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REGARDING THE ECO-MODELS IN THE CHARACTERIZATION OF SOIL POLLUTION WITH HEAVY METALS

Mirela Coman[1], Larisa Muntean[2], Bogdan Cioruța[1]
[1]Technical University of Cluj-Napoca, North University Center Baia Mare, Faculty of Engineering, Baia Mare, ROMANIA, bciorutza@yahoo.com – comanmirela2000@yahoo.com
[2]Babes-Balyai University Cluj-Napoca, Faculty of Mathematics and Computer Science, Cluj-Napoca, ROMANIA, thesuperamazinglifeproject@gmail.com

Abstract: *Pollution is one of the most actual way of damaging the natural heritage. Among the categories of pollutants resulting from human activities, the chemically ones are stable and with long-term toxicity in environment. So, they increase the biggest enviromental management problems. Heavy metal pollutants resulted from non-ferrous metallurgy belong to this category. To base decisions regarding the management of contamination sites with heavy metals is imperious necessary to assess their impact on the natural capital components and socio-economic decisions. The first step in this direction is the knowledge of the distribution and behavior of pollutants in the environment. Present paper emphasizes the role that the mathematical modeling has in assesing contaminated sites. This approach, according to the current state of knowledge, includes conceptual models representing the state of contamination of one site and simulation for the pollutants behavior in our life environment. In terms of basic research in ecology, is a very important direction to couple the migration, the transport models of heavy metals or their bioaccumulation into a dynamic whole.*
Keywords: *systemic ecological models, heavy metals, pollution dynamics.*

1. INTRODUCTION

Nowadays, pollution is one of the most important ways of damage natural capital for our planet.[4]. Among the categories of pollutants, the chemically ones are stable and highly toxic. Heavy metals pollutants resulted from non-ferrous metallurgy belong to this category. To base decisions regarding the management of contaminated with heavy metals is necessary to assess their effects on both the natural capital components and on socio-ecological decisions. The first step in this direction is the finesse characterization of their distribution and behaviour in different systems of the environment [4,8].
Faction of defining the term "heavy metal" are very diverse meanings and found to be satisfactory in terms of the chemical. The first definition of the term in literature is performed by Bjerrum who consider "heavy metals" metals that have shaped elemental density greater than 7g/cm3. Over time this definition register changes, some authors considering the heavy metals the density greater than 4 g/cm3, others awarded a density greater than 5g/cm3 or 6 g/cm3. As a result of the multiplicity of performances was found not to be properly used in order to define, density test. Currently classification is carried out according to the chemical properties of metals, and the term "heavy metal" remains an unclear term natural sciences [10].
In Romania, there are some critical areas in terms of heavy metal pollution, like as Baia Mare, Zlatna or Copşa Mică surface. From all these intensive poluted areals, Baia Mare depression presents the greatest risk of interception of heavy metals through food production, due to high abundance of agrosistema structure [7]. In this context, the question of risk assessment is associated with the use of contaminated land for crops. Risk assessment requires characterizing spatio-temporal distribution of heavy metals, but also the human population exposure.
The are more mathematical modeling which permite us to preview the exposure assessment for human communities with heavy metals and modeling the actual stage in different enviromental subsystems, from dynamic systems point of view, like as soil or subsoil [8,9].

2. SOIL POLLUTION. HEAVY METALS– BACKGROUND AND MAIN ISSUES

The term pollution involve the environmental contamination with a pollutant, and the pollutant is considered a by-product derived from human activities, entering and becomes concentrated in the environment, where it can cause damage the health of the human species and a lot of the other species. Always, the pollutants include, in addition to chemicals, various type of wastes, a high level of noise or vibration, pathogens bacteria ect… So, on the definition of the pollution controversies arise in determining the correct meaning of the term "pollutant" in one moment. To understand soil pollution, we should, in the first instance, define the identity and nature of potential environmental contaminants [13].
The approach for a widely recognized classification of pollutants is a complex activity and are made from the perspective of several classification criteria. One usual method for this kind of classification, which takes into account the nature of chemical pollutants, is shown in the next table [14]**.**

Table 1. Classification of environmental pollutants (adapted by Postolache, 2000)

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	+	+	+	+

As we can see on **Table 1,** along with the classification of pollutants nature, is presented the pollutants action area on the main compartments of all ecological systems. Position "heavy metals" (Pb, Cd, As, Mn, Zn, Cu ect.) indicates, on the one hand, membership in the class of chemical pollutants, on the other hand, the character ubiquitously in their action on all types of ecosistems, because heavy metals are chemical elements that belong to the natural ecological systems. This has led to inflows from anthropogenic sources far exceeds the contributions from natural sources [1].
Along with the potential toxicity of metals, the anthropogenic factor indicates the priority to be given the choice of metals that need to be taken to work [10]. Is very important to notice that the sources of the origin of metals in the environment may be both: natural and anthropogenic. The main natural sources are the rocks and soils and the main anthropogenic sources derived from socio-economic activities, illustrated in **Table 2** [5].

Table 2. Sources from the socio-economic system that generates heavy metals (adapted by Bradl, 2005)

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	+	+	+	+	+	+	+	

Activities like mining, non-ferrous metallurgy, smelting or petrochemical refining are the main sources of pollution at global scale. Studies proved the harmful effects that heavy metals and other elements have on the environment quality and human health. In order to protect the life of citizens, many governments established the limits of different elements in soils and sediments for residential and industrial zones [3, 16].

