**Research**

Our group conducted some literature research in order to identify how researchers have been trying to monitor the problem of coast pollution, what are some basic findings they have had and problems they have encountered in the process.

Several studies have reported the abundance of plastic as a coastal 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.

There have been many other studies around the world regarding littering of the shores. A study in Western Japan and eastern coasts of Russia found out that 55% to 93.4% of items over the Japanese shores were plastic. The second most abundant item was resin pellet, which is a form of plastic too. For the eastern Russian coast plastic items were also the most abundant ~55% litter, with plastic fragments being the most abundant within the plastics category. The composition of litter was similar in the two countries, although the concentration of plastics was much higher in Japan. (International survey on the distribution of stranded and buried litter on beaches along the Sea of Japan Takashi Kusui a,\*, Michio Noda b) Marine Pollution Bulletin 47 (2003) 175–179)

Further on the Asian upper east, hard plastic and Styrofoam were the dominant plastic types on Korean beaches. On average, hard plastic and Styrofoam comprised 32% and 48.5% (by number) of the total debris, respectively.

*An important aspect put in this survey is the part of the beach from which litter is being collected. As mentioned in the research, most studies work on data from the high strandline so they do not produce representative pollution data for the whole beach environment. So, considering that the high strandline accounts for a very small proportion of the whole beach area, micro- and mesoplastic abundance expressed in terms of items per area (items/m2) or volume (items/m3) may produce highly biased information on beach plastic pollution.*

Another important aspect is that hard plastic found in high proportion on certain location may have to do with these locations being highly urbanized and populated, whereas for high Styrofoam accumulation locations it was found that these were places with dense aquaculture fields.

(Characteristics of meso-sized plastic marine debris on 20 beaches in Korea

Jongsu Leea, Jongmyoung Leea,⁎, Sunwook Honga, Sang Hee Hongb,c, Won Joon Shimb,c,

Soeun Eob  [Marine Pollution Bulletin](https://www.researchgate.net/journal/0025-326X_Marine_Pollution_Bulletin) 123(1-2) · September 2017)

In an older study over the region of Caribbean the most common types of debris stranded on the Caribbean coast of Panama were plastic and Styrofoam, with plastics being household or consumer related. Styrofoam packing materials were also abundant, and may have come from trans-shipment activities of Colon's Free Zone, as well as from household trash or from offshore.( Marine Debris Along the Caribbean Coast of Panama STEPHEN D. GARRITY and SALLY C. LEVINGS Marine Pollution Bulletin, Volume 26, No. 6, pp. 317-324, 1993)

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 would be required to confirm this result.

A 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. (Reinold et al., 2020)

As one may easily observe there are quite a few variations in terms of how studies over litter accumulation are conducted. The variation has to do with the time span of the research, the part of the beach from which litter is collected, as well as the categorization of littering. This creates a problem when researchers want to investigate a problem and compare different studies.

The problem basically amounts to assessing changes in accumulation rates and composition, trends over time and the effectiveness of management systems, a hard task without good monitoring methodologies. Although monitoring of marine litter is currently carried out within a number of countries around the world, the methods of survey and monitoring used tend to be very different, preventing comparisons and harmonization of data across regions or time-scales.

This is why the scientific community has been trying to create some common ground which has led to some initiatives joined by many countries worldwide. One of them and probably the most important one is the International Clean Coast (ICC) program-a new, long-term approach for cleaner beaches by various activities such as an increase in the public awareness.

(Chesire et al. (2009). UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter.)

This initiative aimed at a comprehensive litter characterization scheme to be developed that uses both material composition and form. This allows Litter Monitoring Repeated surveys of beaches, sea bed and/or surface waters to determine litter quantities such that information can be compared with baseline data to see if changes occur through time and / or in response to management arrangements.

