

Presence of Toxic or Heavy Metals in Environment

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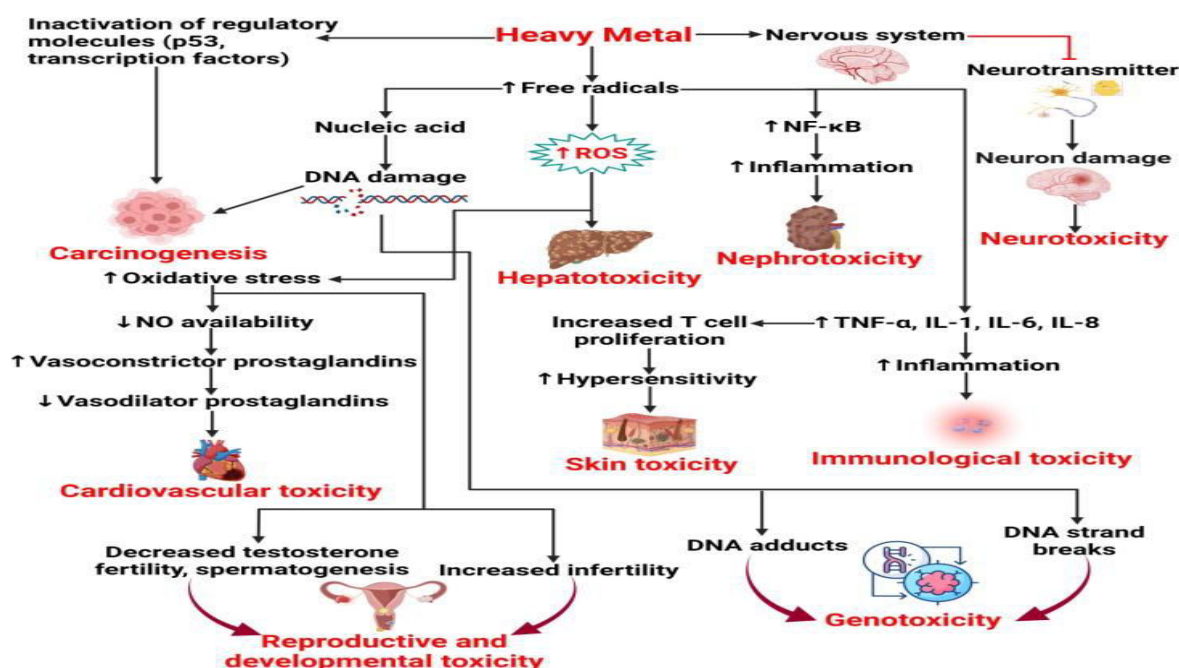
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ABSTRACT: Heavy metals are naturally occurring elements that have a high atomic weight and a density at least 5 times greater than that of water. Their multiple industrial, domestic, agricultural, medical and technological applications have led to their wide distribution in the environment; raising concerns over their potential effects on human health and the environment. Their toxicity depends on several factors including the dose, route of exposure, and chemical species, as well as the age, gender, genetics, and nutritional status of exposed individuals. Because of their high degree of toxicity, arsenic, cadmium, chromium, lead, and mercury rank among the priority metals that are of public health significance. These metallic elements are considered systemic toxicants that are known to induce multiple organ damage, even at lower levels of exposure. They are also classified as human carcinogens (known or probable) according to the U.S. Environmental Protection Agency, and the International Agency for Research on Cancer. This review provides an analysis of their environmental occurrence, production and use, potential for human exposure, and molecular mechanisms of toxicity, genotoxicity, and carcinogenicity.

KEYWORDS: toxic, heavy metals, environment, water, carcinogens, human, exposure

I. INTRODUCTION

Heavy metals are well-known environmental pollutants due to their toxicity, persistence in the environment, and bioaccumulative nature.

