

Macrolitter: Plastic Pollution in the Mouth of the Ishëm River (Albania)

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According to TheOceanCleanup, the River of Ishëm is the most polluted river in Europe with approximately 733,000 kg of trash ending up in the Adriatic Sea. In 2020, *River-Cleanup.org* has come to Albania to change the history of Ishëm River on plastic pollution together with Albanian people, especially the youth awareness, to protect the beauties of their natural resources. Using citizen science are done two cleanings up actions in the Ishëm Mouth. (1) on 8th July, 2020, Ishëm Mouth-Likmetaj Beach towards Cape of Rodon; whereas (2) on 2nd August, 2020, Ishëm Mouth- Godulla Beach towards old Ishëm river bed and Lagoon of Patok. Over 96% of the collected items are plastic, where there are found mostly drink bottles < =0.5 l (G7) with 29.4%, drink bottles >0.5l (G8) with 28.2%, cleaner bottles & containers (G9) with 8%, followed by plastic caps/lids drinks (G21), cups and cup lids (G33), polystyrene pieces 2.5 cm > < 50cm, > 50 cm (G82+G83), flip-flops (G102), other cosmetics bottles & containers (G12), shoes/sandals (G71), bottles, including pieces (G200), medical/pharmaceuticals containers/tubes (G100). Due to a complete lack of waste management, lack of awareness with the communities, the people, the government and the companies leading to uncontrolled human activities, huge amounts of often poisonous trash are ending in the Ishëm River with its final destination being the Adriatic Sea. The impact of this waste ending in nature is very diverse. First of all, it has a huge impact on the natural heritage of Albania. The country's future is dependent on the wise use of its natural resources. The high biodiversity in the region is under huge pressure.

Keywords: riverine-marine litter, riverbank, estuarine, Ishëm River, plastic, pollution.

1. Introduction

Research shows that ocean plastic pollution is a land-based problem. According to European Environment Agency (EEA), plastic makes up 85% of all marine plastic waste and up to 80% comes from land. It is estimated that more than 11 billion kilograms of plastic enter the ocean each year – this equates to 1 garbage truck per minute. Plastic waste in the ocean comes in different forms – beverage bottles, shampoo sachets, takeout food containers, grocery bags, and straws [1, 2, 3].

The first objective of this research has to do with assessment of the abundance, composition, and sources of riverine macro-litter (>2.5 cm) on two sites across the Ishëm Mouth that are discharged in the Albanian coastline – at Rodon Bay, a coastline of the Adriatic Sea on the southeast side. Another objective is to recognise the circumstances about the riverine macro-litter on rivers of Albania.

2. Methods And Materials

2.1. Survey along the Ishëm Mouth

The Ishëm mouth is inside the MPAs Patok-Fushëkuqe-Ishëm with a surface 5,001 ha under protection status: Managed Nature Reserve IUCN Category IV and Important Bird Area (AL006). Near Ishëm Mouth is also Cape Rodon Nature Reserve located within the Protected Landscape/Seascape Area of the Cape of Rodon-Lalzi Bay-Ishmi Forest with a surface area of 2,500 ha and classified under the IUCN Category V [4, 5, 6].

The riverine macro-litter surveys were carried out on riverbanks positioned in Ishëm of the Ishëm Mouth: Ishëm Mouth-Likmetaj Beach and Ishëm Mouth-Godulla Beach, that discharges in the Rodon Bay in Albania during the Summer (Fig. 1). The delta of the Ishëm River is located in Rodon Bay. One of the most important rivers that flows into the Adriatic Sea is Ishmi. This river ends in the Adriatic Sea with a long tongue directed from the northeast and is formed by the confluence of

the Tirana, Lana, Zeza, Tërkuza and Gjola rivers. This river accumulates the pollution of these bodies of water, which through its flow are discharged into the Adriatic Sea. The Ishëm River flows through Central Albania and is formed by the River of Tirana, Lana and the Tërkuza stream. Before joining the waters of Tërkuza, the river of Tirana, which is the main branch of the River Ishmi and at the same time its longest branch, receives the waters of Lana. The Gjola River, after receiving the waters coming from Tirana, joins the Zeza River in the village of Bilaj, forming the Ishëm River. These three branches of the Ishëm River preserve the characteristics of mountain streams [7]. The discharges of the Tirana and Lana rivers into the Ishëm River, cause that these pollutions are also poured directly into the Adriatic Sea.

