Qualitative assessment microlitter in the OSPAR area with a focus on microplastics

1. Introduction

Plastics are valuable resources with numerous societal benefits. Worldwide plastics production reached about 367 million tons, a slight decrease of 0.3% compared to 2019. Despite the Covid-19 pandemic, global levels of production and demand for plastics remain stable, while Europe shows a decline due to the direct impact of the pandemic (PlasticsEurope, 2021). It has been estimated that between 4.8 and 12.7 million tons of plastics enter the marine environment annually from land with rivers as main pathways (Jambeck *et al.*, 2015; Lebreton *et al.*, 2017), causing plastics to form a large proportion of marine litter. A large part of this plastic litter consists of microplastics typically referred to 'synthetic water-insoluble polymers of 5 mm or less in any dimension' (ECHA, 2018).

2. Sources of microplastics in the OSPAR area

Microplastics have been reported for sediments, water and biota globally including across the OSPAR area. Sources of microplastics are varied and often difficult to identify due to their dynamic transport in the terrestrial, freshwater and marine environment and are mainly classified as land and sea-based sources (Figure 1). Land-based sources have been generally assumed to be the main contributors for the entry of plastic waste to the marine environment (Gilardi *et al.*, 2020; Meijer *et al.*, 2021), although sea-based sources are also recognised as an important contributor in the OSPAR region (GESAMP, 2021). For the OSPAR catchments, tyre wear and (macro) litter (breaking down in smaller pieces) were identified as the largest land-based sources of microplastics with estimated amounts of around 100,000 tons year^{-1} (OSPAR, 2017). Sea-based activities also contribute to the global burden of microplastics including fishing, aquaculture, shipping, ocean dumping and other marine activities (Figure 1). To date, estimates of the total contribution of sea-based sources to the OSPAR area is not possible due to the limited available quantification of marine litter inputs from the scientific, peer-reviewed and grey literature (Gilardi *et al.*, 2020).

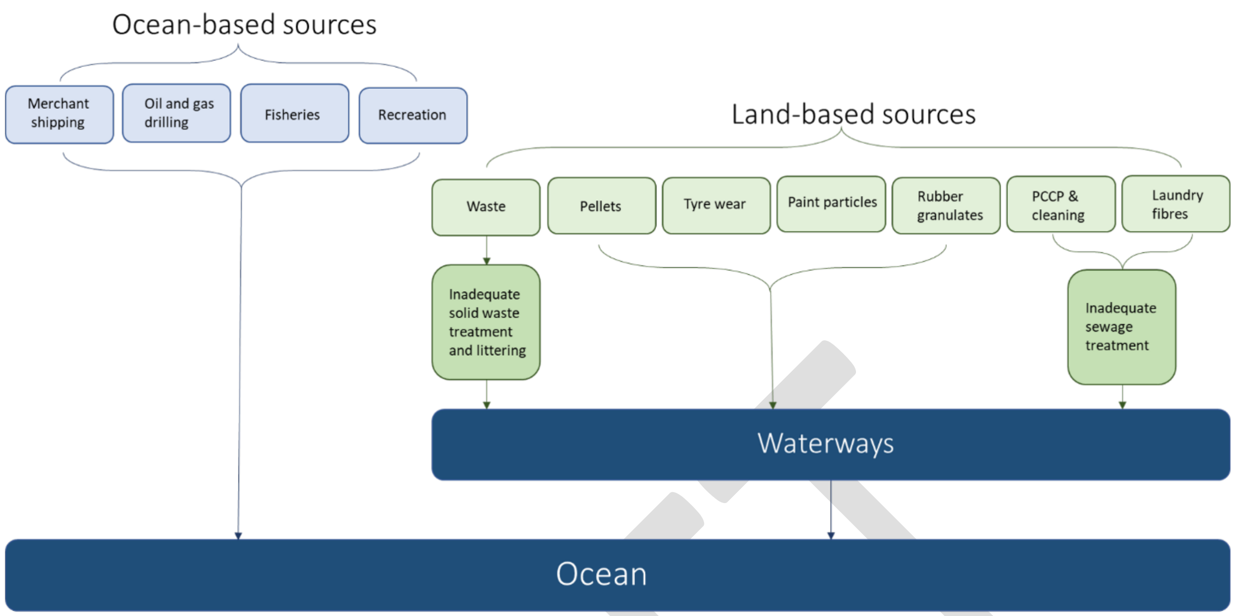

Figure 1. Overview of sources and pathways of microplastics to the marine environment.

