GEOSS Platform Plus

Enhanced GEOSS Platform v2 with 2nd set of applications

Workpackage:	WP3	GEOSS Evolution design, development, integration and deployment	
Task:	T3.4		
Author(s):	GPP Team		
Authorized by	Joost van Bemmelen		ESA
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Abstract:

This document describes the evolved GEOSS Platform and its technical implementation. It describes the GEOSS Portal, Yellow Pages', GEO DAB and other middleware enhancements as resulting from GPP Task T3.4 (*GEOSS Platform Integration and Deployment*), as well as the second set of applications output of GPP Task T3.5 (*Application Design, Development and Deployment*) during the second project cycle. This technical note is providing an overview of the identified applications and the developed evolutions, in particular, will clarify which services/applications/ functionalities are integrated and which data is made accessible.

Document Log

Date	Author	Changes w.r.t. D3.1	Version	Status
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Executive Summary

This document (*D3.4, Enhanced GEOSS Platform v2 with 2nd set of applications*), provides an architectural overview and describes the enhancements identified from the analyses of applications identified in the second project cycle and recognised (and documented as requirements) in the context of WP2, *Use cases definition and user requirements specification v2 [RD-5].* The identified Scenarios (that are based on applications) aim at demonstrating how communities can benefit from the use of the GEOSS Platform ecosystem and how they can contribute to the evolution of GEOSS, and in particular how the wider GEOSS infrastructure contributes with actionable information derived by the use of the applications.

Applications are the bridge between data available in GEOSS and the usage of them. The adopted community driven approach drives the new architecture proposal of the GEOSS infrastructure at large and in particular of the GEOSS Platform capabilities by identifying the main evolutions within the GEOSS Ecosystems.

For this reason, the GEOSS Platform Plus project is focused on the application needs coming from the GEO Communities. The applications highlight what the Global Earth Observation System of Systems (GEOSS) should address and how the GEOSS Platform can evolve as means of implementation of GEOSS and thus how it should evolve to fulfil communities' needs and enforce data usage for generating actionable information. In the first cycle analysis applications were based on Use Cases (see [RD-1]), and in the second cycle analysis the use cases and functional analyses described in [RD-5] and [RD-6] have been considered to identify a set of implementations that address both the GEOSS infrastructure, GEOSS Platform and middleware components.

The following developments have been implemented as GEOSS Platform enhancements and as middleware components enhancements to address the first and second cycle applications needs:

- 1st set of applications
  - AfriGEO Community Portal customisation
  - SDG 15.3.1 for the Land Degradation
  - Replicability, reproducibility and reusability support: VLAB
- 2nd set of applications
  - Community Portal Self Creation
  - The custom dashboard for reporting generation
  - SDG11.7: preparatory work for the use case
  - Eiffel Discovery Cognitive Search
  - Yellow Pages 2.0: development, testing and deployment in pre-production All Atlantic - Phase I
  - Nutrient Pollution in European Inland and Coastal Waters
  - Above-Ground Biomass (AGB) estimation using Machine Learning Techniques
  - Climate Change impact on Noravirus pandemic risk

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1. Introduction

1.1 Purpose and Scope

This document (*D3.4 - Enhanced GEOSS Platform with 2nd set of applications*) has been generated in the context of WP3 - GEOSS Evolution design, development, integration and deployment within the GPP (short for GEOSS Platform Plus) project, Grant Agreement no. 101039118.

The current document provides a technical description of the implemented enhancements in the first and in the second cycle of the GPP Project, in support of the applications requirements grouped within the high-level scenarios described in Table 1.

Scenarios ID	Scenarios	Addressed in Second cycle
S1	Resources discovery and access with linked information	Y
S2	Service Use	Y
S3	Resources Registration	Y
S4	Promotion and collaboration.	Y
S5	Data providers (registration)	Y
S6	Exploiting discovery and access capabilities	Y
S7	Discovering experiment results	Y
S8	Reproducing an experiment	Y
S9	Replicating an experiment	Y
S10	Reusing an experiment	Y

Table 1 Scenarios identified based on applications analysis.

The scenarios are identified in the context of WP2 and documented in[RD-6], and they highlight the need to better improve the usability of the GEOSS data. The use of data is a key driver for the future of GEOSS. To better identify how to use those data a user centric approach has been adopted in GPP by involving the GEO communities and identifying communities' driven applications to non-specialists in the domain of adaptation to extreme climatic events and to changes in climatic conditions. Another important aspect of the project is to enable the generation of actionable information and to fully exploit the GEOSS infrastructure and its components to the benefit of the users, to enable the connections with the data providers (including in-situ), which are relevant for the achievement of use cases, and to provide a user-friendly, up-to-date and therefore familiar environment, by making sure that the current trends in information technology are considered and exploited at maximum extent. The use of data is a key driver for the future of GEOSS. To better identify how to use those data a user centric approach has been adopted in GPP by involving the GEO communities and identifying communities' driven applications to non-specialists in the domain of adaptation to extreme climatic events and to changes in climatic conditions. Another important aspect of the project is to enable the generation of actionable information and to fully exploit the GEOSS infrastructure and its components to the benefit of the users, to enable the connections with the data providers (including in-situ), which are relevant for the achievement of use cases, and to provide a user-friendly, up-to-date and therefore familiar environment, by making sure that the current trends in information technology are considered and exploited as necessary.

In the first implementation cycle the SDG 15.3.1 enhancements, the AfriGEO community portal implementation and an enhancement of VLAB as middleware component have been included, and a

variety of new data sources have been registered, harvested and made available via the GEOSS Platform, such as the interface with the Digital Earth Africa data cube catalogue.

In the second cycle implementation the following enhancements have been implemented: The Community Portal Self Creation, the custom dashboard for reporting generation, the SDG11.7 preparatory work for the use case, interfacing test of the Eiffel Discovery Cognitive Search, the Yellow Pages 2.0: development, testing and deployment in pre-production, the All Atlantic – Phase I and phase II suggestions to improve the usability of the portal, the Nutrient Pollution in European Inland and Coastal Waters, the Above-Ground Biomass (AGB) estimation using Machine Learning Techniques, and the Climate Change impact on Norovirus pandemic risk preparatory phase with generation of sample data.

1.2 Document Organisation

The document is organised as it follows:

- Section 1: Introduction. It describes the purpose and scope of the document and its organization.
- Section 2: Rationale and Context. It contextualizes the content of this document by providing background information and details on the operational landscape encompassing the GEOSS Platform.
- Section 3: Architecture. It describes the general architecture of the system.
- Section 4: The Enhancements. It is the hearth of the document where all the enhancements are described divided by the Project strategic lines.
- Section 5: Requirements traceability. It traces the WP2 User Requirements (functional and non-functional) to the implementation's tasks.
- Annex A. References. List the references used in the document.
- Annex B. Figures and Tables. It provides links to figures and tables in the document.
- Annexes C: The GEO DAB Standards
- Annex D: Terminology. It explains the meaning of the acronyms and definitions used in the document.

1.3 Changes to the previous version, enhancements

During the second application cycle, compared to the previous document GPP-WP3-DEL-D3.1-v1.0 "Enhanced GEOSS Platform with 1st set of applications", the following sections were updated:

Section	Descriptions
1	All Chapter 1 and its subparagraph have been modified
4.2.1.1	WORKFLOWS and NEW DATASETS Registration (completed all workflow and the results in the Dashboard)

the following sections have been added:

Section	Descriptions
4.1.2	Community Portal Self Creation
4.1.3	Eiffel Discovery Cognitive Search
4.1.4	Yellow Pages setup
4.2.3	SDG 15.3.1 End to End solution
4.2.4	Custom Dashboard feature

4.2.5	SDG11.7: preparatory work
4.2.6	Yellow Pages 2.0
4.2.7	All-Atlantic – Phase I
4.2.8	Nutrient Pollution in European Inland and Coastal Waters
4.2.9	Above-Ground Biomass (AGB) estimation using Machine Learning Techniques
4.2.10	Climate Change impact on Norovirus pandemic risk

2. Rationale and Context

2.1 Background and operational context

A central part of GEO's Mission is to build the Global Earth Observation System of Systems (GEOSS).

GEOSS is a social and software ecosystem sharing independent and open Earth observation (EO) information and processing services. It connects and coordinates a large array of observing systems, data systems and processing services to strengthen monitoring of the state of the Earth. It facilitates the sharing of environmental data and information collected by countries and organizations within GEO. GEOSS ensures that these data are accessible, of identified quality and provenance, and interoperable to support the development of tools and the delivery of information services. Thus, GEOSS increases our understanding of Earth processes and enhances predictive capabilities that underpin sound decision-making: it provides access to data, information and knowledge to a wide variety of users.

The GEOSS Platform has been created to provide the technological tool to implement GEOSS. The story of the Platform began in 2008, as Clearinghouse catalogue; in 2012 the platform evolved into a Brokering infrastructure with the inclusion of the GEO Discovery and Access Broker (GEO DAB). The first user interface, the GEOSS Portal was initially created in 2010 and in 2016 has seen great enhancements in terms of user experience and enhanced discovery, access and visualization functionalities. In 2017 the platform has evolved into the currently known GEOSS Platform (see Figure 1).

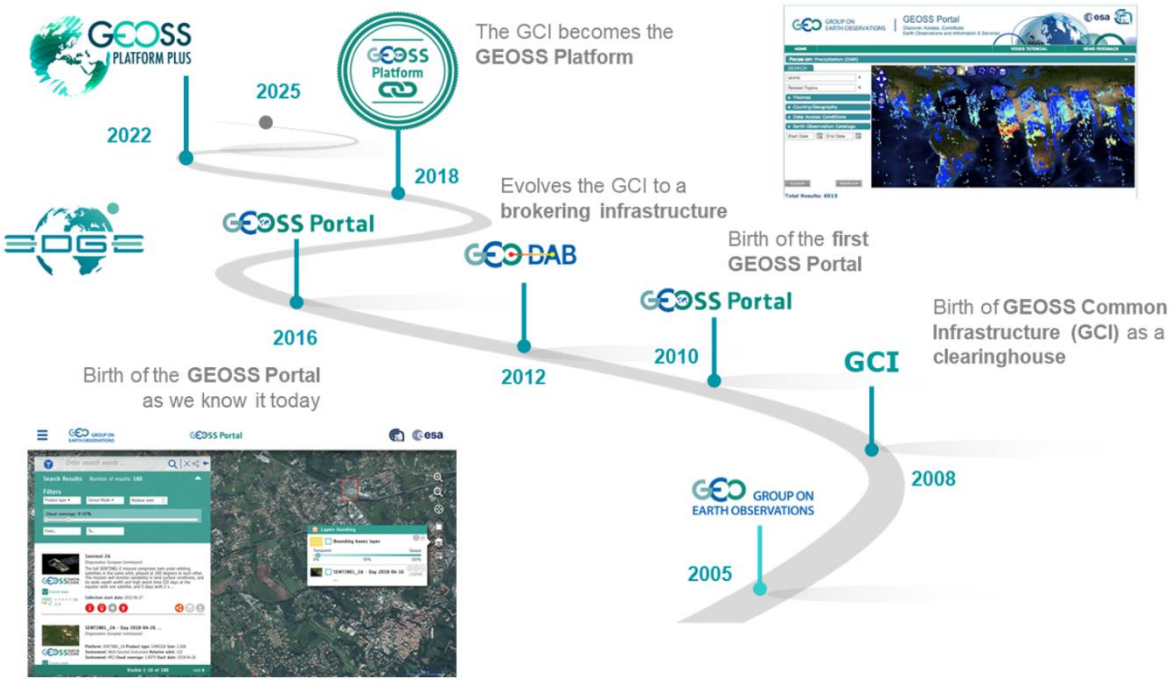

Figure 1 - The GEOSS Platform Journey

A first effort in demonstrating several proofs of concepts experimenting service execution with selection of public cloud-based analytical platforms (e.g. DIASs, AWS), navigation through linked

(context) information and dedicated customisation of community portals features have been implemented and experimented within a development platform in the framework of the EDGE (European Direction in GEOSS Common Infrastructure Enhancements) Project (for more details see [WR-1]).

Another EU effort in contributing to GEO is the GEOSS Platform Plus (GPP) Project with the aim to respond to the new challenges focused on the European Green Deal, implementation of the EU Strategy on adaptation to climate change and the outcomes of the Mid Term Review frameworks (see Figure 3) by developing new tools and functionalities to better address the user needs adopting an user centric approach by engaging User communities, GWP activities, initiatives and flagships and including European efforts in the Climate Change and green deal frameworks (see Figure 2 and Figure 3).

Figure 2 - GEOSS Platform Components

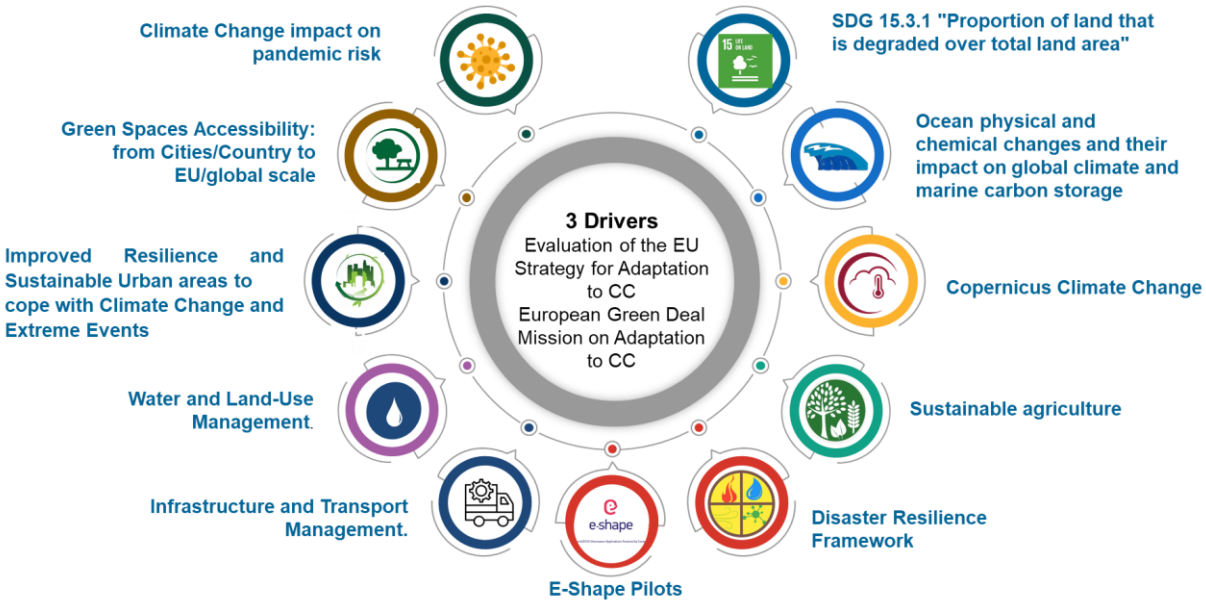

Figure 3 - The GPP Drivers and focus domains

Another objective of the GPP Project is to make the GEOSS Platform usable for a wide variety of users within the GEO communities and beyond it, that covers users coming from scientific communities to non-experts and decision makers. Figure 4 provides a representation of the type of users involved and the functionalities they are interested in when using the GEOSS Platform.

