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Heavy Metal Contamination in Purna River Basin Buldhana District

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Abstract

River water samples from two water quality monitor stations of Purna river basins in Buldhana district, Maharashtra, were gathered between March 2023 and August 2024 in order to assess the present level of hazardous metal concentration in the Purna Rivers. The atomic absorption spectrophotometer was used to evaluate the samples, which were gathered in plastic bottles. Zinc (zn), copper (Cu), iron (Fe), manganese (Mn), chromium (Cr), lead (Pb), cadmium (Cd), nickel (Ni), and cobalt (Co) concentration, Although certain heavy metals are trace elements, several of them have Biotoxic effects that are very concerning for human biochemistry. Therefore, it is necessary to have a correct understanding of the parameters that are dangerous, such as the concentrations and oxidation states, as well as how there biotoxicity happens. Understanding their origins, leaching procedures, chemical conversion, and modes of action is also crucial role. Heavy metal contamination is a critical environmental concern due to its adverse effect on ecosystem and human health .this study presents a analysis of heavy metal concentration in a given sample highlighting the level of copper as 0.87, iron is 1.66, Chromium is 16.6, zinc is 0.41 cobalt is 12.7 Nickel is 20.5, The presence of heavy metals in freshwater represents a global public health issue. The current study aimed to determine the heavy metal concentration and toxicity in freshwater Purna River Basin Buldhana District.

***Keyword**: Environment, Purna River washbasin, toxic waste of heavy metal, tributary Water Quality, water pollution*

Introduction

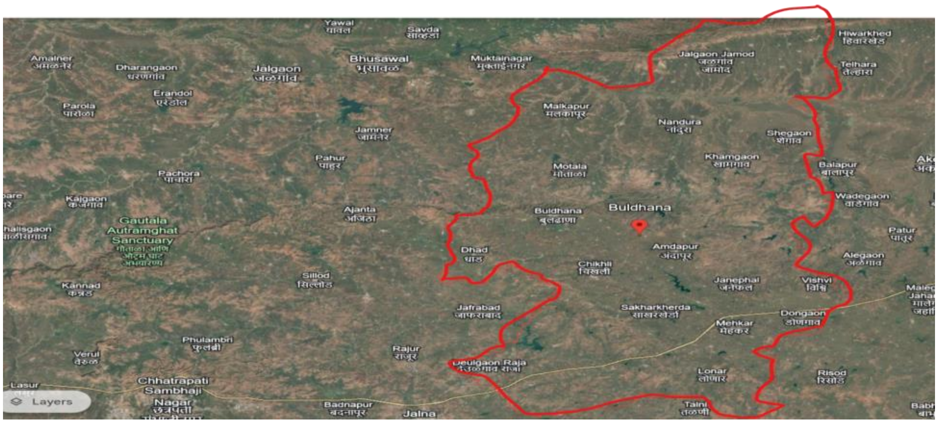
The Indian state of Maharashtra's Amravati division contains the Buldhana district. It is located 500 kilometers from Mumbai, the state capital, on the western edge of the Vidarbha area. Shegaon, Malkapur, Khamgaon, Lonar, Mehkar, and Chikhli are among the towns and c in the district. There are 1444 villages spread throughout 13 tahsils and six subdivisions in the district. Buldhana is home to the district headquarters.. The district is a component of the Tapi and Godavari basins. The two principal rivers that traverse the district are the Purna and the Painganga. The Khandapurna, Nalganga, Gyanganga, Banganga, and Vishwaganaga Gyanganga are the other significant rivers. The main Purna tributaries are the Vishwaganga, the Nalganga, Penganga and Khadakpurna rivers, which are tributaries of the Godavari, typically occupy 42% of the southern and eastern portions of our district, with the Purna and its tributaries making up the remaining portion. The Buldhana district is traversed by roughly thirty-three main and minor rivers. Buldhana district is a component of the Purna and Penganga watersheds and is made up of the Tapi and Godavari basins. The Penganga runs transversely from the southern portion of the district, whereas the Purna flows transferees from the north district. Near Buldhana district, the Penganga River enters. The Purna River flows into Malkapur district close to Dudgaon and into Sangrampur taluka close to Kodi. In Deulgaon Raja Taluka, the Purna River (Godavari) comes close to Chinchkhed and exists,at Lonar Taluka, close to Wazur. Heavy metals can enter the aquatic system through a variety of pathways and have the characteristics of environmental persistence and bioaccumulation (Jarup, 2003). The primary causes of heavy metal contamination in river water are both natural and man-made activities. The concentration of these heavy metals in river water and sediments has rapidly increased over the past few decades, which could have detrimental effects on the aquatic environment's ecological balance. Humans directly consume water, with drinking being prioritized over other uses of water resources. Home water supply is thought to be the most significant use of water.

