

# Micro-plastics and their assessment in Ganga and Yamuna Basin – Snapshots from Agra and Allahabad

*National Policy Workshop Webinar Series*

*On*

*Countermeasures for Riverine and Marine Plastic Litter in  
India”*

*12 -22 May 2020*

# Outline

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# 1.1 Introduction: Microplastics

Micro-plastics are not a specific kind of plastic, but rather any type of plastic fragment that is less than 5 mm in length according to the U.S. National Oceanic and Atmospheric Administration (NOAA).



# 1.1.1 Types

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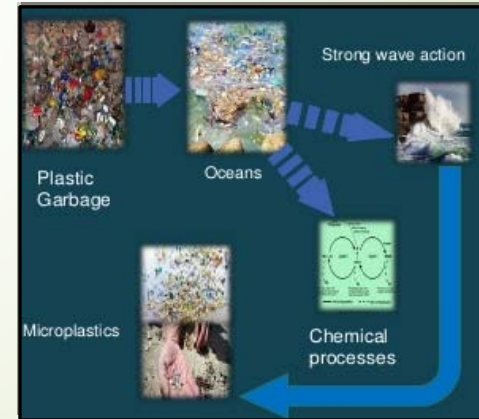
## Primary microplastics

**Source-**personal care products, cleaning products, normal wear and tear of synthetic items, clothing, plastic-based paint, car tires, etc.



## Secondary microplastics

**Source-** plastic fragmented through environmental factors such as animal digestion, waves, etc. and many biodegradable plastics will break into microplastics instead of disappearing completely.



# Types by shape

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Fiber



Films



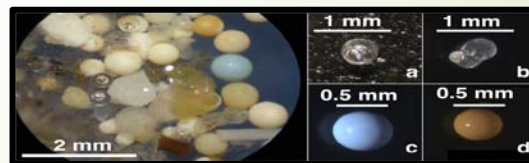
Foams



Pellets



Fragments



Microbeads

## 1.1.2 Properties: Specific Gravity/general behaviour of various polymer types (GESAMP 2016)

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Polymer	Common applications	Specific gravity	Behaviour
Polystyrene (expanded)	Cool boxes, floats, cups	0.02-0.64	Float
Polypropylene	Rope, bottle caps, gear, strapping	0.90-0.92	
Polyethylene	Plastic bags, storage containers	0.91-0.95	
Styrene-butadiene (SBR)	Car tyres	0.94	
Polystyrene	Utensils, containers	1.04-1.09	Sink
Polyamide or Nylon	Fishing nets, rope	1.13-1.15	
Polyacrylonitrile (acrylic)	Textiles	1.18	
Polyvinyl chloride	Thin films, drainage pipes, containers	1.16-1.30	
Polymethylacrylate	Windows (acrylic glass)	1.17-1.20	
Cellulose Acetate	Cigarette filters	1.22-1.24	
Poly Ethylene Terephthalate (PET)	Bottle, strapping	1.34-1.39	
Polyester resin+glass fibre	Textiles, boats	>1.35	
Rayon	Textiles, sanitary products	1.50	
Polytetrafluoroethylene (PTFE)	Teflon, insulating plastics	2.2	

# 1.2 Sources of Microplastics

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## Mismanmanaged Plastic waste



## Inland Navigation



## Wastewater Discharge



## Industrial Activities



# 1.3 Study Area

- ▶ Agra (Yamuna) sampling date 21.02.2020 & 12.02.2020  
Dussera ghat (AGYD2102)  
Kailash Ghat (AGYU1202)
- ▶ Prayagraj (Ganga, Yamuna and Sangam) sampling date 08.02.2020  
River Yamuna, Prayagraj (ALYU0802)  
River Ganga Prayagraj (ALGU0802)  
River Ganga, Prayagraj (ALGD0802)  
Sangam, Prayagraj (ALLSD0802)

