THE MINING RISKS AND THE LANDSCAPE IMPACT ON THE REGIONAL SYSTEM OF THE APUSENI MOUNTAINS

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ABSTRACT. - The mining risks and the landscape impact on the regional system of the Apuseni Mountains. A region can be considered to be critical, when inside of it can occur or it is likely to manifest imminent risk factors (natural or anthropogenic), possibly triggering some risk phenomena that may have negative consequences and can disturb the functionality and the dynamic equilibrium state of the territorial system, the Apuseni Mountains can be included within such a category, that is the critical regions. In the Apuseni Mountains regional system, act or have acted (with obvious traces present) a number of risk factors that have left their mark on the geographical landscape and especially on its functionality, jeopardizing the viability of the territorial system itself and its future development. These factors are either natural or anthropogenic and their effects will be analyzed further, identifying risk phenomena that they cause and the landscape impact.

Key words: mining landscape, critical region, quarry, heap of debris, ponds, Apuseni Mountains.

1. INTRODUCTION

In the economical development of the Apuseni Mountains, three major actions have stood out, in general, with a great impact on the regional system. It is about the *exploitation of the useful minerals* (primarily gold and silver ones), about *wood exploitation and capitalization* and enhancing the *value of the grasslands* (pastures and meadow) to support livestock.

Mining and metal working are among the oldest activities in the area, while still dating around 1000 BC (V. Pârvan, 1926, cited by C.N. Boțan, 2010), have known over the time some variations of intensity so that three periods of intense exploitation can be identified: the Roman period, the period between 1740 and 1989 (Habsburg and Great Romania) and the period after 1948 (communism) (C.N. Boțan, op. cit., Magdalena Drăgan, 2011).

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At the present time most of the Apuseni Mountains mining exploitations have stopped, the mines were closed and the infrastructure was maintained intact. But the effects of this activity on the regional system are multiple: from changes in the components of the natural landscape, a very important transformation of the water quality, generation population flows towards and from the system, mono specialization settlements, high unemployment, increased emigration, particularly young people and adults, emphasizing of the depopulation phenomenon etc.). Many of these issues reveal a critical point of the system, so those will be reviewed in the following.

2. DATA AND METHODS

The research fulfilled within the present study was centred on highlighting the critical conditions which generate dysfunctions and risks induced by mining. During the former stage, a series of field observations were conducted, for the period 2010-2014, which enabled a comparative analysis on the evolution of the entire regional system of the Apuseni Mountains as well as the diachronic interpretation of landscape dynamics under the anthropic factor. The following stage was based on data and information processed in a series of reference works, guidelines for the study area, whose complementary character completes the performed analysis. The field of investigations and research methods have been gradually focused on the analysis of the geographical components undergoing transformations and structural-environmental remodelling. The identification of spatial relations and systemic cooperation raports was made on account of direct observations and use of GIS techniques.

3. RESULTS AND DISCUSSION

3.1.Mining risks – typology and impact

The conducted study aimed at emphasizing the main types of risks induced by mining, with direct or indirect manifestation on the components of the Apuseni Mountains regional system.

***The impact on the relief*.** A first impact generated by the mining activity on the mountain landscape is represented by the emergence of a anthropogenic relief subject to geomorphological risks. Paradoxically, with the introduction of the modern technologies of metal extraction, which meant the transition from the underground mining exploitation to the ones in the quarries, the effects on the environment and especially on the relief, amplified. The quarry exploitation proved to have a major impact on the geosystem (Magdalena Drăgan, op. cit.), with direct consequences on local and regional landscape structures. The most obvious traces left in the landscape, which are presented as a genuine anthropogenic relief, are:

- – *quarries,* which by transferring a huge mass, turning a positive landform into a negative one, generating inversions of landforms and intense degradations of land in the vicinity; for example the Valea Morii quarry (Brad exploitation), opened in one of the Valea Morii slopes, creating a horseshoe-shaped excavation making the slope around unbalanced because of the mass transfer. On this slope gravitational processes (landslides, landfalls) and accelerated erosion started happening (S. Duma, 1988); often the quarries occupy large areas, such as those in the Roşia Montană and Roşia Poieni (351 ha) mining sites (fig. 1); inside the quarries perimeter the current landform modeling processes intensifies (areolar and depth erosion, separation of material masses on the slopes) (V. Gligor, 2005).

