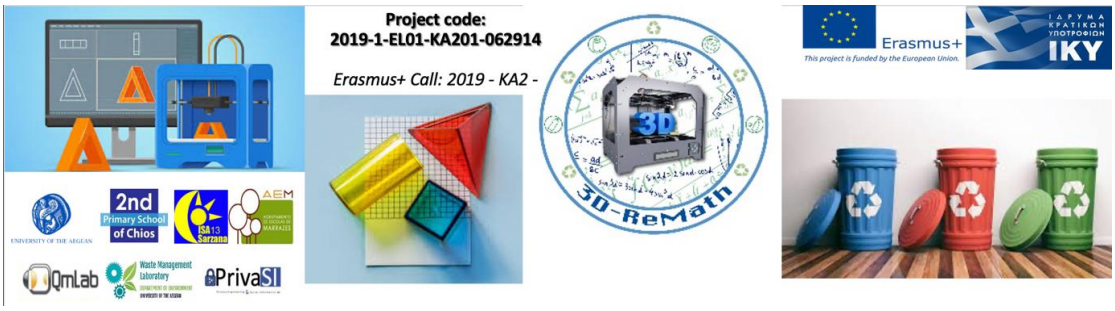

Intellectual Output 4

Curricula on Recycling

Part B

MICROPLASTICS IN THE MARINE ENVIRONMENT AND MARINE LITTER Handbook

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1. General

Marine environment includes the water masses of the planet such as seas and lakes as well as all marine species. It should be protected and conserved due to its vital role on Earth. The seas and oceans are our greatest source of biodiversity since they cover 71 % of the Earth's surface and they contain 90 % of the biosphere.

Marine environment is related to a lot of aspects of our lives, since economic activities such as tourism are based on it and its environmental condition. The EU's aim — according to the Lisbon agenda — is to become the world's most competitive and dynamic knowledge-driven economy by 2010.

Marine litter affects the oceans globally and plastics seem to be a major problem in marine ecosystems' health. Images with plastics in the marine environment are known worldwide. A lot of clean ups are organized to reduce litter from the seas, but this is not the most efficient method.

Plastic seems to be banned in EU and actions like plastic free events are starting to increase between the countries. This seems to agree with the first step of waste management hierarchy, which is prevention. Avoidance of plastic means that we search for alternative solutions and this is the first step to reduce plastic.

Except from plastics, microplastics and their impacts on ecosystems and on human's health are of great concern. We have to understand what microplastics are, what are their impacts and if there is a way to cope with the situation.

3D printing gives an alternative way of management for plastic items. It does not require the same procedure as recycling as it can be done on a smaller scale such as in the case of a school curriculum. 3D ReMath aims to use 3D printing at schools in order to give an alternative management with the participation of students.

2.Human pressure on marine environment

Marine ecosystems include: the abyssal plain (areas like deep sea coral, whale falls, and brine pools), polar regions such as the Antarctic and Arctic, coral reefs, the deep sea (such as the community found in the abyssal water column), hydrothermal vents, kelp forests, mangroves, the open ocean, rocky shores, salt marshes and mudflats, and sandy shores (Europa, 2018).

Some of the main human pressures on the marine environment are:

- Fishing: The pressure is reducing nowadays, but decades of overfishing have affected ecosystem integrity.
- Damage to sea floor habitats is likely to increase with the growth of maritime activities.
- Pollution by nutrient enrichment and contaminants remains an environmental challenge.
- Non-indigenous species are spreading, and their impacts are not fully assessed.
- Marine litter and underwater noise are adding pressures but are still poorly understood.

Image 1. Marine litter problem, **Source:** https://www.unenvironment.org/

There are some important points that need to be stressed. Marine ecosystem consists of different water body mases. Four main types are shown in Figure 1.

Figure 1. Types of water masses

- A lake is a large body of water that is surrounded by land.
- A river is a large, flowing body of water that empties into a sea or an ocean. Streams, creeks, and brooks are smaller tributaries of a river.
- A sea is also a body of salt water, partly or completely surrounded by land, and often connected to the ocean. Seas are generally smaller than oceans.
- Oceans, the largest bodies of water, cover more than two-thirds of the Earth's surface. An ocean is a vast body of salt water that surrounds a continent.

