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Department of Chemistry
Environmental Information System
TCE ENVIS RP - Centre for Plastic Waste Management

NEWS LETTER

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E N V I S

PLASTIC Waste Management

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Editorial Message

Dear Readers,

Greetings,

This issue is mainly focused on the details about the waste plastics in the ocean and it's ill effects to the living beings in the ocean. The plastics which reaches from land to sea are called as "Marine Plastics" and the pattern in which the plastics broke down in to pieces are called as "Micro Plastics". At least 8 million tons of plastic end up in our oceans every year, and make up 80% of all marine debris from surface waters to deep-sea sediments. Marine species ingest or are entangled by plastic debris, which causes severe injuries and deaths. Plastic has been detected on shorelines of all the continents, with more plastic materials found near popular tourist destinations and densely populated areas. The main sources of marine plastic are land-based, from urban and storm runoff, sewer overflows, beach visitors, inadequate waste disposal and management, industrial activities, construction and illegal dumping. Ocean-based plastic originates mainly from the fishing industry, nautical activities and aquaculture. Thus it is very important to create an awareness among public, about marine plastics and its contribution to the environment. This issue will satisfy the readers thirst in knowing about the marine plastics and also on micro plastics.

Thanks and Regards
EDITOR

PLASTIC WASTE MANAGEMENT
TCE ENVIS
MADURAI

Contents

Overview Marine Plastics

More than
150 million tonnes
of plastic exist in the oceans today

An estimated
4.8 to 12.7 million tonnes
of plastic enter the oceans every year

Problems caused by plastic waste in the ocean to:

Marine life

- **Entanglement** and **ingestion** by animals, including damage caused by lost fishing equipment
- Habitat degradation
- Exposure to **chemicals** in the plastics

Human health

- Exposure to **chemicals** through the food chain

Economy

- Estimated cost of marine litter is between **€259 million** and **€695 million**, mainly to tourism and fisheries sectors

Climate:

- Recycling **1 million tonnes of plastic** equals taking **1 million cars** off the road (in terms of CO2 emissions)

1. Drink bottles, caps and lids
2. Cigarette butts
3. **Cotton buds sticks**
4. Crisp packets/sweet wrappers
5. Sanitary applications (sanitary towels, tampons etc.)
6. Plastic bags
7. **Cutlery, straws and stirrers**
8. Drinks cups and cup lids
9. Balloons and **balloon sticks**
10. Food containers, including fast food packaging

Marine Plastics

The introduction by man, directly, or indirectly, of substances or energy to the marine environment resulting in deleterious effects such as: hazards to human health, hindrance to marine activities, impairment of the quality of seawater for various uses and reduction of amenities."