- – *the heaps of debris* (as positive pseudolandscape forms), on which, if they weren't stabilized, very often surface and depth erosion processes and/or gravitational processes started happening (landslides and landfalls); in the Mușca exploitation complex, the heaps occupy an area of approx. 290 ha (O.L. Munteanu et al., 1998); the 3 heaps of debris from Roşia Poieni exploitation had an inclination of about 37-42°, while the maximum allowable stability angle for such heaps was 28° (S. Duma, op. cit.); this makes heaps stability to be very low (fig. 2); also, the water coming from rains, running on the heaps surface, can reach the ground

Figure 1. Poieni quarry (E.M. Roșia Poieni)

Figure 2. Valea Verde heap of debris.

or into the river surface or depth flow, polluting them; inside the Roşia Poieni perimeter, the waters flowing on the strongly acid heaps, are loaded with heavy metal ions (Cu, Fe, Zn) and suspended solids well above the permissible limit (Vătăjelu et al., 2005, cited by Camelia Costan, 2010), therefore Steregoi, Cuibarul, Muntari and Şesei streams are heavily polluted throughout their flow;

– *the ponds*, sometimes with large areas: Valea Şesei ponds (fig. 3) Valea Şesei pond) from Roşia Poieni complex covers an area of 97 ha, plus two smaller ponds (on the Valea Ştefancei); with the possibility of technological risks (broken dams or other accidental spillage) the waters in these ponds may affect the hydrographic network, soil, biotic and human communities downstream or in the proximity;

Figure 3. Valea Şesei pond

Figure 4. Tăul Mare (S=3,8 ha)

– *the artificial lakes*, the water was used in the stamp works – Roşia Montană there are 69 excavations of this type (named „tăuri") which currently only 9 are filled with water, the remaining 60 being drained; of these, only Tăul Mare (fig. 4) is polluted due to water leakage from Cuibaru heap of debris, which belongs to the copper exploitation Roşia Poieni (Camelia Costan, op. cit.);

– plus *other infrastructure works*, such as buildings and communication routes (processing plant, technological roads to access the quarries and heaps, pipelines, roads, railways etc.) and **hundreds of kilometers of tunnels and galleries** build for prospective and productive purpose during the exploitation periods (all together they sum 150 km at Roșia Montană) (Magdalena Drăgan, op. cit.); the last ones are vulnerable to collapse, with the risk of the surface relief to be affected.

In the case of the anthropogenic landforms from the mining areas, geomorphological risk phenomena can occur as a result of specific gradient slopes (slopes greater than 12 - 15 °); so are: the cornices of exploitation quarries (Roşia Poieni, Cetate quarry – Roşia Montană); slope heaps (Valea Verde, Obârşia Muntari, Geamăna, Valea Cuibarului), crumbling cones within Afiniş Mine perimeter (Baia de Arieş) (Camelia Costan, op. cit). The geomorphological risks that may occur within the mining perimeters are many and varied: area erosion, torrents, separation of materials from the slopes of the heap of debris (fig. 5), landslides, deflation on the heaps that have no vegetation, gravitational movements such as landfalls, collapses, rollings and material flows on the exploitation steps of the quarry (fig. 6), subsidence processes, compaction and local cracking (V. Gligor, op. cit.).

Geomorphological processes that occur in mining areas (especially collapses and landslides) may affect the localities in their vicinity (Camelia Costan, op. cit.).

