BIOLOGICAL INDICATORS OF HEAVY METAL IN WATER AND SOIL

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Abstract

The land and water pollution is very frequently encountered. The Black Smith Institute of New York comes out that there are the most polluted places in the world. Hierarchy criteria for creating the rank with the most polluted places were: the number of the people affected the toxicity of the agents and the evidence regarding the health problems caused by pollution in a certain area. The objective of this work is to identify points of view regarding heavy metal pollution as well as providing details on environmental technologies on the rehabilitation of contaminated sites, like GEOLIFE technology. We offered some examples about plants that could be used as bioindicators for soil pollution and about the consequences of the pollution of marine ecosystems by heavy metals, from the Black Sea Coast. The treatment of the contaminated water with ecological product PETROLSYNTH generates rapid decomposition of the existent contaminants, the removal of the existent materials, the appearance of vegetal algae immediately after the treatment, immediate application of the treatment, low costs in order to apply the treatment.

Key words: biological indicators, heavy metal pollution, bio-remedy

Soil and water pollution with heavy metals is the most common occurrence and is among the most polluted places in the world, top drawn by the Blacksmith Institute technical commission from New York. Hierarchy criteria were the number of persons affected, toxicity of substances and the evidence concerning the health problems caused by pollution in the area.

From the etymologically point of view, the word pollution comes from the Latin verb "plluo-polluere" which means *to dirty, to stain, to defile, to degrade*. According to a widely spread definition (Chifu and Murariu, 1999; Acatrinei, 1994), *pollution* is a process of deterioration of the living environment (biotic and abiotic) and of manmade things, process caused mostly by human activities waste, of domestic origin, agricultural, industrial etc., and because of natural phenomena (volcanic eruptions, dust storms, floods etc.).

Water pollution is the phenomenon through which negative qualitative changes of natural properties of the water occur, which have as a result its partial or total removal from usage

By the definition given by the U.N., "*water pollution represents the change either directly or indirectly of its normal composition, to an extent to which it threatens all the uses to which could serve in its natural state*."

The main sources of water pollution with heavy metals are:

- **natural**: geological territories;

-**anthropogenic**: the mining and metal processing industries; industrial and domestic usage of salts of heavy metals (chromium in tanneries, copper and arsenic in pesticides, lead in petrol); from human and animal excrement; from infiltrations from garbage waste dumps.

Soil pollution represents any action that disrupts the normal functioning of the soil.

Because soil is a much more complex system than air and water, pollution affects its properties, and therefore its fertility. In addition, pollutants can move from soil into plants, water, or air and depollution is a difficult process, sometimes even unattainable.

The risk of soil and plants pollution depends on the structure and the characteristics of the soil, plant species, chemical form, combinations of heavy metals in the soil and the metal concentration, climate conditions.

The edaphic factors which influence the mobility of heavy metals and their accessibility for the plants are: soil texture, pH, organic matter content, cationic exchange capacity and the soil's drainage (Chifu and Murariu, 1999; Acatrinei, 1994).

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The sources of heavy metal pollution are:

- domestic and industrial wastewater;
- waste deposits, waste from mining and other industries;
- fertilizers, pesticides;
- transports.

The transport of heavy metals in soil takes the form of:

- dissolved or in suspension compounds;
- gases in the form of volatile compounds;
- leached particles;
- by soil microorganisms which incorporate heavy metals in their biomass.

The accumulation of heavy metals in the soil takes place until the limit of toxicity, causing imbalances of physical, chemical, biological process that take place at this level.

These elements can accumulate in the plant and animal biomass through processes of bio concentration along the food chains.

The purpose of this paper is that of a systematization of existing points of view regarding the heavy metal pollution, as well as providing details about environmentally friendly technologies with respect to the rehabilitation of contaminated areas.

We took as an example, some plant species bio indicators of pollution in the soil, and for the aquatic environment, we wanted to bring up some consequences of heavy metal pollution on the coastal marine ecosystems from the Romanian Black Sea Seaside.