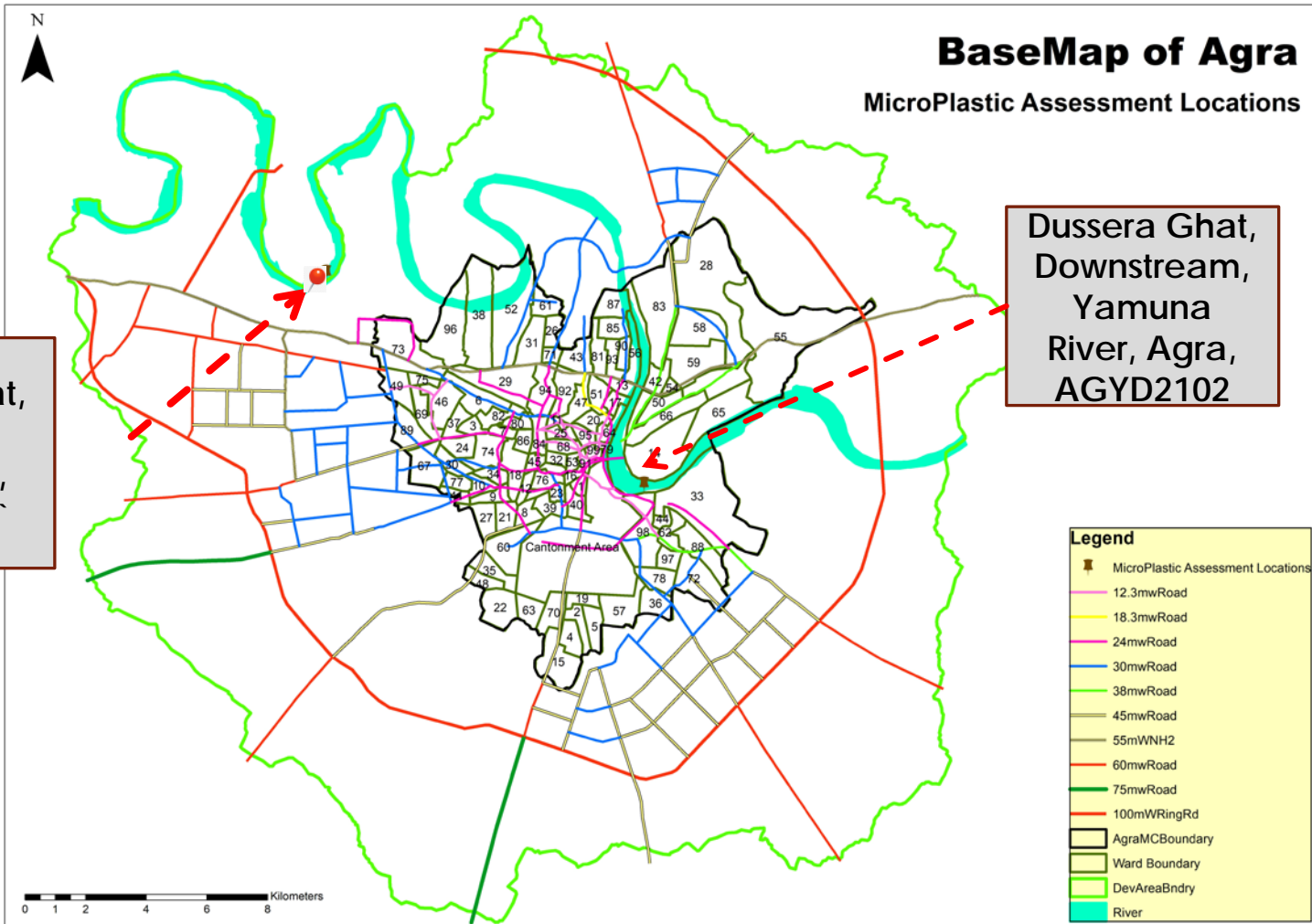


# BaseMap of Agra

MicroPlastic Assessment Locations

Kailash Ghat,  
Yamuna  
River, Agra,  
AGYU1202`

Dussera Ghat,  
Downstream,  
