

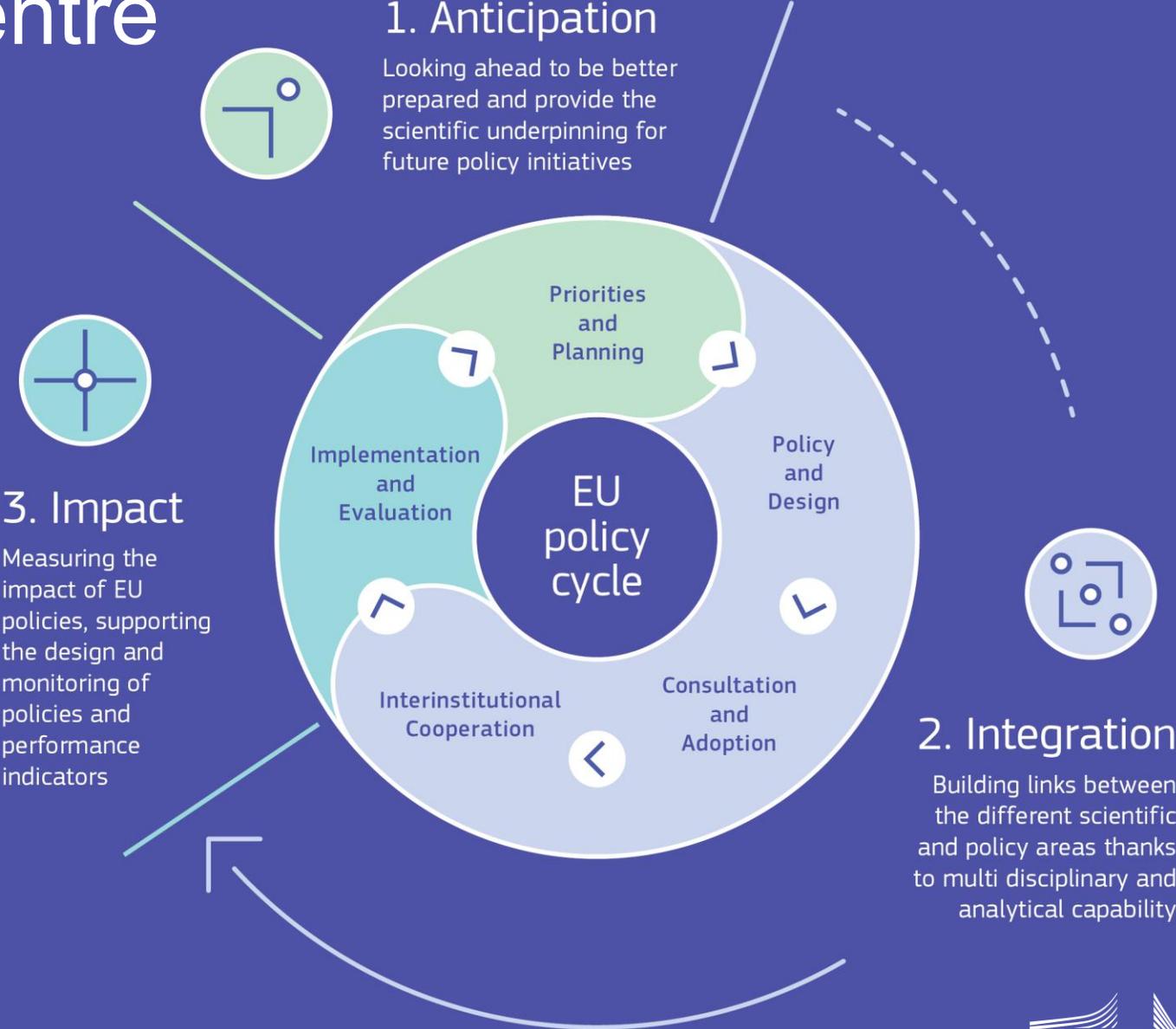
Monitoring changing landscapes: geospatial intelligence by crossing diverse data sets

Corentin Bolyn ¹, Kenji Ose ¹, Giovanni Caudullo ², Carlos Camino ¹, Rubén Valbuena ³, Jörgen Wallerman ³, Pieter S A Beck ¹

1. European Commission, Joint Research Centre (JRC)
2. ARCADIA SIT s.r.l., 27029 Vigevano (PV), Italy
3. Swedish University of Agricultural Sciences (SLU)

The Joint Research Centre

We do science for policy



About the JRC

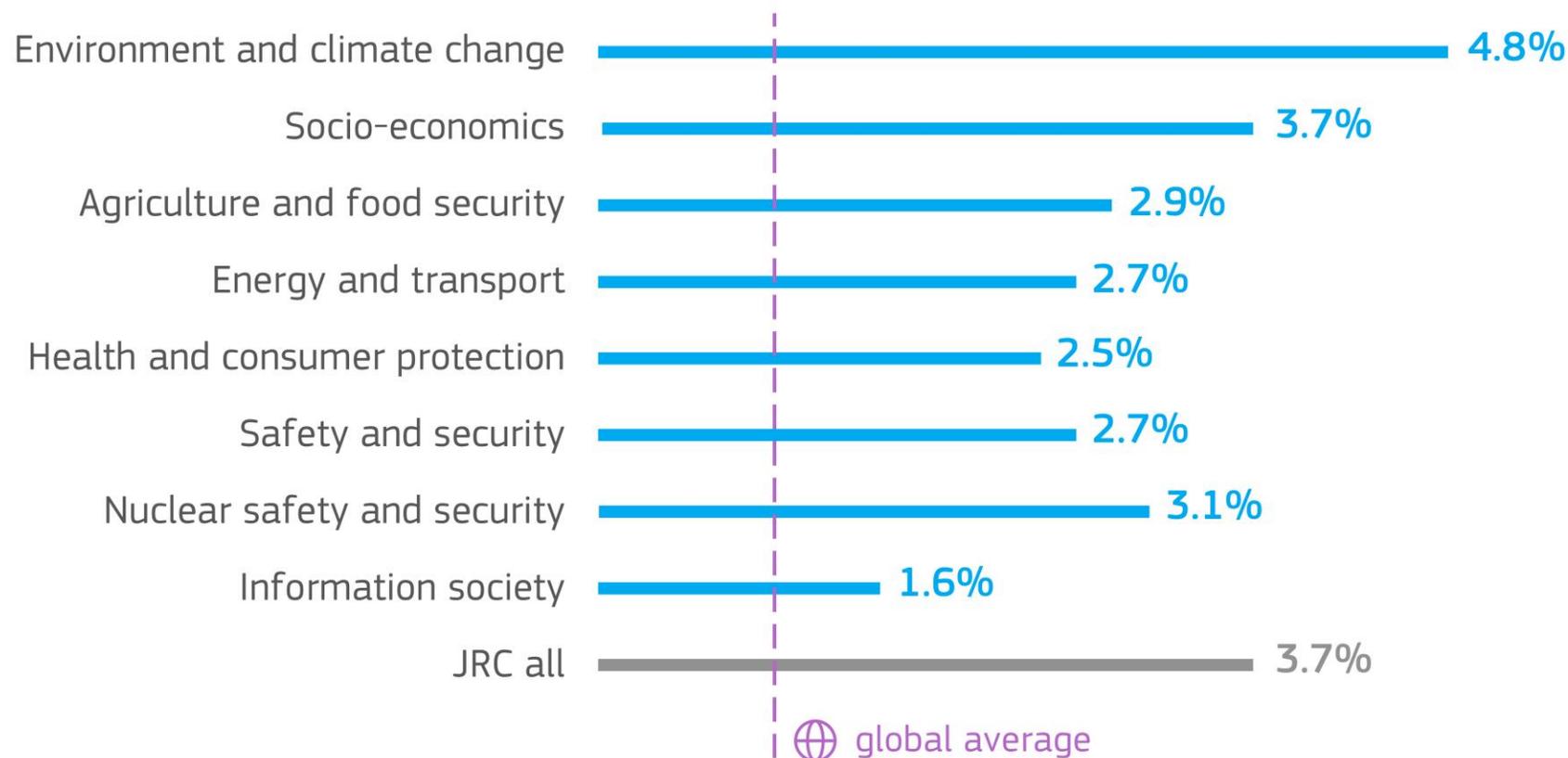
Headquarters in **Brussels**
and research facilities
located in **5 EU Countries**:

