Research Journal of Agricultural Science, 51 (3), 2019

DESIGN OF THE ECOLOGICAL RECONSTRUCTION WORKS OF THE WASTE DUMP BELONGING TO LUPENI HARD COAL EXPLOITATION (BRANCH 3, B BODY)

Mihail, TUREA[1], Izabela-Maria, APOSTU[1], Florin, FAUR[1], Maria, LAZĂR[1]
[1]University of Petrosani, Faculty of Mining
e-mail: izabelamaria.nyari@yahoo.com

Abstract: *Continuing the process of restructuring the mining sector in Romania, more specifically coal mining (and as a result of aligning national energy policies with the common policy of the European Union), means closing in the near perspective of 2 more mining units from Jiu Valley, namely Lupeni M.E. and Lonea M.E. With the cessation of the productive activity of Lupeni M.E., the problem of ecological rehabilitation of the mining perimeter is posed and, among the objectives that are compulsory of this process, is the ecological reconstruction of the waste dump. As at the present moment the sterile rocks are deposited only in the B body of branch 3 (branches 1, 2 and A body of branch 3 being spontaneously covered with grass and revegetated in proportions between 60 and 90%), the present paper presents the stages and the necessary works to achieve the proposed objective (ecological reconstruction) in the shortest period of time. Considering the location of the dump and the aspect of the surrounding areas, from the possible ecological reconstruction options, the naturalistic one was chosen, which will ensure the integration of the dump body into the zonal landscape, and which also involves the least volume of works and implicitly the lowest costs. The optimal alternative of ecological reconstruction was considered the one established using a methodology proposed and published in the literature. This methodology makes it possible to identify the optimal alternative of ecological reconstruction (and to eliminate inopportune ones) by following three phases, in a logical sequence, in which a number of factors and indicators characterizing both the site area (the climate of the region, the morphology, the environmental risks etc.) as well as the degraded land (the waste dump), especially in terms of fertility of the stored material. In this way the risk of making an erroneous decision (on the ecological reconstruction option) that does not meet the proposed objective and at the same time may cause unjustified expenses is minimized.*

Key words: *M.E. Lupeni, waste dump, ecological reconstruction, surrounding landscape, stability*

INTRODUCTION

Extractive activity, no matter how it is carried out (in open pits or underground), always leads to long-term negative effects on the environment. The environmental component that has the most to suffer as a result of mining exploitation is the soil and with it the entire ecosystem in the area (GOLDAN AND NISTOR, 2013; NANU AND MARCHIS, 2013).

One of the problems characteristic to mining is represented by the appearance of waste dumps, dumps that occupy and divert from the initial uses large areas of land.

After the cessation of the extractive activity, the dumps are passed into conservation and ecological programs are required for them. Usually, these projects of waste dumps ecological reconstruction are designed in such a way as to involve as little work as possible (restoration, revegetation etc.) and lower costs, so that on some dumps no works are carried out, being naturally revegetated (spontaneously) (OLTEAN ET AL., 2018).

To obtain the desired results, the type of ecological restoration chosen must match local conditions expressed by restrictions related to the geographical position and must take into account a number of principles of ecological planning (MCHARG, 1969): 1. The principle of globality or inter-causality; 2. The principle of ambient autonomy; 3. The principle of minimum sizing and reversibility; 4. The principle of economy; 5. The principle of respect for tradition; 6. The principle of transparency and democracy; 7. The principle of respect for the demands of the population.

The dump analyzed in this study (more precisely branch 3, B body of the dump), belongs to Lupeni M.E. and is an active waste dump. At this moment it is very difficult to say for how long it will remain active, the reason being the uncertainty that plans on the continuation of the extractive activity at this mining unit.

Therefore, the present paper intends to present the steps that need to be taken for the reconstruction and restoration of the ecosystem on the Lupeni waste dump - branch 3, taking into account the forecast situation regarding the deposits of sterile material at the end of 2019.

MATERIAL AND METHODS

A first step to go through in order to design the ecological reconstruction works of the waste dump is represented by its investigation and the description of surrounding area.

The waste dump

Lupeni mining perimeter is located in the municipality with the same name, in the western part of the Jiu Valley mining basin. The waste dump (formed of three branches) is located 4 km from the main enclosure in a hilly area, with heights ranging from + 780 m, in the Boncii creek area, to + 960 m, on the left side of West Jiul river (HEC, 2015).