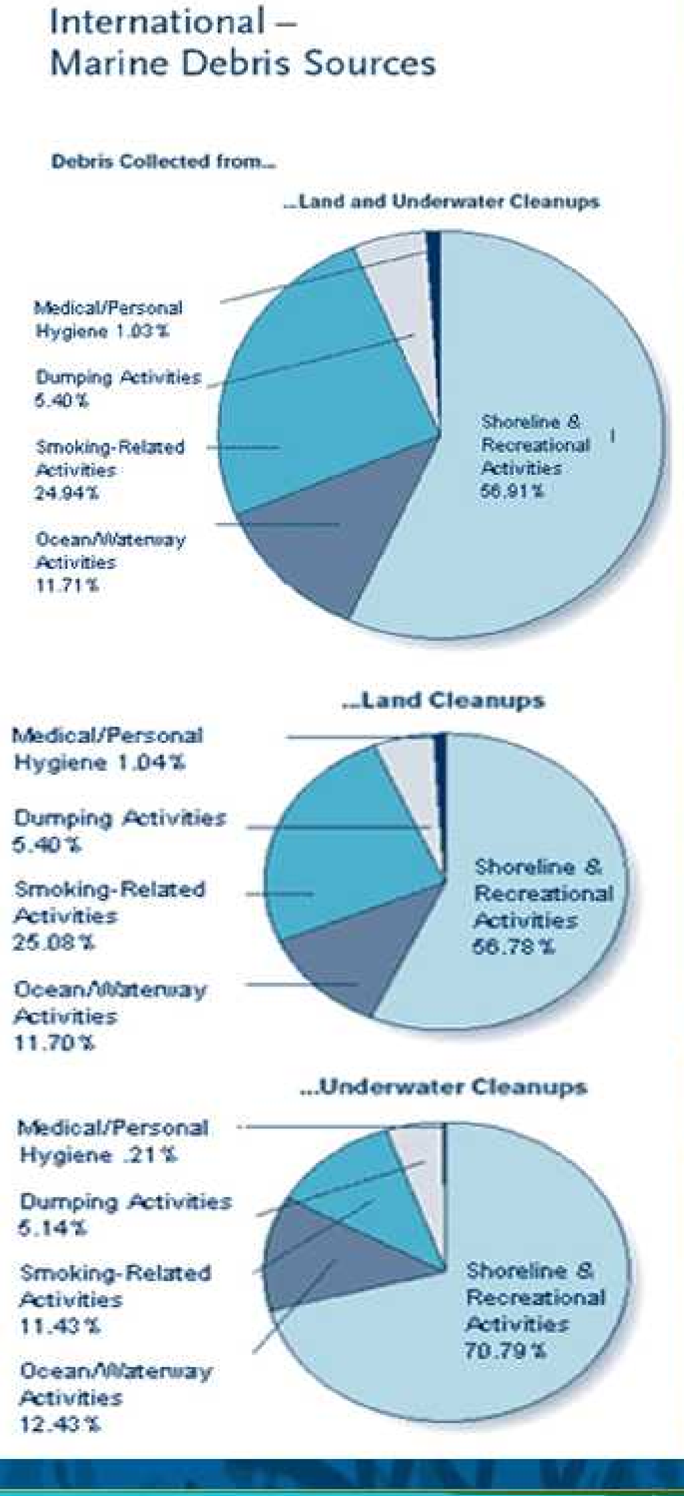
Marine litter is found in all the oceans of the world, not only in densely populated regions, but also in remote places far from obvious sources and human activities. Marine litter is a complex issue with significant implications for the marine and coastal environment and human activities all over the world. The problems it causes are both cultural and multi-sectoral, rooted in poor solid waste management practices, extensive use of marine resources, lack of infrastructure, indiscriminate human activities and behaviours, and an inadequate understanding on the part of the public of the potential consequences of their actions. Marine litter produces a wide variety of negative environmental, economic, safety, health and cultural impacts. Most marine litter has a very slow rate of decomposition, leading to a gradual, but significant accumulation in the coastal and marine environment.

Marine Pollution (UN definition):

Land-based sources pollute estuaries and coastal waters with nutrients, sediments, pathogens as well as many thousands of toxic chemicals, including metals, pesticides, industrial products, pharmaceuticals and more. Following the industrial revolution, increasing amounts of materials have been discharged into the environment from chemical industries, sewage treatment plants, and agriculture, eventually reaching marine ecosystems. Highly visible events such as the Exxon Valdez, and the Gulf of Mexico "gusher" have raised public awareness of marine pollution in recent decades. There is growing scientific evidence demonstrating serious, sometimes disastrous, impacts of pollution in the marine environment. Pollutants of major concern are those that are widespread and persistent in the environment, accumulate in biota, and induce effects at low concentrations.

Sources of Marine Pollution:

Human behaviours and actions – accidental or intentional – are the sources of marine litter. The majority of sea or ocean-based sources of marine litter come from merchant shipping, ferries and cruise liners; fishing vessels; military fleets and research vessels; pleasure craft; offshore oil and gas platforms and drilling rigs; and aquaculture installations. Marine litter dispersion and deposition are strongly influenced by ocean currents, tidal cycles, regional-scale topography, including sea-bed topography and wind.



