PROMOTION OF COUNTER MEASURES AGAINST MARINE PLASTIC LITTER IN SOUTH EAST ASIA AND INDIA

Literature Survey and Desk Review

(Executive Summary)

UN environment programme

Counter MEASURE FOR PLASTIC FREE RIVERS

National Productivity Council

Executive Summary - Deliverable 1

Desktop Review of Plastics and Plastic Pollution in India

Plastic is a polymeric material that has the capability of being molded or shaped, usually by the application of heat and pressure. It is material consisting of any of a wide range of synthetic or semi-synthetic organic compounds that are malleable and so can be molded into solid objects. It is due to their low cost, ease of manufacture, versatility and imperviousness to water, plastics are used in a multitude of products at different scales, so that's why plastics are a key material at the heart of almost every industry and across product streams.

Structure, properties, and classification aspects concerning Plastics:

- Most plastics contain organic polymers, these chains comprise many repeat units, formed from monomers. It has been indicated that to customize the properties of a plastic, different molecular groups are made to connect or hang from the core backbone.

- Plastics are generally categorized by the permanence or impermanence of their form into two types i.e. Thermoplastics and Thermosets, former includes Polyethylene Terephthalate (PET), High Density Polyethylene (HDPE), Low Density Polyethylene (LDPE), Polypropylene (PP), Poly Vinyl Chloride (PVC), Polystyrene (PS), etc. and latter includes Molding Compounds (SMC), Fiber Reinforced Plastic (FRP), Bakelite, etc.

- Polyethylene terephthalate (PET or PETE) is a general-purpose thermoplastic polymer which belongs to the polyester family of polymers. It is used in several packaging, textile, electrical industries. It is being used in many applications in the automotive industry and allied sectors.

- Common Plastic includes Polyamides (PA), Polycarbonate (PC), Polyester (PES), Polyethylene(PE), Polyvinyl Chloride (PVC), etc.

- High performance plastic includes Polyepoxide (epoxy), Polymethyl Methacrylate (PMMA) (acrylic), Polytetrafluor

Polymer with its Brand names and Characteristics:

Brand Name	Polymer	Characteristics/Properties
Bakelite	Phenol-formaldehyde	High electric, heat and chemical resistance
Kevlar	Para-aramid fibre	High tensile strength
Twaron	Para-aramid	Heat resistant and strong fibre
Mylar	Polyethylene terephthalate film	High strength and stiffness, less

Brand Name	Polymer	Characteristics/Properties
		permeable to gases, almost reflects light completely
Neoprene	Polychloroprene	Chemically inert

Additives play a key role in developing and imparting the desired properties. Additives in some common polymers indicating their function and relative proportion are mentioned below:

Polymer	Additive Type	Quantity in polymer (% w/w)	Hazardous (substances)
PP	Antioxidant	0.05-3	Bisphenol A, octylphenol, Nonylphenol
HDPE	Antioxidants	0.05-3	Bisphenol A, Octylphenol, Nonylphenol
	Flame retardant (cable insulation application)	12-18	Brominated flame retardabt, Boric acid, Tris(2-chloroethyl) phosphate
PVC	Plasticizer	10-70	Pathalate
	Stabilizer	0.5-3	Bisphenol A, Nonylphenol

Production and Consumption of Plastics-Global and India:

From about 1.5 Million Tonnes in 1950, global plastic production rose to 348 Million Tonnes by the year 2017 (i.e. over 232 times in just 67 years). The world has seen a drastic shift in lifestyle and change in the course of modernization, resulting in the problem of single-use plastics, which has emerged as a matter needing attention across the world. The western world and European region is significantly high on plastics consumption (139 kg/capita and 136 kg/ capita). If we compare with India, we note that in India there is a moderate level of plastics consumption of 12 kg/capita. The developing world regions are steadily increasing plastics consumption, both from domestic production and via product imports and polymer/plastics imports. It has been recorded and estimated that the production of polypropylene is the highest worldwide. The levels of production of PVC (Poly Vinyl Chloride) and Polyethylene Terephthalate are comparable at 38 and 33 Million Tonnes respectively. It has been highlighted that plastics usage in the packaging sector is the highest at about 35.9% as of the year 2015. The use in the building and construction sector is at the next level at about 16% and in textiles at 14.5%.

In India a wide range of plastic polymers is being manufactured and polypropylene is the major polymer manufactured in India (35.91% of all plastics in 2019-20), and HDPE (18.08%), LLDPE (14.56%), PET (13.12%) and PVC (9.09%), as other key components as of 2019-20. It is observed that there has been a significant rise in the production of LDPE, with a growth increase of 195% from the year 2016-17 levels. Polyethylene

Terephthalate is majorly utilized for bottle production which is utilized by mineral water supply and beverage manufacturing units as the core packaging units.

