ABSTRACT

In the past years, most of the catchments from Bârlad Plateau benefited of detailed studies in Physical Geography, Crasna catchment remaining deficient regarding this. The chosen subject is a pertinent one, the studied catchment facing real problems due to the intensity of geomorphological processes and to the appreciable extension of heavily degraded lands.

In this paper, it is desired a modern and systemic approach of land degradation issues by analyzing the controling factors, determining the intensity, distribution, dynamics and the impact of these processes on the environment quality, and also the ways to prevent and fight to conserve soil and water resources, particularly important in a region with agricultural vocation.

The PhD thesis ***"Geomorphological study of land degradation in Crasna catchment"*** is divided into seven chapters and includes 202 figures (photographs, graphs and maps) and 28 tables.

The first chapter is provided by an introductive part which emphasizes on the geographical location, on working methodology and on scientific research history. We note that the catchment of Crasna is located in eastern part of Central Moldavian Plateau and has a total area of 53 885 ha, representing 7.5% of Bârlad Plateau.

An important success in spatial modeling of degradation processes consisted in realizing the Digital Terrain Model (DTM), obtained by scanning, importing, georeferencing and digitizing contour lines of 127 topographic plans, on 1:5.000 scale. Choosing for a very detailed DTM, in 1:5.000 scale instead of the one in 1:25.000 scale, was based on achieving a high degree of accuracy of estimations with different shades.

The second chapter, entitled **General Considerations on the landscape evolution** is devoted to the analysis of the factors that conditionates the overall evolution of the landscape and contributes to land degradation from Crasna catchment.

In terms of geology, the studied catchment totally overlaps over the Moldavian Platform, remarking the generalized presence of friable sedimentary rocks, of Chersonian, Meotian and Quaternary age. Poor resistance of substrate rocks is responsible for the appreciable intensity and extension of degradation processes, while external shaping of the deposits with generally monoclinal structure influenced the current configuration of the landscape.

The excessive temperate continental climate also has an important role in directing the current geomorphological processes and imposes both trough the thermal regime (7.5-10° C), and trough the pluviometric regime (500-780 mm). The excesivity is highlighted by high thermal amplitudes and by the frequency of torrential rains.

The hydrological factor plays a key role because the studied area is the result of rivers activity, as demonstrated by the appreciable weight of sculptural relief forms. Through its characteristics related to the runnoff and sediment load regime, the stream system influences the transport and accumulation of solid materials in floodplains or in anthropic lakes cuvettes. Compared to the total area of the catchment, the annual average discharge water of Crasna for all three stations is very low, of 0.34 m^3/s to Vineteşti, 0.39 m^3/s to Mânjeşti and 0.08 m^3/s at Curteni. The mean value of sediment discharge, of 0.130 kg/s, recorded in Crasna lower chatchment at Vineţeşti station, is small compared to other catchment basins from Bârlad Plateau, because most of the part of eroded solid material from the slopes is deposited upstream, on the valley bottoms, particularly in anthropic lakes.

The natural vegetation corresponds to steppe and forest areas, but in the last two centuries it was radically altered by cutivating the agricultural lands, which led to the

intensification of degradation processes. The southern and middle part, with digitations towards the northern half of the catchment, corresponds to forest steppe zone, with alternatations of xerothermophilous forests, scrub lands and steppe xerophylous grasslands. The forest area, with xerophylous and xeromezophylous forests occupies both the highest part of the interfluves from the northern half and also the interfluve Lohan-Elan.

From soils, the largest areas are owned by chernozems (19.788.4 ha), but the high percentage of erodic anthrosols (10.4%) and regosols (14.6%) suggests the appreciable intensity of soil erosion.

Irrational use of lands, deforestation, grubbing and over-exploitation of meadows from the slopes, improper placement of roads and the lack of soil and water conservation favored, in turn, the acceleration of land degradation from Crasna catchment.

In the third chapter, ***" Morphography and morphometry "***, are treated a number of morphographic and morphometric features of the relief from Crasna catchment, namely the slopes orientation, hypsometry, slope and the relief energy.

