ANALYSIS ON THE LANDSCAPE AND SOIL FERTILITY POTENTIAL IN UPPER AND MIDDLE BASIN OF THE BEGA RIVER

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Abstract: *Analysis of the natural environment of a region (landscape, climate, hydrography, hydrogeology, soils, etc.) requires separate treatment of each component and identifying inter-relationships that take place between them In the upper and middle basin of the Bega river there are distinguished several major relief units (mountains, hills and plains), represented by: Poiana Rusca Mountains, the western hills and depressions, high plains and Bega River floodplain each unit and/or subunit with different environmental characteristics (geological, geomorphological, hydrological, climatic or pedological). The analysis was based on the works of scientific literature of the studied region, as well as on observations made on the terrain. To make maps of the relief there were used topographic maps, which were subsequently processed with specific software Geographic Information Systems, the same software was used for mapping the delimitation of relief units Subsequently, there were then overlaid with a map of administrative units, it was therefore obtained an overview of the percentage shared by each landscape unit in the territories. For the climate characterizing, the data used was recorded at the Lugoj meteorological station and also data extracted from the specialty literature. Situation on the land fund, fertility and of arable land classes were based on information taken from OSPA Timisoara, these data were further analyzed according to the specific conditions of the region analyzed. In the scientific literature, there are few works dealing separately the upper and middle basin of the Bega river therefore to characterize this region as a whole, all the subcomponents have been studied. Environmental conditions vary from one unit and/or subdivision to another. As surface, the biggest share belongs to the low hills. The climate of the analyzed region is tiered according to altitude: lower altitude brings higher temperatures and reduced rainfall. Surface waters are well represented, the main river is Bega. The most important lake is Surduc storage lake. Groundwater have different characteristics depending on the relief unit. Soils are specific to the mountain and hill area. Of the total agricultural area, the largest share belongs to arable land and pastures, excepting the communes in the mountain and high hill areas, where the grassland share increases. Most of the arable land is classifies within the III and IV quality class.*

Key words*: relief, climate, hidrology, soils, environment*

INTRODUCTION

Analysis of the natural areas (landscape, climate, hydrography, hydrogeology, soils, etc.) requires separate treatment of each component, identifying relationships, influence or mutual conditioning that occurs between these components. The analysis of the relief of a region has a particular importance, in several respects: its characteristics influence climate parameters (air temperature and rainfall, in this case) resulting in a natural setting of their altitudinal display and individualization of topoclimates and microclimates in the region, it has a direct influence on the characteristics of the river and the distribution and characteristics of groundwater, together with other environmental factors (climate, vegetation, etc) it conditions the processes of soil formation and evolution, distribution, their use type and fertility potential.

In the upper and middle B.H. of Bega river there are distinguished several major relief units, mountains, hills and plains, represented by: Poiana Rusca Mountains, the western hills and depressions, high plains and Bega River floodplain each unit and/or subunit with different

environmental characteristics (geological, geomorphological, hydrological, climatic or pedological).

MATERIAL AND METHODS

This study refers to the natural characteristics of the upper and middle basin of the Bega river. The analysis of the natural landscape was based on the works of scientific literature of the region studied, as well as observations in the terain. To make the maps for the relief were used topographic maps, which were subsequently processed with specific software for Geographic Information Systems, the same software was used for making the delimitation of relief units and subunits.

This representation was later overlaid to a map of administrative units, thus it was obtained as an overview of each unit's share, as a percentage, in the landscape of the aforementioned territories. The climate characterization of the area was based on data obtained from the Lugoj meteorological station, concerning the annual average temperature, average monthly temperatures, monthly and multiannual average rainfall. Classification of soil fertility quality classes (for arable land) and the situation of the land in the communes were obtained from OSPA Timisoara, these data are represented and analyzed in accordance with the specific conditions of the studied area.

RESULTS AND DISCUSSION

Landscape. In the upper and middle basin of the river Bega are distinguished several major landscape units, classified in terms of altitude on a very wide range of 76-1374 m (Fig.1).

