EARTH OBSERVATION FOR SDG TARGETS AND INDICATORS, LOT-1

SDG 15.2.1 EO PATHFINDER: EO FOR SUSTAINABLE FOREST MANAGEMENT

D8.1 User Handbook

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E04SDG-Forest

SUSTAINABLE FOREST MANAGEMENT

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Acronyms and Abbreviations

Abbr.	Description
GFW	Global Forest Watch
EO	Earth Observation
ESA	European Space Agency
SDG	Sustainable Development Goals
FAO	Food and Agriculture Organisation
UI	User Interface
TEP	Forestry Thematic Exploitation Platform
SWIR	short wavelength infrared
NIR	Near infrared
VI	Vegetation Index / Indices
NDVI	Normalized Difference Vegetation Index

Reference Documents

Ref.	Title	Date
[RD01]	Transforming our world: the 2030 Agenda for Sustainable Development, 2015 https://documents-dds-ny.un.org/doc/UNDOC/GEN/N15/291/89/PDF/N1529189.pdf?OpenElement	2015/10/21
[RD02]	FACTSHEETS ON THE 21 SDG INDICATORS UNDER FAO CUSTODIANSHIP https://www.fao.org/3/ca8958en/CA8958EN.pdf	2020

Web References

Ref.	URL	Description	Last access
[URL01]	https://land.copernicus.eu/en/products/global-dynamic-land-cover	Dynamic Land Cover	2024/06/26
[URL02]	https://land.copernicus.eu/en/faq/general-questions/what-is-the-nuts-classification	What is the NUTS classification?	2024/06/26
[URL03]	https://f-tep.com/wp-content/uploads/2024/01/F-TEP_Service_Developer_Guide_v2024.01.pdf	F-TEP Service Development Guide	2024/06/26
[URL04]	https://f-tep.com/wp-content/uploads/2020/10/F-TEP_User_Manual_v2019.12.pdf	F-TEP User Manual	2024/06/28
[URL05]	https://f-tep.com/	F-TEP main website	2024/07/01
[URL06]	https://www.globalforestwatch.org/	Global Forest Watch	2024/12/12
[URL07]	https://www.fao.org/forest-resources-assessment/past-assessments/fra-2020/en/	Global Forest Resources Assessment 2020	2023/04/18
[URL08]	https://www.fao.org/forest-resources-assessment/en/	Global Forest Resources Assessments	2023/04/18

1 Scope

This document is designed to provide clarity and guidance to all stakeholders intending to use the services developed during this project.

The document is structured as follows:

Section 2 revisits the policy framework related to UN SDG reporting in the context of Forest Sustainable development.

Section 3 highlights the critical role Earth Observation plays in achieving SDGs.

Section 4 presents an overview of the F-TEP platform, its infrastructure, service creation and development, and specifications of all the requirements the user needs to operate the platform. A guidance for first time users is given.

Section 5 presents a step-by-step guide to accessing and using the EO tools to integrate them into the SDG monitoring or reporting process. The tutorials are based on key Use Cases providing concrete, real-world examples that demonstrate the EO solution in action. Basic guidance on how to read and interpret the EO-derived data outputs is also given.

2 Reporting on SDG

The Sustainable Development Goals (SDGs), also known as the Global Goals, were adopted by the United Nations in 2015 as a universal call to action to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity. The 2030 Agenda for Sustainable Development [RD01] includes 17 SDGs and 169 associated targets. All 193 United Nations member states have committed to achieve sustainable development across its three dimensions – economic, social, and environmental – in a balanced and integrated manner.

The 17 SDGs are integrated—they recognize that action in one area will affect outcomes in others, and that development must balance social, economic, and environmental sustainability. Goal 15 Life on Land is concerned with the protection, restoration and sustainable use of terrestrial ecosystems, and sustainable forest management. Within Goal 15 Targets 15.1 and 15.2 are directly related to forest ecosystems.

The 2030 Agenda has established a reporting framework with goals, targets and indicators, which relies on inputs from local, national and regional levels. The Food and Agriculture Organization of the United Nations (FAO) is the custodian agency for SDG indicators related to Goal 15 Living on land [RD02].

As a custodian agency, FAO is responsible for:

- developing methodologies to measure progress
- collecting data from countries
- compiling and submitting data and storylines to the United Nations Statistical Division; and
- contributing to developing countries' reporting capacity.

Data collection and reporting for SDG Indicators 15.1.1 and 15.2.1 (Table 2 and Table 3) is conducted through the Global Forest Resources Assessment (FRA). FRA is a well-established programme led by FAO's Forestry Department since 1946 [URL08]. It reports on the extent and changes of the world's forest area, as well as on other variables, including forest ownership and management rights, and legal and institutional frameworks for sustainable forest management. The last FRA Report was published in 2020 [URL07]

The process of reporting (to the FRA Programme) on Indicators 15.1.1 and 15.2.1 involves the following steps:

- National Correspondents (NCs), officially nominated by National Forest authorities, compile and submit official national data to FAO, in coordination with National Statistical Offices.
- The FRA team reviews data and reverts to NCs if necessary.
- Countries validate the data. Once finalized by FAO, the data are sent back to the countries for official validation.
- SDG Indicators 15.1.1 and 15.2.1 are compiled by FAO and submitted to the UN Statistics Division.

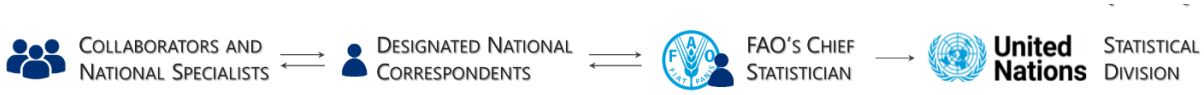

Figure 1 **Reporting workflow for Forest Resource Assessment (FRA)**

3 Use of EO for SDG reporting

Earth Observation (EO) technologies have revolutionized the ability to monitor, understand, and manage natural resources. In the context of the United Nations' Sustainable Development Goals (SDGs), particularly SDG 15: Life on Land, EO provides data and insights critical for tracking progress toward sustainable forest management. By enabling the mapping and monitoring of deforestation, forest degradation, and land-use change, EO supports key SDG indicators which measures progress toward sustainable forest management.

