MACROPLASTIC POLLUTION IN THE GANGA

A CITIZEN SCIENCE APPROACH TO MEASURE AND MAP MACROPLASTIC POLLUTION

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 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.

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About the brief

MACROPLASTIC POLLUTION arises from large (>20 mm) plastic debris, like plastic water bottles or carry bags, which are commonly found strewn in streets. A common challenge with these large-sized plastics is their utility across sectors leading to large volumes of plastic waste being generated. These plastics, often land-based, find their way into the oceans via rivers and accumulate as marine debris. Marine plastic litter thus piled up has adverse impact on the flora and fauna in aquatic environments. Moreover, macroplastics can disintegrate into small-sized meso-(5-10mm) and micro-(<5mm) plastics with potential impacts on human and ecosystem health.

This technical brief focuses on the prevalence, polymer make-up and sources of macroplastics across sites surveyed in four major cities along river Ganga – Haridwar, Agra, Prayagraj, and Patna. The methodological approach of citizen science was used in macroplastic sampling, which not only makes this assessment replicable but is also a means to create public interest in plastic waste management. Citizens from across cities participated in clean-up drives conducted in 2019-20 and 2021 in sites along the Ganga. The policy recommendations and lessons offered by this brief are grounded in scientific and evidence-based research, bringing together the work of scientists, researchers, field workers, laboratory technicians and policy analysts.


Credit: oceancleanupgroup/ unsplash.com

Indiscriminate use and unscientific disposal of plastics is affecting humans as well as the natural environment.

Introduction

PLASTIC IS deemed a wonder material finding wide application across sectors. However, indiscriminate use and unscientific disposal of plastics is affecting humans as well as the natural environment. Due to its non-biodegradable nature, plastic remains in the environment for a long period of time, first in its original form of large-sized plastic goods, eventually degrading into particulate microplastics. These large-sized plastics (>20mm) are commonly referred to as macroplastics.[1,2]

The detriments of macroplastics are aplenty, including the entanglement risk they pose to marine lifeforms, often with lethal consequences.[3] They are also known to be accidentally ingested by fauna and often found in nesting material.[4,5] Plastic debris pose toxicity risk as they soak hazardous pollutants which are then ingested by organisms that accidentally feed on plastics.[6] In fact, research finds that a single plastic particle can absorb up to 1,000,000 times more toxic chemicals than water.[7] Further, macroplastics degrade in the natural environment into microplastics, which are known to enter food chains and water cycles.

Modelled estimates predict that the Asian rivers, especially those located in urban centres, contribute disproportionately high amounts of plastics into the oceans.[8] While nine Indian rivers contribute to a combined 3.9% of global ocean plastic pollution that comes from the world's largest emitting rivers, the Ganga river was noted to contribute to 0.63% of this total.[9] Having identified the role of rivers in carrying plastic debris from land to the ocean causing marine plastic pollution, the CounterMEASURE II project in India sought to identify the different types of macroplastics found across four major cities located along the Ganga river and its tributary Yamuna. The cities of focus were Haridwar, Agra, Prayagraj, and Patna.

Citizen science

Plastic litter and its management is a challenge due to its volume and its high spatial distribution. In addition to strong policies, plastic waste management requires citizen involvement and interest. Further, even though plastic waste is everywhere, there is a limited scientific understanding of types of plastic waste, polymers, sources of plastic waste, and their impacts.

The Federal Community of Crowdsourcing and Citizen Science of the Indonesian federal government describes citizen science as a ‘scientific process’[11]. It identifies the benefits of citizen science as: “Citizen science encourages members of the public to voluntarily participate in the scientific process. Whether by asking questions, making observations, conducting experiments, collecting data, or developing low-cost technologies and open-source code, members of the public can advance scientific knowledge and benefit society.”

Citizen science as an approach for crowdsourcing data was used as early as in 1890 by the US government’s National Oceanic and Atmospheric Administration (NOAA) in their National Weather Service Cooperative Observer Program (COOP). To this day, as a part of the program, citizen volunteers across the country collect and report data used in forecast models.

Three key benefits of citizen science have been noted as follows:[12]

1. It is cost-effective and alleviates some of the logistical and financial constraints in collecting large volumes of data.
2. It is well-suited to investigate environmental issues which occur over broad spatial or extended temporal scales by involving the basic skills of the public.
3. It is an excellent approach for public policy as it can raise awareness, create opportunities for discourse, and encourage citizens to actively engage in understanding the issue and finding solutions.

