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COMBATING THE EROSION PHENOMENON. THE DECANTING PONDFROMFÂNAŢE VILLAGE, BIHOR COUNTY, ROMANIA–CASE STUDY

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Abstract*:Decanting ponds can have a major impact on the environment, as they often contain heavy metals.In the absence of their monitoring and security, but especially during the greening processs, the potential risk of technical accidents occurenceincreased significantly.In such events, both the environment and human settlements are affected; sometimes major pollution with cross-border impact may occur.The Fânaţe decanting pond is located in Fânaţe village, Cîmpani commune, Bihor county, Romania.The arrangement works within the decanting pond aim to establish and consolidate the banks and its base. This paper presents some solutions for combating the erosion phenomenon.*

Key words: erosion, pollution, soil, decanting pond, mining

1. Introduction

In Romania, slope lands occupy more than 2/3 of the country's surface.The triggering and accentuation of the soil erosion process under these conditions is the consequence of the excessive deforestation and the irrational exploitation of agricultural land.In Romania, 28.0 million tonnes of arable soil are lost annually[1-4].
It has been estimated that erosion has already destroyed over 4500 million hectares in different countries. On a global scale, it is estimated that around 10 billion tonnes of soil is eroded annually through natural processes, but man-made erosion is 2.5 times more intense - 26 billion tonnes/year.
This phenomenon is a direct consequence of the inappropriate exploitation of the soil, but also of its pollution.Anthropogenic activities such as industrial, mining, agricultural and household, and the inappropriate disposal of wastes result in the accumulation of some pollutants in the soil surface, causing serious damage to the environment[5-9].In the last decades, the quantities of fertilizers used in agriculture [10] have increased considerably.This can lead to the alteration and deterioration of soil properties and structure [11,12], with direct consequences on the quality and quantity of active and nutritive principles in grown plants[13-22].
Romania has a long history of mining useful substances such as gold, copper, lead, zinc, silver, manganese, salt and coal.However, due to the deplorable years of exploitation of the environment and mineral extraction technologies, mines and related ore processing industries have affected the environment in a negative way, resulting in an important burden on the water, air and soil of ecosystems[3,23-26].

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Fânaţe village is located in the southeast corner of Bihor. It is the largest village of Câmpani commune, in the Depression of Beiuş, at the western foot of the Bihor Mountains.The village has a length of 1.5 kilometers. Located at an altitude of about 400 meters, the village enters the parallel 46°32' north latitude and the 22°30' east longitude [27] and holds one of the decanting ponds of Băița-Ștei non-ferrous exploitation mine.

The continuous erosion of decanting ponds and unprotected mining deposits has a major impact on the environment, threatening large areas by contaminating waters with metals and chemical compounds [28]. Similarly, mining sludge is frequently contaminated with metals and other toxic elements and requires the application of sustainable solutions.

The decanting pond from Fânaţe village has a significant impact on the environment, as it contributes to the destruction of natural ecosystems by: occupying large areas of land for a very long time, polluting surface waters with solid particle suspensions driven by rainwater, material damage due to loss of stability and spillage over neighboring agricultural land. It also influences the occurrence of soil erosion, often causing an involution by destroying existing natural relations.

2. Material and methods

During the year 2017, determinations were made on the slope of decanting pond in Fânaţe, in order to determine soil erosion. Also, ways to combat this phenomenon in order to reduce the negative impact on the environment have been analyzed [29].

Fânaţe pond, occupies an area of 16.2 hectares, and the usefull area is 8.76 ha. The main destination of the land within 1 km of the decanting pond is as follows: forest 6% N; 12.5% NE; 6% E; cultures 12.5% S; 12.5% SW; 12.5% W; pasture 6.5% N; 6.5% E; 12.5% SE; 12.5% NW[27].The pond has the shape of a pyramid trunk (Figure 1). The height of the deposit is variable depending on the natural ground rate, reaching 28.0 m downstream (to Fânaţe village) and 18.2 m upstream.Polymeric ores containing copper, lead, zinc and the ore containing molybdenum, copper extracted from underground are flown in the preparation plant to obtain concentrates.Industrial wastewater from flotation is transported hydrogravitatively to the pond on a 250 mm diameter pipe with a length of 6.2 km. The decanting facility is considered to consist of the decanting pond and the slurry transport pipeline from the Preparation Plantto the pond.The projected capacity of the current Fânaţe decanting pond is 4900000 tonnes of tailings.

Figure1:Decanting pond fromFânaţe village

In order to avoid water, soil and air pollution within the Fânaţe pond, it is acted through measures to combat and reduce erosion [30,31]. Figures 1 and 2 show the practical result of such actions.