Satellite imagery, including data from Sentinel-2 and Landsat missions, offers global and local-scale insights into forest health, biomass, and carbon stock assessments. These data support carbon accounting, emission reduction strategies, and policy implementation by providing standardized, cost-effective monitoring solutions, particularly in remote and inaccessible areas.

Platforms such as Forestry Thematic Exploitation Platform (F-TEP) [URL05] and Global Forest Watch (GFW) [URL06] exemplify how EO applications can be made available to various stakeholder groups and enable governments, researchers, and policymakers to make data-driven decisions. These platforms provide accessible, high-resolution imagery and analytics to detect and monitor deforestation in near real-time, helping countries streamline reporting on forest conservation and restoration efforts.

4 Forestry Thematic Exploitation Platform (F-TEP)

The platform is designed by VTT [URL05] to let users create and modify forestry monitoring services, taking full advantage of Earth Observation and auxiliary databases. The platform offers a collaborative environment, as developers can choose to share their services available to others or make them public altogether. This section is derived from the detailed documentation provided by VTT, found at [URL03]

4.1 Basic features

Services in F-TEP are ready-to-use forest monitoring products that are internally implemented as docker images and are instantiated when a user launches or activates them. They contain all specifications of a Linux virtual machine, including Linux distribution, installed programs, libraries, scripts, and environment variables. Service inputs and expected outputs are also specified in the docker images.

Each worker machine hosts at most two concurrent jobs. The system automatically spawns new worker machines as needed.

The configuration of a worker virtual machine is 8 virtual CPUs, 32 GB of RAM and 128 GB of SSD-type temporary workspace. Output product storage is not currently limited.

The FTEP platform prioritizes maintainability by employing a modular design, which allows for individual components to be updated or replaced without affecting the entire system. This modular approach simplifies maintenance tasks and aids in isolating and resolving issues efficiently. Additionally, comprehensive documentation and standardized coding practices facilitate ease of maintenance and reduce the learning curve for new developers.

Portability is a crucial feature of the FTEP platform, ensuring seamless operation across various environments. The platform achieves high portability through the use of platform-independent technologies and adherence to open standards. Put simply, the platform ensures that users can access it from any location, provided they have an internet connection and a computer. However, to improve the visual experience using the platform's services, a screen width of 1920 pixels is recommended.

4.2 Setting up an account

Forestry TEP can be accessed with one of the available subscription packages that provide different levels of functionality, processing power and storage space. A free 30-day trial account is available for new users. For research and pre-commercial use, you can receive ESA sponsorship to cover the costs of the platform services via the ESA Network of Resources. These options are described at https://ftep.com/subscription/. User authentication for the Forestry TEP platform is managed by the ESA EO Sign In authentication system. The sign-up process is described at https://f-tep.com/get-started.

4.3 User interface and navigation through the platform

The user interface (UI) of the F-TEP is designed to be intuitive and user-friendly, facilitating seamless interaction for users with varying levels of expertise (Figure 2). The platform's UI is primarily divided into several key interfaces, each serving distinct purposes and providing specific functionalities.

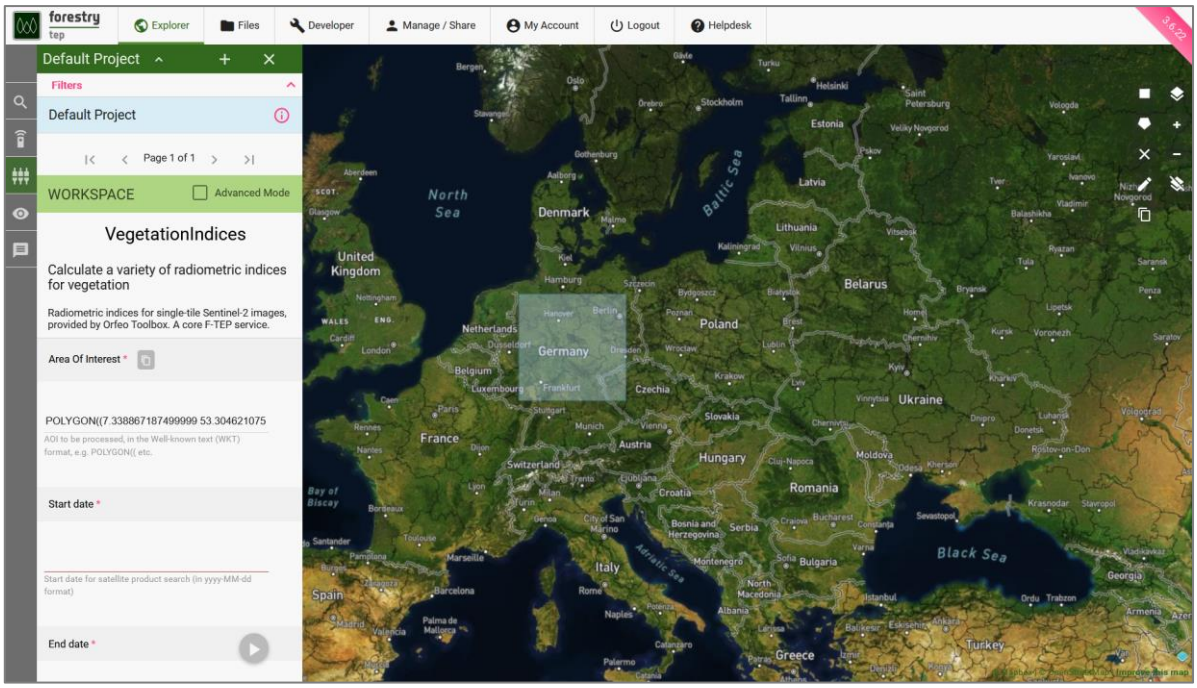

Figure 2. User interface view of F-TEP

Explorer: This is the main, map-based interface for working with the input data, the services and the processing jobs, as described in the next section. The Explorer interface is the central hub for users to interact with the platform. It features a map-based UI where users can specify areas of interest and visualize the footprints of their results. Key functionalities are accessible through icons situated on the left and right sides of the map panel. These icons enable users to perform activities such as searching for datasets, launching services, managing workspace parameters, and accessing data panels and messages. The map tools, found on the right side of the Explorer interface, include functionalities such as drawing polygons, zooming, and selecting base maps. These tools allow users to interact with the map dynamically.

