International Journal of Scientific and Technological Research www.iiste.org
ISSN 2422-8702 (Online), **DOI:** 10.7176/JSTR/7-10-11
Vol.7, No.10, 2021

Studies on Marine Pollution Caused By Litters in the Marmara Sea on the Coast of Turkey

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Abstract
It is aimed to contribute to the marine litter problem by revealing the main sources of marine litter. In this study, the current situation regarding the marine litter problem in the Marmara Sea has been presented and solutions have been proposed for the problem. Industrial development and population explosion are the roots of pollution in the Marmara Sea. The Marmara Sea hosts the two banks of the Bosphorus and is the home to a metropolis, Istanbul, founded in the North Eastern region of the Sea of Marmara and having the most crowd ed population of Turkey, and is the receiver of industrial and domestic wastes of this metropolis. Solid litters in the seas have land-based and marine origins. Marine litters, originate from waterfronts containing shores, piers, ports, marinas, docks and riverbanks, and regions with internal sources. In order to determine the terrestrial sources of marine litter, waste yards, untreated domestic waste water, the load of waste carried by rivers, industrial and tourism facilities operating near the shoreline must all be mapped out. It is necessary to implement integrated waste management components on marine litter and coastal cleaning and to prevent the current confusion of authority based on this. Studies on the prevention of industrial microplastics at source should be initiated and training activities should be provided for fishermen on the management of ghost nets and the capacity of the system should be developed.

Keywords: *The marmara Sea, Marine litter, Microplastic, Population,Waste water*

DOI: 10.7176/JSTR/7-10-11

Introduction

Litters generated as a result of a specific production process and dumping and releasing of these solid materials to marine environment is called marine litters. These litters reach the marine environment with direct dumping as well as indirectly with the effect of the vectors, such as treatment systems discharges, rain water discharges or wind (UNEP,2009).

Marine litters, composed of plastics, paper, wood, metal and other produced/processed residual solid materials are generated as a result of terrestrial activities and maritime transportation and are found especially at beaches and in any depth of the oceans (Galgani et al., 2010). It is estimated that 10 million tons of litters enter the seas each year. 80% of marine litters are of terrestrial origin and 20% are of vessel origin (Ramirez-Llodra et al., 2013).

Scientific studies conducted on marine litters allow us comprehend the negative effects of this problem forming a pressure on marine environment every passing day. Studies on the problems caused by these wastes started to be carried out in the 1960s and the number of the scientific outcomes on this issue increased each passing year. Marine litters, which have been a significant marine pollution problem since the 1960s, have formed a critical threat risk for coastal ecosystems with the increase of plastic materials particularly over the past 20 years (Carpenter et al., 1972). The Sea of Marmara is a 280-km long and 80-km wide intracontinental sea on a waterway between the Mediterranean and the Black Seas.

The surface area, water volume and the greatest depth of the sea is about 11,470 km 2, 3380 km 3 and 1370 m, respectively. It is connected to the saline Aegean Sea (S=38.5‰) via the Çanakkale Strait and to the less saline Black Sea (S=18‰) via the Istanbul Strait. The present sill depths of these straits are -65 and -35 m, respectively (Çağatay et al., 2016). The Sea of Marmara constitutes an oceanographical link between two large semi-enclosed basins: the Mediterranean Sea and the Black Sea. It is a land-locked sea between the Thrace and Anatolian peninsulas and is connected to the brackish Black Sea via the Istanbul (Bosporus) Strait and to the normal marine water of the Mediterranean Sea via the Çanakkale (Dardanelles) Strait (Aksu et al., 2016). Twenty percent of the population of Turkey resides in the Marmara Region (Erel, 1992), primarily within its 46 cities. The coastal area of the Sea of Marmara contains 87% of the population of the entire coastal settlement of Turkey. Increasing industrial and domestic activities in the Marmara Region significantly influence the coastal and shelf areas of the Sea of Marmara. Especially The Izmit Gulf and Golden Horn were significantly affected by industrial and domestic discharges (Tolun et al., 2001; Ergin et al., 1991). The Northern Shelf of the Sea of Marmara is more subjected to increasing human interferences in the form of industrial (metal, food, chemistry, and textiles) waste disposal, fisheries, dredging, recreation and dock activities, than the Southern Shelf. It receives pollution not only from various local land-based sources, but also from the heavily populated and industrialized Istanbul metropolis and from maritime transportation (Polat and Tugrul, 1995). Istanbul is the most heavily populated and industrialized metropolitan area of Turkey. The Sea of Marmara receives pollution from Black Sea inflow (Topcuoglu *et al*.2000). Furthermore, as an important water route between the Mediterranean and the Black Sea, the Sea of Marmara is under pressure of marine transportation (Tasdemir, 2002).The Sea of Marmara region is densely populated and industrialized with more than Turkey's 20% population and 50% industry located in its drainage basin (Orhon *et al.* 1994). The municipal and industrial inputs from its drainage basin, together with nutrients, organic inputs from the Black Sea, have polluted the Marmara Sea since the 1970's (Polat and Tuğrul, 1995). The municipal and industrial discharges are the biggest source of marine litter (Thompson, 2006) and microplastics hold in waste mud from treatment systems (Ziajahromi et al., 2016).

Marine litter enters the sea as a result of pollution originating from land bases and ships, and they turn into small pieces over time (Eriksen et al., 2013). Garbage thrown unconsciously into the sea can be carried to the bottom of the sea (Peng et al., 2018) .