The ICC uses some specific developed categorizations of coast litter, with the most accepted one being the Clean Coastal Index (CCI) protocol, which is very useful, in terms of simplicity and information provided, allowing comparison between different times and places. The CCI protocol is very different from most others having a focus on operational clean-up of beaches as. The CCI is suggested as a tool for evaluation of the actual coast cleanliness. It measures plastic debris as a beach cleanliness indicator, in an easy way precluding bias by the assessor. The CCI also proved to be a useful tool for measuring progress and the success of activities such as education campaigns, media coverage and enforcement actions

(Alkalay, Ronen & Pasternak, Galia & Zask, Alon. (2007). Clean-coast index—A new approach for beach cleanliness assessment. Ocean & Coastal Management. 50. 10.1016/j.ocecoaman.2006.10.002)

A study in Israel followed the CCI protocol and found out that plastic is the most ubiquitous beach litter item. An important contribution of this study has to do with comparing its findings with other Mediterranean beaches showing that plastic might be the dominant pollutant, though non-plastic litter is highly specific to the region and cannot be treated universally. (Marine litter from beach-based sources: Case study of an Eastern Mediterranean coastal town M.E. Portman, R.E. Brennan / Waste Management)

In a study on litter pollution in a region of India, once again the CCI protocol for the categorization of litter was followed. Once again plastic was the main source of litter ~45%, with plastic bags topping the index at ~33%, followed by food wrappers and then plastic cups. Cigarettes/cigar tips were scarcely found amounting to only 5.5%. (Kumar, A.A., Sivakumar, R., Reddy, Y.S.R., Raja, M.V.B., Nishanth,T., Revanth, V., Preliminary study on marine debris pollution along Marina beach, Chennai,India. Regional Studies in Marine Science (2016)

The use of the common protocol in these two studies allows for researchers to compare their findings and create common plastic pollution models, even though the two coasts are continents apart.

Another study conducted at the other side of the Mediterranean, in Cadiz, found that plastic bottles/containers were the most frequent items followed by plastic bags. This research points out that surveys are heavily affected by clean-ups performed at beaches which the importance this activity offers in the shore staying clean. (Distribution of beach litter along the coastline of Cádiz, SpainA.T. Williams et al. / Marine Pollution Bulletin 107 (2016) 77–87).

So even though this study reaches to some important conclusions even on ways to clean coasts the right way, it cannot be easily compared, or its conclusions easily applied even with the case of the study in Israel, which is also in the Mediterranean.

Given the literature above, our group went on to work with a world-wide coastal littering dataset spanning a timeframe of a decade with an interest to see if its findings match the above: be it if plastic is the most abundant litter, within the plastic categories which are the most important subclasses found and could there be a way to computationally monitor the coastal littering problem. For this we followed the CCI categorization of litter.

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",

International survey on the distribution of stranded and buried litter on beaches along the Sea of Japan Takashi Kusui a,\*, Michio Noda b) Marine Pollution Bulletin 47 (2003) 175–179

@article{article,

author = {Kusui, Takashi and Noda, Michio},

year = {2003},

month = {02},

pages = {175-9},

title = {International survey on the distribution of stranded and buried litter on beaches along the Sea of Japan},

volume = {47},

journal = {Marine pollution bulletin},

doi = {10.1016/S0025-326X(02)00478-2}}

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Soeun Eob  [Marine Pollution Bulletin](https://www.researchgate.net/journal/0025-326X_Marine_Pollution_Bulletin) 123(1-2) · September 2017

@article{article,

author = {Lee, Jongsu and Lee, Jongmyoung and Hong, Sunwook and Hong, S. and Shim, Won and Eo, Soeun},

year = {2017},

month = {09},

pages = {},

title = {Characteristics of meso-sized plastic marine debris on 20 beaches in Korea},

volume = {123},

journal = {Marine Pollution Bulletin},

doi = {10.1016/j.marpolbul.2017.09.020}

}

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@article {PMID:12535979,

Title = {Quantification and classification of marine litter on the municipal beach of Ensenada, Baja California, Mexico},

