COUNTERMEASURES FOR PLASTIC LEAKAGE

IDENTIFYING AND MAPPING HOTSPOTS ALONG THE GANGA RIVER

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.

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 (Govt. of India) for sharing data and insights from their field work on macroplastics and macro-plastics along river Ganga.

About the brief

THE UBIQUITOUS use of plastic has resulted in its accumulation on land and in the sea, which poses a huge challenge as plastic is non-biodegradable. While it is possible to keep plastic in the value chain by recycling it, there are roadblocks. Many low-value plastic products, like carry bags and sachets, are often discarded as they are not fit for reuse and are rarely recycled. These low-value plastics exit the plastic value chain and accumulate in sites commonly referred to as '*hotspots*'. Once in the hotspot, plastic waste leaks into land, water, and sea ecosystems resulting in plastic pollution.

A key strategy in mitigating plastic pollution involves identifying hotspots and plugging leakages. Thus hotspot mapping is of importance because it identifies sources and causes for leakage of plastic waste, thereby assisting in creating a robust waste management system.

The three key elements of identifying and mapping a hotspot are:

(1) Determining the type of polymer that is leaking.

(2) Identifying the source of the leak.

(3) Examining the reason behind the leak.

Understanding plastic leakage through these three key elements can help design targeted interventions and identify optimal regulatory instruments to curb plastic pollution.

In this technical brief, leakage pathways, hotspots and the types of plastic waste found in cities along the Ganga river - Agra, Haridwar, Patna, and Prayagraj have been examined. The policy recommendations and lessons offered by this brief are grounded in scientific and evidence-based research, attempting to solve the issue of plastic leakage and in turn address riverine plastic pollution and marine plastic litter.

Hotspots are sites from which plastic leakage is most likely to occur due to mismanaged plastic waste generation and high drainage densities due to topography.

Introduction

PLASTIC HAS long been hailed for the convenience and commerce it offers at a scale unknown previously to humankind. Given the ubiquitous presence of plastics in everything from food packaging to clothing, combined with inefficient waste management system, large-scale plastic pollution on land and in the sea is a reality we live with today.

A key aspect to reckon with is that most discarded plastics do not find their way back into the value chain for reuse or recycling and thus end up leaking out into the environment. Worldwide, only 9% of all plastic ever produced has been recycled; while 12% has been incinerated, the remaining 79% has accumulated in landfills, dumps or in the natural environment.[1] Plastics exiting the value chain could be attributed to lack of a recycling infrastructure and high dependence on single-use plastics. Once they exit the value chain, plastics accumulate on land, along roads, in pastures, open fields, along riverbeds, in drains and eventually in the ocean. One analysis estimates the annual flow of plastic into the ocean will nearly triple by 2040, which is equivalent to 50 kg of plastic for every metre of coastline worldwide.[2]

The challenge with plastic leakage is that it can occur via a variety of pathways (land, water, air) and for a variety of plastics (microplastics, macroplastics) as detailed in the schematic below.

