



## **Features of Environmental Issues Related to Abandoned Mining Exploitations in Albania**

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*Received September 23, 2016; Accepted December 16, 2016*

**Abstract:** Abandoned mining exploitations, which include all the workings, related to the mine opening, preparation and exploitation as well as all the consequences of the mining activity after its completion, require constant attention in order to avoid or minimize their damaging impact on both the environment and the human activity. Previous research has dealt with the methods related to assessment of the susceptibility, vulnerability and the geo-risk in the abandoned exploitations and has recommended concrete technical, administrative and constructive measures to deal with the geo-risk in urban planning and land use in order to provide an appropriate environment not only for humans but also for flora and fauna in general. The interest of researchers begins with recognizing the problem, continues with the involvement of influential factors in the building of the evaluation model and ends with the methodological recommendations that should be implemented to avoid or reduce harmful impacts. In this paper are treated the features of environmental issues related to the abandoned mining exploitations in Albania, taking into consideration the fact that they have not yet received the right attention to implement solutions in accordance with the current requirements and standards. From this point of view they constitute a major field where to explore for real answers that deserve attention in the framework of global solutions, as the environment is not just a regional and national problem, but a global one as well.

**Keywords:** *funnel, sinkholes, trough, sterile, abandonment, damage*

### **Introduction**

The intensive exploitation of mineral resources in Albania has been carried out from the '50s until the '90s of the last century, mainly regarding chrome, iron-nickel, copper, and coal deposits. The main method of exploitation has been that of open stops (Ceci, *et al.*, 1986), which has also determined the way of management of overall stability of openings, either through self-collapsing or through induced collapsing. The first method is used in the chrome mines where the developed tectonics was partly responsible for the quick collapsing of the rock mass while minimizing the rock burst. Whereas the second method is used in the iron-nickel mines aiming the stability of underground openings during the ore extraction and provoking later the collapse of surrounding rock mass in order to prevent the rock bursts. In copper and coal mines it was difficult to ensure the stability of underground openings, due to difficult geological and mining conditions leading to the immediate collapse of the surrounding rocks.

As a result of the use of exploitation methods leading to the collapse of surrounding rocks, the phenomenon observed is that of large displacements in the rock mass located in the roof of the mineral body. In many cases, particularly for shallow deposits, the underground exploitation has an impact on the ground surface in the form of funnels, sinkholes, subsidence or subsidence troughs (Muka, 1989; Zoto, 1987). Figure 1a illustrates a funnel in the chrome mine of Bulqiza, whereas Figure 1b illustrates the estimated subsidence curve (the dashed line) in the coal mine of Valias, Tirana. In the early 1990's, due to the political changes that took place in Albania, many mines were closed due to the lack of profitability. The first ones to be closed were the coal mines, followed by the most of iron-nickel mines. On the other hand the exploitation of chrome and copper, due to the unfavourable position in the market was drastically reduced. The common characteristic of all closed mines was their complete abandonment with no proper projects for mine closure. Even the geological and mine surveying documentation, which fully and thoroughly detailed the exploitation activity was never registered in

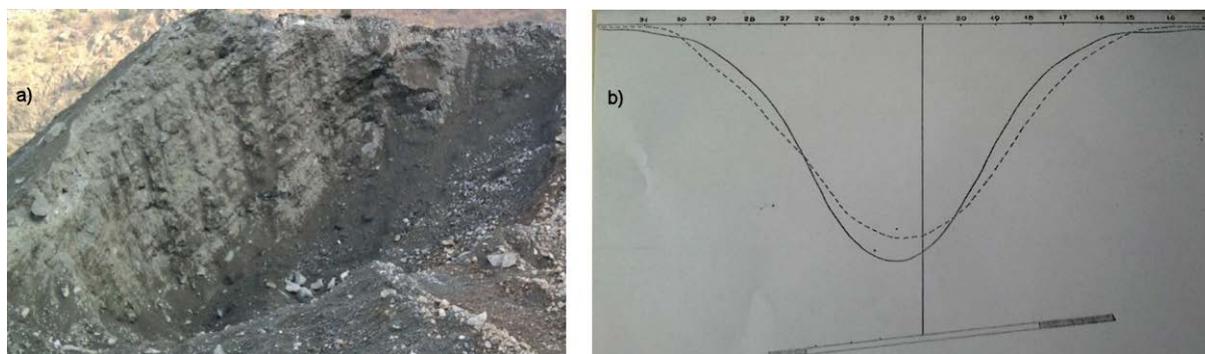
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compliance with the legal requirements, but it was appropriated by those who could lay hands on it. Such a situation gave way to a series of negative easily identifiable consequences because:

- Many serious accidents were reported because of illegal trespassing of residents through open entries to abandoned workings, while attempting to extract different usable materials such as: timber, rails, metal platforms, electrical cables, damaged wagons, etc.
- As the price of chrome and copper in the international market was higher during the period 2005-2006, (Gurra H., 2011) this increased the interest to exploit even those deposits, which were previously considered a technological loss. This new situation required the reactivation of the abandoned exploitations accompanied by an accurate, clear and complete description of their previous mining activity.
- Many of the old technological and operational facilities were reinstated and put to work. Therefore, there was a need for an analysis of their structural solidity and their relative positioning regarding potential implications of the abandoned exploitations.

As a result of these developments, and other events that are related to the re-urbanization of areas over abandoned exploitations, after the evaluation of their impact on the human activity, on flora and fauna, and for an effective land use, there is a need for a more detailed understanding and thorough identification (Muka, *et al.*, 2014).



**Figure 1. a)** Funnel on the soil surface, Bulqizë (Muka, *et al.*, 2014) **b)** Subsidence curve, mine of Valias (Zoto, 1987)

### **Problem presentation**

There is a vast literature (Meier G., 2015, *Environmental Risks of Mining*, 2016, etc.) dedicating specific consideration to the problem of mining impact and the damages inflicted on human activity (on people's life and on objects where they carry out their everyday activity) and on the environment (on the flora, fauna and their general habitat). Based on this, several recommendations are made regarding different methods on analyzing the mining damages (Meier G., 2015) and on assessing the mining environmental impact (*Environmental Risks of Mining*, 2016). In each case, it is required a thorough and complete understanding of the problem, which has its specificity due to the geological, hydro-geological, technical and mining conditions, the methods used for exploitation, the geological and mine surveying documentation, the monitoring methods and recommendations related to the impact assessment and rehabilitation of sectors affected for a more effective use. However, despite the vast experience in the field, its implementation depends on the specific ways different countries have resorted to while dealing with such a case. This article presents briefly some of the environmental issues deriving from the abandoned exploitations in Albania.

Such issues are encountered in:

1. The regionalization of mining areas;
2. The technology used in exploitation;
3. The country's level of economic development.

These three factors have brought about different reactions regarding the assessment of environmental issues.

### ***The regionalization of mining areas***

In Albania, the minerals of chromite, copper and iron-nickel are located in the mountainous regions. Figure 2 shows the regionalization of a chromite mine (Kalimash-Kukës).



**Figure 2.** Entry to the abandoned workings in the chromite mine of Kalimash-Kukës

The natural soil of these regions was characterized by sparse forestation (almost barren), mainly with pines. Alpine pastures were also present in the area. As far as the fauna is concerned, the area was populated by wolves, bears, fox, rabbits, and reptiles (snakes, lizards, etc.) There were also villages close by with a population of approximately 1000 inhabitants who were mostly involved in agriculture and farming. In spite of its recognized negative impact on the natural environment, the mining exploitation in the region was not opposed by the local population because:

**Firstly**, the land was nationalized and no one could raise ownership claims, even when the mine was supposed to be built in areas, which were previously privately owned. From mid '40s to the early '90s, the political system in Albania had sanctioned by state law the ownership on land.

**Secondly**, all protests were banned.

**Thirdly**, the inability to improve living standards through agriculture and farming, made it possible for the new activity to be regarded by locals as a good opportunity to achieve the needed standards. In fact, this expectation was achieved, because the agriculture and farming in the whole country remained underdeveloped.

