National Policy Workshop Webinar Series
on
Counter measures for Riverine and Marine Plastic Litter in India
12 -22 May 2020

Session 1: The Science and technology of Plastics & techniques/best practices of plastics pollution assessment and investigation

Problem of Marine Litter and Initiatives by MoES regarding Plastic Pollution Assessment

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“Marine litter is symptomatic of a wider malaise: namely the wasteful use and persistent poor management of natural resources. The plastic bags, bottles, and other debris piling up in the oceans and seas could be dramatically reduced by improved waste reduction, waste management, and recycling initiatives.”

International Coastal Cleanup, 2010 Report : Trash Travel

Mr Achim Steiner
Under Secretary General , UN
Executive Director , UNEP

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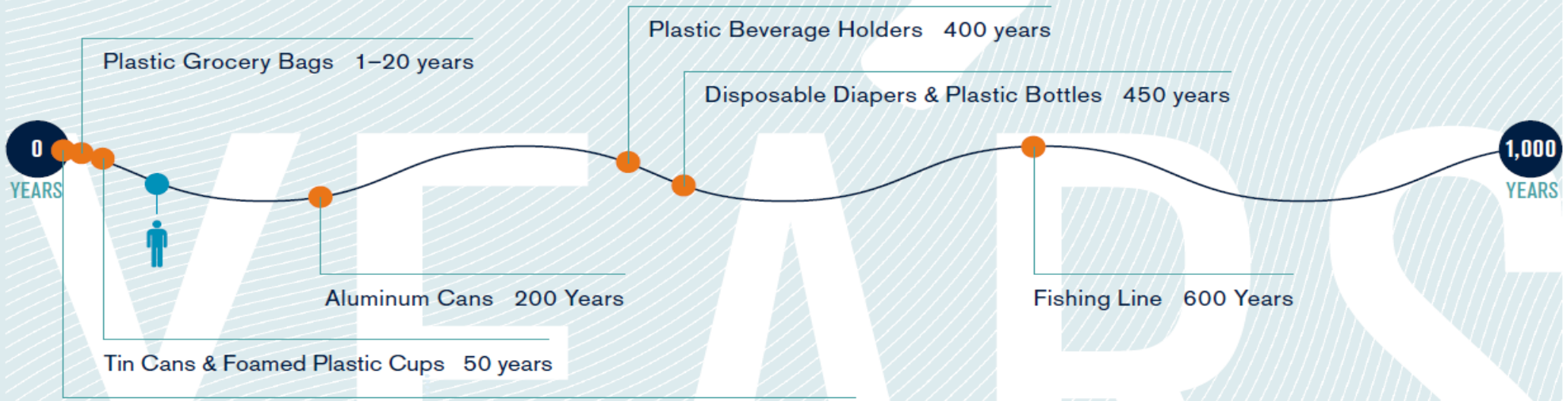
HOW LONG 'TIL IT'S GONE?

Estimated decomposition rates of common marine debris items

AVERAGE LIFE EXPECTANCY



Paper Towels	2–4 Weeks	Waxed Milk Cartons	3 Months
Newspapers	6 Weeks	Photo/Degradable Beverage Holders	6 Months
Cotton Ropes	1–5 Months	Plywood	1–3 Years
Apple Cores	2 Months	Wool Socks	1–5 Years
Cardboard Boxes	2 Months		

NOTE: Estimated individual item timelines depend on product composition and environmental conditions.

Source: South Carolina Sea Grant Consortium, South Carolina Department of Health & Environmental Control (DEHC)—Ocean and Coastal Resource Management, Centers for Ocean Sciences Education Excellence (COSEE) —Southeast and NOAA 2008.

Scale of Plastic Problem- India

- Plastic is the **fastest growing industries** hosting >2,000 exporters, employing 4 million people & > 30,000 units
- Export showed a growth of **17.1 %** from 2016-17 to 2017-18
- **Plan for 18 plastic parks** (investment of 6.2 million US $)
- **43%** of manufactured plastics used for **packaging - single use**.
- **Annual per capita** consumption would be **20 kg by 2022** (Ministry of Petroleum & Natural Gas)
- **Plastic Waste: 660,787.85 tonnes** (2017-18) contribute to **8%** of total **solid waste** (CPCB 2016-17)
- Of the **10 rivers that drain over 90%** of the **total plastic** debris into the **sea** globally, **three flows through India** –Indus (2nd), Ganga and Brahmaputra (6th) (Schimdt et al 2017; Environ. Sci. Technol. 51, 12246-12253)

Say - YES to Plastic NO to Pollution

Why marine litter and micro plastics studies along the Indian coast

Marine plastics pollution has reached at its crisis levels !

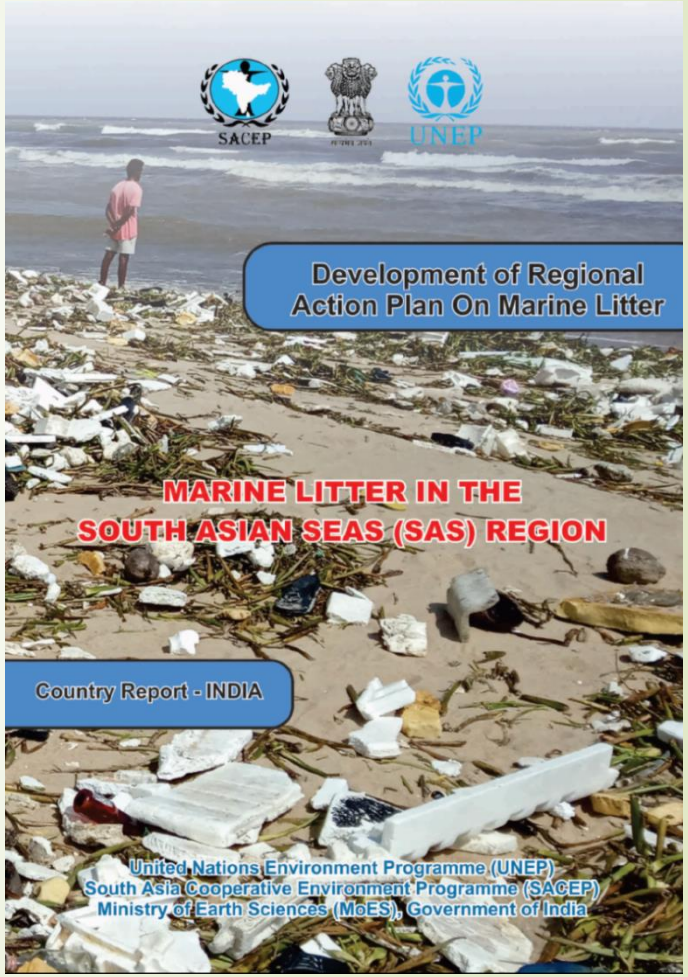
Business- as –usual is not an option

- India does not have National Marine Litter policy. A policy needs to be framed to control and manage the litter at the land boundary as it is impossible to remove the litter once it enters the marine environment.
- NCCR being the nodal agency for “Marine litter and Micro plastics” in association with SACEP in 2018

COUNTRY REPORT

REGIONAL ACTION PLAN ON MARINE LITTER

- NCCR, MoES has initiated a program to study the origin, pathway, degradation and environmental impacts of marine litter and micro plastics along the Indian coast.



