A

Seminar report

On

Phytoremediation

Submitted in partial fulfillment of the requirement for the award of degree
Of Civil

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Preface

I have made this report file on the topic **Phytoremediation;** I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to ……..who assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

Acknowledgement

I would like to thank respected Mr…….. and Mr. ……..for giving me such a wonderful opportunity to expand my knowledge for my own branch and giving me guidelines to present a seminar report. It helped me a lot to realize of what we study for.

Secondly, I would like to thank my parents who patiently helped me as i went through my work and helped to modify and eliminate some of the irrelevant or un-necessary stuffs.

Thirdly, I would like to thank my friends who helped me to make my work more organized and well-stacked till the end.

Next, I would thank Microsoft for developing such a wonderful tool like MS Word. It helped my work a lot to remain error-free.

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Introduction to Phytoremediation

Phytoremediation is the use of plants and trees to clean up contaminated soil and water. It can be used to detoxify sites containing metals, pesticides, solvents, explosives, crude oil, hydrocarbons, and landfill leachates. Sites that have shallow, low levels of contaminants are the best candidates for phytoremediation. This is true because plant roots can only go so deep in the soil, and if contaminants are too deep the roots cant bring them into the plant. Plants can break down, or degrade, organic pollutants or stabilize metal contaminants by acting as filters or traps. The phytoremediation process depends on three important principle mechanisms; extraction, containment, and degradation.

Although phytoremediation cant be used on every site, it is growing in popularity because of the many benefits it presents. It is very cost efficient, aesthetically pleasing, passive, solar-energy driven, and can be used in some sites where earlier methods of detoxification could not work. Phytoremediation is sometimes slower than earlier methods, but the low cost and effectiveness are convincing enough by themselves for anyone to choose phytoremediation over older methods.

What is phytoremediation

The technique of employing green plants and their associated microorganisms, soil amendments and agronomic practices to remove, inhibit or neutralize hazardous environmental contaminants is termed as "phytoremediation". This technique was for the first time used in Germany around 300 years ago. It was used for the treatment of sewage. Phytoremediation also is used to remove organic and inorganic wastes from soil. One of the best yet simple examples of this technique is use of carrots. Carrots have the ability to absorb DDT(dichloro-diphenyl-trichloroethylene).
So they are are cultivated in soils contaminated with DDT and after harvesting they are dried and incinerated to destroy the absorbed DDT.

How does it work?

- Plants in conjunction with bacteria and fungi

in the rhizosphere

- ◆ transform, transport or store harmful

chemicals.

- Plants attributes make them good candidates

- ◆ root system surface area to absorb substances and efficient mechanisms to accumulate water, nutrients and minerals.
- ◆ selectively take up ions
- ◆ developed diversity and adaptivity to tolerate high levels of metals and other pollutants.

Phytoremediaton of organic environmental waste

Plant roots are lypopyhylic in nature and the rate at which they absorb organic contaminants from soils is almost proportional to their relative lypophilicity. Phytoremediation takes place due to the following mechanisms:

1. Absorption of organic matter and accumulation of the same in plant tissues.
2. Translocation of the absorbed organic matter to leaves from where it is volatized through leaf surface.
3. Metabolization of the organic matter inside the plant tissues or in the rhizosphere by the action of plant enzymes.
4. Microorganisms living in association with the plants breakdown the organic matter and degrade them.

Types

Phytosequestration

Also called **phytostabilization**. Many different processes fall under this category which can involve absorption by roots, adsorption to the surface of roots or the production of biochemicals by the plant that are released into the soil or groundwater in the immediate vicinity of the roots, and can sequester, precipitate, or otherwise immobilize nearby contaminants.

Rhizodegradation

This takes place in the soil or ground water immediately **surrounding the plant roots**. Exudates from plants stimulate rhizosphere bacteria to enhance biodegradation of soil contaminants.

Phytohydraulics

Use of deep-rooted plants (usually trees) to contain, sequester or degrade ground water contaminants that come into contact with their roots. In one example of this, poplar trees were used to contain a ground water plume of methyl-tert-butyl-ether (MTBE) (Hong *et al.* 2001. Environmental Science and Technology 35(6):1231-1239).

Phytoextraction

Also known as phytoaccumulation. Plants take up or hyperaccumulate contaminants through their roots and store them in the tissues of the stem or leaves. The contaminants are not necessarily degraded but are removed from the environment when the plants are harvested. This is particularly useful for removing metals from soil and, in some cases, the metals can be recovered for reuse, by incinerating the plants, in a process called phytomining.

Phytovolatilization

Plants take up volatile compounds through their roots, and transpire the same compounds, or their metabolites, through the leaves, thereby **releasing them into the atmosphere**.

Phytodegradation

Contaminants are taken up into the plant tissues where they are metabolized, or biotransformed. Where the transformation takes place depends on the type of plant, and can occur in roots, stem or leaves.

