Marine Litter Assessment on Some Beaches Along the Southeastern Adriatic Coastline (Albania)

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Contents

Abstract Marine litter is a truly global challenge, changing all oceans and seas of the world. Every year, millions of tons of litter end up in the coastal and marine environment worldwide, resulting in environmental, economic, health, and safety impacts. This study investigated the abundance, composition, and sources of marine litter stranded on four beaches located at Durrës Bay and in the Gulf of Drin, which also includes Rodoni Bay and Shëngjini Bay along the Albanian southern-eastern

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Adriatic coastline. During the winter 2015, 12 beach transects were surveyed, covering 12,000 m^2 and extending over 1,000 m of the coastline. The mean litter density of the total four beaches studied was 219 items/100 m and 0.219 items/m^2. The majority of litter items (58%) were plastic or artificial polymer materials. Other bottles and containers (drums) were the most frequently found items with a percentage of 6%, followed by cartons/tetra pack (others) with 5.7% and by cigarette butts and filters with 3.7%. The sites investigated differed in terms of human-induced pressures with two sites classified as semi-urban: one site as urban and one as rural. Litter from shoreline sources such as tourism and recreational activities, including poor waste management practices, accounted for 37.5% of litter collected, accounting for the vast majority of litter items. Sea-based sources of litter (fisheries and aquaculture, shipping) amounted to 8% of total litter items on all beach locations.

1   Introduction

The Mediterranean basin is one of the world's biodiversity hotspots and one of the most polluted and affected seas worldwide by marine litter. In the Mediterranean Sea, marine litter is a major threat for living marine organisms [1–3]. Research indicates that plastic pollution may impact biodiversity, ecosystem services, food security, and human health. Briefly, plastic pollution is a global threat [4]. Plastic marine litter observed in the Mediterranean Sea is widely distributed over various environmental compartments such as water, coastlines, bottom sediments, and biota and poses a considerable risk to ecosystems and human health [5].

The Adriatic Sea is an elongated basin, with its major axis in the NW-SE direction, between Italy and the Balkans, located in the central Mediterranean. The Adriatic Sea is characterized by one of the greatest floating plastic particles pollution among Mediterranean regions [6, 7]. The mean particles' half-life (i.e., the time after which 50% of the particles still remain on the sea surface) is estimated to be approximately 43.7 days [8]. Thus, the Adriatic Sea is a highly dissipative system with respect to floating plastics (in contrast to the global ocean, where the half-lifetime of particles equals 19 years). This result suggests that the main sink of floating plastics is partitioned between the shoreline and the seafloor, posing an additional risk to such ecosystems [7].

About 60% of the Albanian population lives in coastal areas. In 1991, closure of the industries helped diminish environmental pollution including in the coastal water. However, there is also an increase in urban pollution in the coastal area caused by the tourism development mainly in the Adriatic coast and by the increasing number of inhabitants in the main Albanian cities like Tirana, Durrës, and Vlora

[9]. Durrës County has a coastline of some 62 km along the Adriatic Sea, extending from Lalzi Bay till the area of Golem in Durrës Bay. Recent publications also include the quality of the coastal waters at Durrës Bay [10–14]. Plastic was the dominant substance of marine litter in Albanian Adriatic coastal waters in our previous studies [15, 16]. The shoreline of the Gulf of Drin has a length of approximately 60 km and is spotted of cliffs and beaches fed by fluvial imputes. The region is drained by numerous rivers and has formed a characteristic ecosystem and biodiversity.

The first aim of this study is to focus on assessing the abundance, composition, and sources of marine macro-litter (>2.5 cm) on four beaches located along the Albanian coastline – at Durrës Bay, inside the Gulf of Drin, such as Rodoni and Shëngjini Bays, and also Velipoja, as part of the southeastern Adriatic Sea coastline. The second aim is to understand the situation about marine macro-litter on Albanian beaches and to compare them to the Clean Coast Index or other similar studies.

At the national level, this study directly feeds into the implementation of the Regional Plan for Marine Litter Management in the Mediterranean of the Barcelona Convention [17].

2 Materials and Methods

2.1 Study Area

The beach litter surveys were carried out on beaches located at Durrës Bay, Rodoni Bay, the Gulf of Drin, and Shëngjini Bay in Albania (Fig. 1a, b). Durrës County is located on a flat alluvial and coastal plain in the southeastern Adriatic Sea, at one of the narrowest points opposite the cities of Bari and Brindisi in Italy. Durrës is the second largest city in the country with a population of some 200,000 people, and its harbor ranks as the largest passenger port in Albania and one of the largest in the Adriatic Sea [18].

Along the coastline of Durrës Bay, almost all parts have been subjected to human-induced pressures. Undoubtedly, construction works and man-made structures are predominant, while tourism and recreational activities are very intensive. Ishmi village is located 52.6 km from Durrës city center. A river with the same name, the Ishmi River flows through Durrës County and is the biggest river in this area. It is formed by several rivers which have their sources northeast of Tirana in the Skanderbeg Mountains beyond the Kruja area. Durrës plain is divided from Tirana by a long range of hills known as the Kodra e Gjatë to the east of the port city. The Ishmi River discharges into the Adriatic Sea to the southwest of Laç in Rodon Bay, which is bounded on the western edge by the Cape of Rodon and forms part of the Gulf of Drin. According to Pano [19], the drainage basin of the Ishmi covers a total area of 673 km^2. The average discharge at the mouth of the river is 20.9 m^3/s. The highest annual discharge is over six times the annual minimum.

The Gulf of Drin is an ocean basin of the Adriatic Sea within the Mediterranean Sea at the northern coast of Albania. Roughly in a shape of a scythe, it extends

Fig. 1 (**a**, **b**) Locations of studied beaches along the Albanian southern-eastern Adriatic coastline. Maps with the surveyed transects on four studied beaches: (**a**) Plepa, (**b**) Ishmi, (**c**) Velipoja, (**d**) Shëngjini (https://geoportal.asig.gov.al/map/ modified by Erion Gjyli)

immediately from the Delta of Buna in the north, across the port city of Shëngjini, to the Cape of Rodon in the south. The shoreline of the gulf is a combination of sandy shallow beaches, sand dunes, capes, salty and freshwater wetlands, estuaries, pine and coastal forests, reed beds, and coastal meadows. The Velipoja region is located about 28 km away from Shkodër town. Shkodër is the fourth most populated city in Albania and the largest city in the Shkodër County with a population of some 136,000 people. The Velipoja complex consists of Viluni lagoon, Velipoja Managed Reserve, Franz Josef promontory/island, and Buna delta. The freshwater marshes of Domni and Murteme extend along the road to Velipoja. Velipoja as part of the Gulf of Drin is also a touristic center with a wide range of accommodation options and vast opportunities to see the natural wonders of the region and to relax, especially during summer. The sediments of the Buna River also play an important role in the

morphology of the seashore and the coastline with the strong coastal erosion in the Velipoja plain. A pine belt has been planted to stabilize the dunes [20].

The towns of Lezhë and Shëngjini (combined about 30,000 inhabitants) are appropriate centers to start wetland excursions to the Drin delta. Lezhë is situated at the main road from Tirana to Shkodër and Shëngjini town as the city port is about 8 km distant from Lezhë toward the sea. Both cities, especially Shëngjini, offer a wide range of accommodation options and are attractive to tourists not only in terms of nature but also as a vacation site, especially in summer. The sites investigated differed in terms of human-induced pressures with two sites classified as semi-urban, one site as urban and one as rural (Table 1) in accordance with the approach proposed by Semeoshenkova et al. [21].

Marine litter was assessed on all four investigated free-access beaches: Plepa, Ishmi, Velipoja, and Shëngjini (Fig. 1a, b). The first beach is located in the Durrës Bay, the second in Rodon Bay, the third in the Gulf of Drin, and the fourth in Shëngjini Bay, near the port of Shëngjini. The three last beaches are part of the Gulf of Drin, which extends immediately from the Delta of Buna in the north across the port city of Shëngjini to the Cape of Rodon in the south.

2.2   Methods

The beach litter surveys were performed in line with the operational guidelines produced by the EU MSFD Technical Group on Marine Litter and described by Galgani et al. [22]. Three 100 m transects were randomly positioned along the strandline of four beaches, covering a width of 10 m toward the back of the beach and ensuring that they are separated at least by a 50 m stretch. Three sampling units (100 m $\times$ 10 m) were assessed on each beach. During winter, in January and February 2015, 12 beach transects were surveyed, covering 12,000 m^2 and extending over 1,000 m along the coastline. All litter items on the beach surface larger than 2.5 cm in the longest dimension were collected in the area defined by the strandline and all the way toward the back of the beach. In the end all beaches were cleaned.

