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Cover: ***The Peleaga Valley – Retezat Mountains*** *(Photo by Mihaela Licurici)*

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THE SEMIAUTOMATED IDENTIFICATION OF THE PLANATION SURFACES ON THE BASIS OF THE DIGITAL TERRAIN MODEL. CASE STUDY: THE MEHEDINŢI MOUNTAINS (SOUTHERN CARPATHIANS)[1]

Marcel TÖRÖK-OANCE[2], Florina ARDELEAN[2], Alexandru ONACA[2]

Abstract: The paper presents a method for the semiautomated classification of the planation surfaces, using the Digital Terrain Model (DTM) and the object-oriented analysis. The effort undergone for developing such a method has a number of motivations. The first one is that these landforms are very important for *decoding* the geomorphologic evolution of the relief units. The second motivation concerns the fact that their identification and mapping, by using classical means, represents a difficult demarche, which requires a lot of time. Finally, the already-known limits of the relief analysis using the DTM at pixel level impose the testing of an object-oriented analysis, in which the area under study is divided into *objects* of various dimensions, as homogenous as possible from the viewpoint of one or more properties. The method that we propose supposes the following steps: the realisation of the slope model and of the flow model, starting from the DTM; the division, by segmentation into *objects* that are as homogenous as possible from the viewpoint of the slope; the classification of the *objects* into landforms (planation surfaces) by using the fuzzy functions and taking into account more factors simultaneously (the average slope value, the minimum slope value, the flow coefficient and the altitude), and the selection and grouping of the identified surfaces into sculptural complexes. The first stages represent the automated part of the method, while the last one requires a detailed geomorphologic analysis of the area, as well as the validation of the results on the field. The method was firstly developed for the Godeanu Mountains, the map of the levelled surfaces (Niculescu, 1965) being used for the identification of the parameters included in the algorithm, as well as for testing the results obtained in the view of the improvement of the method. Due to the good results thus obtained, the same method was also used for mapping the levelled surfaces in the Mehedinţi Mountains, and, along with the field observations, there was realised the planation surfaces map for this relief unit.

Key words: planation surfaces, Geomorphometry, Digital Terrain Model (DTM), object-based image analysis (OBIA), Segmentation, The Mehedinţi Mountains (Sothern Carpathians)

Rezumat: Identificarea semiautomată a suprafeţelor de nivelare pe baza modelului numeric al terenului. Studiu de caz: Munţii Mehedinţiului (Carpaţii Meridionali). Lucrarea prezintă o metodă de clasificare semiautomată a suprafeţelor de nivelare utilizând Modelul Numeric al Terenului (MNT) şi analiza orientată – obiect. Efortul depus pentru dezvoltarea unei astfel de metode are mai multe motivaţii. Prima ar fi aceea că aceste forme de relief au o importanţă deosebită în „descifrarea" evoluţiei geomorfologice a unităţilor de relief. A doua motivaţie este faptul că identificarea şi cartarea acestora prin mijloace clasice reprezintă un demers dificil, care necesită totodată foarte mult timp. In cele din urmă, limitele deja recunoscute ale analizei reliefului pe baza MNT la nivel de pixel impun şi încercarea unei analize orientate-obiect, în care arealul studiat este împărţit în „obiecte" de diferite dimensiuni, cât mai omogene în funcţie de una sau mai multe proprietăţi. Metoda propusă de noi presupune parcurgerea următoarelor etape: realizarea modelului pantelor şi a modelului scurgerii pornind de la MNT; separarea prin segmentare în „obiecte" cât mai omogene din punct de vedere al pantei; clasificarea „obiectelor" în forme de relief (suprafeţe de nivelare) utilizând funcţiile fuzzy şi ţinând cont de mai mulţi factori simultan (valoarea medie a pantei, valoarea minimă a pantei, coeficientul de scurgere şi altitudinea) şi selectarea şi gruparea suprafeţelor astfel identificate în complexe sculpturale. Dacă primele etape reprezintă partea automată a metodei, cea din urmă necesită o analiză geomorfologică detaliată a arealului respectiv, precum şi validarea rezultatelor în teren. Metoda a fost dezvoltată prima dată pentru Munţii Godeanu utilizându-se harta suprafeţelor de nivelare (Niculescu, 1965), atât pentru identificarea parametrilor incluşi în algoritm, cât şi pentru testarea rezultatelor obţinute în vederea îmbunătăţirii metodei. Datorită rezultatelor bune obţinute s-a utilizat aceeaşi metodă şi pentru cartarea suprafeţelor de nivelare din Munţii Mehedinţiului şi, împreună cu observaţiile din teren, s-a realizat harta suprafeţelor de nivelare din această unitate de relief.

Cuvinte cheie: suprafeţe de nivelare, geomorfometrie, model numeric al terenului (MNT), analiza imaginilor orientată-obiect, segmentare, Munţii Mehedinţiului (Carpaţii Meridionali)

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1. Introduction

Even though they occupy limited areas as compared to the slopes, the planation surfaces and levels have been in the attention of geomorphologists since the end of the 19th century, as these landforms give information concerning the relief genesis and age, being highly important reference points in the establishment of the stages and phases in the evolution of the relief units to which they belong (Posea, 1997).

Regardless of the genesis and of the type of the respective surface, the identification, the mapping and the achievement of the planation surfaces' maps at regional or local scale remains a laborious process, which requires much time and an impressing work volume, including the field activity, in direct proportion with the extension of the area under study. As the geomorphologic cartographic materials do not have national coverage and are not homogenous from the viewpoint of the legend and of the scale, it is very hard or even impossible to do the analysis of these forms for more extended areas, in order to decode the evolution or for practical reasons.

The method that we propose belongs to the area of the ***geomorphometry***, a new research direction among the Earth Sciences, which evolved at the meeting point of geomorphology, mathematics and informatics (Pike et all., 2009). Since the first attempts to digitally analyse the relief, there existed two approach tendencies, so that there can be distinguished a specific geomorphometry, which follows the analysis of the landforms, as discrete elements of topography, and a general geomorphometry, which analyses the relief as a continuous topographical surface (Evans, 1972). In the case of the specific geomorphometry, there were achieved methods for the identification of the linear or circular shapes (Parrot and Taud, 1992), of the narrow ridges (Chorowicz et al., 1995), of the slope types (Irvin et al., 1997; MacMillan et al., 2000; Burrough et al., 2000), or even for the automated extraction of some landforms (Graff and Usery, 1993).

During the last years, at national level, in the field of digital geomorphology, there were certain studies conducted for limited surfaces, but they mainly concerned the morphometric analysis of the relief or the identification of the occurrence areas of various present geomorphologic processes. In this respect, there are to be mentioned the permafrost modelling (Török-Oance, 2001, 2004), the analysis of the gravitational processes (Armaş et al, 2002, 2003), various GIS analyses of mountain geomorphology, including the analysis of the geomorphologic risk (Şandric, 2001; Mihai, 2003, 2004, 2007, Török-Oance, 2005). Few papers deal with the identification proper of certain landforms. There is to be mentioned the first attempt to identify the planation surfaces by using the DTM (Török-Oance, 2001[1]) and the automated classification of the relief elements by using object-oriented classification procedures (Draguț and Blaschke, 2006).

2. Material and methods

The present study comprises two parts: the first one presents the method proposed by us and compares the results obtained by using this method with the planation surfaces' map for Godeanu Mountains, which was realised through careful geomorphologic mapping (Niculescu, 1965); in the second part, there is obtained the planation surfaces map for Mehedinți Mountains – a relief unit for which such a geomorphologic map did not exist. Both areas belong to the Retezat – Godeanu Mountain Group, located in the western part of the Southern Carpathians, where *there appears the most typical and uniform scale concerning the order and number of the erosion steps and their grouping on complexes* (Posea, 2005) and where they were firstly identified by Emm. de Martonne, in 1907.

2.1. The morphometric analysis and the identification of the morphometric elements used in the classification

In order to establish the morphometric elements that best characterise these landforms, the general geomorphologic map of the Godeanu Mountains (Niculescu, 1965) was used as starting point. This was scanned and rectified by using as reference image the digital topographical map, scale 1:25,000, georeferenced in Stereo 1970 coordinates. There were used 34 reference points, mainly confluence points and elevation points (ArcGIS 9.2 soft). The map thus georeferenced was used for the digitizing of the planation surfaces and a vector layer, with polygons differentiated on the three sculptural complexes (Borăscu, Râu Şes and Gornovița), was obtained. This was used to extract and to statistically analyse the data in the morphometric models obtained from DTM.

A SPOT HRS digital terrain model with 30 meters spatial resolution was used in order to realize the morphometric models. The following morphometric models were obtained: the slope

[1] *Aplicații ale Sistemelor Informaționale Geografice în geomorfologie (II). Identificarea şi cartarea suprafeţelor de nivelare cu ajutorul SIG*, paper presented at the Geographic Information Systems Symposium – 9th Edition, *Al. I. Cuza* University, Iaşi.

model, the aspect, the plan and profile terrain bending. Since the planation surfaces are relict forms, usually located on interfluves, on the surface of which there can be identified the remnants of slightly deepened relict valleys at the most, we considered that the mathematical model of the flow concentration can offer important information. The statistical interrogation of the morphometric data was realised for every polygon (planation surface). The descriptive statistical variables analysed for every morphometric index were the following: the minimum value, the maximum value, the average value and the standard deviation. Following this analysis, it was noticed the fact that the mild slope represents the essential feature of these forms, followed by the flow concentration, which displays minimum values of less than 80, and the altitude, the planation surfaces being grouped on different altitudinal steps. With respect to the aspect and the terrain bending, the values are very different from an area to the other, and, thus, they are not defining for these landforms.

2.2. Segmentation

The analysis of the relief, on the basis of the DTM at pixel level, has a series of already well-known limitations, such as the impossibility to include into analysis the topological relations (vicinity, connectivity, inclusion) or the form of the objects (Blasche and Strobl, 2002). The significant results obtained in the automated classification of the relief, through the object-oriented analysis (Drăguţ and Blasche, 2006) proved the obvious superiority of this method as compared to the pixel level analysis.

The transformation from the pixel level to the *object* or *spatial primitives* level was realised by using the Definiens v.5 programme, through the image segmentation process, which requires the specification of the homogeneity rules by setting the size of a scale. This size is a no-dimension one and, at low values, enables the attainment of smaller objects with higher homogeneity degree, while at high values leads to the attainment of heterogeneous, large-sized objects. Since the slope of the terrain is the essential variable in the identification of these forms, the segmentation firstly regarded the realisation of certain areas (*objects*) as homogenous as possible from the viewpoint of the declivity and big enough to ensure a facile subsequent classification (Fig. 1). There were tested more segmentation variants, with scale values of 10, 20, 30, 50 and 100. The selection of the best segmentation was done through the visual analysis of the results that were overlapped on the DTM and were tridimentionally represented. The best result was obtained at a scale value of 20.

2.3. Classification

The classification process of the objects obtained through segmentation took into account more factors, among which the slope is the most important. Taking into account the values that we identified through morphometric analysis and the data collected from the field literature (according to Posea, 1997, S I has a declivity comprised between 5 and 7 ‰, S II = 20 – 30 ‰ and S III = 5 – 20 ‰), more classification variants were tried. The results were compared through the overlapping of the layer with the digitized planation surfaces over the result of the classification. The best result was obtained when the average slope value for each object was used, and not the maximum values. Other problems faced in the classification process regarded the elimination of the objects displaying the same morphometric features as the planation surfaces, i.e. the floodplains, the terraces and the lakes.

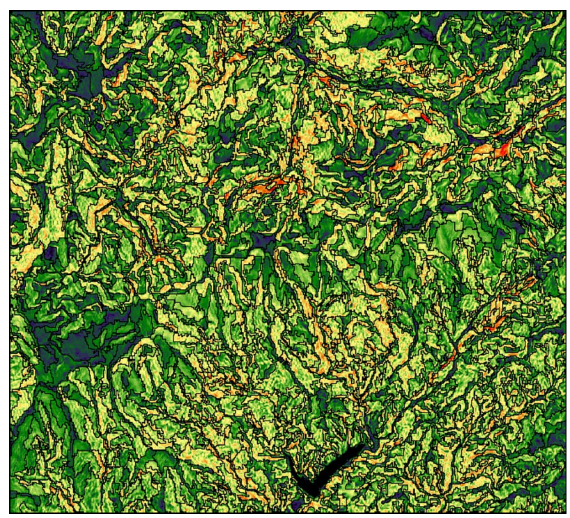

Fig. 1. The spatial primitives or the *objects* obtained through the image segmentation process

Finally, the conditions used in the classification process for the identification of the planation surfaces, were the following:

- the average slope value of under 14 degrees,
- the minimum slope value of less or equal to 2 degrees (in order to eliminate those objects that, although having an average slope value of less than 14 degrees, do not contain horizontal surfaces and, thus, are not planation surfaces),
- under 80 value of the concentrated flow. As previously mentioned, the planation surfaces are relict forms and they are not crossed by any

river. The consideration of this criterion enables a better identification of the planation surfaces, as well as the automated elimination of the flat areas, such as the terraces and floodplains along the rivers,

- an average value of the infrared reflectance of under 45 (there were used Landsat ETM satellite images – band 4). The inclusion of the satellite images in the classification algorithm was necessary in order to exclude the lakes (they can be well noticed in Fig. 1), which, following the *average slope* and *minimum slope* criteria, were classified as planation surfaces.

2.4. Results and discussions

In order to check the correctness of the classification result, this was compared with the map realised by Niculescu (1965) (Fig. 2) and it proved to be 91 percent accurate with respect to the location of these forms. The unidentified surfaces are generally smaller areas that belong to the Râu Șes sculptural complex and that probably have a more accentuated declivity. However, there are to be noticed differences with respect to their shape, as a rule being observed the fact that the proposed method leads to the achievement of slightly bigger surfaces than the real ones. It must be specified the fact that, in contradistinction to the planation surfaces' map realised by Niculescu (1965), in which these forms are strictly represented for the area of the Godeanu Mountains, the result that we obtained covers a much more extended surface, practically all the DTM surface, i.e. also parts of the neighbouring mountain units. These were not included in the evaluation of the method, because of the absence of appropriate geomorphologic cartographic materials.

Practically, following the algorithm, a digital map of the possible planation surfaces is obtained. However, in order to achieve the final map, it is mandatory to further use additional data, such as the field data, the geological data and the aerial photograph-based analysis. Moreover, it is necessary to group them on sculptural complexes, by taking into account the altitude. The method shortens very much the work time and the result is useful both for the field mapping and for subsequent geomorphologic analyses. The utility of the method also lays in the fact that the following elements are accurately known for each identified form:

- the mathematical position, the GPS being successfully used for the field mapping;
- the surface and the perimeter;
- the maximum, minimum and average values and the standard deviations for any morphometric element that is derived from the DTM;
- geological and tectonic data, when such information exist in digital format.

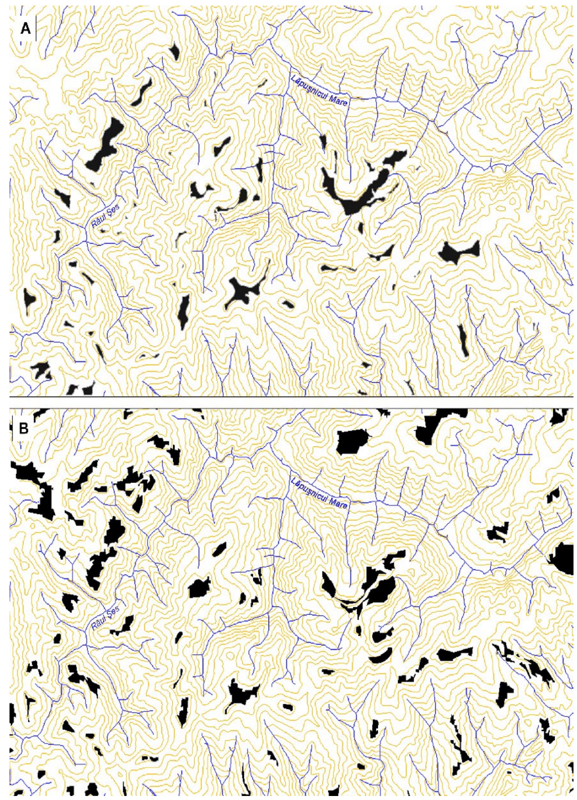

Fig. 2. Comparison between: A, the planation surfaces' map for the Godeanu Mountains (Niculescu, 1965) and B, the result obtained through the object-oriented analysis

The tridimensional visual analysis of the result obtained, or in combination with the anaglyph maps (Török – Oance, 2006), is also very useful in the identification of certain *problematic areas* or in the elimination of errors.

3. The achievement of the planation surfaces' map for the Mehedinți Mountains

In order to realise this map (fig. 3), in the first stage it was used the previously described methodology, including the same type of DTM, and in the second stage the results were validated on the basis of the field mapping, of the digital geological maps (Török – Oance, 2006), of the aerial photograph-based analysis and of the analysis of the DTM-based geomorphologic profiles. In addition to the previously described situation, in the case of the Mehedinți Mountains, the quasi-horizontal surfaces that represent the bottom of the extended karstic depressions were erroneously identified as levelled surfaces. The correction of this error was manually done for the time being, through reclassification; the automated elimination of these situations will be attempted in

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future studies, as this type of errors will probably be encountered in the analysis of any karstic region.

The final map (Fig. 3) was obtained in OCAD 9 programme, by integrating the digital data and the data obtained from field mapping. We chose this solution because in this program it could be built a digital library of conventional signs corresponding to the legend of the general geomorphologic map at big scale (1:25,000), proposed by the Institute of Geography (1993).

4. Considerations on the planation surfaces in the Mehedinţi Mountains

4.1. The Borăscu sculptural complex

The presence of this sculptural complex is signalled in all neighbouring mountain units and it can be presumed that it also existed in the Mehedinţi Mountains. At present, there can be noticed the existence of certain karst erosion outliers that surpass 1,300 meters altitude and are considered remnants of the Borăscu surface: Stan's Peak (1,466 meters), Piatra Mare a Cloşanilor (1,421 meters) and Pietrele Albe (1,335 meters), Culmea Bradului (1,331 meters) and Geanţul Ismenelor (1,343 meters) (Emm. de Martonne, 1907; I. Ilie, 1970; I. Povară, 1997) (Fig. 3).

4.2.The Râu Şes sculptural complex

It appears very well developed in the Mehedinţi Mountains, on crystalline rocks in the northern sector, as well as on limestone, in the central and the southern sectors. It occupies a surface of 19.54 square kilometres, almost equal with that occupied by the Gornoviţa complex (Fig. 3, A). Two levels can be differentiated: the first one is not much extended, it lies at approximately 1,300 meters and it develops exclusively on limestone; the second one, with important extension, is comprised between 1,200 meters in the central part and 800 – 900 meters in the south.

The Râu Şes I level occupies a surface of 3.4 square kilometres, being mostly destroyed by erosion. It appears only on limestone and solely south of Arşasca (Fig. 3). Its greatest extension is in the area of the main ridge of the Mehedinţi Mountains, in the central sector, between the Arşasca and the Ţăsna valleys, where it also registers the highest altitudes, around 1,300 meters. It is dominated by some calcareous peaks that rise up to 150 meters above this level.

It has the shape of small karst plateaus or of planed ridges, which often have structural character, as in the case of those located east of the Pietrele Albe Peak. The great negative karstic forms located between Stan's Peak and Ţăsna deepened in this level (I. Povară, 1997), which can be easily reconstituted; although the calcareous ridge situated westward of the karst depressions is narrow and strongly fragmented, it still remains at a relatively constant level of 1,200 – 1,250 meters of altitude (Photo 1).

South of the Ţăsna valley, the appearance of this level is only exceptional (Fig. 3). It is to be noticed that the altitude of the outliers of this surface decreases towards south: Inălăţu Mare (1,301 meters), which dominates Balta Cerbului karst depression, probably also deepened in this level, Colţu Pietrii (1,229 meters), Şuşcu (1,192 meters) Rudina Mare (1,177 meters) and Grăbănic (1,131 meters), the last one being also developed on the formations of the Severin Thrust-sheet.

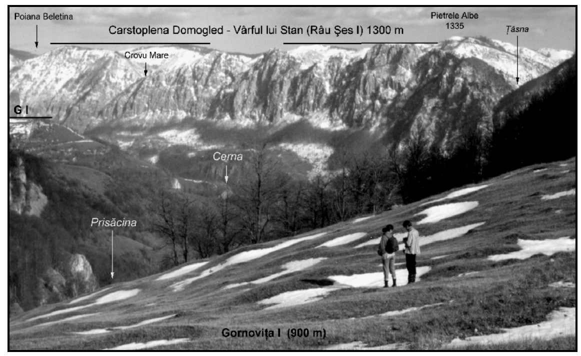

Photo 1 The Domogled – Stan's Peak old Karstplain, seen from the Cerna Mountains

The Râu Şes II level is much more extended than the previous one, covering 16.14 square kilometres (Fig. 3, A). It is present in the northern sector, as well as south of Arşasca. There are to be distinguished two different situations:

- *The Râu Şes II level developed on crystalline rocks* appears in the northern sector, on the Ridge of Cerna and in the southern sector, between Grăbănic Peak (1,131 meters) and Meteriz Peak (722 meters). Depending on the type of rock, there appear differences concerning the morphology and the extension of this level. Thus, in the Ridge of Cerna, where this level cuts off granitoids, it takes the shape if a rounded top, locally levelled into small plateaus, more developed south of Cioaca Înaltă Peak (1,137 meters), but without surpassing 300 meters breadth (L. Badea et al., 1981). The ridge maintains a relatively constant altitude of 1,000 – 1,100 meters and it is dominated by generally rounded peaks, genuine erosion outliers, among which the highest are Cioaca Înaltă and Ştevaru (1,212 meters). These peaks can be considered outliers of the Râu Şes I level. Because of the lower altitude at which the remnants of these surfaces appear, as compared to the central sector, some authors (I. Povară, 1997) consider that the Borăscu and the Râu Şes surfaces are missing in this sector, as a consequence of the total destruction through erosion and that the highest peaks on the Cerna Ridge are remnants of the Râu Şes II level. As previously shown, the absence of limestones, along with other factors, permitted the total destruction of the Borăscu surface. The lower altitudes at which the Râu Şes complex appears here, as compared to the karst regions, can be also explained by the petrography differences. From our viewpoint, the integration of these surfaces in the Gornovița sculptural complex would be erroneous for at least two reasons:

- the much higher altitude, of more than 1,000 meters, at which this surface would appear, as compared to the situation from Godeanu and Cerna Mountains, where the Gornovița level maintains an altitude with 100 – 200 meters lower (Gh. Niculescu, 1965 and D. Gureanu, 2004) on the right slope of the Cerna. Moreover, in the Vâlcan Mountains, the Gornovița surface is registered at a maximum altitude of 900 meters (L. Badea et al., 2001).
- if it is considered that this surface belongs to Gornovița, it appears impossible to correlate it with the other relief steps on the eastern side of the Mehedinți Mountains.

The integration of the surfaces on the Cerna Ridge in the Râu Şes sculptural complex appears, thus, as obvious. The same opinion appears in the chapter dedicated to the Mehedinți Mountains, in the Geography of Romania, volume III (1987). Furthermore, this level appears well represented south of the Milean valley, in Plaiul Păltinei (1,049 meters) and in Cioaca Frasinului, at about 1,100 – 1,150 meters of altitude. It takes the shape of rounded ridges, or even of small plateaus, elongated on the direction of the ridge, remarkably flat sometimes, as in the case of that located south of Cioaca Frasinului Peak, bearing the suggestive local name of Poiana Punții.

In the central sector, on the interfluves bordered by the Țăsna, the Coşuştea and the Carmazanu, this level is present and well represented. It cuts off the wildflysch formation, as well as the ophyolitic complex of the Severin Thrust-sheet and it can be radially followed around Ciolanu Mare Peak (1,135 meters) and up to 950 meters of altitude, on the ridge that starts from Ciolanu Mic Peak and heads towards north-east.

In the southern sector, the Râu Şes II level cuts off the crystalline rocks of the Getic Thrust-sheet. It has the appearance of broad, uniform bridges that level the main ridge and occupy rather important surfaces, such as the one in Poiana Rachelii, covering almost one square kilometre.

- *The Râu Şes II level carved in limestone*, has a different appearance:

- as a suspended old karstplain (M. Bleahu and T. Rusu, 1965), bordered by escarpments or steep slopes, in the central and southern sectors and it is characterised by a particular topography. The planation surface shape is to be found only in the central sector, eastwards of the main ridge, but even there it often has a structural character. South of the Țăsna valley, because of the stronger deepening of the valleys of the tributaries of the Cerna, the karst plateau is divided into small massifs (L. Badea el al., 1981), so that the Râu Şes II level is maintained on smaller surfaces. More extended surfaces are noticeable in the Cociu, the Hurcu and the Şuşcu massifs, where there appear karst plateaus at about 1,100 meters (Fig. 3). Some of these can be considered as relict, such as the one in Culmea Vârtoapelor (I. Povară, 1997). The structural plateau unfold southwards of the Domogled ridge probably also belongs to this level.
- as a flat and extended plateau in the Obârşia ridge, cutting limestone and other sedimentary rocks. It is the most representative area for this type of relief in the Mehedinți Mountains. The plateau, extended on a surface of more than 3 square kilometres, is mostly forested, it maintains 1,000 – 1,100 meters of altitude and is dominated by erosion outliers, probably remnants of the Râu Şes I level: Cioaca Lacului (1,150 meters) and Poiana Mică (1,180 meters).
- as calcareous shelves, with an obvious structural character, on the southern slope of the Piatra Cloşanilor, at 950 – 1,000 meters of altitude.

4. 3. The Gornovița sculptural complex

The surfaces that permitted the reconstitution of this sculptural complex occupy 19.43 square kilometres. The occurrence area of this complex is mainly the eastern slope of the mountains and the northern sector (Fig. 3). Only in rare cases does this surface develop on limestone, mainly appearing on other sedimentary rocks, as well as on metamorphic and eruptive rocks. Two altimetrically differentiated levels were identified:

Gornovița I level is the most extended level within this sculptural complex. It is found on the secondary ridges, under the form of rounded or levelled sectors. It is well represented in the northern sector, where there is to be noticed the hydrographical basin of the Dobrota, in which the secondary ridges leaving from the Cerna Ridge, as well as those leaving from Cioaca Frasinului are levelled at about 850 meters in the origin sector and at 750-800 meters near the confluence with the Capra river. The ridges that descend from the Cioaca Înaltă towards the Dobrota river are deforested and are occupied by numerous small shelters and isolated houses in the levelled sectors. Of these ridges, the longest one is Plaiul Cernei, over 6 kilometres long, descending in steps towards the confluence of the Dobrota with the Capra. It is almost entirely deforested and it is crossed by an old pastoral road that connects the Motru valley, the Cerna valley and, through the Oslea Table land, with the pastures from the Alpine level of the Godeanu Mountains. The southern part of the Cioaca Frasinului small crystalline massif , between the origin of the Iapa Mare gully and Cracu Pietrii, is also a representative area for the occurrence of this level. Because of the mild slope characteristic for the area, the forest was cut and replaced by pastures and numerous shelters.

The secondary elongated ridges that depart from the Obârşia Ridge towards east, formed in the crystallyne rocs of the Getic Thrust-sheet or of the Severin Thrust-sheet, as well as in the wildflysch sedimentary formations, bear the traces of the Pliocene modelling. Generally, the higher ridges, with east-west orientation, such as the Ridge of the Paharnic or the Măgura Ridge bear the traces of the Gornoviţa I level, the morphology of which is that of levelled ridge at about 750-850 meters, marked by the presence of erosion outliers with little altitude differences and with rounded, knolly aspect: Peak of the Paharnic (885 meters), Vârful Înalt (732 meters), Ochianu Peak (757 meters) and Măgura Peak (797 meters).

In the central and southern sectors, the Gornoviţa I level can be recognised on almost all secondary ridges that descend towards the Mehedinţi Tableland. It is to be noticed an altitudinal decrease of this level from the north to the south. Thus, in the Ciobanul, the Costeşti and the Camena river basins it maintains an altitude of about 800 meters, as in the case of the ridges Băia, Padina Turmei, Dealul la Şest and Comoriştea, while south of the Gherghenițu valley, this level appears only at 700 – 750 meters of altitude.

The ***Gornoviţa II level*** is rather characteristic to the Mehedinţi Tableland and especially to the Bahna basin. In the mountains, it appears especially in the northern sector, where it penetrates along the Motru, the Lupşa and the Brebina valleys. Southwards of the Coşuştea it has a discontinuous occurrence in the border sector between the mountains and the tableland. From the morphological viewpoint, it is similar to the previous level, the planed or rounded ridges that maintain 650 - 500 meters of altitude being dominant. This level, much extended on the interfluves between the Lupşa and the Motru Sec, is entirely developed in Cretaceous wildflysch and displays significant flatness and relatively constant altitudes of 600 – 650 meters. Near the Muchii Peak (661 meters), the ridge takes the aspect of a small plateau, with breadths that can surpass 500 meters (Fig. 3).

The Gornoviţa surface in the Cerna basin, on the slope corresponding to the Mehedinţi Mountains, appears under the form of valley replats levels. Gh. Niculescu (1965) is the one to notice the presence, in the upper course of the Cerna, of a number of replats levels that certify the rhythmic post-Miocene deepening of the valley. Among these, the 700 - 900 meters level is considered synchronic with the Gornoviţa level. The subsequent studies (L. Badea et al., 1981; I. Povară, 1997) support this presumption and underline the presence of the valley replats levels also in the middle Cerna basin. Trying to connect these levels, we consider that in the Băile Herculane region, the 750 meters replats level corresponds to the Gornoviţa I level, while the 600 meters one to the Gornoviţa II level. In most of the cases, on the slope of the Mehedinţi Mountains, these replats levels coincide with faulted compartments, lowered in steps towards the Cerna; thus, the integration of these levels in the Gornoviţa sculptural complex is possible but it must be regarded with a lot of reserves.

An interesting situation is that within the lower areas located eastwards of the line of the Geanţuri. In this area, the secondary ridges that descend from the Cerna Ridge are heavily levelled, representing small elongated plateaus that, in the near vicinity of the contact between the granitoides and the limestone, astonish through their horizontal character, strongly contrasting with the surrounding karst ridges. Their integration in the 700 – 800 meters altitudinal level, at which the Gornoviţa level appears on the opposite slope, in the Cerna Mountains (D. Gureanu, 2004), made us presume that these ridges would integrate in the Gornoviţa. Sculptural complex.

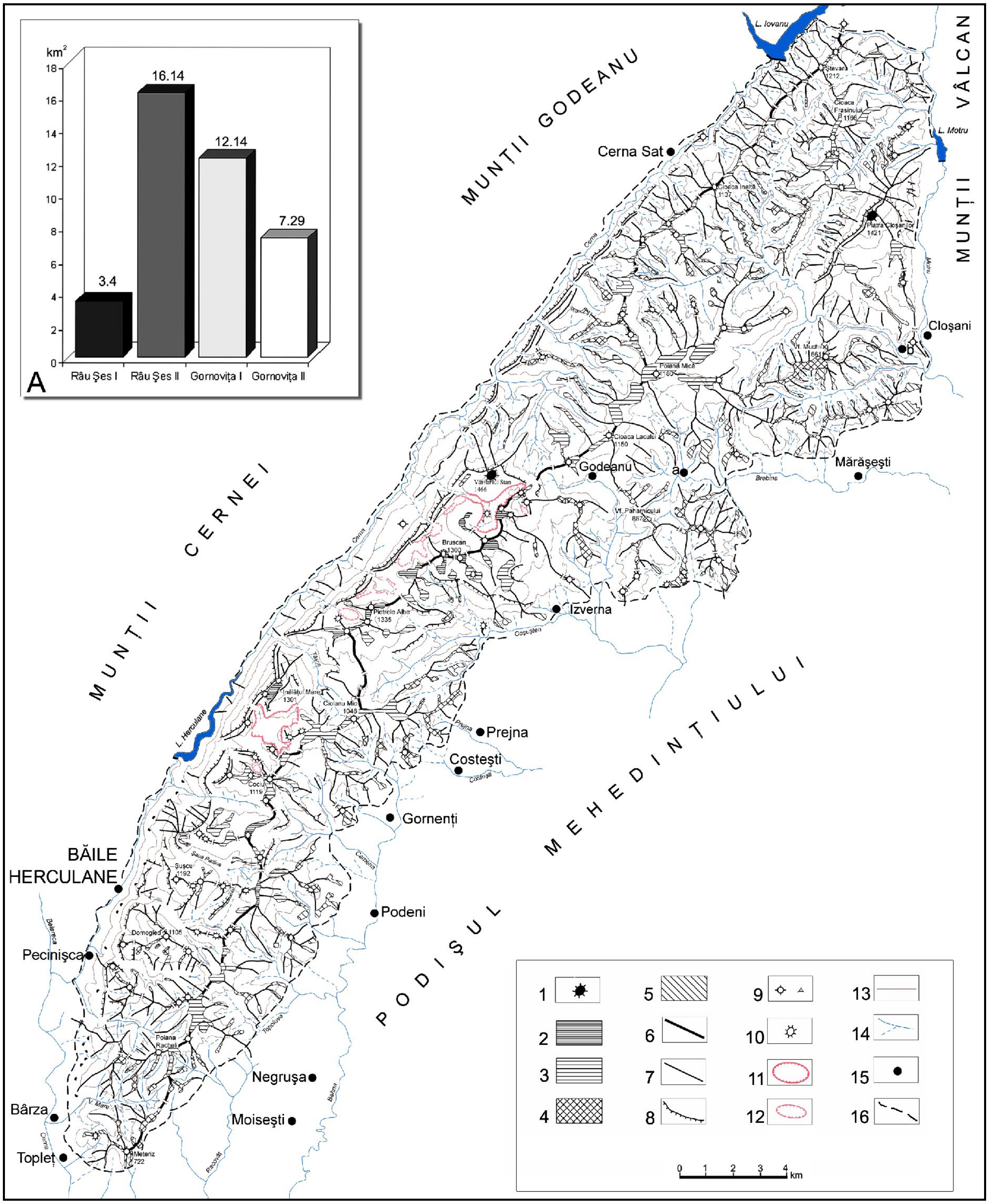

Fig. 3. Map of the sculptural complexes from the Mehedinți Mountains:
1, outliers of the Borăscu level (over 1,300 meters); 2, Râu Şes I (1,100 – 1,300 meters); 3, Râu Şes II (850 – 1,100 meters); 4, Gornovița I (750 – 900 meters); 5, Gornovița II (500 – 650 meters); 6, main ridge; 7, secondary ridge; 8, calcareous escarpment; 9, rounded peak/pyramidal peak; 10, erosion outlier; 11, open karst depression; 12, uvala, doline; 13, contour lines equidistance of 200 meters; 14, rivers; 15, settlement; 16, limits of the Mehedinți Mountains; a, Obârşia Cloşani; b, Motru Sec; A – The surface occupied by each level.

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COASTAL ENVIRONMENTAL CHANGES ALONG THE NORTH -WESTERN COAST OF EGYPT CASE STUDY FROM ALEXANDRIA TO EL ALAMEIN COAST

Gehan MANSOUR EL-BAYOMI[1]

Abstract. The present papers aims at highlighting the urban development, fishing activities, tourism, industrial development and agricultural activities that affect delicate and valuable coastal ecosystems. A supervised classification, post-classification, change detection techniques were applied to Land sat images acquired in 1991 and 2007, respectively, to map land cover changes along the north-western coast of Egypt, from Alexandria to El Alamein. A supervised classification was carried out on the six reflective bands for the two images individually with the aid of true ground data. The truthful ground information, collected during field trips using ancillary data, visual interpretation and experts' knowledge of the area using GIS, further refined the classification results. Post-classification change detection technique was used to produce image through cross-tabulation. Changes among different land cover classes were assessed. During the study period, a very severe land cover change has taken place as a result of agricultural and tourist development projects. These shoreline and land cover changes led to modifications of the environmental properties.

Key words: coast, environment, Geomorphology, Geology.

Rezumat. Schimbările de mediu de-a lungul coastei de nord- vest a Egiptului. Studiu de caz de la Alexandria până pe Coasta El Alamein. Lucrarea doreşte să sublinieze dezvoltarea urbană, activităţile de pescuit, turismul, dezvoltarea industrială şi activităţile agricole care afectează ecosistemele valoroase şi delicate de coastă. O clasificare verificată, post-clasificată şi tehnici de detectare a schimbării au fost aplicate imaginilor Landsat din 1991 şi 2007, pentru a cartografia schimbările de teren pe coasta de nord-vest a Egiptului, de la Alexandria la El Alamein. O clasificare verificată a fost realizată pe 6 benzi reflective din două imagini individuale cu ajutorul datelor reale de teren. Informaţiile reale din teren adunate în timpul aplicaţiilor de teren folosind datele auxiliare, interpretarea vizuală şi cunoştiinţele experţilor despre zonă prin GIS au determinat o perfecţionare a rezultatelor de clasificare. Tehnica de detectare a schimbării de post-clasificare a fost folosită pentru a genera imagini prin tabulare transversală. Schimbările din cadrul diferitelor clase de terenuri au fost evaluate. În timpul perioadei de studiu, o schimbare severă de terenuri a avut loc ca rezultat al proiectelor de dezvoltare agricolă şi turistică. Aceste schimbări din linia coastei şi de teren au dus la schimbări ale proprietăţilor de mediu.

Cuvinte cheie: coastă, mediu, geomorfologie, geologie.

1. Introduction:

During the last century, coastal urbanization has grown dramatically and coastal cities have expanded rapidly, strongly influencing marine and coastal ecosystems, and raising the importance of preserving the coastal environment as a major urban planning issue for sustainable development. In order to understand the interrelation of human impact and landscape evaluation and to determine to what extent cultural changes were environmentally influenced, it is necessary to study key areas where extensive landscape changes as well as early and rapid cultural development took place concurrently. This paper discusses the main environmental changes in coastal areas, the social-economic activities that cause these problems and the benefits identified from the implementation of the Integrated Coastal Zone Management approach.

The paper focuses on the North-Western coast of Egypt, from Alexandria to EL-Alamein, where population increase and economic growth exerted a remarkable pressure on the coastal environment, also due to a non-integrated urban coast planning.

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1.1 The studied area

The studied area is located between 30°13" and 31°10" North and 28°14" and 29°15" East, on the North-western coast of Egypt (Fig 1). Bordered by the Mediterranean Sea to the North, Alexandria to the East, El-Alamein town to the West and Khashm El-Eish ridge to the South, it covers about 3750 sq km. The area is made up of sedimentary rocks, formed during Tertiary and Quarterly geologic ages (Selim, A, A. 1971).

The area has a mediterranean climate, as it lies in the northern extremity of the Western desert of Egypt, parallel to the Mediterranean Sea. The coastal plain is characterized by its sandy flat indented coast line, bays with marches, very shallow lagoons, impeded low sandy ridges and dunes of calcareous rocks, Oollitic limestone, depression backed by plains that rise gradually towards the southern plateau. There are numerous wetlands near the coast that have different trends. In the depression south of Maryiout Lake, urban growth takes place around Lake Maryiout shore lines, mostly to the prejudice of wetlands.

There is a trend of future expansion and changes of land use due to tourist sites and summer resorts along Mediterranean coast such as Marina (the largest resort). All these sites are obvious in the images. The construction of the international coastal highway, located parallel to the Mediterranean shore line, has caused accelerated changes in land use and land cover within the area.

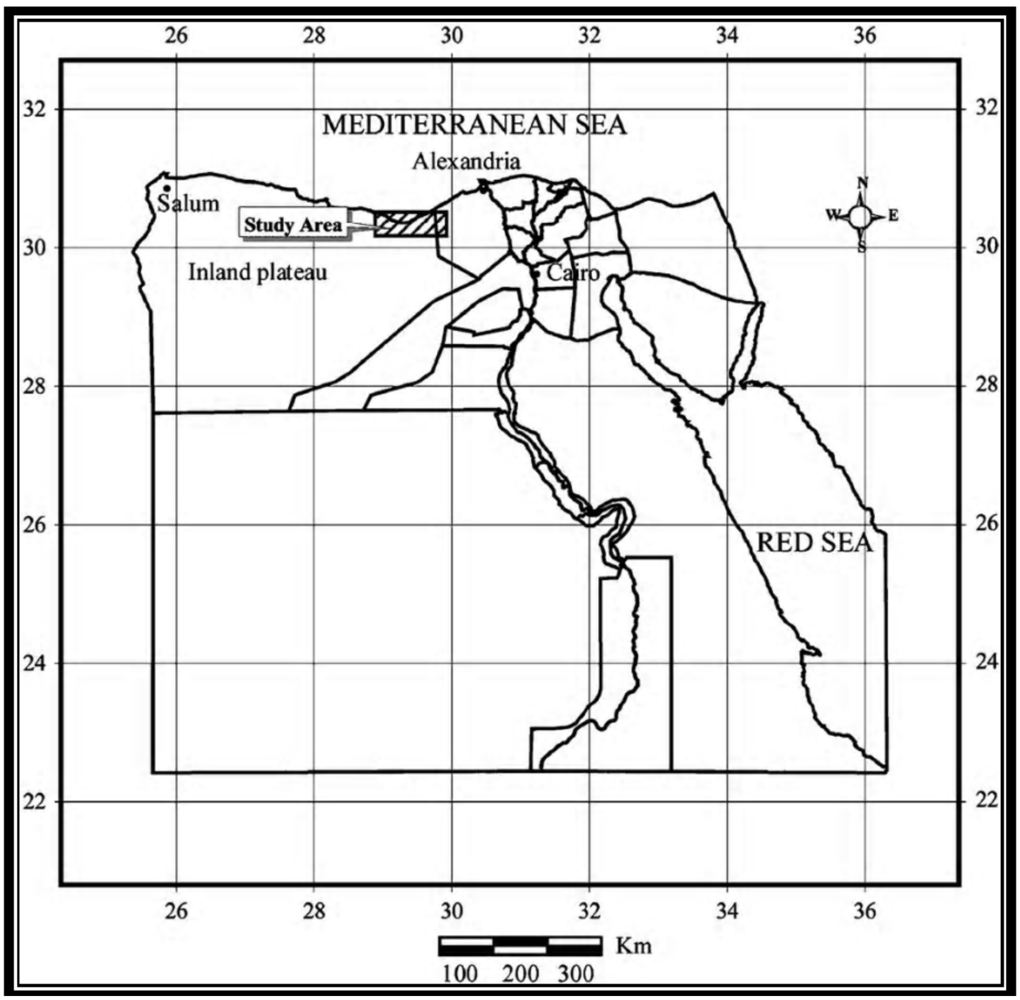

Fig. 1 Location map of the studied area

There is a short rainy winter and a dry summer. The average quantity of precipitation is 150 mm, which makes possible the cultivation of barley. The rains during winter also replenish the shallow wells with water. The water from these wells is used for civic purposes, as well as for irrigation of orchards during summer.

The coastal erosion and accretion phenomena have been greatly affected by the marine factors and processes such as waves, breakers, littoral current tide etc. The dynamic forces affecting the coast play an effective role in sorting processes within each coastal environment.

2. Objectives

1. Identification of the main geological and geomorphologic features and their spatial distribution.
2. Description of the prevailing landforms and their possible determinant mechanism.
3. Determining the environmental changes between 1991 and 2007.

3. Methodology

The study of environmental changes depends on more than one scheme from geographical, geomorphologic and environmental studies. The geographical information system (G.I.S) was also applied using Arc GIS Program, followed by the analysis of space views from 1991 to 2007, but also their connections with previous topographic maps. Topographic maps at the scale 1:250,000 were used.

Land sat TM data has ground resolution of 30 meters and seven spectral bands cover the visible, near infrared and thermal bands of the electromagnetic spectrum, that cover the North Western part coast of Egypt, with two data: 1991 and 2007 (Figs. 2 &3).

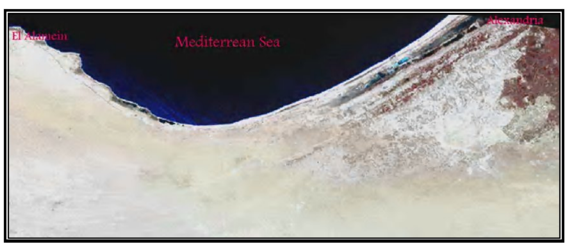

Fig. 2 False colour composite image of Land sat TM (1991) bands 4, 3, 2

Fig. 3 False colour composite image of Land sat ETM (2007) bands 4, 3, 2

Several pre-processing steps were required to standardize and correct the various datasets. Classification processing and techniques used to produce the land-use and land-cover maps are shown in Fig. 4 and 5.

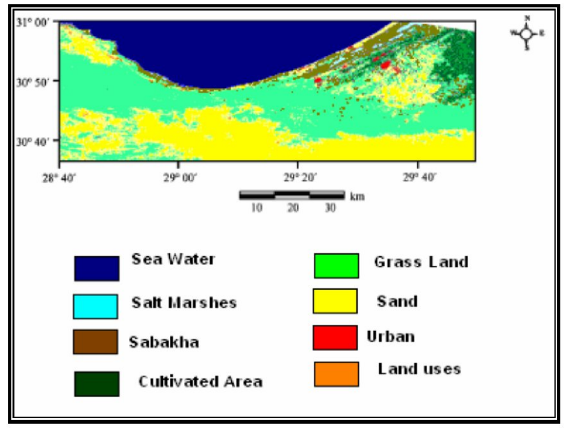

Fig. 4 Land use classified map 1991

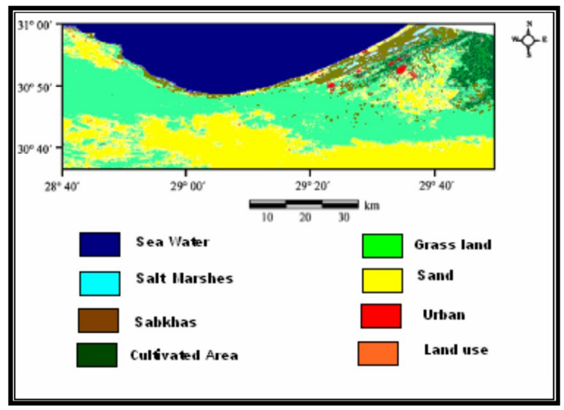

Fig. 5 Land use classified map 2007

4. Previous work

Several Geology and Geomorphology studies have been carried out for the Mediterranean coast of Egypt: Shukri et al. (1955), Butzer (1960) Hilmy, M.E. (1951), Embabe, S, N.(1998), FAO (1970), El-Shazli et al. (1975), Hammad (1986), Ismail et al. (1983), El-Raey et al. (1995), Embabei (2000) and Shata, M,A, M. (1979).

5. Results

5.1 Geological and Geomorphologic features

- Coastal plain

The coastal plain is a zone of variable widths and elevation along the Mediterranean coast. Its width varies from few meters near headlands to some kilometers, along enclosed gulfs. Its elevation varies from sea level to about 100 m, different phases of tectonic upheaval, that took place during Middle until Tertiary (Fig. 6).

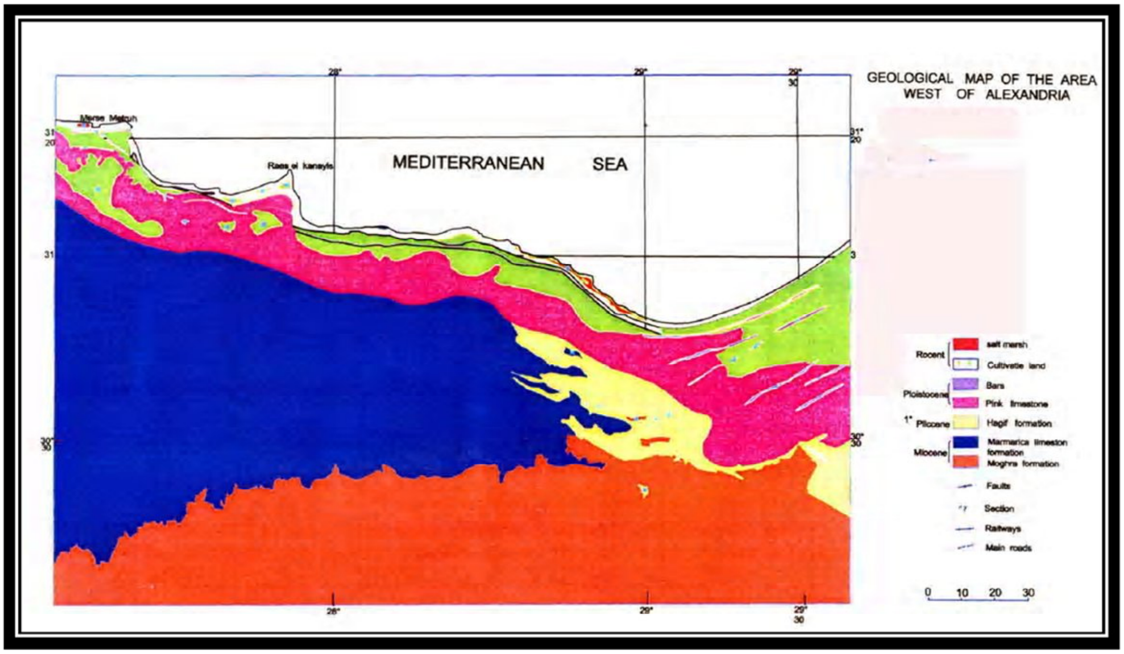

Fig. 6 The Geological formation of the western Mediterranean coast of Egypt
Source: Ahmed M.H. (2002)

The geological formation of the Western Mediterranean coast of Egypt has nine Ridges separated by eight depressions that run parallel to the present Mediterranean coast (Shukri *et al*., 1955)

1- The coastal plain is very narrow or even lacks across headlands. Sometimes it becomes wider, with pronounced successive ridges and depressions. The surface of the plain is undulated, occupied by a series of elongated ridges parallel to the coast line.
Several ridges start near Lake Mariut and gradually become less obvious towards the West.

2- At a regional level, the coastal plain becomes wider eastwards (Eastwards from EL Dabaa) and becomes narrow where the headlands exist (West EL Dabaa).

3- Southwards, the coastal plain is bounded by the cliffs of the structural plateau. Sometimes, the piedmont plain reaches more than 50 m in the south. They alternate with shallow depressions, dissected by shallow dry valleys.

4- The eastern side of the headland represents the outlet of drainages lines; which are close to sea level, giving rise to salt marshes.

5- The headlands themselves are cut by sea waves (such cliffs were formed on Miocene formation (Hammad,1986).

- Beaches

The famous beaches along the Mediterranean sea normally exist between headlands, facing the synclinal embayment. The beaches are 500 m to more than 1.5 km long (Fig. 7); the sandy beaches along shorelines are mainly made up of loose sands eroded in oolitic limestone ridges. The size of sand grains on the beach varies from medium to fine. The sand is mixed with little amount of shell fragments and heavy minerals.

Fig. 7 Beach along EL Alamein area

- Coastal Dunes

The coastal dunes are found close to the beach within synclinal areas; they are well developed and extended recent ridges parallel to the present beaches. They are composed of loose white oolitic carbonate sands washed from the degradation of oolitic coastal ridges, almost the fore shore dunes are impeded by plants the frontal dunes are generally extended as ridges parallel to the shoreline (Fig. 8).

Fig. 8 Coastal dunes cover with Nebak along North Western Coast

- Coastal Ridge

The coastal ridge is an elevated land form slopes gently landward and steeper seaward this ridge is composed of white cross bedded, friable oolitic limestone, locally this ridge is covered by snow white carbonate sand. The Northern elongated ridges are more conspicuous and more recent than the southern and are composed of calcareous aeolianites and are capped by a solid thin brown crust, the ridges generally extend from East to West, with widths ranging between 100 m and more than 500 m (Fig. 9).

Fig. 9 Coastal Ridge in the Western Coast of Alexandria

-Coastal Depressions

It is shallow elongated and oriented in an E-W direction, as it is found between the ridges, the elongated depression represent old Lagoons during Early and Middle Pleistocene glacial and interglacial periods as the surface of the depression approaches sea level, it is turned into salt marshes and lagoons. This surface is almost flat with ground elevation of ± 2 m. It is occupied by reddish brown soil deposits are the product of coastal wad's that drain the depression as in East Ras EL Hekma, EL Alamein, Omaid, along the North Western Coast .

- Lagoons

Lagoonal deposits are widely distributed in the subsoil bellow alluvial deposits, the saline deposits are composed of calcareous loam mixed with oolitic sands and contain high amount of evaporation .gypsum is mined from the second depression in both El Gharbaneyat and Omayed.. The main lagoon along the northern shore lines are eastern and western, Maryiout lagoons (Fig. 10). They are shallow, small longitudinal with small area less than 5 km.

Fig. 10 Maryiout Lagoon

- Salt Marshes and Lagoons

It is found between dissected ridges with lower elevation below sea level as west Matruh, where it is formed due to surface erosion by drainage lines, many Lagoons, 13 sabkhas are distributed along the North Western Coast at El Dabaa, Ras El Hekma, this surface is mostly covered with carbonate dune (Fig. 11).

Fig. 11 Salt Marshes in Dabaa Area

-Off shore land

Off shore lands are separated rocky islets in the Mediterranean sea; they are the remnants of younger ridges, submerged in recent times as new cycle of submergence particularly near Ras El Hikma.

- Inland dunes

They are accumulated on the slope of the ridges. These dunes are composed of both carbonate and quartz sands.

- Inland depression

These are found between the inland ridges, the surface is covered by alluvial deposits.

- Inland ridges

The coastal ridge is followed to the south by a series of elongated Oollitic limestone ridges with an elevation varies from 55.65 to 85 m which are composed of hard Oollitic limestone (Fig. 12).

Fig. 12 Ridges in El Alamein area

5.2 Environmental Impacts

The study of land cover change detection since it provides essential information about the natural and spatial distribution of land cover changes, there are returns to physical processes like waves, storm, littoral current along the shore line; on the other hand, human factors have greatly affected the changing nature of the studied area (Fig. 13). Land degradation processes in the study area are degradation of natural vegetation due to overgrazing and the remarkable inter-annual variation of rainfall (Fig 13).

Land use and land cover in the studied area has different trends in the degrees of changes, as a result of expansions of tourist sites and summer resorts and roads construction, particularly the international coastal highway, which is located parallel to the shoreline, causing accelerated changes in land use and in landscape as whole. The nature of the changes of different land cover classes could be derived from Fig. 14 and 15. The percentage of changes from 1991 to 2007 indicate the increase of salt marches, cultivated areas, greenland urban areas, while there is a decrease of Sabakhas area.

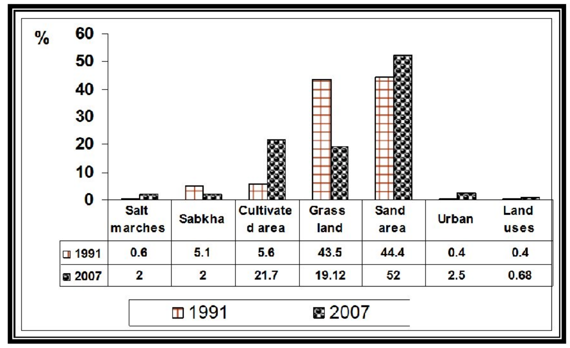

Fig. 15 The percentage of environmental changes along North-Western coast area

6. Conclusions

The objectives of this study were to provide an actual perspective regarding land cover types and land cover changes that have taken place in the last sixteen years, to integrate visual interpretation with supervised classification using GIS and to examine the capabilities of integrating remote sensing and GIS in studying the spatial distribution of different land cover changes.

The analysis outlined that integrating visual interpretation with supervised classification led to increasing the overall accuracy by about 10 percent. The studied area has undergone a very severe land cover change as a result of either agricultural or tourist development projects.

Both a considerable increase of urban settlements, as well as huge increase in agricultural land have taken place. The natural vegetation areas have decreased considerably. Integrating GIS and remote sensing provided valuable information on the nature of land cover changes especially the area and spatial distribution of different land cover changes.

The main causes of land degradation in the study area are removal of vegetation and water logging. This problem needs to be seriously studied, through multi-dimensional fields including social-economic ones, in order to preserve the newly reclaimed land and to increase food production.

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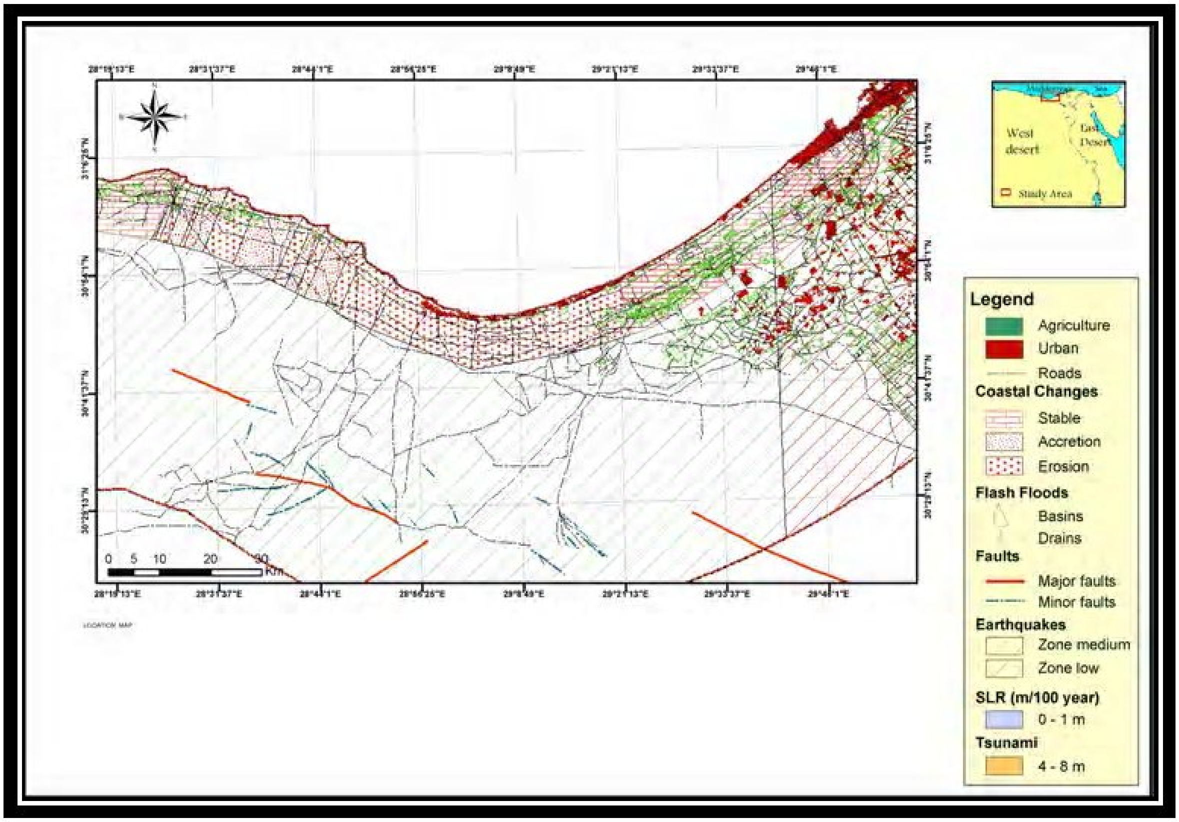

Fig. 13 Changes between 1991-2007

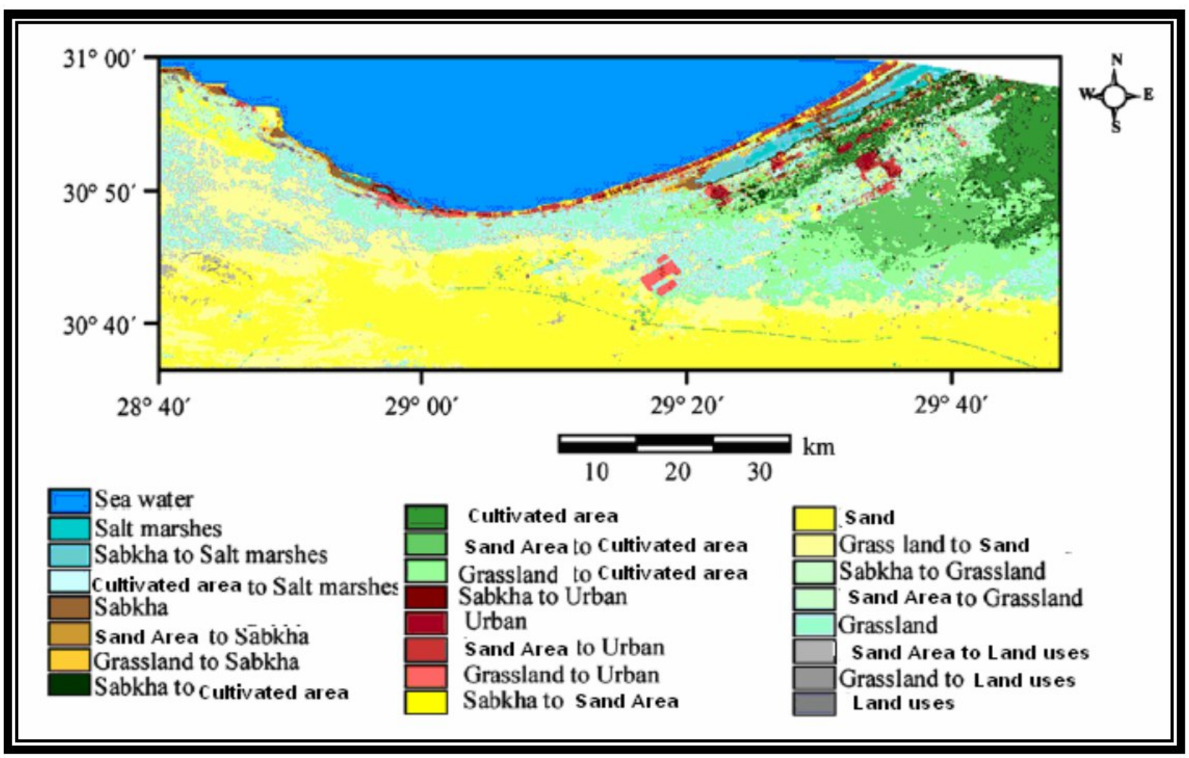

Fig. 14 Land cover change detection image between 1991 and 2007

7. Recommendations

There are recommendations to be made as a result of issues analysed during this study:

1. It is important matter to stop drying marshes in order to prevent sea inundation
2. Cleaning up the inlet-entrances of lagoon to protect the biological ecosystem related to the exchange of water between sea and lagoons.
3. In order to reclaim urban land, it is important to remove mines, particularly near main roads and settlement centers.
4. Improving the harbours along the coast to develop the area in several fields particularly regarding protected sites.
5. The Government must guide its effort to extend water pipes from Nile to the coastal area, and improve the native wells as water resources for domestic use and agriculture.

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THE PRESENT-DAY EROSIONAL PROCESSES IN THE ALPINE LEVEL OF THE BUCEGI MOUNTAINS - SOUTHERN CARPATHIANS

Mircea VOICULESCU[1]

Abstract. A relief that is strongly modelled by extensive erosion processes (sheet erosion, rills and gullies) characterizes the Alpine level of the Bucegi Mountains. All processes are favoured by the geological structure represented by conglomerates, limestone with grit stone intrusions, by strongly degraded podzolic soils with a loamy-sandy texture in the first layer and by some economic activities, such as the overgrazing and the tourism.
We have identified an area with large-scale erosion forms in the sector comprised between Furnica Peak and Piatra Arsă Peak.
This paper analyses the genesis and the manifestation conditions of the erosion processes, as well as the climate, making use of the temperature and the precipitation data provided by the meteorological stations in the region.
Using the Péltier diagram, we framed the region to various seasons. By subsequently using the Péguy diagram, we framed the region to the morphoclimatic conditions and to the river processes. On the other hand, by using GIS, we created geology, slope, soil and vegetation Boolean maps and then the risk map to the erosion processes.
Key words. present-day erosional processes, sheet erosion, rills, gullies, Boolean maps, Alpine level, the Bucegi Mountains, Southern Carpathians

Rezumat. Procese actuale de eroziune în zona alpină a Munţilor Bucegi (Carpaţii Meridionali). Etajul alpin al Munţilor Bucegi se caracterizează printr-un relief puternic erodat de procesele de eroziune (eroziune areolară, rigole, ravene şi ogaşe). Toate acestea sunt favorizate de structura geologică, reprezentată de conglomerate, calcare şi gresie, de soluri podzolice puternic degradate cu textură luto-nisipoasă în primul strat şi de activităţile economice cum ar fi mai ales suprapăşunatul şi turismul.
Noi am identificat un astfel de areal cu forme de eroziune, puternic dezvoltate, în sectorul cuprins între vârfurile Furnica (2102 m) şi Piatra Arsă (2001 m).
În lucrarea noastră, am analizat pe de-o parte geneza şi condiţiile manifestării proceselor de eroziune iar pe de altă parte climatul folosind datele de temperatură şi de precipitaţii de la staţiile meteorologice din regiune.
Folosind diagrama Péltier am încadrat Munţii Bucegi şi implicit arealul nostru de studiu la diferite sezoane. Folosind apoi diagrama Péguy am încadrat regiunea noastră şi Munţii Bucegi condiţiilor morfoclimatice. Pe de altă parte, folosind tehnica S.I.G. am creat hărţile booleene ale geologiei, solului, vegetaţiei, declivităţii şi apoi harta riscului la procesele de eroziune.
Cuvinte cheie. procese de eroziune actuală, eroziune areolară, rigole, ravene, hărţi booleene, etaj alpin, Munţii Bucegi, Carpaţii Meridionali

Introduction

The human activity in the high mountain regions is represented by different economic practices, especially deforestation, overgrazing, leading to grassland deterioration, and tourism, with the appearance of tourist paths (Alewell et al., 2008; Dedkov & Moszherin, 1992; Konz et al., 2009). In these conditions, the geological structure, the slope length and declivity, the vegetation, the high rainfall intensities, the snow pack accumulation represent factors that underlie the soil erosion processes (Briggs, Smithson, 1986; Hamilton, Bruijnzeel, 1997; Molina et al., 2009).

