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INNOVATIVE POSSIBILITIES TO REPRESENT THE BAIA MARE URBAN SYSTEM SOILS POLLUTION WITH HEAVY METALS USING G.S. SURFER

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Abstract: *The mining activity, practices in Baia Mare 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 mining activities left over wide areas ponds, mine waste dumps and the undergroundwaters that come across the existing mine galleries springout 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. This paper proposes to use the G.S. Surfer software in analyzing the concentration variations of the heavy metals recorded in Baia Mare urban system soils in order to present the real situation of the mining activity and the degree of historical pollution of the studied area. There are presented the preliminary results obtained from investigation of the pollution degree made by heavy metals such as arsenic, copper, iron, lead and zinc in the area with a long metallurgical activity; the analysis performed established that the soil of the studied area is worst polluted with concentrations that are higher than the normal values admitted by the Romanian laws. Also from the 2D and 3D pollution graphics is reflected an accumulation of heavy metals in soils especially during the last 30-50 years correlated with depth. So the G.S. Surfer pollution models have a special ecological and technical implication, ensuring the knowledge of the pollutants behavior in soil.*

Keywords: *mining activities, heavy metals, historical polluted soils, G.S. Surfer*

1. INTRODUCTION

Baia Mare urban system is an area of contact between the Someş Platform and The Eastern Carpathians, on the southern side of the eruptive Neocene Gutâi and □ibleş. These massive mountains of volcanic rocks are made up of goldsilver ores and nonferrous metals such as lead, zinc, copper etc [1].

The mining activity, practices in Baia Mare, for over 150 years as the main activity over the centuries, has led to pollution and economic sealing of large areas of land - most mining perimeters today being in storage; it has adversely affected the environment and now poses a significant risk to human health.

The mining activities left over wide areas ponds, mine waste dumps and the undergroundwaters that come across the existing mine galleries springout contaminated and sometimes in an uncontrolled manner [1].

The Industrial and mining activities have been recognized as the major sources of soil heavy metal contamination [6].

Heavy metals are present in the environmental factors from this area and significantly affect local ecosystems and human health [2].

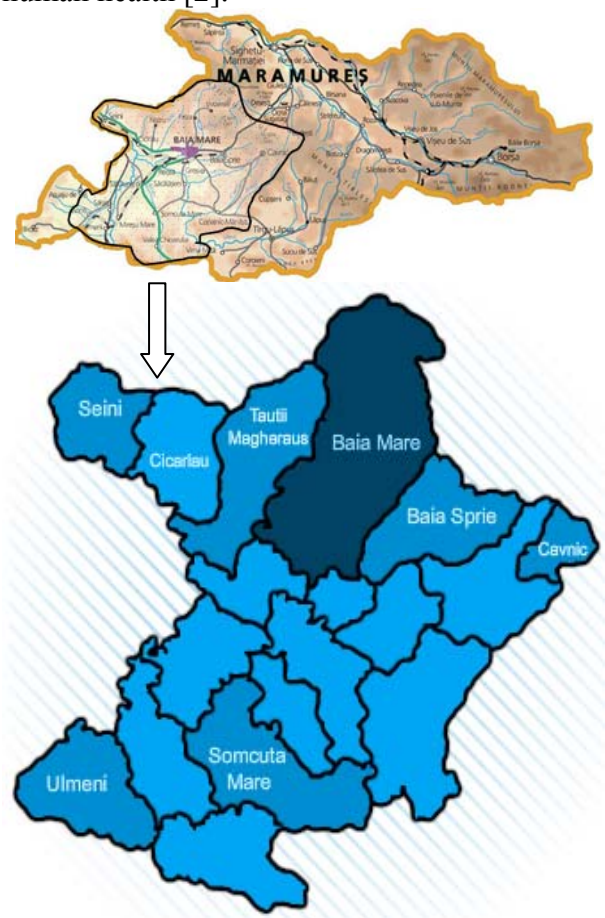

Fig. 1. The position of Baia Mare urban system in Maramure County [8]

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.

This paper proposes to use the G.S. Surfer 9.0 software [3] in analyzing the concentration variations of heavy metals recorded in Baia Mare's urban system soils, the spatial distribution of the contamination level and ecological risk, in order to present the real situation of the mining activity and the degree of historical pollution in the studied area [2].

There are presented preliminary results (Fig. 9-12), in form of 2D and 3D representations, obtained from investigation of the pollution degree made by heavy metals ions especially in the area with a long metallurgical activity.

