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Predicted Impact Of Microplastics On Fish And Human Health In Kolleru Lake After Vijayawada Floods 2024

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ABSTRACT

The recent floods in Vijayawada have exacerbated the issue of microplastic pollution in the Budameru Drain, leading to increased contamination in Kolleru Lake. This study investigates the predicted sources of microplastics, their effects on fish and human health, and provides future research directions for the region. The floods have intensified the flow of water, transporting more microplastics from urban, industrial, and agricultural areas into the Budameru Drain, subsequently raising the concentration of microplastics in Kolleru Lake, a vital habitat for diverse aquatic species. Urban runoff, industrial discharge, and agricultural practices are identified as primary sources of microplastics. The ingestion of microplastics by fish can result in physical blockages, reduced feeding efficiency, internal injuries, and chemical toxicity due to the accumulation of toxic substances on microplastics, adversely affecting fish health and reproduction. Human health is also at risk through the consumption of fish contaminated with microplastics, which may expose humans to harmful chemicals and pathogens. Future research should focus on comprehensive studies of microplastic sources and pathways, long-term monitoring of microplastic levels in water bodies, and their impact on aquatic life. Additionally, developing mitigation strategies to reduce microplastic pollution, such as improved waste management practices and public awareness campaigns, is crucial. This paper aims to provide a foundation for understanding the complex dynamics of microplastic pollution in the region and to guide future efforts in mitigating its adverse effects on the ecosystem and human health.

Keywords: Microplastic pollution, Budameru Drain, Kolleru Lake, fish health, human health, mitigation strategies.

INTRODUCTION

Microplastics, defined as plastic particles less than 5 mm in size, pose significant environmental and health risks due to their small size and widespread presence (Thompson *et al*., 2004). These tiny particles originate from a variety of sources, including the breakdown of larger plastic debris, microbeads in personal care products, synthetic fibers from clothing, industrial processes, and road runoff (Browne *et al*., 2011;

Napper & Thompson, 2016; Duis & Coors, 2016; Kole *et al*., 2017). Once in the environment, microplastics can persist for long periods, accumulating in water bodies, sediments, and soils (Cole *et al*., 2011; GESAMP, 2015). They can be transported over long distances by currents and can settle in sediments at the bottom of water bodies, affecting benthic organisms and the overall health of aquatic ecosystems (Lebreton*et al*., 2017). Microplastics can also become airborne and be transported over long distances, eventually settling in remote areas, including the Arctic and high-altitude regions (Allen *et al*., 2019). In soil, microplastics can affect soil organisms, such as earthworms, which play a crucial role in maintaining soil health (Rillig*et al*., 2017). The presence of microplastics in the environment poses several risks, including ingestion by aquatic organisms, adsorption and concentration of harmful chemicals, and potential health effects on humans through the consumption of contaminated seafood, drinking water, and other food products (Wright *et al*., 2013; Rochman *et al*., 2013; Smith *et al*., 2018). Potential health effects include oxidative stress, cytotoxicity, immune system disruption, and respiratory issues from inhalation of airborne microplastics (Prata, 2018).

MATERIALS AND METHODS

Study Area: Kolleru Lake, located between the Krishna and Godavari deltas, is a significant freshwater body in India. Post-flood conditions may lead to the influx of microplastics from the Budameru Drain, which connects urban, industrial, and agricultural areas to the lake.

Sample Collection: Water and sediment samples may be collected from various points across Kolleru Lake, including inflow areas from the Budameru Drain. Fish samples can also obtain to assess microplastic ingestion. Water samples may be filtered for microplastics, and sediments can be analyzed for microplastic accumulation. Fish may be dissected to examine the digestive tracts for microplastics.

Laboratory Analysis: Microplastics may be identified and quantified using microscopy and FTIR (Fourier-transform infrared) spectroscopy. Fish health can be assessed through histopathological analysis to determine the extent of physical damage and oxidative stress caused by ingested microplastics.

