जल शक्ति मंत्रालय
जल संसाधन, नदी विकास और गंगा संरक्षण विभाग
MINISTRY OF JAL SHAKTI
DEPARTMENT OF WATER RESOURCES,
RIVER DEVELOPMENT & GANGA REJUVENATION

A Global Perspective on Microplastics as Emerging Contaminants and the Integration of Advanced Detection in Climate-Stressed Aquatic Ecosystems



by

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Scientist 'C'
River Rejuvenation Division

Central Water & Power Research Station

Importance of Water



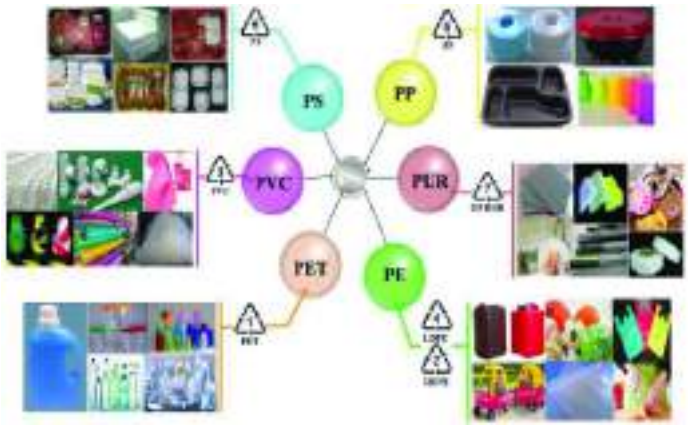
Beyond What We See: Microplastics in Our Waters



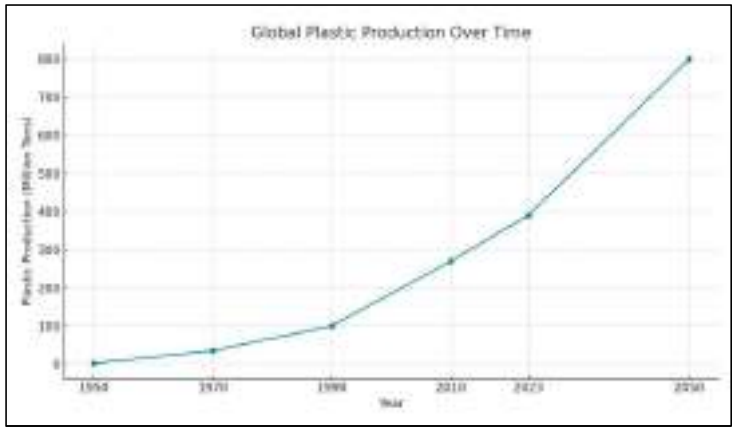
Ref: https://plasticactioncentre.ca/directory/how-plastics-breakdown-into-microplastics/

Plastics-in-our-daily-life

Commonly-used-plastics-in-our-daily-life



Statistics:



Evolution of plastic production:





Info: Plastic production old and new era of industrialization.

Ref : https://doi.org/10.1021/acsomega.1c07291 ACS Omega 2022, 7, 13403−13435

Plastic Waste Burden

National Macro Context: 20 Million Tonnes Plastic Waste Burden

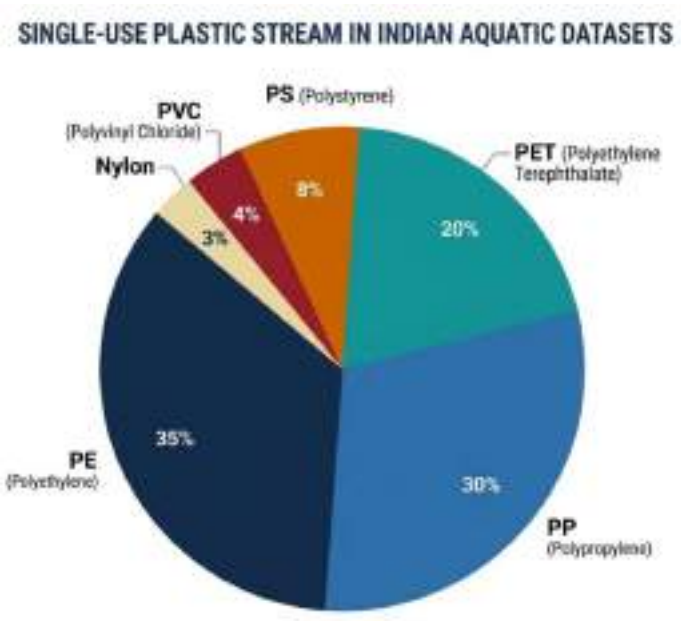
Population Burden:

1.4B population producing ~20 million tonnes/year plastic production capacity.

Recycling Gap: <30% estimated recycling rate drives massive unmanaged & mismanaged plastic waste.

Major River Systems: Ganges, Brahmaputra, Krishna, & Godavari discharge high plastic loads into Indian Ocean.

Dominant Polymers: Polyethylene (PE) and Polypropylene (PP) packaging films dominate urban waste run-off.



Ref : Kumar, A.; Poddar, V. K. et al. Microplastic pollution in rivers and lakes of India: Sources, impacts, and strategies. NanoImpact 2026, 41, 100604; Majeed, L. R. et al. Phys. Chem. Earth 2025, 139, 103942.

Decompose/Degrade…?