Files: This interface (Figure 3) allows to view and manage files that are stored in the platform. Users can upload new files, search for existing ones, and filter them based on ownership and type. The interface supports operations such as file deletion and detailed file information viewing, facilitating efficient data management.

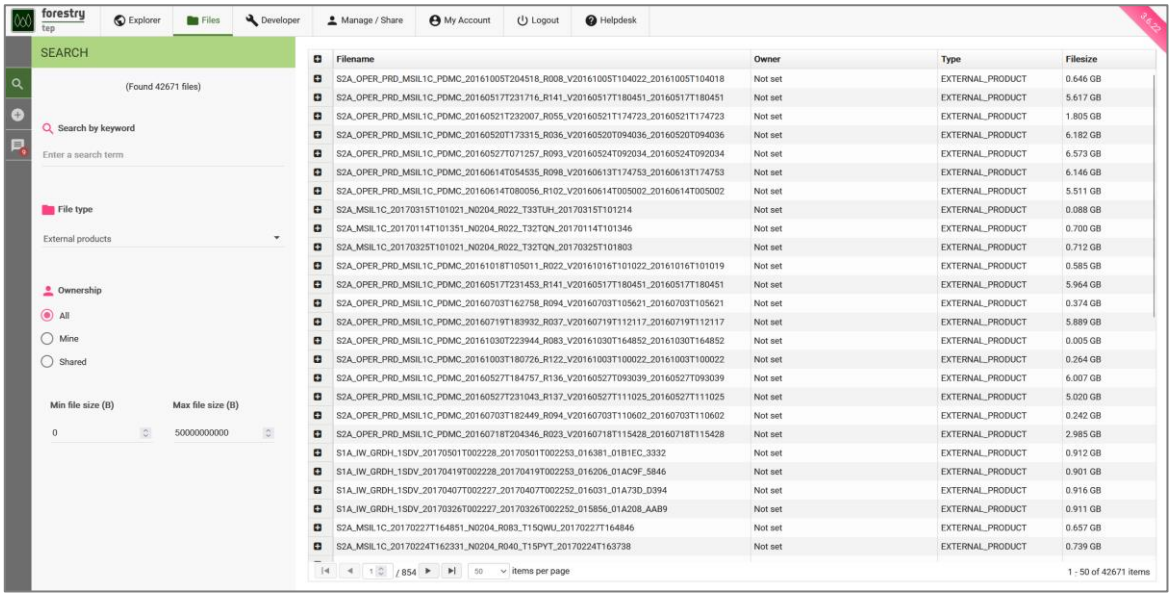

Figure 3. Files interface allows users to view and manage files stored on the platform.

Developer: This interface allows to create new processing services. New services are private at first, but the developer can share them to specific other users or make them public.

Manage / Share: This page allows a user to explore the various groups and projects they belong to as well as access their files, data baskets, logs of their run jobs and any services they have created. This page also allows users to share their services and products with selected users.

My Account: This page provides the user with information on the activities on F-TEP.

Helpdesk: This page (Figure 4) provides the user with access to support materials, including user manuals and tutorial videos. It is designed to assist users in performing actions on the platform and resolving any issues they might encounter.

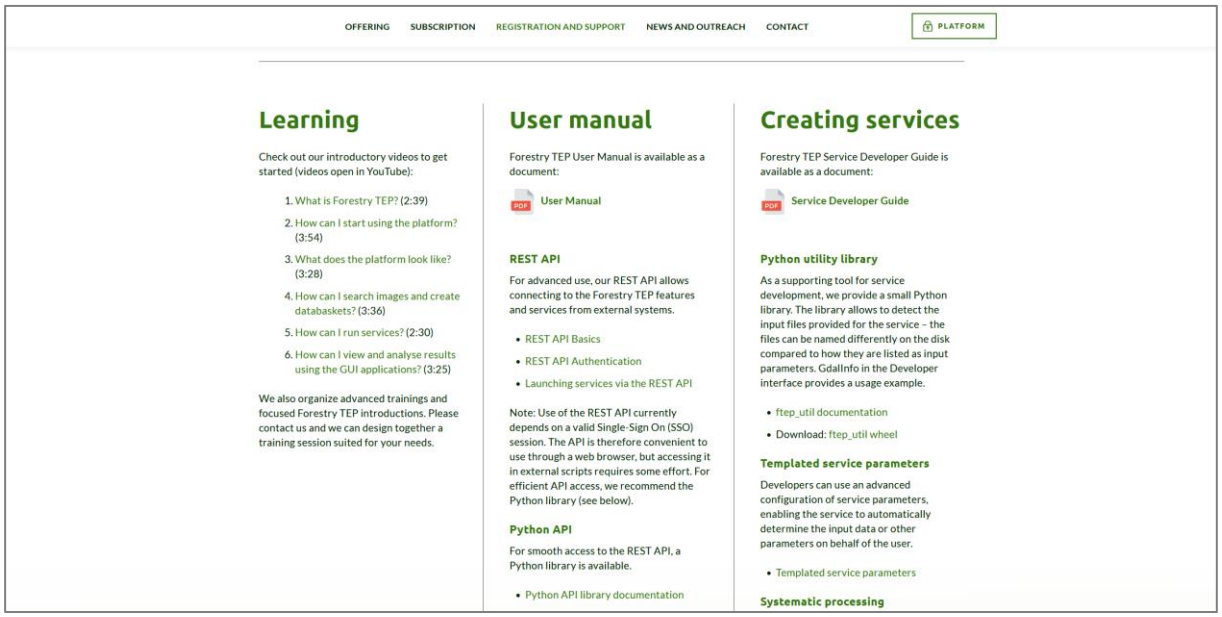

Figure 4. Helpdesk

Read more about the interfaces in the User Manual accessible from the Helpdesk page.

4.4 Instantiating a service

The F-TEP portal allows users to run a selection of algorithms on search results and/or on products ingested in F-TEP itself. It is also possible for users to create their own services in the 'Developer' interface. Available image processing algorithms (known as Services) can be browsed in the 'Services' panel which can be opened by clicking the 'Services' icon on the left-hand side the 'Explorer' interface.

