

## ENVIRONMENTAL AND SOCIAL EFFECTS OF MINING EXPLOITATION IN THE SOUTH AREA OF BANAT MOUNTAINS (ROMANIA)

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**Abstract.** *In the last 25 years, Romania has undergone a large industrial restructuring, which has resulted in the closure of mines or the diminution of mining operations. However, the mining activities have caused negative impacts both on the environment and on the population. The present study summarizes the situation of the mining activity in the south area of the Banat Mountains (Romania) and presents the effects produced by the mining exploitation on the environmental factors but also of the wellness of area's population.*

**Keywords:** *pollution, mining, environment, impact, social effects.*

### 1. INTRODUCTION

The Romanian territory has a great diversity of mineral resources (metallic and non-metallic), as well as energy resources (i.e. coal, oil, gas, and radioactive elements) [1]. In 1989, nearly 300 mines were in operation. Since the late 1990s, mining operations in Romania have encountered huge operating difficulties, so between 2002 and 2012, the government closed 255 mines [2].

The southern Banat Mountains (Fig. 1) is one characterized by rich resources of the basement, which have been exploited since the 16<sup>th</sup> Century. In 1552 the Banat came under Ottoman occupation, starting the gold and copper mining in Oravita and Ciclova Montana. Beginning with 1717, the Banat became part of the Austro-Hungarian Empire, which begins to immediately exploit the mining resources of the area (i.e. gold, copper and coal). In this context, King Carol VI of Austria and Maria Teresa granted certain privileges that could attract miners from the territory of the empire in the annexed area. As such, a smelter would open in Oravita separating the mentioned minerals [3, 4].

Between 1723-1733, one of the first ore washing dams was built on the Oravita stream, and in 1730 was to establish "Banat Mining Direction", what was to play a decisive role in terms of investments, one of them being in 1768, regarding the construction of the Resita Factories. In 1815, the Vienna authorities set up a mint in Oravita ("Baranie"), considered necessary in the regional plan. The progressive development of the studied area

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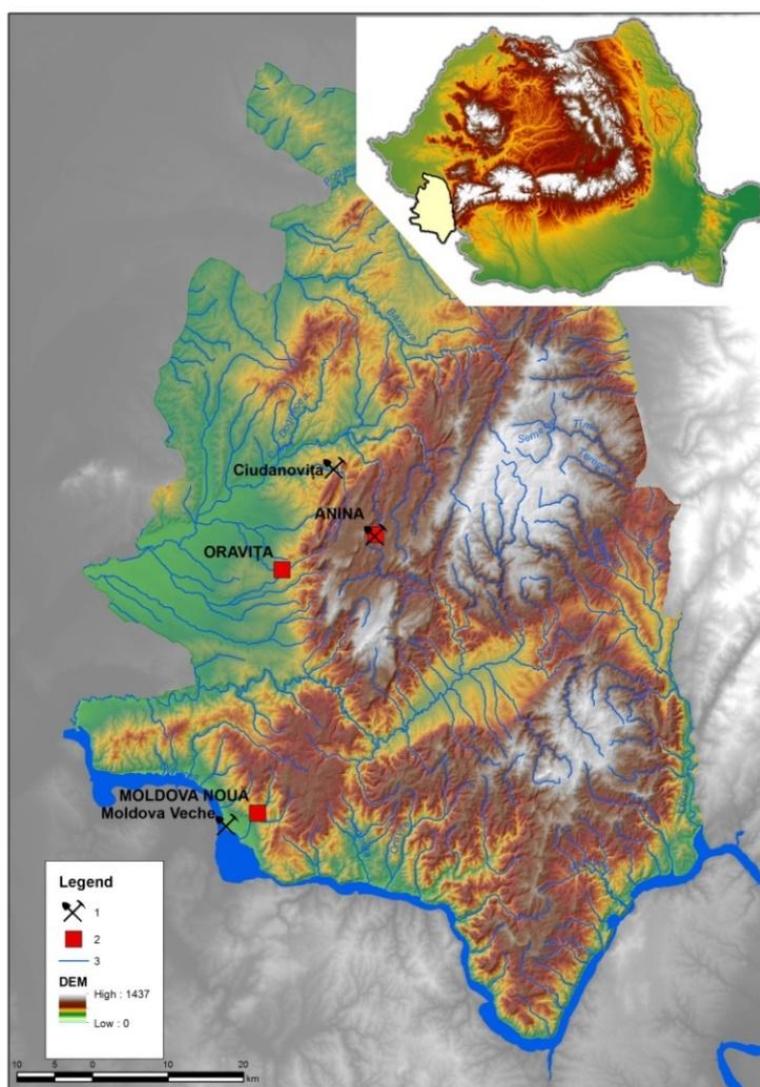
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has attracted, over time, infrastructural and cultural investments, of which can be mentioned the first railway on the present territory of Romania (i.e. Oravita - Bazias, 1854 – in present functional only on the distance from Oravita - Iam), the Viennese baroque theater from Oravita (1816-1817) inaugurated by Emperor Franz Joseph, railway Oravita - Anina (1863).

