Date: Tuesday, 14 November 2023
Title: Remote sensing of aquatic litter and debris
Co-Chairs: Madeline Cowell, Shungu Garaba, Chuanmin Hu

Overview: The breakout workshop was coordinated and supported by the Task Force on Remote Sensing of Marine Litter and Debris (TF-RSMLD). Discussions with stakeholders were focussed on the state-of-the-art technology available for mapping and monitoring of floating and slightly submerged matter in all aquatic environments. Natural and anthropogenic floating litter commonly found included plastic-based items, microalgae, sea snot, pollen, vegetation and other materials in mixed accumulations. The presentations (**Overview Talks in Agenda)** covered themes on the relevant advances in instrument technology, algorithms, datasets and expected stakeholder applications. Interdisciplinary elements of the Task Force were presented with the expected outcome of understanding end-user needs and capabilities of current remote sensing end-products relevant to monitoring aquatic litter. Part of the session was dedicated to a recap and further review of the ESA-NASA Remote Sensing of Marine Litter Workshop[1] that was held in October 2023 at ESTEC, The Netherlands. The session provided a platform for engagement amongst end-users, citizens, policymakers, upstream experts including interdisciplinary researchers.

Key objectives: (i) Appraisal of the TF-RSMLD. (ii) Consensus on future steps, including alignment of remote sensing products retrieved from Ocean Colour sensors and current in-situ observations. (iii) Considering the progress thus far, discuss, select priorities, and plan actions for the next 3 years.

Agenda of Breakout Session
2:30--2:35   Introduction, Motivation and Goals of the Session (Summary of Milestones, Challenges and Outlook. Continue the conversation of next steps. Promote engagement from the IOCS community)
2:35--3:00   Status update from the TF-RSMLD (What is and Who are the IOCCG Task Force RSMLD. Introduce questions from the ESTEC RSML Workshop
3:00--3:45   Overview Talks (12 min talk, 2 min questions, 1 minute transition)
▪   Floating Matter Overview – Shungu Garaba (UOL, Germany)
▪   Technology Overview –Victor Martinez Vincente (PML, UK)
▪   MARLISE Overview – Liesbeth De Keukelaere (VITO, Belgium)
3:45--4:00   *Break + Open Discussion*
4:00--4:20   Outcomes of the ESTEC RSML Workshop Hosted Oct – Shungu and Maddie (Summary from the questions posed at the workshop. Next steps and actions. Open Discussion - What is missing?)

Minutes of Discussion: Updates provided were from the Task Force and the state of the science with the capabilities highlighting the detect, identify, quantify, tracking applications. The diversity of stakeholder expected applications/end-products was emphasized as the key driver in terms of the remote sensing platform and sensor requirements with the least resource intensive being detection needs of litter, soup of natural and anthropogenic. The need for identification descriptors was highlighted as being more resources intensive due to technical requirements in terms of observations using hyperspectral optical sensors with likely fine pixel resolution and signal-to-noise ratios in the infrared spectrum. Alternatively, the synergy and fusion of sensor technologies on various platforms was hinted as a prospective vital strategy for improved sensing capabilities e.g., microwave radar or lidar. Detection, identification and quantification could be further achieved by combining optical sensors with fluorescence lidar techniques to also get the vertical distribution of the litter in the water column whilst radar has the ability to measure through cloudy conditions.

Attendees all agreed that remote sensing offers a complementary monitoring strategy for all stakeholders. The capabilities have been demonstrated in several studies with the caveat that the current sensors were not well fit-for-purpose especially for spaceborne platforms. The importance of continued advancements in technologies and approaches in a collaborative open-science approach was echoed as key to further enhance scientific evidence-based understanding of marine debris dynamics and contribute to effective well-informed mitigation strategies. A concept satellite mission (MARLISE led by VITO) was discussed as a step towards a space laboratory for observing specific accumulation zones e.g., landfills, beaches and windrows. Beyond the detection of the plastics, the RSMLD recommended the extension of

---

[1] https://atpi.eventsair.com/remote-sensing-of-marine-litter/

floating matter of interest, clear definition of terminology as well as capabilities (e.g., direct or indirect observations) of remote sensing technologies. There is an active community utilizing proxies to help identify accumulation zones, such as windrows. An extension of floating matters was highlighted as a necessary step towards improved algorithm/sensor development. A push for well curated hyperspectral open-access datasets was echoed with the example of a dedicated repository and App that could be leverage and adapted for the community e.g., OceanScan[2].

