PHYTOREMEDIATION OF SOILS INFESTED WITH RADIONUCLIDES AND HEAVY METALS

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Among many other problems that Romania has to resolve in the perspective of EU integration is the quality of the ecological factors. Unfortunately, nowadays, even if the monitoring of these factors is close to the imposed demands, the parameters are far from European exigency. The soil is damaged and the costs for redemption are very expensive. On the other hand, phyto-remediation is at hand. This is based on the capacity of some plants to absorb radionuclides and heavy metals from the soil. This process may be active or passive and now it may be made with genetic engineering help.

Key words: phyto-remediation, heavy metals, radionuclide, soil.

INTRODUCTION

Environmental pollution can be defined as the direct or indirect impairment of the environments suitability for supporting life by harmful concentration of materials, whether or not toxic materials. Thus, a very high concentration of a nutrient might be polluting, whereas a deadly poison in great dilution is not.

Earlier in this century, wastes could be discharged into the environment with relative impurity. Two factors have changed this. One is the population explosion – more people mean more pollution. The other factor is the rapid advance of technology and affluence that has occurred in the industrialised countries and which has increased the production of toxic pollutants. Unlike biological wastes, the wastes that result from mining, processing of raw materials and manufacturing are often highly toxic.

Heavy metals like Pb, Cd, As, Zn, Cr, Cu and radionuclides may damage especially soils in the experimental military area. Passive bioaccumulation is based on bioabsorption and biostopping.

Phytoextraction consists in using plants to absorb toxic metals from soils collecting parts in radices, leaves, flowers and fruits. Radices filtration is based on radices property, which grows in well-aired water from precipitations and concentrates toxic metal by phytovolatilisation based on plants property to establish in soil and make them inactive.

Phytovolatilisation is based on extraction by plants of heavy metals from soil and evaporation at the level of leaves.

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These techniques have already been used in the USA and Germany army in target polygons. These plants are: *Thlaspi colruleslens* for Zn, Cd, Pb, *Achillea millefolium* for Zn, *Slyssum* sp. for Ni, cabbage for Pb and Cd. These plants cannot be consumed by animals or people. Plants must be incinerated. Some metal may be recuperated from ashes. Advantages:

- Lower costs for soil decontamination
- Possibility to recuperate the heavy metals
- Minimal perturbation of the environment
- Total leak absence of secondary or tertiary toxic components

Disadvantages:

- One plant can hyperaccumulate a single element
- Depollution time is long.

RADIOACTIVE POLLUTION

One type of radioactive pollution is the contamination that arises from normal operation in the production of nuclear weapons and the operation of nuclear power plants. These operations include the mining, processing, transporting and storing of radioactive ores; the normal operating of power plan and weapon arsenal; the storage and reprocessing of spent fuel and the storage of the radioactive components of decommissioned overage facilities. Possibilities of environmental contamination can occur during the process of producing electricity from nuclear fuel:

1. during the mining and processing of ore;
2. during the operation of nuclear power plants;
3. during the reprocessing of spent fuel;
4. in the storage of radioactive wastes.

Because the mine tailings of uranium ore extraction are themselves radioactive, they represent a threat to the health of miners and anyone else who lives or works in their vicinity for a time. The processing of uranium ore involves its enrichment to increase the proportion of uranium (U^{235}) by three to four times the natural level. Radioactive contamination of the environment generated by the enrichment process is minimal and it not regarded as hazardous.

In the operation of nuclear power plants, minor defects in boiling water nuclear reactors result in a small leakage of radioactivity into the cooling water circulating through the reactor core and thus into the environment. Some krypton-85 also escapes as a gas. Both of these "routine emissions", however, are at such a low level as to be comparable to the normal background of radioactivity from rocks and the cosmic rays from the outer space. Barring accidents, nuclear power plants operation is not regarded by industry as a significant threat to health.

Reprocessing of fuel rods involves dissolving them in concentrated acid and recovering uranium and plutonium. This procedure leaves a waste solution that remains highly radioactive for as long as a million years. The liquid, which is said to boil "like a teakettle", was to be temporarily stored in huge tanks until it cools. Reprocessing regularly results in the emission of radioactive gases (for example krypton-85) more long lived than those emitted during the operation of a power plant. A slight increase in cancer deaths – well under 1 percent – was expected to result in those exposed to this pollution source.

