GEOMORPHOMETRICAL ASPECTS AND THE RELATIONSHIP WITH THE GEOMORPHOLOGICAL PROCESSES FROM THE UPPER BASIN OF BÂRLAD, UPSTREAM OF BĂCEŞTI

Doru Butelcă[1], Ionuț Minea[2]

Abstract. The upper basin of Bârlad is clearly different in comparison to the middle and lower sectors, in what regards the genesis, evolution and specificity of the geomorphological processes. Upstream of Negreşti, the river presents a subsequent character (oriented west-east), which explains the asymmetry of the landscape, with an impressing cuesta front developed on the right side of the river. The strong regressive evolution of the tributaries from the left side (Bozieni, Poienari) and of their tributary caused a strong fragmentation of the landscape, doubled by the highlighting of the 2nd order asymmetry, as an effect of the inclination of the sedimentation deposits on the direction north-north-west - south-south-east. This paper analyses the main morphometric features, strongly conditioned by the lithology and the low base level of the river (140 m on Băceşti), directly linked or interconnected with the major geomorphological processes for this territory. The analysed area includes the sector upstream of Băceşti from the superior course of Bârlad, hydrographical basin with a perimeter of 76.2km and a surface of 215.59 km².

Keywords: *the basin of Bârlad, morphometric parameters, surface erosion, landslides*.

I. Introduction

The upper basin of the river Bârlad is set in the east of Romania, in the north-western part of the hydrographical basin Bârlad, occupying the western part of the physico-geographical unit Central Moldavian Table-Land (fig. 1). The upper course of Bârlad extends to Buhăeşti, being marked on the right side of the superior Bârlad's Coast, cuesta escarpment generated by the general orientation west-east of the river, transversal on the inclination direction of the geological layers from the Moldavian Platform. From a physico-geographical point of view, the studied territory belongs to the Moldavian Tableland (unit of order I), respectively to the Bârlad Tableland (unit of order II), more specifically to the Central Moldavian Tableland (unit of order III).

The limits of the upper basin of Bârlad are clearly outlined. In the west and north-west of the region occurs the long interstream peak that separates upper Bârlad from the middle basin of Siret, with altitudes that frequently exceed 400 m, separated by modulations of the landscape with altitudes situated under this altitudinal limit. In the south, the limit is extremely sinuous and follows the watershed between the obsequent tributaries of upper Bârlad and the

[1] "Al.I.Cuza" University of Iasi, Faculty of Geography and Geology, Department of Geography, Bd.Carol I 20A, 700505, Iasi, Romania
[2] "Al.I.Cuza" University of Iasi, Faculty of Geography and Geology, Department of Geography, Bd.Carol I 20A, 700505, Iasi, Romania, ionutminea1979@yahoo.com

consequent ones of the rivers Lipova and Racova, which are in a direct competition because of the regressive evolution (according to the lithologic specific and the base level of the collectors Bârlad and Racova). In the east and north-eastern part, the limit is conventionally drawn, following the secondary interriver peaks that outline the hydrographical basin of Păltiniş and Gârbovăţ, the last tributaries from the right and left of Bârlad, upstream of Băceşti.

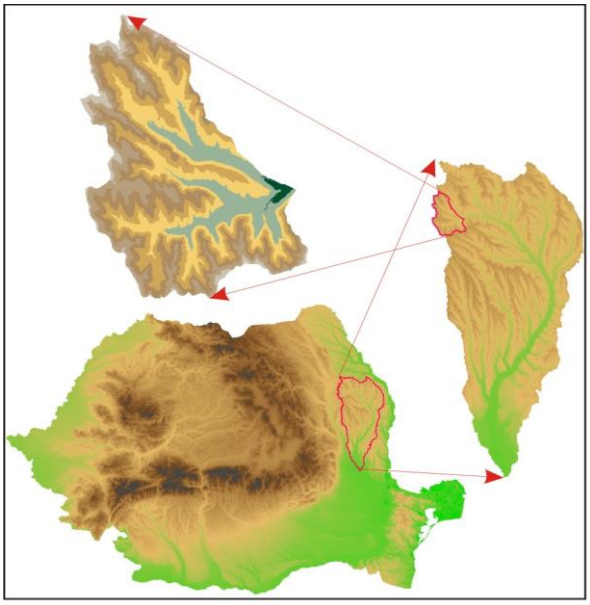

Figure 1: The geographic position of the superior basin of Bârlad upstream of Băceşti

Between the limits presented earlier, the superior basin of Bârlad has a surface of 215.59 km, delimited by perimeter of 76.2 km.

From a tectonic and structural point of view the upper basin of Bârlad belongs to the south-west part of the Moldavian Platform, which fits into the big East-European Platform that descends in steps towards the Eastern Carpathians. The fundament doesn't exercise any influence on the landscape, this being conditioned by the sedimentary formations characteristic to the last sedimentation cycle.

Simultaneously with the fall of the fundament and the sedimentary blanket towards the west, at the level of the Cretaceous formations and newer ones there is a rise of the thickness of the deposits on the same direction (fig. nr. 2). This fact is caused both by the more active sedimentation to the west, because of a share of terrigenous material close to the source area, and to the more active subsidence from this sector. (*Ioniță I.,* 2000).

