ForestNavigator

D9.2 Fully developed Data Explorer visualizing the geodatabase with documentation

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Abstract

The deliverable D9.2 documents the operational public release of the ForestNavigator Data Explorer, a web-based service that provides public access to harmonised Work Package 2 (WP2) forest indicators. The Data Explorer supports interactive exploration of indicators through maps, legends, contextual overlays, and linked summaries, and provides reporting-unit-based statistics (for the European Union (EU27) by default, with national and subnational options). As part of the Data Explorer, indicator-specific documentation is available to enhance usability and transparency of the data for its users through an “About data” panel, including definitions, sources, methodological notes, limitations, and citation guidance.

Published outputs can be downloaded directly from the interface in standard formats for reuse, including Cloud Optimized GeoTIFF (COG) for raster layers and Comma-Separated Values (CSV) where available. The report presents an illustrated guided tour of the interface and summarises the WP2 indicators visualised in the Data Explorer, version notes, and key interpretation points, including the distinction between downloadable raster extent and reporting-unit-based chart summaries.

Keywords

ForestNavigator, Data Explorer, Pathways Explorer, Forest indicators, COG, CSV, EU27

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Nature of the deliverable *	R/DEC

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Abbreviations

BOKU	Universität für Bodenkultur Wien
COG	Cloud Optimised GeoTIFF
CA	Climate Analytics
CSV	Comma-Separated Values
ECGA	Grant Agreement
EU	European Union
EU27	Current 27 member states of the European Union
GIS	Geographical Information System
HA	Hectare Area
IIASA	International Institute for Applied Systems Analysis
M	meter
Mha	Million Hectare
NUTS2	Nomenclature of Territorial Units for Statistics class 2 for basic subnational regions
RDI	Research, Development and Innovation
V	Version (as in v1 and v2)
WP	Work Package
WP2	Work Package2

Executive summary

The ForestNavigator Data Explorer is the first publicly available interface component of the ForestNavigator Portal, allowing exploration of harmonised forest monitoring datasets. The Data Explorer is one of the portal's core components, and it focuses on interactive visualisation and download of published indicators, while the Pathways Explorer is designed to provide access to model-based pathway outputs as they become available. This deliverable (D9.2) documents the operational public release of the Data Explorer, focusing on the publication and visualisation of outputs from Work Package 2 (WP2). It brings together interactive maps, linked summaries, and dataset documentation to support transparent exploration and reuse of forest indicators. This operational public release makes harmonised WP2 indicators publicly accessible in a single interface, supporting uptake beyond the consortium and providing a foundation to expand the published indicator catalogue as additional project outputs become available.

In this release, WP2 datasets are made available through a consistent user workflow. Users select an indicator, choose a year or time-period where applicable, and can explore spatial patterns on the map. Additional features allow users to consult the "About data" information to understand definitions, resolution, methods, limitations, and caveats, and download results for further analysis. The interface supports common exploration needs such as switching between indicators, viewing legends and classifications, and using split-screen comparison to visually check differences between layers or time periods. Download options are provided in standard formats used in Geographical Information System (GIS) and analysis of pipelines (cloud optimised GeoTIFF (COG) and Comma-Separated Values (CSV), depending on the dataset. The Data Explorer has been refined based on partners and stakeholders feedback collected through targeted discussions, which highlighted map view improvements and further data interpretation support needs.

The WP2 indicators currently visible in the Data Explorer include forest status and change dimensions, Forest Aboveground Biomass, Forest Cover and Forest Cover Change, Forest Type, Forest Cover Fraction and Natural Forests, Timber Volume, Forest Canopy Height, and disturbance-related layers (Disturbance Year, Disturbance Fraction, and Disturbance Agent where available), Forest Fragmentation and Forest Fragmentation Change. WP2 indicators are provided in two versions, reflecting iterative updates to selected variables and time coverage while keeping dataset definitions and user-facing descriptions aligned with the portal.

Beyond the current release, additional indicators shared by other partners will be added once they are formally published. Planned additions include forest area per region Nomenclature of territorial units for statistics (NUTS), forest growing stock per forest area, and forest harvest per area, for 2000–2020. Until publication, these indicators are treated as planned content and are not made public through the tool.

1. Introduction

ForestNavigator brings together datasets and tools to support transparent exploration of forest indicators relevant for monitoring and modelling. Within the ForestNavigator Portal, the Data Explorer provides interactive access to published indicators (maps, charts, downloads and documentation), while the Pathways Explorer is intended to present model-based pathway outputs as they become available. This deliverable (D9.2) documents the ForestNavigator Data Explorer as an operational public release, focusing on the WP2 outputs initially published in the tool and the main user workflows for exploring, comparing, and downloading indicators. The Data Explorer is part of WP9, which is responsible for the Portal's technical infrastructure and the interactive services that enable users to access, interpret, and reuse forest datasets in a consistent manner. In the project plan, Milestone 11 defined the availability of a beta Data Explorer as "portal operational, first data visualization", which was achieved as an earlier step towards the public release documented here.

The purpose of D9.2 is to document what has been implemented and made publicly available through the Data Explorer, focusing on the WP2 indicators currently published and the user-facing functions that supports exploration, comparison, interpretation, and download.

1.1. Data Explorer in the ForestNavigator Portal

The ForestNavigator Portal provides a shared platform for accessing and exploring project datasets and tools related to forest monitoring and modelling. Within the portal, the Data Explorer publishes and visualises harmonised indicators through interactive maps, linked summaries, and downloads, while the Pathways Explorer is intended to present model-based pathway outputs as they become available.

1.2. Scope of this release

This deliverable covers the Data Explorer functionalities and the Work Package 2 (WP2) outputs that are currently published through the tool. Specifically, the operational public release documented in D9.2 provides: (i) interactive map-based exploration of WP2 indicators, (ii) selection by year or time period, where relevant, (iii) linked charts and summary statistics, where available, in the interface, (iv) an "About data" information panel that provides dataset definitions and interpretation guidance, (v) split-screen comparison, and (vi) download options in standard formats used in GIS and analysis workflows (COG and CSV, depending on the dataset).

The Data Explorer is designed to present outputs across multiple work packages over the course of the project. However, for this deliverable submission, only WP2 outputs are reported as publicly released content. Additional indicators shared by Universität für Bodenkultur Wien (BOKU) (Total forest area, Forest biomass stock, Forest harvest, and Forest biomass increment) will be added to the Data Explorer once they are formally published by the data providers and cleared for public release.

1.3. Report roadmap

Section 2 provides a guided tour of the ForestNavigator Data Explorer, documenting the main user workflows with screenshots (indicator and year selection, map exploration, charts, reporting units, comparison view, and downloads). Section 3 summarises the published WP2 indicators included in this operational public release, including versioning and key interpretation notes. Section 4 lists references and Section 5 provide annexes with supporting inventory and documentation.

2. Guided tour through the ForestNavigator Data Explorer

This section provides a guided tour of the ForestNavigator Data Explorer as an operational public release. The walkthrough follows the main workflow from selecting an indicator and a year or period, to exploring maps and linked charts, reviewing dataset documentation, comparing layers, and downloading outputs for reuse. Screenshots are included to document the interface and illustrate the key functions available in this release.

2.1. Accessing the tool and landing page

The ForestNavigator Data Explorer is accessed via the ForestNavigator Portal at: https://fn-portal.iiasa.ac.at/. The Portal landing page provides a short orientation to the overall platform and the two interactive components, the Data Explorer and the Pathways Explorer. It introduces Portal as a public interface for exploring forest data on past and current status and future pathways, with an emphasis on transparency and reusability (documentation and downloads available through the interface).

