MICROPLASTICS IN THE GANGA

MEASURING AND DEVELOPING COUNTERMEASURES FOR MICROPLASTICS

COUNTERMEASURE PROJECT
SUPPORTED BY UNITED NATIONS ENVIRONMENT PROGRAMME

Counter MEASURE FOR PLASTIC FREE RIVERS

From the People of Japan

NATIONAL PRODUCTIVITY COUNCIL

iFOREST INTERNATIONAL FORUM FOR ENVIRONMENT, SUSTAINABILITY & TECHNOLOGY

About CounterMEASURE

The CounterMEASURE project has been funded by the Ministry of Foreign Affairs (MOFA), Government of Japan, and executed by the United Nations Environment Programme (UNEP) and its partners. The CounterMEASURE project works to identify sources and pathways of plastic pollution in river systems in Asia, particularly the Mekong and the Ganges. The project has developed plastic leakage models for localities in 6 different countries using an innovative and replicable approach. Deploying technologies like GIS, machine learning and drones has allowed the CounterMEASURE team to augment ground-level research in an efficient and scalable way. This scientific knowledge can then be used to inform policy decisions and actions to beat plastic pollution and ensure rivers are free of plastic waste.

To learn more about the CounterMEASURE project, please refer to https://countermeasure.asia/about/

Technical briefs in this series:

1. Microplastics in the Ganga: Measuring and developing countermeasures for microplastics
2. Macroplastic pollution in the Ganga: A citizen science approach to measure and map macroplastics
3. Countermeasures for plastic leakage: Identifying and mapping hotspots along the Ganga River
4. From awareness to action: Lessons from the perception survey in cities along the Ganga

Acknowledgment

This technical brief series presents research findings, analysis and policy recommendations from the CounterMEASURE project aiming to examine riverine plastic pollution along river Ganga. The CounterMEASURE project has been funded by the the Ministry of Foreign Affairs (MOFA), Government of Japan, and executed by the United Nations Environment Programme (UNEP) and its partners. This brief was written by Apurupa Gorthi and Chandra Bhushan and designed by Raj Kumar Singh.

Special thanks to the Dr Shukla Pal and team at the National Productivity Council, under Department for Promotion of Industry & Internal Trade, Ministry of Commerce & Industry (Govt. of India) for sharing data and insights from their field work on microplastics and macro-plastics along river Ganga. Thanks to Dr. Mahua Saha and team, CSIR-National Institute of Oceanography for carrying out sampling and analysis of microplastic samples in river Ganga.

About the brief

MICROPLASTICS ARE small-sized particles of plastic, no larger than 5 mm in diameter. While microplastics came to light in the early 2000s as products of plastic degradation, they are also manufactured in the form of beads for use in detergents and personal care products. The all-pervasive use of plastics across sectors and applications has not only made plastic waste in the form of visible plastics abundant but has also increased the quantity of microplastics in the environment. The biggest challenge with microplastics is that once in the environment, it is next to impossible to remove them. Today about 14 million tonnes of microplastics are estimated to have accumulated on the ocean floor, a quantity that is only likely to increase without suitable interventions.[1]

This technical brief delves into the issue of microplastic pollution and its prevalence in the Ganga river. Due to the small size of microplastics, their presence in water, land, and other ecosystems can be underestimated. This brief aims to provide scientific data on microplastic pollution in surface water, water column, and sediment samples across upstream and downstream sites in Agra, Haridwar, Prayagraj, and Patna located along the river Ganga and its major tributary, Yamuna. Microplastic abundance has been determined for dry (non-monsoon) and wet (monsoon) seasons.


Credit: Naja Bertolt Jensen/unsplash.com

Oceans are a major sink for microplastics with an estimated 14 million tonnes already accumulated on the ocean floor

Introduction

THE TERM microplastic was first coined by Thompson et al in 2004 when they found plastic fibres and fragments along beaches in the United Kingdom.[2] Microplastics are small fragments of plastic debris measuring less than 5 mm in diameter.[3,4]

There are two major classifications of microplastics – primary and secondary microplastics.[5]