- Belgium (Geel)
- Germany (Karlsruhe)
- Italy (Ispra)
- The Netherlands (Petten)
- Spain (Seville)



We perform well across all of our research fields

Percentage of JRC publications among the globally most cited 1% (2018-2022)





COPERNICUS EMERGENCY MANAGEMENT SERVICE



People walking in a street full of mud following the floods of October 2024, Alfafar, Spain

© European Union, 2024

COPERNICUS EMERGENCY MANAGEMENT SERVICE



On-Demand Mapping



Wildfires



Floods



Droughts



Exposure Mapping



EMSR841 Flood in Vasternorrland County, Sweden

CLOSED

Products Viewer

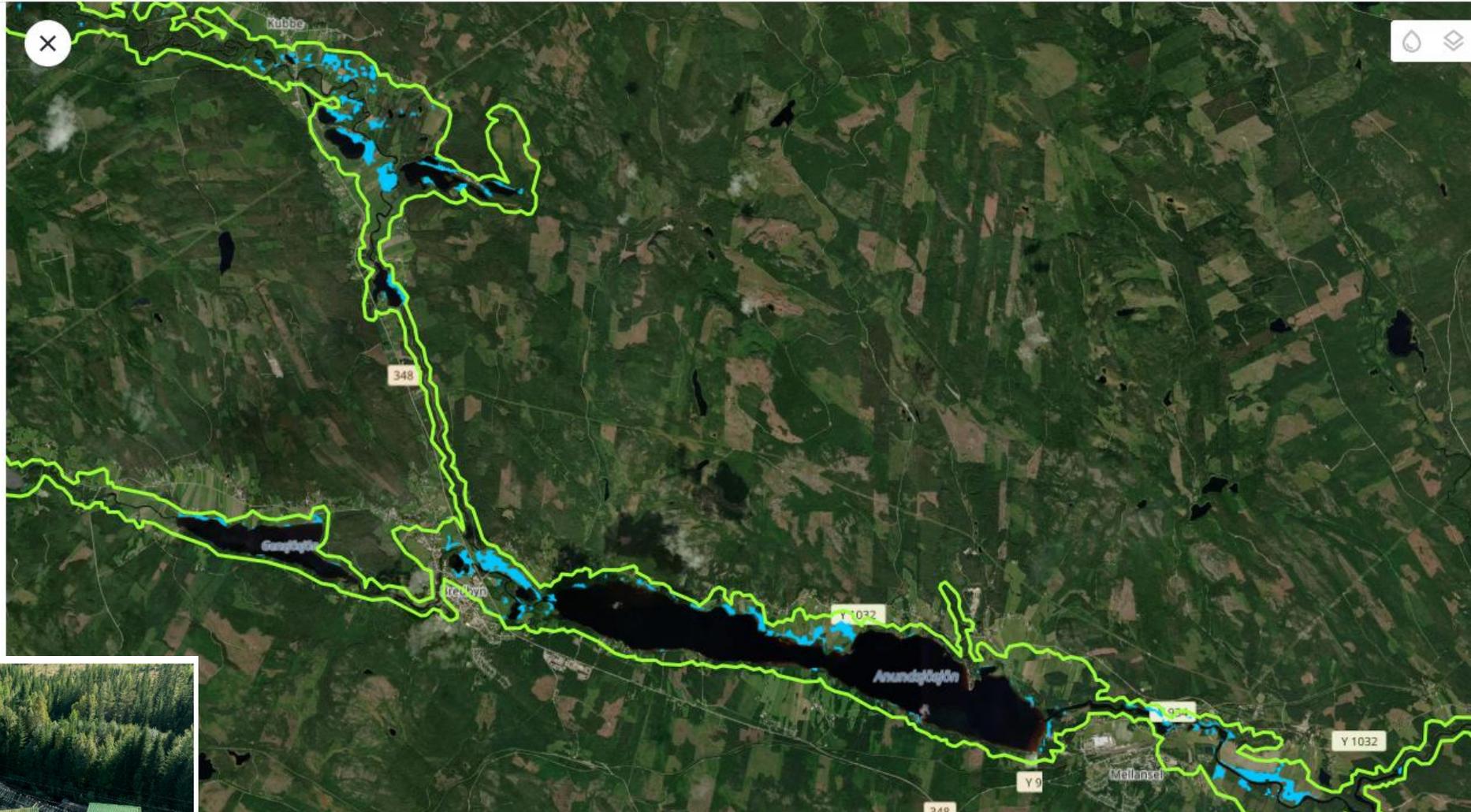
01 Gottne

- Delineation Monitoring 2
Completed (as of 15/09/2025, 05:06)
- Delineation Monitoring 1
Completed (as of 12/09/2025, 16:57)
- Delineation
Completed (as of 11/09/2025, 23:06)
- First Estimate
Completed (as of 10/09/2025, 16:14)



02 Bjasta

- Delineation
Not produced (as of 12/09/2025, 16:57)



Freight wagons derailed due to severe flooding (source: swedenherald)

A tool to provide geospatial intelligence in changing landscapes

- Geospatial intelligence by crossing diverse data sets
- Leverages information in a single web-interface
- For multiple applications – forests as an example

An example using the EU Habitats Directive

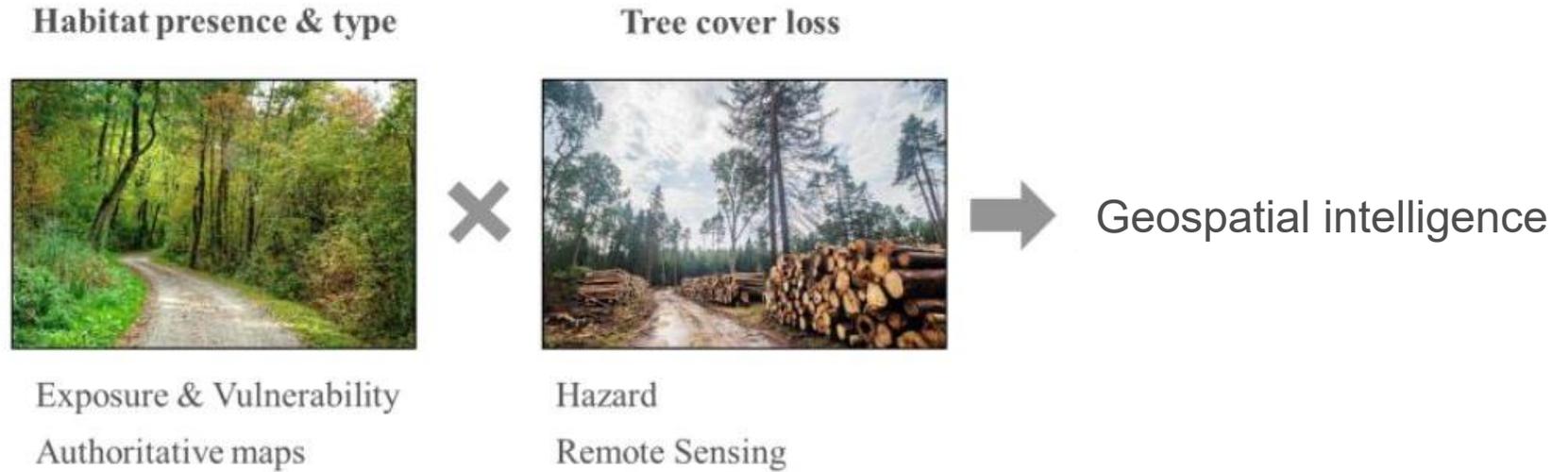
- Natura 2000 network
- Protected habitats listed in Annex I of the Habitats Directive