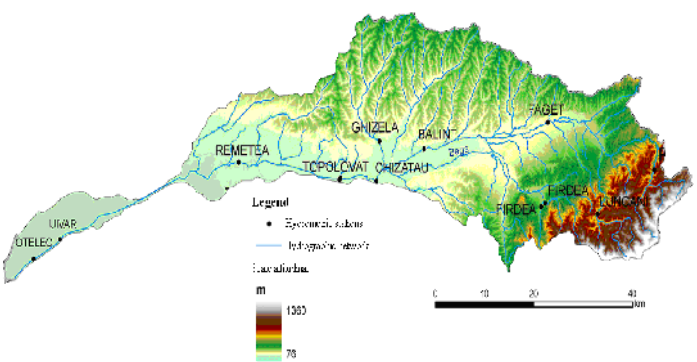

Figure 1 The Hydrographic Basin of the Bega River - physical and geographical map

1. Poiana - Rusca Mountains, occupying the southeastern perimeter studied (fig 1), Overall, Poiana – Rusca Mountains is a massive unit with a maximum altitude of 1374 m recorded in Fades Peak , (Geography of Romania, vol III).

Morphometric characterized by: density fragmentation between 2 to3 km/km^2, the landscape having values of approx. 220 m/km^2; slopes have values from 1 to 10° in its surface leveling, 15-35° in the slope and pipe surfaces and slopes are greater than 40° on petrographic slopes (Geography of Romania, vol III).

From the geological point of view the Poiana Rusca Mountains are composed almost entirely of crystalline schist, plus small areas of limestone (Sasa river basin), crystalline

dolomite, volcanic rocks and sedimentary formations, in marginal areas, resembling to a horst well bounded by marginal grabene (MÂNDRUȚ, 1993).

In terms of geomorphology it can be seen a variety of forms of landscape in conjunction with petrographic and structural detailed composition: landscape carved on limestone rock (clints, sinkholes, poles, blind valleys, caves and small sectors chiei), landscape developed on metamorphic rocks (ridges, pyramid shapes, inter-looking- heavy); landscape modeled on igneous rocks (flat or rounded interfluves, passes and keys) and volcanic-sedimentary formations (forms dull, flanked by steep slopes); landscape modeled on conglomerates, sandstones and clays (columns, towers, arched ridges, narrow interfluves, slides and flows, differential erosion basins), structural landscape - not very well individualized (IELENICZ, 2005); fluvial landscape (erosion forms specific to the storage of minor beds, meadows and terraces); anthropogenic landscape, resulting from exploitation of naturally occurring construction materials, means of communication, storage of various materials (Geography of Romania, vol III).

2. Hills and depresions. Hills of the studied area which belong to the Western Hills are positioned as an intermediate step between the mountains and the plains. The average altitude of these hills is 300 m (a variable figure depending on the author), the lowest values occurring in contact with the plains, 100-120 m and the highest values in contact with the mountains, 400-450 m (MÂNDRUȚ, 1993).

Structurally, in the composition of the Western Hills a crystal foundation is distinguished, represented by blocks of different sizes (precambrian-paleozoic) and a thick over blanket. Sedimentary occurs in two forms: one old (prelaramic), and another batch pleated and neogene, with thick and often slightly monoclinal structure (IELENICZ, 1999).

In the upper and middle B.H. of Bega river, the Western Hills are represented by Lipovei Hills, Surducului Hills (Lugoj Hills by some authors) and Făgetului depression, each divided into several subunits.

Lipovei Hills, on the territory of the upper and middle BH of the Bega river, are present on the southern half (Fig. 2), which forms the northern perimeter of the investigation. This landscape presents its self into two steps: a higher level (over 300 m) in the north and a lowered (200-300 m) in the south and west. It is fragmented by a dense network of valleys. Loose rocks, hills associated with deforestation, erosion phenomena favored increasingly more landslides following heavy rainfalls, more frequently around the settlements of Bara, Ohaba Romana, Rădmăneşti (MUNTEANU, 1999).

