GEOSS Platform Plus

D3.8 - Version 1.0

Enhanced GEOSS Platform User Manual v3 with 3nd Set of Applications

Workpackage:	WP3	GEOSS Evolution design, development, integration and deployment	
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Author(s):	GPP Team		
Authorized by	Joost van Bemmelen		ESA
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Dissemination Level	PU		

Abstract:

This document describes the evolved GEOSS Platform, in terms of capabilities and applications offered and of instructions for using them. In the context of the proposed GPP vision of moving towards a Digital Ecosystem, it regards the advanced GEOSS Portal, GEO DAB (also in terms of APIs, and of instructions for using them), Yellow Pages, new middleware enhancements and applications that use these as from all three project cycle.

Document Log

Date	Author	Changes	Version	Status
29/11/2024	GPP Team	See section 1.3	1.0	Issued

Executive Summary

GEOSS Platform Plus (GPP) evolved the European GEOSS Platform components - which have the aim of linking GEO users with resource providers - in response to call H2020-IBA-CROSS-GEOSS-2021 delivery of knowledge for climate adaptation and mitigation through the GEOSS (Global Earth Observation System of Systems) infrastructure. Evolutions have been implemented considering the GPP vision of moving the Global Earth Observation System of Systems (GEOSS) towards a Digital Ecosystem and with a focus on re-enforcing the GEO Communities involvement and contribution to GEOSS. To achieve its goal, GPP besides evolving user-discovery and access to data, dedicated major efforts to improve the use of these data to generate actionable information by exploiting the GEOSS Platform functionalities and contributing to the GEOSS ecosystem by providing new functionalities, applications, tools and middleware components to benefit users and communities. With this in mind, the GPP project starts from the Applications needed by the different communities to integrate, expand and exploit all the functionalities implemented and made available through and within the platform. In particular, in this document, users can find step by step guidance regarding the functionalities implemented, interfaced and integrated within the GEOSS Platform and other GEOSS middleware components at large.

The main content of the document is divided into two sections: the first one is dedicated to GEOSS Platform Operational Components and the second to the GEOSS Platform implementations.

The Portal is an online web map-based user interface which allows users to discover and access Earth observation data and heterogeneous collections from satellites, airplanes, drones and in-situ sensors at global, regional and local scales, from different providers from all over the world. It connects users to providers, by allowing users to discover and access to existing databases and portals, to provide reliable, up-to-date and user-friendly information – vital for the work of decision makers, and non-specialists in general managers and allow to use data by generating actionable information.

1. Introduction

1.1 Purpose and Scope

This document (D3.8 - *Enhanced GEOSS Platform User Manual v3 with 3rd 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 objective of this document is to provide the necessary documentation for using the evolved GEOSS Platform components, instruments, and new data sources, in terms of functionalities and applications offered and of instructions for using them. It regards the enhancements at different GEOSS levels (architectural, middleware, applications) and GEOSS Platform components as the GEOSS Portal, GEO DAB (also in terms of APIs, and of instructions for using them), and new middleware enhancements driven by identified applications. The developments and enhancements have been technically described in the [RD-2], [RD-6] and [RD-9], following the specification as identified and documented in the context of WP2 in the documents [RD-3], [RD-7] and [RD-10], Functional and Non-functional Enhancements Specification, that underpin the user needs elicited and analysed in the context of the documents [RD-4], [RD-8] and [RD-11], Use Cases Description and User Requirements Document.

The target audience is the wide variety of the GEOSS Portal users but also of the GEO-DAB APIs, including specific user communities, who want to reuse functionalities of the GEOSS Platform in their own portals or wish to have or trigger actionable information all in one place.

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: GEOSS Platform Operational Components: describes the GEOSS Platform interfaces and how to operate them.
- Section 4: GEOSS Platform Implementations: describe applications and provide a step by step guide to use them.
- Annex A: References, List the references used in the document.
- Annex B: Figures and Tables, Provides links to figures and tables in the document.
- Annex C: Terminology, explains the meaning of the acronyms and definitions used in the document.

The document collects contributions from all the partners involved in the GEOSS Platform Plus (GPP) project. The authors are listed below, along with their affiliation:

- Joost van Bemmelen, ESA
- Daniele Giordani, Engineering Support Service (ESS) for ESA
- Eliana Li Santi, Engineering Support Service (ESS) for ESA
- Manuela Marabucci, Engineering Support Service (ESS) for ESA
- Paolo Mazzetti, CNR

- Mattia Santoro, CNR
- Roberto Roncella, CNR
- Fabrizio Papeschi, CNR
- Gregory Giuliani, UNIGE
- Yaniss Guigoz, UNIGE
- Bruno Chatenoux, UNIGE
- Oleksandr Pakhomovk, Eversis
- Piotr Krupa, Eversis
- Daniel Biskupski, Eversis
- Konrad Kajszczak, Eversis
- Maciej Myśliwczyk, Eversis
- Aleksandra Marczuk, Eversis
- Małgorzata Herman, Eversis
- Dominik Sawicki, Eversis
- Johannes Peterseil, Umweltbundesamt GmbH, EAA, AT for AGAME consortium
- Christoph Wohner, Umweltbundesamt GmbH, EAA, AT for AGAME consortium
- Ulf Mallast, Helmholtz-Zentrum für Umweltforschung GmbH, UFZ, DE for AGAME consortium
- Anna Spinosa, Stichting Deltares, NL for AGAME consortium
- Valeria Mobilia, Stichting Deltares, NL for AGAME consortium
- Mario Fuentes Monjaraz, Stichting Deltares, NL for AGAME consortium
- Hendrik Boogaard, Wageningen Environmental Research (WENR), Wageningen University & Research
- Arun Pratihast, Wageningen Environmental Research (WENR), Wageningen University & Research
- Juan Carlos Laso Bayas, International Institute for Applied Systems Analysis (IIASA)
- Jeroen Degerickx, Vlaamse Instelling Technologisch Onderzoek (VITO)

1.3 Changes with respect to the previous version

During the third application cycle, compared to the previous document GPP-WP3-DEL-D3.5-v1.0 D3.5 Enhanced GEOSS Platform User Manual v2 with 2nd set of applications, the following sections have been updated:

Section	Descriptions
1.2	Added the list of authors
2.2	The section “Architecture” has been moved in the “Rationale and Context” section

The following sections have been added:

Section	Descriptions
2.2.3	Towards a GEOSS Digital Ecosystem
4.7	Above Ground Biomass (AGB) estimation using Machine Learning Techniques

4.8	NewLife4DryLands Use Case
4.9	AGAME
4.10	Maps4GPP
4.11	SDG11.7: Accessibility to urban green areas
4.12	GEOSS Platform Landing Page
4.13	AI based search

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).

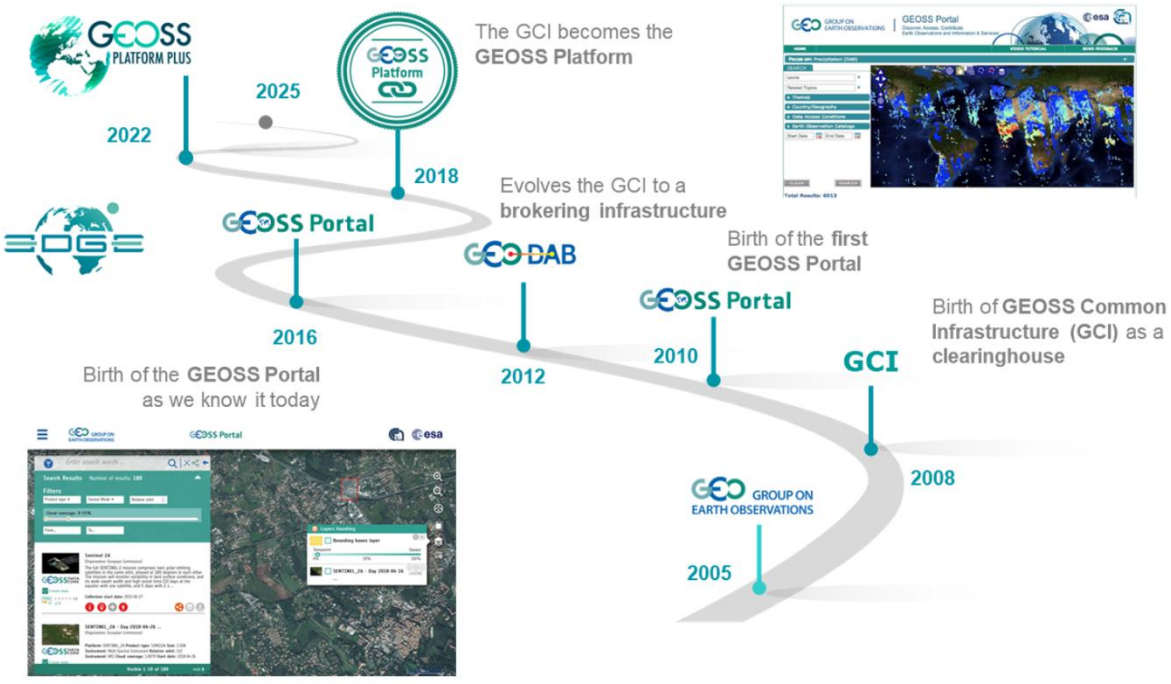


Figure 1 - The GEOSS Platform Journey

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, GEO Work Programme (GWP) activities, initiatives and flagships and including European efforts in the Climate Change (CC) and green deal frameworks (see Figure 2 and Figure 3).

Figure 2 - GEOSS Platform Components

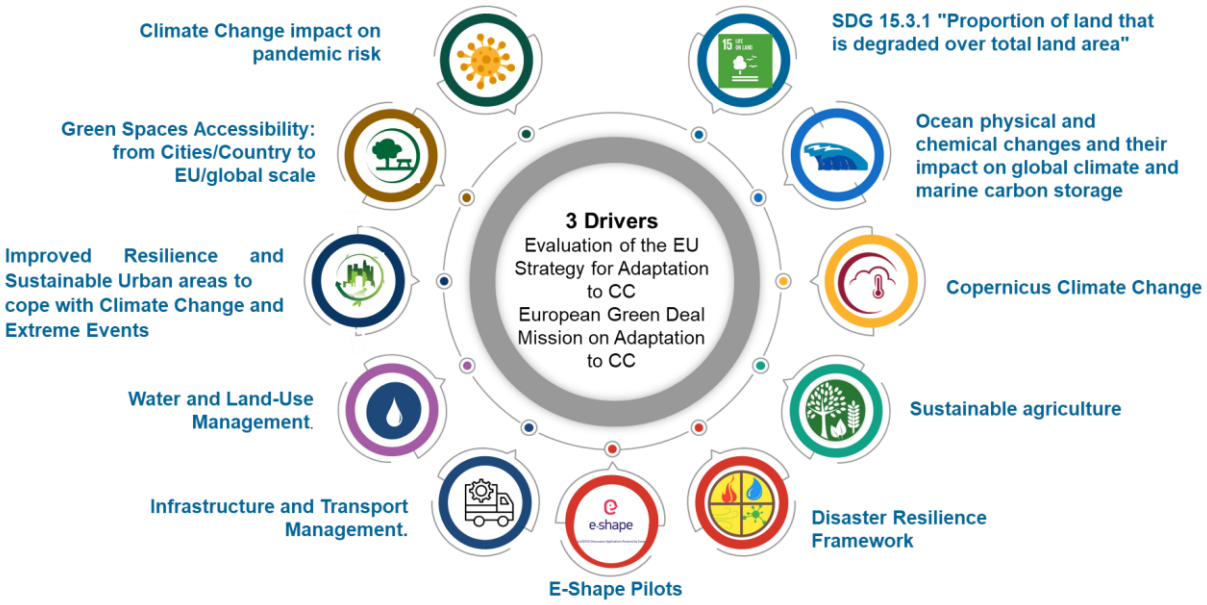


Figure 3 - The GPP Drivers and focus domains

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, 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.

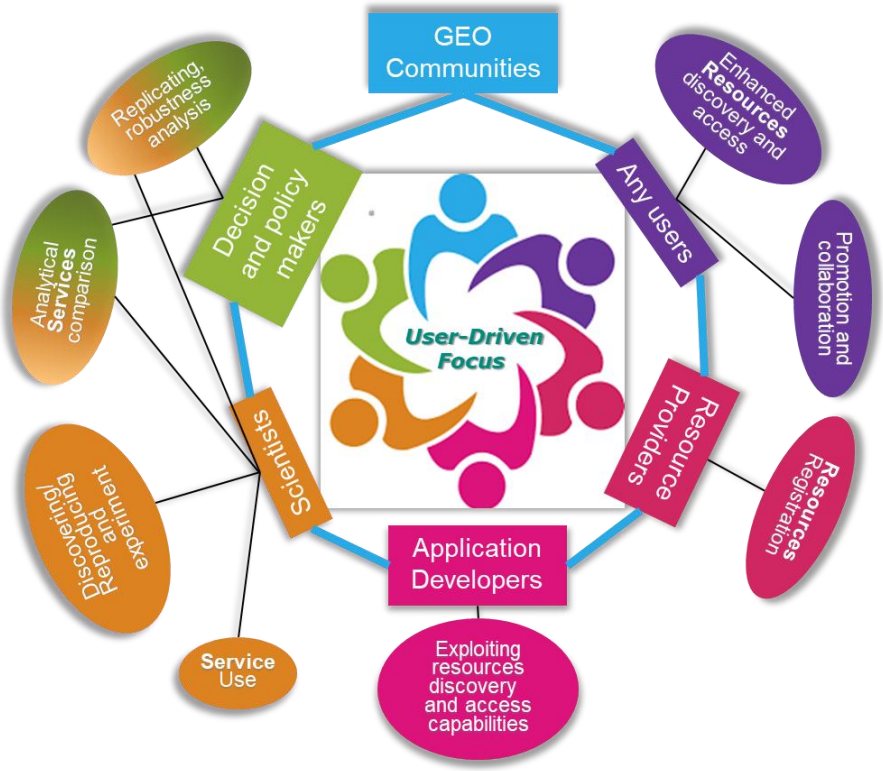


Figure 4 GPP User types and functionalities

2.2 Architecture

2.2.1 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 Societal Benefit Area (SBA), Copernicus-service, ESA Thematic Exploitation Platform (TEP) community, Sustainable Development Goal (SDG), Paris Agreement Target, 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.

During the project, a set of challenges were analysed along with possible solutions, including:

- From discovery and access of data only to discovery and access of data, 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 the GEOSS ecosystem.
- From an obsolete discovery-download process to leveraging cloud technologies supporting **multi-Cloud approach** for actionable information generation.

Figure 5 shows the current relations and the main service components (i.e. infrastructures and platforms) to be considered as part of the GEO/GEOSS landscape.

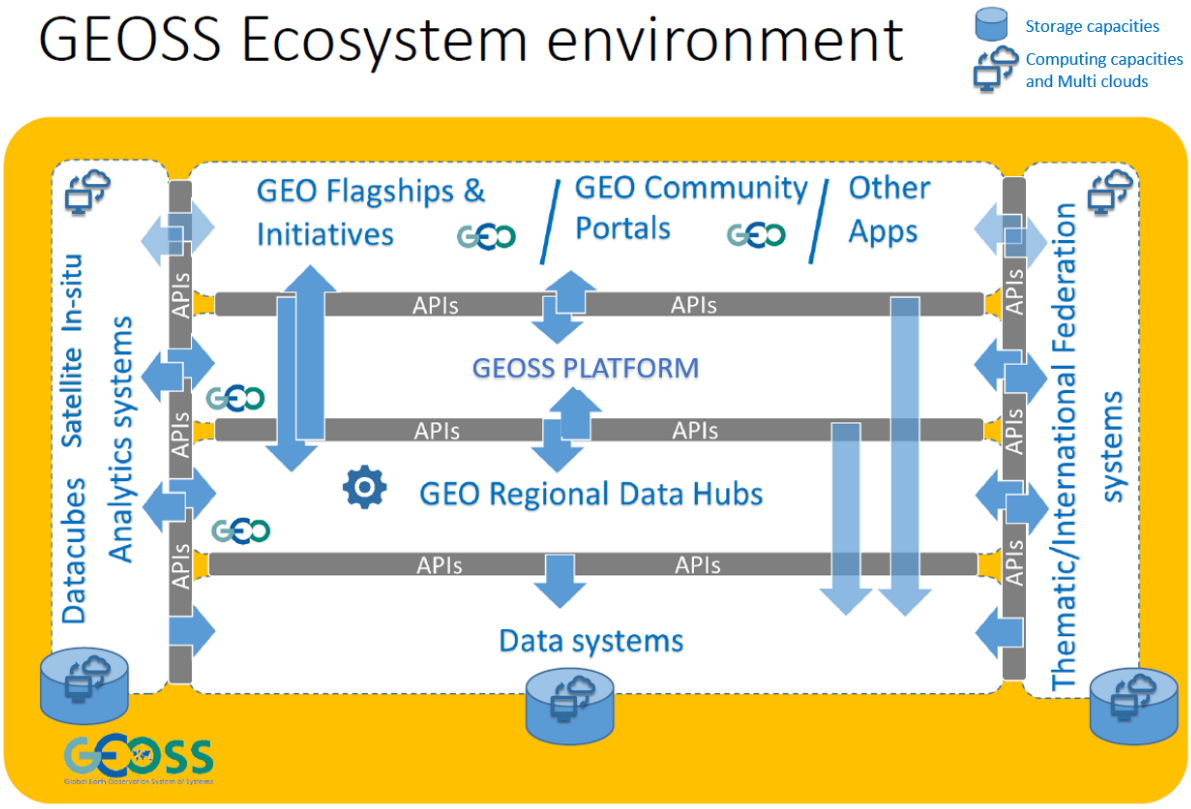


Figure 5 – Current GEOSS landscape for infrastructures and platforms to be considered.

2.2.2 The GEOSS Portal and GEO DAB architecture

Looking at the Figure 5, 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.

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.

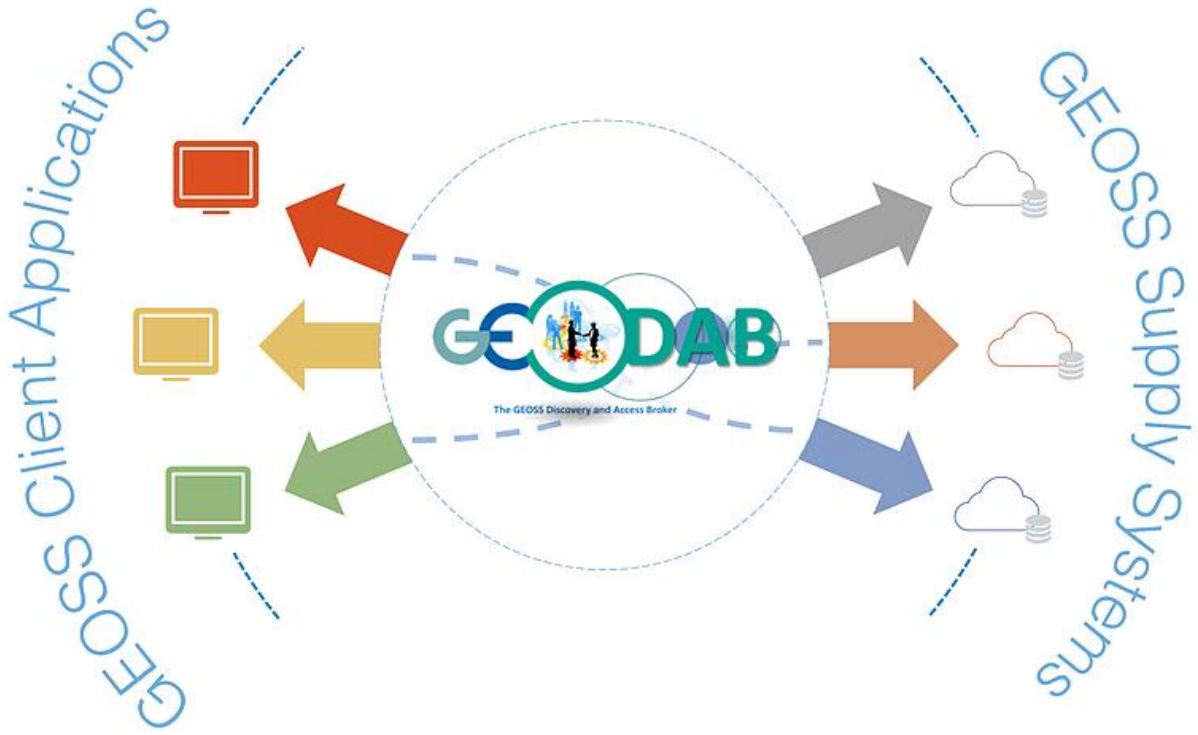


Figure 6 - GEOSS Portal and GEO-DAB interfaces

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.

2.2.3 Towards a GEOSS Digital Ecosystem

The GPP Vision for GEOSS Evolution [RD-12] provides a high-level vision for the future GEO Infrastructure (formerly GEOSS) and, also, a proposal for possible GPP contributions. The document outlines the GPP vision for the evolution of the Global Earth Observation System of Systems (GEOSS) into a Digital Ecosystem (DE) to better address the needs of decision-makers and other stakeholders. The envisioned GEOSS Digital Ecosystem is a forward-looking approach that aims to create a flexible, adaptive environment for knowledge generation and sharing, supported by a robust governance framework and technological integration.

The GEOSS Platform currently represents the midstream layer that enables access and exploitation of EO and non-EO data and other resources (upstream) made available by the providers, in a form that is easily exploitable by (downstream) applications, which are then utilized by the final users.

The GEOSS Platform Plus (GPP) project, in close collaboration with the GEO partners, evolved the European GEOSS Platform components, i.e., the GEOSS Portal, the GEO Discovery and Access Broker and the GEOSS Yellow Pages. Looking at the Core Digital Ecosystem Enablers initially identified in D3.6, it is easy to recognize that these are covered, at least partially, by the current GEOSS Platform components.

Besides, through the development of its use cases, GPP provided a significant contribution in assessing the proposed vision of the GEOSS Digital Ecosystem. In fact, use cases build on top of existing European GEOSS Platform components (which, as observed in previous section, can be considered as first implementations of GEOSS Ecosystem Enablers) and, when needed, develop prototypes of the missing middleware components. Thus, on one hand, GPP use cases can be used to validate the use of European GEOSS Platform components as early implementations of Core Digital Ecosystem Enablers; on the other hand, GPP use cases can be used to prototype new components with the aim of demonstrating how the GEOSS digital ecosystem can be enriched by third-party actors (i.e., intermediate users) and how they could interface and interoperate with the Digital Ecosystem.

In D3.6, we analyze how the developments of GPP use cases contribute to demonstrate the GPP Vision of a GEOSS Digital Ecosystem and its way forward, allowing different actors to contribute to the GEOSS Digital Ecosystem, by providing new tools, services, applications, middleware and other third-party components which exploit and enrich the GEOSS DE.

2.3 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

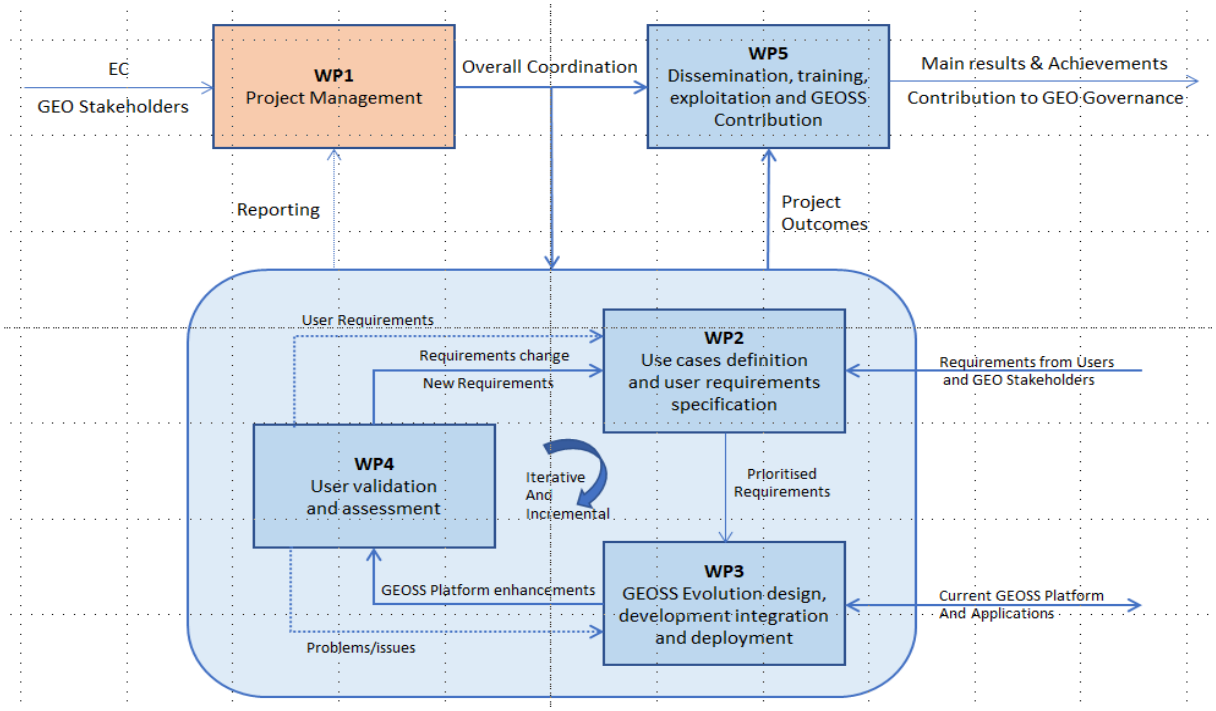


Figure 7 - GPP Work-packages and their relationships

WP3 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. GEOSS Platform Operational Components

3.1 GEOSS Portal

The GEOSS portal - available at www.geoportal.org – has the objective to provide an intuitive and user-friendly interface to allow users and GEO communities to exploit at the maximum extent the discoverability and access to data.

3.1.1 Welcome Screen

Figure 8 - The GEOSS Portal Welcome screen

At the top opening of the portal, you will see a map of the world with a search bar in the centre, a series of icons on the right and header on the top of page.

The header on the top of page includes:

1. The option or hamburger menu icon;
2. GEOSec logo – linked to the GEO Site (http://www.earthobservations.org/).
3. GEOSS Portal logo – linked to geoportal home page;
4. CNR IAA logo linked to the CNR IAA (http://www.iia.cnr.it).
5. ESA logo linked to the ESA site (http://www.esa.int).
6. The Switch language option.

The Search panel in the centre of page includes the following options:

7. Filters;
8. Search button;
9. Share search;
10. Clear search;

11. Hide/Show Search Bar;
12. Targeted/Advanced search.

Icons on the right for basic GIS (Geographical Information System) functionality include:

13. area of interest.
14. layers.

In the bottom right corner there are also:

15. An envelope icon with “Send Feedback” option.
16. The map scale.
17. And the “Tutorial mode” icon that will guide the user to the different icons and provide info on their usage.
18. Tutorial YouTube Channel

3.1.2 Option Menu

Click on the “hamburger menu” icon on the header to open the option menu. You can find the following section:

- About.
- User Support.
- Community Portals.
- Yellow Pages.
- Statistics (to use this section you must have a registered account)
- My workspace (personalized workspace and retrieve information regarding popular/ most used searches)
- Sign-in.

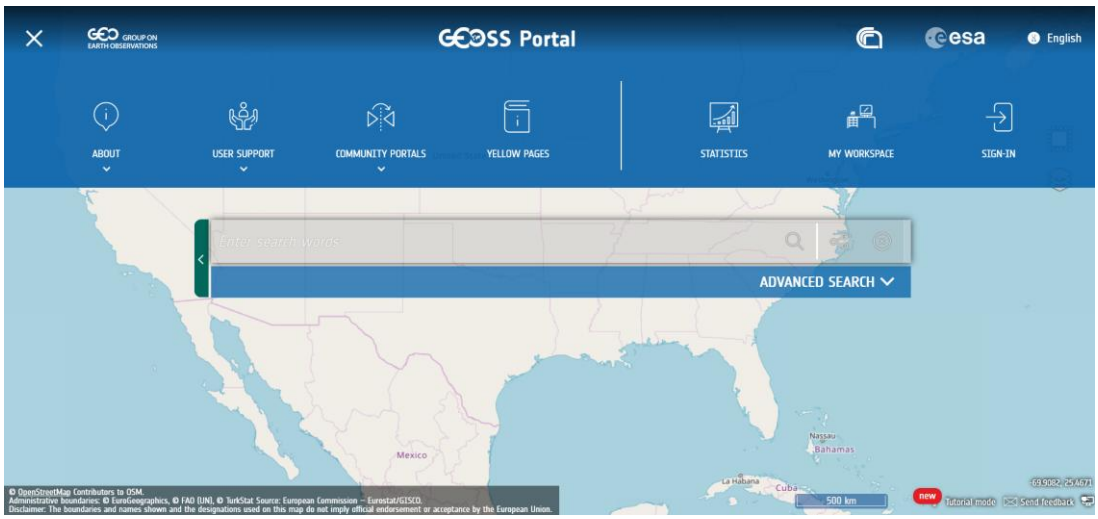


Figure 9 - The GEOSS Portal option menu

3.1.2.1 About Section

The About section contains the following 3 links:

- **General information**
- **Terms & Condition**
- **Release notes**

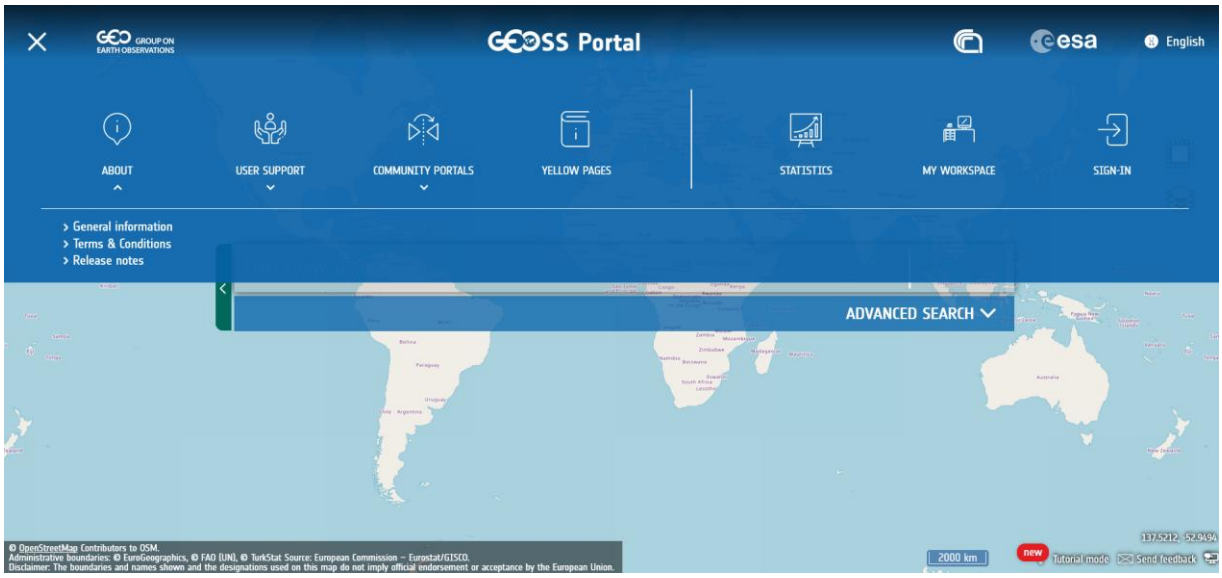


Figure 10 - About section

3.1.2.2 User support Section

The User Support section contains the following links:

- **Help Desk**: clicking on this link you can access to some services like a General information, GEOSS Portal Video tutorial, contact points, provide feedback, info for developers, FAQ.
- **Documentation**: latest updated documents.
- **Tutorials**: you can find some examples of GEOSS Platform and Video Tutorial
- **Highlighted searches**: you can find some prefilled searches

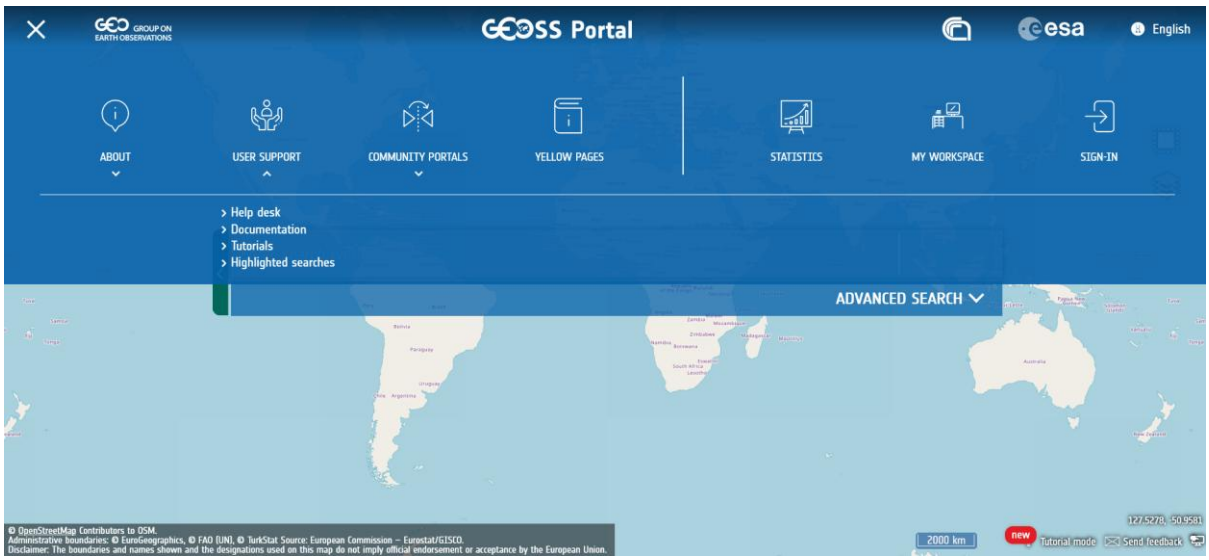


Figure 11 - User Support section

3.1.2.3 Community Portals Section

In this sub-menu you can find the existing community portals where have been implemented some customized views to manage specific data for the community purposes.