More information on water bodies can be found at: https://sciencing.com/differences-between-bodies-water-5776759.html

3. Marine litter

Marine litter is defined as any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment. Marine litter originates from many sources and causes a wide spectrum of environmental, economic, safety, health and cultural impacts. The very slow rate of degradation of most marine litter items, mainly

plastics, together with the continuously growing quantity of the litter and debris disposed, is leading to a gradual increase in marine litter found at sea and on the shores.

More information is available at:

https://www.unenvironment.org/explore-topics/oceans-seas/what-we-do/working-regional-seas/marine-litter,

https://www.marinelittersolutions.com/about-marine-litter/frequently-asked-questions/?gclid=Cj0KCQjwzN71BRCOARIsAF8pjfgYA1eN9IJJb--64MRpWnLjDswrzF1Ky8G9Ztc9cCNJe9rgtnPBYRAaAjQpEALw_wcB

4. Plastics in the environment

Plastics are everywhere. In our daily lives we see them around us, we buy them, we throw them in bins or we recycle them. It is interesting to understand the meaning of the word and to give the definition of plastics. Plastic is a word known worldwide, but it is originated from Greek language. It comes from the Greek word “platho” (πλάθω) which means “I give shape”. This explains why plastics have a lot of different shapes in packaging products. They describe a wide range of synthetic or semi-synthetic materials that are used in a huge and growing range of applications.

In 1909, a Belgian chemist named Leo Baekeland created the first entirely synthetic plastic—and it would revolutionize the way many consumer goods were manufactured. Baekeland called his plastic “Bakelite”. It was lightweight and durable, and it could be molded into nearly infinite shapes, so its use quickly expanded as manufacturers realized its potential.

The evolution of plastic is showed in the following pictures by British Plastics Federation with the main use and products plastic was used.

Image 2. Plastics evolution during 1930 and 1940, **Source**: https://www.bpf.co.uk/

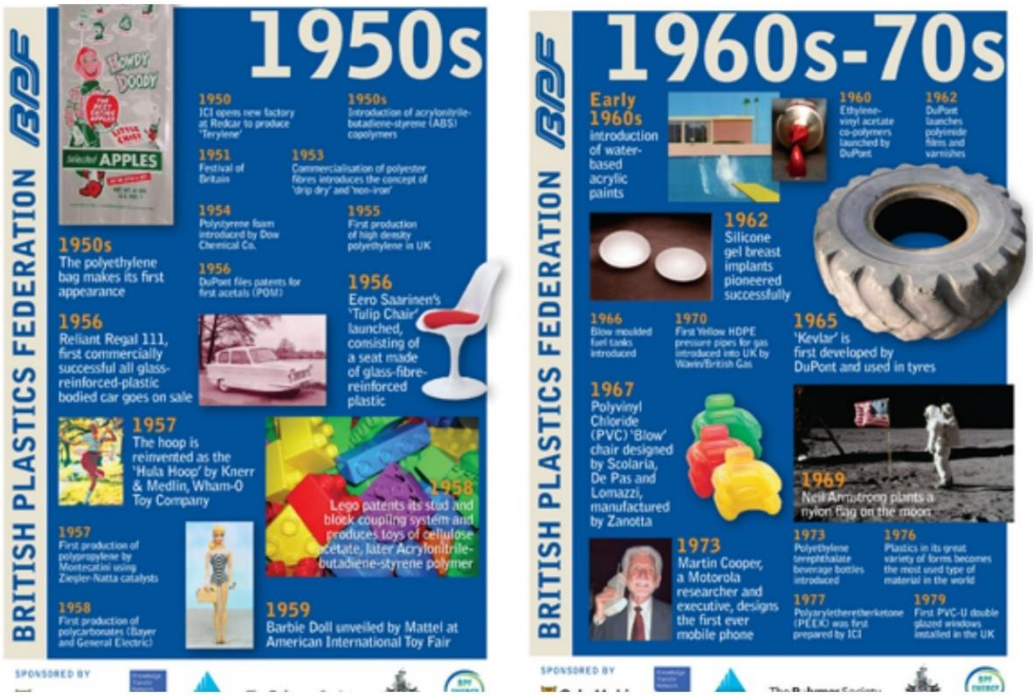

Image 3. Plastics evolution during 1950,1960 and 1970, **Source**: https://www.bpf.co.uk/