In the context of monoclinic general structure of geological substrate from Central Moldavian Plateau, modelers external factors, particularly fluvial erosion and mass wasling have led to the development of a typical hilly terrain. As indicated by David M. (1921, 1922), the structural platforms (plateaus) and the coast relief give the "true character of plateau" in this hilly area.

Crasna catchment has a slightly general curved shape where it is found one of the most impressive morphological asymmetry of Moldavian Plateau, with significant predominance of its development on the right side, where there were distinguished four sections, namely:

1. The upper sector , the most massive one, upstream Buneşti, is oriented NW-SE and covers an area of 9.406 ha (17.5 %). Here, Crasna valley, apparently consequent, falls almost entirely in the category of diagonal subsequent valleys (slanting) highlighting the first order structural asymmetry. The right slope, initially a unitary front with NE exhibition, was cut by a series of diagonal subsequent valleys (Crasna , Dolheşti, Cetățuia) , oriented on WNW - ESE direction , which also highlights the first order structural asymmetry. The left slope, initially a backslope with SV exhibition, was significantly fragmented by reconsequent valleys (Fundu Crasna , Cânepa, Pietrişul, Hruşca) , generaly ordered on N-S direction, that highlights very good the second order structural asymmetry. Therefore, in this sector we are witnessing to a mirror distribution of cuesta fronts, these having a NE exhibition on the right side and a W or NW on the left side of the catchment.

2. The second sector, located between the confluence of Crasna with Hruşca (at Buneşti) and Balcu (at Leoşti), is oriented on N-S direction and occupies an area of 14.924 ha (27.7 %). This is the consequent section of the Crasna valley where the second order structural asymmetry becomes striking. The left slope is a typical cuesta front with western exhibition, more fragmented between Buneşti and Tătărăni localities and more uniform between Tătărăni and Leoşti. The left slope has a backslope role with a eastern general exhibition, is highly fragmented, both by diagonal subsequent tributaries (Mândreşti, Blăgeşti) and by reconsequent ones (Rediu, Balcu). In the first case is highlighted the first order structural asymmetry and on the reconsequent tributaries the second order structural asymmetry. Between the junctions with Hruşca and Blăgeşti there is a combination of two types of structural asymmetries highlighted by the formation of diagonal subsequent valleys (Blăgeşti and Mândreşti), specific to the first order structural asymmetry.

3. The third sector, between Leoşti and Mânjeşti, extends on 14.796 ha (27.5%) and is the most characteristic one because in the context of Crasna orientation on the ENE - WSW direction, there is taking shape one of the most representative examples of "ideal" cuesta. Thus, the left slope is a broad cuesta front, with NNW exhibition, contrary to the general

inclination of geological formations towards SSE, where we witness to a succession of slide amphitheatre and abutments (small secondary hilltop, normally unaffected by landslides). The right slope is, overall, a very large backslope with SSE exhibition, fragmented by a fan of reconsequent valleys. These, also bring out clearly the second order structural asymmetry, very suggestive highlighted by Bălțați, Foleşti, Fundu Văii Țurchea, Burghina, Bahnari and Braniştea valleys.

4. The lower sector, downstream of Mânjeşti, occupies about 3.340 (6.2%) ha and is located downstream of the confluence of Cransa with Braniştea, where Crasna valley is redirecting on the N-S direction, highlighting the same pattern specific to the second order structural asymmetry, but faded by restriction of the right side area, a backslope with eastern exhibition.

Lohan catchment has also a slightly curved shape, but overall asymmetry associated with the area occupied by its two parts is less visible. The right slope, a typical backslope, is very poorly fragmented and has a much smaller development compared with the one of Crasna. The left slope, a cuesta front, is unitary, unfragmented upstream by Dobrina, while the corresponding parallel segment from Crasna valley is the most fragmented. However, downstream of Dobrina, the cuesta front of Lohan is appreciable sectioned by a series of obsecqente valleys, while in Crasna valley, downstream of Leoşti, the cuesta front is almost unitary.