- **Habitat deterioration** shall be avoided
- **Monitor** habitats

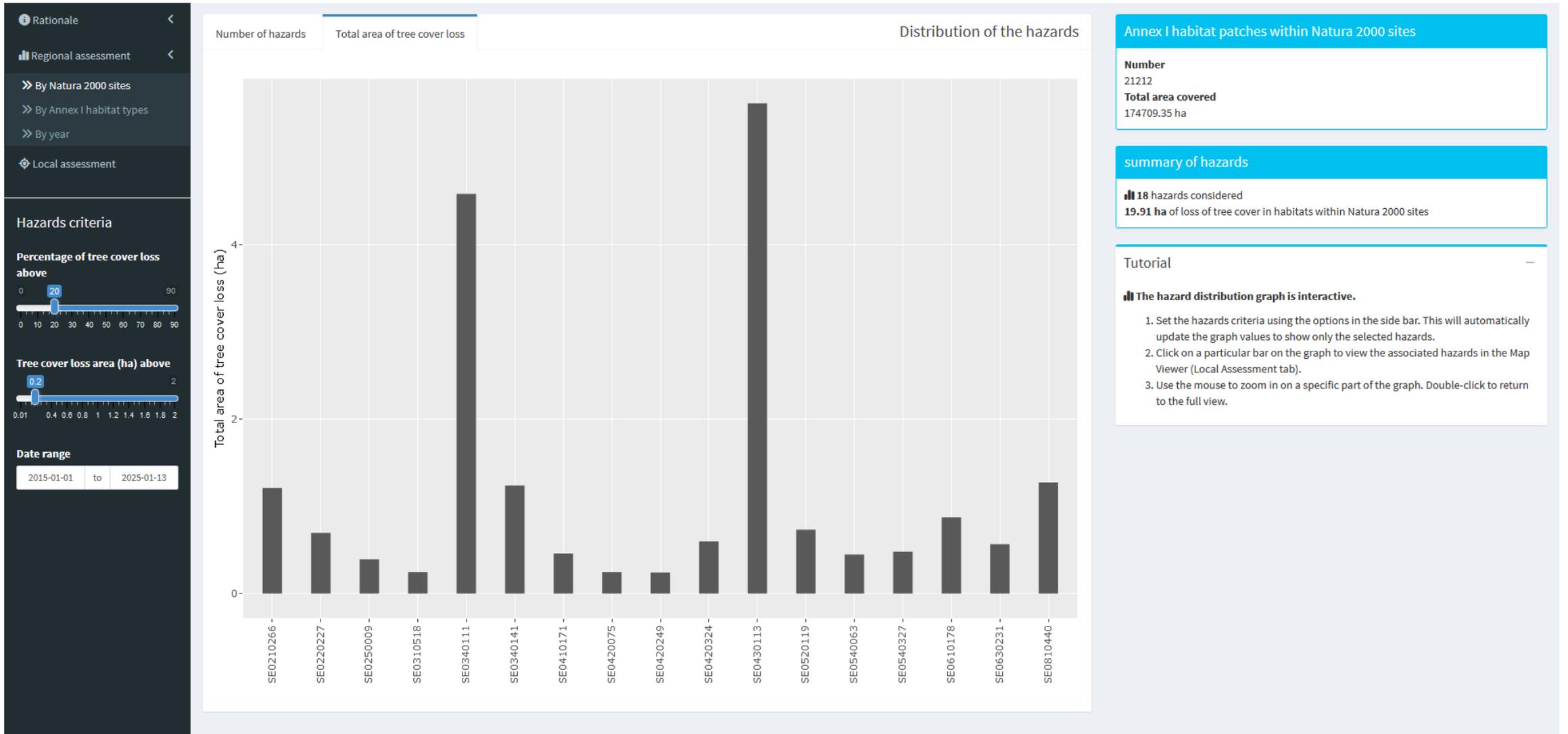
Hazards in forest habitats

- In protected forest habitats, tree cover loss can be considered a hazard to monitor



Aid interpretation

- A user-friendly web interface helps the user explore and assess hazards



- Rationale
- Local assessment
- Regional assessment
- By Annex I habitat types
- By Natura 2000 sites

