Essential Variables workflows for resource efficiency and environmental management

Deliverable 8.3

Dissemination Toolkit
from EVs services and GEOEssential dashboard

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GEOEssential website (www.geoessential.eu)

The first entry point to learn about the GEOEssential project is its website (Figure 1).

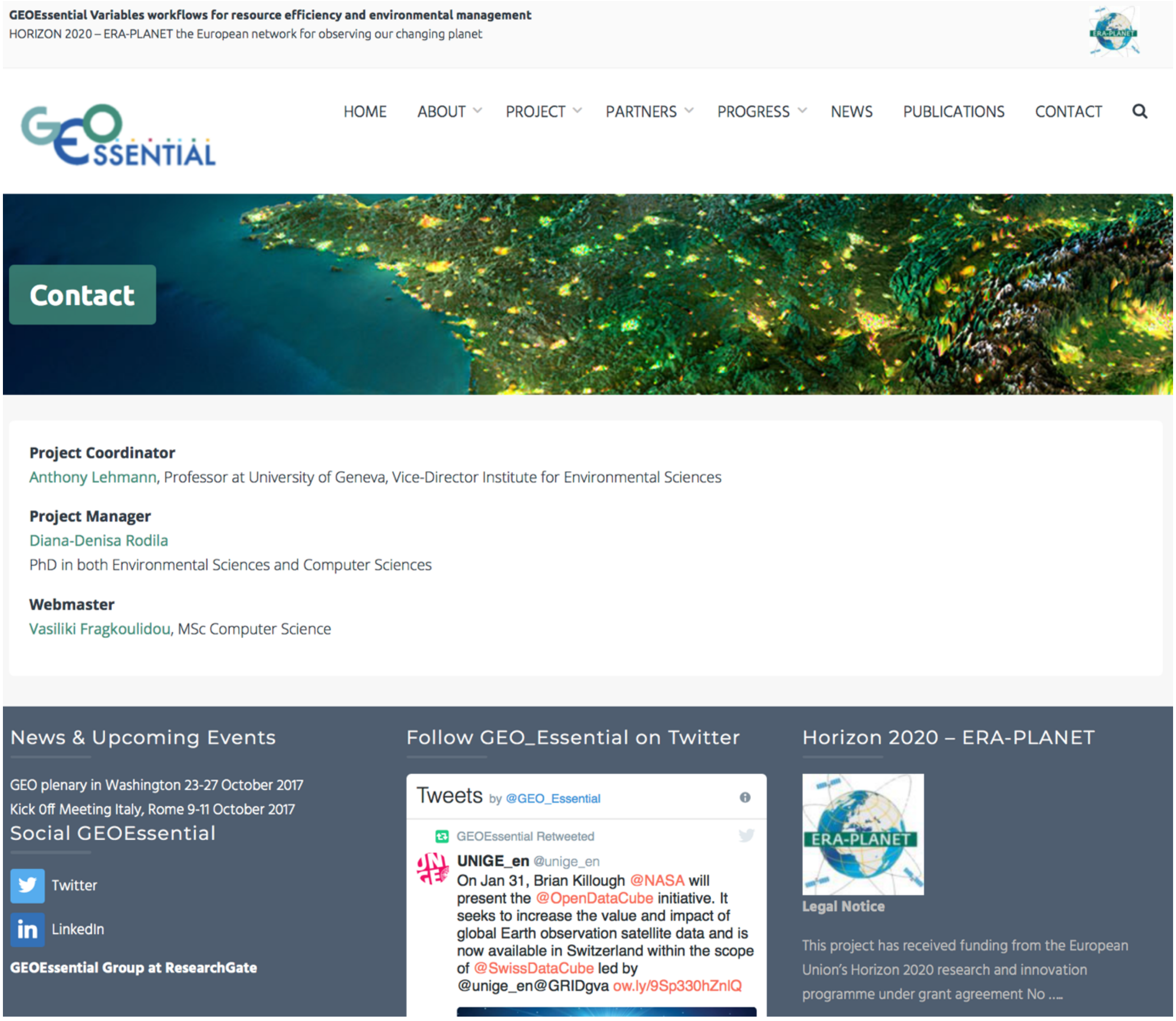

Figure 1 GEOEssential website

GEOEssential flyer

A newly created flyer is now available to distribute during conference and ERA-PLANET events (Figure 2).