The tectonic of the Moldavian Plateau was decoded by Jeanrenaud P. (1971), based on two landmark layers that outcrop in the area, the Repedea limestone and the Nuțasca-Ruseni cinerite**.** The distribution of the altitudinal shares of those landmark horizons show a progressive fall of the layers of 7-8 m/km from north-north-west to south-south-west.

For the landscape of the studied area, the biggest importance is held by the sedimentary formations characteristic to the last sedimentation cycle, Badenian superior-Romanian. The deposits that outcrop belong to the Basarabian, Chersonian and on very small surfaces to the Meotian, made out of rocks progressively younger from north to south and from the lower parts of the landscape to the highest.

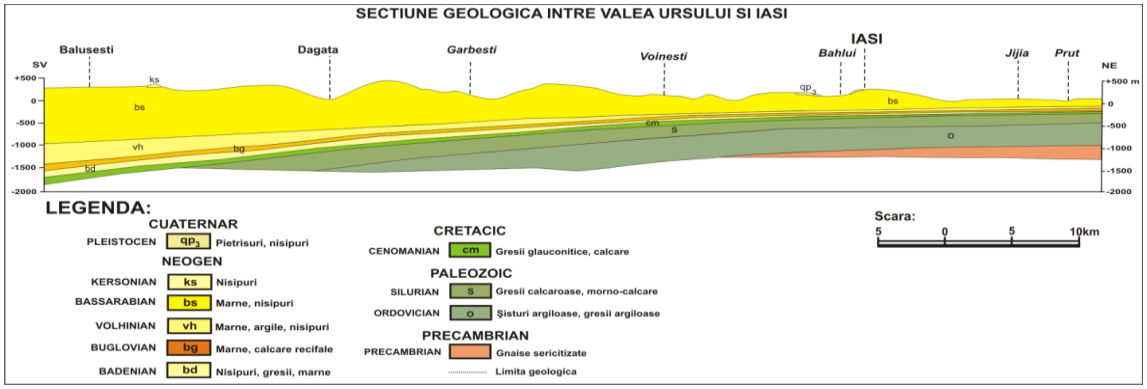

Figure 2: Geological section between Valea Ursului and Iaşi

(processed by the Geological Maps, published by the Geological Institute of R.S.R, at a scale of 1:200000)

The Basarabian represents the first lithological term, mostly met north of the valley of upper Bârlad, being mostly clayey, with intercalations of hard rocks, like the Repedea limestone and Şcheia sandstone, but with sandy facieses like the sands of Bânova and the ones of Şcheia.

The Chersonian *deposits* present certain monotony, being made mostly out of sand, occupied bigger surfaced until the valley of Bozieni, after which they appear isolated under the shape of some erosion peaks.

The Meotian occupies very small surfaces, only in the southern extremity, but sustaining the highest altitudes under the form of erosion witnesses like the hills of Padurea Scaunelor (453,9 m), Piscul Lat (429 m) and Schitului (460,6 m). The deposits of this period begin with the cinerite of *Nuţasca-Ruseni,* that marks the peak of volcanic activity from the west of the Eastern Carpathians.

Based on these geological formations the superficial varied deposits formed (eluvia, deluviums, colluviums, proluviums and alluvia) with diverse thicknesses and different physical and physic-mechanical proprieties (especially grain-size heterogeneity), according to which the main current geomorphological processes are arranged.

II. Materials and methods

In order to draw our study, topographic plans 1:5000 were used, which allowed the detailed representation of certain morphometric parameters, analysed by using the numeric model of the terrain made with the help of the program TNTmips, vs 6.9. The numeric model of the terrain was the base of the creating a series of theme maps such as the hypsometric map, the slides map, the map of the slopes exposition, the map of the landscape's fragmentation depth.

The areas affected by the current geomorphological processes were directly identified in the terrain through observations and measurements, but also by using topographical maps made in different periods and at different scale, of aerial images and of orthophotoplans (from the years 2005-2006). The surface erosion was appreciated based on the soil surveys done by OSPA Neamţ and Vaslui, for the agricultural soils and making of standard soils profiles in forest perimeters without erosion.

1. Under the altitudinal aspect, the superior basin of the river Bârlad, upstream of Băceşti, unfolds between 149 m, in the confluence sector of the river Bârlad with the creek Crăiasa and 466.2 m in Milişte Hill, witness of erosion, sustained by the Chersonian formations, situated in the west of the territory. Over a distance of only 14.97 km, the altitude difference is of 326.2 m, thus resulting an average slope of 21.79 m/km (2.2 %). This aspect explains the intense erosion of the river that has deepened between 4 and 6 m in its own meadow, with the tendency of reaching a stable profile. The eroded material is mostly evacuated out of the system, transported and deposited in the middle and inferior basins of the river. The studied area has been divided into eight altitude steps, starting at less than 150 m and until over 450 m, intervals that allow the highlighting of certain specific aspects for the overall evolution of the superior basin of Bârlad (fig. nr. 3).