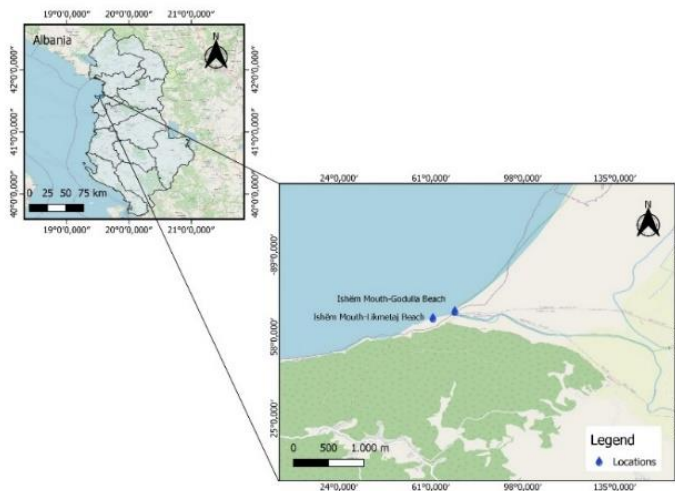


Fig. 1. Locations of the surveyed riverbank, for two surveyed riverbanks of the Ishëm Mouth: Ishëm Mouth-Likmetaj Beach and Ishëm Mouth-Godulla Beach, that discharges at the Albanian southern-eastern Adriatic coastline.

2.2. Study Method of Macrolitter on riverbanks and citizen science

All riverine litter items are collected on a distance 100 m long stretches of riverbank parallel to the watermark there are gather all riverine litter items, whereas the width of sampling area goes at a maximum 50 m (see Fig. 2) [8, 9]. The riverine litter surveys are carry out according to operational guidelines produced by the EU MSFD Technical [10]. On 8th July and on 2nd August 2020 two stretches have been surveyed in a surface 8,000 m². All riverine macro-litter items on the riverbank founded larger than 2.5 cm were collected in the area, cleaning the riverbank at the end.

Citizens science is done from high school students, students, teachers, professors from Durres in collaboration with specialists from Agency of Protected Areas of Durres and Municipality of Durres and Municipality of Kruja who participated in the cleaning up actions.

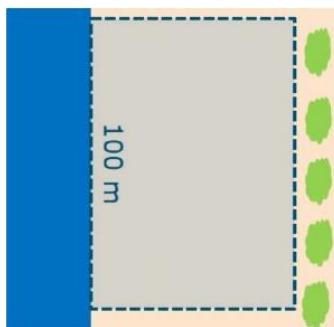


Fig. 2. The River-OSPAR method to sample macrolitter on a 100-m stretch of the riverbank [8].

2.3 Analysis of Data and Processing

The density of macro-litter of riverine litter items per m² -is calculated with formula: $C_M = n/(w \times l)$. C_M is the density of riverine litter items/m², n is the number of riverine litter items recorded, and w and l are the width and length of the sampling unit in meter [11]. The number of riverine items was calculated per 100 m stretch. The riverine litter items recorded - are categorized into eight major groups of material types: as artificial polymer materials, cloth/textile, paper/cardboard,

rubber, processed/worked wood, glass/ceramics, metal and unidentified items and/or chemicals according to the Master List of Categories of Litter Items [10]. The collected riverine macro-litter items were also categorized into three major groups of riverine items: single-use plastics, non-single-use plastics, and non-plastic marine litter items. The sources of riverine macro-litter were categorized into eight classes: (1) shoreline, including poor waste management practices, tourism, and recreational activities; (2) shipping; (3) fly-tipping; (4) fisheries and aquaculture; (5) sanitary and sewage-related; (6) agriculture; (7) medical-related; and (8) non-sourced according [12].