2.3   Data Analysis and Processing

The density of litter items per m^2 was calculated: $C_M = n/(w \times l)$, where C_M is the density of litter items per m^2, n is the number of litter items recorded, and w and l are the width and length of the sampling unit in meter, respectively [23]. The number of items per 100 m stretch was also calculated. The cleanliness of the beach was assessed through the Clean Coast Index (CCI): $CCI = C_M \times K$, where C_M is the density of litter items per m^2 and K is a constant that equals to 20. According to the CCI scale: 0–2 are very clean beaches, 2–5 clean, 5–10 moderately clean, 10–20

Table 1 Key features of four surveyed beaches affecting the beach marine litter densities

Area-Bay	Coordinates of the areas	Beach	Beach type	Development behind the beach	Primary area usage	Secondary area usage	Prevailing winds	Prevailing currents	Distance from the closest harbor[a] (km)	Distance from the closest town[b] (km)	Presence of cleaning activities	Distance from the closest river mouth[c] (km)
Durrës Bay	41°17′05.9″N 19°30′35.7″E	Plepa	Semi-urban	Yes	Tourism and recreation	Residential area	NNW	S	5.5	9.1	Seasonal	17.35
Rodon Bay	41°34′58.3″N 19°27′36.2″E	Ishmi	Rural	No	Tourism and recreation	Coastal fishing	NW	SW	20.0	50.2	Seasonal	8.0
The Gulf of Drin	41°51′45.4″N 19°24′53′E	Velipoja	Semi-urban	Yes	Tourism and recreation	Coastal fishing	NW	SW	15.0	29.9	Seasonal	3.3
Shëngjini Bay	41°48′21′N 19°35′59′E	Shëngjini	Urban	Yes	Tourism and recreation	Residential area	NW	SW	0.8	0.9	Seasonal	6.67

[a]The distance from the closest harbour is calculated for two ports, respectively: Durrës port, Romano port and Shëngjini port
[b]The distance from the closest town is calculated for three towns, respectively: Durrës, Shkodër and Lezhë
[c]The distance from the closest river mouth is calculated for four rivers in the area: Erzeni River, Ishmi River, Buna River and Drin River

dirty, and >20 extremely dirty [24]. According to the Master List of Categories of Litter Items, the marine litter items recorded of our study were classified into eight major groups of material types: as artificial polymer materials, rubber, cloth/textile, paper/cardboard, processed/worked wood, metal, glass/ceramics, and unidentified items and/or chemicals [22]. The collected marine litter items were also classified into three major groups of items: single-use plastics, non-single-use plastics, and non-plastic marine litter items. According to UNEP [25], the following 14 items were considered as single-use plastics: shopping bags, including pieces (G3), drink bottles ≤0.5 l (G7), drink bottles >0.5 l (G8), food containers including fast food containers (G10), plastic caps/lids from drinks (G21), cigarette butts and filters (G27), crisps packets/sweets wrappers (G30), lolly sticks (G31), cups and cup lids (G33), cutlery and trays (G34), straws and stirrers (G35), cotton bud sticks (G95), sanitary towels/panty liners/backing strips (G96), and toilet fresheners (G97). The sources of marine litter were classified into eight major categories: (1) shoreline, including poor waste management practices, tourism, and recreational activities; (2) fisheries and aquaculture; (3) shipping; (4) fly-tipping; (5) sanitary and sewage-related; (6) medical-related; (7) agriculture; and (8) non-sourced as described by Vlachogianni et al. [26]. The sources of marine litter were also classified as three major categories: (1) sea-based sources where fisheries, aquaculture, and shipping-related items are included; (2) land-based sources where shoreline, including poor waste management practices, tourism and recreational activities, medical-related, and agricultural-related items are included; and (3) mixed sources where sanitary and sewage-related, fly-tipping, and non-sourced items are included as described by Vlachogianni et al. [26].

For the statistical processing and the visualization of results, Microsoft Excel 2013 and Minitab 17 were used.

3 Results and Discussion

3.1 Litter Densities of Surveyed Beaches and Beach Cleanliness

The mean litter density of the four beaches studied was 219 items/100 m (range: 152–313 items/100 m) and 0.219 items/m^2 (range: 0.152–0.3131 items/m^2) (Fig. 2). The largest abundant beach in terms of items per 100 m stretch was observed in Ishmi with 313.3 items/100 m (0.313 items/m^2). The second largest was observed in Plepa with 227.3 items/100 m (0.227 items/m^2), followed by Velipoja with 183.3 items/100 m (0.183 items/m^2) and Shëngjini with 152.3 items/100 m (0.152 items/m^2).

Comparing litter density in items/m^2 of our southeastern Adriatic beaches with beaches in the north-western Adriatic coast of Italy (five beaches), the highest value was at Volano, two times higher than Ishmi and three times higher than Plepa litter
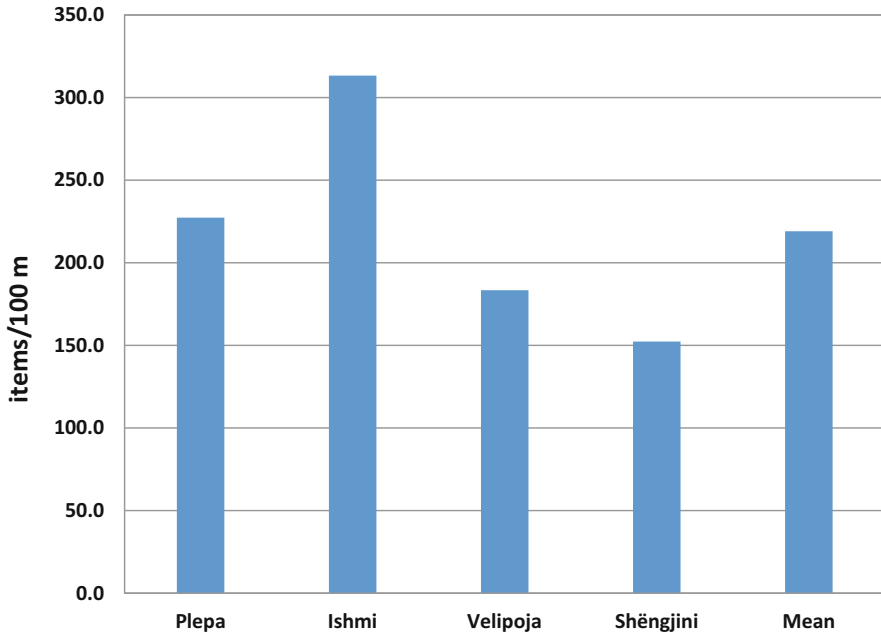
Fig. 2 Abundance of litter items for the beaches Plepa, Ishmi, Velipoja, and Shëngjini and the mean of total beaches (items per 100 m stretch)

density (0.16 items/m^2), whereas in Velipoja and Shëngjini, the situation is almost the same as in Bevano, Casalborsetti, Bellocchio, and Rosolina (Italy) [27].

Comparing the mean litter density of our study to marine litter in Mediterranean coastal and marine protected areas in northern Mediterranean countries [28], the mean litter density in items per m^2 on the beaches in Albania is three times lower than in Mediterranean coastal and marine protected areas of northern Mediterranean countries. If we compare the mean litter density of our study to beaches of the countries bordering the Adriatic and Ionian Seas [26], three times less litter (items/m^2) was detected on the Albanian beaches than on beaches along the Adriatic and Ionian Seas. According to Munari et al. [27], the litter density along the north-western Adriatic coastline of Italy (five beaches) is almost similar to the southeastern Adriatic coast of our study (four beaches). In Pelagos Sanctuary of Italy and on Black Sea beaches of Turkey, the mean litter densities are, respectively, five and four times higher than in our study [29, 30].

On Slovenian beaches and on the coast of Ecuador, the mean litter densities are both six times higher than in our study [31, 32], whereas on Mumbai and Spain beaches, they are, respectively, 314 times higher and two times lower than in our study [33, 34].

If we compare the mean litter density in items/100 m of our study to the Lithuanian Baltic coast, the density of marine litter is about the same as on our beaches, while comparing the mean litter density of our study to the German Baltic

coast, the density of marine litter is five times higher on the German Baltic coast than shown by our study [35].

Comparing the mean litter density of our study to marine litter in Japan and Israel, it is visible that the mean litter density in our study is two times lower than on Japanese beaches and 18 times higher than on Israel beaches [36, 37].

Comparing the results with other studies of Albania, the mean litter density of our study in items/m^2 is two times lower than along the Albanian coastline and almost the same in Zvernec, a protected area along the Albanian coastline [16, 28] (see Table 2).

The mean Clean Coast Index labelled our southeastern Adriatic beaches as a "Clean" beach area (CCI = 4.4). Comparing the mean Clean Coast Index of our southeastern Adriatic beaches with beaches along the north-western Adriatic coastline in Italy (five beaches, CCI = 4.5), both are labelled as "Clean" beaches [27].