Data Analysis: The data may be analyzed to correlate microplastic concentrations with the severity of impacts on fish health. Potential human exposure can be estimated based on fish consumption rates and water contamination levels.

RESULTS AND DISCUSSION

A. **Predicted Sources of Microplastics in Budameru Drain:** Microplastics in the Budameru Drain are predicted to originate from various sources

1. Urban Runoff: Floodwaters have carried urban debris, including tire wear particles, synthetic fibers, and plastic litter, into the drainage system. Urban areas are significant contributors to microplastic pollution due to the high density of plastic usage and waste generation. During flooding events, the runoff from streets, parks, and other urban surfaces can transport a variety of microplastics into the drainage system. These include particles from tire wear, which are a major source of microplastics in urban environments, as well as synthetic fibers from clothing and plastic litter from various sources (Browne *et al*., 2011).

2. Industrial Discharges: Flooding has likely increased the discharge of microplastics from nearby industries into the Budameru Drain. Industrial activities often involve the use of plastic materials and products, which can lead to the release of microplastics into the environment. During flooding, the increased water flow can wash these microplastics from industrial sites into the drainage system. This includes microplastics from manufacturing processes, plastic pellets used in production, and other industrial waste (Lebreton*et al*., 2017).

3. Household Wastewater: The floods have overwhelmed wastewater treatment facilities, leading to the release of microplastics from household products into the drainage system. Household wastewater is a significant source of microplastics due to the presence of synthetic fibers from washing clothes, microbeads from personal care products, and other plastic particles from household items. When wastewater treatment plants are overwhelmed by flooding, they may not effectively filter out these microplastics, allowing them to enter the drainage system (GESAMP, 2015).

4. Agricultural Runoff: The use of plastic products in agriculture has contributed to microplastic pollution, which has been exacerbated by floodwaters. Agricultural practices often involve the use of plastic mulches, irrigation pipes, and other plastic products. During flooding, runoff from agricultural fields can carry these microplastics into the drainage system. This runoff can include fragments of plastic mulch, degraded irrigation pipes, and other plastic debris used in farming (Hurley *et al*., 2018).

B. Impact on Kolleru Lake

Kolleru Lake, a significant freshwater lake, has been affected by the influx of microplastics from the Budameru Drain. The lake's ecosystem and the health of its aquatic life are at risk due to this contamination. Microplastics can be ingested by aquatic organisms, leading to physical harm, reduced feeding, and impaired reproduction. For instance, fish and other aquatic species may mistake microplastics for food, which can cause blockages in their digestive systems and reduce their ability to absorb nutrients. This can lead to stunted growth and decreased reproductive success, ultimately affecting the population dynamics of these species (Wright *et al*., 2013).

Additionally, microplastics can act as vectors for harmful pollutants, which can accumulate in the food web and pose risks to both wildlife and human health. Microplastics have a high surface area to volume ratio, which allows them to adsorb and concentrate toxic chemicals from the surrounding environment. These pollutants can include persistent organic pollutants (POPs) and heavy metals, which are known to have detrimental effects on both wildlife and humans. When aquatic organisms ingest microplastics, these toxic substances can be transferred up the food chain, potentially reaching humans who consume contaminated seafood (GESAMP, 2015).

The presence of microplastics in Kolleru Lake can also affect water quality, potentially leading to decreased oxygen levels and altered nutrient cycles. Microplastics can interfere with the natural processes that regulate oxygen levels in the water, such as photosynthesis and respiration. This can result in hypoxic conditions, where oxygen levels are too low to support most aquatic life. Additionally, microplastics can disrupt nutrient cycles by affecting the growth and activity of microorganisms that play a crucial role in nutrient recycling. This can have cascading effects on the entire ecosystem, impacting not only fish and other aquatic species but also the birds and mammals that rely on the lake for food and habitat (Cole *et al*., 2011).

Overall, the influx of microplastics into Kolleru Lake poses a significant threat to the health and stability of its ecosystem. Addressing this issue requires a comprehensive approach that includes reducing plastic pollution at its source, improving waste management practices, and enhancing public awareness about the impacts of microplastics on the environment (Rao & Rao, 2010).

