

OCCURRENCE AND COMPOSITION OF POLYMERIC MATERIALS IN BEACH MACROLITTER ALONG THE ROMANIAN BLACK SEA COAST

Andreea-Mădălina CIUCĂ^{1,2}, Elena STOICA²,

Ileana-Cristina COVALIU-MIERLĂ¹, Lucica BARBEȘ^{1,3}

¹ Doctoral School Biotechnical Systems Engineering, National University of Science and Technology Politehnica Bucharest, Romania

² Ecology and Marine Biology Department, National Institute for Marine Research and Development “Grigore Antipa”, Constanța, Romania

³ Applied Sciences and Engineering Department, “Ovidius” University of Constanța, Constanța, Romania

* Correspondence: lucica.barbes@365.univ-ovidius.ro; (L.B.).

Received date: March 26th 2026; Accepted date: June 10th 2026; Published date: Sept. 30th 2026

The rapid growth of plastic manufacturing and consumption poses a significant threat to the marine environment, negatively affecting biodiversity, ecosystem functions, and human health through litter accumulation. This study presents an innovative approach for the region by comparing classical visual assessments of marine litter with quantitative indices such as the Clean Coast Index (CCI), the Plastic Abundance Index (PAI) and the Cigarette Butt Pollution Index (CBPI), on two types of beaches with varying degrees of urbanization and use. Thus, the paper presents original data on macrolitter pollution on the Romanian Black Sea coast. The results show notable differences in abundance, composition, and cigarette-butt pollution, with plastic waste dominant.

Keywords: marine litter, macroplastics, pollution indices, Black Sea coast.

© 2026 by the authors. This article is distributed under the terms and conditions of the Creative Commons Attribution (CC BY 4.0) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Biodiversity, ecosystem processes, and even human health are nowadays threatened by the increasing global quantities of litter in the marine environments [1]. Marine litter represents any persistent solid materials that are manufactured or processed and deliberately discarded, disposed of, or abandoned in the marine and coastal environment [2]. Current global data show that plastic waste pollution has intensified, increasing from approximately 2 million tons in 1950 to approximately 438 million tons in 2017, and is projected to exceed an estimated 1,100 million tons by 2050 if the current pace is maintained [3]. Although marine litter comprises a variety of materials, such as plastics, metals, glass and ceramics, paper and wood, textiles, and rubber, plastics are the most abundant, constituting approximately 60-80% of all recorded marine debris [4,5].

Due to fragmentation processes driven by environmental agents, large plastic waste (macroplastics) serves as a precursor to microplastics (<5 mm) [6]. Reviews show that the most common type of beach litter found on coasts, and among the most common personal items, are cigarette butts. Containing thousands of toxic chemicals, such as arsenic, benzene, hydrogen cyanide, polycyclic aromatic hydrocarbons, pyridine, and heavy metals, a single cigarette butt can contaminate up to 1000 liters of water [7,8].

In addition to the environmental consequences of marine litter, many effects on marine biota have been documented globally, particularly regarding different types of interactions and their repercussions. Thus, interactions between biota and plastics include entanglement, ingestion, colonization of plastic objects by marine organisms, and direct contact with or entrapment in plastic (including smothering). Moreover, the bioaccumulation of persistent organic and inorganic pollutants is enhanced by their adsorption on the plastic's surface [9].

The Black Sea is not immune to these global environmental problems. Because it is one of the largest semi-enclosed seas in the world, with limited water exchange, an input of approximately 80% of fluvial origin from the western and northwestern basins, the accumulation of waste is massive and particularly serious [10–12]. Of all waste categories, plastics are the most widespread, being regularly reported in every environmental component of the Black Sea: from the sea surface [13,14] and seafloor [15,16] to beach sediments [17–22], and biota [23–27]. The Danube River is an important source of various types of pollution in the sea, and it has been estimated that it contributes approximately 4.2 tons of plastic waste per day and 1,533 tons per year to the Black Sea [28,29]. The Romanian coast is located in the northwestern sector of the sea basin, in a region recognized as a hotspot for floating marine litter, especially plastics, which is strongly influenced by the discharges of the Danube River, leading to the accumulation of high quantities of waste along the coast [13,30]. Ioakemidis et al. [16] observed average densities of up to 291 ± 237 units km^{-2} of benthic marine debris in the Gulf of Constanta, of which plastics represented $45.2 \pm 4.8\%$, linking these high levels mainly to the strong input from the Danube River.

The Marine Strategy Framework Directive [31] addresses marine litter as a distinct qualitative descriptor, through Descriptor 10 (D10)- “Properties and quantities of marine litter do not cause harm to the coastal and marine environment”, for attaining the Good Environmental Status (GES). Beach macrolitter is evaluated within the criterion D10C1 (primary)- “The composition, amount and spatial distribution of litter on the coastline, in the surface layer of the water column, and on the seabed, are at levels that do not cause harm to the coastal and marine environment” [31]. The threshold value for achieving Good Environmental Status (GES) for beach-based marine litter was set at the median of 20 items or fewer per 100 m of coastline [32].

By monitoring and classifying beach litter, important information on the prevalence and potential sources of different types of litter is obtained, thereby enabling the observation of pollution patterns and the formulation of potential mitigation efforts. [4,33].

In addition to traditional monitoring techniques, the implementation of quantitative indices such as the Clean Coast Index (CCI) or the Cigarette Butt Pollution Index (CBPI) enables quantification of the effects of marine litter on coastal areas and determination of the degree of pollution [34,35].

The aim of the present study is to assess macrolitter accumulation on two beaches from the Romanian Black Sea coastal area, with different use (urban vs. marine protected area) by combining traditional collection and analysis methods with the use of three quantitative indices (CCI, PAI, CBPI) to assess the degree of litter pollution, with an emphasis on plastic litter items and their potential impact on marine organisms.

2. Materials and Methods

To evaluate the occurrence, abundance, and composition of macrolitter on the beach, two complementary assessment approaches were applied. These included a classification-based survey of litter categories and subcategories conducted on collected litter, as well as quantitative indices: the Clean Coast Index (CCI), Plastic Abundance Index (PAI), and the Cigarette Butt Pollution Index (CBPI). Both approaches were implemented at two study sites, Malibu and Vadu Beach, which differed in levels of human use and pollution.

To assess the main litter categories, a monitoring approach was applied following a standardized protocol consistent with the minimum requirements for beach litter surveys under the Marine Strategy Framework Directive (MSFD), as defined by the European Commission- mandated Technical Subgroup on Marine Litter [31,33].

The Clean Coast Index (CCI) is an indicator of beach cleanliness based on the quantification of plastic debris present on the shoreline [34]. Originally described by Alkalay et al. [34] and applied by the Israeli Ministry of the Environment on national beaches since 2005, the CCI was subsequently adopted by the European Environment Agency (EEA) as a standardized tool for assessing beach cleanliness across Europe [36].

The Plastic Abundance Index (PAI) was developed to evaluate plastic pollution on beaches by measuring the proportion of plastic litter relative to the overall amount of litter collected [37].

The Cigarette Butt Pollution Index (CBPI) is a single litter-type focused index specifically designed to evaluate environmental pollution associated with cigarette butts' litter [35].