Coasts of the Sea of Marmara have undergone tremendous environmental degradation over the last decades, resulting mainly from rapid population growth, urbanization and industrialization. As by far the most populated and industrialized part of Turkey, housing nearly half of the total number of industrial establishments and more than one-fourth of the total population, the marine ecosystem of the Marmara Sea is subjected to continuing human-induced pressures(Ozhan et al., 2005) such as dredging, reclamation, industrial and sewage effluents, brine water discharge from desalination plants, and oil pollution. These pressures are creating adverse effects on marine biodiversity (Balkis et al., 2016). Shores of the Marmara Sea, an internal sea, are surrounded by a significant number of industrial facilities and is subject to industrial pollution originating from these facilities.

It is seen that pollution has increased at Istanbul coasts due to crowded population, usage for recreational purpose and pier activities. The Bosphorus is productive in terms of fishery and dumping of plastic, nets, robes, etc. by the fishermen is a significant pollution source. While the amount of waste collected by boat from the sea surface of Istanbul was 4656.5 m3 / year in 2017, the amount of waste collected from the sea surface with a net is 3950773 kg (Doğan,2017).

Results and discussion

Monitoring Studies in Marmara sea surface, bottom and water column

Studies conducted on sea litters at the sea surface, sea bottom or water column in Turkey are of local scale and considerably limited. Considering the Marmara Sea particularlly, these studies are summarized as follows;

- Collection studies conducted at the shore by Istanbul Metropolitan Municipality in 2005.
- Inventory studies conducted by collecting and diving at the coasts in the scope of voluntary activities of the non-governmental organizations,
- Inventory studies of the universities/research institutions conducted (Beken *et al.* 2014) for the Ministry of Environment and Urbanization based on the bottom trawl studies (Yüksek & Beken 2013).

- Regular monitoring studies have started in 8 stations in the scope of the Program of Integrated Pollution Monitoring in Seas, prepared by the Ministry of Environment and Urbanization in recent years to beter implement the MSFD and Regional Conventions.

Due to the fact that wastes may remain in the marine environment for ten, even hundreds of years, conducting only source evaluations should not be deemed sufficient and observations must be made in the field. Various different spatial scales must be taken into consideration when monitoring solid wastes. Similarly, temporal scales must also be determined. Monitoring activities conducted on a national scale on the shores and out at sea may be organized in less frequent intervals. Areas that have been most severely affected must be monitored locally. Areas where seasonal variations should be monitored must also be defined.

Studies regarding the effects of solid wastes should be conducted on a regional scale through the implementation of mutual protocols. Marine litters are global pollution problems and some regional assessments have been made in the scope of global initiative scope of UNEP, including the Mediterranean and Black Sea. With the increased need for researching and monitoring the issue, the Ministry of Environment and Urbanization of Turkey support some studies on the basis of inadequate number of data existing on the distribution, approaches and effects on the ecosystems. In the national level, 90-97% of the material collected in the trawls were made of packaging materials based on the data collected in different times. A small portion of it consisted of wastes originating from fishing activities, marine vehicles and accidents (Yüksek & Beken, 2013).

The collected data were assessed and the sea bottom solid waste distribution areas and their sources were designated. Based on the monitoring outcomes, 75% of the litters distributed in the Marmara Sea were plastic, 10% were metals, and 4% were fabrics, textile and rubber. Glass, wood, paper and others were distributed in the ratio of 2%. Moreover, 80% of the marine litters originated from the packaging (food, drink packaging) industry. 3% came from the fishery activities (Beken et al.,2014).

Considering marine solid waste distribution, it was specified that the highest amount of marine litter distribution in a unit area (13535 adet/km^2 ve 694 kg/km^2) occurred in the monitoring station situated at Izmit Bay where there were low currents and anoxic conditions prevail. Considering marine litter origins, the plastic group was haigher in the middle and inner bay in comparison to the other groups. Inner sections of Gemlik Bay contained the highest level of plastic bags and plastic bottles.

Though this situation resembled the outcomes of the studies conducted in the past years, an important result was that plastic bags and plastic bottles were higher than the other solid waste materials in the South Western areas. The litter intensively distributed mainly around Istanbul metropolitan area; coastal shelf between Büyükçekmece-Yenikapi (northern coastal strip), Tuzla shipyards area (southern coastal strip) and Izmit Bay.

In general, 406 kg/m^2 litter was calculated for unit area which makes 1925 tonnes of litter for the whole seabed. This value is about 16% of the weight of demersal fishcaught during the same survey(Yüksek & Beken,2016). The results obtained for different periods have shown that about 90-97% of the trowled items was composed ofpacking material and a small amount ofthe litter are related tofishing, sea vehicles and accidents. About 50% ofthe pollution caused bypacking material was plastics and other petroleum derivatives and 30% of the litter was cans and other aluminum material. It can be seen in *Figure 1* that the most dispersed litter group in the Marmara Sea is plastic and the least distribution is in paper. Distribution of the different kinds of litter are given in *Figure 1*.

A national monitoring programme has only been performed since 2009 in the Marmara Sea with the support of Ministry of Environment. Institute of Marine Sciences and Management of İstanbul University and Marmara Research Center of TUBITAK have been carried out oceanographic and monitoring cruises in the Marmara Sea since 1986 to collect data for different projects supported by TUBITAK, EU, ministries and the municipalities. The data collected during these cruises have been the basis to understand the oceanography and as well as the eutophication status of the Marmara Sea (Ediger *et al*. 2016). In the scope of the Project called "Microplastic Carriage and Possible Accumulation Fields in Turkish Straits System", supported by TUBITAK, sea water samples were taken at the bays located in the south and east shelves also in Istanbul and Çanakkale Straits at the Marmara Sea.

