

NOAA National Centers for Environmental Information (NCEI) global database on microplastics

Ebenezer Nyadjro - NOAA Northern Gulf Institute

Zhankun Wang, Tim Boyer, Just Cebrian, Kirsten Larsen, Jennifer Webster, Yee Lau

Building a comprehensive archive for microplastics

YouTube
studies

- do literature search; contact research groups, PIs & authors
- acquire, process, QA & QC
- collate, submit, & archive (metadata, standardized data, & GIS)
- Geo- database - provide ArcGIS visualization to facilitate data retrieval of underway microplastics sensor data
- develop user engagement and information services

Microplastics (< 5 mm) pollution is a growing problem affecting marine ecosystems, aquatic life, and human health. Despite the growing awareness, data management of measurements of marine debris lags far behind the needs of the scientific, education, and decision maker communities. The National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI), is creating a global database on microplastics. The goal is to develop a one-stop repository where data on all types of microplastics are aggregated, archived, and served in a consistent and reliable manner. This database will enable new insights in understanding of the global microplastics problems.

https://www.youtube.com/watch?v=OwrjPke_DHs

Marine litter emissions to the seashore and application of machine learning methods to predict them

Sergei Fetisov - P.P.Shirshov Institute of Oceanology RAS
 Irina Chubarenko



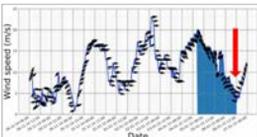
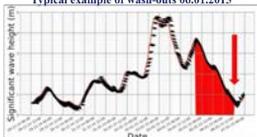
Marine litter emissions to the seashore and application of machine learning methods to predict them

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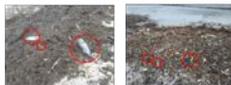
Purpose:

- (i) to analyze the development of a number of meteorological and hydrophysical conditions preceding the massive wash-outs;
- (ii) to determine recurring features and most influential physical parameters of general wind and wave patterns;
- (iii) to obtain a relationship between meteorological and hydrophysical parameters necessary for the development of the artificial neural network (ANN) structure, the formation of input data, and further creation of a predictive model based on an ANN.

Typical example of wash-outs 06.01.2015



The red arrow marks the date of observation of wash-outs during the expeditions. Colour shading shows the phase of storm subsiding, when the wind speed decreases and its direction changes

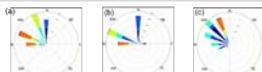


Photos of the beach in the Kalikovo village with a massive wash-outs of marine debris: plastic bottles and other plastic and anthropogenic litter.

Study area in southeastern part of the Baltic Sea



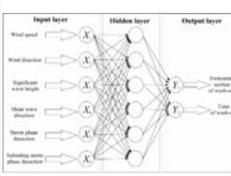
During the observation period (2011–2019) on the shore of Kalikovo village, more than 58 cases of wash-out spots of marine debris were recorded.



Roses of the distribution of the direction of the significant wave for 5 days before the moment of observation: (a) for case 6.01.2015; (b) for case 4.06.2017; (c) for case 27.10.2018.

Conclusions:

- Marine litter wash-outs are observed during the storm subsiding phase (decrease in the significant wave height and wind speed). The duration of the subsiding phase averaged 48 hours.
- Mean wave direction during the entire subsiding phase is predominantly perpendicular to the shore (N–NW).
- The average significant wave height during the wash-out is 0.58 ± 0.28 m.
- A model of an artificial neural network for predicting marine debris emissions was proposed



The ANN structure for analysis of natural conditions.

Beach monitoring shows that certain storm events lead to a large algae emission to the seashore.

Nowadays, such wash-outs carry a lot of anthropogenic litter. At the Baltic Sea shores, the amount of anthropogenic litter within the storm-induced spots exceeds hundred of items/sq.m, which is three orders of magnitude higher than usual contamination of these beaches. Up to now, no effective instruments for predicting the date, time, and locations of the wash-out spots are available. An approach using machine learning methods is suggested to predict litter wash-outs. It is based on in-situ observations and analysis of meteorological and hydrophysical conditions.

Drones for litter mapping: operational insights from UAS4Litter experiences

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INESC Coimbra
Instituto de Engenharia de Sistemas e Computadores de Coimbra

MARE
Marine Research and Assessment

NAVA
National Agency for Maritime Affairs

COMPETE 2020
Operational Program for Regional Development

FCT
Fundação de Amparo à Pesquisa em Portugal

UAS4Litter
Low cost Unmanned Aerial Systems for marine litter coastal mapping
October 2018 - April 2022

<https://en.uas4litter.com/>

<https://www.researchgate.net/project/UAS4Litter-Low-cost-Unmanned-Aerial-Systems-UASs-for-marine-litter-coastal-mapping>

Gil Goncalves, Umberto Andriolo, Filipa Bessa, Paula Sobral, Luis Pinto, Diogo Duarte, Angela Fontán-Bouças, Luísa Gonçalves

you can go thru the slides!

UAS4litter project operationally tested the use of drones and diverse onboard cameras to detect and map stranded litter at three beach-dune systems in the North Atlantic coast.

To categorize items on images, we explored the performances of manual and different machine learning techniques. Litter maps were coupled to environmental forcing and beach slope configuration to understand items dynamics on shore. On dunes, we identified the role played by distinct vegetation in trapping specific litter.

Drone-based litter surveys are not only an alternative to traditional in situ census, but can potentially improve knowledge of litter dynamics and support modelling.

<https://www.researchgate.net/project/UAS4Litter-Low-cost-Unmanned-Aerial-Systems-UASs-for-marine-litter-coastal-mapping>

BEWATS: Beach Waste Tracking System using Satellite, UAV's and Marine Dynamics Models

Fernando Martin -atlanTTic research center for Telecommunication Technologies, University of Vigo

Orentino Mojón-Ojea, Omjyoti Dutta, Beatriz Revilla-Romero, Ana Mancho, Guillermo García-Sánchez, Carmen Otero-Neira, Ana Dopico Parada and Jesús López- Miguéns.



BEWATS continues Litterdrone project (<https://litterdrone.aebam.org/>), in which, drones were used to obtain beach images that were processed to obtain reports of marine debris. Work lines in BEWATS are: 1. Improving Litterdrone software (version 2.3 to 4.1, new options and improved debris detection). 2. New flight campaigns on beaches. PLUS, plastic targets are placed on the seashore and on water to test satellite detection. 3. Use of current data to detect waste streams. Flow detected between “Miño” estuary and “Rías Baixas”. 4. Detecting floating plastic in satellite images. Two algorithms: for small plastics (GMV) and for large masses (UVIGO). 5. Study of possible commercial application using new study methodology (ValRI).

<https://fundacion-biodiversidad.es/es/content/bewats-beach-waste-tracking-system>

Plastic Ingestion by seabirds in the Black Sea

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Elena Stoica, Lucica Barbes, Mihaela Cosmina Tanase

Plastic ingestion by seabirds in the Black Sea



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Justification:

Plastics are some of the most challenging types of waste in terms of impact and management since they reach the sea, where they persist not only in the ecosystem, but also in the organisms that live there.

Seabirds can be good indicators of the state of the ecosystems they belong to, the plastics ingested by them being monitored within the Descriptor 10 of the MSFD.

The novelty of the study is the fact that based on data published so far, this is the first study that identifies and quantifies the fragments of plastic ingested by birds present in the coastal area of Romania and the Black Sea.

Method:

17 marine bird carcasses were collected from the Romanian coastal area of the Black Sea and were subsequently observed for stomach sampling, measurement of the contents and characterization of the observed plastics.

The stomach - gastrointestinal and gizzard - was excised and its contents were washed under running tap water on a 1 mm eye stainless sieve.

After each sample was separated, the liquid stomach contents left on the sieve were transferred to glass Petri dishes and they were left to dry.

After drying, the plastic items were separated from food remains and natural debris, and transferred in separate glass Petri dishes for further analysis.



The quantity of plastic ingested by seabirds reflects the quality of their environment and is one of the MSFD goal in terms of litter ingestion. However, there is a lack of data on seabirds' plastic ingestion in the Black Sea. Here we present the first Black Sea results, obtained in 2021 at the Romanian coast. Of 17 birds, 29.4 % had ingested plastic, mostly white, transparent and brown fragments in color. Our study emphasizes the need for setting-up of seabird litter ingestion monitoring to properly mitigate plastic pollution in the Black Sea.

The role of Stokes drift in the dispersal of North Atlantic surface marine debris

Sofia Bosi - University of Gothenburg

Fabien Roquet

The role of Stokes drift in the dispersal of North Atlantic surface marine debris

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UNIVERSITY OF
GOTHENBURG

INTRODUCTION

Stokes drift is a surface wave effect which causes floating particles in the direction of wave propagation (Fig. 1). As it is stronger at the ocean surface, it affects buoyant objects of ocean time. We investigate its influence on the trajectories of particle beaching by comparing two particle tracking models (PTMs), with and without the Stokes drift.

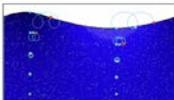


Fig. 1 Visual representation of Stokes drift on particles beaching at different depths in the presence of a deep water wave.

MODEL SETUP

North Atlantic domain
2° (10° particles seeded at surface) for initial 5 years
30° (10° fixed depth)
12 years of time

Particles whose velocity drops under 10⁻³ m s⁻¹ are considered beached (numerical approximation) and removed.

Model	StokesDrift	$V_{surf} = V_{wind} + V_{SD}$
PTM-SD	ON/OFF	$V_{surf} = V_{wind}$
PTM-SD	ON/OFF	$V_{surf} = V_{wind} + V_{SD}$

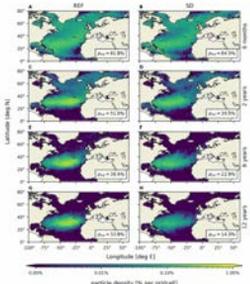


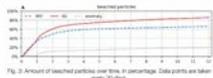
Fig. 2 Trajectories of model output. Columns represent the amount of particles per 2° bin in longitude, relative to the number of seeded particles. Note the significant sink in the western North Sea that indicates the amount of particles that "leaked" out/beached.

RESULTS

Some areas of particle convergence / divergence in the two particle tracking models, but different frequencies (Fig. 2).
14% of particles beach on average every year surrounding the 5 years of seeding in the Stokes drift case (Fig. 3). This is double the value found in the reference case (2.8% particles/year).
Particles released at the edge of the subtropical gyre in the Eastern side are able to cross the ocean in less than a year (mean dispersal distance ~1000km).
Most affected coastal areas are **Northern Europe** (river domains), **West and Central America** (sea-ice-affected).
Visible influence of wind patterns (Trade Winds and Westerlies) in coastal areas with most beaching in Stokes drift case.

SUMMARY

Garbage patches are not favored! Due to Stokes drift, buoyant objects reach the coast at a rate that is 2 times faster in this model! Results suggest that floating debris takes a few years to a decade to disperse from the subtropical accumulation zone and beach, contradicting the idea of permanent "plastic islands".



NEXT STEPS

Improve the analysis by adding: 1) a sinking flux to account for particles sinking through the water column and settling at the ocean bottom and 2) a horizontal diffusion term to account for the possibility that particles may be flushed back into the ocean after beaching.

Marine plastic is often highly buoyant and thus concentrates at the ocean surface. As such, it is impacted by surface wave effects like the Stokes drift, which pushes floating objects in the direction of wave propagation.

In this study, we compare two particle tracking models (PTMs) in the North Atlantic basin, one with and one without the Stokes drift, to highlight its effects on the timescales of beaching. Particles are found to beach at a faster annual rate when the Stokes drift is included. This emphasises that the idea of "plastic islands" floating at the ocean surface for hundreds of years may be a common misconception.

Thermal infrared sensing of floating plastic litter

Lonneke Goddijn-Murphy - North Highland College UHI

Benjamin Williamson, Jason Mclvenny, Barbara Bremner

Thermal infrared sensing of floating plastic litter

Lonneke Goddijn-Murphy¹, Benjamin Williamson¹, Jason Mclvenny¹, Barbara Bremner¹, Paolo Corradi²

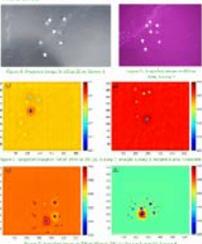
¹ Environmental Research Institute, North Highland College, University of the Highlands and Islands, Thurso, Scotland, UK
² European Space Research and Technology Centre, European Space Agency, Noordwijk, Netherlands



Introduction

Remote sensing of marine plastic litter is still in early stages and most progress has been made in optical remote sensing where optical physics applies. It has become clear that this method based on the surface reflectance of sunlight, would benefit from complementary measurements using different techniques [1-3]. The physics behind surface leaving thermal infrared radiation (TIR) and TIR sensing is a little different [3]. For example, TIR sensing doesn't depend on an external light source like the surface leaving TIR. Radiation is determined by temperature (of surface and background) and thermal emissivity, ϵ , of the surface [3]. ϵ of most (aluminium) target (3) is near one (also) and of plastic somewhere in between. Here, we present results of our UAV surveys of plastic items floating at sea, undertaken by the ERI as part of ESA funded project TRISPLAIL.

Results



We confirmed TIR could monitor floating plastic in the absence of driftage (Sigs, 60.873). TIR was sensitive to air and sea temperatures (Table 1); plastic could appear cooler (Sigs, 60.870) or warmer (Sigs, 7.0) than water. Also we confirmed affected measured TIR, with clouds making everything appear warmer (Sigs, 60.874) compared to clear sky (Sigs, 7.0). TIR images did not show soft foam, as seen in VIS-NIR (Sigs, 48.5), but dark plastic that can be visible in the VIS-NIR was bright in TIR under the right conditions (Sigs, 7.0).

Methods

UAV surveys

We used an unmanned aerial vehicle (UAV) carrying three cameras (Fig. 1).

- FLIR Vue Pro R (40): TIR imaging camera in long-wave infrared (LWIR, 7.5-13.5 μm).
- MAPIR: imaging camera in near infrared (NIR, 850 nm).
- ZENMUSE: X5 imaging camera in visible (VIS).