Under these circumstances, the state was free to operate with no draft project regarding the impact on the environment the underground mining workings, sterile material dumpsites, and the construction of technological and auxiliary objects in mining areas. After the exploitation, all objects were left completely out of control constituting a major environmental problem (Muka, *et al.*, 2014).

The coal mines present a different scenario. In most cases these areas were close to the urban activity. Therefore, all projects regarding technological in situ objects, reserves of sterile materials, and the mining workings were drafted while taking into consideration the environmental impact. Nevertheless, even in these cases, after the cessation of mining activity, no measures were taken in eliminating or minimizing the negative effects of the abandoned exploitations on the environment (Figures 3&4).

### ***The mining exploitation technology***

As a result of the difficult economic situation in implementing its self-isolationist policy until the mid '90s, Albania's mining exploitation technology has constantly been outdated. All processes in the mining workings construction and ore exploitation were carried out with almost depreciated machineries. In such conditions the mineral storage and its transportation, were handled in complete disregard of the environmental impact. The basic principle in place was "effortlessness". Figure 3 illustrates the fact that despite being close to each other, the mining entries do not have a common waste rock storage, which would contribute to the decrease of the "affected" area in the natural territory.



**Figure 3.** Image of the abandoned exploitations in the chromite mine

#### ***The country's level of economic development***

Although the mapping of abandoned exploitations and their negative impact on the environment is completed, there is not yet a national project that would solve the problem by minimizing or avoiding the impact. This is a logical consequence of the low level of economic development. Even when it comes to tragedies when they occur due to the open entries in the abandoned exploitations, there is no real project in place that would seal them in compliance with the requirements. Figure 4 illustrates the entry that is 'formally' sealed. The sealing is referred to as 'formal', because with little efforts, a teenager might easily access the mine resulting in potential loss of human lives. There is also a lack of warning signs regarding possible hazards. In spite of the fact that there is an Albanian entity which is responsible for taking safety measures in the abandoned exploitations (Arapi *et al.*, 2014), such measures have not been put in place because there is a lack in investments regarding their drafting and implementation.



**Figure 4.** Image of the "sealed" entry of an abandoned exploitation

#### **The environmental issues**

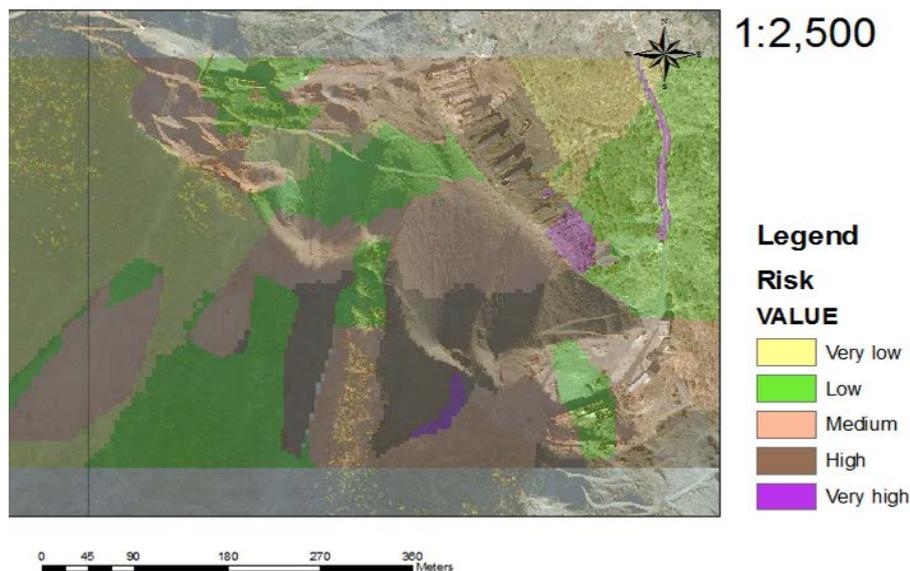
The environmental issues due to the abandoned exploitations in Albania are linked with:

- Movements of the rock mass above old underground mining exploitations;
- The presence of open entries at the abandoned mining exploitations;
- The presence of waste rock dumps;
- The presence of abandoned objects.