Image 4. Plastics evolution during 1980, 1990, 2000 and 2010,
Source: https://www.bpf.co.uk/

Images 2, 3 and 4 show that the quantity of plastic increased with the acquisition of more and more cases in which it could be used. Most objects have a plastic element, from a simple game to an airplane, from a watch to a cell phone. Even medical equipment, furniture and cars contain plastic parts.

It is easy to understand that plastic dominates in many aspects of the economy and society. Many different industries need plastic items either as part of their products or because their product is basically plastic.

5. Microplastics in the environment

The term microplastics generally refers to plastic particles between 0.33 mm and 5 mm in size. They can originate from a variety of sources including, microbeads from personal care products; fibers from synthetic clothing; pre-production pellets and powders; and fragments degraded from larger plastic products.

There are two types of microplastics, primary and secondary.

1 *Primary microplastics:* They are manufactured as microbeads, capsules, fibers or pellets. Examples include microbeads used in cosmetics and personal care products, industrial scrubbers used for abrasive blast cleaning, microfibers used in textiles, and virgin resin pellets used in plastic manufacturing processes.

Image 5. Primary micoplastics, **Source:** https://www.zerowastelady.com/home/from-saint-to-killer-the-rise-fall-of-plastic#/

2 *Secondary microplastics:* They are the result of larger pieces of plastic breaking down into smaller pieces. This occurs when plastic debris is exposed to sunlight and the plastic begins to weather and fragment.

Image 6. Secondary microplastics, **Source:** https://theplasticchallenge.org/what-is-microplastic-pollution

Intentionally added microplastic particles are used in a range of products placed on the EU market including certain types of fertilisers, plant protection products, leave-on and rinse-off cosmetic products, household and industrial detergents, cleaning products, as well as paints and products used in the oil and gas industry.

In consumer goods, microplastic particles are best known for being abrasives (e.g. as exfoliating and polishing agents in cosmetics known as microbeads), but can also have other functions, such as controlling the thickness, appearance and stability of a product. They are even used as glitters or in make-up.

Overall, around 50 000 tonnes of microplastics are estimated to be used in the EU/EEA each year. Around 36 000 tonnes are released to the environment annually (not including releases from infill material used in artificial turfs).

The pollution from microplastics has anegative impact on the following sectors:

- Marine environment 
- Food & Health 
- Climate change  :

Plastic, which is a petroleum product, also contributes to global warming. If plastic waste is incinerated, it releases carbon dioxide into the atmosphere, thereby increasing carbon emissions.

- Tourism 

Plastic waste decreases the aesthetic value of tourist destinations, leading to decreased tourism-related incomes and major economic costs related to the cleaning and maintenance of the sites.

More information is available at : https://www.iucn.org/resources/issues-briefs/marine-plastics)

According to ECHA, animal studies have produced evidence to suggest that our bodies might absorb very small microplastics. (https://www.medicalnewstoday.com/). However, a report by the World Health Organization (WHO) explains that the experimental conditions in these studies resulted in “extremely high exposures that would not occur in drinking water.”

Microplastics accumulate in animals, including fish and are consumed as food by humans. This led ECHA to suggest a wide-ranging restriction in 2019 on intentional uses of microplastics in products placed on the EU/EEA market to avoid or reduce their release to the environment. The proposal is estimated to cut down emissions by at least 85 % and prevent the release of 400 000 tonnes of microplastics over the 20-year period following its introduction.

