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Study on Qualitative and Quantative Analysis of Micro Plastics in Sediment Profile and Its Concentration in Inland Aquatic Systems of Ranchi

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Abstract

In this study, the concentration, type and color of Micro Plastics (MPs) in the sediment profile of multiple inland water bodies across Ranchi was investigated. The totals of 4260 micro plastic particles in 400 gram sample taken from the different points were noted. The Concentration of MPs in the sediment of three different water bodies was about 100 to 150 particles per m2. Standard operation protocols set by National Oceanic and Atmospheric Administration (NOAA) were employed to carry out the experiment. Fibers were the predominant type of MPs in the sediment profile. The most common size was of 2 to 3 mm in the sediment. The dominant color of detected MPs in sediment was red, black and blue. Rayon, polyethylene and polyester were the major polymer types of selected particles. Kanke Dam showed most contamination as compared to Rukka Dam and Hatia Dam. This information may ease in adding our knowledge regarding Micro plastic pollution in inland freshwater ecosystem and provides a future monitoring and assessment of MPs in the inland aquatic system of Ranchi.

Keywords: Aquatic body; Fibres; Micro plastic; Polyester; Sediments

Introduction

Micro plastics are tiny pieces of plastic with a size ranging from 1 Nanometer to 5 millimetres, and they can be found in various forms such as fragments, fibres, and micro beads.These micro plastics are not only present in marine environments but also in freshwater systems, including rivers, lakes, and dams. The widespread use of plastic and the inadequate disposal and management of plastic waste have led to the contamination of freshwater systems with micro plastics. The accumulation of micro plastics in freshwater ecosystems can have adverse effects on aquatic organisms, human health, and the overall functioning of the ecosystem. In this article, we will discuss the issue of micro plastic pollution in freshwater systems, with a focus on theKanke Dam, Rukka Dam, and Hatia Dam Jharkhand, India. Micro plastic pollution has emerged as a significant environmental concern worldwide, with growing evidence of its impact on aquatic ecosystems and human health. The study aims to assess and compare the levels of micro plastic pollution in three prominent dams in Ranchi, Jharkhand, namely Kanke Dam, Rukka Dam, and HatiaDam by employing a systematic sampling approach to collect water and sediment samples from designated sites within each dam, followed by laboratory analysis to quantify and characterize micro plastic particles. The field sampling was conducted at multiple time points to capture seasonal variations and potential factors influencing micro plastic distribution. Water samples were filtered to isolate micro plastic particles, which are subsequently categorized based on their morphology and polymer composition using microscopic and fluorescent techniques. Micro plastic pollution in freshwater ecosystems is crucial due to its potential impacts on aquatic life and human health. In recent years, research has shown that micro plastics are ingested by aquatic organisms, leading to various adverse effects on their health and behaviour. Additionally, there are concerns about the potential transfer of micro plastics through the food chain, ultimately affecting human health. The sources, distribution, and abundance of micro plastics in freshwater ecosystems are vital for developing effective management and mitigation strategies. Micro plastics pollution in freshwater systems can be attributed to various sources such as industrial effluents, agricultural runoff, and domestic wastewater. These micro plastics can enter the water bodies through direct release or indirectly through sewage treatment plants. Once in the water, they can persist for a long time due to their resistance to degradation, and they can be transported over long distances, leading to their widespread distribution. Micro plastics can have detrimental effects on aquatic organisms, including fish, invertebrates, and plankton. These micro plastics can be mistaken for food by these organisms, leading to ingestion and subsequent health issues. The ingestion of micro plastics can cause physical damage to the digestive system, blockage of the digestive tract, and transfer of toxic chemicals to the organism. A study conducted by in the Kanke Ram River in India found micro plastics in the gut of freshwater fish, indicating the potential for ingestion and accumulation of micro plastics in aquatic organisms. Moreover, micro plastics can also have indirect effects on the overall functioning of freshwater ecosystems. They can alter the physical and chemical properties of the water, affecting the growth and survival of aquatic plants and animals. The accumulation of micro plastics on the surface of the water can also reduce the amount of light penetrating the water, leading to a decrease in photosynthesis and primary production. This can have cascading effects on the entire food chain, ultimately impacting the functioning of the ecosystem. Previous Studies on Micro plastics Pollution in Kanke Ram, Rukka Dam, and HatiaDam There have been several studies conducted on micro plastics pollution in freshwater systems in India, with a focus on the Kanke Ram, Rukka Dam, and HatiaDam. A study by Kumar et al. in the Kanke Ram River found high levels of micro plastics, with an average of 25 particles per liter of water. The study also found that the majority of the micro plastics were in the form of fibers, and they were mainly composed

