WELCOME

Wetlands *in action*

SESSION 6

Tools for Climate
Resilient Wetland Restoration

May 6th, 2026 | 10:00-11:30 (CEST) | Online

Speakers:

Jyrki Jauhiainen | Natural Resource Institute Finland, Luke – ALFAwetlands
Christoph Schroder | European Topic Centre for Spatial Analysis and Synthesis, University of Malaga – RESTORE4Cs
Anis Guelmami | Tour du Valat – RESTORE4Cs
Jaime Ribalaygua Batalla | Climate Research Foundation – REWET
Marta Stachowicz | Warsaw University of Life Sciences – WET HORIZONS
Alessandro Gimona | The James Hutton Institute – WET HORIZONS

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BASIC WEBINAR RULES

- **Please note that this session is being recorded and will be accessible via the Sister Projects' communication channels.**
- Use the **Q&A box** to post your **questions and comments**.
- If you have any **technical issues**, please contact the host privately via chat.

zoom

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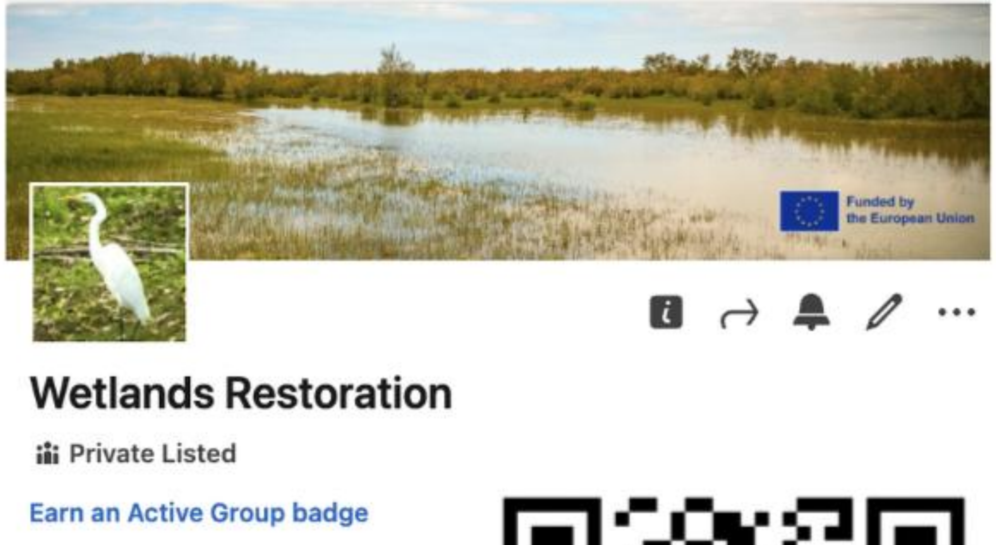
JOINT EFFORT OF 4 WETLAND RESEARCH SISTER PROJECTS

- Hub for wetlands restoration exchange (LinkedIn group)
- 4 Sister Projects admins
- Automatic joining



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RESTORE4Cs

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WET HORIZONS

WEBINAR AGENDA

- 10:00–10:05 – Introduction | **Madeira Scauri,** Restore4Cs
- 10:05–10:20 – Presentation + 5 min Q&A | **Jyrki Jauhiainen**, ALFAwetlands
- 10:20–10:35 – Presentation + 5 min Q&A | **Christoph Schröder & Anis Guelmami**, Restore4Cs
- 10:35–10:50 – Presentation + 5 min Q&A | **Jaime Ribalaygua Batalla**, REWET
- 10:50–11:05 – Presentation + 5 min Q&A | **Marta Stachowicz & Alessandro Gimona,** WET HORIZONS
- 11:05–11:20 – Wrap-up, next session announcement | **Madeira Scauri,** Restore4Cs
  Final feedback questionnaire| **Iryna Shchoka**, ALFAwetlands

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From Leaves to Litter: Measuring Aboveground Carbon Inputs and Losses in Wetland Soils

‘Guidance for assessing mass-based aboveground carbon inputs’

06 May, 2026

Jyrki Jauhiainen – Natural Resource Institute Finland, Luke – ALFAwetlands

Session 6: Tools for Climate-Resilient Wetland Restoration

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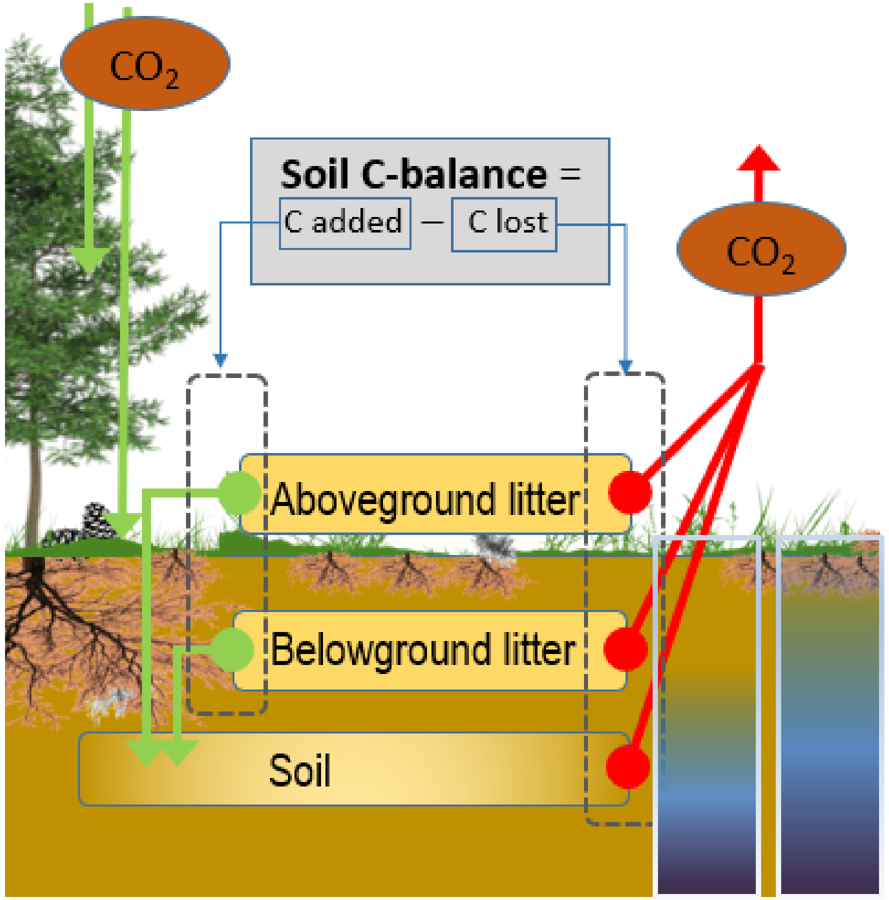
Background I

- Large stored organic soil carbon (C) makes wetlands long-term C sinks but vulnerable to becoming greenhouse gas (GHG) sources under changed conditions, e.g.,
  - Climatic
  - Hydrology
  - Land-use
- Accurate soil C balance require monitoring of both **C inputs and losses,** which are often similar in size annually



Background II

Most soil C balance studies combine manual chamber GHG flux measurements with estimates of litter C inputs