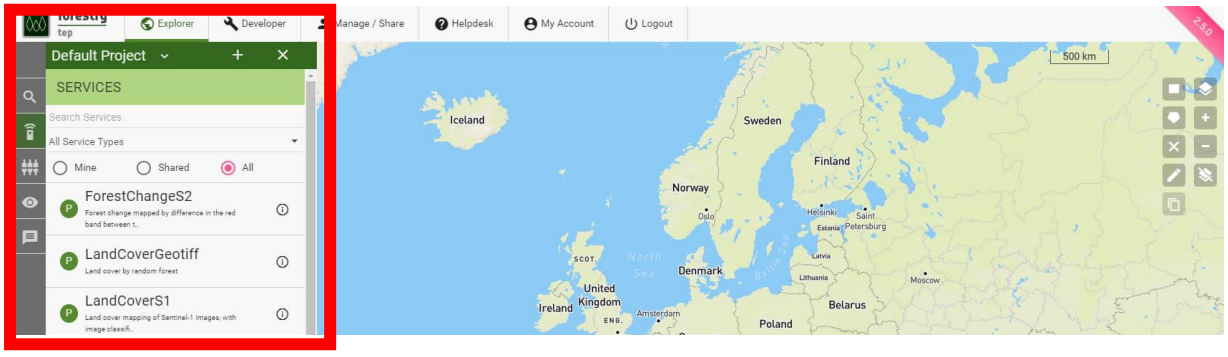

Figure 5. List of Services

When a service is selected, the 'Workspace' panel will open so the user can define the parameters needed for the service to run, including the input and output.

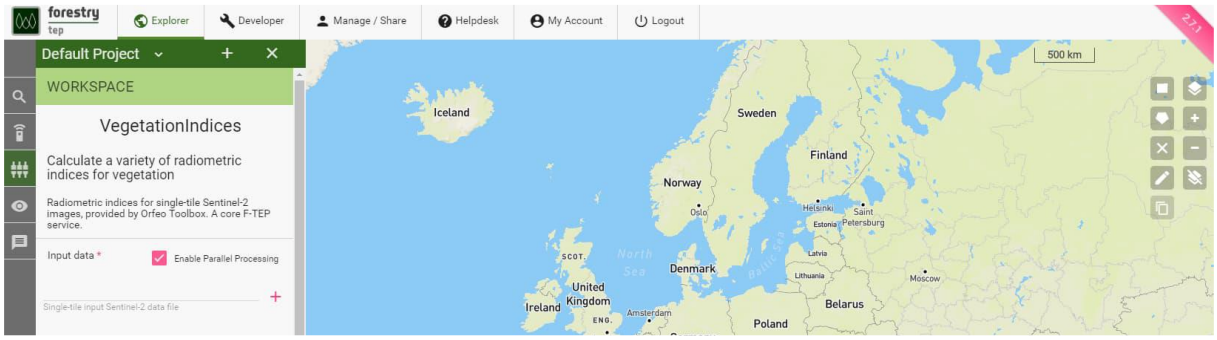

Figure 6. Service window

Once the input data and other parameters have been defined, the service is executed by clicking the 'Launch' button at the bottom of the Workspace panel. After launching, the Data Panel opens at the bottom of screen with the 'Jobs' section open. A full description of how to use is provided in the F-TEP user manual found on the helpdesk page.

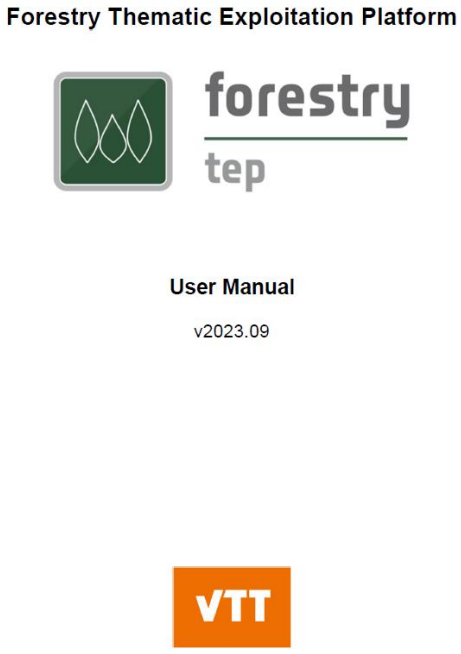

Figure 7. F-TEP user manual

5 Use Case: Augmenting National Reporting with Landscape Metrics

5.1 Introduction

Forests play an essential role in supporting biodiversity, regulating climate, and providing resources crucial to society. Traditional metrics, such as total forest cover, are often used in national forest assessments. However, as environmental changes accelerate, these metrics alone are no longer sufficient. Tracking additional landscape metrics—such as forest composition, fragmentation, and connectivity—provides a deeper insight into forest sustainability and resilience, essential for SDG reporting. These

metrics allow national and regional authorities to assess the health of forested landscapes more accurately, supplementing traditional measurements with detailed information on structural changes within forests. This tutorial provides a step-by-step guide for forestry officials using the GIS Landscape Composition Analysis Service to enhance national reporting on forest sustainability.

5.2 Scenario: Reporting on Forest Landscape Composition for SDG 15.1

Consider forestry officials tasked with reporting on SDG Goal 15, "Life on Land," particularly sub-goal 15.1, which aims for sustainable forest management. The officials' responsibilities include producing detailed assessments on the state and trends of forested landscapes. Previously, reporting might have been limited to aggregate metrics, like total forest area, but updated SDG requirements necessitate a more comprehensive set of indicators. By including spatial metrics—such as forest fragmentation, edge density, and connectivity—forestry officials can offer more nuanced insights into the resilience and sustainability of forests.

The Landscape Metrics Analysis Service enables these officials to efficiently assess forest landscapes over time, presenting essential metrics that can reveal underlying trends and potential challenges in forest structure and health. By following the steps below, forestry officials will be able to generate comprehensive, multi-year summaries of landscape metrics across their country or region.

Within Landscape Metrics, there are three levels of analysis: the patch, defined as neighbouring pixels with the same land cover class; class level metrics, which summarise all patches belonging to one class; and landscape level metrics, which summarise the whole landscape into a single value.

5.2.1 Logging into the Platform

To begin, the user, e.g. a forestry official, should navigate to the F-TEP website. After entering their secure login credentials, they will be taken to a main dashboard, where a variety of analysis tools and the latest platform updates are displayed.