Author = {Silva-Iñiguez, Lidia and Fischer, David W},

DOI = {10.1016/s0025-326x(02)00216-3},

Number = {1},

Volume = {46},

Month = {January},

Year = {2003},

Journal = {Marine pollution bulletin},

ISSN = {0025-326X},

Pages = {132—138},

URL = {https://doi.org/10.1016/s0025-326x(02)00216-3},

}

Reinold et al., 2020

@article{Reinold2020,

author = "Stefanie Reinold",

title = "{Plastic pollution on eight beaches of Tenerife (Canary Islands, Spain): An annual study: Wind and Wave parameters}",

year = "2020",

month = "3",

url = "https://mendeley.figshare.com/articles/Plastic\_pollution\_on\_eight\_beaches\_of\_Tenerife\_Canary\_Islands\_Spain\_An\_annual\_study\_Wind\_and\_Wave\_parameters/11972994",

doi = "10.17632/f7ntbw4rt6.1"

}

Marine Debris Along the Caribbean Coast of Panama STEPHEN D. GARRITY and SALLY C. LEVINGS Marine Pollution Bulletin, Volume 26, No. 6, pp. 317-324, 1993

@inproceedings{Garrity1993MarineDA,

title={Marine debris along the Caribbean coast of Panama},

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year={1993}

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@article{article,

author = {Williams, Allan and Randerson, Peter and Giacomo, Carlo and Anfuso, Giorgio and Macias, Ana and Perales, Jose},

year = {2016},

month = {04},

pages = {},

title = {Distribution of beach litter along the coastline of Cádiz, Spain},

volume = {107},

journal = {Marine pollution bulletin},

doi = {10.1016/j.marpolbul.2016.04.015}

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Marine litter from beach-based sources: Case study of an Eastern Mediterranean coastal town M.E. Portman, R.E. Brennan / Waste Management

@article{article,

author = {Portman, Michelle and Brennan, Ruth},

year = {2017},

month = {08},

pages = {},

title = {Marine litter from beach-based sources: Case study of an Eastern Mediterranean coastal town},

volume = {69},

journal = {Waste Management},

doi = {10.1016/j.wasman.2017.07.040}

}

Cheshire, Anthony & Adler, Ellik & Barbière, Julian & Cohen, Yuval & Evans, Sverker & Jarayabhand, Srisuda & Jeftic, Ljubomir & Jung, Rho-Taek & Kinsey, Susan & Kusui, Takashi & Lavine, Ingrid & Manyara, Peter & Oosterbaan, Lex & Pereira, Marcos & Sheavly, Seba & Tkalin, Alexander & Varadarajan, Sampath & Wenneker, Barbara & Westphalen, Grant. (2009). UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter.

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author = {Cheshire, Anthony and Adler, Ellik and Barbière, Julian and Cohen, Yuval and Evans, Sverker and Jarayabhand, Srisuda and Jeftic, Ljubomir and Jung, Rho-Taek and Kinsey, Susan and Kusui, Takashi and Lavine, Ingrid and Manyara, Peter and Oosterbaan, Lex and Pereira, Marcos and Sheavly, Seba and Tkalin, Alexander and Varadarajan, Sampath and Wenneker, Barbara and Westphalen, Grant},

year = {2009},

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title = {UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter}

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@article{article,

author = {Alkalay, Ronen and Pasternak, Galia and Zask, Alon},

year = {2007},

month = {12},

pages = {},

title = {Clean-coast index—A new approach for beach cleanliness assessment},

volume = {50},

journal = {Ocean & Coastal Management},

doi = {10.1016/j.ocecoaman.2006.10.002}

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Kumar, A.A., Sivakumar, R., Reddy, Y.S.R., Raja, M.V.B., Nishanth, T., Revanth, V., Preliminary study on marine debris pollution along Marina beach, Chennai,

India. Regional Studies in Marine Science (2016)

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author = {Anantha Kumar, Arun Kumar and Sivakumar, Ramamoorthy and Yellasiri, Sai Rutwik Reddy and Raja, M.V. and Nishanth, T. and Revanth, V.},

year = {2016},

month = {01},

pages = {},

title = {Preliminary study on marine debris pollution along Marina beach, Chennai, India},

volume = {5},

journal = {Regional Studies in Marine Science},

doi = {10.1016/j.rsma.2016.01.002}

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