Methodology for macroplastic assessment

IN THIS assessment, the National Productivity Council (NPC) designed a citizen science approach, which included reconnaissance survey, visual inspection, and clean-up drives along selected sites for sampling macroplastics. The clean-up drives brought together students, residents and local non-profits to sites littered with plastic with the goal to collect macroplastics while simultaneously aiding in the cleaning up of the site. The types of data outputs were the percentage of total plastic quantity from each city and site, polymer type, and likely sources of the plastic waste.

1 Site identification

Sites prone to plastic pollution along the river Ganga and its major tributary Yamuna spread across four cities (Haridwar, Agra, Prayagraj, and Patna) were identified for this analysis. Data was collected in 2019-20 and 2021. Data for 2021 was collected for both wet (monsoon, July-August) and dry seasons (non-monsoon).

2 Area demarcation for clean-up site

The clean-up site area was determined with the goal to collect the most representative data on macroplastics. The GPS coordinates of the four corners of the clean-up site were recorded. A record of the site in the form of photographs prior to the clean-up was taken.

3 Registration and orientation of the volunteers

A temporary registration counter was set up to register and inform volunteers of the protocols for the macroplastic collection.

A standard set of protocols were developed for carrying out the clean-up drives. The steps involved were as follows:[13]

(1) Collecting macroplastics,

(2) Segregation *(based on categories identified in Figure 2: Categories of plastic)*, and

(3) Safety precautions.

The same instructions were converted into posters that were displayed on-site.

4 Collection and waste segregation

Volunteers were divided into two teams — one for collection, and the other for segregation. A gunny bag was provided to each volunteer for collecting the waste at the site. Each gunny bag was assigned an identification number and was weighed before and after the waste collection. Collection sites were created to place collected waste for segregation. At the collection sites, the collected waste was segregated as per the plastic classification trash data sheet provided to the volunteers *(see Figure 2: Categories of plastic)*. Each category of plastic was counted and weighed. A datasheet was used to keep a record of the total number of plastic items and their total weight. As a final step, the collected and segregated waste was handed over to the local municipality.

Figure 1: Step-by-step methodology for macroplastic assessment

Source: iFOREST (2022)

Figure 2: Categories of plastics

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

Insights on macroplastic waste in Ganga cities

1 Plastic constituted about half of the waste in cleanup sites with plastic litter density values of up to 10.5 counts/m^2

Data from the clean-up drives across Agra, Haridwar, Prayagraj, and Patna was used to determine quantities of plastic waste in terms of percentage of plastic in total waste and plastic litter density (counts/m^2) at different sites *(see Figure 3: Macroplastic litter density across sites along river Ganga)*. The figure below depicts the data for nine sites across Agra, Haridwar, Prayagraj and Patna. In 2020 over 50% of the waste sampled at the selected sites comprised of plastic waste.[14] In 2021, plastic litter density ranged between ~2.2 and 4.95 counts/m^2 for the wet season and 0.91 and 10.5 counts/m^2 for the dry season.[15]