From the landing page, users can enter the Data Explorer directly using the top navigation (“Data Explorer”) or via the component tiles in the “What can you do with the Portal?” section. The Data Explorer enables users to browse indicators, explore maps and linked charts, compare layers, consult “About data” documentation, and download published outputs. The landing page also communicates the phased rollout of Portal components, including the Pathways Explorer, which is documented separately under the relevant deliverable (D9.3) is not covered in this report.

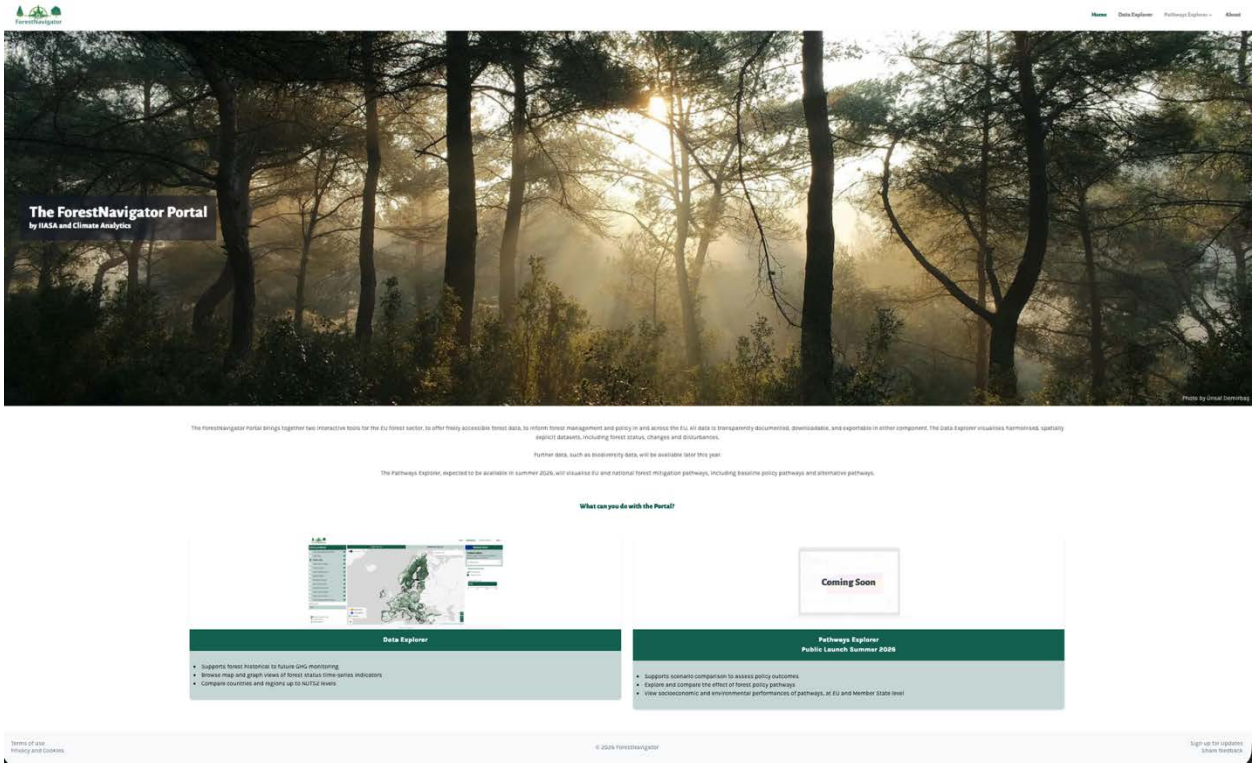

Figure 1a: ForestNavigator Portal landing page with navigation to the Data Explorer and the upcoming Pathways Explorer.

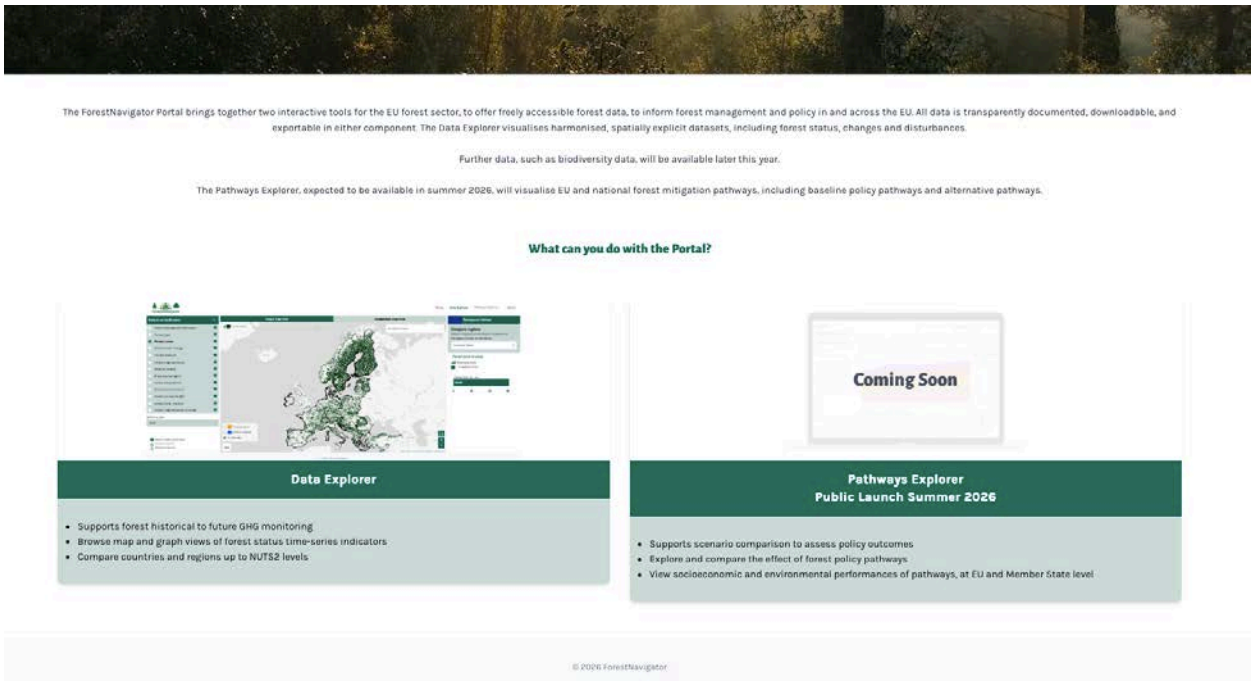

Figure 1b: Close-up of the landing page component tiles summarising the main user actions supported in the Data Explorer and Pathways Explorer.

2.2. Selecting an indicator

Within the Data Explorer, users begin by selecting an indicator from the 'Select an indicator' panel on the left (Figure 2). Indicators are listed as data layers (for example, forest cover, forest cover change, aboveground biomass, timber volume, forest type, and disturbance-related layers). Once

an indicator is selected, the map updates to display the chosen layer and the chart panel on the right updates to present summary statistics for the selected indicator (Figure 3).[i]
As shown in Figure 3, the workflow follows indicator selection (1), map exploration (2), and review of reporting-unit based summary statistics in the chart panel

