Clean Drive Mission at The Doorsteps of Green Technology

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I. SUMMARY

The ever enhancing skills and improvement in technology always provides a pool of opportunities to solve a dilemma in the field of science. But it also becomes tricky to choose the right approach to solve a particular problem as numerous techniques have their sets of limitations. To clean our polluted natural resources needs patience and a method which not only clears the contaminated body but also restores its functions. Here a discussion for the same is made to get briefed up with the recent advancements of remediation and to choose what the best is for the proposed contaminants.

II. THE PRESENT SCENARIO

A quick glance into the history of time will take us to the doorsteps of a nonchalant world, where the waste of a primitive man turned out to be a beautiful tree full of luscious fruits whereas now the present scenario brings to us the challenge to dispose the waste originating from several man-made machines into the natural sinks which are of great worth to humans and its abiotic world. There is no doubt that man has carved his own niche on this planet wherein he is the exploiter of the resources but its consequences are to be equivocally shared by all of the biotic as well as the abiotic world. These natural resources have continually been exploited to fuel all the man-made resources (Gajbhiye et al., 2016). Most of the natural resources are mined from the underneath of the earth‘s crust and post mining its various applications are made at the surface. Eventually due to overexploitation and improper disposal, some of the harmful by-products make its way to several streams, rivers, oceans, soil, air and some of those also leach to the underground aquifers making them highly polluted and inconsumable (Lothe et al., 2016). These contaminants mostly comprises of recalcitrant heavy metals like Pb, Hg, Cd, As, Ni, Cr, Zn, Co etc (Ahmad & Misra., 2014). The heavy metals acts as an integral part for most of the consumables used on day-to-day basis. The problem magnifies when these heavy metals containing products are discarded haphazardly and are left untreated at the end-of-the-pipe treatment (Nazir et al., 2011). Many more pollutants of organic origin like pesticides, solvents, explosives, crude oil and its derivatives, polychlorinated biphenyls etc also pose potential adverse effects on the living organisms if left untreated. The problem escalates when these compounds gets biomagnified within the tissues of organisms who are interdependent on each other to enhance their progeny and for their nutritional necessities. The frequent incidence of metal poisoning, disease causing vectors found in water bodies, people suffering from uninvited diseases due to changes in the enzymatic reactions, birth of abnormal offspring due to noxious agents affecting the reproductive capacity post biomagnification of inorganic and organic compounds, constant exposure of volatile and gaseous metals and organic matter to workers confined within a finite spatial range. All this information make ways to the news papers and television sets making us aware about the increasing need to reform and rejuvenate our conventional processes of manufacturing and bring a new innovative solution keeping in mind the economic growth of our country with its pressure to enter the linage of a developed economy.

III. PROBABLE SOLUTIONS

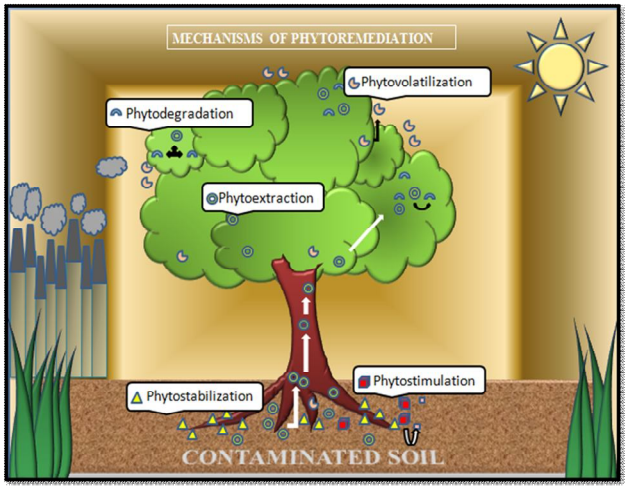
Every problem concerning pollutants can be dealt with four approaches physical, chemical, thermal and biological. Amongst them the most convenient will be the one which causes minimum alteration to the surrounding and is capable of remediating the problem to an utmost extent. Dealing with the pollutants produced at present requires a technology which can be economical and comprehensible, and its repercussions shouldn’t be harmful to the environment. There are many technologies to serve the purpose but the most promising candidature is of phytotechnology which has a biological approach of remediation. Phytotechnology uses plants as efficient remediators. It can remediate contaminated water bodies, contaminated soils and some plants also play an important role in cleaning the surrounding air quality. It helps in regaining the lost vitality and fertility of contaminated sites and also complementarily increases its aesthetic value. Phytoremediation is a subordinate to phytotechnology which uses plants having higher affinity and accumulating potential

towards inorganic and organic pollutants within their tissues (Peer et al., 2005). Amongst these phytoremediators many plants have been studied to check the heavy metals accumulating potential as well as its capability in breaking the organic contaminants to an innocuous state since past few decades, and a worthy 400 plant species have made its way into the list of hyperaccumulator plants (Tangahu et al., 2011). Many models have been proposed and are also functional at few Effluent Treatment Plant, Waste Water Treatment Plant, and Sewage Water Treatment etc.