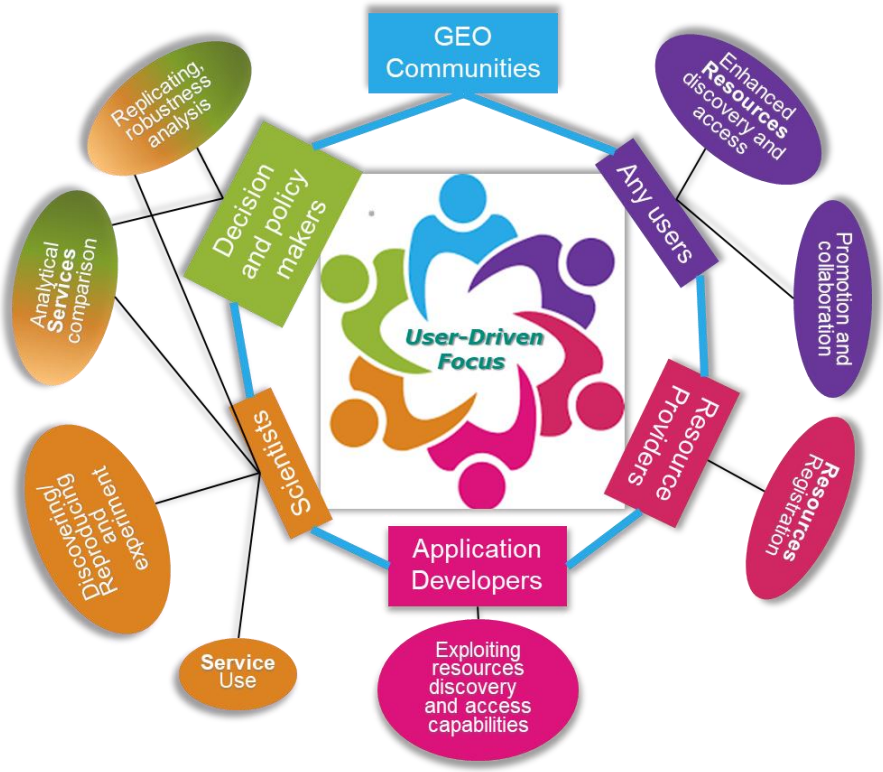

Figure 4 GPP User types and functionalities

2.2 Links with other project activities

GPP identifies five work packages as follows:

- WP1: Project management
- WP2: Use cases definition and user requirements specification
- WP3: GEOSS Evolution design, development, integration and deployment
- WP4: User validation and assessment
- WP5: Dissemination, training, exploitation and GEOSS Contribution

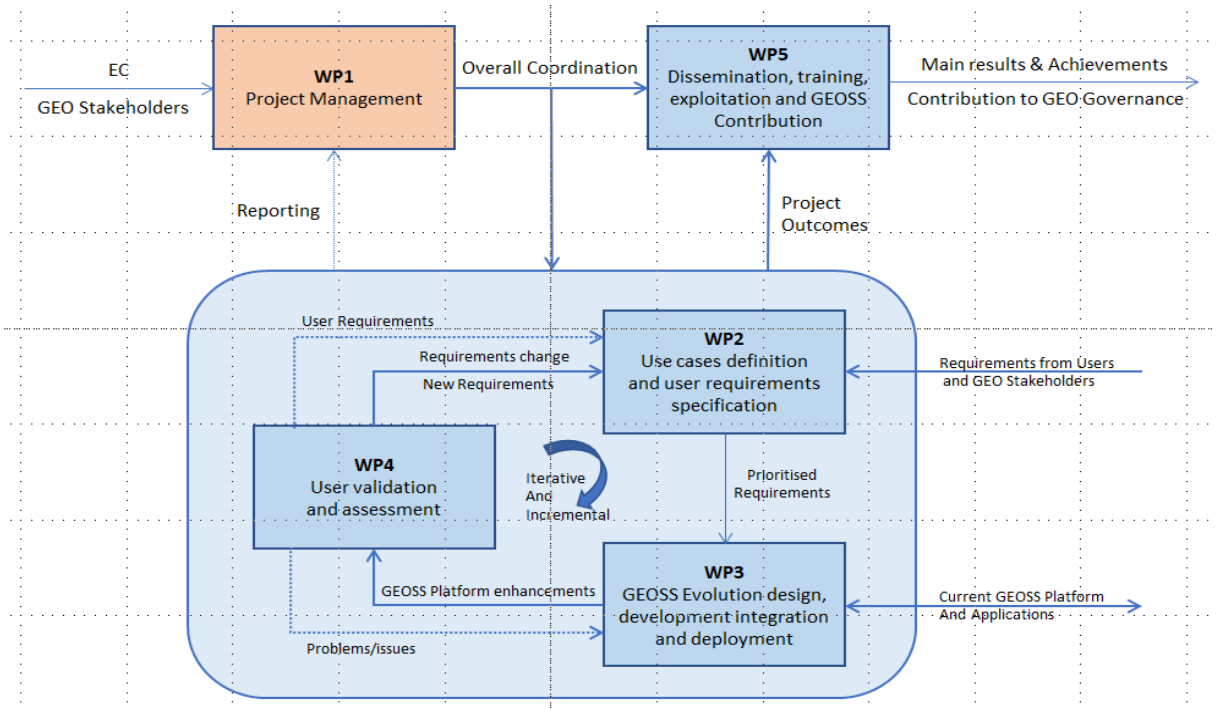

Figure 5 - GPP Work-packages and their relationships

Work-package 3 builds on prioritized GEOSS Platform requirements as input to the identification of enhancements, their implementation and definition of an integration and verification strategy. The output of WP3 is an enhanced GEOSS Platform. On top of the requirements resulting from WP2, current workpackage considers as well requirements and other inputs resulting from other (external activities).

3. Architecture

3.1 Architectural background and challenges for GEOSS

GEOSS has started evolving from a multi-functional system to a Web-based Ecosystem, where several (Web-based) components and technologies co-operate to deliver the services and products required by the GEO Community.

The GEOSS Platform is moving from a data to a knowledge platform providing users besides with the possibility to discover, inspect and access data as well with functionality to use data to derive actionable information and knowledge. Activities are on-going as well to discover, inspect, access and use information and knowledge via the Platform. Such developments are implemented via Platform Tools (or instruments), e.g. via specific Views and can be 'used' via APIs (directly interfacing on a Machine-to-Machine level with the GEO-DAB), via Widgets, or reuse components that are under development and can be integrated into community portals (GEOSS Like or external) in case of set-up for the relevant community(ies) and/or GEO Priority Area (e.g. for a specific SBA, Copernicus-service, ESA Thematic Exploitation Platform community, Sustainable Development Goal (SDG), Paris Agreement Targets, Sendai Framework, etc.).

Along this line, the next evolution should consider the inclusion in such an ecosystem of new components and/or instruments and/or applications (i.e. at infrastructures, platforms, middleware and applications layers) to enable communities to contribute to the evolution of the GEOSS ecosystem and to benefit users and communities using GEOSS by making the new enhancements discoverable, accessible and usable.

In the first project cycle the following challenges and solutions have been analysed and proposed:

- From data discovery and access only to discovery and access to services, information, knowledge, tools models and algorithms.
- Retrace the journey of experiments leading to results through resources links to enable Reproducibility, replicability, reusability and robustness analysis.
- Community Portals customisation freedom by developing an instrument that enable self-creation of community portals and views to foster a broader engagement of new communities and active contribution to GEOSS ecosystem.
- From obsolete discovery download process publish paradigm to Leveraging Cloud technologies supporting **multi-Cloud approach** for actionable information generation

The following figure shows the current relations and the main service components (i.e. infrastructures and platforms) to be considered as part of the landscape and it will be further evolved as output of the WP3 tasks in the deliverable [RD-4].

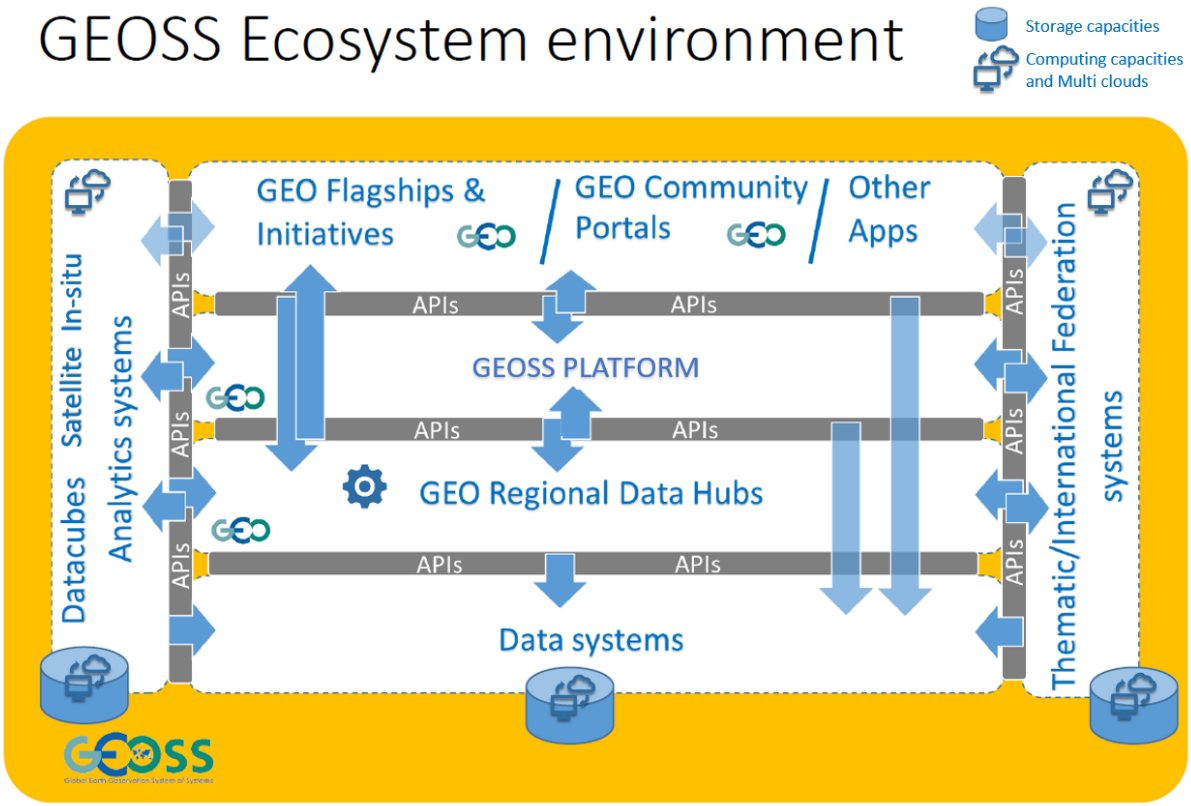

Figure 6 – Current GEOSS landscape for infrastructures and platforms to be considered.

3.2 The GEOSS Portal and GEO DAB architecture

Looking at the Figure 6, due to the multiple APIs and various knowledge perspectives, each component has to be based on a layered architecture. The GEOSS Portal internal architecture of the main component - which is a Single Page Application search part - has been furtherly decoupled to support interoperability even better. The main extracted components of the search are:

- Search Presentation layers – targeted search with various perspectives and various concept models:
  - GEOSS common search – opensearch based resource discovery/download/access;
  - thematic search – supported with internal domain model search in the thematically predefined subdomains;
  - Wikipedia search;
  - Knowledge producer search – supported with GEO-DAB ontology model search of resources and services registered on the DAB;
  - Geo-spatial data visualisation with WMS integration. OGC WMSes are presented based on DAB or Data Providers services.
- Catalogue discovery:
  - DAB opensearch client + CSW metadata explorer;
  - Http(s) portal client for Wikipedia;
  - CKAN catalog browser – under development.

- Domain browser (ontology browser) - intermediate layer that translates the knowledge concept on the resources level like:
    - Core search to opensearch or CKAN or SciHub or other catalogues;
    - SDG concept to DAB view concept;
    - Core search to Wikipedia resources.

The front-end side is supported with Liferay based content management with user workspace functionalities for registered users.

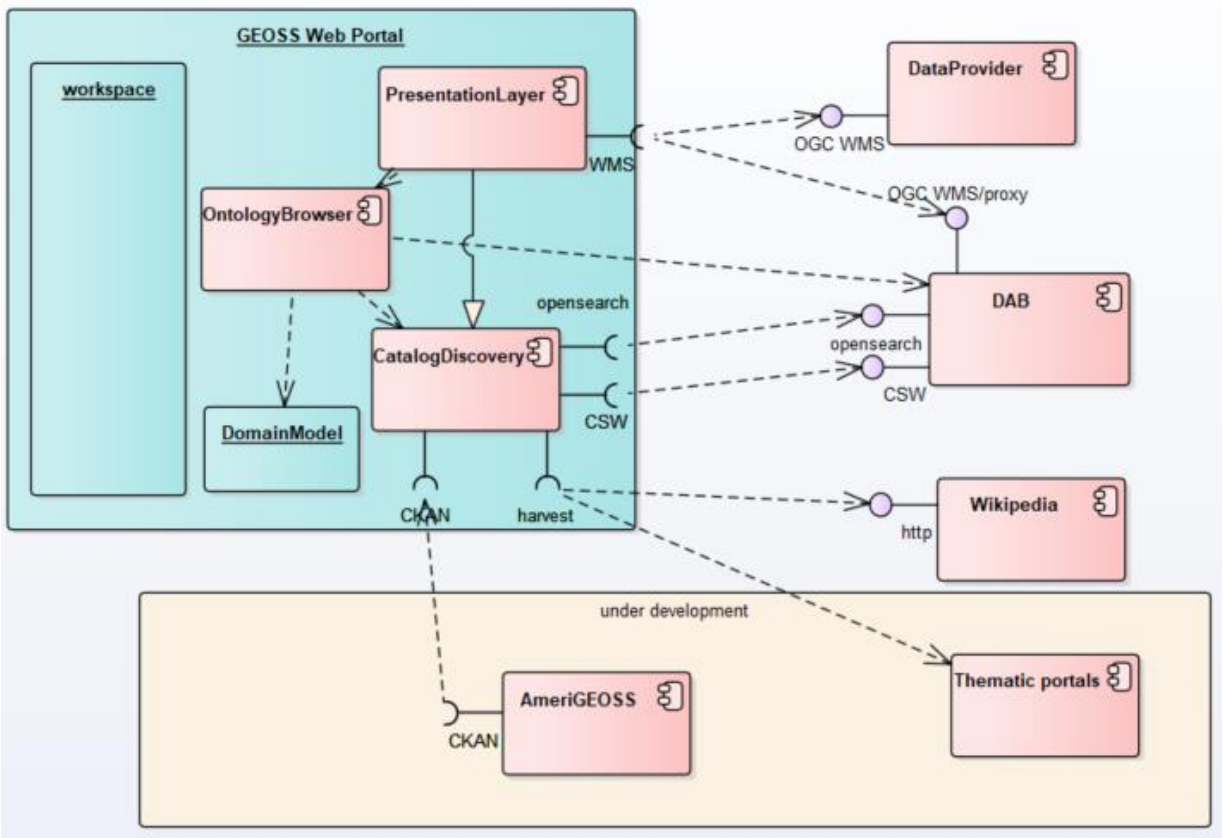

Figure 7 - GEOSS Portal and GEO-DAB Architectures

The GEO DAB transparently connects GEOSS Portal to the resources shared by the GEOSS Data provider. The main goal is to facilitate cross and multi-disciplinary discovery and access of disparate data and information interconnecting several hundreds of autonomous and heterogeneous Supply Systems. The GEO DAB applies the broker pattern, which separates users of services (GEOSS Client Applications) from providers of services (GEOSS Supply Systems). When a client needs a service, it queries a broker via a service interface. The broker then forwards the client's service request to a server, which processes the request. The GEO DAB presently provides broker components for discovery, access and semantics-enabled search.

