EVALUATION OF THE EUROPEAN UNION AND TURKISH LEGISLATION AND PRACTICE IN THE CONTEXT OF MARINE LITTER PROBLEM

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ABSTRACT

EVALUATION OF THE EUROPEAN UNION AND TURKISH LEGISLATION AND PRACTICE IN THE CONTEXT OF MARINE LITTER PROBLEM

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Marine litter is a global issue affecting all the world's oceans, posing environmental, economic, health and aesthetic problems. Linear economies create the problem, and inadequate solid waste management practices and lack of wastewater collection and treatment infrastructure -which enable the collection of microplastics- cause the plastic material flows to rivers and the oceans.

Plastics are the primary driver of marine litter. The resistance of the plastics sector to shift through a lesser plastic dependant future and low-level public awareness on the consequences of user habits and littering are the main reasons for the marine litter problem. Developing the technology to clean up our oceans is one option; however, this will never be an efficient method against marine litter as big plastics flow through the seas will continue if we do not curb the problem at its source. Besides, applying the circular economy model for the solution will be vastly cheaper.

Marine litter is one of the indicators for evaluating the inefficient management of material resources. The loss of valuable materials in the economic loop causes pollution in beaches and seas, damaging our environment and harming human and biota health, instead of being reused as an input for the economy. A circular economy approach is necessary for the solution to the marine litter problem.

The European Union is trying to tackle the problem by integrating the marine litter problem into its waste legislation, Plastic Strategy, environmental protection legislation, and monitoring their measures' success. In Turkey, however, the acknowledgement of the problem is in the early stages. Besides a few scientific field studies and legislative actions, there is no holistic approach to the marine litter problem.

In this study, a legislative analysis of the European Union on marine litter will be performed. Implementation of the Union acquis and Turkish legislation will be evaluated, and a "source to sea core set of marine litter indicators" proposal for the EU and Turkish monitoring system, which aims to establish stronger scientific links with the sources and the sink of marine litter will be submitted.

Keywords: Marine litter indicators, European Union, waste management, plastic pollution, circular economy

ÖZ

AVRUPA BİRLİĞİ VE TÜRKİYE MEVZUATI VE UYGULAMASININ DENİZ ÇÖPÜ PROBLEMİ BAĞLAMINDA DEĞERLENDİRİLMESİ

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Deniz çöpü tüm dünya okyanuslarını etkileyen, çevresel, ekonomik, sağlık ve estetik sorunlara neden olan küresel bir konudur. Sorunu doğrusal ekonomiler yaratır. Yetersiz katı atık yönetimi uygulamaları ve mikroplastiklerin toplanmasını sağlayan atık su toplama ve arıtma altyapısının eksikliği, plastik malzeme nehirlere ve okyanuslara akmasına neden olur.

Plastikler deniz çöplerinin birincil nedenidir. Plastik sektörünün daha az plastik bağımlı bir geleceğe yönelmeye karşı direnci, aşırı plastik tüketimine yönelik kullanıcı alışkanlıkları ve gelişigüzel çöp atmanın sonuçları konusunda düşük seviyeli kamuoyu farkındalığı deniz çöpü sorununun başlıca nedenleridir. Okyanuslarımızı temizlemek için teknoloji geliştirmek bir çözüm seçeneği olabilir. Ancak, sorunu kaynağında çözmezsek, denizlere plastik akışı devam edeceği için temizleme teknolojileri deniz çöplerine karşı verimli bir yöntem olmayacaktır. Ayrıca, çözüm için döngüsel ekonomi modelini uygulamak çok daha ucuza mal olacaktır.

Deniz çöpleri, malzeme kaynaklarının verimsiz yönetiminin ölçümü için göstergelerden biridir. Ekonomik döngüde değerli malzemelerin kaybı, ekonomi için bir girdi olarak yeniden kullanılmak yerine, plajlarda ve denizlerde kirliliğe, çevresel zarara, insan ve biyota sağlığına olumsuz etkilere neden olmaktadır. Deniz çöpü sorununun çözümü için döngüsel bir ekonomi yaklaşımı gereklidir.

Avrupa Birliği, deniz çöpü sorununu atık mevzuatına, Plastik Stratejisine, çevre koruma mevzuatına entegre ederek ve alınan önlemlerin başarısını izleyerek sorunu çözmeye çabalamaktadır. Ancak Türkiye'de sorunun kabulü halen erken bir aşamadadır. Bazı bilimsel saha çalışmaları ve yasal düzenlemeler dışında, deniz çöpü sorununa dair bütüncül bir yaklaşım bulunmamaktadır.

Bu çalışmada, Avrupa Birliği'nin deniz çöpleri ile ilgili yasal düzenlemelerinin bir analizi yapılacaktır. Birlik müktesebatının ve Türk mevzuatının uygulaması değerlendirilecek ve AB ve Türk deniz çöpü izleme sistemi için deniz çöpünün kaynağı ve denizde birikim alanları arasında daha güçlü bilimsel bağlantılar kurmayı amaçlayan bir "kaynaktan denize temel deniz çöpü göstergeleri" önerisi sunulacaktır.

Anahtar Kelimeler: Deniz çöpü göstergeleri, Avrupa Birliği, atık yönetimi, plastik kirliliği, döngüsel ekonomi

To my beloved wife, my constant support in every aspect of my life.

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LIST OF ABBREVIATIONS

CEAP	Circular Economy Action Plan
DenİZ	Integrated Monitoring Programme for Seas
DG ENV	Directorate General Environment
DG MARE	Directorate General Marine Affairs
DPISR	Drivers, pressures, state, impacts and responses
ECHA	European Chemicals Agency
EEA	European Environment Agency
EU	European Union
FAO	Food and Agriculture Organization
GES	Good Environmental Status
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environment Protection
HELCOM	Helsinki Convention
ICZM	Integrated coastal zone management
IMO	International Maritime Organization
JRC	Joint Research Centre
MAP	Mediterranean Action Plan
MARPOL	International Convention for the Prevention of Pollution from Ships
MLW	Marine Litter Watch
MoEU	Ministry of Environment and Urbanisation
MSFD	Marine Strategy Framework Directive
NGO	Non-governmental Organisation
OECD	Organisation for Economic Co-operation and Development
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PRFD	Port Reception Facilities Directive

REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RSC	Regional Sea Convention
SAM	Scientific Advice Mechanism
SDG	Sustainable Development Goals
SUP	Single Used Plastics
SUPD	Single Used Plastics Directive
TGML	Technical Group on Marine Litter
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNGA	United Nations General Assembly
UWWTD	Urban Waste Water Treatment Directive
WFD	Water Framework Directive
WWTP	Waste water treatment plant
ZPAP	Zero Pollution Action Plan

CHAPTER 1

INTRODUCTION

United Nations Environment Programme defines marine litter (or marine debris) as; "*any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment*" (UNEP 2009). Mismanaged plastic waste is the crucial driver of marine litter. The composition of the marine litter varies (e.g. plastics, wood, pater metal), but most litter consists of plastic. Even though other litter items as wood, paper, glass or metals are also considered as a part of the problem, plastic litter can persist in the marine environment for centuries, and it can cause serious harm to aquatic biota and human health (once it is transferred to the human body by consuming sea products). The focus of policy measures, research and monitoring, is plastic litter and plastic pollution, and the marine litter issue widely refers to a plastic pollution problem in the literature. Therefore, this thesis mainly focuses on the plastic portion of the marine litter problem and "plastic pollution" and "marine litter" terminology are numerous times referred to as closely linked with each other.

A study estimated that "*more than 150 million tonnes of plastics have accumulated in the world oceans, while 4.6-12.7 million tonnes*" (Jambeck et al. 2015) are flowing through and accumulating at the seas and oceans annually. Plastics constitute nearly 80% of all marine litter, and it may be found practically everywhere and in every form (macro, micro, and nano) in the marine environment, from beaches to floating litter on the sea surface, in the water column, and on the sea bottom (IUCN, 2018). Marine litter negatively impacts coastal and marine ecosystems posing severe economic, environmental, and health concerns to ocean habitats and services they provide. Marine litter adversely affects marine

ecosystems through litter ingestion, entanglement, and potential toxicity of released chemicals from plastic.

Plastics have become the modern economy's standard material as they combine unique functional properties with low cost. They are instrumental for many purposes, from the aviation sector to daily purposes, as they can be produced hard as steel and soft as silk. The use of plastics increased twenty times in the past fifty years, and it was estimated that this amount would double in the next twenty years (Ellen Macarthur Foundation, 2016) if the resource use is not decoupled from the economic growth. Plastic production has increased at about 9% per year since 1950, from around 1.5 million tons to 311 million tons in 2014. (Plastics Europe, 2016). While 322 million tone plastic were produced worldwide in 2015, this amount increased to 348 million tonnes just in two years in 2017.

Excessive use of plastics, almost for every sector and purpose, and lack of precisely defined responsibilities for plastic waste create environmental, social and economic problems. Although there are worldwide efforts to recycle and reuse materials, our economies are still mostly linear; which means we are not efficiently using materials we extract from Earth. A linear economy merely disposes of the materials or products after use and generates a massive amount of waste. While global resource use has increased rapidly, our social choices and lifestyles have created a “take-make-use and throw” behaviour and waste generation has become one of the main problems of this economy. It is already evident that the business-as-usual linear economy model is unsustainable; further, rising population and resource demand make this paradigm even less so (Veral, 2019).

A significant portion of marine litter results from linear economies. Poor waste management practices and mismanaged plastics are the reasons for plastics leakage into the environment. Plastic is a very cheap material to produce. However, the cost of recycling or incineration is high. This situation results in a lack of voluntary

interest of the producers to deal with the waste generated after use, especially for single-use plastics. Excessive use of this cheap and easy to shape material causes severe environmental impacts and high economic costs.

Our economies must transform into circular economies to curb plastic pollution and the marine litter problem. Reduce, reuse, and recycle are the three Rs of a circular economy. The use of resources is minimised (reduced), product and part reuse is maximised (reuse), and raw materials are reused (recycled) to a high quality (Kenniskaarten, 2020).

Plastic pollution was described as one of the most critical pressure factors for the oceans in October 2017, Our Oceans Conference. Whereas a paper towel can decompose in two weeks, a cotton rope or a t-shirt in one to five months and an apple in only two months, most conventional plastics will persist in the marine environment for up to five hundred years (NAOA, 2015). When plastics are exposed to UV radiation, the surface becomes brittle, and physical abrasions, such as on exposed shorelines or sea surfaces, fragmentation occurs (GESAMP, 2015). Therefore, compared to other litter types, organic materials like wood, paper or ceramics, plastics are major pollutants for the aquatic systems.

Rivers are the most important pathways for plastics as they carry plastics to the oceans. It is estimated that *"1.15 to 2.41 million tonnes of plastic are entering the ocean each year from rivers"* (Laurent et al., 2017). According to a new report, "*over 500 shipping containers of plastic are leaked into the Mediterranean Sea every day, equating to 229.000 tonnes of plastic per year. This will at least double by 2040 unless drastic steps are taken to fix mismanaged waste, the primary cause of leakage*". According to the same report, *"the countries with the highest plastic leakage rates into the Mediterranean are Egypt (74.000 tonnes/year), Italy (34.000 tonnes/year), and Turkey (24.000 tonnes/year)*" (Baucher et al., 2020), owing to vast amounts of poorly managed waste and large coastal populations.

Plastic is less dense than ocean water, does not sink once it encounters the sea and travels over long distances. Plastics persist at the sea surface as they move offshore, carried by convergent currents and eventually accumulating in the patch (Ocean Cleanup, 2019). The biggest of these patches is known as the Great Pacific Garbage Patch (GPGP).

Once plastics coming from the beaches and rivers enter the ocean gyres, they are unlikely to leave unless they degrade into micro pieces with the effects of sun, waves and marine biota. The size of the GPGP is three times that of France, and plastic concentration in the GPGP will continue to increase as we dump more plastic into the rivers and the seas (Ocean Cleanup, 2019). *"Poor practices of solid waste management, wastewater collection and treatment, lack of infrastructure and awareness of the public about the consequences of their actions aggravate the situation substantially"* (EU, 2019).

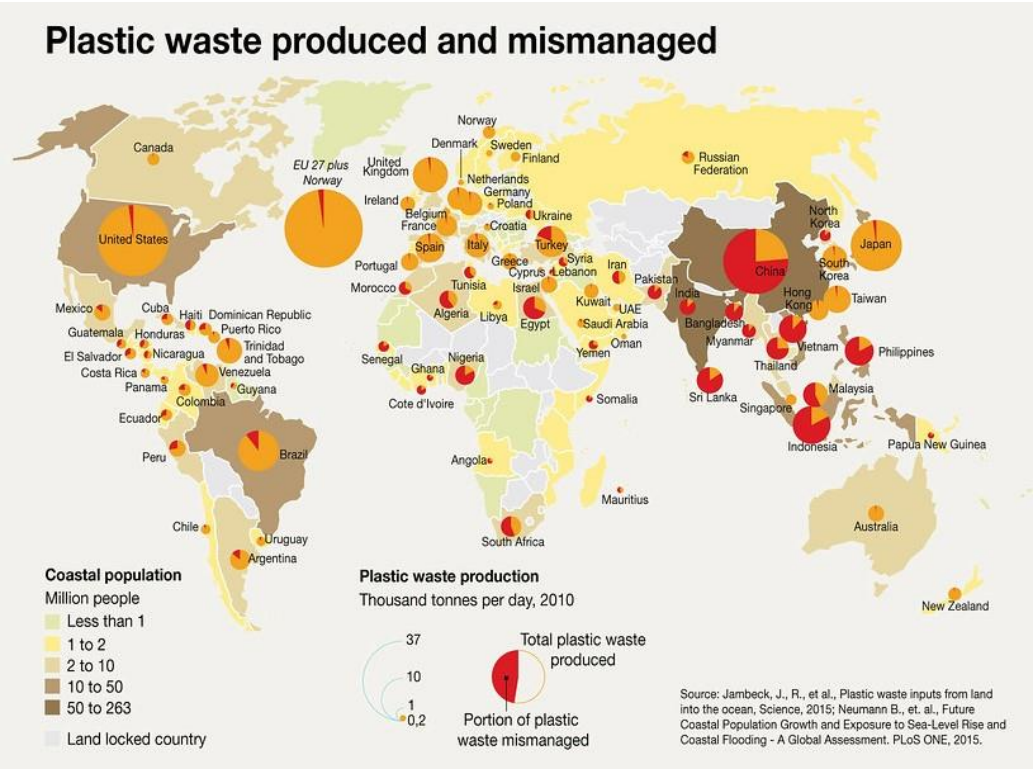

Figure 1. 1. Global Plastic Waste Produced and Mismanaged (GRIDA, 2018a)

Marine litter items are classified as sea-based and land-based according to their origin. Litter released into the water through maritime operations such as shipping, fishing, offshore installations, or garbage dumping at sea is referred to as a sea-based source. The land-based supply comes from industries like tourism and agriculture, but it can also refer to litter blown or carried into the sea from far away, such as towns and industrial sites. It is believed that about 80% of marine litter comes from land-based sources, and this includes both macro and micro litter (Veiga et al., 2017). Incineration of plastics or cleaning up the oceans are examples of solution options to solve the marine litter problem, but not the sustainable and cost-effective ones. The solution is to deal with the problem at its source. Therefore, the EU is moving toward a circular economy approach that focuses on waste prevention and recycling and reuse of materials in the first place. Moreover, limitations on the use of single-use plastics for the solution of the problems at its source. The European Union is acting to deal with the situation by integrating litter dimension to its waste legislation, plastic strategies, environmental protection legislation and monitoring the results of its measures. In Turkey, however, the acknowledgement of the problem is in the very early stages. Besides a few legislative efforts, there is no holistic approach to the marine litter problem.

1.1. Types of Marine Litter

Marine litter is generally clustered under three scales; macro, micro and nano litter. EU Marine Strategy Framework Directive (MSFD) defines litter items bigger than 2,5 cm in diameter as macro litter and items bigger than 5 mm and smaller than 2,5 cm as meso-litter. The definitions of macro and micro litter in diameter are based on standardising the monitoring methodologies. Monitoring of macro litter items is helpful for the description of the items. The monitoring is usually done by assigning each marine litter item to an agreed list of categories. Monitoring results from beach litter surveys are used to identify the types and sources of litter and support and justify management decisions, such as introducing bans or restrictions

on certain items (as in EU Single Use Plastics Directive) to minimise their environmental impacts. EU MSFD Technical Group on Marine Litter (TGML) recently agreed on a threshold value of 20 litter items per 100 meters of the coastal strip as "good environmental status" for macro litter items for the EU Member States (Van Loon, 2020).

Macro litter is visible and therefore easier to clean up at the beaches and river banks. However, once it enters aquatic environments, it becomes harder to clean the litter. It can float (floating litter) or sink (sea bed litter). Besides, macro litter can break into pieces by weathering in time and become micro litter.

There is as yet no consensual scientific or regulatory definition of microplastics. There are different microplastics definitions according to their diameters. Users of microplastics in the cosmetics industry apply the term to granules, which are significantly smaller than one millimetre. In marine protection, however, the term microplastics applies to plastic particles with a diameter of smaller than 5 millimetres (Arthur et al., 2009). Microplastics are, therefore, an umbrella term defining different sizes of plastic particles. EU TGML works on harmonising monitoring methodologies, and they have described microplastics are small pieces of plastic litter < 5mm in diameter. Joint Group of Experts on the Scientific Aspects of Marine Environment Protection (GESAMP) also recommends a standard definition of < 5mm in recognition that several national and regional monitoring programmes are using this definition routinely to encourage a harmonised approach (GESAMP, 2019).

Microplastics can exist in the marine environment of direct discharge (primary microplastics), or they can originate from larger plastic items or particles fragmenting with the effect of sunlight and physical reactions with the water in time (secondary microplastics). The discharge of abrasive ingredients from cosmetic and other products, the release of fibres from the washing of textiles, and

the spilling of pre-production pellets or powders in transit or process before being converted into ordinary plastic items are also significant sources. There has recently been speculation that there are other contaminants besides microplastics (Essel et al., 2015).

Microplastics are not easy to remove with sewage systems. They are usually too small to be removed by the wastewater treatment, and therefore, they can enter to freshwaters and seas. *"Even where particles are removed by sewage treatment, they will exist in sewage sludge. Disposal of sewage sludge is a standard application in farming to enrich the soil with nutrients. Therefore, microplastics still can enter the environment if the sewage sludge is subsequently disposed of onto land or dumped at sea"* (Zubris et al., 2005).

Group of Chief Scientific Advisors of the EU define microplastics as "solid synthetic-polymer-containing particles of no more than five millimetres in their longest dimension, and which may contain additives or other substances" in their 2019 Scientific opinion. The Scientific Opinion also defines microplastic pollution as particles in the range of 1 - 100 nanometres, adding that anything with 0.05 mm (50 micrometres or m) is often imperceptible to the naked eye and defines nano-litter as particles in the range of 1 - 100 nanometres (EU, 2019a). Therefore, nanoplastics can be described as invisible, micro litter particles to the human eye.

Plastics, in micro or macro forms, originating heavily from land-based sources, are leaking to the environment because of poor waste management practices and ending up in our seas and oceans as marine litter. Marine litter is creating negative environmental impacts on marine biota and possible health effects on human health when they enter into the food chain. The impacts of marine litter are not limited to the ecosystems. It also generates economic impacts as clean-up costs, loss of touristic value or damage to sea vessel propellers. Loss of revenue from all sea related sectors suffers from social consequences.

1.2. Impacts of marine litter on biota and human health

Pressures of marine litter on the marine ecosystems can vary from absorption, ventilation, ingestion to transfer of chemicals and entanglement. These pressures on individuals may cause cellular intrusion, changes in gene expression, death, reduced feeding and impairment of the digestive process: impacts on fitness and reproduction and organ damage. Ecosystem impacts may be summarised as; potential for population decline, changes in assemblages and ecosystem functioning. These effects result in the degradation of coastal and marine ecosystems and damage their resilience, which is vital for them to produce the natural, social and economic services they are expected to provide (UNEP, 2017).

Accumulation of plastics in marine biota is not only harmful to marine ecosystems but can also threaten human health. Digestion of aquatic biota, which already embodies plastics, leads to transferring possibly toxic chemicals to the human body.

Although there are existing, proven studies on the effects of marine litter, still many unknown effects remain today, which need to be investigated by the scientific community and national and international institutions. A scientific study in 2015 has projected that by 2050, 99% of seabirds are likely to have ingested plastic (Wilcox & Van Sebilleb, 2015). By combining this fact with the European citizens' given answers on a European Union survey on plastic use, the precautionary approach's need becomes more evident. The survey showed that the vast majority of EU citizens are worried about the impact on their health (74%) and on the environment (87%) of everyday products made of plastics (EU, 2018). The 74 per cent is right to worry. Therefore, the risk of transferring chemical additives from plastics directly to humans is well documented (Galloway, 2015). Plastics are used to leach chemicals in the food industry, particularly fatty substances. Some

leachates can be toxic, mutagenic, carcinogenic or hormone-disruptive, and bio-accumulating (Muncke, 2011).

Inevitably, the effects on marine ecosystems will also affect social and economic structures as they provide valuable services for food, leisure and climate change by carbon depositing of the oceans. Once oceans lose their resilience, this situation might hit the maritime economic sectors and social structure.

1.3. Socio-economic Effects of Marine Litter

Marine litter results from linear economies, improper behaviour of consumers and mismanagement of waste. Cumulative pollution originates from marine but mainly land-based activities, with negative consequences for marine life, economic sectors and communities and an uneven share of costs. *"Marine litter threatens the livelihoods of almost three billion people who rely on the ocean for transportation, telecommunication cables, rescue missions, tourism, marine animals, and food systems"* (Abalansa et al., 2020). The economic costs originate from plastic pollution is big. UN Environment Programme (UNEP) estimated *"the damage caused by plastic litter in the Asia-Pacific region alone for tourism, fishing and shipping industries around 1.3 Billion dollars per year. In Europe, cleaning plastic waste from coasts and beaches costs about 630 million Euros per year"*, UNEP argues, and finally states that *"the studies estimate the total economic damage to the world's marine ecosystem caused by plastic amounts to at least 13 billion dollars every year"* (UNEP, 2018). Cleaning the oceans is one of the options to prevent the economic costs generated by marine litter. However, only the cost of cleaning the North Pacific Gyre is estimated at 317 million Euros (Slat, 2014). Besides, this amount is calculated for only one time, although the plastics in every form and size will continue to leak into the oceans if we do not solve the problem in its source.

Marine litter degrades the ecosystems and the ecosystem services they provide, as it may cause *"population decline, changes in assemblages and ecosystem functioning. Agriculture, fisheries, commercial shipping and recreational boating, coastal municipalities, coastal tourism industry, and emergency rescue services are among the primary economic sectors that have been identified as being impacted by marine litter in the literature*" (Mouat et al., 2010).

Lost or abandoned fishing gear, as well as damage to fishing nets and vessels caused by entanglement or collision with marine debris in general, can result in a loss of output in the fishery industry. Ingestion of debris or chemical contaminants can also be detrimental to marine life (UNEP, 2017).

Table 1. 1. Marine litter concerning economic sectors; sources, amounts and impacts; colour shading increases with the importance of impact (UNEP, 2019a).

ECONOMIC SECTOR	Non construction Zone	Natural risks	Extreme events	Climate change	Agriculture & forestry run offs	Coastal urbanization	Damming (demand on water)	Waste water discharges	Industry	Tourism frequentation	Yachting	Marine mining	Dredging	Desalinisation	Coastal artificialisation	Port operations	Offshore structures	Cables and pipelines	Shipping	Oil and gaz extraction	Renewable energy	Fishing (incl. Recreationnal)	Sea-based food harvesting	Extraction of genetic resources	Aquaculture	Solid waste disposal	Storage of gases	Research and education	Defence operations	Dumping of munitions
QUANTITIES OF MARINE LITTER IN RELATION TO THE ECONOMIC SECTOR																														
Riverine inputs																														
Beach litter																														
Surface litter																														
Sea floor litter																														
Microplastics																														
IMPACTS FROM MARINE LITTER IN RELATION WITH THE ECONOMIC SECTOR																														
Litter Impact/wildlife																														
Litter Impact/human health																														
Litter Impact/ Tourism																														
Litter Impact/ fisheries																														
Litter Impact/ navigation																														
Litter Impact municipalities																														
Litter impact/ cleanups																														

Marine litter can carry pathogens attached to it long distances, with the help of the wind and the waves. Marine ecosystems, which do not recognise these pathogens coming from thousands of miles away, may not have a defence and may get sick or

lose their functions due to litter ingestion. Increased mortality or the introduction of additional infections via marine litter may result in economic losses, such as lower earnings due to a decrease in the number of visitors visiting (Watkins et al., 2015) or loss of income from marine food stocks. If corals get sick due to pathogens, not only do corals die but also all marine life they inhabit also will be lost.

No one would like to swim or sunbathe at a beach covered trash. Marine litter can negatively affect the touristic attractivity of the bathing areas and therefore decrease the income of the commercial actors benefiting from tourism activities. In order to sustain the appeal of their beaches for tourists, communities and businesses must spend efforts and money to clean up before the start of every season. In the United Kingdom, for example, municipalities spend approximately 18 Euro million per year on beach clean-ups. Besides, beach litter caused injuries also affect the insurance sector. Beach and seafloor litter cause injuries. According to a study conducted in Australia, 21.6 percent of beach visitors were injured by beach litter at "clean" beaches (clean coast index - around 1.69 kg of trash per beach), demonstrating that even "clean" beaches can be dangerous (Campbell et al., 2016).

Clean up costs are not limited to beaches. Marine litter can damage the infrastructure (e.g. vessels and water pipes) due to hull-fouling barnacles or infestations of mussels and clams (UNEP, 2017). Therefore, clean-ups of the rivers to prevent litter reach to the seas and clean up oceans with specific devices and vehicles also create costs.

Marine litter pollution has also had a negative economic impact on the shipping and yachting industries, with harbours and marinas incurring the cost of removing marine litter from their facilities to keep them clean and appealing to users, as well as boats with propellers, anchors, rudders, and clogged intake pipes and valves (Mouat et al. 2010). According to the study, collecting marine litter in UK ports and harbours costs an average of 2.4 million euros a year.

Preventing waste is the first and most beneficial stage in the waste hierarchy, followed by minimisation, reuse, recycling, recovery, and disposal. Once the litter is not prevented and cannot be minimised with measures, it needs to be recycled or disposed of. The recycling process is also an economic and environmental cost, which requires energy.

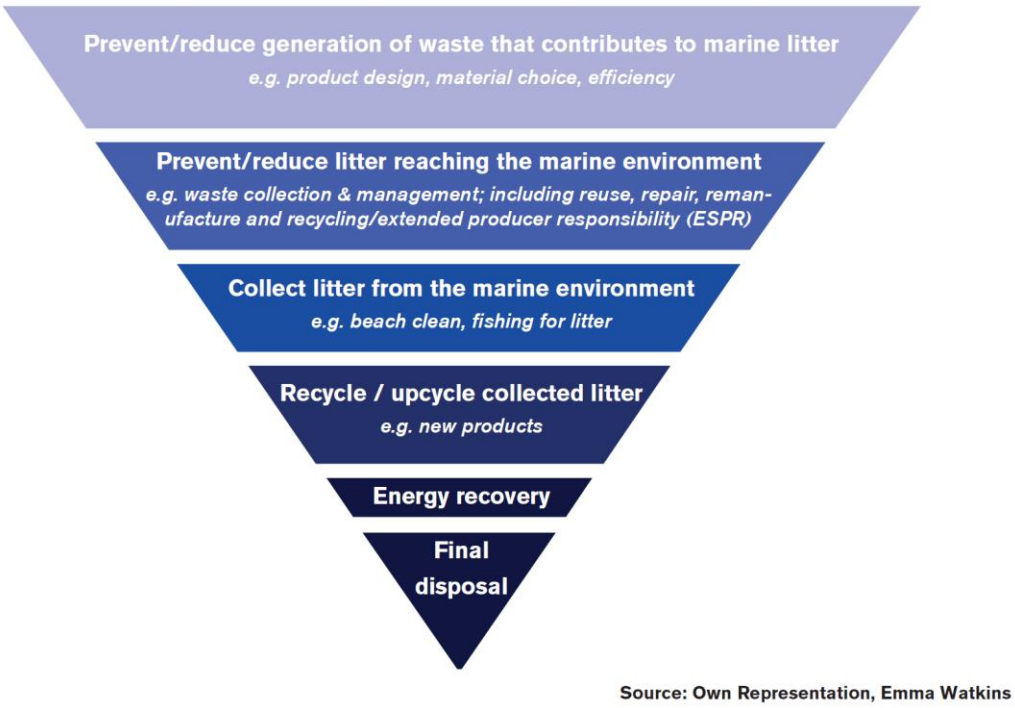

Figure 1. 2. Marine litter hierarchy (Watkins, 2017)

Our economies are mostly linear. We need circular economy approaches to solve the plastics and marine litter problem. Circular economy models must be supported with legislative instruments, such as taxes, charges and extended producer responsibility schemes to reduce marine litter. Clean up, and disposal of marine litter must be the last choice, where only there is no other option. We need a global recognition of plastic pollution and marine litter and a quality monitoring network and marine litter indicators to define the problem better and establish policies to solve the problem from source to the sink.

1.4. Recognition of the Marine Litter Problem in Global Level

Marine litter has been recognised as a severe pollutant for almost half a century. One of the earliest research results published was in 1969 (Kenyon et al., 1969), studying marine litter's digestion by the sea birds. However, concerns related to plastic pollution and marine litter in our oceans have only recently attracted public and international political attention. Minimising marine litter and its consequences is a well-known topic that poses new difficulties for the worldwide community (Raubenheimer, 2016).

The initial step through recognising the problem was in 1989 with the United Nations General Assembly (UNGA) resolution, which expressed its concern that living marine organisms might be entangled in lost or discarded large-scale pelagic driftnets, resulting in injury or death[1]. UNGA resolutions are recommendatory but provide framework and scope to the work of specialised UN bodies.

In 2002, the UNGA reiterated the need to address derelict fishing gear, emphasising that it might result in mortality and habitat loss among marine living resources. In the same year, the UNGA urged countries to keep marine pollution from land-based sources a top priority in their national sustainable development plans (Raubenheimer, 2016).

The plastic component of the land and sea-based pollutants only received specific attention in 2012. The focus on plastic as an essential source of marine environmental contamination at the worldwide policy level has been enabled by the UNGA's careful emphasis on the 'The Future We Want" document in 2012 as an outcome of the UN Conference on Sustainable Development (Rio+20). UNGA

[1] UN General Assembly Resolution 44/225, "*Large-scale pelagic driftnet fishing and its impact on the living marine resources of the world's oceans and seas", preamble paragraph 4* (22 December 1989)

Resolution, which followed Rio+20, endorsed 'The Future We Want', where marine litter's effects on ocean health were raised as a concern, with States committing to achieve significant reductions in marine litter by 2025[2]. Concerns were reiterated in a resolution adopted in 2014 when *the "need for better understanding of the sources, amounts, pathways, distribution trends, nature and impacts of marine debris was recognised"*[3]. This resolution from 2014 also asked for a focus on the issue "Marine debris, plastics, and microplastics" during the seventeenth meeting in 2016 (Raubenheimer, 2016).

Another outcome of Rio+20 was establishing the UNEA, the world's highest-level decision-making body on the environment. The work of the UNEA contributed to the adoption of the 2030 Agenda for Sustainable Development and its seventeen Sustainable Development Goals (SDGs) in 2015. SDG 14 to 'conserve and sustainably use the oceans, seas and marine resources for sustainable development is related to marine litter as well. SDG 14 consists of seven targets and three means of implementation. The first target (SDG 14.1) focuses on marine pollution, including marine litter. UNEA has established several task forces on marine plastic litter and fosters cooperation between the relevant UN bodies.

The annual UNGA resolutions on Oceans and Law of the Sea reiterates the decisions of the UN Environment Assembly (UNEA) concerning marine plastic pollution and microplastic and invites states to implement them (NUS, 2020).

At its first session in mid-2014, the newly constituted UNEA adopted Resolution 1/672, asking governments to take action to address the issue of marine plastic litter and microplastics. At a global level, the need for further research and

[2] UN General Assembly resolution 66/288 "*The future we want*" , paragraph 163 (27 July 2012)

[3] UN General Assembly Resolution 69/245, "*Oceans and Law of the Sea"*, paragraph 181 (29 December 2014)

information about the impact and levels of marine plastic litter is growing. However, calls for stronger legislative frameworks to manage marine plastic litter have been muted. UNEA has issued four resolutions since 2015 with particular attention to the marine litter and plastic pollution problem. UNEA-5 took place on 22-23 February 2021 (UNEA5.1) online with a revised agenda focused on urgent and procedural decisions. Detailed environmental discussions, including marine litter, which require negotiations, will be discussed in UNEA-5 on 28 February– 22 March 2022 (UNEA-5.2).

In response to UNEA resolution 3/7, "Marine Litter and Microplastics"[4], on marine litter and microplastics, an ad hoc open-ended expert group was established. The expert group's mission was "*to look into all barriers to tackling marine pollution and microplastics, as well as voluntary and legally binding governance systems and techniques, to determine the environmental, social, and economic costs and benefits of various solution options, to assess the viability and effectiveness of various response options, and to define new solutions for future work for UNEA to consider*" (UNEP, 2018a).