- Litter and root dynamics forming the soil carbon inputs is far less documented and is prone to greater methodological inconsistency and data gaps

- Methods for soil surface GHG flux measurements are well established due to large number of studies made since 1980's (monitoring frequency, spatio-temporal coverage still vary widely)

- Data availability is uneven across climate zones and notably poor for key processes such as litter production, litter decomposition, and root turnover (roots recently discussed by Freschet et al. (2021).
- Consequently, uncertainty increases in data analysis, integration of existing datasets, and forms a major limit for improvements beyond IPCC Tier 1 emission factors (e.g., Jauhiainen et al. 2019, 2023)

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Wetland vegetation communities are diverse

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Plant species, -heights, -growth forms, and abundance vary

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Our objective is to provide methods applicable across diverse wetland types in temperate and boreal climate regions

- We focus on procedures for the mass-based measurements needed for assessing the following aboveground C-stock components:
  - Understory and ground vegetation biomass and biomass production
  - Annual litter inputs (including woody debris from trees)
  - Aboveground litter decomposition

- Emphasis set for building guidance with
  - Flexibility to various vegetation community structures
  - Reasonable sampling effort (by setting ‘a fair minimum’)
  - Useful for different skill levels (students, technicians and researchers)
  - Flexibility as a guide to be followed ‘step by step’ or by ‘choosing between options’
  - Openness for further improvements

Foundation for this work is based on decades of field research experience, combined first as project-harmonized methods (Life OrgBalt and Horizon ALFAwetlands), and is now being further refined and expanded in manuscript form

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Approach for data collection

- Vegetation vertical structure (vegetation stratification) of **trees, understory**, and **ground vegetation** at the study site.
- **Plant functional types** (PFTs) represent groups of species sharing similar combinations of plant growth strategies, and thus exhibiting comparable ecological responses, such as in biomass formation and litter production.

In this report			**Plant growth forms used in Sloey et al. (2023)**
Vegetation vertical structure & (height)	**Plant functional type**	**Specification**	
Tree layer (>1.3 m) (*	Tree	A woody perennial plant with a single main stem (trunk) that typically grows tall and form tree layer. Can be deciduous or evergreen. Height over 1.3 meters.	Tree
Understory (0.5 -1.3 m) (*	Shrub	Shrubs & subshrubs in understory are woody plants (subshrubs woody only at the base) with multiple stems, usually shorter than trees. Can be deciduous or evergreen perennials. Height between c. 0.5 and 1.3 meters.	Shrub
	Subshrub		Subshrub
Ground vegetation (<0.5m)	Dwarf shrub	A small, low-growing woody plant with multiple stems. Height up to c. 0.5 meters.	
	Graminoid	Grass-like plants, including grasses, sedges, and rushes. Annuals or perennials.	Graminoid
	Forb	Herbaceous (non-woody) flowering plants that are not graminoids. Annuals or perennials.	Forb/Herb
	Fern	Vascular, spore-producing plants (pteridophytes) that do not fit into seed-plant categories. Most are perennial and may be deciduous, or partially or completely evergreen.	
	Moss (**	Non-vascular perennial plants that can form dense mats in moist habitats. Division to *Sphagnum* mosses and "other mosses" by growth form.	Non-vascular (***
-	-		Vine
-	-		Unspecified vascular

(* Most unambiguous division between trees and shrubs is based on the number of stems, and height threshold of 1.3 m is not a standard boundary between tree and shrub classification, but it is often used as a technical boundary in layer classification (ground vegetation / understory / tree layer).
(** Include mostly *Sphagnum* and other moss groups, e.g. 'forest mosses' and 'brown mosses'
(*** Assumed to be comparable to 'moss' in this report, e.g. liverworts and lichen, which can be treated as specific groups when they are abundant.

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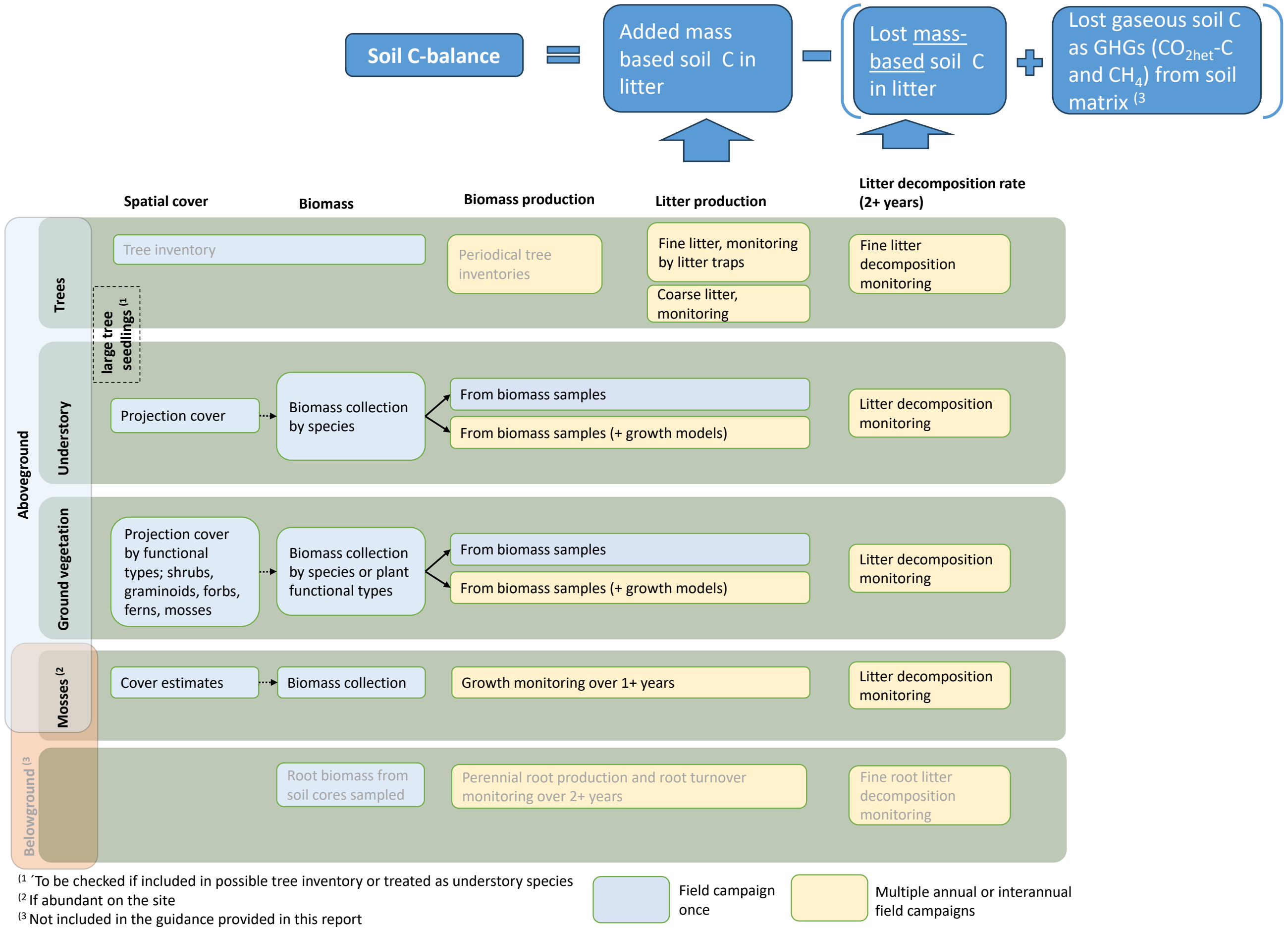
Approach for data collection

