RESEARCH ON MARINE MICROPLASTICS

Marine Plastic Research Inventory in the East Asian Seas

Analysis prepared by the Regional Project Team coordinated by the Centre for International Law (CIL) of the National University of Singapore (NUS)
Data Source: RRI 2.0 (additional references are also included)
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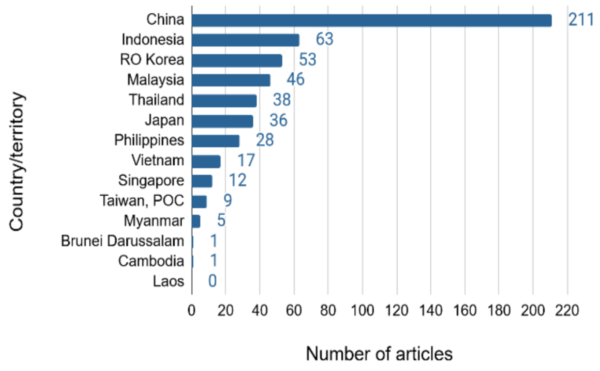
What are microplastics?

Microplastics are plastic particles less than 5 mm in size (GESAMP 2019). Based on their origin, microplastics can be categorised as (1) primary microplastics, which are intentionally manufactured for specific purposes (e.g. microbeads in personal care products, resin pellets, industrial abrasives), or (2) secondary microplastics, which are generated through degradation and fragmentation of larger plastics. Microplastics come in various shapes and morphologies, such as fibers, fragments, films, beads, and foams. Microplastics may also undergo further degradation and become nanoplastics (< 1 µm in size).

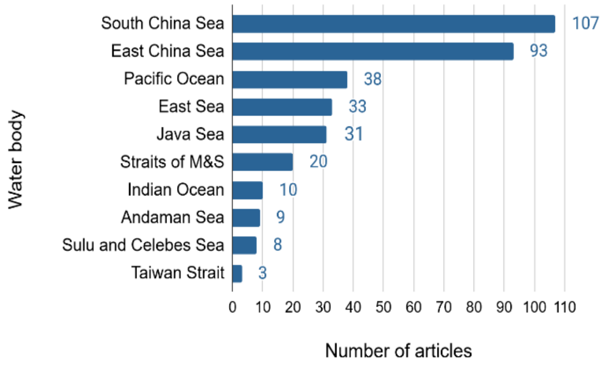
Profile of the research effort

The majority of plastic research conducted in the ASEAN+3 examined microplastics (462 out of 715 studies captured in RRI 2.0), with China having the highest number of papers (Fig. 1A). Most studies examined microplastics found in the South China Sea and the East China Sea (Fig. 1B). Close to 40% of the research papers included "Survey and monitoring/ pollution status" as a research topic, reflecting the ongoing intensive research in the region to obtain baseline information on the status of plastic pollution in different parts of the marine environment. Ecological and environmental impacts were investigated in about 20% of the studies, predominantly on the ingestion of plastic in the wild. Around 17% of papers studied aspects of plastic sources and pathways, mainly on the potential accumulation zones and the degradation process of plastics. The most frequently used approach in studying microplastics was field sampling (Fig. 1C). Water surface, shoreline sediment, and biota are the most frequently sampled compartments, while seagrass beds and coral reefs were the least frequently sampled compartments in the region (Fig. 1D).

(A) Publications that examined microplastics, per country/territory



(B) Publications that examined microplastics, by water body



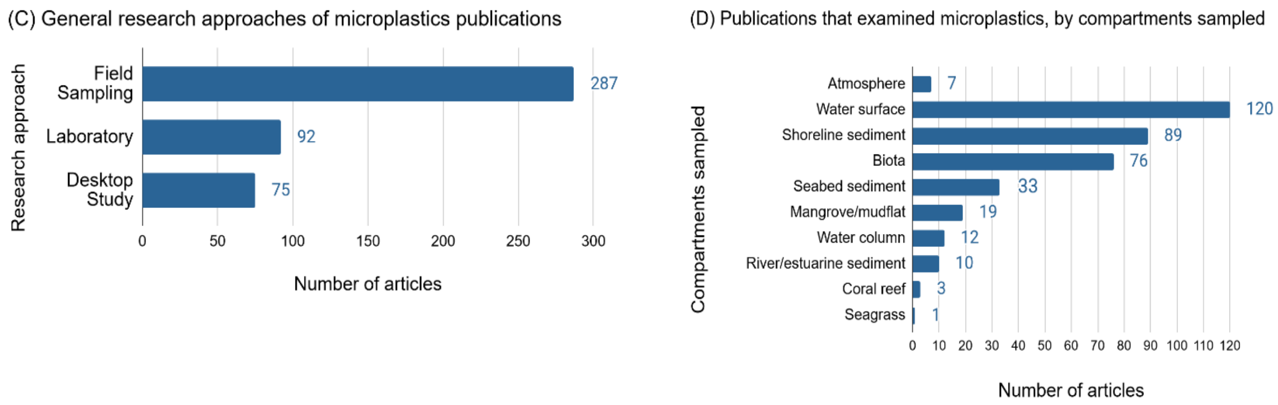


Figure 1. Total number of research papers on microplastics across (A) countries/territories, (B) water bodies, (C) research approaches, and (D) sampling compartments.

