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Soil Pollution with Heavy Metals - Specific Issues for Baia Mare Area

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Abstract

The mining activity, practices in Baia Mare for over 100 years, has led to pollution and economic sealing of large areas of land; it has adversely affected the environment and now poses a significant risk to human health. The actual sources of pollution, current or historical, in Baia Mare Depression are SC Romplumb SA, SC Cuprom SA and CNMPN Remin SA. The mining activities left over wide areas ponds, mine waste dumps and the underground waters that come across the existing mine galleries spring out contaminated and sometimes in an uncontrolled manner. Heavy metals are present in the environmental factors from this area and significantly affect local ecosystems and human health. The paper presents details on soil pollution with heavy metals, problem that has gradually found a solution in the environmental rehabilitation projects, activities that requiring investment of time and specialists in this field.

Keywords: mining activities, heavy metals, environmental impact

1. Introduction

Baia Mare Depression is an area of contact between the Someş Platform and The Eastern Carpathians, on the southern side of the eruptive Neocene Gutâi and Ţibleş. These massive mountains of volcanic rocks are made up of gold-silver ores and nonferrous metals such as lead, zinc, copper etc. Early mining activities in this area are known since II AD [1]. Baia Mare is documentary certified from 1329 and has emerged as a very important gold center in XIV – XV centuries. Mining remained the main activity over the centuries, fact that transformed it in the second half of the twentieth century into a high subsidized field. After the fall of the communist regime the mining activity has been gradually reduced, most mining perimeters today being in storage.

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2. Pollution sources and pollutants

In Baia Mare Depression were identified 7 classes of soils and 13 soil types, with different weights depending on the type of use (table 1). The quality of soil has been affected over time primarily through mining activities, ore preparation and nonferrous iron metallurgy. The mining activities have generated large areas ponds and mine waste dumps and as a consequence, when the underground waters cross the existing mine galleries spring up contaminated and often in an uncontrolled manner. These facts led to the estimation that an area of approx. 25 000 ha is polluted with heavy metals (lead, copper, zinc, cadmium, nickel, cobalt, manganese, chromium). The degree of intensity of heavy metal pollution of this area is shown in table 2. On territory of Baia Mare Depression have been built 6 tailing ponds (table 3) and 55 waste dumps (table 4), inventoried as shown in tables.In terms of perimeter distribution of the metal extraction and processing of Baia Mare Depression, the areas where these dumps have formed are considered "hot spots", spots that exist even in the Baia Mare city.

Table 1. Classes and soil types in Baia Mare Depression (Source: OSPA Maramures and Amenajamentele Ocoalelor Silvice, 2002)

Soil use type	Class and soil type	Area (Ha)	Share (%)
Forest soil	Cambisoils (eutricambisol, districambisol)	25220.3	63.8
	Luvisoils (preluvosol, luvosol, luvosol Albic)	13519	34.0
	Spodisoils (prepodsoluri)	631.9	1.5
	Cernisoils (rendzinic)	383.2	0.5
	Protisoils (litosol, aluviosol)	64.1	0.15
	Pelisoils (pelosol)	9.3	0.05
	Total forest land	**39827.8**	**100**
Agricultural soil	Hidrisoils (gley, stagnosol)	15728	35.55
	Luvisoils (luvosol, preluvosol)	14175	32.04
	Protisoils (aluviosol, regosol)	13283	30.03
	Cambisoils (eutricambisol)	1054	2.38
	Total agricultural land	**44240**	**100**

Table 2. Fields polluted with heavy metals (Source: Report 2008, EPA Maramureş)

Total	Areas affected by pollution with heavy metals	From which			
		weak	moderately	strong	excessive
Ha	25 140	15310	4910	2500	2420
%	100	61.00	19.50	9.90	9.60

Table 3. The situation of tailing ponds in Baia Mare Depression (Source: Fodor and Baican, 2001, Coman, 2006)

No. unit	The name of the tailing pond	Activity	Area (Ha)
1	Bozânta	inactive	105
2	Tăuții de Sus - EM Baia Sprie	inactive	48.6
3	Săsar - Iaz vechi	in conservation	36.5
4	Tăuții de Sus - Iaz vechi	inactive	49
5	Nistru	inactive	0.4
6	Aurul	on a compliance program (operating until the 31st of December, 2010)	93
	Total	**-**	**332.5**

Table 4. Tailings dumps situation in Baia Mare Depression (Source: CNMPN Remin SA Baia Mare)

No. Unit.	Mining unit name	No. of the damp	Type of the stored material	Stored volume (m^3)	Occupied area (Ha)
1	Herja Mine	7	Sterile	67968	2.03
2	Ilba Mine	18	Sterile	320600	7.13
3	Nistru Mine	19	Sterile	158189	5.81
4	Săsar Mine	3	Sterile	43000	2.03
5	EM Şuior	7	Sterile	281458	4.40
6	UP Central Flotation	1	Sterile	920000	3.70
	Total	**55**		**2967324**	**25.1**