3. Results and Discussions

3.1. Densities of Riverine Macro-Litter in the Surveyed Riverbank of the Ishëm River Delta

The mean litter density of the two sites studied Ishëm Mouth-Likmetaj Beach and Ishëm Mouth-Likmetaj Beach riverbank of the Ishëm River was 9,224 items/100 m, respectively 4,983 items/100 m and 13,464 items/100 m; and 2.18 items/m², respectively 1.66 items/m² and 2.69 items/m² (Fig. 3).

The mean riverine litter density resulted 38 times higher in Ishëm delta than in Dutch Rhine–Meuse delta [13]. Making a comparison of the mean riverine litter density of Ishëm River delta to the Nederrijn River, Meuse River, Waal River it is respectively 22 times higher, 33 times higher, 56 times than the Nederrijn River, Meuse River, Waal River [13]. Making a comparison of the mean riverine litter density of this study to riverine litter in German riversides, it is 4 times higher in our study than German riversides [14]. The mean riverine litter of our study is 4 times higher than Erzen River [15]. Making a comparison of the mean riverine litter density of Ishëm River Delta to mean riverine litter in different tributaries of the Ishëm River (Lana Stream, Tirana River, Limuth Stream and Gjola River), Ishëm River delta it is 7 times higher than in different tributaries of the Ishëm River [16]. Riverine litter surveying protocols and riverine litter densities makes the comparison of results difficult when we study them in terms of units.

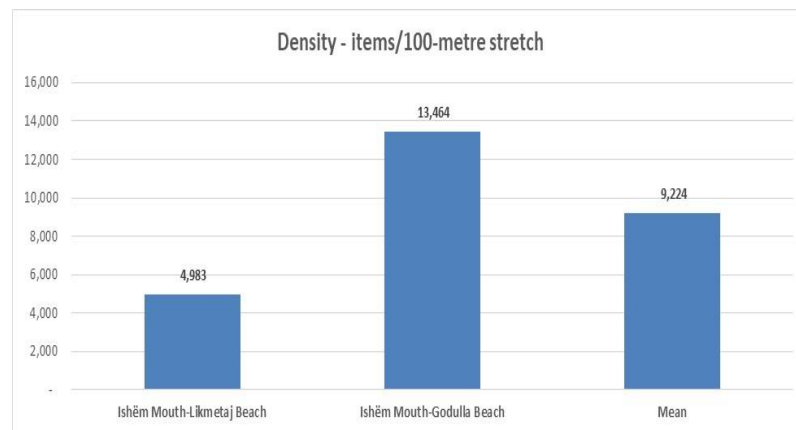


Fig. 3 Abundance of riverine macro-litter items for two surveyed riverbanks of the Ishëm River Mouth: Ishëm Mouth-Likmetaj Beach, Ishëm Mouth-Godulla Beach and the mean of total surveyed riverbank (items per 100 m stretch).

Table 1 Riverbank riverine litter densities worldwide and in the Mediterranean, including Albania

| Survey zone | Number of studied riverbanks | Mean density of riverine litter (items/m ² or items/100 m) | References |
|-----------------------------------------------------------------------------------------------------|------------------------------|-----------------------------------------------------------------------|------------|
| Dutch Rhine–Meuse delta | 291 | 243 items/100 m | [13] |
| Nederin | 192 | 426 items/100 m | [13] |
| Meuse | 93 | 283 items/100 m | [13] |
| Waal | 6 | 166 items/100 m | [13] |
| German riversides | 250 | 0.54 items/m ² | [14] |
| Erzen River | 2 | 2,487 items/100 m | [15] |
| Different tributaries of the Ishëm River (Lana Stream, Tirana River, Limuth Stream and Gjola River) | 4 | 1,269 items/100 m | [16] |

3.2 Riverine Litter Composition of Surveyed Riverbanks in the Ishëm River Mouth

Artificial polymer materials (96%, or 17,718 items of 18,447 total riverine items) belong to most of the riverine macro-litter items at the aggregated level (“aggregate level” which indicates the sum or the aggregation of many individual level units/sum total). Macro-litter in Erzen that belongs to waters plastic items is 93% [15], whereas in aggregated level in different tributaries of the Ishëm River (Lana Stream, Tirana River, Limuth Stream and Gjola River) is 82% [16].