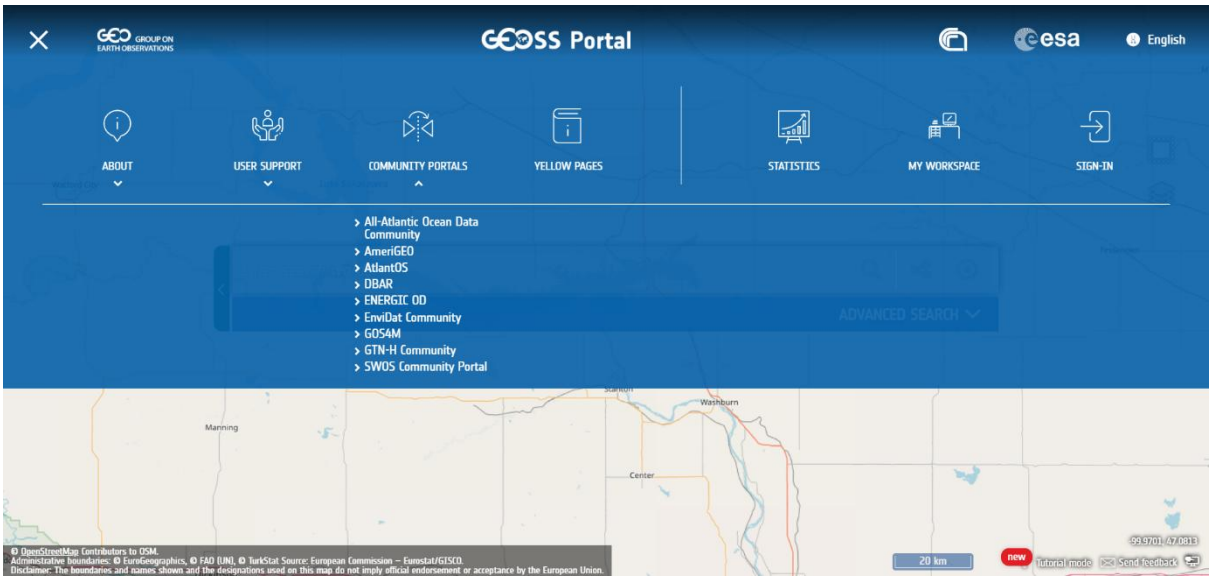


Figure 12 - Community Portals section

3.1.2.4 Yellow Pages section

The yellow pages section contains the list of registered providers for the GEOSS Portal

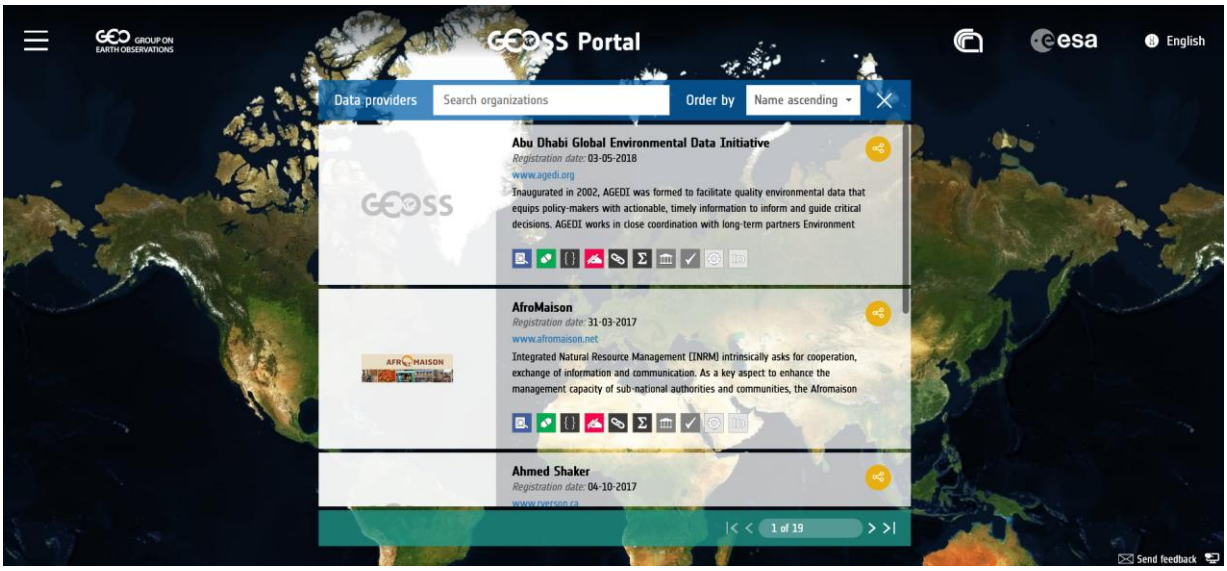


Figure 13 - Yellow pages section

3.1.2.5 Sign-in

In order to obtain credentials to log-in open the Hamburger menu on the top-left corner of the GEOSS Portal website and click on the item Sign-in.

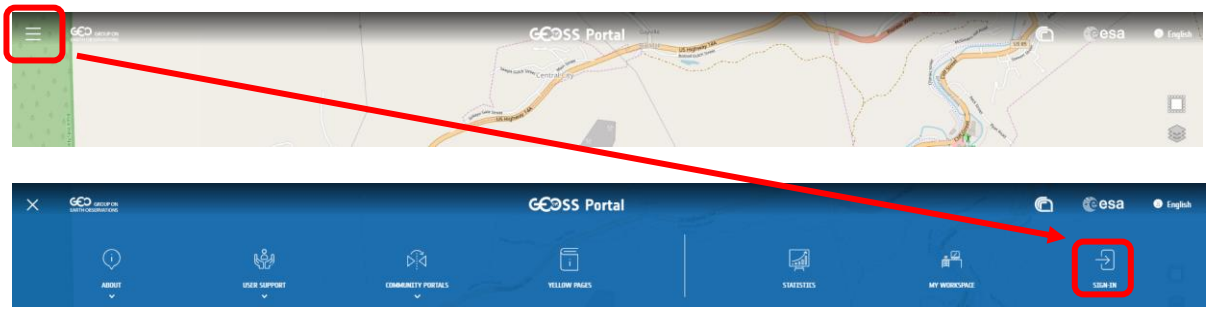


Figure 14 - The Sign-in item

3.1.2.5.1 Special features for logged users

Logged users have more options in portal e.g., can save searches, save runs, bookmark results. They can also see and save as pdf/csv statistics.

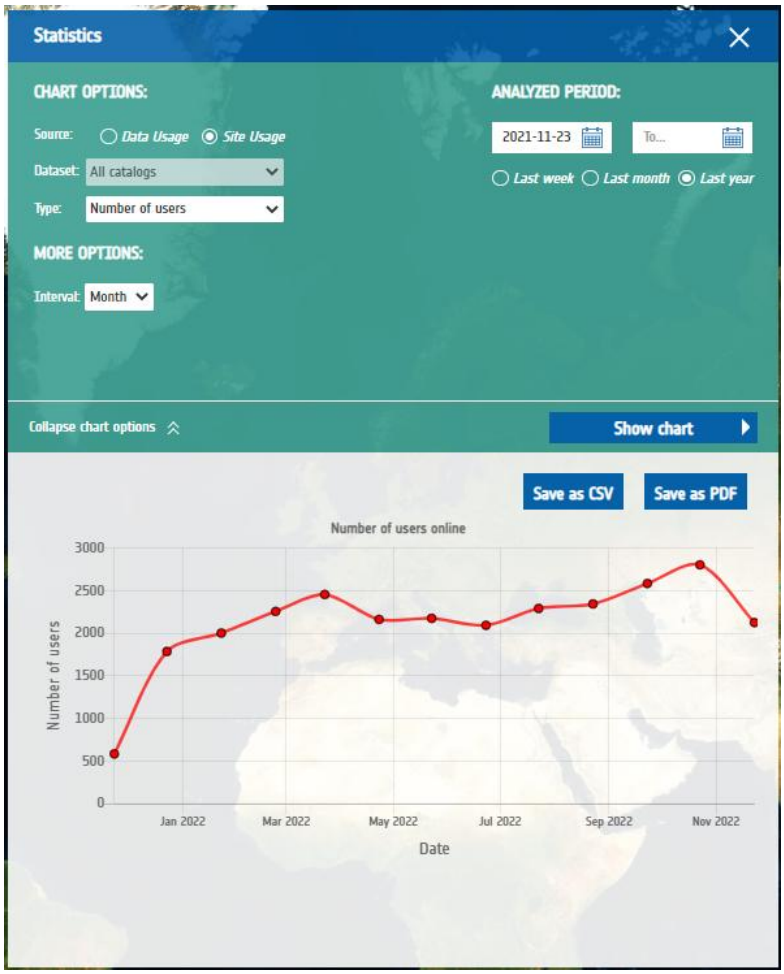


Figure 15 - GEOSS Statistics

3.1.2.5.2 Status Checker

The end-user can search for Earth Observations data and filter available services using as well the Health Status filter provided by the GEOSS Status Checker.

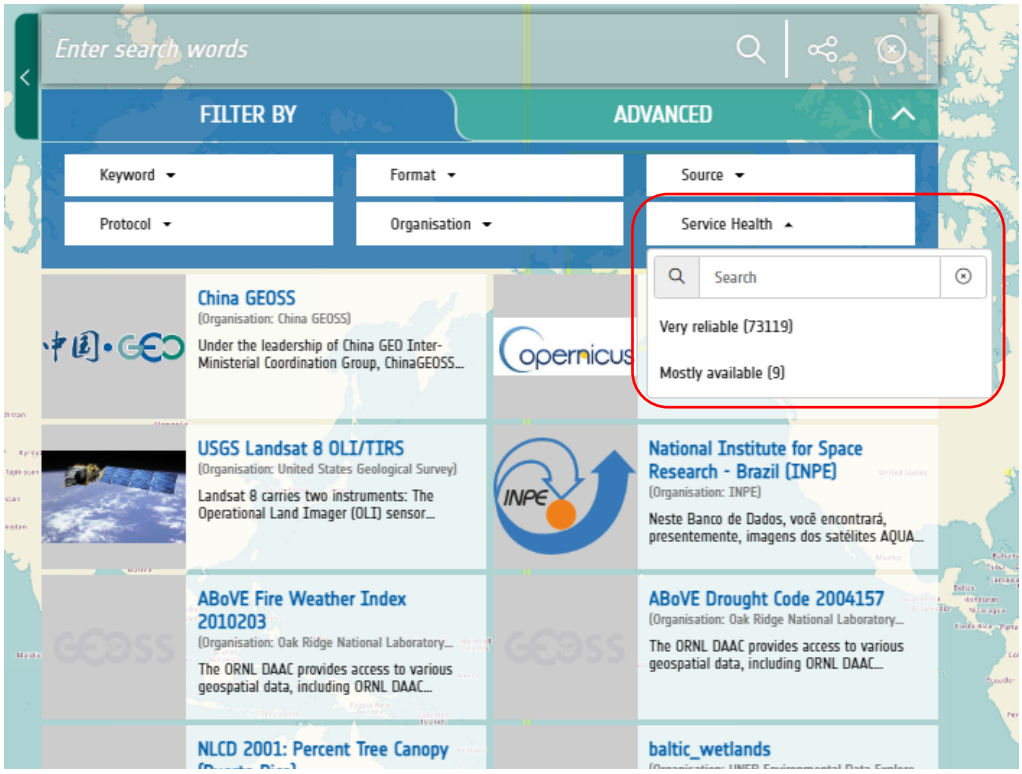


Figure 16 - the Service Health filter

3.1.3 Search for Resources - Multi-Criteria Searches

The multi-criteria search panel can be unfolded selecting the most-left icon in the keyword-based search panel.

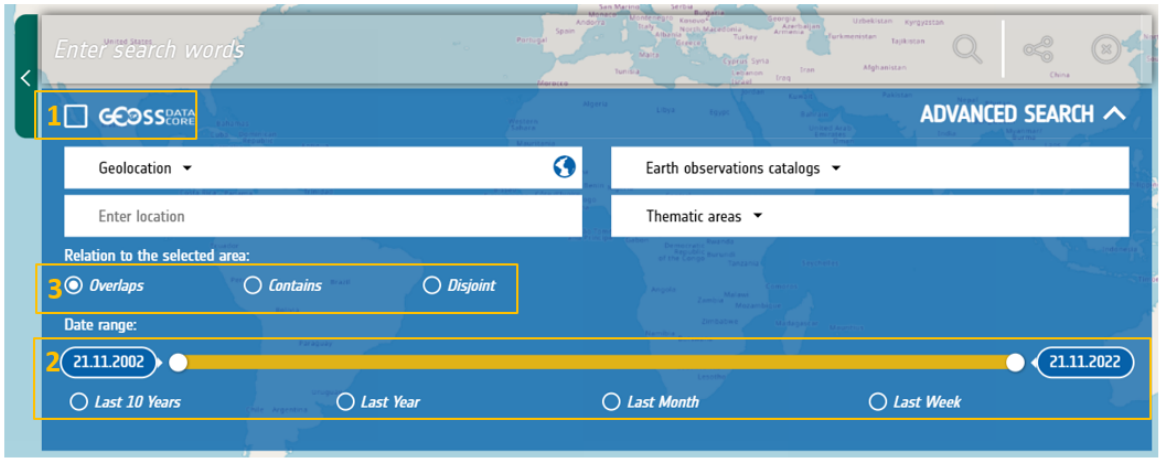


Figure 17 - The multi-criteria search panel

As part of a multi-criteria search, a user can:

1. restrict search results to the freely and openly accessible ones only, so-called GEOSS Data CORE resources (see Figure 17 box 1);
2. Define a timeframe of interest (see Figure 17 box 2)
3. Relations with selected areas allow users to display on the map geographic features that Overlaps, Contains or Disjoint the Area of interest (see Figure 17 box 3)

Other main filtering options are explained below:

- restrict the search to a limited set of Earth observation catalogues of interest to the user;

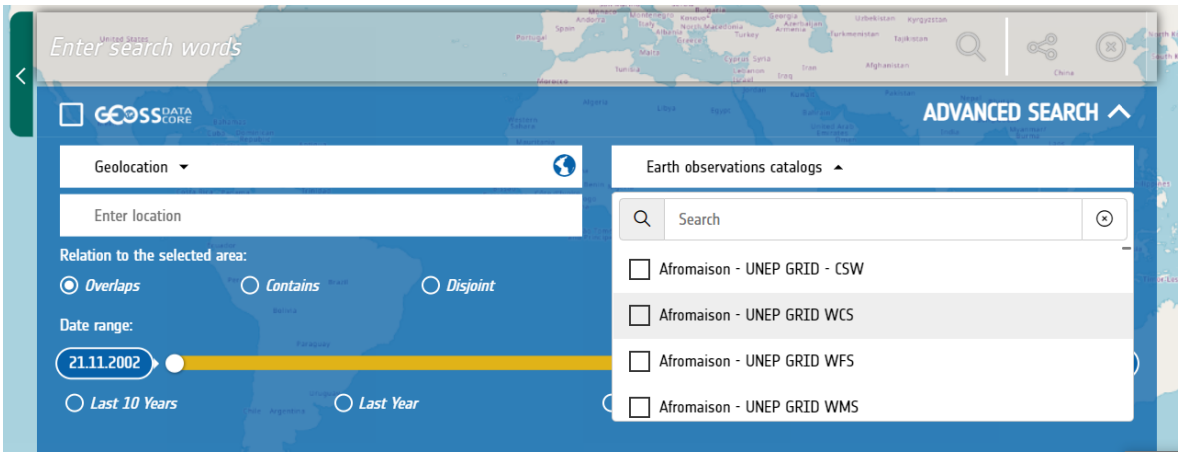
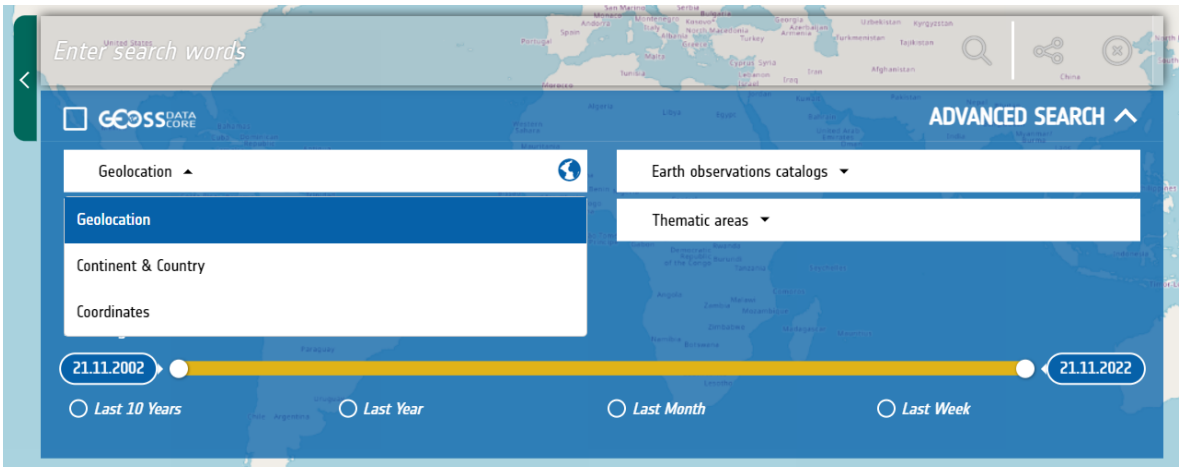


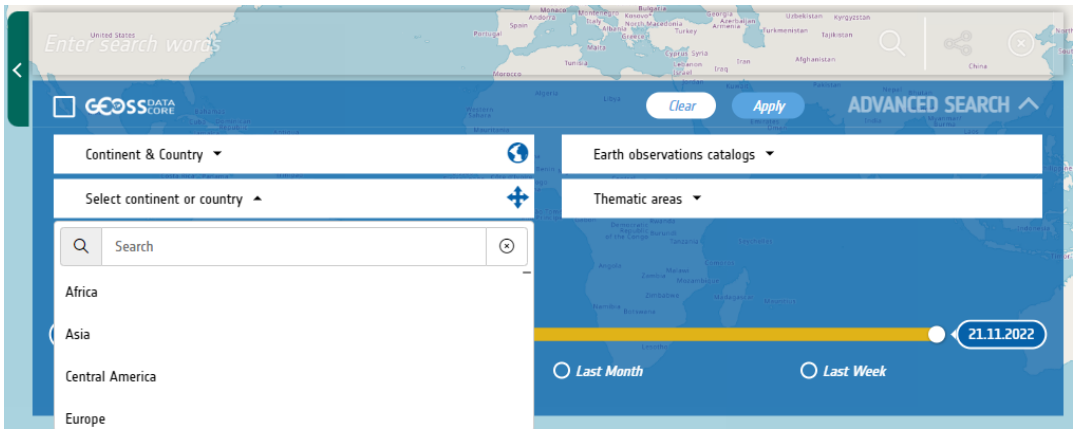
Figure 18 - the Earth Observation Catalogues filter

- define the **Geolocation** of interest using one of these options:
    a. Geolocation (Figure 19 a)
    b. Coordinates (Figure 19 b)
    c. Continent & Country (Figure 19)



a)

b)



c)

Figure 19 - How to specify a location on Earth a), coordinates b) and countries c) filters

- Direct the search towards a specific **Thematic Area** applying predefined views on the data;

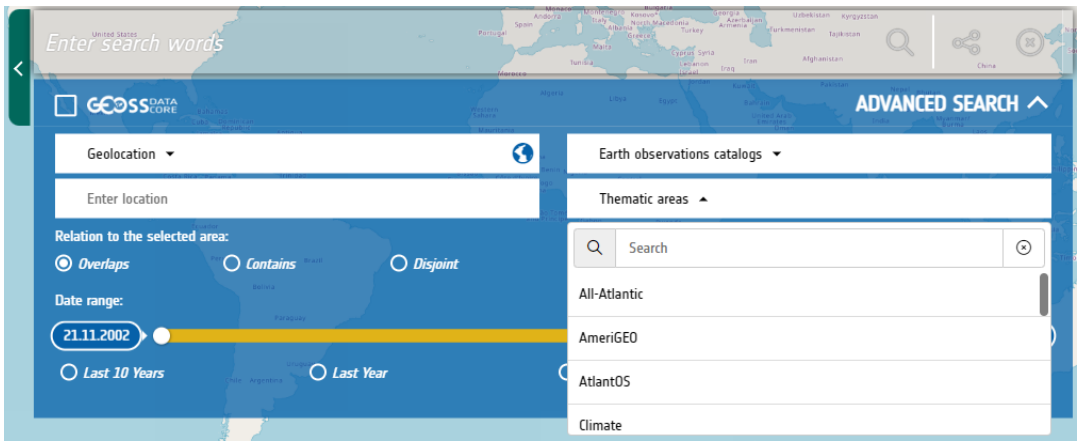


Figure 20 - The thematic areas filters

3.1.4 Results Inspection

After having specified search criteria, you can click on the search button. Results (if any) will appear in the result window.

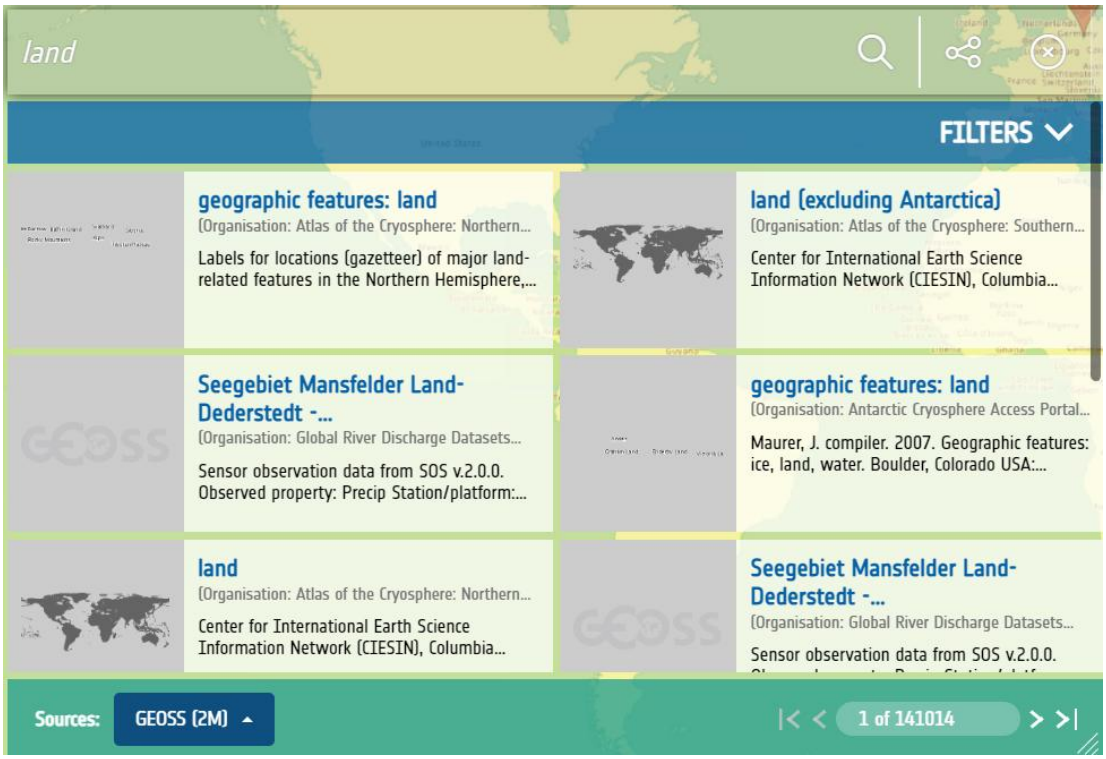


Figure 21 - The result window

The first page of results is displayed (12 results, by default); users can easily access the next (or previous) page of results by clicking the next (or prev) arrow at the bottom of the panel.

Each result item shows a title, a brief description, a browse image (if available), the GEOSS Data CORE flag (which means that the data is freely and openly accessible, according to the GEOSS Data CORE principles), and a series of icons corresponding to applicable functions.

More precisely, the following functions may be available:

Icon	Description
0 0.0	GEOSS Like (assign stars) and watch option the result.
See more	Allow the user to read and know more about the dataset
	Localization of the data on the map either as bounding box or as a placeholder.
	Collaboration and sharing of resources.
	Add a layer to the map in case layers are available from the Data Provider.
	Download the data in formats made available by the Data Provider.

Table 1 - Interface operational icons Description

3.1.5 Filtering

The GEOSS portal provides the possibility to narrow down the search results to a smaller set by applying filters. The type of filters depends on the actual search and results.

3.1.5.1 Default Filters

Default filters are available for most search results and include filtering on keywords, format, source, protocol and organisation. Filtering is progressive, implementing an 'AND' operation and not an 'OR'. For each filter, only one value can be selected.

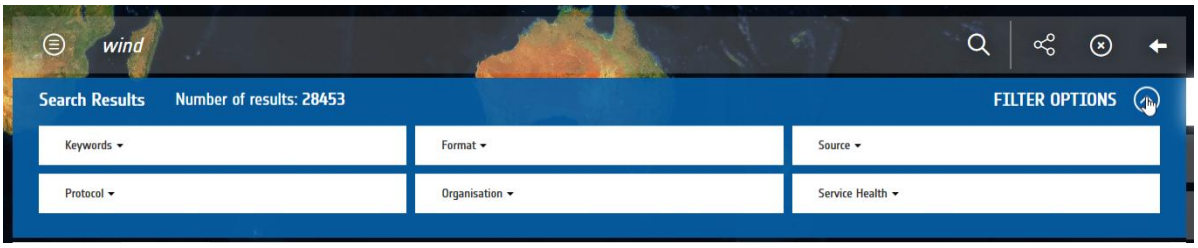


Figure 22 - Default faceted filters

3.1.5.2 Smart Filters

Smart filters and visualisation specificities are implemented for some of the result types. For example, a smart filter considering a combination of cloud coverage, product type, sensor mode and relative orbit has been implemented for data from the Sentinel 2 and the Landsat imagery, and a smart filter considering product type, sensor polarisation, sensor mode, sensor swath and relative orbit has been implemented for Sentinel 1 data.

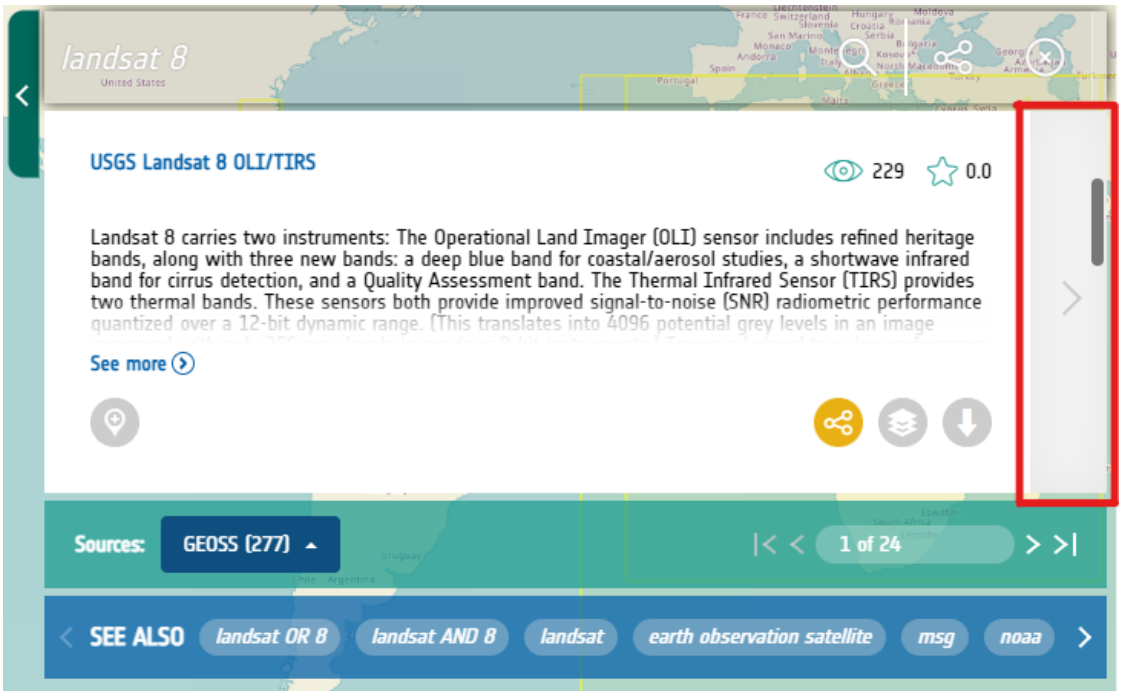


Figure 23 - How to open a collection of homogenous results

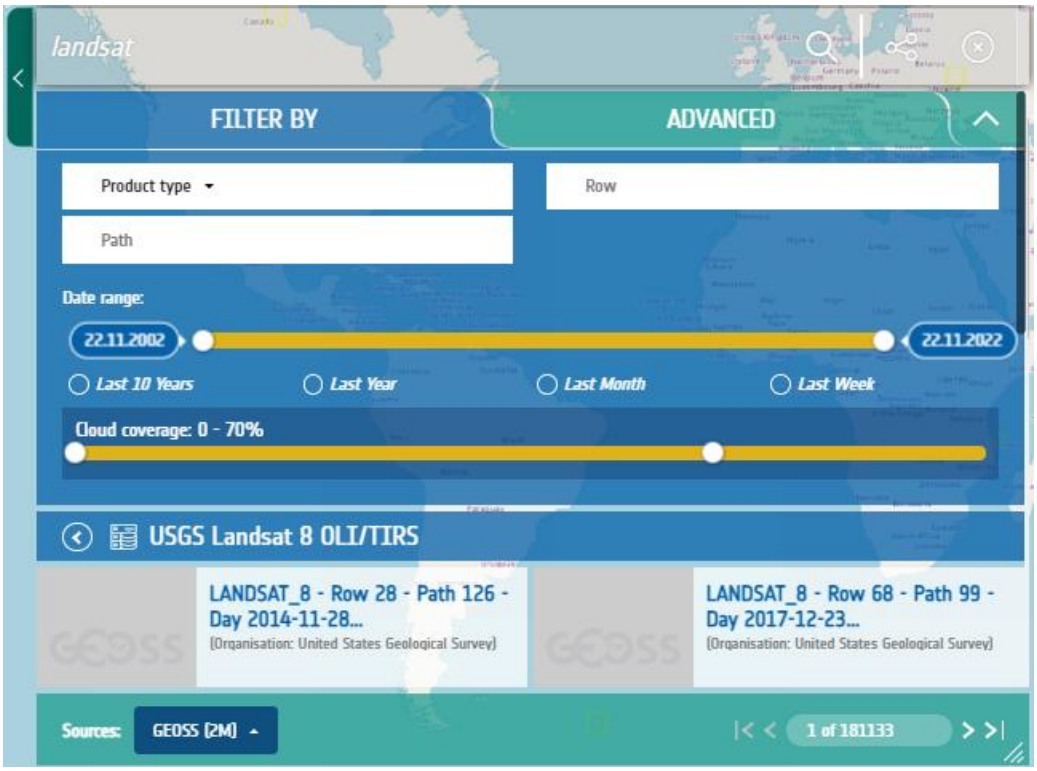


Figure 24 - Smart faceted filters

Other smart filters and specific visualisations are available for earthquake events.

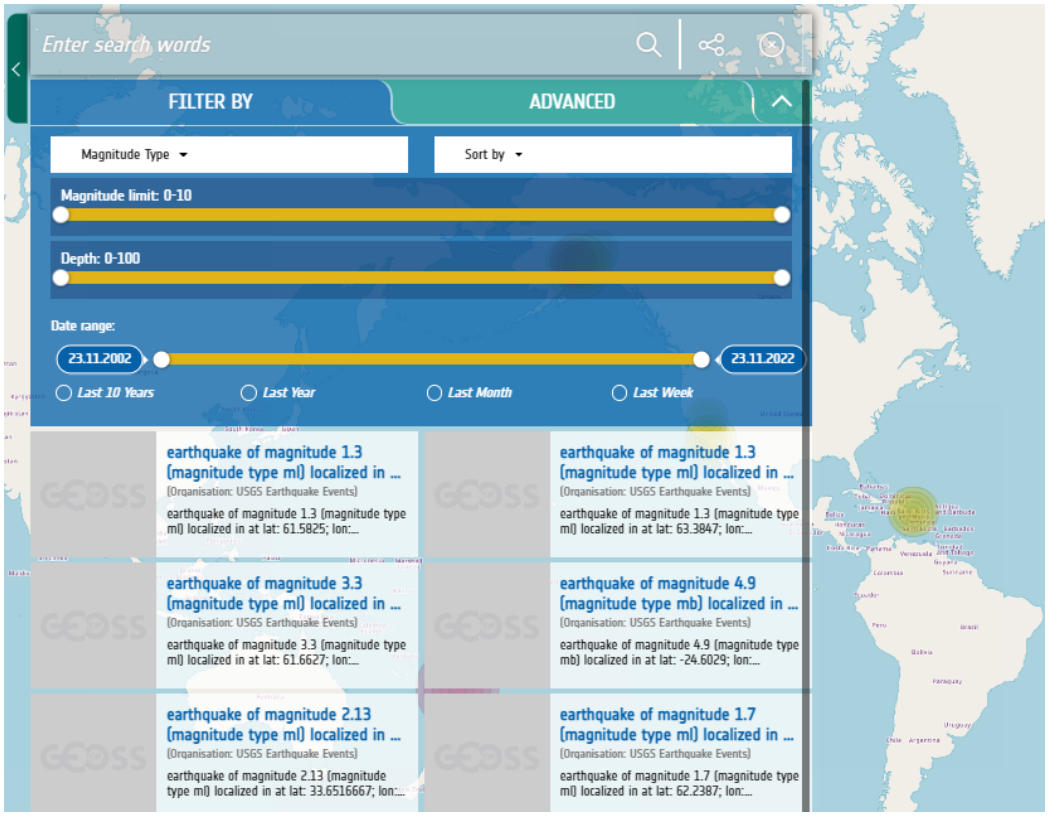


Figure 25 - Smart faceted filters for earthquake events

3.1.6 Take a tour

New users can click on the dedicated icon in the bottom right corner of the screen to enable the tutorial on how portal works. Clicking on the green lamp, it will open a pop up explaining what the button does.

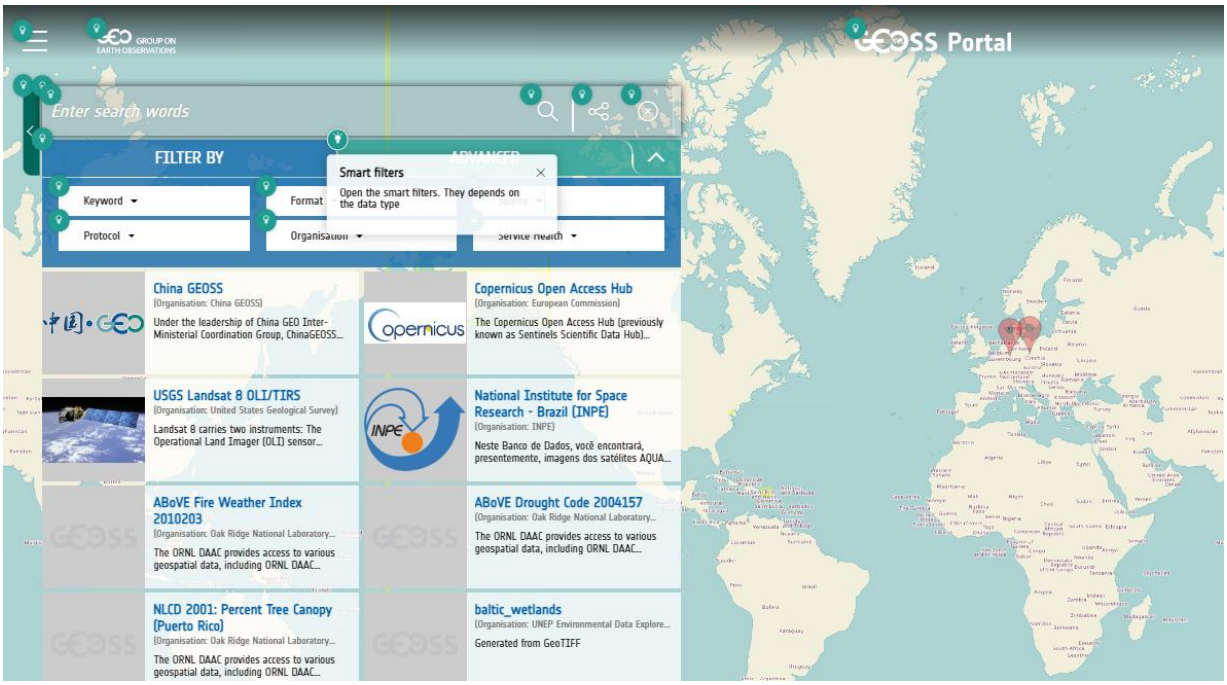


Figure 26 - "Take a Tour" help on-line

3.1.7 Languages

The Portal interface elements are available for English, Polish, Spanish and Chinese languages speakers.