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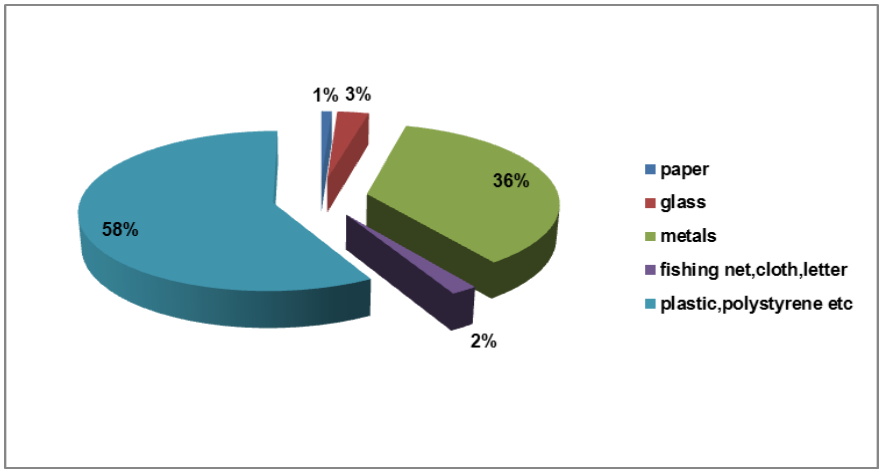

Figure 1. *Distribution of the different kinds of litter*

As a result of this extensive study carried at the Marmara Sea, microplastics were seen in substantially varied types and colors.
Microplastics were analyzed in basic groups, including fiber, hard, nylon, coloring agent, silicon, foam, pellet (raw material) and microbeads, and microplastic amount per square meter was estimated in the study field.
Based on these calculations, outer and middle lines of Bandırma Bay ranked the first among the regions consisting of the most amount of microplastic in the surface water. Inner and middle lines of Izmit Bay ranked second and Erdek and Gemlik Bays had the lowest values among the bays.
Considering the straits, it was determined that the surface water coming from the Black Sea had microplastic amount half as the microplastic amount of surface water of the Sea of Marmara surfacing at Çanakkale Strait. Considering the water columns, middle line of Bandırma Bay and inner line of Izmit Bay had the highest amount of microplastic per square meter, and interiors of Gemlik Bay and Yalova offshore waters had the lowest values (Yüksek, 2019). Microplastic monitoring was carried out at 13 stations in the Marmara Sea by Yuksel, and the monitoring points are given in *Figure 2.*

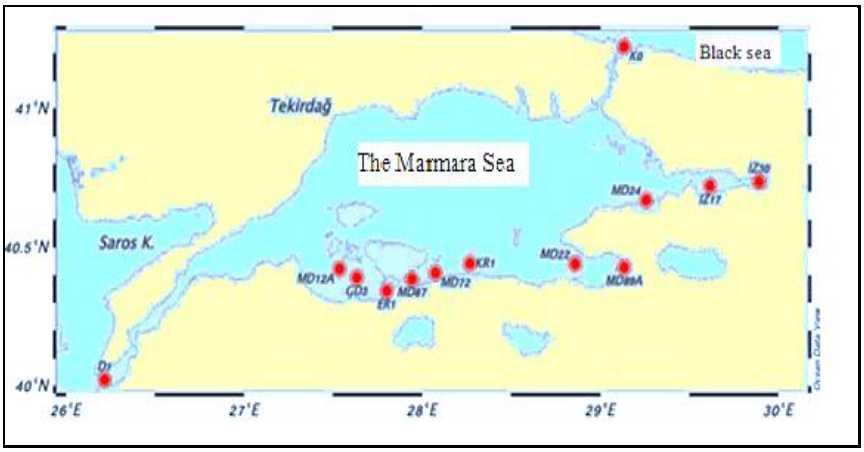

Figure 2*. The Marmara Sea monitoring stations(Yüksek,2019)*

In the microplastic study conducted at the bays and straits of the southern shelf of the Marmara Sea, the groups of all of the plastic pieces obtained in the surface water and water column were compared. The fiber group was the majority (52%) in both of the matrices and hard plastics ranked the second in the surface water and coloring agents ranked the third. The situation was somewhat different in the water

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column. Fiber plastics in this matrix were sampled in a substantially high ratio (79 %) and coloring agents ranked second and hard plastics ranked third *(Figure 3).*