Yamuna  
River, Agra,  
AGYD2102



# BaseMap of Prayagraj

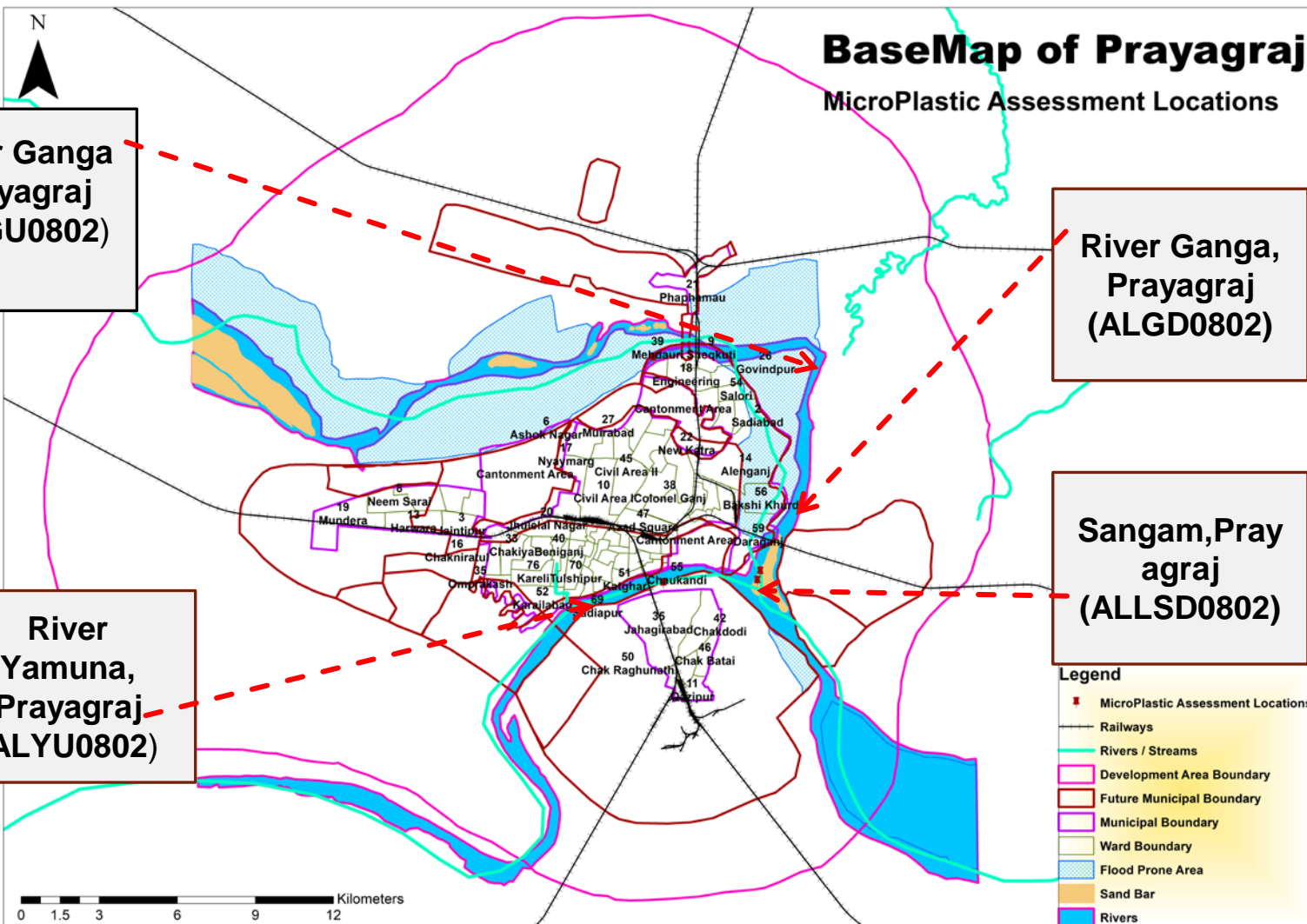
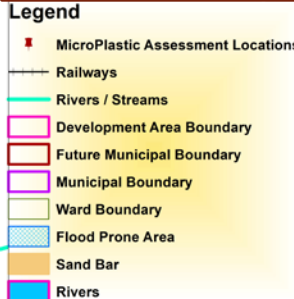
## MicroPlastic Assessment Locations

