Regional Activity Centre
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PLASTICS IN THE OCEANS AND ITS HAZARDS: THE NEED FOR URGENT PREVENTIVE MEASURES

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Even with the political willingness and the necessary financial resources, achieving full sound environmental management of urban waste and minimizing plastic leaks into rivers and oceans in most of the countries of the world is deemed to be a decades-long process. The expected increase in the global production of plastics in the short term, the already existing scientific evidence of harmful effects of persistent plastics and its chemical additives to marine biota and its biomagnification in the food chain, and the health and economic impact of exposure to harmful chemicals present also in plastics like POPs and EDCs, makes the adoption of policy measures to curb the demand of persistent plastics in the short term an urgent necessity, like measures on plastic bags and microbeads in personal care products and the introduction of environmental levies on single-use disposable plastic items made of non-biodegradable polymers and other preventive measures like to boost the substitution of harmful chemicals in the production of plastics, and to stimulate the demand of certified biodegradable bioplastics in food packaging and plastic bags, especially those degradable in the marine environment.

Marine debris is mainly composed by plastics, microplastics and nanoplastics coming mainly from the degradation by different mechanisms of plastic packaging leaked into the sea - bags, bottles, etc. - plastic pellets from industrial production and plastic microbeads that can be found in items as cosmetics and toothpaste, and affects beaches, sea surface, water column, sea floor and sediments. Its persistence in the marine environment is estimated in decades or even hundreds of years, and it is demonstrated by different studies the ingestion of microplastics by marine biota, thus representing a direct threat to fish populations, marine biodiversity richness and to human health. [1,2 3]

It is estimated that 80 percent of ocean plastic comes from land-based sources rather than ocean-based sources such as fisheries and fishing vessels. Of that 80 percent, three-quarters comes from uncollected waste due to the lack of proper waste management facilities in the municipalities in many countries, and the remainder from careless littering and leaks from within the waste management system itself (like urban drains).[3]

Besides the adverse physiological effects to marine organisms that represents the ingestion of pieces of plastic, plastics in the marine environment pose a double chemical hazard: On the one hand, they may have toxic components in their matrix[4] –intentionally added or

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[1] The physical impacts of microplastics on marine organisms: A review. Stephanie L. Wrighta et al. Environmental Pollution, July 2013

[2] Marine Litter Assessment in the Mediterranean. UNEP/MAP, 2015

[3] Stemming the Tide: Land-based strategies for a plastic-free ocean. McKinsey Center for Business and Environment, 2015

[4] Microplastics in marine environments: Occurrence, distribution and effects. Inger Lise Nerland et al. Norwegian Institute for Water Research, 2014.

unintentionally as trace monomers-, like persistent organic pollutants (POPs such as brominated flame retardants BFRs) and other chemicals with endocrine disruptor activity (EDCs) which may leach into the environment when the plastic weathers or by ingestion ; and on the other hand they have a tendency to adsorb chemical compounds that may be present as trace contaminants in the media, like polychlorinated biphenyls (PCBs), DDT and polyaromatic hydrocarbons (PAHs), and from there be transferred via digestive fluids to the tissues of marine organisms[5] by ingestion, thus increasing the total transfer of those toxic chemicals already present in the marine environment to the biota.

There is already scientific evidence of endocrine disruptor activity by the intake of microplastics via the filter-feeding mechanisms of animals like mussels or baleen whales [23], or via the magnifying effect of the food chain[6] in top predators like the swordfish.

The harmful effects of EDCs may be already present at extremely low doses- as most of them mimic natural steroid hormones[7]- which represents a serious hazard to the marine fauna- its biodiversity and its population- and to the human health. Many POPs that may be present in plastics like BFRs, PFOA, etc., apart of its own toxic properties have ED properties as well. Other EDCs may not present persistent properties in the long term, but the continuous flow of "fresh" plastic products and also of wastewater and sediments which may contain microplastics and these chemicals coming from urban and industrial waste water treatment plants[4], may represent an activity level comparable to that of POPs.

As a result, those substances found on marine environment and on plastic waste globally, bioaccumulate in food webs and are linked with several adverse effects including endocrine disruption, decreased fish populations and reduced species evenness and richness.[5 8 9 10 11]. This can have a serious economic impact in the long term by exacerbating poverty in countries/islands where fish is a staple food.

