



Reducing Ocean Plastics - Formative Research leading to Intervention Planning in India

Research Report

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Cover Photo: Malpe Beach, Karnataka, India; Photo Credit: Abdul Latheef.P

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This research is a collaborative work, made possible by institutions coming together. The idea for intervention on ocean plastic evolved from M&S and Swasti Health Catalyst engagement, working on community health intervention (invest for wellness). M&S commitment 70 (related to protecting the marine environment) and commitment 71 (related to plastic packaging -not only recyclable but widely recycled) led the Catalyst group develop a 'business model' in the format of a social enterprise called 'Noble Plastic' that would help M&S and other brands /retailers fulfilling their circular economy and 'zero waste' related commitments. This engagement brought in the idea of intervening and addressing the issue of 'ocean-bound' plastic or plastic already in the ocean. At this stage, Natural Resources Institute of the University of Greenwich, UK got involved and provided technical and financial support for conducting a formative research that can aid in intervention planning. This is the formative research for intervention planning in India, conducted over January to July 2019. The research team deeply acknowledge and appreciate the contribution of all institutions interested and involved in developing a collaborative agenda on ocean plastic.

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LIST OF ACRONYMS

- CMFRI Central Marine Fisheries Research Institute
- CPCB Central Pollution Control Board
- CSR Corporate Social Responsibility
- DOD Department of Ocean Development
- ESSO The Earth System Science Organisation
- EPR Extended Producer Responsibility
- FGDs Focus Group Discussions
- GOI Government of India
- ICAR Indian Council for Agricultural Research
- MT Million Tonnes
- MoEFCC Ministry of Environment, Forests and Climate Change
- MoES Ministry of Earth Sciences
- MSW Municipal Sewage Waste
- NIOT National Institute of Ocean Technologies
- NIFT National Institute for Fisheries Technology
- PCCPs Personal Care and Cosmetic Products
- PWM Plastic Waste Management
- PET Polyethylene Terephthalate (PET)
- PP Polypropylene
- PS Polystyrene
- PE Polyethylene
- PVC Polyvinyl-chloride
- SWQM Sea Water Quality Monitoring
- ULB Urban Local Bodies
- UNEP United Nations Environment Programme
- UTs Union Territories

EXECUTIVE SUMMARY

The overwhelming plastic waste reaching ocean has been causing significant economic and environmental damage. About 335 million tonnes (MT) of plastics were produced globally in 2016 (Europe-Plastics, 2017) and about 242 MT of plastic waste was generated in the same year (Kaza et al., 2018). Recent research by Jambeck et al., 2015 published in the journal of *Science* has highlighted the urgency of preventing unmanaged plastic waste from reaching the ocean. Further, plastic litter are proving to be more damaging in India and there is a need to understand flow, prevention and mitigation of plastic waste from land and other sea-based sources to Indian marine waters (MoES, 2018; Kripa et al., 2016).

In the above context, this research was aimed to advance the current understanding of land based and other sources of plastics entering Indian oceans; government and private sector responses, existing policies and programmes to address plastic waste in India and potential solutions that can address the problem on a scale required as well as ideas for planning of specific interventions in specific hotspots.

Three research methods were used to collect the data namely literature review; expert interviews and interaction with fisherfolks. The findings from this research presented as per the research questions. The report concludes with a range of ideas and insights that can serve as starting points for intervention planning for reducing ocean plastic waste in India, as identified by the research participants.

Key findings and recommendations

Consistent with the literature this research identifies that land based plastic waste as a major source of marine plastic debris in India. Local experiences, as explored in this research, suggest that irresponsible waste management on land leading to release of waste into waterways which finally reaches the ocean. It is therefore coastal areas where waterways are merging into oceans are heavily infested with plastic wastes. The sources of plastics in oceans suggested by interview participants are similar to the ones discussed in the literature, and are primarily related to improper management of land based waste particularly municipal solid waste; loss of debris during fishing; illegal dumping; abandoned fishing gears; the artificial reefs that is created using plastic sacs and bottles to catch cuttle fishes; release of untreated or partially treated domestic waste; recreation and tourism. There was consensus among the respondents that plastic marine debris has increased unprecedentedly particularly in the last few years in India.

The location based study, conducted as part of this research, suggests that plastic debris have impacted livelihoods of fishermen severely (see section 3.4). Decrease in yield, loss of fishnets, increased economic burden for repair of nets; and more fishing time are some of the impacts caused due to increased plastic litter to livelihoods of fishing community.

The Plastic Waste Management (PWM) Rules, 2016 (amended 2018), notified by the MoEFCC guides the disposal and management of plastic waste by urban local bodies (ULBs) as well as other waste generators such as individual household, institutions, residential and commercial establishments and defence establishments etc. While the PWM is captured under legislative framework in India through the solid waste management rules, the challenge lies in implementing these laws with complete compliance (MoEFCC, 2018; TERI, 2018; CPCB, 2018).

This research explored some collaborative approaches that are being practiced locally to retrieve ocean-bound plastic waste. Engaging corporates and mobilising volunteers to act to collect ocean bound plastics are being practiced successfully in certain areas. Another workable and effective solution emphasized by many respondents is encouraging fisherfolks to collect plastic waste during their daily fishing expedition. Several aspects, however, need to be taken care for this approach to work effectively as highlighted by some respondents. Stakeholders primarily government; harbour departments; NGO's; and other relevant institutes need to be collaborated. The Government's help is required for allotting place for the recycling facility that is needed for processing of daily retrieved plastic waste and also for devising financial mechanisms for its operation. Similarly other non-governmental organisations and technical institutions can provide the necessary training and guidance for the workforce to collect, recycle and manage the retrieved waste. Finally, some partners need to be brought on board to promote the reuse and market of recycled plastic. The concern that expressed among interview participants for sustaining this type of effort is the proper and continuous incentives that need to be given for participating fisherfolks and also financial assistance needed to sustain such collaborative and institutional effort on a long run. If this challenge is addressed, then this model works best in the Indian context to retrieve plastic waste from the ocean.

Interview respondents also identified various approaches that are needed for land based plastic waste management in addition to reuse and recycling of plastic waste. These options include reducing plastic dependency, effective enforcement of legislation, enhanced public awareness, and managing plastic waste at source.

The findings of this formative research suggest that 9 possible multidisciplinary actions that are needed to manage ocean plastic. These actions, though not necessarily sequential, are projected as such to provide a semblance of step-wise, systematic and coordinated interventions that are most likely to be successful.

1. **Understand the main underlying factors and their interconnections:** the research found important underlying factors (that are inter-connected) or causes that need effective response to reduce ocean-bound plastic and plastic already in the ocean. Geological context increases the likelihood of ocean-bound plastic. Similarly, inadequate awareness and wrong incentives cannot promote a proper response to prevent 'ocean bound' plastic. At the same time or a consequence to the above factors, improper management of solid waste compound the 'problem'. These underlying factors and their relationships would need to be understood for intervention planning.
2. **Conduct deep-dive research and assessment studies:** given the long coastline of India and the enormity / severity of the problem, more assessment studies are required. These assessments provide the required baseline data for understanding the spatial and temporal distribution of plastics (and micro plastic) in open and coastal oceans (IUCN, 2014). Also these assessments help design adequate monitoring programmes that guide cleaning efforts.
3. **Learn from existing national and international best practices in this space:** as these initiatives have tried out a range of practices for plastic collection from the ocean (scuba diving volunteers, trawler boats, fisherfolk incentivised) and also ocean-bound plastics from land-based collection centres, where local communities are involved and incentivised. These initiatives have also experimented with various technologies for plastic shredding and recycling.

4. **Develop and facilitate business /market-based models:** there is ample opportunity for facilitating business models to address both insufficient waste management facilities and to improve recycling businesses in cities/towns thereby avoiding open dumping or dumping near water bodies. The research has provided some initial understanding of how business models can be developed and sustained.
5. **Use a range of available /tested technologies and approaches for collection and recycling of plastic:** as indicated by this research, ongoing initiatives and technological advancement provides a range of tested technologies and approaches for collection and recycling of plastics. These should be appropriately selected for a location-specific intervention.
6. **Develop Public Private and Community Partnership (PPCP) models and mobilise:** Local authorities, businesses and communities need to come together for planning any intervention for reducing ocean plastics. This needs to be facilitated by implementing consortium of actors. A collaborative agenda would need to be developed through this engagement, wherein specific collaborator can choose to play specific roles.
7. **Advocate with large businesses and brands to take actions** encouraging recycling economy collaborating with ULBs to improve waste collection systems, thereby ensuring that their products are collected and responsibly managed at end-of life (Godfrey, 2019).
8. **Engage in policy forums for stressing the need for a marine litter policy at state and central levels:** We recommend this as an important step to address the growing threat of marine plastic problem in India. Supporting the view of Kripa et al., 2012, we believe that this type of strategy will help 1) Collect litter from the marine environment through incentives 2) Provide Incentives to fisherfolks for marine litter collection (see section 3.5.1) 2) Incentive schemes to promote proper disposal of discarded fishing gear 3) Provision for salvaging yards for fishing vessels.
9. **Finally, advocating improved legislative framework, learning from the UK Plastic Pact and other such Governmental initiatives:** Improved collection provides opportunities to grow local reuse, recycling and recovery economies, which are not possible with high levels of uncontrolled dumping. This research recognises the importance of improved waste collection and strongly recommends for ensuring proper disposal of land-based waste as prescribed by Godfrey, 2019. The UK Plastic Pact is a good example to follow as central and state governments in India can marshal needed resources and work with private sector companies to address the issue.

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1. INTRODUCTION

1.1. Background and rationale

Plastics are synthetic organic polymers. There are two categories of plastics i) Thermoplastics - which can be reheated, reshaped and frozen repeatedly and, ii) Thermosets - which cannot be re-melted and reformed. These plastics are comprised of a variety of materials designed to meet the very different needs of end products and the most common types of plastics include Polyethylene Terephthalate (PET); Polypropylene (PP); Polystyrene (PS); Polyethylene (PE); Polyvinyl-chloride (PVC); Expanded polystyrene (PS-E) etc. (See Europe Plastic, 2017). The use of plastics gained increasing popularity among consumers for their efficient use particularly in packaging, food preservation, medical product efficacy, electrical safety, improved thermal insulation, lower fuel consumption in automobiles and in the construction and agriculture industry. In order to meet the increasing demands of consumers and markets, the global plastic production has continued to dominate. About 335 million tonnes (MT) of plastics were produced globally in 2016 (Europe-Plastics, 2017). Figure 1 shows the global plastic production and future trends¹.

While various applications of plastics have proved beneficial and efficient to the society, its extensive use and improper disposal is leading to enormous generation of wastes across the globe. In 2016, about 242 MT of plastic waste was generated in the world (Kaza et al., 2018). Plastic wastes enter the environment through poorly managed systems primarily through open dumping, open burning, improper solid and liquid waste discharges, etc. In recent times, it has been reported that plastic is ubiquitous and substantial amount of these plastic wastes (both macro and micro plastics) are finding their way into oceans. Many researches have indicated increasing levels of plastics rapidly affecting the marine ecosystem in many ways (e.g. UNEP, 2017; Law, 2017; Thomson et al., 2009; Moore 2008; Jambeck, 2015).

There have been convincing evidence to indicate that marine plastic litter pose serious risks to marine biota and raise socio-economic concerns (Thomson et al., 2009; Ryan et al., 2015). Various researches have documented how marine plastic affect aquatic biota (see for example Kuhn et al., 2015; Rochman 2015; Kiessling et al., 2015). Plastic debris cause the deaths of more than a million seabirds and more than 100,000 marine mammals every year. More than 800 species, 40 percent of marine mammals and 44 percent of seabird species are affected by marine debris ingestion (Ocean Conference, 2017). Further, it is clear that the marine plastic litter exert substantial economic costs, although it is difficult to account indirect intangible impacts of marine plastic litter (See Newman 2015) and social implications including affecting human health and livelihoods of people (see Galloway 2015).

¹ Picture credit: UN ARENDAL (cartographer: Maphoto/Riccardo Pravettoni) <http://www.grida.no/resources/6923>

Furthermore, marine micro plastic debris may compromise human food security, food safety and health as micro plastics have been detected in commercial seafood and other food items and drinking water (Barbozza et al., 2018).

As of 2015, approximately 6,300 MT of plastic waste had been generated, around 9% of which had been recycled, 12% was incinerated, and 79% was accumulated in landfills or the natural environment². If current production and waste management trends continue, roughly 12,000 MT of plastic waste will be in landfills or in the natural environment by 2050 (Geyer et al., 2017).

Analysis by the World Economic Forum - New plastic economy (2016) reveals that in a business-as-usual scenario –there could be more plastic than fish by 2050. (it is estimated that plastics stocks in the ocean of about 850-950 MT by 2050, versus fish stocks of 812-899 MT). Overall the impact of plastic in our ocean is going to be enormous.

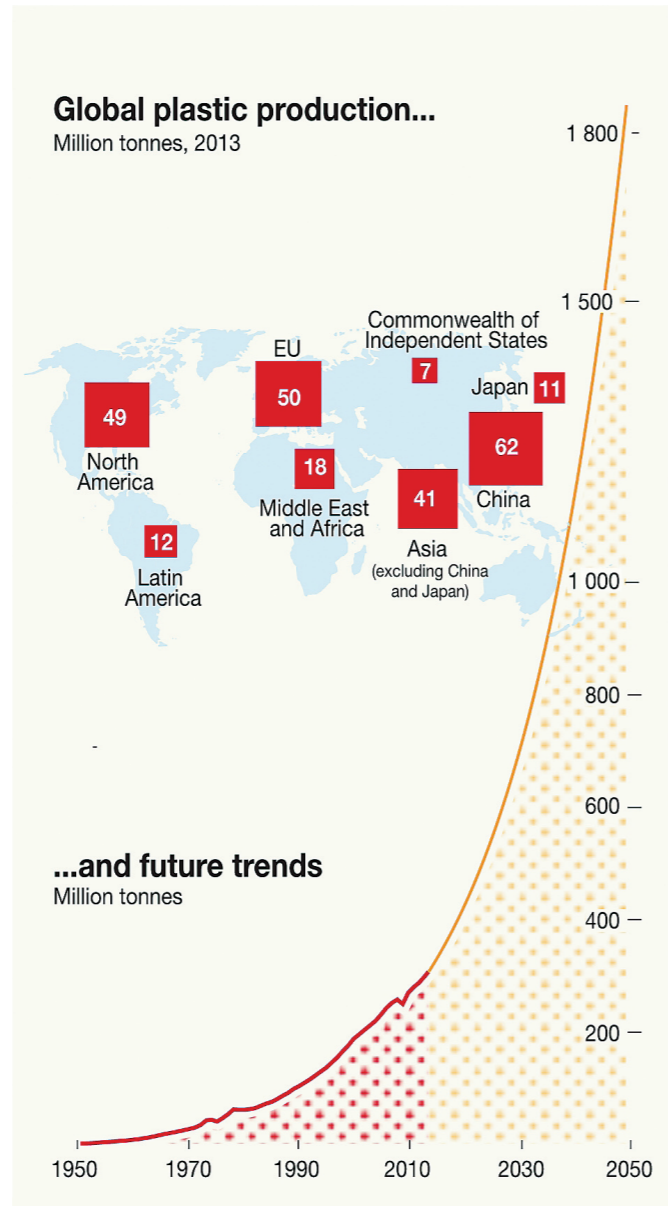


Figure 1: Global plastic production and future trends. Picture credit: UN ARENDAL (cartographer: Maphoto/Riccardo Pravettoni)

In India too plastic has quickly replaced usage of other materials including rubber, metal, stone, concrete, wood, etc. The growth of the petrochemical industry and the increased per capita consumption of plastic accelerated the plastic production in India. As a result, there are currently about 22,000 plastic processing units and about 150 plastics processing machinery manufacturers in India. It is predicted that the domestic plastics consumption in India will reach about 20 million Metric Tonnes by 2020 (MoEFCC, 2018). India, being a populous country, with growing per capita plastic consumption is anticipated to be facing more risks from ocean plastic debris (see Jambeck, 2015; MoES, 2018).

There is, therefore, a need to understand the flow, prevention and mitigation of plastic waste from land and other sea-based sources to Indian marine waters (MoES- UNEP, 2018; Kripa et al., 2016).

Given this context, the current research will serve to advance the understanding of land

² The quantity of plastic entering the ocean from waste generated on land is unknown. By linking worldwide data on solid waste, population density, and economic status, Jambeck et al., 2015 estimated the mass of land-based plastic waste entering the ocean. As per their estimate about 275 million metric tons (MMT) of plastic waste was generated in 192 coastal countries in 2010, with 4.8 to 12.7 MT entering the ocean.

based and other sources of plastics entering Indian oceans; government and private sector responses, existing policies and programmes to address plastic waste in India and potential solutions that can address the problem on the required scale, as well as ideas for planning specific interventions in identified hotspots.

1.2 Research objectives

The authors of this study have carried out an extensive synthesis of existing evidence as well as interviews with experts, stakeholders and communities, with the following research objectives:

1. To understand ‘the problem’ and its severity in different parts of India, particularly to know how plastics from land based and other sources are entering in Indian oceans;
2. To document national level governmental response in terms of policies and programmes to tackle ‘ocean bound’ plastic pollution in the country;
3. To understand the private sector and civil society led interventions in India and their approaches;
4. To study the hotspots in and around coastal areas and cities with inadequately managed plastic waste, thereby increasing likelihood of plastic getting into the ocean;
5. To find ways in which ocean-bound plastic waste and that already in the ocean can be collected locally;
6. To identify effective solutions for recycling and reuse of different types of plastic waste collected locally; how these solutions can be applied and collaborations and collective efforts are needed.

The six research objectives were framed as research questions. Specific aspects focussed under each research question is as depicted in Figure 2.

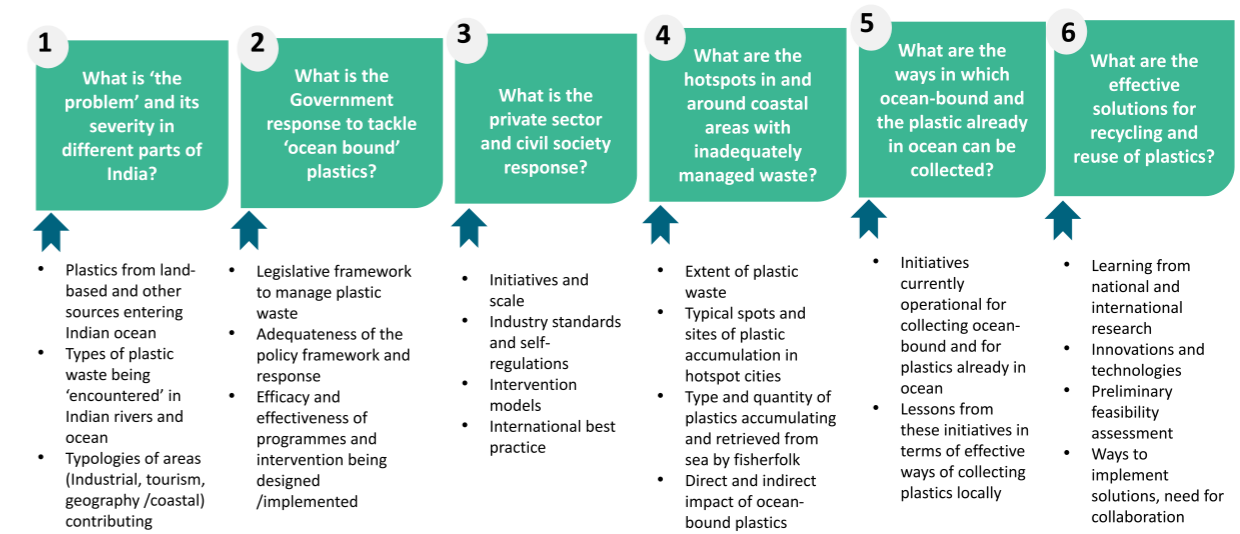


Figure 2. Research questions

1.3 Structure of the report

The report is presented in four chapters, including the Introduction. Chapter 2 describes the research methods adopted to collect data. Chapter 3 presents the research results on the research questions. Conclusions on the findings and suggestions for intervention planning and directions for further research are discussed in Chapter 4.