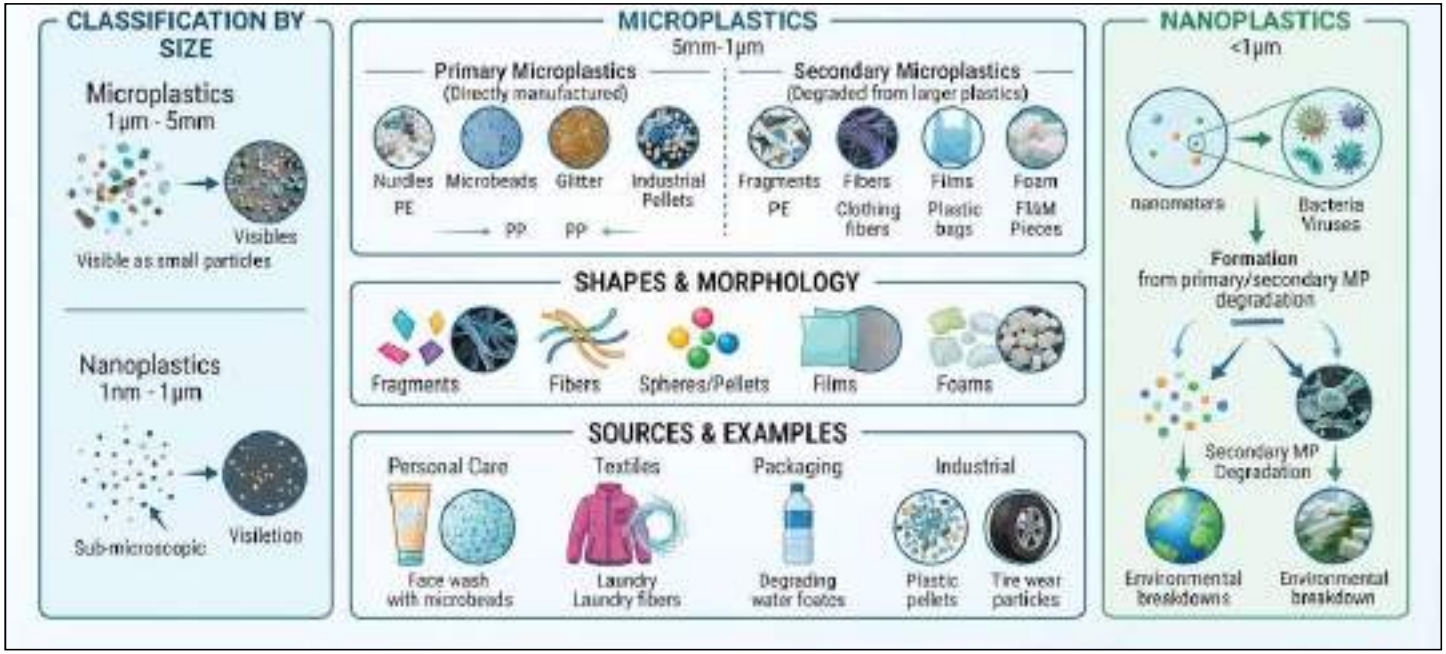
Plastic Doesn't Decompose, It just gets SMALLER



Plastics can remain in the environment for anywhere between 10 and 10,000 years.

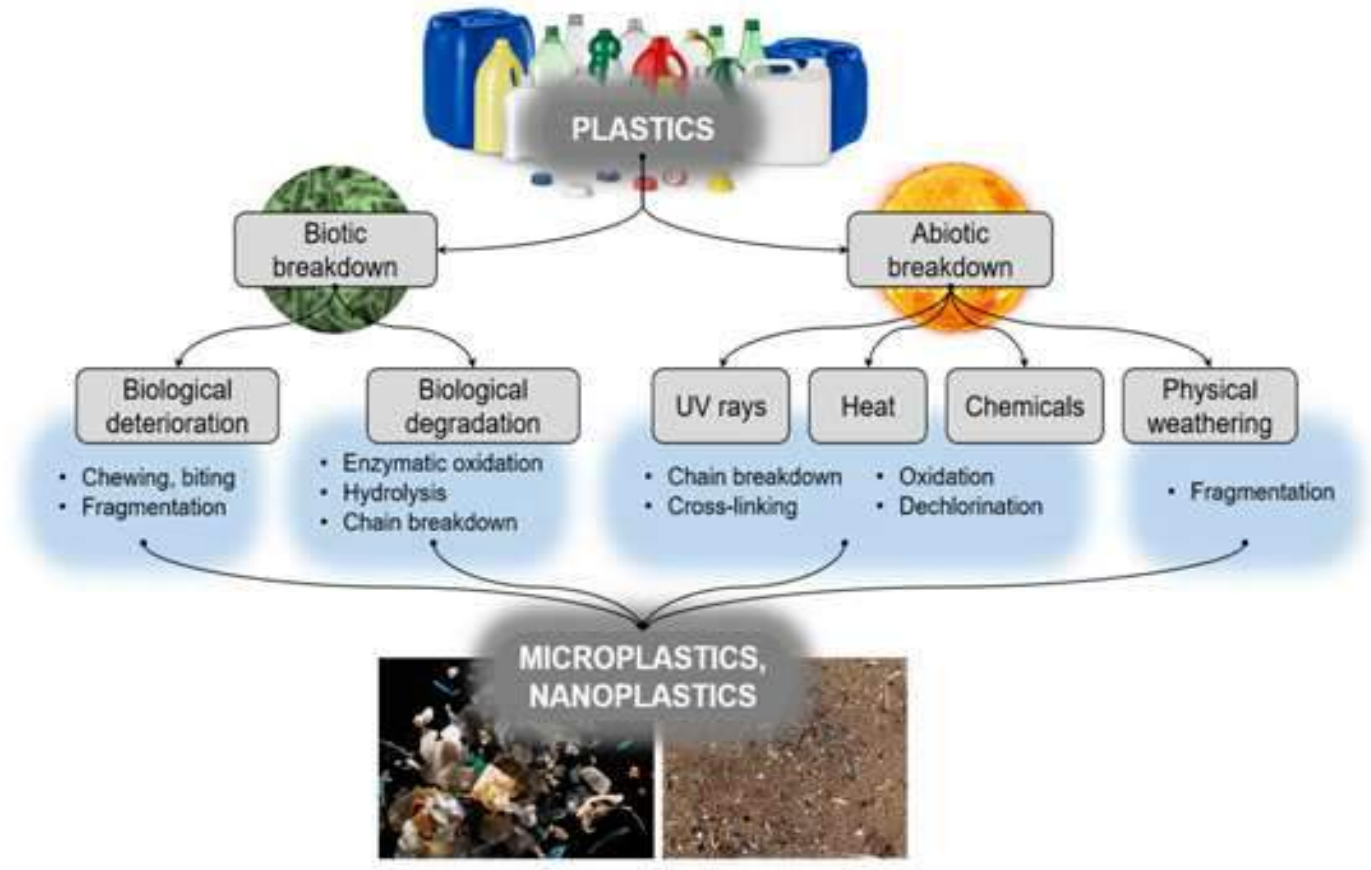
What are microplastics…?

