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## RESEARCH ARTICLE

# Annual Change of Marine Litter in a Rocky Area on the Coast of the Çanakkale Strait

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**Abstract:** Çanakkale Strait is a busy waterway and an important recreational area for the city of Çanakkale frequented by locals and tourists throughout the year. This study was carried out on a constructed coastal rocky area located in the vicinity of the city Center of Çanakkale, between 2021-2022 in order to determine the extent of litter accumulation, type of litter as produced materials and use purposes. A total of 3528 and 1777 items were collected in 2021, and 2022, respectively. Results indicated that litter density was higher than the majority of studies reported from other locations along the Turkish coasts. The most common marine litter was made up of plastics which amounted to 80.24% and 59.65% of total litter composition in 2021 and 2022, respectively. Mixed packing materials were predominant and indicated extensive use of plastic materials in food and beverage sector. Public awareness towards proper ways of litter disposal, use of biodegradable packing materials, beach cleaning and waste management are critical for successful litter management, especially in coastal areas.

### Anahtar kelimeler:

Çanakkale Boğazı  
Deniz çöpleri  
Kirlilik  
Kayalık zon  
Yaşam tarzı

## Çanakkale Boğazı Kıyısında Kayalık Bir Alanda Toplanan Deniz Çöplerinin Yıllık Değişimi

**Öz:** Çanakkale Boğazı işlek bir su yolu olmasının yanında bölge insanı ve turistlerin ziyaret ettiği önemli bir rekreasyon alanıdır. Bu çalışma, 2021 ve 2022 yıllarında Çanakkale Boğazı'nın Çanakkale şehir merkezindeki denizden doldurularak kazanılmış kayalık bir kesiminde, çöp birikiminin boyutu, çöplerin tipleri, malzeme olarak çöpün türü ve kullanım amaçlarını belirlemek için yürütülmüştür. 2021 yılında 3528 adet, 2022 yılında ise 1777 adet çöp toplanmıştır. Çöp yoğunluğu, Türkiye kıyılarında gerçekleştirilen önceki çalışmaların çoğundan çok daha yüksek bulunmuştur. En yaygın deniz çöpünü 2021'de %80,24 ve 2022'de %59,65 ile plastikler oluşturmuştur. En fazla karışık ambalaj malzemelerinin toplanması, gıda ve içecek sektöründe plastik malzemelerin çok yaygın kullanıldığını göstermiştir. Uygun çöp imha yöntemleri, biyolojik olarak parçalanabilen ambalaj malzemelerinin kullanımı, sahil temizliği ve atık yönetimi konusunda halkın bilinçlendirilmesi, özellikle kıyı bölgelerinde başarılı çöp yönetimi için kritik öneme sahiptir.

## Introduction

Marine litter is among the most common problems that affect marine habitats (OSPAR, 2009). It affects all oceans and is considered as a global problem due to poor litter management and causes environmental, aesthetic, economic and health problems (UNEP, 2009).

The source of marine litters are varying materials that are the products of human activities on land. Plastics with 60-80% out of all litters are the major part of marine litters (Derraik, 2002, Barboza et al., 2019). Plastics are used almost everywhere, every sector and every activity. Total annual production of plastics has approached 367

million tons worldwide in 2020, and Europe has a share of 55 million tons (Plastics Europe, 2021). In Türkiye, capacity use of plastic sector is increasing with 70.9% in 2020 and 75.4% in 2021 reaching to 4.5% increase/year annually. In 2021, out of 10.3 million tons plastic production, the production of plastic packing materials amounted to 4.33 million tons (PAGEV, 2021).