2. RESEARCH METHODS

2.1 Introduction

Three research methods were used to collect the data namely literature review; expert interviews and visit hotspots and interaction with fisherfolks.

2.1.1 Review of literature (Secondary research)

Secondary research (i.e. literature review) was conducted primarily to identify, review and synthesise existing evidence related to the study questions. Surveys and technical reports by Central Pollution control board (CPCB) were also reviewed to estimate plastic (statewise) waste generation in India. The literature assessment also provided an understanding of the quantity of plastic waste reaching oceans in India.

The types of documents / literature reviewed include technical reports and journal articles (Plastics and marine litter related); acts and regulations (e.g. *Plastic waste management Rules, 2016; amendments 2018; swachha Bharat Abhiyan 2014*); and waste management plans and reports (e.g. CPCB technical and annual reports; MoES technical reports on marine litter). Information gathered from these documents were verified and explored, where relevant, during the interview process.

2.1.2 Interviews with key informants

In the context of this formative research, it was important to explore perspectives on marine plastic litter from relevant key stakeholders, which was collected through semi-structured interviews. The expert interviews also served to verify information from literature reviews and fill any gaps in understanding of the current responses from government and private sectors in addressing the marine plastic litter challenge.

Selection of interview participants / key informants:

With an intent to collect diverse perspectives, three groups of interview participants were identified - namely government (e.g. regulators, pollution control board staff), academic researchers (e.g. researchers working in central research organisations or universities), and NGO/ private sector professionals.

An initial list of participants was compiled based on the information available in the grey literature (e.g. conference reports, research reports and articles, websites etc) and their contact information was obtained from the respective websites. The desk research showed that very few researchers are engaged in the assessment or quantification of marine plastic litter in the country. The participants were then contacted either through email or telephone to request their participation in the research. An invitation letter describing the summary and significance of the research was sent to all participants prior to interviews. After obtaining their consent to participate, a convenient time was scheduled for the interview. Interviews ranged from 45 to 60 minutes in duration. All in-person interviews took place at the participants' respective offices.

The study team reached out to 21 key informants through email, of which nine did not respond, three declined to participate and nine agreed to do so. These nine interviews were conducted between May and June 2019.

Interview schedule

The interview schedule focused primarily on the following four topics:

- i. Type of plastic litter and the extent of the problem
- ii. Locales of sources/ drivers
- iii. Key government and private sector response
- iv. Interventions: Local approaches adopted to collect plastic waste in the ocean and plastic waste management efforts (recycling and reuse) that are practiced and needed.

Participants were asked several sub-questions to explore their views on, and experience with each of the above. Interview questions differed slightly based on each participant's expertise with respect to their work on marine plastic litter.

2.1.3 Field visit to hotspots and Focus Group Interviews (FDGs) with fisherfolks

Three hotspots namely (a) Kochi, Kerala, (b) Panambur, Karnataka, and (c) Marina, Tamil Nadu were selected. The literature suggests that litter in all of these beaches is strongly influenced by land and marine based anthropogenic activities such as municipal plastic waste, tourism and fisheries activities (e.g. Kumar et al., 2016; Naidu et al., 2018; Sulochanan et al., 2011). The Kochi and Panambur hotspots are situated on the West coast of India and Marina is located on the East coast. The research team visited three hotspot between 15th June and 1st July 2019 to get a sense of the severity of the problem and directly observe the issue of marine plastic waste problem in these areas. During field visit, research team interacted with fisherfolks and local experts to explore:

- Plastic waste being generated by these places, and mapping its pathways to the ocean;
- Typical spots in these coastal towns are where plastic is accumulating (due to currents) and any seasonal/monthly changes;
- Type and quantity of plastics observed / encountered and possibly retrieved from the sea by the fisherfolk;
- Direct and indirect impacts on ocean-bound plastics and plastics already in ocean on fisherfolk livelihoods

2.2 Data analysis

Recorded interviews were transcribed and coded through a grounded approach based on the range of themes that emerged from the participants' responses and from literature reviews.

The overall focus of data analysis was to identify themes amongst participants' responses to understand the status and extent of marine plastic litter problem in India, and also to identify current responses and interventions needed in these areas to advance understanding.



3. RESULTS AND DISCUSSIONS

The findings of interviews and literature review are presented in this chapter. The results are presented as per the research questions. Data from literature review are supplemented with the interview data and analysed under respective themes of research questions. The chapter concludes with needs and approaches to address the issue of plastic waste in India.

3.1. Research question 1: Understanding the ocean plastic waste problem

3.1.1 The plastic problem along the coasts and in oceans is severe and alarming

Worldwide ocean plastic problem has received increased attention in the recent past owing to its threat to marine biota and losses to livelihood of millions of people. In India too oceans are affected by plastic wastes given India's increasing plastic consumption and lack of waste collection and management facilities.

As per Jambeck's research, India has nearly 87% of plastic waste (see Figure 3) that is inadequately managed, which have a high risk of polluting rivers and oceans.

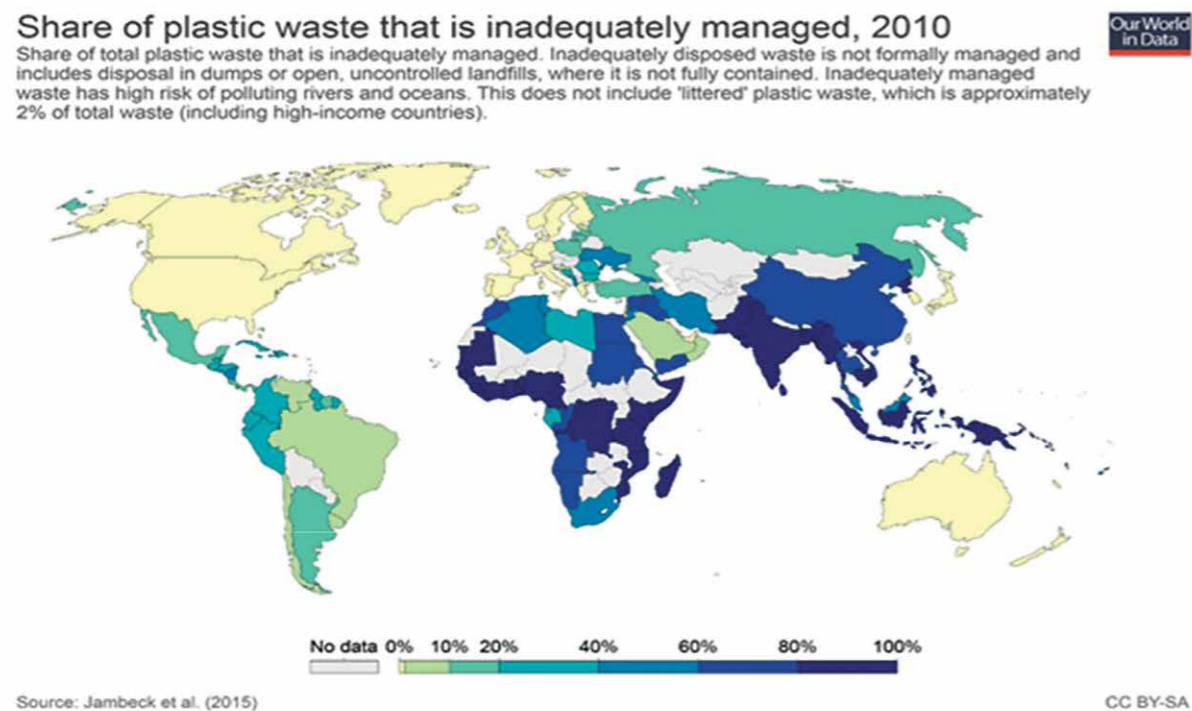


Figure 3: Share of inadequately managed plastic waste in 2010 (source: Jambeck et al., 2015)

All study respondents agreed that plastic infestation has become a serious problem across the Indian coast and in the oceans. There was a consensus among the respondents that plastic pollution has increased unprecedentedly, particularly in the last few years in India. An interviewee who works with fishermen to address plastic issue along the west coast explained that

“In the recent years (3 to 5 years) when we draw the net into the bottom of the sea, we are seeing a steady increase in the amount of plastic getting entangled in the net. This was not the situation 10 to 15 years ago. In recent years the fishermen often find more plastic than fish in their net”

Another respondent who is a consultant described the current state of the problem as very severe. He shared the experience of tourists engaged in water sports such as surfing, scuba

diving and snorkelling. *“They come every season in this area. They shared that earlier plastic waste was not an issue, but today they are unable to photo a coral reef that does not have a piece of plastic on it. Some share videos of plastic being moved along with coral reefs by the ocean currents.”*

A scientist who has been working in the area of marine litter suggested that *“about 90% of marine litter is some type of plastic and these are in micro, meso, macro sizes”*.

One of the respondents who regularly volunteers in coast clean up drives shared his experience

“after one tide we swept clean the entire coast, but when the next tide came at noon the same amount of trash was once again deposited at the shore”

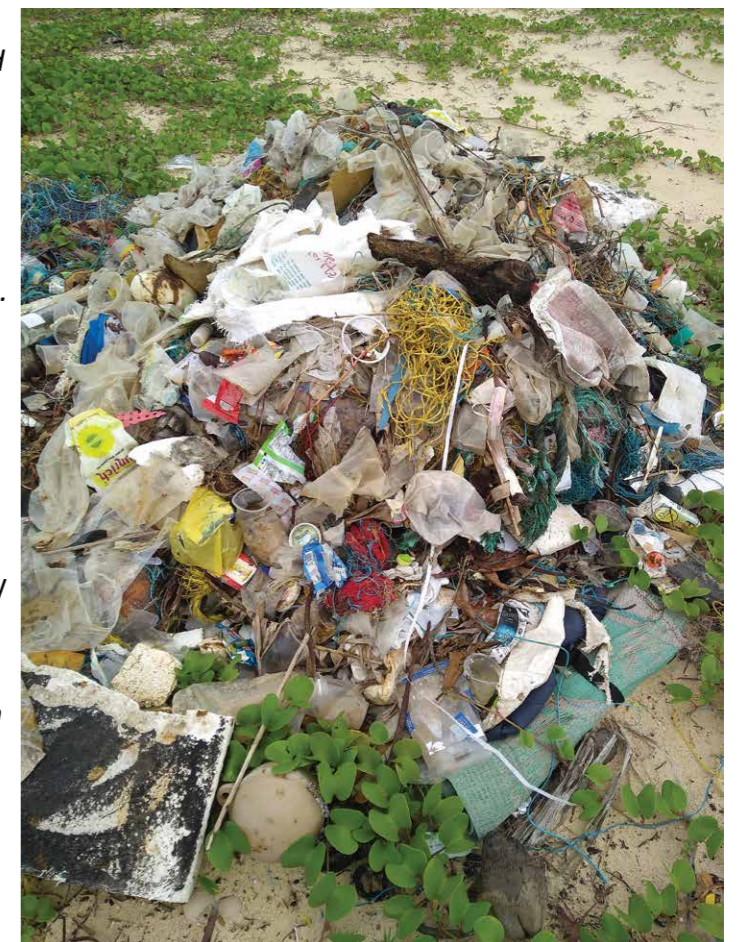


Figure 4: Variety of plastics found in the Panambur beach, Karnataka (June, 2019)

In sum, the plastic problem along the coasts and in oceans is severe and alarming and calls for immediate action to reduce plastic inputs into oceans in India.

3.1.2 Land based plastic waste is a major source of ocean plastic in India

Ocean bound plastic waste has two main sources namely land based and sea based. Literature suggests that about 80% of ocean bound plastic is land based and 20% is sea based. The marine plastic debris are found in various sizes ranging from microns to meters. Depending on their size they are classified as Micro³ and Macro⁴ plastics.

Leakage of macro plastics happen in every stage from its production to usage and final disposal: two main pathways include improper solid waste and waste water management practices. It is considered that the only major source of plastics to the ocean is improperly managed plastic waste generated on land (Jambeck et al., 2015). Therefore, land-based plastics waste contribute extensively (more than 80%) to plastic in oceans⁵. (See Annexure A1 and A2 for a brief account on land based and sea based plastic waste generation activities and their pathways).

³ Plastic particles that are smaller than 5 millimetres in diameter are microplastics (Arthur et al., 2009). Microplastic are widely used as abrasive agents and fillers in a wide range of personal care and cosmetic products (PCCPs) (e.g. toothpaste, facial scrubs, shower gels, sunscreen etc). They are also used as fibres in synthetic clothing. These microplastics are released into wastewater upon washing. The microplastics in the effluent discharge from treatment units ultimately reach the ocean through waterways (capture of microplastics depends on the effectiveness of treatment process) (UNEP, 2016).

⁴ Macroplastics are larger plastic debris (particle size > 5 millimetre) found mainly as litter in the environment

⁵ IMO/FAO/UNESCO/WMO/WHO/IAEA/ UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP). The State of the Marine Environment, Rep. Stud. Gesamp No. 39, Blackwell Scientific Publications, London, 1990, p. 111.

The study explored sources and pathways of marine plastic debris in the Indian context. All respondents suggested that while both fishing industry (sea- based) and land based plastic waste contribute to ocean plastic pollution in India, the mismanaged waste from land based sources, particularly municipal solid wastes and sewage waste are the major drivers of ocean plastics in Indian oceans. One respondent explained that “*primarily the ocean plastics are land based and mostly concentrated around the estuaries emerging through townships*”. Similarly, another respondent noted that “*the majority of the plastic in the ocean is land-based waste such as sachets, biscuit covers, bottles, caps, straws, earbuds, tubes of toothpaste and face wash, pen, clothes, etc*”.



Figure 5: Sources and pathways of ocean plastics

Further, a respondent described it as a problem of irresponsible use of plastic and inability of waste contributors to comprehend the problem of this potentially ocean-bound plastics. He explained that “*there is a culture in our society that is totally blind to misuse of plastic waste in the land and they think – once the waste is thrown away from their sight – the problem is solved – but this ends up in the ocean and affects the marine biodiversity. People in the land cannot see and don’t understand the extent of the problem of ocean plastic and continue to behave irresponsibly. Fishermen knows the depth of the problem and they are seeing it every day.*”

Most respondents confirmed that the land based wastes are reaching the oceans through shared waterways like river systems, streams, backwaters and eventually reaching the ocean. Hence, the places where waterways *especially in the coastal areas where the backwaters are merging with the sea can be considered as hot spots.*”

Types of plastic waste encountered in oceans and waterways as noted by interview participants

Plastic bottles, plastic carry bags, thermocol, sachets, biscuit covers, bottles, caps, straws, earbuds, tubes of toothpaste, face wash, pens, clothes, monofilament fishing nets, broken fishing ropes, beach tourism related waste, sewage, shipping, tourism, industrial related, food packing, milk cover, fragmented fishing nets.



Figure 6: Marine litter found near the coast of Kochi mostly with the rubber items (July 2019)

Illegal dumping is one of the causes for plastic pollution in certain places. The traders or contractors of waste management collect the waste, remove recyclable materials and dump the rest near or in the water bodies.

A respondent shared his experience in detail. He explained it “*as the new trade of plastic waste handling where local plastic waste is brought in legal shipments to Thoothukkudy (coastal town) for the purpose of recycling and non-recyclable material will be dumped to oceans or nearby water bodies. He further said that they “find plastic packets which are not of Indian origin being washed onto the shore.”* He cited following example of illegal dumping:

- In 2006-2007 we had a container coming to Kochi port labelled as material for paper recycling. The container was too large to fit in a truck so the person responsible for receiving the shipment opened the container in the port itself. It was full of municipal waste of New York city. Because it was opened on the port, people found out about the contents and finally government sent it back. We could send back one shipment but we don’t know about the rest.

Few of the respondents were also concerned about the threat by the enormous micro plastics that is collecting at the bottom of the sea. A respondent who is a scientist working in the area explained that “*once the plastic reaches the ocean only 1% floats at the surface, 5% travels to the shoreline and the remaining 94% sinks to the bottom. A major part of this disintegrates into micro plastic*”. The macro plastic reaches the bottom of the sea and have secondary effects.

Ghosts nets is an issue of concern contributing to marine plastic litter in India

Ghost nets are another source of marine plastic litter in India (See Kripa, 2018; FAO, 2015) Ghost nets are classified under Abandoned, Lost or otherwise Discarded Fishing Gear (ALDFG) which includes lines, traps, hooks, dredges and buoys (See FAO and UNEP, 2009). High quality synthetic nets can last in the oceans for decades, and lead to micro-plastic ingestion by aquatic life. Friends of Marine Life – a Thiruvananthapuram based NGO collected 400 kg of ghost nets in 90 minutes from several places off the coast of the Kerala capital⁶. An abstract presented by Dr. Saly Thomas to the National Conference on Marine Litter highlights the increasing threats from an ALDFG problem in India and suggest that about 26% of the

⁶ For more information visit <http://fmlindia.in/>

total beach litter in Kerala was from fish-induced debris (Kripa, 2018,). She further indicates that roughly 15,400 gillnets and 728 traps are likely to be lost/abandoned annually in India⁷.

Many of the key informants specified that the ALDFG is a significant problem in their areas. One respondent explained that *“the ghost nets, which are discarded by the fishermen or torn away or dumped in the ocean as a result of boat capsizing, get deposited at the sea bottom and harm the coral reef. She further described the problem of ghost nets as “Ghost fishing that is unintentional catching of fishes and turtles etc in the remains of fish net that are abandoned or when torn by the passing ships or trollers. This will float and after a period gets fragmented and become micro plastic which the aquatic biota considering it as food consume and feel they are full and yet they have not consumed food and starve to death.”*



Figure 7: Broken and abandoned fishing nets were a common scene along Panambur beach, Karnataka (June 2019)

⁷ Author bases her estimation on FAOs estimate on the average annual loss of gill nets and traps which is 10% and as per CMFRI 2012 census India has 154008 gillnets/drift nets and 7285 traps in operation

Another respondent shared that *“Mono filamentous nets are problematic. They are very transparent, cheap, irreparable and catch fish easily. If broken, they are discarded into the ocean and lead to ghost fishing. Spoiled fishing gear and fishing ropes are thrown into the sea. Micro plastic fibres in the ocean gets back in to our food chain.”*

In addition, the artificial reefs that are created using plastic sacs and bottles to catch cuttle fish leaves huge amount to plastics in the ocean. Many fishermen practices this. A participant explained, *“Some people illegally create artificial reefs using plastic sacs and bottles filled with sand to attract the cuttle fish. The fish stick eggs to it and when they grow in size they are caught from these reefs. This also leaves plastic waste in the sea. The blades or thorn like structure which are stuck to the big ships for protection from sea pirates are also discarded into the ocean. The waste from the ships are sometimes put in big barrels and thrown into the sea which go to the bottom of the sea.”*

In sum, it is evident that incidences of land based and sea based plastic waste reaching ocean in India is high through various routes - primarily mismanaged municipal waste, illegal dumping, abandoned fishing gears, and artificial plastic reefs.

