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STUDY ON THE SOILS OF THE GORJ COUNTY AND THE LIMITING FACTORS OF THEIR QUALITY, IN ORDER TO IMPROVE THEM

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Abstract

This study aimed at inventorying the soils of the Gorj County, classifying them into quality classes and identifying the limiting factors of their quality. Thus, eight soil classes were identified over an area of 192,405.22 ha and soil complexes and associations over an area of 51,362.78 ha. As far as soil quality is concerned, the soils have been divided into quality classes which were done following the 1:10,000 scale survey. The assessment was made according to soil, relief and climate and it was revealed that the largest agricultural area, i.e. 140,898 ha, which represents 57.8% of the total agricultural area, falls into the fourth quality class, which demonstrates the complexity of the relief and soils in the Gorj County. As far as soil quality limiting factors are concerned, it was found that they can be grouped into three main groups: soil-dependent limiting factors (texture, porosity, reaction, $CaCO_3$ content, nutrients content); limiting factors dependent on terrain factors <other than soil> (slope, erosion, landslides) and limiting factors caused by anthropogenic activities (pollution).

***Key words**: land assessment, limiting factors, nutrients content quality, soil.*

INTRODUCTION

The Gorj County is located in the south-western part of Romania, on the middle course of the Jiu River. The total area of the county is 560,174 ha, representing 2.35% of the area of the country, ranking 21st in terms of area. The 560,174 ha cover a natural setting of great variability: foothills, lowlands and mountains, which are represented as follows: 243,768 ha agricultural land, 273,868 ha forests, 10,251 ha non-productive land and 25,787 ha other uses (water, roads, construction).

Sustainable land use is very important to maintain its high production capacity and to preserve the quality of the environment (Zafiu & Mihalache, 2021).

Soil quality is influenced by limiting factors, factors which are the same as in the Romanian bonitation system, but which manifest themselves differently depending on geomorphological, lithological, hydrological and climatic specificities (Teaci, 1980).

The limiting factors of soil quality can be divided into three groups:

1. soil-dependent limiting factors (texture, porosity, reaction, $CaCO_3$ content, nutrient content);
2. limiting factors dependent on terrain - other than soil (slope, landslides, erosion);
3. limiting factors caused by anthropogenic activities (pollution).

With regard to the factors in the first group, several aspects should be mentioned.

Texture is a limiting factor because it cannot be modified in simple ways, directly influencing the hydrophysical properties of the soil.

The effect of the clay fraction is stronger the lower the organic matter content, becoming insignificant when organic matter is present in large quantities (Cochrane & Aylmore, 1994; Thomas et al., 1996).

Soil porosity depends on all soil properties, but is most influenced by texture and structure. Optimum porosity is found in horizons with a glomerular structure, as well as in loose soil, which has non-capillary spaces between aggregates and capillary pores within structural aggregates, with optimum values at: cultivated soils 45%, loamy 47%, clayey 40% (Popescu, 2008).

Soil reaction is a limiting factor of soil quality, being directly related to the degree of base saturation.

In our country, most agricultural plants grow in good conditions at a weak acid to weak alkaline reaction (pH between 5.81 and 8.40), in this situation the soil reaction (pH) is not a limiting factor for soil quality (Popescu, 2019).

The calcium carbonate ($CaCO_3$) content of soils becomes a limiting factor when it is present in large (21-25%) and very large (26-40%) quantities. ***Nutrient content*** can be a limiting factor in soil quality, in particular because important nutrient reserves in soils are in the form of compounds that are inaccessible to plants.

Limiting factors dependent on the land, other than the soil, are given first of all by the configuration of the land - by the slope and the repercussions this has on the soil, namely erosion and landslides - and last but not least by climatic and environmental conditions, which cause excess moisture, or conversely, drought.

Slope determines surface and deep erosion. Landslides are induced by abusive and excessive deforestation that leads to soil destabilization, through the removal of roots that provide its stability (Kalmar et al., 2022). Climatic and environmental conditions can act as limiting factors through excess moisture or drought – which occurs in the summer during the vegetation period, being essentially the major abiotic stress that limits crop production (Bonea, 2020) or through the combination of atmospheric and soil drought, which severely affects agricultural crops, significantly reducing or even completely destroying them (Niţu et al., 2023).

