Policy Brief
July 2025

Enhancing SDG 14 Monitoring and Reporting: How Earth Observation Supports Sea Surface Acidity and Marine Eutrophication Assessment

SDGs-EYES services - Monitoring Sustainable Development Goal 14 - Using Earth observation (EO) data to monitor North Sea acidification & eutrophication

Global mean seawater surface acidity (Eurostat code: 14_50)

Marine waters affected by eutrophication (Eurostat code: 14_60)

KEY MESSAGES

Timely data for ocean health.
Monitoring of ocean acidification and coastal eutrophication is often delayed and spatially limited. Timely data for ocean health encompasses any data source - satellite observations, in situ sensors, or operational modelling systems - that provides marine environmental information at a temporal and spatial resolution sufficient to support immediate or near-term decision-making for ocean management and SDG reporting.

Integrated SDG 14 monitoring services.
SDGs-EYES develops two services: the Sea Surface Acidity and the Marine Waters Eutrophication. They deliver a fully automated system based on Earth observation data to track marine acidity and nutrient pollution in the North Sea. The services combine Copernicus marine data, in situ measurements, and established marine indicators to produce spatially explicit, up-to-date maps of ocean acidity and eutrophication risk.

SDGs EYES

Funded by the European Union

Scene Setting

Ocean acidification and eutrophication pose serious threats to marine ecosystems, driven by increasing CO_2 levels and nutrient pollution from human activities. Since pre-industrial times, the ocean's surface pH has decreased from around 8.2 to values slightly above 8 in 2024, which results in an increase in acidity of about 40%. Meanwhile agricultural runoff and wastewater continue to trigger harmful algal blooms and oxygen-depleted waters.

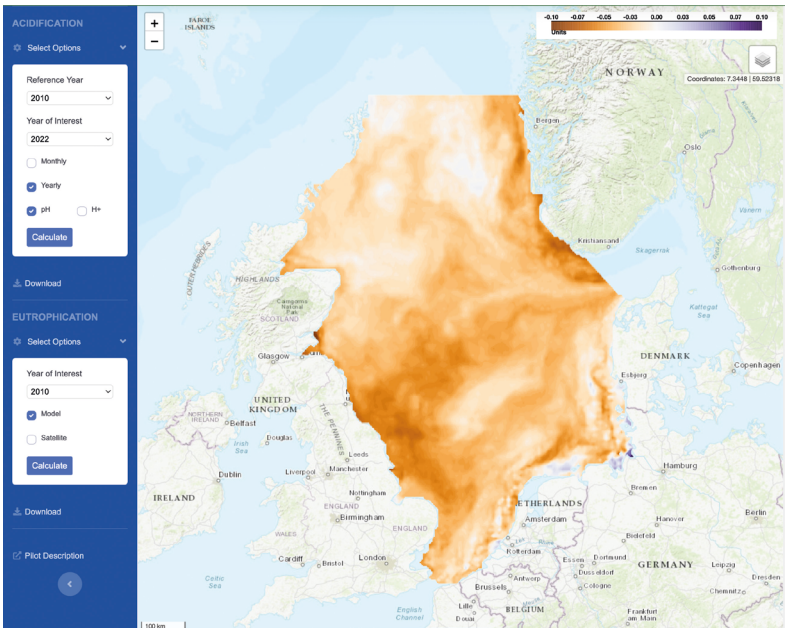
SDG 14 – Life Below Water calls for urgent action to reduce marine pollution (Target 14.1) and contrast ocean acidification (Target 14.3). However, conventional monitoring methods, based on ship surveys and laboratory analyses, are often too slow and spatially limited to capture these rapidly evolving phenomena. Earth observation data and associated modelling technique offer a transformative solution, providing continuous, standardised measurements across wide areas to detect trends, hotspots, and anomalies in near-real time.

Services Sea Surface Acidity and Marine Waters Eutrophication of the SDGs-EYES project demonstrate how Earth observation can fill critical data gaps and enhance the monitoring of SDG 14 indicators by delivering actionable, evidence-based insights for marine policy and management.

Transforming Marine Monitoring with Earth Observation: Advancing SDG 14, the EU Mission Ocean, and Global Ocean Science

The SDGs-EYES project demonstrates how Earth observation-based solutions can bridge key data gaps and strengthen monitoring of SDG 14 indicators. Services Sea Surface Acidity and Marine Waters Eutrophication provide actionable, science-based insights to inform marine policies and ecosystem management.

Focusing on the North Sea, the services deliver a scalable, Earth observation-driven platform for tracking ocean acidification and eutrophication, two critical challenges exacerbated by climate change and pollution. The services integrate satellite observations, Copernicus Marine Service model outputs, and in situ data to assess sea surface pH and eutrophication status.



