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Analysing Heavy Metal Contamination in Water

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Abstract- Water is essential for all living things, and checking its quality especially for heavy metals is very important because it affects human health. "Water quality" means how suitable water is for different purposes, and it depends on several factors that can limit its use. To check water quality, experts take measurements at the site, collect water samples, and analyze them in labs. The source of drinking water can affect the kind of health problems people may face.Heavy metals like cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), cobalt (Co), manganese (Mn), mercury (Hg), nickel (Ni), and zinc (Zn) are harmful and must be checked. Tools like Atomic Absorption Spectroscopy and Differential Pulse Anodic Stripping Voltammetry are used to measure these metals. Water quality can be affected by natural sources like rocks and soils, as well as by human activities like industrial waste, garbage, and old water pipes. Even though we know that heavy metals are dangerous, poisoning still happens, so prevention and treatment are important. Water quality is usually judged by the amounts and forms of substances—both organic and inorganic—in the water, as well as its physical features. Toxic metals such as lead, cadmium, and arsenic can badly pollute drinking water and harm people.

Keywords- Heavy metals, Mechanistic action, Chronic poisoning, ROS, Oxidative stress, water quality.

I. INTRODUCTION

Water is very important for all living things. The World Health Organization (WHO) says that 844 million people don't have clean drinking water, and 230 million people spend over 30 minutes a day just to collect water. This water can come from pipes, wells, rain, or delivered containers. Groundwater is one of the most useful waters. Water gets polluted when it mixes with harmful things. This can happen because of garbage, human and animal waste, factory chemicals, or gases in the water. The amount of metals in our environment is increasing because of things people do at home and in industries . Heavy metals are one of the main types of pollution. They get into water from rocks, waste from cities, farms, and factories . Cities and industries have made this problem worse .Heavy metals can hurt fish, plants, and other water life. They can also enter the food we eat and make people sick. Other dangerous things like cyanide, fluoride, and radioactive materials are also harmful to people and animals.. That's why we need to keep checking the safety of our drinking water and other water sources.

II. SOURCES OF HEAVY METAL CONTAMINATION

Table 1: Common Sources of Heavy Metal Contamination

Source	Associated Heavy Metals
Mining activities	Lead (Pb) , Arsenic (As) , Cadmium (Cd) , Mercury (Hg)
Industrial Effluents	Chromium (Cr) , zinc (Zn) , Nickel (Ni) , Copper (Cu)
Agriculture run off	Arsenic (As) , Cadmium (Cd) , Lead (Pb)
Urban runoff	Lead (Pb) , Zinc (Zn) , Copper (Cu)
Electronic waste	Lead (Pb) , Mercury (Hg) , Cadmium (Cd)

Heavy metals can enter aquatic environments from natural sources like volcanic eruptions and weathering of rocks, but anthropogenic sources predominate today. Key anthropogenic activities include mining, electroplating, chemical manufacturing, battery production, use of fertilizers and pesticides, and improper disposal of electronic waste.

Figure: 1 Sources of Heavy Metal Contamination

III. TOXIC EFFECTS OF HEAVY METALS

Heavy metal exposure can have profound health impacts, including neurotoxicity, carcinogenicity, nephrotoxicity, and disruption of hormonal and enzymatic functions. Vulnerable groups include children, pregnant women, and occupational workers exposed to industrial waste.

Table 2: Health Effects of Common Heavy Metals

Heavy metal	Health effects
Lead (Pb)	Neurological impairment anaemia hypertension
Mercury (Hg)	Neurotoxicity kidney damage cognitive dysfunction
Arsenic (As)	Skin lesions cancer lung bladder (skin)
Cadmium (Cd)	Kidney dysfunction skeletal damage lung cancer
Chromium (Cr)	Respiratory problems carcinogenesis

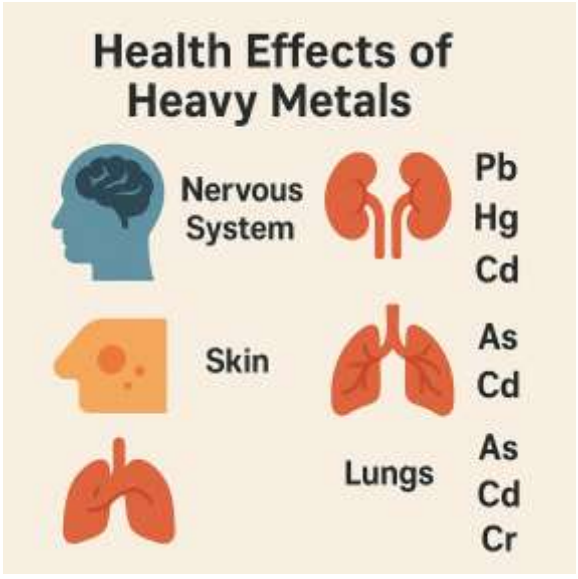

Figure: 2 Health Effects of Common Heavy Metals

IV. ANALYTICAL TECHNIQUES FOR MONITORING

Various advanced techniques have been developed to detect heavy metals in water, ensuring accuracy and reproducibility.

- Atomic Absorption Spectroscopy (AAS)
- Inductively Coupled Plasma Mass Spectrometry (ICP-MS)
- X-ray Fluorescence (XRF) Spectroscopy
- Differential Pulse Anodic Stripping Voltammetry (DPASV)

V. DRINKING WATER STANDARDS FOR HEAVY METALS

National and international organizations have established permissible limits for heavy metals in drinking water.

Table 3: Permissible Limits of Heavy Metals in Drinking Water

Metal	WHO limit (mg/l)	EPA limit (mg/l)
Lead (Pb)	0.01	0.015
Arsenic (As)	0.01	0.01
Cadmium (Cd)	0.003	0.005
Mercury (Hg)	0.001	0.002
Chromium (Cr)	0.05	0.1

VI. REMEDIATION TECHNIQUES FOR HEAVY METAL REMOVAL

Several physical, chemical, and biological methods have been employed to remove heavy metals from contaminated water.

Table 4: Remediation Strategies for Heavy Metals

Method	Principle	Examples
Chemical Precipitation	Formation of insoluble precipitates	Lime precipitation
Ion Exchange	Exchange of metal ions with harmless ions	Zeolites , resins
Membrane Filtration	Physical separation	Reverse osmosis, Nanofiltration
Adsorption	Binding on to absorbent surfaces	Activated carbon , biochar
Phytoementation	Uptake by plants	Water hacinth , duckweed

VII. CONCLUSION

Heavy metal contamination remains a significant challenge for environmental health and safety. Effective monitoring, stringent regulatory frameworks, innovative remediation strategies, and public education are crucial in mitigating heavy metal risks. Collaborative efforts among scientists, policymakers, industries, and communities are necessary to achieve long-term water sustainability and human well-being.

REFERENCES

1. WHO Guidelines for Drinking-Water Quality, 4th Edition.
2. EPA National Primary Drinking Water Regulations.
3. Barakat, M. (2011). Arabian Journal of Chemistry.
4. Ehi-Eromosele et al. (2012). Resources and Environment.
5. Cooper et al. (1999). Journal of Environmental Quality.