All this dynamic and the relief transformation can cause a rupture of some equilibriums and the possibility of geomorphological, hydrological or technological risk phenomena to happen. Thus, during mining activities, there is a

risk that the working surfaces of the quarries to collapse, as a failure to comply with the technological parameters imposed by the exploitation method and by not doing the daily check by its specialists.

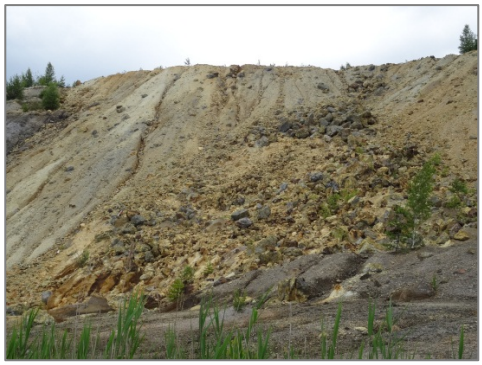

Figure 5. Gully erosion processes, alteration and gravitational movement - Valea Verde heap.

Figure. 6. Rolling and material flows on the exploitation steps of the quarry.

In the case of the ponds there is a risk of spilling over the dam or the occurrence of cracks in the dam due to a blockage of the decantation system, but the biggest risk that ponds and heaps of debris may have on settlements, with catastrophic consequences on population and on the environment is their collapse, for various reasons (slope collapse, damaging to the main pipes, damage by erosion etc.) (Veronica Constantin, 2011). In case of nonfunctional ponds (Valea Cuții pond, Valea Săliștei pond, Brăzeşti pond, Valea Sartăşului pond), due to failure to comply to rules of heap disposal, small lake accumulations have formed in the superior rough terrain or in area where the bordering slopes and heaps connect. These lakes fed by water from rainfall and coastal springs, threatens the possibility of triggering landslides, if the water will eventually infiltrate in the mass heap (V. Gligor, op. cit.).

The impact on the hydrographic component. The second major effect of the mining and ore processing activities has on the natural environment is the pollution of water, considered to be the oldest ecological problem of the region. During the mining activities, the mine waters[2], the industrial waters (technological or from

[2] The groundwater in their passage through the minerals accumulation, is charged with metal ions and are characterized by an acidic pH; after the mining activity the water is discharged to surface forming the mine water (called ”galiţe”). These waters "depending on pH, were classified in acid, neutral and alkaline waters. Out of these, the acid waters have most advanced level of contamination because its acidity or free sulfuric acid. The acidity is due to the oxidation of sulfur compounds contained in

factories, used in the processing factories), the waters from ponds and also the contaminated water from quarries and heaps of debris have consistently shown an acidic pH and exceeding high or very high (sometimes hundreds and even thousands of times) than the norms allowed to a series of water quality indicators (suspensions, TDS, sulphate, heavy metal ions like Fe, Cu, Pb, Zn, sometimes Mn, cadmium and cyanide, which is the most toxic component)[3]. These waters have always reached the main collectors – rivers that pass through the area – often treated poorly, generating a steady and lasting pollution of aquatic ecosystems. It is mentioned, the Arieş river pollution due to spilling of wastewater or partially treated waters, which led to the disappearance of aquatic life. „In the Arieş river the first aquatic life forms appear only after the aeration process of waters from Moldoveneşti" (S. Duma, 1998, p. 244). Also, by aggregating spilled pollutants from Roşia Poieni, Roşia Montană and Baia de Arieş, the Arieş river has become one of the most polluted rivers in the country. In the same context are reported to be the „shock dose" pollutions of 1972 and 1978, when by extinguishing the fires from mines[4], waters with a very acidic pH and with huge loads of metal ions were spilled in the Arieş river, generating a catastrophic pollution of the Mureş river (id. ibid).