On the other hand, some authors mentioned that the forest vegetation represents an efficient means of fighting erosion (Bochet et al., 1998; Rey, 2003; Woo et al., 1997). In the mountain regions, the main processes of this type are represented by sheet, rill and gully erosion (Konz et al., 2009; Hamilton, Bruijnzeel, 1997; Lakhera, 1982; Yang et al., 1998), which represent increasingly severe forms of erosion by channelled water (Hamilton, Bruijnzeel, 1997).

Numerous studies were conducted in different mountain regions: in the Alps (Descroix and Gautier, 2002; Strunk, 2003), in High Tatra (Kotarba, 1984; Kotarba et al., 1987) or in the Southern Carpathians (Voiculescu, Vuia, 2005), in the mountains of Mexico (Descroix et al., 2007), in the Rocky mountains and in the Andes (Coppus and Imeson, 2001; Heede, 1970; Romero et al.,

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2007; Vanacker et al., 2003), in the African mountains (Chaplot et al., 2005), in the Asian ones (Lo, Tsai, 1992; Wu, Cheng, 2005; Zengxiang et al., 1996) or in other mountain spaces of the world (Dedkov & Moszherin, 1992).

The interest was directed towards several erosion analysis directions: mapping of erosion processes (Imhof, Steward, 2007; Zachar, 1982), types and manifestation of erosion processes (Grissinger, 1995; Leopold *et al.*, 1995; Toy *et al.*, 2002), dendrochronological analysis of gully erosion rate (Vandekerckhove *et al.*, 2001), or classification of erosion forms (Poesen *et al.*, 1998; Zachar, 1982).

Study area

Part of the mountain group with the same name, the Bucegi Mountains are situated on the eastern border of the Southern Carpathians (Fig. 1). The high altitudes, over 2,400-2,500 meters (Omu Peak – 2,505 meters), the glacial forms and the very dynamic periglacial processes are the characteristic features of these mountains.

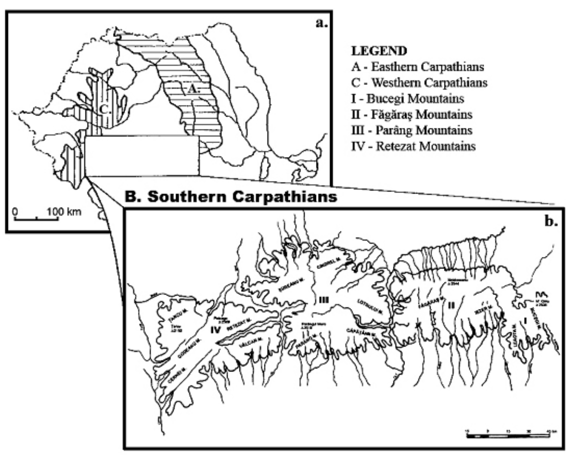

Fig. 1. Geographic position of the Bucegi Mountains

The Bucegi Mountains have the aspect of an upstanding syncline and are predominantly constituted of limestone and conglomerates with grit stone intrusions. They have the form of a semicircle opened to the south, with Omu Peak, the main orographical node (2,505 meters), located at its northern margin. From Omu Peak, two lines of peaks depart towards the east and the west, marking off two structural scarps. The eastern scarp dominates with more than 1,000 meters the Prahova Valley, which is the main water collector of the eastern part of the Bucegi Mountains. The geology, the structural relief and the presence of karst are other characteristics of the Bucegi Mountains (Velcea, Savu, 1983).

The relief is modified because of the geological and soil structure, which constitute the conditional factors, of the climate, through its most important elements - temperature and precipitations, and also because of the causative factors determined by human influence manifested through overgrazing and tourist activities (Popescu, 1990, Voiculescu, 2002).

The study focused on the alpine level of the central part of the Bucegi Mountains, located between the Vârfu cu Dor (2,030 meters) and the Jepii Mici Peak (2,070 meters) (Fig. 2). A degraded relief characterises this sector, where the sheet, rill and gully erosion play the most important role, considering the annual evolution of these processes. The data was collected during several years of observation, between 2000-2004 (Voiculescu, Vuia, 2005) and afterwards, in the interval 2005-2007, in the alpine level of the Bucegi Mountains.

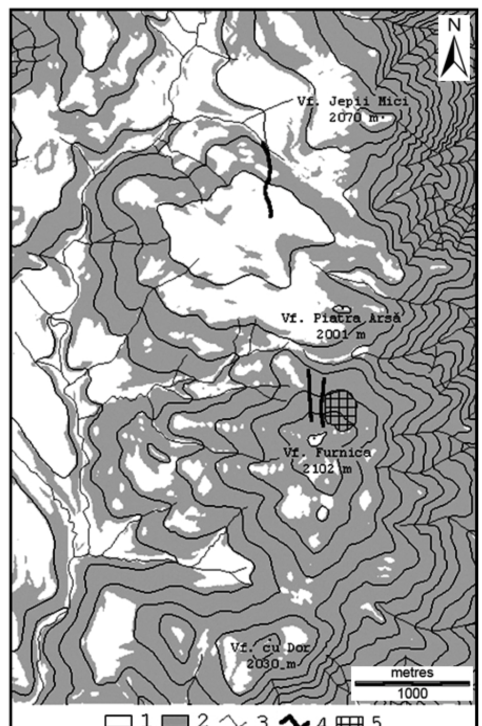

Fig. 2. Topographical map of the study area
1. Hydrological network; 2. Tourist paths; 3. Rills and gullies; 4. Soil erosion; 5. Chalets (Voiculescu, Vuia, 2005)

From the morphological point of view, the relief is represented by the development of cuestas in steps; they are situated under Vârfu cu Dor (2,030 meters) and Jepii Mici Peak (2,070 meters), on the eastern border of the Bucegi scarp, which is facing the Prahova Valley. Their origin is attributed to the grit stone intrusions (the Babele Gritstone) from the conglomerates (Velcea, 1961).

Structurally, the study area belongs to the so-called external structural surfaces (Geological Map of Romania, Moeciu sheet, scale 1:50,000, 1971; Geological Map of Romania, Baiu, Sinaia sheet, scale 1:50,000, 1980), disposed, in this case, on the Vârfu cu Dor (2,030 meters) - Furnica Peak (2,102 meters) - Piatra Arsă Peak (2,001 meters) - Jepii Mici Peak (2,070 meters) alignment.

The dominant soils are represented by strongly degraded podzols, with a loamy-sandy texture in the first layer (S.R.R. Soil Map, Braşov sheet, scale 1:200,000, 1975). The vegetation is mainly represented by alpine and sub-alpine meadows, degraded because of the overgrazing and tourism.

Climatic and morphoclimatic conditions

Climate plays an essential role in the development of the morphogenetic process (Zinck et al., 2001). The most important characteristics of the climate are presented in Table 1, the data being collected from the three meteorological stations in the Bucegi Mountains: Omu Peak (2,505 meters), Babele (2,200 meters) and Sinaia (1,500 meters).

The average annual temperature decreases with the altitude, reaching an amplitude of 6.2º C on a 1,000 meters level difference, between the upper tree line and the highest ridges. Thus, the number of freezing days varies with the altitude, reaching values that range between 155 days and over 254 days, which is important for the development of river processes and river erosion. The amount of precipitation rises with the altitude for both the annual and the daily averages, having important consequences on the spatial and temporal amplitude of the water erosion. It can be observed (Table 1) that the snow cover, through its values (number of days with snow cover and average depth), plays a very important role as water source for the erosion processes and it also blocks the development of the fluvial processes, in accordance with the altitude. In this respect, the ratio between the number of days with snowfall and the number of days with rain is an indicator of the fluvial erosion time development.

At high altitudes, where Omu Peak and Babele meteorological stations are situated, the ratio indicates the predominance of the solid precipitation, while at the timberline (the Sinaia meteorological station), the ratio is sub-unitary, indicating the predominance of the liquid precipitation.

In accordance with the average temperature and annual precipitation values, the study area is situated within a specific thermal, respectively pluviometric level. As specified in the geographic literature concerning the Carpathians (Hess, 1972, quoted by Schreiber et al., 1993) and taking into account the temperature values, there were determined seven thermal levels:

- *warm*, temperature > 8ºC;
- *moderate-warm*, temperature between 8º - 6ºC;
- *moderate-coo*l, temperature ranges from 6º to 4ºC;
- *cool*, temperature ranges from 4º to 2ºC;
- *very cool*, temperature varies from 2º to 0ºC;
- *moderate-cold*, temperature varies from 0º to -2ºC;
- *cold*, temperatures are below -2ºC.

All these being taken into account, our study area integrates in the following levels: cool (at the timberline), moderate cold (in the middle part of the alpine level) and cold (in the upper part of the alpine level).

Furthermore, there are considered the pluviometric levels (Hess, 1972, quoted by Schreiber et al., 1993),

Table 1

The climatic characteristics of the alpine level of the Bucegi Mountains

Meteo St. (m)	Bioclimatic Level	T°C				Nr. of days with t_{min}< 0ºC	Pp (mm)		Snow thickness		nz/np[1]	Thermic Level	Pluviometric Level
		Year	Jan.	July	Ampl.		Year	24 hours	Year (nr. of days)	average (cm)			
Omu Peak (2,505)	alpine level	-2.5º	-10.9º	5.8º	16.8º	254.4	1134.0	107.8	>270	352.5	11.8	cold	nival moderate (subnival)
Babele (2,200)	middle part of the alpine level	-0.2º	-7.7º	7.9º	15.6º	217	582.2	12.6	177.1	589.5	4.6	moderate-cold	nival-pluvial
Sinaia (1,500)	lower part of the alpine level (timberline)	3.7º	-4.8º	13.3º	18.1º	155.2	941.2	23.7	143	133.9	0.2	cool	pluvial-nival

[1] Rapport between number of days with snow and number of days with liquid precipitations

for which the nival coefficient Kz was used; this is expressed as a relation in percentage between the solid precipitation and the total annual precipitation quantity. Therefore, four levels were determined:

- pluvial-moderate, for Kz < 40 percent and altitude under 1,400 meters;
- pluvial-nival, for Kz between 40 and 50 percent and altitudes of about 1,600 meters;
- nival-pluvial, for variable Kz, between 50 and 60 percent, at altitudes over 2,000 meters;
- nival-moderate for Kz > 60 percent, at altitudes over 2,500 meters.

According to this parameter, the study area is included in the pluvial-nival level at the timberline, nival-pluvial in the middle part of the alpine level and nival moderate in the upper part of the alpine level.

On the other hand, having in view the monthly and multi-annual variation of the temperature conditions, as well as the monthly and multi-annual variation of the precipitation conditions, by using a Péguy diagram (Fig. 3) we obtained the appointment of the above-mentioned meteorological stations to different seasons:

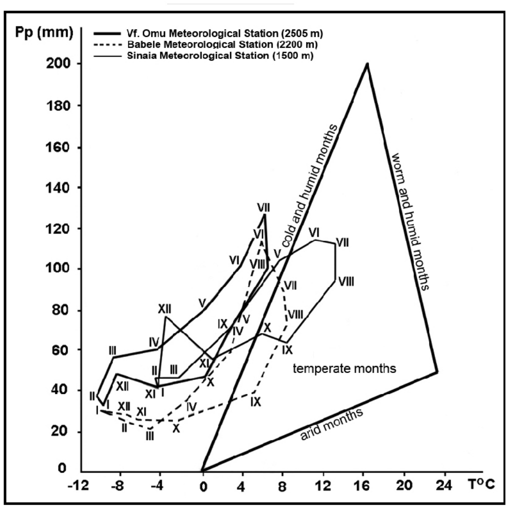

Fig. 3. Péguy diagram representing the variation of the climate conditions of the above-mentioned meteorological stations

- in the case of the highest altitudes, all the months of the year are cold and damp, having a value of 100 percent;
- for the middle part of the alpine domain, where the study area is situated, only three months (July, August and September) are temperate, the others being cold and damp in proportion of about 58.3 percent;
- for the contact zone between the woodland domain and the lower part of the alpine domain, about 5 months (June - October) are temperate, the others being cold and damp, with a proportion of about 41.6 percent.

From the morphoclimatic point of view, the sector located beyond the timberline belongs to the periglacial level (Velcea, 1961). Furthermore, taking into account the thermal criterion of the morphostructural integration and the altitude, applied to the Southern Carpathians, respectively to the Retezat Mountains (Urdea, 2000) and to the Făgăraş Massif (Voiculescu, 2000, 2002), the following structure can be identified for the Bucegi Mountains (Fig. 4):

PERIGLACIAL LEVEL	ALTITUDE
Sublevel of intense weathering (cryoplanation) -3°C (block fields)	⇨ > 2500 m
-1°C (lower limit of the discontinuous permafrost)	⇨ 2200-2300 m
Sublevel of intense periglacial processes 0°C (lower limit of frost)	⇨ 2050 m
Sublevel of solifluction	
2°-3°C (lower limit of periglacial processes)	⇨ 1500-1600 m

Fig. 4 Morphoclimatic ranging in the Bucegi Mountains

The Péltier diagram is applied to point out the annual variability and the differences registered in the characteristic months by the fluvial erosion processes and their intensity in specific morphoclimatic conditions. Thus, at the highest altitudes of the Bucegi Mountains, the conditions are of glacial nature in January (Fig. 5a), periglacial in April, maritime in July (Fig. 5c), boreal in October (Fig. 5d), respectively periglacial-boreal at annual level (Fig. 5d). At the altitudes corresponding to the middle part of the periglacial level, the conditions are periglacial in January (Fig. 5a), boreal in April (Fig. 5b), moderate in July (Fig. 5c), temperate in October (Fig. 5d), respectively temperate at annual level (Fig. 5e). At the lower part of the periglacial level, that coincides with the timberline, the morphoclimatic conditions are boreal in January (Fig. 5a), temperate in April (Fig. 5b), moderate in July (Fig. 5c), temperate in October (Fig. 5c) and at annual level (Fig. 5e).

The precipitations are the most important climatic parameter that influences the course and intensity of the fluvial processes. The precipitation quantities reach the highest values in the warm season (July - August), but these are differentiated on altitude. The smallest values are usually registered in the second part of the autumn season, in October and November and also in the winter months, in January and February (Fig. 6). The manifestation of the erosion processes is widespread,

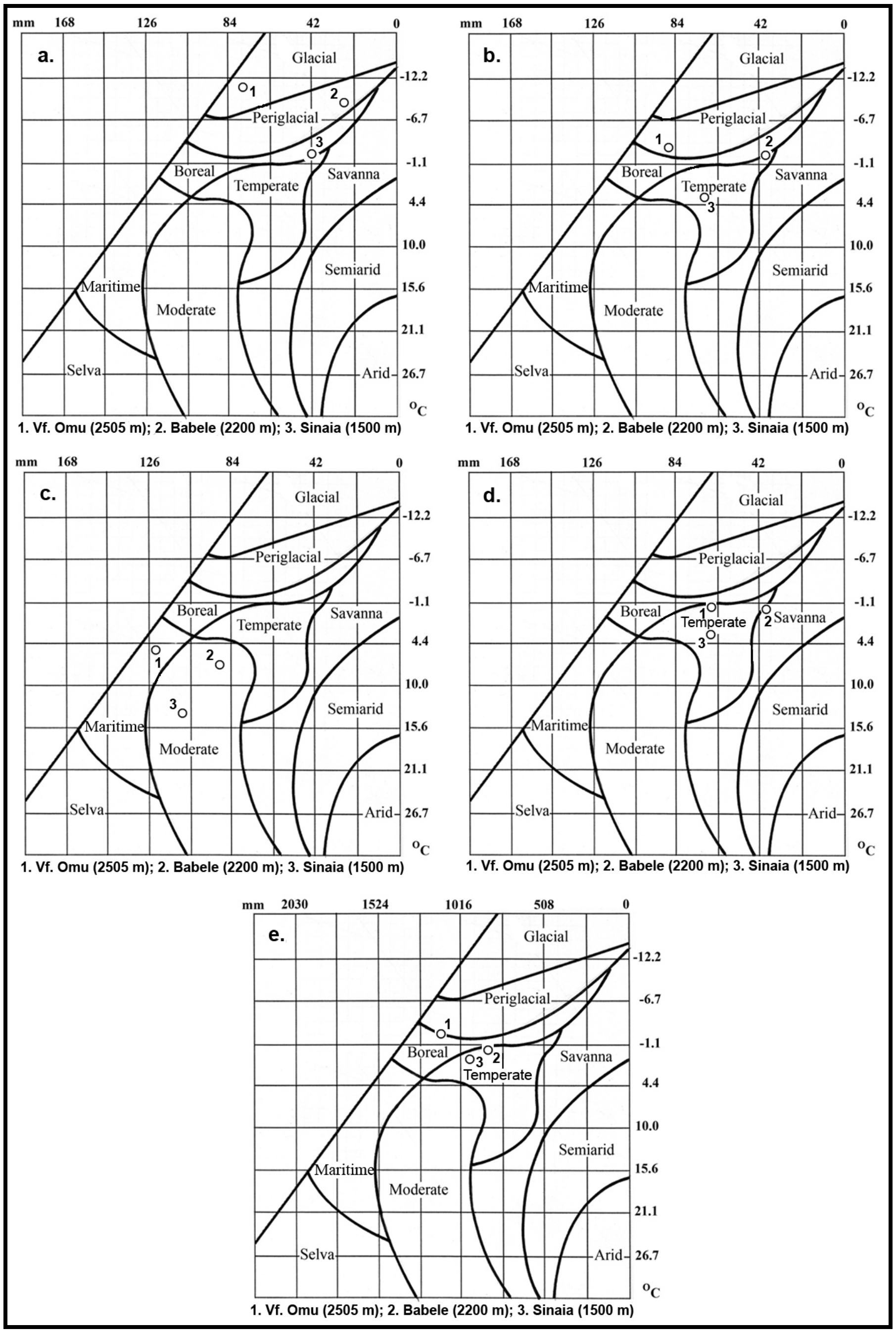

Fig. 5. Péltier diagram representing the location within morphoclimatic conditions of the above mentioned meteorological stations: a. January, b. April, c. July, d. October, e. multi-annual monthly mean values

especially in the spring - summer period, when the snow melting intensifies with the rise of the temperatures. The meltwater overlaps with the occurrence of rains, contributing to the development of the torrentiality, the sheet, rill and gully erosion.

The solid and liquid falls are important elements in the development of the morphodinamic potential of the relief. Thus, in the study area, it can be noticed the predominance of the number of days with snowfall. These are characteristic especially for September - May, with a value of 75 percent at the highest altitudes, and for October - April (58.3 percent), in the lower part of the alpine level and at the timberline (Fig. 7).

It must be noticed that at the periglacial level, the development of the fluvial modelling system is blocked several months a year, taking into account the fact that about 10 months a year (226.3 days or 62 percent of the total) the soil is covered by snow at the highest altitudes. In the middle part of the periglacial level, there are recorded 177.1 days with snow cover (representing 48.5 percent of the total) and in the lower part of the periglacial level - about 7-8 months a year (143 days or 39.1 percent of the total).

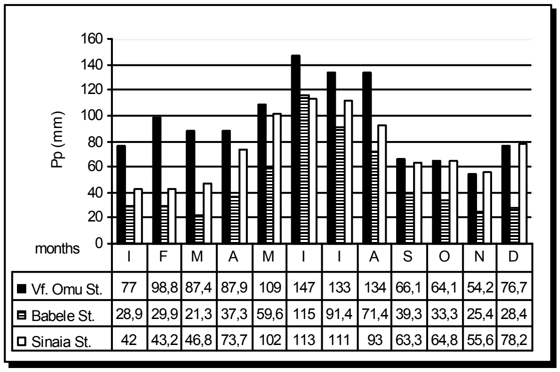

Fig. 6. The variation of precipitations, multi-annual monthly mean values

The liquid precipitations are predominantly characteristic for the warm season, up to September or even October, at the highest altitudes. At the lower part of the alpine level, the highest number of days with rain is registered in September - December, when the action of the fluvial processes is also intensive (Fig. 8).

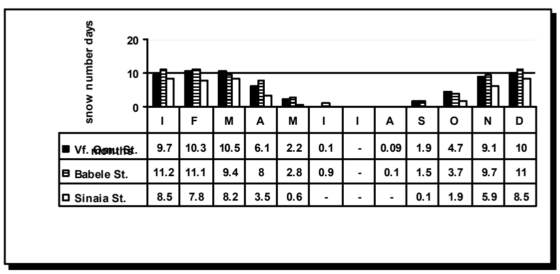

Fig. 7. The variation of the number of days with snow, multi-annual monthly means values

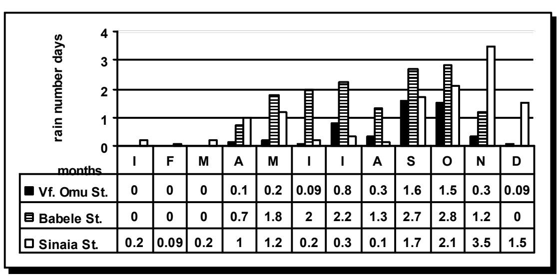

Fig. 8. The variation of the number of days with rain, multi-annual monthly means values

The ratio between the annual number of days with rainfall and of the days with snowfall is also of high significance for the intensity of the fluvial processes. In the study area, this ratio favours the number of days with snowfall, having the value of 11.8 at the highest altitudes and 4.6 in the middle part of the alpine domain. In the lower part of the alpine domain and at the timberline, the value of the ratio is 0.2, thus favouring the liquid precipitations.

The daily precipitation quantities are also analysed, as they play an important erosion role, with the corresponding altitudinal differences. The highest values are registered in the June - August interval, especially at the upper part of the alpine level and at the timberline level. The smallest values are registered in January and February on the highest peaks, in the January - April period in the middle part of the alpine level, respectively in November in the lower part of the alpine level (Fig. 9):

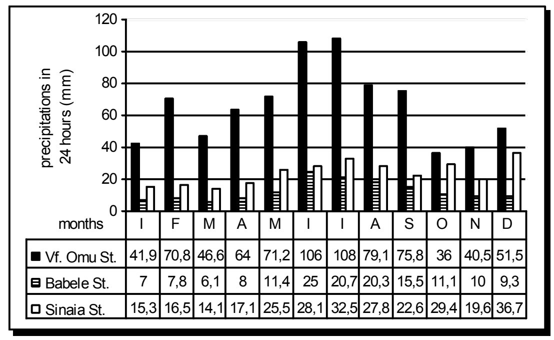

Fig. 9. The variation of precipitations fallen in 24 hours, multi-annual monthly mean values

Erosion forms

Through their surface forms (rill and gully), the morphological effects of erosion are some of the most important morphogenetic processes. The erosion processes are characterised by different intensities, depending on the altitude, climate and lithology (Summerfield, 1994).

It is believed that the sheet and linear erosion are characteristic to the rock walls and rocky slopes, generating debris slopes and debris-mantled slopes (Kotarba *et al.*, 1987), forms of the high-mountain system of sediment transfer. On the other hand, large forms, such as the gullies, have a strong impact on the pastures in the alpine level (Poesen *et al.*, 2003). The sheet erosion affects the entire surface of the north-facing slope of Furnica Peak, transporting down the material resulted from the weathering processes (Fig. 10):

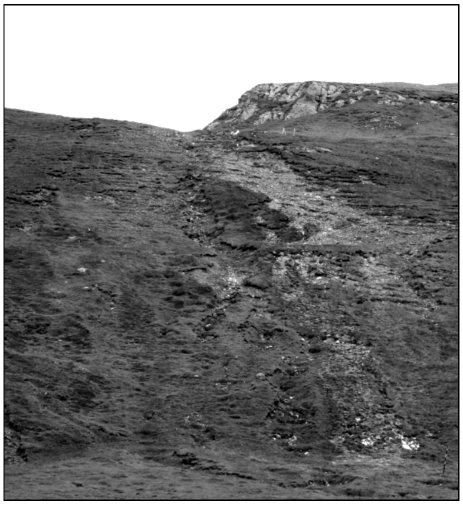

Fig. 10. Sheet erosion under Furnica Peak - 2,102 m (photos by Voiculescu, 2003, 2007)

The erosion processes remove sediments, which are accumulated at the bottom of the slope. The formation and the manifestation manner of these sediments are determined mostly by the structural surface of the slope, by the micro-topography and by the vegetation type (Bryan, 2000). Furthermore, a series of uniformly inclined rills dissect the slope on its declivity direction. Rill erosion represents the process of detachment and transportation of the sediment material by concentrated flow (Lal, 1994) and it develops into more ample forms, i.e. into gully erosion (Toy *et al.*, 2002). The process that leads to the formation of rills (Fig. 11), by detaching and transporting the soil particles through concentrated flow, is a function of the shear of the water flowing in the rill (Romero *et al.*, 2007).

Among all erosion forms, the gullies indubitably represent the most important source of sediments, delivering much more than the surface erosion (de Vente *et al.*, 2005; Ioniță, Mărgineanu, 2000; Mathys, Poesen, 2005; Molina *et al.*, 2009; Valentin *et al.*, 2005; Vandaele *et al.*, 1996) but also water storage and transmission (Molina *et al.*, 2009). Gully processes have a three-dimensional nature represented by factors and processes, by extreme climatic events and by a long antecedent history (Valentin *et al.*, 2005), or by overgrazing, which is often the main cause of gully erosion in mountainous areas (Descroix *et al.*, 2007); they are commonly triggered or accelerated by the land use change (Chaplot *et al.*, 2005; Valentin *et al.*, 2005).

Their importance can be expressed by the following quantifiable parameters: length, width and slope, as well as the sediment material stocked or redistributed at the level of the gullies' bed (Raclot *et al.*, 2005).

The morphodynamic activity of gullies depends on the season (warm or cold, but also on

Fig. 11. Rills between Furnica Peak - 2,102 m and Piatra Arsă - 2,001 m (photos by Voiculescu, 2005, 2007)

the climatic, soil and vegetation factors (Gillijins *et al.*, 2005). In the short warm season (about 4 months/year), the maximum quantity of rain is registered in June, 113.4 millimetres, at 1,500 meters of altitude, 115.2 millimetres at 2,200 meters and 147.4 millimetres at 2,505 meters. Gullies develop in a clay-limestone soil, with continuous vegetation cover and they reach 10 - 15 meters in length, 1.5 - 2 meters in breadth and 1 - 3 meters in depth.

If we take into account that gullies are classified into two categories, continuous and discontinuous gullies (Leopold and Miller, 1956, quoted by Heede, 1970; Heede, 1982), then we could also consider the existence of these forms in the Bucegi Mountains. The continuous gullies start in a headwater with many fingers that coalesce to form the gully and to attain the greatest depths (Heede, 1970, pp. 80) and they may be present as extensions of the drainage net (Grissinger, 1995, pp. 155). The continuous gullies are specific to cold regions, this process being noticeable under Furnica Peak (2,102 meters) (Fig. 12).

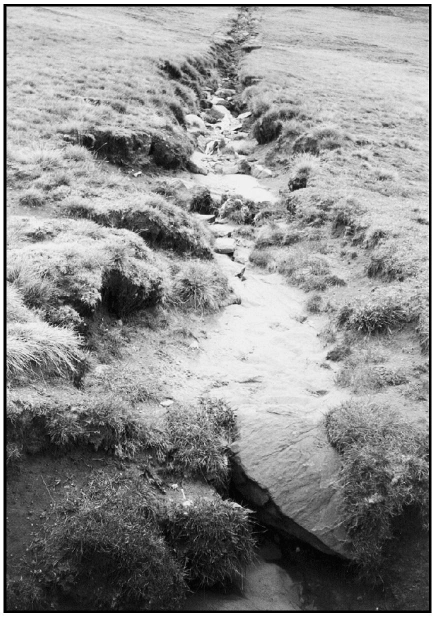

Fig. 12. Continuous gullies under Furnica Peak - 2,102 m (photo by Voiculescu, 2007)

On the other hand, the discontinuous gullies can be found anywhere along the slope and their depth rapidly decreases downstream (Brooks, 2003; Heede, 1970). They (Fig. 13) *begin with a pronounced head cut* (Heede, 1970, pp. 80) determined by the local characteristics of the relief and the aggradation rate (Ioniță, 2006). According to the classification made by Ioniță (2006), the discontinuous gullies in the Furnica Peak - Piatra Arsă sector belong to the single, isolated, or classical type.

Sometimes, in severe cases, the specific forms of morphogenesis appear and develop sub-sequentially in the chemical desegregation layer forms, such as soil erosion, rills and gullies (Kotarba, 1984, 1987) (Table 2).

In the middle part of the alpine level, the river erosion is well developed, as the source of many tributary valleys of the Prahova (situated at the eastern periphery of the Bucegi Mountains, at the bottom of the cliff) are located in the sector under analysis. This is the case of the Jepilor, Urlătorilor and Peleşului valleys.

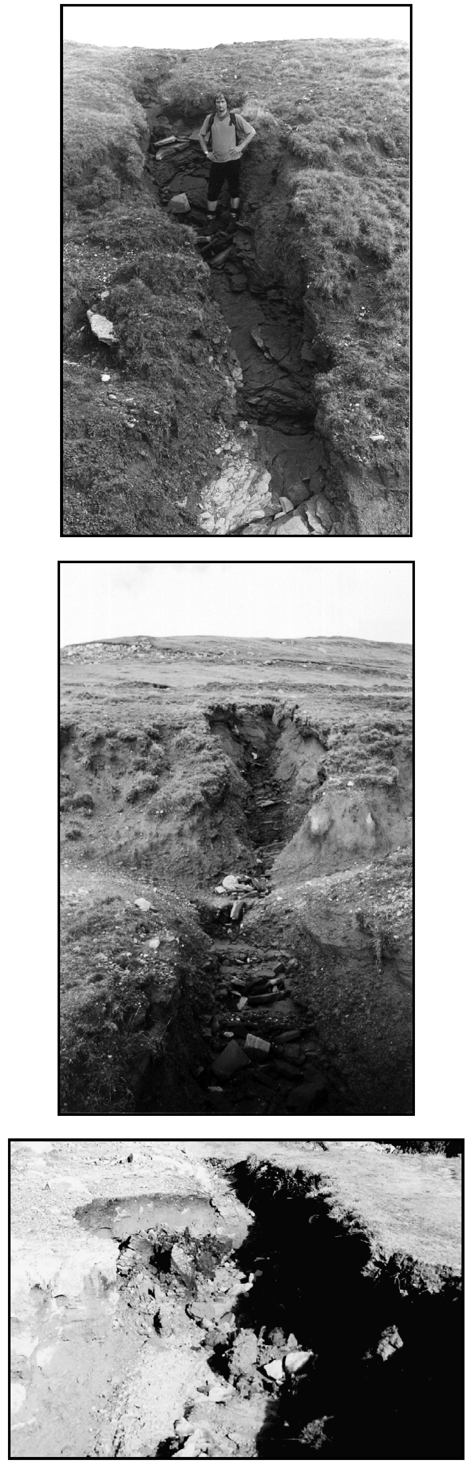

Fig. 13. Discontinuous gullies between Furnica Peak - 2,102 m and Piatra Arsă Peak - 2,001 m (photos by Voiculescu, 2003)

The fluvial processes are monthly differentiated and they are followed with the help of the Péltier diagram. At the highest altitudes, the intensity is minimum in January (Fig. 14a), moderate in April and July (Fig. 14b, fig. 14c), maximum in October (Fig. 14d) and moderate as a yearly average (Fig. 14e).

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Table 2

Geomorphic processes between Furnica Peak (2102 m) - Piatra Arsă Peak (2001 m) (after Kotarba, 1984, 1987, modified)

Main factor	Main transfer process	Main slope form	Secondary forms
Snow and water	Slush avalanching	Alluvial talus	Erosional niche
Meltwater	Ephemeral stream flow		Erosional niche, rills and gullies
Rainstorm water	Sheetwash		Gullies

In the middle part of the alpine level, fluvial erosion intensity is minimal in January (Fig. 14a) and maximal in the other months and as a yearly average (Fig. 14b, 14c, 14d, 14e). At the lowest altitudes of the alpine level, the intensity has maximal values in the characteristic months, as well as throughout the year (Fig. 14a, 14b, 14c, 14d, 14e).

Digital processing of the data

The idea of drawing up a map that would show the risk of relief degradation because of the accentuated sheet and linear erosion processes has emerged as a consequence of the monitoring of these processes. In this massif, the study area offers numerous such situations observed by us during the terrain work and subsequently mapped on the topographic maps, scale 1:25,000. At the same time, we observed the geological, relief, climate, vegetation and soil conditions of the areas where the surface and linear erosion processes appear most often.

In accordance with our working plan we have made a database, using the facilities offered by the GIS programs CartaLinx and Idrisi 32 (Eastmann, 2001). In building process of this database, we started from the idea that the geology, the relief, the climate and the vegetation are the soil generating factors. In irrational land use conditions or if there are no protection measures to impede accelerate erosion, the soil can enter a degrading process through the proliferation of sheet erosion, of rills and gullies.

The Vârfu cu Dor (2,030 meters) - Jepii Mici (2,070 meters) database entails five types of digital thematic maps: a digital elevation model (DEM), a geological map, a slope map, a soil map and a vegetation map.

The digital elevation model was built on the basis of a topographical map 1:25,000, the 1981 edition, obtaining a 4.2 meters resolution. On the same topographic map, we built the vegetation digital map, which entails the alpine pasture areas, the *Dwarf pine* and forest areas. The digital geological map has as a basis the Moeciu (1971) and Sinaia (1980) sheets, scale 1:50,000, which were adapted for the 1:25,000 scale before processing; the soil digital map was obtained by processing the soil maps (1:200,000, *the Braşov sheet*, 1975), which was also adapted to the 1:25,000 scale.

The geological conditions, the slope, the soil and the vegetation features of the area were the tracked down erosion forms occur were extracted from these maps. Thus, there were obtained 4 Boolean maps, in which we have attributed the "0" value to the conditions where there are no degradation aspects and the value "1" to the geological, slope, soil and vegetation conditions where there have been found the degradation aspects (Fig. 15, 16, 17, 18):

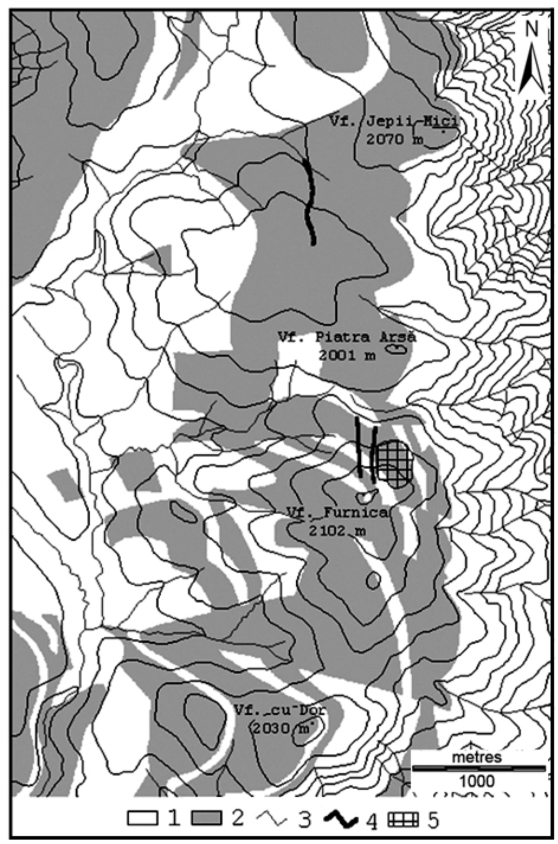

Fig. 15. The Boolean map of geology
1. Other rocks; 2. Rocks on which there appear degradation forms; 3. Hydrological network; 4. Rills and gullies; 5. Surfaces with soil erosion (Voiculescu, Vuia, 2005)

From the geological point of view, it was established that the degradation forms occur in the Babele Grit stone area of Albian age, which was represented with a shade of grey in the Boolean map. The Boolean slope map comprises the areas with a slope smaller than 20 percent and the ones

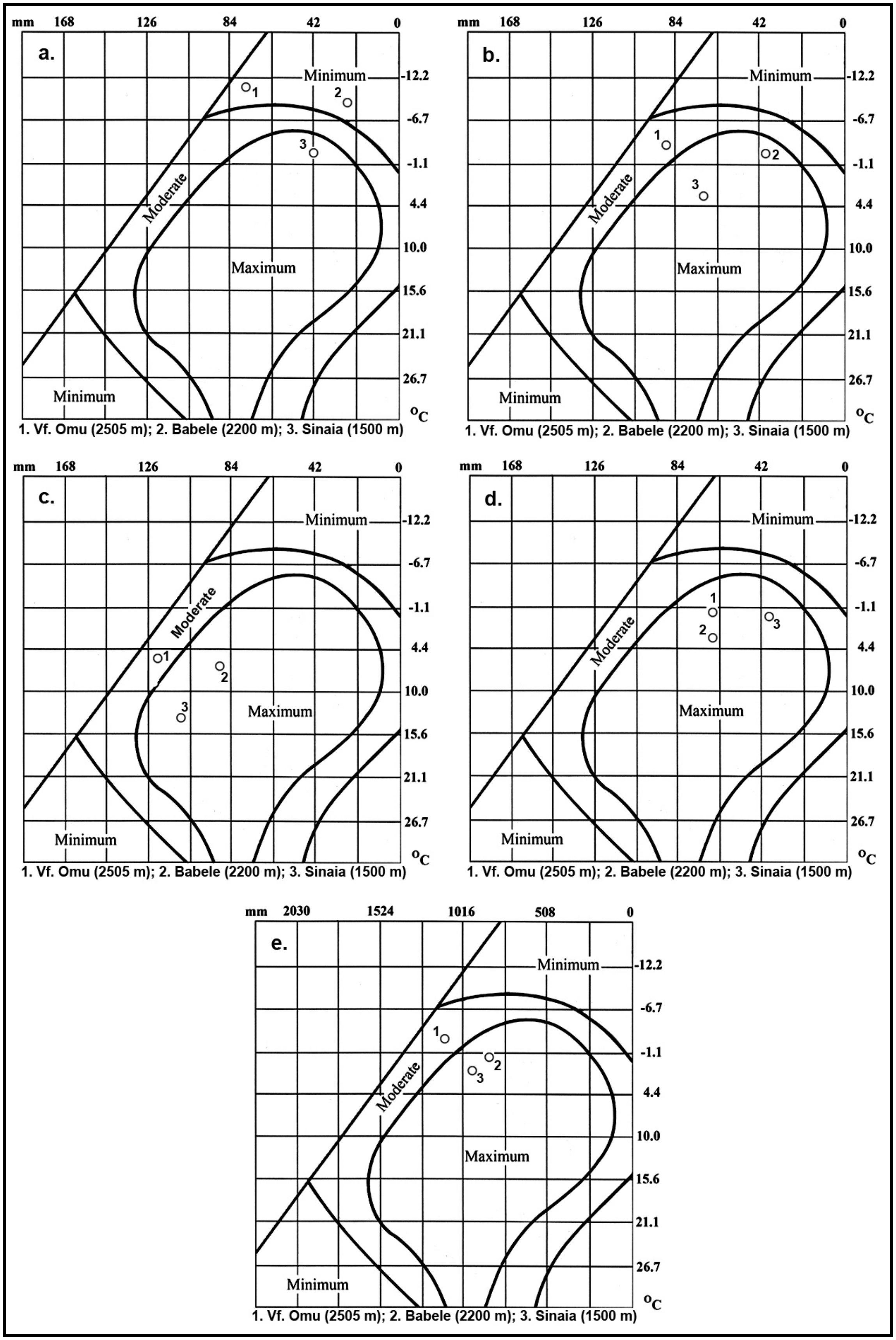

Fig. 14. Péltier diagram representing the location within river processes of the above mentioned meteorological stations: a. January, b. April, c. July, d. October, e. Multi-annual monthly mean values

with a slope higher or equal to 20 percent, necessary for the rill processes initiation (Rădoane *et al.*, 1999). By overlapping the forms mapped on terrain with the soil map, it can be observed that they develop in podzols with a loamy-sandy texture in the first layer, these soils presenting high susceptibility to degradation by linear erosion processes in the high precipitation conditions of the Bucegi Mountains. As far as vegetation is concerned, the terrain and map observations indicate a large presence of degradation in the alpine pasture areas, these having a low capacity to act as a buffer area between the morphogenetic agents (rain, rainstorm and snowfall) and relief.

If we analyze the risk from a social scientific point of view, any form of "natural risk" is produced by humans themselves (Bell, Glade, 2004, p. 118). According to Heinimann (1999, quoted by Bell, Glade, 2004), the risk analysis can be done either in a qualitative, or quantitative manner. On the other hand, the risk assessment comprises three equal elements of risk assessment: risk analysis, risk evaluation and risk management (Bell, Glade, 2004).

With the help of the database, by multiplying the maps, the Boolean analysis allows us to build a map where the value "1" corresponds to the areas that combine the geological, slope, soil and vegetation conditions on terrain and are characterised by accelerated sheet erosion and by the occurrence of gullies. The resulted map (Fig. 19) shows, by shades of grey, the areas where the existence of degradation forms is very probable, these being highly degradation risk areas, as a result of the above-mentioned processes.

Consequently, in the above-mentioned areas, the human intervention through grazing and tourist practices must be rationally managed and where advanced degradation appears, these processes should be slowed down or even stopped. The areas marked in white show no degradation risk. It is to be noticed the fact that in the Vârfu cu Dor - Jepii Mici Peak sector, the areas that need special attention from the land managers are located around the high peaks, such as Vârfu cu Dor, Furnica, Piatra Arsă and Jepii Mici.

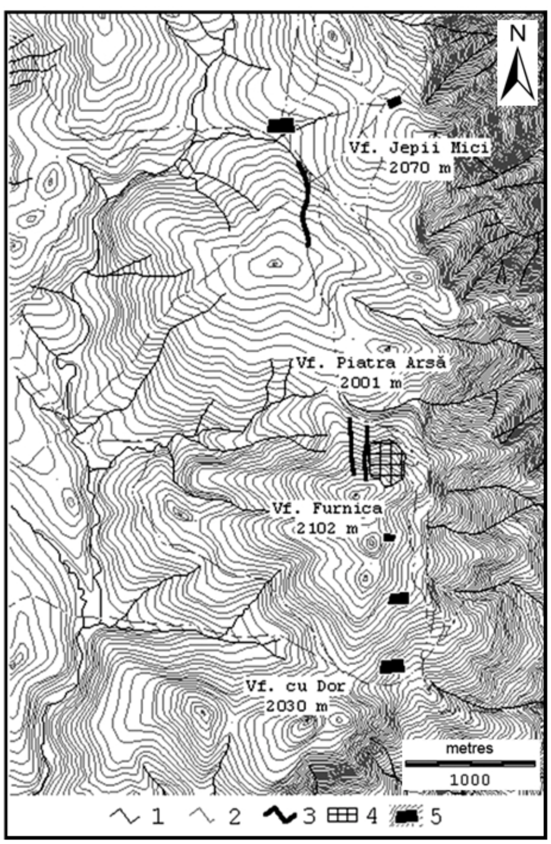

Fig. 16. The Boolean map of declivity
1. Declivity < 20 percent; 2. Declivity ≥ 20 percent; 3. Hydrological network; 4. Rills and gullies; 5. Surfaces with soil erosion
(Voiculescu, Vuia, 2005)

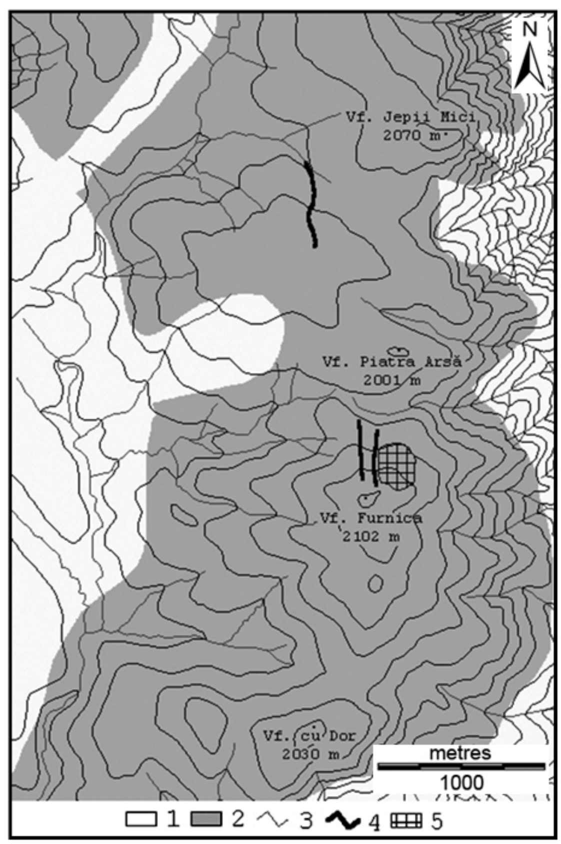

Fig. 17. The Boolean map of soils
1. Other soils; 2. Podzolic soils with a loamy-sandy texture in the first layer; 3. Hydrological network; 4. Rills and gullies; 5. Surfaces with soil erosion
(Voiculescu, Vuia, 2005)

Conclusions

The erosion processes in mountain regions are caused by natural and anthropogenic factors and affect the land use. The erosion processes, especially the gullies, are the main factors of degraded landscapes. Thus, the restoration of gully systems is necessary (Molina *et al.*, 2009). On the other hand, the land use requires specific knowledge on the soil erosion situation (Zengxiang *et al.*, 1996). This is especially important since the area that we examined is in the Bucegi National Park. The future development of erosion processes, in our case rill and gullies, and all aspects regarding their control must be a serious concern to the land managers from mountain regions. Erosion processes and their impacts receive increasing attention from local policy makers (de Vente *et al.*, 2008). Understanding the morphology of erosion processes represents the first step in their assessment (Heede, 1970). The GIS software used by us has proved to be a powerful and efficient tool in capturing, storing, updating, manipulating, analyzing, and displaying all geographical forms (Lo *et al.*, 1992), in our case the erosion processes. It is believed that in these types of issues, the method of the Boolean analysis is easy to apply and therefore satisfactory. It can also be applied in the analysis of other terrain degradation processes.

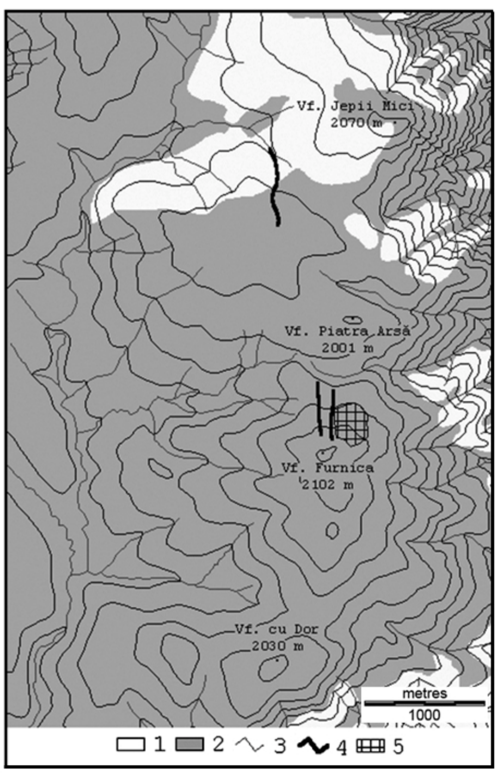

Fig. 18. The Boolean map of vegetation
1. Forest and *Dwarf pine*; 2. Alpine meadow; 3. Hydrological network; 4. Rills and gullies; 5. Surfaces with soil erosion
(Voiculescu, Vuia, 2005)

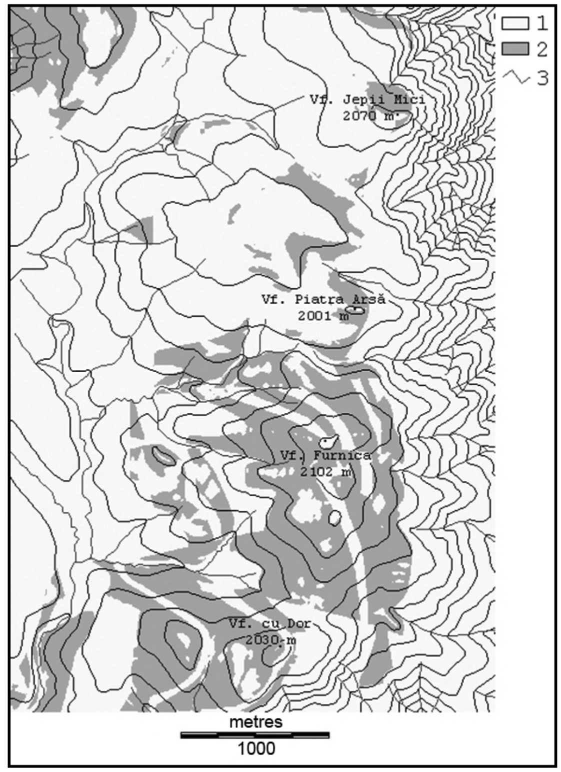

Fig. 19. The risk map of the erosion processes (surface and soil erosion, rills and gullies)
1. Low risk; 2. High risk; 3. Hydrological network
(Voiculescu, Vuia, 2005)

There are landslides, crumbling, rock falls or snow avalanches. The more complex the database is (considering more variables), the more exact the results become. On the other hand, these types of analyses and maps can be used in the territorial planning activities or in the fight against degradation processes.

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INVENTORING AND EVALUATION OF GEOMORPHOSITES IN THE BUCEGI MOUNTAINS

Laura COMĂNESCU[1], Alexandru NEDELEA[2], Robert DOBRE[3]

Abstract. Geomorphosites stand for relief forms or geomorphologic processes that in time have gained an aesthetic, scientific, cultural, historical or economic value, as a result of human perception (Panizza, 2001). Taking into consideration the above mentioned definition, the present paper aims at inventorying and evaluating part of the geomorphosites in the Bucegi Mountains. The final purpose is to propose some measures for a better protection and tourist promotion.
The presence of numerous geomorphosites in the Bucegi Mountains is the direct result of the presence of limestones and conglomerates, as well as the succession of different modelling systems in time (glacial, periglacial, fluvial). We analysed this area since there are many and varied geomorphosites, and at the same time, it is one of the major tourist destinations (the largest number of tourists and the best tourist infrastructure within the Romanian Carpathian Mountains).
Key words: the Bucegi Mountains, geomorphosite, inventory, evaluation.

Rezumat. Inventarierea şi evaluarea geomorfositurilor din Munţii Bucegi. Geomorfositurile sunt forme de relief sau procese geomorfologice care au căpătat în timp valoare estetică, ştiinţifică, culturală, istorică sau economică, datorită percepţiei umane (Panizza, 2001). Pornind de la definiţia de mai sus, în lucrarea de faţă ne propunem să inventariem şi să evaluăm o parte a geomorfositurilor din masivul Bucegi. Acestea au ca finalitate propunerea unor măsuri privind protecţia superioară şi apoi promovarea turistică. Prezenţa a numeroase geomorfosituri în Masivul Bucegi este impusă de existenţa calcarelor şi conglomeratelor, dar şi de succesiunea în timp a diferitelor sisteme de modelare (glaciar, periglaciar, fluviatil), toate acestea conducând la geomorfosituri specifice. A fost ales spre studiu acest areal datorită prezenţei unei game variate de geomorfosituri dar şi valorificării turistice foarte intense (cel mai mare număr de turişti şi cea mai dezvoltată infrastructură din întreg lanţul carpatic românesc).
Cuvinte cheie: Bucegi, geomorfosit, inventariere, evaluare

1.Introduction

The geomorphosite can be defined as the relief form or geomorphologic process that is important for understanding the evolution of the Earth (Panizza, 2001; Reynard, 2004). The value that is given to the geomorphosites due to the human perception has two main components: the scientific value (reconstruction of some paleo-geographic elements) and additional values (cultural, historical, ecologic, economic and aesthetic value) (Reynard 2005) (Fig. 1).

Other terms have equally been used in the geography literature to designate the geomorphosite; however, they are not perfectly synonymous: geomorphologic values, geomorphologic goods, geomorphologic geotops, sites of geomorphologic interest (Panizza, Reynard, 2005).

This new study direction for geomorphology has only recently emerged (1993), when M. Panizza gives the first definition of geomorphosites. In 2003, the most important work in the domain was published – *Cultural geomorphology*.

In Romania, this issue is quite vaguely dealt with. The main contributions were maid by the professors at the University of Oradea after 2000. Taking into consideration all this, the present paper aims to identify and evaluate the geomorphosites within the Bucegi Mountains, for better knowledge, protection and higher capitalization of the geomorphosites within this massive, having a great touristic potential and well capitalized from the tourist point of view.

Thus, the present paper is an integrating part of the research project PNII/ Ideas (*Inventoring, Evaluation and Mapping of Geomorphosites. Case studies: the Dobrodjea plateau and the Southern Carpathians)* financed by CNCSIS.

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Table 1

Terminology used for designating geomorphosites in the geomorphology literature (according to Panizza, Reynard, 2005, complemented)

Term	Equivalent / term in foreign literature	Bibliographical references	Values and evaluation criteria
Geomorphologic values/ assets	Geomorphological assets / Biens géomorphologiques	Panizza şi Piacente, 1993; Quaranta, 1993	The evaluation may be aesthetic (intuitive) and scientific (quantitative one)
Geomorphologic assests	Geomorphological goods Biens géomorphologiques	Carton şi alţii, 1994	The geomorphologic goods are evaluated based on various characteristics categories, i.e. scientific, aesthetic and cultural. The scientific value is given by the paleo-geomorphologic evolution, the possibility for using them as a teaching tool, the ecologic role and character of geomorphologic rarity.
Geomorphosites	Geomorphological sites Sites géomorphologiques	Hooke, 1994	The geomorphologic sites have three main values: an aesthetic, ecologic and didactic one (the possibility of observing different geomorphologic processes).
Geomorphologic geotops	Geomorphological geotopes Géotopes géomorphologiques	Grandgirard, 1995, 1997, 1999	The geomorphologic geotope is that particular element, the value of which is recognised. The inventory of geomorphologic geotope is important and representative for the diversity of the analysed area.
Sites of geomorphologic interest	Sites of geomorphological interest / Sites d' intérét géomorphologiques	Rivas şi alţii, 1997	The sites present great scientific, educational and tourist interest.
Geomophosites	Geomorphosites Géomorphosites	Panizza, 2001	The geomorphosite is a relief form to which some value may be added.

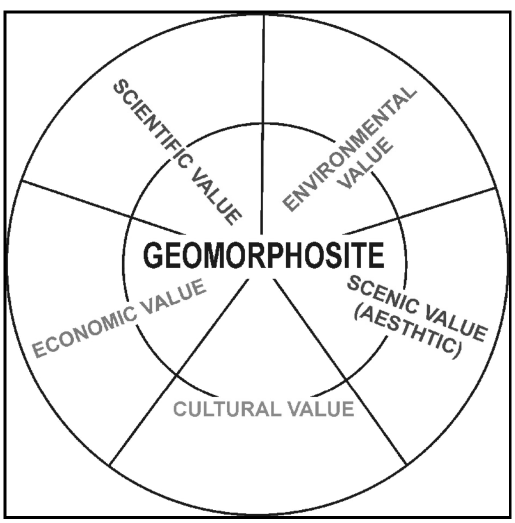

Fig.1 The characteristics of geomorphosites (according to Reynard, 2005, complemented)

2.Area of study

The Bucegi Mountains include massifs disposed as a horseshoe arch, open southwards and fragmented in the central part by the Ialomita valley, with steep slopes and different looking sectors (gorges and depression-like basins (Ielenicz, Comanescu, 2006).

From the geological point of view, in the Bucegi mountains there are more than 1,00 m thick layers of conglomerates (the Bucegi conglomerates), which caused the formation of numerous geomorphosites due to differentiated erosion. Beside conglomerates, there are also limestones (which also have their own geomorphosites) and a marl-sabulous flysh.

The relief of the Bucegi mountains is diverse and complex due to the morphogenetic conditions and to the external agents, that differ in time and space. Consequently, there emerged different types of geomorphosites, the most famous one being the following (Ielenicz, Comanescu, 2006):

- sectors of structural abrupt (Prahova and Bran) with level difference of more than 1000 m and structural plateaus at more than 1800-2000 m;
- the Ialomita valley with the multitude of depression-like basins and especially gorges (Urşilor, Tătarul Mic, Tătarul Mare, Zănoaga Mică, Zănoaga Mare, Orzei);
- the peaks which offer panoramic views or are a tourist attraction in themselves;
- alpine ridges;

- ruined relief forms, as a result of different erosion, as fangs, towers, the most famous are Babele and the Sfinx;
- the glacial relief with complex developed around Omu Peak (Mălăeşti, Țigăneşti, Obârşia, Valea Cerbului);
- karst relief (the most famous being the Ialomita Cave);
- glacial or structural thresholds which generate falls (Urlatoarele).

There were chosen and evaluated geomorphosites from each category following the criteria of importance, complexity, momentousness and degree of tourist exploitation.

3.Method

The inventory and evaluation of geomorphosites is done in several stages:

- reading the existing bibliography and maps (including satellite images);
- trip field to have a complete inventory of geomorphosites;
- making some inventory papers for geomorphosites;
- mapping and evaluation of geomorphosites.

The description ticket for geomorphosites was first conceived by a joint research of the Geography Institute of Lausanne University (E. Reynard and J.P. Pralong), Fribourg University (V. Grandgirard) and Modena and Reggio Emilia University (P. Coratza). The criteria used hint both at the quantitative and qualitative analysis of geomorphosites. If this ticket is applied, there can be done a complete inventory of geomorphosites for different territorial units (region or valley). Here is a model of evaluation paper, a model that was applied for the Bucegi Mountains. Of course, it can be improved.

There are two evaluation methods in the literature for evaluating geomorphosites: *a method for evaluating the global quality of geomorphosites* (IGUL method) which implies an evaluation of scientific value and of additional values; *a method for evaluating the touristic potential* of the sites, which was developed by Jean-Pierre Pralong, a method which led the classification of geomorphologic sites depending on the touristic potential and value.

Table 2

Synthess table regarding the geomorphosites from the Bucegi Mountains

Nr.	Name	Code	Type
1	Babele	PHed1	punctual
2	Sfinxul	PHed2	punctual
3	Ialomicioara Cave	PHkar3	punctual
4	Omu Peak	PHm4	punctual
5	Urlătoarea Falls	PHstr5	punctual
6	Caraiman Plateau	PHstr6	areal
7	Franz Josef Cliff	PHed7	punctual
8	Tătar Gorges	PHkar8	punctual
9	Circul Gaura	PHgla9	punctual
10	Colții Morarului	PHper10	punctual

Where:
ed-differentiated erosion, *kar*- karst, m-morfographic str-structural, gla-glacial, per- periglacial, according to the specialised literature

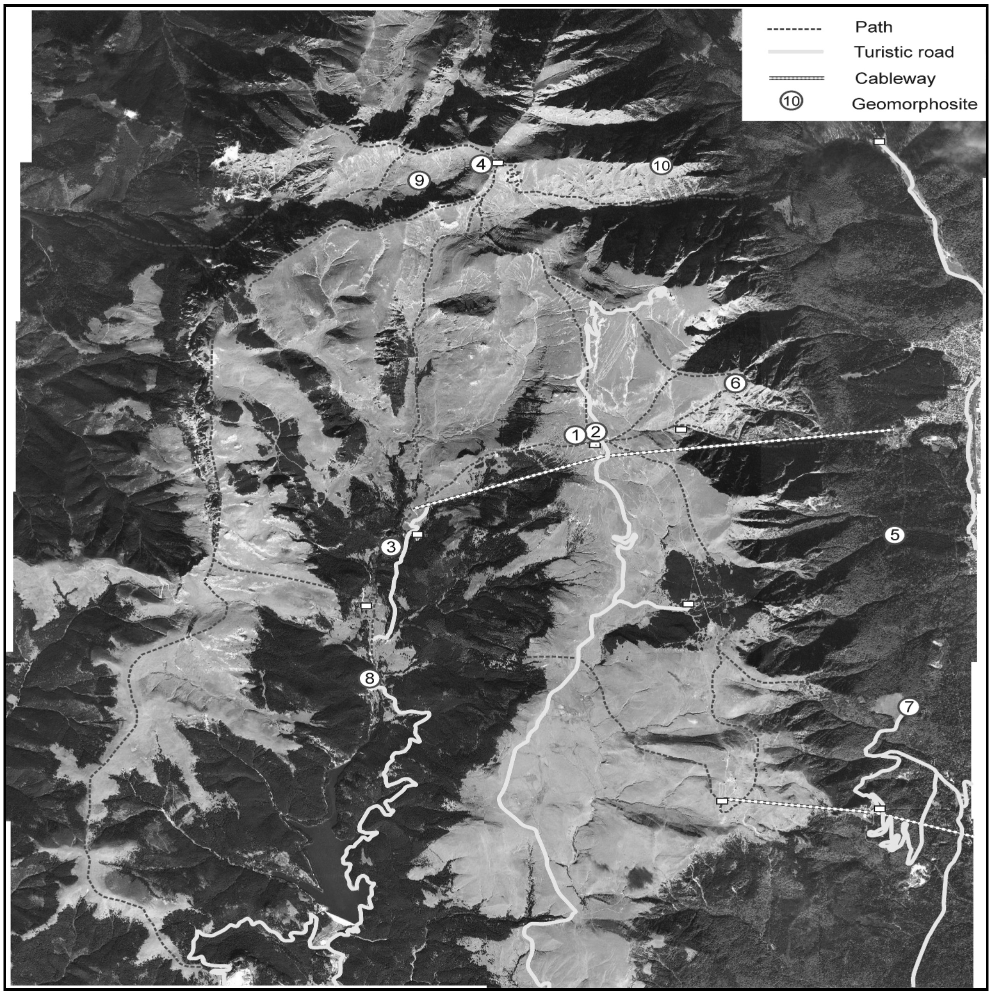

Fig.2. Location of analysed geomorphosites within the Bucegi massive

Results and discussions

The present evaluation was greatly based on the model proposed by Jean Pierre Pralong (2005). The touristic value (table 3) is determined as the average of the four values, according to the formula:

Vtour =(Vsce +Vsci +Vcult +Veco)/4,

where *Vtour* – touristic value, *Vsce* – aesthetic value, *Vsci* – scientific value, *Vcult* – cultural value and *Veco* – social-economic value.

The average of these values has pointed out to the data that are synthesized in the table below; they vary between 0.655 (the Caraiman Plateau), 0.625 (Babele and the Sphinx) and 0.387 (Gaura Cirque). These figures are much higher than those from other tourist mountains, also as a result of the high score regarding the economic value, due to the great number of visitors and their accessibility, including cable transport, forest roads and paths. an areal geomorphosite (the Caraiman Plateau) takes the lead since it includes more punctual geomorphosites which gave good scores (Comanescu, Nedelea, 2009).

Table 3

The evaluationof the global value of the geomorphosites within the Bucegi Mountains

No.	Name	Scenic value	Scientific value	Cultural value	Economic value	Global value
1	Babele	0.75	0.65	0.25	0.85	0.625
2	Sphinx	0.75	0.65	0.25	0.85	0.625
3	Ialomicioara Cave	0.5	0.6	0.45	0.6	0.537
4	Omu Peak	0.75	0.45	0.10	0.65	0.487
5	Urlătoarea Falls	0.4	0.45	0.05	0.85	0.437
6	Caraiman Plateau	0.6	0.47	0.6	0.95	0.655
7	Franz Josef Cliff	0.55	0.45	0.3	0.55	0.462
8	Tătarului Gorges	0.65	0.5	0	0.75	0.475
9	Circul Gaura	0.5	0.55	0	0.5	0.387
10	Colții Morarului	0.9	0.6	0.05	0.65	0.55

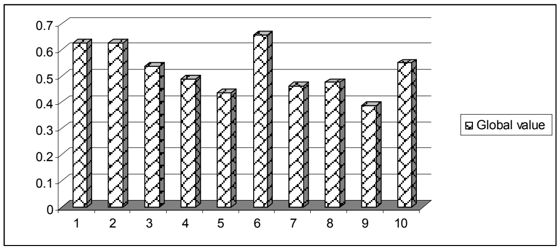

Fig.3. The global value of geomorphosites within the Bucegi massif

In order to determine the scenic value, there were taken into consideration the following elements: the number of visibility points; average distance between the sightseeing points; site area (sqkm) as compared to other sites of the same type within the area; relief intensity; colour contrast. The figures for this value (table 4) vary between 0.9 (Coltii Morarului) and 0.4 (Urlatoarea Falls), mainly due to the lack of sightseeing points and the lack of visibility for the latter (Comanescu, Nedelea, 2009).

