Book of
The First Scientific Conference of the Faculty of Sciences

"Environmental Pollution and Challenges of Environmental Sustainability"

(Reconciliation with the Environment)

Sirte, October, 14, 2025

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Publications of Research and Consultation Center– Sirte University
First Edition 2025

The First Scientific Conference of The Faculty of Science – Sirte University "Environmental Pollution and the Challenges of Environmental Sustainability"

EPESC October 14, 2025

Part One: Dedicated to papers submitted in the English language

Libyan Agency for the International Standard Book Number (ISBN)
📘 **ISBN 978-9959-891-67-9**

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The First Scientific Conference of the Faculty of Science – Sirte University Environmental Pollution and Challenges of Environmental Sustainability (EPESC), Oct. 14, 2025

A Comparative Study of The Presence of Different Pieces of Marine Litter on Five Different Beaches on Western Coast of Libya

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Article History:

Received: 18 March 2025

Revised: 27 May 2025

Published: 15 November 2025

Keywords:

Marine pollution, Marine Litter; plastic; Microplastics; Environmental Monitoring

Abstract: waste enter the world's oceans annually. If current trends persist, it is projected that by the year 2050, the volume of plastic in marine environments could surpass that of fish. Despite its relatively low population density, Libya demonstrates a notably high per capita generation of plastic waste. The quantities of waste deposited along coastal areas vary across different Libyan cities, largely influenced by the nature and intensity of human activities in each location. Furthermore, waste accumulation on beaches is not solely attributed to marine return via wave and tidal actions; a substantial proportion results from uncontrolled and unregulated land-based waste disposal practices in adjacent urban and rural areas. This unmanaged waste dispersal represents a growing environmental concern, particularly in the absence of effective waste management systems along the Libyan coastline.

In this study, five Libyan regions of different nature were selected for each city in which the quantities of marine litter dumped on the shore were studied according to the methodologies approved by the United Nations Environment Program (UNEP) and the Integrated Mediterranean Monitoring Plan (IMAP). The beaches surveyed Farwa protected Island, at the west of Tripoli, Tripoli beach, Ghanima area east of Tripoli, Wadi Ka'am and the beach of Misrata city. The results, revealed that plastic waste was present in all the different beaches surveyed. The total quantities found reached 262, 369, 975, 891 and 956 pieces per 100 meters, for the areas Farwa, Tripoli, Ghanima, Wadi Ka'am and Misrata respectively, which gives an indication of the great role of tourism in increasing the number of wastes on the beaches, especially plastic, which reached 872 pieces per 100 meters in Ghanima Beach.

1. Introduction

Plastic pollution represents one of the most pressing environmental threats to coastal and marine ecosystems worldwide. According to the United Nations Environment Programme (UNEP), plastics constitute approximately 85% of total marine litter, making them among the most hazardous and persistent forms of marine waste. This growing concern stems from both land-based and sea-based sources, with plastic debris continually accumulating in coastal areas due to anthropogenic activities (Browne et al., 2008; UNEP, 2021). Marine litter, particularly plastics, is transported by natural forces such as ocean currents and wind. Recent modelling efforts have demonstrated the strong influence of these environmental factors on the spatial distribution and accumulation rates of marine litter (Ximena et al., 2024). Studies from the North Atlantic coast of Portugal revealed that marine litter, including 38-year-old plastics, can become buried within beach sand dunes, indicating their long-term persistence in the environment (Umberto & Gil, 2022).

There is also a strong correlation between microplastic abundance and human population density (Oerlikon, 2009). Secondary microplastics originate from the breakdown of larger plastic items through physical, chemical, and biological processes on land and at sea (Ryan et al., 2009). Marine litter includes discarded or abandoned processed materials, which negatively impact marine species through ingestion, entanglement, and the disruption of ecological functions (Jepsen & de Bruyn, 2019; Al-Tarshi et al., 2024).

The six most prevalent types of plastic polymers—HDPE, LDPE, PVC, PS, PP, and PET—comprise approximately 90% of global plastic production (Andrady, 2011). These materials are typically classified as microplastics (>25 mm) and microplastics (<5 mm), both of which are widespread in water bodies and sediments (Cole et al., 2011; Romeo et al., 2015). Microplastics are particularly concerning due to their ability to enter the food web and act as carriers for toxic pollutants (Teuten et al., 2009; Al-Tarshi et al., 2024). While wastewater treatment facilities can remove up to 99% of microplastics, their presence in the marine environment remains substantial due to continued inputs (Rochman et al., 2015).