Litters originated from terrestrial environments reach to marine environments via rivers, sewage systems or wind and rain (Galgani et al., 2013, Çevik et al., 2022). Coastal areas are under varying stress factors originated from

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human activities such as pollution despite they are complex and fragile ecosystems. The Çanakkale province of Türkiye has 671 km of coastline on the Aegean Sea, Marmara Sea and Çanakkale Strait (Ergül, 2020). The region is characterized by significant tourism activity in summer despite relatively smaller local population of 557,000 (TUİK, 2019). The Çanakkale Strait is not only a dynamic passage for marine organisms and sea vessels but also an important transport path for terrestrial litters.

A recent review reported 11 studies on macro marine litters from the Mediterranean (five studies) and the Black Sea (six studies) coasts of Türkiye (Çevik et al., 2022). All of these studies were carried out on soft substrate areas such as beaches or dunes. In addition, a study was carried out in Çakalburnu Lagoon on the Aegean Sea (Ertuş et al., 2022). Beaches around Marmara Sea including those from the Çanakkale Strait were investigated for the buried macro marine litters (Artüz et al., 2021). A study on marine litters on the Çanakkale Strait coastlines reported distribution of litters in space and time as well as origin of countries, their materials, usage, quantity and weights (Yenici, 2019).

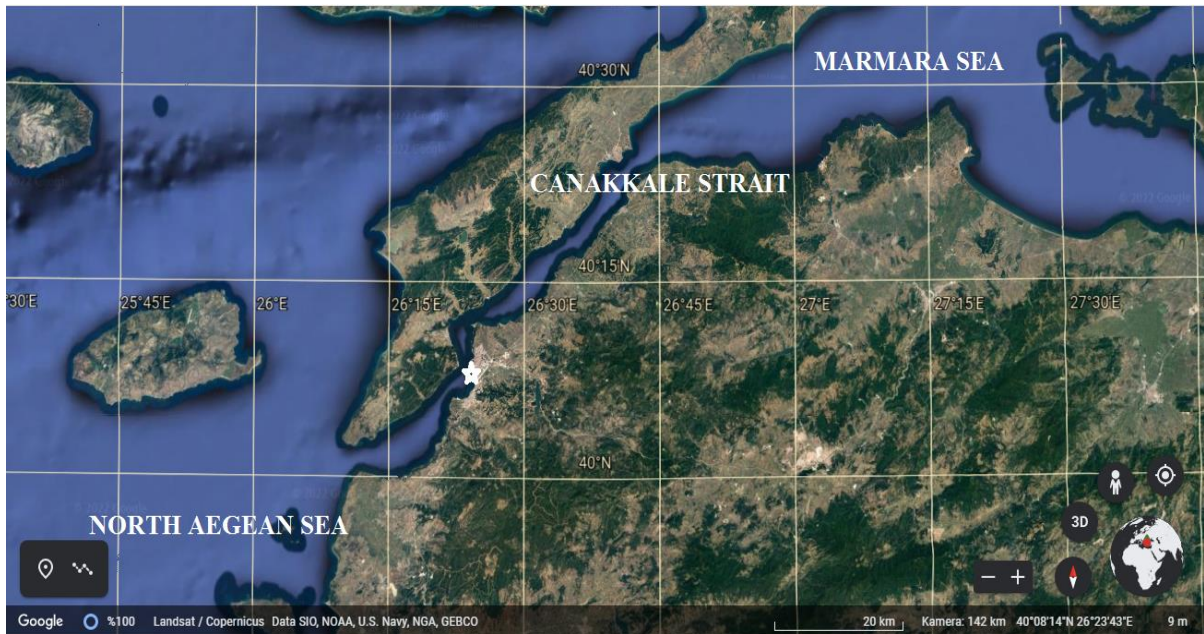
Marine litters in Türkiye have been studied along coastal regions with soft structures and on the seabed but no information on rocky zones exist. The aim of this study is to study marine litters in coastal zones with limited human activities. Results from this study may help to facilitate planning activities related to litter management.