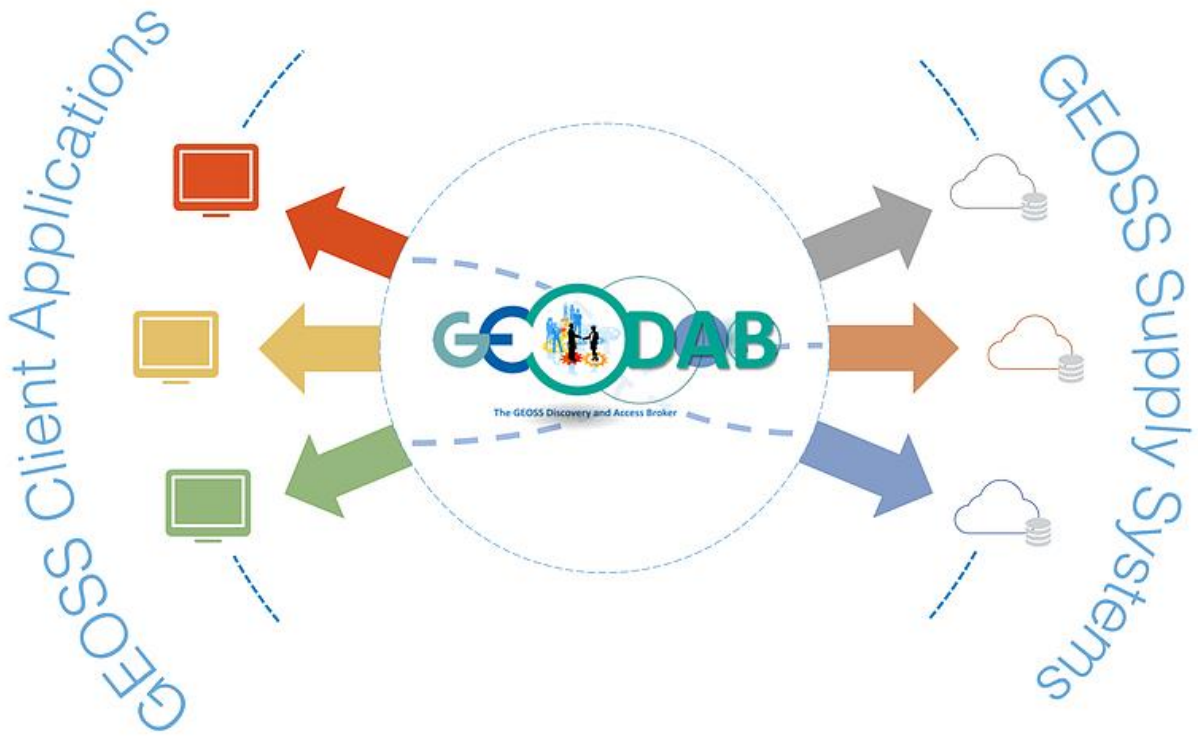

Figure 8 - GEOSS Portal and GEO-DAB interfaces

The main components of the layered architecture are:

- **Data Harmonization**: this layer provides harmonized discovery and access to heterogeneous data systems. The heterogeneity of data sources is hidden, resources appear as a single data source.
- **Data Access**: this layer provides data discovery and access functionalities to heterogeneous data systems.
- **Data Processing**: this layer enriches discovery and access with processing and semantics services.

4. The Enhancements

Strategic Actions lines are the high-level areas for which enhancements have been investigated. Within GPP the following strategic lines have been identified:

- Components-based: APIs, Views, Widgets, Customised GEOSS Portal, Middleware, GEOSS Infrastructure, GEOSS Platform components
- Community-driven: GEO Activities, Initiatives, Flagships and communities' portals, EU Projects, communities' applications
- Reusability, Reproducibility, Replicability: knowledge sharing, experiments replicability, reproducibility and reusability, actionable information generation.

Components-based enhancements refer to all those enhancements to components and/or tools (APIs, Views, Widgets etc) that are made necessary to address the applications needs and are being implemented to fulfil GEO users' requirements and use cases.

Community-driven enhancements refer to all those enhancements coming from the GEO communities (Activities, Initiatives, Flagships) and EU projects (EIFFEL, e-Shape) requirements that drive new evolutions of GEOSS, GEOSS Platform, applications and services and middleware components to support community's needs.

Reusability, Reproducibility and Replicability enhancements refer to all those enhancements that will drive GEOSS evolution in support the scientific paradigm for replicate, reproduce and reuse experiments and enable knowledge sharing capabilities within the GEOSS Platform and GEO Communities and to trigger the generation of actionable information.

In particular, for the first and second evolution cycles the following enhancements have been identified and implemented in GPP:

- Components-based
    - DAB enhancements: harvesting of new catalogues and resources, and the creation of a dedicated view for the AfriGEO Community Portal implementation.
    - Community Portal Self Creation tool
    - Custom Dashboard
    - Yellow Pages 2.0
- Community-driven
    - SDG 15.3.1 Land Degradation enhancements related to the possibility to exploit customisable AOI over Africa for the three mandatory resources: Land cover, Productivity and Soil carbon maps over 3 specified regions Rwanda, Ghana, Uganda, Lesotho, Switzerland and Italy
    - AfriGEO custom community Portal that allowed the AfriGEO community to get access to the customized community Portal package to be installed on their own premises. Customisation is related to DEA (Digital Earth Africa) data registration, View generation, Logo of the portal and whished thematic.
    - All Atlantic
    - Eiffel Discovery Cognitive Search
    - SDG 11.7
    - Water Cycle Pollution
    - Biomass
    - Norovirus

- Reusability, Reproducibility and Replicability
    - Virtual Earth laboratory component enhancements to allow the generation of additional knowledge from the SDG 15.3.1 algorithm with statistics and to enable the possibility to select different cloud resources providers to better satisfy users computing resources needs and familiarity.

4.1 Components-based Enhancements: APIs, Views, Widgets, Customised GEOSS Portal, Middleware, GEOSS Infrastructure, GEOSS Platform components

4.1.1 DAB

DAB is the main data provider of the portal. It serves with high content resource entries and datasets with filters, catalogues, and views. It also provides a registry of other Data Providers.

The latest data sources which were brokered/updated by the DAB are:

- DIONE Catalogue
- Digital Earth Africa (DEA)
- Water Quality Emergency Monitoring Service (WQeMS) Platform
- PRISMA (PRecursore IperSpettrale della Missione Applicativa)
- SEA scieNtific Open data Edition (SEANOE) - ongoing
- European Marine Observation and Data Network (EMODnet) - ongoing
- Webservice Energy Catalog
- TWIGA (in-situ data)
- Data Integration and Analysis System (DIAS) - Japan
- Federated EO Gateway (FedEO) – CEOS
- CEOS WGISS Integrated Catalog (CWIC)
- South African Environmental Observation Network (SAEON)
- PANGAEA
- China GEOSS

In addition, specific enhancements were developed to support the All-Atlantic use case:

- Fine-tuning the metadata coming from catalogues which are part of the All-Atlantic View (keywords, organizations, etc.)
- Creating advanced filters to allow the search for All-Atlantic sister projects (iAtlantic, Atlas, AtlantOS, TRIATLAS, MEESO, SUMMER, Mission Atlantic, AquaVitae, SO-CHIC)
- Brokering of new data sources (e.g. SEANOE)

As far as enhancing the support for in-situ data, GPP is collaborating with EEA to enhance the brokering of EEA data source with the following developments:

- Fine-tuning of metadata harvesting from GEO DAB
- Increasing the visualization feature using the Web Map Service (WMS) or the ArcGIS REST APIs
- Focusing on the discovery of in-situ data and the possibility to tag/categorize them - ongoing

- Enhancing the access feature to allow direct download of EEA products from the GEOSS Portal - ongoing.

Finally, a specific view for the AfriGEO Community Portal was created based on AfriGEO community requests.

4.1.2 Community Portal Self Creation

The second phase of implementation of the Community Portal Self Creation tool resulted into the possibility to replicate most of the operational environment of the GEOSS Portal features, with a couple of exceptions that will be part of future developments.

The following scope of developments has been provided during the second phase:

- Adaptation of components from the current GEOSS legacy architecture
- Creation of new components that replicate the functionalities of the old architecture within the new architecture.

4.1.2.1 Technical Specifications

Within the second phase multiple features have been recreated.

Following list contains the description of changes made, categorized by new architecture components:

- GEOSS-UI Component
- GEOSS-ADMIN Component
- GEOSS-PERSONALDATA Component
- GEOSS-NGINX Component
- GEOSS-SQUID Component
- GEOSS-MATOMO Component
- GEOSS-ELK Component
- GEOSS-PROXY Component
- GEOSS-SETTINGS Component
- GEOSS-CONTENTS Component
- GEOSS-KIBANA Component

In the subparagraph below is detailed each component.

4.1.2.1.1 GEOSS-UI Component

The front-end part of the system for external users.

The following features have been transferred in the new architecture:

- Yellow Pages – recreation of the Yellow Pages system page

Figure 9 – Recreated component: yellow pages

- Statistics – recreation of the statistics system page

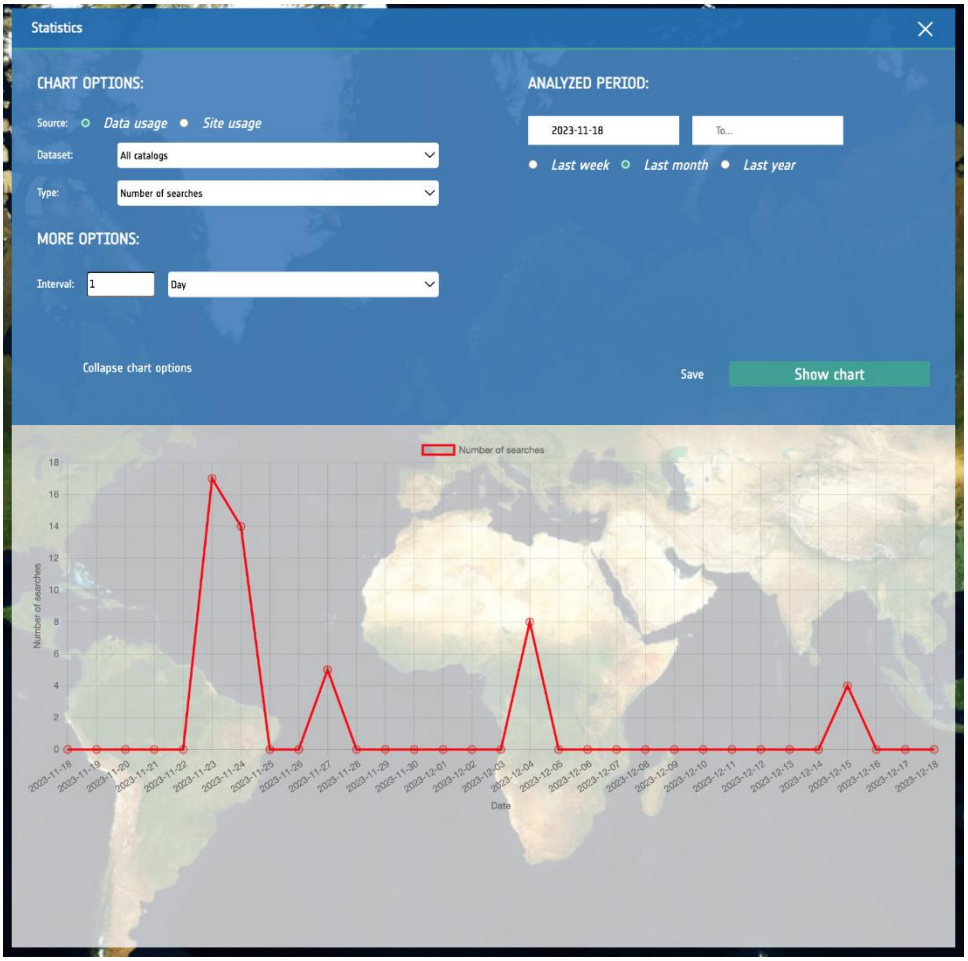

Figure 10 – Recreated component: statistics

- Saved Searches – recreation of the Saved Searches feature, including saving searches and managing them on the dedicated system page

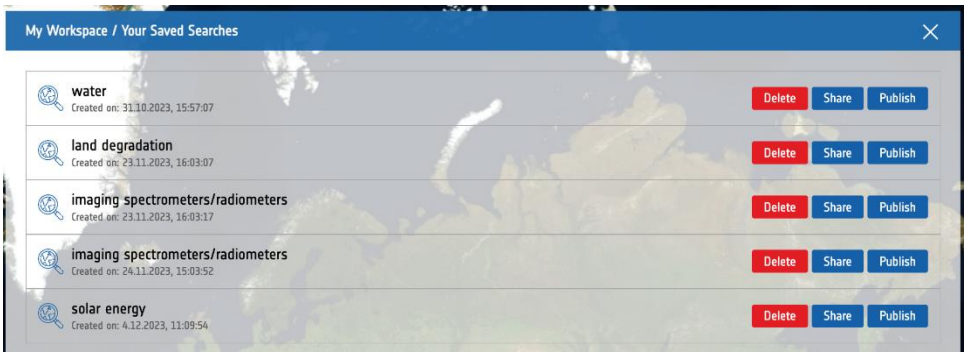

Figure 11 – Recreated component: saved searches

- Highlighted Searches – recreation of the Highlighted Searches feature, including managing them by the administrator on the dedicated system page

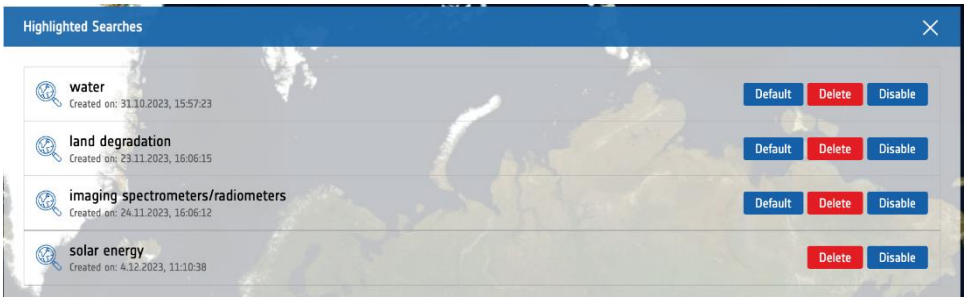

Figure 12 – Recreated component: highlighted searches

- Bulk Download – recreation of the feature

Figure 13 – Recreated component: bulk download

- Translations – recreation of the language switcher

Figure 14 - Recreated component: translation selector

- See Also – recreation of the See Also suggestions

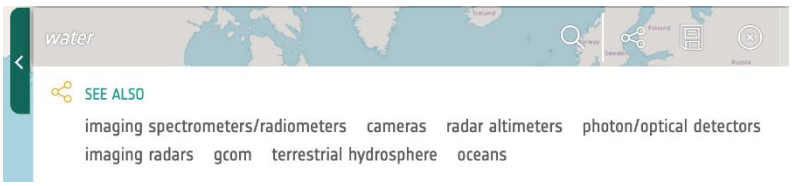

Figure 15 - Recreated component: search suggestions

- Switch to other sources – recreation of the multi-source behaviour of the search results, including sources switch and Data – Information – Service tabs.

