

The Study of Heavy Metal Contamination in Water Regimes: Human Toxicological Profiles and its Chemical Precipitation Treatment

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Abstract:

The global concern over ecological safety and public health has led to the development of a sustainable approach towards pollutant remediation. Recently, heavy metals and organic pollutants have emerged as the two major contaminants, and their remediation has attracted significant attention from researchers. Removing heavy metals from wastewaters is a challenging process that requires constant attention and monitoring, as heavy metals are major wastewater pollutants that are not biodegradable and thus, accumulate in the ecosystem. In addition, the persistent nature, toxicity and accumulation of heavy metal ions in the human body have become the driving force for searching new and more efficient water treatment technologies to reduce the concentration of heavy metal in waters. A literature survey reveals several effective strategies for removing heavy metals from water: adsorption, flotation, ion exchange, chemical precipitation, membrane-based filtration, coagulation, flocculation, phytoremediation, and electrochemical methods. In the examination, this review uniquely integrates heavy-metal sources, way of contamination, the study of toxicological effect on human health and chemical precipitation treatment method.

Keywords: heavy metals; toxicological effect; wastewaters; water treatments; removal.

1. Introduction and background

Global water pollution, particularly from heavy metals, poses a serious risk and raises major concerns, as it poses threats to both the environment and public health. According to the United Nations Environment Programme (UNEP), over one billion people globally are exposed to unsafe water sources, many of which contain heavy metals at concentrations exceeding the safety limits set by the World Health Organisation (WHO, 2018). The spontaneous development of industrialization, urbanization and advanced practices in agricultural fields that enhanced the significantly discharge of inorganic compounds in to the atmosphere (Chidiebere U, 2022, Preonty, 2025, Hama Aziz, 2023). Heavy metals (Dobre, 2024), salts, oxides, sulfates (Gupta, 2003; Karuana, 2024), nitrates (Wang,2023) and some other mineral based inorganic chemical are frequently applied in commercial scale as mining, extraction of metal (Kasongo,2024), electroplating (Rajoria, 2021), fertilizers (Zhang, 2025) and energy production industries (Ajayan,2025). The toxic level of these elements affects the biochemical and physiological system in living being that caused retardation of growth, reduces reproduction and even mortality in living being (Bharti, 2021).

Due to their non-degradable nature, heavy metals accumulate in sediments, aquatic organisms, and human tissues over time (Nambowa, 2024). While high levels of heavy metals are harmful to aquatic habitats, the cascading effects on humans are likely to be more severe (Afzal and Ahamad, 2024). Through bioaccumulation, heavy metals gradually build up in organisms, such as algae and plankton, as they absorb contaminants from their environment. When these smaller organisms are consumed, the metals are biomagnified, becoming more concentrated at each level of the food chain (Miller, 2020). This results in higher concentrations of toxins in larger predators, including fish, which are a major source of essential nutrients for humans (Adepoju, 2022). The level of human exposure is vital in determining the severity of health effects. When humans are exposed to high concentrations of heavy metals through direct intake of contaminated water or consumption of aquatic animals, it can lead to severe abdominal pain, as the abdomen houses vital organs, including the liver (Lentini, 2017). Additionally, there is a significant risk of kidney failure, given that the kidneys are responsible for filtering toxins from the body. Impaired kidney function can also contribute to the onset of conditions such as diabetes. Similar to the role of altered "omes," such as proteome and glycome, in cancer and other life-threatening diseases (Adepoju, 2025), heavy metals alter epigenetic regulators, resulting in dysregulated protein function and gene expression that may drive oncogenesis (Ryu, 2015). These diseases develop silently, without symptoms, mirroring how heavy metals gradually accumulate in the body unnoticed (Takikawa, 2022). This suggests a deep connection between the two, where the silent buildup of heavy metals toxins may contribute to disease progression. For pregnant women, exposure to contaminated consumables, particularly water laced with heavy metals, could be a primary factor in the rising incidence of birth defects (Zinia, 2023). These metals can cross the placenta, disrupting normal foetal development. In the United States, birth defects are responsible for approximately 21% of infant deaths (Eaves, 2023). Over time, individuals exposed to heavy metals may develop a range of neurological and psychological disorders, including fatigue, anxiety, and cognitive decline. This concerns children, as it can hinder cognitive development, impair intelligence quotient, and affect overall intellectual growth (Chen, 2016).