Macro-litter in Rhone River that belongs to waters plastic items is 77% [17], whereas according to [14] who surveyed German riversides the greater majority of riverine litter was made of plastics with 50.5%, including cigarette butts.

The second largest material type of riverine litter items at the aggregated level is glass/ceramics (2.3% or 428 items) as in Erzen River (3%) [15], whereas in aggregated level in different tributaries of the Ishëm River is paper/cardboard (11%), [16]. The second most abundant material type of litter items was paper/cardboard represented 14% in Rhone River waters [17], whereas the second most abundant material type of litter items glass/ceramics (16%) in German riversides [14].

The third largest group of items at the aggregated level in Ishëm Delta is cloth/textile amounts with 0.8% (144 items), same as in aggregated level in different tributaries of the Ishëm River (3%) [16], whereas in Erzen surveyed riverbank is processed/ worked wood amounts (1.3%) [15]. The third most abundant group of items was paper (13%) in German riversides [14]. The third most abundant group of items was metal items in Rhone River waters (5%) [17].

The group was followed by items made of paper/cardboard and metal both (0.4%), rubber (0.05%), processed/ worked wood (0.01) and unidentified or chemicals are not found in Ishëm Delta riverbanks.

The highest percentage of plastics on each studied area is recorded at Ishëm Mouth-Godulla Beach riverbank (98%, 13,178 items), followed by Ishëm Mouth-Likmetaj Beach riverbank (91%, 4,540 items). At Ishëm Mouth-Likmetaj Beach riverbank glass/ceramics includes 5.6%, at Mouth-Godulla Beach riverbank 1.1%. At Ishëm Mouth-Likmetaj Beach riverbank cloth/textile includes 1.8%, at Mouth-Godulla Beach riverbank 0.4%.

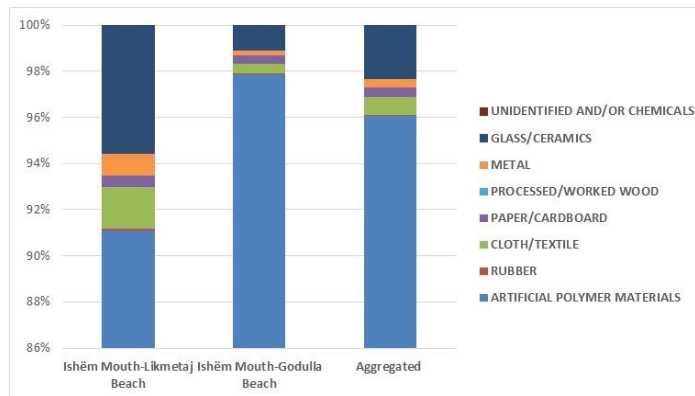


Fig. 4 Percentage (%) of total riverine litter items according eight major groups of material types: artificial polymer materials; cloth/textile; paper/cardboard; rubber processed/ worked wood; glass/ceramics, metal of the Ishëm River Mouth riverbanks: Ishëm Mouth-Likmetaj Beach, Ishëm Mouth-Godulla Beach and aggregated level.

