Phytoremediation of contaminated land

Cleaning up with plants

Plants may be used to clean up contaminated land. It is called phytoremediation.[1] Processes used are:

For land contaminated with metal ions:

- phytoextraction;
- rhizofiltration;
- phytostabilisation.

For land contaminated with organic compounds:

- phytodegradation (phytotransformation);
- rhizodegradation;
- phytovolatilisation.

Phytoextraction

Metal ions in soil are absorbed through plants roots and translocated to plant tissues.

Metal ions tend to be absorbed to greater or lesser extents by different plants. Also, plants differ it the quantities they can absorb before becoming harmed by high levels of the metal ions. Some plants are able to absorb unusually large amounts of certain metal ions. They are called hyperaccumulators and are particularly useful for phytoremediation.

Contaminants present as molecules may be extracted in the same way.

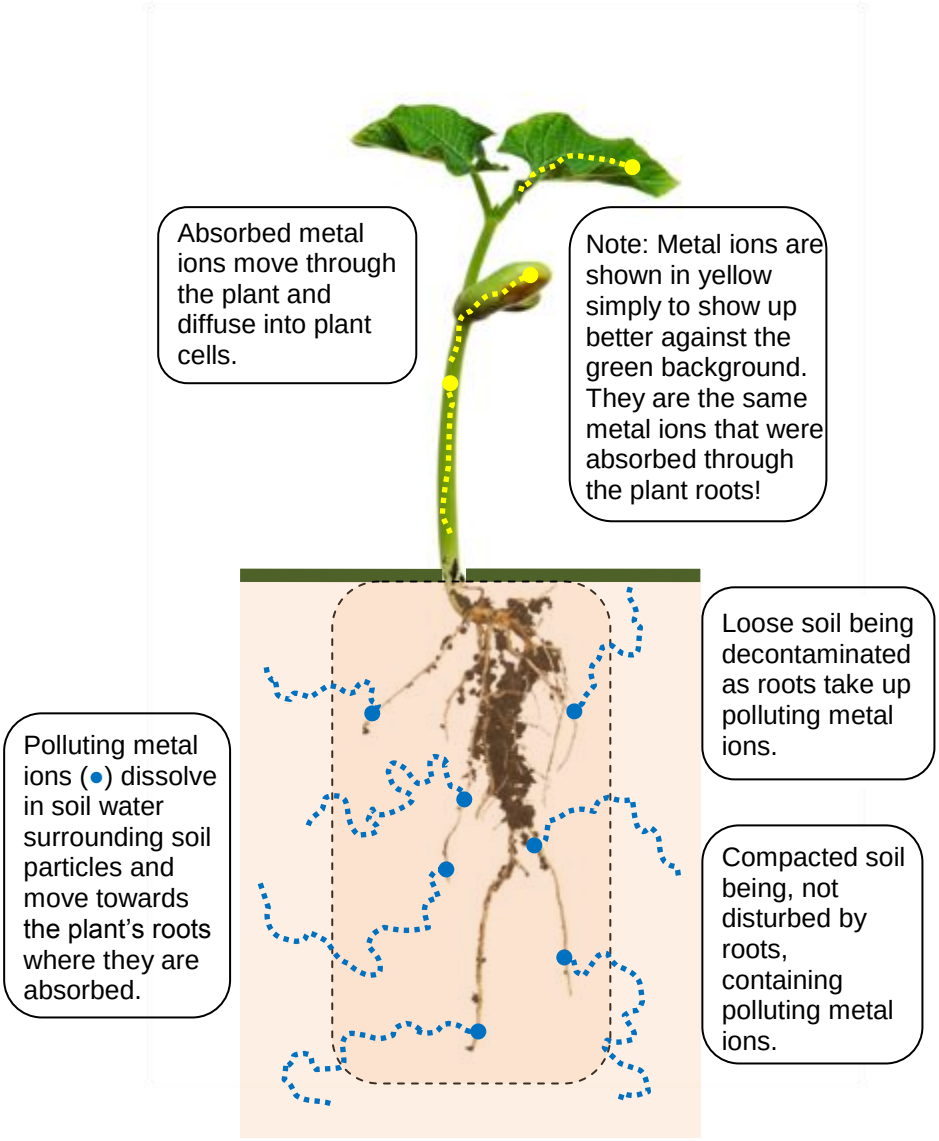

Figure 1 Phytoextraction is the removal of contaminants in soil by plants.