Branch 3 of the waste dump occupies an area of 16.64 ha and has a volume of 1,336,827 m^3 (2,102,620 tons), with no foreseen expansion, and its development is in a single step (the designed capacity of the dump was of approximately 2,387,800 m^3) (HEC, 2015).

Branch 3 of the dump consists of two bodies, A and B, that should have been joined in longitudinal section, one of prismatic form located between the pillars P4 and P6 (in conservation for about 11 years and vegetated) and a conical-shaped dumping body in the common area of the three branches, where the sterile material is currently dumped (between the angular station and the P1 pillar). In this paper only the B body is considered.

The conical-shaped B body (Figure 1), has a height of 30 - 35 m and a slope angle of 37º - 39º. These characteristics are obtained by arranging a leveling platform at elevation + 837.5 m (HEC, 2015).

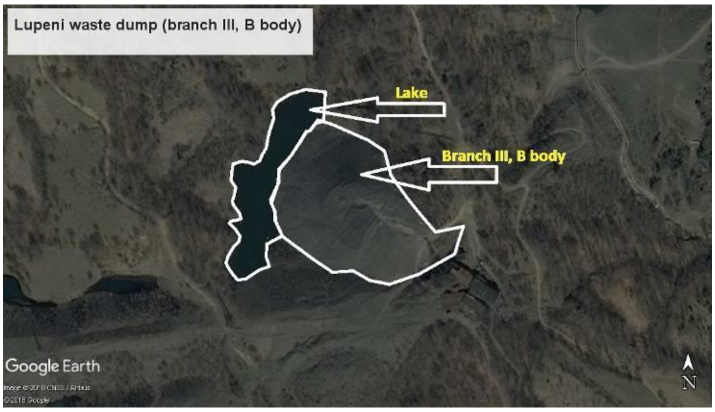

Figure 1. Lupeni mining waste dump (branch 3, B body)

At the contact with the natural terrain, in the longitudinal profile of the funicular axis, a lake is formed (Figure 1). The infiltration of water into the pores of the rocks at the base of the waste dump, may lead to a decrease of the resistance characteristics and the risk of landslides (ROTUNJANU, 2005).

The deposited material comes from the sorting process that takes place at the surface, in the separation section, respectively from mining works (opening, preparation and exploitation).

It consists of a heterogeneous mixture of soft rocks (clays and marls) and hard rocks (sandstones) with an increased unevenness of granulometry and physical-mechanical properties (Table 1). To these are added coal fragments and alluvial deposits (boulders, gravels and sands) that formed the major bedrock of the West Jiul river (FAUR ET AL., 2019).

Table 1

Physical-mechanical characteristics used in stability analysis

Rock type	**Volumetric weight** γ_{nat}, **(kN/m³)**	**Cohesion** c, **(kN/m²)**	**Angle of internal friction** φ, **(°)**
Mixture of waste rocks	17.85	35.00	20.00
Rocks from the direct foundation	26.70	28.00	24.00

The samples collected (8 samples) were also analyzed from the point of view of the chemical composition and the presence of nutrients. These analyzes are necessary to determine the capacity of the waste material to support vegetation and they are presented in Tables 2 and 3 (FAUR ET AL., 2019).

Table 2

Chemical composition of the deposited material

Waste dump	**Determined parameter**								
Lupeni, branch 3, B body	pH	SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	Volatile (%)
	7.32	63.45	10.51	2.23	0.84	0.79	0.96	1.55	19.67

Chemical analyzes show a virtually neutral pH value and do not indicate the presence of elements that could affect human health or would not allow vegetation to develop. The neutral pH value also eliminates the need for additional neutralization works before starting the actual ecosystem restoration.

Table 3

Content of nutrients

Element	Humus (%)	N (%)	P (%)	K (%)	S (%)	Ca (%)	Mg (%)	Fe (%)	Mn (%)	Zn (%)	Cu (%)	Co (%)
	-	Primary macronutrients			Secondary macronutrients			Micronutrients				
Concentration	2.87	0.35	0.044	1.55	0.21	0.79	0.84	2.23	0.029	0.008	0.01	0.002

Fertility parameter analyzes indicate low content of macronutrients (primary and secondary) and low to medium micronutrients. From this point of view the land allows the spontaneous installation of species which are present in the areas adjacent to the waste dump and are unpretentious to the soil (especially birch, wild rose and herbaceous species) (FAUR ET AL., 2019; BRASOVAN ET AL., 2017).