2.1 Study area

The macrolitter collection and subsequent analysis were conducted on two sandy beaches (Vadu and Malibu) along the Romanian Black Sea coast (in the NW of the basin, as shown in Figure 1).

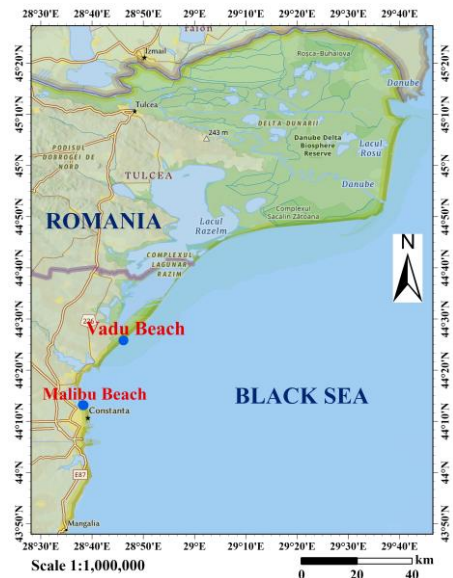


Figure 1. The map location of the selected study beaches - Malibu and Vadu

Both beaches were selected for their general use and proximity to potential pollution sources, and were monitored after the summer tourist season. Data from each field campaign for litter monitoring for each site analyzed are presented in Table 1.

Table 1. Geographical location of the monitored marine beach sites

Sampling zone	Length (m)	Width (m)	Survey coordinates			
			Starting point		Ending point	
			Latitude	Longitude	Latitude	Longitude
Vadu beach (Marine Protected Area) Survey date: 18.10.2024 Natural Reserve	100	14.5	44.430522N	28.769606E	44.43177994N	28.77093758E
Malibu beach (Urban beach) Survey date: 05.11.2024	100	100	44.21927122N	28.63917068E	44.21982087N	28.6365187E

Vadu Beach is part of the Grindul Chituc Marine Protected Area in the Danube Delta Biosphere Reserve, and is a wild, undeveloped beach that can only be reached by private car (Figure 2 - Original photo). The annual number of tourists is small, a consequence of its status as a protected area, but also of the distance from inhabited areas, the village of Vadu being the closest (5 km).



Figure 2. Vadu Beach: (a) image taken with a UAV; (b) image taken from the ground

On the other hand, Malibu Beach is located in the urban area of Constanța, within the national resort of Mamaia. It receives a high number of tourists annually due to its proximity to residential areas and hotels, and its easy access by personal car and public transport (Figure 3 - Original photo).

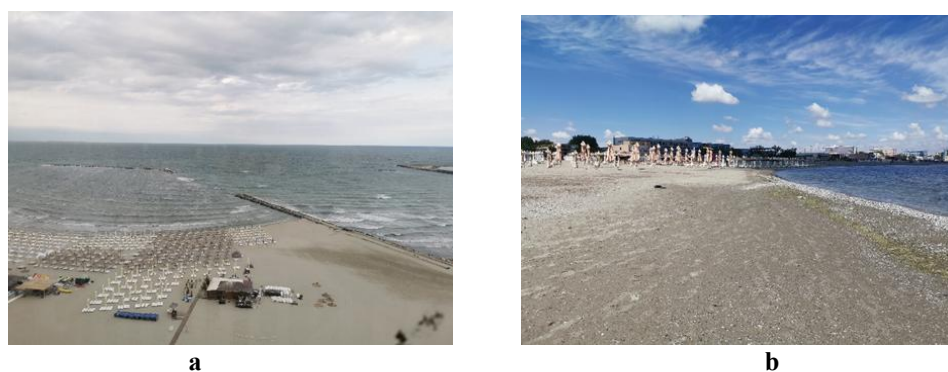


Figure 3. Malibu Beach: (a) image taken with a UAV; (b) image taken from the ground

2.2 Study perimeter delimitation and macrolitter collection

The marine litter collection campaigns were carried out following the EU MSFD TG-ML *Guidance on Monitoring of Marine Litter in European Seas-2023-JRC Scientific and Policy Reports* [32]. For the collection of litter items, 100 m-long, 100 m-wide beach transects were delineated, starting from the breakwater towards the shore. In the case where the beach is narrower, the width is measured starting from the breakwater to the natural (e.g., vegetation) or artificial (e.g., access road) limit of the beach. Thus, on Malibu Beach, litter was collected from the

defined sampling zone with a total surface area of 10,000 m², whereas on Vadu Beach, the sampling area was 1,450 m². From the areas thus delimited, all macrolitter items larger than 2.5 cm were collected and transported to the laboratory. Litter sorting was then carried out in accordance with the Common List of the MSFD Technical Group on Marine Litter and the scheme and codes proposed by Fleet et al. [38]. The EU Online Photo Catalogue of List J, which illustrates and describes each type of item, was used to correctly classify the collected litter [39]. In addition, the catalogue indicates whether the items fall under single-use plastic (SUP) categories or fishing gear, in accordance with EU Directive 2019/904.

2.3 Results analysis

The median item count across all segments was compared with the threshold of 20 items/100 m, as proposed by Van Loon et al. [32], to determine whether the study area meets the Good Environmental Status.

The Clean Coast Index (CCI) was calculated using the formula proposed by Alkalay et al. [34]:

$$CCI = \frac{NT}{AT} * K \quad (1)$$

where:

NT = total number of litter items per transect;

AT = total area of the transect;

K = coefficient of 20.

According to the CCI classification, beaches are categorized based on litter abundance as *very clean* (0–2), *clean* (2–5), *moderately polluted* (5–10), *dirty* (10–20), or *very dirty* (>20) [34].

The Plastic Abundance Index (PAI) was calculated based on the formula proposed by Rangel-Buitrago et al. [37]:

$$PAI = \frac{\frac{\sum \text{Plastic litter items}}{\log_{10} \sum \text{Total litter items}}}{Area} \times K \quad (2)$$

where:

K = constant, 20;

Area = length × width (m²).

According Plastic Abundance Index (PAI) obtained values, plastic pollution is classified into five levels: *absence* (no plastic present; 0), *low abundance* (few plastics; 0.1–1), *moderate abundance* (considerable plastic; 1.1–4), *high abundance* (many plastics; 4.1–8), and *very high abundance* (most of the area is covered with plastic; > 8) [37].

The Cigarette Butt Pollution Index (CBPI) was calculated following the equation proposed by Torkashvand et al. [35]:

$$CBPI = CBD \times E \quad (3)$$

where: CBD = Cigarette Butt Density (Cigarette butts/m²)

E = Environmental coefficient.

The E coefficient is calculated based on the formula proposed by Torkashvand et al. [35]:

$$E = 10 \times S \times P \times R \times G \quad (4)$$

where: S = Soil status;

P = Kind of urban pathways;

R = Annual rainfall (mm);

G = Distance to groundwater (m).

Based on the CBPI obtained values, cigarette butts beach pollution levels were classified as *very low* (≤ 1), *low* (1.1-2.5), *moderate* (2.6-5), *significant* (5.1-7.5), *high* (7.6-10), or *severe* (> 10) [35].

