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On the Challenge of Plastic Wastes and Litter in Oceans: Some Policy Reflections

Shailesh Nayak*
National Institute of Advanced Studies, Bengaluru, India

Abstract. The increasing pollution in oceans, especially of the plastics litter, has degraded health of the oceans in many parts of the world. As plastic degrade very slowly, its accumulation in oceans expected to rise exponentially in coming decades and critically affect marine ecosystems, ocean fauna and humans. Microplastics, generated due to mechanical breakdown of plastic waste, is particularly affecting the pelagic ecosystems and can even alter them. It is necessary to generate and update scientific knowledge about production, transport, sinks of plastics and their impacts, develop innovative approaches to manage plastic waste, and bringing awareness about effects of plastic pollution to communities. The issue of plastic pollution needs be tackled at local as well as regional levels through effective policy and multi-national cooperation.

Keywords: Marine plastics, microplastics, ecosystem impacts, waste management, communication

1. Introduction

Oceans provide ecosystem services and goods for human well-being, such as food, livelihoods and recreational opportunities as well as play a vital role in regulating weather and climate, and influencing hazards. However, land-based activities, related to human settlements, industries and agriculture, discharge municipal waste, effluents and nutrients, respectively, and affect coastal and marine ecosystems. Marine litter also impacts overall ocean's health and thus affect fisheries at local and regional scales. The main issue is an increasing amount of plastic waste, both on land and sea, as it can take decades to centuries to degrade. In view of impact of plastic waste on global oceans, the UN Sustainable Development Goals 14 (Goal 14 | Department of Economic and Social Affairs (un.org)), has specified the need for reducing marine litter, specifically microplastics by 2025. It has been proposed that marine plastic waste may be regarded as a "common concern" that needs to be responded by the global community.[1] Innovations are required to prevent and mitigate marine plastic pollution.

The mass production of plastics began about 70–80 years ago and today its use has increased exponentially and correspondingly, its waste. Plastics are found everywhere, from land to coast to deep sea. Jambeck and co-workers[2] have estimated that out of 275 million metric tons (MMT) plastic waste generated every year due to land-based activities in 2010, about 4.8 to 12.8 MMT found its way to ocean. As plastic waste takes long time to degrade, huge amount of plastics has already accumulated in oceans and will continue to increase in future. India having coastal population of about 190 million, contributes about 1.8 % of these plastic waste to ocean, one of the lowest in the world, while China contributes about 27.6 %.[2] However, in India and many other countries, the major issue is mismanagement of waste which needs an attention.

The understanding of human impacts on ocean environment expected to help in evaluating trade-offs between human use of oceans and preservation of ecosystems as well as protection of goods and services provided by them.

*Corresponding author. E-mail: shailesh@nias.res.in.

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2. Fate and Transport of Marine Plastics

Plastic waste does not decompose but breaks into smaller pieces and are called microplastics (< 5 mm in diameter) and are in form of fragments or fibres. As mega- (> 1 m), macro- (2.5 cm to 1 m) and meso- (5 mm to 2.5 cm) plastics continue to breakdown, the amount of resultant microplastics increases in oceans. It has been found that biodegradable plastics actually disintegrate into smaller particles only and which may not be degradable.[3] Recently, it has been suggested that certain enzymes embedded in plastics can break or disintegrate plastic waste.[4] The true impact of microplastics on ocean environment and the fauna is yet to be understood.

The microplastics provide a floating hard-substrate habitat in oceans. Such floating habitats normally not present in oceans. Microbes, such as bacteria, algae, etc. (>1000 different types) thrive on these tiny particles and get transported along with these particles to different parts of oceans, where they can be invasive. It has been observed that high concentration of microplastics in North Pacific Ocean, has led to increase in density of marine pelagic insects.[5] So microplastics can alter especially pelagic ecosystem as well as spread risk or diseases to ocean fauna and humans. The movement of such plastic debris is governed by coastal currents, surface waves, wind-driven ocean mixing and hence are vertically distributed within the upper water column[6] and hence affect entire pelagic ecosystem. Its concentration increases along the fronts. The estimation of total plastic litter based on surface observations alone, as it is a practice today, likely to lead to underestimation of their concentration.

Microplastics interact with biota, e. g. through ingestion and can disrupt hormonal functioning and reproductive systems of marine fauna[7] as well as degrade liver functions of fish. Microplastics might induce diseases to humans when they consume such fish. Microplastics were also found in planktons and showed increasing trends over time.[8] In India, microplastics particles and threads were found in benthic invertebrates and bivalves off Kochi and Chennai coasts, respectively.[9,10] Further studies are underway to understand its source, and toxicity of these particles.