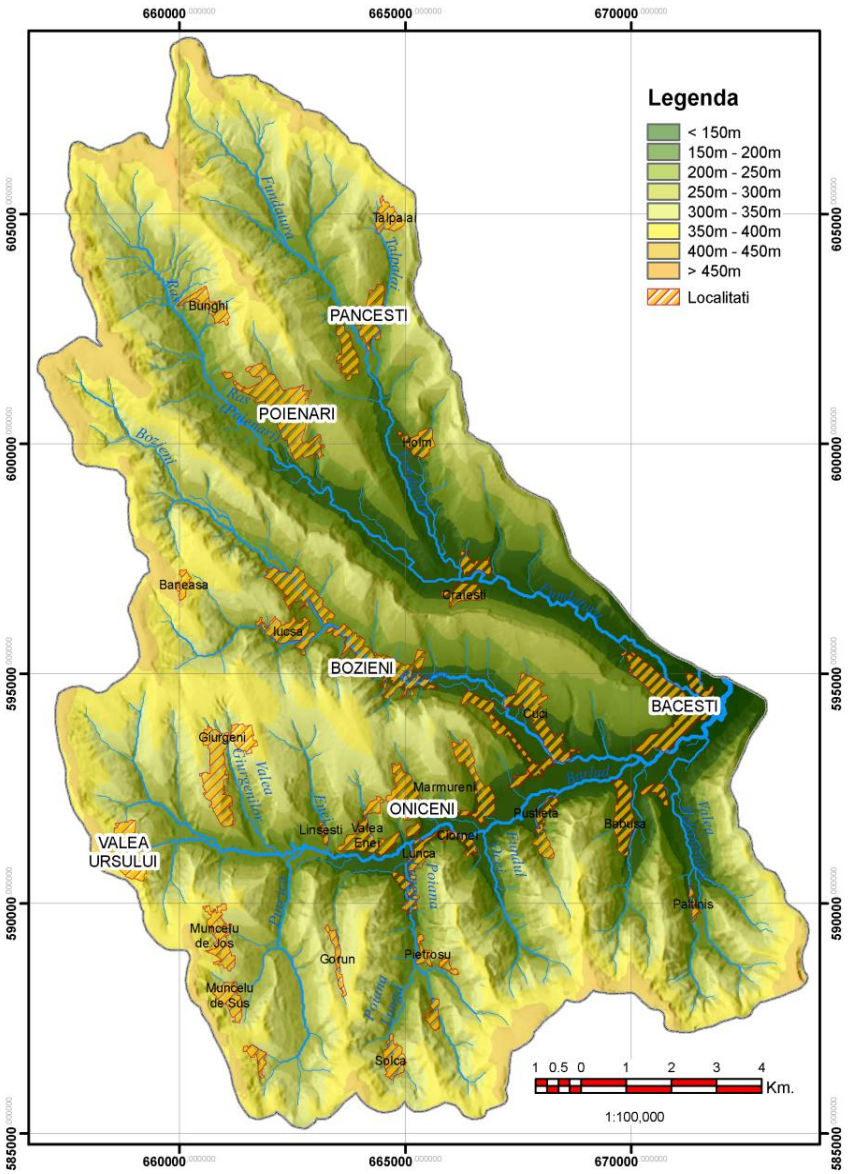

Figure 3: The hypsometric map of the superior basin of Bârlad

The altimetric interval of 140-200 m owns approximately 14% of the surface (fig. nr. 4), which corresponds to the meadow of Bârlad until close to the village Valea Enei, the meadows of the valleys Poienari (downstream of Poienari), Fundătura (up to to Pânceşti), to some sectors of glacis, but also to the inferior part of the slopes from the extreme east of the region (fig. nr. 3). The representative geomorphological processes are the fluvial accumulation in the major river beds, coluvium deposition in the case of glacises and the forming of some proluvial cones. In the subsidiary we also distinguish the linear erosion in the major river bed of Bârlad or of some gullies bottom of valley that extend here.

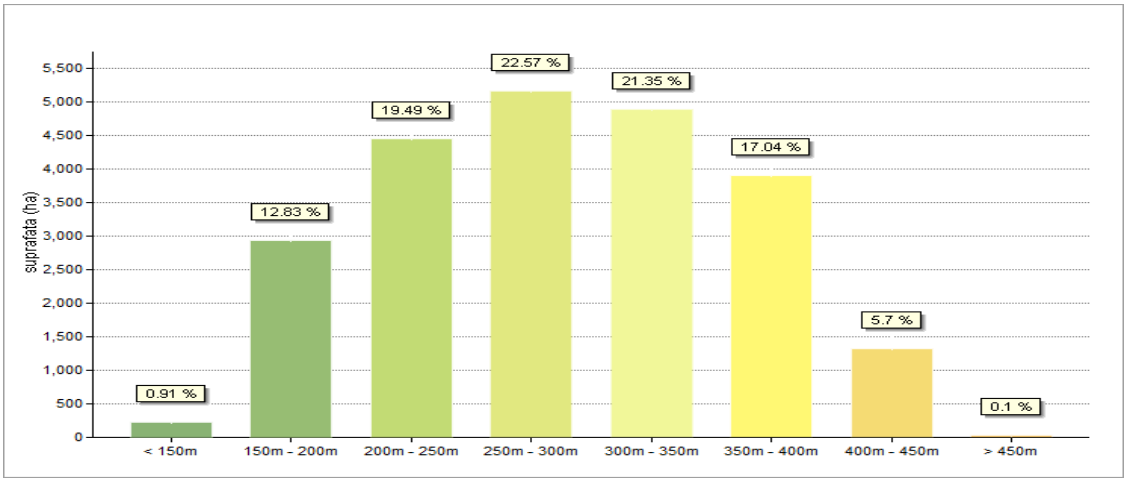

Figure 4: The share of the main hypsometric steps in the superior basin of Bârlad

The hypsometric floor of 200-300 m is the most consistent (42% of the surface of the basin), which mostly corresponds to the inferior and middle slopes from the basin (left if the valley Fundătura, from the flanks of the interriver peaks Bozieni, Bârlad, and Poienari-Fundătura), but also middle and superior slopes that border the interriver peak Poienari–Crăieşti–Bozieni, to which are added the slopes from the inferior and middle third, including some secondary peaks that separate the obsequent tributaries from the right side of Bârlad (fig. nr. 4).