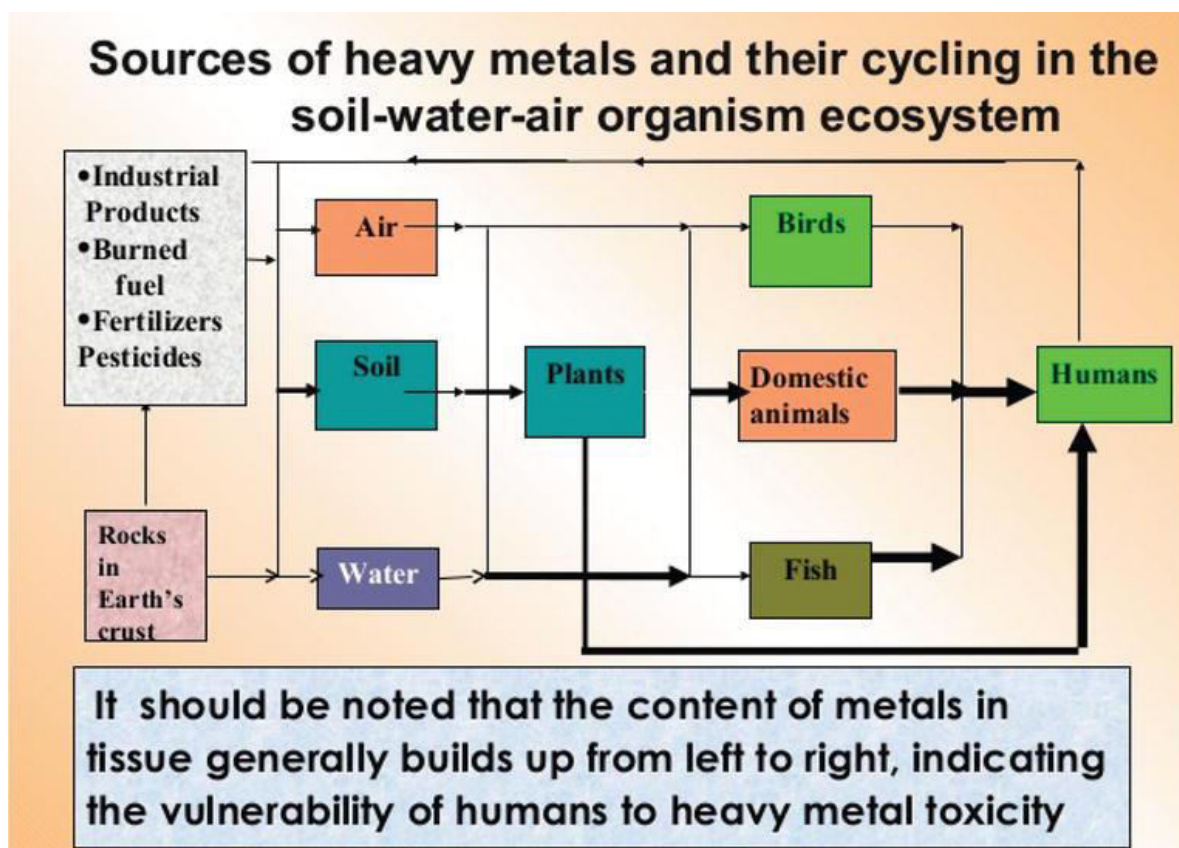


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Their natural sources include weathering of metal-bearing rocks and volcanic eruptions, while anthropogenic sources include mining and various industrial and agricultural activities.