- Biomass data collection based on **vertical structure** – understory, ground vegetation, and moss layer biomass data harvest (tree litter production by litter traps)
- Biomass data collection based on **plant functional types** – shrubs, graminoids, forbs, ferns, mosses
- Timescales at data collection at field
  - 1x for most biomass data
  - Recurrent sampling events
    - Abundant moss cover sites, biomass production over 1 year (1x per year)
    - Tree litter deposition (monthly over 1 year)
    - Litter decomposition over 2-4 years (1x per year)



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Example: Summary of the field work and sample processing

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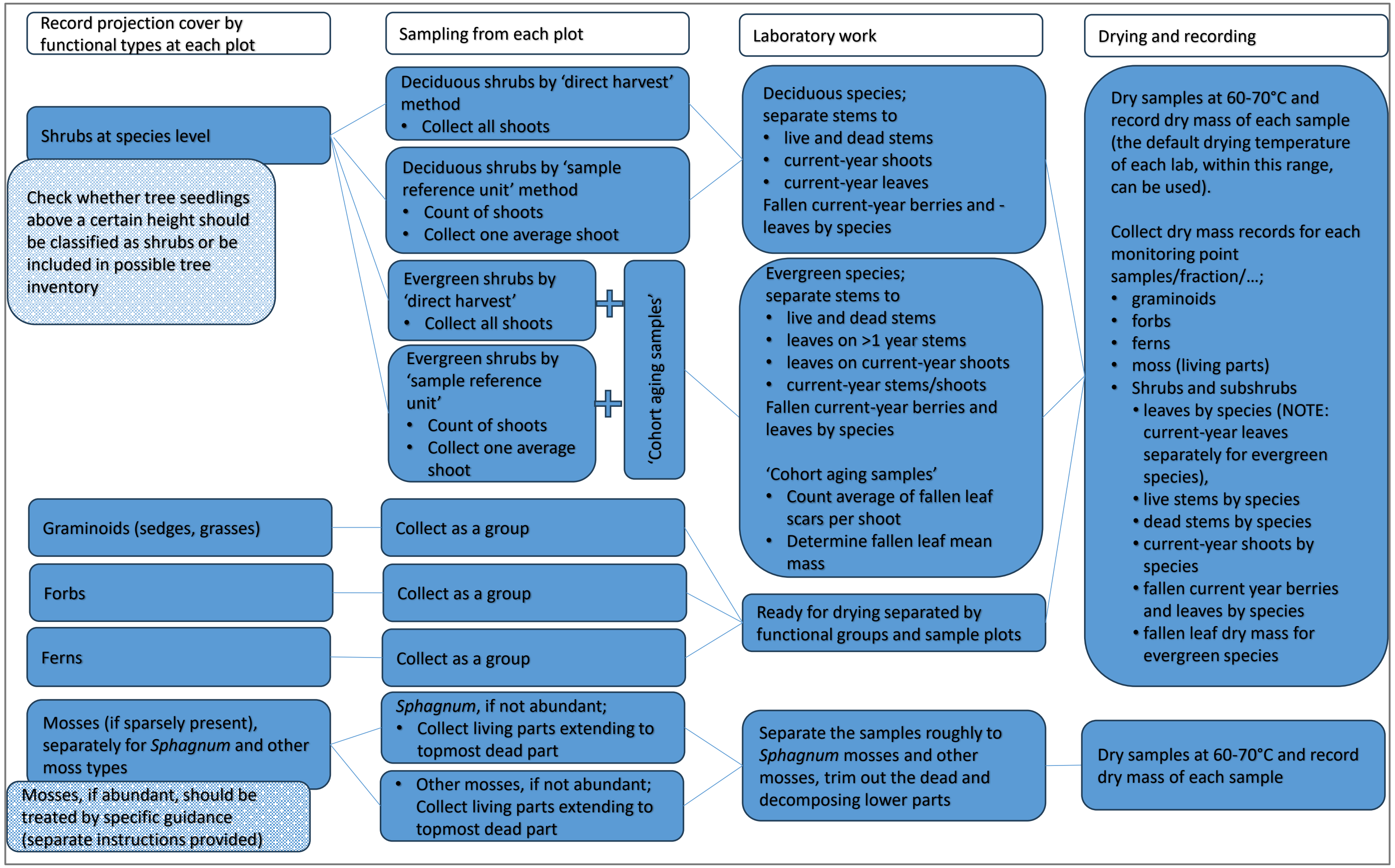

Guidance for aggregating specific sample fractions to derive biomass, annual biomass production and annual litter production by species or plant functional type, at both monitoring plot and site scales

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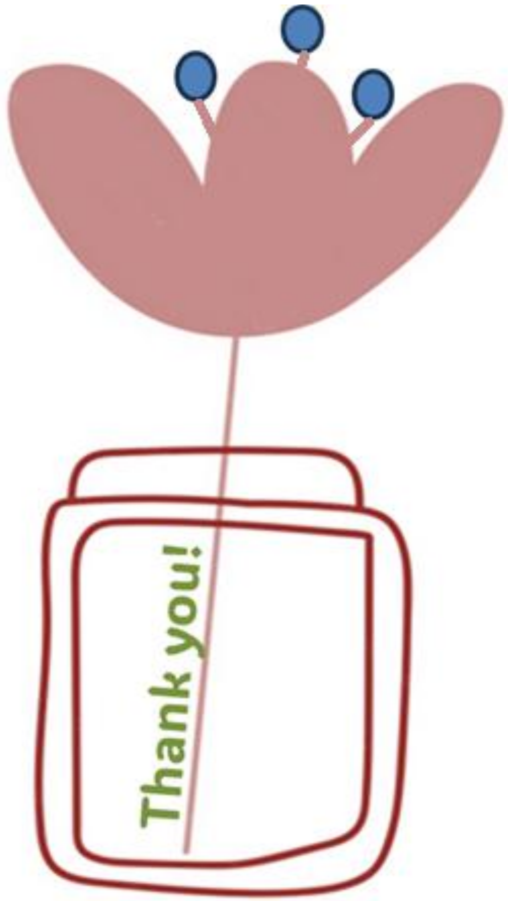
References

- Freschet, G.T., Pagès, L., Iversen, C.M., et al. (2021), A starting guide to root ecology: strengthening ecological concepts and standardising root classification, sampling, processing and trait measurements. New Phytologist, 232: 973–1122. https://doi.org/10.1111/nph.17572
- Jauhiainen, J., Alm, J., Bjarnadottir, B., et al. 2019. Reviews and syntheses: Greenhouse gas exchange data from drained organic forest soils – a review of current approaches and recommendations for future research. Biogeosciences, (16): 4687–4703, https://doi.org/10.5194/bg-16-4687-2019
- Jauhiainen, J., Heikkinen, J., Clarke, N. et al. 2023. Reviews and syntheses: Greenhouse gas emissions from drained organic forest soils – synthesizing data for site-specific emission factors for boreal and cool temperate regions, Biogeosciences, 20: 4819–4839. https://doi.org/10.5194/bg-20-4819-2023
- Sloey, T.M., Ellis, V.S., Kettenring, K.M. (2023). Using Plant Functional Traits to Inform Wetland Restoration. Wetlands, 43:92. https://doi.org/10.1007/s13157-023-01741-z