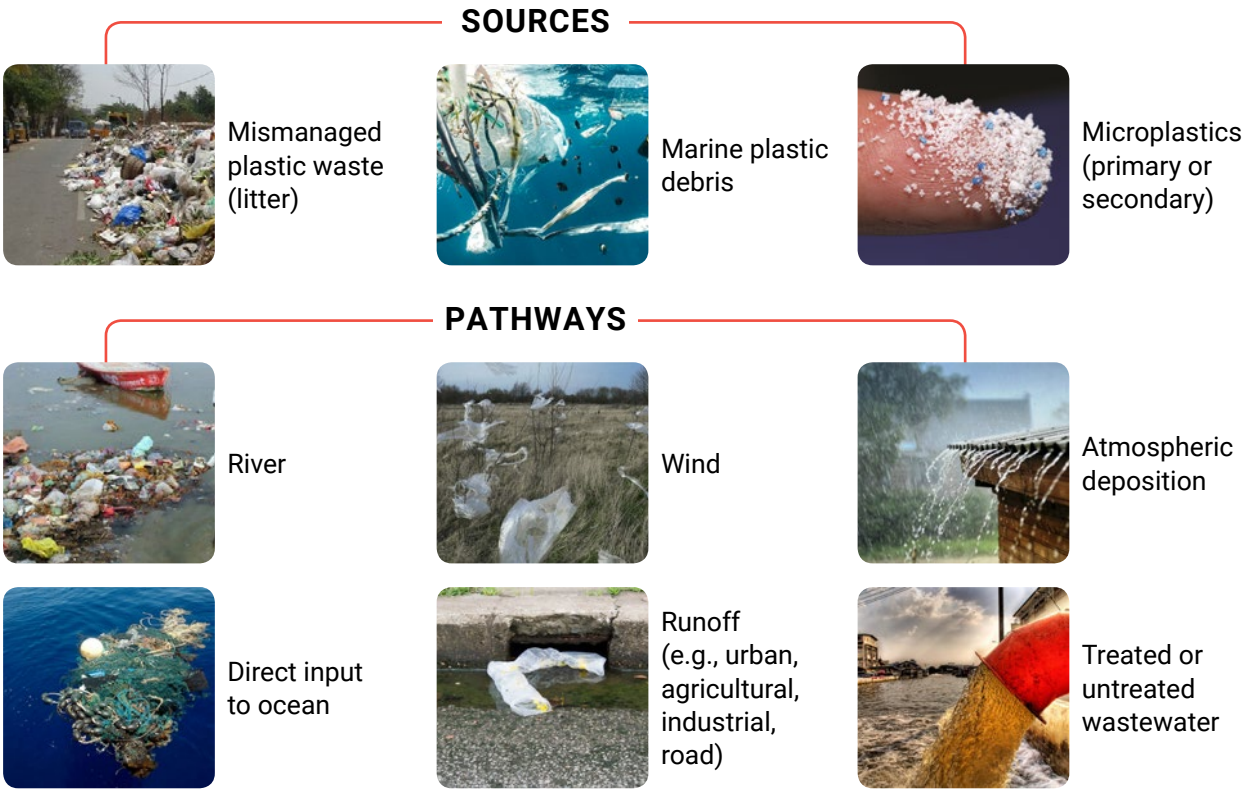

Figure 1: Indicative plastic leakage sources and pathways

iFOREST (2022) based on Rochman, C.M. (2020)

While the pathways can be multiple, ultimately, plastic leakage is a consequence of poor management of plastic waste. Identifying leakage sources for plastic waste can help design targeted interventions and a more robust waste management infrastructure. Existing solutions in the form of demand reduction, substitution, increased recycling, that deliver on societal, economic and environmental objectives have the potential to resolve plastic leakage.

Defining leakage pathways and hotspots

The Plastic Leak Project (PLP), an International Union for Conservation of Nature (IUCN) initiative, defines plastic leakage as follows:

"Plastic leakage is the potential amount of macro- and microplastics that are not kept in a circular loop or properly managed at their end-of-life, and thus leak into the environment."[3] Thus, leakage of plastics into the environment can occur by one of two core streams, either as visible macroplastics mainly from mismanaged waste or mostly invisible primary microplastics released from various sources, such as synthetic clothing, during washing or tyre abrasion from road run-off.

Hotspots are sites from which plastic leakage is most likely to occur due to mismanaged plastic waste generation (due to urban, commercial, market and industrial activity) and high drainage densities due to topography. Another definition of hotspot as per an IUCN-UNEP framework is: "hotspots are a component of the system that directly or indirectly contribute to plastic leakage and its associated impacts, and that can be acted upon to mitigate the leakage itself."[4]

Under hotspots, CounterMEASURE identified four major categories of plastic hotspots within the regional context and its methodological framework, namely:

(1) Plastic value chain hotspot: This hotspot accounts for unintentional loss of plastics during value chain activities like manufacturing, loss of fishing nets and degradation of buoys suspended in water.

(2) Plastic leakage source hotspot: This hotspot accounts for leakage occurring from illegal dumpsites, littering spots, areas without regular/formal waste collection service.

(3) Plastic accumulation hotspot: This hotspot is a location where waste accumulates in waterways and rivers locally and regionally. Examples: Artificial barriers and topographic barriers.

