



WORKSHOP REPORT

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Executive Summary

The GEO Blue Planet Nutrient Monitoring Across the GEO Work Programme workshop was funded through the EU4OceanObs2 Horizon Project implemented by Mercator Ocean International and was organized by GEO Blue Planet, National Oceanic and Atmospheric Administration (NOAA), and Mercator Ocean with support from the UN Environment Programme (UNEP). The workshop convened on January 9, 2025 in Paris, France to determine the need for a task team that supports cross-sector coordination of nutrient and nitrogen species monitoring for the benefit of decision makers.

The envisioned task team would leverage the voluntary participation of diverse Earth observation subject matter expertise from across the GEO Work Programme to create deliverables that demonstrate the value and feasibility of using remote sensing to inform the process of creating National Action Plans to reduce nutrient and nitrogen pollution developed by UNEP Global Partnership on Nutrient Management (GPNM) and Working Group on Nitrogen (WGN). This would include case studies and requirements for a sustained global observing system of the nutrient and nitrogen life cycle based on available remote sensing observations. This task team, composed of expert members from the GEO work programme, will aim to provide coordination and guidance for the co-design of data-based information with the broader scientific community and policymakers.

The workshop successfully achieved the following objectives set forth in the workshop concept note and agenda:

- Determined the need for a Nutrient (+ Nitrogen species) Monitoring Task Team
- Worked on a task team strategy and deliverables list for the first 24 months
- Established next steps for task team implementation

The workshop brought together technical and policy experts from diverse organizations to discuss existing nutrient and nitrogen monitoring efforts and to identify opportunities using satellite remote sensing to advance these efforts. The breakout session discussion was critical to defining the contours of the task team, including determining its scope of action, designing deliverables that demonstrate the value of remote sensing, and identifying next steps to ensure task team progress towards its deliverables. In addition to the workshop webpage and presentations, the tangible results of the workshop include this Workshop Summary Report and a Task Team Strategy paper documenting the rationale, and potential mission, objectives, and strategy of the Task Team.

1. Overview

1.1 Context

Nutrient pollution of the environment through anthropogenic activities poses a threat to ecosystems and human health. Addressing nutrient pollution is particularly challenging and complex, requiring solutions that balance competing economic, social, and political interests. For example, there are numerous sustainable development goals (SDGs) related to nutrients (e.g., SDGs 2, 6, 12, 13,14, and 15); despite the inherent interconnectedness of these SDGs through nutrients, efforts to meet SDG targets related to nutrients often occur in silos. This fragmented approach to nutrient monitoring is true across governments, Earth system sciences, and sectors.

In 2009, the UN Commission on Sustainable Development established Global Partnership on Nutrient Management (GPNM) to address fragmented efforts in addressing nutrient pollution across governments, research institutions, industries, and intergovernmental and non-governmental organizations.

In 2019, the UN Environment Assembly (UNEA) adopted resolution 4/14 on Sustainable Nitrogen Management, triggering the establishment of UNEP’s Working Group on Nitrogen (WGN) to facilitate its implementation. UNEA’s fifth session in 2022 adopted a second resolution on Sustainable Nitrogen Management, resolution 5/2, which seeks to accelerate Member State action on nitrogen management. The WGN is tasked with coordinating the response to both resolutions.

Together, UNEP’s GPNM and WGN provide guidance to pilot countries to develop National Action Plans that utilize evidence-based approaches to sustainable nutrient management. Without being prescriptive, guidance (i.e., workflow) is designed to streamline best management practices and integrated assessments to accelerate the activities related to the development of a country’s strategy to address nutrient pollution. GEO Blue Planet will work in tandem with GPNM and WGN to support their workflow by contributing data on national pollution sources and national and global indicators in the marine environment.