A significant amount of PET is also used for film making that is used for various products related to packaging applications. Packaging of agriculture, and electronics are found to be major domains where plastics consumption is huge in India.

The quantum of imports of polymers by India was about 4200 Kilo Tonnes, which was approximately 29.81% as of 2016-17. The import basket included all the key varieties of plastics such as PVC, PP, HDPE, EVA, LLDPE, LDPE, Styrenics, and others. The maximum percentage of imports amongst polymer types has been PVC which accounted for about 38% in 2016-17. The growth of the plastic industry and its contribution to the economic system is continuing to be on the upward trend globally as well as in India. It has been especially identified that the major growth drivers are likely to be packaging (for food products and others), infrastructure related applications, agriculture applications, consumer durables, healthcare, Solar PV, and other areas.

Plastics Waste generation and Leakage in the Global context is estimated in the order of 10 million tonnes per year (Mt/y). It is indicated that significant additional focused studies are required to assess the plastic waste generation data at the micro level across countries and aggregating the same at national and international levels. The estimates accordingly made for total plastics that have reached the oceans globally over the period since the 1950s till date has been indicated to be 150 Million Tonnes, out of this 62% of plastic comprises of packaging. Estimates and projections have been made that in future about 1 kg of plastics would be in the oceans for every 5 kg of fish and that this was expected to grow. Additional studies have indicated that there is approximately 3% leakage of plastic wastes globally (of approximately 12 Million Tonnes per year). A higher estimate has been put forward by the World Economic Forum(WEF), with an estimated 32% of single-use packaging escaping collection systems.

Plastic Pollution-The estimates, impacts on marine biota and macro / micro distinctions

Plastic pollution is the accumulation, spread, and aggregation of plastic objects and particles (e.g. plastic bottles, bags, and microbeads) in the Earth's environment that adversely affects wildlife, wildlife habitat, and humans and it can affect land, waterways, and oceans. The living organisms, particularly marine animals, can be harmed either by mechanical effects, such as entanglement in plastic objects, problems related to the ingestion of plastic waste, or exposure to chemicals within plastics that interfere with their physiology. The estimates made also indicate that while every year, more than eight million tons of plastic end up in the ocean, costing at least $8 billion (7.1 billion euros) in damage to marine ecosystems. The

assessments regarding inputs of plastics to the marine environment via the riverine pathway have been a parallely focused area of research and analysis.

It has been emphasized that plastics can be encountered in two forms: large plastic wastes called Macro-plastics, which usually enter the marine environment in their manufactured sizes or abraded forms, and Small plastic particulates below 5 mm in size called Micro-plastics.

Mismanaged plastic waste is commonly defined as the plastic waste managed in a way that might include some leakage into the marine environment. This includes waste entering non-sanitary landfills, dumpsites, or tipped/littered. It is highlighted by some studies that East Asia and Pacific contributed to almost 60% of the global mismanaged plastic, while North America and Europe and Central Asia added together contributed to the range of 4.5%.

The main source of Plastic Waste Includes:

- Coastal Mismanaged Plastic Waste (MPW): 8 Mt/y
- Inland MPW: 2 Mt/y
- Lost fishing gear: 0.6 Mt/y
- Primary micro-plastics: 1.5 Mt/y

It is also indicated that in various regions there have been significant efforts to reduce the prominence of free-range plastic pollution, through reducing plastic consumption, litter clean-up, and promoting plastic recycling and this is a practice growing across various countries.

Estimations regarding the India based Plastics Litter and marine pollution contributions and related features:

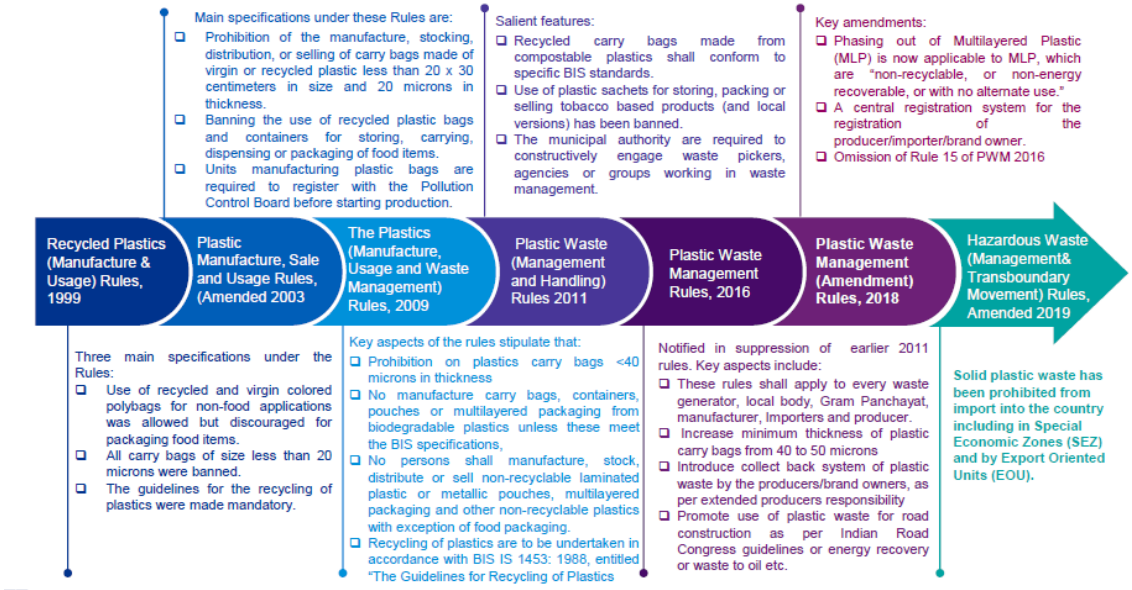
India has been consuming approximately 16.5 million tonnes (MT) of plastic annually – which was expected to increase to 20 MT by 2020. This includes 43% of plastics consumption as manufactured for single-use packaging material. There were reflections that Imports of plastic waste was around 48,000 Tonnes during 2017 - 18 for various purposes, which however by March, 2019 was banned as per amendments in the PWM Rules. It is indicated that plastic waste generation in India has been approximately 26,000 TPD (i.e. 9.4 Million Tonnes per Annum) in 2017-18 and that about 9400 TPD or 3.8 Million Tonnes per Annum has been the uncollected / littered waste (@ about 40%) of what is being generated in India. The treated waste or recycled quantum has been 5.6 Million Tonnes (which is 59%).

Plastic waste leaking into the riverine and marine environment have also been estimated from Indian context and these do need further studies for ground truthing

and verification through suitably designed studies ahead. India is currently considered the 12th largest emitter of marine litter and will become 5th largest contributor by 2025.

Rivers such as Ganga and Yamuna are severely polluted largely due to significant quantum of waste generated from adjoining cities / towns. About 11,625 tonnes of solid waste was being generated every day from cities/towns along these rivers.

Progress on Plastic Waste Management Regulation in India:



The key initiatives that have occurred in India pertaining to management / reuse / recycling of plastics are enumerated below.

- Use in Road Construction as per Indian Road Congress(IRC) guidelines.
- Energy Recovery from plastic waste.
- Conversion of waste plastic into oil through pyrolysis.
- Co-processing in cement kilns (estimated to lead to >80% energy recovery, 100% material recovery)

Challenges of measuring of plastic pollution:

- The need for achieving efficient forecasting of plastic waste pollution levels requires some level of validation from field studies.

- It has been noted that the comparison between modelling and field approaches is leading to variations in results.

- There has been a consistent observation and emphasis that there is a need for standardization of sampling methodologies.

- There have been assessments that micro-plastic abundance tends to differ with depth in the water column. This mainly concerns very small debris (10 μm or 0.01 mm) that present different sinking rates compared to larger micro-plastics.

- It is to be noted that analysis of plastic samples relies upon very manual procedures, which slows the processes and thus reduces the extent and quantum of sampling being achieved.

Conclusion

The major polymers, their applications, specific composition and their hazards can impact terrestrial and aquatic environment if target groups are exposed to waste streams from riparian cities, which are mismanaged in any geographical boundary. For example plastic emissions from uncontrolled dump sites and effluent discharge into water bodies like lakes, rivers seas and oceans. If not properly collected, plastic waste can decay and cause air pollution and degradation of soil, surface and groundwater, and aquatic and marine ecosystems. Micro plastics can also impact non-target species in soil biota. It can be summarized that impacts on terrestrial ecosystem include: (i) micro plastics may have adverse effects on and can be accumulated in soil organisms, ii) additives derived from micro plastics can be accumulated in soil organisms, iii) micro plastics can cause changes in the chemical contents of soil organisms, iv) responses of soil organisms exposed to micro plastics can cause changes in soil characteristics, v) chemicals adsorbed on micro plastics can enter the soil ecosystem, vi) micro plastics can move horizontally and vertically, (vii) plastic and micro plastics impact atmosphere and (viii) plastics and micro plastics can impact ground water. River is one of the main sources of plastic pollution carrying microplastics in the marine environment. Broadly marine wildlife is impacted by plastic pollution through entanglement, ingestion, bioaccumulation, and changes to the integrity and functioning of habitats. While macroplastic debris is the main contributor to entanglement, both micro and macrodebris are ingested across a wide range of marine species.