1. Go to the Forestry-TEP website at https://f-tep.com/ and click on the Platform button on the top-right (Figure 8)

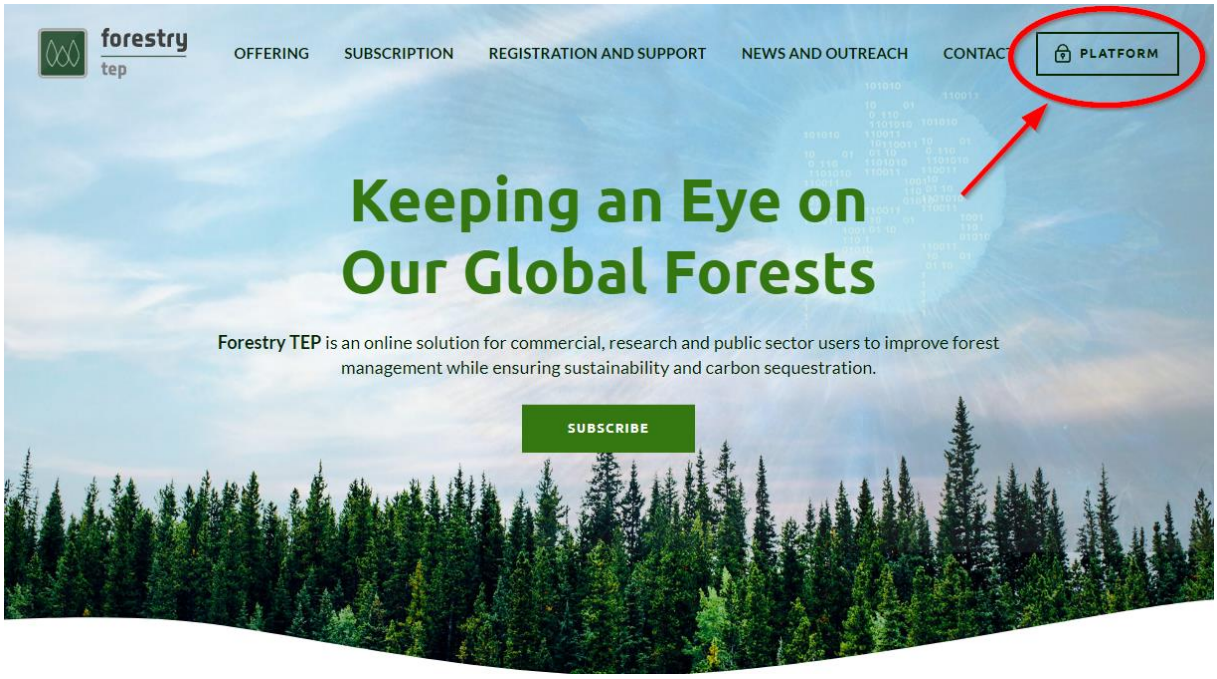

Figure 8. F-TEP landing page

2. You will be taken to the log-in portal (Figure 9). Enter your credentials here. You can see how to create a login credentials in chapter 4.2.

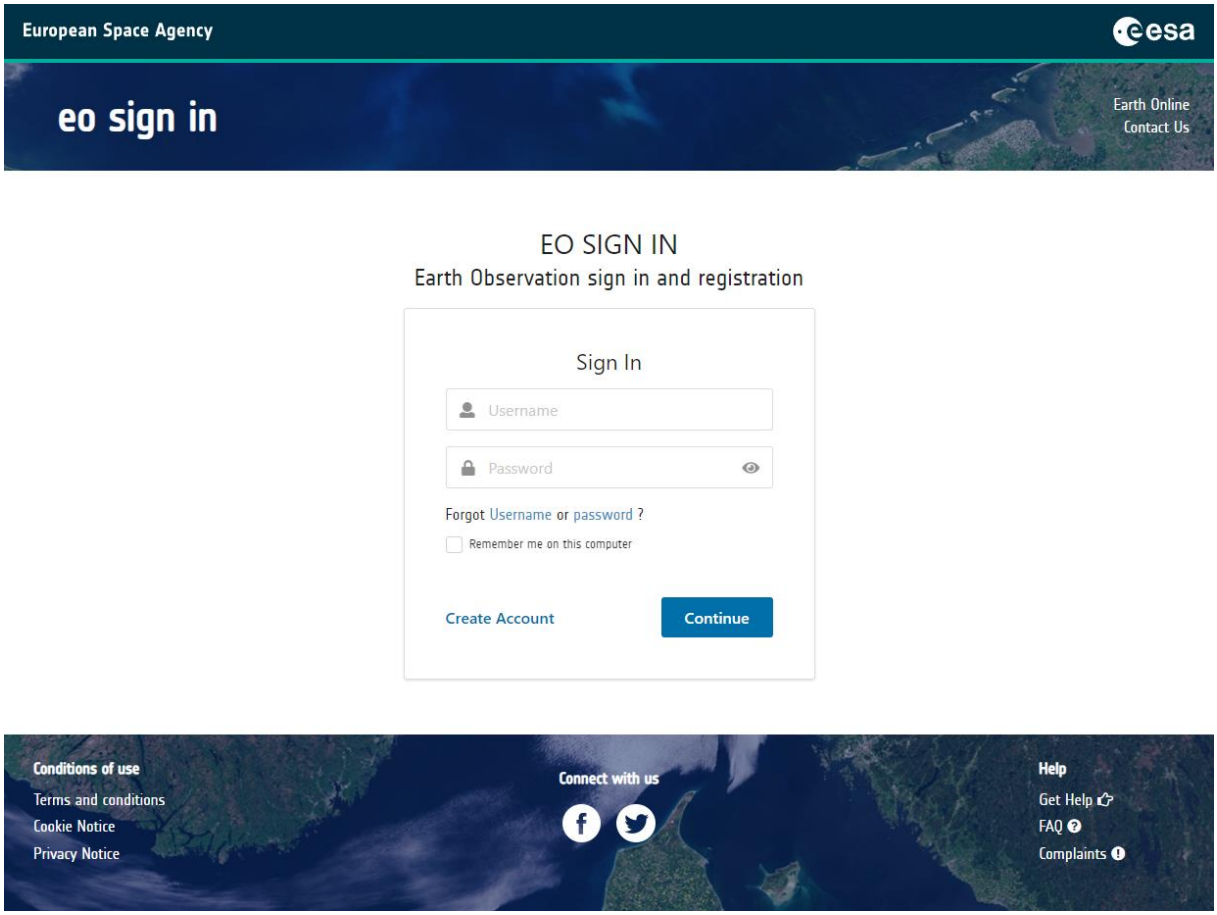

Figure 9. Signing page

3. Upon successful login, you access the main dashboard (Figure 10), which includes quick access to recent analysis tools, saved projects, and available data layers. Click on the “services” button to access the various services provided by EO4SDG.

