ASSESSMENT OF THE ENVIRONMENTAL IMPACT GENERATED BY THE GEOMORPHOLOGICAL CHANGES FROM BERBESTI MINING BASIN

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Abstract: *Berbeşti Mining Basin is an artificial space due to the interaction between anthropic and natural actions/components. The geomorphological modifications in this area are evident with a decisive role in the formation and modeling of local morphology, resulting in a typical geomorphological mining industrial landscape. The impact of the geomorphological changes in the area are given by the spectacular relief inversions, the depression morphology being replaced with horned anthropic forms; the slope profile is modeled by adding or removing different elements; the original morphology is "anthropically parasitized" by mining blueprints (dumps placed in floodplains or hills, open pits etc.). The functional reintegration of the mining superstructures such as waste dumps (post-exploitation management) involves their transformation from degraded and economically ineffective landscapes in agreeable and economically useful areas.*

Key words: *geomorphological changes, impact, mining basin, mining industrial landscape*

1. Introduction

The environmental impact assessment procedure is a decision support system designed to provide competent authorities with certain decision-making elements, scientifically establishing the possible environmental effects of the actions to be implemented. The implementation of the environmental impact assessment is a perfectible and transparent process based on clear working methods and data, informational sources and guaranteed management systems. Being a flexible and open process, it allows for changes in every stage of its realization [7, 8].

Berbeşti area, with up-to-date lignite exploitations, is an artificial space that functions on the basis of new rules imposed by anthropic - natural interaction. The main features of the impact of geomorphological changes are:

- spectacular relief inversions, depression morphology is replaced by varied anthropic horn shapes; while the prominent areas are flattened or even changed in to sub-topographic or underground cavities of anthropogenic origin;
- shaping the slope profile by adding or removing slope elements;
- "anthropic destruction" of the original morphology through mining technical structures (dumps placed in floodplains or hills, open pits etc.);
- the superiority of anthropic modeling both in intensity and in terms of speed of manifestation;
- the establishment of conflicting relations between the natural components of the geomorphological system and the anthropic activity (pollution, landscape changes, lithological changes, pedo-vegetal and hydro-atmospheric degradations, etc.) [2].

As a consequence of the fact that the sterile material does not have an immediate practical utility it is necessary to deposit it (temporarily or definitively) into accumulated anthropic structures of different shapes and sizes, called waste dumps.

The functional reintegration of the supra-topographic mining structures, such as waste dumps (post-exploitation management), involves their transformation from degraded and economically inefficient degraded areas into pleasant and economically useful areas. The achievement of this goal implies paying special attention to the characteristic features of the territory to be arranged (local specificity), all the affected areas being introduced into a regional functional rehabilitation project [7].

2. Mining activities generating impact

The complex of coal-recovery activities (starting from the geological prospecting phase, continuing with the actual exploitation and up to the time of the environmental rehabilitation) leads to a change of the local geomorphologic system equilibrium, inducing a new state (anthropically outlined) [2].

Geological prospecting, through drilling and digging, leads to the appearance of underground material in the sub-aerial space. In this stage there are surface morphological changes, resulting in the following: digging depressions (flat forms), sub-

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topographic forms of relief (ditches, pits), underground cavities (vertical drillings, galleries, etc.), accumulations of excavated materials (marsh, micro waste dumps, etc.) [1].

The actual exploitation action determines the deepest morphological and functional changes of the geomorphological system, having negative consequences on the natural balance existing before the human intervention. Thus, the hilly area between the valleys Târaia and Valea Mare was gradually transformed, starting with 1983, into a open pit cavity (Panga), currently occupying about 364 ha (in 2017), resulting in level differences up to 50 m (from 370 m absolute initial altitude - to 320 m absolute altitude of the open pit base) [1].

The activities of taking over, transporting and storing the materials resulting from the coal mining process lead to a profound artificialisation of the mining areas: destruction of aquifers, modification of local lithology, creation of open or underground gaps, generation of prominent forms of human anthropic relief (e.g.: soil, water, air, noise pollution, aesthetic pollution, etc.) [9].

Another negative effect of the up-to-date exploitation on the original morphology (of natural slopes for Panga open pit) is the remodeling of the natural profile of the slopes by: modifying the morphometric elements (increasing or decreasing the length of the slope sectors and implicitly their surface), introducing rectangular segments (with angles of the exploitation project), the terrain of natural inclined surfaces, the increase of slope segments, the reduction or total destruction of the slopes surface (by excavation) [1].