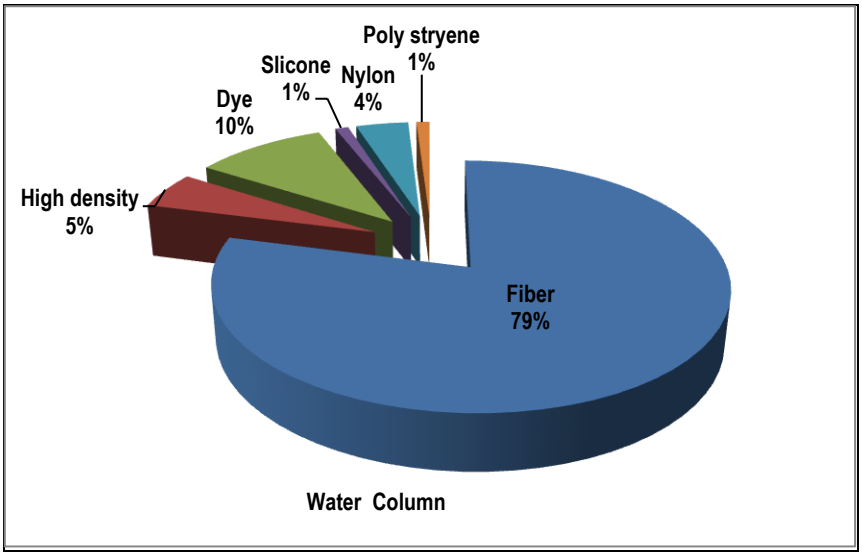

Figure 3. *Compositon of microplastic types throughout the study field*

Microplastic samples were taken at sea waters in 1 station at the inlet of the Black Sea of the Bosphorus at the Marmara Sea. Samples were taken in 1 station at the outlet of the Eagean Sea of Çanakkale Strait, and at a total of 13 stations representing the inner and outer lines at the bays. Fiber group plastics were found the most in the collected samples and this situation was in accord with Gürbüz's master's thesis outcomes (2017) which presented the first records of the Marmara Sea based on the results obtained from the samples collected in 2014-2015 (Yüksek, 2019).

Studies conducted on microplastic pollution in Turkish waters are quite new and in limited numbers. There are only a few studies conducted on sources and distributions of microplastics and their effects on living beings in particularly the Marmara Sea (Gürbüz, 2017). This master's thesis study was conducted by taking horizontal, vertical and sediment sampling in a total of 7 stations at the Marmara Sea in August 2014 and March 2015. Microplastic types distributed extensively at the Marmara Sea were determined as hard plastics and fiber plastics. It was reported that there was higher level of microplastic presence in the regions with extensive river inlets, and microplastic density of the surface water was higher than those of the water column and sediment. Sivri et al (2017), studied sand samples collected at the Sea Marmara, Yeşilköy shores. They aimed to determine the possible marine ecosystem entry ways of macroplastics and microplastics which pass from the shore to the sea. They aimed to scrutinize the effects of these on the coastal areas and at the same time, they aimed to investigate Istanbul's coastal regions and determine the stages macroplastics and microplastics go through to reach the coastal ecosystems. In another study of Tuncer et al, (2018) conducted in the Marmara Sea in the surface waters of 14 stations, they have reported that the fragment (hard with no shape) microplastic type is dominant throughout the sea.

Gürbüz (2017) collected horizontal, vertical and sediment samples in 7 stations at the Marmara Sea during August 2014 and March 2015 and they assessed these samples. They have reported that the most densely distributed microplastic types were hard plastics and fiber. They have also reported that microplastic presence was the highest at the regions with intensive river inlets and surface water microplastic density was higher than those of the water column and sediment. Gürbüz, Ö. 2017 has stated that samples were collected at a total of nine stations, namely two stations in August 2014 and seven stations in March 2015(*Figure 4*).