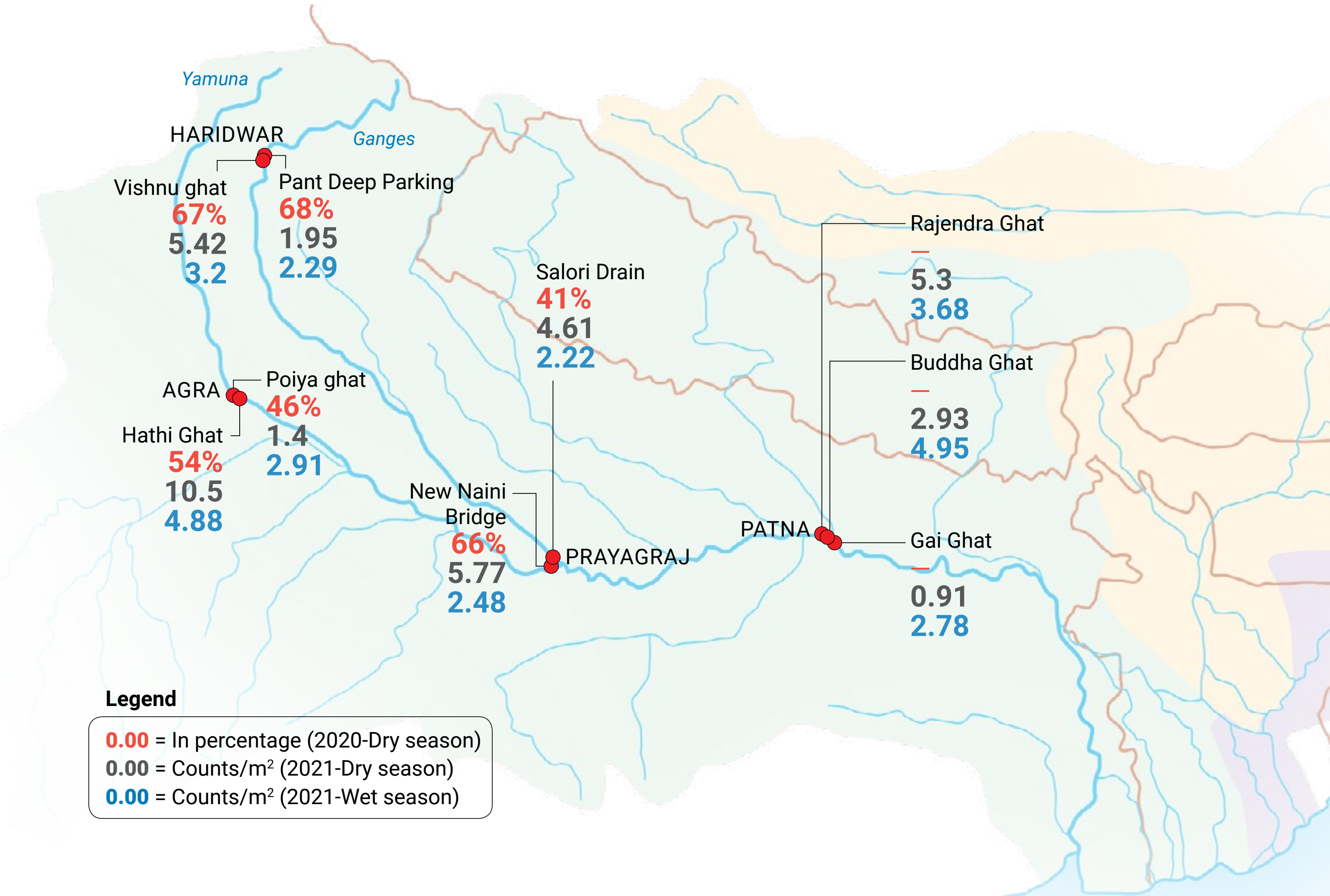

Figure 3: Macroplastic litter density across sites along river Ganga

Source: iFOREST (2022) based on data from National Productivity Council (2020) and National Productivity Council (2022)

2 The major sources of mismanaged plastics were markets, industry, and residential areas

Sources of mismanaged plastics based on land-use did not vary by a lot from city to city. The most common sites for mismanaged plastics were markets, households (including slums), and industry (including cottage industry such as faux leather, synthetic rubber and textile washing) as shown in *Figure 4: Major sources of mismanaged plastics*.[16]

Despite the COVID-19 pandemic, an insignificant contribution of biomedical waste and waste from COVID-19 quarantine centres was observed across the the sites surveyed in the four cities.

