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Heavy Metals Accumulation, its Hazards and Reclamation Practices in Flooded Soil of Koshi Region District Saharsa, Bihar

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The term heavy metal refers to any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations. Examples of heavy metals include Iron (Fe), Zinc (Zn), Manganese (Mn), Copper (Cu) and Arsenic (As) are found in Flooded Soil. Heavy metals are natural components of the Earth's crust. Heavy metals are dangerous because they tend to Bioaccumulate.

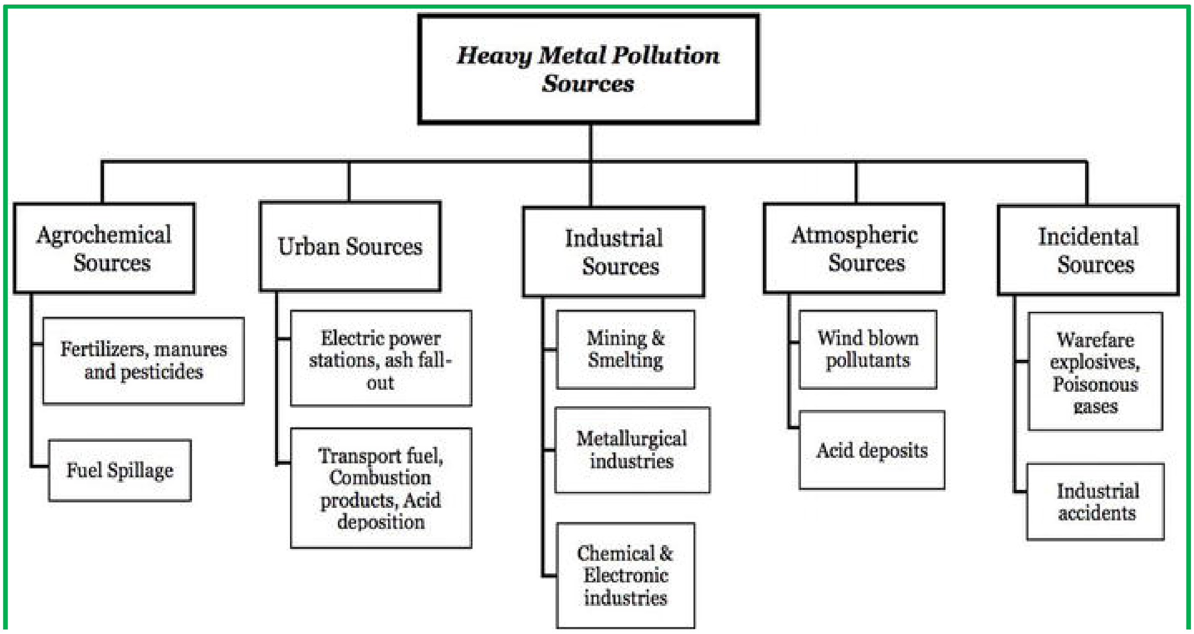
Bioaccumulation means an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment. Compounds accumulate in living things any time they are taken up and stored faster than they are broken down (metabolized) or excreted.

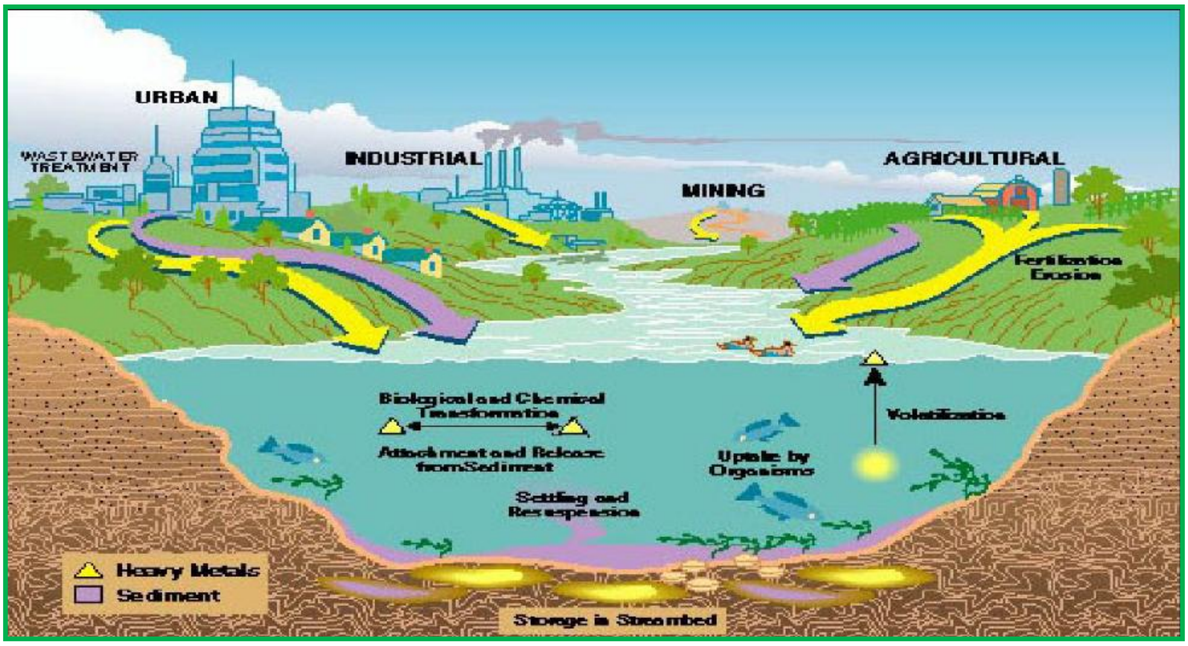
Among the 35 natural existing metals, 23 possess high specific density above 5 g cm^{-3} with atomic weight greater than 40.04 and are generally termed heavy metals. Some heavy metals are either essential nutrients (typically iron, cobalt, and zinc), but can be toxic in larger amounts or certain forms.

