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STUDY OF REDUCING THE DAMAGE AND REUSE OF WASTE TANKS IN THE CERTEJ MINING AREA

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Abstract: *The Certej area is an area of gold mining activities with a history of several hundred years. The only activity with a significant share in the area was the mining activity, which provided the population of Certeju de Sus commune and its surroundings with the means necessary for a decent living. In the case of tailings dumps, the soil suffers a combined impact - by removing large areas of land from the natural circuit and by generating acidic water. The geology and morphology of the region, characterized by the existence of surfaces with different slopes, are natural causes that attribute different levels of vulnerability to land at the onset of degradation processes by erosion, landslides and excess moisture. All these bring limitations in the use of land on the main uses: agricultural, forestry, construction, etc. The paper aims to provide solutions for the reuse of these lands, their use by recultivation, the search for plant species adaptable to soil conditions. A relatively small number of species were determined on the tailings dumps in the studied area, the spontaneous vegetation is visibly stressed by the existing conditions. As such, the method of ecological reconstruction of freshly deposited tailings dumps by the method of forest recultivation is proposed.*

1. Description of the area. Location and topography

The Certej area is an area of gold mining activities with a history of several hundred years. For the medieval period there are some sporadic indications of mining activities, but large-scale mining began in the seventeenth century. Mining began in the eastern area - Săcărâmb - as early as 1745. Systematic exploration and exploitation activities began after 1832, leading to the expansion of mining areas throughout the Certej perimeter.

The only activity with a significant share in the area was the mining activity, which provided the population of Certeju de Sus commune and its surroundings with the necessary means for a decent living.

The cessation of mining activities (March 2006) caused a sharp decline in living standards, while contributing to rising unemployment, the migration of the population to other localities.

The Certej mining perimeter, Hunedoara county is located in the southeastern part of the Metaliferi Mountains, being part of the so-called gold quadrangle Săcărâmb - Brad - Roşia Montană - Baia de Arieş and is located near Hondol, in the central-southern part of Brad-Săcărâmb Neogene basin, at approx. 20 km NE of Deva. It is located on the territory of Certeju de Sus commune, Hunedoara county, about 20 km from Deva.

Current status of the Certej area

The Certej gold deposit is confined to Cretaceous and Miocene sedimentary deposits, andesitic bodies and lavas that intrude and cover the sedimentary. The deposit covers an area 2.5 km long and 1.5 km wide, characterized by a weak magnetism, delimited in the western, northern and eastern part of andesite with biotite, unaltered, and adjacent, at least partially, with the Notandreeas fault, in the southern part. The lack of magnetic characteristics is due to the fact that the magnetite was replaced by pyrite, during the hydrothermal alterations.

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In the area of minimum magnetometricity, a gold mineralization was outlined, with tabular aspect, with a length of about 1500 meters, which extends approximately in an east-west direction, from Dealul Grozii to the Lidia slice, oriented north - northeast.

The mining constructions and the surfaces related to the objectives within the perimeter of Certej SA are:

Table 1 Situation of the land affected by previous activities

No.	Objective / mining construction	The related surface (ha)
1	Coranda open pit	26,06
2	North tailings dump	11,38
3	South tailings dump	13,61
4	Coranda II gallery	-
5	Coranda III gallery	-
6	Coranda II tailings dump	0,40
7	Coranda III tailings dump	0,30
8	Dealu Grozii gallery	-
9	Dealu Grozii dump	0,15
TOTAL AFFECTED AREA		**51,90**

Waste dumps are on the one hand targets with potential stability problems and on the other hand sources of environmental pollution.

In the case of tailings dumps, the soil suffers a combined impact - by removing large areas of land from the natural circuit and by generating acidic water. Due to the physical and geochemical instability (in case of acidic water generation) of the mine tailings dumps, downstream of them can occur the phenomenon of migration of chemical elements (especially heavy metal ions), on the neighboring lands, as well as in the surface and underground waters. The biggest problems of soil contamination are due to the existence of the two active tailings dumps, with the largest dimensions: Coranda South and Coranda North dumps.

In the case of old tailings dumps, their impact on the soil is greatly diminished. It is found that they are already covered with spontaneous vegetation, which in some cases makes it difficult to identify them compared to the natural environment (Ex.: Sewage dump - Horizon 550, Sewer dump - Horizon 600, part of the waste dumps from the Sacaramb sector - Valea Nojagului: Maria dump, Sector IV dump).