The analyses performed established that the soil of the studied area is worst polluted with As, Co, Cu, Ni, Pb, Zn and many others, with concentrations that are higher than the normal values admitted by the Romanian law in the 0-20 and 20-40 cm depth interval [4]. Also is reflected an accumulation of heavy metals in soils, especially during the last 30 years, correlated with depth.

2. BAIA MARE DEPRESION - CURRENT STATUS OF POLLUTION ACTIVITIES

In Baia Mare Depression were identified 7 classes of soils and 13 soil types [6], 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) [1].

Table 1. Classes and soil types in Baia Mare Depression [1]

Soil use type	Class and soil type	Area (Ha)
Forest soil	Cambisoils (eutricambisol, districambisol)	25220.3
	Luvisoils (preluvosol, luvosol, luvosol Albic)	13519
	Spodisoils (prepodsoluri)	631.9
	Cernisoils (rendzinic)	383.2
	Protisoils (litosol, aluviosol)	64.1
	Pelisoils (pelosol)	9.3
	Total forest land	**39827.8**
Agricultural soil	Hidrisoils (gley, stagnosol)	15728
	Luvisoils (luvosol, preluvosol)	14175
	Protisoils (aluviosol, regosol)	13283
	Cambisoils (eutricambisol)	1054
	Total agricultural land	**44240**

The degree of intensity of heavy metal pollution of this area is shown in table 2. On territory of Baia Mare Depress ion have been built 6 tailing ponds and 55 waste dumps [5]. 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 2. Fields polluted with heavy metals (Source:Report 2012, 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

Among the physical characteristics of soils from sites studied for the present project were pursued: soil texture in the upper horizon, degree of compaction (DC, % v/v), hydraulic conductivity (HC, mm/h), resistance to penetration (RP, kgf/cm^2) for several layers: 0-25 cm, 25-35 cm and 35-50 cm.

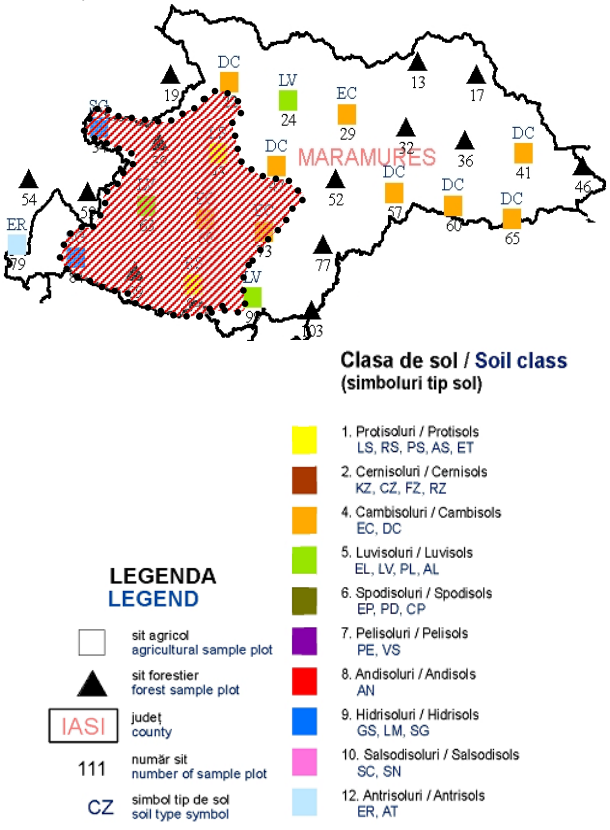

Fig. 2. Maramure county soil classes [9]

Texture or composition of the mineral part of the soil particle size is defined by the percentage of various fine mineral fractions, mainly sand, dust, clay, size and specific properties.

Depending on the dominance of a component are set textural classes and subclasses. In practice, currently, soils are grouped into five major classes.

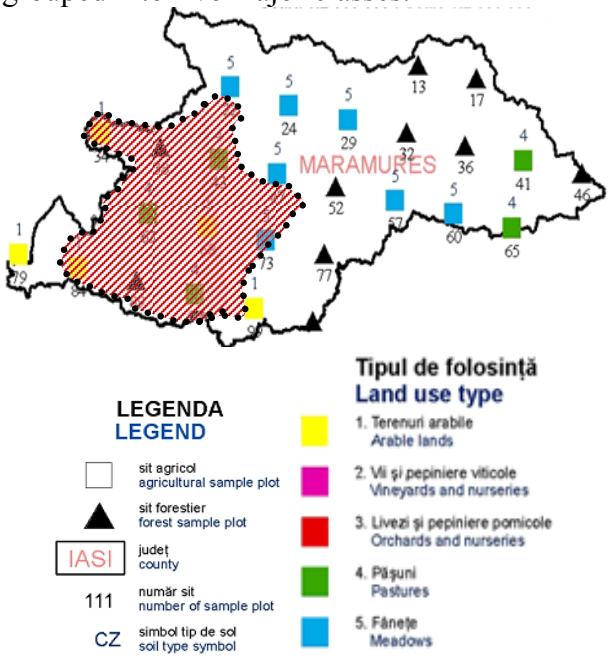

Fig. 3. Maramure county land use types [9]