Limiting factors caused by human activities are manifested through pollution and soil compaction.

Pollution manifests itself in various forms caused by human activities (agricultural methods, forest management, urbanisation, etc.). Human activities have led to soil degradation, causing a decrease in its productive capacity and affecting surrounding ecosystems (Niţu et al., 2023; Corcheș, 2023).

The main sources of pollution are: mining and quarrying, oil and gas exploitation, the energy industry, agriculture (compaction).

Soil compaction is a process caused by natural or artificial causes, as a result of which the bulk density increases greatly and the total porosity and aeration porosity fall below normal values.

In Gorj County, agriculture is of particular importance as an economic branch, primarily to support the livelihood of the local population. For this reason, it is necessary to know as much as possible about the soil, its fertility status, which influences its productive capacity, but also to identify sustainable, diversified and balanced agricultural technologies that ensure the conservation of both the soil and the surrounding environment, in order to provide high, stable and high nutritional quality productions (Hansen et al., 2006; Patzel et al., 2000).

The decrease in soil fertility should be a wake-up call to limit soil degradation and rehabilitate soils by changing production technologies to improve their physical, chemical and biological properties (Zafiu & Mihalache, 2021). Thus, the identification of soil quality limiting factors is of great importance for the development and implementation of sustainable agricultural technologies (Bouma et al., 2017; Davidson, 2000; Rhodes, 2017; Smith, 2012; Várallyay, 2010) which would ensure that the soil can continue to provide quality goods and services (Doran et al., 2000; Toth et al., 2016; European Commission, 2006; EC Law, 2021), and a healthy environment.

MATERIALS AND METHODS

The aim of this study was to present the limiting factors of soil quality in Gorj County and how they contribute to the degradation of agricultural land quality.

Field research (soil sample collection) and laboratory analysis (determination of nutrient content, soil reaction, $CaCO_3$) were carried out for this study. During the research, the raw results obtained in the field and laboratory phases were processed and interpreted in the office phase (determination of structural indices). Also, in parallel, statistical data and documents existing at the Gorj O.S.P.A. were studied and analysed in order to highlight the main problems related to soil quality in the county, but also a review of the literature was made in this regard, in order to provide a better understanding of these phenomena and their intensity (Gorj O.S.P.A. Archives, 1979-2010; 1980-2010; 2010; 31/12/2018).

The study also focused on identifying the main measures that could be taken to prevent land degradation and restore degraded land.

RESULTS AND DISCUSSIONS

The distribution of the agricultural area according to the lithological nature of the main parent materials on which the soils of Gorj County evolved is shown in Figure 1. It can therefore be seen that the highest percentage is represented by silts and alluvial deposits (25% each) and the lowest by limestones (2%).

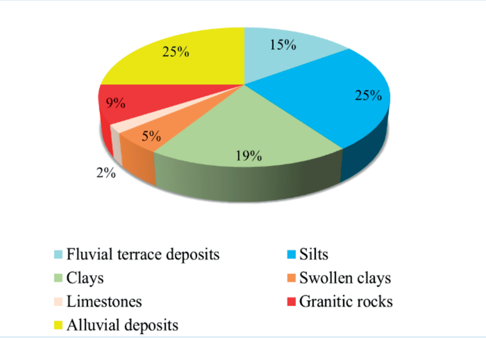

Figure 1. Percentage distribution of lithological materials in the Gorj County

Given the natural framework as well as the environmental conditions existing in Gorj County, a wide variety of soils have evolved and they are divided into the following classes: Protisols, Cernisols, Cambisols, Luvisols, Spodosols, Pelisols, Hydrisols and Anthrisols (Florea & Munteanu, 2012).

As can be seen, the Gorj County comprises eight soil classes, covering an area of 192,405.22 ha, as well as soil complexes and associations covering an area of 51,362.78 ha (Balan, 2021). Thus, soil classes occupy areas of: 1,395.5 ha cernisols; 71,482.81 ha luvisols; 69,894.36 ha cambisols; 5,131.84 ha spodosols; 3,544.45 ha hydrisols; 8,495.42 ha pelisols; 30,143.80 ha protisols; 2,316.74 ha anthrisols. Soil complexes and associations are found on slopes with uneven slopes greater than 20%, where erosion processes and landslides are more intense.