- Microplastics are tiny plastic particles that are less than 5 millimeters in size.
- They exist in various environments, including water, soil, food, and even the air we breathe.



Ref: Vdovchenko, A., & Resmini, M. (2024). Mapping microplastics in humans: Analysis of polymer types, and shapes in food and drinking water—A systematic review. *International Journal of Molecular Sciences*, *25*(13), 7074. https://doi.org/10.3390/ijms25137074.

How microplastics are produced…?

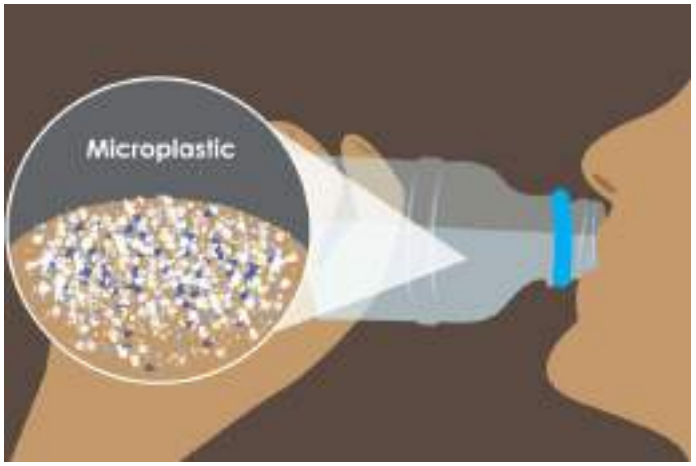


Ref : Environmental Technology & Innovation 28 (2022) 102815 & Environ. Sci. Technol. 53, 2019, 9003–9013. http://dx.doi.org/10.1021/acs.est.9b03105

Microplastics in Water

There are five main water types that have microplastics:

- Tap water
- Bottled water (drinking water)
- Marine water
- Waste water
- Arctic water





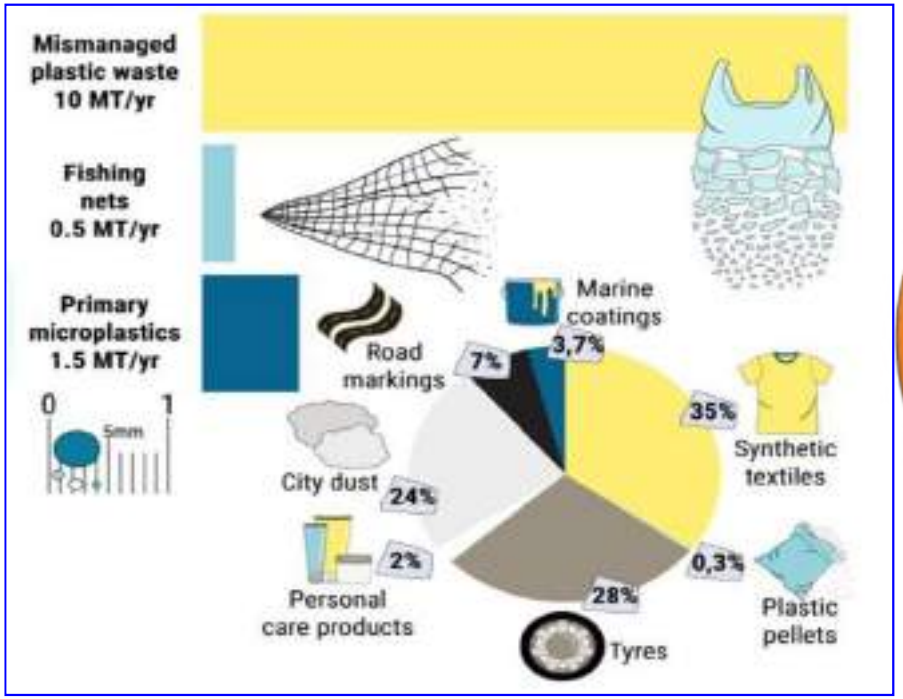




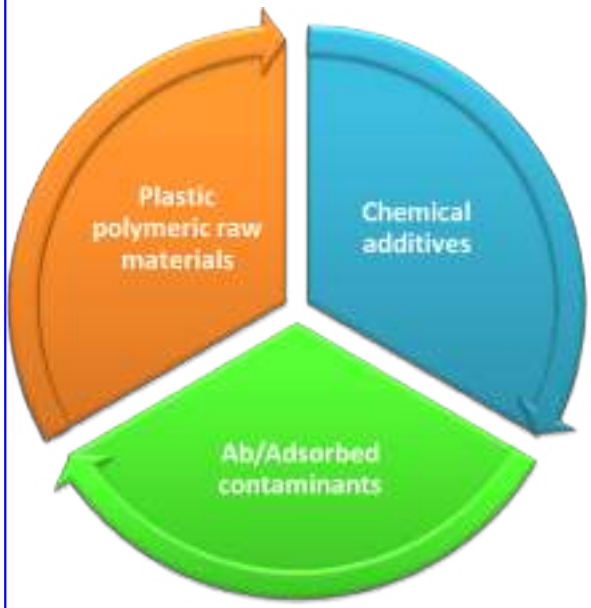


Global Release of Microplastics

Global Release of Microplastics to the World Oceans:



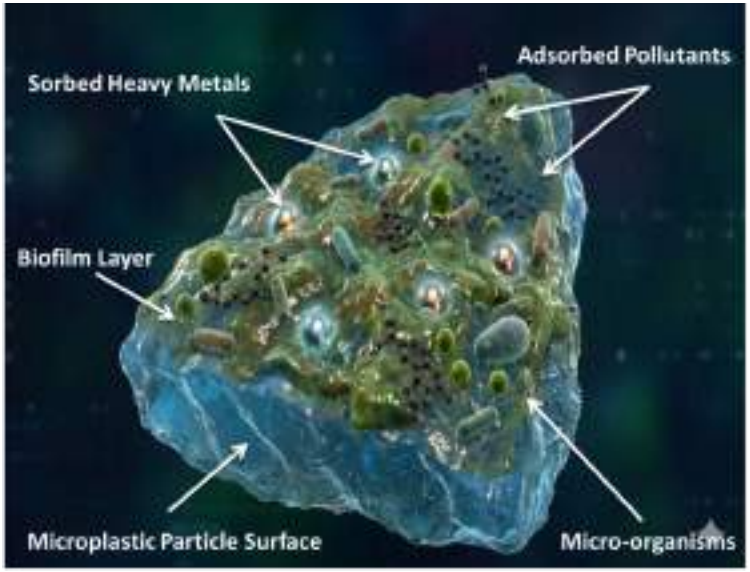
Microplastics & Hazards

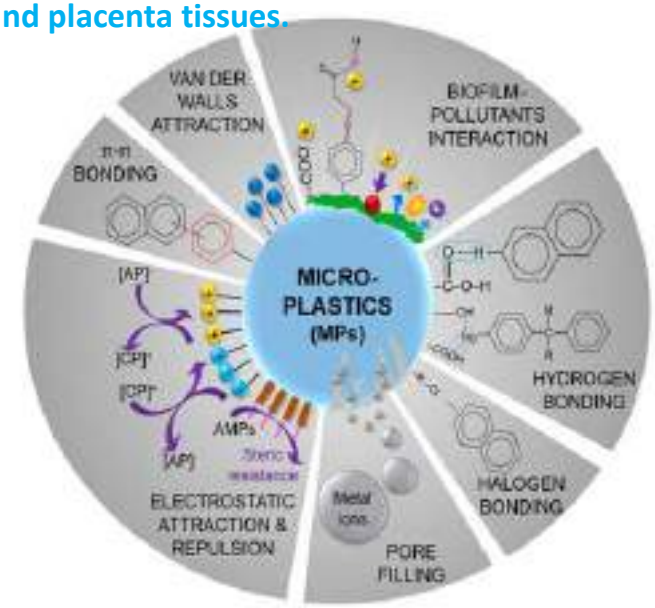


Ref : Li, K.; Du, L.; Qin, C. et al. Microplastic pollution as an environmental risk exacerbating climate change. Carbon Res. 2024, 3, 9; Parvez, M. S. et al. Water Air Soil Pollut. 2024, 235, 201.

Vectors for Toxic Co-Contaminants

- **Chemical Vector Capacity (POPs & Heavy Metals):** High surface area-to-volume ratio sorbs Persistent Organic Pollutants (POPs), heavy metals (Pb, Cd, Cr), and pharmaceuticals.
- **Plastisphere Resistome & ARGs Enrichment:** Biofilms on MPs serve as hotspots for Antibiotic Resistance Genes (ARGs) and pathogenic microbes, promoting horizontal gene transfer.
- **Human Exposure & Physiological Translocation:** Translocation confirmed in human saliva (0.33 p/ind), human blood (2,466 MP/L), breastmilk, and placenta tissues.





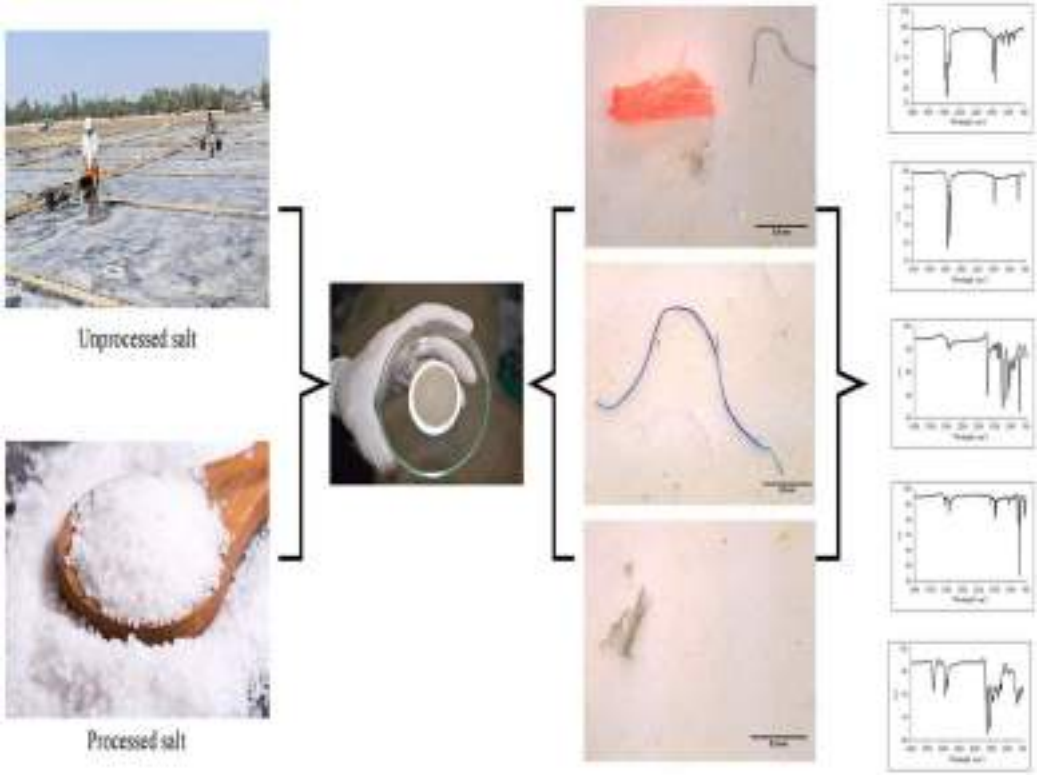
Possible primary binding mechanisms of organic and inorganic pollutants on MP surface

Ref : Queiroga, G.; Vasquez-Ponce, F. et al. Microplastics in marine pollution: Oceanic hitchhikers for antimicrobial-resistant bacteria. One Health 2025, 20, 101056; Zhang, X. et al. npj Biofilms Microbiomes 2026, 12, 24.