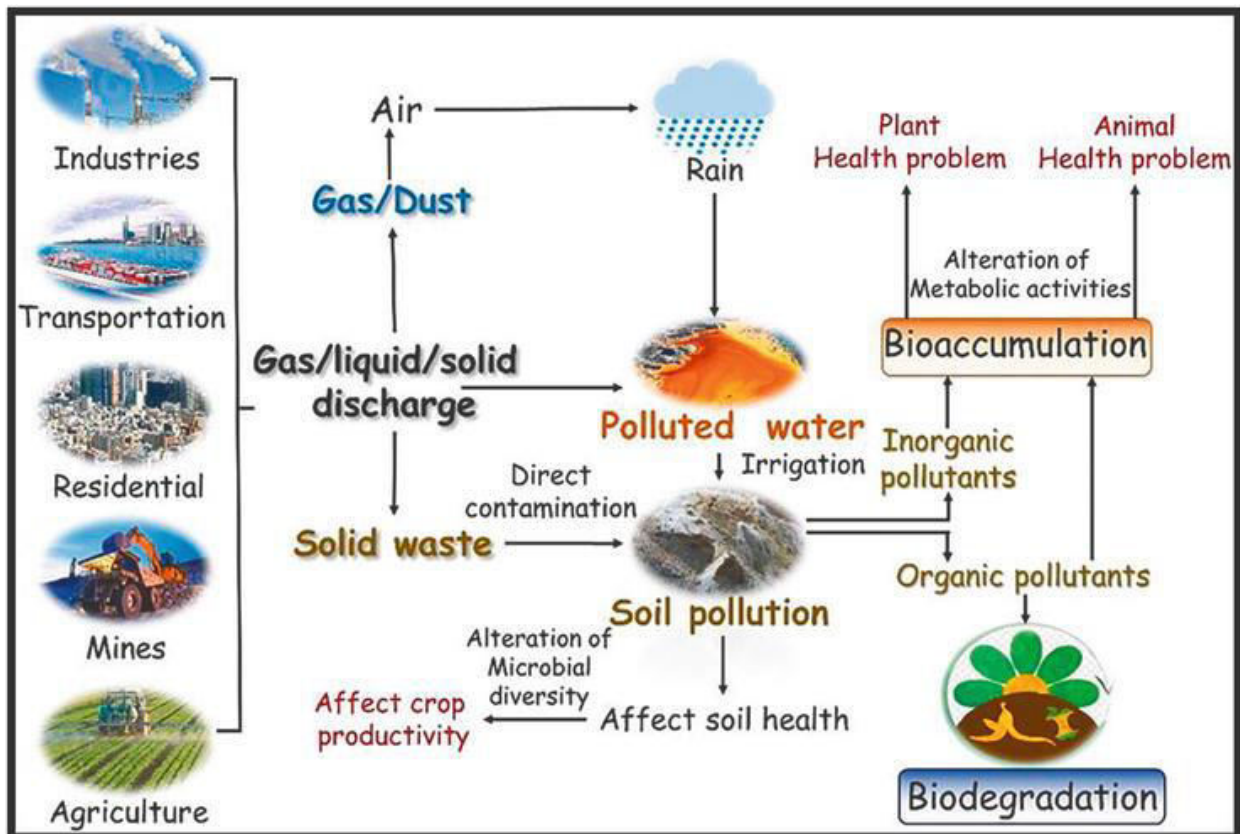
Mining and industrial processing for extraction of mineral resources and their subsequent applications for industrial, agricultural, and economic development has led to an increase in the mobilization of these elements in the environment and disturbance of their biogeochemical cycles. Contamination of aquatic and terrestrial ecosystems with toxic heavy metals is an environmental problem of public health concern. Being persistent pollutants, heavy metals accumulate in the environment and consequently contaminate the food chains. Accumulation of potentially toxic heavy metals in biota causes a potential health threat to their consumers including humans. This article comprehensively reviews the different aspects of heavy metals as hazardous materials with special focus on their environmental persistence, toxicity for living organisms, and bioaccumulative potential. The bioaccumulation of these elements and its implications for human health are discussed with a special coverage on fish, rice, and tobacco.[1,2] The article will serve as a valuable educational resource for both undergraduate and graduate students and for researchers in environmental sciences. Environmentally relevant most hazardous heavy metals and metalloids include Cr, Ni, Cu, Zn, Cd, Pb, Hg, and As. The trophic transfer of these elements in aquatic and terrestrial food chains/webs has important implications for wildlife and human health. It is very important to assess and monitor the concentrations of potentially toxic heavy metals and metalloids in different environmental segments and in the resident biota. A comprehensive study of the environmental chemistry and ecotoxicology of hazardous heavy metals and metalloids shows that steps should be taken to minimize the impact of these elements on human health and the environment.[3,4]

Since heavy metals are persistent in the environment, they enter from the environment to the organisms and accumulate therein.

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As mentioned earlier, the uptake and bioaccumulation of heavy metals in biota depend on several factors. For example, the uptake of heavy metals in plants depends on bioavailability of the metal in soil, which in turn depends on several factors such as metal speciation, pH, and organic matter contents in soil. Metals which are more bioavailable in soil may be accumulated in plants more easily and thus will have more bioaccumulation potential. An assessment of bioaccumulation of heavy metals in plants may be used for an estimation of bioavailability of the metals in soil. Such an assessment may also be used for knowing the contamination status of the environment. It has been reported that plants seem to be more sensitive to environmental changes than soils [68]. Different plant species have been suggested as bioindicators of heavy metal pollution in the environment. Different animal species have also been suggested as bioindicators of heavy metal pollution. For example, the date mussel (*Lithophaga lithophaga*) has been suggested as a valid bioindicator of marine pollution [5,6].