***Movements of the rock mass above underground mining exploitations***

This phenomenon takes different forms depending on the geological conditions, physical and mechanical properties of the rocks in the roof of the exploited area, as well as on the technical and mining conditions of the exploitation (exploitation depth, exploitable thickness, the size of the ore body, etc.) (Muka., 1989, Arapi *et al.*, 2014, Zoto, 1987). In the case of metal ore bodies (chromite, copper), the phenomenon is expressed in the form of funnels, sinkholes and landslides (Muka *et al.*, 2014).

At the current stage have been studied the conditions of stability of underground openings and their impact in the ground surface (Muka G., 1989), the assessment and regionalization of susceptibility (Muka G., 2016), determined the degree of vulnerability of buildings and other objects in vulnerable areas (Muka G., *et al.*, 2014) and is assessed and regionalized the geo-risk. Figure 5 illustrates the mapping of the geo-risk for the vulnerable area in the chromite mine of Bulqiza (Muka G., 2016). Despite these results, there is still no national mapping of the geo-risk regionalization, which would be used in drafting more efficient measures to avoid or minimize the dangerous impact and to rationally use the soil.



**Figure 5.** Mapping of georisk – southern Bulqiza mine

***The presence of the open entries at the abandoned mining exploitations***

The environmental issue in this case is linked with putting at risk the life of people and other living creatures because many open entries are not sealed (Muka, *et al.*, 2014). As such, they become easily accessible to people who are in need (people who want to extract materials as rails, wagons, ventilation tubes, timber used for roof or wall support, etc.), wanderers (such as shepherds or passers-by), young children or other living creatures that are not aware of the risk. As such, by accessing the working site, and sometimes due to any disturbance caused by them, the workings may collapse resulting in injury or death of the ‘visitors’. Accidents like this have happened (Botasot.info, 2013) and no preventive measures have been taken. Figure 6a illustrates the unsealed entries of an abandoned exploitation in the chromite mine of Bulqiza, while Figure 6b illustrates a ‘formally’ sealed entry in the coal mine of Krrabë, which has recently caused the death of two people (Cemeta, 2016). In the meantime, several attempts have been made in mapping the problems related to the entries of the abandoned exploitations (Muka, *et al.*, 2014, Cemeta, 2016), but no measures have been taken in order to avoid the dangers they bring. A complete project regarding the measures to be taken should start with a detailed and thorough identification of open entries, because there are no records on the issue (Muka, *et al.*, 2014).

***The presence of waste rock dumps***

The impact of waste dumps on the environment is observed:

1. Through the area they cover in the natural territory

2. Through the presence of different elements, especially of the harmful ones, (Cu, Zn, Pb, Fe, Cr, etc.) and through their migration by means of natural water streams (rivers, creeks) or rain.

On the other hand they alter the natural flora and fauna and prevent the land for being used for purposes benefiting the human activity. All abandoned mines in Albania have one feature in common, that of generating waste dumps in an unorganized way. Such dumps are found in the whole territory of the former mining area inflicting a ‘dent’ to the territory (Figure 7). The second case is typical for the copper mines. Sterile stocks are spread extensively on the site and they are carried away by water streams, which pose a bigger problem as they transport harmful elements in a vast territory. When these streams meet larger bodies of water (creeks or rivers), then other areas are prone to danger and the impact on the health of humans, of the flora and fauna is bigger (Daci, 2013).



**Figure 6.** a) Unsealed entry of an abandoned exploitation in the chromite mine of Bulqiza b) A ‘formally’ sealed entry in the coal mine of Krrabë