Figure 27 - The language bar

3.1.8 GEOSS Instant Feedback

Users willing to participate in portal improvement can take part in quick survey to share general impression about portal.

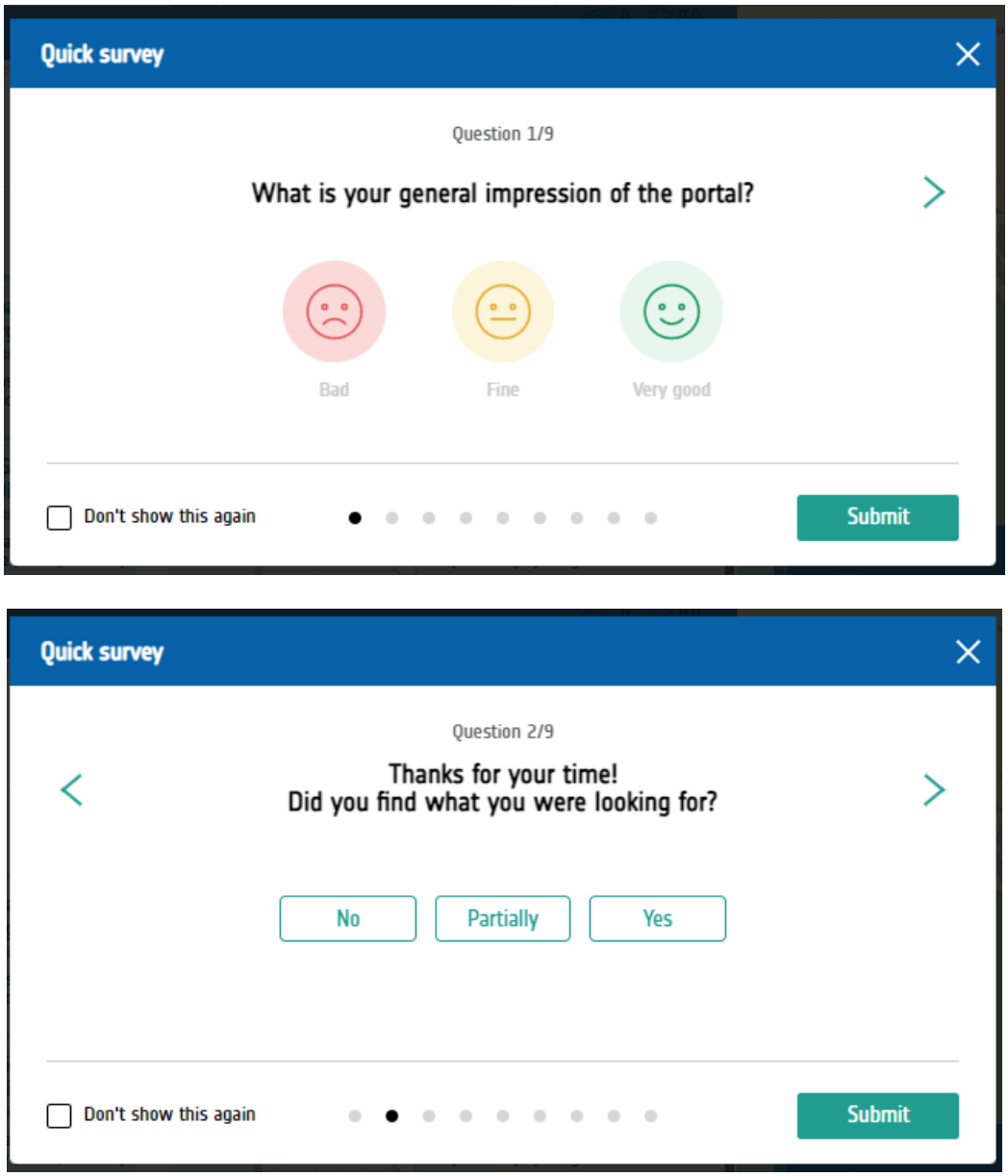


Figure 28 - The instant feedback and survey

3.2 The GEOSS Platform Re-usable Components

3.2.1 GEO DAB API

The GEO DAB is a middleware component which is in charge of interconnecting the heterogeneous and distributed capacities contributing to GEOSS; it provides three main functionalities:

1. **Data/Metadata Harmonization**: provides harmonized discovery and access to heterogeneous data systems. The heterogeneity of data sources is hidden, resources appear as a single data source.
2. **Data Access**: provides data discovery and access functionalities to heterogeneous data systems.
1. **Data Transformation**: enriches access functionalities by allowing users to customize their downloads (e.g. change format and/or CRS).

Since it is a middleware component, GEO DAB users are typically software agents, such as web- based or desktop client applications. These can exploit the GEO DAB functionalities implementing the client-side of one (or more) of the protocols published by the GEO DAB for the above functionalities. The available protocols include:

- OGC Catalog Service for the Web (CSW)
- OpenSearch with geo, time and semantic extensions
- Open Archive Initiative (OAI) PMH
- OGC Web Processing Service
- etc

In order to simplify the development of applications and clients making use of the DAB, the following APIs have been developed:

GEO DAB APIs	Geospatial Expert	Web Dev. Expert
Standard Web Services (OGC Web Services, OAI-PMH, CKAN, etc.)	X	
OpenSearch (Extended)	X	
GEO DAB API JS		X
GEO DAB API REST		X

Table 2 - GEO DAB APIs

GEO DAB API REST and JS are documented at [WR-1]

A set of APIs was developed for the VLab feature too. VLab APIs are documented at [WR-2]

A specific extension of GEO DAB APIs was developed for the use of EIFFEL cognitive search. In particular, it is possible to use a specific parameter which enables the different kind of searches (described in D3.4):

- Text Search
- Cognitive Search
- Cognitive Sorting

3.2.2 GEOSS VIEW

A GEOSS View is a subset of the whole GEOSS resources brokered through the GEO DAB. A GEOSS View can be used to provide to the community access only to a subset of specifically defined resources using temporal, thematic and spatial criteria, to be included in their community Portal.

A GEOSS View is defined by applying a set of clauses:

- Discovery clauses (e.g., spatial envelope, keywords, sources, etc.)
- Access clauses (e.g., data format, access protocol, CRS, etc.) [implementation of this functionality is on-going]
- View clauses, i.e., nested view: allowing defining a view as a sub-view of an existing one. All the clauses from the parent view are inherited by the sub-view, which combines them with its own clauses in an "and" relation. Multiple sub-views can be defined from the same parent view.

Presently, a GEOSS View is created by the GEO DAB operator according to the requests of the specific community.

GEO DAB APIs were enhanced to allow the automatic creation of GEOSS Views.

These new APIs are now in test phase for their use in the self-creation tool.

3.2.3 COMMUNITY PORTAL Self-Creation Tool

Each community can decide to build its own Community Portal, with the same layout of the GEOSS Portal and customize it for their needs.

In the second set of application it has been implemented a single instance in order to be tested the Community Portal self-creation tool and tailored with the desired pages and details.

It has also been provided a document (Community Portal - Administration Guide, see [RD-5]) with all information to build and administrate the Community portal .

3.2.3.1 COMMUNITY PORTAL Self-Creation Tool feature not implemented

In the next phase the user will be able to find the request Community portal button and to download the full package with a wizard to guide the user for simple customisation of the community portal and the full package of the portal allowing community developers to implement and have full control of the Community portal.

3.2.4 Yellow Pages 2.0

The Yellow Pages is a system designed to streamline the process of registering as a GEO data provider. The system features a two-step approval proves, application and registration process history, user, and registration form management.

The above is achieved through three user roles:

1. Owner (also referred to as Administrator)

2. Operator (also referred to as GEO Body)
3. Data provider

Owner role is responsible for system administration, which includes user management and updating the registration form. In addition to administration duties, users with the owner role are responsible for first approval (pre-acceptance) in the two-step approval process.

Operator's role responsibility is the final acceptance in the two-step approval process.

Data providers are the users responsible for maintaining their organization's data provider details. Only one account can be registered per data provider.

End users are freely able to register as data providers through the registration form available from the login page. To register as a data provider, the user, representing an organization providing the data, has to submit a filled in registration form containing details about the provider.

For details on creation of owner and operator accounts, see section 4.1 ("User management") of this document.

3.2.4.1 Registration form

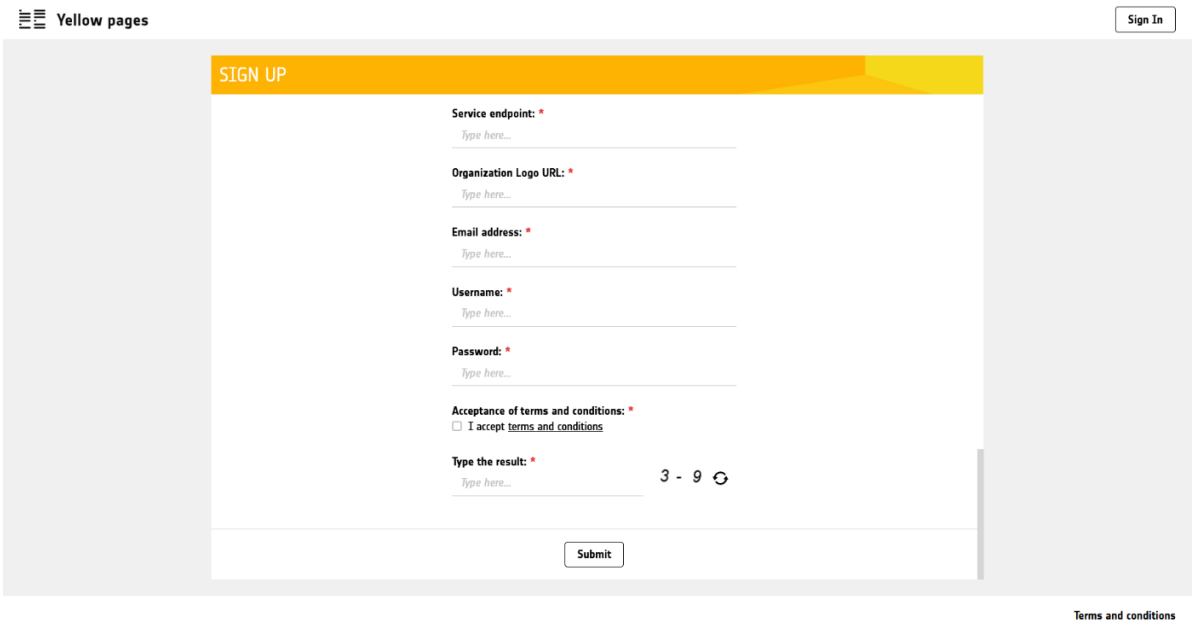


Figure 29 - Registration form with account details fields (email, username, password) and captcha visible

The form consists of fields describing the data provider and data they are providing, account details (username, email, password), and a captcha. All fields are validated on the fly – if any issues are detected, the relevant field will be highlighted, and a short description of the issue will be shown. Forms containing errors cannot be submitted.

To apply, fill all the fields marked as required, solve the dynamically generated captcha, and submit the form.

Successfully submitting the form will generate a confirmation email, which will contain an activation link, leading to a page where the registration process can be confirmed. If the registration process is not confirmed, it will be **automatically discarded after 24 hours**. All data associated with the discarded application is deleted.

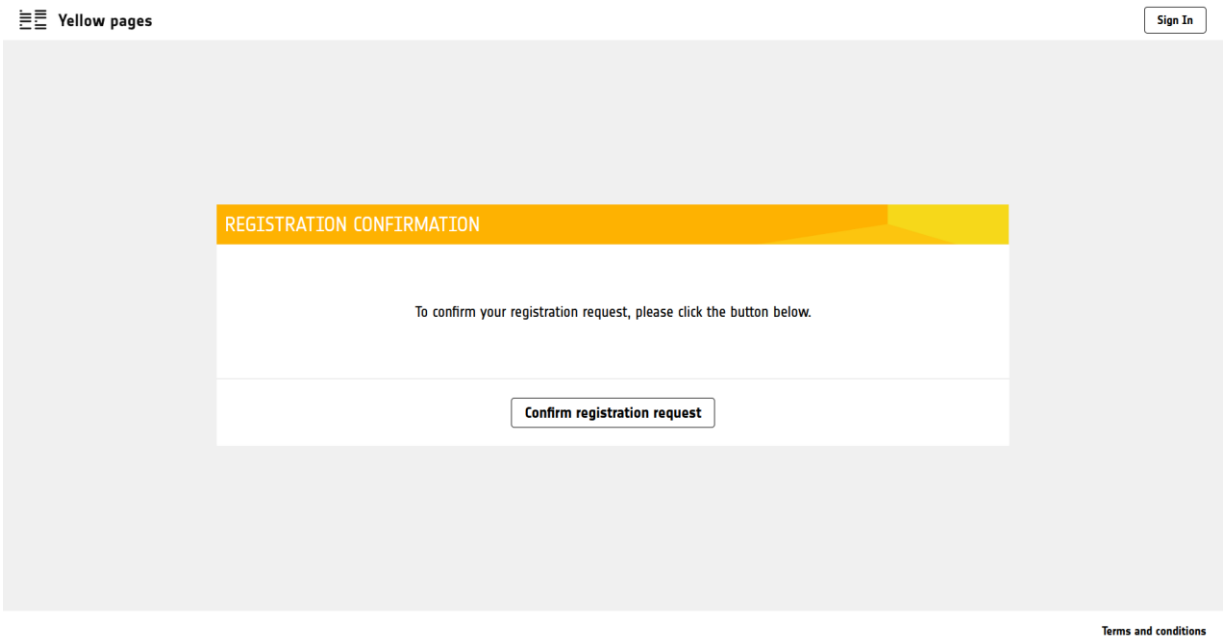


Figure 30 - Registration confirmation page

Afterwards, the application will be sent for approval.

3.2.4.2 Registration approval

Once the application is submitted and confirmed, it will be sent for approval – first to the site owners, then to the operators. The data provider won't be able to log into their account until the full approval has been granted, but they can check the current status of their application, by using the link provided in the registration request completion message (sent after the application has been confirmed).

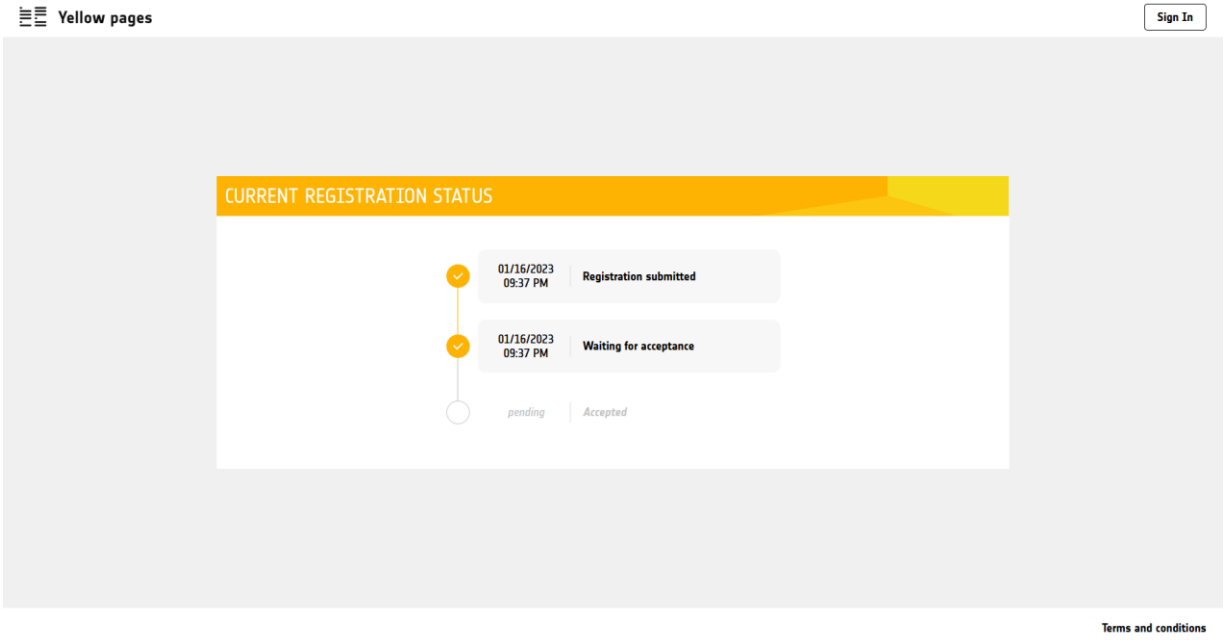


Figure 31 - Registration status page

During this step the application can be accepted or rejected. If it is rejected, all data submitted during the registration will be deleted.

Email notification is generated and sent to the provider once the application status is updated – whether due to rejection or acceptance (in the latter case, notification is sent only the application has been submitted in both steps of the process).

Upon acceptance, the system creates and enables the data provider's account based on the details given during the registration.

3.2.4.3 Editing submitted information

Once the application has been approved, the registering user will be able to log into their account using the details they have provided during the registration. This allows them to review the accepted form, edit their account details, and send updated data provider details.

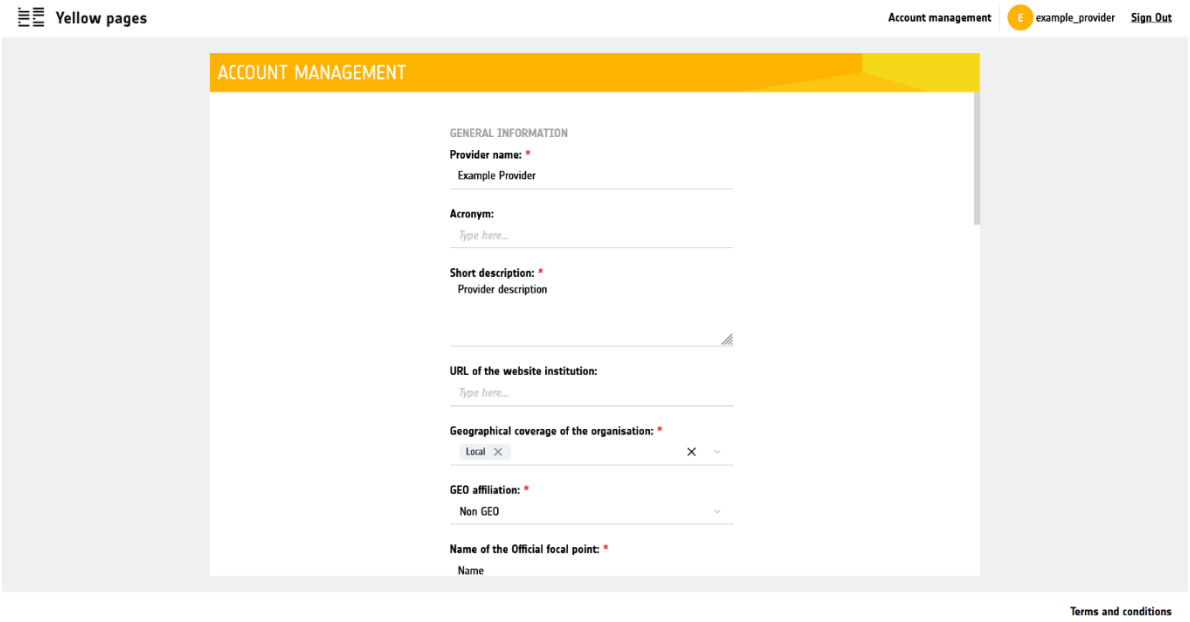


Figure 32 - Account management page with data provider form visible

All of the above is done through the "Account Management" tab, which is the only tab available to data providers.

Data providers wishing to edit the provided provider details, need to edit relevant fields in the form and submit it. Once submitted, the form cannot be edited or viewed until it has been approved or rejected in the process identical to the initial registration.

Account password and email can be edited without re-submitting the provider data for approval. To do so, edit email and/or password fields without editing any general information fields, and submit the form.

All entered changes can be discarded without saving or submitting them. Either by reloading the page, or with the "Undo changes" button at the bottom of the form.

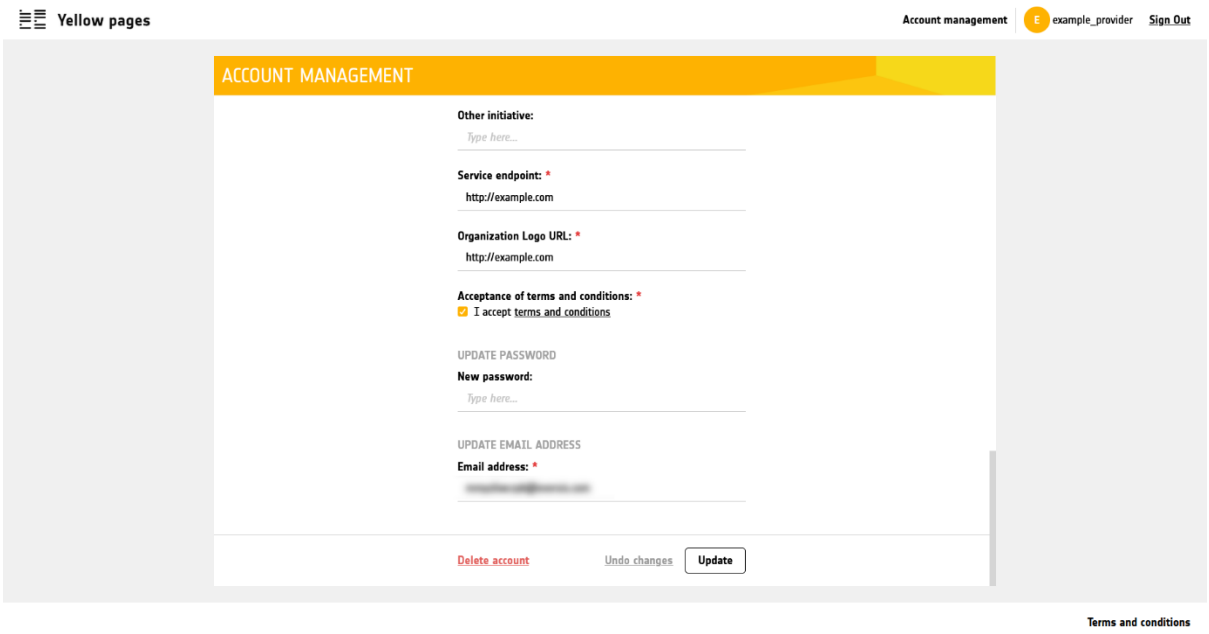


Figure 33 - Account management page with the account information section visible

3.2.4.4 Deleting accounts

All users, regardless of their role, can delete their account at any point. This option is available at the bottom of the form in the "Account management" tab (see Figure 33). User will be asked to confirm their decision to delete their account.

Once deletion has been initiated, neither the initiating user, nor administrators will be able to stop or undo it – **this action is destructive and irreversible**. All data associated with the account (submitted registration forms, account details, email address) will be deleted in the process.

Note that registration status of previously submitted applications is kept for one week by default in anonymized form in the registration history tab. This data is automatically deleted after one week.

Administrator can delete user accounts without involving users in the process (described in section 4.1 of this document).

3.2.4.5 Data provider registration – operator's and owner's perspective

Site owners and operators can see the pending applications in "Registration status" tab. This tab contains a table displaying all applications sent for approval to the user's role.

Applications which have not yet been approved by the owner will not show up for operators. Likewise, if an application has already been approved by an owner, it will not be shown to that user, or any other user with the owner role.

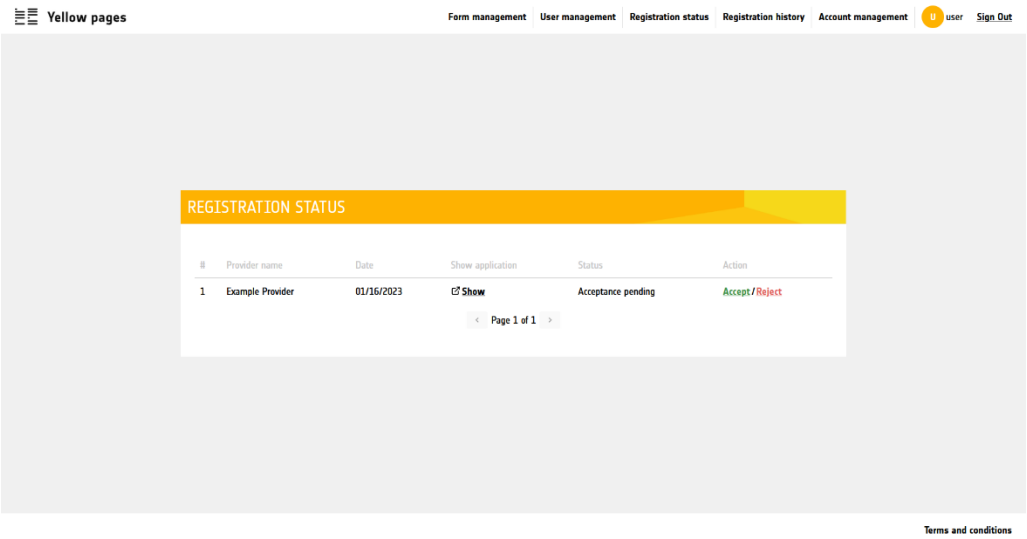


Figure 34 - Registration status page (owner's and operator's perspective)

This table allows the approver to inspect sent applications (“Show” button), accept, or reject them.

Both owners and operators are notified through an email message of new applications as they enter the role’s approval queue.

All pending applications, regardless of the role they are assigned to, can be viewed in the registration history tab, which contains a similar table to the one from registration status.

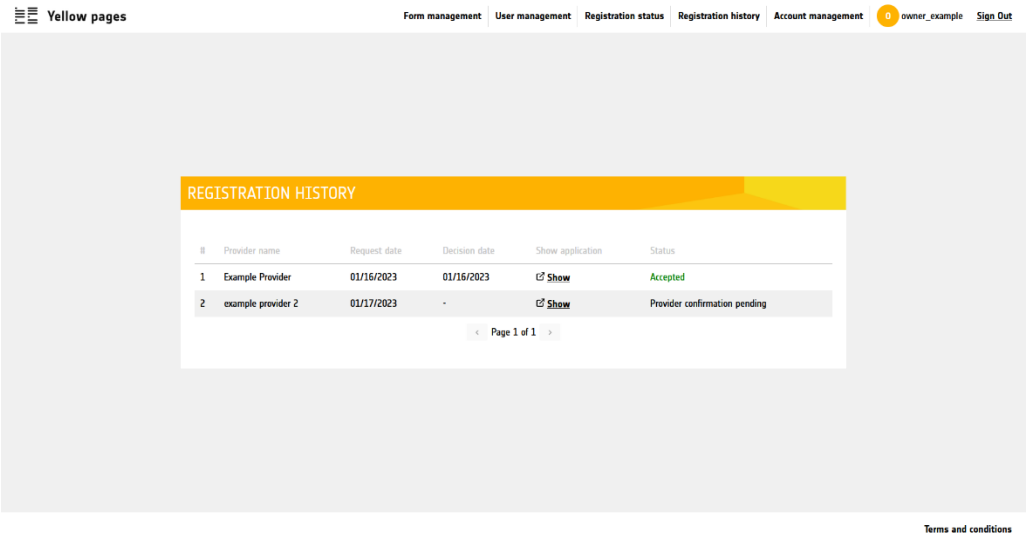


Figure 35 - Registration history page with one accepted and one pending application

3.2.4.6 System administration

All administration options are available to users with the owner role through the tabs at the top of the page. These tabs are:

- Form management
- User management
- Registration status
- Registration history
- Account management

Registration status and history are used for application management and have been described in previous section.

Account management allows the user to edit their account details – this screen is almost identical to the one available to data providers. The one difference is that data provider form is not included for operators and owners. Otherwise, the page functions in the same way as it does for data providers, including account deletion.

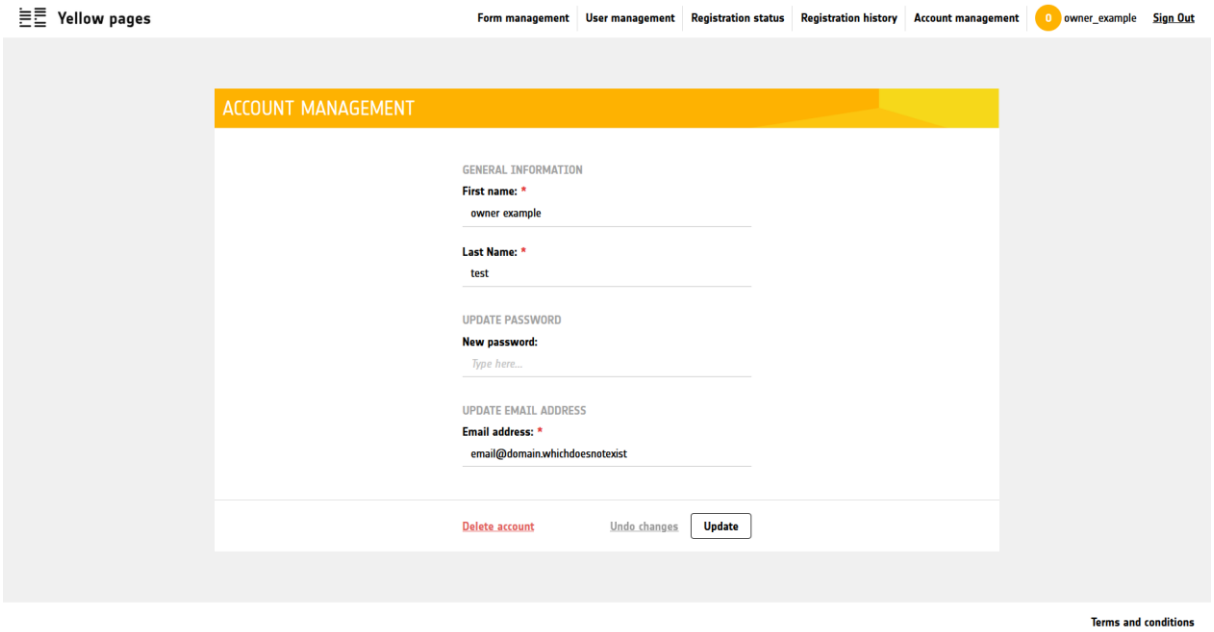


Figure 36 - Account management page (operator's/owner's perspective)

3.2.4.7 User management

By default, the system is populated with only an admin account – site owner is responsible for creating accounts for other administrators and accepting body representatives.

To **create a new account**, open the user management tab, click the “create account” button at the bottom of the page, and fill in the opened form.

It is recommended, when creating new accounts, to set a random password and have the user create password for their account themselves, using the password reset function, available on the login screen (button named “forgot password”).

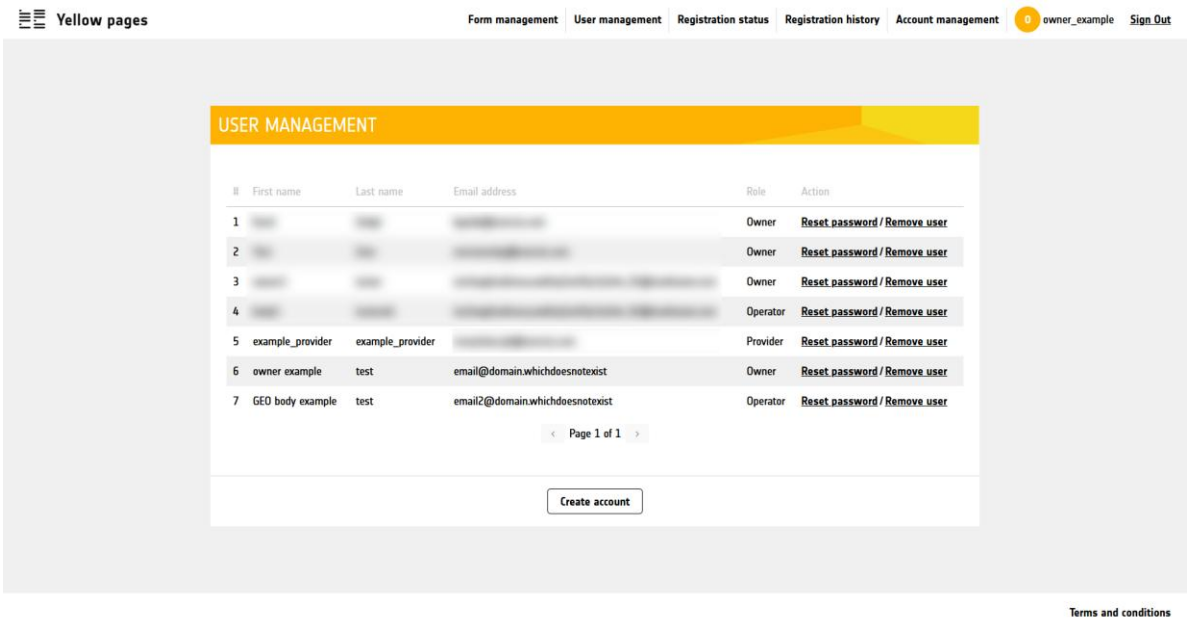


Figure 37 - User management page. Personal information has been blurred out

The table itself lists currently registered users and allows the admin to reset their passwords or delete the accounts entirely.

Resetting the password blocks the selected users from logging in until they set a new password. Instructions on setting a new password are sent in an email message.

Removing a user deletes that user's account and all associated data entirely.

3.2.4.8 Form management

The registration form used to gather information from registering data providers can be edited by the admin from the "form management" tab.

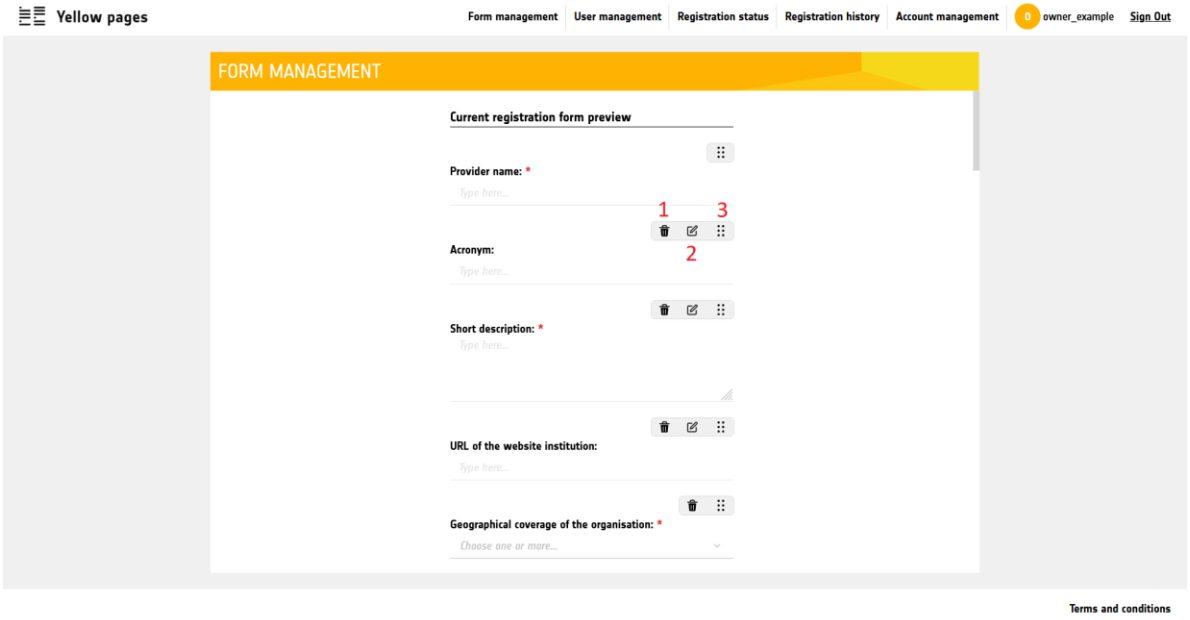


Figure 38 - Form management page. Three buttons are highlighted - 1: delete button, 2: edit button, 3: handle button used for moving fields

All the **fields can be rearranged** by dragging it by the handle button and dropping in the desired position (button 3 on Figure 38).

