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CHARACTERISTICS OF GRAY SOILS AND THE IMPORTANCE OF FORESTS IN THE CUBOLTA HYDROGRAPHIC BASIN, REPUBLIC OF MOLDOVA

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ABSTRACT

Currently, the land fund of the Republic of Moldova is intensively utilized, which has led to the drastic reduction of the areas covered by natural vegetation, and, respectively, to the change in the direction of the evolution of pedogenetic processes in the soils. It is known that the formation of gray soils took place under deciduous forests. The forests of the Republic of Moldova are also in an alarming state. Compared to other countries, the Republic of Moldova shows very low indices specific to forest resources. At the same time, forests are important renewable and strategic natural resources that influence and improve the quality of the surrounding environment. Forests play an important role in combating desertification, mitigating climate change, soil degradation processes, etc.

Different forms of degradation affect the gray soils from the Cubolta catchment, introduced into the agricultural circuit: dehumification, destructuring, erosion, compactation, etc. Following the research carried out by the working group of the Laboratory of Geomorphology and Ecopedology of the Institute of Ecology and Geography, it was established that the gray soils following deforestation and their passage into the agricultural circuit lost about 30-40% of humus.

Key words: grey soil, forest, catchment area, river Cubolta

Introduction

The hydrographic basin of the Cubolta River is located in the north of the Republic of Moldova, within the Forest-steppe Geographical Zone, with an area of 943 km2, representing approximately 3% of the country's territory. Through the pedological studies, it was found that the territory of the researched basin includes pedological units from five soil classes present on the territory of the Republic of Moldova. The gray soils, being representatives of the automorphic soil class, occupy an area of 8442 ha or a 9% share of the basin's soil cover.

Material and methods

The pedological researches within this basin were elaborated on the basis of the specialized scientific literature, published in different periods, in most cases, within larger studies, which were not limited to this basin only. Subsequently, the results of soil cover research at the regional level, assigned only to the given territory, were identified and analyzed. The results of the physico-chemical analyze presented in the paper have a practical-applicative character, which are the basis for planning the methods of land exploitation and land improvements (1).

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The morphological and physico-chemical characteristics of the investigated soils from the Cubolta hydrographic basin were entered into the database, created by recording in electronic form the information accumulated by the Geomorphology and Ecopedology Laboratory of the State University of Moldova, as well as that from specialized publications.

For the cartographic representation of the soils, data were taken from the website soluri.md (figure 1). The information was collected following pedological investigations, carried out with the aim of obtaining data and information about the condition of the soils. The main data provider being the State Company "Design Institute for Territorial Organization" (2,3).

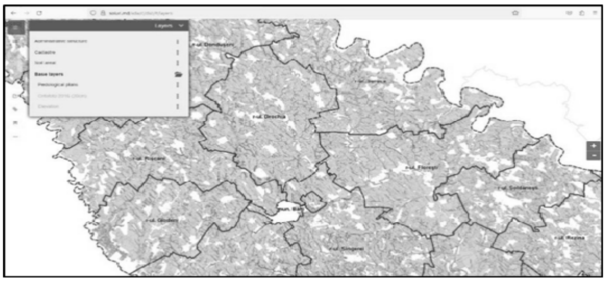

Fig. 1 - Screenshot showing the soil area on the territory of the Republic of Moldova

Results and discussions

The type of gray soil, called *gray earth*, was mentioned and researched by Vasilii Dokuceaev in 1878, near the village of Cuhureşti, Soroca county from Bessarabia (4). It is formed in the conditions of oak with sessile oak and/or oak with cherry, hornbeam forests, with different species of deciduous trees, on the tops and upper parts of the slopes, based on different sandy, loamy and loamy detrital rocks, in the height range of 140 -350 m.

The gray soils are divided into three automorphic subtypes: white, typical, soft and vertical gray - formed on fine clays, being a subtype of transition to vertisol (figure 2).