Examples of areas with mutilations of the natural slopes are found especially in the two major opencast mines (Panga and Berbeşti) and waste dumps (Fig. 1).

Fig. 1. *Halda interioară –Cariera Panga-2018*

Construction of the infrastructure auxiliary to the lignite exploitation activities (access roads, embankments, terraces, riverbeds, mining management facilities, public buildings, etc.), in turn, increase the degradation of the natural elements of the area. The construction of the mine accumulation forms (dumps and mounds) brings important local changes, so the right sector of the Târaia meadow between Amzulesti and Valea Mare was transformed over a length of about 6 km into a hilly area with relative heights that can reach 50 meters. The decommissioning of the exploitation structures has strong negative effects as a result of the degradation of the resistance of the artifact supporting the works. In this case, the rehabilitation process is more difficult, requiring consolidation works (for buildings, mines, quarries, dumps, infrastructure, etc.) [1].

All these anthropic interventions have obvious consequences on the functioning of the local geomorphologic system, thus generating a wide spectrum of local artificialisation.

The sterile material placed in the waste dump structures comes from Panga open pit (located at a distance of 1 km), the transfer of the material being carried out using conveyor belts. The deposit was made in the order of the excavation in the quarry (the fertile soil being placed at the base of the dump) with the help of 2 dumping machines, and the leveling with the help of small bulldozers. The dump was built as two deposit sectors (Valea Mare and Târaia) merging into a unique hillock structure, covering the meadow and partially the minor river bed of Târaia river and Valea Mare creek. The dumping is in progress in 2018 and leveling works are carried out continuously [1].

Sterile dumping is done in the order of the stripping of the sterile material (the fertile material was deposited on the base of the dump). As a result of engineering works, Panga dump has an asymmetrical appearance. The relief consists of nipples, mounds and furrows of material; separate from depression areas (extending from a few m2 to about 700 m2 and depths up to 15 m) seasonally filled with water (non-existent drainage). If the west side (to the localities Valea Mare and Amzulesti) the steps have been partially leveled, the sloppy appearance of the dump with a disorganized landscape (areas with planted vegetation are reduced, spontaneous vegetation is poorly represented, and the frequency of active geo-morphological processes is higher, etc.) [2].

Currently, the western sector of the dump is chaotically cultivated by the locals (in an unorganized manner and without a prior improvement of the protisoil). Being a brittle structure (lithology consisting of: carbonaceous clays, sandy-marly clays, marly-dusty or clay sands and, compacting is insufficient, etc.), the waste presents a greater susceptibility to the onset of geo-morphological processes. Geomorphological shaping of the dump results in an extension of its surface, the most common processes being: rills and ravines, mass displacement movements (shallow landslide on the slopes of the open pit and dump (Fig. 2), mud eruptions, pseudosoilifluxions, creeping, slope falls, sediments, etc.), wind erosion (especially before gazing), compaction (natural and anthropic) [2].

Natural modeling and agricultural use of other dumps, Panga North and South, led to the occurrence of an artificial rectangular morphology resulting from the process of building techno-structures, and so the construction steps are no longer noticeable (Fig. 3) [1].

Fig. 2. *Erosion processes on Panga inner dump*

Fig. 3. *Agricultural crop on Panga exterior dump*

The construction of Panga North, South and the inner dump Pangs has resulted in important transformations in the local geomorphologic system. By analyzing the concrete situation on the ground, we were able to identify the main effects felt at the local level:

