SOILS' ALTERATION IN THE IZVORUL MUNTELUI LAKE WATERSHED UNDER THE INFLUENCE OF THE DEGRADATION PROCESSES

MONICA IOANA MUSCALU⁴

ABSTRACT. Soils' alteration in the the Izvorul Muntelui Lake watershed under the influence of the degradation processes. In the Izvorul Muntelui Lake watershed, soil degradation is due to agricultural activities, such as animal husbandry, specific to mountain areas, crops of corn, potato, fodder beet and vegetables, as well as the construction of communications roads, forestry and tourism activities. The relationship between human pressure and soil quality is inversely proportional to the fact that soils in the studied perimeter are also affected by unfavorable natural factors such as high relief, low temperatures, or constrictive skeleton. The deforestations in recent years emphasize the pluvial erosion and the geomorphological processes of the slope, whose intensification was observed in the basins of Bistrita, Bistricioara, Hangu, Schit, Grintieş, Bolățău and Tifilic rivers. With a view to rendering in use degraded land and reducing soil erosion, measures are needed to limit agricultural production, reforestation, or improve soil quality in the coming years.

Key words: land use, degradation, productivity, soil quality, degradation processes

1. INTRODUCTION

The Izvorul Muntelui Lake watershed is administratively located on the territory of the Neamt and Harghita counties. From the mathematical point of view it is situated at the intersection of the parallel 47^{0} N latitude with the meridian of 26^{0} E longitude. The perimeter of the Izvorul Muntelui Lake is limited by the water divede that unite the highest peaks chatchment of the mountain massifs: Bistrita, Stānisoara, Tarcău, Ceahlău, Călimani, Prisaca, Licaş and Grințieşul Mare. In the north-western part, the perimeter is limited by the western slopes of the Bistrita Mountains (Sabasa, Neamt) at the foot of which is Dorna Depression. In the western part is the Bilbor Depression, located at the foot of the Calimani Mountains, the Tulgheş Depression, located at the foot of the Ceahlău Massif, and

⁴ Bucharest University, Geography Faculty,"Simion Mehedinți Doctoral School, Bucharest, Romania, email: monica_muscalu@yahoo.com

the Borsec Depression, situated at the foot of the Giurgeu Mountains. In the eastern part, the limit is given by the south-eastern slopes of the Stânisoara Mountains, the extension of which are the Pipirig Depression and the Neamt Depression. In the south the watersheds continues with the Bistrita Valley and the Pângărati Lake, bounded by the Gosmanu Mountains. In the south-west, the limit is given by the tributary valley of Bicaz River, which is the boundary between the Ceahlău Mountains and the Tarcău Mountains. In the western part the perimeter is bordered by the western slopes of the Ceahlău Mountains, beyond which the slopes of the Giurgeu Mountains begin. The relief's altitude is between 400m and 1907m, but on the largest surfaces (about 90%) it is below 1300m. The slopes are modeled by torrential erosion at the top, and at the bottom, in the vicinity of the lake, the sliding and collapsing processes are more frequent. The factors that determine or influence the occurrence and evolution of these natural hazards are both climatic, lithological, biogeographic and anthropic. In the investigative approach, we watched the influence of anthropogenic and natural activities on the degradation processes, focusing on the changes of the soil properties, which are important for their economic valorisation.