The mentioned development of this area has attracted two rounds of emigration, and the latter has attracted populations including from Oltenia and Muntenia [5]. In 1790, the Austrians began to operate the coal at Anina [6], which operated continuously until 2007, when it was closed due to a fire. Oravita, on the other hand, is the center of the Banat mining company, which was responsible for the radioactive operations in Ciudanovita and Lisava, and these were subjects to exploitation during 1952-1992. The operation was started through the Soviet Regime, which developed, near the village of Ciudanovita, a mining colony with the same name. The same situation was encountered in Moldova Noua, where the copper mining operations were registered since the period of the Austrian administration's dominance, until 2010. In fact, the actual exploits were carried out in the Golgota area of Moldova Veche. The mining tradition has continued in the region until some regional and local bankruptcy situations have occurred, with socio-economic repercussions.



**Figure 1.** The geographical position of the mining sites in the south area of Banat Mountains and the localities where was realised the study: 1 - mining operations: Moldova Noua (polymetallic sulphides, copper), Ciudanovita (radioactive minerals - uranium), Anina (coal); 2 - localities; 3 – hydrographic network; DEM – altitudes.

## 2. EXPERIMENTAL

The present scientific research includes a field study in the chosen area by visual inspection and field survey. Each method presents various opportunities for collecting as much information as possible about the potential effects of mining activity on the environment and population. For the selected area (the south area of Banat Mountains), 4 localities were visited, where are different types of minerals (polymetallic sulphides, copper, radioactive minerals - uranium and coal) in order to observe the impact of mining activities on the environment. To identify the opinions of the local population on the effects of mining on economic and social welfare, was started a survey based on a questionnaire involving 142 respondents, residents of three urban centers - Oravita, Anina and Moldova Noua and and from the rural town of Ciudanovita.

## 3. EFFECTS OF THE MINING ACTIVITY ON THE ENVIRONMENT

In the current society the effects that the production and consumption activity has on the environment has become a major concern [7]. The entire mining activity has produced, due to its specific nature, multiple and varied negative effects on the environment: waters, landscape and atmosphere [8]. In recent years, there has been an increasing interest in identifying the effects and impact of mining activity on the environment and population health [9-11].

At international level were presented the effects of mining activity on the environment by specialists in the field, for the eastern area of Morocco [12], Vietnam [13], Nigeria [14], South Africa [15], but also for the European states and America [16-19]. Thus, the identified negative effects at the level of these areas can be exemplify: changes of the relief, manifested by the degradation of the landscape [12]; large areas occupied by the activity of exploitation (i.e. waste disposal, storage of useful mineral substances, industrial installations, access roads etc.), the degradation of the land, by vertical and horizontal displacements of the surface and the sliding of the dumps and settling ponds, causing accidents, sometimes even serious; impurification of surface water and groundwater; hydrodynamic imbalance of groundwater [13]; negative influences on the atmosphere, flora and fauna [14]; chemical pollution of the soil, which can affect for many years its fertile properties; noise, vibration and radiation widespread in the environment, with a strong adverse action [20]. In our country, also, it has started studies about the mining influence on environment [21-22], waters [23-26] and socio-economic development [27-29].

