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Original Article

An Insight into the History of Scientific Concerns about Soil Pollution in Maramures County

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Abstract

Expansion of cultivated areas, intensification of agricultural production process, industrialization and excessive urbanization, are so many causes that make the soil unable to fulfill its functions. Through this paper, we try to capture the research evolution on the soil pollution in Maramures county. Soil pollution in Maramures county is known to produce numerous discussions with high methodological importance for environmental impact assessment strategies and sustainable development politics of local and regional community. Taking into account the classical experimental models of soil pollution monitoring and the modern theoretical models of soil pollution assessment, we studied the possibility to implement and update the actual approach in the soil protectection field. Among different methodologies considered over time for characterization of soil pollution, we are doing a comparative study in order to understand the soil pollution evolution concerns. We first index the operating mode of those who in their works have studied soil pollution for the Maramureș county and after we extract the patterns of the methodology approached. The combined use of classical monitoring approach (via standard equipment, classical data preparation and disemination the results) and modern approach (via dedicated applications for all steps monitoring process) is revealed for the last decades and for the well-knowing polluted area of Baia Mare and its surroundings. In the present paper we demonstrated that the innovative technology associated with Environmental Information Systems applied for the soil pollution monitoring and assessment can be an alternative to classical monitoring approach.

Keywords: *classic vs. modern approach, Maramures County, scientific concerns, soil pollution.*

1. Introduction

Soil is the core of terrestrial ecosystems, and, at the same time, the basic support for life and human activities on Earth. In time, the concepts of soil, its role and importance have evolved, passing gradually, in stages, from a naturalist concept to a technicist one [1, 5].

The latter is based on knowledge on some characteristics, specific properties with well-defined numerical values based on different standardized methods, measurements, assessments and calculations [1, 3, 4]. For a better definition and understanding of soil at local, regional and national level, an assessment of soil layer (pedoshere) at large areas, in correlation with climatic regions and an increasing anthropic influence, is needed.

At this stage, the role of soil is widely accepted, not only in promoting and developing

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sustainable agriculture and other human activities, in maintaining environment quality, in global climate change, in biodiversity conservation, but even in the economy development as a whole [1, 2].

As a result of the action and processes caused by different environmental factors, soil - as part of natural capital (Fig. 1) - continuously adapts to changes in natural or artificial environment, recording and storing the main events of this evolution.

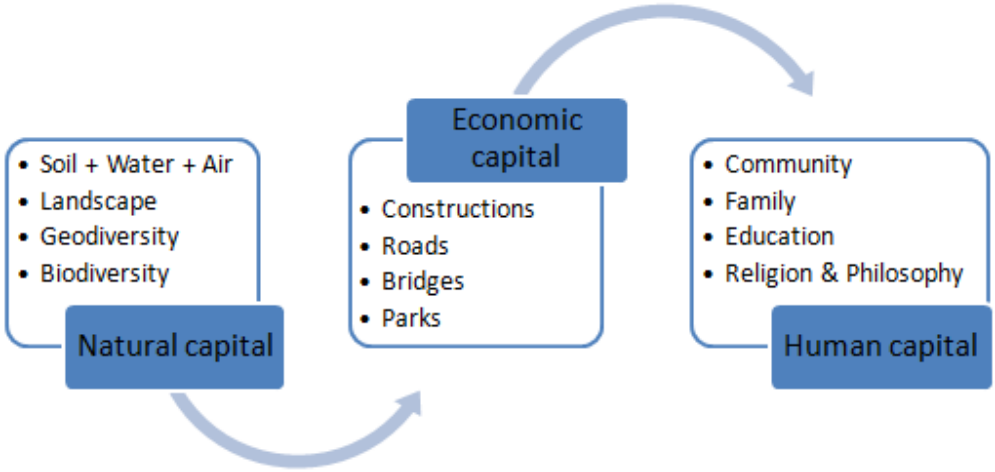

Figure 1. The environment has the structure of the natural - economic - human capital

To highlight the different processes and changes in soil state, even the soil pollution, a comprehensiv system, namely „monitoring system" has been developed.

This is defined as a set of plots where changes of soil characteristics are monitored by periodic measurements of soil parameters.

Soil monitoring is a systematic identification of soil variables in order to record the temporal and spatial changes, and to get a better definition and understanding of soil dynamics, to implement, where appropriate, the best available remediation technologies for polluted soils [3, 4].