Some of the effects of microplastics in aquatic biota are presented in Image 7, while the pathway of plastics is presented in Image 8.

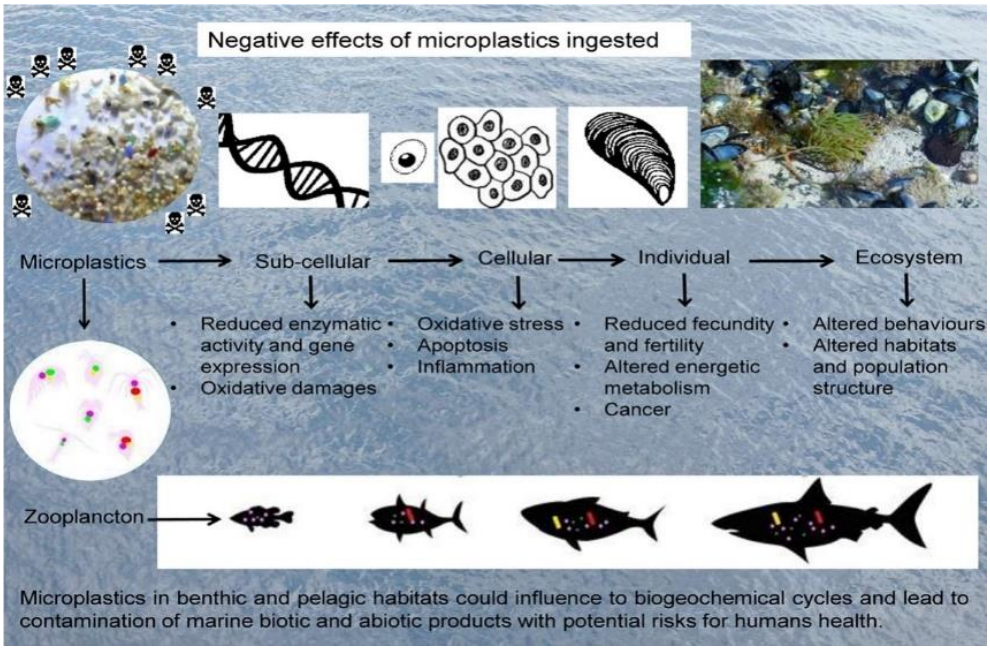

Image 7. Effects of microplastics, **Source**: Guzzeti et al., 2018

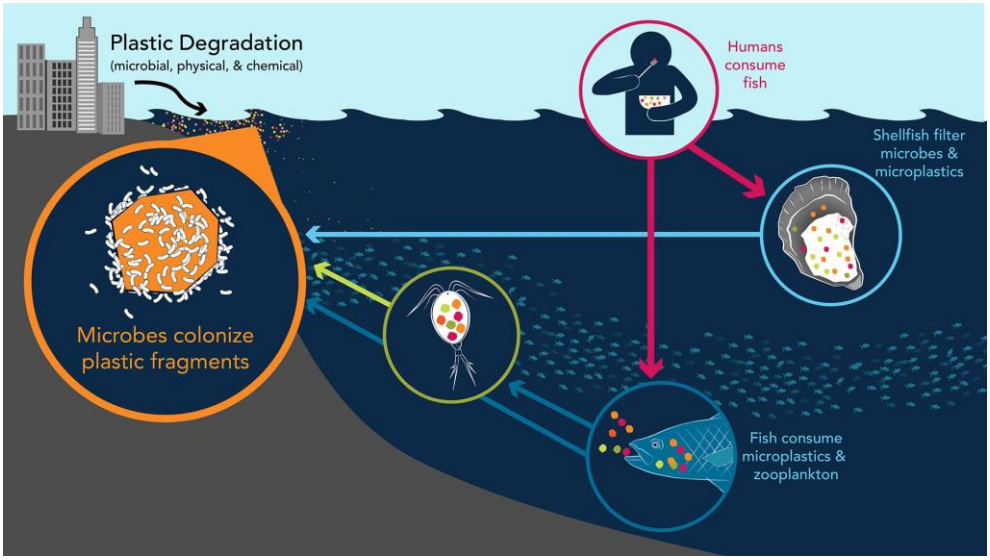

Image 8. Pathway of microplastics, **Source:** UNEP, 2016

Microplastics can reach the marine environment from different sources (Image 9), we couldn't even think some of them. Synthetic textiles in our clothes, car tires even city dust can contain microplastics.