It is estimated that currently one of the topics of great interest for the Black Sea area is linked to the estimation of the intensity of chemical pollution of the marine environment and its impact on the marine organisms (Kostianoy et al, 2008). Worldwide, heavy metal pollution of the aquatic environment has been brought into the spotlight by a series of serious incidents, with implications including on human population, due to poisoning with mercury, cadmium and other metals. It is well known the case of pollution with mercury of Minamata Bay's waters, Japan, due to discharge of industrial waste water. Thus, in 1956 among the local population have been reported about 2,000 cases of alkyl- mercury poisoning caused by eating contaminated fish and shellfish (Mance, 1987). This kind of serious incidents stimulated since the 60s and 70s the studies of marine pollution. Besides natural sources (erosion of rocks, volcanic emissions), heavy metals are released into the environment in large quantities from activities associated to mining, metallurgical industry, manufacture of products, combustion of fossil fuels or waste incineration.

Measurements of heavy metals in the marine ecosystem components (water, surface sediments, mollusks) alongside Romanian seaside were initiated in the 80s within the monitoring program and have been continued until now (Şerbănescu et al, 1980a, 1980b; Mihnea & Pecheanu, 1984; Pecheanu & Mihnea, 1986; Mihnea & Pecheanu, 1988; Mihnea et al, 1991; Oros & Pecheanu, 2001; Oros et al, 2003; Oros, 2008). A series of evaluation studies of natural or anthropic

MATERIAL AND METHOD

During the last decades, increased contributions of contaminants and habitat destruction caused drastic changes in aquatic ecosystems. On this line, the scientific interest for the following areas has increased: accumulation and toxic effects of contaminants on aquatic organisms; taking over and accumulation of contaminants in the marine resources for human consumption.

The effects of the pollutants can be detected at multiple levels of biological organization, from the entire ecosystem to subcellular and molecular level. The most relevant Eco toxicological assessments, from an ecological point of view, are those that describe the changes of the structure and function of ecosystems. These measurements are often difficult, time-consuming and do not allow correlating the degree of modification of the ecosystem with a particular level of contamination.

Biological monitoring or bio monitoring can replace or supplement the instrumental monitoring. Bio indicators are species, populations or groups of species which, due to their variability (biochemical, physiological, ethological or ecological) allow characterization of the condition of an ecosystem and highlight, as early as possible, its natural or anthropogenic changes. The complementarity of the bio monitoring lies in the fact that the instrumental surveillance carries out instant and regular measurements related, in general, to abiotic factors, providing only quantitative information. Biological monitoring, however, can provide an indication of the variation in time, accumulation or the effect of interaction of certain abiotic factors and about the response of individual living organisms or communities of organisms to environmental changes. As for the indicators of pollution, there are three types: sensitive species, that indicate the presence of a pollutant through injury or malformations, accumulating species, which concentrate the pollutant in their bodies, and species that proliferate and become abundant in polluted areas.

Among the plant species that are used as bio indicators for different pollutants there are:
St. John's wort for hydrofluoric acid, coleus for ozone and peroxyacetyl nitrates, zizania for hydrofluoric acid and heavy metals, lamb's lettuce for heavy metals, alfalfa for sulphur dioxide, barley for heavy metals and compounds of fluorine, maize for hydrofluoric acid, sulphur dioxide, heavy metals etc.

One of the groups of organism that are used as bio indicators is also represented by mosses, which are also suitable for biological monitoring.

In order to complete the analysis carried out on water and sediments (Mee and Topping, 1998), for the improvement of the programs of monitoring and evaluation of the degree of pollution of the Black Sea, the use of sessile organisms (molluscs) as pollution bio indicators has been recommended, as they are widely spread in the region.

The term of biomarker defines the biological parameters which are modified when an organism is exposed to the pollutants in the environment. The concept of biomarkers does not refer only to the biochemical measurements but also includes: cellular pathology, physiological processes and even the behavior of an organism exposed to pollutants (Narbonne, 1992; Depledge & co., 1992).

This makes possible the sequential use of biomarkers, starting with the nonspecific ones (physiological) and ending with the specific biochemical and cellular (for example, the activity of mixed function oxidases, metallothionein, intercellular granules, tissular lesions (Couch & co., 1985; Livingstone, 1989; Viarengo, 1989; Stegeman and col., 1992). The magnitude of the answer of the biomarkers, together with the identification of the tissular concentration of the pollutants, contributes to the general evaluation of the impact of pollution.

The behaviour of heavy metals in marine organisms is described by the takeover, storage, excretion and regulation. In order to understand and explain the variability of the tissular levels of metals, general models concerning the takeover and the storage if metals will be discussed.