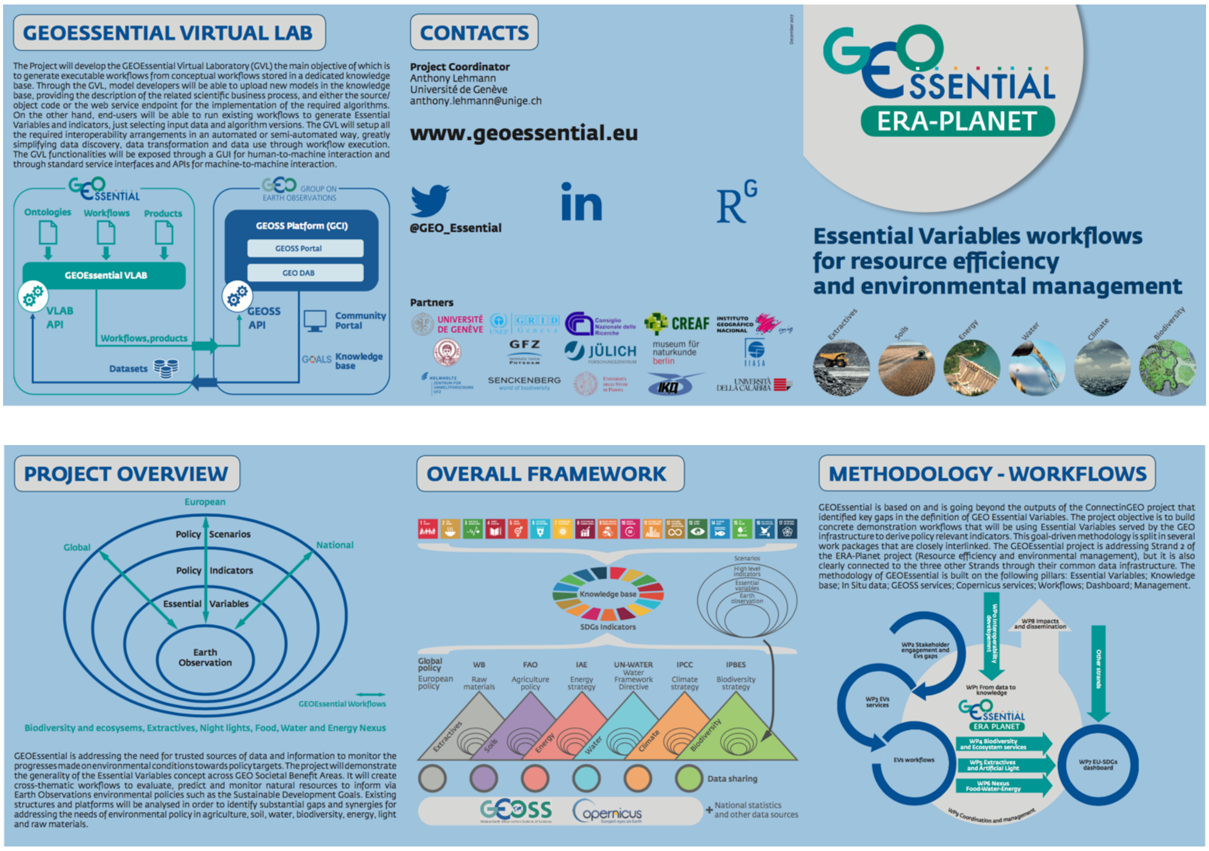

Figure 2 GEOEssential flyer

The GEOEssential flyer is ideally complemented by the following set of two-pages describing the main phases of the GEOEssential project :

A) GEOEssential framework;
B) Stakeholder engagement and gaps in Essential Variables;
C) GEOSS and Copernicus EVs services;
D) EVs workflows; and
E) GEOEssential Dashboard: From EVs to Policy Goals (SDGs).

A) GEOEssential framework

The temptation is great, when defining SDGs or other integrated environmental indicators, to reinvent the wheel instead of using existing initiatives and data available for instance through the Global Earth Observation System of Systems (GEOSS) or Copernicus services. From an Information, Communication and Technology perspective, data interoperability and standardization is critical to improve data access and exchange. Efforts are being made to monitor the state of the environment with Essential Variables (EVs), for instance in the area of biodiversity, water, and climate. EVs are defined by ConnectinGEO as "a minimal set of variables that determine the system's state and developments, are crucial for predicting system evolution, and allow to define metrics that measure the trajectory of the system".

Other sources of information than remote-sensing are used. This includes the aggregation of national statistics, including the EU statistical agencies (Eurostat), and efforts from other scientific communities and data mediators. For example, in the biological domain, the Global Biodiversity Information Facility (GBIF), Catalogue of Life (CoL), the International Nucleotide Sequence Database Collaboration (INSDC) and others. All these examples demonstrate the importance of ICT solutions and requisite data interoperability. It highlights the critical importance for integrated environmental policies (e.g. SDGs, IPBES) to be linked conceptually, operationally and institutionally to already ongoing efforts. The project goes beyond sectorial approaches and identifies the cross-thematic EVs for process analysis. It addresses the Food-Water-Energy Nexus for sustainable and efficient resource management by integrated EO data and products (Figure 1).