C. Effects of Microplastics on Fish

1. **Physical Harm**: Fish ingest microplastics, leading to physical damage to their digestive systems. When fish consume microplastics, these particles can cause blockages and abrasions in their digestive tracts. This physical damage can impair the fish's ability to digest and absorb nutrients, leading to malnutrition and reduced growth rates. In severe cases, the ingestion of large quantities of microplastics can be fatal to fish (Cardozo *et al*., 2018).
2. **Oxidative Stress**: Microplastics induce oxidative stress in fish, affecting their overall health and growth. Oxidative stress occurs when there is an imbalance between the production of reactive oxygen species (ROS) and the fish's ability to detoxify these harmful byproducts. Microplastics can generate ROS, leading to cellular damage, inflammation, and impaired physiological functions. This oxidative stress can negatively impact the fish's immune system, making them more susceptible to diseases and reducing their overall fitness (Bhuyan *et al*., 2022).
3. **Behavioral Changes**: Exposure to microplastics can cause behavioral abnormalities in fish, impacting their survival and reproduction. Studies have shown that microplastics can affect the behavior of fish, including changes in feeding habits, predator avoidance, and social interactions. For example, fish exposed to microplastics may exhibit reduced feeding efficiency, making it harder for them to obtain sufficient food. Additionally, altered behaviors can affect mating and reproductive success, leading to population declines (Liang *et al*., 2023).
4. **Bioaccumulation**: Microplastics can accumulate in fish tissues, potentially transferring to higher trophic levels. When fish ingest microplastics, these particles can become lodged in their tissues and organs. Over time, the accumulation of microplastics can lead to bioaccumulation, where the concentration of microplastics increases within the fish's body. This bioaccumulation can have serious implications for the food web, as predators that consume these fish may also ingest the microplastics, leading to further accumulation and potential health risks for higher trophic levels, including humans (Wootton *et al*., 2021).

D. Effects on Human Health

1. **Consumption of Contaminated Fish**: Humans consuming fish from Kolleru Lake are at risk of ingesting microplastics, which can cause oxidative stress, cytotoxicity, and immune system disruption. When humans consume fish that have ingested microplastics, these particles can enter the human digestive system. Microplastics can induce oxidative stress by generating reactive oxygen species (ROS), which can damage cells and tissues. This oxidative stress can lead to cytotoxicity, where cells are damaged or killed, and can disrupt the immune system, making the body more susceptible to infections and diseases (Fournier *et al*., 2021).

2. Water Contamination: Floodwaters have likely increased the presence of microplastics in drinking water sources, posing additional health risks. During flooding events, microplastics from various sources, such as urban runoff, industrial discharges, and agricultural runoff, can be washed into water bodies that serve as drinking water sources. The presence of microplastics in drinking water can pose health risks, as these particles can be ingested by humans. Potential health effects include gastrointestinal irritation, inflammation, and the potential for microplastics to act as carriers for harmful chemicals and pathogens (Tang *et al*., 2024).

3. Long-term Health Effects: The long-term health effects of microplastic exposure in humans are still being studied, but potential risks include neurotoxicity and the transfer of microplastics to other tissues. Research is ongoing to understand the full extent of the health impacts of chronic exposure to microplastics. Some studies suggest that microplastics can cross biological barriers, such as the gut lining, and enter the bloodstream. Once in the bloodstream, microplastics can potentially reach other tissues and organs, including the brain, where they may cause neurotoxic effects. Additionally, the long-term accumulation of microplastics in the body could lead to chronic inflammation and other health issues (Liu *et al*., 2022).

E. Future Research Directions

Future research should focus on assessing the extent of pollution, evaluating health impacts, and developing mitigation strategies. Detailed studies are needed to quantify the levels of microplastic pollution in the Budameru Drain and Kolleru Lake (Bhan *et al*., 2024). Research should investigate the specific health impacts of microplastic exposure on fish and humans in the region (Tang *et al*., 2024). Effective strategies to reduce microplastic pollution, such as improved waste management and public awareness campaigns, should be developed and implemented (Osman *et al*., 2023).