We analysed one minute of 1 x 6 FLIR images of the UAV stationary over targets at sea at 30 m altitude. The FLIR captured raw data in 14-bit TIRF and we applied flat-field correction to each image to correct for vignetting on the camera (Sigs, 60.7) before averaging digital number (DN), representing the magnitude of the TIR radiance of selected surface pixels across all images.

Temperature and other measurements

We measured air temperature (surface temperature (Fig. 2)), as well water and air temperatures, relative humidity and light intensity (Table 1).

Fig. 1. Photo: Ben Cooper. Temperature: Ben Cooper. Temperature: Ben Cooper. Temperature: Ben Cooper.

Survey conditions

Air and sea temperatures control the TIR signal [3], so therefore executed surveys during different times of the day and seasons (Table 1). The location was Thurso Bay in the North of Scotland.

Table 1. Air and sea temperatures, relative humidity, and light intensity. Table 1. Air and sea temperatures, relative humidity, and light intensity. Table 1. Air and sea temperatures, relative humidity, and light intensity. Table 1. Air and sea temperatures, relative humidity, and light intensity.

Survey day (2021)	UTC	Sky	Temp (°C)				RH (%)	Irrad. (W/m ²)	
			Surf	10 m	30 m	100 m			
11 April	day	00:40	Cloudy	6.1	6.0	7.1	1.9	5290	0%
23 April	night	01:16	Not clear	7.6	6.5	7.1	5	0	48
3 August	day	13:01	Overcast	14.1	17.0	17.9	34.6	1440	36
4 August	night	00:41	Clear	12.7	13.5	13.6	13.7	0	41

Plastic targets

We deployed 0.5 m x 0.5 m plastic targets (1-7) made from common plastic litter items. Target 8 was a reference to measure background TIR and target 9 a non-plastic litter for comparison.

1. PET (Bottle) - reference transparent bottle, clear (0.5).
2. PET bottle, clear (2.1).
3. PET (Expanded Polystyrene) board, white (thickness 1 cm).
4. EPS board, blue (thickness 1 cm).
5. HDPE (High Density Polyethylene) bottles, clear transparent white (2.3).
6. LDPE (Low Density Polyethylene) bag, black, two-thin layers.
7. PE (Polyethylene) tarpaulin, white, single-layer.
8. Aluminium foil over EPS board.
9. Wooden disk (only during summer surveys).



Conclusion

Remote sensing of marine plastic litter in thermal infrared (TIR) has shown great potential for complementary remote sensing in the optical spectrum. We monitored floating plastic targets during the day as well as during the night. Success of TIR sensing depended on environmental conditions, in particular the difference between air and sea temperatures (the greater the better) and cloudiness of the sky. TIR sensing for plastic litter detection will therefore be more suitable for calm locations and times of the day 7-9 than others. It could be particularly useful in low sea level locations, such as at a pier-arm.

Thermal infrared (TIR) sensing can complement other remote sensing techniques for marine plastic litter. We present the results of drone surveys carrying a TIR camera over floating plastic litter targets at sea under varying conditions. These included day and night surveys during different air and sea temperatures, and atmospheric conditions. We could see plastic during the day and night while sea foam and the sea floor did not show in the TIR images. These experiments were supported by our radiative transfer model and measurements in the laboratory.

Administrative: 201. Research not supported by the Division: Research of the Division: Research Agency: 2.0. Funding project: TRISPLAIL (contract number: 101073307/2019/02/01)

Reference: 1. Williamson et al. (2019). Remote sensing of marine plastic litter using thermal infrared. *Remote Sensing*, 11(4), 611. doi: 10.3390/rs11040611

Researcher ID: 101073307/2019/02/01. Researcher ID: 101073307/2019/02/01. Researcher ID: 101073307/2019/02/01. Researcher ID: 101073307/2019/02/01.

2. Goddijn-Murphy et al. (2020). Remote sensing of marine plastic litter using thermal infrared. *Remote Sensing*, 12(1), 101. doi: 10.3390/rs12010101

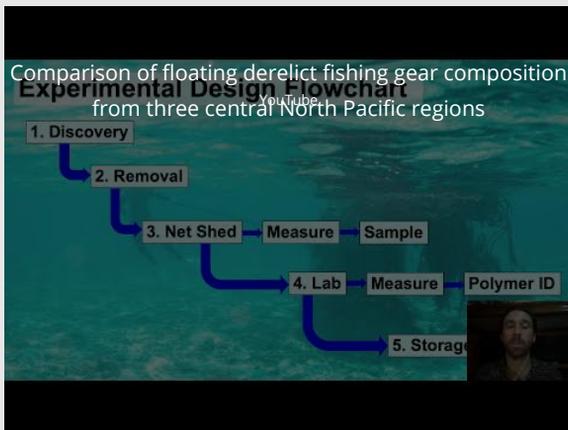
3. Goddijn-Murphy et al. (2020). Remote sensing of marine plastic litter using thermal infrared. *Remote Sensing*, 12(1), 101. doi: 10.3390/rs12010101



Comparison of floating derelict fishing gear composition from three central North Pacific regions

Andrew McWhirter - Hawaii Pacific University Center for Marine Debris Research

Raquel Corniuk, Hank Lynch, Cassandra Walti, Jennifer M. Lynch



Derelict fishing gear (DFG) contributes the greatest mass of floating plastic marine debris to the global ocean. The

North Pacific Ocean is disproportionately affected by DFG, which aggregates in the convergent features of the North Pacific Subtropical Gyre (NPSG). The Hawaiian archipelago extends diagonally to the northwest through the center of the NPSG and is impacted by stranding DFG year round, including damage to coral reefs and endangerment of endemic marine species. To develop effective preventative solutions to this detrimental issue, understanding the composition and sources of the DFG that is affecting the Hawaiian Archipelago and surrounding waters is crucial.

https://www.youtube.com/watch?v=C_9EUo02C0Q

CleanAtlantic sea litter geographical web viewer

Gonzalo González-Nuevo - Instituto Espanol de Oceanografia (IEO)

Jesús Gago Pineiro, Pablo Otero Tranchero, Patricia Perez Perez

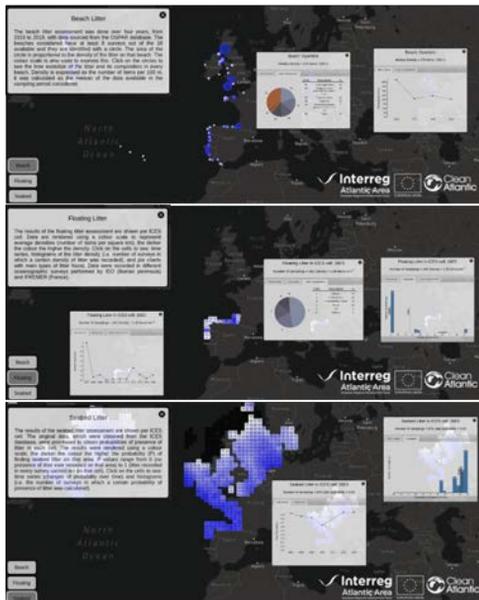


CleanAtlantic sea litter geographical web

Gonzalo González-Nuevo¹, Patricia Pérez², Pablo Otero², Jesús Gago², Silvère André³, Marisa Fernández⁴, Roi Martínez⁵, Jossie Russel⁵, Melanie Brun⁶ and Morgan Le Moigne⁶.

Abstract

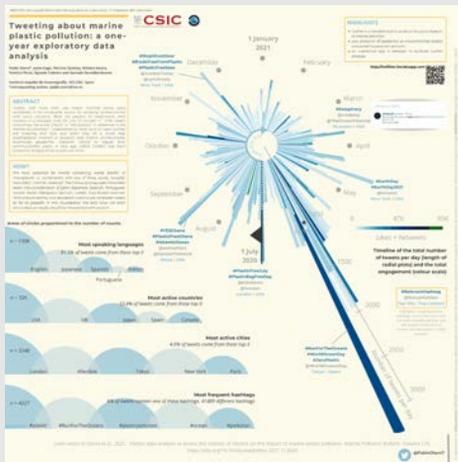
A Sea litter data viewer has been developed in the framework of the CleanAtlantic European project. This web application allows access to the litter data of different compartments of the ocean as beach litter, floating litter, and seabed litter. The users can query the statistical distributions of litter concentrations, time series, and the composition of the most frequent types of litter of each geographical item. In order to facilitate access to this type of information to all types of users independently of their data analysis skills, the viewer has developed following criteria of simplicity and usability.



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Tweeting about marine plastic pollution: a one-year exploratory data analysis

Pablo Otero P. - Instituto Espanol de Oceanografia (IEO)



Twitter, with more than 330 million monthly active users worldwide, is an invaluable source for studying environmental and social concerns. Here, we present an exploratory data analysis of a one-year (July 20- July 21) dataset of ~132K tweets containing the words 'plastic' or 'microplastic' in reference to the marine environment. Understanding what kind of users profiles are tweeting and how and when they do it, could help organizations involved in research and marine environmental awareness to adjust their communication plans. A web app called Twilitter has been created to analyze these results over time.

Using data from marine protected species to guide removal and monitoring of marine debris.

Pilichowski - Hawaii Marine Animal Response

Lauren Chamberlain, Micah Brodsky



Since 2016, Hawaii Marine Animal Response (HMAAR) has responded to hundreds of reports of hooked or entangled sea turtles, seabirds, and Hawaiian monk seals, on the island of Oahu, Hawaii. Data collected on marine protected species injured through fisheries interactions was used to guide in-water dive activity for survey and removal of derelict fishing gear. During the first two years of HMAAR's Marine Debris Program we have removed over 900 pounds of recreational fishing gear from 150 acres of nearshore habitat, which we monitor to enhance understanding of marine debris distribution and accumulation rates on Oahu.

Coastal Pollution with Polyurethane foam : The case of the sea of Azov and the Don River as a major contributor

Aleksey Kleshchenkov - Russian Academy of Sciences

T.A. Lastovina, A.P.Budnyk

Coastal pollution with polyurethane foam: the case of the Sea of Azov and the Don River as a major contributor

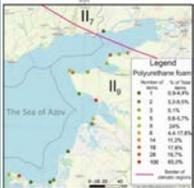
Aleksey Kleshchenkov, Tatiana Lastovina and Andrey Budnyk



Southern Scientific Center
Russian Academy of Sciences

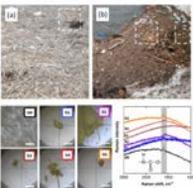
Observing the pollution with PUF

Pollution of aquatic basins and their shores with plastics is continuously growing [1]. Due to the large quantities that have been accumulated globally the degradation of plastic comes into the focus of scientific research [2]. We inspected 20 sites along the Eastern and Southern shores of the Sea of Azov (Fig. Aerial). At each site, marine litter was classified per category in a number of items within 300 m of coastline according to the UNEP/MAP guidelines [3]. We noted that **polyurethane foam (PUF)** fragments constitute a good fraction (ranging from 1 to 65%) of the total plastic debris amount.



The map of monitored sites along the Eastern and Southern shores of the Sea of Azov and the fraction of PUF fragments identified in the coastal debris (4). In half of the sites, PUF items constituted over 4% of the total

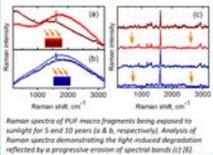
The River Don is the largest water arterial of the region, serving as the main carrier for PUF fragments to travel from multiple points of entry towards the Sea of Azov. Floating macro fragments of PUF were observed (upper photos). Microplastic fragments of PUF were found in surface water (lower photos). Samples were collected by dragging a plankton net for 15 min from a ship and were processed according to the NGMA method [5]. The sites were in two main branches of the Don River in the delta area (5), (6) and in the Taganrog Bay (3,5,6). The microplastic fragments were identified as PUF by micro-Raman spectroscopy in comparison with a reference sample (9S) by a characteristic peak at ~1300 cm^{-1} .



(above) PUF fragments in floating litter on the Don River (4) the delta; (5) the city of Azov-on-Don; (below) The PUF microplastics from surface waters of the Don-River and Taganrog Bay identified (7) by their Raman spectra (6).

Observing the degradation of PUF

Resting on seashore, abandoned plastic is subjected to natural degradation due to weathering. We considered the impact of insolation and temperature in two climatic zones (8), and R_{UV} are the most crossing the studied region. The calculated value of insolation was cycling from 10 to 40 W/m^2 over the year. Temperatures are rising over 30 $^{\circ}\text{C}$ in the summertime. Such factors are likely to accelerate the degradation of PUF on shores. We also measured Raman spectra of PUF fragments being exposed to daylight for 5 and 10 years, as shown in Fig. below. The degradation impacted in the way, which has been observed in the spectra of microplastic fragments of PUF.



References: 1. Lastovina et al. 2020, doi: 10.23887/2692-2019-9-231-241; 2. Lastovina et al. 2021, doi: 10.23887/2692-2021-9-231-241; 3. Gogolev et al. 2018, doi: 10.13155/2018-4; 4. Kleshchenkov et al. 2020, doi: 10.23887/2692-2020-9-231-241; 5. Kleshchenkov et al. 2021, doi: 10.23887/2692-2021-9-231-241; 6. Kleshchenkov et al. 2021, doi: 10.23887/2692-2021-9-231-241; 7. Kleshchenkov et al. 2021, doi: 10.23887/2692-2021-9-231-241; 8. Kleshchenkov et al. 2021, doi: 10.23887/2692-2021-9-231-241; 9. Kleshchenkov et al. 2021, doi: 10.23887/2692-2021-9-231-241; 10. Kleshchenkov et al. 2021, doi: 10.23887/2692-2021-9-231-241.

Shedding light on marine plastic data to build research links between EU and US ocean research

Enrique Wulff - Spanish National Research Council (CSIC)

This poster emphasizes relevant values to build research links between EU and US within the scope of marine pollution data policies. It interprets ocean literacy in the special data case of the global risks posed by plastics (which call for citizen science based tools that can help fill data gaps relevant for policy). And it seeks to demonstrate that the effects of the US interdisciplinary and multiregional collaboration, regarding plastics data on the European partners, respond to the needs of the 21st Century paradigm concerning information. A proposal for a permanent access to marine plastic data is advanced.