Sampling methods and challenges

Differences in sampling methodologies, laboratory protocols as well as reporting results prevent conducting a systematic and meaningful comparison of results. In terms of sampling methods, the most frequently used plankton mesh size to sample microplastics in the water column is 300 to 333 µm (Fig. 2A). The use of this mesh size range pre-determines the microplastic particles captured, and can result in an underestimation of the abundance of microplastics smaller than 300 µm. This also means that there is a general lack of monitoring of microplastics smaller than 300 µm.

For shoreline sediment sampling, in research publications where the information was reported, researchers most frequently collected sediment samples up to 5 cm depth, which is aligned with recommendations from most guidelines (e.g., MSFD 2013, GESAMP 2019). However, one-fifth of the research papers did not specify the sediment collection depth (Fig. 2B).

Contamination during laboratory processing has been highlighted as a critical issue in microplastic studies (Cowger et al. 2020, Prata et al. 2021). It is encouraging that an increasing number of studies have included quality assurance/control in recent years. Between 2020 and 2021, there were 90 out of 132 studies that included quality assurance/control protocols whereas only 110 out of 208 studies did so, between 2015 and 2019, showing a progress of 53% to 68% of the research papers, despite a substantial increase in research effort.

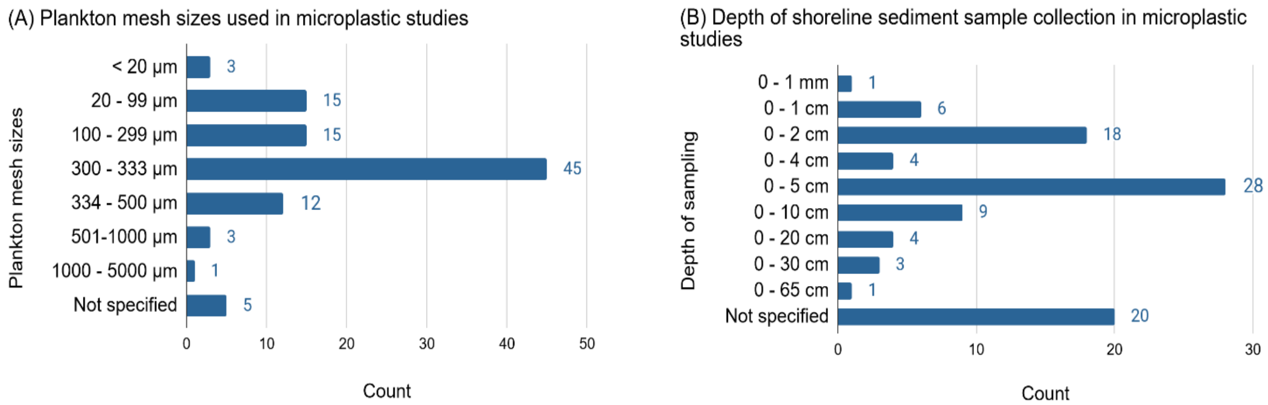


Figure 2. The (A) size ranges of plankton mesh used, and the (B) depth of shoreline sediment collected, as reported in microplastic research papers.

Findings on abundance and distribution

The most commonly reported microplastic shapes found were fragments (36.3%) and fiber (33.6%) and the most common polymer types reported were polyethylene (22.6%) and polypropylene (18.4%). The density of microplastics reported varied greatly across sample compartments and sites. For the water samples, the microplastic abundance ranged from 0.0005 particles m^{-3} in Cherating River, Malaysia (Pariatamby et al. 2020) to 172,000 particles m^{-3} in Saigon River, Vietnam (Lahens et al. 2018). For shoreline sediment, the microplastic abundance ranged from 0.58 particles kg^{-1} sediment in Sha Lo Wan Beach, Hong Kong (Lo et al. 2016) to >200,000 particles kg^{-1} sediment in Phala Beach, Thailand (Bissen and Chawchai 2020). For seabed sediment, the microplastic abundance ranged from 6 particles kg^{-1} sediment in Ticalan, Philippines (Espiritu et al. 2019) to 38,790 particles kg^{-1} sediment in Jakarta Bay, Indonesia (Manalu et al. 2017). It is important to note that these differences may sometimes be explained by differences in sampling tools and methodologies.