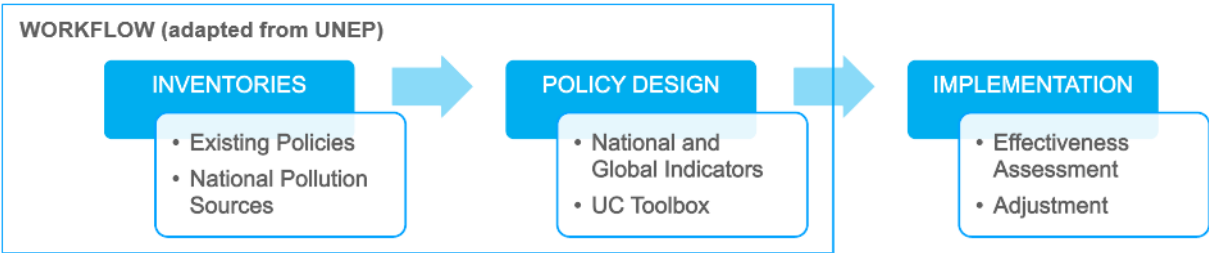


Figure 1. Workflow adapted from UNEP demonstrating how to translate data to policy. The steps outlined by the blue box (i.e., Inventories and Policy Design) are those which GEO Blue Planet can support within the marine environment.

1.2 Purpose

GEO Blue Planet and UNEP, with support from other activities of the GEO Work Programme, convened a hybrid workshop January 9, 2025, to discuss establishing a cross-sector Nutrient Task Team (TT). This TT's main objective would be to examine the feasibility of cross-sector coordination of nutrient remote sensing to inform the UNEP Global Partnership on Nutrient Management (GPNM) and Working Group on Nitrogen (WGN) workflow supporting countries in the development of national action plans.

Coastal eutrophication, fueled by nutrient runoff, threatens marine ecosystems. GEO Blue Planet focuses on activities that support UN SDG 14: Life Below Water, specifically Target 14.1.1a., which aims to measure countries' contributions to coastal eutrophication and the state of coastal eutrophication. GEO Blue Planet is committed to coordinating a sub task team on remotely sensed marine observations to support activities toward this Task Team goals.

However, nutrient and nitrogen pollution are complex issues connected to other SDGs, including Zero Hunger, Clean Water and Sanitation, Responsible Consumption and Production, Climate Action, and Life on Land.

To help UNEP effectively support countries in setting up policies for reducing associated pollution, a more comprehensive understanding of nutrient and nitrogen sources, fate and transport, adverse impacts, and potential solutions is sought. Using remote sensing techniques to monitor this pollution is thus essential to increase our scientific understanding, but also to design and measure effectiveness of policies. This involves data and expertise from various fields and Earth systems, including terrestrial, atmospheric, and water systems.

Over the last few months, GEO Blue Planet has facilitated meetings with UNEP and other interested and relevant GEO Work Programme groups to identify ongoing nutrient-related activities and data collection efforts. This workshop is the result of these communication efforts.

Thus, GEO Blue Planet calls on other groups within the GEO Work Programme to provide sector-specific Earth observation guidance and on the GEO Secretariat to oversee a globally coordinated and sustained action to advise for setting up a satellite-based observing system of the full nutrient and nitrogen life cycles to fill knowledge gaps and address policy-makers needs with adequate data and information.

1.3 Objectives

The workshop objective was to connect the GEO work programme and UNEP representatives to discuss global remotely sensed monitoring in support of national action plans on sustainable nutrient and nitrogen management. The meeting aimed to assist UNEP in articulating their data needs to implement the Global Partnership on Nutrient Management (GPNM) workflow supporting countries in the development of national action plans. The meeting further enabled those assembled to define the contours of a future GEO-wide collaborative task team to leverage GEO's convening power to build the tools that meet the information needs.