This work was part of a public awareness activity under June 5<sup>th</sup> World Environment Day (in 2021 and 2022) programs of Su Ekosistemlerini Koruma Derneği (SuEkos, Association for Saving Aquatic Environments) and carried out with students participating from Çanakkale Onsekiz Mart University. It is expected that this paper will also help to increase public awareness on protecting the marine environment and combating against littering.

### Material and Methods

The present study was carried out in an area along the Çanakkale Strait, a 70 km long water way which connects the Sea of Marmara and the Aegean Seas (Aslan-Cihangir & Pancucci-Papadopoulou, 2011) and surrounded by urban and rural areas of the Çanakkale Province. The section studied (40° 08' 34.97'' N and 26° 23' 51.62'' E) is a constructed rocky area (140 m length x 3 m width) near the city center and next to Sarıçay River (Figure 1). The area behind the rocky shoreline is allocated for pedestrians for recreational activity. There are no containers for litter disposal and rod fishing is allowed in the area.

Litters over 2.5 cm were picked by hand (JRC, 2013; ÇŞB-DİK, 2017) on June 5<sup>th</sup>, 2021 and June 5<sup>th</sup>, 2022. Litters were then classified and counted according to their composition and usage and disposed of properly (Figure 2).



**Figure 1.** Studied location of Çanakkale Strait shown with star

### Results and Discussion

The total number of items collected from the study area were 3528 in 2021 and 1777 in 2022 (Table 1). Higher number of items collected in 2021 can be attributed to

accumulation of litters over the years before 2021. However, there was considerable litter accumulation on the beach during a period of 1 year (Table 1). Litter density was 8.40 items per m<sup>2</sup> in 2021 and 4.23 in 2022,

and these values were higher than those reported in some of the earlier studies that are carried out on sandy beaches (Çevik et al., 2022). For example, 0.03-5.06 items/m<sup>2</sup> were reported from the Black Sea coasts of Türkiye (Topçu et al., 2013; Visne & Bat, 2016; Terzi & Seyhan, 2017; Aytan et al., 2020; Öztekin et al., 2020), and 0.0 -0.92 items/m<sup>2</sup> were reported from the eastern Mediterranean coasts (Aydın et al., 2016; Kıdeyş et al., 2017). In contrast,

higher litter densities were reported from the Marmara Sea coasts (Artüz et al., 2021). However, litter density was lower on beaches with soft structures along the Çanakkale strait (Yenici, 2019). Very high litter density in the present study can be attributed to the geomorphology of the study area. The constructed rocky shorelines facilitate trapping of litters and prevents redistribution of the trapped litter along the shoreline due to wind and rain.



**Figure 2.** Study area (A-C: 5 June 2021, D-F: 5 June 2022)

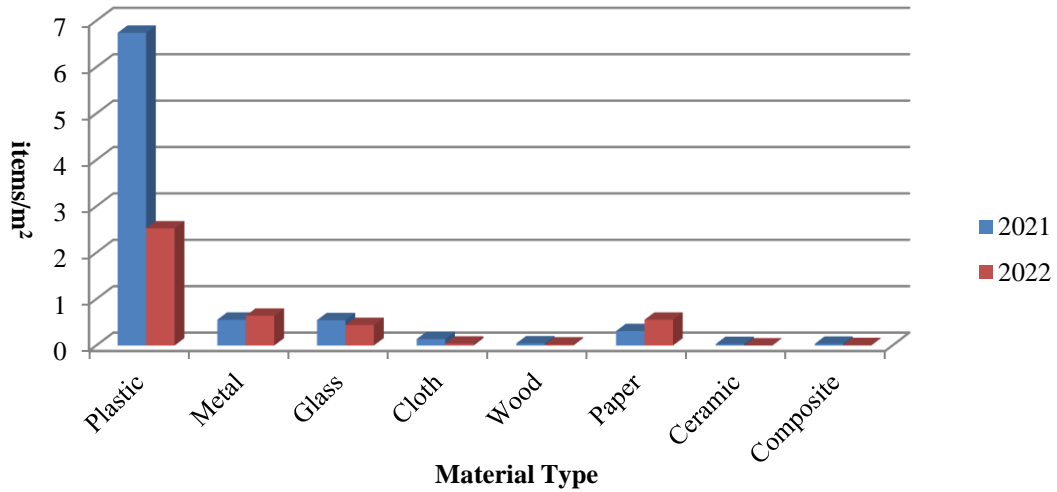
**Table 1.** The number of litters collected from the study area