Hazards criteria

Percentage of tree cover loss above

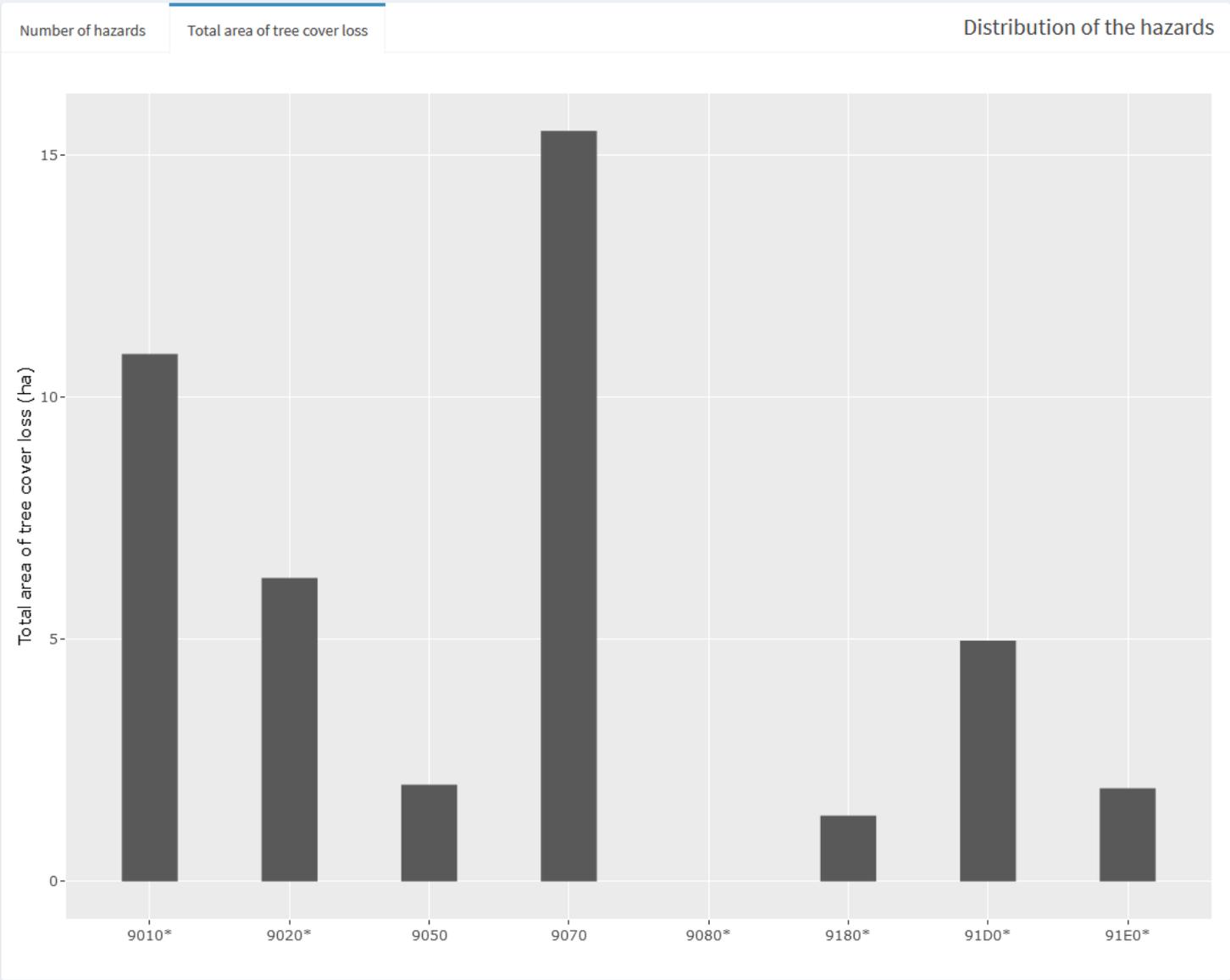
0 20 90

0 10 20 30 40 50 60 70 80 90

Tree cover loss area (ha) above

0.2 2

0.01 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2



Limit analysis to Natura 2000 sites

Natura 2000 site

Not restricted to Natura 2000

Annex I habitat patches

Number
16183

Total area covered
41559.39 ha

summary of hazards

45 hazards considered

42.9 ha of tree cover loss within habitats

Rationale <

Local assessment

Regional assessment <

Hazards criteria

Percentage of tree cover loss above

0 20 90

0 10 20 30 40 50 60 70 80 90

Tree cover loss area (ha) above

0.2 2

0.01 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2

Annex I habitat type code

Any

Natura 2000 site

Not activated

45 hazards to monitor

Map viewer

Map viewer

Map controls: +, -

Legend:

- CIR-NGR last view
- RGB before loss
- RGB after loss
- CHM before loss
- CHM after loss
- Historical map
- Natura 2000 sites
- Forest habitats
- Tree cover loss

Map scale: 50 m, 300 ft

Leaflet | Estonian geoportal

Select a hazard

Hazard number

2

Percentage of tree cover loss:

70 %

Area of tree cover loss (in Natura 2000):

3.86 (0) ha

Habitat patch properties related to the selected hazard

Annex I habitat code

91D0*

Conservation status

National level

EU level

Habitat patch area

5.48 ha

The boundaries of the habitat patch are shown in blue on the map.

Rationale <

Local assessment

Regional assessment <

Hazards criteria

Percentage of tree cover loss above

0 10 20 30 40 50 60 70 80 90

20

Tree cover loss area (ha) above

0.01 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2

0.2

Annex I habitat type code

Any

Natura 2000 site

Not activated

45 hazards to monitor

Map viewer

Map viewer

+

-

Maa-ammet

- CIR-NGR last view
- RGB before loss
- RGB after loss
- CHM before loss
- CHM after loss
- Historical map
- Natura 2000 sites
- Forest habitats
- Tree cover loss

50 m

300 ft

Leaflet | Estonian geoportal

Select a hazard

Hazard number

2

Percentage of tree cover loss:

70 %

Area of tree cover loss (in Natura 2000):

3.86 (0) ha

Habitat patch properties related to the selected hazard

Annex I habitat code

91D0*

Conservation status

National level

EU level

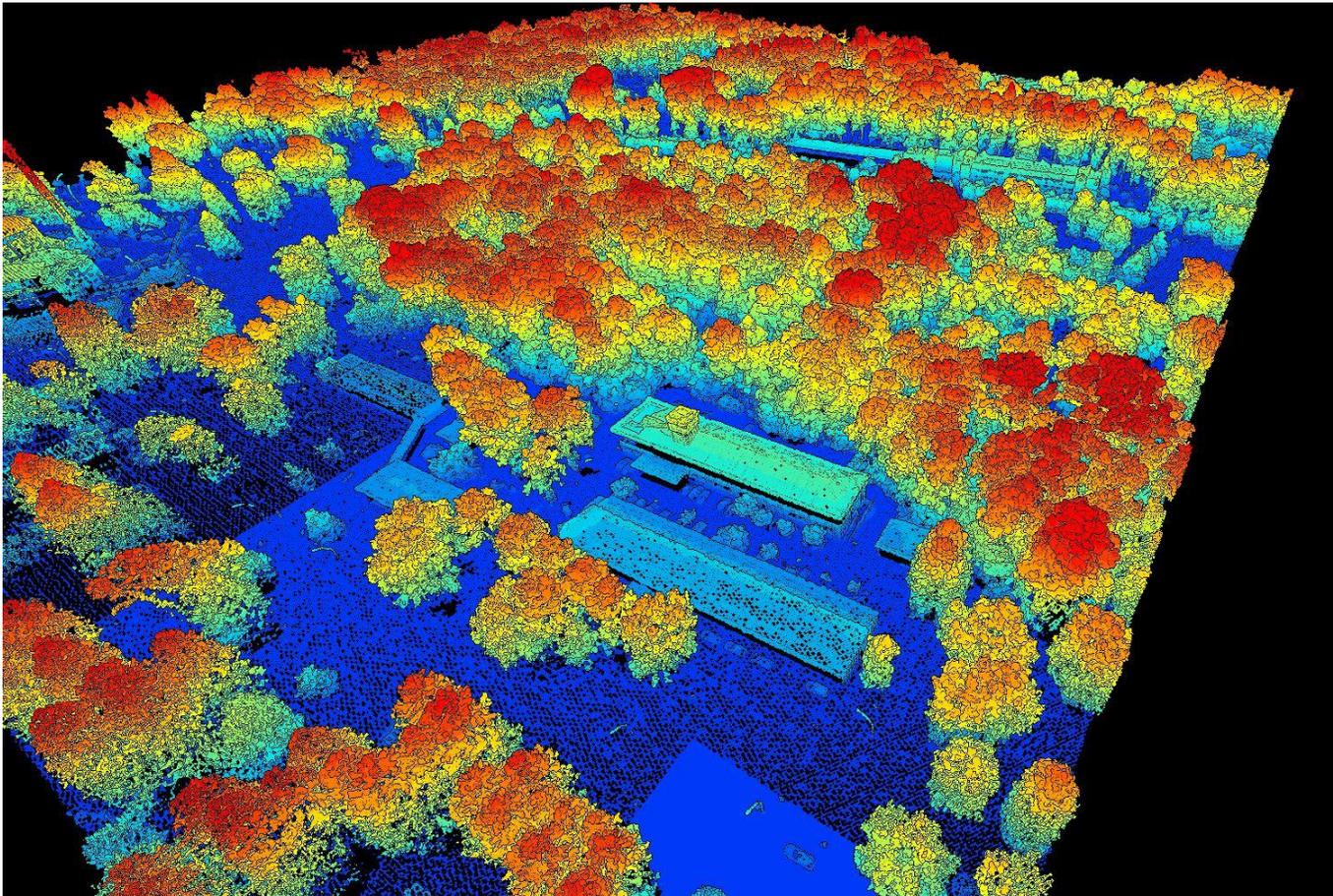
Habitat patch area

5.48 ha

The boundaries of the habitat patch are shown in blue on the map.