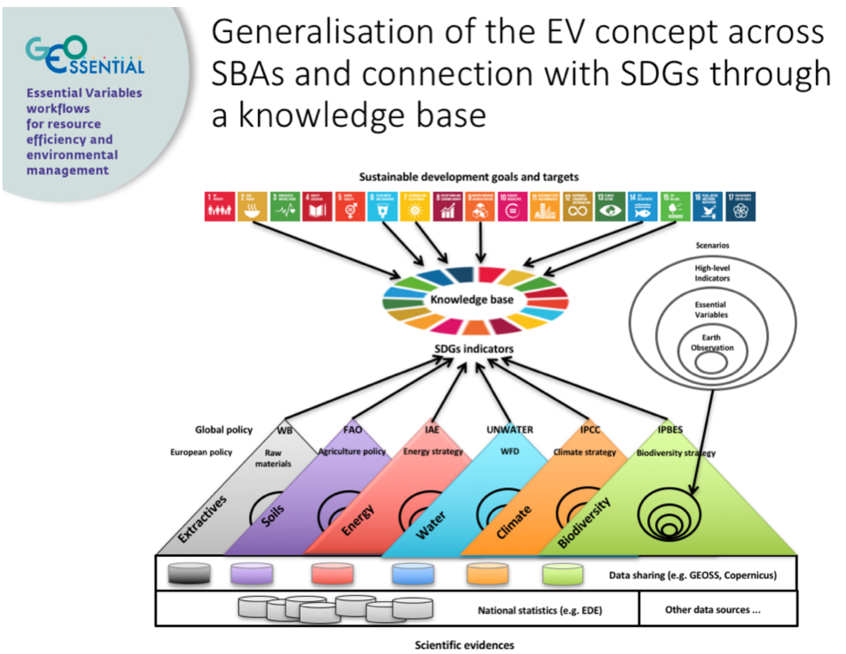

Figure 3 GEOEssential general framework

New satellite sensors, data handling capabilities, image analysis techniques, and free access to large and expanding data repositories (e.g. GEOSS) are greatly improving the opportunities to monitor environmental changes. Timely assessment of such changes is essential for good decision-making and effective management of natural resources.

Objectives

The project aims at demonstrating the feasibility and generality of the concept of Essential Variables across the Nexus of GEOSS Societal Benefit Areas (SBAs) by working on:

- Sustainable and trustable sources of data and information to monitor the progresses made on environmental conditions;
- Cross-thematic workflows and knowledge base to evaluate, predict and monitor Sustainable Development Goals (SDGs); and
- Gaps and synergies for addressing the needs of environmental policy in the nexus of agriculture, soil, water, biodiversity, energy, light, and raw materials.

Main steps

- Finalize the EVs gap analysis started in the ConnectinGEO project;
- Identify and/or create EVs data web services for a maximum of variables;
- Create complete EVs workflows based on a Knowledge Base linking Earth Observation and EVs/SDGs to policy indicators and data providers; and
- Present the resulting EVs and Indicators relation in the GEOEssential Dashboard.

Expected outputs

The main expected outputs of GEOEssential are described in the following sections and the website (Figure 2). GEOEssential transforms EVs into the derived products for which users have identified a specific need. Furthermore, it provides an interactive visualization capability that allows the user to explore the data, for example by displaying trends, and thus facilitates understanding of the data significance, in particular for monitoring the progress towards policies such as SDGs, IPBES, IPCC, EU policies, or national policies.

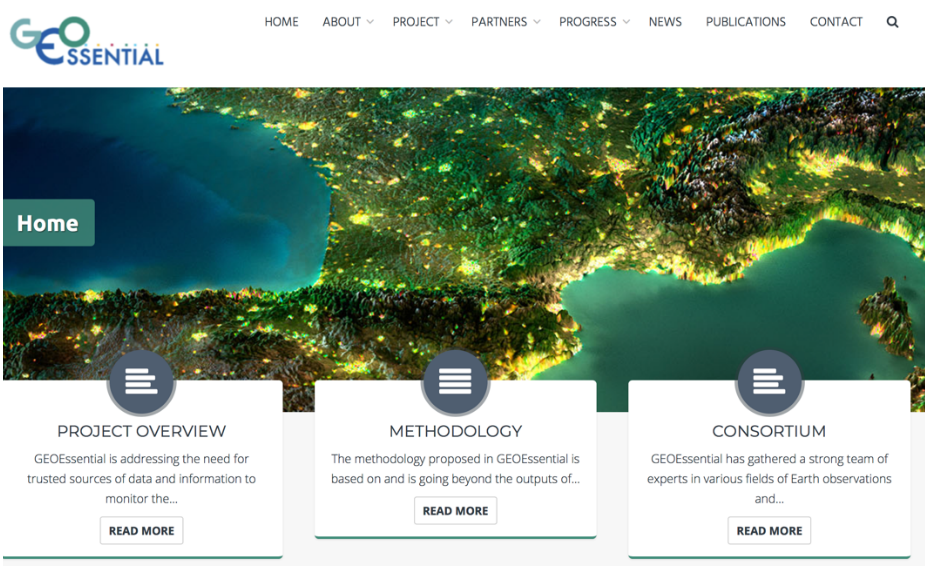

Figure 4 GEOEssential web site (www.geoessential.eu)

B) Stakeholder engagement and gaps in Essential Variables

GEOESSENTIAL
Essential Variables workflows for resource efficiency and environmental management