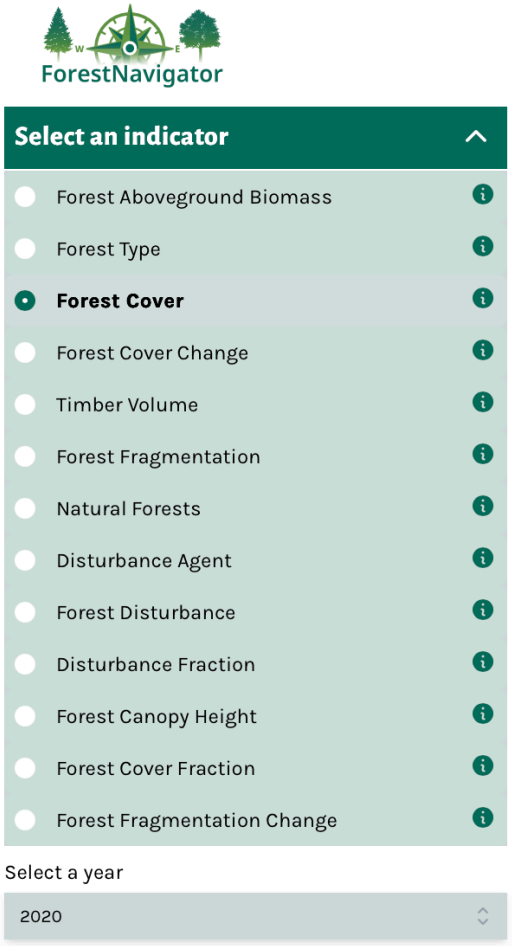

Figure 2: Indicator catalogue panel ('Select an indicator') showing the available WP2 indicators

[i] Note that the boundary of the current 27 member states of the European Union (EU27) is shown as a reference overlay. Some raster layers extend beyond EU27 and are included in downloadable GeoTIFF outputs, while chart summaries use the selected reporting unit (EU27 by default).

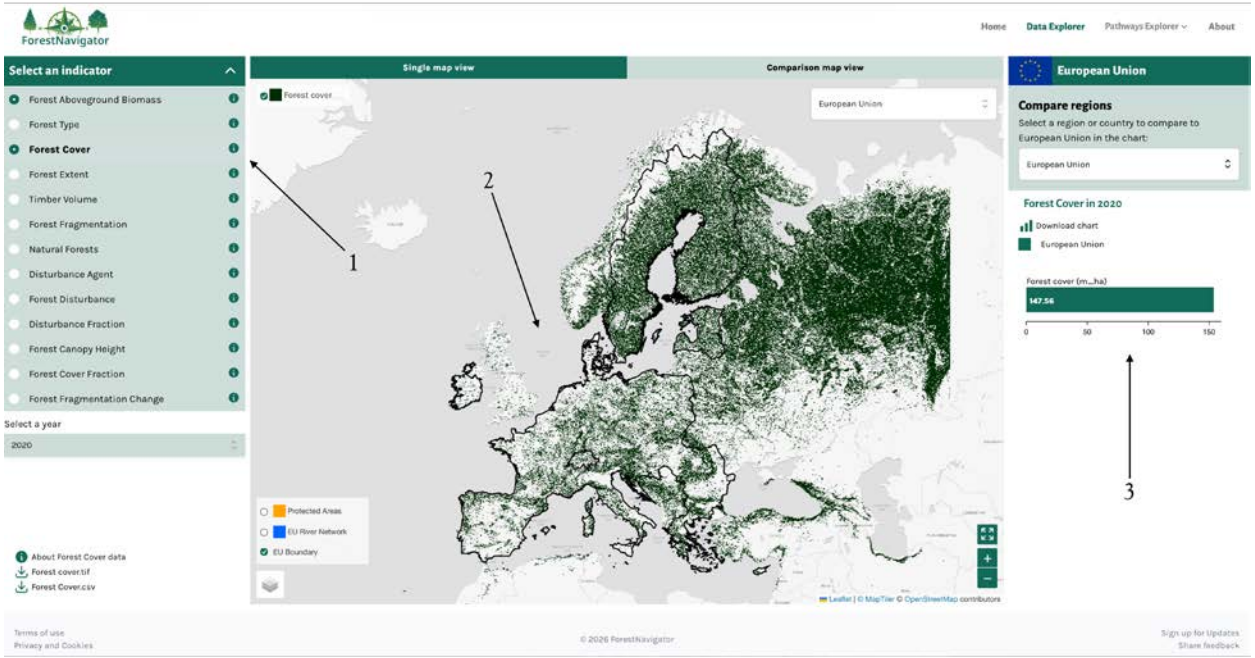

Figure 3: Data Explorer interface overview showing (1) indicator selection panel, (2) map view for the selected indicator, and (3) reporting-unit selection with chart-based summary statistics (example: Forest cover, 2020)

2.3. Selecting a year

Many indicators are available for multiple years. The "Select a year" control allows users to choose the year of interest, and the map and linked chart update accordingly (Figure 4a-b). The availability of years depends on the indicator, some layers describe a single reference year (status indicators), while others support multi-year selections that capture change over time.

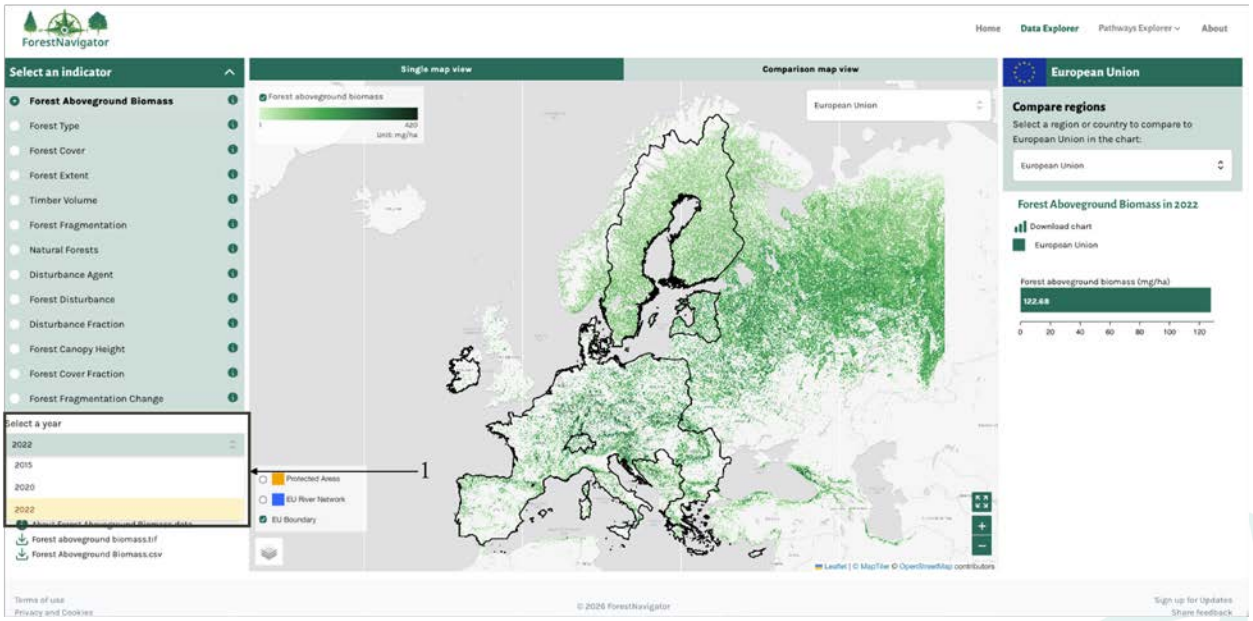

Figure 4a: (1) Year selection control for a multi-temporal indicator in the Data Explorer

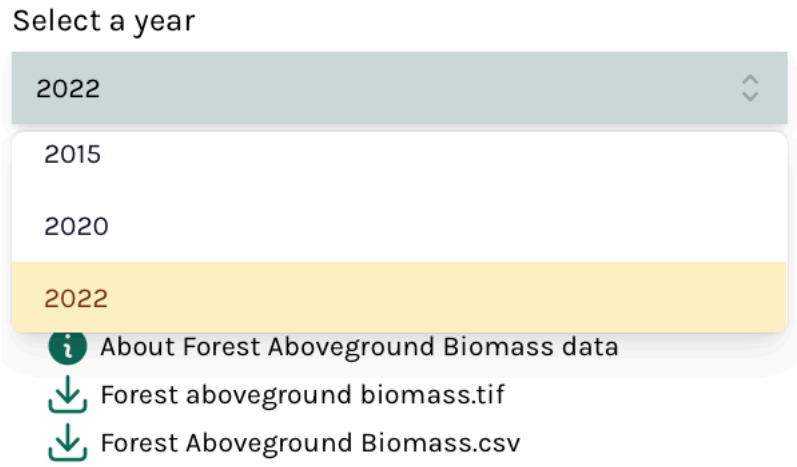

Figure 4b: Close-up of the year dropdown showing available years for the selected indicator

