PROCESSES OF SOIL DEGRADATION AND LIMITATION OF AGRICULTURAL PRODUCTIVITY IN THE UPPER BASIN OF BEGA RIVER

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Abstract: *In the context of conserving and enhancing soil fertility, a detailed analysis of their degradation processes is required, one that must identified the limiting and restrictive factors of the agricultural productivity, their level of intensity and the area of land affected by their action . This analysis provides an overview of soil degradation processes, and also provides the details necessary to intervene later, using preventive or ameliorative measures. Based on soil studies, prepared by the Office for Pedological and Agrochemical Studies, there was calculated the agricultural surface in the upper basin of the river Bega, To identify soil degradation processes in the upper basin of Bega river, ecopedological indicator included in the Elaboration Methodology of Pedological Studies (Vol. III), were used. Based on these indicators, soil characteristics have been established and also the environmental factors leading to land degradation and low production capacity.The soils that were identified in the upper basin of Bega river represents the result of the joint action of pedogenetical factors (climate, relief, lithology, vegetation, hydrology). The variety of these factors, at the scale of the researched area, led to a number of peculiarities in the processes of soil formation and evolution. In a wetter climate, under deciduous forest vegetation, on different parental materials and mineralogical composition, on a generally waved relief, soil formation took on different aspects. The production capacity of the land from Bega Upper Basin is diminished by the degradation processes caused either by some of their properties or by environmental factors. Due to the natural conditions of the studied perimeter - mountain and piedmont areas - areas of land are affected in varying proportions by the limiting factors, Soils are subjected to the action of one or more limiting factors. In Bega Upper Basin, the largest land areas are affected by low reserves of humus, unevenness of the terrain, slope and soil reaction. The studied area studied is located in the mountains and foothills of this basin.*

Key words: *soil, degradation, productivitty*

INTRODUCTION

The soil is "a natural, heterogeneous, multi-phase, dispersed, divided and porous body, with some features that allows it to provide water and nutrients needed for the growth and development of plants" (BLAGA et al., 2005). These features define soil fertility, the essential property of agricultural land, which has developed over time, along with its formation and evolution.

Some features of the land, defined and researched according to the methodology, act as limiting or restrictive factors on agricultural productivity (IANOŞ et al, 1997). So, in the context of conserving and enhancing soil fertility, a detailed analysis of their degradation processes is required, one that must identified the limiting and restrictive factors of the agricultural productivity, their level of intensity and the area of land affected by their action . From the analysis of soil studies results that large areas of land in the upper basin of Bega river are affected by one or more limiting and/or restrictive factors of agricultural productivity.

MATERIALS AND METHODS

Based on data provided by the Office for Pedological and Agrochemical Studies (OSPA), the total agricultural area was calculated by summing all units of land and highlighting the limiting factors of agricultural productivity across the entire region.

To identify soil degradation processes in the upper basin of Bega river, ecopedological indicators, included in the Elaboration Methodology of Pedological Studies (Vol. III), were used. Based on these indicators, soil characteristics have been established and also the environmental factors leading to land degradation and low production capacity.

RESULTS AND DISCUSSIONS

The soils that were identified in the upper basin of Bega river represents the result of the joint action of pedogenetical factors (climate, relief, lithology, vegetation, hydrology). The variety of these factors, at the scale of the researched area, led to a number of peculiarities in the processes of soil formation and evolution. In a wetter climate, under deciduous forest vegetation, on different parental materials and mineralogical composition, on a generally waved relief, soil formation took on different aspects. The soil types within the studied perimeter (13,542 ha) are very varied (Table 1) being classified in five soil classes, as following:

- luvisols occupy 6590.17 ha, respectively 48.66%, the majority in this class being luvosols, encountered on an area of 6174.15 ha, widely spread in the investigated area..

- protisols occupy an area of 2566.32 ha, and these are spread over hills (Lapugiului, Fagetului, Bulzei, Lipovei); in these units are also to be found regosols, litosols and aluvisols are found in rivers.