3.1.3 Plastic production and consumption patterns of India contribute significantly to ocean plastic waste

One of the major causes, as discussed widely in the literature, for the increased plastics in the ocean is increased use of plastic with very less reusing and recycling.

The plastic industry in India has seen a steady growth since its establishment in the 1960s. A study by the Federation of Indian Chambers of Commerce and Industry (FICCI, 2017) indicates that plastics processing industry has grown at a Compound Annual Growth Rate (CAGR) of 10% in terms of volume from 8.3 Mega Metric Tonnes Per Annum (MMTPA) in 2010 to 13.4 MMTPA in 2015 and is expected to reach 22 MMTPA by 2020 (with a growth rate of CAGR of 10.5%) (see Figure 8a).

Current per capita consumption of plastics in India is 11 kg per annum, much less compared to the world average (28 kg) and countries such as the US (139 kg), EU (65 kg); China (38 kg) (FICCI 2017) (see Figure 8 b). However considering its anticipated growth rate coupled with increase in expected population and usage rates, the plastic consumption rate will rise. The broad range of plastic applications in India include packaging films, wrapping materials, shopping and garbage bags, fluid containers, clothing, toys, household and industrial products, and building materials (See Figure 9).

Trend in plastic production in India (m tonne per annum)

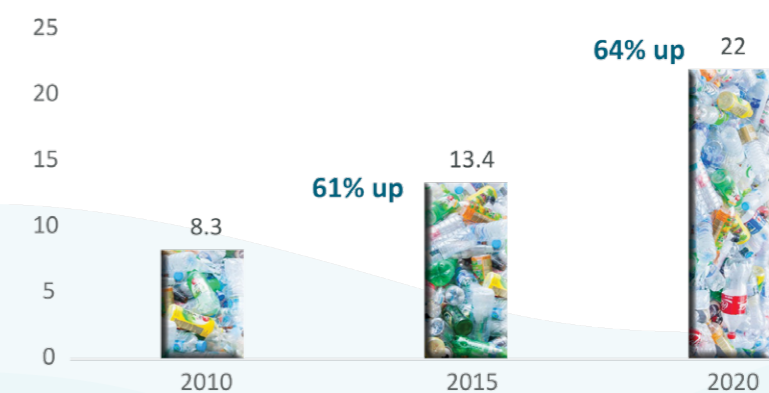


Figure 8 a): Plastic production in India (Source: FICCI, 2017)

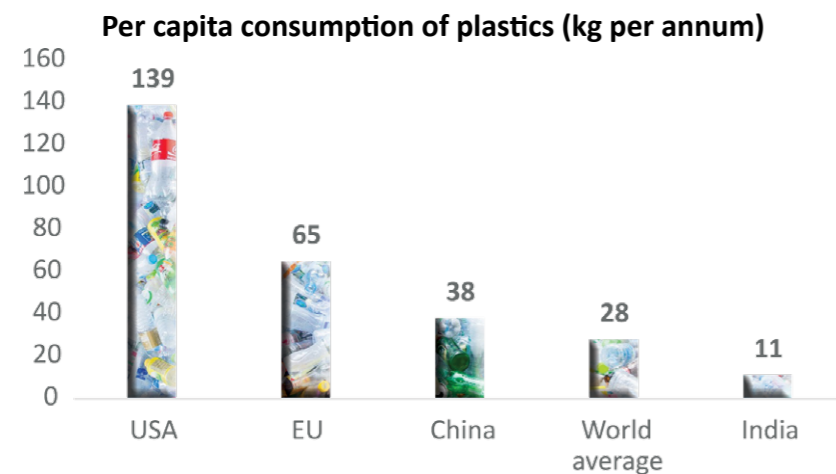


Figure 8 b): Per capita consumption of plastic (Source: FICCI, 2017)

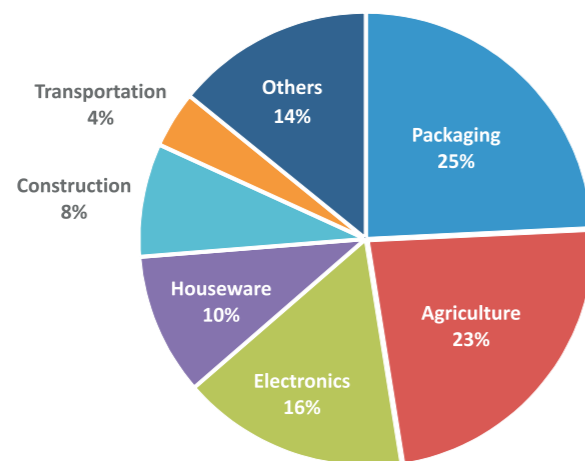


Figure 9: India's plastic consumption by application (Source: MoES, 2018)

3.1.4. Estimate of India's plastic waste generation (land based)

It is estimated that about 62 million tonnes (MT) of waste is generated annually in the country, out of which 5.6 MT is plastic waste (PIB, MOEFCC, 2016). Out of 62 MT waste only about 43 MT is collected, 11.9 MT is treated and 31 MT is dumped in landfill sites (See Figure 10). This means that only about 75-80% of the municipal waste gets collected and only 22-28 % of this waste is processed and treated. In one of the press addresses, the then minister of Environment Shri Prakash Javadekar noted that "Waste generation will increase in India from 62 MT to about 165 MT by 2030". (See Annexure B for composition of plastic waste in India)



Figure 10: Estimate of India's plastic waste generation and management in 2016 (Source: PBI, MoEFCC, 2016)

In another study undertaken by the Central Pollution Control Board (CPCB) in collaboration with the Central institute of plastic engineering and technology quantify plastic waste generation in 60 cities in India during 2012. It revealed that a total of about 4059.18 tonnes of plastic waste per day was generated by these cities with highest being in Delhi (669.5 T/D) followed by Chennai (429.39); Kolkata (425.72); Mumbai (408.27) and Bangalore (310.87) (See table 1)

Table 1: Estimate of plastic waste generation per day in Indian cities

Cities	Total MSW (Tonnes per day)	Plastic Waste (Tonnes per day)	Plastic Waste (Percentage of MSW)
Delhi	6800	669.52	10.14
Chennai	4500	429.39	9.54
Kolkata	3670	425.72	11.60
Mumbai	6500	408.27	6.28
Bangalore	3700	310.87	8.48

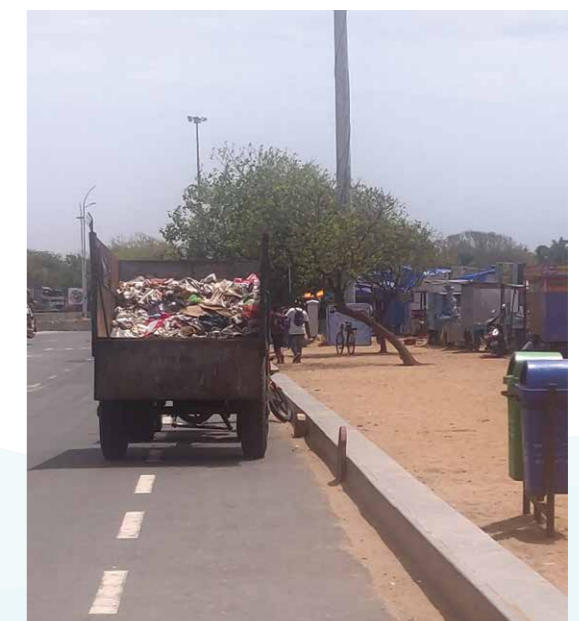
Source: CPCB, 2015

As per the annual data on plastic waste generation collected by CPCB across Indian states in 2013, about 15,342 tonnes of plastic waste was generated every day, of which about 60 percent was recycled, most of it in the informal sector. Twenty-five Indian states/UTs now have some form of ban on polythene carry bags (partial or complete ban), but the implementation is often a challenge and the bags continue to be used (See Annexure C Estimated plastic waste generation in Indian states).

3.1.5 Current practice of plastic waste collection, disposal and management in India is not effective to prevent it from going to the oceans

As discussed, plastic waste generation in India is huge despite India's successful ban on plastic carry bag imposed in many states. Plastic waste collection and segregation in India is predominantly driven by informal waste pickers. In cities, the city corporation is responsible for collection of waste generated at various residential areas of the city. In some cities, waste segregation (as wet and dry) happens at source (collection point at household) and in some cities the extreme segregation is done at the dumpsite. Segregated plastics wastes is sometimes sold to the scrap dealers.

In many cities wastes is collected by rag pickers before dumping in the open dump yard. Several practices have been adopted by cities in India for the disposal of plastic wastes from open dumping to landfilling to post-treatments plants (e.g. incinerators) to plastic recycle units etc. Also, in some cities if open dumping yards are not available then the plastic waste is dumped in nearby waterways primarily rivers. For example, the waste collected in Bhagwati Nagar in Jammu and Kashmir dumps its plastic waste (primarily plastic bags) to Tawi River due to lack of open yards (CPCB, 2015).



It is also possible that the no post-treatment operation for MSW is carried out in the city and all MSW is dumped as land-filling. The study conducted by CPCB (2015) reports that in many cities including the city of Delhi 100% of MSW is dumped as land-filling and there is no post-treatment operation.

It has been found that plastic waste disposal is of a serious concern in India as there is poor compliance to the rules and also no technology has been validated. However, there are several ways of disposal techniques are being practiced in India primarily reuse of plastic waste in road construction, co-processing of plastic waste in cement kilns etc (MoES, 2018; CPCB, 2015). Incineration technique has also been adopted for plastic disposal, however, poor maintenance and several harmful gases that releases raise environmental issues. The other key issues relating to widespread use of sub-standard plastic carry bags and littering in cities and towns and use of plastic sachets.

In the current scenario, waste is the default responsibility of the informal sector -Waste pickers. They collect unsegregated waste from households, schools, offices and shopping malls. They then segregate the waste and sell the recyclables to small waste-handlers. The non-recyclable or wet waste is taken to 'dhalaos'. Municipal trucks pick the waste up from the 'dhalaos' and dump it in landfills. At the landfill, the waste is further segregated by waste pickers who eke out a living by selling recyclables. In most cases, low grade polythene packets, packets of chips and the like do not get recycled.

Source: MOEFCC, 2018

Our interviews confirm that waste collection mechanisms are available in main urban areas, and local urban bodies (i.e panchayath and municipalities) facilitate it. However the problem lies in managing the collected waste. Plastic waste will be collected from each house and only certain portion will be sent for recycling facilities, remaining will go to landfilling and dumping to water bodies. Some of the interviewees expressed concern over mismanagement of plastic waste in towns and urban centres particularly illegal dumping in open land/water bodies. For example an interviewee explained that *"It is not that we do not have the technology to deal with this huge amount of plastic but that we do not want to develop because of lobbying. Waste collection from corporation itself is a big business and many lobby to stop any investment in recycling."*

3.1.6 India's plastic waste finds its way into the ocean from land and sea based sources

India has 9 maritime states and 2 Union Territories (UTs) sharing a coast of 7,500 km. The coastal states include Andhra Pradesh, Goa, Gujarat, Karnataka, Kerala, Maharashtra, Odisha, Tamil Nadu, West Bengal, and UTs - Pondicherry and Diu and Daman. Coastal environments including marine waters are under increasing stress in India given India's high coastal population which is of about 180 million (4 million fisherfolks) (CMFRI census, 2010; Jambeck et al., 2015). In India, various activities contribute to marine litter. The loss of debris during fishing (illegal dumping or accidental) /cargo operations and oil rigs fishing, the release of untreated or partially treated wastes from domestic as well as industrial activities are the main drivers of marine litter primarily non-biodegradable litter like plastics (Kaladharan et al., 2012; Kaladharan et al., 2017). Further, the intense use of beaches for recreation, tourism, and religious activities has also increased the potential for plastic pollution in marine waters

of India (See Jayasiri et al., 2013; Jayasiri et al., 2013). Upto 43 % of Indian beach litter comprised of plastics (Kaladharan et al., 2012). A very few selected studies have estimated marine litter in certain beaches of India. For example, Nicobar Islands (Dharani et al., 2003), Karnataka coast (Sridhar et al., 2009), northern Gulf of Mannar (Ganesapandian et al., 2011), selected beaches of Kerala, Karnataka and Tamil Nadu (Kaladharan et al., 2012), some urban beaches in Mumbai (Jayasiri et al., 2013) and Mangalore coast (Sulochana et al., 2014). A study by Kaladharan et al., 2012, non-biodegradable objects such as polythene carry bags, ropes and sachets were found from 0.145 to 9.8 g per meter square across 8 beaches in India.

The other two important works on Indian marine plastic litter done by international researchers are Jambeck et al., 2015 and Lebreton et al., 2017. The work of Jambeck et al., 2015 is important as it estimates total mismanaged plastic waste that was generated by coastal populations living within 50 km of the coast of India in 2010 from land into oceans in India. Lebreton et al., 2017 study the plastic inputs from Ganges River to ocean.

According to Jambeck et al (2015), countries with long coastal borders and experiencing rapid economic growth, discharge large amount of plastic waste into the world's oceans. The top five countries include China, Indonesia, the Philippines, Vietnam and Sri Lanka. India stands at 12th position producing about 0.09–0.24 Mega Metric Tonnes (MMT) of plastic marine debris every year. The economic growth in these countries have led to improved lifestyle and as a result increased consumption of plastic goods. About 0.60 [millions of metric tonnes] total mismanaged⁸ plastic waste was generated by 187.5 million coastal populations living within 50 km of the coast of India in 2010 (about 85% is mismanaged plastic waste) (Jambeck et al., 2015)

Based on the global river plastic inputs model, Lebreton et al., 2017 show that Ganges is the second largest contributing catchment with an annual input of 0.12 (range 0.10–0.17) MT of plastic waste discharge into the ocean. They further estimate based on the changes in rainfall rates associated with monsoons the discharge from the Ganges River peak in August with 44,500 tonnes per month while the river discharges <150 tonnes per month between December and March. This suggests that weather factors (e.g. rainfall) and their associated activities influence plastic discharge into rivers and then to the ocean. (see Annexure D Literature review on micro plastics marine litter in Indian beaches)

3.1.7. Summary

Plastic consumption in India has steadily increased over the past decades since its first production in 1957. The annual consumption of plastic in 2010 was 8 MMT and it rose to 13.4 MMT in 2015 and it is projected to reach 22 MMT by 2020. Although average per capita consumption of plastic (11kg/annum) in India is much lower compared to the world's average (38kg/person) and other western countries (e.g. US – 137 kg/person), the impact of plastic waste generation will be high in India given the high population and improper management of plastic waste. In most cities, there is no complete waste management system in place and the threat to coastal ecosystem from marine debris is evident (See CPCB, 2015).

Consistent with the literature this research identifies that land based plastic waste as a major source of marine plastic debris in India. Local experiences, as explored in this research, suggests irresponsible waste management on land leading to release of waste into waterways which finally reaches the ocean. Coastal areas where waterways are merging into oceans are heavily infested with plastic waste. Some important sources that were indicated

⁸ Mismanaged waste is the sum of inadequately managed waste plus 2% littering

in our research include municipal solid waste (not properly managed); loss of debris during fishing; illegal dumping; Abandoned, Lost or otherwise Discarded Fishing Gear (ALDFG); release of untreated or partially treated domestic wastes; recreation and tourism. Although, interview respondents are not aware of all India assessments studies that indicate the actual plastic input into our ocean, it is very evident from the experiences that they narrated about the increasing incidence of encountering of plastic waste in oceans by fisherfolks, tourists etc. So far, one study by Jambeck et al., 2015 has estimated the plastic input into oceans in India. According to this study that 0.09–0.24 Mega Metric Tonnes (MMT) of plastic waste is reaching oceans every year in India (i.e, about 85% is mismanaged plastic waste) (Jambeck et al., 2015).

The respondents also expressed their concern about the threat from microplastics in sea and estuarine sediments. Few respondents were particularly concerned about the chances of microplastics entering into food webs.

Undoubtedly, in India, plastic forms the major pollutant among the total quantity of marine debris found on the beaches (e.g. Jayasiri et al., 2013; Sridhar et al., 2016; Kripa et al., 2016; Kaladharan et al., 2017). Since a major source of marine plastic debris is land, focussing on the effective management of the solid waste generated on land is more meaningful. In sum, evidence from our research emphasise that responses to mitigate and manage this marine plastic litter menace is the need of the hour.

