EARTH OBSERVATIONS FOR THE SUSTAINABLE DEVELOPMENT GOALS

EO-based SDG Indicator Country Use Case

SDG Indicator/ Sub-indicator	SDG 14.1.1a Index of coastal eutrophication: 1. Chlorophyll deviations 2. Chlorophyll anomalies 3. Indicator of Coastal Eutrophication Potential (ICEP)
Country or region	Tanzania, Albania
Project Status *(mark with an x)*	_ being used in official SDG Indicator reporting **X** being verified or tested by country _ studying feasibility
Earth Observation Data Used *(include web links)*	Sentinel-3 Level 2 OLCI full resolution water products (WFR) OLCI WFR data, Ocean and Land Color Instrument Water-Framed Reflectance-S3A_OL_2_WFRm Copernicus Data Space Ecosystem | Europe's eyes on Earth
Additional/Other Data Used *(include web links)*	Insula user manual

Description of data access, processing, and analysis, including methodology that was developed, associated tools or applications, and how these are applied to compute SDG Indicator

Overview of Insula as the Processing Platform

In the realm of environmental monitoring, particularly in the context of the Eutrophication Monitoring (Eu-Mon) project aimed at achieving Sustainable Development Goals (SDGs), the integration of advanced Earth Observation (EO) technologies becomes paramount. Within this framework, Insula emerges as a cornerstone solution, offering a comprehensive suite of capabilities essential for harnessing EO data to generate crucial SDG indicators.

The paragraphs below describe at a high level the different features of Insula that contribute to the achievement of the Eu-Mon goals. These features will be further described in the functional requirements.

Access to EO Data Collections

Insula serves as a gateway to a vast array of EO data collections, but in the contest of Eu-Mon special emphasis has to be raised on the Sentinel-3 satellite imagery. In particular as described in the IDI to the Sentinel-3 Level 2 OLCI full resolution water products (WFR) OLCI WFR data, Ocean and Land Color Instrument Water-Framed Reflectance- S3A_OL_2_WFR.

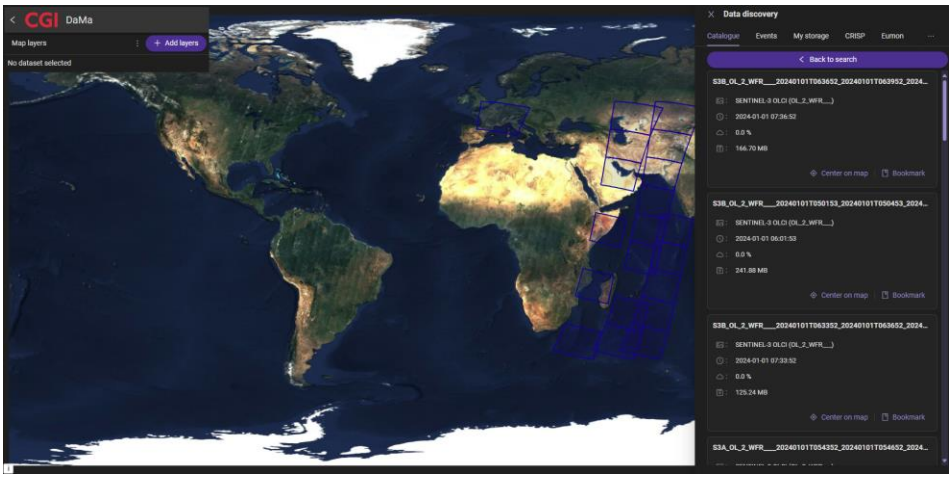


*Figure **Error! No text of specified style in document.**-1 Insula Data discovery*

This Copernicus data source is instrumental in generating key indicators related to eutrophication, including Chlorophyll (CHL), Turbidity (TUR), and Water Transparency (WT). The availability of such precise and timely data is indispensable for accurate monitoring and assessment of environmental conditions.

It has to be noted that in order to have fast access to these datasets the deployment of Insula has been performed on the Copernicus Data Space Ecosystem (CDSE)[1] . The Copernicus dataset are offered via internal network to the Insula platform enabling fast access.

[1] Copernicus Data Space Ecosystem | Europe's eyes on Earth

Development and Integration of the Eu-Mon Dataset Preparation Processor

One of Insula's defining features is its ability to seamlessly integrate processors for extracting valuable information from EO data. By facilitating the incorporation of custom processing algorithms, Insula empowers users to tailor their analytical workflows to specific project requirements. This flexibility ensures that Eu-Mon can leverage state-of-the-art processing techniques to derive meaningful insights from EO datasets.