The page and pen button (marked as number 2 on Figure 38) can be used to **edit the selected field**.

The bin button (number one Figure 38) can be used to delete the selected field.

The manager allows for adding new fields, editing, and deleting existing fields, with some exceptions.

The following fields are static and are required for account creation – they cannot be edited or deleted:

- 'Provider name'
- 'Email address'
- 'Username'
- 'Password'

The following special fields are also restricted due to the required behavior – they can only be edited once the dependent fields have also been removed:

- 'Names of countries and/or regions of geographical coverage'
    - field dependent on 'Geographical coverage of the organisation', appears only when the 'Geographical coverage of the organisation' field value is 'Global' and/or 'National', field 'Names of countries and/or regions of geographical coverage' will be automatically deleted when field 'Geographical coverage of the organisation' is deleted
- 'Other geographical coverage of the organisation'
    - field dependent on the value of the 'Geographical coverage of the organisation', appears only when the 'Geographical coverage of the organisation' field value is 'Other', field 'Other geographical coverage of the organisation' will be automatically deleted when field 'Geographical coverage of the organisation' is deleted
- 'Other GEOSS Data Core'
    - field dependent on the value of the 'GEOSS Data Core', appears only when the 'GEOSS Data Core' field value is 'Other', field 'Other GEOSS Data Core' will be automatically deleted when field 'GEOSS Data Core' is deleted
- 'Type of knowledge body'
    - field dependent on the value of the 'Type of online resource', appears only when value is 'Knowledge Body'

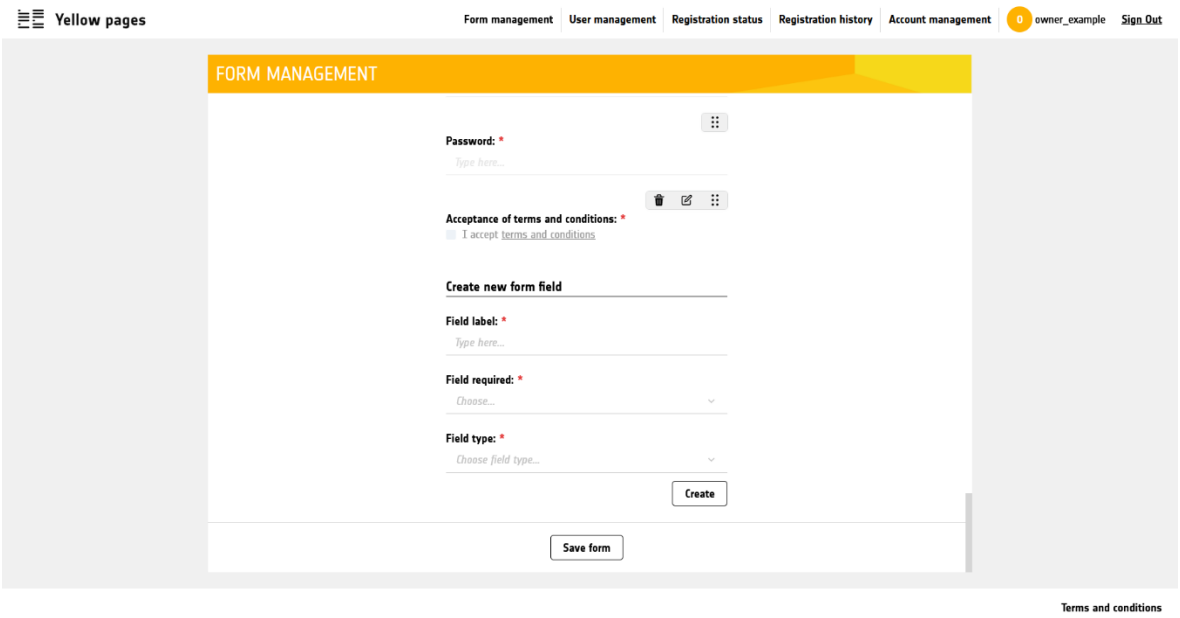


Figure 39 - Form management page with the new field creation form visible

To **add a new field**, scroll down to the bottom of the form, to the “create a new form field” section, fill in all the fields describing its behavior, and click the “create” button”

The following field types are available:

- Input (short text)
  - Subtype: Text
  - Subtype: Email
- Textarea (mullti-line text)
- Select
  - Subtype: Single choice
  - Subtype: multiple choice
- Checkbox

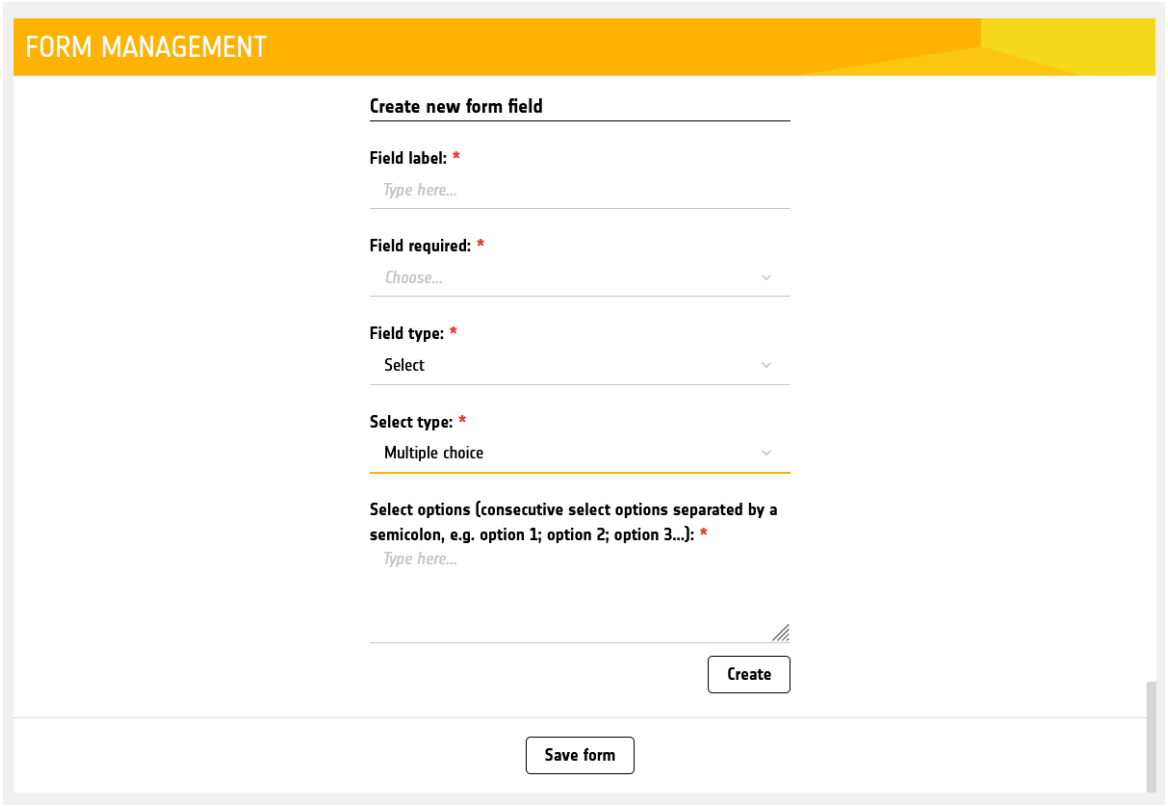


Figure 40 - Example of a multi-choice select field

If the keyword “terms and conditions” is included anywhere in the description text of any of the fields, it will be **automatically transformed** into a hyperlink linking to the site’s terms and conditions page. Similarly, URLs and email addresses will be made into hyperlinks.

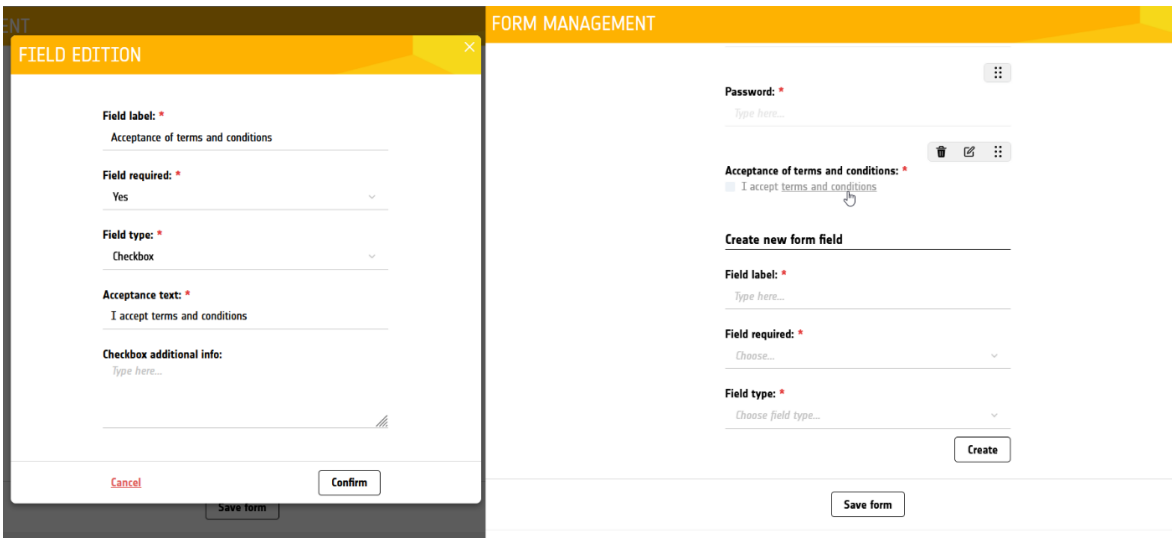


Figure 41 -Example use of the 'terms and conditions' keyword. The keyword is inserted into acceptance text (left) and transformed into a hyperlink in the actual form (right)

Once the form has been updated and saved, data providers will be encouraged to fill it in with a popup message shown after logging in.

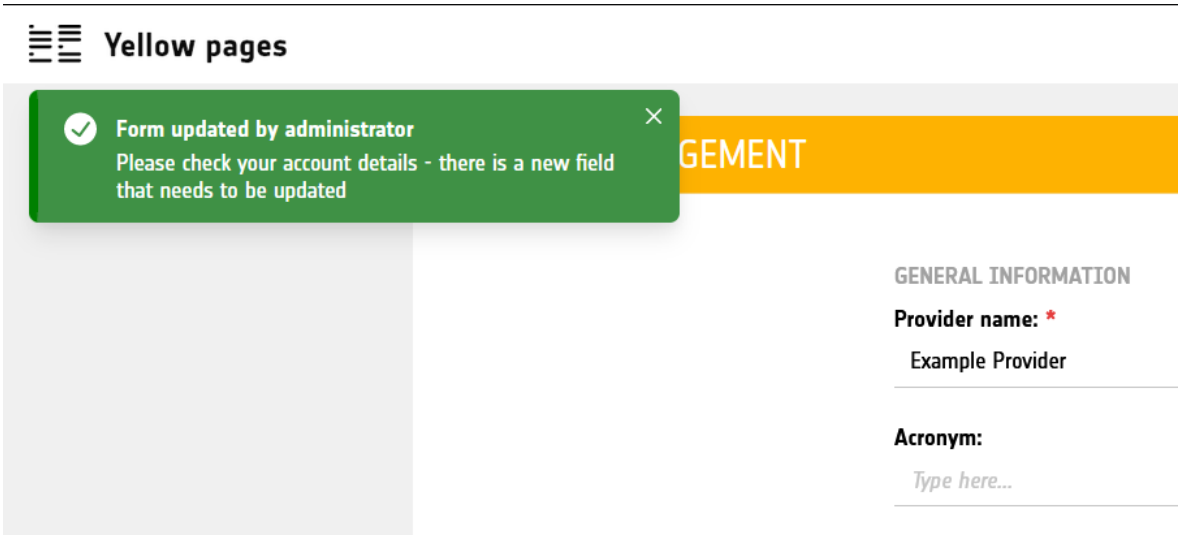


Figure 42 - Popup message encouraging the data provider to update their details

4. GEOSS Platform Implementations

4.1 AFRIGEO Community Portal

It has been provided the software package for the AfriGEO community portal and the Installation Guide ([RD-1]).

In the installation Guide have been reported all the information for the:

- Deployment
- Server configuration
- Features configuration
    - Map
    - Catalogues and Views
    - Menu
- Header Configuration
- Pages management
- Other settings

4.2 SDG15.3.1 Land Degradation

The GEOSS portal (https://www.geoportal.org) is the single web-based discovery and access point of EO resources from various providers all over the world through GEOSS. It is aiming not only to facilitate data and information accessibility but also help users to generate and discover knowledge. To demonstrate the facilitated access and integration of the model and outputs and the separation of concerns proposed by the Model Web approach, the different components of the workflow have been integrated into the GEOSS platform.

The following use scenarios have been defined:

1. An end-user wants to know what the situation of land degradation in Europe is.
2. In the GEOSS portal and a for “Land degradation” is performed.
3. The user obtains a number of resources that matches his search criteria.
4. Under the Knowledge tab, a description about the SDG15.3.1 indicator is provided. The user can then navigate deeper into the knowledge.
5. The user discovers that there is a model available
6. He/She finds that there are some data available for visualization and download and an external link to other resources on SDG15.3.1.
7. He/She can discover three resource layers that can be loaded on the map: indicators at national level from global sources. He selects the national data and his able to visualize it.
8. The user is « not convinced » with the global data sets because he wanted to access more local/national data sets (“trustworthiness in national data”). From here, there are two sub-scenarios:
    a. He/She is a “traditional national user” only searching and accessing more local/national data to generate the SDG indicator 15.3.1
    b. He/She 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, he/she can

inspect the process workflow and search and select data as input to the service. In addition, he/she has the capability to choose a Cloud computing platform of preference among the available (these include all the DIAS Platforms and Amazon Web Services).

9. Discover more national/local data sets.
10. The user login into GEOSS portal and then starts the computation on the selected infrastructure and wait for the results
11. He can now visualize outputs with his own data
12. He can additionally build his own dashboard with the newly widgets implemented (maps; graphs, text, …)
13. He/She is a data provider from the selected country who can register his/her national datasets
14. He/She 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, he can inspect the process workflow and search and select data as input to the service. In addition, he/she has the capability to choose a Cloud computing platform of preference among the available (these include all the DIAS Platforms and Amazon Web Services).
15. Register new as a new data provider and add the necessary data.
    a. the discovery of the model/service
    b. the discovery of the newly registered data to be fed to the service.
16. The user login into GEOSS portal and then starts the computation on the selected infrastructure and wait for the results.
17. He can now visualize outputs with his own data.
18. He can additionally build his own dashboard with the newly widgets implemented (maps; graphs, text, …)

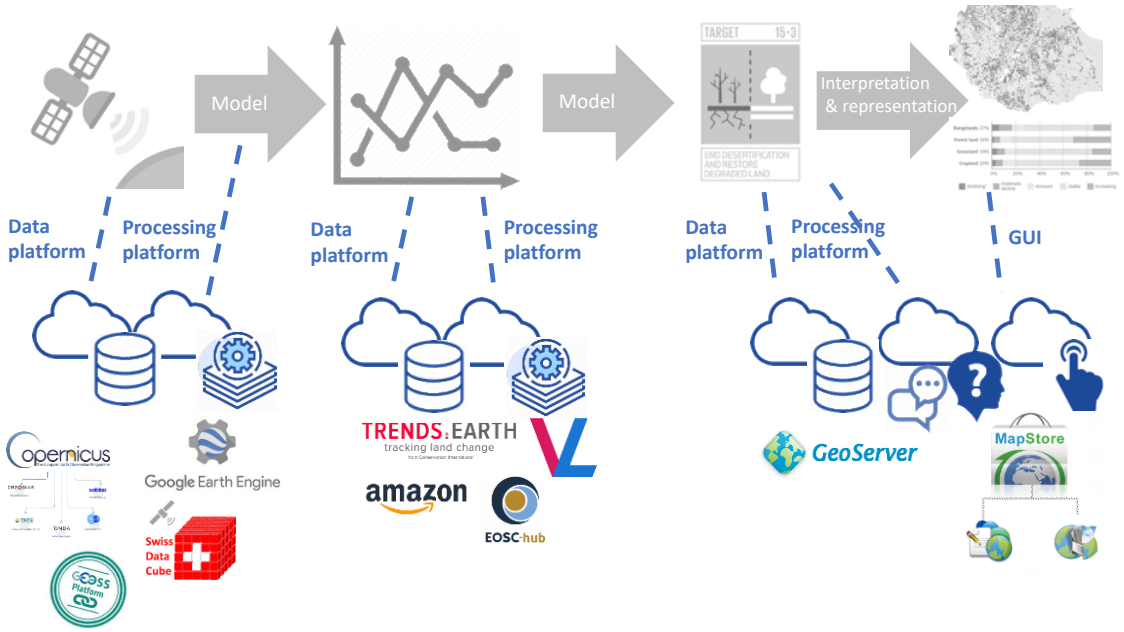


Figure 43 - SDG 15.3.1 Processing

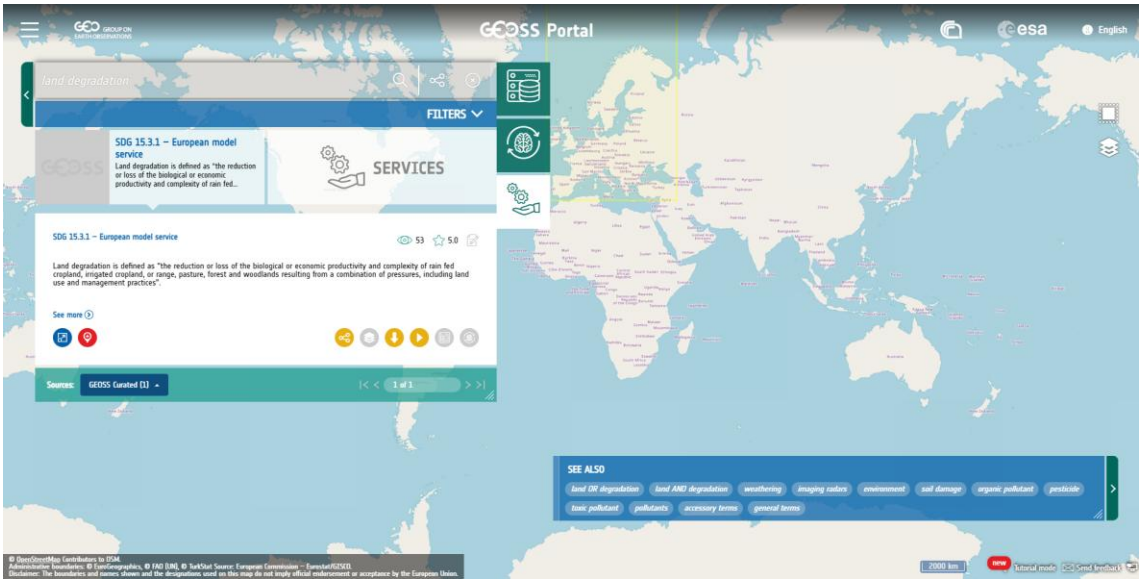


Figure 44 - SDG 15.3.1 GEOSS Portal data discovery

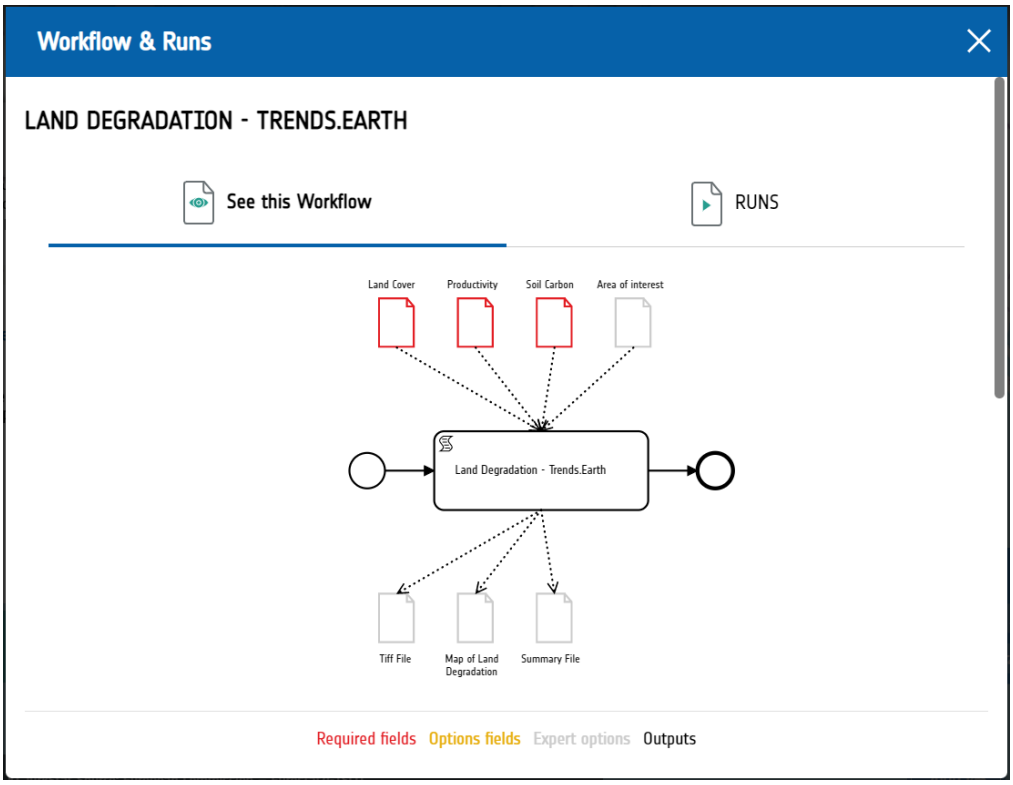


Figure 45 - Land Degradation Workflow

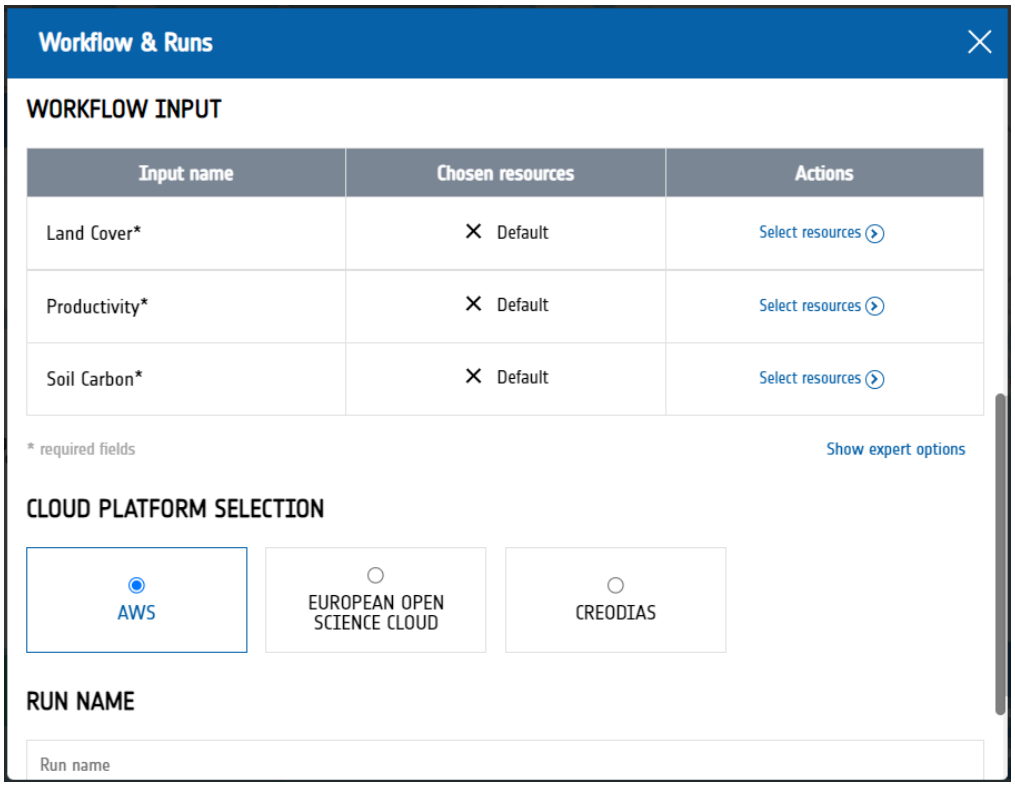


Figure 46 - Land Degradation Workflow Input

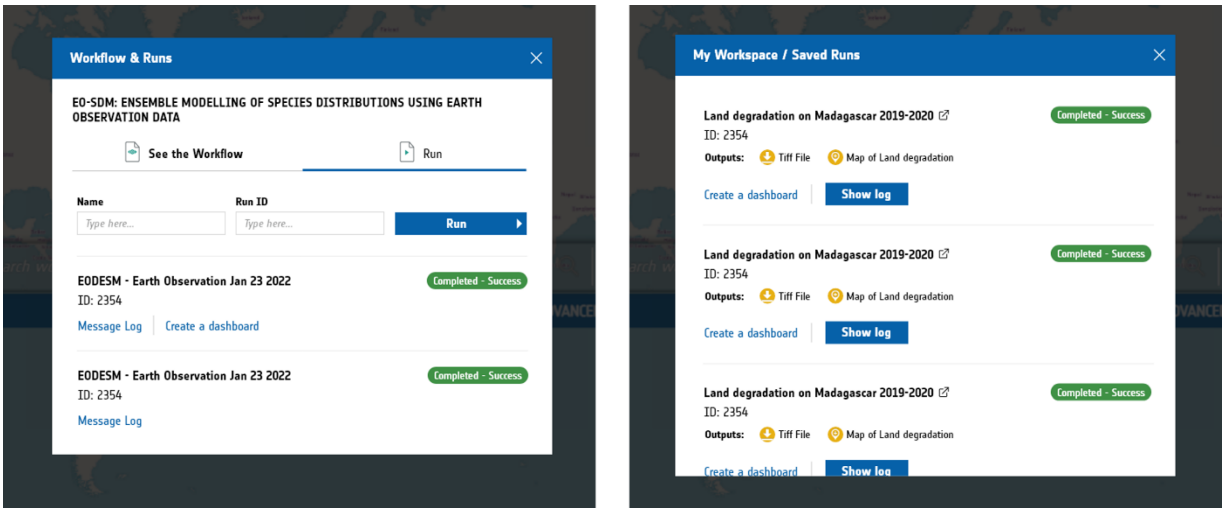


Figure 47 - Land Degradation Runs and Saved Runs

4.3 SDG15.3.1 Land Degradation (Full Workflow and Dashboard)

The tool works as described in the first set of application in section 4.2 but in addition the user can:

Select own AOI though the dedicated functionality: Set bounding box within the show export options from the workflow & run window.

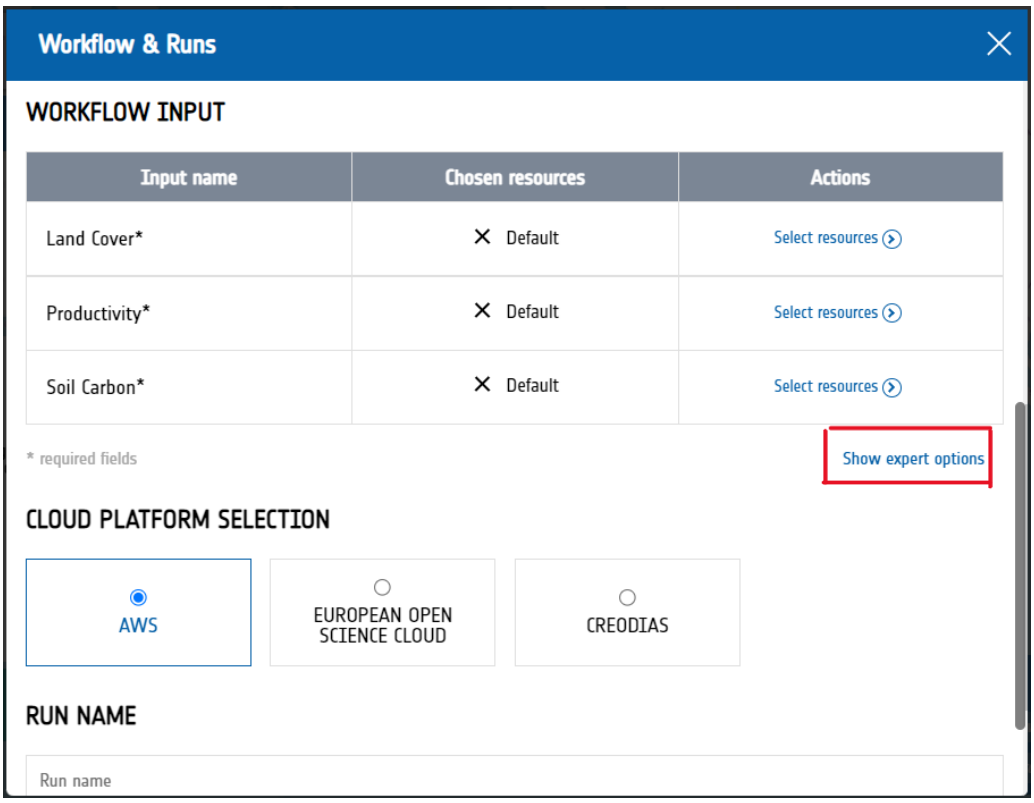


Figure 48 Selection of the own bounding box functionality

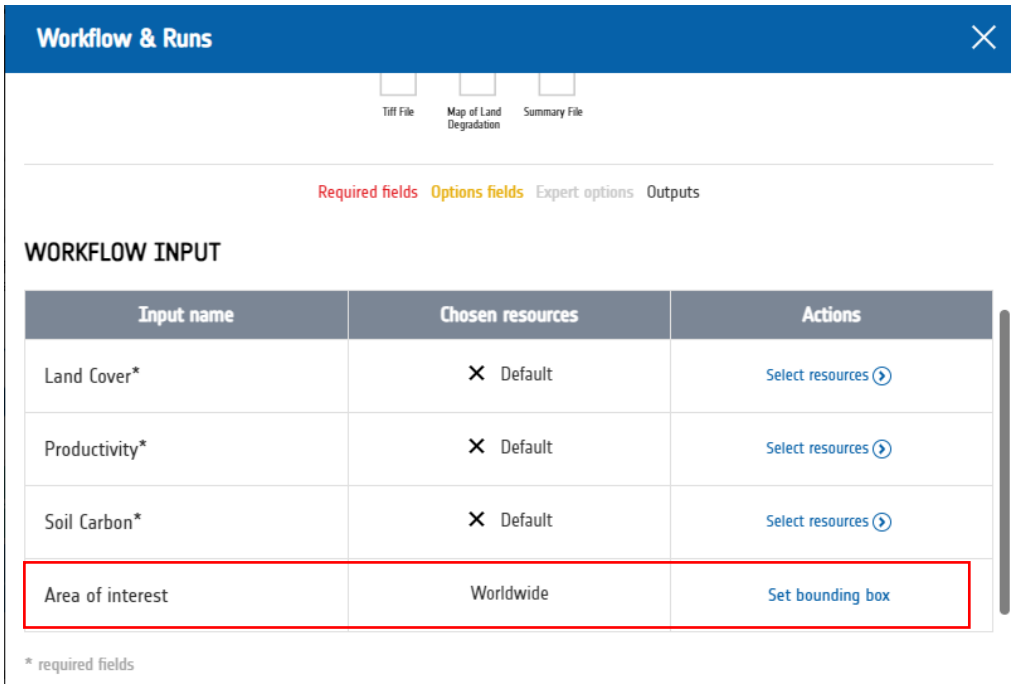


Figure 49 Set up of the bounding boxes coordinates.

The user is redirected to the bounding box filter available in the search panel and can use the different “selection” options.

The Bounding box feature in red on the right side of the panel, or the filters in the advanced search.

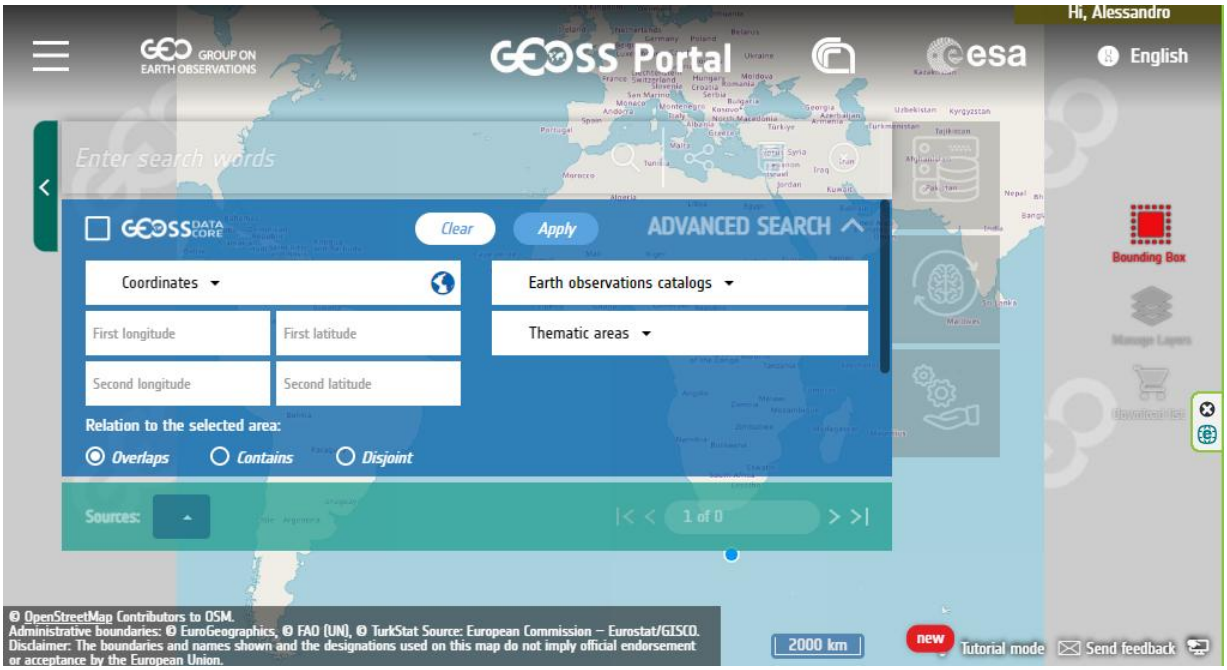


Figure 50 Bounding boxes features available in the Portal.

After the user select the AOI (in the example: Austria), the bounding box is then visible in the Area of Interest of the workflow and run panel, and the run can start.