In fact, the most hazardous metals are those classified as non-essential heavy metals, capable of inducing cancer and other chronic diseases within the bodies of living organisms (Nucera, 2024). Maintaining essential levels of Zn is vital for human health and the optimal functioning of living tissues. This heavy metal is essential for numerous physiological processes and the regulation of diverse biochemical functions within tissues. Nonetheless, an overabundance of Zn can lead to significant health problems, including abdominal cramps, skin irritation, vomiting, nausea, and anaemia (Singh A, 2024). Cu is crucial for controlling metabolism. However, an overload of Cu in living tissues can lead to severe toxicological issues, manifesting in symptoms such as vomiting, cramps, spasms, and, in more severe instances, potential fatality (Rafati Rahimzadeh, 2024). Exceeding its necessary levels, Ni has the potential to induce problems in lungs and kidneys, gastrointestinal discomfort, respiratory fibrosis, and dermatitis of the skin (Dudek-Adamska, 2021). Moreover, it is widely recognized that Ni is a human carcinogen, a toxic substance with the capability to stimulate the proliferation of cancer cells in the body (Guo, 2021). Functioning as a potent neurotoxin, Hg specifically targets nerve cells and severely disrupts the operations of both the central and peripheral nervous systems (López-Berenguer, 2020). Furthermore, elevated levels of Hg accumulation in the body lead to malfunctions in the respiratory system and kidneys, accompanied by symptoms such as chest pain and shortness of breath (Guzzi, 2021). On the other hand, Cd has also been categorized as a potential human carcinogen (Cui Z, 2021). Cd can pose severe threats to human health. Prolonged exposure to Cd detrimentally impacts kidney function, and elevated levels of exposure

have the potential to result in fatal outcomes (Nordberg, 2022). Pb can provoke significant damage to the central nervous system (Samarghandian, 2021). Pb can cause irreparable harm to the kidney, liver, and reproductive system, as well as impair cellular and brain functions (Charkiewicz, 2020). The impairments in the operation of living tissues due to Pb poisoning are mostly connected with manifestations such as anaemia, sleeplessness, migraines, vertigo, restlessness, muscle weakness, hallucinations, and damage to kidneys. Cr can be mainly found in the aqueous phase in two oxidation states: Cr(III) and Cr(VI) (Xing, 2022). Cr(VI) exposure typically has more destructive consequences than Cr(III). Cr (VI) impacts human physiology and readily accumulates in the food web, giving rise to serious health complications ranging from mild skin irritation to potentially fatal lung cancers (Alvarez, 2021).

In recent years, researchers have focused on developing removal techniques to address heavy metal contamination and its detrimental effects on human health and aquatic ecosystems. By the diverse perspectives and incorporating a broad spectrum of methods, including chemical precipitation method our analysis aims to offer a holistic understanding of the current state of heavy metal remediation. Hence, this paper addresses the critical issue of heavy metal removal from water bodies, presenting a study on conventional chemical precipitation technique.

2. Sources of heavy metal pollution

Heavy metals have been present in the Earth's crust since its formation. The upsurge in their use has led to the presence of metallic substances in both aquatic and terrestrial ecosystems (Masindi, 2018). Heavy metals are transferred into the environment through various activities, including urbanization, mining, chemical industries, pesticide use, biomedical waste, sewage plants, and unsustainable agricultural practices (Das, 2023). These can be classified into two categories, namely natural and anthropogenic activities. The anthropogenic contribution of heavy metals to the environment is driven by the increasing trends of industrialization and urbanization. Anthropogenic activities, such as metal mining, metal leaching, metal-based industries, waste dumps, livestock, excretion, automobiles, runoff, and road repairs, are the primary sources of heavy metal pollution. For instance, heavy metals such as Hg, Pb, and Cd in electronic devices like computers and smartwatches, as well as in e-waste, are highly concentrated. They can cause adverse effects to both humans and the environment. Cd has been widely used in paint, pipes, plastics, and battery manufacturing, while Cr is used in petroleum, electroplating, textile, and leather industries. They are released into the environment during mining, smelting, and other industrial processes and re-enter through wet or dry deposition. Industrial wastewater and sewage effluents also contribute to the release of heavy metals into the atmosphere.