Plastics pose severe ecological risks due to their ingestion by marine organisms and entanglement hazards. Composed of synthetic or semi-synthetic polymers, plastics are lightweight, durable, and resistant to degradation (Derraik, 2002; Thompson et al., 2009). While ultraviolet radiation and seawater exposure can lead to fragmentation, the complete degradation of plastic in marine environments remains uncertain (Moore, 2008; Andrady, 2011). Common disposable items, such as plastic bags and utensils, account for about 50% of total plastic production (Hopewell et al., 2009; Al-Tarshi et al., 2024). In addition to their ecological impacts, plastic pollutants disrupt economic activities, particularly tourism and fisheries, and impose significant management costs (Mendelssohn et al., 2012). Beach litter, such as packaging tape and fishing gear, can injure marine animals and deter visitors from polluted coastal areas (Costa & Zalmon, 2019). Interestingly, some species, like ghost crabs, have been observed using marine litter for burrow marking, suggesting complex behavioral interactions with debris (Costa et al., 2022).

Given the diversity in plastic forms—from mega-plastic to microplastic and their wide distribution across habitats, urgent action is required. Effective strategies include the promotion of the 3Rs (Reduce, Reuse, Recycle), extended producer responsibility, and public awareness initiatives. Policymaking at global, regional, and national levels remains vital in mitigating the plastic pollution crisis (Teuten et al., 2009; Al-Tarshi et al., 2024).

This study aims to (I) explore the sources of marine plastic pollution, (II) assess the current state of plastic accumulation and its ecological effects globally and locally, and (III) propose recommendations for improved waste management and policy-making in Libya and beyond. By addressing key knowledge gaps, the paper seeks to contribute to the protection of marine ecosystems and promote a sustainable, plastic-free future.

2. Material and Methods

2.1. Study Areas

Based on the Integrated Monitoring and Assessment Programme (IMAP) Action Plan for the monitoring of marine litter along Libyan coastlines (Figure 1), a selection of five representative beaches along the western coast of Libya was undertaken. The selection criteria were based on the differing characteristics and anthropogenic activities associated with each site. From west to east, the selected locations include: Farwa Island, designated as a protected marine and coastal area; a coastal site located to the east of Tripoli, adjacent to Mitiga Airport and Shaab Port, which reflects urban and port-related influences; Ghanima Beach, known for its recreational and touristic significance; Kaam Beach, located near the estuary of a major regional wadi, which is subject to fluvial inputs; and lastly, a commercial-industrial beach situated within an urbanized coastal zone. This spatial distribution was intended to encompass a broad range of land-use types and environmental pressures relevant to marine litter accumulation patterns as outlined in the IMAP guidelines.

Figure (1) Proposed Selected Monitoring Sites for EO10 for the western Part of the Libyan coast

2.2. Methodology and approach

Monitoring of “Beach litter” (macro- and micro-litter), were conducted in line with the National IMAP Pollution and Marine Litter and according to Methodology for Monitoring Marine Litter on Beaches of The DeFishGear project (fig. 2). Samples collected were identified according to the procedure of UNEP MAP list for the Common Indicator (CI) No 22 which related to Marine Litter

Figure (2) Photos from the beach ML Survey September 2023

3. Results and Discussion

The results for the field survey of beach marine litter were shown in figure below. The figures show the most recent survey of the year 2023 for the sites Ganima and Musrata compared with 3 different sites previous results for the year 2020-2021 (Table 1 and Fig. 3)

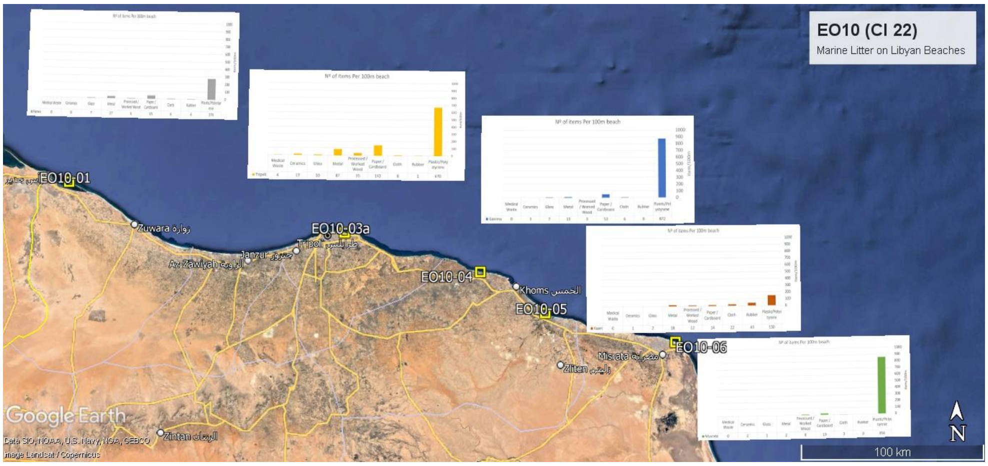

Figure (3) shows the results obtained for the sites.

