GSDR 2015 Brief

Marine Litter: Microplastics

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Introduction

The problem of marine litter was recognized by the UN General Assembly, which in its Resolution A/60/L.22 - Oceans and the Law of the Sea - of 29 November 2005 in articles 65-70 calls for national, regional and global actions to address the problem of marine litter. In response to the GA call, UNEP (GPA and the Regional Seas Programme), through its Global Marine Litter Initiative took an active lead in addressing the challenge, among others, by assisting 11 Regional Seas around the world in organizing and implementing regional activities on marine litter.

The outcome document 'The Future we want' of the United Nations Conference on Sustainable Development in Rio+20 in 2012 particularly mentioned the threat of plastics for the marine environment. Paragraph 163 can be read as followed: *We note with concern that the health of oceans and marine biodiversity are negatively affected by marine pollution, including marine debris, especially plastic, persistent organic pollutants, heavy metals, and nitrogen-based compounds, from a number of marine and landbased sources, including shipping and land runoff. We commit to take action to reduce the incidence and impacts of such pollution on marine ecosystems, including through the effective implementation of relevant conventions adopted in the framework of the International Maritime Organization (IMO), and the follow up of the relevant initiatives such as the Global Programme of Action for the Protection of the Marine Environment from Landbased Activities, as well as the adoption of coordinated strategies to this end. We further commit to take action to, by 2025, based on collected scientific data, achieve significant reductions in marine debris to prevent harm to the coastal and marine environment*.

Scientific background

Plastics have become indispensable 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 (e.g. Ivar du Sol and & Costa 2014). 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.

Microplastics are distributed throughout the ocean, occurring on shorelines, in surface waters and seabed sediments, from the Arctic to Antarctic (GESAMP 2010, UNEP 2014). They may accumulate at remote locations such as mid-ocean gyres, as well as close to population centres, shipping routes and other major sources (GESAMP 2010).

There are two principle sources of micro-plastic particles. Primary microplastics which includes plastic pellets and plastic particles manufactured for particular applications, such as cosmetic products and abrasives, and secondary microplastics produced as a result of fragmentation from larger items. 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 (GESAMP 2014).

Scientists are especially concerned about microplastics because it is well documented (GESAMP 2010, UNEP 2014) that plastic litter causes physical harm to marine mammals, fish and invertebrates and instances of death by entanglement, asphyxiation or blockage of organs are common. It is also known that plastic particles tend to accumulate persistent, bioaccumulating and toxic contaminants such as PCBs,

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DDT and PBDEs (e.g. Ivar du Sol and & Costa 2014, Ogata et al. 2009). Microplastics have larger surface to volume ratios, potentially facilitating contaminant exchange and have been shown to be ingested by a range of organisms (GESAMP 2010). While recent modelling studies show that the flux of contaminants associated with micro-plastics to remote areas is small compared with that from oceanic and especially long-distance atmospheric transport processes, the problem is that plastics with their accumulated contaminant load are directly ingestible by organisms (GESAMP 2014). Particles, including microplastics have recently been found in the circulatory systems and other tissues of filter feeding organisms such as the blue mussels following experimental exposure, i.e. in organisms low down in the food-chain. These particles caused typical inflammatory responses (GESAMP 2014).

Very small (nano-size) microplastics have been shown to cross cell membranes, under laboratory conditions, causing tissue damage (GESAMP 2014). Whether the presence of acid conditions or surface active digestive substances in the guts of such marine organisms can desorb and release contaminants in significant quantities to cause such effects, or whether such a response is to their physical presence or both, still remains to be answered. Microplastics have larger surface to volume ratios, potentially facilitating contaminant exchange and have been shown to be ingested by a range of organisms making contaminant transfer more likely.

In general the scientific community agrees that, that the public and private sector awareness of the potential negative ecological, social and economic impacts of microplastics is much less developed than for macro-litter (UNEP yearbook 2014).

Effective engagement and education at all levels of society (public, government and private sector) is an essential tool to raise awareness and promote positive behavior change. Existing tools, guidance, as the Honolulu Strategy, prepared under the auspices of UNEP and NOAA in 2011 (UNEP/NOAA 2011), could be used as a framework for a comprehensive and global effort to reduce the ecological, human health, and economic impacts of plastics, involving the full spectrum of civil society, government and intergovernmental organizations, and the private sector.

Future actions and recommendations (as in GESAMP 2014)

The threat of plastics and especially microplastics entering the marine environment require targeted actions.

