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REVIEW PAPER

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A CRITICAL BRIEF REVIEW ON PLASTIC POLLUTION IN THE SEA OF MARMARA

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Abstract
During the last two decades, the term “plastic pollution” arises more and more concern for human beings, a growing problem that threatens all areas from rural to industrial areas all around the world. In the ecosystem integrity, this pollution also influenced the oceans worldwide. This plastic material, which is used in all environments where human activities are present, reaches the hydrosphere through both water and air. Thus, both freshwater and marine environments are affected by plastic pollution. The present study highlights the importance of plastic pollution in different marine ecosystems, with special focus on the Sea of Marmara. Along with the conditions of the Marmara basin, missing but critical parts that are still open for search in plastic pollution have been evaluated to provide a base for ecosystem-based management in the region that need urgent attention. In conclusion, reasons for plastic accumulations and their harmful effect on the ecosystem have been noted with special emphasis on different sources of plastic pollutants, the risks for the future of the ecosystem and human beings.

Keywords: Plastic pollution, Sea of Marmara, microplastic, Turkish Strait System

General Overview on Impacts of Plastic Pollution in the Sea of Marmara
It has been reported thaht the formation of the Sea of Marmara (Figure 1) has started by the end of the changes with the Holocene period (Çağatay et al., 2000), known as the sea of changes before and after. Further, the Sea of Marmara has a special meaning for the history of humanity and civilizations. History of human beings in this area dates back to around 8000 BC (Roodenberg et al., 2008), which means that various kinds of human-generated impacts on the Marmara Sea and adjacent water connections are more impactful than in many other seas or areas, as it this sea is as old as the story of humanity.

Today, the Sea of Marmara can be described as an interconnection zone between the Black Sea in the North and the Mediterranean basin through the Aegean in between. The two straits, namely Strait of Istanbul and Strait of Çanakkale connect the Sea of Marmara to the Black Sea in the north and to the Aegean in the west, which is further connected to the Mediterranean in the south (Öztürk et al., 2001). The special characteristic of the Sea of Marmara is that it's directly in between Europe and Asia, connecting these two continents with three suspension bridges in İstanbul, a mega metropole and well industrialized city, causing severe pressure on the Sea of Marmara with anthropogenic influences that has increased remarkably during the last two decades.

Anthropological impacts of urbanization and industrialization is an important matter that needs special understanding for the struggle against pollutants, especially plastic once that may directly or indirectly affect humans through the food chain. Additionally, both today and throughout history, the Sea of Marmara has encountered many different pollutants. Coastal zones or even open sea areas have been under influence by agricultural and heavy industry activities for several decades. This region with the biggest metropole covers the highest population rate of Türkiye, with over 25 million people. There are also plenty of connections to the Sea of Marmara via rivers of different sizes and the inflow of the non-regional river of the Danube (Gedik, et al., 2022) through the upper flow of the İstanbul Strait to the Aegean direction.

