



## Phytoremediation: Using Plants to Treat Environmental Pollution

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### Abstract

Heavy metals are among the most important sorts of contaminant in the environment. Several methods already used to clean up the environment from these kinds of contaminants, but most of them are costly and difficult to get optimum results. Currently, phytoremediation is an effective and affordable technological solution used to extract or remove inactive metals and metal pollutants from contaminated soil and water. This technology is environmental friendly and potentially cost effective

### Introduction

The term phytoremediation comes from the Ancient Greek word phyto meaning “plant” and the Latin word remedium meaning “restoring balance.” It is a technology that uses plants to treat environmental pollution problems. Plants are used either to remove or to stabilize (hold in place) pollution in the soil. Compared to other methods used to remove toxic substances from soils, phytoremediation is often less expensive, although it may take a long time. Another benefit is that it covers the site with an attractive layer of plants that prevents wind and water from carrying the pollution to other places.

Heavy metals are excessively contributing towards the Environmental pollution all over the world. There is a major release of heavy metal from the extraction of ores for mineral and then their processing for their use in different areas leads to the pollution as the heavy metals are highly mobile in the environment that is the main reason of their presence in environment.

The occurrence of heavy metal is becoming much more severe because of the increase in the industrialization and severe disruption of natural biogeochemical cycles. Heavy metals are non-biodegradable elements and they tend to accumulate in the environment for longer run as compared to those of organic substances. Their accumulation in the soils and water bodies leads to the threatening effects on the human health as they are more likely to enter the food chain. Heavy metals have the capacity to bio accumulate in the tissues of human body, they also have the ability to bio-magnify by reaching in to higher trophic level from lower trophic level.

They also cause the decrease in microbial activity by causing toxicological changes in the microbes of soils. Heavy metals are divided in two categories on the basis of their role in the biological system one are essential heavy metals and other are non-essential heavy metals. Essential are those, which are required by living organisms in smaller amount but have a significant role in the biochemical and physiological functioning of living organisms as well. Some essential heavy metals are Fe, Mn, Cu, Ni and Zn, whereas the non-essential ones are not required by the body for any such functioning and the examples of them are Pb, Cd, Cr,

Hg and As Cr. Heavy metals have the tendency to interfere with the normal functioning of human body and they are very harmful for living systems above certain limits.

### **Sources of heavy metals in the environment**

Heavy metals can enter into the environment from both natural and anthropogenic sources. The natural processes that contribute towards heavy metals releases are volcanic activity, weathering processes of minerals and erosion. Whereas the anthropogenic activities concerning with heavy metals are mining processes, electroplating, smelting use of fertilizers and pesticides especially phosphate and also the use of biosolids in agriculture, discharge from industries, dumping of sludge, and deposition of heavy metals through atmospheric processes.

### **Harmful effects of heavy metals on human health**

Heavy metals have the ability to affect the human health on great levels. They are posing adverse impact on the quality of health as they can access the food chain through soil and water because of the contamination of these environments through the natural and anthropogenic activities.

Heavy metals and metalloids have the tendency to cause harmful toxicological effects even if enter in very small amount. They have the capacity to cause oxidative stress as they produce free radicals , increased production of very reactive oxygen species refer to as oxidative stress which can increase the antioxidants in the inside the cell and results in damage or death of the cell . Besides, they also have the ability to replace the enzymes or attach in place of enzymes causing their normal function to disrupt.

The most harmful heavy metals of all are Cd, Hg, As, Zn, Cr, Pb, Sn and Cu because they are more toxic [23,24]. Many of metals in them are non-essential and some of them are essential heavy metals but are trace elements. Different health issues are more likely to be concerned with the heavy metals accumulation and it also depends on their oxidation state and concentration.

The increase in the concentration of heavy metals in the environment has been reported after every passing year. Different cases of heavy metal pollution have been reported, a total  $2.88 \times 10^6$  ha area of land has been disturbed because of the mining activities in China and adding to that another 46700 ha has also been destroyed on annual basis due to the same purpose . These disturbed lands are incapable of producing vegetation and favor more soil erosion and pollution. Other cases reported in Netherlands and Belgium where almost 700 km<sup>2</sup> area of the region is polluted by the deposition of heavy metals from the atmosphere, heavy metals are Zn, Pb and Cd. Because of these issues the need of the hour is to cope up with these challenges lessen the impact of this pollution on the ecosystems. The cleanup of these pollutants is reported to be a challenging job because of their costliness and the techniques required for that are very complex as well.