In particular the Eu-Mon dataset preparation processor was integrated into the platform enabling the generation of Chlorophyll (CHL), Turbidity (TUR), and Water Transparency (WT) map from Sentinel-3.

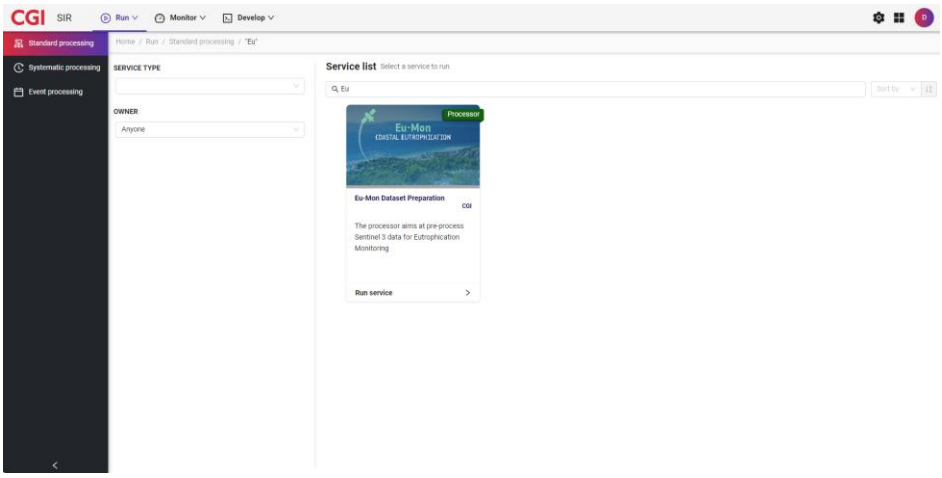


Figure Insula Processor integration

Processing Campaigns and Data Generation

Insula's capability to run processing campaigns over large Areas of Interest (AOIs) is particularly advantageous for the Eu-Mon project. With the ability to define extensive time frames and geographical extents, such as the case of monitoring eutrophication in Albania and Tanzania from January 1, 2017, to December 31, 2022, Insula facilitates comprehensive and efficient data processing on a large scale.

As showed in the picture below the Eu-Mon dataset preparation has been used to run 4842 jobs for the mentioned processing campaign.

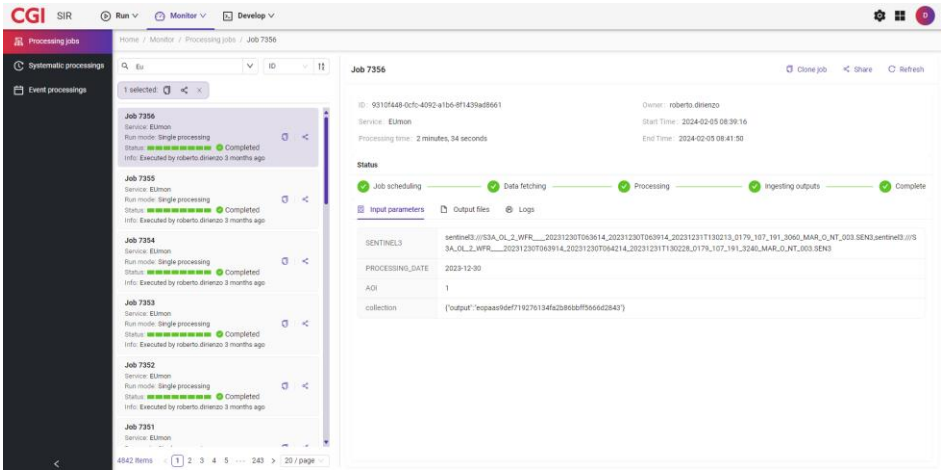


Figure Insula Processing campaign

Insula also offers the possibility to monitor processing campaigns reaching the details level of a single job log.

Insula takes advantage of latest cloud native technologies to analyze huge amount of data. In particular, in the CDSE, T-System offers managed Kubernetes[2] solution which has been exploited to perform dynamic scale of resources when large processing campaign where planned.

Analytical Capabilities and Visualization Tools

Eu-Mon necessitates the analysis of extensive time series data to discern long-term trends and patterns related to eutrophication. Insula's cloud-native architecture is ideally suited for handling large-scale data analytics tasks, enabling seamless processing and analysis of EO data over extended temporal periods. By leveraging cloud computing resources, Insula ensures scalability, reliability, and efficiency in handling vast datasets, thereby facilitating insightful analysis for Eu-Mon.