Table 2 Beach marine litter densities in the Mediterranean and worldwide

Study area	No of surveyed beaches	Mean litter density (items/m^2 or items/ 100 m)	References
North-western Adriatic coast, Italy	5	0.2 items/m^2	[27]
Volano, north-western Adriatic coast, Italy	1	0.57 items/m^2	[27]
Bevano, north-western Adriatic coast, Italy	1	0.16 items/m^2	[27]
Casalborsetti, north-western Adriatic coast, Italy	1	0.14 items/m^2	[27]
Bellocchio, north-western Adriatic coast, Italy	1	0.13 items/m^2	[27]
Rosolina, north-western Adriatic coast, Italy	1	0.12 items/m^2	[27]
Mediterranean coastal and marine protected areas, northern Mediterranean countries	22	0.61 items/m^2	[28]
Zvernec, protected area Albania	1	0.13 items/m^2	[28]
Adriatic and Ionian Seas, all countries	31	0.67 items/m^2	[26]
Pelagos sanctuary, Italy	5	1.06 items/m^2	[29]
Turkey, Black Sea	10	0.884 items/m^2	[30]
Slovenian coast	6	1.25 items/m^2	[31]
Ecuador	26	1.31 items/m^2	[32]
Mumbai coast, India	4	68.83 items/m^2	[33]
Alicante, Spain	56	0.116 items/m^2	[34]
Lithuanian coast	4	222 items/100 m	[35]
German Baltic coast	31	47 items/100 m	[35]
Japanese coast	18	341 items/100 m	[36]
Israel	8	12.1 items per 100 m	[37]
Albania	5	0.14 items/m^2	[16]
Albania	4	0.219 items/m^2 or 219 items/100 m	Our study

The Clean Coast Index classified Ishmi as a "Moderate" beach (CCI = 6.3), whereas the other surveyed beaches were labelled as "Clean": Shëngjini with CCI = 3; Velipoja with CCI = 3.7; Plepa with CCI = 4.5. Comparing the Clean Coast Index of the southeastern Adriatic beaches to the five surveyed beaches along the north-western Adriatic coast in Italy, the beaches of both studies are labelled as "Clean," except for the beaches Volano ("Dirty" (CCI = 11.4), north-western Adriatic coast in Italy) and Ishmi ("Moderate" clean beach, southeastern Adriatic beaches) [27].

3.2 Marine Litter Composition of Surveyed Beaches

The marine litter items recorded were classified into eight major groups of material types: artificial polymer material, rubber, cloth/textile, paper/cardboard, processed/ worked wood, metal, glass/ceramics, and unidentified items and/or chemicals (Fig. 3). The majority of litter items at the aggregated level ("aggregate level"
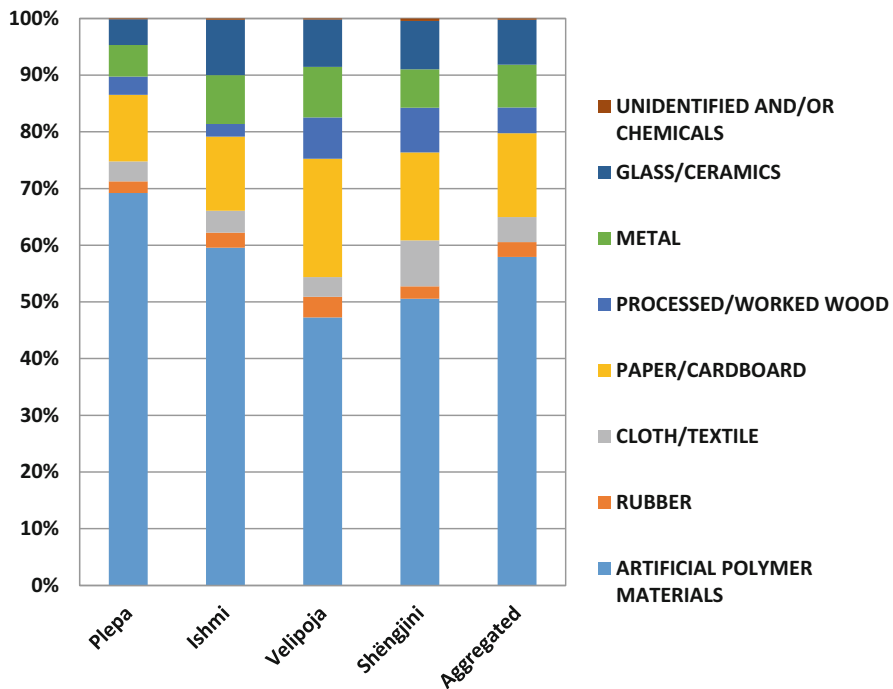
Fig. 3 Results of the percentage (%) of total litter items per material category type (artificial polymer materials, rubber, cloth/textile, paper/cardboard, processed/worked wood, metal, glass/ ceramics, and unidentified items and/or chemicals) on beaches: Plepa, Ishmi, Velipoja, Shëngjini, and the aggregated level

means the sum or the assemblage of many individuals level units/sum total.) were made of artificial polymer materials (58%, or 1,523 items of 2,629 total items). Similar results about the majority of litter items carried out on Slovenian beaches reported an amount of 64% of artificial polymer materials [31]. Italian beaches along the north-western Adriatic coastline had a greater majority of marine litter made of plastic (artificial polymer materials; 81%) [27]. In Durrës Bay and Lalzi Bay, artificial polymer materials (plastics) reached 65% [16].

At the beach level of our study, the percentage of plastics ranged from 47 to 69%, whereas Schernewski et al. [35] show that plastic dominates all transects on Lithuanian beaches with 64–91%. According to the recent study of Vlachogianni et al. [26], in almost all countries of the Adriatic-Ionian region (with the exception of Albania where plastics accounted for 54.3%), plastic items were in the range of 74–92% of total items recorded, while at the regional level of all countries of the Adriatic-Ionian Seas, the amount of plastics reached 91%.

According to Liubartseva et al. [5], in the majority of Mediterranean countries, more than 50% of plastics come from their own terrestrial sources (esp. Turkey, Morocco, Israel, Spain, France, Syria, Egypt, Albania, and Tunisia).

The second most abundant material type of litter items at the aggregated level of our southeastern Adriatic was paper/cardboard (15%, or 389 items). It was also the second most abundant group on Italian beaches along the north-western Adriatic coastline [27], amounting to 7%. In contrast, in almost all countries of the Adriatic-Ionian region, the second most abundant group was glass/ceramics (3.2%) [26]. According to Schernewski et al. [35], the second most common litter was rubber on Lithuanian beaches.

The third most abundant group of items at the aggregated level of our southeastern Adriatic beaches comprises both glass/ceramics and metal and amounts to 8%. The third most abundant group of items at the aggregated level according to Munari et al. [27] also consists of glass and ceramics (3.9%) on the beaches along the north-western Adriatic coastline in Italy. According to Schernewski et al. [35], glass was also the third most abundant group on monitored Lithuanian beaches. The third most abundant group of items at the aggregated level was made of metal (1.5%) in almost all countries of the Adriatic-Ionian region [26].

This group was followed by items made of processed/worked wood (5%) and cloth/textile (4%), as well as rubber (3%) on our southeastern Adriatic beaches. No items classified as unidentified or chemicals related were found. According to Munari et al. [27], on the beaches along the north-western Adriatic coastline in Italy, foamed plastic (3.3%), rubber (1.4%), and wood (1.2%) were found. In almost all countries of the Adriatic-Ionian region, paper (1.4%), cloth/textile (1.1%), and rubber items 0.6% were counted [26].

On each studied beach, the highest percentage of plastics was recorded at Plepa (69%, 472 items), followed by Ishmi (60%, 560 items) and Shëngjini (51%, 231 items), whereas the lowest percentage of plastics was recorded for Velipoja (47%, 260 items). On Velipoja beach, paper/cardboard included 21%, on Plepa beach only 12%.