Among the serious problems reported nationwide as a result of mining activity include air pollution with gaseous. In mineral quarries, the concentration of silicogenic dust is often exceeded by  $6 \text{ mg/m}^3$  against the permissible limit. At the loading points of a mine in cars it can be over  $20 \text{ mg/m}^3$ , on the roads in the quarry the concentration reaches at  $22 \text{ mg/m}^3$ , at the drilling rig there were  $18 \text{ mg/m}^3$ , and the discharge points in collector it reaches at  $12 \text{ mg/m}^3$ . Also, in the preparation facilities there are, in many cases, large exceedances of the powder content of  $\text{SiO}_2$  in atmosphere [21].

Based on the laboratory analyzes for soil samples taken from the Ciudovita, Lisava, Anina and Moldova Noua area, the presence of heavy and radioactive metals was confirmed (Pb, U, Cu, Cr, Cd, Ni, Zn, and Mn), Pb and U show maximum concentrations in samples collected around Lisava and Ciudanovita uranium mine, in the range of

80.26-119.51 mg/kg d.w. and 58.02-70.12 mg/kg d.w. [30]. In the Anina Mountains (Banat Region) was found various concentrations of uranium [31] and on Oravita-Ciudanovita Road were identified higher dose rates due mining activities [30]. The high concentration of Cu and Cd identified in Moldova Noua represented one of most risky environments for human health [30]. In the same time, mining activity produces a significant amount of solid waste, as a result of the construction and operation of the tailings dumps, with contamination effects of underground water.

#### 4. THE EFFECTS OF THE MINING ACTIVITY ON THE POPULATION

Romania has undergone an extensive industrial restructuring over the last 25 years, including the decrease of domestic production and the operational closure of most of the mines, this having direct repercussions on the population in the respective areas. As it was mentioned, for knowing the effects of mining activity in the south area of Banat Mountains, was conducted a survey, based on a questionnaire, attended by 142 respondents, inhabitants of this area. The persons participating of the study worked or had family members who worked in the mining field (104 respondents validated this response). Regarding the territorial distribution of the number of respondents in the study area, can be said that this is balanced, proportional to the territorial surface of the localities (Fig. 2).

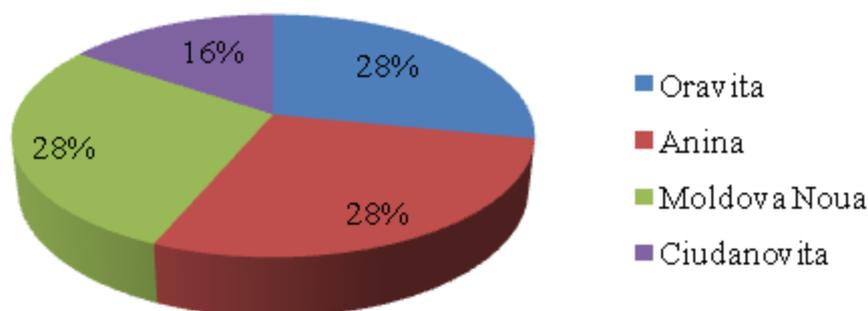


Figure 2. Territorial distribution of the percentage of respondents participating in the study.

The profile of the respondents according to the items - age, sex and type of exploitation mines in which they worked is presented in Table 1.

Table 1. Crosstable analysis of items: age, gender, type of exploitation mines.

Gender	Type of exploitation mines	Age					Total
		20-30	31-40	41-50	51-60	>60	
Male	Coal	0	0	0	0	0	0
	Copper and other polymetallic sulfides	0	0	0	9	10	19
	Radioactive minerals	0	5	9	26	9	49
<b>Total</b>		<b>0</b>	<b>5</b>	<b>9</b>	<b>35</b>	<b>19</b>	<b>68</b>
Female	Coal	0	0	0	0	0	0
	Copper and other polymetallic sulfides	0	0	0	0	0	0
	Radioactive minerals	0	0	9	12	15	36
<b>Total</b>		<b>0</b>	<b>0</b>	<b>9</b>	<b>12</b>	<b>15</b>	<b>36</b>
	Coal	0	0	0	0	0	0
	Copper and other polymetallic sulfides	0	0	0	9	10	19
	Radioactive minerals	0	5	18	38	24	85
<b>Grand Total</b>		<b>0</b>	<b>5</b>	<b>18</b>	<b>47</b>	<b>34</b>	<b>104</b>