The ad-hoc expert group on marine litter has met four times since 2018 and is still preparing a scientific base for the UNEA-5.2, which is currently scheduled for February 2022. The scientific basis is expected to contain two main pieces of information: a review of the current situation and the potential global and regional response options available to tackle marine plastic pollution and microplastics by performing a country marine litter stocktaking exercise (UNEP, 2018a).

There is no preparation for a binding international marine litter treaty at the UN level. The countries are still discussing the binding, and non-binding global and regional policy options, together with establishing a scientific information base for

[4] UN Environment Assembly Resolution 3/7, "Marine Litter and Microplastics", Paragraph 10 (30 January 2018)

marine litter and analysis of the effectiveness of existing and potential response options are being performed on the way to the UNEA-5.2 meeting.

Besides the UNGA and UNEA resolutions, the marine litter problem was recognised under numerous international organisations and agreements. Regional sea conventions are increasingly putting their efforts by including marine litter and plastic pollution problem into their protocols, action plans and monitoring efforts. These efforts will be explained in detail in Chapter Three of this thesis, together with their complementary role to a possible international marine litter agreement.

Europe acknowledges the transboundary nature of the problem and has committed to act at a global level by implementing UN SDGs. The transboundary nature of the problem requires joint action. Therefore, as part of its Plastics Strategy and Circular Economy Action Plan, the European Commission committed to looking into further action to address macro litter. Publishing the Single Use Plastics Directive (SUPD), which brings out binding provisions for producing, using, and recycling single-use plastics, was a positive step towards the solution.

The global and transboundary nature of marine litter requires a holistic and integrated approach for the solution. The countries and legislation, implementation, and monitoring tools they produce should harmonise with each other.

Plastic marine litter is increasing in oceans and seas, posing a threat to ecosystems, biodiversity, and possibly human health, causing worldwide concern (EU, 2018a). Legislative measures, better waste management practices, and sufficient monitoring information are the main priorities to tackle marine litter.

Marine litter has been recognised as a pollutant for almost half a century, but only in the last two decades, the recognition gained momentum through being widely acknowledged. It is evident on the global scale today that plastic pollution is

increasing in significant amounts and affecting marine ecosystems and many sectors linked with it, and therefore must be curbed. However, the level of effort, the method to deal with the marine litter problem and the necessary financial resources are still not precise.

1.5. The Thesis

1.5.1. Research Questions and Methodology

While marine litter is globally recognised as a pollutant and countries are searching for a binding or non-binding legislative solution on a global scale and increasingly describing policies on regional and national scales, there is an emerging need for data and information better to assess the magnitude of pollution and information on trends to evaluate the effectiveness of the policies. This research focuses on the holistic monitoring and assessment dimensions of the problem. Monitoring efforts are relatively immature compared to well-recognised marine pollution sources such as chemicals and nutrients, which already have agreed methodology, well established in-situ worldwide monitoring network and decades of monitoring in time series. Agreed marine litter indicator methodology and existing monitoring time series are inadequate to describe the problem precisely. Besides, the linkages between the source and the sink of plastic waste are based on assumptions. There is a substantial gap between the demand for an urgent description of the problem's magnitude - including information on the sources and pathways - and the available data and information. In this imperfect monitoring setting, robust marine litter assessments require different approaches than conventional assessment methodologies; innovative assessment methodologies are necessary for the holistic assessment of marine litter from source to sink, which can help close the monitoring gaps and build holistic assessments based on the available knowledge.

Two key questions will be examined in support of the above-mentioned arguments:

1. Is the available data and information sufficient to build a robust and holistic assessment of the marine litter from source to sink?
2. Which approach can help us to build holistic marine litter assessments with the available information?

In answering these questions, "a source to sea system framework approach" was used in this study. A source to sea system can be defined as a larger scale to include a sea and its entire drainage area, including river basins. "*Ecosystems along a continuum from source to sea are being degraded as an unintended consequence of economic activities that might happen far upstream or downstream in the source-to-sea system*" (Granit et al., 2017). A literature survey was performed to screen existing data, information on marine litter both in European and Turkish scales and "source to sea" marine litter assessment methodologies and gaps related to existing studies were defined.

Two case studies were examined to demonstrate how existing knowledge can be used for a holistic assessment of the marine litter problem; one on the European scale and one on Turkey's national scale was built on the European scale case example on indicator-based marine litter assessment methodology.

The first case study was based on compiling the available information on marine litter's status on the European scale and describing the monitoring gaps. Following the literature review on the available information, an indicator based marine litter assessment scoping study, which was initially developed by the owner of this thesis and a group of experts in 2019, was used to demonstrate "how to close the information gaps on the marine litter with marine litter related sources and pathways indicators in European scale".

The second case study was developed in this research's context, based on the European scale approach. Initially, available marine litter status information was compiled, and monitoring gaps were described. Following this, Turkish marine litter indicators were scoped from source to sink. A core set of marine litter indicators were defined as necessary to have a robust and scientific sound assessment of marine litter and plastic pollution problem in Turkey's marine space.

1.5.2. Significance of the Study

A significant and, therefore, environmentally most harmful portion of marine litter is plastic. Plastic is a suitable material to cover human needs with low costs, and the list of usage areas are almost endless today. Most of the plastic is used for a single time or short term and eventually become waste. A small portion of the plastics is recycled and returned to the economy. The remaining part is either deposited in waste dumping fields or burned to get rid of it or used for energy production. Marine litter the leakage of waste. Collection and improvement of waste management practices will help the solution of the problem.

We can manage marine litter problem with sound analysis methodology. This study proposes a robust and coherent methodology for Europe and Turkey to enable the source to sea (or source to sink) assessment of marine litter and plastic pollution. Marine litter is a consequence of linear economies and, therefore, leakage of plastics and their sink to the marine environment. This study proposes a multi indicator based marine litter assessment methodology in a drivers, pressures, state, impacts and responses (DPISR) framework, which might help the regional or national authorities to define the flows of plastic litter better, evaluate the policy needs and policy effectiveness with a scientific knowledge base, and finally build on their source to sea framework for marine litter prevention.

DPSIR framework is a valuable tool for dealing with socio-economic problems to provide smart solutions. The DPSIR framework was developed by the Organization for Economic Cooperation and Development (OECD), the European Environment Agency (EEA), and the United Nations Environment Programme (UNEP) as a tool for analysing complex socio-economic and environmental problems. The use of the DPSIR model for marine litter is relatively new. A recent article, which performed a holistic screening of the literature on marine litter, argues on the absence of mature literature for using the DPSIR model in the marine litter domain and recommends "*future research in this direction to fill this knowledge gap*" (Abalansa et al., 2020).

A source to sea approach for marine litter, which uses a DPSIR framework, will help to close the knowledge gap in the literature. A few exist, but the existing policy scale works on implementing the marine litter source to sea approach using the DPSIR framework. One of the institutions, for instance, Stockholm International Water Institute (SIWI), defines their marine litter source to sea marine litter prevention framework as "*a holistic management approach that can be integrated with existing approaches such as Integrated Water Resources Management (IWRM), Coastal Zone Management (CZM) and Marine Spatial Planning (MSP) and can link these management approaches together*". The source to sea framework emphasises river basin management's critical role in preventing marine litter. Breaking the loop of resource constraints at the local level and preventing plastics from leaking into the oceans will require involving a broader group of stakeholders and prioritising investments that encourage behavioural change from the individual to the global scale (SIWI, 2019).

Besides the policy level approaches, there are emerging studies on the more accurate estimation of the plastic leakages and accumulation, which provide crucial information on the waste management performances and abundance of plastics accumulating in the seas. "*The Mediterranean: Mare Plasticum Report*" identified

and quantified the various types of plastics and plastic products discharged into the Mediterranean Sea. Based on a collection of data from field surveys and the footprint methodology, the research estimates the amount of plastic now drifting into the Mediterranean. The report emphasises the significance of developing and implementing a standard framework to harmonise processes for plastics pollution monitoring in order to mainstream science-based decision-making on plastic pollution internationally (IUCN, 2020).

There is a common demand and, therefore, a tendency to develop monitoring/indicator based marine litter assessment tools in the world. UNEA recommendations are in line with this demand. The UNEA resolutions support the collection of marine litter data effectively and harmonisation of the monitoring methodologies, and the creation of a science base for the estimation methodologies where data is not available. This demand is emerging from the need to picture the status of the problem better and to describe the policies to solve the problem and evaluate the effectiveness of the existing policies and actions.

Within the EU Marine Strategy Framework Directive (MSFD), a procedure is required to identify appropriate operational targets, plan, implement, and monitor effective management and mitigation measures (Veiga J.M. et al., 2016). MSFD good environmental status descriptor D10 for marine litter requires, where feasible, information on the source and pathway of the litter. Besides, the definition of the sources and pathways of litter is also important to evaluate the success of the MSFD program of measures of the EU Member States through the collected data and information.

At the global and EU levels, existing matrix scoring methods are already being utilised to identify the sources of marine litter. For the efficient application of the matrix methodology, knowledge of the litter items found in the region's maritime environment is required (Veiga J.M. et al., 2016). The use of this methodology is

based on macro litter monitoring surveys and registry of the items, followed by describing the sources via utilising nearby possible sources of litter. However, this technique is best for the local and detailed description of the sources.

This study provides an indicator based marine litter assessment methodology for the first time in Europe and Turkey. Scoping of the available European and Turkish scale marine litter indicators within the DPSIR framework will help regional or national authorities better to define the leakages and flows of plastic litter, evaluate the policy needs and policy effectiveness, define the gaps in monitoring and information, and finally build on their source to sea integrated legal framework and monitoring framework for marine litter prevention.

Currently, units of monitoring and detail on waste data do not allow meaningful information on their linkages with the marine litter data. Waste management data currently can be used only to receive indirect information on the sources and pathways of litter. Once waste and marine litter data and indicators are tailored to feed each other, we will be able to understand the linkages between the sources, drivers, pressures, pathways of marine litter.

The monitoring system in Europe and Turkey, at present, does not allow to monitor of the exact amount of waste leakage. There are only estimations on the amount of mismanaged waste on European and global scales. There are also no indicators of the trends of mismanaged waste and the proportion of plastics. This study proposes recommendations for the existing monitoring and indicator harmonisation gaps.

Having a robust approach and well-designed legislative system in Turkey in line with the EU and regional actions as regional sea conventions will not only help to prevent the environmental damage and human health problems caused by marine litter but also will have positive impacts on the plastics and waste economy. In

addition, monitoring measures and indicators are necessary to define the information gaps, reflect the trends in marine litter and monitor the success of the actions and policies.

This study proposes necessary provisions and strategies for Turkish environmental legislation while offering implementation and monitoring tools. Implementation of well-designed legislation will improve marine areas' ecological quality, life quality of the coastal residents and economic value of the tourism and fisheries sectors. Decreasing the amount of single-use plastics and banning certain types of plastics will eventually reduce the amount of litter and misuse of natural resources.

The implementation of the EU acquis and Turkish legislation will be evaluated. Based on the evaluation, assumptions on the current and future success of possible solutions to the marine litter problem will be suggested.

Turkey is a party to various environmental treaties and also a candidate country for EU membership. Signed binding international agreements by Turkey will play a significant role via related articles of these treaties related to the marine litter issue. Therefore this study will explore the international binding and non-binding legal instruments that Turkey needs to comply with. Besides, EU Marine Strategy Framework Directive (MSFD) Waste Framework Directive (WFD), the Plastic Strategy and the Draft Single Use Plastics (SUPs) Directive are the main EU acquis, which Turkey needs to comply within the scope of harmonisation with the Environmental acquis. However, there are only a few studies in Turkey regarding marine litter, and none of them is concentrated on a holistic approach. This study will propose a general outline for Turkish litter policy, law and strategies and implementation measures.

1.5.3. Structure

There are seven chapters in this thesis. The research's context and objectives are presented in Chapter One. This chapter also gives an overview of the literature on marine litter, as well as worldwide acknowledgement of the issue and the source-to-sea approach. The thesis' structure, the utilisation of case studies as a technique, and the significance of the research are all laid out in Chapter One.

Chapter Two describes the close relationship between the solution of the marine litter problem with the circular economy model. Marine litter is a consequence of the overuse of plastics and mismanaged waste. This Chapter explains how the upstream circular economy approach and policy measures can help to solve the plastic pollution and therefore curb marine litter at the source.

Chapter Three emphasises global and regional efforts to curb marine litter. The structure of this chapter presents two crucial pillars of solving the problem; international and regional marine litter policies and monitoring of the effectiveness of policy actions. The third section of the Chapter presents regional policies, legislative instruments and action plans, and the European Union's efforts.

Chapter Four scales down the problem from the global to the European level. The status of marine litter on a European scale was described in this chapter, followed by an analysis of the European Union (EU) legislation. Available information sources from the literature review and regional sea conventions (RSCs) were used to describe the status, and they were compiled under the marine litter descriptors of the EU Marine Strategy Framework Directive (MSFD), and conclusions were derived on the data availability and gaps. Recommendations were made on monitoring and evaluation of litter and integration of marine litter legislation. The marine litter status and legislative information compiled in this Chapter was

essential to understand the information and policy gaps better and build on the indicator based marine litter assessment methodology in Chapter Five.

Chapter Five scales down the problem from the European level to the Turkish level. The status of marine litter on Turkish coasts was described, followed by an analysis of Turkish legislation on marine litter. Available information sources from academic researches and the national sea monitoring programme (DENiz) were used to describe the status. The status information was clustered under the MSFD marine litter descriptors, as Turkey is an EU candidate country and adoption of the MSFD is one of the requirements for the harmonisation of EU environment and climate change acquis. Conclusions were also derived for the monitoring and data availability for Turkey. Besides, recommendations were made to improve the monitoring efforts and better integrate the marine litter related legislation.

Chapter Six focuses on the 2019 European Marine Litter Indicators Scoping Study. The indicator scoping study is an attempt to build up an indicator based marine litter assessment methodology. European scale source to sink (or sea) marine litter indicators were scoped with DPSIR methodology, and indicators related to population, tourism, aquaculture, shipping, waste management, plastic production and consumption, pathways of litter (e.g. riverine litter), and status of litter was compiled, and a core set of marine litter indicators were proposed with using multi-criteria analysis (e.g. data availability). Following the scene's setting with the European scale indicator scoping approach, the Turkish marine litter indicators scoping study was presented in this chapter based on the same methodology.

In conclusion, Chapter Seven synthesises the findings and recommendations of the thesis. Conclusions were made for international, regional and Turkey’s efforts on curbing marine litter. This chapter stresses that marine litter assessment methodology is an essential step through closing the information gaps and might be a useful tool to assess policy effectiveness in Europe and Turkey. Finally, the thesis

states the need for future work to use and improve the scoping approach proposed by this Thesis.

CHAPTER 2

MARINE LITTER WITHIN THE CONTEXT OF CIRCULAR ECONOMY

2.1. What is the Circular Economy?

A circular economy is an alternative to the linear "take-make-use-dispose" economic model, which currently dominates world economies. The linear economy model assumes that natural resources are available, abundant, easy to source and cheap to dispose of, but it is not sustainable, as the world is moving towards, and is in some cases exceeding, planetary boundaries (Steffen et al., 2015). On the contrary, a circular economy aims to maintain the utility of materials and products. Circular material use, including recycling, reuse and refurbishment, seeks to reduce waste generation and our economy's dependence on extraction and imports of raw materials. It can bring both environmental and economic benefits, and it is increasingly recognised as the resource use mechanism that would allow societal and environmental sustainability (EEA, 2016).

Previously, the initial focus on waste was after it had been thrown away. Currently, the focus has moved upstream. Addressing the problem at its source; such as designing out waste, preventing its generation, reducing both the quantities and the uses of hazardous substances, minimising and reusing, and, where residuals do occur, keeping them concentrated and separate to preserve their intrinsic value for recycling and recovery and prevent them from contaminating other waste that still has economic value for recovery (Veral, 2019).

Product design strategies, while closing resource loops through recycling are of vital importance, slowing loops through designing for long-life products and designing for a product-life extension, facilitating repair and reuse, thus, preventing new waste generation is as important as, even more, important than closing resource loops (Veral, 2019).

There are different existing visualisations of a circular economy. Figure 2.1 represents a simplified model developed by the EEA.

Figure 2. 1. Circular Economy Model (EEA, 2016)

The figure describes a closed-loop of extraction, production, consumption and recycling of the materials. The outer circle represents the energy flows. As the

energy efficiency and the share of renewables in total use increase, pollution generated by the emissions will decrease.

The material fluxes of the recycling loop are illustrated in the middle circle, which differentiate between abiotic technical materials (such as metals and minerals) and biological materials. The inner circle indicates reuse, redistribution, repair, remanufacture, and refurbishing, which avoids waste generation and recycling and requires less resource input (EEA, 2016).

The circular economy model is defined as a clean production model enabling the reuse of products and raw materials with almost zero waste generation, in which energy and all resources are used efficiently and waste is recycled through a holistic process (Haas et al., 2015). However, the waste that can not be recycled and used for any other purpose will go to landfills and incineration. Waste can still be useful as an input used for energy production at the incineration plants and landfills.

Marine litter is a consequence of the leakage of the waste. The challenging task for waste management is to avoid leakages to the environment. Waste must properly be isolated from the environment to prevent leakage and pollution.

2.2. Avoiding Waste Become Marine Litter

The Circularity Gap Report 2020 found that *"the global economy is only 8.6% circular, which means that over 90% of the resources, including plastics, that enter the economy (100 billion tonnes per year) are wasted"* (CGRI, 2020).

The consequence of the linear economies; unmanaged waste, leaks to the environment, carried by the rivers or wind creates marine litter. Around 80 per cent of the marine litter is plastics, which might persist in the environment for hundreds

of years. With the expected increase in population to 8.5 billion in 2030 (UN, 2019), production and consumption will also grow, increasing the demand for limited natural resources and materials, business as usual scenario (continuation of linear economic models) will lead to larger amounts of waste generated and potentially large marine litter inputs.

Assessing marine litter in the circular economy's context relates to how efficiently societies are using, reusing and recycling plastic materials and how effectively they prevent leakages of valuable resources into the environment.

A recent UN Industrial Development Organisation (UNIDO) working paper defines the origin of the marine-based plastic pollution as *"fisheries, aquaculture, nautical activities and, at times, illegal dumping, and the land-based sources as improper management of waste of plastic packaging and short-lived products originating from various consumer products in numerous sectors"* (UNIDO, 2019). The main drivers of plastic litter are multiple sectors such as construction, cosmetics, tourism, fisheries and agriculture.

Once plastics become waste because of the linear economies, the level of waste management practices of the countries and municipalities define if the macro plastic waste will leak into the environment or not. Strong waste management systems can collect used plastics, reuse, recycle, incinerate or, as a final solution, landfill them properly. Weak systems allow a crucial amount of plastics leak and reach the marine domain. Microplastics (which are usually used in cosmetic, personal care or cleaning products) are released by sewage plants or are simply carried in wastewater in cases where there are no sewage plants.

As explained in Chapter 1, marine litter is not just a subject of the sea domain. Oceans, seas and lakes are the sink areas for litter. We must look at the source of the problem and avoid plastic waste generation and prevent marine litter. Upstream

approaches and measures will be necessary to tackle the problem. Thus, circular economy models will be of utmost importance for the solution of the problem. The circular economy policy measures on a global, regional and national scale will be useful to avoid the inefficient natural resource use in the production of plastics, allow the smart design of products, minimise or ban single-use plastics, reuse and recycling, minimise the generation of plastic waste and proper landfilling and disposal of the plastic waste.

Plastic pollution may be avoided in a circular economy model that focuses on the sources of the marine litter problem by using the plastic economy's waste hierarchy to substantially increase the reduction, reuse, and recycling of plastic waste. Where sustainable or less material-intensive alternatives exist, plastic production must be decoupled from primary feedstocks, and over-packaging or unneeded plastics uses must be avoided (G20, 2017).

Waste management and marine litter are closely linked in the context of the circular economy. The crucial step for avoiding marine litter requires an effective waste management system, which prevents leakages into the environment. Implementing tax measures and extended producer responsibilities to the producers are useful to cover the costs of investments to improve waste management systems and services for non-recyclable materials. Using a circular economy approach to address marine litter has demonstrable benefits for the marine environment while also helping to solve resource constraints and climate change. It also can generate jobs, encourage innovation, and open up new markets (Ellen MacArthur Foundation, 2016).

2.3. Circular Economy Solutions to Curb Marine Litter

Using circular economy policies and solutions are crucial to curb plastic pollution in the terrestrial and marine environment with their upstream approach. There are

existing policy instruments, which help to curb plastic pollution and marine litter on national or regional scales. Figure 2.2. provides a summary of the circular economy loops, plastic waste generated, leakages and the policy instruments and measures that can be used concerning curbing marine litter.

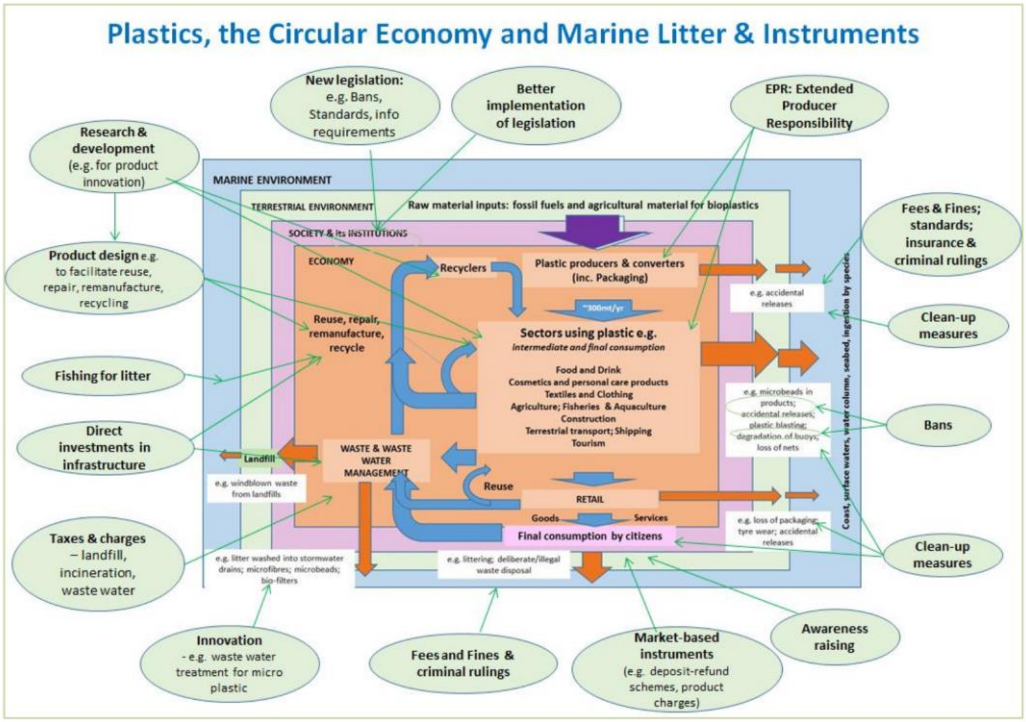

Figure 2. 2. Circular Economy and Marine Litter Policy Instruments (Ten Brick at al., 2016)

The inner rectangle represents the plastics economy starting from the plastics sector for different purposes such as food and drink cups and textiles, agriculture and packaging. Plastics are then used as a final product by the sectors or citizens, and some portion of the plastics is recycled or reused and returned to the economy. The remaining amount is disposed to the terrestrial environment to landfills or as leakages in different forms. As the figure represents, the final sink for the mismanaged plastics is the marine environment. Policy measures proposed by the figure describes legislation or actions to close the loop for the circular economy and to curb marine litter. Proposed policy instruments by the Institute of European

Environmental Policy are: "*extended producer responsibility, research into product design to facilitate reuse, repair, remanufacture and recycling, ban unnecessary products where viable substitutes, improve legislation, make greater use of economic incentives to make market signals part of the solutionenable transparency and labelling, implement waste management measures, raise awareness among consumers and combined incentives to encourage action and develop new products from waste*" (Ten Brick at al., 2016).

In terms of circular economy policies and initiatives, the European Union is a leading player. Plastics is one of the five priority topics in the EU Circular Economy Action Plan, which was announced in 2015. The action plan, which includes legislative suggestions on waste and chemicals policies, lays out long-term goals for increasing the reuse and recycling of critical waste flows generated by the packaging industry. The waste hierarchy is established under the EU Waste Framework Directive. Waste prevention, preparation of materials for reuse, opportunities for recycling and energy recovery following, and eventually disposal as landfilling or incineration with no energy recovery benefits are the goals in order of importance.

Recyclability, biodegradability, and the presence of hazardous substances are all addressed in the EU Plastics Strategy, which was adopted in 2018. Climate action, a low-carbon aim (plastics are largely made from fossil fuels), industrial policy, research, innovation, and the protection of human health and the marine environment are all included in the Strategy. Its goal is to provide a comprehensive view of the problem and to build synergies with other initiatives such as chemical and product policies. Furthermore, the Single Use Plastics (SUP) Directive was published in 2020 to ban particular SUP items, limiting their use, and extending producer duties to the sector.

In addition to the above mentioned circular economy policy measures, the EU Marine Strategy Framework Directive directly requires the solution of the marine litter problem. The EU member states are responsible for sustaining good environmental status at the European seas and beaches concerning marine litter. EU circular economy and marine litter policy and legislation will be broadly described in Chapter 4 of the Thesis.

2.4. Monitoring of Marine Litter from Source to Sea Towards a Circular Economy

At present, there is no holistic and robust way to measure the effectiveness of the EU, a country or even company progress in making the transition to the circular economy, nor are monitoring tools. A monitoring framework and *"individual indicators across multiple levels would facilitate policy development, measure environmental performance and policy effectiveness, benchmark products, sectors and countries, and improve business investment decisions. More robust data are needed on new business trends and sustainable consumption relating, for example, to eco-design, the sharing economy, and repair and reuse. Better descriptive social indicators and industrial symbiosis and waste prevention indicators would also provide more significant insights on progress"* (EEA, 2016).

There are, however, existing indicators that might help to reflect the success of the EU circular economy policies, and therefore build on holistic marine litter assessments. EEA developed an indicator for recycling rates of municipal waste, packaging waste and waste electrical and electronic equipment. The Agency is regularly publishing this indicator and monitoring the trends. Recycling rates are increasing in Europe, indicating a move towards using waste as a resource and a more circular economy (EEA, 2019). Besides, the Agency also monitors the diversion of waste from landfills with an indicator. *"Landfilling has negative*

impacts on the environment and economy and, therefore, should be avoided if at all possible. European countries have made relatively good progress in diverting waste from landfill in recent years for almost all waste streams, particularly for household and similar waste" (EEA, 2019a). In addition to EEA indicators, the European Statistics Institute collects valuable data regarding municipal waste, packaging waste, plastics production and import-export of plastics that might help track the circular economy progress.

As marine litter is a direct consequence of linear economies, poor waste management practices, and a low level of awareness, monitoring of plastics and marine litter from source to sea are beneficial to monitor the success and trends in the circular economy transition process in the country, EU and global level. In other words, moving towards a circular economy will help the solution of the marine litter problem, and monitoring of marine litter from source to sea will provide crucial information on the progress.

Marine litter and its environmental, social and economic effects are a significant concern. However, the solution to the problem does not stand alone by focusing on the consequences. We need a holistic picture to assess the effectiveness of policy measures and quantify the pathways of litter. Therefore, data resulting from monitoring the state and impact of marine litter should be complemented by data that directly reflect sources of mismanaged, i.e. considering the life-cycle of waste and economic activities known to generate marine litter.

Currently, we do not have a full set of indicators for circular economy transition and marine litter, and monitoring data is limited. Therefore, it will be useful to utilise all available indicators from source to sea to close the information gap on the circular economy transition progress and marine litter problem. Trends on the state of pollution at the sea domain say very little on preventive measures' effectiveness. Using socio-economic information related to waste prevention and

management will enable a more holistic picture of plastic pollution from source to sea.

This thesis proposes a source-to-sea marine litter assessment methodology, using available indicators and information in Europe and Turkey, in the following chapters. In order to serve the aim of establishing a holistic assessment methodology for assessing plastic pollution and the marine litter problem, the thesis presents current efforts and policy responses at the global and regional levels in the following chapter. Global legislative action on plastics and marine litter are necessary that also promotes the framework of circular economy measures and change across governance levels to avoid plastic pollution and curb marine litter.

CHAPTER 3

INTERNATIONAL AND REGIONAL EFFORTS TO SOLVE MARINE LITTER PROBLEM

3.1. International Legislative Efforts on Marine Litter

Initial international level reference to marine litter is in 1992, by the UN Conference on Environment and Development in Rio de Janeiro Agenda 21 document. Chapter 17, titled "*Protection of the Oceans, All Kinds of Seas, Including Enclosed and Semi-Enclosed Seas, and Coastal Areas and the Protection, Rational Use and Development of Their Living Resources*" (UN, 1992), establishes States' rights and obligations, as well as an international framework for the protection and sustainable development of the marine and coastal environment and its resources. In paragraph 17.18, the document identified "litter and plastics" as among the "contaminants that pose the greatest threat to the marine environment" and called for an international forum to address *"the protection of the marine environment from land-based activities"* (UN, 1992).

The UNEP Regional Seas Programme embodies some of the purposes of Agenda 21, Chapter 17. Through 18 RSCs and Action Plans, 143 countries are now participating in the Programme. The program aims to stop the degradation of the world's oceans by engaging neighbouring countries to design and implement comprehensive action plans to protect their shared marine areas. Promotion of international and regional conventions, guidelines, and actions for the control of marine pollution and the protection of aquatic resources, assessment of the state of marine pollution and its sources and trends, assessment of pollution's impact on the

marine ecosystem, and coordination of these efforts concerning the management of marine and aquatic resources are all potential strategies.

As a follow-up to Agenda 21, the UNEP held an intergovernmental conference in Washington in 1995 that resulted in the publication of The Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities. The report recognises that there has been international action to prevent the discharge of plastics and other persistent wastes from vessels but notes and estimates that approximately 80 per cent of persistent wastes originate from the land.

With regard to raising concerns over impacts from untethered fishing gear polluting the marine environment, the UN Food and Agriculture Organization (FAO), in 1995, has published a series of provisions and standards, the Code of Conduct for Responsible Fisheries. The Code is voluntary and global in scope; it is directed to both members and non-members of the FAO. Some of the standards are particularly relevant to marine litter. For example, section 8.4.6 provides that "*States should cooperate in developing and applying technologies, materials and operational methods that minimise the loss of fishing gear and the ghost fishing effects of lost or abandoned fishing gear*"[5]. There also are provisions relating to the management of garbage and waste. For example, sections 8.7.2 and 8.7.3 encourage waste minimisation and treatment.

The international community has been highlighting its concern over the need to address marine litter and debris. On 17 November 2004, the UNGA requested that the Secretary-General convened the sixth meeting of the Consultative Process for

[5] Food and Agriculture Organisation of the United Nations Code of Conduct Resolution 4/95, (1995)

Oceans and Law of the Sea the following June and focused on two topics: fisheries and marine debris[6].

In June 2012, the government delegations of almost 200 UN Members States and Observers concluded talks on a resolution entitled "The Future We Want" after ten days of sustainable development meetings in Rio de Janeiro, Brazil. In this resolution, UNGA has stated its concern about the health of oceans and marine biodiversity, including marine litter from various marine and land sources, including shipping and land disposal, as well as that of persistent organic pollutants, heavy metals and nitrogen-based compounds[7]. The UNGA adopted the Sustainable Development Agenda for 2030, including 17 objectives for sustainable development, three years after that. Objective 14.1 states that by 2025, marine pollution of all types, particularly from land-based activities, including marine litter and nutrient pollution, should be prevented and substantially reduced[8].

The UNEA, with universal membership of all 193 Member States, has similarly expressed concern and a desire for further action to address marine litter, including plastics and microplastics. In 2014, the UNEA requested a study relating to the marine litter issue at its second session[9]. Following that second session, the UNEA adopted a resolution asking the UNEP Executive Director to assist Member States, especially developing countries, to address sources of marine litter and to perform *"an assessment of the effectiveness of relevant international, regional and subregional governance strategies and approaches to combat marine plastic litter*

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[6] UN General Assembly Resolution 59/24*," Oceans and the Law of the Sea"* (17 November 2004)

[7] UN General Assembly Resolution 66/288 "*The future we want*", Paragraph 163 (27 July 2012)

[8] UN General Assembly Resolution 70/1 *"Transforming Our World"* (21 October 2015)

[9] UN Environment Assembly Resolution 1/6 *"Marine plastic debris and microplastics"* (2014)

and microplastics."[10]. At its third session, the UNEA resolved to convene an expert group to *"to further examine the barriers to, and options for, combating marine plastic litter and microplastics from all sources, especially land-based sources"*[11]. The resolution underlines the importance of waste minimisation and management. Therefore, the litter problem must initially be tackled at the source.

