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A Review of Heavy Metals in Surface Water in India

Ravi Kant Pareek, Ramoo Ram, Dr. Varinder Singh
Department of Civil Engineering, Vivekananda Global University, Jaipur
Department of Civil Engineering, Guru Kashi University, Talwandi Sabo

Abstract**: In India, owing to the unprecedented and exponentially growing human population, increasing pace of urbanization and rapid industrialization of the country has become inevitable. At present, even from the past, more attention has been focused on the fate of the heavy metals and their derivatives in the aquatic environment. The impact of heavy metals play important role in the environmental pollution. Therefore, a thorough understanding about the toxic effects of metals on living animals is needed nowadays. Though some metals are essential nutrients, they also serve as industrial and environmental hazards. The increasing industrialisation leads to the continual addition of pollutants to the environment. Recently, the accumulations of air-borne metals in plants and soils have received increasing attention. The pollutants from industries change the chemistry of water, thereby, damaging the biotic life. The heavy metals act either synergistically or antagonistically on the aquatic biota and in some cases may cause a decrease in biotic diversity. Heavy metal pollution is one of the most serious environmental problems in China and a large number of people are threatened by heavy metal pollution. Extensive damage to human organs, such as liver, kidney, digestion system, and nervous system can be caused by uptake of excess heavy metals. Heavy metals in the environment can originate from both natural and anthropogenic sources. Although contamination of heavy metals has been known to be a severe environmental problem for decades, it is still getting worse in recent years and there are few feasible approaches to resolve this problem. Due to their high toxicity, prevalent existence and persistence in the environment, lead (Pb), mercury (Hg), cadmium (Cd), chromium (Cr) and arsenic (As) are commonly considered as the priority heavy metals which should be concerned and their emission should be controlled in India. This paper reviewed the pollution of heavy metals in India, focusing on the following four aspects: current status of heavy metal pollution in India, sources of heavy metals in India, toxicity and potential risk, and possible reduction strategies.

Keywords: Environment, Lead (Pb), Mercury (Hg), Cadmium (Cd), Chromium (Cr) And Arsenic (As)

Introduction:

Heavy metal pollution is an inorganic chemical hazard, which is mainly caused by lead (Pb), chromium (Cr), arsenic (As), cadmium (Cd), mercury (Hg), zinc (Zn), copper (Cu), cobalt (Co), and nickel (Ni). Five metals among them, Pb, Cr, As, Cd, and Hg, are the key heavy metal pollutants in India. These heavy metals are classified as strong carcinogens by the International Agency for Research on Cancer. High level of heavy metal exposure can also cause permanent intellectual and developmental disabilities, including reading and learning disabilities, behavioral problems, hearing loss, attention problems and disruption in the development of visual and motor function. In the past 30 years, India's economy has experienced rapid development. Therefore, it led to a huge increase in energy consumption and environmental pollution. Among various types of pollution, heavy metal pollution is a crucial environmental problem. Some traditional pollutants, such as sulfur dioxide and carbon dioxide, have been put under control, but heavy metal pollution, which poses even greater risks to public health; have yet to gain policymakers attention

Sources of Heavy Metals

Alluminium: Common sources of bioavailable Aluminum incorporate: aluminum cookware, flatware and above all coffee pots; aluminum hydroxide anti-acid formulations; some varieties of cosmetics, peculiarly deodorants; and a few herbs or natural merchandise [33-35]. Aluminum cookware is primarily of problem if acid foods are cooked reminiscent of tomato paste (involves salicylates). In cosmetics and deodorants, aluminum chloride is also reward as an astringent. In water purification, alum (sodium aluminum sulfate) could also be used to coagulate dispersed solids and reinforce water readability. Alumina or Al_20_3 is very steady chemically and not bioavailable. Silica limits the solubility of aluminum and aluminum silicate will not be very bioavailable. Clays, bentonite for illustration, contain aluminum that has bad bioavailability. Aluminum food containers are manufactured with polymer or plastic coatings that prevent direct meals-aluminum contact supplied such coatings are not damaged. In the GI tract, phosphates react with aluminum ions forming insoluble aluminum phosphates. If this phosphate-blockading have been 100% effective, then almost no aluminum could be absorbed. Clearly, this phosphate-forming method is incomplete in view that physique tissue levels (such as hair) regularly include measurable quantities of aluminum. Within the body aluminum follows a route of growing phosphate attention: cytosol, plasma, mobile nucleus. Once in the nucleus, it adversely affects protein formation and proper function of the body [36,37]. Lengthy lived cells corresponding to neurons are prone to long-time period accumulation. Aluminum is considered neurotoxic and is implicated as a stabilizing agent (through aluminum phosphate bonds) in neurofibrillary tangles in Alzheimer's ailment

Antimony: Antimony (chemical image Sb) has two valences: Sb^{+3} and Sb^{+5}. Sb^{+3} are the extra toxic however is customarily excreted in feces. Sb^{+5}, much less poisonous, bind less good to physique tissues and is excreted ordinarily in urine. Antimony can be assimilated through inhalation of Sb salt or oxide dirt, ingested with (contaminated) foods or fluids, or absorbed transdermally. Inhalation could occur in industrial areas where smelting or alloying is finished (mainly with

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copper, silver, lead, tin). Sb is present in tobacco at about zero.01% by using weight; about 20% of that is mostly inhaled by means of cigarette smoking. Antimony compounds are generally used for fireproofing plastics and textiles, and this element could also be discovered in battery electrodes, ceramics and pigments [38-40]. Antimony may also be absorbed with the the standard use of firearms or dealing with of gun powder. Exposure of Skin can produce rashes or "antimony spots" which resemble small pox and chicken pox. Certain molds can produce the highlyneurotoxic stibine gas from Antimony; cetylcholinestelase activity is inhibited with stibine.