But the same effect on the fish fauna, leading to its disappearance was noted in other rivers of the mining areas. The presence of Fe in very high concentrations in the Abrud river (fig. 7) let to „reduction of the number of the biological species to extinction, becoming a river characterized by a permanent ecological destruction" (R.H. Bătinaş, op. cit., p.176); we can also mention Roşia Valley from Roşia Montană, Almaş stream from E.M. Zlatna, Crişul Alb from Brad area, Certej at Certej-Săcărâmb exploitation. Ampoi river, downstream from the Zlatna industrial platform was degraded not only chemically but also biologically, being in a biological destruction phase on a distance of about 10 km downstream of Zlatna, its waters cannot be used in any way (L. Dimén, 2005). In some cases, surface waters started to pollute by infiltration, the groundwater levels, affecting water quality in wells that have become undrinkable; at the same time, the possibilities of using the river waters for casual and domestic use were limited.

To these spills and current pollutions, are added in certain situations accidental pollutions. Thus, for Arieş river are mentioned in the 1997-2002 literature, 26 such accidents (of which 14 only for Valea Şesei pond from Roşia Poieni exploitation)

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rocks and ores through which water passes highly oxygenated, but the waters passing through the oxidation of pyrite as it forms sulfuric acid present the most acidity" (R.H. Bătinaş, op. cit., p. 207).

[3] The presence of Fe and Cu ions in wastewater is determined by petrographic constitution in the exploitable deposits from the mining area, but the high concentrations in which they occur is because the discharged treated wastewaters are not treated enough in the treatment plants (mechanical and chemical).

[4] Mine fires, common during the Baia de Arieş exploitation, were produced by self-ignition deposits due to high lithostatic pressure (S. Duma, op. cit.).

due mainly to damage suffered by the transport pipes of sterile to the ponds or at the treatment wastewaters stations or due to damaging to the discharging of treated waters from ponds (inverse probes) (R. H. Bătinaş, op. cit.). In addition to anthropogenic causes often occur the weather conditions causing further damage and increase pollution (Camelia Costan, op. cit.). The result of increased amounts of precipitations, the acid water level is increased in ponds. Causing their discharges above the sterile point deposited and increased flow from the ponds.

Figure 7. Spills of acid waters in the confluence sector Abrud-Arieş (2014)

A special situation regarding the water quality, stands at Roşia Montană, respectively Valea Şesei pond, which is one of the largest mining remnants deposits in the country. The waters that wash Cuibarului and Geamăna heaps of debris, having a very acidic pH and high concentrations of metal ions, reach the pond, making the clear waters discharged from pond acidic (pH 2,3-3,1); these waters are then discharged into Aries, damaging its quality (R. H. Bătinaş, op. cit., Magdalena Drăgan, op. cit.). The National Pollutant and Polluter Inventory (NIPP, quoted by Veronica Constantin, 2011), a series of ponds and heaps of debris from the mining areas in Apuseni Mountains are referred to as water pollutants (for example Valea Seşii, Valea Ştefancei, Valea Săliştei ponds; Geamăna, Valea Verde heaps of debris etc.).

Pollution due to mining activities it is kept for long periods of time in the hydrographic basins which are affected (Cecilia Roman et al., 2006). Often it is considered erroneously, that when mining activity ceases, pollution also disappears. But the abandoned and closed mines, may contain large quantities of high metal waste, which, after flowing or rain water drainage are retrieved and returned in the aquatic circuit (id. ibid.). In the present, several years after the mines were closed, can still be observed increased water pollution. The Arieş river water continues to be polluted by the waters from the ponds, as well from the precipitations, which are running over the heaps of debris.