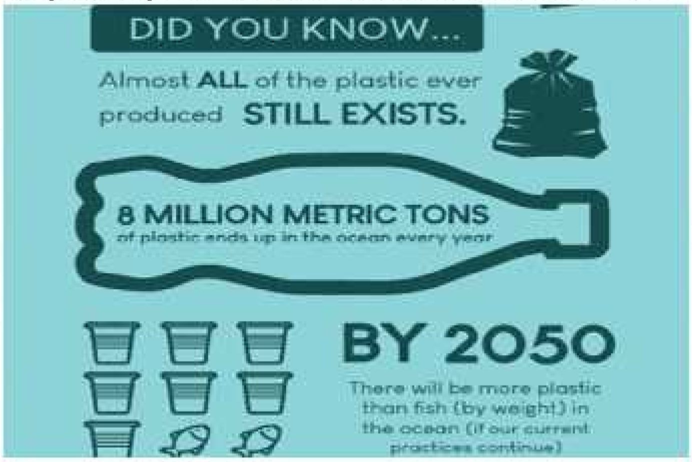
Litter- Marine Debris:

Marine debris is any man-made object discarded, disposed of, or abandoned that enters the coastal or marine environment. It may enter directly from a ship, or indirectly when washed out to sea. Materials can be dumped, swept, or blown off vessels and platforms at sea. Sources of the debris are littering, dumping in rivers and streams, and industrial losses, e.g. spillage of materials during production, transportation, and processing. It is estimated that about 14 billion pounds (6.4_109 kg) of trash end up in the oceans every year. Plastics comprise a large proportion of the debris, and the variety and quantity of plastic items has increased dramatically, including domestic material (shopping bags, cups, bottles bottle caps, food wrappers, balloons), industrial products (strapping bands, plastic sheeting, hard hats, resin pellets), and lost or discarded fishing gear (nets, buoys, traps, lines). Glass, metal, styrofoam, and rubber are used for a wide range of products. While they can be worn away – broken down into smaller and smaller fragments, they generally do not biodegrade entirely. As these materials are used commonly, they are common in marine debris. Derelict fishing gear includes nets, lines, crab/shrimp pots, and other recreational or commercial fishing equipment that has been lost, abandoned, or discarded in the marine environment. Modern gear is generally made of synthetic materials and metal, so lost gear can persist for a very long time.

Marine debris accumulates along shorelines and in coastal waters, estuaries, and oceans throughout the world. It can be blown by the wind, or follow the flow of ocean currents, often ending up in the middle of oceanic gyres where currents are weakest.

The Great Pacific Garbage Patch is one such example; comprising a vast region of the North Pacific Ocean. Estimated to be double the size of Texas, the area contains over 3 million tons of plastic, mostly in very small pieces.

Islands within gyres frequently have their coastlines covered by litter that washes ashore; prime examples being Midway and Hawaii, where plankton tows sometimes come up with more plastic pieces than plankton. The next biggest known marine garbage patch is the North Atlantic Garbage Patch, estimated to be some hundreds of km across. All estimates of the amount of litter are underestimates. Wind pushes the lightweight plastic particles below the surface, suggesting that research into how much plastic litter is in the ocean conducted by skimming the surface may vastly underestimate the true amount .



In addition to the visible litter that washes up on beaches, microscopic plastic debris from washing clothes is accumulating in the marine environment and could be entering the food chain. Researchers traced the "microplastic" back to synthetic clothes, which release up to 1,900 tiny fibers per garment every time they are washed. Earlier research showed plastic smaller than 1mm was being eaten by animals and getting into the food chain. In order to identify how wide spread the presence of microplastic was on shorelines, the team took samples from 18 beaches around the globe, and found that samples contained pieces of microplastic. Polyester, acrylic and polyamides (nylon) were the major ones, and their concentration was greatest near large urban areas. They found exactly the same proportion of plastics in sewage, which led them to conclude that sewage was the source of the fibers.

Types of Marine Pollution

Eutrophication:

When there is an excess of chemical nutrients mainly nitrates and phosphates in the water, it leads to eutrophication or nutrient pollution. Eutrophication decreases the level of oxygen, reduces the quality of water, makes the water inhabitable for fish, affects the breeding process within the marine life and increases the primary productivity of the marine ecosystem.

Acidification:

Oceans act as a natural reservoir for absorbing the carbon dioxide from the Earth's atmosphere. But, due to rising level of carbon dioxide in the atmosphere, the oceans across the world are becoming acidic in nature, as a consequence, it leads to acidification of oceans. Researches and scientists have not been able to uncover the potential damage ocean acidification may have on the Earth's atmosphere. But, there is a strong concern that acidification might lead to dissolution of calcium carbonate structures, that can affect the shell formation in shellfish and also the corals.