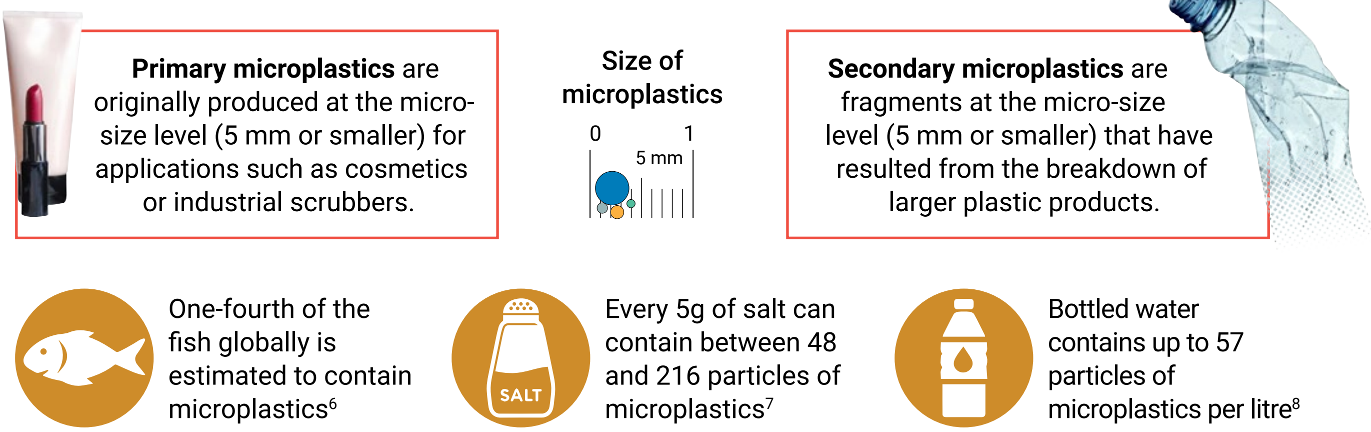

Figure 1: Microplastics in food and water

Source: iFOREST (2022)

Today, microplastics can be found in marine and fresh water sources leading to their presence in fish, salt and bottled water. As a result, humans are susceptible to consumption of microplastics as part of their daily diet.

SOURCES AND PATHWAYS OF MICROPLASTICS

Annually, 1.5 million metric tonnes of primary microplastics are released into the world's oceans *(Figure 2: Global release of microplastic to the world's oceans)*.[9] While mismanaged plastics have the potential to contribute to secondary microplastic release, the sources for primary microplastics are typically synthetic textiles, tyres, city dust and road markings.

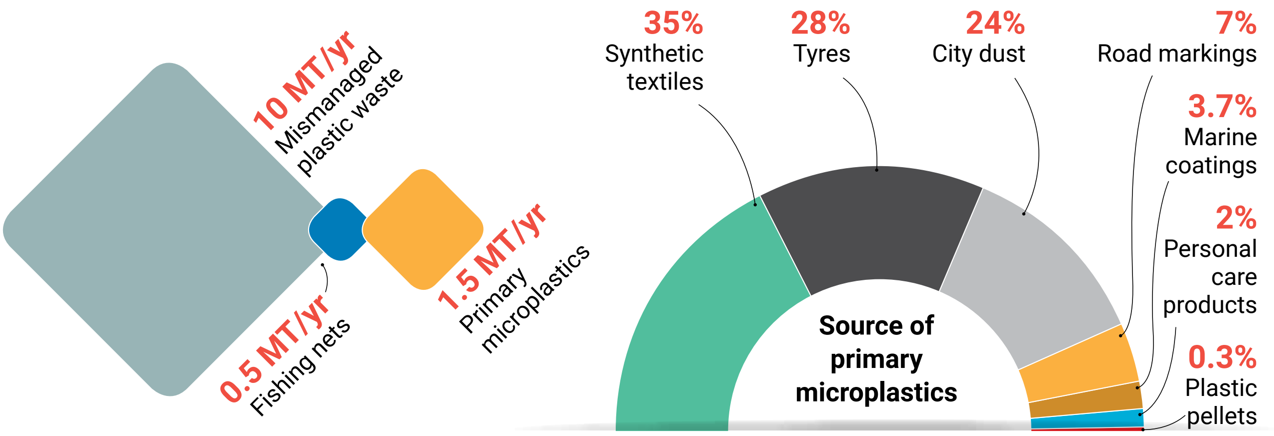

Figure 2: Global release of microplastics to the world's oceans

Source: Based on data from IUCN (2017)

While land-based plastic pollution is the main source of plastics and microplastics, rivers act as highways that carry microplastics from land to the sea. Mismanaged plastic waste, wastewater discharge, and industrial activities from land are the main sources of microplastics in rivers. Once they enter into the oceans, the microplastics interact with the aquatic environment – they float, may be taken up by the biota, get adsorbed onto aquatic flora, or sediment at the bottom of the seabed *(Figure 3: Land to ocean: Microplastic pathways)*.