Year	The total number of litters (items)	Area (m <sup>2</sup> )	Density (items /m <sup>2</sup> )	Change*
2021	3528	420,0	8,40	100.00
2022	1777	420,0	4,23	50.36

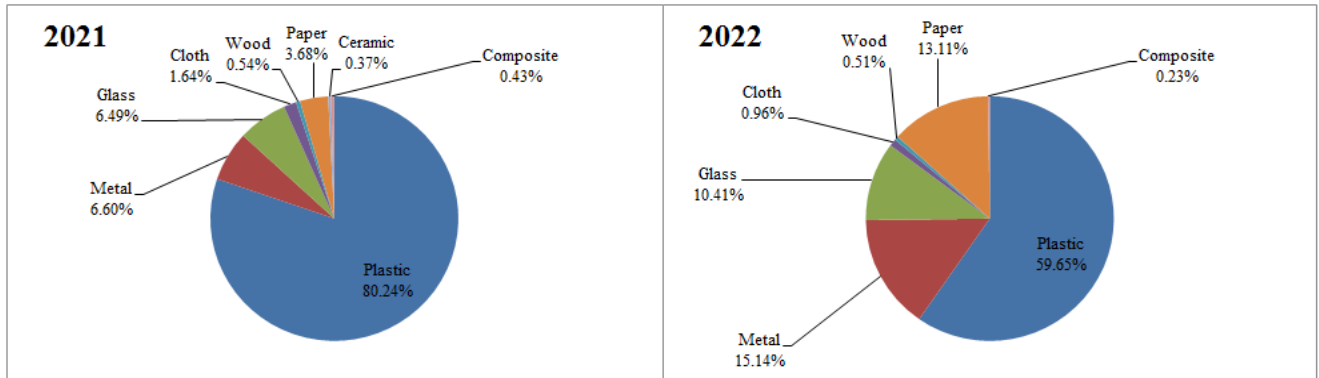
\*2021 is considered base value,100

The most common material of litters collected from the study area was plastics in both years, with 6.74 items/m<sup>2</sup> in 2021 and 2.52 items/m<sup>2</sup> in 2022 (Figure 3). Other most represented items were metals, glasses and papers. Unexpectedly, densities of items composed of metals and papers were higher in 2022 comparing to those collected in 2021. Paper decomposes relatively in a shorter period of

time and this may explain lower occurrence of items composed of paper both in 2021 (3.68%) and 2022 (13.11%) (Figure 4). The number of items composed of metals and glass were similar to those made of paper (Figure 4). Since these materials can easily get buried under the sand, calculated densities of items composed of metal and glass may have been underestimated.



**Figure 3.** Litter densities according to materials used in manufacturing for 2021 and 2022



**Figure 4.** Composition (%) by type of litter collected from the study area in 2021 and 2022

Composition by number of the type of litter collected from the study area highlights the importance of plastics in marine litter (Figure 4). 80.24 and 59.65% of the items collected in 2021 and 2022, respectively, were made of plastics and indicated dominance of single-use convenience food and beverage packaging. A similar trend was observed for items composed of metal which were also dominated by single-use beverage packaging (Figure 4, Table 2). Our findings on plastic litter were similar to those reported in earlier studies from Turkish coasts. For example, the composition of plastics in marine litter were

94.9% and 95.6% on Sarıkum Lagoon in the Sinop Province of Black Sea, 91.1% on the western Black Sea, 87.5%, 79.7% and 61.7% on different parts of coasts of the eastern Black Sea, 79.7% on Mersin and 77.8% on Çukurova area of the eastern Mediterranean, and 76% on the Marmara Sea (Topçu et al., 2013; Aydın et al., 2016; Öztekin, 2016; Terzi & Seyhan, 2017; Terzi et al., 2020; Kıdeyş et al., 2017; Öztekin et al., 2020; Aytan et al., 2020; Artüz et al., 2021). In an earlier study in the Çanakkale Strait 92.45% of marine litter were made up of plastics including foams (Yenici, 2019).

