CONSIDERATIONS CONCERNING TYPES OF RAVINE FROM UNGURAŞ HILLS AND FIZEŞ PLAIN

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Abstract. To sum up, talking about ravines implies first of all a stop upon what water erosion means. That's why it's important to point out that water erosion is a comlex phenomena that affects the soil cover from the Transylvanian Plain and is triggered by a number of changes that act both in time and in space. Water erosion, as well as surface drain and water infiltration on the soil's profile is mainly due to the intensity of the rain, the nature of soils and the vegetation coverage. This study's aim is to assess the types of existing ravines in Northern and North-Western Transylvanian Plain, by taking into consideration the water erosion's effects. For the purpose of this research the ravine's morphology, the soil's texture and structure, as well as the hydraulic permeability and conductivity were analyzed. In conclusion, the evaluation of the current status of ravines from Unguraş Hills and Fizeş Plain have provided a series of observations regarding the typology of the existent ravines in these two regions. Field results revealed a strong correlation of the ravines' formation processes with their control factors, especially with the use of the land, the slopes' inclination degree, climate conditions and geological structure.

Keywords: Unguraş Hills, Fizeş Plain, ravine, soil, erosion, study

INTRODUCTION

Water erosion is one of the phenomena that affects the soil cover from the Transylvaian Plain. According to data collected by the experts from OSPA-Cluj, it affects an area of approximately 1560 ha. Human activities have contribuited to the degradation of flora and pedologic cover, the natural fertility of the soil, the hydrographic network, microclimate, helping the development of the surface water flow. Despite the energy and the financial resources that have been laid over time in cambating land degradation, this process is continuing to be active today. This action of soil degradation is more obvious even after a part of the agricultural land of the region has been abandoned in the last 15 years. Erosion control techniques were, in many cases, poorly adapted to the context of the study area, without a prior characterization of the erosion systems, of the soil properties, fact which lead to obtaining mixed results. The water erosion sitem is a very complex one, especially considering that it takes place at different scales of time and space. The concept of sustainability applied on the agricultural systems can be defined by the capacity of the ecosystems to renew themselves and to continue to function without being influenced by a certain type of degradation, being required a good management of flows (water, soils minerals, fertilizers and so on) and of stocks (the content of organic material, reserves of water in the soil and so on). This implies the existence of a resilient sytem to a number of changes, such as triggering an erosion process. At present, the world is going through an economic transformation in which the globalization, that currently involves a restructuring of the agricultural economy, especially in terms of social and environmental crises, would represent a favorable time for changing the attitudes and the way of thinking about soil resources management from this region. Given the lack of a permanent vegetative cover, with overcoming the stagnation phase and the one of precipitation water's infiltration, they begin to drain along the slope, engaging the soil particles, loam, clay, as well as the organic material which serve as a binder for frigile soils. Water erosion, surface drain and water infiltration on the soil's profile it is mainly due to the intensity of the rain (to the impact energy of raindrops), the nature of the soil (porosity of the horizon's surface) and the vegetation degree of coverage.

The analysis upon the phenomena of hydraulic erosion and the infiltration was performed at different spatial scales between the experimental data and the analitic data of hydromorphological characteristics of soils and especially their surface: at the hydrographic microbasin's scale, at a 100 m^2 parcel's scale (Wischmeier method), at the ravine's scale and at a stationary scale. In order to characterize the studied area from a physico-geographic point of view the current reasearch points out the following 8 main directions:the zone's morphology, the lithology's influence in the evolution of the relief and ravines, the climate characteristics, the soil cover, the territories' geodeclivity,the relief's depth fragmentation, the slopes' orientation type, the problem of ravines from the studied territories. After the study made on the land, it was established that the parameters which have controlled the ravines' development were the flow energy of the surface water, depending on the elapsed water mass multiplied by the square of its speed, closely related to topography and terrain's roughness. Thus, in the analyzed cases, there were determined two slope thresholds which can be decisive for triggering the ravines. Also, the study shows 5 types of ravines in the Norhern and North-Eastern part of the Transylvanian Plain, as follows: „V" ravines, such as those from Unguraş (Daroţ Valley) and Mintiu Gherlii territories, „U" ravines, a form that defines the Tăuşeni and Buza territories, tunnel ravines, spotted in the Tăuşeni and Buza territories, ravines in connected to landslides were determined in all the studied territories and reinstalled ravines, being characteristic for all the ravines analyzed.