The challenge with microplastics is that once they are in the environment, it is next to impossible to remove them. Once in the environment, microplastics have been found to bio-accumulate in aquatic fauna with potential impact on their physiological functioning.[10] More recently, studies have found microplastics in human blood stream[11] as well as human lungs[12]. While there is limited understanding on the impact of microplastics on human health, a World Health Organisation (WHO) study in 2019 stated that risks cannot be ruled out.[13]

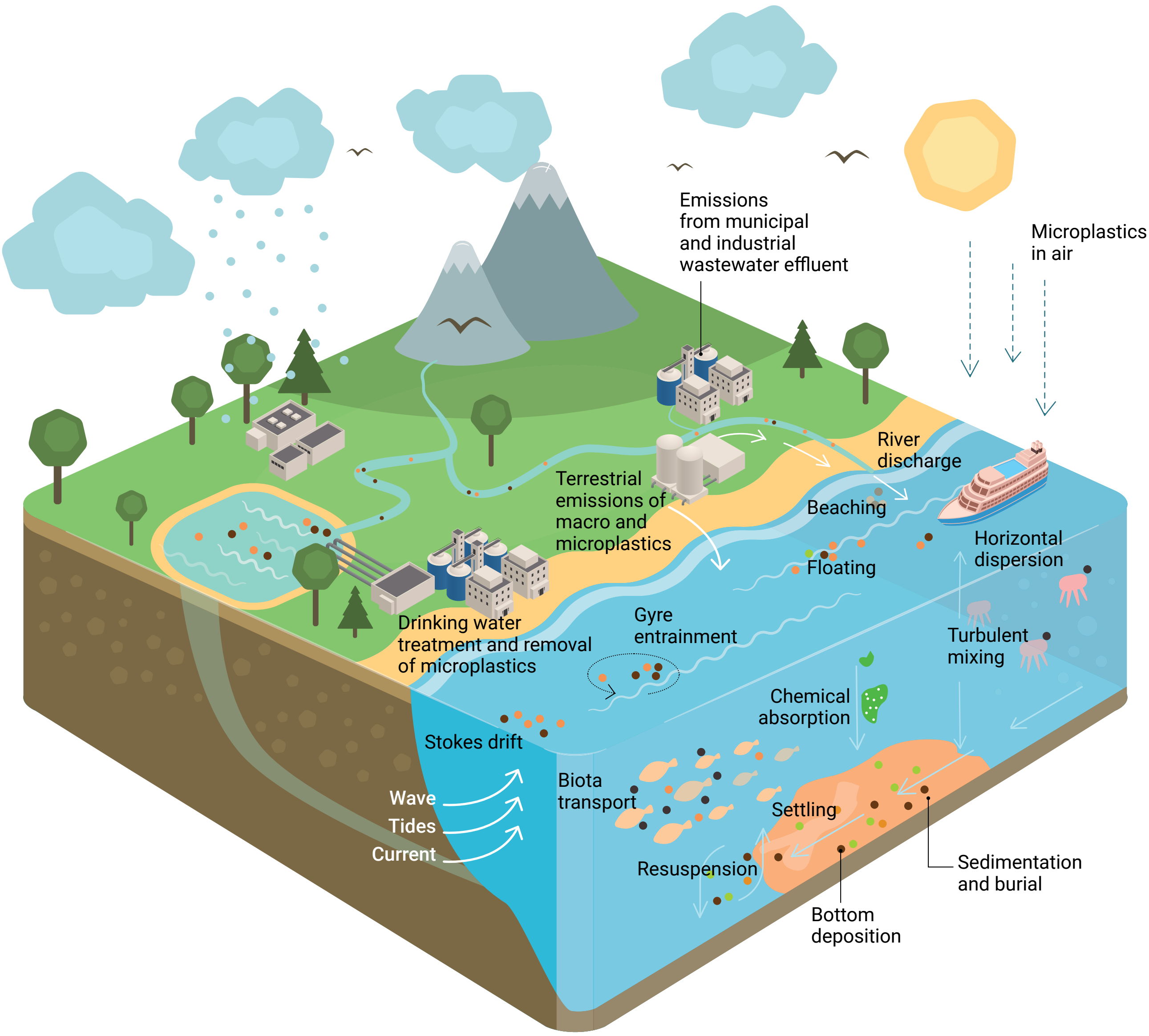

Figure 3: Land to ocean: Microplastic pathways

Source: Modified from Li, Zhang and Tang (2020)