In this altitudinal span the characteristic process is surface erosion with different intensities according to the slope and the using of the terrains. These slopes are also affected by landslides, of variable sizes, mostly stabilized, because of the aridity of the climate. Depth erosion is weakly represented, with the exception of the sectors in which the Bârnova sandy formations have been intercepted by erosion, where a series of gullies of big sizes have appeared, like the ones at Iucşa.

The hypsometric step of 300-400 m owns a big share (38%), having a correspondent in the superior third of the slope, but also in the case of the structural plateaus or the peaks-plateau. The geomorphological processes that affect the slopes are landslides (frequently active) and surface erosion, while for the structural plateaus or the peaks-plateaus it is specific surface erosion made by water and wind.

The hypsometric step that exceeds 400 m owns only 5.8% of the surface having correspondent in the erosion witnesses of Chersonian and Meotian age, situated mostly in the watersheds. The geomorphological processes that affect these surfaces are landslides, mostly old and stabilized. Surface erosion has low intensities because of the high degree of afforestation.

2.The declivity in the superior basin of Bârlad is characteristic to the units of landscape with a hilly fragmentation. The slopes have values of the slope between 3° and 40° (fig. nr. 5). The horizontal surfaces (under 1°) and almost horizontal (1°-3°) are encountered in the meadow areas (Bârlad's meadow, the meadows of creeks Crăiasa, Bozieni and Poienari), in which the geomorphological processes are the ones of accumulation, and the pedogenetical ones are of gleyzation (*15,28% of the territory)*. This kind of declivities corresponds also to the structural plateau Bozieni-Băneasa-Avereș ti and to the peaks-plateau, where surface erosion doesn't exist or is very weak, as it is generated by the water in the precipitation and by the wind.

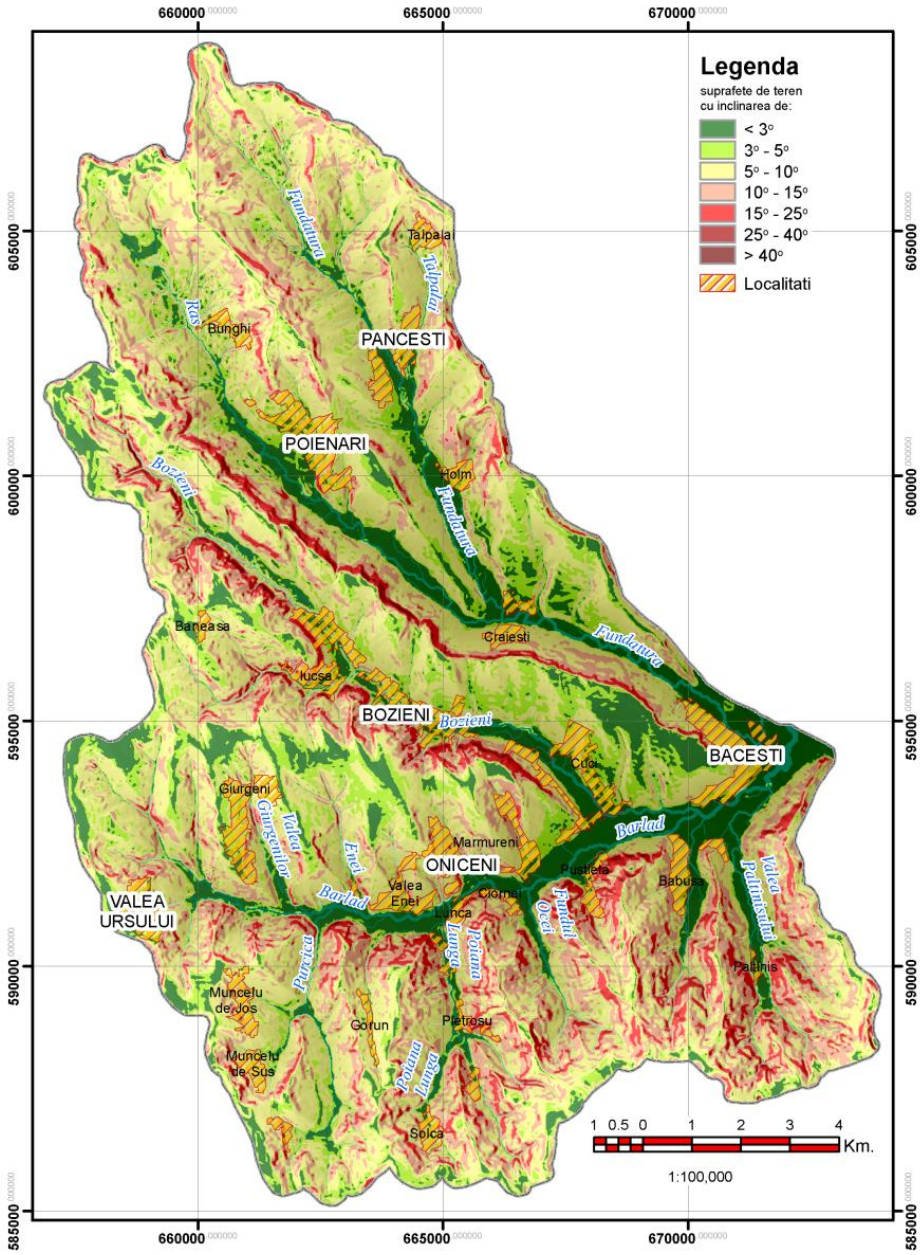

Figure 5: The map of geodeclivity of the terrain from the superior basin of Bârlad