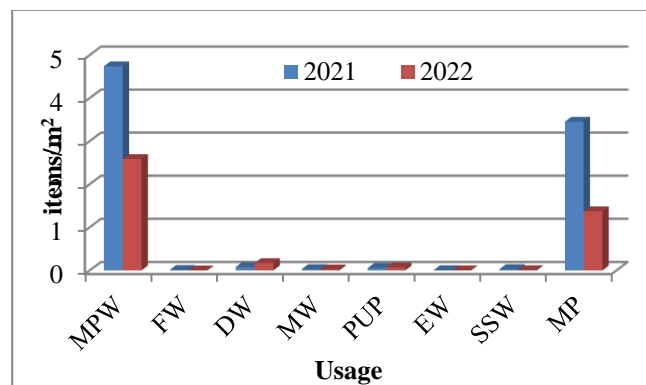
Further classification of litters according to possible use (purpose/type of litters) showed that most of the parts of broken plastics and packing materials belonged to food and beverage packaging (Table 2).

According to usage, the density of mixed packing materials was represented by 4.74 items per m<sup>2</sup> (2021) followed by miscellaneous particles (Figure 5)

**Table 2.** Classification of litters according to their usage and composition

Materials and Usage	The number of litters (items) by years	
	2021	2022
PLASTICS	2831	1060
Plastic parts	1171	373
Food packs	409	464
Bottle caps	665	34
Plastic bottles	56	66
Foams	432	55
Pipettes	13	3
Plastic cups	75	62
Masks	10	3
GLASSES	229	185
Bottles	15	39
Glass pieces	214	146
METALS	233	269
Metal bottle-caps	153	242
Metal boxes	44	11
Metal Parts	36	16
PAPER	130	233
Paper cups	21	24
Vardboard, paper etc.	53	107
Wet tissues	23	30
Paper napkins	33	72
CLOTH	58	17
Rops made from natural materials	54	15
Piece of textile	4	2
WOODS	19	9
CERAMICS	13	0
COMPOSITES	15	4

In both years, the majority of the litter collected were varying packing materials that are mostly used for fast food, finger food and beverages (Figure 6, Figure 7). A portion of unidentified particles which was the second largest group might also have included remnants of packing materials as well.



**Figure 5.** Density of litters according to usage in 2021 and 2022. MPW, “Mixed packing wastes”, FW, “Fishing wastes”, DW, “Domestic wastes”, MW, “Medical wastes”, PUP, “Personal use products”, EW, “electronic wastes”, SSW, “Smoke sources wastes” and MP, “Miscellaneous particles”

The present study demonstrates the extent of marine littering caused by land-based human activities in urban areas. Plastics were the most dominant litter material and highlight the detrimental aspects of contemporary lifestyle and production methods. Public awareness towards proper ways of litter disposal and use of biodegradable packing materials are critical for litter management, especially in coastal areas. Although labor intensive, time consuming and relatively expensive, cleaning of beaches and coastal areas remains to be an effective method to reduce marine litters in coastal areas.