2.4. Exploring the map and legend

After selecting an indicator and year, users can explore spatial patterns through the interactive map. The map legend supports interpretation by displaying value ranges and units for continuous indicators, and class categories for categorical indicators. Figures 5 and 6 illustrate both legend styles and the use of contextual overlays. Figure 5 shows a continuous indicator (timber volume, m^3/ha) with its legend and units, displayed with the protected areas overlay. Figure 6 shows a categorical indicator (forest type) with a class legend, displayed with the European Union (EU) river network overlay being activated. These reference layers (protected areas, river networks, and EU boundaries) help users interpret indicator patterns in their geographic context.

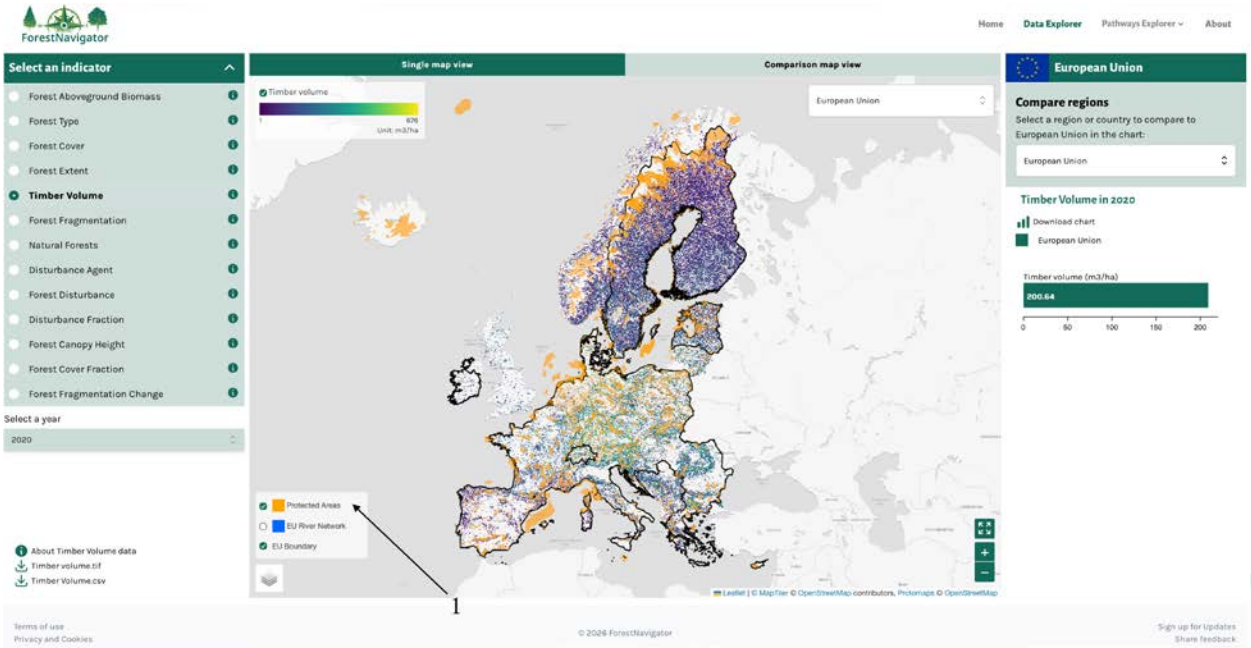

Figure 5: Map view for a continuous indicator with legend and units visible, example: Timber volume (in m^3/ha) with (1) Protected Areas overlay enabled (yellow areas activated from the bottom left interactive box).

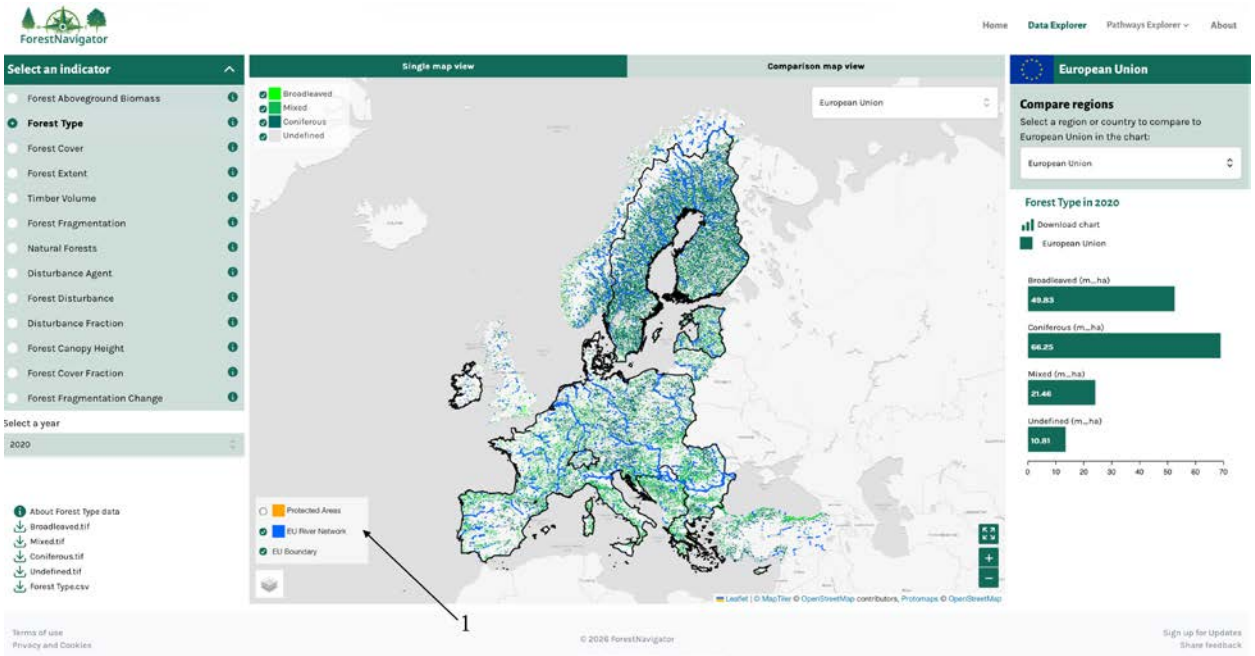

Figure 6: Map view for a categorical indicator with class legend visible, example: Forest type with EU (1) River Network overlay enabled (blue layer activated in the bottom left interactive box)

2.5. Charts and summary statistics

Alongside the map, the Data Explorer provides a *chart panel* that summarises indicator values for the selected reporting unit (default view shown for the EU27), as shown in Figure 7. Users can compare the EU against a selected region or country using the 'Compare regions' control, which updates the chart accordingly. This supports interpretation of indicators through summarised values and simple reporting-unit comparisons, and the displayed chart can be exported using the 'Download chart' option shown in Figure 8. The values shown in the chart panel are derived by aggregating the underlying indicator data within the selected reporting unit, using indicator-specific summary statistics.