A big gap exists in the understanding of plastic leakage pathways and the impacts of macro & micro plastics on terrestrial ecology (air, soil, river bank and shoreline) and aquatic and marine ecosystem in Ganga basin. Further, the impact of plastic pollution on the trophic linkage/food chain and ultimately health does not exist since the basin has many ecosensitive zones/ stretches and serves as a major agriculture,

horticulture and fishery base of India. In this context a number of counter measures can be developed at policy, program, plan and project level to overcome this gap. These countermeasures can be syngergized with ongoing program, plan & project level interventions e.g. Clean India Mission, Namami Gange, Air Quality Monitoring Program, Ground Water Quality Program & Soil Health Card Program in India.

Table 1: Impact Matrix Uttarakhand

	Place / Attribute	Uttarkashi	Rishikesh	Haridwar	Evidence (A) / Gaps (NA)	Remarks
Terrestrial Ecosystem	Air	NA	NA	NA	NA	Haridwar has significant industrial area.
	Soil	NA	NA	NA	NA	Agriculture Area
	Ground Water	NA	NA	NA	NA	Agriculture Area
	Near Banks & shoreline (Macro Plastic)	NA	A	A	Partial	Major Urban Centre
Aquatic & Marine Ecosystem	Sediments on shoreline (Micro Plastics)	A	A	NA	Partial	River enters the plains from the hills
	River Water (Micro Plastics)	NA	NA	A	Partial	Effluent discharge (domestic & industrial)

Note:NA-Not Available, A-Available, P-Partial

Source: Jain Amit, Chief Technical Advisor, UNEP Project, NPC

Table 2: **Impact Matrix Uttar Pradesh**

	Place / Attribute	Bijnor	Anupshahar	Narora	Farukhabad	Kannauj	Kanpur	Allahabad	Mirzapur	Varanasi	Ghazipur	Etawa	Agra	Evidence (A) / Gaps (NA)	Remarks
Terrestrial Ecosystem	Air	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Allahabad & Varanasi are significant industrial area.
	Soil	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Major Agriculture Belt
	Ground Water	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Major Agriculture Belt
	Near Banks & shoreline (Macro Plastic)	A	NA	NA	A	A	A	A	A	A	A	A	A	Partial	
Aquatic & Marine Ecosystem	Sediments on shoreline (Micro Plastics)	A	A	A	A	A	A	A	A	A	A	A	A	A	
	River Water (Micro Plastics)	NA	NA	NA	NA	NA	NA	A	NA	NA	NA	NA	A	Partial	• Kanpur, Varanasi, Mirzapur, Ghazipur, Balia are urban centres. • NW 1 stretch

Note:NA-Not Available, A-Available, P-Partial

Source: Jain Amit, Chief Technical Advisor, UNEP Project, NPC

Table 3: Impact Matrix Bihar

	Place / Attribute	Buxar	Chappra	Patna	Munger	Bhagalpur	Sahibganj	Haldia	Evidence (A) / Gaps (NA)	Remarks
Terrestrial Ecosystem	Air	NA	NA	NA	NA	NA	NA	NA	NA	Major Urban Centres
	Soil	NA	NA	NA	NA	NA	NA	NA	NA	Agriculture Area
	Ground Water	NA	NA	NA	NA	NA	NA	NA	NA	Domestic & Agriculture Use
	Near Banks & shoreline (Macro Plastics)	NA	NA	A	A	A	A	A	P	Major Urban Centres
Aquatic & Marine Ecosystem	Sediments on shoreline(Micro Plastics)	A	A	A	A	A	A	A	A	
	River Water (Micro Plastics)	NA	NA	NA	NA	NA	NA	NA	NA	• Major Stretches are Dolphin Habitat & Part of NW 1. • Major urban centres

Note:NA-Not Available, A-Available, P-Partial

Source: Jain Amit, Chief Technical Advisor, UNEP Project, NPC

Table 4: Impact Matrix West Bengal

	Place / Attribute	Farakka	Behrampur	Nabadip	Barrackpor	Kolkata	Goddakali	Haldia	Fraserganj	Evidence (A) / Gaps (NA)	Remarks
Terrestrial & Coastal Ecosystem	Air	NA	NA	NA	NA	NA	NA	NA	NA	NA	Kolkata is a major Urban Centre
	Soil	NA	NA	NA	NA	NA	NA	NA	NA	NA	Agriculture Belt
	Ground Water	NA	NA	NA	NA	NA	NA	NA	NA	NA	Drinking Water & Agriculture Source
	Near Banks & shoreline (Macro Plastics)	NA	NA	A	A	A	A	A	A	P	
Aquatic & Marine Ecosystem	Sediments on shoreline (Micro Plastics)	A	A	A	A	A	A	A	A	A	Sundarban is a major eco eco sensitivehabitat
	River Water (Micro Plastics)	NA	NA	NA	NA	NA	NA	NA	NA	NA	Major Navigation Route (NW 1) & Sundarban is a major eco habitat

Note:NA-Not Available, A-Available, P-Partial

Source: Jain Amit, Chief Technical Advisor, UNEP Project, NPC