Additionally, fossil fuel combustion and the use of chemical fertilizers contribute to these anthropogenic activities (Zamora-Ledezma, 2021). Heavy metals in agriculture are a secondary source of pollution arising from the use of pesticides, fertilisers, and insecticides (Briffa, 2020 and Akhtar, 2021). Commercially available phosphate-based fertilizers are essential to note due to their heavy metal content. They are generally formed from phosphate rock through acidulation; as a result, the final product contains all the heavy metals from the phosphate rock. The heavy metals in this fertilizer leach into the groundwater and contaminate the resources. Fossil fuel incineration is another primary source of heavy metal pollution. Heavy metals such as Cr, Pb, Cd, Zn, and Zn are released into the air through vehicle traffic. This is supported by the high concentrations of heavy metals in soil and plants along roads in both urban and metropolitan areas. The combustion of coal is also considered another important anthropogenic source of heavy metal pollution (Ali, 2019 and Nyiramigisha, 2021)

Natural sources of heavy metals include weathering, leaching, and volcanic eruption. Weathering refers to the breaking down of rocks and minerals when they come into contact with the atmosphere or living organisms. Heavy metals occur in the Earth's crust as abundant trace elements, with concentrations ranging from ppm to ppb (Balali-Mood, 2021). Conversely, leaching is the separation of metal from its ore using acids or leachates. During rainfall, rock fractures, and the leachable fraction come into contact with aqueous solution, leading to metal leaching into the environment and causing harmful effects. According to studies, volcanic ash contains metals such as Fe, Cd, Cu, Zn, Cr and Al during volcanic eruption (Eterigho-Ikelegbe, 2021). These metals settle onto the soil, where they dissolve in water depending on factors such as redox conditions, temperature, and pH. They are subsequently absorbed by the soil particles and are transferred to the human body. In conclusion, both natural and human activities contribute to the release of heavy metals into the environment. However, anthropogenic sources have more severe impacts than natural sources, posing a significant threat to the environment and human wellbeing.

3. Contaminated water regimes

The water regime including the surface and groundwater bodies is one of the most vulnerable systems on the earth; especially, after the dawn of industrial revolution. Since many decades, the water bodies have been taken for granted and were abused by considering them as the disposal sites. On the scale of relativity, the groundwater systems are much for fragile in comparison to the surface water bodies and hence, it becomes a Herculean task to remediate it (Mufid al-hadithi, 2012). Hence, when the water regime contamination is on the discussion platform, the groundwater too needs a sincere attention.

Mostly, the water bodies are contaminated by multifaceted cause; the heavy metal contamination is the most stubborn and hazardous one (Shtangeeva, 1995). Basically, the heavy metals are the by-products of either industrial setups or mining excavations (Akpore, 2014). The industrial setups like of paints, dyes and pigment, leather, petroleum, etc. are the prime sources of effluents charged with heavy metals (Barakat, 2011). In some cases, the sewage waste water has also been attributed for the heavy metal source. In mining regions too, the heavy metals' leaching has been reported in water and soil systems, demonstrating a descending trend in the contamination, as moved away from the active mining sites. The polluted and shifted surface water bodies, interruption in the hydrological conduits and subsiding water table are the foremost quantifiable effects of mining on the surrounding water systems (Pulles, 1995 and Younger, 2002). The mine water released from the mine is accountable for the pollution as this mine water has been associated with the various contaminants including heavy metals (Singh, 2010) the coal mining region, the coal has been found to be associated with multiple sulphide minerals containing heavy metals (Finkelman, 1981). Once, these metals leach out from the host rock, they migrate to the favouring environments like of water systems. In customary state, the heavy metals won't liberate and migrate, but, in case of catalytic circumstances they leach out (Ganvir and Guhey, 2023).

3.1 Common heavy metals in polluted water

Some common heavy metals in polluted water are briefly discussed in the following subsections.

3.1.1 Lead (Pb)

Lead (Pb) often exists in the + 2-oxidation state in inorganic compounds. The important sources of Pb in polluted water include mining, extraction and smelting of lead ores, Alkyl lead used as fuel additives, lead acid batteries, E-waste, paints and ceramics industries, as well as coal-based thermal power plants. In

polluted water, Pb impacts negatively on the kidney, central nervous system, reproductive system, brain functioning, and basic cellular processes (Briffa, Verma, 2013).

3.1.2 Mercury (Hg)

Mercury (Hg) mostly polluted the water through one or more of the following sources: electrical appliances, hospital waste such as spoiled barometers, thermometers, sphygmomanometers, Chlor-alkali plants, fluorescent lamps, thermal power plants, etc. High concentrations of Hg damage both the kidney and the lung and are extremely harmful to the central nervous system. It also causes dyspnea and chest pain (Qasem, 2021).

