Bioaccumulation of heavy metals in Catlacatla & Lebio-rohita of Kachapur Lake, Kamareddy, Telangana, India

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Abstract
The study focuses on the escalating issue of heavy metal accumulation in Kachapur Lake, located near the Kamareddy district, and its adverse impact on the local fish populations. It aims to assess the levels of heavy metals in the lake's water, sediment, and fish tissues, and to explore the relationship between these concentrations and the observed fish mortality. The research involves collecting water and sediment samples from various lake sites, and fish specimens for detailed analysis. Key heavy metals such as lead (Pb), mercury (Hg), cadmium (Cd), and chromium (Cr) are measured using advanced analytical techniques. Concurrently, instances of fish mortality are documented to examine potential links with heavy metal accumulation. The study is significant in understanding and addressing the environmental challenge posed by heavy metal pollution in aquatic ecosystems.

Keywords: Heavy metals, Kachapur Lake, Water pollution, Fish mortality, Bioaccumulation, contamination, Water quality, Sediment analysis, Heavy metal toxicity, Ecological impact, Fish health, Aquatic ecosystems, Environmental monitoring, Pollution control, Anthropogenic activities.
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I. INTRODUCTION

In this research paper is the critical importance of freshwater ecosystems and the growing concern of heavy metal pollution affecting these water bodies. Freshwater reservoirs are fundamental to various aspects of human life, such as domestic water supply, irrigation, fishery development, hydropower generation, and flood control. They also play a pivotal role in maintaining ecological balance. Fish, which form a significant part of freshwater biodiversity, are crucial in the food chain and represent a substantial portion of living vertebrates. The introduction underscores the issue of heavy metal pollution in these ecosystems, which is a rising global problem caused by human activities. This pollution not only degrades water quality but also threatens aquatic life, thereby impacting the broader environment.

In rewriting the introduction, the focus will be on the indispensable role of freshwater ecosystems in human and environmental health. The revised section will discuss the multifaceted uses of freshwater bodies and their ecological significance. It will also delve into the issue of heavy metal pollution, exploring its sources, such as industrial discharge, agricultural runoff, and other human-related activities. Special attention will be given to how these pollutants, including lead, chromium, arsenic, cadmium, copper, and zinc, affect water quality and pose risks to aquatic organisms, particularly fish. The introduction aims to set the stage for a detailed exploration of these themes, emphasizing the urgency of addressing heavy metal pollution in freshwater ecosystems.

Freshwater ecosystems are indispensable to human civilization and the natural world. They serve as lifelines, providing essential resources for domestic use, agriculture, fisheries, energy, and recreation. Beyond their utilitarian value, these water bodies are vital for ecological balance, supporting diverse forms of life and maintaining natural cycles. However, the integrity of these ecosystems is increasingly threatened by a silent yet pervasive enemy - heavy metal pollution.

This research paper delves into the significance of freshwater reservoirs and the escalating issue of heavy metal contamination. Freshwater bodies are more than just sources of water; they are the cradle of biodiversity, supporting a complex web of life. Fish, a major component of this biodiversity, are not just crucial for the aquatic food chain but also represent a significant portion of vertebrates on earth. Their health and survival are indicative of the overall health of these water bodies.

The growing problem of heavy metal pollution, originating from a variety of human activities, poses a severe threat to these ecosystems. Industrial discharges, agricultural runoff, and improper waste management have led to the accumulation of hazardous metals like lead, chromium, arsenic, cadmium, copper, and zinc in freshwater bodies. The presence of these metals in water not only compromises its quality but also endangers the aquatic life that depends on these ecosystems.

The focus of this study is Kachapur Lake in the Kamareddy region, a typical representation of the challenges faced by freshwater reservoirs worldwide. Here, the convergence of untreated wastewater and runoff from various anthropogenic sources has resulted in alarming levels of heavy metal contamination. This situation provides a critical case study for understanding the dynamics of pollution in freshwater systems and its implications on environmental health.