Cluster analysis was performed to identify the linkage and similarities of the four beaches. Figure 4 shows an example of a dendrogram that used the absolute abundance values of the eight groups of material types of each beach as input data
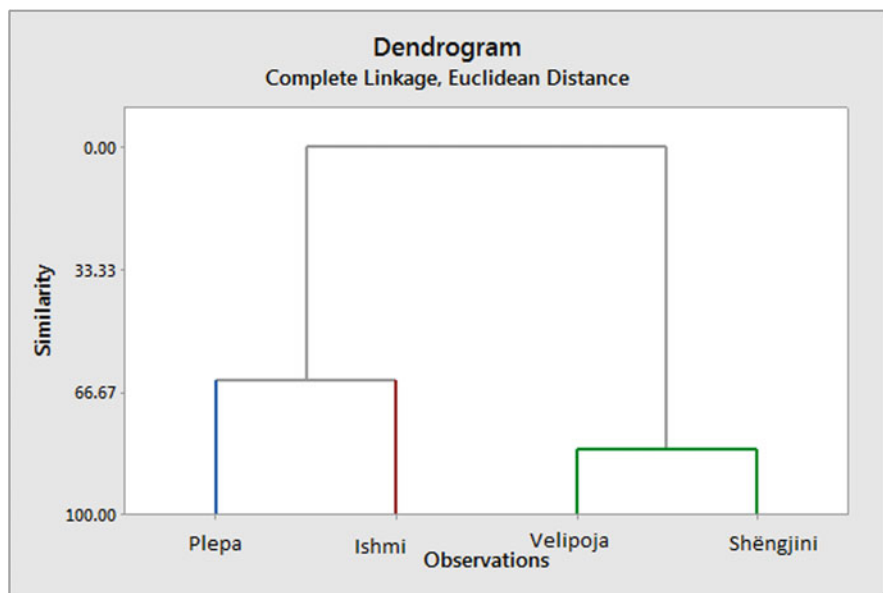
Fig. 4 Dendrogram resulting from a cluster analysis applying the complete linkage method using the Euclidean distance measure of proximity. Absolute abundance values of material types of each beach were used as input data (artificial polymer materials, rubber, cloth/textile, paper/cardboard, processed/worked wood, metal, glass/ceramics, and unidentified items and/or chemicals). Beaches of the same cluster are marked with the same color

(such as artificial polymer materials, rubber, cloth/textile, paper/cardboard, processed/worked wood, metal, glass/ceramics, and unidentified items and/or chemicals). Cluster analysis of the studied sites revealed three distinct groups. The third one refers to the beaches of Velipoja and Shëngjini, which are characterized by a strong similarity (82.5%) in terms of the total abundance of items (550 and 457, respectively) and of artificial polymer materials items (260 and 231, respectively). Ishmi beach is the second cluster due to the highest abundance of marine litter with 940 items, in particular artificial polymer materials with the most abundant item beach use-related cosmetic bottles and containers, e.g., sunblocks (G11), followed by "other bottles & containers (drums)" (G13), but also had the most quantity of paper/cardboard, with the most abundant items cartons/tetra pack (others) (G151); glass and ceramic in particular jars, including pieces (G201) and metal of all beaches, in particular cans (food) (G176). Plepa beach is in the first cluster due to the high abundance of marine litter with 682 items, in particular artificial polymer materials with the most abundant items "other bottles & containers (drums)" (G13), followed by cigarette butts and filters (G27), other plastic/polystyrene items (identifiable) (G124), shopping bags, including pieces (G3), and food containers including fast food containers (G10).

The top 30 items accounted for 73% of all 2,629 items found (Table 3). Among 120 litter item categories recorded, other bottles and containers (drums) (G13) were

Table 3 Top 30 items found on the four studied beaches: Plepa, Ishmi, Velipoja, and Shëngjini, labelled according Galgani et al. [22]: Annex 8.1 – Master List of Categories of Litter Items

|	Material type	*Code TSG_ML (Technical Subgroup on Marine Litter), General Code	General name	Total	%
1	Artificial polymer materials	G13	Other bottles and containers (drums)	158	6.01
2	Paper/cardboard	G151	Cartons/tetra pack (others)	150	5.71
3	Artificial polymer materials	G27	Cigarette butts and filters	98	3.73
4	Artificial polymer materials	G3	Shopping bags, including pieces	92	3.50
5	Artificial polymer materials	G11	Beach use-related cosmetic bottles and containers, e.g., sunblocks	84	3.20
6	Artificial polymer materials	G21	Plastic caps/lids drinks	81	3.08
7	Glass/ceramics	G201	Jars, including pieces	80	3.04
8	Artificial polymer materials	G10	Food containers incl. Fast food containers	78	2.97
9	Artificial polymer materials	G7	Drink bottles ≤0.5 l	73	2.78
10	Paper/cardboard	G156	Paper fragments	71	2.70
11	Artificial polymer materials	G8	Drink bottles >0.5 l	70	2.66
12	Artificial polymer materials	G66	Strapping bands	67	2.55
13	Artificial polymer materials	G124	Other plastic/polystyrene items (identifiable)	67	2.55
14	Metal	G177	Foil wrappers, aluminum foil	66	2.51
15	Artificial polymer materials	G80	Plastic pieces >50 cm	63	2.40
16	Paper/cardboard	G154	Newspapers and magazines	54	2.05
17	Artificial polymer materials	G72	Traffic cones	53	2.02
18	Cloth/textile	G139	Backpacks and bags	53	2.02
19	Artificial polymer materials	G5	Plastic bag collective role; what remains from rip-off plastic bags	47	1.79
20	Glass/ceramics	G202	Light bulbs	47	1.79
21	Metal	G175	Cans (beverage)	41	1.56
22	Artificial polymer materials	G23	Plastic caps/lids unidentified	39	1.48
23	Paper/cardboard	G158	Other paper items	37	1.41

(continued)

Table 3 (continued)

	Material type	*Code TSG_ML (Technical Subgroup on Marine Litter), General Code	General name	Total	%
24	Cloth/textile	G138	Shoes and sandals (e.g., leather, cloth)	36	1.37
25	Processed/worked wood	G172	Other wood >50 cm	36	1.37
26	Metal	G176	Cans (food)	35	1.33
27	Glass/ceramics	G210	Other glass items	35	1.33
28	Artificial polymer materials	G26	Cigarette lighters	33	1.26
29	Artificial polymer materials	G58	Fish boxes – expanded polystyrene	32	1.22
30	Processed/worked wood	G171	Other wood <50 cm	32	1.22

the most frequently found items with a percentage of 6% (158 items). The second most abundant group of items was cartons/tetra pack (others) (G151) with 5.7%, followed by cigarette butts and filters (G27) with 3.7%, shopping bags, including pieces (G3), with 3.5%, and beach use-related cosmetic bottles and containers, e.g., sunblocks (G11), with 3.2%. Plastic caps/lids drinks (G21), jars, including pieces (G201), food containers including fast food containers (G10), drink bottles ≤0.5 l (G7), paper fragments (G156), drink bottles >0.5 l (G8), strapping bands (G66), other plastic/polystyrene items (identifiable) (G124), foil wrappers, aluminum foil (G177), and plastic pieces >50 cm (G80) were among the top 15 items found.

On monitored Lithuanian beaches (five transects on a remote part of the Curonian Spit in Lithuania [35]), eight out of ten most common single items were made of plastic. Most abundant are "Other plastic/polystyrene items" (119 items), "String and cord" (diameter less than 1 cm; 110 items), and "Small plastic bags," e.g., freezer bags (108 items). At the aggregated level, in countries of the Adriatic-Ionian region, according to Vlachogianni et al. [26], among 159 litter categories, plastic pieces larger than 2.5 cm and smaller than 50 cm in the longest dimension (G79), accounted for the highest percentage 19.89% (14,040 items) of the total 70,581 litter items recorded in all surveys, followed by polystyrene pieces 2.5 cm> <50 cm (G82) with 11.93%. The third most abundant group of items was cotton bud sticks (G95) accounting for 9.17% of total items recorded, followed by plastic caps/lids from drinks (G21) with 6.67% and cigarette butts and filters (G27) with 6.6%. According to Munari et al. [27], among 35 litter categories, cigarette butts accounted for the highest percentage (22.9%) on five beaches of the north-western Adriatic coast in Italy, followed by unrecognizable plastic pieces (13.5%), bottle caps (9.2%), mesh bags (7.2%), plastic bottles, and cutlery (6.5% and 6.4%, respectively).
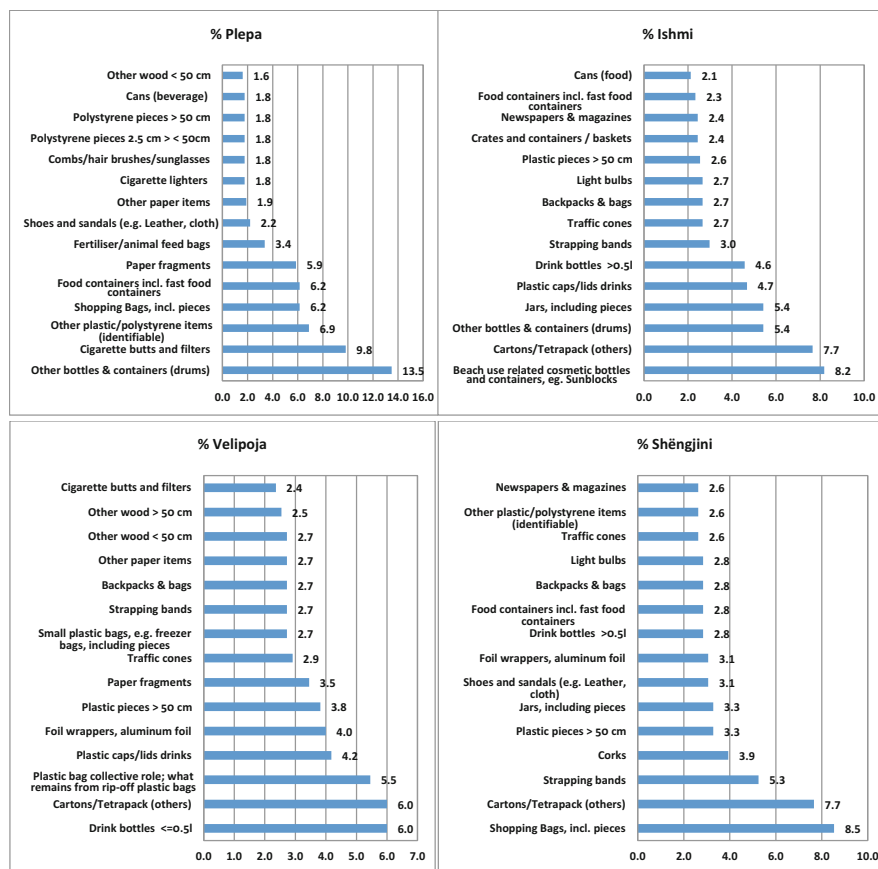
Fig. 5 Percentage of top 15 items found on each of the four studied beaches: Plepa, Ishmi, Velipoja, and Shëngjini