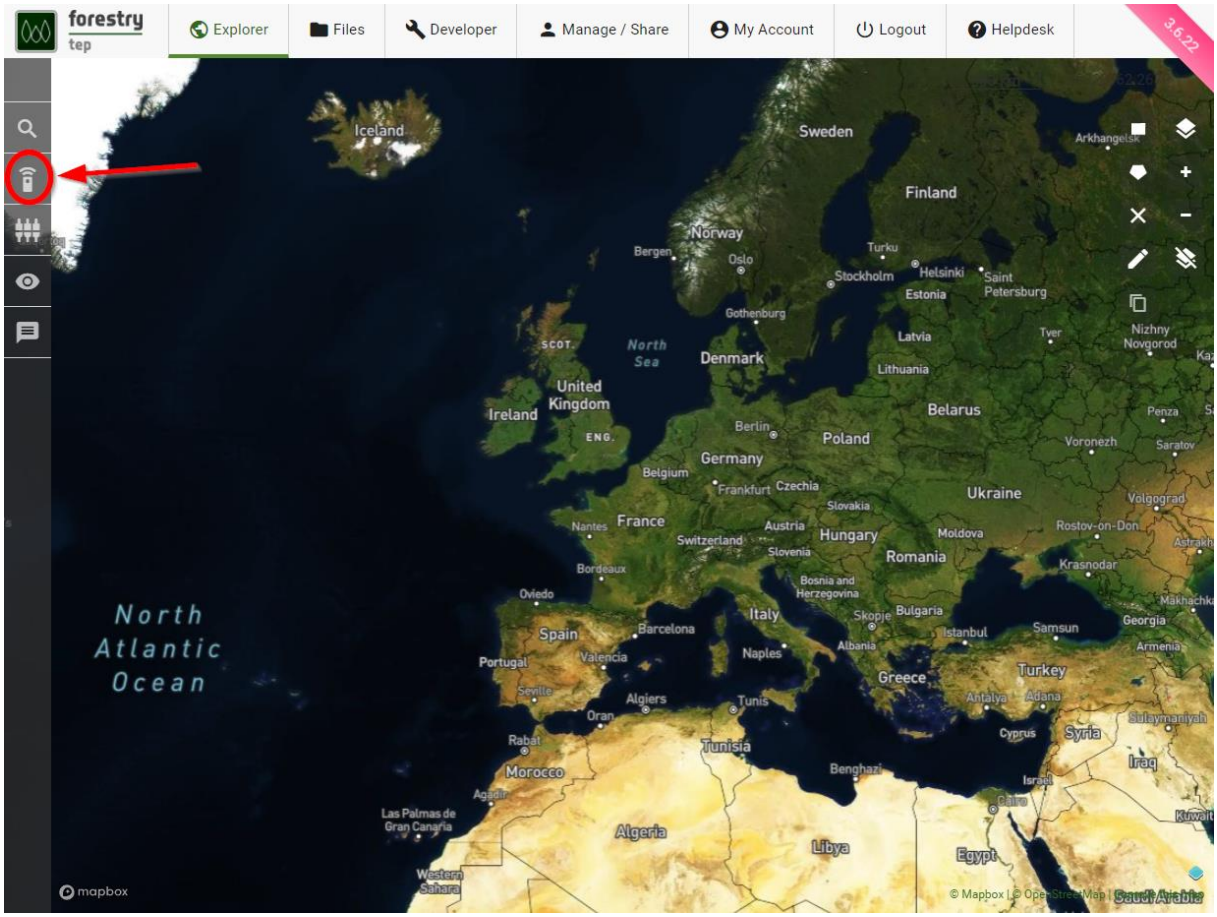

Figure 10. F-TEP Dashboard Explorer View

5.2.2 Defining the Area of Interest (AOI)

The first analytical step is to define the Area of Interest (AOI) for the landscape composition analysis. In this case, since the goal is a national-level assessment, officials select the national boundary layer to encompass the country's entire forested landscape. The platform allows the option to zoom in on specific regions or analyse forest composition within administrative units as required.

4. Select the "National Boundaries" layer from the AOI options. The AOI can be created directly on the platform by clicking the square or polygon in the top right (C) and then clicking on (D). Alternatively, provide your desired AOI in WKT form, for example, POLYGON((105.88 21.32,105.80 21.24, ...))

5.2.3 Running the Landscape Composition Analysis

With the AOI and dataset selected, the officials proceed to the "Landscape Composition" analysis option within the platform. Here, they can select from several metrics crucial for forest sustainability assessments.

While there are many metrics calculated, we will focus on the following:

Mean Patch Area (ha): describes the size of patches and classes and the amount of edge. An edge is defined as the border between two patches of different forest types. These metrics mainly characterize the composition of the landscape and are able to show dominance or rareness of classes.

Patch Shape Index (1: circle, 10+: non-circular): Describes the shape of patches, mainly by using its area and perimeter. This can be important for many research questions, because, e.g., even though,

being equal in size, long and narrow patches have different characteristics than a squared patch of the same size.

Diversity Index (↑ = more diversity): Only available on the landscape level. They describe the abundance and dominance/rareness of classes. Thereby, they show the diversity of present classes.

Officials select the relevant metrics for the SDG report and initiate the analysis, allowing the system to process data across the chosen years and metrics.