- destruction of the horizontal meadow morphology with a horn structure of anthropogenic origin with a chaotic micro relief (morphological and morphometric changes, aspect of heterogeneous landscape with unsightly accents, becoming by greening integrated into the local context etc.);
- modification of land use in the Târaia River meadow. The fertile soil of the meadow was replaced by a hilly area with poorly productive protisoil, still susceptible to degradation. Thus there was a deterioration of the edaphic potential, with implications both for the reduction of agricultural activities and for the substantial replacement of the original meadow vegetation with vegetation of weeds and inferior plants;
- slight dipping of the support surface of the dump with implications on the inhabited area in the immediate vicinity (3 of the constructions have cracks);
- triggering of the contemporary geomorphological processes on the surfaces of the waste dump and in their neighboring areas, as a result of changing the local balance. Thus, there appeared: superficial landslides (on the steps and slopes of the waste dumps), drainage (due to the sandy substrate), pseudosoilifluxions (in the area of glazes or flat forms and at the level of the top of the dump), the compaction (on the smoothed surfaces), low erosion (especially during the construction phase of the dump), muddy flows (on small surfaces, during high precipitation and on the background of some preliminary landslides), wind erosion (causing the dusting of the area of the Târaia valley).
- the modification of the hydrosphere components, as follows: the river Târaia received a new fowing bed, the groundwater underwent changes (both in terms of qualitative and quantitative components), the hydrogeological dynamics underwent local changes, the surface leakage and the ratio of the meteorological water filtration has changed substantially (the consequences: the increase of the solid flow, the increase of the anastomosis tendencies, the over-dimensioning of the dewatering cones and the premature clogging of the lacustrine troughs, etc.), occurrences of flooded area on the waste dumps (due to the poor drainage) and so on.
- modification of the local climatic conditions by generating a specific topoclimate (barrier of the air currents on the aisle's passage, etc.)
- changing the range of natural color shades (green, green-ruby, brown, griver, yellow-gray, etc.) with the shadows of the dressing material

(red, gray, yellow, black-gray, brown-red, etc.). The effect was alleviated by greening;
- the impossibility of developing the public space in the dump's sector due to the instability of the structure;
- degradation of the natural elements of the area (soil, running water, groundwater, visual pollution, etc.);
- changing the infrastructure of the territory by creating access roads for machinery and depositing sterile rocks in the dump, degrading the existing roads, etc. [2].

So there is a strong change in morphology and morphometry; flora and fauna; the pedological and hydro-atmospheric component, etc. on the entire area between Tăraia and Valea Mare rivers.

The commencement of operation at Panga open pit also meant the relocation of nearby houses, the construction of other dwellings, the relocation of the cemetery and the wooden church [2].

The quarries from Berbeşti mining basin, by location and way of evolution, are classified as hilly ones. Prior to the start of the operation, there were hills in the area, covered by hayfields and forests, which were eventually destroyed wholly or only partially. The areas of the Târaia Valley and other secondary valleys have disappeared. It should be noted that the Tăraia valley was regularized in order to take over the water from the interior of the Panga pit [4].

The geometry of the open pits, with the final margins, which were largely completed, were achieved with the adoption of safety measures that took into account the effects of the exposure of the slopes to the atmospheric factors, the decrease in time of the shearing resistance of the rocks following alteration, decompression, reduction of geological load, cracking, drying, etc. [9].

In Panga open pit (case study), the excavation of important rock volumes, with thicknesses between 40-150 m, to the bottom of the pit, represented by the bed of the layer no. V, results in an obvious asymmetry in the direction EV, with heights of about 120 m in the eastern part of the slopes. The slopes in the northern area will have general angles of 11-12°, and those in the east and west, 14-15° [4].

The inner dump consists of 6 steps, with a total height of 105 m and a general slope angle of 6 - 7°. Between the coal crushing area and the inner dump there is a 150 m flat area. The overall angle of the inner dump in this area is of 10°, at a height of 80 m above the ground. Between the working steps of the dump there are flat areas with dimensions of 100 - 110 m.

By location, the quarry and the external dump represent cases of anthropic relief inversion. Anthropic relief forms are characterized by the fact that they are forms of destruction (quarrying) or accumulation (waste dumps). They feature relief elements characteristic of natural shapes such as bridges, edges, foreheads and have extremely varied dimensions, from punctual and local to zonal. They depend on the morphological features of the natural relief category in which they have been introduced. After their formation, they remain in the natural mode of shaping and behave like any relief form created by the action of natural agents [7].

3. Types of impact

3.1. The impact on soil

The impact of changes in the geomorphology of the Berbeşti mining area is manifested by loss of soil (where no protective measures are taken) from the mix of it and storage with waste rocks from excavations in the early stages of the preparatory work. The protective measure applied is the recovery of fertile soil from the agricultural and forestry areas occupied by the open pit and the external waste dumps [4].

The open pits and exterior dumps are close to the final configuration, and so, the annual quantities of recovered soil are small [5].