The percentage of top 15 marine litter items found in each of the four studied beaches: Plepa, Ishmi, Velipoja, and Shëngjini varied as shown in Fig. 5. At Plepa, the top 15 items accounted for 66.3% of all items recorded. The most abundant item was other bottles and containers (drums) (G13) with a percentage of 13.5% of all items recorded, followed by cigarette butts and filters (G27) with 9.8%, other plastic/ polystyrene items (identifiable) (G124) with 6.9%, and shopping bags, including pieces (G3), and food containers including fast food containers (G10), both with 6.2%.

At Ishmi, the top 15 items made up 58.8% of all items found. The most abundant item were beach use-related cosmetic bottles and containers, e.g., sunblocks (G11) with 8.2%. The second most abundant items were cartons/tetra pack (others) (G151) with 7.7%, followed by other bottles and containers (drums) (G13) and jars, including pieces (G201), both with 5.4%, followed by plastic caps/lids (G21) with 4.7%.

At Velipoja, the top 15 items accounted for 54.4% of the total items. The most abundant items were drink bottles ≤0.5 l (G7) and cartons/tetra pack (others) (G151), both with 6%, followed by "plastic bag collective role; what remains from rip-off plastic bags" (G5) with 5.5%, plastic caps/lids drinks (G21) with 4.2%, and foil wrappers, aluminum foil (G177), with 4%. This is similar to Poeta et al. [38], who found plastic fragments, plastic bottles, and bottle caps to have the highest occurrence on the Tyrrhenian shores.

At Shëngjini, the top 15 items accounted for 57.3% of the total items found. The most abundant item was shopping bags, including pieces (G3) accounting for 8.5% of all items recorded, followed by cartons/tetra pack (others) (G151) with 7.7%, strapping bands (G66) with 5.3%, corks (G159) with 3.9%, and plastic pieces >50 cm (G80) with 3.3%.

On all our beaches, plastic (artificial polymer materials) was the first material type found, with other bottles and containers (drums) (G13) at Plepa; shopping bags, including pieces (G3) at Shëngjini; related cosmetic bottles and containers, e.g., sunblocks (G11) at Ishmi; and drink bottles ≤0.5 l (G7) at Velipoja. At Velipoja, however, plastic and paper/cardboard were both the first material types found, with drink bottles ≤0.5 l (G7) and cartons/tetra pack (others) (G151), respectively (both 6%).

Plastic and paper/cardboard were the second material types with cigarette butts and filters (G27) (plastic) at Plepa, cartons/tetra pack (others) (G151) (paper/cardboard) both at Ishmi and Shëngjini, followed by "plastic bag collective role; what remains from rip-off plastic bags" (G5) (plastic) at Velipoja.

The collected marine litter items were classified into three major groups: single-use plastics, non-single-use plastics, and non-plastic marine litter items. Results are presented at the aggregated level and the beach level (Fig. 6). According to UNEP [25], the following items were considered as single-use plastics: shopping bags, including pieces (G3), drink bottles ≤0.5 l (G7), drink bottles >0.5 l (G8), food containers including fast food containers (G10), plastic caps/lids from drinks (G21), cigarette butts and filters (G27), lolly sticks (G31), cups and cup lids (G33), cutlery and trays (G34), straws and stirrers (G35), sanitary towels/panty liners/backing strips (G96), and toilet fresheners (G97). Crisps packets/sweets wrappers (G30) and cotton bud sticks (G95) are not found on our studied beaches.

At the aggregated level, single-use plastics accounted for 29% of the items recorded. At the beach level, the abundance of single-use plastics varied from 16.4 to 58.7%.

The highest abundance of single-use plastics was recorded at Plepa with 58.7%, followed at Shëngjini with 20.6% and Ishmi with 18.8%, while the lowest abundance of single-use plastics was recorded at Velipoja with 16.4%. Same percentage with single-use plastics was found for non-single-use plastics (29%) at the aggregated level.

If we look at a recent study [28], single-use plastic marine litter items at the aggregated level in marine litter in Mediterranean coastal and marine protected areas and single-use plastics in northern Mediterranean countries accounted for one fifth (21%) of the items recorded. In our study this value is 1.5 times higher. Comparing
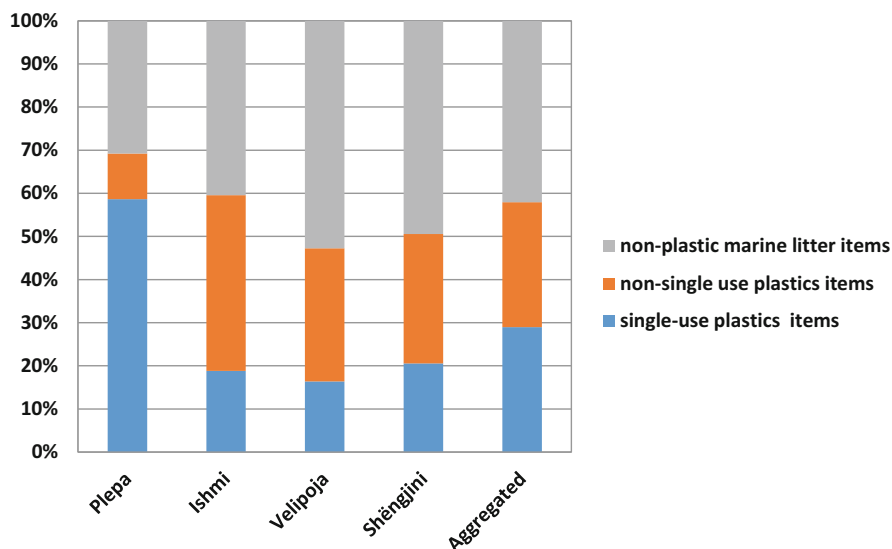
Fig. 6 Percentage of single-use plastic items recorded in beaches: Plepa, Ishmi, Velipoja, Shëngjini, and the aggregated level

our results to a study by Adamo et al. [39] who reported that single-use plastics represent 50% of the total marine litter items found on European beaches in 2016, it is evident that the level of single-use plastics of our study is 2.5 times lower than on other European beaches.

The European Commission has begun to implement regulations [40] on the reduction of plastic production, especially single-use plastic products. The ban will apply to plastic ear sticks, plastic cutlery, straws, mixing sticks for drinks, and balloon holders. All these products will have to be produced only from sustainable materials. EU member states will have to reduce the use of plastic food containers and drink cups and by 2025 will need to organize the collection of 90% of disposable plastic bottles, for example, through a return program [41].

Figure 7 shows an example of a dendrogram that used the absolute abundance values of the 12 single-use plastics at each beach as input data. The following items were considered as single-use plastics: shopping bags, including pieces (G3), drink bottles ≤0.5 l (G7), drink bottles >0.5 l (G8), food containers including fast food containers (G10), plastic caps/lids from drinks (G21), cigarette butts and filters (G27), lolly sticks (G31), cups and cup lids (G33), cutlery and trays (G34), straws and stirrers (G35), sanitary towels/panty liners/backing strips (G96), and toilet fresheners (G97). Crisps packets/sweets wrappers (G30) and cotton bud sticks (G95) are not found in the studied beaches.