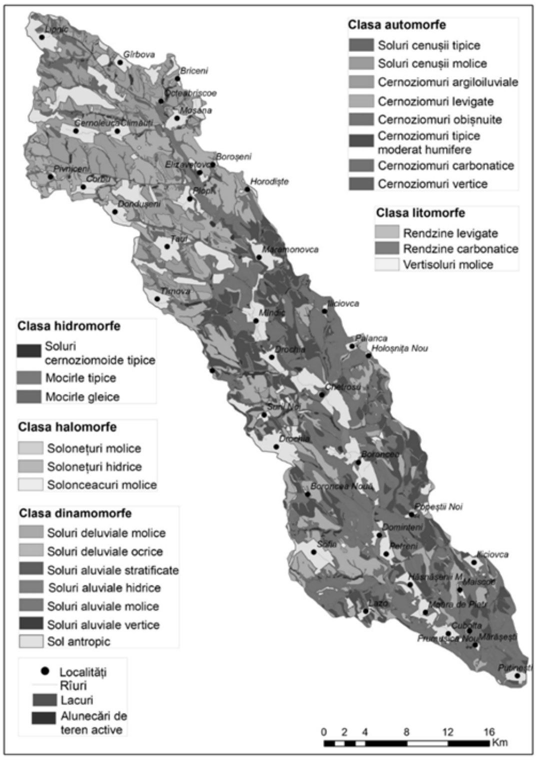

Fig. 2 - Soil map of the Cubolta catchment

Only two subtypes are found on the researched territory: soft gray soil and typical gray soil, formed under oak and cherry forests, in places with sessile oak and other deciduous species. Characteristic for these soils is the obviously differentiated profile: horizon A, with eluvial character, and B - illuvial. The differentiated profile of the gray soils is distinguished by the degrees of highlighting of the processes of eluviation and illuviation, depending on the climatic conditions and thermo-hydric regimes (5).

The variability and geographical distribution of the soils is conditioned by the zonal distribution. In the northern part, soft gray soils are widespread, at heights between 240-290 m, which sometimes descend to 140 m (figure 3). Areas of typical gray soil are distributed between altitudes of 285-305 m, formed under oak groves with a grassy carpet, surrounded by areas of leached chernozem, which demonstrates the altitudinal zonation or the legitimacy of the stratification of the soils (6).

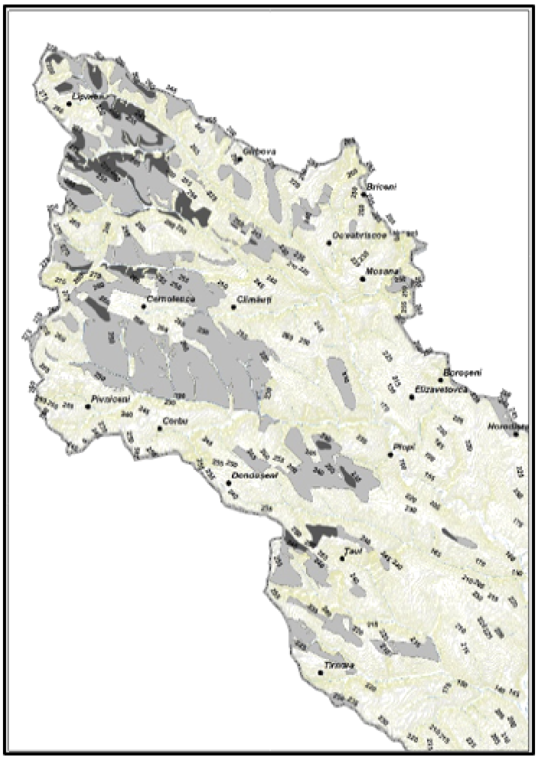

Fig. 3 - Distribution of gray soils

In this altitude range, the sum of multiannual average precipitation exceeds 500 mm, and the soil moisture regime is predominantly percolative (Figure 4) (7).

It is important to mention that the typical gray and soft soils were formed on forested lands. In the past, forests occupied 129.6 km2, with a share of 13.8% of the total area, today it is only 46.2 km2, with a share of 4.9% - the result of various anthropogenic interventions (deforestation, repeated cutting, grazing), which conditioned the reduction of forested areas. (table 1), (figure 5).

