



Xylem India Hackathon

Problem Statement

Innovative techniques to tackle plastic waste in water bodies

Our Team

Understanding the Problem Statement

What is the source of all this marine pollution?

How is India producing so much of plastic waste?

Some Key Insights

How do India currently manage it's waste?

Classification of waste

The actual Condition of waste management in India

Problem in current Waste Management System

How is Plastic waste managed in India?

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Plastic Waste Management

Collection of Waste

The Plastic Waste Management (PWM) Rules, 2022

Role of Producer, Importer & Brand Owners

Indian States and their Waste Management Policies

Conclusion

Source of marine Pollution

Reduce the Plastic Waste Generated

Reduce the size of the problem (Policy based):

REUSE

RECYCLE

Reorient and Diversify

Deal with the legacy

Our Solution

Quick Fix - High Priority Problem:

Quick Fix - Low Priority Problem:

Long-Term Solution - Circular Economy Policies:

Problem Statement

Innovative techniques to tackle plastic waste in water bodies

Plastic garbage takes **decades** or even hundreds of years **to disintegrate**, putting our **water sources** and water **quality** at danger. **Microplastics** have been found in water all **throughout the world**, including our rivers, lakes, and seas. Microplastics detected in these streams **make their way** into our **drinking water** and the fish we eat. Develop **innovative approaches** to tackle plastic pollution in **water bodies** and implement preventive measures that can be **integrated into existing waste management systems, policies, and public consciousness**.



Why this Problem Statement?

Our selection of the problem statement, "**Innovative Techniques to Tackle Plastic Waste in Water Bodies**," reflects a commitment to addressing a critical **global environmental challenge**. Witnessing the **pollution in our local rivers**, like the Yamuna, sparked a deep concern. This is more than a hackathon project; it's a **mission to restore our environment**. The urgency and visibility of plastic pollution in water bodies demand immediate action. By Leveraging innovation, technology, and our collective passion, we aim to make an impact beyond winning a competition. We believe in a world where rivers run clear, and marine life thrives.

Our Team

Team Name : de Valor

Team Members :

- **Sarthak Tyagi** (L), 3rd Year CSE student at GGSIPU
- **Rinkit Adhana**, 2nd Year CSE student at GGSIPU
- **Kiriti Nain**, 2nd Year EEE student at GGSIPU

Team Mentor : Ms. Shivani Singhal

We are a force driven by a shared passion for environmental change. Together, we weave innovation, compassion, and determination into every solution. With each idea, we plant seeds of progress, nurturing a future where technology and heart converge for a sustainable tomorrow

Understanding the Problem Statement

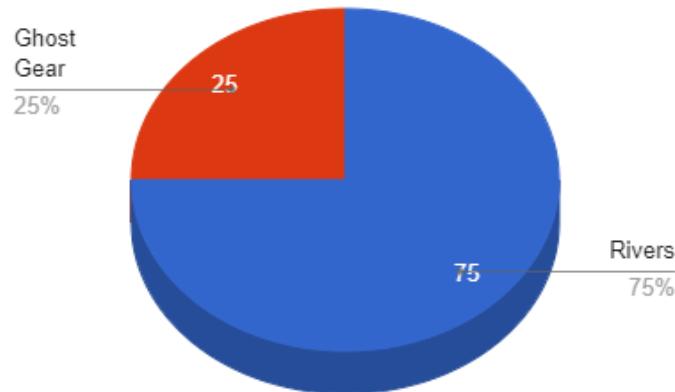
Having acknowledged the pollution of our water sources, the immediate question that surfaces in our minds is:

What is the source of all this marine pollution?

Two main reasons are

- **Most of the plastic** in our oceans comes from **land-based sources**: by weight, **70% to 80%** is plastic that is transported from land to the sea via rivers or coastlines
- The other **20% to 30%** comes from marine sources such as **fishing nets, lines, ropes, and abandoned vessels**. Which is also called *Ghost Gear*.

% share of plastic emission into oceans



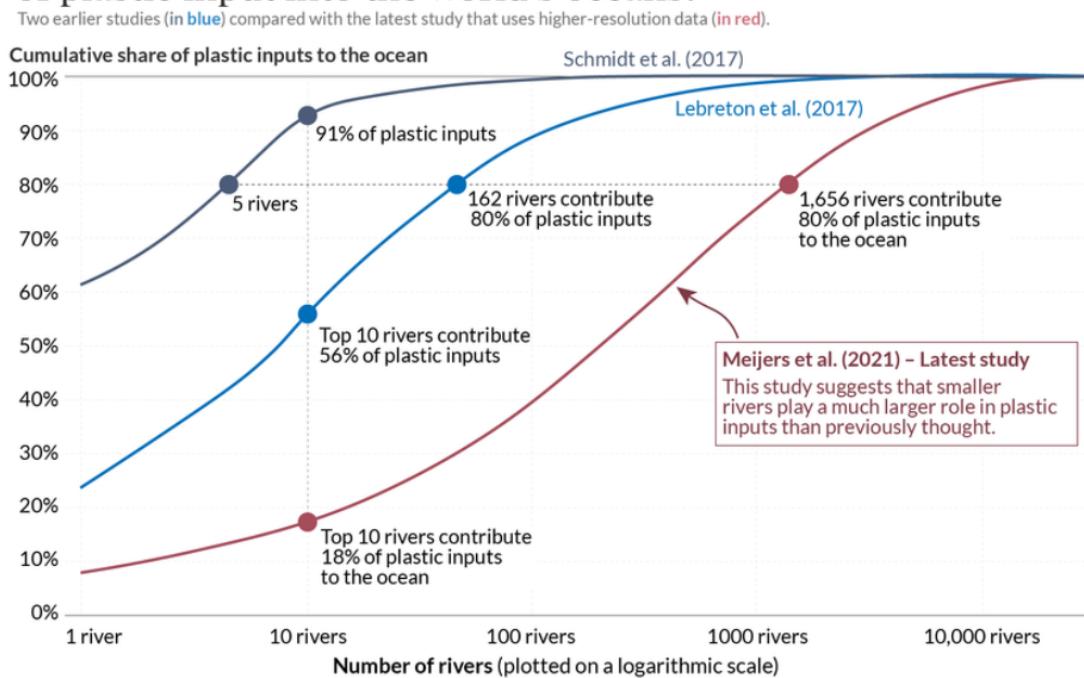
Latest study published in Science Advances found that **rivers** emitted around **1 million tones of plastics** into the oceans in 2015 (with an uncertainty ranging from 0.8 to 2.7 million tones)

It also suggests that

smaller rivers play a much larger role than previously thought.

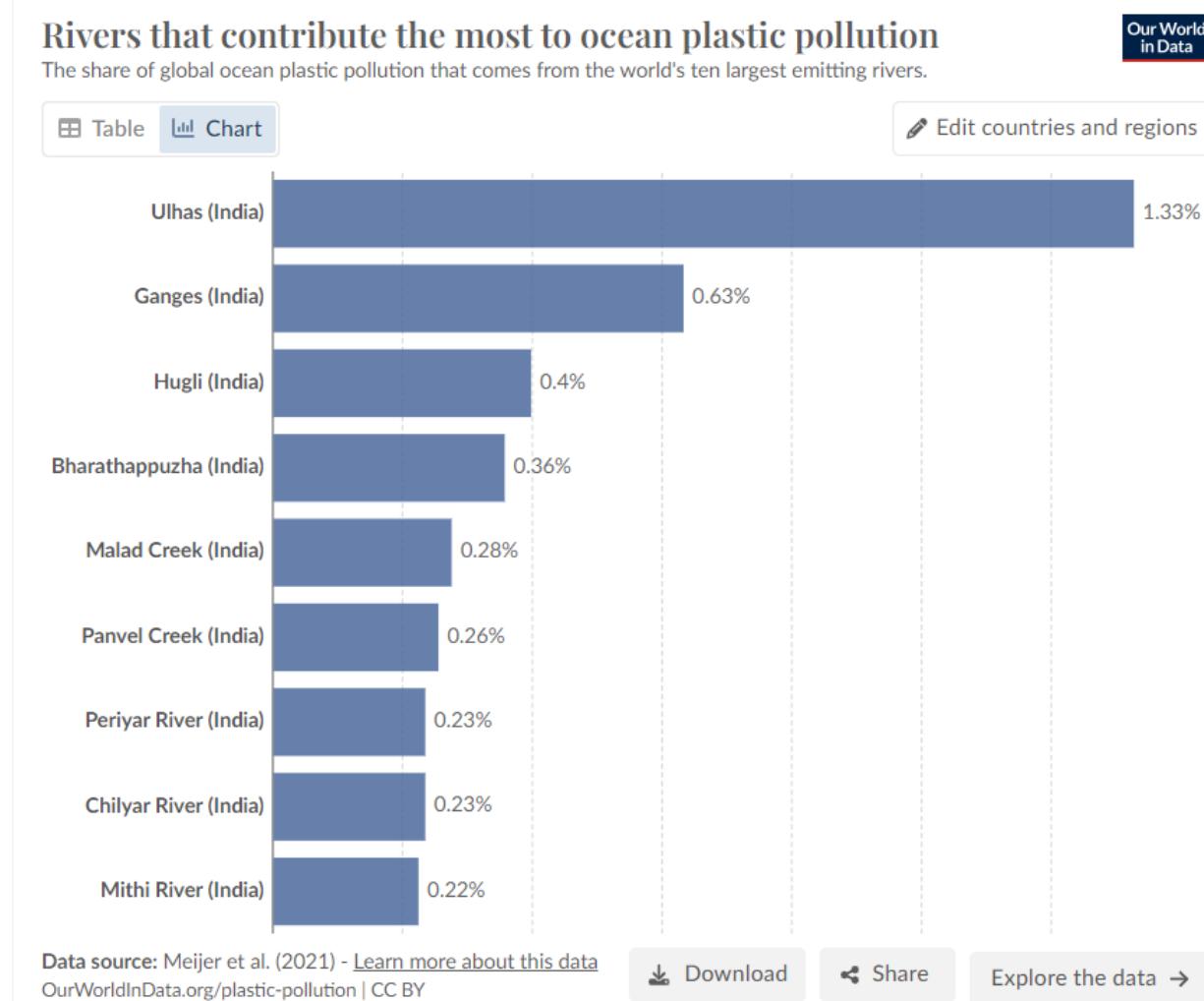
How many rivers are responsible for what share of plastic input into the world's oceans?

Our World
in Data



The above graph indicates 1,656 rivers account for 80% of plastic inputs in the world.