SOURCE (LAND) >>> SINK (OCEAN)

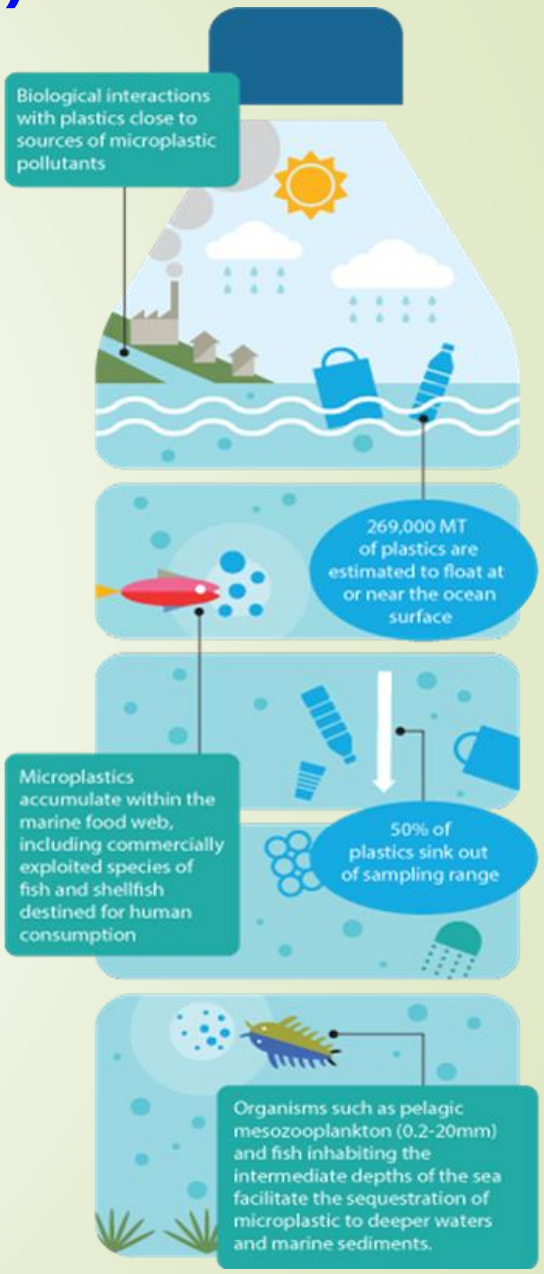
MoES program on Marine Litter & Micro plastics (MPs)

3R – Reduce, Reuse and Recycle

WP1	Sources, Fate of plastic ; Quantification & Modelling
WP2	Impact of plastic pollution on marine eco-systems
WP3	Micro-plastics and health- Toxicity – Food chain
WP4	Social and behavioral change / Awareness campaign
WP5	Design and testing interventions
WP6	Re-designing of the single use of plastics

Research aims to address: The Challenges

- Fate and behaviour of plastics from source to sink
- Quantify marine litter and MPs in the water, sediment and biota along the Indian coast.
- Ecological impact of MPs
- Create awareness, Data- Monitoring , Management and Mitigation measures.
- Marine litter Policy



Classification of plastics

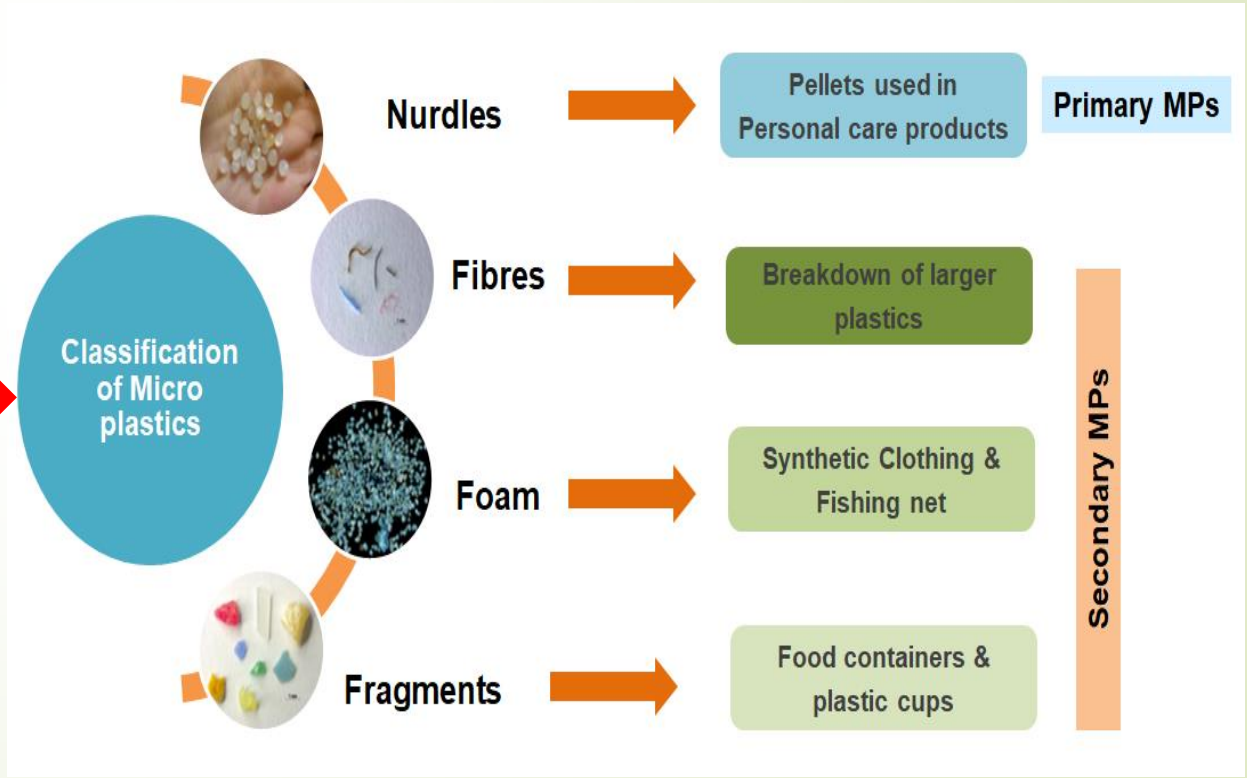
Macro Plastics

Micro plastics (100 nm-5mm)