Description of the surrounding area

The evolution of the air temperature during the year is determined by the annual variation of the solar radiation and the air circulation regime, having a maximum in July of 14.5ºC and a minimum in January of -5.2ºC. In the annual air relative humidity regime, there is a main peak in December (93 %) when the air temperature is low and the minimum is recorded in March-April (77 %). Atmospheric precipitations decrease on average from west to east, they rise with altitude and have an irregular rhythm (FAUR ET AL., 2019). The months with the highest rainfall are June and July. Frequency of torrential rains is low. There are no periods of severe drought and the average atmospheric humidity is 4.59 l/mm^3.

The wind regime is characterized by a calm period (38 %) and a windy one (62 %). The most frequent winds are from southwest (16.5 %), followed by warm winds from southeast (14 %). Winds from west have the highest intensity, but they are less frequent (4 % of the time) and often cause damages by breaking down or plucking trees from the forests (FAUR ET AL., 2019).

The land can be affected by floods only under special conditions (sudden melting of high amounts of snow combined with abundant liquid precipitations).

Vegetation wildfires, caused by natural causes, have not been reported in the region, only small man-made fires that run out of control.

From seismic point of view, according to P100-1 - seismic design code - part I, the peak values of ground acceleration are between 0.10g and 0.15g (g = 9.81 m/s^2) and the control period is 0.7 (MO, 2013).

RESULTS AND DISSCUTIONS

Physical stability of the waste dump

Stability analysis for the north-western slope of the Lupeni dump - branch 3, B body was performed using a specialized geotechnical software (Slide).

Slide is a 2D stability analysis program designed to evaluate the safety factor or the probability of failure, for circular or non-circular surfaces (including polygonal), for poorly cohesive or cohesive materials. Slide analyzes stability by the vertical stripes method at the equilibrium limit. Individual surfaces can be analyzed or methods of determining critical sliding surfaces for a given slope can be applied.

The values used in the stability analysis, the volumetric weight, the cohesion and the internal friction angle were considered for the natural humidity (due to the granulometry of the dumped material it was considered that their saturation is unlikely) were presented in Table 1.

Results for the initial geometry

After modeling the slope, the values of the physical-mechanical characteristics presented in Table 1 are assigned and the calculation program is run, the results of the stability analysis (Table 4) being displayed for three considered situations:

a) without the presence of the lake at the base of the slope;

b) the presence of the lake at the base of the slope and the manifestation of a hydrostatic level in the body of the dump;

c) the presence of the lake at the base of the slope with the manifestation of a hydrostatic level in the body of the dump and the influence of the vertical cracks (observed at the top).

The position of the hydrostatic level was estimated based on observations regarding the level at which the rocks in the dump are wet in the area of contact with the lake.

Table 4

The results of the initial stability analysis - curved surfaces

Section	Situation	Stability analysis - curved surfaces		
		Initial slope (projected at the end of 2019)		
		Fellenius	Bishop	Janbu
L-L’	a	1.085	1.136	1.133
L-L’	b	1.054	1.127	1.107
L-L’	b	1.054	1.092	1.109

The potential sliding surface passes in the "a" situation through the body of the dump, while for the "b" and "c" situations they pass through the body of the dump and through the direct foundation.

As can be seen from Table 4, for the initial situation, even if the lake is drained, the value of the stability coefficient (after Fellenius) is relatively close to the equilibrium limit, the stability reserve being of maximum 8.5%.

Considering that for the ecological reconstruction of the dump it will be necessary to use machines, like bulldozers, and that in the initial stage the presence of humans will be necessary, this coefficient of stability is considered unacceptable.

Usually for the final slopes, in the case of dumps that do not have important objectives in their influence area and for which the variant of ecological reconstruction is the naturalistic recovery, a coefficient of stability of 1.3 is accepted (a stability reserve of 30%) (ROTUNJANU, 2005).

For the reasons presented above in the next paragraph are presented the modeling works to be performed in order to obtain the desired stability coefficient.

Resloping, terrasing and leveling works

Within these works, it is envisaged to ensure a proper geometry of the dump, so that it will ensure the stability of the objective and allow the works from the restoration stage of the ecosystem to be carried out.

Basically, the construction of a terrace in the middle area of the dump is considered and the reduction of the slope angle of the two steps resulted from the initial 35º to 23º for the upper level, respectively 25º for the lower level (Figure 2).