The aims of this workshop were:

- Determine if there is a need for a Nutrient (+ Nitrogen species) Monitoring Task Team
- Work on a strategy
- Establish next steps for implementation
- Advance this nutrient management concept to a Post-2025 GEO initiative

Workshop Deliverables included:

- Workshop Summary Report
- The Strategy paper outlining implementation

2. Workshop Summary

2.1 Opening Remarks

Moderator: N. Lerma

Justyna Nicinska, GEO Programme Board and National Ocean and Atmospheric Administration (NOAA) Representative, opened the workshop with an introduction to the Group on Earth Observations (GEO), an intergovernmental partnership on the availability, access, and use of Earth observations for a sustainable planet. GEO's Post-2025 Strategy focuses on strengthening collaboration across GEO Work Programmes, enhancing data accessibility, and supporting the co-production of knowledge for evidence-based decision-making. The GEO Work Programme consists of activities that make up GEO's work and contributions and are the primary instrument for fostering collaboration to address critical information needs using Earth observations. Nutrient monitoring is a key issue that GEO is well-positioned to contribute to. Nicinska brought up the Global Ecosystem Atlas and the Global Heat Resilience Service as exemplars of GEO efforts to co-design demand-driven, integrated solutions to complex challenges.

Dr. Audrey Hasson, GEO Blue Planet Executive Director and Mercator Ocean International Representative, provided an overview of GEO Blue Planet and its working groups which are addressing marine-related challenges. Dr. Hasson shared how these working groups work with partners to identify and bridge gaps between ocean and coastal data and societal need to deliver actionable information. Details on how GEO Blue Planet contributes to the workflow of translating data to policy were presented to show participants how GEO Blue Planet envisions its contributions to the proposed Nutrient and Nitrogen Monitoring Task Team.

Natalie R. Lerma, GEO Blue Planet US Representative and Knauss Marine Policy Fellow at the National Ocean and Atmospheric Administration (NOAA), provided an overview of the workshop's objectives, agenda, and venue information, including how to access Wi-Fi and the location of facilities.

2.2 Session 1

Moderator: N. Lerma

This session was devoted to oral presentations from three experts in nutrient and nitrogen pollution policy. As a policy-oriented session, the first expert speaker served as an exemplar for moving data to policy, while the third expert speaker discussed the challenges confronting developing countries on nutrient and nitrogen monitoring and management. The second expert speaker bridged these policy extremes by highlighting the global need to address nitrogen pollution through scientific support teams, monitoring frameworks that support National Action Plans (NAPs), and awareness.

Jeanne De Jaegher, European Commission Team Leader on Nitrates, presented on nutrient management and pollution at the European Union (EU)- level. The EU has a long history of addressing nutrient loss and recycling across various sources and sectors to protect water, air, soil, and climate. The various nutrient-related policies and directives' legislative framework have supported increased monitoring and data collection on nutrient pollution in air and water. De Jaegher suggested that NAPs could benefit from a more integrated approach that considers all nutrient and nitrogen pollution sources. Difficulty reconciling various data, monitoring, and assessments, along with modeling the impact of actions on nutrient load reductions to surface waters, can make policymaking and communication more challenging. There is a need to determine nutrient load reduction in a source-to-sea approach that translates this into sectoral action.

Mihai Constantinescu, Ministry of Environment Water and Forests (Romania) and Co-Chair of the Working Group on Nitrogen (WGN), introduced the WGN, which was formalized by the UNEP Executive Director and established to accelerate global action on sustainable nitrogen management. The WGN is based on the United Nations Environment Assembly (UNEA) resolutions on nitrogen. The WGN has two co-chairs and 96 focal points. Since its establishment, the WGN has increased awareness and knowledge sharing on nitrogen management, produced regional

assessments on nitrogen challenges, engaged with various stakeholders, including governments and organizations, and supported National Action Plans, including nitrogen management. Constantinescu spoke of the challenges of developing NAPs, which include a lack of monitoring data, insufficient local expertise, funding constraints for policy implementation, and the weak authority of monitoring agencies. To address these challenges and continue its work on sustainable nitrogen management, the WGN needs to establish a scientific support team, develop implementation plans and frameworks that guide the development of NAPs, secure funding to support these endeavors, and collaborate with relevant organizations, such as GEO.