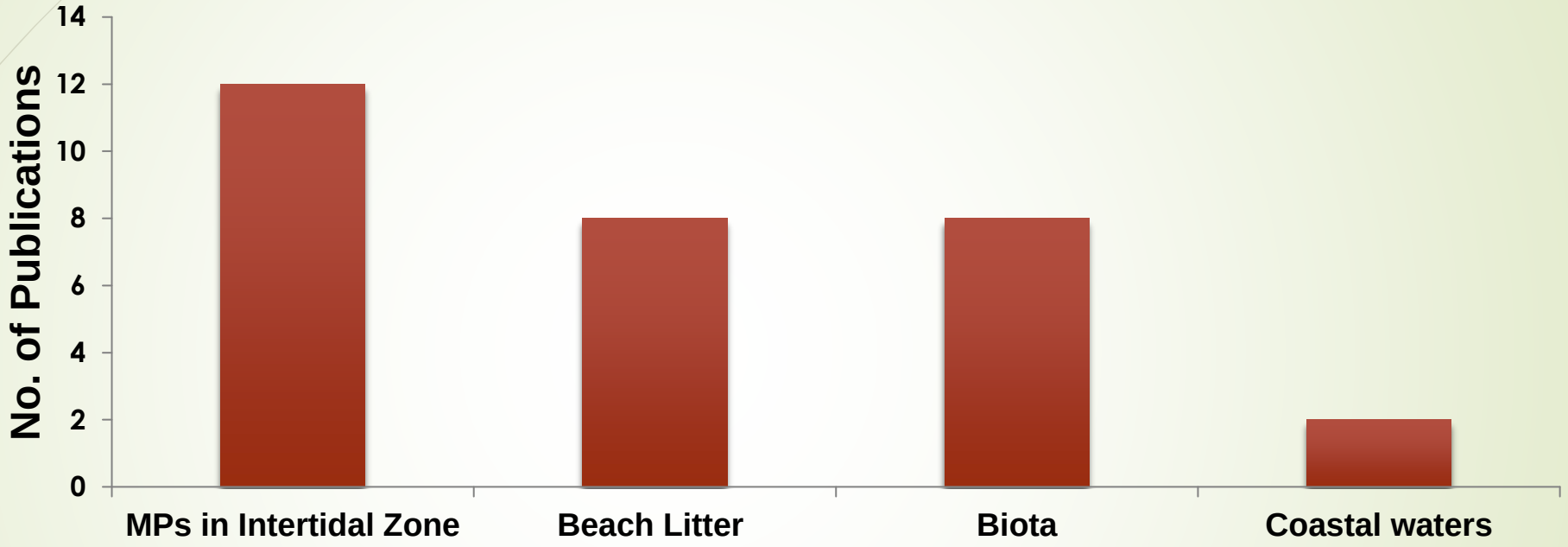
Nano plastics (<100 nm)

Classification of MPs based on origin & shape

Micro plastics (MPs) are plastic particles < 5 mm in their longitudinal extensions (Arthur et al. 2009).

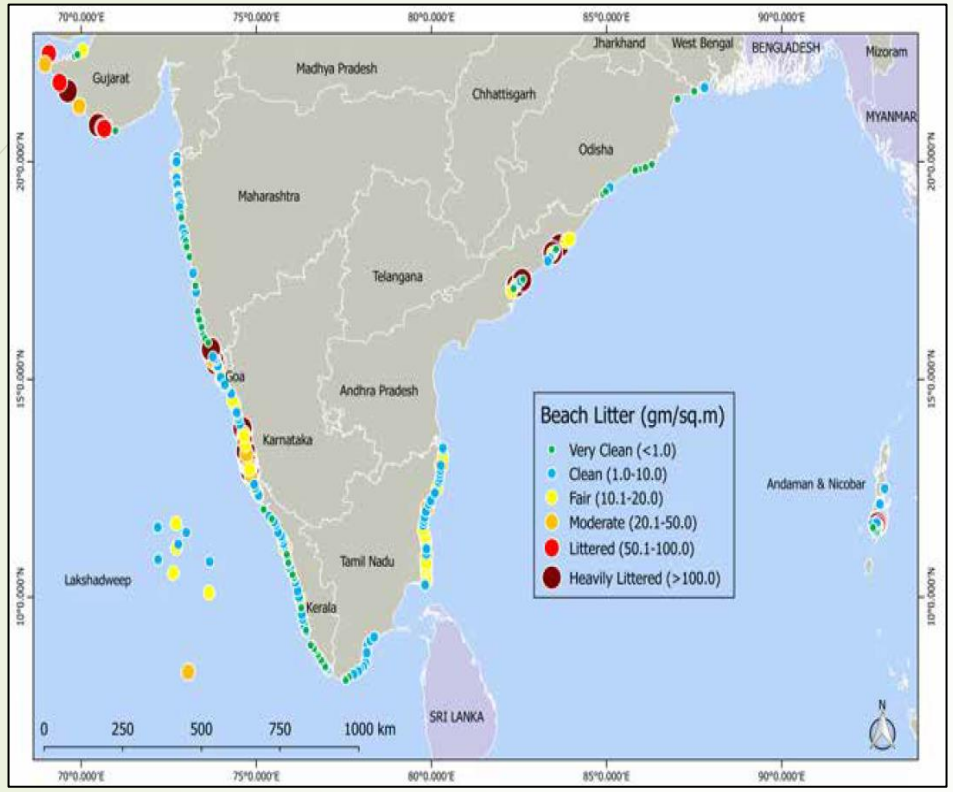


Studies so far along Indian coast



- Most studies from intertidal zones (mega litter & MPs)
- Biota studies focussed on fish (6 out of 8 publications)
- Few studies from coastal waters (3 papers)

Marine litter along the Indian beaches



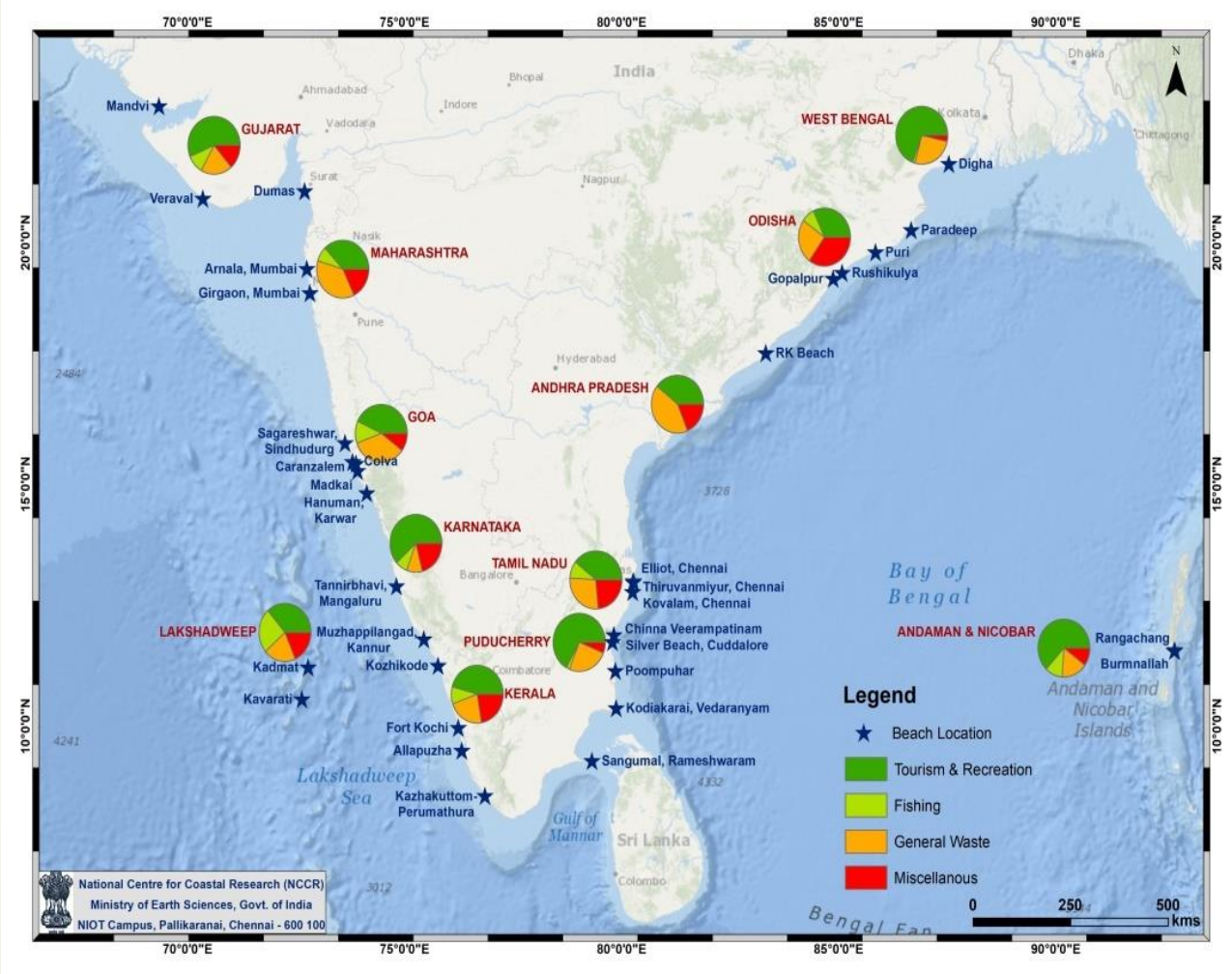
Data on single observation on 254 Indian beaches between October 2013 and January 2014 on marine Litter (Kaladharan et al., 2017) reveals:

- **Odisha coast has the lowest (0.31 g/m^2) quantity and Goa coast (205.75 g/m^2) has the highest quantity** of beach debris.
- **Andaman and Lakshadweep islands recorded higher values than mainland beaches.**
- **Debris collected from these beaches are mostly domestic and anthropogenic discards.**

Plastic litters such as single use carry bags and sachets of soft drinks, edible oils, detergents, beverages, cases of cosmetics, toothpaste, PET bottles, ice cream containers etc., recorded highest mean of 25.47g/m^2 from Goa coast and the lowest (0.08g/m^2) from Odisha.

Marine Litter- International Coastal Clean-up, 2019

State-wise composition of Marine Litter



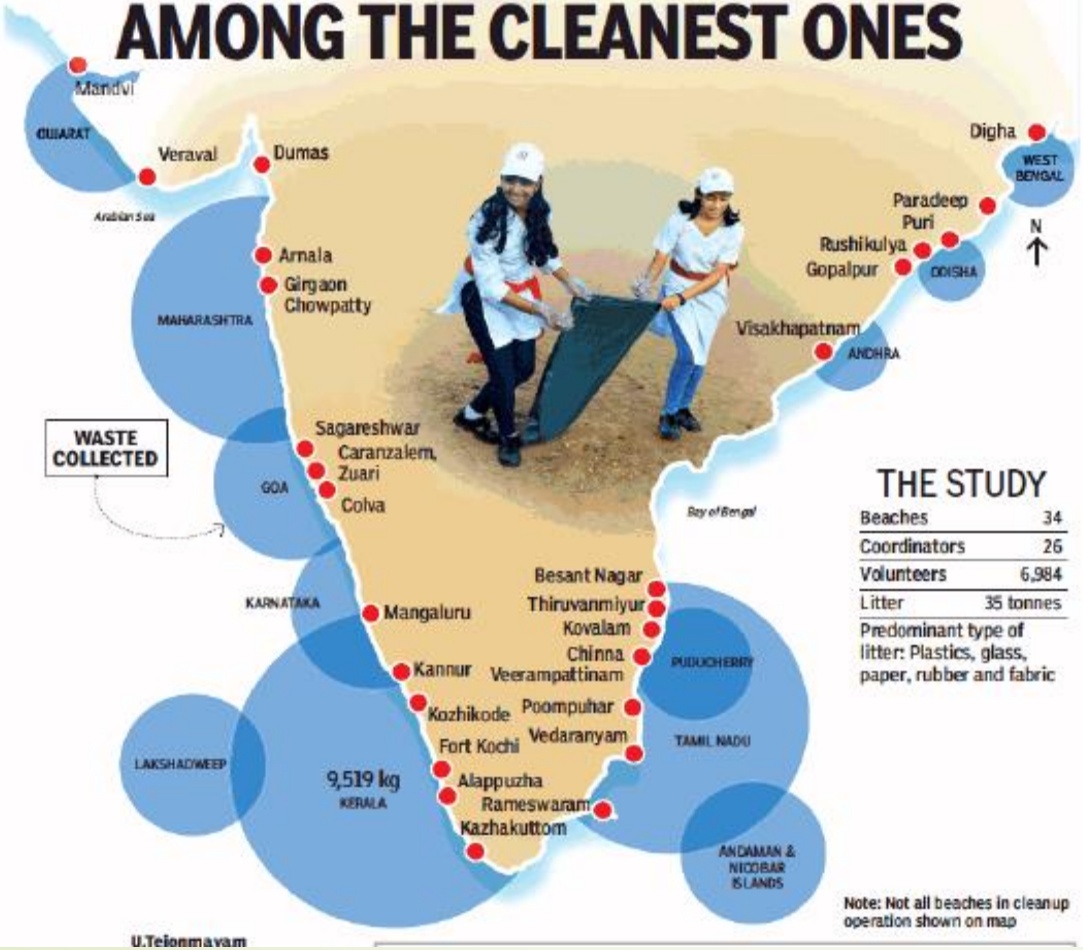
26 Coordinators, 34 Beaches,6,984 Volunteers: ICG, Schools, College, institutes, NGO & Public

Total Litter (kg): 35 tonnes, **Total Litter (No.):** 2,39,095, **Major source:** Recreation & Tourism

THE TIMES OF INDIA, CHENNAI
FRIDAY, JANUARY 3, 2020

A Mountain Of Waste, Nearly 35 Tonnes, Collected From 34 Beaches In Cleanup Operation Across All Coastal States

KERALA, MAHA HAVE DIRTIEST BEACHES, ODISHA AMONG THE CLEANEST ONES



THE STUDY

Beaches	34
Coordinators	26
Volunteers	6,984
Litter	35 tonnes

Predominant type of litter: Plastics, glass, paper, rubber and fabric

Note: Not all beaches in cleanup operation shown on map

U.Tejonmayam

THE DIRTIEST...	WASTE IN KG
Kozhikode (Kerala)	4,022
Sagareshwar (Maharashtra)	3,000
Arnala Palghar (Maharashtra)	2,500
Vedaranyam (Tamil Nadu)	2,100
Mangaluru (Karnataka)	2,057

...& THE CLEANEST	
Kazhakuttom (Kerala)	25
Puri (Odisha)	35
Thiruvanmiyur (TN)	70
Gopalpur (Odisha)	78
Dumas (Gujarat)	132

TYPES OF TRASH (%)