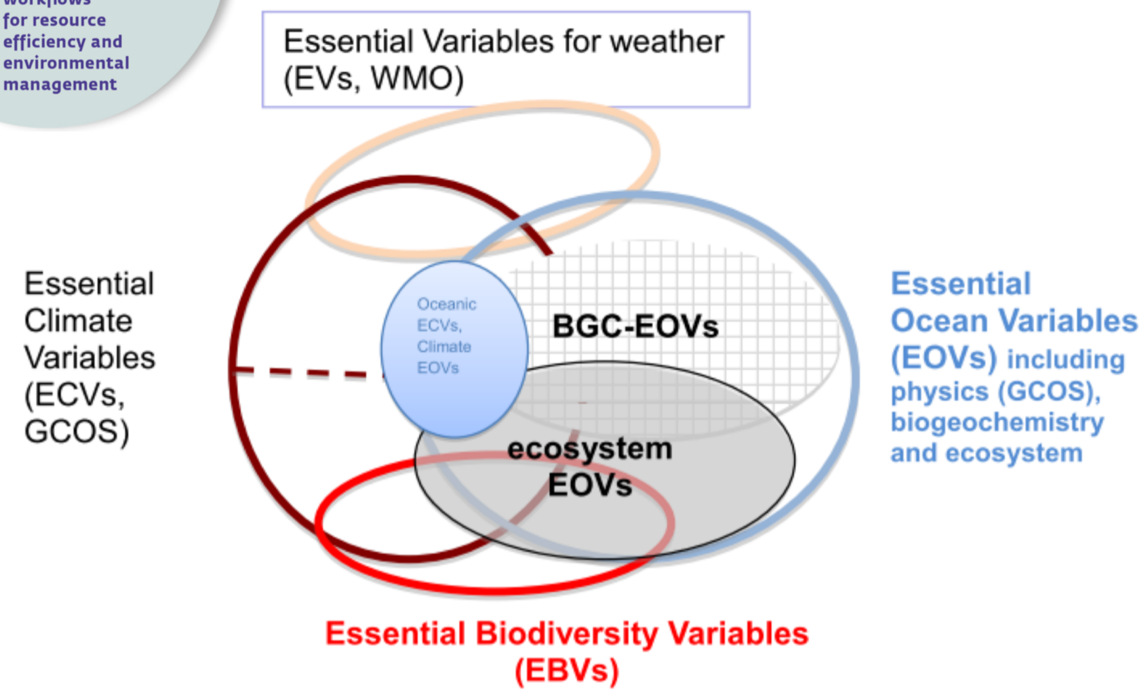

Figure 5 EVs status across different Societal benefit areas (www.connectingeo.net)

The methodology proposed in GEOEssential is going beyond the outputs of the ConnectinGEO project (www.connectingeo.net) that identified key gaps in the definition of GEO EVs (Figure 5). A clear demonstration of their implementations and their extensions to other SBAs will be performed trough GEOEssential. Furthermore, the identification of inherent cross-thematic EVs are still missing.

Objectives

- Address identified gaps in the definition and selection of EVs linked to the above-mentioned SBAs in collaboration with the respective Communities of Practice, stakeholders and identified users (both intermediate and final); and
- Demonstrate the link from EV to SDG indicators and derive the existing gaps.

Main steps

The GEOEssential dashboard will link EV to SDG indicators, and then to environmental policies and data providers (in-situ networks and air-bone/satellite imagery) by extending the ENEON graph implemented on ConnectinGEO (Figure 6). In that previous effort, all existing European networks on in-situ EO were mapped in a triplet dynamic graph built on a JSON document. Each network was described as well in terms of scope, SBA, domain, funding, etc. This work still needs to be perfected and will be continued through GEOEssential.

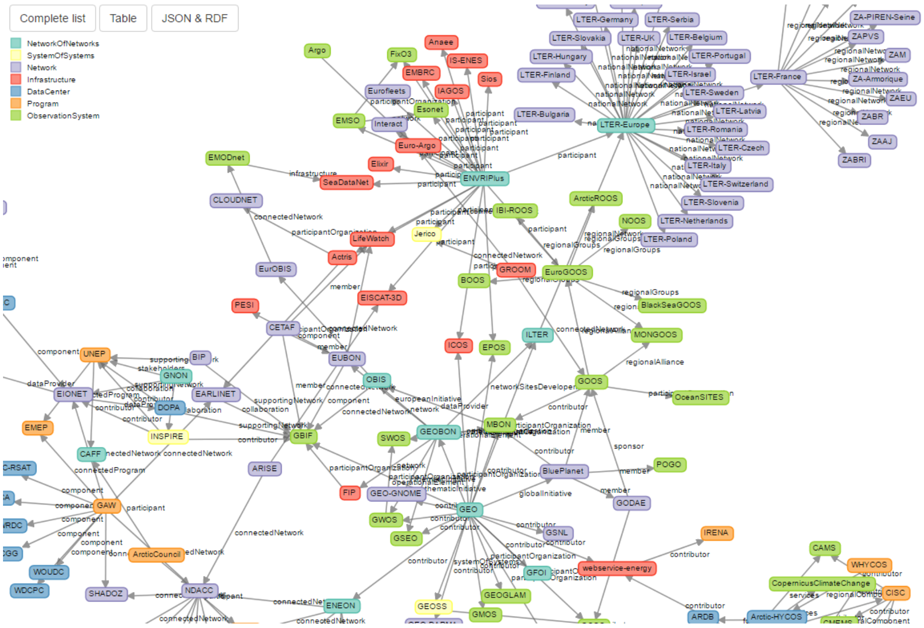

Figure 6. ENEON graph on European in-situ EO networks (www.eneon.net/graph)

But the main improvement within the GEOEssential dashboard will be, as a first step, the link of each network identified in the graph to the EVs they are potentially providing. In a second step, each EV will be related to an SDG indicator so that direct ways to retrieve and monitor SDG can be obtained. This will create an “EV-SDG knowledge base” that will feed the GEO Knowledge Base and the GEOEssential dashboard. As a third step, each EV/SDGs will be linked to environmental policies and data (air-borne and in-situ) providers to complete the whole chain in the environmental monitoring.

To achieve all this, a preliminary work has to be done in analyzing the existing EVs for current domains and suggesting cross-domain ones, or even new ones in case they are needed.