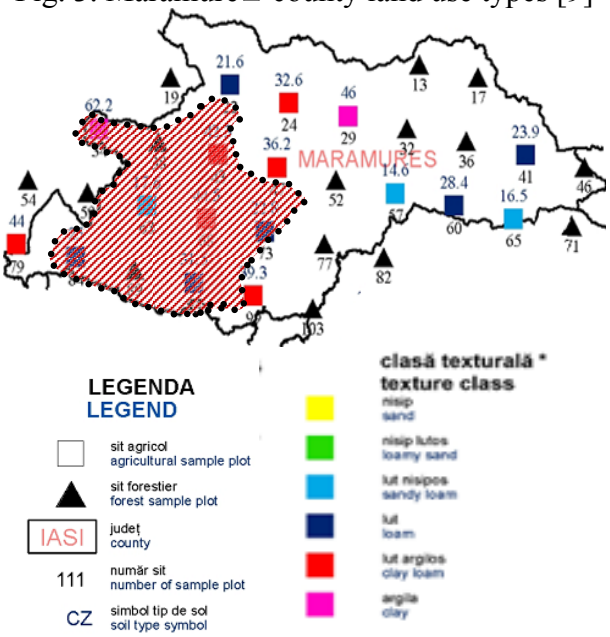

Fig. 4. The texture in the upper horizon for Maramures county soils [9]

The degree of compaction, hydraulic conductivity and resistance to penetration is determined in layers 0-25 cm, 25-35 cm 35-50 cm and shown in the following.

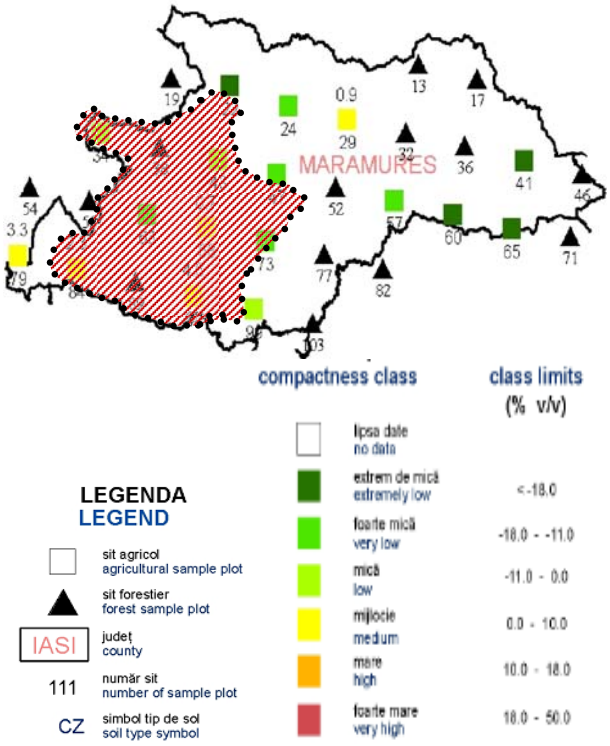

Fig. 5. The degree of compaction for Maramures county soils (0-25 cm) [9]

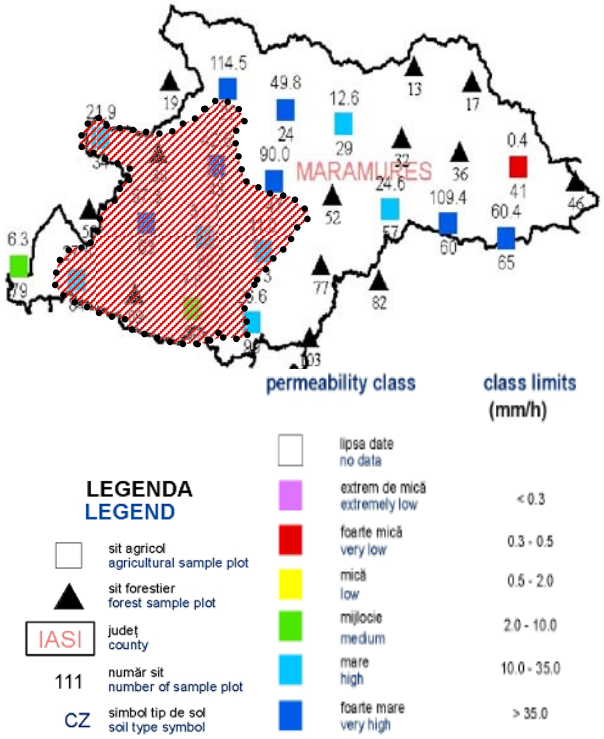

Fig. 6. The hydraulic conductivity for Maramures county soils (0-25 cm) [9]