Around 370 kilos (77%) of trash at this Gujarat beach were dumped by tourists

TOURISM LITTER — Plastic cups, bottles, beverage bottles, food wrappers

RUBBER, PLASTIC, FABRIC & GLASS — Home products and religious (eg: flowers and idols), clothes, rubber

FISHING LITTER — Fishing nets, thermocol

73% of litter in Rameshwaram (TN) comprises household items disposed in the sea

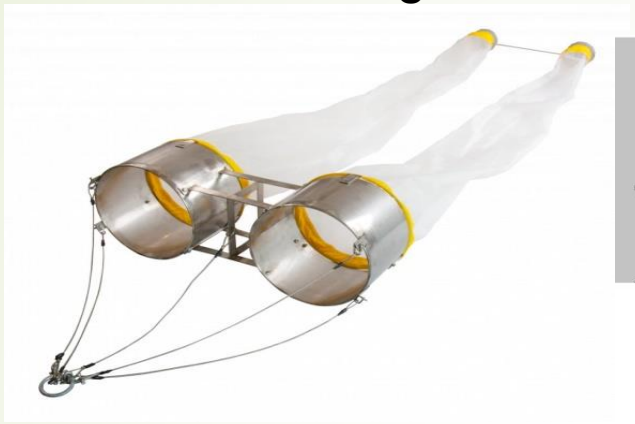
The majority of Lakshadweep beach's waste comes from fishing activities

