GEOMORPHOLOGICAL CONSIDERATIONS IN THE UPPER – MIDDLE CATCHMENT OF THE STAVNIC RIVER

Puflea Suzana – Mirela[1]

Abstract. The upper-middle catchment of the Stavnic River lies within the Central Moldavian Plateau and comprises 14.399 ha. The Stavnic stream is a left tributary of the river Bârlad and has a dendritic river system. This is a typical hilly area, ranging in altitude between 147 and 451 m. The typical landform is the relief of cuestas, in association with the development of a network of consequent and subsequent valleys, which highlights the double structural asymmetry in the entire Moldavian Plateau. Within the upper catchment, the Stavnic Valley is subsequent. Then it turns on consequent pattern and emphasizing the secondary structural asymmetry. This area is subjected to land degradation through: soil erosion, gully erosion and landslides.

Key words: *Central Moldavian Plateau, cuesta, landslide, soil erosion*

1. Introduction

The upper and middle catchment of the Stavnic River is located in the central part of the Central Moldavian Plateau, between 47°4' and 46°58' N lat. and 27°18' to 27°30' E long., and covers 14,399 ha.

The northern limit of the Stavnic catchment is the Iaşi Coast, which is *"the most trenchant contact of all Central Moldavian Plateau, steep sharp maintaining for tens of kilometres"* (Ploscaru D., 1973).

To the west, the study area is delimited by the catchment of Şacovăţ River and in the east the river basin adjoins Rebricea. The river system from the upper and middle catchment of the Stavnic River is a dendritic type, and besides the main river, Stavnic, as the most important tributaries are mentioned the rivers Ciurdea, Stăvnicel, Urşiţa, Brustureţ on the right side and the Carului Valley and the Găunoasa creek, on the left side.

In the upper catchment, upstream of Schitu Stavnicului village, the Stavnic Valley is subsequent because is orientated on the direction west–east, and in the middle catchment, the Stavnic Valley changes its route on the direction north-south and becomes a consequent valley.

2. Material and method

Geomorphological observations of the land were combined with the cartographic materials obtained with the help of the software TNT Mips 6.9. The first result of the application of this program has constituted the achievement of the numerical model of the land (MNT), obtained through the georeference and vectorization of the topographical plans

[1] "Al.I.Cuza" University of Iaşi, Faculty of Geography and Geology, Department of Geography, Bd.Carol I 20A, 700505, Iasi, Romania, mirela_23may@yahoo.com

on the 1:5000 scale. Based on this, afterwards a series of thematic maps have resulted (slope map, aspect map, shading map), maps that were classified through SML language.

As well, for the identification of the areas affected by landslides and gullies were used colour aerial photographs from 2005. After the delimitation, the areas with land degradation were overlapped on the shading map to highlight more correctly their distribution in the study area.

3. Results and discussions

In geomorphological terms, the Stavnic catchment is a representative hydrographical basin within the Central Moldavian Plateau (Băcăuanu V. et. al., 1980).

In this area, the erosion has brought to day geological layers belonging to the Medium Sarmatian (the Bessarabian) and Upper Sarmatian (the Chersonian), plus the recent deposits of quaternary age. The Bessarabian appears extended, and the Chersonian is discontinuous, on the hilltops, in the form of witnesses of erosion (Jeanrenaud P., 1961, 1971, 1995).

The sedimentary cover is represented by clays and loamy sands, which are identified mainly in the area of Voineşti, cap oolitic - fossiliferous sandstones of Şcheia, located between Mogoşeşti and Şcheia villages. The cap sand of Bârnova, reported by Sevastos R. (1922) is situated under the calcareous sandstone plate.

In the higher areas from the middle catchment of Stavnic, geologically stands out the Bessarabian calcareous sandstone plate over which, isolated, follows sands with intercalations of tough sandstones of Păun, which belong to the lower Chersonian.

For the shaping of the characteristics of the landform, the river system of the Stavnic catchment was outlined accordingly to the Strahler system, mentioning that this river is of order 5, which indicates the stage of maturity of the local topography.