<https://www.youtube.com/watch?v=dJpHjE8tFFE>

Shedding light on marine plastic data to build research links between EU and US ocean research
Enrique Wulff, Spanish National Research Council (CSIC)

Marine plastics exceed 100,000 tonnes each year worldwide. The 2015-2016 marine litter survey conducted by the Spanish National Research Council (CSIC) in the central area of the greater ocean basin, which includes the Mediterranean Sea, the Atlantic Ocean and the North Atlantic, has provided the most comprehensive and up-to-date information on the abundance and distribution of marine litter in the world's oceans.

Marine Plastic Data Areas	Challenges
1. Marine Plastic Data Areas where EU-US research links are possible	1. The US Ocean Data and Information System (ODIS) has been established as a marine litter planning and monitoring system. It is a national system that provides a common framework for marine litter data collection and management across all US federal agencies. The US ODIS system is a key element of the US marine litter management strategy.
2. Coastal and ocean planning: As both Europe and the United States embarked on marine spatial planning policies in 2009, opportunities could be offered to exchange best practices in their marine data pollution policies.	2. The US ODIS system is a key element of the US marine litter management strategy. It provides a common framework for marine litter data collection and management across all US federal agencies. The US ODIS system is a key element of the US marine litter management strategy.
3. Marine security and safety: To protect the EU and US maritime interests worldwide the use of port reception facilities for plastic waste, could promote mutual support on data policies to regulate ship-generated plastic waste.	3. The US ODIS system is a key element of the US marine litter management strategy. It provides a common framework for marine litter data collection and management across all US federal agencies. The US ODIS system is a key element of the US marine litter management strategy.
4. Improving marine research: Data research on marine plastic pollution has resulted in US NOAA	4. The US ODIS system is a key element of the US marine litter management strategy. It provides a common framework for marine litter data collection and management across all US federal agencies. The US ODIS system is a key element of the US marine litter management strategy.

Enrique Wulff is a national politician in Spain. He is also a member of the Spanish National Research Council (CSIC).

The poster is a detailed information gathering and assessing that data, and reporting them back to a lead agency, either the European Environment Agency (EEA) or the US Environmental Protection Agency (EPA). This would give an interventional dimension to the marine knowledge and data systems, which are technical in nature but whose political justification can be found in the long term.

Shedding light on marine plastic data to build research links between EU and US ocean research

1. I wish to present a poster entitled "Shedding light on marine plastic data to build research links between EU and US ocean research" for this session on "Digital ecosystems" because the plastic waste needs sources and responses.

2. The proposal of this poster is to establish information clearinghouses collecting and assessing that data, and reporting them back to a lead agency, either the European Environment Agency (EEA) or the US Environmental Protection Agency (EPA). This would give an interventional dimension to the marine knowledge and data systems, which are technical in nature but whose political justification can be found in the long term.

3. Marine Plastic Data Areas where EU-US research links are possible

3.1. Coastal and ocean planning: As both Europe and the United States embarked on marine spatial planning policies in 2009, opportunities could be offered to exchange best practices in their marine data pollution policies.

3.2. Marine security and safety: To protect the EU and US maritime interests worldwide the use of port reception facilities for plastic waste, could promote mutual support on data policies to regulate ship-generated plastic waste.

3.3. Improving marine research: Data research on marine plastic pollution has resulted in US NOAA

Use of X-Band Radars to Monitor Small Garbage Islands

Francesco Serafino - Institute of Bioeconomy (IBE), National Research Council
 Council
 Andrea Bianco

USE OF X-BAND RADAR TO MONITOR SMALL GARBAGE ISLAND (SGI)

Consiglio Nazionale delle Ricerche
Istituto per lo BioEcnomo

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Abstract

The aim of the work is to verify and demonstrate the possibility of using X-band radars to identify, discriminate and follow small floating aggregations of marine litter (Small Garbage Islands—SGI) made up mainly of plastic debris. In this sense, the radar measurement campaign can be carried out in a series of controlled releases into the sea of SGI modules assembled in the lab. The results of this first measurement campaign, that are of interest to the entire scientific community that operates in the field of macroplastics monitoring, have shown that in calm sea conditions the characteristics of the signal reflected by SGI is different, and therefore discriminable, from that reflected by other targets, opening in fact a new experimental avenue for the use of X-band radars also to monitor plastic waste at sea.

System Architecture and Test Site

X-Band Radar

Radar Interface
System architecture

Test Site

Building of Small Garbage Island

Assembly of the Small SGI module

Set of modules used as targets in the measurement campaign

Survey Area

SGI releases

Radar measures and data processing

Identification of the target

Estimation of plastic with areas

Measurement of the maximum of the intensity

Target discrimination analysis

Conclusions and Future Developments

The results of the work have shown that it is possible to identify the characteristics of the signal reflected by SGI, as different and therefore discriminable, from that reflected by other targets. In particular the experimental data have shown that the X-band radar discriminates the experimental targets after the maximum distance of 200 meters under the following conditions: beyond the distance, the signal measured by the radar drops and can compare with other targets and can be the influence of other parameters of the radar. Consequently, the use of radar for the identification of small floating aggregations of marine litter (Small Garbage Islands—SGI) is possible. Furthermore, the experimental data of the radar measurement campaign allow us to verify the radar detection characteristics in the sea conditions and to study the sea state module that can detect the intensity of the backscattered signal with the average noise levels using the sea state module.

The aim of the work is to verify and demonstrate the possibility of using X-band radars to identify, discriminate, characterize and follow small floating aggregations of marine litter (Small Garbage Islands—SGIs) made up mainly of plastic debris. To this end, a radar measurement campaign was carried out on a series of controlled releases into the sea of SGI modules assembled in the lab. The results of this first measurement campaign, that are of interest to the entire scientific community that operates in the field of macroplastics monitoring, have shown that in calm sea conditions the characteristics of the signal reflected by SGI is different, and therefore discriminable, from that reflected by other targets, opening in fact a new experimental avenue for the use of X-band radars also to monitor plastic waste at sea.

TRACE - software system to detect and track large floating marine litter

Tobias Weiss - GFZ Potsdam

Matthias Bochow, Ivan Cester, Michol Ghezzo, Christian Ferrarin, Melissande Machefer



TRACE is a software system to detect and track large floating marine litter. The system consists of components for remote sensing data analysis for litter detection (high resolution optical and SAR satellite imagery) and identification (hyperspectral satellite imagery), oceanographic forecasting, GIS analysis (result evaluation, uncertainty analysis), litter tracking and a web interface for visualization and analysis purposes.

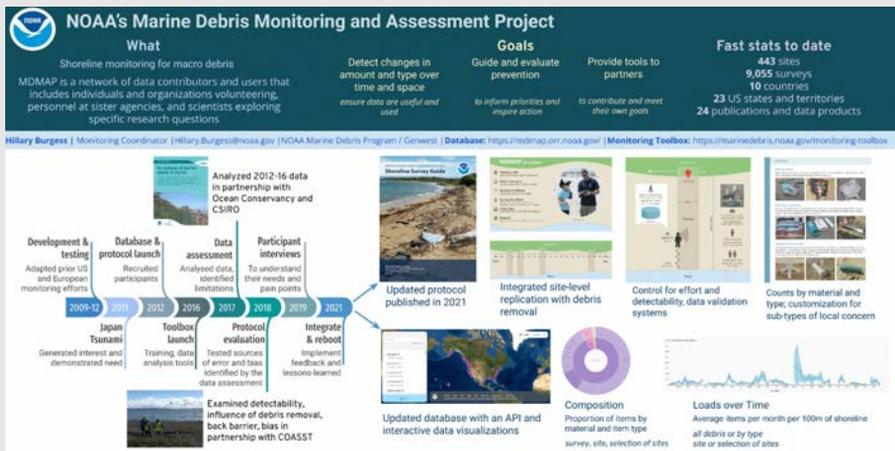
The goal of our project is to obtain precise and reliable data on floating macro-litter regarding their quantity, position, accumulation zones, material properties, floating depth, and sources, which may serve as a basis for litter recovery, source elimination, and prevention of litter dispersal.

<https://www.youtube.com/watch?v=w47InE5BAz4>

NOAA Marine Debris Monitoring and Assessment Project (MDMAP)

Hillary Burgess - NOAA Marine Debris Program

The NOAA Marine Debris Monitoring and Assessment Project (MDMAP) was established in 2011 and is run by the NOAA Marine Debris Program. Data collection follows a rigorous, well-tested protocol designed to document quantity and composition of shoreline marine debris greater than 2.5cm. The MDMAP functions as a network of volunteers, NGOs, and agency and academic personnel who contribute and use the data. The dataset is freely accessible via a browser application or API, and informs research, prevention, and management at local to regional scales. Outcomes range from improved understanding of marine debris accumulation drivers, to assessment of the efficacy of preventative legislation, to development of behavior change campaigns targeting source reduction.



Rivers as sources of microplastics toward the sea: the case of the Chubut River estuary

Rodrigo Hernandez Moresino - Centro para el Estudio de Sistemas Marinos (CESIMAR-CONICET)

Erica Giarratano

Rivers as sources of microplastics toward the sea: the case of the Chubut River estuary

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Introduction

Nearly 90% of ocean plastic debris come from land-based sources (Uma et al., 2020). Rivers represent the major pathways of microplastics (MP) transfer between the atmosphere, land surfaces and aquatic environments and are considered the dominant source of MP to the coastal zone and the sea (Saborido et al., 2021). The Chubut River is the main source of freshwater in Chubut Province (Patagonia, Argentina), with significant importance for the local economy mainly related to agricultural and textile activities, pouring different kinds of wastes and pollutants that finally end in the Atlantic Ocean. The study aimed to investigate the presence and abundance of MPs in the estuary of Chubut River, hoping with these first results to better understand the environmental fate of microplastic pollution and to establish the basis for future studies.

Methodology

Collection
Samples of surface and bottom water (3 l) and top 3 cm sediment (200 g) were taken in 8 sites in the estuary of Chubut River in June of 2021.

Filtration
Water samples (3 l) were gravity-filtered through 20 µm paper filters (MF7 mesh). Filtered grams of dry sediment were placed in capped 250 ml beaker with 100 ml of saturated CaCl₂ solution (3.4 g/cm³) shaken in an orbital shaker at 200 rpm for 30 minutes and then allowed to settle down overnight. The top 10 ml of supernatant were vacuum-filtered through 20 µm paper filters (MF7 mesh). The procedure was repeated three times.

Digestion
Moon collection, all filters were placed in clean labelled 20 ml mesh dishes and digested with 10 ml 0.1M HF solution and H₂O₂ 30% at 50 °C on sand bath to eliminate the organic matter (Hester request) following the NOAA criteria by Mautner et al. (2015).

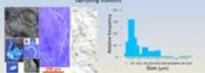
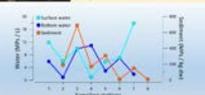
Optical inspection
Filters were examined before and after digestion with a stereomicroscope (10X), first with natural light and then with ultraviolet light to identify white-transparent MP.

Contamination control

Blanks were conducted in order to evaluate the levels of airborne contamination. Paper filters were exposed to fresh distilled water in the processing of samples and used to the stereomicroscope during sorting. Then they were closed, labelled, and examined following the same procedure used for samples.

Results

- A total of 28, 72 and 40% of potential MP were registered before and after digestion in surface water, bottom water and sediment, respectively.
- MPs were found in every sample, being fibers the most abundant type of microplastic (80%), and the size range was 0.4-4370 µm (X = 883, SD = 216).
- Differences in MP abundance between surface and bottom water samples were found in station 7, higher in surface water (lower sediment than in bottom water (higher salinity). This result reinforces the role of the river as a carrier of MP to the sea.
- MP abundance in sediment seems to show a slightly decreasing tendency toward the mouth of Chubut River, but further studies are needed to confirm it.
- Sediment from station 3 presented the highest abundance of MP (more than three fold higher than the other sites), corresponding to the highest proportion (5,71%) of finest particles (<63µm).
- Average MP concentration in water was 7.3 items/L, meanwhile in sediment was 218 items/kg dry weight.



Conclusion

This is the first study that analyzes the abundance and characteristics of MP present in the Chubut River estuary (Argentina). Compared with other estuary systems (Pérez et al., 2021), MP pollution in the area can be considered moderate, mainly attributed to microfibers. Future results from further analysis, currently in course, will allow to identify the type of microplastic found.

The Chubut River is the main source of freshwater in

Chubut Province (Patagonia, Argentina), with significant importance for the local economy mainly related to agricultural and textile activities, pouring different kinds of wastes and pollutants that finally ends in the Atlantic Ocean. This work aims to assess microplastic concentration in water and sediment in seven stations along the estuary. Separation of microplastics was done on filtering superficial and depth water and in sediments by flotation with hypersaline solution plus supernatant filtering. An average of 200 MP/sediment and 7000/m3 water (85% fibers) emphasize the need for rational use of the river.

Inexpensive detection systems for microplastics

Amelia Labbe - University of California at Santa Cruz

Lisa Uttal & Clive Bagshaw

In order to identify microplastics in water samples, basic bright-field microscopes were modified for polarization and Nile Red fluorescence detection. These methods helped distinguish plastic fragments and fibers from natural material. The modifications cost less than \$100, making the approach accessible to community scientists and schools. The procedures were used to bring microplastics to the attention of the public at outreach events and to provide a timely practical exercise in microscopy and environmental science for college students. <https://sites.google.com/ucsc.edu/cbagshaw/outreach/mbnms-microplastics>

<https://www.youtube.com/watch?v=utHs1gTMall>

Inexpensive detection systems for microplastics
Amelia Labbe, Lisa Uttal, and Clive Bagshaw, <https://sites.google.com/ucsc.edu/cbagshaw/outreach/mbnms-microplastics>

UCSC, Santa Cruz, CA, USA

Introduction

Plastic contamination at the nanoscale level is well recognized by the public (e.g. beach litter and wildlife entanglements). However, microplastics are generally a more serious problem when they enter the food chain via filter feeders. In a plankton monitoring program, we frequently found likely anthropogenic fragments and fibers in samples collected in the laboratory bay. In an effort to detect and identify microplastics in these samples, we made inexpensive adaptations to basic microscopes. These procedures are appropriate for community science and outreach programs.



