International Ocean Colour Coordinating Group

Task Force on Remote Sensing of Marine Litter and Debris

Terms of Reference

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Task Force title

Remote Sensing of Marine Litter and Debris

Scientific and programmatic background and rationale

Anthropogenic solid litter and debris is an environmental problem that poses socioeconomic and health risks to humankind. In particular, plastics make up to 80 % of the litter in the aquatic environment. It has been found in rivers flowing into coastal zones and accumulating on the surface and near surface of the water column in remote areas of the open ocean, including polar regions. Multiple studies have reported marine litter related injuries or deaths in the order of millions of seabirds as well as hundreds of thousands of marine biota a year resulting from ingestion or entanglements with derelict fishing gear and plastic litter (UNEP, 2016; Rochman et al., 2013). The annual price tag attached to plastic litter damage within the blue economic activities is over US$1.5 trillion (Forrest et al., 2019). Plastic litter in the marine environment has become of concern for human health, as related harmful contaminants continue being recovered and are identified in seafood (Thevenon et al., 2014; Vethaak and Leslie, 2016).

With plastic litter disposal and dumping expected to increase over the coming years and the long life of this material in the aquatic environments, urgent action is needed to better understand sources, pathways, geo-location and temporal distribution of plastic litter to inform effective mitigation strategies. Net trawl survey counts have been regressed against numerical models to infer the geo-spatial and temporal distributions of plastics, but these data are sparse and come with large uncertainties (van Sebille et al., 2015). Echoing the need for sustainable, innovative and complementary monitoring strategies, remote sensing is anticipated to improve the information gaps about plastic litter. Furthermore, international environmental agencies (e.g. United Nations Environment Programme, UNEP), space agencies (e.g. ESA and NASA), global leaders, stakeholders (e.g. World Bank) and scientists foresee the interdisciplinary prospects of remote sensing technologies in monitoring plastic litter (Maximenko et al., 2019; Martínez-Vicente et al., 2019; Garaba et al., 2018; Biermann et al., 2020). ESA has already dedicated significant resources towards remote sensing of marine litter with initial efforts having started in 2017 and further advanced research funded already underway since July 2020 (ESA, 2020). NASA has also dedicated resources to remote sensing of marine plastic litter activities likely to be funded to start in 2021.

In this context, the Task Force on Remote Sensing of Marine Litter has as an overarching goal **to coordinate the advancement of current and future remote sensing technologies and techniques that have potential to provide observations of plastic litter over all aquatic environments,** in the frame of a wider International Marine Debris Observation System (Maximenko et al., 2019). Considering all remote sensing technologies (with a special focus on radiometric approaches), the Task Force aims to promote a unified interdisciplinary international team of remote sensing experts with the goal to coordinate the development of traceable and transparent approaches for **detecting**, **identifying**, **quantifying** and **tracking requirements** of aggregated plastic litter patches (composed of all size classes of plastic litter and debris). These requirements will be supported by four interlinked core topics that are the foundation pillars of the Task Force: (i) technologies, (ii) algorithms and applications, (iii) datasets and (iv) interdisciplinary aspects. These core topics are essential for creating a **scientific roadmap for remote sensing of plastic litter in all aquatic environments**. Furthermore, the Task Force aims to produce living guidelines on best practices in remote sensing of plastics. It will also thrive to promote **F**indability, **A**ccessibility, **I**nteroperability, and **R**euse (**FAIR** policy) of relevant datasets as well as algorithms. The Task Force will include members already cooperating with the international community, including space agencies, research institutes, companies and foundations, and in international initiatives in the field of marine litter, e.g. with UNEP in the Sustainable Development Goals framework.

Terms of reference (Core Topics)

Technologies

(i) Definition of an internationally coordinated roadmap for remote sensing systems to support marine plastic litter detection, as an integral part of a coordinated effort to develop observation systems. **(ii)** Assessment of the capabilities of current remote sensing technologies to detect, quantify, characterise and track marine plastic litter, including indirect detection performed via proxies, sea surface currents and sea state. **(iii)** Identification of the complementarity/synergy of EO with current and future platforms that can/could be used for marine plastic detection. **(iv)** Identification of the experimental/modelling approaches needed to refine requirements for future marine litter missions.

Algorithms and Applications

(i) Identification of best retrieval and state-of-the-art strategies for each of the available acquisition technologies, attending to their nature, spatial/temporal resolutions and platforms. **(ii)** Targeted algorithm development and action for critical aspects requiring novel approaches/solutions. **(iii)** Identification of ancillary proxy datasets/variables that might be required for the various retrieval methods (e.g. related to current atmospheric correction techniques). **(iv)** Definition of validation procedures and standards in order to obtain comparable metrics and performances from the various algorithms and methods. **(v)** Consolidation of representative “use cases” for assessment of the algorithms and support to the design of simulators/modelling exercises.