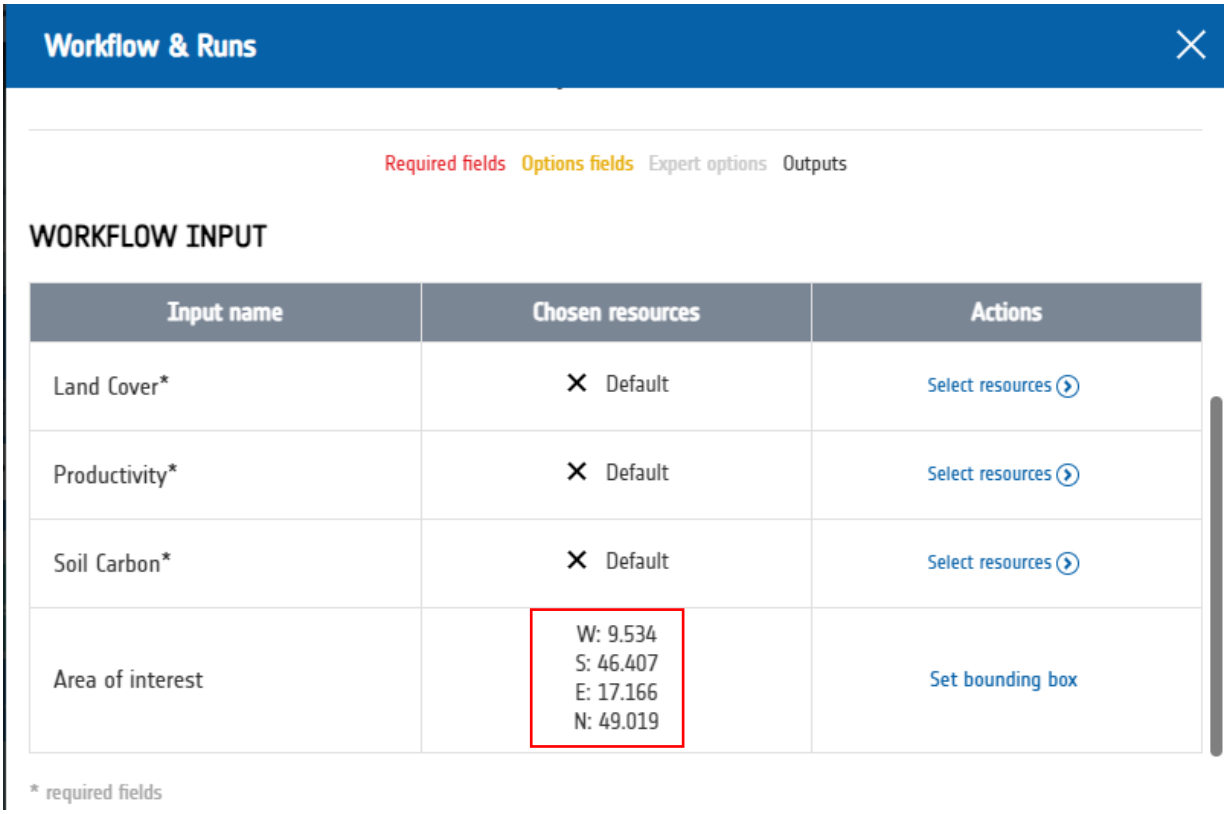


Figure 51 after setting the AOI the coordinates are visible in the panel

When the run is executed, the user can find the results in “my workspace/saved runs” as in the right side picture below (Figure 52).

Figure 52 – My Workspace/Saved Runs

4.4 Custom Dashboard tool

The dashboard tool allows the user to customize and create the reports to be shared with other users and made available as a GEOSS resource.

To create the Own report the user have to explore the saved runs as in the right side picture of Figure 53 and click the create Dashboard button.

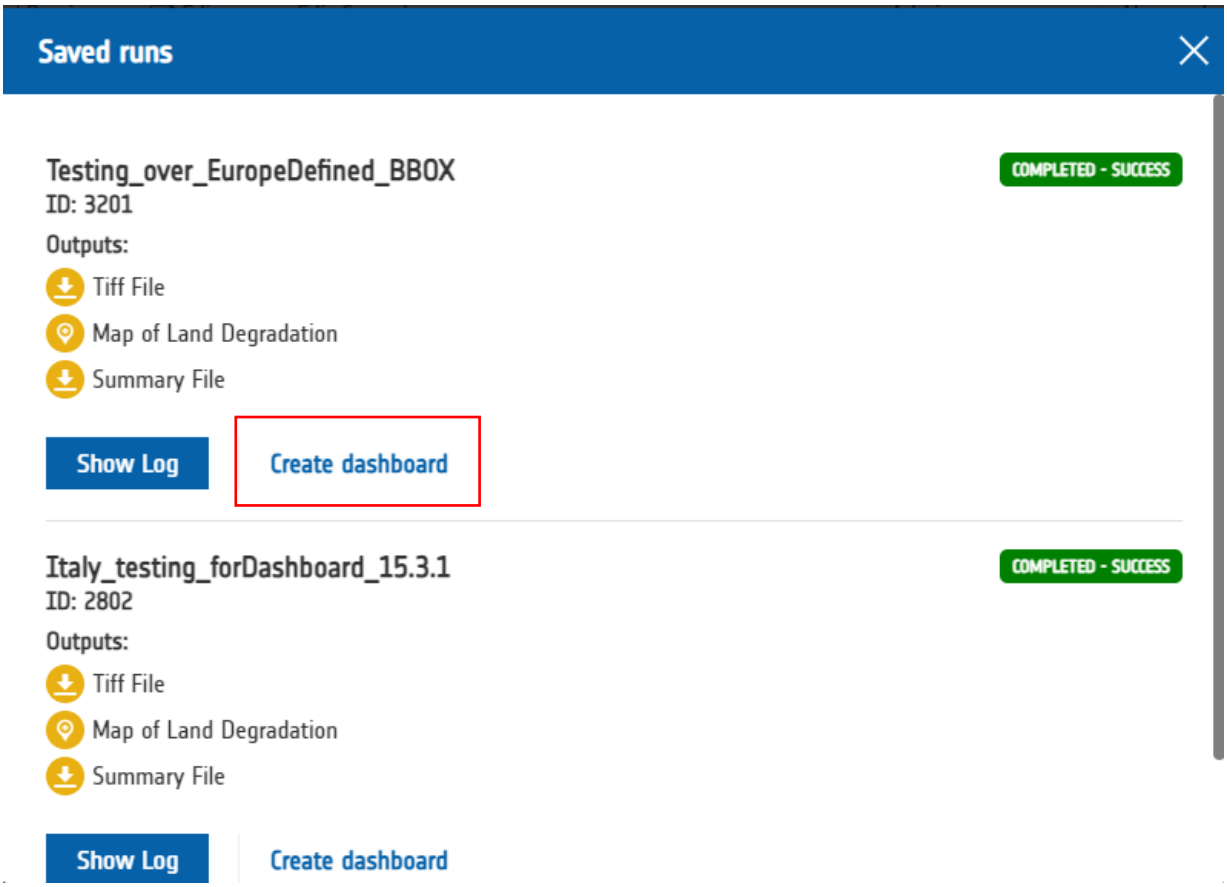


Figure 53 The create Dashboard button.

When clicking the create dashboard button a new feature will open and allow the user to customize the report as shown in Figure 54

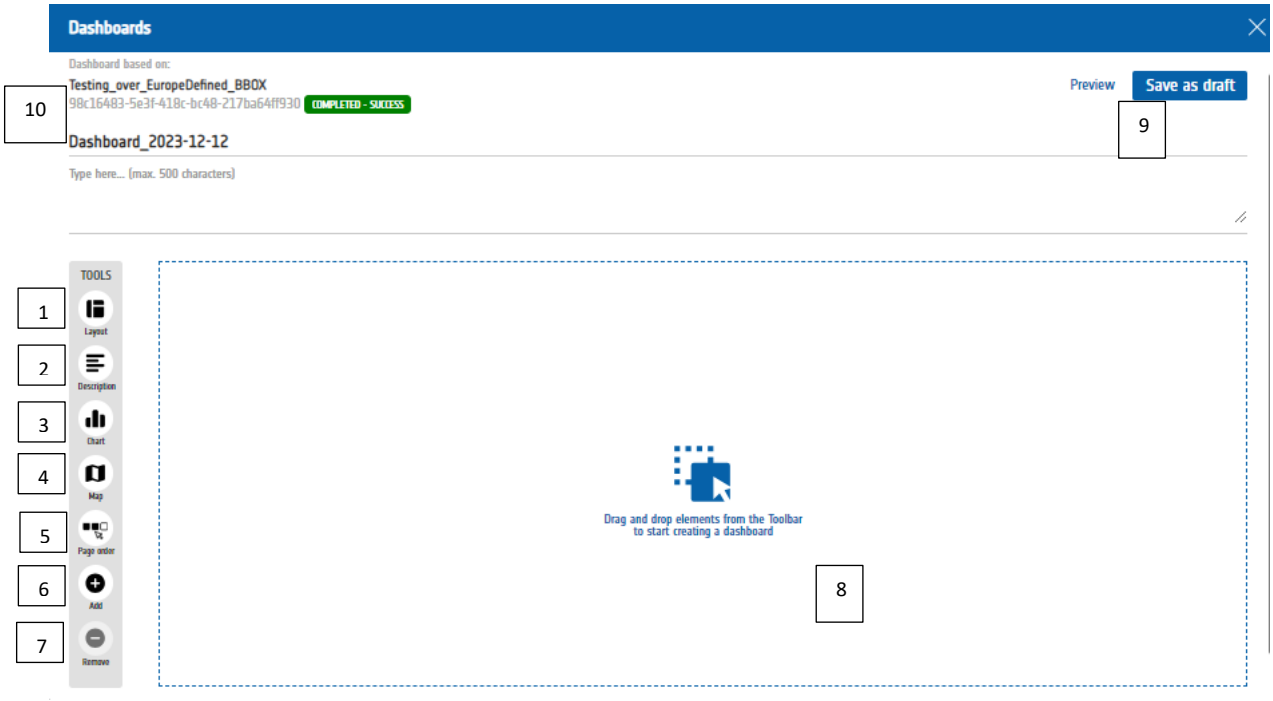


Figure 54 Custom Dashboard feature and possible customisation options

1. Page layout: allows the user to select different page layout option
2. A text block option: allows the user to enter text in a specific section
3. Charts option: allows the user to select different charts obtained by the output of the model and to show them in a dedicated block section
4. Allows the user to select the map and visualize it in the block section
5. Allows the users to select the page order
6. Allows the user to add additional pages
7. Allows the users to remove pages
8. It is the visualisation area where to drag and drop the different options
9. Allows the user to visualize the preview and to save the output as a draft
10. Allows the use to provide a title and a description of the dashboard

Once the dashboard has been saved as draft, the user can find the dashboard saved in my workspace/dashboard (see Figure 55)

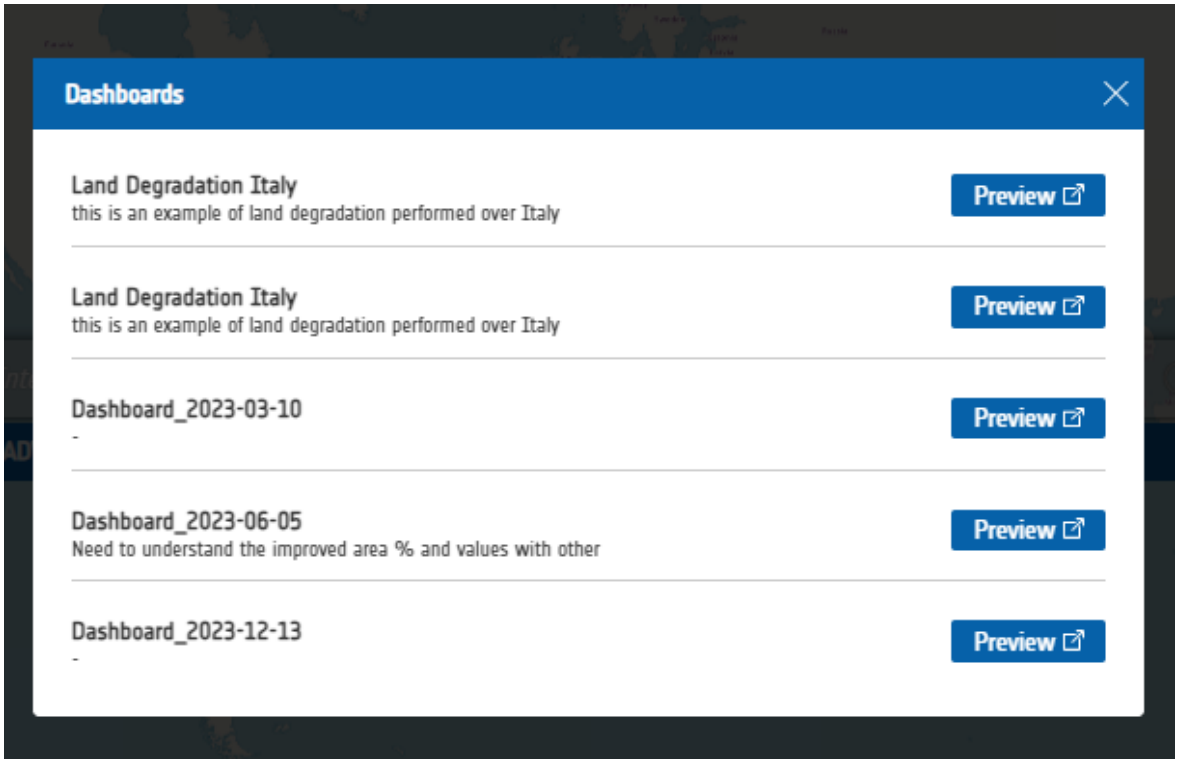


Figure 55 dashboard saved list

From this panel the user can preview a pre-created dashboard as seen in Figure 56.

Figure 56 Preview of the Report generated

4.4.1 Feature not yet implemented

The functionality remaining to be implemented is Report sharing. After implementation, users will be able to share reports generated through custom dashboard with others. Currently, dashboard and reports generated within them are only visible to users who created them.

4.5 All Atlantic updates

During the second project cycle the team has implemented the requirements resulting from UX/UI changes based on All Atlantic suggestions from Phase I.

The following changes have been implemented in the UAT environment:

- AtlantOS has been removed from Community portals menu and replaced with “All-Atlantic Ocean Data”
- Portal logos have been enlarged
- Bulk download list is now visible to logged out users
- Image and other downloadable types have been differentiated
- ‘Image’ and ‘other’ now use different icons for easier differentiation
- Data types are now always shown on downloaded resources
- Data download UI/UX has been further improved
- Added the option to hide thematic areas in advanced search form’s fields

Most of the applied changes concern minor UI and UX improvements and did not modify the underlying logic of processes carried out by our users.

The first such change was replacing the AtlantOS item in community portals menu with All-Atlantic Ocean Data (as shown in Figure 57).

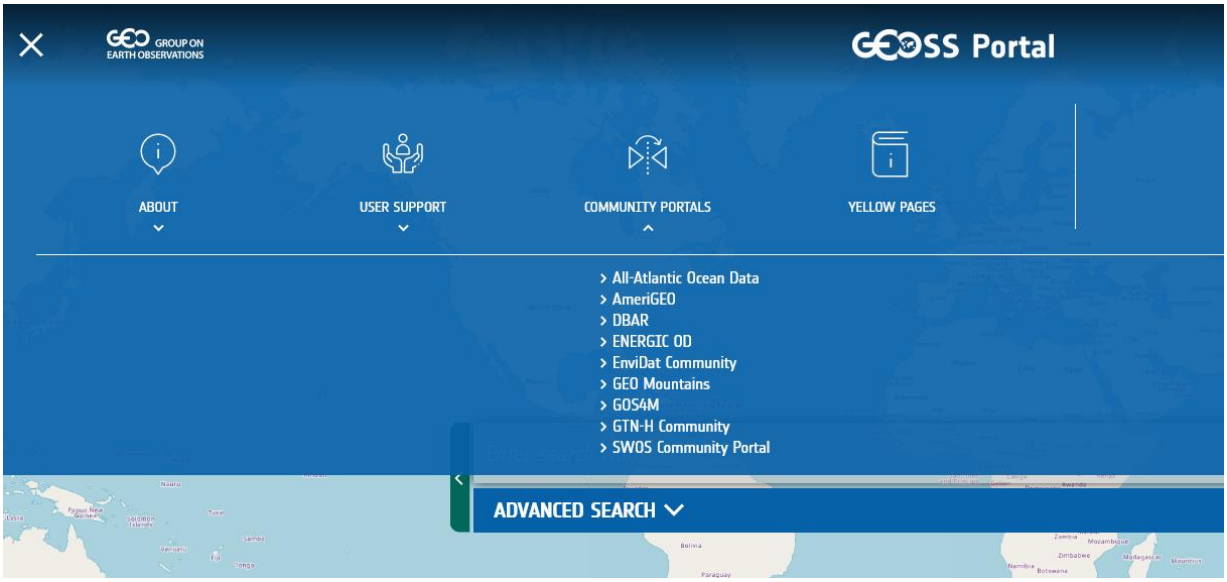


Figure 57 GEOSS Portal UAT Hamburger menu and community Portal section

In addition, in the main portal view:

- Portal logo has been enlarged to make it more apparent which portal the user is currently using

- The bulk download list (now accessible through the shopping cart button) has been made visible at all to all users to make navigation to list of bulk downloads easier – if no downloads are currently available for the user's account, then they will be notified of this after opening the list
- Users are now notified when their query does not return any results – this is done through a popup shown after such query is entered into the search field by the user

Sections of the portal view affected by these changes have been highlighted in Figure 58.

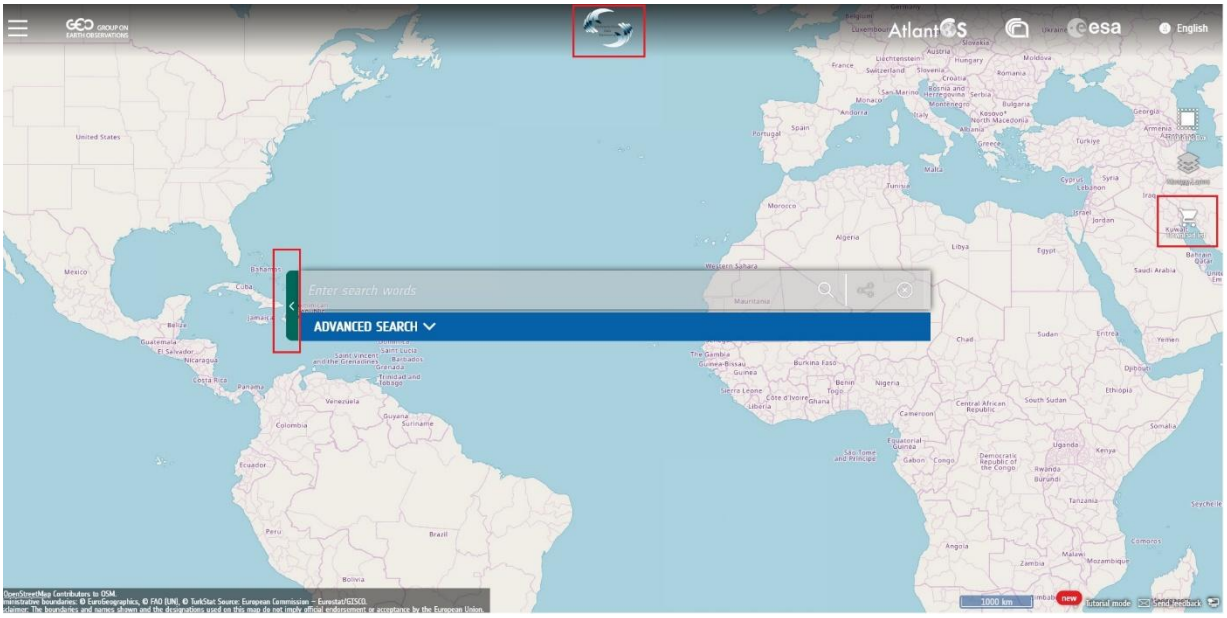


Figure 58 The enhanced All Atlantic Community portal with three areas of interest highlighted (from the top: portal logo, bulk download button/shopping Cart, search field and its advanced options)

The data download process has been improved by providing more descriptive text and names to many of available buttons, tooltips, and other elements. In addition, elements which cannot be used by users who are not logged in are now disabled and greyed out – hovering over such elements displays a tooltip notifying users that they need to log in to access such features.

Additional toasts (messages shown in the application in a form of a popup) are now displayed to clarify the effect of actions the user has performed in the following situations:

- After adding item to bulk download (from both search results and custom download window)
- After requesting a download in custom download window

To aid users in the download process, the following changes in design have been made:

- The bulk download icon has been changed to shopping cart (as shown in Figure 58)
- Data types are shown for all available data, to make it clear what type of resources will be downloaded (for example: HTML, PDF, PNG, XML, and FILE for other formats).

Figure 59 Users can now identify what type of resource formats are available for download

The download flow was simplified to make the process easier through the following changes:

- Bulk download list is now available at all times, even to users who are not logged in
- The options to download now and download later are immediately accessible from download options, without additional intermediate steps
- Resources are now immediately available for download after using the custom download option

The final update in this phase, was adding the system for hiding thematic areas in the advanced search form. This allows the administrator to hide thematic areas, which are not relevant, from community portals.

To open the

1. Log into CMS
2. Navigate to any community portal
3. Open site configuration for the selected community portal
4. Scroll down to the bottom of the configuration page until list of 'global views' becomes visible

Afterwards you will be presented with a list of resources, which can be hidden (or enabled again after being hidden) from showing in the advanced search form.

Page 1 of 2 | 20 Items per Page | Showing 1 - 20 of 34 results. | ← First | Previous | Next | Last →

optionValue	Label	
v6bd09285c0781c1fa54e164fb59989c4	Climate	Show
vb49d8bde613147989ea91defcf358a7f	Water Resources Management	Show
vdd9a0064a20442bd8cb0fc031cfd9e19	Disaster Resilience	Show
v656eb88c14544aca51fb7c217209536	AtlantOS	Default Hide
dbar-view	DBAR focal area	Show
v6bd09285c0784c1fa54e164fb59989c2	GEO Mountains Community	Show
v6bd0928a45911e7abc4cec278b6b50a	Gos4m Community	Show
v675ea24d7f44575a775187b92d28854	Sustainable Caucasus	Show
v610f20774aa458ba53bc4651b358270	AmeriGEO	Show
v6621194704b2a49b38e4494dfe0cf5e	EnviDat Community	Show

Figure 60 List of thematic areas which can be enabled or disabled for a community portal.

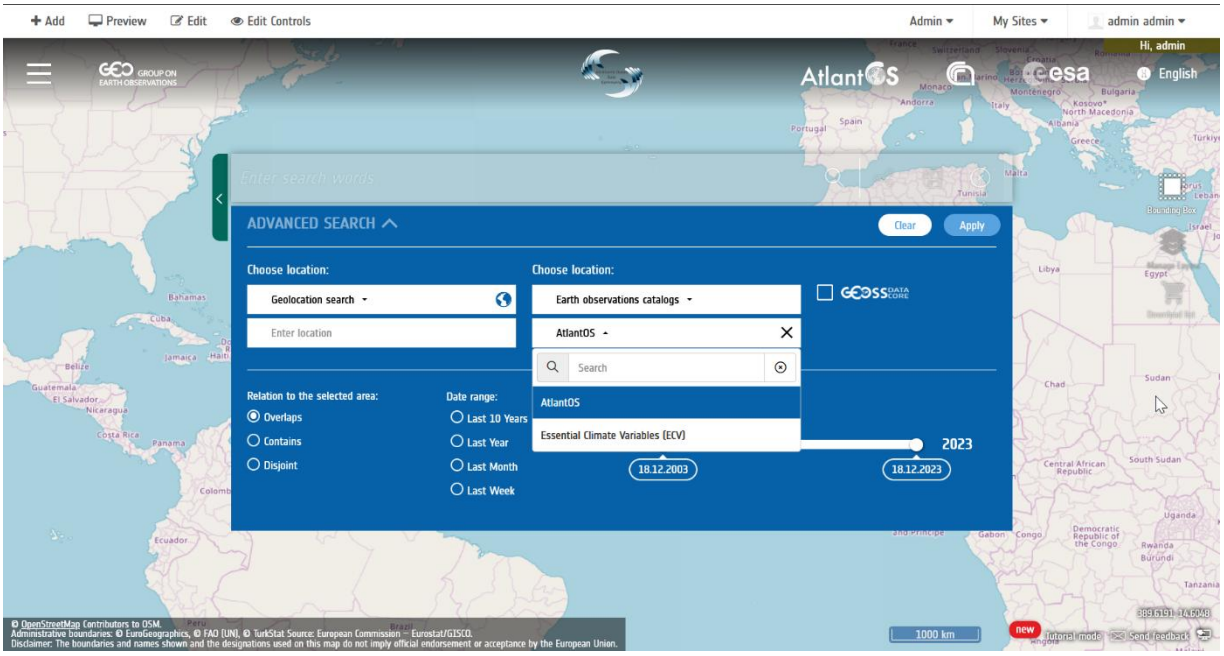


Figure 61 Advance search. Thematic areas in this form have been narrowed down through options in CMS.

4.6 Nutrient Pollution in European Inland and Coastal Waters

For the implementation of this use-case the GREEN model, developed by JRC, was shared in VLab. This allowed its exploitation via VLab 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.

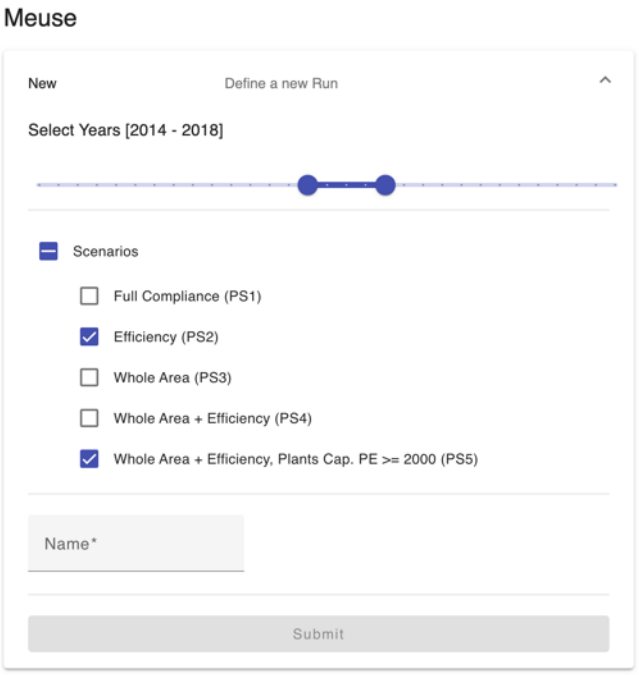


Figure 62 – Definition of the simulation settings in GrEEN Web application

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.

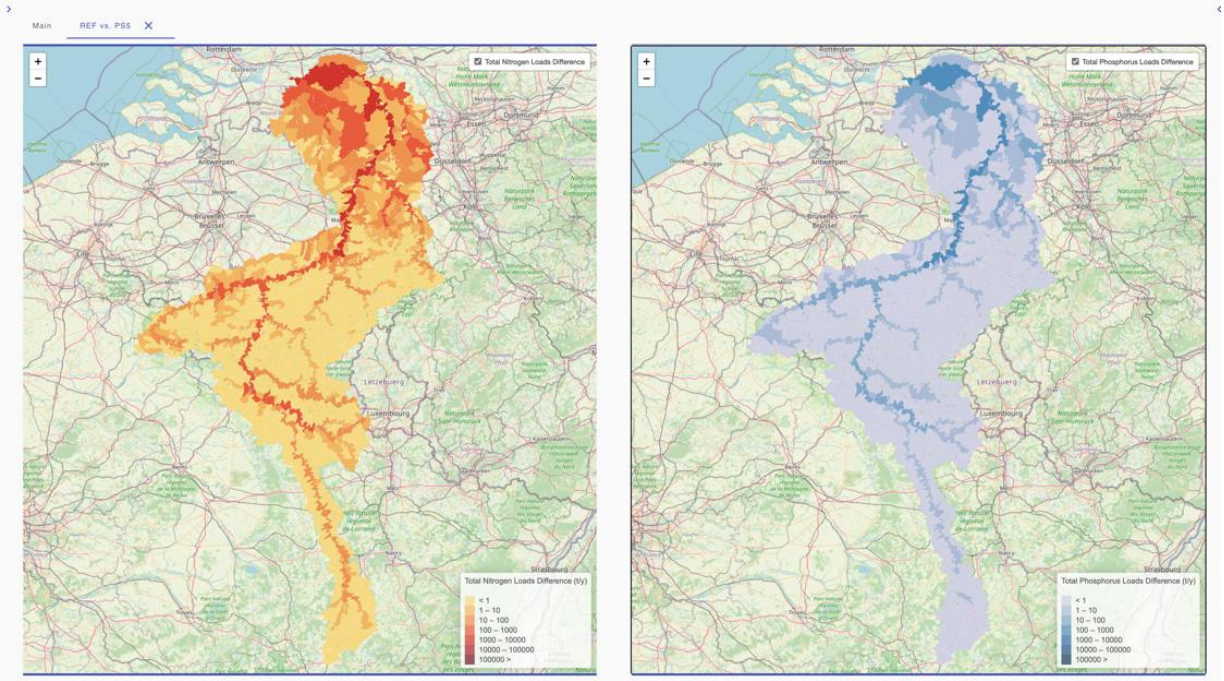


Figure 63 -Difference of nitrogen and phosphorus loads over. Meuse Basin region

4.7 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. In collaboration with EC JRC, different ML models were developed to test the estimation of AGB from Sentinel products. Three different ML models can be used:

- Random Forest
- Gradient Boosting
- Multi-Layer Perceptron

It must be noted that, due to a lack of available training data, the resulting models which were utilized in the use case will require additional refinement to provide more accurate results.

The GEOSS Platform Plus project, in collaboration with EC JRC, developed a proof of concept to enable the execution of these ML models in a multi-cloud environment. The ML models run 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. The

VLab framework was extended to support ML models execution. VLab Web APIs were utilized to create a dedicated Web Application, which users can access to create and visualize biomass maps.

Through AGB Web Application users can select an area of interest and define the settings for the creation of a biomass map, including the time period and the specific ML model to use. Figure 64 depicts the ML model selection form, where users can visualize the high-level description of the different ML models, i.e., the type of model and the indexes and Sentinel product bands which are utilized.

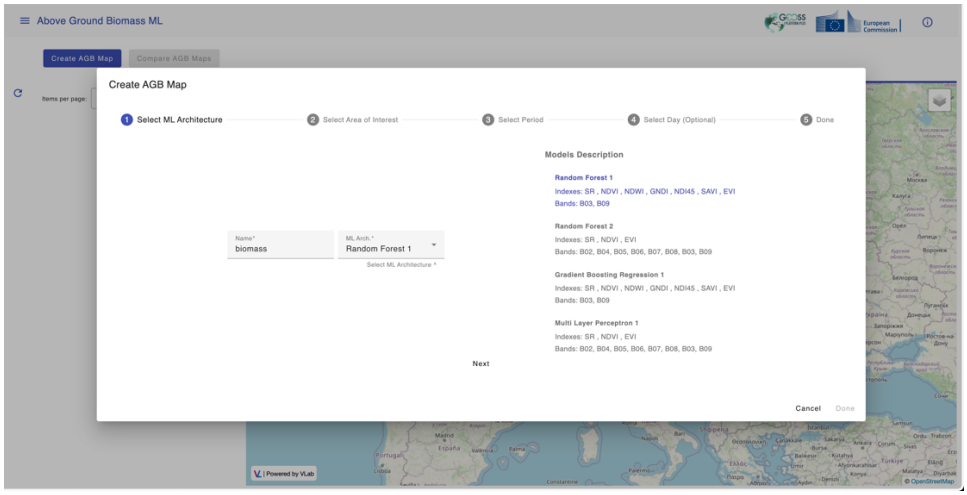


Figure 64 - ML model selection in AGB Web Application

After the model execution completes, users are displayed with the computation details (Figure 65), including:

- The ML model which was utilized
- The selected time period for the execution
- The selected area of interest for the execution
- The execution status
- The execution result
- The execution platform
- The Sentinel products which were utilized as input
- The output biomass map to visualize

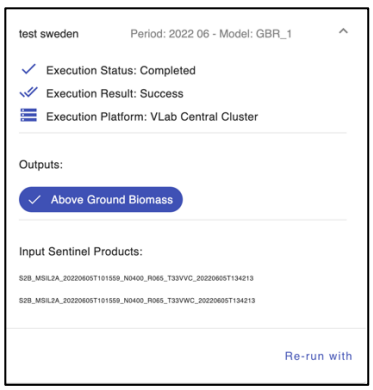


Figure 65 - Visualization of biomass map computation details

It is also possible for users to generate a new biomass map utilizing the same configuration of an existing map, changing only the ML model to be utilized (Figure 66).

This allows to generate maps which are directly comparable, enabling the assessment of the performance of the different ML models. The AGB Web Application allows users to select and visually compare biomass maps on the same area of interest calculated with different ML models as depicted in Figure 67.

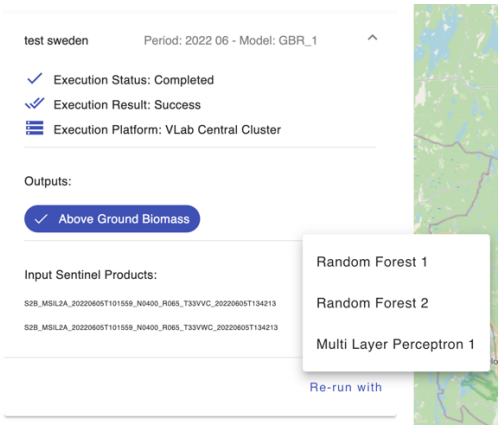


Figure 66 - Re-use of existing configuration to generate a new biomass map

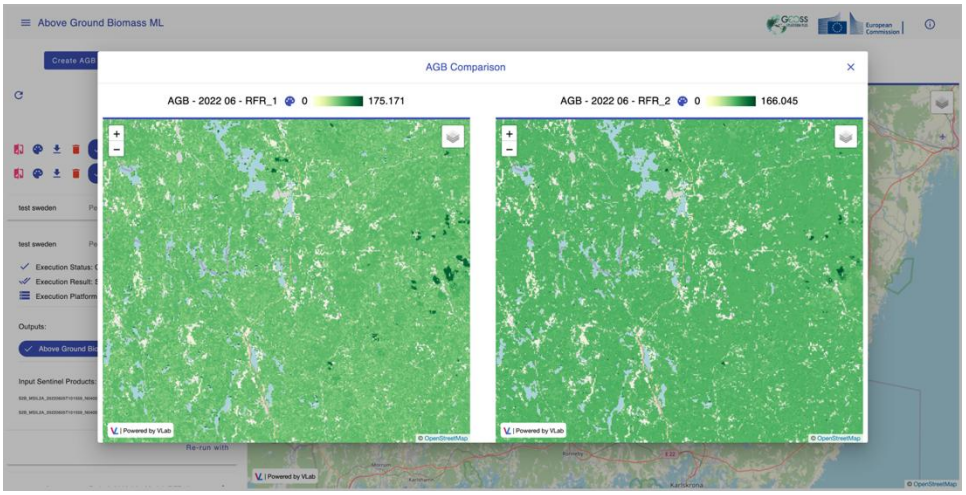


Figure 67 - Comparison of two Biomass Maps on the AGB Web App

4.8 NewLife4DryLands Use Case

This use case builds on the outcomes of the NewLif4DryLands project (funded from the LIFE financial instrument “LIFE Preparatory project – Programme for the Environment and Climate Action” of the European Commission) which extracted a set of **remote sensing-based indices and indicators used as proxies to assess quantification and mapping of Land Degradation at local scale**, trying to answer to the requests, by local institutional decision-makers, of increasingly more details difficult to reach by global/pan-European Union (EU) services (i.e., Copernicus).