Toxins:

There are persistent toxins that do not get dissolved or disintegrate with the marine ecosystem rapidly. Toxins such as pesticides, DDT, PCBs, furans, TBT, radioactive waste, phenols, and dioxins get accumulated in the tissue cells of the marine lifeforms and lead to bioaccumulation hampering the life underwater and sometimes leads to a mutation in aquatic life forms.

Plastics:

The ever-growing dependence of human population on plastic has filled the oceans and the land, it consists of 80 percent of the debris found in the oceans. Plastic dumped and found in the oceans are dangerous for the marine life forms and wildlife, as sometimes it strangles and chokes them to death. The rising levels of plastic dumps found in the oceans are suffocating, ingesting, and entangling the life underwater as well as above it.

Effects of Marine Pollution:

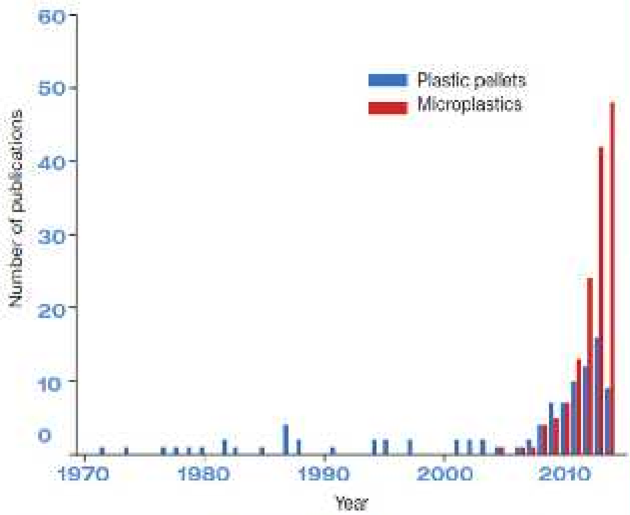
The contamination of water by excessive nutrients is known as nutrient pollution, a type of water pollution that affects the life under water. When excess nutrients like nitrates or phosphates get dissolved with the water it causes the eutrophication of surface waters, as it stimulates the growth of algae due to excess nutrients. Most of Benthic animals and plankton are either filter feeders or deposit feeders take up the tiny particles that adhere to potentially toxic chemicals. In the ocean food chains, such toxins get concentrated upward. This makes estuaries anoxic as many particles combine chemically depletive of oxygen. When the marine ecosystem absorbs the pesticides, they are incorporated into the food webs of the marine ecosystem. After getting dissolved in the marine food webs, these harmful pesticides causes mutations, and also results in diseases, which can damage the entire food web and cause harm to the humans. When toxic metals are dumped or flown into the oceans through drains, it engulfs within the marine food webs. It affects the biochemistry, reproduction process, can affect the tissue matter These can cause a change to tissue matter, biochemistry, behavior, reproduction, and suppress and alter the marine life's growth. Marine toxins can be transferred to several animals feeding on the fish or fish hydrolysate as a meal, toxins are then transferred to dairy products and meat of these affected land animals.
The following are the major classification of the effects of marine pollution:

- Oxygen depletion.
- Higher acidity.
- Choking marine life.
- Spoiling birds' feathers.
- Blocking out the sunlight.
- Dangers to human health.