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 and the pollutants gradually decomposes as a consequence of bio-chemical reactions in a very long time. So, 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 volatilization [6].
Heavy metals are alike both industrial interest as well as biological and ecological interest. Many metals are toxic due to its interchangeable because they are essential for the survival and health of plant and animal organisms, although most frequent emphasis on the aspect of pollution and toxicity. The oldest and the recent studies involved in the functioning of living organisms are either the large amount of Ca, K, Mg, Na, or in traces: Fe, Cu, Mn, Zn, Co, Nb, Se, Cr, Ni, V, Si, I [2].
The problem associated with the heavy metals involves two cases: one related to the excess of certain sections of the ecological system, which causes disturbance of their operation and hence damage to the health of the human species, and the second related to the deficiency quantity of certain metals, in agricultural systems, which determine limiting productivity. Heavy metals are an important category of toxic pollutants set.
Unlike organic pollutants, metals are not biodegradable, have character generally less mobile, and therefore persist in storage compartments (soil, sediment) for a long time. The metals are neither created and nor destroyed by biological or chemical processes. These processes can determine just transition of metals in various chemical species (changing valence) or convert between inorganic and organic forms.
One of the main problems associated persistence is the potential for bioaccumulation and biomagnification of heavy metals, which can lead to increased persistence in the ecosystem pollutant, with long-term risks to the ecological systems. [7,13].

2. SOIL POLLUTION WITH HEAVY METALS – ECOLOGICAL MODELING

Analysis of the behavior of a chemical in one particular ecosystem (plain, grassland, hardwood, river, flood ect.) is a complex problem because its distribution is done both compartments of abiotic and biotic. Transport processes of chemical compounds can be carried in the same compartment (water, air, soil) or between compartments mechanisms advection and/or dispersion. Once entered in complex ecosystems over a period of time long enough metals can be distributed by way of transferring to other departments abiotic ecosystem complexes or compartments biotic ecosystem complex, or in other ecosystems in complex through populations with mobility or passive active [14].
Transport and destination metals at spatial scales larger (regional and continental) is causally related to the physicochemical properties of the metal, environmental crossed and storage area. At ground level the metals are distributed according to the chemical state in which the through flow of surface water flows and groundwater seepage to streams bodies which take about trophic substances in the soil.
The spatial distribution of contaminants and receptors (animal or vegetable organisms) varies in time and space. Ways to transfer bodies are direct and indirect, and in case the contaminated soil is armed with, can develop a conceptual model that identifies predominant pathways of exposure to organisms.
In the vast field of science there are few features that can not be described in mathematical terms or few areas not eligible due to understanding patterns. Modeling has become an important tool in the analysis of ecological systems by offering the possibility of exploring hypotheses that can not be easily tested by field or laboratory experiments [15].
Representations of the term "model" have been proposed by various authors, for example [11] propose a model interpretation of the idea of the particular representation of an idea or condition that vary in complexity from simple form of attribution of an action on a subject to description of processes via mathematical equations. From the perspective of a large group of scientists, model is the formal description of the essential elements of a problem in the system of interest, that offers a simplified representation of reality. All models in ecology and natural sciences are simplifications of ecological systems [12].
The property used to be represented by simplifying reality itself attract a disadvantage inevitable imperfections inducing characteristics attributed model. A well-chosen model, in order to solve a problem, can generate satisfactory answers to explain processes, but at the same time can generate and inconclusive answers on other issues. Since the ecological systems and the features of their normal defined by high complexity and variability, it is inevitable a prioritization approach to conceptualizing to confer application models, a condition which will require, in almost all cases, significant limits [15].
A classification models proposed by Grant et al. and adapted by Jackson et all., systematise the dualization follows:

- physical and abstract ecological models;
- dynamic and static ecological models;

- empirical (correlation) and mechanistic ecological models;
- deterministic and stochastic ecological models;
- simulators (simulation) and analytical ecological models. [11]

But there are more and more detailed classification related to the ecological models used for charcterization of soil pollution with heavy metals one ofthem presented, for example, in **Table 3.**

Table 3. Classification of ecological models used for heavy metals soil pollution simulation approach [12]

The model type	Short characterization
models used for research purposes	used as a research tool
models used in management purposes	used as a management tool
static models	variables that define the system are not time dependent
dynamic models	variables that define the system are time and space dependent
linear models	considered equations of 1st degree
nonlinear models	higher degree equations or nonlinear functions
…	
causal models	inputs, state variables, the outputs are interrelated through causality
autonomous / independent models	variables that define the system are not explicitly time dependent
dependent models	variables that define the system are explicitly time dependent

The mathematical models that describe environmental processes are characterized by heterogeneity, something that the emergence of a criticism of these models by generating redundancy models that describe processes or different methodologies. It can be registered that mathematics provides a general language to describe and analyze environmental issues, without which there would be less possible to resolve them.
However, it is less possible to define a language generalist nature to achieve a model capable of describing a model generally.

4. CONCLUSION

Although from the perspective of local biogeochemical circuits of heavy metals is a relatively simple process, it appears that existing scientific literature is very rich and so far from an unique ecological model of soil pollution with heavy metals characterization.
We agree that the existing models can be grouped into two groups: deterministic models and statistical models.
The advantage of deterministic models is that they are easily generalized to apply to all types of ecosistems where the species are present and for which the models were developed. But from a practical standpoint this theoretical advantage is limited by data availability just for the parameters used in the aplyed models.
At the other extreme, the statistical models are based on total concentration of metals in the soil as independent variables. The disadvantage of this group of models is that generally obtained functions are applicable only to the area where the data was obtained that led to the construction models.
In terms of basic research in ecology, is a very important direction to couple the migration, the transport models of heavy metals or their bioaccumulation into a dynamic whole.
In the current state of knowledge, for the environmental assesment impact studies, usable tools easily assess the risk associated with heavy metals are especially statistical models, because of the simplicity of obtaining the necessary data and financial resources.

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