As can be seen from the data presented in Table 1, the majority of the respondents are man (65.39%); 81.73% (85/104) of the total respondents to the study worked, or had family members who worked in mines that exploited radioactive ores. Regarding the degree of economic development of the settlements in the sloping area 59.16% (84/142) of the respondents consider that the level of development is lower than of the neighboring localities and 40.85% (58/142) appreciated a similar level of economic development of the area.

The closure of the mines in the area was generating economic, social and environmental effects, which seriously affected the quality of life of the inhabitants from the studied community. Descriptive analysis of the question "How was the socio-economic area affected after the mine closure" is presented in the Fig. 3.

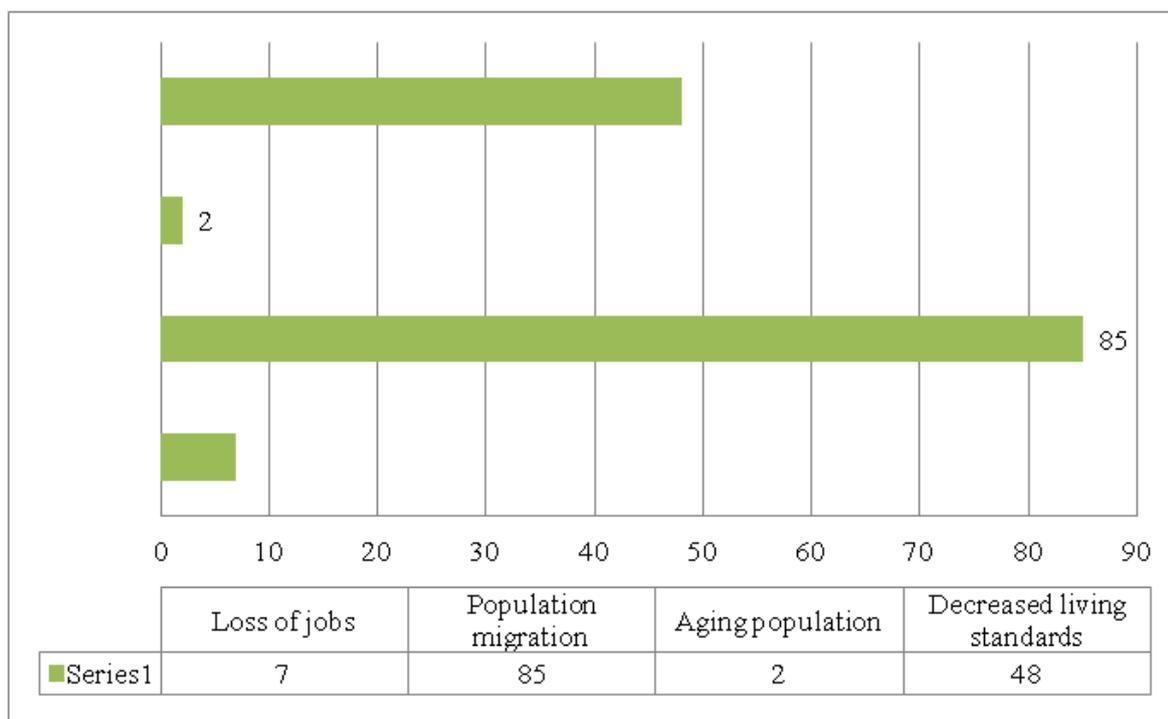


Figure 3. Respondents' views on the main socio-economic difficulties.

The cross-analysis of the 2 variables (*type of mines where they worked and how the area was affected socio-economically after the mine closure*) are not independent and the exploitation of copper deposits and other polymetallic sulfur as well as radioactive minerals influenced socio-economic area where the questionnaire was applied (Table 2).