UNEA-3 Marine litter and microplastics Resolution aims at improving by 2025 the process to achieve UN SDG 14.1 concerning marine and marine pollution (to prevent and significantly reduce all types of marine pollution, in particular, land-based activities including marine and nutrient pollution). It was built upon increased scientific knowledge on marine litter and microplastics, as well as previous marine litter and microplastics reduction initiatives, including the declaration 'Our Ocean, our future: Call-for-Action' and UN member states' resolutions in UNEA.

The global indicator framework, developed by the Inter-Agency and Expert Group on SDG Indicators in March 2016, puts specific targets and requirements to produce indicators on marine ecosystems. SDG 14; *"Conserve and sustainably use the oceans, seas and marine resources for sustainable development"*, is devoted to healthy, productive and resilient oceans and seas, and SDG 14.1 targets to *"prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution, by 2025"*. The UN defined "*14.1.1: Index of coastal eutrophication and floating plastic debris density*" as an indicator to monitor this target. However, there is still no reported global information presented at the UN SDGs website on marine litter yet,

[10] UN Environment Assembly Resolution 2/11 "*Marine plastic debris and microplastics*", Paragraph 21 (27 May 2016)

[11] UN Environment Assembly Resolution 3/7 "*Marine plastic debris and microplastics*", Paragraph 10 (30 January 2018)

probably because of the lack of a standard international methodology and existing information and monitoring gaps on litter.

In March 2019, a report was launched by UNEP, which includes guidance documents and recommendations for reporting on marine litter; 'Guidelines for the Monitoring and Assessment of Plastic Litter and Microplastics in the Ocean' report aims to support reporting in response to the lack of an internationally agreed methodology. The report states that it is critical to understand the scale of the problem and support informed decision making and argues that the need for harmonisation become more vital with the adoption of the SDGs (UNEP, 2019b).

It is not only the information gaps or lack of standard methodology, which prevent a global outlook and monitoring of the marine litter but also the lack of regional indicators produced in line with the SDG 14.1.1 indicator. EUROSTAT decides on the European Union's indicators to be reported on SDGs, and there is no marine litter indicator provided within the EU SDG indicator set by the institution yet.

UNEA approved the resolution on the plastics problem in March 2019, which addresses single-use plastic (SUP) products pollution focusing on management and environmental effects of SUPs. The 4th UNEA resolution follows a similar approach to EU efforts to tackle with plastics problem and focuses on SUPs. However, it still does not point out a future binding international agreement or a responsible institutional structure on SUPs or marine litter. The resolution leaves the management and monitoring of the States. As Linda Fisca states in "Law of the Sea Blog" after the 3rd UNEA resolution in 2017;

"This latest resolution demonstrates where the international community currently stands on the issue. On the one hand, states and stakeholders admit that the issue is severe and complex, they are willing to discuss it on a high level, and they encourage further research that can help to decide what measures to take. On the

other hand, states are not ready to start negotiating a new treaty and prefer to rely on the existing instruments that also regulate plastic and make voluntary commitments on a national and regional level. Presumably, this trend will continue, and the failure or success of the current measures will define how the situation will develop." (Fisca, 2018)

Besides the UNEA Resolutions, which provide politically, institutionally and scientifically the basis, there is no binding international marine litter treaty at the UN level yet. The countries are discussing the options on the way to the UNEA-5.2 meeting, which will be held in 2022. Although marine litter does not have a binding treaty yet, measures to tackle the litter problem are increasingly taking place within existing UN treaty frameworks.

There are other global organisations as International Maritime Organization (IMO) that gives increasing importance to the marine litter problem. On 18 October 2016, the IMO released the Report of the 38th Consultative Meeting and the 11th Meeting of the Contracting Parties. Annex 8 provides that, recalling the Rio +20 outcome document, "The Future We Want", the contracting parties express concern about marine litter and microplastics in the marine environment and encourage member states to "*make every effort to combat marine litter, including through the identification and control of marine litter at source and to encourage monitoring, additional study and knowledge-sharing on this issue*." (IMO, 2016)

On 13th of April 2018, the IMO's Marine Environment Protection Committee (MPEC) referenced Sustainable Development Goal 14, recent studies, and comments relating to marine plastic litter, and agreed to, among other things, "include a new output 'Development of an action plan to address marine plastic litter from ships' in the Committee's 2018-19 biennial agenda." The MEPC agreed on the measures for all ships, including fishing boats, that will be completed by

2025. The action plan reinforces the IMO's commitment to meeting the oceans targets outlined in the UN 2030 Sustainable Development Goal 14 (IMO, 2018).

The Nordic countries as Sweden and Norway, are also pushing the UNEA to establish a binding international agreement on marine litter (Norden, 2019). Nordic Council of Ministers recently published a report on “Possible elements of a new global agreement to prevent plastic pollution”. The purpose of the report is to contribute to international talks by identifying strategic goals for a possible new international agreement, providing a structure for the possible new agreement and defining national implementing measures to achieve the global goal of zero plastic release into the maritime environment (Raubenheimer, K. et al., 2020).

While having a binding, non-binding or hybrid (a mixture of binding and non-binding measures) agreement on marine litter and plastics is a significant discussion to be concluded in the following years, legislative provisions on marine litter and plastic pollution are increasingly taking their place within numerous international and regional agreements, conventions or protocols, which will be presented later in this Chapter. However, the gaps in the current governance frameworks provide a fragmented and inefficient approach to address marine plastic litter and microplastics (Raubenheimer, K. et al., 2020). Currently, binding agreements as the London Protocol and the International Convention for the Prevention of Pollution from Ships focus on the sea-based sources of marine litter that constitutes only 20 per cent of the total pollution. Regional sea conventions and the European Union, on the other hand, focuses both the land and sea-based pollution sources.

There is an obvious need for a framework approach complementing existing international legal and policy frameworks, which would collect the separate legislative measures under one umbrella or to navigating the future legislative actions in a non-binging but guiding approach.

3.2. Existing International Instruments for the Prevention of Marine Litter

There are several international marine litter-related instruments, including general duties to safeguard the maritime environment, particular pollution-prevention commitments, and biodiversity-promotion requirements. Many of these documents were assessed by the UNEP (Figure 3.1).

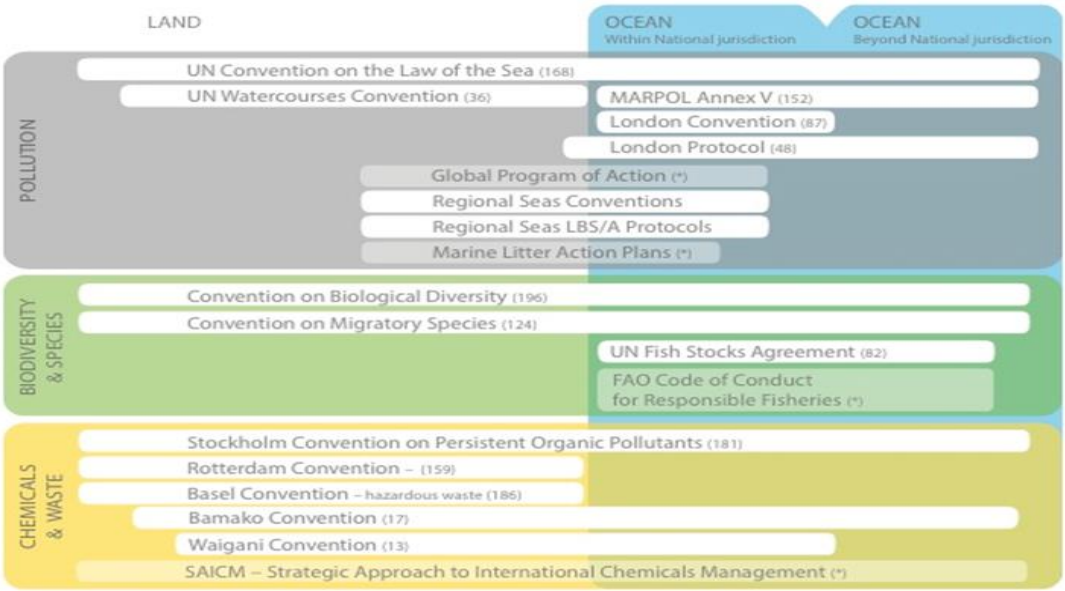


Figure 3. 1. Overview of Relevant Global and Regional Marine Litter Instruments (UNEP, 2018)

3.2.1. United Nations Convention on the Law of the Sea (UNCLOS)

The United Nations Convention on the Law of the Sea (UNCLOS) is an international agreement governing the uses of the oceans and their resources[12]. The Convention entered into force in 1994. Part XII of UNCLOS addresses the preservation of the marine environment. Within that Part, Article 194 provides the general direction that *"States shall take, individually or jointly as appropriate, all*

[12] United Nations Convention on the Law of the Sea 1833 U.N.T.S. 397, 21 I.L.M. 1261.

measures consistent with this Convention that are necessary to prevent, reduce and control pollution of the marine environment from any source, using for this purpose the best practicable means at their disposal and in accordance with their capabilities, and they shall endeavour to harmonise their policies in this connection". Provisions particularly relevant to the issue of marine litter are Articles 207, 210, and 211.

Article 207 directs states to "adopt laws adopt laws and regulations to prevent, reduce and control pollution of the marine environment from land-based sources, including rivers, estuaries, pipelines and outfall structures, taking into account internationally agreed rules, standards and recommended practices and procedures". Articles 210 and 211 have similar provisions concerning pollution by dumping and pollution from vessels. Additionally, under Article 192, States have a general obligation to protect and preserve the marine environment. At present, 168 parties have ratified the UNCLOS. The agreement, however, has not resulted in significant reductions in marine litter, particularly plastics and microplastics.

In 1995, participants to the United Nations Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks adopted the UN Agreement to implement the provisions of the UNCLOS relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (UN Fish Stocks Agreement). The purpose of the Agreement is to ensure international cooperation for the conservation and sustainable use of fish stocks and highly migratory fish stocks. Article 5(f), which is of particular relevance, provides that States shall *"minimise pollution, waste, discards, catch by lost or abandoned gear through measures including, to the extent practicable, the development and use of selective, environmentally safe and cost-effective fishing gear and techniques".* In response,

States and Regional Fisheries Management Organizations have taken some actions to address lost or abandoned fishing gear[13].

3.2.2. The International Convention for the Prevention of Pollution from Ships (MARPOL)

MARPOL addresses pollution of the marine environment by ships, including accidental pollution and that from routine operations. The Convention was adopted in 1973 but had not entered into force when the Protocol of 1978 was enacted. The combined instrument came into force in 1983. The Protocol of 1997 entered into force in 2005, amending the Convention to include the new Annex VI. The Convention currently includes six technical annexes aimed at preventing and minimising pollution from ships.

Annexes IV and V are particularly relevant to marine litter. Annex IV contains requirements to control pollution of the sea by sewage, and Annex V addresses the operational discharge of garbage from ships and sets standards for where and when specific waste may be discharged. Significantly, Annexe V imposes a complete ban on the dumping into the sea from ships of plastic, such as "synthetic ropes, synthetic fishing nets and plastic garbage bags". Thus, MARPOL regulations focus on the flow of plastic from ships to sea, but they do not address land-based sources of marine debris.

[13] UN General Assembly Resolution 63/112 *"Sustainable fisheries, including through the 1995 Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, and related instruments"* (5 December 2008)

3.2.3. London Convention and London Protocol

The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matters (London Convention) and London Protocol requires Contracting Parties to take adequate measures to prevent pollution of the marine environment caused by dumping at sea.

Article IV of the Convention prohibits parties from dumping any wastes or other matter, except for certain substances identified in an annexe and those that require a permit to dump. The Convention defines "dumping" as requiring a deliberate act, including "any deliberate disposal into the sea of wastes or other matter from vessels, aircraft, platforms or other man-made structures at sea." The Convention does not apply to accidental discharges, such as those incidental to routine operations or releases from land-based sources.

3.2.4. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal

The 1992 Basel Convention established limitations on exports, imports and disposal of hazardous waste around the world. The primary objective of the Basel Convention is to prevent the negative consequences of hazardous waste on human and environmental health, including a vast variety of waste categorised by their origin, content and features, as well as domestic waste materials and incinerator ash.

The limitations on the movement of such wastes include the prohibition of their export or import to/from a non-party nation (unless under a separate multilateral or bilateral agreement); a requirement of notification of transboundary movements between parties or through territories of non-parties; and requirements for their packaging, labelling, and transportation.

In 1995, the "Ban Amendment"[14] to the Basel Convention was adopted. This Amendment requires Parties listed in Annex VII and members of the Organisation for Economic Co-operation and Development (OECD), European Union, Liechtenstein to prohibit all transboundary movements of hazardous wastes destined for recovery or recycling operations from OECD to non-OECD States. The Ban Amendment has not yet been ratified by three-fourths of the Member States and, therefore, at present, has not entered into force.

Since 2002, the Conference of the Parties has worked on the management of plastic wastes. One of the significant problems with plastics is the export of plastic waste from developed countries to developing countries. Recently, on May 10th 2019, the 14th COP took a big step through marine protection and a fair circular economy to include mixed, unrecyclable and contaminated plastic waste exports. With exceptions listed in the Annexes of the Convention, the import of plastic waste will be classified as hazardous waste, and its trade will require the consent of the control regime.

3.2.5. The Convention on Biological Diversity

On December 29, 1993, the Convention on Biological Diversity entered into force. The Convention has three primary goals: *"biological diversity conservation, sustainable use of its components, and a fair and equitable distribution of the benefits resulting from the use of genetic resources"* (UN, 2012). The contracting parties must adopt national policies for the protection and sustainable use of biological diversity under Article 6, *"General Measures for Conservation and Sustainable Use"*. Article 8, "*In-situ Conservation*", requires each party, as far as possible and appropriate, to develop strategies and take action aimed at protecting ecosystems. In 2012, the Secretariat of the Convention published a report on the

[14] Amendment to the Basel Convention, Decision III/1, Nov. 28, 1995, UNEP/CHW.3/35

impacts of marine litter on biodiversity (UN, 2012). In 2016, the Secretariat published another report focusing on the issue of marine litter, "*Marine Debris: Understanding, Preventing and Mitigating the Significant Adverse Impacts on Marine and Coastal Biodiversity"* (UN, 2016).

3.2.6. UN Watercourses Convention

The Convention on the Law of Non-Navigational Uses of International Watercourses, adopted on 21 May 1997 and entered into force on 17 August 2014, provides a framework for the governance and management of international watercourses. Article 7 imposes upon the Watercourse States the obligation to "take all appropriate measures to prevent the causing of significant harm to other watercourses States."[15]

Article 21 requires Parties to use an international watercourse to prevent, reduce, and control pollution of an international watercourse. Pollution is defined as "any detrimental alteration in the composition or quality of the waters of an international watercourse which results directly or indirectly from human conduct".

3.3. UNEP Regional Seas Programme

Since its inception in 1974, the UNEP Regional Seas Programme has been the most critical regional framework for protecting the marine and coastal climate. It is a results-oriented initiative that carries out region-specific activities by bringing together stakeholders such as governments, scientific communities, and non-governmental organisations (UNEP, 2021).

[15] UN Convention on the Law of Non-Navigational Uses of International Watercourses (21 May 1997)

Each Regional Seas Convention (RCS) and action plan has a normative and implementation mandate. They express shared regional goals, such as those outlined in global mandates such as the UN 2030 Agenda, provisions of environmental agreements, and UNEA resolutions. UNEP oversees the implementation of five regional seas conventions and two action plans. The Mediterranean, Caribbean, East Asian Seas, Eastern Africa, North-West Pacific, and Western Africa regions are among them. Non-UNEP administered RSCs were formed under UNEP's auspices, but another regional body provides the secretariat and administrative functions. Whereas the Black Sea RSC is non-UNEP administrated, the Baltic Sea and the North Atlantic RSCs are independent (UNEP, 2021).

Marine litter is one of the main working areas of the RSCs, which are working to strengthen regulations that prohibit businesses and individuals from littering the oceans and the seas worldwide. RCSs focus on developing, implementing monitoring of regional action plans for marine litter and assist the national governments in enforcing their marine litter related legislation.

3.4. Pan-European Regional Seas Conventions

There are four RSCs at the pan-European scale. They cover the four regional seas around Europe. European Union is a party to all RSCs except the Bucharest Convention since Turkey and Russia have reservations for the EU membership. The EU is supporting marine litter actions in the Black Sea basin via EU funded projects. All RSCs have published regional action plans on marine litter. They have an essential role in the protection of the European seas. However, the least active RSC is BSC among the four RSCs, primarily because of ongoing political problems in the region and a low level of environmental awareness.

RCSs are significant players in the marine environment domain in Europe. RSCs have produced protocols, action plans, monitoring networks and scientific information for marine ecosystems for decades.

3.4.1. The Baltic Sea: Helsinki Convention (HELCOM)

HELCOM adopted a marine litter regional action plan in 2015, intending to achieve a *"significant reduction of marine litter by 2025 and prevent harm to the coastal and marine environment"*. Action plan objectives align with the EU waste management hierarchy and achievement of the MSFD good environmental status. The action plan encourages the Contracting Parties to set monitoring programs and monitoring indicators. It incorporates regional and voluntary national actions;

"i. Land-based sources of marine litter (measures for the general improvement of waste management, tackle with top items, removal actions)
ii. Sea-based sources of marine litter (ship-based waste, waste delivery in ports, fishing-related waste, removal measures)
iii. Education and outreach on marine litter" (HELCOM, 2015)

3.4.2. The Black Sea: Bucharest Convention

Black Sea Strategic Action Plan (BSSAP) included recommendations for setting short, mid and long term targets to combat marine litter. Marine litter is one of the descriptors under Ecosystem Quality Objectives 4 within BSSAP. Besides, the Contracting Parties were urged to prepare action plans, strategies and regional/national monitoring and assessment methodologies.

The Commission adopted a marine litter regional action plan and marine litter guidelines. There are still no binding actions for the contracting parties. Unfortunately, ongoing political and economic problems in the region are

hindering the environmental priorities of the region. The Secretariat does not have the financial and human resources to communicate and coordinate the implementation of the actions effectively.

From the positive side, Turkey is an EU candidate country and has an advanced level of established monitoring capacity at the Black Sea, Georgia and Ukraine are willing to implement the MSFD, and there are successful ongoing EU funded marine projects as Environmental Monitoring in the Black Sea (EMBLAS) and Assessing the Vulnerability of the Black Sea Marine Ecosystems to Human Pressures (ANEMONE) for the monitoring and evaluating the Black Sea environment. These projects help to define standard policies and actions based on marine monitoring, including marine litter.

3.4.3. The North East-Atlantic Ocean: Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention)

OSPAR's 2014 Regional Action Plan for the Prevention and Management of Marine Litter in the North-East Atlantic sets out the policy context for OSPAR's work on marine litter. Regional Action Plan on Marine Litter covers the years from 2014 to 2021, and it is prepared in line with the UNEA resolution and The EU Marine Strategy Framework Directive's objectives. The action plan includes 84 actions to reduce marine litter and was divided into four themes, which will describe responsibilities for country or secretariat level;

"• *Actions to combat sea-based sources of marine litter (Harmonisation of the legislation with the EU acquis and MARPOL, develop best practices in the fishing industry and fines for waste disposal to the sea, development of sustainable production and packaging and zero pellet loss)*

- *Actions to combat land-based sources of Marine Litter (Improved waste prevention and management, reduction of sewage and storm water release, incentives for responsible behaviour and disincentives for littering)*
- *Removal Action (Fishing of litter, changing environmental compartments and keeping them clear)*
- *Education and Outreach"* (OSPAR, 2014)

Contracting parties to the OSPAR Convention are required to conduct periodic joint evaluations, including evaluating the efficiency of the measures. To monitor the Regional Action Plan, OSPAR is now evaluating beach litter, seabed litter, and plastic particles in the stomachs of fulmars as part of its monitoring and assessment program. These allow for quantifying, trends, and composition of marine litter in the OSPAR Maritime Area for different marine compartments (coast, seafloor and floating). Furthermore, OSPAR has been developing a possible indicator for microplastics in sediments.

3.4.4. The Mediterranean: Barcelona Convention (Mediterranean Action Plan)

A marine litter regional action plan was adopted in 2015, and the timetable for the implementation of the action plan measures is between 2016 and 2025, with most of the measures to be implemented by 2020 (UNEP MAP, 2015).

The action plan sets out objectives for the prevention of land-based and sea-based sources of litter. Marine litter indicators for beach litter and microplastics in the water column were set for monitoring the status. UNEP MAP has also published several guidelines and socio-economic impact studies on litter.

Mediterranean countries are much diversified in social and economic structures. Northern countries as Italy, Spain and Greece are EU members, and they are

already obliged with implementing the measures for MSFD, SUP Directive and waste management legislation. Therefore, EU members are the driving force in the region for the solution of the litter problem. There are several EU neighbourhood funds and environmental projects ongoing for the southern Mediterranean countries to comply with environmental standards.

3.5. Non-governmental Organisations (NGOs)

NGOs are instrumental in awareness rising for action and changing the behavioural habits of the citizens. Their efforts push the policymakers and plastic sector to act on marine litter. They are excellent facilitators in the emergence of new ideas and initiatives.

There are hundreds of NGOs working on different compartments of marine protection on a pan-European scale. More than thirty-five major NGOs are organising beach clean-up or monitoring events with the EEA Marine Litter Watch (MLW). The data collected is actively being used to support EU policies concerning marine litter.

The value and use of NGO data have been discussed in the scientific field. Decision-makers have been supporting the emergence and general use of citizen science. However, it has not been accepted yet as “monitoring” and labelled as “awareness-raising activities” by scientists. Many NGOs worldwide are organising beach clean-ups and monitoring under marine litter initiatives as EEA MLW (citizen/community science), and their monitoring data is being used as input or complementary data by some countries.

3.6. The European Union

European Union is the global lead actor in the environment field. Having jurisdiction from the subsidiarity principle, the Union has enforced vast environmental legislation in the last few decades. Turkey is a candidate country to the EU, and harmonisation of the EU environmental legislation is also a part of membership requirements.

EU marine protection legislation is based on the Marine Strategy Framework Directive (2008/56/EC). Marine litter is one of the 11 descriptors of the Directive on good environmental status. Circular Economy Action Plan (COM/EU/614), Plastics Strategy (COM/2018/028), and Single Use Plastics Directive (EU/2019/904) are the pillars establishing bridges between source and the sink; the plastics economy and the environment, which lead the way through a plastic-free future. EU Waste Framework Directive (2008/98/EC), Water Framework Directive (2000/60/EC), Port Reception Facilities Directive (EU/2019/883), Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Regulation (1907/2006/EC) are complementary legislation including measures and linkages on different compartments of plastics and marine litter. In contrast with the holistic efforts on marine litter, the most crucial environmental legislation for the fresh waters and coastal environment, Water Framework Directive, does not include any measures related to marine litter, which is pending to be corrected in the following years. Marine litter is a problem beyond the sea, and legislative measures must cover the plastics issue from the source to the sink.

The following two Chapters will focus on the policy and monitoring of marine litter in Europe and Turkey and describe a better understanding of the magnitude of the problem, gaps in policies and knowledge, and recommendations, which will be the basis for the indicator-based holistic marine litter assessment methodology.

CHAPTER 4

MARINE LITTER STATUS AND ACQUIS IN THE EUROPEAN SEAS AND BEACHES

4.1. Status of Marine Litter in Europe's Seas and Beaches

A literature survey was performed under this section, and available European marine litter data was compiled to define the state and monitoring gaps on marine litter. The purpose of this survey is to evaluate the level of success on MSFD D10 with the available scientific studies and monitoring efforts in the pan-European scale and define gaps.

EU-level and regional assessments of marine litter focus on analysing the composition, amount and spatial distribution of macro litter along coastlines, on the seabed and in surface waters; of microlitter in the water surface layer; and of litter ingested by marine biota. In some litter types as "beach litter", data was available for all European seas. However, not all analyses have the same geographical scope. Thus, not all European marine regions are included for each type of litter because of a lack of data and information.

4.1.1. Beach Litter

It was easier to find clean-up and monitoring data on beach litter compared with the other types. Although it is RSC established for the North East Atlantic Ocean, OSPAR is performing/collecting beach surveys for all European seas for many years, and the EEA MLW Initiative has a well-established NGOs network collecting and reporting beach litter items since 2014.

The analyses of collected litter items under the EEA MLW initiative indicates the top three items found on monitored beaches are: cigarette butts and filters, plastic pieces, and polystyrene pieces. Artificial polymers are by far the most common material, being present in 82% of the collected marine macro litter on Europe's beaches. Around 70 % of the plastics are single-use items. Comparisons of different marine regions show that the types and material composition of items vary spatially (EEA, 2018). OSPAR screenings for European beaches give a similar figure with 84% plastic items (OSPAR, 2017).

According to MLW surveys (2014-2018), Black Sea beaches are the most polluted, followed by the Mediterranean, Baltic and North Atlantic Seas.

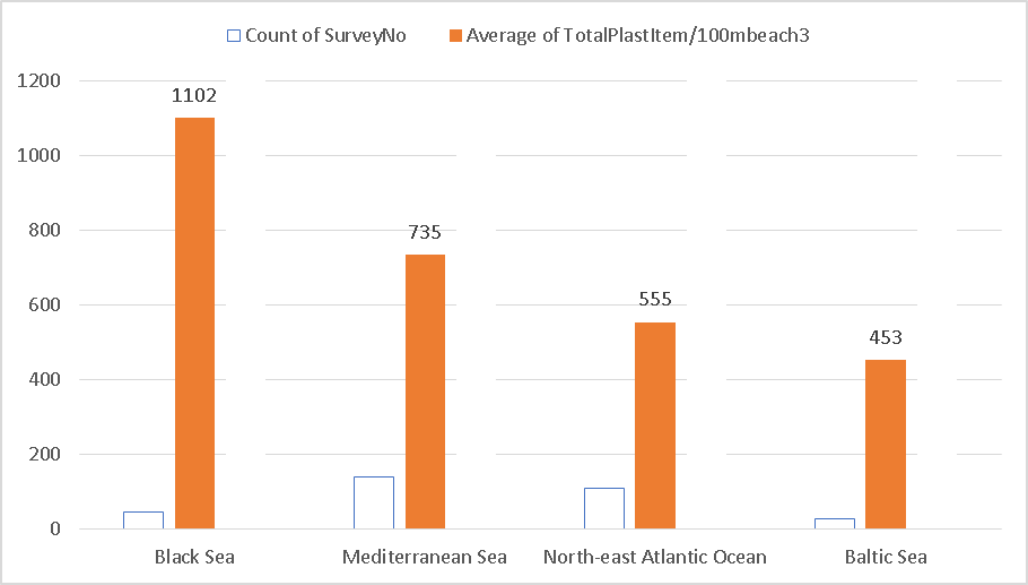


Figure 4. 1. Pan-European, only sea-beach data from MLW monitoring 2014-2018 (Kıdeyş, 2019)

Cigarette butts and filters are dominating items for the Black Sea and Mediterranean beaches but not for the Baltic or North-east Atlantic Seas. Top items vary according to socio-cultural differences. The top 10 litter items list were used as a building block for the SUP Directive.

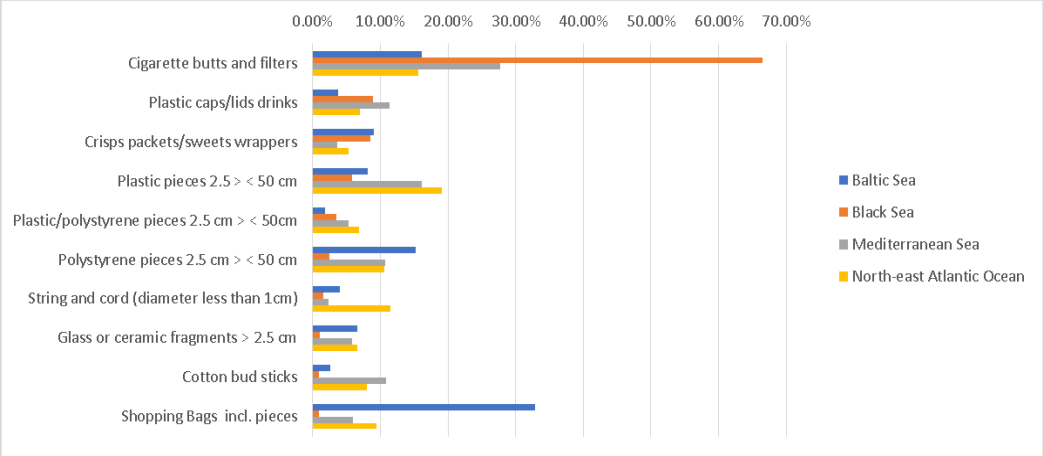


Figure 4. 2. The pan-European Top 10 Single-use Plastic Items MLW monitoring 2014-2018 (Kıdeyş, 2019)

OSPAR screenings and MLW data differ by percentages in the Top 10 list. However, the items are the same in both.

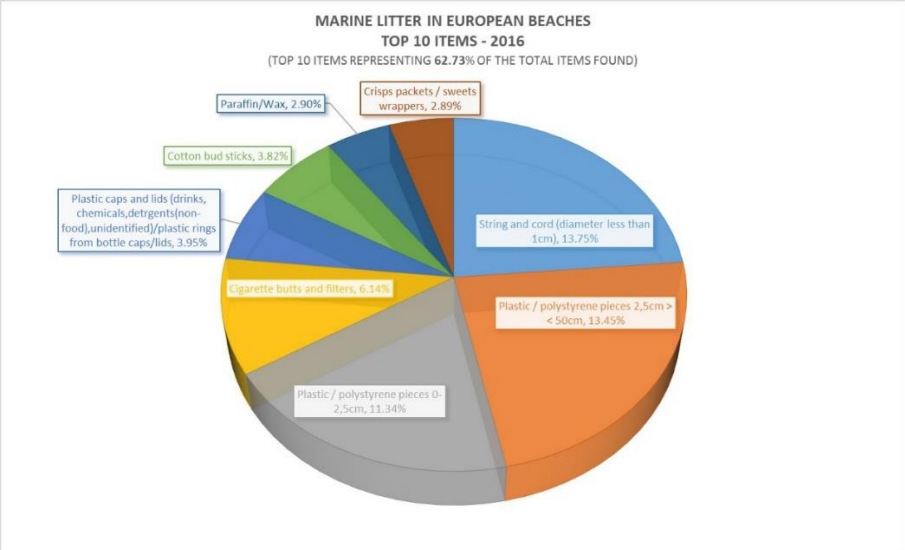


Figure 4. 3. OSPAR Top 10 Beach Litter Items (OSPAR, 2017)

4.1.2. Macro Litter on the Sea Floor

Sufficient information on seabed macro litter (including in the deep sea) was not available for the Black Sea.

- Baltic Sea: Marine litter was found in slightly more than half (58%) of the 1,599 Baltic Sea hauls reported between 2012 and 2016. The Western Gotland Basin had the largest average number of items. Plastic was the most frequent litter material on the Baltic Sea scale, accounting for roughly 30% of the total number of pieces and 16% of the total weight. Over the study period, there was a small but statistically significant increase in seabed litter made up of non-natural elements (HELCOM, 2018).
- North East Atlantic: an assessment of seabed litter was conducted in 2017 as part of OSPAR's Intermediate Assessment of the State of the North Atlantic Marine Environment. The study discovered that litter is prevalent on the seabed in all locations studied, with plastic being the most often detected item. The eastern Bay of Biscay, the southern Celtic Sea, and the English Channel were found to have more litter and plastic than the northern Greater North Sea and Celtic Seas. (OSPAR, 2018). A previous study has discovered that the Bay of Biscay gets a considerable amount of litter from local rivers and sea currents. Furthermore, floating and sinking waste go in different directions and gather in different hotspots that may or may not always coincide (2017, OSPAR).
- Mediterranean Sea: The Adriatic is one of the world's most contaminated basins, with an average litter density of 913 80 items/km2. A number of plastic items were found to be the most prevalent material (80 percent) and weight in a study (62 percent). Bags, sheets, and mussel nets were the most common plastics. Coastal locations, particularly front river mouths, coastal communities, and mussel farms, have higher trash volumes. Litter hotspots in deep waters were linked to the busiest shipping lanes, indicating an additional litter input to the basin. Litter composition was significantly influenced by proximity to local sources, such as mussel farming

sites and the busiest shipping routes (Pasquini et al., 2016). Another research project in Heraklion Bay was completed in 2015. From the two regions, a total of 245 litter items were recovered. Plastic litter pieces were found in all trawls. The number of litter items and litter diversity was equivalent in both areas. Plastic was the most common litter material in both sites (>76%) (Papadopoulou, 2015).

• Scientists from the MEDITS project, in cooperation with other experts, estimated that the global quantity of large plastic debris in deep-sea sediments is in the range of 71,5-116 billion (Galgani, 2015).

