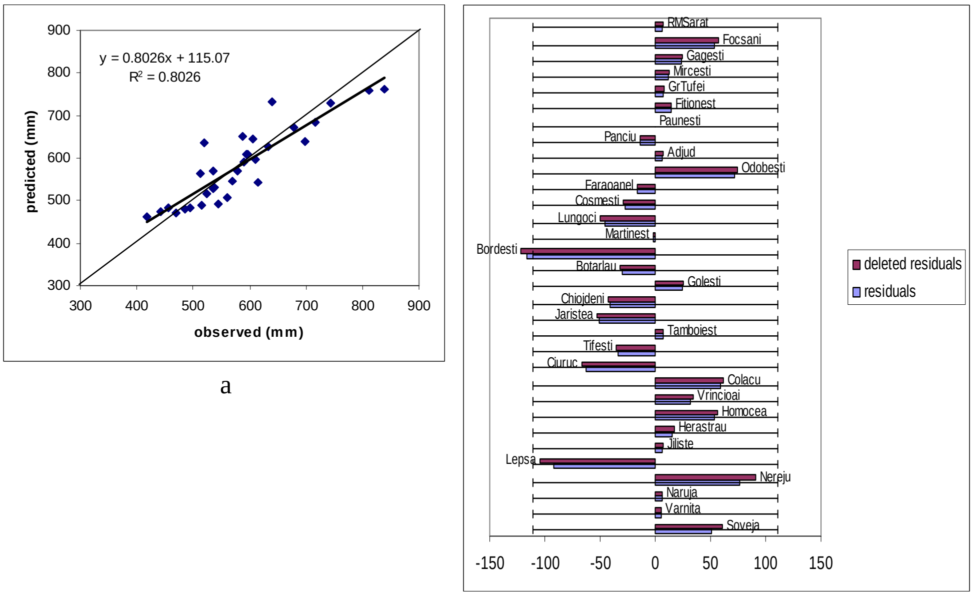


Fig.6 ***Residual kriging approach for mapping the mean annual precipitations***

We come now to the final question of our analysis: which of the 2 models, ordinary kriging or residual kriging) is better suited for the mean annual precipitations spatialisation in our region? To answer it, we compared the cross-validation of the ordinary kriging output with the cross-validation of the altitude regression model and the standard error parameters of the ordinary kriging and residual kriging (fig. 8). We notice that there is a significantly better observed vs. predicted correlation for the altitude regression cross-validation and that all the standard error parameters (mean, minimum, maximum, standard deviation) have smaller values in the residual kriging approach, therefore indicating the superiority of this method.



a

b

Fig. 7 ***Observed vs. predicted mean annual precipitations (a) and comparison between actual and deleted residuals (b) without the 2 outliers***

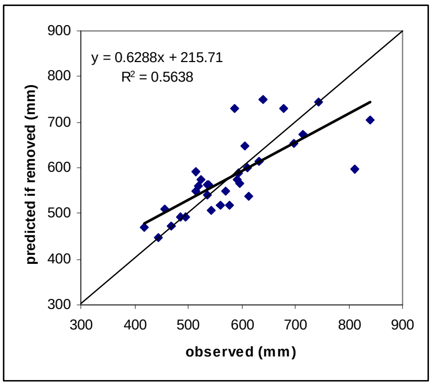
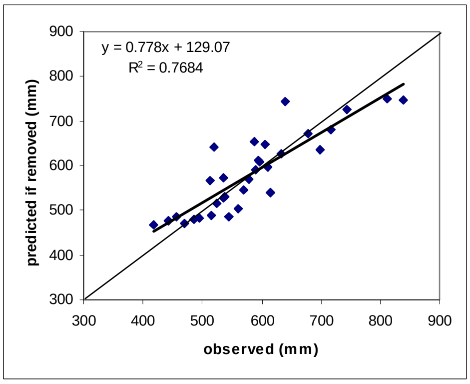
 cross-validation – ordinary kriging	 cross-validation – altitude regression
Standard error parameters of ordinary kriging of observed data - mean: 12.663 - min: 0.017 - max: 50.634 - standard deviation: 13.568 a	Standard error parameters of ordinary kriging of regression residuals - mean: 8.076 - min: 0.004 - max: 49.176 - standard deviation: 10.851 b

Fig. 8 ***Comparison between the performances of ordinary kriging (a) and residual kriging (b) for mapping mean annual precipitations***

5. CONCLUSIONS

When applying statistical methods for deriving digital spatial models of climatic variables one must take great care in identifying and assessing the sources of uncertainty. There are many such sources of different nature which can easily mislead us towards wrong unrealistic conclusions. Our article deals with the georeference errors and data errors / uncertainty, showing how such errors can affect the quality of our spatial models. The ordinary kriging or cokriging approaches are often used for deriving precipitation fields. However, our analysis shows that combining the regression and ordinary kriging in a residual kriging approach leads to better results, at least for mean annual precipitation values.

REFERENCES

Dobesch, H., Dumolard, P., Dyras, I., (editors, 2007), *Spatial Interpolation for Climate Data. The Use of GIS in Climatology and Meterology*, ISTE, 320 pp.

Hengl, T., (2007), *A Practical Guide to Geostatistical Mapping of Environmental Variables*. JRC Scientific and Technical Research series, Office for Official Publications of the European Comunities, Luxembourg, EUR 22904 EN, 143 pp.

Patriche, C.V., (2005), *Aportul metodelor statistice de interpolare la ameliorarea spaţializării parametrilor climatici*, Memoriile Secţiilor Ştiinţifice, seria IV, tom XXVIII, Edit. Academiei Române, p. 93-107.

Patriche, C.V. (2007), *About the influence of space scale on the spatialisation of meteo-climatic variables*, Geographia Technica, Nr. 1 / 2007, Cluj University Press.

THE SPATIAL DISTRIBUTION OF TOURISTIC RESOURCES IN THE SĂLAJ COUNTY

C. Pop[1]

ABSTRACT
Covering an area of 3,850 square kms, the county of Sălaj lies in the north-westwer side of Romania, as a passage between the Western and Oriental Carpathians. As it borders the counties of Satu mare and Maramureș in the North, the county of Bihor in the South-West and Cluj in the South and East. Geographically, the county of Sălaj stretches in an alternation of hills and valleys, alongside the rivers of Almaşu, Agrij, Someş, Sălaj, Crasna and Barcău. To the South-West, ethere are two Northern branches of the Apuseni Mountain Chain, namely Meseș and Plopiş. Vallwys are the dominant landscape on this territory and they represent important agricultural and urban areas. Evidence of the Dacian culture and civilization can be found all over the county. The most impressive trace is that of the stronghold built on the heights of Măgurea Șimleului, in Șimleu Silvaniei. Other notable traces of the Roman conquest in this Romanian region would be the Roman „castrum" of Buciumi, Romita (Certinae), Tihău, Sutoru (Optatiana) and Românaşi (Largiana). Besides several fortresses and monuments, the architectural heritage in this region is well represented by more than 70 wooden churches, dating since the 15-18th ceturies. Among the most representative spas in the region one can note those of Boghiş, which lay in the valley of Barcău river, 15 km away from Șimleu Silvaniei, appreciated for the miraculous therapeutic effects of its thermal waters (of 42 degrees Celsius), its sulphur, bicarbonate waters and famous for its exquisite landscape. Tourists can take advantage from the excellent mineral waters to be found in the resort of Bizuşa, laying in the valley of Someş, in the middle of a coniferous and leafy forest. Taking into account the need to ensure the existence of an efficient road network in the territory, the main economic and social developing issues in the nort-west of Romania and the main traffic flows in the region, plans are being analysed for the achievement of a highway placed on the axis Cluj-Zalău-Oradea-the Romanian-Hungarian border, and of an express road Zalău-Satu Mare-Halmeu.

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1. INTRODUCTION

Situated in the North-western part of Romania, at the juncture between the Oriental and Western Carpathians, Salaj County is known from ancient times as the Land of Silvania or the Land of the Forests. The county stretches over 3850 square metres and it is neighbouring the counties of Satu-Mare, Maramures in the North, Bihor in the West and South West, and Cluj in the South and South East. Salaj County is a region with hills and valleys along the rivers Almas, Agrij, Somes, Salaj, Crasna and Barcau. The valleys are the areas used for agriculture as well as for living. The Plopis and Meses mountains are situated in the South West being a continuation of the Western Carpathians. According to the last census, the population of the county was of 258.109 people, 70.842 of which were living in Zalau. The other towns have a population of around 20.000 people each. Of the total population, 72% are Romanians, 24% Hungarians, 3% Roma, 0,6% Slovaks, and 0,4% other nationalities. At the end of 2005 the active population of Salaj numbered 99.836 people. The number of employees at that time was 42.146 persons, and there were 6090

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unemployed people. The rate of unemployment rangers between 5,9 to 6%. The professions with the most unemployed are the unqualified workers, the mechanics, the carpenters, the merchandisers, lathe operators, teemers, electromechanic workers. The average wage at the end of 2005 was around 200 EURO per month, whereas the minimum wage for the entire economy is around 100 EURO. The town of Zalau, situated on the river with the same name, in the centre of the county, is the capital of Salaj. The first historical records of Zalau date from year 1220, being one of the first towns in Transilvania, although there are traces of dwellings dating back to year 900. The other towns in the county are Jibou, Cehu Silvaniei and Simleu Silvaniei. The county numbers 56 communes and 281 villages. The railway network is well developed, especially in the northern part of the county. Jibou is an important railway node, having links with the major cities of the country. The road network is 1128 km long, of which 227 are national and international roads while the rest are county roads. By train, Zalau is at 159 km from Cluj-Napoca, at 81 km from Baia-Mare ant at 124 km from Satu-Mare. By car, Zalau is at 84 km from Cluj-Napoca (DN1/E81), at 90 km from Baia-Mare (DN1H and DN1C) and at 90 km from Satu-Mare (DN1F/E81 and DN19) and 120 km from Oradea (DN1h, DN1). For aerial transport Zalau uses the airports of Cluj-Napoca, Satu-Mare, Baia-Mare and Oradea.

2. OPPORTUNITIES AND TOURISM IN THE SALAJ COUNTY

The relations in geographic field means motion, the motion requiring thus a series of interventions among which for the cotemporary touring these is established interpersonal, ideation, produced, markets, etc. A marvel of activize a relations of the in of touristy field is interfere the timeliness, stand so relevant in the cotemporary Roumanian touring. Beside timeliness, be due to interferes for the completion and the completeness necessary picture the complementarity and dumpbility as bases of the agreement all_the forms of spatial interaction of invoice antropical therefore and touristy. The touristic opportunities as the size is defined as a potential must for a touristic his product touristic job, which identify and capitalization with an advantageous process can generate the profit in future for gestionation firm. The principals sizes of timeliness in touring am the economic size, generation of profit, the conceptual were, profitability, the contextual size, with conditional manifestation the situational is the is the size view, a reality futureless. Among the funds opportunities in touring remember them on one scientific, grafted on ample studies and complex, the technological what funds put at hand the necessary instruments of touristic papers, the commercial his funds of the touristic market, the normative funds his which existences can to appear in order to create a large frame the legal maul of touristic activity, the financial funds, the funds informatics, the funds educational and the managerial funds. Aside from funds, sizes, legal frame etc., the opportunities in touring is based and on a series of ideation, such as, an investment with precise target, hobby of an investor, a new product appeared on a niche of the touristic market, but and on chance, experience, competence, required, desire etc. The transferability seen as touristic act the is size is can taken down this in matrix through the of a realization market-research and of a analyses SWOT for diagnostic area of touristic base of the in the county Salaj, through choises of the preferences of current tourists, through the of a identification the parcel of bids and touristic jobs for the potential tourists, through profilation touristic activity of more county on relaxation, thermal waters the is range afferent jobs. The creation of conditions for the installation of foreign investors is an another marvel of functional size, what size offers such in charge where as the is example offer the possibility of the connexions of what in looks the balneary touring through the thermal waters the one cultural is through festivals, the facilitation of the contacts of national agencies with agents of touring's from foreign countries, the renovation and keep objective the historians and their inclusion a circuits with theme of interest international with insistent about the connexions Transilvaniei with zones from Hungarian and The Austria, quotient and through the of a establishment centre of business and the touring for the coordination of the relations, the facilitation partnerships and the promotion identity county through touristic events. The one three marks have in content the of a construction touristic territorial which his identities individualize touristic local bid his is promote the historic identity the cultural is of the county, what appearance can be secure through complex studies of geography of which his touring join the analyses of physical geography with one ale of human geography that to answer or of guy waves found out the optimum place for touristic the adorn, how we identify and we apply investition nail is addressed his investment the adorn, wherefore he is necessary the intervention and why don't, when this investment shall be absorbed, advantageous and of a real success. Between the principals touristic funds remember them, on one natural, with big notes of accessibility waves I taken down the mountains Mesesului and Plopisului, the zones piscatorial and hunting from Somesului valley, from the forest Lapisului, the lakes, the resorts with thermal waters from Boghis, Bizusa, Ileanda, Mesesenii de Jos, Jibou, Simleu Silvaniei. Also the cultural funds, waves are worthy of mentioned the woody churches in number of seventy approximate situate on whole the territory of the county, the folk folkway, the folkloric zones reserved offer through them addressing a lot of reasons of relaxing and cultural enrichment. The historic funds, such as, the Romanian castes from Moigrad, Românaşi, Romita, Tihău and Buciumi, the fortresses medieval from Almas, Simleu Silvaniei, Cheud, the mansions from Jibou, Treznea and Zimbor, have the touristic role don't just complementary the whole is the dimensional background which is can prop up the durable development of the touring of the in the county Salaj.

3. THE ROMAN "CASTRUM"

The Roman castrum from Porolissum (fig. 1), most strong fortification with role of defense from of north-west the province Dacia Of the novel. Is seated on hill of Moigrad and massive Pomăt and Citera, really natural bastions of defense, carry constituted developmental the area of the best famous the Rumanian town from northwestern territory of Romania. Northern most town of Dacia, putted in he Carries Mesesului.

Fig. 1 ***Porta Praetoria***

The appearance of the fortress is incident to strategic present the Roumanian (Roma) army in zone, Porolissum in the same time an emporium of big importance. For Porolissum have the certainty be of a placement dacic with same name. Existed to a certain distance of the area which erect in the central nucleus of Roumanian defense, respectively big fortress from the hill" Pomat", and the others fortifications and the Roumanian town. The dacic placement was placed on the hill Măgura desisted from else exists soon after the Roumanian conquest. The Roumanian (Roma) town it has the origin in the civil agglomeration from besides the erect fortifications of which troops stood to Porolissum. This thing is confirmed of the way which in is willing the placement in ground, immediate in approach the fortifications. Conceivably, according as he demonstrates it material a typical of invoice dacic, as the Roumanian took over and a good part of the population from the placement dacic from" Măgura", can and from another close places from zone. From ancient shadow less placement temples, amphitheatres, necropoles, and bathes etc., what appearances indicates an intense the cultural life this in part country. The fortress from Buciumi is placed to the eastern half of eastern northern boundary Roumanian Empire, be a fortress of average sizes. The strategic role multiple age, give the a very good possibility supervisions about of a sector of limes very stretched, the simultaneous check duo transient importance’s and the of a assurance very good connections with whole line of castre situate of Agrijului valley, Brebi, Românaşi, Tihău. A strong point fortified the in the defensive system of Daciei novels, assuring the defense of the zone Porolissum.The fortress obturate he built the in the year 114 d. Hr., and age the center of the garrison Cohorts II Augusta Britton. The fortress from Romanasi, he is placed between one from Buciumi and complex of services from Porolissum and assures what road binds the colony from Napoca of the town Porolissum. The fortresses from Tihau and Sutor, they had a major importance in the defensive system of the province. The fortress from Romita, he has impressive sizes for an auxiliary fortress, what I burn be permitted one little companion two military concomitant .The role blocked the access in the province Dacia from skidoo Agrij, but diminished possible with the whole constitution of the defensive system from Porolissum.

4. THE WOODEN CHURCHES

In the county Salaj are a near 70 of woody true churches historic monuments of the churches ansamble and of rhea folk architecture, from which 44 the gate Holy keepsake of Archangels Mihail and Gavril. The churches from Skidoo Agrij, meet them to Răstolțu Mare, a church builded and what in 1840 lives one else old which the inhabitants gave the community from Carries of Salaj. The which elements attract the by-pathes an wooden beautiful ornate gate with geometric elements which is tacked down big the what year 1857 calls to mind the appearance olden church, beside table of which altar on the lateral parts has inscriptions with Cyrillic what letters mentions the year 1879. To Rastoltu Desert were rise the in the doorway drain. Of Xix, with hramul" Adormirea The nun of the gentleman" and he is of sizes the little maul the which gift keeps better the original elements. In Bozna, the church with keepsake of " Sf. Apostles Petru and were" builded last I drain. Were, restored ante 1990 is taken down in the category of rectangular formal shelters with absida decrosata square. In the locality Păuşa the church is erect to the year" 1730 after day August". Full Ciumărna has the teeny woody church with the keep side of" Sf. Mihail and Gavril" were builded in the beginning I drain. Of XVIII. Woody churches this in part of the county of the maul is to Poarta Sălajului, Chichişa, and Romita (Fig. 2). Famous by-path and the woody churches from common Creaca, from full Borza, the church” Sf. Archangels

Mihail and Gavril" builded the in the rectangular plan, with decrosata, square" begined wall up it an in a year 1758", to Brebi the church" Sf. Archangels Mihail and Gavril" with the inscription on what porch the date" 1759 in that weather this church was constructed", also in Creaca the church" Sf. Hierarch Nicolae" moved on the spot current to 1600, in Jac the church" Sf. Archangels Mihail and Gavril" keeps the inscription 1756, in Prodăneşti the church" Sf. Gheorghe" were, enjoined in the year 2000 and leaded to an workshop in Salt works Sugatag for repairs. Famous he is and his church Horea from Cizer that is his Vasile Nicula Ursu which church is a paragon of architectonical a folkway from Maramureş and Transilvania and is full in full wooden even the nails and the key from entrance, having yes the year 1773.