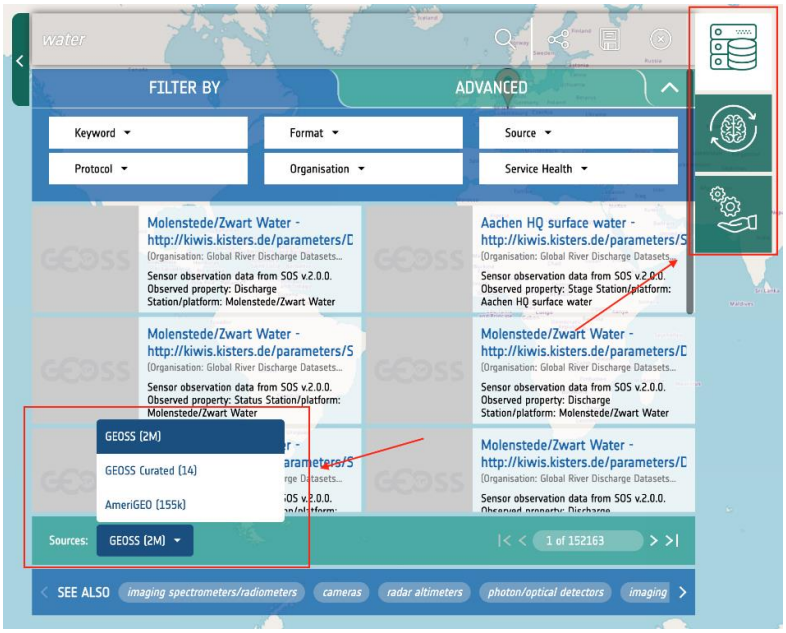

Figure 16 - Recreated component: source switching

4.1.2.1.2 GEOSS-ADMIN Component

The fronted part of system for administrators.

Following features has been recreated in new architecture:

- Translations support for contents – recreation of the content translations mechanism, for static contents, menu items, etc.

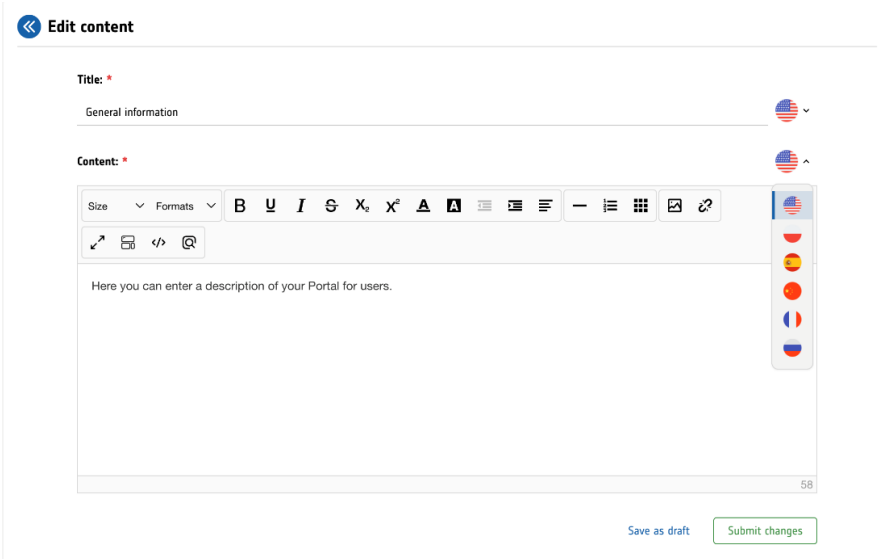

Figure 17 - Recreated component: CMS translation support

- GEOSS-CR Recommendations – recreation of the legacy recommendation handling

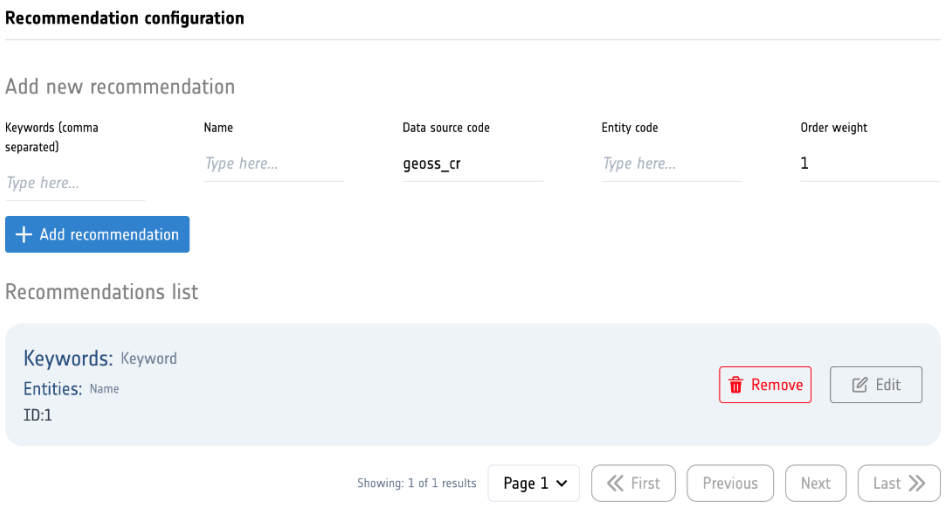

Figure 18 - Recreated component: GEOSS-CR recommendations

4.1.2.1.3 GEOSS-PERSONAL-DATA Component

The backed component responsible for user data management.

Following features has been recreated on the new architecture:

- Support for Saved Searches – creation of the REST API endpoints required for proper Saved Search handling

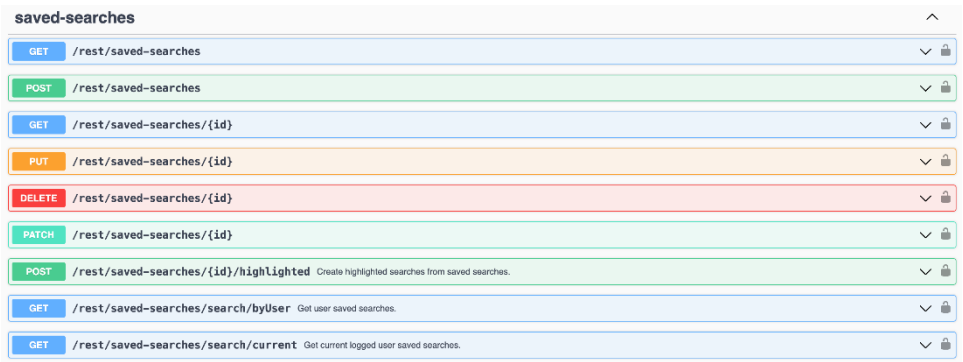

Figure 19 - Recreated component: representation of Saved Search API endpoints

- Support for Highlighted Search – creation of the REST API endpoints required for proper Highlighted Search handling

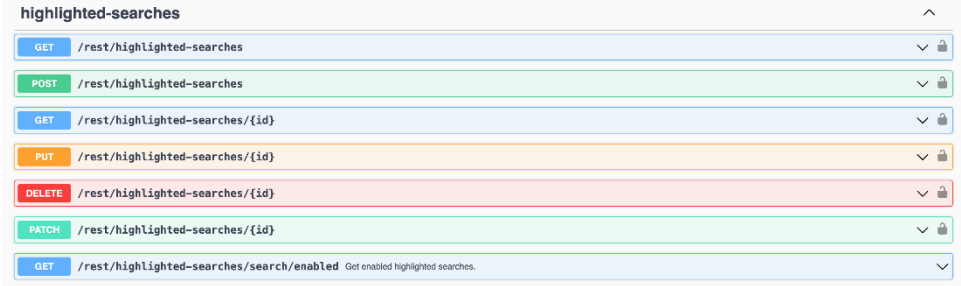

Figure 20 - Recreated component: representation of Highlighted Search API endpoints

- Gathering Survey data API – creation of the REST API endpoints required for proper Survey handling

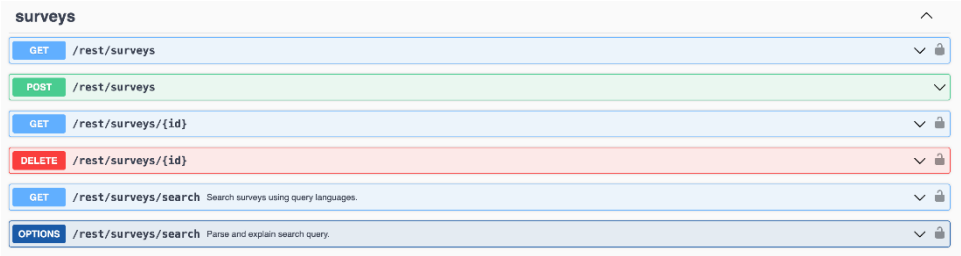

Figure 21 - Recreated component: representation of survey API endpoints

4.1.2.1.4 GEOSS-NGINX Component

The backend component related to server settings.

Following features have been recreated in new architecture:

- Proxy to DAB request for Yellow Pages – necessary configurations for external Data Providers list handling
- Proxy to GEOSS-Matomo for Statistics – transfer requests from Statistics page to Matomo, keeping the authentication token on the backend side

4.1.2.1.5 GEOSS-SQUID Component

The backend component related to data caching.

Following features has been recreated in new architecture:

- Caching DAB request for Yellow Pages – to improve performance of the Yellow Pages page, there was a caching system implemented in new architecture.

4.1.2.1.6 GEOSS-MATOMO Component

The backed component related to behavioural data collecting.

Following features has been recreated in new architecture:

- User configuration – default admin user configuration after initialization of the Matomo application, through API scripts
- Site configuration – default site configuration after initialization of the Matomo application, through API scripts
- Events configurations – default event triggers after initialization of the Matomo application, through API scripts

4.1.2.1.7 GEOSS-ELK Component

The backend component related to internal system data storage and search.

Following features has been recreated in new architecture:

- Component configuration – initialization of the backend application
- Possible data migration from old ELK geoss_index – verification of the possibilities of transfer current geoss_index from legacy Elasticsearch component to new Elasticsearch component.

4.1.2.1.8 GEOSS-PROXY Component

The backend component related to request handing.

Following features has been recreated in new architecture:

- API for Popular - REST API popular-controller for getting the See Also suggestions on the fly

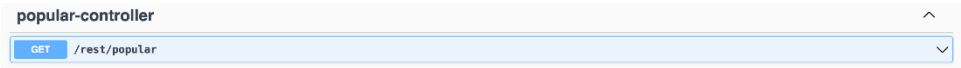

Figure 22 - Recreated component: representation of search suggestions API endpoint

- API for Statistics with Matomo query translator – REST API statistics-controller used for retrieving data for Statistics page

Figure 23 - Recreated component: representation of Matomo API endpoints

- Indexer – REST API log-controller, for storing statistics data

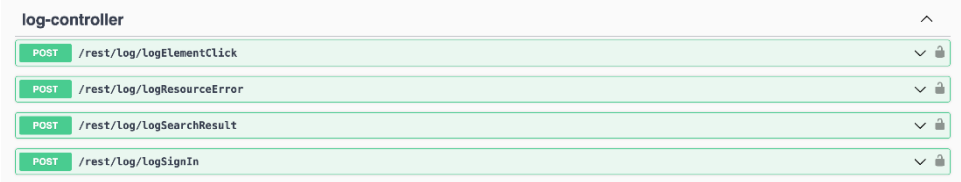

Figure 24 - Recreated component: representation of log controller API endpoints

4.1.2.1.9 GEOSS-SETTINGS Component

The backend component related to system settings.

Following features has been recreated in new architecture:

- Translations for menu, tutorial, other similar elements – from now on, each setting has a multilingual type of storing field value, if applicable

Figure 25 - Recreated component: representation of page data structure

- Tutorial tags configuration – REST API for configuration of the Tutorial Tags

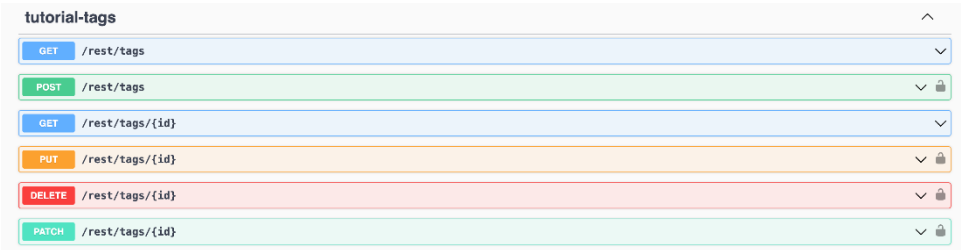

Figure 26 - Recreated component: representation of tutorial tags API endpoints

- Language configuration – REST API regional settings for the portal

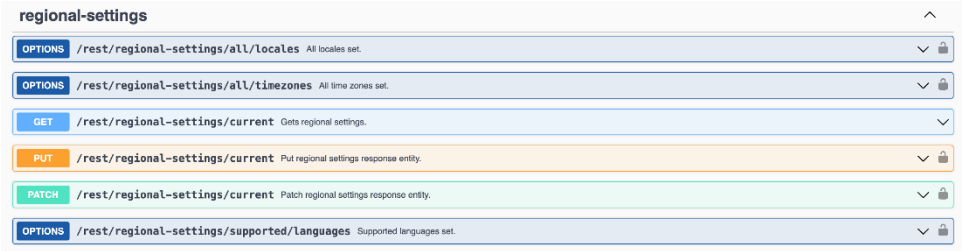

Figure 27 - Recreated component: representation of language configuration API endpoints

4.1.2.1.10 GEOSS-CONTENTS Component

The backend component related to system contents.

Following features has been recreated in new architecture:

- Translations for contents – from now on, each content has a multilingual type of storing field value.

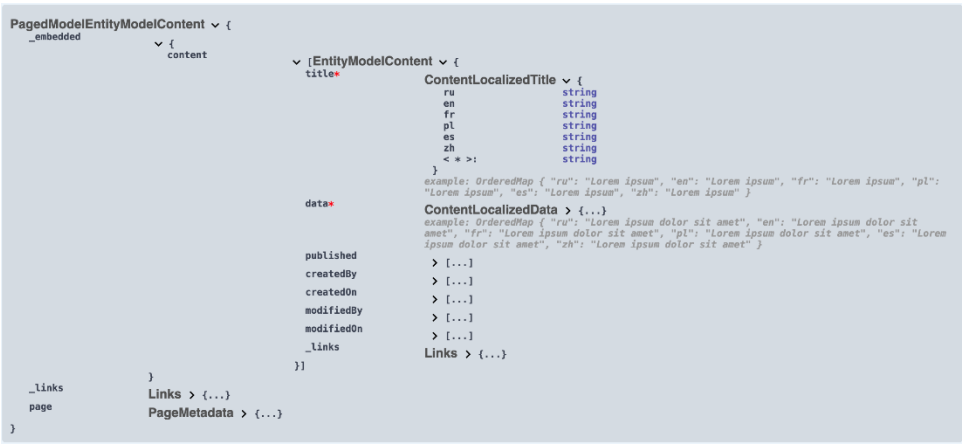

Figure 28 - Recreated component: representation of page data structure

4.1.2.1.11 GEOSS-KIBANA Component

The backend component related to internal system data dashboard for administrators.

Following features has been recreated in new architecture:

Component initialization – as a baseline for further development

4.1.3 Eiffel Discovery Cognitive Search

In collaboration with EIFFEL project, GPP developed a proof of concept for the integration of EIFFEL cognitive search functionalities in GEOSS Platform.

The EIFFEL project developed a system that comprises an AI language model optimized for Clima Change-related text and queries[1]. To do this, GPP provided EIFFEL with a subset of the GEOSS Platform metadata, that was utilized for training the AI language model.

In order to exploit this capability in the GEOSS Platform environment, GPP and EIFFEL projects collaborated to implement a set of specific APIs which enable the discovery of GEOSS content not only with traditional text-based searches, but also taking advantage of the EIFFEL cognitive search. In particular, two integration approaches were implemented:

- Cognitive Search
- Cognitive Sorting

From the technical point of view, the two approaches differ in how user's queries are fullfilled. The following provides the high level steps which are executed.

Cognitive Search:

a) DAB sends query to EIFFEL API, including paging information
b) EIFFEL API returns a sorted list of record ids
c) DAB filters the returned record ids according to user's constraints (e.g., bounding, etc.)