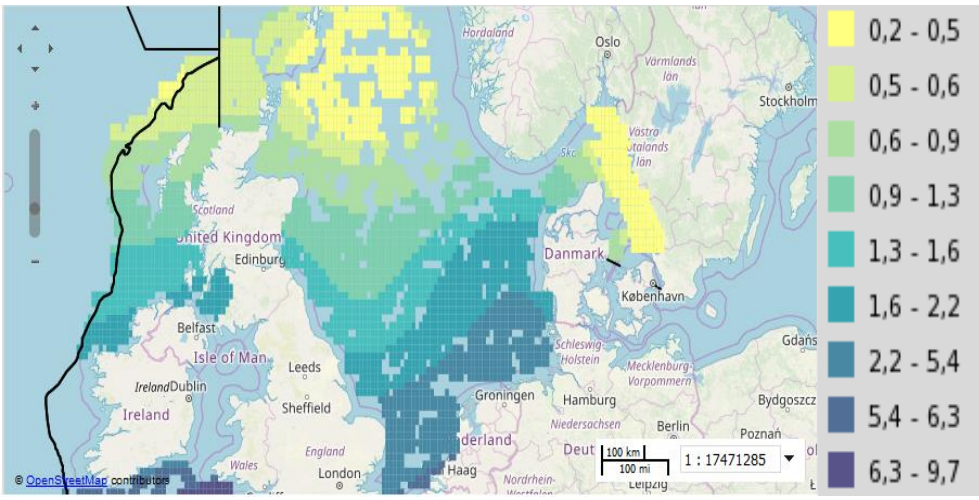


Figure 4. 4. Composition and spatial distribution of litter on the North-East Atlantic seafloor - Total count of plastic items caught in trawls (OSPAR, 2017)

4.1.3. Macro litter on the Sea Surface

• Mediterranean Sea: In a North-western Mediterranean field study, floating macro surface litter was found in all net tows. The greatest amounts of plastic were observed in areas far from land and within the first km of the shoreline. Plastic concentrations were shown to be substantially linked with proximity to a coastal human population. Hundreds of thousands of plastic fragments per km² were found in regions near major human populations. It was anticipated that the existence of a high concentration of plastic, especially tiny plastic objects, would have significant

environmental, health, and economic consequences (Pedrotti et al. 2016). In a recent study for the Adriatic Sea, expected plastic sources were defined as; shipping and fishing activities, populated urban and tourist centres, Adriatic rivers (Po and Adige Rivers). A high amount of small-sized plastics (2.5 -5 cm) were found compared to previous studies, which was an essential concern regarding the environmental status of marine waters, as these small-sized items cannot be controlled and prevented. The study recorded *"average macroplastics densities of 251 ± 601 items km², one order of magnitude higher than previously considered. Results from manta net tows for microplastics revealed an average abundance of 315 ± 568 items km²"* (Zeri et al., 2018). Overall, The findings show a wide range of litter and accumulations in convergence zones, continental shelves, heavy sedimentation areas, adjacent beaches, metropolitan areas, and canyons. (Ioakeimidis et al., 2017).

- Black Sea: The EMBLAS II project surveys found very high concentrations of marine litter, exceeding 201-810 items/km² in some parts of the Black Sea, whereas *"the average concentrations were between 4 and 30 items/km². (Suaria et al. 2015) found between 30 and 136 items/km² in the north-western Black Sea, thus significantly less than the monitored peak concentrations"* (EMBLAS-II, 2016).

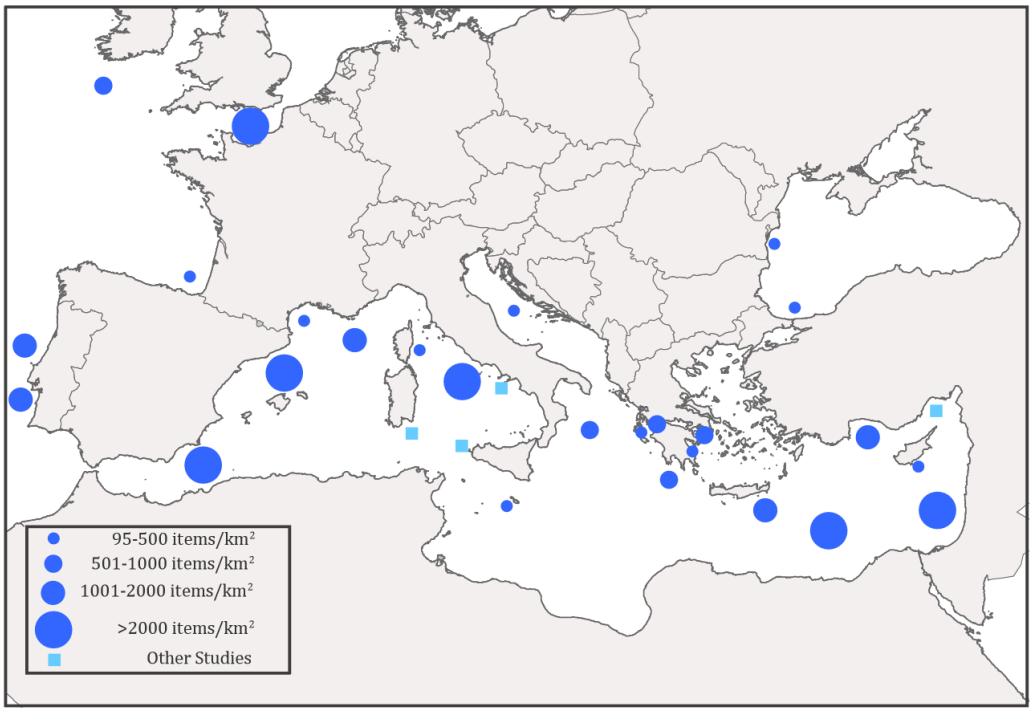


Figure 4. 5. Seafloor marine litter distribution in the Mediterranean (Ioakeimidis et al., 2017)

4.1.4. Riverine Litter

Rivers play a significant role in transporting litter items from the terrestrial to the marine environment, which also causes the fragmentation of larger litter items making it more challenging to identify their source. Besides, the riverine litter domain is comparatively new, and there is a lack of data and information for riverine litter.

Macro riverine litter across the EU is being monitored by the European Joint Research Centre's (JRC) Riverine and Marine floating macro litter Monitoring and Modelling of Environmental Loading (RIMMEL) project since 2016, which shows a predominance of plastic item categories (artificial polymer materials) going into Europe's seas. Thus, as *"a whole, plastic items made up to 80.8% of all objects, with plastic and polystyrene fragments comprising 45% of the identified items in*

the database. SUPs such as bottles, cover/packaging and bags were also ranked among the most frequently found floating litter. There were similarities in the Top 10 and Top 20 riverine litter items entering the different marine regions, which, together with SUPs scoring high in the ranking, support the need for joint actions against plastic pollution at the EU level" (JRC, 2017).

There is not a standard methodology and indicators at the European level for riverine litter. Besides, there is not good data coverage and time series. EEA MLW initiative receives river banks and lake beaches. According to the surveys reported to MLW, river banks are cleanest with 173 items per 100m beach strip, followed by the lake beaches with 492 items and the sea beaches 664 items.

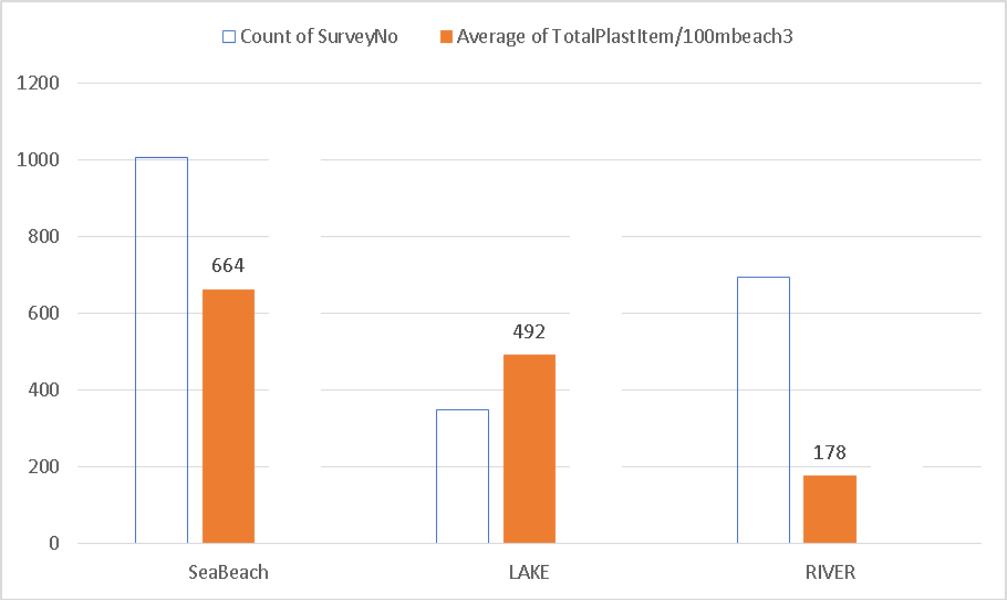


Figure 4. 6. Comparison of European Sea and Fresh Water beaches marine litter according to MLW data (Kıdeyş, 2019)

4.1.5. Micro Litter

- *Baltic Sea:* Microlitter has been sampled in the Baltic Sea for a few years, using various methods and sampling devices; nevertheless, coordinated, regular

monitoring is still being developed. The Gulf of Finland recorded 0.3-2.1 particles per cubic metre, whereas the South Funen Archipelago and Belt Sea recorded *"0.04-0.09 particles per cubic metre, both investigations utilising manta trawls with mesh sizes exceeding 333 micrometres"* (HELCOM, 2018).

- *Mediterranean Sea:* Results from the DeFishgear project for the Adriatic and Ionian subregions indicated high microplastic pollution in the former. Fishing areas of the Adriatic Sea showed *"a relatively high concentration of microplastic particles (4.3x 105items/km2), where plastic fragments were the most common microplastic category, followed by filaments and foams"* (DeFishgear, 2016).
- *Black Sea: "Due to excessive river discharge from multiple industrialised countries into this semi-enclosed sea, plastic pollution is regarded as one of the most important and severe environmental problems in the Black Sea. Microplastics (0.25 mm) were discovered in 92 percent of zooplankton samples collected during two voyages along the Black Sea's south-eastern coast in November 2014 and February 2015 (each boat collected neuston samples at 12 locations using a WP2 net with 200 m mesh). These high microplastic concentrations indicate that the Black Sea is a hotspot for microplastic pollution, and it is critical to learn more about their origins, transit, and consequences on marine life"* (Aytan 2017).

4.1.6. Impacts of Litter on Marine Biota

- *Baltic Sea and the North-East Atlantic Ocean:* There were no plastic particles larger than 0.1 mm (excluding fibres) in the stomachs and intestines of pelagic and demersal fish from these seas, according to a pilot study, but over 45 percent of North- and Baltic Sea fish samples contained microplastics smaller than 0,1 mm. However, the total amount of small microplastics was relatively modest. The Baltic Sea had a small microplastic content of less than 20 g per fish or pooled sample (36 fish), and the North Sea had a small microplastic content of less than 15 g per pooled sample (25 fish) (Scholz-Böttcher, 2017).

• *North-East Atlantic Ocean:* Although it is presently only active in the North Sea, OSPAR has developed an indicator based on the stomach contents of northern fulmars to assess changes in the quantities of floating litter and offer an indication of its influence on biota. OSPAR's long-term goal is to reduce the number of fulmars in the North Atlantic with more than 0.1 g of plastic in their stomachs to fewer than 10%. (OSPAR, 2017).

Plastic particles in fulmar stomachs were assessed in 2017 as part of the OSPAR Intermediate Assessment, which covered 2010-2014. Plastic intake by fulmars in the North Sea appears to have stabilised since the early 2000s, with roughly 60% of individuals exceeding the 0.1 g level of plastic consumption. Although the long-term goal has not been met anywhere in the North Sea, given the increase in maritime activity and the number of plastics in waste, the indicator's stability could be considered as a positive (OSPAR, 2017).

In a study of litter consumption by common dolphins in NW Spain, researchers discovered 411 plastic items in the stomachs of the dolphins (using a stereoscopic microscope). Even though trash abundance differed from one dolphin stomach to the next, microplastics were found in all the common dolphins studied. Small plastic fibres made up the majority of the objects (96.59 percent), while plastic fragments (3.16 percent) and pellets (0.25 percent) were also found (Hernandez, 2017).

Microplastics were found in the digestive tracts of 11 percent of the 761 fish studied in research on microplastics ingestion by mesopelagic fish in Irish waters (Lusher 2017a). Microplastics were found in all marine mammal species analysed (dissolving method) in a review incidences of *"plastic (macro and micro) reported in the digestive tracts of stranded and by-caught marine mammals on the Irish coasts from 1990 to 2015, with 11 of the 21 stranded species containing macro- and/or microplastics"* (Lusher, 2017b).

• *Mediterranean Sea:* The Italian Ministry of Environment funded the Plastic Pelagos Survey, which looked into the overlap between microplastic dispersion and fin whale feeding grounds in the Pelagos Sanctuary's convergence zones (gyres) (which is a Special Protected Area of Mediterranean Importance in the North-Western Mediterranean Sea). The high occurrence of microplastics (0.0090.260 items/m2) in the neuston/plankton surface water samples, as well as a strong overlap with locations demonstrating high macroplastic density, were shown by this plastic data set (Spearman R50.6127) (Fossi 2017).

From 2003 to 2015, researchers in the Western Mediterranean *"identified, categorised, measured, and weighted the plastics collected in the stomachs of 316 shearwater and gull species mistakenly caught by longliners. Scopoli's shearwaters (Calonectris diomedea) had the highest plastic frequency (71.58%), followed by Balearic shearwaters (Puffinus mauretanicus, 46.91%), and Yelkouan shearwaters (Puffinus mauretanicus, 46.91%). (Puffinus yelkouan, 56.86 percent). The gulls, on the other hand, had the lowest plastic frequency"* (Codina-García et al., 2013).

4.1.7. Conclusion on the Status of Marine Litter in Europe

It was possible to state, as a conclusion, that the European beaches and seas are not clean and all types of litter in macro and microforms exists starting from rivers to the deeps seas. All scientific studies and monitoring efforts on marine biota and ecosystems reflect that macro and microplastics affect marine biota.
Key conclusions in particular:

• In Europe, plastic objects are the most abundant and harmful component of marine litter. SUPs (single-use plastics) pose a danger to the marine ecosystem. The top ten most common SUP items account for half of all litter items discovered on European beaches. Plastic-containing fishing gear accounts for another 27% of marine litter items collected on European beaches.

- European rivers play an essential role in carrying litter items from the land to the seas.
- Litter is abundant on beaches in the European Seas. The most common types of litter detected are plastic pieces, fishing-related trash, and packaging. Over 80% of goods are made of plastic.
- Despite the lack of frequent regional monitoring, all scientific studies conducted too far suggest the presence of significant levels of micro litter in rivers and seawater across the four regional seas.
- A diverse spectrum of fish and bird species accidentally ingest in European seas. Plastic intake by fulmars in the North Sea seems to have stabilised at around 60% o f individuals above the 0.1 g plastic ingestion threshold.
- Because of litter ingestion, entanglement, the spread of non-native species, and the potential toxicity of compounds generated by plastic, marine litter influences marine ecosystems.
- There is insufficient information on marine litter in bottom sediments and entanglement to include in this survey.
- There is insufficient data on the sea bed, sea column, microplastics, and effects on biota in Europe scale.
- To get better estimates of the abundance and consequences of marine litter, standardised monitoring techniques and monitoring efforts should be enhanced.

4.2. European Union Marine Litter Legislation

Marine litter finds its place in legislative documents of the EU increasingly since the last decade. The most important among these policies is the MSFD, which aims to sustain good environmental status at the European seas. This section provides an overview of the EU legislation that includes provisions on marine litter in an order that represents their priority for curbing marine litter.

As the marine litter problem requires integrated actions for the solution, the EU legislation also moves towards a more integrated structure. Therefore, marine litter and plastic pollution issue, and the measures for the solution are being reflected in the EU acquis such as its overarching Green Deal and its relevant strategies; Circular Economy Action Plan, Plastics Strategy and Zero Pollution Action Plan, and EU strategy documents, regulations and directives below were provided in an order, according to their level of relevance with the marine litter. Therefore the section 4.2.1 starts with the MSFD.

4.2.1. Marine Strategy Framework Directive (MSFD)

MSFD is the overarching marine protection legislation for the European Union. One of the 11 main pillars of the Directive is marine litter. EU Member states are expected to ensure properties and quantities of marine litter do not cause harm to the coastal and marine environment. Commission Decision (EU) 2017/848 of 17 May 2017 defines the criteria and methodological standards on the good environmental status of marine waters. EU countries are expected to achieve Good Environmental Status (GES) by 2020. By the definition of the Directive in 11 areas, including marine litter. This ambitious goal was not satisfied yet. Monitoring results already reflect the fact that most of the counties are far below the expected achievement. Besides, there are existing gaps in joint monitoring and implementation methodologies. Only one common GES threshold value for Europe for marine litter was agreed in 2020 for macro beach litter (20 items per 100-meter beach strip).

MSFD GES descriptors define the monitoring parameters for the sea ecosystems. Types of macro and micro litter are subject to monitoring. In addition to these status indicators, impacts of marine litter on marine biota must also be measured. However, there is still a lack of data on the impacts. There are well-known effects as entanglement, digestion, accumulation, genetic malfunctioning. Scientific

researches give different results and assumptions on the level of impacts. It is so hard to establish GES thresholds for the impacts when there is no solid information on “which amount of litter” creates serious health effects for the biota yet. There are a number of observations that were made related to the methodologies and information used for MSFD marine litter assessments as a result of the literature survey for the current information in Europe for marine litter.

To improve the monitoring methods, the EU MSFD Technical Group on Marine Litter (TGML) is continuously working on a number of activities related to up to date and coordinated monitoring protocols. The members of the technical group are experts from the Member States. The group's mandate is to facilitate implementation by the Member States of MSFD requirements related to marine litter, including determination of GES according to the 2017 GES Decision. GES is currently defined by the Member States themselves, and better harmonisation is necessary. TGML is progressing by establishing baselines for quantities of marine litter and regulatory threshold values; the initial results of this process was seen by the end of the year 2019. A threshold value for the first time was set for beach litter GES (20 items per 100 meter beach strip). Threshold values are usually defined in terms of the level of harm inflicted on the environment. However, in the field of beach litter, there is a lack of knowledge and data; therefore, the value was based on the median calculation of quantities of litter.

The Commission report on assessing the Member States’ programmes of measures under the MSFD was published in 2018. Member States reported their measures concerning marine litter (Descriptor 10 of the MSFD), as required under the existing legislation such as waste management, port reception facilities, urban wastewater treatment. Some Member States also defined independent measures or new measures. Existing measures are, for instance, recycling targets defined under the waste legislation, whereas new measures address the loss of containers and awareness campaigns.

The Commission's conclusion on Member States' programmes of measures is that reported measures were not specific and measurable. Besides, only 6 out of 16 coastal Member States expect to achieve the good environmental status of their marine waters by 2020 for marine litter. There is a need to complement the measures under MSFD with more targeted measures to tackle the individual sources of litter in coastal areas and the sea.

Monitoring the amount of litter does not only help to comply with the environmental standards but ensures direct links with the amount of plastic produced, consumed and recycled. SUP Directive is a good example of synergies between the MSFD and other EU legislation. European Commission used beach litter surveys (necessary for MSFD Descriptor 10 assessments) to define Top 10 and Top 20 SUPs in European beaches and used the results to establish priorities for its plastics strategy and SUP Directive.

4.2.2. European Green Deal

The European Commission published the Green deal (COM/2019/640) on the 11th of December 2019. This ambitious European strategy aims to make Europe the first carbon-neutral continent by 2050. It is a response to climate change and biodiversity crises, which threatens life on Earth. It aims "*to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use. It also aims to protect, conserve and enhance the EU's natural capital, and protect the health and well-being of citizens from environment-related risks and impacts*" (EU, 2019b).

The Green Deal brings new strategies and legislation on climate change (Climate Law), biodiversity (Biodiversity Strategy 2030), smart transport (revision of the EU Directives on transport), healthier food and sustainable agriculture (Farm to

Fork Strategy), pollution, and aims to update the Circular Economy Action Plan (CEAP). EU aims the mainstreaming all its legislation through a sustainable path with an integrated approach, with a systems thinking to ensure connectivity of all EU legislation and its implementation. The Green Deal and its strategies are interlinked with each other and designed to feed and support each other's objectives. Among these strategies, the CEAP and the ZPAP are the most related to curbing plastic pollution and marine litter objective.

4.2.2.1. Zero Pollution Action Plan

ZPAP (COM/2021/400), including actions for plastic pollution, was adopted by the European Commission on the 10th of May 2021. The ZPAP aims to *"secure clean air, water and soil, healthy ecosystems and a healthy living environment for Europeans, and mainstream the zero pollution ambition into all its policy developments and decouple economic growth from the increase of pollution, in line with United Nations efforts"* (EU, 2021a). Besides, the EU confirms its commitment to follow up on resolutions by the UNEA and promote a global agreement for plastics with ZPAP.

The ZPAP has close linkages with the CEAP with its "*Towards zero pollution from production and consumption"* pillar. It aims to establish circular supply chains that wastes or by-products from one industry are repurposed as raw materials for another. In order to achieve the goal of zero pollution in production and consumption, the Action Plan targets the transformation through safe and sustainable chemicals and materials, starting from their design and during their life cycle.

Marine litter and therefore decreasing plastic pollution is one of the main targets of the ZPAP, which includes the 2030 target of reducing 50% plastic litter at sea and 30% fewer microplastics released into the environment. To implement these

targets, ZPAP states that Horizon Europe Programme will support research and innovation relevant to the zero pollution ambition as one of its priorities. Besides, the ZPAP requires the European Commission to review the MSFD by 2023 to reduce plastic and other litter, to address microplastics pollutants into the review of the Urban Waste Water Treatment Directive (UWWTD).

The revised Drinking Water Directive, according to the ZPAP, will improve human health safety by establishing more stringent water quality requirements, addressing pollutants of concern like endocrine disruptors and microplastics, and resulting in even healthier tap water for everyone – and fewer plastic bottles (EU, 2021a).

As conventional monitoring efforts and official monitoring cycles of the European policies have not successfully provided timely, sufficient and actionable knowledge for policymakers, ZPAP encourages the European institutions and the EU Member States to utilise technologic developments and use innovative monitoring, assessment and forecasting methodologies. Action plan indicates that satellite monitoring, use of drones, citizen science and mobile apps can close the data gaps and acquire real-time monitoring data for the European seas in the next decade, and modelling of pollution, artificial intelligence, machine learning can contribute to forecast the future trends and define trajectories, with the help of innovative assessment methodologies.

The change and evolution of the EU monitoring and assessment approach are apparent in the ZPAP and its recent Commission staff working document Digital Solutions for Zero Pollution (COM/2021/140). Decades of “Directive based” two, three (and for some policy cycles even six years), policy-specific monitoring and reporting approach is evolving through holistic, integrated and timely (real-time where possible) monitoring, utilising high technology solutions and citizen science.

4.2.2.2. Action Plan for the Circular Economy

CEAP (COM/2015/614), published in 2015, is the overarching policy for plastics. It aims to close the loop not only for the plastics economy but also for all sorts of material use, from extraction to recycling/reuse. *"The action plan includes measures that will help Europe's transition towards a circular economy, boost global competitiveness, foster sustainable economic growth and generate new jobs "(*EU, 2019c).

Two revisions on the action plan were made until now; first, in July 2018, which set clear objectives for reducing waste and establishing a path for waste management and recycling, and the second revision following the publishing of the Green Deal, in March 2020. Key elements of the 2018 revised waste proposal were:

- EU target for recycling 65% of municipal waste by 2035 (the figure was 42.4% in 2013 (EEA, 2016a));
- EU target for recycling 70% of packaging waste by 2030 (the figure was 40.9% in 2017 (Plastics Europe, 2017));
- EU target for recycling paper and cardboard: 85 %, Ferrous metals: 80 %, Aluminium: 60 %, Glass: 75 %, Plastic: 55 % (the figure was 31.1 % in 2016 (Plastics Europe, 2017))
- A mandatory landfill percentage to minimise landfill to a maximum level of 10% of municipal waste by 2035 (which was 23% in 2017 (Plastics Europe, 2017));
- Separate collection obligations are strengthened and extended to hazardous household waste (by the end of 2022), bio-waste (by the end of 2023), and textiles (by the end of 2025).
- To increase governance and cost-efficiency, minimum requirements for extended producer responsibility systems were devised.

• Prevention aims are greatly enhanced, with Member States being required to adopt specific actions to combat food waste and marine litter as part of the EU's commitments to the UN SDGs.

The Action Plan necessitates the revision and integration of EU law, particularly in the areas of waste and environmental protection. By 2030, 70 percent of packaging waste and 55 percent of plastic material should be recycled. The latest figures on packaging waste show that the EU is so close to the 2030 targets on packaging waste (67% by 2017 (EEA, 2016)). However, the figures are less impressive for plastics waste recycling (31% of plastics recycled in 2017 in EU member states (Plastics Europe, 2019). Domestic recycling is insufficient, and it is based on the assumption that exported plastics will be recycled in the destination country. There is no guarantee that the exported plastic recyclets will not end up as marine litter.

The rest of the plastics were either incinerated (41.5%) or landfilled (27%). Unfortunately, there is no figure on the amount of plastic waste which was not collected. EU does not have data on the leakage of plastic waste, which ends up as marine litter and originates from the mismanagement of the waste. Therefore, 100 % recycling for plastic waste would indicate a successful waste management system. However, it is still necessary to collect all the plastic waste produced to prevent leakage and close the loop for a circular economy.

While the main principles set by the CEAP demand less input and use of natural resources, to increase the share of renewable and recyclable resources and energy, to design for circularity, to keep the value of products, components and materials in the economy, lower emissions and few material losses; the current situation for the material loop needs much more than it is functioning right now to comply with these requirements.

Plastics are mainly based on fossil fuels, which means more extraction of natural resources. The share of recycling is low for two main reasons; mismanagement of the waste and low economic value of certain types. An essential share of plastics is designed for single-use, where circular economy demand is "design for circularity". Even if they are not designed for single-use, plastic products are not much durable as wooden or metal products. Their value is limited to keep them. The leakage is high as they are not much valuable, which causes a highly persistent, hazardous substance to accumulate in the environment.

The revised action plan in 2020 The new CEAP brings additional measures to improve the current situation through *making "sustainable products" the norm in the EU,* e*mpowering consumers and public buyers to choose sustainable products,* f*ocusing on the sectors that use most resources and where the potential for circularity is high, including packaging, plastic and textiles,* e*nsuring less waste,* m*aking circularity work for people, regions and cities and leading global efforts on the circular economy"* (EU, 2020a)

The 2020 Action Plan will hopefully boost the efforts in circularity with the help of European legislation and funding mechanisms. Such a sustainable transition will require massive investments from the plastics sector, and public funding cannot cover all costs.

4.2.2.3. Plastics Strategy

EU Plastics Strategy (COM/2018/28), which was published in January 2018, is a pillar of the overarching EU CEAP (2015) and aims to establish a road map and provide solutions for the problems mentioned above legislative measures and actions on plastics. The strategy has four pillars;

- *"Improve the economy and quality of plastics recycling*
- *Drive investments and solutions towards circular solutions*
- *Curb plastic and waste littering*
- *Harness global solution"* (EU, 2018)

All actions driven by the strategy will eventually help to tackle the litter problem as they reflect a step from the source to the sink of the plastics. "Curb plastic and waste littering" is the most important pillar regarding marine litter since it requires direct actions to combat. The Strategy acknowledges the massive amount of plastics leaking to the environment and aims to bring solutions to prevent leakage.

The Plastics Strategy aspires to create an innovative, creative, and sustainable plastics economy in Europe, where design and production are working in line with the needs of reuse, repair, and recycling. The transformation of the plastics economy to a clean, regenerative and circular economy is crucial for the solution of the marine litter problem. Plastics Strategy also helps the EU reduce greenhouse gas emissions and its reliance on imported fossil fuels.

According to the Plastics Strategy, by 2030, all plastic packaging placed on the EU market must be reusable or recyclable. It seeks to achieve high levels of separate plastic trash collection and to recycle more than 50% of all plastic waste generated on the same day.

The Strategy acknowledges the need for the modernisation of the recycling sector to comply with the requirements. Modernisation and expansion of the industry are seen as an opportunity for 200,000 new jobs in Europe. Recycling is assumed to lower down Europe's substantial fossil fuels demand and cut CO2 emissions from the extraction and production of virgin raw materials.

There is a long list of measures and actions in the EU's Plastics Strategy, the Member States and the plastics industry to transform through a circular plastics economy, curb the plastic pollution and marine litter problem. If the Plastics strategy is successfully implemented, high rates of reusing and recycling of plastics will decrease plastic waste and, therefore, leakages to the environment. This is an essential upstream circular economy approach to curb the marine litter problem.

Regarding the developments for the implementation of the Plastics Strategy, recently published the Single Use Plastics Directive is a significant step through legislative action to curb marine litter originated from land-based sources. The directive is a prompt reply to the public concerns for plastics impacts, which has grown tremendously in the last decade.

Several EU bodies work to implement the measures and actions of the Plastic Strategy; a crosscutting issue needs holistic solutions. Directorate General Environment (DG ENV) is responsible for the coordination of the collective efforts against litter. Directorate General Marine Affairs (DG MARE), Directorate General Transport (DG MOVE), Joint Research Centre (JRC) and European Environment Agency are the central EU bodies who are responsible for policy-making and monitoring of the implementation research or environmental assessment. These EU institutions continuously communicate and coordinate collective actions and strategies.

Measures on marine litter were almost limited with the MSFD Descriptor and, therefore, on the status/sink of litter before the publishing of the plastics strategy. However, member states have to provide the program of measures connected with the MSFD descriptors, only a few provided measures, which carry links with waste management legislation. Plastics strategy is expected to boost the efforts on a more holistic approach for the solution. Publishing of the SUP Directive and the Port Reception Facilities Directive and integration of “microplastics” within the

REACH Regulation process are the three outstanding successes of the Strategy for Plastics in 2019.

For implementing the Plastic Strategy and the SUP Directive, consultation meetings between the European Commission and the industry representatives are ongoing. Besides, “Biodegradability of Plastics in the Open Environment Report” of the Commission’s Scientific Advice Mechanism (SAM) Group of Chief Scientific Advisors was published with a focus on biodegradability in the marine environment in 2020. This scientific opinion report provides aims to inform society, consumers, sectors and policymakers.

There is a need to implement the amended Waste Framework Directive in connection with the MSFD and the Water Framework Directive (WFD) to comply with the strategy's requirements on plastic pollution. This action requires the alignment of programs of measures under the MSFD and new waste management plans and to include litter measures under WFD, which are needed for the holistic solution of the problem but do not exist yet under the Directive.

It is not a surprise that these and many other actions are planned but will take a long time before they will be settled and implemented. Bringing out new monitoring and implementation of responsibilities for the member states under many Directives will require more money and time to comply. One can argue that several more years need to pass before reaching to more holistic management of the marine litter within the Union’s legislative instruments. Holistic implementation might take more than several years as we can see the implementation of MSFD D10 criteria has not been adequately set yet after more than ten years from publishing the MSFD.

DG ENV works on the REACH Regulation revisions for the plastics and ban of certain micro-plastics in products in 2021 in particular. If the ban would not get the

necessary support at the policy-making level, reporting and labelling requirements will also be considered. It is hard to ban certain types of microplastics as they do not have alternatives for the industry. Transition periods for the banned products will be seven years, which means the products will no longer be available in the market seven years after the ban. Chief scientific advisor opinion on microplastics was rather precautionary; "even chemical hazard is not proved, we need to act now before the accumulation".

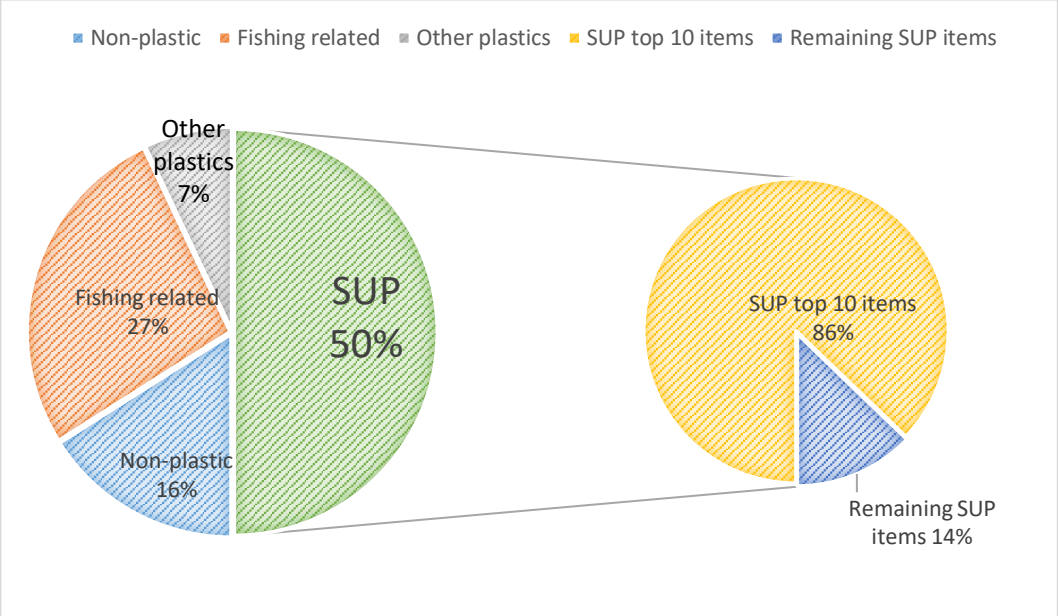
4.2.3. Single Use Plastics Directive

Measures of Plastics Strategy for the "actions to reduce single-use plastics" and "actions to monitor and curb marine litter more effectively" require the determining of the scope of a legislative initiative on single-use plastics and improved monitoring and mapping of marine litter and support MSFD. "Actions to reduce single-use plastics" is still ongoing, and the proposal for the reduction of the impact of certain plastic products on the environment, SUP Directive (EU/2019/904), was enforced on 12 June 2019.