Other heavy metals, such as cadmium, mercury, and lead, are highly poisonous. Soils may become contaminated by the accumulation of heavy metals and metalloids through emissions from the rapidly expanding industrial areas, mine tailings, disposal of high metal wastes, leaded gasoline and paints, land application of fertilizers, animal manures, sewage sludge, pesticides, wastewater irrigation, coal combustion residues, spillage of petrochemicals, atmospheric deposition.

Heavy metals can degrade air, water, and soil quality, and subsequently cause health issues in plants, animals, and people, when they become concentrated as a result of industrial activities. Soils are the major sink for heavy metals released into the environment by anthropogenic activities.

Heavy metal contamination of soil may pose risks and hazards to humans and the ecosystem through: direct ingestion or contact with contaminated soil, the food chain (soil-plant-human or soil-plant-animal human), drinking of contaminated ground water, reduction in food quality (safety and marketability) via phytotoxicity, reduction in land usability for agricultural production causing food insecurity, and land tenure problems. Serious toxic effects of heavy metals, including cancer, brain damage and death, rather than the harm they may cause to one or more of the skin, lungs, stomach, kidneys, liver, or heart.





Recent examples of heavy metal contamination and health risks include

i. 1932 Minamata Sewage containing mercury is released by Chisso's chemicals works into Minimata Bay in Japan. The mercury accumulates in sea creatures, leading eventually to mercury poisoning in the population.
ii. 1952 Minamata Syndrome In 1952, the first incidents of mercury poisoning appear in the population of Minimata Bay in Japan, caused by consumption of fish polluted with mercury, bringing over 500 fatalities. Since then, Japan has had the strictest environmental laws in the industrialised world.
iii. 1986-11-01 Sandoz Water used to extinguish a major fire carries c. 30 t fungicide containing mercury into the Upper Rhine. Fish are killed over a stretch of 100 km. The shock drives many FEA projects forwards. See also "Pollution of the Rhine at Basel / Sandoz".
iv. 1998-04 Spanish nature reserve contaminated after environmental disaster Toxic chemicals in water from a burst dam belonging to a mine contaminate the Coto de

Donana nature reserve in southern Spain. C. 5 million m_ of mud containing sulphur, lead, copper, zinc and cadmium flow down the Rio Guadimar. Experts estimate that Europe's largest bird sanctuary, as well as Spain's agriculture and fisheries, will suffer permanent damage from the pollution.

Effects on Soil

Heavy metals are considered one of the major sources of soil pollution. Heavy metal pollution of the soil is caused by various metals, especially Zn, Fe, Cu, Mn and As. Heavy metals exert toxic effects on soil microorganism hence results in the change of the diversity, population size and overall activity of the soil microbial communities. Soil contamination by heavy metals is of most important apprehension throughout the industrialized world. Heavy metal pollution not only result in adverse effects on various parameters relating to plant quality and yield but also cause changes in the size, composition and activity of the microbial community. Therefore, heavy metals are considered as one of the major sources of soil pollution.

Range of Heavy Metals (ppm) in Soil.