3.2 Research question 2: National level government response in terms of policies and programmes to tackle plastic pollution in the country

3.2.1 Institutional arrangements for marine and coastal pollution management in India

In India, policies, programmes and research concerning marine and coastal resources management have been implemented through various research centres under the Ministry of Earth Science (MoES) (see Figure 11). The MoES is the nodal Ministry for organising, coordinating and promoting ocean development activities in the country. The Ministry of Environment, Forests and Climate change (MoEFCC), on the other hand, is the nodal agency to implement policies and programmes relating to prevention and abatement of pollution (including plastic pollution) and conservation of the country’s natural resources. Since major drivers of ocean bound plastic are land based, waste management programmes or policy interventions of MoEFCC have the clear impact in addressing the marine litter pollution. Further, Central for Marine Fisheries Research Institute (CMFRI) and National Institute of Fisheries Technology (NIFT) under the Indian Council of Agricultural Research (ICAR) of Ministry of Agriculture Research and Farmers’ Welfare have the mandate to monitor and assess the marine fisheries resources of the Exclusive Economic Zone (EEZ) including the impact of climate and anthropogenic activity and develop sustainable fishery management plan. CMFRI has a dedicated department conducting research and assessment studies of plastic litter in the ocean. (Please refer Annexure E for detailed description on roles and responsibility of MoES, MoEFCC and ICAR)

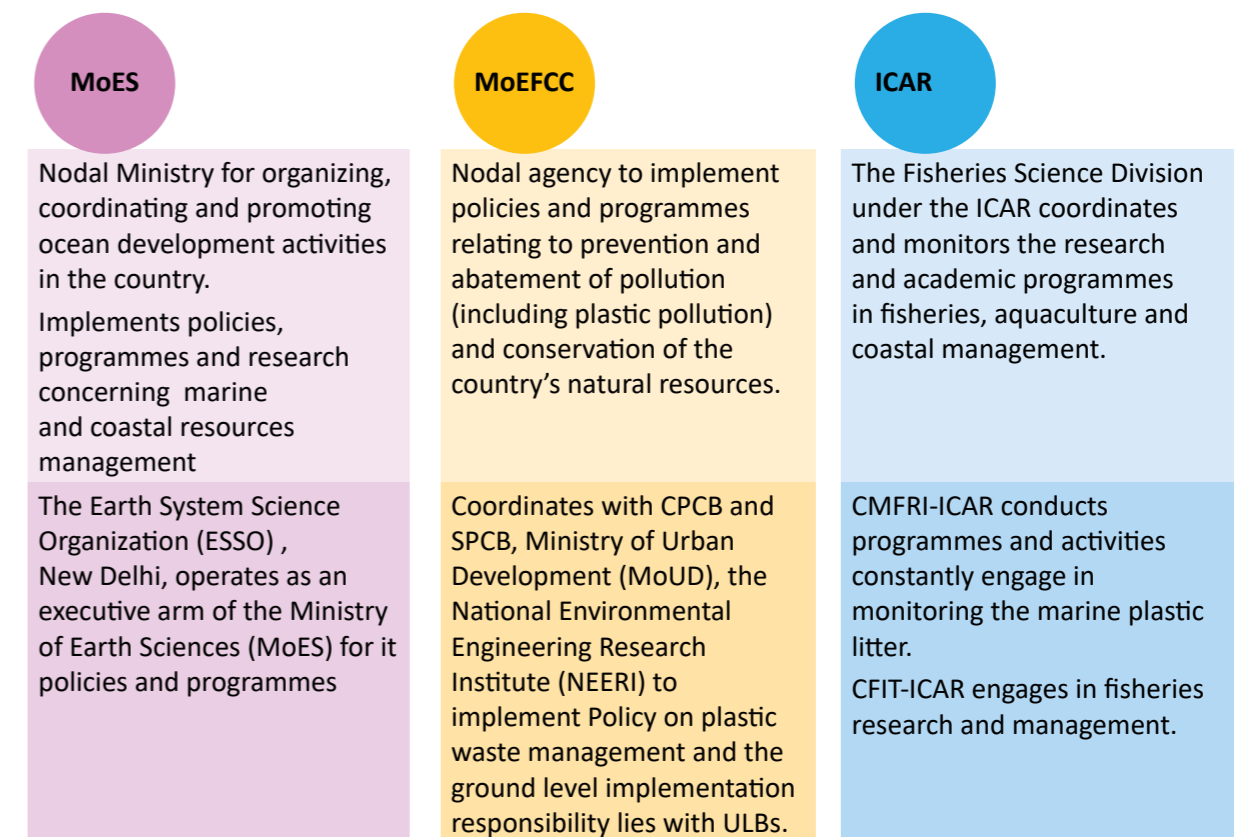


Figure 11: Institutions involved in marine pollution management in India

3.2.2 Plastic Waste Management (PWM) Rules, 2016: Legislative framework for plastic waste management in India

To address the challenge of plastic waste pollution in the country, the Government of India (GOI) has undertaken several measures at different levels. India steadily introduced ban on plastic bag consumption since 2002. In India, the regulatory framework for disposal and management of plastic waste by ULBs as well as other waste generators (e.g. individual household, institutions, residential and commercial establishments and defence establishments etc) is provided by the Plastic Waste Management (PWM) Rules, 2016, notified by MoEFCC. In March 2016, the PWM Rules, 2016 replaced the former Plastic Waste (Management and Handling) Rules 2011. These rules apply to every waste generator, local body, gram panchayat, manufacturer, importer, producer and brand owner throughout India. To give thrust on plastic waste minimisation, source segregation, recycling, involving waste pickers, recyclers and waste processors in collection of plastic waste fraction either from households, any other source of its generation, or intermediate material recovery facility; and to adopt polluter’s pay principle for the sustainability of the waste management system, the Central Government reviewed the Plastic Waste (Management and Handling), Rules 2011 (Detailed provisions of PWM Rules, 2016 is provided in Annexure F1, F2)

Salient features of PWM Rules, 2016

- Responsibilities on waste generators
- Manufacturers to register with PCBs
- Extended Producer Responsibility (EPR)¹
- Alternatives uses (e.g. road construction)
- Recycling, reuse
- Ban on carry bags <50 microns

Amendment to the Plastic Waste Management Rule, 2016: (March 2018)

In order to phase out of manufacture and the use of multi-layered plastic which are non-recyclable or non-energy recoverable or with no alternative use, the GoI amended the existing Plastic Waste Management Rule 2016 in March 2018. Further, the provision under the Parent Rules requiring shopkeepers and street vendors willing to provide plastic carry bags for dispensing any commodity to register with a local body has been omitted.

The amended Rules also prescribe a central registration system for the registration of the producer/importer/brand owner. Further, they specify that any mechanism for registration should be automated and account for ease of doing business for producers, recyclers and manufacturers. The centralised registration system will be evolved by CPCB for the registration of the producer/importer/brand owner. While a national registry has been prescribed for producers with a presence in more than two states, a state-level registration has been prescribed for smaller producers/brand owners operating within one or two states (MoEFCC, 2018)

Implementation status of PWM, 2016

In terms of implementation of PWM Rules, 2016, implementation analysis reports⁹ indicate that PWM 2016 has not been effective in completely addressing the issue of plastic waste in the country as there are still a number of issues need to be addressed. These include

- I. Plastic carry bags of less than fifty microns (<50µm) continue to be manufactured, stocked and sold in the majority of States/UTs. Besides, carry bags/films are manufactured, stocked sold and used without proper label or marking.
- II. Widespread littering of plastic waste continues unabated in public spaces including road-side, railway tracks, open areas, open drains, river banks, sea-shores, beaches, public places like bus-stops, open market etc.
- III. A number of unlicensed/unregistered plastic manufacturing and recycling unit operate in residential or non-conforming areas.
- IV. Accumulation of plastic waste leading to choking of drains, land infertility, death of cattle through ingestion etc.
- V. No proper system evolved by majority of Municipal Authorities for collection, segregation and disposal of plastic waste.
- VI. Many States/UTs have not constituted State Level Monitoring Committee (SLMC) Body for implementation of PW (M&H) Rules, 2011.
- VII. Open burning of plastic waste continues and may contaminate ambient air quality resulting in spread of diseases

Further, the report by TERI (2018) states that the idea of “the EPR introduced by the PWM 2016 rules was novel but lacked detailing” as there is an absence of guidance to municipalities on successful EPR models for engaging with the plastic producing companies to collect used plastic. It further states that the PWM 2016 law fails to ensure sustainable financial mechanisms for municipalities and Urban Local Bodies (ULBs) to operate and sustain this service every day of the year. Finally, the effective implementation of the ban of plastic bags (<50µm) legislation has been a challenge for many municipalities as these bags are used roadside hawkers and vegetable markets owing to their cheaper price and continued local manufacturing.

⁹ CPCB develops annual report on the implementation of PWM Rules, 2016 and also refer TERI 2018

Most interview respondents did not particularly mention about the implementation of PWM rules 2016, however they generally expressed that Government could do a lot using legislative instruments to address the issue of ocean plastic. Some of them said that strictly enforcing the regulation would improve the current problems of littering and plastic reaching oceans etc.

One respondent described the situation as follows

“There is law – but no proper waste management system. No Government guidance and mechanism on where to throw waste and how it is to be managed. Government should first make necessary mechanism for the people to properly dispose which is then properly and regularly removed. Then they should strictly enforce laws on littering plastic and on its use.

Furthermore, one participant expressed that the EPR from PWM Rules 2016 is not doing much good. He explained, “even though there is a CSR (corporate social responsibility) mandate and especially on EPR side nothing is happening. If you look at the latest plastic management rules there is EPR and brands should support or they have to invest money in municipalities to manage plastic waste especially the low value plastic. But the law does not say how it is to be ascertained, managed or monitored. The plastic companies especially the brands they have come up with PROs and they subcontract to the waste management service providers. For example Nestle engaged some agency and asked them to go around different cities and collect all Nestle product wrappers. After collecting – they took it to the nearest Cement Kiln to burn it and get a certificate and Nestle would pay them INR 5 per kilogram. They provide a certificate on waste disposal and get paid and company claims that they have accomplished their EPR. Actually the company merely shifted the waste from the ground into the sky in the form of smoke which could be more toxic. The waste can be managed more effectively if the companies pay the money directly to the municipality.

3.2.3. Programmes and activities to manage marine plastic litter in India

In India, various programmes and activities are being undertaken to address the ocean plastic problem. Some of the initiatives undertaken by GOI suggest that the issue of ocean plastic pollution is gaining attention of both policy makers and public. Some of the key programmes are discussed as follows:

- **Coastal clean sea campaign for Indian beaches**

One of the core activities of NCCR under the water quality monitoring is to conduct coastal clean campaign for Indian beaches. As part of this commitment, the government has planned to establish a national and regional marine litter action campaign in line with the Coastal Clean Seas campaign of United Nations and Environment Agency (UNEA)¹⁰. As part of the clean coast sea campaign programme, beach cleaning activities, educating school kids, raising awareness among the public are being actively pursued (NCCR, 2018).

- **Sea water quality monitoring (SWQM)**

To identify the periodical changes in seawater quality, the Department of Ocean Development (DOD) has been implementing a nationally coordinated research programme on “Coastal Ocean Monitoring and Prediction System (COMAPS)” since 1990 which is presently called “Sea Water Quality Monitoring (SWQM)” Programme¹¹. The data generated under this programme is probably the only long term dataset on the coastal water quality

¹⁰ <https://www.unenvironment.org/news-and-stories/press-release/india-sets-pace-global-race-beat-plastic-pollution>

¹¹ <https://nccr.gov.in/?q=activities/coastal-water-quality>

available in the country. In this programme coastal locations near major settlements and industries are being monitored for various water, sediment and biological parameters of ecological relevance. The activities on the monitoring of marine litter and micro-plastics have been initiated recently along the Indian coastline and coastal waters to have a scientific understanding on the type, source, process and distribution of marine litter that would be supportive to frame a “Marine Litter Policy” for India¹². The NCCR is also conducting studies on Marine Litter and Micro plastics. The NCCR along with South Asia Co-operative Environment Programme (SACEP) prepared a Country Report on Marine Litter -India which serves as a baseline report for further actions against marine litter in the country. The basic goal is to create a clean coastal seas and beaches by 2022¹³.

- **Blue Flag Certification¹⁴**

The MoEFCC in association with the society of integrated coastal management conceived BEAMS (Beach Management Services) to control existing pollution pressure on beaches and to strive for “Blue Flag Certification” in India. Blue Flag Certification is a Certification given by the Foundation for Environmental Education, Copenhagen based on stringent quality standards for (i) Bathing water quality, (ii) Environment management, (iii) Environmental education, and (iv) Safety and Services. A total of 4,413 Blue Flags are waving across 46 countries. Given its long 7,500 km. coastline, India has a huge potential to obtain the 1st Blue Flag Beach in Asia. Based on some preliminary assessment, 13 beaches, one in each coastal States/UTs of India have been identified to achieve Blue Flag Certification (see Annexure G for the list of selected beaches).

- **Beat the plastic pledge at the world environment day 2018**

The Government of India has organised and promoted the World Environment Day (WED) celebrations in 2018 with the theme of “Beat Plastic Pollution”. As part of the WED celebration GOI urged governments, industry, communities, and individuals to come together and explore sustainable alternatives and reduce the production and excessive use of single-use plastic polluting our oceans, damaging marine life and threatening human health. A series of activities and events generating strong public interest and pan-Indian plastic clean-up drives in public areas including beach clean-up activities were undertaken. Also, India committed to eliminate all single-use plastic in the country by 2022¹⁵.

- **Swachh Bharat Mission (Clean India Mission)**

The GOI has launched Swachh Bharat Mission to achieve total sanitation and cleanliness in the country. Under the aegis of the Swachh Bharat Mission, GOI is working enthusiastically on various aspects of pollution particularly plastic pollution. Under this mission, an advisory has been released to ban plastics completely in and around Protected Areas (National parks, wildlife sanctuaries and zoos) (MoEFCC, 2017)

- **Plastic bans in several states**

The GOI has initiated a programme of phasing out single use plastic shopping bags and promoting the usage of cotton/jute cloth bag. Twenty-five Indian states/UTs now have some form of ban on polythene carry bag (especially in coastal areas, national parks, tourist places, hill stations, university campuses, protected areas), but the implementation is often a challenge and the bags continue to be used (MoEFCC, 2018). In Karnataka and Punjab, a ban

12 https://wedindia2018.in/presentations/National_Centre_for_Coastal_Research.pdf

13 <https://www.icmam.gov.in/?q=activities/coastal-water-quality>

14 https://wedindia2018.in/presentations/Blue_Flag_Beaches.pdf

15 <https://www.unenvironment.org/news-and-stories/press-release/india-host-world-environment-day-2018>

has been in place since 2016.¹⁶

- **The national mission for clean Ganga: the ‘Namami Gange Programme’¹⁷**

The Ganga National River Basin Authority was constituted in 2009 and the GOI has set up Ministry for Water Resources, River Development and Ganga Rejuvenation for the cleaning of Ganga. The Namami is an integrated conservation mission, approved as ‘Flagship Programme’ by the GOI in June 2014 with budget outlay of Rs.20,000 Crore to accomplish the twin objectives of effective abatement of pollution, conservation and rejuvenation of National River Ganga.

3.2.4 Summary

To address the challenge of plastic waste pollution in the country, GOI has brought Plastic Waste Management (PWM) Rules 2016, notified by the MoEFCC. This regulatory framework guides the disposal and management of plastic waste by ULBs as well as other waste generators such as individual household, institutions, residential and commercial establishments and defence establishments etc. Further, an amendment was made to PWM Rules, 2016 in 2018 in order to phase out the manufacture and use of multi-layered plastic which are non-recyclable or non-energy recoverable or with no alternative use. While Indian legislative framework captures laws to prevent and mitigate land based plastic waste generation (e. g. MSW), the challenge lies in implementing these laws with complete compliance (MoEFCC, 2018; TERI, 2018; CPCB, 2018). Evidence from the literature, particularly the analysis done by TERI 2018 indicates the weak implementation of PWM Rules, 2016 in the country with respect to its EPR and its inefficient financial and technical support to ULBs to successfully explore models to manage plastic wastes

That being said, some programmes and activities have been undertaken by GOI towards creating awareness among the public about the ocean bound plastic problem. Coastal Clean Sea Campaign, Blue Flag Certification, Swachh Bharat Mission, etc. are some of the initiatives taken by GOI in this regard.

Overall, the plastic waste management is captured under legislative framework in India either directly or indirectly through the solid waste management rules. However, the enforcement has been largely ineffective. Further, there is no distinct legislation on marine plastic debris exist in India which address marine based plastic pollution. The need for such marine litter strategy in India has been widely argued (See Kripa et al., 2016; MoEFCC, 2018; MoES, 2018).

3.3. Research question 3: Private sector and civil society led interventions currently operational in India and their approaches

3.3.1 Private sector and civil society led interventions in India

There are several clean up campaigns and drives that are regularly organised by private sector organisations/individuals in coastal cities of India. Some of the organisations are solely working on initiatives to address the land based plastic wastes and thus indirectly contributing to reducing plastic waste reaching into oceans.¹⁸ An MoEFCC report on plastic waste management and a book of abstracts and success stories by the National Conference on Marine Litter document several of such efforts by individuals and organisations across the

16 <https://wedindia2018.in/presentations/MoEFCC.pdf>

17 <https://nmcg.nic.in/NamamiGanga.aspx>

18 See Kripa 2018 and MoEFCC 2018 for more information on land based plastic waste management initiatives

country. These case studies demonstrate that cleaning cities, making roads using plastics, creating partnership models are some effective solutions to manage land based plastic wastes.

A summary of three important initiatives by private sectors which are making good impact in creating awareness and also providing solution, in part, to address the issue of ocean bound plastics in India is provided Figure 12. Information and data on these are explored from interviews and also accessed from the websites of respective organisation and from other published sources.

	Friends of Marine Life/Afroz Shah	Suchitwa Sagaram Initiative	Plastics for Change
	<i>Trivandrum, Kerala, Beaches in Goa</i>	<i>Sakthikulangara, Neendakara Fisheries harbours in Kerala</i>	<i>Bangalore, Karnataka</i>
<i>Key activities</i>	<ul style="list-style-type: none"> • Clean up drives on the ocean floor • Afroz Shah professionally motivated large number of volunteers to undertake beach clean up 	<ul style="list-style-type: none"> • Plastic waste collection from sea bed (various collection centres established) • Sorting/segregation of plastic wastes, washing, drying and shredding 	<ul style="list-style-type: none"> • Plastic waste collection & recycling • Mobile technology to create stable livelihoods for informal waste picker, who are independent recycling entrepreneurs.
<i>Modes operandi</i>	<ul style="list-style-type: none"> • Training fisherfolk and volunteer for scuba diving • Volunteer led beach clean up (Afroz Shah) 	<ul style="list-style-type: none"> • Working with fishing boat operators • PPP initiative, with Government of Kerala • Business model as it can potentially pay for itself, with recycled plastic generating income 	<ul style="list-style-type: none"> • India's 1.5 million informal waste workers make up the primary collect back system • These informal waste workers at the base of the supply chain, are provided fair market prices for the discarded plastics they collect.
<i>Results so far</i>	<ul style="list-style-type: none"> • Debris clean up, Ghost nets removal • 4000 tonnes of Versova beach clean up /UN Environment Prize 	<ul style="list-style-type: none"> • Pilot has demonstrated its potential • Funding is needed to scale up 	<ul style="list-style-type: none"> • Plastics For Change is working with global brands and manufacturing industries to embrace the EPR strategy and transition towards a circular economy

Figure 12: Summary of private sector / civil society initiatives

Among the many initiatives studied, Suchitwa Sagaram initiative and Plastics for Change initiative stand out. These initiatives are not only multi-faceted - engaging range of government and private sector stakeholders - but are also exploring a business model which can ensure their continuation. Any new intervention being planned should learn from these initiatives. Further details on private sector initiatives are provided in Annexure H.

3.3.2 Industry standards, self-regulations and any sustainability certifications that incentivise reduced plastic litter in India

It is found that there are no exclusive standards set for industries besides those set out for manufacturers in PWM Rules, 2016. However some companies under the CSR activities have come forward to contribute to plastic waste reductions. Regulation in India can learn from internationally recognised UK Plastic Pact.

- **The UK Plastic Pact**

The UK Plastic Pact is a unique collaboration which brings together businesses from across the entire plastics value chain with UK governments and NGOs to tackle the scourge of plastic waste and thus brings together all links in the chain under a shared commitment to act. It focuses on innovation, better packaging design and end-of-use systems. This pact sets an ambitious set of targets to eliminate problematic or unnecessary single-use packaging through redesign, innovation or alternative (reuse) delivery model, namely:

- 100% of plastics packaging to be reusable, recyclable or compostable.
- 70% of plastics packaging effectively recycled or composted.

- 30% average recycled content across all plastic packaging

The partners and members are already doing some progress towards these targets.¹⁹ For example: six of the participating mega companies including Pizza Hut Restaurants, Marks & Spencer, Morrisons Asda and Lidl have stopped/replaced 90% plastic giveaways. Asda has removed the plastic from six million swedes, resulting in a 14 tonne reduction of plastic. In 2017, Bairform reused over 1 billion items, representing the same reduction in carbon emissions generated from manufacturing over 4 billion plastic bags. Further many of these companies have local authority recycling collections at approximately 70% of their stores, as well as carrier bag recycling bins in all their large stores.

3.3.3 International best practice in this area

Across the globe, several successful examples have been demonstrated in managing and reducing plastic reaching the marine environment. Some of the important policy and technical interventions are discussed here (Figure 13).