Bulzei Hills (Frăgulii) are separated from the Lipovei Hills by the Căpâlnaşului Valley, and Icuiului Valley distinguishes them from Lăpugiului Hills. They have a varied lithology: andesite pyroclastic and debris covered the Miocene marl and clay, basalt, pyroxene andesite, limestone, clays, sands, sandstones and marls tortonian and panonian age (MUNTEANU, 1999). In terms of altitude sometimes they exceed 400 m (478 m Dambul Gomila, Dambul Horn 437 m).

In the scientific literature there can be identified several ways to classify the hills of north-west part of Poiana Rusca Mountains. Some authors treat separately Lăpugiului Hills and Lugoj Hills (between Bega Luncanilor and Lugoj Planes), the situation shown in Fig. 2, while other authors consider Lăpugiului Hills and Lugoj Hills as subunits of Surducului Hills (MUNTEANU, IELENICZ, ARDELEAN, etc). In this paper we make the classification according to the latter, considering Lăpugiului Hills, Fagetului Hills and Lugoj Hills as compartments of Surducului Hills.

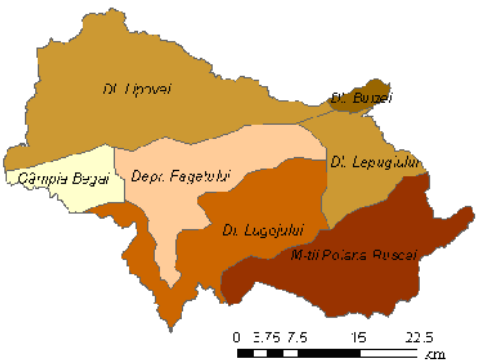

Figure 2 Relief units from B.H. Bega

Surducului Hills located in the north-western part of the Poiana Rusca Mountains. Due to differences in lithology, the separation from the mountains it is obvious on the alignment of Crivina, Hăuzeşti, Gladna Romana, Zolt and Tomeşti settlements considered to be contact lowlands. The eastern boundary is formed by Sasa River (Bega Luncanilor) up to the Crivina settlement and the northern boundary is given by Bega river terraces (MUNTEANU, 1999).They consist of Pannonian rcks, clays prevail, sands and gravel, deposited on a foundation composed of crystalline schists and strongly faulted and divided into blocks. The hydrographic network of highly fragmented rocks forms rounded or smooth ridges, reaching an altitude of about 500 m, within the Surduc crystalline height (496 m), a spur within the Poiana Rusca Mountains (IELENICZ, 1999). he hydrographic network divides these hills into several compartments, morphologically distinct (ARDELEAN, 1979):

- Lăpugiului Hills (Fig. 2), partially contained within the researched perimeter, located between the Icui valley and the Homojdia valley
- Făgetului Hills (Bucovat), located between Bega Valley and Gladna Valley are limited to the west by the crystalline spur of Surduc, in the north and east by the Bega valley and terraces, and the southern boundary is formed by the mountain frame;
- Lugojului Hills in the north and north – west have the Glaviței valley, in the south-west limit have the Timis valley and at the eastern boundary there is the crystalline spur of Surduc;

Făgetului depression, sits along the Bega river with an elongated shape, direction east – west (Fig. 2) and has as axis the Sărazului valley. The contact with neighboring units is marked by obvious irregularities. The hearth of the basin inclines to the east (cca. 170 m) to west (cca. 150 m) and the landscape consists of lower terraces of the Bega River, developed mainly on the left side and a wide meadow, set for flooding (Geography Romania vol IV, 1992).

3. The plains of the analyzed area are subunits of the Banat Plain. Its altitude ranges from 80-180 m, with a slope that decreases from east to west, consistent with the overall characteristics of the territory. In the area investigated, the Banat Plain is represented by:

- Plains of terraces, respectively Sudriaş-Dumbrava Field, with the southern border represented by the Lugoj Hills and Făget Hills, and the northern border by the meadow of Bega River.
- Low plains with alluvial – pluvial deposits, represented by the Bega River Bay Plain (PUSCA, 2002) or Glaviței Plain (POSEA, 1992), stretching from upstream Faget to downstream Costei

4. Meadows are the latest forms of landscape (holocene), covered by materials, generally coarse, having different appearances depending on the area crossed by the rivers. The Bega River meadow, in the upper sector has a smaller area, with an average longitudinal slope of 1-2 m/km, while in the middle sector the area increases in size, the longitudinal slope is reduced and becomes a more unified sector (PUSCA , 2002).

