Water Contamination by Heavy Metals and their Toxic Effect

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ABSTRACT

Water pollution by heavy metals is a serious problem affecting humans and animals. Heavy metal ions can cause health problems such as liver and kidney damage, skin diseases, mental retardation and cancer. To avoid the harmful effects of these toxic metals, it is important to find an environmentally friendly and cost-effective way to remove heavy metal ion pollution from diseases. Biosorption is an environmentally friendly process based on plant biomass.Algae and agricultural waste and microorganisms. This method is environmentally friendly and does not require much investment. This review provides basic knowledge on heavy metal pollution research and environmental removal.

Keywords- heavy metals, Groundwater Quality, diseases and risk.

I.   INTRODUCTION

Water is one of the most important natural resources relied upon by humans in various aspects of life(23). It is an essential source for drinking, irrigation, and economic development, with its uses intertwined with most human activities(1). However, water pollution has become one of the biggest environmental challenges the world faces today, due to the increase in industrial activities and urban expansion in many regions. While the demand for water is rising, these resources are exposed to numerous pollutants that directly impact their quality and safety(2).

Among these pollutants, heavy metals are considered one of the most dangerous contaminants that negatively affect the environment and human health. Heavy metals such as lead, mercury, cadmium, and arsenic are toxic elements that accumulate in the environment and persist for long periods, making them an environmental and health hazard. These elements cause water pollution through leakage into rivers, lakes, and other water bodies as a result of industrial activities such as mining, power plants, and industrial waste containing these heavy metals in large quantities(4). Thus, the problem of water pollution by heavy metals arises, leading to the degradation of water quality and threatening the health of living organisms that depend on it, including humans (3).

These pollutants are among the primary sources threatening aquatic environments in many countries, as they poison both groundwater and surface water(5). Therefore, maintaining water quality from heavy metal pollution is a vital issue that must be addressed through the implementation of stricter environmental policies and the development of effective purification technologies (6).
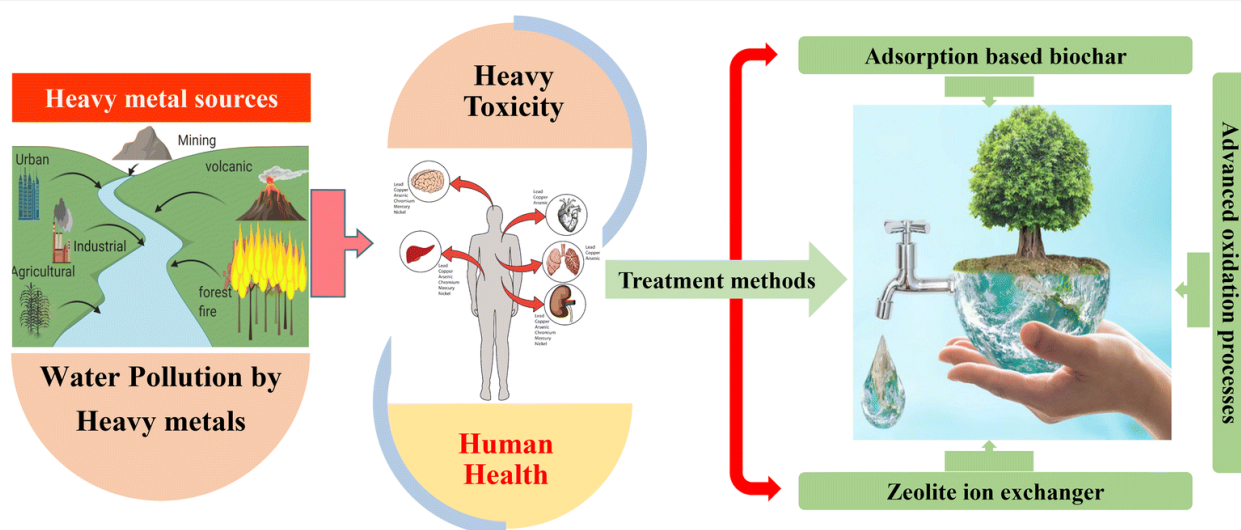
Fig. 1 An overview of the sources of heavy metal pollution, their associated health risks, and low-cost, effective methods for removing heavy metals from wastewater.

II. DETRIMENTAL EFFECTS

The negative effects of heavy metals "bind to essential cellular components such as structural proteins, enzymes and nucleic acids and impair their function. [7] Symptoms and side effects may vary depending on the solvent combination or solvent and the dose involved. In general, exposure to toxic heavy metals can cause cancer, central and peripheral nervous system and circulatory effects. For humans, typical exposures are related to exposure to some of the "classic" toxins[8]

Heavy metals, chromium (another toxic heavy metal) and arsenic (a metalloid) are shown in the table.