The NewLif4DryLands project focused on 6 study sites representing a wide variety of ecosystems in the Mediterranean landscape as drylands, coastal or mountainous, with high or low extension, threatened from different pressures causing Land Degradation (LD). Hence, the analysis by RS data results not site-dependent rather specific for Mediterranean ecosystems identifying a proper protocol for the monitoring of their LD status. The GPP project included 2 of the 6 sites in the use case, namely Alta Murgia National Park (Italy) and Nestos Protected Area (Greece).

The model for creating the different RS indexes was published in the VLab framework, which utilises the European cloud computing platforms, including the Copernicus DIASes and the European Open Science Cloud, for the execution of scientific models.

Building on VLab Web APIs, a dedicated Web application was developed for a seamless search and generation of the RS indexes for the specific sites that were selected.

After selecting the specific site they’re interested in, users can search and/or generate available RS indexes. To generate the RS indexes, users must specify a time period and can, optionally, request to use products with a maximum threshold of cloud cover. The Web Application displays available products which can be used for different days in the selected period and users can choose the most appropriate products (Figure 68).

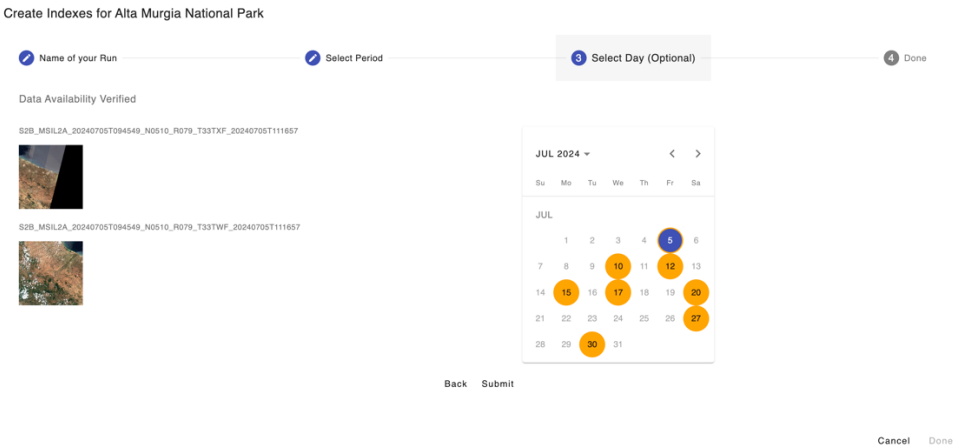


Figure 68 - Input Products selection for NewLife4DryLands Web Application

After a few minutes the produced data is available for visualization (Figure 69) and visual comparison with indexes calculated on the same site in other dates.

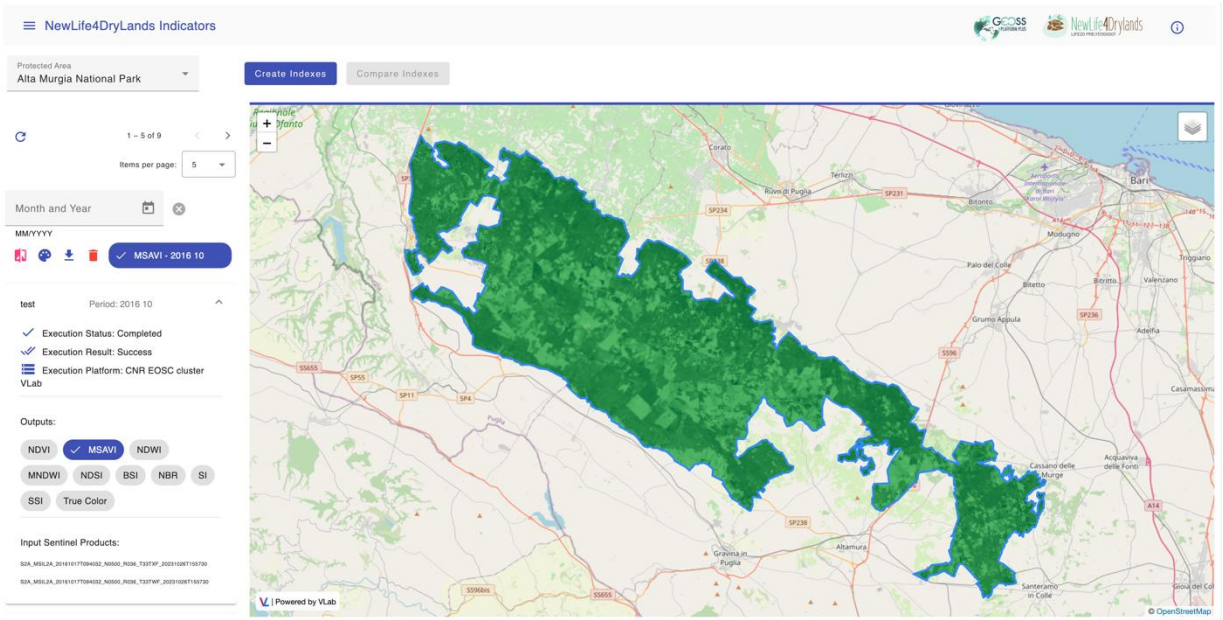


Figure 69 - MSAVI Index over Alta Murgia National Park in October 2016

4.9 AGAME

Site and Platform Coordinators require spatially explicit time series data on gross primary production (GPP). They need this information to investigate declines in carbon uptake due to global warming and to predict future biosphere conditions influenced by changing climate and land use. Both scenarios are vital for promoting the use and adoption of AGAME products and services.

Providing quality controlled and up-to-date data is an important prerequisite for informed environmental policies and the implementation of management decisions especially on local and regional scale. In this respect, AGAME:

- provides consistent data products together with detailed metadata. The availability and accessibility of data and derived products will stimulate their exploitation by a wide range of users in the biodiversity sector.
- generates added value products that will facilitate the use of remote sensing data in new applications involving the vision of new operational products in the GEOSS portal that will lead to an increased understanding of Earth processes.

The data requirements as well as functional requirements to access and use these data has been developed and aligned already in an early stage of the process with users' needs and requirements. AGAME offers a service co-designed and co-developed with users that provides information of gross primary production on local scale and can be used to give direct and focused answers to specific questions from the targeted scenarios.

The project adopts an end-user centred approach, benefitting from the cooperation with local stakeholders, their knowledge and expertise. Potential users have been engaged in the service design and validation in an iterative process in the different project phases.

AGAME exploits the benefit of integrating Copernicus Products (remote and local data) and other diverse data sources (local, regional or global) by delivering tailored information and services co-designed with the users. It incorporates EO data from Sentinel missions, local monitoring data and data-driven modelling in the GEOSS platform to improve biodiversity management.

By doing so, AGAME contributes to the development of the GEOSS platform by delivering information on gross primary production accessible via the GEOSS Platform.

Moreover, the AGAME Gross Primary Production product serves as an additional layer of information within eLTER's site and information cluster. This addition enriches eLTER's research capabilities and aims to sustain AGAME products beyond the project's runtime. By integrating AGAME offerings into eLTER's framework, both scenarios promote the use and adoption of AGAME products and services while providing a long-term perspective for their utilization and impact.

4.9.1 Use case discovery and access

The implemented solutions serve the use cases and requirements for four stakeholder groups, the eLTER Site and Platform managers, the eLTER RI Head Office, the wider science community, as well as the GEOSS users. The use cases encompass the discovery, evaluation and access of the data products defined for the AGAME showcase.

Discovery, access, usage and uptake of Gross Primary Production data product

1. The user connects to the GEOSS platform.
2. The user either:
    a. searches for “Primary Production” in general, or
    b. selects 'AGAME' or 'ICOS' as data catalogue and applies the criteria.
3. The user obtains results obtained by their search criteria.
4. The user can discover different data sets and select the products suitable for their needs.
5. The user can visualise the selected product. A description of the product is provided as part of the metadata.
6. The user can access product metadata.
6. The user can display the details for the data product.
7. The user can download the data following the link for the download resource.
9. The user can then navigate deeper into the knowledge package.

Additional workflow steps:

1. The user can access the workflow used to generate the product and/or training materials.
2. The user can ask for support or assistance regarding the product/access to the product.

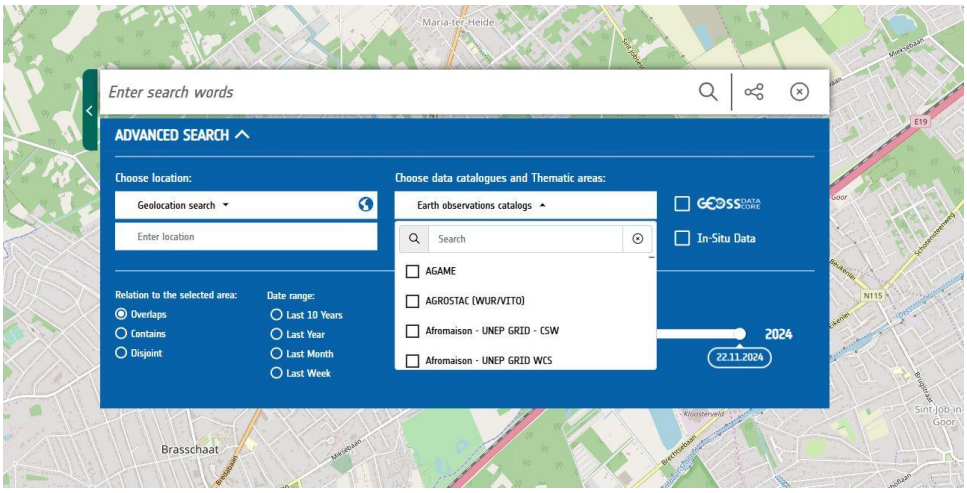


Figure 70 User selects 'AGAME' as data catalogue

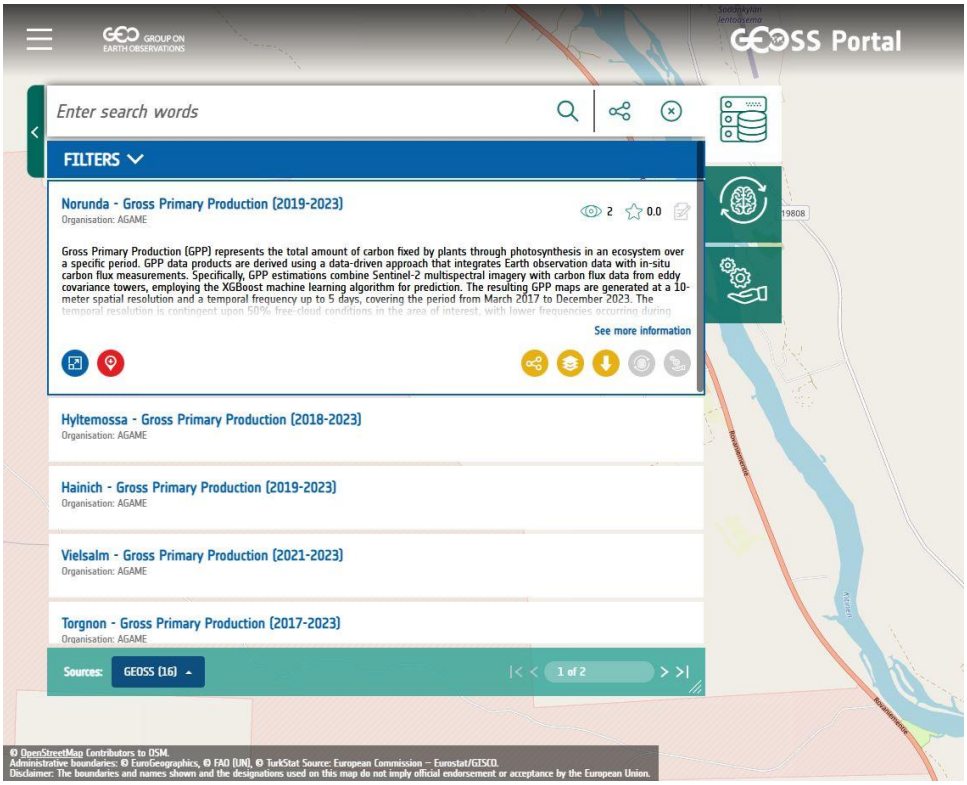


Figure 71 - after searching for the data products on AGAME and 'Gross Primary Production' the list of relevant datasets is shown

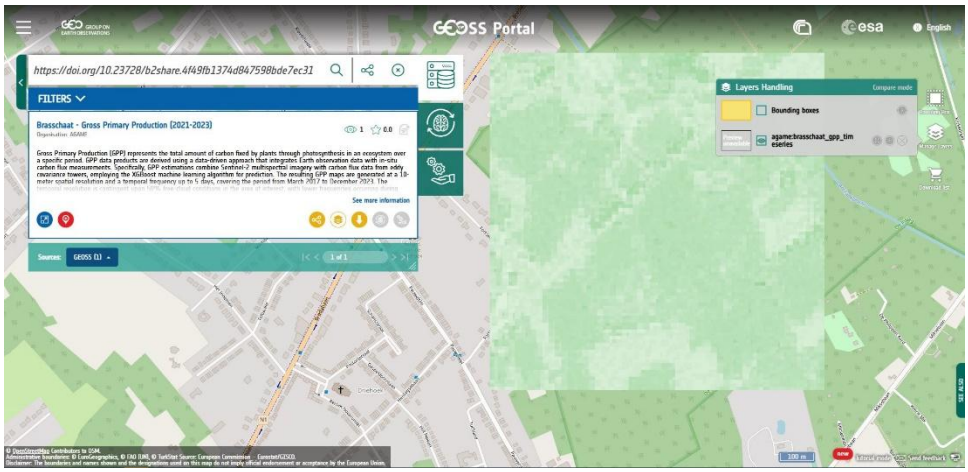


Figure 72 - Visualisation of the Gross Primary Production data product for Braaschat

Based on the detailed view of the metadata the user can download the Knowledge Package on Gross Primary production providing all data layers and relevant information on the usage and limitations. The data package is stored in the public repository B2SHARE which is linked in the metadata.

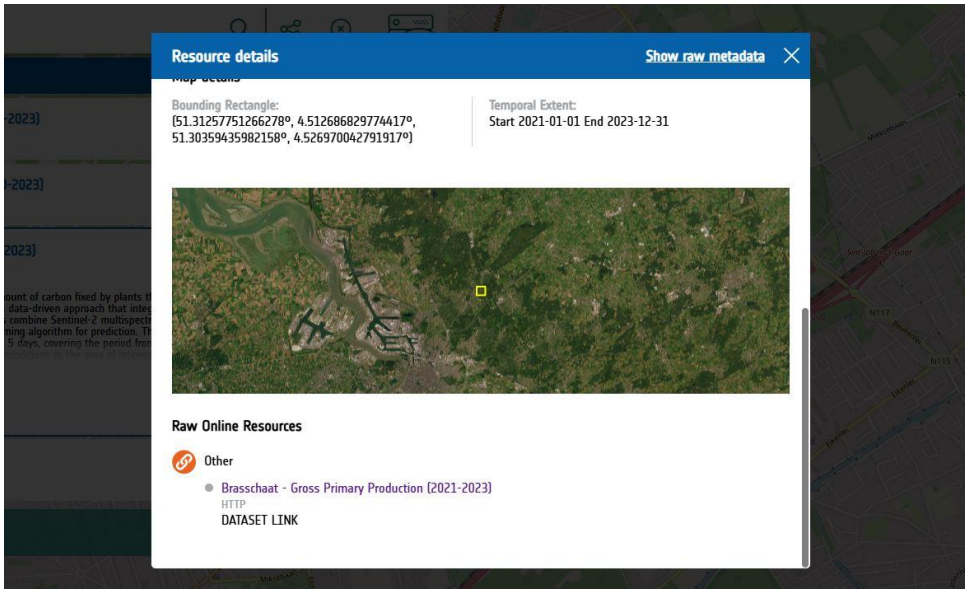


Figure 73 - Detailed view on the metadata and download link for the Gross Primary Production data product for Braaschat (https://doi.org/10.23728/b2share.4f49fb1374d847598bde7ec31022fd99)

The Knowledge Package is provided as ZIP package for download containing the following information products:

- data layers for gross primary production (GPP) for the time period and a respective long-term observation facility (as zip archive);
- data layers for valid areas to estimate error of gross primary production for the year and a respective long-term observation facility (as zip archive);
- data error estimates per year and a respective long-term facility (as zip archive);
- data product factsheet (as pdf file).

Data license, acknowledgement, and citation are provided in the detailed metadata.

In addition, the Data Product Factsheet is published as separate document providing information on the methods, data structures and use limitations of the Gross Primary Production data product. The document is published via B2SHARE.

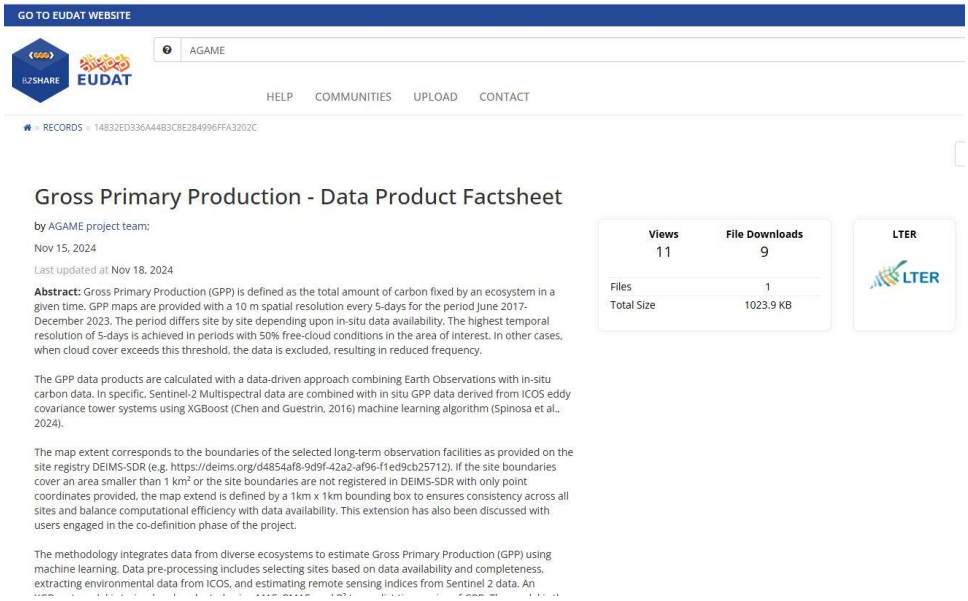


Figure 74 - Data product factsheet for the AGAME Gross Primary Production data product (https://doi.org/10.23728/b2share.14832ed336a44b3c8e284996ffa3202c)

The user can access the code and Information on the developed model via the eLTER GitHub (https://github.com/eLTER-RI/agame).

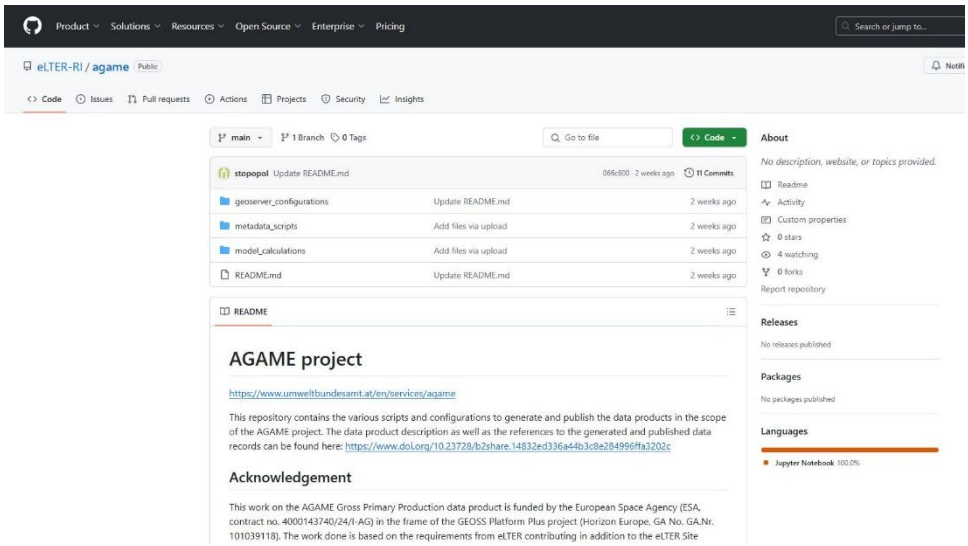


Figure 75 - Sharing of the model code for Gross Primary Production data product via the eLTER-RI gitHub

List of service URLs

- eLTER catalogue (https://catalog.elter.cerit-sc.cz/)
- Example for an AGAME record (https://catalog.elter.cerit-sc.cz/lter/grhg7-mx469)
- Example for ISO serialisation (https://catalog.elter.cerit-sc.cz/lter/grhg7-mx469/export/iso19139)
- GeoServer (https://spatialnode.elter.cerit-sc.cz/geoserver)
- Layer list (https://spatialnode.elter.cerit-sc.cz/geoserver/web/wicket/bookmarkable/org.geoserver.web.demo.MapPreviewPage?2&filter=false)
- GetCapabilities (https://spatialnode.elter.cerit-sc.cz/geoserver/ows?service=WMS&version=1.3.0&request=GetCapabilities)
- PyCSW (https://catalog.elter-ri.eu/csw)
- B2Share (https://b2share.eudat.eu/records/?q=agame)
- AGAME GitHub Repository (https://github.com/eLTER-RI/agame)
- Training material: Product/Service Development - Gross Primary Production - eLTER SPF Webinar (https://www.youtube.com/watch?v=MQQxYL7eUZg)

4.9.2 AGAME Gross Primary Production Software user manual

This chapter describes the modelling activities performed to generate the AGAME products. The workflow is schematized in Figure 76. The methodology mainly consists of three parts: i) data collection and preparation; ii) model implementation for GPP time series estimation, and evaluation; iii) generation of maps and unsupervised classification for accuracy estimation. Those steps are explained in more details in the following sections.

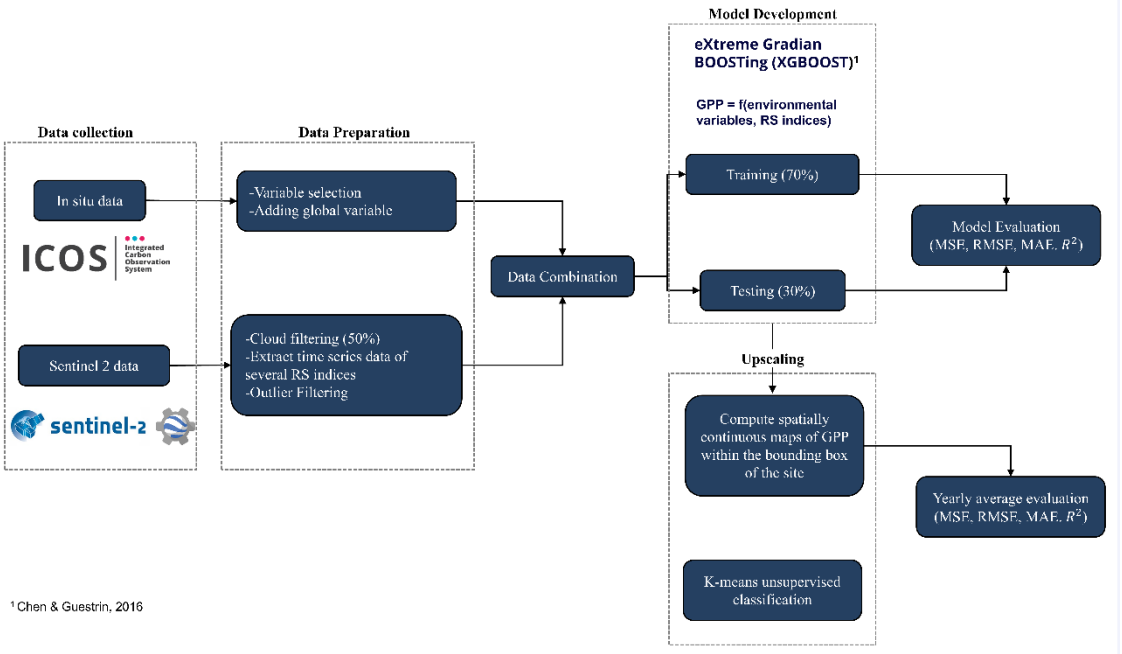


Figure 76 - AGAME workflow overview

Data collection and preparation

- **In-situ measurements**

In-situ measurements are gathered from ICOS (Integrated Carbon Observation System) portal (https://www.icos-cp.eu/). ICOS provides free and open access to products data. The ARCHIVE data product for ecosystem measurements at daily resolution are collected, for the period 2017-2023. The ARCHIVE data product contains a set of meteorological variables gapfilled and/or downscaled from the ERA-interim dataset. To ensure model reproducibility, only those variables available for all the chosen study sites are used. Table 1 shows the full list of variables used as predictors for GPP. The Gross primary CO2 production from daytime partitioning method, percentile 50 estimations (GPP_DT_VUT_USTAR50), determined by method by Lasslop et al. (2010)[2], is chosen as the target variable for the prediction task. More detailed information regarding the processing step of the data, including the gap-filling and downscaling of ERA-interim dataset, and the calculation of the GPP_DT_VUT_USTAR50, can be found in Pastorello et al. (2020)[1].

Table 1: in-situ and ERA5 modelled data gathered from ICOS

Variables	Description
LW_IN_ERA	Downward longwave radiation flux (ERA5)
LW_IN_JSB_ERA	Adjusted downward longwave radiation flux (JSBACH model in ERA5)
PA_ERA	Surface pressure (ERA5)
P_ERA	Total precipitation (ERA5)
SW_IN_ERA	Downward shortwave radiation flux (ERA5)
TA_ERA	Air temperature at 2 meters (ERA5)
VPD_ERA	Vapor pressure deficit (ERA5)
WS_ERA	Wind speed at 10 meters (ERA5)
GPP_DT_VUT_REF	Gross Primary Production (GPP) - daytime (VUT_REF model) (ICOS)

- **Remote sensing data**

The Copernicus Sentinel-2 mission features two identical satellite, Sentinel-2A and Sentinel-2B, orbiting at the same trajectory to give a revisit frequency of 5 days at the Equator. The multi spectral instrument samples 13 spectral bands, four of which at a 10 m, six at 20m and three at 60 m spatial resolution. Level-2A Sentinel-2 products, resampled at 10 m spatial resolution, are used in AGAME for the calculation Vegetation Indexes (VIs). VIs have been extensively used for monitoring changes in vegetation growth. Here we use 8 different VIs, sensitive to both greenness and water content. Specifically, NDVI, MNDVI, EVI, EVI2, CIr, LSWI, MNDWI, and NDII are calculated. Specifics can be seen in Table 2.

- **Sentinel-2 preprocessing**

Sentinel-2 data are accessed through the Google Earth Engine (GEE) data catalogue. GEE allows to speed up the preprocessing process. Sentinel-2 images are retrieved with defined locations and time periods. The time period corresponds to the time availability of the in-situ measurements, since those are used as ground truth, while the location corresponded to the coordinates of the flux tower with a certain buffer area. Images with cloud coverage of more than 30% are excluded.

VIs are calculated as average value of the pixel value within the selected buffer area (see Spinosa et al., 2023 for more details). The process was followed by interpolation to fill the gap dates for which there were no available images. This resulted in a daily time series data for each VI retrieved from the Sentinel-2 data for each site.

Table 2: Remote sensing based vegetation indexes used in the AGAME's workflow. Adopted from Spinosa et al., 2023.

Index	Description
Normalized Difference Vegetation Index (NDVI)	NDVI is the most common VI in studies of vegetation covers. It combines the near-infrared band (NIR) with the red band (R).
Enhanced Vegetation Index (EVI)	EVI is an improved version of the NDVI that handles the saturation of this index in high biomass ecosystems. It combines the near-infrared (NIR), red (R) and blue (B) bands.
Two-bands Enhanced Vegetation Index (EVI-2)	EVI-2 is an alternative to the EVI using only the near-infrared (NIR) and red (R) band .
Red-edge Index (CLr)	CLr is a vegetation index built with the narrow red-edge bands of Satellite products with high spectral resolution. It combines the red-edge bands with a central wavelength of 705 nm (Re1) and 783 nm (Re3).
Modified Normalized Difference Vegetation Index (MNDVI)	MNDVI is a normalized difference between the narrow red-edge bands with a central wavelength of 705 nm (Re1) and 783 nm (Re3).
Modified Normalized Difference Water Index (MNDWI)	MNDWI is a normalized difference between the green (G) and the short-wave infrared band (SWIR1).
Land Surface Water Index (LSWI)	LSWI is a normalized difference between the near-infrared (NIR) and the short-wave infrared band (SWIR1). Other authors have studied the same combination of bands under the name of Normalized Difference Water Index (NDWI) or Normalized Difference Moisture Index (NDMI).
Normalized Difference Infrared Index (NDII)	NDII is a normalized difference between the near-infrared (NIR) and the short-wave infrared band (SWIR2).

Model implementation for GPP time series estimation

- **XGBoost**

XGBoost (Extreme Gradient Boosting) is a scalable, distributed gradient-boosted decision tree (GBDT) machine learning. A decision tree is a hierarchical structure used for decision making. When applied for regression tasks, the target is a continuous variable. XGBoost builds an ensemble of decision trees in a sequential manner (Ahmetoglu and Das, 2022). By minimizing a loss function and using gradient descent to improve accuracy, XGBoost can handle complex, nonlinear relationships in data. Additionally, it has built-in classifier efficiently handling missing values, preventing overfitting, and decreasing running time through parallel and distributed calculations (Lou et al., 2021), making it highly effective for predictive modelling in large datasets. The XGBoost implementation utilises the XGBoost package for Python (XGBoost Python Package, 2024). The collected EVs (Table 1) and the derived VIs (Table 2) are used as model predictors. The target variable is the GPP_DT_VUT_USTAR50 detailed in Table 1.

- **Evaluation Metrics**

To evaluate the XGBoost model, the data set is split, with 80% used for training and 20% for testing. In the model setup, the XGBoost model is trained using the selected 80% of the input variable. The model parameters are fine-tuned to improve accuracy. Then, the remaining 20% of testing data is used to evaluate the model's performance by comparing its predictions against in-situ GPP data.

To evaluate the predictive model performance, four evaluation metrics are used. Those are the Mean Squared Error (MSE), RMSE, Mean Absolute Error (MAE), and coefficient of determination (R2).

Maps Generation

The computation of the map is done by applying the trained model to the ecosystem boundaries. The map extend corresponds to the boundaries of the selected long-term observation facilities as provided on the site registry DEIMS-SDR (e.g. https://deims.org/d4854af8-9d9f-42a2-af96-f1ed9cb25712). If the site boundaries cover an area smaller than 1 km² or the site boundaries are not registered in DEIMS-SDR with only point coordinates provided, the map extend is defined by a 1km x 1km bounding box to ensures consistency across all sites and balance computational efficiency with data availability. This extension has also been discussed with users engaged in the co-definition phase of the project. Maps are generated at a 5-day time resolution, if the cloud coverage does not exceed 50% of the area.

- **Unsupervised classification/Accuracy estimation**

An unsupervised classification algorithm, namely the k-means clustering algorithm, is used to identify pixels having similar vegetation of those within the footprint.

The k-means clustering algorithm developed by Arthur and Vassilvitskii (2022) was used to perform the unsupervised classification and implemented through the Clusterer.wekaKMeans method of the "ee" package in python. By assuming that those identified regions have vegetation with similar biophysical properties, photosynthesis activity and GPP seasonality of those within the footprint, the annual error metrics calculated can be used.

4.9.3 Functionalities not implemented

A number of additional functionalities specified in the requirements could not be implemented during the project run time. This mainly encompass the extraction of time series by area or pixel and visualisation of the resulting graph for the users. Details are given in deliverable D3.7.

4.9.4 References

Ahmetoglu, H. and Das, R., 2022. A comprehensive review on detection of cyber-attacks: Data sets, methods, challenges, and future research directions. Internet of Things, 20, p.100615.

Arthur, D.; Vassilvitskii, S. k-means++: The Advantages of Careful Seeding; Stanford InfoLab: Stanford, CA, USA, 2006; Available online: http://ilpubs.stanford.edu:8090/778/ (accessed on 12 December 2022).

Lasslop, G., Reichstein, M., Papale, D., Richardson, A.D., Arneth, A., Barr, A., Stoy, P. and Wohlfahrt, G., 2010. Separation of net ecosystem exchange into assimilation and respiration using a light response curve approach: critical issues and global evaluation. Global change biology, 16(1), pp.187-208.

Luo, J., Zhang, Z., Fu, Y. and Rao, F., 2021. Time series prediction of COVID-19 transmission in America using LSTM and XGBoost algorithms. Results in Physics, 27, p.104462.

Pastorello, G., Trotta, C., Canfora, E., Chu, H., Christianson, D., Cheah, Y.W., Poindexter, C., Chen, J., Elbashandy, A., Humphrey, M. and Isaac, P., 2020. The FLUXNET2015 dataset and the ONEFlux processing pipeline for eddy covariance data. Scientific data, 7(1), p.225.

Spinosa, A., Fuentes-Monjaraz, M.A. and El Serafy, G., 2023. Assessing the use of Sentinel-2 data for spatio-temporal upscaling of flux tower gross primary productivity measurements. Remote Sensing, 15(3), p.562.

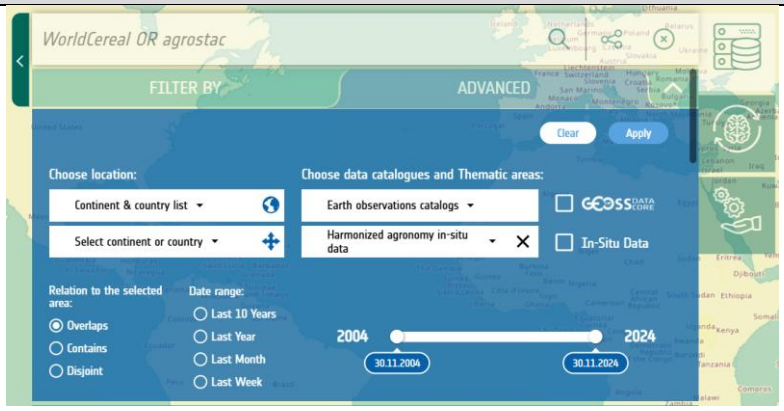
XGBoost Python Package." https://xgboost.readthedocs.io/en/stable/python/index.html, 2024. Accessed on Nov 11, 2024.