Climate. Among the elements that characterize a region's climate, in this paper we will refer only to air temperature and rainfall.

While average annual temperature increases with decreasing altitude, from 2°C on the highest peaks, up to 10-11°C in the lowlands.

To 30-year annual average (1980-2010) in 2010 and 2011, annual average temperatures were higher, especially for 2010 (Table 1).

Table 1

Climatic conditions at the meteorological station Lugoj

Years	Air temperature												Anual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1980 - 2010	-0.4	1.1	5.8	11.2	16.4	18.7	21.3	21.0	16.1	11.2	5.7	1.3	10.8
2010	0.1	3.2	6.3	11.8	16.5	20.3	22.3	22.0	15.8	9.1	10.1	1.0	11.5
Deviations	-0,3	+2,1	+0,5	+0,6	+0,1	+1,6	+1,0	+1,0	-0,3	-2,1	+4,4	-0,3	+0,7
2011	-0.6	-0.7	6.1	12.4	16.0	20.4	22.0	22.1	19.3	9.6	2.3	3.3	11.0
Deviations	-0,2	-1,8	+0,3	+1,2	-0,4	+1,7	+0,7	+1,1	+3,2	-1,6	-3,4	+2,0	+0,2
Rainfall													
1982 - 2010	61.7	40.1	43.0	62.8	68.6	87.9	59.3	61.3	55.3	49.2	52.3	61.6	703.1
2010	88.7	50.9	30.7	56.9	153.6	77.0	54.7	69.0	25.4	25.9	39.5	68.3	740.6
Deviations	+27	+10,8	-12,3	-5,9	+85,0	-10,9	-4,6	+7,7	-29,9	-23,3	-12,8	+6,7	+37,5
2011	30.5	40.7	22.7	31.1	51.8	37.6	122.1	7.0	15.9	23.7	0.0	38.3	421.4
Deviations	-31,2	+0,6	-20,3	-31,7	-16,8	-50,3	+62,8	-54,3	-39,4	-25,5	-52,3	-23,3	-281,7

In 2010, the average monthly temperatures remain higher than the annual average until early autumn, when a slight decrease from this (Table 1) and a further increase in november (the difference of approx. 5°C) is observed.

The year 2011 starts with temperatures lower than the annual average (january and february) and continues with values slightly above the average, until september, when there is a further decline, followed by exceeding the average during the months of november and december (Table 1).

The amount of rainfall in 2010 exceeds the normal value by 37.5 mm. During the year the precipitation vary as follows: they decrease from winter to early spring, they increase slightly in april and suddenly in may, when it is registered the highest monthly average, then they decrease gradually until early autumn, the season in which there are registered the lowest values and a new growth occurs is in december.

In 2011 the precipitation are very low, marking a dry period, then they rise sharply in july, marking the highest value, then there is a severe decline and they remain at very low values by the end of the year (Table 1). Compared to the annual average, there is a deficit of -281.7 mm. The year 2011 stands as the most poor in precipitation in the last 30 years.

Hydrography and hydrogeology. The main *river* that drains the researched area is the River Bega. It comes from Poiana Rusca Mountains, under Padeşu Peak, from an altitude of 1150 m. It is formed by the union of two arms and Bega Luncani and Bega Poieni, near Curtea. In the upper stream Bega and its tributaries have a mountain character, with narrow valleys, with no major beds and longitudinal slopes ranging from 5 to 30 m/km, with an average of 15 m/km

In the oothills, Bega River has a large valley with terraces on both sides and and a well-developed meadow. Due to low slopes, about 1 m/km and even smaller and larger flow rates, Bega rambles, tending to deviate to the right.

Both the mountain area and in the foothills, Bega has many tributaries, with permanent or temporary courses, which come from Poiana-Rusca Mountains (Sasha, Vadan, Gladna, Carpeni, etc.), or Lipovei Hills (Topla, Cladova, etc) or Surducului Hills. These are rivers with low flows, some of them dry during the summer-autumn (Topla), when precipitation are low.