The impact on air quality.*Air pollution* has been a serious problem during the mining activities and functioning of the metallurgical plant in Zlatna. The main pollutants released into the mine and quarry air or in the area of industrial sites, were

SiO_2 powders that have affected the health of workers and local residents, the silicosis cases were frequent; then were added the aerosols of floatation reagents, the most toxic ones were the sodium cyanide and sulfuric acid aerosols (S. Duma, op. cit.). Following the activities from the metallurgical industry large qualities of SO_2 and powders of heavy metal oxides were released into the atmosphere; in combination with the atmospheric humidity, they form the acid rains and fogs, which are extremely damaging to vegetation and soil (Magdalena Drăgan, op. cit.). Zlatna area was very polluted with SO_2 and therefore, is an area with many acid rains (L. Dimén, op. cit.). In Zlatna depression before closing the SC Ampellum SA Zlatna plant, which was the main polluter, there were frequently recorded exceedings of maximum allowable concentration of sediment powders, the pollution was made by heavy metals (Cu, Pb, Cd) (ADR Centru, 2004, cited by Magdalena Drăgan, 2011). The area, although attractive in terms of landscape, was avoided by investors and tourists and the locals migrated to plains (S. Duma, op. cit.).

It is obvious that with the cessation of industrial activities from all environmental components, the air is the one that is least affected. Therefore, from this point of view, Zlatna depression, currently deals only with the remaining environmental stress during the maximum activity of the factory (L. Dimén, 2005).

The impact on the edaphic component. Another serious problem that the region is facing is the *soil pollution*. In the mining perimeters, the soil was removed by scraping or was covered by heaps. The heaps of debris are causing chemical pollution to the edaphic shell around them, following erosion processes (rain-wash, gully erosion) that take place on their surface. Also, soil pollution in the heaps area, is due to the waters that contain heavy metal ions, particularly copper and iron and their acid property, affecting an area of 1-2 ha at the base of the heaps (Ipromin, 1999, cited by Camelia Costan, 2010). In the Zlatna depression, the soil below the heaps of debris, and also the soil from an area of about 50 m around them, is compromised for a very long period of time, due to rain water infiltration into the heap's material and then due to the resulting acid compounds in the soil layer (L. Dimén, op. cit.).

Near the ponds, as a result of raising the groundwater level, swampy or soil salinization phenomena are observed, and due to too much humidity, because of the obstruction of the groundwater horizons, landslides occurred on the slopes (S. Duma, op. cit.).

Contamination of soils on the slopes near the quarries or in the meadows with harmful elements such as cadmium, copper, lead, zinc affects their productive potential, causing poor development of vegetative biomass. „ In the alluvial soils of Arieş meadow the presence of copper was noted, containing 300-500 mg/kg, which explains the low production on agricultural crops. Copper is taken in the alluvial soils of shallow ground waters or deposited with flood deposits” (id. ibid., p. 245).

In 1997, in the mining area Certej „50 ha of agricultural lands were clogged, exceeding 10-15 cm thick deposits, the soil quality being compromised in the long term" (id. ibid., p. 282).

In some cases, the affected areas are more extensive, such as Zlatna depression. Here, the soil was polluted by heavy metal accumulation, by SO_2 emissions and acid rains, making this area one of the most polluted in the country. After the data provided by ADR Center (2004, quoted by Magdalena Drăgan, 2011), about 12.800 ha of forests and agricultural lands are heavily polluted and 11.200 ha are moderately polluted.

One of the worst effects that the industrial acidifying emissions can cause, is the destruction of the soil organic matter, that can even lead to stopping the humification process (L. Dimén, op. cit.).

In addition to the direct contamination of the edaphic shell, that have as a result a long term destruction for agriculture and sylviculture, it can also be mentioned the loss of land due to quarries and building industrial platforms. It has been calculated that, for copper exploitation, in metal deposits with low concentration of copper, for each tonne of copper extracted, 3,2 m^2 (mining exploitation) and 27,62 (quarry exploitation) of land are removed from the natural circuit, which amounts to about 110 tons of rock excavated and processed to obtain a tonne of copper (Călina Ana Buțiu, 1999, cited by Magdalena Drăgan, 2011).