Methodology for measuring microplastics

GIVEN THE role of rivers in carrying and depositing land-based plastics, the CounterMEASURE project focused on identifying sources and pathways of plastic pollution in river Ganga. Measuring microplastic pollution in the Ganga river was a key component of this effort. Surface water, water column and sediment samples were collected in 2021 from Haridwar, Agra, Prayagraj, and Patna, both, for wet (monsoon, August) and dry (non-monsoon, December) seasons. Upstream and downstream sampling sites were identified, and potential sources of pollutants were noted. Surface water samples were collected using *single plankton net* of 300 micro metres mesh size.[14] Water column samples were collected from two different depths of the river using *Niskin water sampler*. The sediment samples were collected with a *Van veen grab sampler*.[15] Samples, thus collected, were used to determine microplastic abundance in surface water, water column, and sediment for each site as well as city-wise averages.

In the laboratory, the samples were passed through various physical and chemical separation methods to remove organic matter and extract microplastics. A stereomicroscope was used to identify the type (bead, fibre, pellets, fragments, films, foams or microbeads) of microplastics and an FTIR (Fourier Transform-Infrared Spectroscopy) was used to determine the different polymer types of microplastics.[16]

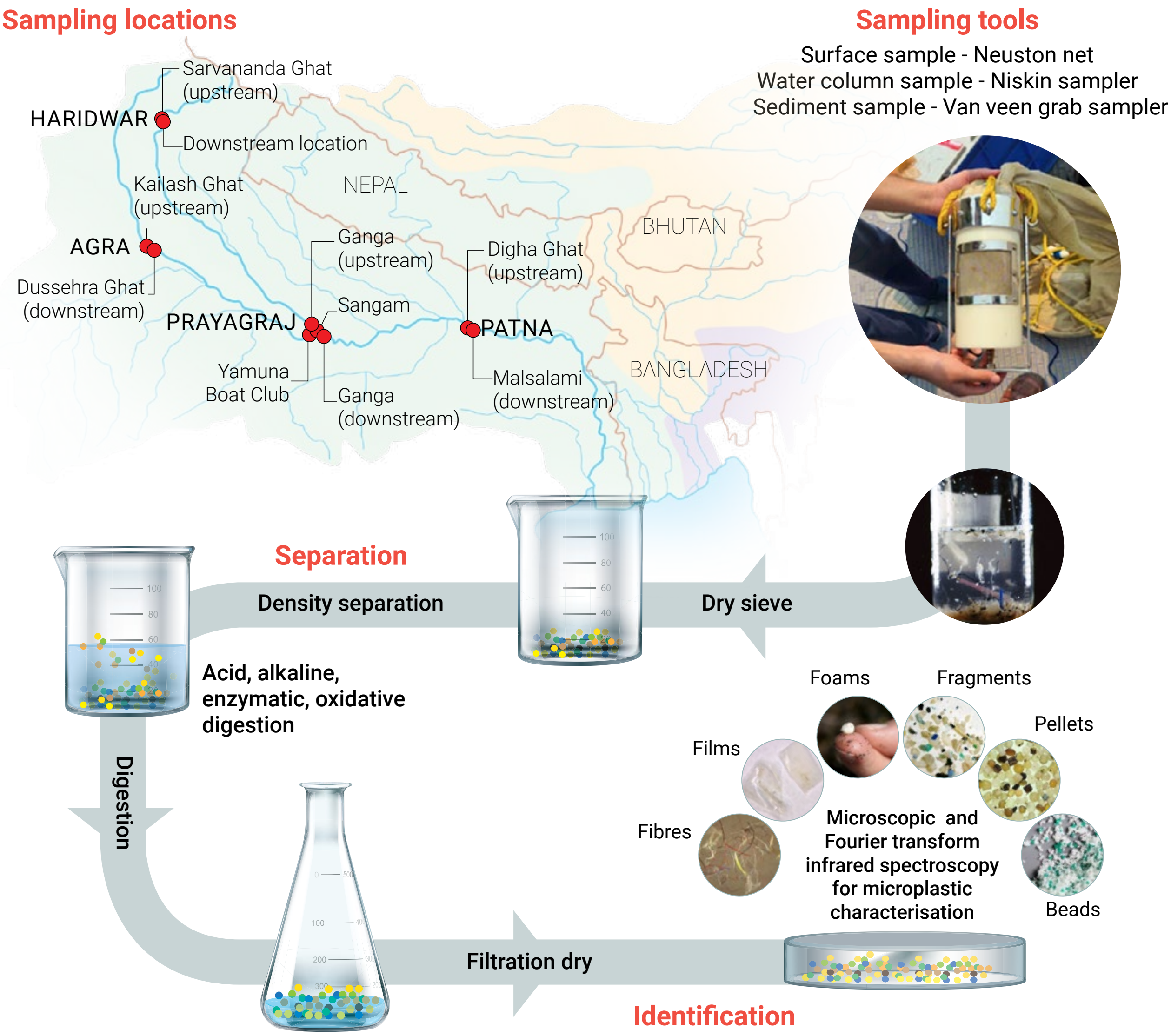

Figure 4: Methodology for measuring microplastics

Source: iFOREST (2022) based on National Productivity Council (2020, 2022).

Insights on microplastic pollution in river Ganga

1 Major sources of microplastics were laundry discharge, road dust, and packaging waste