3.1.3 Chromium (Cr)

Chromium (Cr) (VI) are generally found in the environment via industries like electroplating, leather, tanning, textile, and leather. The most common Cr that exists in the environment are the trivalent Cr (III) and hexavalent Cr (VI) forms of Chromium. Cr (VI) is characteristically poisonous and is largely produced from the chromate salt industry. The Cr (III) is not as toxic as Cr (VI), but very damaging when in excess. Cr (VI) can adversely impact human physiology; it is carcinogenic and also irritates the skin (Rajoria, 2023).

3.1.4 Cadmium (Cd)

Cadmium (Cd) is the most dangerous of all heavy metals. It emanated into the environment from polluted water from industries such as cadmium-nickel batteries, electroplating, insecticides, metallurgical, ceramics, metal-finishing industries and from used electronics (Vidu, 2020 and Carolin, 2017). Even at low amounts, Cadmium and its compounds are extremely toxic and have negative effects on the liver, lungs, kidneys and result in other grave illnesses like osteoporosis, renal failure, cancer, etc. (Gęca, 2023 and Snoussi, 2016).

3.1.5 Arsenic (As)

Arsenic (As) exists naturally in groundwater from geogenic sources. It also found its way into the environment through thermal power plants, fuel, mining and smelting operations, etc. High exposure to As (III) could result in diseases including hyperpigmentation, skin lesions, kurtosis, respiratory, cardiovascular, haematological, gastrointestinal, neurological, and birth disorders, and also cancer (Chibueze Izah, 2015 and Sultan, 2024).

3.1.6 Nickel (Ni)

Nickel (Ni) occurs in polluted water from the battery industry, mining, extraction and smelting processes, and thermal power plants. Direct contact with nickel-containing compounds for a prolonged time may result in severe skin irritation and nickel allergy for some people.

3.1.7 Zinc (Zn)

Zinc (Zn) hardly exists in nature and enters water via electroplating, mining, and smelting operations. It can be extracted with ease from its ores such as ZnS, ZnO, Zn₂SiO₄, ZnCO₃, etc. Zn is vital in trace quantities and is essential for sustaining human health, such as physiological functions of living tissue, and influences different metabolic activities (Qasem, 2021). Conversely, excessive amounts of zinc in humans can result in severe health issues like skin irritations, anaemia, nausea, vomiting, and stomach upset and also harms aquatic organisms (Pohl, 2020 and Fu, 2011).

3.1.8 Copper (Cu)

Copper (Cu) is one of the heavy metals employed for various uses. It is usually found in polluted water from fertiliser, pulp, and paper industries, fungicides, semiconductors, used electronic chips, spent batteries, cell phones, plumbing, insecticides, catalysts, antifouling paints, and in metal smelting

operations. Cu is a vital element for humans as it is crucial for the formation of haemoglobin in the bloodstream. However, a lack of Cu in humans leads to anaemia, cardiovascular, bone, and gastrointestinal problems. It also interrupts the marine biota (Neisan, 2023 and Buema, 2011).

3.1.9 Other heavy metals

Other heavy metals are rare, but are still dangerous, including aluminium, tungsten, molybdenum, manganese and uranium, which are released through natural or industrial processes.

4. Environmental and human health impacts of heavy metals

Heavy metal pollution is a very serious environmental problem, often causing long-term and irreversible damage to ecosystems and to human health. Heavy metals remain in the environment and may accumulate in soil, water and living organisms because they are not biodegradable, unlike many organic pollutants (Das, 2023). Heavy metals cause toxicity at the molecular level primarily by producing reactive oxygen species (ROS), which, by means of oxidative stress mechanisms, damage proteins, lipids and DNA. The result is apoptosis, cellular dysfunction, and long-term diseases. In addition, co-exposure to multiple heavy metals can cause antagonistic or synergistic interactions, which makes risk assessment and treatment planning more difficult. These mechanistic considerations underline the need for sophisticated and targeted remediation techniques (Mansoor, 2023).

4.1 Toxicity of heavy metals

The toxicity level of heavy metals depends on the metal type, concentration, bioavailability, exposure duration, and the physiological traits of the organisms exposed. The ecological integrity of aquatic systems is usually impacted by the presence of heavy metals, which results in their physical, chemical, and biological characteristics (Kadim, 2022). Adverse effects on flora and fauna caused by heavy metal toxicity frequently result in biodiversity decline. Heavy metals like lead (Pb), cadmium (Cd), and mercury (Hg) can inhibit the photosynthetic process of the aquatic plants and algae, which are the primary producers of the aquatic ecosystems. Metal toxicity can affect the survival, growth, and reproduction of fish and invertebrates (Jomova, 2025).