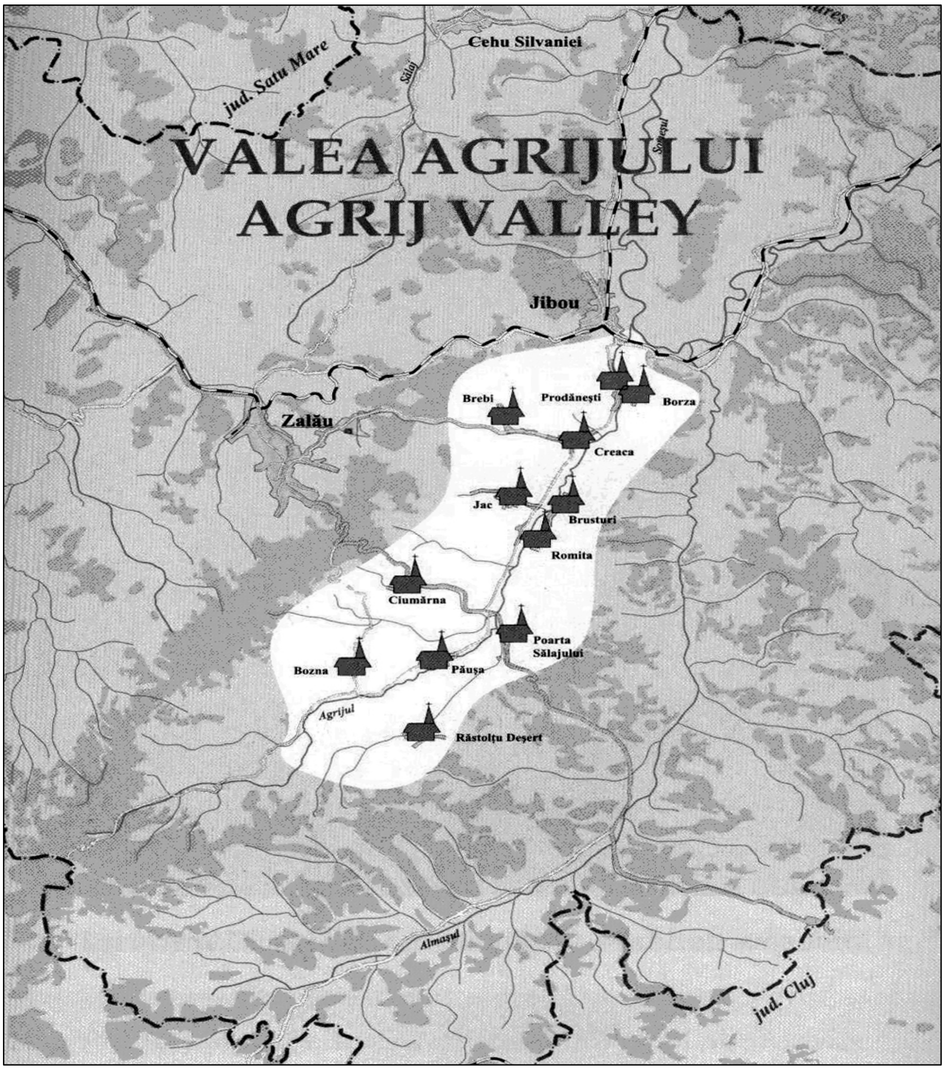

Fig. 2 ***The spatial distribution of wooden churches in the Agrij valley***

5. THE ABBEYS

The holy ABBEYS Crooked Abbey, whereat begined the construction of the abbey flapped the century XV, rather from the year 1470. After break activity for precinct 280 of years, firm in 1993 her reestablishment. The name comes seemed from a crooked faithful the lame which bequeathed the place church. The location was found out to the brim of the village Păduriş what appertains common Hida (fig. 3), be alone friary from the county Salaj again alone building the ex monastic which ensemble is kept and today is the wooden church, with the keepsake" Adormirii The nun Of the God", that after the year 1996 he built a new monastic which were holy in 15 August 2002.

Fig. 3 ***The wooden churches of the Crooked Abbey***

The abbey" Sf. Third" from Bic (fig. 4), is placed to five kilos of the town Simleu Silvaniei and carries the keepsake" Cut head Sf. Joan the Baptize" were putted the in the year 1720, the new church and the larders. He is alone abbey duration in Salaj after the year 1700. From spring until the snow put on the hills of Salaj the courtyard of the abbey is flower, I carry yes give birth to of a true cascades of colors and another fragrances abbeys are to Rus in the passage of the valley of Somes and to Bălan on Skidoo Almas.

Fig. 4 ***The abbey" Sf. Third" from Bic***

6. THE BALNEARY RESORTS

On the territory of the county Salaj can find some locations which offers through the natural availabilities the human of which dispose or were endows with conditions among most good for practication of the touring of the balneary resorts scilicet to Boghis, waves the resort disposes so watery cold how much the watery thermal. The resort is placed in conjointly Nuşfalău on the district road 191D offering the treatment for the apparatus witch help for walking, for the nervous system the peripheral etc. He is endowed with three shadows less basins, a covered basin, base of treatment, and hotel with 50 of places and cottages with a capacity of accommodation of 120 of places. To Şimleu Silvaniei thermal water has a flow of 5 l /s (Buta, I., 1978), is adequate in affections for rheum, articulate, digestive the one of nervous system peripheral. Disposes of the shadow less basin and cabins and the access is done from the national road 1H. On skidoo Salt, in around the town Jibou with access from DN 1 H, I can doctor the affections of rheum's, the one for entrails, gynecological specific what is met fractionally and to Crişeni on same route artery. Cold sulphurous water helps the apparatus helps you to walk is found at Zalnoc in conjointly Bobota with access from DJ 110B, to Top Mesesenii de Jos and to Zăuan Bathes in conjointly Ip on DJ 109P. The resort Bizusa Bathes, is placed on DN 1C on the left versant of Secatura valley. This resort benefits of a placement extremely beautifully, in a garden firry and broad-leaved trees and which the big years the number the visitor by reason of the large range of affections which in his waters minerals have a favorable effects. Is a resort with permanent character, waves were putted the obvious in strate plutonic aquifer with thin waters minerals. Sparkling water springs from the many maul places from under the rocks from skidoo. The varlet, from the warehouses Oligocene wagons begin in a continental facies, constituted complex of grey clays fossils, which in is lasted a layers of lignite, sandstones, step with concreturide which pyrite give the minerality of the waters of Bizuşa. Sparkling water is nameable as the adorning interestedly local from 1932, be capture in duo springs by dint of a Bunkie stations. Water is thin sulphurous, very thin chlorine, calcium, sodium etc. For this waters deposit is present gas up H2S and CO2. The hydrogen sulphide (H2S) he has the values of 0, 7 mg l in derricks and of 4, 2 mg l in springs and is composed carry confers the different these qualities waters, incite for internal cure in affections hepatic, nutritional and urination, and in external cure in affections ale the which apparatus helps with the motion, rheum generative, sechele postreumatice and affections ale the nervous system of the peripheral. As decorations for the operation of the base of treatment exist a swimming place as have inside decorations. As spaces of accommodation and massage, the resort Bizusa offers 110 places of accommodation in the hotel Ceres of a star, in modernize rooms which dispose of all the comfort, pavilions with base of treatment, cottages, and massage maybe be eased in the restaurant of his hotel of the in garden estival.

7. CONCLUSIONS

The study follows the presentation vendible form the principals funds truly potential touristic for the county Sălaj (Pop, C.C., 2008). From the natural funds to one with a more load antropic the geographic what space this designees the county disposes of elements among most unpublished, variously, unique what I can be offered the athirst for tourist culture, beautifully and spirituality. The study feels like offers and a scientific origination in the future shares so that to is satisfied the requirements tourists, to is in concordantly complete with the programs development and promotion that to answer just economic activize of the county. Succeeded this in the demarche is the necessity of the implication local communities through the taking of measures for the preservation local authenticity and the patrimony, is the necessity also of valorize the scenario and the productive systems of special in the context of espousal of The European Union.

REFERENCES

Bențe, F. (1974), *Depresiunea Şimleului-Studiu de geografie regională*, Rezumatul tezei de doctorat, Bucureşti, 45 p.

Buta, I., Iacob, E., Simu, M., Buz, V. (1978), *Apele subterane din nord-vestul județului Sălaj şi posibilitățile de valorificare*, Studia UBB, seria Geologia-Geographia, nr. 2, Cluj-Napoca, pp. 40-44.

Clichici, O. (1969), *Tectonica şi evoluția paleogeografică a părții de est a Bazinului Şimleu*, Studia Univ. Babeş-Bolyai, Geologia-Geografia, 1, anul XIII, Cluj-Napoca, pp. 53-81.

Gîrbu, S. (2006), *The Assessment of the Tourism Potential of Codrilor Region*, Geographia Technica, nr. 2, Cluj-Napoca.

Ilieş, G., Ilies, M. (2006), *trends in 3D tourist mapping*, Geographia Technica, nr. 2, Cluj-Napoca.

Moroti, Elisabeta (2001), *Scurtă priviere istorică asupra dezvoltării economice a oraşului Zalău*, Alma Mater Porolissensis, nr. 4, Zalău, pp.36-40.

Pop, C. C., (2003), *Dimensiunea geografică a axei Jibou-Zalău-Şimleu Silvaniei-Marghita. Studiu de geografie integrată*, Editura Silvania, Zalău, 262 p.

Pop, C.C., (2008), *Turism şi dezvoltare durabilă. Județul Sălaj*. Casa Cărții de Știință, Cluj Napoca, 193 p.

HAPPINESS AND ITS SOCIO-ECONOMICS FACTORS. OVERVIEW AND ECONOMETRIC ESTIMATION

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ABSTRACT
This article synthesizes the main results of some specialty studies of the economical profiled magazines regarding the individual happiness and the economic - social factors which influence it. Using the cluster analysis for the classification of 31 European countries according to the Human Development Index (HDI) and the happiness index (HPI) has resulted four groups, homogeneous on the inside and different one from another. The dates were extracted from the 2006 Human Development Report and from the 2006 nef report. Throughout three econometric models we have tested the influence of HDI, GINI and the number of marriages of 1000 persons over some indicators which synthesize the life satisfaction.
Keywords: *life satisfaction, Human Development Index, Happy Planet Index, cluster analysis, OLS.*

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1. INTRODUCTION

This study makes a classification of the EU 27 member states, of Croatia (an EU adhering candidate), of three EFTA (European Free Trade Association) member countries: Iceland, Norway, Switzerland, and also deals with the finding of some factors which influence happiness. In 2005, the year from which the information of this article dates, the European Union had 25 state members and Bulgaria, Romania and Croatia were running for EU adhesion.

The information gathered in this study is from the 2006 Human Development Rapport made by UNDP (United Nation Development Programme), from the 2006 "The (Un) Happy Planet" rapport made by nef (New Economic Foundation), from the studies made by Eurostat and also by World Bank. The analyzed variables refer to two lines of study and interest such as human development and happiness of the above mentioned European countries.

The 31 analyzed states are classified upon two complex variables: HDI (Human Development Index) and HPI (Happy Planet Index), making four classes for each case. Another aspect of this study will focus on finding the influence factors of happiness. Some authors (FERRER - I – CARBONELLA A., 2005) consider the notions of happiness, welfare and life satisfaction as being equivalent. This matter of happiness, welfare and personal satisfaction doesn't represent a novelty for the world of science, being dealt by economists, psychologists, sociologists trying to solve "the mystery", to find out what makes us happier or unhappier. The following articles make reference to different factors of influence, but also explain the concept of "happiness". Thus, BINSWANGER M (2006) adds two other concepts, besides those already existent in literature (hedonic treadmill, positional treadmill), such as: multi- option treadmill and time- saving treadmill. All these four modalities of the lifestyle have an effect upon the happiness of an individual.

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There is a tendency of people to relate to a reference group, to its way of life, and as much as they struggle for happiness, the less happy they are, giving them less time for personal pleasures. KEELY L. C. (2005) analyses welfare as a dependent function of the income growth and the variety of consumer goods. The conclusion they reach is that, although income and the variety of products are growing continuously in the developed countries, this growth doesn't lead to a likewise evolution of happiness up to a certain point.

ALESINA (2004) had studied the inequality effect in society over the individual happiness, making a comparison between Europeans and Americans, reaching to the conclusion that individuals have the tendency to consider themselves less happy when a bigger inequality is shown between social classes. GRAHAM C. et. al. (2004) had shown on a sample number of persons from Russia that there are many different elements which affect human welfare, among which one part is determinate by individual behavior: self esteem, optimism and others are determinate by socio- economic and demographic variables: marital status modifications, income fluctuations, educational level. People with a high level of happiness have more chances to enlarge their income in the future.

2. REPRESENTATIVE INDICATORS – HDI, GINI, HPI

HDI, Human Development Index, represents an important alternative of other traditional indicators for measuring the human development level, for example the GDP or the adjusted GDP. For further, more detailed explanations see SAGAR & NAJAM, 1998.

According to the **nef (new economic foundation)** rapport: "The (Un) Happy Planet Index" (July 2006), an improved alternative of HDI is HPI (Happy Planet Index). This new indicator takes into account objective data, but also subjective ones, doesn't use income as a explicit variable and take into consideration the planet's resources which lead to a longer and happier life. The purpose of development is to offer high standards of human welfare taking into account a responsible behavior of the resource consume. HPI reflects the way in which every country of those analyzed (178) fulfills the above mentioned goal..

GINI coefficient measures the degree of inequality of income levels, representing the relative average difference between everyone's incomes. The coefficient size shows the part of the total income which should be redistributed if it be wanted to obtain an equal distribution of income.

The GDP is criticized for the fact that it doesn't capture the changes for the entire population, while GINI shows how the income distribution changed for the wealthy and poor people.

The most developed European countries have a coefficient between 0,24 and 0,36 while the coefficient of the United States of America is bigger than 0,4. The Americans confront with a more accentuated inequality concerning the income distribution. GINI coefficient was estimated between 0.56 and 0.66 for the entire world.

Demographic data

The analysis made upon the 31 European countries used also some demographic variables such as: activity rate, unemployment rate, number of divorces and marriages of 1000 persons and the percentage of smokers/ non- smokers. The data were taken from the studies made by Eurostat.

3. RESULTS AND DEBATES

G8 international forum made of Canada, France, Germany, Italy, Japan, United Kingdom, Russia and USA gathers 65% of economic world power, but also the military one (7 of these countries taking top positions in the most powerful states classification from the military point of view). United Kingdom, USA, Russia and France hold 98% of the declared nuclear weapons.

Although G8 forum members considers themselves to be the most industrialized democracies of the world (the used criteria of classification is GDP), if we take into account other indicators this fact leaves room for discussions.

If HDI would be taken into account as an indicator of ranking industrialized democracies, then the present G8 would just include Canada, Japan and USA, classifying on the last three positions of the most developed 8 states. The other members of G8 would be, in decreasing order of the human development level: Norway, Iceland, Australia, Ireland and Sweden. On the other hand, if G8 would take into consideration the happiest 8 countries of the world and with the lowest negative impact on the natural environment (HPI), then none of the present members would hold the nowadays positions. In the HPI hierarchy these countries take the last places, however Italy is the best ranked, on the 66 place.

For the developed countries, Footprint significantly increases with the GDP and it is the cause for the diminution with 50% of the happiness index, while life expectancy doesn't modify and life satisfaction increases very little. On the other hand, for the states with a low level of development, life satisfaction is the main cause of the modification of HPI level. This means that, at a national level, the most significant increases of welfare are due to a low to moderate income.

The classification of countries based on HDI

The countries which are recording high values of the human development level are considered to be the best places for establishing the residence. These states have an excellent healthcare system, GDP/person and a high level of education. In accordance with the latest United Nation rapport, Human Development Report 2006, the first countries are Norway, Ireland and Austria. We might believe that many residents of these countries are very content with their life. But most of the states labeled as being well developed (based on HDI) have a mediocre level of welfare.

Having done the classification based on the HDI variable had resulted 4 groups. The cluster analysis was preferred instead of a simple segmentation because it allows an "optimal" grouping, taking into account the homogeneity of the resulted groups. The groups are being validated through ANOVA analysis.

The first group, the largest one, gathers 15 countries which record the highest values of the human development index: 0.947 (see The groups componence classified on HDI variable), on average, these countries being also the first ones in the hierarchy made by UNDP. These countries' residents from group 1 have a high level of education, reflected by the literacy rate variable, with a medium value of 98.89%, approximately 71% of those with an age from 25 – 64, graduates of high school at least. The level of the activity rate proposed by The European Council from Lisbon (March 2000) as an aim for the year 2010, that is 70% for the age group 15 – 64 and 60 % for women, was surpassed by the countries from this group in 2005 with 0.05%, respectively with 3.28%. This can be explained by the fact that the inhabitants have a high level of education which easily permitted them to get a job, the persons with a superior level of qualification having a 42.44 % and those with elementary occupations having 8.57%. The medium value of GDP/ person, in this group, is in average of 34, 216 USD (PPP), the value close to that of Norway, considered the most developed country. The highest value is recorded in Luxembourg. The life expectancy is, in average, of 79.1 years, the highest value being recorded in Iceland (80.7 years) and the lowest in Denmark (77.2 years). This variable reflects a well organized health system and a big percentage from GDP given to the health system.

The groups componence classified on HDI variable

Table no. 1

Group 1	Group 2	Group 3	Group 4
Austria Belgium Denmark Switzerland Finland France Ireland Island Italia Luxembourg United Kingdom Norway Holland Spain Sweden	Bulgaria Romania	Czech Republic Croatia Estonia Latvia Lithuania Malta Poland Slovakia Hungary	Cyprus Germany Greece Portugal Slovenia
$\overline{HDI}$ **: 0. 947**	$\overline{HDI}$ **: 0. 811**	$\overline{HDI}$ **: 0. 861**	$\overline{HDI}$ **: 0. 914**

Norway, the first place occupant in the global hierarchy, succeeded to become the most developed country, after that in 1970 it ranked among the last in Europe. The explanation of this ascension is given by the fact that the Norway’s economy has a favorable growth period, with low rates of unemployment and inflation. All these reflect the globalization effects, from which Norway fully beneficiated (more than other members of The Organization for Economic Cooperation and Development - OECD): it supplies electric power and other goods at high prices and imports other goods at low prices. The liberalization of the economy, the tradition in commerce, the embracement and a fast spread of new technologies and a stable macroeconomic politic are some characteristics that led to this success. At the same time, Norway is one of the most productive countries from OECD.

The second group is made up of only Bulgaria and Romania, these two countries having the lowest values of HDI, 0.816 and respectively 0.805. Romania is situated on the last place of the 31 countries took into account. This could be explained by the evolution of the GDP that increased only from 2000 with a 1.8% increase in 2000. In 2001 Romania had the highest rate of inflation in comparison with the other former communist countries. It must be taken into account the fact that the used data are from 2005, before the adhesion to the European Union. Probably that the present situation has changed, but another studies could not be done due to the lack of information and because the calendar year is not over. However, Bulgaria surpassed us, being a little more developed than we are.

Between group 1 and group 2, being at extremes, situate groups 3 and 4.