(4) Plastic application hotspot: This hotspot is related to a plastic application or an activity related to the plastic application that are most likely to increase leakage of plastic into the oceans and/or are suspected of generating environmental or human health impacts from the leakage. Plastic application refers to a product or packaging partially or completely made of plastic. Examples: Disposable cutlery, multilayer food packaging, sachets (example, tobacco), fishing gears, items associated with worship and festivals (example textiles, flowerpots).

Credit: National Productivity Council (2020)

Vacant land in Prayagraj with discarded plastic carry bags. This is a plastic leakage source hotspot, the most common type of hotspot observed across the four cities.

Significance of leakage pathways and hotspots

The National Guidance on Plastic Pollution Hotspotting and Shaping Action[6] identified three elements that form the backbone of addressing plastic pollution.

Credit: Brian Yurasits/unsplash.com

Leakage assessment and hotspot mapping are essential elements to solving the problem of plastic pollution.

1 A component of the system that directly or indirectly contributes to the magnitude of plastic leakage and/or its impacts. It can be a component of the system, a type of product/polymer or a region within the country.

2 An action that can be taken to mitigate the leakage from a given hotspot or reduce its impacts.

3 A practical way to implement the intervention and enable progress instruments.

EXAMPLES

- Illegal dumpsites
- Artificial barriers in city drains
- Rural areas with low rates of waste collection

- Implement better eco-design and chemical recycling
- Reduce plastic bag use in the country
- Increase waste collection

- Develop funding mechanism through extended producer responsibility (EPR) scheme
- Ban on plastic bags/introduce re-usable alternative
- Help local waste pickers to create a revenue stream

Figure 2: Relationship between hotspots, interventions and instruments

Source: iFOREST (2022) based on UNEP (2020)

Methodology for hotspot mapping

A HARMONISED methodology co-developed by UNEP, IUCN, and the Life Cycle Initiative having a combination of 'Systemiq framework' has been adopted for the hotspot mapping in Haridwar, Agra, Prayagraj, and Patna. The basic steps followed include:

- Perception survey with key stakeholders to determine leakage pathways and hotspots based on their knowledge of plastic waste.
- Vulnerable areas for plastic pollution were identified using the fuzzy logic approach in the geographic information system (GIS). The hotspots were determined from the vulnerable areas using criteria such as population density, waste generation rate, percentage of plastic in the waste stream, waste collection rate, distance to shore, catchment run-off, slope, and wind patterns. Hotspots also included illegal dumpsites and littering spots and poorly serviced areas mapped through field surveys. Data was collected in years 2019-20 and 2021. Data for 2021 was collected for both wet (monsoon, July-August) and dry seasons (non-monsoon).
- Collection of secondary data including data on plastic production, plastic consumption, plastic waste generation and management and waste disposal were undertaken from various departments/agencies such as urban local bodies (ULBs), industry associations, department of industries, pollution control board, and plastic recyclers. Additional information pertaining to drainage networks, wastewater discharge, land-use/land-cover, demography, and rainfall was collected.
- Based on the information gathered from the perception survey, the reconnaissance survey was undertaken in the city to determine watershed and identify physical features of the city. Validation of data was carried out through visual devices such as 360 degrees cameras and mobile phones with in-built GPS system. The main objective was to map plastic waste leakage density using multi-source geospatial data.
- A combination of hybrid MFA-LCA (Material Flow Analysis-Life cycle Assessment) was used in identifying and classifying the hotspots. A combination of input-output tables and waste management data was used to determine the material balance of plastics in the cities.
- Finally, a consultation workshop was conducted with regulators to validate identified hotspots and classify them into four categories namely, plastic value chain hotspot, plastic leakage source hotspot, plastic accumulation hotspot and plastic application hotspot *(for definitions refer to the box titled Defining leakage pathways and hotspots)*.

Data collection

- Perception survey on stakeholder perceptions on leakage pathways and hotspots in their surroundings.
- Secondary data to build material balance on plastic waste as well as topography of the city to map leakage pathways and hotspots.

Data validation

- Reconnaissance survey for watershed identification and physical features of the city. The main objective was to map plastic waste leakage density using multi-source geospatial data.
- A combination of hybrid MFA-LCA (Material Flow Analysis-Life cycle Assessment) was used in identifying and classifying the identified hotspots

Hotspot identification

- GIS-based identification was carried out to understand pathways of leakage and hotspots.
- Consultation workshops help validate and classify hotspots into categories.