Brief introduction to selected heavy metals

A collection of metals and metalloids with an atomic concentration higher than 4 g/cm3 or five times or more that of water are commonly referred to as heavy metals (Hawkes, 1997). However, being a heavy metal mostly refers to its chemical characteristics rather than its concentration. The toxicity will likewise be higher if the electro-negativity is higher (Wittmann, 1979). Even if the source is removed, heavy metals remain in the environment for a long time since they are not ecological.

Thus, in toxicological research, heavy metals are regarded as the most dangerous. The metals that are most frequently detected in surface water—24Cr, 25Mn, 26Fe, 27Co, 28Ni, 29Cu, and 30Zn—are the main emphasis of this review. These metals are part of the first periodic transition series are recognized to promote the generation of reactive oxygen species (ROS) in the systems of living organisms. The toxicity is caused by this generation of ROS. Surface waters contain colloidal, particulate, and dissolved forms of all heavy metals, though solute concentrations are typically modest. The pH of the water, the kind and concentration of ligands that the metal could adsorb on, the oxidation state of the mineral elements, and the redox environment system all play a major role in determining the solubility of heavy metals in surface waters (Kennish, 1992).

Map showing Buldhana Distract The Purna River basin



Chromium

It is not found naturally in pure metal form and is one of the most prevalent contaminants in the environment. There are different oxidation states of this element. Its hexavalent (Cr6+), trivalent (Cr3+), and divalent (Cr2+) oxidation states are stable, nevertheless. According to Oldewage et al. (2010), the hexavalent form of Cr is accepted across aquatic creatures' biological membranes. The concentration of Cr in typical waters is low, ranging from 1 to 2 lg/l.

Manganese

There are numerous oxidation states in which it can occur. Mn is most stable in the following oxidation states: +2, +3, +4, and +7. Many industrial applications, including the steel industry, welding wire emissions, fuel preservatives, dry cells, alloys, and others, release it into the environment without any restrictions.

Iron

Additionally, it can be found in a number of oxidation states, including +2, +3, +4, +5, and +6. However, ferrous (Fe2+) and ferrous (Fe3+) are the most stable states of active solution; the latter is the most common form in surface waters (Department of Water Affairs and Forestry, 1993). The development of runoff from the processing of minerals, iron and steel, alloys, acid mine drainage, the chemical, dye, fertilizer, and organic chemical industries, among other things, is the primary cause of the higher than previously observed concentration of iron in the aquatic environment.

Cobalt

Its oxidation states are +2, +3, and +4. Nonetheless, its most stable forms are (Co2+) and (Co3+). Better cobalt concentrations in aquatic environments are mostly caused by galvanizing, drying reagent preparation, catalyst manufacture, and turbines. production, alloys, high-speed instruments, powdered cobalt metal for moisture detection, and those used in porcelain painting.

Copper

Water naturally contains 5 lg/l of copper. Anthropogenic pathways include mining, plating, coatings, pulp and paper mills, fertilizers, oil refining, steel mills, copper fungicides, cooling water discharge, pipe corrosion, municipal sewage/wastewater, fly ash, cooling water discharge, industry, the use of copper salts to control aquatic undergrowth, and the introduction of fertilizers containing copper (Nussey, 1998).

Zinc

Batteries, pigments and paints, electroplating, fly ash, coal combustion, petrochemicals, organic chemicals, fertilizers, steel foundries, the zinc, lead, and copper smelting industry, the manufacture of brass alloys, iron galvanization and steel, and household products containing zinc.

Collection and analysis of water sample from Purna River In Buldhana District;

Water from the Purna River in Buldhana District was collected and analyzed in glass bottles that had been previously cleaned and acidified. The bottles were taken straight to the lab, where they were acidified to a pH below 2.0 using pure HNO3. In accordance with APHA (2005), the water samples were examined for the presence of heavy metals (Cu, Ni, Fe, Co, Mn, Cr, and Zn). The purpose of the water was to measure the dissolved oxygen (D.O.). Standard methods were used to determine the total solids (T.S.), total dissolved solids (T.D.S.), and suspended solids (T.S.S.) (APHA, 2005). A laboratory thermometer (Deluxe, 6) and pH strips (S.D Fine chemicals, 0 – 0.1) were used to record the temperature and pH on-site.

Blank setup

With every sample set, blanks were prepared. Setting up the standards Typical Standard methods were used to create heavy metal solutions (APHA 2005).

Instrumentation

An atomic absorption spectrometer (Perkin Elmer, AA 800, multi-cathode release lamps) with specific cathode release lamps for each metal and nitrous oxide-acetylene as a flame was used to analyze water samples for the heavy metals Cu, Ni, Fe, Co, Mn, Cr, and Zn. The atomic absorption of these metals was performed under the following analytical scenario.