Water sample collection & Processing for MPs

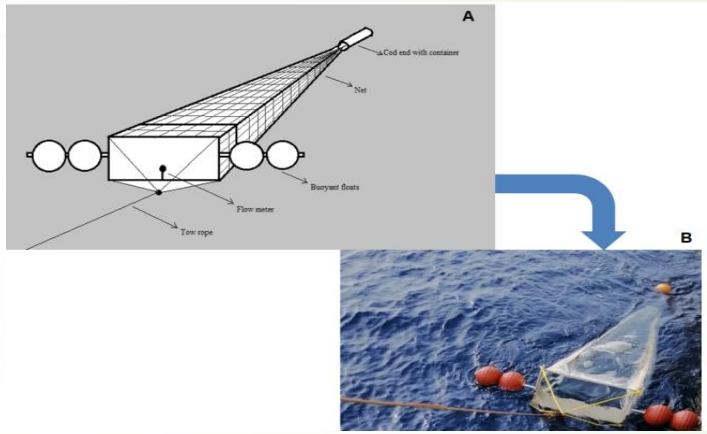
Water sampler for collection

Niskin's Sampler

Bongo Net



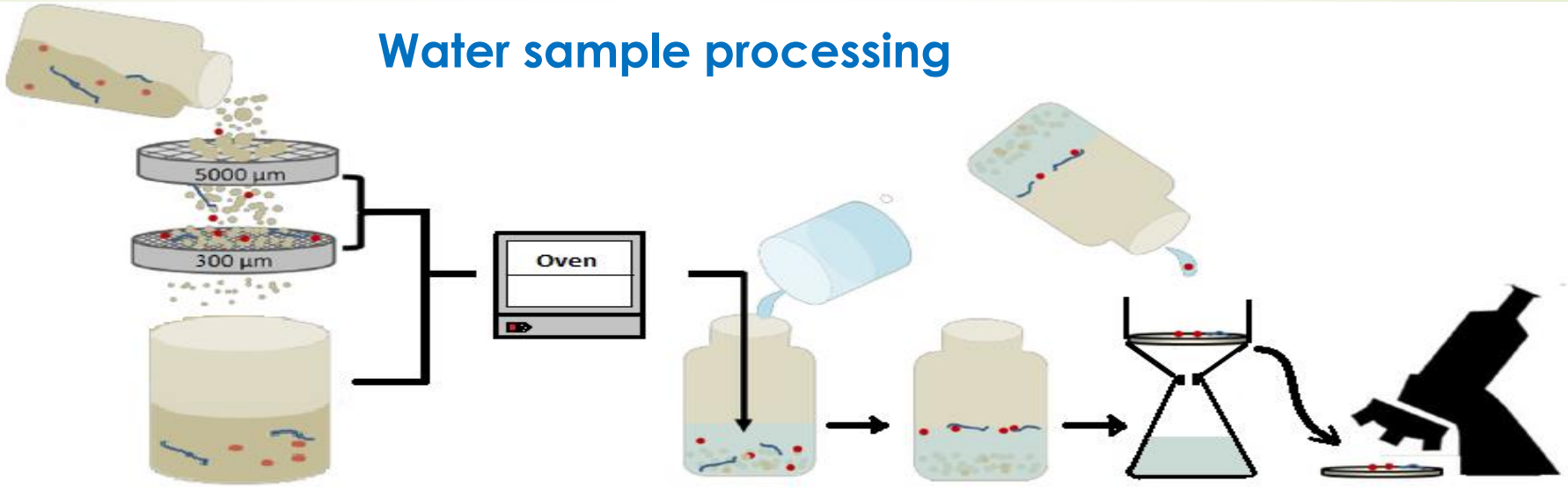
Manta Net



Plastic Particle Pump

Source: kc-denmark.dk

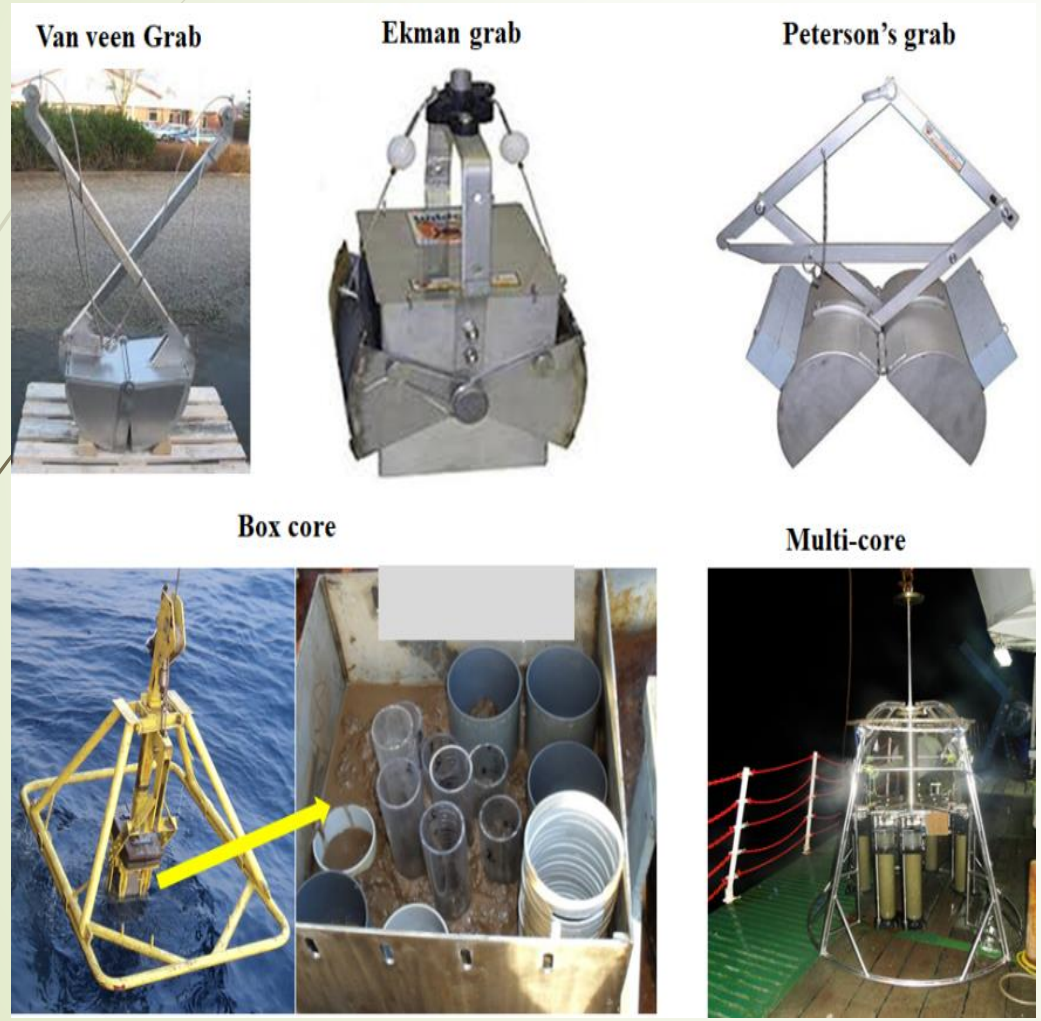
Water sample processing



Wet Sieving | **Drying** | **Wet Peroxide Oxidation** | **Density separation (NaCl)** | **Identification - microscope**

Sediment collection & Processing for MPs

Samplers for sediment collection



Sediment Processing for MPs

WEIGHT DETERMINATION

Wet weight of samples → Dry at 60 °C for 72 hrs → Dry weight of samples

DENSITY SEPARATION
Floatation of microplastics

- Mix 50 g of dried sediment with 200 mL of saturated salt solution (NaCl with ρ= 1.20 g/mL) in 500 ml glass beaker → Take samples in replicates (n=3)
- Stir with the glass rod for 5 minutes and allow to settle for 3-4 hours
- Transfer supernatant into a clean dry 500 ml beaker

WET PEROXIDE OXIDATION
(For removal of organic matter)

- Add 5 ml of 30% H_2O_2 to the supernatant and keep for 24 hours
- Vacuum filter the solutions through Whatman G/F Filter paper (1 µm)
- Dry filter paper at 60°C for 24hours

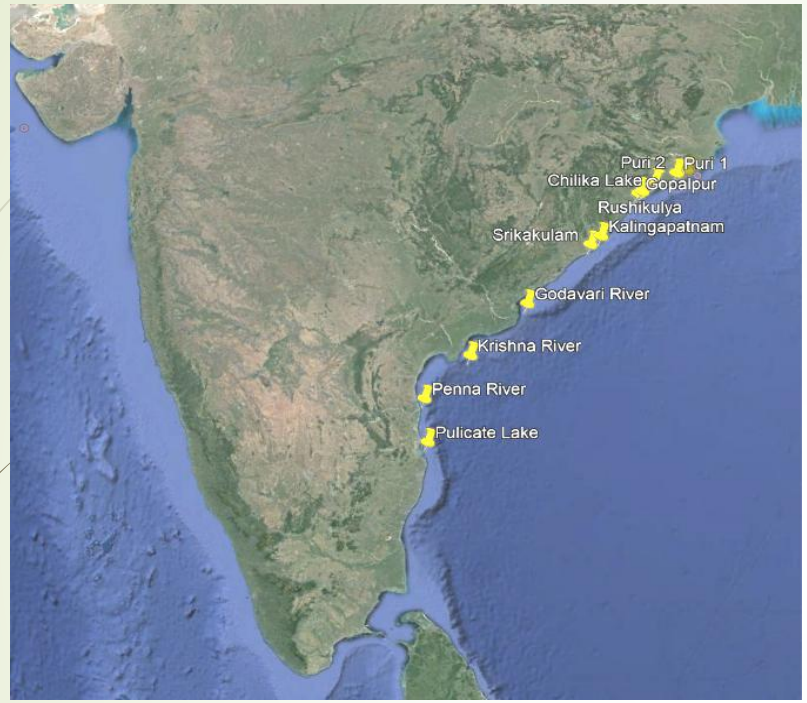
QUANTITATIVE ANALYSIS

- Microscopic examination- counting, size, identify based on shapes & colour

QUALITATIVE ANALYSIS

- Confocal Raman microscopy for determining the type of plastics

MPs in coastal waters (East Coast)



Cruise: CRV *Sagar Manjusha*

Sampling Period: July-August 2019

Sampler: Manta Net (towed for 10 mins)

Location: Chennai – Konark (1100 km)

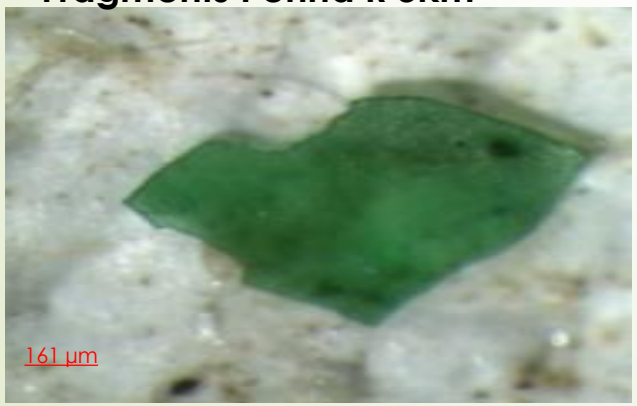
Stations: 15 transect (3 & 10 km)