Primary microplastics are intentionally manufactured at sizes smaller than 5 mm for applications in cosmetics, pharmaceuticals, and household detergents. In Haridwar, Agra, Prayagraj, and Patna, the most common sources of primary microplastics were found to be drains carrying residues from laundry discharge, personal care products, and untreated sewage, all of which ended up in the river.

Analysis on the types of polymers of microplastics in water samples showed that road dust, comprised of tyre abrasion and road marking paints, and packaging waste were a common source of secondary microplastics for all four cities. Small-scale industry sites also contributed to microplastics in some cities. For example, faux leather, textile washing, synthetic rubber industries were sources of microplastics in Agra and Haridwar. For cities like Prayagraj and Patna, plastics used in religious activities such as plastic ornaments, polyester flowers, and multi-layered plastic packets used for religious offerings were found to be a common source of microplastics.[17]

2 Secondary microplastics were more abundant than primary microplastics

Across sites, secondary microplastics – a product of plastic degradation – were more commonly found in surface water samples than primary microplastics such as pellets and beads, fibres, followed by fragments, were the two main types of secondary microplastics, while 12% or less of the surface water samples comprised of film-shaped microplastics. The relative quantity of fragment and film increased in the wet season relative to dry season, while that of fibres decreased.[18] *(see Figure 5: Shape of microplastics in surface water samples (in %))*.

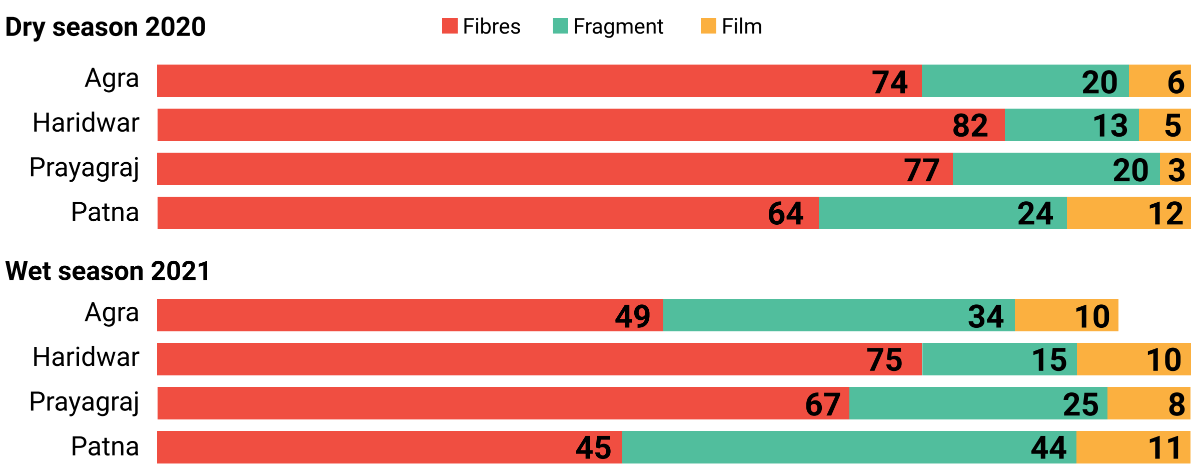

Figure 5: Shape of microplastics in surface water samples (in %)

Source: iFOREST (2022) based on data from National Productivity Council (2022)

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While microplastic abundance in surface water samples for the wet and dry seasons were observed in similar ranges, greater seasonal variation was observed for water column and sediment samples.

