

IMDOS

INTEGRATED MARINE DEBRIS OBSERVING SYSTEM

Strategy Document

Placeholder for Partners

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INTEGRATED MARINE DEBRIS OBSERVING SYSTEM



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Summary

The Integrated Marine Debris Observing System (IMDOS) aims to support the development of a global interoperable marine debris monitoring system to benefit the research community, as well as policy- and decision-making bodies and the private sector.

By providing guidance on harmonizing data, standardizing monitoring methods, leveraging technology, and harnessing the power of a global community, IMDOS aims to support and strengthen a network of sustained observations to enhance marine debris research and to inform actions to tackle the growing global plastic pollution problem. IMDOS will allow data from multiple sources to be interoperable, comparable, and accessible.

Global marine debris integrated monitoring is essential to provide reliable data to further our baseline knowledge of marine debris pollution on national, regional, and global levels, which is critical to establish and evaluate effective policies and mitigation plans.

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1. Introduction

1.1. Marine Debris Pollution

Marine Debris Pollution is a growing transboundary, multi-dimensional problem with environmental, cultural, economic, and human health risks and associated costs, as highlighted by the United Nations Environment Programme (UNEP)¹.

From derelict fishing gear to cosmetic microbeads, its various forms and sizes are found in all investigated marine compartments from pole to pole, from coastal shores to the depths of the oceans. Marine debris is a hazard to marine life and potentially also to human health. Large items cause entanglement and transport potentially invasive species, whereas smaller pieces, when ingested by marine animals, can cause starvation and be vectors for pollutants and pathogens. It is now clear that **Marine debris poses a growing threat to marine ecosystems, maritime activities, and the wellbeing of ocean users.**

UNEP defines marine litter as “any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment”². IMDOS will address all litter and/or debris in the marine environment, regardless of origin or impacts of this type of marine pollution.

Plastic waste makes up most debris identified in aquatic systems, accounting for more than 80% of the total debris by number³. In 2021, the total weight of plastics present in the oceans was estimated as 75 – 199 million tons⁴, with annual emissions projected to increase from 19 to 23 million metric tons in 2016 to 53 million metric tons by 2030, even with ambitious government targets⁵.

Plastic pollution is poorly reversible -if not completely irreversible. Even if sources cease immediately, the existing environmental load and its continuous weathering will result in ongoing pollution for a prolonged period⁶. Moreover, along with other human-generated pollutants, it exceeds the established limits for a safe planetary environment⁷ due to the rapid growth of plastic production surpassing the global capacity for governance.

¹ [Global Assessment of Marine Litter and Plastic Pollution- from Pollution to Solution](#) (2021)

² United Nations Environment Programme, & Intergovernmental Oceanographic Commission (2009). UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter. <https://wedocs.unep.org/20.500.11822/13604>.

³ Morales-Caselles et al., An inshore–offshore sorting system revealed from global classification of ocean litter. *Nature Sustainability*, 4(6), 484-493 (2021). <https://doi.org/10.1038/s41893-021-00720-8>

⁴ United Nations Environment Programme (2021). *From Pollution to Solution: A global assessment of marine litter and plastic pollution*. Nairobi.

⁵ Borrelle et al., Predicted growth in plastic waste exceeds efforts to mitigate plastic pollution. *Science*, 369(6510), 1515–1518 (2020). <https://doi.org/10.1126/science.aba3656>

⁶ MacLeod et al., The global threat from plastic pollution. *Science*, 373(6550), 61–65 (2021). <https://doi.org/10.1126/science.abg5433>

⁷ Persson et al., Outside the Safe Operating Space of the Planetary Boundary for Novel Entities. *Environ. Sci. Technol.*, 56(3), 1510–1521 (2022). <https://doi.org/10.1021/acs.est.1c04158>