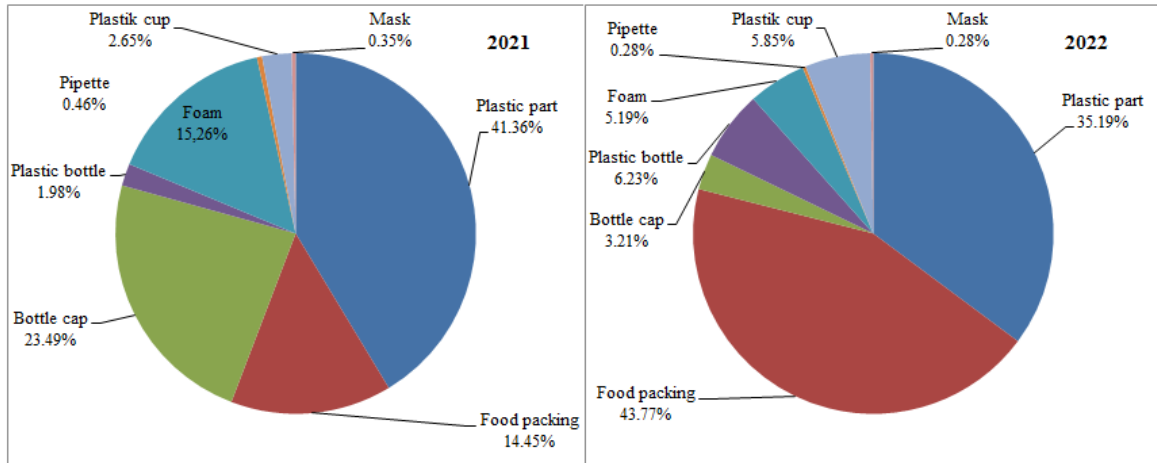


Figure 6. Percentages of litter according to usage for 2021 and 2022

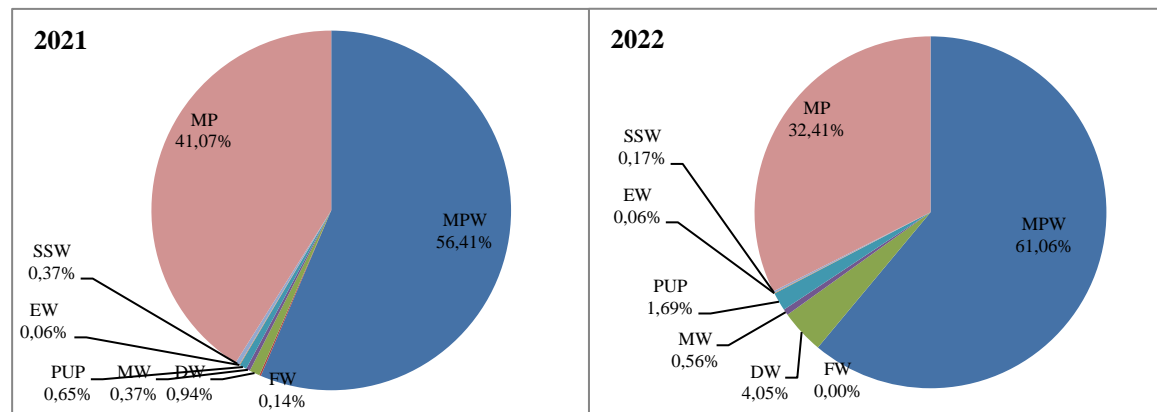


Figure 7. Percentages of litters according to the use purpose by years 2021 and 2022 MPW, “Mixed packing wastes”, FW, “Fishing wastes”, DW, “Domestic wastes”, MW, “Medical wastes”, PUP, “Personal use products”, EW, “elektronik wastes”, SSW, “Smoke sources wastes” and MP, “Miscellaneous particles”

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### Conflict of Interest

There is no conflict of interest between the authors.

### Author Contributions

Dr. Aslan designed the research and write the first draft of the manuscript. Analysis was done by Dr. Yenici. The article was written by Dr. Yenici and Dr. Uludağ. All authors contributed to the data collection and the checking last version.

### Ethics Approval

This study is not required to ethics approval.

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