2. Research

Plastic pollution has been a serious threat for a long time and this is increasing everyday globally. If waste is not managed properly, it is estimated that the amount of plastic litter that enter our oceans will increase by several folds (Jambeck et al., 2015).

There are several sources of marine pollution worldwide. One way of finding out the source of marine pollution is analysing the litter types and litter composition in the marine environment. Sources can be land-based or from the oceans (Ryan et al., 2009). Some of the ocean-based litter could also end up in the shorelines but knowing the category of the litter might help in identifying the sources. This provides important information to develop pollution reduction measures for the future (Galgani et al., 2011).

Several studies have been conducted on marine plastic pollution in the recent years and various publications reporting various aspects of marine pollution. For this research Web of Science search in the whole document for “marine plastic pollution’ yielded over 2,000 results. This was refined to only articles in the last three or five(???) years, which resulted in 947 documents.

There are various types of marine plastic debris everywhere and they have been categorised according to size. Most commonly used classification on the basis of their sizes are marcrodebris (20>mm), mesodebris (5-20mm) and microdebris (<5mm) (REFERENCE??). Megadebris also exists which is usually large objects (>100mm). The problem of marine debris in terms of geographical distribution, litter type and sources has been discussed extensively by Niaounakis (2017).

Pelamatti et al. (2019) have reported the results of floating plastic monitoring programme in Banderas Bay, Mexico. The samples were collected on weekly basis for two years (May 2016-April 2018). With 100km of coastline, Banderas Bay is one of the biggest bays in Mexico. They report that 57% of the samples collected were plastic with most of them being 1-2mm in size. The smaller sizes also indicates that they were fragmented from the larger objects. They also found that more plastic pollution was recorded during hurricane season indicating the seasonal variation.

Several studies have reported the abundance of plastic in the beach litter through survey and citizen science. A 12-year dataset on coastal debris pollution in Taiwan using Citizen science also revealed that most debris items found were plastic (Walther et al., 2018). 19 categories of debris items were collected during the clean-up events. The five most commonly recorded debris categories were plastic shopping bags, plastic bottle caps, disposable tablewares, fishing equipment, and plastic drinking straws.

Another long term study was conducted on marine litter composition in south-eastern Black Sea by Terzi et al.(2020). Between 2009and 2018 eleven beaches on Tarbzon city near the south-eastern Black Sea coast in Turkey were investigated. Marine litter were sampled from 11 data stations by the volunteers. They recorded 4138 numbers of litters which weighed around 108.75kg in which plastic was found to be the most abundant litter recorded (79.69%). In this study litter composition did not change much between the years. 95.61% of marine litter found were categorised as plastic in 2015/2016 study as well (Öztekin et al., 2019).

Recent annual study (2016/2017) on 8 beaches in Tenerife in Canary island also found that plastic was the most abundant litter. They also reported that there were more accumulated plastic debris in remote beaches compared to the beaches near the city indicating that more debris were transported by tides. More long term study is required to look at the changes in the results reported over time.

Marine plastic pollution has been a problem in many remote islands as well. Study carried out by Dunlop et al.(2019) between 2009 and 2019 on Cousine Island, Seychelles showed significant increase in daily accumulation rates of litter between years. This study also confirmed that most of litter collected (80%) included some form of plastic.

# Interestingly, in a study carried out on the beach of Ensenada, Baja California, Mexico reported wood as the most abundant litter (Silva-Iñiguez and Fischer, 2003). However, this study only looked at one season and more data is required to confirm this result.

To be used for discussion later: OR a paragraph to be added in research section regarding the use of citizen science data for our project.

Citizen science projects have been used successfully to monitor biodiversity (e.g., [Dickinson et al., 2010](https://www.sciencedirect.com/science/article/pii/S0025326X18305897" \l "bb0070); [Hochachka et al., 2012](https://www.sciencedirect.com/science/article/pii/S0025326X18305897" \l "bb0130); [Hong et al., 2018](https://www.sciencedirect.com/science/article/pii/S0025326X18305897" \l "bb0135); [Sullivan et al., 2014](https://www.sciencedirect.com/science/article/pii/S0025326X18305897" \l "bb0285)). The use of citizen scientists to monitor marine pollution has also grown exponentially over the last 30 years and was recently reviewed in [Thiel et al. (2014)](https://www.sciencedirect.com/science/article/pii/S0025326X18305897" \l "bb0300), [Cigliano et al. (2015)](https://www.sciencedirect.com/science/article/pii/S0025326X18305897" \l "bb0045) and [Hidalgo-Ruz and Thiel (2015)](https://www.sciencedirect.com/science/article/pii/S0025326X18305897" \l "bb0120). While there is a diversity of approaches and goals to citizen science, most studies focused on the distribution and composition of coastal marine debris over local, regional, and international scales ([Hidalgo-Ruz and Thiel, 2015](https://www.sciencedirect.com/science/article/pii/S0025326X18305897#bb0120)). There are generally six conservation-related outcomes that citizen science projects can potentially support: policy, education, community capacity building, site management, species management, and research ([Cigliano et al., 2015](https://www.sciencedirect.com/science/article/pii/S0025326X18305897" \l "bb0045)). All reviews concluded that citizen science is an effective approach to conservation and education as well as the generation of large and valuable datasets which increase the available information on marine litter sources, distribution, and ecological impacts.