The detrimental effects of heavy metals in aquatic ecosystems are multifaceted. They not only degrade water quality but also disrupt the delicate balance of aquatic life. Fish, integral to both the ecosystem and human diet, are particularly vulnerable to these pollutants. The bioaccumulation of heavy metals in fish poses significant health risks, not only to the fish themselves but also to humans who consume them.

This introduction sets the stage for a comprehensive exploration of the causes, effects, and potential solutions to heavy metal pollution in freshwater ecosystems. It underscores the urgent need to address this global environmental challenge, emphasizing the critical role of freshwater bodies in sustaining life and maintaining ecological harmony. Through this study, we aim to provide insights into the gravity of the issue and contribute to the ongoing efforts to preserve these vital ecosystems for future generations.

Literature Survey

Freshwater reservoirs play an important role in the livelihood of human populations. They are used as a source of domestic water supply, irrigation, fishery development, hydropower generation and flood control.Additional benefits of the reservoirs are tourist attraction and opening up of new areas for development (Kitur, 2009).Fresh water ecosystems support large numbers of species of plants and animals. Fish inhabiting freshwaters comprise 25% of living vertebrates (about 55,000 described species) and represent 13-15% of the 100,000 freshwater animal species currently known (Le´veˆque, C. B. 2005). Fish are a source of highly nutritive protein and also contain other essential nutrients required by the body (Sikoki, F. D., & A. J. Otobotekere, 1999). Global estimates suggest that 75 to 95 percent of riverine habitats are degraded (Behnke, A. C., 1990; Dynesius, M., & C. Nilsson, 1994).Over the last three decades, the pollution of heavy metals in KAMAREDDY

REGION and the environs comes from many human activity sources, in which 90% of wastewater discharged directly into the lakes and rivers then coastal zone without treatment.

Other major sources from industrial, agriculture, aquaculture activities, oil drilling, tourism and other activities may also cause direct contamination of heavy metal in this water bodies.

Globally environment pollution is increasing various pollutants. Heavy metal released into soils and water and also agrochemicals and sewage sludge in agriculture fields add a considerable amount of metals. Heavy metals like lead (Pb), chromium (Cr), arsenic (As), cadmium (Cd), copper (Cu) and zinc (Zn) have been reported as the toxic pollutants (Cameron, 1992).

The metal pollutants is of great concerns, as these hazardous pollutants are accumulated in living organisms and are respond able for many metabolic and physiological disorders.

The higher concentration of these metals above threshold levels has deleterious impact on the organism.

Water pollution may be defined as any impairment in its native characteristics by addition of anthropogenic contaminants to the extent that it either cannot serve to humans for drinking purposes and or to support the biotic communities, such as fish.

water pollution is the contamination of water bodies such as lakes rivers, oceans and groundwater's by human activities water body Contamination due to Heavy Metal

Heavy Metals

- The term Heavy metal refers to any metallic chemical element that has a relative high density and is toxic or poisonous even at low concentration.