The surfaces with slopes between 3°-5° are characteristic to some interriver peaks, the marginal sectors of the structural plateaus, some portions of the superior slope or at the contact between the inferior third of the slopes and the meadow sectors, in the coluvial, proluvial, deluvial or mixed glacises. This category of slope owns 13.6% of the territory (fig. nr. 6). The geomorphological processes are the ones of coluvial, proluvial and mixt accumulation, being sometimes met landslides, of big amplitude and small thickness.

The slopes between 5°-10° have the largest share *(44.85%)*, with appearances at the contact of the slopes with the interrivers and most part of the cuesta reverses. In the case of this category dominant are the agricultural use terrains (mostly arable), and the geomorphological processes are marked by surface erosion, manifested with weak-moderate intensities, according to the physic and physic-mechanic proprieties of the soils and the surface deposits. The improper use of the terrains and ploughing on the direction hill-valley contributes to the rise of the annual rate of soil formation and lost by erosion. Locally, there are also bottoms of valley gullies, but which have a low frequency and affect small surfaces.

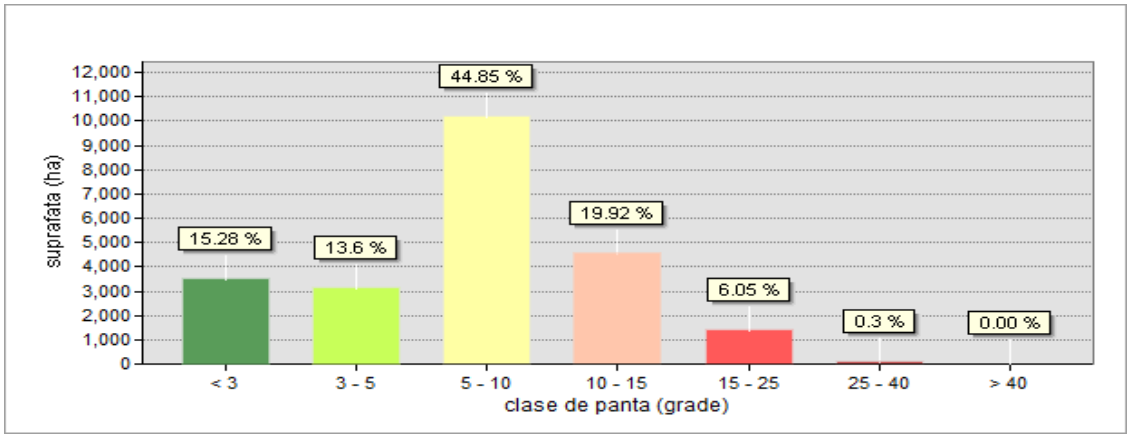

Figure 6: The histogram of the slopes classes in the superior basin of Bârlad

The slopes of 10^0-15^o are characteristic to the different categories of slopes (19.92 % of the territory). On these terrains, the geomorphological processes have an important spread, landslides being dominant, favoured by the Basarabian mostly clayey strata. In the sectors in which the sandy facies dominate **(**especially the sands of Bârnova), depth erosion has settled, represented through some of the most spectacular forms, like the gullies from Iucşa, from the front of cuesta Bozieni.

Bigger slopes (15 - 25°) appear on disjunctive areas, where both the altitude and energy of landscape have higher values, especially on the slopes situated south of the valley of Bârlad, on the forehead of cuesta Bârlad, Bozieni, Poienari, in the sectors of ancestry of the valleys Fundătura, Tălpălăi, Poienari, Valniţa etc. In all these cases a wide range of geomorphological processes manifest and the virulence of these makes that the morphogenesis overcomes the soil formation, the soils being mostly regosols and erodosols, and the agricultural terrains marked by multiple degradations (natural and anthropogenic).

The surfaces with slopes between 25° and 40° have a low share, being characteristic to the highly inclined slopes, associated to some detachment cornices, like the slide cornice "Stogu de pământ", the slide cornice from the Porsipitura Hill, the slide cornices from the superior part of the Bozieni cuesta foreheads, but also to the flanks of some big sized gullies (Iucşa, gullies from the cuesta forehead Bozieni, digged in the Bârnova sands).

The detailed analysis of the slopes map also highlights the existence of morphostructural asymmetries of order I and II, underlined by *Ioniță I.(1997, 2000)*, as it can be clearly noticed in the analysis of the interrivers Bârlad-Bozieni and Bozieni-Poienari.

3. Slope exposition influences the appearance and dynamic of some geomorphological and soil forming processes that manifest different, in specific thermic and hydric conditions. On the background of the main incline of the layers on the direction north-north-west – south-south-east and of the secondary one on the direction west-east, but also of the intense fragmentation of the landscape, the slopes have different orientations (fig. nr. 7).