Chart & Statistics panel

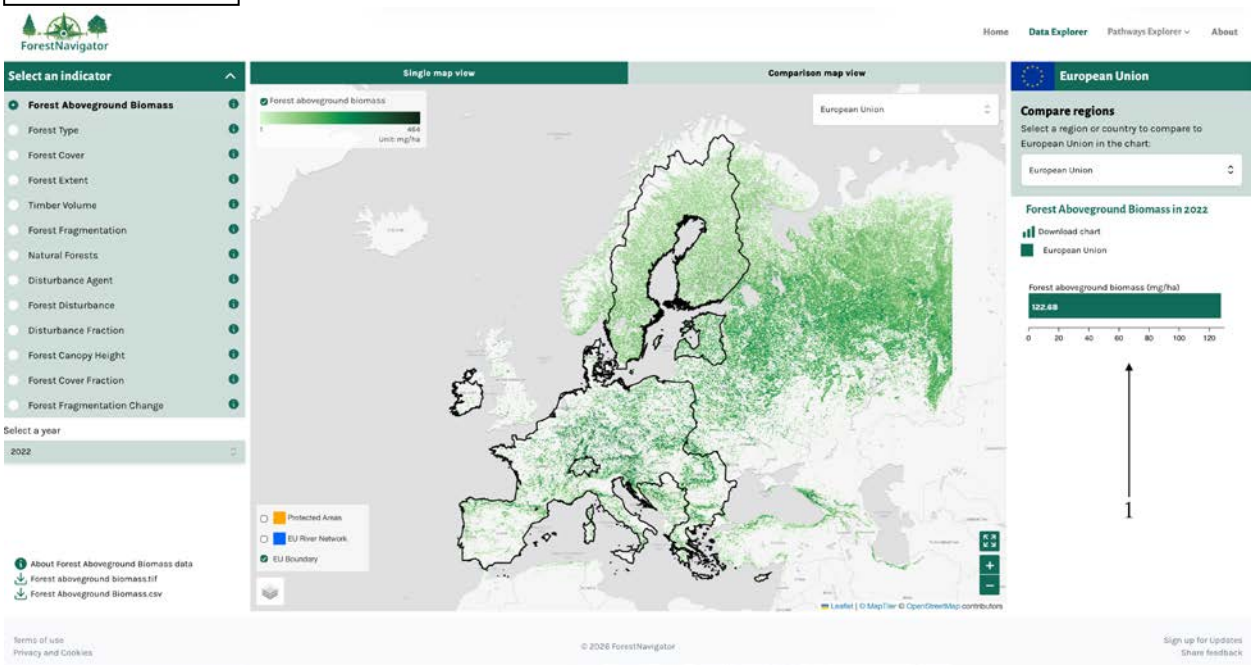

Figure 7: Chart and summary statistics panel for a selected indicator (example: Forest aboveground biomass in 2022)

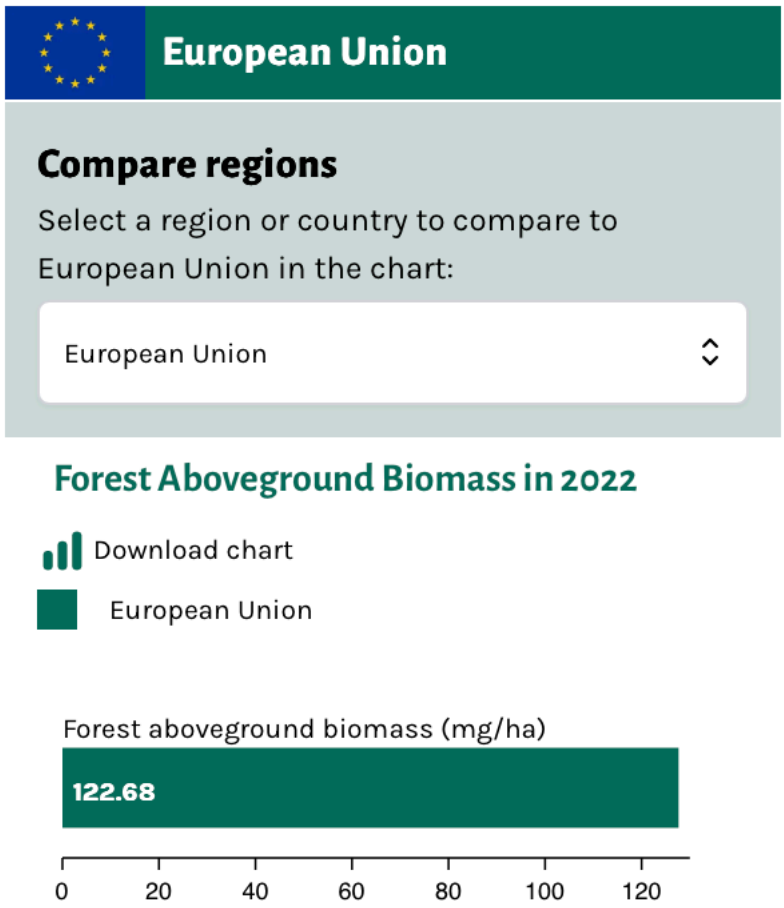

Figure 8: Zoomed-in chart and summary statistics panel for a selected indicator (example: Forest aboveground biomass in 2022)

2.6. Regional summaries and subnational reporting (NUTS2)

The chart panel reports indicator summaries for a selected region. Chart values are computed by spatially aggregating the selected indicator layer within the chosen region boundary. The aggregation approach depends on indicator type, for example mean (or other summary statistics) for continuous indicators, and total area by class for categorical indicators (that is, the chart reports the area of each class within the selected region, it is not summed across different indicators).

By default, summaries are shown for the EU, but users can switch the selected region to a specific country or sub-national region (Nomenclature of territorial units for statistics level 2 (NUTS2), basic subnational regions, where available). Users can also select an additional region in the “Compare regions” control to display a side-by-side comparison in the chart panel. Figures 9 and 10 illustrate a country-level selection (Germany versus Austria) and an example of a NUTS2-level selection applied within the interface.

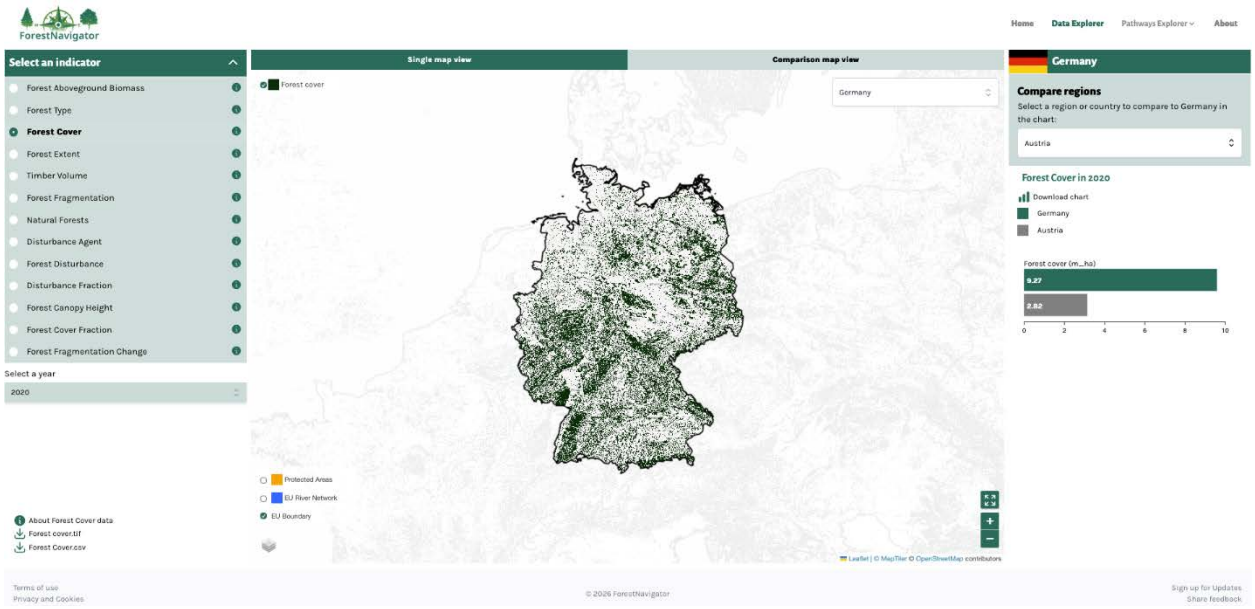

Figure 9: Chart panel comparing the selected indicator between Germany (selected region) and Austria (chosen in “Compare regions”) (example: Forest cover, 2020)