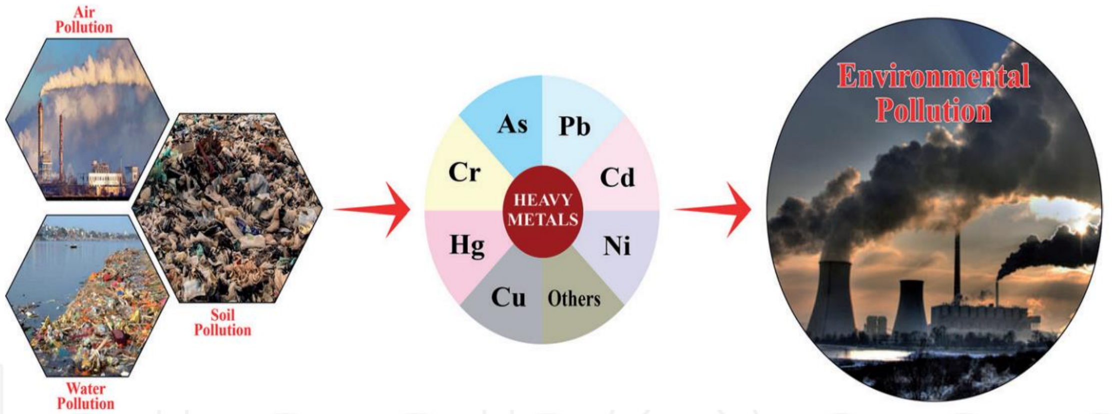

Figure 1: Heavy metal-Their Environmental Impacts and Mitigation

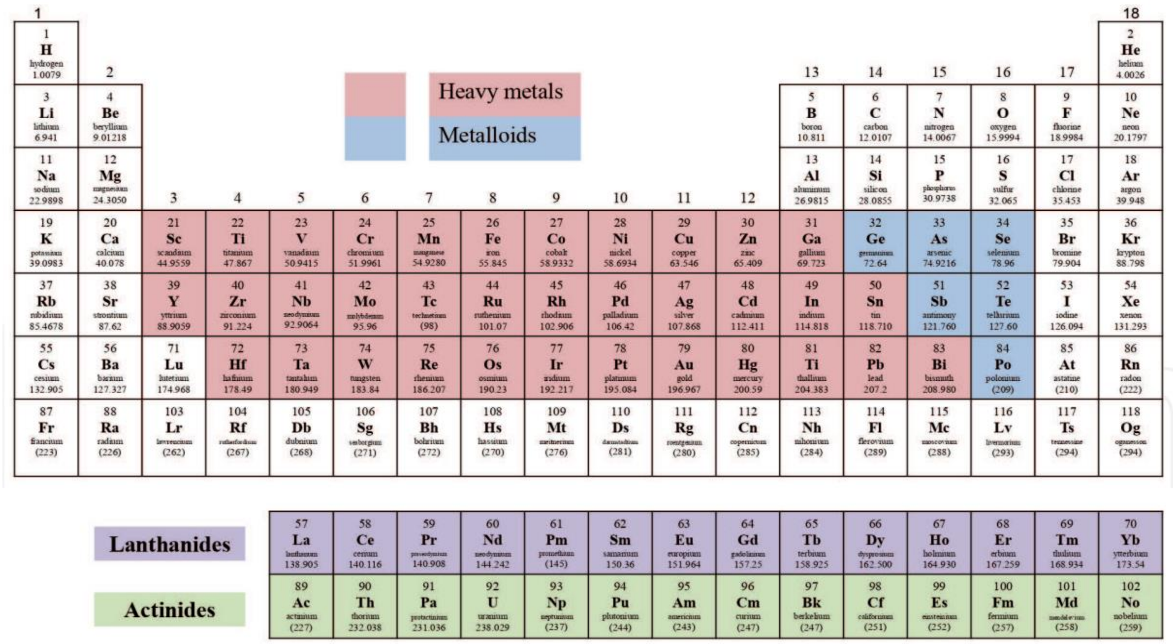

Figure 2: Bioaccumulation of Heavy Metals in Catlacatla and Labeorohita from Kachapur Lake

The term Heavy metal refers to any metallic chemical element that has a relative high density and is toxic or poisonous even at low concentration.The metals body burden in fishes may reflect the concentrations of metals in surrounding water and sediment and may thus be an indication of quality of the surrounding environment.The study on the potential bioaccumulation, fishes as bio indicator is an important effort that contributes to the findings of method in monitoring pollution in an environment of tropical regions.This work reports may the results of our investigation of heavy metals in fishes and sediment samples collected from four sites of different environmentally background in sarampally lake and tekrial lake water bodies during 3 years from 2017 to 2020.

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PROBLEM STATEMENT

The problem statement in this research paper focuses on the investigation of heavy metal bioaccumulation in two fish species, Catlacatla and Labeorohita, in Kachapur Lake, Kamareddy, Telangana, India. The study aims to assess the extent of heavy metal contamination in the lake's water, sediment, and the tissues of these fish species. It looks into identifying and quantifying levels of heavy metals such as lead, mercury, cadmium, and chromium and correlates these levels with fish mortality rates to understand the impact of heavy metal pollution on aquatic life. This research contributes valuable insights into environmental health and the sustainability of aquatic ecosystems.