AGRICULTURAL USE OF SOILS

In Fig. 1 According to the data provided by the communal mayoralties of the Izvorul Muntelui Lake perimeter, in terms of land use, in the year 2018, the largest share, over 60%, was occupied by the forests occupied by the forests, followed by the land for the breeding of animals, under natural pastures and meadows, and the smallest is the share of land under communications. In figure 1, we can see the weight of the different land according to the way of use. Territorial repartition of lands by landuse can be analysed using Fig. 3, where it can be observed that: arable lands are distributed mainly around the settlements, in the vicinity of running waters that flow into Izvorul Muntelui Lake and on the terraces of Bistrita River. The main crops are: corn, sugar beet, barley, potatoes, and vegetables adapted to climatic conditions. The pastures and hayfields are specific to slopes wigh high gradients that belong to all mountainous masses in the area. The meadows are also encountered near the localities at lower altitudes. An important territorial weight, especially around the localities Buhalnita, Grozăvești, Hangu, Grinties, Izvorul Alb, with the predominance of plum and apple species. f from rural and urban localities, shows a high density of the population occupying this territory, averaging 30 loc/km², and with regard to the size of the settlements, most of them are small and medium rural localities, but also large settlements with over 4,000 loc/km² as: Poiana Teiului, Pângărati.



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Fig. 1. The plot of land use in the perimeter of Lake Izvorul Muntelui, based on data from 2018

It can be noticed that the areas for pastures and natural grasslands far exceed the arable land, due in part to the natural geomorphological and climatic conditions for the herbaceous plants, and on the other hand to the tradition of livestock farming in the area. In the region there are sheep, cattle, pigs, goats,



Fig. 2 The plot of livestock distribution in the perimeter of Lake Izvorul Muntelui in 2018

horses, poultry and apiculture. According to the estimated data for the studied area in 2018 and shown in Fig. 2, in the area of animal husbandry. poultry represent the highest share of 64%, followed by sheep, with 21% of livestock and, then cattle, with a share of 11% of the livestock. Poultry is practiced in individual households, based on maize crops in intra-mountain depressions and broader valleys, while sheep and cattle breeding are based on mountain pastures and natural or cultivated meadows.

Agricultural crops in the area generally cover people's own needs, predominantly corn, potato, beet and vegetable crops, as seen in Fig. 3, representing lands with different cultivated plants from the total arable lands from the studied area. In the past 5 years, average yields were 1000 kg/ha of potato, 800 kg/ha of corn and 500 kg/ha of vegetables (Fig. 4).



Fig. 3 Share of the areas occupied by different types of agricultural crops in the perimeter of Lake Izvorul Muntelui in 2018



Fig. 4 The graph of the average production of the main agricultural crops in the last 5 years, in the perimeter of Izvorul Muntelui Lake

It is noticed that the productivity is not high, due to the division of the agricultural land into small individual areas, which do not allow and make the investments in agriculture unprofitable. According of Chamber of Commerce Neamt and Harghita Countries in the area there are only 28 tractors, 28 plows with animal

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traction and 6 animal - trailed sowers. This equipment with agricultural machines allows the utilization of the agricultural land in 100% of which 60% mechanized and in a proportion of 60% is done pest control and herbicide. In order to increase production, natural fertilizers are used, accounting for 80% manure.

2. PROCESSES AND FORMS OF LAND DEGRADATION THAT INFLUENCE SOIL QUALITY

The working hypothesis is that, as far as soil quality is concerned, we expect a continuous decline under the conditions of growing human pressure, exerted by various inappropriate agricultural practices, the expansion of buildings and human settlements, industry or tourism. The soils in the studied area offer different types of constraints in the agriculture practice due to low temperatures, texture and unfavorable skeleton (unrooted carbonate, the presence of over 15% coarse material in the surface layer volume (maximum soil thickness) of 30 cm. and the presence of rocks, unfavorable chemical properties (acidic soils), lands with slopes higher than 12%, different bio-physical indicators that do not allow agricultural activities. At altitudes of more than 600m appear mountain grasslands, becoming permanent at over 1200 m, on the natural alpine level. If along the Bistrita Valley and in the immediate vicinity of Izvorul Muntelui Lake, a specific variety of agriculture can be practiced in the mountain range at altitudes above the limit of permanent residence, the share of areas occupied by permanent meadows are harvested through grazing in the warm season or as mowing hay in the cold season. At altitudes ranging from 800-1700 m, on the coniferous and deciduous woods mixed with conifers level, but also in the beech forests, the size of land degradation is smaller in proportion, although this mountainous area has a surface larger than the alpine area. This is due to the anti-erosion role of the forest, proven by the presence of degradation processes only in places where forest vegetation is absent. The most common forms of land degradation in this mountainous area are: landslides, landfalls caused by mass movements, occurring more often at the lower part of the slopes, as well as degradation forms due to erosion, fluvio-torrential (Grecu, Florina, Palmentola, G. 2003).