These works, which aim primarily to increase the stability reserve and secondly to ensure the conditions for the restoration of the local ecosystem, were designed so that a small volume of material is displaced, and the works are executed by moving the material from the top to the bottom, with the help of bulldozers.

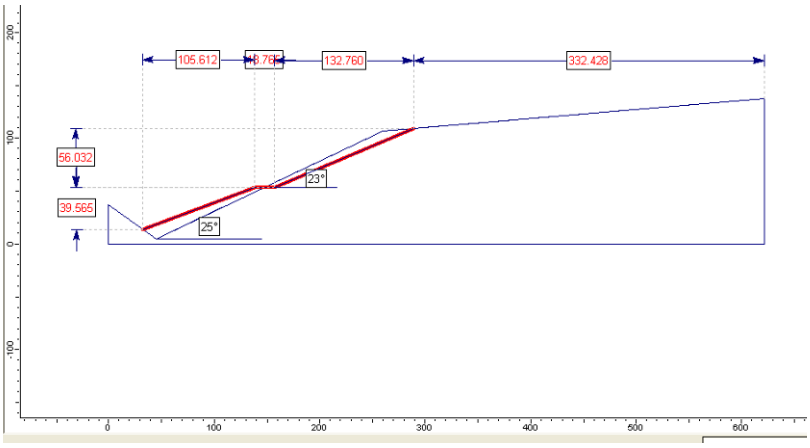

Figure 2. Longitudinal section after the resloping and terracing works

As can be seen from Figure 2, it results in two slopes and a terrace with a width of approx. 19 m. These works have been designed in such a way that the volume of material moved from the top (sublevel 2) is equal to the volume deposited at the bottom (sublevel 1).

Thus, in order to calculate the volume of material to be moved for the execution of these works, the surface of the body, in the longitudinal section, to be pushed by the bulldozer was first calculated (from Figure 2), and then this surface was multiplied by the length of the circle arch from the middle part of the slope measured on the situation plan:

S = (120*9.5/2)*sin67 + (115*30/2)*sin135 = 1,744.45 m^2
V = S * L = 1744.45*278 = 484,957.1 m^3

Considering that these works will be executed with the help of three bulldozers, with a capacity of 3,900 m^3 per day, results that the total number of days required for the execution of the projected works is about 40.

The leveling works of the upper platform of the dump, will not be performed separately from the resloping/terracing works of the dump. As can be seen from the longitudinal profile from Figure 2, the leveling is done with the construction of the dump and the way in which this leveling is carried out also ensures the corresponding slope, necessary to drain the water from the precipitation.

Stability analysis of the dump for the projected situation

After carrying out the works mentioned in the previous paragraph (resloping and terracing) it is necessary to carry out a new stability analysis to verify if the proposed objective, to obtain a stability coefficient greater than 1.3, has been achieved.

For this, in the Slide software the longitudinal section obtained after the resloping and terracing (Figure 2) was modeled and the calculation program was run again, for the superior, inferior and general slopes.

The values of the calculation parameters are the same as for the initial analysis, presented in Table 1, and it was considered the "c" situation (the presence of the lake at the base of the slope with a hydrostatic level in the body of the dump and the influence of the vertical cracks), the most unfavorable from the point of view of the objective stability. The results of the stability analyzes for the final designed situation are presented in Table 5 and Figures 3 - 4.

Table 5

The results of the stability analysis for the designed situation - curved surfaces

Section	Slope	Stability analysis – curved surfaces		
		Final projected profile		
		Fellenius	Bishop	Janbu
L-L’	superior	1.320	1.396	1.389
L-L’	inferior	1.578	1.696	1.653
L-L’	general	1.346	1.405	1.403

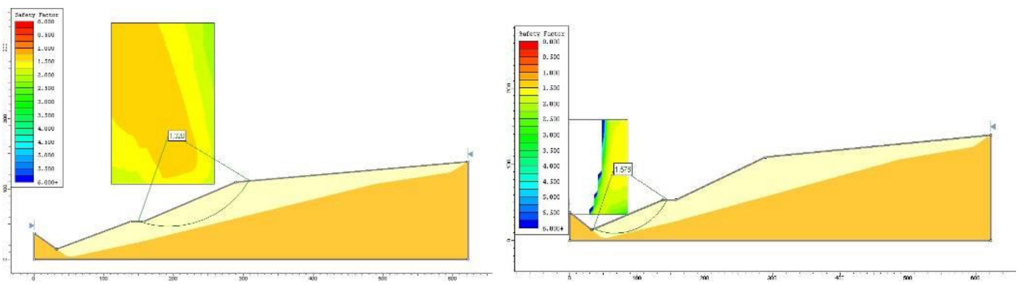

Figure 3. Stability of the superior and inferior slopes (after Fellenius)