Microplastic abundance in surface water samples for wet and dry seasons were observed in similar ranges of 0.003-0.06 particles/m3 and 0.007-0.02 particles/m3, respectively *(see Figure 6: Microplastic abundance in surface water samples)*. The highest microplastic abundance was observed in the wet seasons for Haridwar and Agra, while the lowest values were observed in Prayagraj and Patna.[19]

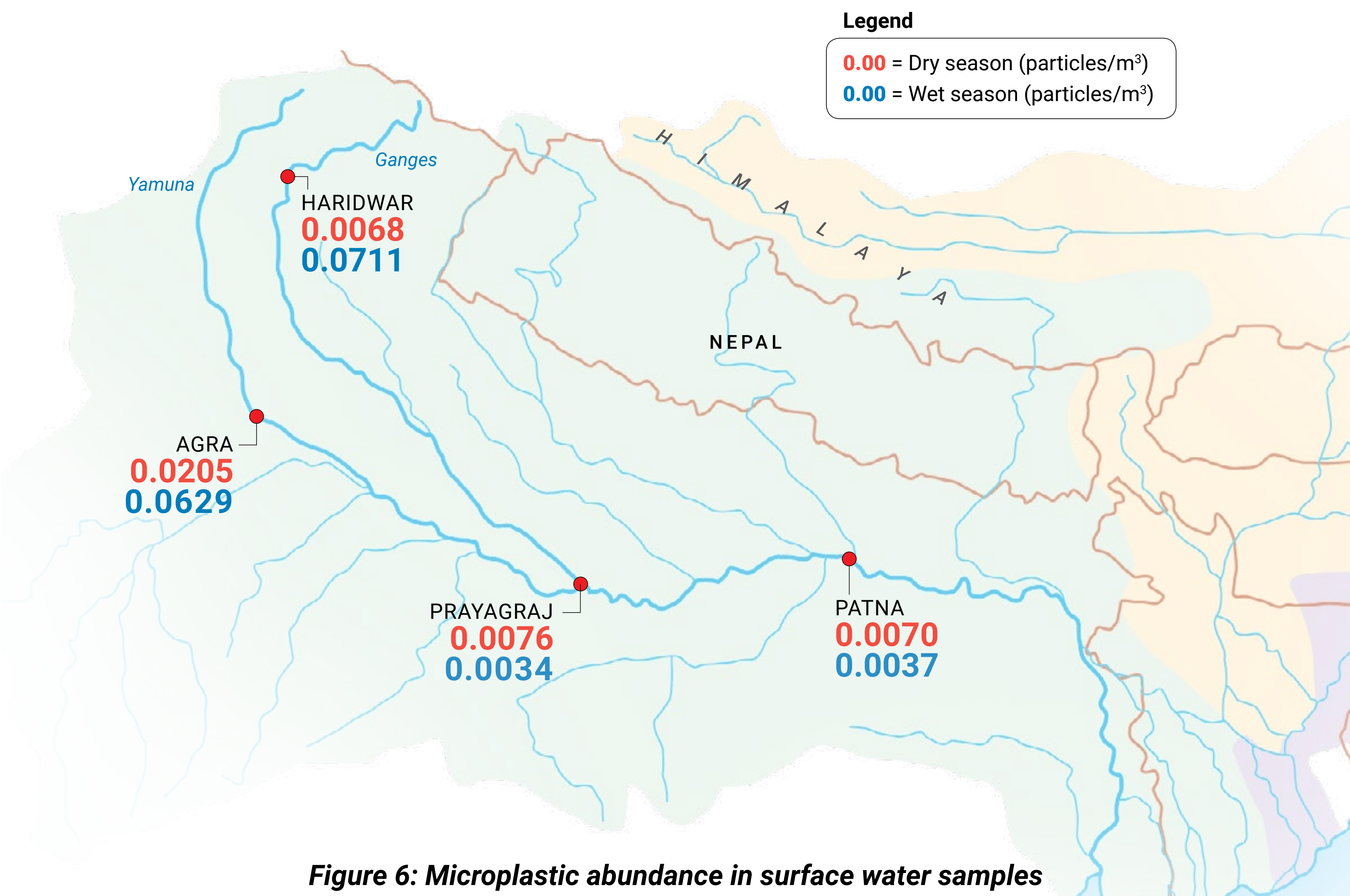

Figure 6: Microplastic abundance in surface water samples

Source: iFOREST (2022) based on data from National Productivity Council (2020) and National Productivity Council (2022)
Note: Microplastic abundance for dry season 2020 is for two sites in Agra and four sites in Prayagraj. For wet season 2021, microplastic abundance data is for each city and not sites.