The impact on biodiversity. In the investigated area the anthropic activity exerted on the genetic resources, in order to increase the value of natural resources, determined a increased vulnerability in time of the ecosystems due to mining and agricultural activities and also the irregular extension of built perimeters, resulting in deforestations, habitat fragmentation and degradation of the environmental quality (V. Gligor, 2011).

The most affected by the action of the acid mining waters, heavy metals and sediments from the heaps of debris are the aquatic ecosystems, which due to the changing of their physico-chemical composition, may lose their specific habitats, leading to their disappearance (Eisler, 2004, cited by Camelia Costan, 2010). The forest vegetation was affected, primarily by massive deforestation and also due to dust powder deposits on the leaves, which reduced their growth rate, resulting in the phenomenon of *dwarfism*. The copper from the soil is taken up by plants, preventing their normal development. In the Arieş meadow, the meadow vegetation and the one next to the ponds is underdeveloped. In the vicinity of the Zlatna metallurgical plant, due to toxic emissions, the forests and the herbaceous vegetation were severely affected until extinction, their restoration requiring time (S. Duma, op. cit.). The metals in the soil are absorbed by plants through their roots system and are accumulated in their tissues, from where are consumed by other links of the trophic chain, animals and humans. Through the process of

bioaccumulation, their concentration increases within each trophic level and can have long term effects on human and animal health.

The process of desalinization, minimizing the forest areas in the Zlatna depression is not due to deforestation in order to gain new lands or for wood exploitation, but it is due to the impossibility of natural regeneration or reforestation, as a result of environmental pollution with heavy metals, sulfur compounds, acidic pollutants etc. (L. Dimén, op. cit.). Under these conditions, the affected forest area doe to the drying phenomenon was estimated at 32.000 ha (id. ibid.).

The impact on human communities. After the evaluation of the environmental factors in the mining sector was found that in the case of a lot of mines (functioning, closed or abandoned) it is required a urgent rehabilitation of the mining project and the monitoring procedures of the environmental factors from the heaps of debris and ponds, in order to minimize the risks of disasters as much as possible (Veronica Constantin, op. cit.). Because in the mining perimeters of Arieş basin the exploitation fields are interfering with the human settlements, certain critical conditions can turn into real disasters, caused by the instability of the heaps of debris which threatens with landslides; for example Valea Verde heap of debris from Roşia Montană is located approx 450 m above Corna village (fig. 8) (V. Gligor, 2005).

One of the most serious ***technological accidents*** occurred in 1971 at the Certej-Săcărâmb mine, when a damaged suffered at one of the ponds determined a dam break and the sliding of the pile of debris from the ponds; the resulting slide advanced at such a great speed, that in a quarter of an hour, destroyed from the ground up, several buildings situated downstream at about 100-150 m, causing 89 deaths and considerable property damage, and the 300.000 m^3 of debris covered everything on of a 500 m radius (I. Petrescu, 1993, Veronica Constantin, op. cit.).

Figure 8. Inadequate location of Valea Verde heap of debris to Corna village center

Given the fact that for the ponds, a period of 15-30 years of environmental reintegration is required and 15-20 years for the heaps of debris (V. Gligor, 2005), it is easy to understand the risks presented by the existence of these elements in the Apuseni

Mountains for the local population and for the geographical environment. To all these changes to the natural components, the exploiting activities and mineral processing caused deep mutations socially, such as population displacement, monospecialization of some areas, unemployment rising due to ceasing the activity in the area massive migration of young and adult population, depopulation, thereby generating ***demographic*** and ***social risks.***

The presence of lead and zinc in the soil has the effect of reducing yields and the accumulated cadmium in great concentrations in certain crops can affect health. The radiometals (uranium, radium 226, radon 222 from Arieşeni mining area, Avram Iancu, Băița-Plai) found in the heaps and rocks are emanating radiations which determine a high risk on the population health (Bardan, N., 1996, cited by Veronica Constantin, 2011).