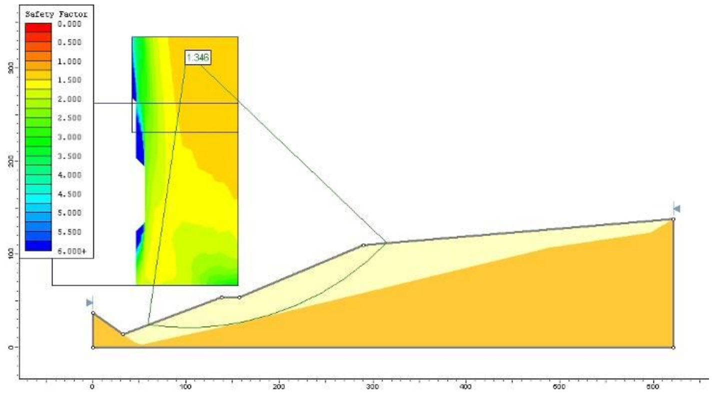

Figure 4. Stability of the general slope (after Fellenius)

As can be seen from Table 5 and from Figures 3 - 4, after the resloping and terracing works, the imposed stability conditions are fulfilled. Thus, the lower values, obtained by Fellenius method, are higher than the imposed one (of 1.3). This fact certifies the obtaining of a sufficient stability reserve that will allow the continuation of the works of restoration of the ecosystem on the Lupeni dump - branch 3, B body in safe conditions.

Establishing the ecological reconstruction variant

In order to establish the optimum variant of ecological reconstruction of the Lupeni waste dump, branch 3, B body we used a three-step methodology published in the specialized literature (LAZĂR ET AL., 2017) and which was tested/implemented through another study (FAUR ET AL., 2019). By analyzing the results presented in the 2 studies (LAZĂR ET AL., 2017; FAUR ET AL., 2019), we have established that the optimal type of ecological reconstruction for Lupeni waste dump - branch 3, B body, is the one using *Pinus sp.* (different species of pine tree).

The species requirements are closer to those offered by the stored sterile material (in terms of fertility) and the surrounding area (in terms of climatic conditions, morphology, accessibility, presence of water sources etc.) and, as a consequence, prove to be the optimal alternative for the ecological reconstruction of the mining waste dump.

Ecosystem recovery - establishing the forestation formula

For the Lupeni waste dump - branch 3, B body is proposed the variant of naturalistic recovery of the land. This option was chosen because it has two major advantages, namely it ensures the restoration of the landscape and the ecosystem in the area and involves the lowest costs.

Although, as stated for the situation for A body of the same dump, the vegetation is installing spontaneously, the time required for this process is relatively large. Thus, based on field observations, even after 10 years, the dump body A is not completely covered with vegetation, so we cannot talk about a complete restoration of the local ecosystem.

For these reasons for the restoration of the ecosystem on the Lupeni dump - branch 3, B body, we opted for the establishment of a pine plantation (during field visits we noticed that very good results were obtained on the older dumps of Lupeni M.E. on which such plantations were established, reaching massif state, and the age of the trees being between 10 and 20 years) (STRETENIE, 2017).

Another remark is that the pine was installed on the adjacent areas, also occupied by waste dumps, without planting works. In other words the pine was spontaneously installed in these areas, finding favorable pedo-climatic conditions.

Pine seedlings are planted at a distance of 2 m between them and 1.5 m between rows, alternately. Planting takes place in spring or autumn (preferably autumn) in pits with a depth of 40 - 50 cm, which is then filled with fertile soil (preferably forest soil). In the first 2 to 3 years they do not require cutting or cleaning, only then they can be cleaned by shortening the branches that make up the skeleton.

In order to ensure diversity, seedlings from the three common species in Romania will be used (PÂRVU ET AL., 1985): black pine, red pine and wild pine. Based on recommendations (MAPPM 1, 2000), for best results, the planting scheme from Figure 5 was chosen.