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of polyester and acrylic polymers. These polymers are commonly used in the textile industry, indicating the potential source of micro plastics pollution in the river. In the Rukka Dam, a study by Radha et al. Found micro plastics contamination in the sediment samples, with a concentration of 289.8 micro plastics per kilogram of sediment. The study also identified different types of micro plastics, including polyethylene, polypropylene, and polystyrene. These micro plastic are commonly used in packaging materials, indicating the potential source of contamination in the dam. Similarly, a study by Kaur et al. in the HatiaDam found micro plastics contamination in the sediment samples, with a concentration of 215.7micro plastics per kilogram of sediment. The study also found that fibres were the most abundant type of micro plastics, and they were mainly composed of polyester and nylon. These materials are commonly used in clothing and textiles, indicating the potential source of micro plastics pollution in the dam. The studies conducted in these three freshwater systems highlight the widespread contamination of micro plastics and the potential sources of pollution. The presence of micro plastics in the sediment samples also indicates the potential for long-term accumulation and persistence in these ecosystems [1-4].

Material and method

Study area

For The analysis for micro plastics in the sediment of three dams located in Ranchi, Jharkhand - Kanke Dam, Rukka Dam, and HatiaDam were selected in accordance international SOP by NOAA (Figure 1).

Figure 1: Showing the locations of different sites from where the samples were collected from respective three Dams (Kanke, Rukka and Hatia) of Ranchi.

Sampling

The first step in the analysis of microplastics in the sediment of the three dams is the collection of samples. The sampling locations should be chosen carefully, considering factors such as water currents, sediment deposition, and presence of potential sources of microplastics. In this case, the sampling locations would be near the dam walls, in areas with slow-moving water, and where there is a high possibility of sediment accumulation.

The sampling equipment required includes a sediment corer, a sieve with a mesh size of 0.2mm, and a container for collecting the sediment samples. The sediment corer should be inserted into the sediment at least 10-15cm deep to ensure an adequate sample size. The collected sediment should be transferred to the container and labelled with the sampling location, date, and time (Figure 2).

Figure 2: Showing the laboratory analysis and estimation of different MPs particles in Lab.

Sample preparation

Once the sediment samples are collected, they need to be prepared for analysis. The first step in sample preparation is to remove any macroplastics, such as plastic bags or bottles, from the sample. Then, the sediment needs to be air-dried to remove excess moisture. After drying, the sediment should be sieved through the 0.2mm mesh size sieve to separate the microplastics from the larger particles [5-7].

Identification of micro plastics

The separated microplastics are then ready for identification. However, due to the small size of microplastics, they are not visible to the naked eye. Therefore, a stereo microscope with a magnification of 10-40X is required for their identification. The microscope should be equipped with a light source and a camera to capture images of the microplastics for further analysi.

The identification of microplastics can be done following two methods - visual identification and chemical analysis. In visual identification, the characteristics of microplastics, such as shape, colour, and texture, are observed to determine their type. On the other hand, chemical analysis involves treating the microplastics with specific chemicals to differentiate them based on their chemical composition. The most common chemicals used for this purpose is Nile Red.

Counting and data analysis

After the identification of microplastics, the next step is to count them and analyse the data. The microscope images of the microplastics can be used to count the number of particles in each sample. However, since microplastics are present in large numbers, it is impractical to count every single particle. Therefore, a representative sub-sample size is selected, and the microplastics are counted in this sub-sample. The total number of microplastics is then estimated based on this sub-sample size.

The data obtained from the microplastic analysis is then analysed to determine the types and sizes of microplastics present in the sediment. This data can also be compared with previous studies or data from other dams to understand the level of microplastic pollution in these dams.

Quality control

To ensure the accuracy of the results, quality control measures were implemented throughout the analysis process. This includes using clean and sterile equipment, following standard operating procedures, and replicating the analysis with a different sub-sample to check for consistency in results [8-10].

Reporting

The final step in the analysis of microplastics in the sediment of the three dams is reporting the results. The report included the sampling locations, date and time of sampling, sample preparation methods, identification and counting techniques, and data analysis. The report also duly provides a detailed analysis of the types and sizes of microplastics found and their potential sources. The results should be presented in graphs and tables for better understanding. Recommendations for the management and mitigation of microplastics in the dams should also be included in the report.

Results

The study investigated the concentration, types, and colors of Micro Plastics (MPs) in the sediment profiles of Kanke Dam, Rukka Dam, and Hatia Dam in Ranchi, Jharkhand. The average concentrations of MPs varied among the dams, with Kanke Dam showing the highest contamination levels compared to Rukka and Hatia Dam. Specifically, the average concentration ranged from 100 to 120 particles per m^2 of sediment acrossRukka and Hatia Dam but the MPs concentration in Kanke Dam ranges upto 170 to 190 particles per m^2.