4.10 Maps4GPP

Agronomy in-situ data plays a pivotal role in enhancing the precision and reliability of monitoring and studying global crop production. There are several institutes, projects and programs providing agronomy in-situ data in a standardized way (Analysis Ready Data - ARD) that can be used in support of monitoring GEOGLAM's essential agricultural variables (EAV). Two relevant examples are the ESA funded WorldCereal project and AGROSTAC, both collecting and harmonizing agronomy in-situ data to train and validate algorithms, models, and products. Currently, there is no central place where these different ARD datasets can be found and used. Therefore, Maps4GPP aims to strengthen the agronomy in-situ data component of the Global Earth Observation System of Systems (GEOSS) platform by adding the WorldCereal and AGROSTAC repositories to the data portal of the GEOSS platform as a central hub where users can explore and download data. The initiative aims to ease the finding, understanding and use of harmonized agronomy in-situ datasets and demonstrate the enhanced value of these data in generating crucial spatial layers such as land cover and crop maps for regional crop productivity analyses and assessments of agricultural externalities.

4.10.1 Exploring and leveraging the WorldCereal and AGROSTAC harmonized in-situ data

The harmonized agronomy in-situ data of WorldCereal and AGROSTAC can be found in the GEOSS portal via different ways, explained in the following table:

GEOSS portal element	Example of screen
In the "Advanced search" panel, select the Thematic area: "Harmonized agronomy in-situ data"	

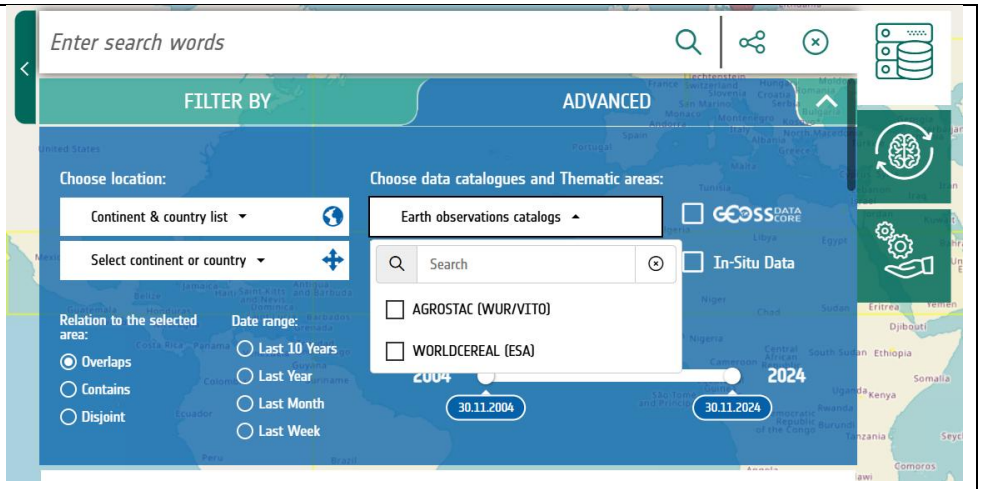
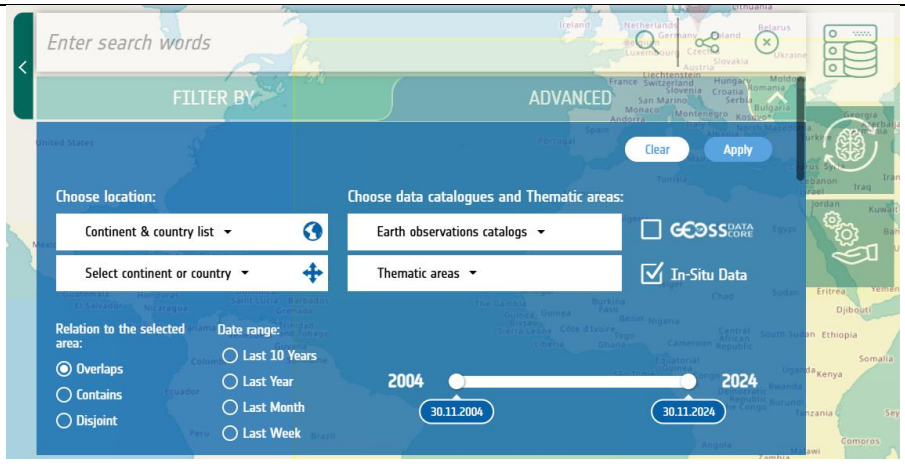
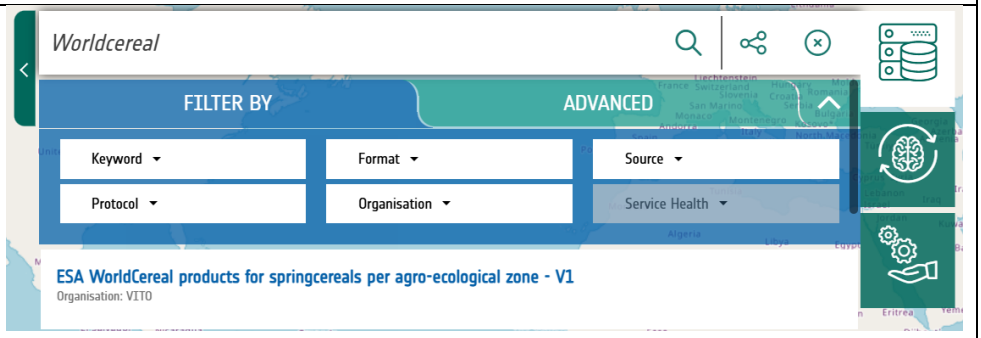
Further, from the "Earth observation catalogues", a user can further select AGROSTAC or WorldCereal as needed	
Another strategy is to just select "In-Situ Data" checkbox in the Advanced panel which also leads to data of WorldCereal and AGROSTAC	
Alternatively, a user can employ the "Search" box and look for WorldCereal and AGROSTAC data sets among other WorldCereal products.	

Table 3 – GEOSS Portal - Thematic Area for Maps4GPP

Each of these different search strategies returns a list of harmonized agronomy in-situ datasets.

The number of datasets depends on the choices made e.g. combining both WorldCereal and AGROSTAC or selecting only one. Please note that all the WorldCereal and AGROSTAC returned datasets are part of the source GEOSS (see source selector in the red box):

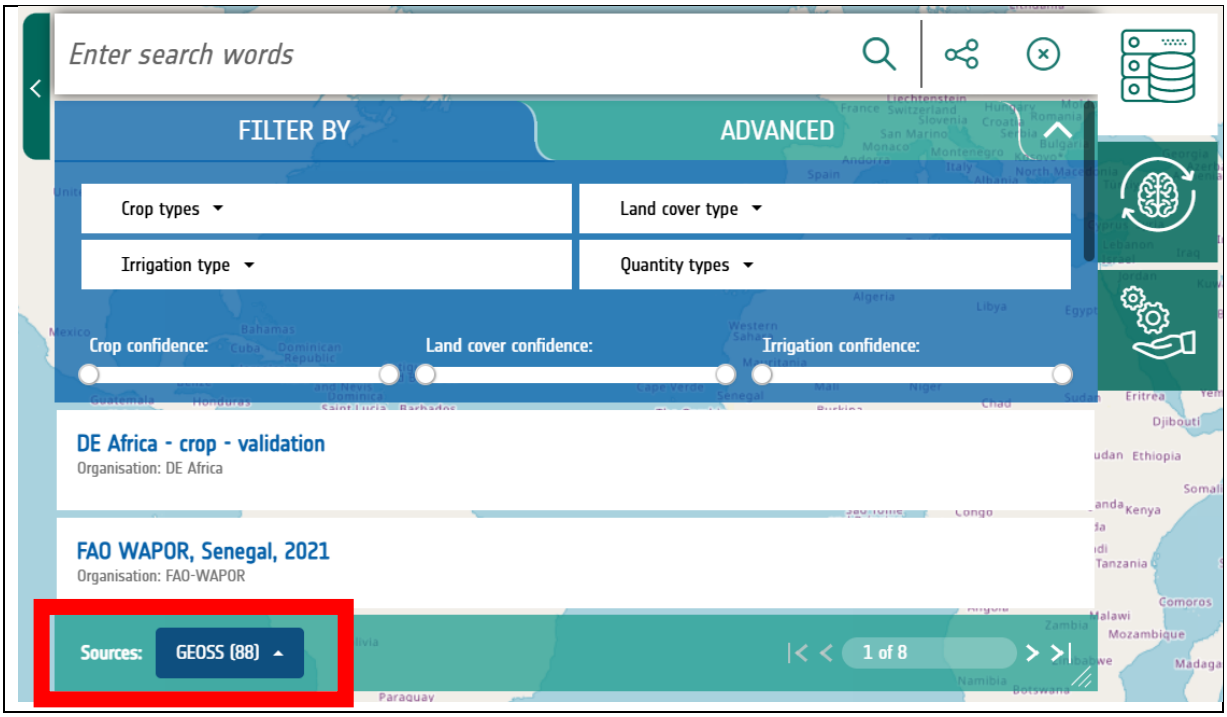


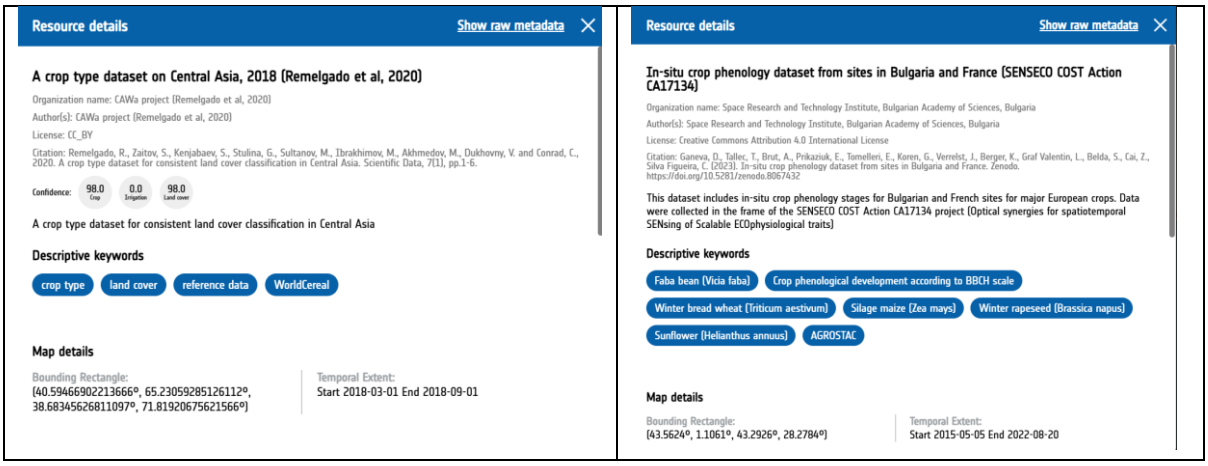
Figure 77 - Maps4GPP returned Datasets (AGROSTAC and WorldCereal)

Next, a user can inspect any of the datasets shown by clicking on it and looking at the available metadata and supporting documents. Further information can be displayed by clicking the link "See more information" on the lower right corner, where more metadata is displayed (see example below), including:

1. Dataset name
2. Dataset description
3. Organization, holder of the original dataset
4. Author of the original dataset
5. License of the original dataset, to be checked before re-using the data
6. Citation of original dataset, relevant for certain license types
7. Keywords (at least the name of the underlying repository)
8. Spatial extent
9. Temporal extent
10. Confidence score (only for WorldCereal)

Specifically, the metadata items **License** and **Citation** are crucial as they determine how the data set can be re-used by other parties e.g., acknowledgement through citation, use by commercial parties etc.

WorldCereal	AGROSTAC
	



The supporting documents differ per repository. Below is a description of these for WorldCereal and AGROSTAC:

WorldCereal	
Background Information on Curation: Dataset specific PDF document	A description of the curation and standardization applied to the original data before publishing the data via the WorldCereal repository
WorldCereal Legend: https://ewoc-rdm-ui.iiasa.ac.at/details/WorldCereal_crop_legend_ui_v2_20240709.pdf	Explanation of the WorldCereal labels for land cover (LC) and crop type
Irrigation Legend: https://ewoc-rdm-ui.iiasa.ac.at/details/WorldCereal_irrigation_legend_ui_v2_20240709.pdf	Explanation of the WorldCereal labels for irrigation types
Confidence Score: https://ewoc-rdm-ui.iiasa.ac.at/details/WorldCereal_ConfidenceScoreCalculations_v1_1.pdf	Background information on how the confidence score is determined for a dataset
Calculation of date: https://ewoc-rdm-ui.iiasa.ac.at/details/WorldCereal_DerivingValidityTime_v1_1.pdf	Background information on how the validity date is determined in case a data on observation date was missing in the original dataset
DOI: Dataset specific URL to the original dataset	The URL points to the download location of the original dataset
Download complete dataset (not filtered): Dataset specific download of the complete harmonized dataset	Download of the harmonized dataset in Geoparquet format
AGROSTAC	
AGROSTAC API description:	Description of the AGROSTAC REST API

https://agrostac.wenr.wur.nl/pdf/AGROSTAC-API-crop.pdf	
Data curation URL: https://agrostacwiki.containers.wur.nl/index.php	AGROSTAC curation wiki holding information on the data curation and data standardization applied on the original dataset before publishing the data via the AGROSTAC repository
Source URL: Dataset specific URL	The URL points to the download location of the original dataset

The supporting documents can be accessed either via clicking the link “See more information” or the download button (circled button with a downward arrow on the lower right corner).

After clicking the download button, the following options are available:

1. HTML button holds URL links
2. FILE button (download complete dataset) gives access to the complete data regardless filtering e.g. on crop type. This button is only available for the WorldCereal repository
3. PDF button holds links to online PDF documents
4. LINK/Chain button (download filtered data) gives access to a subset of the data according to the applied filtering e.g. on crop type

Options 2, 3 and 4 can either download the file(s) right away or add the file(s) to the bulk download. The latter option is only available when users are logged on to the GEOSS portal.

There are three ways to filter datasets:

1) The “Advanced” panel offers selection by region (country, continent, input co-ordinates by drawing a bounding box) and/or by year range
2) The “Filter by” panel offers generic selection by keyword, organisation, source, protocol, format
3) The “Filter by” panel also offers specific selections relevant for thematic area: “harmonized agronomy in-situ data”

Thus, the latter filter option is only available when the thematic area: “harmonized agronomy in-situ data” is selected. The options differ between WorldCereal and AGROSTAC (see also table below):

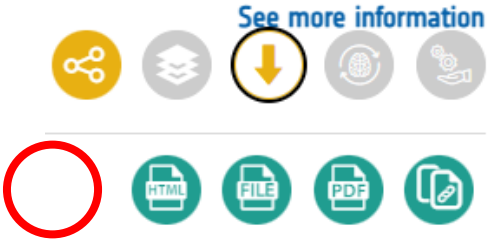
- WorldCereal: available filters are crop type, land cover type, irrigation type and confidence score

- AGROSTAC: available filters are crop type and quantity type (please note that confidence score must be ignored for AGROSTAC as confidence score is not available for AGROSTAC)

WorldCereal:

AGROSTAC:

Data of a selected dataset can be downloaded (see most right green button, red encircled):



The data included in the download is determined by the filters that are available in case the thematic area “harmonized agronomy in-situ data” has been selected. For example, in case crop type ‘maize’ is selected, only a subset of the data set that includes maize records are part of the download. If no crop type is defined, the download covers all data. Other filters work similarly.

The download of a WorldCereal dataset includes (id = datasetid):

- <dataset-name>.json (data)
- <dataset-name>.xml (metadata)

Example of the 2018asremelgadopoly111.json file:

```
{
    "geometry": {
        "coordinates": [[
            [
```

```
                    71.19293205159194,
                    40.58683615475164
                ],
                [
                    71.19311552168892,
                    40.58685654138776
                ],
                [
                    71.19344222623442,
                    40.58689227963878
                ],
                [
                    71.19378308816613,
                    40.58698003158469
                ],
                [
                    71.19344986442658,
                    40.58768300545674
                ],
                [
                    71.19287928933699,
                    40.58846824254292
                ],
                [
                    71.19217866021661,
                    40.58823618551669
                ],
                [
                    71.19293205159194,
                    40.58683615475164
                ]
            ]],
            "type": "Polygon"
        },
        "type": "Feature",
        "properties": {
            "irrigation_status": 0,
            "extract": 1,
            "sample_id": "2018_AS_CAWA-project_POLY_111_1",
            "quality_score_lc": 98,
            "valid_time": "2018-09-01",
            "quality_score_ct": 98,
            "ewoc_code": 1101060000,
            "h3_l3_cell": "8320aefffffffff"
        }
    },
```


The relevant data items in the download file are:

- ewoc_code: land cover and crop type label (see supporting document WorldCereal Legend)
- irrigation_status: irrigation label (see supporting document Irrigation Legend)
- valid_time: observation date (see supporting document Calculation of date)
- quality_score_lc: quality score of dataset for land cover (see supporting document Confidence Score)

- quality_score_ct: quality score of dataset for crop type (see supporting document Confidence Score)

The download of an AGROSTAC dataset includes (id = datasetid):

- Agrostac_dataset_id_<id>.json (data)
- Agrostac_dataset_id_<id>.xml (metadata)

Example of the Agrostac_dataset_id_31.json file:


```
{"CropDataByArea": [
   {
       "cropcode": "WHBW",
       "dateavg": "2016-12-02",
       "crop_dev_bbch": "00",
       "datasetid": 31,
       "lon": 1.1061,
       "lat": 43.5495,
       "objectid": 299362,
       "geom_accuracy": 10
   },
```


The crop code and quantities code (e.g. crop_dev_bbch) are explained in document Codes_Agrostac_dataset_id_31.pdf. Furthermore, objectid refers to the object as defined in AGROSTAC and geom_accuracy is the spatial accuracy expressed in meters. The other elements (dateavg, lon and lat) do not need any further explanation.

Downloaded data files of WorldCereal datasets can easily be combined as the files have the same structure. The same applies to AGROSTAC. However, the user cannot combine the json files of WorldCereal and AGROSTAC without any restructuring of one of the files.

4.10.2 Generating WorldCereal cropland mask

Introduction

In addition to exploring and downloading harmonized agronomy in-situ data, the user can generate a cropland mask at 10m resolution via the WorldCereal processing system using the harmonized in-situ data of the WorldCereal repository. The WorldCereal cropland mask is a binary layer indicating whether a certain pixel contained temporary crops within a certain year or not. A temporary crop is defined as a crop which is harvested maximum 12 months after sowing/harvesting, including some exceptions such as sugarcane, cassava and asparagus. This definition matches the Non-Perennial Cropland Mask as defined by GEOGLAM's Essential Agricultural Variables.

Through the GEOSS portal, anyone can launch a processing request to generate a cropland mask, anywhere in the world. Generation of the product is done in the cloud, on the Copernicus Data Space Ecosystem (CDSE), using an OpenEO processing pipeline which has been seamlessly integrated with the GEOSS portal.

Prerequisites

To be able to access and run this service, a user needs to:

- Have or create an account on the GEOSS portal
- Have or create an account on CDSE

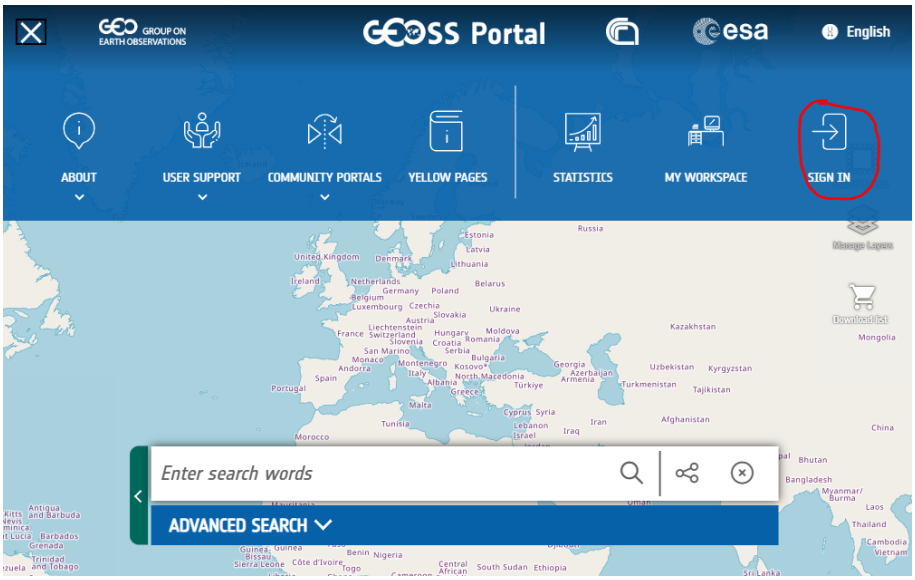
Processing costs

Currently, the spatial extent of each individual request cannot exceed 2500 km². A user is of course free to launch multiple requests. Each request will consume a number of processing credits, depending on the spatial extent. Roughly 250 credits are used for processing an area of 2500 km². Upon registration on the CDSE platform, each user currently receives 10,000 free processing credits, which are automatically replenished every month. This already allows for quite a bit of free testing. Additional processing credits can be purchased. The reader is referred to this link for more information.

Running the service

Follow this step-by-step guide to generate a cropland mask:

- Navigate to the GEOSS portal and sign in by accessing the menu using the button on the upper left of the page.



- Enter “WorldCereal” or “WorldCereal cropland” in the search bar, hit search and click the “services” button on the right. The WorldCereal cropland service will be returned. Behind the “See more information” button more information the user will find a detailed description, keywords, and links.

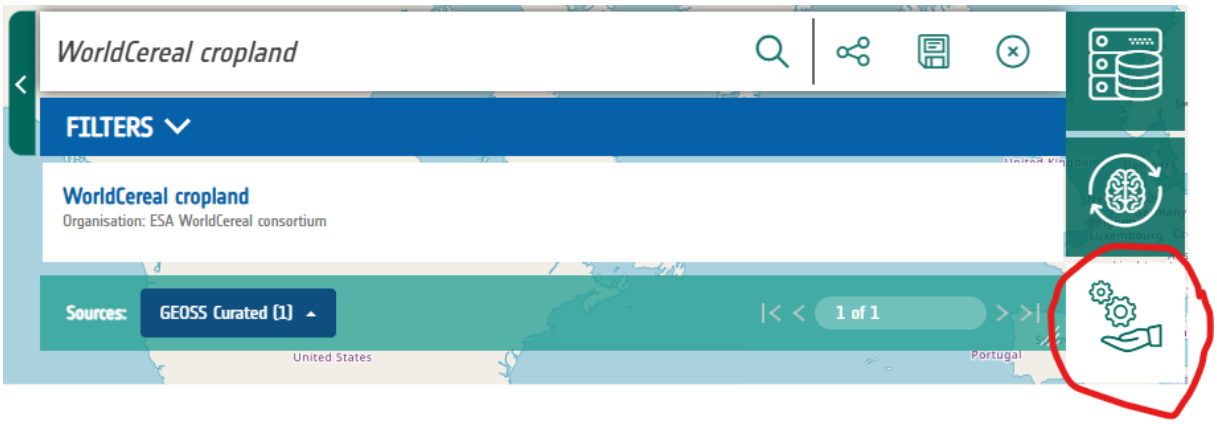


Figure 78 – Maps4GPP Searches for WorldCeareal

- Click the service and hit the Workflow ( ) button. You will be requested to sign in to the CDSE cloud processing platform.
- Next, enter the required input parameters to generate a cropland mask:
    - **Run name**: a unique name allowing you to keep track of the different products you are generating.
    - **Date range**: the service uses a timeseries of satellite data spanning exactly one year. The timeseries needs to start the first day of a month, and will automatically end 12 months after the start date. Currently, the service is not yet available for the year 2024, so in order to guarantee good results, the user should select a start date not later than January 1st 2023. Also, to ensure optimal results, a user should make sure the main growing season in his/her area of interest is nicely centered in the selected time range. For instance, the main growing season for summer crops in Argentina

runs from October to June, so I would select August 2021 – September 2022 if I were interested in the growing season ending in 2022.

- **Bounding box coordinates**: use the interactive draw tool to draw a rectangular bounding box on the map. In case the size of your bounding box exceeds 2500 km², you will be asked to draw again.

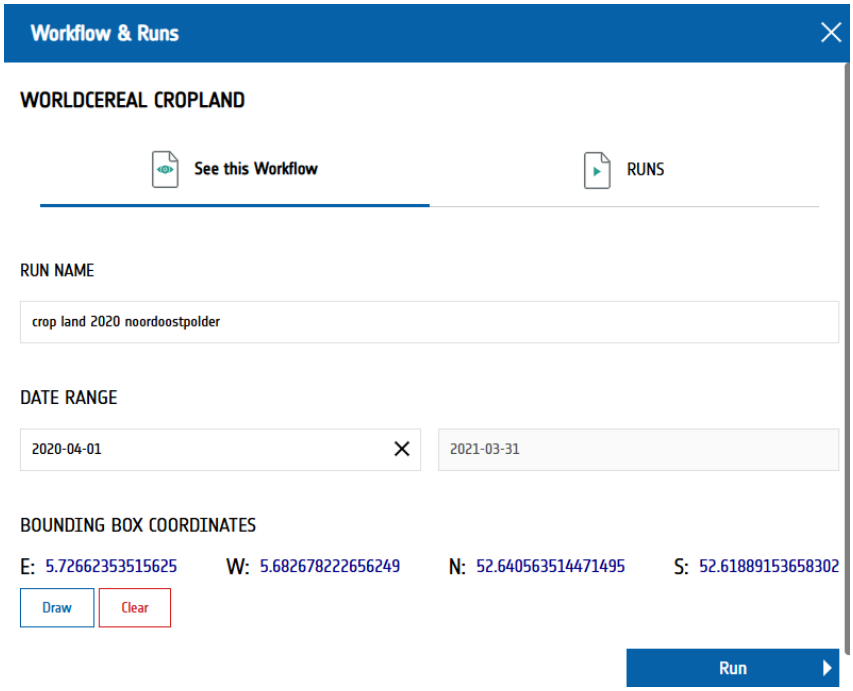


Figure 79 – Maps4Gpp: Worldceral execution

- By hitting the Run button, a processing request is sent to the CDSE environment. On average, this would take max. 30 mins, again depending on the size of your area of interest.
- You can check the status of the processing job by again entering the service, going to the "Runs" tab and hitting the "OpenEO jobs" button. Note that experienced users can also track the status of their processing jobs through the OpenEO editor on CDSE.

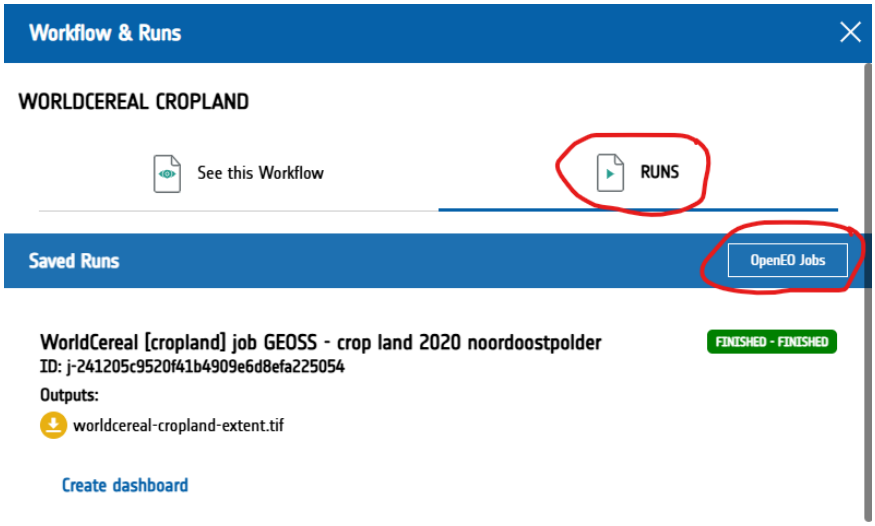


Figure 80 - – Maps4Gpp: Worldceral execution (runs)

- For each job you can see the status (Finished, Running or Error) and download the generated maps upon successful completion.
- Note that this list will display ALL your OpenEO processing jobs on CDSE. You can recognize the ones started from the GEOSS platform through the following prefix in the job's title: "WorldCereal [cropland] job GEOSS - ".
- Each processing job will generate one multi-band .tif file, which can be visualized in QGIS after downloading the product (using the button):
    - Band 1 contains the classification label: 1 for temporary crop and 0 for other land use.
    - Band 2 contains the probability of the winning class (ranging between 0 and 100). The higher this number, the more confident the model was about its prediction.
    - Band 3 contains the probability of a pixel being not annual cropland.
    - Band 4 contains the probability of a pixel being annual cropland.

Example output of an individual run is displayed in the next figure, with red areas on the map indicating cropland and transparent pixels signifying other land use:

Figure 81 – Maps4GPP: WorldCereal Cropland Map

4.11 SDG11.7: Accessibility to urban green areas

Over the last three decades, cities worldwide have altogether increased in size by an area equivalent to Ireland. Currently, more than half of the world population live in cities and this number is likely to increase to 66% by 2050. In addition, 59% of cities have also observed a rise in land consumed per new resident. Consequently, urban sprawl and inefficient use of land are important issues with many consequences. Two important ones are the expansion of existing urban settlements and creation of new ones, and the increase of density and use of urban areas. These issues not only put pressure on urban infrastructures (e.g., road and water supply/sewage networks, transport infrastructures) but also have significant impacts on the use of open and green spaces such as threat of their privatisation or loss of their original functions. Therefore, there is a strong need to optimise the use of available space requiring efficient and effective land use management strategies to enhance inclusive and sustainable urbanisation.

Public space has an essential role to play in making cities liveable and is interlinked with various other development issues such as environment and climate change, economic development, urban poverty,

security, community cohesion, social interaction, civic identity, entertainment, gender and social equality and quality of life. Even if public space can be difficult to define (e.g., different features/elements, different geographical and cultural contexts), one key element towards the sustainability of cities is when there is a good balance between private and public spaces. Public spaces can be regarded as symbols of equality because they are usually accessible, safe, open, inclusive (e.g., sex, age and disability) and available to everyone. However, according to United Nations (UN)-Habitat, public spaces in cities have gradually diminished in recent years. Such privatisation of public space increases exclusion and marginalisation, underlining the need for policies and strategies that ensure appropriate planning, design and management of public spaces].

Sustainable development cannot be achieved without significantly transforming the way urban spaces are built and managed. The UN 2030 Agenda for Sustainable Development recognises the importance of cities, including the Sustainable Development Goal (SDG) 11 to *"Make cities and human settlements inclusive, safe, resilient and sustainable"* that defines a specific target on public space (SDG 11.7) "*by 2030, provide universal access to safe, inclusive and accessible, green and public spaces, particularly for women and children, older persons and persons with disabilities"*. This target is supported by two indicators, one of them (SDG 11.7.1) based on calculating the "*Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities*". According to the official UN Metadata Repository, the rationale for this indicator is that the value of public spaces is often overlooked or underestimated by policy makers, political leaders, citizens and urban developers. Consequently, this indicator aims at monitoring the proportion of land that cities dedicate to public space (e.g., open spaces and streets). Together with the *"New Urban Agenda"* (i.e., the key policy that drives urban resilience and sustainable urban development at local level*,* the SDGs provide for the first time a platform where public space can be globally monitored, recognising cities as key enablers for the world's sustainable future, and acknowledging the increasing role of cities and local communities in the implementation of the SDGs.

The greenness of European cities has raised by 38% over the last two decades while globally increasing by 12% over the same period. It is estimated that approximately 40% of total urban areas of European cities are covered by vegetation with a share of 18.2 m2 of publicly accessible green space per inhabitant and 44% of population living within 300 m of a public park. Nevertheless, there is a great variability, ranging from cities with forested areas in city centres to a lack of green areas, particularly in Eastern and Mediterranean regions.

Consequently, city planners should engage to deliver sufficient variety and quality of life by providing ample green public space for local inhabitants and visitors. They should not only supply enough space but also ensure its conditions so that it can deliver its full potential. This raises the concern about not only the quality of the public space but also its accessibility to users in different neighbourhoods. To effectively deliver its services, a public area should be easily accessible by soft mobility (e.g., foot, bike, public transport) to all types of users as well as be safe and inclusive.

To answer this need of enhanced information on public space conditions, timely and spatially disaggregated information is essential, but currently its supply is lagging and not widely adopted by urban planners. Earth Observations (EO), acquired remotely (e.g., satellite), in-situ (e.g., sensors) or by citizens (e.g., crowdsourcing), is considered to be a valid, reliable, timely and continuous source of information to support evidence-based decision-making for sustainable urban development. EO data can therefore be a good complement or can enhance traditional data sources on urban areas.

Based on the approach used in Giuliani et al. (2021) https://doi.org/10.3390/rs13030422 and implemented at the national scale in Chênes et al. (2021) https://doi.org/10.3390/geomatics1040022

the objective of this use case is to implement the methdology as a service into the GEOSS platform allowing to compute this SDG indicator in any city around the world.

The service is available at:

https://gpp.uat.esaportal.eu/?m%3AactiveLayerTileId=osm&targetId=geoss_geodab_http%3A%2F%2Feu.essi_lab.vlab.core%2Fworkflow%2Fautogenerated-1726563166228-process&f%3Aphrase=green&f%3AdataSource=services under the tab “Services”

https://gpp.uat.esaportal.eu/?m%3AactiveLayerTileId=osm&targetId=geoss_geodab_http%3A%2F%2Feu.essi_lab.vlab.core%2Fworkflow%2Fautogenerated-1726563166228-process&f%3Aphrase=green&f%3AdataSource=services under the tab “Services”

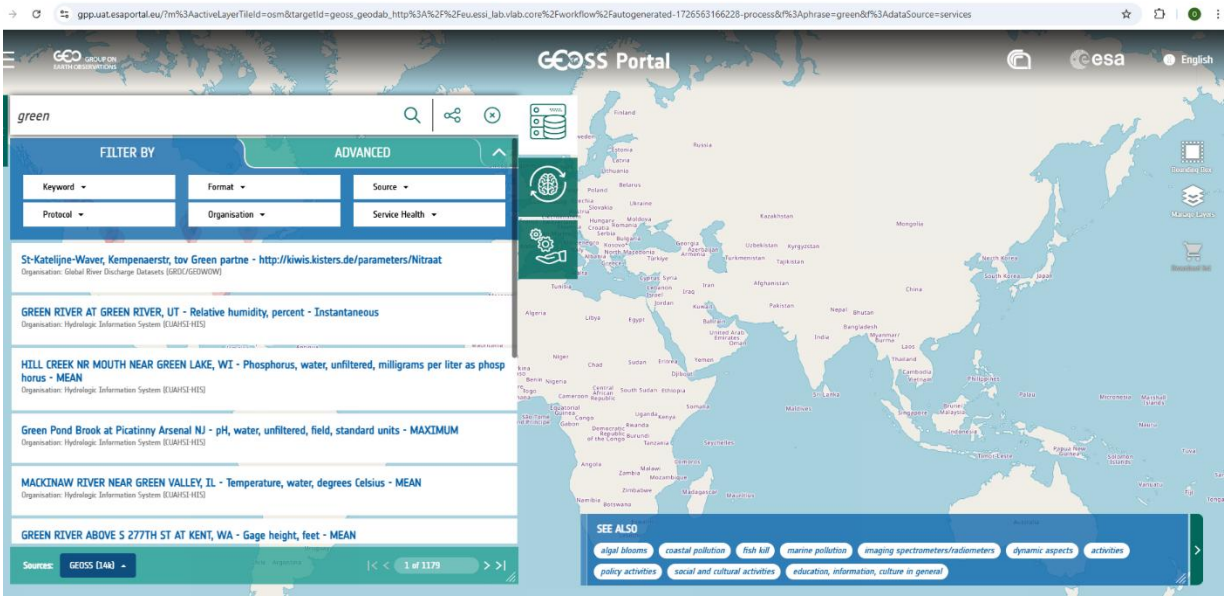


Figure 82 – SDG 11.7 Urban green search on GEOSS portal

It is implemented as a VLab model using in the background inAccessMod for data preparation and AccessMod for accessibility modeling.