IV. PLANTS AT WORK

Every piece of land goes through different anthropogenic exposures and pressures and the ecosystem prevailing there also has a defense mechanism to deal with it. But, some of the pollutants are such which changes the normal constituency of flora and fauna prevailing there. Such enormous changes to the natural habitats were observed during the period of industrial revolution. Hence phytoremediation emerged during the concluding decades of the 19th century. Recent researches frame it to be the most reliant, economical, fathomable and favorable choice amongst other below mentioned conventional approaches such as vitrification, fixation, extraction, immobilization etc. All these conventional technologies have a greater environmental footprint and on the contrary uses abundant resources to remediate the contaminants when compared to phytoremediation (Truu et al., 2015). Whereas phytoremediation not only helps in sequestering, storing and biodegrading the heavy metals and other volatile and non-volatile organic contaminants but also provides a carbon sink there by contributing to reduce the concentration of the most potent green house gas in the atmosphere. It also improves the aesthetic value of the site and helps in increasing the fertility of the soil. Phytoremediation uses the virtue of plants intelligence to cure soil of its organic and inorganic contaminants. The basic principle with which this technology works is by using the apoplastic and symplastic movements of water and nutrients into the plants via negative geotropism through xylem (Mahurpawar., 2015). Plants while taking up the essential nutrients from the soil along with water, in due course of time also uptakes the unwanted inorganic and organic contaminants from the site. Some of the inorganic heavy metals gets stored into the vacuole of the plant cells or are oxidized and subjected to transpiration while some of the organic contaminants like PAHs, explosives, pesticides etc are degraded to innocuous state and metabolized without getting biomagnified in the food chain. After the plants have sequestered the pollutants into the above ground plant parts these parts are then subjected to different treatments of disposal such as incineration where under high degree of temperature it is turned into ashes which is then buried into the landfill, the other sustainable method of dealing with the leftover biomass is phytomining wherein the heavy metals are recovered back to a form which can be reused.

V. MECHANISM USED BY PLANTS



1. **Phyto-extraction (Phyto-accumulation):**

A process in which the plant roots absorbs the contaminants along with other nutrients and water and store them in roots or shoots but do not degrade them. Through this process the contaminant is permanently removed from the soil. In order for this clean-up method to be feasible, the plants must (1) extract large concentrations of heavy metals into their roots, (2) translocate the heavy metal into the surface biomass, and (3) produce a large quantity of plant biomass.

2. **Phyto-degradation:**

This process is also referred to as phytotransformation. It involves the degradation of complex organic molecules to simple molecules or the incorporation of these molecules into plant tissues. When the phytodegradation mechanism is at work, contaminants are broken down after they have been taken up by the plant. It has been observed to remediate some organic contaminants, such as chlorinated solvents, herbicides, and munitions, and it can address contaminants in soil, sediment, or groundwater.

3. **Phyto-stimulation :**

Phyto-stimulation refers to the breakdown of contaminants within the plant root zone, or rhizosphere. The microfauna which exist in the root zone of the plants help in mobilizing and break down of the contaminants into an

innocuous state. In short we can say that it's a process wherein the plants enhance the biological degradation by providing nutrients to the microorganisms who symbiotically manages to thrive and converts the hamful contaminants into harmless state.

4. **Phyto-stabilization:**

This method is primarily used for the remediation of soil, sediment, and sludge wherein the plants intelligently manages to hold or arrest the inorganic and organic contaminants near their root zone and prohibiting their further entry via plants tissue. This technique can also be used to re-establish vegetational cover at sites where natural vegetation fails to survive due to high metals concentrations in surface soils or due to physical disturbances to surface materials.

5. **Phyto-volatilization:**

Phytovolatilization have the potential to convert organic as well as inorganic compounds that have volatile forms, such as selenium, and arsenic into a state which can easily be converted into a volatile form which is less toxic and released into the atmosphere..

Table 1: SOME OF THE COMMON STUDIED HYPERACCUMULATORS

Scientific Name	Common name	Types of contaminants
TERRESTRIAL SPECIES		
Brassica napus	Rapeseed	Cr, Hg, Pb, Se, Zn
Brassica juncea	Indian mustard	Cu, Ni, Pb, Zn
Pinus spp.	Pine spp.	Petroleum hydrocarbons, Organic solvents, TCE and by-products, Cs-137, Sr-90
Salix spp.	Osier spp.	Ag, Cr, Hg, Se, petroleum hydrocarbons, organic solvents, MTBE; Cd, Pb, U, Zn
AQUATIC SPECIES		
Spirodela polyrhiza	Giant Duckweed	Cd, Ni, Pb,
Pistia stratiotes	Water lettuce	Hg, Cr,

VI. BENEFITS

When compared to other technologies this approach has set a benchmark for dealing with the pollutants in the most sustainable manner. They can be briefly summarized as below:

- It uses minimum space and resources to deal with the contaminants
- It's application is sustainable and suitable for the ecosystem
- It's application do not lead to further distortion of the land and in contrasts it increases the fertility of the soil (Moosavi & Seghatoleslami., 2013)
- It employs simple farming techniques and requires addition of few amendments to enhance its pollutants up-taking efficiency
- It does not require a great labor force or constant monitoring unlike other mechanical devices used to treat pollutants
- It rejuvenates the land and helps restoring it's lost ecological balance
- It's economical and easily comprehensible technology

VII. CONCLUSION

In this technology driven centaury it wouldn't be unjust in saying that every type of pollutant has a different technology with which it can be remediated but choosing the right one is a challenging question to be answered in the present scenario as every technique has its own share of virtues and vices. As every human has an individual fingerprint so do every plant has a unique capability to deal with the contaminants, hence aligned to the present requirement it can be said that using the immobile plants and cultivating them to restore the fertility of the soil seems to be an intelligent choice.

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