Plastic will **only enter** rivers and the ocean if it's **poorly managed**. In **rich** countries, nearly all of its plastic waste is **incinerated, recycled, or sent to well-managed landfills**. It's not left open to the surrounding environment. **Low-to-middle income** countries tend to have poorer waste management infrastructure. Waste can be **dumped outside of landfills, and landfills that do exist are often open, leaking waste to the surrounding** environment. *Mismanaged* waste in low-to-middle income countries is therefore much higher.



The chart above illustrates the **varying contributions of different rivers in India** to the input of plastic into the ocean.

Up to this point, we've established the fact that **plastic contamination in oceans** is largely attributed to the use of **plastic products on land**. This pollution is **transported** into the oceans **through smaller tributaries and rivers**, as highlighted by the varying contributions of different rivers in India, as depicted in the chart above.

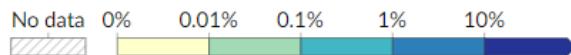
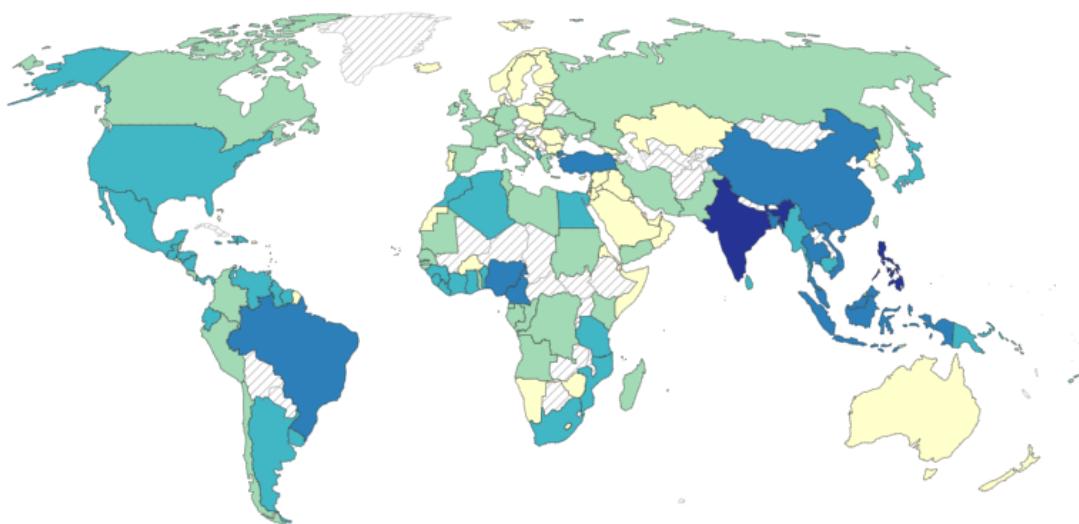
Share of global plastic waste emitted to the ocean, 2019

Our World
in Data

Annual estimate of plastic emissions. A country's total does not include waste that is exported overseas, which may be at higher risk of entering the ocean.

Table Map Chart

World



Data source: Meijer et al. (2021) - [Learn more about this data](#)
OurWorldInData.org/plastic-pollution | CC BY

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Explore the data →

The above heat map represents the annual plastic emission of various countries.

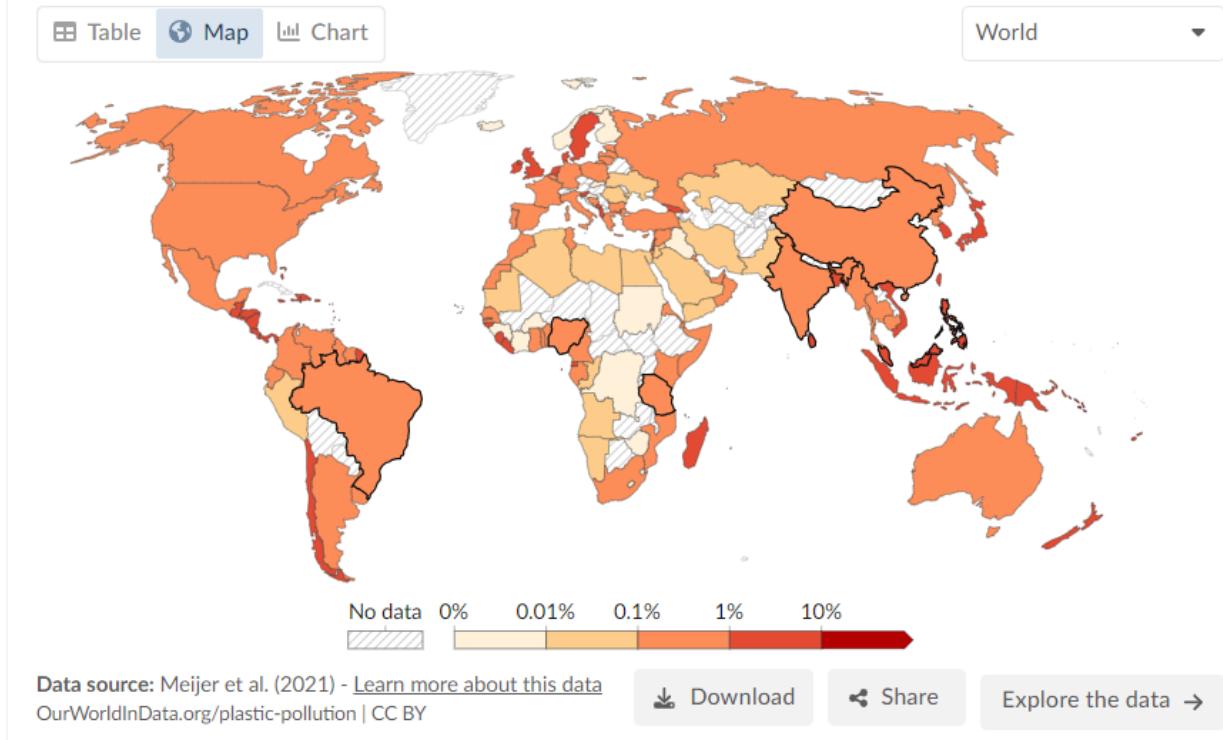
India holds the **second position** in the ranking of countries contributing to **plastic emissions into the oceans**.

The probability that this mismanaged plastic waste reaches river networks, and then the ocean. **The climate, terrain, land use, and distances within river basins** affect the **probability** that mismanaged plastic waste is **emitted to the ocean**.

Probability of mismanaged plastic waste being emitted to the ocean, 2019

Our World
in Data

Mismanaged plastic waste is waste that is not recycled, incinerated, or kept in sealed landfills. It includes materials burned in open pits, dumped into seas or open waters, or disposed of in unsanitary landfills and dumpsites. A country's total does not include waste that is exported overseas, which may be at higher risk of entering the ocean.



The probability of mismanaged plastic waste entering the ocean by country is shown in the chart. This probability is much higher in countries such as the Philippines (a 7% probability); Malaysia (4.4%); and Sri Lanka (3.4%) than China (0.2%) or India (0.5%). This is why smaller rivers in these countries play a larger role than we might assume.

How is India producing so much of plastic waste?

The **disparity** in waste generation becomes apparent when considering that India, with a **population** of approximately **1.4 billion**, produces **22 metric tons of plastic**, in contrast to countries such as the United States (49 Mt), the European Union (55 Mt), and China (78 Mt). However, the effectiveness of waste management diverges significantly, as India's **recycling rate** hovers between **5-20%**, contingent on the type of plastic, whereas **other nations** surpass this rate by recycling **more than 30%** of their plastic waste. This underscores the need for enhanced waste management strategies and infrastructure in India to align with global sustainability standards.

Item	India	EU	China	Pakistan	USA	Brazil	South Africa	Australia
Population (in millions) (according to 2020) Region	1380 (Data source: [24]) Asia	447.32 (Data source: [25]) Europe	1410.93 (Data source: [24]) Asia	220.89 (Data source: [24]) Asia	329.48 (Data source: [24]) North America	212.56 (Data source: [24]) South America	59.31 (Data source: [24]) Africa	25.687 (Data source: [24]) Oceania
Plastic production (in Mt)	22 Mt per year (according to 2020) [26]	Around 55 Mt (in 2020) [27]	78 Mt (in 2020) [28]	0.745 Mt (as of 2020) [29]	49 Mt (in 2019) [30]	7.1 Mt (as of 2019) (mainly processed plastics) [31]	9.0 Mt (between 2009 and 2015) [32]	Approximately 1.4 Mt was processed in local manufacturing industries using either virgin resins (both locally manufactured and imported) or recycle-based resins [33]
Plastic consumption	20 kg/capita/year (predicted for 2022) [34]. In 2017–18, total of 16.5 Mt was consumed [35]	84 and 129 kg per capita per year [36], 112 kg/person (for the period 2010–2019) [36]	46 kg/capita (as of 2017) and annually, 63 Mt [37]	6.5 kg/capita [38]	37 Mt/year [39]	6.5 Mt (in 2017) [40]	24.5 kg/capita/year (including local primary production) [32]	Total: 3.4 Mt (as of 2019–20) [33], 130 kg/capita/year [41]
Plastic waste generation	9.4 Mt/year (as of 2019) [26]	33.48 kg/person (plastic packaging in 2018) [42]. In 2020, more than 29 Mt of plastic post-consumer waste was collected [43]	In 2019, 335.46 Mt (between 2004 and 2019) [44]. In 2019, 26.74 Mt was generated [45]	3.9 Mt (in 2020) [46]	35.7 Mt in 2018, which was 12.2 percent of MSW generation. [47]	11.85 Mt/year [48]	1.144 Mt [32]	2.5 Mt/year [49]
Source of plastic waste generation (main sectors/products)	Plastic packaging from grocery to food and vegetable products, to cosmetics and consumer items [50]	Packaging, non-packaging household, construction and demolition, electrical and electronic equipment, automobile agriculture [51]	Sectors: packaging, building and construction, automotive, electronics, agriculture. Materials: PE, PP, PVC, PS, ABS [37]	Plastic bags, pet bottles [52]	Bags, sacks and wraps; other packaging; polyethylene terephthalate (PET) bottles and jars; high-density polyethylene (HDPE) natural bottles; and other containers [47] (overall recycling rate) (in 2018), PET bottle and jars recycling rate was 29.1% and HDPE natural bottles was 29.3% [47]	high-density polyethylene (HDPE), low-density polyethylene (LDPE), polypropylene (PP), polyethylene (PE), terephthalate (PET), and polystyrene (PS) [53]	LDPE, PET, PP, synthetic rubber, polyester, HDPE, PS, PVC [54]	PET, HDPE, PVC, LDPE, PP [33]
Plastic waste recycling rate	Between 5% and 25% identified by Siddiqui and Pandey [55]	41% (in 2019) [56]	30% [45]	33% [57]		25.8% [40]	43.7% (as of 2017) [58]	13.1% (as of 2019–20) [33]

Despite producing nearly **half the amount** of plastic as compared to other nations, India ranks as the **second-largest contributor** to plastic waste in the environment.