- cambisols class, represented by eutric cambisols, occupy an area of 947.49 ha and are found, in particular, on the slopes of hills mentioned above.

- hidrisols occupy a total area of 764.15 ha, respectively 5.63% of the agricultural area, being spread on flat landforms, the patio areas and river valleys.

- antrisols class, represented by erodosol, occupies an area of 282.09 ha, respectively 2.08%.

Table 1

The percentage of the classes and soil types within the agricultural area

Class and soil type		**Surface**	
		ha	%
Luvisol	Preluvosol (typical, stagnogleizat, amfigleizat, vertic, gleizat)	416.00	3.07
	Luvosol (typical, stagnogleizat, vertic)	6174.15	45.59
		6590,17	48,66
Cambisol	Eutricambosol (typical, gleizat, stagnogleizat, amfigleizat)	947,49	6,98
		947,49	6,98
Hidrisoluri	Stagnosol (typical, luvic)	282,97	2,08
	Gleiosol (typical, cambic)	481,18	3,55
		764,15	5,63
Protisoluri	Litosol (typical)	344,73	2,54
	Regosol (typical, calcaric)	1271,40	9,38
	Aluvisol (typical, gleizat)	950,19	7,01
		2566,32	18,93
Antrisoluri	Erodosol (typical, argic)	282,09	2,08
		282,09	2,08
Soil associations		2391,80	17,66
Total		**13542,00**	**100,00**

In the case of the above mentioned soils, due to their characteristics and/or under the action of environmental factors, a wide range of degradation processes are identified, with repercussions on their production capacity. Thus, upon the productive capacity, one or more limiting factors can operate. Their action way, intensity and the land on which they occur, will be presented below.

SOIL REACTION

The process of soil acidification is characteristic of areas with cool, wet climate of the mountain and piedmont areas, and is specific to the class of luvisols. Following the dealkalization of the colloidal complex, soils acquire high acidity, there is also an increased solubility of elements such as Al, Fe, Mn, etc., so much that deficiencies in some elements or phytotoxicity phenomena could appear (BORZA I, 1997).

Due to high acidity, the activity of some microorganisms (symbiotic nitrifying bacteria) is disturbed and cultivation of certain plants susceptible to acid soil reaction (lucerne, sugar beet, barley) is restricted.

In the upper basin of Bega river, soil reaction is the limiting factor on approx. 7126.32 ha (52.62% of the studied area) due to low and moderate values (Table 2), in this basin being predominantly soils with acid reaction (Table 1).

Table 2

Limitations due to chemical characteristics of soils

Limiting factor		Surface	
		ha	%
Acidity	Moderate acidity (pH 5,5 – 5,8)	3512,40	25,93
	Moderate acidity(pH 5,1 – 5,4)	3106,13	22,93
	Strong acidity (pH ≤ 5)	507,79	3,74
Humus reserve	Low reserve of humus	7787	57,50
	Moderate reserve of humus	1065,08	7,86
	Very low reserve of humus	2994,89	22,11
	Extremely low reserve of humus	27,94	0,20

LOW HUMUS CONTENT AND NUTRITIVE ELEMENTS

Humus is the component of soil affecting its physical, chemical and biological properties, thereby determining, to a large extent the productive potential of soil (BORZA I, 1997). The decrease of humus reserve is determined by a number of factors, most important being the erosion, scraping and clogging (IANOȘ et al, 1997).

Soil is the main source of nutrients for plants, basic elements being nitrogen, phosphorus and potassium. Soil depletion in these elements, coupled with other negative features, confer a low fertility to those lands (RAUF C, 1983, quoted by BORZA I, 1997). Plants most demanding for the content of humus are: vegetables, beets, potatoes, sunflowers, lucerne, clover, corn, etc..

In the upper basin of Bega river, humus reserve is one of the main limiting factors, affecting an area of 11,874.91 ha, representing 87.68% (Table 2).