Bibtex references:

Walther at al., 2018

@article{WALTHER2018862,

title = "Type and quantity of coastal debris pollution in Taiwan: A 12-year nationwide assessment using citizen science data",

journal = "Marine Pollution Bulletin",

volume = "135",

pages = "862 - 872",

year = "2018",

issn = "0025-326X",

doi = "https://doi.org/10.1016/j.marpolbul.2018.08.025",

url = "http://www.sciencedirect.com/science/article/pii/S0025326X18305897",

author = "Bruno A. Walther and Alexander Kunz and Chieh-Shen Hu",

keywords = "Beach cleaning, Citizen science, Coastal conservation, Marine anthropogenic litter, Marine macro-debris, Plastic pollution",

abstract = "Man-made coastal debris pollution is a growing concern for Taiwan. In 2004, Taiwanese environmental organizations led by the “Society of Wilderness” began gathering data on 19 categories of debris items collected during cleanup events. We present our analysis of the resulting 12-year dataset collated from 541 events held between October 2004 and December 2016. In total, 904,302 items weighing 131,358.3 kg were collected, and 63.6% and 27.2% of items were made of either plastic or plastic mixed with other materials, respectively. The five most commonly recorded debris categories were plastic shopping bags, plastic bottle caps, disposable tablewares, fishing equipment, and plastic drinking straws. We estimated that during the 12-year period on average between 3.7 and 7.9 million items weighing 560–1110 metric tons polluted Taiwan's coastline. We offer recommendations for improving the quality of data collected during Taiwan's cleanup events and report some policy changes due partly to previous reports of this dataset."

}

Terzi et al., 2020

@article{TERZI2020139,

title = "Marine litter composition and sources on coasts of south-eastern Black Sea: A long-term case study",

journal = "Waste Management",

volume = "105",

pages = "139 - 147",

year = "2020",

issn = "0956-053X",

doi = "https://doi.org/10.1016/j.wasman.2020.01.032",

url = "http://www.sciencedirect.com/science/article/pii/S0956053X20300404",

author = "Yahya Terzi and Coşkun Erüz and Koray Özşeker",

keywords = "Plastic, Black Sea, Source, Pollution, Composition",

abstract = "Long-term monitoring of marine litter composition and density has been conducted between 2009 and 2018 on eleven beaches of Trabzon city located on the south-eastern Black Sea coast in Turkey. All unnatural litter items were collected from randomly selected transects on the beaches. A total of litter items 4138 in number and 108.75 kg in weight were collected during the study. The highest litter density was 22.00 items/m2 which is categorized as extremely dirty by Clean-Coast Index. The ANOVA results revealed that there was a significant difference in density between years (p < 0.05). However, no significant difference was found between stations, substratum and whether the station is located on a river mouth (p > 0.05). Plastic (79.69%) was the most commonly found litter followed by metal (7.37%) and glass (5.58%). The main source of the litter items was found to be river transportation (21.96%)."

}

Reinold et al., 2020

@article{REINOLD2020110847,

title = "Plastic pollution on eight beaches of Tenerife (Canary Islands, Spain): An annual study",

journal = "Marine Pollution Bulletin",

volume = "151",

pages = "110847",

year = "2020",

issn = "0025-326X",

doi = "https://doi.org/10.1016/j.marpolbul.2019.110847",

url = "http://www.sciencedirect.com/science/article/pii/S0025326X19310033",

author = "Stefanie Reinold and Alicia Herrera and Carlos Hernández-González and May Gómez",

keywords = "Plastic, Microplastic, Marine pollution, Marine debris, Beach pollution, Canary Islands",

abstract = "Stranded marine debris from eight beaches of Tenerife (Canary Islands, Spain) was analyzed. Sampling was conducted along the high tide line every 35 m over the whole lengths in periods of 5 weeks for one year. Evaluated particles included all materials bigger than 2 mm, which were subdivided in Mesoparticles (2–10 mm) and Macroparticles (>10 mm). There was a great variability of plastic abundance regarding the locations and the sampling dates. In contrast, the occurrence of debris along the beaches showed consistency and even zones of high and low accumulation. The most polluted beach was Poris, which is indeed infrequently visited, but highly affected by the main current. Plastic particles were principally mesoparticles and white/transparent color. This study not only confirms, that the Canary Islands are highly affected by the marine plastic pollution, but also for the first time shows, that stranded plastic accumulates in restricted areas of sandy coastlines."