According to Eurobarometer public opinion research (EU, 2017c), 74% of the European citizens are worried about daily life use health effects, and 87% are concerned about the impact of plastic products on the environment. In June 2019, the EC adopted ambitious measures to cover public concerns and to minimise the marine litter coming from the Top 10 single-use plastic items most often found on European beaches. Abandoned fishing gear and oxo-degradable plastics were also a part of the measures.

The beach litter surveys were the critical information to establish the measures to be taken with the Directive. OSPAR Convention's regular surveys since 2001 were used to define Top 10 SUPs found in European beaches. The importance of the availability of monitoring data was once again prominent.

Table 4. 1. OSPAR Beach Litter Monitoring Results (OSPAR, 2017)



The SUP Directive is a significant step towards the implementation of the Plastics Strategy. It brings out measures to promote less harmful SUP alternatives and market bans for available sustainable options. In the condition that the SUP items do not have a sustainable alternative, the SUP Directive requires prevention measures (design requirements, consumption reduction and consumer information) and better waste management practices (separate collection, extended producer responsibility and clean-up).

The SUP Directive brings out the below measures for the SUPs;

"• A ban on selected single-use products made of plastic for which alternatives exist on the market: cotton bud sticks, cutlery, plates, straws, stirrers, sticks for balloons, as well as cups, food and beverage containers made of expanded polystyrene and on all products made of oxo-degradable plastic.

• Measures put into reducing consumption of food containers and beverage cups made of plastic and specific marking and labelling of certain products.

• *Extended Producer Responsibility schemes covering the cost to clean-up litter, applied to products such as tobacco filters and fishing gear.*
• *A 90% separate collection target for plastic bottles by 2029 (77% by 2025) and the introduction of design requirements to connect caps to bottles, as well as target to incorporate 25% of recycled plastic in PET bottles as from 2025 and 30% in all plastic bottles as from 2030"* (EU, 2019d).

The SUP Directive states the necessity for the monitoring of the SUP data concerning measures to reduce the consumption of SUPs to evaluate the impact of the measures envisaged and take into account future evolutions. The Directive proposes monitoring based on the data of the single-use plastic products put on the market in a year.

The preamble defines clear links with the MSFD and Waste Framework Directives. It gives a role to the Commission to evaluate the SUPs Directive. This evaluation will be based on experience gathered and data collected during the implementation of the SUPs Directive and data collected under MSFD and Waste Framework Directives. Data collected under the MSFD should refer to D10 (especially beach litter data and seafloor and seabed macro litter data).

The SUP directive complements the Marine Strategy Framework Directive. MSFD D10 is dedicated to marine litter and requires Member States to ensure GES. The Context part of the SUP Directive proposal refers to the work undertaken under the MSFD to monitor marine litter on European beaches as the legislative proposal's scientific base. It goes further than the MSFD requirements by focusing on individual sources of pollution.

Identifying the sources, drivers and pathways of marine plastic pollution is the key to curb the marine litter problem. Monitoring for the litter must be an integrated effort, and it is only entirely possible to understand the state and impacts of litter

(necessary for MSFD and SUPD assessments) by having reliable information on the sources and pathways of litter. However, the current monitoring practice is not mature to establish the direct correlations between waste data and the marine litter status at the sink. This issue is one of the areas in this study that would like to offer an innovative approach for future marine litter assessments in Europe, with its attempt on ensuring direct linkages with the source and the sink.

4.2.4. Waste Framework Directive and Waste Package

Marine litter is the result of the leakage of waste into the environment. The solution to the problem includes proper waste management practices and legislation. Circular economy principles and the Waste Framework Directive (2008/98/EC) are prominent policy documents to solve the problem at the source.

The European Commission adopted the Waste Package (EU/2018/851) in May 2018, to be transposed by the Member States by 2020, to bring new targets for the Member States, including plastic waste. The package includes amendments for the Waste Framework Directive, the Packaging and Packaging Waste Directive (94/62/EC) and the Landfill Directive (1999/31/EC).

Article 11 of the Waste Framework Directive requires, by 2015, separate collection for at least paper, metal, plastic and glass, and by 2020, increase for re-use and the recycling to a minimum of overall 50 % by weight. Directive on Packaging and Packaging Waste was amended on 27 April 2018 with Waste Package. With the changes in EU legislation, oxo-degradable plastic will not be considered as bio-plastics. The amendment set the target for the recycling of plastic waste to 55% by 2030.

The leakage of waste is the main reason for marine litter. Leakage is generally caused by landfilling activities or littering. Littering by citizens and lack of public

awareness, specific measures should be laid down in waste prevention programmes and waste management plans (EU, 2018c). The amended Waste Framework Directive requires a connection between waste management plans and the MSFD; waste management plans are regularly updated; however, it is unclear whether specific guidance in this regard is needed and whether the European Commission services should produce such guidance. There is no study ongoing on this matter individually as yet.

The Waste Package brings out restrictions for the landfilling of municipal waste. Member States are obliged to reduce the amount of municipal waste landfilled to 25 % or less by 2035 (by weight). Environmental, economic and social benefits from restricting landfilling in the Member States are acknowledged in the amendment's preamble for the landfill and, therefore, starting with waste streams that are subject to separate collection, such as plastics, metals, glass, paper and bio-waste (EU, 2018d).

The separate collection of the waste is also significant to establish decoupling of waste data with the marine litter monitoring data to establish links with the sources and sinks of litter. Separate collection practices should allow the plastics data and SUP data separately to make comparisons with the source and the sinks that a very high percentage of packaging is at the same time also single-use plastics. Currently, the monitoring links are weak in the means of units and methodology. This issue will be further examined in the following chapters of this study. If there is no data, there is no assessment. If there is no assessment of the status and background factors, there is no clear understanding of the policy solutions.

4.2.5. Port Reception Facilities Directive (PRFD)

Although the majority of the marine litters comes from terrestrial activities, sources such as shipping (including fishing and leisure sectors), discharging plastics and

fishing gear straight into the ocean are also significant contributors to marine litter (EU, 2018e).

The PRFD (2000/59/EC), which aligns with the IMO Convention MARPOL 73/78, aims to reduce pollution originating from the waste produced by sea vessels. The PRFD; repealing the Directive 2000/59/EC and amending the Directive 2009/16/EC and the Directive 2010/65/EU, was published 7 June 2019 to better tackle waste from shipping. The PRFD contributes to the marine litter goals of the MSFD, which seeks to achieve good environmental status in the European seas. The Directive also aims to complement the Circular Economy Strategy to reduce lost fishing gear found at sea by 30% in 2020. The PRFD brings out provisions for the ships to collect plastic waste and carry them to the port reception facilities and the concept of green ships. The EC will soon start to work on the definition of green ships (only waste-based assessment), ship-based plastics, the possible inclusion of litter in the scope of the ship-source pollution Directive and the International Marine Organisation marine litter action plan.

There is also an ongoing study on SUP and PRF directives. DG MARE has initiated a study on fishing gear, and a standard will be prepared for the circular design of fishing gear. DG MARE has already asked member states for collection and recycling data for the fishing gear, but such data were not collected by the member states yet. The current problem of PRFD is the fees brought by the Directive for plastic waste. The maritime sector is asked to collect the marine litter, and they are also obliged to pay a fee for the litter they bring to the port reception facilities. One can argue that people might choose to throw them back and not to bring them.

4.2.6. Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Regulation

There is an ongoing restriction process under the REACH Regulation. The European Commission's SAM Group of Chief Scientific Advisors has delivered its most recent Scientific Opinion on the Environmental and Health Risks of Microplastic Pollution. The document is in line with the REACH file. In conclusion, of the SAM opinion, the group accepts the lack of scientifically proven health risks of microplastics. However, a precautionary approach is necessary. The opinion suggests taking reasonable and proportional measures "to prevent the release of microplastics into the environment and their formation from the break-up of macroplastics. These measures" suggested were:

"a. limit the unnecessary use of plastic;
b. Restrict the intentional use of microplastics;
c. Prevent or attenuate microplastic formation over the life cycle of plastics and plastic-containing products;
d. Avoid release into the environment as near to the source as possible, and e. mitigate and control at critical points in pathways from source to sink" (EU, 2019).

European Chemicals Agency (ECHA) also prepared a file for a restriction proposal on microplastics intentionally used in products. ECHA's scientific committees are assessing the file. The REACH committees' final opinion will be a baseline for the Commission to prepare an amendment to the REACH Directive's restriction list (Annexe XVII).

As risks are not scientifically proven, ECHA proposes to justify the restriction based on the extreme persistence of microplastics in the environment, possible effects and increase in accumulation if no action is taken.

The most difficult actions to take on microplastics might be in cosmetics, in particular for products such as sun creams, as the cosmetic industry might come up with powerful opposition based on socio-economic impacts. The second problem might occur with the products with no substitutes in the market as a list of polymers used in cosmetics.

Most of the microplastics intentionally used in products end up in wastewater treatment plants and later in the soil as sludge of the plants are used for fertilisers. The REACH restriction will define biodegradability standards.

4.2.7. Plastic Carrier Bags Directive

The Plastic Carrier Bags Directive (EU/2015/720) acknowledges the adverse environmental effects of plastic bags and their contribution to littering. The limit value for the light plastic bag is given as 50 microns, and they are generally produced for single-use purposes and recycling rates are very low.

The Plastic Carrier Bags Directive requires the Member States to take measures such as national reduction targets, maintaining or introducing economic instruments as well as marketing restrictions. The targets set for annual consumption level is *"90 lightweight plastic carrier bags per person by 31 December 2019 and 40 lightweight plastic carrier bags per person by 31 December 2025, or equivalent targets set in weight"* (EU, 2018f). The free provision of lightweight plastics at the sale points was banned by the 31st of January 2018.

The Directive sets special provisions for biodegradable and compostable plastic bags. Member States are to ensure labelling for those types. Although biodegradable and compostable plastic bags are exempted from the Directive's objectives, the EU is still describing the effects. As there is no separate collection

for these types and they are not easy to degrade even in particular conditions, they cannot be called environmentally friendly alternatives yet. However, a specific solution would gradually ban the use of biodegradable or oxo-degradable bags and promote the use of canvas bags, backpacks or other types of reusable shopping bags. The EU recently proposed with the Plastic Strategy harmonised rules for defining and labelling compostable and biodegradable plastics. The European Commission has started a recent study on the impacts of oxo-plastics. The results of this study might be a sound basis for future provisions for the Directive.

All EU countries are taking action to minimise lightweight plastic bags in line with the Directive. The recent plastics report on adopting the measures reflects that 18 months after the end of the transposition period of the Plastic bags Directive, most countries have adopted standards, but often with limited scope and ambition (EEA, 2019b).

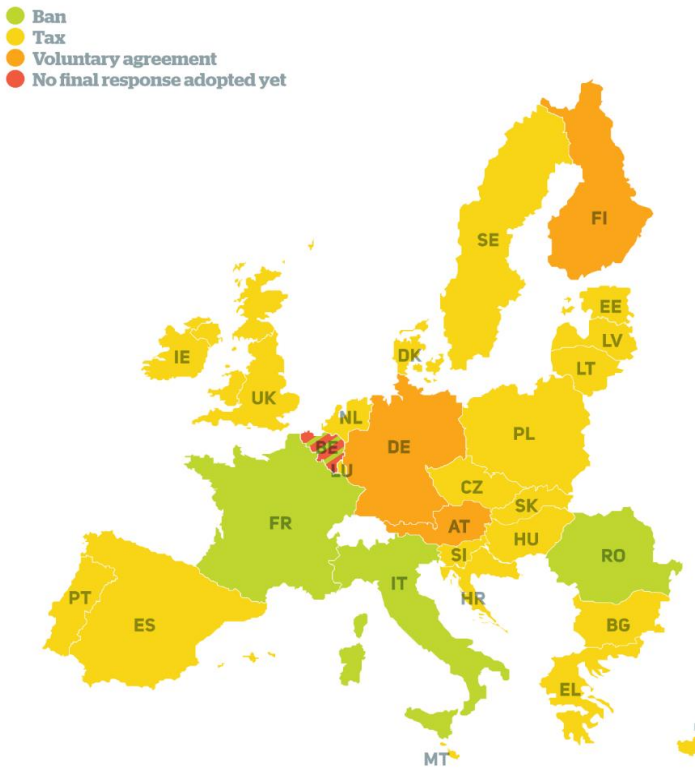


Figure 4. 7. Information on EU Member States legislations against lightweight plastic bags (between 15 and 50 microns) by 2018 (EEA, 2019)

4.2.8. Blue Growth Strategy

The European Union's long-term policy for supporting sustainable growth in the marine and maritime sectors as a whole is known as Blue Growth. The European seas and oceans are economic drivers with enormous potential for innovation and growth.

The blue economy aspires to boost the marine and maritime sectors' 5.4 million jobs and €500 billion in annual gross added value. The strategy also aims for environmentally sound and long-term growth.

The strategy consists of three components:

"1. Develop sectors with a high potential for sustainable jobs and growth, such as; aquaculture, coastal tourism, marine biotechnology, ocean energy and seabed mining.
2. Essential components to provide knowledge, legal certainty and security in the blue economy; marine knowledge to improve access to information about the sea; maritime spatial planning to ensure efficient and sustainable management of activities at sea and integrated maritime surveillance to give authorities a better picture of what is happening at sea.
3. Sea basin strategies to ensure tailor-made measures and to foster cooperation between countries" (EU, 2012).

Blue growth is an economic growth strategy, which takes the environmental dimension into account. Therefore, Marine Spatial Planning Directive (2014/89/EU) (MSPD), which is closely linked with the blue growth, obliges the member states to prepare their spatial plans in accordance with an ecosystem-based approach. The MSFD and its objectives are linked to each other with the MSPD

ecosystem-based approach, and establishing a good environmental status for marine litter is an objective of marine spatial plans.

Approximately 20% of marine litter is caused by marine and maritime activities. Blue growth strategy supports the solution of marine litter problem caused by these activities (such as maritime-related plastic waste, lost fishing gear and nets) through the European Maritime and Fisheries Fund (EMFM). The EMFM targets to support projects aiming to reduce the amount and harm of marine litter from sea-based sources, monitor and quantify the contribution of sea-based sources of marine litter and removal and recycling.

4.2.9. European Research and Innovation Framework Programmes

In addition to the legislative and implementation efforts, the European Union is also working on closing gaps in the scientific knowledge on marine litter and microplastics, supporting the innovative approaches for the circular economy, and financing projects on the solution of marine litter problem from source to the sea, through the European Research and Innovation Framework Programmes. The 2020 work programme under Horizon 2020 includes calls on circular economy solutions, plastic pollution monitoring, the analysis of pathways and the potential impacts on human health.

There are a number of ongoing EU funded projects on plastics, which aim to define the extend of environmental impacts of plastics, bring out innovative approaches for the collection and high-quality recycling, support the implementation of EU policies and legislation, and provide scientifically sound marine litter data and to evaluate the success of EU measures (EU, 2021).

4.2.10. Gaps in the EU legislation and implementation

EU legislation has improved dramatically since 2008 with regard to plastics and marine litter issues. Public interest in the subject was effective on policy and decision-makers to take actions against the problem. Plastics Strategy, SUP Directive, PRFD were adopted, and fitness check studies for freshwater legislation has stated the need for inclusion of marine litter provisions in freshwater legislation.

Currently, the Water Framework Directive (WFD) do not include measures to prevent marine litter. Mapping of marine litter and riverine litter is not an obligation in the Directive. Several Member States measure it voluntarily. JRC has completed the Riverine and Marine Floating Macro Litter Monitoring and Modelling of Environmental Loading (RIMMEL) project for the monitoring of floating riverine litter and establishing monitoring methodologies. At the EU level, there are no obligations set to prevent riverine litter, although approximately 80% of the marine litter is estimated to origin in rivers.

A fitness check for the WFD was completed in 2019, and the inclusion of riverine litter was suggested. Inclusion of provisions for litter to the Directive would be a very positive step through a more holistic approach. Measures in UWWTD will also be included with the ongoing fitness check.

The gaps in freshwater legislation reflect the necessity to move towards a more integrated way to tackle the marine litter problem. Litter is not only a marine problem. The rivers are the most important pathways for carrying the litter in macro and microforms to the oceans. There can be no solution without revealing the pathways.

DG ENV finalised two evaluations in 2020: the WFD fitness check and the evaluation of the UWWTD. The discussion on plastic/ micro-plastics, therefore, is necessary, as the WFD does not yet cover this issue. Similarly, the issue of micro-plastics is not reflected in the UWWDT, which might be reviewed due to the evaluation. It is challenging to remove micro-plastic material from the sludge, and a high percentage (50-60%) of sludge is used later in agriculture.

The MSFD was published in 2008, and the second cycle of the programme of measures was evaluated in 2020. The GES objectives of the Directive should have been met by the same year. However, the countries have neither provided sufficient monitoring information on each type of marine litter and only one threshold value has been defined. Therefore, there will be no GES assessment possible for marine litter in Europe. Unfortunately, we are unaware of how far the member states are to the GES thresholds for two reasons; no threshold values defined for a comparison, lack of monitoring data and standard monitoring methodologies. Member states are working on the establishment of GES thresholds at the TGML group. During the group's work, several sub-groups were established to study standard methodologies for monitoring and defining GES thresholds. The task is a hard one. The European Commission Decision (2017) requires a marine litter threshold below the limits of environmental harm for every type of litter. Beach litter is the most available type to start with, in which the data availability is high, and the standard monitoring methodology is at an advanced level. EU MSFD TGML only recently set a threshold value for beach litter (20 items per 100 meters coastal strip). It is not hard to imagine how challenging the task will be for microplastics.

The SUP Directive measures were built on beach litter monitoring data. Thanks to the availability of long-time beach litter surveys, it was possible to establish proper measures for the most found SUPs. Some of the policies and actions can only be built on information for status and trends. Moreover, information on sources and

pathways can also be crucial to the solution. Therefore, MSFD monitoring should be regular, and threshold values must be defined for GES marine litter.

Finally, all efforts to include marine litter in all related compartments of the EU environmental legislation is the right approach. There is a need for integration. However, this effort is so broad and takes too much time. Implementation will take more time, and each provision in a legislative text comes with a monitoring obligation for the member states, which does not always end up with a successful outcome. Member states do not monitor or do not provide quality information even they were obliged by the Directives. More provisions and more rules do not necessarily guarantee the solution.

EU supports the policy, capacity building and scientific research projects under several different funds. However, the projects overlap in some cases as they are operating under different funding mechanisms.

EU is not a homogeneous body. The socio-economic structure of the countries vary a lot, and the level of awareness differs too. Environmental priorities are not always on the top for southern or eastern Member States, especially those not directly linked with human health. The most successfully implemented EU environmental legislation is usually the ones, which directly interrelated with human health as Urban Waste Water Treatment Plants Directive (91/272/EEC), Drinking Water Directive (98/83/EC) or Bathing Water Quality Directive (2006/7/EC). The lack of reliable scientific evidence on the effects of plastics on human health causes actions to take place so slowly. The lack of reliable and well-distributed monitoring data cannot provide sufficient flows for knowledge-based marine litter assessments.

There is a lack of data on the social and economic effects of marine litter. The EU legislation should at least allow collecting the financial costs of mismanaged

plastics and cleaning up marine litter. EU projects and research programmes should be implemented to support the information base in this field.

4.2.11. Recommendations for EU legislation and Policy Measures

The EU marine litter monitoring efforts and legislation related to marine litter and plastics pollution from source to sea were analysed in Sections 4.1 and 4.2. Some gaps and needs were defined to improve the legislation and actions, which were listed below.

Recommendation 1: Enable the integrated and holistic policy and legislation cover to prevent marine litter

The EU acquis acknowledged the marine litter problem in 2008 by the EU MSFD. Since then, several strategies, action plans and legislation were published and amended, mainly aiming at a circular economy, which was described in detail in Chapter 4.

There is an increasing trend in the legislative field to reach an integrated structure for cross-cutting issues on waste and litter. With acknowledging the marine litter problem, numerous EU policies came into force, targeting and addressing marine issues directly. With the publishing of the MSFD, which addresses marine litter as one of the descriptors of "good environmental status" in the European seas, and the Circular Economy Action Plan, which aims to "*close the loop"* and requires *"the change and integration of EU legislation through a material-efficient economy"*, and its Plastics Strategy, which will help the plastics economy to transform into a clean, circular and resource efficient economy and minimise land and sea based plastic leaks, and amendment of Waste Framework Directive, Waste Package amending several waste directives in line with the Circular economy and Plastic Strategy objectives, and the restrictive measures on single-use plastic items brought

by the recent SUP Directive, Plastic Carrier Bags Directive aiming *"to minimise the adverse environmental effects of plastic bags and their contribution to littering"*, the proposed REACH Regulation amendment bringing restrictions and bans for microplastics, and recently adopted marine litter collection measures within the Port Reception Facilities Directive; the EU now have well-defined strategies and legislative tools that aim for more cross-cutting integration to tackle marine litter problem, and precise production, recycling, reduction and collection targets for plastics. This positive approach should be continued and improved. Waste legislation and management should be improved to be able to prevent leakages before and from waste landfills.

Although remarkable steps were taken in recent years, legislative integration efforts are still in very early stages, and there are still significant gaps, especially for the freshwater legislation concerning marine litter. There are no provisions for achieving "good status" and monitoring marine litter in WFD. Besides, UWWTD does not carry out any measures regarding the microplastics accumulating in the sewage sludge or filtering the plastics to prevent them from reaching rivers and the seas. The problem of litter cannot be solved by only regulating the sea and beaches. The EU acquis is missing one of three main pillars for the solution; freshwater legislation must include active measures and clear targets for a complete and holistic structure.

Besides integration needs, the legislation must allow a complementary monitoring framework from source to sea, which will enable a robust assessment of the leakages of plastics and a description of their pathways.

Recommendation 2: Increase monitoring efficiency for all types of marine litter, its health effects and enable decoupling with the waste data

Although EU TGML is working effectively on methodological issues, data collection methodologies for marine litter (e.g. beach, floating, seabed litter) on macro and micro levels have not been harmonised yet. Besides, marine litter data and waste data are not easily comparable and are challenging to use together in assessments for building cause and effect relationships.

Assessing and monitoring beach macro litter is most developed among all marine litter types, partly harmonised but well-represented in all EU regional seas in terms of aggregation, linkage, spatial and temporal coverage, interpretation, and data availability.

While EU acquis is moving towards a more integrated structure for solutions, monitoring efforts should also follow for good policy feedbacks. Harmonised monitoring methodology and monitoring efforts should be improved to assess the abundance and effects of marine litter. Besides, waste indicators should enable coupling with the marine litter indicators to monitor the problem from the source to the sink. An excellent example of coupling can be on the beach litter indicator. The indicator is based on the number of items per 100 m beach strip. However, waste data is usually defined by kilograms or tonnes. The methodology difference does not allow a good description of comparing plastic waste leakages and their accumulation at the beaches. Although the classification of litter items according to their material types helps define policies on SUPs and fishery-related items, there is still a need to include the weight of collected waste in monitoring surveys to provide coupling with the waste indicators at the source.

There is a lack of data for freshwater environments. The methodological developments in the riverine litter are at the early stages. Rivers are crucial for understanding the relationship between the source and the sink of marine litter. A particular focus must be attributed to the development of riverine litter methodology and monitoring.

There are no existing monitoring requirements for the waste water treatment plants (WWTP) to monitor plastic waste in the discharge water. This gap is a major one in calculating microplastics flows to the rivers and the seas.

Recommendation 3: Address feasible and more robust substitution and ban strategies for macro, micro and nanoplastics

The SUP Directive brought limitations, bans and producer responsibility schemes for the single-use plastic items. The amendment of the REACH Regulation requires bans and limitations on certain products, including microplastics. PCB Directive helps to the minimisation. All mentioned legislation is positive but insufficient. For decades, scientists and environmental experts warn politicians and citizens about the urgent need for strict measures in every ecological field. The policy and implementation measures are far behind the required level of actions to keep our planet and its inhabitants safe. This situation is relevant to also plastics problem. The substitution and bans brought by the SUP Directive and the REACH Regulation are limited to a few numbers of items and substances and can only be referred to as "a good beginning" for an extended list of macro and microplastics.

For nano-plastics, the situation is worse. Environmental and Health Risks of Microplastic Pollution Scientific Opinion of the Commission Group of Chief Scientific Advisors states, "*Despite the fact that the field of microplastics research is relatively new, it is worrying that more detailed insights are not emerging quicker on even the presence and fate of submicron-sized plastic particles (i.e. nano plastics), let alone on their potential health and ecological impacts*" The Opinion also states that "toxicity is expected to increase with decreasing plastic particle size" (EU, 2019).

Recommendation 4: Focus on social and economic impacts for solutions

European policymakers and the public needs information on the social and economic costs of marine litter. However, the current studies provide a limited information base to describe these costs. There are only a few estimations on the clean-up costs of plastic from the oceans and the beaches. Policymakers, plastic producers and the public will act on evidence-based side effects of the plastics economy, and thus policy actions will follow swiftly. European institutions and the Member States should invest in calculating the costs generated by the mismanagement of waste and its harm to ecosystem services and human wellbeing. A positive step through a circular economy can be achieved by revealing the facts on plastic pollution economically and describing how the mismanagement costs more than it brings to our economies. This description can help to convince the policymakers and the companies to shift through more sustainable and profitable solutions, which will also allow sustainable transitions to the plastics economy.

Recommendation 5: Promote global cooperation, high-quality scientific exchange and policy coherence

Marine litter is a transboundary problem. Ocean currents and the wind carries litter far distances from where it was originated. The problem can be solved by the participation of all the world states. An international binding agreement and action must be in effect. EU is a lead actor in the environmental field and should play a leading role in establishing a marine litter agreement at the UN. Besides, international scientific standards, monitoring methodologies need to be developed urgently to define the status, impacts, sources and pathways of marine litter.

CHAPTER 5

MARINE LITTER STATUS AND LEGISLATION IN TURKEY

5.1. Marine Litter Monitoring in Turkey

Turkey's coastal waters were geographically described, three main parameters (salinity, depth and seafloor morphology) were evaluated, and coastal typologies were defined according to the hierarchical classification of these parameters with the Marine and Coastal Waters Quality Determination and Classification (DeKos Project, 2014). Twenty-six coastal water types and 75 water bodies were defined for Turkish coastal waters due to the project.

The project analysed Turkish national monitoring efforts in coastal waters by examining spatial coverage of monitoring activities and assessing the monitored parameters/indicators from the MSFD and the WFD monitoring requirements.

Although the number of monitoring stations varies from year to year, an overall of 223 monitoring stations (most recent stations) were taken into consideration in the study's scope. Among these stations, 173 stations were used to monitor 15 coastal water types, and 175 stations are used to monitor 57 coastal water bodies, differing in spatial densities among types and water bodies.

The number of monitoring stations in Turkey increased to 330 (for water column monitoring). However, microplastics monitoring is being executed at pilot monitoring stations only, and four beach litter monitoring points were selected to be monitored after 2017.

National spatial sea pollution monitoring coverage is low in Turkey. Turkey monitors only 50% (13/26) of its coastal water types defined, and 76% (57/75) of coastal water bodies are monitored annually. The DeKos Project proposed many statements and recommendations for the improvement of coastal monitoring activities in Turkey:

• Monitoring frequency: Some parameters need higher frequencies for sampling and measurements to obtain the best available information about the "state" of the marine and coastal environments.
• Data quality: Monitoring activities are performed by various institutions (because of bidding by central government), sometimes resulting in differing data acquisition techniques.
• Monitoring capacity: There is still a considerable gap in baseline data. Innovative techniques are needed to monitor such a large and varying system. The most updated catalogue of monitoring networks, the analysis showed that Turkey should reorganise its monitoring activities (spatial, temporal and parameter-based) for WFD, MSFD and other related EU directives, in addition to RSC requirements (Kaboğlu, 2013).

The Ministry of Environment and Urbanisation implements an "*Integrated Monitoring Programme for Seas*" (DenİZ) in the Turkish seas since 2014. The DenİZ programme intends to monitor the quality and pollution of coastal and marine areas and establish a base for the marine protection policy and strategies. New parameters are added to the programme in line with the European Union MSFD and Turkey's priorities. While only microplastics were monitored between 2014-2017, beach litter was also added to the monitoring parameters for 2017-2019.

As pointed out by the DeKos project, different time-frequency and geographical diversification of monitoring are necessary for each waterbody type. Current

monitoring efforts in Turkey are limited to the available resources. Moreover, micro litter is being monitored in only seven stations, and beach litter in four stations. For the Mediterranean Sea, there are only three stations in Mersin, in which micro litter is being monitored. According to Prof. Dr Ahmet Kıdeyş, three stations for Mersin is the minimum standard for monitoring work. The cost of monitoring work was a minimum of about 40.000 Turkish Liras for microlitter (once in one year, twice the following year) in 2019, and 5000 Turkish Liras for beach litter (for four stations) (A. Kıdeyş, personal communication, April 11, 2020).

It is evident that marine litter monitoring efforts are in the early stages in Turkey at the moment, and they must be improved. There are four parameters officially being monitored; microplastics in sea surface, water column and sediments; seafloor litter, litter in marine biota (fish), and recently beach litter.

If we divide 40.000 TL spent in Mersin to two (as it was for 2 years) and estimate seafloor litter surveys at the same level of cost (20.000 TL annual) and add 5.000 TL for both beach litter surveys (for two months in a year) and microplastics in fishes, annual monitoring costs for three parameters would be 50.000 TL for Mersin. Therefore, a rough estimate for yearly monitoring of microplastics, seafloor and beach litter, with the minimum requirements, would be approximately more than 1.3 million Turkish Liras per year (8483 km total coastal length of Turkey/320 km Mersin coastal length=26.5 times 50.000 TL monitoring costs for the beach, fishes, seafloor and microplastics monitoring costs per year 30 coastal provinces). This amount would increase dramatically if the monitoring was designed according to water body classifications, expanded to all litter types and implemented for all Turkish provinces to include rivers and lakes.

A detailed study should be made to define better the costs of necessary marine litter monitoring in Turkey since many factors influence the cost of monitoring. "*Cost of*

human resources, laboratory analyses, equipment and shipping, are a few examples. Fundamental ways to reduce monitoring cost are related to technical/methodological developments, joint monitoring and other opportunities to reduce costs, refining monitoring programmes and the use of volunteers" (JRC, 2013). Besides, "The Marine Litter Indicators Scoping Study" and "A proposal for monitoring based holistic assessment methodology for marine litter, which will be presented in Chapter 6, can be used to monitor and build assessments for the marine litter cost-effectively. Currently, marine litter monitoring is dominated by a lack of sufficient time series, frequency and coverage in Turkey. The holistic assessment methodology proposed by this thesis allows producing more knowledge on marine litter, derived from what is available, via compiling all marine litter related data and information from source to sea. Therefore, policymakers and decision-makers can effectively use the assessment methodology to close the monitoring gap on marine litter data and information, allowing them to interpret better marine litter status and problem at the land, pathways and the sea domains.

5.2. The Status and Impacts of Marine Litter in Turkish Seas and Beaches

5.2.1. The Mediterranean Sea

DenİZ micro litter surveys were performed in 3 stations in Mersin Bay. The findings indicate that the microplastic levels are moderate, according to baseline average values (200000-500000 items) for sea surface microliter proposed by UNEP MAP.

While sea surface (floating) and water column values were higher at Seyhan (SEYSW3), river mouth and Mersin city centre (MERSWR), the highest values for sediments were observed at Taşucu station (TASSW1) due to lack of currents at this location.

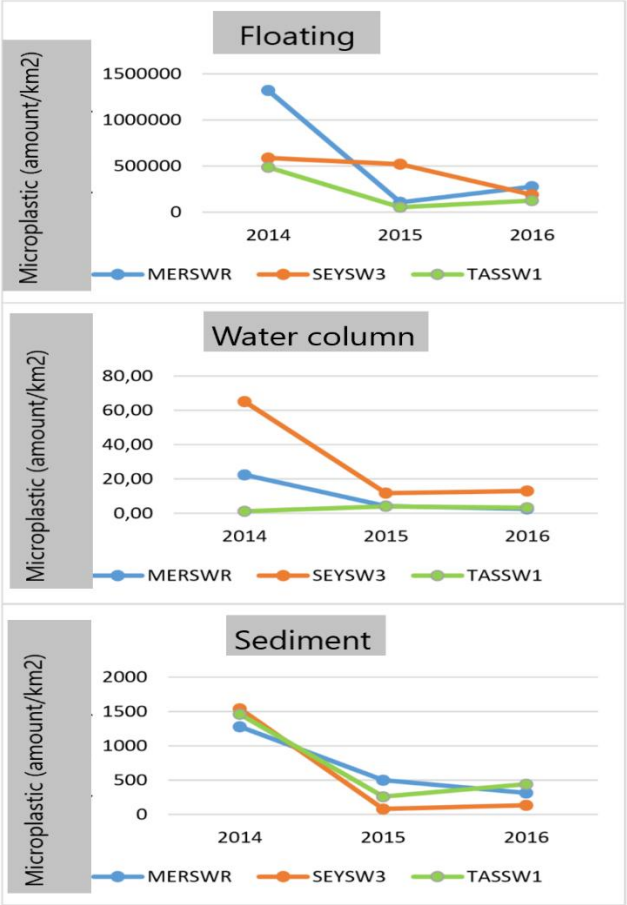


Figure 5. 1. Detected microplastic amounts in the Mediterranean Sea Between 2014-2017 (ÇŞB, 2017a)

The surveys showed that 53% of the fish samples (92 out of 175) carried microplastics in their digestive systems. The results reflected a similarity with an Eastern Mediterranean study in 2015 with the findings that 58% of the fish (out of 1337 individuals) contained microplastics (Guven at all, 2015).