In comparison, microplastic abundance observed in surface water samples of rivers located in the North and South American regions showed values as low as 0.03 particle/m^3 and typically below 1 particle/m^3.[20,21] Similarly, the microplastics concentration in the English Channel was measured at 0.27 particles/m^3 and 0.28-1.11 particles/m3 along the Beijing River.[22, 23] For water column samples, dry season samples showed higher abundance of microplastics (7.8-26.8 particles/L) than wet season (2.6-11 particles/L) *(see Figure 7: Microplastic abundance in water column samples)*.

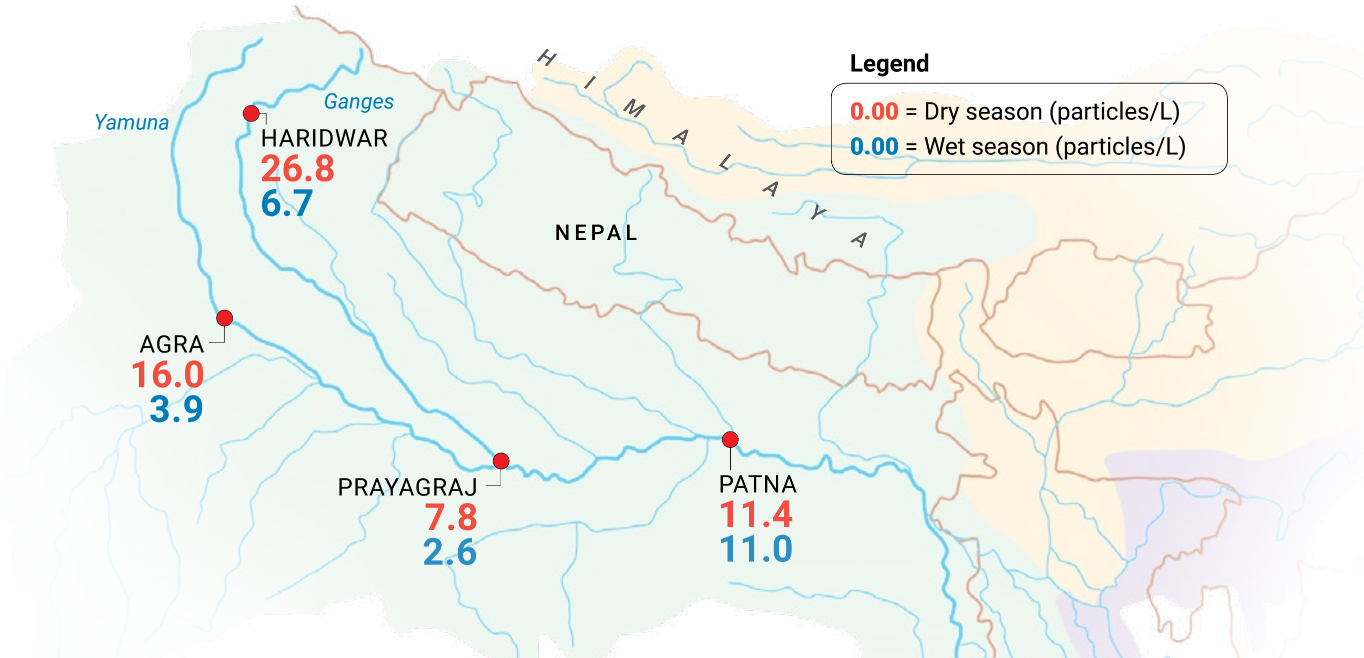

Figure 7: Microplastic abundance in water column samples

Source: iFOREST (2022) based on data from National Productivity Council (2020) and National Productivity Council (2022)
Note: Microplastic abundance for dry season 2020 is for two sites in Agra and four sites in Prayagraj. For wet season 2021, microplastic abundance data is for each city and not sites.