Methods

Seawater samples were examined with a microscope under bright field illumination, crossed polarizers and fluorescence excitation following Nile Red staining. These adaptations require polarizing film, a blue LED flashlight and a yellow or orange emission filter. The total cost of these ad-hoc items is less than \$100, making them accessible to schools and community scientists. Known plastic fragments (e.g. polystyrene, nylon and cigarette filter fibers) were examined as controls. Plastics usually appear bright under crossed-polarizers. Samples stained with Nile Red did not glow yellow, orange or red fluorescence, depending on the hydrophobicity of the plastic. Blue color from scattering by other debris in the sample. See Labbe et al. (2020).



Results



(a) Microscope set up for fluorescence detection. (b-d) Sample collected from the Santa Cruz wharf with a 200 µm mesh net. (b) Under bright field illumination, plastic fragments or fibers are sometimes distinguished from particles of natural origin by the lack of internal structure. (c) Under crossed-polarizers, plastics often stand out due to their birefringent properties. (d) Nile Red staining highlights extraneous contamination by the fluorescence emission observed through an orange filter.

Conclusion

Microplastic detection and identification methods in research laboratories involve techniques such as mass spectrometry, infra red and raman microscopy which are beyond the reach of community scientists. Polarization and fluorescence microscopy have also been used, but even these techniques have required research grade microscopes. Here we show that basic microscopes, as available in schools, community groups, and teaching laboratories can be used with simple adaptations. Both polarization and Nile Red staining suffer from false positives and there is much discussion in the literature as to their efficacy for identifying microplastics. Students from community college tested our procedures and reported that their interest in finding microplastics compared with using bright field inspection alone. Even with these caveats, the methods provide a way to reveal microplastics to the public in outreach events, leaving microplastics front-and-center in a first step in acknowledging a problem that affects us all.

References

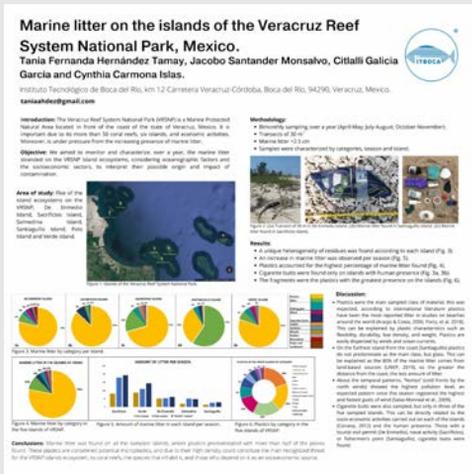
Labbe, A. R., Bagshaw, C. R. and Uttal, L. (2020) Inexpensive adaptations of basic microscopes for the identification of microplastic contamination using polarization and Nile Red fluorescence detection. *J. Chem. Educ.* 97, 11, 4020-4025. [doi:10.1021/acs.jchemeduc.3c00011](https://doi.org/10.1021/acs.jchemeduc.3c00011)



Marine litter on the islands of the Veracruz Reef System National Park, Mexico.

Tania Hernandez - National Technology of Mexico / Technological Institute of Boca del Río

Jacobo Santander Monsalvo, Citlalli Galicia García and Cynthia Carmona Islas.



The Veracruz Reef System National Park (VRSNP) is a Natural Protected Area of 65,516 hectares with 28 reefs and six islands, located in the Gulf of Mexico. It is threatened by marine litter, recognized worldwide for its adverse impacts on biodiversity, human health and socio-economic activities. This work aims to characterize and monitor marine litter stranded on the island of the VRSNP, using quadrants, considering the oceanographic pattern, seasonality and coastal socioeconomic activities, to interpret its possible origin and impact. The main material found is plastic, but marine litter changes according to the location and management category of each island.

Estimation of plastic marine debris abundance on beaches using unmanned aerial vehicles and image processing based on deep learning

Shin'ichiro Kako - Kagoshima University

Tetsuya Tanedaa, Mitsuko Hidakab, Daisuke Sugiyamab, Koshiro Murakamib, and Daisuke Matsuokab

Estimation of plastic marine debris abundance on beaches using unmanned aerial vehicles and image processing based on deep learning

Shin'ichiro Kako^a, Tetsuya Taneda^a, Mitsuko Hidaka^b, Daisuke Sugiyama^b, Koshiro Murakami^b, and Daisuke Matsuoka^b
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1. Introduction

Microplastic pollution on beaches is a growing global marine debris (PMD) problem. It is a serious environmental issue because of its abundance and persistence. The approach that can accurately, rapidly, objectively, and economically estimate the PMD abundance on beaches has not yet been established.

The purpose of the present study is to propose a novel approach for estimating the volume of PMD by combining UAV surveys and image processing based on deep learning.

2. Material and Method

2.1 UAVs

To obtain accurate results, only the PMD is photographed using UAV. The procedure is shown in Fig. 1.

- EXETER with 4K camera
- Using the Pix40 application: it can be easily flown in the field. It can be used without setting skills.
- It is possible to fly near the beach in a wide range to grasp the PMD volume in a wide range.

This is a major strength. The main study is for approximately 10 min and does not require the special equipment. The PMD is estimated on the ground.

3D photogrammetry

- Images captured from four different views are reconstructed by the "Metashape" (Structure) software. Measurements can be automatically and accurately obtained.
- The "Metashape" can be used to create 3D point cloud, digital surface model (DSM), and orthorectified images of the beaches.

2.2 Field experiments

- Surveys using the UAV were conducted on beaches in Shari, Kagoshima, Japan. The beach is about 100 m long and 10 m wide. The PMD is mainly composed of PS.
- Known volumes of test objects of various colors were placed on the beach. The PMD is estimated on the ground.
- Using the results, we validated the accuracy of the results.

2.3 Automatic detection of PMD using image processing based on deep learning

- The proposed image processing method is based on the output of neural networks.
- The edge boundaries of the PMD are extracted by the edge detection using an edge-detection algorithm based on a deep learning.
- To estimate the volume of PMD, we use the volume of the PMD.
- Images are processed by using the edge-detection method. The PMD is estimated on the ground by using the edge-detection method.

3. Results

3.1 Results of UAV surveys and 3D photogrammetry

The results of UAV surveys and 3D photogrammetry are shown in Fig. 2.

3.2 Results of deep learning

The results of deep learning are shown in Fig. 3.

The results of the edge detection using deep learning were input into the DSM.



The test area and height are marked by the edges. The volume of each PMD is estimated from the DSM.

- Our method can detect the PMD volume accurately.
- The volume of each PMD is estimated from the DSM.
- The volume of each PMD is estimated from the DSM.

3.3 Comparison between measured and estimated volumes of the test debris.

Measured value	0.87	0.87	0.80	0.80	1.04	1.04	1.04
Estimated value	0.98	1.01	0.71	0.98	0.94	1.00	1.08
difference	0.11	0.14	0.09	0.18	0.04	0.04	0.04

The difference between the measured and estimated values is small. The difference is about 10%.

The volume of each PMD is estimated from the DSM. The volume of each PMD is estimated from the DSM.

4. Discussion

To evaluate the effectiveness of the proposed method, a field survey was conducted on the beach. The results of the field survey are shown in Fig. 4.

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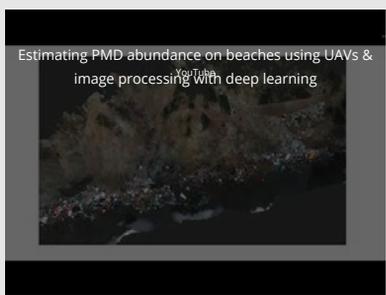
The results of the field survey are shown in Fig. 4. The results of the field survey are shown in Fig. 4.

4.1. Future studies

- Our method can detect the PMD volume accurately.
- The volume of each PMD is estimated from the DSM.
- The volume of each PMD is estimated from the DSM.

To help address plastic marine debris (PMD) problem, a novel approach for estimating PMD abundance using a combination of unmanned aerial vehicle (UAV) surveys and image processing based on deep learning is proposed. A three-dimensional model and orthoscopic image of a beach, constructed via Structure from Motion software using UAV-derived data, enabled PMD volumes to be computed by edge detection through image processing. Compared with subjective methods based on beach surveys, this approach can accurately, rapidly, and objectively calculate the PMD volume and can be used to improve the efficiency of beach surveys and identify beaches that need preferential cleaning.

https://www.youtube.com/watch?v=OwrPjke_DHs



5. Conclusions

The results of the field survey are shown in Fig. 4. The results of the field survey are shown in Fig. 4.

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Fig. 1 The main survey area and the location of the test objects on the beach.

The PlasticNet Project

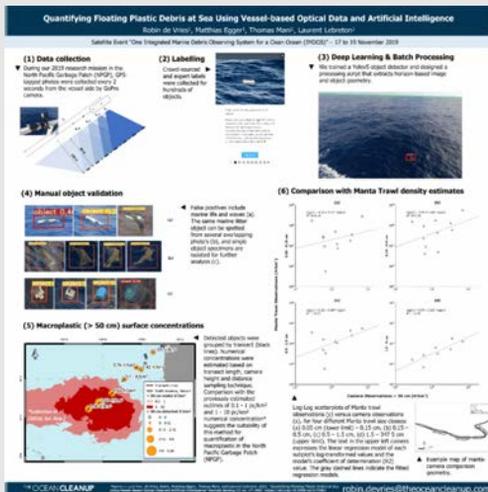
Naeem Altaf - IBM

Minsik Lee; Colin Alstad

"The PlasticNet Project is an "IBM Tech for Good" open-source project developed by the IBM Space Tech team to build a repository of AI object detection models to classify types/brands of plastics, trash on beaches, trash in the ocean, etc. We can scale this effort with the global community of developers participating and contributing towards this noble effort, with long-term goals to help with ocean cleanup and positively impact climate change."

Quantifying Floating Plastic Debris at Sea Using Vessel-based Optical Data and Artificial Intelligence

Robin de Vries - Ocean CleanUp



Despite recent advances in remote sensing of large accumulations of floating plastic debris, mainly in coastal regions, the quantification of individual macroplastic objects (>50 cm) remains challenging. Here, we have trained an object-detection algorithm by selecting and labeling photos of floating plastic debris recorded offshore with GPS-enabled action cameras aboard vessels of opportunity. Macroplastic numerical concentrations are estimated by combining the object detection solution with bulk processing of the optical data.

Our results are consistent with macroplastic densities predicted by global plastic dispersal models, and reveal first insights into how camera recorded offshore macroplastic densities compare to micro- and mesoplastic concentrations collected with neuston trawls.

Marine Litter Database and associated products

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Marine Litter Database and associated products

WHAT IS THE MARINE LITTER DATABASE (MLDB)?

EMODnet Chemistry set up the MLDB in 2018 to gather and harmonize available marine litter data at the European scale. Several publicly accessible visualization products are regularly updated from the contents of this database.

GOAL

The aim of the MLDB and the visualization products associated is to provide a synthetic and intuitive sight of the high quantity of information and relevant aspects collected in the marine litter datasets at the Pan-European scale.

CONTENT



VISUALIZATION PRODUCTS

Viewer: <https://ec.europa.eu/browser.net/emodnet/>
→ using OGC web services

BEACH LITTER: 8 MAPS FOR EACH TYPE OF SOURCES

- Beaches locations and litter list used
- Number of surveys and temporal coverage
- Material categories percentage
- Median number of items: total, cigarette items, fishing and aquaculture plastic items, plastic bags items

SEAFLOOR LITTER: 5 MAPS (FOR ALL SOURCES)

- Trawls location
- Material categories percentage
- Density: total, fishing related items, plastic bags related items

METADATA

Each product is associated with:
• A DOI (Digital Object Identifier)
• A metadata record

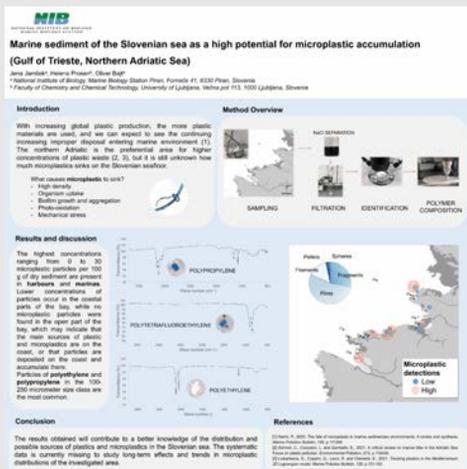
Metadata catalog:
<https://www.emodnet-chemistry.eu/products/catalogue>

EMODnet Chemistry set up a Marine Litter Database (MLDB) in 2018 to gather and harmonize available marine litter data at the European scale. This database contains data of beach and seafloor litter and data of floating micro-litter. Data are mainly provided by EMODnet project partners though there are additional sources from EU Member States and neighboring countries. Datasets have been collected over a long period (2001-2020), in the framework of MSFD monitoring programs, research projects or by European citizens through Citizen Science tools.

Many data products, like beach and seafloor litter distribution or composition have been created from this database.

Distribution of microplastic particles in the surface sediment of Slovenian sea

Jena Jamsek - National Institute of Biology - Slovenia



The northern Adriatic is the preferential area for higher concentrations of plastic waste, but it is still unknown how much microplastics sink on the Slovenian seafloor. Therefore, surficial sediment samples were collected using Van Veen grab. The polymer composition of the extracted particles was identified using Fourier transform infrared spectroscopy. The highest concentrations ranging from 0 to 28 microplastic particles per 100 g of sediment are present in harbours and marinas. Polyethylene and polypropylene were the most common plastic materials. The results obtained will contribute to a better knowledge of the distribution and possible sources of plastics and microplastics in the Slovenian sea.