Main consequences from hormone disruption in animals caused by EDCs are [7, 12]:

- Decreased fertility.
- Weakened immune systems.

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[5] Transport and release of chemicals from plastics to the environament and to wildlife. Teuten et al. Philosophical Transactions of the Royal Society, 2009.

[6] Do endocrine disrupting chemicals threaten Mediterranean swordfish? Preliminary results of vitellogenin and Zona radiata proteins in Xiphias gladius. M. Cristina Fossi et al., 2001.

[7] EDCs effects are studied within the field of endocrinology, not classical toxicology.
Endocrine-Disrupting Chemicals: An Endocrine Society Scientific Statement. Diamanti-Kandarakis E et al. 2009

[8] Ingested plastic transfers hazardous chemicals to fish and induces hepatic stress, Rochman et al. Scientific Reports, 2013.

[9] Hirai, H. Et al. Organic micropollutants in marine plastic debris from the open ocean and remote urban beaches. Mar. Pollut. Bull, 2011

[10] McKinley et al. Impacts of contaminant sources on marine fish abundance and species richness: a review and meta-analysis of evidence from the field. Mar. Ecol. Prog. Ser. 2010

[11] Johnston et al. Contaminants reduce the richness and evenness of marine communities: A review and meta-analysis. Environ. Pollut. 2009

[12] Special report on environmental endocrine disruption: an effects assessment and analysis, prepared for the Risk Assessment Forum U.S. Environmental Protection Agency, 1997
The impacts of EDCs on wildlife, people and their environments. UNEP / WHO report, 2012

- Sexual disorders (feminisation of male fish, birds and mammals and the reverse).
- Deformities.

They have been linked as well with increasing incidence of certain types of cancer like breast and prostate cancers in humans and neurological disorders like autism and ADHD [7, 8]

EDCs are present in many everyday products, including soft plastics (phthalates, tribromophenol, bisphenols, UV filters,…), rubber (resorcinol, triphenyl phosphate..), electronics and textiles (PFOS, BFRs..) and cosmetic products (parabens..). [11]

The SIN (Substitute It Now!) List[13], developed by ChemSec, identifies 32 EDCs of high concern which would require immediate action towards substitution, and 14 more chemicals with ED properties and additional hazardous properties as well. A more comprehensive list of chemicals with ED properties can be found at the document "A Compilation of Lists of chemicals Recognised as Endocrine Disrupting Chemicals (EDCs) or Suggested as Potential EDCs", International Panel on Chemical Pollution (IPCP), 2016. [14]

According to a series of studies released by the Endocrine Society in 2015, current exposure to EDCs costs only to the EU €157 billion annually[15]. Without immediate action, the environmental impacts and the economic costs is due to getting much worse in the short term: according to the business projections figures of the plastic companies, it is predicted that the global quantity of plastic in the ocean will nearly double to 250 million metric tons by 2025 [16]— or one ton of plastic for every three tons of fish.

On average, plastic consumption reached 100 kg per person and year in Western Europe and North America, and 20 Kg in Asia [17], and these figures are expected to grow rapidly as urban population increases globally (specially in developing countries) and urban dwellers must typically purchase all of their (packaged) food and beverage. The strongly increasing global tendency of plastic production and consumption makes extremely uncertain to achieve already stablished objectives of reduction of marine litter at national or regional levels[18 19 20.]

The case of the Mediterranean Sea is specially worrying: it is by far the most marine litter affected Sea of the world, due to its semi-closed nature and by its heavily populated coastal

[13] http://chemsec.org/publication/endocrine-disruptors,reach,sin-list/the-32-to-leave-behind-edcs-relevant-for-reach-2015/

[14] http://www.unep.org/chemicalsandwaste/SAICM/EndocrineDisruptingChemicals/tabid/130226/Default.aspx

[15] Estimating Burden and Disease Costs of Exposure to EDFCs in the EU. Journal of Clinical Endocrinology and Metabolism (2015).
Health costs in the EU. How much is related to EDCs? Health and Environmental Alliance (2014)

[16] Jenna R. Jambeck et al. "Plastic waste inputs from land into the ocean," Science, 2015

[17] Global Plastic Production Rises, Recycling Lags. Gaelle Gourmelon. Worldwatch Institute, 2015

[18] The Honolulu Strategy, the global framework to prevent marine litter, does not prescribe specific marine debris reduction targets but expects "substantial progress" by 2030. The UN's Sustainable Development Goal number 14 (Sustainable Oceans) aims to "prevent and significantly reduce" marine litter in 2025. In the European Union, a 30% reduction for beach litter by 2025, compared with 2015 levels, has been proposed for all its regional seas.