Through automated data processing, the services generate spatially resolved data aligned with SDG 14.3.1 (Ocean acidity) and SDG 14.1.1 (Eutrophication) indicators. These results are presented via an interactive web dashboard, allowing users to explore patterns, seasonal shifts, and high-risk areas with ease. Regular updates ensure timely insights, overcoming the limitations of traditional, manual monitoring approaches.

SDGs-EYES services align with the objectives of EU Mission 'Restore our Ocean and Waters by 2030', which specifically calls for the deployment of digital solutions and enhanced monitoring systems to reduce pollution, protect and restore marine and freshwater ecosystems and support climate-neutral ocean governance. SDGs-EYES and the services' ability to automatically process and deliver updated eutrophication and acidity indicators precisely align with this objective.

Furthermore, by offering rapid, high-resolution monitoring, the services also support the ambitions of the European Green Deal, which aims, among other objectives, to restore biodiversity and protect ecosystems, including marine environments. Additionally, they contribute to the United Nations Decade of Ocean Science for Sustainable Development (2021–2030), which calls for transformative, science-based solutions to improve ocean health, enhance forecasting capabilities, and support sustainable marine resource management globally.

Main Features of the Services

SDGs-EYES service Marine Waters Eutrophication integrates Copernicus marine model outputs, specifically ocean colour observations and biogeochemical models, to monitor chlorophyll concentrations, track eutrophication trends, and detect seasonal algal blooms. For the acidity, service Sea Surface Acidity makes use of modelled pH fields which are combined with in situ records to enhance accuracy and correct for regional biases.

These services are available through a cloud-based platform which is fully automated. Its workflow ensures seamless access to data and continuous updates of marine indicators.

The services were co-designed with national statistical offices, marine scientists, and environmental agencies to ensure direct alignment with reporting structures required by the Marine Strategy Framework Directive (MSFD). The MSFD legally requires EU Member States to achieve Good Environmental Status (GES) of marine waters. This includes specific obligations to reduce eutrophication and mitigate the impacts of ocean acidification. SDGs-EYES services Sea Surface Acidity and Marine Waters Eutrophication directly support this mandate by providing high-resolution, regularly updated indicators aligned with MSFD Descriptor 5 (Eutrophication) and Descriptor 7 (Hydrographical conditions). The services' spatially explicit maps and trend analyses enable national and regional authorities to meet monitoring and reporting obligations under the MSFD with greater precision and timeliness.

By delivering detailed, actionable data, the services complement broader EU environmental strategies. In particular, they support the implementation of the European Climate Law by informing marine adaptation efforts and improving assessments of measures to reduce greenhouse gas emissions under initiatives like the Fit-for-55 package. Ocean acidification, monitored by the services, is directly linked to atmospheric CO_2 levels. Tracking pH changes offers critical feedback on the ocean's role in climate regulation and on progress towards climate neutrality goals.

Through these contributions, SDGs-EYES services Sea Surface Acidity and Marine Waters Eutrophication position themselves as key enablers of integrated EU marine governance, connecting SDG 14 monitoring with climate, biodiversity, and pollution-reduction policies in a coherent, operational framework.

By providing cross-cutting, spatially detailed marine indicators, the services enhance Europe's ability to deliver integrated, evidence-based ocean governance.

The Technical Side of the Services

SDGs-EYES services Sea Surface Acidity and Marine Waters Eutrophication systematically integrates Copernicus Marine Service reanalysis products, satellite observations, and in situ data to generate values for the indicators on ocean acidity and eutrophication.

For acidification, service Sea Surface Acidity, there are two datasets already available on the service's platform:

- the original modelled pH fields provided by North West Shelf - Monitoring Forecasting Centre (NWS MFC),
- the blended product with in situ pH measurements.

The blending was developed during the project's co-design process to further enhance the accuracy by validating the data from two different sources and to expand the domain to inner coastal areas. The workflow itself, organised as the set of Jupyter notebooks and Python functions, provides the possibility to not only assess the differences between the pH spatial fields both on annual and monthly scales, but also to calculate the spatial distribution of trends over time, thus making it possible to perform the detailed analysis of the ongoing changes in different areas of the North Sea.

In a similar fashion, the eutrophication workflow (developed in service Marine Waters Eutrophication) provides two different types of the chlorophyll datasets:

- satellite-derived chlorophyll concentrations,
- modeled chlorophyll dataset from the NWS MFC.

The workflow uses two different approaches of assessing the eutrophication status of the waters: the percentile-based approach (Eurostat, 2025), also used as part of Eurostat methodology, and the so-called NEAT index (Terauchi et al., 2014) based on the combination of chlorophyll trend sign and its absolute values to map the areas of potentially eutrophic or oligotrophic waters and track their seasonal dynamics.

Assuming that some technical conditions are fulfilled, the latest version of the workflow is designed so that the end-user can use their own datasets. That makes the workflow more flexible in terms of the data used, and provides the opportunity to transfer the whole workflow to other marine areas.