In **the third group** there are 9 countries with a level of development closer to the countries from group 2 than to the countries from group 1, having a HDI average value of 0.861. Most of the countries from this group were former communist one, but apparently they have succeeded to reach to a medium level of development. From certain points of view, these countries are not doing so well: it has been recorded a lower rate of activity (the unemployment rate being higher – approximately 5%), a higher percentage of inactive persons (especially in countries with a lower level of education), farmers are more numerous than in the first group countries (less persons with a high level of qualification). The highest inactivity rate is recorded in Lithuania, both in the case of youngsters and women (approximately 70%).

Group 4 has only 5 countries with a pretty high level of development, close to the values recorded in the countries from group 1 (a 0.914 average). Cyprus and Portugal, although having a high level of development (0.904), have the lowest level of education, only 46% of its inhabitants graduate high school. In Portugal there is also the lowest value of the literacy rate variable (only 92%). The average GDP per capita in this group is 22, 776 USD (PPP), a significantly smaller value than the one recorded in the first group.

The classification of countries based on HPI

A factor not taken into account by HDI is the price paid for welfare by the rich countries. For example, Norwegians consume in average 3.5 times more than their share of world's resources (value quantified by the Footprint dimension, a HPI component). Since global resources are limited, it is not possible as all the countries of the world to "buy" welfare at the same price to which developed western countries got used to. But a high level of resource consumption doesn't lead to a high level of welfare, and what is the most important, a high level of welfare can be acquired with smaller resource consumption.

HPI supplies precise data referring to the fact that in the economic development model there is a certain threshold. More precisely, once that GDP/ person reached a certain level, the economic growth has negative effects, causing more damage than good and reduces the welfare level for the next generations with a very small or zero effect for the current generation. This hypothesis was initially given in the "Index of Sustainable Economic Welfare". This aspect is very well illustrated by three Mediterranean countries: Greece, Portugal and Spain. All three had as a government form the military dictatorship until 1970 and adhered to European Union in the 80's. They can be considered as a typical example of a successful development.

While inhabitants' welfare had to gain, the negative impact upon the natural environment is more accentuated and continues to accentuate.

HPI gives an alternative, namely the need for development to stay in the limit of moderate resource consumption and to take also in consideration the personal satisfaction of the inhabitants.

The 31 European countries were grouped according to the happiness index in 4 classes. These classes were validated with the help of the ANOVA analysis.

The 4 groups' composition is given in the table below:

The first class is made of the countries with the highest level of happiness (the HPI average in this group is 49.398). Malta takes the leading position in Europe regarding the level of happiness (HPI = 53.3), but it ranks only on the 40th place in the world. Although it is situated in the green zone of two of the component dimensions of the happiness index, namely life satisfaction with a 7.5 value and with a life expectancy at birth of 78.4 years. Regarding the impact upon the natural environment it is seen that Malta is in the yellow zone, having a Footprint of 3.5, which denotes an irresponsible behavior towards the present consumption and also an inefficient allocation of resources. Although the other four countries from this group record values of life satisfaction and life expectancy components which takes them on the green color, the Footprint variable lowers them in the classification. To sustain these states' population it would be needed more than four planets like Earth at the present resource consumption.

The groups componence classified on HPI variable

Table no. 2

Group 1	Group 2	Group 3	Group 4
Austria Switzerland Iceland Italia Malta	Belgium Cyprus Croatia Germany Luxembourg Holland Slovenia Spain	Bulgaria Estonia Latvia Lithuania	Czech Republic Denmark Finland France Greece Ireland United Kingdom Norway Poland Portugal Romania Slovakia Sweden Hungary
$\overline{HPI}$: **49.398**	$\overline{HPI}$:**44.533**	$\overline{HPI}$: **27.707**	$\overline{HPI}$: **37.844**

The 2nd group includes 8 countries with a medium level of happiness of approximately 44. It is noticed that the individuals living in these countries are satisfied by their private life, having a life expectancy at birth of more than 75 years, but denotes an irresponsible behavior regarding their impact upon the natural environment (the Footprint dimension is on the red zone).

Among **the third class** we find the most unhappy European inhabitants, respectively Bulgarians, Estonians, Lithuanians and Latvians. They are extremely unsatisfied by their life, with an average life expectancy of 72 years, but with a red Footprint.

In **the last group**, which records a medium level of happiness of 37.844, is also situated Norway, among other 13 states. According to the level of development, Norway takes the first place, but in the **nef** classification Norway is on the 115th position. A possible cause of this could be the very high value of the ecological Footprint dimension of the HPI, of 6.2, meaning a major negative impact upon the natural environment. According to the Kyoto Agreement, Norway wants to develop a series of policies and instruments to reduce pollution. In October 2006, a commission proposed a strategy for reducing GHG (Greenhouse gas) emissions with 50 to 80% until 2050. Romania is a component of this class situating on the 120 position in the **nef** classification. The Romania's proximity to Norway is explained the 2.7 value of the ecological Footprint variable, compensating in the HPI calculus the lower value for life satisfaction (5.2), comparing to that of Norway of 7.4. What happens in the case of Poland regarding the Footprint variable? Its value dropped from 4.88 in 1989 to 3.34 in 2002, despite the fact that in that period an economic growth also took place. This made possible by introducing new technologies.

In time, different hypothesis were made regarding the elements and factors which influence happiness. Most of the studies have shown the happiness dependence to the income growth, determining also the happiness growth up to a certain point, when income increase doesn't determine the modification of the happiness level. But happiness is not influenced just by its own income, but also of its reference group, individuals being more happy as their income is bigger than the reference group (FERRER -I- CARBONELLA A. 2005, "Income and well- being: an empirical analysis of the comparison income effect").

This study tries to find other factors which determine happiness. To quantify happiness, life satisfaction was considered as a dependent variable, having an equivalent relation with happiness. Earlier was mentioned that life satisfaction is determined in quantitative researches as an answer to the question: "How happy are you momentarily compared with your life so far?".

Life satisfaction is used by HDI in a 77% proportion and as more factors are being introduced in this model, the proportion increases to 83%.

The most important factor which influences happiness is the human development level. This indicator subsumes life expectation at birth, literacy and enrollment rate and GDP per capita. There is a strong correlation between life satisfaction and HDI (0. 879), this being possible because the dimensions of the development level contribute to the increase of personal satisfaction and individual welfare. As bigger the development level of a country is, as easier is for the resident population to have access to a qualitative educational system, which assures a work place adequate to his professional training and therefore a bigger income. All these elements contribute to the increase of the happiness level of an individual. The model has the following formula:

$$\textit{Life Satisfaction} = \beta_0 + \beta_1 * HDI + \varepsilon \qquad (1)$$

- where ε - the effect of other factors upon Life Satisfaction

Regression 1

Table no. 3

Source	SS	df	MS
Model	28.117	1	28.117
Residual	8.239	29	0.284
Total	36.357	30	1.212

Number of obs	= 31
F(1, 29)	= 98.96
Prob > F	= 0.000
R-squared	= 0.773
Adj R-squared	= 0.766

Life Satisfaction	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
HDI	20.836	2.095	9.95	0.000	16.552	25.119
_cons	-12.268	1.905	-6.44	0.000	-16.163	-8.373

According to table no. 3, relation (1) becomes:

$$\textit{Life Satisfaction} = -12.268 + 20.836 * HDI + \varepsilon \qquad (2)$$

By introducing another factor in the model it was expected to explain the endogen variable, life satisfaction, in a greater deal:

$$\textit{Life Satisfaction} = \beta_0 + \beta_1 * HDI + \beta_2 * GINI + \varepsilon \qquad (3)$$

In the table below shows that by introducing another exogenous variable, happiness can be explain in a proportion of 80% by the level of the human development and by the unequal distribution of income.

According to table no. 4, relation (3) has the following formula:

$$\textit{Life Satisfaction} = -10.294 + 20.466 * HDI - 0.052 * GINI + \varepsilon \qquad (4)$$

As long as there is a bigger discrepancy between the rich and the poor, the less happy people are, a hypothesis shown by relation (4) through the GINI index coefficient (-0.052). Regarding the level of development it was noticed that its influence on the happiness by introducing another factor hadn't significantly modify.

Regression 2

Table no. 4

Source	SS	df	MS		
Model	29.426	2	14.713	Number of obs	= 31
Residual	6.930	28	0.248	F(2, 28)=	59.45
Total	36.3568	30	1.212	Prob > F	= 0.000
				R-squared =	0.809
				Adj R-squared	= 0.796

Life Satisfaction	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
HDI	20.466	1.961	10.43	0.000	16.448	24.484
GINI	-0.052	0.023	-2.30	0.029	-0.099	-0.006
_cons	-10.294	1.974	-5.21	0.000	-14.338	-6.250

For a better explanation of happiness a new exogenous variable (3) was introduced in the above model looking like this:

$$Life\ Satisfaction = \beta_0 + \beta_1 * HDI + \beta_2 * GINI + \beta_3 * Marriage + \varepsilon \quad (5)$$

- where Marriage - number of marriages to 1000 persons

By introducing the number of marriages to a thousand persons in the model, the happiness explained by HDI, GINI and the number of marriages increased with 2% apart from the happiness presented in the previous model.

Regression 3

Table no.5

Source	SS	df	MS		
Model	30.761	3	10.254	Number of obs	= 31
Residual	5.595	27	0.207	F(3, 27)	= 49.48
Total	36.357	30	1.212	Prob > F	= 0.000
				R-squared	= 0.846
				Adj R-squared	= 0.829

Life Satisfaction	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
HDI	21.220	1.819	11.66	0.000	17.487	24.953
GINI	-0.052	0.021	-2.48	0.020	-0.095	-0.009
Marriage	0.242	0.095	2.54	0.017	0.046	0.437
_cons	-12.224	1.960	-6.24	0.000	-16.246	-8.203

Relation (5) becomes:

$$Life\ Satisfaction = -12.224 + 21.220 * HDI - 0.052 * GINI + 0.242 * Marriage + \varepsilon \quad (6)$$

Happiness is also influenced by the marital status of the persons, meaning that married persons are happier. Divorces have a negative influence upon life satisfaction, although this influence has little significance in the present study. Although marriage makes people happier, a personal satisfaction increase doesn't determine the individuals to commit themselves in a marriage.

Recent psychology studies show that persons who give great importance to material aspects like money, fame, physical appearance and their possessions are less content by their life than those who consider these things of less importance.

The psychologist Tim KASSER states that the need of material possessions represents an extrinsic motivation (a motivation not valuable in itself; come from the need of acceptance

by the others). Intrinsic motivations are associated with the feelings of autonomy and happiness, and the extrinsic ones are associated with dissatisfaction and anxiety.
Life satisfaction is positively bound with variables like loyalty, creativity, need for adventure and negatively associated with a stable government, welfare. In other words, those who consider loyalty and creativity as being the most important characteristics are happier than others.

5. CONCLUSIONS

The anthropologist Jared DIAMOND explains in his book "Collapse" that over the centuries, civilizations disappeared because they haven't realized when their way of life outrun the limits imposed by the natural environment. Common sense tells us that is impossible that every country to carry on its activity like the western countries, when this way of life means a resource consumption which outruns the physical limits of the planet. HPI shows that are another ways to reach the wanted level of development; similar levels of welfare can be reached with a lower ecological cost.
More and more, in recent researches, it is said that life is less idyllically in the contemporaneous western societies that what is seemed to indicate GDB, HDI or other indicator of progress. The rate of those who suffer from depression increased in all groups of age, being an ascendant trend in drug consumption, suicides and crimes made by young people in these developed countries.
It is worth mentioning that HPI doesn't try to find the country in which we wish to live, from the all points of view. It is highly possible to be persons extremely satisfied by their life in every country of the world; as well as persons completely dissatisfied by their life. A good HPI score doesn't indicate that in the respective country there are no problems, that the current level of welfare is a high one or the resource consumption is equitable.
It has to be mentioned the fact that very poor countries benefit locally and nationally, in a certain way, from the economic growth. In the latest researches, **nef** suggests that a development based on a global increase is inefficient from the poverty reduction perspective. If welfare and not richness is the purpose of development, efforts must be made to ensure that the respective country doesn't have a development with a negative impact upon certain aspects of life like its social aspect, the community.
For this study made upon a sample of 31 European states, a classification according to two indexes, human development and happiness, leads to groups of different components. This is possible due to the calculus methodology of those two indicators. There are differences between classes when making classifications on the HDI and HPI variables, however there are some resemblances. The happiest countries (Austria, Switzerland, Iceland, Italy) records also the highest level of human development, Malta being the only exception. Anyway, Malta has the best score for happiness from Europe, from the development point of view it is less developed, situating in the third group with an average HDI score of 0.861. The rest of the countries which are considered as highly developed (Belgium, Denmark, Finland, France, Ireland, Luxembourg, United Kingdom, Norway, Holland, Spain, Sweden) have a medium level of happiness ($\overline{HPI}$ = 40. 99). About the less developed countries we ca say that Bulgaria has a very unhappy population, the citizens of Romania are a little bit happier than Bulgarians. Estonia, Latvia and Lithuania fits in the same group with Bulgaria from the Happy Planet Index perspective.
It could be seen that the level of happiness, measured through the life satisfaction variable, was influenced in a great proportion (0. 809) by HDI and also by the GINI inequality

coefficient in a negative way and the number of marriages. These independent variables explain the endogen variable, life satisfaction, in a 84.6% percentage. Thus, it is said that people who have made a family in the countries with a high level of human development, where there is a big discrepancy between the poor and the rich, are happier. Other factors on which human happiness depends are the political stability ($R^2 = 0.27$) and the Voice and Accountability Index ($R^2 = 0.67$).
The obtained results on the factors which influence happiness are in concordance with the results obtained by other studies mentioned in the first part of the article (1. Introduction).

REFERENCES

Alesina, A. et al., (2004), *Inequality and happiness: are Europeans and Americans different?*; Journal of Public Economics, pp.2009- 2042

Binswanger, M., (2006), *Why does income growth fail to make us happier? Searching for the treadmills behind the paradox of happiness*; The Journal of Socio- Economics, pp. 366- 381

Buiga, A.(2001), *Metodologie de sondaj şi analiza datelor în studiile de piaţă*; Editura Presa Universitară Clujeană, Cluj Napoca

Diamond j., (2005), Collapse: How Societies Choose to Fail or Succeed

Diener E., (2000), Subjective well-being: The science of happiness, and a proposal for a national index; American Psychologist

Everitt, B.S. et al., (2001), *Cluster analysis*; Oxford University Press US

Ferrer, I- Carbonell, A., (2005), *Income and well- being: an empirical analysis of the comparison income effect*; Journal of Public Economics, pp. 997- 1019

Graham, C. et al. (2004), *Does happiness pay? An exploration based on panel data from Russia; Journal of Economic Behavior & Organization*, pp. 319-342

Johnson, J. , Dinardo, J., *Econometric Methods*; McGraw- Hill, Fourth Edition

Kasser T. (2002), *The high price of materialism*; Cambridge, MA: MIT Press.

Keely, L. C. (2005), *Why isn't growth making us happier? Utility on the hedonic treadmill*; Journal of Economic Behavior & Organization, pp. 333- 355

Morse, S. (2004), *Putting the pieces back together again: an illustration of the problem of interpreting development indicators using an African case study*; Applied Geography, pp. 1- 22

Pecican, E. (1994), *Econometrie*; Editura ALL, Bucureşti

Sagar, A. D. & Najam, A., (1997), *The human development index: a critical review*; Ecological Economics, pp. 249- 264

Electronic sources:

http://epp.eurostat.ec.europa.eu

www.neweconomics.org nef 2006, The (Un) Happy Planet Index

www.**oecd.**org Report OECD 2002

www.**oecd.**org Report OECD 2007

www.**undp**.org UNDP 2006, Human Development Report

www.**undp**.org UNDP 1990, pp. 10;

www.wikipedia.org

www.worldbank.org

FEEDBACK MECHANISMS BETWEEN MORPHOLOGY, STORM DURATION AND HYDROGRAPH SHAPES

P. Sólyom[1]

ABSTRACT
Relationships between runoff hydrographs discharged from drainage basins shaped by precipitation events of different characteristic duration are analysed. Feedbacks between hydrograph shapes and landscape shaping storm duration are identified: hydrographs resulting in catchments shaped by typically short and intense storms are thinner and peakier for a given precipitation input than hydrographs of catchments in environments of longlasting storms. This finding can be used to extend the well known relationship between catchment planform and hydrograph shape to include the effect of storm duration on hydrograph shape and morphogenesis. The study is based on numerical modelling of landscape evolution and rainfall routing.

*

1. INTRODUCTION

Feedback relations between hydrograph shapes and catchment morphology are one of the basic relationships of hydrology and fluvial geomorphology: catchment morphology affects hydrograph shapes, while the topography is eroded by erosion of the runoff hydrograph. This mutual dependency is reflected in the concept of geomorphological unit hydrograph (Rodriguez-Iturbe and Valdez, 1979) and in the early acknowledgment of the effect of catchment shape on peak discharges (Strahler, 1964). The feedback scheme can further be detailed by incorporating storm duration as the third factor, because storm duration affects hydrograph shapes. For short storm durations the shape of the hydrograph is close to the instantaneous unit hydrograph, while for longer precipitation events hydrograph shape approaches a flat, rectangular shape. Hydrograph shapes drive surface erosion, while they are governed by both surface morphology and storm duration.

In an earlier paper (Sólyom and Tucker, 2004) the author has studied the effect of storm duration on landscape evolution and identified compensatory mechanisms between storm duration and hydrograph shapes. It was found that landscapes generated by shorter storms produce peakier hydrographs for the same precipitation event than landscapes generated by long storms. This phenomenon can be interpreted in terms of the energy minimization principle: landscapes strive to minimize their total energy, and this is achieved by maximizing erosion (Rodriguez-Iturbe et al., 1992). For landscapes shaped by dominantly short storms peak discharge is the dominant erosive factor rather than total runoff (Wolman and Miller, 1960), therefore landscapes during their evolution try to maximize peak discharge values. This is achieved by rearranging the flow path structure to produce hydrographs with the highest possible peak discharge values for a given precipitation input. This phenomenon has a number of practical consequences in terms of flood prediction and catchment management. This paper would like to get more explicit about the identified compensatory mechanism by introducing a non-dimensional variable, the hydrograph peakedness factor and studying its evolution in detail.