2. Ground coating

The soil stored in the three piles of soil in the form of stacks, identified as waste, will be reused for the restoration of the land on the mining site after the cessation of activity. It is recommended that soil storage dumps be properly arranged to limit erosion processes and the possibility of drainage of rainwater that can qualitatively affect neighboring soils as well as those in deposits.

The aforementioned pedological study identified and delimited a number of 53 soil units (US). For the physico-chemical characterization of the soil units, a number of 79 soil samples were collected and analyzed.

From a genetic point of view, the soils delimited in the studied perimeter belong to three soil classes and to eight soil types. The soil units in the studied perimeter are centralized in figures 1 and 2.

The analysis of these graphic representations reveals the fact that in the studied area soils from the luvisoils class predominate, followed by those from the protisoils class.

The geology and morphology of the region, characterized by the existence of surfaces with different slopes, are natural causes that attribute different levels of vulnerability to land at the onset of degradation processes by erosion, landslides and excess moisture. By adding anthropogenic causes, the degradation processes are intensified. All these bring limitations in the use of land on the main uses: agricultural, forestry, construction, etc.

The special pedological study mentioned above identified and delimited the surfaces with the soil cover affected by degradation processes. Geomorphological processes are: surface erosion, deep erosion, landslides, excess moisture from precipitation and lateral runoff and anthropogenic activity.

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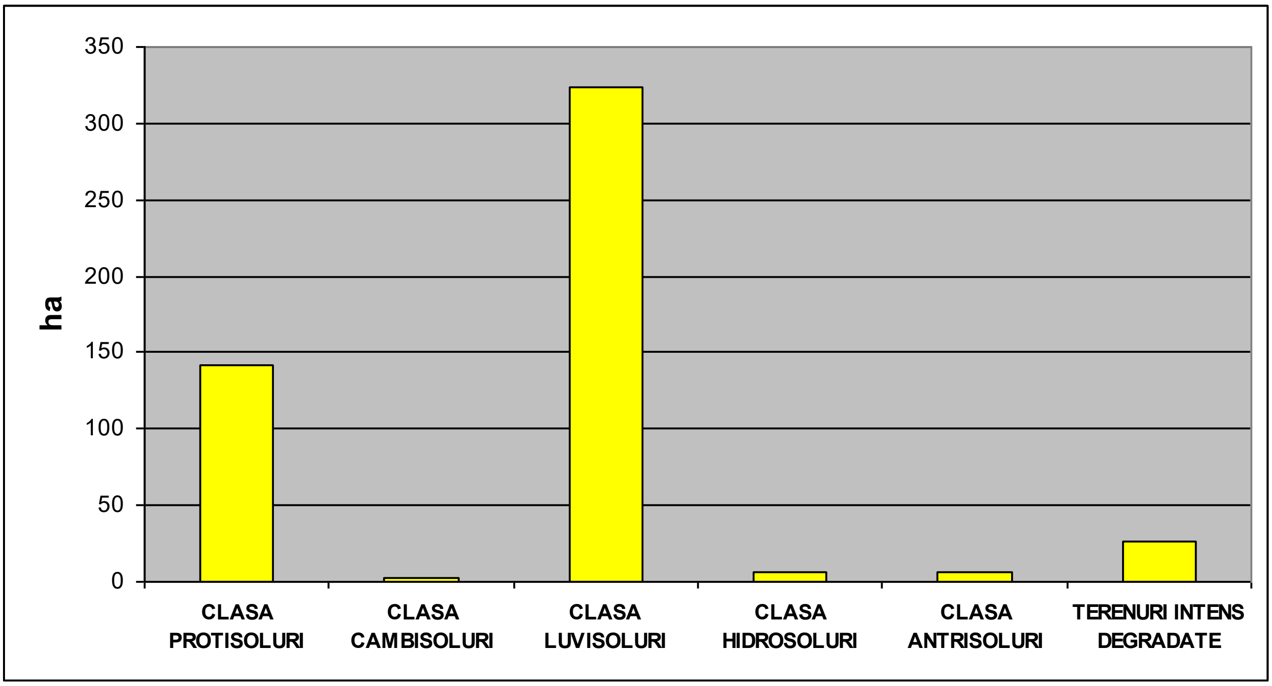