The slopes with a northern exposition, shaded, have on the background of a more reduced evapotranspiration in comparison with the sunny slopes, that are warmer and dryer.

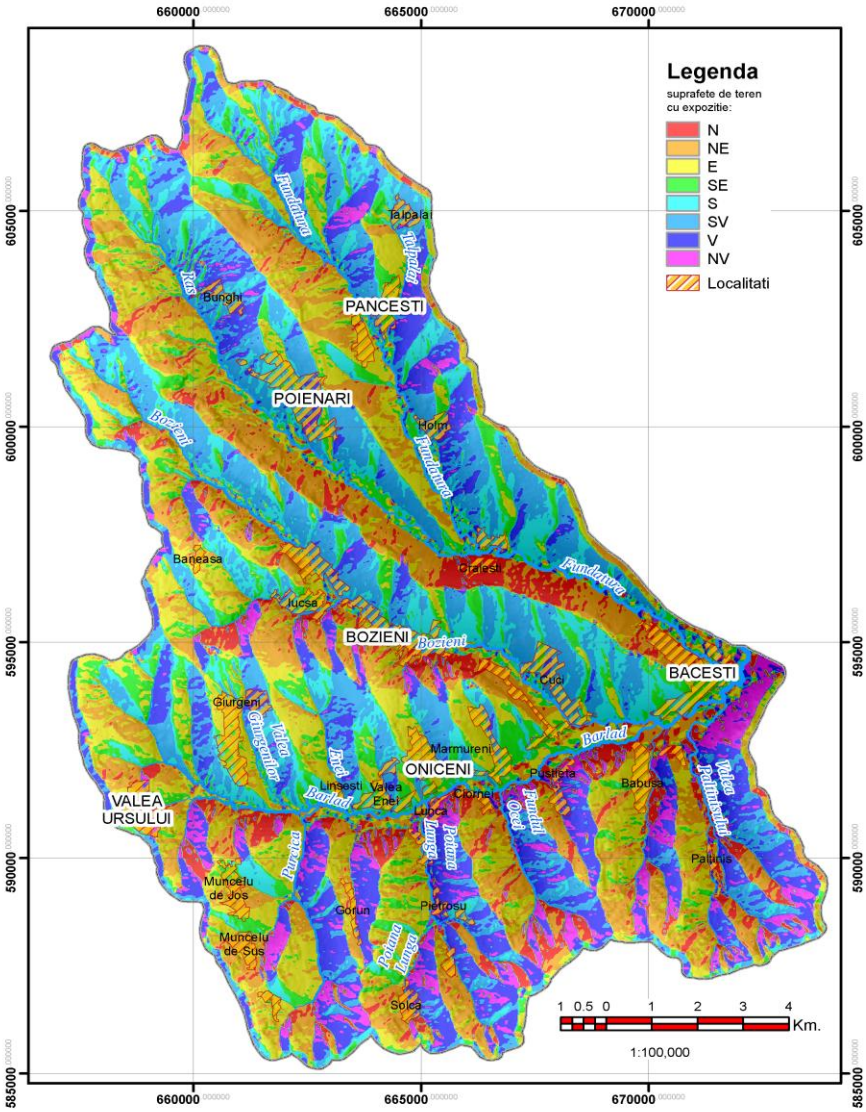

Figure 7: The map of the slope orientation in the superior basin of Bârlad

On the slopes with southern exposition, because of the stronger insolation, in spring the snow melts faster, so that the water drains to the surface of the soils, the infiltration drops and surface erosion and linear intensify. On the northern slopes, the melting of the snow happens in a longer time, and the biggest part of the liquid water gets infiltrated into the soils, generating an excessive humidity, which favours landslides.

The analysis of the graphic that shows the share of the exposition classes from the superior basin of Bârlad indicates the fact that big values have the exposition classes north-east and south-west (*18,1%*, respectively *17.5%*), then north and south (*7%*, respectively *10.5%*), that reflect the morphostructural asymmetry of order I (fig. nr. 8).

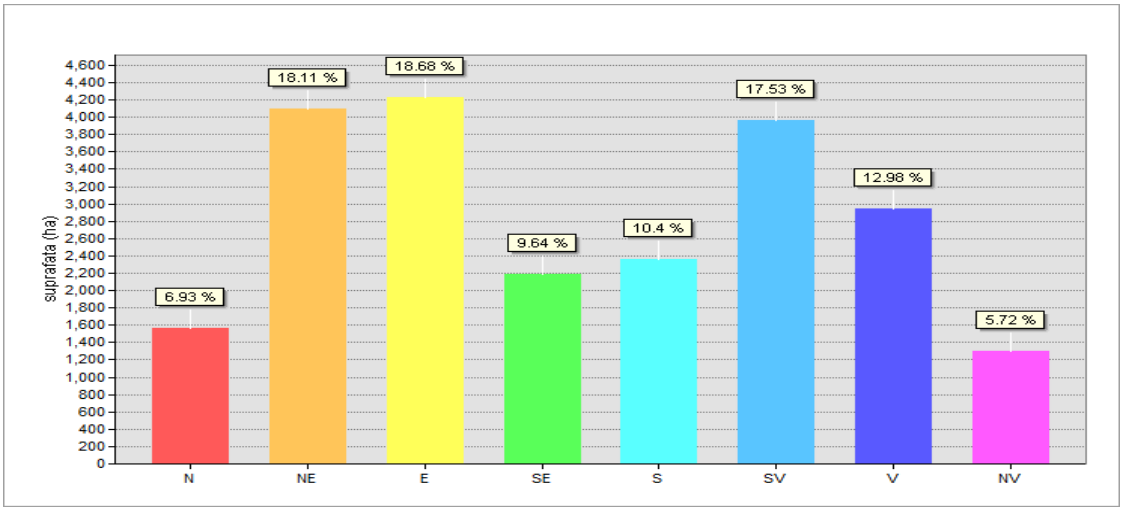

Figure 8: The share of the exposition classes of the terrain in the superior basin of Bârlad