3. Results and Discussion

This study reports findings from 2024 surveys conducted on two beaches, analyzing the quantity, density, spatial distribution, and potential effects of marine litter on marine organisms. The novelty of this research lies in its first regional application and comparative assessment of the Clean Coast Index (CCI), Clean-Beach Pollution Index (CBPI), and Plastic Abundance Index (PAI) on the Romanian Black Sea coast, integrated with more traditional visual surveys of marine litter. Despite its high potential to better quantify and assess coastal pollution levels beyond traditional methods, this complementary approach has not been used in the given areas before.

A total of 1,626 litter items were collected from the two beaches analyzed, with notable differences in terms of total abundance and density. Being located in an urban area, Malibu Beach recorded a total of 1,481 litter items and a density of 0.15 items/m². In contrast, Vadu Beach recorded only 145 items and a density of 0.10 items/m².

Stoica et al. [21] observed a similar trend during 2018-2019 in the same areas, with Malibu Beach having more litter items than Vadu Beach. The repetition of this pattern most likely indicates greater persistence and higher levels of pollution and litter at Malibu Beach than at Vadu, likely due to the type of beach use and high anthropogenic pressure. The rest of the Black Sea basin is no exception, with studies reporting higher amounts and densities of litter on beaches. In Turkey, a field survey conducted at 37 sampling stations documented high levels of environmental litter. A total of 29,610 litter items were recorded, with the average litter density across all stations estimated at 0.8 ± 0.07 items/m² [20].

Monitoring activities on 40 beaches from Bulgaria's coastline during 2018–2022 revealed an average density of 0.44 ± 0.04 items/m². The number of observed litter items increased by 261% in 2022 compared to 2018, with mean densities fluctuating between 0.21 ± 0.02 and 0.73 ± 0.04 items/m² over the study period [40]. Considering the established threshold of 20 items/100m of beach proposed by Van Loon et al. [31], our results indicate exceedances at both selected beaches. At Malibu Beach, an estimated 148 items/ 100m linear transect were recorded, exceeding the 20 items/100 m threshold by 7.4 times, while at Vadu Beach, an estimated 100 items/ 100m linear transect were recorded, exceeding the threshold by 5 times. Coastal zone assessments conducted between 2020 and 2021 indicate a total macro-debris abundance of 684 items/ 100 m in the Black Sea region. Although this value is the highest reported in the European region, it represents a decrease of approximately 30% compared to the 2015–2016 period, when 973 items/ 100m were recorded [41].

The Clean Coast Index (CCI), further supports the observed differences between the two beaches. Malibu beach scored a CCI value of 2.95, classifying it as Clean, while Vadu beach showed a much lower CCI value of 2.0, corresponding Very clean category (Figure 4). Both studied sites had values corresponding to favorable levels of cleanliness, but the more intense anthropogenic activities on Malibu Beach, compared to Vadu Beach, are reflected in the higher CCI value.

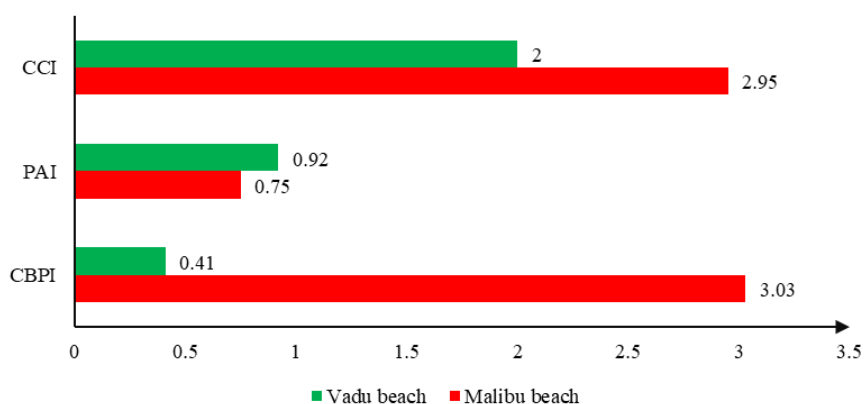


Figure 4. Comparison between the values obtained for the Clean Coast Index (CCI), Plastic Abundance Index (PAI), and Cigarette Butt Pollution Index (CBPI) for the two analyzed sites

In terms of the Plastic Abundance Index (PAI), both Malibu Beach and Vadu Beach fell into the Low Abundance category (little plastic), with index values of 0.75 and 0.92, respectively. Although a much higher total amount of waste was observed on Malibu Beach, its abundance was lower due to the much larger working surface area (10,000 m²). On the other hand, a much higher ratio of plastic waste to the total number of waste items was observed at Vadu Beach, on a much smaller surface area (1,450 m²), with PAI values well within the moderate abundance

threshold (1.1-4). The results show that plastics accumulate even in undisturbed areas with low anthropogenic pressure, such as Vadu Beach, which is part of a marine protected area.

The contrast between the two sites analyzed is even greater when comparing the values of the Cigarette Butt Pollution Index (CBPI) (Fig. 4). With a cigarette butt density of $0.033/\text{m}^2$, the environmental leakage coefficient (E) was calculated to be 90 for Malibu beach, as the environmental factors were assigned the following values, based on the site's characteristics: soil status (S)=2 (coastal and sandy areas), kind of urban pathways (P)=1.5 (footpath with a line of trees or shrubs), annual rainfall (R)=1.5 (301-500 mm), distance to groundwater (G)=2 (> 3m) [35]. Malibu Beach recorded a CBPI score of 3.03 (moderate) reflecting drainage conditions and the degree of urbanization of the beach that favors the transport of pollutants into the environment. On the other hand, Vadu Beach recorded a cigarette butt density of $0.006/\text{m}^2$ and an E of 60, calculated on the following environmental factors values: soil status (S)=2 (coastal and sandy areas), kind of urban pathways (P)=1 (simple footpath), annual rainfall (R)=1.5 (301-500 mm), distance to groundwater (G)=2 (> 3 m) [35]. The CBPI value of 0.41 (very low), indicates a much lower impact of cigarette butt litter on the environment. The analysis of the collected macrolitter shows that, for both beaches analyzed, the predominant category was artificial polymer materials (APM), constituting up to 80.26% of all waste. Metal accounted for approximately 9.04% of the total, followed by paper/cardboard, glass/ceramics, processed wood, rubber, and fabrics/textiles at smaller percentages (Figure 5).

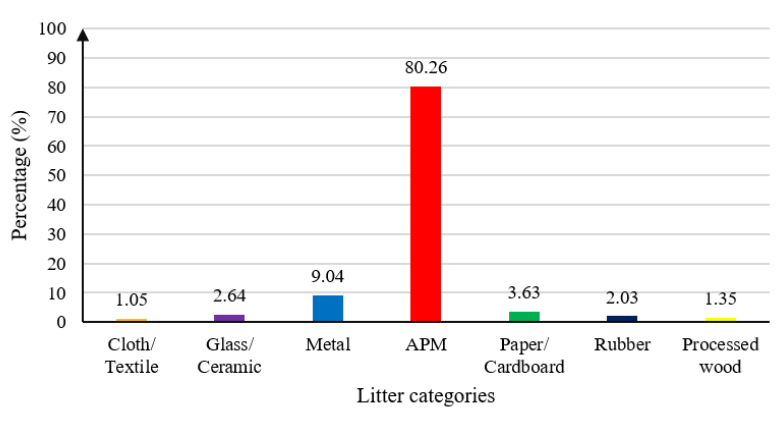


Figure 5. The proportion of macrolitter categories observed on both beaches analyzed (APM = Artificial polymeric material/plastic)

A similar division of macrolitter categories was observed at both sites, with slight variations in percentages depending on location.