Type	Primary Source/Cause	Effect
Nutrients	Runoff approximately 50% sewage, 50% from forestry, farming, and other land use. Also airborne nitrogen oxides from power plants, cars etc.	Feed algal blooms in coastal waters. Decomposing algae depletes water of oxygen, killing other marine life. Can spur algal blooms (red tides), releasing toxins that can kill fish and poison people.
Sediments	Erosion from mining, forestry, farming, and other land-use; coastal dredging and mining	Cloud water; impede photosynthesis below surface waters. Clog gills of fish. Smother and bury coastal ecosystems. Carry toxins and excess nutrients.
Pathogens	Sewage, livestock.	Contaminate coastal swiming areas and seafood, spreading cholera, typhoid and other diseases.
Alien Species	Several thousand per day transported in ballast water; also spread through canals linking bodies of water and fishery enhancement projects.	Outcompete native species and reduce biological diversity. Introduce new marine diceases. Associated with increased incidence of red tides and other algal blooms. Problem in major ports.
Persistent Toxins (PCBs, Heavy metals, DDT etc.)	Industrial discharge; wastewater discharge from cities; pesticides from farms, forests, home use etc.; seepage from landfills.	poison or cause disease in coastal marine life, especially near major cities or industry. Contaminate seafood. Fat-soluble toxins that bio-accumulate in predators can cause disease and reproductive failure.
Oil	46% from cars, heavy machinery, industry, other land-based sources; 32% from oil tanker operations and other shipping; 13% from accidents at sea; also offshore oil drilling and natural seepage.	Low level contamination can kill larvae and cause disease in marine life. Oil slicks kill marine life, especially in coastal habitats. Tar balls from coagulated oil litter beaches and coastal habitat. Oil pollution is down 60% from 1981.
Plastics	Fishing nets; cargo and cruise ships; beach litter; wastes from plastics industry and landfills.	Discard fishing gear continues to catch fish. Other plastic debris entangles marine life or is mistaken for food. Plastics litter beaches and coasts and may persist for 200 to 400

Micro Plastics

Plastics have become indispensible in many areas of modern life, used for clothing, storage, transportation, packaging, construction and a host of consumer goods. One of plastics' greatest properties, its durability, is also one of the main reasons that plastics present a threat to the marine environment. The risk increases as long as plastic continues to enter the ocean. The term microplastics was introduced within the last decade to describe small pieces of plastic found in the ocean, commonly defined as < 5mm in diameter.



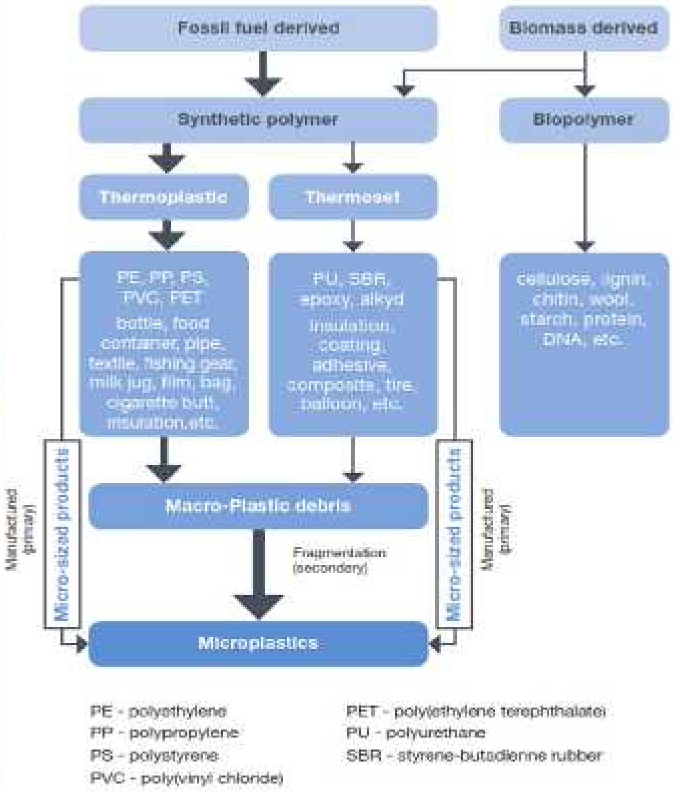
Plastic pellets © Hideshige Takada

Publications mentioning 'microplastics' and 'plastic pellets', up to July 2014 © Sarah Gall

The origins of microplastics

Plastic, a type of synthetic polymer, may be derived from fossil-fuels or biomass. Global production is dominated by a few well-known materials, but a huge range of plastics with differing compositions and properties are manufactured each year. Some microplastics are manufactured to fulfill particular functions, such as industrial abrasives or in domestic cleaning and cosmetic products such as toothpaste.