Cluster analysis of the studied sites revealed four distinct groups. The fourth one refers to the beach of Shëngjini, which is dominated by shopping bags, including pieces (G3) (41% of the total abundance of single-use plastic items in this beach). The third cluster on Velipoja beach is dominated by drink bottles ≤0.5 l (G7) (37%
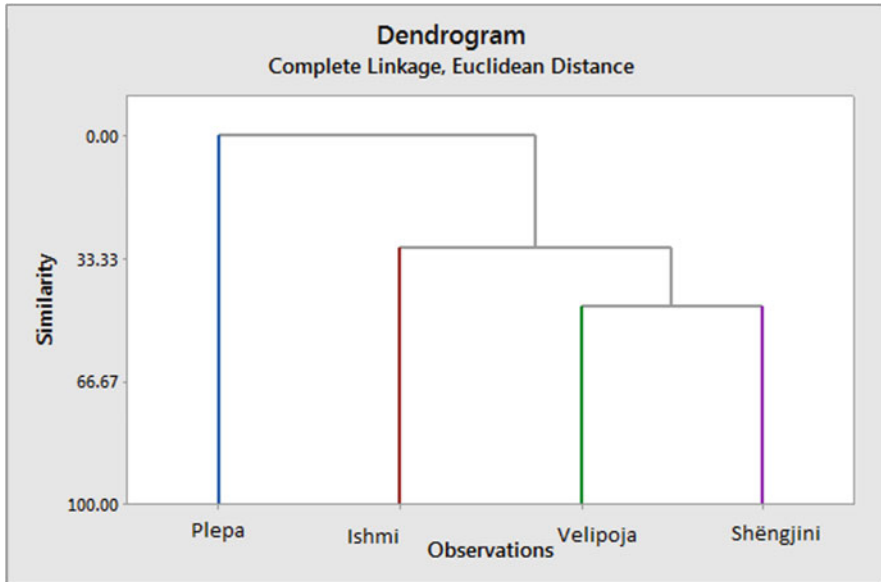
Fig. 7 Dendrogram resulting from a cluster analysis applying the complete linkage method using the Euclidean distance measure of proximity. Absolute abundance values of the 12 single-use plastics at each beach were used as input data. The following items were considered as single-use plastics: shopping bags, including pieces (G3), drink bottles ≤0.5 l (G7), drink bottles >0.5 l (G8), food containers including fast food containers (G10), plastic caps/lids from drinks (G21), cigarette butts and filters (G27), lolly sticks (G31), cups and cup lids (G33), cutlery and trays (G34), straws and stirrers (G35), sanitary towels/panty liners/backing strips (G96), and toilet fresheners (G97). Beaches of the same cluster are marked with the same color

of the total abundance of single-use plastic items on this beach). The second cluster on Ishmi beach is dominated by plastic caps/lids from drinks (G21) (24.9%) and drink bottles >0.5 l (G8) (24.3% of the total abundance of single-use plastic items on this beach). The first cluster of Plepa beach is dominated by cigarette butts and filters (G27) (36.6% of the total abundance of single-use plastic items in this beach).

With regard to smoking-related marine litter items, on the aggregated basis, 5% of the total litter items collected fell under one of the following category types of litter: tobacco pouches/plastic cigarette box packaging (G25), cigarette lighters (G26), cigarette butts and filters (G27), and paper cigarette packets (G152) (Fig. 8). Comparing our study to related studies in Mediterranean coastal and marine protected areas in northern Mediterranean countries, the level of smoking-related items is similar to the aggregated basis (3%) [28].

The highest percentage of smoking-related items was recorded on Plepa beach (12% of sampled items) (Fig. 8). The lowest percentage of smoking-related items was observed at Shëngjini beach (2%), followed by Ishmi and Velipoja (both 3%).
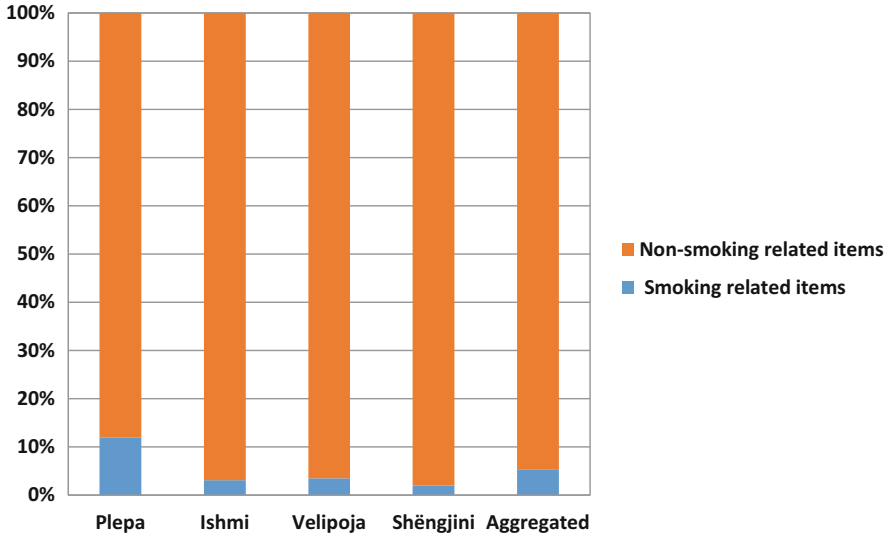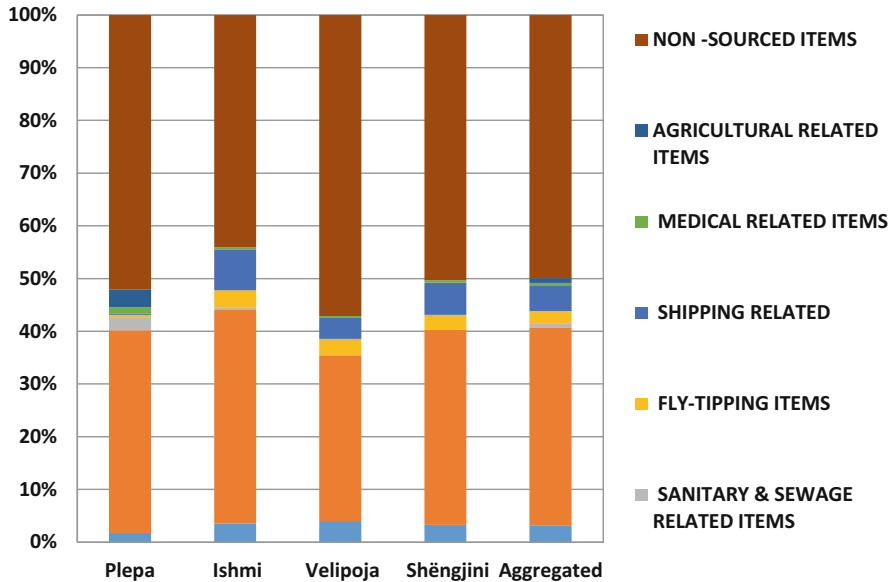
Fig. 8 Percentage of smoking-related items recorded in beaches: Plepa, Ishmi, Velipoja, Shëngjini, and the aggregated level

On Plepa beach, 9.8% of total items were recorded as cigarette butts and filters (G27) (Fig. 5), as the second most items found on the beach. Similar situations where cigarette butts are the first or second most frequent found type of litter are reported by other studies carried out at beaches located in Italy [27] Slovenia [31], Spain [34], and Albania [16].

3.3 Marine Litter Sources of Surveyed Beaches

At the aggregated level, 50.1% or 1,316 items of all litter items collected could be attributed to one of the following sources: tourism- and recreational-related items (including poor waste management), fishing-related items, shipping-related, fly-tipping, agricultural-related items, sanitary sewage-related, and medical-related (Fig. 9). Litter items from shoreline sources such as tourism and recreational activities, including poor waste management practices, accounted for 37.5% or 987 items of all litter items collected, while smoking-related items were 14% or 138 items of litter items from shoreline sources such as tourism and recreational activities. The related sources of the second most often found items were shipping-related items (4.8% or 125 items), while the third most were from fisheries and aquaculture (3.1% or 81 items). Fly-tipping-related items accounted for 2.4% or 64 items, while agricultural-related items, sanitary and sewage-related items, and medical-related items accounted for 0.9% or 23 items, 0.8% or 20 items, and 0.6% or 16 items, respectively.