In the investigated perimeter of major importance is the Surduc storage lake It is situated on the river Gladna at a distance of 2 km in upstream of Surducu Mic town. The storage lake of Surduc is in use since 1976, the dam has a height of 35.5 m and a length of 130 m from the canopy, the lake is 538 hectares and has a water volume of 66.27 million m^3 (MUNTEANU, 1999). Among its most important features are: the supplementation of water flow, from Bega, during dry periods, mitigating flood waves on the river Gladna, water supply, tourism and recreation purposes.

Groundwater. In the mountains, due to lithological and morphological characteristics, the optimal conditions for accumulation of aquifers themselves, are not met. Ground water temporarily accumulates debris, flysch deposits dejection cones or alluvial deposits in riverbeds (Munteanu, 1999).Groundwater flows in the mountain range from 2 to 5 l/s/km^2, with a low degree of mineralization (below 250 mg/l), being predominantly bicarbonate type (PATRU ILEANA et al, 2006).

Groundwater in the piedmont hills is discontinuous due to the high degree of fragmentation of the landscape and has a continuous character in piedmont plains and aprons. Groundwater level is located at varying depths depending on the landscape, it is lower in higher areas and on interfluves and it ascends to the surface in the lowlands. Ground waters are bicarbonate type (cutting across hills and piedmont plains) and chlorinated (lower areas), the degree of mineralization and duress strengthen while the altitude decreases altitude, from east to west (PĂTRU ILEANA et al, 2006) .

Free aquifer layers are found at the base of terraces, within the flysch deposit of the slopes and meadows.

The deep waters. The major deep aquifer layers, both quantitatively and qualitatively, are stationed in panonian deposits consisting of clays, marls and sands deposited as layers, at depths of 200-400 m. And are in general, drinking waters, being exploited for this purpose by many settlements, their flow is variable, with values of 0.5 l/s at 5 to 10 l/s, in the plains areas.

Most are deep groundwater and drinking waters, of particular importance to the public water supply, but also that of the various human activities.

Soils. Geographical location and physical-geographical conditions make the formation of a varied and very complex variety of soils: in mountain areas the lithosols, regosols or associations of soil in which they predominate, are specific, as the altitude decreases the soil blanket contains mainly preluvosols and luvosols and in the lowlands cambisols, hidrisoluri, gleysols, etc are present.

Land situation in the upper and middle basin of the river Bega presented by settlements in table 2.

Within the data in Table 2 can be seen that the total agricultural area is the largest share of arable land and pastures, excepting the municipalities which expand their territory in the mountains and high hills areas (Pietroasa, Tomeşti) the share of arable land decreases and increase the hay fields area (table 2). So in this case, a classification of the land use categories can be made according to the altitude, therefore a classification of the potential for soil fertility can also be made: parallel with the increase in altitude the area occupied by arable land

decreases and increase the pastures and meadows areas (Table 2).A similar situation is observed about the percentage of total agricultural area: within the communes situated at higher altitudes (Fig. 3) the agricultural area is under 30% of the total (Tomeşti, Pietroasa, Margina, Fardea), a large percentage of the area being represented by forests.

Table 2

The situation in the commune land (ha) (according to OSPA Timisoara)

Nr. Crt.	Communes	Total area	Total agricultural area	Arable land	Pastures	Hay fields	Vineyards	Orchards
1	Balinţ	5560	4935	3601	1160	103	0	71
2	Bara	7067	5694	2192	2350	708	0	444
3	Bethausen	9027	7255	4764	2066	318	0	107
4	Bârna	7862	3935	1792	1568	513	2	60
5	Curtea	4434	2408	862	1211	225	0	110
6	Dumbrava	5667	4816	3335	977	329	1	174
7	Făget	15087	9600	4795	3816	920	1	68
8	Fârdea	13107	4696	1478	2417	589	3	209
9	Margina	13285	4949	1821	1843	1223	0	62
10	Mănăştur	4186	3099	1830	1037	180	0	52
11	Ohaba Lungă	10479	4950	2208	1948	737	4	53
12	Pietroasa	15646	4364	570	2450	1299	0	45
13	Tomeşti	14094	4218	626	2465	1103	0	24
14	Traian Vuia	6976	5998	4111	1392	176	1	318

As shown in Table 2, the smallest area are occupied by fruit-growing plantations.