[1] For more information about phytoremediation, see the United Nations Environment Programme at http://www.unep.or.jp/ietc/Publications/Freshwater/FMS2/2.asp

Rhizofiltration

Similar to phytoextraction, this removes pollutants from groundwater rather than the soil. Pollutants may be adsorbed onto root surfaces or absorbed by plant roots. Plants need to be prepared for use by establishing healthy root growth before planting in the contaminated area. When roots are saturated with contaminates they are harvested and disposed of safely before the next planting. After the Chernobyl incident sunflowers were used in this way to remove radioactive pollutants.

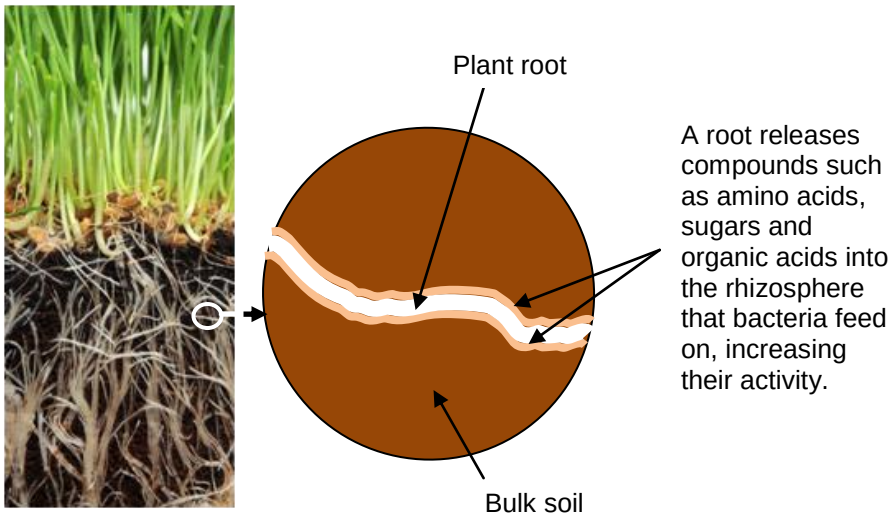

Figure 2 The rhizosphere is a region of soil about 1 mm wide around a root. Its biochemical and physical properties differ to those of bulk soil.

Phytostabilisation

Contaminants are precipitated in the rhizosphere, absorbed and accumulated by roots, or adsorbed roots surfaces. Contaminants do not move through the plant. They are immobilised and their bioavailability reduced.

Phytodegradation

Molecules of polluting organic compounds are broken down in the rhizosphere by compounds such as enzymes produced by the plant. Others are absorbed by plants, broken down by enzyme-catalysed reactions and used as metabolites that help the plant grow faster. Chlorinated solvents and some herbicides can be degraded by plant enzymes.

Rhizodegradation

Organic pollutants can be broken down by bacteria in the soil. Plants exude a variety of compounds through their roots, including sugars, alcohols and organic acids. Some of these provide food for the microorganisms and, therefore, enhance their growth and activity.

Phytovolatilisation

In this process organic pollutants are absorbed through plant roots and transported through the plant. When they or their metabolites reach a leaf surface they are released into the atmosphere, just as water transpires.

Finding out

Phytoremediation is up to 1000 times cheaper than excavation and reburial. But there are disadvantages. What are the advantages and disadvantages of phytoremediation compared to other methods or remediating soil?

Bioremediation is a promising area for photosynthetic organisms. This can include the breakdown of toxic organic compounds into harmless products or the removal of nitrate from drinking water. What are photosynthetic organisms and what advances are being made by genetic engineering?