3. MATERIAL AND METHODS

The soil is a dynamic system where short-term fluctuations occur, such as variations in humidity and pH levels, in redox conditions; it is also the place where the organic matter gradually decomposes as a consequence of changes in nature [5].

Through field and laboratory tests, soils can be characterized from a physical, chemical and biological perspective.

The total metal content of soils is the result of varied metal input – parental material, atmospheric deposits, chemical fertilizers and improvements, organic fertilizers and other organic and inorganic polluting substances – minus metal output resulted from cropping or from leaching and volatilisation [6].

Problems generated by soil contaminations with different pollutant substances have recently interested more and more researchers worldwide. Nowadays, one of the major problems of environment in industry is the historical pollution. It has dramatically consequences on the environment, especially on the ecosystems and regarding life quality and health of the peoples living in or near the affected areas [5].

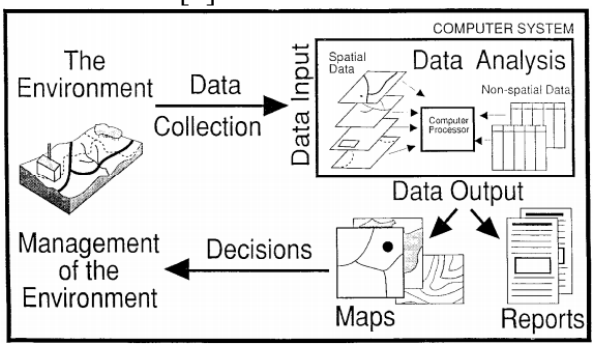

Fig. 7. The methodology for studying the heavy metals concentration in soils [5]

At the onset and maintenance of pollution effects due to industrial emissions, a special role has the combinations of heavy metals with soil strata. In this area, the processing activities of metal concentrates carried over the last years led to pollution of great-seed surfaces of terrain and adversely affected the environment and the quality of life [6].

The accumulation of heavy metals (Zn, Pb, Cr, Mn, Fe, Cu, Cd, As) in soils has a special ecological implication because of their toxicity and their compounds, but also because of the

form of the chemical bindings which affect the soil reaction. Ensuring the protection of soil quality, as a mean to enhance soil resources and the environmental protection, foresees, among other things the use of remediation methods and the technologies designed to neutralize or block the flow of pollutants required to ensure the desired efficiency and enforcement of laws regarding soil quality protection.

Soil sampling procedures from the research area were conducted according to Order 184/1997 [7]. The soil samples were gathered from different depths depending on the vegetation of the respective soil: 0-20 cm for arable land and grass, 20-40 cm for orchards and vineyards. For each material studied, we used the specific methods mentioned in our literature and complied with the experimental parameters and requirements of our study procedures.

The analytical data referring to the content of heavy metals in the studied soil revealed a wide variation of heavy metals contents. The concentration of heavy metals determined at the assays from Baia Mare area were compared with the average value of the normal contents with the maximum allowable values and with the values of the warning threshold and intervention one, for soil less sensible according to Order 756/1997 [4] law regarding soil quality protection and volatilisation.

Surfer software, registered as a trademark of Golden Software Inc., is a powerful contouring, gridding and surface mapping program for scientists, hydrologists, engineers, geologists, archeologists, oceanographers, biologists, foresters, geophysicists, medical researchers, climatologists, educators, students or anyone who needs to generate maps quickly and easily [3].

4. RESULTS AND DISCUSSIONS

Expansion of cultivated areas, intensification of agricultural production, irrational exploitation of forests, industrialization, urbanization etc are all causes of soil no longer be able to fulfill, in part or in full, its basic functions.

Currently soil is subjected to a wide range of impacts increasingly becoming more intense, causing or intensifying its quality harmful phenomena and processes, including erosion, salinisation, acidification and alkalinization or nutritional disequilibrium. All these phenomena constitutes land degradation meaning the whole range of harmful soil processes and phenomena, if we refer to the introduction in the soil or land of substances or energy characteristics that can cause changes in its physical, chemical or biological, affecting current or future use of it.