Approximately 55% of the Seafloor macro litter were plastics, whereas 6.10 kg/ m^2 plastics were found in the monitoring studies.

In a research, the majority of litter in the 13 beaches were plastic. Plastic articles make up more than 73% of all trash articles on 11 of the tested beaches. A total of 17,024 items from 13 beaches have been gathered. The average density was 0.92 ±

0.36 items per square meter. According to the Clean Coast Index, the average weight was 7,43 ± 2,68 g/m2 (Alkalay et al. 2007). Three of the beaches were sampled either clean or very clean, two moderate and eight dirty. Food and smoking littered products were almost one half of the total litter collected while, in total, agricultural, industrial and fishing sectors accounted for just 6% of the total number of products (Aydın et al., 2016).

5.2.2. The Aegean Sea

DenİZ microplastic surveys were performed at two stations in the Aegean Sea. The results are given in Table 5.1.

Table 5. 1. The Aegean Sea Microplastic Levels 2015-2016 (ÇŞB, 2017b)

Station	Replica	Sea surface km2		Sea surface m3		Water column m3		Sediment L	
		2016	2015	2016	2015	2016	2015	2016	2015
ALİSW1	R1	1001992	682006	5,01	3,41	19,02	67,26	360	1900
	R2	1637400	-	8,19	-	9,85	-	380	-
	R3	458600	-	2,29	-	16,30	-	740	-
İZMSW3	R1	600000	510014	3,00	2,55	18,34	33,12	1360	3060

The surveys found that 60% of the fish samples (162 out of 269) carried microplastics in their digestive systems.

Share of plastic material varies from 94% (less than 50 m) to 44% (50-99 m) and finally to 9% (100-199 m) in bottom trawls in Edremit Bay. The amount of total marine litter varies from 50 kg/m^2 (less than 50 m) to surprisingly 7 kg/m^2 (50-99 m) and finally to 76 kg/m^2 (100-199 m). Plastics share is much less in Saros Bay in first 50 m with 7%, due to dominant share of military ammunition trawled (World War I remains). The amount of total marine litter varies from 138 kg/m^2 (50-99 m) to again, surprisingly, 1 kg/m^2 (100-199 m) and finally to 128 kg/m^2 (200-299 m).

5.2.3. The Black Sea

DenİZ microplastic surveys were performed at two stations in the Aegean Sea. The results are given in Table 4.2. More amount of sea surface and water column microplastics were found at the TRK46 station, close to a river mouth.

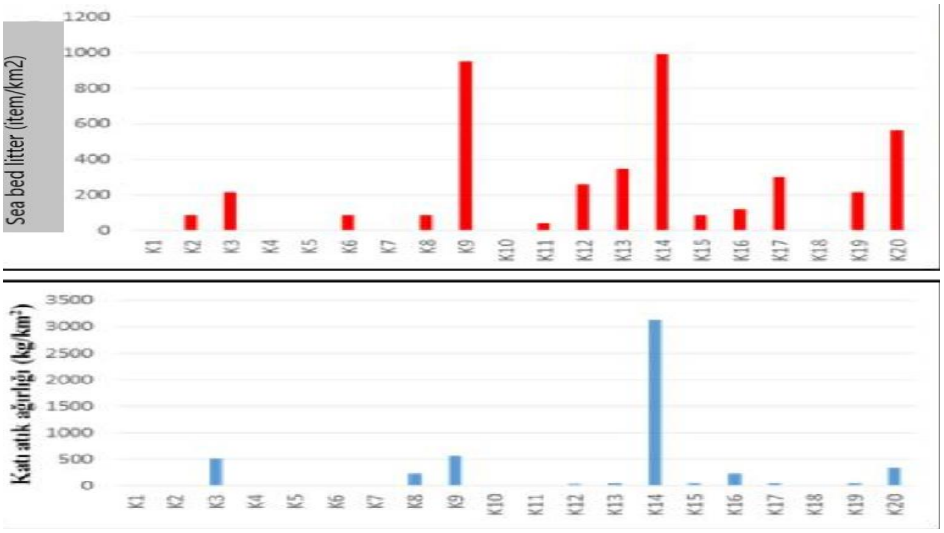
Table 5. 2. The Black Sea Microplastic Levels 2015-2016 (CŞB, 2017c)

Station	Replica	Sea Surface km2		Sea Surface m3		Water column m3		Sediment L	
		2016	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**
TRK46	R1	4008065	942857	20,04	4,71	19,86	91,88	920	2000
	R2	844262	-	4,22	-	10,69	-	1580	-
	R3	998390	-	4,99	-	7,81	-	1300	-
TRK53	R1	1378357	2306000	6,89	12,23	9,631	-	2780	1780
	R2	482315	-	2,41	-	9,723	-	3940	-
	R3	599042	-	3,00	-	4,722	-	1240	-

The surveys showed that 66% of the fish samples (174 out of 263) carried microplastics in their digestive systems.

Trawling was performed in 20 stations in an extensive geographical coverage (west and Mid-black Sea region). While 70% of the items trawled were plastics, they constitute 84% of the total waste weight.

Table 5. 3. The Black Sea seabed macro litter surveys 2015-2016 (ÇŞB, 2017c)



In a study covering ten beaches of the Turkish Western Black Sea coast, *"beach litter abundance was collected from 20 m long transects during four different seasons. Therefore, litter density varied from 0.085 to 5.058 items m^2. The beach litter items were mainly composed of unidentifiable small size (2–7 cm) plastic pieces and beverage-related litter such as bottles and bottle caps. About half of the labelled litter was of foreign origin, including 25 different countries, 23% of which are in the Black Sea region"* (Topçu et al., 2012).

5.2.4. The Marmara Sea

DenİZ microplastic surveys were performed at three stations in the Marmara Sea. The results are given in Table 5.4.

Table 5. 4. The Marmara Sea Microplastic Levels 2015-2016 (CBS, 2017d)

Station	Sea surface km2		Sea surface m3		Water column m3		Sediment L	
	2016	2015	2016	2015	2016	2015	2016	2015
İZ30	418788	413242	0,94	1,78	17,05	44,84	243	500
İZ17	381060	-	0,92	-	8,62	-	187	-
MD24	407470	352381	0,90	2,17	5,88	-	94	940

Trawling was performed in 18 stations in a comprehensive geographical coverage (west and Mid-black Sea region). While 75% of the items trawled were plastics, they constitute 35% of the total waste in weight. The stations showed the highest amount of seabed litter were high-density population areas, which also had a low level of biodiversity due to increased human pressure.

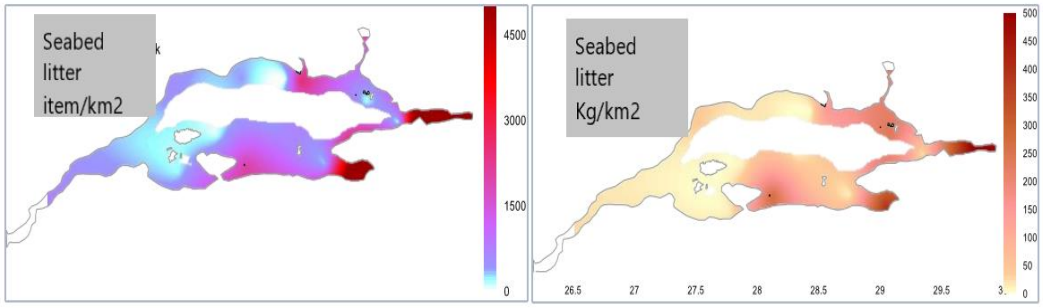


Figure 5. 2. Marmara Sea Seabed Macro Litter Distribution 2015-2016 (ÇŞB, 2017d)

There was no information in the scope of the Denİz monitoring programme regarding the plastics found in biota for the Marmara Sea

5.2.5. Conclusion on the status of marine litter in Turkey

Turkey started an official monitoring programme for its seas in 2014. Before this date, only available marine litter information was based on several scientific research studies and in pilot areas. Beach litter was included in the monitoring programme in 2017. There are only a few stations for the monitoring, and therefore

the geographical coverage is low, and there is still no comprehensive information on the status of marine litter. There is almost no information on the pathways and sources.

However, it is possible to state as a conclusion based on the available data and information that the Turkish seas are not clean, and all types of litter in macro and microforms exist from the seafloor to the deeps seas. Available information also reflects that Turkish beaches in the surveys areas were not clean. Similar to Europe's marine litter status assessment, monitoring efforts on marine biota and ecosystems reflect that macro and microplastics exist in marine biota. It is not possible to make statements on trends; therefore, there is not sufficient monitoring time series and data coverage yet.

Key conclusions in particular:

- There is undoubtedly a need for beach litter surveys to monitor the abundance of plastic items and single-use plastics. SUPs are a significant threat to the marine environment and beaches. Litter was abundant in the case study for the Caspian beaches.
- According to surveys performed at the river mouths, Turkish rivers play an essential role in transporting all sorts of litter items from the terrestrial to the marine environment.
- Litter is abundant on beaches in the Turkish Seas. Plastic fragments, fishing-related litter and packaging are the most common types of litter found. Plastics comprise over 80% of items.
- Litter is widespread on the seafloor across the areas assessed, with plastic being the predominant material.
- There is no monitoring and information to generate a broad picture of amounts of macro and micro litter in the rivers.

- There are data and assessment gaps on the sea bed, sea column, microplastics, and effects on biota in Turkey. However, ingestion of plastic is widespread by fish species in the Turkish seas. Levels of microplastic ingestion by fishes in Turkey is around 53-66%.
- Effects on marine species are not well known, and there is no sufficient scientific source found.
- There is not sufficient information found on the marine litter in the seabed sediments and entanglement to present in this survey
- Harmonised monitoring methodology and monitoring efforts should be improved in order to have better assessments of the abundance and effects of marine litter.

5.3. Turkish Marine Litter Legislation

Turkey is not a party to the London Convention, Watercourses Convention, London Protocol and UNCLOS, and a contracting party to MARPOL, BASEL Convention and Biological Diversity Convention.

By geographical scope, Turkey is located both in the Mediterranean and the Black Sea basins and a party to Bucharest and Barcelona Conventions. Regional sea conventions establish a vital basis to cooperate on environmental problems related to marine ecosystems. Besides, Turkey is a candidate country to the EU and Turkish waste management legislation is at a good level of harmonisation with the EU acquis.

One of the main pillars of Turkey's Environment Law no 2872 is the "polluter pays" principle. Turkish waste management and marine protection legislation take their basis from the Environment Law. Turkey has enforced several amendments on the Environment Law and enforced By-laws, particularly to harmonise with the EU legislation and implementation since its candidate status was approved in 1999.

In 2019 Turkey's EU Progress Report, European Commission describes the progress in the alignment and implementation with the waste acquis as; "*Turkey has recently adopted a strategy promoting a zero-waste management approach, efficient use of natural resources, landfilling reduction and increased recycling and reuse. Legislation introducing a ban on the free distribution of lightweight plastic bags came into force in January 2019. Alignment and capacity for sorting, recycling and medical waste treatment have increased. Significant efforts are necessary to implement waste management plans at the local and regional levels. Economic instruments to promote recycling and the prevention of waste generation are improving, but remain limited*" (EU, 2019e).

The EU harmonisation level in waste management legislation is good, but the implementation is far behind the EU average. The share of plastic waste in total waste in Turkey is 7.86%, and 30% of the packaging waste is plastics (ÇŞB, 2016). Thirty-two million tonnes of municipal waste was collected, and 67.2% of this amount was stored in controlled landfill sites, and only 12.3% were sent to waste recovery facilities in 2018. Moreover, 20% of the total municipal waste was transferred to municipal dumping sites (TURKSTAT, 2019) (unsanitary disposal). This figure was 30% in 2014. It is promising to see an improvement of 10% in landfilling diverted to controlled facilities just in four years. Nevertheless, Turkey still needs to complete a fundamental goal to store municipal waste in controlled waste facilities to prevent leakage of the collected amount. Otherwise, there is still a severe risk of leakage.

Municipal waste indicators, 2016, 2018

	2016	2018
Total number of municipalities	1 397	1 399
Number of municipalities providing waste services	1 390	1 395
Rate of municipal population served by waste services in total municipal population (%)	98.6	98.8
Amount of waste collected (Thousand tonnes)	31 584	32 209
Average amount of waste per capita (Kg/capita-day)	1.17	1.16
Rate of collected waste according to disposal and recovery methods (%)		
Delivery to controlled landfill sites	61.2	67.2
Delivery to municipal dumping sites	28.8	20.2
Delivery to recovery facilities	9.8	12.3
Other disposal methods(1)	0.2	0.2

Figures in table may not add up totals due to rounding.

(1) Data refers to disposals by burning in an open area, dumping into river/onto land and burying.

Figure 5. 3. Turkey's Municipal waste storage in 2018 (TURKSTAT, 2019)

Besides site-specific scientific studies and macro litter clean-up efforts of NGOs and municipalities, acknowledging the marine litter problem is still in the early stages in Turkey. There was not any legislative measure specific to litter until 2019. By 2019, a circular on marine litter was published by the Ministry of Environment and Urbanisation (MoEU/ÇŞB), which obliges marine litter action plans in provinces.

Turkish marine litter legislation was presented with an order of importance and relevance below.

5.3.1. Environment Law

The Environment Law (Law No: 2872), which was ratified on 09 August 1983 and entered into force on 11 August 1983 (Official Gazette Number: 18132), is the foundation for environmental protection legislation in Turkey. The Environment Law was amended in 2006, and the objective of the Law was defined as *"to ensure that the environment, which is the common asset of all living things, is protected in line with the principles of sustainable environment and sustainable development"*.

The Law constitutes general provisions on each subtopic of environment and waste, freshwater and marine protection. General provisions of the Law enables the enforcement of by-laws and circulars in Turkey, describing the implementation of the Law in detail.

The Environment Law defines environmental pollution as *"All sorts of negative impacts that occur in the environment that may disrupt the health, environmental values and ecological balance of living things"*. The basic principles for the Law are "sustainable use and protection of natural resources" and "polluter pays" principles. Therefore, the Law includes provisions regarding fees for environmental pollution and damage.

Article 8, "Pollution prohibition" of the Environment Law, forbids to release of any type of waste to the environment in a way that can damage the environment. Article 8 describes the pollution hierarchy as; prevention of pollution, and if pollution cannot be prevented, polluters are made responsible for taking necessary measures to minimise the effects. While Article 9 "Protection of the environment" Paragraph "h" aims to protect the marine, surface and ground waters against pollution, Article 11, "Acquiring permit, treatment and elimination obligation" defines the standards for solid waste management and wastewater treatment to prevent land-based and sea-based pollution. Article 12, which is crucial for implementing pollution prevention measures, provides the inspection responsibility to the related governmental authorities. Besides, Article 20/3 defines the fines paid by the sea vehicles for the sea pollution they may create. Therefore, the Environment Law defines a full spectrum of measures from prevention to minimisation, elimination and finally, the inspection of the pollution and the punishment of the polluter, which constitutes a well-established legal basis for the prevention, minimisation and elimination of plastic pollution and marine litter.

With the amendment of the Environment Law on 10 December 2018, recycling contribution fee obligations were brought for producers, importers, and consumers of products (tires, plastic packages, batteries, etc.).

5.3.2. The Law Pertaining to Principles of Emergency Response and Compensation for Damages in Pollution of Marine Environment by Oil and Other Harmful Substances

The Law Pertaining to Principles of Emergency Response and Compensation for Damages in Pollution of Marine Environment by Oil and Other Harmful Substances (Law No: 5312), which was ratified on 03 March 2005 and entered into force on 11 March 2005 (Official Gazette Number: 25752), is prepared in accordance with the MARPOL 73/78, and it aims to assure marine safety and prevent marine pollution. The Law establishes the rules to be implemented by the liable parties of the ships of 500 gross tons or bigger, carrying petroleum or other harmful substances. It sets out the principles concerning "response and preparedness for eliminating the risk of pollution, reducing, containing, or eliminating pollution in emergency incidences stemming from ships or operations of coastal facilities, and the principles for determining and compensating for damages resulting from an incident".

"Pollution" was defined as *"mixing of petroleum or other noxious substances with the marine environment, as a result of an incident, in a way that might cause harm to living resources and marine life, constitute a hazard to human health, hinder maritime activities including fishing and other legal utilisation of the seas, change the quality of seawater, and disturb ecological balance".* Separate collection of the plastic waste in ships and punishment of dumping of the plastics to the sea is also subject to the Law implementation. Therefore, the definition of "pollution" clearly allows to forbid and punish any littering activity.

Besides, MARPOL Annex V (regulation for preventing pollution by garbage from ships) was amended and entered into force on 1 March 2018. The amendments include criteria for determining whether cargo residues are harmful to the marine environment and a new Garbage Record. MARPOL Convention requires the separate collection of plastic waste in the ships.

5.3.3. By-Law on Collection and Control of Ship Generated Waste

The By-Law was enforced on 26 December 2004 (Official Gazette no: 25682) and was amended two times in 2010 and 2017 to regulate ship-based pollution and better alignment with the MARPOL 73/78 Convention and the EU Port Reception Facilities Directive. It covers all sorts and sizes of ships. Ships are obliged to collect waste separately and deliver it to waste reception ships or port reception facilities.

Damping of all types of waste originated from ships are regulated with this legislation, and fees are foreseen for the ships discharging their waste to the marine environment. By-law also describes the process and conditions for port reception facilities and waste management plans to be prepared by the ships.

The Circular on the Maritime Waste Application, which was prepared in line with the By-law on Collection and Control of Ship Generated Waste, regulates the procedures and principles regarding the Maritime Waste Application, which includes the notification methods to be applied regarding the wastes and cargo residues arising from the normal activities of the ships in the maritime jurisdictions of Turkey, and the Ship Waste Tracking System and the Blue Card System that the waste buyers should use during the management of the wastes.

5.3.4. By-Law on Control of Water Pollution

The By-Law was enforced on 31 December 2004 (Official Gazette no: 25687) and aimed to protect the surface and underground waters of Turkey. Article 23-b(6) prohibits ships from releasing their waste into the marine environment. The ships are obliged to deliver all sorts of waste to licenced waste collection ships or waste collection facilities.

5.3.5. By-Law on Monitoring of Surface Waters

The By-Law was entered into force on 30 November 2012 (Official Gazette no: 28483), and it was revised in 2015 to better comply with the EU WFD requirements. Its scope is coastal, transitional and inland surface waters and ground waters. The objective of the By-Law is the definition, classification, monitoring of the water quality and quantity, and sustainable use of water resources, and implementing management measures for achieving "good status" of waters.

Monitoring of marine litter is not in the scope of the By-Law. The MoEU performs marine litter monitoring efforts in Turkey at the coastal areas since 2011.

Monitoring of transitional, coastal and sea waters was started in the 1980s in Turkey to comply with the requirements of Barcelona and Bucharest regional sea conventions, and later on, strengthened (after Turkey's EU candidateship) to harmonise with the EU MSFD monitoring requirements.

5.3.6. Circular on the Preparation and Implementation of Provincial Marine Litter Action Plans

A Marine Litter Circular was published on 10 June 2019 by the MoEU to combat marine litter. The Circular is prepared in parallel with Barcelona Convention,

Bucharest Convention, Basel Convention and MARPOL 73/78 provisions and Environment Law, By-law on General Principles of Waste Management and By-Law on Collection and Control of Ship Generated Waste.

A variety of initiatives have been planned in collaboration with the institutions and organisations involved at regional and national levels to prevent marine litter successfully. The action plan included preventing marine litter from being created at the source, taking specific measures for the location, executing coordinated and planned work to dispose of existing marine litter, and distributing national training and awareness-raising efforts.

With the Circular enactment, the responsibility of preparation and implementation of the Marine Litter Provincial Action Plans was given to the governors of the 28 coastal provinces. It was planned to implement sea litter provincial action plans under governors' responsibility in all provinces located on the coast.

The five-year marine litter action plans for 28 coastal provinces will be prepared under the coordination of provincial directorates, will be approved by the Local Environmental Boards, and the Ministry with annual reports will follow the studies. In case of failure in the action plans, the compensatory actions will be planned and carried out under the governors' responsibility.

The action plans must include the description of the marine litter problem and its sources in the provinces (land-based and sea-based sources), preparation of risk maps (which take wind, flow and sources into account), preventive actions on pathways of litter and actions on macro litter cleaning (beaches and sea bed), and finally the activities to increase public awareness.

Marine litter Circular is a positive step through recognising, definition and decreasing the litter problem in Turkey. Action plans will help coastal provinces

and the public acknowledge the marine litter problem as a priority, oblige the government and local administrations to provide information on the sources, pathways and sinks of litter and establish actions to minimise the litter. As the acknowledgement of the problem is in the early stages in Turkey, the current simple structure of the action plans make them achievable. Once the provinces complete them, they will serve as a suitable piece for holistic marine litter picture information and establish essential solutions. Besides, marine litter action plans required with the Circular are insufficient to provide a systematic and advanced level of knowledge and actions. The required information lacks a comprehensive and harmonised methodology for collecting data, the definition of sources and pathways, preventive measures, and finally, completing the coastal provinces marine litter puzzle. As every province will have a different approach and methodology due to technical inequalities, each piece of the puzzle will be separate, and it will not be possible to build them together to establish a holistic picture of marine litter in Turkey.

5.3.7. National Action Plan for Waste Management

National Action Plan for Waste Management, aiming to move towards a circular economy, was prepared in 2016, covering 2016-2023. The plan was prepared following waste hierarchy principles. Waste prevention, reuse, recycling, recovery and disposal were considered as priorities. The polluter pays principle was highlighted regarding the financing responsibilities. Above all, it sets specific and measurable targets for waste management. Implementation of the Waste Management Strategy and Action plan will pave the way through a circular economy and minimise the plastic pollution at the source.

Illegal dumps aimed to be gradually rehabilitated according to the Plan. Turkey needs to collect the whole percentage of municipal waste and landfills in controlled landfill areas to prevent leakages to the environment.

Five million tonnes of packaging waste was produced in Turkey in 2015, and 26 % of this amount was recycled. Until 2023, the recycling rate is aimed to be raised to 35 % and the collection of 100 % of the packaging waste at its origin. The current rate for the separate collection of packaging waste, including plastics, at its origin, is 5 %, and it is aimed to raise this figure to 12 % in 2023. The recovery rate for plastics were 54 % in 2014. The specific target is to achieve a recovery rate of 60 % for plastics (ÇŞB, 2016).

The target for the household waste recovery share is 23 %. (the figure was 6 % in 2014) The action plan sets a target to decrease disposal rates from 88.7 % to 65 %.

The national action plan defines the investment requirements and responsibilities to reach 2023 waste management targets. Increase of environment tax share for the municipalities, government support to municipality waste management investments and establishment of extended producer responsibility schemes were broadly described. With the amendment of Environment Law no. 2872 on 10 December 2018, recycling contribution fee obligations were brought for producers, importers, and consumers of products (tires, plastic packages, batteries, etc.). The MoEU will describe the rates for the recycling contribution fees with a By-law. A Draft By-law was prepared in 2019.

5.3.8. By-law on Zero Waste

On July 12, 2019, the Zero Waste Bylaw was published (Official Gazette No: 30829). It outlines the steps for establishing a zero-waste management system in various businesses and industrial facilities, primarily industrial zones, airports, educational and healthcare institutions, shopping malls and supermarkets, hotels, local governments, and public organisations.

The objective of the By-law is to create and build a zero-waste certificate and management system that adheres to the concepts of circular and effective waste management. It establishes the principles and processes for the formation of a "zero waste management system" and the issuance of a "zero waste certificate" for sites where the construction of a zero-waste management system is required and for those who choose to do so voluntarily (Yıldız, 2019).

Two districts were selected as pilot areas for Zero Waste implementation (Kızılcahamam, Ankara and Ladik, Samsun), and they continue to work on installing the system. Besides, the Turkish Housing Development Administration plans to carry out all the projects that will be built, especially in hospitals, schools and residences, according to the zero-waste system.

5.3.9. By-Law on Waste Management

The By-law on Waste Management dated 2 April 2015 (Official Gazette No: 29314) collects three different waste regulations under one framework in Turkey and repeals By-law on Solid Waste Control dated 14 March 1991, By-law on Hazardous Waste Control dated 14 March 2005 and the By-Law on General Principles of Waste Management dated 5 July 2008. The By-law was prepared in order to comply with the EU waste management legislation. Therefore, general principles are in line with the EU waste management hierarchy. The waste pyramid from prevention to reuse, recycling, recovery and disposal were set.

MoEU is responsible for preparing national and regional scale waste management plans. Waste collection practices for the municipalities were described according to geographical, demographic and economic attributes. Other essential amendments brought by the By-Law are:

- Facilities must apply to the Ministry for an exemption from obtaining an environmental license.
- Metropolitan Municipalities must establish and/or operate a transfer station for municipal waste.
- Waste producers must now submit a waste management plan to the Ministry's Provincial Directorate, which outlines the producer's plans to avoid and reduce wastes and obtain approval.
- During the export of hazardous wastes, a prior notice form and an international movement document form must now be used (Yıldız, 2019).

5.3.10. By-Law on Landfilling of Waste

The Monitoring, control, closure, and aftercare procedures of landfill facilities are outlined in the By-law on Waste Landfilling, which was published in the Official Gazette on March 26, 2010 (Official Gazette No: 27553). It has also built a reporting system and a database to help. By-Law is related to marine litter as it aims to prevent solid waste leakages, which might in time be carried to the sea, originating from the landfills.

A draft national strategy has also been drawn up to reduce the quantity of biodegradable waste disposed of at landfills. This strategy shall include activities to be taken using recycling, composting, biogas manufacturing or energy/material recovery. The EU Landfill Directive will be implemented by 2025, in line with the strategy.

5.3.11. By-Law on Control of Packaging Waste

The By-law was published on 24 August 2011 (Official Gazette No: 28025) and was amended in line with the National Waste Management Action Plan in December 2017. To reach the 60 % recovery target for packaging waste was set as

obligatory for 2023. In addition, new targets were set to decrease plastic carrier bags use. Their free distribution for shopping (including online sales) was banned starting from 01 January 2019. Sales point must charge for all plastic carrier bags (excluding thinner than< 15 μm thickness) used as primary bags in contact with food. The initial price was put as 0.25 Turkish Lira, and increases will be determined by the Packaging Commission established by the MoEU. The target for reducing plastic bags by 31 December 2019 is 90 bags per person and 40 bags in 2025.

By-law requires extended producer responsibility measures from the packaging producers. They are obliged to use at least 8 % recycled packaging material by 2020, use easily recyclable material, register their exports and imports into the packaging material database and organise educational activities for packaging waste management.

Separate collection facilities were entailed for industrial and commercial establishments and housing over 100 flats, and their collection responsibility is attained to the municipalities and authorised companies.

The By-law is a very positive step through registration, separate collection and recycling of the plastic packaging waste to improve the Turkish waste management system.

5.3.12. Other Legislation Relevant to Curbing Marine Litter

Besides a number of legislative documents, which are more linked with curbing plastic pollution and marine litter, there are also other Laws, By-Laws or circulars relevant for preventing marine litter in Turkish legislation. Aquaculture Law (Law No: 1380) which was ratified on 22 March 1971 and entered into force on 04 April 1971 (Official Gazette Number: 13799), for instance, prohibits the dumping of

substances that might harm aquaculture or the health of those who consume or use them or damage the means of production, materials, equipment and tools; into inland waters and into or around the production places in the sea.

By-Law on Environmental Management of Dredging Equipment dated 14 January 2020 (Official Gazette No: 31008) regulates the environmental management of dredging activities in the sea and coastal areas and river mouths, the beneficial use of dredging materials resulting from these activities and their discharge or disposal into the marine environment in a way that will not harm the environment and human health. Besides, the Circular on the Implementation and Transfer of Authority for Dredging and Discharge Activities dated 20 February 2020 (Circular No: 2020/4) defines the environmental management methods of dredging material.

The Circular on the Marine Pollution Inspection Personnel to be Assigned in the Control of Marine Pollution and the Training to be given to this Personnel dated 10 May 2010 (Circular No: 2010/8) is crucial for inspections and prevention of all sorts of marine pollution.

5.3.13. Gaps in Turkish legislation and implementation

Turkish environmental legislation has improved since the 2000s with EU candidateship and partially aligned with the EU acquis. Improvement of waste management and marine protection issues took their place more comprehensively in the legislation with the amendments of several laws and amendment/enforcement of by-laws, covering plastics and marine litter issues in recent years.

While the Environment Law (1983) lays out the general provisions and principles on curbing sea pollution, the Law Pertaining to Principles of Emergency Response and Compensation for Damages in Pollution of Marine Environment by Oil and

Other Harmful Substances (2005) and By-Law on Collection and Control of Ship Generated Waste (2004) support the actions related to curbing sea-based marine litter and the protection of marine ecosystems.

By-Law on General Principles of Waste Management (2004) and By-Law on Landfilling of Waste aims the improvement of waste management system in Turkey. Therefore, their implementation is crucial for a circular economy and to prevent the leakage of waste into the environment. By-Law on Control of Packaging Waste (2011), By-law on Landfilling of Waste and National Waste Management Strategy (2016) brought solid waste reduction, recycling, reuse and landfilling targets to Turkish legislation. Besides, fees for recycling costs and producer responsibility schemes that were recently introduced into Turkish Environment Law are in line with the Waste Management Strategy.

2018 and 2019 were acknowledgement years for legislation, in particular to marine litter and plastics. Environmental fee for the plastic carrier bags, publishing of Marine Litter Circular, By-Law on Zero Waste and amendment of Environment Law to include recycling fees, in parallel with the Waste Management Strategy was very positive steps through establishing the legislative basis for a more circular economy and solution of the marine litter problem. However, newly introduced legislation is still in the early stages, and Turkey does not have SUPs legislation or monitoring yet.

Besides positive developments and legislative improvements, Turkish marine legislation still lacks an integrated and comprehensive structure concerning marine litter. The issue is only directly referred to in the recent Marine Litter Circular. All remaining relevant legislation on marine or waste domains is indirectly helping to combat the litter problem. For instance, there is no individual provision regarding marine litter in Turkish marine legislation. Plastics and litter issues can only find a place under a general prohibition as; “dumping of any waste”. Plastics and are not

seen as a priority. Loss of fishing gear, which is an essential origin of the sea-based marine litter, is not even mentioned in the legislation. The situation is the same for the collection of plastic waste inside the ships. A separate collection of plastics is not mentioned as an individual headline for ship waste reports yet. They remain under “household waste” in the reporting forms.

There is no by-law on marine litter, enabling the integration of waste and marine litter issues in one framework. More importantly, there is not framework legislation for marine protection in Turkey. There are ongoing EU funded projects for the harmonisation with the EU MSFD. DenİZ monitoring programme also creates a sound basis for MSFD monitoring. However, the harmonisation with the MSFD is not in place yet, and there are no thresholds defined for marine litter.

Currently, Turkish freshwater legislation does not include measures to prevent marine litter, and riverine litter is not considered as a part of water quality. Rivers are not included in the DenİZ monitoring programme. There are no provisions in By-Law on Urban Waste Water Treatment and By-law on Use of Household and Urban Waste Treatment Sludge regarding microplastics. Besides, the By-law on Registration, Evaluation, Authorisation and Restriction of Chemicals (2017), which aimed for harmonising the EU acquis, does not include a restriction process for microplastics.

Improvements in waste management legislation are promising for the future. However, the current figures are not sufficient to prevent the leakage of waste into the environment. A significant amount of waste is still deposited in uncontrolled waste dumping areas. Uncontrolled waste can easily be carried out to the rivers and the seas with heavy rain and wind. Besides, the leakage of waste into underground water is also a threat to the environment.

The recycling rates are still too low, and the current economy represents a linear structure. Social and economic differences are high amongst the regions, making the implementation of legislation at the same level for all regions not possible.

Public interest in the subject is increasing, however, not at a sufficient level yet. This argument can be supported by the public reactions to the plastic carrier bags fee put in 2019. Many citizens criticised the government for putting a fee on carrier bags (Haberturk, 2019). These reactions are mainly related to the low income of the Turkish population. The economic concerns for the public are still much crucial than environmental issues.

DenİZ monitoring programme is a very positive step through monitoring of marine litter, but monitoring efforts are still at a very early level, and geographical coverage is limited. Waste statistics do not provide detailed information on marine litter related sources information.