5. Select the desired service

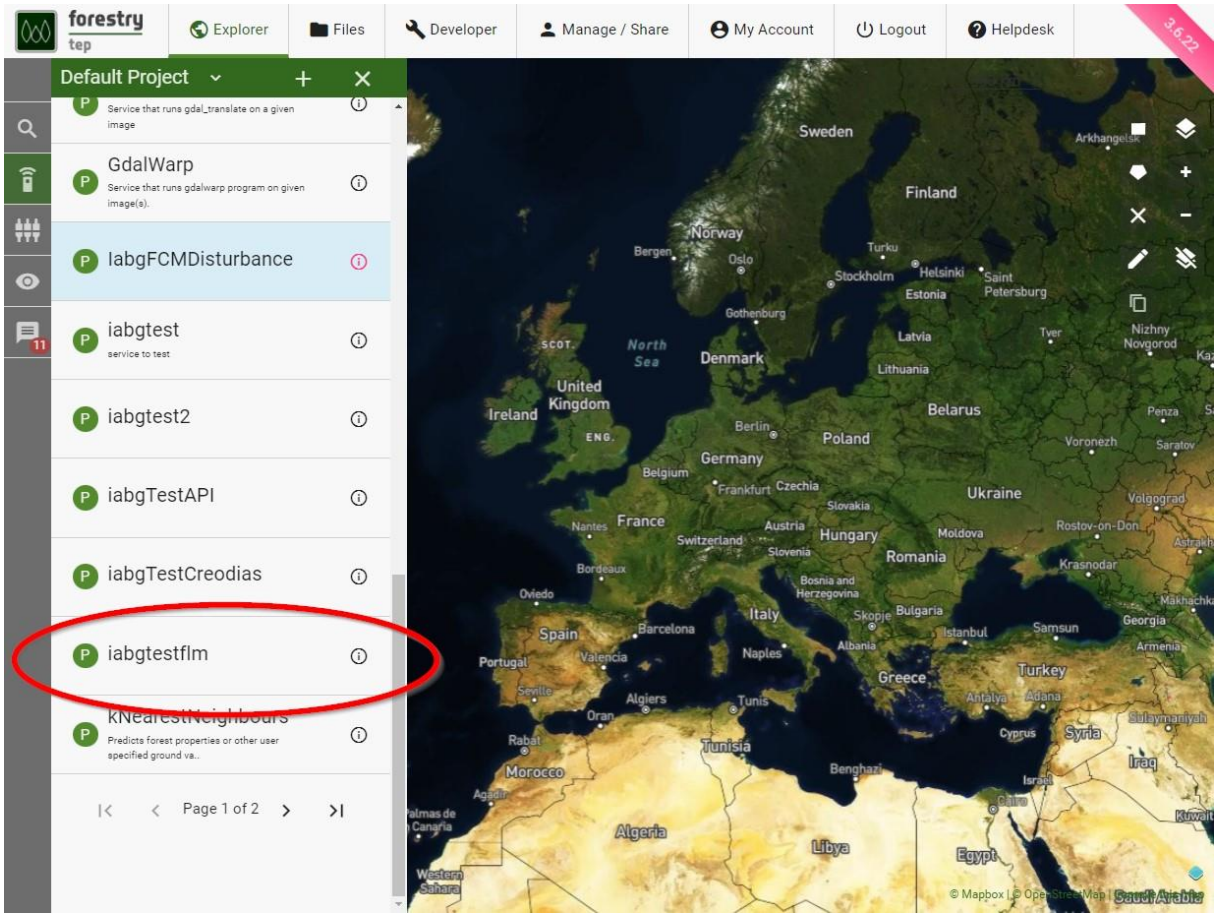

Figure 11. Service selection

Metric Selection: Choose metrics such as Edge Density, Core Area Ratio, and Connectivity Index.

5.2.4 Reviewing the Results

Once the analysis is complete, results are presented in raster format but can be converted to both tabular and graphical formats, allowing forestry officials to visualize trends and assess year-over-year changes in forest composition. This output highlights areas where fragmentation has increased or connectivity has declined, helping officials identify potential vulnerabilities within the forest landscape.

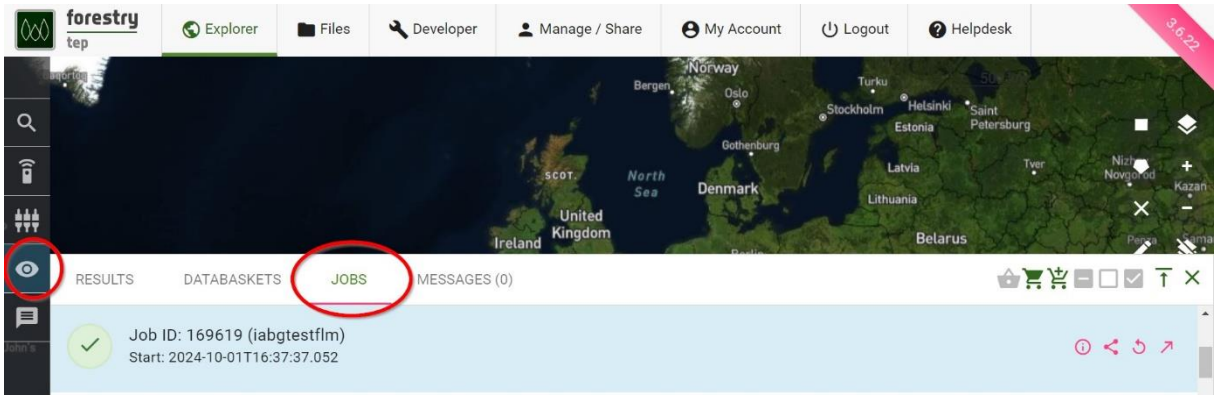

Figure 12. Output

In this following we loaded the resulting maps into software for statistical and GIS analysis and overlaid the maps with the Administrative Units (level 3) of Vietnam inside a specific Province (level 1). We then aggregated the results by averaging them across the whole Administrative Unit (level 3).

Patch Area

Municipalities outside of urban centres and further away from the sea are richer in forest and have larger average patch areas. Satellite imagery and the patch distribution across the region support this finding.