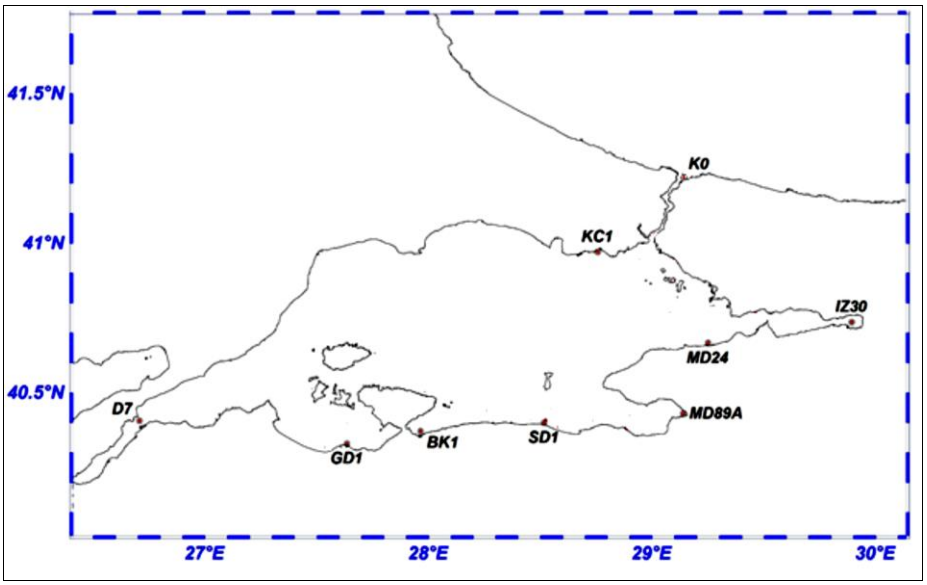

Figure 4. *Studied stations and locations(Gürbüz,2017)*

They have reported that it is possible to analyze the change over the time in the amounts of solid wastes collected during their fishing/biodiversity field studies conducted by using trawls in the depth range of 20-200m in the Marmara Sea; based on the assessments of the years 1994, 2000, 2005 ve 2010. According to the 2000 data, which were presented as an example, significant statistical data were gathered, a sea bottom waste map was drawn, and it is reported that biodiversity was at the lowest level in the regions where marine litters were dense in the comparisons made by using the biodiversity index (Yüksek & Polat, 2013). Based on the outcomes of sea bottom solid waste samplings made by using trawls in different time periods in the Marmara Sea, though the pollution sources varied over the years, the source is the packaging industry with 90-97%. The source is fishing, vessels or sea accidents and ammunition with a small ratio. More than 50% of pollution with packaging source is made of petroleum derivatives (plastic, packages, etc.) and nearly 30% was metals (aluminum drink cans, oil and tin cans, etc.). In order to give support to more effective sea surface and coastal waste management, a characterization process was carried out on the waste samples collected in the 10 selected regions, including sea surface and coasts during 2016 as to represent the four seasons, namely April, August, October and December. The waste samples collected by the coastline teams and 8 sea surface cleaning vessels were grouped for the characterization study and they were weighted. As a result of the characterization study conducted, the weighting results were assessed and it was found that a critical portion of the sea surface waste contents in Istanbul Province was made of biodegradable wastes (approximately 70%). Moreover, the recyclable wastes and other wastes were also present in the wastes collected in the sea (Doğan, 2017).

Municipalities having coastlines to the Marmara Sea have conducted monitoring studies at the sea bottom, sea water and sediments concerning the marine litters in the Marmara Sea. In addition, they have been conducting coastline cleaning studies and nearly 5,000 m3 wastes were collected at the sea surface in 2016 by sea surface cleaning vessels (*Figure 5*). Waste amounts collected at the sea surface in the Marmara Sea by years are given in *Figure 5*.

Nearly 39,000 m3 of wastes were collected at the shores and beaches by 442 personnel in 2016. The collected wastes are bagged and transported to Istanbul Metropolitan Municipality waste disposal plants (Alarçin, 2017). In the sea and coastline cleaning study scope, effects of large ratio of floating materials were studied. These were coming from the creeks running to the Golden Horn, which is a sea intrusion separating the historical peninsula and Beyoğlu tableland at the south eastern tip of Çatalca Peninsula in Istanbul. Barriers were placed at the creek mouths so that the wastes would not be included in the Golden Horn and mixing of these materials in the Golden Horn was prevented (Yüksel et al.,1999). In 2017, litter study was carried out at a coast in pilot scale for the first time. The study was conducted at Kınalıada shores and litters were collected in a nearly 3,000 m2 of area. Based on weight distribution, it was designated that the litters were in the plastic category the most

ISSN 2422-8702 (Online), **DOI:** 10.7176/JSTR/7-10-11
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(approximately 46%) and metal followed it with 26% and wood materials followed it with 9%. Based on the amount of litters collected in the same area again, plastic was found at the highest level with 85%. Paper followed it with 8% and metal litter ratio was 4%. Litter amount per unit area was found as 4/m^2 (Beken et al., 2017). Kınalı Island Beach % litter amount distribution is given in *Figure 6.*