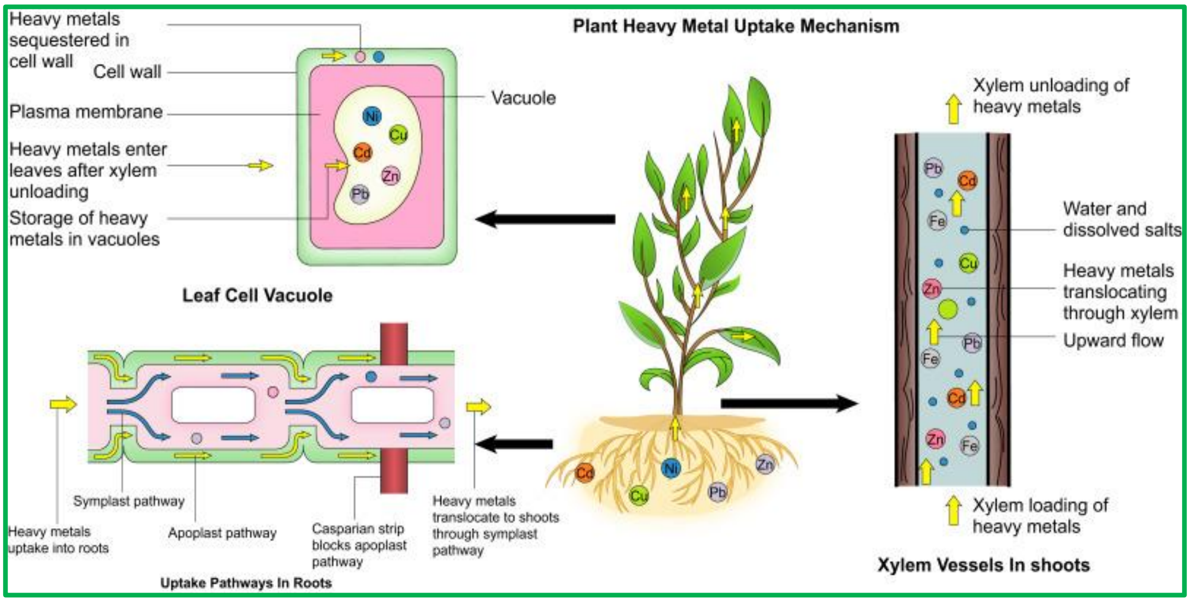
Rating	Zinc	Iron	Copper	Manganese	Arsenic
Acutely deficient	<0.3	<3.5	<0.2	<0.2	<0.2
Deficient	0.3-0.6	3.5-5.5	0.2-0.4	0.2-0.4	.2-1
Marginally deficient	0.6-0.9	5.5-7.5	0.4-0.6	0.4-0.6	1-5
Adequate	0.9-1.2	7.5-9.5	0.6-0.8	0.6-0.8	5-20
High	1.2-1.8	9.5-11.5	0.8-1.0	0.8-1.0	20-30
Very high	>1.8	>11.5	>1.0	>1.0	>30

Conclusion

The heavy metals enter the body from different ways including drinking water, air, food, or occasionally dermal exposure. Following absorption, heavy metals are retained, and they accumulate in the human body. Bioaccumulation of toxic metals leads to a diversity of toxic effects on a variety of body tissues and organs. Metal toxicity can have acute or chronic manifestations. Heavy metals disrupt cellular events including growth, proliferation, differentiation, damage-repairing processes, and apoptosis. Toxic metals can also promote epigenetic alterations which can influence gene expression. Comparison of the mechanisms of action reveals similar pathways for these metals to induce toxicity including ROS generation, weakening of the antioxidant defense, enzyme inactivation, and oxidative stress. On the other hand, some researches have shown that the metals selectively bind to specific macromolecules. The interaction of Pb with ALAD and ferrochelatase is within this context. Reactions of other heavy metals with certain proteins were discussed as well. Some toxic metals including Cr, Cd, and As cause genomic instability. Defects in DNA repair following the induction of oxidative stress and DNA damage by these metals is considered as the cause of their carcinogenicity. The application of chelation therapy for the management of metal poisoning has not been reviewed here. This could be another aspect of heavy metals to be reviewed in the future. Developing specific biomarkers for monitoring heavy metals will be a major achievement in the field. Future research will benefit from the evaluation of new targets as protective procedures against organ toxicity induced by heavy metals.

Reclamation of Heavy Metal Pollution in Soil

The prevention of soil contamination by inorganic toxic compounds, particularly heavy metals, can be achieved by either eliminating or drastically reducing the application of the toxins to soil or by managing the soil-crop system in a manner that leads to the prevention of further recycling of the toxins. Industrial managers and decision-makers need to recognize that soil is an important natural resource with finite capacity and it can be damaged by accidental contamination through the addition of inorganic toxins. There must also be judicious reductions in the intended applications to soil of the wastes containing toxic compounds in quantities that may interfere with the normal behaviour of the soil. The continuous cycling of toxic inorganic chemicals can be reduced by following such judicious soil and crop management practices, which keep the chemicals in the soil and reduce their uptake by plants. The cycle of soulplant-animal (human) through which toxic elements exert their effect is broken by immobilizing the toxins in the soil The soil becomes a sink for the



toxic elements. For example, if the soil p}{ can be maintained neutral or above (by liming of acid soils), most of the tovic elements are rendered less mobile and less available. Similarly, the drainage of wet souls helps in the formation of oxidized forms of several toxic elements, which are generally less soluble and less available for plant uptake Heavy phosphate applications to soil can also lead to reduced availability of toxic cations. The fact that crop species or varieties differ in extracting toxic elements from the soil can be used to decontaminate the soils, though to a limited extent. The removal of Se in large quantities by some crop species as compared to others demonstrates the effectiveness of phytoremediation for reducing the amount of Se in the soil. The accumulator plants should, however be avoided if the harvests are to be fed to human beings or domestic animals. During recent years, many treatment options like physical, chemical, and biological were implied to remediate heavy metal contaminated soil, water, and sediments. Such methods include thermal treatment, adsorption, chlorination, chemical extraction, ion-exchange, membrane separation, electrokinetics, bioleaching etc.