"The formation of 'secondary' microplastics, by fragmentation of larger 'macro-size' debris, is influenced by a combination of environmental factors and the properties of the polymer."



the assessment scope:

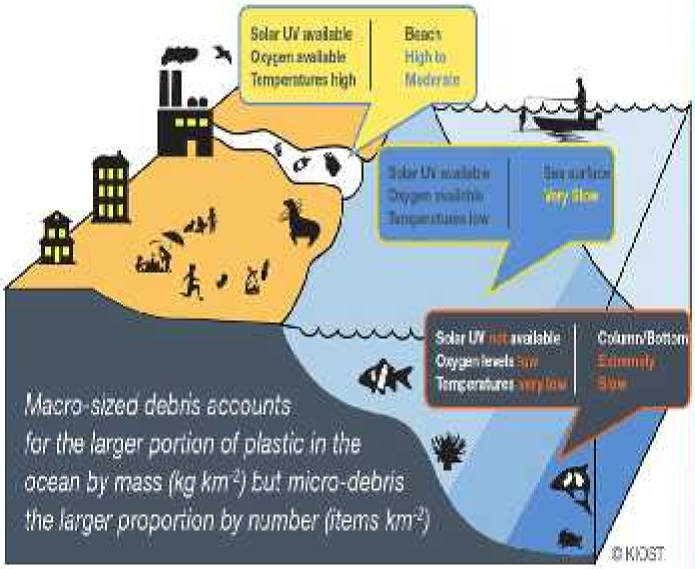
- key sources and types of microplastics
- weathering and fragmentation processes
- global distribution in the surface ocean using observations and circulation models
- physical and chemical effects on marine organisms
- social aspects, including public awareness
- key challenges and recommendations

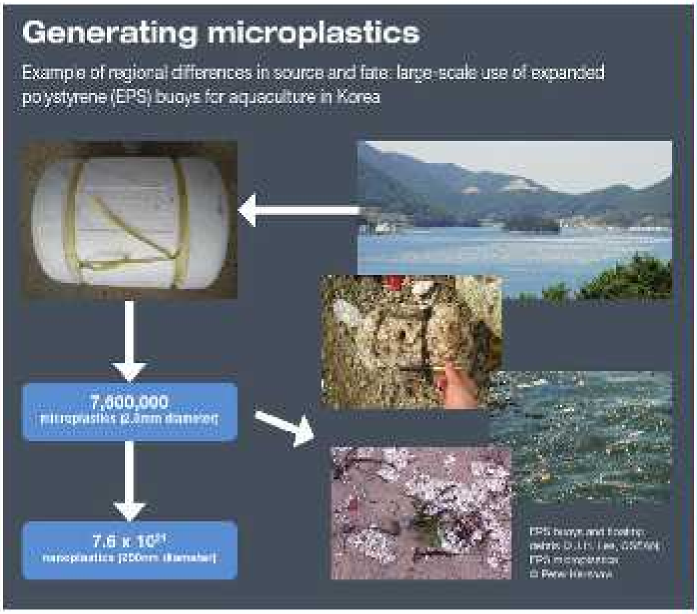
expertise:

- materials science
- marine ecology
- physiology
- ocean physics
- ecotoxicology
- chemistry
- science-policy
- public awareness and communication

Micro Plastics

The production of microplastics by the fragmentation of larger plastic items is most effective on beaches, with high UV irradiation and physical abrasion by waves. Once submerged, cooler temperatures and reduced UV means fragmentation becomes extremely slow.