1.2. Global Policy Instruments

Marine debris poses a major risk to ocean health, and the need for global monitoring and reporting has been recognized by the United Nations (UN) by setting Sustainable Development Goal (SDG) target 14.1 on marine pollution, informed by a specific indicator on marine litter (14.1.1b) under the custody of UNEP. SDG 14.1 sets out as one of its targets to “by 2025, prevent and significantly reduce marine pollution of all kinds, from land-based activities, including marine debris and nutrient pollution”. However, tackling marine debris and plastic pollution requires action across the plastic full lifecycle, including its production, design, and disposal and thus must consider many other SDGs (6, 11, 12, 15 and 17). The way forward has recently been paved by the historic resolution (Resolution 14 of UNEA-5.2) to end plastic pollution and forge an international legally binding agreement by 2024, henceforth referred to as “Plastic Treaty”, endorsed by representatives from 175 nations at the 5th session of the United Nations Environment Assembly (UNEA-5) in March 2022. **To succeed in its design and implementation, the treaty needs reliable information on the volume and long-term changes of plastics entering and accumulated in the ocean. This information shall be based on global, harmonised, and integrated monitoring.**

Reports of marine plastic pollution emerged as early as the 1970s, and the number of studies skyrocketed after 2010⁸. However, the development of global marine debris indicators and assessments has been limited by lack of harmonized monitoring approaches. To achieve the ambitious goals of the UN SDGs and upcoming Plastic Treaty, there is a critical need for accurate, up-to-date information on marine debris, plastic pollution, and related topics. However, coverage, resolution and quality of data remain heterogenous, lacking global coordination. **The current state of the observing system is unable to meet the recommended science and policy requirements for global scale monitoring**⁹. Monitoring global marine plastic debris and understanding its transport are key pillars for the establishment of accessible plastic debris reduction targets and the policies to reach these targets.

⁸ Tekman et al., Impacts of plastic pollution in the oceans on marine species, biodiversity and ecosystems (2022). <https://doi.org/10.5281/zenodo.5898684>

⁹ GESAMP (2019). Guidelines on the monitoring and assessment of plastic litter and microplastics in the ocean (Kershaw P.J., Turra A. and Galgani F. editors), (IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP/ISA Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). Rep. Stud. GESAMP No. 99, 130p.



2. Why IMDOS?

There is a strong demand for global marine debris monitoring expressed by the research community, and also by policy- and decision-making bodies and the private sector.

A global and integrated marine debris monitoring system is critical to enable scientists to assess marine debris pollution true extent and provide informed guidance for effective actions including setting targets and develop, implement and adjust policies. Consolidating the baseline knowledge in marine debris distribution on national, regional, and global levels is necessary for operational assessments.

Our Vision:

A globally coordinated and sustained observing system of marine debris to fill knowledge gaps and to address diverse stakeholder needs with adequate data and information.

Furthermore, an integrated marine debris dataset is also essential as input but also to improve and evaluate numerical model simulations, which can then be used to assess the effectiveness of policies through “what if” scenarios, as with the Digital Twins of the Ocean¹⁰.

Some marine debris monitoring programs have already been initiated through action plans of the Regional Seas Programmes (e.g., OSPAR), the G7 Navigation Plan and the G20 Implementation Framework. Actions are also conducted at national (e.g. CSIRO, NOAA, SOA) and regional or inter regional (e.g., European Union Marine Strategy Framework Directive) levels. Several agencies of the UN are supporting on-going efforts to develop global marine debris monitoring: International Maritime Organization through the Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) Working Group 40, UNEP through the Global Partnership on Plastic Pollution and Marine Litter (GPML), the Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO) and the International Atomic Energy Agency (IAEA) through its NUTEC Plastics initiative.

The Integrated Marine Debris Observing System (IMDOS) is being developed following the OceanObs'19 Community White Paper¹¹, as a joint initiative of the Global Ocean Observing System (GOOS), the Group on Earth Observations (GEO) Blue Planet Initiative and UNEP GPML. Furthermore, IMDOS works hand in hand with the Communities of Practice established for the development of the GPML Digital Platform¹² to ensure the alignment of objectives and outcomes.