Some Key Insights

- India produces the most plastic waste out of all the countries listed, at 9.4 Mt/year.
- The recycling rate in India is only between 5% and 25%, which is significantly lower than the recycling rate in China (30%) and the United States (30%).
- This means that a significant amount of plastic waste in India is not recycled and ends up in landfills or the environment.
- The main source of plastic waste in India is packaging.
- An estimated 8.93 Mt/year of plastic waste is not recycled in India.

Insight	Value
Amount of plastic waste produced per year	9.4 Mt/year
Recycling rate	5% to 25%
Amount of plastic waste not recycled	8.93 Mt/year
Expected growth in plastic waste production by 2030	100%
Government recycling goal for 2030	60%

```
# Import libraries
import pandas as pd

# Create a dictionary from the data in the image
data = {
    "Country": ["India", "China", "United States"],
    "Plastic Waste (Mt/year)": [9.4, 78, 49],
    "Recycling Rate (%)": [5, 41, 33],
    "Main Source of Plastic Waste": ["Packaging", "Construction and Demolition", "Pack"]
}
```

```

# Create a DataFrame from the dictionary
df = pd.DataFrame(data)

# Select the data for India
india_data = df[df['Country'] == 'India']

# Calculate the amount of plastic waste that is not recycled in India
unrecycled_plastic_waste = india_data['Plastic Waste (Mt/year)'] * (1 - india_data['Re

# Insights about India
india_insights = [
    "India produces the most plastic waste out of all the countries listed, at 9.4 Mt/",
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    f"An estimated {unrecycled_plastic_waste.values[0]:.2f} Mt/year of plastic waste i
]

# Print the insights
print(india_insights)