As for the scientific value (Table 5) (which also includes the ecologic value), there were evaluated the paleo-geographical interest, their representativeness, area (per cent), uniqueness, integrity and ecologic interest. It varies between 0.65 (Babele and the Sphinx) and 0.45 (Urlatoarea Falls) (Comanescu, Nedelea, 2009).

Table 4

The evaluation of the scenic value of geomorphosites within the Bucegi Mountains

No.	Name	Scenic value					
		Sc1	Sc2	Sc3	Sc4	Sc5	Total
1	Babele	1	1	0,25	0,5	1	0,75
2	Sphinx	1	1	0,25	0,5	1	0,75
3	Ialomicioara Cave	0	0,25	0,5	0,75	1	0,5
4	Omu Peak	1	1	0,25	1	0,5	0,75
5	Urlătoarea Falls	0,25	0,5	0,5	0,5	0,25	0,4
6	Caraiman Plateau	0,75	0,75	0,5	0,75	0,25	0,6
7	Franz Josef Cliff	0,25	0,5	0,25	0,75	1	0,55
8	Tătarului Gorges	0,5	0,75	0,5	0,5	1	0,65
9	Circul Gaura	0,5	0,5	0,25	0.75	0,5	0,5
10	Colții Morarului	1	1	0,5	1	1	0,9

The cultural value (Table 6) is determined based on the symbolic relevance and the cultural heritage, iconographic representations, historical and archaeological relevance, religious and archaeological relevance, art and culture events. The figures are very low sometimes (0) as a result of the lack of iconographic representations or some history, archaeology or symbolist elements. the Caraiman Plateau has the highest value (0.6), which is present in numerous iconographical representations or different types of geo-tourist products (Comanescu, Nedelea, 2009).

Table 5

The evaluation of the scientific value of the geomorphosites within the Bucegi massif

No.	Name	Scientific value						
		St1	St2	St3	St4	St5	St6	Total
1	Babele	0,75	1	0,75	0,75	0,75	0	0,65
2	Sphinx	0,75	1	0,75	0,75	0,75	0	0,65
3	Ialomicioara Cave	1	0,5	0,75	0,25	0,75	0,25	0,6
4	Omu Peak	0,5	1	0,5	0,25	1	0,25	0,45
5	Urlătoarea Falls	0,5	0,75	0,75	0,25	0,5	0	0,45
6	Caraiman Plateau	0,25	0,5	0,25	0,5	0,75	0,5	0,47
7	Franz Josef Cliff	0,25	0,25	0,75	0,75	0,75	0,25	0,45
8	Tătarului Gorges	0,25	0,5	0,5	0,5	0,75	0,5	0,5
9	Circul Gaura	0,5	0,5	0,5	0,5	1	0,25	0,55
10	Colții Morarului	0,5	0,75	0,5	0,5	1	0,25	0,6

Table 7 presents the economic value. It is determined as the average of accessibility, natural risks, annual number of visitors, official level of protection, attraction. The values are very high (0.95 for the Caraiman Plateau, due to its accessibility and high tourist flows); Gaura Cirque has only 0.5, because it requires longer routes, which are taken only by the well trained tourists (Comanescu, Nedelea, 2009).

5.Conclusions

This method was used only for the mountainous areas from different countries (Italy, Switzerland, Spain, Greece). There is no doubt that there is a need for developing this type of study in Romania as well, taking into consideration the great tourist potential of the Romanian Carpathians in general and the Bucegi Massif in particular. the ultimate aim of our scientific research is to continue the study of geomorphosites and the achievement of some geo-tourist products.

Table 6

The evaluation of the cultural value of the geomorphosites within the Bucegi Massif

No.	Name	Cultural value					
		C1	C2	C3	C4	C5	Total
1	Babele	0,25	1	0	0	0	0,25
2	Sphinx	0,25	1	0	0	0	0,25
3	Ialomicioara Cave	0,5	0,25	0,5	1	0	0,45
4	Omu Peak	0,25	0,25	0	0	0	0,10
5	Urlătoarea Falls	0	0	0	0	0,25	0,05
6	Caraiman Plateau	0,5	1	1	0,5	0	0,6
7	Franz Josef Cliff	0,5	0,25	0,75	0	0	0,3
8	Tătarului Gorges	0	0	0	0	0	0
9	Circul Gaura	0	0	0	0	0	0
10	Colții Morarului	0	0,25	0	0	0	0,05

Table 7

The evaluation of the economic value of the geomorphosites within the Bucegi Mountains

No.	Name	Economic value					
		E1	E2	E3	E4	E5	Total
1	Babele	1	0,25	1	1	1	0,85
2	Sphinx	1	0,25	1	1	1	0,85
3	Ialomicioara Cave	1	0	0,5	1	0,5	0,6
4	Omu Peak	1	0	0,5	1	0,75	0,65
5	Urlătoarea Falls	0,75	0,5	1	1	1	0,85
6	Caraiman Plateau	1	0,75	1	1	1	0,95
7	Franz Josef Cliff	0,5	0.25	0,5	1	0,5	0,55
8	Tătarului Gorges	1	0,75	0,5	1	0,5	0,75
9	Circul Gaura	0,25	0,75	0,25	1	0,25	0,5
10	Colții Morarului	0,25	1	0,5	1	0,5	0,65

In order to fully validate this method, the criteria that were used, and the values granted should be tested in different physical-geographical units (mountains, hills, plains, shore) and tourist units (mass tourism, individual tourism etc.) to be able to adapt the scale for the evaluation. this approach may be subsequently used for defining the geomorphosites capacity to cope with the tourist function, as well as their evolution depending on the exploitation.

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THE IMPORTANCE OF THE ASYMMETRY OF SMALL HYDROGRAPHIC BASINS IN THE OCCURRENCE OF MAJOR FLOODS IN THE RARĂU MASSIF

Cristian-Dan LESENCIUC[1]

Abstract: The present study approaches a series of geomorphological aspects specific to hydrographic basins of small sizes which, in certain circumstances, favor the occurrence of floods having major effects upon the human settlements. We focused our attention on three neighboring hydrographical basins, located in a mountainous area in the north of the Romanian Carpathians, where on the 24th of July 2008, following some heavy rains, there occurred major floods. Although the three rivulets the Valea Seacă, the Izvorul Alb and theValea Caselor are tributaries on the right side of the Moldova river, the behaved differently during the above mentioned flood. The particularity is that within the Izvorul Alb hydrographic basin the maximum flow during the flood was two time lower than in the case of the other two basins between which it is located. Given the fact that the quantity of precipitations received by all three basins did not differ and the physical-geographical features are similar, there was performed the morphometric analysis of all three hydrographical basins in order to outline the morphometric variables with a role in the concentration of the runoff: the surface, the slope, the roundness, the shape coefficient, etc. The conclusion drawn from this case study is that the asymmetry of the basin is an essential parameter in making the difference in respect to the behavior of small hydrographical basins during the formation of exceptional floods.
Key words: flood, hydrographic basin, asymmetry, Rarău

Rezumat: Importanţa asimetriei bazinelor hidrografice mici pentru producerea viiturilor majore din Masivul Rarău. Studiul de faţă abordează o serie de aspecte geomorfologice specifice bazinelor hidrografice de dimensiuni reduse care favorizează, în anumite condiţii, producerea unor viituri cu efecte majore asupra aşezărilor umane. Atenţia noastră a fost direcţionată spre trei bazine hidrografice învecinate, situate într-o zonă montană din nordul Carpaţilor României, unde în ziua de 24 iulie 2008, în urma unor ploi torenţiale, s-au produs viituri majore. Deşi cele trei pâraie Valea Seacă, Izvorul Alb şi Valea Caselor sunt afluenţi de dreapta ai râului Moldova, acestea s-au comportat diferit în timpul viiturii amintite. Situaţia particulară constând în faptul că în bazinul hidrografic Izvorul Alb debitul maxim din timpul viiturii a fost de două ori mai mic decât în cazul celorlalte două bazine între care se află poziţionat. În condiţiile în care cantităţile de precipitaţii primite de cele trei bazine nu au fost diferite iar caracteristicile fizico-geografice sunt asemănătoare s-a efectuat analiza morfometrică a celor trei bazine hidrografice cu scopul evidenţierii variabilelor morfometrice cu rol în concentrarea scurgerii: suprafaţa, panta, circularitatea, coeficientul de formă etc. Concluzia ce se desprinde din acest studiu de caz este accea că asimetria bazinului este un parametru esenţial în diferenţierea comportamentului bazinelor mici la formarea viiturilor excepţionale.
Cuvinte cheie: viitură, bazin hidrografic, asimetrie, Rarău.

At the level of small hydrographic basins there are a series of geomorphologic characteristics which, in certain circumstances, cause floods with major negative effects upon the human settlements. Among these extremely important characteristics there are the morphometric variables having a role in the concentration and propagation of surface runoff. The asymmetry of the hydrological basin is one of the variables which influence the runoff within the three hydrographical basins afferent to the Valea Seacă, the Izvorul Alb and the Valea Caselor rivulets, tributaries on the right side of the Moldova river, which drain the north-east sector of the Rarău Massif (Figure no. 1).

This massif is located in the north-central sector of the Orientali Carpathians being grafted on a sublayer which, from the structural-lithological point of view, belongs to the crystalline-intermediate area.

The hydrographic basins represent geomorphologic fluvial systems which can be described by a high number of variables. Part of the variables and the existent relations between them had been identified for the first time by Horton (1945), who pursued an entire group of experts interested in this domain. In Romanian, Zăvoianu (1978) was among the first people who focused on the research of the relations between the morphometric variables of the hydrographic basins. Subsequently, there was quite an explosion of the studies based on the morphometry of hydrographical basins, approaches which, in a certain measure, remain timely due to the variety

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of geomorphologic aspects analyzed. Of great practical importance remain the geomorphologic studies based on issues concerning the risk to floods existent in certain inhabited areas.

The present study had been initiated after the occurrence of some major floods, on the 24th of July 2008, which affected differently the human objectives located on the above mentioned valleys.

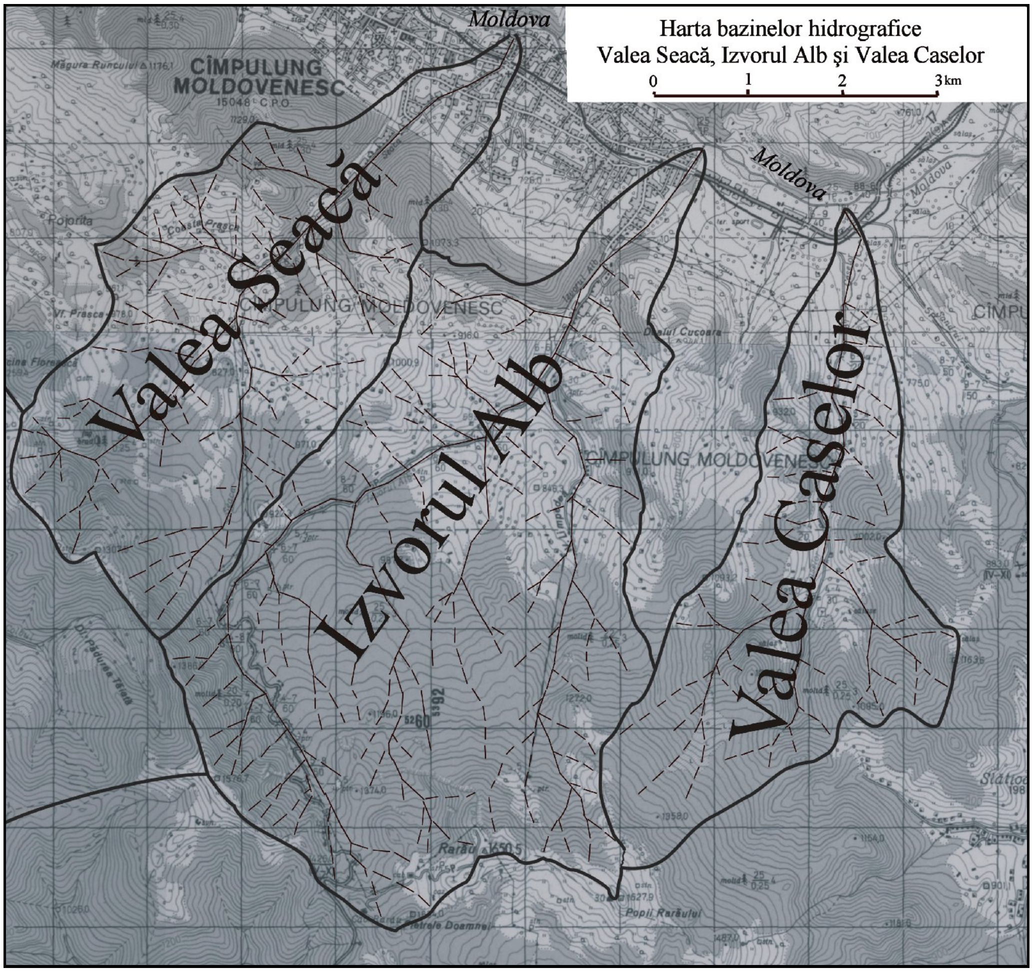

Fig.1 The map of the hydrographic basins analyzed

The working methods consisted in: 1. applying the method of crosscut section to determine the maximum flows occurred; 2. applying the morphometric method of analysis for hydrographic basins; 3. mapping the fluvial geomorphogic processes along the valleys analyzed; 4. making the inventory of the losses caused by the flood (houses, appendixes, lands, roads etc).

It is remarkable that, pursuant heavy rains superincumbent on a three days period with important precipitations, the Valea Seacă, a rivulet with a hydrographical basin of about 15 km^2 and with an average flow estimated to 0,15 m^3/s, registered an increase of the flow which at high amplitude (2 ^{15} hrs from the 24th of July 2008), reached the estimated value of approximate 20 m^3/s. During the maximum flow of the flood, the rivulet raised with approximate 3,5 – 4 m affecting directly a number of approximate 30 dwellings located along the valley on the riverside terrace of 1-2 m (Fig. 2 and 8).

In the same time an important flow increase was also registered on the Valea Caselor rivulet, whose hydrographical basin has about 11 km^2, with an average flow estimated to approximate 0,14m^3/s. In this valley the water level raised during the maximum flood with approximate 3-3,5 m, reaching a maximum flow estimated to approximate 10-15 m^3/s. Though, also in this place, the water level raised a lot, there were directly affected only 12 dwellings located on the riverside terrace of 0,5-1,5m, because the house density here is smaller here than in the Valea Seacă, nearby the center of the Câmpulung Moldovenesc city.

Between the two hydrographic basins considered for the analysis there is the Izvorul Alb rivulet, whose hydrographic basin is larger

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(about 25km^2) with a total surface approximate equal to the surface summed up from the other two hydrographic basins Valea Seacă and Valea Caselor. The average annual flow, estimated for this rivulet, is approximate 0,35m

Fig. 2 The maximum level of the flood on Valea Seacă

During the flood occurred on the 24th of July 2008, it reached a maximum flow of approximate 15-20 m^3/s raising its level with approximate 2 – 2,5 m. Unlike the Valea Seacă and the Valea Caselor, during the flood on the Izvorului Alb valley, only a touristic complex build nearby the river bed was damaged. The fact that on this valley there were not any cases of flooded houses during the flood is because the houses are located on the riverside terrace of, terrace which was not affected on this occasion. Consequently, in this valley the most important material losses were registered due to the damage caused to the access road on certain sectors and by the damage of a crossing bridge over the rivulet.

From the analysis of this events there result the fact that at the level of the Izvorul Alb rivulet hydrographic basin there are a series of particularities which differentiate it from the other two basins from the point of view of its behavior during the flood.

We mention the fact that all three hydrographic basins received similar quantities of precipitations (66 mm/24 hours at the Rarău station – 1572 m altitude and 68 mm/24 hours at the Pojorâta hydrometric station – 700 m altitude). Also their distribution during the 24 hours, as well as the torentiality are similar, given the fact that during the time interval 1^{45} – 2^{30} on the 24th of July 2008 there were registered maximum flows on all three rivulets analyzed to which we add the Izvorul Giumalăului rivulet where there is a hydrometric station (Fig.3).

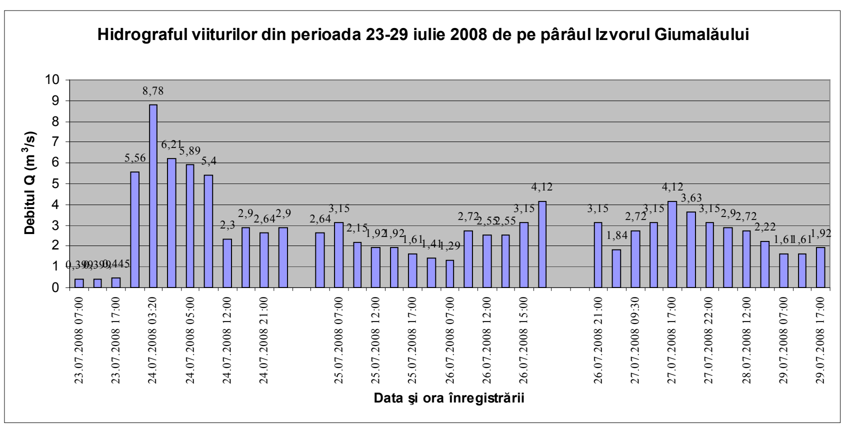

Fig. 3 The flow hydrograph from the Izvorul Giumalăului rivulet

It is important to mention the fact that the Izvorul Giumalăului hydrographic basin is located at the border between the Rarău and the Giumalău massifs. This hydrographic basin (hydrological monitored) had the same type of response to the heavy precipitations (Figure no. 3). The maximum flood had been registered in the same time as for the basins analyzed, but its flow did not increased too much, taking into consideration the surface of 30 km^2, because the air masses direction was performed from the east to the west and among the three analyzed basins and the Izvorul Giumalăului was interposed the Munceii Înşiraţi of Rarău ridge which covered the basin taken into consideration, a great quantity of precipitations being discharged on the eastern side of this ridge. The same time of orographic barrier was also felt at the level of the Putna hydrographic basin, tributary of the Moldova river, a basin located west of the Giumalău main ridge. This ridge determined an outpashing in the registration of the maximum flow with a delay of almost 24 hours, and the amplitude of the flood was not as high as for the other three hydrographical basins analyzed, if we take into consideration the big surface of the hydrographic basin – 120 km^2 (Fig. 4).

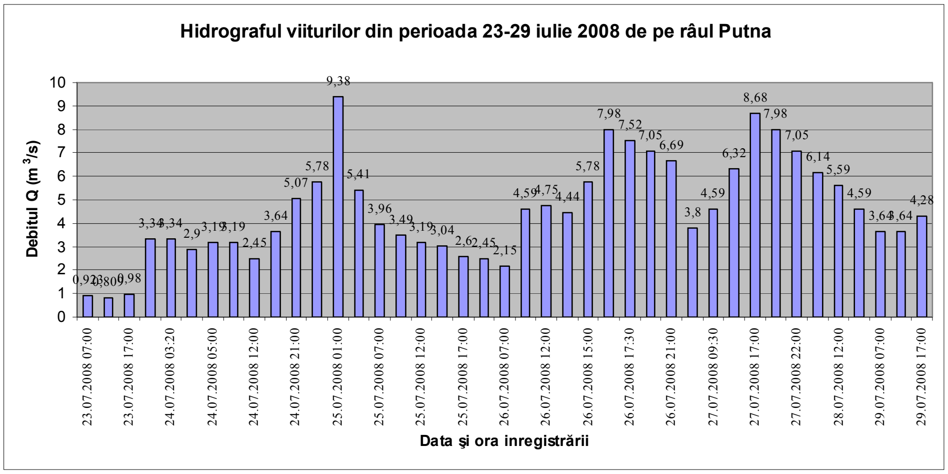

Fig. 4 The flow hydrograph from the Putna river

If, at the level of the quantity of precipitations there were not differences, then the research must take into consideration other physical-geographic factors from the level of the three basins. The geological sublayer is similar to a bigger correlation between the Valea Seacă and the Izvorul Alb basins (Figures no. 5, 6, and 7).

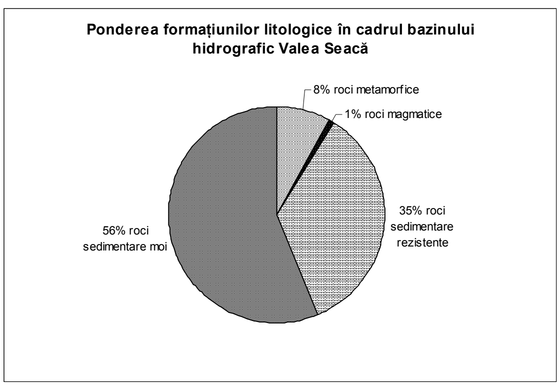

Fig. 5 The Valea Seacă hydrographic basin – the percentage of petrographical formations

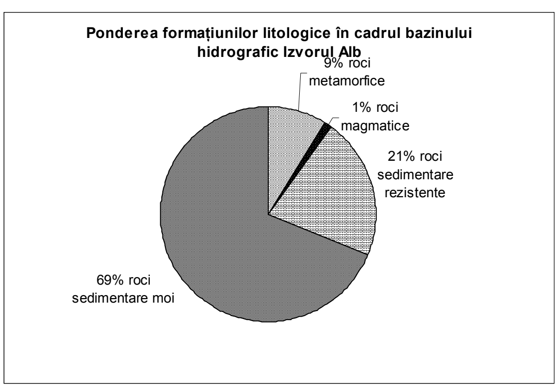

Fig. 6 The Izvorul Alb hydrographic basin – the percentage of petrographical formations

The reflection of the geological sublayer within the geomorphology of the area does not differentiate substantially the two basins from the Izvorul Alb hydrographic basin. In the same time, the percentage of different categories of vegetation, as well as its condition is similar for all three hydrographic basins, the human impact, concerning the deforestations, affecting all three perimeters in the same percentages.

Fig. 7 The effects of the flood from 24 of July 2008 on the Valea Seacă brook

The only significant differences between the Valea Seacă and the Valea Caselor hydrographic basins, on one hand, and the Izvorul Alb, on the other hand, are noticed at the level of morphometric parameters. The surface of the Izvorul Alb hydrographic basin, almost two times bigger, should be reflected within a higher flow compared to the other two hydrographic basins, registered during the maximum flood. In practice, this supposition was not verified and the explanation could be given by a higher capacity of the runoff to concentrate in smaller hydrographic basins (with a surface ranging between 10 – 15 km^2).

In order to evidence this aspect it was performed the analysis of the Izvorul Alb hydrographic basin of 4th degree (Strahler system) having a surface of about 12 km^2. The field researches did not confirmed the occurrence of a flood similar to the other two (the level of the rivulet raised with maximum 2 m), therefore the differentiation is not given by the surface.

Even the rest of the morphometric parameters are not different for the Izvorul Alb hydrographic basin (if we keep the percentages), please refer to the table attached. Therefore, the shape coefficient is higher (0,49) than the one for the Valea Seacă (0,40) or for the Valea Caselor (0,32) and the roundness of the basin is 1,39, being placed between the value for the Valea Seacă (1,32) and the one for Valea Caselor (1,49), (Table no.1) .

Table no. 1
Morphometric features of the hydrographical basins

	Valea Caselor	Izvorul Alb	Valea Seacă
Strahler order	4	5	5
Surface of the basin, Sb, (km^2)	10,9	24,6	15,3
Average altitude (m)	1050	1130	990
Maximum altitude (m)	1501	1651	1351
Minimum altitude (m)	603	611	628
Maximum energy, E max, (m)	898	1040	723
The diameter of the inscribed circle, d, (km)	2,2	4,2	2,9
The diameter of the circumscribed circle, D, (km)	6,88	8,64	7,4
Shape coefficient d/D	0,32	0,49	0,4
Relief ratio RR=Emax/D	130,5	120,1	97,5
Circumference of the basin (km)	17,2	24,5	18,3
Circularity of the basin P/2(Π*Sb)	1,49	1,39	1,32
Length of hydrographic network, Lt, (km)	54,4	144,4	80,4
Number of segments of I order, N1	125	277	162
Network density Dt=Lt/Sb (km/km^2)	5	5,8	5,2
Asymmetry index (Sst-Sdr)/Sb	0,21	-0,45	-0,16

As a consequence, the only morphometric parameter which contributed to the reduction of the flood on the Izvorul Alb rivulet is the asymmetry coefficient. In case of the Izvorul Alb hydrographic basin, the coefficient of asymmetry is very high (-0,45), fact which determines a flow in stages with an important advance for the left sector with steep and short slopes. This geomorphological feature prevents the formation of catastrophic flows similar to the ones registered on the Seacă and Caselor valleys.

A conclusion drawn from this case study performed on small hydrographic basins, with similar physical-geographic features, is that the asymmetry of the basin is an essential indicator in differentiating the behavior in cases of exceptional floods.

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THE RELIEF OF THE SHUMEN'S PLATEAU IN GIS ENVIRONMENT

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Abstract. This report deals with the digital modelling of the relief on Shumen's Plateau. There are many methods for the digital modelling of the relief and the best are those that work in GIS environment. TIN and GRID spatial data models are mostly used. These models can be used to perform spatial analysis and to produce hardcopy and digital maps. A geographic data model represents the real world.
Key words. GIS, DEM, WGS-84, UTM, TIN, GRID, DXF, Shumensko plateau, relief

Rezumat. Relieful Platoului Shumen în GIS. Acest articol tratează modelarea digitală a reliefului din Platoul Shumen. Există numeroase metode de modelare digitală a reliefului şi cele mai bune sunt acelea care lucrează în mediul GIS. Modelele spatiale de date TIN şi GRID sunt cele mai folosite. Aceste modele pot fi folosite pentru efectuarea analizei spaţiale şi pentru producerea de copii şi hărţi digitale.Un model geografic de date este o reprezentare a lumii reale.
Cuvinte cheie. GIS, DEM, WGS-84, UTM, TIN, GRID, DXF, Platoul Shumensko, relief

Over the last decades, computer technologies became a powerful and unique means for solving different kinds of problems in numerous fields of human labour and knowledge. Computer technologies allow reliable and short time exchange and versatile processing of a huge amount of information. An important achievement of the contemporary management technologies are the Geographic Information Systems (GIS). In fact, GIS is a technology that allows the creation of an abstract model of the real world (or parts of it) via people, hardware, and software (Fig. 1). GIS is a dynamic structure, where people constantly collect, enter, process and update various information. The database (Fig. 2) contains information about objects from the real world, the description of the relations between objects, as well as between objects and subjects, the description of conditions etc. [1, 2].

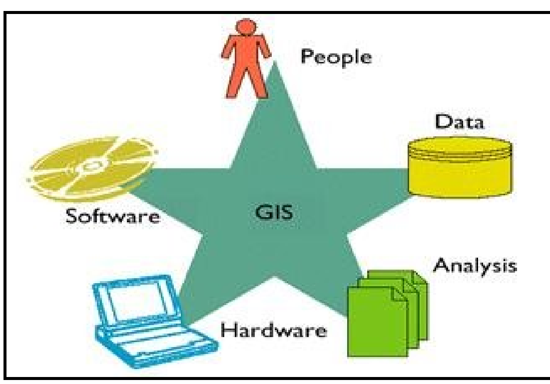

Fig. 1. Integration of the main components of GIS

The information that is being collected, saved and processed concerns real geographic objects, situated on and around the Earth surface. They are combined due to their common characteristic features. For example, the lakes and the reservoirs are combined in water territories, the roads, the streets, the highways, the ports - in transport territories etc. The database created for each group of geographic objects forms an information layer in GIS [4, 6, 8, and 10]. In each layer, the information is graphical and attributive. The graphical information is related to the defining of the coordinates, which are common to the geographic objects from all layers (Fig. 3) [3, 5, 14, and 20].

GIS products represent information that updates the database of the system and they comprise graphics, maps, schemes, lists, references etc. [7, 9, and 13]. GIS results can present the current state or the progress in time (prognoses).

GIS objects are presented in three major groups of models, called space data models: vector, raster (Fig. 4, 5), and TIN models. The vector data model is made up of coordinate pairs or of a list of coordinate pairs, which describe points, lines and ranges. Raster data are made up of ranged and coloured (or in different shades of grey) points (pixels) [12, 18, 19].

The separating lines are called orographic lines or structural lines. Due to the close relation between relief and hydrography, these lines are also called water sheds.

The horizontal segmentation characterizes the complexity and the variety of the relief and depends

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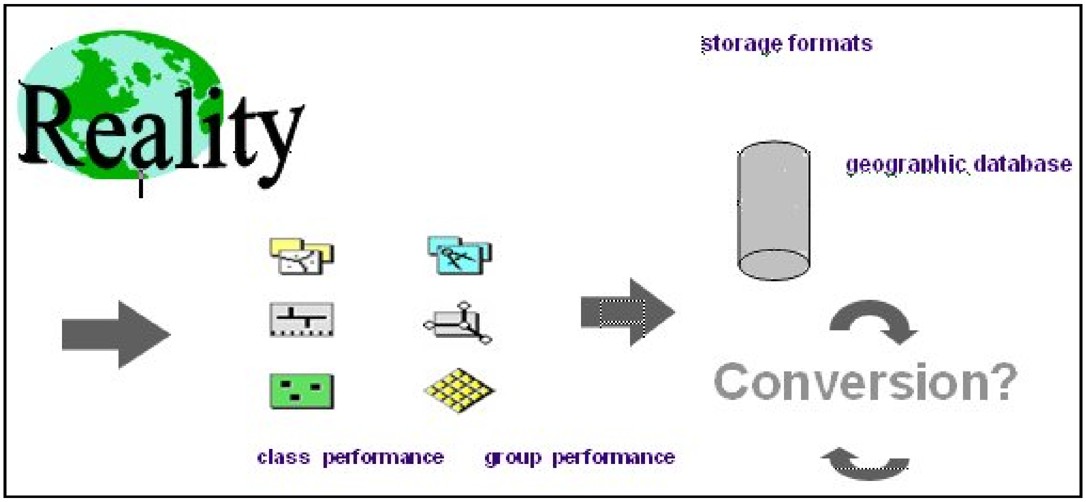

Fig. 2. The database and its storage

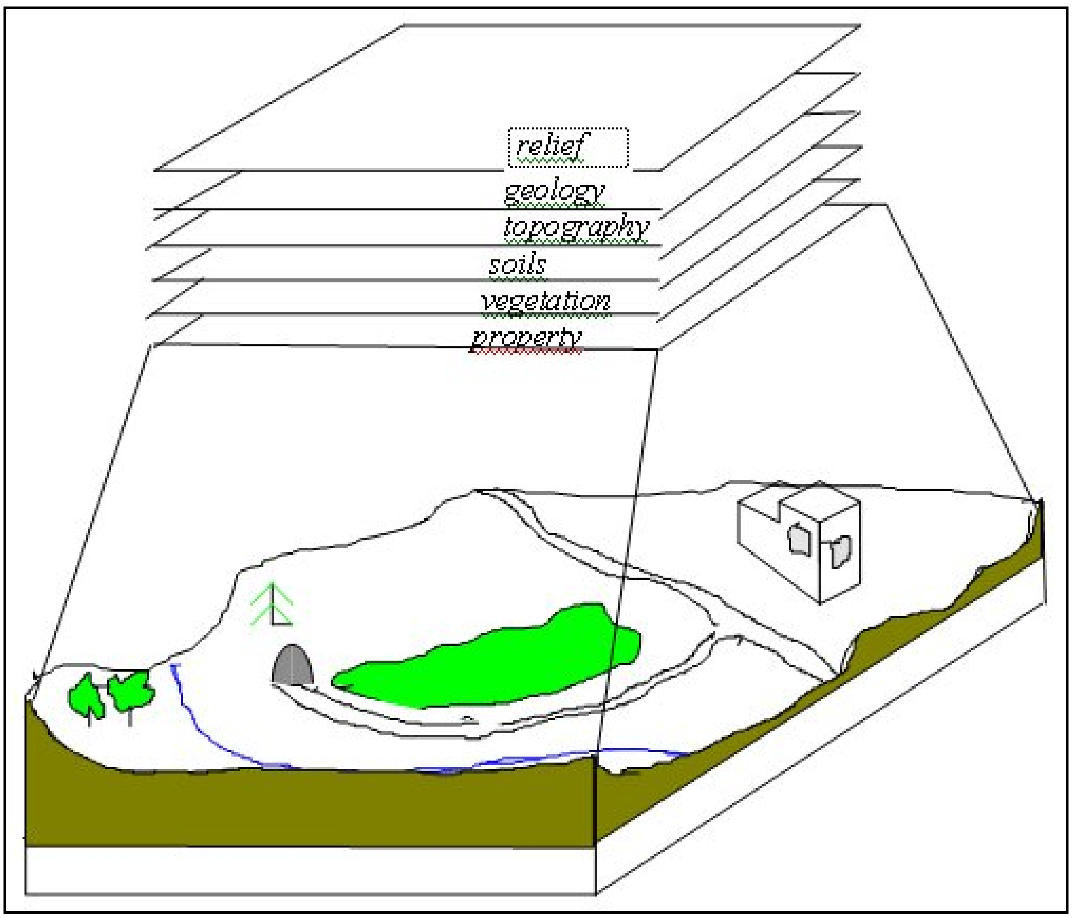

Fig. 3. Geographical sites and the storage of information related to them in separate layers

on the amount of orographic lines in the region. It is defined as an average distance between two extreme points that are adjacent and of opposite sign. It can be estimated by the following indicators: average area of the separate slopes, average length of the orographic lines, average density of the orographic lines etc. [12, 13]. The vertical segmentation characterizes the relief in altitude. The most important indicator is the average altitude. Other indicators used are: the average exceeding between two extreme points that are adjacent and of opposite sign, the average exceeding between two extreme points that are adjacent and of the same sign. With computer raster models, points are rather cells organised in a net of rows and columns.

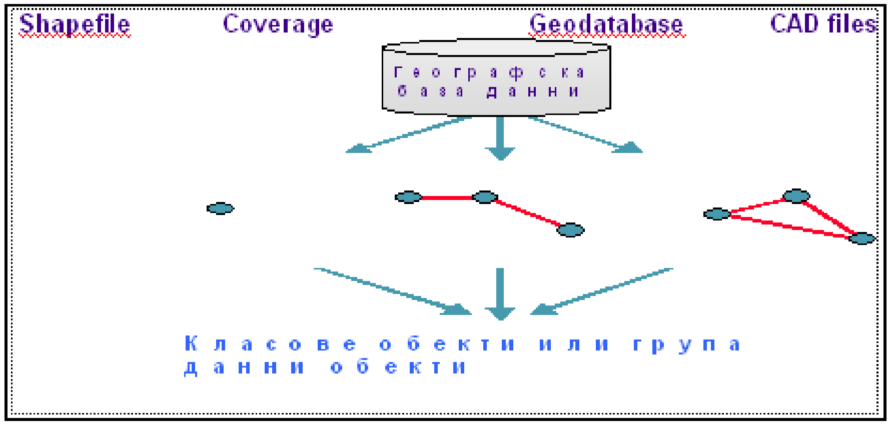

Fig. 4. Raster data models

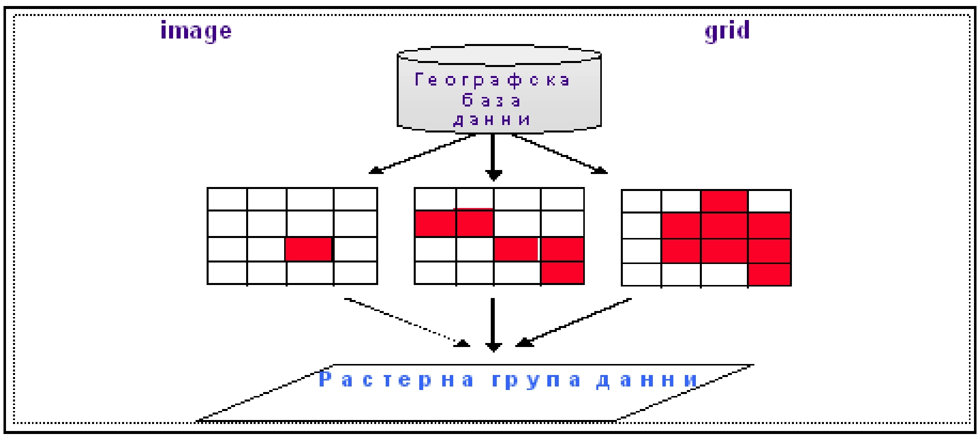

Fig. 5. Raster image data

The convenience of using pictures comes from the fact that not only static objects are presented, but also the dynamics and the intensity of events. The TIN model (Triangulated Irregular Network) is a vector data model with established topology. Suggested in the early 70s of the last century, it serves to present the Earth surface by using irregular network of triangles (surfaces), whose angles are spatially defined (Fig. 6).

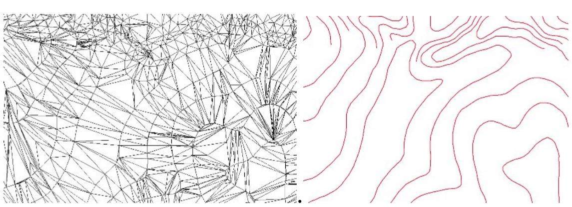

Fig. 6. Structure of the TIN model

The GIS environment provides several functions for entering information in implicational formats. Generally, these functions are classified according to the following features: digitalizing of existing graphic materials; the digitalizing system is used with a distinct purpose; converting data from other graphic systems; one of the ways to insert a drawing in the GIS layers is by using the DFX format; an input of information from ASCII files; an input of raster information [10, 11, 12].

The development of automated methods for spatial information processing led to the emergence of a new kind of modelling – the digital modelling in GIS environment (Fig. 7). As compared to data models, the digital ones differ by the processing format. Nowadays, authors use different definitions for digital terrain models (DTM) and the difference is based mostly on the output models and on the problems that are to be solved. While solving some practical problems, an evaluation of the general characteristics of the relief in the respective region is needed. Some of the important characteristics are: the horizontal segmentation, the vertical segmentation, the average gradient, the average radius of visibility between objects etc. The digital information about the horizontally presented relief forms is used to create digital relief models. The relief itself represents a continuous phenomenon on the Earth surface, reflecting its undulation and segmentation. The major relief features are the absolute altitude and the structure-geomorphologic characteristics. The complex relief surface could be divided into separate elementary segments, called slopes, between which a narrow structural connection exists [13, 15].

In order to obtain the DMR, different

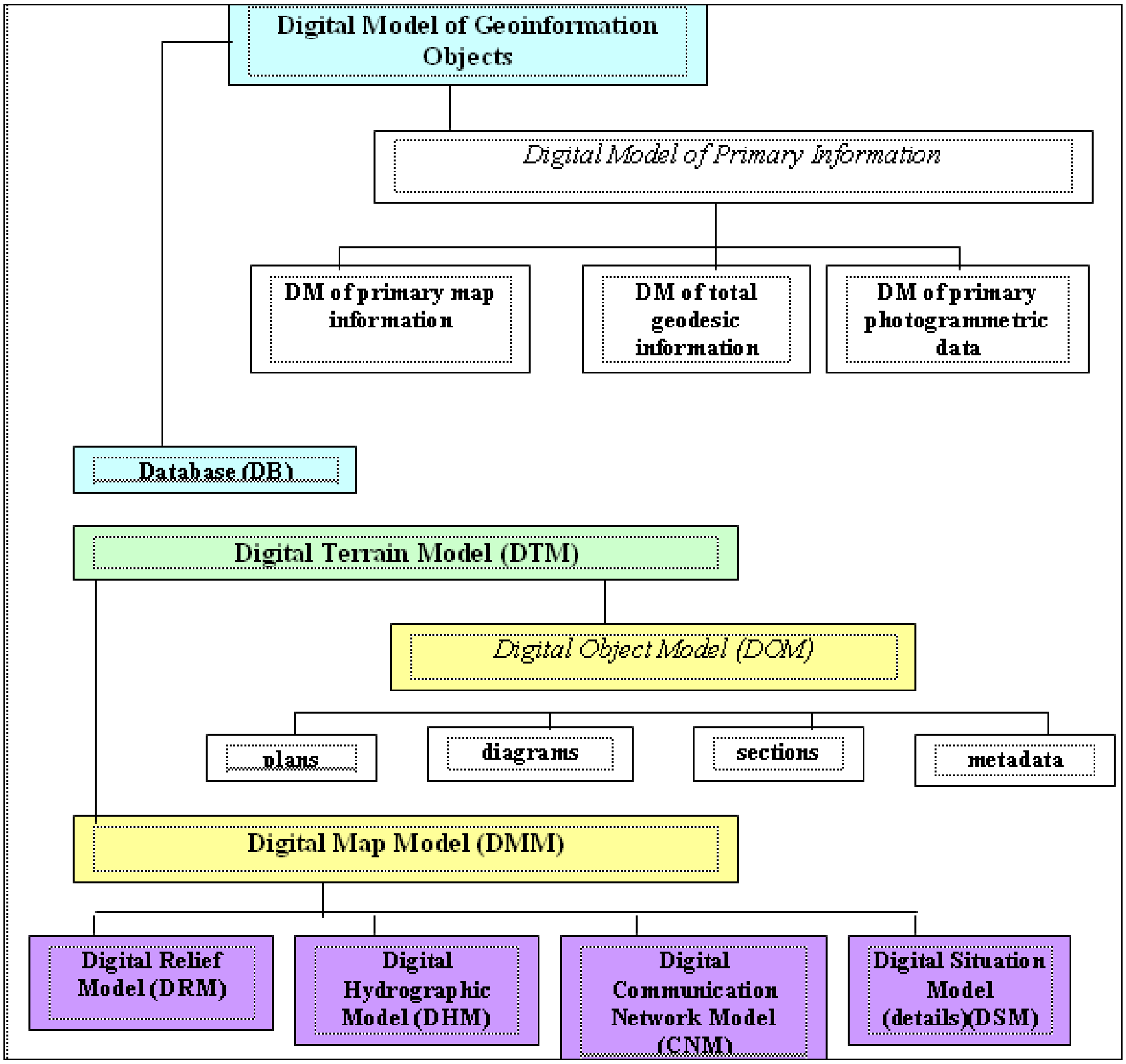

Fig. 7. Digital model structure

information sources are used. The most precise of these is the aimed object itself – the real relief. However, other already created relief models can also be used. Such models are the measurement data, the air photos, the cartographic relief originals etc. (Fig. 8) [15].

As a main source for the creation of a GIS model of the *Shumensko plateau* relief, we used a cartographic relief original - a map, scale 1: 25,000, where the main contour lines are represented at intervals of 10 meters, called intersection height (Fig. 9). The latter is defined by the scale and the region type. To further enhance the precision (at intervals of 1/2 from the intersection), auxiliary (at intervals of 1/4 from the intersection) contour lines are also used. They are aimed to picture specific shapes and details of the relief. On the relief originals, there are also illustrated landforms that cannot be represented by the contour lines: rocks, pits, ravines etc. On the maps, there are data about the absolute altitude (elevation) of the specific points and the objects on the site: peaks, highest points of watersheds, passes, saddles, lowest points of valleys and ravines, landmark points (crossroads, borders of the vegetation cover, wills, separate trees, buildings etc.)

The model of the relief, represented via contour lines (horizontals), can be defined as permanent-discrete. The information is permanent on both axes (X and Y) and discrete on the third one (H). The rest of the information on the relief original (rocks, hills, pits, ravines etc.) reflects the local discontinuances of the surface.

The contour lines, as a model of the real relief, are permanent and provide the most important feature – the height, which reflects the measurability of the real object. The premise was to begin only with the digital transformation of the information about the contour lines and, during a later stage, to add the information about the relief shapes, which is not represented via isolines. A digitizer was used through the semiautomated method of work, allowing the measuring of the coordinates of points in a rectangular coordinate system.

Fig. 8 Map of the Shoumen Plateau – M 1:40,000

The registering device is positioned in each point of the working area. Generally, the reading of the coordinates can be based on different principles: mechanical, electrostatic, inductive. Some of the important parameters of the digitizers are: the size (from A4 to A0) and the precision of the positioning (from 0.01 to 0.5 millimetres). The digital transformation of the cartographic information about the contour line, via the digitizer, was accomplished by tracking. After having the height of each given contour line, this was traced via the registering device. The coordinates of the points of the isometric line were registered automatically, at a certain time interval, or space, or both. The digitizer requirements are: the digitizer format is bigger than the original size and the accuracy of the positioning is better than that of the original. The time registering is preferable because it makes possible the regulation of the registered points. With more complex curves, the registering device moves slower and we have more points. With automatic time registering, there must exist the control of the repetition of one and the same point. The contour lines can be also tracked automatically, via the tracking digitizer. Its registering device is supplied with an optical head and engines for moving. The optical head defines the intensity of the light in the point above which the managing impulses providing the motion of the registering device are generated. The operator positions the device at the beginning of the contour line and it follows the automated tracking. Intervention is necessary only in conflict situations: contact of the contour lines, interruption, crossing of other objects etc. With the automatic method for digital transformation of the information about the relief, the original map with the contour lines is scanned. The scanning transforms the analogue picture of the original into a digital matrix. The transformation process is called discretisation and is made up of two parts: positioning and quantification. The first one represents the possibility of positioning an extreme multitude of points from the whole studied area. In this case, these are points at even distance on the scanning rows. The illustration characteristics (brightness, in this case) are registered in each point. The quantification represents the choice of discrete values in the area of brightness change. In the case of the positioning, it is measured by the minimal interval between the discrete points – from 0.5 to 0.01 mm. With quantification, it is measured by the number of levels of brightness which can be identified by the optical system. Usually, it is an exact power of 2: 2, 4, 8, 16, 256 etc. and defines the amount of bits needed to save a point (pixel) of the picture. The major features are: the *accuracy* (of positioning a given discrete point and it is usually smaller than the resolution ability), the *format* (the maximal size of the area which is to be scanned), the *type* (drum scanners, flatbed scanners, and handheld scanners) and the *speed of scanning* (the scanning time). After the scanning, we get a raster picture (Fig. 11). With some technologies, the contour lines are marked with different colours and that requires the scanning to have more levels. Subsequently, the scanned picture is submitted to additional processing in order to transform the contour lines into vectors. There also exist methods for the automated appropriation of the heights. In this case, the digital transformation of the information about the contour lines was accomplished by scanning.

Digital information about the contour lines. The contour line represents a line connecting points of equal height. The main characteristics of this line are its position and its height (Fig. 10). *The position of the contour line* can be given a digital description by representing it as a sequence of points on the line of the horizontal. The process is called digitizing. While connecting these points, we have a broken line which has to approximate the contour line precisely enough. We usually get the coordinates of the points on the coordinate system of the picture (raster). To make the transformation in another rectangular coordinate system possible, it is necessary to save the coordinates of the peaks of the map sheet. *The horizontal height is a digital characteristic,* expressed in a certain measurement unit (meters, decimetres). This characteristic is added by the function "properties" in Autocad [12, 14]. To facilitate the control and the further processing of the digital information, a code is saved for each horizontal. The height and the code contain semantic information about the horizontal, whereas the points describing its position contain measurement information.

Fig. 9 Map of the Shoumen Plateau - M 1:25,000

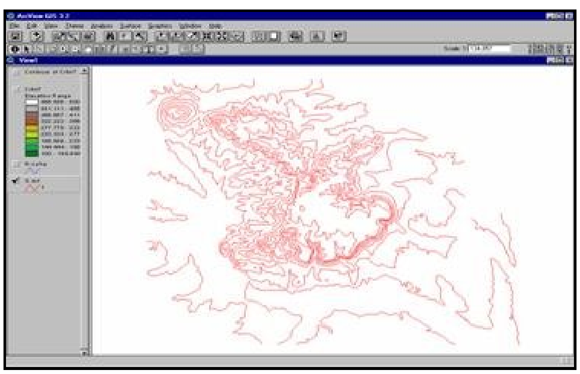

Fig. 10 Digitized contour lines

Presentation and organisation of the information in GIS (Fig. 11-15). The coordinates of the points of the contour lines are saved in the coordinate system used for the digitizing. The only requirement is that all the coordinates are positive.

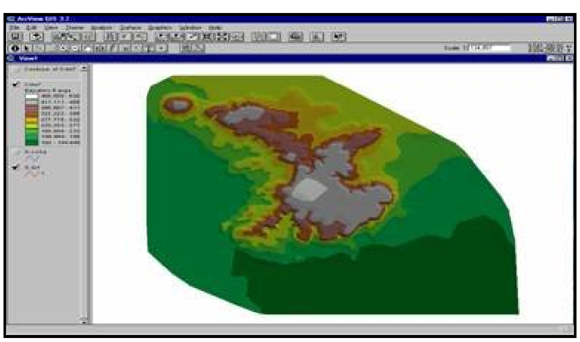

Fig. 11 Colour representation of the altitudinal zones

The coordinates of each point register its position with respect to the beginning of the coordinate system in measurement units. The digital information about the contour lines is organised in files and map sheets. The processing is accomplished in map sheets, scale 1:50,000.

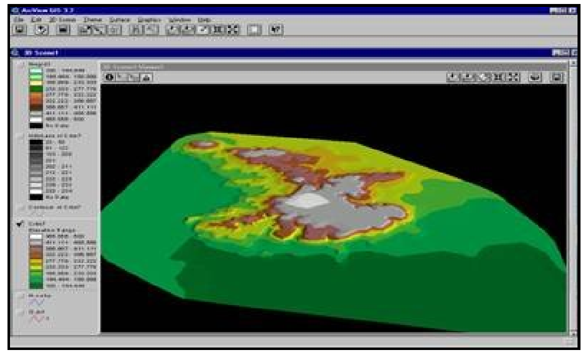

Fig. 12 Advanced colour representation of the altitudinal zones

We used the relief original map or its copy as source. The final product has digitalized contour lines recorded as vectors with a certain format. The file with the information about the isometric lines is transformed in .SHP file. After the defining of the properties of the view (dimensions, projection etc.), the TIN model is implemented.

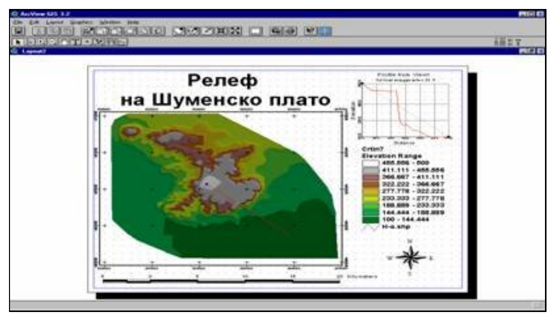

Fig. 13 Elevation ranges

The modelling concerns the area that provides information about the contour lines. The height is the major criterion with modelling. After having created the TIN model, we can get information about the gradients of the relief, the slopes and views from different points.

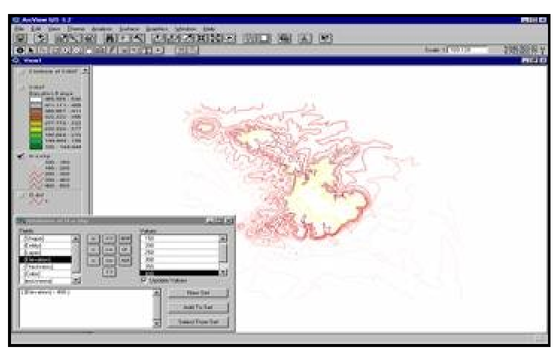

Fig. 14 Presentation and digitized contour lines

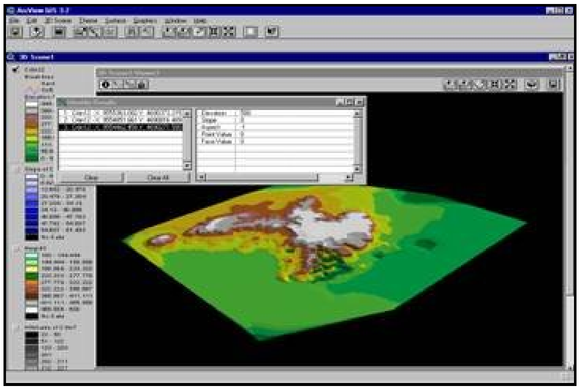

Fig. 15 Specific items of the altitudinal belts

The creation of scenes showing the 3D model is quite possible. The digital model of the Shumensko

The creation of scenes showing the 3D model is quite possible. The digital model of the Shumensko plateau relief, created in GIS environment, enables the access to information of different types. What follows is the evaluation of the effectiveness of the created model. Generally, the evaluation criteria are the precision and the reliability of the model. Table 1 shows the scanning precisions at different technical parameters – scale, number of points in a pixel, size of objects etc.

Table 1

Digital representation of the major characteristics of the images

Scale of photo image	**Resolution** *dpi*	**Size of pixel** *micron*	**Size of Earth element** *m*	**Memory in the photo image** *(23 x 23) MB*	**Planning precision** in the photo *mm*	square degree average *m*	**Height precision square degree average** *m*
1: 5,000	2,400	10.5	0.05	478	0.007	0.035	0.06
	1,200	21.5	0.1	119	0.015	0.07	0.12
	600	42.3	0.21	30	0.03	0.14	0.24
	400	63.5	0.32	13	0.044	0.22	0.37
	300	84.6	0.42	7	0.059	0.29	0.48
1:10,000	2,400	10.5	0.1	478	0.007	0.07	0.12
	1,200	21.5	0.21	119	0.015	0.15	0.24
	600	42.3	0.42	30	0.03	0.29	0.48
	400	63.5	0.63	13	0.044	0.44	0.72
	300	84.6	0.85	7	0.059	0.59	0.98
1:15,000	2,400	10.5	0.16	478	0.007	0.11	0.18
	1,200	21.5	0.32	119	0.015	0.22	0.37
	600	42.3	0.63	30	0.03	0.44	0.72
	400	63.5	0.95	13	0.044	0.66	1.09
	300	84.6	1.27	7	0.059	0.89	1.46

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CLASSIFICATION SYSTEMS FOR THE HYDROGRAPHICAL NETWORK

Ion ZĂVOIANU, Gheorghe HERIŞANU, Nicolae CRUCERU[1]

Abstract. The paper discusses the main systems of classification and codification starting from the mainstream to the smallest tributaries and the other way round, from the smallest tributaries to the mainstream systems. A new drainage basin coding system is developed based on the Horton-Strahler principles of classification. The new system is supposed to be useful both for scientific research and the management of water resources.
Key words: drainage network, codification.

Rezumat. Sisteme de clasificare a reţelei hidrografice. Lucrarea tratează sistemele principale de clasificare şi codificare începând de la cursul principal până la cei mai mici afluenţi şi invers, de la cei mai mici afluenţi la sistemele cursului principal. Un nou sistem de codificare al bazinului de drenaj s-a dezvoltat pe baza principiilor de clasificare Horton-Strahler. Noul sistem se presupune că este util atât pentru cercetarea ştiinţifică cât şi pentru managementul resurselor de apă.
Cuvinte cheie: reţea de drenaj, codificare

Introduction

Following the present technologic and social-economic development, the scientific researchers must find solutions for an accurate evaluation of the resources of the natural environment and their careful management in accordance with the demands for a sustainable development. Consequently, the issues related to the spatial distribution, formation and variation in time and space, evaluation, exploitation and management of the water resources are of major concern. At present, the research conducted for classifying the hydrographical network and basins follows two main directions. On the one hand, there is a global research for achieving a comprehensive view of the potential of the fresh water resources that can be found on the planet, starting from the global resources, to the continental and hydrographical basin of various sizes, which is considered the basic unit for the landscape.

On the other hand, some research is being done from local to global scale, from simple to complex, paying great attention to the phenomena at larger scale, which offer the fundamental knowledge about the elementary formation processes and variation in time and space of water resources, in order to elaborate a correct mathematic modelling and prognosis of the extreme hydrological phenomena with negative, sometime severe effects for the social and economic development. A larger scale research also implies the study and quantification of the interdependence relationships between the hydrological processes and the rest of the physical-geographical factors, in order to determine their influence on the quantity of water resources.

According to both directions of study, the hydrographical basin is the basic unit not only for the issues related to the modelling of hydrological processes, but also for those related to the monitoring and effective management of this resource, which, in certain circumstances, may be considered as a strategic resource.

Taking into consideration the water dynamics and its role in modelling the relief, it is highly necessary to have detailed knowledge about the physical environment, its morphometrical characteristics in order to be able to quantify them and to use the interdependence relationships between them. This is even more necessary as there is quite a small number of hydrological stations to measure the quantity and quality of water resources, and there are large areas where measurements are not performed; in this case, the evaluation is done based on some territorial generalization relations, which are already established.

Classification systems for the hydrographical network

Due to the large number of rivers and rivulets within a drainage system, including the entire hierarchy of basins and sub-basins, there has always been need of finding some criteria for their hierarchy and codification. This became more acute as the electronic methods for evaluation and determination have been perfected, adding numerous pieces of information, which must be arranged and systematized in order to be most efficient.

Among the used classification and codification methods, starting from large to small, from general to particular, it is worth mentioning the ones below.

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According to ***the classification proposed by Gravelius*** (1914), the first order is given to the main river of a drainage system that flows into a sea, lake or ocean. All the tributaries that flow directly into the first order water-course are considered to be second order and so on, to the tiniest water-courses, which will have the highest order (Zăvoianu, 1985). This way, the order depends only on the position the river segment has within a given hydrographical basin. For the Danube for instance, which is a first order river, tributaries such as the Siret, the Calmatui, the Ialomita or the Olt are second order water-courses, and their tributaries are of third order and so on.

If we analyse water courses that have the same order according to this classification system, it becomes obvious that rivers like the Siret, the Călmățui, the Olt and the Drincea, which are all second order rivers, are not similar from the hydrological or morphometrical point of view but for the position towards the main river. Consequently, the flows and catchment areas of hydrographical basins of the same order may greatly vary, and basins covering approximately similar areas may be given quite different orders (Fig. 1a). This classification system was used in many cases; the survey of Romania's waters was carried on based on this classification system. The survey has been used since 1962. The codification system for Romania disregarded the Danube as the first order river; every water course, considered to be more important, was seen as a first order river. These rivers bear a name and Roman figures (Tisa I), counter clockwise up to the Prut, XIII. The Danube's smaller tributaries bear the code Danube XIV, while those in Dobrogea, which flow directly into the Black Sea, are named Littoral XV.

Beside this first part of the codification, there are also some figures, beginning with 1 for the main course, followed by those with 2, from the mouth to the springs. However, this system includes only those water courses, the basins of which cover an area of more than 10 sq km and have a minimum length of 5 km. Using the above mentioned system, there were codified water courses for the first to the sixth order. The numeric code given to every order is separated from the upper and the lower ones by a dot, the figures assembly having no numeric significance (1.28.3.15.2).

This way, in Romania there were codified 4,864 water courses varying from the first to the sixth order, the hydrographical network being 78,905 km long. The 1962, the survey was the starting point for various editions of the Atlas, this principle being still valid.

The classification proposed by Pfafstetter (1989) is also widely used for dividing the drainage area both at the continental and at the basin level in sub-basins, complying with the following principles (Furnas, 2001; Zhang, 2007):

- the main water course with code 4 in Fig. 1 b drains the largest area of the basin;
- the first four tributaries having the largest areas of the basin, are given the codes 2, 4, 6 and 8 respectively from downstream to upstream; these figures come next to the code of the main river, becoming 42, 44, 46 and 48 respectively;
- the remaining area is divided into 5 inter-basin areas, codified from downstream to upstream with 1, 3, 5, 7 and 9, which are added, in their turn, to the code of the main water course, becoming 41, 43, 45, 47 and 49;
- then, the three conditions apply to the tributaries and inter-basin areas that were previously codified, leading to a second codification level. For instance, the sub-basins within the sixth basin area, are given, according to the size of their area, the codes 2, 4, 6 and even 8, which are added to the previous code; there results 462, 464, 466 and even 468. For the inter-basin areas, there are the codes 1, 3, 5, 7 and even 9 added to the previous code, leading to 461, 463, 465, 467 and 469 (Fig. 1 b);
- the action is repeated to the smallest sub-basins and inter-basin areas. Passing from one level to another depends on the surface of the drainage area. The endoreic areas within a basin or sub-basin bear the code 0 (Furnas, 2001). The number of digits equals the number of subordination levels that were used.

Such a code given to a particular area takes into consideration the code of the main water course and, at the same time, identifies the topological position within the system (Vogt, 2007).

The system is quite detailed and may be used for a thorough analysis, but the areas between the sub-basins are sometimes difficult to compare due to the difficulties posed by the basin dividing, that sometimes, catchment areas of the same size bear very different codes. The limited number of digits for every level requires that some sub-basins should not be included into the corresponding category.

The binary codification method proposed by Li et. all (2006) topologically characterizes the relationships of the river networks using the following conditions (Zhang, 2007):

- for every knot there is only one tributary that flows into the main river;
- between two knots there is only one river segment;

- for this codification system, 0 is given to the main river;
- along the river, upstream, it is noted "1" at the right of the code of the main course for the last sector of the first tributary and "0" for the upstream sector and then, the operation is applied for the entire system.

Although useful for determinations and topological location, sometimes there are numerous symbols (0 or 1) when there are many tributaries within the upper sector of the river (Fig. 1 c).

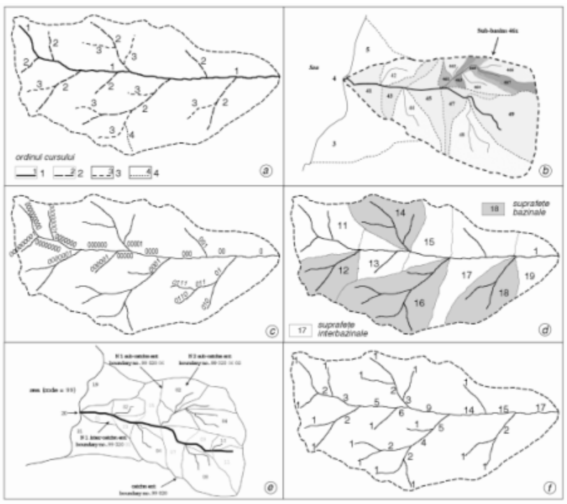

Fig. 1 Classification systems for the hydrographical network : a – Gravelius; b – Pfafstetter (after Voght, J. & Foisneau, S., 2007); c – Li; d – LAWA; e – ERICA (after Arakelyan, S., Mkrtchyan, A. 2007); f – Shreve

LAWA German classification system is almost identical with the one proposed by Pfafstetter, but in this case the codification starts from the springs towards the mouth of the river and not from the mouth (Fig. 1d).

ERICA codification system was proposed after the evaluation of two previous systems – the Norwegian one – REGINE – and the German one – LAWA (Flavin et al., 1998). This system codifies the sea basins where the rivers flow into, the sea shoreline, the inter-basin areas that are drained towards the sea and the afferent basins. The code includes 2 digits for the sea code, 3 for the shoreline code, 8 for the four detailing levels of the basin and inter-basin areas and 1 digit for the littoral strip. This system allows the codification of 49 tributaries with their catchment area using odd numbers, from 2 to 98, while for the inter-basin areas there are even numbers, from 1 to 99. Thus, there are codified all the main water courses and inter-basin areas, starting from the river mouth towards the springs (Fig. 1e).

The system also has its inconveniences, because although the codification potential is great, it is rather difficult to identify 49 tributaries, especially within the small sized catchment areas.

The second category of classification systems refer to those that start from simple to complex, from small to big, i.e. from the tiniest water courses, which begin with a spring, and end at the first confluence; they are considered to be the first order. Then, by cumulating the catchment areas and water flows, their size gradually increases.

According to ***Shreve classification method,*** a river network includes outer segments of rivers, that begin with a spring and end at the first confluence, and inner segments, between the confluences. The number of outer segments in this system equals the number of river segments of the first order in the Horton-Strahler system. From the union of two segments of the first order, there results one of the second order, and continuously, by adding new segments, the size order of the network and implicitly that of the basin increases (Fig. 1 f). Consequently, if two segments of the size n_1 and n_2 unite, the resulting segment will have the size n_1+n_2 (Zăvoianu, 1985).

The classification method proposed by Horton in 1945 and modified by Strahler in 1952 is based on the following rules:

- the river segments that start with a spring, end at the first confluence and between the two points have no tributaries, are considered to be of 1st order;
- the union of two segments of the 1st order leads to a segment of the 2nd order;
- the union of two segments of the 2nd order leads to a segment of the 3rd order and so on;
- a river segment of a given order may have lower order tributaries, without changing its order. Passing to an upper order takes place only when there is a confluence between two segments of the same order (Horton, 1945).

This method, which was applied in numerous regions, has proved to be a useful research instrument, its results proving that the morphometry of the hydrographical networks and basins comply with some probability laws that may be acknowledged through the morphometrical analysis.

The research that was done has clearly testified that most of the morphometrical elements analysed depending on the size order form direct or indirect geometric progressions, their coefficients and constants being easily determined from the quantitative point of view (Zăvoianu, 1985).

Network and basins codification in Horton-Strahler system

The detailed analysis of the morphometrical characteristics of the physical and hydric environment using this classification system also implies the introduction of a system for network codification that should meet the following demands:

- to allow the individualization, spatial positioning and access of the data base for every river segment, irrespective of the size order;
- to ensure the data base for quantitative evaluation of the morphometrical elements of the hydrographical network at different order confluences and at the chosen points along the longitudinal profile of the main rivers and hydrometric stations;
- to allow the grouping of morphometrical characteristics on size orders;
- to function even if a hydrographical system is not so evolved as to include the basin of the highest order, and has only some sub-basins.