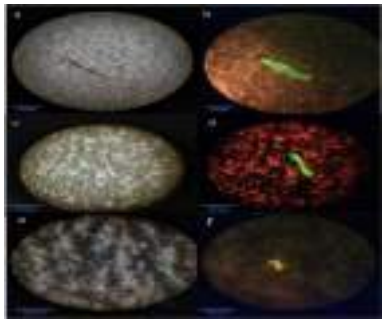
Recent studies on microplastics

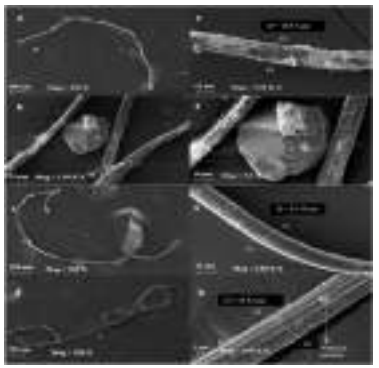


Microplastic contamination of sea salts



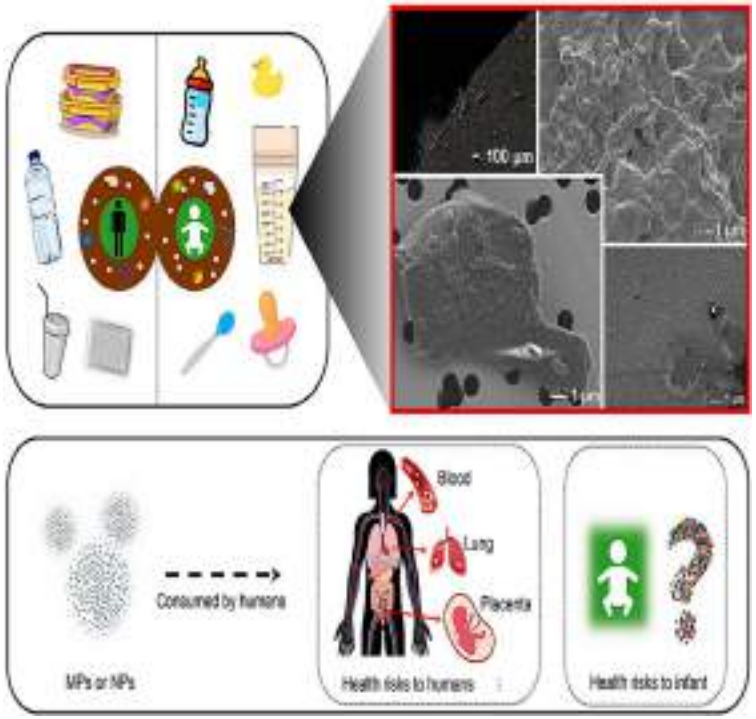
Microscopic & fluorescence & images of isolated particles from salt samples

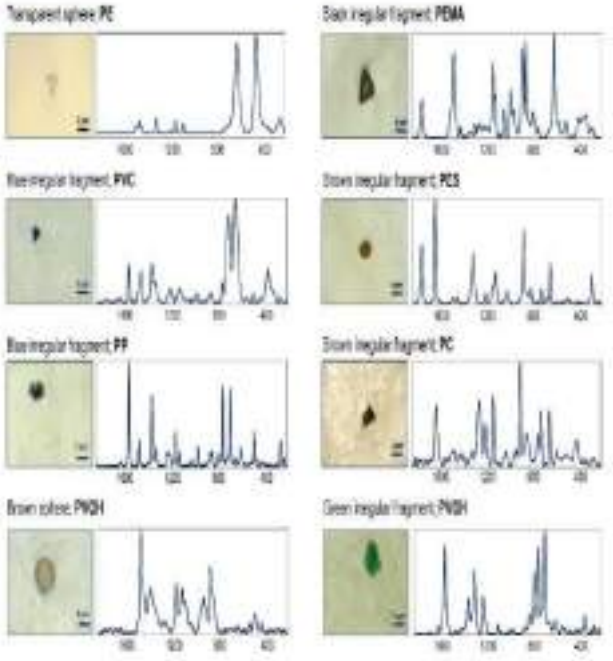




Ref : Microplastic contamination in processed and unprocessed sea salts from a developing country and potential risk assessment. https://doi.org/10.1016/j.chemosphere.2022.136395.; Kuttykattil, A., Raju, S., Vanka, K.S. et al. Consuming microplastics? Investigation of commercial salts as a source of microplastics (MPs) in diet. Environ Sci Pollut Res 30, 930–942 (2023). https://doi.org/10.1007/s11356-022-22101-0.