Soil pollution in Maramures county is known to produce numerous discussions with high methodological importance for environmental impact assessment strategies and sustainable development politics of local and regional community. Through this paper, among different methodologies considered over time for characterization of soil pollution, we are doing a study, to understand the soil pollution evolution concerns in Maramures.

2. Material and Method

Expansion of cultivated areas, intensification of agricultural production process, industrialization and excessive urbanization, unreasonable exploitation of forests, are so many causes - precursors of environmental pollution - that determine the soil, implicitly the entire habitat, to be unable to fulfill, in part or in full, its fundamental functions [5, 6].

Nowadays, soil from Maramures county, according to the numerous articles in the scientific literature, is subject to a growing and increasing range of impacts that causes or intensifies phenomena and processes harmful to its quality - established around the process of transfer of pollutants into the soil, among which erosion, salinisation, alkalinisation or acidification, nutritional imbalances, etc.

All these phenomena are part of soil degradation, meaning the whole range of soil phenomena and processes, or soil pollution, if we refer to the introduction into the soil or on land of substances or energies that can cause changes in their physical, chemical or biological properties (Fig. 2) which affect its current or future use [5, 6].

Although soil pollution is an old phenomenon, closely linked to the many human activities that have been carried out at different stages of civilization development [6], due to its great self-purification capacity, the terms "pollution" and "historical pollution" have been imposed worldwide only after the United Nations World Conference on in the Environment, and the science of preventing and combating soil pollution still has a form of contact science.

Activities like mining, smelting or petrochemical refining are the main sources of soil pollution at national and global scale, even in Maramures county area [6].

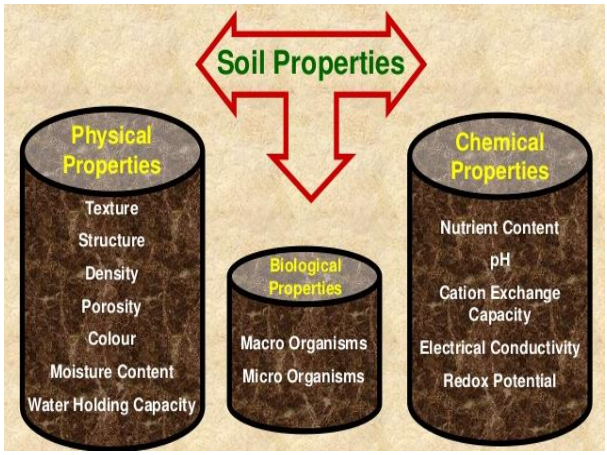

Figure 2. The physical, biological and chemical properties of soil

Studies proved the harmful effects that heavy metals and other elements have on the environment (soil) quality and human health.

The sources of soil pollution in Maramures county may be both natural (the rocks and soils) and anthropogenic (derived from socio-economic activities), as presentes in Table 1 [7].

Soil (continental) pollution, as in the case of Maramures county, starts from surface to depth, and is done by the transfer of pollutants, that is, by gravity deposition and under precipitation, or acts as a pressure factor.

Along with the classification of pollutants, in Table 2, is presented the pollutants action area on the main compartments of ecological systems [7].

Table 1. Examples of sources from the socio-economic system that generates heavy metals

Sources	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn
mining and ore processing	+	+		+		+		+
metallurgy	+	+	+	+	+	+	+	+
chemical industry	+	+	+	+	+	+		+
alloys industry					+			
paint industry		+	+		+			+
glass industry	+				+	+		
...								
fertilizers industry	+	+	+	+	+	+	+	+
oil refining	+	+	+	+	+	+		+
burning coal	+	+	+	+	+	+	+	

Table 2. Classification of environmental pollutants

The nature of pollutants	Compartment / Ecosystem affected			
	atmospheric	continental	limnos	marine
physical pollutants				
ionizing radiation	+	+	+	+
thermal pollution	+	+	+	+
chemical pollutants				
hydrocarbs	+	+	+	+
plastic materials		+	+	+
pesticides	+	+	+	+
...				
detergents		+	+	+
mineral particles	+	+		
heavy metals	+	+	+	+
other compounds of synthesis	+	+	+	+
biological pollutants				
dead organic matter	+	+	+	+

Among different methodologies considered over time for characterization of soil pollution in Maramures County, we are doing an incipient study in order to understand the soil pollution evolution concerns. We first index the operating mode of those who in their works have studied soil pollution for the Maramureș county, and after we extract the patterns of the methodology approached.

The combined use of classical monitoring approach (via standard equipment, classical data preparation and disemination the results) and modern approach (via dedicated applications for all steps

monitoring process) is revealed for the last decades and for the well-knowing polluted area of Baia Mare urban system and its surroundings.