In terms of altitude, in the study area stands out the mean value of the relief of 267 m, provided that the maximum altitude of 450 m is found in the Teiului Hill-Poiana Mănăstirii and the minimum altitude of 147 m is located in the river floodplain of the Stavnic River.
The altitudinal decline of terminal confluences of the successive orders of the river basins is explained through a progressive increase in the maximum energy of about 270 m in the case of the catchments of order 5, and of the standard deviation of 66 m (Patriche C.V., 2005).

The mean value of the steepness of the land in the Stavnic catchment is 15.7%. In the study area land inclining up to 18% is dominant, but restricted, on the very steep land, located on the cuesta fronts, the value of the slopes exceeds 27%.

As a reflection of the general monocline structure of the deposits from the substratum, the Stavnic catchment presents, generally, a surface asymmetry and one of the average slope, the surface asymmetry being less pronounced than that of the average slope.

In the Stavnic river basin can be noticed the biggest percentage of the land situated on the right side, of 58% of the total area, as opposed to the left side, which has only 42%. This differentiation of the percentages between the left hillslope, respectively the right hillslope is due to the second order structural asymmetry, corresponding to the secondary dipping of the geological layers, towards east.

Based on the geological characteristics and the morphometric and morphographical analysis of the local topography three main types of relief are highlighted, respectively structural, sculptural and depositional landforms.

The structural relief is represented by the structural – lithological plateaus and by the types of valleys developed within the monocline structure.

The structural – lithological plateaus are situated in the area of the hilltops larger

extended, which have developed on the harder rock such as oolitic limestones of Repedea and sandstones of Şcheia, of bessarabian age. These structural – lithological plateaus (platforms) are typical for the Central Moldavian Plateau and they were consecrated in the literature by David M. (1920, 1922, 1941) such as Şcheia, Ipatele and Zarea Domniţei-Poiana Mănăstirii plateaus which present a slight dipping to SSE.

The Şcheia plateau, in the Ruptura Pietrăriei outcrop (342 m), is grafted on the alternation of the oolitic limestones of Repedea, of 3 m thickness, at an altitude of 319 m, with the sands and sandstones of Şcheia, at the height of 326 m, with a thickness of 10 m. Then over 350 m, in the Şcheia Hill (399 m), follows a witness of erosion formed on sands and the chersonian sandstone of Păun (P. Jeanrenaud and A. Saraiman, 1995).

Another structural plateau, Ipatele, emerged on the oolitic limestones, at an altitude of 340 m and on the cap sandstone of Şcheia which appears at an altitude of 390 m.

In the Cheia Domniţei plateau is noticed that the oolitic appears at 400 m altitude, above which, at an altitude of 440 m, follows the cap sandstone of Păun, constituted of tougher calcareous sandstone.

The main types of valleys developed on monocline structure are: consequent, reconsequent and subsequent valleys, according to their flow direction in relation to the dipping of the geological layers brought to day by erosion.

Downstream of Hadâmbu, in the middle and lower section, the Stavnic Valley is a consequent one because of shifting its orientation to south. In the upper catchment, between Hadâmbu and Schitu Stavnic, the Stavnic Valley is diagonally orientated, on NW – SE direction and is included in the category of the subsequent skew valleys. Upstream of Schitul Stavnic, the Stavnic Valley is transversally orientated, on west – east direction and becomes typical subsequent.

What particularly strikes at the Stavnic Valley is the radical change of the direction of the valley from the upper catchment regarding the situation from downstream of Hadâmbu and implicitly the changing of the type of the valley. This change occurred in the pattern of the upper Stavnic Valley can be explained through the faster regressive evolution of the stream system from the Voineşti catchment. This development, dictated by a basic level lower in the Bahluiului river plain, led to the capture of the consequent sector on the upper Stavnic catchment and to the movement towards south of the Iaşilor Coast. A testimony in support of this hypothesis is the atypical asymmetry of the cross valley of the upper Stavnic, namely that the left hillslope, back slope with southern orientation is mildly expanded, even subordinated as rate regarding with the right hillslope, cuesta front with northern aspect.