5.3.14. Recommendations for Turkish Legislation and Policy Measures

Recommendation 1: Enable a framework marine protection legislation and continue to work through a circular economy to prevent marine litter

Turkey's waste legislation is at an adequate level of harmonisation with the EU acquis. Turkey should continue efforts to comply, and implementation of the legislation must be strengthened. Intensive work through a more circular economy is required to reach the National Waste Management Plan's objectives and targets. Besides, recent amendments to the BASEL Convention regarding scrap plastic trade must be adopted to national legislation immediately. Turkey should not accept other countries waste and avoid imports of scrap plastic.

A By-law on SUPs should be enforced to curb the most urgent problem for the marine litter, responsible for 50% of the beach litter. Restriction, substitution and ban of a particular type of SUPs should take their place in the legislation.

Turkey needs to have a framework for marine protection legislation. EU MSFD harmonisation efforts should speed up in order to better regulate the preservation of marine ecosystems. Marine litter should be one of the significant pillars of marine protection legislation.

It is recommended that Turkey should even not wait for a framework of marine legislation and enforce a by-law on marine litter. Therefore, the intense legislative and implementation efforts on waste legislation in recent years should be immediately combined with marine legislation in an integrated way. The current political atmosphere, which sets waste management as a priority, can easily be supported by marine litter legislation to curb the plastics problem more effectively.
Microplastics and nanoplastics might have severe effects on marine biota and humans. A percussionist approach is necessary. Amendments are needed for By-Law on Registration, Evaluation, Authorisation and Restriction of Chemicals, which sets restrictions and bans on the use of micro and nanoplastics in certain products.

Freshwater legislation should be including provisions concerning prevention, treatment and monitoring of marine litter. Waste management and marine legislation cannot solve the problem without the most crucial pathway of litter (rivers and urban wastewater) are also regulated.

Finally, all legislation about marine litter from source to sink should be addressing each other to build up an integrated structure, which enables it to work in harmony and effectively.

Recommendation 2: Increase monitoring efficiency and geographical coverage for all types of marine litter, its health effects and enable decoupling with the waste data

Improvement of the DenİZ programme's geographical coverage is necessary. Current monitoring efforts are not sufficient to cover more than 8000 km long coastline of Turkey. Besides, threshold values for litter in line with the RCSs and MSFD are needed to define a good marine litter status target to work through.

Marine litter provincial action plans can be used to collect data for beach litter and riverine litter. The data collected by the provincial staff and NGOs can be an excellent basis to describe the problem's magnitude.

A monitoring programme for at least for the major rivers of Turkey must be started as pathways are crucial for assessing litter flowing to the seas. European experiences on monitoring river banks litter (EEA MLW) and floating litter (EU JRC RIMMEL Project) might be used as a basis for monitoring methodology.

Waste management data and monitoring should allow couplings with the marine litter monitoring in order to be able to monitor the policy effectiveness and change in the abundance of litter from source to sink. Waste data should provide comparable indicators, especially for the SUPs with the marine litter data.

Recommendation 3: focus on implementing the integrated coastal zone management (ICZM) with an ecosystems based approach. ICZM can help the protection of coastal areas and minimising marine litter with its integrated planning and management approach. Besides, coordination and communication of the stakeholders during the planning of land and marine sides of the coastal areas are at the core of the ICZM, and therefore, can enable better implementation of marine litter action plans of the coastal provinces.

In Turkey, currently, ICZM is not applied with legally binding measures. Due to the lack of legal infrastructure, the implementation of ICZM remains a guidance initiative (Gülbitti et al., 2019). Turkey is a party to the Convention for the Protection of the Mediterranean Sea Against Pollution (Barcelona Convention) but did not sign its Protocol on ICZM in the Mediterranean. The protocol's signature is a politic level decision; however, ICZM principles can still be implemented via enforcing national and legally binding measures.

Recommendation 4: Increase public awareness and support NGOs

The socio-economic structure of the public in Turkey is not as advanced as in developed and wealthy nations. People might have more urgent daily economic and social problems compared to environmental priorities. As in the example of public critics of plastic carrier bags fee, environmental taxes and fees can sound like a new burden. Introducing nationwide campaigns, educational programmes and training activities can help to recognise environmental problems. Besides, environmental problems bring public severe health consequences. Once the public is ready to prioritise the environmental problems, habits will change to curb the marine litter problem in Turkey.

NGOs are vital organisations for the reflection of public efforts in a more organised way. Activities related to increasing public awareness can be in many different forms as media campaigns and training. The continuity of awareness is best possible by being a part of the solution. NGOs allow the public not only to be a passive listener of the messages but act as an active party to the solutions. Supporting NGOs will boost the effect of the actions related to curbing the marine litter problem.

CHAPTER 6

HOLISTIC ASSESSMENT OF MARINE LITTER PROBLEM

6.1. Holistic Assessment of Marine Litter with Source to Sea Approach

Source of the marine litter is a problem beyond the oceans. The sources and the pathways of plastic pollution must be well examined to understand the entire spectrum. We must identify land-based sources of plastic pollution and create an evidence-based to understand their impacts from source to sea. The "source to sea" approach, which was described in Chapter 1, can be implemented in different scales from policy to monitoring. The policy level approach focuses on the cross-sectoral management of the sources and establishing the cooperation between the policymakers and the stakeholders to achieve a circular plastics economy. A monitoring scale source to sea approach, therefore, creates the necessary information base for the holistic assessment of the marine litter and plastic pollution problem, and it is complementary to the policy scale approach. These two different scale approaches can complete each other in scales and feed each other with the information and knowledge they create.

A monitoring level source to sea approach should be based on the collection of all available data and information related to the drivers of plastics pollution, which create the demand for it (e.g. population growth), the pressures related to plastics (e.g. plastic waste creation and leakages from landfills), pathways of plastics (e.g. urban wastewater treatment plants and rivers), the state of the marine environment (e.g. beach litter, microliter accumulation), its environmental and socio-economic impacts (e.g. clean-up costs, loses in tourism revenues) and finally the responses to the problem (e.g. plastic packaging recycling rates).

As marine litter is a direct consequence of linear economies, poor waste management practices and low level of awareness; assessing the magnitude of the problem do not only rely on marine litter state and impact monitoring but also including the European level indicators related to production, waste prevention and waste management into the assessments. This approach can assess the state of litter pollution in light of specific waste and circular economy performances.

This chapter aims to propose a monitoring based holistic approach for marine litter assessments in Europe and Turkey, based on the "source to sink" methodology and circular economy principles. Besides, the holistic assessment approach supports the recommendation "Increase monitoring efficiency for all types of marine litter, its health effects and enable decoupling with the waste data", put in Chapter 4 for Europe and Chapter 5 for Turkey.

A scoping study, which was performed in 2019 by the EEA, aimed for linking the source and sink of litter based on the available driver, pressure, pathways, and state and impact indicators on a European scale (DPSIR approach). The scoping study was performed by five experts (Mustafa Aydın, Joana Mira Veiga, Prof. Dr Ahmet Kıdeyş, Spela Koren and Stefan Tradan; unpublished report on the scoping study was broadly used in this Chapter). The methodology and outputs of the study were summarised and proposed as a holistic assessment approach for Europe. Based on this study, a similar case study will be provided for Turkey to assess the marine litter problem in an integrated way in the future.

6.2. The Marine Litter Indicators Scoping Study for Europe

Cross-cutting legislative integration, efforts in EU acquis are emerging the same demand: holistic data and information need on the sources, pathways and sinks of marine litter, to be able to monitor and assess the implementation and integration of the measures. The EEA scoping study is in line with the EU policy targets, and it is based on the idea that an integrated legislative approach should be supported with an integrated monitoring effort.

The scoping study is in line with the EU policy targets, aiming to harmonise the legislative actions and establish links with the source and sink, where possible. This Chapter seeks to create the necessary basis for a future marine litter assessment to provide valuable information for EU policies. Scoping study aims to screen the European scale indicators related to marine litter and selected a core set of indicators, which will be used to evaluate the cause and effect relationship and to establish correlations with the state and source for a holistic assessment. Based on the idea that monitoring for the litter must be an integrated effort, and this is only entirely possible to understand the state and impacts of litter (necessary for MSFD assessments) by having reliable information on the sources and pathways of litter.

A set of marine litter indicators were selected with multi-criteria analysis (defined by the study team and EU stakeholders), which might be candidates for integrated monitoring and assessment. For example, plastic waste packaging indicators can be matched by the Top 10 litter items found on the European beaches to measure SUP Directive's success and measure the consistency in trends of production data and litter abundance and type trends at the beaches. Using indicator sets will help make better decisions and decrease monitoring costs by making crosschecks possible between two data sets.

The objective of the scoping study was to map drivers, pressures, pathways, impacts and state indicators in regards to marine litter, which are already implemented on a European scale or are being developed, covering the whole story of the plastics from source to sink. The suitability of these indicators and proposing a coherent set of "core indicators" for integrated assessment of marine litter were assessed in the study's scope, based on defined criteria.

In the context of the scoping study, "*source*" was referred to the economic sector or human activity that creates the litter (e.g. tourism, aquaculture, fisheries, and shipping), *pathway* as the physical and/or technical means by which litter enters the marine environment. Scoping study refers to sources when considering the processes of waste generation (pressure) and management (responses), as these will

determine the magnitude of mismanaged waste, which can leak into the environment.

The scoping study intended to highlight the need to integrate plastics production, waste generation and management when assessing marine litter from a policy prevention perspective. It is designed to initiate a more in-depth exploration of how existing environmental indicators, used in different policy domains, can be integrated to consider the entire causal chain, from sources to the state of pollution. The study focused mainly on macro plastic litter. Therefore, indicators on macro litter both for waste production and marine litter pathways and status are more mature on the European scale.

6.2.1. General approach and methodology

The DPSIR framework was used as the basis. The DPSIR model is an analytical framework that can be useful to assess the interactions between human processes and the environment and help establish an integrated indicator system (Ness et al., 2010). Besides, the DPSIR model has proved to be a useful tool to generate appropriate measures of action. Many organisations widely adopt the DPSIR framework, including the OECD, UNEP and also EEA.

The process to apply the DPSIR framework to marine litter creates a broader picture of the complexity of the issue and establishes causal links between waste performances and marine litter.

Examples of relevant indicators that related to different DPSIR levels include:

- *Drivers:* e.g. human activities, such as tourism, aquaculture, fishing and shipping; population density; land-use; material consumption; plastic production, etc.;
- *Pressures:* e.g. waste generation;
- *Responses:* e.g. waste treatment, including recycling; re-use of packaging, etc.;

- *State:* e.g. riverine litter; beach litter;
- *Impact:* entanglement of marine animals; ingestion of litter by turtles

Table 6.1 below provides examples of relevant indicators, link with DPSIR level and "source-pathway-sink".

Table 6. 1. How indicators address DPSIR and Sources, pathways, sinks levels (Koren, 2019)

Indicator	***DPSIR*** **level concerned**	***Source-pathway-sink*** **level concerned**
Tourism intensity	Driver	Source
Waste generated	Pressure	Source
Waste recycled	Response	Source
Riverine litter	State	Pathway
Beach litter	State	Sink
Litter ingested by turtles	Impact	Sink

Following the decision on the general framework to be used, the approach for the scoping study consisted of the following steps:

1. Mapping of relevant indicators, across the different DPSIR levels, based on desk research;
2. Describing features of each indicator (metadata);
3. Pre-selecting list of indicators based on the expert judgement of the team;
4. Applying a multi-criteria analysis to select the "core" set of indicators

The mapping exercise consisted of identifying as many relevant indicators as possible, grouped under the different DPSIR levels. The exercise covered, among others, the indicators associated with the MSFD, Waste and Packaging Directives but also indicators adopted by institutions such as the EEA, UN (SDGs) and Regional Seas Conventions. Indicators that do not exist or are still in an immature state of implementation were also considered.

For each indicator, the following metadata information was collected from the literature and other available sources:

a. Definition of the indicator – description and relevant details on how the indicator is computed and what it measures;
b. Unit – unit(s) of indicator;
c. Relevance – the importance of indicator in informing about marine litter issue/management/prevention; link to specific policies and legislation;
d. Implementation and adoption; how broadly are the indicators implemented in Europe or within a Regional Sea Convention;
e. Level of detail generated – whether the data provide very detailed information, e.g. on different plastic items
f. Spatial scale – geographical coverage of the data (e.g. national)
g. Temporal scale – temporal coverage of the data (e.g. annual, monthly);
h. Standardisation issues – for the indicator in question whether a well-standardised methodology exists or not;
i. Reporting / data sources (including specific links to data source) – exact location of the data for the indicator or platform where data may be available.

A set of criteria were defined to support the selection of the most suitable set of indicators:

- Policy relevance – Which policies are the indicator directly linked to, and how well does the indicator inform about progress and targets?
- Issue relevancy – What is the level of relevance of the indicator?

- Applicability – Is the indicator applies to all EU regions/countries?
- Maturity – Are indicator methodologies well agreed and standardised?
- Data availability – Are data collected regularly and easily accessible?
- The detail level - Do the data associated with the indicator can provide about the topic it targets?

The complete list of 60 European scale indicators was ranked according to the above criteria.

6.2.2. Results of the Scoping Study

Forty-two indicators were selected out of 60 that are directly or indirectly related to marine litter have been identified as candidates for core indicators.

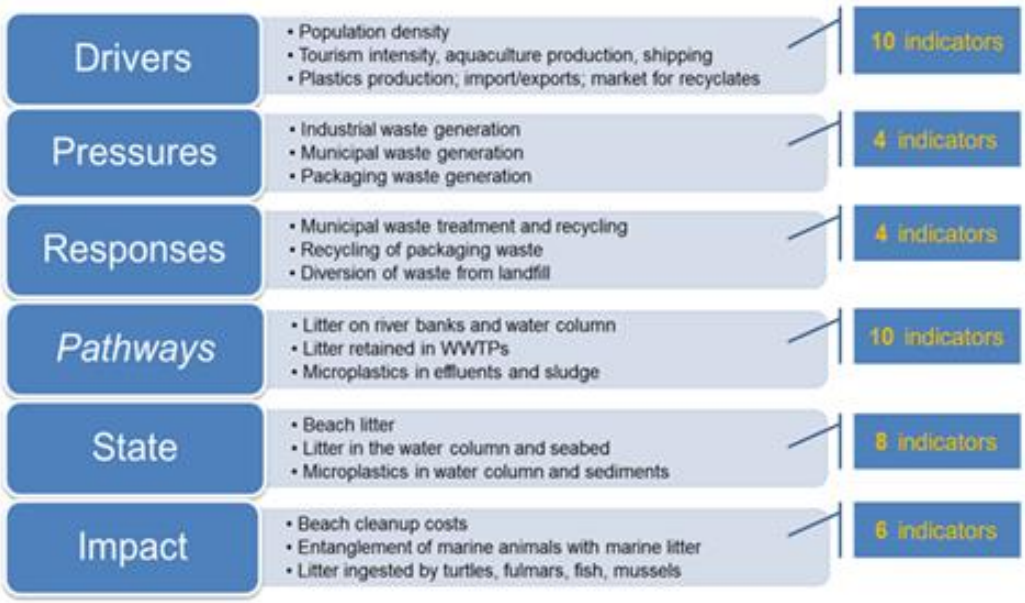


Figure 6. 1. Examples of mapped indicators (over 42 indicators) across the different DPSIR levels (Koren, 2019)

6.2.2.1. Indicators on Drivers of Marine Litter

The sources of marine litter are directly related to linear economies. Plastics are widely and unfortunately recklessly used in every part of life as they are functional, easy and cheap to produce. The drivers of litter are the sources of the marine problem. It is of utmost essential to monitor the sources of litter to curb the problem.

Out of ten driver-related indicators on the European scale for driver factors as population density and sectors such as tourism, agriculture, fisheries, the scoping study found four were addressing the "upstream" plastic material flow. The indicator on plastic production (plastic production per category of use) provides information on the demand for plastics (needs to be considered together with plastic waste generation, treatment and possibly plastic waste found in the environment); the indicator on material consumption (domestic material consumption per capita) provides insight into the consumption stage of material flow (needs to be considered together with waste generation); import/export of plastic waste by EU countries (traded volume of plastic waste); and market drivers (material prices for recyclates). The latter indicator can provide important insight into the recycling economy, as it can be a driver for recyclates demand.

Six indicators were linked to product demand and waste generation drivers of society in general and specific economic sectors: one indicator on demographics (population density in NUTS 3 regions); one on tourism (nights spent at tourist accommodation establishments by coastal and non-coastal area); one on land use (land-use change; for agriculture); and three related to maritime activities, such as shipping (transported goods through shipping), aquaculture (aquaculture production), and fisheries (losses of fishing gear). All four economic activities (tourism, shipping, aquaculture and fishing) present potential direct sources of marine litter.

Four driver-related indicators were directly or indirectly linked to the EU Circular Economy Action Plan. “Plastic production per category of use” indicator was also explicitly linked to the SUP Directive, and the “material prices for recyclates” and “traded volume (import/export) of plastic waste” indicators to the Waste Framework Directive. The rest of the indicators were linked to several other policies. Those are mainly the indicators for which the EUROSTAT and the EEA collect data. The maturity of indicators in this group was mainly good and fair, with the distinction of the indicator losses of fishing gear, which merely indicates trends in abandoned/lost fishing gear.

6.2.2.2. Marine Litter Pressures Indicators

The holistic approach requires seeing the bigger picture for the marine litter problem. Although pressure means marine litter itself for the sea domain in the MSFD, the pressures related to marine litter were defined as waste generated by the drivers within the scoping study. Once generated, waste has a significant potential to leak into the environment and flow to the seas through pathways (wind and rivers). Therefore, a holistic assessment needs to monitor and assess waste management performances and mismanaged waste.

Four of the pressure-related indicators found on the European scale were addressing waste generation at different stages: industrial (the industrial waste in Europe), packaging waste generation (packaging waste generated), waste generation during production and consumption phase (waste generation during production and consumption phases), and general waste generation, including from consumers (municipal solid waste generated). All four indicators were relevant for the Circular Economy Action Plan and the Waste Framework directive. Three of the indicators had “fair” maturity.

A common denominator among all four indicators were units (tonnes, tonnes/year) and geographical coverage of the data (spatial scale; country). The data is being published in annual and biannual periods. There were no specific indicators

available to address waste generated by coastal tourism, which poses direct pressure on the marine environment.

6.2.2.3. Marine Litter Response Indicators

The four response-related indicators reflect how waste is prevented or dealt with once was produced, two of which were specific to packaging, a fraction of waste that tends to dominate marine litter: re-use (reuse of packaging), recycling (recycling of packaging waste), municipal waste treatment (municipal waste treatment, including waste recycling), and diversion from landfill (diversion of waste from landfill).

All four indicators were relevant for the Circular Economy Action Plan and the Waste Framework Directive. Besides, the not-yet-implemented indicator reuse of packaging will also link to the SUP Directive and the Packaging Directive. The indicators were fairly or poorly mature; one was not yet developed. All four indicators are non-homogenous in terms of units (mass/year, e.g. tonnes, tonnes/year, kg/capita, % of waste). The data are published annually, except at the indicator “Reuse of packaging”, which is not yet implemented; therefore, the data are not being collected.

6.2.2.4. Marine Litter Pathways Indicators

Disposed and mismanaged waste, plastic waste in particular, are transferred to the seas partially with the wind and vastly via rivers. The indicators identified for litter pathways provided some degree of information on rivers or sewer systems, thus reflecting mismanaged waste that is potentially being transported from land into the sea. These indicators are mainly based on pilot studies, as there were currently no standardised monitoring for these domains. Therefore the indicators are still in development, and the data are irregular and limited.

Five indicators refer to rivers and can be divided into indicators describing macro- and microliter in three main compartments of the river (riverbank, water column, and sediment) (litter items on river banks using UNEP, OSPAR or the MSFD litter categories; river surface macro litter (from observation); river water column (collected items); microliter particles at surface and subsurface; and river sediment microliter). The three indicators that refer to the wastewater treatment plants (WWTPs) were divided into indicators describing microplastic retained in WWTPs by mechanical filtration (litter retained in WWTPs), microplastics in sludge (microplastic in sludge) and effluent waters of WWTPs (microplastics in effluent waters of WWTPs).

In addition to the eight indicators directly addressing waste (e.g. River surface macro litter), two supporting indicators were essential for understanding/calculating the indicators (annual average river flow and percentage of the national population connected to wastewater treatment facilities). Only two indicators with good maturity in this group were the supporting indicators (annual average river flow and percentage of the national population connected to wastewater treatment facilities). The rest of the indicators were less mature (fair or poor).

All of the indicators were variable in terms of units (data reported in items per area/volume/mass, e.g. items/100 m, items/river section x time, m3/s, items/V of wastewater, items/weight of sludge), spatial (local/national/EU) and temporal scale (irregular). The data availability is fair to poor for ML related indicators and suitable for supporting indicators referring to the WWTP network.

These indicators were generally based on the pilot as there is currently no standardised monitoring for these domains. Therefore the indicators are still in development, and the data is irregular and limited.

6.2.2.5. Marine Litter State Indicators

State indicators defined in this study's scope refer to the health of our seas and the marine biota. The monitoring efforts at the sink of litter; the sea domain provides crucial information on the accumulation and trends of litter. Existing indicators that inform us about the state of pollution were related to the MSFD Marine Litter Descriptor 10; for the macro and microlitter fractions. Indicators address litter in all compartments of the sea: coast, water column/surface and seafloor.

Except for indicators for beach macro litter, all other indicators were relatively mature. The indicator on beach macro litter is well developed, with a harmonised methodology and used in the four European Regional Seas. This is probably the most widely sampled compartment, and monitoring efforts to date have been variable and carried by different organisations, from NGOs to research institutes. In OSPAR, for example, a time-series exist since 2001 for the North-East Atlantic Ocean, while the EEA hosts a substantial amount of data on beach litter resulting from the Marine Litter Watch citizen-science initiative.

All of the indicators were variable in terms of units (data reported in items per area/volume/mass, e.g. items/100 m, items/volume, items/dry weight of sand), spatial (local, pan-European) and temporal scale (seasonal/annual/irregular). The data detail level was high for the indicators regarding macro litter and medium at indicators regarding microliter. The data availability is fair, except on beach macro litter (good) and water column macro litter (no data).

Existing indicators on the impact of marine litter inform on negative consequences of marine litter on biota and about socio-economic impacts. The indicators were developing with great intensity in recent years via several projects (e.g. on turtles) and scientific research. Indicators on marine litter's impact on biota mainly relate to cetaceans, fishes, birds, and turtles.

The negative consequences on biota can be addressed by indicators on (micro and macro) litter ingested by animals (litter ingestion by sea turtles; litter ingested by fulmars; litter ingested by fish; and litter ingestion by mussels) or entanglement of marine animals (entanglement of marine animals with marine litter). They were partially in line with related to MSFD indicators on impact.

The indicator on beach clean-up costs was included as it directly reflects one of the socio-economic impacts of marine litter, although it is not systematically collected. Since beach litter can significantly reduce the aesthetic value of beaches, the affected municipalities put their effort into preventing marine litter.

Indicators regarding the "Impacts" on marine litter were in line with MSFD. Only two of the indicators have good maturity and a high level of data details (litter ingestion by sea turtles; litter ingested by fulmar); the rest of the indicators are fairly or poorly mature with a medium level of data details. The data availability for all the indicators is fair, or even no data are available (e.g. microplastic ingestion in mussels). The data are generally expressed in "number of items" (e.g. number of entangled animals, number of ingested items) with additional data on mass and/or litter type.

There was better homogeneity in terms of data units at indicators describing "Impacts" and indicators relating to "Drivers, Pressures and Responses" (all in weight units), but the discrepancy in comparison to the data units at indicators describing "Pathways" and "State of pollution" (number of items vs mass).

6.2.3. Monitoring Based Holistic Assessment of Marine Litter in Europe

From forty-two gathered indicators directly or indirectly related to marine litter, the proposal for a set of indicators was prepared. Selection criteria, presentation of the set of indicators and recommendations for future development are presented below.

Based on a multi-criteria analysis on suitability and relevance of indicators, a sub-set was selected, ensuring that all stages of the DPSIR framework but also pathways from Sources-to-Sea were covered. The proposed list and the key results of the multi-criteria analysis are presented in the Tables below.

Although the development level was one of the criteria, the proposed set of indicators includes a mix of mature and less mature indicators, kept due to their importance in the whole picture on source impacts of marine litter. The final list of indicators across DPSIR and possibly EU policies directly link to each indicator is presented as a table.

Table 6. 2. Legend for the Marine Litter Core Indicator Selection

Policy relevance	Applicability	Issue relevancy	Maturity	Data availability	Level of detail
Strong relevance	*Broad*	*Good*	*Good*	*Good*	*High*
Fair	*Fair*	*Fair*	*Fair*	*Fair*	*Medium*
No relevance	*Limited*	*No relevancy*	*Poor*	*No data*	*Low*

Table 6. 3. Proposed indicators on drivers and results of multi-criteria analysis

		Type/topic	Indicator	Policy relevance						Applicability	Issue relevancy					Maturity	Data availability	Level of detail
				MSFD	C. Econ	Waste D	SUP D	Pack D	Others		D	P	S	I	R			
		DRIVERS																
CORE	1	Demographics	Population density (nr inhabitants/km2) in NUT 3 regions (EUROSTAT)								x							
SITE SPECIFIC	2	Tourism	Nights spent at tourist accommodation establishments by coastal and non-coastal area (EUROSTAT)						x		x							
SITE SPECIFIC	3	Agriculture	Land use change								x							
SITE SPECIFIC	4	Aquaculture	Aquaculture production (EEA)						x		x							?
SITE SPECIFIC	5	Fisheries	Losses of fishing gear (EUROSTAT)	x					x			x						
SITE SPECIFIC	6	Shipping	Transported goods through shipping (EUROSTAT)						x		x							?
CORE	7	Material consumption	Domestic material consumption per capita (similar to SDG 12.2.2) (EUROSTAT)		x				x		x							
CORE	8	Plastic Production	Plastic production per category of use (NACE Plastics Europe)		x		x		x		x							

Table 6. 4. Proposed EU indicators on pressures and responses and results of multi-criteria analysis

		Type/topic	Indicator	Policy relevance						Applicability	Issue relevancy				Maturity	Data availability	Level of detail
		Pressures															
CORE	9	General waste generation	Municipal Solid Waste (MSW) generated per year (kg/capita, ktonnes) (EEA, EUROSTAT)		x	x			x			x			x		
CORE	10	Packaging waste generation	Packaging waste generated (tonnes/year; kg/capita) (EUROSTAT)		x	x	x	x				x			x		
		RESPONSES															
CORE	11	Treatment	Municipal Waste Treatment Waste recycling (tonnes/year; kg/capita) (EEA) SDG indictor 12.5.1		x	x			x			x			x		
CORE	12	Recycling	Recycling of packaging waste (EEA, EUROSTAT)		x	x		x				x			x		

Table 6. 5. Proposed EU indicators on "pathways", state of pollution and impact and results of multi-criteria analysis

		Type/topic	Indicator	Policy relevance						Applicability	Issue relevancy				Maturity	Data availability	Level of detail
		PATHWAYS															
CORE	13	River banks	Litter items on river banks using OSPAR or MSFD litter categories (NGO data)	x	x				x			x	x				
CORE	14	River water column	River surface macrolitter	x	x				x			x	x				
		STATE of Pollution															
CORE	15	Coastline	Beach macrolitter (EEA, MSDF, OSPAR, HELCOM and Barcelona Convention, EMODnet)	x			x						x				
CORE	16	Sea water column	Seasurface macrolitter	x			x						x				
CORE	17	Seafloor	Seabed macrolitter (Datras/ICES, EMODnet)	x			x						x				
		IMPACTS															
CORE	18		Beach cleanup costs (thousands €/year or/km)	x										x			NA
CORE	19	Entanglement biota	Entanglement of marine animals with marine litter (Ecoq04/11 c3 - candidate indicator for the Black Sea; future indicator for OSPAR, c1-24 common indicator for Mediterranean, nothing for HELCOM)	x										x			
SITE SPECIFIC	20	Ingestion - Turtles	Litter ingestion by sea turtles (EO10 - common indicator 24 for Barcelona Convention, candidate indicator for OSPAR by 2021)	x										x			
SITE SPECIFIC	21	Ingestion - Birds	litter ingested by fulmar (common indicator for OSPAR)	x										x			

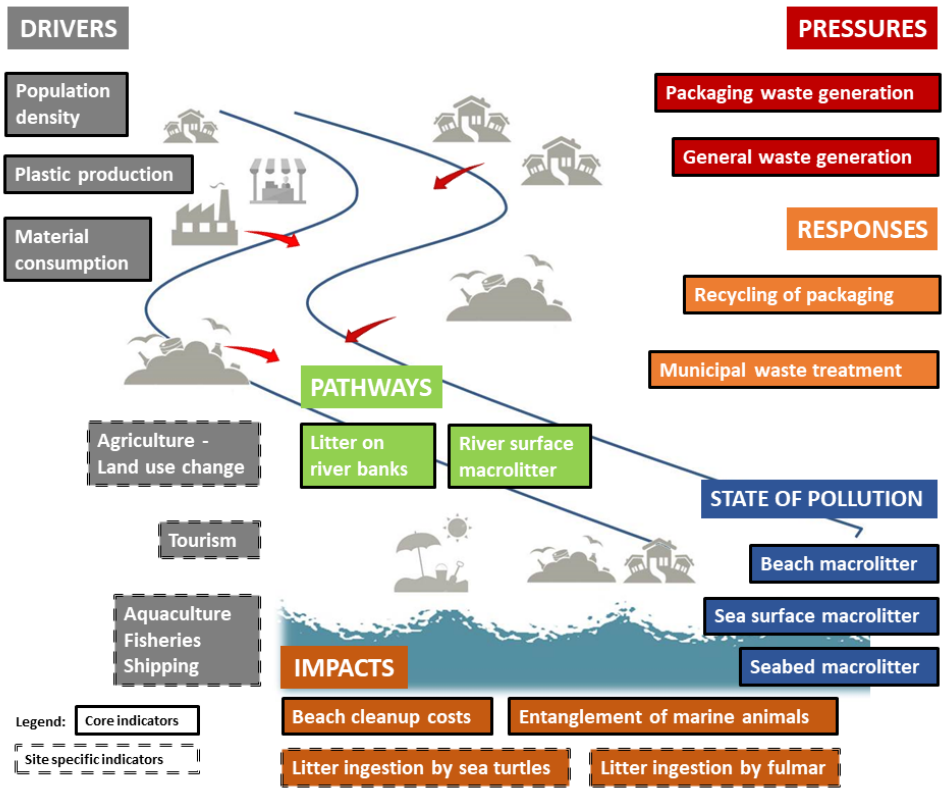


Figure 6. 2. Proposed core marine litter indicators (Veiga et al., 2019)

Based on the scoping exercise and proposal for a set of indicators for an integrated assessment of marine litter, in this section, we discuss some of the results and provide some recommendations for future developments.

6.2.4. Recommendations for Holistic Assessment of Marine Litter in Europe

Recommendation 1: invest in further developing indicators from sources-to-sea and emerging technologies. Some of the indicators are well developed and implemented in Europe (e.g. waste management indicators, beach litter indicators); others need to be further developed but are very valuable (e.g. riverine litter indicators).

There is a lack of data for freshwater environments, rivers and lakes. The methodological developments in the riverine litter are at the early stages. Rivers are

crucial for understanding the relationship between the source and the sink of marine litter. A particular focus must be attributed to encourage riverine litter monitoring and the development of harmonised methodologies.

Development of indicators on wastewater treatment plants, as they represent opportunities to intercede and measure waste from urban effluents

Recommendation 2: develop indicators of socio-economic impacts. Include beach-cleanup costs, as they reflect a direct socio-economic impact on recreation and tourism and data may be easily retrieved.

Recommendation 3: indicators across different land-sea domains need to be comparable. Improvement of indicators is necessary to enable an integrated assessment: e.g. marine litter vs waste indicators are often expressed in different units (nr items/area or/volume vs mass/year or /capita). Solid waste data do not identify plastic items in detail, nor does marine litter data provide information on mass/volume of waste but the number of items. This hinders the comparison and integration of the data from these two domains.

Different scales (e.g. tonnes for waste and items for litter) and detail levels between the waste and litter indicators do not allow a fair comparison of sources and sinks of litter.

While the EU acquis is moving towards a more integrated structure for solutions, monitoring efforts should also follow to provide healthy policy feedbacks. Harmonised monitoring methodology and monitoring efforts should be improved in order to have holistic assessments on the origins, pathways, abundance and effects of marine litter. Therefore, waste indicators should enable decoupling with the marine litter indicators to monitor the problem from the source to the sink.

Recommendation 4: To support the integrated assessment of marine litter, policies need to be well aligned. Although many positive steps were taken in recent years,

legislative integration efforts are still in very early stages, and there are still significant gaps, especially for the freshwater legislation, concerning marine litter. There are no provisions for achieving "good status" and monitoring marine litter in Water Framework Directive. Besides, UWWT Directive does not carry out any measures regarding the microplastics accumulating in the sewage sludge or filtering the plastics to prevent them from reaching rivers and the seas. The problem of litter cannot be solved by only regulating the sea and beaches. At its current integration level, the EU acquis is missing one of three main pillars for the solution: freshwater legislation must include strong measures, clear targets and monitoring indicators (harmonised with the MSFD) for a complete and holistic legislative structure.