2. THEORY

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Landscape evolution models simulate the temporal change of the topography. The equations solved numerically on a discretized spatial basis capture the significant hydrological, erosional and tectonic processes (e.g. Howard, 1994; Tucker and Slingerland, 1997). Runoff is often modelled as a linear function of the contributing area corresponding to the rectangular hydrographs of long-lasting storms. To introduce the shape of hydrographs in the model, and to allow for additional feedbacks to develop, hydrograph-related quantities have to be used. Considering that hydrograph duration (Th) separated from the base flow is equal to storm duration (Tr) plus the concentration time (Tt) of the catchment, and that the concentration time can be expressed using longest flow path length (L; the path the water particle has to travel to reach from the most distant location of the catchment to the outlet) and average routing velocity (Uf), one can write:

$$T_h = T_r + \frac{L}{U_f} \qquad (1)$$

Runoff volume in a given catchment after a storm event ((R-I)AT_r) can be equated with the corresponding hydrograph volume ($T_h Q_p F_{hs}$) and solved for peak discharge using (1):

$$Q_p = \frac{(R-I)A}{F_{hs}} \frac{T_r}{T_r + L/U_f} \qquad (2)$$

- where R is time- and space-averaged rainfall intesity, *I* is time- and space-averaged infiltration rate ($I<R$), *A* is contributing area, Q_p is peak discharge, F_{hs} is hydrograph shape factor giving the ratio of the hydrograph within the T_h, Q_p rectangle, it takes values between 0 and 1, e.g. 0.5 for triangles.

Erosion exerted by running water can be related to shear stress expressed as a power function of hydrograph flow depth (Q(t)) and local slope (S) (Whipple and Tucker, 1999). Considering that a flood hydrograph Q(t) can be nondimensionalized by scaling with peak discharge Q_p, and time t with T_h respectively, the storm-averaged erosion rate E can be given as:

$$E = \frac{1}{T_h} \int_0^{T_h} K[Q(t)]^m S^n dt = K{Q_p}^m S^n \int_0^1 Q`(t`)^m dt` =$$

$$\frac{K(R-I)^m A^m S^n F_{he}}{{F_{hs}}^m} \frac{{T_r}^m}{(T_r + L/U_f)^m} \qquad (3)$$

- where K is erosion coefficient, S is slope, Q’ and t’ are nondimensional hydrograph and time respectively, F_{he} is the integral of $Q’(t’)^m$, m and n are positive constants usually between 0 and 2. Both F_{he} and F_{hs} take values in the range of 0 to 1.

For long storms (T_r>>L/U_f) F_{he}~F_{hs}~1 and equation (3) simplifies to $E=K(R-I)^m A^m S^n$, which is the standard erosion equation for steady and uniform runoff. For short storms, however, equation (3) becomes sensitive to both the storm duration-travel time relationship and to the contributing area-flow path length relationship. This latter relates to the planshape of the catchment and guarantees higher peak discharge and erosion values for round catchments than for elongated ones.

3. NUMERICAL SIMULATIONS

Using equation (3) simulations have been performed and dynamic equilibrium landscapes produced for long-storm and for short-storm conditions. The simulations were detachment limited (Howard, 1994) in the sense that eroded material was removed immediately and not cascaded downslope as in the case of the transport limited erosional system. This approach mimics the characteristic of arid landscapes that thin soil is easily removed by erosion, and transport capacity generally exceeds detachment capacity. Dynamic equilibrium has been reached when denudation at every point on the surface has counterbalanced the rate of the spatially constant uplift rate (Hack, 1960). The simulation domain was an initially flat 40*40 raster with an additional random noise to facilitate network formation.

Two dynamic equilibrium topographies were simulated, one with long storms (T_r>>L/U_f) and one with markedly short storms: the $T_r/(T_r+L/U_f)$ fraction at simulation window-length was 1/40. In order to compensate for the total precipitation decreasing effect of decreasing storm duration, rainfall rate (R) for the short storm case has been increased to generate identical total precipitation (T_r*R) in both cases. In this way the tectonic uplift rate has been counterbalanced by the same amount of time-integrated precipitation fallen, only the duration and intensity of the modelled events were different: higher intensity for the short-storm case, and gentle intensity for the long-storm case. In the short-storm case F_{he} and F_{hs} were given the typical value of 0.4. As it will be demonstrated later at low storm duration F_{hs} takes values in a relatively stable range, so that using the fixed value of 0.4 does not introduce considerable amount of bias into the calculations.

Figures 1a and 1b present the two surfaces. The long-storm surface shows a sinuous channel network pattern, whereas the short storm surface is characterised by straight channel segments. The surfaces presented in Figures 1 and 2 represent end-member-cases on a continuous scale. Differences in landscapes shaped by storms of different duration can be less pronounced than in this rather demonstrative case. It is also acknowledged that changes in storm duration and rainfall intensity can have simultaneously a number of different outcomes as well, such as changes in the vegetation cover or in the grain size distribution, but here we remain focused on the consequences of the changing storm duration.

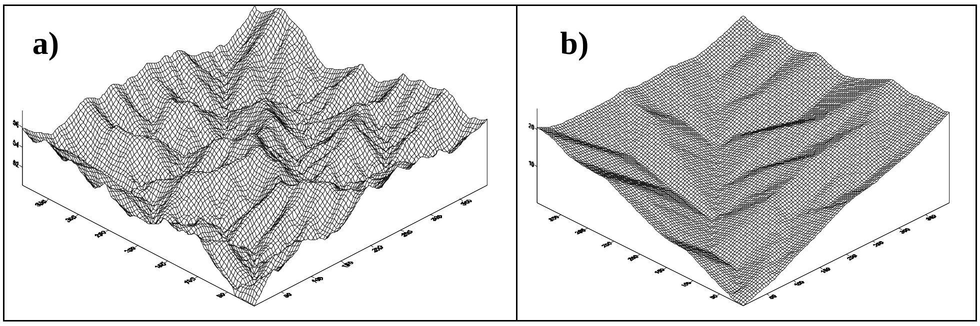

Fig. 1. ***Simulated dynamic equilibrium surfaces. In the case of surface a) storms were infinitely long, while surface b) has been simulated with storm durations markedly shorter than the concentration time of the basin. One corner outflow has been applied, and both runoff (m) and slope (n) exponents were set to unity.***

In order to analyse the flood wave producing characteristics of the two surfaces a rainfall-runoff simulator with constant runoff velocity has been used. A series of storm events with increasing duration was simulated and hydrograph metrics were recorded at the outlet. The hydrograph metrics recorded for each flood event were: peak discharge, the hydrograph shape factor (F_{hs}) relating the area under the hydrograph curve to the peak discharge-hydrograph duration window, and the hydrograph peakedness factor (F_{hp}) comparing peak discharge to the square root of hydrograph volume:

$$F_{hp} = \frac{Q_p}{\sqrt{Q_p T_h F_{hs}}} \, . \qquad (4)$$

Substituting Q_p with (2) and using travel time, T_t, (identical to concentration time) instead of L/U_f:

$$F_{hp} = \frac{(R-I)^{0.5} A^{0.5}}{F_{hs}} \frac{T_r^{\ 0.5}}{T_r + T_t} \, . \qquad (5)$$

For short storms (T_r<<T_t) (5) reduces to F_{hp}~$Tr^{0.5}$, while for long storms (T_r>>T_t) F_{hp}~$Tr^{-0.5}$. According to this hydrograph peakedness increases with increasing storm duration when storms are short, while it decreases when storms are long. The physical explanation for increasing peakedness at low storm durations is that runoff volume increases linearly with storm duration but hydrograph duration increases only less than linearly. The cause for decreasing peakedness at long storms is that peak discharge stops growing as soon as storm duration equals the concentration time while hydrograph duration still increases. This general picture, however, is somewhat modified by the changing value of F_{hs} for it increases slowly from low values (~0.4) towards unity, but this effect does not change the general trend of the peakedness dynamics.

To answer the question when the hydrograph peakedness factor reaches its maximum equation (5) can be differentiated with respect to storm duration and solved for 0. Given that no analytical expression between F_{hs} and T_r is known and that F_{hs} changes only slightly for T_r<T_t, F_{hs} has been considered as an independent constant in the differentiation. For constant F_{hs} F_{hp} reaches maximum when T_r=T_t. Hydrographs are the peakiest or in other words they are most effective in transforming runoff volume into peak discharge when storm duration is equal to or comparable to the concentration time of a catchment.

4. RESULTS AND CONCLUSIONS

Figures 2-4 show the hydrograph metrics of the rainfall-runoff simulations. For both surfaces peak discharge values grow with increasing storm duration until they reach maximum, in this case 1600 units, corresponding to the area of the simulation field times rainfall intensity. For the long-storm surface (SL) maximum runoff is reached at around storm duration 100, for the short-storm surface (SS) already at around storm duration 50. This is due to the considerably shorter concentration time in the second case. Additionally to this there is a difference in the style of the growth rate of peak discharge with increasing storm duration. In the case of SL peak discharge grows close-to-linearly, while for SS the peak discharge curve is upward convex. This is due to differences in the drainage area organisation between the two surfaces: SS is characterized by stronger flow path convergence than SL. At low storm durations, which correspond to the genetic storm duration of the topography, SS is more sensitive in terms of hydrograph peak flow to changes in storm duration than SL.

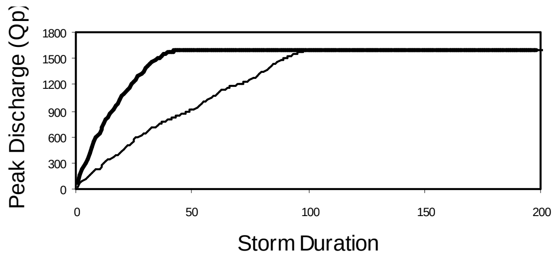

Fig. 2. ***Peak discharge rates at the outlet of the simulated topographies for storms of different duration. Thin line stands for the long-storm surface, thick line for the short-storm surface.***

The changes in the hydrograph shape factor F_{hs} are less for storm durations below the concentration time, than for storm durations exceeding it (Fig. 3). In this latter case F_{hs} grows steadily towards 1. For storm durations below concentration time SS shows lower F_{hs} values (<0.4) than SL (>0.4) indicating thinner hydrographs due to different flow path organisation.

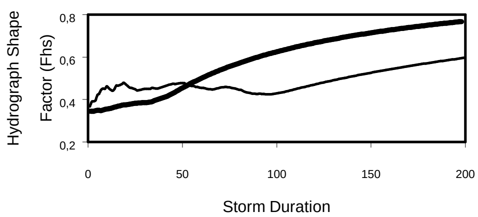

Fig. 3. ***Hydrograph shape factor at the outlet of the simulated topographies for storms of different duration. Thin line stands for the long-storm surface, thick line for the short-storm surface.***

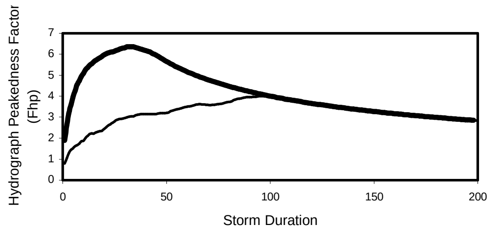

Fig. 4. ***Hydrograph peakedness factor at the outlet of the simulated topographies for storms of different duration. Again, thin line stands for the long-storm surface, thick line for the short-storm surface.***

The hydrograph peakedness factor (F_{hp}) shows the dynamics outlined in the discussion of equation (5). For low storm duration it relates to the square root of storm duration, for higher storm duration to the inverse of the square root of storm duration. In addition to this there is a good agreement with F_{hs} dynamics accounting for small-scale patterns in the F_{hp} curve. In general SS shows higher F_{hp} values due to lower basin concentration time and thinner hydrographs (lower F_{hs}).

The results outlined above point to the fact that surfaces created by short and intense precipitation generate hydrographs that are more peaked in shape and also higher than the hydrographs of the same precipitation in basins originally shaped by long-lasting storms. This is due to the different morphology responsible for differences in concentration time and in drainage area organisation. One way to interpret this phenomenon is to consider it as an outcome of landscape self-organisation. According to equation (3) storm-averaged erosion rates, in environments where the typical duration of storms is less than basin concentration time, relate more to peak discharge than to total runoff. Erosion rates in these environments can be maximized, and hence total energy minimized by maximizing peak discharges of flood hydrographs. This is achieved by reorganizing the landscape through the work of erosion to decrease flow path length and increase the area-length ratio and flow convergence at key locations.

The more practical consequences of this study concern scenarios of climate change. Climate change in Central-Europe is likely to increase the probability of high magnitude precipitation events, basically that of intense and short-storms. The consequences in terms of flood prevention are obvious, more intense storms result higher flood waves. Less obvious is the fact that landscape evolution will additionally boost the generation of severe flash floods by shifting landscape morphology towards surfaces typical of short-storm environments. This means that hydrographs will get peakier (F_{hp}) and thinner (F_{hs}) for a given storm event than they were before, and that the sensitivity of peak discharge values to changes in storm duration will increase producing higher peak discharge increments for a given climate shift than before. The hydrological consequences of climate change are immediate, but most of the geomorphological changes take place only on a longer timescale.

REFERENCES

Hack, J.T., (1960) *Interpretation of erosional topography in humid temperate regions,* American Journal of Science, v. 258A, p. 80-97.

Howard, A.D., (1994) *A detchment-limited model of drainage basin evolution*, Water Resources Research, v. 30, p. 2261-2285.

Rodriguez-Iturbe, I., Rinaldo, A., Rigon, R., Bras, R.L., Marani, A., Ijjasz-Vasquez, E., (1992) *Energy dissipation, runoff production and the three-dimensional structure of river basins*, Water Resources Research, v. 28, p. 1095-1103.

Rodriguez-Iturbe, I. and Valdes, J.B., (1979) *The geomorphologic structure of hydrologic response*, Water Resources Research, 15(6): 1409-1420.

Strahler, A.N., (1964) *Quantitative geomorphology of drainage basins and channel networks*, In: V.T. Chow (Editor), Handbook of applied hydrology.

Sólyom, P.B., and Tucker, G.E., (2004) *The effect of limited storm duration on landscape evolution, drainage basin geometry and hydrograph shapes*, Journal of Geophysical Research, v. 109.

Tucker, G.E., and Slingerland, R.L., (1997) *Drainage basin response to climate change*, Water Resources Research, v. 33, no. 8, p. 2031-2047.

Whipple, K.X., and Tucker, G.E., (1999) *Dynamics of the stream power river incision model: implications for height limits of mountain ranges, landscape response timescales and research needs*, J. Geophys. Res., v. 104, p. 17,661-17,674.

Wolman, M.G. and Miller, J.P., (1960) *Magnitude and frequency of forces in geomorphic processes*, Journal of Geology, 68(1), 54-74.

THE DEALUL SIBIULUI BASE POINT OF THE TRANSYLVANIAN SURVEYS

G. Timár[1], B. Kovács[2], Zs. Bartos-Elekes[3], C. Păunescu[4]

ABSTRACT
The history of the set up of the temporary astronomical observatory near Sibiu (Hermannstadt, Nagyszeben), Romania, is briefly given as well as the coordinates of the later geodetic base point in its place in the historical and modern geodetic networks. This overview is completed by the description of the present terrain situation around the base point. According to our research, the observatory was not a permanent one. It was in a small, temporary wooden house and the astronomic equipments were there only during its location definition campaign in summer and autumn of 1841. No traces of the observatory site are found in the field search. Its place is kept by the modern base point and it can be deduced as identical to the old observatory as the fitting of the second survey sheets using this point as a base control point, is accurate.
Key words: *Sibiu; Hermannstadt; Vízakna; Second military survey; Habsburg Empire; Transylvania; geodetic network*

1. INTRODUCTION

The second military survey of Transylvania has been carried out in the 1860s but the geodetic fieldworks preceded the cartographic phase. In these times, geodetic works start with astronomical latitude and longitude determination of some distinct points, or at least of one astronomical base point. For this purpose, astronomical observatories offered the best locations.

In the middle of the 19th century, the astronomy for geodetic purposes was developed enough for using provisional or temporary field observatories. For example, even a hundred years earlier, during the 1769 expedition of Maximilian Hell and János Sajnovics to Vardø (NE Norway) for observing the passage of the Venus before the Sun, a temporary observatory was constructed and used properly (Csaba, 1997).

For the astronomical base point in Transylvania, a hilltop northwest of Sibiu (its historical German name is Hermannstadt; Hungarian is Nagyszeben) was selected. Why a point so far from the geometric center of Transylvania was was chosen? The main reason could be the fact that the area was densely populated the ethnic Germans (Saxons) and this population was utterly loyal to the Habsburg régime. Later, in 1890, under the direct Hungarian jurisdiction, the similar reason was considered in the selection of the later geodetic center near Tîrgu Mureş/Marosvásárhely, a place with Hungarian population. The selected place beside Sibiu is now called Dealul Sibiului but in the Hungarian literature it is mentioned as 'Vízaknai-hegy' (Jankó, 2001), Mt. Vízakna, after the nearest village further northwest of the point, which is Vízakna in Hungarian (Ocna Sibiului in Romanian and Salzburg in German). In the German literature the base point is simply referred to as

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’Hermannstadt’ (Hofstätter, 1989) or ’bei Hermannstadt’ (Hawliczek, 1841). The German name of the mount (Salzburger Berg) is not mentioned as a name of the base point. On this hilltop, a small, provisional astronomical observatory was set up in 1841. We have no information on how long it worked as an observatory, later it was converted to a simply geodetic base point. Nowadays, it is used also as this, as a part of the Romanian first-order triangulation network.

2. THE SET UP AND THE USAGE OF THE “OBSERVATORIUM BEI HAERMANNSTADT”

The real start of the geodetic works of the second survey of Transylvania was the set up of the observatory and the determination of its astronomical coordinates during the summer of 1841. The full documentation of these measuring campaign can be found in the ÖstA Kriegsarchiv, Vienna (Hawliczek, 1841; Fig. 1), describing the measurement methods and data as well as a plan of the observatory building.