This system is very useful for the detailed studies and can be achieved either by direct digitization on maps at the scale 1:25,000, or by processing the information from the Numeric Model of the Terrain, having a very good resolution.

If the digitization is done manually, using the maps at the scale 1:25,000, it is highly recommended that the tiniest highlighted and measured basin units be of the second order; when necessary, the characteristics of those of the first order are easily calculated. The digitization should start from the second order because it is very easy to highlight the starting point at the confluence of two segments of the first order, well figured on the maps. In case the digitization starts from the first order, then the starting point would be somewhat arbitrarily chosen, and the length of the segments, as well as the other morphometrical elements would have quite significant errors, not to mention the work to be done. The end of a second order segment is always fixed at the confluence with another segment of the same order, or a higher one, even if downstream it has other segments of the first order. When the digitization process of a river segment is over, the data base also includes the size order, its name and code. The digitization always begins from upstream to downstream, paying great attention to the configuration of level curves. When two segments of the second order merge, there results a third order segment and the digitization of the rivers segments continues up to the highest order segments, which usually ends with a confluence or to a lake, sea or ocean that it flows into.

After the digitization of the hydrographical network was carried on from upstream to downstream, there should be individualized the water courses of every order, this time beginning with the highest orders. At the same time, the hydrographical network is codified in the data base.

Thus, the fifth order river is delineated. In the case given as example, it is the highest order and will bear the code 5(1) in the data base. This part of the general code will accompany all the rivers and their corresponding basins, of lower order, within the main basin. As for the fourth order basins, they are delineated from the spring to the mouth of the river and codified, starting from the first basin of the fourth order, which will bear the code 5(1)4(1). The second will be 5(1)4(2), up to the last basin of this order; by its code, it gives information about the number of basins of the fourth order.

There follows the codification of third order river segments, which are found in all the basins of the fourth order or as direct tributaries of the main water course, using the same codification procedure. For instance, the first basin of the third order within the basin 5(1)4(1) will bear the code 5(1)4(1)3(1); the first part of the code – 5(1)4(1) is common for all the sub-basins of the first basin of the fourth order (Fig. 2).

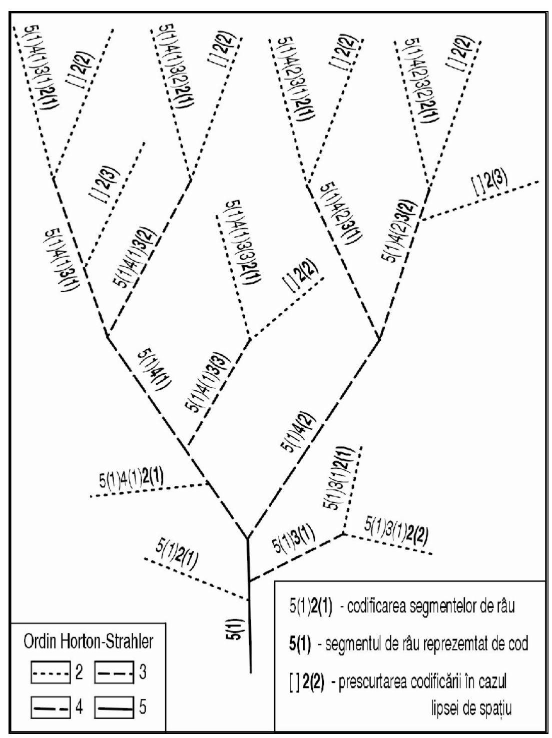

Fig. 2 The codification of hydrographical network based on Horton- Strahler classification

When a river segment of the third order is a direct tributary of the main river, its code will not include the indicative for the fourth order and the code will be only 5(1)3(1). The action of delineation continues, as well as the one of codification of the third order water courses within the upper basin of the order 5(1)4(1)3(1). In this case, the codification follows the same rule for keeping the same label, to which there will be added the second order basins within the third order one. The first basin of the second order will bear the code 5(1) 4(1) 3(1) 2(1). When coming to the next rivers of the fourth order, the same rule for demarcation and codification applies; the code for the second basin will be 5(1) 4(2), to which there are added the codes of the lower order basins.

Within this system, a water course of a given order may have direct tributaries of lower order, without changing the size order. For a fifth order basin, it may have, besides the fourth order tributaries, third and second tributaries, without changing its size order. In this case, for the third order segments, labelled from the spring to the water mouth, when setting the code there must be taken into consideration the fact that the fourth order is missing; consequently, the code of the first basin of the third order that flows directly into the fifth order will be 5(1) 3(1). Forwards, for the lower orders within this sub-basin bear the same code, followed by the numbers for the second order codes.

The first tributary of the third order that flows directly in the fifth order river will bear the code 5(1) 3(1), and the first river of the second order will have the code 5(1) 2(1), without the intermediate orders that may have 4(0) 3(0), but in order to be simpler, they are not used. This way, the code offers information about the fact that the basin 5(1) 2(1) flows directly into the main river. This is also true for the fourth order basins that have direct tributaries of the second order. Thus, the first basin of the third order that flows directly into 5 will have the code 5(1) 3(1), and the first water course of the second order that flows directly into 5 will be 5(1) 2(1). The number between brackets always gives information about the number of segments of each category, and may have different values. All these codes are given and registered in the data base; they can be obtained only by interrogation, without loading the image (but for larger scales, they may be shown). If some of the water courses have their own names, they may be given to the main river or the basin in the database and used accordingly.

The data base made up of points, lines and polygons offer enough possibilities of gathering the necessary data for the detailed morphometrical analyses of the environment as support of water resources. By using the points that mark the start and the end of each segment and the Numeric Model of the Terrain, we can find out their height and the relief intensity of each segment, no matter its size. Then, they also offer the possibility for each point marking a confluence to be the bearer of the entire data base for the basin upstream. Along the main water course, there may be various points at the confluences or at the hydrometric stations, which have all the characteristics of the basin situated upstream of this particular station. In all the cases, the data base also offers the necessary information to highlight the law of level differences for river segments of ever increasing orders.

With respect to the lines, the interrogation of the data base gives information for pointing out the law of river number, average lengths and average perimeters (Zăvoianu, 1985). Knowing the relief intensity and the lengths of all river segments of different orders, there can be determined the slope law for all the river segments, and then an average slope for the entire hydrographical network within the analysed basin.

The present system of codification may also identify the points based on the geographical coordinates.

In case the digitization could not be achieved and there was stopped at a sub-basin or along the main river, the process may be stopped by establishing an ending point on the main river that should gather the entire information. When the digitization begins again, the rest of the basin will be integrated into the data base, keeping the codification rules.

If a particular basin of any order was given a wrong code, it may be corrected in the data base, but following the implications of the new correct code.

Since the system is conceived for detailed studies and the work carried on for small areas, it is necessary that for a codification, they be analysed independently, but also to offer the possibility for being integrated. In this case, assuming that the basin 6(1) is part of a larger basin, having the position 6(2), only this part of the code will be modified, the remaining tributaries codes being the same. Thus, they are integrated into a higher order basin.

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ASSESMENT OF DEGRADATION PROCESSES AND LIMITATIVE FACTORS CONCERNING THE ARENOSOLS FROM DĂBULENI – ROMANIA

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Abstract: Soil degradation can be described as a process by which one or more of the potential ecological functions of the soil are harmed and also like a process that lowers the current and/or future capacity of the soil to produce goods and services. The arenosols from Dăbuleni Plain, located in the SW of the Romanian Plain, have a large extension due the aeolian sand deposits which covers the Danubian loess terraces. The main degradation processes affecting the arenosols are the removing and deposition of soil material by wind forces. This type of degradation causes loss of topsoil and severe sand accumulation, which reflects in terrain deformation. The loss of topsoil induces a decrease in depth of the A horizon due to the removal of soil material by the wind because of their sandy texture and insufficient protection offered by vegetation. We should also mention that the forest shelter belts are being destroyed. An irregular removal and depositions of soil material by wind action causes deflation hollows, hummocks and dunes which lead to "terrain deformation" with severe consequences concerning land quality.
Key words: soil degradation, limitative factors, arenosols, Dăbuleni Plain

Rezumat: Evaluarea proceselor de degradare şi a factorilor limitativi privind arenosolurile din Dăbuleni - România. Degradarea solului poate fi descrisă ca un proces prin care una sau mai multe din potenţialele funcţii ecologice ale solului sunt afectate, dar şi ca un proces care diminuează prezenta sau/ şi viitoarea capacitate a solului de a produce bunuri şi servicii. Arenosolurile din Câmpia Dăbuleni, situată în sud- vestul Câmpiei Române, au o mare extindere datorită dunelor de nisip care acoperă terasele de loess danubian. Principalele procese de degradare care afectează arenosolurile sunt îndepărtarea şi sedimentarea materialului din sol de către vânt. Acest tip de degradare cauzează pierderea stratului de sol superior şi acumulări masive de nisip, care se reflectă în deformarea terenului. Pierderea stratului superior de sol determină o descreştere în adâncime orizontului A datorită îndepărtării materialului din sol de către vânt datorită texturii lor nisipoase şi protecţiei insuficiente oferită de vegetaţie. Ar trebui să menţionăm de asemenea că zonele de adăpost ale pădurii sunt distruse. O îndepărtare neuniformă şi sedimentările materialului din sol prin acţiunea vântului determină concavităţi prin deflaţie, movile şi dune care duc la "deformarea terenului" cu consecinţe grave asupra calităţii terenului.
Cuvinte cheie: degradarea solului, factori limitativi, arenosoluri, Câmpia Dăbuleni.

Introduction

Land degradation is defined as deterioration of soil and its environment below natural capacity to sustain in a durable manner the natural and/or man-made ecosystems (Dumitru and Munteanu, 2002).

In the context of current climate change, the regions with sandy soils are directly affected by drought and desertification. Regarding these, through the United Nation Convention to Combat Desertification, at which Romania adhered, a special interest has been given for controlling the effects of these processes since 1994. Also, the International Soil Reference and Information Centre (ISRIC) have coordinated a series of projects evaluating the current state of degraded lands. One important project is SOVEUR (Mapping of Soil and Terrain Vulnerability in Central and Eastern Europe), completed in 2000 by publishing a soil and terrain database and map at 1:2.5 million scale, on the status of soil degradation.

The processes of land degradation and limitative factors regarding the agricultural production have been studied with the aim of counteracting their negative effects on soil quality.

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The National Strategy and Actions Programme to Combating Desertification, Land Degradation and Drought (MWFEP, 2000) states that most of degradation process are to be found in the area with dry-subhumid climate, as well as in that affected by drought.

From these processes, in the study area, wind erosion occurs with higher intensity only on sandy and loamy sandy soils.

The sandy soils from Romania have been studied since the beginning of the 20^{th} century. The study regarding the sands from the south of Oltenia by Chiriță and Bălănică in 1938 refers to the characterization of the main types of forest sites on the sands of Oltenia and the establishment of relationships between the properties of sands and sandy soils and the vegetation of different forest species, especially the acacia. A more comprehensive study on the Arenosols from Romania was performed by Florea et al. in 1988, where it is presented the distribution on various forms of relief, specific properties, development of sandy soils and also the origin of sand deposits. One important aspect refers to the capacity of sandy soils to sustain agricultural land use.

The present work focuses on clarifying some aspects of soil degradation, expansion of this phenomenon and assessment of limitative factors concerning the sandy soils from Dăbuleni Plain. In this area, with a predominantly agricultural land use, there were identified two main types of landscapes. One is the landscape of semi-stabilized dunes, with agricultural crops (mainly cereal crops), and forest shelterbelts partially destroyed, on the west side of the plain, near the Jiu River. The other one refers to mobile dunes landscape, with orchards, vineyards and cereal crops, in the central part of the territory. The loss of almost all the forest shelterbelts and the malfunction of the Sadova-Corabia irrigation system have led to the reactivation of sand dunes with direct impact on the land quality.

Dăbuleni Plain is located in the south of the Romanați Plain, subunit of the Oltenia Plain, which is part of the Romanian Plain. This unit comprises the terraces of the Danube and the Jiu Rivers, and has a great extension, with large surfaces of terraces, which are blurred by aeolian sands. Terrace deposits are covered by loess and aeolian sands. The relief microforms consist on fixed dunes disposed as continuum, large, and flat waves, elongated on few kilometers, and mobile dunes, easy to observe, with ridges aspect. The thickness of the sand deposits is larger near the Danube, on the lowest/youngest terraces, and on the west-side of the plain (about 20-25 m), and decreases northward and eastward, as the distance from the sand sources increases (the flood plains of the Danube and the Jiu) and the influence of the dominant winds diminishes (Geography of Romania, 2005). From the same causes, the highest dunes (about 15-20 m) and the largest mobile sand areas occupy the lowest terraces of the Danube and the Jiu Rivers, near to the localities Lişteava, Bechet and Dăbuleni.

The parent materials of which Arenosols were formed and developed have an aeolian origin. These consist of sand deposits (aeolian reshuffled) with coarse sand, sandy loam or loamy-sand texture, and loess and loess-like deposits with loamy or loamy-sand texture.

The climate is characterized by hot and dry summers with few precipitations, mainly showers, and moderate winters, with rare snowstorms and frequent warming periods due to the advection of warm air from the south and the south-west. The mean annual temperatures exceed 11°C (11.1°C at Corabia). Although the mean annual values of precipitation are between 525 and 550 mm (with 530 mm at Bechet), there still occur extensive dry spells and drought periods (30-60 consecutive days). These phenomena occur especially in the central part of the plain and correlates with the lack of the permanent hydrographic network and high depth of the groundwater. Dryness and drought justify the construction of Sadova-Corabia Irrigation System.

Natural vegetation has been restricted at less than 5% of the plain surface, the rest being occupied by arable lands. The forest shelterbelts consist of acacias and poplars (*Populus alba* and *Populus nigra*) and herbaceous species, such as *Bromus tectorium*, *Poa bulbosa*, and *Stellaria media*.

Material and methods

For the study, seven soil profiles (pits) were morphologically described, and disturbed and undisturbed soil samples were collected for physical and chemical determinations. Samples were taken at two depths per soil profile within differentiated horizons. The sampling locations were recorded using the Global Position System (GPS). The soil diagnostics were based on the concept of elementary pedogenetic processes reflected in the soil features and properties. The soil names were given in agreement with the World Reference Base for Soil Resources (IUSS-ISRIC-FAO, 2006).

The following analyses were made: texture, bulk density, hydraulic conductivity, penetration resistance, regarding the physical properties and pH, $CaCO_3$ content, organic matter – humus, total nitrogen content, C/N ratio and total phosphorus content concerning the chemical properties. Interpretation of the analytical data was made using the Soil Survey Methodology (in Romanian) – Part III, Ecopedological Indicators (ICPA Bucharest, 1987). Also, for establishing soil contamination a series of analyses were made: the content of pesticide residues (organochlorine insecticides like DDT and HCH), heavy metals, nitrates ($N\text{-}NO_3$) and ammonium nitrate ($N\text{-}NH_4$). Interpretation of pesticide residues and heavy metals content on soil samples was made according to the Order no. 756/1997 of Ministry of Waters, Forests and Environmental Protection for the approval of Regulation concerning the environment pollution assessment.

Results and discussion

Distribution of the Arenosols

The main characteristic of arenosols is the sandy texture of parent material (Grigoraş, 2003; Blaga et al., 2005; Grigoraş et al., 2006). In Dabuleni Plain the eutric and mollic subtypes are the most developed ones. Arenosols are widespread in the area, with sands and dunes, on the left side of the Jiu River (between the settlements Căciulăteşti, Sadova, Piscu Sadovei), where they are in association with Luvisols and shifting sands. One important area is in the southern and central of Dabuleni Plain (between Călăraşi, Dăbuleni and Ianca), where arenosols are associated with shifting sands, occupying a considerable area (Fig. 1). Mollic Arenosols, with the profile of: Am-AC-Cn or Am-Cn_1-Cn_2, occur in depressionary areas (interdunes) and the Eutric Arenosols (Ao-Cn_1-Cn_2 or Ap-Ao-AC-Cn) characterizes the relief with dunes and they are often associated with Eutric Regosols and shifting sands.

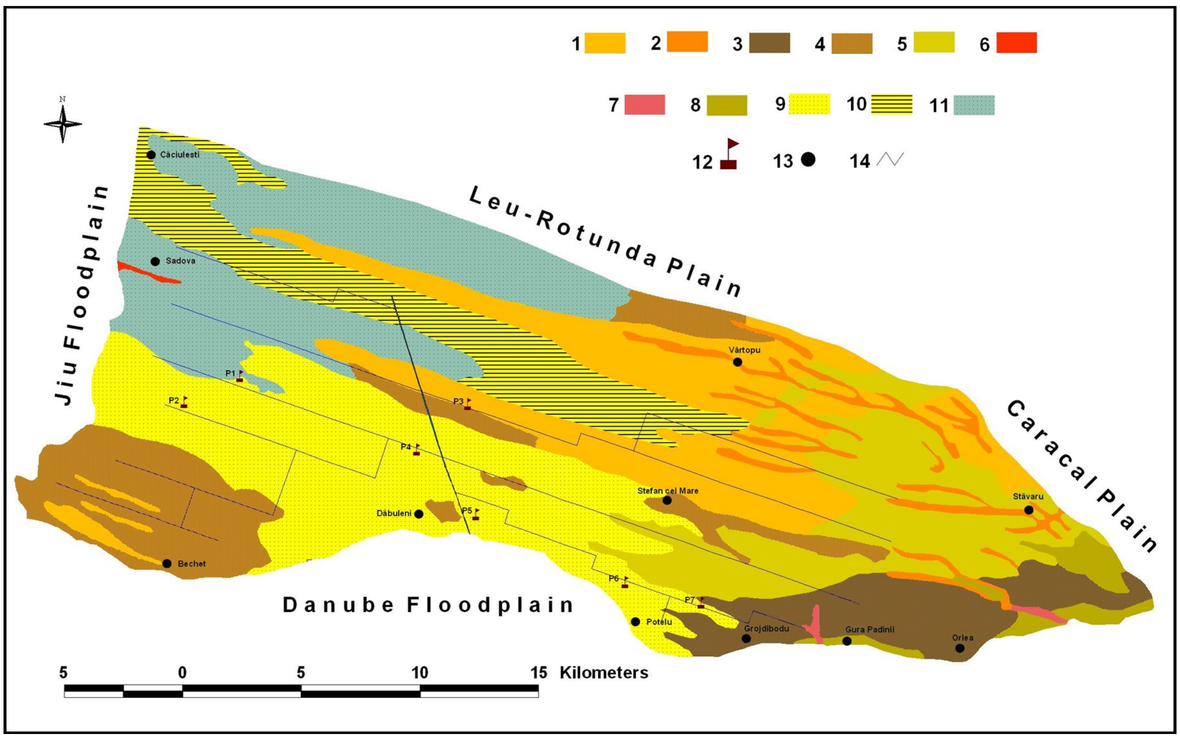

Fig. 1. Soil map of Dăbuleni Plain – classification according to WRB-SR 2006, FAO and SRTS 2003, Romania (after the Map of Romanian Soils, scale 1:200 000, 1969):

1, Haplic Chernozems / Cambic Chernozems; *2*, Haplic and Luvic Chernozems / Cambic and Argic Chernozems (in small-size depression on loess and loess-like deposits); *3*, Haplic and Luvic Chernozems / Cambic and Argic Chernozems, in depression (Aeolian rolling relief); *4*, Haplic Chernozems / Cambic Chernozems, on sand deposits (Aeolian rolling relief); *5*, Vermic Chernozems / Cambic Chernozems var. vermic; *6*, Haplic Chernozems, Haplic Chenozems (eroded phase) and strongly eroded soils / Cambic Chernozems, Eroded Cambic Chenozems and Erodisols (on slopes); *7*, Calcic Chernozems and strongly eroded soils / Typically Chernozems and Erodisols (on slopes); *8*, Vermic Calcaric Chernozems / Epicalcaric Chernozems var. vermic; *9*, Shifting Sands, Arenosols and Haplic Chernozems / Shifting Sands, Psamosols and Cambic Chernozems, on sand deposits (Aeolian rolling relief); *10*, Shifting Sands, Arenosols and Lamellic Luvisols / Shifting Sands, Psamosols and Psamic Preluvisols var. lamellic (Aeolian rolling relief); *11*, Lamellic Luvisols, Arenosols and locally strongly eroded soils / Psamic Preluvisols var. lamellic, Psamosols and locally Erodisols (Aeolian rolling relief); *12*, soil profiles; *13*, localities; *14*, irrigation channels.

Analytical Characteristics of the Arenosols

Physical Properties

In Dabuleni Plain, the arenosols have a loamy coarse sand or coarse sandy texture, regarding the two soil sampling levels, in the surface (Ao, Am, Ap) and subjacent horizons (AC, Cn_1). Clay content <0.002 mm varies between 0.9 and 12.1 percent. Particular to arenosols is the high content of coarse sand (44.2-71.9 percent) of aeolian origin (Fig. 2) compared with the fine sand (20.1-34.1 percent), which induces a characteristic single grain structure. Because of the extremely low content of clay and silt (2.3-9.6 percent) they are dusty, in terms of vulnerability to deflation, being devoid of any form of aggregation on depths of 1.5-2 m, with loose (non-coherent) consistence of soil mass (Table 1).

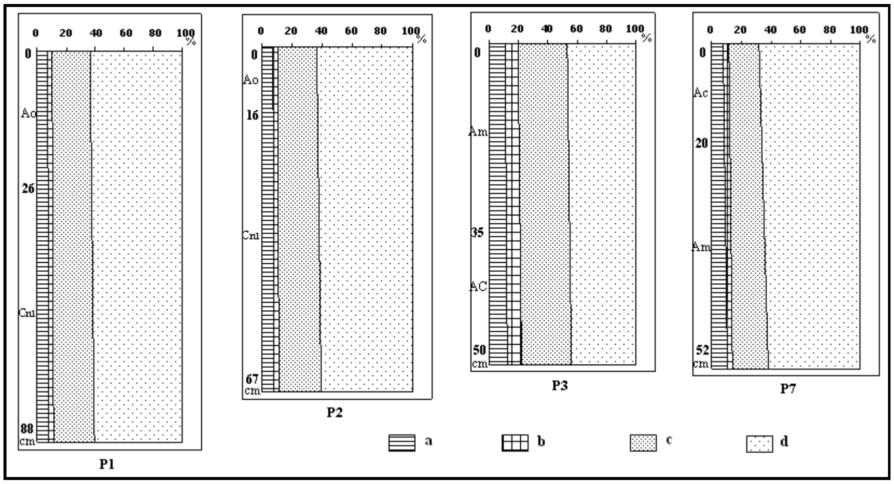

Fig. 2 Particle size distribution (%) of some selected soil profiles: a. clay; b. silt; c. fine sand; d. coarse sand.

Bulk density is low-medium (1.42-1.50 g/cm3) in surface horizons and medium to very high (1.48-1.76 g/cm3) in underlying horizons, which corresponds to a middle-high (44-47 percent) and small-medium (44-35 percent) total porosity. They have a very high permeability to water with high values of hydraulic conductivity (K) ranging between 42.06 and 189.4 mm/h in surface horizons and 57.22-201.24 mm/h in underlying horizons. P3 is the exception as its permeability is high in the horizon AC (18.60 mm/h) and very high (42.06 mm/h) in Am.

Arenosols resistance to penetration is very low with values of 2-9 kgf/cm^2 (range of values for the two levels of analysis). Moisture content at sampling moment varies between 3.0 and 7.6 percent 100g soil and, generally, it maintains within the same limits on both levels.

Chemical properties

The influence of relief microforms is noted in the accumulation of humus thickness, greater in depressions in comparison with dune ridges. The morphology of arenosols is characterized by the presence of a simple accumulation of humus with variable thickness, depending on relief microforms and age of stable dunes (Oancea et al., 1972). Eutric Arenosols are very poor in organic matter (humus), regardless the thickness of accumulation, with a very low content (0.51-0.60 percent) or extremely low (0.45 percent at P4) in the surface horizon and extremely low (0.03-0.29 percent) in the underlying horizon. The chemical data analysis indicates a weak acid reaction in the horizons Ao, Ap (pH 5.89-6.35) and in the parent material (Cn_1 horizon), with values of pH between 6.00 and 6.75. The total nitrogen (N) is very low in all samples analyzed, with values between 0.026 and 0.050 percent in Ao, Ap and 0.016 and 0.040 percent in Cn_1. The content of total phosphorus (P), is low-medium (0.016-0.072 percent) for soil profiles P1 and P6, low (0.017-0.022 percent) for P2 and low to high (0.014-0.091 percent) for P4.

Regarding the nitrate-N content (NO_3-N) with values of 5.4-16.0 ppm in surface horizon and 3.0-5.9 ppm in underlying horizon, Eutric Arenosols belong to the category of unfertilized arable soils (Lăcătuşu, 2006) with NO_3-N values below the 20 ppm (fertilized soils contain between 20 and 40 ppm). The ammonium nitrogen (NH_4-N) is low (2.40-4.80 ppm) for profiles P1 and P2 and medium (7.21-8.41 ppm) for P4 and P6.

Concerning the Mollic Arenosols, the soil reaction is weak acid with values of the pH between 5.90 and 6.40 in the horizon Am, Ac (A horizon covered with wind-borne sand) and AC (P3, P5) and neutral to weak alkaline for P7.

Table 1

Pedological data of the studied profiles (hyphen=no data)

Horizon	Depth (cm)	Colour (Munsell)	Structure	Texture	Granulometrical fractions (% g/g)			
					Clay <0.002 mm	Silt 0.002-0.02 mm	Fine sand 0.02-0.2 mm	Coarse sand 0.2-2.0 mm
P1, Lamellic Eutric Arenosol, cultivated land								
Ao	0-26	10YR4/3	SG	LCS	6.9	3.4	24.7	65.0
Cn_1	26-88	10YR 5/4-6	SG	CS	5.2	2.8	27.6	64.4
Cn_2l	88-140	10YR 5,5/4	SG	CS	-	-	-	-
P2, Eutric Arenosol, cultivated land								
Ap	0-16	10YR 3/4	SG	LCS	7.3	2.8	26.3	63.6
Ao	16-33	10YR 3.5/4	SG	LCS	7.7	3.8	27.7	60.8
Cn_1	33-67	10YR 5/4.5	SG	LCS	-	-	-	-
Cn_2	67-101	10YR 5/4	SG	LCS	-	-	-	-
P3, Mollic Arenosol, cultivated land								
Am	0-35	10YR 3/2	GL+SG	LCS	10.8	8.6	33.7	46.9
AC	35-50	10YR 3/3	SG	LCS	12.1	9.6	34.1	44.2
Cn	50-80	10YR 4/4	SG	LCS	-	-	-	-
P4, Eutric Arenosol, cultivated land								
Ap	0-27	10YR 3.5/4	SG	LCS	6.7	3.8	24.5	65.0
Ao	27-42	10YR 4/3	SG	CS	5.4	5.4	29.6	59.6
AC	42-53	10YR 4/4	SG	LCS	-	-	-	-
Cn	53-110	10YR 5/4	SG	CS	-	-	-	-
P5, Mollic Arenosol with severe sand accumulation, grassland								
Ac_{53}	0-23	10YR 4/4	SG	CS	4.5	4.1	30.9	60.5
Am	23-50	10YR 3/3	SG	LCS	7.8	3.2	32.0	57.0
Cn_1	50-89	10YR 3.5/4	SG	LCS	-	-	-	-
Cn_2	89-108	10YR 4/3	SG	LCS	-	-	-	-
P6, Eutric Arenosol, cultivated land								
Ao	0-37	10YR 4/4	SG	CS	0.9	7.1	20.1	71.9
Cn_1	37-60	10YR 5/4	SG	CS	5.2	2.3	21.3	71.2
Cn_2	60-81	10YR 4/4	SG	LFS	-	-	-	-
Cn_3	81-120	10YR 5/4-6	SG	CS	-	-	-	-
P7, Mollic Arenosol with moderate sand accumulation, grassland								
Ac_{52}	0-20	10YR 4/2	SG	LCS	7.9	3.7	20.1	68.3
Am	20-52	10YR 3/2	GL+SG	LCS	10.4	3.5	24.2	61.9
Cn_1	52-76	10YR 3/3	SG	CS	-	-	-	-
Cn_2	76-100	10YR 4/3	SG	CS	-	-	-	-

Structure: SG: single grain; GL: glomerular ;
Texture: CS: coarse sand; LCS: loamy coarse sand; LFS: loamy fine sand

Humus content (0.33-0.81 percent) and total N (0.022-0.050 percent) of the surface and underlying soil horizon is very low: mollic subtypes are slightly more humiferous compared with eutric ones. The Total P is very low-low (0.014-0.024 percent) in P3 and P7 and small-medium (0.029-0.060 percent) at P5. Generally, arenosols are very weak to moderate insured with total phosphorus. Regarding the content of nitrate nitrogen, Mollic Arenosols belong to the category of unfertilized arable soils with NO_3-N values below 20 ppm, between 5.3 and 6.3 ppm in upper horizon and 4.7-9.6 ppm in underlying horizon. Mollic Arenosols have a medium content of NH_4-N (6.00 ppm) in the surface horizon (Borlan and Hera, 1972) and low (3.60-4.80 ppm) in the underlying at P3 and P5.

Degradation Processes and Limitative Factors

Two categories of a soil degradation process are recognized, displacement of soil material (e.g., soil erosion by wind forces) and in situ soil deterioration covering chemical or physical soil degradation.

Displacement or coverage of soil material represents the main degradation processes, which affect the arenosols, in particular and the landscape, in general. Wind erosion or deflation is the process of displacement, transport and deposition of solid particles from the soil surface by wind. This process affects the upper soils horizon (usually A horizon) in which thickness is gradually reduced, with lost of soil material instead (Munteanu, 2000; Munteanu et al., 2004). Wind erosion was attenuated in Dăbuleni Plain by achieving shelterbelts forest, leveling the primarily aeolian relief and fitting irrigation systems. At present, the deforestation of shelterbelts and the malfunction of the Sadova-Corabia irrigation system have led to the reactivation of sand dunes with direct consequences regarding land quality. Nevertheless, the analyzed soil profiles are not affected by wind erosion, with all the surface horizons having thicknesses which do not include them into wind erodibility classes according to the Romanian System of Soil Taxonomy (2003) - the 20^{th} indicator on the degree erosion or soil striping.

Silting/colmatation defines a process of soil degradation resulting from the deposition on the soil surface of a layer of dispersed fine particles and development of a thin layer with dense and platy structure and low permeability (Canarache et al., 2006). In our case, silting or colmatation can refer to the coverage with infertile sediments, which concerns the deposition of sandy materials on the soils, derived from the process of wind erosion. In Dăbuleni Plain, there appear some areas covered with shifting sand that was blown by "outbreaks" of wind erosion from the neighbouring areas. These surfaces become virtually infertile and dry. Addition of sand by wind may also become a threat to agricultural crops (Fig. 3).

Thus, soil profiles P5 and P7 (Mollic Arenosols) are degraded as a result of sand accumulation. Soil profile P5 is covered by a coarse sandy layer of aeolian origin, and that compared with the thickness (23 cm), represents a severe sand accumulation on the upper soil layer (Am) (Fig. 4); the same situation is within the profile P7, with the difference that the sandy material has less thickness (20 cm) so that the soil is characterized by a moderate sand accumulation.

The effects of accumulated sand are insignificant regarding the permeability to water, which is still high due to coarse texture, but can

Fig. 3. Vineyard covered by shifting sands near Potelu

cause severe damages concerning the development and growth of plants, which depends on humus presence, even in small quantities. Of arenosols, only the mollic ones ensure a good plant development, the humus improving the trophic conditions of which sandy soils offer to the plants (Florea et al., 1988; Parichi, 1989).

Chemical deterioration can refer to the loss of nutrients or organic matter, acidification and pollution. Arenosols are very poor in organic matter (humus) and nutrients, having a weak acid reaction and critical moisture regime, especially on dunes, which represent limitative factors, not the results of chemical deterioration.

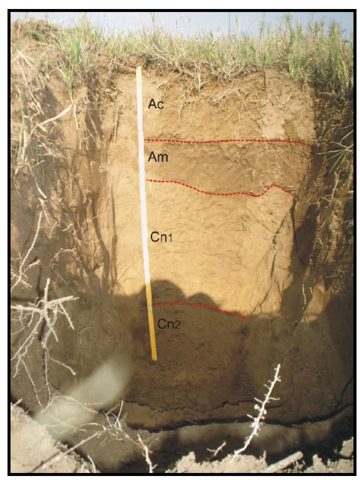

Fig. 4. Mollic Arenosol (P5) affected by coverage with infertile sediments of Aeolian origin

In order to prevent the acidification, it is necessary to promote a balanced fertilization, in case of chemical fertilizers, because the most vulnerable soils to acidification are the sandy soils, poor in humus and having an acid reaction (Florea, 2003).

Pesticide residue content is low, with some HCH values exceeding the maximum concentration limit (<0.005 mg/kg), but being lower than the alert threshold for a sensitive land use. The arenosols are not contaminated with pesticides, also due the fact that DDT contents are less than the maximum concentration limit (Table 3).

Analytical data of heavy metals content shows no contamination of the soils. All the values are below the AT - the alert threshold, which indicates that soils can sustain a sensitive land use. Some of the increased values of the elements can be attributed to previous historical contamination.

Table 3

Heavy metals and pesticide residue content (for a sensitive land use)

Profile no.	Soil type and subtype (WRB-SR 2006)	Horizon ; depth, cm	Sample depth, cm	Zn	Cu	Fe	Mn	Pb	Ni	Co	Cr	Cd	HCH tot.	DDT tot.
				mg/kg										
P1	Eutric Arenosol	Ao, 0-26	0-20	17.6	7.9	6274	165	29.8	17.8	28.8	5.0	*	0.012	0.015
		Cn_{1}, 26-88	30-50	11.9	3.8	5216	135	29.8	17.8	20.9	*	0.013	0.015	0.020
P2	Eutric Arenosol	Ap, 0-16	0-15	23.9	2.5	5745	165	29.8	29.4	13.0	5.0	0.044	0.013	0.015
		Cn_{1}, 33-67	35-50	22.8	3.8	4952	160	*	6.2	20.9	*	*	0.014	0.022
P3	Mollic Arenosol	Am, 0-35	0-20	19.3	3.2	8123	214	*	17.8	28.8	*	*	0.014	0.016
		AC, 35-50	35-50	15.3	3.8	8388	220	*	29.4	20.9	5.0	*	0.011	0.013
P4	Eutric Arenosol	Ap, 0-27	0-20	14.2	9.3	5216	152	*	29.4	13.0	13.9	*	0.015	0.023
		Ao, 27-42	27-42	21.1	2.5	6009	160	*	41.0	20.9	*	*	0.012	0.013
P5	Mollic Arenosol	Ac, 0-23	0-20	11.9	8.6	3102	84	*	6.2	*	*	*	0.011	0.015
		Am, 23-50	30-45	15.3	3.8	6802	176	45.3	6.2	13.0	5.0	*	0.008	0.005
P6	Eutric Arenosol	Ao, 0-37	0-20	24.5	20.8	4424	143	*	29.4	20.9	*	0.772	0.003	0.006
		Cn_{1}, 37-60	40-55	15.3	7.9	3895	106	*	17.8	13.0	*	0.066	0.001	0.005
P7	Mollic Arenosol	Ac, 0-20	0-15	17.6	42.5	7859	227	29.8	17.8	36.7	*	0.052	0.001	0.015
		Am, 20-52	30-50	28.0	21.1	8916	259	*	17.8	20.9	*	0.250	0.002	0.019
NV – normal values				**100**	**20**		**900**	**20**	**20**	**15**	**30**	**1**	**<0.005**	**<0.15**
AT – alert threshold				**300**	**100**		**1500**	**50**	**75**	**30**	**100**	**3**	**0.25**	**0.50**
IT – intervention threshold				**600**	**200**		**2500**	**100**	**150**	**50**	**300**	**5**	**0.50**	**1.00**

Conclusions

Soil environment quality in this area is in strong correlation with the humus content and the nature of parent material, which is relevant for the intensity of aridity processes, due to the strong heating and evaporation and few soil water accumulations. Also the reactivation of the sandy substrate and the formation of mobile sand dunes, with features of desert landscape increases drought severity, which will led in the end to desertification.

The specific pedogenetic processes of arenosols increase the water deficit affecting the development of grass vegetation cover and determine the sensitivity of the soils to deflation. The coarse texture determine a strong mineralization of organic matter and a more active mobilization of the various constituents of soil, with consequences regarding the migration of substances - including the nutrients – as the result of faster and deeper penetration of water into the soil. The loss in fine materials and organic matter by erosion and mineralization, together with climatic aridity, bring about specific landscapes characterized by soils with predominant ochric horizons that cannot support a sustainable agriculture without irrigation and protection against aeolian processes.

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SOIL QUALITY CARDS FOR PARTICIPATORY SOIL QUALITY ASSESSMENT IN ORGANIC AND SMALLHOLDER AGRICULTURE

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Abstract: Healthy soil is the basis of high quality food production. Increased awareness toward safe and healthy environment further aggravated the significance of soil quality evaluation and adoption of rational management practices. Evaluation of soil quality is crucial but expensive task for organic growers and smallholder agriculture. Participatory approach in soil quality assessment, thus, can serve the purpose of soil quality assurance for quality production. Physical, chemical and biological soil quality parameters are identified through participatory discussion and they are integrated in a way familiar to farmers. Farmers evaluate their farm soils based on their existing knowledge, agro-ecological condition and farming system of the area. This approach bridges farmers' ideas with scientific facts with minimum financial investment. Initiatives have already been taken in this line, however, strengthening and institutionalization of the process is needed to replicate this practical technique. Preliminary work in Baccheuli, Chitwan, Nepal indicated the approach as practical, easy, cost effective and convincing to farmers. Moreover, this enhanced confidence to farmers of their soil quality and supported for further strengthening of organic and smallholder agriculture in Nepal.
Key words: soil quality, organic farming, sustainable agriculture, smallholder farmers

Rezumat: Fişe de proprietăţi ale solului pentru evaluarea participativă a calităţii sale în agricultura organică practicată în fermele mici. Un sol sănătos reprezintă baza pentru obţinerea unei hrane de înaltă calitate. Creşterea gradului de conştienţă cu privire la un mediu sănătos şi sigur au mărit semnificaţia evaluării calităţii solului şi adoptarea unor practice raţionale de management. Evaluarea calităţii solului este vitală, dar reprezintă o sarcină costisitoare pentru cei care practică agrigultura organică şi pentru micii fermieri. Abordarea participativă în evaluarea calităţii solului poate astfel servi la asigurarea calităţii acestuia şi implicit a calităţii producţiei. Parametrii fizici, chimici şi biologici de calitate sunt identificaţi prin discuţii participative şi sunt integraţi într-un mod familiar fermierilor. Fermierii îşi evaluează solurile pe baza cunoştiinţelor dobândite, a condiţiei agro-ecologice şi a sistemului agricol din zonă. Această abordare permite integrarea ideilor fermierilor cu datele ştiinţifice cu un efort financiar minim. Deja au fost lansate anumite iniţiative, totuşi este nevoie de instituţionalizarea procesului pentru a aplica această tehnică practică la scară mare. Cercetarea preliminară din Baccheuli, Chitwan, Nepal a indicat această abordare ca fiind practică, facilă, eficientă financiar şi foarte convingătoare pentru fermieri. Mai mult, a determinat creşterea gradului de încredere a fermierilor în calitatea solurilor lor şi dus la întărirea agriculturii organice practicate de micii proprietari în Nepal.
Cuvinte cheie: calitatea solului, culture organice, agricultură durabilă, mici fermieri

Introduction

Scientific assessment of soil quality is essential to monitor sustainability of agricultural systems. However, soil quality itself is a complex subject, encompassing many valuable services to the human being and terrestrial ecosystems (Franzlubbers and Haney, 2006). Soil quality signifies the capacity of a specific kind of soil to function within natural or managed ecosystem boundaries to sustain plant and animal productivity, to maintain or enhance water and air quality, and to support human health and habitation. Soil functions for maintenance of good soil quality include, sustaining biological activity in a soil in high equilibrium level with substantially high productivity, regulating water and solute flow; filtering and buffering, degrading, immobilizing and detoxifying organic and inorganic contaminants in soil. This emphasizes storing and cycling of nutrients and other elements within the earth's biosphere; and ultimately provides support to the socioeconomic structures of the area (Seybold *et al*, 1998).

Soils vary naturally in their capacity to function; therefore, quality is specific to its type. Soil quality, however, includes two distinct but interconnected parts: inherent quality and dynamic quality. Characteristics, such as texture, mineralogy, etc., are innate soil properties determined by the factors associated with soil forming processes. Collectively, these properties determine the inherent quality of a soil or its productive capability. Recently, soil quality has come to refer to its dynamic quality and

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defined as the changing nature of the soil affected from human use and management. Management practices, such as use of cover crops and organic manures can have a positive effect on soil quality, whereas, other management practices, such as rigorous tilling of soil in wet condition adversely affects soil by increasing the compaction (Friedman *et al*., 2001).

Healthy soil is the foundation for high quality and surplus food production in sustainable manner. Thus, without understanding soil as a living, dynamic entity, and their complex inter-relationships, soil building process will not start functionally (Bot and Benites, 2005). Revitalization of the degraded land requires social, scientific, and ethical considerations. Soil, nutrients, and organic matter are being lost from Nepalese soils at the rate far exceeding the sustainable level (Pariyar, 2006) thus urging the need of rational soil management and assessment of the management approaches. Thus, renewed attention on developing locally led high-quality food production systems to achieve a global vision of environmental stewardship has been developed to attain sustainability in food production system in safe production environment. This paper presents various parameters for the participatory evaluation of the soil quality parameters especially focusing on the organic and smallholder agriculture along with few field experiences.

Indicators of soil quality

Soil quality indicators vary greatly depending on land condition and management practices. Basically, they are divided into three main classes i.e. soil chemical, physical and biological properties or processes. Indicators of soil quality, however, should reflect the capacity of soil to produce healthy crop, cycling and retaining nutrients in soil and releasing them to roots for efficient plant production and storing carbon in soil and releasing it to the atmosphere in a dynamic balance that stabilizes atmospheric concentration of CO_2; supplying plants with water, nutrients, and plant-growth promoting compounds; protecting water quality from nutrient and pathogenic contamination, providing physical stability and support for vegetation, buildings, and roads; enabling animal habitat and serving as a reservoir for biodiversity (microscopic and visible); buffering against toxic accumulation and transport of natural and synthetic compounds; filtering elements to protect animals, plants, and the environment from undesirable exposure (Magdoff and Weil, 2004).

More over these indicators should be:

- Easy to measure
- Detect changes in soil function
- Integrate soil physical, chemical, and biological properties and processes
- Accessible to many users and applicable to field conditions
- Sensitive to variations in management and climate
- Encompass ecosystem processes and relate to process-oriented

Variety of soil properties or processes can be selected to indicate soil functional capabilities (Table 1). These set of indicators include soil physical and chemical conditions, and structure and function of highly active soil microbial communities that creates less stressful condition for plant growth (Franzlubbers and Haney, 2006).

Table 1.

Minimum data set of indicators for participatory soil quality assessment

Indicator	Relationship to Soil Health
Soil organic matter (SOM)	Soil fertility, structure, stability, nutrient retention, soil erosion, and available water capacity
Physical	
Soil structure	Retention and transport of water and nutrients, habitat for microbes, and soil erosion
Depth of soil and rooting	Crop productivity potential, compaction, and plow pan
Infiltration and bulk density	Water movement, porosity, and workability, water holding capacity, Water storage and availability
Chemical	
pH	Biological activity and nutrient availability
Electrical conductivity	Plant growth, microbial activity, and salt tolerance
Extractable N, P and K	Plant available nutrients and potential for N and P loss
Biological	
Microbial biomass C and N	Microbial catalytic potential and repository for C and N
Potentially mineralizable N	Soil productivity and N supplying potential
Soil respiration	Microbial activity

(Seybold *et al*., 1998)

Soil quality assessment in organic and smallholder agriculture

Several organizations have been working for improvement of soil quality since decades by encouraging the best management practices to get rid of major soil problems such as erosion and nutrient depletion. As soil quality has emerged as a leading concept in natural resource conservation and protection, stronger emphasis is now being placed on the relationship between specific dynamic soil properties and soil performances (USDA-NRCS, 2001). Practices such as minimum tillage, and rational management of nutrient, pest, and pastureland (Figure 1) enhance the dynamic processes in the soil. For example, a typical method for improving soil quality by increasing organic matter involves reducing tillage and allowing the minimum erosion. Moreover, it stabilizes soil respiration to escalate the biological activity and release the nutrients for better profitability, and, in long run, high resilience of smallholder farmers against environmental flux and associated disasters.

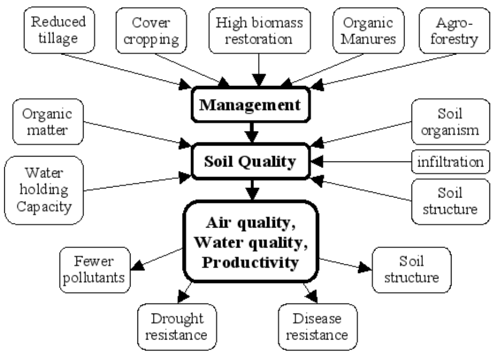

Fig. 1 Relationship between soil management practices, soil quality, and environmental quality

Participatory assessment of soil quality is required to evaluate and improve soils in organic and smallholder agriculture as all the components and interactions of a soil system are viewed together by linking biological, physical, and chemical properties of soil (Franzlubbers and Haney, 2006). This integrated approach leads to more comprehensive solution to assessing soil properties independently (USDA-NRCS, 2001). Participatory approach includes use of soil health/quality card, use of soil quality test kit, or simple laboratory analysis techniques for soil quality evaluation depending on the need and capacity of farmers, farming system situation and local knowledge, so that this is accessible to the smallholder agriculture and newly emerging organic sector in Nepal.

Soil quality cards

Smallholder agriculture and newly developing organic sector demands the development of simple, easy and less costly techniques of soil quality evaluation of their farms. Moreover, hazards of chemicals used in sophisticated laboratory analysis to the environment cannot be overlooked. The soil quality cards contain farmer-selected soil quality indicators and associated ranking descriptions typical to local producers (Table 2) that can be assessed even without the aid of technical or laboratory equipments (USDA-NRCS, 2001).

Soil quality cards integrate physical, biological, and chemical properties in the ways that are familiar and accessible to farmers. For example, use of terms like tilth that refers to the physical structure of soil and also depends on biological properties that makes the evaluation more sensible. Similarly, soil color is an indicator of soil organic matter and thereby predicts many biological and chemical processes in soil. Selection of these properties as indicated by farmers and preparation of data set in the form of cards usable by farmers or field workers can be the best solution to know an monitor soil quality of agricultural farms. Directions for the use of card are designed in each card for farmers and field technicians' easy understanding. Qualitative score of each of the indicators based on farmer's judgment along with other important data, like management practices, fertilizer rates, pest management, manure application etc. provides best insight on soil quality (USDA-NRCS, 2001).

Experiences of participatory assessment in Chitwan, Nepal

Soil quality evaluation is rarely practiced in Nepalese agriculture. Government service for the assessment of soil physical and chemical quality parameters is not effective in a practical sense. Private laboratories established with the objective of serving society became unable to server their purpose because of the extremely high running cost i.e. not affordable to smallholder farmers. Organic agriculture is in the edge because of the several challenges including quality assurance of the products and its production environment. We realized the need of evaluation of soil quality of organic farms, especially small farms as an initiative toward participatory soil quality assessment. In this first level assessment, soil quality cards were not fully developed as described in previous sections, however, some important parameters of soil quality have been set through group discussion, evaluation technique for these parameters discussed and soil quality was evaluated in joint effort of farmers, field technicians and experts.

Thirty three farmers of the Tharu Organic Producer Women Group, Bachheuli, Chitwan (Photo 1) were selected for the participatory evaluation of soil quality of their farms.

Photo 1. Farmers of the Tharu Organic Producer Women Group, Bachheuli, Chitwan

One day orientation meeting was conducted focusing on the importance of soil quality evaluation in small organic farms and evaluation techniques (Photo 2).

Photo 2. The orientation meeting on soil quality

Quality parameters were set based on the discussion of the group members to evaluate their soils. Soil color, texture and structure were observed on the field of each participant farmers and ranked verbally as good, fair, and worse.

Soil chemical quality preferably condition of major nutrients were tested using soil testing field kit and measured on five qualitative scales i.e. very high, high, medium, low and very low.

Qualitative estimate of major nutrients of thirty three farms indicated variable nutrient status in the observed area. Fifteen farms were very low, nine farms were low and nine were medium in available nitrogen content. None of the soils registered surplus in nitrogen nutrition of the crop. However, soils were medium to high in terms of plant available phosphorus and potassium supply.

Table 2.

Soil quality card template for assessing soil quality indicators

INDICATOR	SOIL QUALITY RANKING			SCORING		
	Low	**Medium**	**High**	L	M	H
Earthworms	Few worms per shovel, no casts	More worms per shovel, some casts	Many worms per shovel, many casts			
Soil Organisms	Few insects, worms, fungi, or soil life	Some insects, worms, fungi, soil life	Soil full of variety of organisms			
Smell	Swampy smell	Little or no smell	Fresh earthy smell			
Surface OM	No visible roots or residue	Some residue	Lots of roots /residue in various stages of decomposition			
Residue Dec.	Very slow or rapid decomposition	Some visible, non-decomposed residue	Residue at various stages of decomposition			
Compaction	Hard layers, tight soil, restricted root penetration, roots turned awkwardly	Firm soil, slightly restricted root penetration, moderate shovel resistance beyond tillage layer	Loose soil, unrestricted root penetration, no hardpan, mostly vertical root plant growth			
Workability	Many passes and horsepower needed for good seedbed, soil difficult to work	Soil works reasonably well	Tills easily and requires little power to pull implements			
Soil Tilth/ Structure	Soil clods large and difficult to break, crusting, or soil very powdery	Moderate porosity, some crusting, small clods, soil breaks with medium pressure	Soil crumbles well, friable, porous			
Soil Aggregates	Soil surface is hard, clumps and does not break apart, very powdery	Soil crumbles in hand, few aggregates	Soil surface has many soft small aggregates which crumble easily			
Porosity	Few worm and root channels	Weak plow pan, some new and old root and worm channels	Many worm and root channels, many pores between aggregates			
Crusting	Soil seals easily, seed emergence inhibited	Some surface sealing	Soil surface open or porous all season			
Water Infiltration	Water on surface for long period of time after rain or irrigation	Water drains slowly after rain or irrigation, some ponding	No ponding after heavy rain or irrigation, water moves steadily through soil			
Drainage	Excessive wet spots in field, ponding, root disease	Some wet spots in field and profile, some root disease	Water is evenly drained through field and soil profile, no evidence of root disease			
Water Holding Capacity	Plant stress immediately following rain, soil requires frequent irrigation	Crops are not first to suffer in area from dry spell, soil requires average irrigation	Soil holds water well for long time, deep topsoil, crops do well in dry spells, soil requires less than average irrigation			
Erosion	Obvious soil deposition, large joined gullies	Some deposition, few gullies, some colored Runoff	No visible soil movement, no gullies, clear or no runoff			
Crop Vigor	Stunted growth, uneven stand, discoloration, low yields	Some uneven or stunted growth, slight discoloration, signs of stress	Healthy, vigorous, and uniform stand			
Plant Roots	Poor growth, brown or mushy roots	Some fine roots, mostly healthy	Vigorous, and healthy root system, good color			
Root Mass	Very few roots, mostly horizontal	More roots, some vertical, some horizontal	Many vertical and horizontal roots, deep roots			

Only one farm had high plant available phosphorus and four farms were low in its supply, the rest of 28 farms were medium in phosphorus supply. Similarly, twelve farms were very high, thirteen high and seven farms were medium in potassium supply. Only one farm was low in available potassium supply (Figure 2).

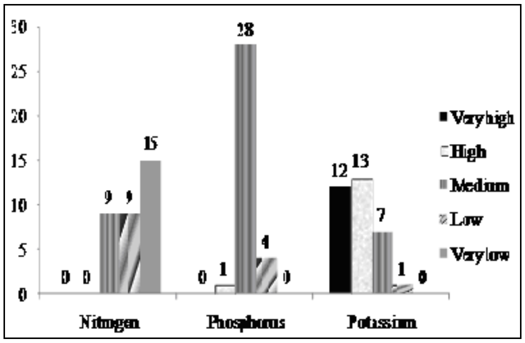

Fig. 2 Field assessment of soil chemical quality in Bachheuli, Chitwan, Nepal

Similarly, participatory evaluation of twenty-four farms of Women Farmers' Group, Pithuwa, Chitwan following the same orientation and test procedure as in Bachheuli and setting three scales i.e. high, medium and low in the measurement of major nutrients showed that most soils (21 farms) were low in available nitrogen. However, phosphorus was medium in fourteen farms and potassium was medium in sixteen farms. Similarly, one farm was high in phosphorus whereas seven farms were high in potassium. Phosphorus supply was low in nine farms examined during this evaluation. The tested soils were neutral to moderately acid in pH (pH range of 5.5 to7). Discussion at the time of result dissemination of the analysis concluded the need of sustainable management practices to upgrade soil quality especially through application of well-decomposed organic manures, crop residue, and green manures. Nitrogen should be enriched and the phosphorus and potassium, which are medium to high in status, should be maintained or improved in the soils.

Conclusions

Soil quality is the intricate subject as soil varies naturally in their capacity to function. Soil quality assessment is a tool used to evaluate the effects of management system on the health of the soil.

Sets of techniques are available to assess the soil quality in farmers' field. Participatory soil quality evaluation technique is a low cost technique of examining soil with the active involvement of farmers. These techniques serve for the assurance of soil quality, confidence to the farmers and indirectly to the sustainability of agricultural system. Moreover, this adds strength in promotion of organic agriculture as good quality soil gives good harvest, habitable and safe environment, and increases confidence to the smallholder farmers to join the organic agriculture movement.

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NOTIONS REGARDING THE RELATION BETWEEN LANDFORMS AND SOIL IN THE EASTERN AND NORTH-EASTERN REGION OF THE ROMANIAN PLAIN

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Abstract: The present study aims at rendering the way the geomorphologic features of the eastern and northeastern regions of the Romanian Plain, influenced by the subsidence movements, is reflected in the soil cover. For its achievement, there was used Romania Soil Map, 1:200 000 scale and field mapping, inventorying the soil cover at the level of class, type and, partially, subtype.
In the mentioned area located between the Argeş and the Siret, besides the soils (chernozems, phaeozems, reddish preluvosols) the genesis of which is triggered by the bioclimatic conditions characteristic to steppe, forest steppe and nemoral zone, there also develop soils with azonal and intrazonal character.
Thus, the presence of large floodplains imposed the noticeable extension of the soils developed on recent fluviatile deposits (alluviosols). At the same time, the altitude and reduced relief intensity impose an increased phreatic level, which is mineralized in many areas and, consequently, certain soils are affected by hydromorphism (Gleysols and gleyic subtypes) and salinization (solonchaks and salinic subtypes, solonetz and alkalic subtypes). Another characteristic of the studied region is linked to the presence of certain soils buried under alluvial and proluvial deposits.
The calculation of the topographical-pedogenetic index (Florea, 1997), as a rapport between non-zonal and zonal soils, emphasizes the pregnant influence of the local conditions from the Buzău and the Lower Siret subsidence plains compared to a series of higher plains (Râmnic, Galaţi).
Key words: zonal soils, non-zonal soils, phreatic aquifer, salinization, buried soils, subsidence plains.

Rezumat: Noţiuni privind legatura dintre relief şi sol în regiunea estică şi nord-estică a Câmpiei Române. Studiul de faţă are ca scop interpretarea modului în care caracteristicile geomorfologice ale regiunilor estice şi nord-estice ale Câmpiei Române, influenţată de mişcările de subsidenţă, este reflectat în învelişul de sol. Pentru realizarea acesteia, s-a folosit Harta Solurilor României, scara1: 200.000 şi cartarea de teren, inventariind învelişul de sol la nivelul clasei, tipului şi parţial subtipului.
În zona menţionată, situată între Argeş şi Siret, în afară de soluri (cernoziomuri, faeoziomuri si preluvosoluri roscate), geneza lor este declanşată de condiţiile bioclimatice caracteristice stepei, silvo-stepei şi zonei nemorale; se dezvoltă de asemenea soluri cu caracter zonal şi azonal.
Astfel, prezenţa unor câmpii de umplere a impus expansiunea notabilă a solurilor dezvoltate pe depozite fluviatile recente (aluvisoluri). În acelaşi timp, altitudinea şi intensitatea redusă a reliefului a impus un nivel freatic ridicat, care este mineralizat în multe zone şi, în consecinţă, anumte soluri sunt afectate de hidromorfism (gleisolurile şi subtipurile gleice) şi salinizare (solonceacuri şi subtipuri salinice; soloneţuri şi subtipuri alcalice). Altă caracteristică a regiunii studiate este legată de prezenţa anumitor soluri îngropate sub depozitele aluviale şi proluviale.
Calcularea indexului topografic- pedogenetic (Florea, 1997), ca raport între solurile azonale şi zonale, accentuează influenţa pregnantă a condiţiilor locale de la subsidenţa câmpiilor Buzăului şi Siretului Inferior faţă de serii de câmpii mai înalte (Râmnic, Galaţi).
Cuvinte cheie: soluri zonale, soluri azonale, acvifer freatic, salinizare, soluri îngropate, câmpii de subsidenţă.

1. Methodological principles, location

For the plain region located between the Argeş and the Siret rivers, neotectonics emphasized by an active subsidence, may be reflected in pedogenesis through the extension of recent fluviatile deposits, as well as through the development of small areas with shallow and frequently salted phreatic aquifers.

In terms of general bioclimatic conditions, zonal soils (unconditioned by local pedological factors) from the Romanian Plain located east of the Argeş River are represented by chernozems, phaeozems, reddish preluvosols, characteristic to stepped, forest steppe, and nemoral zone (plain forest). Within this bioclimatic framework, relief (through the development of subsident sectors) generates characters of intrazonality and azonality reflected by soil cover.

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This phenomenon is conditioned by the presence of certain large floodplains and of sectors with shallow phreatic aquifers.

Starting from this premise, we have inventoried the soil cover at a taxonomic level (S.R.T.S., 2003) of class, type, and subtype (partially) on the basis of Romania soil map, scale 1:200 000, and of field surveys in 15 sites.

Within subsidence plains, the influence of relief in pedogenesis is manifested in several ways:

-low relative altitude and reduced fragmentation keeps phreatic level increased (0-5 meters); phreatic water becomes the main pedogenetic factor determining the development of gleyzation processes combined with the salinization and alkalinization ones in the areas where the water table is mineralized;

- subsident areas represent local base levels, which polarize the drainage system and determine alluvia discharge on large surfaces;

- the extension of floodplains or of alluvial fans characterized by the presence of soils in their incipient evolution phase (alluviosols) located above the buried zonal soils.

In order to render the transformations imposed to pedogenesis by the relief factor, we comparatively analysed, together with the subsidence plains (Titu-Sărata, Buzăului, Siretului Inferior), the other genetic types of plains located between the Argeş and north of the Siret, at the contact with the sub-Carpathian hills (hilly plains – glacis and piedmont plains) and at the limit of the subsidence area (terminal-piedmont, tabular, terrace plains etc.).

These plains are: Târgovişte-Ploieşti, Istrița, Vlăsia, Brăila, Central, Southern Bărăgan, Mostiştea, Râmnic, Lower Siret, Buzău, Galați. The subsident area extends from the Argeş River to the Siret River, its width varying between 5 (in the central and eastern sector of the Titu-Sărata Plain) and more than 50 kilometers (in the Lower Siret Plain).

2. Results and discussions

The issue of the soils influenced by the phreatic level. The shallow phreatic level determines the development of certain hydromorphic soils; the ones displaying a strong hydromorphism (phreatic level below 1.5 meters) are included to hydrisols – Gleysols (typical, cernic, salinized), while those with a less intense hydromorphism (phreatic level between 2 and 5 meters) are gleyic subtypes of other soils (alluviosols, chernozems and phaeozems, solonchaks); in their proximity, within drier areas, chernozems and phaeozems display a humid phreatic character.

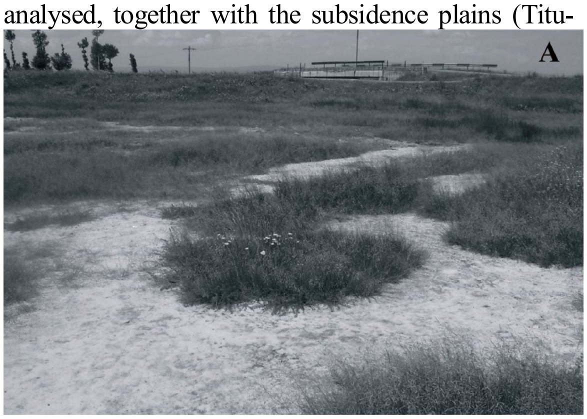

Photo 1 – Powders of easily soluble salts at the surface of certain solonchaks from the northeast of the Titu-Sărata Plain, Săhăteni settlement (A) and from the Buzău Plain, northeast of Surdila-Greci settlement (B)

Photo 2 – Salinized entic alluviosol within the Buzău Floodplain (the Buzău Plain)

Intense mineralization of the phreatic water in certain sectors and the exudative moisture regime determine the development of some soils affected by salinization, either at the type level (solonchaks and solonetz belonging to Salsodisols class) or subtype level (salic or alkalic subtypes of alluviosols, chernozems, Gleysols). Salsodisols cover the areas where mineralized phreatic water is located above the critical soil salinization depth (2 – 3.5 meters).

Representative areas with salt-flats, predominantly solonchaks, are located in the northeast of the Titu-Sărata Plain (Photo 1 A) and in the Buzău Plain, especially in its southern part, but also in the north (Photo 1 B). Together with

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solonchaks, within the Buzău Plain, there frequently develop salic subtypes of alluviosols, even of those emerging on recent levees (photo 2).

The soils the genesis of which is influenced by the accumulation of easily soluble salts are used for low productivity meadows; there grow small graminaceous plants e and bushes of *Artemisa sp.* In the areas where salts precipitate at the surface, vegetation misses, whitish spots emerging (popularly called *chelituri*). These areas are delimited by clusters of *Salicornia herbacea* that have a reduced coverage degree.

Salinic entic alluviosol from the Buzău Floodplain (located at about 300 meters north of the relatively flat contact pointed through a dislevelment of 4-5 meters between the Brăila and Buzău Plains) displays finely stratified alluvial material in the first 20 centimeters, with sequences of less than one centimeter (especially in the first 10 centimeters).

At the surface, the material that is finer (clayish sand to sandy clay) than the rest (sandy-clayish texture) forms polygonal squames (limited by cracks) that display salt powders. Along the rest of the profile to the depth of 60 centimeters, alluvium has a more compact character and presents oxidation spots, as well as reduction spots (weakly green colours) at the base, induced by the oscillation of the phreatic level, located at more than one meter depth.

In the western part of the Lower Siret Plain (in the area of Corbu Nou-Gulianca settlements), on a higher sector overlapped on the ending parts of the piedmont fans of the Râmnic River, there appears an area (more than 5,000 hectares) with typical solonetz (in the central and western part of the area), as well as northwards and eastwards, where the soils are influenced by the phreatic aquifer (moist phreatic, gleyic, salinic).

They are used for low productivity meadows dominated by *Salicornia herbacea*. The presence and spatial distribution of these solonetz supposes a desalinization of the solonchaks and, consequently, a lowering of the phreatic level (linked to the active subsidence characterizing the confluence between the Buzău and the Siret rivers).

Northwards, in the area of Latinu-Voineşti settlements, at the confluence of the Buzău with the Siret, phreatic level is higher being located at less than 0.5 meters depth and, seasonally, water stagnates at the soil surface. Here, alluviosols display a swampy character and they are used for rice crops, but under irrigation (Photo 5 A, B).

The issue of unevolved soils within floodplains. Within subsident areas, there occurs important alluvia discharge (sand, clay, silt) on large surfaces (Photo 3). Rivers form large meanders and they exceed their bed during floods. In the floodplains, there develop alluviosols, inclusively entic ones (incipiently solified alluvia), which sometimes have gleyic, salinic or sodic character.

Photo 3 – Alluvia accumulations at the confluence between the Buzău and the Siret

The most representative sector from this point of view is the Lower Siret Plain, which corresponds to the floodplain and floodplain terrace at the surface, while in the fundament, to the area of maximum subsidence. Here, the alluvial plain (that includes the floodplain terrace and the floodplain) is more than 20 kilometers wide and alluviosols cover large surfaces (61%).

Photo 4 – The contact between the Brăila Plain and the Lower Siret Plain within the perimeter of Muchea settlement

Immediately after Muchea settlement located in the north of the Brăila Plain (Northern Bărăgan), at the foot of the Danube's terrace scarp, at the contact with the Siret divagation plain, phreatic level is at about one meter depth. Here, on the floodplain terrace of the Siret, alluviosols (Photo 4) display gleyzation marks at the base of the profile (gleyic alluviosols). As mentioned before, at the confluence of the Buzău with the Siret, the water seasonally stagnates at the soil surface. There developed alluvic Gleysols (on recent fluviatile deposits) used for rice crop under irrigation (Photo 5 A, B).