River Ganga  
Prayagraj  
(ALGU0802)

River Ganga,  
Prayagraj  
(ALGD0802)

Sangam, Prayagraj  
(ALLSD0802)

River  
Yamuna,  
Prayagraj  
(ALYU0802)



# 1.4 Methodology for Micro-plastic Assessment

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Sampling

Extraction

Identification

Quantification



# 1.4.1 Sampling



Selective Sampling

Volume Reduce Sampling

Bulk Sampling

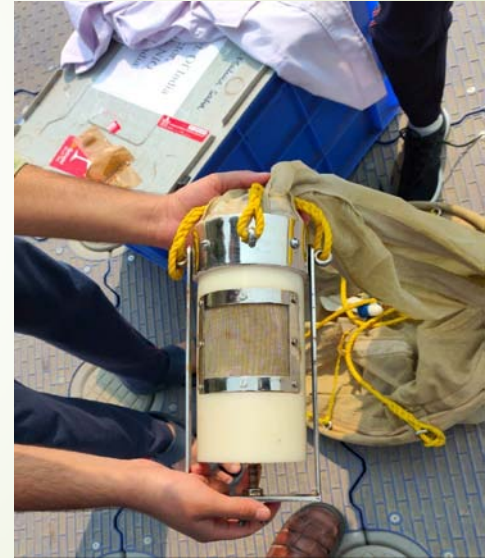
# 1.4.1.2 Key parameters

<b>Tow Duration</b>	10 to 30 minutes
<b>Tow Distance</b>	500 meter
<b>Vessel Speed</b>	~1 to 3 Nautical
<b>Sweep area and filtered water volume</b>	-500 ml
<b>Tow Position</b>	Sampling net was towed at one side of the vessel with less influence from its turbulence.
<b>Net Immersion depth</b>	about 1/2 to 3/4 of the height of the net's mouth.
<b>Meta Data recorded</b>	Time of day and date, latitude, longitude, initial and final flowmeter reading

# 1.4.1.1 Sampling Equipment Used

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Neutson Net with mesh size 300 micrometer, flow meter at the top of the net and sample collection bottle at the bottom



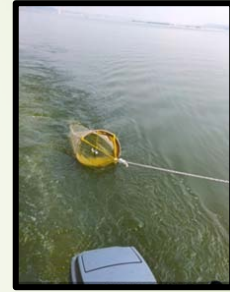
# Flow chart of microplastic sampling

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Water collection from neuston net  
mesh size 300 micronmeter

Towing of neuston net and sampling of  
microplastics



Transfer of Collected Sample via funnel  
for Laboratory testing



Transfer and Labeling of microplastics  
sample





# 1.4.2 Extraction

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- Pre treatment- biological digestion-formalin was added to digest the organic substance.
- Picking out Micro-plastics
- Counting and measuring sizes of Micro-plastics



# 1.4.3 Identification

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Identification of microplastic in Stereomicroscope with OLYMPUS SZX10 attached with OLYMPUS DP7 camera



**Stereomicroscope**

# 1.4.4 Quantification

Polymer types were identified using FTIR-Microscope (AIM-3800 made of Shimadzu) AIM-View software with Spectrum resolution: 16 cm<sup>-1</sup>; number of scans: 100 (400-4000) hz.