3. Results and Discussions

Soil pollution in Maramureș County. The physico-geographical and pedological conditions of Maramures county, derived from those of Romania, present a great diversity for the main landforms, resulting in the wide variation of some parameters such as altitude, land slope, land use types, edaphic units, as well as soil quantitative and qualitative characteristics.

The soil physical characteristics of the agricultural monitoring sampling considered for Maramures county are as follows: soil textural class of the upper and intermediate horizon, structural instability index, the degree of compaction, saturated hydraulic conductivity, resistance to penetration, and edaphic volume.

Soil texture or particle size distribution of mineral part is defined by a certain proportion of particles, namely the fine part (sand, silt and clay), with specific sizes and properties.

Depending on the dominance of a certain component, classes and subclasses of soil texture are set up. Currently, soils from Maramures county are grouped into 5 major classes, but soil survey studies use, normally, a more detailed scale. It is also a simple feature with relatively high stability and utmost importance to soil pollution characterization in general, especially for agricultural land.

In the same context, one of the most important physical properties for soil fertility status is structural stability and shape of aggregates, which reflect micro-morphological, agro-physical and agronomic aspects. Another complex indicator, which characterizes the settlement of the soil as a function of total porosity and soil texture, is the degree of compaction. Both, the structural stability and degree of compaction, reflect the dynamics of soil pollution, and are used to establish soil management requirements for excessively polluted soils.

Alongside the previously mentioned indicators, a particular impact on the characterization of soil pollution in Maramures county is attributed to the saturated hydraulic conductivity, resistance to penetration and edaphic volume. In this sense, the saturated hydraulic conductivity characterizes the soil permeability to water for the control section, the resistance to penetration is the resistance that soil opposes to a complex application, and edaphic volume is showing the fine material content without skeleton, useful to plants, which can be integrated in different soil remediation techniques.

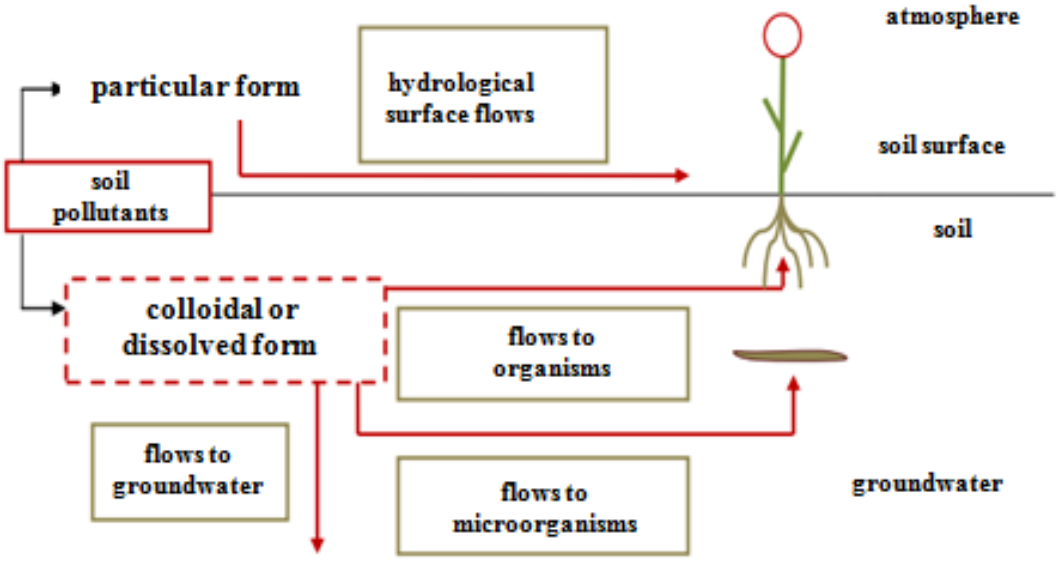

Figure 3. The schematic presentation of the pollutants transfer to the ground

The soil from Maramures area 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 and human activities over time.

The total pollutants content in this soils is the result of varied input - parental material, atmospheric

deposits, chemical fertilizers and improvements, organic fertilizers and other organic and inorganic polluting substances - minus pollutants output resulted from cropping or from leaching and volatilisation.

Problems generated by soil contaminations with different pollutant substances have recently interested more and more researchers worldwide, even from Romania, in particular from Maramures.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 of the peoples living in or near the affected areas. Soil contamination by heavy metals and oil products has an undesirable effect on environment quality and in human activities.