```

Country	Plastic Waste (Mt/year)	Recycling Rate (%)	Population (millions)	Plastic Production (Mt/year)	Plastic Waste per Capita (kg/year)	Plastic Waste per Unit Production (kg/kg)
India	9.4	5	1406	22	6.69	0.67
China	26.74	30	1444	78	53.34	0.95
United States	35.7	30	332	49	147.29	0.74

```

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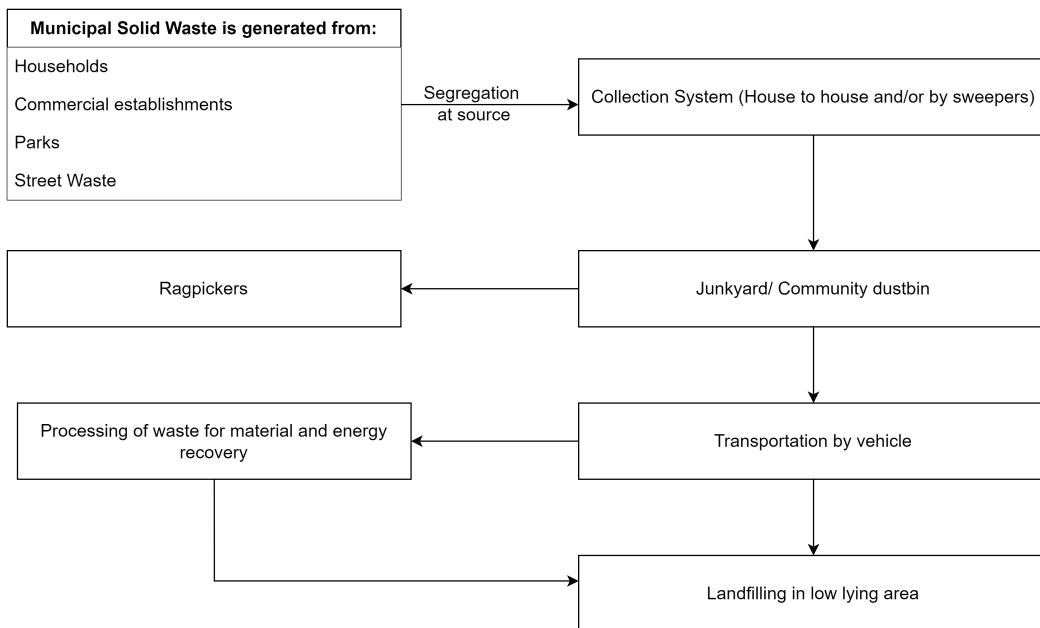
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Clearly the biggest concern with plastic waste in India is **not the amount of waste** produced but **ineffective waste management**, such as improperly collecting and recycling waste.

Management Includes :

- Collection of waste
- Recycling of waste

How do India currently manage it's waste?

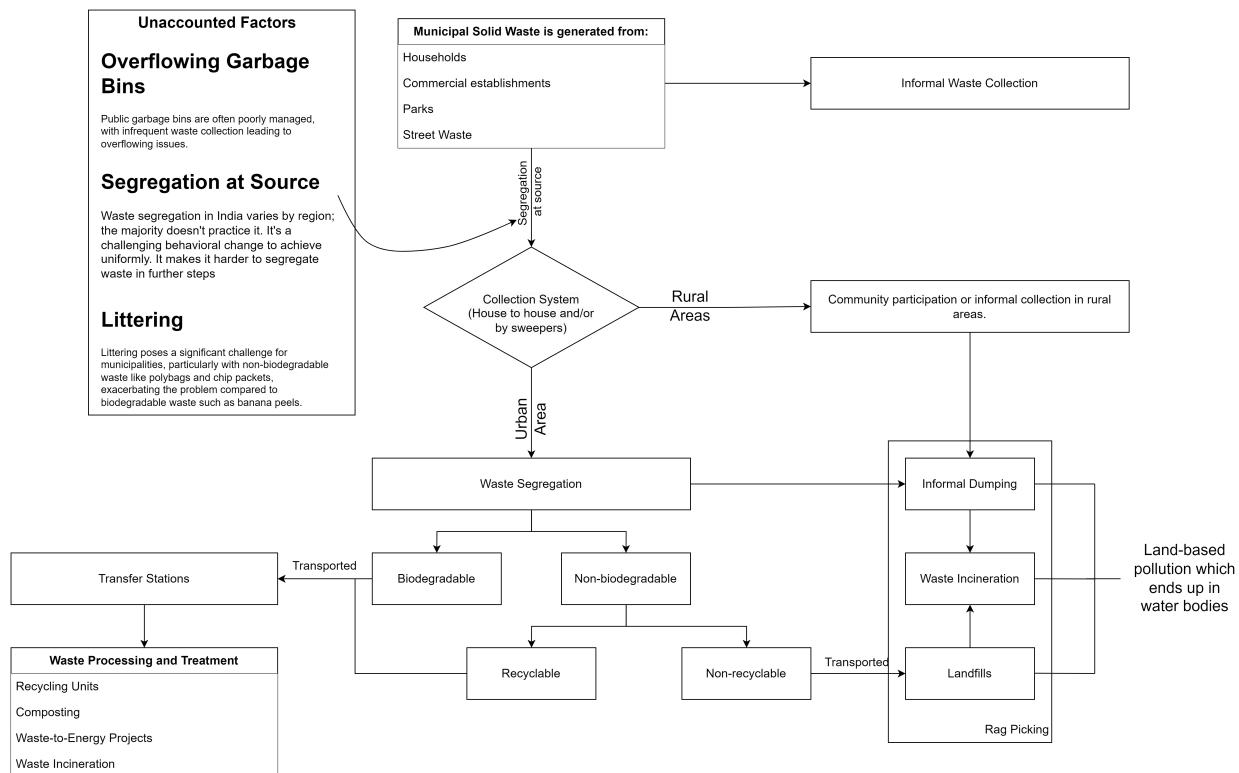


The above chart represents how our waste should be managed in India.

Classification of waste

- **Solid waste**- vegetable waste, kitchen waste, household waste etc.
- **E-waste**- discarded electronic devices such as computer, TV, music, systems etc.
- **Liquid waste**- water used for different industries, tanneries, distilleries, thermal power plants
- **Plastic waste**- plastic bags, bottles, bucket, etc.
- **Metal waste**- unused metal sheet, metal scraps etc.
- **Nuclear waste**- unused materials from nuclear power plants

The actual Condition of waste management in India



Problem in current Waste Management System

- 1. Insufficient Collection Infrastructure:** In areas with inadequate waste collection infrastructure, garbage may not be systematically gathered from households and businesses, leading to littering and illegal dumping.
- 2. Lack of Recycling Facilities:** Ineffective waste management often involves a dearth of recycling facilities. Without proper mechanisms for recycling, a significant portion of recyclable materials may end up in landfills.
- 3. Poor Waste Sorting Practices:** Ineffective waste sorting at the source or at collection points can result in mixed waste streams, making it challenging to separate recyclables from non-recyclables.
- 4. Limited Public Awareness:** Lack of awareness among the public about the importance of proper waste disposal and recycling can contribute to irresponsible waste disposal practices.

5. **Inadequate Disposal Sites:** Improperly managed landfills or insufficient disposal sites may lead to environmental contamination, including soil and water pollution, as well as the release of greenhouse gases.
6. **Absence of Hazardous Waste Management:** Ineffective waste management often neglects the proper handling and disposal of hazardous waste materials, posing risks to human health and the environment.
7. **Weak Regulatory Frameworks:** A lack of stringent regulations or ineffective enforcement of existing waste management laws can undermine efforts to manage waste effectively.
8. **Limited Investment in Waste Management Technology:** Outdated or insufficient waste management technology and equipment can impede efficient waste disposal and recycling processes.
9. **Inadequate Financial Resources:** Limited funding for waste management programs can hinder the implementation of effective waste collection, recycling, and disposal initiatives.

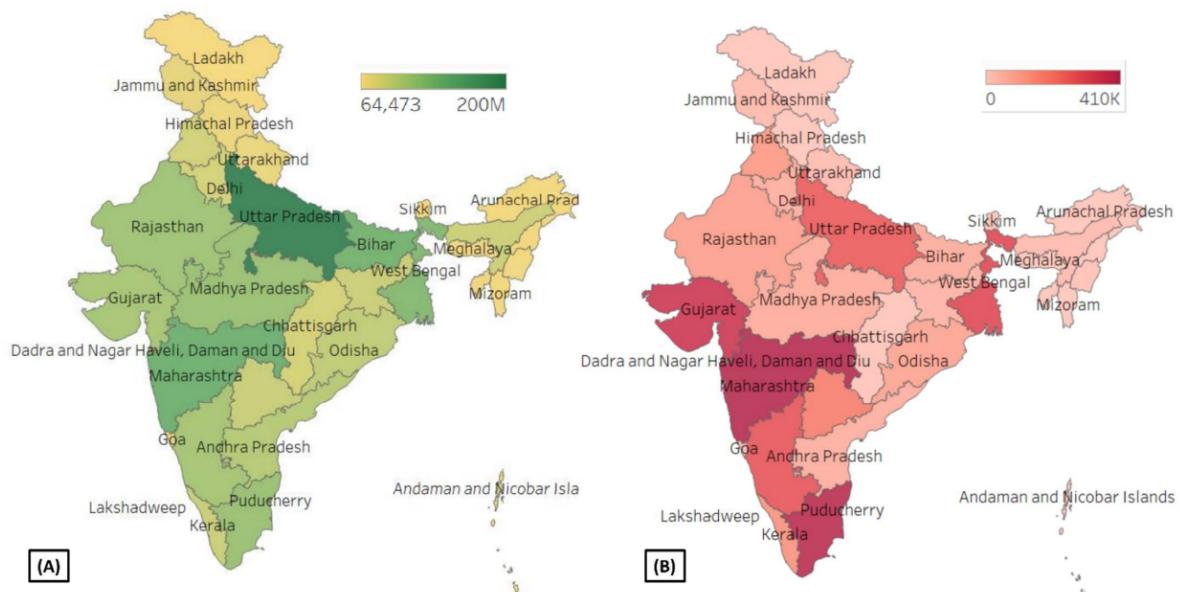
How is Plastic waste managed in India?

Before we delve deep into current model of plastic waste management and it's setbacks, let's take a look at how much different states in India produce plastic waste.

State	Population as per Census 2011	Plastic waste generated in tons (FY 2018-19)	Annual per capita plastic waste generation (in grams)	Per capita plastic waste generation (in grams per day)
Tripura	3,673,917	26	7.131	0.02
Sikkim	610,577	6	9.27	0.03
Mizoram	1,097,206	13	12.127	0.03
Nagaland	1,978,502	268	135.547	0.4
Chhattisgarh	25,545,198	6,000	234.878	0.6
Meghalaya	2,966,889	1,263	425.698	1.2
Himachal Pradesh	6,864,602	3,672	534.918	1.5
Bihar	104,099,452	68,903	661.899	1.8
Madhya Pradesh	72,626,809	72,327	995.877	2.7
Assam	31,205,576	32,278	1,034.36	2.8
Uttar Pradesh	199,812,341	254,402	1,273.20	3.5
Andhra Pradesh	49,576,777	66,314	1,337.60	3.7
Rajasthan	68,548,437	104,704	1,527.45	4.2
Jharkhand	32,988,134	51,455	1,559.79	4.3
Odisha	41,974,218	90,139	2,147.48	5.9
Lakshadweep	64,473	148	2,295.54	6.3
Haryana	25,351,462	68,735	2,711.29	7.4
Arunachal Pradesh	1,383,727	3,787	2,737.08	7.5
Jammu and Kashmir	12,541,302	34,367	2,740.34	7.5
National Average	1,210,854,977	3,360,043	2,774.94	7.6
Uttarakhand	10,086,292	31,093	3,082.70	8.4
West Bengal	91,276,115	300,236	3,289.32	9

State	Population as per Census 2011	Plastic waste generated in tons (FY 2018-19)	Annual per capita plastic waste generation (in grams)	Per capita plastic waste generation (in grams per day)
Dadra and Nagar Haveli, Daman and Diu	586,956	1,948	3,318.31	9.1
Maharashtra	112,374,333	409,630	3,645.23	10
Kerala	33,406,061	133,316	3,990.77	10.9
Punjab	27,743,338	119,415	4,304.26	11.8
Manipur	2,855,794	12,454	4,360.89	11.9
Karnataka	61,095,297	272,776	4,464.76	12.2
Andaman and Nicobar Islands	380,581	1,850	4,860.99	13.3
Telangana	35,004,000	183,015	5,228.39	14.3
Tamil Nadu	72,147,030	401,091	5,559.36	15.2
Gujarat	60,439,692	356,873	5,904.61	16.2
Puducherry	1,247,953	8,433	6,757.47	18.5
Chandigarh	1,055,450	11,715	11,099.91	30.4
Delhi	16,787,941	224,810	13,391.16	36.7
Goa	1,458,545	32,581	22,337.69	61.2

Let's make this data easier to understand



(A) Population (as per census 2011) and (B) PW generation (in tons) in various states in India in the financial year 2018–2019

Some insights from this data

1. Regional Disparities:

- States with smaller populations like Sikkim and Mizoram tend to have lower total plastic waste generation, but their per capita plastic waste generation is relatively higher.
- Larger states like Uttar Pradesh and Maharashtra have significantly higher total plastic waste generation due to their large populations.

2. Per Capita Generation:

- States like Goa, Delhi, and Chandigarh have high per capita plastic waste generation, indicating that, on average, individuals in these regions generate a substantial amount of plastic waste.

3. Impact of Population Size:

- Larger states such as Uttar Pradesh and Maharashtra, while having high total plastic waste generation, may have lower per capita figures, as the waste is distributed across a larger population.

4. Efficiency in Waste Management:

- Some states with smaller populations, like Himachal Pradesh and Manipur, show a relatively lower total plastic waste generation, which could be indicative of efficient waste management practices or lower consumption patterns.

5. Urbanization and Plastic Waste:

- Urbanized regions like Delhi, Mumbai, and Chennai tend to have higher per capita plastic waste generation, likely due to increased consumption and a more significant urban population.

6. Awareness and Practices:

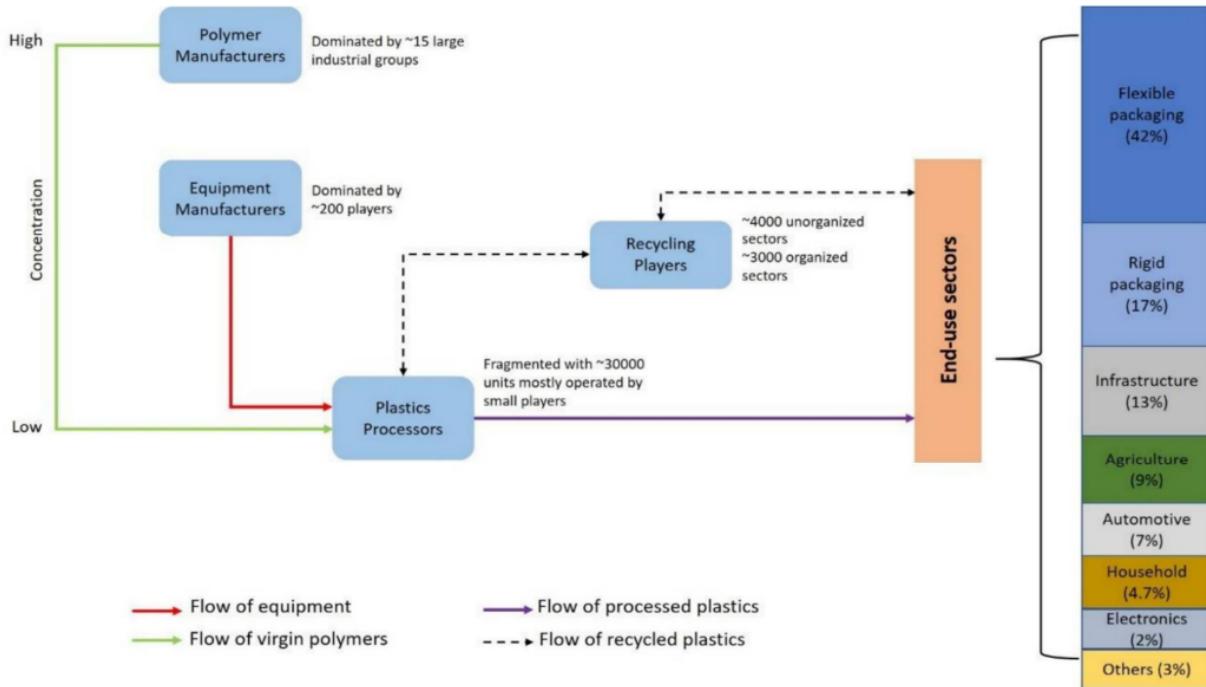
- States like Sikkim and Tripura, despite having relatively low total plastic waste generation, have higher per capita figures, possibly indicating a need for awareness campaigns and improved waste management practices.

7. Policy Impact:

- The variation in per capita plastic waste generation across states could also reflect the effectiveness of waste management policies and initiatives implemented at the state level.