**FTIR Microscope**

# Abbreviations used

<b>EVOH</b>	<b>Ethylene vinyl alcohol</b>
<b>PP</b>	Polypropylene
<b>HDPE</b>	High Density Polyethylene
<b>LDPE</b>	Low Density Polyethylene
<b>PVC</b>	Polyvinyl Chloride
<b>EVA</b>	Ethyl vinyl alcohol
<b>ABS</b>	Acrylonitrile butadiene styrene
<b>PET</b>	Polyethylene Tetrathalate
<b>PIP</b>	Poly Isoprene
<b>PES</b>	Polyether sulfone
<b>PVAL</b>	Poly vinyl alcohol
<b>PVDC</b>	Polyvinylidene chloride
<b>PVB</b>	Poly vinyl butyral
<b>PMMA</b>	Polymethyl methacrylate

# Polymers used in Flexible MLP

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Plastic polymer	Applications
Polyethylene (PE)	breathable packaging for fresh produce (LDPE, HDPE) carton liners (LLDPE)
Polypropylene (PP)	modified atmosphere packaging thermoformed containers for microwavable packaging, hot-filled packaging
Polyamide (PA)	boil-in-bag packaging thermoformed packaging
Polyethylene terephthalate (PET)	plastic bottles for carbonated softdrinks, meat and cheese packaging, snack food wrapper boil-in-bag, sterilisable pouches, ovenware containers
Polystyrene (PS)	breathable packaging for fresh produce (e.g. fresh-meat packaging) printable outside layers
Ethylene vinyl alcohol (EVOH)	modified atmosphere packaging packing of oxygen- sensitive food
Polyvinylidene chloride (PVDC)	modified atmosphere packaging applied as coating or coextruded film

# Polymers used in Flexible MLP

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Plastic polymer	Applications
Polycarbonate (PC)	microwavable packaging, hot-filled packaging modified atmosphere packaging barriers for fruit juice cartons
Polyvinylchloride (PVC)	fresh food packaging (e.g. PVC/PE films) modified atmosphere packaging (e.g. PVC/EVOH/PE films)
Polyethylene naphthalate (PEN)	for hot refills, rewashing, reuse beverage bottles (e.g. beer)
Glycol modified polyethylene terephthalate (PET-G)	
Ethylene acrylic acid (EAA)	

Many packaging materials, especially for high value foods (e.g. dried soups, herbs, spices), contain a layer of aluminium foil - effective barrier against moisture, air, odours and UV light





Source: J RC Technical Reports, European Commission

# River Yamuna, Agra

51 types of polymers are found in the microplastic sample.

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Further, based on macroplastic assessment studies, land based waste sources have been correlated with microplastic survey as depicted below:

Types of Plastic found in Macroplastic assessment study in Agra	Total plastics by count (in %)	Microplastic polymer
<p>Multilayer Large and Medium Size packets of snacks, chips, Namkeen, biscuits etc.</p> 	12	EVOH, PVAL, EVA, PVC, Polyimide, PP, LDPE, Polyacrylamide, Acronitrile film, PE/PP, Polyester film, HDPE, Poly ethylene oxide
<p>Monolayer Plastic Packaging used for food, detergent etc.</p> 	4	Polyethylene, polypropolyene
<p>Synthetic woven bags used for cement packaging etc.</p> 	2	Polyester
<p>Polythene bags (colored white, black)</p> 	62	Polyethylene

Disposable plastic Cups/Glasses, take away food containers



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Polyamide,  
Styrene/Isoprene,  
PIP, PES, Polyester  
film, HDPE,  
Polycarbonate

Packing used for water, milk etc.



5

Polyethylene

Ritual Material



2

Polyethylene, PP,  
PIS

Plastic Sheet & other thicker plastic bags Color-Black & White



2

Polyethylene

Tobacco, Pan Masala Sachet/Wrap



2

EVOH, PVAL,PET,  
Polyethylene,  
PVC, PS, PVDC,  
Polypropolene











# Prayagraj (Ganga, Yamuna and Sangam)

Polymer types found: **Yamuna : 40 Nos.** and **Ganga : 17 Nos.** Co-relation of microplastic survey- macroplastic assessment

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Types of Plastic found in macroplastic assessment	Total plastics by count (in %)	Polymer types found in microplastic survey
Food packaging material for snacks, chips, namkeen, biscuits etc. 	28.2	EVOH, PVAL, PP, PVB(Polyvinyl butyral), LDPE, Polyethylene, polycarbonate, Polyamide, PVC
Multilayer Sachets for Shampoo, Tobacco, tea, coffee, tomato sauce etc. 	10.2	EVOH, PVAL, PP, PVB(Polyvinyl butyral), LDPE
HDPE bottles, tray, PVC etc. 	1.8	Polyethylene, PVC
Polythene bags (colored white, black) 	21.4	Polythene

Contd..