The phenomenon of soil pollution in Maramureș area is well-known, but also, widely studied - by numerous authors in their scientific papers - in all parts of the ecosystem, using classical, as well as modern soil monitoring approach (Fig. 3).

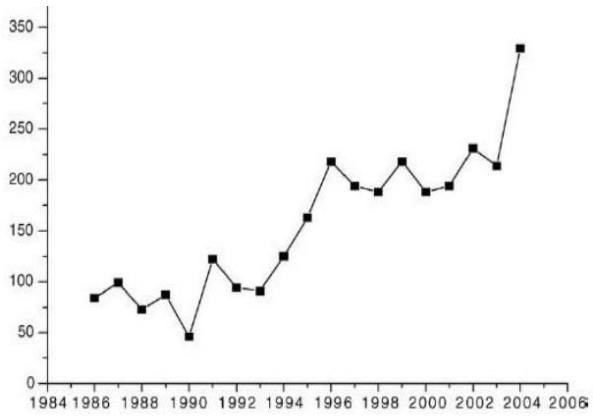

Figure 4. Evolution of interest for soil pollution in relation to the articles published in 1986-2004

The following areas are considered to be critical from the point of view of soil pollution, and integrated into modern approach (via dedicated applications - Fig. 4): the Baia Mare urban area, the tailing ponds area, the tailings dumps and the mining perimeters, the river meadows and valleys - due to the non-ferrous metallurgy.

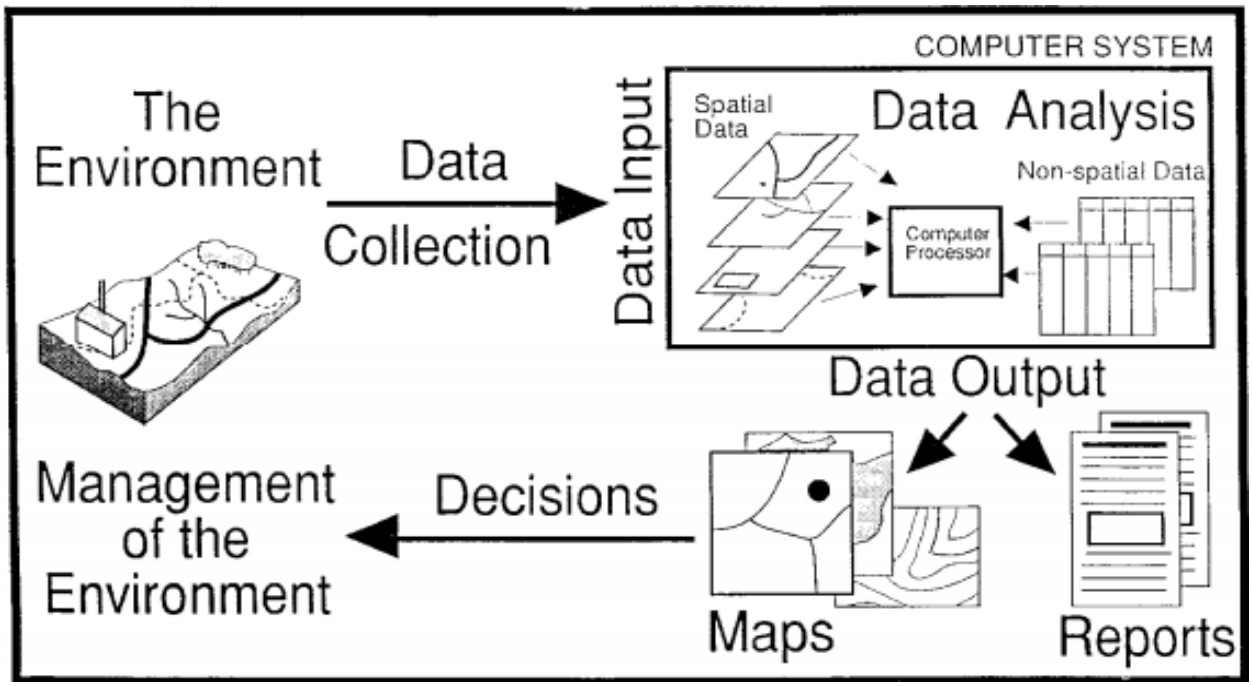

Figure 4. The methodology and procedures for studying the critical soil pollution areas

According to the scientific literature we considered, at first glance, without trying to be exhaustive, there are various sources of information related to soil pollution, most of them focusing on critical areas in terms of pollution, such us Săcel [8, 9, 12], Baia Mare [10, 11, 13, 15-18], Zlatna, Copșa Mică, Băiuț [14] etc.