Arsenic: Arsenic is a highly reactive metal, forms a varities of compounds, either inorganic or natural. Natural Arsenic compounds like Arsenosugars, Arsenocholine, Arsenobetaine and Tetramethylarsonium salts incorporate carbon and are commonly determined in sea-living organisms. Arsenate derivative of Arsenic are often identified to be extra toxic and are most of the time of geological origin. These can be located in agricultural soil and groundwater used for consuming or irrigation, Industrially, Arsenic and its compounds are regularly used in the construction of pesticides, herbicides and pesticides as good as in semiconductor [41-43] manufacturing to improve copper and lead alloys throughout batteries manufacturing system. In relation to Arsenic, the peripheral anxious procedure is the fundamental target. Early indicators of Arsenic publicity are immoderate perspiration, muscle tenderness or weakness and changes in the skin pigmentation.

Cadmium: This element is insidiously toxic with chronic accumulations affecting renal function, pulmonary and cardiovascular tissues, bone, and the peripheral nervous procedure. Without intervention, the organic half of-lifetime of Cadmium in humans exceeds twenty years. Cadmium extra incorporate: hypertension, weight reduction, microcytic-hypochromic anemia, lymphocytosis, proteinuria with losing of beta-2 macroglobulin, emphysema and pulmonary fibrosis (if inhalation was a route of infection), atherosclerosis, steomalacia and lumbar affliction, and peripheral neuropathy. Acute inhalation of Cadmium dusts, fumes or soluble salts may just produce cough, pneumonitis, and fatigue. Environmental sources incorporate: mining and smelting events, pigments and paints, electroplating, electroplated ingredients (e. G., nuts and bolts), batteries (Ni-Cd), plastics and artificial rubber, photographic and engraving techniques, ancient drum. Excess heavy metal [44-46] accumulation in soils is toxic to humans and other animals. Exposure to heavy metals is normally chronic (exposure over a longer period of time), due to food chain transfer. Acute (immediate) poisoning from heavy metals is rare through ingestion or dermal contact, but is possible. Chronic problems associated with long-term heavy metal exposures are: Lead –mental lapse.Cadmium– affects kidney, liver, and GI tract. Arsenic-skin poisoning, affects kidneys and central nervous system. The most common problem causing cationic metals (metallic elements whose forms in soil are positively charged cations e.g., Pb^{2+}) are mercury, cadmium, lead, nickel, copper, zinc, chromium, and manganese. The most common anionic compounds (elements whose forms in soil are combined with oxygen and are negatively charged e.g., MO_4^{2-}) are arsenic, molybdenum, selenium, and boron.

Contamination Caused by The Heavy Metals

Soil Contamination: Excess heavy metal [**Figure 1**] accumulation in soils is poisonous to humans and different animals. Publicity to heavy metals is as a rule chronic (publicity over an extended interval of time), as a result of food chain switch. Acute (immediate) poisoning from heavy metals [47-50] is infrequent by means of ingestion or dermal contact, however is possible.

Drastic Problems associated with long-term heavy metallic exposures are:

Lead–intellectual lapse.

Cadmium–affects kidney, liver, and GI tract.

Arsenic–dermis poisoning, impacts kidneys and central frightened approach.

Essentially the most usual problem inflicting cationic metals (metallic elements whose Types in soil are positively charged cations e.G., Pb^{2+}) are cadmium, mercury, lead, nickel, copper, zinc, chromium, and manganese [51-54]. The most common anionic compounds (elements whose types in soil are combined with oxygen and are negatively charged e.g. MO_4).

Water contamination: Water contamination proves to be probably the most involving human effects on the environment. Enterprise, urbanization and agriculture mostly introduce various pollutants including heavy metals, bacteria, agrochemicals [55], and medications. This pollution could have direct effects on human well-being; inflicting a broad sort of afflictions starting from diarrhea to melanoma. Water infection proves to be one of the crucial regarding human effects on the atmosphere. Industry, urbanization and agriculture commonly introduce more than a few pollution including heavy metals, microorganism, agrochemicals, and medications .These pollutants would have direct results on human well-being, causing a huge sort of afflictions starting from diarrhea to melanoma. New industrial and urban centres and agriculture and livestock have resulted in deforestation. Illness of surface water with faecal-derived pathogens poses a large risk to human health and represents a predominant barrier for the utilization of untreated river water for consuming or different domestic functions. Just lately, some pollution concerning antrophic pursuits like heavy metals and trace elements as Ag, Al, As, Be, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, U and Zn [56-57].