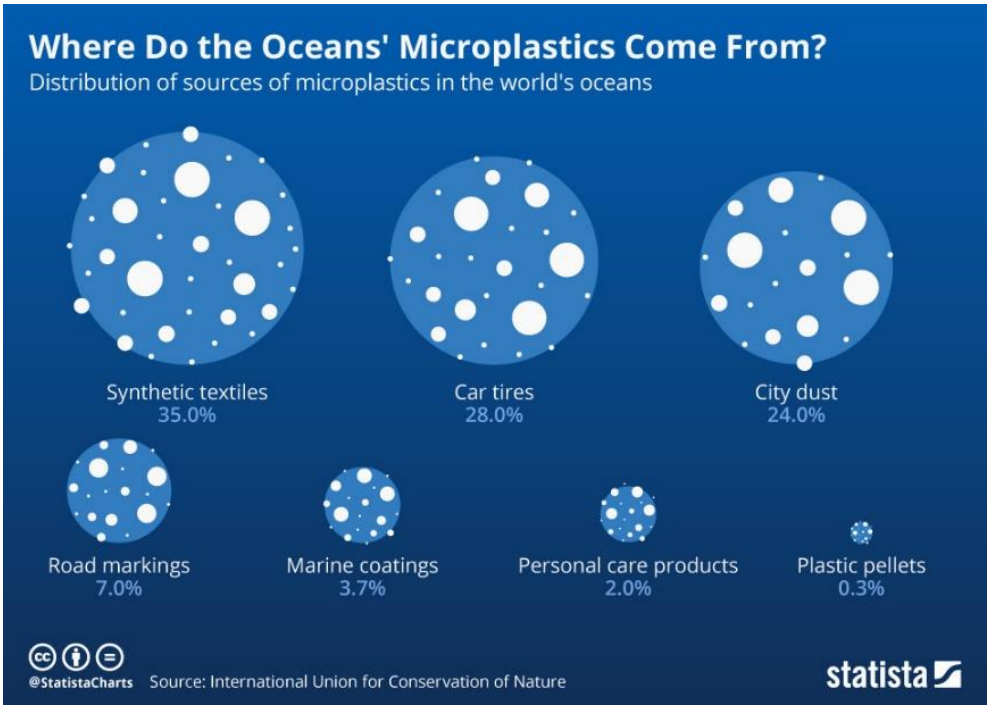

Image 9. Sources of microplastics, **Source:** https://europeansting.com

6. Environmental effects of marine litter

A short list of the major effects of marine litter on marine environment includes the following:

- Impacts on fisheries and aquaculture
- Impacts on shipping and ports
- Clean-up costs of floating, seafloor litter and beach
- Decrease in the aesthetic value and beauty of the coast
- Perceptions of society about marine litter
- Human health risks
- Ecosystem services
- Harm to biota
- Socioeconomic harm

More information is available on the following link: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC104308/lbna28317enn.pdf

7. Current situation

7.1. Legislation on the use of microplastics

European Union has published the European Strategy for Plastics in a Circular Economy (European Commission, 2015) and the Directive (EU) 2015/720 of the European Parliament and of the Council of 29 April 2015 amending Directive 94/62/EC as regards reducing the consumption of lightweight plastic carrier bags. The focus is on reducing plastic bag carrying items. The directive sets goals for quantitative reduction but separates the bags according to their thickness.

The measures taken by Member countries shall include either or both of the following:

(a) the adoption of measures ensuring that the annual consumption level does not exceed 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. Very lightweight plastic carrier bags may be excluded from national consumption objectives.