Bioaccumulation of heavy metals in biota is important from environmental, ecological, and human health point of view and has important implications for wildlife and human health. Contamination of aquatic and terrestrial food chains with potentially toxic heavy metals poses a threat to the health of consumer organisms including humans. In aquatic ecosystems, organisms are simultaneously exposed to different metals, which may have additive, synergistic, or antagonistic interactions [7,8]. The topic of bioaccumulation of heavy metals in biota is a very broad topic. Here, the discussion of the topic will be limited to bioaccumulation of heavy metals in fish and rice, which serve as the major dietary sources of heavy metal exposure for the general human population. Additionally, bioaccumulation of heavy metals in cigarette tobacco will also be discussed as tobacco smoke acts as an additional source of heavy metal exposure for the smoking human population.

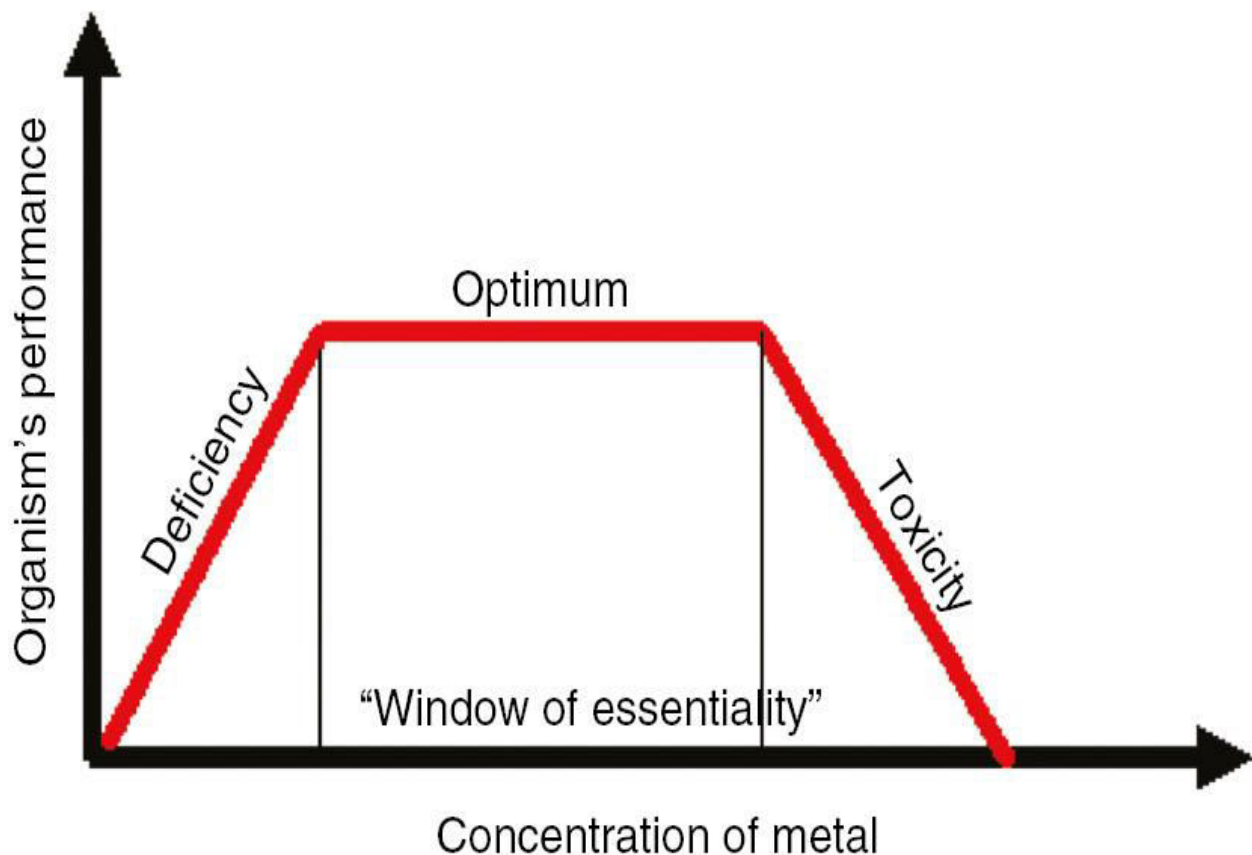
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II. DISCUSSION

The techniques in Bioremediation/Phytoremediation include the application of appropriate plants for in-situ risk reduction through contaminant removal, detoxification or containment in contaminated soil, sediments, and ground water.