Table (1). Number of ML Items on study Sites

Category	Nº of items Per 100m beach				
	Tripoli	Farwa	Kaam	Ganima	Musrata
Plastic/Polystyrene	670	274	150	872	856
Rubber	1	4	43	0	0
Cloth	8	6	22	6	3
Paper / Cardboard	143	45	14	52	19
Processed / Worked Wood	35	6	12	3	8
Metal	87	27	18	13	2
Glass	10	7	2	7	1
Ceramics	17	0	1	3	2
Medical Waste	4	0	0	0	0

The results obtained reveal that all the touristic sites have shown high level of ML reflecting on the need for reaising awareness, it also indicates weak enforcement of the law. The results also on the necessity to put in place a systematic monitoring measurements programme of ML, that need to be linked with the integrated Monitoring and assessment Programme (IMAP) for implementation. The results shows expected pattern of accumulation of plastics in on the beaches surveyed particularly in tourism season for all the sizes of the classified four types: mega plastics, microplastics, mesoplastics, and microplastics. The density of plastics plays major role on their distribution in the marine environment. Microplastics were seen in the water column, such as Polypropylene (PP) and polyethylene (PE) float in water due to low density of plastics, while polystyrene (PS), polyvinyl chloride (PVC), polyamide (PA), and polyethylene terephthalate (PET) with higher density were very mostly abundant in marine soil beach and coastal systems and were found in the surveyed beaches as a result from the in situ environmental degradation and subsequent fragmentation of larger size plastics by physical, chemical, and biological processes (Browne et al., 2010; Wang et al., 2018). The large quantity found on the beach of the coastal area may inter into the marine systems, and poses adverse effects on the ecological life of different zones, including biodiversity, economic activities, and to human health (Galgani et al., 2010), as microplastics are ingested by different kinds of marine organisms (Leslie et al., 2017). Salinity levels around

35‰ (parts per thousand) have been identified as a critical environmental factor influencing the chemical degradation of plastic debris in marine environments. Elevated salinity enhances the susceptibility of plastic materials to fragmentation processes, thereby accelerating the formation of microplastics through oxidative and hydrolytic mechanisms. It is so important to implement the integrated approach with international, regional, and the national level as mitigatory strategies to improve plastic waste_management by reducing the load of plastic garbage sea costal and marine system. Environmental contamination due to plastic waste mismanagement is a growing environmental control tool. It is clear now that marine litter is a serious anthropogenic along the surveyed beaches and became an issue with apparent effects that may cause harm to the natural systems, despite the fact of the limited information on c effects of marine plastic and impact on ecosystem services, and subsequently on human wellbeing. These results are consistent with what was found by (Koray, et al 2024), who found that the highest concentrations of litter were in the fall, and that it consisted mainly of single-use items, with plastic being the most abundant, followed by metal and paper. The subcategories of plastic trash bags, lids/caps, lighters, cosmetic containers, gloves and plastic parts were also found to be the most abundant litter in terms of number.

The studies reveal that all the touristic sites have shown high level of ML. The result reflects on the need for raising awareness and more enforcement of the law. It appears that there are good capabilities in terms of expertise to monitor and assess CIs for EO5, EO9 and EO10, as well assure potential to deliver on the systematic monitoring and analytical laboratory measurements required for the IMAP implementation. However further coordination and technical knowledge are needed in order to guarantee a successful and functional implementation of the monitoring programme for the years to come of the IMAP implementation cycle.

4. Conclusion

Marine and coastal ecosystems represent intricate and dynamic systems that offer substantial ecological and economic value, contributing significantly to human well-being through the provision of a wide array of ecosystem services. However, recent assessments indicate that all surveyed beaches are experiencing considerable degradation due to a combination of natural forces and anthropogenic pressures. Among these, industrialization and urban expansion have been identified as primary drivers of human-induced pollution, particularly the accumulation of plastic debris within marine and coastal environments. The large quantify of plastic found on the beaches surveyed by plastic pollution requires ways to identify management priorities and implementation of mitigation_measures accordingly. The adverse effects, and sinks of plastics in the marine environment is highly fact that will occur. This study has addressed this problem and identified the above gaps on scientific data needed for on all aspects of plastic pollution in the marine and coastal habitats. The study has also identified the current status of on the degree of pollution and of plastic debris accumulation along the coastal area. There were necessity of mitigation and managing action \ to protect the in marine and coastal environments and for reducing and controlling the plastic pollution in this valuable biodiversity of the aquatic ecosystems.

Acknowledgments

The study team is pleased to express its gratitude to the Libyan Ministry of Environment and UNEP/MAP Components (INFO/RAC, MED POL, PAP/RAC, SPA/RAC, and Plan Bleu) for their support and funding of this study.

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