

Heavy Metal Pollution in Ground Water - A Review

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Abstract: Advancement of human civilization has put serious questions to the safe use of groundwater for drinking. The problem of ground water pollution due to heavy metals is one of the major concerns in major metropolitan cities. These toxic metals entering the ecosystem may lead to geo-accumulation, bioaccumulation and biomagnifications. It has been found that in many parts of the world, ground water become contaminated with heavy metals such as zinc, lead and copper as a result of mining and associated activities. Exposure to heavy metals has been linked to developmental retardation, various cancers, kidney damage and even death in instances of very high exposure. Due to the importance given to groundwater, as well as the effects of heavy metals for human health, a large number of studies related to heavy metals removal in groundwater have been studied. These studies include quality assessment, source identification and bioremediation etc. which have brought to us useful information for the management of groundwater resources.

Key words: *Ground water, Heavy metal, bioaccumulation and bioremediation.*

Introduction

Groundwater is one of the prime natural resources upon which the survival of mankind as well as the social and economic development of the nation are dependent. Only 2.5% of the world's water is non-saline fresh water. Since water is a universal solvent and which provides the ionic balance and nutrients, supports all forms of life¹. It has been used for drinking for a long time and its purity has made it a well known source of potable water. Advancement of human civilization has put serious questions to the safe use of groundwater for drinking². Several factors such as climate, characteristics of soil, circulation of ground water through rock types, topography of the area, human activities on the ground etc. possess several effects on the quality of water³.

In some coastal areas, intensive pumping of fresh ground water has caused salt water to intrude into fresh-water aquifers¹. Heavy metal pollution represents an important environmental problem due to its toxic effects and bioaccumulation throughout the food chain. The main sources of heavy metal pollution include electroplating, painting and surface treatment industries⁴. Some transition metals at trace levels in our metabolism are important for good health. Heavy metals normally occurring in nature are not harmful to our environment, because they are only present in very small amounts. However, if the levels of these metals are higher than the levels of healthy life, the roles of these metals change to a negative dimension.

The direct sources of the heavy metal ions are food and water and, indirect sources are industrial activities and traffic⁵. Some heavy metals such as Cu, Fe, Mn, Ni and Zn are compulsory micronutrients for flora –fauna and microbes. The quantity of copper compounds in nature is minimal. Cu enters the groundwater from weathering of minerals and rocks which contain copper. Copper (Cu) is essential to human life and health but, like all heavy metals, is potentially toxic as well as continued inhalation of Cu containing spray is linked with an increase in lung cancer among exposed worker⁶. On the other hand, lack of copper intake causes anemia, growth inhibition and blood circulation problems³. Symptoms of severe copper poisoning include extensive hemolysis, hepatic necrosis, nephropathy, coma, Wilson's disease. If not treated it may lead to death. Lead poisoning has been recognized as an occupational illness for centuries and it is linked with both severe and subtle health damages.

Higher concentration of lead in drinking water has adverse effect on central nervous system, blood cell and may cause brain damage². Chromium is present in small quantities in nature. It is present maximum in rocks than in those of silica type. The toxicity of chromium depends on its physico-chemical shape; hexavalent salts are considered the most dangerous¹. Nickel is also non-toxic element, but it affects physiological process at very high concentration⁴. The high level of nickel in waters are due to mixing of variety of wastes including that of automobile repair shops, electroplating units, utensil manufacturing process, sewage, agricultural runoff. High heavy metal concentration is attributed to runoff into the water body. Mercury is a toxic element and serves no physiological function in man i.e., non essential element³. Water containing high mercury content is not suitable for drinking. Keeping in view the hazardous nature of heavy metals contamination in water, it is imperative to initiate this study to assess the problem and suggest ways and means to decrease the risk of toxic heavy metals contamination of drinking water⁷. To know the maximum acceptable concentration of heavy metals in drinking water, guidelines have been set by different International organizations such as USEPA, WHO, EPA and the European Union Commission.

Materials and Methods

Standard procedures for the determination of heavy metals concentration in ground water were followed by the different authors in their research works. The methods used are atomic absorption spectroscopy by Abdul Jameel et al, Balakrishnan A et al, A. Zahir Hussain et al and atomic absorption spectrophotometry by Ponnusamy Thillaiarasu et al, K.Ramesh et al, Deepali, K et al, K. Brindha et al and Inductively coupled plasma- optical emission spectroscopy by O.Venkata Subba Raju et al and Inductively coupled plasma- mass spectroscopy by Mushtaq Hussain et al. The ground water samples were collected in polyethylene bottles. Supra pure grade nitric acid is added to acidify the samples and also to prevent the loss of metals. All the collected ground water samples are preserved at 4°C by using thermo-coal box with ice packs (O.Venkata Subba Raju et al). The samples were filtered using Whatman 42 filter paper and were diluted to bring down the TDS 200ppm for further analysis (Mushtaq Hussain et al). The determination of concentration for heavy metals in their research papers (particular) were Pb, Cr, Cu, Fe, Ni, Hg, Zn, Mn. The concentrations of resulting heavy metals were compared with the standards proposed by national and International organizations (WHO-2008, USEPA, EPA, EUC). The effects of heavy metals were found to be more/less than the maximum admissible limits. Thus the aim of this study is to review the research work on heavy metals done by respective authors on heavy metals in drinking water sources from their origin.