As far as the distribution of land by quality classes is concerned, this was done following boning, according to soil, relief and climate. Thus, it was revealed that the agricultural area of Gorj county, i.e. 243,768 ha, falls into the fourth quality class with an average score of 36 points, as follows: arable land (101,622 ha) is in the fourth quality class with an average score of 36 points, grassland and meadows (122,070 ha) in the fourth quality class with an average score of 35 points, vineyards (7,604 ha) in the fourth quality class with an average score of 31 points, orchards (12,472 ha) in the fourth quality class with an average score of 32 points (Table 1).

Table 1. Distribution of agricultural area in the Gorj County by quality classes and categories of use

Item No.	Category of use	Surface (ha)	Quality class														
			II			III			IV			V			Class	
			Surface ha	Points No.	%	Surface ha	Points No.	%	Surface ha	Points No.	%	Surface ha	Points No.	%	Average	Points No.
1	Arable	101,622	4,971	65	4.89	26,154	43	25.74	62,502	34	61.50	7,995	18	7.87	IV	36
2	Pastures + meadows	122,070	10,050	67	8.23	27,031	45	22.14	63,891	33	52.34	21,098	17	17.28	IV	35
3	Vines	7,604	216	64	2.84	946	41	12.44	5,465	31	71.87	977	15	12.85	IV	31
4	Orchard - trees	12,472	267	61	2.14	2,105	44	16.88	9,040	31	72.48	1,060	18	8.50	IV	32
5	Agricultural land total	243,768	15,504	65	6.36	56,236	44	23.07	140,898	33	57.80	31,130	17	12.77	IV	36

Soil-dependent limiting factors refer to soil physical properties (texture, porosity) and chemical properties (soil reaction - pH, calcium carbonate content - $CaCO_3$ and nutrient content).

Texture manifests itself as a limiting factor of soil quality in Gorj County, depending on the parent material on which the existing soil types evolved. Thus, texture is a limiting factor in soils of the luvisols class (typical preluvisols, typical luvisols, white luvisols), which evolved on clays as parent material, and in vertosols which evolved on swollen clays. These parent materials, having a high clay content and especially colloidal clay, gave the soils in the upper horizons and on the control section a fine texture (LA-AL-A). Fine texture is a limiting factor on an area of 59,958 ha of which: 47,631 ha soils evolved on clays and 12,327 ha soils evolved on swollen clays.

Coarse and medium-coarse texture is also a limiting factor for soil quality, but to a lesser extent. This texture is found in soils that have evolved on coarse-textured parent materials. Coarse texture affects soil quality on 5,327 ha (NL) and medium-coarse texture 80,487 ha (LN).

The loam texture is not a limiting factor for the quality of soils in the Gorj County, since the grain size fractions have a balanced distribution, and this is found on an area of 104,496 ha, where the soils have evolved on medium parent materials. The medium texture gives the soil favourable physical and chemical properties, i.e. better water permeability of the soil, water retention, accumulation and yield capacity, good porosity, etc.

Total porosity is a limiting factor for the quality of soils in the Gorj County, over an area of:

- 59,958 ha, on fine-textured soils (clayey) in the upper horizon and on the control section, where the degree of subsidence is high and the total porosity low;
- 5,327 ha, on sandy soils, where porosity is high and the soil loose.

In terms of **soil reaction**, soils in Gorj County have a pH between 4.4 (strongly acidic soils) and 9.1 (strongly alkaline soils).

The soils covering the agricultural area of the county are characterized by a wide range of variation (Figure 2) which highlights the difficulties in soil cultivation and choice of uses. Soil reaction is not a limiting factor for soil quality in the Gorj County on an area of 168,638 ha (69.17%) where it falls into the categories of the weakly acid reaction (16.91%), neutral reaction (18.23%) and weakly alkaline reaction (34.03%).