Figure 1 Distribution of soil unit areas by soil classes

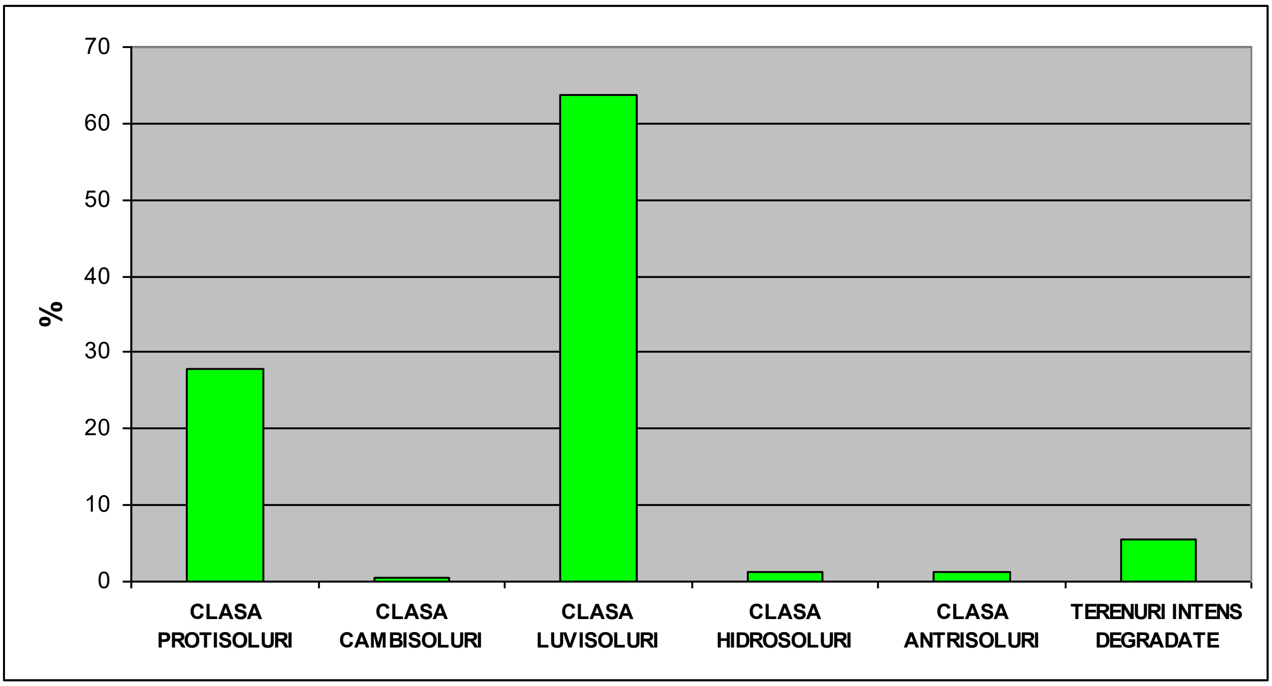

Figure 2 Percentage distribution of soil unit areas by soil classes

2.1. Surface erosion

Surface erosion is the process of detachment and transport of soil particles under the action of water that drains on the slope in the form of unstable cloth or streams. It is the most developed process within the studied area that affects 291.85 ha - 57.4% of the total area [1].

In poorly evolved young soils represented by lithosoils and regosoils were included in this group because their evolution is affected by surface erosion and the resistance of the parent rock to the alteration process.

The presentation by categories of erosion intensity is shown in figure 3.

Moderate surface erosion affects 97.55 ha - 27.37%, and strong erosion affects 47.92 ha - 9.42%, while very heavily eroded soils were identified on an area of 5 ha - 0.98% , and the excessive surface erosion affects only 2.34 ha - 0.64%.