MATERIAL AND METHOD

In this study there has been sought an assessment of the types of existing ravines in Northern and North-Western Transylvanian Plain. The erosive ecosystem is a complex system that take place at different scales, both in time and space. In space, it appears, as well, in different stages: particle, slope, hydrographic basin and continent. The water erosion's effect over time are also varied and the results are reflected in the agricultural landscape. Under conditions in which the influence of water erosion upon soil is becoming increasingly important – at least from the human's point of view – developing a uniform methodology to address these problems has come, more and more, into the agricultural and geomorphological attention.

To conceive and complete this study, there were analysed: the ravine's morphology, the soil's texture and structure, the hydraulic permeability and conductivity. *Linear erosion*, by run-off or drains – it's the most common form and it manifests by the drainage water's accumulation into the natural microdepressions of the slopes, in a series of drains; this represents the boundary between the surface erosion and the depth one. It manifests as drains, gullies, ravines and torrents.

The analysis upon the phenomena of hydraulic erosion and the infiltration was performed at different spatial scales between the experimental data and the analitic data of hydromorphological characteristics of soils and especially their surface.

- *at the hydrographic microbasin's scale* there was studied the spatial distribution of soil units in the landscape, followed by physicochemical analysis for each unit in order to assess the risck of soil erosion and drainage of surface water;

- *at a 100 m^2 parcel's scale (Wischmeier method)*, in which was establish a quatification of the surface water's drain, band and channel erosion to determined the role of some risc factors such as the impact of the raindrops, the influence of the soil type, the slope and the use of land;
- *at the ravine's scale* the device consists of planting pickets, on the top zone, on sides and at the bottom of the ravine, pickets that allowed the measurement of soil's cross section in order to evaluate the ablation processes or the stability, using a rope (1 kg tension) between the two slides of the ravine. The surveys and gully measurement processes and the determination of variables were performed with a straight wire after each erosive rainfall episode;
- *at a stationary scale* the method of study consists in: 1) an inventory of the different surface skin types (the skin type and roughness of the ground surface), 2) description of the morphology of the surface crust.

In order to characterize the studied area from a physico-geographic point of view the current reasearch points out the following 8 main directions:

1. The zone's morphology

The territory of study is part of the Transylvanian Plain, respectively of Unguraş Hills and Fizeş Plain. In these pshysical-geographical units there are well highlighted the phenomena of diapirism, including the salt's day appearance. Unguraş Hills are characterized bz a relief of hills and well defined cuestas, corresponding to the highest sector from the Transylvanian Plain, exceeding 639 m. The altitude, the brittle formations and local sagging area from the cofluence zone of Someşul Mare River with Someşul Mic River lead to rather pronounced slope processes. The main vallezs, direted towards Someşul Mare River, like thos of Unguraş, Batin and Daroţ, wenr deep in the sedimentary formations with 150-350 m, gave verz broad meadows, relative to the riverbed, as a result of slopes' intense withdraw in Holocene (they are connected with the slopes by extended glacis). Relief's evolution from Fizeş Plain was influenced by the presence of the diapirs (Cojocna, Sic, Băile Gherla etc.). The salt's rising imposed also higher altitudes (550-600 m). In the central and South zone there can be find domes. The relief is characterized by structural froms (cuesta slopes oriented towards Someşul Mic River and Someşul Mare River). Local cuesta are on the slopes of the Fizeş River's subsequent tributaries and the the semicircular ones are on the valley of the slopes that cut the domes. The Landslides have large dimensions (glimee, at the contact between the Badenian and Sarmatian) and they connect with torrents, existing secundary valleys developed on the sinclinals between the diapirs or the ones which cross the lower sectors between domes.