As pH decreases or increases, plants suffer, as soil reaction becomes a limiting factor in soil quality. Thus, soil reaction is a limiting factor in the Gorj County on an area of 75,130 ha (30.83% of the county's agricultural area), of which:

- strong acid reaction occurs on an area of 20,541 ha (8.43% of the agricultural total);
- the moderately acid reaction occurs on an area of 52,570 ha (21.57% of the agricultural total);
- strong alkaline reaction occurs on an area of 819 ha (0.34% of the agricultural total);
- the moderately alkaline reaction occurs on an area of 1,200 ha (0.49% of the agricultural total).

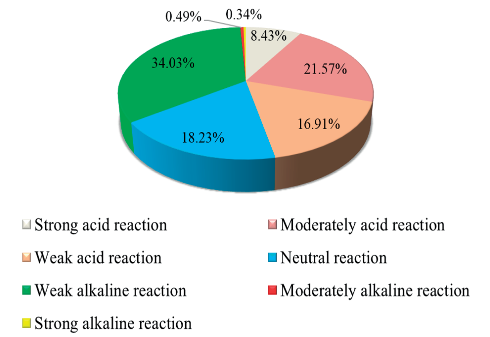

Figure 2. Areas and classes of soil reaction variation on agricultural lands

Knowing the reaction of soils, it is possible to place agricultural crops appropriately, knowing that some plants prefer soils with an acid reaction (potato, lupin, barley, rye) and others prefer soils with an alkaline reaction (alfalfa, asparagus, etc.).

Also, knowing the negative effect of the reaction of soils, the most appropriate measures can be taken for their improvement and rational use. Thus, for the improvement of acid soils, carbonate or calcium oxide-based amendments are used ($CaCO_3$, CaO). The amelioration of the strong alkaline reaction is much more complicated and is achieved by the administration of gypsum or phosphogypsum-based amendments, concomitantly with the application of washing and desiccation works.

In the Gorj County **soil calcium carbonate content ($CaCO_3$)**, is not a limiting factor for soil quality, exceeding normal limits in very rare cases. One of these cases is the regosols, where quantities higher than 20% are found especially in the upper horizons.

As far as **nutrient content** is concerned, in the Gorj County soils they are found in low and even very low assimilable forms.

In order to highlight the nutrient content of the soil, agrochemical mapping was carried out on representative areas under different agricultural uses. Table 2 shows the agrochemical mapping area by agricultural use.

Nitrogen supply to soils is generally low and medium due to low doses of this macro-element being administered, lack of organic fertilisation, degraded state of soils and also due to low humus content.

The degree of nitrogen supply is determined by the humus content and the nitrogen index. The nitrogen supply situation by nitrogen index is shown in Table 3.

Table 2. Situation of agrochemical mapping areas

Category of use	Total surface area (ha)	Mapped area (ha)	Mapped area (% of total use)
Arable	101,622	80,571	79.28
Pastures - meadows	122,070	88,694	72.66
Orchards - trees	12,472	9,176	73.57
Vines	7,604	4,045	53.20
Total	243,768	182,486	74.86

Thus, of the total agricultural area of 182,486 ha with agrochemical mapping, 175,124 ha (95.97%) are poorly and moderately supplied with nitrogen, 6,640 ha (3.64%) are well supplied and only 722 ha (0.39%) are very well supplied with nitrogen. The arable area of 80,571 ha with agrochemical mapping is as follows: 78,336 ha (97.23%) are poorly and moderately supplied with nitrogen, 2,235 ha (2.77%) are well and very well supplied with nitrogen. Of the 88,694 ha of grassland and meadows with agrochemical mapping, 83,923 ha (94.62%) are poorly and medium supplied with nitrogen, and 4,771 ha (5.38%) are well and very well supplied with nitrogen.

Phosphorus supply to soils in the study area is low due to low humus content, low phosphorus fertilisation, as well as due to the degraded state of soils, and in particular due to soil acidity and mobile aluminium present on 30.82% of the soil surface.