The differences noted above are considered to be closely related to the evolution of those two valleys, namely Lohan valley that has been formed later than Crasna valley. This valley, being more evolved trough its faster deepening and moving to the left, reduced/limited the appreciable extension of the Lohan right's slope (a backslope) and hence the lack of length and area asymmetry between the two sides of the Lohan catchment. However, the backslope character of Lohan's right slope can be seen in the local morphology, being sustained by the asymmetry of inclination (low-moderate slope compared to the high inclination from the cuesta front), by the asymmetry of current geomorphological processes (only soil erosion) and by the asymmetry related to land use (predominantly arable and vineyards compared to the left slope occupied by forest and grassland).

In this context, there were separated only three sections, namely:

1. The upper sector runs from upstream of Dobrina saddle and occupies an area of 3.292 ha. The main stream of Lohan is reconsequent, oriented on N-S direction and highlights very well the second order structural asymmetry. Unlike downstream sectors, the left slope with a cuesta front role is poorly fragmented and has a low amplitude. The right slope is much larger, has reduced declivity and is poorly fragmented by a series of small consequent valleys.

2. The middle sector extends between Dobrina saddle and Olteneşti, occupying an area of 6.679 ha. The main stream has a diagonal subsequent character with an NW-SE orientation, which emphasizes the first order structural asymmetry. The left slope is a representative cuesta with NW orientation. Unlike the previous sector, in this case, the cuesta front has a large amplitude and is intensely fragmented by a series of small torrential catchments where are located most of the localities from the catchment. The right slope acts as a long backslope, slightly inclined and with reduced fragmentation, reprezenting the most favorable agricultural land.

3. The lower sector extends to thesouth of Olteneşti, where Lohan's main stream is redirecting on the N-S direction, highlighting the same pattern specific to the second order structural asymmetry.

The altitudes decrease gradually from north to south and from west to east, in accordance with the general inclination of layers. The maximum altitude of 424.8 m, records

on Vaslui-Crasna interfluvial hilltop, in Velnița Chirceşti Hill and the minimum of 86.9 m at the confluence with the Bârlad river. The average altitude of the catchment is 224 m.

The average slope of the slopes from the studied area is 7.5 °, but most of them present slopes greater than 5% (88.6% of total), which emphasizes a high erosion potential.

The fourth chapter, entitled ***"The main genetic types and landfroms"*** is dedicated to the geomorphological analysis of Crasna catchment, which describes the main features of structural-lithological relief, sculptural relief (fluvio-denudational) in general monoclinal structure and of fluvial depositional relief.

The structural-lithological relief plays a secondary role, subordinated to the sculptural relief (fluvio-denudational) in general monoclinal structure. Geological layer, composed mostly of brittle rocks, easily removed by erosion, imposed in the local morphology as plateaus and benches, only where near the surface appeared rocks more resistant to erosion.

The sculptural relief has a remarkable spread with a weight of over 75% of Crasna catchment. Although predominantly, it must be remembered that it evolved under the direct influence of the monoclinal support and undergo transformations under the action of current geomorphological processes.

Fluvial depositional landform occupies 16.4% of the river catchment, of whom floodplains and glacisses are wider compared to fluvial terraces. The most significant development it is represented by Crasna floodplain which reaches a maximum width of 1.2 km to the junction with Bârlad. Instead, apparently surprising, Lohan's meadow is narrow which shows both the younger age of its valley and also the control exercised by the evolution on Crasna catchment over the expansion limiting of Lohan catchment.

Due to the predominance of brittle substrate, loamy, the have been preserved few terraces, these covering an area of 840 ha. In most cases, upper terraces are severely degraded and, in the best case, there have been preserved the gravels from the base acumulation. The levels of the middle (65-70 m a.r.) and lower (20-25 m a.r.) terrace were maintained better and have the greatest extend.

The fifth chapter ***"Land degradation geomorphological processes"*** corresponds to the study of current geomorphological processes as key elements of land degradations. The range of geomorphological processes involved in land degradation is the one characteristic to whole of Moldovian Plateau, the local specificity being influenced by the structural-lithological, morphoclimatic particularities and by land usage.