The protection of the stored soil quality until its reuse is achieved by fulfilling certain conditions, such as:
- not to be subject to degradation due to precipitation;
- not to be subject to degradation, contamination, alteration, impurities caused by harmful substances;
- not to be subject to degradation by mechanical actions of leveling and compacting;
- not to be contaminated with products of geological nature;
- the surface of the deposit can be cultivated or covered with vegetation;
- construction of leaking slopes and rainwater drains [6].

The exploitation and dumping activities, conjugated in some instances, with the effects of underground mines, produces changes in the quality of soils and their physical and chemical equilibrium by generating slides, or surface erosion. The problem lies mainly in the northern part of Panga quarry and the dump area, where in 2009 there was a landslide, stabilized by specific works [9].

"In situ" actions to stop the expansion of such phenomena are permanent, along with specialized studies to elucidate the causes, better knowledge of the geology of the slopes and the foundation, the settling and stability of the waste dumps [7].

A source of soil pollution, disturbing its physico-chemical balance, is the whole of the complementary works to exploitation of coal, especially the surface ones, from which we mention:

- prospecting and geological exploration activities;
- land preparation activities, such as deforestation, diverting water courses, access roads, roads and railways, parking;
- waste disposal activities, spare parts, machinery, coal;
- excavation activities for construction of sewerage, water supply, electrical networks;
- designing the pathways of the conveyor and distribution lanes, of the access ways, of the parking lots;
- diverting of water courses, construction of dams, surface drainage, drainage by guard channels;
- activities for the repair of mining machinery and equipment;
- the transport activity;
- storage of fuels and lubricants and their handling [6].

The activity of excavating, transporting and storing coal and sterile is the sedimentary dust generator, whose presence in the soil is beneficial under certain concentration limits [7].

Appropriate organizational, exploitation, transport and warehousing measures within Berbeşti Mining Exploitation can limit the effects of soil degradation.

Human (dwelling) or industrial related activities resulting from the development of mining in this perimeter or adjacent areas have negative effects on the soils in the area (dwelling and social constructions, roads, sewerage, storage, maintenance - repairs) [3].

3.2. The impact on the climate

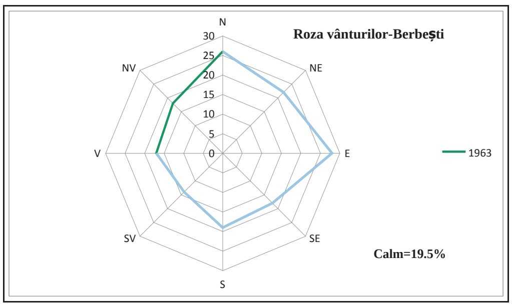
The geomorphological changes in Berbeşti mining basin is a source of pollution of the atmosphere almost exclusively with sedimentary dust and dust dispersion thus having an impact on air/climate.

Excavated rocks, mostly friable, with low mechanical strength, to which low humidity can be added, especially in the warm season, lead to the formation of sedimentary dust [4].

Air quality is mainly affected by technological processes in the open pit, in the dumping site and coal deposit, and leads to an increase in certain points of the mining perimeter and at certain times of the concentration of gases, smoke, dust from the motor vehicles, combustion processes etc. [5].

Compared to 1963, the 2017 winds direction (Fig. 4) show a domination of the wind frequencies of 8.7% from the south-east compared to the north, north-east as it was in 1963, when the relief was unchanged, with intact slopes. The current wind regime influences the dispersion of the dust, its sedimentation causes the occurrence of the mounds, the cones, plus geomorphological processes and phenomena on the dump and open pit [2].

The current macro and micro relief modify the thermal, pluviometric and wind regime through the diversity of the slopes, the shape of the slopes, the vegetation by the way it covers the relief, the soil through the color, the texture. All this require a current microclimate different from the one encountered before the exploitation of the lignite in the Berbeşti area [2].



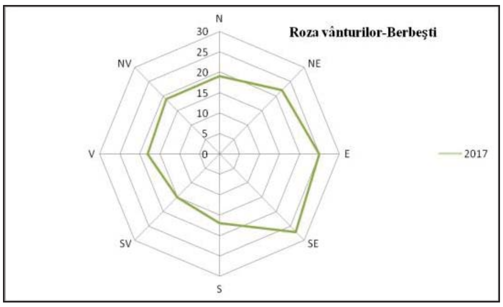


Fig. 4. *The wind regime in Berbeşti area - 1963 versus 2017*

The most important particulate matter emissions occur in the phases of excavation and dumping of tailings and coal, including transport, crushing and loading in wagons [5].