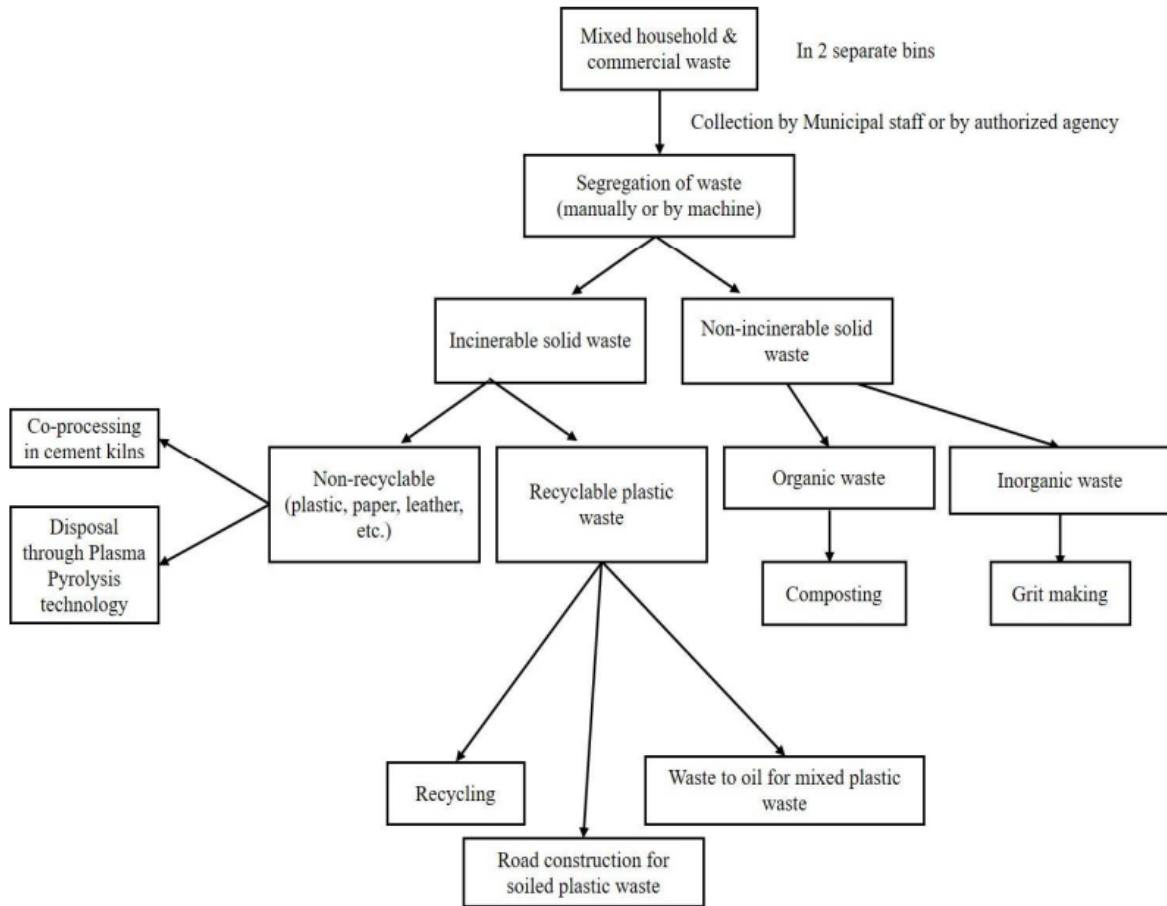
Plastic Waste Management

Let's look at the structure of Indian plastic industry



- The flow diagram shows the flow of materials in the plastic industry, from the production of virgin polymers to the recycling and reuse of plastic waste.
- The diagram shows that the majority of plastic waste is generated in the post-consumer phase, which is after the product has been used and discarded by the consumer.
- A significant portion of plastic waste is not recycled, but is instead disposed of in landfills or the environment.
- The diagram also shows that the production of virgin polymers is a resource-intensive process that requires the use of fossil fuels.

In **30 states/UTs**, there are **4953 registered units** with 3715 plastic manufacturers/producers, **896 recyclers**, 47 compostable manufacturing, and 295 multilayered packaging units however, 823 unregistered units have been reported from different states.



Above flowchart represents the flow of plastic waste from its source to management plants and landfills.

Collection of Waste

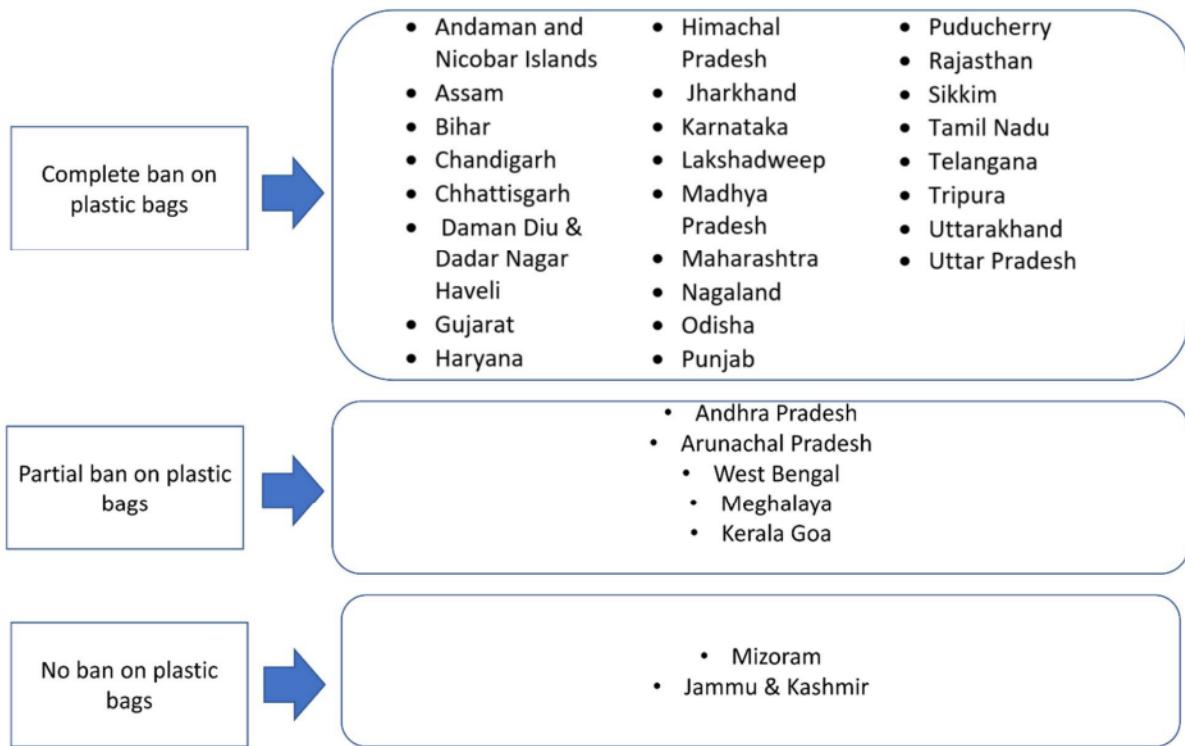
Responsibility :

- Local government bodies,
- producers,
- importers and brand owners.

In Contrast **42-86 per cent** of the plastic waste in India **flows through** the informal sector to material recovery facilities operated by **multinational corporations in partnership with local governments** or otherwise. They then **divert this waste material to landfills due to a lack of knowledge** and the waste material collected by the informal sector is **not channeled transparently**. Material recovery facilities and recyclers in the waste management industry often **receive contaminated waste that cannot be recovered and is eventually disposed of in landfills**.

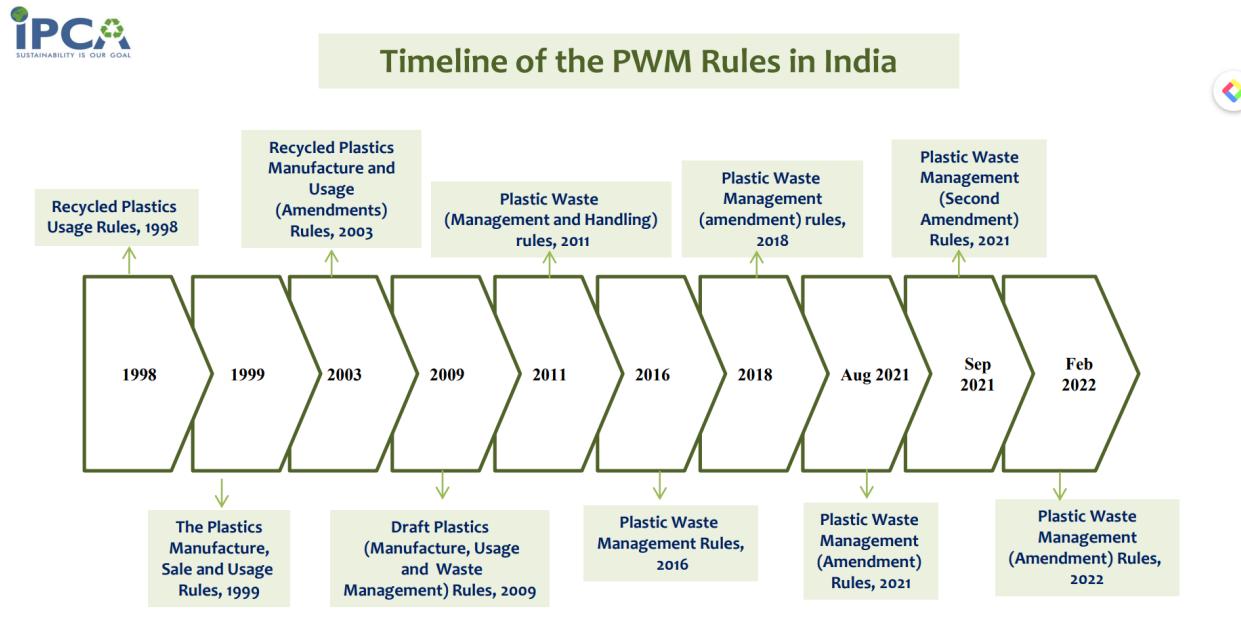
The Indian government claims that 60% of the country's plastic waste gets recycled.

- 20% of plastic waste is diverted to **co-incineration, plastic-to-fuel**, and road construction, implying that **20% of our plastic waste gets burnt** and 68% is unaccounted for.



Various states and their ban on plastic bags under 50 microns.

The Plastic Waste Management (PWM) Rules, 2022



1. Carry Bag Thickness:

- Carry bags made of virgin or recycled plastic must be at least 75 microns until December 31, 2022, and 120 microns thereafter.

2. Recycled Plastics in Food Packaging:

- Carry bags or plastic packaging made of recycled plastics can be used for food packaging according to FSSAI standards.

3. Restrictions on Plastic Sachets:

- Plastic sachets are prohibited for storing, packing, or selling guthka, tobacco, or pan masala.

4. Thickness Standards for Plastic Sheets:

- Plastic sheets not integral to multilayered packaging must be at least fifty microns thick, unless functionality is impaired.

5. Extended Producer Responsibility (EPR):

- Producers, Brand Owners, and Importers must establish a mechanism to collect an equivalent quantity of plastic waste introduced to meet their EPR obligation.

6. Registration Requirements:

- Producers, brand owners, importers, and Producers Responsibility Organizations (PWPs) must register with the State Pollution Control Board/Committee or Central Pollution Control Board through the CPCB's online portal, especially if operating in more than two states.

7. Phase-out of Single-Use Plastics:

- Single-use plastics like plastic sticks, balloons, flags, earbuds, decorative items, spoons, forks, cups, glasses, and cutlery will be phased out by July 2022.

8. Elimination of Non-Recyclable Packaging:

- Plastic packaging that cannot be recycled or used as an alternate energy source will be phased out.

9. Utilization of Multi-Layered Plastic Packaging:

- Multi-layered plastic packaging can be co-processed and used as an alternate energy source in waste-to-energy projects, cement kilns, road construction, pyrolysis, and gasification.

10. Regulation of Plastic Manufacturers:

- Manufacturers of plastic are prohibited from selling or providing raw materials to unregistered producers/processors.

11. Guidelines for Plastic Recycling:

- Plastic waste recycling must adhere to the standards outlined in IS14534:1998.

12. Local Body Infrastructure Responsibility:

- Local bodies are responsible for establishing the necessary infrastructure for effective plastic waste management.

The Plastic Waste Management Rules 2016, 2018 and the amendment in 2021 focus on single-use plastics. It prohibits identified single use plastic items which have **low utility and high littering potential by 2022**. It notifies that the **manufacture, import, stocking, distribution, sale and use** of following single-use plastic, including polystyrene and expanded polystyrene, commodities shall be prohibited with effect from the 1st July, 2022

•

Ear buds with plastic sticks, plastic sticks for balloons, plastic flags, candy sticks, ice-cream sticks, polystyrene [Thermocol] for decoration

- *Plates, cups, glasses, cutlery such as forks, spoons, knives, straw, trays, wrapping or packaging films around sweet boxes, invitation cards, and cigarette packets, plastic or PVC banners less than 100 micron, stirrers*



Role of Producer, Importer & Brand Owners

- **PIBO Registration:**
 - Producers, Importers, and Brand Owners (PIBOs) are required to register through the centralized online portal developed by the Central Pollution Control Board (CPCB).
- **Action Plan Submission:**
 - PIBOs must submit an Action Plan outlining Extended Producer Responsibility (EPR) targets through the CPCB's online portal when applying for registration or renewal under the Plastic Waste Management (PWM) Rules, 2016.
- **Brand Owner Obligations:**
 - Brand Owners are mandated to provide details of plastic packaging purchased from Producers and/or Importers separately. Quantities attributed to each Producer and Importer, which are covered by the obligation upon the Brand Owner, will be deducted from the obligations of Producers and Importers.
- **Record Maintenance by Producers and Importers:**
 - Producers and Importers are required to maintain records of the quantity of plastic packaging material made available to Brands.
- **Annual Returns for Extended Producer Responsibility:**
 - Producers, Importers, and Brand Owners are obligated to file annual returns on the collection and processing of plastic packaging waste to fulfill their Extended Producer Responsibility. These returns must be submitted to the Central Pollution Control Board or the relevant State Pollution Control Board or

Pollution Control Committee by June 30th of the following financial year, following the pro forma prescribed by the CPCB.

Indian States and their Waste Management Policies

State	Status
Andaman and Nicobar Islands	Segregated plastic waste used in recycling and road construction
Andhra Pradesh	i. Recyclable plastic channelized to recyclers ii. Non-recyclable plastic sent to cement plants and used in road construction
Arunachal Pradesh	No information
Assam	Non-recyclable plastic waste utilized in road construction and co-processing in cement industry (proposal underway)
Bihar	No information
Chandigarh	Non-recyclable plastic used in RDF processing plant