¹⁰ See information for one example of a Digital Twin Ocean <https://digitaltwinoccean.mercator-ocean.eu/>

¹¹ Nikolai Maximenko et al., Toward the Integrated Marine Debris Observing System. *Frontiers in Marine Science*, 6, 25 (2019). <https://doi.org/10.3389/fmars.2019.00447>

¹² <https://digital.gpmarinelitter.org/>



3. Our Mission

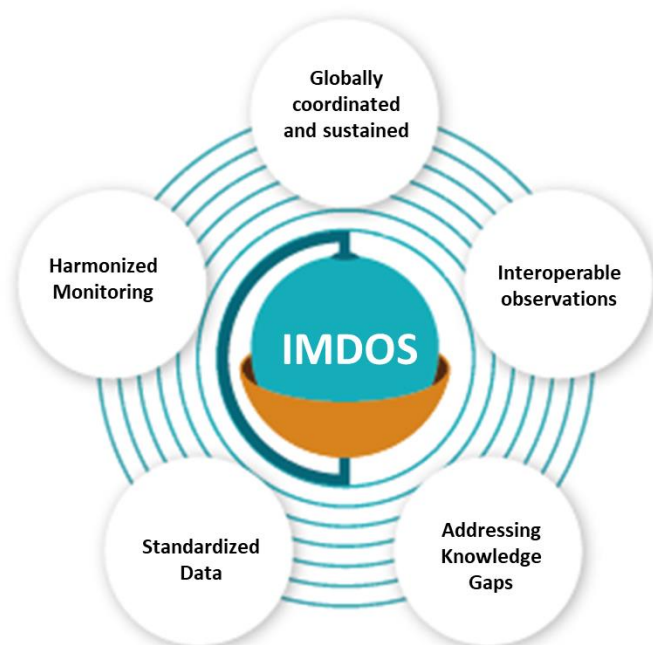
IMDOS carries a vision shared by many stakeholders from researchers to policy makers to coordinate a globally coordinated and sustained marine debris monitoring framework. As a coordination body **IMDOS will facilitate the long-term global monitoring of marine debris** across different ocean ecosystems: from the sea surface, coasts to open ocean, and down to the deep seafloor.

Our Mission:

Provide coordination and guidance to lead the marine debris community in establishing a sustained global observing system and facilitating open access to data.

To achieve this, **IMDOS will promote interoperability for the integration of a range of observing elements**, from citizen science initiatives to advanced technological tools, endorsing the use of state-of-the-art techniques throughout the monitoring process.

Addressing knowledge gaps and diverse stakeholder needs is crucial for establishing a sustained marine debris observing system, which can only be achieved through a holistic approach. The proposed observing system consists of three complimentary approaches that inform one another: in situ observations, remote sensing, and numerical modelling.



- In situ observations provide sparse but critical ground truth information on abundance and distribution of marine debris in all dimensions.