Gabrielle De Souza, Ministry of Agriculture, Land and Fisheries (Trinidad and Tobago), presented on nutrient management in Trinidad and Tobago. While progressive and ambitious in their environmental policy, policies in Trinidad and Tobago are fragmented and lack specificity. Gaps in nutrient management in Trinidad and Tobago can be attributed to the absence of nutrient and nitrogen-specific policies, lack of data and expertise, deficient monitoring systems, insufficient interagency coordination, and limited training opportunities. De Souza also pointed out that addressing the nutrient pollution challenge requires shared action across sectors, including agriculture, aquaculture, transportation, energy, waste, recycling, and consumption. To support these cross-sector actions, there needs to be coordinating mechanisms established, data collection and monitoring regulatory measures, and public awareness campaigns.

This session concluded with a guided panel discussion in which the previous speakers served as panelists. **Itsuki Kuroda**, Ministry of Environment (Japan) and GPNM representative, also served as a panelist.

2.3 Session 2

Moderator: A. Hasson

This session focused on data for monitoring nutrient and nitrogen pollution, emphasizing its sources, impacts, and the importance of data in understanding and managing this environmental challenge. The speakers of this session underscored the need for in-situ and remotely sensed data collection, analysis, and collaboration across sectors and Earth systems to effectively tackle nutrient and nitrogen pollution and its wide-ranging impacts on the environment and human health.

Dr. William "Bill" J. Bealey, UK Centre for Ecology & Hydrology and Global Partnership on Nutrient Management (GPNM) Representative, presented the sources and flows of nitrogen pollution, its fate in water and air, and its impact on quality. Bealey described data types, networks, and methods, highlighting that scientific data is essential for understanding the state of the environment, the impact of human activities, and the effectiveness of intervention efforts. Data collection, analysis, and sharing are crucial for informed decision-making and adaptive management strategies.

Dr. Ning Liu, UNEP Programme Management Officer, provided an overview of the Global Partnership on Nutrient Management (GPNM). Launched by the United Nations (UN) in 2009 at the UN Headquarters, the GPNM was created to optimize nutrient use and address nutrient pollution. The United Nations Environment Programme (UNEP) hosts the GPNM secretariat. Since its launch, the GPNM has received funding from the Global Environment Facility (GEF) for two projects: 1) the Global Nutrient Cycle and 2) the International Nitrogen Management System (INMS). The UNEA resolutions 4/14 and 5/2 have pushed the GPNM agenda as a UN priority. GPNM desires a multi-stakeholder platform similar to the digital platform for the Global Partnership on Marine Litter (GPML) to provide data, knowledge, and a workspace to support action on nutrient pollution.

Natalie R. Lerma, GEO Blue Planet US Representative and Knauss Marine Policy Fellow at National Ocean and Atmospheric Administration (NOAA), presented nutrient pollution as a significant environmental challenge from anthropogenic activities, such as agriculture, fossil fuels, and land degradation. GEO Blue Planet's work relates to SDG 14 (life below water) and nutrient pollution is connected to its work on Target 14.1.1a, which examines how excess nutrients can lead to eutrophication. The consequences of eutrophication include hypoxic and anoxic ecosystems, economic losses from reduced catch sizes, beach closures, and reduced property values, and threats to human and ecosystem health. GEO can play a crucial role in nutrient monitoring by providing data on land cover, soil health, population density, and other factors that can be used to inform indicators of nutrient pollution. GEO Blue Planet is already supporting UNEP with SDG 14.1.1a on eutrophication by providing data on chlorophyll-a anomalies globally; however, GEO Blue Planet cannot support UNEP's ambitious source-to-sea approach, which requires expertise across sectors and Earth systems. Lerma proposed a task team on nutrient and nitrogen monitoring, comprising representatives across GEO Work Programmes and UNEP, which could advance nutrient and nitrogen monitoring efforts and support impacted SDGs.

This session concluded with a guided panel discussion in which the previous speakers served as panelists. **Kentaro Hayashi**, Professor at the Research Institute for Humanity and Nature, also served as a panelist.

2.4 Session 3

Moderator: N. Lerma

The speakers of this session served as primers to the breakout group discussion, providing examples of successful collaborative efforts.