	Social Plastics	WasteAid	Alliance to End Plastic Waste
	<i>Haiti and other Latin American countries</i>	<i>Kenya and other African countries</i>	<i>South East Asian countries</i>
<i>Key activities</i>	<ul style="list-style-type: none"> • Enabling the exchange of plastic for money, items, or Blockchain secured digital tokens (provide consistent above-market rates for plastic waste) • Establishing or revitalising recycling units 	<ul style="list-style-type: none"> • Plastic waste collection (various collection centres established, incentivising collection) • Recycling solutions (roof tiles from plastic waste etc.) developed • Large scaling establishment of recycling training centres • Community Solid Waste management in Kenya 	<ul style="list-style-type: none"> • Funding waste collection and recycling projects across many countries • Help design waste management systems in cities
<i>Modes operandi</i>	<ul style="list-style-type: none"> • Community empowerment and livelihoods based approach /local entrepreneurs support in plastic collection enterprises, where plastic waste is the currency • Recycled plastic waste is sold as social plastic brand 	<ul style="list-style-type: none"> • Multi-faceted partnerships with donors (UK Govt and UK public), companies and communities • Business model as it can potentially pay for itself, with recycled plastic generating income 	<ul style="list-style-type: none"> • Plastic producers and users including Shell, ExxonMobil, LyondellBasell, Chevron and P&G are investing US\$1.5 billion over the next five years to fight plastic waste, with a focus on Southeast Asia. • The alliance was coordinated by the World Business Council of Sustainable Development (WBCSD)
<i>Results so far</i>	<ul style="list-style-type: none"> • Stopping ocean-bound plastics while contributing to poverty reduction 	<ul style="list-style-type: none"> • Pilots in Kenya and other countries in Africa have demonstrated its potential • Funding has been mobilised for scaling up solutions 	<ul style="list-style-type: none"> • The fund has been set up

Figure 13: Examples of international best practice in plastic waste collection and recycling

Another international best practice recorded is by Plastic ByFusion Blocker -“from plastic pollution to building solution.”²⁰ The ByFusion Blocker is an industrial machine for municipalities and recycling facilities that can convert 100% of plastic waste into an advanced new building material by shredding and superheating discarded plastic and fusing it into Byblocks. ByFusion makes it financially profitable to solve the plastic that is choking our environment and landfills.

19 <http://www.wrap.org.uk/content/uk-plastics-pact-progress-against-targets>
 20 <https://www.bypassion.com/plastics-new-life/>

3.4 Research question 4: Study of hotspots in and around coastal areas and cities, with increasing likelihood of plastic getting into ocean

India has a coastline of 7,500 kms and a coastal population of 180 million (with 4 million fisherfolks) (CMFRI Census, 2010). A few studies have been conducted at some places such as the Nicobar Islands, Northern Gulf of Mannar, beaches along the coast of Kerala, Karnataka and Tamil Nadu, urban beaches in Mumbai which indicate marine plastic litter pollution. However, no comprehensive study has been undertaken on the quantification or assessment of beach plastic debris in the country (Jayasiri, 2018; MoES, 2018; Kumar and Sivakumar 2016). Few important researches published on marine plastic litter in Indian coast and their key findings are discussed in Annexure I.

3.4.1 Selection of hotspots

Based on extensive literature review, we selected three hotspots in and around coastal areas, with inadequately managed plastic waste. We initiated a primary data collection to understand the effects of marine plastic debris to fishing operations. Also it provided a better perspective to various problems that fishermen are facing due to ocean plastic waste.

Three hotspots namely Kochi, Kerala; Panambur, Karnataka and Marina, Tamil Nadu were selected. The literature suggests that litter in all of these beaches are to be strongly influenced by land and marine based anthropogenic activities such as municipal plastic waste; tourism and fisheries activities (e.g. Kumar et al., 2016; Naidu et al., 2018; Sulochanan et al., 2011). The Kochi and Panambur are situated in the west coast and Marina in the East coast of India.

Research team visited Kochi, Panambur and Chennai beaches between 17th June and the 1st of July 2019. The visit to these places provided a first-hand understanding of the issue of marine plastic waste problem in these areas. During the field visit, research team interacted with community (e.g. residents; fisherfolks etc); regulators (e.g. municipality staff) and local experts (Please see section 2.1.3).

3.4.2. Findings from field survey and interaction with fisherfolks

3.4.2.1 Marina (Foreshore estate and Pattinapakkam), Chennai, Tamil Nadu

Focus Group Discussions (FDGs): Two FDGs were conducted, one at Foreshore estate (n=5), the other at the Pattinapakkam (n=6). Contrast views were expressed by the participants wherein FGD-1, participants mentioned that so far they haven't encountered problems such as plastics getting caught in their fishing nets. However they acknowledged the presence of plastic waste at the seashore due to the draining of sewage and other solid waste directly



Figure 14: Research team interacting with fishing community in Kochi

into the sea. Participants also shared a recent initiative by Chennai Corporation called 'beach clean-up project' funded by the central government. Through the project they have purchased eight tractor-driven beach cleaning machines for cleaning plastic waste from Marina. Tonnes of garbage have been cleared from Marina through this initiative. They also informed that Marina to Foreshore (3 km) Municipal Corporation was doing a good job in plastic collection and disposal. One of the participants mentioned that the Government drive on "no plastic" is very useful and effective in keeping the sea shore clean.



Figure 15: Tractor-driven beach cleaning machines for cleaning plastic waste from Marina beach, Tamil Nadu (July 2019)

In contrast, FGD -2 (Pattinapakkam) participants said that they are facing severe plastic pollution and during the rainy season the overflow of Canal which directly goes to sea causes plastic pollution where all the plastics and garbage directly mixes in the sea. They also shared that because of the plastic pollution they are not able to net enough fish. One of the participants shared that they collect almost 2 to 3 kg of garbage daily in the fish net and this increases when overflow of canal during rainy days. **All the members shared that plastic pollution affects their life and they have been experience this in the past five to ten years while fishing in the sea.** All participants mentioned that the Municipal Corporation garbage cleaning drive service is only from Marina to Foreshore estate not to Pattinapakkam, because the former is a popular tourist and public spot. They felt that the Government was not keen on initiatives for the plastic pollution in their place.



Figure 16: Fisherfolks at Pattinapakkam, Tamil Nadu (July 2019)

Interview with local expert: The local expert working with the fisherfolk community on waste management for the last 20 years held a view similar to that of the second FGD participants. According to him, "the area from the Foreshore estate to Pattinapakkam stretch (4 kms) has been badly polluted by plastics mostly from the public and canal overflow where the lake water mixes with the sea." He blamed the Municipal Corporation for cleaning plastic only on tourist places and not on residences living alongside the seashore. He expressed great concern that plastic accumulating in the sea is increasing day by day and

said that some of the fishermen tell him that **they are not getting fish in the nets, only garbage.**

Overall, stakeholders views confirm that the Foreshore estate to Pattinapakkam area is heavily polluted with plastic waste and affecting the livelihood of fisherfolks. The Marina beach stretch (3 kms) is relatively clean as the municipality organises daily clean up drive in this place. This suggests that municipality efforts are primarily focussed on tourists' places.

3.4.2.2 Panambur beach, Mangalore, Karnataka

Interview with local experts: Two local experts were interviewed during the visit. The biggest source of plastic waste in this area is the river channels (viz -Phalghuni and Netravathi). All types of plastic wastes are found to be in the sea. For example, when asked about the type of plastic waste that they generally see, one of the local experts said *"Whatever you get in malls are those you can see in the ocean like shampoo sachets, soft drinks and drinking water bottles, pouches, handbags, straws, diapers etc. These waste items keep rotating at shore and sea through tides"*. He also said that because of the construction of check dams, of late the plastic inflow to sea has been reduced, but these check dams are heavily polluted with all sorts of litter. In addition to land based plastic waste, fishing nets are huge wastes that were commonly seen. Another local expert said that *"The problems that fishermen are facing from plastic waste in the ocean is basically death of many fishes and financial burden on fishing community for buying additional nets."*

In terms of local effort, Panambur Beach Tourism Development Project, Ram Krishna Mission and Amala Bharati are three major organisations involved in cleaning ocean wastes and raising voice against it. The municipality garbage



Figure 17: Land based and sea based plastic litter found along the Panambur beach (June 2019)

cleaning department also collects waste from seashore to take to recycle/dumping yards. In addition, during beach festivals 300-500 volunteers are mobilised and organise clean up drives

FDG with fisherfolks and community: Seven fishermen participated in the FGD. According to them, rivers are the main channels through which plastic waste reaches the ocean. There is no mechanism to filter out plastic before it enters beaches and direct dumping plastic waste to ocean is very less, a large junk comes from water routes which brings water to ocean especially during monsoon. In addition, they mentioned that broken fishing nets are also one of the biggest contributors to plastic waste (refer pictures). The composition of plastics in marine litter, as observed by these fishermen, is about 40-50% rest all clothes and other debris. When asked about the problems they face due to plastic waste they said that *"major impacts we experienced are breaking nets or net will form as balls with these waste, and low fish catching in the net which affect our livelihood. Waste accumulation in the net means lesser fish being caught and more time at sea to get the amount of fish required."* They suggested that beach clean-up activity and beach festivals and other awareness programmes organised are contributing to the plastic waste reduction.

Transect walk: To understand the problem an observatory transect walk was undertaken from Panambur to Khana area (3 kms stretch). Within the stretch of the transect walk about 27 garbage collection points were seen and each such garbage point containing an average of 30-50pet bottles, 45-60 disposable spoons and plates and 25-30 plastic carry bags (See table 2). In addition, abandoned fish nets (at least 7) were a common sight along the transect walk (refer photographs).

3.4.2.3 Fort Kochi beach, Kochi, Kerala

FGD with Fisherfolks: According to fisherfolks rivers routes and some of the wastewater canals get these plastics to ocean. They mentioned that the ban of plastics in many districts of Kerala which reduced inflow plastics to ocean to a good extent. The common plastic waste item they encounter include plastic carry bags, non-woven carry bags, flex banners made of plastics, straws, bottles, spoon, pouches, sheets, thermocol, etc. Plastic forms about 40 % among all types of marine litter. The problem impacts the fishing community through the damage of fishing nets. They also mentioned that *"during fishing the accumulation of plastic inside the net distract the fish, which affects our livelihood."*

FDG participants mentioned that two interesting initiatives were taken to minimise plastic use. They are

1. Ban of single-use plastics and thermocol items in and around Fort Kochi beach by the District Collector. Instructions were given to the city Police Chief, the Kochi Corporation Secretary and the Fort Kochi Sub-Collector to ensure proper enforcement of the ban. Violators are fined Rs 1,000 while those selling the banned items pay a penalty of Rs 2,000. If a person repeats the offence, he or she is fined up to Rs 10,000.
2. The Civic body has purchased 7,500 steel plates and glasses at the cost of Rs.9 lakh to provide it on a rental basis to the public. The corporation authorities have also decided to distribute the steel plates and cutlery items to the three community development societies of the Kudumbashree so that it can be provided on a rental basis to the public and private parties to serve food and snacks during various events and thus avoid using plastic.

Interview with local expert: A local expert who works closely with District administration shared that apart from tourists, land side waste which flow through rainwater during the

monsoon season is the major source of plastic waste. While describing the plastic problem as severe in the recent years he mentioned that *“We were never bothered too much earlier. Since last 5 years people started getting the feel of it. The extent is slowly getting severe.”* He further mentioned that apart from plastic food containers, plastic bottles, gift pack papers, thermocol, plastic disposables, ice cream wrappers etc, there are broken fishing nets also seen in the seashore as plastic waste. In terms of impacts, he indicated that

“Small fishermen (Manchi Boat) face many issues on their livelihood like losing fishnets, plastic and other stuff like green leaves (payam) which cover their net and doesn't allow to fish.”

Table 2: Plastic waste found during transect walk on Fort, Marina and Panambur beach areas

Sl No	Type of waste	Number of waste (Panambur - 3 kms)	Number of waste items(Fort - 2 kms)	Number of waste (Marina - 2 kms ²)
1	Plastic (PET) bottles	500	5	40
2	Plastic cups	-	-	10
3	Plastic straw/ spoons	1200	100	4
4	Juice tetra pack	-	40	4
5	Plastic carry bags	800	-	-
6	Abandoned / broken fishing nets	20	3	-
7	Rubber slippers	about 100 pairs	about 100 pairs	-
8	wood branches		15	
9	Leather waste products		5	5
10	Glass bottles		9	-

3.4.3 Concluding remarks/ summary

- Sources, composition and types of plastic debris:** In all three places, drivers of ocean bound plastic waste is primarily rivers and wastewater routes. In all three places plastic forms major part of marine debris - approximately half of the total (40%-50%) debris found in marine waters was plastic (as noted by fishermen). With regard to types of plastic waste, not much difference found in these places except in Fort Kochi beach lot of rubber based waste was seen. Common types of plastic debris found were plastic carry bags, plastic bottles, plastic cups, gift wrapper and ice cream wrappers, flex banners made of plastics, straws, spoon, pouches, sheets etc.



- Impacts on livelihood:** It is evident from the location based study that plastic waste debris have impacted livelihoods of fishermen. Impacts could be categorised into direct impacts (e.g. reduction in the yield) and indirect impacts (e.g. increase of expenditure for repair or replacement; extra time spent etc) (See Nash 1992). All fisherfolks that the research team met confirmed that plastic debris was affecting their livelihoods. The overall impacts of plastic debris according to fishermen in above areas are as follows a) not netting enough fish, b) damage to fishnets, c) financial burden on fishing community for buying additional nets, d) death of many fishes, e) more time needed to net required quantum of fish.
- Cleaning efforts:** As detailed above despite cleaning efforts at all three places involving municipality, local NGOs and volunteers, plastic litter continues to be a problem. In Chennai, they claim that the efforts are focussed only around tourist places and other places need more attention.

3.5 Research question 5: Ways in which ocean-bound plastic waste or plastic already in the ocean can be collected locally

Given the large amount of plastic present in our oceans and the severe problems it is causing for the health of the biota and livelihood of millions of people, it is important to understand and learn the approaches that the local community is practicing to retrieve the plastic from marine waters and along coasts. We explored this aspect of the research during our interviews. Interview participants discussed some important approaches that are practiced locally to address the issue. They indicated that the use of trawl boats, engaging corporates, green protocol movement, and regular beach clean ups as being adopted currently to deal with the problem. These are discussed below.

3.5.1 Use of trawling boats to retrieve plastic waste in the ocean²¹

Most of the respondents suggested trawling²² boats could be effective in collecting plastics from the ocean. One of the participants said *“We recognise that this is the best strategy which is practical and cost effective – if the fishermen bring the plastic they get from the ocean to the shore and process it. Even if we invest crores of rupees – no other system can be as effective and practical as this”*

In this approach, fisherfolks are encouraged to collect plastic waste that they encounter in their daily fishing expedition from the sea and bring to the shore. Each fishing boat are given 2 bags which would hold approximately 50 kg plastic. Also, fishermen are sensitised to ensure non-biodegradable waste (e.g. plastic bottles, plastic containers, and carry bags) which they take along to carry the provision in the boat while going for fishing will be brought back to the shore after use and not be thrown into the ocean. Fisher women or other female labour would be mobilised and trained to segregate, wash and dry the plastic waste brought from the ocean. Finally, arrangements and mechanism will be made in processing units to store and process retrieved plastic waste from the ocean. In such processing units, segregated and cleaned plastics will be shredded and sent for further use mainly for road tarring.

One respondent noted that in their experience “about 50 tons of plastic waste was retrieved during the last one year through this programme”

However, interview respondents identified that several issues need to be addressed for this to work effectively. Primarily the participating fishermen should be given some form of incentive (e.g. subsidy in diesel) for taking part in the expedition as they will be spending

²¹ Please refer Annexure H for Suchitwa Sagaram initiative - a successful example of retrieving plastic using trawl boats.
²² Trawling is a method of fishing that involves pulling a fishing net through the water behind one or more boats

their valuable time of catching fish and also collecting plastic. Second, a segregation mechanism by the government is required to ensure proper sorting and recycling of the retrieved plastic waste. Third, regular awareness and skill building programmes to be conducted for fisherfolks and workforce to keep them motivated for the retrieval and recycling of plastic waste from the sea.



A respondent while suggesting the need for incentives explained that *“Government can announce some benefits or incentives for the boats or for the fisherfolks. The boats should be given diesel in a subsidised rate which will make them responsible for collecting plastic. Small boats needs at least 300 litres of diesel and big boats 800 litres of diesel a day. An average of 12,000 litres diesel is needed for a boat in a month and if the programme can give 200 litres of diesel at for the boats actively participating in the programme – the benefit will reach the labourers and it will be more motivating and it will be very much helpful. Once this is done – we can push the fishermen to collect the plastic. If the Kerala government gives at least a subsidy of Rs.2 per litre to diesel to the boats taking part in suchitva sagarm the boat owners will surely take part in this programme more actively. In Karnataka a trawling boat is given Rs. 63,000 per month as subsidy for diesel, which is deposited into their account which is subsidy of Rs.7 per litre. If the Karnataka government demands that to avail this subsidy a boat should retrieve a specific amount of plastic from the ocean then automatically each boat owner will do it.*

However another interviewee advised that this is a local action through local bodies and this collaboration effort may not work in all situations. He explained that *“If you look at the Kerala governance system - local bodies have power, but it won't work in Tamilnadu. In Kerala right now there is a direction, vigour and people have the spirit - so it is happening. Therefore the importance of a robust institutional mechanism. But in Tamilnadu or many other state it is not happening. In Sikkim it is happening. In Bhutan and also in Himachal Pradesh it is working. The states which are on ecologically fragile zone are doing more of this. Maharashtra also is trying but we do not see any results on ground”.*

Collaboration could be challenging in some cases due to lack of ownership. One respondent described it as a gap and said that *“since there is no one department that owns and leads the programme, hence this is a challenge.”*

3.5.2 Engaging and campaigning corporates to act

Another important approach suggested by some participants was to involve corporates in addressing the problem. There are two clear imperatives for companies to act swiftly on addressing this issue. The EPR is one (see section 3.2.2 and footnote 13) and CSR is another. This approach particularly has proved to be beneficial in developing countries where businesses (brands/ corporations) need to explore ways of partnering with local municipalities (urban bodies) to improve waste collection systems, thereby ensuring that their products are collected and managed responsibly (Godfrey 2019). One participant who works as a scientist supports the view of involving corporates for retrieval of waste from

the ocean *“.....retrieval and collection (of plastic from the ocean) is expensive and time consuming and big companies under CSR can do this. Retrieval is easy but the retrieved things should be properly cleaned, segregated and managed well.”*

Similarly another participant described his experiences involving corporates as a meaningful strategy to address ocean plastics. He explained that *“In Kerala the main brand is Milma. In Chennai they got Pepsi and Coke and on a global level it is Pepsi, Coke and Nestle. We are just naming them. We do a litter study and come up with samples and list the brands to which most of these plastic wastes belong and this study would continue. The level of building pressure is happening and Ellen Macarthur Foundation is facilitating a process of bringing together the brand owners and the activists under one platform. Some of these companies are changing their packing. For example a shampoo selling company which used to sell in sachets made the shampoo in powder form and now it can be packed in paper. So there is no issue of plastic sachets.”*

Engaging these companies and brands to minimise the use of plastic in their products is one way to plastic waste reduction. The other way is to campaign for brands to act to collect back their plastic waste through evidence based research. The Global networks of waste management such as BFFP (Break Free from Plastic) and GAIA movements working along with local NGOs to engage companies based on evidence creation. For example a respondent explained that *“.....they [BFFP and GAIA] are involved in evidence creation and to push the brands to act. Evidence building to shaming brands so that either they change their product or they have to come up with take back system.”* he further explained that *“BFFP is formed just two years back and has already made a good impact. They are actually addressing the issue of plastic right from the production itself. We are networking with more NGOs to align with such kind of movement so that there should be a public pressure on brands and since political pressure is not going to work as they are already bought.”*

3.5.3 Green protocol movement / Volunteer mobilisation

Another strategy that seems to be working in the state of Kerala and Karnataka is the power of green protocol movement where volunteers are being mobilised to create mass awareness and action. As one participant argued *“although green protocol is not mandatory it is very effective as it build peer pressure for following it.”* He further said that *“when we started it in Attingal Pongala people initially opposed as they could not imagine how it can be implemented. Once initiated and we mobilised around 500 youth volunteers in Trivandrum in the first year. Last year we could reduce the plastic and other non-biodegradable waste from 300 tons to 70 tons. Attingal pongala is seen as one of the largest women's gatherings for offering pooja to the deity. With this success now almost all the festivals throughout the state now they are trying to implement green protocol. This is getting copied also in Delhi, West Bengal and other places.”*

He further noted that *“green protocol is effective in making people aware of the ill effects of plastic and hence it get people onboard to resist using plastic- especially single use plastic²³ and eventually that should compel government to act.”* For example through green protocol the Thiruvananthapuram Corporation passed a bill in their council and their health inspectors are going and raiding materials. They are not going just to the small shops. They are going to big stores like Pothys, Ramachandra, and where they get carry bags in huge quantity. In one raid they got about 1 ton of carry bags.