In the studied area, it is found that around 1600 m - 1700 m the erosion is much more pronounced along the secondary network which is even denser, 2-3 km/km², because there is a large inclination of the thalvegs which varies between 20 m/km, up to 100 m/km, with frequent slope breaks, and a torrential drain (Fig. 6 B, D). Thus, on the peripheral courses, deep erosion and transport of the resulting materials are characteristic, the streams propagate at high velocity, break from their own water bed and can dislodge the banks and the base of the slopes, giving rise to some landslides or landfalls. In this way, land occupied by forests, pastures or

meadows is destroyed, communication routes are damaged, or constructions located in the winds of the localities, there is a need to regulate the leaks on the slopes, and hydrotechnical works, and silvicotechnical works made both on the slopes and in longitudinal profile.

The main arteries belonging to the rivers Bistrita, Bistricioara, Hangu, Grinties, Tifilic, Schit, Bolătău reveal a complexity of the river processes that are transmitted to the landslides, although the deep erosion is dominant, it shows the variable intensity in the longitudinal profile due to flow variations, and slope variations, with erosion being more intense in the key and gorge slopes with larger slopes. Thus, the depth of the river bed leads to the sublimation of the slopes bed, through erosion processes - evorsion, which causes the release or accentuation of some landslides or landfalls affecting the superficial deposits or the underlying rock. Thus, roads and railways are being endangered or damaged, electrical networks located in the vicinity of watercourses, requiring defense and bank consolidation and stabilization of the fairly expensive slopes. In lower slope areas, the Borsec, Bilbor, Tulghes intra-mountain depressions are specific to alluviations in the minor and major river bed, meandering, mowing, dropping courses, overflows, floods, processes that can affect large areas with various economic destinations. In addition, the lowest parts of the depressions also suffer from excessive moisture, occurring on large spaces, sloughing and marshy phenomena. The Izvorul Muntelui Lake is a diminishing factor for the land degradation by regulating the drainage and by reducing the erosive and transport capacity of Bitrita River (Gâstestescu, P., Stoleriu, C., 1975). At the same time, the intensity of deep erosion is diminished by the erosion of the local base, but in the lake, the accumulation is favored, the erosion being still strong in the upper sector of the of the tributary rivers, there is a large intake of eroded material, so the accumulation reduces the slope of the longitudinal profile, and leads to a new dynamic balance, transfered from upstream to downstream, a phenomenon that exhibits fluctuations over time, depending on the oscillation of water level from the lake. Geological, hydrogeological and geomorphological conditions of the Flish, Palaeogene and Cretaceous mountains determine a great potential for movement, but reduced by the extension of the forests (Băncilă, I., 1958). However, there are spaces in which the forest vegetation can not stop land movements, such as the ones generated by a very high slope, or on deforested land, or occupied by pastures and meadows (Fig.6, A,C). Such areas were identified on the slopes of the Bilbor, Borsec, Tusnad depressions, on the slopes of the main valleys (Bistrita, Bistriciora, Hangu, Grinties, Ceahlău), but also in the deforested basins where the torrential erosion is more intense, and used economically. Torrential and fluvial erosion is the general triggering factor of landfalls and landslides. At the base of the slopes they tend to propagate to the upper part of the slope, which means that there are measures to prevent and fight as quickly as possible. Due to the abundant infiltrations, overmoistening and plasticization of marno-clayey horizons occur, which leads to overcoming the shear resistance, and the appearance of massive and deep landslides at