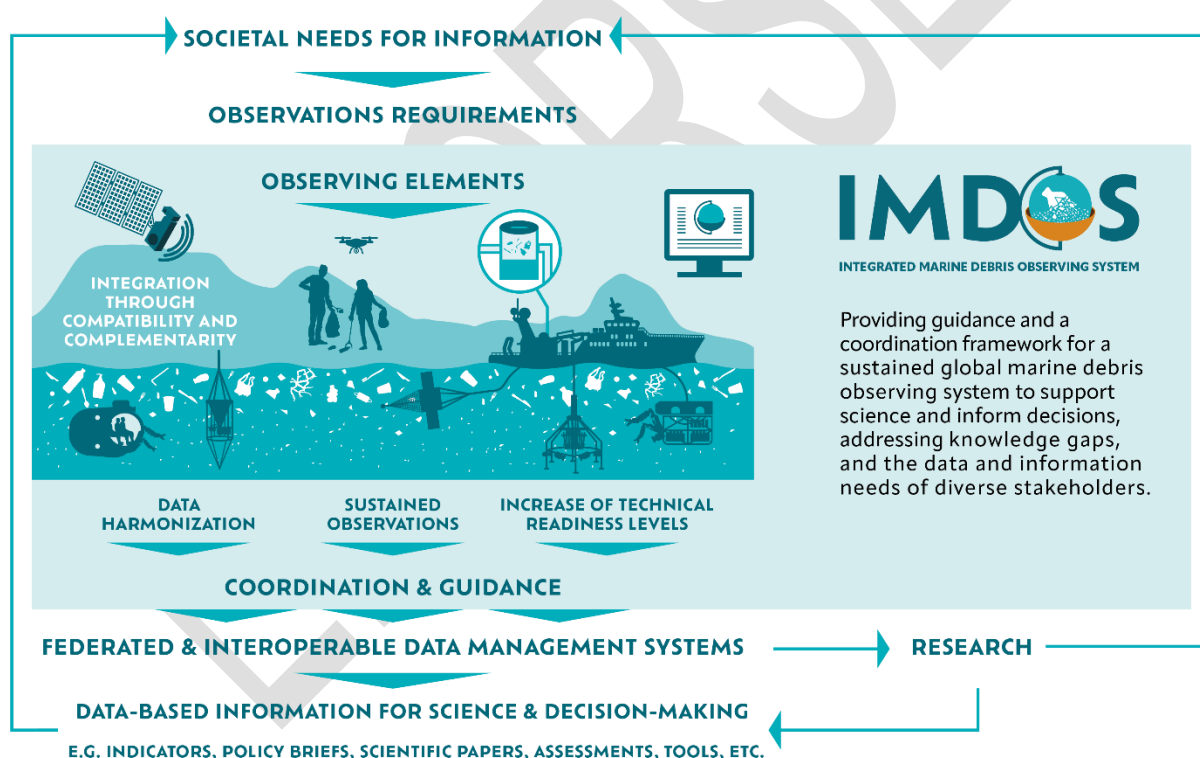
- Remote sensing observations can provide large-scale view of sea surface abundance and distribution of marine debris. These observations include platforms such as satellites, high-altitude platforms, airplanes, remotely piloted aircraft systems (drones), ship-based and fixed systems on the ground.

- Modelling provides a continuous estimate in all dimensions that can inform transportation pathways, sources and sinks of marine debris.



IMDOS' vision also entails **harmonising existing framework guidelines towards globally recognized standards, ensuring robust and sustainable monitoring of marine debris.** By doing so, future efforts will generate adequate, FAIR (Findability, Accessibility, Interoperability, and Reuse), and open data that can effectively inform regional and global marine debris indicators. Federated data management systems will be established in line with marine debris research requirements, based on standardized data and metadata structures. This system will enable data harmonization across various studies, data centres, and monitoring programs that will be able to feed the GPML Digital Platform and enable the Digital Twin of the Ocean for marine debris, as well as the Framework for Ocean Observing. Together with successful dissemination of these federated data management systems, investigators will be able to share their data for the benefit of all.

Through a globally coordinated and integrated monitoring system, **IMDOS will support the capacity for model development, regular scientific assessments, and science-based decision-making.**





4. Strategic Objectives

IMDOS will coordinate activities to gradually increase the readiness level of the global observing system and associated data management systems, aiming for operational capacity by 2030.

To achieve this aim, the following objectives have been set up, which will be elaborated further with an implementation plan:

4.1. Engagement and Coordination

1. Advocate for the transition to a long-term, coordinated, global marine debris (MD) observing system.
2. Discover and engage with existing and proposed MD monitoring, remote sensing, and numerical modelling initiatives to propose coordination under a common framework.
3. Foster communication and synergies within the expanding MD community, and with researchers and decision-makers.
4. Advise on the development of MD information products for assessment reports for all stakeholders.

4.2 Expertise and Guidance

5. Provide recommendations on the design and evolution of a global MD observing system.
6. Give guidance on assessment and harmonization of MD monitoring methodologies.
7. Promote guidelines for harmonization, standardization, and quality control of MD data towards federated and interoperable data management systems.
8. Ensure open access MD data following the Findability, Accessibility, Interoperability, and Reuse (FAIR) principles.