Element	Acute exposure *usually a day or less*	Chronic exposure *often months or years*
Cadmium	Pneumonitis (lung inflammation)	Lung cancer Osteomalacia (softening of bones) Proteinuria (excess protein in urine; possible kidney damage)
Mercury	Diarrhea Fever Vomiting	Stomatitis (inflammation of gums and mouth) Nausea Nephrotic syndrome (nonspecific kidney disorder) Neurasthenia (neurotic disorder) Parageusia (metallic taste) Pink Disease (pain and pink discoloration of hands and feet) Tremor
Lead	Encephalopathy (brain dysfunction) Nausea Vomiting	Anemia Encephalopathy Foot drop/wrist drop (palsy) Nephropathy (kidney disease)
Chromium	Gastrointestinal hemorrhage (bleeding) Hemolysis (red blood cell destruction) Acute renal failure	Pulmonary fibrosis (lung scarring) Lung cancer
Arsenic	Nausea Vomiting Diarrhea Encephalopathy Multi-organ effects Arrhythmia Painful neuropathy	Diabetes Hypopigmentation/Hyperkeratosis Cancer

III.   REMEDIATION

Humans

In humans, heavy metal poisoning is usually treated using chelating agents. [9] These are chemical compounds such as CaNa2EDTA (calcium dinodium ethylene diamine tetraacetate) converts heavy metals into neutral substances that can be eliminated without interacting with the body. Chelates have no side effects and can remove beneficial metals from the body. For this reason, vitamin and mineral supplements are sometimes prescribed at the same time.[12][13]
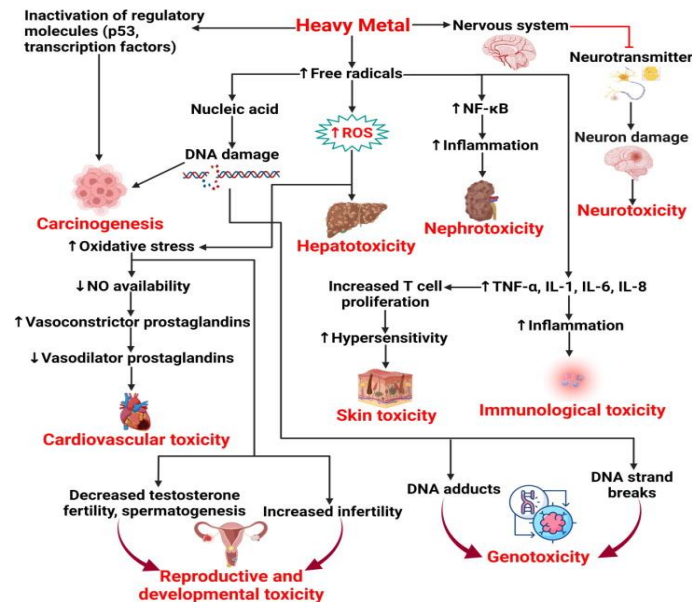

Fig. 2 Impacts of heavy metals toxicity on human health.

IV.   ENVIRONMENT

Soil contaminated with heavy metals can be remedied by one or more of the following technologies: Separation(10). void; reduce toxicity; physical separation; containment is the use of caps, membranes, and underground barriers to try to contain contaminated soil(11). The purpose of tillage is to change soil conditions to prevent movement of heavy contaminants. Detoxification attempts to oxidize or reduce toxic heavy metal ionsChemical or biological substances are converted to a less toxic or mobile form(14,24). Physical separation involves removing contaminated soil and separating metal contaminants by mechanical means. Extraction is an on-site or off-site process that uses chemicals, high-temperature vaporization, or electricity to remove contaminants from soil(15). The process or processes used will vary depending on the contamination and the conditions of the site .(25)

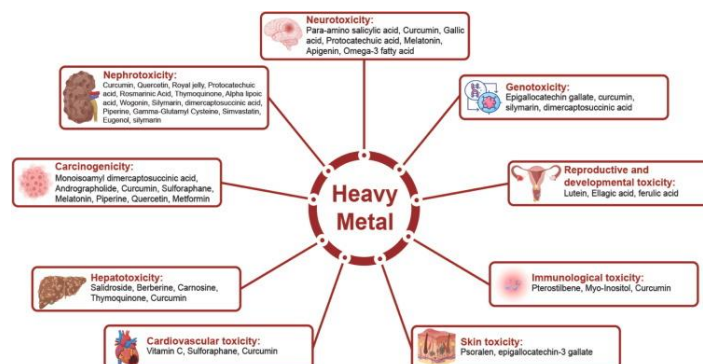**Fig. 3 sources of heavy metal pollution.**

Contamination sources:

Toxic metals are determined clearly withinside the earth, and emerge as focused due to human activities, or, in a few instances geochemical processes, inclusive of accumulation in peat soils which are then launched whilst tired for agriculture.[16] Common reassets are mining and business wastes; automobile emissions; motor oil; fuels utilized by

ships and heavy machineries; production works; fertilisers;[17] pesticides; paints; dyes and pigments; renovation; unlawful depositing of production and demolition waste; open pinnacle roll-off dumpster; welding, brazing and soldering; glassworking; concrete works; roadworks; use of recycled materials; DIY steel projects; burning of joss paper; open burning of waste in rural area; infected air flow system; meals infected through the surroundings or through the packaging; armaments; lead-acid batteries; digital waste recycling yard; handled woods; growing old water deliver infrastructure;[18] and microplastics floating withinside the world's oceans.[19][20] Arsenic, cadmium and lead can be found in kid's toys at degrees that exceed regulatory standards. Lead may be utilized in toys as a stabilizer, shadeation enhancer, or anti-corrosive agent. Cadmium is on occasion hired as a stabilizer, or to growth the mass and luster of toy jewelry. Arsenic is idea for use in reference to coloring dyes.[21] Regular imbibers of illegally distilled alcohol can be uncovered to arsenic or lead poisoning the supply of that is arsenic-infected lead used to solder the distilling apparatus. Rat poison utilized in grain and mash shops can be every other supply of the arsenic.[22]

Fig. 4 heavy metal in environmental

Metal toxicity:

Metal toxicity or steel poisoning is the poisonous impact of sure metals in sure bureaucracy and doses on life(31).Some metals are poisonous once they shape toxic soluble compounds. Certain metals don't have any organic role, i.e. aren't critical minerals, or are poisonous whilst in a sure shape.[26] In the case of lead, any measurable quantity may also have terrible fitness effects.[27] There is a famous false impression that most effective heavy metals may be poisonous, however lighter metals along with beryllium and lithium may be poisonous too.[28] Not all heavy metals are in particular poisonous, and a few are critical, along with iron(30).The definition can also consist of hint factors whilst abnormally excessive doses can be poisonous. An choice for remedy of steel poisoning can be chelation therapy, a way related to the management of chelation dealers to do away with metals from the frame. Toxic metals once in a while imitate the motion of an critical element, interfering with the metabolic tactics ensuing in illness. Many metals, in particular heavy metals are poisonous, however a few are critical, and a few, along with bismuth, have a low toxicity. Metals in an oxidation nation odd to the frame can also grow to be poisonous: chromium(III) is an critical hint element, however chromium(VI) is a carcinogen. Only soluble steel-containing compounds are poisonous. Soluble metals are known as coordination complexes, which encompass a steel ion surrounded via way of means of ligands. Ligands can variety from water in steel aquo complexes to methyl companies as in tetraethyl lead. Usually steel complexes encompass a aggregate of ligands.(29)

Research Objectives:

1. To study the impact of water pollution by heavy metals on the environment and human health.
2. To analyze the main sources contributing to water pollution by heavy metals.
3. To suggest solutions to reduce heavy metal pollution in water.

Importance of the Research:
- Increasing awareness about the dangers of water pollution by heavy metals and its environmental and health effects.
- Providing scientific and technical solutions to reduce water pollution by heavy metals and protect water resources.
- Providing a scientific database that can be used in future studies to develop effective strategies to combat this pollution.

V.   RESEARCH PROBLEM

The main research problem lies in water pollution by heavy metals, a problem faced by many countries due to industrial activities that use toxic materials without considering environmental protection. The research problem can be broken down into the following points:

1. The spread of water pollution by heavy metals as a result of industrial activities such as mining and power plants.
2. Lack of awareness about the risks of water pollution and prevention methods, especially in areas with intensive industrial activity.
3. Health and environmental impacts caused by water pollution by heavy metals, such as their toxic effects on marine organisms, plants, and human health.

VI.   PREVIOUS STUDIES

1. Nriagu, J. O. (1988). A review of the contamination of water bodies by heavy metals in developing countries.

In his study, Nriagu discussed the impact of heavy metal contamination in water bodies in developing countries. He pointed out that many rivers and lakes in these regions experience severe pollution due to industrial activities such as mining and manufacturing, in addition to industrial waste being dumped into water bodies. The study emphasized that heavy metals such as mercury, lead, and cadmium accumulate in water, affecting the environment and human health over the long term. Moreover, research in these regions often lacks sufficient focus on developing effective technologies to address this pollution. The study also found that most of these activities are not adequately monitored by government bodies, making it difficult to mitigate the damage caused by these pollutants.