The issue of buried soils. The passage between the hilly plain (glacis and piedmont plain) and the subsidence plain is marked by a slow modification of slope and the appearance of a line of phreatic discharge from the alluvial fans.

This phenomenon brought to the burying of the zonal soils (frequently chernozems) developed at the contact between the two genetic types of plains by alluvial-proluviale deposits. Presently, these soils are buried and fossilized by a new generation of alluviosols.

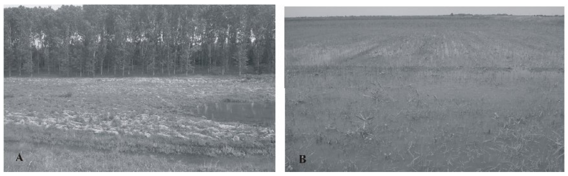

**Photo 5 A, B - Swampy alluviosols at the confluence of the Buzău and the Siret rivers, in the area of Latinu-Voineşti settlements.
Phreatic water stagnates at the soil surface.**

Buried soils were identified in the following locations: Fântânele (photo 6 a), at the contact with the glacis plain of Istrița and the subsidence plain of Sărata, within the Bălana stream floodplain; Nicoleşti (photo 6 b), between the piedmont plain of the Râmnic and the Lower Siret subsidence plain. At Fântânele, the buried A mollic horizon displays its upper limit at 60 centimeters (low-depth buried soil), at about 250 meters away from the right bank of the Bălana stream.

At about 50 meters north-eastward (towards the sub-Carpathians hills) of the profile area (about 300 meters of the right bank of the Bălana stream), the A Mollic horizon has the upper limit at 30 centimeters (depth determined by means of pedological sampler) and, at about 400 meters of the right bank of the Bălana stream, the A Mollic horizon appears at the surface as chernozems characteristic to this region.

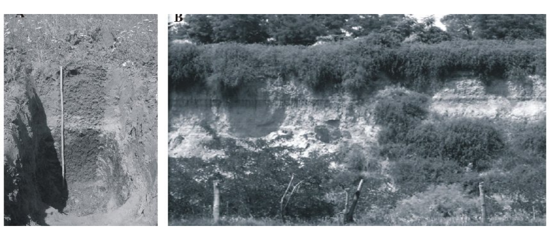

Photo 6 – Buried soils in the area of Fântânele settlement (A). It may be noticed a dark horizon on the soil profile resulted from an A mollic horizon of chernozems covered by alluvia. Buried soils in the perimeter of Nicoleşti settlement (B)

3. Conclusions

The comparison of the share of the soils located within floodplains (alluviosols with different subtypes belonging to Protisols class) and influenced by phreatic water (solonchaks and solonetz belonging to Salsodisols class and Gleysols from the hydrisols class) from the Lower Siret Plain and the Buzău Plain (within these two plains there are to be found most of the subsident sectors) with a series of plains located out of the subsidence area reflects the above mentioned issues very well.

Fig. 1 – After the interpretation of *Romania Soil Map, scale 1:200 000,* the Romanian Geology Institute, Bucharest (computerized cartography Săvulescu I., Faculty of Geography, the University of Bucharest).

In the second category, there were included the hilly plain of Râmnic and the Galați Plain (Table no. 1), with large plateau-like interfluves and terraces, which display the same climatic conditions as the steppe and forest steppe regions (characterized by the extension of Cernisols class).

Table 1.
Share (%) of non-zonal soils within floodplains and sectors with shallow phreatic aquifers. Comparison between the Siret-Buzău subsidence plain and a series of higher external plains (Râmnic and Galați)

SOIL CLASS	Buzău Plain	Lower Siret Plain	Râmnic Piedmont Plain	Galați Plain
CERNISOLS	31	17	89	88
PROTISOLS	34	61	9	10
SALSODISOLS	32	11	1	1
HYDRISOLS	3	11	1	1

At the same time, analyzing at the level of taxonomic type and subtype the distribution of soils within the East and Northeast Romanian Plain (east of the Argeş), one may notice the extension, within the subsidence plains (Titu-Sărata, Buzău, Lower Siret), of the soils the genesis of which is influenced by other pedogenetic factors not by the bioclimatic conditions specific to the region. Such soils are considered non-zonal (fig. 1). Their genesis and evolution, as previously emphasized, is imposed by the depositing of alluvial materials within floodplains and by the high phreatic level (either mineralized or not).

Table 2.
Topographic-pedogeographical index (It). Comparison between the Siret-Buzău subsidence plains and a series of higher external plains (Râmnic and Galaţi)

It	Buzău Plain	Lower Siret Plain	Râmnic Piedmont Plain	Galaţi Plain
value	2.23	4.88	0.12	0.14

In order to better emphasize this situation, one may calculate a synthetic index, called the topographic-pedogeographical index (**It**), as a rapport between non-zonal soils (intrazonal and azonal) and the zonal ones (influenced by the bioclimatic conditions). This index (Florea, 1997) was calculated for the soils within the Buzău, the Lower Siret, the Râmnic, the Galaţi plains.

The lowest the value of this index is the lowest the share of non-zonal soils is (Table no. 2). The highest value was registered for the Lower Siret Plain (4.88).

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METEO-CLIMATIC RISKS IN THE TIMIŞ PLAIN WITH IMPACT ON AGRICULTURE

Rodica POVARĂ[1], Iulica VĂDUVA[1]

Abstract: The paper aims at investigating the thermal stress and risk factors within the maximum sensitivity period of the winter wheat (heading - flowering - grain filling). Through their intensity, frequency and duration, they may have negative effects on the vegetation state, finally determining the reduced, moderate or severe crop yield reduction. The study was carried out at two meteorological stations, situated in the Timiş Plain: Timişoara and Banloc.
Knowing the incidence, frequency, duration and intensity of the agrometeorological stress and risk parameters and of crops vulnerability, it gives the possibility to minimize their impact on the yields by adopting certain efficient strategies and measures for protection at local level.
Key words: meteo-climatic risk, critical phenophase, winter wheat, agriculture, the Timiş Plain.

Rezumat: Riscuri meteo-climatice în Câmpia Timişului cu impact asupra agriculturii .
Lucrarea are ca obiectiv investigarea factorilor de stres termic şi de risc din perioada de maximă sensibilitate a grâului de toamnă (înspicare – înflorire – umplerea bobului). Prin intensitatea, frecvenţa şi durata lor pot avea efecte negative asupra stării de vegetaţie, determinând în final reducerea uşoară, moderată sau severă a producţiei. Studiul s-a desfăşurat la două staţii meteorologice situate în Câmpia Timişului: Timişoara şi Banloc.
Cunoscând incidenţa, frecvenţa, durata şi intensitatea stresului agrometeorologic şi ai parametrilor de risc şi ai vulnerabilităţii recoltei, apare posibilitatea de minimizare a impactului lor asupra producţiilor prin adoptarea anumitor strategii şi măsuri de protecţie la nivel local.
Cuvinte cheie: risc meteo-climatic, fenofază critică, grâu de toamnă, agricultură, Câmpia Timişului.

The Timiş Plain, as part of the Banat Plain, offers extremely favourable conditions to cereal and technical crops through its agroclimatic resources. The large variability of meteo-climatic factors determines the appearance of thermal, hydrological and combined risks, which have an important role in the fluctuation of yields from year to year. The analysis of the evolution of the climatic parameters on long periods, of the intensity, duration, frequency and vulnerability of the main crops enables an optimal usage of the climate through/by:

- choosing the variety and the hybrids with respect to the bioclimatic requirements and the hydrothermal potential of crop area (Bîlteanu, 1998);
- adapting the geotechnical measures, which correspond to the agrometeorological conditions specific for each vegetation season, by taking preventive measures, especially during the periods and in the areas with a big probability of producing the risk phenomena (Ceapoiu, under coordination, 1984);
- adopting the right decisions in the optimization of crop plans and the optimal exploitation of the irrigated areas (Grumeza, Merculiev, Klepş, 1989).

In this way, one of the basic characteristics of a variety of winter wheat is the stability of the yields, that is “the full expression of the production potential under restricting conditions of the environment” (Săulescu, 1984).

During the vegetation season of winter wheat, its requirements towards the meteorological conditions differ from a phenological phase to another, reaching the highest values during the critical periods, specific for the crop. If during these periods there are positive or negative deviations from the optimal values necessary for the development of the vegetative processes in good conditions, the agrometeorological factors become stressful, sometimes of risk, with different intensities in accordance with the dimension of the deviations, having in this way a negative impact on the vegetation state and on the obtained yield (Povară, 2000).

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In this paper there are analyzed the parameters of stress and thermal risk for the interval May-June, which corresponds to the phenological phases with maximum requirements for winter wheat: heading- flowering- grain filling.

THERMAL RISKS

In May and June, the winter wheat crosses critical phenological phases of heading-flowering-grain filling with an optimum necessary of daily average temperatures between 16°C and 22°C (table 1). On the temperatures scale there are certain lower and upper limits in which the intensity of the biological processes is in an obvious correlation with the values of this parameter. Besides these limits, the intensity of the processes decreases considerably or even stagnates, the respective temperatures becoming in this way a stressful factor and even a factor of risk for plants (Povară, 1998).

Table 1.

Winter wheat requirements in relation to air temperature

Month	The potential phenological phase	Air temperature (°C)			
		Lethal	Mini-mum	Optimum	Maxi-mum
May	- straw extension - heading - flowering	< 8°; > 35°	8° - 10°	16° - 20°	30°-35°
June	- heading - flowering - milk material - wax material - complete material	< 8°; > 35°	8° - 10°	16° - 22°	30°-35°

Thermal anomalies have the highest frequency 30,5 percent respectively 25.0 percent, both in the warm and cold years at Timişoara, and the grade of thermal normality in the Timiş Plain is very high at both stations in June (Table 2).

Table 2.

Thermal anomalies in the months with maximum requirements

Station/ month	Warm		Cold		Normal	
	V	VI	V	VI	V	VI
Timişoara	30.5	19.4	25.0	19.4	44.5	61.2
Banloc	26.3	21.1	26.3	21.1	47.4	57.8

The maximum critical temperatures ≥ 32°C

In May, maximum critical temperatures are present as a stressful phenomenon at both stations in the Timiş Plain with a low frequency (11.76 percent at Banloc and 8.82 percent at Timişoara), but higher (20.59 percent) in June. The stressful years were: 1961, 1962, 1963, 1965, 1967, 1968, 1969, 1981, 1983, 1991, 1993, 1994, common years in majority, and the years of risk were: 1962, 1963, 1967, 1968, 1994 (Table 3).

Table 3.

The frequency (%) of the maximum critical temperatures ≥ 32°C in stressing years

Years	Timişoara		Banloc	
	May	June	May	June
1961	-	8.82	-	5.88
1962	-	20.59	-	20.59
1963	-	20.59	-	17.65
1965	-	8.82	-	8.82
1967	-	14.71	-	8.82
1968	8.82	17.65	5.88	11.76
1969	8.82	8.82	11.76	-
1973	2.94	-	-	-
1981	-	-	-	8.82
1983	5.88	-	-	-
1991	-	8.82	-	-
1993	-	5.88	-	5.88
1994	-	11.76	-	11.76

Source: data processed from NAM

The minimum critical temperatures ≤ 14°C and ≤ 10°C

The thermal stress produced by these temperatures is more severe in May than in June. Thus, the crops were affected at both stations in May and on the whole analyzed period, with a maximum frequency (91.18 percent) of those of ≤14°C in the stressful years 1976, 1978, 1987, 1991 and 1992. In June, it has been observed a small decrease of the thermal stress with a maximum frequency of only 61.76 percent in only three years: 1967, 1989, and 1993. The minimum temperatures ≤10°C, more dangerous for plants, had a rather high frequency in May (maximum 64.71 percent) at Timişoara in 1991, and the thermal stress was much diminished in June, the maximum frequency (29.41 percent) has been observed at both stations only in 1962 and 1967 (table 4). The stressful years, which became of risk due to the high frequency of minimum temperatures of ≤14°C were: 1968, 1969, 1973, 1976, 1978, 1980, 1983, 1987, 1989, 1991, 1992, 1993 (May) and 1961, 1962, 1967, 1989, 1991, 1993, 1994 (June). For the minimum temperatures of ≤ 10°C, the stressful years turned into years of

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risk were: 1976, 1980, 1987, 1989, 1991, 1992, 1993, 1994 (only for May).

Table 4.

The frequency (%) of the minimum critical temperatures in stressing years

Years	Timişoara				Banloc			
	Min. T. < 14°C		Min. T. < 10°C		Min. T. < 14°C		Min. T. < 10°C	
	May	June	May	June	May	June	May	June
1961	-	52.94	-	2.94	-	58.82	-	0.00
1962	-	52.94	-	29.41	-	50.00	-	29.41
1963	-	47.06	-	5.88	-	44.12	-	8.82
1965	-	47.06	-	5.88	-	50.00	-	5.88
1967	-	61.76	-	29.41	-	58.82	-	23.53
1968	67.65	50.00	20.59	11.76	55.88	35.29	20.59	8.82
1969	76.47	-	26.47	-	67.65	-	29.41	-
1972	-	41.18	-	2.94	-	-	-	-
1973	82.35	-	41.18	-	-	-	-	-
1976	91.18	-	55.88	-	85.29	-	55.88	-
1978	88.24	-	44.12	-	91.18	-	38.24	-
1980	85.29	-	61.76	-	82.35	-	58.82	-
1981	-	-	-	-	-	29.41	-	2.94
1983	73.53	-	29.41	-	-	-	-	-
1984	-	-	-	-	82.35	-	32.35	-
1987	91.18	-	52.94	-	91.18	-	47.06	-
1989	82.35	-	47.06	-	88.24	61.76	47.06	8.82
1991	88.24	52.94	64.71	8.82	91.18	-	70.59	-
1992	91.18	-	47.06	-	88.24	-	52.94	-
1993	-	55.88	-	8.82	82.35	61.76	23.53	20.59
1994	-	50.00	-	14.71	-	55.88	-	17.65

Source: data processed from NAM

The impact of critical temperatures on the wheat crop

The excessive temperatures starting from the period of straw extension until the end of vegetation are harmful to winter wheat, their negative effect become more prominent if they are accompanied by the insufficiency of the air and soil humidity (Povară, 2006). During the heading - flowering - grain filling period, the pedological drought together with the atmospheric drought and high temperatures (days of intense heat) create a disequilibrium in the metabolism of the planet, the level of perspiration exceeds the one of absorption, the migration of substances towards the grain is greatly diminished, producing the phenomenon of shriveling the grains. These temperatures registered in successive days, on a longer period of time, cause an earlier development of phenological phases and force the processes of ripening by shortening the period of grain filling. Thus, it may frequently appear disparities between the normal data and the real one of materialization of the respective phases up to 10- 15 days (Povară, 1999). Regarding the heading phenophase, which occurs earlier than the normal phase in the Timiş Plain, in 62 percent of cases, due to the very early spring, generated by the Submediterranean influences, specific to this geographical region (table 5), in comparison to the Romanian Plain, where the frequency of earlier producing is of 41-52 percent.

Table 5.

The frequency (%) of the heading anomalies in comparison with the Romanian Plain

Station	Normal	Earlier	Later
Timişoara	34	**62**	4
Băileşti	48	48	4
Alexandria	41	52	7
Călăraşi	52	41	7

Source: data processed from NAM

The minimum temperatures under 14°C and 10°C produced in a large number of successive days in May can influence drastically the yield, for example the year 1992, when the whole month of May had minimum temperatures under these critical values. At Timişoara, it was recorded a quarter of the productive potential of Fundulea 29 variety (fig. 1).

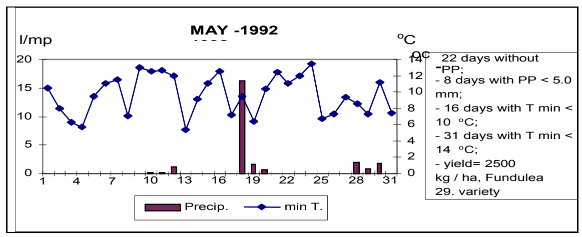

Fig. 1 Meteo-climatic parameters in the heading – flowering – grain filling period of the winter wheat – Timişoara

Conclusions

The analysis of meteo-climatic parameters of stress and thermal risk of the maximum sensitivity period of winter wheat in the Timiş Plain pointed out the following:

- the thermal anomalies had normally the grade 1 and 2 and they have occurred in intervals of maximum 2-3 successive years, at both stations;
- the frequency of the years with days of intense heat (maximum temperatures ≥32°C) was higher at both stations in June during the extremely stressful years: 1962, 1963, 1968, 1994, causing the phenomenon of shriveling the grains;
- in the Timiş Plain, the phenomenon of shriveling the grains is less frequent and intense in comparison with the agricultural areas from the Romanian Plain and implicitly the yields are less affected;
- the minimum critical temperatures ≤14°C and ≤10°C were presented as phenomenon of risk in both months and at both stations, the highest frequency, up to 91.18 percent, being that of ≤14°C in May, in the very stressful years, which

became years of risk: 1976, 1978, 1987, 1992;

- the climatic stress determined by the maximum and minimum critical temperatures it is not always produced simultaneously in the both consecutive months, fact which favours in a way, the agricultural crops;
- the highest reductions of yield determined by the action of stress and thermal risk are due to the high frequency and succession of minimum critical temperatures of ≤ 10°C during the heading-flowering- grain filling period (in May and June).

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CONSIDERATIONS UPON THE HEAT WAVE FROM JULY 2007

Ion MARINICĂ[1]

Abstract. The present paper renders the analysis of the evolution of the heat wave that affected Romania between the 15th and the 24th of July 2007. This was the most intense heat wave registered in July; it also had the longest duration in the entire period since Romania made systematic meteorological observations. It affected the entire country, especially the southern and western regions, with the exception of mountainous area, where the effects were minimal. The maximum temperature for July was exceeded by 0.8°C, outlining an important increase in the evolution of July temperature, which may hold increased significance on the background of global warming. The heat wave mainly affected Hungary, Italy, Greece, Romania, Republic of Moldova, and Ukraine. All activity branches felt the consequences of this evolution. Thus, the paper is extremely useful to the experts in climatology, meteorology, to those who try to achieve a master or PhD thesis, to students and to all those interested in climatologic issues.
Key words: heat wave, absolute maximum temperatures, canicular days, red code.

Rezumat. Consideraţii privind valul de căldură din luna iulie 2007. În lucrare este analizată evoluţia valului de căldură, care a afectat România în intervalul 15-24 iulie 2007. Acesta a fost cel mai intens val de căldură al lunii iulie şi cu durata cea mai mare din toată perioada de când se fac observaţii meteorologice sistematice în România. A afectat întreaga ţară, cu excepţia arealului de munte unde efectele au fost minime şi în mod deosebit sudul şi vestul. Temperatura maximă absolută a lunii iulie a fost depăşită cu 0.8°C, marcând un important salt în evoluţia temperaturilor lunii iulie, care în contextul încălzirii climatice globale are semnificaţii importante. Valul de căldură a afectat în mod deosebit Ungaria, Italia, Grecia, România, R. Moldova şi Ucraina. Consecinţele acestei evoluţii au fost resimţite în toate domeniile. Lucrarea este utilă specialiştilor în domeniul climatologiei, meteorologiei doctoranzilor, mesteranzilor, studenţilor şi tuturor celor interesaţi de problemele climatologiei**.**
Cuvinte cheie: val de căldură, temperaturi maxime absolute, caniculă, cod roşu.

1.Introduction

Geographical features of Oltenia. Oltenia is located in the southwestern part of Romania, within the large Carpathian-Balkan depression, which is somehow closed by these mountains in the western part, but largely opened eastwards. Crossed by the parallel of 45° N. lat. and the meridian of 24° E long., the region stands in front of different air masses; the Carpathian-Balkan mountain chain, through its interaction with air circulation, plays an important role for the climate pattern within this part of Romania, the surface of which is 29,224 sq km representing 12.2% of the total surface of the country (Apostol & al., 1969). It is both exposed to the advection of polar continental and arctic air coming from north and northeast during the cold season and to warm dry, warm humid maritime tropical and to humid maritime polar air masses during the warm season. Oltenia is one of the country regions where sub-Mediterranean influences are quite pregnant and they overlap continental climatic influences. Consequently, summers are hot, with frequent dryness and drought phenomena; autumns are long and there occurs the second annual precipitation maximum, while winters are warm, due to the waves of tropical air that thaw the snow cover and generate floods, speeding up spring arrival.

The climatic system is subject to a non-periodical variability. Thus, there occurred numerous positive and negative deviations when the southern territories of Romania were covered by cold polar or arctic air, which determined freezing winters, temperature inversions, and minimum values of less than -25°C (e.g. 1941-1942, 1953-1954 etc. winters). The penetration of tropical maritime or continental air led to warm winters with temperatures of 10-20°C, thin snow cover or absence of snow (e.g. 1920-1921, 1935-1936, 1947-1948, 1990-1991, 2000-2001 etc. winters) or to extremely hot summers with exceptional maximum temperatures lasting for long periods, which were also absolute maximum monthly values for certain meteorological stations or even for the entire country (e.g. the summers of 1916, 1936, 1946, 1951, 1952, 1994, 2000 etc.).

In the last period, on the background of global warming, we witness an increase of the frequency of these warm summers, with frequent exceeding of the absolute maximum temperatures, which confirms

[1] *MPP1 CMR Oltenia*

a rapid evolution of the climate general warming (Bogdan, Octavia, Niculescu, Elena (1999), Bogdan, Marinică, Ion (2006, 2007, 2008), Octavia, Marinică Ion (2007, 2008).

The summer of 2007 represents such a special case. It came after the Mediterranean winter from 2006-2007, which was warm within the entire country. The summer of 2007 started with an excessively hot June, especially in the last decade, when a strong heat wave affected the entire country, but particularly its southern regions. The warm weather was accompanied by a strong complex drought (atmospheric and pedological), which badly damaged firstly the wheat crops (60%) at the level of the entire country and then, in the second part of June, maize, sunflower, bean crops etc. were also affected, as well as meadow vegetation; it led to the dry up of wells and had severe economic effects. Then, the drought and canicular days from July 2007 worsened the destructive effects and led to the rapid dry up of maize crops, hayfields, and meadow vegetation etc.

2. Study methodology and data source

In order to establish the features of this heat wave, we performed a synoptic analysis and compared this wave with other heat waves registered in July. We used hourly synoptic observations from the Romanian meteorological stations, statistical analysis of long data chains that contain the results of the observations and data processing for more than 120 years from the data archives of the Regional Meteorological Center (R.M.C.) Oltenia and the National Administration of Meteorology (N. A. M.) Bucharest. We used the archives of synoptic maps of Wetterzentrale Meteorological Center (Germany) (www.wetterzentrale.de/), the results of the processing made in rapid flux by RMC Oltenia, as well as the results of mathematical and physical models for weather forecast.

3.Results

During the analyzed interval, weather warming process in Europe and especially in its southern part started on the 15th of July, when the heat wave, of moderate intensity (22-24°C at the level of 850 hPa isobaric surface above Germany and Austria, fig. no 1 and 35…37°C at 2 m level). From the very beginning, this heat wave drew forecast meteorologists' attention due to the presence of an extremely hot air nucleus, cT (tropical continental), with temperature values of 30°C at the level of 850 hPa isobaric surface. This air mass came from northern Africa, crossing Tunis Cape and the Mediterranean Sea quite rapidly up, to the proximity of Sardinia and Corsica Islands.

The synoptic situation was favorable for the extension of this heat wave over our country, as well.

3.1 The analysis of the synoptic situation from the 15th of July 2007, 00 UTC.

At the surface level. It can be noticed that there were many main baric centres above Europe. The Iceland Depression was a vast field, which emphasized two cyclonic centres, one located above the Atlantic Ocean, southwest of the Great Britain (fig. no. 3), with a central pressure of 1005 hPa and the second one centred on the Scandinavian Peninsula, of 1005 hPa.

The Azores Anticyclone was united with the North-African one and this vast anticyclone field, dominated most of Europe (more than 2/3 of the southern part of the continent). A secondary center developed within it and reached 1020 hPa, covering the north of Italy, the Former Yugoslavia, Romania and the Balkan Peninsula. It is worth mentioning that this type of synoptic situation characterizes the positive phase of the North-Atlantic Oscillation, phase that persisted almost the entire winter, in spring and summer.

The subsequent evolution confirmed these forecasts. Temperature increase occurred slowly from one day to another, but in the last three days (22, 23, 24) it accelerated and, thus, on the 24th of July 2007, canicular days reached their maximum in our country (fig. no. 1 and 2).

At the surface level

At this hour, it can be noticed the presence of a weak depression field above the Balkan Peninsula, less than 1010 hPa, which triggers air weak southern circulation (reduced wind velocity) in the air layer located in the proximity of the soil. Thus, it favoured the penetration of the extremely hot air mass from the Balkan Peninsula toward our country (fig. no. 4).

3.2. The analysis of the synoptic situation on the 24th of July 2007, 00 UTC.

At the level of the 500 hPa isobaric surface, one may notice that air circulation is tropical continental (cT) and, in northern Africa, there appears a nucleus of high geopotential, its central values exceeding 590 damgp. The field of relative topography 500/1000 emphasizes warm air penetration in the lower troposphere but at great distance, north of our country (fig. no. 4).

The thermal field at the level of 850 hPa isobaric surface displays the 24°C isotherm located in the south of our country (Oltenia), while the 25°C isotherm is south of the Danube (fig. no. 5). This means that extremely hot air continues to penetrate toward southwestern Romania.

On the 24th of July 2007, the penetration of extremely hot air above Romania continued. Thus, the phase of maximum temperature increase at the

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2 m standard level and at the soil surface occurred between 4 p.m. and 6 p.m. RSH (RSH = Romanian summer hour), when there were registered the maximum thermal values for this date in our country, many of them becoming absolute thermal maximum values for July (fig. no. 2).

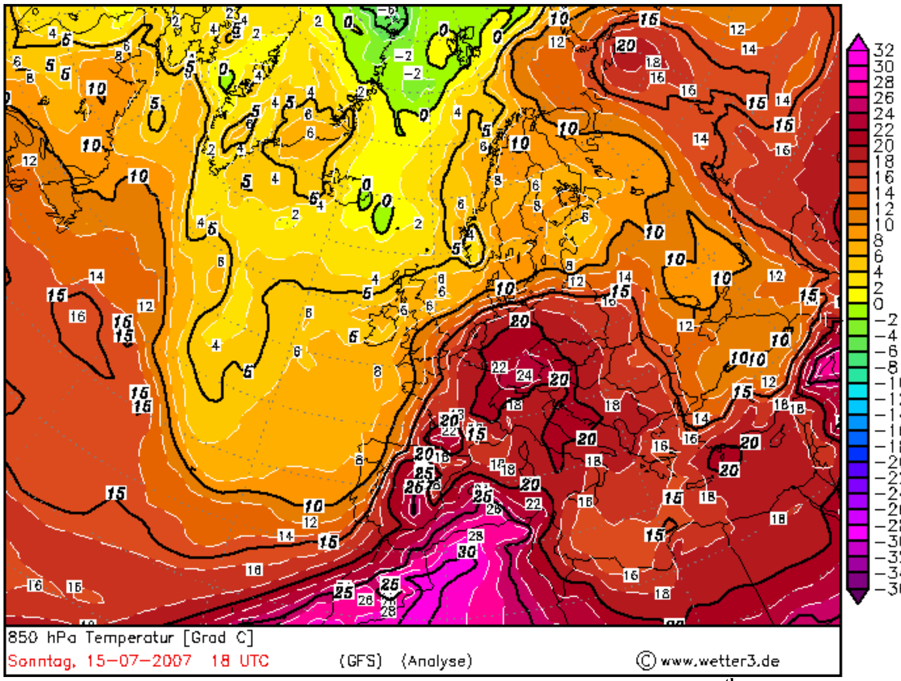

Fig. 1 Thermal field at the level of the 850 hPa isobaric surface on the 15th of July 2007, 18 UTC, at the initial stage of the heat wave (after Karten Archiv)

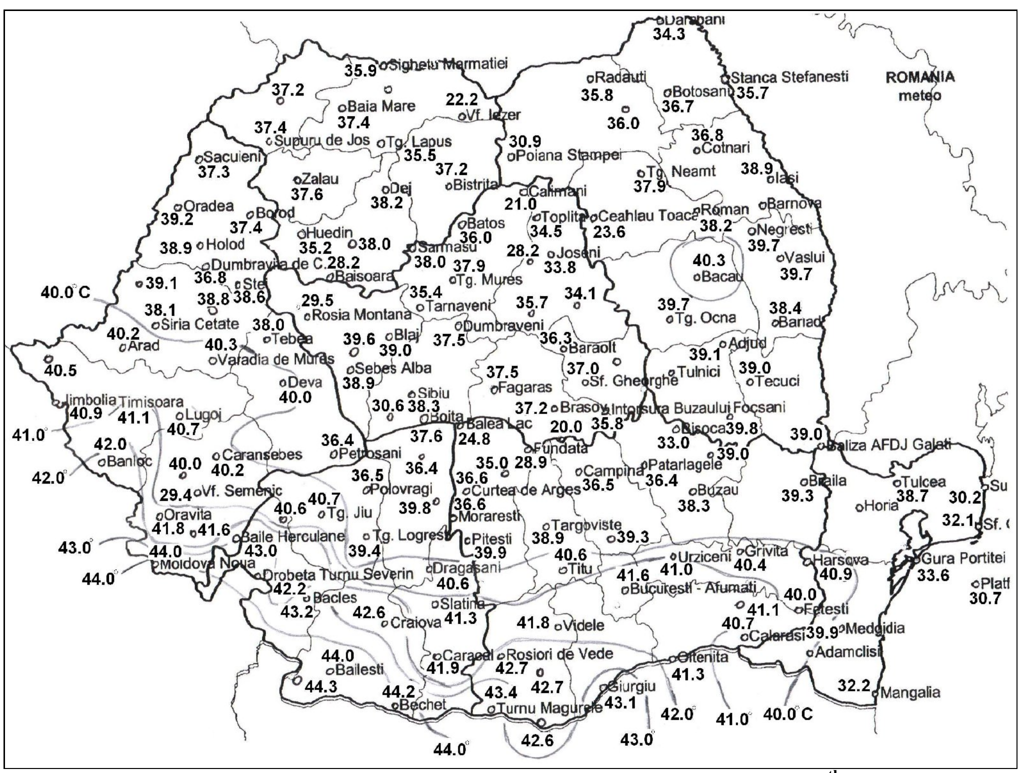

Fig. 2. Air temperature maximum values registered in Romania on the 24th of July 2007 (Source: processed data from the Archives of M.R.C. Oltenia)

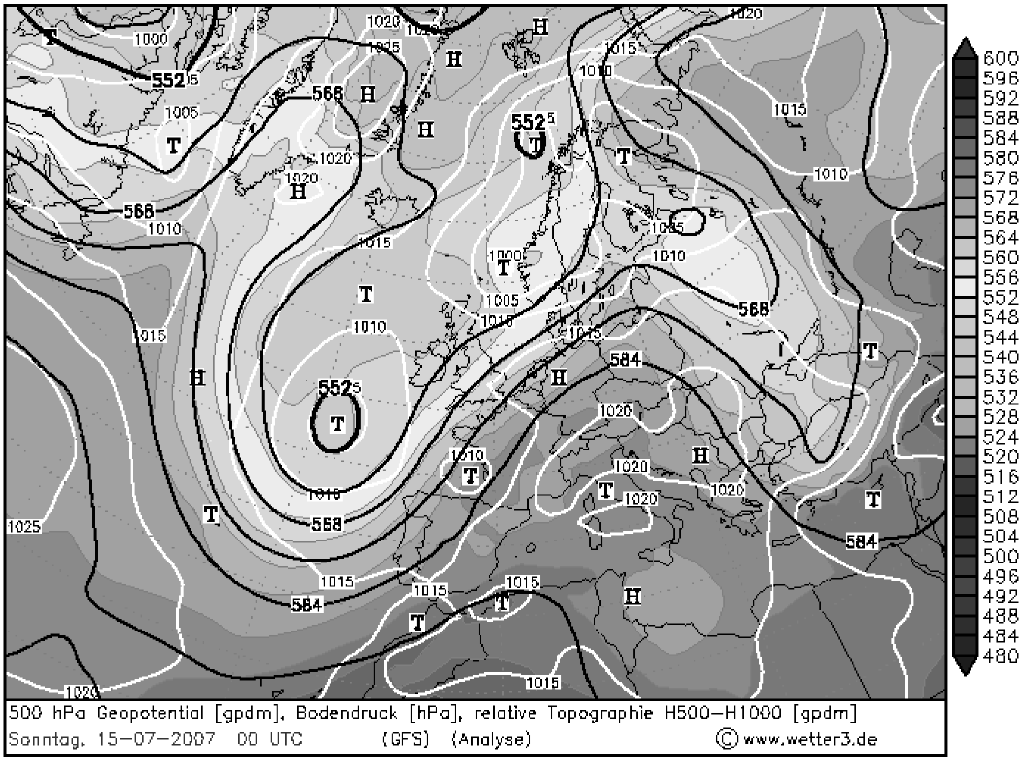

Fig. 3 Surface synoptic situation, geopotential field at the level of 500 hPa isobaric surface and relative topography TR 500/1000 hPa, on the 15th of July 2007, 18 UTC (after Karten Archives)

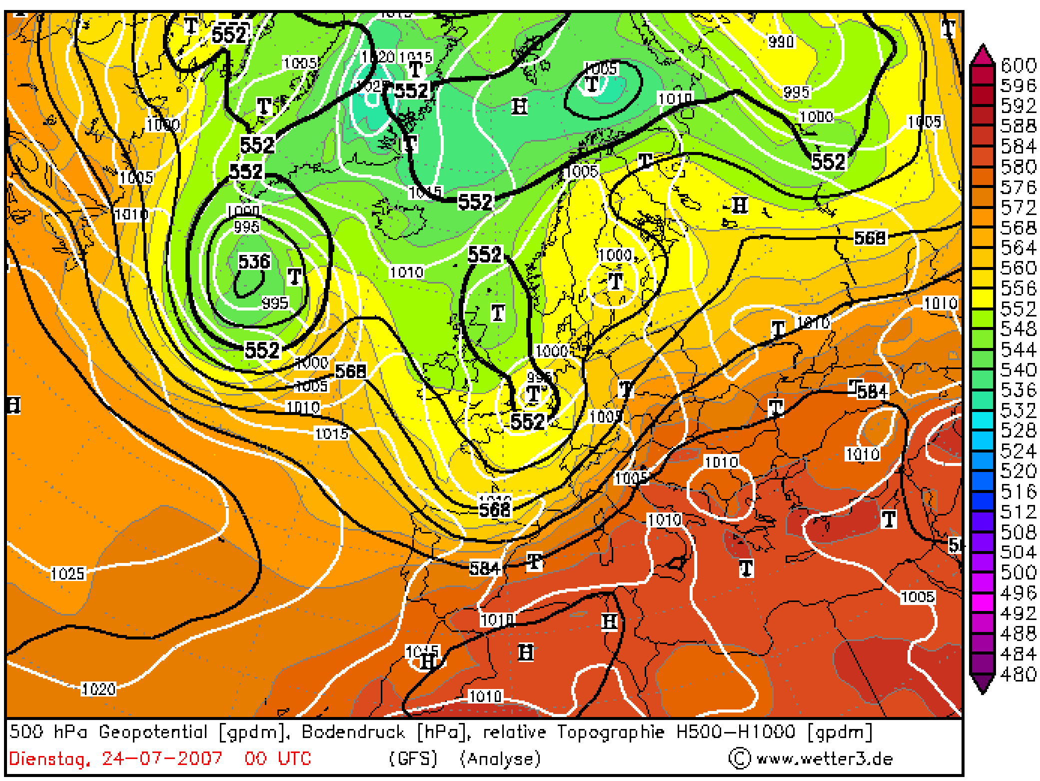

Fig. 4 Surface synoptic situation, geopotential field at the level of 500 hPa isobaric surface and relative topography TR 500/1000 hPa, on the 24th of July 2007, 18 UTC, at the beginning of the maximum phase of the heat wave (after Karten Archives)

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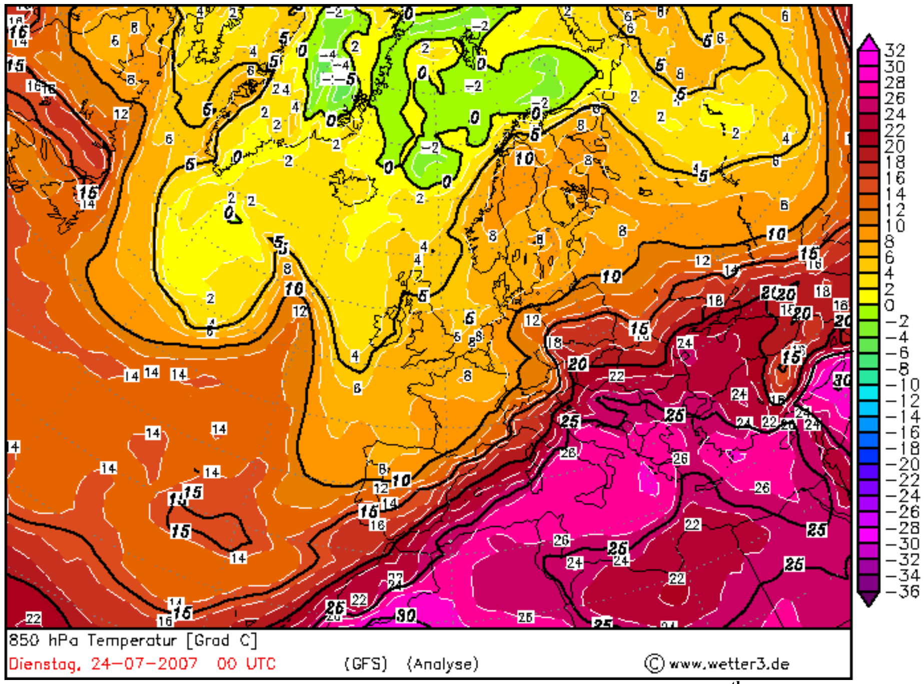

Fig. 5 Thermal field al the level of the 850 hPa isobaric surface on the 24th of July 2007, 00 UTC, at the beginning of the maximum phase of the heat wave (after Karten Archives)

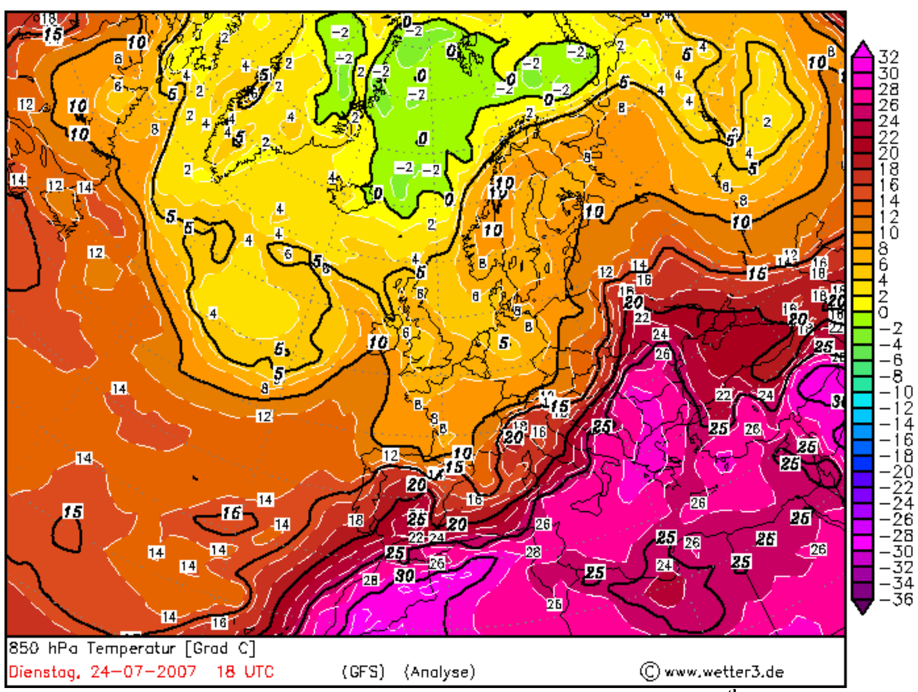

Fig. 6 Thermal field al the level of the 850 hPa isobaric surface on the 24th of July 2007, 18 UTC, at the summit of the maximum phase of the heat wave (after Karten Archives)

The summit of the maximum phase of hot air penetration above Romania was reached at 18 UTC (9 p.m. RSH), when the 30°C isohypse was placed above the southwestern part of the country at the level of 850 hPa (about 1,520 m according to the geopotential map for the 850 hPa level, fig. no. 6).

In the entire history of the systematic meteorological observation in Europe, there has never been registered such a situation (with values of the thermal field of more than 30°C at 850 hPa, in the south of Romania).

As the cold front advanced from the west of Europe toward our country, there developed a strong warm air advection in front of it (fig. no. 7). We mention that the maximum phase of the warming processes usually occur 12 hours before the penetration of the cold front and the displacement of the warm air due to this dynamic process.

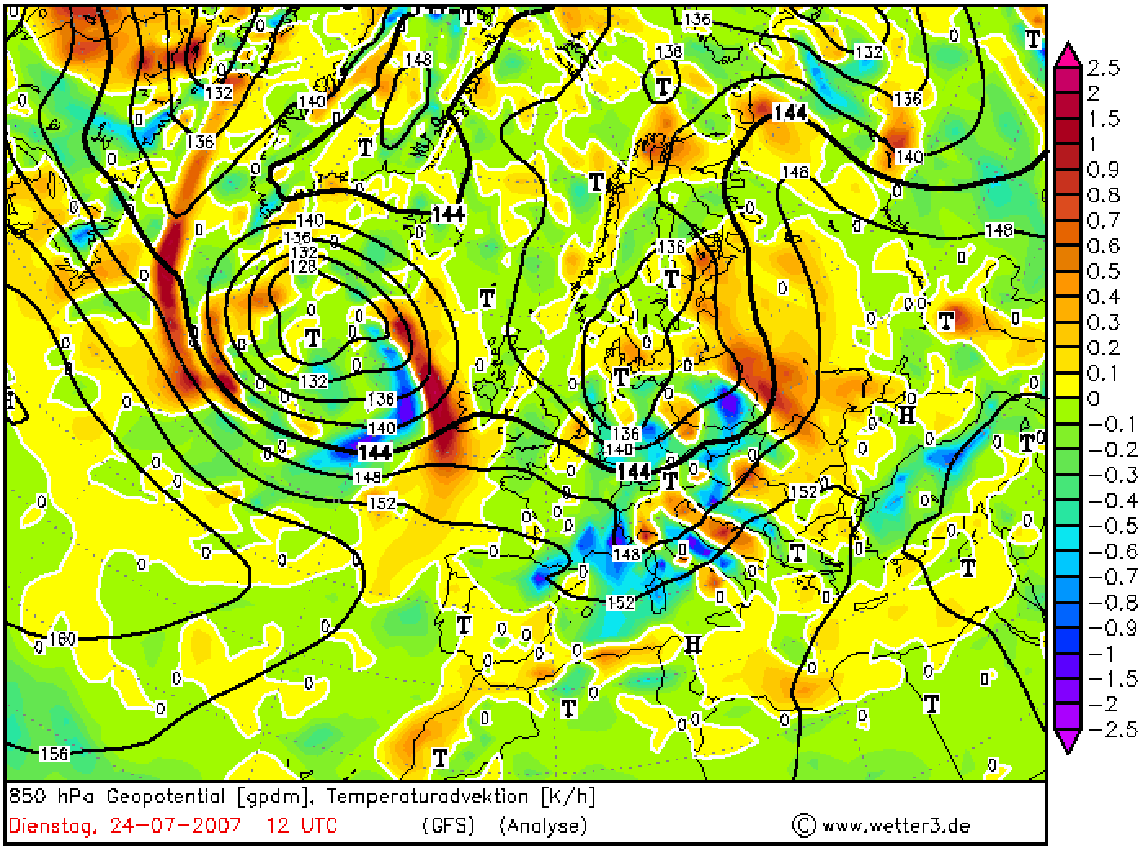

Fig. 7 Geopotential Field at the level of the 850 hPa isobaric surface and temperature advection (in Kelvin degrees/hour), on the 24th of July 2007, 12 UTC, at the summit of the maximum phase of the heat wave (after Karten Archives)

An important increase of the air temperature may also be a consequence of the compression thermo-adiabatic process induced by the force exerted by the cold front upon the obstacle, in this case the extremely hot air. The displacement of warm air usually occurs during night, when the rapid advancement of the cold front is possible as temperature drops.

The cooling occurred on the 24th/ 25th of July 2007, at night, and it was significant (10-15°C lower than the maximum values registered the previous day). However, from the meteorological point of view, weather was still warm, the temperature maximum values locally exceeding 35°C, even the next day. In the southeast of the country, the temperature minimum values registered in the morning, on the 25th of July 2007, were extremely high, due to the easternward movement of the altitude warm air nucleus on the one hand, and, on the other, to the fact that warm air advection in front of the cold front maintained and even intensified during night.

Among the thermal minimum values of more than 25°C, registered in the morning, on the 25th of July 2007, we mention: 25.4°C at Bucureşti Filaret, 25.1°C at Slobozia, 25.2 at Turnu Măgurele, 25.5°C at Olteniţa, 26.2 at Giurgiu and Alexandria, 26.7°C at Feteşti, 27.0°C at Zimnicea, and 27.1°C at Călăraşi.

The values of the thermal comfort temperature humidity index (THI) reached and exceeded the critical threshold 80 in the entire country, even in the mountainous area (fig. no. 8). In Oltenia, at Calafat, on the 24th of July 2007, in only ten minutes, from 4^{10} p.m. RSH and 4^{20} p.m. RSH, air temperature increased from 43.6°C to 44.3°C (0.7°C in ten minutes), which emphasizes both the intensity of the warm air advection and the rapidity of air temperature increase

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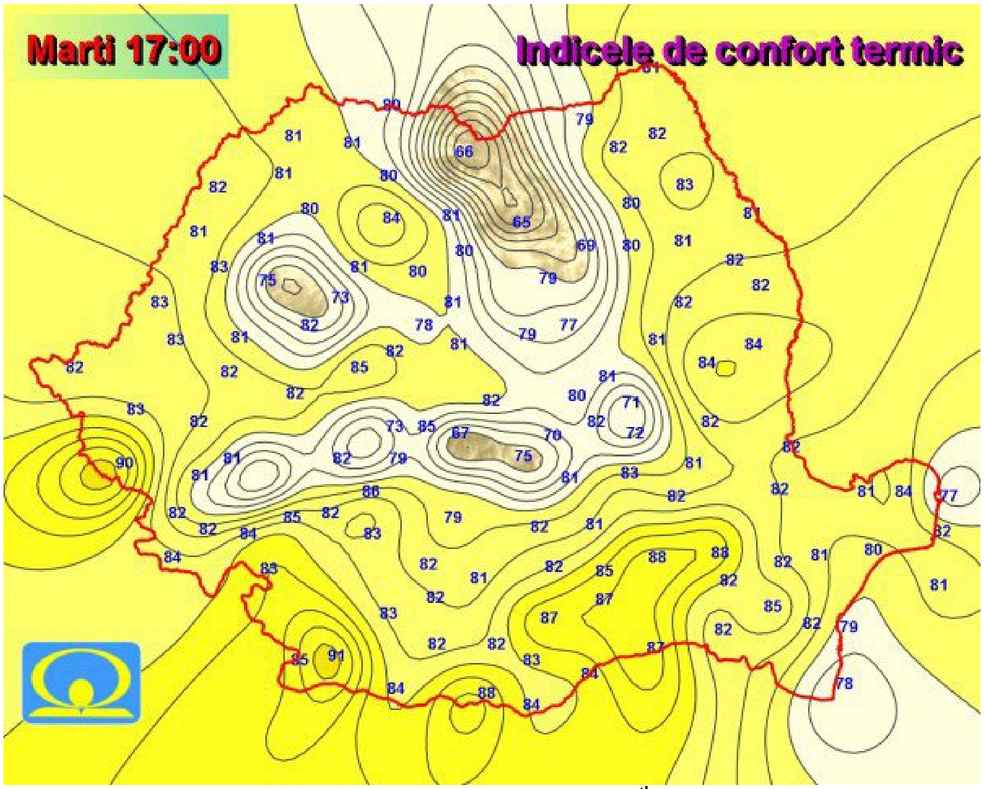

Fig. 8 Values of the thermal comfort index THI, on the 24th of July 2007, at 5 p.m. RSH, at the summit of the maximum phase of the heat wave. (after NAM)

4. Discussions

The heat wave registered between the 15th and the 24th of July 2007 was the most intense for this month for the entire period of meteorological observations. The maximum thermal value of July was exceeded with 0.7°C (at Calafat, there were 44.3°C on the 24th of July 2007, value that presently represents the absolute thermal maximum of July for Romania – the former absolute maximum value was 43.5°C, registered at Giurgiu on the 5th of July 2000). The former maximum value of July, registered in the last century, at Alexandria, on the 5th of July 1916, had reached 42.9°C, but it was exceeded with 0.6°C, 84 years later, on the above mentioned date. Thus, up to that date, we notice a slow evolution of the absolute maximum values in July, but, then, in seven years, there occurred a spectacular 0.7°C increase.

The evolution of the temperature maximum values in July

The next graphic (fig. no. 9) renders the evolution of the maximum temperatures registered in July:

-the 5th of July 1916, 42.9°C at Alexandria in Teleorman County, located in the proximity of Oltenia; this value represented the absolute thermal maximum of July for 84 years.

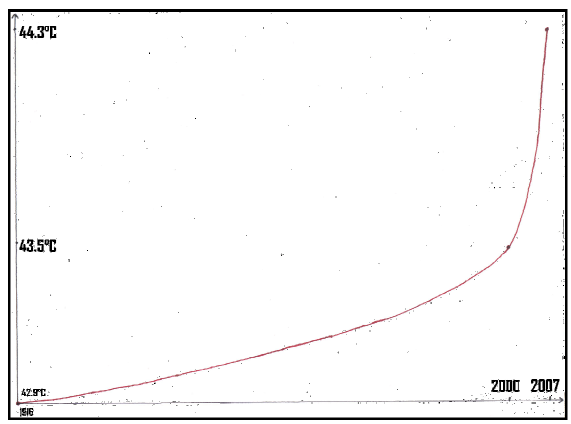

Fig. 9 Variance of the temperature absolute maximum values in July starting with 1916. (Source: processed data from the N. A.M. Archives)

-the 5th of July 2000, 43.5°C at Giurgiu in Giurgiu County, near Oltenia; it became the absolute thermal maximum of July for 7 years.

-the 24th of July 2007, 44.3°C at Calafat in Dolj County, in Oltenia, the present absolute thermal maximum of July.

Consequently, one may notice the increase tendency: 1916-2000 a 0.6°C increase in 84 years, 2000-2000 a 0.8°C increase in just seven years (for this parameter there are only these three values). It results a rapid decrease reported to the time scale.

We notice that, in July 2007, air temperature reaches and exceeds the 44°C climatologic threshold for the first time. Values of 44°C and even higher have been registered only once in Romania since meteorological observations were performed. It is about the 10th of August 1951, when four meteorological stations registered 44°C or more (within the Bărăganul Brăilei Plain, at Măruntelul settlement, Ion Sion farm, 44.5°C, which is the absolute thermal maximum of Romania and 44.0°C at Amara-Slobozia and Valea Argovei). In July 2007, 44°C or more were registered at the following meteorological stations – Băileşti and Moldova Veche 44.0°C, Bechet 44.2°C, and Calafat 44.3°C, which signify that the area affected by extremely hot air is much larger as compared to the previous century (fig. no. 2).

This intense and persistent heat wave affected Hungary, Italy, Greece, Romania, the Republic of Moldova, Turkey and Ukraine, and, on the 27th of July 2007, forest fires provoked by canicular days[1] covered extended surfaces and mass-media appreciated that the south and the east of Europe were "in flames" (news on the 27th of July 2007).

Consequences. *The drought registered in the summer of 2007 provoked crops and vegetation damage in many counties of the country, especially in the south and east, unbalancing life, causing animals' death and drying up wells and streams etc.*

Consequently, thermal maximum values exceeded the climatologic threshold of 44°C in the southwest of the country.

In Romania, 12 deaths were registered only on the 24th of July 2007, a total of 19 people being declared dead during the entire hot interval (July 16-24, 2007). The press indicated a number of 33 dead people till the 30th of July, as canicular afternoons continued till the 29th of July (on the 28th and the 29th, air temperature reached maximum values of 39°C in Oltenia, locally, in the southern half of the region). In the night of July 29/30, 2007, weather cooling in Romania was significant, and thermally speaking, it came back to normal.

This extremely intense heat wave strengthened drought in our country. Vegetation dried up on large surfaces, crops were badly damaged, and forest fires started, an average of 170-175 fires per day. Electric power consumption at national level was twice greater than normally and, due to the fact the grid was overloaded, there occurred frequent power breaks.

In Romania, for the first time, it was released the ***red code warning*** for canicular days. Consequently, a series of ***measures considered adequate for population's protection*** were taken:

- setting up first aid points in the streets of the cities.
- setting up certain teams able to help people at need – for example, shopping first necessity products, such as mineral water, bread etc.

There were also some measures we consider inadequate or even contraindicated:

- closing certain public institutions;
- stopping public transport in some cities;
- sending community police in markets to force merchants to close their sale points etc.

This heat wave caused serious problems to population and biosphere, generally, not only in Oltenia. Extremely severe forest and vegetation fires burst in Southern Europe, mainly in Greece, Italy, Bulgaria, and Spain (especially on the Canary Islands). In Greece, the forest from the proximity of Athens, considered the only green "lung" of this city completely burnt. Tourists were jeopardized by these fires, and there were registered some casualties.

We mention that Greece registered temperatures of 45°C; on the 24th of July 2007, at Veliko Târnovo in Bulgaria, there were registered 44.5°C.

We also mention that severe floods occurred in China during the same period; large surfaces were affected and 700 people died.

Causes triggering these climatic changes are:

- *natural causes*, mainly related to the increase of solar radiation intensity and other cosmic causes. We mention that the forecasts of the research team of ***Cosmic Research Center Colorado***, led by Douglas Beseker, estimate that solar activity will reach a maximum by the end of 2011 and the middle of 2012.

This continuous increase of solar activity will have as consequence the development of a maximum number of solar spots. The average will be 90…140 new solar spots higher than before, which means the increase of solar radiation intensity with important consequences for global warming phenomenon. We expect the thermal equator of the planet to extend in latitude and, thus, intensely heated areas will become vaster. There would occur *strong magnetic storms* that cause damages to electromagnetic equipments on the Earth. Presently, the solar activity forecast is required by many companies interested in protecting their electronic equipments.

[1] The term of ***canicular days*** characterizes those weather situations when air temperature, measured in standard conditions at the meteorological stations, reaches or exceeds the 35°C threshold (***dog days weather***).

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We exemplify through the position of the thermal equator of the planet, above the western hemisphere, at the level of 850 hPa, on the 24th of July 2007, 00 UTC (fig. no. 10). In this figure, we may notice the large northward extension of the thermal equator, marked by two strong "lobes", one starting from Northern Africa toward our country. It represented the heat wave that affected Europe and Western Turkey. The other lobe started from the Arabian Peninsula toward Eastern Turkey.

Causes are linked to the North-Atlantic Oscillation (NAO), as well.

- during the positive phase of the North-Atlantic Oscillation, the increase of the number of days with insignificant precipitation (0-5 l/sq m) and the drastic decrease of the days with significant precipitation or even their total lack during drought periods;
- during the negative phase of the North-Atlantic Oscillation, the increase of rain showers' frequency, leading to catastrophic floods.

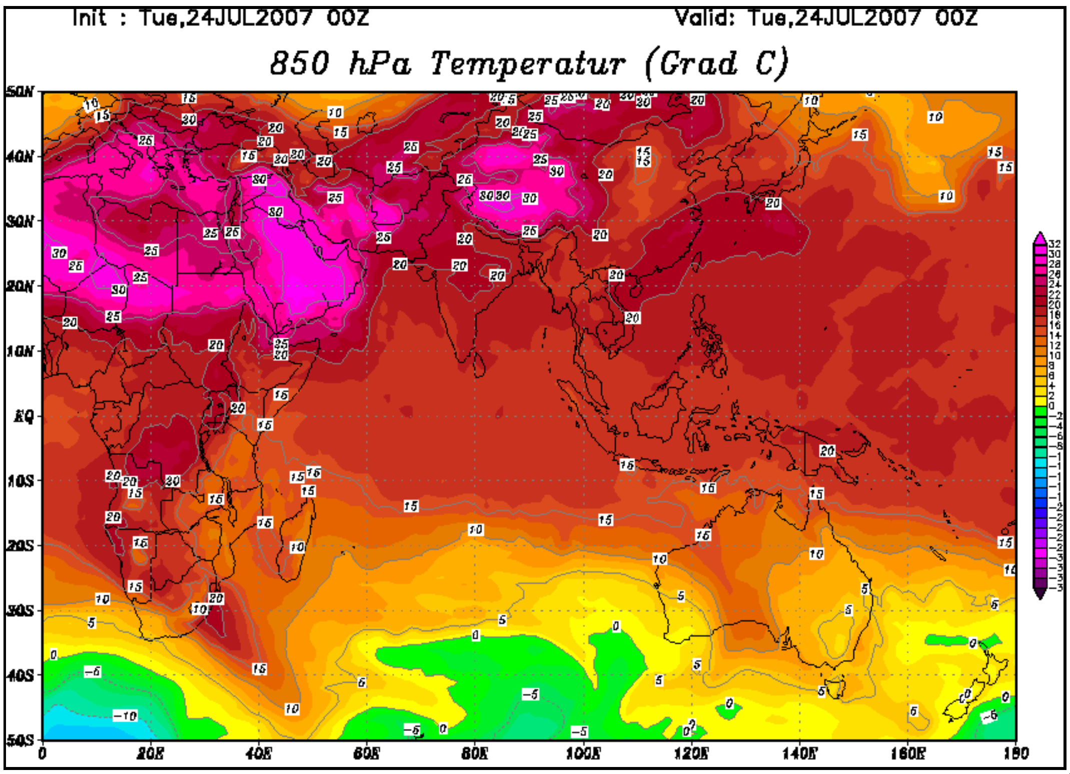

Fig. 10 Thermal field at the level of the 850 hPa isobaric surface above the eastern hemisphere on the 24th of July 2007, 00 UTC, at the start of the maximum phase of the heat wave.
This marks the position of the thermal equator of the planet (the area with more than 25°C temperatures) at this moment (after Karten Archives).

Such an evolution may bring, in a short period, to the extension of the transition climate from the temperate continental toward the Mediterranean climate with exceptional consequences for the biosphere.

- *anthropogenic causes* induced by pollution of the atmosphere with greenhouse gases, of the environment and, mainly, of the terrestrial surface with different substances; we also mention massive clearings, different works that modified the albedo of the terrestrial surface increasing the absorbed heat amount and the transfer to the atmosphere, which, in its turn, modified atmospheric and oceanic circulation.
- *local causes that locally amplify warming phenomena: for Oltenia,* an important part is played by the interaction of air circulation, at mesoscale, with local landforms and the relief of the Balkan Peninsula. The penetration of warm air within Oltenia is achieved along two corridors: one for the warm air coming from the west of the continent – The Danube, and the second for extremely hot Mediterranean air coming from the south or southwest, on the Timok Valley. The second corridor displays an important role in highlighting the peculiarities of the climate, especially in the area of Bechet- Calafat-Cujmir-Vânju Mare- Dr. Tr. Severin – Halânga, which is

emphasized by the above-mentioned maps and whenever warming occurs in this part of the country.

5. Conclusions

The present study has a general and practical importance as we emphasize the occurrence of an exceptional heat wave, of a climatic record for these phenomena, which is confirmed by the site of the NMA Bucharest that describes the situation as it follows:

In Romania, in July, there have been registered 220 cases when the maximum temperature was equal or higher than 40^{0}C since meteorological measurements of air temperature were performed in standard conditions (namely in the meteorological shelter, 2 m above the ground surface). These values were registered in the south and southeast of the country, especially after 1985. The most frequent situations were signaled at Turnu Măgurele (16 times), Roşiori de Vede (14), Giurgiu (13), Bechet and Zimnicea (10), Călăraşi (9), and Bucureşti-Filaret (8).

Also in July, the absolute maximum temperatures at the meteorological stations were mostly registered between the 4th and the 5th of July 2000 and they exceeded 42^{0}C. On the 5th of July 2000, at Giurgiu, there were registered 43.5^{0}C and this was the absolute maximum temperature of July for the entire country till 2007. *On the 24th of July* 2007, this record was exceeded at Calafat, *where temperature reached 44.3^{0}C. On the same day, temperatures above 44^{0}C were also registered at Bechet (44.2^{0}C), Moldova Nouă* (at Moldova Veche also 44.0^{0}C) *and Băileşti (44.0^{0}C).*

From the analysis of the data of nine meteorological stations with data chains of more than 100 years and considered representative for the Romanian territory, it was noticed that the duration of the interval with tropical days (daily maximum temperature higher or equal to 30^{0}C) in July was of 24 days in 1904 at Drobeta-Turnu Severin. Great periods were also registered in 2002 at other stations located in the south of the country – 22 days at Bucureşti-Filaret, 19 days at Călăraşi, and 12 days at Constanţa.

These results confirm one of the conclusions of the 4th Report of IPCC, according to which it clearly appears an increase of the frequency and intensity of extreme weather phenomena as a consequence of the intensification of climate global warming phenomenon (according to the data posted on the site of the NAM, *inmh.ro,* in July 2007).

This heat wave as well as other meteorological risk phenomena studied by the author confirms significant climatic changes that also represent ***indicators of climatic change at regional level***. We mention for Oltenia:

- increase of the frequency and intensity of heat waves in the warm semester from 2… 3 per decade to 5…6 or even more; for June, the present tendency is that of ten times increasing frequency as compared to the last century;
- increase of the duration of canicular days from several days to 2…3 weeks or even more;
- increase of the number of summer days, tropical days, and tropical nights;
- extremely early occurrence of intense heat waves in the southwest of the country (Oltenia), starting with the first decade of April, which gives us the impression that spring disappeared and summers suddenly start;
- higher frequency of warm winters, from 1…2 per decade to 2…4 or even more, with a tendency of increase; some winters displayed a Mediterranean character in the south of the country, especially in Oltenia (for example 2006-2007);
- lower frequency of winter climatic phenomena or even their total lack;
- higher frequency and duration of droughts, as well as an extension of the surfaces affected by them;
- intensification of aridization phenomena and processes in the south of Oltenia, as a direct consequence of the above-mentioned phenomena;
- diminution of the intensity and frequency of cold waves in winter, or even their absence;
- excessively hot and dry summers.
- earlier arrival of spring, more frequent longer and warmer autumns;
- ***Oltenia is among the most affected regions in Romania***, climatic changes having a strong impact here.

All these led to the occurrence of important meteorological-climatic risk phenomena, which determined important material damage and casualties. They affected population and economy and consequently, poverty tendency, especially within rural areas, increased.

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DRAINAGE EVOLUTION DETERMINED BY THE DYNAMICS OF FOREST AREAS WITHIN THE MOTRU HYDROGRAPHIC BASIN

Oana IONUŞ[1]

Abstract. The paper presents the evolution of drainage within the Motru hydrographic basin over the last 20 years, outlining the influence of the modifications occurred within the forested areas. The different degree of foresting in space (within the three sectors: mountainous, Subcarpathian and piedmont) and time (over the last 20 years) has major consequences over the regime of the water resources.
Therefore, the main role comes directly to the azonal factor, which has a regularizing and compensatory role for the water resources, and indirectly to the human factor, more and more obvious, which leads to the withdrawal of forest areas.
Key words: specific average drainage, forest area, maximum flow, minimum flow, hydrographic basin

Rezumat. Evoluţia scurgerii determinată de dinamica suprafeţelor forestiere în bazinul hidrografic Motru. Lucrarea prezintă evoluţia scurgerii, din ultimii 20 de ani, în bazinul hidrografic Motru, cu accent pe influenţa modificărilor înregistrate în arealele împădurite. Gradul diferit de împădurire atât spaţial (pe cele trei sectoare: montan, subcarpatic şi piemontan), cât şi temporal (în ultimii 20 ani) are consecinţe majore asupra regimului scurgerii şi a resurselor de apă. Astfel, rolul primordial revine în mod direct factorului azonal care are rol de regularizator şi compensator al rezervelor de apă, şi indirect, factorului antropic, din ce în ce mai pregnant, ce conduce la influenţa restrângerii suprafeţelor forestiere.
Cuvinte cheie: scurgere medie specifică, suprafaţă forestieră, debit maxim, debit minim, bazin hidrografic

Introduction

The Motru river forms its biggest sub-catchment area within the Jiu hydrographic basin, covering an area of 1,895 sqkm. The Motru hydrographic basin unfolds on several geomorphologic units:

- The mountain sector – where the course of the Motru river and its tributaries drain the western slopes of the Valcan mountains and the eastern slopes of the Mehedinţi Plateau and Mehedinţi Mountains;
- the Subcarpathian sector begins at the Apa Neagra-Glogova couloir, cutting through the western extremity of the Getic Subcarpathians and the high hills of the Getic Piedmont, up to the confluence with the Coşuştea river;
- the piedmont sector is located downstream of the confluence with the Coşuştea, the lower course of the Motru river drains the western limit of the Getic Piedmont, known as the Motru Piedmont.