4.3 System Integration

9. Enhance synergies between in-situ and remote sensing MD observing components for their integration through compatibility and complementarity.
10. Integrate the modelling and observing MD capabilities to enable the development of interactive virtual representations (digital twins) and observing system design.
11. Integrate citizen science and innovative MD observing initiatives.
12. Support technological advancements and innovations to increase technical readiness levels of all MD observing elements.



5. IMDOS Early Implementation

Inspired by the collective vision of the marine debris scientific community and guided by an international Interim Scientific Committee, **IMDOS is built upon existing partnerships and joint scientific initiatives established around marine litter monitoring** on a global level by IOC-UNESCO, UNEP and the G7/G20 countries, among others, and those established by GOOS structures around sustained ocean observations.

As a coordinating body, IMDOS brings different initiatives together targeting marine debris monitoring, data standardisation and harmonisation, remote sensing, and modelling. These organisations include but are not limited to the Scientific Committee on Oceanic Research (SCOR) Working Group 153, GESAMP Working Group 40, the International Ocean Colour Coordinating Group Task Force on Remote Sensing of Marine Litter and Debris, Ministry of Environment Japan (MOEJ) and GEO Blue Planet Marine Litter Working Group. Together with these initiatives, the technological readiness level of existing systems towards a sustained monitoring of marine debris will be assessed. IMDOS also participates in the GPML Communities of Practice for the implementation of their Digital Platform in order to foster synergies and provide when relevant technical support.

IMDOS will enable the integration and synthesis of global marine debris monitoring and modelling efforts into indicators and decision-support tools through relevant data centres and knowledge platforms. As a part of this approach, existing data harmonisation guidelines to be integrated are being developed by international experts based on the marine debris data management practices of the MOEJ, European Marine Observation and Data Network (EMODnet) and NOAA National Centers for Environmental Information (NCEI), among others. This approach will ensure interoperable management activities for open, and FAIR access to marine debris data accessible to stakeholders, e.g., via the GPML Digital Platform.

IMDOS is an endorsed GOOS Project and will promote the potential of existing monitoring programs (e.g., coordinated by GOOS) of ship-based, fixed-point, autonomous, and other platforms for measuring marine debris pollution in the open, coastal, and deep ocean. This includes oceanographic data collocated with both surface and water column observations of marine plastics; institutional, opportunistic and citizen science sampling of floating and beached litter; co-designed environmental monitoring of marine habitats (e.g., seagrass, macroalgae) with seafloor litter surveys; and better interfacing the rapidly evolving capacity for remote sensing detection with environmental monitoring to expand and validate its use for modelling, scientific assessments and informed decision making.

Following the guidelines of GOOS, a new type of human pressure **Essential Ocean Variable (EOV)** was developed as the Marine Plastics EOV to address the need for sustained, integrated, and harmonized observations of marine debris. The proposed EOV (sub)variables complement and expand the current set of level 1 (global) SDG 14.1.1b indicators, in line with state-of-the-art guidelines for global monitoring of marine debris published by GESAMP WG 40.



IMDOS Activities are overseen by an international scientific committee guided by the strategic objectives defined above.

An interim Scientific Committee has been established in 2022 with members from international organizations and regional initiatives spearheading the process of regional to global coordination of marine debris monitoring. The final Steering Committee (SC) will comprise experts representing various observing approaches, data management expertise, and geographic balance, among other criteria. The SC aims to be an independent coordination body, responsible for overseeing the execution of strategic objectives defined above. The SC will coordinate activities distributed in task teams that will address specific actions in line with the strategic objectives.

The early stage of IMDOS coordination is at present supported by research-based funding from EuroSea and EU4OceanObs (2021-2023). A successful implementation of IMDOS will require a transition from short-term, research project-based funding to long-term, sustained funding.

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