Emissions were assessed using AP - 42/98 emission factors and taking into account the maximum production capacity estimated at 46 mil. cm/an.(Panga open pit) [2].

Under these conditions, particulate matter emissions have the following values:

- excavation (coal and sterile) 124 t/year;
- conveyer transportation 1906 t/a;
- sterile dumps and coal handling 375 t/y. [2]

In addition to these emissions, particulate emission can be mentioned due to the operation of the equipment and the means of own transport and leased in the mining perimeter. For vehicles and means of transport, the annual consumption was estimated at 250 tons. Thus, exhaust emissions into the atmosphere through exhaust gases and pulverization from quarry and access roads, estimated using AP - 42/98 emission factors and the COPERT program are as follows:

- suspended particles 5683.0 k /year, 0.6580 g/s;
- SO 2041.0 kg/year 0.2360 g/s;
- NO_x 58.0 kg/year 0.0660 g/s;
- CO 142.0 kg/year 0.0160 g/s;
- COVnm 15.6 kg/year 0.0018 g/s [2].

Emissions are small, with strictly local effects within the mining perimeter, where STAS 12574/87 "Air in Protected Areas" does not apply and their impact can be easily neglected from the one produced by the productive activities themself [3].

The previous measurements made by ICIM Bucharest in M.E. Berbeşti highlighted that the maximum recorded values are met in the immediate vicinity of the equipment, and at distances of about 100 m they fell within the boundaries of the area [2].

It has been found, however, generally that the average concentrations have always been in line with the legislation in force. We can also mention the phenomenon of self-ignition of coal, which, when produced, is accompanied by emissions of carbon monoxide, sulfur etc. [4].

It can be said that the geomorphological changes have local influence through the dispersion of dust and dust emissions. The evaluation of the effects of the pollutants emitted in the Berbeşti mining basin was done by mathematical modeling of the dispersion of the pollutants. Input data of the model include the calculation grid, emission data, meteorological parameters. The obtained results (ICIM Bucharest) are presented in Table 1 [2].

Table 1. *Particle concentrations in air in Panga open pit (source ICIM Bucharest)*

Source	Pollutant	$C_{med.}$ anuală ($\mu g/m^3$)	CMA anual ($\mu g/m^3$)	$C_{max\ 30}$ min ($\mu g/m^3$)	CMA_{30} min ($\mu g/m^3$)
Excavation	Particles	46	75	270	500
Transport on conveyors		65	75	380	500
Sterile charging + coal		165	75	930	500
Total productive activities		208	75	1130	500

The assessment of atmospheric pollution levels was made in relation to the maximum allowable concentrations (CMAs) provided in STAS 12574 - 87 "Protected Air".

From the above data, it is clear that the STAS 12574-87 provisions are fully complied with in areas outside the open pit and external dumps.

3.3. Assessment of the impact of geomorphological changes on flora and fauna

Flora suffers an impact generated by geomorphological changes characterized by:

- modulation of microrelief and macrorelief, the emergence of positive, negative relief forms and hence the negative impact on the local ecosystem;
- destruction of natural flora and fauna as a result of soil removal activities;
- diminishing the forest fund by deforestation in the area of the open pits and exterior dump sectors and the complete disappearance of forest ecosystems on these areas;
- diminishing wood exploitation from the forest fund, even after the ecological reconstruction of the areas;
- diminishing the balance of the predominant ecosystems in the area, the productivity of the ecological systems or even the disappearance of some associations;
- reinstallation of vegetation on dumps in a fast system, a few years, but with modified structure (Fig.5).
- rehabilitation of natural vegetation with associations of species characteristic of the area over long periods of time [4].

Fig. 5. *Consolidation of the inner dump from Olteţ with stone walls, reinstallation of the forest vegetation with modified structure*

The impact of geomorphological changes on fauna is manifested by:

- the topographical, local morphological change, and the ecological restoration is lasting and with other faunistic components;
- lips of wealth of species and individuals, of invertebrate fauna;
- ecosystem imbalances through the disappearance of key faunistic groups, species, numerical reduction of individuals due to stress factors;
- migration of terrestrial reptiles and amphibians in areas neighboring exploitation;

- modification of the area of typical birds, especially hatching, away from the area of exploitation;
- reducing the population of mammals to zero in the area by removing them to neighboring areas to the mining field, with the same characteristics of the ecological niche [2].