Results

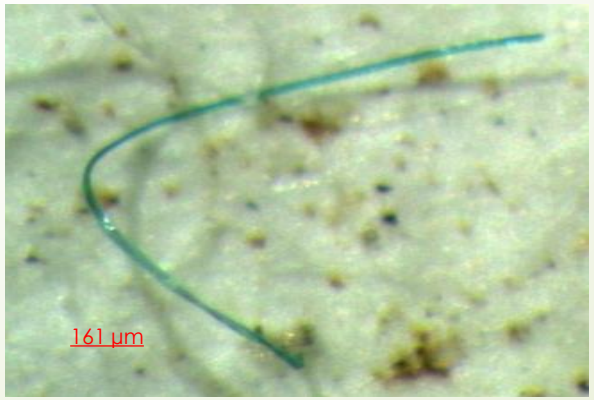
Dominant MPs: Films & Filaments

Type: Polystyrene & polyethylene

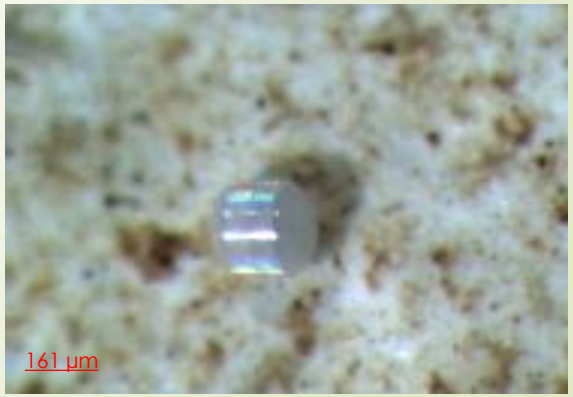
Fragments Penna R 3km



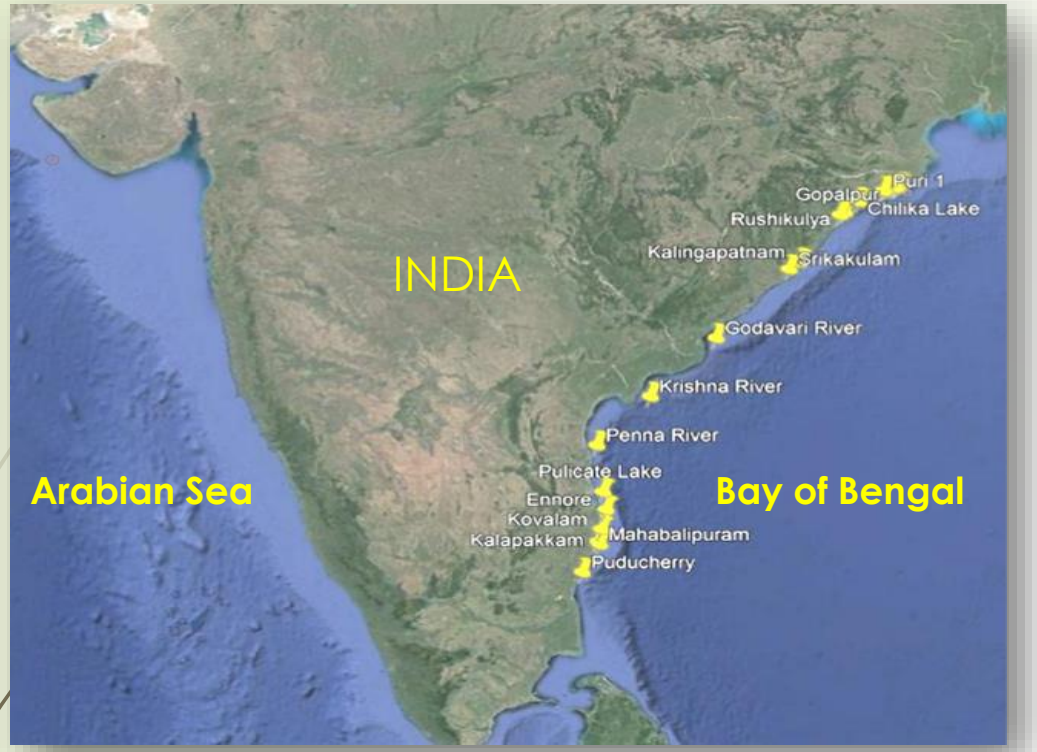
Fiber -Chilika 3km



Nurdles-Puri 3 km



MPs in coastal sediments (East coast, India)



Cruise: *Sagar Purvi*

Sampling Period : March & July 2019
Location: Chennai to Pondicherry (150 km)
Stations: 12 transects (1 & 10 km)

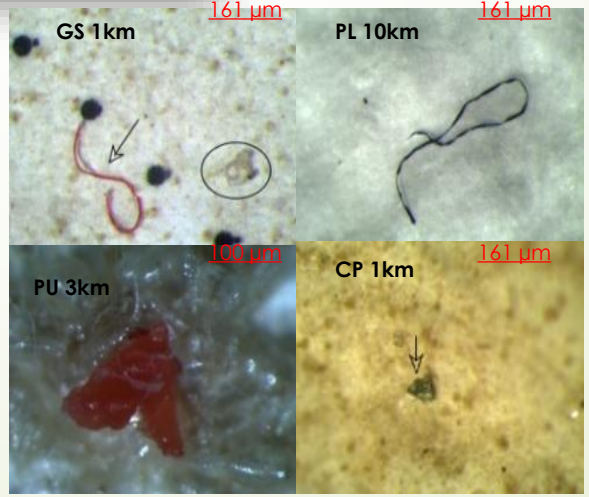
Cruise: *Sagar Manjusha*

Sampling Period : July 2019
Locations: Chennai to Konark (1100km)
Stations: 15 transects – 3 & 10 km

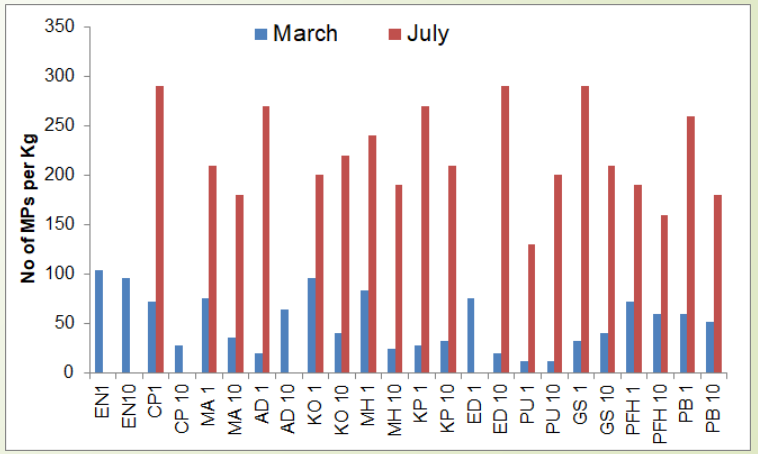
Chennai - Puducherry

Number: 12-104 (Mar) and 130-290 no. Kg^{-1} (Jul). **Higher values in July**

- **Shape:** Filament (Source-waste water discharge &Fishing)
- **Fragments:** larger plastics break down
- **Type:** Polystyrene & polyethylene