Different types of chemical physical and biological approaches have been used for the cleanup. There are many conventional methods for this purpose that are soil incineration, soil washing, solidification, soil washing, soil flushing, excavation and landfill, stabilization of electro-kinetic systems, in situ verification. The methods with physical and chemical techniques have various limitations as they are not really cost effective, require more labour, leads to the disturbance in the micro flora of the soil and leads to irreversible changes in the properties of soil. Chemical techniques are not really trustable as they lead to the formation of secondary pollutants some way or the other. So, it is the need of the hour to execute a cost-effective approach which is side by side environment friendly and efficient method for the remedy of heavy metals. Phytoremediation is that novel approach which is a green solution as compared to other solutions.

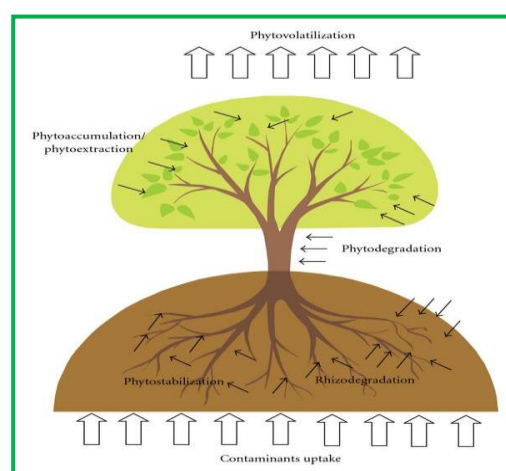
## Advantages and limitation of phytoremediation technology

Advantages	Disadvantages
Applicable to both inorganic and organic contaminants.	Not accessing elements below the root depth
It can be applied in situ	Management of plant matter after phytoremediation.
Reduces the amount of waste going to landfills	Low bioma.
Does not require expensive equipment or highly specialized personnel.	The bioavailability of the pollutants.
Phytoremediation is cheaper than conventional remediation methods.	Restricted to sites with low contaminant concentration
Easy to implement and maintain. Plants are a cheap and renewable resource, easily available	Introduction of inappropriate or invasive plant species should be avoided (non-native species may affect biodiversity).
Environmentally friendly, socially accepted.	Environmentally friendly, socially accepted.
Less noisy than other remediation methods.	Possibility for contaminants to enter food chain through animal and plant consumption.

## Techniques of phytoremediation

Different techniques have been introduced to exploit the potential of plants for the removal of hazardous compounds from contaminated water and soil. Schwitzguebel has explained different technological subsets of phytoremediation :

- **Phytoextraction (Phytoaccumulation):** Removal of pollutants using the plants having the ability to accumulate pollutants from the soil and store them in their shoots so that they can be harvested.
- **Phytotransformation:** It is the phenomenon in which the complex organic molecules are converted into the simpler one by degrading them and the simpler one can then be incorporated in the tissues of plants.
- **Phytostimulation:** This process includes the stimulation of enzymes present in the rhizosphere which can lead to the bioremediation using microbes or fungal degradation by releasing exudates.
- **Phytovolatilization:** In this the plants take up the pollutants and then they can volatile from the surface of the leaves.
- **Phytodegradation:** In this technique, there is the use of enzymes for the breakdown of harmful organic pollutants like herbicides or trichloroethylene. This can happen both inside or outside the plants as the plants can also secrete the enzymes outside.
- **Phytorhizofiltration:** It is the inhibition of organic pollutants from mixing into the water streams or groundwater using roots for filtration purpose as they can absorb or adsorb the pollutants.
- **Phytostabilization:** This technique involves the prevention of mobility of organic pollutants into the soil thus reducing its bioavailability and stops them from entering into the food chain



The mechanisms of heavy metals uptake by plant through phytoremediation technology

## Conclusion

Heavy metals are said to be persistent in the environment leading to cause pollution by entering into groundwater and food chain. They cannot be degraded in the environment so there is a need to develop a proper remedial plan for their removal from the environment. Plants are being used for the betterment of the effected soils in several areas by the scientists. The use of plants for the removal of contaminants from the soil is phytoremediation, a green solution for the problem of heavy metals. This is the fast, innovative, emerging, ecofriendly and cost effective alternate to the conventional remedial method. Further research is obligatory to observe the economic and ecological competences of Phytoremediation.

## References

1. Bieby Voijant Tangahu, Siti Rozaimah Sheikh Abdullah, Hassan Basri, Mushrifah Idris, Nurina Anuar and Muhammad Mukhlisin (2011)., Hindawi Publishing Corporation International Journal of Chemical Engineering Volume 2011, Article ID 939161, 31.
2. Rohma Razzaq (2017)., J Environ Anal Chem 2017, 4:2 DOI: 10.4172/2380-2391.1000195
3. Kokyo Oh, Tiehua Cao, Tao Li, and Hongyan Cheng (2014)., Journal of Clean Energy Technologies, Vol. 2, No. 3.