It follows the resuability and replicability supported by GPP by:

1. Re-use the same conceptual approach as the SDG15.3.1 use case: Data-Information-Knowledge

   Data: OSM, DEM, Population, rivers, roads, …

   Information: AccessMod model

   Knowledge: Dashboard

2. Re-use the new component(s) (e.g., Vlab, dashboard)
3. Replicate the approach proposed by Giuliani et al. (2021)

   Combination of satellite & crowdsourced EO Data

   Compute the “Share of urban population without green urban areas in their neighbourhood”

Data preparation (inAccessMod)

inAccessMod is a R package that allows the user to easily download and prepare all the required layers for AccessMod. A proper folder structure is created in order to manage multi-temporal data and/or multiple analysis scenarios. The layer downloading, cropping, masking, resampling, exporting processes are automated to a large degree, making the preparation of the inputs quick and straightforward.

Once a city is selected by the user, then automatically required data covering the selected city are downloaded and structured to then further used on the accessibility analysis.

download_boundaries: Downloads the required administrative boundaries from the geoBoundaries database.

download_dem: Downloads the Digital Elevation Model (DEM) raster for the country/area of interest from the Shuttle Radar Topography Mission (SRTM) dataset.

download_population: Downloads the population count raster for the target country/area from the WorldPop project.

download_landcover: Downloads the land cover raster for the country/area of interest from the Copernicus Land Monitoring Service.

download_osm: Downloads road, river, lake, and other natural barriers shapefiles from the OpenStreetMap (OSM) platform

process_inputs: Processes all the raw input data by cropping, masking, projecting, and resampling the geospatial layers with customizable user parameters.

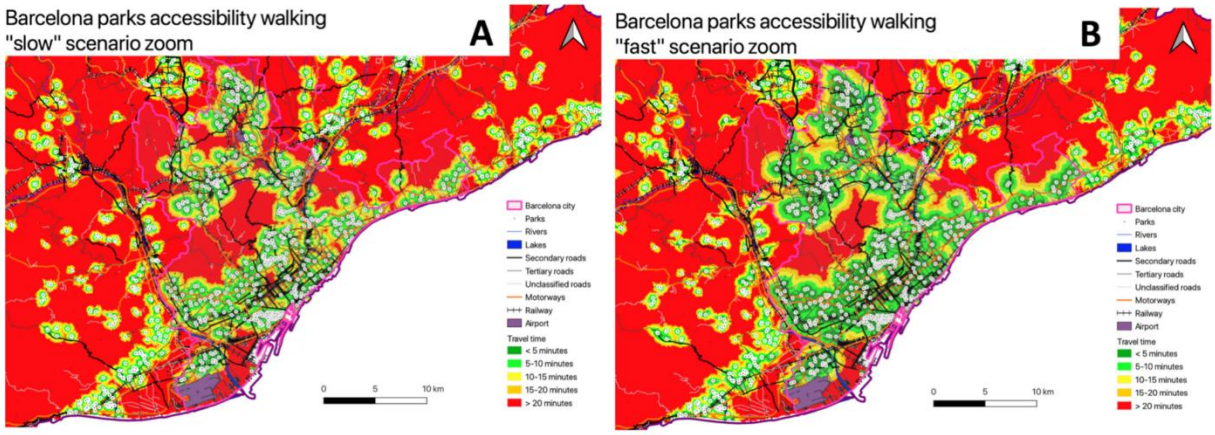
compile_processed_data: Compiles all the processed data into one single folder, making it easier to import the input data into AccessMod.

Data analysis (AccessMod)

AccessMod 5 is a tool to analyze geographical accessibility to or from given locations, using anisotropic movements and multimodal transport processes (e.g. walk, bicycles, motorized vehicles). This package may help to analyze catchments of peoples who can reach a central point in a given time and transport model or determine where new public services should be scaled up in priority.

The final outputs of the analysis that can then be further reused in the Dashboard component of the platfom look like:

Accessibility



- Scenario "slow":
  - 3 km/h walking in town and on roads/footpaths.
  - 2 km/h walking in rural areas off-road.
- Scenario "Fast":
  - 5 km/h walking in town and on roads/footpaths.
  - 2 km/h walking in rural areas off-road.

Figure 83 – SDG11.7 Accesibility to urban green areas dashboard

And statistics (provided as csv table)

Statistics

Table 3. Share of urban population without green urban areas in their neighbourhood, with two walking scenarios (slow and fast), and computed with 2018 population density estimates.

	Geneva		Barcelona		Goteborg		Bristol	
Walking Time	**Slow**	**Fast**	**Slow**	**Fast**	**Slow**	**Fast**	**Slow**	**Fast**
5 min	29.39	16.54	78.72	58.74	52.91	33.86	73.66	47.53
10 min	14.35	11.43	50.29	26.61	29.09	19.32	36.94	14.62
15 min	11.79	10.74	31.21	15.05	20.94	14.08	17.32	11.3

Table 4. Share of urban population without green urban areas in their neighbourhood, with two walking scenarios (slow and fast), and computed with 2012 population density estimates.

	Geneva		Barcelona		Goteborg		Bristol	
Walking Time	**Slow**	**Fast**	**Slow**	**Fast**	**Slow**	**Fast**	**Slow**	**Fast**
5 min	29.24	16.28	78.59	58.55	52.66	33.48	73.76	47.54
10 min	14.12	11.3	50.12	26.45	28.73	19.09	36.94	14.64
15 min	11.66	10.67	31.06	14.92	20.67	13.92	17.3	11.31

Figure 84 – SDG 11.7 Statistics

4.12 GEOSS Platform Landing Page

The GEOSS Landing Page is a newly designed website that serves as a gateway to the GEOSS ecosystem. It provides users with a clear and structured entry point to explore resources, access data, and engage with the GEOSS community.

4.12.1 Objectives of the Landing Page

The Landing Page has been developed to achieve the following objectives:

- Promote the GEOSS Portal as the central hub for Earth Observation data.
- Educate users about the GEOSS ecosystem, its features, and benefits.
- Facilitate user engagement with GEO Communities through intuitive navigation and resources.

4.12.2 Key Features

The GEOSS Landing Page introduces the following features to enhance user experience:

4.12.2.1 Homepage

The homepage serves as the central hub for users and includes the following sections:

Hero Section

- Features a title, descriptive text, and two CTAs linking to the About Page and the GEOSS Portal.

Portal Features Section

- Highlights key platform functionalities using feature cards with:
    - Icons and concise descriptions.
    - Pagination support for mobile devices.

Community Portals, Catalogues, Thematic Areas

- Highlights links to community portals and resources for data providers.
- Includes CTAs encouraging engagement, such as registering as a data provider.

Articles Section

- Displays the latest articles with:
    - Article cards featuring an image, title, and publication date.
    - A CTA to the "Articles List" page for detailed exploration.

Footer

- Includes:
    - Contact details for user inquiries.

- Partner logos.
- Links to Terms and Conditions for legal compliance.

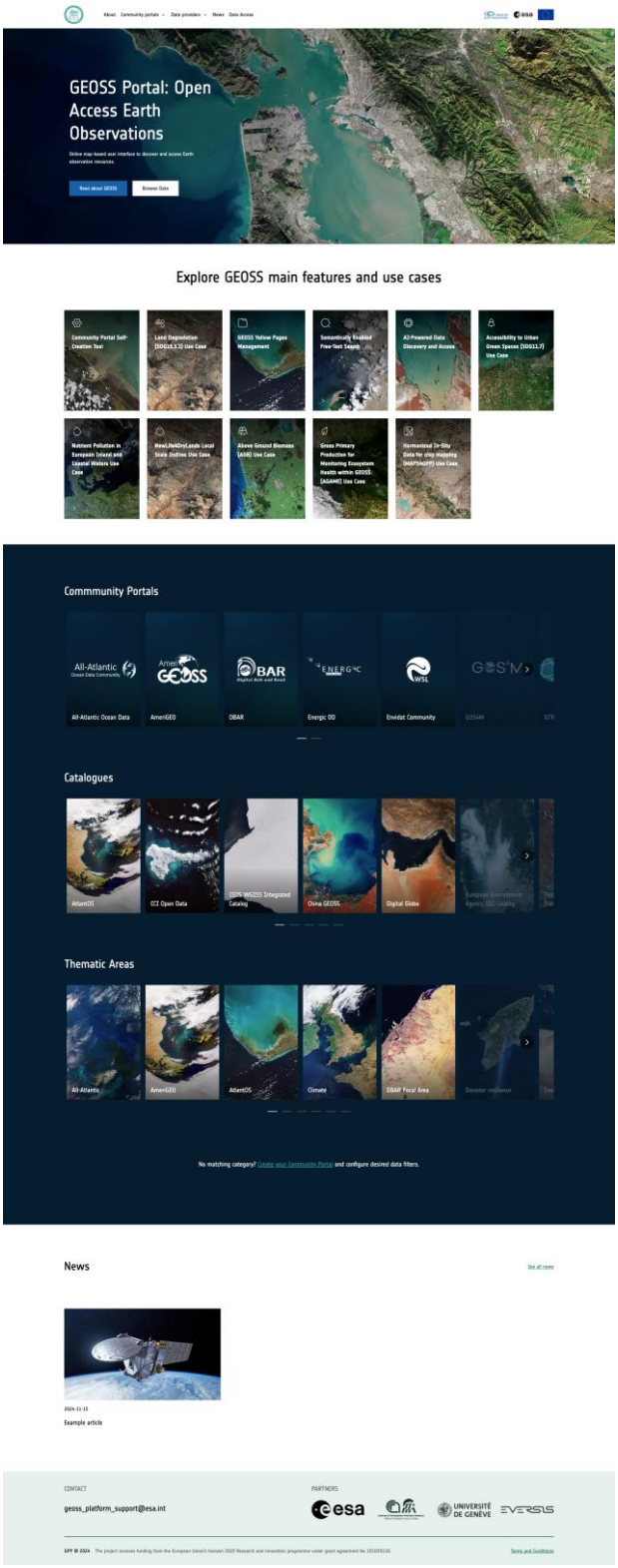


Figure 85 Landing Page - Homepage

4.12.2.2 About Page

- **Purpose**: Provides an overview of the GEOSS platform, its mission, and its ecosystem.
- **Features**:
  - Informational sections with objectives and services.
  - FAQs and toggle lists for user convenience.
  - Infographics and "Learn More" links.

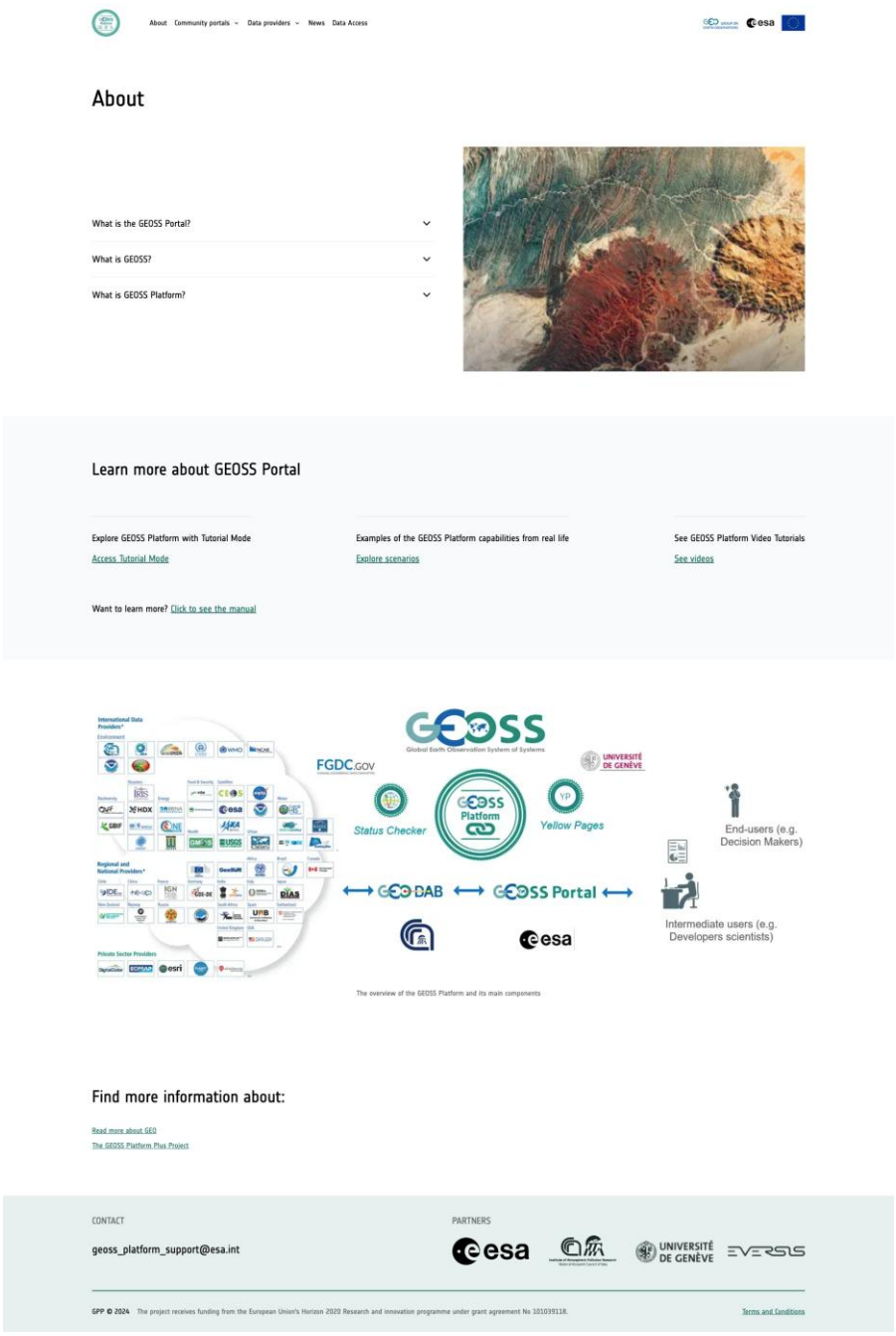


Figure 86 Landing Page – About

4.12.2.3 Articles List Page

- **Purpose**: Offers a central repository for news and educational content.
- **Features**:
  - Sorted article listings with images, titles, and publish dates.
  - Pagination for easy navigation.
  - Links to individual article pages.

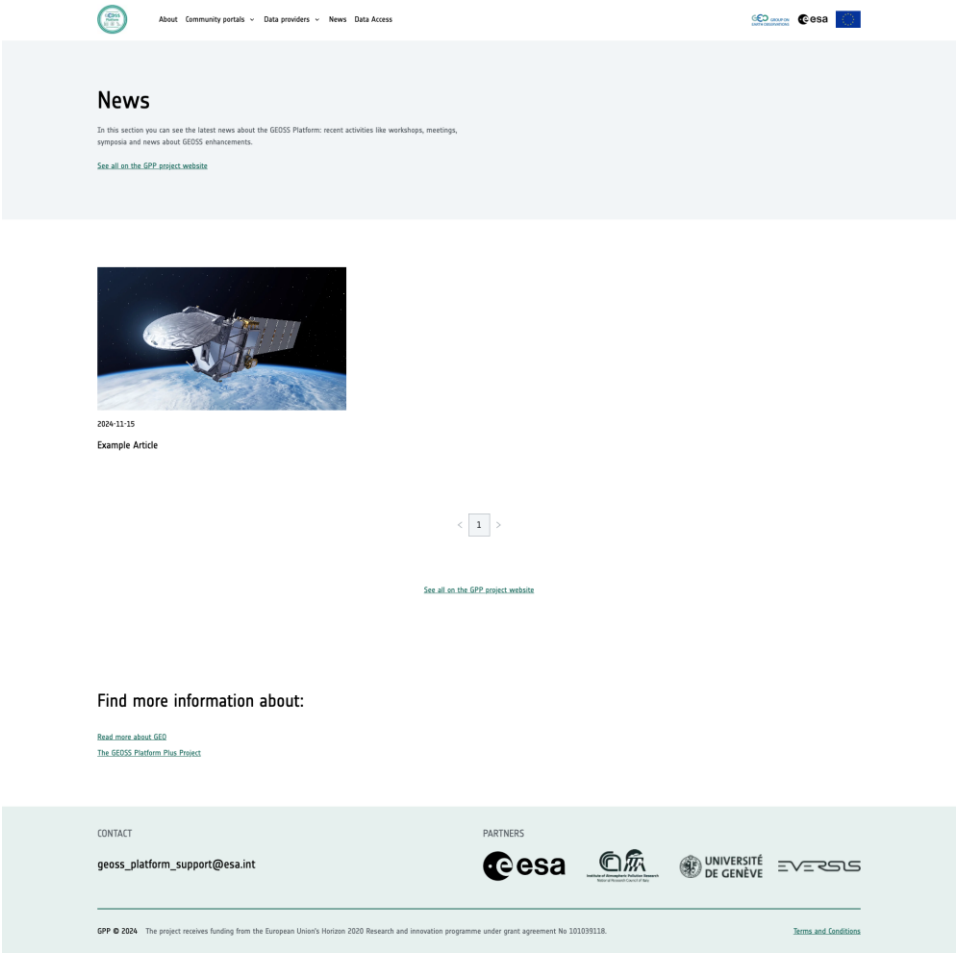


Figure 87 Landing Page - Articles list

4.12.2.4 Article Page

- **Purpose**: Displays detailed content for a specific article.
- **Features**:
  - Title, publication date, and detailed content section.
  - Multimedia elements, including images and embedded videos.
  - Suggestions for related articles.

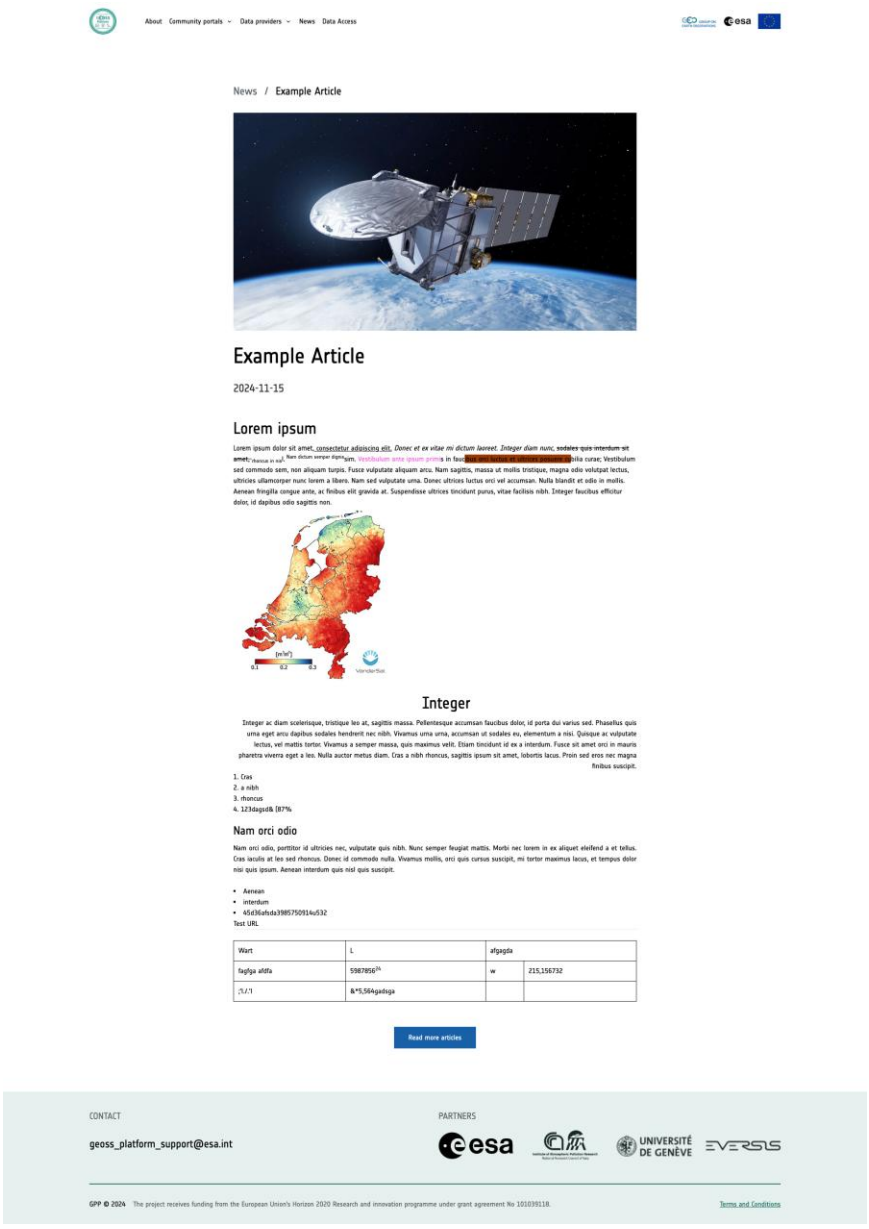


Figure 88 Landing Page - Article

4.12.2.5 List of Data Providers

- **Purpose**: This page serves as a directory of data providers within the GEOSS ecosystem, offering users insight into available data sources and contributors.
- **Features:**
    - Allows users to search for specific data providers

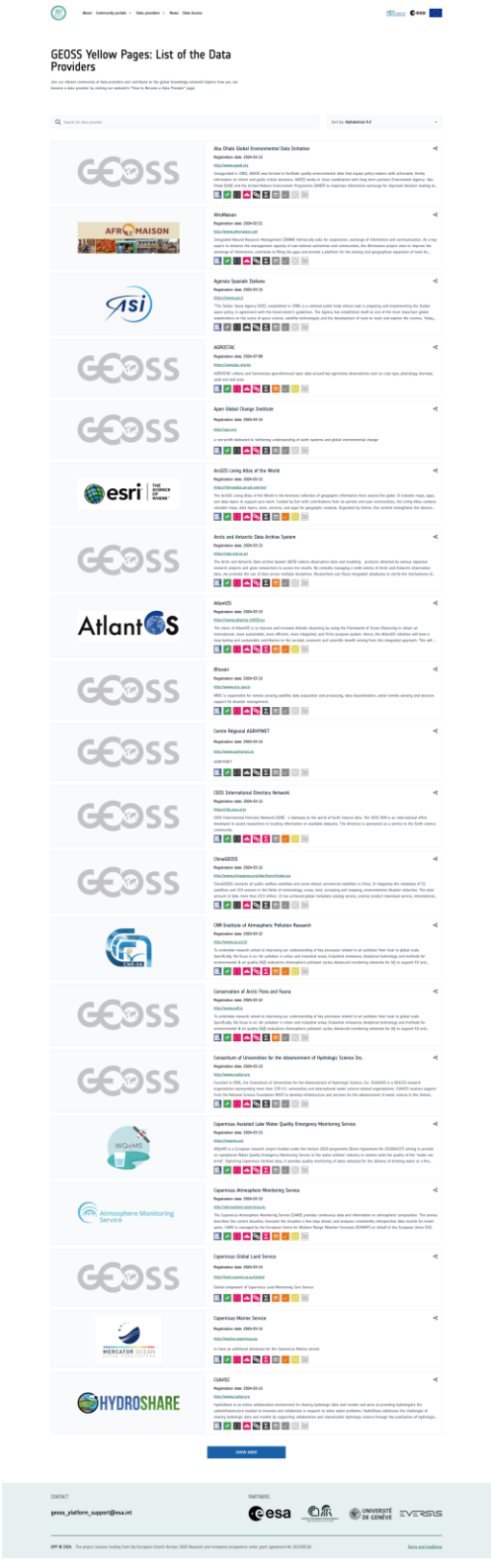


Figure 89 Landing Page - List of Data Providers

4.12.2.6 Use Cases

- **Purpose**: Provides structured workflows and guides for users.

- **Features**:
    - Titles, descriptions, and action-oriented CTAs.
    - Layouts with balanced visuals and text.

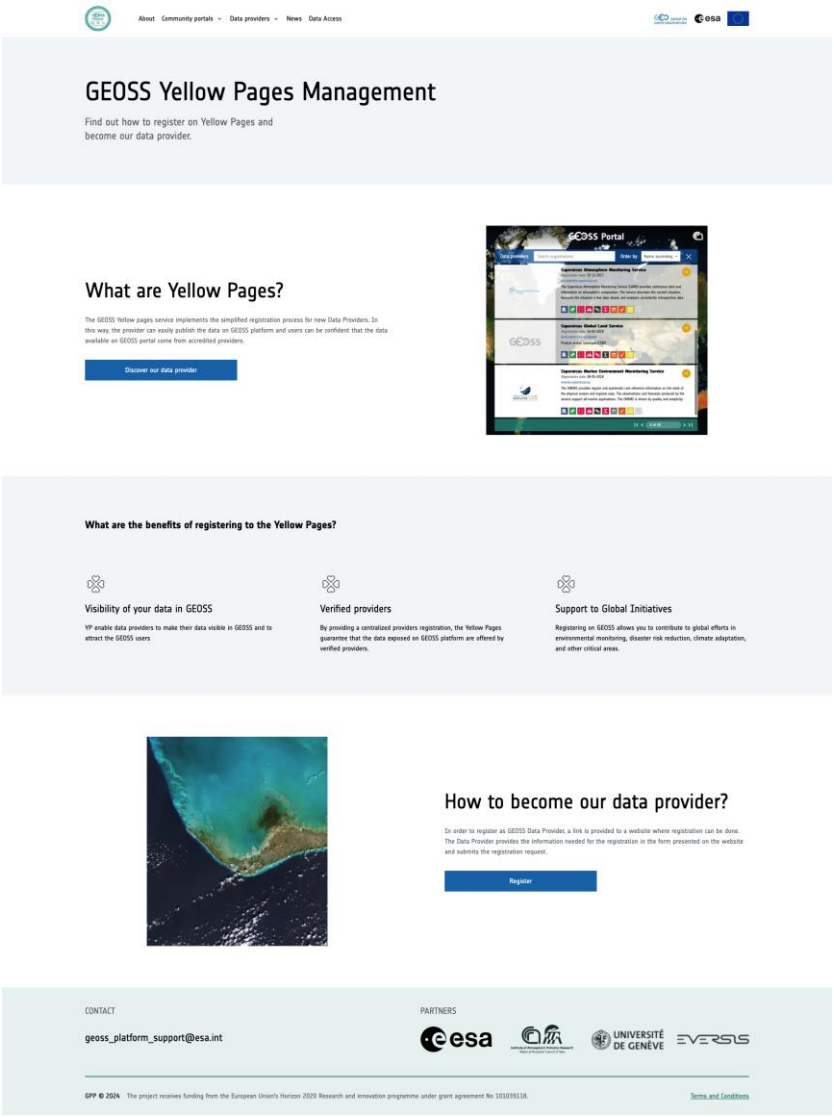
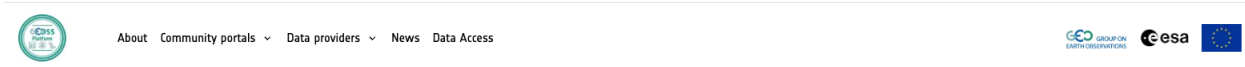


Figure 90 Landing Page - Use Case

4.12.2.7 Global Navigation

- The main menu includes:
    - About Page.
    - Community Portals ("About Community Portals" and "List of Community Portals").
    - Data Providers ("How to Become a Data Provider" and "List of Data Providers").
    - Data Access: A direct link to the GEOSS Portal.
    - News
- Partner logos (GEO, ESA, EU) are prominently displayed.



4.12.2.8 Cookie Notice

- Implements GDPR-compliant cookie management consistent with the GEOSS Portal.

4.12.2.9 Content Management System (CMS)

- A user-friendly admin panel allows content managers to:
  - Publish and edit articles.
  - Manage homepage and feature sections dynamically.

4.13 AI based search

The AI Proof of Concept (PoC) introduces advanced capabilities to the GEOSS ecosystem, leveraging AI to enhance data discovery and user interaction. This chapter provides an overview of the features available in the AI PoC and their functionalities.

4.13.1 Introduction

The AI PoC is designed as an exploratory tool to demonstrate the potential of AI-powered features within the GEOSS ecosystem. It focuses on improving data discovery processes, enhancing user interaction, and providing intelligent dataset recommendations. The PoC serves as a foundation for testing AI integration and guiding future implementations.

4.13.2 Key Features of the AI PoC

4.13.2.1 Natural Language Query Processing

The AI system enables users to interact with the platform through natural language queries. By interpreting the intent behind user inputs, the system identifies relevant datasets that match the query. This functionality simplifies the data search process and makes it more accessible to users without technical expertise.

4.13.2.2 User Interface for AI-Powered Search

The AI PoC includes a dedicated, user-friendly search interface that integrates AI-powered capabilities. Features like query autocomplete and intuitive navigation improve the overall user experience and simplify interaction with the system.

4.13.2.3 Security and Privacy

The system is designed with robust security and privacy measures to protect user data. All interactions, including search queries and dataset recommendations, are handled in compliance with data protection regulations, ensuring confidentiality and secure data handling.

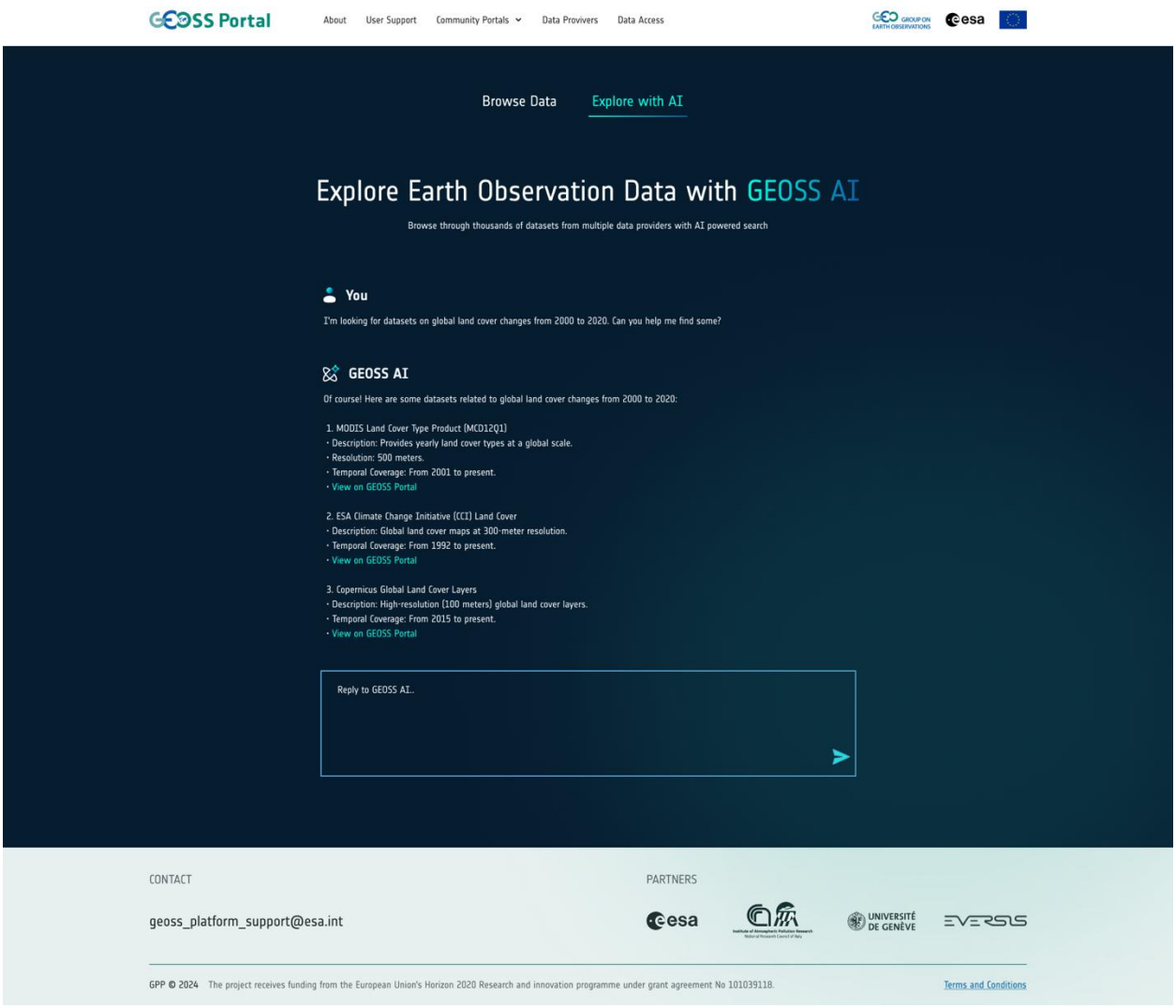


Figure 91 AI based search mockup

4.13.2.4 Proof of Concept Disclaimer

The AI Proof of Concept is an initial step to explore and validate AI-powered data discovery within the GEOSS ecosystem. It is a testing phase, and the functionalities demonstrated may evolve based on user feedback and technical evaluations. The insights gained from this PoC will inform further development and refinement of AI integrations.

Annex A. References

Reference Documentation

[RD-1] GPP-WP3-DEL-AfriGEOSS_installation_guide_1.0

[RD-2] GPP-WP3-DEL-D3.1 Enhanced GEOSS Platform with 1st set of applications

[RD-3] GPP-WP2-DEL-D2.2 Functional and non-functional enhancements specification v1.0

[RD-4] GPP-WP3-DEL-D2.1 Use Cases Description and User Requirements Document

[RD-5] GPP-WP3-DEL-Community Portal - Administration Guide

[RD-6] GPP-WP3-DEL-D3.4 Enhanced GEOSS Platform v2 with 2nd set of applications

[RD-7] GPP-WP2-DEL-D2.4 Functional and non-functional enhancements specification v2.0

[RD-8] GPP-WP3-DEL-D2.3 Use Cases Description and User Requirements Document v2.0

[RD-9] GPP-WP3-DEL-D3.7 Enhanced GEOSS Platform v3 with 3rd set of applications

[RD-10] GPP-WP2-DEL-D2.6 Functional and non-functional enhancements specification v3.0

[RD-11] GPP-WP3-DEL-D2.5 Use Cases Description and User Requirements Document v3.0

[RD-12] GPP-WP3-DEL-D3.6 The GPP Vision for GEOSS Evolution

Web reference documentation

[WR-1] GEO DAB API REST and JS are documented at http://api.geodab.eu/

[WR-2] VLab APIs are documented at https://vlabdev.geodab.org/vlab/docs/

[WR-3] EDGE GEOSS Portal enhancements at https://www.earthobservations.org/documents/articles_ext/EDGE-WP3-DEL-D3.4-v2.0.pdf

Annex B. Figures and Tables

Tables

Annex C. Terminology

C.1 Acronyms and Abbreviations

AGAME	**Automated Gross Primary Production Application for Monitoring Ecosystem**
GPP	GEOSS Platform Plus
CA	Consortium Agreement
CEOS	Committee on Earth Observation Satellites
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
DOA	Description of the Action
EAB	External Advisory Board
EC	European Commission
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
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
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
PIMB	User and Technical Board
WBS	Work Breakdown Structure
WGISS	Working Group on Information Systems and Services
WP	Work Package
WPL	Work Package Leader