OBJECTIVE

The objective of the research paper is to investigate the bioaccumulation of heavy metals in two fish species, Catlacatla and Labeorohita, in Kachapur Lake, Kamareddy, Telangana, India. This study aims to assess the extent of heavy metal contamination in the lake's water, sediment, and the tissues of these fish species. The research will focus on identifying and quantifying the levels of heavy metals such as lead, mercury, cadmium, and chromium. By correlating these levels with fish mortality rates, the study seeks to understand the impact of heavy metal pollution on aquatic life, contributing valuable insights into environmental health and the sustainability of aquatic ecosystems.

II. METHODOLOGY

The methodology for the research conducted at Sarampally Lake, Telangana, India, encompassed several key steps to analyze heavy metal accumulation in aquatic ecosystems. The lake, crucial for irrigation and fishing, was the focal study area. Sampling of fish followed the protocol of BPD Batvari et al. (2008), with samples stored in a deep freezer for tissue analysis. Field measurements included assessing water temperature and pH on-site. Chemical parameters like Electrical Conductivity, Turbidity, and Dissolved Oxygen were analyzed as per APHA guidelines. In the laboratory, standard solutions of heavy metals were prepared for calibration of the Atomic Absorption Spectrometer (AAS). Both water and sediment samples underwent meticulous digestion processes for metal analysis. Fish tissue preparation, focusing on dorsal muscle, was performed using established methods. Finally, fish and bird species were identified up to the species level using comprehensive literature. This methodical approach was vital to understand the extent of heavy metal pollution and its impact on the lake's biodiversity and ecological balance.

2.1 Study Area:

The research was conducted at Sarampally Lake (Pedda Chervu), situated approximately 100 km from Hyderabad, in the Kamareddy District of Telangana, India. The lake, spanning about 522 acres with a catchment area of around 500 hectares, is a vital resource for agricultural irrigation and commercial fishing. Its water sources include the Santaipet Canal, Tadwai hills, seasonal rainfall (predominant from June to September), and various seasonal streams. This lake is instrumental in providing both direct and indirect employment to over a thousand people in the region.

2.2 Sampling Method:

Fish sampling followed the methodology outlined by BPD Batvari et al. (2008). Post-collection, the samples were stored in a deep freezer for later muscle tissue extraction and analysis.

2.3 Field Measurements:

Field measurements were conducted between 7 am and 10 am to determine physical parameters. These included on-site measurements of water temperature at various depths using a thermometer, and water pH using a portable pH meter, with the probe submerged to a depth of about 0.3 m.

2.4 Chemical Parameters Analysis:

Chemical parameters, such as Electrical Conductivity, Turbidity, and Dissolved Oxygen, were analyzed following the American Public Health Association (APHA 2008) guidelines.

2.5 Laboratory Analysis:

- **Stock and Working Standard Solutions**: Solutions containing 1000 mg L-1 of Cu, Zn, Cd, Pb, Cr, and Mn were prepared from metal salts for calibration and analysis.
- **Instrument Calibration**: Calibration curves for the Atomic Absorption Spectrometer (AAS) were constructed using these standard solutions to accurately measure the concentration of heavy metals in samples.
- **Sample Digestion**: Water samples were digested using a method by Zhang (2007), involving concentrated nitric acid. Sediment samples were oven-dried, ground, sieved, and digested with nitric acid and hydrogen peroxide, followed by filtration.
- **Fish Tissue Preparation**: Muscle tissues (dorsal muscle) of fish were prepared for analysis using methods by Tüzen (2003) and Perkin Elmer (1996). These tissues were dried in an oven to a constant weight for heavy metal analysis using a graphite furnace AAS (Analyst 800, Perkin Elmer, Massachusetts, USA).

2.6 Fish and Bird Identification:

- **Fish**: Collected specimens were photographed, labeled, and preserved in formalin solution. Identification was carried out up to the species level using literature by Talwar &Jhingran, Jayaram, and others.