3. The way of transfer and the receptors for heavy metal pollutants

Heavy metals reach the soil from the other environmental factors, air and water, the answer at this type of pollution being different and depending on its nature. From the surface these pollutants migrate through a complex process of diffusion, adsorption, dissolution, etc. using water as a solvent. In the soil, a variety of microorganisms can make heavy metals soluble and cause imbalances physical, chemical and biological imbalances in the nature. Being absorbed by the roots of plants, these pollutants end up in different organs of plants and, through the biological chains they migrate in animal and human bodies, there they can accumulate and cause various diseases. The research done in this field show that crop such as fodders, corn and root plants have recorded accumulation of heavy metals. In plants, lead builds up in organs that contain chlorophyll, obstructs the process of photosynthesis, and the most severe forms change the reproductive

process, leading to a shortage of flowers and fruit in the affected areas [9].

For animals, e.g. sheep, cattle and horses, expert analysis revealed copper deposits in the kidneys, liver and blood, causing them anemia, liver and kidney diseases and vitamin and mineral deficiency conditions.

Lead present in the human body causes anemia, acts on the nervous system and in cases of severe intoxication, causing lead poisoning. Copper and zinc, micronutrients that are normally present in the human body, in high concentrations produce different types of poisoning.

Also, cadmium poisoning affects the liver, leading to a decreased erythropoiesis, anemia and low levels of calcium.

Arsenic poisoning produces metabolic and digestive disorders, headache, dizziness and vascular disease.

4. The monitoring of heavy metal polluted soil

To determine the pollutant load of soil, in Baia Mare Depression has been done a long-term monitoring and analyze of heavy metals (Pb, Cd, Cu, Zn, Ni) in full form. In table 5 and table 6 are the results from the 2008 harvest for two depths, e.g. 5-10 cm (A1) and 20-30 cm (A2) on the land use categories, namely sensitive soils and land use with less sensitive use.

The research has revealed that for Baia Mare zone the highest frequencies of exceeded of the reference level has been recorded on lead 84.4%, that has an alert level at 62.5%, being followed by zinc.

The lowest frequency of exceeded recorded have been in the case of nickel, 3.1%, but only at small depths of up to 10 centimeters.

Table 5. The frequency of exceeding the benchmark on the use of sensitive soil

No. Unit.	Monitored Indicator	Sampling depth	The frequencies of exceeded (%)		Reference level – Order 756/1997 (mg / kg of dry substances)	
			Alert	Intervention	Alert	Intervention
1	**Pb**	A1	84.4	62.5	50	100
		A2	78.1	62.5		
2	**Zn**	A1	31.2	21.9	300	600
		A2	34.4	28.1		
3	**Cu**	A1	28.1	12.5	100	200
		A2	18.7	9.4		
4	**Cd**	A1	18.7	12.5	3	5
		A2	18.7	12.5		
5	**Ni**	A1	3.1	0	75	150
		A2	0	0		

Table 6. Frequency of exceeding the benchmark at soil less sensitive at use in Baia Mare area

No. Unit	Monitored Indicator	Sampling depth	The frequencies of exceeded, (%)		Reference level – Order 756/1997 (mg / kg dry substances)	
			Alert	Intervention	Alert	Intervention
1	**Pb**	A1	50	37.5	250	1000
		A2	50	50		
2	**Zn**	A1	50	25	700	1500
		A2	37.5	25		
3	**Cu**	A1	37.5	37.5	250	500
		A2	37.5	37.5		
4	**Cd**	A1	12.5	0	5	10
		A2	37.5	25		
5	**Ni**	A1	0	0	200	500
		A2	0	0		

It appears that for soils with less sensitive use have not been recorded exceeded frequencies above 50%, regardless of the depth of probation. Lead records the most important overruns, but nickel has not exceeded the allowable limits.

Also, for the lead and cadmium indicator have been recorded high values at lower depths, indicating the propensity of these metals to accumulate in lower horizons.

As spatial distribution, the results show that there are recorded significantly higher concentrations in areas under direct impact of pollution sources.

The area with the highest values of metal concentrations in soil is Baia Mare, including neighboring perimeters. In this zone, stand out in soil samples near SC Cuprom SA and SC Romplumb SA due to the influence over time that these pollution sources had on soil.

5. Conclusions

Industrial processes from Baia Mare Depression led to the removal of the economic cycle of at least 357.6 ha of land, represented by the areas of ponds and waste dumps.

The pollution of all environmental factors in Baia Mare Depression with heavy metals significantly affects ecosystems and human health from this area.

By human actions and inherent reactions there has been reached a phase that requires close monitoring of Baia Mare Depression, investment projects and environmental remediation of the affected perimeter.

Translating these objectives into practice will succeed if applied a longer period of time and only in a multidisciplinary specialty work environment.

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