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Tracing of Microplastic Footprints in the Narod River, Natore, Bangladesh

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Abstract

Microplastic contamination causes a remarkable threat to aquatic ecosystems and biodiversity worldwide. Narod Rivers in Natore, Bangladesh, is also threatened by microplastic pollution, which is a vital water source for the local population, industrial discharge, agricultural runoff, and urban waste. This study aims to recognize the concentration of microplastics in the Narod River. Water samples were strategically collected from five sampling locations along the river to comprehensively assess pollution sources such as industrial discharge and densely populated areas. The separation of microplastics was conducted by using Nitric Acid (68%) and filtering the sample with a filter paper. A digital microscope was employed to identify microplastic concentrations. The study revealed that the concentrations of microplastics in the Narod River were 13.8±3.27 particles/L. These findings indicate that the Narod River has a significant amount of microplastic presence. The presence of microplastics in such concentrations represents a serious environmental concern, especially to the surrounding community. Therefore, this research underscores the urgent need for monitoring and mitigation strategies to address microplastic contamination in the region.

Keywords: *Microplastic, Narod River, Water pollution, River pollution.*

1 Introduction

Plastic pollution is an enduring global issue, with the primary answers signifying its impact on the living and non-living mechanisms of the situation, courting backbone for more than a half-century. Plastics are commonly utilized as materials for everyday items due to their characteristics (Thompson et al., 2017). Worldwide plastic manufacture has more than quadrupled since 2000, reaching over 460 million tons in 2019. Due to the extensive practise of plastic in everyday items, it is anticipated that global plastic production will triple by 2025 (Bellasi et al., 2020). Consequently, throughout the past 60 years, there has been a significant growth in the manufacture of plastics (Hopewell et al., 2009). When particle size is < 5 mm and ≥ 1 µm, it signifies a newly identified synthetic plastic pollutant (microplastics to nanoplastics) that requires urgent consideration (Thompson et al., 2004).

There are two main causes of microplastics in the environment, which produce plastic particles of different sizes: the primary source and the secondary source. It is challenging, if non unbearable, to identify the precise source of microplastics present. The primary sources for microplastics are paint, sludge from toilets, washer wastewater, plastic track surfaces in schools, synthetic grass, rubber roads in local governments, plastic pellets, microbead-containing personal care products, and tire wear. Agricultural film, fishing rubbish, city plastic bags and bottles, and other important plastic wastes are proof of secondary sources in the interim. Vehicle tire damage is believed to be one of the most significant bases for ecological microplastics since the number of cars on the road is increasing quickly (An et al., 2020).

Bangladesh, one of Asia's fastest developing and most densely populated countries with over 166 million people in 130,170 km², has seen financial growth determined by development and industrial development (Hossain et al., 2021a). Over the past 20 years, the country's capacity to produce plastic has grown drastically (Hossain, 2016). Per capita plastic ingestion went up drastically from 2.07 kilogrammes in 2005 to 4.5 kilogrammes in 2014 due to the country's unintended financial development (Mourshed et al., 2017). Insufficient infrastructure, resources, and funding for waste management guide to unsuitable plastic management strategies (Ramírez, 2022). As microplastics become a significant area of interest in modern days, many researchers work on this.

In Bangladesh, surface water becomes polluted when effluent from residential, commercial, and industrial locations mixes with it. Plastic waste is also mixed with this effluent, which leads to microplastic pollution that is carried into the river water and hinders biodiversity (Islam et al., 2022). Recently, in Bangladesh, two studies have been directed to find the occurrence of microplastics in the Padma River water, the Jamuna River water, the Turag River Water, the Karnaphuli River Water, the Balu River water, the Rupsha River and the water of different lakes in Dhaka city (Khan et al., 2023). It was reported that microplastic was found at 36 items/L, 33 items/L, and 19 items/L in the superficial waters of Hatir Jheel, Dhanmondi Lake, and Gulshan Lake, respectively (Fariha et al., 2023).

Natore, a historical city in northwestern Bangladesh, is home to the Narod River, a small but vital waterway that flows right through the middle of the city. For years now, the area has been struggling with recurring droughts. However, alongside water scarcity, water pollution has become a serious issue, especially in the part of the river that runs through the city. Narod River, which stretches about 15 kilometres, is now heavily polluted due to a mix of industrial waste, chemicals from nearby farms, and garbage from residential areas. Factories often release untreated wastewater filled with harmful chemicals. At the same time, fertilizers and pesticides from farmlands wash into the river during rains, adding to the damage (Nur-E-Alam et al., 2016). Because the river doesn't flow strongly, pollutants tend to build up over time, making the situation even worse for the environment and the creatures that live in the water. While many researchers have studied different aspects of the Narod's water quality, one major issue still needs more attention: microplastic pollution. This research aims to trace the microplastic footprints in the Narod River.