Microplastic from breastmilk storage bags

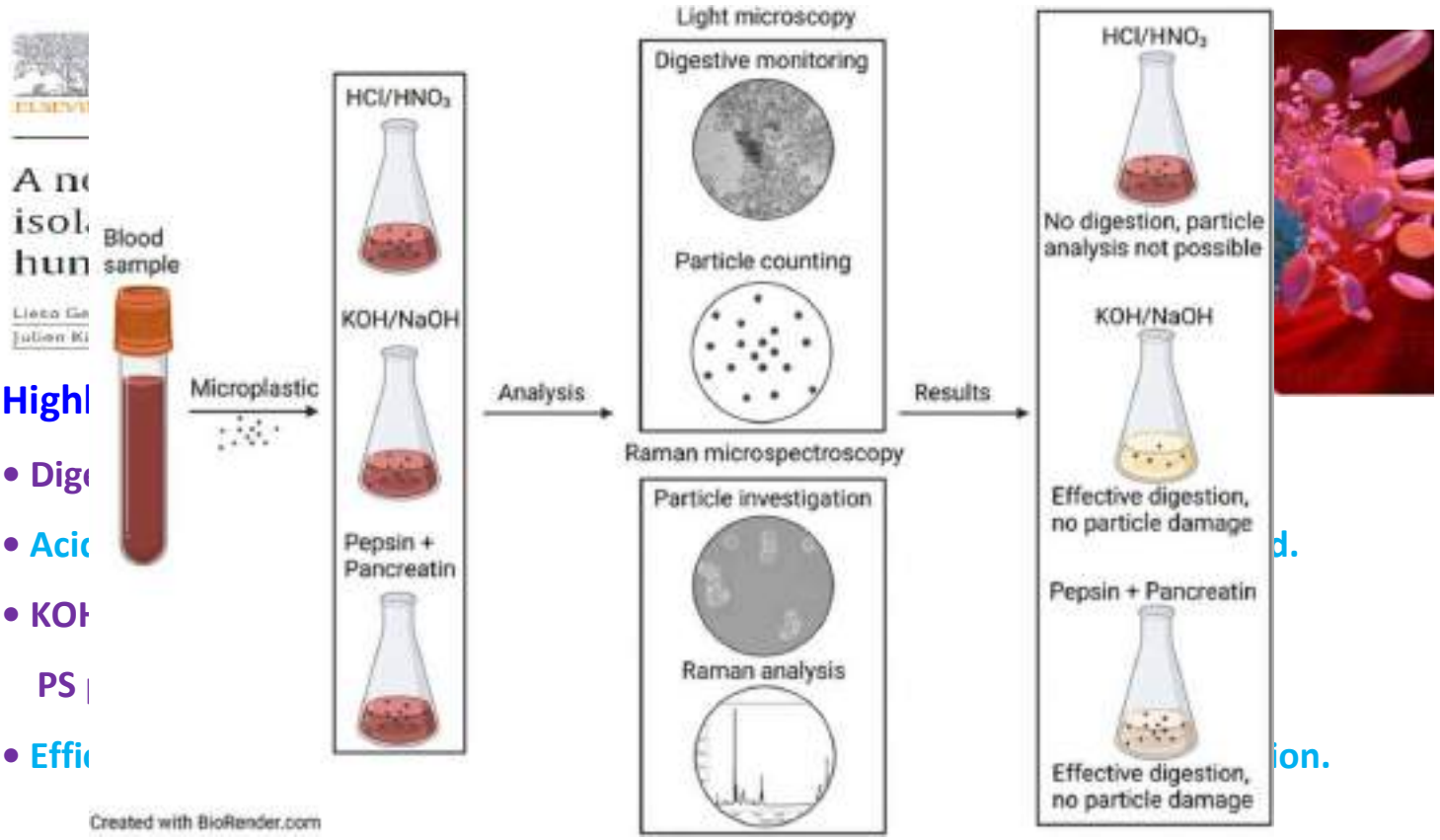




Ref : Release of microplastics from breastmilk storage bags and assessment of intake by infants: A preliminary study, https://doi.org/10.1016/j.envpol.2023.121197.

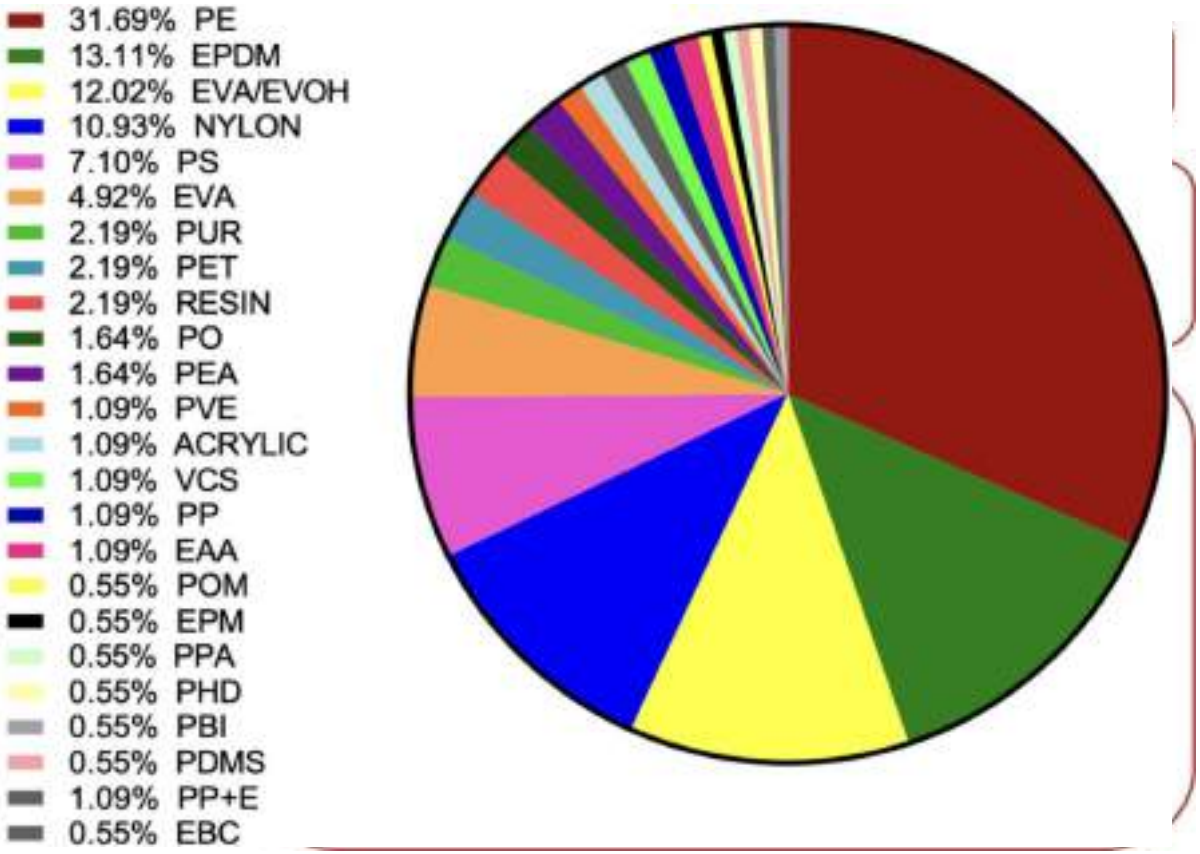
Ref : Ragusa, A., Notarstefano, V., Svelato, A., & Belloni, A. (2022, Juni). Raman Microspectroscopy Detection and Characterisation of Microplastics in Human Breastmilk. ResearchGate. Retrieved Oktober 17, 2022.

Microplastics in human blood



Ref : Environment International 188 (2024) 108751.