The top 20 riverine items attribute for 93% of all 18,447 riverine items registered (Table 1). Among 43 litter items categories recorded, drink bottles ≤ 0.5 l (G7) are the most repeatedly found items with 29.4% (5,418 items). In the second place with more riverine items are drink bottles > 0.5 l (G8) with 28.2%, cleaner bottles & containers (G9) with 8%, plastic caps/lids drinks (G21) with 7%, cups and cup lids (G33) with 6.2%, followed by polystyrene pieces 2.5 cm $>$ $<$ 50cm, $>$ 50 cm (G82+G83), flip-flops (G102), other cosmetics bottles & containers (G12), shoes/sandals (G71), bottles, including pieces (G200), medical/pharmaceuticals containers/tubes (G100), shoes and sandals (e.g. leather, cloth) (G138), plastic pieces 2.5 cm $>$ $<$ 50cm, $>$ 50 cm (G79+G80) jars, including pieces (G201) and food containers incl. fast food containers (G10) are between the top 15 items found.

In Ishëm Mouth the top 10 riverine items contribute 94.4% of total items with 9 plastic (artificial polymer materials) material category and 1 glass/ceramics. Whereas in Erzen River the top 10 riverine items contribute up to 86.8 % of total items with all plastic (artificial polymer materials) material category [15]. In the Mediterranean Sea region riverine data, the top 10 riverine items compose 82.8% of total riverine items of subsequent material type 7 plastic, 2 paper/cardboard and 1 metal [18].

In aggregated level in different tributaries of the Ishëm River the top 10 riverine items contribute 86.1% of total items with 7 plastic (artificial polymer materials) material category, 2 paper/cardboard and 1 cloth/textile [16].

In Ishëm Mouth the top 20 riverine items account for 99.3%, including the following material categories: 13 plastic (artificial polymer materials), 2 glass/ ceramics, 2 paper/cardboard, 1 cloth/textile and 1 metal. In aggregated level in different tributaries of the Ishëm River the top 20 riverine items accounted for 95.8%, including the following material categories: 13 plastic, 2 paper/cardboard, 2 glass/ ceramics, 1 cloth/textile and 1 unidentified and/or chemicals [16].

Table 2 Top 20 items found at aggregated level on the two studied riverbanks of the Ishëm River: Ishëm Mouth-Likmetaj Beach and Ishëm Mouth-Godulla Beach [10]. Annex 8.1 – Master List of Categories of Litter Items.

| Ranking | Items name | Code | Material type | Total | % of Total Items |
|---------|----------------------------------------------------|---------|------------------------------|-------|------------------|
| 1 | Drink bottles <=0.5l | G7 | ARTIFICIAL POLYMER MATERIALS | 5418 | 29.4 |
| 2 | Drink bottles >0.5l | G8 | ARTIFICIAL POLYMER MATERIALS | 5206 | 28.2 |
| 3 | Cleaner bottles & containers | G9 | ARTIFICIAL POLYMER MATERIALS | 1481 | 8.0 |
| 4 | Plastic caps/lids drinks | G21 | ARTIFICIAL POLYMER MATERIALS | 1291 | 7.0 |
| 5 | Cups and cup lids | G33 | ARTIFICIAL POLYMER MATERIALS | 1135 | 6.2 |
| 6 | Polystyrene pieces 2.5 cm > < 50cm, > 50 cm | G82+G83 | ARTIFICIAL POLYMER MATERIALS | 951 | 5.2 |
| 7 | Flip-flops | G102 | ARTIFICIAL POLYMER MATERIALS | 691 | 3.7 |
| 8 | Other cosmetics bottles & containers | G12 | ARTIFICIAL POLYMER MATERIALS | 531 | 2.9 |
| 9 | Shoes/sandals | G71 | ARTIFICIAL POLYMER MATERIALS | 380 | 2.1 |
| 10 | Bottles, including pieces | G200 | GLASS/CERAMICS | 335 | 1.8 |
| 11 | Medical/Pharmaceuticals containers/tubes | G100 | ARTIFICIAL POLYMER MATERIALS | 281 | 1.5 |
| 12 | Shoes and sandals (e.g. Leather, cloth) | G138 | CLOTH/TEXTILE | 135 | 0.7 |
| 13 | Plastic pieces 2.5 cm > < 50cm, > 50 cm | G79+G80 | ARTIFICIAL POLYMER MATERIALS | 89 | 0.5 |
| 14 | Jars, including pieces | G201 | GLASS/CERAMICS | 88 | 0.5 |
| 15 | Food containers incl. fast food containers | G10 | ARTIFICIAL POLYMER MATERIALS | 87 | 0.5 |
| 16 | Cans (beverage) | G175 | METAL | 72 | 0.4 |
| 17 | Pens and pen lids | G28 | ARTIFICIAL POLYMER MATERIALS | 46 | 0.2 |
| 18 | Cartons/Tetrapack Milk | G150 | PAPER/CARDBOARD | 41 | 0.2 |
| 19 | Cartons/Tetrapack (others) | G151 | PAPER/CARDBOARD | 32 | 0.2 |
| 20 | Plastic caps/lids chemicals, detergents (non-food) | G22 | ARTIFICIAL POLYMER MATERIALS | 23 | 0.1 |