On Malibu Beach, 80.96% of the litter was classified as artificial polymeric materials (APM), consistent with the site's intense recreational use and its urban

context. 45.76% of the total plastic litter identified was represented by the following subcategories: *tobacco products with filters* (22.75%), *fragments of non-foamed plastics 2.5 cm $\geq$ 50 cm* (14.71%), and *the part that remains from tear-off plastic bags* (8.3%). The presence of fragmented plastic litter, such as fragments and bag pieces, provides evidence of active fragmentation and degradation in the study area. The categories represented by Metal (9.66%) and Paper (3.85%) were the next most abundant, followed in smaller percentages by Glass, Rubber, Processed Wood, and Textiles. The results show that Malibu Beach, located in an urban area, is strongly influenced by visitors' habits and activities, as well as by waste originating from urban sources (Figure 6).

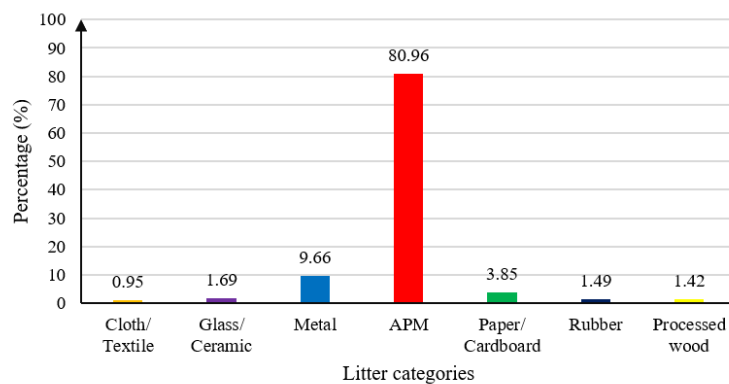


Figure 6. The percentage of litter-type categories on Malibu Beach

Vadu Beach also showed a predominance of plastic litter (APM: 73.1%), though with slightly higher relative contributions from glass (12.41%) and processed wood (8.28%) than in Malibu. Metal, textile and paper items were present at lower levels. The litter composition at Vadu reflects its more natural and less urbanized character, with reduced direct human pressure and fewer sources of urban waste (Figure 7).

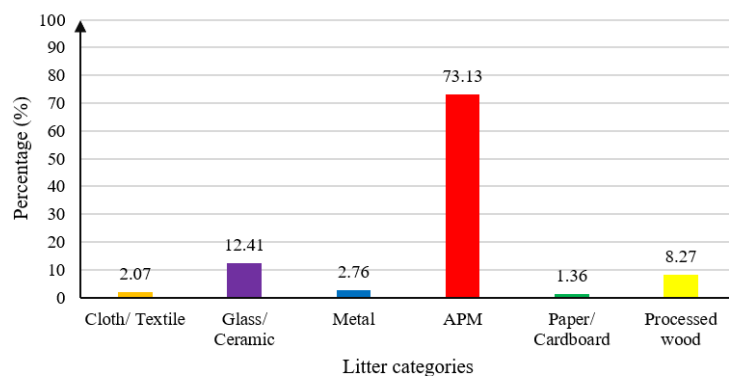


Figure 7. The percentage of litter-type categories on Vadu Beach

At this site, *fragments of foamed polystyrene from 2.5 cm to 50 cm* (26.2%), *plastic caps/ lids drinks* (8.27%), *tobacco products with filters (cigarette butts with filters)* (6.89%), and *the part that remains from tear-off plastic bags* (6.2%) made up to 47.56% of the total litter items were observed. Our findings are consistent with previous studies worldwide, including those by Derraik et al. [42], which reports that plastics account for approximately 60–80% of marine litter. This pattern has also been widely observed across the Black Sea region [22,43–45]. Cigarette butts are consistently reported as the most commonly collected type of litter in both urban and natural environments [46,47]. Beyond their toxic potential, Belzagui et al. [48] found that cigarette filters can shed approximately 100 microfibers/day, estimating that up to 0.3 million tons of microfibers/year may reach aquatic environments via this source alone.

In terms of abundance, cigarette butts, plastic bags, plastic bottle caps, and foam take-away containers rank among the most frequently encountered single-use plastics in the environment [49]. Lightweight plastics, including bags and foam-based materials, are particularly mobile and they can be easily transported by wind, remain buoyant in water, and fragment into smaller particles over time [50]. The high percentage of foamed polystyrene (2.5–50 cm) observed in our study can be explained by its widespread use in food-container manufacturing and as building insulation in urbanized environments [49]. Despite documented ingestion of numerous plastic items, plastic bags and utensils are most strongly associated with the highest risks to seabirds, turtles, and marine mammals [51].

Given their potential to cause entanglement and ingestion, as well as to act as vectors for invasive species, pathogens, and organic pollutants [9], all litter items encountered on beaches can be regarded as harmful to marine ecosystems. The number of species affected by marine litter has increased to 817 [1]. Although the immediate effects of marine debris entanglement are often visible injuries or mortality, the long-term effects of debris ingestion are still poorly understood. In both situations, sublethal effects can be observed that can affect individual health and performance, in some cases leading to population declines, especially in protected marine species that are vulnerable to multiple stressors [9,52]. Moreover, microplastics (<5 mm) [53], plastic fragments resulting from the fragmentation of macroplastics, due to their small size, are bioavailable to a wide range of marine animals, from primary producers to top predators [54]. The toxic effects of microplastics ingestion can be enhanced by various environmental pollutants adsorption, such as bisphenol A (BPA), on their surface [55]. The results obtained in this study show that artificial polymeric materials are predominant, raising concerns about targeted measures and strategies for efficient waste management and the reduction of this type of pollution in the Romanian coastal area of the Black

Sea. We acknowledge that the limited number of sampling sites and the absence of seasonal replication restrict the generalizability of the results.

4. Conclusions

This study presents a novel approach for the Romanian Black Sea area by combining the application of three quantitative pollution indices, the Clean Coast Index (CCI), the Clean Beach Pollution Index (CBPI), and the Plastic Abundance Index (PAI), alongside traditional visual methods for monitoring marine litter. The results obtained in the study show exceedances of the threshold value for marine litter on both beaches analyzed. Malibu Beach exhibited a higher degree of contamination due to the large number of cigarette butts and plastic fragments, whereas at Vadu Beach, a relatively higher ratio of plastic waste was observed over a smaller area. Plastic litter predominated at both study sites, regardless of use type (urban or marine protected area), highlighting the prevalence of litter and increased pollution even in areas with low urbanization. The index-based approach has proven effective for assessing beach pollution and has great potential to support regional management and mitigation strategies.

While the present study provides valuable data, future research directions should aim to increase the number of sampling sites and include monitoring campaigns in different seasons. Even though plastic pollution has gained significant attention lately, especially regarding the marine environment, there remains a gap in existing knowledge. There is an imperative need for standardized monitoring methods to comprehensively obtain comparable information on the abundance, distribution, fragmentation processes, and the impact of macroplastics on biota.