[2] Kubernetes

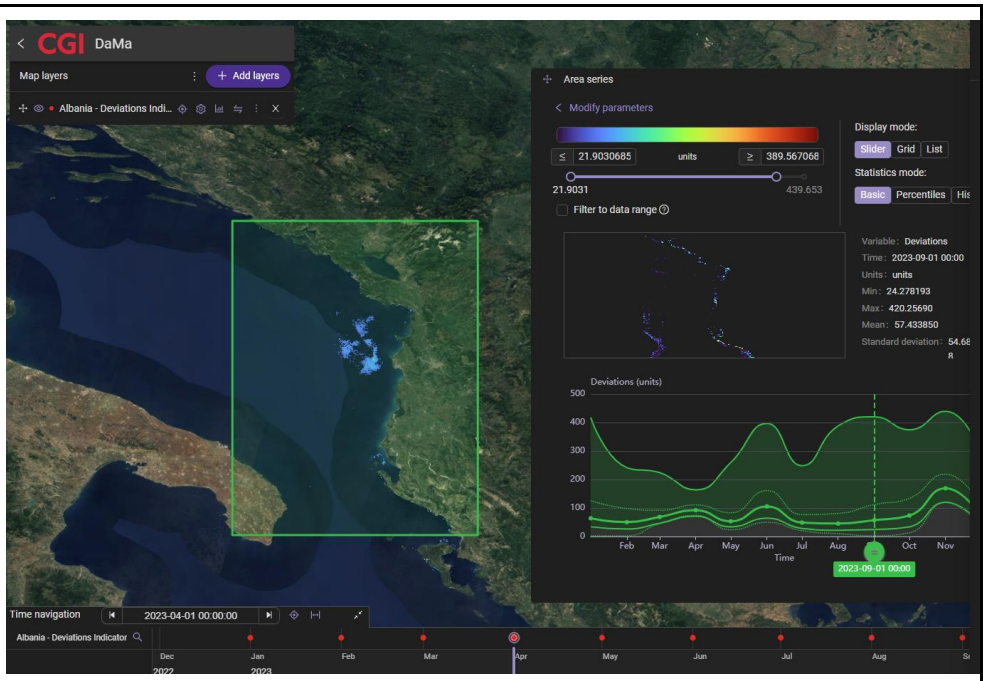
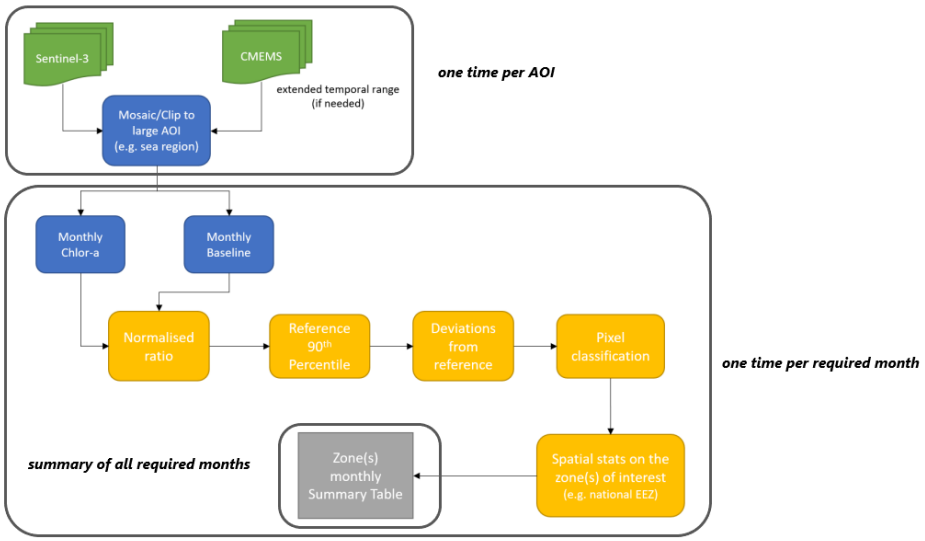