2. The lithology's influence in the evolution of the relief and ravines

Regarding the influence of the hills and valleys configuration there were determined 3 situations:

- *the preponderence of clay or marl layers* that have developed broad valleys, swampy sectors and intrefluves with clipped clopes, being specific the territories Buza, Nicula and Tăuşeni; here, on the slopes, washing in surface and landslides dominate;

- *the preponderence of slightly cemented sandy facies* where were formed narrow valleys with sharp downhill slopes, with structural policies, heavily affected by rain erosion, specific to the Unguraş territory (Daroţ Valley) and where the interfluves are rounded and appear often as headlands and peaks are high-pitched and separated by saddles;

- the prezence of hard rock horisons alterning with brittle rocks; from the Unguraş and Mintiu Gherlii territories, in the valleys' profile as well as in the hills' ones are differentiated many steps: on the peaks there are crests and deep saddles while on the slopes occur run-off, torrents, different sizes slides.

3. The climate characteristics

The climate is characterized by an annual average temperature of 8°C and annual average precipitation amounts of 700 mm/year (in the Unguraş Hills), as well as annual average temperature of 8.5-9°C and annual avegerafe precipitation amounts of 600 mm/year (in Fizeş Plain). During the analyze upon the formation and evolution of ravines from the studied territories, there were examined the following climatic parameters, considerated to be determined: the maximum quantity of precipitation fallen during a 24 hour period (75.9 mm), the precipitation's maximum intensity (8.64 mm/min), the average amount of precipitation (653.1 mm), the average number of rainy days (124), the avarage number of days with the quantity of precipitation more or equal to 5 mm (48), annual average temperature (8.6°C), the number of frost days (110), the number of summer days (71), the number of tropical days (15.8). According to the data analysis from the weather stations in Dej and Bistriţa, during a period of 25 years, there were observed the following: a high frequency during a calendar year of periods of 3 consecutive rainy days (10.1 periods); frequencies and periods of 4 consecutive rainy days (8 periods); the existence of at least a period of 8 consecutive rainy days, due to the active influence of the Western air masses. The highest precipitation intensities occur in May and June, when they take place in forms of short duration showers, producing, over some thresholds, a leak of unsaturated soils. During autumn months (October-November) and spring ones (March-April), the maximum intensities values of precipitation are much lower, so that the surface water flow occurs only after a complete saturation of the soil, an exception making th water flow resulting from snowmelt produces on a frozen ground.

4. The soil cover

The dominant soils are from the Cernisols class, respectively with typical chernozem for the Buza territory, typical faeoziom for the Nicula and Tauşeni territory, from the Protisols class, with limestone regosol for the Unguraş territories (Daroţ Valley) and Mintiu Gherlii. Except the chernozem from the Buza territory and the faeoziom from the Nicula territory, the rest of the soils are poor in humus, with an avarage content of $CaCO_3$, with a surface horizon strongly affected by erosion, but having o good structure stability. The total porosity in this soils presents high and very high values, especially during the first rains, and gradually decreases until there is no total infiltration, through complete saturation, as well as through the formation of a surface crust (Table 1). From that moment on also appeared the run-off, forming an erosion potential.

5. The territories' geodeclivity

This parameter brings out the existence of certain limit thresholds for triggering some erosive denudational processes, on one hand, and the land's suitability for certain establishments, on the other hand. In the studied areas there dominate the inclinations with values of 10-12° and 20-25°, favorable for the development of the torrential organisms and landslides. The most pronounced slopes (declivity greater than 25°) are in the Eastern and North-Eastern part of the Unguraş Hills and in the closeness of the cutwater (the slides' detachment area).

6. **The relief's depth fragmentation**

At the scale of the pedological studies' accomplishments, 1:10000, for the Unguraş (Daroţ Valley), Mintiu Gherlii and Nicula territories, the depth fragmentation has values between 100 and 185 m/km^2, while for the Buza and Tăuşeni territories, the values of the depth fragmentation are between 50 and 110 m/km^2. Instead, at a small scale (1:5000), for all territories analyzed, the depth fragmentation is between 5 and 20 m/km^2 which increases the degree of accuracz in the deep erosion forms' analysis.

