PHYTOREMEDIATION

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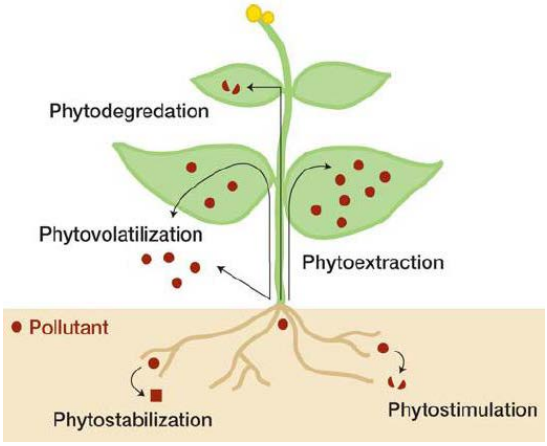
Heavy metals are individual metals and metal compounds that can impact on human health. Eight common heavy metals are arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. These are all naturally occurring substances which are often present in the environment at low levels. But, due to many human activities these levels have been elevated which can be very dangerous. Generally, humans are exposed to these metals by ingestion (drinking or eating) or inhalation (breathing). Working in or living near an industrial site which utilizes these metals and their compounds increases ones risk of exposure if the metal bases have been improperly disposed. Scientists are looking for many efficient and cost effective solutions to overcome this problem as it has become a big issue in many areas all over the world.

In this context *Phytoremediation* is a very interesting phenomenon that can be addressed a number of environmental problems due to heavy metals. Interesting advantage of this is the trapped metals can be extracted via special chemical methodologies so that the extracted small amounts of metals can be utilized as a bulk. Also, usability of low cost plants such as grass would be economical. Of course, this is not a novel technique and many countries such as South Africa, New Zealand, Canada, etc. have used this technique for various pollution control. As a developing country, such low cost methods must be adopted in Sri Lanka to mitigate the environmental pollution as our native plant species can be utilized in this regard.

Phytoremediation is the direct use of green plants and their associated microorganisms to stabilize or reduce contamination in soils, sludge, sediments, surface water, or ground water etc. In other words, phytoremediation encompasses microbial degradation in rhizosphere as well as uptake, accumulation and transformation in the plant. Pytoremediation is a natural process and an effective remediation method on numerous contaminants. However, sites with low concentrations of contaminants over large clean-up areas and at shallow depths are the especially favourable conditions for phytoremediation. Plant species are selected for this purpose based on factors such as ability to extract or degrade the contaminants of concern, types and concentration of contaminants, adaptation to local climates with high biomass and easy maintenance. The technique is commonly used to extract heavy metals such as Hg, Ag, Au, As, Pb and hazardous chemicals such as Cyanides. Depending on the application, appropriate native metal accumulating species (depending on the availability, geographic regions with varied weather conditions) should be selected for effective results.

A range of processes mediated by plants are useful in treating environmental problems:

- Phytoextraction: uptake and concentration of substances from the environment into the plant biomass.
- Phytostabilization: reducing the mobility of substances in the environment, for example, by limiting the leaching of substances from the soil.
- Phytotransformation: chemical modification of environmental substances as a direct result of plant metabolism. [often resulting in their inactivation, degradation (phytodegradation), or immobilization (phytostabilization)].
- Phytostimulation: enhancement of soil microbial activity for the degradation of contaminants, typically by organisms that associate with roots. This process is also known as rhizosphere degradation. Phytostimulation can also involve aquatic plants supporting active populations of microbial degraders, as in the stimulation of atrazine degradation by hornwort.
- Phytovolatilization: removal of substances from soil or water with release into the air, sometimes as a result of phytotransformation to more volatile and/or less polluting substances.
- Rhizofiltration: filtering water through a mass of roots to remove toxic substances or excess nutrients. The pollutants remain absorbed in or adsorbed to the roots.



Types of phytoremediation
http://systemsbiology.usm.edu/BrachyWRKY/WRKY/Phytoremediation.html

Application of Phytoremediation
http://www.letsgarden.info/info/ecology/phytoremediation.html

This technique is presently used in sewage and wastewater treatment, groundwater and soil treatment, etc. Yet, there is a number of areas where research is required. For example, the rate of biodegradation and mineralisation during phytoremediation is usually affected by the nature and concentrations of contaminants present, as well as surrounding oxygen levels, soil/air moisture, pH, temperature, soil elemental contents and their availability. Plant physiological and root growth expansion studies are needed to optimise plant uptake of contaminants and to maximise process output performance. Research is needed to determine the best density of plants per unit area to achieve the maximum utilisation of resources (too many plants can negatively adverse the processes, weaken the plants and be costly during disposal processes), and to determine the proper timing for irrigation and harvesting in order to control the amount of biomass produced and removed at harvest. Other areas requiring further research include the effect of fertilisers and conditioners on the soil characteristics and the fate of these compounds.

References:

Leon V. Kochian (2000) Phytoremediation: Using Plants To Clean Up Soils. *Agricultural Research magazine.* http://www.ars.usda.gov/is/ar/archive/jun00/soil0600.htm (March 20, 2014).

United Nations Environment Programme (2014) *Phytoremediation: An Environmentally Sound Technology for Pollution Prevention, Control and Redmediation.* http://www.unep.or.jp/Ietc/Publications/Freshwater/FMS2/1.asp (February 28, 2014).