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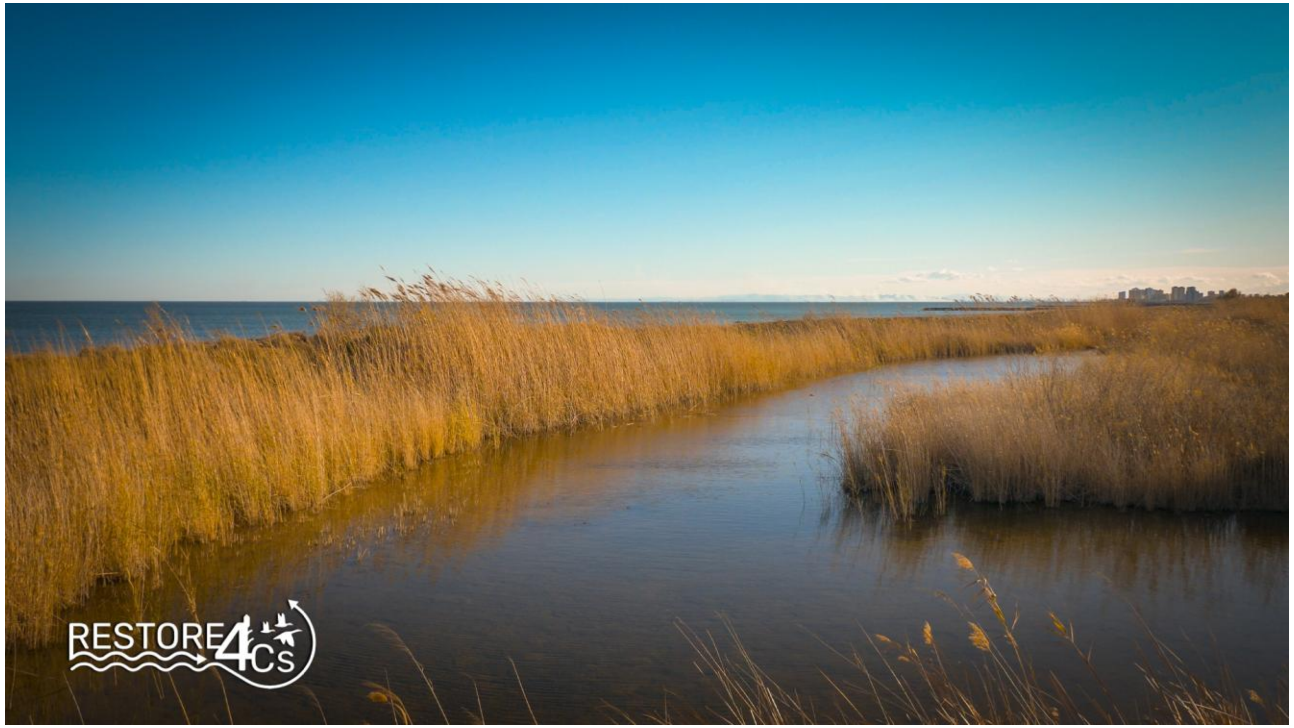
Q & A - 5 MINUTES

European Coastal Wetlands Interactive Platform

Anis Guelmami, Tour du Valat

Christoph Schröder, ETC – University of Malaga



“Wetlands in Action”

Tools for Climate-Resilient Wetland Restoration

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gather

upscale

integrate

- Remote Sensing Solution
- Wageningen Research
- Fondation Tour du Valat
- MedWet
- Vertigo Lab
- Universidade de Aveiro
- Universidad de Malaga
- Universitat de València
- Universitat de Barcelona
- Ecologic Institut
- Klaipeda University
- Wasser Cluster Lunz
- University of Bucharest
- Consiglio Nazionale delle Ricerche
- Università del Salento/ LifeWatch ERIC

RESTORE4Cs is a Horizon Europe project led by the **University of Aveiro**, which aims to evaluate the effect of **restoration actions on wetlands' ability to mitigate climate change** and provide various ecosystem services. The project's mission involves **collecting data** on the effectiveness of restoration and land use management, forming a **European Community of Practice (ECoP)** to support **new EU policies**, expanding models and **assessment tools** to broader geographical and ecological contexts, and designing a multi-actor approach for **stakeholder engagement**.

The project hopes to create a digital platform that serves as a **Decision Support System (DSS)** for stakeholders. This platform will provide **more accurate estimates of the costs and benefits of wetland restoration** efforts to help prioritize and promote them. Additionally, the project will investigate the **social acceptability of wetland restoration** to develop a transdisciplinary approach to wetland management that considers long-term sustainability. Overall, the RESTORE4Cs project presents a promising opportunity to preserve the **ecological, environmental, and social values** of wetlands while enhancing the well-being of local communities.

First and only information platform and toolbox dedicated to coastal wetland ecosystems.

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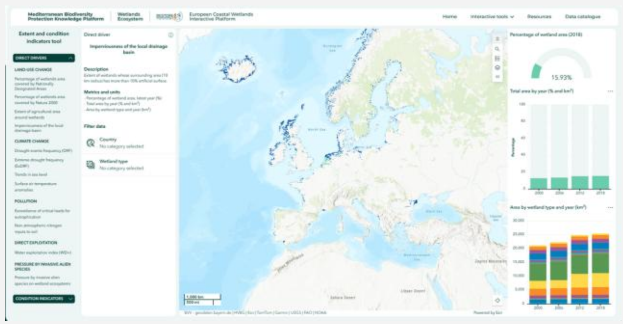
Main goals and design

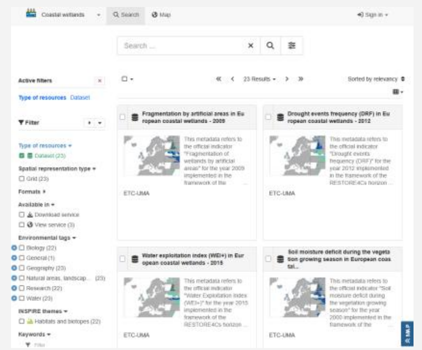
- To facilitate the **exploration and discoverability** (incl. visualisation and download) of spatially explicit data on coastal wetlands.
- To provide **access to and consultation of spatial indicators** (Policy Progress indicators and Extent and Condition Assessment indicators) through **targeted and comprehensive interactive dashboards**
- To support to the **spatial prioritisation and identification of restoration actions** across European coastal areas through an interactive decision-support system.