Cognitive Sorting:

a) DAB filters according to user's constraints (e.g., bounding, etc.)
b) DAB sends the first N records (according to the requested paging) of step a) to EIFFEL API
c) EIFFEL API returns the N records sorted according to NLP

The implementation was completed and is now under testing.

4.1.4 Yellow Pages setup

The Yellow Pages (YP) has been completely redesigned to be fully integrated in the GEOSS platform, using the same look-and-feel and adding new functionalities enabling data providers to manage their records.
The pre- production instance is now available on UNIGE servers and is waiting the final approval from GEO sec/GIDTT to be put online.
A full installation guide of the YP component will be also available covering the following aspects:
Prerequisites:

1. Open network communication between app_server and database_server
2. Open network communication between app_server and smtp_server
3. Active domain SSL certificate and key

Database requirements:

- Database one of MariaDB, MySQL or PostgreSQL
- Created empty scheme with encoding UTF-8 and time zone UTC

[1] https://meetingorganizer.copernicus.org/EGU23/EGU23-16662.html

- Crated user with permissions to DDL (Data Definition Language), DML (Data Manipulation Language), and TCL (Transaction Control Language) to the scheme
- Granted access to database from application server

E-mail requirements:

- SMTP server
- Created account for sending emails
- Connection to the SMTP server should be secured by SSL or TLS
- Granted access to smtp from application server

The installation consists in 9 steps:

- Step 1 – check and install available updates
- Step 2 – install docker and rest of the components
- Step 3 – unzip installation files
- Step 4 – change working directory
- Step 5 – import images
- Step 6 – edit environment variables
- Step 7 – set environments
- Step 8 – copy SSL certificate
- Step 9 – run containers

4.2 Community-driven Enhancements: GEO Activities, Initiatives, Flagships and communities' portals, EU Projects, communities applications

4.2.1 SDG 15.3.1 Land Degradation

Avoiding, reducing and reversing land degradation and restoring degraded land is an urgent priority to protect the biodiversity and ecosystem services that are vital to life on Earth. There is an immediate need to enhance national capacities to undertake quantitative assessments and corresponding mapping of their degraded lands.

The user wants to calculate the related SDG indicator 15.3.1 at the national scale, based on the official GPG 2.0 guidance document from UNCCD, using the GEOSS platform. The objectives of this indicator include the dissemination of knowledge on land degradation. The GEOSS Portal enables the user to independently start the computation of chosen resources in terms of land degradation and visualize the outcome in various forms and also add it to a customized dashboard.

The users shall be also enabled to add the finished dashboard in My Workspace menu and share it with the specified users.

The user could be enabled to share the dashboard with all the GEOSS users, upon verification by the Administrator.

Flow

1. The user connects to the GEOSS platform and does a search for "Land degradation".
2. The user obtains a number of resources that matches his search criteria.
3. The user can discover (or a pre-selection can be made) of the required sub-indicators (see data domain) available in the GEOSS platform and selects the most suitable for his/her needs.
4. The user can discover different data, services and knowledge and their relationship associated to the SDG 15.3.1 indicator. The user can then navigate deeper into the different sources.
5. The user discovers a dedicated model to compute the SDG indicator
6. The user realizes that there is a Service associated to this model. The GEOSS Platform associates the model to the actual processing services that enable its computation, which the user can access and run in a user-friendly way. In particular, the user can inspect the process workflow and search and select data as input to the service. In addition, the user has the capability to choose a Cloud computing platform of preference among the available (these include all the DIAS Platforms and Amazon Web Services).
7. In case the user has registered newly data, it will be possible the discover and select them as input to the service.
8. The user can now start the computation on the selected infrastructure and wait for the results
9. The user can visualize the outputs in a dedicated dashboard (that can be further elaborated/modified and shared afterwards).
10. The created dashboard can be added in My Workspace, the user who created the dashboard can chose between sharing his work with other specific users or to render it accessible to all the platform users. In this case the User who created the dashboard should become a data provider or need the Administrator authorization.
    The procedure regarding the acceptance or rejection by the Administrator is the following :
    a. Administrator can reject the dashboard creation and provide information why the rejection happened. User, that created the dashboard can then update it according to the provided information or discard the whole process.
    b. Administrator can accept the dashboard and in this case this dashboard will be accessible for both User, that created it and Users, that are looking for similar data in within the system. The data will be obtainable within the information tab.

4.2.1.1 WORKFLOWS and NEW DATASETS Registration

To implement the new features of the SDG15.3.1 it has been updated the name of the model, to make it more generic from "European Model" to a more generic "Land Degradation Service". This allows the user to run the model not only over a predefined European area, but also to some African regions and like: RWANDA, GHANA, UGANDA and SWITZERALND, ITALY, LESOTHO, and EUROPE.

New datasets have been prepared and registered by the DAB and made discoverable and accessible via the GEOSS Portal. The following datasets have been made available:

- EUROPE: Land Productivity, Soil Carbon, Land Cover
- ITALY: Land Productivity, Soil Carbon, Land Cover
- SWITZERLAND: Land Productivity, Soil Carbon, Land Cover
- LESOTHO: Land Productivity, Soil Carbon, Land Cover
- UGANDA: Land Productivity, Soil Carbon, Land Cover
- RWANDA: Land Productivity, Soil Carbon, Land Cover

- GHANA: Land Productivity, Soil Carbon, Land Cover

Another feature added is the possibility to process a map of land degradation and an excel file with statistics about the different parameters and regions of the Land degradation and the possibility to select among two different cloud providers. Currently only AWS and EOSC are available.

4.2.2 AfriGEO Community Portal

The AfriGEO initiative seeks to identify challenges and put in place measures to enhance Africa's participation in, and contribution to, GEOSS. This participation will support the continent's efforts to bridge the digital divide and build a knowledge-based economy using GEO networks and GEOSS infrastructure.

The main requirement is to deliver for the AfriGEO a frontend component of the GEOSS Platform that will allow to set up on AfriGEO premises a Community portal with a look and feel present in the GEOSS Portal. Due to the time limitation, delivering the complete solution with a set-up tool and decomposed backend components is impossible. Therefore, certain functionalities, such as those requiring logging in or those not part of the Operational system (present in other environments such as SIT, UAT or Development), will not be present within this first step.

The end product is an installation package which needs to be deployed according to instructions and configured via configuration files on the User premises.

The design and solution proposed in this first step is a proof of concept. We want to clarify that this temporary solution will be scratched later in the project to make space for a new solution with a new architecture approach.

4.2.2.1 Technical specification

This chapter describes what software and hardware requirements must be met to set up the GEOSS Platform's frontend components.

AfriGEO component is a standalone static website with Vue.js (version 2) based Single Page Applications for a Search and Yellow Pages modules and static HTML5 / CSS3 / JavaScript content pages. It can be hosted on any service that provides static website support (FTP, Cloud hosting, VPS).

Minimal hosting Hardware requirements:

- CPU: minimum 2 vCPU/Cores (single-threaded), 4 vCPU (2 cores with hyperthreading or 4 physical cores) recommended
- RAM: 4 GB at minimum
- Hard Disk: 25GB at minimum, including space for the OS installation (not including the need for backups, other services, etc.)

Software:

- A Linux distribution of choice (Ubuntu/Debian/Fedora/Rocky Linux)
- A web server of choice – nginx/Apache HTTPD/Lighttpd (nginx recommended)
- Software allowing remote access possibility, to upload the web application package (for example vsftpd for FTP functionality, or properly configured SFTP on SSHD)

Libraries and plugins:

Name	URL	License
Axios	https://github.com/axios/axios	MIT License
Open Layers	https://github.com/openlayers/openlayers	BSD-2-Clause license
Vue.js	https://github.com/vuejs/vue	MIT License
Vuex	https://github.com/vuejs/vuex	MIT License

NOTE: Requirements and technical specifications will be changed when the Mirror Site Tool Scenario is developed.

4.2.2.2 Elements in the Portal

Within the installation package following elements of the portal shall be present:

- **Configuration file:**
  - Logo image source
  - Site name
  - External API URLs
  - Menu elements
  - List of views and default view

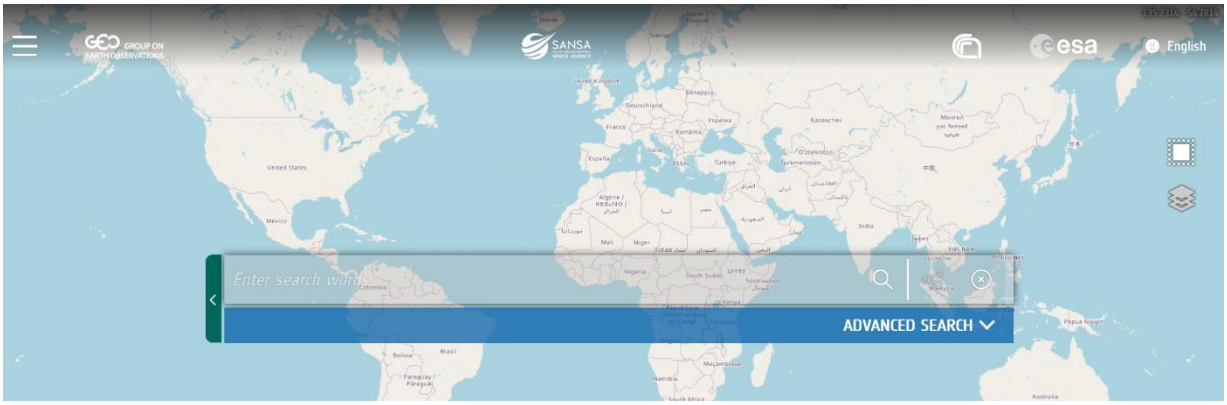

Figure 29 - AfriGEO Community Portal, homepage

The configuration file will contain all necessary configuration details, saved as a JSON text file.

- **Pages:**
  - General Information
  - Terms and Conditions
  - Release notes
  - Help Desk
  - Documentation
  - Tutorials
  - Yellow Pages

Each page will be delivered as an empty one for the User to set up its description. This will be possible via the source code of the page. The only exception will be Yellow Pages, which will fetch the data about data providers via the DAB endpoint and present them similarly to GEOSS Portal.

- **Menu:**
  - About
  - User Support
  - Community Portals (menu you will consist of static links leading to currently present Community Sites and Geoss Portal)
  - Yellow Pages

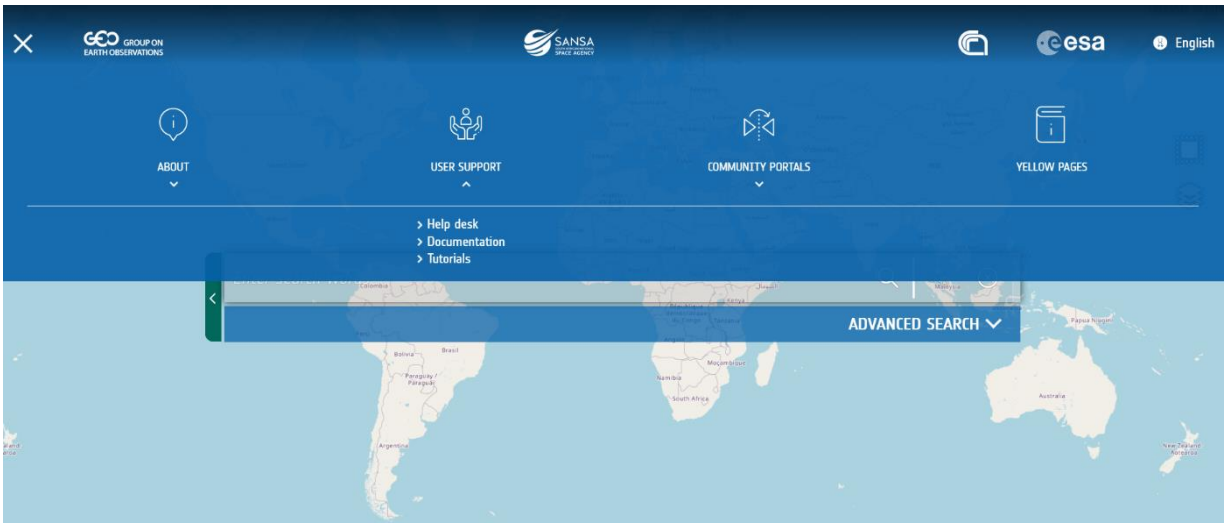

Figure 30 - AfriGEO Community Portal, Menu

- **Search component:**
  - Possibility to run a search via DAB component (dedicated endpoint to be configured via configuration files)
  - Advance search with a dedicated list of catalogues and views. A view can be chosen by default, which will be used to search for datasets. (to be decided if the view should only consist of AfriGEO or other views as well)
  - Continent and Country or Coordinates filter
  - Relation of the selected area
  - Date range filter
  - Facet filters built based on the response from the DAB component
- **Yellow Pages component**
  - Possibility to run a search for a data provider via the DAB database
  - Results sorting and pagination
  - Result entry with logo, title, description, link, traits and link sharing
- **Map component**
  - Base map provider
  - Area of Interest
  - Layers including comparison tool

4.2.2.3 List of functionalities not implemented

Hereafter there is a list of functionalities that will not be accessible due to the short implementation time or the fact that they are not yet operational.

- Geolocation and "Did you mean" component,
- Running workflow processes via VLAB,
- Enrichment of the resources,
- Saving searches,
- Tutorial mode,
- Send feedback,
- Extended View,
- Additional sources outside of DAB,
- Statistics,
- My workspace (with all its contents),
- Sign in,
- "See also" and "Popular" search hints,
- Survey.

4.2.3 SDG 15.3.1 End-to-End solution

New enhancements compared to the previous version

The possibility to add user selected AOI

All the enhancements covering the full use-case presented in the section 4.2.1 are now operational.

In particular, now users have the ability:

- to select an Area of Interest (AOI) during the Run creation based on a drawing tool (defining a specific AOI) or by selecting a given country and or region
- The dashboard functionality now allows selecting which map to show (SDG 15.3.1 indicator and/or sub-indicators); same for the graphs; possibility to add several pages.
- Select a computing backend (i.e., AWS, CreoDIAS, …)
- Share a selected dashboard.
- Search for available dashboards in the platform

It is now possible to add a user-selected AOI during the Run creation. When user is interested in creating a computation run, along with other inputs one can specify the desired Area of Interest, by enabling "expert options" below the "Workflow inputs" table.

WORKFLOW INPUT

Input name	Chosen resources	Actions
Land Cover*	✕ Default	Select resources
Productivity*	✕ Default	Select resources
Soil Carbon*	✕ Default	Select resources

* required fields → Show expert options

Figure 31 - Enabling expert options during run creation.

WORKFLOW INPUT

Input name	Chosen resources	Actions
Land Cover*	✕ Default	Select resources
Productivity*	✕ Default	Select resources
Soil Carbon*	✕ Default	Select resources
Area of interest	Worldwide →	Set bounding box

* required fields Hide expert options

Figure 32 - Workflow input table with a highlighted option for setting AOI.

By default, Area of Interest is set to “Worldwide”, however it can be freely changed with “Set bounding box” button, which enables selection of an area on the map, via filtering AOI tool.

Figure 33 - Example of a custom-selected AOI

After selecting the area, user is redirected to computation run creation and may complete the inputs of the run, with the coordinates of the area filled in.