7. **The slopes' orientation type**

The level given by the great hights' limit makes a clear demarcation between the Northern slopes (NV, N and NE) and the Southern ones (SV, S and SE). The largest group is the Southern one, where the wetting cycles – drying and freezing - thawing have a higher frequency and can encourage the emerge and development of ravines, situation due to the presence of clayey and sandy-clayey soils' texture resulted from the weathering of marls and sandstones, to which is added the role of contractile clays and their response to the humidity's influence.

8. **The problem of ravines from the studied territories**

The ravines from the present Unguraş Hills and Fizeş Plain territories are spectacular in appearance, but their activity was quite variable in time and space. Some are hundreds of years old, such as the Tăuşeni Raven, but which stabilized after a long period of activity, due to the lithology (the presence of a harder rock-based layer), the climatic or socio-economic changes (by switching from the agricultural usage mode to the pasture mode). Some ravines are very recent, from approximately 40-60 years, the Unguraş (Daroţ Valley) and Mintiu Gherlii territories, having an aggressive development in relation to the high values of the exceptional precipitation.

RESULTS AND DISCUSSION

In these regions with a slightly soil humidity deficit, especially during the spring-summer season, using less suitable land for agriculture, overgrazing during inappropriate periods, with a high humidity level in the soil, as well as with the application of an improper agrotechnic have increased the risk of upper soil erosion and ravines formation. After the study made on the land, it was established that the parameters which have controlled the ravines' development were the flow energy of the surface water, depending on the elapsed water mass multiplied by the square of its speed. The flow mass depends on the following parameters: the maximum amount of rainfall within 24 hours, which in the analyzed period, 2010-2012, was 51 mm. The adundance and rainfall's frequency, especially during the summer, have an important role in mitigating the soil saturation deficit, given that, in winter, the soil is, most of the time, strongly saturated with water. Depending on the clay's content determined for the analyzed soil types, it was discovered that water storage capacity is two times higher for the chernozem and faeoziom than for the limestone regosol. The speed drainage on the slope depends on the topography and terrain's roughness. Thus, in the analyzed cases, there were determined two slope thresholds which can be decisive for triggering the ravines. Under a slope of 1% water leakage occurs in a cloth form and less concentrated, without being able to trigger ravines' formation, while in a case of a slopes with more than 40% declivity, the ravines' formation process is replaiced by landslides. The field's roughness induced by vegetation, micro-dams (arragements with erosion control role) and the soil surface, covered by litter furrows, stones and so on, can also significantly reduce the leakage rate and, therefore, its transport ability (its competence and duty to load the sediments); and from this comes the explanation regarding to the presence of basic scattering cones. Soil's apparent density and porosity influence the capacity of water retention, permeability, aeration etc., playing an important role in adjusting leakage/seepage ratio. The types of structures that have a high degree of water stability and are formed of microaggregates present the most favorable conditions for infiltration. At a 4% increase in the proportion of the hydrostabile aggregates with a diameter larger than 0.25 mm, the infiltration doubles. Hydraulic conducticity, admeasurement that defines the soil's feature of being crossed by a water under the action of a potential difference, sets the leakage/seepage ratio. Regarding the hydraulic conductivity, for the analyzed soils was obtained a fairly good correlation, respectively -0.874, which means that while the hydraulic conductivity is increasing, the erodibility decreases.