COARSE TEXTURE

Texture plays a central role in ensuring conditions for growth and fructification of plants. Coarse-textured soils (sandy or sandy-clay) have excessive permeability, low water retention capacity and are poor in humus and nutrients (IANOȘ et al, 1997) being unfavourable for plant development.

Within the perimeter of the studied area, coarse texture a characteristic of fluvisols, constitutes a limiting factor on the surface of 347.34 ha, 2.56% (Table 3).

Table 3.

Limitations due to physical characteristics of soil

Limiting factor		Surface	
		ha	%
Soil texture	Coarse texture	347,34	2,56
	Fine texture	1862,37	13,75
Compactness		3580,51	26,43
Edaphic low volume		2921,84	21,57
Ground lift	Moderate bearing land	2163,69	15,97
	Poor land temporarily lift	1378,91	10,18
	Land with low bearing	140,90	1,04

FINE TEXTURE

Fine texture (clay and loam-clay) confer a low permeability to soils and high water retention capacity. Because of this, infiltrations are difficult to produce, leaching is weak, and physical and mechanical properties are unfavorable. Although the soils are rich in humus and have a great capacity to retain nutrients, the plants don't always get optimal growth and development because of water and air antagonistic regime (IANOȘ et al, 1997). In conditions of normal amounts of precipitation soil can be quickly reached saturation within the upper horizon, and the rest of the water remains at the surface. If they get wet, these clay soils become adherent and difficult to work. If they get dry, cracks may occur due to increased cohesion and a high resistance to plowing begins to appear.

Within the perimeter of the studied area, fine texture is a limiting factor on the surface of 1862.37 ha, 13.75% of agricultural area (Table 3).

SOIL COMPACTNESS

Compactness of the soil represents its property to oppose forces that tend to disjoin mechanically the particles that compose it. The degree of compaction of the soil is influenced by its granulometric composition, water content, humus content and the nature of adsorbed cations. Compaction has maximum values in the case of soils with high clay content and has negative effects on plants because it prevents root penetration to deeper layers in the soil and create a poor aero-hydric and nutritional regime.

It affects large areas of Fagetului, Lăpugiului and Bulzei Hills due to the presence of luvisols, estimated areas to 3580.31 ha, respectively 26.43% (Table 3).

EDAPHIC USEFUL VOLUME

Edaphic useful volume is the amount of fine material that can be available to plants to supply them with nutrients and water. Its size depends on the total depth of soil up to hard rock and on skeletal content. Typically perennial plants and woody plants in particular have deeper rooting and requires a greater volume of soil, while the yearly ones explore a more superficial layer.

Since it is of great importance in plant growth and development, in the area studied, edaphic useful volume is a limiting factor on an area of 2921.84 ha, 21.57% (Table 3), the reason for this being a high proportion of protisols.

LAND CARRYING CAPACITY

Land carrying capacity represents how the soil reacts when it is required to support additional loads (farm machinery, livestock, etc.). This property is expressed by the maturation index of the soil, according to which it can be appreciated when the soil has reached physical maturity and the time interval it keeps this quality, elements of great importance in terms of

timing the agricultural works.

In the upper basin of Bega river, soil carrying capacity represents a limiting factor on an area of 3683.50 ha (27.20% of the total area), a phenomenon present in the case of certain soils from the classes: luvisol, cambisol, hidrisol.

TERRAIN SLOPE

By its degree of tilting, terrain slope is the main factor involved in initiation and manifestation mode of superficial and deep erosion, landslides, and the differential use of technologies and agricultural machinery. The higher is the inclination of the slope, the greater is the possibility that land masses be put in motion. The movement of land masses takes place under the action of gravity, but also due to other factors such as versant declivity, amount of precipitation, the weight of the particles and forces of friction between them, or the mode of action of the vegetation cover. As a result of the research done, it has been highlighted the influence of slope on the production capacity: increasing slope inclination decreases production of all crops.

Since the upper basin of Bega river is located in the piedmont area, the relief is characterized by versants with high declivity, terrain slope being one of the main limiting factors. Depending on the degree of inclination, the agricultural land can be classified in several categories of slope (Table 4), the total area affected by it being 8754.63 ha representing the 64.64% of the agricultural area.