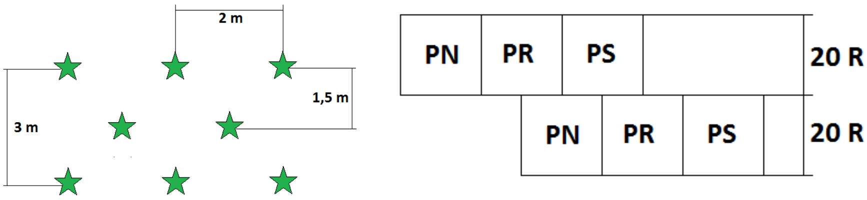

Figure 5. Scheme for planting pine seedlings and alternating arrangement in bouquets

As can be seen from Figure 5 the forestation scheme involves planting on rows at a distance of 1.5 m between seedlings (3 m in axis between seedlings). To ensure accessibility to light and water, the seedlings will be arranged alternately (on rows). The 3 species of pine will be planted in alternating bouquets of 400, arranged on 20 rows (Figure 5) (STRETENIE, 2017).

Purchase of the necessary biotic elements

The ecological restoration of the degraded land from Lupeni dump - branch 3, B body will be carried out two distinct stages:

1. Grassing of the upper platform and of the terrace - these works will be carried out in the spring. Grassing aims at preventing the excessive infiltration of water from the precipitations and/or its accumulation in the micro-depressions that are formed as a result of the waste material settling.

The surface of the 2 areas that will be initially grassed is of 2.5 hectares (as determined from the situation plan). For this, grass seeds will be purchased from the internal market. An amount of 400 kg grass seeds will be purchased, needed for a specific dose of 15 g/m^2 (ZAHARIA AND VINTER, 2013).

2. Pine seedlings (Figure 6) will be purchased from the nurseries in the country (preferably from Jiu Valley). Three species, namely black pine, red pine and wild pine, will be procured in equal numbers. Seedlings are delivered in vegetation pots at the age of two.


Figure 6. Pine seedlings in vegetation pots (2 years old) and the planting scheme

As it turns out from the situation plan, the total area of the dump that will be planted with pine trees is of 5.6 ha. According to the established forestation scheme, which involves planting 5,000 seedlings per hectare, a total number of 28,000 seedlings are required.

Sowing and planting works

Sowing works (grassing) will be executed in the spring after the reconstruction of the dump (resloping, terracing and leveling). This works can be done manually or mechanically where the land allows the access of the machineries.

The pine seedlings plantation will be done in the fall under the careful supervision of the specialized personnel from the Lupeni Forestry District and the representative of the company providing the seedlings.

For planting, in the first phase, the land will be marked (planting will be done on the upper platform, on the slopes and on the middle terrace) after which the contracting staff will dig the pits and will actually plant the pine seedlings. After this, the entire perimeter will be surrounded by a protective fence, so that the animals do not destroy the seedlings.

Culture monitoring

Monitoring the culture will be carried out by specialists and will follow the growth rate of the plants, the number of plants reaching maturity, the degree of coverage with mature plants of the recovered surface etc.

The annual control of the pine culture is carried out from September 1 to October 31 and aims to determine the success of the regeneration and the development mode of pine seedlings, as well as to establish the works necessary to be carried out (maintenance, filling the gaps, the number of seedlings needed). The control surfaces are executed according to the technical guidelines for carrying out the annual control of the regenerations (MAPPM 2, 2000).

Filling the gaps in the forestation works - the completions will be executed manually in the first 2-3 years after planting, in case of uniformly spread or grouped losses. The species that are introduced by additions will have to ensure the proportions established by the planting scheme. The percentage of additions can reach a maximum of 15% in the second year after planting and 5% in the third year after planting (STRETENIE, 2017).

Costs estimation

In order to make the necessary arrangements (resloping, terracing and leveling) the costs are given by renting the necessary equipments, namely 3 bulldozers, the rest of the costs are related to the purchase of grass seeds and pine seedlings. The total costs, without including labor (planting the seedlings), are 162,000 RON, to which will be added any costs for completion of the forested area (STRETENIE, 2017).

CONCLUSIONS

When the extraction activity ceases, recovery of the land occupied by the mining waste dumps is a compulsory activity, which belongs to the project owner. The specialized literature presents a series of variants of recovery of these lands, variants that must be weighed very carefully, so that they allow some flexibility, but at the same time to obtain satisfactory results.

The purpose of the present paper was to identify the variant and design the works necessary for the reorganization and restoration of the ecosystem on the Lupeni waste dump - branch 3, B body.