4.2 Human health impacts

Heavy metals seriously endanger human health through the ingestion of polluted food and water, as well as through inhalation and skin contact in work environments. The majority of heavy metals have the potential to cause acute and long-term health effects, though their toxicity varies (Zhang, 2023).

4.2.1 Neurotoxicity

Metals such as lead (Pb) and mercury (Hg) are well-known neurotoxins. In children, lead exposure is linked to developmental delays, lower IQ, learning disabilities, and behavioural problems. Mercury can damage the brain and nervous system, especially during fetal development (Balali-Mood, 2021).

4.2.2 Carcinogenicity

Metal	Common sources	Primary health effects
Lead (Pb)	Paints, plumbing, batteries, e-waste	Developmental delays, neurotoxicity, and kidney damage
Cadmium (Cd)	Batteries, fertilisers, and mining	Bone fragility, kidney dysfunction, and cancer

Mercury (Hg)	Coal combustion, thermometers, and mining	Brain and kidney damage, fetal development issues
Arsenic (As)	Pesticides, groundwater, and mining	Cardiovascular disorder, skin lesions, and cancers.
Chromium (Cr)	Dyes, leather, and electroplating.	Lung cancer, skin ulcers, and respiratory issues
Nickel (Ni)	Steel production and electroplating	Respiratory issues, allergic reactions, and potential carcinogens

Many heavy metals are associated with several cancers after prolonged exposure. Arsenic-contaminated water is often linked with cancer of the skin, lungs, bladder, and liver. Hexavalent chromium (Cr-VI) utilised by the electroplating industry is connected to cancers of the nose and lungs. Cadmium (Cd), which is present in tobacco smoke and industrial emissions, is a well-known carcinogen, causing kidney and prostate cancers (Collin, 2022).

5. Chemical Precipitation Methods

The chemical precipitation treatment method proves to be a highly effective and practical approach for mitigating environmental challenges arising from heavy metal pollution. Its simplicity and cost-effectiveness in operational conditions make it a widely adopted water treatment technique in various industrial applications. In this process, designated reagents, known as precipitants, react/interact with heavy metal species, resulting in the formation of insoluble components that precipitate out of the solution (Wang, 2024). The resulting precipitate compounds can be easily separated from the aqueous phase using subsequent sedimentation or filtration techniques.

In this context, robust alkaline chemicals such as quicklime (calcium oxide, CaO), limewater (calcium hydroxide, Ca (OH)₂), ammonia (NH₃), sodium carbonate (Na₂CO₃), sodium hydroxide (caustic soda, NaOH), and sodium sulfide (Na₂S) are commonly employed to elevate the pH of the contaminated water (Razzak, 2022). As a result, soluble heavy metal ions (mostly positively charged cations) transform into insoluble metal hydroxide, metal carbonate, or metal sulfide species.

Nevertheless, the precipitating agents mentioned earlier exhibit various limitations. Firstly, the majority of heavy metal species primarily exist in their ionic form, often cationic, exclusively in highly acidic environments characterized by low pH values. The use of sulfide-containing reagents in such acidic conditions can lead to the release of toxic hydrogen sulfide gas (H₂S), posing a destructive impact on human health, equipment, and the ecosystem. Meanwhile, the challenge arises in isolating the resulting heavy metal sulfide precipitates due to their minute particle size. Additionally, certain amphoteric heavy metal species, such as Cr and Cu, which can function as both base and acid, are prone to forming water-soluble compounds when exposed to solutions with a pH surpassing the optimal limit. Furthermore, it is crucial to pay attention to the considerable corrosive impact of robust alkaline precipitants on the equipment.

5.1. Hydroxide Precipitation

Hydroxide precipitation stands out as the most extensively utilized chemical precipitation method, owing to its distinctive and attractive characteristics. These include uncomplicated operational procedures, cost-effectiveness in terms of reactants (i.e., chemicals and reagents), and the ease with which pH control can be maintained throughout the entire process. The solubilities of various metal hydroxides, such as Zn(OH)₂, can be minimized by adjusting the pH to the range of 8.0–11.0. Within this specific pH range,

heavy metal hydroxides formed exhibit the highest inclination to precipitate. The resulting heavy metal hydroxide species can be removed from the aqueous solution through separation methods like flocculation, filtration, or sedimentation. Various hydroxide-containing chemical compounds have been employed to isolate heavy metal ions from contaminated waters. In this context, quicklime (calcium oxide, CaO) emerges as the most suitable precipitating agent, or precipitant, with the potential for industrial-scale use due to its cost-effectiveness, availability, and ease of handling and storage (Pohl, 2020).