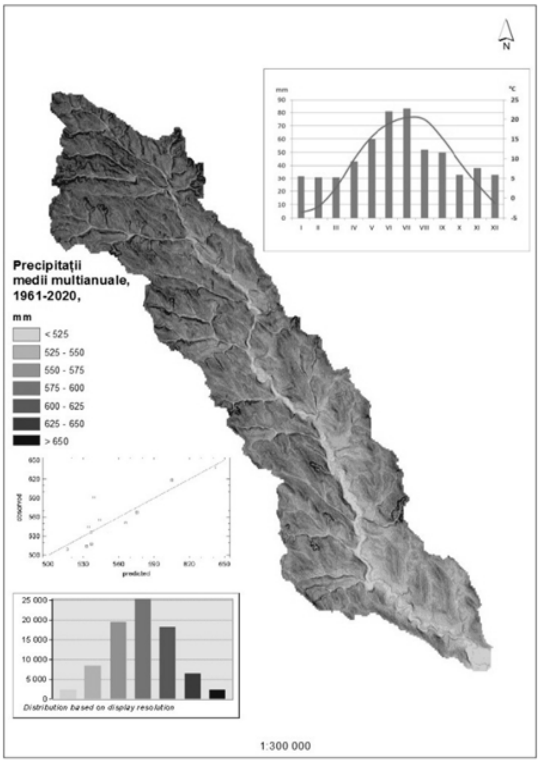

Fig. 4 - Multiannual average precipitation (1961-2020)

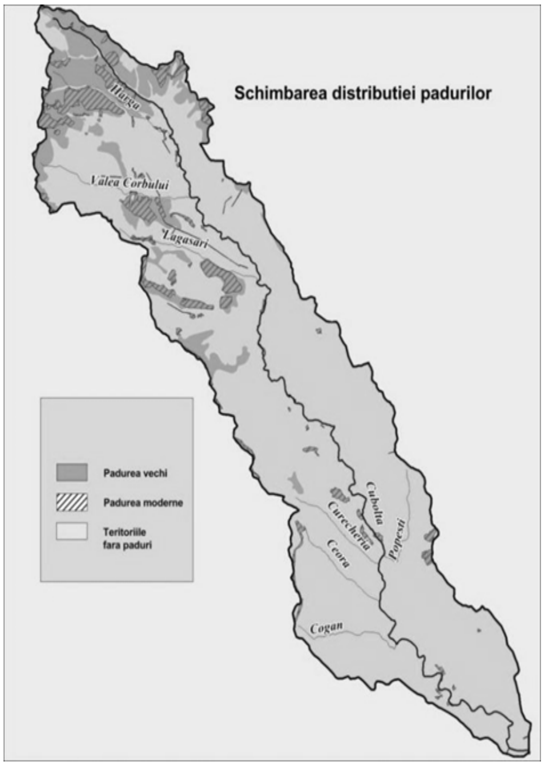

Fig. 5 - The distribution of forests in the past and present / Reconstructed based on the soil map 1:200 000 (1986)

Gray soils are the soils of the forested steppe, being predominantly occupied by the pedunculate oak (*Quercus robur*). The current specific composition of the oaks is a result of the initial composition and the transformations conditioned by anthropogenic activity (regeneration from shoots of stands, late maintenance cuts, grazing, etc.).

Table 1- Dynamics of forested areas

In the past	Actually
129,6 km^2	46,2 km^2
13,8%	4,9%

A strict relationship and interdependence between current forest types and soil subtypes is difficult to restore. However, we can state with all certainty that the total area of gray soils (including the eroded variants) represents the total area of pedunculate oak forests, which includes different stands derived from the natural-fundamental type of forest, which consists of species of mixture, such as hornbeam, lime and silver linden or common ash (8).

Regarding the quality of the soil subsequently exploited, as a result of the deforestation, after their inclusion in the agricultural circuit (Figure 6), the destructive processes (erosion, landslides) intensify, which lead to the degradation of the soils and the decrease of their fertility. Land exploitation led to the intensification of the dehumification process (9).