Although the soil pollution is an old phenomenon, closely linked to many human activities conducted throughout the different stages of the development of civilization, because of the problems involved at present it require special attention and management.

The indicators, that were considered, were determined in accordance with the analysis standards in force, and the obtained values have been reported to the values from Order no. 756/1997 - Annex no.1, for soils use.

In terms of legislation in force concerning the methods for determining the specific toxic pollutants from soil, the metals are determined by atomic absorption spectrophotometry, in accordance with the standard analysis ISO 11047-1999 - the total form and the values were reported at the values specified in the Order no. 756/1997 [4]. For the present paper we consider the case of the soil pollution with Cu, Pb, Zn, Mn.

In soils, the natural copper content may be 20 mg/kg of dry matter; for the Baia Mare depresion case were established about 4500 ha of land with higher copper content of 300 mg/kg and 15500 ha with a content between 100 - 300 mg/kg.

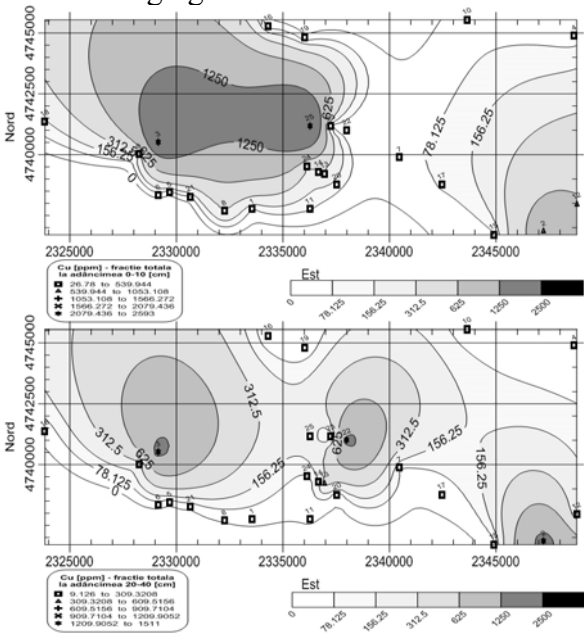

Fig. 8. The soils pollution with copper (Cu) in Baia Mare urban system

In soils lead falls can be reached by air or contaminated landfill (waste mining, metallurgy) being circulated by air or by water runoff from rainfall.

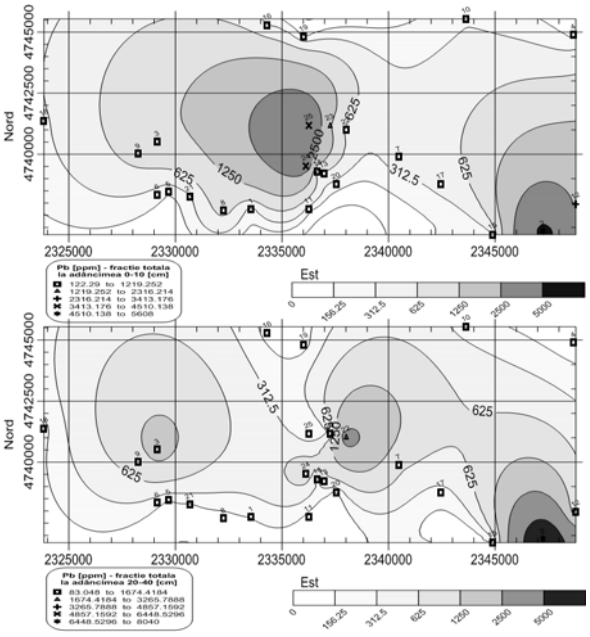

Fig. 9. The soils pollution with lead (Pb) in Baia Mare urban system

5. CONCLUSIONS

Current state of soil pollution inside Baia Mare area - is the result of 150 years of processing different heavy metals concentrates especially lead and zinc. The used technologies have excessively polluted the environment and affected the human health.

The concentration levels with heavy metals in uncontaminated dry soil mentioned in literature are: chrome 50 mg/kg, copper 12 mg/kg, lead 526 mg/kg, magnesium 450 mg/kg, cadmium 0,4 mg/kg, zinc 40 mg/kg.

As a result, environmental agencies are placed in charge in remediating, monitoring and mitigating the soil contamination sites. According to actual trend, Surfer software is used to monitoring the metal contaminants in the soil horizons, so the G.S. Surfer pollution models have a special ecological and technical implication.

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