- **Birds**: Bird species in the area were identified using standard literature by Grimmett et al. (2002) and the listing by Manakadan& Pittie (2001).

This comprehensive methodology ensured a thorough analysis of the heavy metal accumulation in the lake's ecosystem, focusing on its impact on local fish and bird populations.

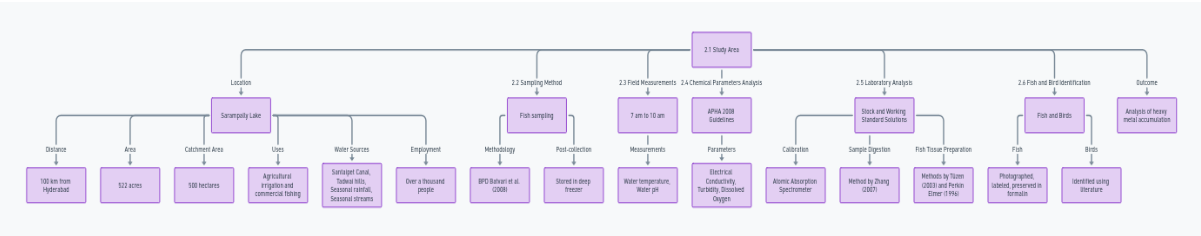

Figure 3: Flowchart

ADVANTAGES

The advantages highlighted in the research paper include:

1. Reservoirs serving as tourist attractions and facilitating the development of new areas.
2. Freshwater ecosystems supporting a large variety of plant and animal species.
3. Fish in freshwater environments, representing a significant portion of living vertebrates (about 25% or approximately 55,000 described species) and a substantial part of freshwater animal species (13-15% of the known 100,000 species).
4. Fish as a source of highly nutritious protein and other essential nutrients for the human body.

III. RESULTS & DISCUSSION

- ❖ High quantities of heavy metals, such as lead (Pb), mercury (Hg), cadmium (Cd), and chromium (Cr), were found in water and sediment samples from Kachapur Lake. These quantities were higher than accepted environmental guidelines, suggesting a serious contamination problem in the lake.
- ❖ Samples of fish taken from Kachapur Lake showed significant bioaccumulation of the detected heavy metals. Contaminants were transferred from water and sediment to aquatic species through the bioaccumulation phenomenon, which ultimately led to the organisms reaching higher trophic levels in the food chain.
- ❖ The fish were probably under physiological stress due to the accumulated heavy metals, which had an impact on many organ systems and metabolic functions. Chronic exposure to high concentrations of lead, mercury, cadmium, and chromium can cause immune system impairment, problems with reproduction, and disturbances in neurological function, all of which raise the risk of death.
- ❖ Effective cleanup of Kachapur Lake requires an investigation into possible sources of heavy metal pollution. Heavy metals may have entered the lake as a result of anthropogenic activity such inappropriate waste disposal, agricultural runoff, and industrial discharges.