The tributaries of the Stavnic River are either subsequent, generally the right tributaries (Ciurdea, Stăvnicel, Urşiţa, Brustureţ), either reconsequent, usually the left tributaries, most valleys presenting asymmetrical transverse profiles (Carului Valley, Găunoasa creek).

The rarity of the symmetric valleys is explained by Ioniţă I. (1998, 2000) through the narrow area, corresponding to the "monoclinic resultant" of the two systems of stratigraphic slopes: north - south, of 6 to 7 m/km and west - east, of 3 m/km.

The sculpturing relief (fluvio-denudational topography) in general monocline structure is dominant in the local morphology and it is represented by the hilltops and the diluvial slopes.

The aspect of the hilltops in the upper and middle catchment of the Stavnic River is oblong or widely extended in the form of plateaus, imposed by tougher cap rocks, such as Şcheia Hill, Ipatele Hill or Teiului Hill-Poiana Mănăstirii. In terms of altitude, the mean altitude of the right drainage divide is higher, 318 m, than the altitude of the left drainage

divide, which has an average altitude of 305 m.

Sculptural hilltops are slightly dipped frequently slopes being between 1° and 3°, sometimes up to 5°.

The hillslopes represent the dominant landform from the Stavnic river basin and they are closely related to the relief of cuestas, because in the majority of the cases they play the role of back slope or cuesta front. Slopes facing north, north - west or west are the cuesta fronts, whereas the slopes facing east, south and south - east are back slopes.

The diversity of the cuestas from the Moldavian Plateau is explained by Ioniţă I. (1998, 2000) through the evolution of the river system in a "double system of stratigraphic slopes". Thus, the author previously mentioned, distinguishes two types of structural asymmetries namely the first-order structural asymmetry, corresponding to the main dip of the geological layers, north - south, which includes all the subsequent valleys and leads to the shaping of the cuesta fronts with northern aspect and the second order structural asymmetry, corresponding to the secondary dipping, west - east, highlighted by the majority of consequent/reconsequent valleys, which imprints in the relief cuesta fronts with western orientation and back slopes with eastern aspect.

Depending on the type of structural asymmetry, the first order or the second order, reported by Ioniţă I. (1998, 2000), can be highlighted the mirror arrangement of the cuestas in the middle Stavnic catchment. Thus, on the right side of the Stavnic River emerge cuesta fronts with northern or north - eastern orientation and back slopes which incline to the south and to the south-west. Instead, on the left side of the Stavnic River the cuesta fronts have predominantly western and north - western aspect, and the back slopes have eastern and south - eastern orientation.

Another type of relief which emerges in the upper and middle catchment of the Stavnic River is the depositional landforms, represented by floodplains, river terraces, colluviums, proluviums, glacises.

The floodplain of the Stavnic River is widely developed due to the floodplain alluvium accumulated during the wetter periods of the Holocene and due to the reduced longitudinal slope.

The width of the tributaries floodplains in the upper and middle catchment of the Stavnic River varies depending on the rivers that formed them. In the junction area there is a noticeable enlargement of the floodplain. Also, the thickness of the alluvial deposits increases from upstream to downstream and in relation to the size of the rivers, being about 3 to 5 m.

The river terraces from the study area have a reduced development, remarking a few small junction terraces.

The lack of middle and upper river terraces from the current morphology of the Stavnic Valley is explained by their destruction under the influence of slope processes and of erosion.

Among the present day geomorphic processes are mentioned soil erosion, gullying, landslides and sedimentation.

Soil erosion occurs on hilltops, but is distinguished mainly on areas with high slopes and especially on land that is farming with spaced growing crops or it is subjected to overgrazing.

For the area of the upper and middle catchment of the Stavnic River, the mean annual rate of soil erosion is 4-5 t/ha/year. On cuesta fronts that have a stronger declivity, the mean annual rate of soil erosion is over 16 t/ha/year (Patriche C.V., 2005).

The most representative geomorphological process which affects hillslopes from the study area is represented by landslides, which "*are natural movement of the rock masses on*

slopes, involving water under the action of gravity" (Donisă I., Boboc N., Ioniţă I., 2009).