Within its hydrographic basin, the Motru river receives 13 tributaries on the right side (the Scarisoara, Motrul Sec, Brebina, Crainici, Pesteana, Gardoaia, Lupsa, Cosustea, Jirov, Cotoroia, Husnita, Slatinic and Talapan) and 3 tributaries on the right side (the Lupoaia, Plostina and Stangaceaua). The hydrometric activity (measurements and registrations) is developed at the level of 4 hydrometric stations on the main course and at 8 stations on the tributaries.

The vertical zonation of the basin on a difference level of approximate 1,700 m (1800 m at the spring level, the Orlea massive, and 102 m at the confluence with the Jiu river) makes the variety of geomorphologic units to leave their print upon the characteristics of the surface water drainage. Mainly, the relief vertical zonation causes the vegetation vertical zonation (in this case, the basin surfaces ranging between 700 m – 1,200 m altitude and covered with decidous forests: beech, hornbeam, holm and oak have the greatest share) at the level of which the main role comes to the forest surfaces, because they have a higher value of the hydrological protection index compared to the other types of land use. At the same time, the forest represents "a factor of equilibrium" for the "surface drainages, which are lower for the lands covered with forests, compared to the uncovered lands" (Arghiliade C., 1977, p.176).

This phenomenon is also demonstrated by the fact that "the importance of investigating hydraulic

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properties of trees is highlighted by recent studies showing that they may play a role in ecological strategies of species and that they can underlie the response to environmental changes." (Cruiziat, P. et all., 2002, p. 390).

Data and methods

The analysis of the forest surfaces at the level of the basin is based on the cartographic support of the topographical map 1:50000 (the edition from 1989) and the land use map (Corine Land Cover, 2006). The forest representations dynamics on these documents reflect the modifications of the values of the hydrological parameters characteristic for the drainage (registered at all 7 hydrometric stations taken into consideration), respectively the annual maximum flow and the specific average flow.

Table 1

Characteristic hydrometrical stations from the Motru hydrographic basin

River	Hydrometric station	Altitude (m)	Surface (km^2)
Motru	Cloşani	1019	109
Motru	Târmigani	751	304
Motru	Broşteni	526	646
Motru	Faţa Motrului	384	1740
Brebina	Tarniţa	529	77
Coşuştea	Corcova	482	420
Huşniţa	Strehaia	257	310

Source: Atlasul Cadasrului Apelor din România, 1992

Comparing the percentages of forest surfaces from the total surface of the Motru hydrographic basin, the afforestation coefficient, respectively, based on the digitization of the corresponding polygons in GIS environment, permitted a better understanding of the restructuration of the afforested surfaces and also led to the real emphasis of the impact which this phenomenon has upon the surface drainage.

Therefore, the analysis of the hydrological data series for the 1989-2008 interval, at all the 7 hydrometric stations, was based on bibliographic references (authors from the domain of hydrology), on the processing of raw data from the Atlas of Water in Romania and the ones taken from the hydrological yearbooks.

The visible influence of the reduction of forest surfaces upon the surface drainage is better felt at the level of maximum and minimum flows by the perturbation in their occurrence, depending on the development of phonological phases.

In respect to the above mentioned, the specific average flow (q = 1000 Qan /F) represents the hydrological parameter which better outlines the impact of the dynamics of the forest surfaces upon the surface drainage, more precise the influence of the forest upon the average flow.

Results and discussions

In order to determine the influence of the forest on the surface waters drainage within the Motru hydrographic basin, the analysis of the dynamics of the forest surfaces in space (on major steps of the relief, at the level of the main water course and implicitly at the level of the first order sub-basins) and in time (on a determined period, 1989-2006) was carried out.

Thus, the map representing the distribution of the vegetation in the Motru hydrographic basin in 1989 was achieved (Fig.1) using the topographical map 1:50000. Subsequently, based on the land use map (Corine Land Cover, 2006), there were highlighted the surfaces of vegetation on categories of use: vineyards, orchards, secondary pastures, agricultural-forest lands, deciduous forests, coniferous forests, mixed forests, natural grasslands, subalpine vegetation and transition areas with shrubs (Fig.2).

Comparing the two categories of maps, we notice the reduction of the forest surfaces in the hydrographic basins afferent to the Crainici and Coşuştea rivers, as direct tributaries, on the right side of the Motru river.

Therefore, if we take into consideration only the areas covered with forests (deciduous forests, coniferous forests and mixed forests), it is obvious that they shrunk within the entire hydrographic basin of the Motru river, from 668.43 sqkm (The Atlas of Water Survey in Romania, 1992) to approximately 500 sqkm (Corine Land Cover, 2006, calculation of forest surfaces in GIS environment). Most of the reduced areas had been a direct effect of the Law no 18/1991 regarding the landed fund and rendering the forest into possession. As a result, nowadays, it is necessary to use the term of "ecological sylviculture" which consists in the "reduction of wood quantities exploited and in a longer cutting cycle, sometimes resulting a short term profits decrease for the wood industry" (Pătroescu, M., 2008, p.485).

The dynamics of the forest surfaces which consisted in the reduction with approximate 168.33 skm, at the level of the entire hydrographic basin has negative effects in the evolution of the surface drainage, a phenomenon exemplified by the analysis of the maximum flows and the specific average drainage for a period of 20 years (1992 - 2006) at the following hydrometric stations: Cloşani, Târmigani, Broşteni, Faţa Motrului (on the Motru river), Tarniţa (on the Brebina river),

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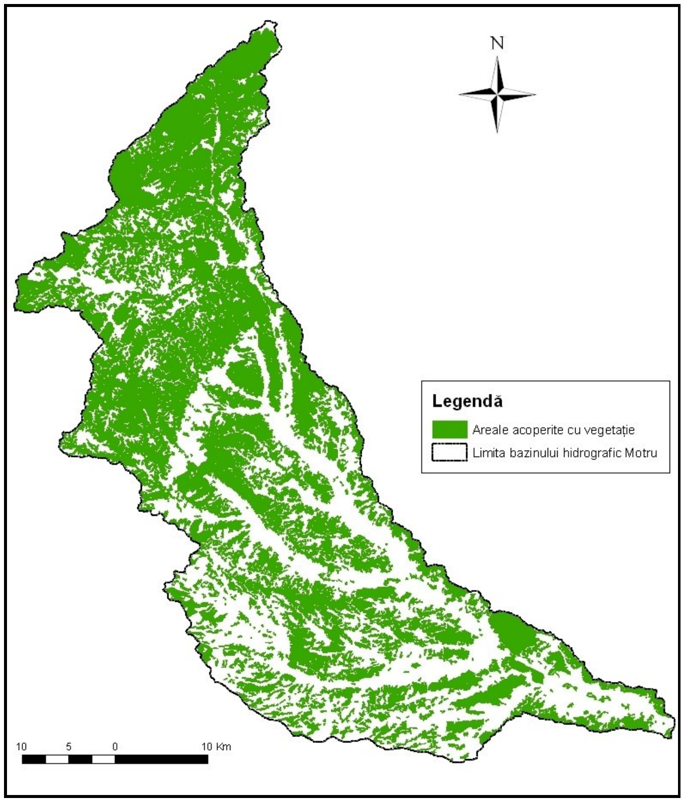

Fig. 1 The surfaces covered with vegetation from the Motru hydrographic basin (processed after the topographic map 1:50 000, 1989)

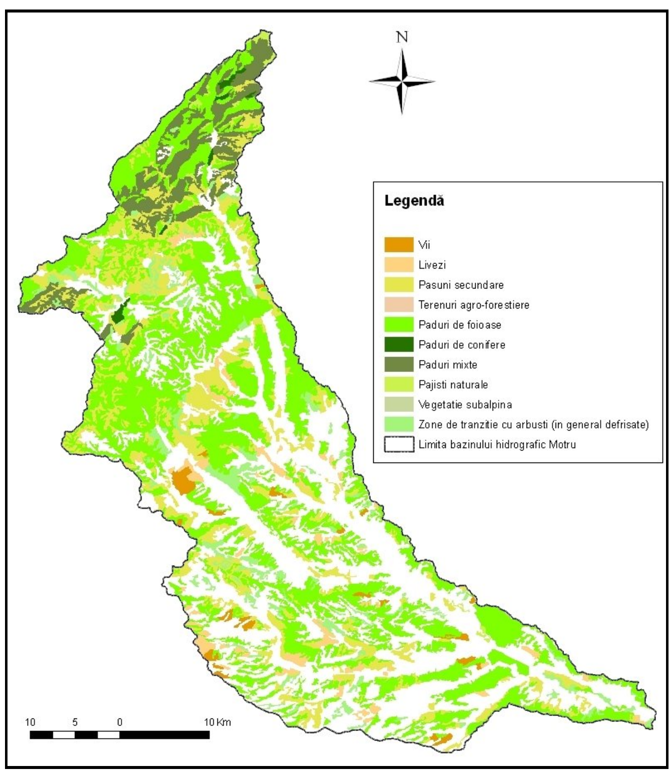

Fig. 2 The categories of surfaces covered with vegetation from the Motru hydrographic basin (processed after Corine Land Cover, 2006)

Corcova (on the Coşuştea river), Strehaia (on the Huşniţa river).

In this respect, the minimum drainage is highly reduced and takes place later, without determining the dewatering in the river bed corresponded to forested areas, respectively in the upper basin of the Motru river. At the level of the middle and lower basin, the reduction of the areas with forests determine the dewatering of the water resources in the lower river bed, especially at the level of the tributaries, a phenomenon which causes the "draining".

Based on the considerations from above, it is highly evidenced that the maximum drainage does not cause (in a forested area) events of sudden and rapid increase of the water level and respectively of the water flows (Fig.3).

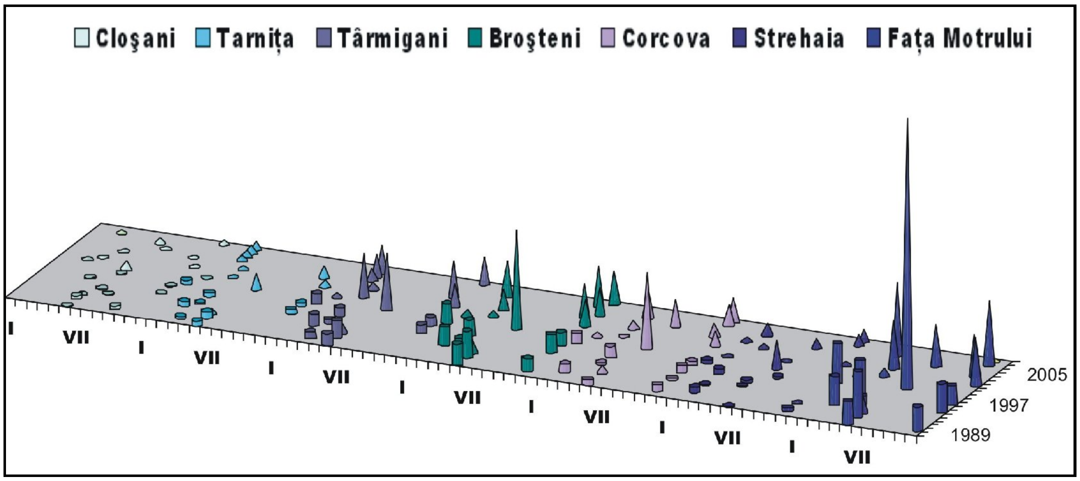

Fig. 3 The annual variation of the maximum flows at the hydrometric stations taken into consideration from the Motru hydrographic basin

At the Cloşani hydrometric station (on the Motru river), the maximum drainage, at the level of the period taken into consideration (1989 - 2008), represents values distributed almost uniformly from the seasonal point of view, this phenomenon being due to the fact that in high areas (over 1,000 m), where the coniferous and mixed forests are predominant, the influence of the forest is felt during the entire year. We mention the fact that, as the altitude drops, the influence of the forest is felt during the period when the values of the maximum flows occur.

On the hydrometrical stations from Târmigani (on the Motru river), Tarniţa (on the Brebina river), Broşteni (on the Motru river) and Corcova (on the Coşustea river) we noticed two distinct annual periods when maximum flows are registered, during winter and spring, and on the fact that from the altitudinal point of view, the respective stations, are located between 500 – 700 m altitude (from 751 m - Târmigani to 482 m - Corcova), actually in the deciduous forest zone where the snow melting and the spring rains are not obstructed by the trees without leaves compared to the coniferous forests zone.

It is obvious that "during the summer-autumn period when usually rain drops, the forest, depending on its characteristics (density, age), influences by retaining on the canopy a certain amount of precipitations, as well as by retaining on the litter a higher amount of water from the precipitations reaching the soil" (*Diaconu, C., p.60*).

It is worth mentioning that the respective hydrometric stations are located in the piedmont area, where the deciduous forests are predominant – the level of the beech and oak – and "their influence appears more important during their vegetation period by retaining during a certain amount of precipitations the vegetation period" (*Diaconu, C., p.61*).

After the leaves drop, the canopy of the deciduous forest "retain a very small quantity of precipitations, varying between 7.4%, at a consistency of 0,9-1, and 3.8%, at the consistency of 0,6 in case of old beech trees" (*Arghiliade C., 1977, p.171*).

In this respect, two separate cases constitute the monthly variation of the maximum flows registered at the hydrometric stations in Strehaia (on the Huşniţa river) and Faţa Motrului (on the Motru river). At the hydrometric stations in Strehaia, the distribution of the almost uniform annual maximum flows at the seasonal level is due to the lithology of the Huşniţa river bed (gravels and sands which cause frequently the draining phenomenon, even on certain sectors to an underground drainage) and to the afforestation phenomenon which is not representative in the Huşniţa hydrographic sub-basin. So, there occurred a maximum drainage with destructive effects in July 1999, when there was registered a maximum flow of 154 m^3/s, instead of 0.79 m^3/s – the multiannual average flow. These elements impose regularization and calibration activities of the river bed for taking over the maximum drainage values – (*Ionuş, Oana, 2008, p.106*).

At Faţa Motrului hydrometric station (on the Motru river), the highest values of maximum flows - 1488 m^3/s (July 1999), 407 m^3/s (March 2006), 264 m^3/s (April 2003), 253 m^3/s (June 1991), 229 m^3/s (July 2005) and 194 m^3/s (April 2006) were registered during the spring – summer period due to the contribution of the Motru tributaries, the quick meltdown of the snow in deforested areas and the location of the respective station on the lower course.

Thus, for an exact analysis regarding the influence of the dynamics of the forest surfaces upon the evolution of the surface drainage, in special literature, one recurs to the calculation and interpretation of the specific average drainage within a hydrographic basin.

The specific average drainage represents the water quantity drained during a period of time on a surface unit and has as unit measure l/s.skm. Its value is calculated based on the determination of the liquid flow (Q) in a section of a river and the surface of the hydrographic basin (F) afferent to the section, using the relation: **q = 1000 Q an /F.**

Table 2

The variation of the multiannual specific average flow at the hydrographic stations considered from the Motru hydrographic basin

River	Hydrometric station	Multiannual specific average flow (establisment-1967*) $l/s.km^2$	Multiannual specific average flow (establisment-2004**) $l/s.km^2$	Multiannual specific average flow (establisment-2008***) $l/s.km^2$
Motru	**Cloşani**	year of establishment 1965	**20,1**	**21,0**
Motru	**Târmigani**	**22,3**	**21,3**	**21,4**
Motru	**Broşteni**	**14,2**	**12,9**	**13,2**
Motru	**Faţa Motrului**	**8,40**	**7,2**	**7,57**
Brebina	**Tarniţa**	year of establishment 1970	**31,7**	**34,4**
Coşuştea	**Corcova**	**9,35**	**7,7**	**7,98**
Huşniţa	**Strehaia**	year of establishment 1969	**2,9**	**2,68**

* Diaconu, C., 1971, p. 120
** Savin, C., 2009, p. 249
*** Serviciul Prognoze, DAJ

It is worth noticing the multiannual specific flow for the years 1967, 2004 and 2008 registered at 7 hydrometric stations from the Motru hydrographic basin; it confirms the fact that “the values of the specific drainage q have a relatively small decrease, as the surface F increases, due to the continuous water appurtenance” (Diaconu, C., p.129).

At the two hydrometric stations located on the upper course of the Cloşani (on the Motru river) and Tarniţa (on the Brebina river), there is registered a small increase for the value of the multiannual specific flow (in 2004 compared to 2008) due to the partial reduction of the forest surfaces (coniferous and mixed forests) and to the increase regarding the frequent occurrence of the extreme hydrological events which cause increased values of the multiannual average flow.

Compared to this two cases, at the other hydrometric stations there were registered reductions of the multiannual specific average flow (major reduction under 1 l/s.km2 from the level registered in 1967 until 2008); the values registered at the Corcova station (9,35 l/s.km2, 1967 and 2,68l/s.km2, 2008) located on the Coşuştea river 9s most significant. Its hydrographic basin registered the highest reductions of the forest surfaces (Fig.1, 2).

By calculating and representing the annual specific flow (Fig. 4) at all 7 characteristic stations located in the Motru hydrographic basin, beside the fact that "for most of the rivers springing from the Carpathians it is characteristic the gradual decrease of the specific average flows toward the discharge" (Diaconu, C., p.127), there are also individualized some particularities.

From the analysis of the annual specific average flow in the Motru hydrographic basin presented in the series of the seven diagrams (Fig.4).

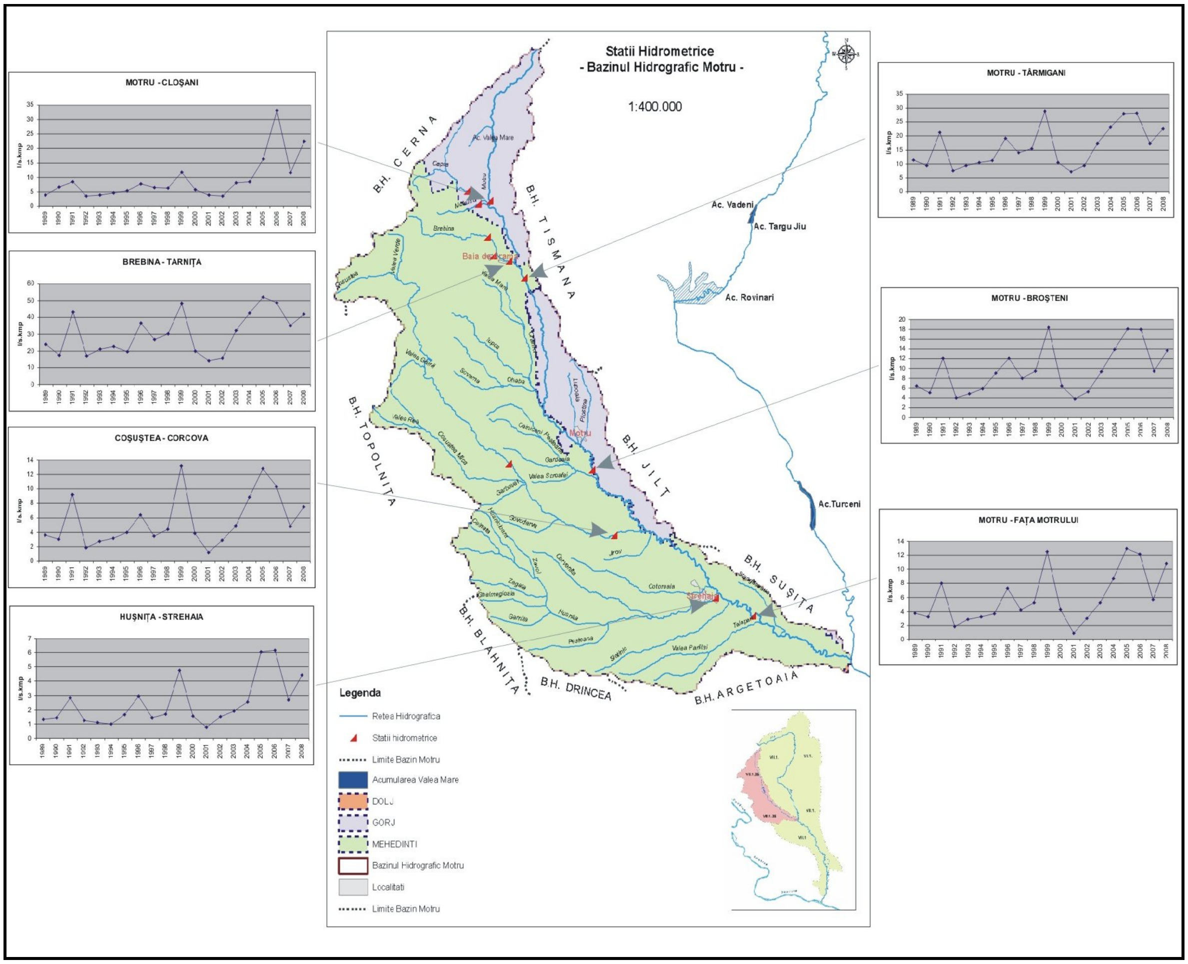

Fig. 4 The variation of the annual specific drainage at the hydrometrical stations characteristics in the Motru hydrographic basin (period 1989 - 2008)

There are evidenced the characteristic years from the point of view of the extreme hydrological phenomena, respectively the values of the flows in 1991, 1996, 1999, 2005 and 2006. Therefore, the high annual average flows generated in their turn a high annual specific flow: Cloşani, 33.119 l/s.skm (2006); Târmigani, 28.881 l/s.skm (1999); Broşteni, 18.421 l/s.skm (1999); Faţa Motrului, 12.988 l/s.skm (2005); Tarniţa, 48.181 l/s.skm (1999); Corcova, 13.19 l/s.skm (1999); Strehaia, 6.151 l/s.skm (2006).

There are also individualized two periods characteristic to the low values of the specific average flow, during the intervals 1992-1994 and 2000-2003: Cloşani – 3.412 l/s.skm (2002) and 3.422 l/s.skm (1992); Târmigani – 7.269 l/s.skm (2001) and 7.5 l/s.skm (1992); Broşteni – 3.746 l/s.skm (2001) and 3.978 l/s.skm (1994); Faţa Motrului – 0.908 l/s.skm (2001) and 1.821 l/s.skm (1992); Tarniţa – 14.285 l/s.skm (2001) and 17.013 l/s.skm (1992); Corcova – 1.204 l/s.skm (2001) and 1.204 l/s.skm (1992); Strehaia – 0.79 l/s.skm (2001) and 0.99 l/s.skm (1992).

We explicitly mention that the first period, 1992-1994 is caused by the reduction of the annual average flows and by the deforestation performed pursuant the entrance into operation of the Law 18/1991, while the second period is the result of the occurrence of extreme hydrological phenomena consisting in the reduction of annual average flows until draining, a phenomenon characteristic to respective droughty years.

If we also take into consideration the health of the forests at the national level, we notice that during the first period "Results on Romanian forest health status over the period 2000-2002 show that for all species the share of damaged trees (classes 2-4) registered values between 9.7% in 1991 and 21.2% in 1994. For conifers, the share of damaged trees was between 7.0% (1991) and 16.6% (in 1993) and for broadleaves between 10.4% (in 1991) and 22.9% (in 1994)" (*Badea, O. et al., 2004, p.222*).

As a specific element we present the uniformity of the diagram corresponding to the Cloşani hydrometric station which is based on the location of its catchment area in a predominant mountainous area, with a high coefficient of afforestation and to the location of the Valea Mare upstream reservoir.

On the Brebina river, at the Tarniţa hydrometric station, from the determination of the specific average flow resulted values ranging from 52.207 l/s.skm (2005) up to 14.285 l/s.skm (2001) which are the highest values compared to the ones from the other stations, namely because of the surface of the basin taken into consideration (see table 1).

The temporary character of the Huşniţa river is felt in expressing the specific average flow having the lowest values in the entire hydrographic basin of the Motru river, respectively 0.79 l/s.skm (2001) and 6.151 l/s.skm (2006).

Conclusions

The evolution of the surface drainage at the level of the Motru hydrographic basin is caused by the dynamics of the climatic and non-climatic factors among which, based on the determinations performed results that the vegetation has an important role. Therefore, the importance of this study is also given by the fact that, presently, there is a predominant tendency to reduce the forest surfaces (more or less controlled deforestation) existent in the Motru hydrographic basin, fact with negative implications upon the drainage surface and implicitly upon the "stability of the aquatic ecosystems" from the point of view of the "integrality of respective ecosystems", a concept "representing the state in which an ecosystem is entirely functional" (*Pătroescu, M., 2008, p.55*).

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THE ROLE OF CULTURAL ECONOMY IN URBAN COMPETITION, WITH A SPECIAL EMPHASIS ON MUSEUMS

László GULYÁS[1]

Abstract: Traditional industries were pushed into the background in urban economies of the post-Fordist period, and both in capital turnover, as well as in employment it was the service industries, that became dominant. Consequently, those towns were in winning positions in this urban competition, in which the tertiary branches of the economy and improved services (information economy, R+D sector) could become the engines of urban development. The role of cultural economy in urban competition has recently been upgraded. Our study examines the role of cultural economy in urban competitions.
Key words: urban competition, cultural economy, cultural-products industries

Rezumat: Rolul economiei culturale în competiţia urbană, cu accent special pe muzee. Industriile tradiţionale au fost împinse pe un plan secundar in economiile urbane ale perioadei post- Fordiste, şi ambele în schimbarea capitală, ca şi în angajare unde au fost industriile serviciu, care au devenit dominante. În consecinţă, acele oraşe au fost pe poziţie de câştig în această competiţie urbană, în care ramurile terţiare ale economiei şi serviciile îmbunătăţite (economia informaţiei, sectorul R+D) ar putea să devică motoarele dezvoltării urbane. Rolul economiei culturale în competiţia urbană a fost recent îmbunătăţit. Studiul nostru examinează rolul economiei culturale în competiţiile urbane.
Termeni cheie: competiţie urbană, economie culturală, industrii ale produselor culturale.

1. Introduction

I.1. The notion of urban competition

The idea of the so-called European town – also called medieval town – was born in the 12^{th}-13^{th} centuries. There had been towns in the ancient times as well, but these "antique towns" were significantly different from the medieval ones; the latter ones represented autonomous communities of trades people and craftsmen. The medieval towns were different by their inhabitants' mentality as well, and they also possessed certain rights, being different from those of the neighbouring settlements, collected in urban charters (Katus, L. 2001).

Also, there was a significant competition between medieval towns in order to be able to serve in various functions. The occurrence of a variety of questions, concerning the acquisition of the function of the seat of a certain territorial unit (shire), or the right to hold a fair, is the proof that urban competition existed as early as the Middle Ages.

By the beginning of the industrial revolution, the competition between towns had become keener, and it was the towns with several attractive factors - e.g. the proximity of coal mines and ore deposits, or the wet climate, indispensable for textile manufactures etc. - that were able to rise (Lengyel, I. and Rechnitzer, J. 2004). In a simplified way it can be stated, that those towns were the winners in contemporary urban competition, which had attracted a number of significant industries.

On the other hand, traditional industries were pushed into the background in urban economies of the post-Fordist period, and both in capital turnover, as well as in employment it was the service industries that became dominant. Consequently, those towns were in winning positions in this new competition, in which the tertiary branches of the economy and improved services (information economy, R+D sector) could become the engines of urban development (Horváth, Gy., 1998).

After this brief historical survey the question of definition necessarily arises. The notion of urban competition is a debated one in Hungarian specialist literature. Some regionalists use "urban competition", others prefer the term "urban success", while some other specialists are in favour of the phrase "successful town"(Tímár, J. 2003).

It is impossible for a study of this scope to describe in detail the similarities and differences related to these definitions. This is why we can only underline here that our study is based on the definition which approaches the problems from the point of view of objectives.

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According to this notion the main objective of any urban competition should necessarily be economic growth or development, as well as constant rise in the given town's revenue (Tímár, J. 2003).

1.2. The notion of cultural economy

The main difficulty is that the word "culture" has about 200 different definitions, and it is the fact that explains why the notion of cultural economy is also extremely difficult to define. From the 1960s onward, economists in the English-speaking world began to use their own techniques for analyzing topics, including family and emotional issues, sexuality and crime, which were seemingly unrelated to economics. The first classical product of the economic investigations of culture was the book written by Baumol and Bowen, which was published in 1966 (Baumol, Bowen, 1966). It is to be noted here, that in the USA the market-oriented view of culture has gained strong supporters since that time. The same idea has become popular in post-communist Hungary, too.

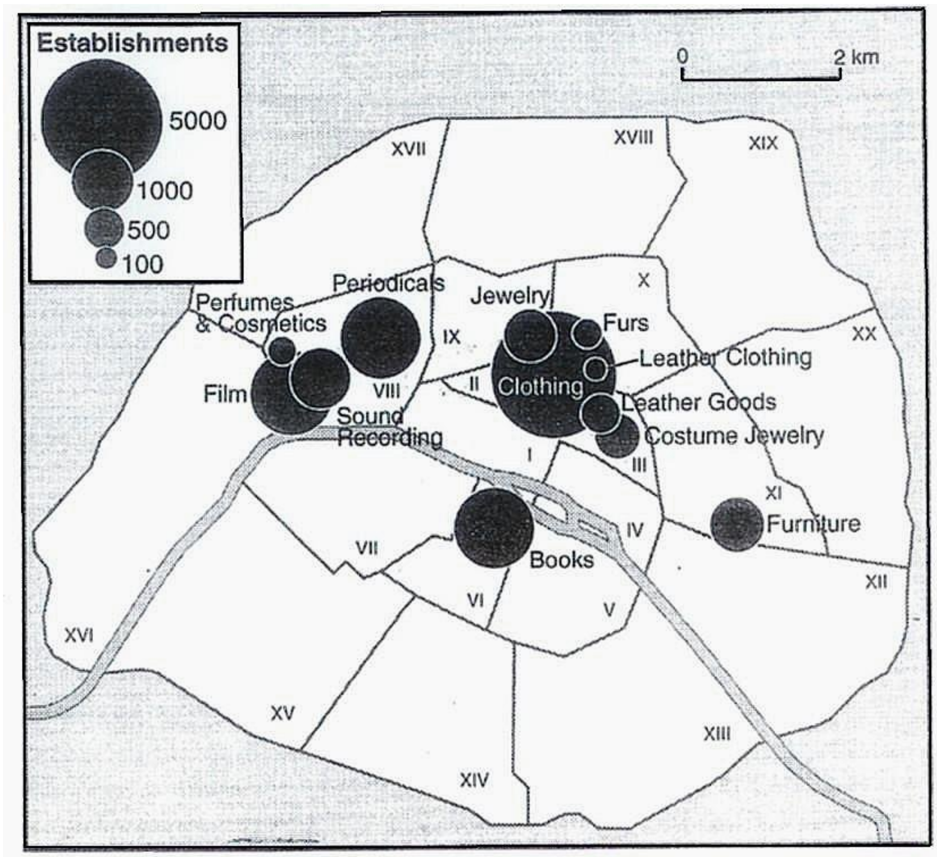

Fig. 1: Main industrial districts in the cultural economy of Paris
Source: Scott 2000. pp. 195.

The most significant product of Hungarian specialist literature, focusing on cultural economic issues, was a volume edited by György Enyedi and Krisztina Keresztély. This book comprises 8 studies of utmost significance (Enyedi, Gy. And Keresztély, K. 2005). In the introductory chapter of the volume, György Enyedi expounds that cultural economy has two main branches. First, it comprises traditional cultural services, including general and public education, different other cultural services, as well as tourism. Second, it also comprises cultural-products-industries, including publishing, jewelry-making or fashion industry.

For example, Paris has a very extended cultural-products-industries, the main part of this being: film, books, periodicals, perfumes and cosmetics, jewelry, furs, clothing, leather clothing, leather goods, etc (see Map 1.).

Our study has been based on György Enyedi's definition and description of cultural economy.

2. Cultural Economy and Urban Competition

The role of cultural economy in urban competition has recently been upgraded (Scott, A.J. 2000). Several regions in developed countries, that suffered from depression in the past, have been successfully rehabilitated, and this fact demonstrates that intellectual life, culture and cultural services can be used as developmental tools and by enhancing the reorganization of socio-economic relations of towns in crisis, culture and cultural services can also contribue to their competitiveness

(Horváth, Gy. 1998). Three examples can be quoted to illustrate the above statement:

1. The opening of the Ruhr University in Bochum, Germany's Ruhr region.
2. The introduction of conference tourism in the former industrial cities of the English Midlands, especially in Birmingham.
3. The foundation of the Pittsburgh Cultural Trust, comprising 14 cultural institutions in Pittsburgh, Pennsylvania, USA, a city which used to be the centre for American iron and steel industry.

The common characteristic feature of all these three examples is that it was the development of cultural economy that helped these cities to regain their strong position in urban competition. Pittsburgh, for example, has become the fourth most popular destination of cultural and art tourism in the U.S.

Considering the main points in specialized literature, published either in English (Bianchi, F. Parkinson, M 1993, Wynne, D. 1992), or in Hungarian (Enyedi, Gy. 2005 and Horváth, Gy. 1998), it can be concluded that cultural economy has three main functions in the life of a town:

1. As a mediator of values, it satisfies the inhabitants' intellectual needs.
   In order to meet this requirement, cultural institutions are needed, that can represent high' culture. These institutions include opera houses, theatres, philharmonic orchestras, art museums and exhibition halls.
2. As a manufacturer, it is a producer of values, and in this role culture can contribue to the growth of a town's financial and economic basis. This function means that cultural economy, while it is rooted in the traditions of the given community, will launch new products.
3. Through its prestige-making function, the elements of culture can also attract capital.
   One of the manifestations of this function is that cultural areas attract highly qualified workers, who eventually will make it possible to operate a dynamic, knowledge-based economy.

If a town utilises all these three functions, then it will be able to achieve considerable success (Keresztély, K. 2005, Lukovich, T. 2005). It is outlined in Zsolt Czene's doctoral dissertation, that cultural factors play a role in the development of a region (Czene, Zs. 2003). Further more, he argues that cultural factors embody communities, value systems, ethic norms, traditions, and, cultural inheritance. In addition, other cultural factors, like knowledge, work ethics, social cohesion and identity are all present in any individual's life; consequently, they will have an overall impact on the development of their region as well.

3. The Role of Museums in Cultural Economy

Since the lecture this study is based on was originally delivered at a conference, organised by the Ferenc Móra Museum in Szeged, the role museums play in cultural economy, is of special significance. According to a survey, conducted by Gábor Michalkó and Tamara Rátz, by being the targets of cultural tourism, museums play an outstanding role in the cultural economy of Hungarian towns. (Michalkó, G. and Rátz, T. 2005).

Table 1

Cultural fascination of cities in Hungary 2000-2002

Type of fascination	Visitors
Castles	50,128
Museums	23,594
Libraries, Theatres, Cultural centre	22,802
Events connection with wine	12,889
Temples	12,582
Cultural events	10,062

Source: Michalkó G.-Rátz T. 2005. 135. pp.

According to the conventional notion of what a museum should be, it can be described as a building with educational and cultural functions, in which objects are displayed, studied and stored. Simultaneously with the changing of the role of cultural economy, the notion of the tasks of museums has lately also changed. The museums of big cities have become multifunctional institutions, in which visitors are not only entertained, but also served. This phenomenon can be described along three main tendencies (Enyedi, Gy. 2005):

1. The increased number of temporary exhibitions.
2. The transformation of museum shops into supermarkets.
3. The appearance of additional services in or near the museum buildings.

Table 2 serves to illustrate the growing number of temporary exhibitions, as well as their success story, proven by the fact that they could boast several hundred thousand visitors.

When examining the most visited, and thus the most successful Munkácsy exhibition from the point of view of an economist, two characteristic features have to be emphasised.

1. The gross revenue from ticket sales totaled 280 million HUF.
2. The regular adult ticket price of 1,500 HUF was paid only by one third of the visitors. Another third of them bought some kind of discount ticket and there was also a significant number of visitors, who visited the exhibition free (Tóth, I. 2005).

Table 2
Most visited exhibitions on Budapest 2003-2005

The title of temporary exhibition	Place	Visitors
Munkácsy Mihály	Hungarian National Gallery	360 000
Light and shadow	The Gallery (Műcsarnok)	300 000
Monet and friends	Museum of Fine Arts	256 000
Mednyánszky László	Hungarian National Gallery	176 500
Dinosaurs	Hungarian Natural History Museum	173 223
After the pharaohs	Museum of Fine Arts	85 000
Joan Miró	Museum of Fine Arts	80 061
Klimt, Schiele, Kokoscha	Budapesti History Museum	72 521
Amazing stones	Hungarian Natural History Museum	57 182

Source: Authors owns construction

The other main trend in museums is the transformation of museum shops into cultural supermarkets. It means that the visitor can buy all kinds of souvenirs there, ranging from Van Gogh T-shirts to replicas of Roman-age coins. Today no major museum exists without a large and significant museum shop, which offers a great selection of replicas and souvenirs. The museums of Hungary have not yet grown up to this trend, especially when the purchase of copies and replicas is concerned.

The third major trend is the appearance of different service providers in or near the museum buildings. It means that restaurants, cafés, galleries, second-hand bookshops and antiquities shops open in or near the museum buildings themselves.

4. Lessons to be Learnt by Museums in Hungary

'Culture is a big business. It is one of the leading sectors in the period of the post-Fordist economic revolution and it has served as basis for several urban developmental programs.'

These sentences appeared on the blurb of a book by the renowned regionalist, A.J. Scott. (Scott, A.J.) On the other hand the slogan of the Ferenc Móra Museum, one of Hungary's most significant museums, reads like this: *'The museum is a place for visitors.'*

Eventually, it is the lesson to be learnt by Hungary's museums from Scott's theory, as well as from the main ideas of this study, that remains to be identified. The directors of Hungarian museums often complain about financial problems, saying that the revenue from ticket sales does not cover the costs of their exhibitions, and the maintenance of the museum, as an institution. Contrary to this, economists emphasize that consumer functions, appearing more recently in museums, produce profit.

The solution seems to be simple: museums are to keep their original cultural functions, but they are also to welcome these new consumer functions as well. Museum directors are to recognize the fact that their institutions, in addition to being cultural spaces, are places for consumption as well. This recognition can be summed up by the following statement, which might also serve as a new slogan: *'The museum is a place for visitors. But, visitors are also to shop for consumer goods in them.'*

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THE EVOLUTION OF THE URBAN PUBLIC TRANSPORT DURING THE 1950-2006 PERIOD IN ROMANIA

Costela IORDACHE[1]

Abstract. Although it has numerous tangencies with road transport, the passengers' urban transport represents a transitional sector between the road transport and the railway transport. The increase of the number of inhabitants and the development of the cities, alongside the population's need to move, determined the evolution of the urban transport. The scope of the present study is to show the dynamics of the number of cities with common transport, the evolution and the geographical distribution of the tram, bus, minibus and electric bus networks between 1950 and 2006. Another objective of this paper is to show the dynamics of the fleet and passengers transport during the same interval. The evolution of the transport network, of the carriages and the transport of passengers by metro between 1980 and 2006 was also analysed.

Key words: urban transport, evolution of the passenger's traffic, network

Rezumat. Evoluţia transportului public urban în România în perioada 1950 - 2006. Deşi are numeroase tangenţe cu transporturile rutiere, transportul urban de călători reprezintă un sector de tranziţie între transporturile rutiere şi cele feroviare. Creşterea numărului de locuitori şi extinderea oraşelor, alături de nevoia de deplasare a populaţiei au determinat evoluţia transportului urban. Scopul prezentului studiu este de a arăta dinamica numărului de oraşe cu transport în comun, evoluţia şi repartiţia geografică a reţelei de tramvaie, de autobuze, microbuze şi troleibuze în perioada 1950-2006. Dinamica parcului de autovehicule şi a transportului de pasageri în acelaşi interval de timp este un alt obiectiv al acestui articol. De asemenea, am analizat evoluţia reţelei, vagoanelor şi transportului de pasageri cu metroul între anii 1980-2006.

Cuvinte cheie: transport urban, evoluţia traficului de pasageri, reţea, România

1. Introduction

Staring with the introduction of the omnibus (1848), the tram (1872 – with animal haulage, 1894 - electric), the bus (1904), the electric bus (1955) and the metro (1979), the urban transports have developed a lot. There were significant transformations concerning the number of cities having common transport, regarding the structure and the length of the routes, concerning the number of transportations and passengers.

The number of cities having urban public transport raised to 27 in 1950, to 195 in 1975, while after that an involution began. If, in 1980, there were 187 cities, in 1990, there were only 181, and in 2000, their number dropped to 115, precisely that in 2006 to drop to 103, which means a decrease of 1.8 times during the last two decades (Fig. 1).

2. Material and methods

In order to make this study, the basic material statistical data concerning the number of cities with urban transport, the length of the tram, bus, electric bus and metro routes, the fleet with transportation vehicles and the number of passengers were used. Statistical data refer to the period 1950-2006. These data have been taken from the 1981, 1995, 2003 and 2007 editions of the Romanian Statistical Yearbook. The research methodology was based on the use of statistical, cartographic, geographic, comparative-historical methods, on the analysis and synthesis.

3. The transport by trams

In chronological order, the transport by trams is being performed in the following cities: Bucharest, Timişoara, Galaţi, Brăila, Sibiu, Cluj-Napoca, Arad, Oradea, Reşiţa, Ploieşti, Craiova, Constanţa, and Botoşani.

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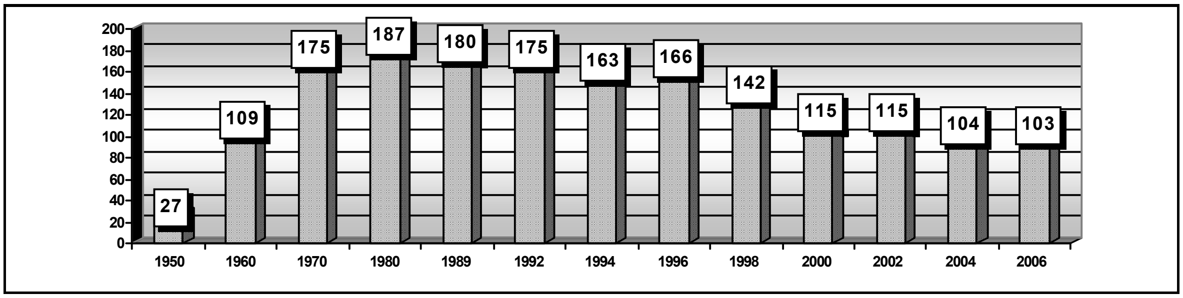


Fig. 1 The dynamics of the number of cities having a urban public transport between the years 1950 and 2006

The tram networks increased 4.3 times between 1950 – 1989, from 345 kilometres to 1493 kilometres, afterwards it slowly reduced, reaching approximately 920 kilometres in 2006 (Fig. 2). For the last reference year, the highest percentages in the total length of the simple tram line came to the Bucharest – Ilfov regions, having 37.0%, the West region, 21.3% and to the South-East region, 18.1%, on the last place being situated the region in the centre having only 11 km. This type of transport can be found only in 14 cities, among which there can be noticed: Bucharest (340.3 km), Arad (96 km), Timişoara (90 km), Iaşi (84 km), Galați (67.9 km), Brăila (53 km), Constanța (45.8 km) and others(Fig. 3).

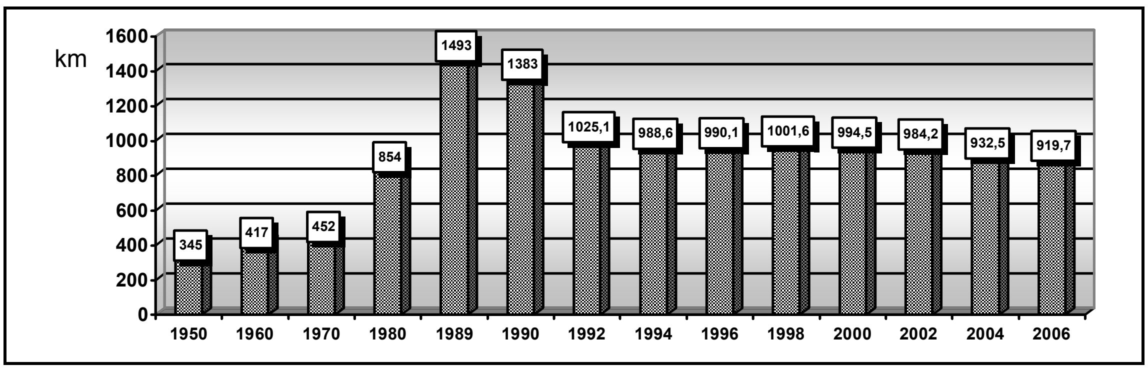


Fig. 2 The tram network dynamics between 1950 and 2006

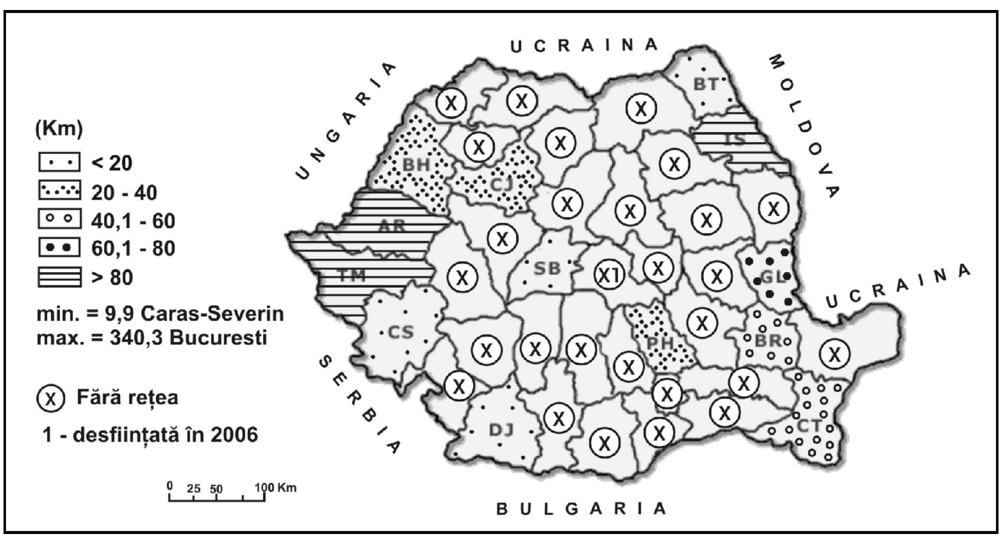


Fig. 3 The geographical distribution of the tram network in 2006

The number of street-cars had an oscillatory evolution, with an increasing trend until 1998, the extreme values ranging between 2428 in 1989 and 1198 in 1950 (Fig. 4).

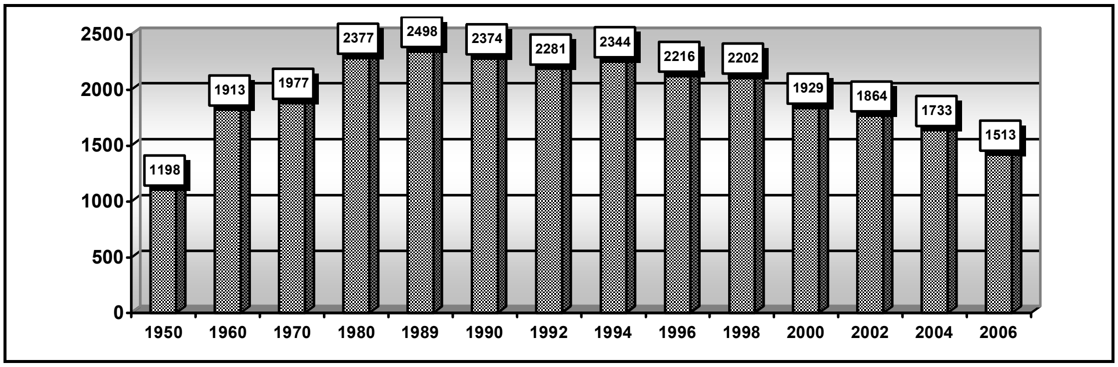


Fig. 4 The dynamics of trams fleet between 1950 and 2006

From the total number of street-cars exiting in the inventory in 2006, most of them were in Bucharest – Ilfov (35.2%) and in the North – East (11,4%) regions, to the opposite pole being the Central Region, having only 3 street-cars existing in the inventory of Sibiu county (for the route outside the city Sibiu – Răşinari). In the profile of the county, the following cities stand out: Arad (14.3%), Timişoara (10.7%), Iaşi (9.6%), and Oradea (7.7%).

The traffic of passengers slowly increased, between a minimum of 640 million persons in 2006 and a maximum of 1.1 billion persons in 1992 (Fig. 5). The highest percentage in the transport of passengers characterizes Bucharest – Ilfov region with 57.4%, followed by the West region with 10.5%, the North – West region with 10% and the North – East with 8.1%. The most important values at the city level are as follows: Bucharest (57.4%), Iaşi (7.6%), Oradea (6.0%), Timişoara (4.9%), Arad (4.3%), Cluj-Napoca (4.0%), Craiova (3.6%), and Brăila (3.4%).

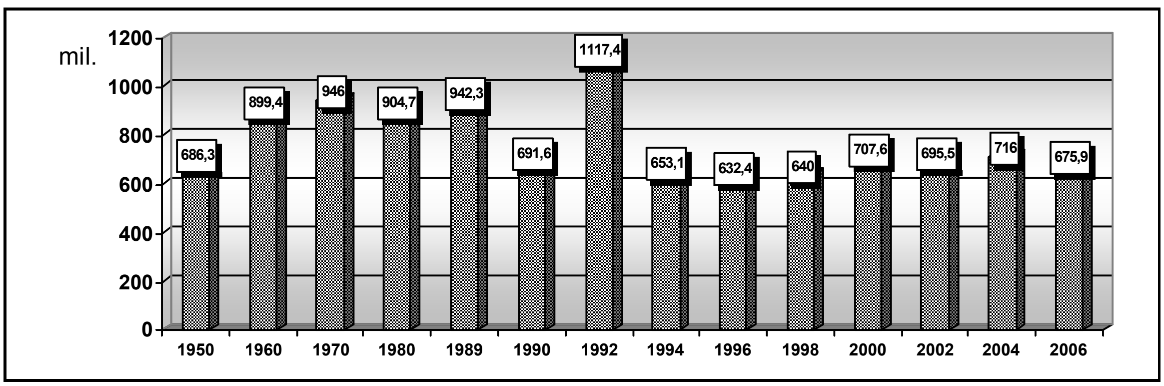


Fig. 5 The dynamics of the passengers' transport by tram between 1950 and 2006

4. The transport by buses and minibuses

The transport by buses and minibuses dominates the urban transports, and its evolution was determined by the development of the cities.

The length of the routes served by the buses increased 41.9 times between 1950 and 1990 (Fig. 6). During the transition period, beginning with 1991, in the statistics this parameter does not appear anymore because of the association with the minibuses that do not have strictly stable routes.

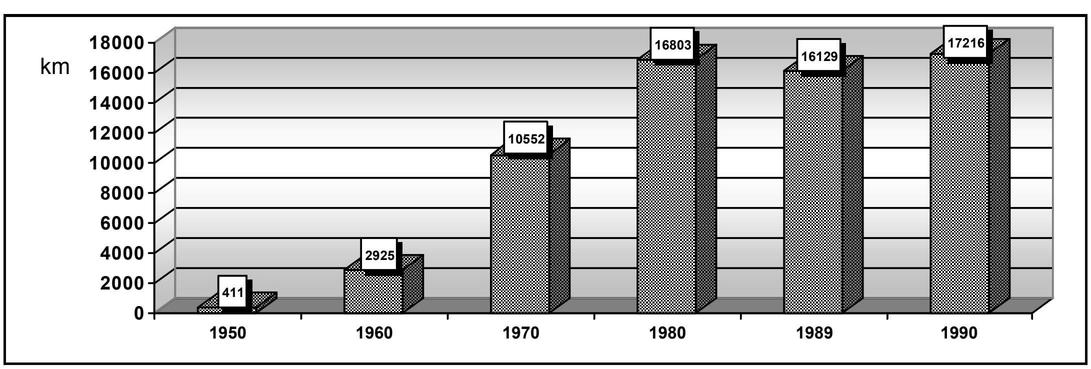


Fig. 6 The dynamics of bus routes between 1950 and 1990

The number of buses and minibuses experienced an explosive increase, from 330 in 1950 to 11,601 in 1980; afterwards, the fleet of this transporting means halved (Fig. 7). In 2006, over 45% of these vehicles were concentrated in Bucharest – Ilfov and South – East regions. At the county level, the highest number was found in Galați (529; 8.8%), Cluj (331; 5.5%), Constanța (293; 4.5%), Dolj (3.8%), Prahova, Brăila, Braşov and Iaşi, each of them having over 200 vehicles (Fig. 8).

Between 1950 and 1980, *the number of passengers* who used the bus increased 28.9 times from 86.6 million persons to 2,504.5 million persons. During the next period, there were registered progressions and regressions; for the last two decades it decreased 1.2 times. The highest percentage in the transport of passengers by buses and minibuses is held by Bucharest – Ilfov region with 38.2%, followed by South-East regions with 14.5% and North – West region with 12.0%. Among the counties, we notice the following: Constanța (6.5%), Cluj (5.5%), Braşov (4.8%), Dolj (4.7%), Iaşi, Galați, Prahova (each having over 35 million passengers). The last place is occupied by Covasna county, having only 586.9 thousand passengers, 121 times less than Constanța. The explanation lays in the different territorial and demographic dimension, as well as in the exploitation of the tourist potential, which generates a strong circulation during the summer season in Constanța county.

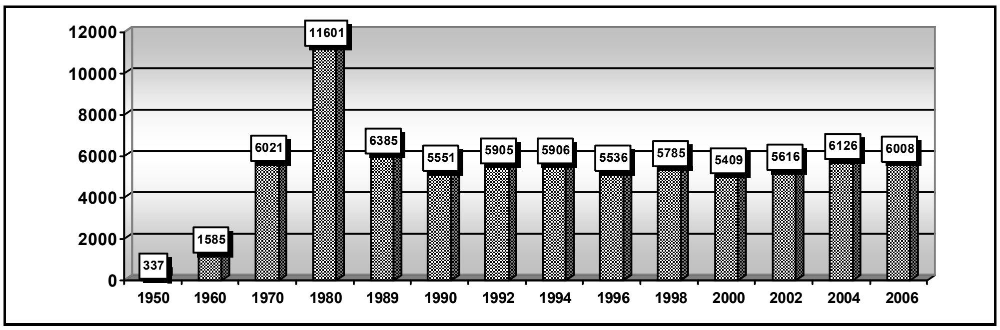


Fig. 7 The dynamics of the buses and minibuses fleet between 1950 and 2006

Fig. 8 The geographical distribution of buses and minibuses in 2006

5. The transport by electric buses

Due to the relatively late introduction of electric buses in the traffic and to the high financial costs needed for the infrastructure, as well as to the competition of other categories of urban transport, the transport by electric buses has had a slower general evolution.

The routes served by the electric buses increased from 7 km in 1950 to 267 in 1970 and to 594 km in 1989, which means it increased 85 times. The same ascendant trend is noticed during the transition period, when it was registered a maximum of 973.8 km in 2000; after this year, there begins the rapid regression, evidenced by a decrease of 1.7 times in only six years (Fig. 9).

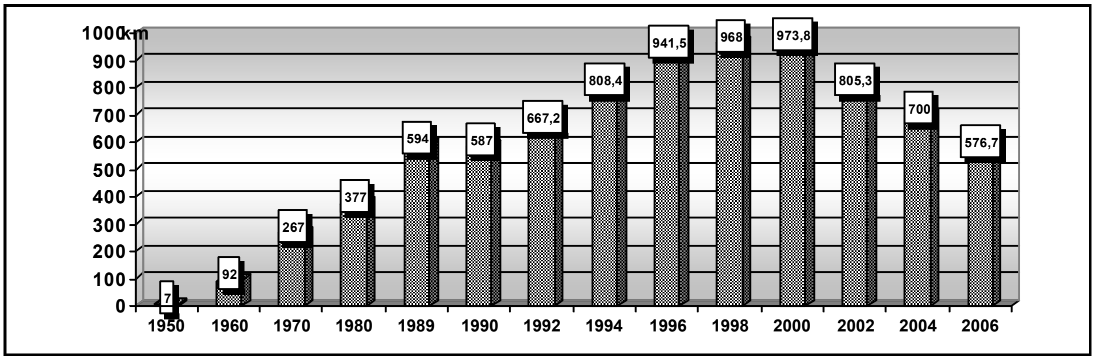


Fig. 9 The dynamics of electric bus network between 1950 and 2006

The longest electric bus routes are located in Bucharest – Ilfov region (155.3 km; 26.9%), in the Central (about 115 km; 19.9%) and in the North – East region (104 km; 18 %). Out of the 13 counties where this type of transport is being practiced (in 2006, it was liquidated in Dâmboviţa, Satu Mare and Suceava counties), we notice the network from: Iaşi (73 km; 12.7%), Sibiu (70.6 km, 12.2%), Timiş (60 km; 10.4%), Braşov and Cluj (over 40 km); Galaţi (25.4 km), Neamţ (21 km), Constanţa (19 km).

The electric bus fleet followed an ascendant trend until 1980, when there were registered 103 times more street-cars than in 1950. On the background of a constant evolution manifested for two decades, around the value of 900 street-cars/ year, the electric buses have been modernized. There should be mentioned the constant set-back from the latest years (Fig. 10). From the 698 street-cars existent in 2006, almost 40% were located in the Bucharest – Ilfov region, followed by the North – West region with 18.1% and by the Centre with 16.3%. Considering the counties (which correspond to their residential towns), we distinguish the following: Cluj (15.8%), Braşov (90%), Timiş (8.2%), Iaşi (4.0%), Neamţ (3.9%), Constanţa (2.9%).

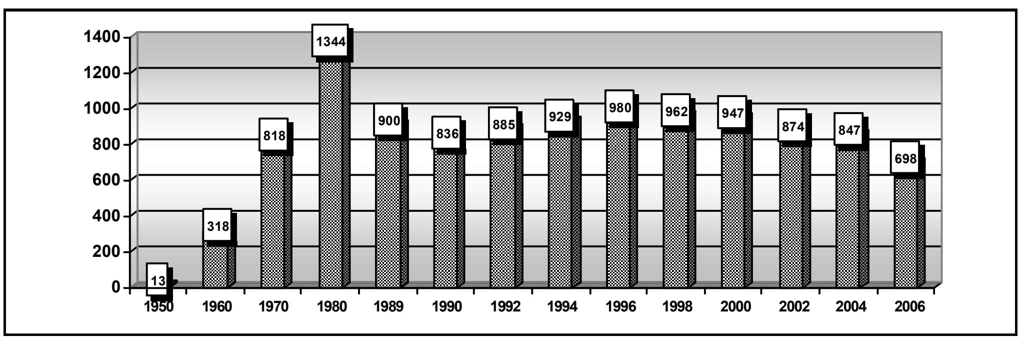


Fig. 10 The dynamics of the electric bus fleet between 1950 and 2006

The number of passengers transported by electric bus increased from 2.6 millions in 1950 to 362.4 millions in 1970 and to 368.7 in 1989. During the transition period, it is registered a maximum of 473.1 millions in 1992, where after the trend is descendent (Fig. no 11). The total number of passengers in this transport category, the Bucharest – Ilfov region registers 44.5%, then the North – West region with 22.9% and the Centre with 12.4%. The highest percentages come to the Cluj-Napoca municipality (19.9%), Timişoara (7.9%), Braşov (7.4%) and Constanţa (3.9%).

6. The metro

The problem concerning the construction of the metro in Bucharest was raised since the inter-wars period (1930). After a failed attempt in 1950, the issue was raised again after two decades, the works starting in 1975.

The need for building the metro results from the demographic and territorial dimension of Bucharest, the spatial distribution of the social-economic objectives and the congestion of some routes.

The metro network was built in several stages, the first section being inaugurated on the 19th of December 1979. With a length of 8.1 km and 6 stations, the section realizes the connection between the Semănătoarea and Timpuri Noi stations. The second route opened in 1981 is a continuance of the previous one, for a length of 9.4 km, between Mihai Bravu – Republica stations. After two years there was performed a branch of 8.6 km between the Eroilor and Industriilor stations.

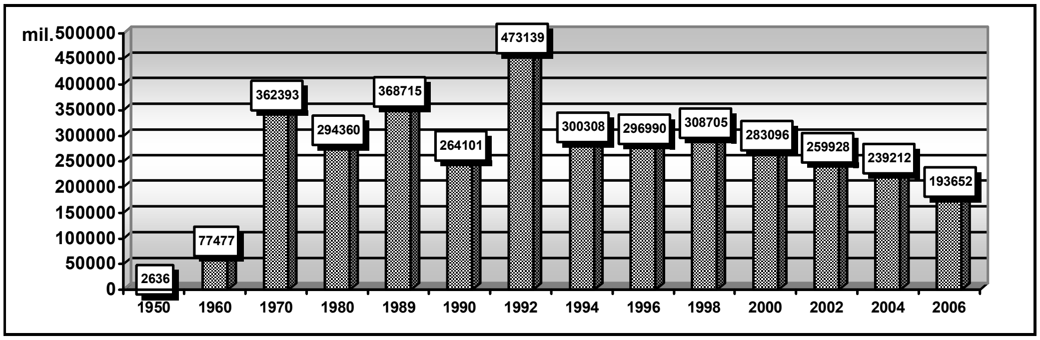


Fig. 11 The dynamics of the passenger's transport by electric bus between 1950 and 2006

In 1984, the first section is extended with approximately 1 km up to the Crângaşi station, and in 1987 with another 2.8 km up to the Gara de Nord. In 1989, there were added 7.8 km to the route between Piața Victoriei and Dristor 2, completing the third main line. In 2000 the fourth main line was finished (3.6 km) between Gara de Nord – 1 Mai (Fig. 12 – www.metroul.ro).

Presently, the metro network is being structured on four main routes (M):

- M1 – opened in 1979, on the route Pantelimon – N. Grigorescu – Eroilor – Gara de Nord – Piața Victoriei – Dristor;
- M2 – achieved in 1986, on the route: Berceni – Piața Unirii – Piața Victoriei – Pipera;
- M3 – inaugurated in 1983, on the route: A. Saligny – N. Grigorescu – Eroilor – Industriilor;
- M4 – opened in 2000, on the route: Gara de Nord – 1 Mai.

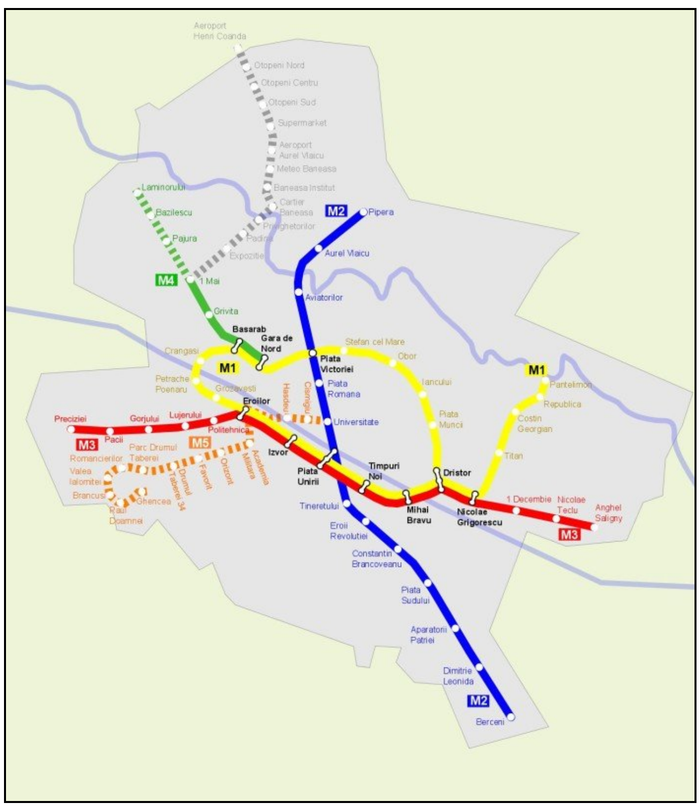
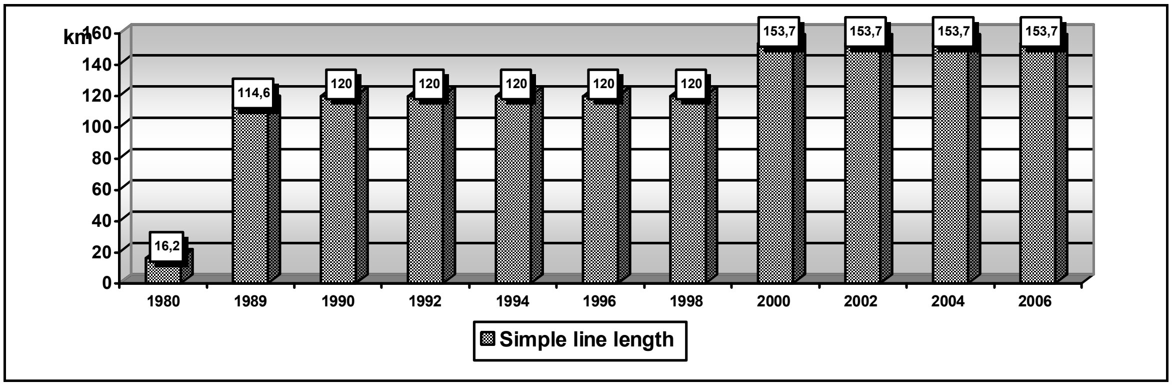


Fig. 12 The main lines of the metro in Bucharest (www.metroul.ro)

The simple line network increased 9.5 times between 1980 and 2006, from 16.2 km to 153.7 km. *The number of carriages* rapidly increased during the first decade of the metro existence, from 24 in 1980 to 438 in 1990, meaning an increase of 18.3 times (Fig. 13).