What Does This Mean for Policy?

Services Sea Surface Acidity and Marine Waters Eutrophication provide marine authorities, environmental agencies, and statistical offices with practical, evidence-based services for timely monitoring of ocean health. It delivers granular, up-to-date information that complements traditional monitoring approaches, helping institutions meet reporting obligations under SDG 14 and EU-level Directives like the MSFD.

Authorities can also identify emerging hotspots of acidification or potentially disruptive eutrophication conditions and target interventions more effectively. By providing consistent, spatially detailed data, the services strengthen the capacity of national and regional bodies to protect marine ecosystems and coastal communities.

The co-design approach ensures that the services integrate smoothly into existing policy workflows. Earth observation-based indicators can be cross-validated with national monitoring systems and adopted gradually, supporting a seamless transition that preserves long-term data continuity. This enhances the reliability and trust in using Earth observation-based data for official marine indicators reporting.

From Barriers to Action: Enabling Earth Observation-based SDG Reporting

Data Fragmentation

The Challenge: Marine data are often stored in separate, incompatible systems, making integration difficult.

Strategic Response: Open data standards and cloud-based workflows, as used in these services, harmonise diverse data sources into an integrated system.

Institutional Inertia

The Challenge: Agencies may hesitate to adopt satellite-based methods that could disrupt existing reporting routines.

Strategic Response: Co-design with end-users and phased implementation ensure Earth observation data can complement and validate existing inventories without replacing them.

Capacity Gap

The Challenge: Many authorities lack the technical infrastructure or expertise to process satellite data.

Strategic Response: The platform is cloud-based, automated and user-friendly, thus enabling its easy adoption with minimal local infrastructure and targeted training.

Weak Ground Validation

The Challenge: Limited in situ measurements can undermine confidence in satellite-derived indicators.

Strategic Response: The pilot's blending of in situ and modelled pH data improves accuracy. Partnerships with research institutions and standardised validation protocols further enhance credibility.

Resources Constraints

The Challenge: Maintaining Earth observation systems can be financially challenging.

Strategic Response: Leveraging free Copernicus data, open-source services, and EU funding opportunities reduces costs and supports long-term sustainability.

By addressing these barriers, SDGs-EYES services Sea Surface Acidity and Marine Waters Eutrophication demonstrate how Earth observation can become a trusted and operational part of SDGs monitoring.

Experimental Results and Operational Validation

SDGs EYES services demonstrated clear and actionable findings. Between 2000 and 2020, sea surface pH in the North Sea decreased by approximately 0.04 units, confirming a measurable acidification trend. The eutrophication indicators show that around 100,000 km^2 – nearly one-fifth of the North Sea surface – consistently exhibited eutrophic conditions, especially along the southern and eastern coasts.

The services successfully captured interannual variability of areas experiencing potential eutrophic conditions. The overall pattern of potentially eutrophic waters localisation in the southern parts of the North Sea aligned well with independent data from OSPAR[1] assessments and *in situ* monitoring records, validating the services' accuracy.

The co-design process was central to the services' success. User feedback during workshops and webinars led to important improvements, including the addition of monthly eutrophication indices and the integration with in-situ pH data. This collaborative development ensured that the services met real-world policy and reporting needs.

[1] OSPAR is the Commission for the Protection of the Marine Environment of the North-East Atlantic.

Through sustained validation and stakeholder engagement, SDGs-EYES services Sea Surface Acidity and Marine Waters Eutrophication have proven ready for operational use, providing reliable, high-quality data that can directly support marine management and the reporting of SDG indicators.

Forward Looking

SDGs-EYES services Sea Surface Acidity and Marine Waters Eutrophication sets the foundation for scalable, Earth observation-based ocean monitoring. Future developments will focus on expanding the blending of real-time in situ data with Copernicus model outputs, enhancing the accuracy of both acidity and eutrophication indicators.

The services' modular design makes it easily transferable to other marine regions, such as the Baltic or Mediterranean seas, and the project team plans to engage with other stakeholders to support wider adoption of this platform. Integration with policy reporting systems, such as national SDG submissions or Eurostat workflows, is a key next step. Automating the data flow into official reporting channels will streamline national and European marine assessments.

Finally, linking the marine services to related SDGs – such SDG 6 - Clean Water and Sanitation and SDG 13 - Climate Action could provide more comprehensive environmental insights and support cross-sectoral policy development.

By building on these advances, the North Sea services can become a long-term, operational contribution to sustainable ocean governance, strengthening evidence-based action to protect life below water.

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SDGs-EYES in short

SDGs-EYES aims to boost Europe's capacity to monitor the Sustainable Development Goals by harnessing the power of Copernicus Earth observation data. The project focuses on building a portfolio of decision-support tools to enhance the production and use of SDG indicators, with an emphasis on accessibility, reliability, and impact.