(b) the adoption of instruments ensuring that, by 31 December 2018, lightweight plastic carrier bags are not provided free of charge at the point of sale of goods or products, unless equally effective instruments are implemented. Very lightweight plastic carrier bags may be excluded from those measures.

More information is available on the full text of the directive at:

https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32015L0720

Recently a new European Directive (2019/904) has been published on the reduction of the impact of certain plastic products on the environment (EU, 2019). Each member country should embed the Directive on its national legislation.

7.2. Project's Presentation

7.2.1. PTwist Project

PTwist is a project of Horizon 2020 coordinated by: ARISTOTELIO PANEPISTIMIO THESSALONIKIS in Greece. The project was implemented from 1/1/2018 until 31/12/2019. PTwist aims to design, deploy, and validate an open platform which will twist plastic reuse practices, by boosting citizens awareness, circular economy practices, and sustainable innovation in line with the new plastics economy vision. Specifically, the action taken by Greece in the context of the program is the creation of a playground from plastic waste. By collecting marine plastic waste from the clean-up activities, plastic industries will produce a plastic resin to create benches, canoes, tiles, swings and other types of outdoor equipment.

Image 10. Benches for the project playground, **Source:** https://ptwist.eu/

More information for the project is available at: https://ptwist.eu/

7.2.2. Azores Project

WASTE FREE OCEANS (WFO) is an organization acting globally against marine litter. It has established partnerships all over the world including Europe, Asia, America and Turkey. The aim of the organization is to reduce the global impact of marine litter. By mobilizing fisheries, recyclers, manufacturers and policy makers, WFO aims to reduce, reuse and ultimately recycle marine litter, mitigating the impact on both the environment and natural resources.

A big project on marine litter in Europe is the Azores project. The main target is to collect marine litter and to find ways to transform it to a new product. Once the plastic is collected, the next step is to find creative ways to reuse it. Many companies have started using recycled

plastic as it is suggested by a circular economy scheme. The use of plastics and their transformationinto useful goods can help in tackling marine pollution.

More information for the project is available on : https://www.wastefreeoceans.org/

7.3. Reduction in the use of microplastics as a part of corporate responsibility

Actions aiming in reducing plastics are appearing more and more globally. They are initiated usually by private companies so as to increase their corporate responsibility, or by foundations. It may involve reducing it as packaging material or as a single use item. In this section some of them are presented.

7.3.1. Barilla

Several companies have begun to shy away from plastics. For example, Barilla a famous Italian food company is reducing plastic from its packaging. The packaging system has been designed in compliance with the guidelines of EU Directive 94/62 on Packaging and Packaging waste. Some of the main goals are:

- Reducing the quantity of packaging material, utilizing all of the technological tools and latest materials on the market.
- Minimizing the use of composed materials, focusing choices on materials made up of homogeneous components that are easier to dispose of after consumption.
- Seeking logistical optimization to maximize saturation in storage and transportation.

More information is available at: https://www.barillagroup.com/en/groups-position/barilla-principles-sustainable-packaging

7.3.2 Coca-Cola – Print your city

Coca-Cola participated in a project in Greece named “Print your city COCA COLA 3D printing from plastics”. The quote of the project is “your litter my treasure” and explains that plastic waste can acquire a different value through the use of 3D printing.

More information is available at: https://www.coca-cola.gr/zero-waste-future/print-your-city-ta-skoupidia-sou-o-thisauros-mou)

7.3.3 Italy’s ski resort

Another action against plastic pollution is a resort without plastics. In Italy, the 1st ski resort which bans plastic is found. The plastic-free initiative -- which will be accompanied by signs urging guests to limit the plastics they bring into the resort -- is the first step in a longer program at Val di Sole.

The area also uses hydroelectric plants to provide energy for the valley and buildings are heated via a biomass plant, which burns wood scraps from the local timber industry.