The area under landslides covers 70% of the studied catchment (10.110 ha) and most of them are old, deep-seated and stabilized landslides (Figure 1).

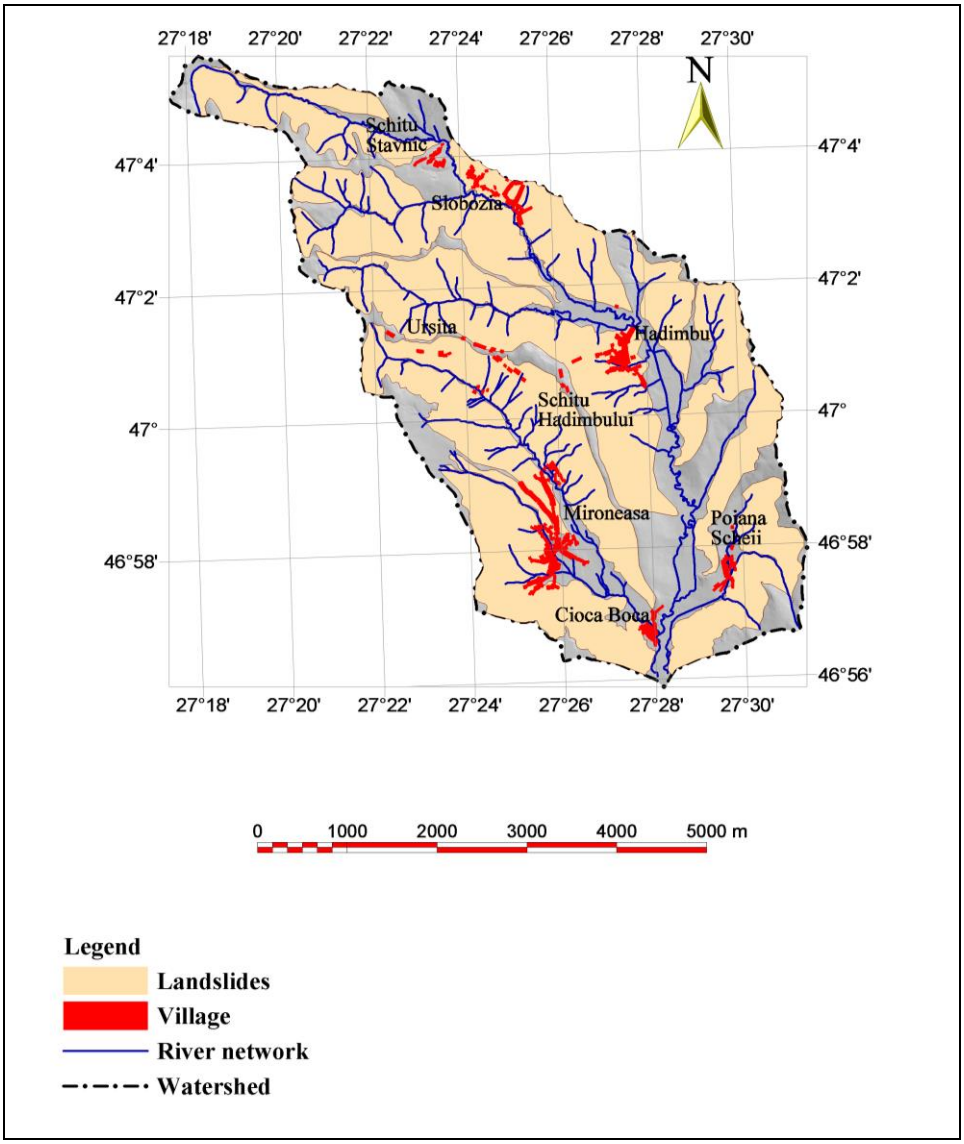

Figure 1: Landslides distribution in the upper and middle catchment of the Stavnic River (processed after aerial photographs, 2005)

The biggest and significant rate is held by the stabilized landslides whose distribution is especially related to the interference of two parameters, namely the relatively high degree of afforestation and the climate desertification occurred since the summer of 1982.