}

Dunlop, 2019

@article{DUNLOP2020110803,

title = "Plastic pollution in paradise: Daily accumulation rates of marine litter on Cousine Island, Seychelles",

journal = "Marine Pollution Bulletin",

volume = "151",

pages = "110803",

year = "2020",

issn = "0025-326X",

doi = "https://doi.org/10.1016/j.marpolbul.2019.110803",

url = "http://www.sciencedirect.com/science/article/pii/S0025326X19309592",

author = "S.W. Dunlop and B.J. Dunlop and M. Brown",

keywords = "Daily accumulation rate, Marine litter, Marine debris, Seychelles, Small island developing states, Western Indian Ocean",

abstract = "The daily accumulation rates, composition, sizes and potential sources of marine litter collected on a remote island within the Western Indian Ocean were investigated. In total, 9119 items of marine litter were collected during 40 surveys, which equated to 0.0082 items·m−1·d−1. Between 2003 and 2019 there was a significant increase in the amount of litter deposited, with the highest daily accumulation rate recorded in 2019 (0.0255 items·m−1·year−1). All specific litter types increased over time and also differed significantly in their accumulation rates, with polystyrene fragments/pieces (0.00249 items·m−1·d−1), plastic items (0.00135 items·m−1·d−1) and plastic bottles (0.0011 items·m−1·d−1) being the most commonly encountered during this study. The majority of the litter found was ≤5 cm in size. Nearly all (>80%) litter collected was made of or contained some form of plastic. Recommendations for improved management of litter and the importance of establishing regular beach clean-ups within the Seychelles are briefly discussed."

}

Jambeck, 2015

@article {Jambeck768,

author = {Jambeck, Jenna R. and Geyer, Roland and Wilcox, Chris and Siegler, Theodore R. and Perryman, Miriam and Andrady, Anthony and Narayan, Ramani and Law, Kara Lavender},

title = {Plastic waste inputs from land into the ocean},

volume = {347},

number = {6223},

pages = {768--771},

year = {2015},

doi = {10.1126/science.1260352},

publisher = {American Association for the Advancement of Science},

abstract = {Considerable progress has been made in determining the amount and location of plastic debris in our seas, but how much plastic actually enters them in the first place is more uncertain. Jambeck et al. combine available data on solid waste with a model that uses population density and economic status to estimate the amount of land-based plastic waste entering the ocean. Unless waste management practices are improved, the flux of plastics to the oceans could increase by an order of magnitude within the next decade.Science, this issue p. 768 Plastic debris in the marine environment is widely documented, but the quantity of plastic entering the ocean from waste generated on land is unknown. By linking worldwide data on solid waste, population density, and economic status, we estimated the mass of land-based plastic waste entering the ocean. We calculate that 275 million metric tons (MT) of plastic waste was generated in 192 coastal countries in 2010, with 4.8 to 12.7 million MT entering the ocean. Population size and the quality of waste management systems largely determine which countries contribute the greatest mass of uncaptured waste available to become plastic marine debris. Without waste management infrastructure improvements, the cumulative quantity of plastic waste available to enter the ocean from land is predicted to increase by an order of magnitude by 2025.},

issn = {0036-8075},

URL = {https://science.sciencemag.org/content/347/6223/768},

eprint = {https://science.sciencemag.org/content/347/6223/768.full.pdf},

journal = {Science}

}

Silva-iniguez 2003

@article{SILVAINIGUEZ2003132,

title = "Quantification and classification of marine litter on the municipal beach of Ensenada, Baja California, Mexico",

journal = "Marine Pollution Bulletin",

volume = "46",

number = "1",

pages = "132 - 138",

year = "2003",

issn = "0025-326X",

doi = "https://doi.org/10.1016/S0025-326X(02)00216-3",

url = "http://www.sciencedirect.com/science/article/pii/S0025326X02002163",

author = "Lidia Silva-Iñiguez and David W. Fischer"

}

@article{article,

author = {ÖZTEKİN, Ayşah and Bat, Levent and G. BAKİ, Oylum},

year = {2019},

month = {03},

pages = {},

title = {Beach Litter Pollution in Sinop Sarikum Lagoon Coast of the Southern Black Sea},

volume = {20},

journal = {Turkish Journal of Fisheries and Aquatic Sciences},

doi = {10.4194/1303-2712-v20\_3\_04}

}