Regulations provided that the liquid be converted to a solid form within 5 years and shipped to an approved depository within 10 years. What some regard as the main problem with nuclear power occurs at this point; no generally satisfactory way has been found of permanently storing these wastes for as long as thousands of years, let alone hundreds of thousands. Storage of the liquid in tanks has not proved practicable. Not only it is impossible to design a tank that will last for even 100 years, but between 1969 and 1980, 16 cases of leakage from tanks occurred in the United States, permitting the escape of over 1.3 million l of radioactive liquid into the environment.

The impasse over the storage problem and the problem associated with reprocessing nuclear fuel has halted all reprocessing since 1972. One approach to storage is to incorporate the liquid into solid blocks of glass for storage in abandoned salt mines equipped with remote-control television cameras for continual monitoring.

TOPSOIL POLLUTION

It is easy to see why we should conserve short supplies of renewable resources. Yet slowly renewable resources need to be guarded just as closely. Topsoil, for example, that upper portion of the soil from which the roots of food crops absorb their nutrients, is not only essential for growing such crops, but also for maintaining natural communities. It accumulates very slowly in grasslands, at a rate of only a few centimetres per century. Without proper protection, however, a single storm can wash or blow away a layer of topsoil several centimetres deep. Most of the soil is then lost to lakes or oceans.

However, the loss of the earth's topsoil reaches a high crisis in many parts of the world. Nowadays, deforestation and overgrazing are producing a worldwide pattern of topsoil destruction similar to that which occurred in most of the Mediterranean countries. Destructive landslides as well as silting and flooding of lowlands have been increasing as a result.

MATERIALS AND METHODS

In Clinceni area we find that some heavy metals accumulate in some local flora as a resultant of targeting. After drying and mortaring, the probes were transferred in the measure box of an analyser multichannel PCA_P SUA BICRON with a detection probe in the spectrometric range and with a scintillator NaI(TI)3*3 inches and an analysis program for atomical absorption spectroscopy QUANTUM ASSAYER. In the whole year 2001, in a 1.1 km area, we obtained the results presented in Table 1.

Table 1

The plant	**Concentration (mg/ kg soil)**				
	Pb	**Cd**	**Zn**	**Cu**	**Mn**
Bunias orientalis blind	10	1.25	45	12	11
Bunias orientalis	840	22.5	788	19	107
Achillea millefolium	442	35.2	527	20	40
Verbascum phlomoides	172	4	263	20	2
Convulus arvensis	157	8.5	683	32	99
Sinapsis arvensis	40	4	28	21	46
Caucalis platicarpos	83	5	–	–	–
Linaria vulgaris	31.5	4.25	–	–	–
Metal in soil	1250	48.75	2657	94	323

These determinations are made with plants treated with hot air. Large accumulations were signalled in superior parts of Achillea and Bunias. Allelopathy was noticed between those two plants and there were found together. These two plants are considered having high efficiency in phytoremediation.

So, 35 tons from the phytocenosis ***Bunias / Achillea*** can be annually extracted per hectare: 24.8 kg Pb, 0.78 kg Cd and 32.3 kg Zn. *Bunias orientalis* can stabilise eroded soils. Some technical plants like sunflower can be used with good results. This is a project in progress.

REFERENCES

1. Kumar P.B.A., Motto H., Raskin I., *Phytoextraction: The use of plants to remove heavy metals from soils,* Environment Sci Tech, vol. 29, 1995, pages 1232–1238.
2. Reeves R, Baker A. J., *Phytoremediation of toxic metals,* Review of Plants for Future Publication, London, 1997.
3. Barnett, Abramoff, Kumaran, *Millington Ecology*, Prentice Hall, Marquette University, 1990.
4. Ehrenfeld D.W., *Biological Conservation Halt,* Rinehart and Winston, New York, 1980.
5. Turk J., Turk A., *Environmental Science*, Saunders, Philadelphia, 1984.
6. Wagner R.H., *Environment and Man*, Norton 3rd, New York, 1978.

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