In the study area profound landslides of large dimensions are noticed, situated on the cuesta fronts, such as the active landslide "*La prăpastie*" on the cuesta Urşiţa, with northern orientation, or the landslides on the cuesta facing W-NW of Hadâmbu village. In general, landslides that characterize this area involve small thick diluvium of 1-5 m or an average

thickness of 5 to 10 m. The total area occupied by the gullies in the upper and middle catchment of the Stavnic River is over 95 ha, which represents 7% from the study area.

The gullies have the depth between 1 and 5 m and frequently there are discontinuous gullies, valley-side, characterized by an average annual rate of regression around 1 m per year (Ioniţă I., 2000). In relation to the monocline structure and slopes aspect, most gullies and the highest density of them is reported on the slopes facing NE and SW.

Conclusions

The topography from the Stavnic river basin is typical hilly, specific to the Central Moldavian Plateau, in which are imposed equally the structural – lithological plateaus, in the form of witnesses of erosion and the cuesta fronts with general northern or western aspect.

The sculpturing relief (fluvio-denudational topography) in general monocline structure is the dominant type of relief. Within the river basin the hillslopes have the main rate and, frequently these play the role of cuesta front or back slope.

In the studied river basin the most important geomorphological processes are soil erosion and landslides.

References

1. Băcăuanu V. et. al., (1980) – *Podişul Moldovei. Natură, om, economie,* Editura Ştiinţifică şi Enciclopedică, Bucureşti
2. David M. (1920) – *O schiţă morfologică a Podişului Sarmatic din Moldova*, Bucureşti, Soc. Rom. Geogr. XXXIX
3. David M. (1922) – *Cercetări geologice în Podişul Moldovenesc.* An. Inst. Geol. Rom., IX, 1915-1921, Bucureşti
4. David M. (1941) – *Relieful Coastei Iaşilor şi problemele pe care le ridică sub raportul geomorfologic şi antropogeografic,* Lucr. Soc. Geogr. „D. Cantemir", t.III, Iaşi
5. Donisă I., Boboc N., Ioniţă I. (2009) – *Dicţionar geomorfologic cu termeni corespondenţi în limbile Engleză, Franceză şi Rusă*, Editura Universităţii "Alexandru Ioan Cuza", Iaşi
6. Ioniţă I. (1998) – *Studiul geomorfologic al degradărilor de teren din bazinul Bârladului mijlociu*. Teză de doctorat, Universitatea "Alexandru Ioan Cuza", Iaşi
7. Ioniţă, I. (2000) – *Geomorfologie Aplicată. Procese de degradare a terenurilor deluroase*, Editura Universităţii "Alexandru Ioan Cuza", Iaşi
8. Ioniţă, I. (2000) – *Formarea şi evoluţia ravenelor din Podişul Bârladului*, Editura Corson, Iaşi
9. Ioniţă I. (2000) – *Relieful de cueste din Podişul Moldovei*, Editura Corson, Iaşi
10. Jeanrenaud P. (1961) – *Contribuţii la geologia Podişului Central Moldovenesc*, An. şt. Univ. Iaşi, s.II, t.VII. 7.2
11. Jeanrenaud P. (1971) – *Geologia Moldovei centrale dintre Siret şi Prut*, Rezumatul tezei de doctorat, Iaşi
12. Jeanrenaud P., Saraiman A. (1995) – *Geologia Moldovei Centrale dintre Siret şi Prut,* Editura Universităţii "Alexandru Ioan Cuza", Iaşi
13. Patriche C. V. (2005) – *Podişul Central Moldovenesc dintre râurile Vaslui şi Stavnic - studiu de geografie fizică,* Editura Terra Nostra, Iaşi
14. Ploscaru D. (1973) – *Podişul Central Moldovenesc – studiu geomorfologic*, teză de doctorat, Editura Universităţii "Alexandru Ioan Cuza", Iaşi
15. Sevastos R. (1922) – *Limita sarmaţianului, meoţianului şi a ponţianului între Siret şi Prut,* An. Inst. Geol. Rom., t. IX (1915 – 1920).