In Table 3 and Table 4, we propose to explain some of the information sources, which treats pollution with heavy metals and petroleum products, but also involves various approaches, according to the authors' vision, with the projects requirements, or with the technological stage applied.

Table 3. Synthesis of existing information in the literature on the state of agro-systems and soil pollution in Maramureş county (few examples)

Bibliographic source	The way of obtaining information	Study area identification	Sample type analyzed	Observations (dissemination of information)
Răuță et al., (1997)	F	Baia Mare (BM)	Cu, Zn, Pb, Cd - total forms	variation intervals for pollutants concentration
Lăcătușu et al., (1998)	F + S	Baia Mare (BM) Zlatna (Z) Copșa Mică (CM)	Cu, Zn, Pb, Cd - total forms	statistical parameters, medium values
Tainã et al., (2001)	F	Baia Mare (BM)	Cu, Zn, Pb, Cd	micromorpholo-gical analysis
Dumitru et al., (2001)	F + P	Baia Mare (BM)	Cu, Zn, Pb, Cd - total forms	medium values
Lăcătușu et al., (2002)	F + S	Baia Mare (BM) Zlatna (Z) Copșa Mică (CM)	Cu, Zn, Pb, Cd - total forms	statistical parameters, graphic representations
Dumitru et al., (2004)	F + L + P	Baia Mare (BM) Zlatna (Z) Copșa Mică (CM)	Cu, Zn, Pb, Cd - total forms	variation intervals for pollutants concentration
Dumitru et al., (2005)	F + P	Baia Mare (BM)	Cu, Zn	variation intervals for pollutants concentration
Lăcătușu et al., (2005)	F + S	Baia Mare (BM) Zlatna (Z) Copșa Mică (CM)	Cu, Zn, Pb, Cd - total forms	statistical parameters, graphic representations
Konradi et al., (2008)	L	Baia Mare (BM)	Cu, Pb	relative values of the pollutants concentration
Manea et al., (2008)	F	Baia Mare (BM)	Cu, Zn, Pb, Cd, Mn	primary data, graphic representations

Legend: F - field studies | **L** - laboratory studies | **P** - processing analysis | **S** - statistical modeling (dedicated software)
BM - Baia Mare | **Z** - Zlatna | **CM** - Copșa Mică | **S** - Săcel

Table 4. Synthesis of existing information in the literature on the state of agro-systems and soil pollution in Maramureş county (few examples)

Bibliographic source	The way of obtaining information	Study area identification	Sample type analyzed	Observations (dissemination of information)
Big et al., (2012)	F + L + P	Baia Mare urban system	Cu, Pb	graphic representations
Cioruța et al., (2013)	F + L + S	Baia Mare urban system	Cu, Pb	graphic representations
Chira et al., (2014)	F + L + S	Baia Mare urban system	Cu, Zn, Pb, Cd - total forms	graphic representations
Cioruța et al., (2015)	F + L + S	Baia Mare urban system	Cu, Pb	graphic representations
Hreniuc et al., (2015)	F	Săcel (S)	soil classes, land use type, oil products concentration	graphic representations
Coman et al., (2016)	F + L + P	Săcel (S)	pH, oil products concentration	primary data, graphic representations

Legend: F - field studies | **L** - laboratory studies | **P** - processing analysis | **S** - statistical modeling (dedicated software)
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4. Conclusion

Through this paper we have tried to show that the available literature on the pollution of Romanian agro-systems, in particular the soil pollution in Maramureş county, presents studies whose data sets are characterized mainly by general information (primary data, average values, variation intervals etc.). This situation makes it impossible to generate statistical models of pollutants bioaccumulation in both soil and crop plants.

Another notable issue is the lack of georeferenced data on soil pollution, basically the lack of a specific approach to EISs and EI, which makes it impossible to assess the risk associated with a precise spatial delimitation within agro-systems.The modern approach and the statistical models - used in the soil pollution prediction in Maramures county - are of particular importance to the risk assessment and need to be applied only after a rigorous analysis of the area in which are intended to be used. Existing models in literature and the predictions, made so far, regarding the pollution associated risks, show large differences from one model to another.

This identified aspect highlights the fact that the development of statistical models, in the transition from the classic (via standard equipment, data preparation and disemination the results) to the modern approach (via dedicated applications), must be done specifically for both the pollutant involved in the transfer to the environment and the complex of analyzed ecosystems.

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