Fig. 9 Percentages of the sources of marine litter: fisheries and aquaculture, shoreline sources such as tourism and recreational activities, sanity and sewage-related items, fly-tipping items, shipping-related items, medical-related items, agricultural-related items, and non-sourced items recorded in beaches: Plepa, Ishmi, Velipoja, Shëngjini, and the aggregated level

Comparing the percentage of litter from shoreline sources such as tourism and recreational activities, including poor waste management practices in our study (37.5%) to other studies, litter from shoreline sources, such as tourism and recreational activities and poor waste management practices, was almost 1.5 times higher (27% [28]) in our study than in Mediterranean coastal and marine protected areas of northern Mediterranean countries. On German Baltic beaches, this percentage was 1.5 times higher (50% [35]) than in our study. On the beaches of the north-western Adriatic coast in Italy, marine litter sources were primarily the shoreline and recreational activities (37.9% [27]) such as in our study, with the same situation in countries of the Adriatic-Ionian region (33.4% [26]). Comparing our results to the global average in 2010 (68.2% [42]), the percentage of litter from shoreline and recreational activities was almost two times higher than the global average. Compared to the Mediterranean average (52% [43]), the Mediterranean average was 1.5 times higher than in our study. Comparing the percentage of litter from shoreline sources such as tourism and recreational activities, including poor waste management practices, our study reveals 1.5 times lower results than along the Albanian coastline-Durrës beaches (58.5% [16]).

At the individual beach level (Fig. 9), the inputs of litter from the different sectors and their comparative importance were quite similar, with shoreline sources such as tourism and recreational activities accounting for the vast majority of litter items collected (range: 31.6–40.6%). Ishmi (40.6%) accounted for the highest percentage

of litter from shoreline sources such as tourism and recreational activities and poor waste management practices, followed by Plepa (38.4%), Shëngjini (37.0%), and Velipoja (31.6%).

The highest marine litter inputs from shipping were recorded at Ishmi with 7.8% and Shëngjini with 6.1%. Fishing-related items range between 3.3 and 3.8% in three beaches except Plepa (1.8%). The highest fishing-related items were found at Velipoja. The highest number of items from fly-tipping-related waste was recorded at Ishmi with 3.2%. Agricultural and sanitary and sewage-related items as well as medical-related items were found in very small percentages in all studied beaches or not at all. Agricultural-related items were not found at Ishmi, Velipoja, and Shëngjini and sanitary and sewage-related items not found at Velipoja and Shëngjini.

Figure 10 shows an example of a dendrogram that used as input data the absolute abundance values of the eight groups of sources in each beach as attributed to one of the following sources: fishing-related items and aquaculture, shoreline sources such as tourism and recreational activities (including poor waste management), sanity and sewage-related items, fly-tipped items, shipping-related items, medical-related items, agricultural-related items, and non-sourced items. Cluster analysis of the studied sites revealed three distinct groups. The third one refers to the beaches of Velipoja and Shëngjini, which are characterized by a strong similarity (70%) in
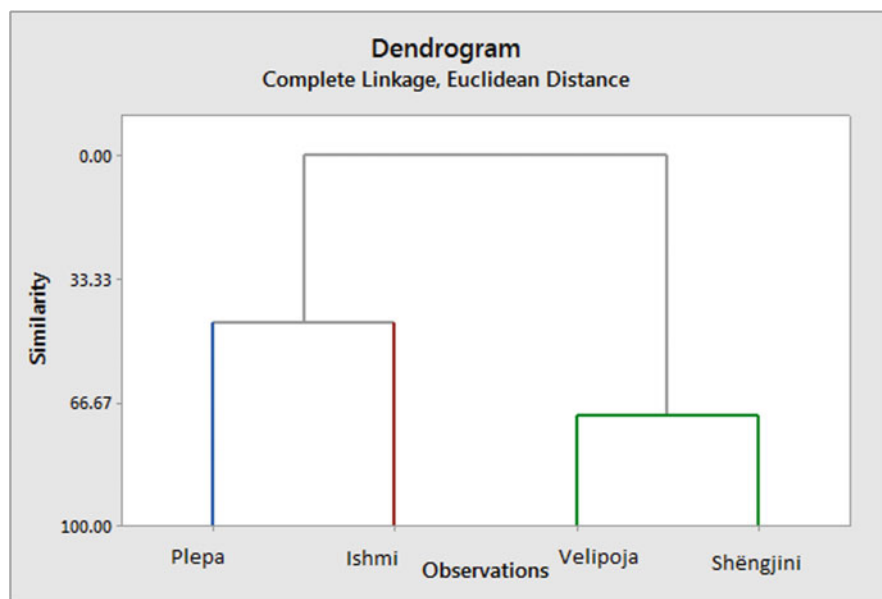
Fig. 10 Dendrogram resulting from a cluster analysis applying the complete linkage method using the Euclidean distance measure of proximity. Absolute abundance values of the sources of marine litter at the individual beach level: fisheries and aquaculture, shoreline sources such as tourism and recreational activities, sanity and sewage-related items, fly-tipping items, shipping-related items, medical-related items, agricultural-related items, and non-sourced items. Beaches of the same cluster are marked with the same color

terms of the total abundance of sources, especially tourism- and recreational-related items, respectively, with 174 items or 17.6% and 169 items or 17.1% from the aggregated tourism- and recreational-related items for all beaches (987 items). The second cluster is located at Ishmi that has the largest abundance of source items (940 items), especially tourism and recreational (382 or 38.7%) as well as shipping-related items (73 items or 58.4%) from the aggregated shipping-related items for all beaches. Plepa beach is in the first cluster due to the high abundance of source items (682 items), especially tourism- and recreational-related items with 262 or 26.5% of the aggregated tourism- and recreational-related items.

In our study, we assessed the contribution of the sea-based sources (fisheries and aquaculture, shipping), the land-based sources (shoreline, tourism and recreational activities, agriculture, medical-related), and the mixed sources (sanitary and sewage-related, fly-tipping, non-sourced items). At the aggregated level, the items coming from sea-based sources resulted in 7.8% versus 39% of items attributed to land-based sources (Fig. 11). Comparing the results to beaches in the Adriatic Sea and Mediterranean basin, the highest contribution of sea-based vs. land-based sources was observed for Italy (14.8% vs. 27%) and Greece (13.2% vs. 48.0%), while the lowest contribution was recorded for Montenegro (1.5% vs. 74.1%) and Bosnia and
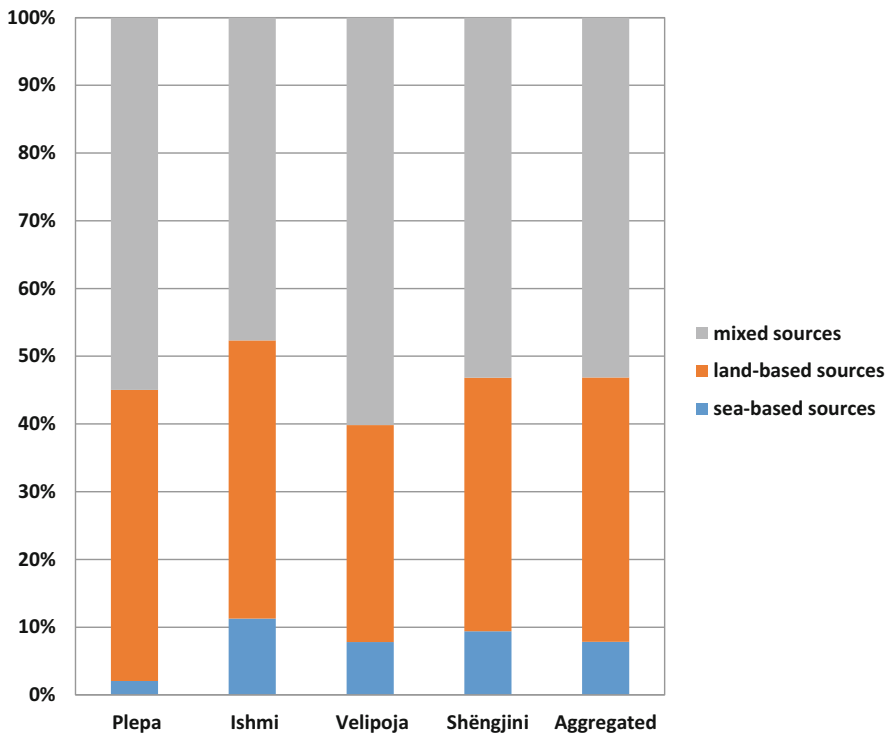
Fig. 11 Percentages of three different sources categories: land-based, sea-based, and mixed sources recorded in beaches: Plepa, Ishmi, Velipoja, Shëngjini, and the aggregated level

Herzegovina (1.9% vs. 82.8%) [26]. For the Mediterranean Sea, PNUE/PAM/ MEDPOL [43] reported that most of the marine litter comes from land-based rather than sea-based sources.

At the individual beach level (Fig. 11), the inputs of litter from sea-based sources range from 2.1 to 11.3%. In contrast, litter from land-based sources accounts for 32–43%. The highest contribution of sea-based sources vs. land-based sources was observed at Ishmi (11.3% vs. 41.1%), followed by Shëngjini (9.4% vs. 37.4%), Velipoja (7.8% vs. 32%), and Plepa (2.1% vs. 43%). On five north-western Adriatic beaches (Italy), the majority of marine litter also comes from land-based sources [27].