Expected outputs

- A complete list of existing EVs and a proposal for new EVs in those domains where there’s a lack of them. When possible, cross-domain EVs will be favored instead of creating new ones. This work will start from ConnectinGEO results and other previous work done by GEOEssential partners.
- A more comprehensive and complete status on the European in-situ EO networks shown in the ENEON graph.
- A proposal linkage between networks and EVs as potentially EVs data providers.
- A proposal linkage between EVs and SDG indicators.
- A proposal linkage between EVs/SDGs and environmental policies.
- An EVs-SDG Knowledge Base that will connect SDG indicators to possible EVs to monitor them. EVs/SDGs will be linked to existing networks to provide the data to evaluate them and to environmental policies creating a complete Knowledge Base on environmental monitoring and policy management. Beyond just simplifying access to existing EVs, the dashboard transforms these existing EVs into the derived products.

C) GEOSS and Copernicus EVs services

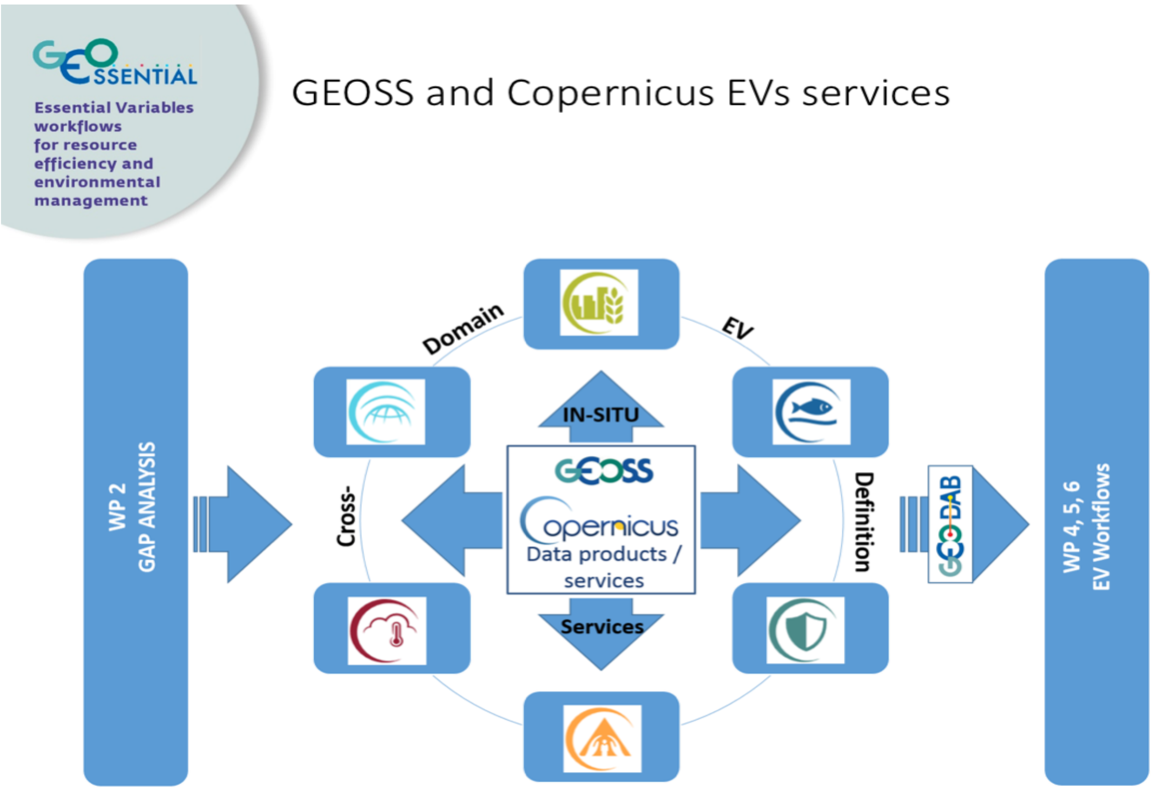

Figure 7 GEOEssential EVs services

Online services and platforms are essential for an efficient use and further acceptance of remote sensing based EVs service products across disciplines and use cases. Currently the situation surrounding Copernicus data services and EVs service products is not widely known. Different European countries are currently working on national service platforms (e.g. EODC) for providing service products that are also partly focussing on EVs. Furthermore, numerous European and global level developments are in progress or have been planned.

Objectives

- Improve the availability of EVs services from GEOSS and Copernicus platforms;
- Definition of cross-domain EVs for services and modelling;
- Assess the potential of synergies between ground (in situ, citizen science, national monitoring, etc.) and satellite observations for calibration, validation, data integration, and quality check; and
- Evaluation of different data tools and platforms for accessing recently processed and upcoming Copernicus data and contributing missions.

Main steps

First, GEOSS, Copernicus and TEP data products and services will be analysed against defined targets and needs for e.g. Aichi Biodiversity Targets, FAO Essential Climate Variables (ECVs), and Global Climate Observing System (Figure 7). Gaps and limitation for the use of remote sensing based products to develop indicators for that platform will be analysed based on the

GEOEssential EVs gap analysis. Potential parameters that will be checked for their availability as EVs are for example soil moisture, soil organic matter or vegetation heterogeneity for biodiversity assessment.