Advantages

- the cost of the phytoremediation is lower than that of traditional processes both *in situ* and *ex situ*
- the plants can be easily monitored
- the possibility of the recovery and re-use of valuable metals (by companies specializing in "phyto mining")
- it is potentially the least harmful method because it uses naturally occurring organisms and preserves the environment in a more natural state.

Limitations

- phytoremediation is limited to the surface area and depth occupied by the roots.
- slow growth and low biomass require a long-term commitment
- with plant-based systems of remediation, it is not possible to completely prevent the leaching of contaminants into the groundwater (without the complete removal of the contaminated ground, which in itself does not resolve the problem of contamination)
- the survival of the plants is affected by the toxicity of the contaminated land and the general condition of the soil.
- bio-accumulation of contaminants, especially metals, into the plants which then pass into the food chain, from primary level consumers upwards or requires the safe disposal of the affected plant material.

Importance of Phytoremediation

Phytoremediation is special application of bioremediation. It is a natural biological process of degradation of xenobiotic and recalcitrant compounds responsible for environmental pollution. The word phyto stands for 'plant' hence the remediation mediated by plant system. The mechanisms of phytoremediation are similar to biological remediation employing microbial agents. Microbes have been utilized to remove, destroy toxic substances like thiocarbamates, herbicides, insecticides, organophosphorus compounds, chlorinated aliphatic and aromatic chemicals, aromatic amines, sulfonates and heavy metals; they also convert lignin, cellulases, hemicellulases into fuels, solvents, SCPs and other useful products. Phytoremediation is used for similar purpose but have many advantages as compared to microbial remediation. Plant system solely is capable of remediation. It does not require any support from external agency or labor and uses its own natural processes to clean up the site. It not only decontaminates pollutants but also inhibits spreading of pollutant/s from one site to other. Therefore the pollution remains localized, confined to particular area. Here the root system plays an important role; soil particles remain bound to roots even during rainy season. If the soil is polluted it is not washed away by rainwater to aquatic bodies or carried away by winds to far locations. Plant system is the only living agency that prevents spread of pollution. The most important advantage is that plants can directly be planted on contaminated sites.

Selection of plant for remediation:

Depending upon location of contaminated sites such as air, water or land; the plants growing in respective habitats can be chosen. Thus aquatic plants or algae will be used for water and arboreal plants or tall tree species will be suitable for remediating air pollution. Generally, the plants selected are the trees. Because tree roots are tap roots and reach deep underground in search of water and nutrients. It is assumed that plants can clean up the pollution as deep as their roots. Most of the tree species grow without dormancy period and are annual. Trees can also bear harsh environmental conditions like heavy rain, snow fall, heat or winds. Tree species like poplar, mulberry, birch, pine and maple have been recommended for phytoremediation. If grasses and bushes are selected for remediation, then they should have short life cycle. So that they can be harvested, destroyed or recycled for further use. New crop again can be planted for continual remediation. Grasses and bushes/shrubs like rye, wheat, Bermuda, buffalo and hydrilla, water velvet and indigo bush have been used for short term bioremediation program. Grasses are selected as plant agents for bioremediation when soil contamination is superficial

and recent. Recently, the attempts were made to incorporate bacterial biodegradation genes into plants to enhance their biodegradation potential. Plant breeding programmes to develop plant verities hypertolerant to toxic concentrations of heavy metals and pesticides are also fruitful and encouraging.

Precautions and mechanism:

Precautions: Before on field application of phytoremediation, some precautionary measures needs to be taken. The plant should not release harmful gases into air during the remediation. Number of plants and types to be used, disposal sites and plantation time should be determined. Weather like frost or snow fall should be avoided for plantation. If this is not considered it may create trouble to clean the site of destroyed plants for remediation. The plant agent should be tested for its insect pests if any. Because these insects after feeding on plant host may carry toxic traces of pollutants and eaten by frogs (assume so) of particular food chain. This can lead to bioconcentration of toxic chemical into food chain and affecting its every component.

Mechanisms: Phytoremediation involves many processes which are carried out by plant during their growth on contaminated site. A contaminant is treated by plants using all or some of these reactions like phytoextraction, phytostabilization, phytotransformation, phytostimulation and phytovolatization. Of these, phytoextraction that is uptake of pollutants into plant biomass via roots is first step of phytoremediation. Sometimes, plants do not absorb but immobilize and stabilize pollutants in the soil (Phytostabilization). Plant then secretes root exudates that attract and stimulate rhizobacteria (Phytostimulation). Immobilized pollutants are later on degraded by stimulated rhizobacteria of that plant. Sometimes, only roots are involved in remediation. They remove toxic compounds by filtering them along with water absorbed via dense root hairs (Rhizofiltration). During phytotransformation, toxic chemicals are converted to inactivated form by plant metabolism; inactivated substances are further degraded by soil bacteria or released into air (Phytovolatization).

Conclusion

Although much remains to be studied, phytoremediation will clearly play some role in the stabilization and remediation of many contaminated sites. The main factor driving the implementation of phytoremediation projects are low costs with significant improvements in site aesthetics and the potential for ecosystem restoration.

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