EO based services that aim to detect marine pollution using freely available Sentinel imagery

Filipe Brandao - GMV

João Vitorino; Beatriz Revilla Romero; Omjyoti Dutta

MARINE POLLUTION DETECTION USING EARTH OBSERVATION AND ARTIFICIAL INTELLIGENCE

One Integrated Marine Debris Observing System for a Clean Ocean virtual event

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Marine pollution is an increasingly devastating problem that urges for new conceptual and technological solutions to help prevent, detect, monitor and mitigate the consequences of this environmental degradation. Earth Observation (EO) with its capabilities, every day enhanced and accessible with the growing number and diversity of constellations, can contribute for solutions to this problem.

It is in this sense that GMV is developing an EO based service capacity aiming to detect marine pollution (plastics and spills) using Sentinel 1 and 2 (optical and SAR) imagery.



MARINE POLLUTION DETECTION AND MONITORING SERVICES – TECHNICAL SOLUTION

These services being developed by GMV rely on the advantages of using free-of-charge multispectral imagery together with artificial intelligence, to automatically and continuously detect, classify and quantify floating plastics and marine spills at global scale.

These services are based on the fact that the presence of plastics and / or spills in an Earth Observation image pixels influences each individual pixel's reflectivity, allowing the development of a model to estimate the % of each pixel area covered by plastics / spills.



PLASTIC DETECTION



Marine plastic identification by Sentinel 2 satellite imagery provided by the author

SERVICES OUTPUTS

SPILLS DETECTION



Oil spill detection by Sentinel 1 SAR satellite imagery provided by the author

MARINE POLLUTION DETECTION AND MONITORING SERVICES IMPACTS

- Support of existing legal frameworks and information needs, whilst promoting and opening avenues to the development of new legal frameworks, capable of harnessing more novel advances.
- Identification of marine pollution hotspots and problematic areas
- Understanding flow dynamics in terms of marine pollution



Local community cum EO: An inclusive approach for marine debris monitoring and circularity.

Elegbede, Isa Olalekan - Brandenburg University of Technology (BTU)

Lauren Chamberlain, Micah Brodsky

It's not again saying that marine debris is becoming a menace to humans and aquatic plants and animals. Due to these circumstances, various policies at the local, regional and global areas have been initiated. However, implementation of these regulations is yet to be actualized. This situation is caused by neglect of the local community and good use of innovative technologies. This study presents the creative use of local communities, visualized sensors, with ocean observation technologies to track ocean and coastal debris from origin to destination and connect to the circularity of the marine litter. Possibilities of ensuring inclusivity of both humans and technologies to monitor and recycle this debris for local and industrial benefits will significantly contribute to the SDG goals with the UN decade of action frameworks and secure empowerment possibilities for the local communities.

Long-term monitoring of marine debris throughout the Hawaiian Islands by active networking of multiple non-governmental organizations

Megan R. Lamson - Hawaii Wildlife Fund
Carl Berg, Hannah Bernard, Cheryl S. King, Rachel Sprague

Long-term monitoring of marine debris throughout the Hawaiian Islands by active networking of multiple non-governmental organizations.

Megan R. Lamson and Hannah Bernard-Hawaii Wildlife Fund, Carl J. Berg-SurfRider Foundation, Cheryl S. King-Sharkastics, Rachel Sprague-Pūlama Lānaʻi

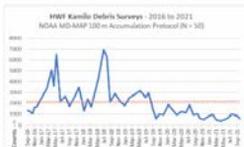


Figure 1. Counts of marine debris (0-2.5 cm) within a set, standardized 200 x 22 m survey area at Kamille Point, Hawaii's Island (see at Hawaii Wildlife Fund). Orange line is the mean count (2,068 items / survey).

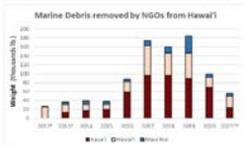


Figure 3. Total weight of marine debris removed on Kauai*, Hawaii*, and Maui Nui (Maui + Lana'i) by author's NGOs over the past decade (2012-21). *Maui Kauai data available until mid 2013. **Partial year.

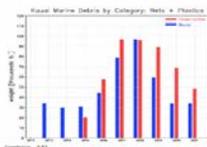


Figure 2. Total weight of marine debris removed from Kauai's shorelines (by SurfRider Foundation) and amount of model debris arriving in Hawaii* from remote sources (predicted by Dr. Jan Richter & Dr. Nicolas Marmorino-IPRC, Univ. Hawaii*).



Figure 4. Map of the main Hawaiian Island chain with approximate debris collection sites on four islands by the author's NGOs and community volunteers for this study.

Abstract:

Multiple NGOs organized volunteer citizen scientists to island-specific activities in order to optimize efficiency for collecting and recording marine debris. Activities ranged from NOAA standardized 100m surveys to community beach cleanups, targeted net patrols, and helicopter airlifts of debris from inaccessible shorelines. Efficiency was greatest when large deposits of derelict fishing gear were targeted by small experienced crews. Long-term records of debris collected have shown a recent decline in debris loads over the past several years. Only through long-term collaborations within the IS-MDAP network would these findings be possible.



Funding for marine debris removal activities, in part, was made possible by NOAA Marine Debris Program competitive grant awards.

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Trans-disciplinary approach to reduce the impact of derelict gear from the North Pacific eel fisheries

Carl J. Berg - Surfrider Foundation

Lauren Bickley - Surfrider Foundation, Yeohun Kim and C. Semee Rhee - OSEAN

Trans-disciplinary approach to reduce the impact of derelict gear from the North Pacific eel fisheries

Carl J. Berg and Lauren Bickley
Surfrider Foundation, Hawai'i Region

and
Yeohun Kim and C. Semee Rhee
Our Sea of East Asia Network (OSEAN)



Introduction: Derelict fishing gear from the Hagfish eel and Conger eel fisheries of the coastal North Pacific Ocean is carried in ocean currents, into the Great Pacific Garbage Patch, and washes ashore along the entire 2,400km of the Hawaiian Island chain which annually serves out thousands of these black plastic trap entrances along with hundreds of tons of larger nets, ropes and buoys from the international deep water fishing fleets. Surfrider Foundation harvests - 50 tons of derelict fishing gear from the shore of the island of Kauai each year and while not the largest component of this gear, eel trap entrances are a significant portion, as they land the second of highly endangered and rare Hawaiian monk seal pups, causing starvation.

Project Goal 1: To identify the source of trap parts washing upon Hawaii's shores and work with eel fisheries-of-origin to reduce the loss or discarding of trap entrances and the degrading of the trap entrances, thereby reducing the incidence of trap-seal interaction.

Trans-disciplinary, trans-Pacific, approach by working with:

1. Government fisheries departments and eel fishers themselves to identify locations and size of eel fisheries on west coast of North American and coast of East Asia
2. NGOs in Asian countries and US to collect traps for identifying source fisheries.
3. Scientists to identify biofouling fauna to identify where traps were set or where they floated. Also to identify species alien and invasive to Hawaii.
4. Fishermen to devise methods to reduce trap entrance loss.
5. Private companies to explore possible biodegradable materials for trap manufacture.
6. Computer scientists to use AI for image analysis and grouping to identify most common models of trap entrances.



Impact: Data provided by NOAA Pacific Islands Fisheries Science Center documents that in Hawaii over the past five years 7 monk seal pups were rescued from eel traps. Northern Elephant Seals and Pilot Whales are known to have ingested parts of the eel traps. Identification of alien biofouling species is underway. Breakdown of trap pieces to microplastic fragments on our beaches is obvious.

Project Goal 2: To reduce trap-seal interaction by collecting trap entrances from shorelines around the North Pacific, not especially from monk seal pupping areas in Hawaii during pupping season.

Monk seal pup protection approach by working with:

1. Citizen science volunteers to remove trap parts from shorelines across the north Pacific. We will reach out by a large concerted effort using social media, marine debris and marine mammal list servers, newspapers, television, email lists and coordinate with other NGOs, trans-Pacific.
2. Marine Mammal Response teams to remove trap parts from monk seal pupping sites during the pupping season and from entangled pups.
3. US State and Federal agencies to document monk seal and other marine mammal entanglements, and identify sources of responsible trap parts.

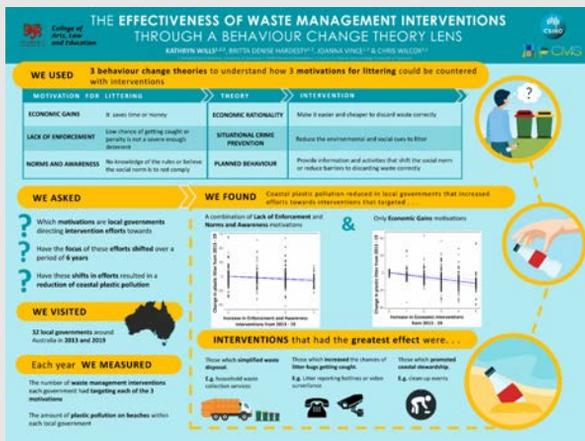
The eel fishing industries in the North Pacific Ocean contribute significant amounts of derelict fishing gear being washed ashore on the Hawaiian Islands. Cone-like trap entrances of derelict traps entangle and endanger Hawaiian monk seal pups and bring degrading marine plastics and alien species to Hawaii. To

mitigate gear loss and the harmful impact on Hawaii's marine life, OSEAN and Surfrider Foundation are employing a transdisciplinary approach by working with citizen scientists, fishing cooperatives, governments, and relevant industry stakeholders to identify opportunities for innovative solutions to help prevent derelict gear and ultimately reduce harmful impacts on marine life and ecosystems.

Investigating the effectiveness of waste management interventions through a behaviour change theory lens.

Kathryn Willis - CSIRO Oceans and Atmosphere

Britta Denise Hardesty, Joanna Vince, Chris Wilcox



Regardless of where plastic pollution originates, management at the local level is crucial to the global success of reducing plastic pollution. There currently lacks a quantitative framework that connects local actions to measurable reductions of plastic in the coastal environment. We used three behavioural theories to characterize how local governments across the continent of Australia have targeted their waste management interventions, how those targeting interventions have changed over 6 years and identified which underlying behavioural approaches generated the greatest reduction in pollution. Interventions that encouraged stewardship of coastal areas or simplified waste disposal were correlated with reductions in local plastic pollution.

Overview of the dispersion of floating plastic debris, possible sources and hotspots points of litter accumulation on beaches and Marine Protected Areas (MPAs) on the North Coast of São Paulo State

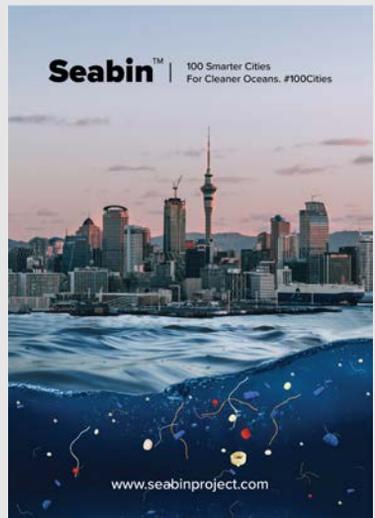
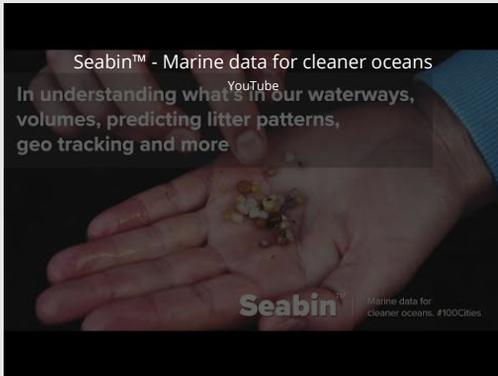
Maria Eugenia Fernandes - Asian Institute of Technology

My study aimed to provide an overview of the dispersion of floating plastic debris, possible sources and hotspots points of litter accumulation on beaches and Marine Protected Areas (MPAs) on the North Coast of São Paulo State - Brazil. A hydrodynamic numerical model and a particle dispersion model were used along with progressive and regressive vector techniques over time. To identify if there were differences with seasonal variations, the simulations were conducted considering data from January and July 2019. The results include relevant data that can be used by stakeholders to drive conservation actions for coastal and marine ecosystems, including MPAs.

Seabin Project

Solomon Wadani - Seabin Project

Mahi Paquette



"Seabin™ is a data driven, clean tech, environmental start up that has established itself as a leading global authority in marine health monitoring, specialising in plastic pollution capture technology including micro plastics and micro fibres.

Seabin™ hosts critical and detailed baseline data sets that focus on the prevalence and diversity of marine litter in metropolitan settings. Seabin™ data can therefore be used by key decision makers to facilitate policy and behavioural change to ensure healthier oceans and prosperity for our planet.

Our goal is to service 100 cities by 2050 via our scalable and sustainable model, that involves people, planet and profit.

https://www.youtube.com/watch?v=RdkTv_5GdtU

Litter Intelligence: Quality Citizen Science Inspiring Litter Action

Camden Howitt - Sustainable Coastlines



How quality citizen science can inspire litter action.

OBJECTIVES

Monitor litter and plastic pollution present major risks to people, culture, environment and recreation beyond the beach. Globally, we lack reliable and standardised data to inform better decision making. And though concerns over these issues is relatively widespread, communities often lack the capability, opportunity and motivation to engage in solutions.

At the 2017 UN Ocean Conference, New Zealand-based NGO Sustainable Coastlines launched an ambitious voluntary commitment to create a centre for Pacific and global coastal clean-up actions to manage litter and plastic pollution.

METHODS & TOOLS

In 2018, with funding from NZ's Ministry for the Environment, and in collaboration with Stats NZ and the Department of Conservation, Sustainable Coastlines developed the country's first national litter monitoring programme, enabling communities to collect robust scientific data, gain insights and take action to prevent litter.

The data collection methodology is a localised adaptation of the United Nations Environmental Program's (UNEP) International Oceanographic Commission Guidelines on Survey and Monitoring of Marine Litter.

