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Phytoremediation: Trees for soothing contaminated soil

Swati Shedage and Dipika Ayate

Abstract
This article is the overview of phytoremediation by using tree components. Trees are the very important natural resource, in phytoremediation techniques plant used their natural function i.e. uptake and accumulation to remediate soils from the heavy metals. Phytoremediation is a fast-developing field, since last 10 year's lots of field application were initiated all over the world. Phytoremediation successfully reduces harmful effects of toxic heavy metals, but yet to become a commercially viable technology in India. Globally, Phytoremediation is still in the evolving stage. Many researchers reported that tree can be used to renovate soils in the heavy metal contaminated area.

Keywords: phytoremediation, trees, heavy metals, contaminated soils

Introduction
Soils generally get polluted by adding heavy metals trough different industrial and mining activities. Application of pesticides, oil spills, fertilizers are also the activities that are responsible for heavy metal contamination in to the soil. Heavy metals that have been identified in the polluted environment include As, Cu, Cd, Pb, Cr, Ni, Hg and Zn. The presence of any heavy metal different from place to place, mostly depend on source of pollutant. If the uptake heavy metals by the plants in more quantity it would become harmful to plants growth, may produce toxicity in human nutrition, and cause acute and chronic diseases. For instance, Cd and Zn can lead to acute gastrointestinal and respiratory damages and acute heart, brain and kidney damages. Heavy metals high concentration in the soil interfere with metabolic functions in plants, including physiological and biochemical processes, inhibition of photosynthesis, and respiration and degeneration of main cell organelles, even leading to death of plants. Tree has shown potential in treating soil and groundwater that is contaminated by organic chemicals and heavy metals. Number of trees have been identified for uptake and accumulation of different heavy metals. Mechanisms of metal uptake at whole plant and cellular levels have been investigated.

Phytoremediation: Phytoremediation is also called as dendro-remediation. It is an environmental remediation technology. Phytoremediation uses plants to clean-up contaminated soil and groundwater, as trees have natural abilities to uptake, accumulate, and/or degrade constituents of their soil and water environments.

There are five basic types of phytoremediation techniques

1) Rhizofiltration a water remediation technique involving the uptake of contaminants by plant roots. Rhizofiltration refers to the use of plant roots to absorb, concentrate, and precipitate toxic metals from contaminated groundwater. Rhizofiltration can be conducted in the original field if the ground water located within rhizosphere. Alternately, rhizofiltration may involve the pumping of contaminated groundwater into troughs filled with the large root systems of appropriate plant species. The large surface areas provided by these root systems allow for efficient absorption of metals from the contaminated groundwater into root tissues.
2) Phytoextraction, a soil technique involving uptake from environment. The use of plants to remove contaminants from the environment and concentrate them in above-ground plant tissue is known as Phytoextraction.
3) Phyto-transformation, applicable to both soil and water, involving the degradation of contaminants through plant metabolism. It is the ability of plants to change the molecular

composition of certain chemicals. In most cases, plants are able to create a non-toxic molecule from a toxic molecule. Remediation of a site by phyto-transformation is dependent on direct uptake of contaminants from the media and accumulation in the vegetation.

4) Phyto-stimulation or plant-assisted bioremediation, also used for both soil and water, which involves the stimulation of microbial biodegradation through the activities of plants in the root zone.
5) Phyto-stabilization, using plants to reduce the mobility and migration potential of contaminants in soil. Phyto stabilization is the plants used to absorb and precipitate contaminants, due to this it reducing its impact on human being. This method of phytoremediation useful to establish a tree cover at polluted sites, on this site vegetations are from long time due to the dominance of toxic metals. Metal-tolerant species can be used to restore vegetation to the sites, thereby decreasing the potential migration of contamination through wind erosion and transport of exposed surface soils and leaching of soil contamination to groundwater.