Whereas in Erzen River, the top 20 items accounted for 94.5%, including the following material categories: 15 plastic (artificial polymer materials), 3 glass/ ceramics, 1 processed/worked wood and 1 paper/cardboard [15].

At Ishëm Mouth-Likmetaj Beach riverbank (Fig. 5), the top 15 items contribute up to 96.9% of the total riverine items. The largest items took place drink bottles < =0.5 l (G7) with 25.3%, followed by polystyrene pieces 2.5 cm > < 50cm, > 50 cm (G82+G83) with 16.1%, plastic caps/lids drinks (G21) with 14.2%, drink bottles >0.5l (G8) with 13%, and cups and cup lids (G33) with 4.7%.

At Ishëm Mouth-Godulla Beach riverbank (Fig.5), the top 15 items contributed up to 99.2% of the total riverine items. The most considerable riverine items are drink bottles >0.5l (G8) with 33.9%, followed by drink bottles < =0.5 l (G7) with 30.9%, cleaner bottles & containers (G9) with 9.8%, cups and cup lids (G33) with 6.7% and flip-flops (G102) with 4.8%.

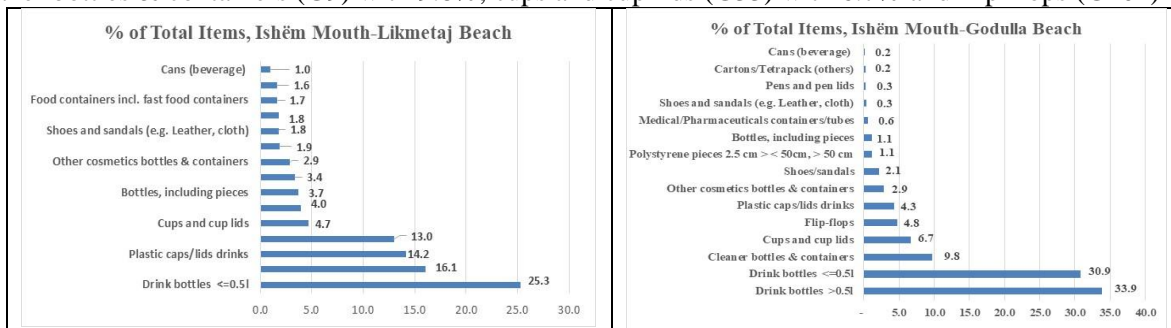


Fig. 5 Top 15 riverine macro-litter items in % placed at each of the two surveyed riverbanks of the Ishëm River Mouth: Ishëm Mouth-Likmetaj Beach and Ishëm Mouth-Godulla Beach.