The study shows 5 types of ravines in the Norhern and North-Eastern part of the Transylvanian Plain, as follows:

1.*„V" ravines*, such as those from Unguraş (Daroţ Valley) and Mintiu Gherlii territories, were developed on homogeneous materials such as fine marls and argillites. Once the upper soil's horizon is removed, the ravine's formation process evolves in 2 steps. During the first period, for several months, the rock grinds due to the alternation effect of the wet and dry periods and leads to the coarse sand's formation. These coarse particles migrates towards the bottom of the ravine under the influence of the raindrops' energy. In the second phase, during a heavy shower that falls upon an already wet soil, the bottom of the ravine is etched by rain runoff from the slope, which consist in a mixture of water with coarse sand, stones and an alterit matrix, or on the ravine from slightly inclined slopes, with a drain that has a transport task between 5 and 100 $kg/^3$. The vertically deepening under the sediments deposited during the first period of development, maintained the balance between the banks and the ravine's form (V) during its development. In order to stabilize the ravines, it's sufficient to reduce the sediments' discharge from the adjacent banks by applying a threashold of hard rocks, so that the fall of the slope is reduced until the balance slope's level, as well as by populating with vegetation the banks of the ravine. To rehabilitate the ravine, it has to be reduced by the peak of the water drain from that hydrographic sub-basin, an action difficult to accomplish;

2. *„U" ravines*, a form that defines the Tăuşeni and Buza territories, were developed on heterogeneous parental materials, such as the upper soil's horizon (juvenile form) and marl crusts. The first gullies that appeared on the land's surface, in cases when they are not removed by techniques of agricultural cultivation or prezervation, sink down etching the bottom until a hard substrate appears; the force of the water's action was exerted on sides, in order to evacuate the amount of transported sediments. Ravine banks regressively evolved throygh collapse, followed by the evacuation of soil's horizons resulted due to this degradation process;

3. *tunnel ravines*, spotted in the Tăuşeni and Buza territories, were formed inflatable claysmontmorillonite-ilite type, rich in coluble slats (calcium carbonate). The water flows through the soil's mass charged with clay or soluble salts and formes a series of linear array of wells progressively developed after the collapse of the roof. These so-called *hidden ravines* progressed in leaps through a subdigging process. These are the most dangerous types of ravines for the agricultural landscape and for the conservation work

because their evolution is unpredictable and difficult to stabilize through land works improvements due to the expansion of active drainage and deceleration of sedimentary materials' evacuation.

Table 1

Limestone Regosol (Unguraş – Daroţ Valley)

Horizons	**Ao**	**A/C**	**Cca**		
Depth (cm)	3-16	16-51	51-121		
Depth of sample collection (cm)	6-10	20-32	62-70		
GRANULOMETRIC ANALYSIS					
Coarse sand (2,0-0,2mm) %	0.17	0.07	0.20		
Soft sand (0.2-0.02mm) %	20.01	18.29	16.48		
Dust I (0.02-0.05mm) %	7.67	10.78	6.57		
Dust II (0.05-0.002mm) %	20.47	18.98	18.97		
Physical clay (<0.002mm) %	51.68	51.88	57.78		
Texture's interpretation	*AL*	*AL*	*AL*		
Skeleton %	-	-	-		
PHYSICAL ANALYSIS					
Wettability %	9.86	9.54	9.27		
Bulk density g/cm^3	0.93	0.98	1.03		
Total porosity %	65	64	61		
Interpretation	*Very large*	*Very large*	*Very large*		
The degree of compactation % v/v	-21.59	-19.73	-12.11		
Interpretation	*Very loose*	*Very loose*	*Loose*		

4. *ravines in connected to landslides* were determined in all the studied territories, being defined by the geographers through the opposition that exists between erosion (ravines) and mass movements (landslides). If the run-off is prevalent, the ravine's deepening process will mark the slopes' evolution, while, if the water infiltration in the soil's profile or of the surface sediments dominate, the risk of the deposits to slipp from the slope will increase. In fact, on the surveyed territories in the Northern and North-Eastern sectors of Transylvanian Plain was observed the presence of 2 processes that are acting sequentially in time, meaning that either the ravine's formation was preceded by a mass movement from the top of the concave slope, which brought together the surface water and sometimes even the hypodermic drains, or there was a cimprehensive ravine's formation process leading to an imbalance of the slopes followed by successive unhooking.