2 Methodology

2.1 Study Area

The sampling locations were strategically designated lengthways the course of the Narod River through Natore (approximately located at 24.4206° N, 88.9632° E) to capture an accurate representation of differences in water quality between upstream and downstream areas. The sites were evenly spaced and included locations near known sources of pollution, such as residential neighbourhoods, commercial zones, and areas with direct human contact and waste disposal. Distinct attention was given to choosing sites that are affected by human actions, confirming that the presence and spreading of microplastics could be accurately assessed concerning local pollution sources. Availability and safety were also key factors in the selection process, ensuring that data collection could be conducted efficiently while prioritising the well-being of the research team. The following figure 1 shows the study area using Google Earth.

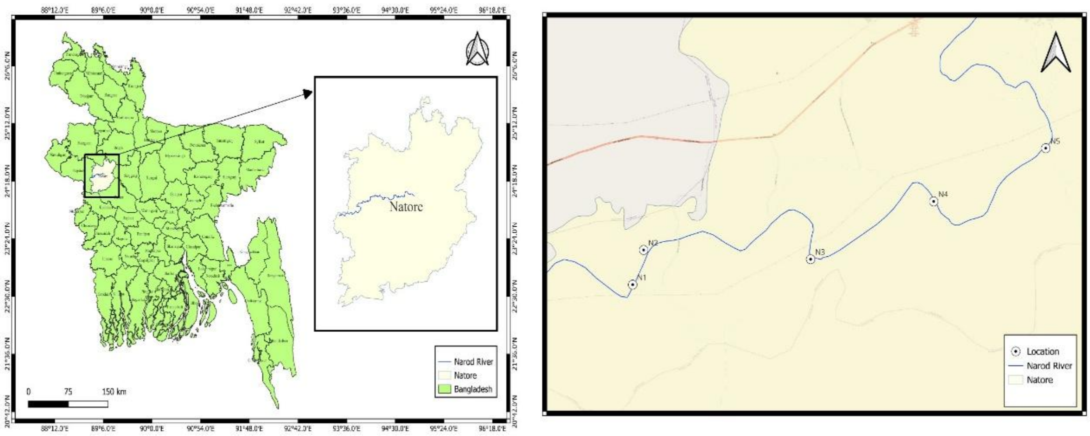

Figure 1: Study Area.

2.2 Sampling

The Rapid Sampling of Non-Specific Distance method was used for sampling, as this method is used when fixed-interval sampling isn't practicable due to access, safety, or environmental boundaries (Browne et al, 2011). The coordinates of the sampling point are shown in Table 1.

2.2.1 Sample Collection

While conducting this study in April 2025, samples were taken from 5 different points of the Narod River. Every point had a distance of approximately 2 km from the other. While collecting the sample, the time and name of the point with a note of that point were kept using GPS. All samples were collected during the daytime. Plastic bottles were used for the sample collection as per Figure 2. During the sample collection, precautions were taken to prevent further contamination of microplastics.

Table 1: Water Sampling Point for Microplastics.

Sampling Point	Coordinate
N-1	24°21'18"N 88°53'03"E
N-2	24°21'33"N 88°53'49"E
N-3	24°21'29"N 88°54'24"E
N-4	24°21'54"N 88°55'20"E
N-5	24°22'17"N 88°56'11"E

(a)

(b)

Figure 2: Water Sample Collection for Microplastic Identification.

2.2.2 Sample Preparation:

Several studies have shown that microplastic separation can be achieved through chemical digestion. It can be either acid digestion or another chemical digestion method (Tirkey et al., 2021). For chemical digestion, 30% concentrated H_2O_2 (Hydrogen Peroxide) is an efficient chemical. For acid digestion, HCl and HNO3 can both be used to dissolve the living ingredients present in the water sample. In microplastic analysis investigations, it has been shown that HNO3 is the most effective substance for acid breakdown of the biogenic chemicals contained in the sample. However, because HCl distorts the surface of polyethene terephthalate and polyvinyl chloride, it is not highly preferred (Ali et al., 2017). Here, the separation of microplastics from the water sample was done by using 65% concentrated HNO_3 (Nitric Acid) (Scherer et al., 2020). Fifty millilitres of concentrated nitric acid (65%) was added to a sample that included 1000 millilitres of water in 2000 millilitres beakers. For seven days, the sample was left at 25°C. Then, the samples were filtered using a 0.45 µm nylon filter paper. The filter papers were left to air dry for a full day to be further examined in glass Petri dishes.

2.2.3 Detection of Microplastic & Data Analysis

Microplastic data were physically counted through visual examination using a Digital USB Microscope with 1600x zoom. The outcomes were then analysed and systematised using Microsoft Excel for further clarification and reporting purposes.

3 Results & Discussion

3.1 Microplastic Source & Abundance

Table 2 presents the probable sources of microplastic pollution in the Narod River, based on observed local activities. Based on the visual observation and manual counting, a large number of fiber-shaped microplastics existed in the aquatic sample of Narod River, Natore. Figure 3 shows the concentration of microplastics present in the water sample. The amount of microplastics found in different water samples was in the range of 9-18 particles/L. The average amount of microplastic in Narod River was 13 particles/L.