Results and Discussions

The work done on heavy metals in ground water by different authors in their respective work has been studied. The quantity of heavy metals found in their research have stated with their maximum permissible limits. The final trace elements resulting with their concentrations in ground water were compared with the standards proposed by several International Organizations such as WHO, USEPA, EPA, EUC, MAC etc. The mean concentrations of all investigated metals in the waters tested were not prominent in their desirable limits (WHO-2008) and several health related risks were resulted.

Heavy metals in ground water samples are related with chronic diseases⁷. The concentration of heavy metals during pre monsoon is high compared to post monsoon. This is due to evaporation during pre monsoon. Most of the groundwater samples have high content of Cu, Mn, Pb, Cd and Hg³. The concentration levels of Arsenic, Nickel, Selenium, and Lead observed higher levels than acceptable limits of IS: 10500⁵. Multivariate statistical approaches showed that the polluted surface water is strongly influencing the quality of ground water in the Bolaram and Patancheru industrial area in Andhra Pradesh⁹. The maximum lead content 0.875 ppm and minimum 0.041ppm have been recorded at different sites Gulf of Mannar sea shore area. This study shows most of the ground water sample has high lead content. i.e above the maximum permissible limit³.

Both lead and chromium are highly toxic metals and they should normally be present only in traces. Lead (Pb) is used principally in the manufacturing of lead acid battery and alloys. Chromium was found to be high in many stations in both the seasons. Lead is generally toxic and it accumulates in kidney and skeleton. In fact, children up to the age of 6 years and pregnant women are most susceptible to its adverse effects. It is seen that all the samples has lead level above the WHO standard of 0.01ppm. This could be as a result of the use of leaded petrol in cars, generators and even some mechanic workshops around these areas especially battery chargers. Lead contamination of the ground water may be the result of entry from industrial effluents, old plumbing, household sewages, agricultural run-off containing phosphatic fertilizers and human and animal

excreta. In addition to the symptoms found in acute lead exposure, symptoms of chronic lead exposure could be allergies, arthritis, hyperactivity, mood swings, nausea, and numbness, lack of concentration, seizures and weight loss¹. High levels of Chromium were observed in sampling wells located near tannery industries¹⁰. The study shows that the main cause of increase in chromium levels in ground water is due to the textile and tannery effluents and thus it has to be treated well before disposal.

Table 1 : Comparative Studies on Concentration of Heavy Metals in Ground Water in Examined Water Samples

S.No	References	Cu (WHO; MAC=1 mg/l)	Cr (WHO: MAC=0.05 mg/l)	Pb (WHO: MAC=0.05 mg/l)	Study Area
1	A. Abdul Jameel et al (2012)	0.05 mg/l	0.08 mg/l	>0.01mg/l	Between Tamilnadu and Pondicherry - Karaikal
2	Ponnusamy Thillaiarasu et al (2014)	0.007 to 0.027 mg/l.	0.0001 to 1.954 mg/l	0.0002 to 0.059 mg/l	Tiruchendur, Tamilnadu,
3	Balakrishnan A et al (2014)	0.014 to 0.091mg/l	0.001 to 0.009 mg/l	0.875 mg/l	Gulf of Mannar Seashore Area
4	A. Zahir Hussain et al (2013)	0.52-0.68 mg/l	0.12-0.26 mg/l	0.01-0.07mg/l	Bank of Cooum river at Chennai City
5	O.Venkata Subba Raju et al (2014)	-	<0.01 mg/l	<0.01 mg/l to 0.035 mg/l	Selected Coastal area of Spsr Nellore District, Andhra Pradesh,
6	K.Ramesh et al (2014)	0.07 mg/l	0.65 mg/l	0.07 mg/l	Tannery Industrial area of Pallavaram, Chennai

The concentrations of heavy metal Cr is threatening and thereby posing a serious health hazard. It is not that the effect is alone to human health but also economical in way that the people has to spend a reasonable part of their income towards purchasing better quality water for drinking and other domestic needs as a precautionary measure to avoid health impacts. Thus indirectly in a way to avoid health impacts the social cost of living of the people is made high. Thus, there is as alarming need to mitigate the water quality problems due to heavy metals in the study area⁶. The study area of A. Zahir Hussain et al shows that the most of the groundwater sampling stations are polluted by the intrusion of Cooum river water, dumping of waste and percolation of domestic sewage by inhabitants. Even though, the condition is very bad at present, but if the same continues in future groundwater source will be completely polluted and become unfit for drinking and other purposes. This observation indicates contamination of the environment. Therefore, most of the water from these wells is suitable for domestic use and it's unlikely to pose a major health risk to consumers. Thus dumping of waste polluted materials should be avoided and they should not be let into the river. A lot of precaution should be done to avoid consequence. It is high time to preserve and protect this valuable ground source.

Conclusion

Based on the research work of different authors, it has been observed that, the ground water samples contain metal concentration more than the permissible and desirable levels. The authors in their paper concluded from their work that the water samples need constant monitoring of various water sources as the results showed levels of pollution higher and unfit for drinking. There is a need that the drinking water of the areas should be filtered by the quality control agencies. The water can be used for drinking purposes unless it is passed through special water treatment. People may suffer through disease on drinking water with higher concentration of heavy metals. They may have physiological effects as on kidney, digestive system, circulatory system, nervous system etc. various other organs and various systems of the body. Since development,

environment and public health are interlinked, it is necessary for all concerned to adopt sustainable utilization of the available water resources.

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