Supplementary Materials

The following supporting information are shown in:

Table S1. List of macro-litter items collected from Malibu beach and the proportion of each category and subcategory.

Table S2. List of macro-litter items collected from Vadu beach and the proportion of each category and subcategory

Author Contributions

Conceptualization, A.M.C. and E.S.; methodology, A.M.C.; E.S.; L.B. and I.C.C.M.; validation, I.C.C.M. and L.B.; formal analysis, E.S.; L.B.; I.C.C.M.; investigation, A.M.C.; E.S. and L.B.; writing—original draft preparation, A.M.C. and L.B. ; writing—review and editing, E.S. and I.C.C.M.; supervision, E.S. and L.B; funding acquisition, A.M.C. and E.S. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

Data supporting the findings of this study are available upon reasonable request from the corresponding author.

Funding

This research received no external funding.

Acknowledgments

The authors acknowledge the support provided through the “Study on the Black Sea Integrated Marine Ecosystem Monitoring Programme according to the requirements of the Marine Strategy Framework Directive (2008/56/EC)”, MEWF Contract nr. 50/21 April 2023.

Conflicts of Interest

The authors declare no conflict of interest.

Artificial Intelligence Disclosure

No artificial intelligence-based or generative tools were used in the preparation of this manuscript.

Publisher’s Disclaimer

The statements, opinions, and data presented in this publication are solely those of the author(s) and contributor(s) and do not necessarily reflect the views of the publisher, editor(s), or affiliated institutions. The publisher and editor(s) disclaim responsibility for any errors, omissions, or consequences arising from the use of the information, methods, instructions, or products described in the publication.

REFERENCES

- [1] Secretariat of the Convention on Biological Diversity; Scientific and Technical Advisory Panel—GEF. *Impacts of Marine Debris on Biodiversity: Current Status and Potential Solutions*. CBD Technical Series No. 67; Montreal, Canada, 2012. Available online: <https://www.cbd.int/doc/publications/cbd-ts-67-en.pdf> (accessed on 23 September 2026)
- [2] United Nations Environment Programme (UNEP). *From Pollution to Solution: A Global Assessment of Marine Litter and Plastic Pollution*. Nairobi, Kenya, 2021. Available online: <https://wedocs.unep.org/handle/20.500.11822/36963> (accessed on 23 September 2026).
- [3] Geyer, R. Production, Use, and Fate of Synthetic Polymers. In *Plastic Waste and Recycling: Environmental Impact, Societal Issues, Prevention, and Solutions*; Academic Press: Cambridge, MA, USA, 2020; pp. 13–32. <https://doi.org/10.1016/B978-0-12-817880-5.00002-5>.
- [4] Galgani, F.; Hanke, G.; Werner, S.; Oosterbaan, L.; Nilsson, P.; Fleet, D.; Kinsey, S.; Thompson, R.C.; van Franeker, J.; Vlachogianni, T.; et al. *Guidance on Monitoring of Marine Litter in European Seas: A Guidance Document within the Common Implementation Strategy for the Marine Strategy Framework Directive*. Publications Office of the European Union: Luxembourg, 2013. Available online: <https://doi.org/10.2788/99475> (accessed on 23 September 2026).
- [5] Barboza, L.G.A.; Cózar, A.; Gimenez, B.C.G.; Barros, T.L.; Kershaw, P.J.; Guilhermino, L. Macroplastics Pollution in the Marine Environment. In *World Seas: An Environmental Evaluation*, 2nd ed.; Sheppard, C., Ed.; Academic Press: Cambridge, MA, USA, 2019; 3, pp. 305–328. <https://doi.org/10.1016/B978-0-12-805052-1.00019-X>.
- [6] Ryan, P.G. A Brief History of Marine Litter Research. In *Marine Anthropogenic Litter*; Bergmann, M.; Gutow, L.; Klages, M., Eds.; Springer: Cham, Switzerland, 2015. https://link.springer.com/chapter/10.1007/978-3-319-16510-3_1.

- [7] Araújo, M.C.B.; Costa, M.F. A Critical Review of the Issue of Cigarette Butt Pollution in Coastal Environments. *Environ. Res.* **2019**, *172*, 161–169. <https://doi.org/10.1016/j.envres.2019.02.005>.
- [8] Torkashvand, J.; Farzadkia, M.; Sobhi, H.R.; Esrafil, A. Littered Cigarette Butt as a Well-Known Hazardous Waste: A Comprehensive Systematic Review. *J. Hazard. Mater.* **2020**, *383*, 121242. <https://doi.org/10.1016/j.jhazmat.2019.121242>.
- [9] Tekman, M.B.; Walther, B.A.; Peter, C.; Gutow, L.; Bergmann, M. *Impact of Plastic Pollution in the Oceans on Marine Species, Biodiversity and Ecosystems*. WWF: Berlin, Germany, 2022; pp. 1–221. <https://zenodo.org/records/5898684>.
- [10] Castro-Rosero, L.M.; Hernandez, I.; Mestres, M.; Liste, M.; Alsina, J.M.; Espino, M. Numerical Modeling of the Dispersion and Accumulation of Marine Litter from the Dniester River in Coastal Areas of the Northwestern Black Sea. *Mar. Pollut. Bull.* **2025**, *213*, 117602. <https://doi.org/10.1016/j.marpolbul.2025.117602>.
- [11] Karageorgis, A.P.; Kourafalou, V.H.; Anagnostou, C.; Tsiaras, K.P.; Raitos, D.E.; Papadopoulos, V.; Papadopoulos, A. River-Induced Particle Distribution in the Northwestern Black Sea (September 2002 and 2004). *J. Geophys. Res. Oceans* **2009**, *114*, C12. <https://doi.org/10.1029/2009JC005460>.
- [12] Vespremeanu, E.; Golumbeanu, M. Catchment Area of the Black Sea. In *The Black Sea*; Springer: Cham, Switzerland, 2018; pp. 15–25. https://doi.org/10.1007/978-3-319-70855-3_3.
- [13] Castro-Rosero, L.M.; Hernandez, I.; Alsina, J.M.; Espino, M. Transport and Accumulation of Floating Marine Litter in the Black Sea: Insights from Numerical Modeling. *Front. Mar. Sci.* **2023**, *10*, 1213333. <https://doi.org/10.3389/fmars.2023.1213333>.
- [14] Berov, D.; Klayn, S. Microplastics and Floating Litter Pollution in Bulgarian Black Sea Coastal Waters. *Mar. Pollut. Bull.* **2020**, *156*, 111225. <https://doi.org/10.1016/j.marpolbul.2020.111225>.
- [15] Cincinelli, A.; Scopetani, C.; Chelazzi, D.; Martellini, T.; Pogojeva, M.; Slobodnik, J. Microplastics in the Black Sea Sediments. *Sci. Total Environ.* **2021**, *760*, 143898. <https://doi.org/10.1016/j.scitotenv.2020.143898>.
- [16] Ioakeimidis, C.; Zeri, C.; Kaberi, H.; Galatchi, M.; Antoniadis, K.; Streftaris, N.; Galgani, F.; Papatheodorou, E.; Papatheodorou, G. A Comparative Study of Marine Litter on the Seafloor of Coastal Areas in the Eastern Mediterranean and Black Seas. *Mar. Pollut. Bull.* **2014**, *89*, 296–305. <https://doi.org/10.1016/j.marpolbul.2014.09.044>.
- [17] Bekova, R.; Prodanov, B. Spatiotemporal Variation in Marine Litter Distribution along the Bulgarian Black Sea Sandy Beaches: Amount, Composition, Plastic Pollution, and Cleanliness Evaluation. *Front. Mar. Sci.* **2024**, *11*, 1416134. <https://doi.org/10.3389/fmars.2024.1416134>.
- [18] Bat, L.; Öztekin, A.; Öztürk, D.K.; Gürbüz, P.; Özsandıkçı, U.; Eyüboğlu, B.; Öztekin, H.C. Beach Litter Contamination of the Turkish Middle Black Sea Coasts: Spatial and Temporal Variation, Composition, and Possible Sources. *Mar. Pollut. Bull.* **2022**, *185*, 114248. <https://doi.org/10.1016/j.marpolbul.2022.114248>.
- [19] Marin, D.; Ciucă, A.-M.; Filimon, A.; Stoica, E. Marine Litter and Plastic Detection on Black Sea Beaches by Using Unmanned Aerial Vehicle (UAV). *Ovidius Univ. Ann. Chem.* **2024**, *35 (I)*, 43–50. <https://doi.org/10.2478/auoc-2024-0006>.
- [20] Terzi, Y.; Gündoğdu, S.; Yandi, İ.; Altınpinar, İ.; Öztürk, R.Ç.; Gedik, K. Marine Litter on the Turkish Black Sea Shoreline: Abundance, Composition, and Sources. *Waste Manag.* **2025**, *205*, 115027. <https://doi.org/10.1016/j.wasman.2025.115027>.
- [21] Stoica, E.; Nenciu, M.; Creangă, S.M.; Tănase, M.C.; Marin, D.; Ciucă, A.M.; Pătrașcu, V. Assessment of the Marine Litter on the Romanian Black Sea Beaches. *Cercet. Mar. Rech. Mar.* **2021**, *51*, 49. <https://doi.org/10.55268/CM.2021.51.49>.