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different points of the slope profile (Grecu, Florina, 1997). Another phenomenon is due to overmoistening, especially in the spring, and during sliding, the soil is also mobilized through the soliflution phenomenon (Grigore, M., Achim, F., 2003). Around the Izvorul Muntelui Lake, there appears the abrasion phenomenon that submerges the banks, with frequent degraded sectors being seen in the landfalls from the slopes and in the deposits from upper terraces of Bistrita River, a phenomenon that endangers the households in the nearby villages and the national road (Săndulache, I., 2007). Degradation forms specific to flish startups - are due to the alternation of sandstone and clay-marn shale, the rhythmic succession of aquifers, the great thickness of the slopes, and the large slope gradients.



A.Izvorul Muntelui Village

B) Tulgheş Commune

C) Ceahlău Village

D) Near Borsec town



Fig. 6 Forms of soil degradation identified in the perimeter of Izvorul Muntelui Lake

Fig. 7 Map of susceptibility to landslides in the perimeter of Lake Izvorul Muntelui according ARC GIS

From the analysis of the land susceptibility map to landslides (Fig.7), it can be noticed that a very high degree of susceptibility is present on the steep slopes of the Bistricioara river valley, and its tributaries, Grințişul Mic and Grințişul Mare, the slopes belonging to the Bistrița Mountains, as well as the eastern slopes of the Ceahlau Mountains belonging to Piciorul Ciocanu, Piciorul Verdele and Obcinele Chica Baicului. High and very high susceptibility is represented by the western slopes of the Stânişoarei Mountains (Ichim, I 1979) that come into contact with the lake waters, in the area of Poiana Teiului, Poiana Largului, Roseni, Topoliceni, Hangu, Chirițeni, Grozăvești. The gravitational processes are still present upstream Poiana Teiului and continue up to the Izvorul Muntelui, being easily observed on the left slope of the Bistrita valley.

The degradation of the land due to the alteration process is less common in the studied area, appearing only in the Ceahlău Mountains (Albota, M. G., 1992) in tectonic-erosive escarpments located at the border of the concordant suspended synclines. There are rock detachments, rock torrents, or accumulations of rock debris that destroy the trees, fragment the wooded area and compel it to regress, causing damage to some roads, such as Durău – Izvorul Muntelui – Bicaz road.

As far as chemical alteration is concerned, it is only present by dissolution and precipitation in the limestone portions (Cotet, P., 1971), generally in the mountains covered with forest and grass vegetation under the conditions of cool and humid climate. We found an intensification of chemical alteration and biochemical as a process of soil formation without causing the decrease of the natural qualities of the zonal soils (Rauta, C., Stelia, C., 1983). Humification of organic matter determines the increase of chemical alteration through the action of humic acids. The main processes encountered in the area are the decomposition of the litter, the degradation of the silicates, the decarbonation, the accumulation of acidic humus, the undergrowth, all of which increase in intensity with the altitude causing the soil to be differentiated vertically. Podzols are specific to the solification process in the mountain area, being more intense, where the surfaces have lower gradients, which allows the active circulation of the soil solution, elution of bases and colloids in the horizon A, which determines the increase of the silica content and acidity. In addition, these components are illuminated in Horizon B, which becomes impermeable, thus causing the podzol to be accompanied by another negative process - gleyzation The soils formed have a reduced fertility, some of which are unusable: such as the limestone rendzinic, the gleichydromorphic, turbogleic and peat soils in the Bilbor and Borsec depressions. In these depressions, excess water is due to local climatic, geological, hydrographic, geomorphological and hydrogeological conditions: piedmont fluvial-lake deposits favoring the accumulation of groundwater; reduced gradients, favoring alluviations, overflows and floods, as well as meandering and divagations that

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reduce the possibility of natural drainage, along with rich precipitations that exceed the natural evapotranspiration capacity, abundant runoff and excess water regime, a large number of springs feeding from cantonated waters into piedmont and glaciers, and groundwater near the surface all cause the appearance of hydrotechnical, silvicotechnical, and agrotechnical facilities for the drainage and improvement of some terrains in order to restore their economic circuit.