European Coastal Wetlands Interactive Platform



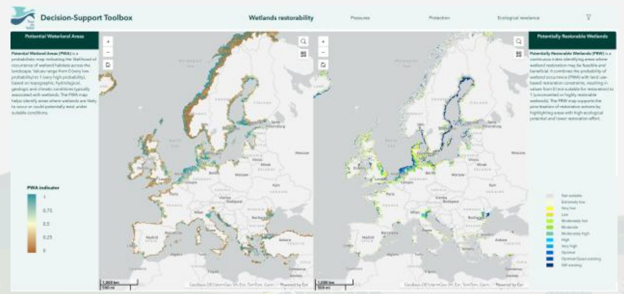
Interactive dashboards

Visualise and access indicator layers



Catalogue and metadata

Catalogue based on GeoNetwork



Toolbox

Decision-support tool

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Mediterranean Biodiversity Protection Knowledge Platform | Wetlands Ecosystem | RESTORE4Cs European Coastal Wetlands Interactive Platform

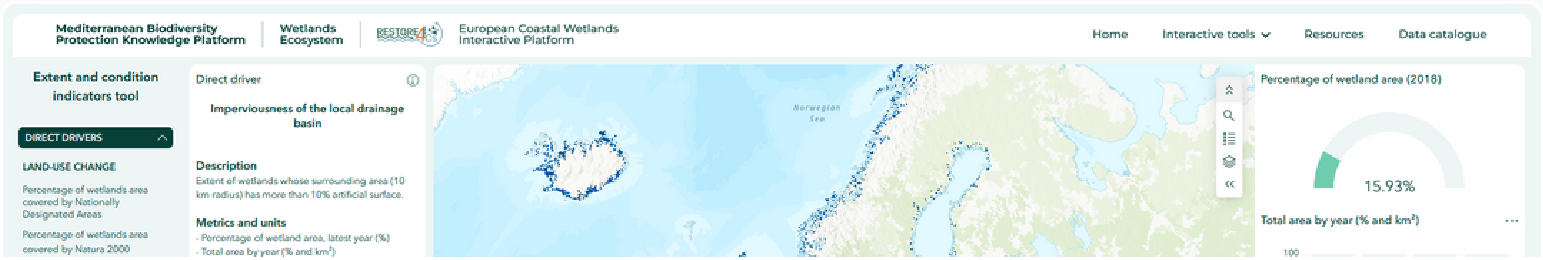
Home | Interactive tools | Resources | Data catalogue

European Coastal Wetlands Interactive Platform

Access interactive tools and spatial data to understand, monitor and support the conservation of coastal wetlands across Europe. From continent-wide insights to in-depth data from our six pilot sites, the platform is the Restore4Cs hub for evidence-based decision-making and research

Visit the RESTORE4Cs website for additional project information, news, events, results, etc., and stay connected and updated via social media

Explore the Interactive Platform



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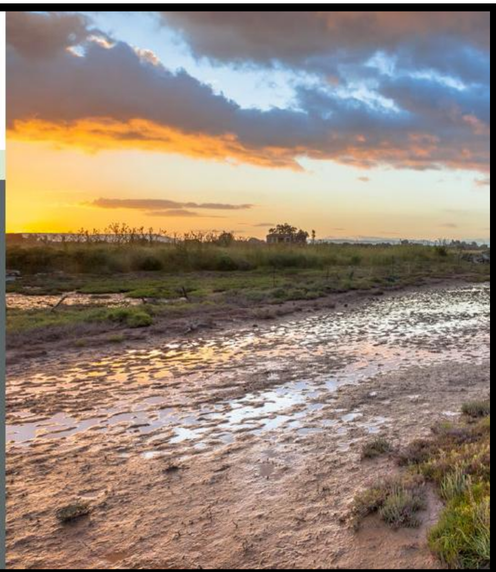
Home | Interactive tools | Resources | Data catalogue

POLICY BRIEF

European Coastal Wetland Indicators: A proposal for monitoring policy processes across space and time



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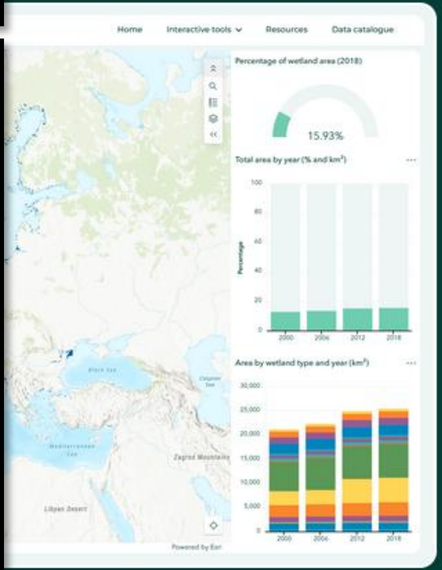
ETC UMA

Assessment of extent, state and GHG profile of European coastal wetlands



Indicators and data

Tools for tracking policy progress indicators and visualising spatial indicators

Policy progress indicators
Explore the monitoring dashboard for tracking policy progress through indicators and metrics, and find out the state of coastal wetlands in your country

Ecosystem extent and condition assessment indicators
Dashboard to explore and extract metrics at the national level by type of wetland

Information and access

Policy progress tracking tool

Policy progress indicator

Background paper
European Coastal Wetland Indicators: A proposal for monitoring policy progress across space and time

- **Extension of Coastal Wetlands Protected and Strictly Protected**
- Representativity of Coastal Wetland Habitats in Protected Areas
- Coastal Wetland Restoration Rate
- Vulnerability to Climate-Related and Natural Disasters
- GHG Emissions Abatement from Coastal Wetland Land Use Conversion and Restoration
- Share of Utilised Agricultural Area (UAA) under Supported CAP Commitments in Coastal wetlands
- Overall funding sources for coastal wetlands

Extension of Coastal Wetlands Protected and Strictly Protected

Metric	Units
1. Total coastal wetland extent in Protected Areas and in Strict Protected Areas	% / km²
2. Total coastal wetland extent in Natura 2000 sites	% / km²
3. Total coastal wetland extent designated as Ramsar and/in Natura 2000	% / km²
4. Total coastal wetland protected as a proportion of coastal wetlands	% / km²

Filter data

Country
Spain

Wetland type
No category selected

Include...

- (selected) All wetlands
- Only natural wetlands
- Only artificial wetlands

Esri, USGS | Instituto Geográfico Nacional, Esri, TomTom, Garmin, FAO, NOAA, USGS   Powered by Esri