Chhattisgarh	i. Recyclable plastic sent for recycling to registered recyclers ii. Non-recyclable plastic used in co-processing in cement industry and as alternate fuel
Dadra and Nagar Haveli, Daman and Diu	No information
Delhi	Plastic waste processed through waste-to-energy units
Goa	i. 26,279.38 tonnes baled RDF sent for co-processing in cement kilns ii. 6057.62 tonnes waste recycled iii. 243.52 tonnes of inert waste disposed in sanitary landfills
Gujarat	26,279.38 tonnes baled RDF sent for co-processing in cement kilns
Haryana	Plastic waste proposed to be used in construction of roads
Himachal Pradesh	Plastic waste processed through waste-to-energy unit, co-processing in cement plants and in road construction
Jammu and Kashmir	No information
Jharkhand	i. Plastic waste used in road construction and co-processing in cement plants ii. Reverse vending machines used to collect back the plastic waste
Karnataka	i. 25,500 tonnes processed through co-processing in cement industry ii. 47,500 t recycled

State	Status
Kerala	Recyclable plastic waste collected through 117 resource recovery facilities and 513 material collection facilities
Lakshadweep	Recyclable plastic waste sent to Kochi for recycling
Madhya Pradesh	i. 52,559 MT recycled ii. 18,283 MT co-processed iii. 1,222.5 t of non-recyclable plastic waste used in road construction
Maharashtra	No information
Manipur	No information
Meghalaya	Non-recyclable waste used in construction of roads (1 km road built in Nongkynjeng village in West Khasi Hills)
Mizoram	Recyclable plastic sent for recycling (through plastic waste collection centres)
Nagaland	i. Recyclable plastic sent for recycling (through material recovery facilities) ii. Non-recyclable plastic used in road construction
Odisha	Non-recyclable plastic waste sent to ACC Ltd at Bargarh for co-processing in cement kiln
Puducherry	i. Amcor India Pvt Ltd built a 100-metre road using plastic waste ii. 272 MT MLP waste collected by Hindustan Unilever Ltd and sent for co-processing
Punjab	Recyclable plastic waste sent for recycling; collection done through ragpickers
Rajasthan	No Information
Sikkim	No Information
Tamil Nadu	i. Recyclable plastic waste sent for recycling ii. Non-recyclable plastic waste used in road construction and co-processing in cement kilns
Telangana	i. 6.34 MT used in road construction ii. 494 tonnes recycled iii. Warangal Municipal Corporation using 4-5 tonnes of waste per day in cement industries for co-processing
Tripura	No Information
Uttar Pradesh	i. 21.37 MT used in cement Industries for co- processing ii. Uflex Ltd using non-recyclable plastic waste (6 tonnes per day) for the production of fuel, carbon black and gas iii. Waste-to-oil generation plant (3 TPD) installed in Jhansi

State	Status
	iv. GPL Polyfills recycled 78,625.7 MT of PET bottles for production of fibres in 2018-19 v. Reliance Industries Ltd recycled 14,941 MT of PET bottles for the production of raw material in 2018-19 vi. Plastic waste used in road construction
Uttarakhand	Collected segregated plastic recycled through 25 recyclers
West Bengal	Polymer bitumen roads constructed by Kalyani, Chandernagore, Ashokenagar and Kalyangarh ULBs and the New Kolkata development Authority

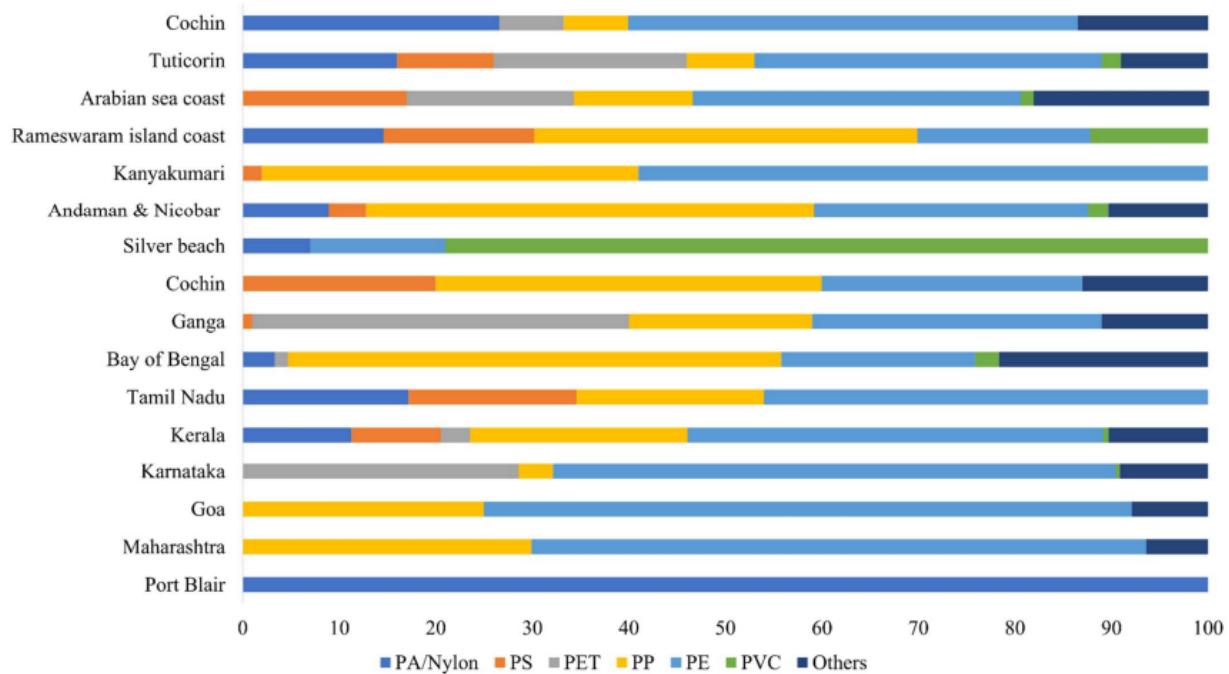
Conclusion

Source of marine Pollution

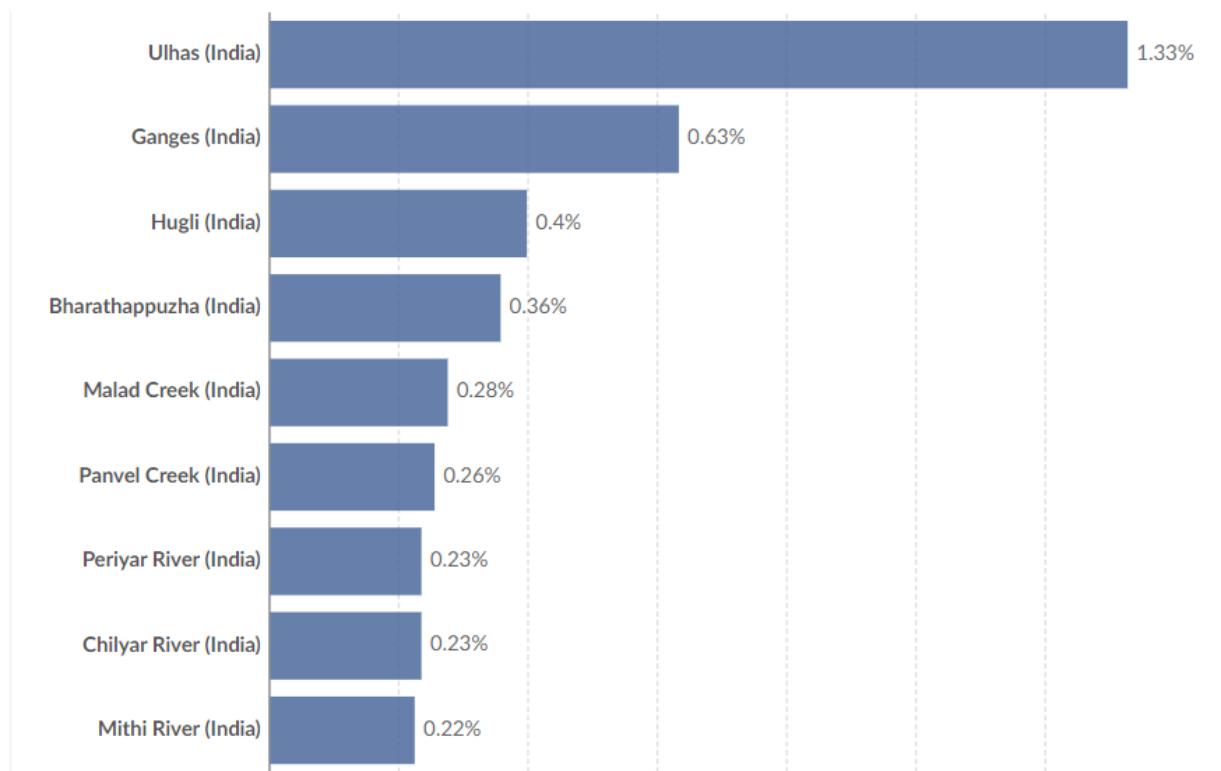
- It is clear that **main source of marine plastic pollution is land based plastic products**. Which are usually transported via smaller rivers and tributaries.
- Despite having a **population of approximately 1.4 billion**, India produces **22 metric tons** of plastic products, significantly less than the United States, the European Union, and China. But the waste generated it is a **second largest contributor** of plastic waste into the marine life.



This highlights the **inadequacy of India's management** of plastic products once they reach the end of their life cycle. ~P1



Polymer composition in different aquatic, terrestrial, and marine sediments of coastal areas in India.



*The chart above illustrates the **varying contributions of different rivers in India** to the input of plastic into the ocean.*

The two graphs above reveal that various rivers and regions in India contribute varying amounts of plastic emissions to the oceans. Additionally, there is a significant variation in polymer composition, indicating diverse types of plastic waste in each region.

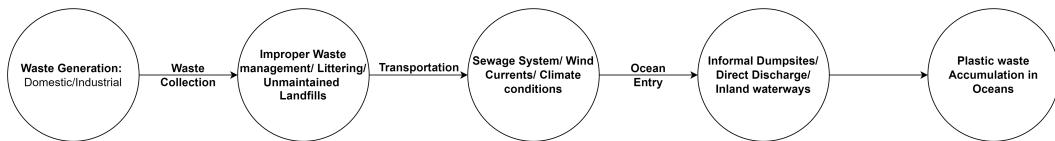


"One solution works for all" strategy **won't work** here as different regions in India have different policies, climate, policies regarding plastics. So a robust solution is needed. ~P2

Clearly the biggest concern with plastic waste in India is **not the amount of waste** produced but **ineffective waste management**, such as improperly collecting and recycling waste.

Management Includes :

- Collection of waste
- Recycling of waste



The chart above illustrates the pathway of land-based plastics entering marine ecosystems. To stop the plastic waste from reaching the marine life we need to **eliminate it from the source itself**.



The cleanup of water bodies is a positive step, but its impact may be limited if the root causes of pollution is not dealt with firstly, leading to a recurrence of the same issues.

So it's crucial to identify the flaws in current Plastic industry,

The current plastic industry is facing a number of challenges that threaten its sustainability and long-term viability. These challenges include:

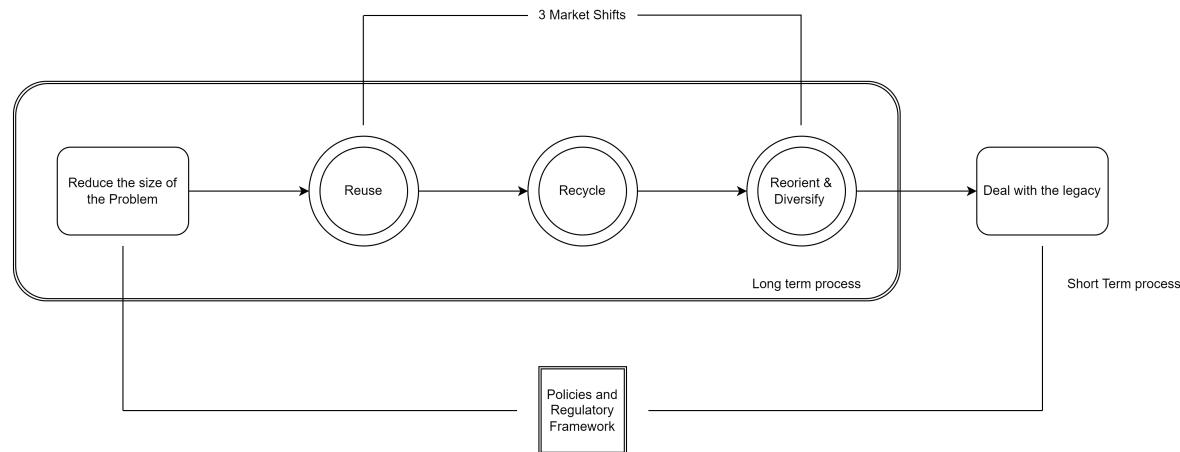
1. **Linear Production Model and lack of Circularity:** The current plastic industry operates on a linear production model, where plastic is **produced, used, and then discarded**. The plastic industry lacks a circular economy approach, where **plastic waste is recycled and reused** instead of being discarded
2. **Excessive Reliance on Fossil Fuels:** Plastic production is heavily reliant on fossil fuels, which are non-renewable resources that contribute to greenhouse gas emissions. This reliance on fossil fuels makes the plastic industry a major contributor to climate change.
3. **Inefficient Waste Management:** A large portion of plastic waste ends up in landfills, oceans, and other environments, causing harm to wildlife and ecosystems. The current waste management systems are often inefficient and unable to handle the growing volume of plastic waste. The flaws in waste management are:
 - a. **Presence of Informal Sector**
 - b. **Lack of awareness**
 - c. **Lack of segregation of waste by consumers**
4. **Design for Recyclability:** Many plastic products are not designed for recyclability, making it difficult or impossible to recycle them. This leads to a decrease in the recycling rate and an increase in plastic waste.

5. **Consumer Behavior:** Consumer behavior plays a significant role in plastic waste generation. Single-use plastics are a major source of waste, and consumers often lack awareness of the environmental impact of their plastic consumption.
6. **Economic Incentives:** The current economic system does not incentivize sustainable practices in the plastic industry. Producers and consumers often prioritize cost and convenience over environmental considerations.