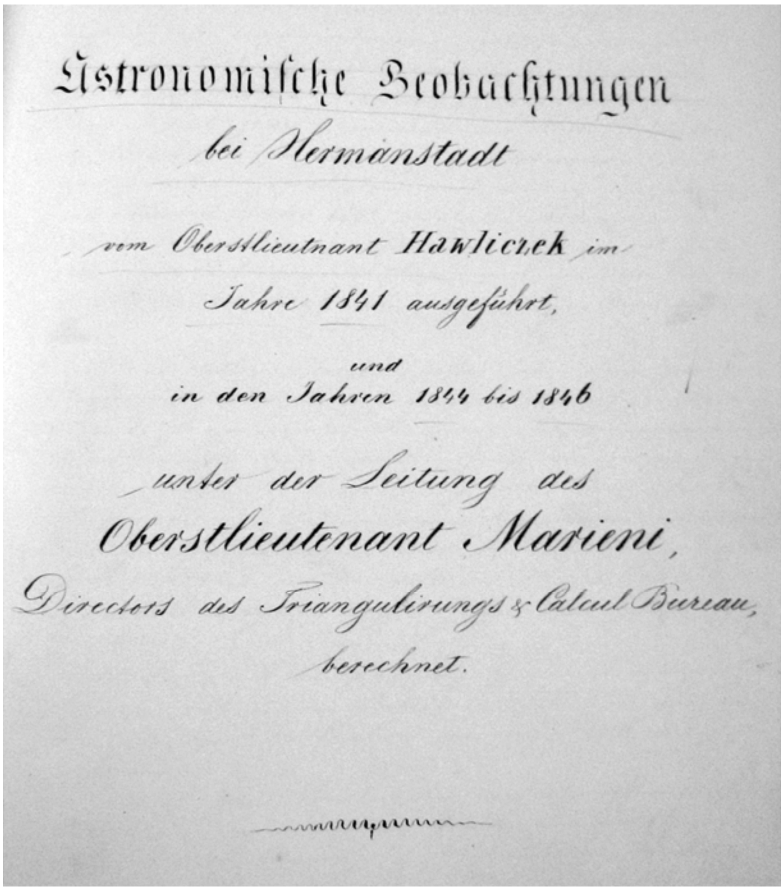

Astronomische Beobachtungen
bei Hermanstadt
vom Oberstlieutnant Hawliczek im
Jahre 1841 ausgeführt,
und
in den Jahren 1844 bis 1846
unter der Leitung des
Oberstlieutenant Marieni,
Directors des Triangulirungs & Calcul Bureau,
berechnet.

Fig. 1 ***The title page of the record of the field works at the Hermannstadt observatory by Hawliczek (1841)***

The observatory building was relatively small, apparently made of wood; according to its plan, the length of the structure in east-west direction was 10 meters (5 fathoms, 1 foot and 8 inches in Viennese units), the width in south-north direction was 3.8 meters (2 fathoms) and the inner height was 1.89 meters (1 fathom) with a 1.5 meters (4 feet and 9 inches) high roof, so the highest point of the roof was 3.4 meters. The astronomic center was slightly east of the center of the building and the universal instrument was placed on its eastern side (Fig. 2).

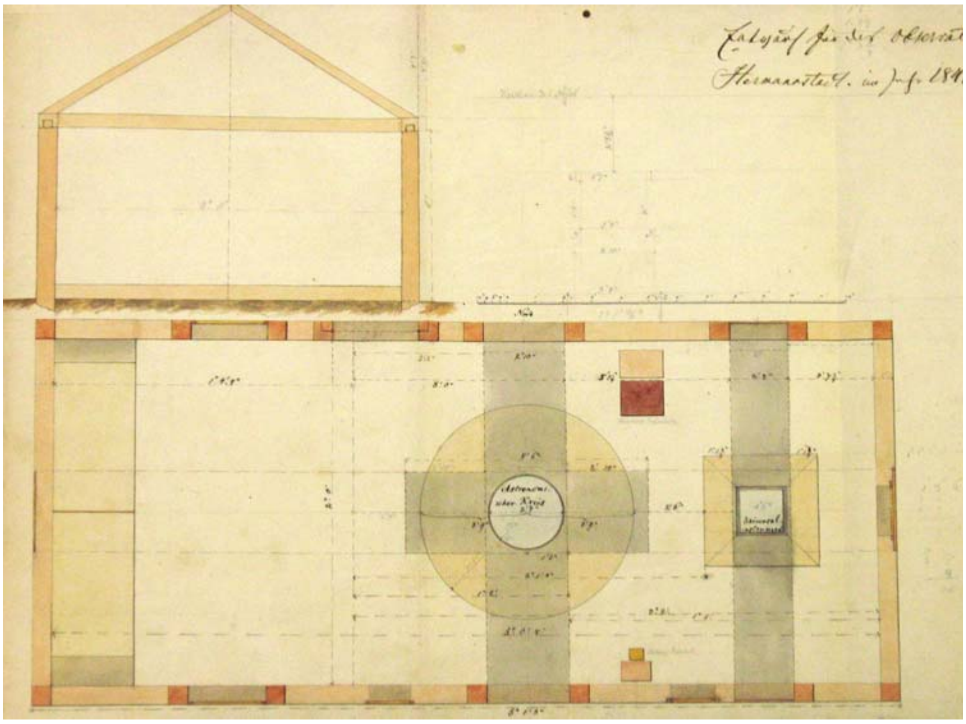
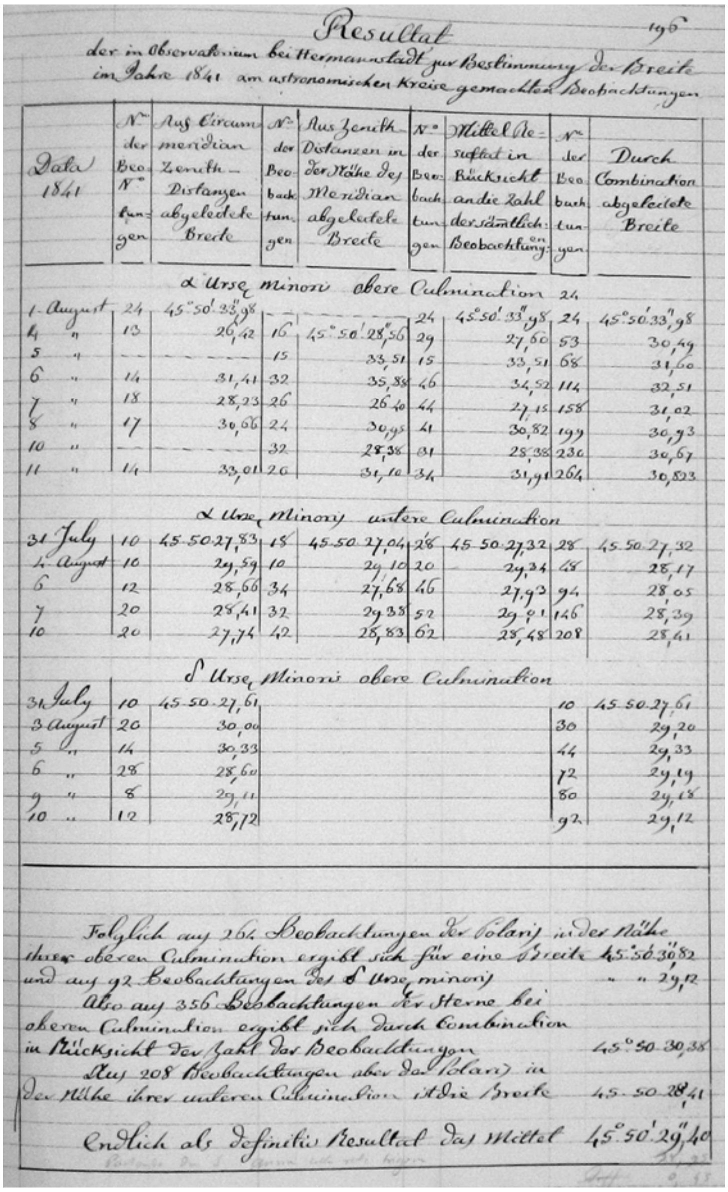


Fig. 2 ***The plan of the provisional observatory building (Hawliczek, 1841). Note that all distances are given in Viennese***

The determination of the astronomical (geographic) latitude was based on several hundred star culmination observations from 29 July to 2 October 1841 (Fig. 3) using a pendulum clock as auxiliary instrument. Culmination of distinct stars was determined by several hundred observations (Fig. 4) and the drift of the pendulum clock wwerealso recorded to get the correction between the star and the clock time (Fig. 5). The azimuth from the observatory to the base point 'Presbe' was also determined by astronomical measurements (Fig. 6).



Resultat 196

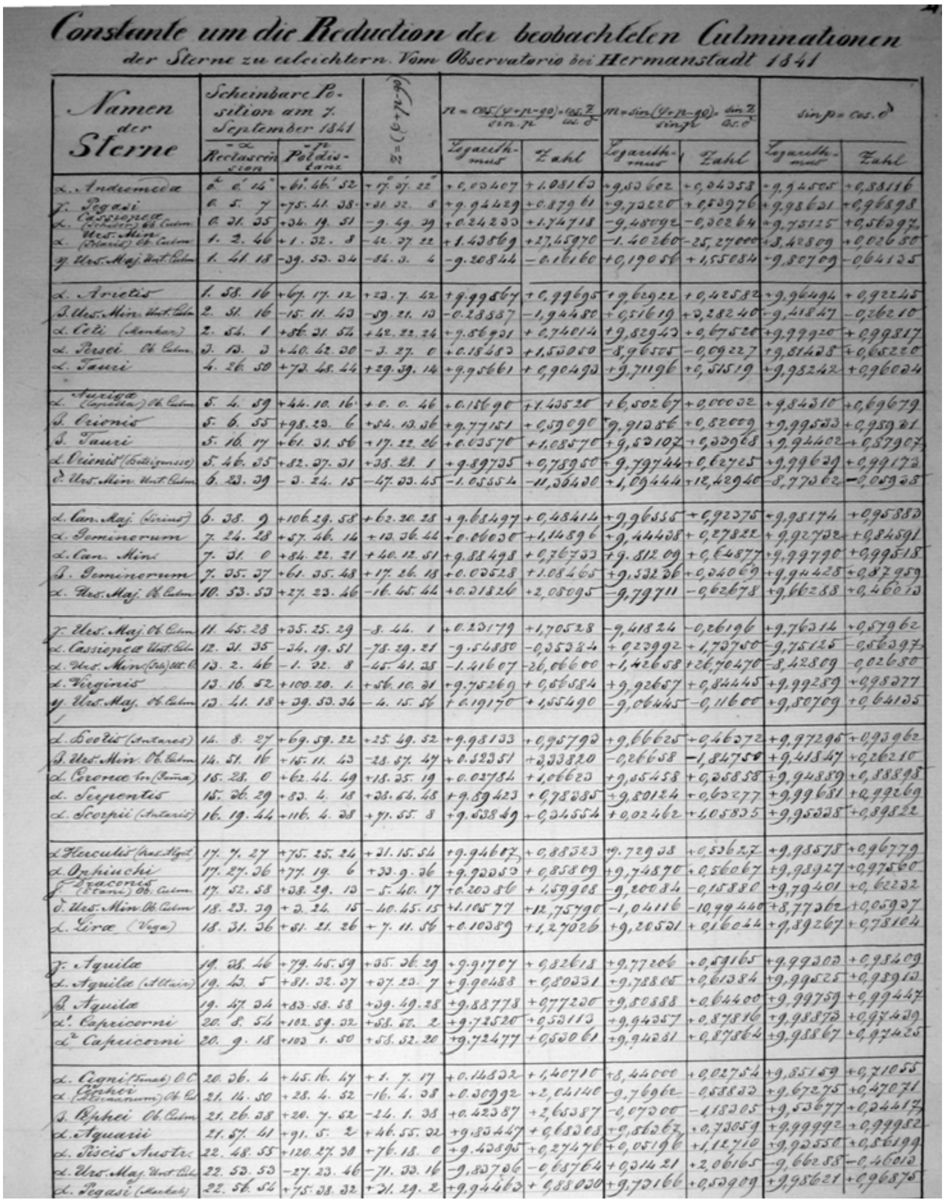
der im Observatorium bei Hermannstadt zur Bestimmung der Breite im Jahre 1841 am astronomischen Kreise gemachten Beobachtungen

Data 1841	N° der Beobachtungen	Aus Circum-meridian Zenith-Distanzen abgeleitete Breite	N° der Beobachtungen	Aus Zenith-Distanzen in der Nähe des Meridian abgeleitete Breite	N° der Beobachtungen	Mittel Resultat in Rücksicht an die Zahl der sämtlichen Beobachtungen	N° der Beobachtungen	Durch Combination abgeleitete Breite
		α Ursæ minoris obere Culmination 24						
1 August	24	45°50'33",98	—	—	24	45°50'33",98	24	45°50'33",98
4 "	13	26,42	16	45°50'28",56	29	27,60	53	30,49
5 "	—	—	15	33,51	15	33,51	68	31,60
6 "	14	31,41	32	35,88	46	34,52	114	32,51
7 "	18	28,23	26	26,40	44	27,15	158	31,02
8 "	17	30,66	24	30,95	41	30,82	199	30,93
10 "	—	—	32	28,38	31	28,38	230	30,67
11 "	14	33,01	20	31,10	34	31,91	264	30,823
		α Ursæ minoris untere Culmination						
31 July	10	45.50.27,83	18	45.50.27,04	28	45.50.27,32	28	45.50.27,32
4 August	10	29,59	10	29,10	20	29,34	48	28,17
6	12	28,66	34	27,68	46	27,93	94	28,05
7	20	28,41	32	29,38	52	29,01	146	28,39
10	20	27,74	42	28,83	62	28,48	208	28,41
		δ Ursæ minoris obere Culmination						
31 July	10	45.50.27,61					10	45.50.27,61
3 August	20	30,00					30	29,20
5 "	14	30,33					44	29,33
6 "	28	28,60					72	29,19
9 "	8	29,11					80	29,18
10 "	12	28,72					92	29,12

Folglich aus 264 Beobachtungen der Polaris in der Nähe ihrer oberen Culmination ergibt sich für eine Breite 45°50'30",82
und aus 92 Beobachtungen des δ Ursæ minoris " " 29,12
Also aus 356 Beobachtungen der Sterne bei oberen Culmination ergibt sich durch Combination in Rücksicht der Zahl der Beobachtungen 45°50'30,38
Aus 208 Beobachtungen aber der Polaris in der Nähe ihrer unteren Culmination ist die Breite 45.50.28,41

Endlich als definitiv Resultat das Mittel 45°50'29",40

Fig. 3 ***Results of the latitude measurements of the observatory***



Constante um die Reduction der beobachteten Culminationen der Sterne zu erleichtern. Vom Observatorio bei Hermanstadt 1841

Namen der Sterne	Scheinbare Position am 7. September 1841: Rectascension (α)	Scheinbare Position am 7. September 1841: Poldistanz (p)	$z=(\varphi+p-90)$	$n=\frac{\cos(\varphi+p-90)}{\sin p}\cdot\frac{\cos z}{\cos\delta}$: Logarithmus	Zahl	$m=\frac{\sin(\varphi+p-90)}{\sin p}\cdot\frac{\sin z}{\cos\delta}$: Logarithmus	Zahl	$\sin p=\cos\delta$: Logarithmus	Zahl
α. Andromedae	0. 0. 14	+61. 46. 52	+17. 37. 22	+0,03407	+1,08163	+9,53602	+0,34353	+9,94505	+0,88116
γ. Pegasi	0. 5. 7	+75. 41. 38	+31. 22. 8	+9,94429	+0,87961	+9,73220	+0,53976	+9,98621	+0,96898
α. Cassiopeae (Schedir) Ob. Culm.	0. 31. 35	+34. 19. 51	−9. 49. 39	+0,24233	+1,74718	−9,48092	−0,30264	+9,75125	+0,56397
α. Urs. Min. (Polaris) Ob. Culm.	1. 2. 46	+1. 32. 8	−42. 37. 22	+1,43869	+27,45970	−1,40260	−25,27000	+8,42809	+0,02680
γ. Urs. Maj. Unt. Culm.	1. 41. 18	−39. 53. 34	−84. 3. 4	−9,20844	−0,16160	+0,19056	+1,55084	+9,80709	−0,64135
α. Arietis	1. 58. 16	+67. 17. 12	+23. 7. 42	+9,99867	+0,99695	+9,62922	+0,42582	+9,96494	+0,92245
β. Urs. Min. Unt. Culm.	2. 51. 16	−15. 11. 43	−59. 21. 13	−0,28887	−1,94480	+0,51619	+3,28240	−9,41847	−0,26210
α. Ceti (Menkar)	2. 54. 1	+86. 21. 54	+42. 22. 24	+9,86931	+0,74014	+9,82943	+0,67520	+9,99920	+0,99817
α. Persei Ob. Culm.	3. 13. 3	+40. 42. 30	−3. 27. 0	+0,18483	+1,53050	−8,96505	−0,09227	+9,81438	+0,65220
α. Tauri	4. 26. 50	+73. 48. 44	+29. 39. 14	+9,95661	+0,90493	+9,71196	+0,51519	+9,98242	+0,96034
α. Aurigae (Capella) Ob. Culm.	5. 4. 59	+44. 10. 16	+0. 0. 46	+0,15690	+1,43520	+6,50267	+0,00032	+9,84310	+0,69679
β. Orionis	5. 6. 55	+98. 23. 6	+54. 13. 36	+9,77151	+0,59090	+9,91386	+0,82009	+9,99533	+0,98931
β. Tauri	5. 16. 17	+61. 31. 56	+17. 22. 26	+0,03570	+1,08570	+9,53107	+0,33968	+9,94402	+0,87907
α. Orionis (Betelgeuse)	5. 46. 35	+82. 37. 31	+38. 28. 1	+9,89735	+0,78950	+9,79744	+0,62725	+9,99639	+0,99173
δ. Urs. Min. Unt. Culm.	6. 23. 39	−3. 24. 15	−47. 33. 45	−1,05554	−11,36430	+1,09444	+12,42940	−8,77362	−0,05938
α. Can. Maj. (Sirius)	6. 38. 9	+106. 29. 58	+62. 30. 28	+9,68497	+0,48414	+9,96555	+0,92375	+9,98174	+0,95883
α. Geminorum	7. 24. 28	+57. 46. 14	+13. 36. 44	+0,06030	+1,14896	+9,44438	+0,27822	+9,92732	+0,84591
α. Can. Min.	7. 31. 0	+84. 22. 21	+40. 12. 51	+9,88498	+0,76733	+9,81209	+0,64877	+9,99790	+0,99518
β. Geminorum	7. 35. 37	+61. 35. 48	+17. 26. 18	+0,03528	+1,08465	+9,53236	+0,34069	+9,94428	+0,87959
α. Urs. Maj. Ob. Culm.	10. 53. 53	+27. 23. 46	−16. 45. 44	+0,31826	+2,08095	−9,79711	−0,62678	+9,66288	+0,46013
γ. Urs. Maj. Ob. Culm.	11. 45. 28	+35. 25. 29	−8. 44. 1	+0,23179	+1,70528	−9,41824	−0,26196	+9,76314	+0,57962
α. Cassiopeae Unt. Culm.	12. 31. 35	−34. 19. 51	−78. 29. 21	−9,54880	−0,35384	+0,23992	+1,73750	−9,75125	−0,56397
α. Urs. Min. (Pol.) Unt. C.	13. 2. 46	−1. 32. 8	−45. 41. 38	−1,41607	−26,06600	+1,42658	+26,70470	−8,42809	−0,02680
α. Virginis	13. 16. 52	+100. 20. 1	+56. 10. 31	+9,75269	+0,56584	+9,92657	+0,84445	+9,99289	+0,98377
η. Urs. Maj. Ob. Culm.	13. 41. 18	+39. 53. 34	−4. 15. 56	+0,19170	+1,55490	−9,06445	−0,11600	+9,80709	+0,64135
α. Bootis (Arcturus)	14. 8. 27	+69. 59. 22	+25. 49. 52	+9,98133	+0,95793	+9,66625	+0,46372	+9,97296	+0,93962
β. Urs. Min. Ob. Culm.	14. 51. 16	+15. 11. 43	−28. 57. 47	+0,52351	+3,33820	−0,26658	−1,84750	+9,41847	+0,26210
α. Coronae bor. (Gemma)	15. 28. 0	+62. 44. 49	+18. 35. 19	+0,02784	+1,06623	+9,55458	+0,35858	+9,94889	+0,88898
α. Serpentis	15. 36. 29	+83. 4. 18	+38. 54. 48	+9,89423	+0,78385	+9,80124	+0,63277	+9,99681	+0,99269
α. Scorpii (Antares)	16. 19. 44	+116. 4. 38	+71. 55. 8	+9,53849	+0,34554	+0,02462	+1,05835	+9,95338	+0,89822
α. Herculis (Ras Algeth)	17. 7. 27	+75. 25. 24	+31. 15. 54	+9,94607	+0,88323	+9,72938	+0,53627	+9,98578	+0,96779
α. Ophiuchi	17. 27. 36	+77. 19. 6	+33. 9. 36	+9,93353	+0,85809	+9,74870	+0,56067	+9,98927	+0,97560
γ. Draconis (Etanin) Ob. Culm.	17. 52. 58	+38. 29. 13	−5. 40. 17	+0,20386	+1,59908	−9,20084	−0,15880	+9,79401	+0,62232
δ. Urs. Min. Ob. Culm.	18. 23. 39	+3. 24. 15	−40. 45. 15	+1,10577	+12,75790	−1,04116	−10,99440	+8,77362	+0,05937
α. Lyrae (Vega)	18. 31. 36	+51. 21. 26	+7. 11. 56	+0,10389	+1,27026	+9,20531	+0,16044	+9,89267	+0,78104
γ. Aquilae	19. 38. 46	+79. 45. 59	+35. 36. 29	+9,91707	+0,82618	+9,77206	+0,59165	+9,99303	+0,98409
α. Aquilae (Altair)	19. 43. 5	+81. 32. 37	+37. 23. 7	+9,90488	+0,80331	+9,78805	+0,61384	+9,99525	+0,98913
β. Aquilae	19. 47. 34	+83. 58. 58	+39. 49. 28	+9,88778	+0,77230	+9,80888	+0,64400	+9,99759	+0,99447
α¹. Capricorni	20. 8. 54	+102. 59. 32	+58. 50. 2	+9,72520	+0,53113	+9,94357	+0,87816	+9,98873	+0,97439
α². Capricorni	20. 9. 18	+103. 1. 50	+58. 52. 20	+9,72477	+0,53061	+9,94381	+0,87864	+9,98867	+0,97425
α. Cygni (Deneb) O. C.	20. 36. 4	+45. 16. 47	+1. 7. 17	+0,14832	+1,40710	+8,44000	+0,02754	+9,85159	+0,71055
α. Cephei (Alderamin) Ob. Cul.	21. 14. 50	+28. 4. 52	−16. 4. 38	+0,30992	+2,04140	−9,76962	−0,58833	+9,67275	+0,47071
β. Cephei Ob. Culm.	21. 26. 38	+20. 7. 52	−24. 1. 38	+0,42387	+2,65387	−0,07300	−1,18305	+9,53677	+0,34417
α. Aquarii	21. 57. 41	+91. 5. 2	+46. 55. 32	+9,83447	+0,68308	+9,86367	+0,73059	+9,99992	+0,99982
α. Piscis Austr.	22. 48. 55	+120. 27. 30	+76. 18. 0	+9,43895	+0,27476	+0,05196	+1,12710	+9,93550	+0,86199
α. Urs. Maj. Unt. Culm.	22. 53. 53	−27. 23. 46	−71. 33. 16	−9,83736	−0,68764	+0,31421	+2,06165	−9,66288	−0,46013
α. Pegasi (Markab)	22. 56. 54	+75. 38. 32	+31. 29. 2	+9,94463	+0,88030	+9,73166	+0,53909	+9,98621	+0,96875