Tabel 4

Limitations due to erosion and landslides

Limiting factor		Surface	
		ha	%
Slope	Weak and moderately sloping land (slope 5,1 -15,0%)	1919,30	14,17
	Moderately sloping land (slope 15,1 – 25,0%)	2435,33	32,49
	Moderately sloping land (slope 25,1 – 100%)	4400,31	32,49
Surface erosion,including erosion hazard	Land with little danger	1425,93	10,52
	Medium risk land	586,69	4,33
	Land with high and very high hazard	2390,47	17,65
Erosion depth		2063,73	15,23
Landslides		2691,54	19,87

EROSION AT THE SURFACE, INCLUDING THE DANGER OF EROSION

Erosion is defined as "a natural geological process (possibly more enhanced by anthropogenic action) of detachment and transport of particles from the soil surface under the action of external dynamic agents (IANOŞ et al, 1997). The activation and sustenance of erosion is due to a variety of factors: terrain slope (the main factor), weather patterns, the degree of homogeneity of the vegetation cover and some physical properties of the soil. To the above-mentioned natural factors, anthropogenic action is added by applying inappropriate crop systems, the combined result of these factors being the onset and amplification of erosion processes, which determine mainly a decrease in fertility.

In the specific conditions of the upper basin of Bega river, erosion at the surface is the limiting factor for an area of 4403.09 ha, representing 32.51%.

DEEP EROSION

Deep erosion occurs due to high speed and temporary leakage on surface of land with inclination more or less pronounced where the amount of water which cannot infiltrate carries along its way particles of soil or rock. These large quantities of water result from heavy rains or sudden melting of snow. Land affected by deep erosion has unevenness that creates difficulties

in the use of agricultural machinery.

In the area studied, terrain slope, periodic large quantities of precipitation, the presence of some friable rocks or discontinuity of the vegetation cover, causes deep erosion, a phenomenon that affects an area of 2063.73 ha, 15.23%.

LANDSLIDES

Landslides represent a form of rapid evacuation of material from the stratum of soil formation or alteration, and generate on the versants a variety of forms of microrelief, depending on the intensity of the phenomenon, which changes every recrudescence of it.

Lands that are most exposed to these events are those located on high declivity slopes, with porous rocks, less cohesive, placed over layers of impermeable rock, in areas with large amounts of precipitation. Due to the above mentioned conditions, in the upper basin of Bega river, landslides are present on a surface of 2691.54 ha, representing 19.87%

LAND COVERING WITH ROCKS AND/OR BOULDERS

They are specific to the accumulative land of alluvial and aluvo-proluvial types (major river beds, cones of dejection, aprons) or mountainous areas where erosion has brought to light skeletal material. Their presence creates major difficulties in performing mechanical agricultural works and contributes to an inferior exploitation of agricultural lands.

In the perimeter studied such phenomena are present in the alluvial plain of Bega river and on some terrace-like forms on the hills, and occupy 597.52 ha, 4.41%.

Table 5.

Limitations due to land cover or its lack unevenness

Limiting factor		Surface	
		ha	%
Land cover with rocks and boulders	Poor stony land	572,07	4,22
	High rocky land	25,45	0,18
Field uniformity	Very poor uneven land	1874,20	13,83
	Slightly uneven land	3992,78	29,48
	Moderately uneven land	207,59	1,53
	Highly uneven land	4865,27	35,92
	Strongly uneven land	697,68	5,15

LAND UNEVENNESS

Land surface is smooth in a very few cases. Due to certain processes like suffosion, compaction, subsidence or after versant processes, irregularities are created with different levels and different frequencies, which limits the use of that land. Unevenness affects an area of 11,637.52 ha, 85.93% respectively.