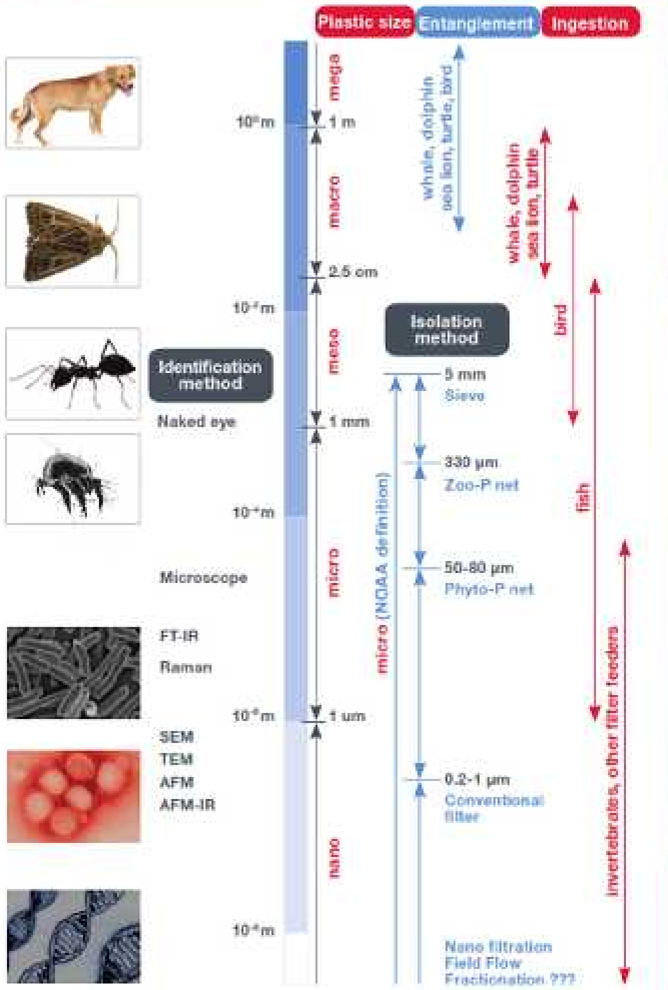




Size is Important

Different sizes of plastic particle or larger plastic objects need different types of equipment to sample them in the ocean and different analytical techniques in the laboratory. Size also determines the likely impact on ocean life and human activities such as fisheries.

Particles in the size range 1 nm to < 5 mm were considered microplastics for the purposes of this assessment.



Sampling and isolation:

- Mega- & macro -sizes — direct observation
- Meso-size — sieving
- Micro-size — towed plankton nets
- Nano-size — filtration

Direct external effects:

- Mega- & macro–sizes — (entanglement) whales, seals, dolphins, turtles, fish, birds
- Meso-size — unknown
- Micro-size — unknown
- Nano-size — unknown

Direct & indirect internal effects (ingestion):

- Macro–size — whales, seals, dolphins, turtles & birds
- Meso-size — birds, fish & invertebrates
- Micro-size — fish, invertebrates & other filter feeders
- Nano-size — invertebrates & other filter feeders

Action-orientated recommendations

Challenge 1

to reduce the entry of plastics and microplastics into the marine environment

Identify the main sources and categories of plastics and microplastics entering the ocean → **modelling, social and economic indicators, observations**

Challenge 2

overcoming social, technical & economic barriers

Utilise end-of-life plastic as a valuable resource as an important part of an overall waste reduction strategy → **promoting reduction, re-use and recycling & the circular economy**

Challenge 3

influencing perceptions and behaviour, to complement legislation

Promote greater awareness of the impacts of plastics and microplastics in the marine environment → **utilize expertise from the social sciences**

Recommendations to improve a future assessment

Challenge 4

assessing the risk from nano-plastics

Consider particles in the nano-size range when assessing the impact of plastics in the sea → **include expertise from a wider range of disciplines, including pharmacology and mammalian toxicology; encourage greater research focus, including method development**

Challenge 5

assessing the importance of plastics and microplastics as a vector for the transfer of organisms

Evaluate the potential significance of plastics and microplastics as a vector for organisms

Challenge 6

quantifying the chemical exposure risk from ingested microplastics

Evaluate the potential pathways and rates of chemical transfer and ecotoxicological risk → **include expertise on field & laboratory studies, animal behaviour, physiology and the gut environment for target species**

TCE ENVIS ACTIVITY

03 JAN → Handled GSDP Lecture on Plastic waste management at IIT Madras conducted by TN ENVIS, Chennai.

18 JAN → Guest Lecture by our Co-ordinator at PVI 2020 Global Sustainability Seminar in Mumbai.

28 JAN → Handled GSDP Lecture on Plastic waste management conducted by SULABH ENVIS RP, New Delhi.

06 FEB → Towards Green Road Mission Layed Plastic Tar Road at "The Study School", Pondicherry.

18 FEB → Handled Waste Plastic Awareness Program for school students at Thangalacherry Village.

07 MAR → Awareness Lecture and Survey on Single Use Plastic at Meenakshi College, Madurai.