Metric 1: wetland extent in Strict Protected Areas

1.04%
Area: 31.77 km²

Reference year: 2025

Metric 2: wetland extent in Natura 2000

60.63%
Area: 1,855.17 km²

Reference year: 2023

Metric 3: wetland extent as Ramsar and Natura 2000

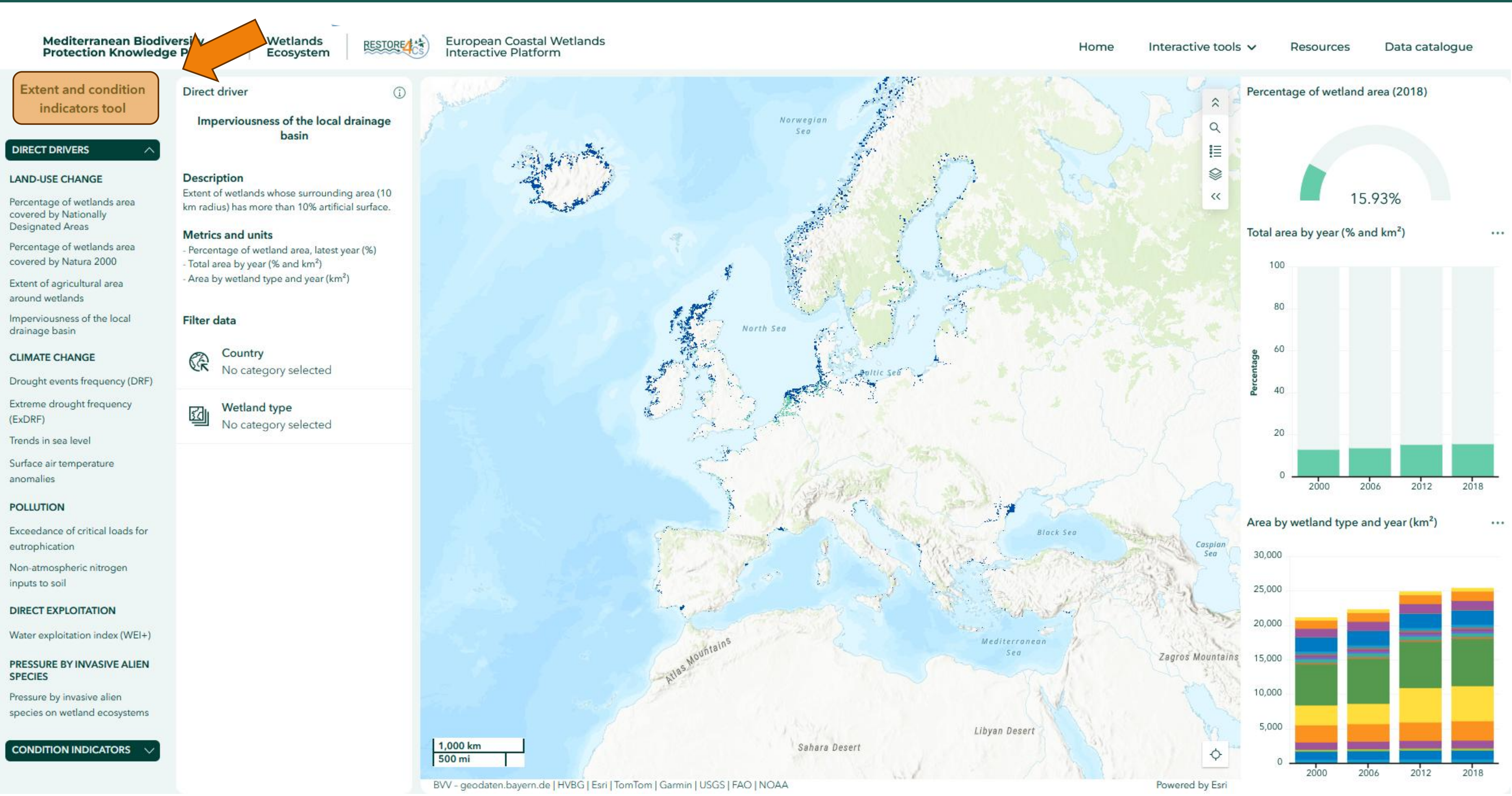
35.19%
Area: 1,076.73 km²

Reference year: 2025

Metric 4: coastal wetland protected

55.95%
Area: 1,711.71 km²

Reference year: 2024



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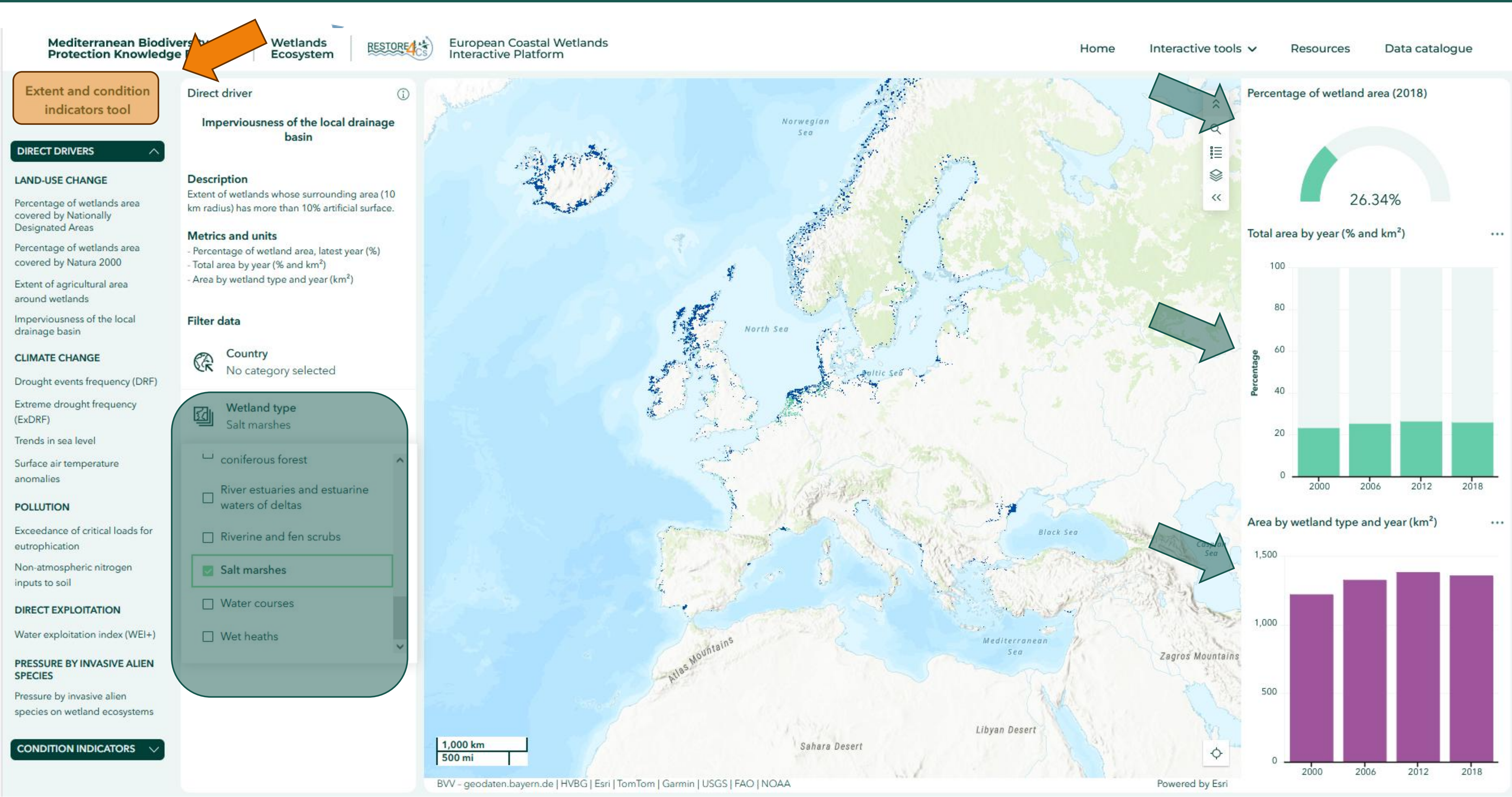
Data catalogue
Extent and condition indicators tool
DIRECT DRIVERS
LAND-USE CHANGE
Percentage of wetlands area covered by Nationally Designated Areas
Percentage of wetlands area covered by Natura 2000
Extent of agricultural area around wetlands
Imperviousness of the local drainage basin
CLIMATE CHANGE
Drought events frequency (DRF)
Extreme drought frequency (ExDRF)
Trends in sea level
Surface air temperature anomalies
POLLUTION
Exceedance of critical loads for eutrophication
Non-atmospheric nitrogen inputs to soil
DIRECT EXPLOITATION
Water exploitation index (WEI+)
PRESSURE BY INVASIVE ALIEN SPECIES
Pressure by invasive alien species on wetland ecosystems
CONDITION INDICATORS
Direct driver
Imperviousness of the local drainage basin
Description
Extent of wetlands whose surrounding area (10 km radius) has more than 10% artificial surface.
Metrics and units
- Percentage of wetland area, latest year (%)
- Total area by year (% and km²)
- Area by wetland type and year (km²)
Filter data
Country
No category selected
Wetland type
No category selected
Norwegian Sea
North Sea
Baltic Sea
Black Sea
Caspian Sea
Mediterranean Sea
Atlas Mountains
Zagros Mountains
Libyan Desert
Sahara Desert
1,000 km
500 mi
BVV - geodaten.bayern.de | HVBG | Esri | TomTom | Garmin | USGS | FAO | NOAA
Powered by Esri
Percentage of wetland area (2018)
15.93%
Total area by year (% and km²)
Percentage
100
80
60
40
20
0
2000
2006
2012
2018
Area by wetland type and year (km²)
30,000
25,000
20,000
15,000
10,000
5,000
0
2000
2006
2012
2018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Protection Knowledge
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Filter data
Country
No category selected
Wetland type
Salt marshes
coniferous forest
River estuaries and estuarine waters of deltas
Riverine and fen scrubs
Salt marshes
Water courses
Wet heaths
Norwegian Sea
North Sea
Baltic Sea
Black Sea
Caspian Sea
Mediterranean Sea
Atlas Mountains
Zagros Mountains
Libyan Desert
Sahara Desert
1,000 km
500 mi
BVV - geodaten.bayern.de | HVBG | Esri | TomTom | Garmin | USGS | FAO | NOAA
Powered by Esri
Percentage of wetland area (2018)
26.34%
Total area by year (% and km²)
Percentage
100
80
60
40
20
0
2000
2006
2012
2018
Area by wetland type and year (km²)
1,500
1,000
500
0
2000
2006
2012
2018