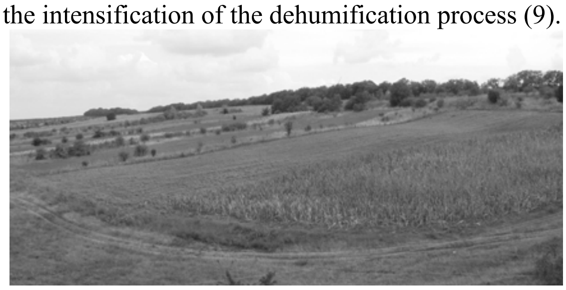

Fig. 6 - Agricultural land used as a result of deforestation

The typical gray soils occupy an area of 1183 ha or 1.3% of the total area of the basin, the upper horizon is humified, coarse, gray in color, loose, well structured, with a nut-shaped structure in the A horizon and polyhedral in B (figure 7).

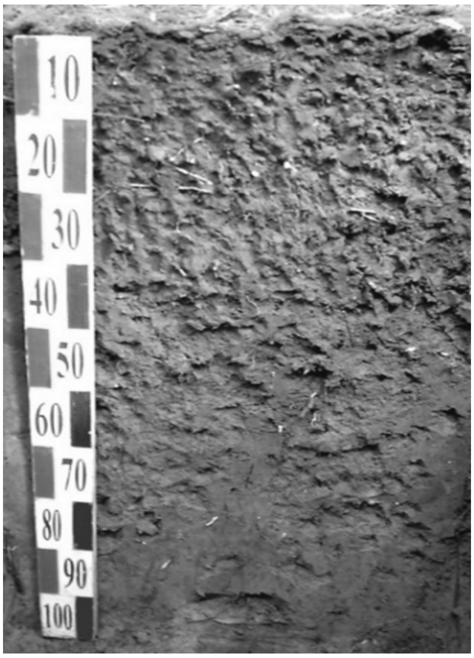

Fig. 7 - Typical gray soil profile

Morphological description
A1 (0-10 cm) gray-brown, moist, weakly compacted , small and medium nut-shaped structure, loamy-clay
A2 (10-35 cm) gray-brown in wet state, gray in dry state, weakly compacted, nut-shaped structure, large, clay loam
B1 (35-55 cm) dark brown, moist, compacted, nut-like-prismatic structure, unclear, weakly pronounced, clay loam
B2 (55-83 cm) brown, wet, prismatic, with films of *R2O3*, clayey, compacted
BC (83-120 cm) yellowish-brown, moist, unclear structure, clay loam.

The upper horizon is moderately humiferous, structured and loose. However, the humus content decreases suddenly with depth. The pH of the soil is weakly acidic, calcium predominates in the exchangeable complex (21.2-22.8 me/100 g soil), but the amount of cations is low (24.4-28.0). The hydrolytic acidity in the upper part of the profile is 4.2-4.7 me/100 g of soil and decreases towards the depth, the degree of saturation in bases – 83-87% (Table 2).

Table 2 - Physico-chemical composition of the typical gray soil
(Trebisăuţi Forest, Briceni, Silvosteppe of the Northern Plain)

Depth, cm	Humus, %	pH (KCl)	Exchangeable cations			Hydrolytic acidity	Degree of saturation in bases
			Ca^{++}	Mg^{++}	$\sum Ca^{++}+Mg^{++}$		
			me/100g soil				%
0-10	4,4	5,6	22,8	5,2	28,0	4,2	83,0
20-30	2,7	5,8					
40-50	1,6	5,2	21,2	3,2	24,4	3,9	87,0
65-75	0,9	4,9					
90-100	0,7	4,8	22,8	3,6	26,4		

The upper horizon is moderately humiferous, structured and loose. However, the humus content decreases suddenly with depth. The pH of the soil is weakly acidic, calcium predominates in the exchangeable complex (21.2-22.8 me/100 g soil), but the amount of cations is low (24.4-28.0). The hydrolytic acidity in the upper part of the profile is 4.2-4.7 me/100 g of soil and decreases towards the depth, the degree of saturation in bases – 83-87% (table 3).