Single-use plastics, non-single-use plastics and non-plastic riverine litter items were also another categorization of riverine litter items for the two studied riverbanks and at the aggregated level (Fig. 6). The successive riverine items are

calculated as single-use plastics: shopping bags, including pieces (G3), drink bottles >0.5 l (G8), drink bottles ≤ 0.5 l (G7), plastic caps/lids from drinks (G21), food containers including fast food containers (G10), cigarette butts and filters (G27), cups and cup lids (G33) and sanitary towels/panty liners/backing strips (G96), crisps packets/sweets wrappers (G30), cotton bud sticks (G95), lolly sticks (G31), cutlery and trays (G34), toilet fresheners(G97) and straws and stirrers (G35) according [19]. Shopping Bags, incl. pieces (G3), cigarette butts and filters (G27), crisps packets/sweets wrappers (G30), lolly sticks (G31), cutlery and trays (G34), straws and stirrers (G35), cotton bud sticks (G95), sanitary towels/panty liners/backing strips (G96) and toilet fresheners (G97) are not noticed in Ishëm delta riverbanks.

At the aggregated level, single-use plastics contribute up to 71% of the riverine items in Ishëm Mouth. At the aggregated level, single-use plastics contribute up to 66% of the riverine items in different tributaries of the Ishëm River Ishëm River [16]. In Erzen River single-use plastics contributed up to 26% of the riverine items or 3 times higher are single-use plastic items in Ishëm Mouth than Erzen River [15]. The amount of single-use plastics at riverbanks range from 59% at Ishëm Mouth-Likmetaj Beach riverbank to 76% to Ishëm Mouth-Godulla Beach riverbank.

Almost 3 times higher is the percentage of single-use plastics compared with non-single-use plastics (25%) at the aggregated level of Ishëm Mouth.

On July 2, 2021, there are banned plastic ear sticks, plastic cutlery, straws, mixing sticks for drinks, and balloon holders according the [Directive on Single-Use Plastics](#) in the European Union (EU).

On June 1, 2022, there are banned plastic carrier bags and oxo-degradable and oxo-bio degradable bags with a finer thickness than 70 microns according the decision of the Council of Ministers no. 367/2022.

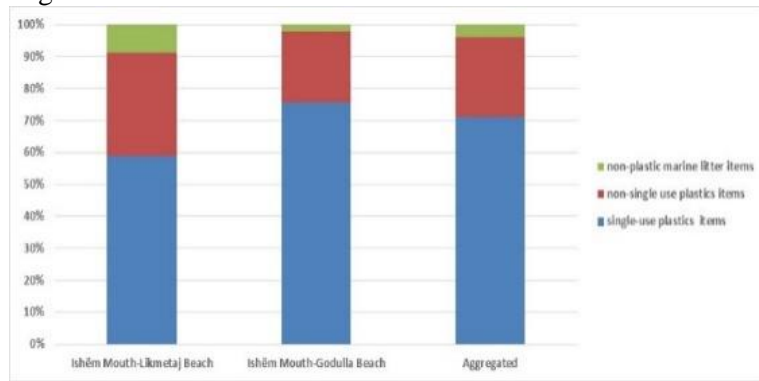


Fig. 6 Single-use plastic items in % noted in two surveyed riverbanks of the Ishëm River Mouth: Ishëm Mouth-Likmetaj Beach, Ishëm Mouth-Godulla Beach and the aggregated level.

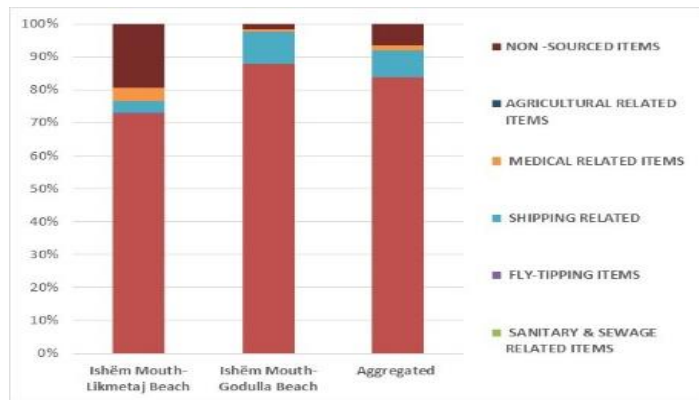


Fig. 7 Sources of riverine litter in % where are included shoreline sources such as tourism and recreational activities items, fisheries and aquaculture items, fly-tipping items, sanity and sewage-related items, shipping related items, agricultural-related items, medical-related items, and non-sourced items noted in riverbanks of the Ishëm River Mouth: Ishëm Mouth-Likmetaj Beach, Ishëm Mouth-Godulla Beach and aggregated level.