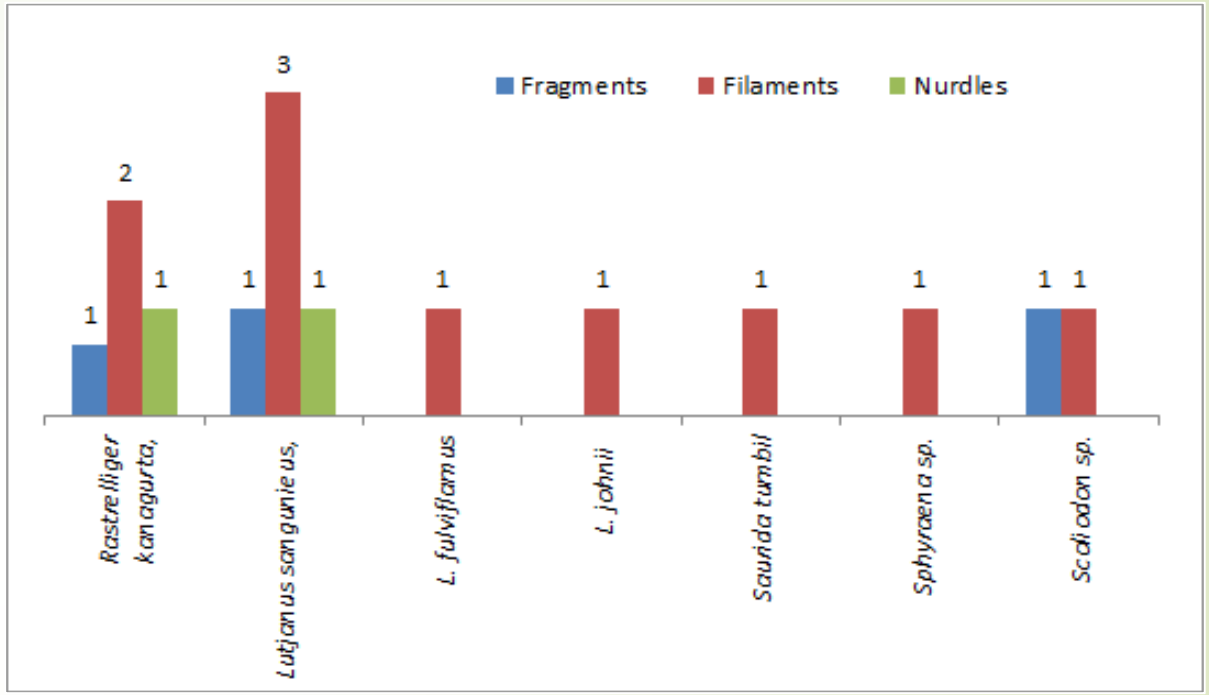
Temporal variation in MPs



MPs in commercial fish species

Commercial fish species

Variation of MPs in Fish



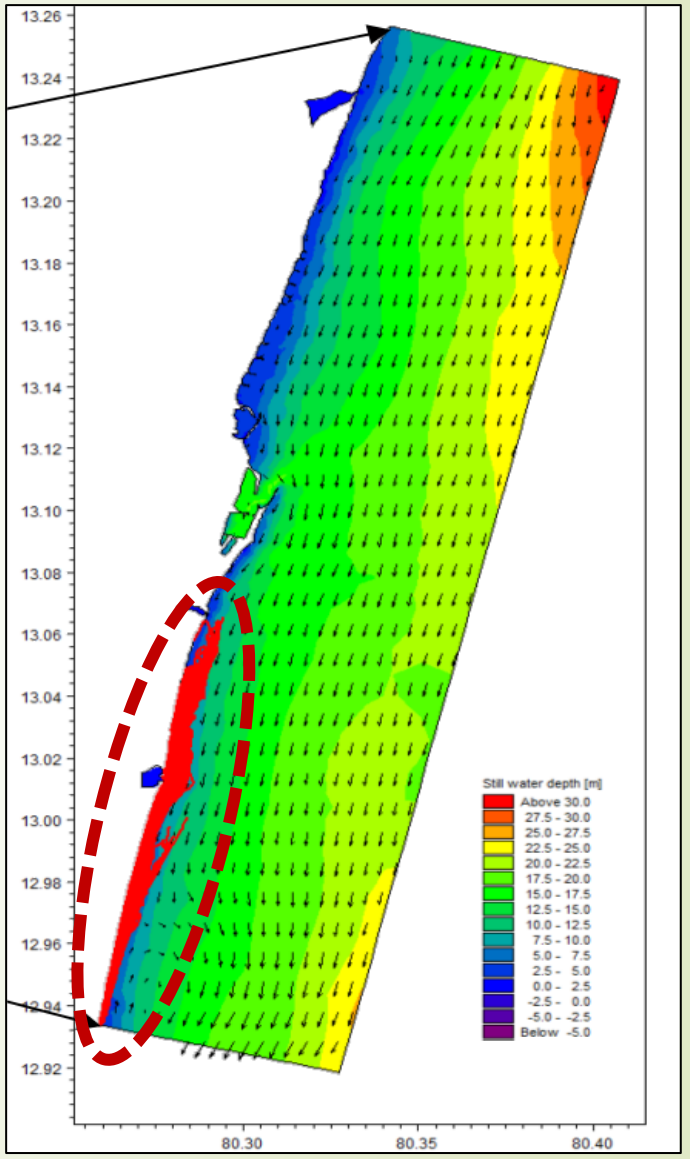
Filaments- Gut

Fragments- Gills

- **MPs** present in 80% of fish
- **Count:** 3-6 nos.
- **Dominant:** Filaments
- **Size:** 0.1-2 mm
- **Colour:** Red
- **Type:** Polystyrene & polyethylene

Marine litter on beaches – Source and Transport

a) Coum river bank, b & c) Adyar, d) Marina , e) Elliot and f) Thiruvanmiyur beaches



CURRENT SCIENCE, VOL. 115, NO. 8, 25 OCTOBER 2018

SCIENTIFIC CORRESPONDENCE

Marine litter: post-flood nuisance for Chennai beaches

Anthropogenic litter on the coastal beaches, sea surface and seabed has increased in the recent decades across global oceans[1]. Also, massive plastic production and usage have accumulated plastic waste of 4.8–12.7 million metric

beaches, interlocked between the Cooum and Adyar rivers, and visited by 30,000–50,000 tourists daily. The Elliot and Thiruvanmiyur, two relatively narrow beaches of 1.5 km long each, are located south of the Adyar river mouth. These

Corporation. Larger debris breaks down into meso particles (5 mm–2.5 cm) and micro particles (<5 mm), causing more abundant and floating litter carried over long distances by winds and currents[3]. In order to assess the dispersion and

Low cost floating trap in Chennai

https://www.alphamers.com/

In one year 20,000 Metric Tons of litter including 2000 metric tons of plastics.

These barriers arrests thousands of tons of trash and plastics at NIL energy cost and brings it to river bank, from where it is removed every few days by land based gear.

Recommendations

- Segregation of the wastes at source – more focus on single use plastics into usable recycle products using low cost technology.
- Responsibility should be of the manufacturer / seller to recycle the used plastic products from the consumers through incentives/ caution money deposit scheme through public participatory approach.
- Adoption of beaches for regular monitoring by civic societies / bodies - local university, institutes and NGOs
- Deployment of low cost traps in rivers, creeks, canals - Cleaning and monitoring activities at regular intervals.
- Introduction of bio-degradable materials - plastic litter being non-degradable, it is highly essential to promote appropriate alternatives *e.g.* Fishing nets
- National Marine Litter policy - A policy needs to be framed to control and manage the litter at the land boundary as it is impossible to remove the litter once it enters the marine environment.
- Exploring opportunities and benefits of shifting to a circular plastic economy.

Suggestions for scientific activities

- Research on marine litter, especially microplastics is initiated a decade ago; adequate information is still missing.
- Optimization of routine microplastic sampling methodologies for better comparison of data the result from different study areas.
- Development of appropriate methods for detecting minute microplastics and nanoplastics within the water-column and sediment (Quantification).
- Understanding the fate and behaviour of microplastics within the water-column, including the effects of fragmentation and bio-fouling (Modelling).
- Determining microplastic uptake by biota affecting the marine food-web and expand the use of sentinel species (e.g. bivalves) in detecting microplastic abundance. (Toxicology)
- Assessment of the impact i.e. mortality, morbidity and/or reproduction of ingested microplastics and leached plastic additives on marine biota, and their effect on the the food-chain. (Experiments)

Thank You