More information is available at: https://edition.cnn.com/travel/article/italy-plastic-free-ski-resort-trnd/index.html)

7.3.4. Portugal plastic-free flights

Portugal is on the list with an action taking place on flights. Plastic-free flights is a project that Portugal is trying to implement. Flights are a service that is directly linked to the use of plastic. The estimated number of plastics during flights in 2016 was 5.2 milion tones. The world's first single-use 'plastic-free' flight took passengers on a Boxing Day trip from the carrier's base in

Lisbon to Natal, Brazil. That was followed by a trial period that saw three further plastic-free flights in addition to a series of 12 reduced plastic journeys to and from Brazil over the Christmas and New Year holiday period.

More information is available at: https://en.reset.org/blog/portuguese-airline-starts-trialling-plastic-free-flights-01242019

7.3.5 Plastic Litter Project 2018, 2019, 2020 (University of the Aegean)

The project started in 2018 from the Marine Remote Sensing Team of the University of the Aegean to detect plastic marine litter. Detection of plastic on the marine ecosystem is crucial to manage their expansion. Detecting plastics in the sea is difficult due to their transport and the reflection of sunlight. Plastic's size can also play a significant role. The smaller the pieces are the harder their detection is.

More information about the project is available at:
https://mrsg.aegean.gr/?content=&nav=55

7.4. Organizations

In addition to the various actions, there are also organizations and foundations that operate in the same direction.

7.4.1. Aegean Rebreath

Aegean Rebreath was established in 2017 to respond to the urgent need to clean the seabed and to promote the protection of Aegean biodiversity. There are activities taking place on different Greek islands during the year. Aegean Rebreath engages in various fields of activity aims in developing interrelated actions that will aim in understanding the extent of the problem of marine pollution, while identifying holistic solutions. Educational seminars are one of the main actions taking place in Greece. Marine litter collection stations are very important for achieving their goals and strengthening their relations with fishermen and coastal communities. The stations are established at harbors, where mainly fishing communities operate and are equipped with bins and relevant signage that helps citizens and fishermen place collected litter by the sea and coastal zones

More information is available at: https://www.aegeanrebreath.org/en/

7.4.2. Sto potiri mou

"Sto potiri mou" means in my glass and is a movement against the use of single use plastic when we need to drink coffee outside the house. The main idea is that we can carry our own reusable bottle or cup. The store can fill our cup and even gives citizens a reduction in the price. On their website (http://stopotirimou.gr/), it is easy to find stores all over Greece participating in the program. You can also find out about the reduction they offer to the products if you bring the reusable bottle or your cup.

7.4.3 A.C. LASKARIDIS CHARITABLE FOUNDATION

The foundation is located in Greece. It deals with waste management through programs implemented in Greek islands, mainly in Cyclades. Their aim is to act as a catalyst for a greater change than we could not achieve alone. The names of the projects are Typhoon Project, Sea Change Greek Islands. Some of the islands participating in the programs are Folegandros, Sikinos, Kimolos and Serifos. Each program aims at the participation of local communities and theincrease in their environmental awareness.

The foundation has developed a mobile application as well, named SeaDoc. Sea Doc is a free online application that was created to motivate those who love the sea and are interested in the environment to become part of the solution. The user of the application can enter data for the cleaning of the coast that participates in the map that appears on its screen.

Detailed information can be found at https://www.aclcf.org/

7.4.4. Let's Do it Foundation

Let's Do It Foundation aims at unite the global community, raise awareness and implement true change to achieve their final goal – a clean and healthy planet. The story of the Foundation began in Estonia in 2008 when 50,000 people came together to clean up the entire country in just five hours. In 2011, Let's Do It Foundation was established to spread this model to clean one country in one day. Now the foundation exists in many countries such as Greece, Italy and Portugal. The goal is to clean the beaches with the participation of local communities. Their involvement in such actions is important for increasing environmental awareness.

More information is available at https://www.letsdoitworld.org/

8. What can we do?

It is important to understand the ways we can act to help reducing the problem. Individual action is a key as well as the involvement of many individuals in reducing marine litter and its effect on the environment.