Table 2. The Chi-square test - type of mines where respondents worked vs. socio-economically effects.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	50.924	3	0.000
Likelihood Ratio	36.552	3	0.000
Linear-by-Linear Association	17.714	1	0.000
N of Valid Cases	142		

As a result of the mining activity interruption, unemployment in the region increased, the income level decreased, which led to the massive emigration of the labor force to Timisoara or abroad [32]. Within the area, unemployment is between 65-90% and the migration rate is very high [33]. After the closure of the mines, most of the population, both

female and male, migrated to other countries in Europe, or to other cities in western Romania. In this sense, can be affirmed that the studied area facing a massive depopulation. A reported situation of this kind is related to the pollution degree in the Ciudanovita - Lisava area where ecological work was carried out on the former radioactive tailing dumps, but the population in the colony faces financial and health difficulties. Anina, in turn, after the closure of the mine in its territory, has a high degree of unemployment, and the related urban area is covered with coal dust. Similarly, can be mentioned the pollution in the area of Moldova Noua, with tailing dumps from the former settling lake and the mining residues are driven by wind and transported both on the city and on the territory of Serbia, which led to a conflict international [34-40].

The analysis of a link between a future strategic program for the optimal exploitation of mining resources and the need for such a program is demonstrated by a contingency table in which future programs for exploitation of mining resources are highlighted, such as: mines reopening, exploitation of local and regional resources, the exploitation and growth of a base for transport and processing of resources and evaluation of the necessity for this program with five predefined response variants from 1 (not at all) to 5 (very large measure) (Table 3).

**Table 3. Crosstable analysis of items related to necessity for a future strategical program**

Proposed programs	None at all	To a small extent	Mean extent	To a great extent	Very great extent	Grand Total
	1	2	3	4	5	
Mine reopening	2	3	6	112	5	128
Exploitation of local and regional resources	0	0	10	0	0	10
Exploitation and growth of a base for transport and processing of resources	0	0	4	0	0	4
<b>Grand Total</b>	<b>2 (1.4%)</b>	<b>3 (2.1%)</b>	<b>20 (14.1%)</b>	<b>112 (78.9%)</b>	<b>5 (3.5%)</b>	<b>142 (100%)</b>

As can be seen, a majority percentage (78.9%) of the total respondents (112/142) considers that a program for mine reopening is necessary in a great extent for the analyzed area. Generally, from all respondents, 90% (128/142) consider it necessary to reopen the mines, 7% (10/142) consider as necessary to exploit local and regional resources and only 3% (4/142) considered that the exploitation and growth of a base for transport and processing of resources is a potential program necessary for the redevelopment of the area. The analysis of the concordance between the two analyzed variables (*A future program for the exploitation of mineral resources should aim* and *To what extent do you consider that a program of mining resources for the area would be needed*) highlights that there is a difference between variables link, in the sense that a future mineral resource recovery program should aim to reopen the mines (Table 4).

**Table 4. The Chi-square test – future exploitation programs vs. necessity for this type of program.**

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	94.741	8	0.000
Likelihood Ratio	67.007	8	0.000
Linear-by-Linear Association	25.333	1	0.000
N of Valid Cases	142		

Regarding the factors that could prevent the exploitation of the mining resources in the area, the high costs obtain the majority share 83% (118/142), the other answers: the natural framework (3/142), the state of the infrastructure (5/142), the competition of other exploitation centers (6/142), inefficient investments in mining capitalization (6/142) or there is no impediment (8/142) registered much lower weights, below 10% (Fig. 4).