Yana Gevorgyan, GEO Secretariat Director, discussed the GEO Secretariat's role in coordinating the Global Ecosystem Atlas, emphasizing its curation of data and partnerships. The initiative was driven by the need to harmonize diverse ecosystem data for the Global Biodiversity Framework. Key elements of its success included validating the need with stakeholders, maintaining momentum through regular meetings and engagement, and securing seed funding from the UK

government and UNEP. The first proof of concept was developed by October 2020, demonstrating the vision and the group's ability to engage with partners and countries.

Keith VanGraafeiland, Environmental Systems Research Institute, Inc. (ESRI) Representative and GEO Blue Planet Eutrophication Working Group Co-chair, described how ESRI Geographic Information System (GIS) tools can support GEO activities and provided an example of their support of GEO Blue Planet's coastal eutrophication work. VanGraafeiland explained how eutrophication, an excess of nutrients in a body of water, can cause excessive algae growth and disrupt the balance of organisms and water quality. Using satellite-derived chlorophyll-a measurements, the Index of Coastal Eutrophication quantifies the number and severity of eutrophication events in nearshore waters globally. The Index of Coastal Eutrophication results are shared with UNEP and the broader community through the ArcGIS Living Atlas of the World and a web application. ESRI's ArcGIS Pro allows organizations like GEO Blue Planet and UNEP to make their workflows scalable, repeatable, and understandable.

Dr. Audrey Hasson, GEO Blue Planet Executive Director and Mercator Representative, provided a summary of the presentations from Session 1 and 2, and the guided panel discussions that followed. She also followed up with details about the structure of the breakout group session, including the merging of virtual and in-person participant groups.

2.5 Session 4

Dr. Merrie Beth Neely, Global Science & Technology, Inc. (GST), dually representing GEO Blue Planet and GEO AquaWatch as GEO Blue Planet's Eutrophication Working Group Co-Chair, summarized the breakout session which was jointly compiled by Dr. Neely and **Dr. Christopher Wendell Brown**, GEO Blue Planet Representative and University of Maryland. The contents of Dr. Neely and Dr. Brown's summary are described in the section *Key Findings*.

Dr. Audrey Hasson, GEO Blue Planet Director and Mercator Ocean International Representative, and **Dr. Ning Liu**, UNEP Programme Management Officer, provided the closing remarks. They thanked participants for their contributions and attendance at the workshop.

3. Key Findings of the Breakout Group Discussion

The breakout group discussed the need for a task team to advance a strategic framework for nutrient monitoring and management, focusing on nutrients and other nitrogen species. The team emphasized the importance of integrating data from various sources, primarily from remote sensing, and the need for coordination among different organizations. Specifically, the Task Team should include representatives from across sectors and Earth systems and include monitoring of complex nitrogen flows. Sustained, active engagement, participation and attendance by participating organizations will be essential to task team success.

The Task Team aims to assess the feasibility of supporting UNEP in developing national action plans (NAPs) using satellite data alone. This activity starts with a pilot study to test the spectrum of data availability. The Task Team will be technical and focus on remote sensing data sources with a purview of capacity development and outreach activities that support its work. The team will identify three scenarii: 1) one with substantial in-situ and remotely sensed data, 2) one with growing in-situ data collection capabilities and remote sensing data usage, and 3) one with little to no in-situ data.

Table 1. Data availability scenarii and potential pilot countries to conduct research activities for demonstration

	Scenarii		
	substantial in-situ observation and remotely sensed data	limited in-situ observations and remotely sensed data	remotely sensed data only
Pilot Country 1, e.g. in the EU or Japan	X	X	X
Pilot Country 2, e.g. one of GPNM pilot countries		X	X
Pilot Country 3, e.g. in Africa			X

The goal of the pilot study is to demonstrate the feasibility and value of using satellite data to inform national action plans (NAPs) for nutrient and nitrogen management, supporting the GPNM process. It was proposed that the Task Team should utilize a phased approach, starting with a pilot study and expanding based on the results. While discussing which countries should be selected as pilot study locations, the need for updated and independent data analysis in Africa was

brought up. It was noted that some countries still rely on outdated studies. For this reason, an unspecified African country was proposed as one of the pilot locations. Comparing data sources with model outputs was also suggested. However, concerns over model inputs and output validation were voiced. A pilot study for a European country or Japan was proposed because of the rigorous monitoring standards and availability of high-quality data in Europe and Japan.