- [22] Machitadze, N.; Bilashvili, K.; Gvakharia, V.; Gelashvili, N.; Kuzanova, I.; Trapaidze, V. Analysis of the Monitoring of the Beach Litter in Georgia. In *Marine Litter in the Black Sea*; Aytan, Ü.; Pogojeva, M.; Simeonova, A., Eds.; Turkish Marine Research Foundation (TUDAV): Istanbul, Türkiye, 2020; pp. 37-47.
- [23] Mihova, S.; Doncheva, V.; Stefanova, K.; Stefanova, E.; Popov, D.; Panayotova, M. Plastic Ingestion by *Phocoena phocoena* and *Tursiops truncatus* from the Black Sea. In *Environmental Protection and Disaster Risks*; Springer: Cham, Switzerland, 2023; pp. 295–307. https://link.springer.com/chapter/10.1007/978-3-031-26754-3_26.
- [24] Aytan, U.; Esensoy, F.B.; Senturk, Y. Microplastic Ingestion and Egestion by Copepods in the Black Sea. *Sci. Total Environ.* **2022**, *806*, 150921. <https://doi.org/10.1016/j.scitotenv.2021.150921>.
- [25] Şentürk, Y.; Esensoy, F.B.; Öztekin, A.; Aytan, Ü. Microplastics in Bivalves in the Southern Black Sea. In *Marine Litter in the Black Sea*; Aytan, Ü.; Pogojeva, M.; Simeonova, A., Eds.; Turkish Marine Research Foundation (TUDAV): Istanbul, Türkiye, 2020; pp.303-313.
- [26] Aytan, U.; Esensoy, F.B.; Senturk, Y.; Arifoglu, E.; Karaoglu, K.; Ceylan, Y.; Valente, A. Plastic Occurrence in Commercial Fish Species of the Black Sea. *Turk. J. Fish. Aquat. Sci.* **2021**, *22*. <https://doi.org/10.4194/TRJFAS20504>.
- [27] Ciucă, A.-M.; Manea, M.; Barbeş, L.; Stoica, E. Marine Birds' Plastic Ingestion: A First Study at the Northwestern Black Sea Coast. *Estuar. Coast. Shelf Sci.* **2025**, *313*, 109032. <https://doi.org/10.1016/j.ecss.2024.109032>.
- [28] Lechner, A.; Keckeis, H.; Lumesberger-Loisl, F.; Zens, B.; Krusch, R.; Tritthart, M.; Glas, M.; Schludermann, E. The Danube so Colourful: A Potpourri of Plastic Litter Outnumbers Fish Larvae in Europe's Second Largest River. *Environ. Pollut.* **2014**, *188*, 177–181. <https://doi.org/10.1016/j.envpol.2014.02.006>.
- [29] Radu, M.; Diacu, E.; Ionescu, P.; Ivanov, A.A. Application of Multivariate Statistical Techniques to Assess Water Quality of the Lower Danube. *U.P.B. Sci. Bull., Series B* **2017**, *79*.
- [30] Stoica, E.; Atabay, H.; Bat, L.; Ciuca, A.; Creanga, S.; Marin, D.; Öztekin, A.; Tanase, M.; Tolun, L. Marine Litter Occurrence in the River-Influenced Black Sea Coast. In *Marine Litter in the Black Sea*; Aytan, Ü.; Pogojeva, M.; Simeonova, A., Eds.; Turkish Marine Research Foundation (TUDAV): Istanbul, Türkiye, 2020; pp. 49–62.
- [31] European Commission. Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 Establishing a Framework for Community Action in the Field of Marine Environmental Policy (Marine Strategy Framework Directive). *Off. J. Eur. Union* **2008**. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32008L0056> (accessed on 23 September 2026)
- [32] Van Loon, W.; Hanke, G.; Fleet, D.; Werner, S.; Barry, J.; Strand, J.; Eriksson, J.; Galgani, F.; Gräwe, D.; Schulz, M.; et al. *A European Threshold Value and Assessment Method for Macro Litter on Coastlines*. Publications Office of the European Union: Luxembourg, 2020. Available online: <https://publications.jrc.ec.europa.eu/repository/handle/JRC121707> (accessed on 23 September 2026)
- [33] Galgani, F.; Ruiz-Orejon, L.F.; Ronchi, F.; Tallec, K.; Fischer, E.K.; Matiddi, M.; Anastasopoulou, A.; Andresmaa, E.; Angiolillo, M.; Bakker Paiva, M.; et al. *Guidance on the Monitoring of Marine Litter in European Seas: An Update to Improve the Harmonised Monitoring of Marine Litter under the Marine Strategy Framework Directive*. Publications Office of the European Union: Luxembourg, 2023. Available online: <https://op.europa.eu/en/publication-detail/-/publication/43d9f818-9a30-11ee-b164-01aa75ed71a1> (accessed on 23 September 2026)