The stability analyzes showed that the waste dump is very close to the equilibrium limit, which is why it was necessary to design refurbishment works. These consisted of reducing the angle of the slope (resloping) and creating a terrace in the middle of the slope.

Following the completion of these works, the stability of the dump was re-analyzed for the designeded geometry, and the results of this analysis showed that the dump has a sufficient stability reserve, which will allow the safe restoration of the ecosystem.

It was decided to set up a pine plantation, which would ensure the re-incorporation of the dump into the surrounding landscape and the restoration of the ecosystem. The chosen species gave very good results on other dumps nearby, proving that it adapts to the pedo-climatic conditions of the area.

Given the similar composition of the waste material and the practically identical environmental conditions, the ecological reconstruction model of Lupeni dump, branch 3, B body, can be successfully applied to other dumps in Jiu Valley.

BIBLIOGRAPHY

BRASOVAN A., BURTESCU R.F., OLAH N.K., PETEAN I., CODREA V., BURTESCU A., 2017 - Algorithm for assessing soil rehabilitation of sterile dumps, Studia Universitatis Babes-Bolyai, Chemia, 62 (2), Tom 1, pp. 81-93, Cluj, Romania.

FAUR F., LAZĂR M., APOSTU I.M., 2019 - Substantiating the decision regarding the ecological reconstruction of mining waste dumps – case study for Lupeni dump, Quality – Access to Success, 20 (S1), pp. 235-240, Bucharest, Romania.

GOLDAN T, NISTOR C.M., 2013 - Considerations regarding the risk of land degradation induced by mining operations in coal open pits, International Multidisciplinary Scientific GeoConference: SGEM: Surveying Geology & mining Ecology Management, Vol. 1, pp. 357-362, Albena, Bulgaria.

HEC (HUNEDOARA ENERGY COMPLEX), 2015 - Technical Memorandum, "General operation program for Lupeni Mining Exploitation" (in Romanian), Petrosani, Romania.

LAZĂR M., FAUR F., DUNCA E.C., CIOLEA D.I., 2017 - New methodology for establishing the optimal reuse alternative of degraded lands, Environmental Engineering & Management Journal (EEMJ), 16 (6), pp. 1301-1308, Iasi, Romania.

MCHARG I., 1969 - Design with Nature, Nat. History Press, 208 p., Garden City, New York, USA.

MAPPM 1 (MINISTRY OF WATERS, FORESTS AND ENVIRONMENTAL PROTECTION), 2000 - Technical regulations regarding compositions, schemes and technologies for regeneration of forests and forestation of degraded lands, Vol. 1, Inter-Print Publishing House, 253 p., Bacau, Romania.

MAPPM 2 (MINISTRY OF WATERS, FORESTS AND ENVIRONMENTAL PROTECTION), 2000 - Technical regulations for the care and management of tree plantations, Vol. 2, Inter-Print Publishing House, 176 p., Bacau, Romania.

MO (MINISTERIAL ORDER) NO. 2465, 2013 - for approving the technical regulation P100-1 – seismic design code – part I (in Romanian), Romanian Official Monitor, No. 558, Romania.

NANU G., MARCHIS D., 2013 - Identifying the pollution sources in Peşteana quarry and assessing the impact on the environment, Annals of the University of Petrosani, Mining Engineering, 14, pp. 277 – 287, Petrosani, Romania.

OLTEAN I.L., GOLDAN T, NISTOR C.M., 2018 - Prevention and monitoring environmental impact of open pit coal mining activities, Research Journal of Agricultural Science, 50 (4), pp. 259-264, Timisoara, Romania.

PÂRVU C., GODEANU S., STROE L., 1985 - Guide in the world of animals and plants (in Romanian), Ceres Publishing House, 324 p., Bucharest, Romania

ROTUNJANU I., 2005 - Natural and artificial slope stability (in Romanian), Infomin Publishing House, 352 p., Deva, Romania.

STRETENIE C.M., 2017 - Reconstruction and restoration of the ecosystem from Lupeni waste dump – branch III (in Romanian), Project for Bachelor of Engineering, 65 p., University of Petrosani, Romania.

ZAHARIA C., VINTER R.V., 2013 - Recovery and capitalization solutions for the land from Poiana Mare, Sesul Serbanilor and Galbena waste dumps, from Campu lui Neag area. Annals of the University of Petrosani, Mining Engineering, 14, pp. 209 – 222, Romania.