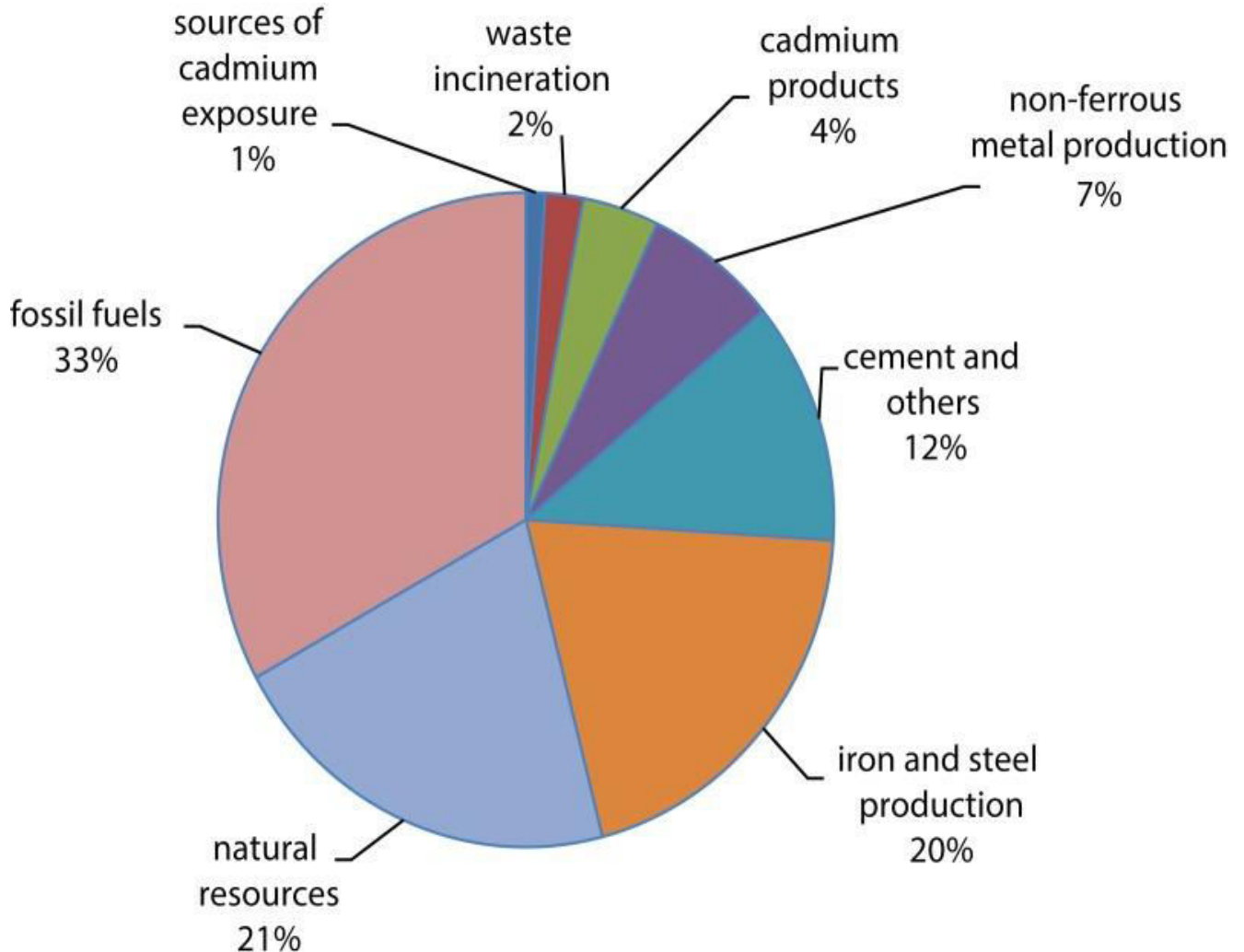
This strategy/approach can be used along with or, in some cases, in place of mechanical cleanup methods. Cleanup can be accomplished to certain level within the reach of plants' roots. Such sites need to be maintained and monitored (watered, fertilized, and monitored). Microflora associated with plants; endophytic bacteria, rhizosphere bacteria and mycorrhizae have the potential to degrade organic compounds in association with plants and this process is termed rhizoremediation. Bioremediation processes can also be accessed through a multifaceted approach such as: Natural attenuation, sensing environmental pollution, metabolic pathway engineering, applying phyto- and microbial diversity to problematic sites, plantendophyte partnerships and systems biology; plant physiology, agronomy, microbiology, hydrogeology, and engineering are combined to select the proper plant and conditions for a specific site. The specific application will depend on the mobility, solubility, degradability, and bioavailability of the contaminant(s) of concern[9,10]. Metal resistance mechanisms and their phytoremediation potential has been investigated in wide range of experimental model systems such as *Scenedesmus quadricauda*, *S. bijugatus*, *Chlamydomonas reinhardtii*, *Sorghum bicolor*, *Zea mays*, *Brassica juncea*; *Ceratophyllum demersum*, *Vallisneria americana* and *Lemna trisulca* and phytomass derived products as adsorbents for toxic metals