Table 3. Nitrogen supply situation by nitrogen index

Category of use	Mapped area (ha)	Nitrogen supply status according to I.N.											
		Poorly supplied			Averagely supplied			Well supplied			Very well supplied		
		I. N.	Surface	%	I.N.	Surface	%	I.N.	Surface	%	I.N.	Surface	%
Arable	80,571	2	53,930	66.93	3	24,406	30.29	5	1,982	2.46	6	253	0.31
Pastures - meadows	88,694	2	52,430	59.11	3	31,493	35.51	5	4,348	4.90	6	423	0.48
Orchards - fruit trees	9,176	2	5,352	58.33	3	3,579	39.00	5	218	2.38	6	27	0.29
Vines	4,045	2	2,411	59.60	3	1,523	37.65	5	92	2.27	6	19	0.47
Total	182,486	2	114,123	62.54	3	61,001	33.43	5	6,640	3.64	6	722	0.40

Table 4. Soil phosphorus supply status

Category of use	Mapped area (ha)	Phosphorus supply status														
		Very poorly supplied			Poorly supplied			Averagely supplied			Well supplied			Very well supplied		
		P ppm	Surface	%	P ppm	Surface	%	P ppm	Surface	%	P ppm	Surface	%	P ppm	Surface	%
Arable	80,571	8	21,229	26.35	13	20,336	25.24	27.05	18,584	23.07	54.05	12,172	15.11	72	8,250	10.24
Pastures - meadows	88,694	8	37,421	42.19	13	22,211	25.04	27.05	14,280	16.10	54.05	7,901	8.91	72	6,881	7.76
Orchards - fruit trees	9,176	8	3,605	39.29	13	2,400	26.16	27.05	1,531	16.68	54.05	978	10.66	72	662	7.21
Vines	4,045	8	1,101	27.22	13	1,279	31.62	27.05	837	20.69	54.05	517	12.78	72	311	7.69
Total	182,486	8	63,356	34.72	13	46,226	25.33	27.05	35,232	19.31	54.05	21,568	11.82	72	16,104	8.82

According to the data in Table 4, the following conclusions can be drawn: out of the total agricultural area with agrochemical mapping of 182,468 ha, 144,814 ha (79.36%) are very poorly - medium supplied with phosphorus, 21,568 ha (11.82%) are well supplied with phosphorus, and 16,104 ha (8.82%) are very well supplied with phosphorus. Of the total agricultural area, the agrochemical mapping arable area of 80,571 ha, is as follows: 60,149 ha (74.65%) are very poorly - medium supplied with phosphorus, 12,172 ha (15.11%) are well supplied, and 8,250 ha (10.24%) are very well supplied with phosphorus.

Regarding the area occupied by grassland and meadows, of the 88,694 ha with agrochemical mapping, 73,912 ha (83.33%) are very poorly - medium supplied with phosphorus, 7,901 ha (8.91%) are well supplied, and 6,881 ha (7.76%) are very well supplied with phosphorus. In terms of soil **potassium** supply, it is found that of the total mapped agricultural area of 182,468 ha, 101,508 ha (55.63%) is poorly and moderately supplied with potassium and 80,978 ha (44.37%) is well and very well supplied with potassium (Table 5).

Poor and medium supply status is caused by irrational, unbalanced fertilisation, lack of organic fertilisation application, as well as soil degradation status.

Of the 80,571 ha of arable land with agrochemical mapping, 44,785 ha (55.58%) are poorly and moderately supplied with potassium and 35,786 ha (44.42%) are well and very well supplied with this element.

Of the 88,694 ha of pasture and meadow area covered by agrochemical maps, 49,393 ha (55.69%) are poorly and moderately supplied with potassium and 39,301 ha (44.31%) are well and very well supplied with this element.

Table 5. Soil potassium supply status

Category of use	Mapped area (ha)	Potassium supply status											
		Poorly supplied			Averagely supplied			Well supplied			Very well supplied		
		K ppm	Surface	%	K ppm	Surface	%.	K ppm	Surface	%	K ppm	Surface	%
Arable	80,571	66	11,718	14.54	99,05	33,067	41.04	166.05	21,297	26.43	200	14,489	17.98
Pastures - meadows	88,694	66	14,303	16.13	99,05	35,090	39.56	166.05	21,539	24.28	200	17,762	20.03
Orchards – fruit trees	9,176	66	1,677	18.28	99,05	3,370	36.73	166.05	2,165	23.59	200	1,964	21.40
Vines	4,045	66	748	18.49	99,05	1,535	37.95	166.05	947	23.41	200	815	20.15
Total	182,486	66	28,446	15.59	99,05	73,062	40.04	166.05	45,948	25.18	200	35,030	19.20