Table 3 - Physico-chemical composition of soft gray soil
(Gârbova Forest, Silvostepa of the Northern Plain)

Depth, cm	Humus , %	pH (H_2O)	Exchangeable cations			Hydrolytic acidity	Degree of saturation in bases
			Ca^{++}	Mg^{++}	$\sum Ca^{++}+Mg^{++}$		
			me/100g soil				%
0-5	**10.05**	6.45	30.75	5.01	35.76	5.86	86.90
5-15	**3.59**	5.14	11.50	5.37	16.87	10.05	55.61
15-40	**2.43**	5.37	11.32	4.18	15.50	5.78	73.02
40-70	1.33	5.92	13.26	3.03	16.29	2.67	85.98
70-90	0.75	6.03	11.00	2.75	15.65	1.75	90.96

The soft gray soils occupy an area of 7515 ha or 8.1% of the total area of the basin, being located on detrital rocks, at lower altitudes than the typical gray soils, between 220-290 m and showing a subtype of transition to the type of chernozem. It forms mainly under rare oaks, with a layer rich in grasses. The soil profile is obviously mummified in the upper part. The nut-shaped structure is characteristic of these soils. Currently, most of the soft gray soils are exploited.

The exploitation of gray soils leads to the considerable reduction of humus reserves and the worsening of the properties of the productive potential, the humus content being 10.05% (0-5 cm), decreasing to one percent in the plowed arable layer (table 4), (figure 8).

The soil reaction is almost neutral, with a tendency towards alkalization in the reclaimed soil; the sum of exchangeable cations increases in arable soil up to 25.25 me/100 g soil; as hydrolytic acidity decreases; the degree of saturation with bases is 97.81%.

At the same time, as a result of anthropic intervention, the litter disappears, the development of the eluvial-iluvial processes is reduced, the physical properties change, which lead to settling, the porosity decreases, the nut-shaped structure changes into a dusty structure of the soil. The utilization of gray soils influences the modification of the soil aero-hydric regimes. In terms of productivity potential, soft gray soils approach chernozem, with typical soils being less productive. They are suitable for fruit and leguminous crops.

Fig. 8 - Soft gray soil profile

Table 4 - Physico-chemical composition of the plowed soft gray soil
(Gârbova Forest, Silvosteppe of the Northern Plain)

Depth, cm	Humus, %	pH (H_2O)	Exchangeable cations			Hydrolytic acidity	Degree of saturation in bases
			Ca^{++}	Mg^{++}	$\sum Ca^{++}+Mg^{++}$		
			me/100g soil				%
0-20	**1,82**	7,50	25,25	4,87	30,12	0,25	99,31
20-40	**1,92**	7,45	20,75	4,67	25,42	0,57	97,81

Conclusions

1. The forests of the Moldovan Northern Plateau contributed to the formation of gray soils, which predominate in the composition of the soil cover of the northern part of BH Cubolta; forest vegetation, ensuring the preservation of the properties and substantial composition of soils.

2. Deforestation of natural forests led to the expansion of arable land surfaces on gray soils. Currently, the area of forests has decreased by approximately 3%, compared to the 60-70s of the last century (Soil Map 1:200000, 1986).

3. The utilization of gray soils led to the modification of the morphological constitution of the profiles and the substantial composition. Dehumification, destructuring and mixing of the upper horizons took place.

Rezumat

Actualmente, fondul funciar al RM este intens valorificat ceea ce a condus la diminuarea drastică a suprafețelor acoperite de vegetație naturală, și, respectiv la schimbarea direcției evoluției proceselor pedogenetice în soluri. Este cunoscut faptul, că formarea solurilor cenuşii a avut loc sub pădurile de foioase. Pădurile Republicii Moldova de asemenea sunt într-o stare alarmantă. Comparativ cu alte țări, Republica Moldova denotă indici foarte mici specifici resurselor forestiere. În același timp pădurile sunt importante resurse naturale și strategice regenerabile, care influențează și ameliorează calitatea mediului înconjurător. Pădurile joacă un rol important în combaterea deșertificării, diminuarea schimbărilor climatice, a proceselor de degradare a solurilor etc.

Solurile cenuşii din bazinul hidrografic Cubolta, introduse în circuitul agricol, sunt afectate de diferite forme de degradare: dehumificare, destructurare, erodare, compactare, etc. În urma cercetărilor realizate de către grupul de lucru al Laboratorului de Geomorfologie şi Ecopedologie al Institutului de Ecologie şi Geografie s-a stabilit că solurile cenuşii în urma defrişărilor şi trecerii acestora în circuitul agricol au pierdut circa 30-40 % din cantitatea de humus.

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