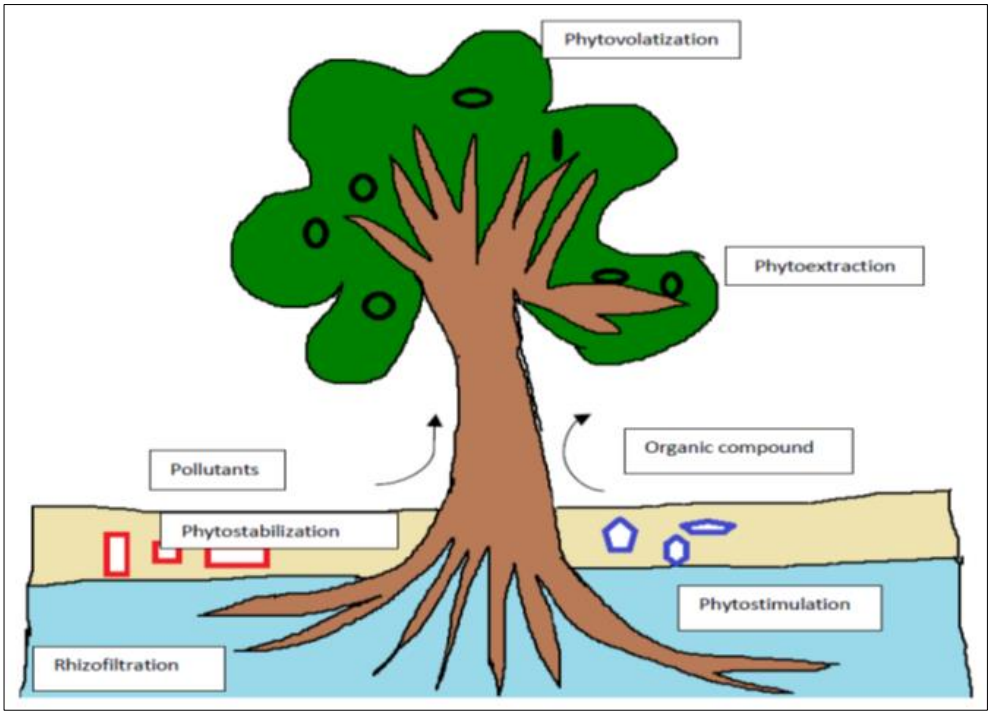

Fig 1: There are five basic types of phytoremediation techniques

Tree species suitable for phytoremediation

In recent time many researchers conducted to establish linking role of trees in phytoremediation to resolve the sustainability issues and effectively solve the challenges of ever-increasing contaminated sites. Some of the important findings are as follows.

Table 1: Some of the important findings are as follows.

Sr. No	Reference	Research findings	Tree species
1	Xingmao *et al*. (2004)	The research reveals that methyl *tert*-butyl ether (MTBE) was taken up by hybrid poplar cuttings and volatilized to the atmosphere.	Hybrid poplar
2.	Vwioko *et. al.*, (2005) [19]. Huang *et. al*., (2011) [7]. Lu et. al., (2005) [9]. Costa *et. al*., (2012) [4]. Olivares *et. al*., (2013) [14]. Giordani *et. al*., (2005) [5].	Ricinus cummunis reported by different workers from the world to grow on the soil contaminated by lubricant oil, DDTs, Cd, Pb Zn Arsenic and other heavy metals.	*Ricinus cummunis*
3.	Schnoor JL (2000) [3]	Phytoremediation of heavy metal contaminated soil	*Populus*
4.	Robinson *et al*., (2000) [16], Sebastiani *et al*., (2004) [18] Baldantoni *et al*., (2014) [2], chen *et al*., (2015)	Phytoremediation of Cd, Cr, Cu, Pb and Zn.	*Populus*
5	King *et al*., (2008) [8], Wu (2010) [20] Arriagada *et al.* (2007) [1], Nenman *et al.* (2012) [13]	Phytoremediation of soil contaminated with As and other heavy metals and Bioaccumulation of Pb, Zn and Cr	Eucalyptus
6	Miller *et al*., (2011) [12] Meers *et al*., (2007) [11]	Phytoremediation of Cd and Zn from contaminated soil. Bioaccumulation heavy metals from contaminated soil	Salix
7	Mathur *et al*., (2010) [10]	A study revealed the efficiency of *Prosopis cineraria* for phytoremediation of TPHs in a contaminated desert soil when compared to *Acacia senegal* (L.) Willd. and *Acacia nilotica* (L.)	*Prosopis cineraria*
8	Paterson *et al*., (1994) [15]	Reported that more than 70 organic chemicals were found to be taken up	-

		and accumulated by 88 species of plants and trees	
9	Glenn *et al*. (1999) [6]	Leguminous trees that serve for nitrogen supply such as Acacia spp. and Prosopis spp. have been reported as successful in the Western United States	-

Phytoremediation for wasteland/degraded land development: Phytoremediation (PR) strategies involve the use of different plant species in combating the alterations in the environmental conditions induced due to natural and artificial causes. This technique is very useful to improving the quality of polluted soil and water. It offers eco-friendly degraded land conservative approaches. This eco-friendly programme may help society in rehabilitating and improving the degraded lands. For adapting this approach in proper way there is need to adapt some management practices

1. Government has to give priority to phytoremediation action programme terms of funding, encouragement, and policy-making
2. There is need to fix priority degraded areas for development.
3. Need to assess the infrastructure available to meet the requirement.
4. There should be involvement of the government, NGOs and local people in to the programme.
5. There is need to maintain working body of local people, NGOs and other groups can contribute to the implementation and monitoring of WL development programme on a regular basis.
6. Promoting conservation of natural resources through traditional knowledge.
7. Promoting ideas to consider the village as an ecosystem and to maintain its integrity.
8. Providing examples of the practices done at different places.
9. Integrated village ecosystem planning with watershed approach needs to be espoused for sustainable development.

This would enhance the total natural resource base by restoration and management of degraded lands, production of basic biomass needs of the village community and equity in distribution of biomass resources.

Conclusion

The broadest definition of phytoremediation extends possible linkages with forest trees. Dendroremediation could include planting fast growing trees for land reclamation and restoration and on disturbed or mined lands to improve soil conditions, control invasive species, and provide a transition. The most important challenge is to improve the efficiency of phyto-technologies depending upon dissemination of results, risk assessment, public awareness and acceptance of this green technology, as well as the promotion of networking between scientists, industrials, stakeholders, end users, non-governmental organizations and governmental authorities.

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