Fig. 4 *The stars (left row) and their reduction constants used for the measurements*

The longitude of the observatory was not measured. It would indeed a measurement of longitude difference with respect to another point, involving *simultaneous* astronomical observations in real time. This was a very hard task at that time, involving e.g. the eclipses of the Jupiter-moons that can be observed simultaneously from different locations of the Earth. Indeed, the meridian of the observatory could be used a real prime meridian for Transylvania. The value of its longitude is important if only we convert the coordinates from the Hermannstadt-centered system to another (e.g. to a modern) one. Even in this case, a more or less precise but consequently used value works well. Later, the longitude difference between the Hermannstadt observatory and Vienna was determined by triangulation.

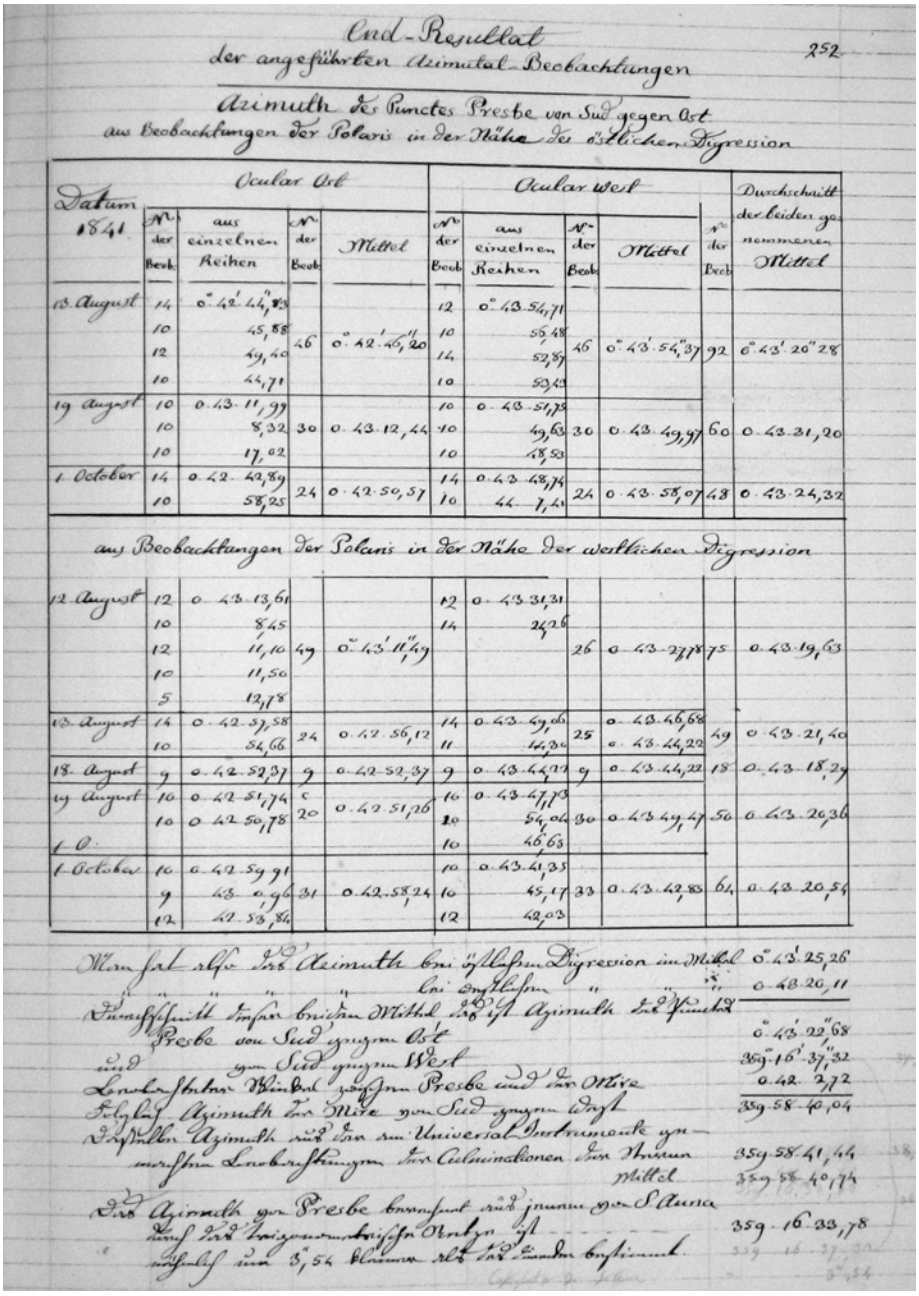


Fig. 5 ***Record of the drift of the pendulum clock used for time measurements***

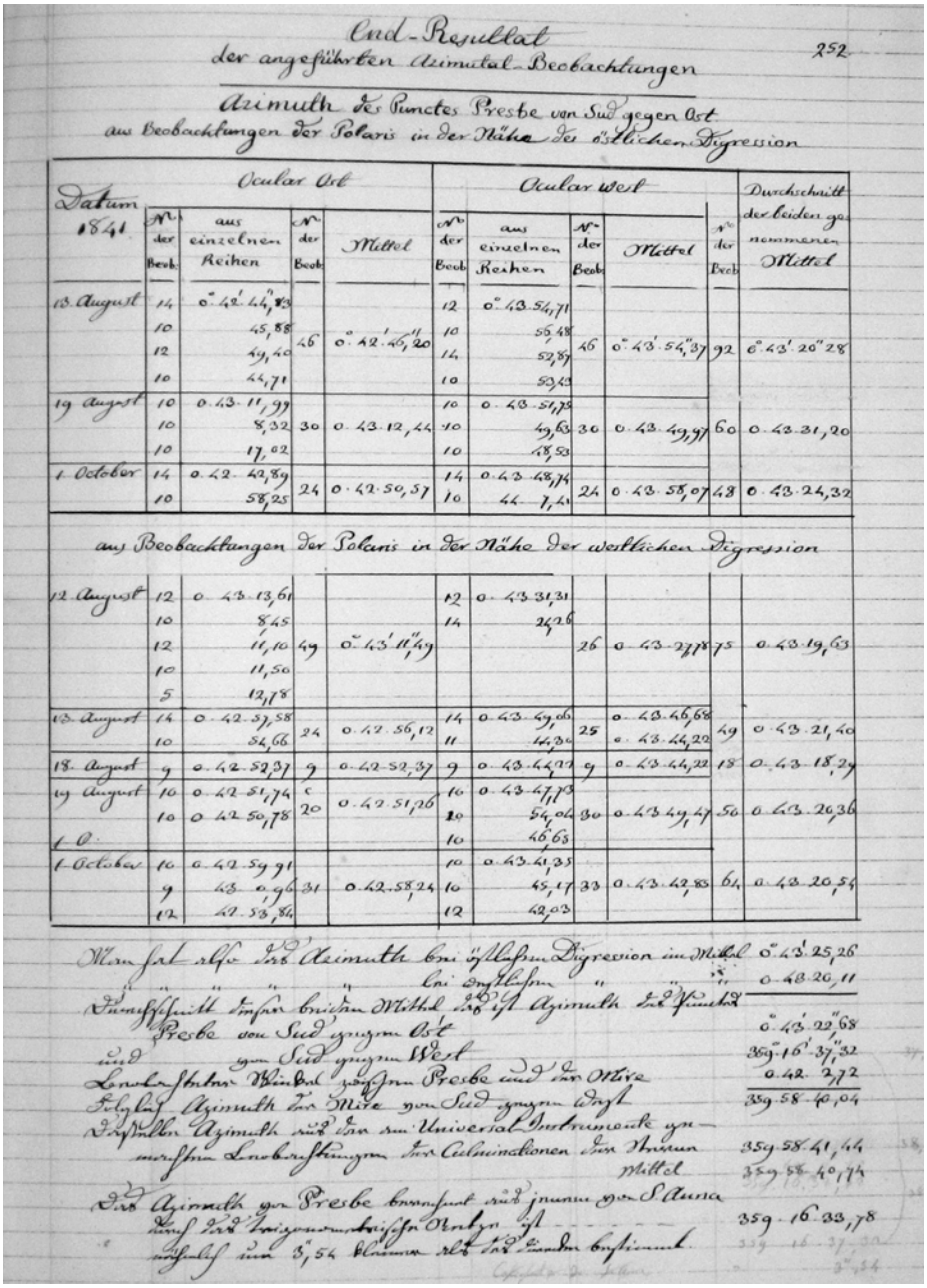


Fig. 6. ***Results of the azimuth measurement to the Presbe point***

The observatory, or at least the base point on its former position and its coordinates were later used during the first triangulation of Walachia (Oltenia and Muntenia) and

Dubrudsha, made by the Habsburg military triangulation institute during the Habsburg occupation of the Danube Principalities in the Crimean War, between 1855 and 1857 (MGI, 1859; Timár, 2008). The Dealul Sibiului base point was the northern end of the triangulation chain along the Olt River that reached the Danube-line at its southern end.

3. THE OBSERVATORY ON THE TOPOGRAPHIC

Although we have no information about how long the observatory building remained on the Dealul Sibiului (the portable instruments were surely carried back to Vienna after the measurement campaign), we can see the observatory on later maps of the area.

As a center of the Transylvanian coordinate system of the second survey, this location was a corner point of four sheets. No more than a sign of a single triangulation point with the inscription 'Observatorium' were indicated on all four sheets, completed at the end of the 1860s (Timár et al., 2007a; Fig. 7).

The point was a member of the first order geodetic network of the Habsburg Empire compiled in the 1870s and 1880s, later, after its proper geodetic adjustment, resulted in the unified Hermannskogel 1892 datum (of the Bessel 1841 ellipsoid) of the Empire. The coordinates of the point in this system are indicated in *Table 1*.

As a normal geodetic base point, it is indicated on the 1:75,000 scale sheet of the third survey, compiled in 1878, even before the completion of the geodetic network adjustment. Later, this sheet was used as a basis of the 1:25,000 scale sheet in the 'Marosvásárhely' system (Timár et al., 2007b), on which we find also a text 'Observatorium' although the map was completed after 1890 (Fig. 8). Our opinion is that these texts are referred to the *former* observatory and not even as a working one or a reserve building.

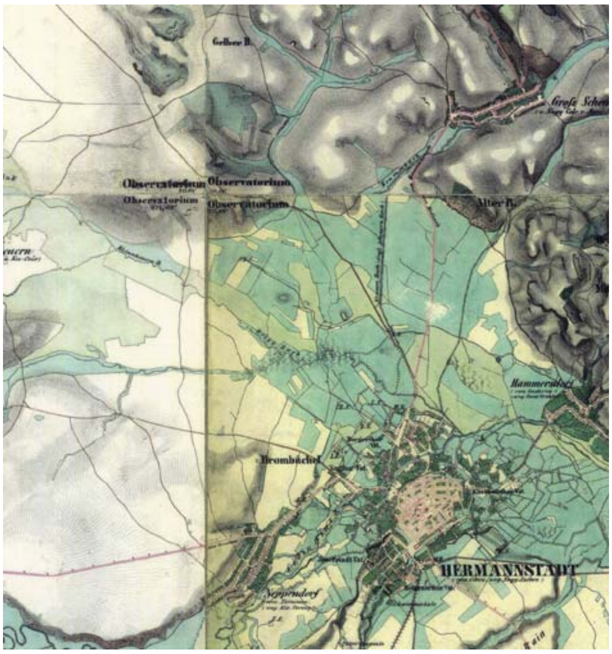


Fig. 7 ***The place of the observatory is at the corner of four different sheets in the mosaic of the second military survey (Timár et al., 2007a)***

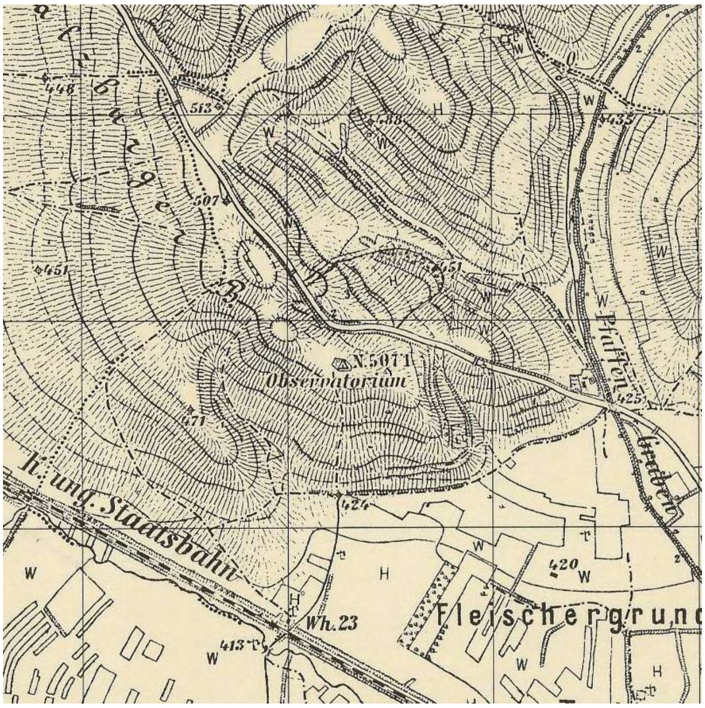


Fig. 8 ***The place of the observatory in the 1:25,000 sheet of the third survey (magnified from the 1:75,000 sheet from 1878; Biszak et al., 2007)***

4. THE LOCATION NOWADAYS

After these historical, archive and cartographic analyses, let's take a tour to the location of the former observatory to see the present topography of the neighborhood. Knowing the modern Stereo-70 coordinates of the base point, we can easily deduce its WGS84 coordinates (*Table 1*). Putting these coordinates into a GPS, we can find the terrain position of the base point that is supposed to be identical to the former observatory. It is on the southeastern end of the Dealul Sibiului ridge, in a bush (Fig. 9) near to the southeastern end of a row of walnut trees (Fig. 10) that can be identified also in the high-resolution satellite images provided by the Google Maps (Fig. 11). The other, smaller bush northeast to the point covers the water reservoir that is indicated in the modern map (Fig. 12). Around the base point in the bush, chain remnants were found that seemed to be quite old but not a real sign or evidence of the former observatory site were detected (Kovács & Bartos-Elekes, 2007).