Microplastics in human blood



Microplastic polymer types identified in blood samples

Microplastics sampling procedure

Manta Net





Grab Sampler

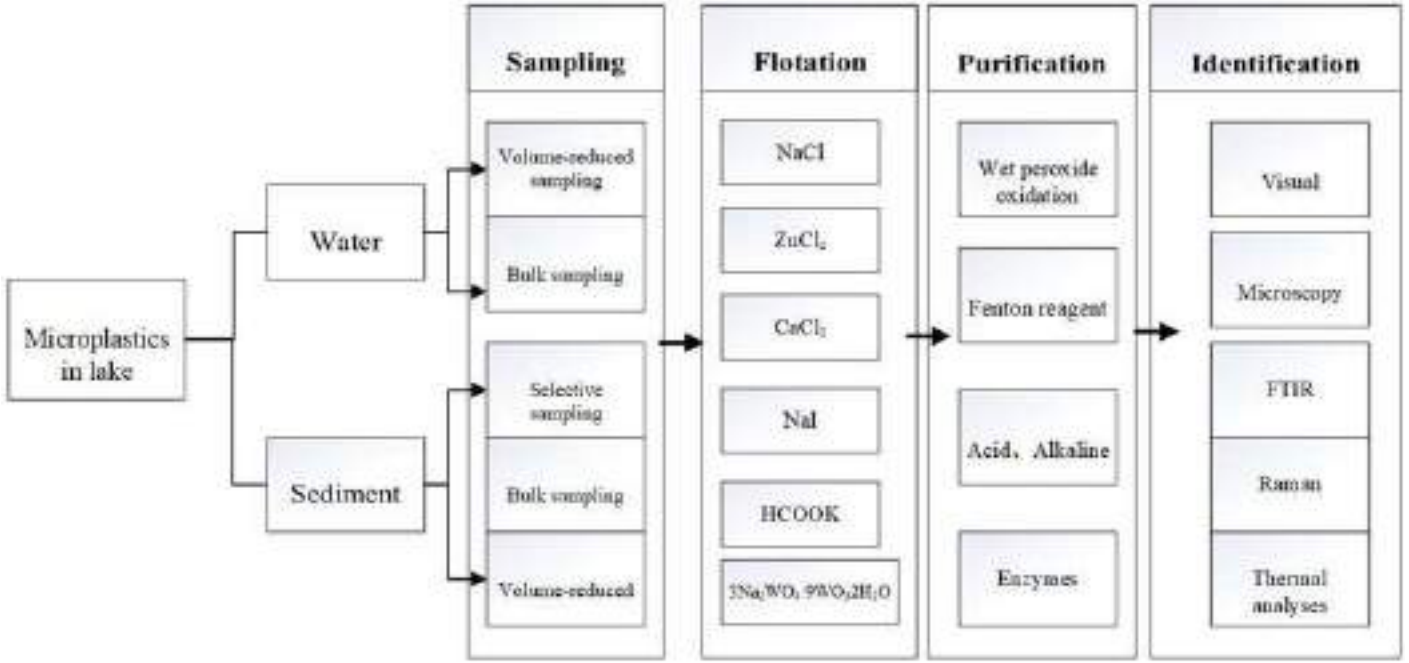




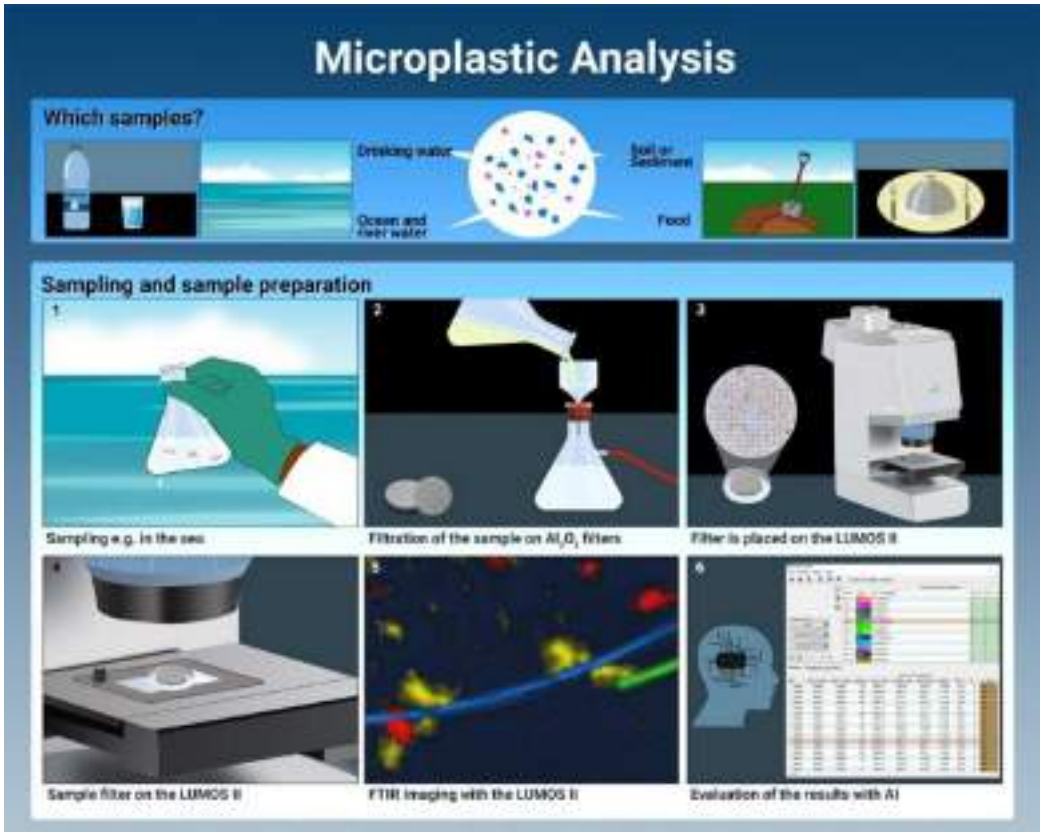


Ref : https://doi.org/10.1016/j.scitotenv.2020.144495

Typical procedure for sampling & analysis



Typical procedure for analysis



Ref : BRUKER; & Chem. Rev. 2021, 121, 19, 11886-11936

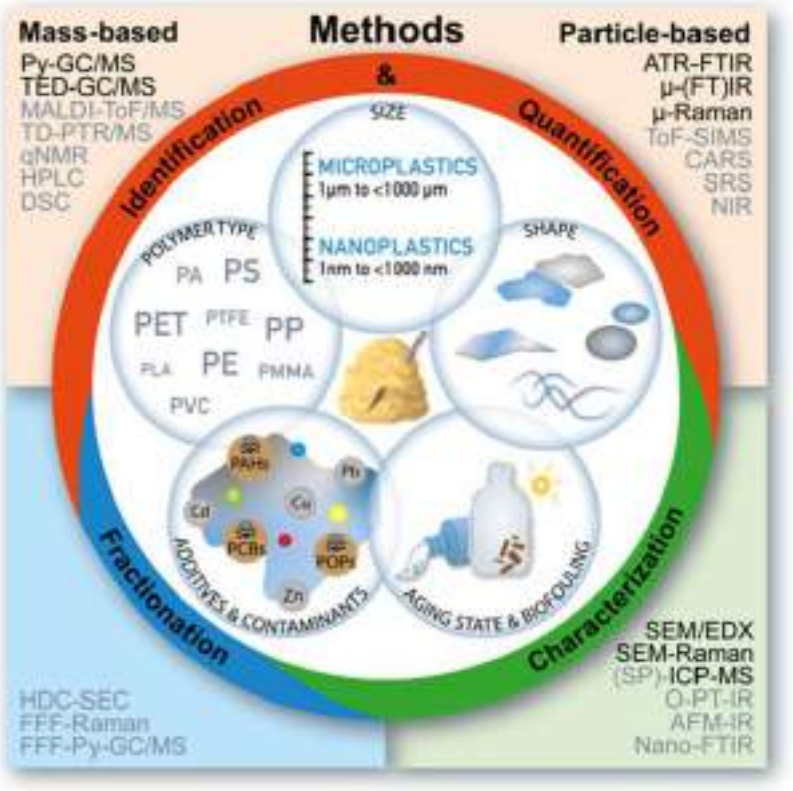
Microplastics Analysis Techniques

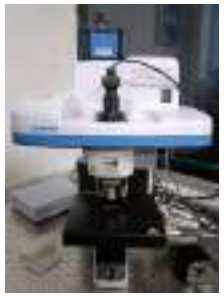


Microscopy



FTIR spectroscopy





Raman



SEM



Mass spectrometry

Ref : Chem. Rev. 2021, 121, 19, 11886-11936

Microplastic Loads

Freshwater and Coastal Monitoring Reveals Microplastic Loads Ranging from 80 to 1,640 Particles/m³

Water Body / Region	Type	Water Conc. (particles/m³)	Dominant Polymers	Primary Contamination Source
Ganges River (Varanasi-Patna)	River	180 – 640	PE, PP Fragments	Urban solid waste, WWTP effluent
Brahmaputra River (Assam)	River	210 – 520	PE, PP, PET Fibres	Agricultural plastics, urban runoff
Mula River (Pune)	River	320 – 580	PET, PP Fragments	Industrial effluents, untreated sewage
Bhopal City Lakes (Upper/Lower)	Urban Lake	890 – 1,640	PE, PP, PET Films	Stormwater leaching, solid waste
Eastern India Rivers/Ponds (WB)	Urban Water	420 – 680	PET, PP Fibres	Textile washing, dense urban litter
Sundarbans Mangrove Estuary	Estuary	240 – 820	PE, PP, PET Fibres	Fishing gear, estuarine trapping
Arabian Sea Coast (Mumbai/Goa)	Coastal Marine	80 – 340	PE, PP Films	Monsoon runoff, maritime activities
Chilika Lagoon (Odisha)	Lagoon	180 – 480	PET, PA Fibres	Synthetic fishing nets, plastic litter

Ref : Gupta, D. K. et al. J. Contam. Hydrol. 2025, 273, 104575; Verma, M. et al. Environ. Pollut. 2025, 373, 126091; Prasad, G. et al. Integr. Environ. Assess. Manag. 2025, 21, 843–857.

Microplastics & Flooding & Storm Surges

Flooding & Storm Surges: 40-Fold Amplification of Riverine Transport

- Riverbeds act as temporary sinks during low-flow periods, storing dense fragments in hyporheic zones.

Catastrophic Catchment Flooding: Single major flood exported 0.85 tonnes of microplastics in riverbed sediment.

Monsoonal Storm Spikes: Extreme rainfall triggers up to 40-fold concentration surges in surface runoff.