Soil erosion occurs with different intensities on the slopes with inclinations above 5%. According to the model proposed by *Moțoc M. et al.* (1975, 1979), in Crasna catchment, the annual average soil losses on agricultural lands due to soil erosion are 22,04 t/ha/year. From the agricultural surface, 12.205,1 ha (28.8%) present acceptable values of soil erosion, more <7 t/ha/year. Much more extensive are the agricultural lands with average losses of >7 t/ha/year, which occupies 30.188,6 hectares, respectively71.2%.

As soil types, as expected, those most affected by soil erosion are vertisols (73,4 t/ha/year), regosols (36.3 t/ha/year), anthrosols (35 t/ha/year) and luvisols (32,4 t/ha/year), the opposite being situated the aquisalids (0,27 t/ha/year), fluvisols (6,4 t/ha/year), stagnosols (9 t /ha/year) and gley soils (14.7 t/ha/year).

Trough affected areas and the extent of the process, gullying has a secondary role in Crasna catchment, not reaching the magnitude observed in other regions of the Bârlad Plateau (Tutova Hills and Fălciu Hills). The area affected by gullying occupies 528 hectares and represents only 0.9% of the total, which does not diminish at all the role of gullying in the intense process of degradation and lengthy of affected lands. Numerically, valley-side gullies are predominant, which commonly are singular discontinuous, and rarely consecutive. Even if a significant number of gullies are forested, given the predominantly sandy layer and climatic conditions , they represent an important source of solid material wich is deposited

mostly as debris fans and/or alluvial deposits. The performed measurements on two of the representative gullies with eTrex Garmin GPS 30 and compared to the information from 1:5.000 topographic plans , 1974 edition, points out that during the 38 years, între1974 – 2012, the main gully from Valea Rației catchment extended with 19,03 m^2/year and Boscany hully with 1,33 m^2/year.

Landslides are the most representative of geomorphological processes that contribute to land degradation from Crasna catcgment. They occupy an area of 23.118 ha (42.9%), of which over 97% are stabilized. Mostly they develop on the cuesta front slopes with N, W, NW or SW exhibition, with slopes greater than 15 °, used as grasslands. The most active landslides were formed, in fact, trough reactivation of old deluviums dating from wetter periods of the Holocene or late Pleistocene.

The range of degradation geomorphological processes from Crasna catchment is completed by the sedimentation process with significant influences in meadows agradation and accumulation clogging. The average value of sedimentation rate between 1986-2012 is higher in the upper catchment, in Podu Oprii accumulation (3.46 cm/year) and lower in the lower catchment at Mânjeşti (0.77 cm/year), which highlights the buffer role played by the accumulation upstream Mânjeşti. Therefore, the presence of numerous small accumulations in the upper and middle catchment leads to reduced value of sedimentary delivery ratio in Lower Crasna.

The sixth chapter is devoted to the land use and soil and water conservation works from Crasna catchment. A special attention is paid to the dynamics of land use between 1894-2005.

The appreciable distribution of the crops with a weak anti-erosion protection, the traditional system culture on hill-valley direction and the rudimentary agrotehnics led to the considerable expansion of degraded lands. Currently, agricultural lands occupy 72% of the total area, while the non agriculturalones 28%, distribution wich denotes the intense transformation of natural vegetation by replacing them with surfaces taken aside.

Of landscaped areas before 1990 in accordance with the rules of combating soil erosion, remarkable is that today there are still 8.835 ha, representing 22.8% of the agricultural area. On 6.047 ha the lands are cultivated on the contour lines, and on 1.873 ha it is still practicing of crops system into strips or grass strips. Agricultural terraces occupy 916 ha.

The PhD thesis concludes with a final chapter for ***conclusions***. Thus, the physical-geographical and social-human conditions from Crasna catchment require appropriate measures to prevent and combat soil erosion by reinserting the organisational and anti-erosional works of agricultural lands and by establishing of forest plantations on lands occupied by gullies and/or affected by landslides.

The information in this paper may be very helpful for the public institutions of the state (prefectures, municipalities, environmental agencies, development agencies, agricultural directorates, cadastre and land registration offices, etc.) for judicious management of natural resources into perspective of sustainable development of these rural communities.