Secondly, GEOEssential will furthermore identify benefits arising when using EO data beyond domain boundaries. The cross-domain analyses of data and the identification of new processes as well as the extraction of information will become an important issue in the future. In particular, the derivation of inherent cross-domain EVs gathered from the combination of different data sources will be defined for services and modelling and therefore the assessment of the GEOSS SBAs. EVs will be analysed for cross domain usability (e.g. GEOGLAM, GEOBON, GFOI) for different spatial and temporal scales. High quality remote sensing based EVs retrieval requires a validation of the retrieved products.

Thirdly, existing in-situ observation standards for validation of EO based products, including data quality standards such as ISO 19157, UncertML and QualityML, need to be implemented into data acquisition and processing. This is not a standard nowadays. Strategies will be defined on how to deal with different existing standards, and on how to use these data jointly for specific EV validation. If the gap analysis shows missing standards for specific parameters, GEOEssential will propose solutions for that. The aim is to connect in-situ measurements with space borne observations, with a focus on hydrological parameters (e.g. evapotranspiration, soil moisture, groundwater levels, biogeochemical parameters of inland surface water bodies), soil and vegetation parameters (e.g. soil organic matter, soil moisture, plant water content, chlorophyll content, vegetation cover, vegetation type), and biodiversity indicators (e.g. vegetation heterogeneity). ENEON-based in situ networks will be considered for test and evaluation of in-situ observation standards, and could serve as a platform for validation of EO-based products. The project will work closely with representatives of the JECAM, GEOBON, and GFOI sites to analyse, improve or define new protocols for validation of EO-based products. Also, current protocols and best practices available through the CEOS Cal/Val will be heavily utilized in the project.

Finally, the project considers the access to Copernicus processed-data in general (Sentinel + in-situ). Therefore, the status of European and national platforms for processing and providing Sentinel data will be analysed. GEOEssential will investigate the documentation, the algorithm applied, the data terms and conditions for use and access, potential cloud processing capabilities, and the implementation of algorithms for product generation.

Expected outputs

- GAP analysis report of products services and platforms;
- Report for cross-domain EV development;
- Strategy paper for improving RS and in-situ data combination for EO based products and services including standards; and
- Status report of European data processing tools and platforms and future developments.

D) EVs workflows

To facilitate the implementation of SDG agenda, there is a clear need to move from Data to Knowledge Management. This entails the management of knowledge bodies like processing algorithms, scientific models, and workflows. In particular, workflows are playing an essential role to support EVs generation and use. Besides, to run workflows and generate advanced products (including EVs), Data resources management is essential –e.g. discoverability, access, transformation, and use. GEOSS Platform (and in particular the GEO DAB functionalities) will serve this purpose.

The scientific business processes for the generation of EVs and related indicators can be formalized in workflows specifying the necessary logical steps. As high-level representations of scientific business processes, such workflow descriptions are extremely valuable artifacts to be stored in a knowledge base for communicating a knowledge generation process. However, they are not usable for the concrete generation of information. The transformation of the conceptual workflow into an executable workflow requires adding the necessary low-level technical details, such as the software code implementing the required algorithms, or the data transformation and adaptation.

To this aim, GEOEssential will develop a GEOEssential Virtual Laboratory (GVL) the main objective of which is to generate executable workflows from conceptual workflows stored in a dedicated knowledge base (Figure 9). Through the GVL, model developers will be able to upload new models in the knowledge base, providing the description of the related scientific business process, and either the source/object code or the web service endpoint for the implementation of the required algorithms. On the other hand, end-users will be able to run existing workflows to generate EVs and indicators, just selecting input data and algorithm versions. The GVL will setup all the required interoperability arrangements in an automated or semi-automated way, greatly simplifying data discovery, data transformation and data use through workflow execution. The GVL functionalities will be exposed through a GUI for human-to-machine interaction and through standard service interfaces and APIs for machine-to-machine interaction.

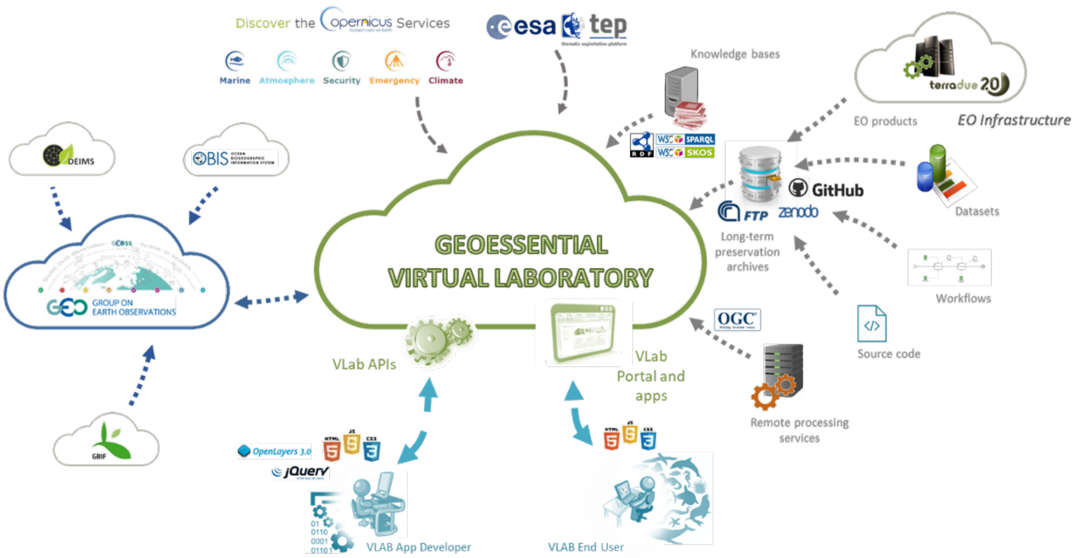

Figure 8 General architecture of the GEOEssential Virtual Laboratory

The GVL will be based on previous experiences carried out in the context of GEO-related projects and initiatives. Of course, it will provide a two-way interoperability with the GEOSS Platform, accessing GEOSS datasets on one side, and providing data, products and workflow description to GEOSS (Figure 9).