The Task Force RSMLD following a recent appraisal and gathered scientific evidence-based knowledge is working towards a restructure expected to further improve advances on the topic and engage a wider pool of interdisciplinary stakeholders. The taskforce will combine the core topics to pull together all members contributing to the community. The core topics will remain as themes to help communicate efforts; however, the goal is to increase community engagement. To ensure continued development, there will be the establishment of Tiger Teams to focus on specific actions and deliverables. The smaller, tiger teams are to provide ownership beyond the coordinating committee as resources are strained. A smaller team also allows for agile reaction to established tiger teams, and new teams to be formed over the years. The steering committee will stay intact and will help guide actions to support the remote sensing of marine debris litter roadmap and agencies.

SMART Goals / Tiger Teams:
1. Development of the RSMLD Taskforce Roadmap **What**: *Living open-access document* to be reviewed and revised every 2 years. **Who**: RSMLD with the support of Space Agencies and stakeholders. **When:** Draft expected April 2024.
2. Spectral Library and Database **What**: Curated open-access hyperspectral reference library of diverse endmembers for algorithm development and RTE sensitivity analyses. **From where:** Controlled experiments, in-situ observations with ideally match-ups or reference RGB photos. **How:** Data mining and community contributions e.g., OceanScan, TF-RSMLD website. **Who:** TF-RSMLD with the support of all stakeholders. **When:** Ongoing and draft version expected October 2024.
3. Sampling Protocol Definition **What**: *Living open-access protocols* for ships-of-opportunity, citizen science and upcoming agency campaigns. **How:** Stakeholder engagement to define essential metadata, affordable, easy-to-use and sustainable sensors for databases. **Who:** TF-RSMLD with the support of all stakeholders. **When:** First draft expected June 2024
4. Awareness and downstream user engagement **What:** Create a published document to educate the various data layers and paired technologies as well as communicate external to the marine debris community to engage stakeholders and promote interdisciplinary science. **How:** Communicate the realistic capabilities and limitations of relevant remote sensing technologies with regards to Detect, Identify, Quantify Track applications through community generated infographics/terminology. **Where:** During presentations, discussions, meetings. **Who**: TF-RSMLD with the support of all stakeholders. **When:** Ongoing

The importance of further stakeholder engagement was proposed and to be achieved through a review of the priorities from the stakeholders by (i) Asking for "why or so what - remote sensing" meaning, why do the stakeholders care e.g., map extent to say the scope, locating sources/sinks, cleanup activities related to socio-economics like tourism or social good, (ii) How do they want the information?, What action do they plan to take form the data product, Management outcomes dictates level of data/information, and (iii) Impact story > what is the story we can highlight that informs how pollution impacts science. Any expected deliverable could be in the form of an article on the lessons learned from the stakeholder interviews. The article is anticipated to be generated by the TF-RSMLD towards end of 2024.

The attendees were consulted on the current Terms-of-Reference of the TF-RSMLD and agreement was echoed as efforts combine natural and anthropogenic floating matter. Peer-reviewed articles are expected to provide common standard terminology for stakeholders on the topic. The final recommendation from the session was to improve interagency support to promote interdisciplinary science. More work needs to be done to formulate the ask on this topic and will be produced through further development of the TF-RSMLD Roadmap. The action is on the taskforce steering committee to ensure the roadmap includes this interdisciplinary ask across agencies.

---

[2] https://www.oceanscan.org/