- [34] Alkalay, R.; Pasternak, G.; Zask, A. Clean-Coast Index—A New Approach for Beach Cleanliness Assessment. *Ocean Coast. Manag.* **2007**, *50*, 198–208. <https://doi.org/10.1016/j.ocecoaman.2006.10.002>.
- [35] Torkashvand, J.; Godini, K.; Jafari, A.J.; Esrafil, A.; Farzadkia, M. Assessment of Littered Cigarette Butt in Urban Environment, Using a New Cigarette Butt Pollution Index (CBPI). *Sci. Total Environ.* **2021**, *769*, 144864. <https://doi.org/10.1016/j.scitotenv.2020.144864>.
- [36] Portman, M.E.; Brennan, R.E. Marine Litter from Beach-Based Sources: Case Study of an Eastern Mediterranean Coastal Town. *Waste Manag.* **2017**, *69*, 535–544. <https://doi.org/10.1016/j.wasman.2017.07.040>.
- [37] Rangel-Buitrago, N.; Mendoza, A.V.; Mantilla-Barbosa, E.; Arroyo-Olarte, H.; Arana, V.A.; Trilleras, J.; Gracia, A.; Neal, W.J.; Williams, A.T. Plastic Pollution on the Colombian Central Caribbean Beaches. *Mar. Pollut. Bull.* **2021**, *162*, 111837. <https://doi.org/10.1016/j.marpolbul.2020.111837>.
- [38] Fleet, D.; Vlachogianni, T.; Hanke, G. *A Joint List of Litter Categories for Marine Macrolitter Monitoring: Manual for the Application of the Classification System*. Publications Office of the European Union: Luxembourg, 2021. Available online: <https://op.europa.eu/en/publication-detail/-/publication/109e96ce-903f-11eb-b85c-01aa75ed71a1/language-en/>
- [39] European Commission. *Online Photo Catalogue of the Joint List of Litter Categories*. Available online: European Commission Joint List of Litter Categories Photo Catalogue Available online: <https://mcc.jrc.ec.europa.eu/main/dev.py?N=41&O=459>.
- [40] Bekova, R.; Prodanov, B. Assessment of Beach Macrolitter Using Unmanned Aerial Systems: A Study along the Bulgarian Black Sea Coast. *Mar. Pollut. Bull.* **2023**, *196*, 115625. <https://doi.org/10.1016/j.marpolbul.2023.115625>.
- [41] MSFD Technical Group on Marine Litter; Hanke, G.; Walvoort, D.; Ruiz-Orejón, L.F.; Van Loon, W.M.G.M.; Giorgetti, A.; Molina-Jack, M.E.; Vinci, M.; et al. *European Coastline Macro Litter Trends 2015–2021: Methodology Development and Trend Results for the Marine Strategy Framework Directive*. Publications Office of the European Union: Luxembourg, 2025.
- [42] Derraik, J.G.B. The Pollution of the Marine Environment by Plastic Debris: A Review. *Mar. Pollut. Bull.* **2002**, *44*, 842–852. [https://doi.org/10.1016/S0025-326X\(02\)00220-5](https://doi.org/10.1016/S0025-326X(02)00220-5).
- [43] Aytan, U.; Esensoy Sahin, F.B.; Karacan, F. Beach Litter on Sarayköy Beach (SE Black Sea): Density, Composition, Possible Sources and Associated Organisms. *Turk. J. Fish. Aquat. Sci.* **2020**, *20*, 85–96. https://doi.org/10.4194/1303-2712-v20_2_06.
- [44] Erüz, C.; Terzi, Y.; Ismail, N.P.; Özşeker, K.; Başkan, N.; Karakoç, F.T. From Source to Sink: A Comparative Study of Streamside and Beach Litter in the Black Sea. *Waste Manag.* **2023**, *161*, 94–105. <https://doi.org/10.1016/j.wasman.2023.02.025>.
- [45] González-Fernández, D.; Hanke, G.; Pogojeva, M.; Machitadze, N.; Kotelnikova, Y.; Tretiak, I.; Savenko, O.; Bilashvili, K.; Gelashvili, N.; Fedorov, A.; et al. Floating Marine Macro Litter in the Black Sea: Toward Baselines for Large Scale Assessment. *Environ. Pollut.* **2022**, *309*, 119816. <https://doi.org/10.1016/j.envpol.2022.119816>.
- [46] Heaton, C.G.; Cummings, K.M.; O'Connor, R.J.; Novotny, T.E. Butt Really? The Environmental Impact of Cigarettes. *Tob. Control* **2011**, *20*, 207–212. <https://doi.org/10.1136/tc.2011.043729>.
- [47] Munari, C.; Corbau, C.; Simeoni, U.; Mistri, M. Marine Litter on Mediterranean Shores: Analysis of Composition, Spatial Distribution and Sources in North-Western Adriatic Beaches. *Waste Manag.* **2016**, *49*, 483–490. <https://doi.org/10.1016/j.wasman.2015.12.010>.
- [48] Belzagui, F.; Buscio, V.; Gutiérrez-Bouzán, C.; Vilaseca, M. Cigarette Butts as a Microfiber Source with a Microplastic Level of Concern. *Sci. Total Environ.* **2021**, *762*, 144165. <https://doi.org/10.1016/j.scitotenv.2020.144165>.

- [49] United Nations Environment Programme (UNEP). *Single-Use Plastics: A Roadmap for Sustainability*. 2018. Available online: UNEP Single-Use Plastics Report (accessed on 12 January 2025).
- [50] Jambeck, J.R.; Geyer, R.; Wilcox, C.; Siegler, T.R.; Perryman, M.; Andrady, A.; Narayan, R.; Law, K.L. Plastic Waste Inputs from Land into the Ocean. *Science* **2015**, *347*, 768–771. <https://doi.org/10.1126/science.1260352>.
- [51] Wilcox, C.; Mallos, N.J.; Leonard, G.H.; Rodriguez, A.; Hardesty, B.D. Using Expert Elicitation to Estimate the Impacts of Plastic Pollution on Marine Wildlife. *Mar. Policy* **2016**, *65*, 107–114. <https://doi.org/10.1016/j.marpol.2015.10.014>.
- [52] HELCOM. *Beach Litter: HELCOM Core Indicator Report*. 2023. Available online: HELCOM Beach Litter Core Indicator Report (accessed on 12 January 2025).
- [53] Arthur, C.; Baker, J.; Bamford, H. *Proceedings of the International Research Workshop on the Occurrence, Effects, and Fate of Microplastic Marine Debris*. NOAA Technical Memorandum NOS-OR&R-30; NOAA: Silver Spring, MD, USA, 2009.
- [54] Wright, S.L.; Thompson, R.C.; Galloway, T.S. The Physical Impacts of Microplastics on Marine Organisms: A Review. *Environ. Pollut.* **2013**, *178*, 483–492. <https://doi.org/10.1016/j.envpol.2013.02.031>.
- [55] Cîmpean, I.-A.; Chiriac, F.L.; Ștefan, D.-S. Preliminary Assessment of Bisphenol A Adsorption on Microplastics: Capacity, Efficiency and Control Factors. *U.P.B. Sci. Bull., Series B* **2026**, *87*.

Supplementary Materials

Table S1. List of macro-litter items collected from Malibu beach and the proportion of each category and subcategory.