3. MEASURES TO PREVENT AND COMBAT GEOMORPHOLOGICAL PROCESSES AND SOIL EROSION

A form of pluvial or wind soils erosion is associated with their use as grasslands, pastures or natural havfields. Nowadays, the limiting factors of the production determine a mean state of the grassland quality in the Izvorul Muntelui Lake, due to degradation processes caused by low temperatures in the cold season, the drought periods, the acidity of the soils in the area, their high skeletal content (fragments of mother rock, a texture too sandy, specific to the soils in this region) (Rădoane, N., 2002), the loading or overloading with animals, the invasion of woody vegetation such as bush species or different trees, as well as the invasion of different weed species, the lack of soil correction, and organic or chemical fertilizing elements. Unrational grazing in humid weather, chaotic animal traffic, long stalling, lack of minimal maintenance work such as harrowing and mowing of unused portions from pastures. These limiting factors determine the degradation of the vegetal carpet and of the soils, and can be remedied by carrying out agro-phytoameliorative works such as over-sowing, reforestation, erosion control on the slopes, water supply, animal shelter (Barbu, N, Lupascu G, Rusu C, 1981). Mean productivity of meadows is 12.28 t/year in the perimeter. According to the research of the academician M. Motoc (Motoc, M. et all, 1975), an estimation method of the erosion aims at summing the surface erosion volume with the deep erosion volume and the contribution from the landslides. And the determination of effluent erosion is the product between the total erosion and the effluent coefficient. According to these assessment methods, the perimeter of Izvorul Muntelui Lake falls within the total erosion category of 5-10 t/ha/ year. As a result of this estimation and calculation method, in the perimeter of Izvorul Munteului Lake the surface erosion contributes with 54% to the total quantity of eroded material, while the landslides and the deep erosion as a whole contribute with 46% and the most complex ones land degradation processes are more active in regions with a low share of

afforestation. According of my personal reaserch the forest areas in the perimeter of the Izvorul Muntelui Lake are affected by landslides on 1.5% of the area, surface erosion on 2.3% of the surface, the appearance of rocks on surface with 16.7% and deep erosion on 0.8% of the forest area. Forests with poor and moderate erosion predominate on 94.1% of the areas affected by degradation. In order to decrease the impact of these forms of degradation, it is necessary to maintain the forest vegetation in order to avoid the extension of these processes and to stop them in the already affected areas. The main method used is afforestation due to the antierosion and hydrological role played by the forest (Pierzyneski, J., Thomas, S., George, F., 2005)

Depending on the differentiated hydrological capacity of the forest vegetation, in this perimeter were identified: mature trees with high hydrological efficiency (class A) that ensure the maximum soil protection against erosion, representing 28% of the total area of the forest fund; middle-aged trees providing moderate protection (class B), which occupies about 54% of the forest fund area; young trees and trees under the lower limit of forest vegetation (class C) have a reduced hydrological efficiency and represent 15.8% of forest area, and forest land in D category, not covered by forest vegetation, construction or roads, including unproductive land or degraded, have the lowest hydrological efficiency and a share of 2.4% of the forest area.

CONCLUSIONS

Soil degradation processes, in the perimeter of the Izvorul Muntelui Lake, occur mainly in the marsh-clayey horizons, and are manifested by landfalls, landslides, torrential and chemical alteration. The erosion of soils is due to these processes and to the exploitation from agricultural activities, or cereal, vegetables and fodder plant crops. Remedial measures aim at carrying out agro-phytoameliorative works, through sowing, combating erosion on the slopes, animal shelters, fencing, and water supply. These measures are added to the maintenance of vegetation on the slopes, and tree re-planting, in a differentiated way, depending on their hydrological efficiency.

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