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“Shallow coastal litter in South Aegean Sea islands: abundance and sourcing”

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Abstract The problem of marine litter has garnered increasing scientific, governmental and civilian attention in the last 20 years due to its severe environmental, economic and logistical impacts. Coastal and islandic regions with high touristic value, are particularly vulnerable to said impacts. Diver-led cleanups constitute a common approach to that issue by combining litter collection alongside their monitoring, with community engagement by non-disruptive means. This study showcases the findings of one such effort across 16 islands of the Southern Aegean Sea over a two-year period. The results indicate the dominance of plastic and metallic items, associated with recreational and fishing activities, as well as urban/householding sources.

Keywords: Marine Pollution, Plastic Waste, Aegean Sea, Benthic Litter, Visual Census

1. Introduction

Studies suggest that marine litter is abundant in the Mediterranean Sea, and diver-led operations are a vital method for monitoring and removing marine litter, especially in areas where mechanical methods are impractical or harmful. Divers also excel in complex environments like rocky reefs and shallow coastal zones where equipment such as trawls may cause environmental damage (Galgani, 2013). Their ability to conduct visual surveys and targeted removals allows precise interventions, particularly for plastics, fishing nets, and other anthropogenic waste not easily caught or detected by different methods.

Several studies have previously been conducted in Greece by utilizing a plethora of techniques as to determine the abundance of litter in specific locations, potential sources and environmental repercussions. Katsanevakis and Katsarou (2004) investigated the distribution, composition and influences of marine debris in shallow coastal areas in Greece via the use of scuba divers, emphasizing the impact of artisanal fishing and urbanization. Kouvara (2024a) showcased the state of Saronicos Gulf, by employing a multi-perspective approach (public databases, literature, visual surveys, scuba dives, ROVs and trawlers), and combining data from both beaches and the seafloor. Kouvara (2024b) also applied visual census methods via ROV’s and scuba divers for the assessment of litter in Thermaikos Gulf.

The aim of this study is to present the composition, abundance and spatial distribution of marine benthic litter in ports across the South Aegean Sea, a significant source of marine pollution to the Mediterranean.

2. Materials and Methods

Acquisition of data was conducted during diver-led cleanup missions which were supported by the Athanasios C. Laskaridis Charitable Foundation[3] and led by the environmental organization "Dive-In-Action- S.A.V.E." (Santorini's Active Volcanic Environment)[2] in collaboration with the Oceanus Lab, of the University of Patras[1], across beaches and ports of the Southern Aegean during the period 2022-2023. Civilians and professional divers counted and categorized each find. All operations were underwater, and the equipment used was typical scuba dive equipment, as well as commercial weighting scales. In total, 37 different operations were carried out on 16 islands, covering 30 different locations, of whom 7 were cleaned multiple times. Operational depths ranged from 2 to 10 m and the average surface area covered was 0.4 hectares (from 0,124 to 0,753 h). Each different litter type was assigned a code based on the European JCODE litter classification system, implemented in 2019 by the Marine Strategy Framework Directive (MSFD) Technical Group on Marine Litter (TG ML), to facilitate consistent data collection and analysis across regions. Densities of items per hectare were also calculated in order to compare the results to existing literature.

3. Results

Overall, 10,409 items were collected, for a total weight of 5493.85 kg and estimated volume of 23831.79 l. 92 different J-Codes were assigned, signifying the diversity of the dataset. Plastics rule the majority of dataset at 60.92 %, followed by metallic and cloth litter at 25.12% and 3.85% respectively (Fig.1).

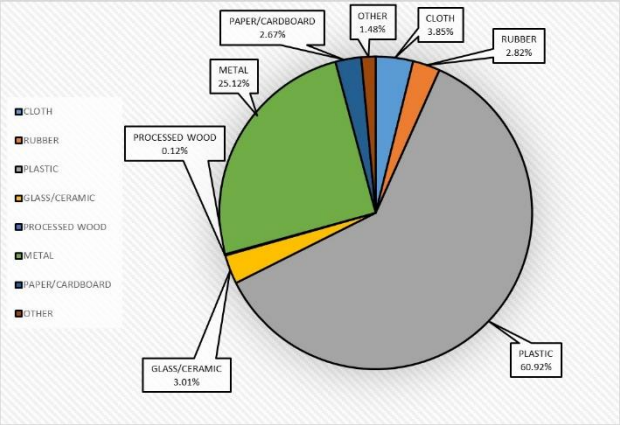

Figure 1. Distribution of Major litter materials.

Conversely, when it comes to specific litter types based on the JCODE, the most prominent regarding its occurrence across all locations is metal drink cans (J175) at 17.28%, with plastic drink bottles >0.5 l (J8) and plastic bags (J3) following closely at 16.26 % and 8 % (Fig. 2).

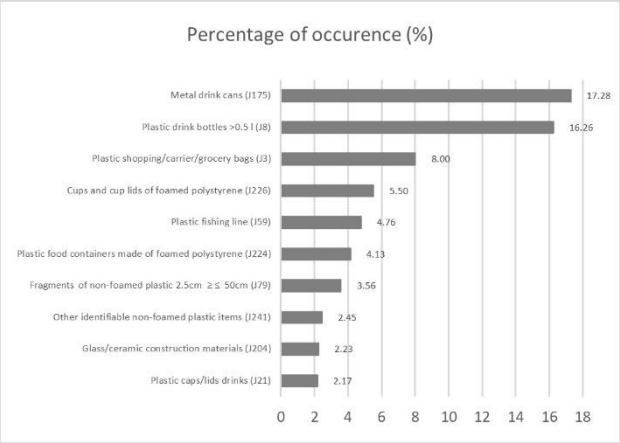

Figure 2. Percentage of occurrence of the top 10 most abundant litter types across all 37 locations.

Litter density ranged from 53.22 to 6211.36 items/hectare with a mean of 468.61. Notable outliers were the ports of Aigina Is. (6211.36 i/h) and Therma (3193.55 i/h), Bouali (2326.58 i/h) in Kalymnos Is., as well as Agios Georgios of Sikinos Is. (53.22 i/h) and Perissa (64.57 i/h) of Thira Is..

4. Discussion

Compared to existing literature on litter in Greek coastal and nearshore environments, the findings of this study are generally consistent, with some notable deviations. Plastics remain the dominant material. Common litter types such as metal drink cans, plastic water bottles, plastic bags, and SUPs continue to be among the most frequent (Kouvara, 2024a). Recreational activities, fishing, and urban waste are potential sources of this pollution, considering the touristic value of these areas, as well as the prevalent nautical and fishing culture.

Litter densities appear higher compared to Saronikos and Thermaikos Gulf (Kouvara, 2024a & 2024b) at shallow coastal areas, possibly driven by the enclosed nature of the cleanup sites, like commercial ports, marinas and fishing shelters, where proper water circulation is limited. Additionally, outlier sites—such as overactive, small ports and protected areas—also show distinct accumulation patterns, likely due to a combination of factors such as tourism and high traffic, as well as the efforts of previous cleanups.

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