Potential fertility of the soil, expressed with different quality classes depending on specific conditions of the researched perimeter (Table 3).

According to OSPA Timisoara, the arable land of the villages of upper and middle basin of the river Bega are classified into 5 classes, as shown in table 3.

Table 3

Fertility classes (quality) for arable use category (ha) (based on data from OSPA Timisoara archive)

Nr. Crt.	Commune	Arable land (ha)	I Class (81-100 pct.)	II Class (61-80 pct.)	III Class (41-60 pct.)	IV Class (21-40 pct.)	V Class (0-20 pct.)
1	Balinţ	3601	52	755	627	1329	838
2	Bara	2192	-	5	1128	676	383
3	Bethausen	4764	-	502	1325	2553	384
4	Bârna	1792	-	-	533	696	563
5	Curtea	862	-	29	356	442	35
6	Dumbrava	3335	-	322	1741	999	273
7	Făget	4795	-	23	1771	2052	949
8	Fârdea	1478	-	-	506	758	214
9	Margina	1821	-	25	706	796	294
10	Mănăştur	1830	-	102	452	926	350
11.	Ohaba Lungă	2208	-	209	619	845	535
12.	Pietroasa	570	-	-	49	126	395
13.	Tomeşti	626	-	-	104	398	124
14	Traian Vuia	4111	116	827	1933	1180	55

Because the analyzed territory overlaps largely to a mountainous and hilly areas (fig. 3) most of the arable land is within the III and IV quality class (Table 3).

Land classified in the I quality class has a low percentage in the total area – these are found only within the territories of the Traian Vuia and Balint municipalities, communes settled in the plains area (Fig. 3). With increasing altitude, the quality of arable land decreases, so that, in hilly and mountainous areas most of the arable land can be classified in class IV (Table 3).

Figure 3 - Upper and middle basin of the river Bega, landforms and communal areas

The territory with the largest areas classified in the V quality class is found in Pietroasa: out of the 570 hectares of arable land, 395 belong to this class (Table 3) this situation is explained by the fact that a large part of the communal area is overlaped by mountainous and hilly areas with a higher elevation (fig.3).

CONCLUSIONS

In the upper and middle B.H. of Bega River there are distinguished several major landscape units, classified in terms of altitude in a very large (ranging from 76 – 1374 m), resulting in different environmental conditions from one unit and / or subunit to another. The largest share of the researched area analyzed belongs to low hills.

The climate of the researched area is tiered according to altitude: lower altitude brings higher temperatures and reduced rainfall. Temperatures of the two years analyzed (2010 and 2011) exceed the annual average, especially for 2010 (by 0.7°C). The amount of rainfall in 2010 exceeded the normal value of 37.5 mm, while in 2011 rainfall is much lower than normal, registering a deficit of -281.7 mm.

Surface waters are well represented, the main river is Bega. This has many tributaries, coming both from the mountains and from the hills, with temporary or permanent courses and flows that are generally low. The most important lake is Surduc storage lake. Groundwater and deep groundwater, have different characteristics, depending on the terrain unit, also the depth where they are found differs also according to this factor. Most are drinking waters and are particularly important for the water supply of both population and various economic activities.

The soils of middle and upper basin of the Bega river, specific to the mountain and hill area are: lithosols, regosols, luvosols, preluvosols and in the lower altitude zones eutric, gleysols, stagnosols, etc, are found. Of the total agricultural area is the largest share belongs to arable lands and pastures, excepting municipalities which expand their territory in the mountains and high hills area(Pietroasa Tomeşti) where the share of arable land decreases and share of meadows increases.

Productive potential of the soils varies depending on many factors (climate, terrain, soil characteristics, etc.) in the investigated area it can be observed a direct relationship between altitude and fertility - which is increasingly reduced while the altitude increases. Most of the arable land are classified into the III and IV quality class.

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