At the programme's core is a world-class database and technology platform, providing instant and open access to marine litter data, data visualisations, and analysis tools. Microsoft provided additional funding to build image-recognition tools that further enhance data quality.

Sustainable Coastlines currently trains and supports citizen scientists to monitor their quarterly at 250 coastal sites around New Zealand.

Data.
Citizen Science programme collecting long-term, scientifically rigorous litter data. Strict open data and transparency principles are adhered to.

Insights.
Interactive toolmaking for data entry, trends, comparisons and insights. Raw data for download and in-depth analysis.

Action.
Inquiry-based schools education programme and library of inspiring community litter prevention actions.

RESULTS TO DATE [Read more at www.litterintelligence.org/action](http://www.litterintelligence.org/action)

Our marine environment 2019

For the first time in New Zealand citizen scientists have contributed to official "Tier 1" national environmental reporting, informing major changes in plastics and waste policy. Litter Intelligence is one of only five programme globally that enable communities to monitor official progress against the Sustainable Development Goals.

Glass company Athorn Windows and Doors responded to local citizen scientists' concerns, by switching to their blue plastic float-pails, which replaced their glass sheets, to curb pollution. Taranaki Conservationists, a Litter Intelligence monitoring group, had noticed these during their surveys and contacted the company to notify them of the issue.

Students from Waikanae's Te Hunaiki School took action on single-use cups after discovering their school's 'cup caps were PLA' (read: After completing a Litter Intelligence survey on their local beach, they noticed a lot of disposable coffee cups. They wrote letters to the area to highlight the problem and to the cup company to clarify their marketing.

NEXT STEPS

To provide more holistic data, freshwater and stormwater litter data are being integrated into the platform, with land litter data integrated next. The programme was launched in Samoa for SPIREP's 2019 Pacific Environment Forum, and in September 2020 groups across Samoa, Tonga and Wallis & Futuna established 6 pilot monitoring sites.

View data. Explore insights. Take action. www.litterintelligence.org

Communities want to participate in environmental monitoring that drives change, but seldom can do so with the scientific rigour that reporting programmes require. Litter Intelligence, developed by NGO Sustainable Coastlines, is New Zealand's first national litter monitoring programme, enabling communities to contribute robust scientific data from over 250 coastal sites. Designed in collaboration with the Ministry for the Environment, Stats NZ and the Department of Conservation, Litter Intelligence has already achieved major milestones, allowing citizen scientists for the first time to contribute to official 'Tier 1' national environmental reporting and informing major changes in plastics and waste policy.

The UNEP Global Partnership of Marine Litter - Digital Platform

Anne Bowser - UNEP

Heidi Savelli, Marta Ottogalli, Dany Ghafari, Saiful Ridwan, Lud Coppens, Caroline Kamau, Sarah Chitaha, and Clementine Logan

The GPML Digital Platform

1. How will the platform address the global problem of marine litter and plastic pollution?

- From Duplication and lack of information
 - To Integrated Knowledge and Data
- From Lack of harmonization
 - To promoting unified approaches
- From Lack of coordinated action
 - To a common framework
- From Limited collaboration
 - To co-developed solutions

2. What is a Center of Excellence?

An entity that provides leadership, data, resources, and/or training in a particular focus area. Centers of Excellence will include GPML and UNEP partners that demonstrate leadership in a topical research area or geographic region. For example, research centers might curate data on marine debris, while regional centers might include countries pilot testing the National Source Inventories approach.

3. How will Centers of Excellence Support the GPML Digital Platform's Goals?

- By working with a range of partners to bring together data in a particular area of authority or expertise.
- By ensuring that aggregated data are published in the data catalogue and/or GIS platform.
- By collaboratively developing and implementing data governance processes, including to secure open access to information, and to support data validation and quality assurance/ quality control.



Global Partnership
on Marine Litter

The Global Partnership on Marine Litter (GPML) Digital Platform connects and informs all actors working to address marine litter and plastic pollution through a lifecycle approach. The Platform's Data Hub provides a Geographic Information Systems (GIS) interface and API-enabled data catalogue to share open data and other relevant information related to a range of SDGs, including 6, 11, 12, and 14. As part of a larger federated ecosystem, the Platform and data hub will support and foster expert communities through a Centers of Excellence model that helps advance good practices in a range of topical areas or encourages regional coordination.

Monitoring of beached litter and microplastics in the water in the seas of Russia

Alexandra Ershova - Russian State Hydrometeorological University

Tatjana Eremina, Irina Makeeva, Yurii Tatarenko

The study presents several approaches used for monitoring of marine litter and microplastics in the Russian Federation by RSHU. Monitoring of beach litter pollution is done according to the two methods using a sieve ("frame method") and a rake ("rake method") with a mesh diameter of 2 mm in different parts of the beach from the wrack line to the vegetation line. The two methods are simple and relatively cheap and easy to use complementing each other and providing information on the visually distinguishable fraction of micro-debris (>2 mm). For water sampling RSHU has developed 2 models of the filtering device HydroPuMP (HydroPump for MicroPlastics) – a water sampling instrument with several replaceable meshes with sizes of up to 50 microns.

The Portuguese man o' war *Physalia physalis*, indicator of global health is threatened by plastic ocean contamination

Susel Castellanos-Iglesias

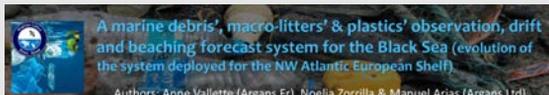
Programa de Pós-Graduação em Zoologia. Universidade Federal do Paraná

Maria Angélica Haddad, Miodeli Nogueira Júnior

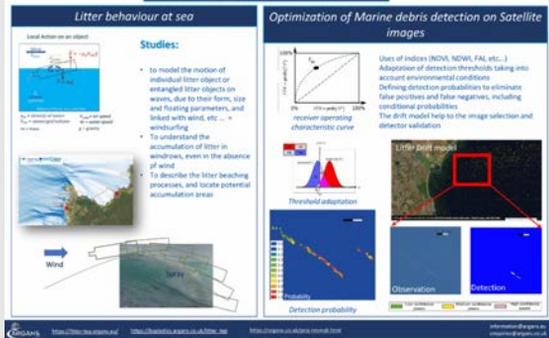
Physalia physalis (Linnaeus, 1758) is one of the most toxic organisms on the planet affecting human health. Due to the presence of a gas bladder, it floats on the sea surface and depends on winds and marine currents to feed, reproduce and disperse in warm waters. The increase in reports in colder areas suggests it as a possible indicator species of climate change and as an invasive species in areas never reported. Contamination of plastic waste floating in the sea and plastic debris are threats to the ecology of this species and marine organisms that interact with it, which can affect predictions of ocean climate change and monitoring of the negative effects of ocean contamination on human health at local and global level.

A marine debris', macro-litters' & plastics' observation, drift and beaching forecast system for the Black Sea -evolution of the system deployed for the NW Atlantic European Shelf

Anne Vallette - Argans Ltd
Noellia Zorrilla & Manuel Arias



On-going R&D activities



Further to i. a pre-feasibility study of an Earth-Observation satellite mission dedicated to the detection and mapping of marine litter presence which was conducted for ESA in cooperation with space industry, NGOs and academic research institutions (<https://argans.co.uk/proj-resmali.html>), and to i. an internal research study on the sources of litter in urban and rural areas, Argans deployed iii. a generic forecast system for litter pollution spreading from the NW Atlantic European watersheds, shores and cities (<https://litter-tep.argans.eu/>), developed iv. macro-litter detection schemes using current operational satellites for the (pan-)European waters (NW Atlantic, the Med and the Black Sea), and v. improved the parameterization of litter drift and beaching models (<https://bsplastics.argans.co.uk/litter-tep>) to prepare for the assimilation of observations from space. Critical to further progress is (a) the understanding of the processes for their beaching, washing, wearing, breaking, dispersing and sinking at/near the shore, as well as (b) the calculation of the lifetime of drifting macro-litter, which needs a proper model of the way they 'sail' or windsurf.

Plastic contamination in surface waters at the Yongala Shipwreck, Great Barrier Reef, Australia

Cherie A. Motti - Australian Institute of Marine Science (AIMS)

Michaela E. Miller, Marina F. S. Santana, Carine Lefevre, Samantha Jaworski and Frederieke J. Kroon

Plastic contamination in surface waters at the Yongala Shipwreck, Great Barrier Reef, Australia: Temporal evaluation leads to a nation-wide pilot monitoring program

Cherie A. Motti¹, Michaela E. Miller^{1*}, Marina F.S. Santana^{1,2}, Carine Lefevre¹, Samantha Jaworski¹, and Frederieke J. Kroon¹

¹Australian Institute of Marine Science, Townsville, QLD, Australia; ²AIMS@JCU, Townsville, QLD, Australia; ³James Cook University, Townsville



Introduction

Marine plastic pollution will likely increase should projections of increased plastic production eventuate and if there are no changes in solid waste management. Hence, scientists are interested in temporal and spatial status and trends of marine plastic contamination in the marine environment. To accurately assess associated changes to the health of marine ecosystems and inform environmental management.

Methods

A monitoring pilot program was established in 2016 at the Yongala National Reference Station.

Three years of data (2016 – 2019) was processed and analyzed for marine plastics.

Monitoring program expanded in 2021 to an Australian-wide plastics monitoring program including an additional 6 locations

Results

Yongala NRS 2016 - 2019

- Plastics in every tow (except one)
- 0.02 to 0.06 plastics m⁻³ (av. 0.03 ± 0.07 S.D. plastics m⁻³)
- 344 fragments and 389 fibres - macro-, meso- and microplastics
- Contamination fluctuated but no annual increase
- Mainly PE, PP and PET polymers
- Extreme weather events caused spikes in plastic concentrations

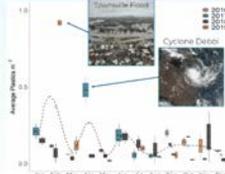


Figure 1. Mean (± standard deviation) of the monthly plastic concentrations (plastics m⁻³) at the Yongala NRS from Feb 2016 to Dec 2019. The mean plastic concentration was used to compare the monthly plastic concentrations to monthly precipitation (mm) for each month from Feb 2016 to Dec 2019. The mean plastic concentration was used to compare the monthly plastic concentrations to monthly precipitation (mm) for each month from Feb 2016 to Dec 2019.



Figure 2. Map of Australia showing the locations of the six pilot monitoring sites. The Great Barrier Reef is also shown. The location of the Yongala National Reference Station (NRS) is also shown.

Lessons Learnt

- Physicochemical variables should be monitored alongside to determine influences on plastic distribution and levels of contamination.
- Multiple timepoints are required to determine baseline levels and account for outside influences.
- Low levels compared to global estimates (1000 ± 24,000 plastics m⁻³)
- Multiple sites are required to determine whether this trend is specific to this area or whether it is also observed across the Australian coastline!

Conclusions

- Yongala NRS pilot monitoring is the first temporal assessment of plastic pollution in Australian waters and more specifically the GBR
- Important to scale up plastic monitoring across both time and space to provide reliable data for managers to aid in mitigation efforts
- Linking to existing monitoring programs (i.e. IMOS) allows for comparison of plastic (particularly microplastic) monitoring data with continuous oceanographic data to more accurately describe the temporal and spatial trends observed

Acknowledgements

We acknowledge the Mulgurukals, Kinsid, Whidduk Noogoo, Laralala, Gwaggal, Rarramanga, Gora, Narangala and Gungulimra people as traditional owners of the land and sea country which this research took place and recognise their contribution as the original scientists of this land. Special thanks to our collaborating partners on the expansion: IMOS, SARDI, Deakin University, and CSIRO.

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Tackling the Challenge of Marine Debris with Participatory Transdisciplinary Case Studies

Hans Peter Plag - Old Dominion University

Rene Garello

Tackling the Challenge of Marine Debris with Participatory Transdisciplinary Case Studies

Hans-Peter Plag¹ and Rene Garello²

¹ Department of Earth and Ocean Sciences, and Mitigation and Adaptation Research Institute, Old Dominion University, 2307 Atlantic Blvd., Norfolk

Preventing and mitigating marine debris poses a wicked problem to society. Besides the need to inform those who are engaged in tackling different facets of this problem with comprehensive observations of the marine debris that enters the ocean from different sources and what is in the ocean, there is a need to bring a wide range of stakeholders from all societal sectors together in transdisciplinary efforts. The "Plastics in the Ocean" initiative of IEEE/OES utilizes participatory modeling and transdisciplinary case studies to identify the societal information needs and to develop interventions for prevention and mitigation.

At two workshops organized in November 2018 and December 2019 in Brest, France, a participatory approach was utilized to develop a road map for a transdisciplinary approach to the wicked problem of mitigating the threat marine debris poses to the marine biosphere (Plag, 2020a).

The participatory modeling at the workshop engaged in knowledge creation that was fully problem driven and aimed at high user participation (Fig. 1). Followed a template for case studies of wicked problems (Fig. 2), the workshop participants first create a part understanding of the problem and visualized a desirable future. A next step focused on a better understanding of the decision space through a mapping of stakeholders. These steps established a basis for the conceptual modeling of the system that represents plastic flow from production and use to the handling of waste and the leaking into the environment.

Fig. 1 Evolution in the complexity of knowledge production and user participation. From Kivimäki et al. (2018).

The road map aims to organize the work of the initiative towards the overarching goal of supporting society in efforts to tackle the challenge of ocean plastics through evidence and knowledge-based decision and policy making. The road map lays out goals that need to be reached in order to make progress towards a vision of an ocean with significantly reduced plastics and, more generally marine debris.

The road map includes six months, two years, and five years goals. These goals can be grouped under four main themes (Fig. 3):

- 1) linking data and knowledge to actions and informing governance;
- 2) mitigation of plastics and reducing its presence;
- 3) observation and monitoring;
- 4) community building.

Fig. 2 The MAAR Case Study Template for tackling wicked problems with a transdisciplinary approach. From Plag (2021).

Fig. 3 The structure of the goals and activities that were identified for the road map during the 2018 Workshop. From Plag (2020b).