Complementarity of data sources

Spatial accuracy enabled by Airborne Laser Scanning (ALS)



- Bi-temporal ALS acquisition for change detection
- Sharp tree cover loss map
 - High spatial accuracy
 - High level of detail

Orthophoto

An aerial orthophoto showing a dense forested area. A prominent road or path runs horizontally across the upper middle of the image. The terrain is uneven, with various shades of green indicating different vegetation types and topography. Several irregularly shaped land parcels are outlined in black, suggesting a cadastral or planning map overlay. The overall scene is a mix of dense forest and open, possibly cleared or less vegetated areas.

- ia Ruumiamet

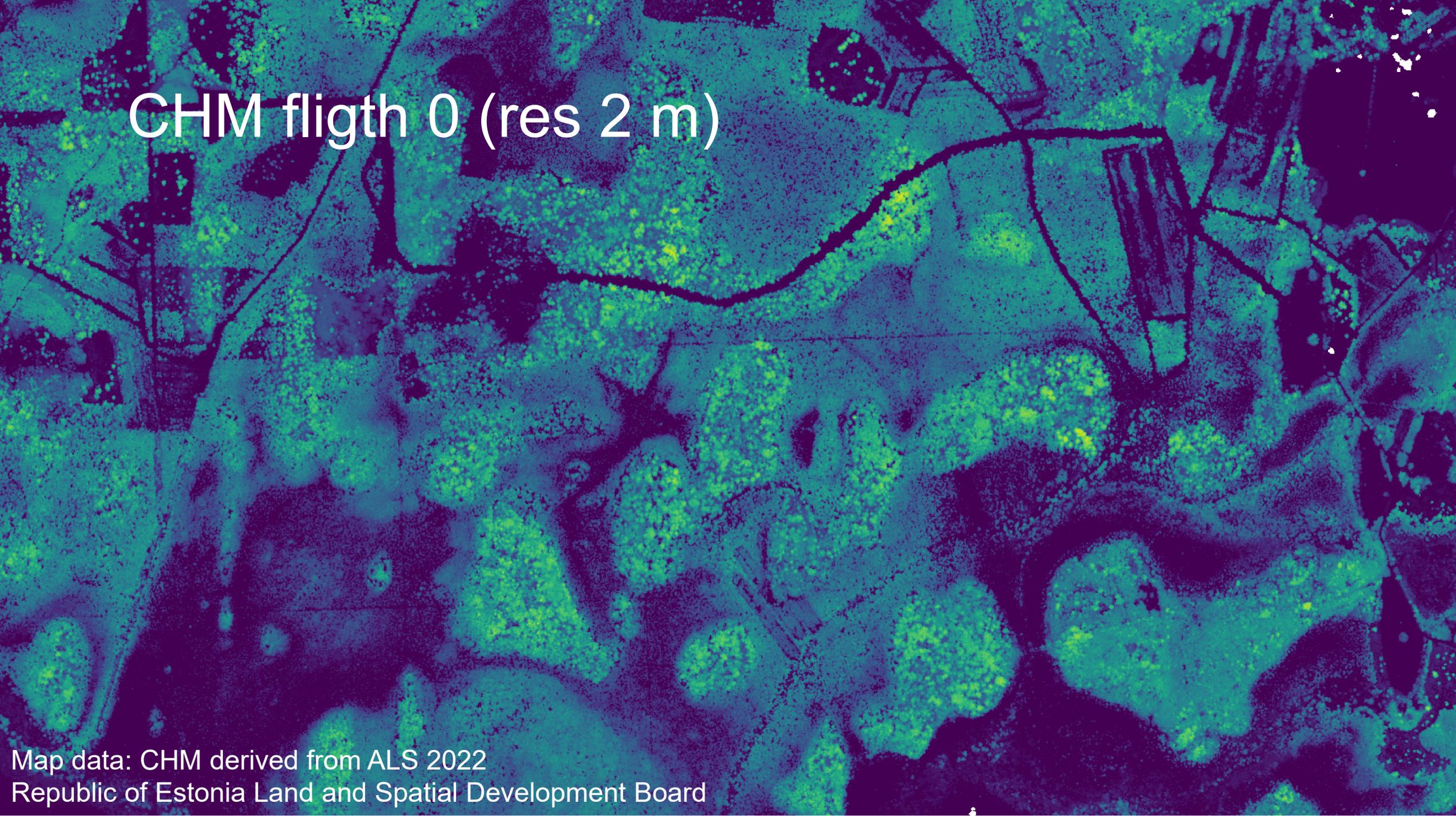
- ia Ruumiamet

Map data: orthophoto 2022
Republic of Estonia Land and Spatial Development Board

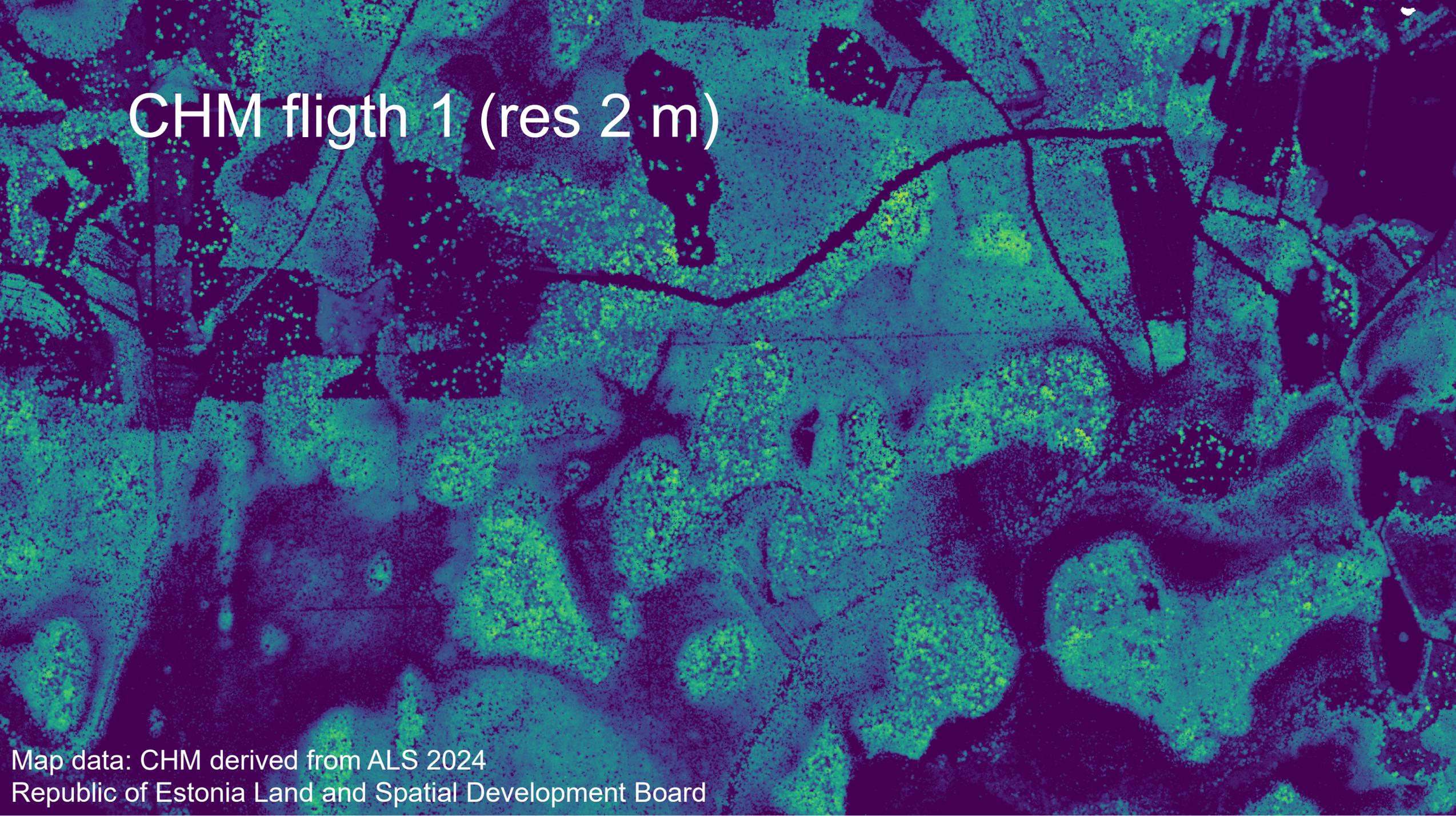
- ia Ruumiamet

- ia Ruumiamet

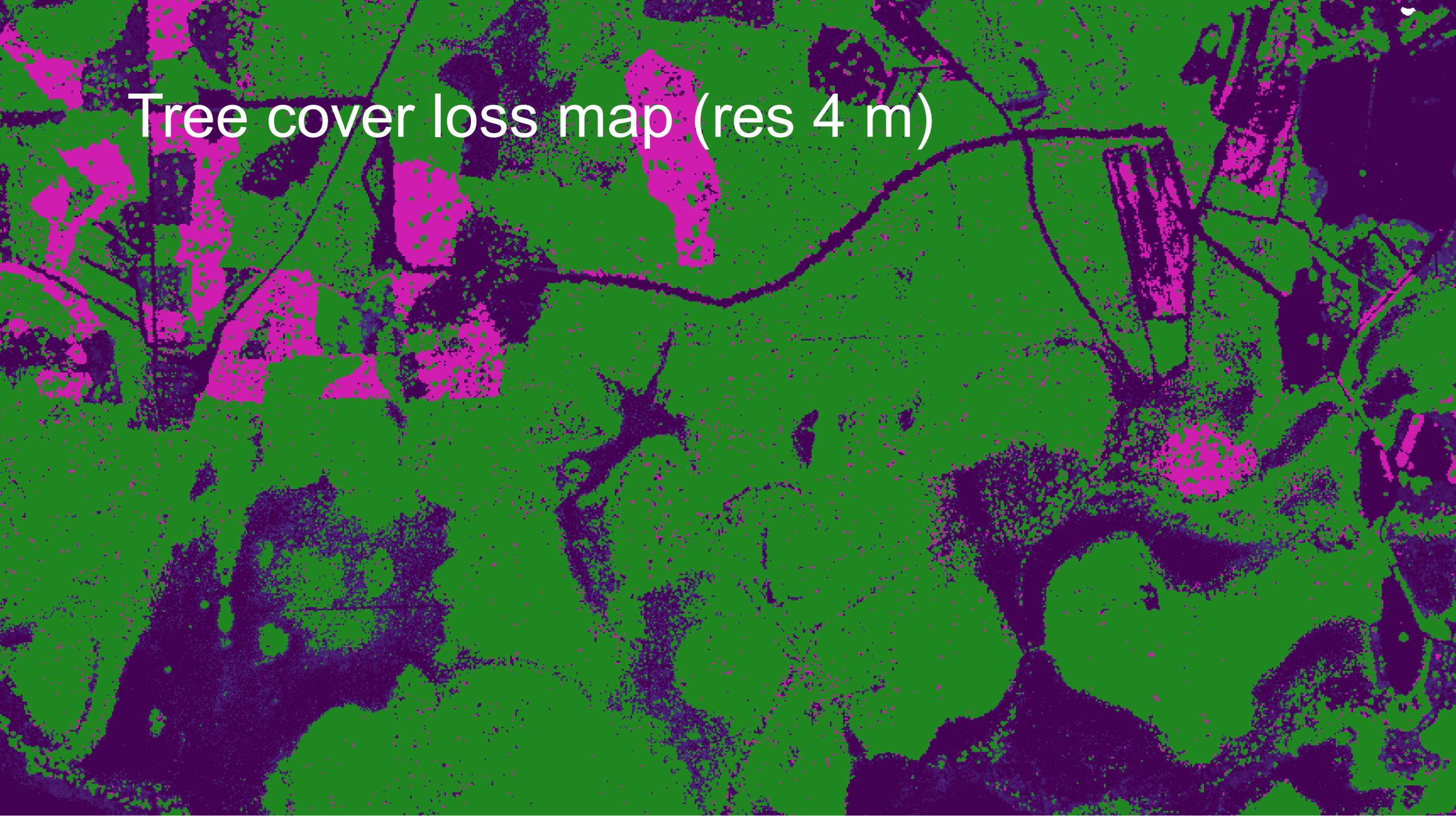
CHM flight 0 (res 2 m)

An aerial view of a forest with a red boundary line. The forest is dense with green trees. A red line runs across the forest, starting from the top left and curving towards the right. The line is approximately 2 meters wide. The forest is surrounded by a road and some buildings.

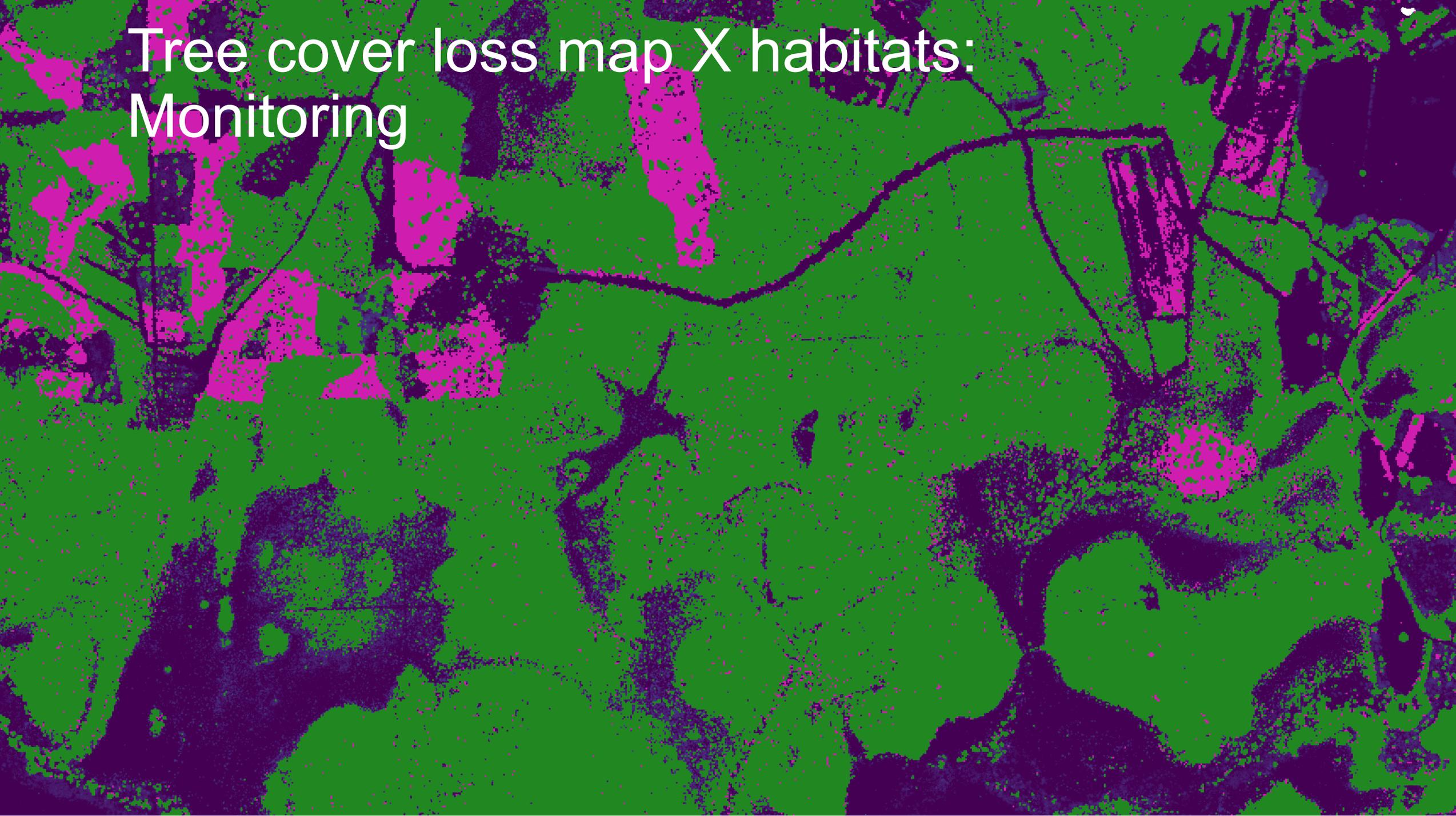
CHM flight 1 (res 2 m)