European Coastal Wetlands Interactive Platform

Access interactive tools and spatial data to understand, monitor and support the conservation of coastal wetlands across Europe. From continent-wide insights to in-depth data from our six pilot sites, the platform is the Restore4Cs hub for evidence-based decision-making and research

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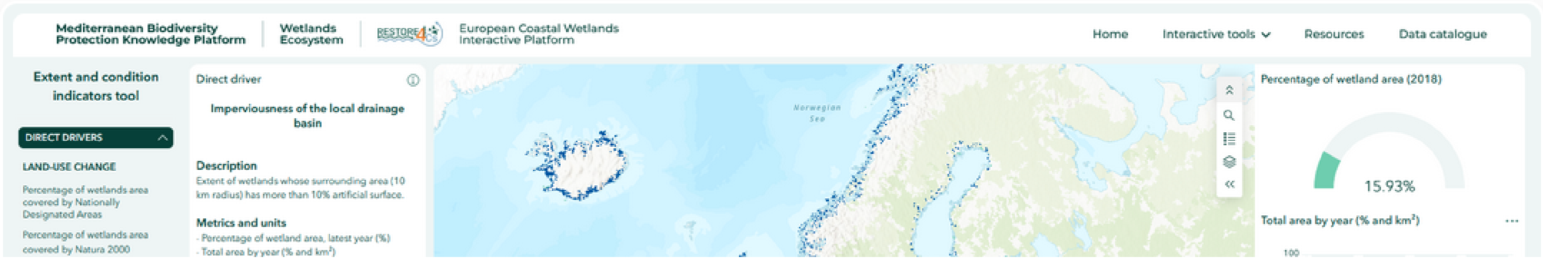
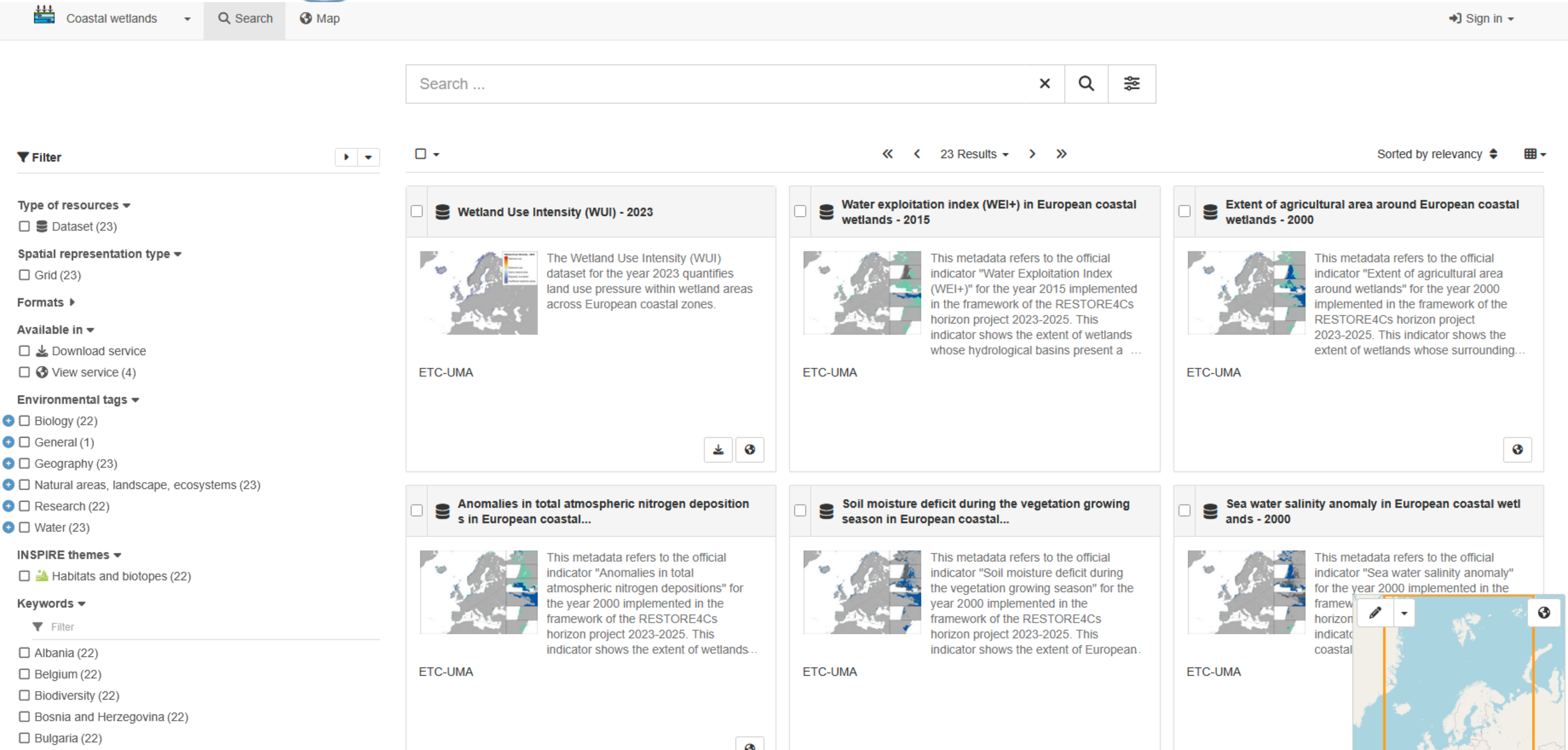
Explore the Interactive Platform



Interactive Online Platform (ETC-UMA)

Data Catalogue



Interactive Online Platform (ETC-UMA)

Data Catalogue

Coastal wetlands | Search | Map | Sign in

Search ...