Table 2: Probable Sources of Microplastic Pollution

Sampling Point	Source
N-1	Market Waste
N-2	Household Waste
N-3	Household Waste
N-4	Household Waste.
N-5	Household and Market Waste.

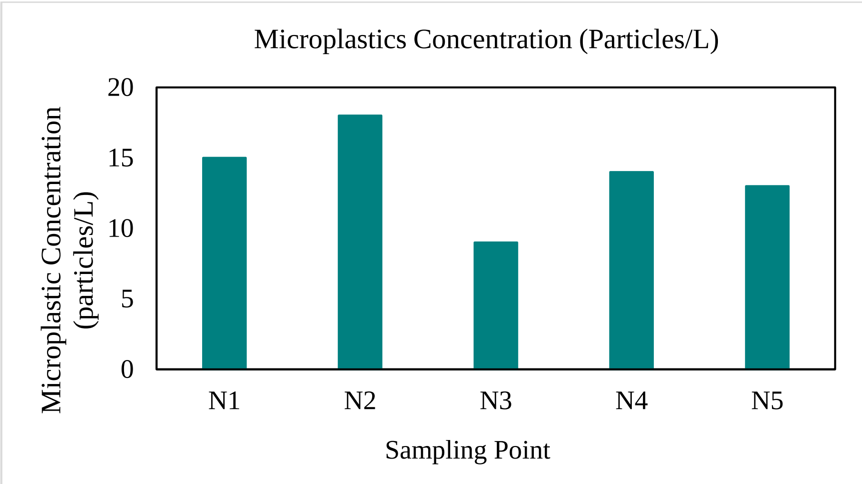

Figure 3: Microplastic Concentration

Here, the maximum concentration of microplastic was found in sampling location N2. The location is situated in Dastanabad Moddhopara. A large number of houses and a local market surrounded the sampling point. Every day, waste from the houses and market shops was thrown into the river. The waste contaminated the river water, and they are the main cause of microplastics in the Narod River. Again, the minimum concentration of microplastic was present in sample N3, where the only source of microplastic was the household waste.

Figure 4 provides a detailed visual representation of the different types of microplastics detected in the water sample, mainly fragments and fibers. Each type was identified through microscopic analysis, highlighting the variety and presence of microplastic contaminants in the Narod River.

(a)

(b)

Figure 4: Microplastics' different shapes found by using the Microscope; (a) Fragment, (b) Fiber

3.3 Impact of Microplastics

The detected microplastic concentrations at five sampling points (N1-N5) were 15, 18, 9, 14, and 13 items/L, respectively, indicating a widespread contamination throughout the Narod River. The presence of microplastics in this river is a serious concern as their carriage poses a threat to both aquatic ecosystems and human health.

Aquatic species frequently ingest microplastics, mistaking them for food, which can cause internal injuries, false satiation, nutrient deprivation, and reproductive impairments (Lusher et al., 2013). Furthermore, microplastics act as carriers of dangerous substances that can concentrate in aquatic organisms through the food chain, ultimately affecting humans (Ragusa et al., 2021). Human exposure to microplastics primarily through contaminated water and aquatic food sources has been related to cellular irritation, hormone disturbance, and oxidative stress (Cox et al., 2019). These health implications underscore the growing concern surrounding microplastic pollution in freshwater systems. A related study by Islam et al. (2022) on the Buriganga River in Bangladesh found microplastic concentrations ranging from 4.33 to 43.7 items/L, which is consistent with the findings in the Narod River, highlighting the broader issue of microplastic contamination in Bangladesh's urban rivers. The evidence points to an urgent need for improved waste management particles, strict control of industrial discharge, and enhanced public awareness to safeguard both ecological and human health.

4 Conclusion

This study provides clear evidence of significant microplastic contamination in the Narod River, with measured concentrations ranging from 9 to 18 particles per litre and an average of 13.8 particles per litre. The highest concentrations were observed near densely populated residential and market zones, suggesting a strong correlation between human activity and microplastic pollution. The prevalence of fiber-shaped microplastics indicates that domestic wastewater, textile residues, and synthetic fibers from clothing are major contributors to this pollution.

The environmental implications of such pollution are alarming. Aquatic organisms are at risk of ingesting microplastics, mistaking them for food, which can result in internal damage, starvation, and reproductive disorders. Additionally, microplastics are known to absorb and transport toxic contaminants, which can be collected through the aquatic food web, eventually posing serious health risks to humans. Potential health concerns include hormonal disturbance, oxidative anxiety, and irritation.

To mitigate this environmental uprising hazard, immediate and coordinated actions are essential. These include the implementation of efficient waste management systems, strict enforcement of environmental regulations regarding industrial and domestic effluent discharge, community-based education programs, and comprehensive policy reforms aimed at reducing plastic consumption and promoting sustainable practices. The findings from this study emphasize the need for continuous monitoring and proactive mitigation strategies to address microplastic pollution in the Narod River and beyond.

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