Another participant similarly noted that they have been able to mobilise 300-500 local

²³ Single-use plastics are disposable plastic items that are commonly used for packaging and include items intended to be used only once before they are thrown away or recycled.

volunteers to clean the beaches during every annual beach festival. During one such event they mobilised about 11,000 volunteers who collected about 98 trucks of waste from only one beach area. He further mentioned that mobilising and training volunteers is an effective measure as *“local youth who join us during clean campaign are trained on the importance of cleanliness, impact of plastic and other waste on ecosystems. They are called “Beach Martials” they keep an eye on trespassers with waste. They also blow whistle during such acts.”*

Overall, organising regular coastal clean-up drives involving formal and informal waste pickers and also mobilising volunteers plays a critical in greatly reducing plastic waste along the shores.

3.6 Research question 6: Effective solutions for managing plastic waste collected locally

Various options like adopting technological innovations in recycling to reducing plastic dependency to awareness creation are discussed in the literature as effective solutions for recycling and reuse of different types of land based plastic waste collected locally. Similarly, interview participants expressed varied approaches that could work in the local contexts to manage collected land based plastic waste. Diverse solutions that were supported by respondents are discussed below:

3.6.1 Technological intervention for recycling of local plastic waste

Adopting technological innovations is an important way to resource recovery from plastic waste²⁴. However, respondents' views differed regarding availability and adoption of technological interventions in Indian recycling context. Some participants suggested technological solutions are available and could be appropriate but they face different challenges in recycling business. As one of the respondents who is a scientist expressed that there is an unwillingness to invest in recycling business. *“Urban areas have waste collection mechanisms. Each house, for a fee of Rs. 150 per month is given two carry bags to segregate the biodegradable and nonbiodegradable waste. The waste is collected at a central point and from there lorries take it and segregate and send to Tamilnadu or Karnataka. Only 9 or less than 9 percent is recycled. The remaining plastic remains in the land and finally reaches the ocean. It is not that we don't have the technology to deal with this huge amount of plastic but that we don't want to develop because of lobbying. Waste collection from corporation itself is a big business and many lobby to not make any investment in recycling.”*

Another respondent who has been working in this sector as an expert consultant expressed that adopting technologies in the recycling business cannot be feasible in Indian context. *“Technically there is no solution. The process of recycling is very toxic and after two or three recycling actually it is downcycling – the quality drops. Whatever solutions we talk about they are not solutions but compromises as we have a problem and no permanent solution. How can engineers think about making bricks out of plastic and build houses with that? Houses are where people live and we know in normal temperature plastic emits toxic substances. So these are all weird ideas coming up as solutions – but they are not real solutions.”* In the view of this participant, there are new technology available to recycle plastic in safer manner and environment friendly manner in the world, they are not available in India as these technologies are patented and are not economically viable. He further described the current state of recycling business as doing more harm by emitting more toxics because *“even now*

²⁴ There are successful examples of adopting various technologies to convert plastic waste into reusable materials - see <https://www.timesofisrael.com/israeli-firm-says-it-can-turn-garbage-into-plastic-gold/>

we [in India] are using very crude method of boiling it and making it into lumps and excluding it through some other machines.”

3.6.2 Managing plastic waste at source, adopting efficient waste management system and strict enforcement of legislation are required

Majority of the ocean plastic is land-based. This mismanaged land based plastic waste is released into the natural environment which eventually finds its way to oceans through shared river systems and waterways. As per the modelling undertaken by Jambeck et al (2015), India's mismanaged plastic waste accounts for about 600,000 tonnes a year. This suggests the dire need for improving waste collection and management services in cities and towns in India.

Many respondents suggested that there should be a proper and efficient waste management system of land based waste which is currently lacking in our country. Some of the participants also expressed that reduction of plastic waste generation plays a crucial part. One of the interviewees, for example, said that *“behavioural change within the people's mind-set about use and reuse, controlling or complete stop of gift wrappers and plastic food containers; filtration and segregation of land-based waste at every entry point and treat or recycle.”* are key to managing waste. Similar views were expressed by two other respondents as follows *“People are not aware of the problem or they don't feel it as a problem and they are very much used to plastic products. Prevention is better than cure. Prevention at the source point itself is needed. Once it is into the marine ecosystem it is difficult to manage”.* Similarly another participant noted that *“Solution should come from the policy level and interventions focussed on reduction of plastics itself. We are not against plastic, or saying that plastic should be banned. It is needed for the growth of economy. But more than 50% of plastic is single use plastics, used once and thrown away.ost of this is used in packaging and can be reduced and controlled. By doing so you reserve the resources, for instance Butane (natural gas) is used for making raw material for plastic – so when used for single use and thrown away – we are wasting and misusing natural resources. Save energy to save resources, we cannot afford this throw away culture.”*

Some respondents also expressed the view that legislative support is the key to reducing plastic waste and also minimising the use of single-use plastics. As one interviewee expressed that *“they [regulators] should strictly enforce laws on littering plastic and on its use. If after establishing the system people don't follow it then place cameras to identify and punish the offenders. In this way we can stop or minimise the problem. Once the government strictly enforces the laws people will gradually get used to it and it will become a habit.”*

Similarly another responded noted that *“single use plastic should be banned or we should reduce its use. Government should take the initiative but they are not doing so and people are not aware of the problem”.*

Thus, effective enforcement of law is key for the things to work. While emphasizing this fact an interviewee described as follows:

“The awareness has to be created so that people change their habit of throwing waste into water bodies and there should be strict enforcement of law. Laws are present, so If someone contaminate water bodies they may face 3 months imprisonment and a fine of up to Rs. 2 lakh. This need to be strictly enforced. Some of the local bodies started enforcing this law. Informers are remunerated if they give information on those who throw waste into water bodies.”

3.6.3 Enhanced public awareness and student education on waste management

The UNEP (2018) research report, based on the experiences from 60 countries, draws up action plans for private sectors and governments to reduce production and use of single use plastic. One of the key recommendations of this global study is the importance of creating social awareness and education. Social awareness and education are essential to shape and encourage changes in consumer behaviour. The awareness activities should focus not only on the reuse and recycling of resources, but also on encouraging responsible use and minimisation of waste generation and litter (UNEP, 2018).

All Interview participants strongly agree that awareness creation is an important part of the change. As one of the respondents said *“people are not aware of the problem or they don't feel it as a problem and they are very much used to plastic products”*. She gave an example of lack of awareness of ill effects of plastic waste make few people engage in burning of plastic waste. *“Though there is a system of collecting bio degradable and non-biodegradable wastes from homes, very few people are using that facility. Even the educated and affluent people are reluctant to pay Rs. 150 per month - the user fee to avail that service - and every Sunday they burn the plastic. Though they have some awareness on the carcinogenic effects of burning plastics, the general public is unaware of this entering into food system. We have to popularise these research findings by publishing articles on this which are now limited to scientific journals and papers; and use media more effectively to boost the awareness. We have to convert academic expertise into layman's well-being”*.

She further suggested that *“topics like environment and environmental protection should be made part of the school curriculum. A separate course should be developed on that. Only the students who pass the course should be promoted to higher classes. Use audio visual media to impart this information.”*

Similarly, another respondent highlighted the relevance of education and awareness. *“Through Doordarshan and other private channels public service advertisements should be aired We should have a curriculum that is more towards the environment.”*

In an opinion of a respondent changing of cultural attitude and behaviour of people is a gradual and transformational process and therefore it is a continuous process. The respondent said that *“...people's behaviour change and attitude change is very slow. What is needed is a cultural or behavioural change which takes time.”*

3.6.4 Summary

Interview respondents identified various approaches that are needed for plastic waste management in addition to reuse and recycling of plastic waste. These options included reducing plastic dependency, enabling legislation, enhancing public awareness, and managing plastic waste at source. One of the respondents felt that adopting technologies to resource recovery cannot be economical.

Overall all of the respondents strongly favoured minimising waste production, creating awareness and policy intervention as effective strategies that work in India to address the issue of plastic waste.

4. CONCLUSIONS AND EMERGING INSIGHTS FOR INTERVENTION PLANNING

This section summarises the research findings and provide conclusions based on evidence collected. The section also distil lessons and emerging insights for planning intervention for reducing ocean plastics in India, while also highlight areas that require future research.

4.1 Conclusions

Ocean plastic waste problem is severe in India

Plastic production and consumption patterns in India suggest that there has been a steady increase in its use over the past decades and so as the generation of plastic waste. The annual consumption of plastic in 2010 was 8 MMT and it is projected to reach 22 MMT by 2020. Although average per capita consumption of plastic (11kg/annum) in India is much lower compared to the world's average (38kg/person), the impact of plastic waste will be high in India given the high population and improper facilities for the management of plastic waste. In most cities, there are no complete waste management system in place and the threat to coastal ecosystem from marine debris is evident (See CPCB, 2015).

In terms of plastic waste estimates, India produces about 62 MT of municipal solid waste annually and in that about 5.6 MT is plastic waste (PIB, MOEFCC, 2016)²⁵. Out of 62 MT of municipal waste only about 75-80% of the municipal waste gets collected and only 22-28 % of this waste is processed and treated in India. It is unclear as to the fate of nearly 75 % of waste that is being produced in the country.

Given this state of waste management in India, it is expected that plastic waste litter will continue to pose a huge risk, particularly in our waterways, estuaries and eventually to oceans. Increasing incidences of encountering plastic waste in the oceans by fisherfolks and tourists have been reported by many respondents in this research. All our respondents agreed that plastic infestation has become a serious problem across coastal areas. There was a consensus that plastic marine debris has increased unprecedentedly, particularly in the last few years. Also, it is evident from the location based study that plastic debris have impacted livelihoods of fishermen severely (see section 3.4). Decrease in yield, loss of fishnets, increased economic burden for repair of nets; more fishing time are some of the impacts caused due to increased plastic litter to livelihoods of fishing community. Overall, the plastic problem along the coasts and in oceans is severe and alarming and calls for immediate and comprehensive actions.

The major source of ocean-bound plastic is land based in India

Consistent with the literature, our research identifies that land based plastic waste is the major source of marine plastic debris in India. Local experiences, as explored in this research, suggest that irresponsible waste management on land leading to release of waste into waterways which finally reaches the ocean. It is therefore coastal areas where waterways are merging into oceans are heavily infested with plastic wastes. Some important sources

²⁵ <http://pib.nic.in/newsite/PrintRelease.aspx?relid=138591>

of ocean bound plastic include improper management of land based waste particularly municipal solid waste; loss of debris during fishing; illegal dumping; abandoned fishing gears; the artificial reefs created using plastic sacs and bottles to catch cuttle fishes; release of untreated or partially treated domestic waste; recreation and tourism. There is also concern about the threat from micro plastics in the beach and estuarine sediments. Respondents were particularly concerned about the chances of micro plastics entering into food webs.

Consistent with Jayasiri et al., 2013; Sridhar et al., 2016; Kripa et al., 2016; Kaladharan et al., 2017 and others, the location based study conducted as part of this research confirms that plastic forms the major pollutant among the other marine debris found in the beaches and ocean waters of India. Further, location based study identifies the direct and indirect impacts of plastic debris on livelihoods of fishing community. Since a major source of marine plastic debris is land, focussing on the effective management of the solid waste generated on land is more meaningful. In sum, evidence from our research emphasis that responses to mitigate and manage this marine plastic litter menace is the need of the hour.

The existing legislative instruments need to be more effective to address land-based plastic waste management

To address the challenge of land based plastic waste pollution in the country, the GOI has brought Plastic Waste Management (PWM) Rules, 2016 (amended in 2018). This regulatory framework guides the disposal and management of plastic waste by ULBs as well as other waste generators such as individual household, institutions, residential and commercial establishments and defence establishments etc. While Indian legislative framework captures laws to prevent and mitigate land based plastic waste generation (e. g. MSW), the challenge lies in implementing these laws with complete compliance (MoEFCC, 2018; CPCB, 2018; TERI, 2018). As some evidence from the literature and interview data discussed in the results section, indicate the weak implementation of PWM Rules, 2016 with respect to its EPR and its inefficient financial and technical support to ULBs to successfully explore models to manage plastic waste in urban centres.

Overall, the plastic waste management is captured under legislative framework in India either directly or indirectly through the solid waste management rules. However, the enforcement has largely been ineffective. Further, there is no distinct /specific legislation on marine plastic debris exist in India which address marine based plastic pollution. The need for such strategy in India has been widely argued (See Kripa et al., 2016; MoEFCC, 2018; MoES, 2018) and our research suggest that enforcement of current legislative instruments is lacking and ineffective to manage the plastic waste given the enormity and severity of the ocean plastic problem in the country.

Use of trawling boats to retrieve plastic from the ocean is one of the most effective ways

It is widely accepted that retrieving plastic waste from the ocean is a costly affair. However, some collaborative approaches are being practiced locally to retrieve plastic waste. It is reported that the practice of engaging corporates and mobilising volunteers to collect ocean bound plastics has been successful in certain areas. An important workable and effective solution to collect marine plastic litter as emphasized by many respondents is encouraging fisherfolks to collect plastic waste during their daily fishing expedition. Several aspects, however, need to be taken care for this approach to work effectively. Stakeholders, primarily the government, Harbor departments, NGOs, and other relevant institutes need

to collaborate. The government's help is required for allotting place for the recycling facility needed for processing of daily retrieved plastic waste and also to devise financial mechanisms for its operation. Similarly other non-governmental organisations and technical institutions can provide training and guidance for the workforce to collect, recycle and manage the retrieved waste. Finally some partners are required to promote the reuse and market of recycled plastic.

The concern that expressed among respondents for sustaining this type of effort is the proper and continuous incentives for participating fisherfolks and also financial assistance needed to sustain such collaborative and institutional effort on a long run. If this challenge is addressed, then this model works best in the Indian context to retrieve plastic waste from the ocean.

Awareness creation and waste reduction are key to solving plastic waste problem

There was an unanimous agreement that there needs to be a greater level of effort for creating awareness among residents, students fisherfolks, local community, tourists, etc. It was suggested that achieving change of attitude towards matters like plastics cannot happen solely through awareness campaigns, rather it should be embedded in the curriculum from a young age. The wide range of awareness activities suggested include campaigns, screening of videos of real problems, daily news articles, and advertisements. These activities should focus not just on the reuse and recycling of resources, but also on the ill effects of littering and motivating them to reduce waste production.

4.2. Emerging insights for intervention planning and implementation for reducing ocean plastics in India

Our research has led to identification of a range of ideas and insights that can serve as starting points for intervention planning for reducing ocean plastic waste in India. These are summarised in Figure 18 and elaborated further sequentially. The research demonstrates how any interventions on ocean plastic has to be multidisciplinary, focussed on social science, ocean science, engineering, business models and management, awareness and advocacy etc. Clearly, any effective intervention on reduction of ocean plastic would require a collaborative mode of working as a single agency intervention won't be feasible or effective. Collaborators in any initiative would need to find their niche and specific roles. The findings of this formative research suggest that 9 possible multidisciplinary actions are needed. These actions though not necessarily sequential but are projected as such to provide a semblance of step-wise, systematic and co-ordinated interventions that are most likely to be successful.

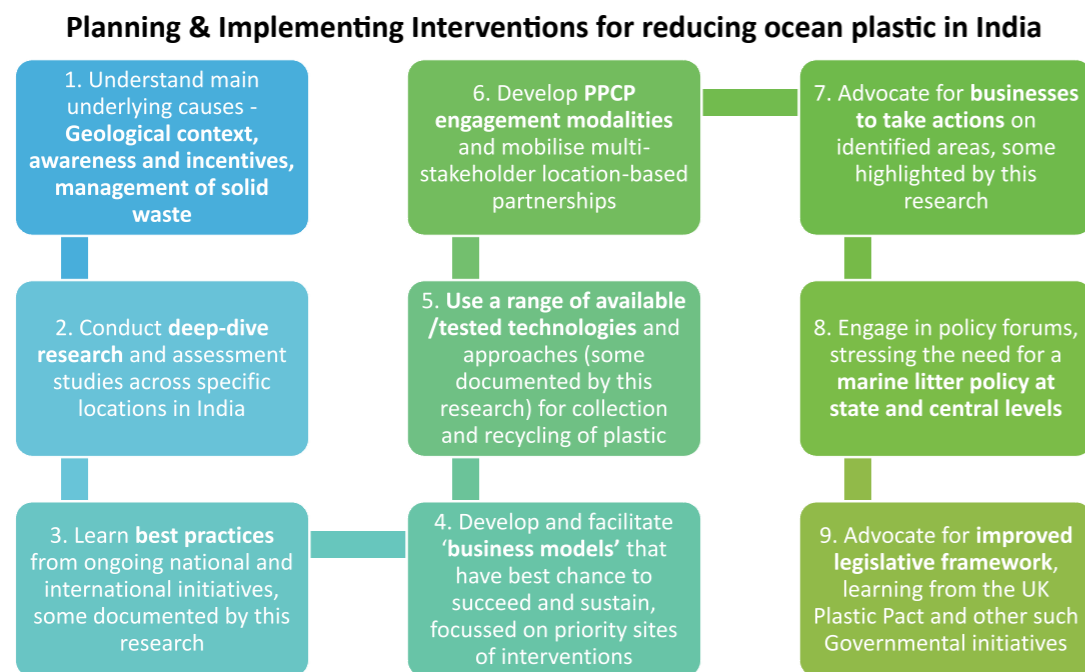


Figure 18: Ideas and insights for intervention planning

First, understand the main underlying factors (and their interconnections) in any specific locations where interventions are planned: Evidence from our research emphasise that responses to mitigate and manage this marine plastic litter menace will require understanding of main underlying causes (as depicted in Figure 19). The flow of plastics to ocean is influenced by a range of geological factors such as large habitation in and around coastal areas, rainfall, weather patterns and water currents that increase the flow of plastic litter from water bodies to ocean. At the same time, inadequate awareness and sensitivity around ocean plastic reflect in low-scale initiatives taken so far to address the problem. In many instances, our respondents cited how wrong incentives are inspiring 'no actions' as some businesses have vested interest in not solving the problem. Further improper management of solid waste at the municipality level increases the likelihood of more plastics moving towards ocean. Informal plastic waste collection system also makes it tougher to implement reforms though it can also be an opportunity. These and many other underlying causes would need to be studied in more detail, as these can then aid in effective intervention planning.