The first thing on the list is to understand the waste management pyramid. Prevention is the key. Avoiding plastic objects by choosing other materials is the first step. Reusing them either with techniques ' such as 3D printing or ideas, crafts, DIYs on an individual level is the second step. Recycling is the following step. Last is the disposal in landfills which should be avoided.

It seems that there are some basic steps to follow. Those basic steps to success are summarized in the following three:

1. Get informed about plastic pollution and its impact on their own community, the country and the world.
2. Promote internalization of concepts and environmental values associated to the problem of plastic pollution.
3. Empower your community with the civic engagement skills necessary to take action to help end plastic pollution.

More information for the steps is available on the following links: https://www.earthday.org/what-you-can-do-to-end-plastic-pollution/, https://www.earthday.org/plastic-pollution-calculator-2/

9. Activity

Participation in actions against plastic pollution is of great important in order to understand the problem from another point of view. The first step is to learn and understand the problems theoretically. But an action like participating on a clean-up of a beach can give a completely different aspect on the problem we have to deal with. Students could search the web and find information on the current situation and practices in their countries about plastic and marine litter. Let's do it world is a foundation aiming in a clean and health planet. Everything began from Estonia during a trial of clean up the entire country and now Let's do it is a movement in different countries globally. The main idea is students with let's do it of their countries, Let's

Do It Greece, Italy and Portugal to organize a cleanup of a beach at their region. Links of the websites are the following:

- https://www.letsdoititaly.org/
- https://www.letsdoitgreece.org/
- http://www.amoportugal.org/

At school, special forms can be made that list the materials and the quantities can be supplemented so that the children have a quantitative assessment of the situation they have been taught in the theory. They could process the data they have collected and present it at an event open to the public in the form of a campaign against marine littering.

The next step is the organization of a campaign. The campaign should be open to the public to inform as many people as possible about the great significance of replacing single use plastics and reducing marine litter in general. They could inform people in their neighborhoods, they can use social media, parents and try to interact with their communities. The interaction between different members of society is necessary and is the key to understand and solve all issues. Interaction with students and not with experts could have a positive impact on the change of small societies' habits.

In their campaign students can present videos, songs, results of the clean-up create a moto, a logo or a theatrical work on plastics and generally express themselves the way the think it is better to inform the public.

Because the campaign is dedicated to the fight against plastics, it must be carried out without the use of plastic objects. In this way it will seem possible to start living without the plastic objects in our daily lives.

References

Faggariba, C., Song, S., 2017. Assessment of Impediments and Factors Affecting Waste Management: A Case of Accra Metropolis, Academia Journal of Environmental Science 4(8): 144-162

Directive (EU) 2015/720 amending Directive 94/62/EC as regards reducing the consumption of lightweight plastic carrier bags

https://www.safeopedia.com/definition/2370/waste-prevention

https://de.freepik.com/vektoren-premium/afroamerikanerkinder-die-abfall-fuer-die-wiederverwertung-sammeln-muelleimerset-sortieren_5549089.htm

https://www.eu-fusions.org/index.php/italy-household/117-eco-point-initiative-for-bulk-sales-italy

https://www.zerowastelady.com/home/from-saint-to-killer-the-rise-fall-of-plastic#/

https://theplasticchallenge.org/what-is-microplastic-pollution

https://www.letsdoititaly.org/

https://www.letsdoitgreece.org/

http://www.amoportugal.org/

https://www.letsdoitworld.org/

https://www.earthday.org/what-you-can-do-to-end-plastic-pollution/

https://www.earthday.org/plastic-pollution-calculator-2/

https://www.aclcf.org/

http://stopotirimou.gr/

https://www.aegeanrebreath.org/en/

https://en.reset.org/blog/portuguese-airline-starts-trialling-plastic-free-flights-01242019

https://edition.cnn.com/travel/article/italy-plastic-free-ski-resort-trnd/index.html

https://circulareconomy.europa.eu/platform/sites/default/files/plastic_pledge_statement_barilla.pdf

https://ptwist.eu/

https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32015L0720

(https://www.iucn.org/resources/issues-briefs/marine-plastics