In what concerns the *transport of passengers*, their number increased 19 times during the first decade, from 14.2 million persons to 271.2 million persons in 1989. Afterwards, there follows a set-back until 2003, when it was registered a 2.3 times decrease, while after this year the passenger traffic increases 1.3 times, due to the congestion of the surface transport generated by the excessive multiplication of the cars' number (Fig. 14).

In the development strategy of the metro until 2014 it is foreseen the extension of the fourth main line, the performance of the fifth main line (on the section Drumul Taberei – Universitate – Pantelimon), the connection of Progresul station with Gara de Nord, the extension of bottom belts and the modernization of the train fleet (www.metrorex.ro).



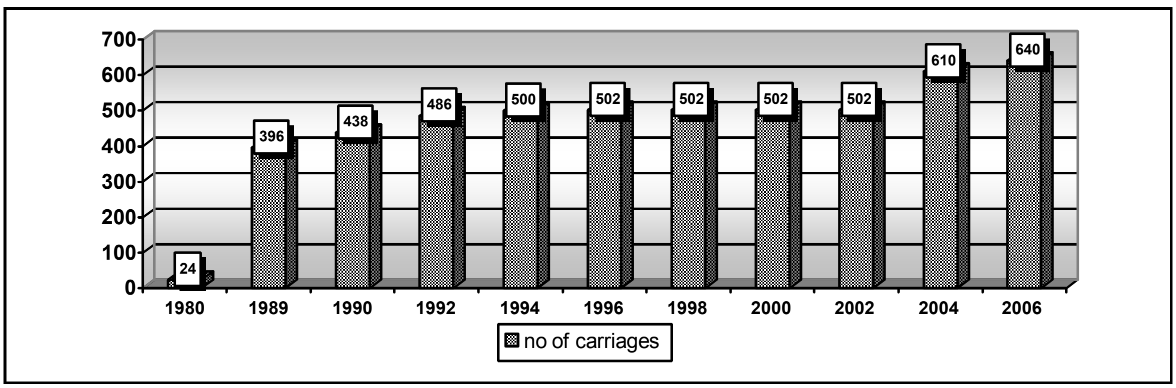


Fig. 13 The dynamics of the metro network and carriages between 1980 and 2006

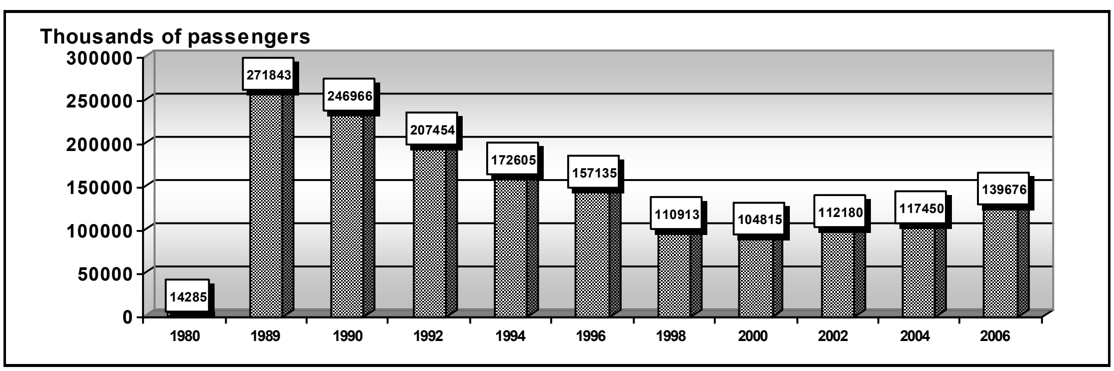


Fig. 14 The dynamics of the passengers transport by metro between 1980 and 2006

Conclusions

The intensification of the urbanization process was accompanied by a significant dynamics of statistic concerning the urban population and, implicitly the city surface. At the same time, the development of industrial units, the urban endowments and the traffic roads determined the increase of the urban routes and the development of the passenger transport. Also, the communication routes and the transports between cities and the settlements found in their administration have been diversified and modernized.

The analysis upon the passenger urban transport during the period 1950-2006, led to the following aspects: the increase in number of the cities which have common transporting means from 27 to 103; presently, over 32% of the cities are served by means of urban transport; the tram network registered an increase of only 2.7 times compared to the length of the routes for the buses, which increased 42 times and that of the electric buses, which extended 82.4 times; if at the beginning of the analyzed period, in the routes structure there predominated the ones for the trams or buses, at the end of this period, the supremacy was held, to a great distance, by the buses; the fleet increased 1.3 times for trams, 17.8 for buses and minibuses and 53.7 times for electric buses; in what concerns the number of passengers, there had been noted a slight set-back (two stages of development) for the tram transport (0.9 times more) and increases for the bus transport (of 12.7 times) and electric bus transport (73.5 times); taking into account its status of capital city, Bucharest has specific elements in the structure of the transport lines and in the number of passengers.

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THE CHANGES OF THE FOOD PROCESSING INDUSTRY IN WESTERN TRANSDANUBIA FROM THE TIME OF THE DEMOCRATIC TRANSFORMATION TO OUR DAYS

Imre VIDÉKI[1], Roland STÁRICS[1], Sándor SZABÓ[1]

Abstract. During the nearly last two decades, the importance of the Hungarian food processing industry definitely declined. Nowadays, this sector employees altogether 101.5 thousand persons and the share of the production is below 10%. After the transition period, the sectorial structural and organizational troubles, as well as the technological and efficiency problems became more and more serious. Similarly to the nationwide trends, but with more powerful effects, there was a recession in food processing industry in the study area - the Western Transdanubia, a region having good quality agricultural potential. Nevertheless, according to the number of employees and to the value of production, the food processing industry takes the second place within the regional sectors. The importance of meat industry, manufacture and processing of poultry meat, manufacture of vegetable oils and manufacture of sugar declined the most during the transformation period between 1990 and 2007. Within these three subsectors, many big- and medium-size enterprises of considerable importance in Hungary having significant traditional background finally closed the production. The absolute winner of the transformation within food processing industry are the producers of beverages and baking industry. These two subsectors coped rather successfully with the period with lots of economical problems after the transition, just as with the term of the factory-close-downs at the beginning of the new millennium. According to the number of employees, the distribution of the working food processing industry enterprises can be expressed by the significant proportion of micro- and small-size enterprises. There can be only found 11 big-size enterprises altogether, employing more than 250 persons which have regional head office. At present, the most significant regional centers of food processing industry are the following: Győr, Mosonmagyaróvár, Répcelak, Sárvár, Sopron, Zalaegerszeg and Zalaszentgrót.

Key words: food industry, Western Transdanubia, meat and vegetables processing

Rezumat. Schimbările industriei de prelucrare alimentară în Transdanubia de vest, din timpul transformării democratice până în prezent. În timpul ultimelor două decade importanţa industriei de prelucrare alimentară a scăzut în mod evident. În prezent acest sector are un număr de 101,5 mii de anagajaţi şi procentul producţiei este sub 10%. După tranziţie problemele sectoriale, structurale şi organizaţionale şi problemele tehnologice şi de eficienţă au devenit din ce în ce mai serioase. Similar tendinţelor naţionale, dar cu efecte mai puternice, a existat o recesiune a industriei de prelucrare industrială în uona noastră de cercetare, Transdanubia de Vest, o regiune cu un potenţial agricol de bună calitate. Cu toate acestea, în funcţie de numărul angajaţilor şi de valoarea producţiei, industria de prelucrare alimentară ocupă locul secund printre sectoarele din regiune. Importanţa industriei cărnii, producerea şi prelucrarea cărnii de pui, fabricarea uleiului vegetal şi a zahărului a scăzut cel mai mult în timpul transformării din perioada 1990- 2007. În cadrul acestor trei subsectoare multe companii mici şi mijlocii de importanţă considerabilă în Ungaria, cu un fond tradiţional semnificativ, şi-au închis producţia în final. Câştigătorii absoluţi de pe urma transformării din industria de prelucrare alimentară sunt producătorii din industria băuturilor şi de panificaţie. Aceste două subsectoare au făcut faţă cu succes perioadei cu multe probleme economice de după tranziţie, şi a închiderii fabricilor de la începutul lui 2000. În funcţie de numărul angajaţilor distribuţia muncii în fabricile din industria de prelucrare alimentară pot fi exprimate prin procentul semnificativ al întreprinderilor mici şi foarte mici. Se găsesc doar 11 mari întreprinderi care au peste 250 de angajaţi, care au sedii regionale. În prezent cele mai importante centre regionale ale industriei de prelucrare alimentară sunt următoarele: Győr, Mosonmagyaróvár, Répcelak, Sárvár, Sopron, Zalaegerszeg şi Zalaszentgrót

Cuvinte cheie: industria alimentară, Transdanubia de Vest, procesarea cărnii şi a legumelor.

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***Introduction to the Hungarian food industry*[1]**

This knowledge did not mean only growing and producing knowledge, but due to the sectorial connection, it had effects on other economic factors (e.g. research, agricultural machine factory).

During a longer period, agriculture accounted for 6-8 per cent of the GDP, while food processing industry produced only 4-5 per cent. The proportion of food economy amounted to one fourth-fifth part of the whole Hungarian exports. In 1995, agriculture produced 7.0 per cent of the GDP, while food processing industry accounted for 4.8 per cent. These two sectors achieved 21.6 per cent of the whole Hungarian exports in 1996. These sectors employed 8.3 per cent and 3.5 per cent, respectively of the occupied population during that same year. It is a well-known fact that the important factors of food economy, such as agriculture and food processing industry, lost heavily its significance beginning with the 90's. The agriculture employed 4.7 per cent of the whole Hungarian employed population, producing 3.6 per cent of the GDP in 2007. Fifteen per cent of the jobs in the processing industry were in the food processing sector; the share of the production of this sector decreased to 9.7 per cent.

Between 1991 and 2007, the number of the jobs in the food processing industry decreased from 192,000 to 101,500. Food processing industry accounted for 6.3 per cent of the Hungarian export, realizing a surplus amount of 342 billion Ft. It is remarkable that in the recent years, the import of food processing industry has been increasing more significantly than the export, therefore the above mentioned export surplus has been decreasing.

The structural changing of the ownership of the share capital was the following: In 1995, 12 per cent belonged to the state, 35 per cent to national owners and the remaining 53 per cent to foreign owners. In 2005, the state had only 1.5 per cent of the capital, 46.7 per cent was domestic, 49.3 per cent foreign and 2.5 per cent of the capital belonged to others (farmer's cooperative, local government etc.) The proportion of the foreign ownership exceeds 90% in sugar factory, brewing and vegetable oil factory; on the other hand, it does not reach 25 per cent in distilling industry, winemaking and milling industry. This proportion is 30 per cent in the basic meat industry, while it reaches nearly 66 per cent in the basic dairy industry *(Csizmadia 2007).* It has to be mentioned that these proportions can be changed; on the other hand, it is also probable that the proportion of the state and other ownership will remain unremarkable within a reasonable time.

After 1990, the efficiency of food processing industry was basically influenced by the decreasing of domestic demand, the driving out of the early traditionally - eastern - markets. It is worth mentioning that in Hungary, we had to learn not only from the frequently emphasized fall of the above mentioned market, but from the wrong trade policy as well. In our opinion, the measure of the withdrawal from the well-known market of the third most populous countries in the world at that time could have been minor. (Where were the banks who could have credited for instance the value of the Hungarian poultry export?)

After the transition period, the structural and organization troubles and the technological and productivity problems of the sector deepened. Due to these circumstances, the utilization of capacities declined powerfully. The production of food processing industry reached its peak in 1987, while in 1996, for instance, this industry gave only 90 per cent of the 1985's production. The use of capacities was the common problem in the sector and it still is today. During the transition period, among the 12 working sugar factories, only the one in Kaba had that daily processing capacity which could be considered economic in the European comparison. There were many sugar factories - in Mezőhegyes, Sarkad etc. - where due to the minor daily processing capacity, the processing period lasted longer. This kind of troubles also occurred in other subsectors.

In the milling industry there were 116 working factories with nearly 9,000 t/day capacity of milling in 1996 for instance. The number of the milling factories declined to 74 and the processing capacity hardly reached the above mentioned value in 2006 *(Agrár Európa, 2007)*. It is very possible that other milling factories will be closed down due to the already significant company concentration. On the other hand, certain company groups (e.g. ABO Mill) also purchased foreign milling factories, just as in Romania. Regarding the milling industry, it has to be mentioned that while the grain-farmers can be considered as the winners of the EU-accession since the EU buys up the wheat, the majority of the milling factories without enough storage capacity and money for stock purchasing have basic material supply difficulties. In Hungary, the wheat is produced plentifully and it is of good quality, but, on the other hand, the price of the raw material is extraordinary high for the milling factories due to the intervention measures.

The decrease in the number of products in the food processing industry, the absorbing specialization and the increasing number of the special products were the ones that remarkably

[2]In this article, food processing industry means the manufacture of food products, of beverages and of tobacco products. The differences from this meaning will be marked in the text.

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developed in the nineties.

The recession of the Hungarian food economy is considerable, partly because:

- Hungary has definitely favourable natural conditions for growing raw materials,
- it has enviable producing tradition,
- it has the ability for making much more products than the domestic market needs.

On the other hand, the sector is not so sensitive to the economic boom, which means that the demand for its products is rather constant.

It is a trivial fact that those national economies have the ability for significant output which make special products – such as hungaricum, italicum etc. – in accordance with their natural conditions and producing experiences.

The ever declining significance of food economy raises the question whether it is needed at all or not? It is evident that besides the employment and social problems, lots of other troubles would occur, such as supply safety or the frequently uncertain origin products. Regional development plans would not be realised entirely if the processing of the local raw materials is not carried out in local district.

The Hungarian food processing industry heavily depends on domestic raw materials (30-70 per cent). On the other hand, it occurred that for instance pork had to imported due to the limited basic materials. This raises the question of predictability. In the dairy industry, the low price that is received, below the cost price, has been causing serious problems for a long time, therefore the production is loss-making for the farmers *(http://www.tejtermek.hu /up/doc_news/tt15_26d9f524.pdf)*.

In the following pages, the characteristics of food processing industry in the counties of Western Transdanubia will be introduced. Naturally there can be found those effects influencing the global and domestic economy in this region. The objects of our research are the following: the changing of the role in the economy, the company structure and distribution by sales returns of the food processing industry and the most important enterprises at present in this region, possessing significant traditions.

The main processes of food processing industry in Western Transdanubia after 2000

In 2000, engineering industry, textile, leather and footwear production (light industry) and food, beverage and tobacco production (food processing industry) are still the determining factors of the industrial structure in Western Transdanubia. Within the three main sectors, there can be found a certain emphasis change during the examined period. Engineering industry is still in the leading position; moreover, it realised a significant increase (in the region 23 per cent of the industrial jobs were in the engineering industry in 1992, while in 2007, there were 42 per cent).

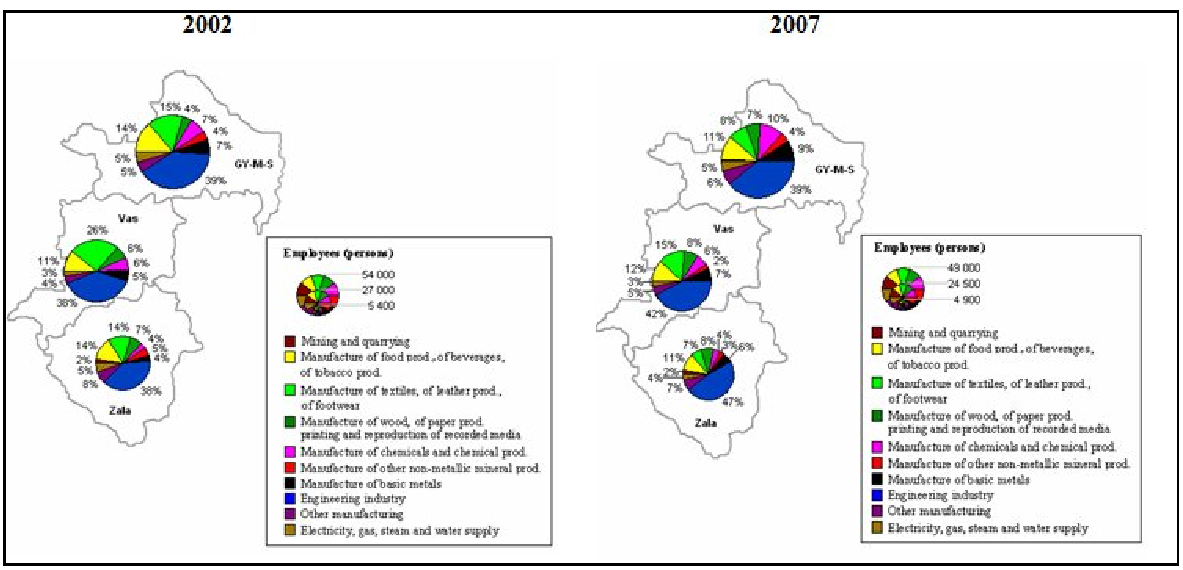

Fig. 1 The industrial structure of the examined three counties according to the number of employees in 2002 and 2007

Edited by Szabó S. on the basis of the data from the county statistical annals of the year 2002 and 2007

There was a change of place between textile, leather and footwear on the one hand, and food processing on the other hand during the examined period. According to the number of jobs in 2002, textile, leather and footwear production was in the second place, while food processing industry took this position by 2007. The cause of this process is the prompt collapse of the formerly significant textile industry (in 2002, the textile, leather and footwear production accounted for 18 per cent, the food, beverage and tobacco production for 13 per cent, while in 2007, there were only 10 per cent, and 11 per cent, respectively). Examining the processes on the county level (Fig. 1), food processing industry is more significant in Győr-Moson-Sopron and Zala county and by 2007 food processing industry outpassed the textile, leather and footwear production. According to the number of jobs, food processing industry still remains only the third industrial sector in Vas county.

According to the value production, food processing industry following the top-leader engineering industry also took the second place in the region (in 2002 10%, in 2007 7%). Countywide food processing industry realises 5-8% of the whole industrial value production in Győr-Moson-Sopron and Vas county, while food processing industry makes 22-28% of the industrial value production in 2002 and 2007 in Zala county; this fact can be explained by the minor importance of engineering industry within this county (in 2002, the industrial value of the food processing industry was higher than that of the engineering industry). On the contrary, engineering industry has a significant importance in the industrial value production of certain years in Győr-Moson-Sopron and Vas counties.

It is worth following the changes in the volume of food processing industry production (Fig. 2.). At the beginning of the decade, there was a gradual, but with a lesser degree production recession in the Győr-Moson-Sopron county. In the middle of the decade, the recession ended and there followed a significant production increase of 14% in 2006. Then, this outstanding year was followed by a new decreasing period. According to the value production of the sector, the most significant extreme can be found in Vas county. At the beginning of the years 2000, there was a serious recession (24% of the production of 2001) which can be explained by the decreasing competitiveness of the sector and the stagnation of foreign market sale. The serious recession was followed by a powerful increasing in 2003 and 2004, due to the expansion of foreign market sale possibilities of meat and poultry industry *(Statistical guide of Vas county 2003/4)*. This growth root did not last long, as the second half of the decade was marked mainly by recession. Zala county can also be described by the gradual decreasing of the food processing industry efficiency in the last 9 years. Production growth can be observed only in 2000, 2001 and 2003. From the middle of the decade, the recession of the sector was more and more significant.

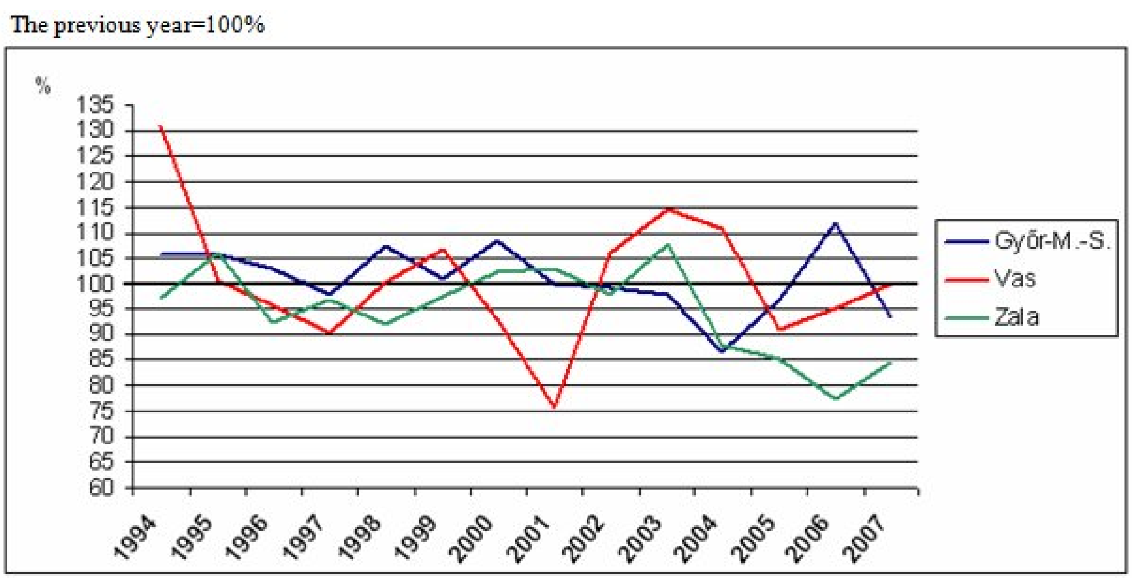

Fig.2: The changes in the volume of the food processing industry production, as percentage of the production of the previous year. The previous year=100%

Edited by Szabó S. on the basis of the data from the county statistical annals of the year 1994-2007

It is worth surveying the main processes and events of the food processing industry subsectors in the region looking back on the last 9 years.

Meat industry went through significant changes during the nearly 10 last years mainly due to the production decrease. Two important companies determining the regional meat industry went bankrupt: Ringa in 2003 and Zalahús in 2005. These factory closings took place due to the increasing competitiveness after the EU-accession, the increasing deficits and the following rationalizing processes. The last "victim" of the unfavorable processes and the economic crisis is Hunnia Húsipari Ltd. with the head office in

Keszthely in 2009. **Poultry industry** went through the same path as the meat industry. In the last one-two years, two important poultry manufacturing companies of the region also went bankrupt: Zalabaromfi in Zalaegerszeg (liquidation in 2009, closed down without successor) and Pannon Baromfi in Győr (liquidation in 2008, closed down without successor – production is continued by Pannon Szárnyas Ltd.). The most important poultry manufacturing company in the region, the SÁGA FOODS Plc. with the head office in Sárvár, seems to be steady in spite of the increasing market competition and the present economic crisis.

For the last decade, **dairy industry** of Western Transdanubia faced two processes: firstly, the selection (partly due to the unfavourable processes connecting with the EU CAP reform), then the concentration. The most important dairy industry companies in the region are the following: Pannontej (cheese producing in Zalaegerszeg and Répcelak), Óvártej (cheese producing in Mosonmagyaróvár), SOLE-MiZo (in Csorna) and the works of Veszprémtej in Keszthely.

Milling and baking industry are also an important subsector of food processing industry in Western Transdanubia. The regional centre of milling industry was Győr for a long time, due to Pannon Gabona Plc. In 2004, the Austrian ownership decided to launch Pannomill Plc. by concentrating its two Hungarian branches with the head office in Komárom; therefore, milling industry closed down in Győr. Pannomill Plc. built a modern, second-generation mill catering for all tastes in Csorna to replace the former one in Győr. The other important regional centre of milling industry can be found in Zalaszentgrót (Zala-Cereália-Malom Ltd.). Compared to the nationwide processes, the successful companies of the regional deepening market and price competition of baking industry are the following: bakeries of the commercial chain stores, independent store networks (Lipóti Pékség) and companies making special products (Ceres, Fornetti). The most significant baking industry centre of the region is Győr, which is the head office of Ceres Plc. (Cahrt 2). This company has not only a determining regional role, but a national one too.

Winemaking and brewing industry of the region are also significant due to the centuries old winery traditions and the considerable brewing companies. In Western Transdanubia, there can be found three wine-growing regions (in Sopron, Somló and Pannonhalma); the grapes are processed in little firm structure and domestic winery. The only regional important company of brewing industry is Heineken Hungária Plc. (in Sopron). In 1999, the beer factory in Nagykanizsa was closed down. The domestic breweries producing for local market should be also mentioned.

During the last decade, two previously regional important subsectors of food processing industry were liquidated: **sugar industry** and **vegetable oil manufacturing**. Following the transition period, there were two working sugar factories in the region (in Sárvár and Petőháza). The sugar factory in Sárvár was closed down in 1999 relatively early, then the sugar factory in Petőháza also finally finished the production at the end of 2007. The drastic fall of the nationwide and regional sugar industry can be explained by the EU sugar reform began in 2006, which caused the decline of the supported sugar production and the rising of the prices. Furthermore, the EU significantly supports the companies having started the structural changing (by decreasing their sugar quota or closing down the production) *(http://hvg.hu/hvgfriss/2006.42/200642HVGFriss159.aspx)*. Regional vegetable oil manufacturing had been working until October 2000. However, the production at the vegetable oil factory in Győr, with the French ownership Cereol Holding multinational company, was closed down at the end of 2000. The French company explained the serial domestic factory close-downs (also the one in Győr) by the drastic decline of the global market price of vegetable oil and the over-production of domestic factories.

Company structure of the regional food processing industry

From the middle of the 80's, similarly to the national trends, the radical transformation of company structure can be also easily followed in the counties of Western Transdanubia. The significance of this transformation can be expressed by the powerful change not only of the scale, but also of the sectorial number and the sales returns structure during the last twenty-five years. The most important transformation was that of the companies size, since the medium- and large-size state-owned companies with hegemony position during the socialist decades, were replaced by a new company structure made up of private small- and medium-size enterprises (SME) and the foreign large companies[3].

As there are no complete data available for the 90's, the processes and county characteristics of regional company structure of the last 10 years will be introduced next. Nowadays, there are 394 working food processing enterprises recorded in the Western Transdanubia, which is 63 more than it

[3] Small- and medium-size enterprises refer to the companies where there are less than 250 employees.

was nine years ago (Fig. 3.). In spite of the increasing number of enterprises within the seven Hungarian planning-statistical regions, the least working food processing industry companies can be found in the Western Transdanubia. According to the number of companies, most of them can be found in Győr-Moson-sopron county (187 pc, 47.6%), taking precedence over Zala (124 pc, 31.5%) and Vas county (83 pc, 21.1%).

According to the distribution of the working food processing enterprises, understandably, the most enterprises manufacture bakery and farinaceous products (126 pcs), the manufacture of beverages (91 pcs), meat industry (64 pcs).

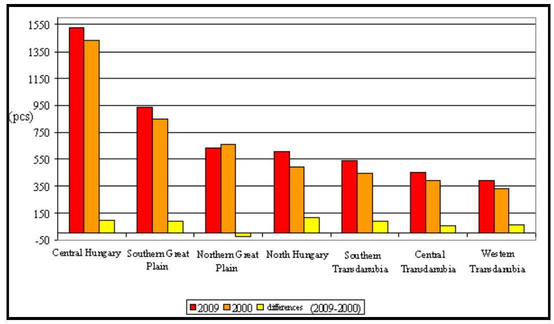

Fig. 3 The changes in the number of working food processing enterprises in Hungary (2000-2009)
Edited by Stárics R. on the basis of the data in KSH Cég-Kód-Tár of the1 st quarter of year 2009

Table 1

The distribution of the working food processing enterprises in the Western Transdanubia (1st quarter of year 2009)

Variable	Western Transdanubia	Győr-Moson-Sopron county	Vas county	Zala county
Number of the working food processing enterprises (pcs)	**394**	**187**	**83**	**124**
Distribution according to subsectors (%)				
Processing and preserving of meat, production of meat products	16.5	16.6	19.3	14.5
Processing and preserving of fruit and vegetables	5.6	6.4	4.8	4.8
Manufacture of vegetable and animal oils and fats	1.8	1.1	3.6	1.6
Manufacture of dairy products	4.1	3.7	6.0	3.2
Manufacture of grain mill products, starches and starch products	2.5	1.6	2.4	4.0
Manufacture of bakery and farinaceous products	32.0	32.1	37.3	28.2
Manufacture of other food products	9.1	8.0	10.8	9.7
Manufacture of prepared animal feeds	5.3	4.8	2.4	8.1
Manufacture of beverages	23.1	25.7	13.3	25.8
Distribution according to the number of employees (%)				
0 person and unknown	27.9	25.1	33.7	28.2
1-9 persons	43.9	48.1	38.6	41.9
10-19 persons	10.9	8.0	15.7	11.3
20-49 persons	8.1	8.6	6.0	8.9
50-249 persons	6.3	7.5	1.2	8.1
250 and more persons	2.8	2.7	4.8	1.6
Distribution according to sales returns (%)				
Unknown	9.1	10.2	10.8	6.5
0-20 million Ft	47.5	47.6	47.0	47.6
21-50 million Ft	10.9	9.6	13.3	11.3
51-300 million Ft	17.5	18.7	16.9	16.1
301-500 million Ft	2.3	2.1	0.0	2.4
501-700 million Ft	1.3	1.1	2.4	2.4
701-1000 million Ft	2.3	2.1	1.2	3.2
1001-2500 million Ft	3.8	3.2	4.8	7.3
2501-4000 million Ft	1.3	0.5	1.2	2.4
4001and more million Ft	3.0	4.8	2.4	0.8

Edited by Stárics R. on the basis of the data in KSH Cég-Kód-Tár of the 1st quarter of year 2009

These four subsectors include eight tenth (318 pcs) of all the enterprises, determining the powerful concentration. The importance of the other food processing industry subsectors is negligible, altogether accounting for 1-6 per cent. The main winners of the transformation of the company structure in the last decade are the beverage manufacturers, and also the meat and bakery industry, the number of such enterprises having increased. The structural transformation affected especially the manufacturers of dairy products and prepared animal feeds and milling industry. The importance of processing and preserving of fruit and vegetables, manufacture of vegetable and animal oils and fats and manufacture of other food products also declined. The professional distribution of enterprises can be examined on county level as well. Bakery and meat industry have significant traditional background in all the three counties, with a high number and proportion of enterprises. It is worth mentioning that more than one half of the regional beverages manufacturing and fruit and vegetables processing enterprises are working in Győr-Moson-Sopron county. According to the regional milling industry and manufacture of prepared animal feeds, every second enterprise is found in Zala county.

The distribution of the working food processing enterprises according to number of employees mirrors the great importance of the micro- and small-size enterprises. Nowadays, 71.8 per cent of the enterprises are micro (283 pcs), 19 per cent are small-size (75 pcs). The category of medium-size enterprises account for 14.4 per cent (25 pcs), while the proportion of big-size enterprises is below 3 per cent. In the first quarter of 2009, there are 11 big-size enterprises with regional head-office recorded, with 7 less than it was nine years ago (Table 2). The decline of the number of big-size enterprises can be explained especially by the powerful reduction of the traditional meat industry in Zala county and confectionery industry in Győr (Győri Keksz Ltd.). From the point of view of the regional food processing industry during 2000 and 2009, the finally or temporarily production close-downs in three big-size enterprises in Zalaegerszeg (Zala Húsipari Plc., Zalabaromfi Szárnyas Húsfeldolgozó Plc., Goldsun Hűtőház Plc.) and in several SME-s are definitely heavy losses.

Table 2

The big-size food processing industry enterprises in the Western Transdanubia

Name of the big-size enterprise	Head office	Subsector
Ceres Sütőipari Plc.	Győr	manufacture of bakery and farinaceous products
Ferrosüt Sütő- és Édesipari Ltd.	Szombathely	manufacture of bakery and farinaceous products
Heineken Hungária Sörgyárak Plc.	Sopron	manufacture of beverages
Kaiser Food Élelmiszeripari Ltd.	Abda	processing and preserving of meat, production of meat products
Kapuvári Hús Húsipari Plc.	Kapuvár	processing and preserving of meat, production of meat products
Pannon Szárnyasfeldolgozó és Értékesítő Ltd.	Győr	processing and preserving of meat, production of meat products
Pannontej Tejtermékgyártó és Kereskedelmi Plc.	Zalaegerszeg	manufacture of dairy products
Sága Foods Élelmiszeripari Plc.	Sárvár	processing and preserving of meat, production of meat products
Taravis Baromfi és Élelmiszeripari Ltd.	Sárvár	processing and preserving of meat, production of meat products
Wewalka Cukrásztermék Gyártó és Kereskedelmi Ltd.	Celldömölk	manufacture of bakery and farinaceous products
Zalabaromfi Szárnyas Húsfeldolgozó Plc.	Zalaegerszeg	processing and preserving of meat, production of meat products

Edited by Stárics R.. on the basis of the data in KSH Cég-Kód-Tár of the1st quarter of year 2009

According to the categories of sales returns, the annual sales returns of the majority of the working food processing industry enterprises – 85 per cent of all, 335 pcs - are below 300 million forints. Moreover, the annual sales returns of nearly half of all the enterprises (187 pcs) are bellow the 20-million-forint-level, while altogether 12 enterprises (3 %) have the amount of more than 4 billion forints.

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TYPES OF RURAL LANDSCAPES IN THE OLTENIAN SUBCARPATHIAN DEPRESSIONS

Mihaela PERSU[1], Daniela NANCU[2]

Abstract: Types and territorial distribution are governed by natural resources, demographic and economic factors. The evolution of the human factor in time, the changes occurred in the structure and spread of human settlements, the management of the commons for economic purposes have engendered a huge variety of landscapes in the Curvature Subcarpathians. The evolution of the population (of the labour force) is the main criterion differentiating rural landscapes on the basis of the geomorphic analysis. This landscape dynamics was found to be sliding steeply, moderately or spiralling up. The agro-economic criterion (land use) distinguished the following agricultural landscapes: very extended (80% of the communes) with cultivated fields (bocage variant), wine and fruit-tree plantations, agro-pastoral and mixed-agriculture types. Owing to the diversity of natural factors, the rural landscape in the Bend area has good conditions to develop. The century-old man/ nature relationship has created several human-based rural landscape types, influenced by the type of economic activities.
Key words: rural landscapes, types, Romania.

Rezumat: Tipuri de peisaje rurale în depresiunile Subcarpatice Oltene. Tipurile şi distribuţiile teritoriale sunt guvernate de resurse naturale, factori demografici şi economici. Evoluţia factorului uman de-a lungul timpului, schimbările apărute în structura şi împrăştierea aşezărilor umane, managementul general pentru scopuri economice au dat naştere la o mare varietate de peisaje în Subcarpaţii Curburii. Evoluţia populaţiei (a forţei de muncă) este criteriul principal în diferenţierea peisajelor rurale pe baza analizei geomorfice. Dinamica peisajelor s-a transformat rapid, moderat sau spiralat.
Criteriul agro-economic (utilizarea terenurilor) a diferenţiat următoarele peisaje agricole: foarte extinse (80% din comune) cu câmpii cultivate (varianta bocage), plantaţii de viţă de vie şi pomi fructiferi, tipuri agro-pastorale şi agricultură mixtă. Datorită diversităţii factorilor naturali, peisajul rural din zona de Curbură dispune de condiţii bune de dezvoltare. Relaţia dintre secole- om şi natură a creat diferite tipuri rurale de peisaje influenţate de om şi de tipul de activităţi economice.
Cuvinte cheie: peisaje rurale, tipuri, România.

The approach of the concept of landscape in the Romanian geography goes down to the beginning of the 20th century, when George Vâlsan (1929) introduces the scientific description of landscapes classifying them in *spatial landscapes* (which aim the geographical position, the altitude), *physical landscapes* (which refer to the presentation of climate, water, relief-rock elements), *biological landscapes* (which express the vegetal and animal life), *psycho-social landscapes* (where human elements are dominant, expressing the urban or rural way of life, the economic activities, the cultural-religious and ethnographic specificity of settlements etc.).

In Vintilă Mihăilescu's view (1968), another titan of Romanian geography, the concept of landscape is approached systematically, as he considers it "the assembly of outside features specific for a territory, the society being part of the system, as a product and an active factor".

In fact the landscapes express the qualitative aspects of the territory, but also the way of life, concretized in the human-nature relationship and spatially materialized along the time.

The general definition of the landscape was updated with the occasion of the European Convention of Landscapes (the 20th of October 2000), being considered as: "a part of the territory perceived by the population as it is, the character of which is the result of the action of natural and human factors".

Scientifically, the landscape analysis comes first to geographers, as they have the capacity to study it as a whole, considering it as the result of a complex of factors, both physical and economical-geographical, being able to outline its components, the relations between them and to remove its

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individuality through its fundamental, objective and permanent attributes (Zăvoianu, I., Alexandrescu Mihaela, 1994). This fact is obvious through the implication of numerous Romanian geographers, well known in the special literature, in the study of landscapes: S. Mehedinți (1946), P. Coteț (1976), I. Donisă (1979), V. Tufescu (1981), Al. Roşu (1983), I. Velcea (1996), C. Vert (1992), M. Ielenicz (1996), V. Cucu (2000) etc.

Emphasizing the type of landscapes implies the establishment of certain clear criteria which aims to the physical-geographical background and the human pressure through the degree of economic exploitation and the degree of territorial inhabitation.

A recent classification for the type of landscapes which characterizes the Romanian geographical space was proposed by I. Mac (2000). Through this classification there are established, not only the determinative causes which separate the landscape in the two big classes (natural and human), but there is also better outlined the type of landscape, considering the representativeness criterion for a certain area of an element or a group of elements. Thus, depending on the dominant form of relief there can be: *mountain, hilly, piedmont, field, deltaic landscape etc.;* the vegetation can impose a *forest* or *a steppe, forest-steppe landscape etc.*, and the hydrographic component determines according to its specificity: *the marine, the lacustrine, the seashore, the glacial landscape etc.*; in what concerns the human activity, this is reflected into the landscape by its economic specificity, by the organization of the habitat or by the way of inhabitation: *agricultural landscape, industrial landscape, urban landscape, rural landscape, touristic landscape, etc.*

These types can be constituted in superior degree landscapes, to which we can integrate, on various hierarchic steps, landscape of various degrees, using the category of representative elements for a certain unit spatially defined. For example, in the human landscape, the agricultural one can enclose the subtypes of *pomiculture landscapes, vineyard landscapes, landscapes of cultivated fields, etc.* Of course that any other feature of a landscape which makes it different from the others may represent a classification criterion, beside the ones already mentioned and which has to be as close as possible to an objective reality, specific to each territorial reality approached.

Rural landscapes are predominant in the Oltenia Subcarpathian depressions if we take into account that this category of landscapes represents over 90% from the territory, depending on the dominant form of settlement – rural and the dominant economic activity – agriculture.

The rural landscape belongs to an anthropogenic environment, personalized by its dominant component – *the village*. Between the rural landscape, the rural habitat and the rural settlement there is a close relationship of successive integration of all three geographical entities.

The rural habitat – reflects the human pressure upon the geographic landscape; it is complementary to the rural landscape and it subordinates to rural space.

The rural landscape strongly differentiated, in time and space, from the point of view of territorial organization, the degree of concentration or dispersion of houses in the heartland of the village, depending on the level of socio-economic development of the villages.

The typology of rural landscape was a subject less approached in Romania. The studies realized by now, took into consideration especially the analysis of agricultural structures and the level of appliance of the land improvement methods (Dumitraşcu, 2006). In the special literature, there are papers approaching this subject which frequently analyzes three major types of rural landscapes: *open field landscapes*, based on the culture of the cereals, from the steppe; the *pomiculture-viticulture landscapes*, characteristic to hilly regions, *agropastural landscapes* from the mountain region. There are also analyzed the rural landscapes which interfere with other categories of landscapes: the agro-industrial landscape, the agro-forest landscape, the agro-piscicol landscape, ş.a.

In the present study we are trying to identify the types of rural landscapes at the level of Oltenia Subcarpathian depressions considering the representative criterion which aims the demographic component (the dynamics of population), the agro-economic one (land use) and the interaction of physical and human factors (its direction of evolution).

In its geographical assembly, the appearance of this territory is expressed by the relief through the *hilly landscape type*. The Oltenia Subcarpathian depressions are part of the Getic Subcarpathians, belonging from the administrative point of view to Gorj and Vâlcea counties (Fig. 1). Due to the natural conditions and to the specific method of exploiting the economic potential, the rural settlements enclose two forms of organization: permanent settlements – the actual villages and the temporary settlements with a pastoral specificity (the sheepfolds). The network of permanent settlements (Table no 1) sums up about 64 villages

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and only 3 towns, in 2008, which confers a strong rural character.

Here the village manifested an evident preference in choosing the location, for the depressions, valley couloirs and the contact area with the mountain.

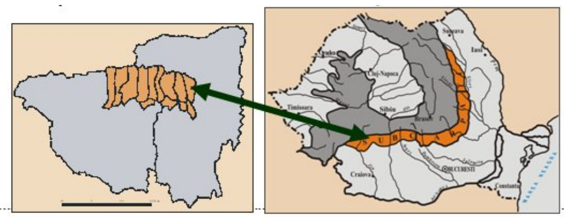

Fig. 1. Geographical position (administratively and physical-geographical)

Table no1

Statistical-demographic characteristics of the settlements network (2008)

Units of relief	Number of settlements		Density		Average size	
	Villages	Towns	villages Villages/ 100 km^2	towns towns/ 1000 km^2	of villages no of inhabitants / village	of towns no of inhabitants/ town
The Romanian Subcarpathians	1 842	36	11,2	2	800	15 000
The Getic Subcarpathians	596	14	12,7	2,6	600	14 000
The Oltenia Subcarpathian depressions	64	3	4,5	< 1	560	8 050

The demographical and morphological size of the villages differ depending on the potential habitat of the terrain on which was organized the heartland of the village and their economic profile. Considering the number of population, the average size of the villages within this Subcarpathian depressionary space of Oltenia is 560 inhabitants. The small villages are numerous, 500 inhabitants, their percent being of 40% from the total number of rural settlements. Most villages, included in this category, are concentrated in the eastern part, where the natural conditions are less favorable, because of the relief intensity. The middle and big villages, between 500–2000 inhabitants and over 2000 inhabitants, are frequently located in the entire subcarpathian space analyzed and they have a mixed economic profile.

Types of rural landscape differentiated after the demographic criterion – the dynamics of the population

The population, an essential element in the rural landscape, is correlated with the territorial component represented by the natural background and economic one represented by the land use and other activities. Taking into consideration the demographic factor, base on the criterion selected, the *demographic dynamics*, there had been determined for the period 1992-2002, three types of rural landscapes:

The rural landscapes with a demographical dynamics severely descending

The demographic characteristics of this type of landscape are: reduced demographic potential, negative natural increase and migration rate, aging of population. The characteristics of villages: scattered houses, irregular texture due to unfavorable natural and economic conditions.

Territorial distribution: villages located at the contact area of the depression with the mountain area – Buzeşti, Arşeni, Bârcaciu, Bistriţa, Roşoveni and Dumbrăveşti, whose decreasing dynamic varies between -20 and -75% (Fig. 2).

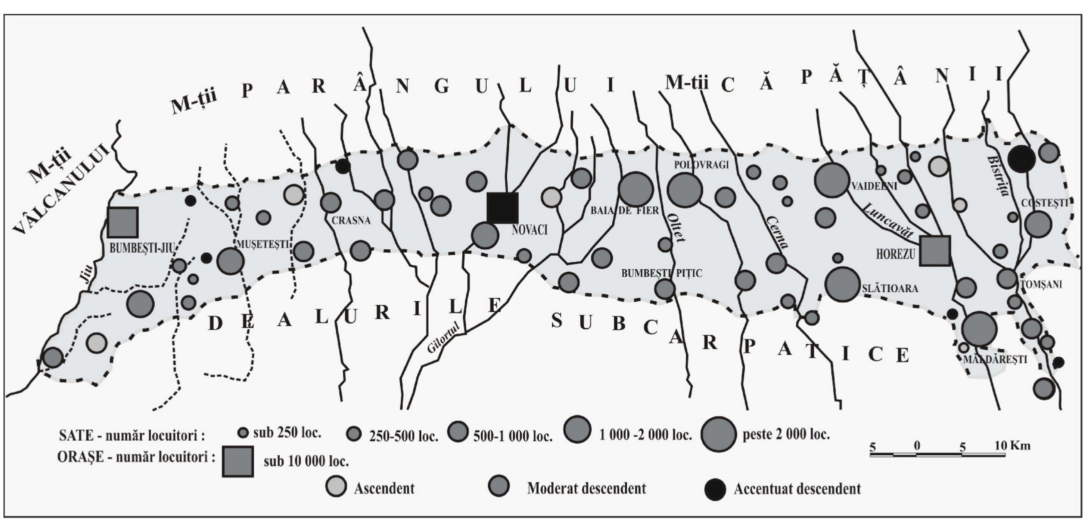

Fig. 2 The territorial distribution of rural landscapes, differentiated based on demographic dynamics

This type of landscape has a reduced extension in the territory, in this category being included only 6 rural settlements to which is added the Novaci town.

Rural landscapes with a demographic dynamics moderately descending. Demographic characteristics: positive natural increase, negative migration rate. Small and middle rural settlements are predominant, their descending dynamics varying between -1 and -20%. The territorial distribution signals a higher frequency in the Oltenia Subcarpathian depressions.

Rural landscapes with ascending demographic dynamics. Demographic characteristics: increase of the population between 1 – 22%, balanced age group structure. The villages are located close to urban centers and have a higher economic standard. This type of landscape is equally represented in the Subcarpathic area from Gorj and Vâlcea (Fig. 2).

The rural landscapes differentiated after the agro-economic criterion

The human transformations changed significantly the natural environment, interrupting the natural succession of vegetation. During the last century, the human pressure upon the environment increased, and the forests and grasslands had been frequently replaced with arable surfaces and orchards.

Considering the structure and repartition of the categories of land use and agricultural fields, we can distinguish, in the Oltenia Subcarpathian depressions the following types of agricultural landscapes:

The agricultural landscape of closed cultivated fields – is usually located on the terraces, in depressions and on the slopes. The fields are bounded by embankments or fences of twigs and have various sizes connected to the extension of familial properties. There are usually present in the contact area of the hills with the plain, where the arable lands represent 30% of their agricultural surface (Fig. 3). It is best represented on the territory of the Muşeteşti commune. There are predominant the single houses, with an intense fragmentation of the lands.

The compact pomiculture landscape denotes the presence of orchards on extended surfaces in the Oltenia depressions, especially in Vâlcea county (Tomşani commune – 15% pomiculture terains) and on the Olt-Gilort watersheds. Favorable natural conditions are conferred by the south-east exposure of the sides, by the presence of fertile soils and the shelter microclimatic conditions offered by the Meridionali mountain range, which border the depressions in the north, but also by the existence of some deep valleys which are draining the depressions.

The discontinuous pomiculture-viticulture landscape gathers small parcels with vineyards and fruit trees, associated to the agricultural lands from the single houses. This type of landscape generally overlaps on the area of the *mixed* agricultural landscape and characterizes those communes which structure of land use is under 10% for vineyards and orchards.

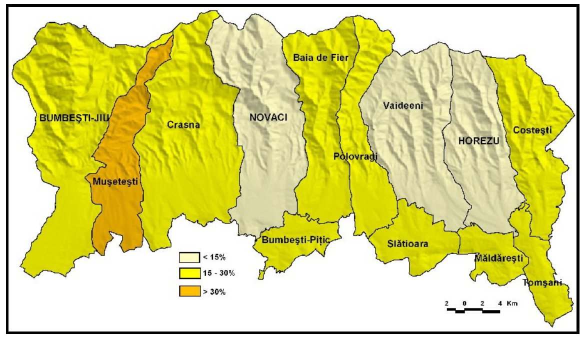

Fig. 3. The territorial distribution of the agricultural landscapes of cultivated fields

The agro-pastoral hilly landscape. It is present at altitudes ranging between 500-700 m, where there are extended surfaces with pastures, natural grasslands and where there are organized temporary settlements destined for breeding. The agro-pastoral landscape is better represented in the Gorjului Subcarpathians, where on certain areas the terrains covered with pastures occupy between 60-80% and even over 80% from the total agricultural land (Fig. 4). It is important to mention the fact that the Subcarpathians are crossed by numerous roads for transhumant shepherds.

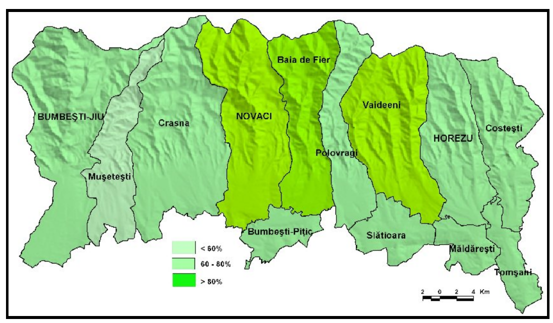

Fig. 4. Territorial distribution of agro-pastoral hilly type landscapes

The grazing in the mountainous area of Oltenia is pointed out by two concentration poles for this kind of activity, Novaci and Vaideeni. The shepherds from these areas, especially the ones from Vaideeni, have been practicing the transhumance from ancient times. During the summer they were going with the herds up in the mountain to the Obârşia Lotrului and during the winter they were descending in the meadow of the

Danube, up to the Dobrudja Piedmont. During the XIX[th] century there was a road for the transhumance of the sheeps, parallel with the Cerna of the Olteț, and in the mountainous area there were numerous sheepfolds, their names being same as the ones of the heights they were located on (Fig. 5).

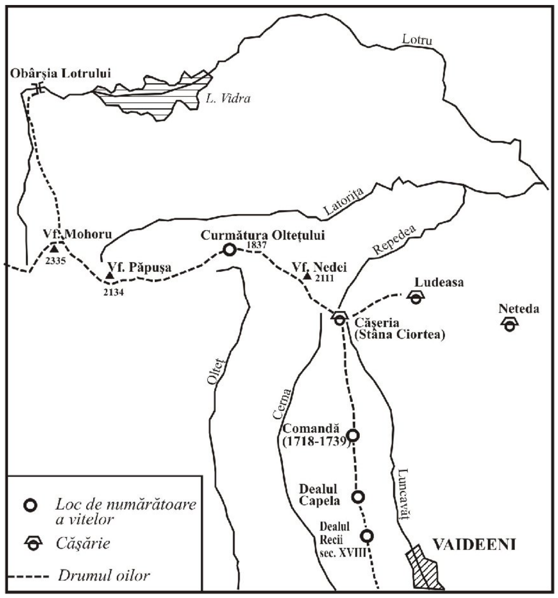

Fig. 5. Road for the transhumance of the sheep from Vaideeni

The mixed agricultural landscape is extended on large surfaces, in each of the three subcarpathian groups and combines associated agricultural spaces (arable, pastures, vineyards-orchards), a puzzle structure according to the variety of the environmental conditions.

The forest landscape. The forests occupy 26,7% from the national territory and are not uniformly distributed in the territory. According to some elaborated studies concerning the growing stock, in Romanian there are large surfaces of degraded lands, about 7 million hectares. Large surfaces of degraded terrains are found in the subcarpathian hilly region (The Muntenia Subcarpathians, the Moldavia Subcarpathians) and in the plateau (the Getic Plateau, the Transylvania Plateau, the Moldavia Plateau and the Dobrudja Plateau).

In the conditions of a passing from the natural economy to the industrial one (siècles XIX-XX), there took place essential modifications in the forest domain, both in the structure, in the composition of the tree species, as well as, by the pronounced reduction of the forest surfaces. A great importance in the rehabilitation of forest landscapes is reforestation, a high problem in the areas with big surfaces deforested.

The growing stock of the Subcarpathians is extended on approximate 28 percent from the total surface of the area. The forest landscape is best represented in the Oltenia Subcarpathian depressions (Fig. 6), at the level of the Costeşti (77.9 percent forests from the total surface) and the Muşeteşti communes (66 percent forests from the total surface).

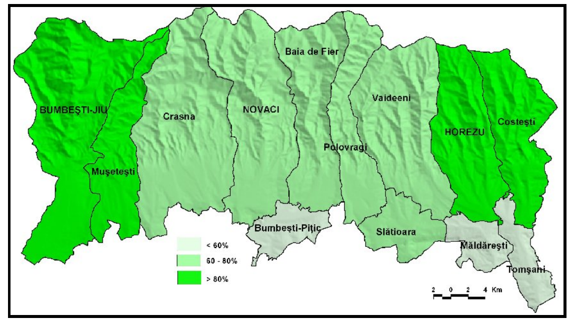

Fig. 6. Repartiția teritorială a peisajelor forestiere

The actual aspects of humanization of the forest domain are present in the landscape through the areas of forest exploitation, places of collection and wood processing, special roads for transport (forest roads and railways along the Bistrița Vâlcii, the Olteț, the Gilort valleys), but also by the industrial wood processing centers.

The types of rural landscapes determined by the interaction of human factors upon the environment reflect the natural degree of landscapes.

The dynamics in time and space of different forms of land use, expressed by the increase of the surface of agricultural lands, of the pastures or the reduction of forested surfaces, then the extension of human settlements, of the roads, of the surfaces affected by industrial activities, all these have an impact upon the environment changing it step by step in landscapes more or less humanized.

The moderately humanized landscapes found all over the Subcarpathians of Oltenia, express a relative balance between the natural and human potential. They are characterized by the variety of land use methods and by the intensity of the areas of forest ecosystems.

The strongly humanized landscapes appeared in connection to the development of industrial activities, especially the exploitation of subsoil resources (limestone–Bistrița) and the hydrographic resources (Bumbeşti-Jiu).

The artificialization of landscapes by creating human ecosystems, as a result of excessive energy consumptions, when they exceed certain limits, they can become dangerous to the human society and to the nature.

* * *

The social-economic process of durable development at the level of local communities is based on management strategies, generally aiming various landscapes, especially the agricultural ones. The economic value attributed to the landscape, as well as the interdependence between the local economic structures and the landscape carries a special interest in satisfying the social demands, in reduction the environment costs for landscape rehabilitation. In this respect we mention the major role held by a series of ampleness projects initiated at the European level, also applied in our country, with entire or partially external financing.

Such a project initiated by SAPARD programme, aims the professional training for the development of competencies connected to the application of agricultural practices destined to protect the environment and to maintain the rural landscape. Among the objectives proposed in order to develop the rural economy (priority axis no 3) we mention the agro-environmental measures in accordance with the subject of rural landscapes:

- The development of practical experience for the implementation of agricultural-environment measure, at the administrative and local level, respectively at a farm level, according to the principles of Common Agricultural Policy, will speed up the process of harmonizing the laws that Romania is performing, as well as taking over the experience of EU member states.
- The Ministry of Waters, Forests and Environmental Protection already started the preparation of the legal context for the implementation of the agricultural-environment measures, by approving the major elements of the law in this domain, as for example the Government Ordinance no 34/1999 regarding the organic production and its certification.
- According to the provisions of art. 22 from the Council Regulation (CE) no 1257/1999, the measures for agricultural production destined to protect the environment and to maintain the rural specificity (agricultural-environment) shall contribute to the multiplication of actions that fulfill the objectives according to the community policies regarding the agriculture and environment. Especially, the support offered by this measure will promote the application of pilot projects as an operational objective, aiming to convert to an organic agriculture, the protection of areas with a special biodiversity/natural importance and maintaining/improving the rural landscape or the one of the natural environment.

We also notice such an agricultural-environment measure for the geographical space (the Oltenia Subcarpathian depressions) analyzed in the case study:

- *Improving the quality of the environment* (setting up an ecological transfer point for waste – on an emplacement located on the public property of the Măldăreşti City Hall, which will serve for the entire area, being easily accessed by all component settlements of the Horezu Depression: Slătioara, Vaideeni, Horezu, Tomşani, Măldăreşti, Costeşti. It is recommended fully perform the project, and all its components, because it is enclosed in a durable development strategy of the area, which provides the success and the feasibility of the investment.

In conclusion, we mention the presence within the Oltenia Subcarpathians depressions of several types of rural landscapes which dynamic and complex character outlines the permanent interaction between the components of the natural and human environment.

The structure and the territorial distribution of the types of rural landscapes, express the intense exploitation of the assembly of conditions offered by this geographical space.

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VULNERABILITY TO NATURAL HAZARDS IN ROMANIA

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Abstract: The vulnerability assessment integrates the analysis of the conditions and the characteristics of a system that is exposed to a certain type of natural hazard. In the model that has been used in the present paper, the vulnerability was assessed at the administrative unit (county) level, as a result of the interaction between hazard and the exposed components of the system. The assessment of the exposure was done by measuring the total value of goods, resources and population that are exposed to natural hazards. There were selected 39 indicators, which were included into four major groups, depending on the main factors (physical, social, environmental and economic) that enhance the susceptibility of communities to natural hazards and on the elements that are exposed to these events. Each indicator was classified on a scale from 1 to 5 (1 – very low, 5 – very high). The sum of the indicators was reclassified according to the same model and, finally, the total exposure was obtained. The natural *hazard* was assessed according to the same principle, the earthquake, flood and landslide prone surfaces being taken into consideration. The total vulnerability was determined by overlapping the results. The analysis of the vulnerability enables the identification of the regions that need the allocation of financial resources in order to diminish the negative impact of natural hazards. Moreover, the vulnerability studies can be added to the natural hazards analyses, thus representing the fundament of the correct assessment of the risk that is associated to natural hazards.
Key-words: natural hazards, exposure, vulnerability, assessment.

Rezumat: Vulnerabilitatea la hazarde naturale în România. Evaluarea vulnerabilităţii integrează analiza condiţiilor şi caracteristicilor existente într-un sistem expus la un anumit tip de hazard natural. În modelul folosit în acest articol, vulnerabilitatea a fost evaluată la nivel de unitate administrativă (judeţ), ca rezultat al interacţiunii dintre hazard şi componentele sistemului expuse. Evaluarea *expunerii s-a realizat prin* măsurarea valorii totale a bunurilor, resurselor şi populaţiei expuse hazardelor naturale. Au fost selectaţi 39 indicatori, incluşi în 4 grupe majore, în funcţie de factorii principali (fizici, sociali, de mediu şi economici) ce măresc susceptibilitatea comunităţilor la hazarde naturale şi de elementele expuse acestor evenimente. Fiecare indicator a fost clasificat pe o scară de la 1 la 5 (1-foarte scăzut, 5-foarte mare). Suma indicatorilor a fost la rândul său reclasificată după acelaşi model, până la determinarea, în final, a expunerii totale. *Hazardul* natural a fost evaluat după acelaşi principiu, luându-se în discuţie suprafaţa cu potenţial de producere a cutremurelor de pământ, inundaţiilor şi alunecărilor de teren. Prin suprapunerea rezultatelor a fost determinată vulnerabilitatea totală. Analiza vulnerabilităţii oferă posibilitatea identificării regiunilor care au nevoie de alocarea resurselor financiare în vederea diminuării impactului negativ al hazardelor naturale. De asemenea, studiile de vulnerabilitate se pot adăuga celor ce vizează analiza hazardelor naturale, putând astfel constitui baza în evaluarea corectă a riscului asociat hazardelor naturale.
Cuvinte cheie: hazarde naturale, expunere, vulnerabilitate, evaluare.

Introduction

At the international level there is a large variety of definitions concerning the vulnerability and this is caused by the diverse conceptual and methodological approaches. There are multiple factors that can determine the vulnerability of a system (physical, social, cultural, economic and politic ones) and they interact in a complex manner, depending on the particular features and the location of that system. That is why most of the researchers think that it is essential to define vulnerability by taking into account the context (Downing *et al*., 2003) and the aim of the research.

The vulnerability is a concept with multiple dimensions (ecological, economic, social and institutional) and it represents *the degree in which a system can be affected by the impact with a perturbation or stress factor and its capacity of recovering or adaptation to the consequences of the impact* (Kasperson *et al*., 2002, Turner *et al*., 2003).

The vulnerability assessment integrates the analysis of the conditions and the characteristics of

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a system that is exposed to a certain type of natural hazard. In other words, it identifies the relation between hazard and the elements exposed to it.

The vulnerability assessment process is realized for a certain exposure unit (which may be a region, an ecosystem, an economic sector or a community - Kasperson *et al*., 2002).

Vulnerability assessment in Romania

The research conducted at national level concerned mainly the vulnerability of different types of systems to extreme events. The concept is initially mentioned in a series of synthesis works or articles having a theoretical character and referring to hazards and risks. Furthermore, it is to be noticed the assessment of the vulnerability of the Romanian territory to different climatic risks, on the basis of the exposure to these phenomena (Bogdan and Niculescu, 1999).

Subsequently, just like at the international level, the concept of vulnerability integrated the occurrence probability of extreme phenomena, their impact, as well as the capacity of the affected systems to rehabilitate/to adapt to the new context (Benedek, 2002; Bălteanu, Costache and Tanislav, 2003; Bălteanu and Şerban, 2005; Bălteanu and Costache, 2006).

From the methodological point of view, there were realised assessments of the biophysical vulnerability, especially in the framework of the geomorphologic research (eg.: Armaş *et al*., 2003; Armaş *et al*., 2005). At the same time, there are to be noticed approaches to the social vulnerability: the distribution of marginal social groups in Romania (Ianoş, Popescu and Tălângă, 1996), the analysis of the social stress at national level (Guran and Turnock, 2001), the social and economic fragility index corresponding to the underprivileged mining areas (Popescu *et al*., 2003), the identification of the underprivileged and vulnerable social groups (Guran-Nica and Roznovieţchi, 2002; Guran and Mocanu, 2005).

Raţiu (2007) estimates the vulnerability of rural settlements located in the Someş Plain, by taking into account several indicators of the social-economic and natural potential, while Goţiu and Surdeanu (2007) propose a methodology for the assessment of the population vulnerability to extreme events, depending on the proximity to the affected area and quantify the resilience of the human settlements under study on the basis of the average incomes of the inhabitants.

It is necessary to evaluate the vulnerability to different stress factors through the correlation of certain indicators that are relevant for the multiple dimensions of vulnerability (Sorocovschi, 2007), respectively the ecological, the social-economic and the institutional dimensions. However, a complex vulnerability index, which would integrate the exposure and hazard indicators, as well as those for the adapting capacity, has not been developed yet.

In Romania there is the Law No. 575/2001, concerning the approval of the National Territory Arrangement Plan – Section V, Natural Risk Areas, together with the Romanian Governmental Decision No. 477/2003, for the approval of methodological standards regarding the elaboration manner and the content of the natural risk maps. However, the studies and papers that deal with these natural extreme phenomena at national or county level concern solely the hazard analysis (through the discrimination of the areas depending on the distribution of the phenomena or of their occurrence probability), the aspects that concern the vulnerability assessment not being taken into account.

Methodology

Starting from the field literature (Odeh, 2002; Borden *et al*., 2007; Simpson and Human, 2008), we chose to use a system vulnerability quantification model that considers the result of the interaction between a potentially harmful event (the hazard) and the systemic components that are exposed to this event, according to the formula:

$$Vulnerability = Exposure * Hazard$$

In a similar way, this model is also used in the Natural Hazards Mitigation Plans in certain American states, being approved by FEMA (Federal Emergency Management Agency).

The first stage in the assessment of the vulnerability concerned the estimation of the exposed components, while the second concentrated upon certain hazard types, i.e. upon their spatial extension. By superposing the results, we determined the total vulnerability.