5. *reinstalled ravines*, being characteristic for all the ravines analyzed and which don't always develop in connection with the water volumes drained from the upstream side: they may depend on the presence of a vacuum created by widening a local road or river (both functioning as basic local levels) or by the existence of the preasure on the aquifer head and reflected by the appearance of brook. The difference in the operation of such ravines is important, but not always easy to observe on the field, only through the appearance of a maximum slope's development, at the level of the meadow's terrace or in the occurrence sector of a brook. Specialists consider that only this type of ravines may be capable of dividing a hill into 2, because the slope's origin can be found at its bottom. The

upper part of the ravine is often buried in the soil, especially the bottom of it, well highlighed as a deep form and which corresponds to a temporary appearance of a suspended underground water. As a result of this ravine's formation process, in Unguraş (Daroţ Valley) territories was observed the existence of a sequence of shorter ravines arranged in waterfalls.

Table 2

Typical Chernozem (Buza)

Horizons	**Amp**	**Am**	**A/C**	**Cca**	
Depth (cm)	0-20	20-41	41-72	72-123	
Depth of sample collection (cm)	5-11	24-35	46-55	75-85	
GRANULOMETRIC ANALYSIS					
Coarse sand (2,0-0,2mm) %	0,06	0,41	0,23	0,03	
Soft sand (0.2-0.02mm) %	27,74	20,34	20,94	32,34	
Dust I (0.02-0.05mm) %	4,45	5,65	6,14	7,57	
Dust II (0.05-0.002mm) %	16,35	14,30	17,79	15,82	
Physical clay (<0.002mm) %	51,40	59,30	54,90	44,24	
Texture's interpretation	*AL*	*AL*	*AL*	*TT*	
Skeleton %	-	-	-	-	
PHYSICAL ANALYSIS					
Wettability %	7,33	12,59	12,98	7,58	
Bulk density g/cm^3	1,24	1,25	1,30	1,34	
Total porosity %	54	54	52	50	
Interpretation	*Medium*	*Medium*	*Medium*	*Small*	
The degree of compactation % v/v	-2	+2	+4	+4	
Interpretation	*Unsettled*	*Poorly compacted*	*Poorly compacted*	*Poorly compacted*	

Table 3

Typical Faeoziom (Tăuşeni)

Horizons	**Am**	**A/Btw**	**Btw**		
Depth (cm)	2-28	28-62	62-110		
Adancimea de recoltare a probei (cm)	3-12	34-42	67-79		
GRANULOMETRIC ANALYSIS					
Coarse sand (2,0-0,2mm) %	0.3	0.27	0.15		
Soft sand (0.2-0.02mm) %	25.14	18.1	25.46		
Dust I (0.02-0.05mm) %	9.25	11.02	7.03		
Dust II (0.05-0.002mm) %	12.53	13.36	7.88		
Physical clay (<0.002mm) %	52.78	57.25	59.48		

Texture's interpretation	*AL*	*AL*	*AL*		
Skeleton %	-	-	-		
PHYSICAL ANALYSIS					
Wettability %	9,53	10,64	7,28		
Bulk density g/cm^3	1,13	1,22	1,39		
Total porosity %	58	55	49		
Interpretation	*Large*	*Medium*	*Small*		
The degree of compactation % v/v	*-7*	*-2*	*+11*		
Interpretation	Unsettled	Unsettled	Moderately compacted		

CONCLUSIONS

The evaluation of the current status of ravines from Unguraş Hills and Fizeş Plain have provided a series of observations that refer to the typology of the existent ravines in these two regions. Field results revealed a strong correlation of the ravines' formation processes with their control factors, especially with the use of the land, the slopes' inclination degree, climate conditions and geological structure. Areas with risc for shallow or low depth landslides, run-off and gullying have the largest share in these territories. Alternation of marls, friable sandstones and clays and high anthropogenic pressure favor the production of a large range of geomorphological processes, which in many cases overlapped. Gullies had an even greater impact on agricultural activities. Grasslands are the most affected, mainly due to the overexploitation.

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