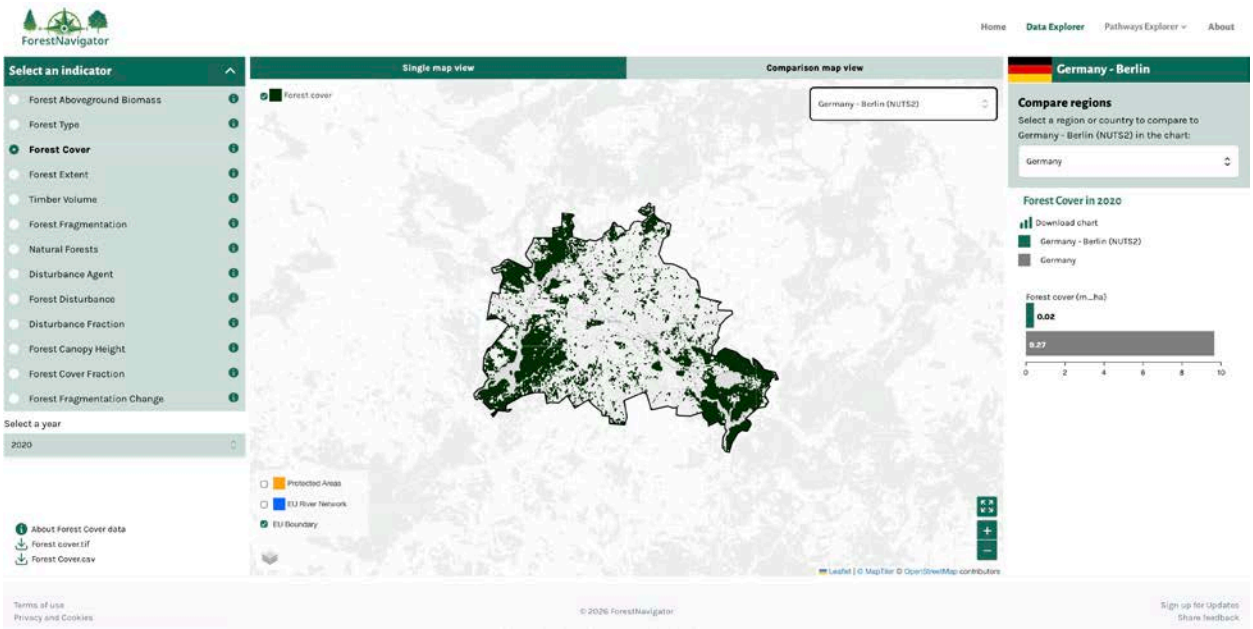

Figure 10: Chart panel comparing a NUTS2 region (Germany, Berlin) against the national total (Germany) for the selected indicator (example: Forest cover, 2020).

2.7. Comparison map view (split-screen)

The Data Explorer provides a comparison map view that enables side-by-side visual inspection of two map selections. In this view, users can choose an indicator and year independently for each panel, while keeping the map extent aligned (Figure 11a). This supports quick visual comparison of spatial patterns between indicators (for example, aboveground biomass versus forest cover) or between time selections for the same indicator.

Chart-based comparisons across regions are provided through the chart panel (Sections 2.5–2.6), while Figure 11a illustrates map-based split-screen comparison. Figure 11b provides an example of the same comparison view applied at NUTS2 level.

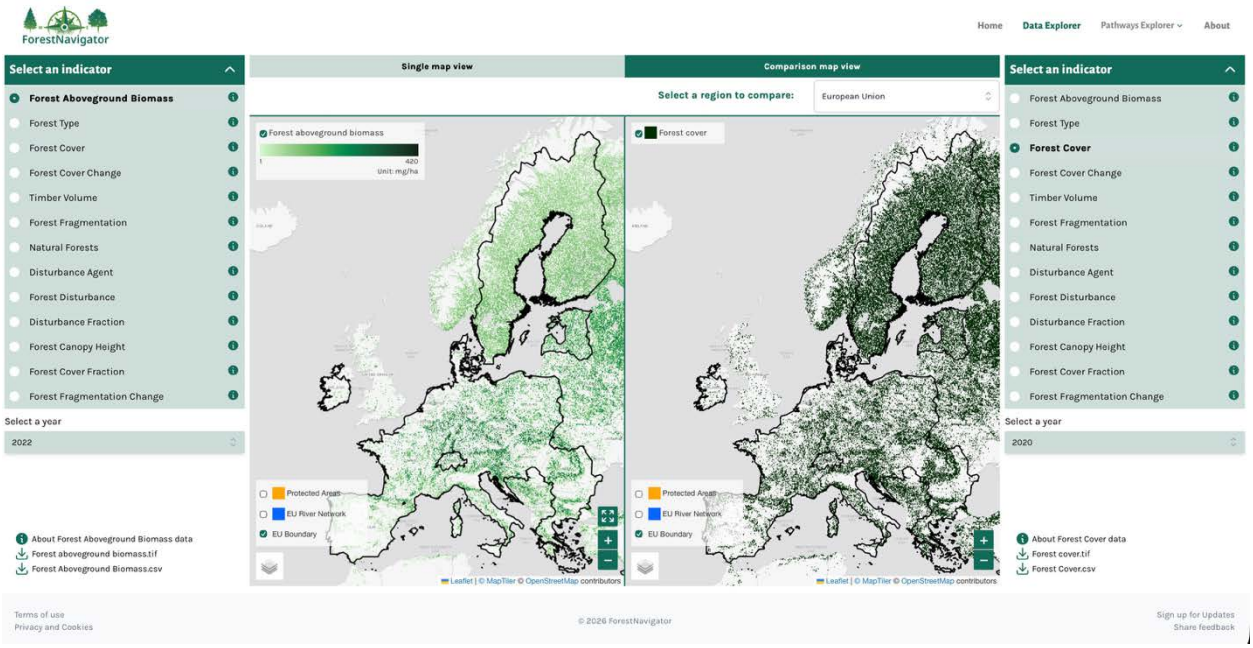

Figure 11a: Comparison map view enabled, showing side-by-side maps with independent indicator and year selection