Riverine litter items recorded at aggregated level at the Ishëm Mouth attribute to the successive sources such as tourism and recreational activities items tourism and recreational-related items including poor waste management, fisheries and

aquaculture items, shipping-related, sanitary sewage-related, fly-tipping items and medical-related in quantity 93.6% or 17,271 riverine items (Fig. 7). In different tributaries of the Ishëm River 61.2% or 1.5 times more in Ishëm Mouth than in different tributaries of the Ishëm River [16], whereas in Erzen River 38.8% riverine items or 2.5 times more in Ishëm Mouth than Erzen River [15]. Agricultural-related items are not noticed. At the aggregated level, litter items from riverine bank sources such as tourism and recreational activities, (including poor waste management practices), contributed up to 83.8% or 15,464 items of all riverine litter items. The second most often noticed items are sources shipping-related items that contribute up to 8.1% or 1,489 items, while the third most noticed items were sources medical related items for 1.6% or 296 items.

At the individual riverbank level (Fig. 7), the notes of riverine litter sources such as tourism and recreational activities contributed up to 72.9% at Ishëm Mouth-Likmetaj Beach riverbank, whereas 87.9 % at Ishëm Mouth-Godulla Beach riverbank.

4. Conclusion

The present study assesses riverine litter pollution in the Ishëm Mouth that is discharged at south-eastern Adriatic coast also polluting the pearl of Durres county, Cape Rodon. The Ishëm mouth is inside the MPAs Patok-Fushëkuqe-Ishëm. The largest part of riverine litter items at the aggregated level for Ishëm Mouth are made of artificial polymer materials (96%). The second largest material type of riverine litter items at the aggregated level is glass/ceramics. The mean riverine litter density of the Ishëm Mouth is 9,224 items/100 m and 2.18 items/m². What we find mostly in the Ishëm Mouth among 43 items there are drink bottles ≤ 0.5 l (G7) with 29.4%, drink bottles > 0.5 l (G8) with 28.2%, cleaner bottles & containers (G9) with 8%, plastic caps/lids drinks (G21) with 7% and plastic caps/lids drinks (G21) with 6.2%.

In Ishëm Mouth the top 10 riverine items contribute 94.4% of total items with 9 plastic (artificial polymer materials) material category and 1 glass/ceramics. In the Mediterranean Sea region riverine data, the top 10 riverine items compose 82.8% of total riverine items of subsequent material type 7 plastic, 2 paper/cardboard and 1 metal

At Ishëm Mouth-Likmetaj Beach riverbank the most considerable riverine items are drink bottles ≤ 0.5 l (G7), polystyrene pieces 2.5 cm $>$ 50cm, $>$ 50 cm (G82+G83), plastic caps/lids drinks (G21), drink bottles > 0.5 l (G8) and cups and cup lids (G33). At Ishëm Mouth-Godulla Beach riverbank the most considerable riverine items are drink bottles > 0.5 l (G8), drink bottles ≤ 0.5 l (G7), cleaner bottles & containers (G9), cups and cup lids (G33) and flip-flops (G102).

At the aggregated level, single-use plastics contribute up to 71% of the riverine items in Ishëm Mouth, showing that single-use plastics contribute more to the pollution of the river. On July 2, 2021, there are banned plastic ear sticks, plastic cutlery, straws, mixing sticks for drinks, and balloon holders according the [Directive on Single-Use Plastics](#) in the European Union (EU). On June 1, 2022, there are banned plastic carrier bags and oxo-degradable and oxo-bio degradable bags with a finer thickness than 70 microns according the decision of the Council of Ministers no. 367/2022.

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