Recommendation 5: Lay vision for potential data that may result from future technological developments (e.g. data from remote sensing – satellites, drones, automated measurements at sea) in order to create real-time databases with broader geographical coverage, and use digital technologies (e.g. machine learning, artificial intelligence and digital twins) to provide actionable knowledge for the decision-makers.

Recommendation 6: Further develop forecasting methodologies to model the plastic waste cycle better and estimate plastic leakages into the environment. A critical quantification is on "mismanaged waste" (as this is what leads to marine litter), which can only be estimated based on other waste indicators and based on what is found in the environment.

6.3. Marine Litter indicators Scoping Exercise for Turkey

Turkey has already developed country-level indicators on waste and marine litter, which might help to establish a similar approach with the "Marine Litter indicators Scoping Study for Europe". The Ministry of Environment and Urbanisation and the Turkish Statistical Institute publishes indicators regularly on population, tourism, municipality solid waste, packaging waste and fisheries. Besides, the

MoEU DENiz monitoring programme collects data on the status of marine litter that can be used as a sound basis for establishing marine litter indicators (in line with the MSFD). The essential but missing piece is the riverine litter data collection and indicators at the moment.

In this section, a scoping of the available indicators from source to sea was made, and a core set of marine litter indicators were proposed to be used for the assessment and prevention of the Turkish marine litter problem. The same methodology and approach were applied with the "Marine Litter indicators Scoping Study for Europe".

From gathered national indicators directly or indirectly related to marine litter, the proposal for a set of indicators was prepared. Based on a multi-criteria analysis on suitability and relevance of indicators, a sub-set was selected, ensuring that all stages of the DPSIR framework and Sources-to-Sea pathways were covered. The proposed list and the key results of the MCA are presented in the Figures below. A list of indicators across the DPSIR framework was presented as a table.

6.3.1. Results of the Scoping Exercise

Thirty-one national indicators were selected directly or indirectly related to marine litter, and they have been identified as candidates for core indicators. There was less lumber of national indicators available/developed compared to the European level.

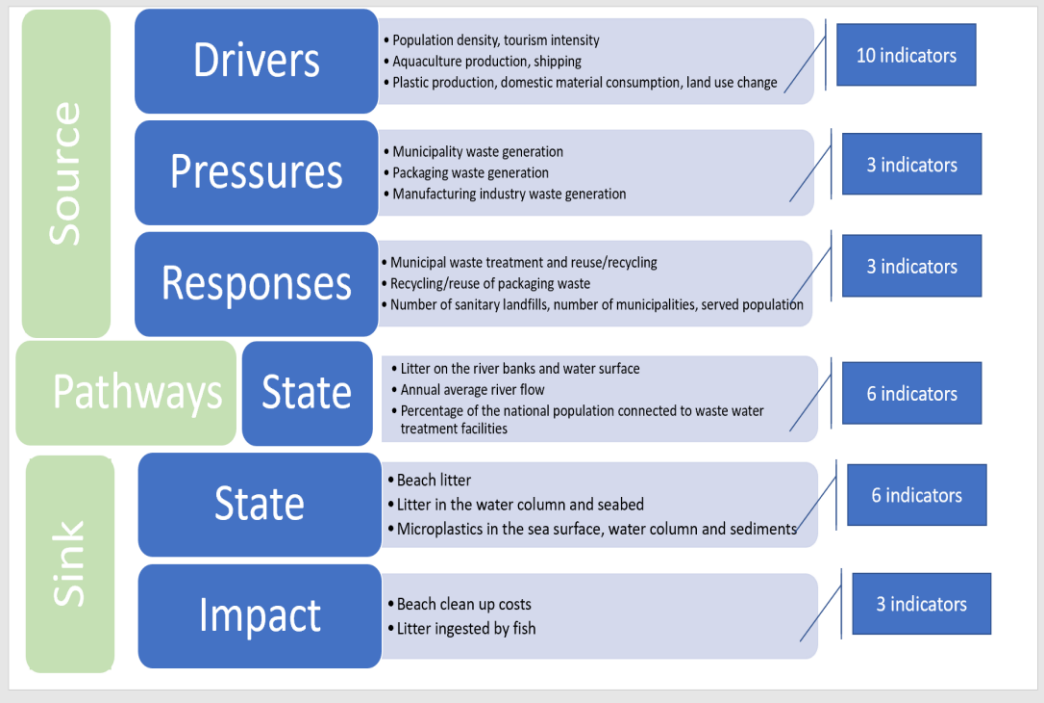


Figure 6. 3. Examples of mapped Turkish indicators across the different DPSIR levels

In most cases, indicators relevant to the European level were also found on Turkey's scale. Besides, driver indicators are also in line with the EU terminology and units. This situation is also relevant for pressures, responses, and state and impact indicators. Therefore, we may conclude that the European level marine litter indicators scoping approach can also be implemented for Turkey. However, some indicators available on the European level were missing in Turkish indicator sets.

6.3.1.1. Indicators on Drivers of Marine Litter

Ten drivers-related indicators were collated. All indicators available at the European level were also available on Turkey's scale. The maturity of indicators in this group is mainly good. The drivers-related indicators are variable in terms of reported units (e.g. tonnes, number of inhabitants/km^2) but relatively uniform in terms of spatial and temporal scale of reporting (mostly national level and monthly/annual). The data available in this group of indicators are mainly good.

All driver indicators are addressing macro litter (and specifically macroplastics), and none of the indicators is addressing the production of primary microplastics. There is no data collected in Turkey, which can provide information on the production of primary microplastics. Therefore "Pathways" indicators related to WWTPs or "state" indicators for riverine microplastic loads can be used for microplastics. There is no monitoring effort in Turkey for WWTP microplastics or riverine loads. This area was a significant gap for defining the links between sources and sinks for marine litter. Therefore, some of the indicators for WWTPs and riverine litter and microplastics were also selected to be developed in the future and to be used for marine litter assessments.

6.3.1.2. Marine Litter Pressures Indicators

Three pressure-related indicators were available in Turkey. Screened indicators were mainly addressing waste generation in the manufacturing industry, packaging waste generation and municipal solid waste generated. Indicators were relevant to the National Waste Strategy and waste legislation. Three of the indicators have "fair" maturity. There is no data collected on waste generation during the production and consumption phase. Therefore, the European level indicator of waste generation was excluded from the scoping. There is no direct information for the pressure created by coastal tourism or lost fishing gear on the marine environment.

6.3.1.3. Marine Litter Response Indicators

The four response-related indicators reflect how waste is prevented or dealt with once it is produced, two of which are specific to packaging, a fraction of waste that tends to dominate marine litter: re-use (reuse of packaging), recycling (recycling of packaging waste), municipal waste treatment (municipal waste treatment, including waste recycling). There was no information available for the diversion of waste from landfill and the not-yet-implemented EU indicator reuse of packaging. All related response indicators were relevant to the National Waste Strategy and waste

legislation. The indicators are fairly or poorly mature and non-homogenous in terms of units.

6.3.1.4. Marine Litter Pathways Indicators

The indicators identified for "pathways" were providing to some degree information on litter that is found in riverine or sewer systems (WWTPs), thus reflecting mismanaged waste that is potentially being transported from land into the sea. These indicators are mainly based on pilot studies (EU level), as there are currently no standardised monitoring for these domains. Therefore the indicators are still in development, and the data are irregular and limited. However, there are no monitoring efforts in Turkey for riverine litter or microplastics in WTTP sludge. Some of these indicators (which still are in the development stage in Europe and do not exist for Turkey) were selected for the Turkish core indicator set, as they are necessary to be developed for a successful assessment of litter from source to sea in Turkey. Currently, only the "Percentage of the national population connected to wastewater treatment facilities" indicator may provide information on implementing measures related to sanitary/sewage-related litter items. Besides, the "annual average river flow" indicator can be used for the estimation of litter flowing to the sea.

6.3.1.5. Marine Litter State Indicators

"State" indicators are originated from harmonised MSFD monitoring efforts of Turkey. MoEU monitors the state of the seas with a number of parameters in line with the MSFD since 2011 (including marine litter). Except for the beach macro litter (monitoring started in 2019), all other indicators are fairly mature. Beach macro litter indicator methodology is well developed in Europe and already used in the four European Regional Seas. Turkey can quickly adopt and use this indicator on the country scale. The data availability is fair for seafloor macro and micro litter, sea bed micro litter and sea column micro litter. Data is scarce or do not exist for the remaining types of litter.

The only developed and monitored indicator on the impact of marine litter is "Digestion of microliter by fish". The data level is fair for this indicator. Besides, there is no indicator of the socio-economic impacts of litter. Although it was not developed for Turkey yet, the indicator on beach clean-up costs was included as it directly reflects one of the socio-economic impacts of marine litter, although it is not systematically collected and used. Since beach litter can significantly reduce the aesthetic value of beaches, the affected municipalities put their effort and cost to prevent the impact of marine litter.

6.3.2. Proposal for Monitoring Based Holistic Assessment of Marine Litter in Turkey

From thirty-one gathered indicators directly or indirectly related to marine litter, the proposal for a set of indicators was prepared.

Based on a multi-criteria analysis on suitability and relevance of indicators, a sub-set was selected, ensuring that all stages of the DPSIR framework but also pathways from source to sea were covered. The proposed list and the key results of the multi-criteria analysis are presented.

Level of development was one of the main criteria. However, the proposed core set of indicators include a mix of mature and less mature indicators, kept due to their importance in the whole picture on source impacts of marine litter. The final list of indicators across the DPSIR framework is presented as a table. Turkey does not have a framework for marine, freshwater legislation or SUPs regulation yet, but aims to comply with the EU legislation in the future; "policy relevance" was provided with EU legislation for the core set indicators table.

Regarding drivers, pressures and responses stages, Turkish indicators are well developed, and they are well aligned with EU level indicators, in most cases. However, pathways indicators need to be developed and monitored to establish the links between sources and sinks.

State indicators are not directly linked to the requirements of national marine legislation. Although there is not a marine strategy framework regulation for the monitoring of the marine environment in Turkey, there is a well-developed monitoring effort in line with the EU MSFD, which also includes the monitoring of the state of litter.

This study concludes that Turkey has the capacity and existing data and monitoring network to develop the same EU monitoring approach to assess marine litter proposed in Chapter 6. However, “pathways” indicators need to be developed and monitored for a better assessment of litter.

Table 6. 6. Proposed Turkish indicators on pressures and responses and results of multi-criteria analysis

		Type/topic	Indicator	Policy relevance						Applicability	Issue relevancy					Maturity	Data availability	Level of detail
				MSFD	C. Econ	Waste D	SUP D	Pack D	Others		D	P	S	I	R			
		DRIVERS																
CORE	1	Demographics	Population density of provinces by years (TURKSTAT)								x							
CORE	2	Material consumption	Domestic material consumption per capita (TURKSTAT, Ministry of Environment and Urbanisation)		x				x		x							
CORE	3	Plastic Production	Plastic production per category of use (TURKSTAT, PAGEV)		x		x		x		x							
SITE SPECIFIC	4	Tourism	Tourism Income, Expenditure and Average Number of Nights (TURKSTAT)						x		x							
SITE SPECIFIC	5	Agriculture	Land use change (Ministry of Agriculture and Forestry)								x							
SITE SPECIFIC	6	Aquaculture	Aquaculture production (TURKSTAT)						x		x							NA
SITE SPECIFIC	7	Fisheries	Fishing Fleet (TURKSTAT)	x					x		x							
SITE SPECIFIC	8	Shipping	Transported goods through shipping (Ministry of Transport and Infrastructure)						x		x							NA
		Pressures																
CORE	9	General waste generation	Municipal Solid Waste (MSW) generated per year (TURKSTAT, Ministry of Environment and Urbanisation)		x	x			x			x			x			
CORE	10	Packaging waste generation	Packaging waste generated (TURKSTAT, Ministry of Environment and Urbanisation)		x	x	x	x				x			x			
		RESPONSES																
CORE	11	Treatment	Municipal Waste Treatment Waste recycling (Ministry of Environment and Urbanisation) SDG indictor 12.5.1		x	x			x			x			x			
CORE	12	Recycling	Recycling of packaging waste (TURKSTAT, Ministry of Environment and Urbanisation)		x	x		x				x			x			

Table 6. 7. Proposed Turkish indicators on "pathways", state of pollution and impact and results of multi-criteria analysis

		Type/topic	Indicator	Policy relevance						Applicability	Issue relevancy					Maturity	Data availability	Level of detail
				MSFD	C. Econ	Waste D	SUP D	Pack D	Others		D	P	S	I	R			
		PATHWAYS																
CORE	13	River banks	Litter items on river banks using OSPAR or MSFD litter categories	x	x				x			x	x					
	14	River flow	Annual average river flow (General Directorate of State Hydraulic Works)	NA	NA	NA	NA	NA	NA			x						NA
CORE	15	River water column	River surface macrolitter	x	x				x			x	x					
		STATE of Pollution																
CORE	16	Coastline	Beach macrolitter (Ministry of Environment and Urbanisation, Scientidic researches and projects)	x			x						x					
CORE	17	Sea water column	Seasurface microlitter (Ministry of Environment and Urbanisation, Scientific researches and projects)	x									x					
CORE	18	Sea water column	Watercolumn microlitter (Ministry of Environment and Urbanisation, Scientidic researches and projects)	x									x					
CORE	19	Seafloor	Sediment microlitter (Ministry of Environment and Urbanisation, Scientidic researches and projects)	x									x					
CORE	20	Seafloor	Seabed macrolitter (Ministry of Environment and Urbanisation, Scientidic researches and projects)	x			x						x					
		IMPACTS																
CORE	21		Beach cleanup costs (thousands €/year or/km)	x										x				NA
SITE SPECIFIC	22	Ingestion - Fish	Microplastic ingestion by fish (Ministry of Environment and Urbanisation, Scientidic researches and projects)	x										x				

6.3.3. Recommendations for Implementing the Holistic Assessment of Marine Litter in Turkey

Recommendation 1: invest in further developing indicators from sources-to-sea and especially for pathways indicators. There is a lack of monitoring for freshwater environments, rivers and lakes. Development of indicators on WWTPs and WWTP sludges, as they represent opportunities to intercede and measure waste from urban effluents, is necessary.

There is a lack of data for macro beach litter data. There is a comparatively mature methodology for this indicator on the world scale. It is recommended to improve monitoring efforts for a beach litter indicator in Turkey.

Recommendation 2: develop indicators of socio-economic impacts. Include beach clean-up costs, as they reflect a direct socio-economic impact on recreation and tourism, and data may be easily retrieved.

Recommendation 3: Different scales (e.g. tonnes for waste and items for litter) and detail levels between the waste and litter indicators do not allow a fair comparison of sources and sinks of litter. Harmonised monitoring methodology and monitoring efforts should be improved to have holistic assessments on the origins, pathways, abundance and effects of marine litter. Therefore, waste indicators should enable decoupling with the marine litter indicators in order to monitor the problem from the source to the sink.

Recommendation 4: support the harmonisation and monitoring of MSFD, Waste Framework Directive and SUPs Directive. EU policies need to be well aligned to establish well-defined targets and monitoring indicators. Although many positive steps were taken in recent years, legislative integration efforts are still in very early stages, and there are still significant gaps, especially for the MSFD harmonisation in Turkey. Besides, the existing measures aiming to curb marine litter in freshwater legislation are insufficient.

Recommendation 5: Build on scoping approach and further develop methods to model the plastic waste cycle better and estimate plastic leakages into the environment. Use modelling tools for the assessment of riverine litter and other litter types, where data gaps exist. Focus on the amount of "mismanaged waste" and the comparison of what is found in the environment to establish strong links between the source and the sink of litter.

CHAPTER 7

CONCLUSION

7.1. International and Regional Efforts on Curbing Marine Litter

Marine litter has become subject to scientific researches since the 1960s but globally recognised as an environmental problem since 1992, the UN Conference on Environment and Development in Rio de Janeiro. The Conference adopted Agenda 21, which defined "*litter and plastics*" as among the "*contaminants that pose the greatest threat to the marine environment*". Various international treaties have integrated marine litter into their provisions since Agenda 21.

The marine litter issue initially found its place in marine-related international law. International legislative efforts to curb plastic pollution and prevent marine litter have started after the 1990s, and meanwhile, at the sink of litter. FAO, in 1995, published a series of provisions and standards, the Code of Conduct for Responsible Fisheries. UNCLOS, in 1995, added provisions to prevent abandoned fishing gear. MARPOL Convention in 1997, Annex V imposes a complete ban on the dumping into the sea from ships of plastic, such as synthetic ropes, synthetic fishing nets and plastic garbage bags.

In 1995, the Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities recognised that there has been "international action to prevent the discharge of plastics and other persistent wastes from vessels", but notes and estimates that "approximately 80 per cent of persistent wastes originate from the land". Land-based sources of marine litter gained attention only after the 2000s. As a result of the evolving understanding of the problem, the first UNEA resolution in 2014 was a milestone for the holistic recognition of the marine litter problem on an international scale. The Assembly

requested the Member States to address marine litter sources and undertake "an assessment of the effectiveness of relevant international, regional and subregional governance strategies and approaches to combat marine plastic litter and microplastics. Since 2014, three more resolutions were published by the UNEA on marine litter.

A binding international agreement and effort is necessary but is possible with investing in scientific research on biological and environmental effects of macro, micro and nano-plastics, to convince decision-makers and the public with concrete evidence. We must remember that today's global awareness and binding actions on climate change is based on decades of scientific monitoring and research on greenhouse gasses and the effects of their accumulation in the atmosphere.

UNGA and UNEA resolutions are building blocks for the development of a binding international agreement. A binding international marine litter agreement can accelerate the global efforts for the solution as it can help to harmonise country and regional scale methodology and approaches and regulate the integration of international environmental legislation with regard to litter.

Around 80 per cent of marine litter consists of plastics. Therefore, the marine litter problem generally refers to a plastic pollution problem, which is a result of linear economies and mismanaged plastic waste. A fair approach to achieving a global circular economy is necessary. Economic differences between north and south countries should also be considered while working through the solution. Developed countries must help developing countries to build their practices on, especially proper waste management. Besides, developed countries must stop using developing countries (where uncontrolled waste dumping percentage is high and recycling capacity is so low) as their dumpsites for plastic waste.

Regional sea conventions are vital for developing and implementing marine litter legislation, regional action plans, and monitoring. Inclusion of marine litter provisions to RSCs existing regulations and protocols has already started. All RSCs

produced marine litter action plans recently, covering pan-European seas. Their efforts on regional monitoring of litter are essential to define the status, impacts and trends, which set the basis for policymaking.

The recent amendment of the BASEL Convention, which sets out control for the plastic waste trade, should be taken to a further step to ban the waste trade. If one looks at the magnitude of the plastics trade, it is easy to understand the importance of the BASEL decision: recycled plastic is a globally traded commodity. 78 % of the exports are done by the top ten countries, which are high income at the same time. In total, they have exported 168 million tonnes from 1988 to 2016, equivalent to 65 billion US dollars economic value (Our World in Data, 2018). EU is an essential exporter to third countries. Developed countries must stop exporting their waste to developing countries, where recycling technology and legal control are not strong enough to guarantee a successful recycling process.

Once it occurs, pollution has harmful effects on human health and the ecosystems. Besides, cleaning up the pollution after it occurs at its sink requires immense effort and finances. The recent mucilage problem in the Marmara Sea is an excellent example of the results of exceeding the carrying capacity of the sea system. In the absence of biological treatment facilities around the Marmara Sea, nitrogen and phosphorus loads that have entered the sea for the last 20-30 years finally enabled excessive biological production. Excessive land-based loads created deoxygenation, which was the same reason that caused mucilage, which recently covered a vast area of the Marmara Sea surface (Yücel, 2021). In response, the MoEU published a Circular on the Implementation of the Sea of Marmara Action Plan dated 07 June 2021 (Circular No: 2021/12) to clean up the mucilage. Remediation or cleaning up the pollution is essential. However, it is the least preferred solution to pollution as it refers to a state that most of the environmental harm has already taken place. In mucilage or plastic pollution and marine litter, to avoid undesired consequences on human health and the ecosystems, pollution prevention should be the primary purpose.

7.2. Marine Litter within the Context of Circular Economy

The purpose of a circular economy is to keep resources and goods in use. Circular material usage aims at reducing waste creation and our economic dependency on extraction and importations of raw materials, including recycling, reuse and repair. A circular economy is vital to solving the plastics problem, close the loop in material flow and therefore prevent plastics from becoming waste.

We have been using plastics for only 70 years. However, there has been a gradual and unprecedented increase in the use of plastics in every part of life. About 8 billion tonnes of plastic have been produced since the 1950s, and by 2015, 6.3 billion tonnes of those have become waste. As our economies are still linear, unfortunately, a crucial portion of the plastic in use will also become waste. We are not doing well when it comes to recycling and keeping plastics in the economic loop.

The consequence of the linear economies; mismanaged waste, and therefore plastics, particularly leaks to the environment, carried by the rivers or wind, is the reason for marine litter. Around 80 per cent of the marine litter is plastics, which might persist in the environment for hundreds of years.

We need to act to move away from linear production and consumption of plastics to avoid marine litter. A different perspective now is more circularity and more sustainability and smarter use, which means using less plastic more rationally and returning used plastics to the economy. The safe and sustainable design of plastics products is of utmost essential. It can reduce the impact on climate, the leakage of pollution to air and water and minimise toxicity to humans and nature. Where it is still not possible to avoid plastic waste; recycling, incineration, and proper landfilling are good options to prevent marine plastic litter.

The marine litter problem cannot be solved without upstream circular economy approaches. Plastics economy lies at the heart of the problem and the solution. If

we want to solve the marine litter problem, we need everyone to act globally, coordinative. Without globally agreed extended producer responsibility schemes, the economics of recycling simply do not stack up. Collecting, sorting and recycling plastics are more expensive than producing virgin plastics, and this creates a significant global economic gap. If we may achieve an international agreement that includes mandatory extended producer responsibility schemes, we can create a fair and competitive plastics market. Thus, recycling rates for plastic packaging can meaningfully increase.

We need to invest in recycling and waste management sectors to prevent leakages. Besides, the plastics industry requires a bulk amount of investment to produce more sustainably and circularly. Legislative measures are also crucial to the change we produce and consume. We must ban the use of single-use plastics to the most possible extend and will bring mandatory extended producer responsibility schemes for the producers and support innovation in the plastics sector. Besides, we must educate the public to change consumer behaviour and choices.

Monitoring the circular economy performances can also provide information on the drivers of change for marine litter. As marine litter is a direct consequence of linear economies, poor waste management practices, and a low level of awareness, monitoring of plastics and marine litter from source to sea are beneficial to monitor the success and trends in the circular economy transition process in the national, the EU and global level. In other words, moving towards a circular economy will help the solution of the marine litter problem, and monitoring of marine litter from source to sea will provide crucial information on the progress.

7.3. The European Union Efforts on Curbing Marine Litter

Beaches along the European Seas are littered. The most common types of litter detected are plastic pieces, fishing-related litter, and packaging. Over 80% of items found are made of plastic. Plastic is the most common type of litter found on the seafloor in all of the places investigated. Despite the lack of regular regional

monitoring, scientific studies and EU programs show that rivers and seas contain a significant microlitter.

With the acknowledgement of the marine litter problem, in the last decade, numerous EU policies came into force, targeting and addressing marine issues directly. The major policies are the EU Marine Strategy Framework Directive (2008), which addresses marine litter as one of the descriptors of "good environmental status" in European seas; the Circular Economy Action Plan (2015), which aims to *"close the loop"* and requires the change and integration of EU legislation through a material efficient economy; its Plastics Strategy (2018); Waste Framework Directive (2008) setting measurable targets for recycling, and Waste Package (2018) amending Waste Framework Directive, Packaging and Packaging Waste Directive and the Landfill Directive in line with the Circular economy and Plastic Strategy objectives; and the restrictive measures on single-use plastic (SUP) items brought by the recent Single-Use Plastics Directive (SUP Directive, 2019); Plastic Carrier Bags Directive (2015) aiming to minimise the adverse environmental effects of plastic bags and their contribution to littering; the proposed Registration Evaluation Authorisation and Restriction of Chemicals; proposal in 2019) regulation amendment (proposal in 2019) bringing restrictions and bans for microplastics; recently adopted marine litter collection measures within the Port Reception Facilities Directive (2019).

With the European Green Deal and its strategies on Circular Economy and Zero Pollution, the solution of the plastic pollution and marine litter problem gained new momentum. Green Deal is a comprehensive policy commitment, which brings an integrated and holistic approach to solve environmental problems.

Europe now has well-defined strategies and legislative tools that aim for more crosscutting integration to tackle the marine litter problem, precise production, recycling, reduction and collection targets for plastics. This positive approach should be continued and improved. Waste legislation and management should be improved to be able to prevent leakages before and from waste landfills.

Although many remarkable steps were taken in recent years, integration of the legislation is still in the early stages, and there are still significant gaps, especially for the freshwater legislation concerning marine litter. The litter problem cannot be solved by only regulating the sea and the beaches; freshwater legislation must include active measures and clear targets for a complete and holistic solution.

While the EU acquis is moving towards a more integrated structure for solutions, monitoring efforts should also be enhanced for good policy feedbacks. Harmonised monitoring methodology and monitoring efforts should be improved to assess the abundance and effects of marine litter. Besides, waste indicators should enable decoupling with the marine litter indicators to monitor the problem from source to the sink.

There is a lack of data for freshwater environments. The methodological developments in the riverine litter are at the early stages. Rivers are crucial for understanding the relationship between the source and the sink of marine litter. A particular focus must be attributed to the development of riverine litter methodology and monitoring.

EU is a dominant actor in the environmental field and should play a leading role in establishing a marine litter agreement at the UN. Besides international scientific standards, monitoring methodologies need to be developed urgently to define the status, impacts, sources and pathways of marine litter.

7.4. Turkey's efforts on Curbing Marine Litter

There is undoubtedly a need for beach litter surveys to monitor the abundance of plastic items, and single-use Litter was abundant in the case study for the Mediterranean beaches. Turkish rivers play an essential role in transporting litter items from the terrestrial to the marine environment. Litter is widespread on the seafloor across the areas assessed, with plastic being the predominant material. There is no monitoring and information to generate a broad picture of amounts of

macro and micro litter in the rivers. Levels of microplastic ingestion by fishes in Turkey is high (around 53-66%). Harmonised monitoring methodology and monitoring efforts should be improved to have better assessments of the abundance and effects of marine litter.

Having a robust approach and well-designed legislative system in Turkey in line with the EU and global, regional actions as regional sea conventions will not only help to prevent the environmental damage and human health problems caused by marine litter but also have positive impacts on the plastics and waste economy. In addition, monitoring measures and indicators are necessary to define the gaps, reflect the trends in marine litter and monitor the success of the actions and policies.

Turkey's waste legislation is at a good level of harmonisation with the EU acquis. Turkey should continue efforts to comply, and implementation of the legislation must be strengthened. Intensive work through a more circular economy is required to reach the National Waste Management Plan's objectives and targets. Besides, recent amendments to the BASEL Convention regarding scrap plastic trade must be adopted to national legislation immediately. Turkey should not accept other countries waste and avoid imports of scrap plastic.

Legislation concerning marine litter from source to the sink should address each other and build up in an integrated structure, which enables to work in harmony and effectively.

Turkey has urgent daily economic and social problems compared to environmental priorities. Introducing nationwide campaigns, educational programmes, training activities, and support of environmental NGOs can help the public to recognise environmental problems as important as economic ones.

7.5. A Proposal for Holistic Assessment of Marine Litter in Europe

While the EU acquis is moving towards a more integrated structure for solutions, monitoring efforts should also follow to provide healthy policy feedbacks. Harmonised monitoring methodology and monitoring efforts should be improved in order to have holistic assessments on the origins, pathways, abundance and effects of marine litter. Therefore, waste indicators should enable coupling with the marine litter indicators to monitor the problem from the source to the sink.

The marine litter indicators scoping study has revealed that some of the European scale indicators were well developed and implemented (e.g. waste management indicators, beach litter indicator). Other indicators need to be further developed but are very valuable (e.g. riverine litter indicators). Europe should invest in also developing indicators from sources-to-sea and emerging monitoring technologies and harmonise indicators across different land-sea domains.

The proposed core set of marine litter indicators are a sound basis for future marine litter assessments in Europe. This approach can assess the state of litter pollution in light of specific waste performances. It is recommended to use the scoping study further to develop methods for modelling the plastic waste cycle and estimate plastic leakages into the environment. Marine litter status assessments can be supported by drivers, pressures, pathways indicators to explain the causalities between the source of the litter and the sink.

A critical quantification to be focused for future marine litter assessments must be on “mismanaged waste”, which leads to marine litter, and it can only be estimated based on other waste indicators and based on what is found in the environment.

7.6. The Marine Litter indicators Scoping Exercise for Turkey

Indicators are crucial tools to monitor the policy progress and establish meaningful links on the policy goals and targets. They provide an understanding of the

relationship between the environmental pressures and their sources. A good example of an multi-indicator based assessment is the UN "System of Environmental-Economic Accounting 2012–- Experimental Ecosystem Accounting", which focuses on defining the relationships between the environment and economy with an ecosystems based approach with the help of a variety of indicators from source to sink, and covering economic, social and environmental systems (UN WGSEEA, 2020). Multi-indicator based assessments can help to provide better solutions for the sustainability.

Turkey must continue to invest in further developing indicators from sources-to-sea, and especially for pathways indicators. Drivers, pressures and responses indicators are well developed, and they have a good level of maturity compared to EU indicators. However, the lack of monitoring for riverine litter hinders the opportunities to measure waste flows from the source to the marine environment.

Lack of data for macro beach litter data can easily be covered with investing in monitoring efforts and NGO networks' help. Therefore, beach litter methodology is mature enough in the EU scale and data easier to collect than riverine or sea litter data. It is recommended to improve monitoring efforts for beach litter indicator in Turkey immediately, to have a better picture of litter accumulation and flows.

Given the vast range of economic, social and environmental consequences, it is difficult to calculate the entire economic cost of marine litter. Some of the effects, such as higher marine litter cleaning costs, are easier to quantify in economic terms because they are more direct (Newman et al., 2015). A relatively mature and easy to monitor/estimate indicator to evaluate marine litter impacts is "beach clean-up costs". Many communities and businesses must clean their beaches before the start of the summer season to stimulate the appeal of their facilities (EEA, 2016c). Around € 18 million is spent annually on clean-ups in the United Kingdom. The theoretical projected cost for maintaining the total clean of 34 million kilometres of world coasts is $69 billion (EUR 50 billion) per year (UNEP, 2017). Turkey should develop indicators on socio-economic impacts, which might provide valuable

information and allow for the assessment of economic and social costs of (from tourism to fisheries) marine litter.

Turkey should accelerate the harmonisation and monitoring of the MSFD, Waste Framework Directive and SUP Directive. EU policies need to be well aligned in order to establish well-defined targets and monitoring indicators. Although many positive steps were taken in recent years, legislative integration efforts are still in very early stages, and there are still significant gaps, especially for the MSFD harmonisation in Turkey. Besides, there is no freshwater legislation concerning marine litter.

Source to sink indicator based marine litter assessment approach proposed by this study should further be developed to model the plastic waste cycle better and estimate plastic leakages into the environment. Indicator based scoping approach might help to monitor provincial marine litter plans, as it utilises existing available data on drivers, pressures and responses and therefore, it is useful to fill in data gaps on marine litter. Where the core set of indicators will not be sufficient to describe a clear picture of the marine litter problem, its sources, pathways and state and impacts, modelling tools for the assessment of riverine litter and other litter types can be used for estimations.

7.7. Future Work

A source to sea, indicator-based holistic assessment methodology, which uses the DPSIR framework, was presented in this thesis. The proposed core set of marine litter indicators are selected from the available indicators in European and Turkish scales. The core set can be updated according to the availability of future indicators and information on sources, pathways and the status of marine litter.

A future assessment methodology based on the marine litter indicators in a DPSIR spectrum can be developed and implemented to utilise the core set of indicators proposed by this thesis. Existing analytical methodologies and available data can

be used and sustain the assessment. The use of “multi-metric indicator-based assessment tools”, which are widely used for the HELCOM and the EEA marine assessments, is recommended for assessing marine litter status in the sea domain. Multimetric indicators are generated by averaging or summing metrics. Available different types of macro and microliter information on indicators (status and impact indicators) can be overlapped, and data gaps might be minimised by using multi-metric indicator-based assessment tools. These tools help overlay various indicators and provide a “good” or “bad” status as a single outcome of the status.

For the amount of waste generated at the sources, “material flow analysis” can be used to describe mismanaged plastic waste and the waste performances of the countries. In recent years, several methodologies using material flow analysis have been developed and applied for plastic waste. Up until now, the methodology was not applied Europe-wide for plastics. The EEA is currently implementing a project to use this methodology on a pan-European scale. The results will be available at the end of 2021.

Hydrological transport models can be used to estimate discharges of plastics and the riverine flows of litter.

The combined use of the tools mentioned above (material flow analysis for the land domain, hydrological models to assess the waste flows through pathways and multi-metric indicator-based assessment tools for the marine litter status of seas) might help assess the marine litter in a holistic context, from source to sink.

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