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Environmental pollution is a global problem for man and animals.



Pollutants from industrial waste enter into the livestock production systems and then into food chain. In most developing countries it is often attributed to industrialization with improper waste disposal. In developed countries impact of pollution on domestic and wild animals due to chemical toxicities are reported. Pollution is a serious problem in India, threatening the animal and human health. Heavy metal pollution is becoming a serious health concern in recent years. High levels of heavy metals in soil, water and animals have been reported in different parts of India due to pollution. Heavy metals from industrial waste contaminate drinking water, soil, fodder and food. The toxic heavy metals like Cd, Pb and Hg affect biological functions, affecting hormone system and growth. Many heavy metals accumulate in one or more of the body organs in food animals and are transmitted through food causing serious public health hazard. These toxicants are accumulated in the vital organs including liver and kidney and exert adverse effects on domestic animals. Many surveys involving human population in industrial, mining and urban areas have indicated toxicities due to effluents. Pesticides, heavy metals and other agro-chemicals are some of the major causes of environmental toxicity in farm animals. The impacts of pollution on animals result in serious economic losses. In this review we have tried to concise the information available in literature about the heavy metal pollution in soil, water, fodder and its consequences in livestock (blood, dung) and their presence in livestock products (milk, meat, egg).[11]

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III. RESULTS

The process of urbanization is a dynamic and multi-faceted progression.

River	Chromium	Lead	Iron
Ganga	Exceeds		Exceeds
Yamuna			Exceeds
Brahmaputra			Exceeds
Ramganga		Exceeds	
Rapti	Exceeds		Exceeds
Narmada			Exceeds
Godavari			Exceeds

SOURCE: CENTRAL WATER COMMISSION STUDY

The relationship between land use change and environmental quality has been affected by the rapid rate of urbanization, industrialization, rural land conversion, and unexpected growth of population which can cause the degradation in the environmental quality. The fast phase of urbanization causes series environmental issues and diverse kinds of pollution with evolution of time and technology and is sensitive in the accumulation of heavy metal contamination in both spatial and temporal aspects. The urban and economic growth plays a massive impact in polluting the environment by discharging the wastewater which inputs pollutants particularly of toxic heavy metals. The natural source of heavy metals is the result of paedogenic process of weathering of parental rock materials in the environment. The natural distribution of heavy metals depends on the environmental conditions and the bed rock type (igneous rock, sedimentary rock and metamorphic rock) present in the area. Soil formation from the lithogenic sources also contributes considerable amount of heavy metal concentration. Several studies state that natural disasters like forest fire and volcanic eruption will also contribute to the high concentration of heavy metals [12,13]

Geo-accumulation index (I_{geo})

The geo-accumulation index was proposed by Muller, a German scientist in the year 1979, to determine the concentration of accumulation of metal in the sediments by comparing the present with pre-industrial levels. This can be used to determine the contamination of aquatic sediments by organic and inorganic substances. The geo-accumulation index can be calculated by the following relation.