The quality of the environmental factors of vegetation and fauna is primarily affected by a severe ecosystem imbalance caused by total disappearance, migration or reduction of the number of individuals of the vast majority of species in the mining perimeter under exploitation [7].

4. Impact assessment

Impact matrices consist of dual input tables, in which the analyzed environmental components, divided and grouped into categories, are enrolled on the lines, and the columns show the elementary actions in which the project activity was decomposed [7, 8].

Each matrix cross (at the intersection of the column line) represents a potential impact relationship between the factors of the project under discussion and the factors of the natural environment (potential impacts).

Matrices play an important role because they are an immediately understood and repeatable way of organizing information when impact assessments are made, but they are rigid and oversized for some aspects and undersized for others [7, 8].

In general, more commonly used are quantitative matrices, which have the purpose of evaluating, by means of a numerical score, both the individual impacts for the components of the project, and the overall impact of the project, and are constructed by assigning to each crossing point a numerical coefficient expressing the importance of that interaction with each other. In this case, matrices become operational tools of the analysis and assessment phase of impacts [2].

The matrix shown in table 2 comprises 11 horizontal lines in which the main environmental components of the area affected by the geomorphological changes are specified, the last line being calculated the cumulated impact of the changes on the environment. The contiguous matrix and 10 columns in which the main geomorphological changes are specified [2].

The global assessment of the environmental impact produced by the geomorphological changes in Berbeşti was done using a geomorphological modification impact assessment matrix tailored to the specificity of the lignite exploitation activity in Panga open pit [2].

In the impact matrix we have noted on the columns the most important geomorphological changes and phenomena in the Berbeşti Basin: dumping, quarrying, erosion, slides, sediments, ravens, suffusion, creep, and on the lines the environmental components affected by the processes: geomorphology, the soil and the subsoil, the surface and deep waters, vegetation, fauna, ecosystems and local communities. The waste dumps modify the geomorphology on large areas of land by the emergence of positive topographical forms, by diversion of land from initial uses, by visual impact, by the high costs of land rehabilitation, by increasing the level of stress of the local community [2].

The open pits have a major impact on the landscape through the emergence of negative relief forms, on morphology through the risk of accidents/rock fall, visually on the landscape, on the water, it leads to the formation of quarry lakes, the shrinkage, the increase of the quantity of evaporated water, the appearance of palustrian vegetation, the disappearance of fauna, the emergence of new ecosystems, the risk of drowning for the community, the modification of microclimate [2].

Landslides have a major negative impact on local landscape and geomorphology by altering topography, soil modification, local geology, large material and human damage, ecosystem damage, destruction of water-air-nutrients balance in soil, photosynthesis, plants, CO_2 growth in the air, greenhouse effect [2].

The soil is affected by the removal and deposition of sterile. Local vegetation and fauna have almost disappeared due to the appearance of the pit (the forests have been grazed, the wild animals have migrated to other places, lack of soil has led to the impossibility of installing some plant species). Geomorphology and landscape architecture have been profoundly modified; whole hills were excavated, watercourses disappeared; instead of valleys, real hills have emerged through the storage of waste rocks. The human population also suffered from the existence of the open pits: houses were demolished, residents were moved, villages were destroyed.

The rest of the geomorphological changes and phenomena have a local impact, especially in the open pits, being associated with the relief unit, the geology, the slopes of the area, the design type, the excavation, the dump, the meteorological phenomena, the appearance of the local topoclimates, the local ecosystems, ecological reconstruction [2].

The advantage of using the matrix is the fact that the local geomorphologic changes are made with the environmental factors and conditions existing in the mining perimeter and the surrounding impact area, at the present and future of the activity, but also with the mining activities and those related to the mining activity [7, 8].

Within the Berbeşti mining basin, the excavation and dumping activities were considered as specific and also the most important in the exploitation as a whole, and as related activities the preparatory, topsoil removal, geological investigations, industrial support activities, water evacuation activities, land recovery, households displaced [2].

However, the presence of environmental protection and ecological remediation actions, in the general exploitation activities, has the role of limiting the negative environmental impact, in time and space, of permanent control of the produced effects, and ultimately, the repairing role of environmental conditions, damaged by mining activities, with the improvement of the living conditions of the local population [7].