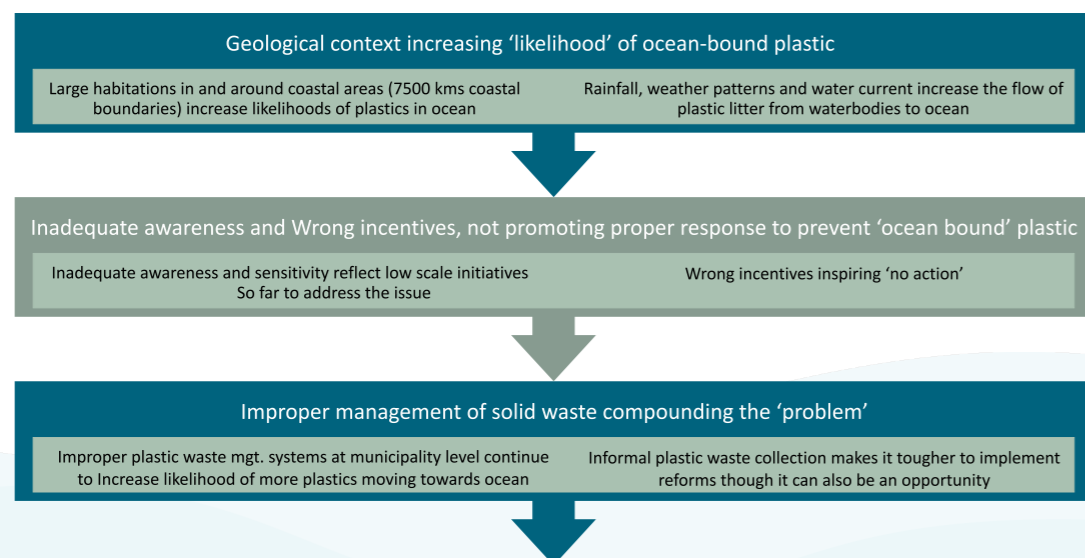


Figure 19. Important underlying factors (inter-connected) that need effective response to reduce ocean-bound plastic and plastic already in ocean

Second, conduct deep-dive research and assessment studies in specific locales: Data from interviews and literature reviews in this research suggest that very few assessment studies have been carried out in India (see Kumar and Sivakumar, 2016)²⁶. Given the long coastline of India and the enormity / severity of the problem, more assessment studies are required to provide the required baseline data for understanding the spatial and temporal distribution of plastics (and microplastic) in open and coastal oceans (IUCN, 2014). The assessments would also help design and monitoring programmes that guide cleaning efforts. Further, the estimates of baseline abundance and composition of plastic litter are vital in order to develop and implement litter reduction policies.

Third, learn from existing national and international best practices in this space: As discussed in section 3.3, it is important to learn and adopt from ongoing national and international initiatives. These initiatives have tried out a range of practices for plastic collection from the ocean (scuba diving volunteers, trawler boats, fisherfolk incentivised etc.) and also ocean-bound plastics from land-based collection centres, where local communities are involved and incentivised. These initiatives have also experimented with various technologies for plastic shredding and recycling. Alternative products such as roof tiles, concrete road material are being made from recycled plastic. Many of these existing initiated are cited by our research and provide important lessons for designing new initiatives.

Fourth, develop and facilitate business /market-based models: As explored in this research, there is a huge amount of plastic waste being generated daily in India and there is a lack of waste management facilities available to manage the waste. Hence, there is ample opportunity for facilitating business models to address both insufficient waste management facilities and to improve recycling businesses in cities/towns thereby avoiding open dumping or dumping near water bodies. The research has provided some initial understanding of how business models can be developed and sustained.

Fifth, use a range of available /tested technologies and approaches for collection and recycling of plastic: As indicated by this research, ongoing initiatives and technological advancement provides a range of tested technologies and approaches for collection and recycling of plastics. These should be appropriately selected for a location-specific intervention.

Sixth, develop Public Private and Community Partnership (PPCP) models and mobilise multi-stakeholder location-based partnerships: Local authorities, businesses and communities need to come together for planning any intervention for reducing ocean plastics. This needs to be facilitated by implementing consortium of actors. A collaborative agenda would need to be developed through this engagement, wherein specific collaborator can choose to play specific roles. This can also lead to formation of location-based multi-stakeholder partnerships, steering the design and effective implementation of the initiative.

Seventh, advocate with large businesses and brands to take actions: The results of this research suggest involving businesses/corporates as crucial for minimising waste and also encouraging recycling economy collaborating with ULBs. This is both for fulfilling their extended producer liabilities as well as corporate social responsibility. Business needs to explore ways of partnering with local municipalities in developing countries, in order to improve waste collection systems, thereby ensuring that their products are collected and responsibly managed at end-of life (Godfrey, 2019).

²⁶ The authors argue that debris characteristics, accumulation and transport pathways along the Indian coastline are poorly studied

Eighth, engage in policy forums for stressing the need for a marine litter policy at state and central levels:

Several research works resonated the need for integrated marine litter strategy (e.g. Kripa et al., 2012; MoES, 2018). We recommend this as an important step to address the growing threat of marine plastic problem in India. Supporting the view of Kripa et al., 2012, we believe that this type of strategy will help 1) Collect litter from the marine environment through incentives 2) Provide Incentives to fisherfolks for marine litter collection (see section 3.5.1) 2) Incentive schemes to promote proper disposal of discarded fishing gear 3) Provision for salvaging yards for fishing vessels. Salvaging of fishing vessels crafts occur on beaches itself as there are no exclusive salvaging yards in India and approximately each of salvaging canoe can shed 25- 30 kg of fiberglass with plastic matrix debris (Kaladharan et al., 2012). 4) Encourage marine clean up campaigns.

Finally, advocating improved legislative framework, learning from the UK Plastic Pact and other such Governmental initiatives:

As a way forward to reduce plastic input into ocean in developing countries, Godfrey 2019 argues that improving waste collection systems must be a priority in developing countries in order to deal with broader waste management challenges (See Annexure J). Encouraging transportation of collected waste to appropriate end-of-pipe treatment facilities like engineered landfills, or recycling or recovery centres etc to ensure that plastic has little opportunity to “leak” into the environment is required (Godfrey 2019). Improved collection provides opportunities to grow local reuse, recycling and recovery economies, which are not possible with high levels of uncontrolled dumping. This research recognises the importance of improved waste collection and strongly recommends for ensuring proper disposal of land-based waste as prescribed by Godfrey, 2019. The UK Plastic Pact is a good example to follow as central and state governments in India can marshal needed resources and work with private sector companies to address the issue.

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ANNEXURES

Annexure A1: Land based source and pathways

There are two ways in which micro plastic debris released into oceans 1) primary micro plastics: which are produced either from direct use or as precursors to other products in the form of plastic pellets, industrial abrasives, exfoliants and other consumer product especially in PCCPs. 2) Secondary microplastics: which are formed in the environment from breakdown of larger plastic material, especially from marine plastic debris.

Leakage of macro plastics happen in every stage from its production to usage and final disposal: two main pathways include improper solid waste and waste water management practices. It is considered that the only major source of plastics to the ocean is improperly managed plastic waste generated on land (Jambeck et al. 2015). Therefore, land-based plastics waste contribute extensively (more than 80%) to plastic in oceans

MACRO PLASTIC			MICRO PLASTIC		
Sector	Activities and waste	Pathways	Sector	Activities and waste	Pathways
Packaging	Sanitary items, shopping bags, food & drink packages and other disposables goods	Water ways, waste water treatment units, solid waste management sites, direct into the ocean	Personal care and cosmetics products (PCCPs)	Abrasive agents and fillers facial scrubs, toothpaste shower gels, sunscreen lotions etc	Waste water treatment units/ waterways/ rivers
Agriculture	irrigation pipes, planting containers and Protective meshes and sheets.	Waterways/ rivers	Textiles and clothing	Mechanical washing of fibres	Treatment units /direct release into river
Construction	Building and construction materials	Solid waste treatment units	Terrestrial transportation	Emission of plastic dust from tyres	Direct release/ rivers
Coastal tourism	Recreation facilities (e.g. hotels, resorts, restaurants, ports, marinas, fishing and diving outlets)	Multiple routes	Plastic producers and fabricators	Accidental loss of resin pellets during transport, transhipment or at manufacturing facilities.	Waste water treatments/ Rivers/ waterways

MACRO PLASTIC			MICRO PLASTIC		
Sector	Activities and waste	Pathways	Sector	Activities and waste	Pathways
			Ship maintenance and ship dismantling	Original plastic abrasive powder, flakes of paint etc used in ship cleaning	Water ways
			Fragmentation of macro plastics	Fragmentation	Waterways/ rivers

Annexure A2: Sea based sources and pathways

MACRO PLASTICS			MICRO PLASTICS		
sector	Activities	Pathways	Sector	Activities	Pathways
Fisheries	Loss of fishing gear (e.g. nets, ropes, floats, fishing line), loss of ancillary items (e.g. gloves, fish boxes, strapping bands), galley waste and release of fibres and other fragments due to normal wear and tear (e.g. use of ground ropes).	Illegal disposal; solid waste and waste water treatment units; accidental loss	Fisheries	Fragments and fibres from operational use of fishing gear, ropes	Direct release
Aqua culture	Loss due to wear and tear of anchor ropes, because of storms, and due to accidents/ conflicts with other maritime users.	Illegal disposal; solid waste and waste water treatment units; accidental loss	Aqua culture	Fragments and fibres from operational use of nets, ropes and \ buoys	Wear and tear of equipment during use
Commercial shipping and offshore industries	Plastic resin pellets	Direct release into ocean	Commercial shipping and offshore industries	Plastic resin pellets	Accidental loss of plastic resin pellets
Recreational activities	Tourists cruises	Direct release into ocean	Ship-based tourism	Wear and tear of equipment during use	Direct release into ocean
Maritime-based tourism	Solid wastes from cruise ship is put ashore at ports on small islands with inadequate waste infrastructures	Solid waste treatment	Maritime activities	PCCPs	Waste water treatment

Source: UNEP, 2017; Law, 2016; Karshaw et al, 2016; Thomson et al., 2009; Moore 2008

Annexure B: Composition of plastic waste in India²⁷

Municipal solid waste in India generally comprises of five types of plastics wastes namely

1. Polyethylene Terephthalate (PET) (e.g. Drinking water Bottles, Soft drink Bottles, Food jars, Jelly pickles, Plastics Films, Sheets)
2. High Density Polyethylene (HDPE) Low Density Polyethylene (LDPE) (e.g. Plastics bags, Food containers, woven sacks, Bottles, Plastics Toys, Milk Pouches & Shopping Bags, Metalized Pouches);
3. Polyvinyl Chloride (PVC) (e.g. Pipes, Hoses, Sheets, Wire, cable insulations, Multilayer Tubes);
4. Polypropylene (PP) (e.g. Disposable Cups, Bottle caps, Straws); Polystyrene (PS) (e.g. Disposable Cups, glasses, Plates, spoons, trays, CD Covers, Cassette Boxes, Foams);
5. Others: Thermoset, Polycarbonate (PC), Polyurethane (PU) (e.g. CD, Melamine Plates, Helmets, Shoe soles).

PET is easily recyclable and HDPE is most commonly recyclable while PVC is least recycled and PP is very difficult to recycle

Annexure C: Estimated plastic waste generation (Tonnes per annum) in Indian states

States	MT/year	Ban of carry bag (>50 microns)
• Andhra Pradesh	82863	The EFS&T Dept. is under process of issuing Executive Orders on ban of carry bags less than 50 microns. However, partial ban under in majority of ULBs are plastic Waste (as per 2016 data).
• Arunachal Pradesh	6	Ban on the use of plastic bag
• Assam	24030	There is no ban using plastic carry bags
Andaman & Nicobar	365	Andaman and Nicobar Administration has imposed complete ban on usage of plastic carry bags through Andaman Nicobar Gazette Notification No.202 dated 02-08-2015 (2016 data).
• Bihar	2280	Not imposed complete ban on plastic carry bags.
• Chandigarh	12775	Complete Ban on plastic carry bags
• Chhattisgarh	7300	Complete Ban on plastic carry bags
• Goa	106	
• Gujarat	269808	< 50 micron carry bags are banned
• Himachal Pradesh	255	Complete Ban
• Haryana	23369	Complete Ban of use of plastic carry bags

²⁷ CPCB 2015

States	MT/year	Ban of carry bag (>50 microns)
Jammu & Kashmir	27870	<50 microns carry bags are banned in J & K State
• Jharkhand	35853.5	
• Karnataka	41900	Complete Ban
• Kerala	Information not available	
• Lakshadweep	Information not available	
• Madhya Pradesh	61037	Complete ban
• Maharashtra	21420.33	50µm is the thickness, size of carry bags and also type of material used & recycling status. All the registered Manufacturers complied and marking/labelling
• Manipur	24	There is a complete ban on manufacture, mport, storage, transportation, sale and use of plastic carry bags in the State.
• Meghalaya	15.096	There is a partial ban on the use of plastic carry bags in some places.
• Mizoram	6396	
• Nagaland	14052.5	The Government of Nagaland has banned the use of poly bags/plastic carry bags in the State with effect from 1st January 2004. Provision for marking and labelling of carry bags are followed in Kohima and Dimapur City.
• Odisha	12092.2	Complete ban on Plastic carry bags
• Punjab	54066.1	Government of Punjab has completely banned use of plastic carry bags in the State
• Pondicherry	9252.25	G.O. was issued on December 2009, banning plastic carry bags of lesser than 50micron thickness.
• Rajasthan	Information not available	Complete ban
• Sikkim	102.7	Plastic bags have been banned as per Sikkim Urban Development vide Notification No. GOS/UD&HD/97- 98/6(85) dated 4th june,1998.
• Tamil Nadu	79114.792	
• Telangana	120961	
• Tripura	28.5	There is a complete ban on manufacture, import, storage, transportation, sale and use of plastic carry bags in the State.

States	MT/year	Ban of carry bag (>50 microns)
• Uttarakhand	3016.3	There is a complete ban on manufacture, import, storage, transportation, sale and use of plastic carry bags in the State.
• Uttar Pradesh	206733.4	There is a complete ban on manufacture, import, storage, transportation, sale and use of plastic carry bags in the State.
• West Bengal	Information not available	
• Total	1109792.668	

Source: CPCBs (Annual Reports on plastic wastes), 2016; 2017; 2018

Annexure D: Literature review on microplastics marine litter in Indian beaches

Microplastics are basically plastic particles smaller than 5 millimetres in diameter (Arthur et al. 2009). Few estimation studies have been conducted in India on microplastic pollution in marine and estuarine areas. Important one is the assessment done by Karthik et al 2018 where about 25 locations were studied to evaluate the extent of microplastic pollution along Tamil Nadu coast (1076 km) in India. All samples were showed significantly higher abundance of microplastic. Beaches adjacent to rivers exhibited relatively higher microplastic abundance compared to those influenced by tourism and fishing activities. Out of the total detected debris, plastic fragments were the maximum (47–50%). The results indicate that microplastics accumulation in the coastal environment, especially close to the river mouths, may be a serious concern, due to its ability to enter into the marine food web and highlights the necessity of microplastics screening from estuarine, coastal waters and other potential sources. Similarly in another study Shruthy and Ramaswamy 2016 recovered microplastics from all sediment samples at Vembanad Lake and estuarine ecosystem, indicating their extensive distribution in the lake. The abundance of microplastics recorded from the sediment samples is in the range of 96 to 496 particles per m². Both of theses studies confirms the microplastic ingestion in fishes and conclude that these microplastic pose severe threat of contaminating the food web particularly when local population is dependant on fish for protein sources.

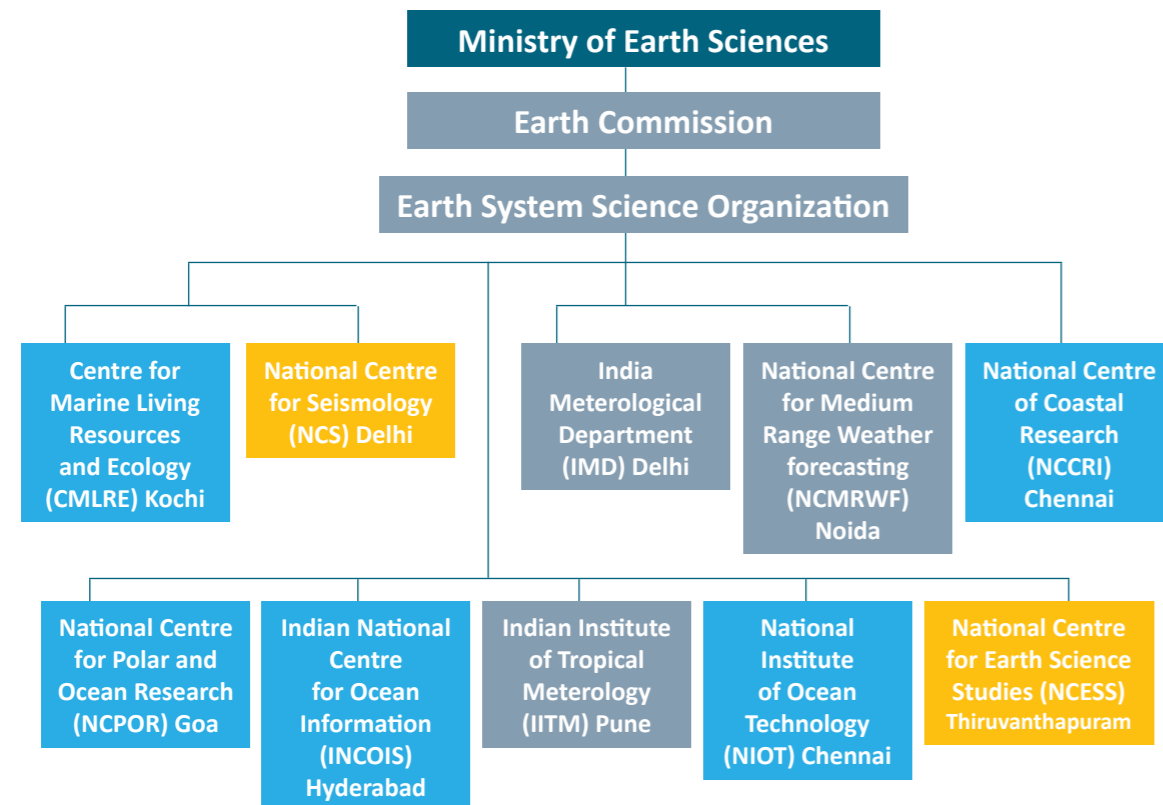
Annexure E: Information on MoES, MoEFCC and ICAR

- **Ministry of Earth Sciences (MoES)**

The Department of Ocean Development (DOD) was created in July 1981 as a part of the Cabinet Secretariat. The Government of India (GOI) reorganized the Ministry of Ocean Development to form the new Ministry of Earth Sciences (MoES) in 2006. The creation of the new ministry emerges from the government’s idea of taking up an integrated view of earth system sciences that includes the land, the ocean and the atmosphere²⁸. The Ministry of Earth Sciences (MoES) is the nodal Ministry for organising, coordinating and promoting ocean development activities in the country. The MoES is guided by the 12-member Earth Commission. The Earth System Science Organization (ESSO) , New Delhi, operates as an executive arm of the Ministry of Earth Sciences (MoES) for it policies and programmes. The ESSO provides overall direction for the centres/units and review the implementation of the

28 <https://www.downtoearth.org.in/news/ministry-of-ocean-development-gets-a-new-name-7888>

programmes. The ESSO was established in October, 2007 as a virtual organisation, bringing all meteorological and ocean development activities under one umbrella, recognising the importance of strong coupling among various components of the earth viz. atmosphere, oceans, cryo-sphere and geo-sphere. The overall vision of the ESSO is to excel in knowledge and technology enterprise for the earth system science realm towards socio-economic benefit of the Indian sub-continent and in the Indian Ocean region. The marine or coastal management related policies and programmes are being pursued through its centres as shown in Figure below



2 Subordinate Offices, 2 Attached Offices, 1 Project Directorate and 5 Autonomous Bodies

● **Ministry of Environment Forests and Climate Change (MEFCC)**

The Ministry of Environment, Forests and climate change (MoEFCC), on the other hand is the nodal agency to implement policies and programmes relating to prevention and abatement of pollution (including plastic pollution) and conservation of the country’s natural resources. Since major drivers of ocean bound plastic are land based, waste management programmes or policy interventions of MoEFCC have the clear linkage in addressing the marine pollution or marine litter. The MoEFCC coordinates with Central and State Pollution Control Boards, Ministry of Urban Development (MoUD), the National Environmental Engineering Research Institute (NEERI) to implement Policy on plastic waste management and the ground level implementation responsibility lies with the ULBs.