Large plastic litter may cause suffocation and affect digestive system in birds, fish and mammals.[11] Plastics litter and microplastics are also found in deep sea, even in the Mariana Trench, almost 11000 m below the surface.[12] Such increasing accumulation of litter in deep sea has been recognised by the UNEP-Regional Sea Initiative. Such litter may lead to suffocation of animals, physical damage to sessile fauna, propagation of invasive species and release of toxic chemicals.[13] Studies to assess impact of microplastics on deep fauna are very few. There is a need to develop methods to monitor and quantify and the abundance and to identify potential sources and sinks of microplastics.[14]

3. Plastic Waste Management

The size of population, especially in coastal areas and waste management practices largely decide how much waste likely to find their ways to ocean. A major improvement in waste management is required, otherwise drastic increase in ocean litter is expected in this century. A study on monetary value of healthy ocean estimated that if anthropogenic activities continue to pollute, the decline in ocean services can cost the global economy US $430 billion per year by 2050 and US$ 2 trillion per year by 2100.[15]

The United Nations Convention on Law of the Sea (UNCLOS), though addressed protection of marine environment, it does not specifically mention about marine litter.[16] The United Nations Conference on Environment and Development (UNCED) in 1992 had recorded the harmful impacts of marine litter on marine environment as a part of Agenda 21.[17] There are many other regional conventions/agreements dealing with the marine pollution. The European Union had adopted a ‘Marine Strategy Comprehensive Framework Directive’ which directed member states not to produce any marine litter beyond 2020.[18] This is probably one of the best multilateral regional policies adopted by regional groups as well as given effect through policy and legal instruments at the national levels.

For instance, the plastic waste management rules have been formulated in India in 2016 and further improved in 2018 to provide a framework to regulate and manage use of plastics. This national policy has been tuned with the UN Environment’s global ‘Clean Seas Campaign’. Still, plastic litter do find its way to ocean especially during monsoon. In one such study on the Chennai coast, it was found that plastic items formed the majority of all debris

collected.[19] Major components were, thermocol (31 %), plastic bags (28 %), bottles (14 %), straws (13 %) and food wrappers (9 %). Plastic products are used extensively and it will not be prudent to ban them completely. However, we need to address the problem of plastic litter which is likely to increase significantly. A legally binding multi-lateral treaty has been proposed to reduce plastic pollution.[1] It is necessary to prepare a regional action plan for the Indian Ocean Rim countries. The *Draft Policy Framework on India's Blue Economy* has also addressed issues related to marine litter[20] and may be expanded to address this regional issue.

4. A Way Forward

How do we manage ocean litter for better future of our blue economy? The following aspects could provide us a healthy way forward for taking appropriate policy, legal and institutional steps to address the current challenge:

a. Waste management Strategy:
   i) *Upstream Management*: Efficient collection, segregation and transport to scientifically designed landfills and dumping grounds to be undertaken.
   ii) *Recycling of waste*: An efficient plan for recycling of waste has to be put in practice. It is necessary to consider that those companies responsible who generate and use plastics should bear cost of proper disposal and recycling of waste. A provision to provide incentives to consumers including fishermen for proper disposal should be made. The focus should be on development of low-cost technologies to recycle plastic products.
   iii) *Regulations*: Global efforts should be initiated to reduce use of plastics as well as its waste management. India has committed to phase out single use plastics by 2022. Efforts should be made to encourage people to use less plastics and ultimately eliminate its use.
   iv) *Collection of washed debris*: Efforts to be made to collect trash from beaches, rivers and streams than from open ocean as it is easier and simpler. The development and deployment of low-cost traps should be encouraged. The 'clean-up' operations should be synchronised as with a national and regional efforts and coordination. The 'Blue Flag' beaches identified on the Indian coast have implemented very efficient system for collecting litter. Such system should be put in place for all beaches.
   v) *Coordination*: Different regulating agencies related to urban, environment, earth science, industry and agriculture, are required to coordinate activities related identify source regions of plastic waste, its disposal and recycling and improved management of anthropogenic activities.

b. Research
   i) *Scientific Knowledge*: Intensive research to be directed to generate sufficient knowledge on production of plastics, transportation pathways and their journey to oceans.
   ii) *Health Index*: A health index to be developed for assessment of condition of oceans.[21]
   iii) *Study impact of spatial distribution* of marine litter on coastal and marine ecosystems, ecosystem goods and services and on fisheries.
   iv) *Scientific Collaboration*: Joint efforts with developed countries required to address above mentioned issues.

c. Outreach
   i) *Awareness*: Continuing efforts should be made to bring awareness about harmful effects of marine litter to coastal communities including students.
   ii) *Education*: Appropriate training to be imparted for management of marine litter and waste to all stakeholders.
   iii) *Human Behaviour*: Changing life style and behaviour for encouraging reduced use of plastics, especially single use plastics needs to be advocated.

5. Conclusion

Marine plastic pollution is a major concern globally. There is a scope to further improve our waste management strategy. Low-cost and innovative approaches to be designed for collection, segregation and disposal as well as recycling plastic

waste. So that we can minimise the amount of plastic waste reaching to oceans. Second, drastic changes in behaviour of both producers and consumers are required to reduce plastic waste to control ocean pollution. Ultimately, we need to work towards elimination of single use plastics. The role of governments, industries and hospitality industries is crucial. An education system that produce scientists and managers who specialises in waste management is needed to implement such approach. The capability to educate all stakeholders at a regional, national, institutional and individual level need to be enhanced. We need to generate and continuously update scientific knowledge on production of plastics, pathways and their journey to oceans. At the same time, efforts should be made to bring awareness about harmful effects of marine litter to communities. A national policy synchronising with best international practices for managing plastic waste has be formulated for protecting health of oceans so that we continue to have benefits of marine ecosystem goods and services.

To sum up, the protection of environment and developmental agenda need to be balanced by improving policy, legal and institutional measures for evaluating trade-offs as well as prioritising scientific research, efficient management of waste and raising public awareness about the need for shifting to circular plastic economy.

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