Figure 3: Steps in hotspot identification

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

Insights on plastic waste hotspots

1 Low-value plastics were dominant in hotspots

Across cities, the dominant types of plastics found in hotspots were low-density polyethylene (LDPE) and multi-layered plastics (MLP) – that is – largely low-value plastics *(see Figure 4: Composition of plastic debris for wet and dry season)*. Among MLPs, tobacco packets (locally known as *pan masala*) were the most common plastic waste found at various hotspots.[8]

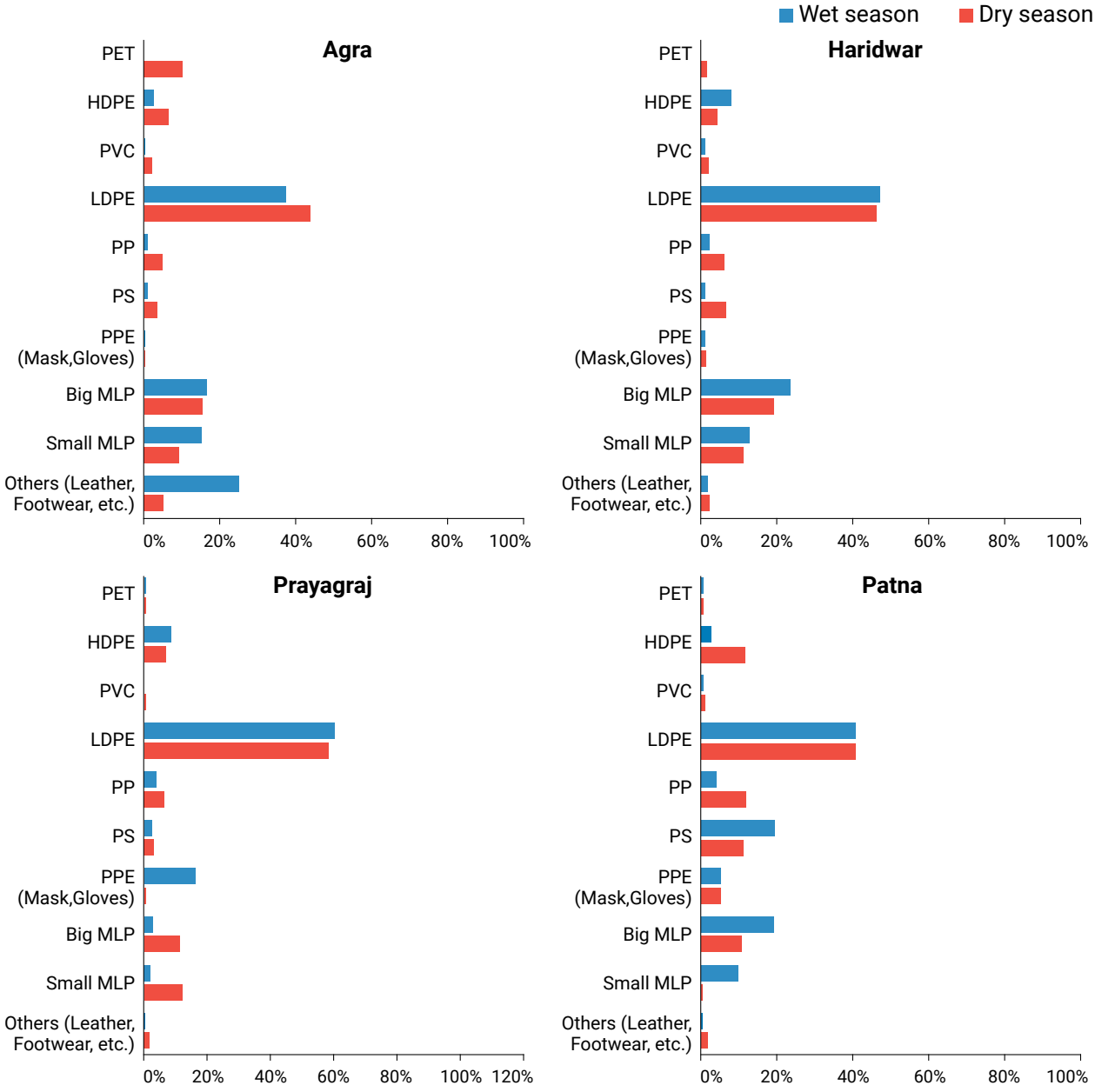

Figure 4: Composition of plastic debris for wet and dry season

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

PET = Polyethylene Terephthalate; HDPE = High-Density Polyethylene; PVC = Polyvinyl Chloride; LDPE = Low-Density Polyethylene; PP = Polypropylene; PS = Polystyrene; PPE = Personal Protective Equipment; MLP = Multi-layered plastic