Figure 2:Combating the erosion phenomenon within the decantingpond in Fânaţe with the help of silt fances

Figure3:Combating the erosion phenomenon within the decanting pond in Fânaţe with the help of forest plantations

The long-term stability of the dam and the slopes includes static and dynamic stability, as well as resistance to wind and water erosion [32,33].

3. Results and Discussion

Determinations made in 2017 on the slope of the decanting pond in Fânaţe with an inclination of: 15%; 25%; 30%; 40% showed that soil loss increases with inclination growth, so at 15% inclination the loss is 7.2 t/ha compared to the loss of 18.8 t/ha at aninclination of 40%, according to Table 1.

Table 1. Influence of the inclination on the soil losses on the slope of the Fânaţe decantating pond, without silt fences, 2017

Slope planted with inclination in %	Degree of vegetation coverage %	Soil losses		Difference	
		t/ha	%	t/ha	%
15	60	7.2	100	-	-
25	55	8.4	116.6	1.2	16.6
30	40	12.6	175	5.4	75
40	15	18.8	261.1	11.6	161.1

When silt fences exist (Table 2) it can be seen that the soil loss is much smaller in all variants and the degree of vegetation coverage of the slope increases up to 78% when the inclination is 15%.

Table 2. Influence of the silt fences on the soil losses on the slope of the Fânațe decanting pond, 2017

Slope planted with inclination in %	Degree of vegetation coverage %	Soil losses		Difference	
		t/ha	%	t/ha	%
15	78	3.5	100	-	-
25	63	6.2	177.1	2.7	77.1
30	50	9.4	268.5	5.9	168.5
40	28	12.2	348.5	8.7	248.5

The works for the consolidation of the decanting pond base are carried out through: forest plantations and cross-sectional construction works.If the surface of the decanting pond base is dry, it is recommended to plant brier, hawthorn, wild olive. The transversal works include thresholds or dams arranged perpendicularly on the thread of the erosion forms in deep.These can be made of wood, wood with stone, earth, stone, concrete, reinforced concrete. The transverse woodworks include: granisages, fascine works, and silt fences.

In order to reduce the impact of the Fânațe pond on the environment and human health, there is an obligation to include it in the landscape. This can be done by planting a plant protection curtain and by planting species resistant to specific pollutants.The pond consists of very fine particles that can be shattered by the wind; the only protection against this phenomenon remains the afforestation on the terraces of the pond.

Deep erosion control works either to recover and re-integrate erosion-borne areas into agriculture and forestry or to stop the phenomenon; this can be achieved by anti-erosion forestry plantations.

Problems generated by tailings from the processing of useful minerals are more complex than rock tailings generated by mining. This influences both the selection of cover types and related technologies.

The reshaping of the decanting pond system creates a new surface that must also ensure a stable drainage regime.The design will take into account the sedimentation and deformation processes at the level of the body below the tailings, during and after decommissioning, especially if sedimentation is expected to play an important role in stabilization.In order to ensure stable drainage conditions, it is advisable to accelerate consolidation in areas along drainage ditches where finetailings packets of great thicknesses and/or characterized by varying degrees of sedimentation are found.

The arrangement of a soil cover on the surface of the decanting pond system of the useful mineral processing plant seeks to achieve the same basic remediation objectives as those described in the case of rock wastes dumps.However, there are certain specific issues to be taken into account, namely: processing tailings usually contain large amounts of cantonated water in pores, often at the saturation limit, at least in certain parts of the decanting pond; sedimentation/consolidation of processing tailings, especially those in the form of slurry, may be significant.This has to be taken into account to determine the optimal profile of the cover and the technology to install it. The settlement of the banks of the decantig pond shall be carried out concomitantwith itsfoundation works and shall be ensured, where appropriate, by grassing, afforestation, covering with various materials and supporting walls.Consolidation is made through forest plantations, both shores and slopes are planted and can be between 10 and 15 meters wide; depending on the degradation of the land, consolidation is also carried out by means grassing and is applied to the sectors that can be plug.

Figure 4:Stabilization works of the slopes of the decantingpond Fânațe

4. Conclusions

The lack of long-term stability of the dam or slopes can be remedied by diminishing the downstream slope and/or the overall height of the dam. If the dam is built from processing tailings, it must be covered with inert material, and the notion of long-term stability should also include the geomechanical stability of the cover layer.

It is recommended to make silt fences to reduce the erosion phenomena on the slope of the Fânațe decantating pond, Bihor County.

The arrangement works within the Fânațe decanting pond are aimed at establishing and consolidating the banks and its base, as well as reducing the phenomenon of shattering.The reprofilation of the decanting pond creates a new surface that must also ensure a stable regime of the runoff waters, as well as the arrangement of a soil cover on the surface of the decanting pond.

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