The share of the slopes with western opposition is *13%*, and those with eastern exposition is of *18.7 %*, which points out the morphostructural asymmetry of order II (*Ioniță I.*, 2000) subordinated to the order I morphostructural asymmetry. Structural asymmetries involve also adaptations of the using method of the arable terrains being concentrated on the southern, south-western and eastern expositions, while the forest perimeters group on northern and north-eastern expositions. The northern exposition, north-western and western, cumulate the most intense geomorphological processes, being marked also by a strong fragmentation of the terrains and the using categories (uses and cultures).

4.Landscape energy is the difference of altitude calculated on a standard surface, in our situation being of 0.25 km^2 (grid with a side of 0.5 km).

The surfaces with energy of landscape (amplitude) with values between 0-30 m correspond to the horizontal and cvasihorizontal surfaces, respectively to the alluvial floodplains, interriver peaks, structural surfaces Bozieni-Băneasa-Averești, connection surfaces between the alluvial floodplains and slopes (fig. nr. 9). In this perimeter the morphodynamic processes have a low manifestation potential.

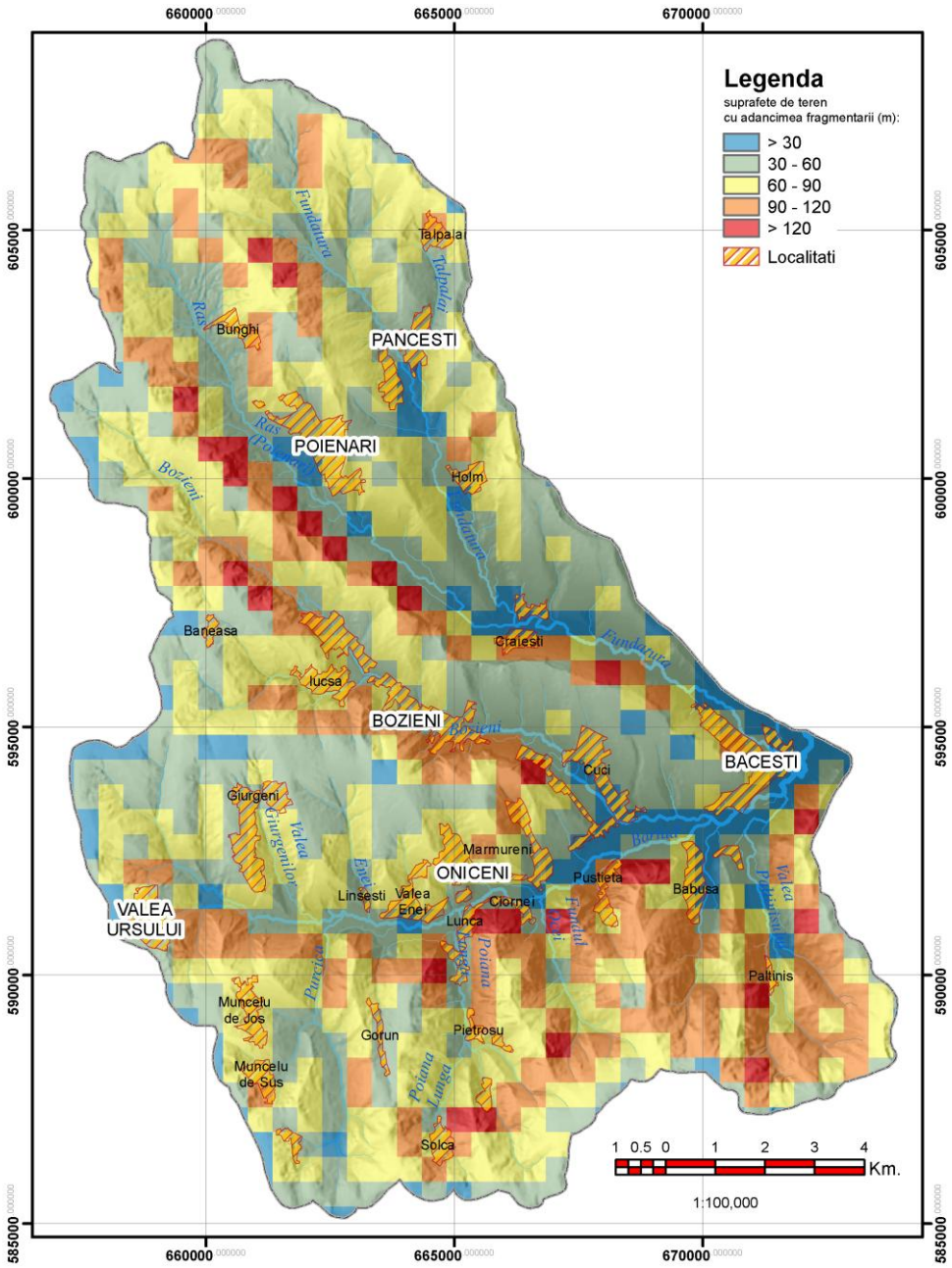

Figure 9: The landscape fragmentation depth map

The areas with a landscape amplitude between 31-60 m overlap to the connection surfaces between the plains and slopes, to the inferior third reverse of Poienari cuesta, and also to the inferior third of the other slopes.