Fig. 9 ***The bush covering the Dealul Sibiului base point in 2007 (Kovács & Bartos-Elekes, 2007)***

Fig. 10 ***The walnut tree row pair leading to the former observatory site (Kovács & Bartos-Elekes, 2007)***

No wonder, a small, temporary wooden house built more than one and a half century has no sign on the field nowadays. There is no direct evidence of its location just two indirect ones:

- the location of the modern basepoint that is supposed but not proven to be identical with the old observatory place, and

- the accuracy of the fitting of the second survey map sheets (with the projection center at the old observatory site) to the modern ones, based on the location of the old basepoint (Fig. 13).

Fig. 11 ***The base point site in the data of Google Maps with the size of the former observatory building***

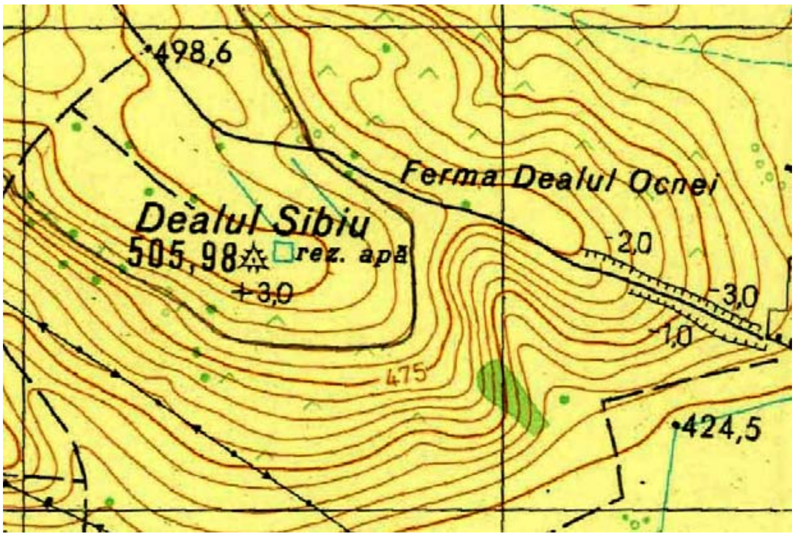


Fig. 12. *The surrounding of the base point on a modern 1:25,000 Romanian military map*

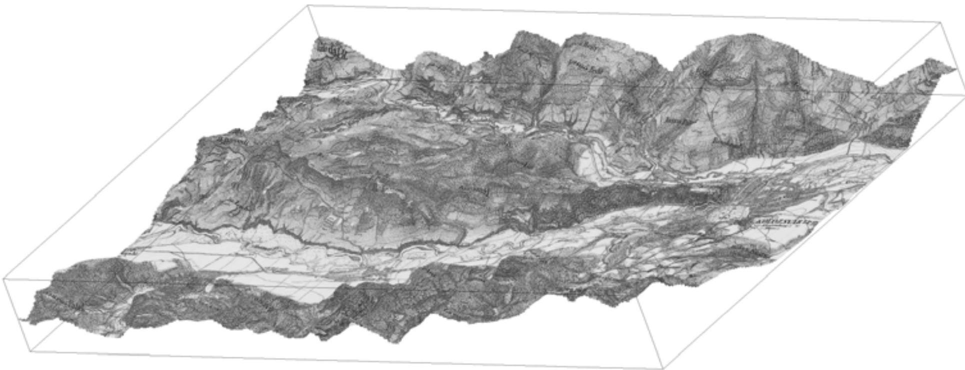


Fig. 13 ***Fitting the shetts*** *of the second military survey to the modern databases: the sheet of Kolozsvár/Cluj* ***combined with the SRTM elevation dataset (Farr et al., 2007) to get a three-dimensional view***

5. SUMMARY

The observatory on the Dealul Sibiului was the first known astro-geodetic base point in Transylvania. It was set up, supposedly for just one season, in 1841. Astronomic measurements for the determination of its latitude and the azimuth to the point Presbe were carried out from July to October 1841. The longitude of the point was later deduced from triangulation campaigns from Vienna. It was the geodetic and projection center of the second military survey of Transylvania.

As the base points of the second survey of different territories of the Habsburg Empire are usually the projection centers of the stable cadastre of the 1850s, we can suppose that this point is also a theoretical cadastral center (Marek, 1875). Although till now, no evidence of the stable cadastre in Transylvania is known by the authors. Its importance is in the science history and the rectification of the map sheets of the second military survey in Transylvania (Timár et al., 2006; Fig. 13).

Acknowledgements. The authors are grateful to Dr. Róbert Hermann, the head of the Hungarian delegation to the Österreische Staatsarchiv, Kriegsarchiv, Vienna, for the availability of the historical documents and manuscripts of the Austrian triangulation and astronomic works concerning the subject.

REFERENCES

Csaba, Gy., G. (1997): A csillagász Hell Miksa írásaiból. Magyar Csillagászati Egyesület, Budapest, 63 p.

Biszak, S., Timár, G., Molnár, G., Jankó, A. (2007): Digitized maps of the Habsburg Empire – The third military survey, Ungarn, Siebenbürgen, Kroatien-Slawonien, 1867-1887, 1:25000. DVD-issue, Arcanum Database Ltd., Budapest, ISBN 978-963-73-7454-8

Farr, T. G., Rosen, P. A., Caro, E., Crippen, R., Duren, R., Hensley, S., Kobrick, M., Paller, M., Rodriguez, E., Roth, L., Seal, D., Shaffer, S., Shimada, J., Umland, J., Werner, M., Oskin, M., Burbank, D., Alsdorf, D. (2007): The Shuttle Radar Topography Mission. *Reviews of Geophysics* 45: RG2004, doi:10.1029/2005RG000183

Hawliczek, A. (1841): Astronomische Beobachtungen bei Hermannstadt. Triangulierungs & Calcul Bureau, Wien. Manuscript in the ÖSTA Kriegsarchiv, ReG.I.Ster No. 118.

Hofstätter, Ernst (1989): Beiträge zur Geschichte der österreichischen Landesaufnahmen, I. Teil, Bundesamt für Eich- und Vermessungwesen, Wien, 196 p.

Jankó, A. (2001): A második katonai felmérés. *Hadtörténeti Közlemények* 114: 103-129.

Kovács, B., Bartos-Elekes, Zs. (2007): A második katonai felmérés erdélyi főalappontjának felkeresése GPS segítségével. *Geodézia és Kartográfia* 59(12): 24-25.

Marek, J. (1875): Technische Anleitung zur Ausführung der Trigonometrischen Operationen des Katasters. Pénzügyminisztérium, M. Kir. Állami Nyomda, Budapest, 397 p.

MGI, Militär-Geographische Institut (1859): Trigonometrische Vermessungen in der Wallachei, ansgeführt durch Offiziere des k.k. Ingenieur-Geografen Corps, in der Jahren 1855, 1856 und 1857. Manuscripts in the Kriegsarchív of Österreiche Staatsarchív, Wien, Archive ID: Triangulierung 194.

MGI, Militär-Geographische Institut (1902): Die Ergebnisse der Triangulierungen des K. u. K. Militär-Geographischen Institutes, Band I-II. Druck der Kaiserlich-Königlichen Hof- und Staatsdruckerei, Wien, Abschnitt I.: Geodätische Coordinaten, pp. 1-122.

Timár, G. (2008): Habsburg geodetic and cartographic activities in the Old Romania. *Studii şi Cercetări, Seria Geologie-Geografie [Complexul Muzeal Bistriţa-Năsăud], in review*

Timár, G., Molnár, G., Székely, B., Biszak, S., Varga, J., Jankó, A. (2006): Digitized maps of the Habsburg Empire – The map sheets of the second military survey and their georeferenced version. Arcanum, Budapest, 59 p. ISBN 963-7374-33-7

Timár, G., Biszak, S., Molnár, G., Székely, B., Imecs, Z., Jankó, A. (2007a): Digitized maps of the Habsburg Empire – First and Second Military Survey, Grossfürstenthum Siebenbürgen. DVD-kiadvány, Arcanum Adatbázis Kiadó, Budapest. ISBN 978-963-73746-0-9

Timár, G., Molnár, G., Imecs, Z., Păunescu, C. (2007b): Datum and projection parameters for the Transylvanian sheets of the 2nd and 3rd Military Surveys. *Geographia Technica* 2(1): 83-88.

Anexes

The coordinates of the Dealul Sibiului base point in various surveys and geodetic datums

Table 1

survey	**Ellipsoid**	**latitude**	**longitude**	**m.**	**reference**
1841 astronomical	astro. (geoid)	45° 50' 29.40"	not specified		Hawliczek (1841)
Walachia 1855-1857	Walbeck 1821	45° 50' 35.75"	41° 46' 38.44"	F	MGI (1859)
Cadastral overview	Zach-Oriani	45° 50' 25.13"	41°46' 32.713"	F	Marek (1875)
3rd survey	Bessel 1841 (Hermannsk.)	45° 50' 24.8802"	41°46'37.0834"	F	MGI (1902)
modern	Krasovsky (S-42)	45° 50' 26.014"	24° 6' 35.634"	G	
modern	WGS84	45° 50' 24.918"	24° 6' 29.986"	G	

USING G.I.S TECHNIQUES TO IDENTIFY AND ANALYSE LANDSCAPE. CASE STUDY: THE MĂCIN MOUNTAINS

Maria-Cornelia Urdea[1]

ABSTRACT

Human activities have generated major changes in the structure of geographical landscape: in time, natural surfaces became smaller. They were replaced by agricultural fields or artificial surfaces and the vegetation suffered major composition and structure changes.

The main purpose of this study is to create a map of the Măcin Mountains landscapes using Geographic Information System (G.I.S) technologies. The identification of the landscapes was made according with CORINE Land Cover classes of land cover. In analyzing the landscapes certain information was used: morphometrical data (hipsometry, geodeclivity, etc.) issued by operating the Digital Elevation Model of terrain, data provided by soils and geological maps and data taken in the field.

*

1. INTRODUCTION

The studied area includes the Măcin Mountains summits and the lowlands around, a total surface of approximately 490 square kilometers situated on the North-West part of the Dobrogea Plateau (figure 1). The long evolution in an open air regime has determined altitudes of less than 500 m. Therefore in this area there is no climatic stratification, nor a stratification of the landscape.

The semiarid climate imposes a xero-thermophyle vegetation type. This overlays on a large variety of soils, from lithosols on the abrupt slopes, to mature and profound soils in lowland areas.

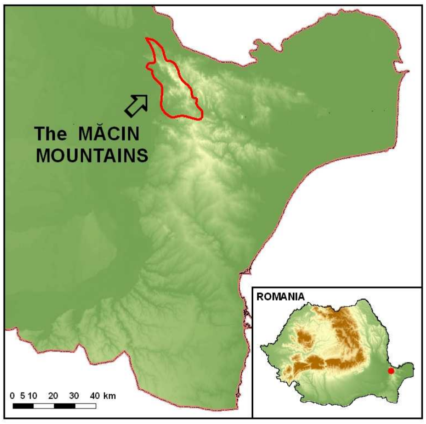


Fig. 1 *Location within Romania and Dobrogea Plateau*

2. DATA

1:50000 scale topographic maps, published in 1982, and 1:200000 scale geological map and soil map, were used. The data were completed with observation taken in the field.

In order to create maps in G.I.S, it was necessary to convert them in digital format by scanning, georeferencing and digitizing. Thus, the existent elements on maps (altitudes, contour lines, settlements etc.) were converted in vectors and stored in separate layers for each type of entity (point, line, polygon). The thematic layers were completed through the attachment of attributes in the table database for each polygon according to the terrain use.

The Digital Elevation Model (DEM) of terrain – figure 2, used most frequently as input to quantify the characteristics of the land surfaces, was created using the interpolation through the triangulation process. Slope and Aspect function applied on DEM generated the digital model for the slope map (figure 3) and the aspect map.

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The inventory of the landscape in the Măcin Mountains area was made using CORINE Land Cover (CLC) method, from „Addendum 2000" report of the European Environmental Agency (EEA). CORINE nomenclature sets three hierarchical levels for land cover – a total of 44 classes. Because of the vast area and the socio-economic characteristics of land use in Romania, this analysis stopped at the second level. G.I.S applications ladscapes modification's realized in Moldova (Boboc, N., et. al. 2006) and Apuseni Mountains (Rus., I. et. al., 2006). Through the overlay method I have integrated the spatial data referring to the land cover with the data referring to the slope gradient, aspect and fragmentation, thus evidencing the characteristics of the landscapes.

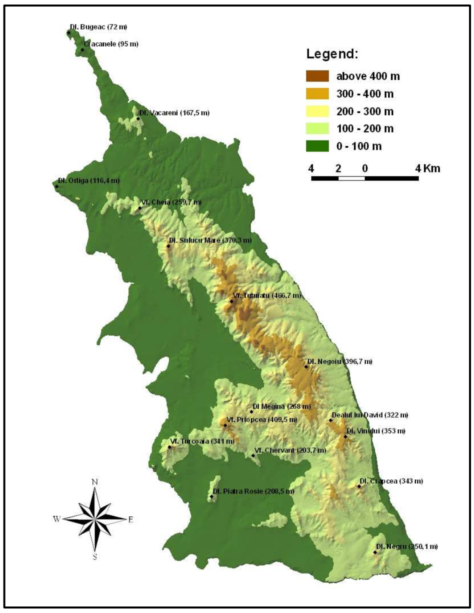

Fig. 2 *Măcin Mountains relief map*

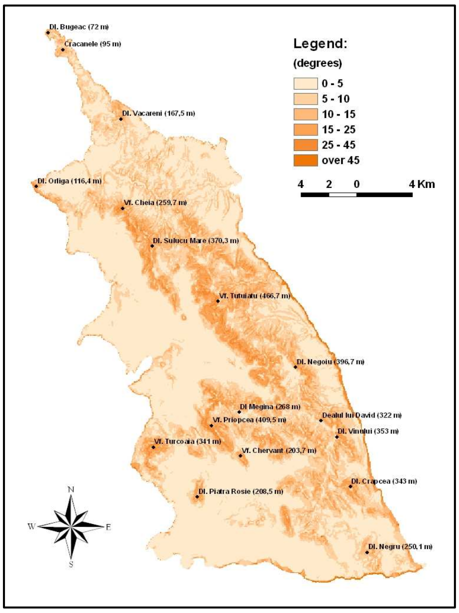

Fig. 3 *Măcin Mountains slope map*

3. RESULTS

The inventory made in the studied area showed as belonging to the second hierarchical level of the CORINE nomenclature the following landscapes: artificial surfaces (1), agriculture areas (2), forests and semi-natural areas (3) and water bodies (5).

Artificial surfaces. The *urban fabric* landscape *(1.1)* is present in the outskirts of the studied area represented in most cases by rural settlements – according to A. Ursu et al. (2006) the clustered structure, sometimes even compact structure of the hearts allows the framing of the rural settlements in class 1.1. Excepting Văcăreni, Garvăn and Mircea Vodă villages, the settlements are located in the bordering lowlands of the mountains. Fertile soils (kastanozems and chernozems) and the high level of accessibility encouraged the concentration of settlements on the Danube Cliff (six of nine places).

Altitude analysis of the Măcin Mountains habitat

Table no. 1

No.	Settlement	Maximum altitude (m)	Minimum altitude (m)	Amplitude (m)
1	Măcin	70	10	60
2	Greci	91,7	30	61,7
3	Jijila	45	10	35
4	Garvăn	50	10	40
5	Văcăreni	75	10	65
6	Cerna	80	40	40
7	Mircea Vodă	150	105	45
8	Carcaliu	25	10	15
9	Turcoaia	90	10	80

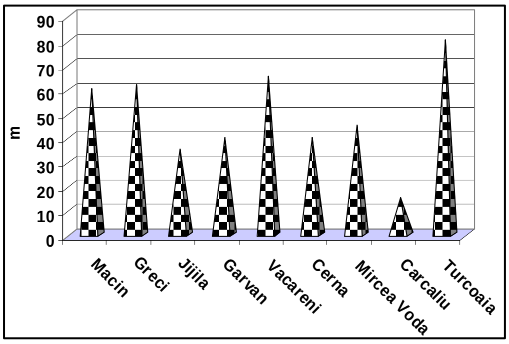

Fig. 4 ***The amplitude variation in the Macin Mountains area***

The maximum altitude of the habitat is of 150 m, and the minimum of 10 m (the superior edge of the Danube Cliff). Morphometrical and morphographical features determine the settlements structure – the hearts are gathered or slightly spread on the slopes - and an agroindustrial feature.

The maximum amplitude of the habitat (80 m) is reG.I.Stered in Turcoaia settlement (figure 4), where the built area (houses and household annexes) tends to spread on the Iacobdeal inselberg slopes.

Settlements sites are located on the pediment level, where the slope gradient is reduced (10-15°), fact which causes no problems of terrain stability. On the other hand, the lithology with loess dominating, facilitates the appearance of pipping funnels on the top of the Danube Cliff (at Turcoaia and Văcăreni) and of torrents (Mircea Vodă).

Six settlements were excluded from this analysis (Balabancea, Nifon, Hamcearca, Traian, Luncavița, Horia) because only part of their hearth is situated in the studied area (the rest is located on the neighboring structures – Niculițel and Babadag Plateaus).

On this territory we can also find the classes of *industrial, commercial and transport units (1.2)* and *mine, dump and construction sites (1.3)*, but their surfaces cannot be found in the CORINE standards. Therefore these two types of land cover were excluded from the analysis.

Agricultural areas represent almost ¾ of the studied area, including annual crops, permanent crops, vegetables crops, pastures and, in an insignificant percentage, uncultivated fields.

The *arable land (2.1)* distribution in territory is determined by the relief morphometry and the soils features. The loess substratum facilitated the development (on quasi-horizontale surfaces or smooth gradient slopes – up to 10°) of soils with high natural fertility. As a result, over 26300 hectares, were introduced in the agricultural circuit, as arable land. Crops entirely replaced the steppe and forest steppe vegetation from Măcin-Greci and Cerna-Mircea Vodă lowlands, and also the natural vegetation from Taița, Luncavița and Jijila valleys.

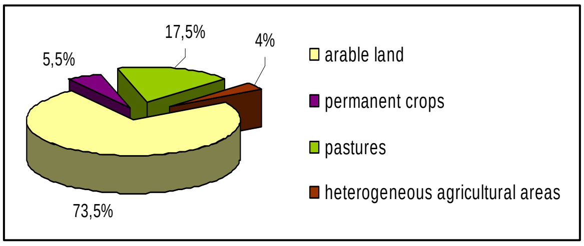

Fig 5 ***The structure of arable land class***

Permanent crops class (2.2) represents 5,5 % from all agricultural areas (figure 5). Vine finds here a favorable topoclimate: mean annual temperature of 10-10.5°C, less than 500 mm of precipitation in one year and over 1650 hours of direct solar exposure on the conventional period of vegetation (http://romvinicol.ean.ro). Soils are represented by chernozems, cambic chernozems, gray soils and regosoils, which are, in general, fine-textured clay soils. Vineyards (2.2.1) are present on the gentle surfaces of the north pediment, with southern, southeastern, and even northeastern aspect. The total vineyard surface goes over 1700 hectares.