In order to reduce the entry of plastics and microplastics into the marine environment, the main sources and categories of plastics and microplastics entering the ocean have to be identified, locally and globally. There is a clear need to improve the

Sources of plastic litter in the ocean (including micorplastics) – Direct and indirect internal effects ingestions (GESAMP 2014, UNEP yearbook 2014)

Sea-based sources:
- *Merchant shipping – rope, galley waste*
- *Fishing – nets, boxes, rope, wrapping bands, galley waste*
- *Aquaculture – nets, floats, rope*
- *Offshore oil and gas platforms – galley waste, sewage-related*
- *Cruise ships – galley waste, sewage-related*
- *Recreational boating – galley waste, sewage-related*

Land-based sources include:
- *Coastal tourism – packaging, cigarette filters*
- *Population centres – sewagerelated, storm drains, street litter*
- *Horticulture/agriculture – plastic sheeting, tubing*
- *Poorly controlled waste sites and illegal dumping – all waste types*
- *Industrial sites – plastic production and conversion, packaging*
- *Ship-breaking*

Direct & indirect internal effects (ingestion):
Macro–size (2.5 – 100 cm) - – whales, seals, dolphins, turtles & birds
Meso-size (1 mm – 2.5 cm) – birds, fish & invertebrates
Micro-size (1 µm – 1 mm) – fish, invertebrates & other filter feeders
Nano-size (<1 µm) – invertebrates & other filter feeders

modelling of distribution patterns, to establish social and economic indicators and observations.

In the future we have to overcome social, technical and economic barriers, major paths could be the utilization of end-of-life plastic as a valuable resource as an important part of an overall waste reduction strategy, the promotion of reduced plastics use, as well as the re-use and recycling and implementing of closed circles of use in industries.

But to achieve societal change and to complement existing legislation, there is a clear need to influencing perceptions and behavior. The scientific community has to promote greater awareness of the impacts of plastics and microplastics in the marine environment and has to include the expertise from the social sciences.

But not only the legislations has to become improved, there are still several knowledge gaps, which have to be filled.

Current knowledge assessing the risk from nanoplastics is insufficient. To obtain the information on whole plastics threaten the ocean, the effects on nano-size range particles have to be considered as one major risk to marine life.

The role of plastics and microplastics to act as a vector for the transfer of organisms is another possibility has to be evaluated.

In addition the scientific community is asked to advance in quantifying the chemical exposure risk from ingested microplastics and to evaluate the potential pathways and rates of chemical transfer and ecotoxicological risk, which causes a higher invest in local expertise on field and laboratory, to conduct more studies on animal behavior, physiology and the gut environment for target species.

To promote the threat of microplastics at the UN level and stimulate the scientific process IOC-UNESCO and UNEP are the main sponsors of the Working Group 40 of GESAMP on 'Sources, fate and effects of micro-plastics in the environment'. GESAMP is the United Nations mechanism for collaboration and coordination which conducts assessments and in-depth studies to evaluate the state of the marine environment, including socio-economic aspects, and identify emerging issues. Under IOC-UNESCO's coordination the working group conducted so far two assessments, which inform on the threat of plastics in the ocean in more detail (GESAMP 2010, GESAMP 2014).

References:

GESAMP -IOC, Paris(France); IMO/FAO/IOC/WMO /UNIDO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection. (2014) Microplastics in the ocean

GESAMP -IOC, Paris(France); IMO/FAO/IOC/WMO /UNIDO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection. (2010). Proceedings of the GESAMP International Workshop on micro-plastic particles as a vector in transporting persistent, bio-accumulating and toxic substances in the oceans. (82).

Ivar do Sul, J. A., & Costa, M. F. (2014). The present and future of microplastic pollution in the marine environment. Environmental Pollution, 185, 352-364.

Ogata, Y., Takada, H., Mizukawa, K., Hirai, H., Iwasa, S., Endo, S., Mato, Y., Saha, M., Okuda, K., Nakashima, A., Murakami, M., Zurcher, N., Booyatumanondo, R., Zakaria, M.P., Dung, L.Q., Gordon, M., Miguez, C., Suzuki, S., Moore, C., Karapanagioti, H.K., Weerts, S., McClurg, T., Burres, E., Smith, W., Van Velkenburg, M., Lang, J.S., Lang, R.C., Laursen, D., Danner, B., Stewardson, N., Thompson, R.C., (2009). International Pellet Watch: Global monitoring of persistent organic pollutants (POPs) in coastal Waters. 1. Initial phase data on PCBs, DDTs, and HCHs. Mar. Pollut. Bull 58, 1437–1446.

UNEP yearbook 2014 (2014)Smith, Chapter 8: Plastic debris in the ocean.

UNEP/NOAA (2011). The Honolulu strategy: a global framework for prevention and management of marine debris. The United Nations Environment Program (UNEP), Nairobi, Kenya, and National Oceanic and Atmospheric Administration (NOAA) Marine Debris Program, Silver Spring, Maryland, USA.