Type-Code	Macro-litter type	TOTAL (%)
CHEMICALS		0
CLOTH/TEXTILES		0.94
ct nn tex	other textiles	0.2
ct cl clg	clothing	0.74
FOOD WASTE		0
GLASS/CERAMICS		1.69
gc nn gfr	pieces of glass/ceramic (glass or ceramic fragments ≥ 2.5 cm)	1.62
gc nn occ ogli	other glass items	0.07
METAL		9.64
me nn b&c lids	metal bottle caps, lids & pull tabs from cans	0.2
me co cab	metal cables	0.2
me fc b&c cans bevg	metal drinks cans	7.22
me nn foi	metal foil wrappers, aluminium foil	1.82
me nn ome smal	other metal pieces $2.5\text{cm} \geq \leq 50\text{cm}$	0.13
me nn wir	wire, wire mesh, barbed wire	0.07
ARTIFICIAL POLYMER MATERIALS /PLASTIC		80.99
pl ag ghs	plastic sheeting from greenhouses	0.07
pl cl ftw flip	plastic flip-flops	0.07
pl cl glv hogl	plastic gloves (household/dishwashing,	0.07

	gardening)	
pl_co_oco_	plastic construction waste (not foamed insulation)	0.07
pl_fc b&c dbot smll	plastic drink bottles ≤ 0.5 l	0.33
pl_fc b&c lids drnk	plastic caps/lids drinks	5.06
pl_fc b&c pfoc_	plastic food containers made of hard nonfoamed plastic	0.13
pl_fc tab cups hpcp	cups and lids of hard plastic	1.01
pl_fc tab cupt cutl_	plastic cutlery	0.4
pl_fc tab stst stir	plastic stirrers	0.27
pl_fc tab stst strw	plastic straws	3.8
pl_fc wrp cwls crsp	plastic crisps packets/sweets wrappers	6
pl_fc wrp cwls loly	plastic lolly & ice-cream sticks	4.25
pl_fi net smal	plastic nets and pieces of net $2.5 \text{ cm} \geq \leq 50 \text{ cm}$	0.07
pl_hy ohy	other plastic personal hygiene and care items	0.07
pl_hy stt tamp_	plastic tampons and tampon applicators	0.07
pl_hy wws	plastic wet wipes	5.2
pl_md_omd_	other plastic medical items (swabs, bandaging, adhesive plasters etc.)	0.33
pl_md_pha_	plastic medical/ pharmaceuticals containers/tubes/ packaging	0.07
pl_md syg_	plastic syringes/needles	0.07
pl_nn b&c lids olid	plastic caps/lids unidentified	1.01
pl_nn b&c lids ring	plastic rings from bottle caps/lids	0.74
pl_nn bag dogb_	plastic dog/pet faeces bag	0.07
pl_nn bag ends	the part that remains from tear-off plastic bags	8.3
pl_nn bag smbg	small plastic bags	0.27
pl_nn cbt	plastic cable ties	0.7
pl_nn frg_fopy_smal_	fragments of foamed polystyrene $2.5 \text{ cm} \geq \leq 50 \text{ cm}$	2.02
pl_nn frg_nofp_smal_	fragments of non-foamed plastic $2.5 \text{ cm} \geq \leq 50 \text{ cm}$	14.71
pl_nn pen_	plastic pens and pen lids	0.13
pl_nn rps_strg_nodr_	plastic string and cord (diameter less than 1cm) not from dolly ropes or unidentified	1.35
pl_nn stb	plastic strapping bands	0.2
pl_re toy	plastic toys and party poppers	0.13
pl_sm_but_	tobacco products with filters (cigarette butts with filters)	22.75
pl_sm lht	plastic cigarette lighters	0.5
pl_sm_tob_	plastic tobacco pouches / plastic cigarette packet packaging	0.7
PAPER/CARDBOARD		3.83
pp_fc tab cups	paper cups	0.33
pp_nn frg	paper fragments	3.03
pp_nn opp	other paper items	0.07
pp_sm cig	paper cigarette packets	0.4
RUBBER		1.5
ru_hy con	rubber condoms (incl. packaging)	0.07
ru_nn_bnd_	rubber band (small, for kitchen/household/post	0.29

	use)	
ru nn oru	other rubber pieces	0.06
ru re bln	rubber balloons	1.08
PROCESSED/WORKED WOOD		1.41
wo nn owo smal	other processed wooden items 2.5 cm $\geq \leq$ 50 cm	0.07
wo fc b&c cork	wooden corks	1.21
wo_fc_ice_	wooden ice-cream sticks, chip forks, chopsticks, toothpicks	0.13

Table S2. List of macro-litter items collected from Vadu beach and the proportion of each category and subcategory.

Type-Code	Macro-litter type	TOTAL (%)
CHEMICALS		0
CLOTH/TEXTILES		2.07
ct nn tex	other textiles	2.06
FOOD WASTE		0
GLASS/CERAMICS		12.41
gc nn_gfr_	pieces of glass/ceramic (glass or ceramic fragments $\geq$ 2.5 cm)	12.41
METAL		2.76
me nn b&c lids	metal bottle caps, lids & pull tabs from cans	2.76
ARTIFICIAL POLYMER MATERIALS /PLASTIC		73.13
pl co fom pain insu	foamed plastic insulation, including spray foam	1.38
pl_co_oco_	plastic construction waste (not foamed insulation)	1.38
pl fc b&c lids drnk	plastic caps/lids drinks	8.27
pl_fc_b&c_pfoc_	plastic food containers made of hard nonfoamed plastic	0.7
pl fc tab cups hpcp	cups and lids of hard plastic	2.07
pl fc tab stst strw	plastic straws	2.75
pl fc wrp cwls loly	plastic lolly & ice-cream sticks	2.75
pl_fi_net_strg_drop_	plastic string and filaments exclusively from dolly ropes	0.7
pl_fi_ofi_	other plastic fisheries related items not covered by other categories	0.7
pl hy wws	plastic wet wipes	1.37
pl nn b&c lids olid	plastic caps/lids unidentified	2.07
pl nn b&c lids ring	plastic rings from bottle caps/lids	3.44
pl nn bag_ends	the part that remains from tear-off plastic bags	6.2
pl nn bag_smbg	small plastic bags	0.7
pl nn cbt	plastic cable ties	1.38
pl_nn_frg_nofp_smal_	fragments of foamed polystyrene 2.5 cm $\geq \leq$ 50 cm	26.2
pl nn pai	plastic paint brushes	0.7
pl_nn_rps_strg_nodr_	plastic string and cord (diameter less than 1cm) not from dolly ropes or unidentified	0.7
pl nn stb	plastic strapping bands	1.37
pl_nn_tag_	plastic tags (fishing, shipping, farming and	0.7

	industry)	
pl_re_toy	plastic toys and party poppers	0.7
pl_sm_but_	tobacco products with filters (cigarette butts with filters)	6.9
PAPER/CARDBOARD		1.36
pp_fc_tab_cups	paper cups	0.68
pp_nn_frg	paper fragments	0.68
RUBBER		0
PROCESSED/WORKED WOOD		8.27
wo_nn_owo_smal_	other processed wooden items $2.5\text{ cm} \leq 50\text{ cm}$	8.27