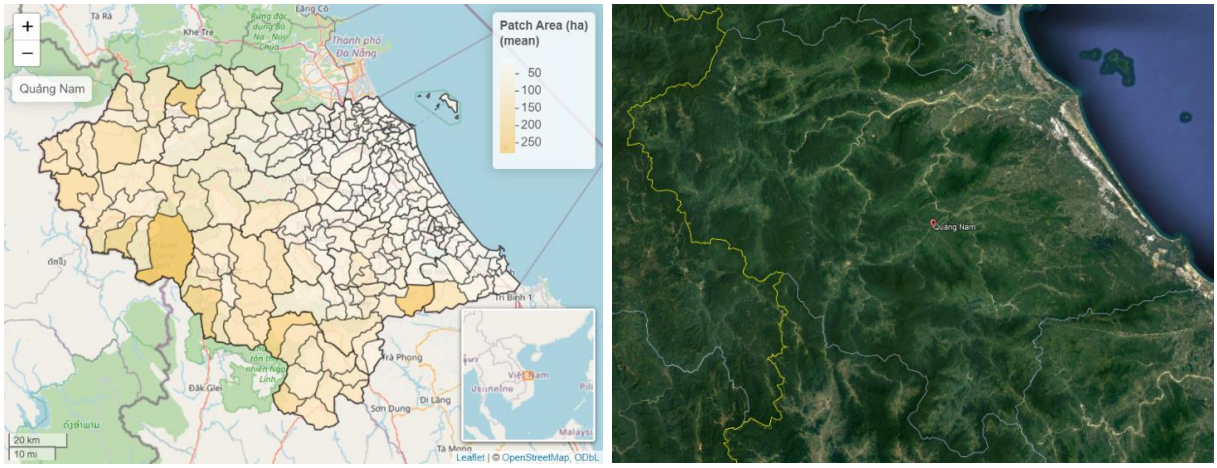

Figure 13. Patch area

Shape Index

The forest patches in Quang Nam, regardless of their location within their respective regions, do not have very complex and close to squared shapes.

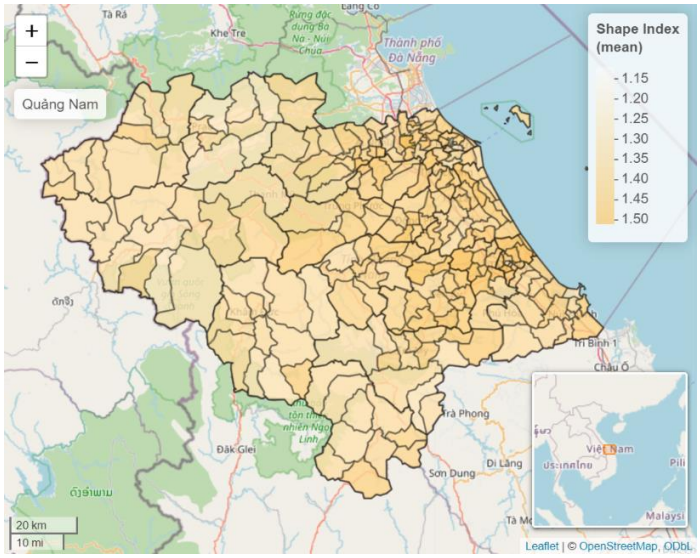

Figure 14. Shape index

Shannon's Diversity Index

Municipalities with the lowest diversity scores have a clear dominance of closed evergreen broad leaf forests over all forest types. Although other forest types may be present in these municipalities, the Shannon's diversity metric takes the abundance of a species into account in its calculation. Therefore, the lack of dense broad leaf forests towards the coast gives way to other species that are relatively more abundant, increasing the diversity index accordingly.

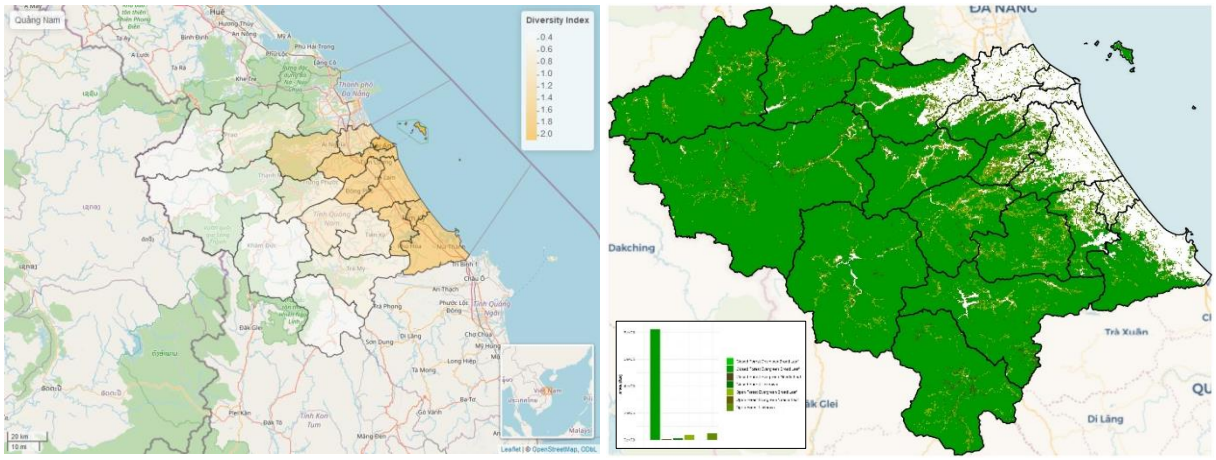

Figure 15. Shannon's Diversity Index

Additional visualization can be performed on a series of metrics and plotted into a graphical representation of each metric over time, noting significant trends.

To integrate the results into national SDG reporting, forestry officials can export the data in several formats, including CSV for tabular data, PDF for printable reports, and GIS-compatible formats (e.g., shapefiles, GeoJSON) for spatial data. These exports support further analysis and integration into other reporting platforms.

5.2.5 Using the Data for National Reporting

The data generated by the analysis is now ready for inclusion in the annual SDG report. The expanded insights into forest composition provide policymakers with an enhanced view of forest resilience, allowing for targeted, region-specific actions to promote sustainable forest management.

5.3 Conclusion

The Landscape Metrics Service offers forestry officials a streamlined approach to augment traditional reporting with spatial landscape composition metrics. By incorporating these additional indicators, forestry departments can support national SDG commitments with a more comprehensive view of forest health and resilience. Through these steps, forestry officials can add valuable insights into forest sustainability assessments, informing more effective policies for sustainable forest management and conservation.

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