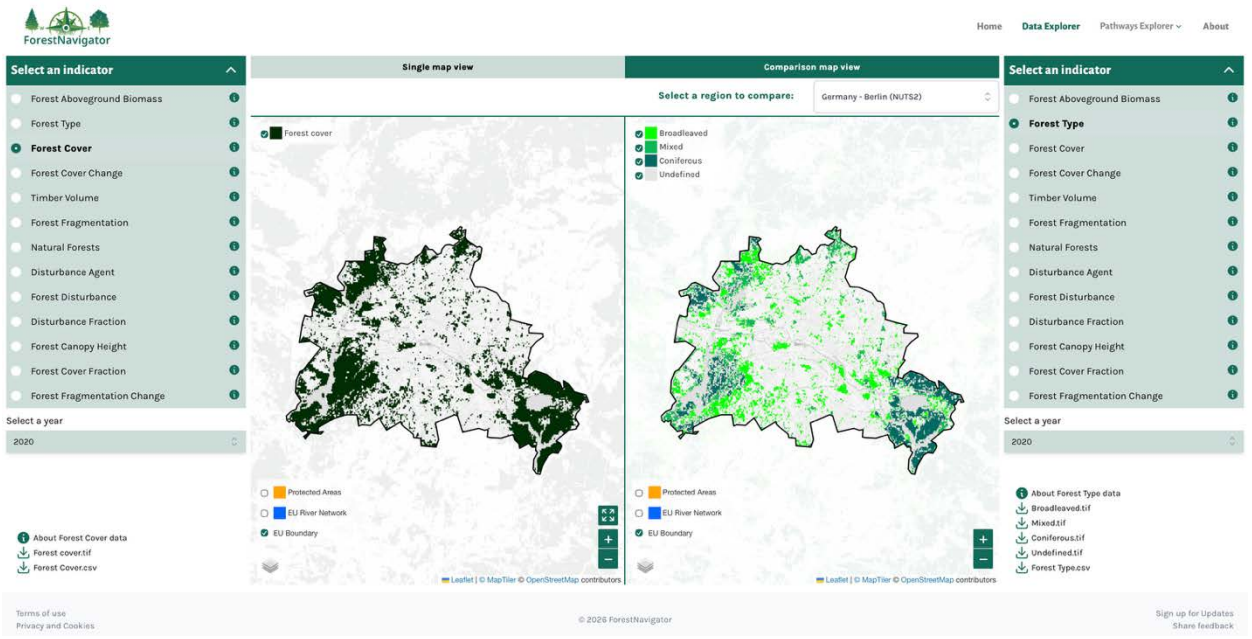

Figure 11b: Comparison map view with a NUTS2-level region selected (Berlin, Germany), showing side-by-side maps for two indicators (Forest cover and Forest type, 2020) within the same selected region.

2.8. "About data" information and download

For each indicator, users can open an "About [indicator name] data" panel via the information (i) button located at the bottom left, directly above the download links. From the same area, users can download published outputs from the interface. Spatial layers are provided as COGs, and tabular outputs are provided as CSV files where available. Placing the "About data" information next to the download links supports correct interpretation and reuse by presenting key definitions, sources, and caveats at the point of access.

Downloads provide the full raster extent published for each indicator (COG), while the chart reflects the selected reporting unit (EU27 by default)

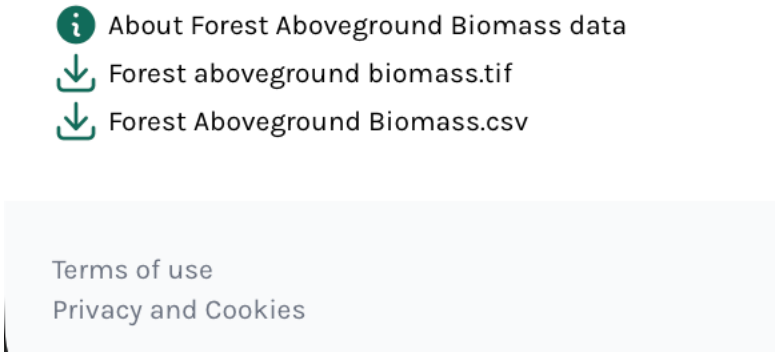

Figure 12: Data access area in the interface showing the "About … data" link and download links for cloud-optimised GeoTIFF and CSV outputs

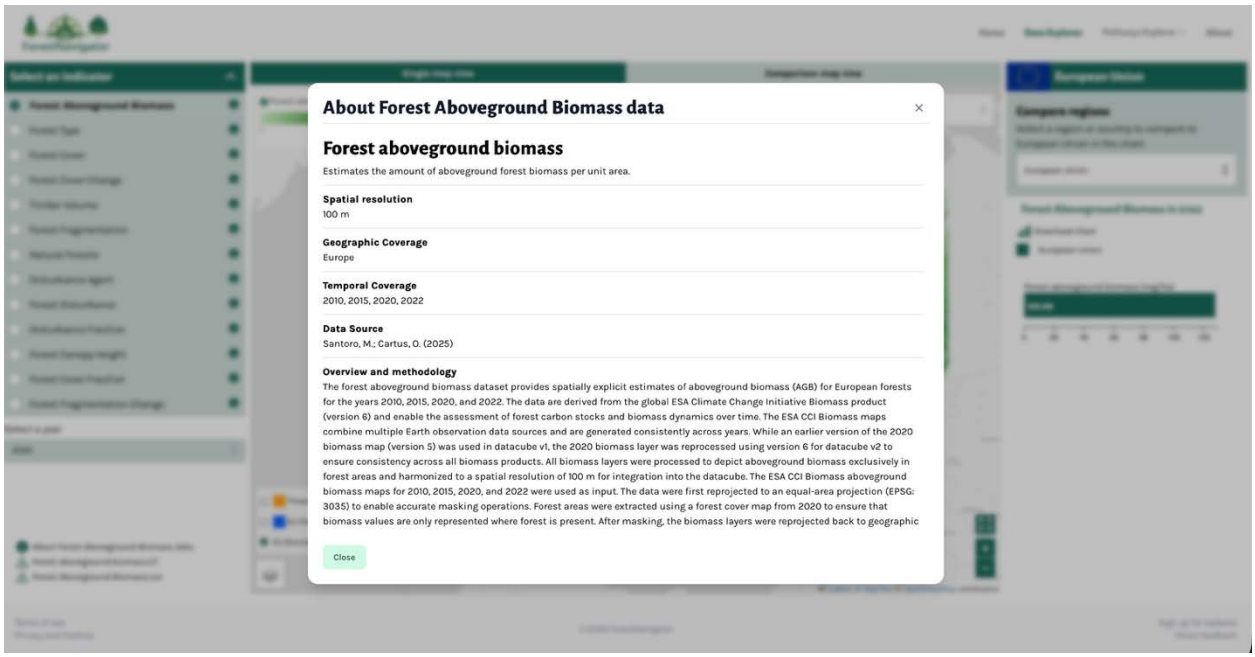

Figure 13a: "About Forest Aboveground Biomass data" panel showing indicator description, spatial resolution, geographic and temporal coverage, data source, and overview and methodology