EXCESSIVE PHREATIC HUMIDITY

The presence of stagnant groundwater in the soil profile causes significant changes both in terms of morphological properties of the soil, and in terms of physical, chemical and biological characteristics of it. Gleysation is manifested in the low plain areas, in the meadows and in the valleys of erosion, where the groundwater is shallow (IANOŞ et al, 1997). The presence of the groundwater in the soil profile creates anaerobic conditions, followed by intense processes of reduction of the Fe and Mn compounds or their oxidation processes at a lower intensity of the gleyzation process (BORZA I, 1997).

In the upper basin of Bega river, soils affected by phreatic humidity (gleysols, alluvisols) occupy an area of 1533.77 ha, 11.32% (Table 6).

Table 6.

Limitations due to humidity excess

Limiting factor		Surface	
		ha	%
Groundwater excess moisture	Land with excessive moisture reduced groundwater	515,13	3,80
	Land with excessive moisture moderate groundwater	414,26	3,05
	Land with excessive moisture groundwater	604,38	4,46
Excess surface moisture	Low excess land surface moisture	1344,22	9,92
	Moderate excess land surface moisture	1494,84	11,03
	Excessive moisture land surface	537,48	3,96
Flooding by flood		2111,90	15,59
Excess moisture on the slopes		263,61	1,94

EXCESSIVE SURFACE HUMIDITY

Stagnogleyzation process is similar to the gleyzation process with main difference being that excess moisture that causes him comes from rainfall, leaks or flooding. It usually manifests itself in the conditions of a cooler and wetter climate, and on terrains with external drainage lowered by the presence of a pedolitologic substrate predominantly impermeable or from anthropic interventions, which led in artificially compacted soil horizons (IANOŞ GH et al, 1995).

In the perimeter studied, the excessive surface humidity is the limiting factor on an area of 3376.54 ha, 24.93% respectively, with soils being affected in areas of terraces (stagnosols, preluvisols) or on flat landforms.

INUNDABILITY BY OVERFLOWING

During periods rich in precipitation, due to heavy rains or due to the sudden melting of snow, Bega River may flood the lands near the riverbed (less than once every five years). This situation is emphasized by the presence of a shallow layer of gravel on certain areas or by the presence of the skeletal material within the soil profile.

The lands affected by this phenomenon amounts to an area of 2111.90 ha, 15.59%.

EXCESSIVE HUMIDITY ON VERSANTS

In the perimeter studied, these limitations are present in small areas (263.61 ha representing 1.94% of the agricultural area) (Table 6).

CONCLUSIONS

In accordance with the natural conditions, pedogenesis processes have led to the formation of soils specific to hilly area (luvisols, cambisols, protisols), in the upper basin of Bega river being included hills areas and to meadow areas (alluvisols, hidrisols).

These soils, due to their own characteristics or due to environmental factors, are subject to degradation processes which lead to reduction of their productive capacity, thus, the land units may be affected by the action of one or more limiting factors.

Due to the natural conditions of the studied perimeter - mountain and piedmont areas - areas of land are affected in varying proportions by the limiting factors, as follows:

- humus reserve 7126.52 ha, 52.62%
- terrain unevenness 11637.52 ha, 85.93%
- terrain slope, 8754.63 ha, 64.64%
- soil reaction, 7126.32 ha, 52.62%
- erosion at the the surface 4403.09 ha, 32.51%
- land carrying capacity, 3638.50 ha, 27.20%

- compactness, 3508.31 ha, 26.43%
- excessive surface humidity 3374.54 ha, 24.93%
- edaphic useful volume, 2921.84 ha, 21.57%
- landslides, 2691.54 ha, 19.87%
- inundability by overflowing 2111.90 ha, 15.59%
- deep erosion , 2063.73 ha, 15.23%
- fine texture, 1862.37 ha, 13.75%
- excessive phreatic humidity, 1533.77 ha, 11.32%
- land covering with rocks and boulders, 597.52 ha, 4.41%
- coarse texture, 347.34 ha, 2.56%
- excessive humidity on versants, 263.61 ha, 1.94%

Above is presented the area affected by each limiting factor, relative to the agricultural area, but a field unit is generally affected by simultaneous action of several factors.

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