The assessment of the *exposure* was realised by measuring the total value of goods, resources and population exposed to natural hazards. There were selected 39 indicators, included into four major groups (comprising nine sub-groups), depending on the main factors that increase the susceptibility of communities to natural hazards and on the elements that are exposed to these events. The formula used for the quantification of the exposure is the following:

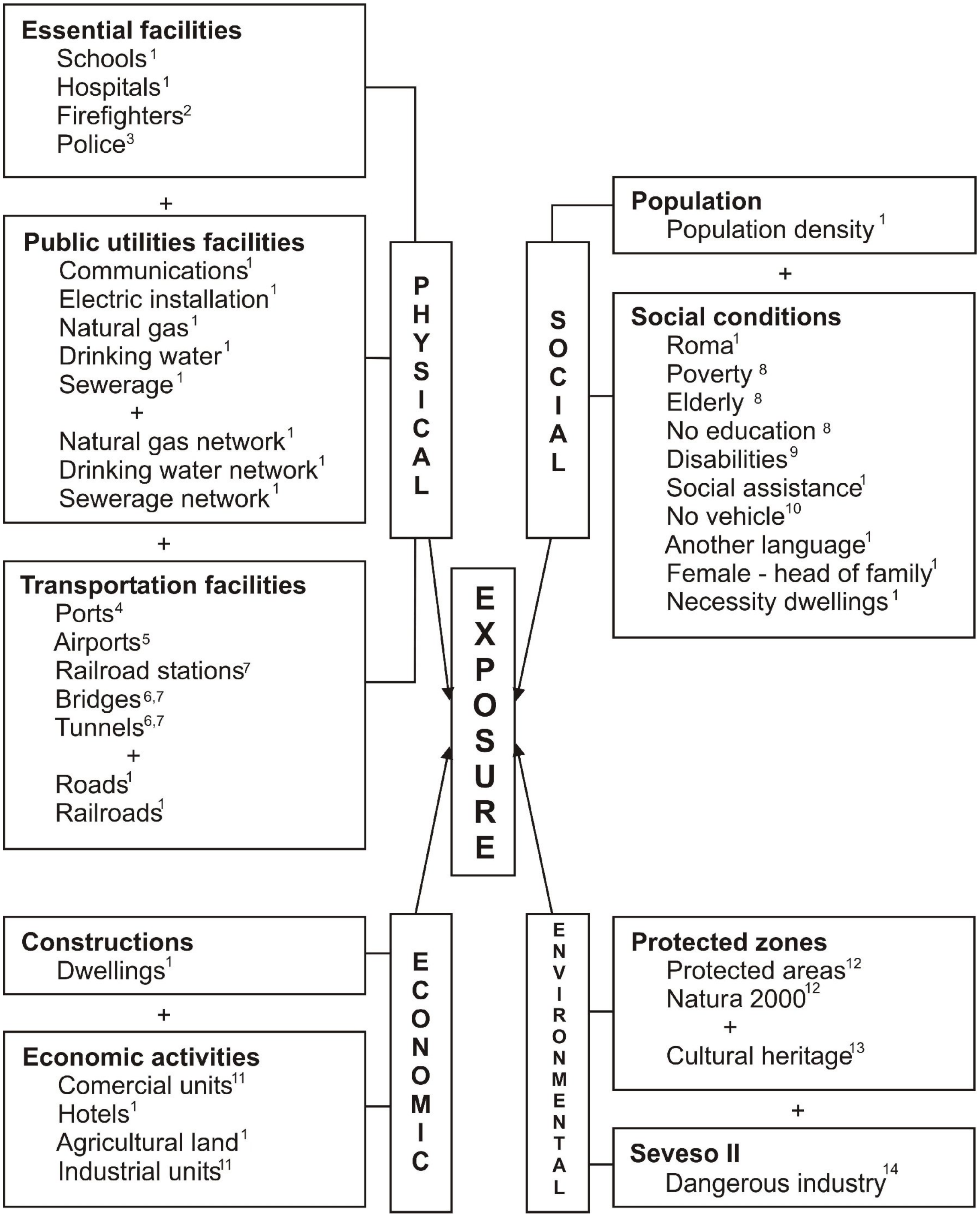

Fig. 1. Conceptual Model for the Exposure Degree Assessment

Exposure = PhysExp + SocExp + EnvExp + EconExp

Each and every indicator (expressed through its density, i.e. the ratio between the total value and the surface of the administrative unit) was classified on a scale from 1 to 5 (1 – very low, 2 – low, 3 – average, 4 – high, 5 – very high), using the Natural Breaks Method in ArcView GIS. In its turn, the sum of the indicators was reclassified according to the same model, the total exposure being finally determined (Fig. 1). Multiple data sources were used for the indicators (1 – 14, see the references).

The natural *hazard* was evaluated according to the same principle, taking into discussion the earthquake, flood and landslide prone surfaces (as percent of the total surface of the county), following the formula:

Hazard = Earthquakes + Floods + Landslides

Description of the variables

(A). Physical exposure (PhysExp)

The analysis concentrated on the critical facilities, as they play a major role in the response and reconstruction activities.

(a). Essential facilities

1. schools (nurseries, elementary schools, high schools and universities);
2. hospitals (also including TB sanatoriums and health resorts);
3. firefighters (detachments, sections, intervention guards);
4. police (municipality and city police; rural police).

(b). Public utilities facilities

5. communications (subscribers to the fixed phone network and Internet special access);
6. electric installations (settlements with households endowed with electric installations);
7. natural gas (settlements where natural gas is being distributed);
8. drinking water (settlements with supply installations for drinking water);
9. sewerage (settlements with public sewerage installations);
10. the natural gas network (the total simple length of the natural gas distribution pipes);
11. the drinking water network (the total simple length of the drinking water distribution network);
12. the sewerage network (the total simple length of the sewerage pipes).

(c). Transportation facilities

13. ports (zone master's office, harbour master's office, other offices);
14. airports (international and national);
15. railroad stations;
16. bridges (on roads and railroads);
17. tunnels (on roads and railroads);
18. roads (the length of the public national, county and communal roads);
19. railroads (the length of the railroad lines in use).

The most exposed administrative units (Fig. 2) are Bucharest city and Ilfov County (the high population concentration required the existence of numerous essential facilities, of an important density of utilities network and of transportation facilities – airport, railroad stations), but also Prahova County (with many schools, dense drinking water and sewerage networks, railroads stations and high density of public roads).

The least exposed counties are Tulcea and Harghita (due to the natural conditions that led to a low concentration of population and reduced facilities), Brăila, Ialomița, Vaslui, Caraş Severin, Neamț, Covasna, Teleorman, Giurgiu, and Călăraşi.

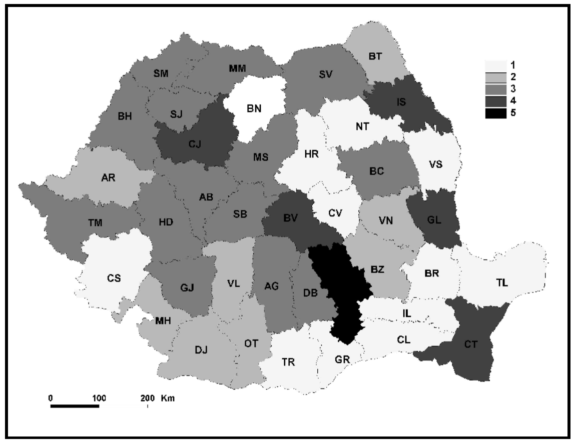

Fig. 2. The physical Exposure (Critical Facilities)

(B). Social exposure (SocExp)

There are taken into account the demographical features that highlight the areas with low human potential, while the financial resources are too limited as to ensure the passing over exceptional situations; there is to be noticed a strong dependency on the public institutions and resources.

The indicators that concern the social conditions (21 - 30) are expressed as percentage, being referenced to the county population (part of the total population). In order to preserve a similarity with the other indicators under analysis, the result is subsequently correlated with the population density at county level.

(a). Population

20. population density

(b). Social conditions

21. Roma (stable gypsy population – the Roma);
22. poverty (the poverty rate, respectively the part of the population that lives under the poverty[4] threshold in the total population);
23. elderly (the population being 65 years and over);
24. no education (the population being 15 years and over, which did not finish any school or graduated only the primary school);
25. disabilities (persons with handicaps, children or adults, in families or institutionalised);
26. social assistance (retired persons who benefit from the state social insurance,

[4] In accordance with CASPIS, the poverty threshold is defined depending on the household consumption, including an alimentary and a non-alimentary component. The alimentary component is calculated as value of an alimentary basket with a content of 2,550 calories, taking into account the structure of the alimentary consumption characteristic of the population within the second and the third deciles. The non-alimentary component is evaluated as that non-alimentary consumption level affordable for the households with an alimentary consumption equal with the alimentary threshold.

unemployed persons who benefit from redundancy payments, the beneficiaries of the soup kitchens);

27. no vehicle (persons that do not own a motor vehicle);

28. another language (the permanent population with a mother tongue different than Romanian);

29. female – head of family (the female population whose legal status is divorced or widow);

30. necessity dwellings (persons that live in necessity units: spaces with other destinations, temporary constructions or mobile units).

The most exposed counties (Fig. 3) are Giurgiu and Dâmboviţa (as a consequence of the predominance of the aged population and of the population without education), Bihor, Călăraşi, Teleorman, Mehedinţi (especially because of the high poverty rate, of the numerous households with female breadwinners, of the persons without education, without vehicle and of the important number of gipsy persons), Buzău, Prahova and Bucharest city (especially because of the high population density).

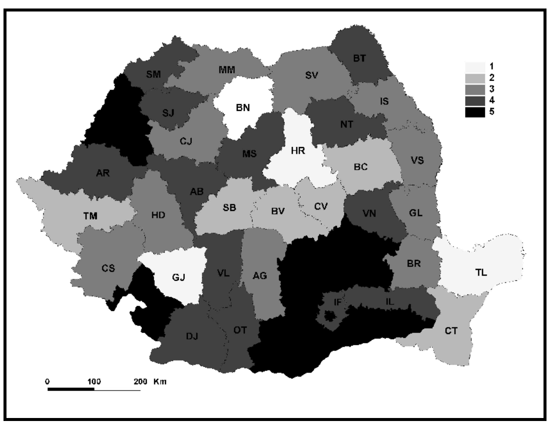

Fig. 3. Social exposure

Among the counties characterised by the lowest exposure, partially due to the reduced population density, there are to be noticed: Gorj, Harghita and Tulcea (also displaying low values of the indicators concerning the gypsy population, the population with disabilities or that receiving social assistance).

(C). Environmental exposure (EnvExp)

It concerns those environmental elements that can worsen the natural hazard impact or that can be severely affected by it. On the one hand, there are the areas having ecological significance (rare species, unique landscapes, built-up areas with exceptional value), and on the other hand, there are locations related to the appearance of secondary effects (units where dangerous economic activities are conducted).

(a). Protected zones

31. Protected areas (biosphere reserves, Ramsar sites, national or nature parks, nature monuments or reserves);

32. Natura 2000 (Sites of Community Interest and Special Protection Areas);

33. cultural heritage (the built-up patrimony with cultural value of exceptional national interest – historical monuments, architectural complexes, archaeological sites).

(b). Seveso II

34. dangerous industry (industrial units that conduct activities involving dangerous substances – according to the Seveso II Directive).

The most exposed units under analysis (Fig. 4) are: Bucharest city (the most numerous heritage monuments of exceptional national value and Seveso II industrial units), Hunedoara, Constanţa, Alba and Cluj (as a consequence of the high density of protected areas, especially the nature areas). The least exposed counties are: Sălaj, Vaslui, Galaţi and Ialomiţa (due to the small surfaces occupied by protected areas and to the scarcely represented industrial activities).

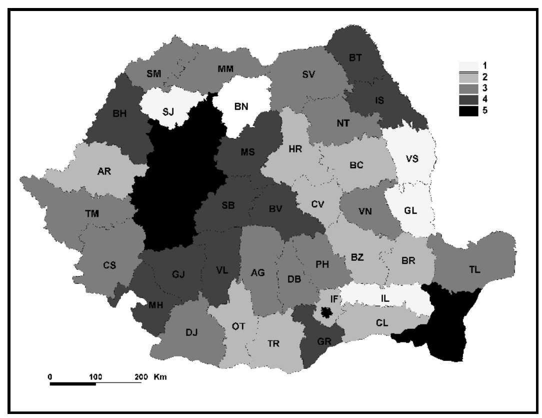

Fig. 4. Environmental Exposure

(D). Economic Exposure (EconExp)

It concerns the identification of the inhabited centres and of the major economic activities, on which the impact of the hazards can have severe effects; it becomes obvious in the material loss, the decrease of the incomes or the unemployment.

(a). Constructions

35. dwellings (the housing fond in public or private property).

(b). Economic activities

36. commercial units (local wholesale or retail trade units, with more than 50 employees);

37. hotels (and motels),

38. agricultural land (arable surfaces, pastures, hay-fields, vineyards and orchards);

39. industrial units (local units in the extractive or manufacturing industry, with more than 250 employees).

The most exposed (Fig. 5) are Bucharest city and Prahova County (which concentrate numerous houses, but also intense economic activities – with industrial, trade and tourism units). The least exposed counties are: Tulcea, Caraş Severin, Bistriţa Năsăud (characterised by small population densities), Gorj, Vrancea, Suceava, Harghita (generally less economically developed).

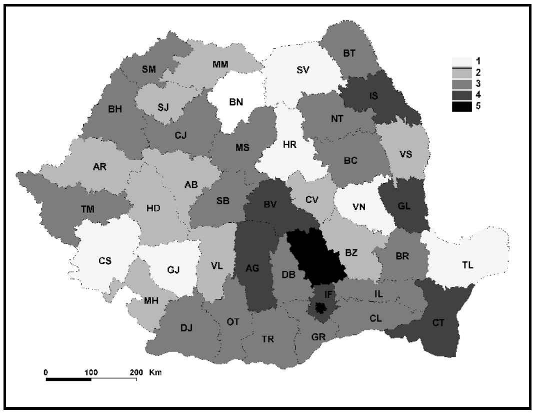

Fig. 5. Economic Exposure

Concerning the *total exposure degree* (Fig. 6), the most susceptible units are Bucharest city and Prahova County, while counties like Harghita, Tulcea, Vaslui and Covasna are at the antipode.

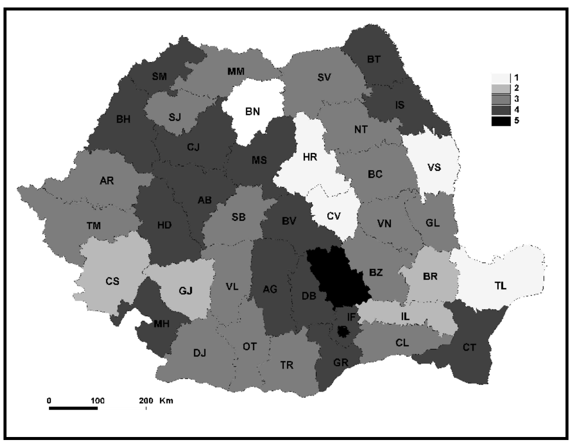

Fig. 6. The Total Exposure Degree

Natural hazards. The indicator includes quantifying elements that concern three hazard types (earthquakes, floods and landslides), as follows:

(a). earthquakes

The zonation of the Romanian territory is considered on the basis of the peak values of the field acceleration for projecting, in the case of earthquakes with an Average Recurrence Interval of 100 years (in accordance with the Order No. 1711/2006 of the Ministry of Transportation, Constructions and Tourism, which regards the approval of the Technical Regulation *The Seismic Projecting Code – part I – Building Projecting Stipulations*, indicative P 100-1/2006 and was published in the Official Journal No. 803 bis/September 25th, 2006).

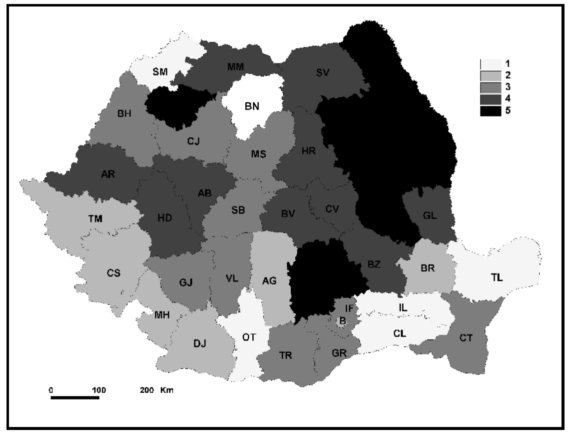

Fig. 7. Natural Hazards

(b). floods

We took into account the surface of the administrative-territorial units affected by floods caused by river overflowing and/or torrential flowing (in accordance with Annex 5 of the Law. 575/2001, concerning the National Territory Arrangement Plan – section V, Natural Risk Areas, published in the Official Journal No. 726/November 14th, 2001).

(c). landslides

We considered the surface of the territorial-administrative units that were affected by primary and/or reactivated landslides, depending on their occurrence potential – low, average or high (in accordance with Annex 7 of the Law. 575/2001 concerning the National Territory Arrangement Plan – section V, Natural Risk Areas, published in the Official Journal No. 726/November 14th, 2001).

The most exposed to extreme natural phenomena (Fig. 7) are the following counties: Bacău (earthquakes and floods), Neamț (floods), Vaslui (landslides), Sălaj (floods and landslides), Vrancea and Prahova (earthquakes), Botoşani, Iaşi, Dâmbovița (landslides). The least exposed are the counties located in the low regions, where there may not be conditions for the landslide occurrence (the slope is mild, the argillaceous rocks are missing), or there may have been realised defence works against floods (damming): Olt, Ialomița, Satu Mare, Călăraşi and Tulcea.

By combining the exposure value (Fig. 6) with the hazard value (Fig. 7), we obtained the total vulnerability value (Fig. 8).

The very high vulnerability is characteristic for the counties that overlap areas with high susceptibility to the occurrence of extreme phenomena: (1) Prahova county (high population density, numerous buildings, which required the development of critical facilities, a certain social exposure and an intense economic development); (2) Iaşi (high density of population and of related critical facilities, to which there are to be added numerous protected built-up areas and the big extension of the agricultural surfaces); (3) Dâmboviţa (high population density overlapping unfavourable social factors, caused by a predominance of the rural population); (4) Botoşani (social exposure and dangerous industrial activities).

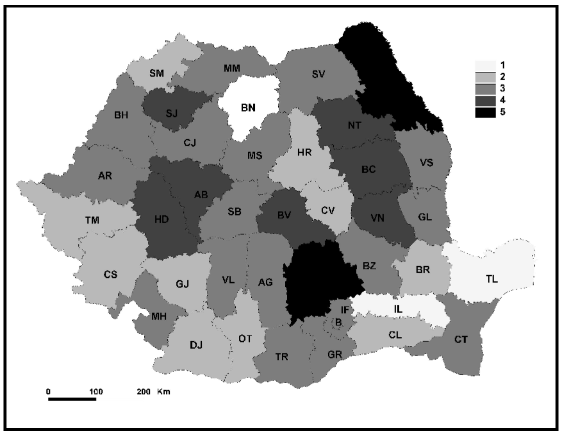

Fig. 8. Vulnerability to Natural Hazards

The least vulnerable counties are located in areas that are not exposed to extreme natural phenomena: Tulcea (the lowest population density, reduced facilities, low social exposure and poor economic development) and Ialomiţa (low population density, reduced critical facilities, few protected areas and insignificant economic development).

Conclusions

The analysis of vulnerability at county level enables the identification of the regions that need the allocation of financial resources in order to diminish the negative impact of the natural hazards. Moreover, the detailed analysis, through the focused research within the most vulnerable counties, will highlight the administrative units (urban centres and communes) that are vulnerable.

The vulnerability studies can be added to those that deal with the natural hazard analysis, thus representing the fundamentals in the correct assessment of the risk associated to these hazard phenomena.

The vulnerability undergoes changes in time because of the extension of the surfaces occupied by human settlements and of the daily transformations at the level of the population and of the economic activities; the changes also appear as a consequence of the major environmental transformations that lead to mutations in the magnitude and frequency of the natural hazards.

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THE POSITION OF RURAL-URBAN FRINGE IN THE FRAMEWORK OF HUMAN SETTLEMENT SYSTEM

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Abstract. The term of rural-urban fringe is more or less used in the specialized Romanian literature, which might be a consequence of the fact it superposes or confounds itself, as delimitation, with the periurban area or/and urban periphery. A brief presentation of the terms included in the equation of territorial delimitation, starting with the urban CBD to the effectively rural region, clarifies the succession of different concentric areas in a certain proportion. In order to reveal the expectancy horizon of this term, it is also necessary to study the situation at international level, where it is used to the prejudice of periurban or where both terms are used. This study emphasizes that an empirical research on terminology is far from being sufficient, the analysis of the methods used in determining the limits being also quite necessary, as our main target is to observe if the areas are superposed or if they are complementary.
Key words. rural-urban fringe, space, periurban, urban periphery, human settlement system

Rezumat. Poziţia franjei rur – urbane în cadrul sistemelor de aşezări. Termenul de franja rur – urbană este mult mai puţin utilizat în literatura românească de specialitate, ceea ce ar putea fi o consecinţă a faptului că se suprapune, se confundă în delimitare cu zona periurbană sau/ şi cu periferia urbană. O trecere în revistă a termenilor ce intră în ecuaţia delimitării teritoriale, începând cu CBD-ul urban până la regiunea eminamente rurală, limpezeşte într-o oarecare proporţie succesiunea diferitelor areale concentrice. Dar pentru a dezvălui orizontul de aşteptare al acestui termen este necesară analiza accepţiunii la nivel internaţional, acolo unde este utilizat în detrimentul periurbanului sau acolo unde se întâlnesc ambii termeni. Această analiză scoate însă la lumină faptul că o cercetare empirică asupra terminologiei nu este suficientă, fiind necesară şi prioritizarea metodelor utilizate în determinarea limitelor, pentru a observa dacă arealele se suprapun sau sunt complementare.
Cuvinte cheie. franja rur – urbană, spaţiu, periurban, periferie urbană, sisteme de aşezări

Introduction

As an open system, the town is an organism within which and through which the matter and energy flux do not cease at the limit of the built perimeter, as it marked by inputs and outputs, as well as by modifications or alterations of the recently mentioned capital. Taking into account these ideas, it is obvious that the initial system becomes a subsystem within the framework of an ampler vision of the territorial system.

The issue of delimitations or, generally, the study of human settlement system is the object of international documents that represent norms for the implementation of principles and methods on the base of which decisions aiming at sustainable development are taken. Among the most important documents, we mention – The Habitat Program of the UN (Habitat II), Green Book on the Urban Environment, Agenda 21, ESPON Program. All these programs developed at an international level deal with the argument of human settlements systems, recommending the inclusion of the close outside cities to urban centers – the cities, but they do not clarify the limits and the succession of the belts. Consequently, delimitation, used methods, and, seemingly, terms depend on the researchers, all these varying from one case to another or from one country to another.

The aim of this research is to synthesize, as much as possible, the terms used in the specialized literature regarding the urban-rural transition space through an analysis of the terminology and international linguistic problems. We also present the methods used in the delimitation of the aforementioned space using the situation of different international urban centers, which are significant for the analysis of the rural-urban perimeter.

Definition of the terms

The main actor within human settlement systems is obviously the *town,* which influences

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settlements through its position and rank. The human geography dictionary defines this term as an entity with a concentration of the inhabitants' number starting from a minimal threshold (which differs from one country to another), with a professional structure preponderantly involved in the tertiary and secondary sector, as a space characterized by a specific architecture and a great number of services offered to people. The outer limit of the city is not hard to be determined in the territory, because its features are easily noticeable, starting from its name or from the term of urbanism, which comes from the Latin word *urbs* that signified "the art of building the city". Thus, it is defined as the surface covered by buildings and equipped with town infrastructure.

Problems occur when trying to determine the internal limits of the town, especially *the center* and *the urban outskirts,* but also its functional zones. The center is the symbol of the concentration of the administrative and economic-commercial activities; of course, it is facile to determine the residential zones, as well as the former industrial platforms that presently are included to the city (but, as we shall further observe, they can be also considered as part of the rural-urban fringe, if we evaluate these zones in terms of landscape and, especially, if these units are no longer used). In this case, what is periphery and where do we place it?! I think the difference or its location is mainly related to the correct usage of the term. If we use urban outskirts/ outskirts of the urban, then we clearly aim at the inner urban / built-up space and if we use the term of town outskirts, then we aim at the space located out of the city urban limit, which belongs to the suburban zone and represents an indicator of the urban pressure upon the neighbouring space. Topologically, the term of outskirts indicates the limit, the edge of something steady (systematization of the elements emphasizes the same features), while axiologically, it indicates the way or the zone through which it is achieved the limits' exceeding (Stan, 2008). International literature encompasses the area formed by the outskirts both inside the urban space (Canada, Australia), as well as outside it (France, England), both variants being accepted, but with the specification of urban outskirts (namely built-up outskirts, as part of the urban) or of outskirts of the town (where the town networks are no longer present and living conditions are not optimal); the two terms express different things, the outskirts of the city being shared with the suburban zone.

Out of the urban limit, there are *the suburban settlements,* which, through their specificity, are dominated by the town activity and represent the main source of the town labour force. Specific especially in the USA, the suburban zone represents the place where new residential districts and commercial complexes of the shopping mall type develop.

There appears a new dilemma – suburban settlements are included or not to *the periurban*; the two terms refer to two distinct areas or to the same area. I believe, the key for solving this dilemma, is the analysis of the inhabitants' professional structure and, more obviously, of the land use and of the living way of the communities from the respective perimeter. One may say that suburban zones can be even centers inside the periurban zone, settlements-centers that distinguish themselves through a greater density of the buildings as compared to the periurban zone, where the density of building (especially the residential ones) is much lower and land use is mainly agricultural.

Definitely, the two zones with completely different features are completed by *rural zones*, where labour force is involved in the primary sector. Land use is characteristic to agricultural activities and the inhabitants' way of life is specifically rural.

The human geography dictionary defines the term of "rururban" as the area located between the town and the rural zone, without delimiting it accurately in space, where the urban functions intermingle with the rural ones. It practically defines the *rural-urban fringe*, specifying its limits and position within the framework of territorial systems only at a descriptive level, as a transition zone between the two extremes. The Oxford Dictionary of Geography presents the term as being the transition zone between urban and rural, but also between urban and suburban, a defining element being land use (sport grounds, airports, malls, parks), which gives an urban note to the rural zone. The inner and outer limits of this zone are the most accurately determined through the method elaborated by L. Weiguo and F. Tian (2002). They propose an analysis of the satellite images for delimiting different types of land use achieving the distinction among urban, rural, and transition zone at the pixel level. The calculus gives the threshold among the three zones, the preponderant percentage emphasizing the limit through a t – test of differentiation of the rural-urban continuum, also rendered by Ianos and Heller (2006).

In Asian countries, especially in China, rural-urban fringe is defined as the surface located outside the urban outskirts/ the limit of the built-up surface to the region with rural features. It is preferred the term of fringe instead of periurban because it is considered that the force of the town alters the features of the fringe and not vice versa through the penetration of the village features into the town or the fringe perimeter (Xu Feng, 2004).

Coming back to the regime of the urban theory (as we have mentioned above, for a sustainable development, the areas surrounding the towns must be seen as a whole), liberal economic policy considers that territorial systems develop by means of private capital and partly public capital. This situation is legislated by public administration for ensuring environmental protection and harmonious development of the human settlement system (Stone – 1993), as we shall further notice by analyzing the methods used for the delimitation of the rural-urban fringe.

Analysis of methods

In order to exemplify the methods for determining the rural-urban limits, we shall use the quantification and systematization achieved by N. Gallent, J. Andersson, and M. Bianconi (2006), based on the frequency these instruments are used by experts in the field. We shall further detail the most frequent and scientifically important methods, classifying them as it follows:

1. *Margin of built-up zones* – the base principle for settling the inner margin of the fringe is imposed by the margin of the built-up surface, specificity of the urban, while the outer margin is given by the rural area. This method is the most frequently used by Countryside Agency – UK (2002), Bunker and Halloway – Australia (2001), Foot – Italia (2000), Urban Planning Act, Japan (1968).
2. *Land use* – method briefly rendered previously, developed by L. Weiguo and F. Tian (2002) and used by ReUrbA – UK and Olanda and Broughton – UK (1996). It involves the analysis of land use for establishing the margins on the base of the binary pixels principle. If 1 is attributed to the cells where urban predominates and 0 to the cells where rural predominates, then the transition area develops where the values combine and there is also located the rural-urban fringe and its margins.
3. *Transition zones* – method that involves the determination of the margins through the empirical analysis of the transition area between urban and rural as a discontinuity / differentiation of the geographical space; the method was used by Hite – USA (1998).
4. *Metropolitan zones* – it is the case of Montreal model that uses the functional and structural features of the territorial administrative units within a metropolitan zone for settling the margins of different zones from the studied perimeter.
5. *Inside the rural* – a less frequent situation, through which the urban functions can be found within a specific rural perimeter due to delocalization; the most used principle is that of the densification of the buildings and built-up surfaces generally (Heimlich and Anderson, 2001).
6. *Urban meets rural* – it is the situation where the urban continuum appeared for a long period and the analysis of the present town infrastructure and of the services offered to population defines the margins of the fringe; a peculiarity of this case is the possible lack of the traditional fringe.
7. *Pressure zones* – it is expressed as the urban shadow through which the town exerts pressure upon the neighbouring regions and involves the study of the influence the center and the urban outskirts have upon neighbouring areas through the influence the last one acquires for penetrating the margins.
8. *Population* – it is an indicator frequently used in different studies of human settlements geography through the analysis of demographic structures and their distribution in space. Such an example is represented by the zones of urban influence established based on the demographic density values (Fig. 1). It can be achieved in GIS system using the administrative territories and the inhabitants' total number. By means of interpolation and Voronoi analysis there are obtained isolines that limits the areas characterized by different values of the same influence. Consequently, there is achieved an analysis of the dynamics of the parameters during time, but also at present, by superposing different used values (demographic structure, professional and educational structure, inhabitants' number, number of owned vehicles, etc.) of what the areas making up the metropolitan zone represent.
9. *Territorial – administrative policy* – a decisive factor for establishing the margins of the fringe through the decision power of imposing restrictions for horizontal development or, on the contrary, permissive measures according to the sustainability capacity of the territory. The method may be applied using the model proposed by Alonso

(1986), where the limit urban – rural is given by the optimum of the agricultural rent vs. the incomes generated by rents, which may lead to an excessive horizontal extension of the town without a restrictive administrative policy. As it can be noticed in fig. 2, the increase of the rent value (curve C), on the background of urban extension and of a greater life quality within the fringe, leads to the renunciation at the income generated by agricultural rent in favour of a potential greater income generated by rent. The inner margin of the fringe migrates outward from UF1 to UF2. This method is extremely precise for settling the inner margins, but less accurate for the outer margins, due to the reduced differences of the rural-rural rent.

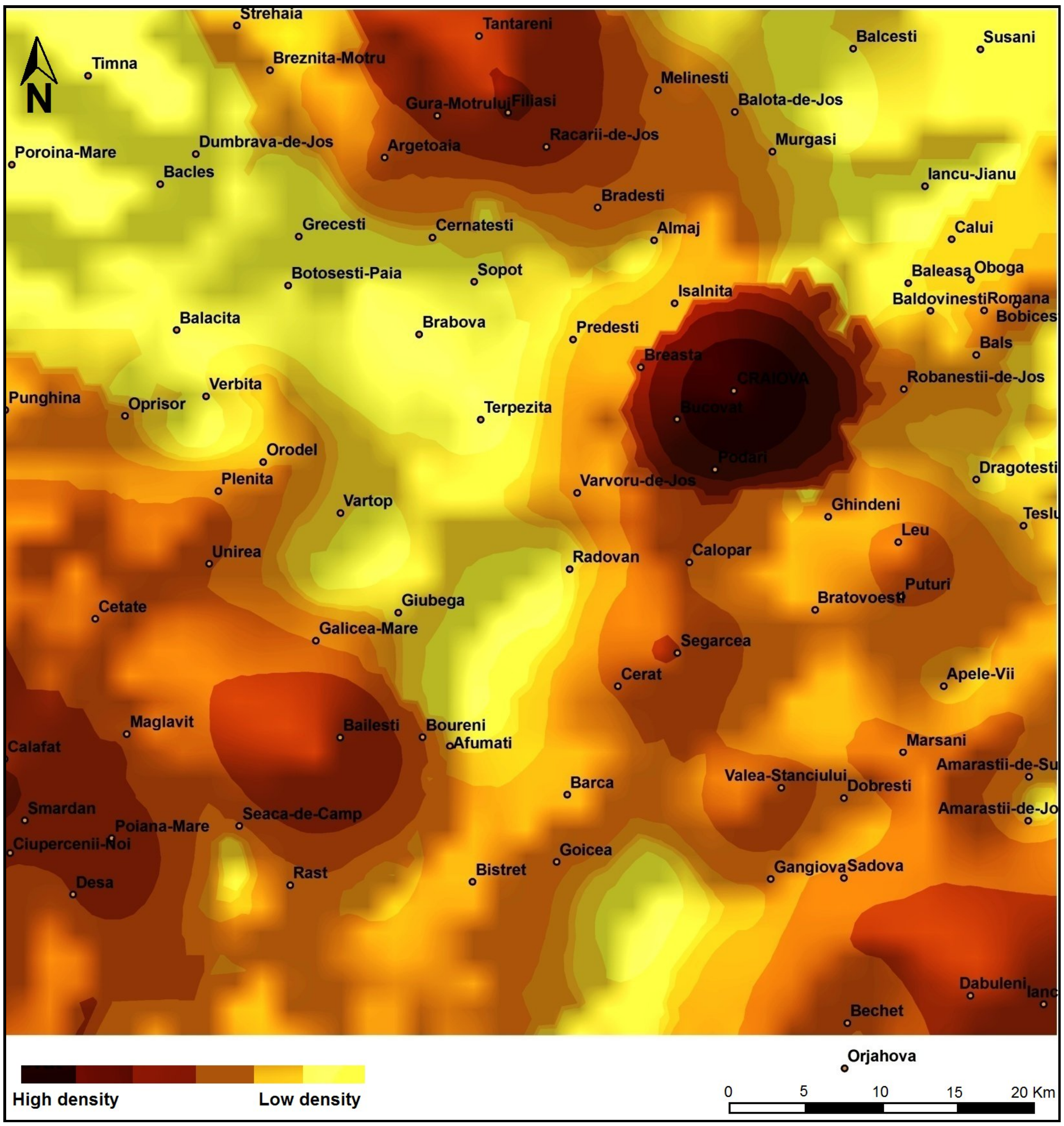

Fig. 1. Zones of urban influence by means of demographic density

10. *Economy* – it is the binder of present civilization. Through a restrictive policy meant to preserve the natural areas from the green-yellow belt of the cities, it is determined an increase of the value of the terrains belonging to rural-urban fringe (Fig. 3). The method involves the utilization of microeconomic principles that helps us determine both the inner and the outer margins of the fringe by analysing the demand and offer and by monitoring the land price.

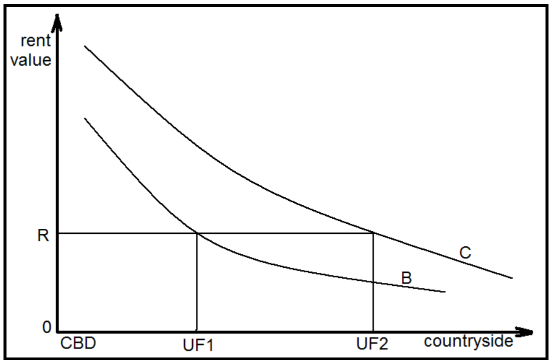

Fig. 2. Determination of the fringe margins through the analysis agricultural rent vs. incomes generated by rent (after Alonso's model, 1986)
(B=rent value before urban extension, C= rent value after extension, UF= fringe margin, R= rent value)

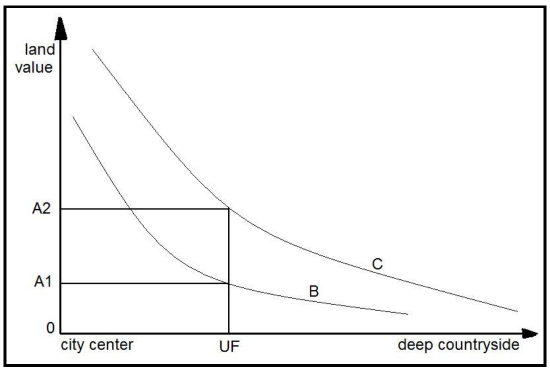

Fig. 3. The effect of urban extension upon land value
(B=land value before urban extension, C= land value after extension UF= fringe margin aleatory chosen, A1=land initial price, A2= the price after extension)
Source: Pacione M., 1999

11. *Accessibility* – as a method of studying the fringe limits it refers to the quality, quantity, and distribution of road infrastructure that, due to its nature, may be a limiting factor for the fringe or an expansion factor on both sides of the access route, as well as along it, due to its capacity of shortening the distances to the working place; for example, railway infrastructure, through the possibility of reducing distances, but only in case there are permanent trains at favourable intervals and regular-established stops; tram/subway lines have the same impact and may be taken into account for settling the margins of the rural-urban fringe.
12. *Landscape* – as a value of geographical continuity it can be used as a method for determining the spatial territorial limits. The note of the transition dominant landscape raises certain problems as those of the railway lines that introduce the fringe inside the urban space through the corridors they create, imposing the aspect of the fringe landscape.
13. *Way of life* – it is defining in the areas where the margin is subject to certain interferences and where this aspect can be analysed, because it supposes the presence of a permanent inhabitancy and of a social life expressed at the community level.

Study models of the rural-urban fringe

By applying the theories upon the territorial systems on the base of the aforementioned methods, it resulted a series of models of the fringe positioning and shape. The simplest or the most idealist model is that when the belts display different features and succeed each other concentrically (Fig. 4) starting from the town center – residential zone and/or former industrial zone – urban outskirts (which make up the urban perimeter) – suburban zone – periurban zone (which make up the rural-urban fringe zone).

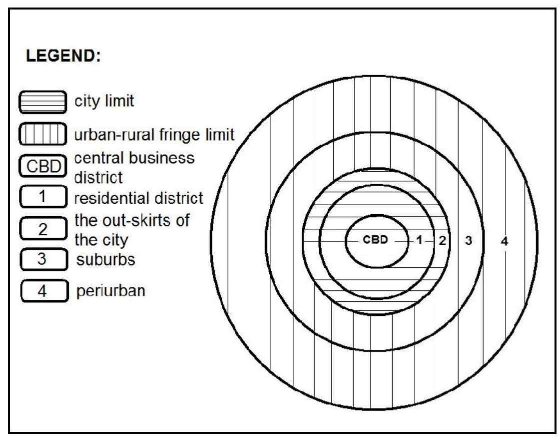

Fig. 4. Processing after Burgess model for urban models of land use

The model that includes the variable – suburban settlement to belong to the periurban perimeter, is proven by David Waugh (2000). The rural-urban continuity is given by the inclusion of the fringe, through intense transformations of the area exerted by the urban, which permanently alters its functions (Fig. 5).

The model that emphasizes the best field reality in the analysis of the rural-urban fringe is that of Montreal city. It used the functional and structural features of the territorial-administrative units within a metropolitan zone in order to settle the limits of different zones from the studied perimeter (Fig.6). The model starts from the premises of studying the functions of the main urban pole, of the secondary urban poles and of the rapport between them and the perimeter located.

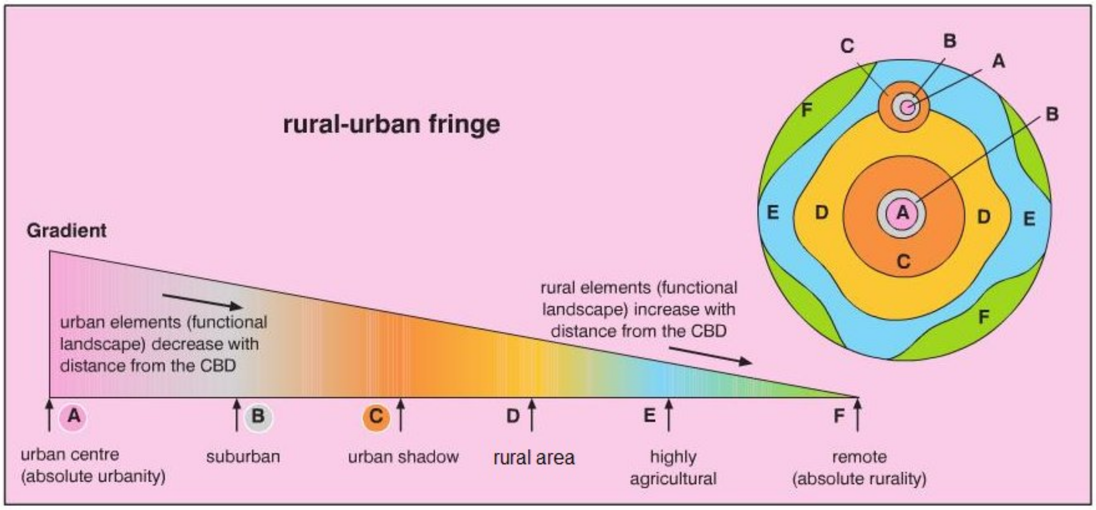

Fig. 5. Rural – urban continuum proposed by David Waugh (2000)

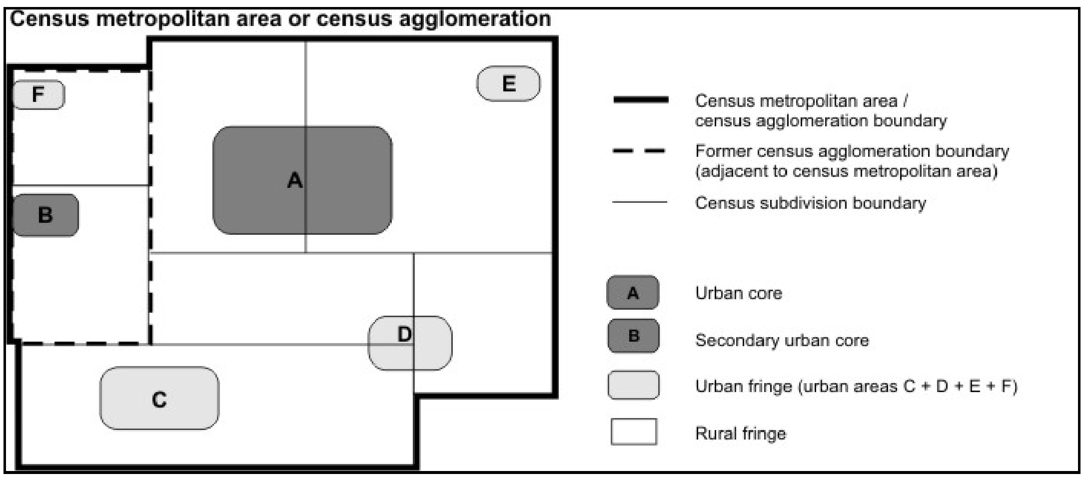

Fig. 6. Main and secondary urban poles and the positioning of the fringe types (Montreal model, 2006)

between them. It also makes the difference between the fringes of all studied urban centers, as well as of the rural fringe.

Conclusions

By briefly rendering the terminology used within the framework of territorial systems in order to analyse and denominate the urban-rural transition space, it resulted that the rural-urban fringe/belt includes the area of suburban settlements and the periurban zone, its limits varying from one case to another. The inner margin of the fringe is generally given by the contact with the town built-up surface, through its outskirts, while the outer margin by the contact with the truly rural area. The initially proposed model is a simple model, because it does not include either the suburbs variable included in the periurban as independent human settlements with a greater density of the built-up surfaces or the variable of inclusion of the secondary urban poles within the extended fringe through the externalization of certain functions of the main urban pole.

However, the model allows us a better vision upon the concentricity of the belts and their space succession. Consequently, it may represent a theoretical model for the initiation of the researchers in identifying the aforementioned zones, for a better implementation of territorial planning and a supporting instrument for decision makers.

Models that are more complex prove the difficulty in dealing with the argument because each case is true. At the same time, all the three presented models are correct as they represent only a starting point in the analysis of the territorial systems, and especially of the rural-urban fringe. Difficulty consists in precisely determining the zone because its functions are quite diverse and the mixed character between rural and urban persists, aspect derived from the name itself.

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GERMANS IN ROMANIA BETWEEN THE 1930s AND THE 2002s – GEOGRAPHICAL ASPECTS

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Abstract. In Romania, German ethnics arrived from Central Europe in several waves – during the XIIth-XIIIth and XVIIth-XIXth centuries – and settled mostly in the historical regions of central and Western Romania (Transilvania, Banat and Crişana) – that time under Hungarian domination or integrated in the Habsburg Empire. During the second part of the XXth century – beginning of the XXIst century, the number of these ethnics decreased – from 745.421 persons in 1930 to 60.088 in 2002 – as a consequence of Romanian's and German's government disloyalty from the Second World War (1940-1945), the lack of material and juridical base for the after-war generation during the communist governance, the fear, the isolation that continued after 1989 and the discredit towards the minorities' rights, proclaimed after the Revolution of December, 1989.

Key words. German people, Saxons of Transylvania, Swabians, deportation, emigration, Romania.

Rezumat. Germanii din România între anii 1930 şi 2002 – aspecte geografice. Etnicii germani au sosit în România din Europa Centrală în mai multe valuri, în timpul secolelor XII- XIII şi XVII- XIX, şi s-au stabilit în special în regiunile istorice din centrul şi vestul României (Transilvania, Banat şi Crişana), sub dominaţie ungară în acele timpuri sau integrate Imperiului Habsburgic. În cea de-a doua parte a secolului XX- începutul secolului XXI, numărul acestor etnici a scăzut- de la 745 421 persoane în 1930 a 60 088 în 2002- ca o consecinţă a lipsei de loialitate a guvernului român şi german din cel de-al Doilea Război Mondial (1940-1945), a lipsei bazei materiale şi juridice pentru generaţia de după război în timpul guvernării comuniste, a fricii, a izolării care a continuat după 1989 şi a discreditării faţă de drepturile minorităţilor, proclamate după Revoluţia din Decembrie, 1989.

Cuvinte cheie: populaţia germană, saşi, şvabi, deportare, emigraţie, România

The geodemographic study of national minorities is absolutely necessary, being added both to the historical and geopolitical approaches. In this respect, the academician Vladimir Trebici (1996, 61) considers that *first of all*, *it is interesting to outline the evolution of numerical and demographic structure of national minorities, their territorial distribution, social, economic and national characteristics.*

The German minority is one of the representative minorities in Romania, which influenced the history and culture of their living environment. The German population in our country is very heterogeneous from the point of view of the provenience and period when their settlement took place (12^{th}-13^{th} and 17^{th} -19^{th} centuries). Saxons, or Germans of Transylvania, also known in historic documents as Flandreuses, Teutons or Saxons, were colonized by Hungarians during the 12^{th}-13^{th} centuries, from the regions situated West of the Rhine, with the specific purpose of creating *centers of urban life they could afterwards exploit through taxes* (M. Ruffini, 1993, p. 30). They were grouped in the South and North of the province, in Sibiu, Braşov, Târnave and Bistriţa regions, where they were organized in chairs and Saxon districts. Favoured by the Hungarian Royal Administration, they stood apart among the nationalities in the province by the construction of numerous towns (Braşov, Sibiu, Mediaş, Sighişoara, Sebeş, Bistriţa) and fortified churches (at Biertan, Moşna, Valea Viilor, Şeica Mare, Şeica Mică etc.). Still in Transylvania, landlers, also known as transmigrants were brought over in Sibiu's neighbourhood during the 18^{th} century.

During the 17^{th} -19^{th} centuries, roaches from Banat and Satu Mare were colonized by the Austrians, being brought as agriculturers from Würtenberg region; also, tipters from Maramureş (as wood carpenters) and Germans from Bucovina. The Germans of Southern Basarabia (Tarutino and Tatar Bunar) and Dobrudjea were brought by Russians. The Germans in Banat, originary from Bohemia, reached the province during three major settlement phases - Caroline, Terezian and Josephine – and founded numerous settlements in the center, North-West and forest or mining

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regions (R. Crețan, 2005, p. 83); beginning with 1775 and until 1848, twenty seven German colonies were founded, as recommended by the emperor Josef, 2nd (1780-1790), (Vl. Trebici, 1996, p. 123).

Although at January, 8th, 1919, the National Meeting of Transylvanian Saxons took place at Mediaş, approving the political deeds of December, 1st, 1918 at Alba Iulia, aknowledging *the legitimate right of the Romanian people to unite and form an estate*, the territorial autonomy of the minorities was not respected, the counties' maires being appointed by the government; the habits of the national authorities were not known by the Saxons of Transyvania, delaying the adaptation process (Th. Nägler, 2004, 60).

According to the census of 1930, 745,421 persons of the Romanian inhabitans had Germanic origins during the inter-wars period, representing 4.1 percent of the country's population. Judging by this percent, the German ethnic group occupied the third place in the national structure of our country, after Romanians (71.9 percent) and Hungarians (7.9 percent); they were numerous in Transylvania (253,426 persons), Banat (223,167), Basarabia (81,089), Bucovina (75,533) and Crişana-Maramureş (67,259). Their percent within these historical provinces only outnumbered the average national percent in Banat (23.7 percent), Bucovina (8.9 percent) and Transylvania (7.9 percent). After a minute analysis of the data in the general population census of December, 29th, 1930, S. Manuilă (1940, p. 194-195) described the Germans in the West and the center of the country as *a well balanced group from a demographic point of view (the share of the urban and the rural population) and possessed an eminent economic and cultural position*; due to the *appropriate settlement among the fertile regions they could reach very high social standards.* But, this superiority *implicitly brought the evolution: the lowering capacity of biological increase and the lowest population growth of all the people in Romania.*

Between 1930 and 1956, the number of the German population in Romania reduced almost by half, reaching 384,708 persons (Fig. 1) which meant 2.1 percent of the national population. This drastical diminution was generated both by a low population growth, but also by the historical-political events of that time. The most influencial were: a) the territorial losses suffered by Romania; b) the second world war; c) deportation. Thus, before Romania's active participation in the war, after Ribbentrop-Molotov pact (August, 23th, 1939), North Bucovina and Basarabia were taken over by U.S.S.R., meaning a population of 30,000 German people.

In 1943, during the war, Germany took over most German ethnics in its army, according to the Romanian government. Due to this new situation made that, after Romania passed on the side of the Soviet front, soldiers and officers taken by the German army remained faithful untill the end of the conflict.

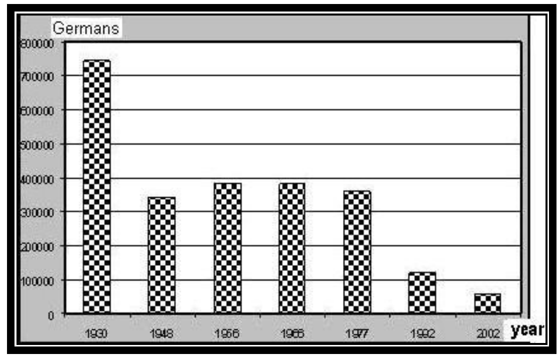

Fig. 1 The numerical evolution of German ethnics in Romania between 1930-2002

The fear induced by the entrance of the Soviet army in Transylvania generated the retreat of most Saxons of Transylvania from Bistrița and Reghin regions. Most of them arrived in Austria and Southern Germany, where they settled permanently. Although the king of Romania and premier of Romania, General Rădescu protested, part of the Germans capable of work, that had remained on the territory of Romania, were deported in the Soviet Union. During this period, the British prime minister, Winston Churchill appreciated that using Germans from Estern Europe to reunite the USSR was a legal right of the Russians (Th. Nägler, 2004, p. 61-62).

According to statistics, over 30,000 Transylvanian Saxons were deported in the Soviet Union, which, according to the census of 1941 would represented about 15 percent of the German population of Transylvania. Nine out of ten people arrived on the territory of Ukraine, in Dnepropetrovsk, Stalino and Voroşilovgrad regions and the rest in Ural Mountains' region. From the Saxons of Transylvania deported in the 85 existent camps, one third were working in mines, one fourth in construction and the rest in industry, agriculture and camp administration. Very few of them accomplished types of work that corresponded to their studies. The first Germans unfit for work were repatriated in Transylvania at the end of the 1945's. Between 1946-1947, about 5,100 Saxons of Transylvania were brought about in Frankfurt an der Oder, Germany, using special transport for sick people. About 12% died (3,076 persons), the percent being of 3 dead men to 1 dead woman and after their release from deportation, one fourth of them were sent away to Germany (from them, only 7 came back in Transylvania). The year of liberation for persons fit to work was 1948 (an overall of 49 percent) and in October 1949 the camps were abolished. The last third of deported persons came back to Transylvania. About 50% of the persons deported in the Soviet ocupation area of Germany were allowed to come back home. Most of the others passed in West Germany, few remaining in the Democrat Republic of Gemany. Only 202 persons were allowed to come back home in the period comprised between 1950 and 1952, while 7 deported persons decided to stay in the USSR (Http://ro.wikipedia.org/wiki/Deportarea_germanilor_din_Rom).

The consequence of the already presented events affecting the German population is very well reflected by the numerical evolution of the Saxons of Transylvania, which lowered from aproximately 250,000 persons in 1941 to about 157,000 in 1948. Also, a negative impact on the spiritual status of the German population in Romania had:

a) the nationalization of agricultural areas (March, 1945), factories, workshops, banks etc. (June 1948);

b) the deportation of 10,000 German people to Bărăgan in 1951;

c) the trials during the 60's, which resulted in sentencing some German intellectuals in Cluj and Braşov.

But Romania also offered some rights to the German minority, such as: a) the existence of German schools or schools with German teaching profiles; b) the editing of magazines, newspapers and books in their mother tongue; c) the existence of a German section within the National Theatre in Sibiu (founded, according to the decree no. 56771, at Novermber, 1st, 1956 as a section within the National Theatre and approved by the Executive Commitee of the People's Council of Stalin/Braşov region) and even a National German Theatre at Timişoara (also from 1956).

It is important to outline the fact that during those dramatic moments for the German minority, the Evanghelical Church of Augustan Confession was an unifying factor and moral support for the Saxons of Transylvania, with its headquarters in Sibiu and the Romano-Catholic Church in the case of the Swabian people in Banat.

As a result, the period comprised between 1956 and 1977 was characterized by a continuous numerical decrease of the German ethnics because of their emigration: from about 382,600 persons in 1966 to 359,109 persons in 1977 (Fig. 1). For the ones wishing to leave Romania, their relatives in West Germany or other Western countries were compelled to pay consistent amounts of money to officials or Romanian diplomats, reaching tens of thousands of Deutsche Marks per person (W. Schreiber, 2000-2001, p. 86).

As compared to the previous period (1930-1956), from 1956 to 1977 the decreasing rate of the German population decreased. Moreover, in some towns founded by Saxons in Transylvania, their number registered a slight increase. Thus, the number of Saxons came to reach 8,064 persons in 1956 and 13,080 in 1977 in Mediaş; 5,096 to 5,881 in Sighişoara; and 1,385 to 2,877 in Sebeş etc. (I. Mărculeț, Cătălina Mărculeț, 2000, p. 197-198; I. Mărculeț, Alina Bejinariu, M. Popa, 2002, p. 24-25).

In 1977, most Germans were found, as well as during the inter-wars period, in Transylvania (165,117 persons; 45.9% of the entire Germaan population), Banat (113,886; 31.7%) and Crişana-Maramureş (44,474; 12.3%), and the record regarding life environment situation was the following: 53.5% living in the rural areas and 46.5% in the urban ones. Within the historical provinces, the German population established in the urban areas was dominant in Muntenia (98.1%), Oltenia (89.5%), Dobrogea (82.3%) and Moldova (63.1%).

After 1977, Germans' emigration process towards the origins' areas progressively intensified. The fundamental causes of their leaving were not the political or ethnical persecutions, but had rather a psychological nature – by their desire of ethnical preservation – or an economic one, as the difference of the living conditions in West Germany and Romania were well known. Emigration was encouraged and even supported by the Romanian government and the foreign Saxon or Swabian associations. Thus, the unwritten agreement of 1978 between West Germany's chancellor, Helmut Schmidt and the Romanian president, Nicolae Ceauşescu, represented the starting point in raising the number of German emigrants, in exchange for certain sums of money. The phenomenon, unique in our history, was intensified by the fear of those who wished to leave Romania in order to avoid becoming too expensive. About 11,000 Germans were estimated to emigrate per year, but in 1989 their number raised to 14,598 persons per year (Fig. 2). Only between 1985–1989, the number of Germans leaving Romania raised to 60,818 persons (37.6% of our country's emigration). Because of the high rate of emigration, at the end of the 1989's, the German population in Romania only counted about 265,000 persons (W. Schreiber, 2000-2001, p. 86-87; http://ro.wikipedia.org/wiki/Germanii_din_Rom). The houses of the Germans that already emigrated were taken over by the state, and, in most cases, rented to homeless Hungarian, Gipsy or Romanian families. As a consequence, the old settlements or residential neighbourhoods, with homogenous German population were transformed into neighbourhoods with heterogeneous population, most constructions being deteriorated out of negligence.

The Germans' exodus from Romania, starting with the second world war, could not be stopped after 1989, being maintained both because of fear, isolation fright, which did not disappear, by the gregarious spirit and the distrust regarding the minorities' rights in Romania, proclaimed after the revolution of December, 1989, but also by not knowing the real situation of the emigrants in Germany (Th. Nägler, 2004, p. 63; I. Mărculeț, Cătălina Mărculeț, Elena Herda, 2007, p. 135). As a consequence, only during 1990, 60,000 Germans emigrated from Romania (Fig. 2). This flow continued until the summer of 1991, when Germany hardened receiving conditions. If in 1990, the monthly average emigration rate was of 5,006 persons, it lowered to 1,297 in 1991, 738 in 1992 and 495 in 1993 (http://ro.wikipedia.org/wiki/Germanii_din_Rom).

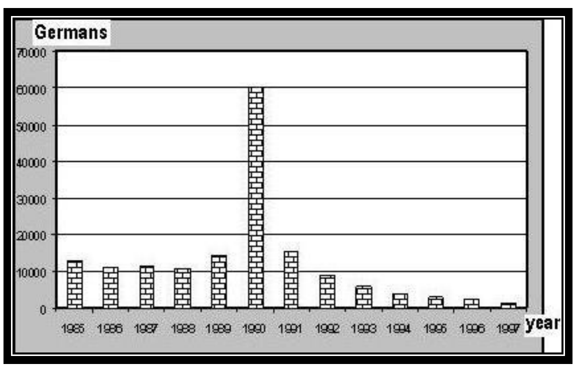

Fig. 2 The evolution of German people in Romania between 1985-1997
(Apud:Http://ro.wikipedia.org/wiki/Germanii_din_Ro)

According to W. Schreiber (2000-2001, p. 87), in 1990, the monthly average rate was of 9,265 persons and gradually lowered to 680 in 1991, 1,345 in 1992 and under 500 in 1993.

In 1992, according to the data registered at the census of January, 7th, the German population only counted 119,462 persons (aproximatively 0.5% of Romania's population) and occupied the fourth place in the ethnical structure of the country, following Romanians (89.5 percent), Hungarians (7,1 percent) and Gipsies (1.8 percent). As well as the preceding years, most of them lived in Transylvania (43,532 persons; 36.4 percent of the total), Banat (38,709 persons; 32.4 percent) and in Crişana-Maramureş (28,722 persons; 12.2 percent) (Fig. 3). But, this time a great change regarding the habitation environment occurred: 32.8 percent lived in villages and 67.2 percent in towns. The largest concentrations of population in urban environment were found in larger towns. Thus, over 10,000 of this ethnical group's representatives lived in Timişoara, about 5,500 were present in Sibiu and Reșița, and between 2,000 and 5,000 were established in Bucureşti, Arad, Braşov, Satu Mare, Mediaş and Lugoj.

Still following the statistics of 1992's, we can observe that 59.4% of the Germans in Romania had a Romano-Catholic confession, 22.8% Evangelical religion of Augustan confession, 6.8% Orthodox, 2.4% Evangelical Sinodo-Presbiterian, 2.3% Reformated (Calvinist) etc. (Fig. 4). The Germans having a Romano-Catholic religion predominantly lived in Banat, Crişana, Maramureş and in Bucureşti municipality, while the Augustan confession ones lived in Transylvania. The Orthodox and Greco-Catholic Germans come from the mixt marriages with Romanians and extremely rare, with Gipsies, while the Reformed ones, from the marriages with Hungarians.

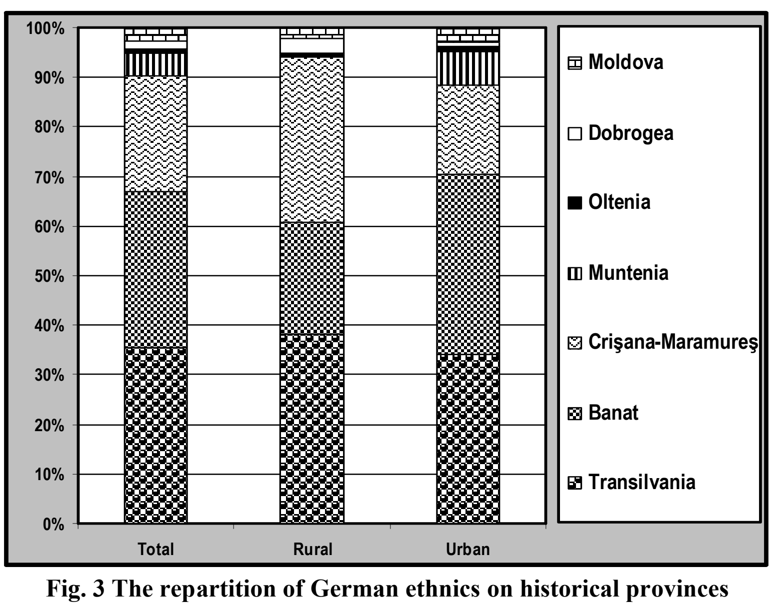

Fig. 3 The repartition of German ethnics on historical provinces and on habitation environment in 1992

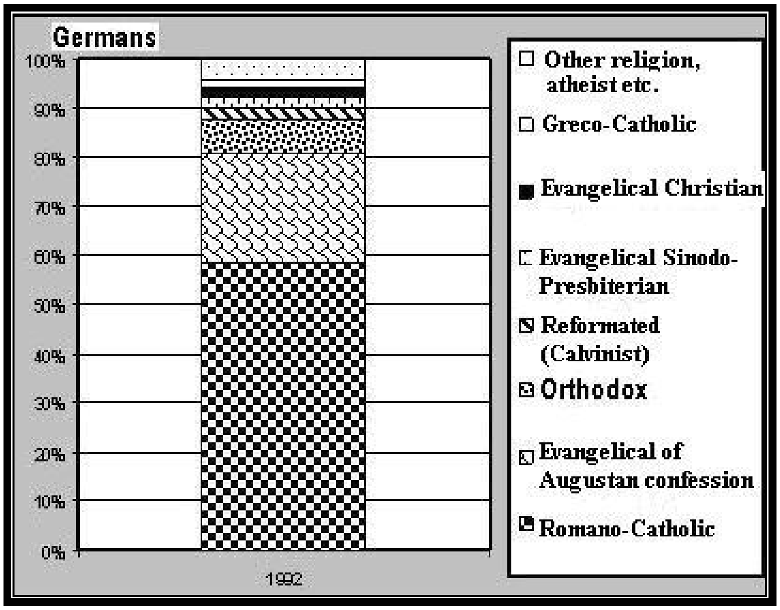

Fig. 4 The confessional structure of the German population in Romania in 1992

The numerical lowering of the German people continued during the last decade of the 20th century, so that at the last official census, in 2002, Germans in Romania only reached 59,764 persons, which represented only 0.27 percent of the country's population. By this percent, the German ethnics descended on the 5th place in the national structure after: Romanians (89.47 percent), Hungarians (6.60 percent), Gipsies (2.46) and Ukrainians (0.28 percent). Most of them lived in Timiş county (14,174 persons), Sibiu (6,554), Satu Mare (6,417), Caraş-Severin (6,149), Arad (4,852), Braşov (4,418), Mureş (2,045) and Maramureş (2,012). Within these administrative-territorial units, in the ethnical structure of Germans, percentages comprised between 1.5 percent and 2 percent were found in Sibiu (1.5 percent), Satu Mare (1.7 percent) and Caraş-Severin (1.8 percent) and over 2 percent only in Timiş (2.1 percent) (Fig.5).

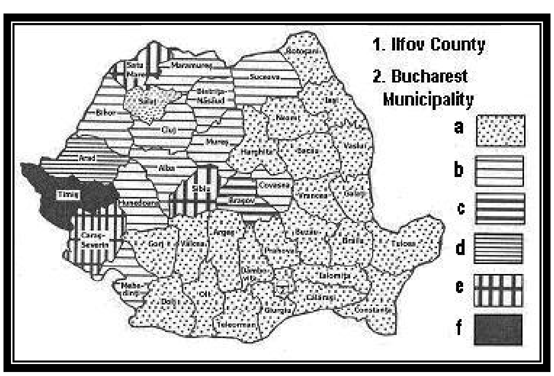

Fig. 5 The percentage of the German population in Romania's counties in 2002:
a) below 0.1%; b) 0.1-0.5%; c) 0.6-1.0%; d) 1.1-1.5%; e) 1.6-2.0%; f) over 2.0%

Regarding the repartition on settlements, in 2002, the highest percetages of Germans were found in the following towns: Timişoara (7,157 persons), Reşiţa (2,696), Sibiu (2,508) Bucureşti (2,358), Arad (2,247), Braşov (1,717), Satu Mare (1,607), Lugoj (1,319) and Mediaş (1,137).

Resuming the most important aspects which constituted the target of this scientifical approach, we can state the following:

a) the higher percentage of German ethnics in the historical provinces from the center and the West of Romania (Transilvania, Banat, Crişana and Maramureş), that have been under Hungarian domination or integrated within the Habsburgic Empire;

b) the predominantly descendant evolution of this nationality along the entire period we have studied, as a consequence of losing material and juridical basis, necessary for the generation following the second world war, the disappearance of double loyalty during this worldwide war, the fear, isolation and distrust feelings which did not disappear after December, 1989.

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