Table 6. Anthropogenic degradation processes

Item No.	Specification	Factors and types of pollution									General Total	Str. (%)
		Physical pollution				Chemical pollution and dust						
		Excavations	Waste dump cleaning	Underground activity	Total	Mixed P+A.S	Salt water	Term. powders	Cement powders	Total		
1	Cambisols Class	2,017.38	2,295.10	69.20	4,381.68	68.10	125.30	8,295.00	8,501.00	16,989.40	21,371.08	27.08
2	Luvisols Class	2,394.86	752.50	631.60	3,778.96	291.80	163.70	24,671.00	3,194.00	28,320.50	32,099.46	40.68
3	Pelisols Class	68.01	-	-	68.01	-	195.40	78.00	-	273.40	341.41	0.43
4	Protisols Class	134.75	119.30	-	254.05	29.50	1.00	12,425.00	3,101.00	15,556.50	15,810.55	20.04
5	Soil complexes and associations	2,006.50	514.60	2,030.80	4,551.90	-	-	4,531.00	204.00	4,735.00	9,286.90	11.77
	Total	6,621.50	3,681.50	2,731.60	13,034.60	389.40	485.40	50,000.00	15,000.00	65,874.80	78,909.40	100.00

The main sources of **pollution** in the Gorj County are: day mining, oil and gas natural extraction, industrial and energy activity, non-rational agriculture – compaction. Anthropogenic degradation processes in the Gorj County are shown in Table 6.

Thus, from Table 6 it can be seen that the most polluted soils are:

- Eutricambosols belonging to the Cambisols class (affected by physical pollution on 4,381.68 ha and by chemical pollution on 16,989.40 ha);
- Luvisols of the Luvisols class (affected by physical pollution on 3,778.96 ha and by chemical pollution on 28,320.50 ha).

The surface area of the Gorj County is affected by pollution sources on 78,909.40 ha of which: physical pollution on 13,034.60 ha (16.52%) and chemical pollution on 65,874.80 ha (83.48%).

The soils most affected by pollution processes are soils of the cambisols class represented by eutricambosols (21,371.08 ha) representing 27.08% of the total area affected by pollution and of the luvisols class represented by luvisols (32,099.46 ha) with a percentage of 40.68%.

Day mining is a source of pollution through the extraction of lignite, which causes physical and chemical pollution. Thus, by excavation and welding, geological deposits of different ages are brought to light, their distribution being different both vertically and horizontally. Thus, the surface affected by mining in the Gorj County is 13,034.60 ha.

Oil and gas extraction is also a source of anthropogenic pollution, generating both physical pollution (through the location of oil equipment) and chemical pollution (with oil and salt water).

Chemical pollution in this case manifests itself on the surface of 874.8 ha. The impacts of oil and salt water pollution are soil salinization, primarily due to sodium chloride and potassium chloride, salt-satured soils having a chlorine content greater than 12 mg/100 g of soil.

Saltwater pollution occurs during oil and gas drilling. Because of the pressure, salt water gushes out affecting the soils.

The energy sector is the main polluting factor due to ash deposits and the presence of heavy metals from thermal power plants, affecting an area of 50,000 hectares. This corresponds to 79.90% of the territory impacted by chemical contamination and 63.36% of the total polluted areas in the whole Gorj County.

Compaction is a limiting factor for the quality of soils in Gorj County, on an area of 26,580 ha, as a result of the practice of non-national agriculture, which requires deep tillage on an area of 17,718 ha.

In the Gorj County, the distribution of areas according to the **slope of the land** is as follows (Figure 3):
- very gently sloping land (slope between 0 and 5%) or unrestricted land, which covers an area of 104,332.70 ha representing 42.80% of the total agricultural area of the Gorj County;
- gently sloping land (slope between 5 and 10%), or land with reduced restrictions, which is found on an area of 23,864.89 ha, representing 9.79% of the agricultural area;
- moderately sloping land with two slope limits, namely: slope between 10 and 15%, occupying a area of 24,839.96 ha, representing 10.19% and slope between 15 and 25% occupying an area of 37,832.79 ha, representing 15.52% of the total agricultural area, these being severely restricted land;
- steeply sloping land, with a slope of more than 25%, occupying an area of 52,897.66 ha, i.e. 21.70% of the agricultural area in Gorj, which is also land with very severe restrictions.