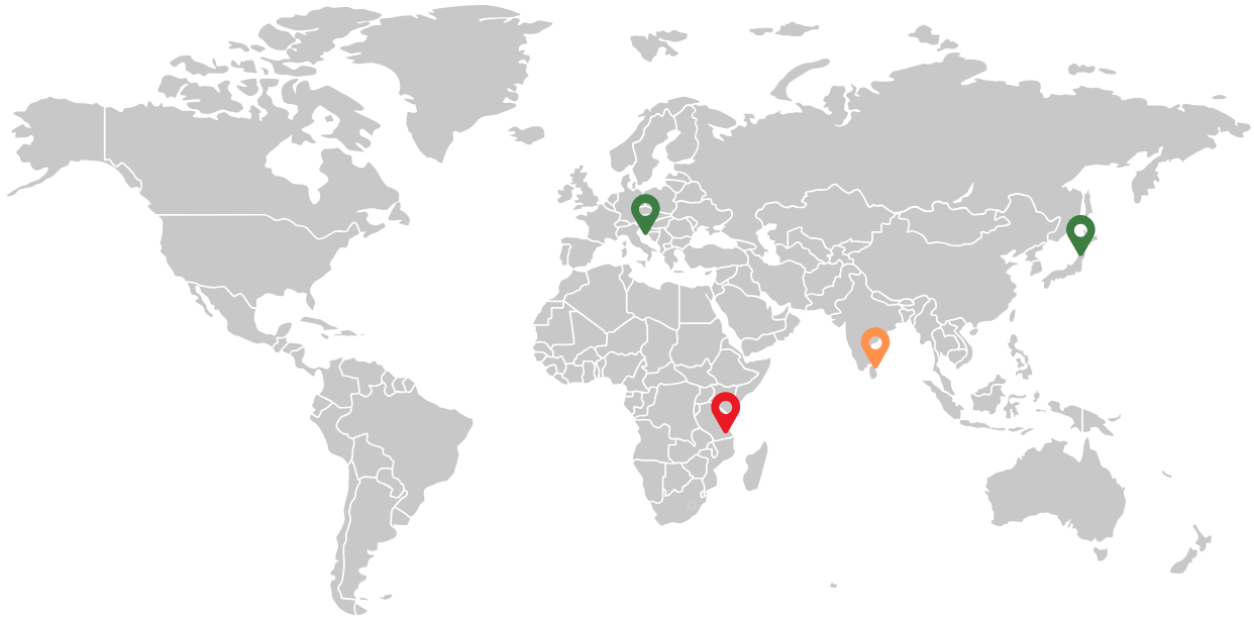


Figure 2. Global map with pins identifying countries or regions proposed as potential case studies for the demonstrator project. The green pins indicate countries or regions with abundant in-situ and remote sensing data sources (e.g., Europe or Japan). The orange pin indicates a country with growing in-situ capabilities and remote sensing (e.g., Sri Lanka). The red pin indicates a region with little to no in-situ data and remote sensing (e.g., Africa).