3. Occurrence and abundance of microplastics in the OSPAR area

While monitoring data for microplastics are limited for the OSPAR Maritime Area, some data are available on the abundance of microplastics for sediments (seafloor, subtidal, beach and estuaries), surface and near-surface waters, water column and biota for various locations. Lack of standardised analytical and reporting protocols make comparisons between datasets difficult. International efforts are currently being focused on the production of guidelines at national and international levels to produce monitoring data which can be used for national, regional and sub-regional assessments. Microplastics have been reported for all the environmental compartments assessed (sediments, water, and biota) for the OSPAR regions (I: Arctic Waters, II: Greater North Sea, III: Celtic Seas, IV: Bay of Biscay and Iberian Coast and IV: Wider Atlantic). A knowledge gap in monitoring data was identified for region V with a lower number of available studies reporting the abundance of microplastics for the area. Reported concentrations of microplastics varied greatly according to the environmental compartment targeted and across locations.

i. Microplastics in surface-, near-surface waters and the water column

Microplastics in surface and near-surface waters were reported for the Arctic waters, Greater North Sea, Celtic seas, Bay of Biscay, Iberian Coast and for the Wider Atlantic. Very high concentrations of microplastics were reported for the Arctic water column (9-1,287 items m^{-3} (Tekman *et al.*, 2020)). Higher concentrations of floating microplastics were also reported for the North Sea (max. 245.4 items m^{-3} (Lorenz *et al.*, 2019) and the Wider Atlantic (corresponding to the European offshore and Azores) (mean concentration of ~ 190 items m^{-3} (Enders *et al.*, 2015).compared to other OSPAR regions. Reported concentrations by Enders et al. (2015) were substantially higher than the concentrations reported by Lusher at al. (2014) for the same region with a mean reported concentrations of ~ 5 items m^{-3}. Variations in reported concentrations was however attributed to differences in sampling strategies rather than variations in microplastics concentrations for the area (Enders *et al.*, 2015). Reported polymer types appeared to be consistent across regions with a prevalence of PE and PP and polyester. Main reported type of microplastics were fibres and fragments.

ii. Microplastics in marine biota

Microplastics have been reported for a wide range of organisms ranging from invertebrates (e.g. marine worms (Van Cauwenberghe *et al.*, 2015), to mussels and crustaceans to fish (e.g. Lusher *et al.*, 2013) to larger organisms (e.g. sharks (Maes *et al.*, 2020) and mammals (Nelms *et al.*, 2019; Zantis *et al.*, 2020). Microplastics in biota were mainly reported for regions I, II, III and IV with limited information for region V. The wide range of reported organisms indicated the widespread occurrence of microplastics for a range of trophic levels. Concentration of ingested microplastics varied greatly according to organism investigated and across locations. Reported polymer types appeared to be consistent across regions with a prevalence of PE, PP and polyester. Main reported type of microplastics were fibres, followed by fragments.

iii. Microplastics in sediments (beach, estuarine, subtidal and seafloor)

To date, only a few studies have focused on the occurrence of microplastics in seafloor sediments with most studies focusing on beach and subtidal compartments. Despite the variation in applied extraction and analytical techniques, there is a clear agreement that microplastics are present for sediments across the OSPAR area (available data for regions I-V) acting as potential sinks (Leslie *et al.*, 2017; Maes *et al.*, 2017; Lorenz *et al.*, 2019). Microplastics were reported for deep sea sediments from the Arctic (42-6,595 particles kg^{-1} dry weight sediment (Bergmann *et al.*, 2017)) which was substantially higher than the maximum concentration of microplastics reported in seafloor sediment for the North sea (3,146 and 3,600 particles kg^{-1} dry weight sediment reported by Maes *et al.*, 2017 and Leslie *et al.*, 2017, respectively). North Sea sediments were also considerably more contaminated than surface waters (Lorenz *et al.*, 2019). Reported polymer types appeared to be consistent across regions with a prevalence of PE, PP, PS, PVC and polyester. Main reported type of microplastics were fibres, followed by fragments.

4. Summary and conclusions

Despite the absence of harmonised protocols for the analysis of microplastics in environmental samples, there is a common consensus that microplastics are widely present in the marine environment. Microplastics have been reported in sediments (beach, estuarine, subtidal and seafloor), surface waters, water column and in biota for the OPSAR region at different levels. The lack of applied standardised sampling and analytical protocols for the monitoring of microplastics makes, however, the comparison between datasets difficult and a fully integrated qualitative assessment was not feasible.

There is, therefore, an urgent need to develop and adopt common indicators for the monitoring of microplastics for the OSPAR area. Seafloor sediments have been identified as likely sinks for microplastics in the marine environment (Woodall *et al.*, 2014). Work is currently on-going to develop guidelines for their monitoring for the OSPAR area allowing for future spatial and temporal assessments, better integration with monitoring of other contaminants as well as understanding subsequent risks to marine life and impacts on key environmental processes (e.g., global nutrient cycle and oxygen levels in the ocean (Kvale *et al.*, 2021)).

5. References

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