Urban Stormwater Discharge: Unfiltered municipal run-off flushes accumulated tire wear & urban debris.

Ref: Hurley, R.; Woodward, J.; Rothwell, J. J. Microplastic contamination of river beds significantly reduced by catchment-wide flooding. Nat. Geosci. 2018, 11, 251–257; Rolf, M. et al. Micropl. Nanopl. 2026, 6, 32.

Microplastics Present an Escalating Water Security Risk

GLOBAL PERVASIVENESS

80-1,640

Particles/m³ Range in Indian Surface Waters

- Microplastics (<5mm) are ubiquitous in rivers, lakes, and sediments, acting as vectors for organic pollutants, heavy metals, and pathogens.
- Microplastics (80–1,640 particles/m³) detected across Indian freshwater, estuarine, and coastal compartments.





CLIMATE AMPLIFICATION

40× Increase

MP Levels During Storms & Flood Events

- Accelerated hydrological cycles and severe floods flush riverbed sediment reserves, driving sudden massive transport downstream to coastal sinks.
- Extreme flood events flush up to 0.85 tonnes of MPs per storm; monsoon surges trigger 40× concentration spikes.

Microplastics Present an Escalating Water Security Risk





GOVERNANCE VACUUM

< 30% Recycled

20M Tonnes/Yr Indian Plastic Production

- India generates 20M tonnes/year plastic with <30% recycling.
- Absence of BIS/CPCB standardized sampling and monitoring protocols creates a critical gap in evidence-based water resource management.





Strategic Action Plan & Recommendations

Issue National SOPs

Publish standardized SOPs for microplastic sampling and characterization.

Integrate into NWQMP

Formally incorporate microplastics as a regular monitoring parameter across all national river basins.

IS 10500 Code Gap

Mandates testing for chemicals but currently excludes microplastic and nanoplastic limits.

Scale AI & Remote Sensing

Fund low-cost AI spectral tools for SPCB labs and drone surveillance for hot-spot tracking.

Event-Based Protocols

Require flood and storm event sampling to capture climate-amplified sediment flushing loads.

Acknowledgements

River Rejuvenation Division

Central Water and Power Research Station, Pune-24

Government of India.

IIWW

सत्यमेव जयते

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RIVER DEVELOPMENT & GANGA REJUVENATION

Service through Research


THANK YOU
Keep our Waters Clean