Aerial CHM map showing a forest with a road and a stream. The map is color-coded by elevation, with green representing lower elevations and yellow representing higher elevations. A road runs horizontally across the middle of the image, and a stream flows from the top right towards the bottom center. The forest canopy is visible as a textured surface with varying colors.

Tree cover loss map (res 4 m)



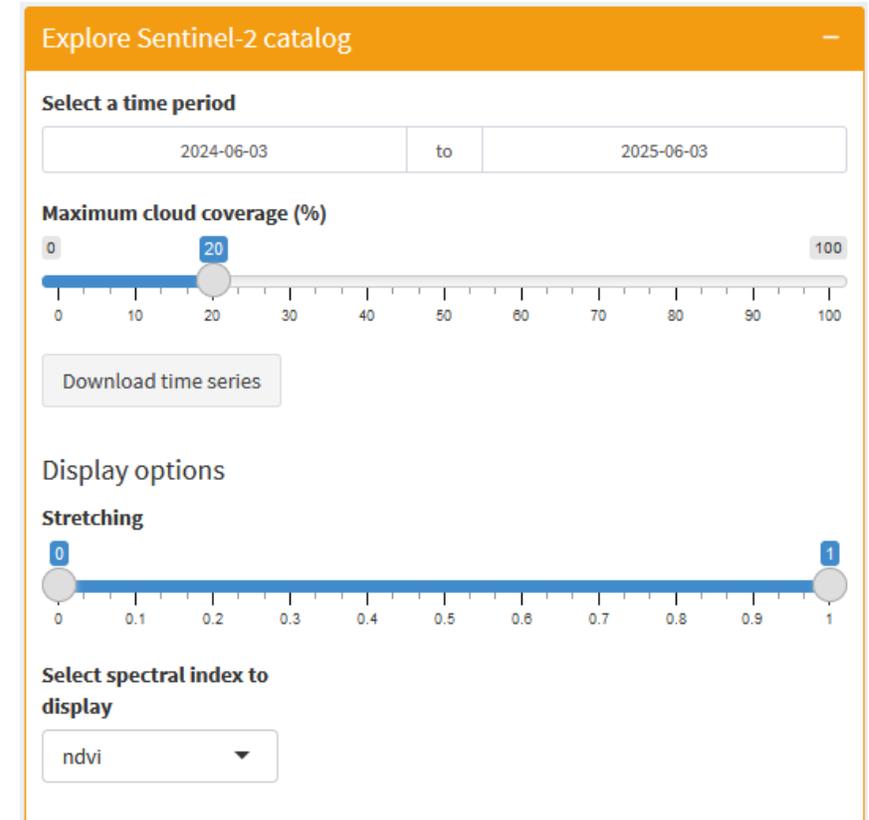
Tree cover loss map X habitats: Monitoring



Complementarity of data sources

Temporal accuracy enabled by satellite imagery

- SpatioTemporal Asset Catalogs (STAC) integrated into the GEOINT tool
- Embedded access to S2 online catalogues: upload and view images on demand



The screenshot displays the 'Explore Sentinel-2 catalog' interface. It features a search bar for a time period from 2024-06-03 to 2025-06-03. Below this is a slider for 'Maximum cloud coverage (%)' set to 20%. A 'Download time series' button is present. The 'Display options' section includes a 'Stretching' slider set to 1 and a 'Select spectral index to display' dropdown menu currently set to 'ndvi'.



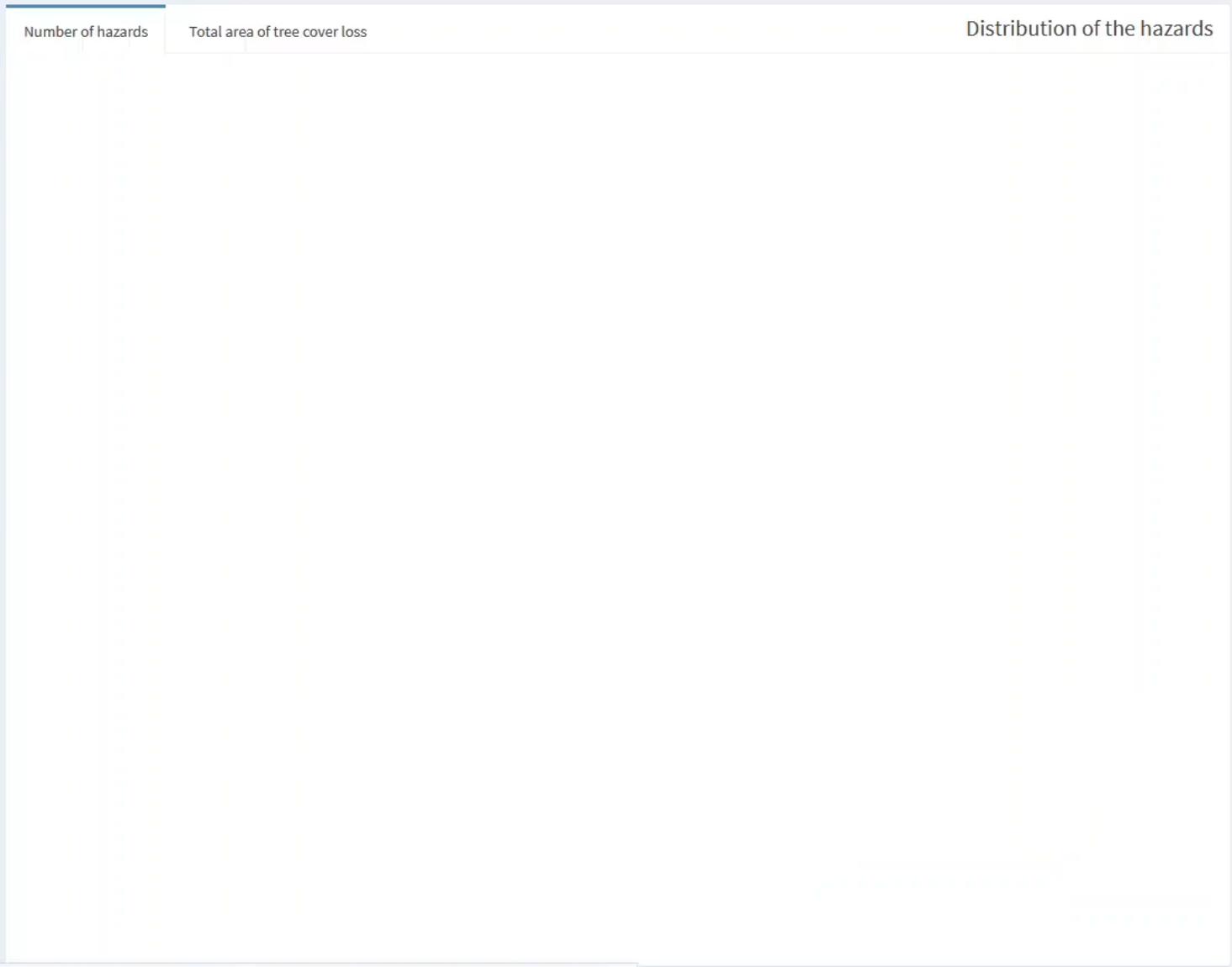
- Rationale
- Regional assessment
 - By Natura 2000 sites
 - By Annex I habitat types
- Local assessment