Types and sizes of MPs

Types: Fibres were identified as the predominant type of MPs in the sediment profiles of all three dams. These fibres are commonly derived from textiles and likely enter the freshwater systems through various wastewater streams.

Sizes: The most common size range of MPs found in the sediment was approximately 2 to 3 mm, indicating that larger particles tend to accumulate and persist in the sediments of aquatic body (Table 1 and Figure 3).

Colours and polymer types

Colours: The dominant colours of MPs detected in the sediment under microscopic view were red, black, and blue, suggesting a diverse source of plastic debris entering the dams.

Polymer types: The major polymer types identified in the MPs includesthe various fibrous and thread like structure of MPs which may constitute polyester, nylon etc. which are widely used in textile manufacturing and packaging industries.

Apart from these the fragment of different sizes of MPs were identified under microscope as given below (Figure 4).

Discussion and conclusion

The findings and the laboratory analysis of the different size and particles of the MPs of respective three Dams emphasises the fact that the Dams experiences the heavy stress by various anthropogenic activities of the Ranchi city results in widespread presence of micro plastics in these three Dams. The study reveals the fact that due to emergence of different anthropogenic waste of different nature deteriorates the physico-chemiccal characteristics of the water of three Dams. It was also found that the different sizes , their colour and nature of the MPs in the sediments gives a concrete idea about the characteristics of different MPs inland freshwater ecosystems, highlighting Kanke Dam

Table 1: Showing the overall Micro-plastic particles in the sediments of respective three Dams of Ranchi city.

Sample collected from different locations of Dam	No. of MPs particles in sediments of Kanke Dam	No. Of MPs particles insedimentsof Rukka Dam	No. Of MPs particles in sediments of Hatia Dam
A1	220	159	120
A2	160	140	100
BI	200	138	150
B2	180	100	135
C1	120	120	130
C2	120	110	110
D1	100	140	180
D2	114	160	160
E1	121	139	130
E2	180	134	190
TOTAL	**1515**	**1340**	**1405**

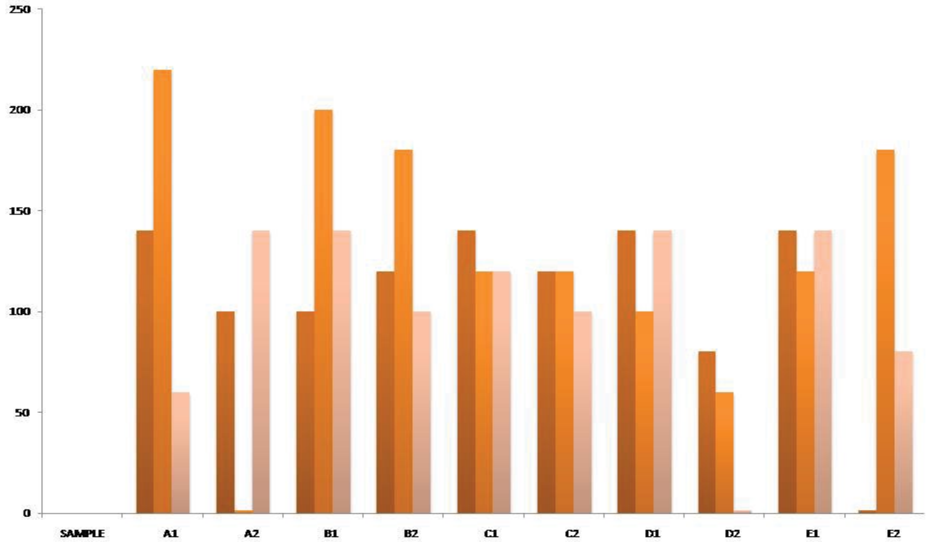

Figure 3: A graph showing the overall concentration of micro-plastics in the sediments of three respective Dams of Ranchi city.