2 Illegal dumpsites were the most common type of hotspot in these cities

The major sources of mismanaged plastic waste across the four cities were markets, industrial belts, and residential areas (including slums). In Agra, in addition to the aforementioned sources, the leather cottage industry was a major source of plastic waste.[9]

In terms of major hotspots categories in the cities, plastic leakage source hotspots were found to be the most common (*see Figure 5: Number of hotspots observed*). Plastic leakage source hotspots are typically illegal dumpsites, littering spots, or areas without regular/formal waste collection service. For instance, in Haridwar, a majority of litter was observed in vacant land which often became illegal dumpsites. Other major hotspots in Haridwar included transfer stations (locally referred to as *dhalos*), street litter in markets, and open sites in residential areas.[10]

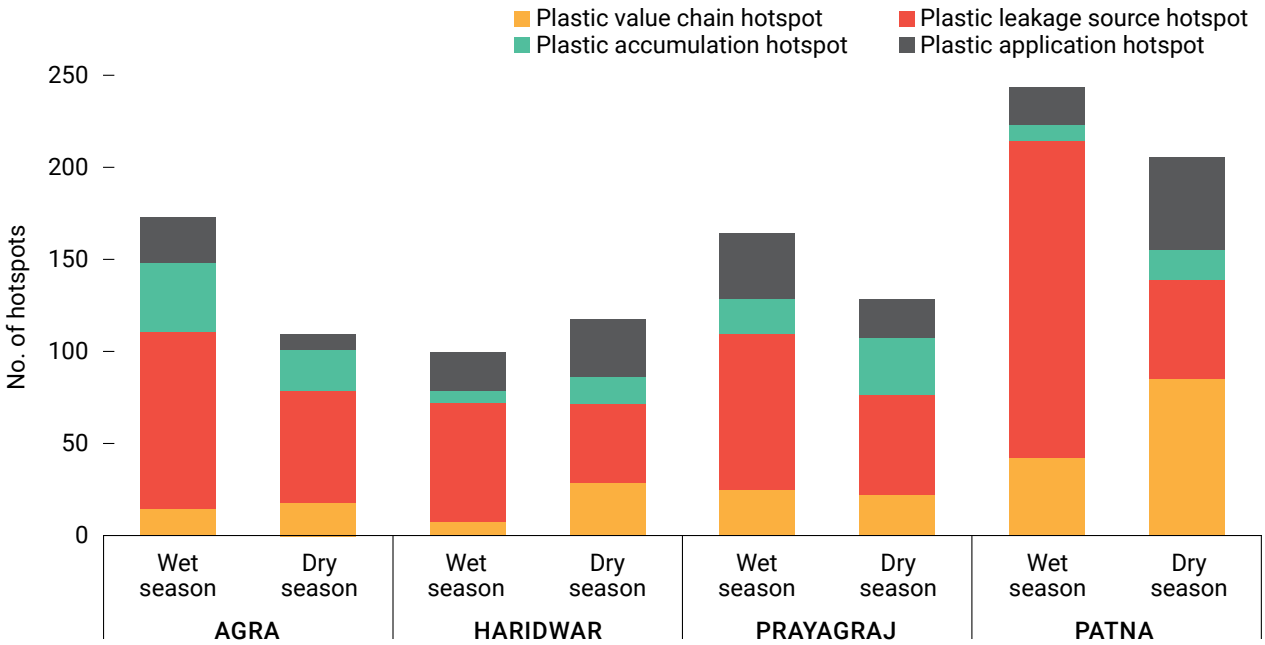

Figure 5: Number of hotspots observed

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

3 Littering was the main source of plastic leakage

Across all the cities, littering was one of the main sources of plastic leakage. About 1% of plastic waste generated in a day was found to be littered, making littering a major cause for plastic exiting the value chain. Other sources of plastic leakage were open drains flowing through slum/market areas which brought significant waste to the riverbank. Residents also directly disposed waste from religious activities (considered as holy) into the river.[11]