Figure Insula analytics

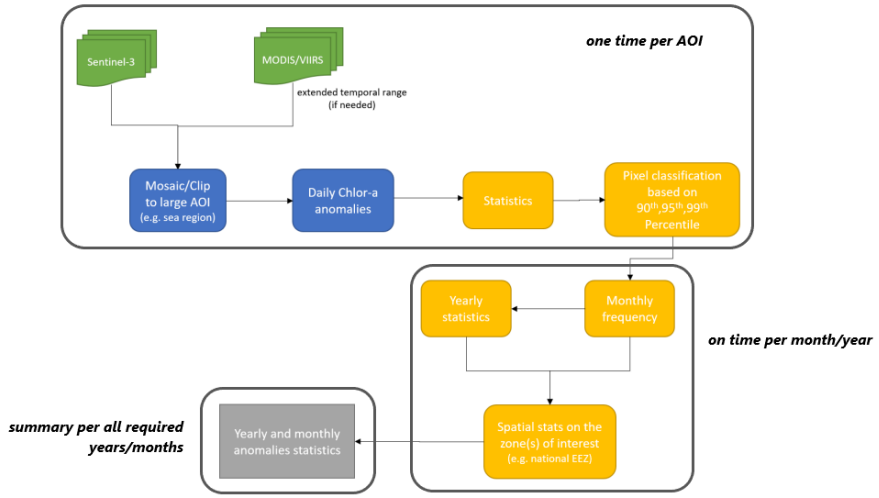
In addition, the plug-in design pattern enables high level of flexibility in the design of the UI enabling to create dedicated vertical applications.

Workflow

Chlorophyll-a deviations, as an improvement of Level 1 indicator in UNEP guidelines.



Chlorophyll-a anomalies, as an improvement of Level 1 indicator in UNEP guidelines



ICEP, adapting method described in REF5

Lessons learned, any gaps, key issues, and recommendations

Algorithm Validation with lack of in-situ data

One of the primary challenges faced during the project was the validation of the algorithm in the absence of sufficient in situ data. Accurate validation is crucial for ensuring the reliability and accuracy of the EO-based solutions. However, the lack of recent and high-quality ground truth data in key areas posed significant difficulties. Nonetheless, the consortium managed to perform a qualitative validation using CMEMS (Copernicus Marine Environment Monitoring Service) products. This approach provided a valuable alternative for assessing the algorithm's performance and ensuring its robustness.

Onboarding Additional Stakeholders from the Statistical Office

The process of onboarding additional stakeholders from the statistical office was another challenge, also complicated by changes in government in Tanzania.

	Overcoming these obstacles required persistent efforts to establish clear communication channels and adapt to the evolving political landscape. ## Challenges in Albania: Coastal Monitoring and Data Utilization Feedback from Albania highlighted several key challenges and lessons learned. Variations in the Adriatic and Ionian Seas are influenced by both geographical features and human activities, with the Adriatic Sea's coastal zone being particularly susceptible to abnormalities due to higher levels of human activity and intensive tourism. The need for on-site monitoring data was emphasized, as EO data and the developed product serve as valuable sources of information. These tools can guide the National Environmental Agency in designing specific monitoring programs for sensitive areas or regions where abnormalities are more frequent or extreme. Additionally, the dynamic development of coastal areas should be informed by scientific data to ensure that development projects are planned in ways that minimize negative impacts. Measures for water quality protection in marine areas, such as reducing marine pollution and eutrophication through river basin management action plans targeting the most polluted rivers, are essential for sustainable coastal development. ## Challenges in Tanzania: Water Quality Monitoring Timely and reliable water quality information is crucial for monitoring eutrophication and making informed decisions and policies on water quality. However, the lack of recent, high-quality ground truth data in key areas of Tanzania's waters has been a major setback. The most recent in situ data was collected in 2021, with the majority of data dating back to 2012-2013. This significant gap in data collection prevents meaningful comparisons and hinders effective decision-making. Additionally, the current in situ water quality measurements do not cover most of Tanzania's extensive coastline, limiting data coverage to just a few areas. Expanding data collection by exploiting EO data along the entire coastline is essential for more informed decision-making and stronger environmental management. ## Integration of Processor and Processing Campaign The integration of the processor and the processing campaign were not complicated due to the exploitation of mature solutions like Insula. This facilitated a smooth and efficient implementation process, allowing the project to leverage existing, proven technologies. As a lesson learned, we recommend the future exploitation of such mature solutions to streamline project execution and enhance overall efficiency. This approach not only reduces complexity but also ensures reliability and scalability in processing EO data.
Supporting material about this use case. ***(include links, publications, etc.)***	The following abstracts have been submitted for LPS 2025: - F.04.07 Earth Observation for Tracking Global Sustainability and Biodiversity Targets: "*EU-Mon: Scalable national solutions for coastal eutrophication monitoring (SDG 14.1.1a), serving*

	Statistical Offices and beyond" Di Lauro, Ceriola, Cotrufo, Drimaco, Marin, Di Rienzo. - D.04.05 "*From the Research Lab to a Global Map: Scalable and Sustainable EO Algorithm Development and Workflows: Leveraging Insula for Advanced Eutrophication Monitoring in Albania and Tanzania*", Marin, Di Rienzo, Di Lauro, Ceriola.
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