These first two classes, stand out by the lack or weak manifestation, slow or sporadic of the current geomorphological processes, weak erosion in the surface, superficial slides and stable, which causes the fitting in the quality classes IInd and IIIrd and of suitability for

different usages and cultures. Most of the arable terrains are included in the slope classes of under 5^o and with an energy of landscape of under 60 m.

The areas with an energy of landscape between 60-90 m, where both the declivity and density of the fragmentation have big values, present a bigger potential of manifestation of the erosion and denundation processes, marked through landslides, gullying and sheet erosion. These processes manifest with intensity in the perimeters with an energy of landscape of under 90 m, corresponding to the fronts of cuesta, where the quality and suitability are inferior (IV-V), which induces severe restrictions in comparison with the way of using the terrain (*Rusu C.*, 2008).

For these reasons the pastures and hayfields occupy over 50% of the overall terrains with agricultural use (6844 ha), and the forest have a share of 30% from the total surface of the superior basin overcoming a lot the average from the Plateau of Bârlad and even the country's average.

III. Results and discussions

Between the morphometry and the main current geomorphological processes are established multiple direct relationships, most of these being specific to the Central Moldavian Plateau (some with extensions to all the Bârlad Plateau), while some types of relationships are characteristic only to the superior basin of Bârlad. On the other side, extremely frequent are the correlations of the mentioned earlier components, but also the reverse conditioning, in that the intense or violet manifestation of some geomorphological processes quantifies in the changing of the morphometrical parameters. In addition, for the studied territory we have noticed an inverse proportional ratio between the morphogenesis and the pedogenesis, in which the morphometry implies significantly.

IV Conclusions

The analysis of the geomorphometrical parameters highlights a series of defining issues for the studied territory:

-The altitude of the landscape varies between 140 m (minimum value) and 466m (maximum value), resulting an altitudinal difference of 326 m, which favours the appearance of the zonal bio-pedo-climatic tendency;

-The slope of the landscape fits between very wide limits (0 and 40^o), while the slopes orientation is diverse, but in a close relationship with the major lines of the landscape, the geological structure and types of valleys dominating the slopes with northern and north-eastern orientation, respectively southern and south-western, big shares having also east and west orientations;

-The big values of the energy and hill landscape fragmentation, cause without a doubt the virulence of the current geomorphological processes between which detached surface erosion (over 80% of the agricultural terrains and about 71% of the whole territory) and landslides, which affect 50,6% of the superior basin of Bârlad, upstream of Băceşti;

-The values of the morphometrical parameters clearly highlight the presence of morphostructural assymetries and cuesta landscape, as well as the general asymmetry of the superior basin of Bârlad, mostly developed on the left side (65.87% of the total basin).

Acknowledgements

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References:

1. Băcăuanu V. şi colab. 1980. *The Moldavian Plateau, Nature, human, economy*, Ed. Ştiinţifică şi Pedagogică, Bucureşti.
2. Ionesi L., Ionesi B., Roşca V., Lungu Al., Ionesi V. 2005. *The medium and superior sarmatian of the Moldavian Platform*, Ed. Academiei Române, Bucureşti.
3. Ioniţă I., 1985. *Soil Erosion and arrangement of the terrains in the Moldavian Plateau*, Vol. Geomorpholohical research for works of land improvement, Bucureşti.
4. Ioniţă I. 1997. *The geomorphological study of the terrain degradation d from the middle basin of Bârlad*, doctorate thesis held at Universitatea „Al. I. Cuza" Iaşi.
5. Ioniţă I. 2000. *The cuesta landscape from the Moldavian Plateau*, Editura Corson, Iaşi.
6. Jeanrenaud P. 1971. *The geological map of Central Moldavian between Siret and Prut*, în „ The Scientific annals of the University „A.I. Cuza" Iaşi, secţ. II, tom. XVII.
7. Moţoc M., Ioniţă I. 1983. *Some problems concerning the method of establishing the rain and vegetation indes, for short interval rains*. Bul. inf. ASAS, nr. 12, Bucureşti.
8. Patriche C.V. 2005. *The Central Moldavian Plateau between the rivers Vaslui and Stavnic-Study of geography*, Ed. „Terra Nostra", Iaşi.
9. Rădoane M., Rădoane N., 2001. *The erosion of the terrains and the transport of aluvium in the hydrographic systems Jijia and Bârlad*, Rev. De Geomorfologie, vol. 3, Bucureşti.
10. Rusu C., coord., 2008. *The impact of the hydro-climatic and pedo-geomorphological risc over the envinroment in the basin of Bârlad-research report*, Ed. Performantica, Iaşi.
11. Surdeanu, V. 1998. *The Geography of degraded terrains. Landslides*, Presa Univ. Clujeană.