3.2.The impact of mining on landscape and aggressive destructive forms

Very often, in the case of mining exploitations, the industrial perimeter, including the processing plant, was built even during the mining activities, in an elements of ***aggression towards the landscape***. Once the activities have been suspended, the abandoned objective created a derelict appearance, with abandoned mines, heaps without any vegetation, toxic lakes, disused installations (Magdalena Drăgan, op. cit.).

Among the risks associated with mining, even after their closure, the most serious and with the highest negative consequences on the environment are: inadequate water treatment, heaps of debris landslide (especially since the heaps stability is low), acid water leakage from heaps of debris, damaging to the ponds (Camelia Costan, op. cit.).

Although we referred especially to the impact that the mining exploitation have had and continue to have on the regional system, we must also mention the exploitation of construction rocks which affect the landscape as well. The limestone quarries usually opened in the keys walls can affect the tourism potential of the area; Tureni quarry ending the Tureni keys, Poiana Aiudului quarry, although small compared to the attractive natural landscape, was an element of aggression on the landscape (Magdalena Drăgan, op. cit., S. Duma, op. cit.)

Although the exploitation activity and ore processing were largely closed[5], the pollution of the environmental components is long term, and its effects are still felt in time. Even after the selfpurification water process takes place, some rivers start to recover, such as Abrud river which is registering a steady reduction in the concentration of heavy metal ions (R.H. Bătinaş, 2010), the hydrographical network in the mining areas is still affected, showing exceeding levels above aloud

[5] The year 2006 marks the ceasing of mining activities in Apuseni, even though, today, to Roșia Poieni the exploitation of the copper ores restarted (Magdalena Drăgan, op. cit.)

limits for different substances. For example, for the river streams in Roşia Montană, the legal limit exceedings for chemical substances are very high: 1,3 times for cadmium, 5,2 times for arsenic, 73,6 times for iron, 96,3 for zinc (http://www.rmgc.ro/).

The ponds remained as potential sources of pollution, particularly harmful, although there were undertook a series of ecological restoration and consolidation works and are continued to be monitored by the authorities. At the level of the heaps deposits erosion processes took place that led to the gathering of large quantities of suspension materials in rivers, contributing to the deterioration of their quality.

Even after ceasing the exploitation, there is still a risk of changing of the air quality, in a negative way: matter particles and gases during the closing and rehabilitation activities are generated through excavation works, waste management, buildings demolition, setting up water treatment stations; in mining perimeters, the wind gathers even today fine particles from the ponds and from heaps of debris (Camelia Costan, op. cit.); radon and radioactive dust connected with uranium exploitation can be generated in the air as a result of reprofilation and relocation activities, or the handling of radioactive waste and soil, resulting in a serious problem in terms of radiation protection; the radon resulted from the uranium mines can migrate from underground to the surface through cracks or fractures (Veronica Constantin, op. cit). As seen, soil fertility and productive potential can be on long term compromised and affected vegetation requires a long time to recover.

Taking out from the natural and economical circuit of certain lands necessary for depositing the industrial waste, although appears to be temporary process, is equivalent in terms of sustainable development with the inability of using these lands for long periods of time because we have to take into account not only the planning stages (1-3 years) and exploitation (15-30) of industrial mining platforms but also the necessary time for re-ecologyzing and post-monitoring (15-20 years) (L. Dimén, op. cit.).

CONCLUSIONS

Even though the direct pollution sources have disappeared or have considerably decreased, restoring the ecosystems is slow, and sometimes the quality changes in the environmental components and landscape transformations are irreversible.

Given the fact that copper ore exploitations at Roşia Poieni were reopened and that there are three more exploitation projects of gold-silver ore in the Apuseni Mountains (the best known and publicized and controversial being the one form Roşia Montană), we believe that the facts presented above, in the attempt to show

the risks generated by these activities and the critical aspects they can induce, may draw a warning about the future of this region and the human communities that live here. Without special attention and without respecting the norms in state at the EU level, all these phenomena can be replayed and/or reactivated.

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