Analysis of statistics

Samples were taken three times. The mean ± S.D. is used to represent values. ANOVA was applied on the data. Duncan's multiple range test (Duncan 1955) was used to determine significant variations between means. the Purna River heavy metal are the subject of this study's investigation into their harmful impacts. Roughly the sequence of the heavy metals found was Fe > Cu > Zn > Mn > Ni >Co > Cr. Water quality has historically been assessed using physical-chemical analysis. Since any change in temperature, pH, DO, TSS, and TDS indicates the level of toxic waste in natural waters, these parameters are frequently utilized as water quality indicators. They were suitable for However, the Fe and Ni concentration of fish feed beyond the recommended limits established by the United States UNEP Global Environment Monitoring System (UNEPGEMS, 2006).

Table 1: Physico-chemical Parameter of The Purna River Buldhana district heavy metal water.

Parameter	Water
Temperature	32.0℃
Ph	7.5
Dissolved Oxygen	6.7 mg/l^{-1}

Values are Mean±S.E, (n=5), Values are expressed in mg k^{1}.dry weight Means with comparable letters in arrow are statistically similar at P > 0.01

S.No.	Heavy metal	Concentration
1	Copper	0.87± 0.003
2	Iron	1.66± 0.11
3	Chromium	16.6 ± 0.92
4	Zinc	0.41± 0.05
5	Cobalt	12.7± 0.18
6	Nickle	20.5±0.88

Result and Discussion

According to the analysis of the provided data, the concentrations of heavy metals show fluctuations in their amounts. The discovered concentrations and their consequences are further discussed in the following discussion:

0.87 ± 0.003 mg/L of copper The sample has a comparatively low copper concentration. At large concentrations, copper, a necessary trace element, turns poisonous. According to the observed value, the copper content is within the range that is acceptable for the majority of biological or environmental systems.

1.66 ± 0.11 mg/L iron, Despite being a common element, iron can cause issues at high amounts because it can stain water and have an impact on aquatic life. The measured concentration shows moderate levels of iron, which may need to be addressed in situations involving groundwater or industrial effluent discharge.

16.6 ± 0.92 mg/L of chromium, Among the metals examined, chromium has the highest concentration. High quantities of chromium are extremely harmful and provide major threats to human health and the environment, particularly when they are hexavalent. The fact that this figure is so high suggests that there may be sources of contamination, such as inappropriate waste disposal or industrial processes.

0.41 ± 0.05 mg/L of zinc,Another necessary trace metal is zinc, although too much of it can be harmful to the ecosystem. Since there is little contamination from zinc-based sources like galvanization or batteries, the observed zinc concentration is minimal.

(12.7 ± 0.18 mg/L) Cobalt, Although cobalt is a necessary micronutrient, high concentrations make it hazardous. The comparatively high concentration that has been reported may be related to industrial processes like mining, alloy manufacturing, or electronic trash.

20.5 ± 0.88 mg/L of nickel the sample's second-highest concentration is nickel. Because nickel is hazardous to humans and aquatic habitats, this high quantity is concerning. Industrial operations like electroplating, metal refining, or wastewater discharge may be at blame for these high amounts.

Discussion:

According to the statistics, there are notable differences in the levels of heavy metals, with nickel and chromium having the highest concentrations. These results raise the possibility of contamination from man-made sources such mining, industrial operations, or inappropriate waste disposal. To avoid harmful effects on the environment and human health, the high concentrations of some metals, especially chromium and nickel, call for prompt research and cleanup. In contrast, the lower levels of zinc and copper indicate less contamination from these metal-related sources. However, to guarantee adherence to environmental regulations and to reduce any hazards, ongoing monitoring and evaluation of all heavy metals are essential. In order to combat heavy metal pollution, this analysis emphasizes the significance of locating the sources of contamination and putting into practice efficient management techniques.

Conclusion

The water quality beneath the study was impacted by overflow from heavy metal-containing industry. Current evaluation reports and the opinions of other aquatic toxicology specialists have led to the understanding that a battery of biomarkers is slightly more necessary for biomonitoring investigations than a single parameter. The assessed levels of the heavy metals Fe, Ni, Mn, and Cr were found to be higher above the allowable limits for water quality for both human health and flora and fauna. Fish physiology is similarly impacted by these heavy metals. Therefore, to restore the health of commercial fish in ecologically challenging settings, a scientific detoxification procedure is required. These have an immediate impact on the flora and animals in addition to the water quality. Thus, biomarkers the health of aquatic fauna may be monitored with the help of indicators including bioaccumulation, lipid and protein profiles, pathological marker enzyme activity, enzymatic and non-enzymatic antioxidants, lipid peroxidation, DNA damage, and tissue damage. Through food and water, these heavy metals will infiltrate the food chain and have negative health impacts as those shown in sign creatures. There is no denying that industry is necessary for advancement, but it also significantly reduces the number of people who can find employment. Since almost all of the metals that were analyzed high concentration,the government would have unharmed laws to industry to mange &discharging waste water bodies.

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Conflicts of Interest
The authors declare that there are no conflicts of interest regarding the publication of this paper.

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