● **Indian Council of Agricultural Research (ICAR) -CMFRI**

The Fisheries Science Division under the Indian Council of Agricultural Research (ICAR) coordinates and monitors the research and academic programmes in fisheries and aquaculture of five resource specific fisheries research institutes including ICAR-Central Marine Fisheries Research Institute (CMFRI) and ICAR-Centre Institute for Fisheries Technology (CIFT) which are also supported by a wide network of their Regional/Research/Field centres.

With the mandate to monitor and assess the marine fisheries resources of the Exclusive Economic Zone (EEZ) including the impact of climate and anthropogenic activity and develop sustainable fishery management plans, the CMFRI operates through various regional and research centres located along the coast of India. The multi-disciplinary approach adopted by CMFRI, its programmes and activities constantly engage in monitoring the marine plastic litter.

Annexure F1: Details on provisions of Plastic Waste Management 2016

Few Under the rules of the legal framework, the manufacture, importer stocking, distribution, sale and use of carry bags, plastic sheets or like, or cover made of plastic sheet and multi-layered packaging, shall be subject to the following conditions, namely: -

- Carry bags and plastic packaging shall either be in natural shade which is without any added pigments or made using only those pigments and colorants which are in conformity with Indian Standard: IS 9833:1981 titled as “List of pigments and colorants for use in plastics in contact with foodstuffs, pharmaceuticals and drinking water”, as amended from time to time;
- Carry bags made of recycled plastic or products made of recycled plastic shall not be used for storing, carrying, dispensing or packaging ready to eat or drink food stuff’;
- Carry bag made of virgin or recycled plastic, shall not be less than 50 microns in thickness;
- Plastic sheet or like, which is not an integral part of multi-layered packaging and cover made of plastic sheet used for packaging, wrapping the commodity shall not be less than fifty microns in thickness except where the thickness of such plastic sheets impair the functionality of the product;
- The manufacturer shall not sell or provide or arrange plastic to be used as a raw material to a producer, not having valid registration from the concerned State Pollution Control Boards or Pollution Control Committee;
- Sachets using plastic material shall not be used for storing, packing or selling gutkha, tobacco and pan masala;
- Recycling of plastic waste shall conform to the Indian Standard: IS 14534:1998 titled as
- Guidelines for Recycling of Plastics, as amended from time to time;
- The provision of thickness shall not be applicable to carry bags made up of compostable plastic. Carry bags made from compostable plastics shall conform to the Indian Standard: IS 17088:2008 titled as Specifications for Compostable Plastics, as amended from time to time. The manufacturers or seller of compostable plastic carry bags shall obtain a certificate from the Central Pollution Control Board before marketing or selling; and
- Plastic material, in any form including Vinyl Acetate - Maleic Acid - Vinyl Chloride Copolymer, shall not be used in any package for packaging gutkha, pan masala and tobacco in all forms.

Annexure F2: The authorities responsible for implementation of the PWM 2018 Rules²⁹

Authority	Mandate
The State Pollution Control Board (SPCBs) – states Pollution Control Committee (PCC) – UT	Enforcement of the provisions of these rules relating to registration manufacture of plastic products and multi-layered packaging, processing and disposal of plastic waste. Prepare and submit an Annual Report to the CPCB on the status of implementation of these rules
The concerned Secretary-in-charge of Urban Development of the State or a Union Territory	enforcement of the provisions of these rules relating to waste management by waste generator, use of plastic carry bags, plastic sheets or like, covers made of plastic sheets and multi-layered packaging.
The Gram Panchayat	<ul style="list-style-type: none"> ensure segregation, collection, storage, transportation, plastic waste and channelization of recyclable plastic waste fraction to recyclers having valid registration; ensuring that no damage is caused to the environment during this process; create awareness among all stakeholders about their responsibilities; and ensure that open burning of plastic waste does not take place

Annexure G: Selected beaches for Blue Flag Certification

1. Shivrajpur, Dwarka, Gujarat
2. Ghoghla, Diu, Daman & Diu
3. Bhogve, Sindhudurg, Maharashtra
4. Miramar, Panjim, Goa
5. Padubidri, Udupi, Karnataka
6. Kappad, Kozhikode, Kerala
7. Emerald, Karaikal, Puducherry
8. Mahabalipuram, Chennai, Tamil Nadu
9. Rushikonda, Visakhapatnam, Andhra Pradesh
10. Chandrabhaga, Konark, Odisha
11. Tajpur, Purba Mednipur, West Bengal
12. Radhanagar, Havelock, Andaman
13. Bangaram, Lakshadweep Based on a pre

²⁹ The Authorities referred to in sub-rules (1) to (3) shall take the assistance of the District Magistrate or the Deputy Commissioner within the territorial limits of the jurisdiction of the concerned District in the enforcement of the provisions of these rules.

Annexure H: Some important initiatives undertaken by private sectors in India

● **Friends of Marine Life**

Friends of Marine life (FML) is registered and an indigenous coastal community voluntary organisation based at Trivandrum. The FML regularly organizes clean up drives the floor of oceans. It also trains fisherfolks and volunteers on scuba diving and engages them in clean up drives. FML’s marine debris clean up venture has two stages of implementation i) the Process of Debris clean up and ii) Ghost net removal.

An important one of several of FML’s clean up drives is the clean-up drive organised to clean the marine debris accumulated in the seabed as a result of Ockhi cyclone (see MBA 2018). Three teams of two divers each conducted clean up dives in different depths in Kovalam and after an hour long clean up drive they brought 71 Kg of debris in to the shore. Among the on-biodegradable substances, plastic wastes alone weighed 19 kilograms which was 27.02% of the total waste collected. Micro-plastics were found in the sediment samples and 68 micro-plastics were seen in 1 kilogram of sediment samples. Fibre type is the predominant type of micro-plastic found. Similarly in another two day clean up drives (one hour each day) plastic waste alone weighed 42.2 Kg which among the collected debris collected (53.3 %)The ghost net removal was conducted in two locations at Vizhinjam during the same time. The FML diving team and volunteers were able to remove 400 Kg of nylon ghost nets..

● **Suchitwa Sagaram Initiative: a noble initiative to eradicate plastic from oceans**

Suchitwa sagaram initiative was initiated to collect the plastic and other garbage from the sea bed at Sakthikulangara and Neendakara Fisheries harbours in Kerala. The partnering organisation the cooperation of the fishing boat operators take the collected plastic waste to shredding units at the harbours where it will be sorted, washed and crushed and make it ready for recycling. Several institutions including the Suchitwa mission (Government of Kerala), Society for Assistance to Fisherwomen (SAF), Department of Fisheries, Kerala, Harbour Engineering Department (HED), Clean Kerala Company, Boat Operators Association, Kollam District and NETFISH-MPEDA have been working to make this model a success while contributing to the cleaning of ocean. The Hon. Minister for Fisheries Smt. J, Mercykutty Amma was the sole inspiration of the project. Each of these entities are contributing technical; financial; monitoring; human resource etc support to implement this project.

How it works: A total of 30 workers are involved in this project for collecting the bags from fishing vessels, sorting/segregation of plastic wastes, washing, drying and shredding. Various collection centers have been started in and around the harbour to collect the bags that reach the harbour. Everyday fishing vessels will be given 2 eco-friendly collection bags to collect the plastic material that comes across the sea while fishing. Around 30-40 bags each weighing about 40-50 kg are collected every day at the shredding unit at Sakthikulangara harbour.

Sustainability of the project: The project operations are trying to make the operation and maintenance sustainable. The wages are proposed to be productivity linked in order to have a maximum out turn from the workers. It is expected that about 350Kg plastics can be shredded every day. Based on the average selling price of Rs. 20/- per kg the income of Rs. 7000.00 per day is could be generated from the project. this can be spent towards the wages of workers and towards the power charges, maintenance etc. Additional fund requirement is planned to be met by sponsorship. However, a viability gap funding will be required to meet the wages during the monsoon when it will be difficult to collect, wash and dry the plastics. (MBA, 2008)

- **The ghost fishing net removal initiative by IISDA in Sindhudurg coastal waters of India**

Due to the rocky terrain of Sindhudurg coastal waters, several types of nets used by fishing population get entangled in rocky bottom and due to the failure in retrieval of these nets; fishermen cut the nets which remains underwater forever. To address this issue, the court's first scuba diving institute Indian Institute of Scuba Diving and Aquatic Sports (IISDA)" (established by the Tourism department of Government of Maharashtra) devised a plan. IISDA conducted capacity building programme for 20 local youths in professional scuba diving under the GOI-UNDP-GEF initiative. As a part of the course, each student was to carry out 40 dives to qualify the dive master program. These dives were used to carry out the removal of ghost fishing nets. About 800 hours were spent underwater to trace and remove ghost fishing net and the team has cleared of over 2 lakh square meters of abandoned nets from the bottom of the sea and have rescued hundreds of turtles, fish, and invertebrates.

It is estimated that removal of 2 lakh square meter of net may have saved loss of over 200 tonnes of fish annually thus saved loss of Rs. 4 Crore fishery resource and it saved loss to thousands of local fishermen. Further, this activity has created greater degree of awareness among local fishermen communities, youths as well as many NGOs.

- **Afroz Shah : An organiser of world's largest beach clean-up project**

Afroz Shah an advocate by profession motivated millions of volunteers to clean Versova beach in Mumbai. He started his clean-up drive in 2015 along with one of his neighbours every weekend since, Shah has inspired volunteers to join him. Shah created awareness among residents and fisherfolk explaining the damage marine litter causes, now plans to expand his group's operation to prevent litter from washing down the local creek and onto the beach

So far, the volunteers have collected over 4,000 tons of trash from the 2.5 kilometre beach. Mr. Shah has been awarded UN Environment award for his achievement.

Annexure I: Literature review on marine plastic debris studies conducted in India

Following are very few important researches published on marine plastic litter in Indian coast and their key findings

- **Plastic fragments in marine sediments along the Alang-Sosiya ship-breaking yard, India: Reddy et al., 2006**

In this study the accumulation of small plastic debris in the intertidal sediments of the world's largest ship-breaking yard at Alang-Sosiya, India was assessed. Small plastics fragments were collected by flotation and separated according to their basic polymer type as polyurethane, nylon, polystyrene, polyester and glass wool. This study reports that there were on average 81 mg of small plastic fragments per kg of sediment. These plastic fragments were believed to have resulted directly from the ship-breaking activities at the site.

- **Land-based plastic debris in beaches of Mumbai: Jayasiri et al., 2013 and 2014**

Two studies by Jayasiri et al 2013 and Jayasiri et al 2014 have been conducted to assess plastic litter in the beaches of Mumbai. Each of these studies quantified plastic litter on four sandy beaches in Mumbai. In one study, the mean abundance of 7.49 g and 68.83 items per square metre was recorded with predominant presence of plastic fragments (1–20 mm) and 41.85% of microplastics (1–5 mm). In another study, the average abundance of 11.6

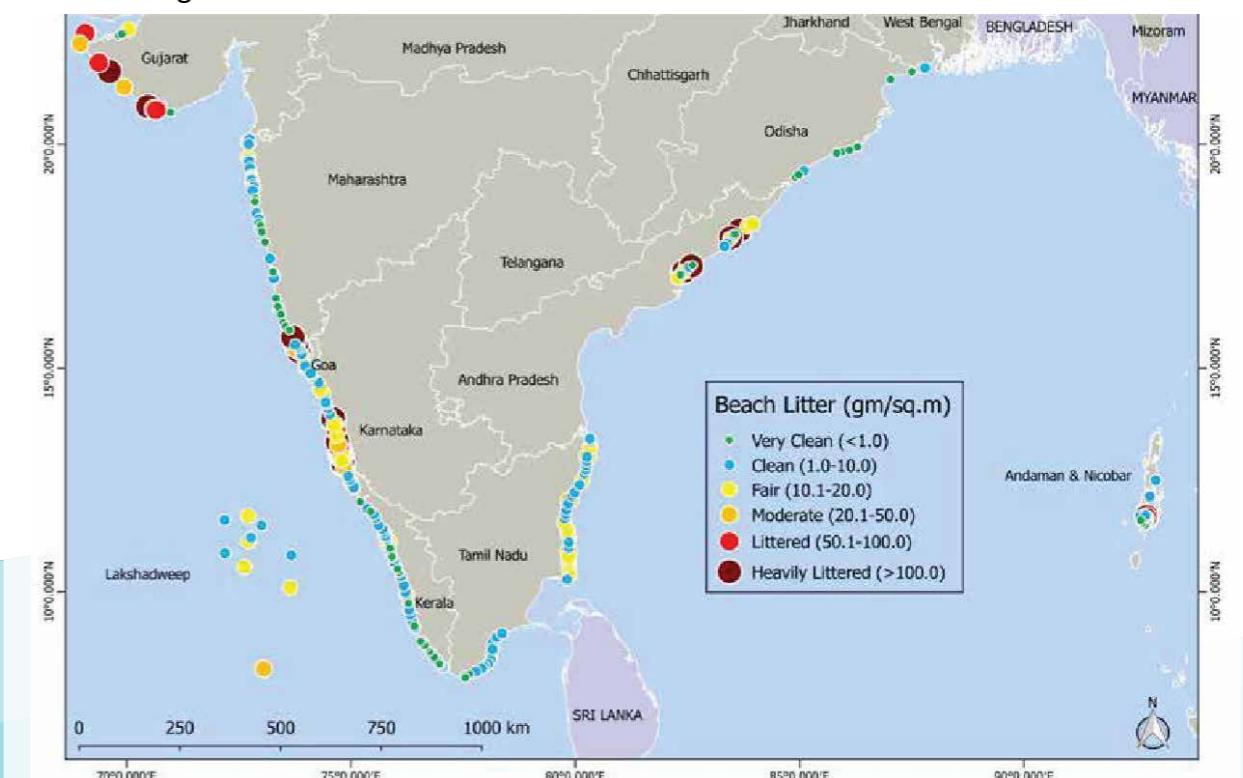
items per m⁻² (0.25–282.5 items m⁻²) and 3.24 g m⁻² (0.27–15.53 gm⁻²) plastic litter was recorded. More than 80 % of plastic particles were within the size range of 5–100 mm both by number and weight. Predominant presence of small fragments of plastics pose a high risk to marine life due to ingestion. These studies concluded that the major contributing factors for the abundance of plastic litter is their usage for activities such as recreational, tourism and religious suggesting that the land-based sources provide major inputs to plastic pollution in these beaches.

- **Riverine is the major source of microplastic pollution along the south east coast of India: Karthik et al., 2018**

This work studied the microplastic particles at 25 beaches along the southeast coast of India. All samples showed significantly higher abundance of microplastic with highest abundance of microplastics recorded on beaches adjacent to river mouth compared to those influenced by tourism and fishing activities. Out of the total detected debris, plastic fragments were the maximum (47–50%).

- **Presence of plastic litter along the Indian beaches -Kaladharan et al., 2016**

This is an important study brings out synoptic picture of status and composition of beach litter from 254 selected beaches along the maritime States of Peninsular coast of India as well as the UTs of Andaman and Lakshadweep Islands from the one time observation conducted between October 2013 and January 2014 for the first time. Beach litter from different maritime States and the UTs showed that Odisha coast has the lowest (0.31 g/m²) quantity and Goa coast (205.75 g/m²) the highest quantity of beach debris. Samples of debris collected from beaches revealed that all the items were domestic and anthropogenic discards. Plastic litter (e.g. carry bags and sachets of soft drinks, edible oils, detergents, beverages, cases of cosmetics, toothpaste, PET bottles, ice cream containers), recorded highest mean of 25.47g/m² from Goa coast followed by beaches in Karnataka (21.91g/m²). Beaches were grouped as clean to heavily littered beaches based on the quantity of litter as shown in Figure



Source: Kaladharan et al 2017

- **Marine plastic debris pollution along Marina beach, Chennai, India - Kumar et al., 2016**

This study examined marine debris including plastic debris in the Marina beach, Chennai India. The average number and weight of the debris per 100m is found to be 171.8 and 3.24 kg respectively. Plastic debris formed the majority of all the debris items (44.89 %) collected on the beaches during the survey period. The main sources of beach debris were shoreline/ recreational activities (74.46 %). The plastic debris abundance on Marina beach was higher than that reported in other beaches in India.

- **Micro plastic pollution in benthic invertebrates from the coastal waters of Kochi - Naidu et al., 2018**

This study examined microplastic particles present in benthic invertebrates from the surface sediments of off-Kochi, southwest coast of India. The microplastic particles and thread-like fibres detected in these organisms were identified to be polystyrene. The study provides preliminary evidence of the presence of microplastics in benthic fauna from the coastal waters of India

Annexure J: Options for governments and businesses to reduce plastic input into oceans

Method/ approach	Who can adopt	Opportunities	Risks
Ban (Ban single-use plastics)	Governments, where they are unable to improve waste collection services and where they have little control over the design of products in their market	Near immediate relief if properly implemented	The local plastic sector (manufacturing and imports), argues the potential job losses that can be expected as a result, complicating often difficult local economic climates
Product Replacement (single-use plastics with alternative bio-benign material)	Businesses (e.g., brand owners and retailers), where they have little control over improving waste collection services, and no appetite for reducing product consumption, is to switch to alternative product designs	Theoretically replace problematic product with an environmentally benign alternative	But seen as a threat by businesses particularly those unwilling and unable to diversify
Improved Waste Collection	Developing countries	There is a possibility that 100% waste collection may not be achievable financially - operationally	Improved collection provides opportunities to grow local reuse, recycling and recovery Reduction in uncontrolled dumping

Source: Godfrey, 2019



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