# SOIL REMEDIATION TECHNIQUES SUPPORTING ENVIRONMENTAL RENOVATION ACTIVITIES: A REVIEW

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**ABSTRACT** *Agricultural soils are getting incredible amount of pollutants from a variety of sources. Heavy metal contamination in agricultural soils leads to the functional disorders of soils which retards plant growth and damages the health of humans through contamination of food chain. The heavy metals or metalloids do not undergo microbial and chemical degradation and continue in the soil for a long time. This review emphasizes on the remediation methods involved in their removal of contaminants from the soil.*

***Keywords:*** *Remediation, heavy metals/metalloids, pollutants, encapsulation.*

## Introduction

Soil pollution has been a major concern for environmentalists all around the World. With an ever-increasing population and expanding industrial economies, there is a corresponding increase in environmental pollution. Contaminants in roadside soil can easily be found in many areas of the world, and these contaminants, some of which are metals, can be identified and quantified. The persistent and non-biodegradable nature of heavy metals eases their accumulation in the environment. Agricultural soils are receiving tremendous amount of pollutants from the various sources. During the last few decades, rapid urbanization, industrialization, injudicious and faulty agricultural practices influence the release of metal contaminants in the agricultural fields. Heavy metal contamination in agricultural soils may impart functional disorders of soils, retarded plant growth and even harm the health of humans through contamination of food chain.

The heavy metals bio-accumulate in the living systems and their concentrations increase as they pass from organism of lower tropic level to higher tropic level, a phenomenon known as biological concentration. Some metals, such as lead and manganese, are not biologically useful. Even if metal has biological functions, they can exist in too high of concentrations so as to be toxic, such as the case with iron, zinc and copper. This toxicity leaves plants struggling to live in such polluted soils. The contamination can also leach through the soil strata and eventually into the local water supply, a resource essential to every land-dwelling organism. The elevated heavy metal levels in the agricultural soils depend on the characteristics of the soil and the rate of application by the supplier with its elemental concentration. These heavy metals or metalloids do not undergo microbial and chemical degradation and persist in the soil for longer duration. Due to the increasing awareness among the public and the detrimental effects of these contaminants on human health, scientific communities are focusing on development of some new technologies for removal of these metals from contaminated soils. This review focuses on the various sources of heavy in the soil, the technologies involving the removal of heavy metals from the contaminated soils.

## Sources of Heavy Metals in Soil

Excess heavy metals in the soil originate from many sources, which include atmospheric deposition, sewage irrigation, improper stacking of the industrial solid waste, mining activities, the use of pesticides and fertilizers , etc. Both natural and anthropogenic inputs are correlated with the distribution of heavy metals in the soils. Natural sources include geological breakdown of parent rock materials, volcanic eruptions etc. Anthropogenic inputs like extensive use of agrochemicals (inorganic and organic) fertilizers, pesticides, waste water irrigation, sewage sludge supplementation, higher atmospheric depositions by industrial units and combustion of fossil fuels have led to elevated level of inorganic pollutants in the soils. Fungicides, phosphate fertilizers and inorganic fertilizers have variable levels of Pb, Cd, Cr, Ni, Zn etc depending upon their sources. The repeated use of phosphate fertilizers continuously making the agricultural soils enriched with heavy metals. Both natural and anthropogenic sources of heavy metals in the environment are illustrated in Figure 1.

Figure: 1. Sources of heavy metal pollutants

**Types of Soil Remediation Techniques for removal of Heavy Metals from the Soil**

Soil remediation, which is sometimes also called soil washing, is a term used for various processes used to decontaminate soil. Healthy soil is better able to grow vegetation, as well as contributing to healthy air and groundwater. There are a number of different processes for soil remediation, each employing a distinct technique for *removing contaminants from soil.* However, each has an indicated best use, so care must be taken to select the right method of soil remediation services for each unique application. The best approach is determined with a proper soil sampling.

**a) Thermal Soil Remediation**

Thermal soil remediation is a method that removes specific types of contaminants that are best removed by subjecting soil to high temperatures. This process is typically reserved for soil that has been tainted with contaminated water or by hydrocarbon compounds such as oil or other petroleum products. Typically, this takes place in an oven, fed by conveyor belt.

Essentially, the way it works is by baking the soil causing contaminates to evaporate. The extracted materials are captured and cooled for later disposal. The treated soil is then cooled and removed from the remediation machinery via a conveyor system. After the process is finished, the soil is then ready for recycling or further testing.

**b) Encapsulation**

This process of soil remediation is somewhat different from other techniques, as most remediation uses a process to filter contaminants from soils; encapsulation ensures they cannot spread any further. It's akin to a medical quarantine. Instead of treating a disease by giving a patient antibiotics or retroviral to combat the disease, the patient is isolated to prevent the contagion from spreading further.

The most common technique of encapsulation is to mix the contaminated soil with lime, cement and concrete. This prevents any other soil from coming in contact with the contaminants contained inside. While it is effective, it also precludes using the treated soil for any cultivation of any sort. Therefore, you shouldn't consider encapsulation unless the soil in question is never going to be used in any capacity for growing anything.

**c) Air Sparging**

The air sparging method of soil remediation is indicated when soil has been contaminated by toxic gases or vapors. However, it does differ from other methods of remediation in that it has to be applied directly to the soil rather than used on soil extracted for treatment.

Air sparging is done by injecting large volumes of pressurized air into contaminated soil or groundwater, removing volatile organic compounds that might otherwise be removed by carbon filtering systems. It's most commonly used for removing hydrocarbon contaminants, but is best applied when the soil cannot be removed first, as it must be done in situ. Sparging is one of the most common methods of in situ remediation, so this something to consider when looking at a soil remediation method.

**d) Bioremediation**

Bioremediation is also an in situ remediation technique, but uses a biological mechanism rather than a mechanical method of filtering for removing contaminants. Contaminated soil is treated in situ by applying engineered aerobic and anaerobic bacterium that feed on the specific type of contaminant that a parcel of soil is contaminated with. The bacterium goes to work consuming and breaking down the hydrocarbons or other contaminants in the soil. Much like yeast feeding on sugar in a batch of beer, the bacteria die off after the supply of contaminants is consumed. However, bioremediation requires specific and stable conditions to be able to work. It works best when a soil temperature of 70 degrees F and only occasional rain. It can work in colder climates if soil is insulated and covered, but will take longer to take effect. It is a very effective method of in situ remediation, but again requires conditions to be amenable to work efficiently.

**Conclusion:**

Many processes are explained in the paper above. Choosing the process that is "best" can be a difficult task. "Proper evaluation of bioremediation options begins by determining what constitutes an acceptable cleanup goal; for example, one must determine whether destruction, detoxification, or physical removal of the chemical target(s) is the goal of the remediation. It is the result of a rather thorough literature review, but the authors does not claim to have included all methods in use for soil and water remediation. Some methods are chemical specific, while others apply to a broad range of pollutants. Techniques covered for soil remediation included the general categories of biological, chemical, and physical treatments as well as the more specific encapsulation, air sparging, bioremediation and thermal methods.

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