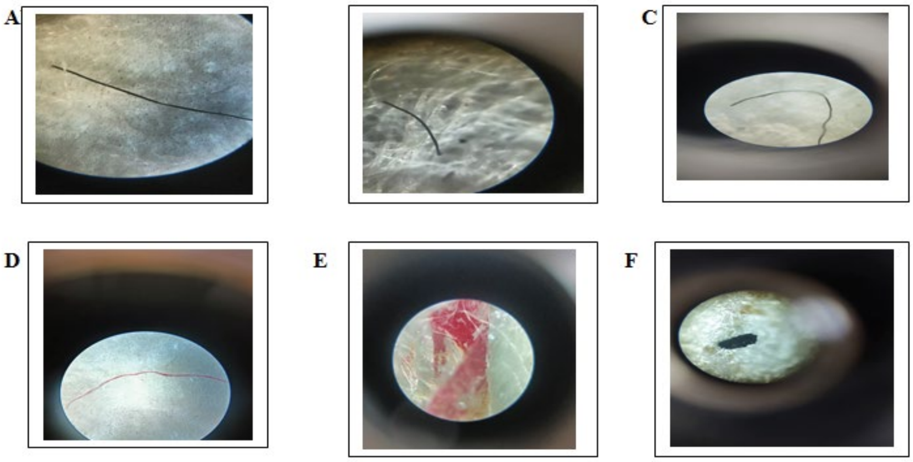

Figure 4: Fibres and fragments of micro plastics in sediments.

as particularly vulnerable to contamination. The higher concentration of MPs in Kanke Dam compared to Rukka and Hatia Dam could be attributed to several factors, including differences in upstream sources of pollution, hydrological characteristics, and sedimentation rates.

Implications of micro plastics pollution

Micro plastics pollution in freshwater ecosystems poses significant ecological and potential human health risks.

The ingestion of MPs by aquatic organisms can lead to physical harm, digestive blockages, and the transfer of toxic chemicals. Furthermore, the persistence of MPs in sediments can alter the physical and chemical properties of water bodies, affecting ecosystem dynamics and biodiversity.

Comparative analysis with previous studies

Previous studies in the Kanke Ram River, Rukka Dam, and Hatia Dam have also reported significant levels of micro plastics contamination in both water and sediment samples. These studies align with our findings, emphasizing the persistent nature of micro plastics pollution in these freshwater systems and the need for continuous monitoring and mitigation efforts.

Limitations and future directions

Despite employing rigorous sampling and analysis techniques, the study is not without limitations. The focus on sediment samples provides insights into long-term accumulation but may not fully capture seasonal variations or dynamics in micro plastics distribution. Future research should consider expanding the study to include water column analysis and more comprehensive spatial and temporal sampling.

In conclusion, the study contributes valuable insights into the prevalence and characteristics of micro plastics pollution in inland freshwater ecosystems of Ranchi, Jharkhand. The findings highlight the urgent need for enhanced monitoring and management strategies to mitigate the impacts of micro plastics on aquatic organisms and ecosystem health. By understanding the types, concentrations, and sources of MPs, stakeholders can develop targeted interventions to reduce plastic pollution at its source and safeguard freshwater resources for future generations. The data presented in this study serve as a baseline for further research and policy development aimed at preserving the integrity of inland aquatic systems amidst growing environmental challenges posed by plastic contamination.

References

1. Laden F, Schwartz J, Speizer F, Dockery D (2006) Reduction in fine particulate air pollution and mortality – extended follow-up of the Harvard six cities study. Am J Respir Crit Care Med 173: 667-672.
2. Kunzli N, Jerrett M, Mack W, Beckerman B, Labree L, et al. (2005) Ambient air pollution and atherosclerosis in Los Angeles. Environ. Health Perspect 113: 201-206.
3. He C, Morawska L, Hitchins J, Gilbert D (2004) Contribution from indoor sources to particle number and massconcentrations in residential houses. Atmos Environ 38: 3405-3415.
4. Dobbin NA, Sun L, Wallace L, Kulka R, You H, et al. (2018) The benefit of kitchen exhaust fan use after cooking - An experimental assessment. Build Environ 135: 286-296.
5. Kang K, Kim H, Kim DD, Lee YG, Kim T (2019) Characteristics of cooking-generated PM10 and PM2.5 in residential buildings with different cooking and ventilation types. Sci Total Environ 668: 56-66.
6. Sun L, Wallace LA, Dobbin NA, You H, Kulka R, et al. (2018) Effect of venting range hood flow rate on size-resolved ultrafine particle concentrations from gas stove cooking. Aerosol Sci. Tech. 52: 1370-1381.
7. Rim D, Wallace LA, Nabinger S, Persily A (2012) Reduction of exposure to ultrafine particles by kitchen exhaust hoods: The effects of exhaust flow rates, particle size, and burner position. Sci Total Environ. 432: 350-56.
8. Singer BC, Pass RZ, Delp WW, Lorenzetti DM, Maddalena RL (2017) Pollutant concentrations and emission rates from natural gas cooking burners without and with range hood exhaust in nine California homes. Build Environ. 43: 3235-3242.
9. WHO (2005) Air Quality Guidelines - Global update 2005.
10. Kim H, Kang K, Kim T (2018) Measurement of particulate matter (PM2.5) and health risk assessment of cooking-generated particles in the kitchen and living rooms of apartment houses. Sustainability 10: 843.