Heavy Metal Toxicity

Commonly, irritable wellbeing challenge related to heavy metal (accumulation) perhaps customarily divided into 2 types, i.e. heavy metallic poisoning induced by way of immoderate extrinsic publicity and genetic issues equivalent to Wilson disease.

Many metals, in hint quantities, are as a rule relevant to common physiological procedures; for examples, iron in oxy-

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gen transport, manganese and selenium in antioxidant method and zinc in metabolism. With these main metals toxicity happens when concentrations are either too low or too high [58,59].

Acute and persistent arsenic toxicity, as good as arsine gas toxicity involves adverse effects on the fearful, cardiovascular, respiratory, gastrointestinal, hepatic, renal, hematopoietic, immunological, and dermatologic programs. Mercury exposure, together with exposure to brief chain alkyl mercury, elemental mercury, and acute inorganic salt. Lead, cadmium, and manganese have discovered a kind of makes use of in enterprise, craft, and agriculture as a result of their bodily and chemical homes. Poisoning precipitated through excessive concentration of those metals adversely has an impact on on kidney, hematopoietic cells, anxious system, and bones. It additionally seems that the penalties of exposure to lead in adults are much less severe than the types of exposure related to hyperactivity in neonates.

It has also been hypothesized that these metals exert their poisonous outcomes by using damaging biological safety, which exist within the body to serve as protecting mechanisms in opposition to exogenous toxins. The challenge of metallic toxicity becomes even more tricky as a result of simultaneous or successive publicity of the final population to extraordinary physical, chemical, biological, and psychological explanations in the environment [60-62].

Method of Removing Metal Pollution

Bioremediation

Bioremediation is considered replacement processing approaches for casting off the heavy metals ions from polluted subject. Bioremediation [63,64] is of course residing organisms to cut down the environmental pollutants into less toxic forms. It's adopted through bacteria and fungi or vegetation to degrade or detoxify hazardous components to human well-being /or the atmosphere. The microorganisms are also remote from an indigenous contaminated discipline or elsewhere and follow to the contaminated website online. Contaminant materials are modified with the aid of dwelling organisms through reactions that take location as a part of their metabolic tactics. The usage of microbial metabolism method has offered a potential, safer, extra efficient and less pricey for cleaning of pollutions. The concepts of the bioremediation may also be divided into a few tactics that including:

- Biofilters
- Bioventing
- Biosorption
- Composting
- Bioaugmentation
- Bioreactor
- Land farming

These causes include the presence of microbial populace educated of degrading the pollution, the availability of contaminants to the microbial [65,66] populace and the atmosphere explanations as like as soil style, temperature, pH, the presence of oxygen or other electron acceptors, and vitamins and minerals. Bioremediation are specified process for cleansing the polluted environments from the surroundings (industrials emissions and soil vent gases), solids (soils, sediments and also sludge), beverages (groundwater, industrial effluents) and uncooked substances from industrial processing. Residing or non-residing microorganisms can use their enzymes to achieve within the mission [67-68].

The following recommendations are put forward for effectivewater quality management in India:

1. Protection of water resources: Treatment of domestic and municipal wastes and industrial effluents before they are discharged into surface water bodies, and management of agricultural run- off should be initiated.

2. Proper Implementation of laws and rules: Govt. has made several laws and rules to control the water polluti on in aquatic ecosystem but there is a lacking in implementation. Strict follow- up is necessary.

3. Efficient water use: A system of incentive and disincentives should be adopted to encourage efficient water use.

4. Water safety: BIS/WHO guidelines should be adopted and effective methods should be designed in providing adequate safe water to people.

5. Capacity building: Facilities should be created to edify and train personnel in water management skills. Mechanism of laboratory inspection and accreditation must be int roduced for ensuring the quality of data generated.

6. Public awareness and participation: The public should be made aware of the dangers of pollution especially In rural/slum areas. Academia, NGO's and local communities should Be involved to aware the people so that they can also participate in the management and conservation of water resources.

7. Water security: Water security should be achieved by harvesting of rainwater and recycling of municipal waste water.

8. Remediation techniques: Remediation techniques can be an effective tool for the conservation of surface water bodies. Amongst them, phytoremediation is the best technique that does not required much efforts and money also

Conclusion

The overall populace does now not face a significant wellbeing danger from methyl mercury, despite the fact that distinctive groups with excessive fish consumption may just gain blood levels related to a low hazard of neurological damage to adults. Considering there is a threat to the fetus in specific, pregnant females must restrict a high intake of precise fish, such as shark, swordfish and tuna. Fish, corresponding to

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pike, walleye and bass, taken from polluted contemporary waters will have to specifically be avoided. Lengthy-time period exposure to arsenic in consuming water is mostly regarding accelerated risks of skin cancer, but also another cancers, and different epidermis lesions corresponding to hyperkeratosis and pigmentation changes. Occupational publicity to arsenic, chiefly by means of inhalation, is causally related to lung cancer. Clear exposure–response relationships and excessive dangers have been observed.

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