Hazards criteria

Percentage of tree cover loss above



Tree cover loss area (ha) above



Limit analysis to Natura 2000 sites

Natura 2000 site

Not restricted to Natura 2000

Annex I habitat patches

summary of hazards

Tutorial

The hazard distribution graph is interactive.

1. Set the hazards criteria using the options in the side bar. This will automatically update the graph values to show only the selected hazards.
2. Click on a particular bar on the graph to view the associated hazards in the Map Viewer (Local Assessment tab).
3. Use the mouse to zoom in on a specific part of the graph. Double-click to return to the full view.

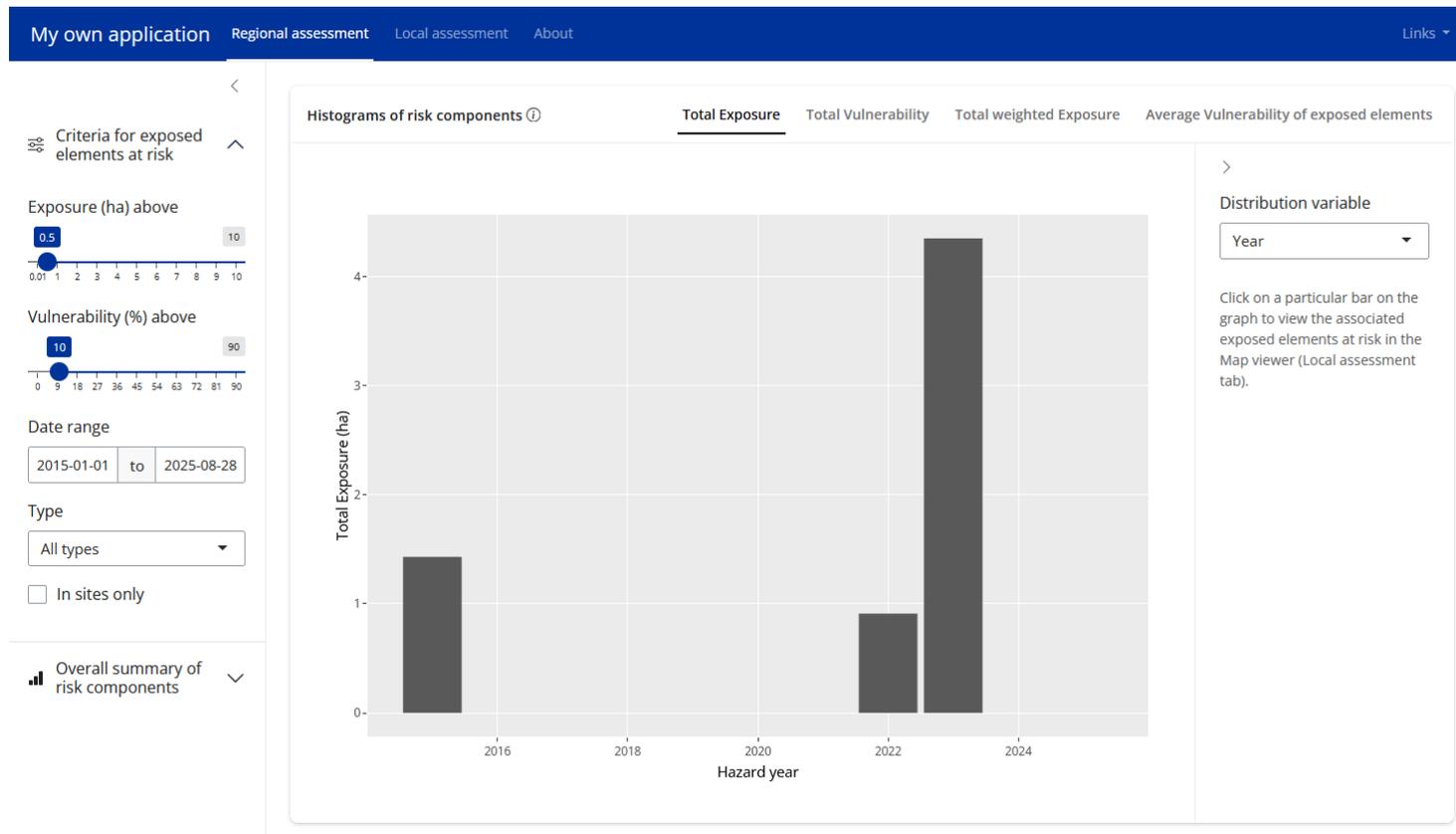
R-package under development

- Deploy the application using your own datasets

```
run_app(  
  title = "My own application",  
  elements_dsn = "user_element_path.fgb",  
  hazards_dsn = "user_hazards_path.fgb",  
  sites_dsn = "user_sites_path.fgb",  
  type = "label",  
  date = c("date_0", "date_1"),  
  site_name = "name",  
)
```

R-package under development

- Deploy the application using your own datasets



R-package under development

- Deploy the application using your own datasets

The screenshot displays the application interface with a dark blue header containing navigation links: "My own application", "Regional assessment", "Local assessment", and "About". A "Links" dropdown menu is visible in the top right corner.

Criteria for exposed elements at risk

- Exposure (ha) above: Slider set to 0.5 (range 0.01 to 10)
- Vulnerability (%) above: Slider set to 10 (range 0 to 90)
- Date range: 2015-01-01 to 2025-08-28
- Type: All types (dropdown)
- In sites only

Map viewer

The map shows a geographical area with labels for "Unione dei comuni del Medio Verbano", "Motta Pivione 256 m", "Ispra", "Monte dei Nassi 268 m", "Barza", "Cadrezzate", "Uponne", and "Barzola". A red location pin is placed on the map.

Map viewer controls:

- Display an exposed element:
- Select an element: element 1 (dropdown)
- Explore Sentinel-2 time series:
- Time period: 2026-03-10 to 2026-03-10
- Maximum cloud coverage (%): Slider set to 10 (range 0 to 100)
- Display time series: button

Selected element properties

- Exposure: 8.5 ha**
- Vulnerability: 6.2 %**
- Area: 1 ha
- Exposure within protected site: 0.2 ha
- Vulnerability within protected site: 89 %
- Hazard date: 2019-06-12
- Type: type b
- Protected site: site a

Overall summary of risk components

R-package under development

- Deploy the application using your own datasets
- Customize the application to your use case
- Get direct access to geospatial functions in R
- Open-source package

Thank you

PIETER.BECK@ec.europa.eu
CORENTIN.BOLYN@ec.europa.eu