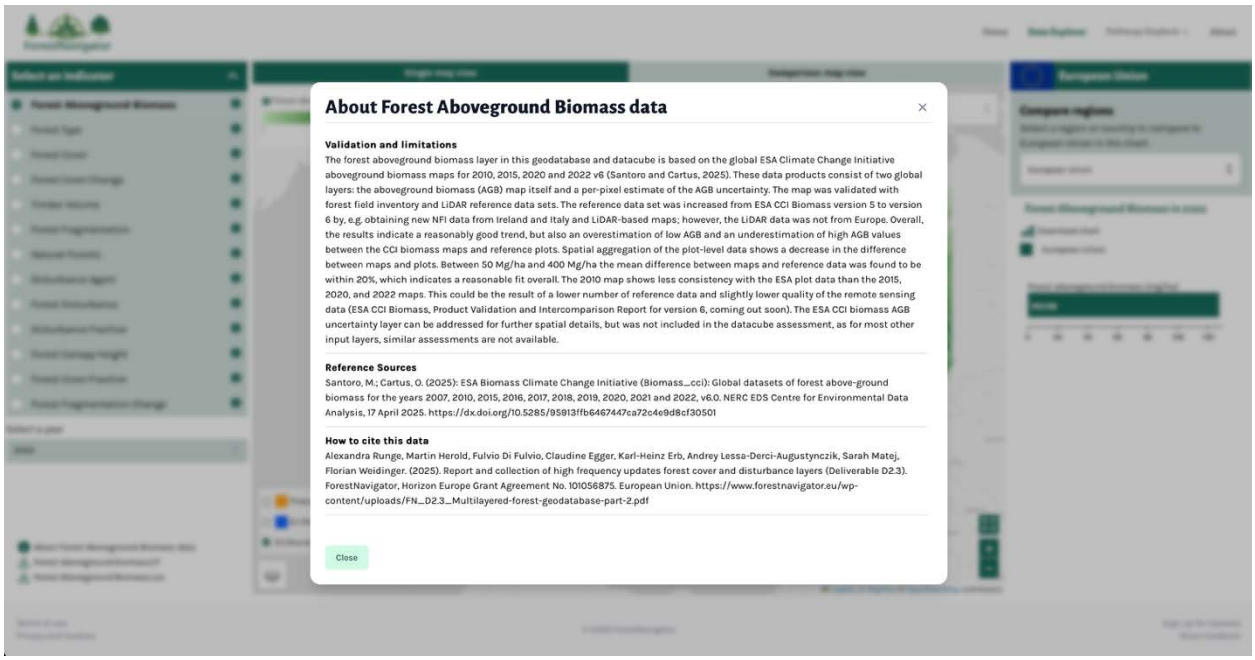

Figure 13b: "About Forest Aboveground Biomass data" panel showing validation and limitations, reference sources, and recommended citation text

2.9. Published WP2 content, versions, and interpretation notes

2.9.1. WP2 content included in this operational public release

The Data Explorer publishes harmonised WP2 forest monitoring layers as spatial datasets and linked reporting-unit summaries. Indicators available in this release include forest cover and forest cover change, forest aboveground biomass, timber volume, forest type, canopy height, fragmentation and fragmentation change, natural forests, and forest disturbance layers, including disturbance fraction and disturbance agent.

Table 1: WP2 indicator groups available in the Data Explorer (summary)

Indicator group (as shown in Data Explorer)	Data type	Temporal coverage in release	Notes
Forest cover and forest cover fraction	Raster	2020	Forest cover is binary; forest cover fraction is fractional cover per pixel.
Forest cover change	Raster	2000-2020	Represented through stable, loss, and gain layers derived from the 2000 and 2020 forest extent.
Aboveground biomass	Raster	2010, 2015, 2020, 2022	Includes multi-year above-ground biomass layers.
Timber volume	Raster	2020	Provided as a continuous indicator (m^3/ha), with documented uncertainty characteristics
Forest type	Raster	2020	Classified into broadleaf, coniferous, mixed, and undefined classes.
Disturbance indicators	Raster	1985-2023 (where available)	Includes disturbance occurrence, year, fraction, and disturbance agent categories.
Canopy height & Fragmentation indicators	Raster	varies by indicator	Includes canopy height and fragmentation-related indicators.

Source: ForestNavigator WP [2]

2.9.2. Data versions used in the Data Explorer (versions 1 and 2)

This section clarifies the WP2 data versions underlying the indicators published in the Data Explorer for this operational public release. The published WP2 multilayer forest geodatabase, which has been released in multiple versions (version 1 (v1) and version 2 (v2)). Compared with v1 and v2 update includes, for example, disturbance layers extended to 2023 (previously 2020), additional aboveground biomass maps for 2010, 2015, and 2022, and updates or additions to selected variables (including timber volume), as documented in WP2 deliverables.

Table 2: What changed from datacube v1 to datacube v2 (user-relevant summary)

Indicator/Topic	V1 (initial geodatabase)	V2 (update)
Disturbance coverage	Disturbance layers available until 2021	Disturbance-related layers updated to extend through 2023, and a disturbance agent layer added.
Aboveground biomass	Earlier processing of biomass layers (ESA CCI Biomass v 5.1)	Multi-year biomass maps included (2010, 2015, 2022) and the 2020 biomass layer updated using the ESA CCI Biomass product v 6.
Timber volume	Not included in v1 set	Timber volume layer added (continuous indicator).

Indicator/Topic	V1 (initial geodatabase)	V2 (update)
Forest mask used for processing	Forest cover map prepared in v1	The 2020 forest cover map from v1 is retained and used as the forest mask to ensure consistency across layers, including v2 updates.

Source: ForestNavigator WP [2]

2.9.3. Key interpretation notes and caveats (cross-cutting)

1. Cross-cutting interpretation notes (all layers)
    - **Derived chart statistics:** Chart values are calculated by aggregating the selected indicator within the selected region. The aggregation method differs by indicator and is documented in Annexes (Table 3).
    - **Selected region vs download extent:** Downloadable rasters may extend beyond EU27, while chart summaries reflect the selected region (EU27 by default, unless changed by the user).
    - **Layer documentation:** Validation and limitation notes are provided for each layer in the "About data" panel.
2. Indicator-specific examples (non-exhaustive)
    - **Disturbance year:** shows cumulative disturbance, for clearer visualization and to reduce over-interpretation of year-by-year layers, we aggregate annual layers into cumulative disturbance periods from the 1985 baseline (1985 to 1990, 1985 to 1995, 1985 to 2000, 1985 to 2005, 1985 to 2010, 1985 to 2015, 1985 to 2020, 1985 to 2023).
    - **Continuous indicators (for example AGB, timber volume):** The "About data" panel includes a short summary of accuracy and where values may systematically over- or under-estimate.

3. Conclusion and next steps

Deliverable D9.2 documents the operational public release of the ForestNavigator Data Explorer, providing public access to harmonised WP2 forest indicators with integrated interpretation guidance and downloads. The key result is a documented, end-to-end workflow from exploration to reuse within a single interface.

The impact of this release on the project is twofold. First, it provides a functioning public interface for accessing harmonised forest indicators, supporting transparency and uptake beyond the consortium. Second, it establishes a consistent approach to publishing indicators with accompanying metadata, chart aggregation rules, and interpretation notes which can be extended as additional project outputs become available.

Further maintenance and extension of the Data Explorer will be led by the WP9 team at Climate Analytics, coordinated with IIASA for hosting. Priority actions include integrating additional indicators once they are formally published and cleared for public release by data providers (including indicators from the BOKU D2.2 dataset) and incorporating feedback from partners and early users to refine usability and documentation. In parallel, WP9 will continue coordination with other work packages to identify which additional outputs are suitable for publication through the Data Explorer, while modelling-derived outputs will be channeled through the Pathways Explorer as they mature.

Further work in this Research, Development and Innovation (RDI) area will focus on extending the published indicator catalogue, strengthening documentation and reproducibility of derived statistics, and preparing subsequent public updates of the Data Explorer as new datasets become available. This includes planned iterative releases aligned with partner publication timelines and project milestones, ensuring that the Data Explorer remains current, transparent, and useful for policy, research, and operational for users.

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5. Annexes

Table 3: Chart statistics and aggregation rules by indicator.

Indicator (portal layer)	Legend unit shown	Chart statistic shown	Chart unit
Forest Aboveground Biomass	Mg/ha	Average	Mg/ha
Forest Type	Categorical classes	Total area by class	million ha (Mha)
Forest Cover	adimensional	Total forest area	million ha (Mha)
Forest Cover Change	Classes (stable, loss, gain)	Total area by class	million ha (Mha)
Timber Volume	m^3/ha	Average	m^3/ha
Forest Fragmentation	adimensional	Average	million ha (Mha)
Natural Forests	adimensional	Total area by class	million ha (Mha)
Disturbance Agent	Categorical classes	Total disturbed area by agent	million ha (Mha)
Disturbance Year (cumulative periods)	adimensional	Total disturbed area per period	million ha (Mha)
Disturbance Fraction	adimensional	Average	million ha (Mha)
Forest Canopy Height	meter	Average	M (meter)
Forest Cover Fraction	adimensional	Average	million ha (Mha)
Forest Fragmentation Change	adimensional	Average	million ha (Mha)