Different technologies among which the GEOLIFE technology, offer products that insure the biological treatment, without the contribution of chemical substances, rehabilitating the areas contaminated with hydrocarbons and petroleum products (PETROLSYNTH) or heavy metals and radioactive elements (RADIOSYNTH).

PETROLSYNTH contains a formula composed of an assembly of facultative aerobics and anaerobic produced by microorganisms derived from selected spontaneous processing and fermentation adapted for soil and areas contaminated with hydrocarbons and their derivatives, heavy metals, solvents, chemical colorants etc. (*figure 1).*

Figure 1 **Presentation of the product PETROLSYNTH**

As a concentration of degradation enzymes and microorganisms selected in order to be applied on soil and areas contaminated with hydrocarbons, the product operates those forms of continuous activity in the decomposition of complete substances in simple elements. Multiple colonies of vital microorganisms helped by C.O.H. concentrations (organic hydrolytic catalysers) activate their own reactions into an ample spectre between the superior pH values, activating the principles of complex decomposition.

ANALYSIS: Aerobic, anaerobic and facultative bacteria in concentrations which are not inferior at each 10 gr.

70.000 Proteases/Casein Digesting unit./g

1.200 Lipases

7.000 Celluloses

MAIN ELEMENTS:

Micronutrients-Proteases - Nocardia - Cellulase - Pseudomonas putida strain 1/2/3 - Bacillus Amyloliquefaciens - Lipases - Aspergillus Orizae – Humic acides –Fulvic acid - Ureasis - Lipoproteins - Trypsin - Phosphorylases - Transaminase - Phenolase - Peptidase - Nucleotidase - Carbonates - Zeolites - Silicates – Optimal activity with pH 7 - 10,5 / average activity with pH 3,5-13,0

ANALYSIS TECHNIQUES:

Priteases/Lipases./Cellulase

PETROLSYNTH is a product 100% ecologic product, chemical free, without GMO (genetically modified organisms), without pesticides, without heavy metals, hormones and phyto-stimulators, it's not a pathogen, it does not have Salmonella, it is not corrosive, it is not toxic for people, animals and the environment.

Hydrocarbons pollution can be treated up to 50 cm, in layers of 20-25 cm, on condition that there should be a level of humidity high enough in the soil (min. 40%), otherwise the surface must be watered from time to time. The amount of PETROLSYNTH needed on an area unit depends on the organic loading (the bigger the organic loading, the bigger the amount of Petrolsynth product).

RESULTS AND DISSCUSIONS

Petrolsynth product accelerates the kinetics of the oxidation process-decrease which decompose organic products, under the action of amylase, cellulases, nucleotides, hydratases etc.

This means a good acceleration in organic decomposition, and a good extractive capacity of bacterial strains, leading to the decontamination of waters used in repeated processes of chemical decomposition.

The biocalaytic-enzymatic composition of the product, can be finally changed into substances such as pyruvates, through metabolization, due to its organic structure.

Results obtained through the combined application of the enzymatic biocatalysis products and Bauxsol Technology products:

- rapid decomposition of the existent contaminants (mineral oil from 12000 mg/kg after a 3 day

treatment there is a decrease with approximately 98, 5 %, *table 1*);
• the removal of the existent materials (decrease over 99%, *table 1*);
• the appearance of vegetal algae immediately after the treatment);
• immediate application of the treatment;
• low costs in order to apply the treatment.

Table1

Results of the Treatments with PETROLSYNTH, SIMAM, 02.08.2004 – the treatment of waters contaminated with hydrocarbons and the existent metals (As,Cd, Hg, Fe)

Parameters	Concentrations before the treatment	Concentrations 3 days after the treatment	Concentrations 5 days after the treatment	Concentrations in final residues
pH	7,7	7,4	7,3	6,9
Oil (mg/Kg)	12.000	180	103	n.a
Mercury µg/kg	3	3	<0,03	<0,005
Arsenic µg/kg	25	25	0,23	<0,05
Cadmium µg/kg	106	106	0,95	<0,05
Iron µg/kg	360	360	3,6	<0,05

CONCLUSIONS

The present study aimed at reorganising the already existent points if view concerning the heavy metals pollution, at the same time underlining the importance and the need of an investment for ecological products having a practical use in the environmental protection and the sustainable development.

Investing in the future depends to a great extent on the way and the concept that we choose follow, which can meet many of the requirements imposed, with a positive reflection on average and long term, concerning both the environment and the health of human beings.

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