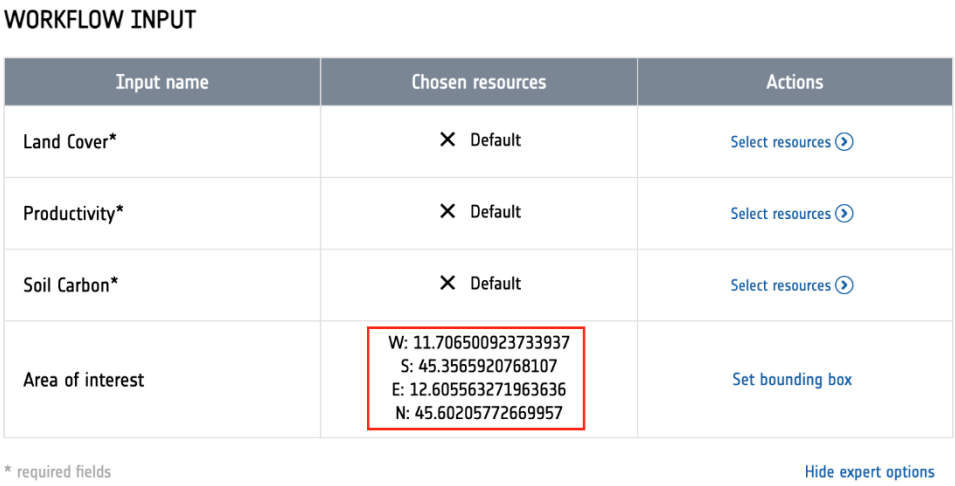

Figure 34 - Example of a custom-selected AOI within the workflow input table. AOI coordinates are highlighted.

4.2.3.1 List of functionalities not implemented

It is still under implementation: the possibility to add user own datasets.

To enable the sematic link among the resources available to support the paradigm of Replicability, Reproducibility, Reusability (see session 4.3)

Functions that are still in consideration to be implemented in the next round of developments:

- Possibility for users to upload their own datasets.
- Add a semantic link among the resources available to support the paradigm of Replicability, Reproducibility, Reusability (see session 4.3)

4.2.4 Custom Dashboard feature

During the second cycle it has been finalized the Dashboard functionalities already implemented in the first cycle. The main implementation was the custom Dashboard used to reporting the results of the experiences. These functionalities are implemented on the UAT environment.

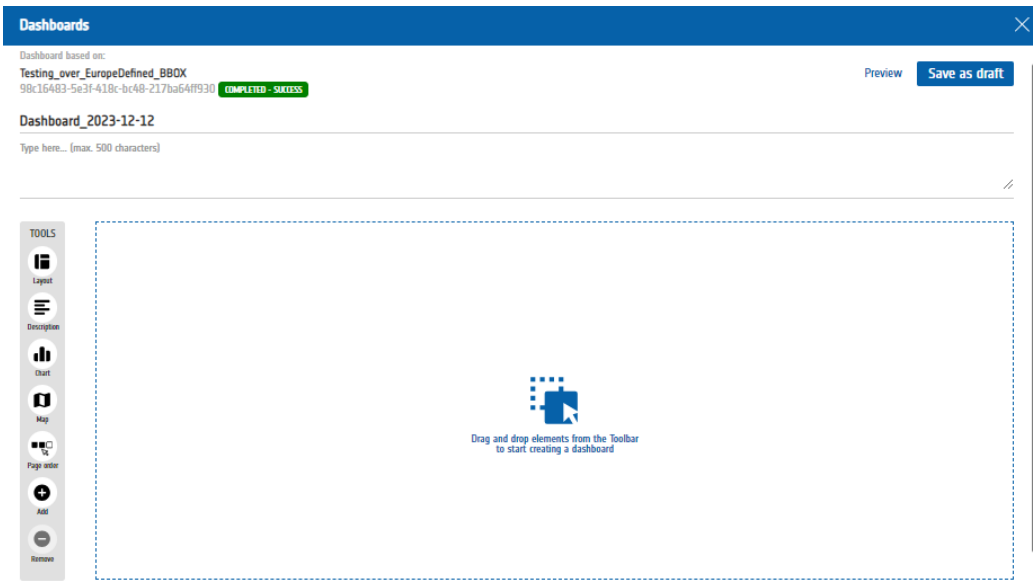

Figure 35 Custom Dashboard feature and possible customisation options

4.2.5 SDG11.7: preparatory work for the use case

Preparatory work for the use case.

The methodology for this use case has been established. It will follows five steps:

1. Generate a maximum NDVI dataset (April–August) over the urban areas.
2. Delimit built-up area of the city.
3. Create a mask of public vs. private areas using a mix of solutions (e.g., cadaster, Volunteered geographic information (VGI)).
4. Overlay the mask with the NDVI dataset to identify only vegetated and public areas. This gives an estimation of the total public green space.
5. Model the physical accessibility of the population to the nearest public green space, and compute accessibility coverage.

It will be tested on four cities: Geneva, Barcelona, Bristol and Goteborg. All necessary data to model the physical accessibility as well as maxNDVI, delimitation of cities, and public mask have already been gathered.

We are currently evaluating how best publishing the AccessMod model (either in the VLab or in an existing processing infrastructure) to efficiently run the simulations.

4.2.6 Yellow Pages 2.0: development, testing and deployment in pre-production (UAT)

Regarding the YP, it is almost ready to be published in production.

The next steps are the following:

1. Agree on final domain name (ideally something like yellowpages.geoportal.org)
2. Create accounts for validation, administration etc…?
3. Transferring the content of the YP1.0 to 2.0
4. Final approval from GEO sec/GIDTT to put it in production mode (first maybe in pre-production in UAT and then on the main portal).

These steps are strongly dependant on the governance of the platform and from the GEO sec/GIDTT

4.2.7 All Atlantic - Phase I

Changes to the Geoportal user interface, requested by the All Atlantic Community has been split into two phases. In the first phase of adjustments, following topics have been addressed:

- Enlarging portal logos
- Hiding resources for advanced search
- Data download process optimization
- Deleting "AtlantOS" link from the menu
- Separating "img" and "other" icons
- Shopping cart always visible
- Always showing data file type

In the followings paragraph they are explained in details.

4.2.7.1 Enlarging portal logos

Enhancement of the main community logotype to fit the larger, more horizontally oriented images in the header of the portal.

Figure 36 – Example of an enlarged portal logo

4.2.7.2 Hiding resources for advanced search

Enhancement of Advanced Search views management, letting the community administrator to choose single view as a default, unchangeable, single-value filter for the results

Figure 37 – Example of advanced searh form whose values have been customized

4.2.7.3 Data download process optimization

Multiple UI/UX changes to improve the download process across the Geoportal (including labels text changing, minor layout changes, headings changes, etc.) enhancing “Shopping Cart” pipe approach.

4.2.7.4 Deleting "AtlantOS" link from the menu

All Atlantic and AtlantOS community resources have been merged into single catalogue containing resources from both communities (governed from now on by All Atlantic)

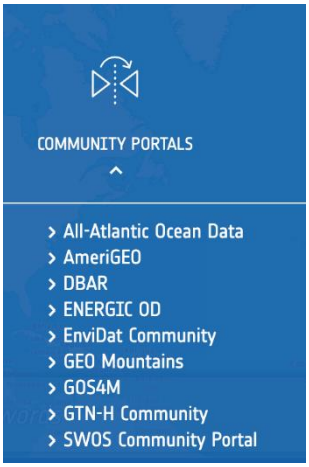

Figure 38 - Community portals menu after merging

4.2.7.5 Separating IMG and OTHER files icons

Improvement of file downloads format detection represented by icons, letting to distinguish images as PNG and JPG, and other formats as PDF, WMS service, HTML link, etc.

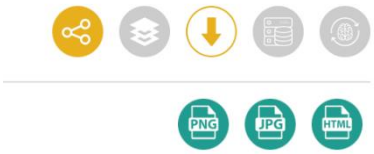

Figure 39 – Example of data types being listed in download options

Second phase of the All Atlantic suggestions, oriented mostly on the enhancement of the search results, is planned for future deliveries.

4.2.8 Nutrient Pollution in European Inland and Coastal Waters

In Europe, intensive agricultural practices together with high population density represent important sources of nutrients for fresh and coastal waters. Nutrient pollution is one of the major pressures on European aquatic ecosystems altering their condition. At present in the EU more than half of water bodies are not in good ecological status, with nutrient being one of the major causes of degradation.

Ambitious water policies are in place in the European Union (EU) for protecting and restoring aquatic ecosystems. Among these, the Urban Wastewater Treatment Directive (UWWTD) has the objective to "protect the environment from adverse effects of wastewater discharges from urban sources and specific industries".

The EU's Urban Wastewater Treatment Directive currently in force is more than 30 years old. Since its adoption in 1991, the quality of European rivers, lakes and seas has dramatically improved. The review of the Directive is one of the actions of the Zero Pollution Action Plan, one of the pillars of the European Green Deal.

In October 2022, the Commission revised the Directive, adapting it to the newest standards, in line with the results of an evaluation and on the basis of an extensive impact assessment. Impact assessments form a key part of the European Commission's "Better regulation" agenda, which seeks to design and evaluate EU policies and laws so that they achieve their objectives in the most efficient and effective way. Impact assessments collect evidence (including evaluation results) to assess whether future legislative or non-legislative EU action is justified and, if so, how it can best be designed to achieve relevant policy objectives.

One of the objectives of the revision was to improve water quality by addressing remaining urban wastewater pollution. To this aim, the GREEN model, developed by the EC Joint Research Centre, was utilized to quantify the current pressures of point and diffuse nitrogen and phosphorus emissions to European fresh and coastal waters and analyze the effects of different policy scenarios of nutrient reduction.

GREEN is one of the models documented in MIDAS, the Modelling Inventory and Knowledge Management System of the European Commission. MIDAS documents models and their contributions to Commission impact assessments. It describes a model's purpose and intended use, provides information on model structure, quality and transparency, as well as access to model documentation, useful references and the supported impact assessments.

The GEOSS Platform Plus project, in collaboration with the TIDE project led by JRC, developed a proof of concept to enable the execution of GREEN model in a multi-cloud environment. GREEN runs through

the Virtual Earth Laboratory (VLab), which utilises the European cloud computing platforms, including the Copernicus DIASes and the European Open Science Cloud, for the execution of scientific models.

Taking advantage of cloud technology, VLab facilitates the sharing of scientific models and enables their exploitation via simple Web APIs, allowing to create dedicated Web applications. The GREEN Web application, developed by GEOSS Platform Plus project and the Joint Research Centre, allows the replication of GREEN model results of the impact assessment, contributing to a transparent and evidence-informed policy making process, according to the principles of the European Commission Better Regulation agenda.

Through GREEN Web application users can select an area of interest and define the settings for the simulation, including different policy scenarios.

After a few minutes, users can visualize the simulation results. By selecting one policy scenario, the user displays the resulting yearly average load of nitrogen in the entire selected area.

It is possible to compare how the different simulated policy scenarios perform. By selecting the nitrogen result, users can display the calculated total yearly average load, both to the river outlet and in the entire region.

When two policy scenarios results are selected, users can visualize the difference of nitrogen and phosphorus loads over the entire area of interest.

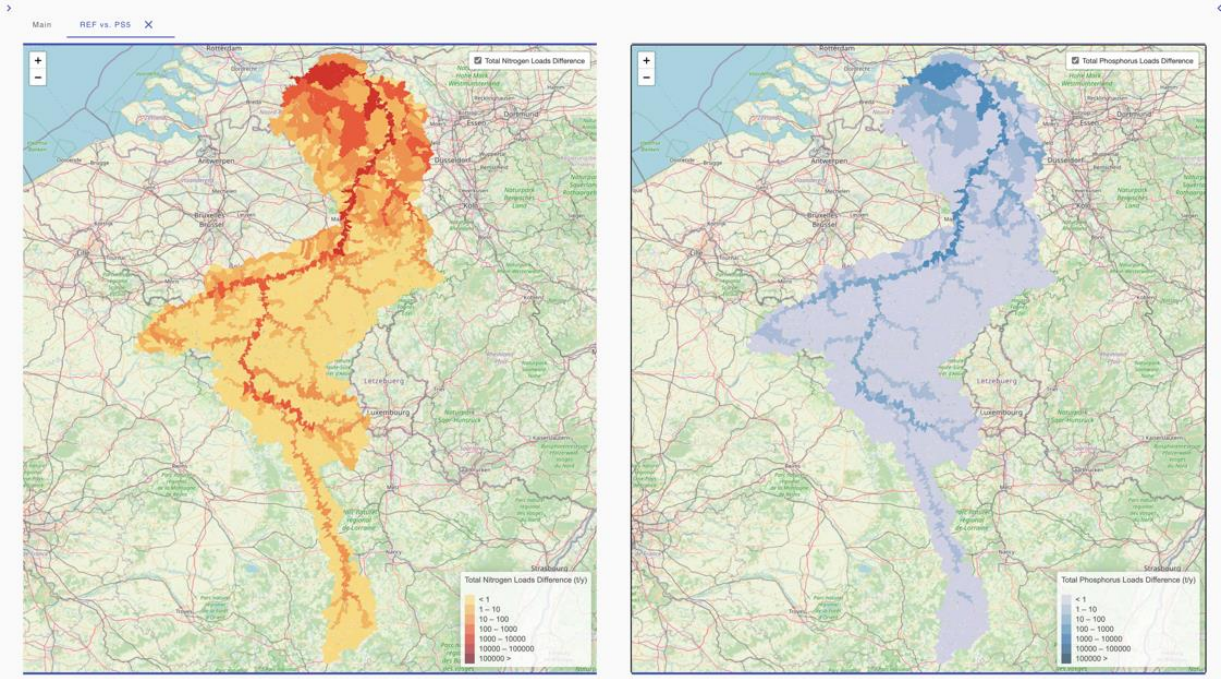

Figure 40 - Difference of nitrogen and phosphorus loads over. Meuse Basin region

4.2.9 Above-Ground Biomass (AGB) estimation using Machine Learning Techniques

The quantification of forest above-ground biomass (AGB) over large areas is used as a proxy for the quantification of carbon stocks, particularly referring to Reduced Emissions from Deforestation and forest Degradation (REDD+) projects, for the quantification of forest resources and ecosystem services,

the creation of fuel maps to be used as input to wildfires spread models, and for biodiversity and climate change models. According to the definition of the Intergovernmental Panel on Climate Change (IPCC 2006), Above-Ground Biomass is defined as "All living biomass above the soil including stem, stump, branches, bark, seeds and foliage."

The use case aims at allowing users to calculate the map of biomass based on observation points (in-situ data) and vegetation indices (VIs) from remote sensing imagery. The user can compare results obtained by different Machine Learning (ML) models. EC JRC is developing a ML model to estimate AGB from Sentinel products. One or more ML models are under investigation, including:

- Support Vector Machine (SVM)
- Decision Tree (DT)
- Artificial Neural Network (ANN)
- Random Forest (RF)

The model(s) will be executed through VLab.

The implementation of this use case is scheduled for the final year of GPP project.

4.2.10 Climate Change impact on Norovirus pandemic risk

Norovirus is a rapidly mutating and highly infectious virus, for which there are no pharmacological treatments or vaccines. It is ranked first by the WHO as potential source of infections and pandemics worldwide.

It is expected that climate change may affect the onset of epidemic outbreaks in different geographical regions due to multiple reasons: a) direct environmental changes due to modification of climate patterns; b) modification of ecological niches of the many species potentially acting as intermediate hosts for animal-to-human transmission.