Fruit tress and berry plantations cover class (2.2.2) covers approximately 280 hectares. Orchards are present in the proximity of human settlements, in the shape of small plots.

Pastures (2.3) are located on high gradient fields, unsuitable for mechanized crops. They occupy vast areas in Pricopan and Priopcea Summits. They also appear on the western slopes of Măcin Summit, in Morsu basin, at Iacobdeal inselberg foot and on Dălchii Hill slopes. Pastures surface represents 12,6 % of the studied area.

According to the CLC 2000 regulation, surfaces less than 25 hectares, with different agricultural exploitation, may be classified into *heterogeneous agricultural areas class (2.4)*. Thus, 1255 hectares were identified. Such a mosaic of land cover is visible in the outskirts of Greci village and Priopcea Summit foot.

In ***forests and semi-natural areas class***, 10008,7 hectares of *forests (3.1)* and 725,4 hectares of *shrub and/or herbaceous vegetation association (3.2)* were identified.

In the middle of the nineteenth century the forestry area of the North Dobrogea was about 140000 hectares. Along one century of exploitation the surface diminished to half. During the communist period, deforestation was replaced by tree planting and so the forest vegetation can still be seen on the Măcin Mountains summits.

The low altitude and the semiarid climate of Dobrogea permitted the deciduous temperate forest to develop: under 250 m xerophyte and thermophilous species (like *Quercus pedunculiflora* and *Q. pubescens*) and above 250 m mesophyllous species (e.g. *Q. petrea*). The forestry area presents itself in a cvasi-compact form in the upper basins of Taița and Luncavița. It corresponds to the luvisols domain, associated in the high gradient areas with lithosols – upper part of the Măcin Summit between Moroianu and Crapcea peaks. Forests grow better on the shady and semi-shady slopes of the eastern flank of the Măcin Mountains.

The shrub and/or herbaceous vegetation association class includes meadows and silvosteppe vegetation. Meadows can be found inside the forest area. In the southern part of the Măcin Summit and at the foot of the Crapcea Hill, the transition between the forest and the arable land is made by patches of small xerothermophilous tress alternating with stepic grassland. The area occupied by the silvosteppe is getting smaller. Because of the massive deforestation there are only a few patches in an advanced state of degradation that can still be seen today.

Rocks are frequently met on the mountains summits, but not on large surfaces. They can be seen on Pricopan and Priopcea Summits, Bujoarele Hills and in the central part of

Măcin Summit. The characteristic vegetation is represented by moss and lichens. *Silene compacta* and *Dianthus nardiformis* are present in patches.

According to the surrounding vegetation, the rock surfaces can be included in one of the two above mentioned classes.

Inland waters class (5.1) weight in the studied area is very low, just 0,3 %. The main cause consists in the semiarid conditions of Dobrogea.

The only natural ***water bodies*** are situated in the western half of the area, between Măcin town and Greci village: Lake Sărat (with a medium surface of 40 hectares) and Lake Slatina (after periods of heavy rain this may reach 80 hectares). Both of them belong to the shot category. In CORINE norms the anthropic lake on Taița valley, upstream Horia village, is also included.

4. CONCLUSIONS

Analysing the way land is used in Măcin Mountains area, eight types of landscape were found: urban fabric (1.1), arable land (2.1), permanent crops (2.2), pastures (2.3), heterogeneous agricultural areas (2.4), forests (3.1), shrub and/or herbaceous vegetation association (3.2), inland waters (5.1) – figure 7.

The lack of vertical climate zonality transforms the soils and the morphometrical characteristics of the relief (slope gradient, aspect, fragmentation) into determinig factors for the natural landscapes. Eastern slopes, with a less drier topoclimate, with luvisoils and grey chernozems have a typical mesophyllous forest landscape. On western slopes, with brown chernozems, the natural vegetation of xerophyte forest has been almost entirely replaced with crops.

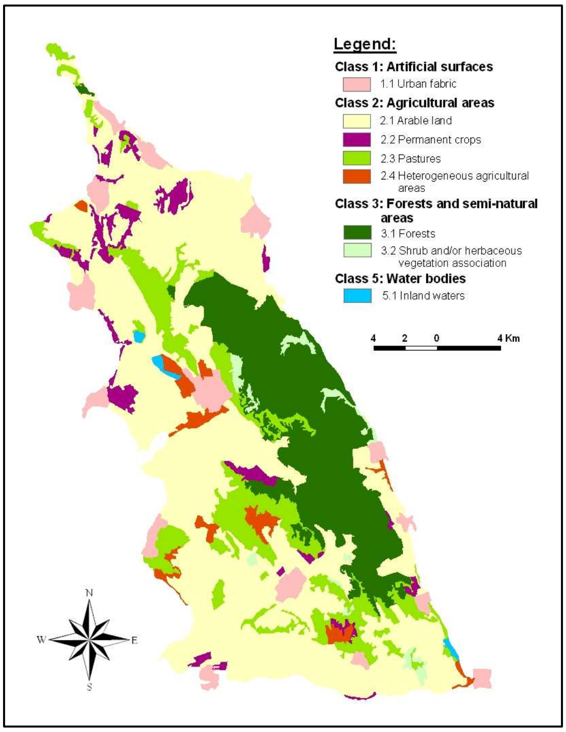

Fig. 6 ***The structure of Măcin Mountains landscape***

The total weight of articial surfaces and agricultural areas inside the studied area is over 75 % (figure 6). This places the Măcin Mountains in the category of highly anthropic areas. Therefore, I consider the identification of landscapes according to the CLC2000 classes as relevant.

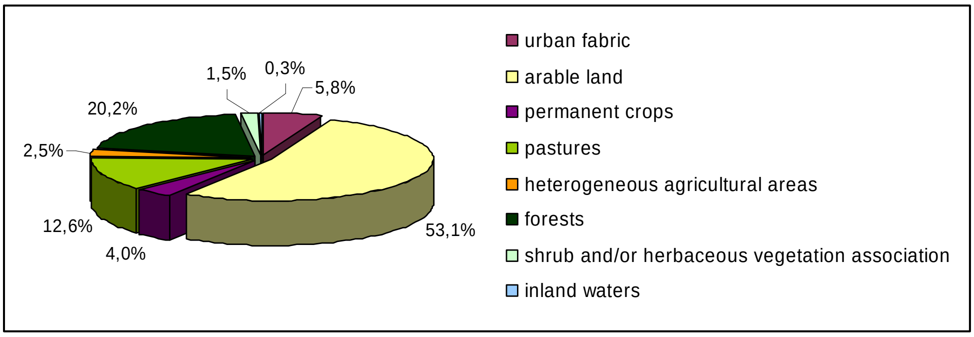

Fig. 6 ***Landscapes map***

REFERENCES

Armaş, Iuliana, Damian, R., Şandric, I., Osaci-Costache, Gabriela (2003), *Vulnerabilitatea versanţilor la alunecări de teren in sectorul subcarpatic al văii Prahova*, Editura Fundaţiei România de Mâine, Bucureşti, 88-98 p.

Boboc, N., Bejan, I., Muntean, V., Tănase A., (2006), Studiul dinamicii modificărilor peisajelor silvice din bazinul Bucovăţului din 1880 până în prezent cu ajutorul S.I.G, „Geographia Technica, no.1, 2006, ISSN 1842-5135, p.31-37, Cluj-Napoca

Bossard, M., Feranec, J., Otahel, J. (2000), *CORINE Land Cover Tehnical Guide-Addendum 2000*, „Tehnical report", no.40, Copenhagen (EEA), http://ww.eea.eu.int

Burcea, Nela (2002), *Dobrogea de Nord-Vest. Studiu geomorfologic* (teză de doctorat), Facultatea de Geografie, Universitatea Bucureşti, 221 p.

Doniţă, N. (1969), *Pădurile Dobrogii ca fenomen geografic* in „Studii geografice asupra Dobrogii. Lucrările primului Simpozion de geografie al Dobrogii", Bucureşti, 133-137 p.

Haidu, I., Haidu, C. (1998), *S.I.G. - Analiză Spaţială*, Editura HGA, Bucureşti, 318 p.

Muică, Cristina (1991), *Influenţa modului de utilizare a terenului asupra dinamicii peisajului*, rev. Terra, nr. 2, Bucureşti, 16-19 p

Osaci-Costache, Gabriela, Armaş, Iuliana (2004), *Peisaje subcarpatice şi susceptibilitatea la alunecări de teren in lungul Văii Prahova*, Analele Universităţii Spiru Haret, Seria Geografie, vol. 7, Bucureşti, 93-98 p.

Rus, I., Surdeanu, V., Petrea, D., Goţiu, D., (2006), Geolandscapes in the Pădurea Caiului Mountains, G.I.S versus adjectival approach, „Geographia Technica, no.1, 2006, ISSN 1842-5135, p.169-175, Cluj-Napoca

Ursu, A., Stoleriu, C., Sfîc, L., Roica, B. (2006), *Adaptarea nomenclaturii Corine Land Cover la specificul utilizării terenului in România*, Geographia technica, no.1, 193-196 p.

*** (1995), *CORINE Land cover. Part 1: Methodology. Part 2: Nomenclature*, Commission of the European Communities

http://earth.unibuc.ro

http://romvinicol.ean.ro

DATABASE RESOURCE IN G.I.S FLOOD SIMULATIONS

B. Văduva[1] , I. Haidu[2]

ABSTRACT
This paper purpose is to present some general issues concerning databases associated with G.I.S and in particular the databases necessary in G.I.S flood simulations. There are a variety of database structures which can be used to store data about spatial features. As database systems we mention RDBMS (Relational Database Management Systems), OODBMS (Object Oriented Database Management Systems) and ORDBMS (Object Relational Database Management Systems). One common feature is the retrieval system that is based on SQL (Structured Query Language).

*

1. INTRODUCTION

1.1. G.I.S data

The author of this paper is gone presume that the reader know what the acronyms G.I.S (Geographic Information System), GPS (Global Positioning System) stands for and is gone focus on the data associated with G.I.S.

We will start with some general information about data (within G.I.S context). Any data to be useful in G.I.S must have some qualities:

1. To be digital (in an electronic or digital format).
2. To have relevance to our/your G.I.S
3. To be similar to a table with columns, identifiers, and parameter values.
4. And a new feature which is good to have, are indexes used for faster retrieval

We know that scanned maps and other pictures can be input into a G.I.S, but we have to understand that images have no spatial value until they are georeferenced. Georeferencing means that we assign coordinate values to locations on an image.

GPS can also be used to identify specific spatial information (x, y, and z) for a particular location. Most GPS come with software that allows transferring the GPS collected points. The same software also allows adding attributes to the collected points. As information we can add for example:

- soil type
- water chemistry
- geology
- and other.

Spatial objects are those objects to whom, the G.I.S information is attached. There are two types of spatial objects:

- raster
- vector

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The fact that spatial objects are linked to the data is what differentiates a G.I.S application from an ordinary database application.

Explanation:

1. raster – surface divided into grid cells. A grid cell has assigned a value that can be elevation, land use or geology (fig. 1).

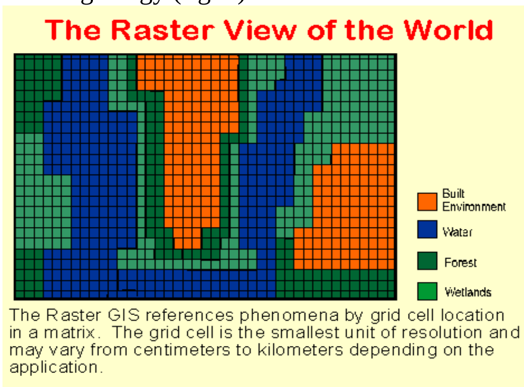

Fig. 1

2. vector – vector objects doesn't cover the entire spatial surface and are represented by points, lines or polygons (fig. 2).

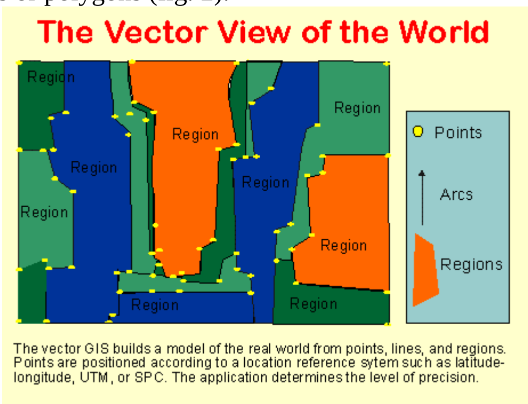

Fig. 2

Knowing what spatial objects are is very important because you (as G.I.S developer) have to decide what kind of data is necessary for different projects. Data needs to be organized into a database. Creating the G.I.S database is very important because of the time and effort involved. Time component is very important because it could take as up to three-quarters of the entire time. G.I.S databases are like any other database and represent objects from the real world. The plus that G.I.S databases offers are the linkage between spatial and non-spatial data. That relationship assures the information about where and what things are and can be represented as follows:

- Location <<< >>> What Is There
- Spatial Data <<< >>> Non-Spatial Data
- Geographic Features <<< >>> Attributes

1.2. The cause of flooding.

We will present very shortly the causes of flooding:

- River flooding - typically the result of heavy or prolonged rainfall causing high volumes of run-off into a river system.
- Coastal and Tidal Flooding - described simply as the inundation of low lying coastal areas by the sea.
- Estuarial Flooding - may occur either due to abnormal coastal or river flows or through a combination of the two factors where river flow is constricted by an incoming tide.
- Groundwater Flooding - resulting from prolonged periods of heavy rainfall. In this case it can cause the flooding of basements and inundation of other underground structures, the accumulation of water in low lying areas and the re-emergence of normally dry groundwater springs.
- Overland Flow Flooding - overland sheet flow or pluvial flooding; overland flow flooding is characterized by water flowing over the ground surface where there is no drainage system to accept it.
- Flooding from Artificial Drainage Systems - when the scale of a rainfall or storm event exceeds the capacity of ditches, drains, culverts and sewers.
- Climate Change

With G.I.S, we can link the geographical information stored in a database with images. The information stored should be available for queries and analysis. By overlaying or intersecting different geographical layers, flood areas can be identified and targeted for stricter floodplain management practices. G.I.S applications for flood management was realized in the Hydrographic Basin of Someşul Mic (Bilaşco Şt., Haidu I., 2006) or the Hydrographic Basin of Crişul Alb and Crişul Negru (Constantinescu V., et. colab, 2007)

2. OUR DATA

Due to the fact that we are gone simulate flooding we will need a database to store the relevant information.

We tried to answer to the following questions:

- Where? – a small region in Apuseni Mountains
- What? – simulate flooding
- When? – we have to verify our simulation model on existing data and try to forecast future events
- How? – this is our objective. We have to show/test methodologies for simulation.

The majority of databases in use today are relational database management systems (RDBMS) and we will use RDBMS databases. These RDBMS consist of tables, containing related data which are linked to each other. These tables are known as entities and the links as relations. The process of dividing the data into tables and establishing the relations is known as normalization. Normalization is the process which produces a database with minimal redundancy and was suggested by Codd (1970). Shortly we will present the steps of normalization process:

1. remove any repeating data from the initial groupings
2. eliminate redundant data
3. eliminate columns not dependent on key
4. Boyce-Codd normal form
5. isolate independent multiple relationships
6. isolate semantically related multiple relationships

Again we will not insist on normalization, but keep in mind that we will have to use it when we will develop our G.I.S database.

But we don't have to forget the purpose of our study "to simulate flooding". In this context we identified two elements (like all the others before us) for our G.I.S:

- spatial objects
- database associated with those objects (values)

As spatial objects we need:

- Romanian map (1: 50000 from 1970)
  with the followings layers:
  1. borders
  2. rivers
  3. roads
  4. railroads
  5. levels
- for our region of study:
  1. soil type
  2. water chemistry (if available)

As values we identified the following:

- minimum temperature
- maximum temperature
- average temperature
- rain quantities

As for tables we could have:

Rain_Intensities		
ID	**Name**	**Range (Start Value -> End Value)**

Rain		
ID	**Name**	**Date**

Rain_Values			
ID	**Rain_ID**	**Value**	**DateTime**

All the above tables must be linked with spatial objects. Without the linkage we don't have a G.I.S database we only have **a database.**

Regarding the methodology for simulation we could use the existing commercial G.I.S products (ESRI products for example – even in this products we have to write small programs) or we can try building/developing our own specialized software.

We have to keep in mind that our tables could change during the study or we can learn something new that could ask for new data and new spatial objects or values.

3. CONCLUSIONS

The G.I.S will provide reliable information and will try to simulate natural conditions thus enabling prioritizing issues and channeling attention to the most appropriate areas.

REFERENCES

Bilaşco, Şt., Haidu, I., The valuation of maximum runoff on interbasinal areas, assited by G.I.S, „Geographia Technica, no.2, 2006, ISSN 1842-5135, p.1-7, Cluj-Napoca.

Chapter 2 in Bolstad, Paul. 2005. *G.I.S Fundamentals: A First Text on Geographic Information Systems*, 2nd. ed. White Bear Lake, MN: Eider Press.

Chapters 3-5 in Chang, Kang-tsung. 2006. *Introduction to Geographic Information Systems*, 3rd. ed. Boston: McGraw Hill.

Chapter 3 in Clarke, Keith C. 2003. *Getting Started with Geographic Information Systems*, 4th ed. Upper Saddle River, NJ: Prentice Hall.

Crăciunescu, V., Stăncălie., Ghe., Constantinescu Şt., Ovejeanu, I., (2007), *Web-based geo-information system for transboundary flood management*, „Geographia Technica, no.2, 2007, ISSN 1842-5135, p.20-33, Cluj-Napoca.

Burrough, P.A. 1986. *Principles of Geographical Information Systems for Land Resource Assessment*. New York: Oxford University Press.

DeMers, Michael N. 2005. *Fundamentals of Geographic Information Systems*, 3rd ed. Wiley.

Huxhold, W.E. 1991. *An Introduction of Urban Geographic Information Systems*. New York and Oxford: Oxford University Press.

Longley, P.A., M.F. Goodchild, D.J. Maguire, and D.W. Rhind. 2001. Geographic information systems and science. John Wiley & Sons, LTD: England.