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Preventing and mitigating marine debris poses a wicked problem to society. Besides the need to inform those who are engaged in tackling different facets of this problem with comprehensive observations of the marine debris that enters the ocean from different sources and what is in the ocean, there is a need to bring a wide range of stakeholders from all societal sectors together in transdisciplinary efforts. The Plastics in the Ocean initiative of IEEE/OES utilizes participatory modeling and transdisciplinary case studies to identify the societal information needs and to develop interventions for prevention and mitigation.

Taxonomy of a Digital Ecosystem for Preventing and Mitigating Marine Debris

Hans Peter Plag - Old Dominion University

Taxonomy of a Digital Ecosystem for Preventing and Mitigating Marine Debris

Hans-Peter Plag

Department of Earth and Ocean Sciences, and Mitigation and Adaptation Research Institute, Old Dominion University



Considering the importance of marine debris as part of the Anthropocene Risk to the ocean, it appears mandatory to make an effort to fully exploit the wealth of the increasing relevant global data resources utilizing leading edge technologies, approaches and concepts. There is a proliferation of data and knowledge platforms that are an enhanced data integration and improved access to knowledge derived from data. Most of these platforms take a thematic approach or are targeting specific user groups. A fundamentally different alternative approach aims for a global digital ecosystem for the environment (GDE4E), which utilizes the rapid development of new technologies and methodologies to create an ecosystem of active species interacting with each other and users. A "healthy" ecosystem has a broad diversity of active species that interact with each other and evolve over time. Developing the concept of an ecosystem that integrates data, information derived from the data, and knowledge co-created in a collaboration of human agents with data requires identification of the species that live in this ecosystem.

Similar to a biological ecosystem, it is fundamental to recognize the keystone species that are central to the functioning of the ecosystem and that determine the nature of this system. The taxonomy of the GDE4E defined here includes five domains. Each of these domains has classes that consist of a number of families, and each family comprises a number of species.

The initial domains considered are:

- 1) data collection (DCO): digital software agents that collect raw data and generate a flow to those species that represent data products;
- 2) data representation (DRO): digital agents that represent data objects and can provide information extracted from these objects, as well as, give access to the data in the objects and receive feedback on data and the users;
- 3) data representation (FRD): digital agents that give access to models and data processing tools;
- 4) knowledge representation (KRO): digital agents that represent knowledge created by interaction (human and digital agents);
- 5) best practices (BPO): digital agents that represent best practices and can provide training.

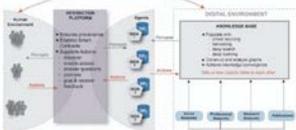


Figure 1. The GDE4E enables a transition for data as passive objects (DPO) to data as active subjects (DAS). In the DAS concept, each data product (including knowledge) is represented by an intelligent semantic data agent (ISDA, Plag and Julek-Plag, 2020). The ISDAs utilize the graph data in a knowledge base to discover applications and users that could benefit from their data products. They interact with those users, or user that contact them, to provide knowledge or manage access to data. All interactions that impact the data are recorded to ensure provenance. The knowledge base generates graph data based on information obtained through crowd sourcing or extracted from social and research networks and publications. While most of the agents in the DCO are reflective agents, the agents in the other domains have to be learning agents that combine model-based, goal-based and utility-based agents. These agents also need semantic capabilities (Fig. 1). A first implementation of the GDE4E can utilize the infrastructure available through the Web. The standardized protocol for the communication between the different agents requires a major development within the framework provided by the Web.

Reference:

Plag, H.-P., Julek-Plag, S.A., 2019. A Transformative Concept: From Data Being Passive Objects to Data Being Active Subjects. *Data*, 4(4), DOI: 10.3390/data4040130

Considering the importance of marine debris as part of the Anthropocene Risk to the ocean, it appears mandatory to make an effort to fully exploit the wealth of the increasing relevant global data resources utilizing leading edge technologies, approaches and concepts. While the proliferation of data and knowledge platforms is enhancing data integration and improved access to knowledge, a digital ecosystem with a broad diversity of active species that interact with each other and evolve would fully utilize the information wealth. The taxonomy of the ecosystem is developed and possible approaches to the implementation are described.

Estimating the Risk of Future Marine Debris Resulting from the Coastal Built Environment

Kelly Jones - Old Dominion University

Hans-Peter Plag, Dan Martin



Estimating the Risk of Future Plastic Marine Debris Resulting from the Urban Coastal Built Environment

MAFRI Center, Dr. Hans-Peter Plag, Dan Martin
Department of Oceanography, Old Dominion University
Investigation and Education Research Institute, Old Dominion University



Introduction

The coastal urban built environment (URBE) is rapidly increasing, but only to the global population growth, and increasing fraction of the population is living in the URBE. As the development of the city, urbanization, increases, plastic debris is increasingly entering the natural environment. Additionally, the coastal URBE is exposed to a changing spectrum of hazards. It is increasingly the coastal URBE poses the risk of future plastic marine debris entering the ocean. Risk is the possibility of consequences when the natural or man-made (plastic) debris enters the ocean. To quantify this risk, the product of hazard probability, fragility of the urban coast, and the exposed assets, measured in the amount of plastic, is used.

Methodology

Phase	Inputs	Outputs
1. Risk of Plastic Marine Debris from the Coastal Built Environment	URBE, Urbanization, Population, Plastic Debris	URBE, Urbanization, Population, Plastic Debris
2. Fragility of the Urban Coast	URBE, Urbanization, Population, Plastic Debris	URBE, Urbanization, Population, Plastic Debris
3. Amount of Exposed Assets	URBE, Urbanization, Population, Plastic Debris	URBE, Urbanization, Population, Plastic Debris

Hazard to the Urban Coast



Urbanization, Population, Plastic Debris
Hazard to the Urban Coast
Fragility of the Urban Coast
Amount of Exposed Assets

Fragility of the Urban Coast

Case Study Analysis:

- 1. Characterize the Urban Coast regional location
- 2. Building and infrastructure distribution
- 3. Infrastructure from general and specific site
- 4. Infrastructure systems
- 5. Damage to building codes, rules and regulations for building
- 6. Assessment of fragility to urban coastal built to determine the fragility of urban coastal assets in specific hazards

Case Studies:

- 1. The URBE system, American Hurricane impact on the American coastline is one where the probability of the hazard is high for the coast of population was increasing. This resulted in a catastrophic loss of the coastal built environment.
- 2. In the case of the URBE disaster is apparent only the exposure level depending on the probability of the hazard. The population is increasing and so is the risk to the coastal built through infrastructure exposure.
- 3. The study of assets is an increase of high probability hazard from the coastal built to the urban coastal built environment resulting in a coastal built to the coastal built.

Amount of Exposed Assets

The amount of exposed assets is measured in terms of plastic debris. Approach is to estimate the amount of plastic debris in the urban coast.

- 1. The total quantity to estimate is given by:

$$A_{URBE} = A_{URBE} \times A_{URBE}$$
- 2. The total quantity to estimate is given by:

$$A_{URBE} = A_{URBE} \times A_{URBE}$$

URBE, Urbanization, Population, Plastic Debris

Risk

Risk Equation: $Risk = Hazard \times Fragility \times Assets$

Risk Assessment with Hazard

Risk Probability of Hazard

2. The fragility of the coastal built to the coastal built

Risk of coastal built to the coastal built

The URBE Assessment:

- 1. The size of the urban coast is larger in 2025 to 2050 around 100,000 units of assets.
- 2. The size of the urban coast is larger in 2025 to 2050 around 100,000 units of assets.
- 3. The size of the urban coast is larger in 2025 to 2050 around 100,000 units of assets.

Identifying the risk of plastic marine debris is important in the urban coast area as well for understanding the risk to the marine biosphere and human health. The way we build ourselves in the coastal area increases the risk of plastic marine debris for current and future generations.

Old Dominion University, Department of Oceanography, Investigation and Education Research Institute, Old Dominion University, Norfolk, Virginia, USA

MAFRI Center, Dr. Hans-Peter Plag, Dan Martin, Kelly Jones, 2025-2026

Investigation and Education Research Institute, Old Dominion University, Norfolk, Virginia, USA

The expanding urban coast poses a rapidly growing risk of marine debris entering the ocean with unknown consequences for the marine biosphere and for current and future generations. The urban coast is exposed to a spectrum of hazards including storms, tsunamis, and sea level rise. The risk of plastic marine debris entering the ocean is quantified by the product of hazard probability, fragility of the urban coast, and the amount of plastic accumulated in the urban coast. The results indicate that the risk of future marine debris exceeds by far the amount estimated to be currently in the ocean.

A Virtual Community Center Addressing the Challenge of Marine Debris

Hans Peter Plag - Old Dominion University

Kelly Jones, Kimberly Allen, Dan Martin

A Virtual Community Center Addressing the Challenge of Marine Debris

Hans-Peter Plag^{1,2}, Kelly Jones¹, Kimberly Allen³, Dan Martin¹

¹ Department of Earth and Ocean Sciences, Old Dominion University,
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³ Department of Psychology, Old Dominion University

Marine debris poses a growing threat to the marine biosphere and, through contamination of marine food sources, also to human health. Many efforts are under way to monitor and understand the impacts of marine debris, but the many stakeholders are not well connected. Existing social media and newly developing platforms are limited in cross-sectoral community support. The Marine Debris Virtual Community Center (MDVCC) offers a place for the stakeholders to interact from local to global scales in communities of practice. The MDVCC focuses on literacy, access to knowledge, education, training, collaboration, citizen science, in-group communication, and outreach.

Virtual Community Center

- Exhibition Hall with topics of interest, organizations and groups
- Classrooms for lectures and courses
- Meet Experts with spaces for experts, formal community members and the public
- Engagem for reviewing knowledge and skills
- Citizen Science Carving out citizen science projects
- Collaborate an environment for community groups to build real-world projects
- Chatrooms for asynchronous chats about community topics
- Open Hall Opening and participating in meetings and other events
- Newsroom with community news and public involvement
- Library with access to comprehensive online material

Fig. 1. Concept of the Virtual Community Center. The darker shaded components are those that inform community members and the general public about the VCC and provide access to relevant knowledge. The lighter shaded components facilitate learning, collaboration, and deliberations. From Plag et al. (2021).

A VCC combines elements for learning and skill development with elements for collaboration, activities, and information (Fig. 1). There is emphasis on citizen science.

Focus on Literacy:

- Information Literacy
- Sustainability Literacy
- Risk and Resilience Literacy

Built around 5 Pillars:

- Environmental and sustainability literacy skills
- Modeling, simulation and visualization
- Storytelling and narrative skills
- Community advocacy skills
- Environmental justice

Fig. 2. The Marine Debris Virtual Community Center (MDVCC) is a place for the cross-sectoral dialog and collaboration of stakeholders engaged in tackling the wicked problem of reducing marine debris and limiting the impacts of marine debris on the marine biosphere and humanity.

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Marine debris poses a growing threat to the marine biosphere and, through contamination of marine food sources, also to human health. Many efforts are under way to monitor and understand the impacts of marine debris, but the many stakeholders are not well connected. Existing social media and newly developing platforms are limited in cross-sectoral community support. The Marine Debris Virtual Community Center (MDVCC) offers a place for the stakeholders to interact from local to global scales in communities of practice. The MDVCC focuses on literacy, access to knowledge, education, training, collaboration, citizen science, in-group communication, and outreach.

Integration of observing systems of marine debris and biodiversity

Nikolai Maximenko - University of Hawaii

Artur P. Palacz, Lauren Biermann, James Carlton, Luca Centurioni, Mary Crowley, Jan Hafner, Linsey Haram, Rebecca Helm, Verena Hormann, Cathryn Murray, Gregory Ruiz, Andrey Shcherbina, Justin Stop, Davida Streett, Toste Tanhua, Cynthia Wright, and Chela Zabin

Integration of observing systems of marine debris and biodiversity

Nikolai Maximenko¹, Artur P. Palacz², Lauren Biermann³, James Carlton⁴, Luca Centurioni⁵, Mary Crowley⁶, Jan Hafner⁷, Linsey Haram⁸, Rebecca Helm⁹, Verena Hormann¹⁰, Cathryn Murray¹¹, Gregory Ruiz¹², Andrey Shcherbina¹³, Justin Stop¹⁴, Davida Streett¹⁵, Toste Tanhua¹⁶, Cynthia Wright¹⁷, and Chela Zabin¹⁸

Abstract

Marine debris and biodiversity are two of the most pressing environmental issues of our time. While both have received significant attention in the scientific community, the integration of observing systems for these two fields has been limited. This paper presents a comprehensive overview of the current state of research and monitoring in both areas, highlighting the challenges and opportunities for integration. We discuss the importance of understanding the interactions between marine debris and biodiversity, and the need for coordinated efforts to address these issues. The paper is organized into several sections, including an introduction, a review of current research, a discussion of monitoring systems, and a conclusion. The introduction provides a brief overview of the topics and the structure of the paper. The review of current research discusses the latest findings in both marine debris and biodiversity, and the challenges of integrating these two fields. The discussion of monitoring systems explores the various methods used to monitor marine debris and biodiversity, and the potential for integrated systems. The conclusion summarizes the key findings and provides recommendations for future research and monitoring efforts.

Introduction

Marine debris and biodiversity are two of the most pressing environmental issues of our time. While both have received significant attention in the scientific community, the integration of observing systems for these two fields has been limited. This paper presents a comprehensive overview of the current state of research and monitoring in both areas, highlighting the challenges and opportunities for integration. We discuss the importance of understanding the interactions between marine debris and biodiversity, and the need for coordinated efforts to address these issues. The paper is organized into several sections, including an introduction, a review of current research, a discussion of monitoring systems, and a conclusion. The introduction provides a brief overview of the topics and the structure of the paper. The review of current research discusses the latest findings in both marine debris and biodiversity, and the challenges of integrating these two fields. The discussion of monitoring systems explores the various methods used to monitor marine debris and biodiversity, and the potential for integrated systems. The conclusion summarizes the key findings and provides recommendations for future research and monitoring efforts.