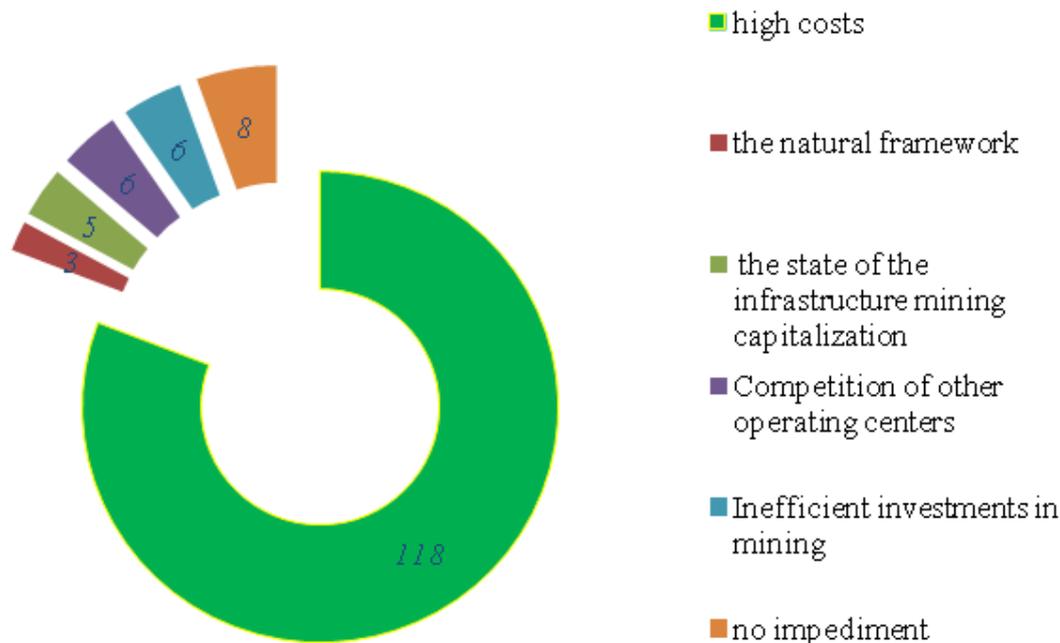


Figure 4. Potential factors that may contribute to preventing mining operators.

Contingency table applied to the multiple-choice questions in which it was desired to know the opinion of the respondents on how the mining, storage and transport activity of the minerals and the tailing dumps affect the environment, as well as, the measures for depollution and conservation of the area, applied by to the local authorities are presented in Table 5.

Table 5. Crosstable analysis of items related to environmental pollution mining and the measures applied by central authorities.

Consider that the mining, storage and transportation activities of the minerals and the tailing dumps have polluted the environment	Consider that local and central authorities have adopted and applied measures for pollution and conservation			
	Yes	No	No answer	Grand Total
Yes	2	136	1	139
No	0	0	0	0
No answer	0	0	3	3
<b>Grand Total</b>	<b>2</b>	<b>136</b>	<b>4</b>	<b>142</b>

Generally, from all respondents, 139 respondents consider that mining operations affect the environment and 98% (136/139) of them consider that local authorities can be involved to an appropriate extent in terms of environmental storage and conservation

measures. Among the measures needed to improve the areas that respond to the questionnaire, it considers the tax solutions of the affected areas.

## 5. CONCLUSIONS

Romania is a country rich in natural resources, but the mining industry has slowed down over the last 25 years. If before 1989 the annual ores production exceeded 20 million tonnes, in 2007 it barely reached the quota of 50,000 tonnes. The mining activity causes great imbalances in the terrestrial and aquatic ecosystems, both at local and regional level, thus increasing the concerns of the specialists in the knowledge of these phenomena and the involvement in actions necessary for the protection, conservation and restoration of the environment.

Radioactive minerals in the south area of Banat Montains have been widely exploited for up to 20 years. The consequences of these activities are many tailing dumps with high concentrations of heavy and radioactive metals, such as: Pb, U, Cu, Cr, Cd, Ni, Zn, and Mn [30]. The survey, conducted within the present study, contributed to obtaining a relevant point of view of the population regarding the degree of development and socio-economic wellness. As a result of the closure of the mines the population was seriously affected from socio-economic point of view, the unemployment reached high levels, there was a massive migration of the population (both, female and male), the decrease of the living standard etc.

As the mining activity affects environment and population, the authors consider that strategic planning, the implementation of cleaner technologies, the development of an environmental management system and the integration of development durable objectives can constrain the efficient and sustainable development of the mining industry in Romania.

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