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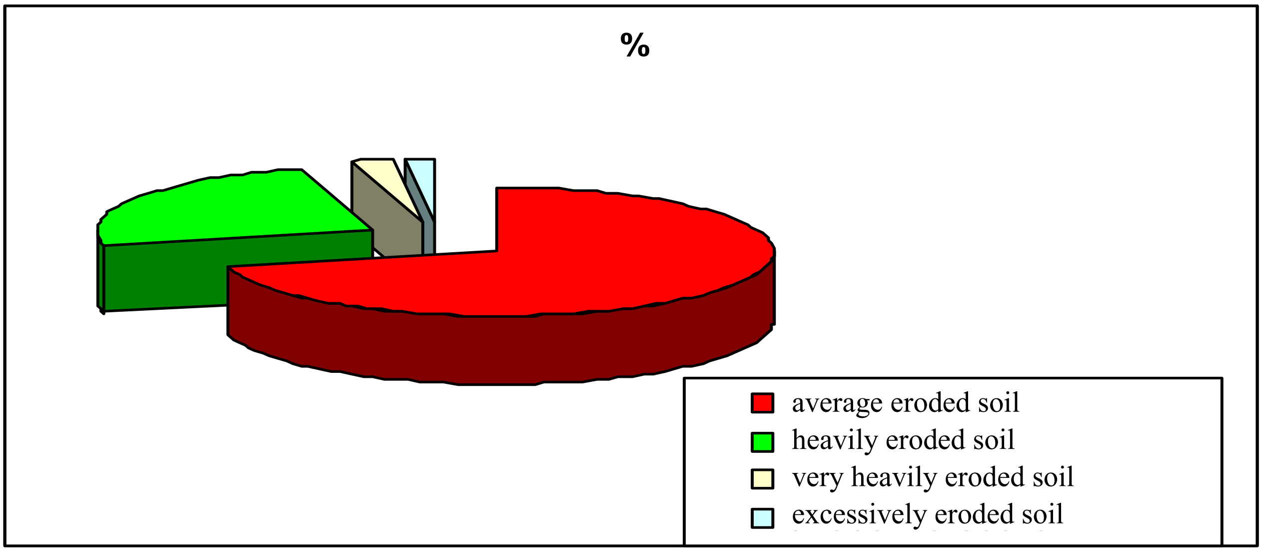

Figure 3. Distribution of areas affected by surface erosion on intensity categories

2.2 Microbiological activity of the soil

In an ecological conception, soil can be defined as "the seat of a complex of substances - sources of nutrients and energy - of organisms and microorganisms, properties and processes, determined both by its own composition and architecture, and by all pedogenetic factors. which influences it uninterruptedly, especially climatic factors and very frequently the hydrological ones". The soil has the ability to provide plants with support, water, nutrients, air and heat, essential for their life and productivity. It has an ecological specificity, which determines its productive potential or fertility [2].

The most important source of organic matter in the soil is the huge amounts of plant material deposited annually as litter (accumulations of leaves, bark fragments, seeds, etc.) in which recently fallen plant material is only partially decomposed, so that plant organs can be still identified. It forms a 1-3 cm thick layer in coniferous forests and 3-6 cm in deciduous forests.

The quantities stored locally are difficult to estimate and vary depending on the geographical position, climate, nature and age of the plants, the type of soil and to any extent, the organic input from animal organisms and microorganisms.

Environmental factors play an important role, as they influence the nature, number and activity of microorganisms. These are: humidity, soil atmosphere, temperature, pH, season, depth.

Soil, in general, is a suitable environment for the development of microorganisms, illustrated by both their number and their diversity much greater than in the aquatic environment.

Due to its heterogeneity, the soil carries populations of microorganisms with very different biological and biochemical characteristics, which compete for fluctuating concentrations of nutrients, unevenly distributed and frequently insoluble and in response to fluctuations in pH, oxygen tension, ionic concentration, relative humidity, etc. Soil micropopulations are made up of bacteria (eubacteria, actinomycetes, cyanobacteria), microfungers, algae and protozoa.

The information from the specialized literature regarding the study of the distribution of microorganisms in the genetic horizons of different soil types led to the highlighting of the following conclusions:

⁎ the distribution of microorganisms in different soil types is very difficult to compare, even if the horizons are known and the data come from a single researcher, who used a certain set of methods;

⁎ the number of heterotrophs is closely correlated with the concentration of organic matter. Exceptions are environments with extreme conditions, such as peat, which has an acidic pH. This is a case of limiting the development of microorganism populations by means of the least favorable environmental factor;

⁎ protozoa and algae are relatively unimportant in the soil, even when their development is maximum as in peat;

⁎ the number of chemotrophic bacteria is much smaller compared to heterotrophs.

In order to highlight the soil microbiota in the area of the Certej exploitation perimeter, a number of 12 soil samples were characterized, the bacteriological indicator analyzed being the mesophilic bacteria developed at 37 0 C; soil samples were taken from a depth of 0-10 cm.