CONCLUSION

The September 2024 floods have highlighted the urgent need to address microplastic pollution in the Budameru Drain and Kolleru Lake. Protecting these water bodies requires a comprehensive approach involving improved waste management, stricter industrial regulations, and increased public awareness.

Microplastic Pollution Threatens Kolleru Lake

Research warns of a serious threat to Kolleru Lake and its surrounding ecosystems: microplastic pollution. Microplastics, tiny and persistent plastic particles, pose a significant danger to aquatic life and potentially harm human health. The study identifies several sources of microplastic pollution entering the lake via the Budameru Drain. These include urban runoff, industrial discharges, household wastewater, and agricultural runoff. Microplastics wreak havoc on aquatic life. Fish suffer physical harm, oxidative stress, and behavioral changes due to microplastic ingestion. This ultimately impacts their survival and reproduction.The problem doesn't stop there. Humans who consume contaminated fish or drink water potentially containing microplastics face health risks as well. These risks include oxidative stress, cytotoxicity, and immune system disruption. The study underscores the need for further research to fully understand the extent of microplastic pollution, its health impacts, and how to mitigate this growing threat.

RECOMMENDATIONS

Based on the findings and recommendations in the document, I propose the following actions to address the microplastic pollution in Kolleru Lake:

1. **Strengthen Waste Management:** Implement robust waste management systems to reduce plastic waste generation and prevent plastic debris from entering the drainage system.
2. **Promote Sustainable Practices:** Encourage the use of biodegradable and reusable alternatives to plastic products in both household and industrial settings.
3. **Improve Wastewater Treatment:** Upgrade and maintain wastewater treatment facilities to ensure effective removal of microplastics before discharge into the lake.
4. **Monitor and Assess:** Conduct regular monitoring and assessment of microplastic levels in the lake, sediments, and aquatic organisms to track pollution trends and evaluate the effectiveness of mitigation measures.
5. **Public Awareness Campaigns:** Launch public awareness campaigns to educate the local community about the dangers of microplastic pollution and promote responsible plastic consumption habits.
6. **Interdisciplinary Collaboration:** Foster collaboration among government agencies, researchers, NGOs, and local communities to develop and implement comprehensive solutions to address microplastic pollution.
7. **Policy Development:** Implement and enforce strict regulations to control the use and disposal of plastic products, particularly those that contribute to microplastic pollution.

By taking these actions, we can effectively mitigate the impact of microplastic pollution on Kolleru Lake, protect its biodiversity, and safeguard human health.

REFERENCES

1. Bhan, C., Anita, & Kumar, N. (2024). Sources, impacts and distribution of microplastics in different environmental matrices: a review. Environmental Sustainability, 7, 171-180.
2. Bhuyan, M. S., *et al*. (2022). Effects of Microplastics on Fish and in Human Health. *Frontiers in Environmental Science*, 10, 827289.
3. Browne, M. A., *et al*. (2011). Accumulation of microplastic on shorelines worldwide: sources and sinks. Environmental Science & Technology, 45(21), 9175-9179.
4. Cardozo, A. L., *et al*. (2018). Microplastic ingestion by fish in a Neotropical reservoir: Effects of environmental and biological factors. *Environmental Pollution*, 234, 347-355.Cole, M., *et al*. (2011). Microplastics as contaminants in the marine environment: a review. Marine Pollution Bulletin, 62(12), 2588-2597.
5. Duis, K., & Coors, A. (2016). Microplastics in the aquatic and terrestrial environment: sources (with a specific focus on personal care products), fate and effects. Environmental Sciences Europe, 28(1), 2.
6. Fournier, E., *et al*. (2021). Impact of Microplastics in Human Health. *Handbook of Microplastics in the Environment*. Springer.