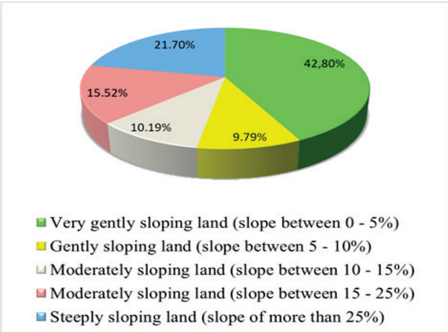

Figure 3. Distribution of agricultural area by slope category

Landslides affect 47,806 hectares, representing 19.61% of agricultural land in Gorj (Table 7). Out of these, stable and semi-stable landslides occupy 43,106 hectares (90.17% of the landslide-affected area), while active landslide areas cover 4,700 hectares (9.83% of the total landslide-affected area).

Excess moisture is manifested on 80,968.27 ha, affecting 33.22% of the agricultural area of the county. As stated above, excess moisture is related to gleization and stagnogleization. Thus, the land affected by gleization occupies an area of 10,628.36 ha (13.13% of the area affected by excess moisture) and the land affected by stagnogleization occupies an area of 70,339.91

ha (86.87% of the area affected by excess moisture).

The most extensive areas affected by excess moisture are found in the northern region of the county, in areas with flat relief, where soils of the Luvisol class predominate and where the phenomenon manifests itself with significant intensity, covering an area of 31,573 ha.

Table 7. Landslides by soil type

Specification	Surface (ha)	Landslides			
		Stable + Semistable	Active	Total (ha)	Str. (%)
Cernisols	1,395	35	-	35	2.51
Luvisols	71,483	9,231	1,200	10,431	14.59
Cambisols	69,894	57	173	230	0.33
Spodosols	5,132	15	-	15	0.29
Hydrisols	3,544	-	-	-	-
Pelisols	8,496	395	840	1,235	14.54
Protisols	30,144	502	133	635	2.11
Anthrisols	2,317	-	-	-	-
Complexes, associations	51,363	32,871	2,354	35,225	68.58
Total	243,768	43,106	4,700	47,806	19.61

Drought is a limiting factor for soil quality during the summer growing season. It is particularly prevalent in the southern part of Gorj County and becomes a limiting factor in years when rainfall is below 520 mm per year. Due to the uneven distribution of rainfall in one year out of ten, drought sets in from July to October. The lack of rainfall in the southern part of the county, but at the same time its uneven distribution, requires the introduction of irrigation in dry summer periods.

In the Gorj County, **erosion** is the most widespread limiting factor, since 57.2% of the county's agricultural area is on slopes greater than 5%, strongly affecting soil properties and its production capacity. Of the total agricultural area of 243,768 ha, erosion occurs on 139,027.95 ha which represents 57.03% of the agricultural area, of which: surface erosion occurs on 134,940.26 ha, representing 97.06% of the eroded area, and deep erosion on 4,087.69 ha, representing 2.94% of the area affected by erosion (Table 8). Erosion also affects the environment by contributing to the pollution of rivers, lakes, reservoirs, by increasing the percentage of solid silt, i.e. soil or rock particles, transported by surface runoff.

Soil types in the Gorj County are affected by surface or deep erosion in different proportions, (Table 8). Thus, the most affected by erosion are spodosols (100%), followed by luvisols (82.37%), then soil complexes and associations (81.03%), cernisols (80.65%), protisols (32.07%), pelisols (31.78%) and cambisols (28.47%).