Despite the COVID-19 pandemic, instances of biomedical waste pile-up in hotspots were limited. PPEs such as masks were found in small quantities mostly in residential areas (0.3% in Agra, 1.3% in Haridwar, and ~0.5% in Patna). There was one instance of rejected masks from the manufacturing industry found at one hotspot in Prayagraj.[12]

Recommendations

COUNTERMEASURES FOR PLASTIC LEAKAGE HOTSPOTS

1 Map hotspots and leakage pathways

The approach and methodology for hotspot identification, visual inspection, and clean-ups were customised and adopted for Indian conditions. This methodology can be used for hotspot mapping and leakage pathway analysis for other cities.

2 Implement Extended Producer Responsibility for low-value plastics

The types of plastics found in hotspots were LDPE and MLPs – that is – largely low-value plastics. Among MLPs, tobacco packets (locally known as *pan masala*) were the most common plastic waste. Interventions such as EPR should target such low-value plastics for collection and recycling.

3 Conduct regular clean-ups in hotpots

'Plastic leakage source hotspot' was the most common type of hotspot across the four cities. These are typically illegal dumpsites, littering spots, and areas without regular/formal waste collection service. Local municipalities must organise regular clean-ups at the identified hotspots and design interventions to prevent littering at these hotspots.

4 Improve waste management services

Littering was the most common source of plastic leakage. Further, as observed before, illegal dumpsites, littering spots, and areas without regular waste collection service were the most common type of hotspot in the four cities. Thus, there is a need to improve waste collection services by instituting door-to-door waste collection in areas prone to littering.

References

1 https://www.unep.org/interactive/beat-plastic-pollution/

2 PEW. (2020). Breaking the Plastic Wave – A comprehensive assessment of pathways towards stopping ocean plastic pollution. https://www.pewtrusts.org/-/media/assets/2020/10/breakingtheplasticwave_distilledreport.pdf

3 Ibid

4 UNEP. (2020). National guidance for plastic pollution hotspotting and shaping action - Introduction report. https://plastichotspotting.lifecycleinitiative.org/wp-content/uploads/2020/07/National-Guidance-for-Plastic-Hotspotting-and-Shaping-Action-Final-Version-2.1.pdf

5 UNEP. (2020). Plastic Leakage Assessment and Monitoring in river basins in Asia – A Conceptual Framework. CounterMEASURE for Plastic Free Rivers.

6 UNEP. (2020). National guidance for plastic pollution hotspotting and shaping action - Introduction report. https://plastichotspotting.lifecycleinitiative.org/wp-content/uploads/2020/07/National-Guidance-for-Plastic-Hotspotting-and-Shaping-Action-Final-Version-2.1.pdf

7 Ibid

8 National Productivity Council. (2022). Report on mapping of hotspots and plastic leakage pathway (India - Agra, Haridwar, Prayagraj and Patna) Wet Season 2021. CounterMEASURE.

9 National Productivity Council. (2022). Report on mapping of hotspots and plastic leakage pathway (India - Agra, Haridwar, Prayagraj and Patna) Wet Season 2021. CounterMEASURE.

10 National Productivity Council . (2020). Plastic Leakage Scenarios for selected locations in identified cities/ study area. CounterMEASURE.

11 National Productivity Council. (2022). Report on mapping of hotspots and plastic leakage pathway (India - Agra, Haridwar, Prayagraj and Patna) Wet Season 2021. CounterMEASURE.

12 National Productivity Council. (2022). Report on mapping of hotspots and plastic leakage pathway (India - Agra, Haridwar, Prayagraj and Patna) Wet Season 2021. CounterMEASURE.

Counter MEASURE FOR PLASTIC FREE RIVERS

From the People of Japan

NATIONAL PRODUCTIVITY COUNCIL

iFOREST INTERNATIONAL FORUM FOR ENVIRONMENT, SUSTAINABILITY & TECHNOLOGY