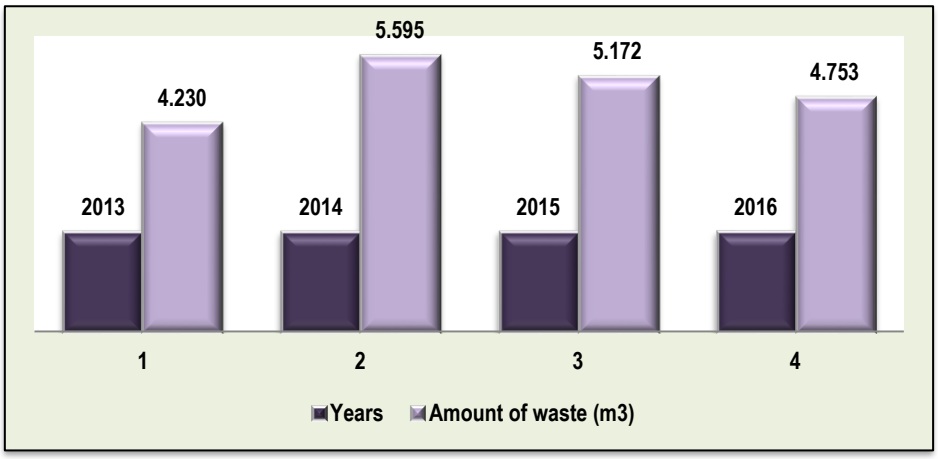

Figure 5. *Waste amounts collected at sea surface in the Marmara Sea by years*

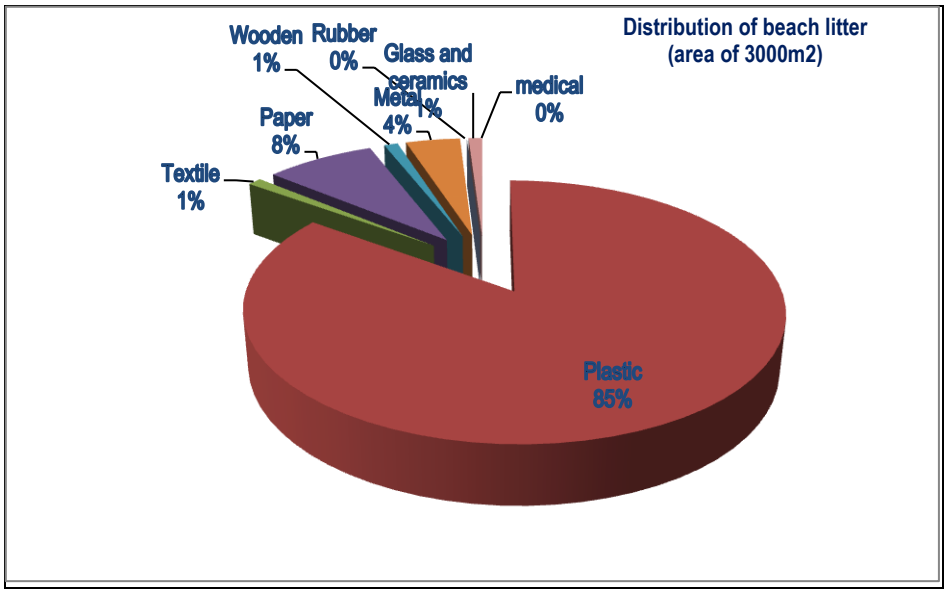

Figure 6. *Kınalı Island Beach % litter amount distribution(Beken et al., 2017)*

It is fair to state under the light of the mentioned limited studies that the major source of litters in Turkey's seas is carriage with rivers from the litter deposition areas at the shores and tourism activities (sea and coastline tourism). Based on the observations recorded in the coastline and sea studies of Istanbul University, Institute of Marine Sciences and Management conducted in the Sea Marmara and the Black Sea for many years, wastes are collected regularly and intensively at 4 coastal regions at the Marmara Sea and 2 coastal regions at the Black Sea. The locations of the discussed accumulation areas are shown on the map (*Figure 7).*

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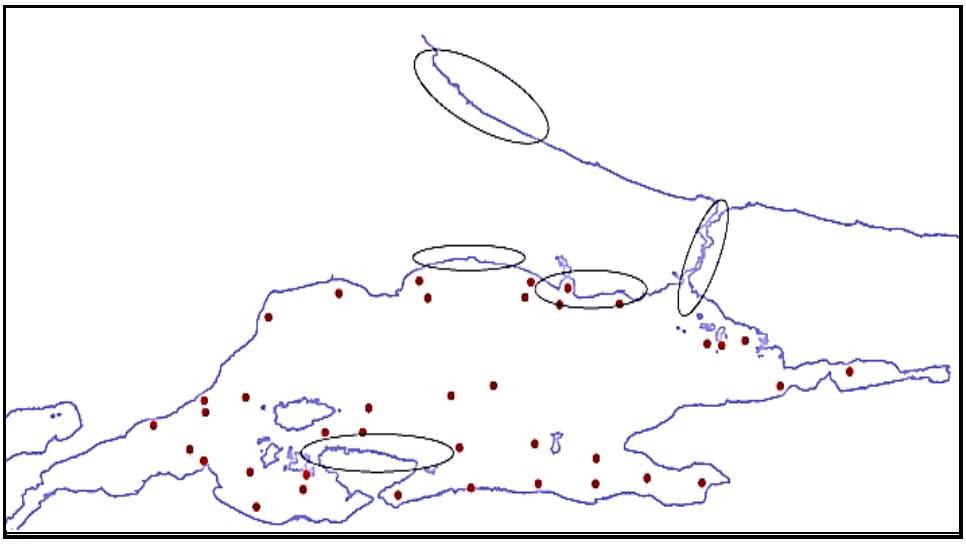

Figure 7. *Litter accumulation areas at the coastal reigons of the Marmara Sea and the Black Sea (this map was drawn based on the data received in Dekos Project, 2014 by Istanbul University, Institute of Marine Sciences and Management)*

Based on these data, monitoring studies need to be carried out to follow up the trend for marine litter amount, content and change over time particularly in the regions where human pressuring is high in Turkey's seas (Beken et al.,2017).

Coastline cleaning studies conducted by the municipalities having shores by the Marmara Sea

4,276 m3 of wastes were collected at the sea surface and 23,300 m3 of wastes were collected at the shores and beaches by the end of 2012 at 59 beaches throughout Istanbul at 515 km of coastline and at the Golden Horn and the Bosphorus by Istanbul Metropolitan Municipality by 12 teams consisting of 180 persons between May and September (Yaman, 2013). It is well known that Istanbul Metropolitan Municipality has been continuing its studies at Istanbul shores, beaches and creek mouths regularly and intensively since 2005 and that there are data and assessments emphasizing the change over time in the collected solid waste amounts. Based on the data provided by Istanbul Metropolitan Municipality, the waste amounts collected at the coasts and beaches at 17 coastal counties during the 2010-2012 period and scaled with garbage bags of standard sizes are shown in *Figure 8*. In this way, it is understood clearly which counties have generated more solid wastes as related with coastal usage particulary and there are no significate differences over the years.

Despite it is not possible to estimate the collected solid waste amounts in weights, it is understood that solid waste collection and disposal studies were conducted in a wide scale and regular basis as a result of these activities(Beken et al., 2014).