2. Alloway, B. J. (1995). Heavy metals in soils. Springer Science & Business Media.

In this book, Alloway examined the pollution of soils and water by heavy metals and their impact on the environment. The author pointed out that heavy metal pollution is not limited to the soil but also extends to both groundwater and surface waters through seepage. He explained how these metals transfer from soil to water due to improper irrigation or seepage from industrial plants. He also focused on the effects of these metals on wildlife and plants, particularly the impact of mercury and lead on biodiversity in polluted areas.

3. Nriagu, J. O., & Pacyna, J. M. (1988). Quantitative assessment of worldwide contamination of air, water, and soils by trace metals.

Nriagu and Pacyna conducted a quantitative assessment of heavy metal pollution in air, water, and soil worldwide. The researchers found that the main sources of water pollution by heavy metals include industrial waste and, in some cases, agricultural activities. They concluded that certain regions, particularly in developing countries, suffer from very high levels of pollution, posing significant risks to both the environment and public health.

4. Mahimairaja, S., & Bolan, N. S. (2011). Environmental pollution by heavy metals and their effects on human health.

In this study, Mahimairaja and Bolan focused on the effects of water pollution by heavy metals on human health. They reviewed the impact of lead, mercury, and cadmium on human health, particularly in areas that rely on contaminated water for drinking and irrigation. They explained that prolonged exposure to these metals could lead to various health problems, such as kidney failure, blood poisoning, and neurological damage. The study also discussed the importance of modern technologies to purify water from these metals to reduce health risks.

5. Kimbrough, D. E., et al. (1999). Lead and mercury in the environment: Effects on human health.

This study explored the effects of lead and mercury on human health. It showed that prolonged exposure to these elements can lead to environmental poisoning, putting humans at risk of developing chronic diseases. The study also found that toxic substances accumulate in water due to industrial activities, increasing the risk of water pollution by these metals. The authors recommended the activation of government policies to limit pollution from industrial activities and highlighted the need for more effective water treatment methods.

6. Chen, H., et al. (2018). Heavy metal pollution in the surface water and sediments of the Chao Lake in Eastern China:

In this review, Chen and colleagues analyzed heavy metal pollution in the surface water and sediments of Chao Lake in Eastern China. They discussed the sources of pollution, which include industrial effluents and agricultural runoff, and the accumulation of metals like cadmium, lead, and mercury in the lake's sediments. The study found significant effects on both the aquatic ecosystem and human health, and it highlighted the need for stricter environmental monitoring and regulation to prevent further contamination.

VII.   RESEARCH METHODOLOGY

The research follows an analytical methodology focusing on documentary analysis of previous studies related to heavy metal contamination in water. The work will be divided into the following stages:

1. Data Collection : Data will be gathered from reliable sources, including scientific journals, environmental books, and government reports concerning heavy metal contamination in water. This will include field and experimental studies conducted in various parts of the world.

2. Data Analysis : Previous studies will be classified and analyzed based on the types of heavy metals studied (e.g., mercury, lead, cadmium, arsenic), the methods used to measure pollution levels in water, and the identified environmental and health impacts.

3. Focus on Field Studies : The focus will be on studies conducted in industrial areas, mining regions, and areas with intensive pesticide use, to determine the impact of human activities on water quality.

4. Comparison of Results : The results of different studies will be compared to assess the extent of heavy metal contamination in water and evaluate preventive measures taken in various countries.

Results :

1. Heavy Metal Water Pollution : All studies analyzed revealed that heavy metal contamination of water is one of the most significant environmental threats faced by different countries. In mining and industrial areas, these metals leach into groundwater and surface water, leading to severe deterioration of water quality.

2. Health and Environmental Impacts : The main findings indicate that heavy metal water contamination poses a significant threat to public health. The most harmful metals are mercury and lead, which cause serious damage to the nervous system and kidneys. Pollution also leads to a decline in biodiversity, especially in rivers and lakes.

3. Main Causes of Water Pollution : Industrial activities, including mining and mineral extraction, are the primary sources of heavy metal contamination in water. Additionally, the uncontrolled disposal of industrial waste and pesticides contributes to increased pollution levels.

VIII.   RECOMMENDATIONS

1. Strengthen Environmental Legislation : Governments must enforce stricter regulations on industrial activities, such as mining, and improve the implementation of environmental laws to prevent pollution.

2. Use Advanced Purification Technologies : Advanced water purification techniques should be developed and employed to remove heavy metals from water, such as filtration technologies using nanomaterials and adsorption technology.

3. Increase Public Awareness : The public should be educated on the importance of protecting water from pollution and how to reduce health risks from contaminated water.

4. Conduct More Field Studies : More field studies should be conducted in regions suffering from heavy metal contamination to identify the best methods for treating pollution.

5. Encourage Innovation in Environmentally Friendly Industries : Industries that use environmentally friendly technologies should be encouraged to reduce the toxic waste discharged into water bodies.

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