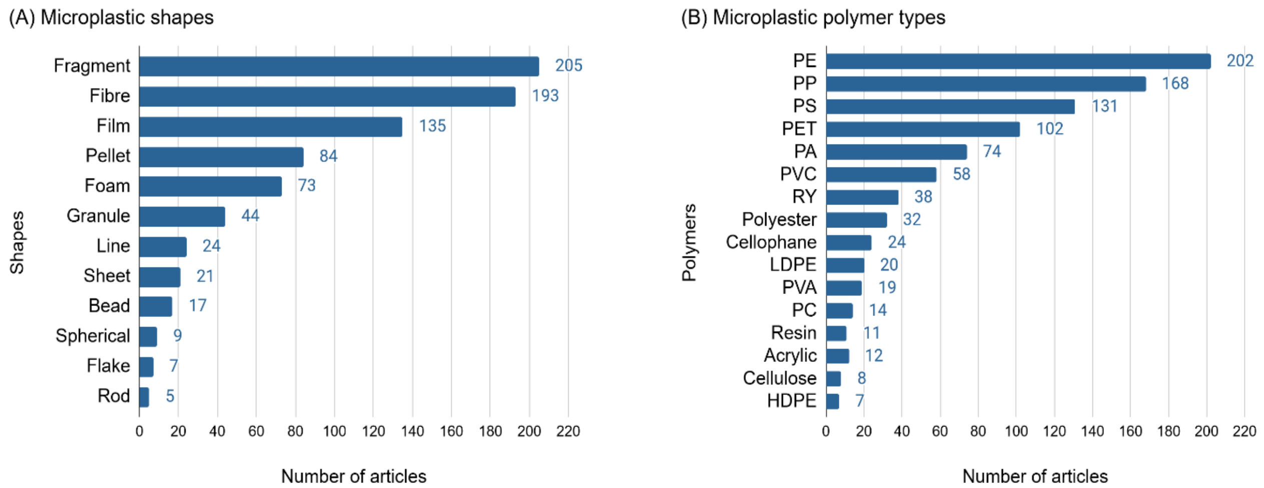


Figure 3. (A) Shapes and (B) polymer types reported in microplastic papers in the ASEAN+3 countries/territories.

Societal concerns and response

Prevalence of microplastics in marine organisms, including seafood such as fish, mussels, oysters, sea cucumbers, and shrimps, is another subject of emerging concern as this may potentially threaten food security and human health. While the effects of plastics on human health is not fully understood based on current state of knowledge (Campanale 2020), significant risks are highlighted in several studies (Barboza et al. 2018, Smith et al. 2018).

Growing concerns over the prevalence of microplastics in the marine environment and its impacts on aquatic life have resulted in the adoption of national regulations, including bans on microbeads. First introduced in the Netherlands, several countries including Australia, Canada, Italy, New Zealand, Sweden, the UK and the US have also banned plastic microbeads in cosmetics and personal care products (OECD 2021). Among the ASEAN+3 countries, the Republic of Korea is the only country that prohibits the use of microbeads in cosmetics since 2017. China has also announced plans to ban microbeads in cosmetic products and production of thin plastic bags (Reuters 2021).

Unanswered research questions

The source, fragmentation, and transport processes of microplastics in the marine environment remains poorly understood. It is hypothesized that microplastics are more abundant in the near-coast areas, but differences in sampling methods, processing protocols, and units of which the results were reported hinder this factsheet from firmly drawing that conclusion. Key marine habitats such as coral reefs and seagrass beds are poorly sampled (8 articles in RRI 2.0 examined seagrass or coral reef habitats, out of 702 articles), resulting in a knowledge gap regarding the extent of microplastic pollution in critical habitats for the region.

Bivalves such as mussels and oysters have been proposed as species to be sampled as an indicator of the concentration of microplastics in the marine environment Li et al. 2019, Ding et al. 2021). This proposal is based on the fact that they have widespread distribution, uptake microplastics directly from the environment, and are consumed by humans. Several species of bivalves are already widely used as a bioindicator of concentration in persistent organic pollutants (POPs). However, a study by Ward et al. (2019) suggests that bivalves may not be the best microplastic bioindicator species because they selectively filter only certain microplastics and microplastics are readily expelled from their bodies within short time scales. Further studies are therefore needed to further investigate the suitability of these or other species as indicator species of concentration in microplastics. Standardised methodology for the sampling of such indicator species would also be needed.

References:

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