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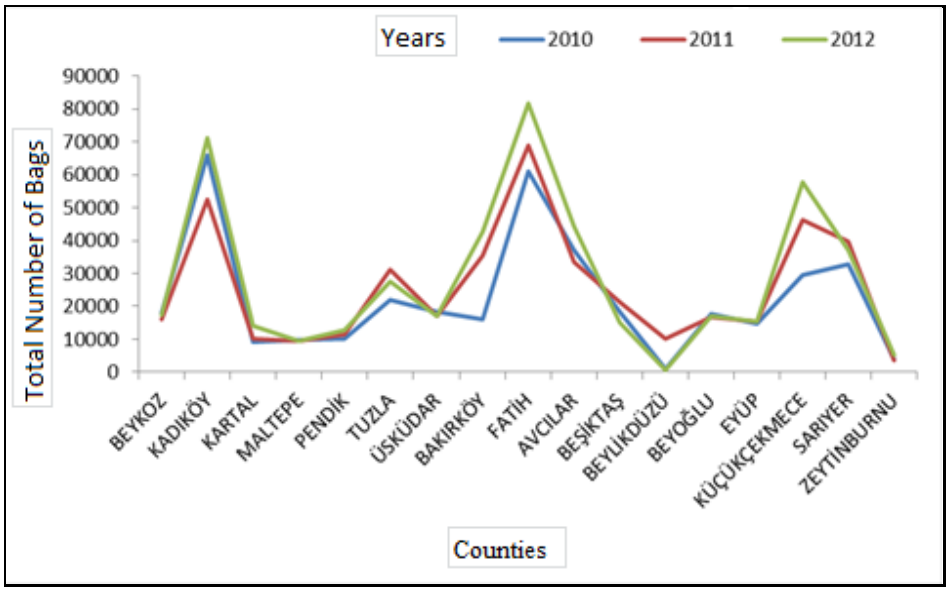

Figure 8. Number of bags collected in Istanbul counties during 2010 and 2012

- Bursa Metropolitan Municipality has collected nearly 39,000 m^3 wastes at the coastlines and beaches by 442 workers in 2016. The collected wastes were put into bags and transported to the waste disposal plants of Istanbul Metropolitan Municipality. In 2015 and 2016, it is reported that a total of 380 m^3 of litters were collected at the sea surface by using skimmers. This amount was 230 m^3 in 2015 and it was 150 m^3 in 2016 (Bebek, 2017).
- In the scope of "Izmit Bay Water Quality Monitoring Project" carried out in collaboration with TUBITAK/ MAM since 2007, a pilot study is being conducted concerning marine litters in some beaches, the sea and some creeks. Determining changes in the amount and types of macro garbage reaching the Izmit Bay by over time and taking measures depend on the source of the garbage (Bostan, 2017). Cleaning up marine litter, which is floating or accumulates in various places, was carried out in 2017 by 4 Sea Sweepers operating under Kocaeli Metropolitan Municipality.

Studies of Non-Governmental Organizations

Modifying behaviors of people about coastline cleanness is critical. In this context, it is necessary that municipalities and non-governmental organizations should strengthen their dialogues and awareness studies must be carried out with the support of sociologists and behavioral scientists and public service announcements must be popularized. These studies must be conducted synchronously with the systematic enforcements implemented regarding this subject.

Various activities (surveys, trainings, awareness studies, etc.) are organized to put forward the negative effects of marine litters on sea water quality and ecology in the coastlines and marine environment and to create awareness in any section of the society and to improve sensitivity of the public about this issue. In the scope of the studies conducted throughout 2017, training and awareness studies were conducted with the participation of nearly 10,000 people (Alarçin, 2017). Non-governmental organizations are conducting sea surface and coastline cleaning studies in Turkey.

Coastline cleanness studies are being carried out under the coordination of Marine Cleannes Society since 2002. In the activity organized in the framework of International Coastline Cleanness Campaign in 2017, a pilot regional study was conducted at Istanbul coastlines and approximately 155 kilograms of litters, including primarily plastic, metal and glass and cigarette butts were collected. Marine Clean Association / TURMEPA International Coastal Cleanup (International Coastal Cleanup - ICC) "campaign event, held on 15 October 2016 with the participation of 1071 volunteers across Turkey 3202 kg of waste was collected (Geyik and Dagdeviren, 2016). Most of the collected waste consists of plastic parts of various sizes, including plastic bags and water bottles, and the Sea of Marmara constitutes an important part of this study. The goal of the activity is to create self-consciousness by emphasizing %80 of sea pollution caused by human activities and through land.

The collected wastes were delivered to Istanbul Metropolitan Municipality teams. In the scope of Happy Fish Project, implemented in collaboration with Istanbul Metropolitan Municipality and Beşiktaş Municipality and Turkish Plastic Industrialists Research Development and Training Foundation (PAGEV) with the support of the Ministry of Environment and Urbanization, it has been aimed to raise awareness about earning income by collecting wastes at the sea surface during fishing ban period for fishermen and to recycle the collected wastes and to add value to the economy (Doğan, 2017). In the scope of Happy Fish Project, which is started to be implemented along with the fishing ban, fishermen will be able to clear the sea surface from various wastes, including metal, glass and plastic by using a special net, and these collected wastes will be added to the economy again as a gain. Thousands of square meters of nets are trapped by the rocks at the sea bottom and left there by the fishermen who fish by using bottom constricted nets (seine nets) or nets broke off and are left under the water, and these nets affect soft coral species, which are protected by many international conventions where we are also a party, and they affect living habitats of many protected marine species.

The amounts of lost fishing tools, which cause ghost fishing in Istanbul coastline fishing, were determined and it has been calculated that 229,48 km of guarding nets, 2,700 m of longliners and 14 rockling were lost. The mostly lost nets were primarily shield nets with 54.73%. The other lost nets were respectively bonito nets with 16%, red mullet nets with 7.36& and trammel nets with 4.8% (Yıldız & Karakulak, 2016).

In the study conducted by Ismen et al., (2019) at 34 stations in the Marmara Sea between March 2017 and December 2018, 626 garbage components were identified and it was determined that the amount of garbage in 2018 increased significantly compared to 2017.