3.4   Options to Manage the Litter of Beaches

The present study shows that shoreline sources such as tourism and recreational activities, in addition to the poor waste management practices, are the main sources of beach litter deposited on surveyed beaches. We recommend the following priority management options based on the beach litter outline of each of the surveyed beaches:

– Measures to deal with cartons/ tetra pack (others) paper cardboard items

In all studied beaches, with exception of Plepa, cartons/tetra pack (others) (G151) is the first or second most frequently found type of litter.

There are serious problems in recycling of composite beverage cartons that completed their lifetime and became waste. This packaging waste is disposed in landfills. It is important to recycle and recover Tetra Pak's due to the different types of recyclable materials (includes 75% paper, 20% polyethylene, and 5% aluminum. Tetra Pak films were cut into over 40 mm pieces and charged to the reactor with stirring and chloroform. Thus paper, aluminum, and polyethylene dissolve in chloroform [44]. Tetra Pak packaging is considered an important source of high-quality waste paper for the pulp industry. Processing of UTPC (used Tetra Pak cartons) is rising rapidly and driven by stricter regulations in terms of waste disposal, as well as by decreasing supply of waste paper in digital era [45].

– Measures to tackle plastics, including single-use plastic items

The same percentage of single-use plastics was found for non-single-use plastics (29%) at the aggregated level. On the aggregated level of studied beaches, plastics (artificial polymer materials) were the first source items found. Non-single-use plastic other bottles and containers (drums) (G13) were the first most often litter items found (in Plepa and Ishmi), and beach use-related cosmetic bottles and containers, e.g., sunblocks (G11), were the fifth most often litter items found (in Ishmi).

Whereas single-use plastics at the aggregated level were the third most often litter items found, cigarette butts and filters (G27) dominated especially Plepa

beach. The fourth most often litter items were ranked shopping bags, including pieces (G3), and found in Shëngjini and Plepa as the most frequented beaches, whereas the sixth most often litter items were plastic caps/lids drinks (G21) on Ishmi and Velipoja beaches.

A public awareness-raising campaign to highlight citizens' role, especially targeted to tourists, local residents, and other coastal and marine users toward a behavioral change to reduce consumption of single-use plastics, is imperative in combatting plastic pollution and marine litter.

The European Commission has begun implementing regulations [40] on the reduction of plastic production, especially single-use plastic products. By 2021, the legislative actions for banning certain items as also foreseen under the EU Single-Use Plastics Directive that includes bans on single-use plastic cutlery, single-use plastic plates, plastic straws, cotton bud sticks made of plastic, and plastic balloon sticks as well as oxodegradable plastics, food containers, and expanded polystyrene cups [40]. More details are found in "Moving away from single-Use" [46]. Plastic pollution from plastic bags and their respective pieces has been accepted by the Albanian decision-makers, and thus, the Council of Ministers of Albania decided in 2018 [47] to introduce a ban on lightweight plastic bags, making it illegal to import, manufacture, use, sell, or bring such bags into the country. Since the beginning of July 2018, plastic bags in Albania must have a minimum thickness of 35 μm in order to be reusable and have a recycling value.

– More investments to build other landfills

At the moment, there are only three sanitary landfills available in Albania in Tirana, Elbasan, and Fier [48]. The State of the Environment Report of the European Environment Agency [49] highlights that the Albanian national legal framework related to the integrated management of waste has been completed in accordance with the EU Directive on waste; however much work is needed to fully implement this, while raising public awareness and making more investments in building other landfills according to EU standards are imperative.

– Contaminated Ishmi River Rehabilitation by Dredging Soil Treatment and Water Purification

The largest abundance in terms of items per 100 m stretch was observed in Ishmi with 313.3 items/100 m. Highest abundance of marine litter is found on Shen Pjetri beach in Lalzi Bay (located in the vicinity of Ishmi River and Erzeni River) with 510 items/100 m [16]. It seems that riverine inputs from Ishmi located in the vicinity might be the prevalent pathway of litter deposits on Ishmi and Shen Pjetri beaches. According to Cullaj et al. [50] Ishmi River shows that high levels of nitrites were detected in rivers including Lana and Tirana tributaries; they exceed the EC guide values for high-quality fresh water (<0.01 mg/L for Salmonid waters and <0.03 mg/L for Cyprinid waters). According to ARCADIS ECOLAS/IEEP/Metroeconomica/ Enviro-L Content 06/11347 [51], Ishmi River and Gjanica River are the most polluted rivers in Albania. Problems are caused by micropollutants (BTEX), BOD5, COD, phenols, etc. According to Baumann [52] among all Albanian rivers,

it is particularly Ishmi River that causes great concern: Around one third of Albania's 2.8 million inhabitants live along this river which is the most polluted river of the country. It flows through Tirana District, including the capital city Tirana, Vora, and Kamza, and collects almost all sewage waters of the region as well as significant amounts of solid waste of industries and inhabitants. There is scientific evidence for this visible pollution of the Ishmi River Basin and its tributaries, particularly the Lana but also the Zeza. These rivers show the highest pollution of all rivers in Albania, with harmful substances exceeding by far EU standards and increasing levels of pollution. The pollution threatens the health of people and has extinguished an important sea turtle breeding ground as well as fishes and other life under water. Furthermore, the touristic potential of the area is minimized, which otherwise would be very attractive due to a high biodiversity and some of the few historic sites that have survived communist times. According to Baumann [52], cleaning Ishmi River is needed: (1) awareness raising among stakeholders; (2) municipality cooperation to improve waste collection in the Ishmi River Basin; (3) reduction of Cd and Pb in the river to harmless levels; (4) establishment of "Constructed Wetlands" as a traditional sewage treatment method in a rural hotspot community; and (5) wastewater treatment in the municipalities of Tirana, Kamza, and Vora.

4 Conclusions

The present study provides the assessment of marine litter pollution on four beaches along the southeastern Adriatic coast. In this study about the Bay of Durrës and the Gulf of Drin, which include Rodoni Bay and Shëngjini Bay, the average density of beach litter amounted to 0.219 items/m^2 or 219 items/100 m ranging from 152.3 to 313.3 items/100 m. The largest abundant beach in terms of items per 100 m stretch was observed in Ishmi with 313.3 items/100 m.

The studied beaches were in human-induced pressures and were classified either as urban, semi-urban, or rural. Plastics or artificial polymer materials were the majority of marine litter items on beaches, with an average of 58%. The most abundant item was G13 (other bottles and containers (drums)) with 6%, followed by G151 (cartons/ tetra pack (others)) with 5.7%, G27 (cigarette butts and filters) with 3.7%, and G3 (shopping bags, incl. pieces) and G11 (beach use-related cosmetic bottles and containers, e.g., sunblocks), respectively, with 3.5% and 3.2%. At the aggregated level, single-use plastics accounted for 29% of the items recorded. The highest abundance of single-use plastic items was recorded at Plepa beach with 58.7%. Plepa as semi-urban beach is classified as the most frequented beach from visitors comparing to other studied beaches, as we also find the second most items G27 (cigarette butts and filters). Litter from shoreline sources such as tourism and recreational activities, including poor waste management practices, accounted for 37.5% of litter collected, while the shipping-related items accounted for 4.8%. Sea-based sources of litter (fisheries and aquaculture, shipping) accounted for 8% of total litter items on all beach locations, contrary to 39% of items attributed

to land-based sources (shoreline, tourism and recreational activities, agricultural-related items, medical-related items). It seems that riverine inputs from Ishmi Basin located in the vicinity of Ishmi beach might be the prevalent pathway of litter deposits on this beach with the highest abundance of items.

Our findings may give insights into human nature behavior to manage marine litter deposition on the southeastern Adriatic coast. The litter that was deposited in situ, especially on Ishmi beach (36%), suggests mitigation actions that may substantially help to address the problem such as: (1) awareness raising campaigns to promote concept of "Leave No Trace" to tourists, local residents, and other beach users; (2) increasing targeted clean-up, particularly in summer months when the number of tourists is very high; (3) expanding direct intervention through signage and patrols; (4) legislative actions prohibiting the dumping of marine litter in rivers, as the Ishmi river is heavily polluted by Tirana County; (5) legislative actions for banning certain items as foreseen also under the EU Single-Use Plastics Directive that includes bans on single-use plastic cutlery, plastic plates, plastic straws, cotton bud sticks made of plastic and plastic balloon sticks, as well as oxodegradable plastics, food containers, and expanded polystyrene cups; and (6) fostering broader education and awareness in youth and students about marine litter consequences in the ocean.

Moreover, these results emphasize the key role of coastal areas in the Mediterranean Basin, which also include the Albanian coastline and sustainability of the Integrated Coastal Zone Management (ICZM) at a national level.

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