5.2. Carbonate-based precipitation of heavy metals

As an alternative to hydroxide precipitation, carbonate precipitation is notably effective, particularly at lower pH levels. This method employs either sodium carbonate (Na_2CO_3) or calcium carbonate (CaCO_3). While it often results in reduced sludge volume, it is important to highlight that carbonate precipitation releases carbon dioxide (CO_2) and requires a higher amount of chemicals for efficient precipitation. Utilizing this technology targets and effectively removes Cu and Mn with high efficiency. Furthermore, efficient removal of Zn and Pb is also achievable. The integration of the Fenton reaction significantly improves the removal efficiency of chemical precipitation methods. Fenton or Fenton-like oxidation is applied to de-complex heavy metal complexes. It is essential to highlight that the pH adjustment is conducted through the chemical precipitation mechanism, commonly involving NaOH. The intricate Fenton chemistry encompasses a series of reactions driven by various active intermediates, including $[\text{Fe}^{4+}\text{O}]^{2+}$ and OH radicals. Additionally, $\text{Fe}^{3+}\text{-H}_2\text{O}_2$ (Fenton-like) and $\text{Fe}^0\text{-H}_2\text{O}_2$ (advanced Fenton) represent alternative methods to $\text{Fe}^{2+}\text{-H}_2\text{O}_2$.

5.3. Sulfide Precipitation

The sulfide precipitation technique is effective in addressing water contamination caused by toxic heavy metal species. A notable advantage of employing precipitants containing sulfide (e.g., Na_2S) is that the solubilities of the resulting metal sulfide precipitates (e.g., ZnS) are significantly lower compared to their hydroxide counterparts (Miao, 2023). Additionally, sulfide precipitates, being non-amphoteric, exhibit greater stability than hydroxide precipitates under both acidic and basic conditions. Consequently, the sulfide precipitation method exhibits a greater capacity for removing/detoxifying heavy metals across a broader pH range compared to the hydroxide precipitation method. Metal sulfide precipitates can effectively decrease the free water content of resulting sludges, displaying favorable thickening characteristics compared to their hydroxide counterparts. This analogous behavior is also evident when comparing the ability of sulfide-based precipitates to reduce the floc-bound and capillary water content of sludges (i.e., dewatering characteristic) with that of hydroxide-based precipitates.

5.4. Other Techniques Using Chemical Precipitation

Other reagents used in wastewater treatment by chemical precipitation are as follows:

- Ferrous sulfate is usually used together with lime for water softening. The aggregates consist of calcium sulfate and ferric hydroxide. The condition for a successful removal process is that the wastewater must contain dissolved oxygen that is required by the chemical reaction to form the precipitate.
- Aluminum for the removal of phosphate and water softening. The reaction takes place with phosphate or various alkaline compounds (i.e., bicarbonate, hydroxide or carbonate) that form insoluble aluminum slats.
- Ferric chloride forming insoluble iron salts together with phosphates or alkaline compounds.
- Polymers, which can be anionic, cationic or nonionic. They can be used for neutralization or as links coagulants after they are added to wastewaters.

6. Conclusion

Water is the most important resource for living beings, and one of the greatest challenges of our time is to keep it accessible, adorable and reliable for our planet. Heavy metal ions are among the most dangerous pollutants. The heavy metals are common contaminants in the water systems associated with the industrial and mining setups. These contaminants act stubborn and remain long lasting in the contaminated systems. In addition, efficient treatment of wastewater, regular monitoring of water sources by protection agencies, and public awareness of health risks associated with heavy metals exposure are highly recommended in order to reduce heavy metals contamination. Based on the literature survey performed herein, it has been found that the strategies for removing heavy metals from water bodies are adsorption, flotation, ion exchange, chemical precipitation, membrane-based filtration, coagulation, flocculation, phytoremediation, and electrochemical strategies. This review investigated the sources of heavy metal contamination of water regime, there toxicological effect of particular metal as pollutant on human health and their treatment via chemical precipitation treatment method with different compounds based precipitation . Chemical methods like precipitation are cost-effective but generate substantial sludge. Future research should prioritize cost-effective materials, and the development of efficient, environmentally friendly techniques for metal recovery.

7. Reference

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