Table 2. *The impact generated by the geomorphological changes from Panga open pit over the environment*

	Dump	**Open pit**	**Erosion**	**Land-slide**	**Subsidence**	**Gullies**	**Suffusion**	**Falls**	**Torrent**	**Creep**
Geomorphology	5	5	3	4	4	3	3	5	5	3
Landscape	5	5	3	4	3	2	3	4	5	3
Soil	5	5	4	4	5	3	3	5	5	4
Subsoil	3	5	1	3	1	0		5		
Surface water	2	2	1	1	1	0	1	0		1
Underground water	2	3	0	2	0	0	0	0	2	p
Vegetation	5	5	4	4	3	2	3	4	4	1
Fauna	4	4	1	2	2	1	1	1	1	1
Ecosystem	4	4	4	5	1	1	1	3	2	1
Communities	2	2	2	4	1	1		3	2	p
Total	3.7	4	2.3	3.1	2.1	1.3	1.5	3	2.6	1.4

0 – impactless; 1 - minor impact; 2 - moderate impact; 3 - strong impact; 4 - very strong impact; 5 - degraded environment close to the ecological disaster; p – positive impact.

5. Conclusions

The environmental impact of geomorphological changes is significant, inevitable and irreversible, with effects on aquifers, water and air quality, natural mineral resources, soil and subsoil, climate, geomorphology and landscape, land use, related industrial activities, human collectives and dwellings.

Running on a large surface and having a duration of tens of years, the impact is even stronger as the affected environmental factors do not have the possibility to return to their initial state. The effects are local or regional, both on short and long term, cumulative, being generated over the entire exploitation period. Even after the cessation of activity, an important period of time will be required for the area to establish a certain complex ecological balance.

The main forms of impact caused by the geomorphological changes of the Berbeşti Mining Basin are:

- over land: land degradation, morphology degradation, risk of rock detachment and landslides, destruction of cultural assets, occurrence of waste dumps;
- over the air: noise, vibrations, dust caused by traffic and wind, smog and smoke from self-ignition of dumps, noxious gases, potential changes of microclimate;
- over surface waters: degradation of nutrients level (eutrophication risk), wastewater pollution, pollution due to erosion intensification;
- over groundwater: reduction of hydrostatic level, deterioration of underground water quality;
- over the ground: grubbing up of exploitation perimeters, loss of agricultural crops, soil drying, risk of landslide by local restoration of hydrostatic level, erosion;
- over flora: total destruction in working areas, destruction or partial alteration in adjacent areas as a result of lowering the hydrostatic level;
- over the fauna: the migration and/or disappearance of the fauna;
- over the human community: conflicts over land use, displacement, destruction of settlement zones.

The land areas are generally affected by: the modification of the topography of the area due to excavation at deep depths as well as the deposition of significant amounts of tailings in the waste dumps, the two elements representing cases of anthropic relief inversion, dust discharges into the atmosphere and deposition on soil, mainly generated by mining, coal and tailings transport, storage and handling; changes in surface water quality - suspensions, metals, organic substances - through the discharges of quarry and household waters; combustion gases and particulate matter emissions from solid fuel thermal power plants and local car transport; soil damage as a result of the location of coal and tailings deposits, the realization of all industrial constructions, and the uncontrolled disposal of waste, materials or equipment.

The local geological structure, including the underground aquifers, alters the initial physical and dynamic physical and dynamic conditions due to excavations at depths of hundreds of meters as well as the replacement, after the cessation of exploitation, of native rock masses with excavated tailings dumps, where the configuration and geological structure of deposits are different.

Geomorphological changes have an impact on the environment by excavating the mining mass and storing the tailings in the waste dumps, by the black color of the coal in the generally green landscape, local damage to vegetation and fauna, changing the groundwater regime and aquifers, exposing the area to uncontrolled land use, affecting local communities.

Also, the danger of further slippage of the dumps adds a prospect of degradation of new soil surfaces. The indirect action of industrial activities related to mining causes the erosion to increase the vulnerability of the soil.

Another activity with major anthropogenic impact is the de-forestation and the destruction of the vegetation cover that have resulted in the destruction of some species or the migration of others to areas that would ensure the living conditions and the climate characteristic of the species concerned.

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