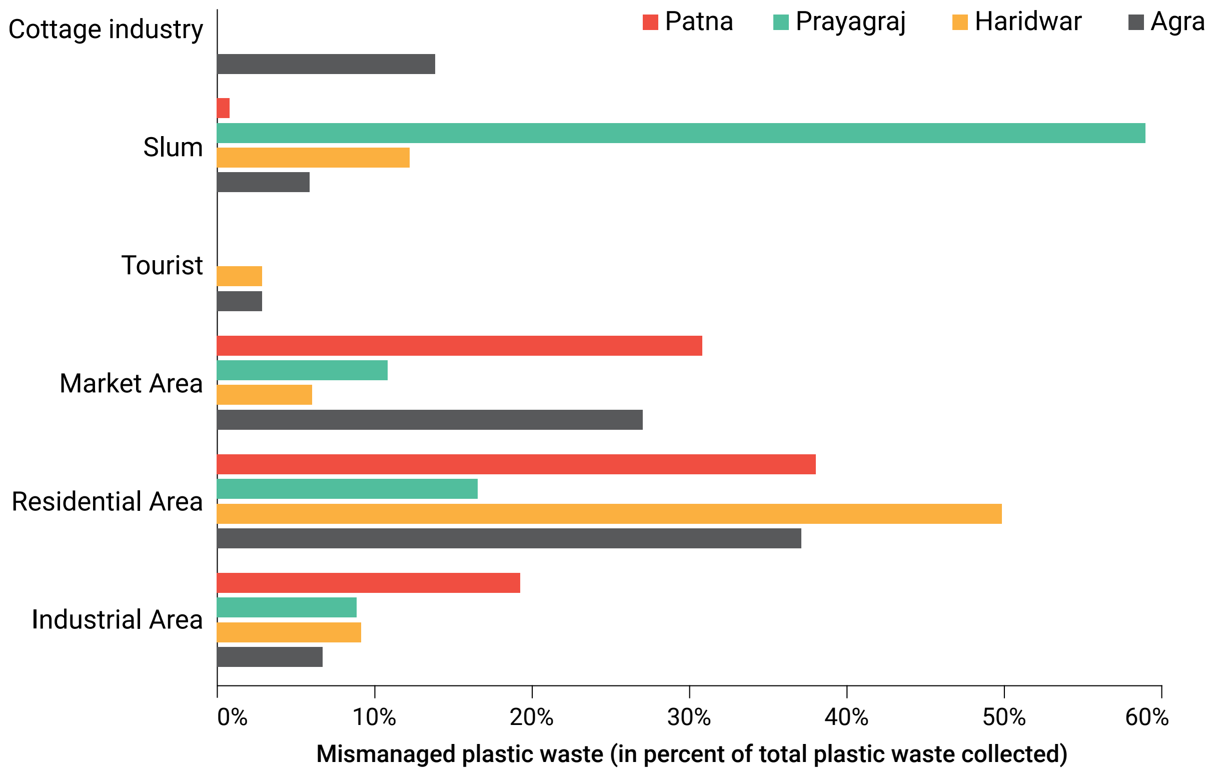

Figure 4: Major sources of mismanaged plastics

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

3 Low-value plastics like LDPE & MLP were the most common type of plastic waste

Analysis of data from the clean-up drives provided insights on the different types of plastics found in waste. Interestingly, while some categories of plastic waste were seen across all four cities, some were unique to each city as depicted in *Figure 5: Plastic waste categories found in sites across the four cities*.

A key finding here was that polyethene carry bags (typically LDPE) and MLPs were the most common types of plastic waste across all cities. Plastic products such as plastic coated single-use utensils, milk packets, and single use plastic utensils were also common across cities. Thus, dominant polymer types observed in the waste were MLP, HDPE, LDPE, and PP.

Plastic waste unique to each city was traced back to socio-economic activities observed in the city. For example, in Agra synthetic leather was a major type of plastic waste due to the leather cottage industry in the city. In Patna, a significant amount of disposable cutlery was found strewn across major drains passing through market areas.[17]

UNIQUE TO CITIES

Agra	Haridwar	Prayagraj	Patna
Synthetic leather, ritual related waste, rubber sheet	MLP sheets, silver foil	Nylon sacks, thermocol, medical bottles, PET bottles, monolayer packaging, surgical mask, disposable plates (rejects from industry)	HDPE carry bag, food trays, wrapping paper, thermocol, gift wraps, medicine packaging, synthetic clothes

COMMON ACROSS CITIES

Agra | Haridwar | Prayagraj | Patna

Polythene carry bags, MLPs- large & small (e.g. snack bags and tobacco sachets), plastic coated single-use utensils, milk packets, boxes, single-use plastic utensils

Figure 5: Plastic waste categories found in sites across the four cities

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

Credit: National Productivity Council (2020)

Plastic waste segregation is essential to a successful waste management system.

Recommendations

COUNTERMEASURES FOR MACROPLASTIC POLLUTION

1 Promote waste segregation at source as a best practice

In 2019-20, plastic waste constituted an average of 41-68% of the total waste collected across Agra, Haridwar, and Prayagraj. Plastic waste thus constitutes a significant type of waste in cities necessitating immediate interventions such as source segregation.

2 Identify typical land-use for plastic litter

Marketplaces, residential areas, and industries were dominant sites for high plastic litter density. Mapping of plastics gave insights for prioritisation and monitoring of the geographical area of the city vis a vis type and dominance of plastics becoming waste. Thus, mapping land-use and its relationship to the type of plastic litter can be a valuable strategy in limiting plastic pollution in cities.

3 Implement extended producer responsibility for low-value plastics

The most common plastic uses across all cities were low-value plastics such as sachets, snack packets, polyethene bags, plastic pouches, disposable plastic glasses, pipes, and bottles. Thus, dominant polymer types in plastic waste were MLP, HDPE, LDPE, and PP. Interventions such as extended producer responsibility should target such low-value plastics for collection and recycling.

4 Adopt citizen science for city clean-up drives

Given the wide-spread challenge of mismanaged plastics, and lack of capacity in urban local bodies, involvement of citizens is essential. Citizen science is an important tool in this regard and should be widely to generate data and increase awareness.

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