7. **Insufficient Government Policies:** Governments around the world have not implemented comprehensive and effective policies to address the challenges of plastic waste management. This lack of strong policy measures hinders progress towards a more sustainable plastic industry.

Addressing the pervasive issue of plastic pollution, we have to

- **Reducing Plastic Waste Generated**
- **Improving Plastic Waste Management:**

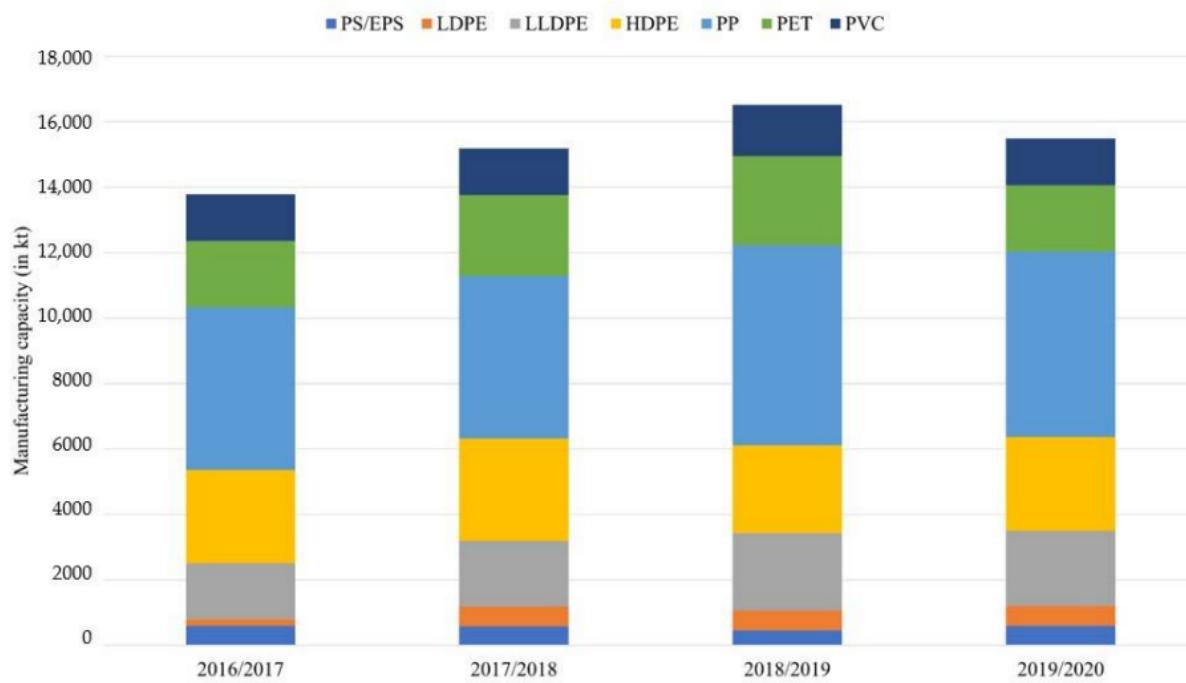
Reduce the Plastic Waste Generated



Reducing the production of plastic waste is roughly a 5 step process :

Reduce the size of the problem (Policy based):

We need to decrease the amount of **fossil based plastic** items we are producing



Manufacturing capacity of various fossil based plastic polymers in India

To achieve that we can start from **eliminating the production of unnecessary plastics**. Unnecessary plastics are those with **low utility**, like over-packaging, that can be replaced without loss of function. This includes **plastics designed for short use** when reusable alternatives exist. Substitution with more sustainable materials, validated by Life Cycle Assessment studies, is key.

Criteria to help identify problematic or unnecessary plastic uses (EMF 2020):

1. It is **not reusable, recyclable or compostable** in practice and at scale (as per Global Commitment definitions).
2. It contains **hazardous chemicals** that pose a significant **risk to human health** or the environment (applying the precautionary principle).
3. It **can be avoided** (or replaced by a reuse model) while maintaining utility.
4. It hinders or **disrupts the recyclability or composability** of other items.
5. It has a **high likelihood** of being **littered** or ending up in the natural environment.

Some examples are

Unnecessary Plastic Product	Estimated Annual Production in India
Plastic straws	8.2 billion
Plastic cutlery	5.4 billion
Plastic bags	120 billion
Plastic food packaging	25 million metric tons
Plastic sachets and packets	2.4 million metric tons
Plastic glitter	1,800 metric tons
Plastic balloons	200 million

Unnecessary Plastic Product	Estimated Annual Production in India
Plastic toys	14.4 billion
Plastic wet wipes	2 billion
Plastic cigarette filters	1 trillion

REUSE

1. Addressing Demand-Supply Gap:

- Implement reuse schemes to manage increased demand and reduced supply of plastic products by allowing a single item to serve multiple purposes.

2. Diverse Reuse Models:

- Explore various reuse models, from simple in-store bulk dispensers to complex systems involving deposits, packaging take-back, washing, and repair.

3. Examples of Reuse Models:

- Examples include reusable water bottles, food containers, bags, refill dispensers, bulk systems in retail, low-packaging subscription services, concentrated product capsules, and take-back services with reverse vending machines.

4. Depreciation of Product Value:

- Acknowledge that the value of a product used multiple times may depreciate and address this by introducing a virgin plastic tax to reduce the price gap between virgin single-use products and those promoting reduced demand for virgin plastic.

5. Costs of Shifting to Reuse:

- Recognize the substantial costs associated with transitioning to reuse models, estimating private costs at around USD 609 billion between 2021 and 2040.

RECYCLE

1. Recyclability Challenge:

- 80% of short-lived plastic products are not economically recyclable due to design issues, additives, and material combinations.

2.

Common Design Rules:

- Governments should establish common design rules to increase reuse rates and promote economically recyclable plastics, especially in sectors like packaging.

3.

Economic Recycling Incentives:

- Improve the economics of recycling by aligning design incentives, ensuring safe recycling practices, and addressing the issue of virgin plastic being cheaper than recycled materials.

4.

Plastic Waste Trading:

- Trading plastic waste from areas without recycling infrastructure to regions with surplus capacity can enhance circularity and ensure a stable supply of feedstock.

5.

External Cost Consideration:

- Governments may implement a virgin plastic tax to account for the external costs of the linear plastics economy, incentivizing the use of recycled materials.



What can be called recyclable?

According to the EMF (2020) a packaging or a packaging component is recyclable if postconsumer collection, sorting and recycling is proven to work in practice and at scale. A package can be considered recyclable if its main packaging components, together representing more than 95 per cent of the entire packaging weight, meet this requirement, and if the remaining minor components are compatible with the recycling process and do not hinder the recyclability of the main components.

Design for recycling	<ul style="list-style-type: none"> • Enhanced barrier properties for mono-materials including paper and compostables • Design additional recycling solutions for replacing multi-materials • Household goods made from recyclable mono-materials, or modular products designed for disassembly and recycling
Collection	<ul style="list-style-type: none"> • Reduced collection costs in low-income areas (especially rural, remote and other low-density areas) • Improve profitability, productivity, and working conditions for the informal sector through technology, tools and aggregation markets
Sorting and mechanical recycling	<ul style="list-style-type: none"> • New models for sorting and aggregation of waste, including automated sorting • Scaling and simplification of source separation in collection systems through regulation, education, incentives and improved standards • Improved technology to reduce sorting losses, handle food contamination, or create higher-quality output affordably, particularly for food-grade outputs • Investment in innovation in sorting and recycling technology is identified as a priority by EIB (2023)
Chemical conversion	<ul style="list-style-type: none"> • Technology, business or financing solutions to reach widespread collection of low-value plastics in remote and low-income countries • Improve process efficiency to increase naphtha fractions and reduce emissions • Technology to allow variety in feedstock composition and quality

Reorient and Diversify

Exploring alternative materials to replace virgin plastics is a critical upstream outcome in the systems change scenario to achieve a decrease in overall virgin plastic production and enable circular end-of-life management.

- Researching for better solution that is less harmful/toxic for the environment while
- Continuous research for a better solution till we reach a solution that have net zero effect on our environment.

Deal with the legacy

- Once we're done the 4 step process we can focus on cleaning the already polluted oceans.

- After dealing with the source, it is only make sense that we clean and deal with the already existing plastic waste in our water bodies.

Our Solution

	High Priority	Low Priority
Quick Fix	CleanUp Connect App Picking up our waste	Awareness Campaigns CleanUp Connect Website
Long Term Fix	Implementation of Policies Investing on Research	Implementation of education policies Educating informal Dumping Zones

In response to the identified problem statement, we have categorized the solutions into two distinct types based on temporal considerations and priority levels.