Table 8. Soil erosion by soil type

Specification	Surface (ha)	Erosion			
		Surface erosion (ha)	Gully erosion (ha)	Total (ha)	Str. (%)
Cernisols	1,395	1,000	125	1,125	80.65
Luvisols	71,483	57,804	1,078	58,882	82.37
Cambisols	69,894	19,420	480	19,900	28.47
Spodosols	5,132	3,397	1,735	5,132	100.00
Hydrisols	3,544	-	-	-	-
Pelisols	8,496	2,700	0	2,700	31.78
Protisols	30,144	9,372	295	9,667	32.07
Anthrisols	2,317	-	-	-	-
Complexes, associations	51,363	41,247	375	41,622	81.03
Total	243,768	134,940	4,088	139,028	57.03

CONCLUSIONS

At the level of the Gorj County, all the limiting factors related to the soil (texture, porosity, pH, $CaCO_3$ content, nutrient content), soil-dependent limiting factors (slope, landslides and erosion), as well as limiting factors caused by anthropogenic activities (pollution and compaction, etc.) are manifested, with more or less intensity. The heterogeneous natural framework at the level of the studied territory has determined the formation and evolution of specific soil classes: protisols, cernisols, cambisols, luvisols, spodosols, pelisols, hydrisols and anthrisols, as well as a complex of soils which, depending on the conditions of their formation and especially their evolution, have undergone degradation processes to varying degrees as a result of the limiting factors listed above. Relief, one of the important factors of soil genesis, is the space in which the degradation process, manifested on the largest surface, i.e. erosion, takes place.

The occurrence of limiting factors on slopes is closely related to exposure, slope gradient and slope shape. In general, soils on slopes are shorter and less evolved, and erosion and landslides are more intense on slopes. The steeper the slope and the lower the vegetation cover of the slopes, the more intense the erosion and landslide phenomena are. Slope shape plays a particular role in the erosion process. Convex slopes are subject to erosion processes and concave slopes favour the accumulation of eroded material.

On uniform slopes, whole soils are found, while on uneven, stepped or unevenly sloping slopes, complexes and associations of soils are found.

Lowlands and terraces are less affected by capacity limiting factors. In the meadows and terraces there are medium-textured soils, unaffected by excess rainfall, with a fairly good degree of fertility. In the microdepression areas of the meadows, where the groundwater is at a shallow depth, gleaming phenomena occur.

Areas in the vicinity of rivers may be affected, but less frequently, by flooding. In the internal depression, more precisely in the secondary depressions of Tismana, Peștișani, Crasna, Novaci, Polovragi, there are soils evolved on fluvial gravels with a strong acidic character, brought from the mountains. In this case, acidity may manifest itself as a limiting factor due to the high hydrogen content. In addition to acidity, these soils contain a high percentage of skeletal material, which manifests itself as a limiting factor by reducing the soil's edaphic volume.

Although texture is a limiting factor, with its high content of fine fractions (clay) and coarse fractions (sand), this physical property cannot be improved, as it is the most stable property of soil, which does not depend either on human activity or on natural factors acting in the area. It influences soil porosity, (low in the case of clay texture and high in the case of sandy texture), which can be brought to normal parameters, about 50% of soil volume, by applying measures that collaterally improve other soil properties, (i.e. administration of organic fertilizers, which replenish the humus reserve, deep tillage, which improves compaction and application of irrigation that achieves a proper water regime).

Acidity can be improved by administering fertilizers with a physiological alkaline reaction, alkalinity - by using fertilizers with a physiological acid reaction, compaction by deep tillage applied at least once every three years, replenishment of the nutrient reserve - by root fertilisation, replenishing the moisture deficit can be done by building local irrigation systems, especially in the south, where rainfall amounts are lower.

Returning areas of land to the agricultural circuit as a result of day mining, given that large areas of land are taken out of the agricultural circuit every year, by laying the excavated material in separate layers and arranging them in such a way that the surface soil comes from humus-rich material. As this operation is more difficult to carry out in practice, it is beneficial for the Gorj County area, that these terrains be afforested especially with acacia plantations (Robinia Pseudocacia).

Preventing and combating erosion involves a range of measures and techniques designed to minimise soil loss and protect water quality and the environment. These include: anti-erosion organisation of the territory, establishing the crop structure according to the degree of erosion and the protection it provides for the soil, the use of a cropping system to reduce the speed, flow and volume of water running down the slopes, shaping the surface of the land to retain as much rainfall as possible, carrying out special hydro-technical works to intercept and drain water from the slopes, maintaining works to combat soil erosion.

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