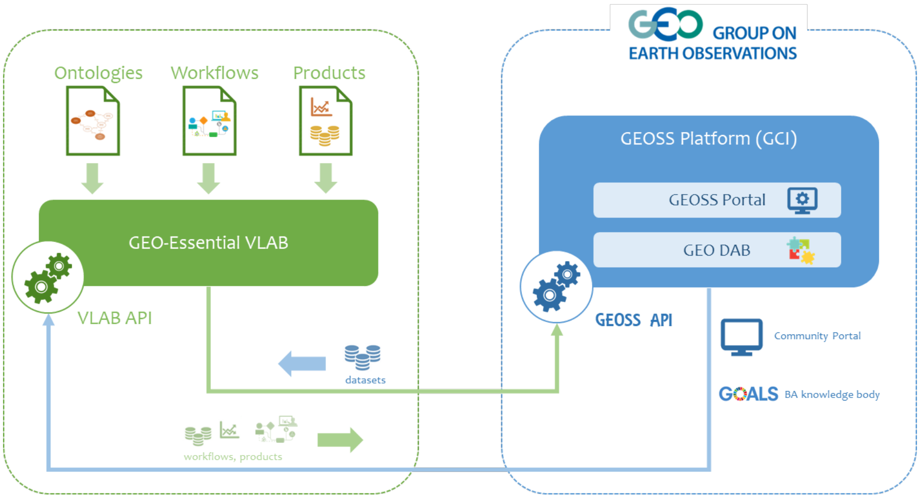

Figure 9 Interoperability of the GEOEssential Virtual laboratory and the GEOSS Platform

Objectives

- Develop specific data workflows for the generation of EVs from data (data → information) and indicators from EVs (Information → Knowledge);
- Setup a knowledge base of scientific business processes (workflows) for the generation of EVs and indicators;
- Setup a GEOEssential Virtual Laboratory for workflow generation and execution;
- Assure the interoperability of the GEOEssential Virtual Laboratory with GEOSS; and
- Contribute to extend the GEOSS platform capabilities, reusing the GCI DATA management services.

Main steps

- Setup of the GEOEssential Virtual Laboratory Platform, based on previous experience in GEO-related projects and initiatives (namely H2020 ECOPOTENTIAL, H2020 EDGE);
- Integration of the GEOEssential Virtual Laboratory Platform and the GEOEssential Dashboard;
- Development of workflows for the generation of EVs and indicators; and
- Interoperability tests with the GEOSS Platform.

Expected outputs

- GEOEssential Virtual Laboratory Platform allowing: a) upload of new workflows by model developers; b) running existing workflows by end-users;
- Accessibility of the GVL through a dedicated GUI integrated in the GEOEssential Dashboard;
- Accessibility of the GVL functionalities through standard service interfaces and dedicated APIs; and
- Full interoperability with the GEOSS Platform.

E) GEOEssential Dashboard: From EVs to Policy Goals (SDGs)