Temporal Solutions:

1. Immediate Action Strategies (Quick Fix):

- Implementation of promptly executable measures, such as community-led clean-up initiatives and heightened awareness campaigns, aiming for swift mitigation of plastic pollution in water bodies.
- Installation of immediate interventions, including trash traps and debris-collecting devices in water bodies, to rapidly alleviate the presence of plastic waste.

2. Strategic Long-Term Initiatives (Long-Term Fix):

- Adoption of comprehensive policies governing plastic production, usage, and disposal to effect systemic changes over an extended timeframe.
- Investment in research and development endeavors focused on alternative, biodegradable materials as a sustained solution to replace conventional plastics.
- Implementation of educational programs to instigate enduring shifts in societal attitudes towards plastic use.

Priority-Based Approaches:

1. High-Priority Measures:

- Immediate implementation of community-led clean-up initiatives to address the urgency of plastic pollution in water bodies.
- Stringent enforcement of regulations governing plastic production, usage, and disposal, aligning with the critical nature of the issue.

- Intensified awareness campaigns to promptly educate the public on the imminent threats posed by plastic pollution to water sources.

2. Low-Priority Interventions:

- Local implementation of ordinances to restrict single-use plastic usage, acknowledged as a measure of relatively lower urgency.
- Encouragement of innovative waste-to-energy technologies, considered a long-term approach to gradually alleviate the impact of plastic waste.
- Installation of debris-collecting devices in water bodies, representing a measure of lesser immediacy in comparison to high-priority actions.

This systematic classification offers a comprehensive and nuanced approach to addressing plastic pollution, encompassing both the urgency of implementation and the relative priority of each proposed solution.

Quick Fix - High Priority Problem:

Solution: "CleanUp Connect" Mobile App

Objective:

To address urgent and high-priority plastic waste issues in specific locations.

Features:

1. User-Driven Reporting:

- Develop a mobile app, "CleanUp Connect," allowing users to report plastic waste hotspots, informal dump sites, and pollution incidents with geotagged photos.
- Users earn rewards or points for each verified report.

2. Real-Time Alerts:

- Implement real-time alerts and notifications to local cleanup teams and authorities based on user reports.
- Encourage quick response and cleanup efforts.

3. Community Engagement:

- Foster community engagement by gamifying the cleanup process. Users with the highest impact (verified cleanups, reports) receive recognition and additional rewards.

4. Enhanced Feature for Circular Economy:

- Introduce a circular economy initiative within "CleanUp Connect" to promote responsible consumption.
- Subsidize specific plastic products, such as milk packets, incentivizing users to participate in the circular economy model.
- Users buying subsidized products will receive a unique QR code on the packaging.

5. Return and Reward System:

- Encourage users to return empty product packaging to the point of purchase using the QR code.
- Shopkeepers play a key role by collecting returned items and sending them back to producers or designated recycling facilities.
- Users are rewarded with their subsidy returned to the app, creating a cycle of responsible consumption.

6. Waste Segregation and Management:

- By facilitating the return of specific plastic items, the app promotes waste segregation at the source.
- Collaborate with producers and waste management facilities to ensure the returned items are efficiently recycled or reused.

7. Educational Component:

- Include an educational aspect within the app, providing users and shopkeepers with information on the environmental benefits of the circular economy.
- Promote awareness about the importance of returning used packaging to reduce overall plastic waste.

Quick Fix - Low Priority Problem:

Solution: "CleanUp Connect" Website [link - <http://xylemcleanup.netlify.app/>]

A website to showcase different solutions for plastic solutions for different use cases.

Purpose and Focus:

- The website is designed to serve as a comprehensive platform addressing the prevention and collection of both Macroplastics and Microplastics.
- Emphasis is placed on offering quick and accessible solutions suitable for localities, acknowledging the immediate need for intervention.

1. Nature of the Website:

- Positioned as a quick fix solution, the website offers immediate guidance to individuals unsure about the appropriate method for debris collection in nearby water bodies.
- Recognizing the low-priority nature, the focus is on gradual, localized efforts rather than urgent, large-scale interventions.

2. User-Friendly Interface:

- The website features a user-friendly interface, ensuring ease of navigation for individuals seeking practical solutions for plastic pollution in their vicinity.
- Interactive tools and guides facilitate a straightforward decision-making process.

3. Local Relevance:

- Tailored to address the needs of diverse localities, the website takes into account geographical variations and allows users to identify solutions best suited to their specific environment.

4. Education and Awareness:

- A key aspect of the website is its role in educating users about the different methods available for plastic debris prevention and collection.
- Users are empowered to make informed decisions based on their locality's unique challenges and characteristics.

5. Empowering Communities:

- By providing accessible information and resources, the website empowers communities to take ownership of their local environmental concerns, aligning with a gradual, community-driven approach.

Long-Term Solution - Circular Economy Policies:

Solution: "GreenPlast India" Circular Economy Initiative

Objective:

To implement sustainable, long-term policies for plastic waste reduction and management.

Strategies:

1. Stop Production of Single-Use Plastics:

- Advocate for and collaborate with policymakers to enforce strict regulations against the production and use of single-use plastics.
- Promote alternatives and eco-friendly materials.

2. Encourage Plastic Reuse:

- Launch awareness campaigns promoting the reuse of plastic items through community initiatives, workshops, and educational programs.
- Partner with businesses to encourage the use of reusable packaging.

3. Establish Efficient Recycling Systems:

- Collaborate with waste management authorities to enhance recycling infrastructure.
- Introduce incentives for businesses and individuals participating in recycling programs.

4. Research and Innovation:

- Establish a dedicated research fund to explore alternative materials that are less harmful to the environment.
- Support research projects focusing on innovative solutions for plastic reduction.

5. Plastic Waste Remediation:

- Invest in technologies for the effective remediation of existing plastic waste in water bodies and land ecosystems.
- Collaborate with environmental agencies for large-scale cleanup initiatives.