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Relevant paper is under review by *Oceanography* magazine.
Contact: nmaximenko@hawaii.edu
Project webpage: www.fishbase.org, www.gesrescience.org, www.marines.org

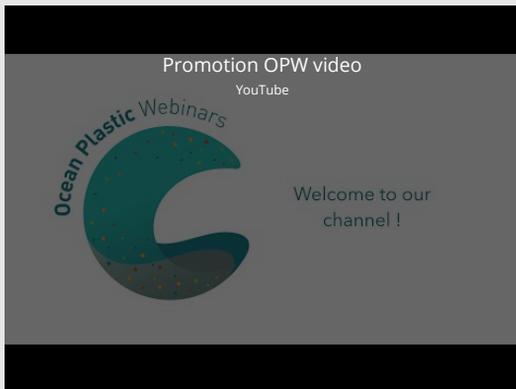
The Ocean Plastic Webinars

Audrey Hasson (Mercator Ocean International)

Delfine Lobelle (university of Utrecht)

Ryota Nakajima (JAMSTEC)

Takunda Chitaka (University of Western Cape)



The Ocean Plastic Webinars (OPW) series is a new space created by four early-career ocean professionals (ECOPs) where scientists from different fields with an interest in the origin and fate of ocean plastics can network efficiently, share their research, and exchange ideas.

Since our first webinar in June 2020, we have already organized 15 events covering a wide range of topics from physical oceanography to biochemistry, having specialists answer a total of over 300 questions from our live viewers. Our webinars, which are available on our YouTube channel, have reached over 7,000 views in total and are mobilizing scientists from across the globe.

Visit our website for more in this webinar series:
> www.oceanplasticwebinars.wixsite.com/homepage

Ocean BRIDGES

Delphine Lobelle (University of Utrecht)
Sigi Gruber (Advisor for the EU Commission)
Audrey Hasson (Mercator Ocean International)

Goals

Provide a platform for inter-generational knowledge sharing between **early career ocean professional (ECOPs)** and **experienced ocean professional (EOPs)**

Create task teams linked to the **UN Ocean Decade Challenges** and the **European Mission** "Restoring our Ocean and Waters by 2030" Collaborate globally with other networks

Organise **stakeholder engagement** workshops & events

Benefits ECOPs enjoy "Strongly motivated by the WG"	Benefits EOPs enjoy "Having a good outlet for their"
Benefit from and take advantage of their skills	Experience from previous roles and their knowledge across organisations
Learn and gain networking and communication skills in a Safe, Trustful, Supportive	Exchange views of key observations, policies and evidence generated
Professional development	Access to specific leadership opportunities
Beneficial contribution to the general public	Further expand their role as ECOPs, supporting their professional and personal development and leading change
Non-institutionalised perspectives	Knowledge of the functioning of institutions within national policy objectives and a strategic approach to international cooperation
	Global to national level of the knowledge
	Motivated to leading environmental change and bring activities to laboratory capacity

OceanBRIDGES

Bridging (Ocean) Research, Innovation and Diversity across Generations of Experts and Stakeholders Working Group

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Working Group co-founders

Sigi Gruber (Active Senior Advisor for the EU Commission)
Audrey Hasson (CEO Blue Planet European Coordinator)
Delphine Lobelle (Postdoctoral researcher at Utrecht University)

Diversity is key for addressing the observed changes in the Ocean as it affects everyone via the sharing of global commons. Career stages are one aspect of diversity. The added value of this Working Group is therefore the two-way expertise-sharing between Early Career Ocean Professionals (ECOPs) and Experienced (mid to late career) Ocean Professionals (EOPs) working towards ocean solutions. ECOPs face challenges when working to advance knowledge, develop skills and thrive as future ocean leaders

Bridging ocean research, innovation and diversity across generations of experts and stakeholders by addressing specific challenges the global ocean is facing today.

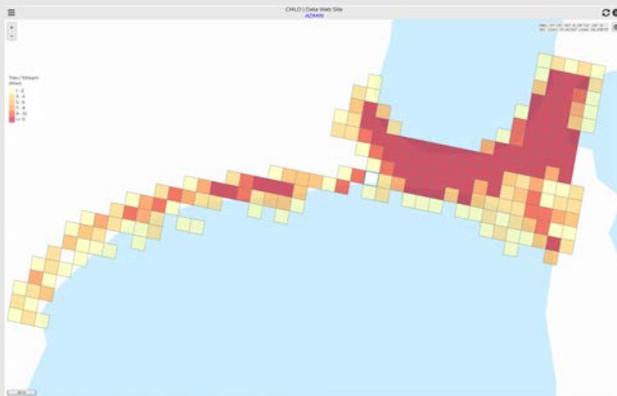
<https://forms.office.com/r/KiKQn3uCc>

https://docs.google.com/document/d/1AX_bALI9mP32eTe2FmoAy5mBNcmeqVpK3hyBPp3N1m8/edit?usp=sharing

Coastal Marine Litter Observatory (CMLO)

K. Topouzelis (Aegean)

A. Papakonstantinou, A. Moustakas, M. Simos



The presence of Marine Litter (ML) has been recognized as a significant environmental problem, as it can dramatically affect flora and fauna and produce severe economic impact on coastal communities, tourism, and fisheries. Existing data collection and monitoring systems are limited and unable to respond to the spatiotemporal change and the dynamics of their concentrations in the marine and coastal environment. In this context, the Marine

Remote Sensing Group (MRSG), Department of Marine Science, University of the Aegean, has created the Coastal Marine Litter Observatory (CMLO)

<https://cmlo.aegean.gr/>, which aims to detect and map the marine litter in the coastal zone with the combined use of Unmanned Aerial Systems (UAS) and machine learning methods.

CMLO aims to improve the detection and mapping of marine litter in the coastal zone. The results presented through CMLO are open through a dedicated geospatial portal. In the CMLO system, the detection of marine debris in the coastal zone is visualized as density maps. The system provides functionalities for interaction with the results of the detection for every beach that is monitored.

Best Practices for Marine plastic Sampling and Analysis in the Northern Indian Ocean

R Venkatesan S Ramasundaram

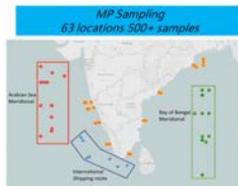
(National Institute of Ocean Technology, Ministry of Earth Sciences, Govt. of India)

Best Practices for Marine plastic Sampling and Analysis in the Northern Indian Ocean

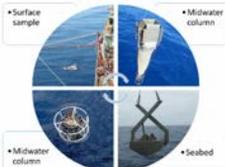
R Venkatesan S Ramasundaram

National Institute of Ocean Technology, Ministry of Earth Sciences, Govt. of India.

The National Institute of Ocean Technology is jointly working with the National Centre for Coastal Research to study the presence of plastics (macro and micro) in the Northern Indian Ocean. This Marine Debris sampling in the Open Ocean project is funded by the Ministry of Earth Sciences. A Best Practice method is developed following international practice which was published in the OCEP Newsletter July 2021. Two years of sampling experience, significant field observations and various sampling gears developed to collect and isolate macro and micro plastics on surface, mid-water column and on seabed and correlation to oceanographic phenomena prevailing in that region are presented in this poster. This work can be followed by many Buoy Operators to do such sampling with an incremental effort and cost as a part of IMDOS under the GOOS IOC.



Sampling Methods



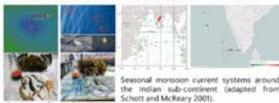
Standard Laboratory Analysis Procedure



Images from Microscopic & FTIR analysis



Study of Marine litter in Lacadive Islands (seasonal) - Arabian Sea
A large patch of marine debris was observed to be trapped in the Lacadive High, a large anticyclonic gyre forming in the south eastern Arabian Sea, on 6th December 2019.



MP Drifter to mimic Pathways of MP in Ocean

- Developed a drifter with GPS to mimic movement of plastic in marine environment
- The drifter was deployed from East Coast of India in an estuary during December 2018 to study the possibility of plastic discharge through estuaries.
- Drifter indicated a southward trajectory following Coastal Current.



MarPlastS App

- A mobile app MarPlastS compatible to IOS and Android platforms has been developed for carrying out MP in the coastal waters.

Results from samples collected during 2019-2021



Conclusion

- Microfibrils of type Nylon are the most common form of particle found in all depths of the water column, while fragments are the least common, and the size of particle <math>< 500\mu m</math> is dominant (75%).
- Combination of Oil slicks with Buoyfishing and Marine Debris, was noticed in Arabian sea in Ship/Fishing Vessel traffic route.
- Microplastics observed were a noticeable type of plastics degraded from floating nets (trap, line, and net).
- The polymers observed in the study are Polypropylene (PP), Polypropylene (PP), Polypropylene (PP), Polyethylene terephthalate (PET), Polyethylene (PE), and Polyamide-Ei (Nylon).

Detecting Macro Floating Objects on Coastal Water Bodies using Sentinel-2 Data

Raquel Carmo, ESA Φ-lab
Jamila Mifdal, Marc Russwurm



Detecting Macro Floating Objects on Coastal Water Bodies using Sentinel-2 Data



Raquel Carmo*, Jamila Mifdal*, Marc Rußwurm[†]

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(raquel.carmo@esa.int, jamila.mifdal@esa.int, marc.russwurm@epfl.ch)

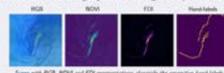
1. Introduction

Marine litter is one of the permanent pollutants of the marine ecosystem, consisting of anthropogenic waste discharged into the ocean via rivers, lakes or extreme weather events. It is growing into a serious threat to biodiversity and human life. Detecting marine litter by means of remote sensing technology is challenging due to the small sizes of objects that constitute marine litter [1, 2, 3, 4]. Thanks to environmental processes, such as winds and ocean currents, large patches of agglomerated floating debris are naturally formed and can be identified remotely. In this work, we present a refined and diverse large-scale hand-annotated dataset for floating objects detection on Sentinel-2 images over water bodies [1] and explore an approach to detect and delineate floating targets by means of deep learning-based segmentation models.

2. Dataset preparation

Google Earth Engine (GEE) was used to inspect Sentinel-2 (S2) images covering coastal areas for the labeling process, which went as follows:

1. Visualize S2 scene of a region likely to contain floating targets.
2. Compute and visualize NDVI and FDI [5] indices of the scene.
3. Hand-label the floating objects after ruling out ships, land, etc.



Scene with RGB, NDVI and FDI representations alongside the respective hand labels.



World map with the regions of manually labeled floating objects.

3. Contribution

The contribution of our work consists in:

- Providing a large-scale labeled S2 dataset in various meteorological conditions worldwide.
- Testing data-driven classifiers, such as U-Net and MA-Net, on the labeled dataset.
- Comparing with classical classifiers: Naive Bayes (NB), Random Forest (RF), Support Vector Machine (SVM) and Histogram-based Gradient Boosting (HGB).

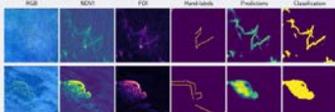
4. Experiment

After applying neural networks (NNs) on the labeled S2 dataset, we observed the following:

- The NNs learnt and predicted quite efficiently the spatial patterns of the floating objects.
- The classified patterns look similar to the FDI representation and more accurate than the labels.

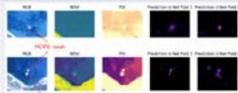
This learning process is a difficult one and a few issues should be highlighted:

- **Domain shift:** the variety of regions and the atmospheric conditions could be sources of bias.
- **Label noise:** the hand labeling lacks precision due to the S2 spatial resolution.



Prediction results for different scenes. The results (NDVI, FDI and MA-Net (bottom row)) predicted accurately the presence of the labeled floating debris, regardless of their geometrical shape.

5. Validation on PLP data



→ The neural networks managed to accurately spot the deployed targets despite their small sizes, which demonstrates the potential of using NNs for this task.

Predictions on the deployed targets from the Plastic Litter Project 2013 [6] in Marone, Greece. Acquisitions refer to the 12th of June 2013 (top row) and 22th of June 2013 (bottom row).

6. Conclusions

In this work we presented a refined large-scale labeled Sentinel-2 dataset for the detection of floating targets on water bodies. The dataset covers regions worldwide throughout various meteorological conditions. We utilized neural networks on the dataset to learn the spatial patterns of the floating targets and predict potential existings on an unseen coastal area. The experiments showed that the neural networks learnt and predicted efficiently the macro floating debris. We validated our experiments on verified floating objects from the 2021 PLP edition, where the neural networks managed to detect accurately the deployed targets in spite of their small sizes. We also highlighted some issues encountered in our experiments, such as the domain shift problem linked to the high variety of regions. Many positives (on ships, clouds, etc.) and false labels are challenges that will be tackled in future work.

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Standardization of methods to measure plastic pollution by 2024 ?

Amy Lusher - Norwegian Institute for Water Research (NIVA)



Standardization of methods to measure plastic pollution by 2024?

EUROqCHARM faces up to the challenge

 @EUROqCHARM

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EUROqCHARM Project Manager

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EUROqCHARM will use a multi-stakeholder approach to identify and develop cost-effective monitoring strategies for plastics (nano-, micro-, macro-) in all environmental matrices.

EUROqCHARM will facilitate developments for European plastic monitoring programmes and the realization of international best-practices.

Goals:

- Provide a platform to discuss and validate methods for monitoring of plastics in environmental samples.
- Develop blueprints for standardization.
- Recommend revision of current EU policies and instruments.

How?

- EUROqCHARM will evaluate existing methods for the assessment of plastic pollution.
- Harmonize these methods on a European level - with rigorous quality control - and reinforce European monitoring capacities.

Why?

- Major actions to evaluate, optimize and harmonize monitoring and assessment of plastic pollution are urgently needed.
- This will support substantial improvements in international environmental sustainability and socio-economic development

EUROqCHARM will deliver the necessary methodological harmonization to successfully implement long-term strategies for combating plastic pollution.

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This project has received funding from the European Union's Horizon 2020 coordination and support action under grant agreement No. 101000805 (EUROqCHARM). This output reflects only the author's view and the European Union cannot be held responsible for any use that may be made of the information contained therein.