The calculation of ecological niches is executedby using the OpneModeler model. This predicts species distribution based on a set of environmental parameters. The OpenModeler model was successfully shared and executed in VLab, utilizing sample data for functional testing. The main next steps for the finalization of the use case implementation will focus on:

- Identify Species to ingest
- Identify Relevant Environmental layers for species distribution

4.3 Re-usability, Re-producibility, Replicability enhancements

4.3.1 The Virtual Earth Laboratory (VLab)

The Virtual Earth Laboratory (VLab) is a framework that implements all required orchestration functionalities to automate the technical tasks required to execute a model on different computing infrastructures, minimizing the possible interoperability requirements for both model developers and users. VLab is conceived as a framework to support a science-informed decision-making process, which requires the generation of knowledge from collected data and scientific models. Although, current cloud technologies provide valuable solutions for addressing several of the Big Earth Data challenges. Building a workflow that implements a scientific process to generate knowledge on a multi-cloud environment is a complex task requiring multiple expertise on policy needs, different scientific domains, data and model interoperability, cloud services management. Therefore, it is necessary to automate, as much as possible, the technical tasks, in order to lower the existing barriers and allow the different stakeholders to focus on their specific fields of expertise.

Through VLab, modelers can publish models developed in different programming languages and environments. After being published on VLab, a model becomes available as a resource on the web for machine-to-machine interaction. Using the VLab RESTful APIs (documented in GPP Deliverable D3.2), software developers can build mobile and desktop applications exploiting the framework capabilities to run models. In this way, developers can build applications tailored to end-users, including policy-makers and decision-makers, widening the scope of models and their potential user audience.

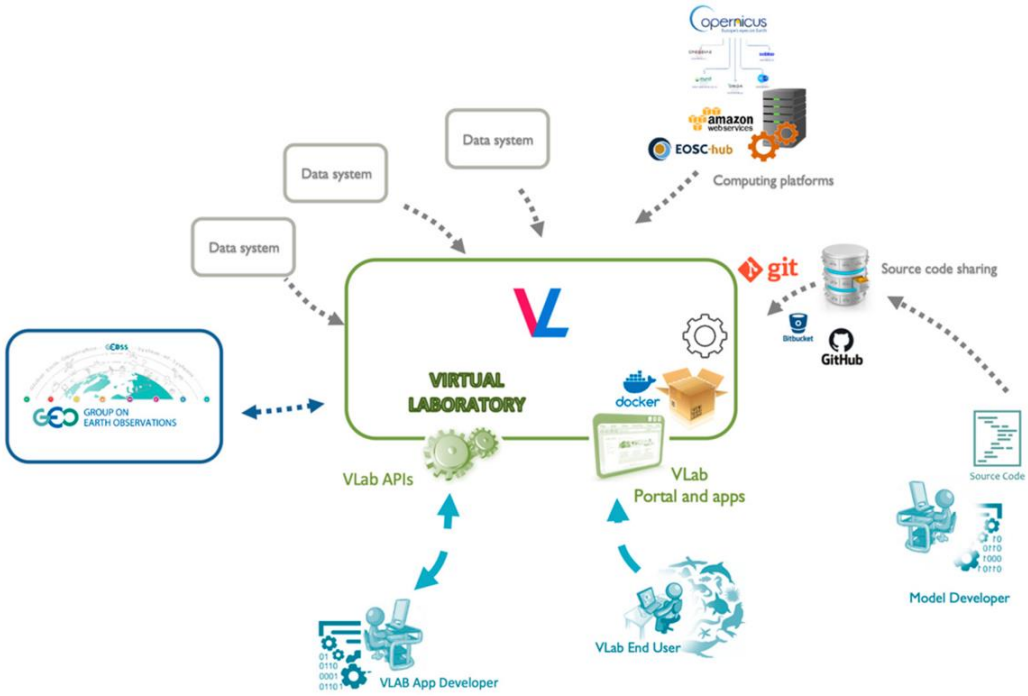

Figure 41 - Conceptual Framework of VLab Experimentation

VLab was developed in the context of different H2020 projects: ECOPotential, ERA-PLANET, ESOC-hub, and EDGE. In the context of GPP project, VLab was improved to support new requirements coming from the identified use cases. In particular, VLab APIs were enhanced to provide additional metadata about the produced outputs and request the execution on a specific cloud platform. Besides, a proof-of-concept component was implemented to enhance the support of multi-cloud environments.

Supporting Open Science Paradigm

In line with the GEO Statement on Open Knowledge, VLab contributes to support the concepts of Reproducibility, Replicability and Reusability – the pillars of the Open Science paradigm. Table 2 lists the current support of these three concepts by the VLab framework.

	Description	Supported	Required Enhancements
Reproducibility	Reproduce an experiment with same data and model implementation	Supported	

Replicability	Replicate an experiment using different data and same model implementation	Partially Supported [Users must know which datasets to use]	Enhancements required to automatically detect datasets which comply (at least syntactically and semantically) with model implementation requirements
Reusability	Reuse/apply the approach in different contexts, change the model implementation and/or data sources	Partially Supported [Same as above + users must know that two implementations realize the same model]	Same as above + need to semantically characterize model implementations

Table 2 - VLab Support for Open Science Paradigm

5. Requirements traceability

5.1 User Requirement traceability

This section presents the traceability matrix between the system required capabilities and the Use cases, User requirements found in document [RD-5] and the Jira Issue, together with the information if the capability has been implemented on the operational platform or the proof of concept.

User Req.	UR Title	Section	System Req.	Use Case	Environment/ JIRA Ticket
UR-AFG-01	A dedicated portal for the AfriGEO community	4.2.2	SR-NFC-002	UC-AFG-01	Delivered Package
UR-AFG-02	The AfriGEO search keywords	4.2.2	SR-NFC-001	UC-AFG-01	Delivered Package
UR-AFG-03	The AfriGEO Region of Interest	4.2.2	SR-NFC-001	UC-AFG-01	Delivered Package
UR-AFG-04	The AfriGEO search domain	4.2.2	SR-NFC-001	UC-AFG-01	Delivered Package
UR-AFG-05	The AfriGEO filtering capabilities	4.2.2	SR-NFC-002	UC-AFG-01	Delivered Package
UR-AFG-06	Accessing data, information and knowledge from AfriGEO	4.2.2	SR-FUN-009	UC-AFG-02	Delivered Package
UR-LDG-01	SDG indicator 15.3.1 computation service discovery	4.2.1	SR-FUN-003	UC-LDG-01	UAT
UR-EIF-01	Discovery of Eiffel Pilot 3 data	4.1.3	SR-FUN-004 SR-FUN-006 SR-FUN-007 SR-FUN-008 SR-FUN-013	UC-EIF-01	UAT
UR-EIF-02	Access and visualization of Eiffel Pilot 3 data	4.1.3	SR-FUN-007 SR-FUN-008 SR-FUN-009 SR-FUN-011	UC-EIF-01	UAT

UR-EIF-03	Discovery of Eiffel Pilot 4 data	4.1.3	SR-FUN-004 SR-FUN-005 SR-FUN-006 SR-FUN-007 SR-FUN-008 SR-FUN-012 SR-FUN-013	UC-EIF-02	UAT
UR-EIF-04	Access and visualization of Eiffel Pilot 4 data	4.1.3	SR-FUN-007 SR-FUN-008 SR-FUN-009 SR-FUN-011	UC-EIF-02	UAT
UR-LDG-02	SDG indicator 15.3.1 computation service execution	4.2.1	SR-FUN-003	UC-LDG-01	UAT, partially
UR-LDG-03	Visual representation of SDG indicator 15.3.1 computations	4.2.3	SR-FUN-003	UC-LDG-01	UAT
UR-LDG-04	My Workspace Dashboard	4.2.4	SR-FUN-003	UC-LDG-01	UAT
UR-LDG-05	Acceptance of the visualizations	4.2.4	SR-FUN-003	UC-LDG-01	UAT
UR-CSP-01	Community Portal package access	4.1.2	SR-FUN-002	UC-COM-01	UAT
UR-CSP-02	Community Portal General Configuration	4.1.2	SR-FUN-002	UC-COM-01	UAT
UR-CSP-03	Views Selection	4.1.2	SR-FUN-002	UC-COM-01	UAT
UR-CSP-04	Views Setup	4.1.2	SR-FUN-002	UC-COM-01	UAT
UR-CSP-05	Link to the Community Portal from the GEOSS Portal	4.1.2	SR-FUN-002	UC-COM-02	UAT
UR-CSP-06	Community Portal information	4.1.2	SR-FUN-002	UC-COM-02	UAT
UR-CSP-07	Administration rights	4.1.2	SR-FUN-002	UC-COM-02	UAT
UR-CSP-08	Add Community Portal in the Community Portal section	4.1.2	SR-FUN-002	UC-COM-02	UAT
UR-YPG-02	Wizard Registration	4.2.6	SR-FUN-001	UC-YPG-01	UAT
UR-YPG-03	Terms of Service Acceptance	4.2.6	SR-FUN-001	UC-YPG-01	UAT
UR-YPG-04	User Notifications	4.2.6	SR-FUN-001	UC-YPG-01	UAT
UR-YPG-05	Data Modification\Deletion Identifier	4.2.6	SR-FUN-001	UC-YPG-01	UAT
UR-YPG-06	Data Provider Account Request	4.2.6	SR-FUN-001	UC-YPG-01	UAT
UR-YPG-07	Search and Visualization of Registered Data Providers	4.2.6	SR-FUN-001	UC-YPG-01	UAT
UR-YPG-08	Widget download		SR-FUN-001	UC-YPG-02	UAT
UR-YPG-09	Widget Installation	4.1.4	SR-FUN-001	UC-YPG-02	UAT
UR-YPG-10	Yellow Pages Authorization	4.2.6	SR-FUN-001	UC-YPG-02	UAT
UR-YPG-11	Yellow Pages Authorization Response	4.2.6	SR-FUN-001	UC-YPG-02	UAT
UR-YPG-12	Data Modification	4.2.6	SR-FUN-001	UC-YPG-02	UAT
UR-YPG-13	Data Provider Account Management	4.2.6	SR-FUN-001	UC-YPG-02	UAT
UR-YPG-14	Data Provider Registration Process Status	4.2.6	SR-FUN-001	UC-YPG-02	UAT

UR-GSA-01	Urban Green Spaces Accessibility Model	4.2.5	SR-FUN-005 SR-FUN-007 SR-FUN-008 SR-FUN-009 SR-FUN-010 SR-FUN-011 SR-FUN-012 SR-FUN-013	UC-GSA-01	In development
UR-GSA-02	GSA Data	4.2.5	SR-FUN-004 SR-FUN-007 SR-FUN-008 SR-FUN-009 SR-FUN-011 SR-FUN-013	UC-GSA-01	In development
UR-ATL-01	Discovery and Access to the EMODnet Marine Physics Datasets	4.2.7	SR-FUN-004 SR-FUN-006 SR-FUN-008 SR-FUN-009 SR-FUN-011 SR-FUN-013	UC-ATC-01	UAT, partially
UR-ATL-02	Discovery and Access to the Brazilian Observatory Service	4.2.7	SR-FUN-005 SR-FUN-006 SR-FUN-007 SR-FUN-008 SR-FUN-009 SR-FUN-011 SR-FUN-012 SR-FUN-013	UC-ATC-02	UAT, partially
UR-MAC-01	Discovery and Access to the EMODnet Chemistry, EU baseline	4.2.8	SR-FUN-004 SR-FUN-006 SR-FUN-007 SR-FUN-008 SR-FUN-009 SR-FUN-011 SR-FUN-013	UC-MAC-01	Delivered Package
UR-MAC-02	Discovery and Access to the EMODnet Chemistry, Marine Litter	4.2.8	SR-FUN-004 SR-FUN-006 SR-FUN-007 SR-FUN-008 SR-FUN-009 SR-FUN-011 SR-FUN-013	UC-MAC-02	Delivered Package
	Above Ground Biomass	4.2.9		UC-JRC-02	UAT

UR-CCP-01	Norovirus Risk Maps Model based on ecological niches	4.2.10	SR-FUN-005 SR-FUN-007 SR-FUN-008 SR-FUN-009 SR-FUN-010 SR-FUN-012 SR-FUN-013	UC-CCP-01	UAT
UR-CCP-02	Norovirus epidemiologic data	4.2.10	SR-FUN-004 SR-FUN-007 SR-FUN-008 SR-FUN-009 SR-FUN-011 SR-FUN-013	UC-CCP-01	UAT
UR-CCP-03	IPCC scenarios data	4.2.10	SR-FUN-004 SR-FUN-007 SR-FUN-008 SR-FUN-009 SR-FUN-011 SR-FUN-013	UC-CCP-01	UAT
UR-CCP-04	Species Distribution data	4.2.10	SR-FUN-004 SR-FUN-007 SR-FUN-008 SR-FUN-009 SR-FUN-011 SR-FUN-013	UC-CCP-01	UAT
UR-CCP-05	GWP/VLab Enhancement	4.2.10	SR-FUN-010	UC-CCP-01	UAT

Table 3. Requirements traceability

5.2 Scenarios vs system required capabilities

#	Code	Title	System Requirements
1.	S1	Resources discovery and access with linked information	SR-FUN-002 – Mirror Site SR-FUN-003 – SDG - 15.3.1 Dashboard SR-FUN-004 – Data discovery (with relationships to associated concepts) SR-FUN-005 – Service Discovery (with relationships to associated concepts) SR-FUN-006 – Information Discovery (with relationships to associated concepts) SR-FUN-007 – Inspection of search results SR-FUN-008 – Selection of search results SR-FUN-009 – Access to selected resource
2.	S2	Service Use	SR-FUN-003 – SDG - 15.3.1 Dashboard SR-FUN-010 – Service execution
3.	S3	Resources Registration	SR-FUN-003 – SDG - 15.3.1 Dashboard SR-FUN-011– Data provision (registration) SR-FUN-012 – Services provision (registration) SR-FUN-013 – Information provision (registration)
4.	S4	Promotion and collaboration.	SR-FUN-011– Data provision (registration) SR-FUN-012 – Services provision (registration) SR-FUN-013 – Information provision (registration)
5.	S5	Data providers (registration)	SR-FUN-001 – Yellow Pages Management
6.	S6	Exploiting discovery and access capabilities	SR-FUN-002 – Mirror Site SR-FUN-003 – SDG - 15.3.1 Dashboard SR-NFC-001 – Configurability of search domain SR-NFC-002 – Portal Customizability
7.	S7	Discovering experiment results	SR-FUN-006 – Information Discovery (with relationships to associated concepts) SR-FUN-007 – Inspection of search results SR-FUN-008 – Selection of search results SR-FUN-009 – Access to selected resource SR-FUN-013 – Information provision (registration)
8.	S8	Reproducing an experiment	SR-FUN-006 – Information Discovery (with relationships to associated concepts) SR-FUN-007 – Inspection of search results SR-FUN-008 – Selection of search results SR-FUN-009 – Access to selected resource SR-FUN-010 – Service execution SR-FUN-013 – Information provision (registration)

#	Code	Title	System Requirements
9.	S9	Replicating an experiment	SR-FUN-003 – SDG - 15.3.1 Dashboard SR-FUN-004 – Data discovery (with relationships to associated concepts) SR-FUN-006 – Information Discovery (with relationships to associated concepts) SR-FUN-007 – Inspection of search results SR-FUN-008 – Selection of search results SR-FUN-009 – Access to selected resource SR-FUN-010 – Service execution SR-FUN-013 – Information provision (registration)
10.	S10	Reusing an experiment	SR-FUN-003 – SDG - 15.3.1 Dashboard SR-FUN-004 – Data discovery (with relationships to associated concepts) SR-FUN-005 – Service Discovery (with relationships to associated concepts) SR-FUN-006 – Information Discovery (with relationships to associated concepts) SR-FUN-007 – Inspection of search results SR-FUN-008 – Selection of search results SR-FUN-009 – Access to selected resource SR-FUN-010 – Service execution SR-FUN-013 – Information provision (registration)