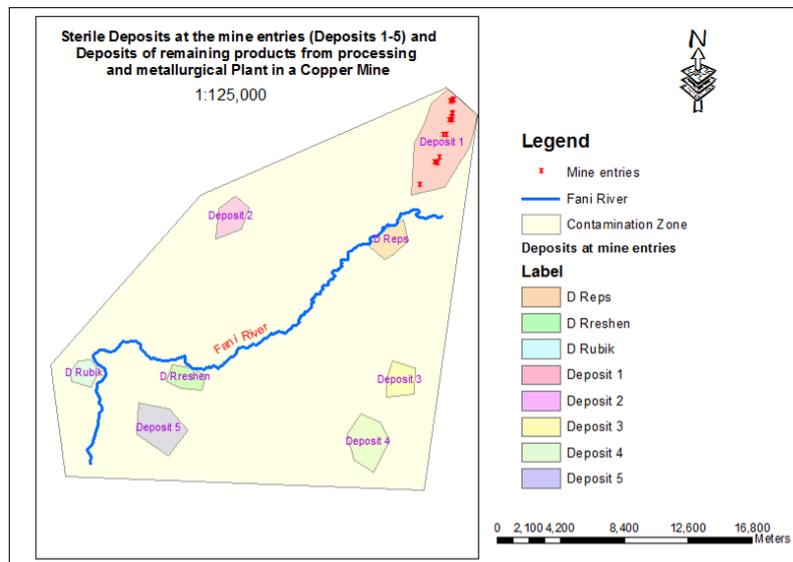


**Figure 7.** A “dent” in the territory due to the sterile stocks in the chromite mine of Bulqiza

Figure 8 illustrates the sterile dumps near the mine entries, the waste from copper enrichment and from metallurgical processes, and the land spreading of the harmful elements (region of Mirdita) by regionalizing the contaminated surface, whose area is estimated as 500 km<sup>2</sup>. The deposits 1 to 5 consist of small deposits, which are located at the open entries of underground mining exploitations. Therefore Deposit 1 consists of 17 smaller sterile dumps. The deposits at Fan River (D Repts, D Rreshen and D Rubik) are waste deposits from the processing plants, mainly metallurgical ones. The stocking of such deposits was not handled in compliance with the standards for environmental preservation, so its impact on the environment and on the river’s fauna is very harmful.

This situation is observed in the whole territory of Albania. Several attempts have been made in order to assess the area and the volume of the sterile deposits (Muka, *et al.*, 2014), but there are still no

official records. Therefore this is a very important requirement in the framework of the mapping of the land use in Albania.



**Figure 8.** Sterile deposits with harmful content in the territory of a Copper Mine

***The presence of abandoned objects***

The exploitation of useful minerals requires the construction of several technological and operational objects in the mining site. No project regarding the environmental impact was implemented for building such objects. The basic principle applied was minimizing costs. Figure 7 illustrates the fact that many objects, mainly the operational ones, were built within the area of sterile rock dumps. Because of this, and due to the fact that they were in a dangerous area under the influence of underground mining exploitation and consequently affected by it, the objects were declared useless and their relocation was required (Arapi, 2014). After being abandoned, and with no land rehabilitation projects in place, such objects are still standing in ruins. Figures 9a and 9b illustrate this grim scene. The environmental issue of the abandoned objects is related to:

- The occupation of the area, preventing the land use.
- The free access to humans and other living creatures, putting their lives at risk.

Avoiding such a problem requires the mapping of all abandoned objects and their situation. This would be the framework for projects that will rehabilitate the abandoned exploitations' sites.



**Figure 9.** Images of abandoned objects a) at a chromite and b) a coal mine (Cemeta, 2016)

**Conclusions**

- The specificities of environmental issues related to abandoned exploitations in Albania are their regionalization, the mining exploitation technology and the country's low level of economic development.

- The impact of underground mining exploitation is manifested in the form of funnels, sinkholes and landslides, which constitute the basic forms of impact. Their occurrence creates the conditions for the assessment of the susceptibility, vulnerability and the geo-risk mapping of the abandoned mining exploitations.
- The location of the sterile dumps in every mine entry has contributed in their disproportionate spreading, covering quite a large areas of land, harming the natural flora and fauna. Their disposition in few concentrated dumps constitutes an important obligation in alleviating such an environmental problem.
- The hazardous dumps are actually contaminating vast territories, posing a life-threatening danger to humans, other living creatures and to landscape in general.
- The lack of projects for the rehabilitation of the abandoned mining exploitation increases the severity of their harmful effects, not only on the current situation but also in a longer term perspective. This impact should not be seen merely as a regional impact, since its consequences tend to spread more widely.

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