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The method of analysis applied for the determination of mesophilic bacteria-microorganisms that grow at 22oC and 37oC, capable of forming visible colonies on nutrient media, under certain culture conditions (according to SR EN ISO 6222/2004) is the internal standard INCD ECOIND, processed and accredited RENAR [3].

The principle of the method consisted in inoculating, by mixing some sample volumes or its dilutions with a culture medium specified in Petri dishes, followed by incubation at 22 ± 2 ° C for 68 ± 4 hours / 36 ± 20 ° C for 44 ± 4 hours. Calculate the number of colony-forming units per ml of sample from the number of colonies formed in the medium.

The analytical results are centralized in table 2 and represented graphically in figure 4.

Table 2 Results of microbiological analyzes - soil samples perimeter Certej

Indicative test	**Sampling point**	**Geographical coordinates (Stereo70)**		**Mesophilic bacteria at 37^0C (UFC / g texture)**
		East	**North**	
B1	North preparation plant	346790	501620	**2414 x 10^4**
B2	West preparation plant	346650	501475	**2754 x 10^4**
B3	East preparation plant	346830	501440	**19575 x 10^4**
B4	South preparation plant	346701	501245	**423950**
B5	South-west exterior North dump	345675	501920	**3136 X 10^2**
B6	North exterior North dump	345950	502910	**5612 X 10^2**
B7	East exterior North dump	346285	502450	**1767150**
B8	South exterior Nord dump	346550	501640	**52195 X 10^2**
B9	North-west exterior South dump	345195	500895	**189 X 10^5**
B10	Proposed road	347023	501903	**17125 X 10^2**
B11	CIL lake	346280	503938	**598 X 10^4**
B12	Flotation lake	346465	502610	**21063 X 10^3**