Datasets

(i) Establish generic living protocols as recommendations for high quality data collection, handling, processing, storage and presentation for any relevant platform and technology. **(ii)** Support and promote the sustainable discrete as well as continuous gathering of relevant high quality data about a) virgin and weathered plastics found in the green and blue planets, b) ground truth and validation targets (artificial and natural), c) remote sensing observations of direct and indirect/proxy variables. **(iii)** Quality control and quality assurance of essential metadata based on FAIR policy and Ocean Best Practices. **(iv)** Support and maintain a platform for collaboration, source for datasets-of-opportunity, forum for community to request feasible and reasonable data acquisition by peers. **(v)** Promote open-access to long-term archived high quality and easy to merge datasets as well as open-source processing software tools to handle data in a generic traceable systematic manner.

Interdisciplinary Aspects

(i) Continue to evaluate the range of alternative sensors and platforms for plastic detection and monitoring ranging from smartphones, fixed observatories, shipborne, aerial or balloon-based as well as satellite missions. **(ii)** Further research of alternative approaches to traditional remote sensing techniques and data processing, including emerging machine learning techniques, data normalisation approaches, plastics detection and classification phone apps, and emerging software for data processing. **(iii)** Support and further develop the new interdisciplinary plastics science composed of a growing community from data science, information technology, limnology, oceanography, remote sensing, biology, chemistry and ecology backgrounds. **(iv)** Promote a platform/network of information supporting plastics and society, collecting and updating scientific and societal user requirements, and reliable up-to-date remote sensing information (imagery, statistics), which is made accessible to individuals and/or groups ranging from businesses/services, to outreach enterprises raising awareness, to grassroots initiatives lobbying for change in legislation. **(v)** Support the generation and dissemination of remote sensing information contributing to prevention and mitigation plastic policies in the form of end-products in ‘ready to use’ formats as defined by the requirements of non-experts/general downstream users and stakeholders, as well as the collection and updating of these expected requirements by end-users.

Functioning of the Task Force

- The Task Force aims to collaborate with interested entities including IOCCG working groups, CEOS (e.g. AHT-SDG, COAST) and GEO.
- The IOCCG is requested to fund one meeting of the Task Force Executive Committee every year or during other meetings of opportunity so as not to impinge on the IOCCG budget (e.g. IOCS breakout meeting, Ocean Optics).
- Agency members are encouraged to cover their own expenses to attend meetings (in the case of in-person meetings).
- Regular virtual meetings of Task Force members are planned to ensure work plan timelines are met.
- Executive Committee members are expected to actively participate in Task Force activities and attend at least 50 % of planned meetings.
- Assessments of the progress made by the Task Force will be carried out at the annual IOCCG Committee meeting. A written progress report detailing the programme of the work, accomplishments and future plans will be used to evaluate whether the group merits continuation or termination. The programme of work and progress report will supplement the terms of reference described above.
- The need for the Task Force and the relevance of its terms of reference will be reviewed and modified as appropriate by the IOCCG two years from the Task Force establishment.
- The Task Force Chairs in consultation with the IOCCG Executive committee will be responsible for updating Terms of Reference.
- The first meeting of this Task Force is expected early 2021.

Members

- The Agency Co-Chairs and Scientific Co-Chair will coordinate the Task Force.
- Scientific Co-Chair will be a rotating post every two years, drawn by the Task Force Executive Committee.
- Executive Committee members, consisting of the Core Topic Coordinators, will be nominated by the Task Force Co-Chairs.
- Each Core Topic will have a Coordinator responsible for gathering expert members and coordinate the discussions with the goals to achieve the Expected Outcomes.
- Consultants and non-member experts will be invited to attend meetings when a particular subject or objective is to be addressed.

Authors' membership (last names in alphabetic order)

	Name	**Affiliation**	
Agency Co-Chairs	Paolo Corradi	ESA, Netherlands	
	Laura Lorenzoni	NASA, USA	
	Debashis Mitra	ISRO, India	
	Hiroshi Murakami	JAXA, Japan	
Scientific Co-Chair	Shungudzemwoyo Garaba	University of Oldenburg, Germany	Proposed as initial Coordinator of "Datasets"
Founding Members	Manuel Arias	ARGANS, France	Proposed as initial Coordinator of "Algorithms and Applications"
	Lauren Biermann	PML, UK	Proposed as initial Coordinator of "Interdisciplinary Aspects"
	Francois-Regis Martin-Lauzer	ARGANS, France	
	Victor Martinez-Vicente	PML, UK	Proposed as initial Coordinator of "Technologies"

Members of the Task Force will be from an international pool of experts and agency representatives dedicated and interested in the remote sensing of marine litter. The members are expected to be from a variety of institutions and organizations and will comprise both agency and non-agency representation and include a broad range of relevant disciplines and competencies.

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