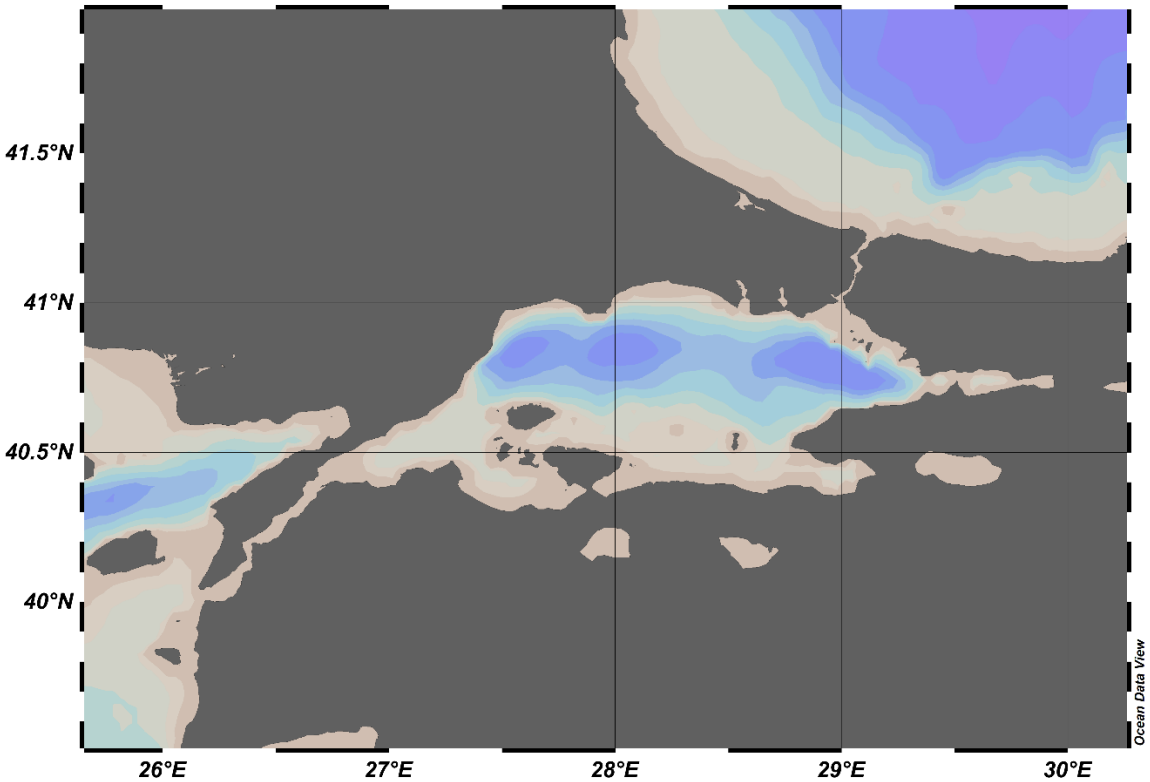

Figure 1. The Sea of Marmara, with two strait connections. İstanbul Strait in the north and the Çanakkale Strait in the south (ODV, 2023).

The use of plastic materials has been introduced to our lives via several sources, and since the 1950s the use of plastic material has been increased significantly. Further, the types of plastic became diverse with mass production of plastic material in the last decade (Ronca, 2017). Thus, the Sea of Marmara is under strong influence by plastic pollution (Aytan et al., 2023), that is an

ecological matter to be considered for the future of the oceans and sustainability of the marine ecosystem.

In the present review, the conditions of plastic pollution in the Sea of Marmara, have been evaluated with focus on emerging management plans to re-establish polluted areas.
Therefore, the present study questioned the following topics;
(a) why and at what level can plastic pollution danger the ecosystem?
(b) what is the current level of plastic pollution in the Sea of Marmara?
(c) what are the rapid responses for the prevention of effluents into the sea environment?

Difference of plastic material from other pollutants

As mentioned earlier, along with several kinds of pollutants, plastic pollution is another type of pollution that severely affects marine life and the ecosystem in the Sea of Marmara. Despite the fact that plastic is not the only pollutant in the area, it is a significant issue that needs rapid response and emerging action plans. The main difference of plastic from other pollutants lies in the reality that plastic is not dissolvable in the nature and remains significantly for a long time. Plastic, the immortal substance of the mortal world, crumbles only under certain influences. These effects are radiation, temperature, water, liquid, air, carbon dioxide, air pollutants, gases, fog, biological factors, stress factors, the physical action, incompatibility factors, usage factors and particulates (Gray et al., 1999). Thus, a large plastic litter can become small enough to be eaten even by zooplankton. This makes it more uncomplicated for the plastic material to circulate voluntarily in the food web (Gürses et al., 2022).

Plastic pollution in the Sea of Marmara

Similar to the oceans and marine areas around the world, plastic pollution has been reported recently in the surface water body of the Sea of Marmara (Tunçer et al., 2018). The rivers are the main key players in the transport of plastic material into the marine environment (Lebreton et al., 2017). This may be the case for the Sea of Marmara as well, where nearly twenty rivers flow directly into the area. Since some of these rivers pass through the borders of Istanbul, it can be assumed that the amount of these loads have remarkably increased over the recent years. In addition, the seabed around the Istanbul Strait and the Prince Islands is already contaminated with plastic material (Erkan et al., 2021). These plastics, already spread and contaminated the marine environment, have potentially affected the aquatic environment. Plastic pollution has been reported to influence a wide range of aquatic organisms from fish (Aytan et al., 2023) to mussels (Gedik et al., 2022), which are also a concern for zooplankton (İşinibilir et al., 2020) in the Sea of Marmara. Therefore, developing rapid management responses with short-term as well as long-term plans comprising control mechanisms is an urgent issue for the sustainability of the region. The collection and withdrawal of plastic from the marine environment, however preventive measures can be driven, as was reported by Vardar et al. (2021), who showed that direct filtration of wastewater can prevent certain amounts of plastic prior to discharge into the aquatic environment. Although the filtration from wastewater is an effective method, the deployment of special traps in front of river mouths with floating barriers could be an effective method to prevent the passage of plastics into the marine system (Helinski et al., 2021). Plastics that have already entered the marine system can be collected with specialized products such as different float-cleaners (Sahoo et al., 2021; Parker-Jurd et al., 2022), that can support reducing the plastic load in the marine environments.

Conclusion

Plastic pollution is already a global problem that needs collaborative attention by local as well as intercontinental organisations. It can be underlined that plastic pollution is a reality of the Sea of Marmara. However, rapid response and preventive actions may reduce the litter to a considerable extent. More research on the subject is essential for the sustainable future of the Sea of Marmara and its adjacent waters. The amount of plastic entry from the straits and the rivers, and its accumulation level is a critical question, which is open for research that needs to be answered immediately. In addition, the determination of the situation in the deep trenches of the Sea of Marmara is essential to detect possible accumulation of organisms both in the water column and in the deep sediment. Besides, research with an insight to the possible contamination of seafood that comprises an important share of the food demand of human beings is encouraged in future investigations.

Ethical approval

No ethical approval needed for this study.

Informed consent

Not available

Conflicts of interest

There is no conflict of interests for publishing this study.

Funding organizations

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Contribution of authors

Rıdvan Kaan Gürses: conceptualization, writing original draft, investigation, methodology, resources, validation, visualization, and finalizing paper.

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