Enhancing Access and Usability of Earth observation Data

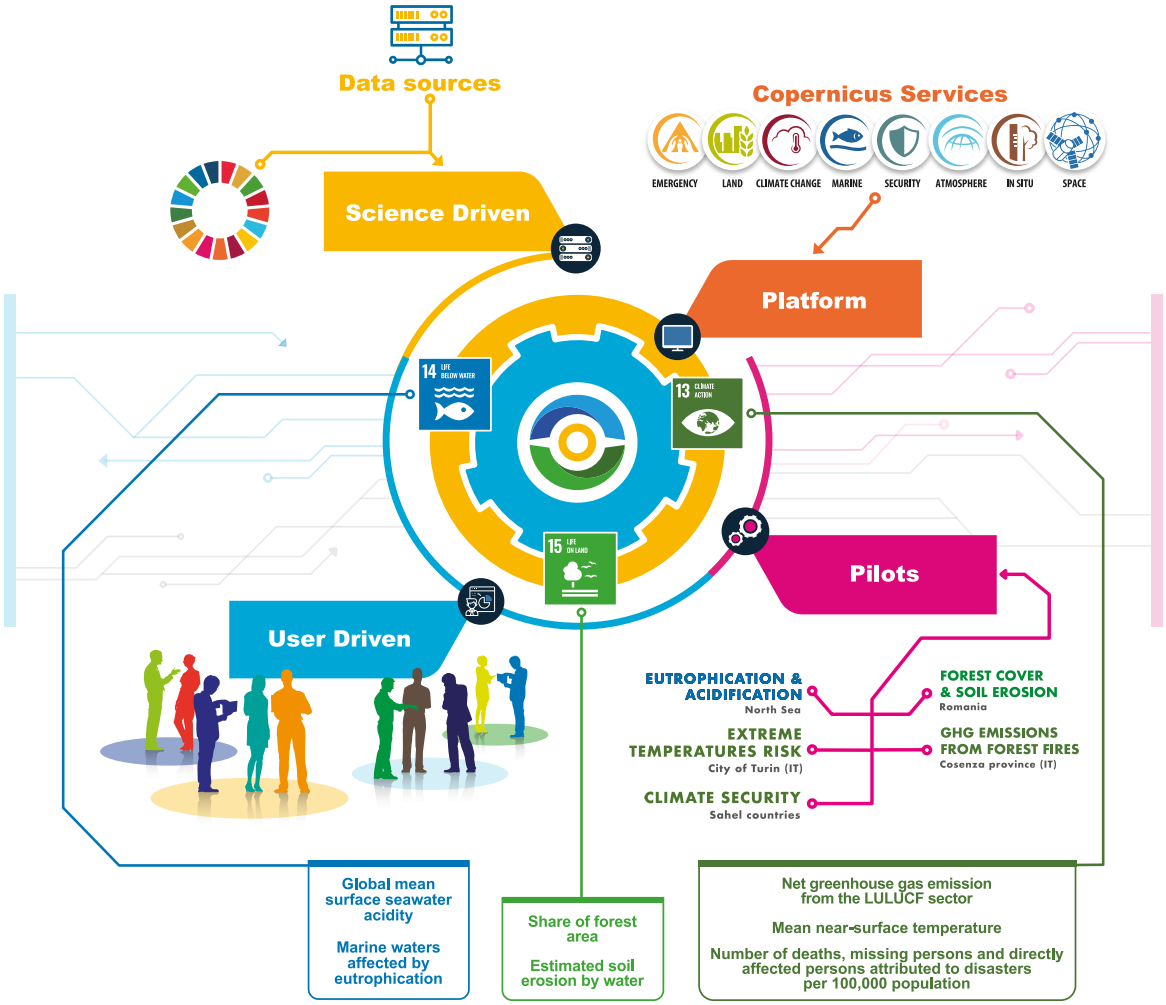
SDGs-EYES develops a scientific and technological framework to build robust and accurate indicators. It aggregates and processes data from Copernicus's six core services - along with space-based and in situ sources - to make Earth observation information more accessible and actionable.

Improving the Quality of SDG Indicators

The project demonstrates Copernicus-enhanced measurement for seven indicators across three SDGs goals (SDG 13 - Climate Action, SDG 14 - Life Below Water, SDG 15 - Life on Land). A cross-cutting indicator has been developed to assess the exposure of vulnerable communities to multiple and overlapping climate extremes.

Building Stakeholder Capacity for Societal Impact

SDGs-EYES delivers service-oriented data products that simplify the tracking and reporting of SDG indicators. These tools have been co-designed with users - including public authorities, researchers, and environmental agencies - to ensure usability and relevance in decision-making contexts.



SDGs EYES

Find Out More

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