[19] Marine Litter study to support the establishment of an initial quantitative headline reduction target. ARCADIS & EUCC. DG Environment, 2013.

[20] The Trouble with Targets and the Merits of Measures. EUNOMIA, 2016

areas, with a lack of basic environmentally sound urban waste management infrastructures in many of its countries, a problem which is also common to most countries of the world.

Urgent actions needed at global level: Policy reforms, Levies and Prevention measures

Although there is still need to carry out focused scientific research to fill the knowledge gaps about the impacts of plastic litter in the marine environment, the food chain and human health, there is already scientific evidence to support actions with immediate impact in the short term [21] [22] [23], like policy reforms addressing the banning of plastic bags, the microbeads in personal care products and levies on single-use disposable plastic items made of non-biodegradable polymers. Even with the political commitment and the predictable great amounts of financial resources required to invest in waste management facilities and waste management collection, achieving full environmentally sound management of urban waste may be a decades-long process even in developed countries, so radical policy actions to curb plastic packaging on the demand side on the short term, or to increase in the very short term the collection rate of plastic waste - like the deposit-refund schemes for plastic beverage bottles which have a demonstrated high rate of success in different countries- are strongly needed at national or regional level.

Taking in mind that it would be unrealistic to pretend the elimination of plastic packaging consumption- the plastic items most likely to end up in the oceans-, due to the benefits that they represent for the society in terms of convenience, hygiene, preservation of food, etc.-, working with companies, especially in the food sector, to promote innovation and technology transfer via ecodesign to avoid persistent plastics in their packaging and the sound chemical substitution of POPs and EDCs in their packaging and products -avoiding by all means regretful substitutions-, and the promotion of the use of certified biodegradable bioplastics for food packaging, especially in the marine environment, are avenues of work on sustainable consumption and production that should be fully explored and implemented in the short and medium term by the public and private sectors. Although a biodegradable bioplastic labelling should not be by any means regarded by the consumer as a license for littering, its potential impact in case of leaking into the sea is expected to be denial when compared with persistent plastics or plastics with toxic additives. [24]

The legitimate concern of generating a new problem by promoting biodegradable bioplastics, like the high food cost problem that was triggered by setting too ambitious binding targets for

[21] Precautionary principle by virtue of which where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation

[22] The Pelagos Sanctuary for Mediterranean marine mammals: Marine Protected Area (MPA) or marine polluted area? The case study of the striped dolphin. Maria Cristina Fossi et al., 2013

[23] Are baleen whales exposed to the threat of microplastics? A case study of the Mediterranean fin whale. Maria Cristina Fossi et al, 2012

[24] Further research is needed in the field of bioplastics, like to find more materials being degradable in marine environments -such as polyhidroxyalcanoates (PHAs)-; to develop a standard properly describing the biodegradation in marine waters; and the potential environmental impacts of the whole life cycle of the different types of biodegradable and compostable plastics, its ingestion by biota, their potential capacity to adsorb chemical pollutants, and their decomposition mechanisms and rates in different marine environments.

replacing petro-fuels by bio-fuels, thus creating competition between crops for bio-fuels and crops for food production, should be thoroughly addressed by the scientific, industrial and policy makers communities, but it should be taken into account that the scale of the problem is not by any means comparable, as plastic packaging production only consumes around 4% of the petrol produced[25], while petrol consumed for fuels manufacturing represents around 80% of the global demand of petrol[26]. Furthermore some crops used for bio-plastics production only use part of the plant (like the pod in the rapeseed), while the rest of the vegetal and the waste after extracting the oil can be used as livestock feed and soil fertilizer, which increases circular economy, job creation opportunities and helps to mitigate climate change.

[25] Plastics: the facts. PlasticsEurope, 2015. Plastic packaging represents the 39% of the total plastic production in Europe, and plastics for agriculture around 3%.
[26] Wikipedia, consulted on September 2016