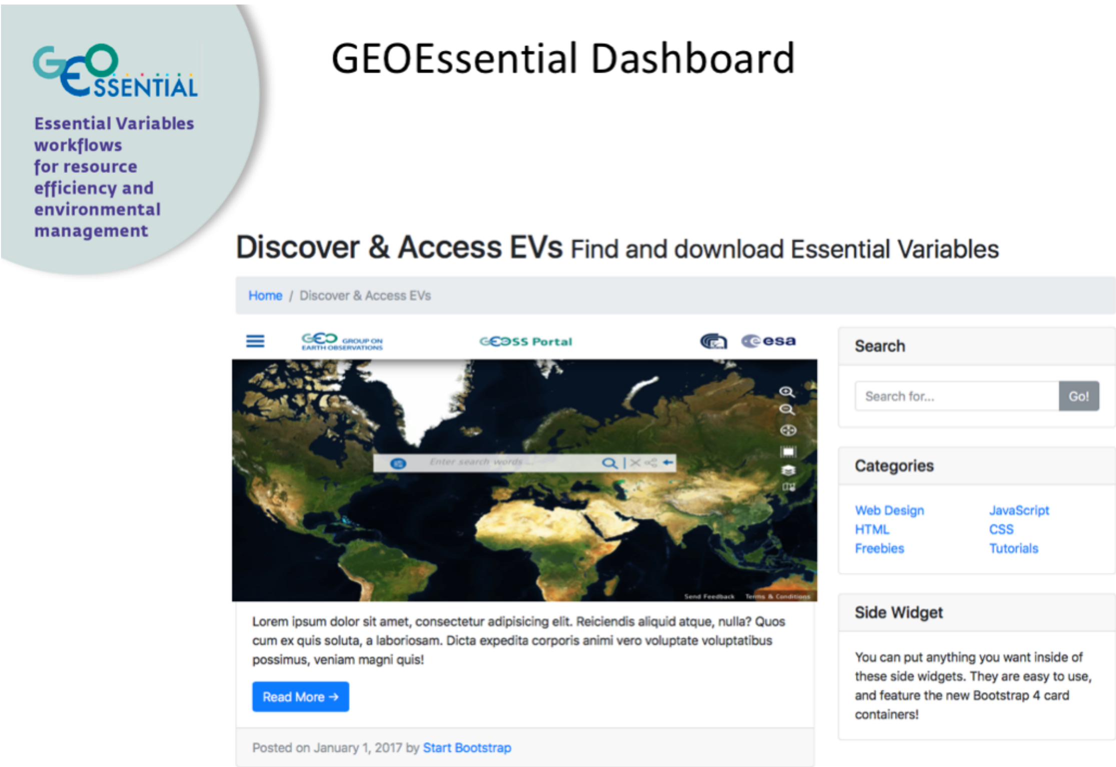

Figure 10 GEOEssential dashboard

The GEOEssential Dashboard will be the visual front-end, exposing the major outputs/results of the different thematic workflows on biodiversity, ecosystems, extractives, night light, and the food-water-energy nexus, while using the GEOSS platform capacities (Figure 10).

Through a set of dedicated modules, it will allow users to:

(1) discover and access various Essential Variables;
(2) track progresses towards SDGs using official UN statistics;
(3) compute a selection of SDG indicators using Earth Observations data; and
(4) explore different pilots' studies related to SDG monitoring using EO data (e.g. Data Cubes, ECV and EBV monitoring).

The GEOEssential Dashboard will use as much as possible the GEOSS platform tools such as the GEOSS API, GEOSS View, GEOSS Mirror and GEOSS Widget.

GEOEssential Dashboard will demonstrate the data value chain from EVs to indicators (e.g., SDG). The Dashboard will be a generic (i.e., applicable to other indicators), replicable (i.e., expandable to other contexts), and scalable (i.e., national to regional to global) open web-based platform automating the transformation of Earth Observation data into indicators (as graphs or/and maps) through EVs. This will show that EO, when matched with appropriate tools and services, can contribute filling the gap between science and policy for decisions, management and reporting (Figure 11).

Objectives

- Build the GEOEssential EVs Hub with a dashboard from EVs to SDGs making use of the developed workflows; and
- Simplify and promote the use of EVs across the EO Communities of Practice and beyond.

Main steps

- Determination of candidate EVs and workflows to be implemented;
- Determination of the technical solutions to implement the workflows (e.g., GEOSS platform tools), use the content of GEOSS (e.g., discovering and access data), and compute/generate information products;
- Implementation of the thematic workflows; and
- Implementation of the web-based visual interface (the GEOEssential Dashboard).
- Refinement and improvement following different users' feedbacks.

Expected outputs

- A portal component to discover and access Essential Variables;
- An indicator toolbox that makes use of EVs and the Knowledge base to generate different indicators;
- Thematic workflows on biodiversity, extractives, night lights, food-water-energy nexus to demonstrate the data value chain from EVs to indicators;
- Pilots studies using different technologies like Data Cubes to generate indicators; and
- A dedicated platform to integrate all the previously mentioned component.

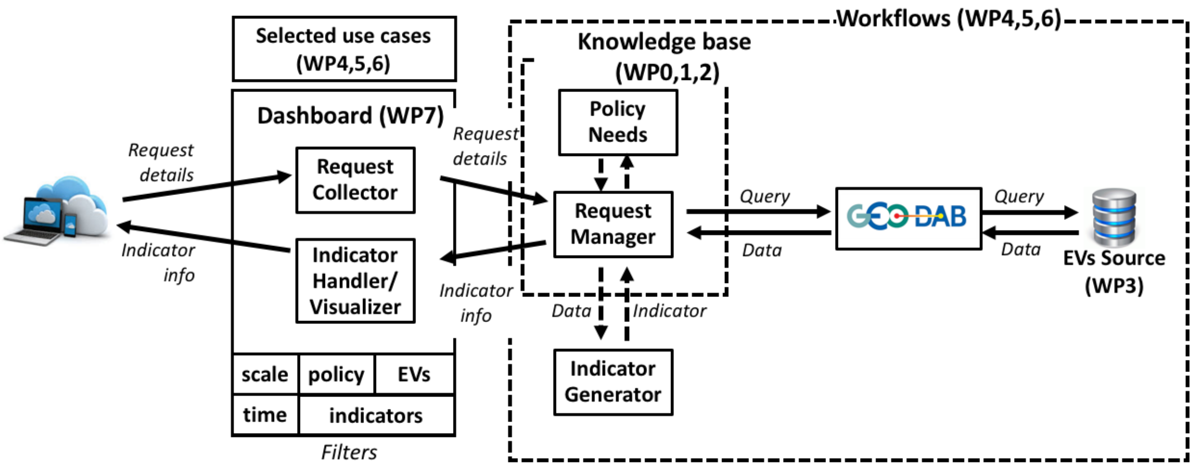

Figure 11 GEOEssential architecture and flow of requests