4. Action Items & Next Steps

The progress of the Task Team will be reported to the WGN. Participants proposed meetings for updates between the Task Team and the WGN at six-month intervals; however, meeting frequency with the WGN and within the Task Team can be decided later. The Task Team will be organized over a two-year period with the following deliverables:

- Value statement supporting satellite proxies' data in each GEO domain for nutrient management in national action plans (documents user needs, existing inventory, and what has been done before, ensures User Experience is stakeholder approved to meet needs). Any data products supplied or produced for this Task Team will include any limitations or associated data needed for quality reasons
- Identify a country or countries with limited in-situ data to serve as pilot case studies for the comparative analysis of satellite data vs. in-situ data vs models (physics and data driven)
- Convene a co-design workshop with stakeholders, including representatives from the working group on nitrogen, to gather user needs and requirements for the task team's work.
- Pilot demonstrator of methodology (& associated Info Hub/Website if desired)
- Prepare a peer-reviewed scientific publication
- Prepare a policy-oriented 1-pager for country-level use
- Create a video explainer for communicating findings of pilot case studies

To ensure the Task Team makes progress on its proposed deliverables, the following next steps were identified:

- Organize a follow-on GEO group meeting next week (16 January 2025)
- Draft a Task Team call for action (GEO Blue Planet)
 - Present the call for action at the GEO Forum in Rome, Italy to (re)engage interest
 - Give a talk in plenary at this meeting (May 2025)
- Organize the agenda for next WG Nitrogen meeting and get feedback on this concept (March 2025)
- Convene workshop participants to prepare and review the deep data dives and the strawman Terms of Reference (ToR) document (March 2025 – Eutrophication team leadership will step down at this time and may be a favorable transition point)
- Prepare whitepaper to cover work specifications for the demonstrator pilot (prepared by UK CEH and paid by Mercator/GEO Blue Planet European office - due date TBD)

5. Evaluation of Workshop

The workshop is evaluated by objectives and deliverables it set forth in its agenda shared with participants.

Did the workshop:

- Determine if there is a need for a Nutrient (+ Nitrogen species) Monitoring Task Team
 - Yes, the workshop determined there is a need for a Nutrient and Nitrogen Species Monitoring Task Team through a dedicated breakout session where participants discussed the benefits of a coordinated GEO-wide effort. Discussions highlighted the lack of coordination across sectors and Earth systems and the necessity of a task team to integrate data from various sources, primarily remote sensing.
- Work on a strategy
 - Yes, the workshop identified a strategy for the task team, including a two-year timeline with specific deliverables such as a value statement, pilot case studies, and a co-design workshop.
- Establish next steps for implementation
 - Yes, the workshop identified five next steps to move the task team agenda forward and progress on the deliverables, including drafting a refined concept of the task team, establishing a communication plan (e.g., presenting the draft to the broader GEO community at the GEO Global forum in May 2025 and at a WGN meeting in March 2025), and securing funding for research activities that support the task team's pilot project.
- Advance this nutrient management concept to a Post-2025 GEO initiative
 - Partially. While the workshop laid the groundwork for this objective, it wasn't fully achieved due to time constraints, lack of diverse GEO Work Programme representation during breakout discussions, and the need for further refinement of the concept. Action items were identified to move the concept toward this goal including to prepare a refined concept and a Terms of Reference (ToR) document to present in March 2025 at the next Working Group on Nitrogen meeting and to present the concept in a plenary at the GEO Global Forum in Rome, Italy in May 2025.

Has the Workshop resulted in the following deliverables:

- Workshop Summary Report
 - Yes, this document serves as the workshop summary report.
- The Strategy paper for next steps
 - No, a strategy paper detailing the next steps for the Nutrient and Nitrogen Monitoring Task Team has not been initiated. However, follow-on meetings with workshop participants and GEO Work Programme representatives

(including the January 16, 2025, follow-on meeting) will hopefully address this deliverable.

The workshop was successful in bringing together experts from diverse organizations to discuss nutrient and nitrogen monitoring efforts and advance these efforts through a task team. The breakout session discussions allowed participants to develop the task team, including determining its scope of action, designing deliverables that would demonstrate the value of remote sensing, and identifying next steps to ensure the task team makes progress towards its deliverables. While one objective and one deliverable item were not achieved during the workshop meeting, concrete action items were identified to ensure their completion within a 6-month timeframe. Future workshops would benefit from clearer messaging about the goal of the workshop, GEO Blue Planet's (and other GEO Work Programmes') role in a task team, the rationale on the remote sensing focus, and what participants are expected to contribute.

6. Contributors

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