$$I_{geo} = \log_2 \left(\frac{C_x}{1.5 \times B_x} \right)$$

where C_x is the concentration of metal 'x' in the sediment and B_x is the geo-chemical background value of metal 'x'. The factor 1.5 is used in the equation to compensate the variations in background data due to lithogenic effects.[14]

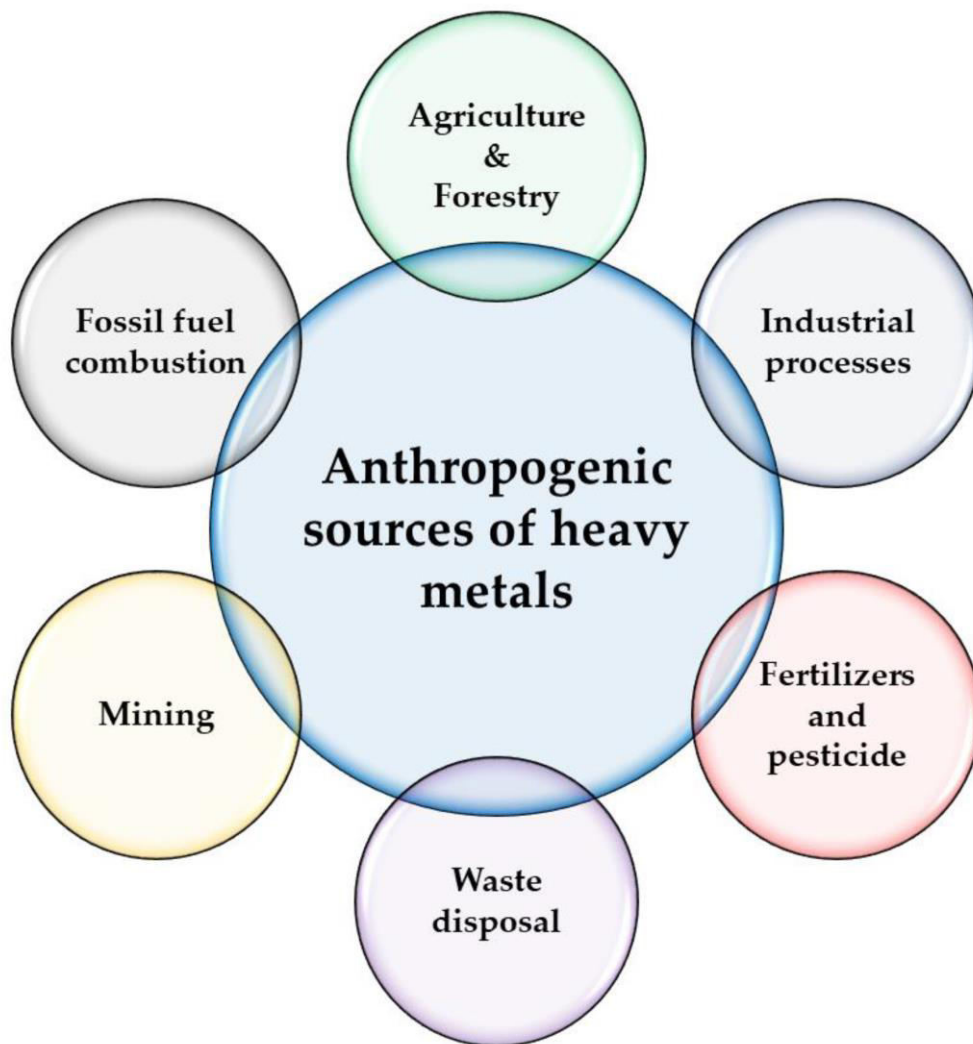
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IV. CONCLUSIONS

Heavy metal pollution poses a serious threat to all forms of life in the environment due to the toxic effects of long-term environmental pollution.



These metals are extremely sensitive at low concentrations and can be stored in food webs, posing a serious public health risk. Different organic pollutants and metals are not degradable and remain in their environment for a long time. Remediation using conventional physical and chemical methods is uneconomical and produces large volumes of chemical waste. The balance of hazardous metals has shown a strong and growing interest over the years. The use of biosensor microorganisms is eco-friendly and cost-effective. Therefore, microorganisms have a variety of mechanisms of metal sequestration that hold greater metal biosorption capacities. Finally, we provide suggestion from microbial tools to remove, recover metals, and metalloids from solutions using living or dead biomass and their components.[15]

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