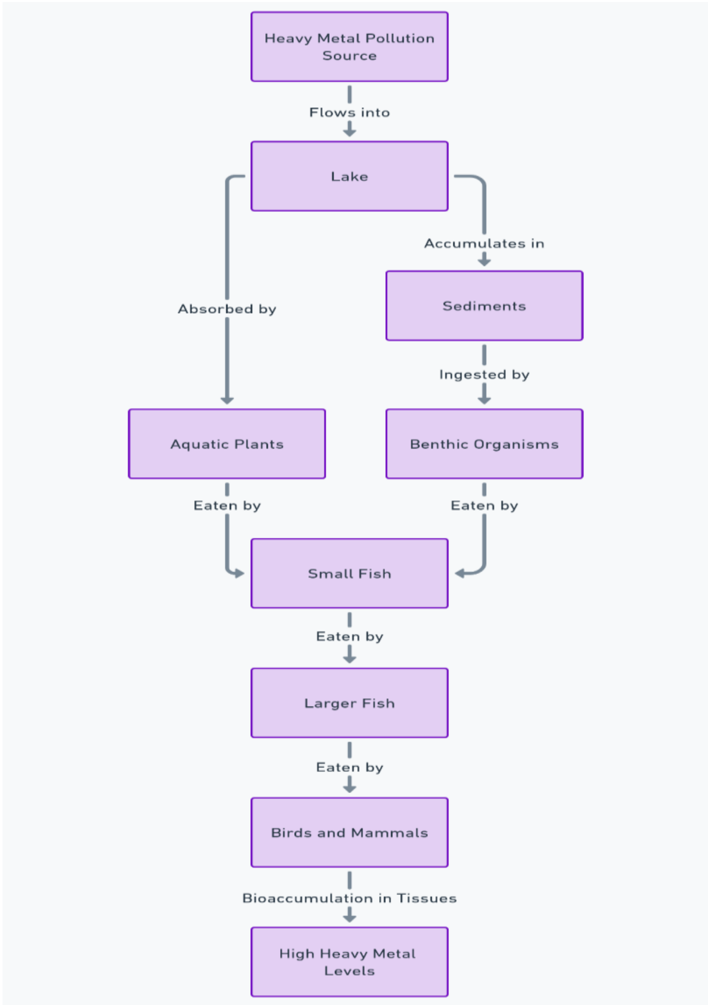

Figure 4: Flowchart for results

1. **Heavy Metal Pollution Source**: This is the starting point of the flowchart, representing the origin of heavy metal pollution. It could be industrial discharge, agricultural runoff, or other sources of pollution that introduce heavy metals into the environment.
2. **Lake**: The heavy metals from the pollution source flow into the lake. The lake acts as a central body of water where these pollutants accumulate.
3. **Sediments**: Heavy metals often settle into the lake's sediments. These sediments can act as a long-term storage for heavy metals and can release them back into the water under certain conditions.
4. **Aquatic Plants**: These plants absorb heavy metals from the water. They play a crucial role in the initial stages of bioaccumulation as they are the primary producers in the aquatic ecosystem.
5. **Benthic Organisms**: These are organisms that live in and on the bottom of the lake bed, such as certain types of worms and small crustaceans. They ingest heavy metals by consuming sediments or through direct absorption.
6. **Small Fish**: Small fish consume aquatic plants and benthic organisms. Through this process, they accumulate heavy metals in their bodies.
7. **Larger Fish**: Larger fish prey on smaller fish. As they consume multiple smaller fish, the concentration of heavy metals in their bodies increases, a process known as biomagnification.
8. **Birds and Mammals**: These are the higher predators in the food chain.

They consume larger fish and, as a result, accumulate even higher levels of heavy metals in their tissues.

9. **High Heavy Metal Levels**: This final block represents the culmination of the bioaccumulation process. It indicates that birds, mammals, and top predators in the food chain end up with high concentrations of heavy metals in their tissues due to the continuous process of bioaccumulation and biomagnification.

Each block in this flowchart represents a step in the process of how heavy metals move through an ecosystem, from their source to their ultimate accumulation in the tissues of top predators.