7. GESAMP (2015). Sources, fate and effects of microplastics in the marine environment: a global assessment. *IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection*, 90.
8. Hurley, R. R., *et al*. (2018). Microplastic contamination of river beds significantly reduced by catchment-wide flooding. *Nature Geoscience*, 11(4), 251-257.
9. Hurley, R. R., Woodward, J. C., & Rothwell, J. J. (2018). Microplastic contamination of river beds significantly reduced by catchment-wide flooding. Nature Geoscience, 11(4), 251-257.
10. Kole, P. J., Löhr, A. J., Van Belleghem, F. G., & Ragas, A. M. (2017). Wear and tear of tyres: A stealthy source of microplastics in the environment. International Journal of Environmental Research and Public Health, 14(10), 1265.
11. Lebreton, L. C., *et al*. (2017). River plastic emissions to the world's oceans. Nature Communications, 8, 15611. : Allen, S., Allen, D., Phoenix, V. R., Le Roux, G., Durántez Jiménez, P., Simonneau, A., … & Galop, D. (2019). Atmospheric transport and deposition of microplastics in a remote mountain catchment. Nature Geoscience, 12(5), 339-344.
12. Lebreton, L. C., *et al*. (2017). River plastic emissions to the world's oceans. Nature Communications, 8, 15611.
13. Liang, Y., *et al*. (2023). Effects of microplastics, pesticides and nano-materials on fish health. *Frontiers in Physiology*, 14, 1217666.
14. Liu, G., *et al*. (2022). Food chain microplastics contamination and impact on human health: a review. *Environmental Chemistry Letters*, 20, 1034-1052.
15. Lusher, A. L., Hollman, P. C., & Mendoza-Hill, J. J. (2017). Microplastics in fisheries and aquaculture: status of knowledge on their occurrence and implications for aquatic organisms and food safety. FAO Fisheries and Aquaculture Technical Paper, 615.
16. Napper, I. E., & Thompson, R. C. (2016). Release of synthetic microplastic plastic fibres from domestic washing machines: Effects of fabric type and washing conditions. Marine Pollution Bulletin, 112(1-2), 39-45.
17. Osman, A. I., *et al*. (2023). Microplastic sources, formation, toxicity and remediation: a review. Environmental Chemistry Letters, 21, 2129-2169.
18. Prata, J. C. (2018). Airborne microplastics: Consequences to human health? Environmental Pollution, 234, 115-126.
19. Rao, K. S., & Rao, K. V. (2010). Kolleru Lake is a Ramsar site in India. *Wetlands*, 30(5), 1017-1026.
20. Rillig, M. C., Ziersch, L., & Hempel, S. (2017). Microplastic transport in soil by earthworms. Scientific Reports, 7(1), 1362.
21. Smith, M., Love, D. C., Rochman, C. M., & Neff, R. A. (2018). Microplastics in seafood and the implications for human health. Current Environmental Health Reports, 5(3), 375-386.
22. Tang, K. H. D., *et al*. (2024). Health risk of human exposure to microplastics: a review. *Environmental Chemistry Letters*, 22, 1155-1183.
23. Thompson, R. C., *et al*. (2004). Lost at sea: where is all the plastic? Science, 304(5672), 838.

24. Urban drainage channels as a pathway for microplastics in riverine systems: A case study of Delhi, India | Water Science & Technology | IWA Publishing: Effects of Microplastics on Fish and in Human Health - MDPI: Microplastics in Fish and Fishery Products and Risks for Human Health: A Review | IJERPH
25. Wootton, N., *et al*. (2021). Microplastic in fish – A global synthesis. *Reviews in Fish Biology and Fisheries*, 31, 753-771.
26. Wright, S. L., *et al*. (2013). The physical impacts of microplastics on marine organisms: a review. *Environmental Pollution*, 178, 483-492.
27. Wright, S. L., Thompson, R. C., & Galloway, T. S. (2013). The physical impacts of microplastics on marine organisms: a review. Environmental Pollution, 178, 483-492.
28. Rochman, C. M., *et al*. (2013). Ingested plastic transfers hazardous chemicals to fish and induces hepatic stress. Scientific Reports, 3, 3263.