In order to determine the possible accumulation areas of microplastics in the Marmara Sea by Gürkan et al., (2019), microplastic sampling was carried out in August 2016 from sea water at a total of 13 stations, in gulfs and strait outlets, and from the sediment surface at 9 stations in 2015. It has been determined that there is a high number of fiber plastics in seawater. Rigid plastics have generally been found to be higher in regions with high industrialization and river input.

In Turkey, the "project of preparation of marine litter action plans and pilot scheme" was carried out to control marine litters. In the project scope, "Istanbul Marine Litter Action Plan" was prepared to effectively combat with marine litters.

In order to fix the legislation loophole concerning this issue, "Marine Litter Provincial Action Plan Preparation and Implementation" circular note was issued in the project scope. It is planned that it will be implemented in all cities having a coastline by the sea in the framework of the circular note. It is understood that there is a pilot scale monitoring program to monitor sea litters in the Sea of Marmara.

Conclusions and recommendations for future work

When the distribution was examined in general, it was found that plastic bags and plastic bottles were higher than other solid waste materials (Yüksek et al., 2016). Considering the origin of marine litter, the plastic group is higher in the middle parts and inner bay compared to the other groups, and the region with the highest number of plastic bags and pet bottles is the inner parts of Gemlik Bay. This situation is similar to the researches conducted in the previous years, but a significant finding is that plastic bags and plastic bottles are higher in number than other solid waste materials in the southwestern area.

A large amount of microplastic enters the domestic wastewater treatment plant through sewage systems (Akarsu et al., 2019) and forms an important source of pollution in water environments. The most important source of microplastics to meet with the aquatic ecosystem is the fibers in cosmetics and clothing in the effluent of domestic wastewater treatment plants (Akarsu et al., 2017). Pollution monitoring studies conducted in the Marmara region showed that the source of microplastics originated from the cosmetics and textile industry. In the Marmara Sea, microplastic removal mechanisms should be investigated in Wastewater Treatment Plants for the reduction and prevention of microplastics. On the other hand, considering that microplastics accumulate in the food chain, tissues or organs of creatures such as zooplankton, macro invertebrates and fish (Yurtsever, 2015), various studies and controls should be carried out to protect the Marmara Sea.

A national monitoring program must be developed for sea litters, a very critical pollution element, and financial budget must be allocated for this issue. Numbers of personnel and litter collection vehicles must be increased and capacity must be expanded in the Sea of Marmara region.It is necessary that we must be knowledgeable about the geographical roots of litters in the coastal regions in order to implement acts aiming to decrease litter pollutions and regular litter studies must be carried out, and

outcomes on the local air conditions and geomorphologies of the coastlines must be analyzed. The existing different yet adaptable methods for monitoring must be adapted by considering the regional differences such as the currents that are dominant in the coastlines or sea regions (Gal-gani et al., 2013). Despite it is accepted that the use of the methods suggested in the guide of MSFD marine litter technical sub group (TSG-ML) is an adaptable tool to assess the marine litters, regional and national legal and administrative tools must be developed with the implementation of the larger regional and national monitoring and assessment programs, which consist of the suggested methods (Visne & Bat, 2015). Sea litters is a global issue and marine litter decreasing activities should be developed in global scale and must be coordinated in regional level and applied in national level. In order to decrease marine litters and their negative effects, local, national and regional strategies and policies must be implemented. The existing litter pollution and their resources must be known in order to absolutely assess the effectiveness of the taken measures to decrease litters. We have very limited knowledge about the sources, reasons, distribution and amount of the litters in Turkey right now. Marine litter researching in Turkey's seas must be encouraged. Policies must be developed for solution of the issue.
Land-origin and sea-origin litters must be decreased, regional and national collaboration must be developed between the sectors concerning marine litter related activities, waste production and disposal behaviors of the people must be changed, and environmentally friendly tourism applications must be developed.
In this study; research papers, articles, regional and international agreements, publications and organizational efforts to educate the public were reviewed concerning marine litter. Solving the marine litter issue will require every country's, region's and everyone's cooperation.
Marine litter is a global problem and mitigation actions should be developed around a global framework, coordinated at the regional level and implemented at the national level. We need standardized methodologies for quantification and characterisation of marine litter to be able to achieve global estimates. To mitigate marine litter and its undesirable consequences, a number of local, national as well as regional strategies and policies will need to be implemented. We need to identify litter sources and evaluate the amount present in our seas in order to assess and evaluate precisely the effectiveness of measures implemented to reduce marine litter pollution. The current state of knowledge about the sources, causes, quantities and distribution of marine litter at the region level in Turkey is very poor. Academia and industry is required to encourage to research to marine pollution and debris in our seas. It is crucial to formulate policies for dealing with the problem.
We need to reduce land-based waste and sea-sourced litter; improve regional, national and inter sectoral coordination on marine litter related activitties; influence people's waste generation and disposal behaviors; develop and implement environmentally-friendly tourism. Recently, the tourism industry to act in environmentally sensitive management approach began to be seen as a necessity. Blue flag beaches, which are an indicator of clean sea water, are one of the best indicators of this.
The blue flag application is a symbol that gains importance as it is an indication that businesses act with an environmentally friendly or environmentally friendly management and management approach (Blue Flag, 2019). Keeping the beach clean and well-maintained at all times, and having no litter in any way is a mandatory criteria for a Blue Flag beach. It is very important to consider the marine litter problem as a topic that can be easily understood by the general public, to organize cleaning activities in coastal areas and river basins, to support litter hunting, and to support artistic studies on awareness-raising activities are considered to be beneficial for the protection of the marine environment.

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