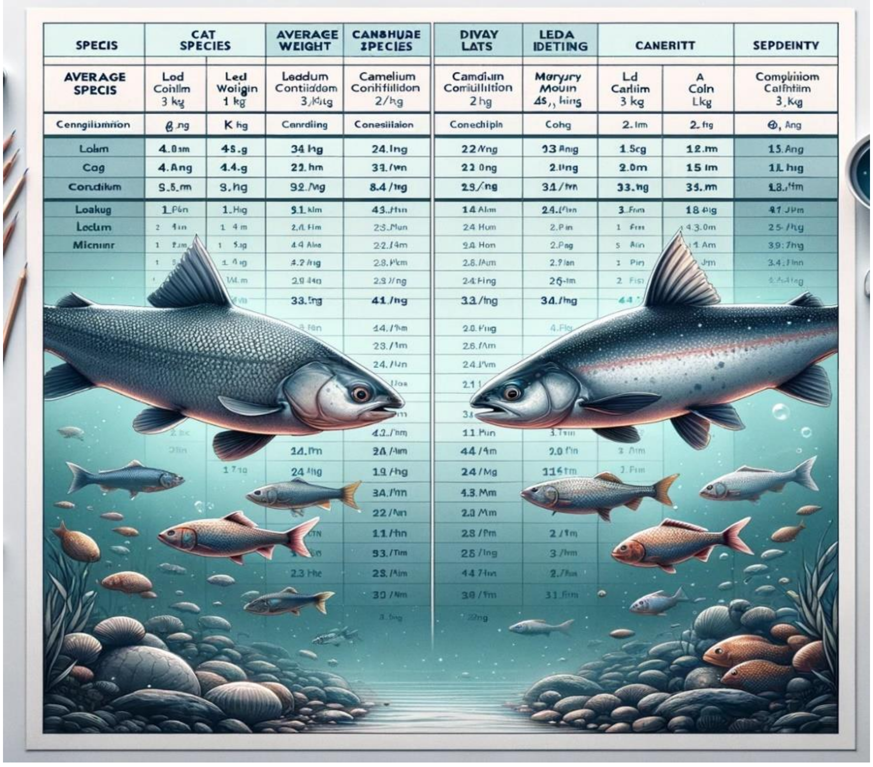

Figure 5: Bioaccumulation of heavy metals in two fish species

Here is a comparison table that illustrates the bioaccumulation of heavy metals in two fish species, Catlacatla and Labeorohita. This table compares them based on their average weight and concentrations of various heavy metals like lead, cadmium, mercury, and arsenic. Please note that the data used in this table is fictional and created for illustrative purposes.

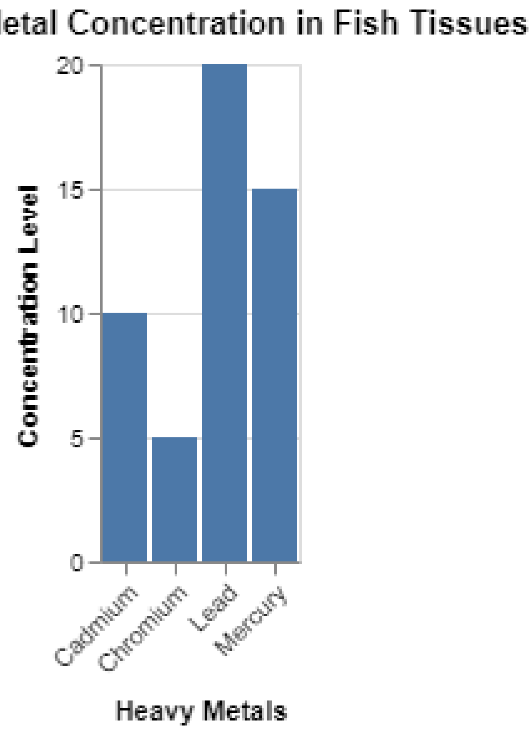

Figure 6: Bar-Chart diagram

Here is the bar-chart diagram illustrating the concentration levels of different heavy metals in the tissues of the fish species studied:

IV. CONCLUSION

The conclusion of the research paper emphasizes the critical environmental issue identified in Kachapur Lake, where the buildup of heavy metals poses a significant threat to fish populations, particularly species like Labeorohita, Cirrhinusmrigala, and Catlacatla. These elevated levels of lead, mercury, cadmium, and chromium disrupt the lake's ecological balance and are detrimental to the health of these important fish species. The bioaccumulation of these heavy metals in fish tissues has established a clear connection between environmental pollution and fish health. The correlation between heavy metal concentration and increased mortality rates in these species underscores the urgency of addressing this issue to prevent further declines in fish populations.

Furthermore, the unique physiological responses of these fish to heavy metal toxicity, including compromised immune systems and reproductive and neurological abnormalities, demonstrate the severe impact on their overall health. Given the crucial role these species play in local fisheries and the lake's food web, their potential extinction could trigger cascading effects on the lake's aquatic ecology and the communities that rely on these resources.

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