Table 4. Scenarios vs system required capabilities

5.3 System requirement capabilities vs User requirements

#	Code	Title	Linked User Requirements
1.	SR-FUN-001	Yellow Pages Management	UR-YPG-01- Graphic Banner UR-YPG-02- Wizard Registration UR-YPG-03- Terms of Service Acceptance UR-YPG-04- User Notifications UR-YPG-05- Data Modification\Deletion UR-YPG-06 – Data Provider Account Request UR-YPG-07- Search and Visualization of Registered Data Providers UR-YPG-08- Widget download UR-YPG-09- Widget Installation UR-YPG-10 – Yellow Pages Authorization UR-YPG-11 – Yellow Pages Authorization Response UR-YPG-12 – Data Modification UR-YPG-13 – Data Provider Account Management UR-YPG-14 – Data Provider Registration Process Status
2.	SR-FUN-002	Community Portal	UR-CSP-01 – Community Portal package access UR-CSP-02 – Community Portal General Configuration UR-CSP-03 – Views Selection UR-CSP- 04 - Views Setup UR-CSP-05 - Request to link a Community Portal UR-CSP-06 – Community Portal information UR-CSP-07 – Administration rights UR-CSP-08 – Linking a Community Portal
3.	SR-FUN-003	SDG – 15.3.1 Dashboard	UR-LDG-01 – SDG indicator 15.3.1 computation service discovery UR-LDG-02 – SDG indicator 15.3.1 computation service execution UR-LDG-03 – Visual representation of SDG indicator 15.3.1 computations UR-LDG-04 – My Workspace Dashboard UR-LDG-05- Acceptance of the visualizations
4.	SR-FUN-004	Data Discovery (with relationships to associated concepts)	UR-EIF-01 – Discovery of Eiffel Pilot 3 data UR-EIF-03 – Discovery of Eiffel Pilot 4 data UR-ATL-01 – Discovery and Access to the EMODnet Marine Physics Datasets UR-MAC-01 – Discovery and Access to the EMODnet Chemistry, EU baseline UR-MAC-02 – Discovery and Access to the EMODnet Chemistry, Marine Litter UR-CCP-02 - Norovirus epidemiologic data UR-CCP-03 – IPCC scenarios data UR-CCP-04 – Species Distribution data UR-GSA-02 – GSA Data

#	Code	Title	Linked User Requirements
5.	SR-FUN-005	Service Discovery (with relationships to associated concepts)	UR-LDG-01 – SDG indicator 15.3.1 computation service discovery UR-EIF-03 – Discovery of Eiffel Pilot 4 data UR-ATL-02 – Discovery and Access to the Brazilian Observatory Service UR-CCP-01 - Norovirus Risk Maps Model based on ecological niches. UR-GSA-01 – Urban Green Spaces Accessibility Model
6.	SR-FUN-006	Information Discovery (with relationships to associated concepts)	UR-LDG-05- Acceptance of the visualizations UR-AFG-06 - Accessing data, information and knowledge from AfriGEOSS UR-ATL-01 – Discovery and Access to the EMODnet Marine Physics Datasets UR-ATL-02 – Discovery and Access to the Brazilian Observatory Service UR-MAC-01 – Discovery and Access to the EMODnet Chemistry, EU baseline UR-MAC-02 – Discovery and Access to the EMODnet Chemistry, Marine Litter UR-EIF-01 – Discovery of Eiffel Pilot 3 data UR-EIF-03 – Discovery of Eiffel Pilot 4 data
7.	SR-FUN-007	Inspection of search results	UR-LDG-01 – SDG indicator 15.3.1 computation service discovery UR-LDG-04 – My Workspace Dashboard UR-LDG-05- Acceptance of the visualizations UR-EIF-01 – Discovery of Eiffel Pilot 3 data UR-EIF-02 – Access and visualization of Eiffel Pilot 3 data UR-EIF-03 – Discovery of Eiffel Pilot 4 data UR-EIF-04 – Access and visualization of Eiffel Pilot 4 data UR-AFG-06 - Accessing data, information and knowledge from AfriGEOSS UR-ATL-02 – Discovery and Access to the Brazilian Observatory Service UR-MAC-01 – Discovery and Access to the EMODnet Chemistry, EU baseline UR-MAC-02 – Discovery and Access to the EMODnet Chemistry, Marine Litter UR-CCP-01 - Norovirus Risk Maps Model based on ecological niches UR-CCP-02 - Norovirus epidemiologic data UR-CCP-03 – IPCC scenarios data UR-CCP-04 – Species Distribution data UR-GSA-01 – Urban Green Spaces Accessibility Model UR-GSA-02 – GSA Data
8.	SR-FUN-008	Selection of search results	UR-LDG-01 – SDG indicator 15.3.1 computation service discovery UR-LDG-04 – My Workspace Dashboard UR-LDG-05- Acceptance of the visualizations UR-EIF-01 – Discovery of Eiffel Pilot 3 data UR-EIF-02 – Access and visualization of Eiffel Pilot 3 data

#	Code	Title	Linked User Requirements
			UR-EIF-03 – Discovery of Eiffel Pilot 4 data UR-EIF-04 – Access and visualization of Eiffel Pilot 4 data UR-AFG-06 - Accessing data, information and knowledge from AfriGEOSS UR-ATL-01 – Discovery and Access to the EMODnet Marine Physics Datasets UR-ATL-02 – Discovery and Access to the Brazilian Observatory Service UR-MAC-01 – Discovery and Access to the EMODnet Chemistry, EU baseline UR-MAC-02 – Discovery and Access to the EMODnet Chemistry, Marine Litter UR-CCP-01 - Norovirus Risk Maps Model based on ecological niches UR-CCP-02 - Norovirus epidemiologic data UR-CCP-03 – IPCC scenarios data UR-CCP-04 – Species Distribution data UR-GSA-01 – Urban Green Spaces Accessibility Model UR-GSA-02 – GSA Data
9.	SR-FUN-009	Access to selected resource	UR-LDG-01 – SDG indicator 15.3.1 computation service discovery UR-LDG-04 – My Workspace Dashboard UR-LDG-05- Acceptance of the visualizations UR-AFG-06 - Accessing data, information and knowledge from AfriGEOSS UR-EIF-02 – Access and visualization of Eiffel Pilot 3 data UR-EIF-04 – Access and visualization of Eiffel Pilot 4 data UR-ATL-01 – Discovery and Access to the EMODnet Marine Physics Datasets UR-ATL-02 – Discovery and Access to the Brazilian Observatory Service UR-MAC-01 – Discovery and Access to the EMODnet Chemistry, EU baseline UR-MAC-02 – Discovery and Access to the EMODnet Chemistry, Marine Litter UR-MAB-01 – Discovery and Access to the EMODnet Bathymetry services UR-CCP-01 - Norovirus Risk Maps Model based on ecological niches UR-CCP-02 - Norovirus epidemiologic data UR-CCP-03 – IPCC scenarios data UR-CCP-04 – Species Distribution data UR-GSA-01 – Urban Green Spaces Accessibility Model UR-GSA-02 – GSA Data
10.	SR-FUN-010	Service Execution	UR-LDG-02 – SDG indicator 15.3.1 computation service execution UR-LDG-04 – My Workspace Dashboard UR-CCP-01 - Norovirus Risk Maps Model based on ecological niches UR-CCP-05 – GWP/VLab Enhancement

#	Code	Title	Linked User Requirements
			UR-GSA-01 – Urban Green Spaces Accessibility Model
11.	SR-FUN-011	Data Provision (Registration)	UR-EIF-02 – Access and visualization of Eiffel Pilot 3 data UR-EIF-04 – Access and visualization of Eiffel Pilot 4 data UR-ATL-01 – Discovery and Access to the EMODnet Marine Physics Datasets UR-ATL-02 – Discovery and Access to the Brazilian Observatory Service UR-MAC-01 – Discovery and Access to the EMODnet Chemistry, EU baseline UR-MAC-02 – Discovery and Access to the EMODnet Chemistry, Marine Litter UR-CCP-02 - Norovirus epidemiologic data UR-CCP-03 – IPCC scenarios data UR-CCP-04 – Species Distribution data UR-GSA-01 – Urban Green Spaces Accessibility Model UR-GSA-02 – GSA Data
12.	SR-FUN-012	Service Provision (Registration)	UR-LDG-01 – SDG indicator 15.3.1 computation service discovery UR-LDG-02 – SDG indicator 15.3.1 computation service execution UR-ATL-02 – Discovery and Access to the Brazilian Observatory Service UR-EIF-03 – Discovery of Eiffel Pilot 4 data UR-CCP-01 - Norovirus Risk Maps Model based on ecological niches UR-GSA-01 – Urban Green Spaces Accessibility Model
13.	SR-FUN-013	Information Provision (Registration)	UR-LDG-03 – Visual representation of SDG indicator 15.3.1 computations UR-ATL-01 – Discovery and Access to the EMODnet Marine Physics Datasets UR-ATL-02 – Discovery and Access to the Brazilian Observatory Service UR-MAC-01 – Discovery and Access to the EMODnet Chemistry, EU baseline UR-MAC-02 – Discovery and Access to the EMODnet Chemistry, Marine Litter UR-EIF-01 – Discovery of Eiffel Pilot 3 data UR-EIF-03 – Discovery of Eiffel Pilot 4 data UR-CCP-01 - Norovirus Risk Maps Model based on ecological niches UR-CCP-02 - Norovirus epidemiologic data UR-CCP-03 – IPCC scenarios data UR-CCP-04 – Species Distribution data UR-GSA-01 – Urban Green Spaces Accessibility Model UR-GSA-02 – GSA Data
14.	SR-NFC-001	Configurability of search domain	UR-AFG-02 - The AfriGEO search keywords UR-AFG-03 - The AfriGEO Region of Interest UR-AFG-04 – The AfriGEO search domain
15.	SR-NFC-002	Portal customizability	UR-AFG-01 - A dedicated portal for the AfriGEO community

#	Code	Title	Linked User Requirements
			UR-AFG-05 - The AfriGEO filtering capabilities

Table 5. System vs User Requirements Traceability

Annex A. References

[RD-1] D2.1 Use Cases Description and User Requirements Document – v1.0

[RD-2] D2.2 Functional and non-functional enhancements specification - v1.0

[RD-3] D3.2 Enhanced GEOSS Platform User Manual v1 with 1st set of applications

[RD-4] D3.3 The GEOSS Overarching Architecture

[RD-5] D2.3 Use Cases Description and User Requirements Document – v2.0

[RD-6] D2.4 Functional and non-functional enhancements specification v2.0

[RD-7] D3.2 Enhanced GEOSS Platform User Manual v2 with second set of applications

[WR-1] https://www.earthobservations.org/article.php?id=458

Annex B. Figures and Tables

List of Figures

List of Tables

Annex C. GEO DAB Standards

The table below provides an overview of all the standards handled by the GEO DAB

OGC CSW 2.0.2 AP ISO 1.0	INPE
OGC CSW 2.0.2 ebRIM EO	CKAN/DKAN
OGC CSW 2.0.2 ebRIM CIM	DCAT
ESRI GEOPORTAL 10	GI-cat
OAI-PMH 2.0	ESRI GEOPORTAL 10
OpenSearch 1.1	NCML-OD
OpenSearch 1.1 ESIP	BCODMO
OpenSearch GENESI DR	NCML-CF
CKAN	NetCDF-CF 1.4
CUAHSI HIS-Central	FTP populated with supported metadata types
ESRI REST API 10.3	WAF Web Accessible Folders
OGC WCS	GeoNetwork (2.2.0 or greater)
OGC WMS	Ecological Markup Language 2.1.1
OGC WFS 1.0.0, 1.1.0, 2.0.0	NERRS (National Estuarine Research Reserve System)
OGC WMTS	HMA CSW 2.0.2 ebRIM/CIM
OGC SOS 1.0.0, 2.0.0, 2.0.0 Hydro Profile	HDF
OGC WPS 1.0.0	IADC DB (MySQL)
OGC CSW 2.0.0 Core	GrADS-DS
OGC CSW 2.0.2 AP ISO 1.0	FedEO
OGC CSW 2.0.2 ebRIM/EO AP	ARPA DB (based on Microsoft SQL)
OGC CSW 2.0.2 ebRIM/CIM AP	ESRI Map Server
IRIS Station	SHAPE files (FTP)
IRIS Event	KISTERS Web - Environment of Canada
HYRAX THREDDS SERVER 1.9	Environment Canada Hydrometric data (FTP)
OAI-PMH 2.0 - Harvesting	OpenSearch 1.1
GBIF	Earth Engine
DIF	RASAQM
HYDRO	EGASKRO
UNAVCO	SITAD (Sistema Informativo Territoriale Ambientale Diffuso)
CDI 1.04, 1.3, 1.4	File System
ISO19115-2	GDACS
THREDDS 1.0.1, 1.0.2	GeoRSS 2.0
THREDDS-NCISO 1.0.1, 1.0.2	Degree catalog service 2.2
THREDDS-NCISO-PLUS 1.0.1, 1.0.2	OpenSearch GENESI DR
Healthsites API Json	

Table 6 - Standards handled by the GEO DAB

Annex D. Terminology

Acronyms and Abbreviations

EDGE	European Direction in GEOSS Common Infrastructure Enhancements
BON	Biodiversity Observation Network
CA	Consortium Agreement
CAMS	Copernicus Atmosphere Monitoring Service
C3S	Copernicus Climate Change Service
CEOS	Committee on Earth Observation Satellites
CLMS	Copernicus Land Monitoring Service
CMEMS	Copernicus Marine Environment Monitoring Service
CNR-IIA	Consiglio Nazionale delle Ricerche – Istituto per l'Inquinamento Atmosferico
CO	Confidential
DESCA	Development of a Simplified Consortium Agreement
DEL	Deliverable
DG	Directorate-General
DN	Direct Negotiation
DOW	Description of Work
EAB	External Advisory Board
EC	European Commission
EGU	European Geosciences Union
EMS	Emergency Management Service
EO	Earth Observation
EOP	Earth Observation Programme
ESA	European Space Agency
ESAW	European Ground System Architecture Workshop
ESRIN	European Space Research Institute
EU	European Union
FP7	Seventh Framework Programme
GA	Grant Agreement
GCI	GEOSS Common Infrastructure
GEO	Group on Earth Observation
GEO DAB	GEO Discovery and Access Broker
GEOSS	Global Earth Observation System of Systems
GFOI	Global Forest Observation Initiative
GLAM	Global Agriculture Monitoring
GPE	GEOSS Portal Enhancements
GSNL	Geohazard Supersites and Natural Laboratories
GWOS	Global Wetlands Observing System
H2020	Horizon 2020

INT	Internal Note
IPR	Intellectual Property Right
JRC	Joint Research Centre
MOM	Minutes of Meeting
OTH	Other
PD	Project Director
PP	Programme Participants
PQMP	Project Quality Management Plan
PRE	Presentation
PSB	Project Strategic Board
PU	Public Usage
QA	Quality Assurance
QAS	Quality Assurance Support
RE	Restricted
SDG	Sustainable Development Goal
SUS	System Usability Scale
TBD	To Be Defined
TEP	Thematic Exploitation Platform
UNICEF	United Nations International Children's Emergency Fund
USGS	United States Geological Survey
UTB	User and Technical Board
WBS	Work Breakdown Structure
WGISS	Working Group on Information Systems and Services
WP	Work Package
WPL	Work Package Leader
UTF-8	8-bi Unicode Transformation Format
UTC	Coordinated Universal Time
RDBMS	Relational Database Management System
DDL	Data Definition Language
DML	Data Manipulation Language
TCL	Transaction Control Language
SMTP	Simple Mail Transfer Protocol
SSL	Secure Sockets Layer
TLS	Transport Layer Security
SPA	Single-page Application
API	Application Programming Interface
REST	Representational State Transfer
CORS	Cross-Origin Resource Sharing
CSP	Content Security Policy

Table 7 - Acronyms and Abbreviations