There was an observed increase in microplastics from dry to wet season in all the sites except Patna *(see Figure 8: Microplastic abundance in sediment samples)*. Presence of microplastics in sediment samples were observed to be in the range of 5-24 particles/10g for the dry season and 10-40 particles/10g for the wet season.[24]

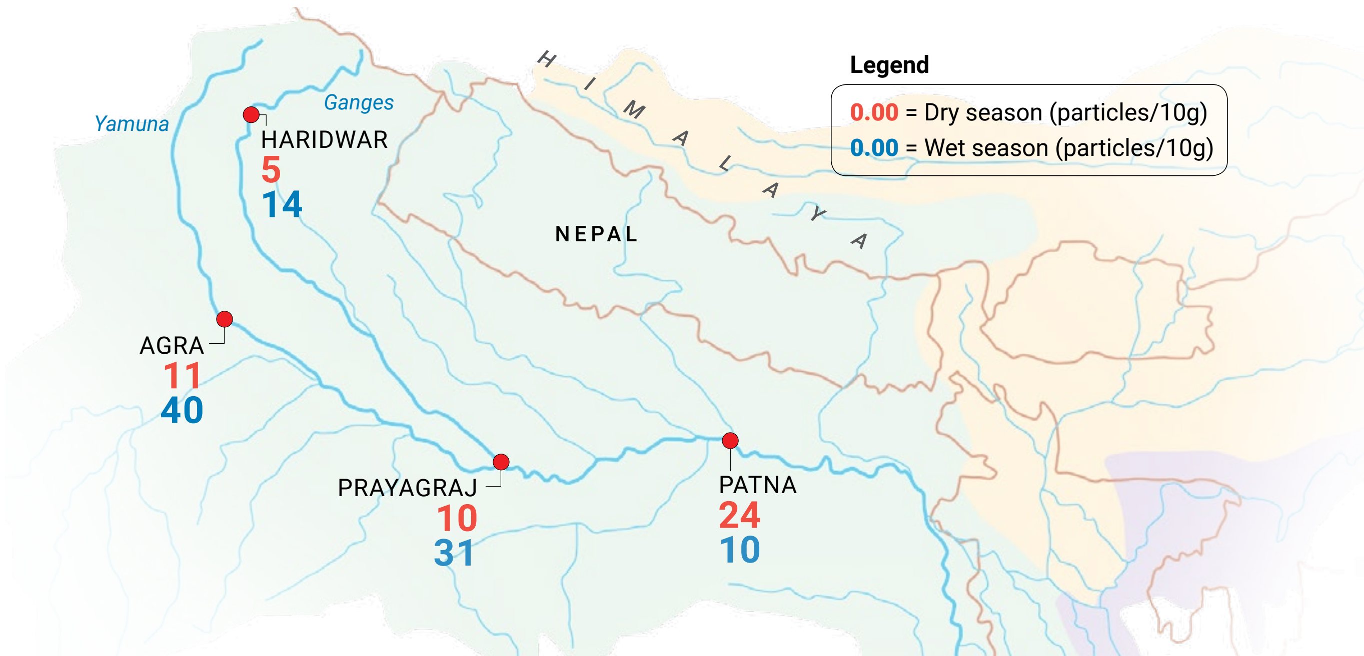

Figure 8: Microplastic abundance in sediment samples

Source: iFOREST (2022) based on data from National Productivity Council (2020) and National Productivity Council (2022)
Note: Microplastic abundance for dry season 2020 is for two sites in Agra and four sites in Prayagraj. For wet season 2021, microplastic abundance data is for each city and not sites.

Recommendations

COUNTERMEASURES FOR MICROPLASTICS

1 Adopt standardised methodology for microplastic assessment

Standardised methodology as described in this brief should be adopted to measure the concentrations of microplastics. The methodology adopted in this brief offers tools and lessons for microplastic assessment, necessary for long-term monitoring.

2 Implement large scale monitoring for microplastics

Data on microplastics is currently sparse and dispersed, necessitating a comprehensive microplastic monitoring plan for water bodies and associated ecosystems including aquatic organisms.

3 Focus on secondary microplastics typically arising from low-value plastics

Secondary microplastics such as fibres or fragments resulting from photodegradation and/or mechanical degradation of low-value plastics were commonly observed in the study samples. Low-value plastics are typically not recycled, thereby leaking into the environment. Efforts to reduce leakage of low-value plastics into the environment needs to be a priority in waste management interventions in these cities.

4 Ban or limit primary microplastics

Primary microplastics, while found in small quantities in this study, have been found to be emitted through laundry effluents and personal care products. These then enter rivers and the ocean through drains in the city. Bans or limits should be placed on the use of primary microplastics.

5 Legislate standards for microplastics

Current rules, such as the Plastic Waste Management Rules of 2016, do not provide for/require monitoring of microplastics. The current study shows microplastic abundance in surface water, water column, and sediment sample for sites from four cities along river Ganga. There is a need to recognise microplastics as a pollutant and develop standards in terms of water quality to limit microplastic pollution in water bodies.

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