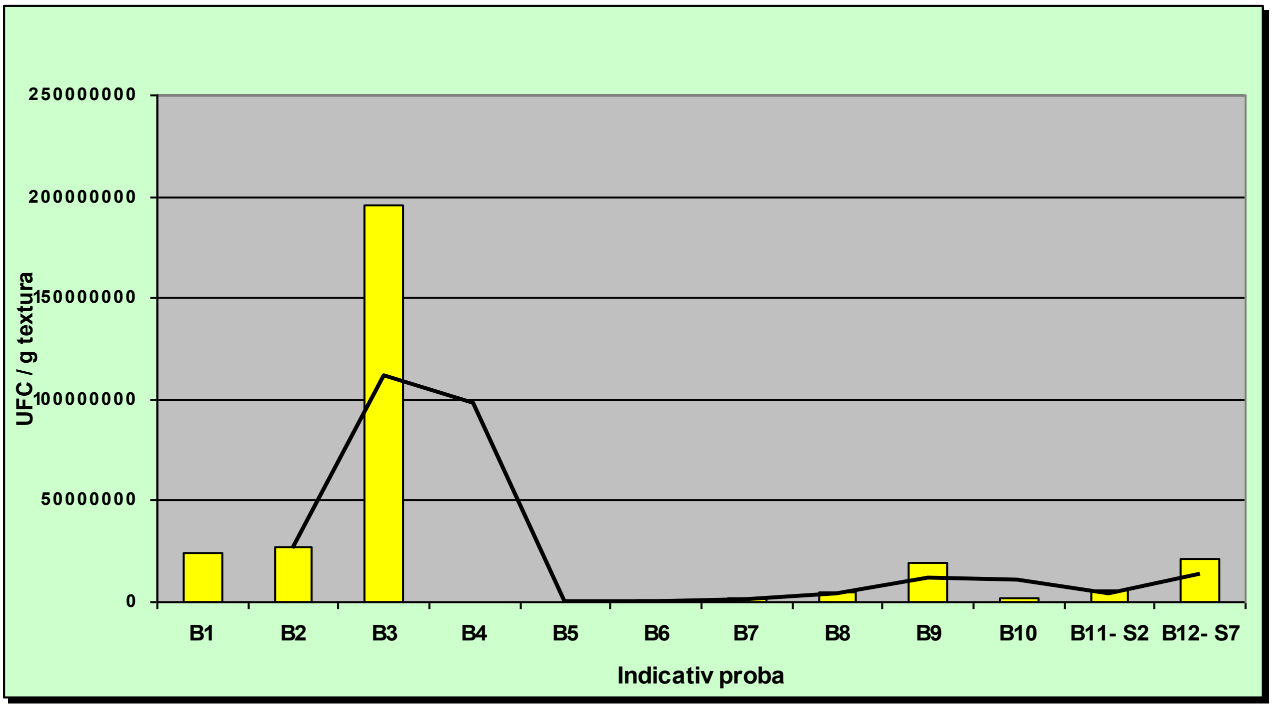

Figure 4. Graphical representation of the results of microbiological analysis

It is found that the microbiological activity of the soils in the analyzed perimeter is present and active, and the fact that the previously mentioned influencing factors are manifested differently, and the soil samples are characterized by an obvious heterogeneity, explains the large range of variation of the indicator microbiologically analyzed. The sample with the code B3 located in the eastern area of the site recorded a maximum microbiological activity, as a result of favorable conditions accumulated from the manifestation of influencing factors.

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3. Conclusions regarding the reconstruction of vegetation in the Certej mining area

Ecological reconstruction is one of the most frequently applied processes in the situation of anthropically degraded lands, because it has a high sustainability, is durable over time, does not involve very high costs compared to other systems, allows the ecosystem to self-regulate and easily reintegrate into the natural environment.

The recultivation of tailings dumps consists of a complex of technological and biological measures that aim to stop the phenomenon of deflation (removal and transport of ash particles under the action of the wind) and to finally transform a large surface deposit, which was a strong source environmental pollution in a new space, able to support plant development.

The bare soil must be sown with grass in order to obtain immediate protection against erosion, and trees or shrubs can be planted later in order to stabilize. If the predetermined conditions are met, the location of the dump can be left to the natural cycle of vegetation regeneration. In order to ensure a temporary or permanent protection and a normal development of the vegetation, the dump could be fenced. Natural regeneration cycles have the advantage of low or even zero costs. The disadvantage is that of a very long period of time (decades, centuries) until reaching the optimal period of vegetation development and until the formation of a vegetative soil substrate.

The method of ecological reconstruction of freshly deposited tailings dumps by the method of forest recultivation is proposed. From the monitoring of forest crops installed on tailings dumps (Deva, Certej, Petroşani, Borşa, Dragomireşti, Baia Sprie, Tăuţi Măgherăuş, Anina, Ceahlău), it was found that three categories of factors must be taken into account when choosing the species: economic (the species with the highest market demand, with constant demand and high value, with less competition from other species, with a specificity that makes them easy to exploit in a certain place and at a certain stage, etc.), ecological (suitability of species for a certain substrate and for certain climatic conditions) and technical (indirect methods of tillage, drainage, irrigation, amendments, fertilizers, chemical control, etc.).

It is proposed to plant the following species: Robinia pseudacacia L. (acacia), Elaeagnus argentea Pursh (willow), Hippophae rhamnoides L. (sea buckthorn), Ligustrum vulgare L. (wood-cane), Pinus nigra J.F.Arnold. (black pine), Cotinus coggygria Purpose. (expensive), Ulmus glabra Huds. (ulm), Fraxinus exelsior L. (ash), Acer pseudoplatanus L. (maple), Gleditsia triacanthos L. (maple). Some of the recommended species grow spontaneously in the area [4, 5].

The fabaceous species represented by Mellilotus officinalis, Trifolium pretense, Medicago sativa, Vicia craca have an important role in the physico-chemical improvement of the dumped materials. In fact, in the area, works have been started to improve the soil structure on the dumps (manure administration and calcium fine).

An extremely wide range of hypothetical reuses of degraded lands is known to cope with any situation or need, most often applied are: naturalistic recovery, which aims to restore the natural cadence of the degraded landscape, including specific nature protection measures; recreational and leisure recovery, similar to naturalistic recovery, which provides in addition to the realization of specific structures; productive recovery, indicated for the areas that are part of a territory with high agricultural productivity, in which the affected areas are inserted, thus obtaining a solution of continuity, and the affected areas can be rearranged and destined for agricultural crops, forest plantations, calves vineyards or orchards; other types of reuse such as construction of residential, commercial, hotel buildings, construction of military installations, runways and cemeteries, culturally recovered or recovered for productive and technological installations.

It should be emphasized that cessation of activity and decommissioning of targets does not lead to the immediate elimination of all sources of adverse effects on environmental components.

The effects produced by these sources on the environment will be long-term and will require specific investments.

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