<p>Disposable paper cups coated with plastic film, Take away food containers, disposable cup &amp; plates</p> 	3.8	Polyamide, Styrene/isoprene copolymer, styrene/Isoprene, polysulfone
<p>Packing used for water, milk etc.</p> 	3.6	Polyethylene
<p>Shopping Bags/ Grocery Bags:</p> 	3.7	Polyethylene
<p>Synthetic Clothes</p> 	4.7	Polyester
<p>Tobacco, Pan Masala Sachet/Wrappers</p> 	15.9	EVOH, PVAL, Polyethylene, PVDC, PVC, PP, PS, PET
<p>others</p>	6.6	PE, PP, PVC



## MAJOR POLYMER TYPE EVOH, Polyisoprene, PVC, PVAL.

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Polymer	Origin	Remarks
<b>EVOH</b>	Used in Multilayer Packaging which binds with Oxygen molecule To maintaining hygiene inside the packet	Maximum Multi layer packets in the litter.
<b>Polyisoprene</b>	Found in rubber bands, rubber material, footwear, etc	Probably coming from footwear clusters
<b>PVC</b>	Used in footwear and also in medicine packaging, multilayer packaging	Blister used for medicine packaging.
<b>PVAL/MLP</b>	Polyvinyl alcohol	Same functionalities as EVOH in Multilayer packaging
<b>Polyethylene</b>	multilayer packaging	



## Types of plastic product waste found in microplastic sampling but not found in macroplastic samples are as given below:

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### River Ganga & Yamuna, Allahabad

Waste	Polymers leached out
Rubber material waste	Polyisoprene
Laminated films such as silver foil, laminated disposable plates.	Polysulfone

### River Yamuna, Agra

Waste	Polymer
Laminated films such as silver foil, laminated disposable plates.	PET, LDPE, Polysulfone
Foams	Polyurethane
Toys	Polybutene
Automobile parts, window glass	PMMA (Polymethyl methacrylate)
bearings, piston parts, pumps, automotive, etc	Polyetheretherketone (PEEK)
Nonstick cookware coating	PTFE
Skin care product	Poly 1-butene

# Major findings from perception surveys

- ▶ Widely prevalent plastics litter in Prayagraj. are use and throw plastic cups, plastic bottles for sanitary products and the plastic medicine packaging, packaging material of food/ snacks, tobacco sachets, etc
- ▶ Widely prevalent plastics litter in Agra are Multilayer packets, thin polyethene bags , sachets of shampoo and other hygiene products, etc.

# Lesson learnt

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- ▶ Observing so many varieties of polymers in water. All sources needs to be investigated
- ▶ Another source of Microplastic is wastewater both domestic as well as industrial which is drained into the river. Microplastic survey also needs to be undertaken in wastewater falling into river
- ▶ Microplastic survey results can be a very good source of information in developing plastic leakage scenario.
- ▶ The analytical data will also be helpful to develop the risk assessment and mitigation strategies.

# Conclusion

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- ← Microplastic sampling indicated presence of polymers that are likely present in food packaging and Tobacco, Pan Masala sachet (EVOH, PVAL, PE, PP, PVC, PET), thermo packaging material (Polyamide), disposable cups and plates (polystyrene, styrene) thin polybags and plastic bags (LDPE, HDPE).
- ← Microplastic analysis validates our primary studies and macro assessment studies in Prayagraj and Agra.



# Way ahead

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- There is a requirement to make a comprehensive microplastic monitoring plan in water, sediments, fishes and other aquatic plants to understand its impact
- Microplastic survey has to be validated through macroplastic assessment studies leading to identifying the polymers in macroplastic being leaked into the natural environment
- This study has to be undertaken in other major rivers along the major plastic waste generating cities in the country

**THANK YOU**