Filter

Type of resources
- ☐ Dataset (23)

Spatial representation type
- ☐ Grid (23)

Formats

Available in
- ☐ Download service
- ☐ View service (4)

Environmental tags
- ☐ Biology (22)
- ☐ General (1)
- ☐ Geography (23)
- ☐ Natural areas, landscape, ecosystems (23)
- ☐ Research (22)
- ☐ Water (23)

INSPIRE themes
- ☐ Habitats and biotopes (22)

Keywords

Filter

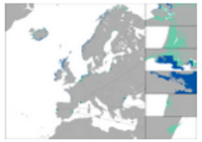
- ☐ Albania (22)
- ☐ Belgium (22)
- ☐ Biodiversity (22)
- ☐ Bosnia and Herzegovina (22)
- ☐ Bulgaria (22)

Wetland Use Intensity (WUI) - 2023

The Wetland Use Intensity (WU dataset for the year 2023 quan land use pressure within wetla across European coastal zone

ETC-UMA

Anomalies in total atmospheric nitrogen dep s in European coastal...



This metadata refers to the off indicator "Anomalies in total atmospheric nitrogen depositi the year 2000 implemented in framework of the RESTORE4C horizon project 2023-2025. Th indicator shows the extent of w

ETC-UMA

Wetland Use Intensity (WUI) - 2023

The Wetland Use Intensity (WUI) dataset for the year 2023 quantifies land use pressure within wetland areas across European coastal zones.

Each raster is provided in GeoTIFF format at 10 m spatial resolution, in Lambert Azimuthal Equal Area projection (EPSG:3035), tiled to the EEA 100 km reference grid. These data sets are provided in three layers that show the wetland use intensity within the boundaries of 1. EEA's Extended Wetland Ecosystems Layer, 2. RAMSAR Sites and 3. ALFAwetlands' European Wetland Map.

The dataset supports monitoring of land use pressures on wetlands, restoration planning, and policy indicator development within the RESTORE4Cs framework. RESTORE4Cs is funded by the European Union under Horizon Europe.

Temporal extent

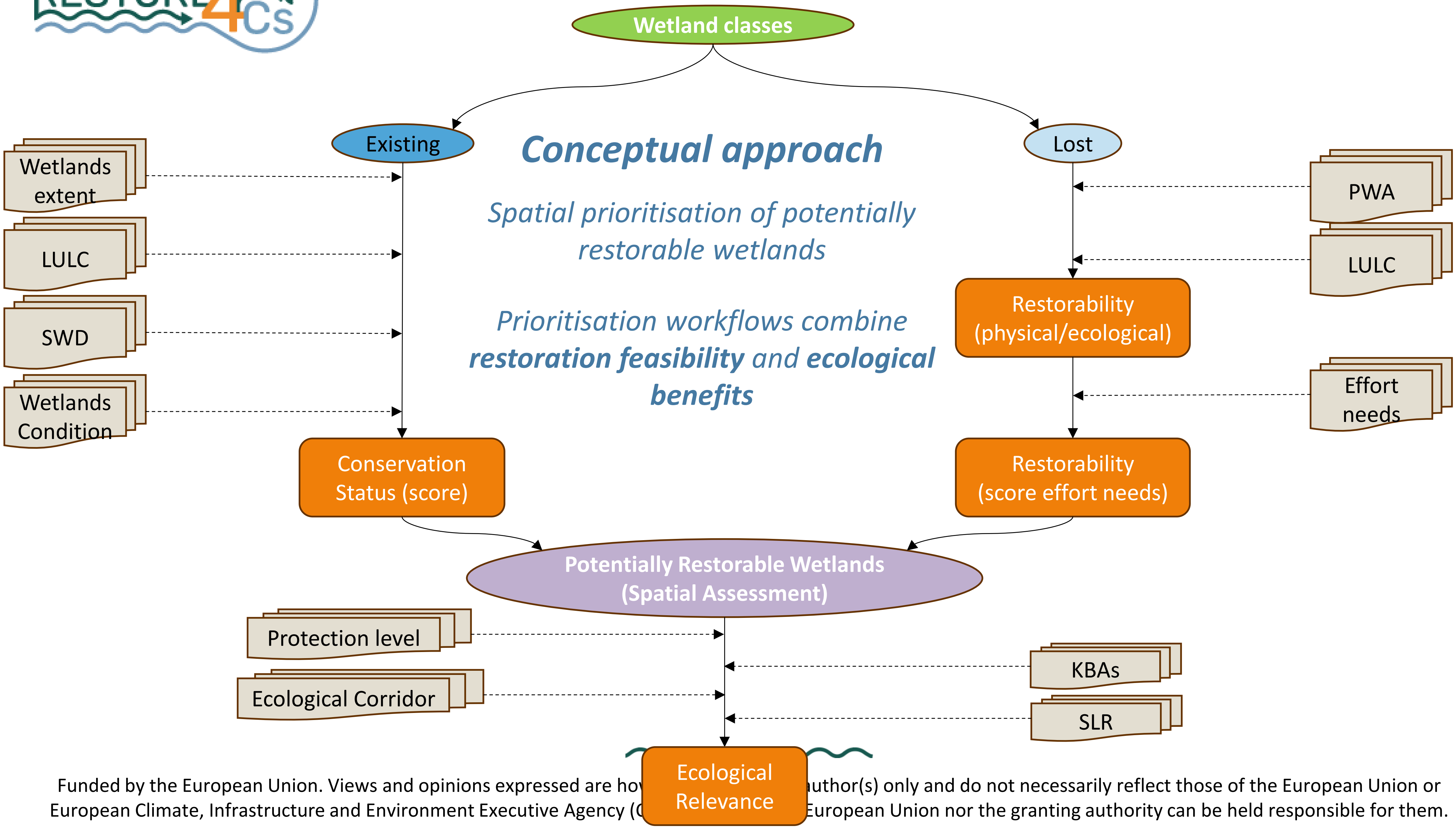
31-12-2022 ➞ 30-12-2023

Environment | Inland water | Wetland

Discover data

EEA39

Decision-Support Toolbox (TdV)



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Decision-Support Toolbox (TdV)

Mediterranean Biodiversity Protection Knowledge Platform | Wetlands Ecosystem | RESTORE4Cs European Coastal Wetlands Interactive Platform

Home | Interactive tools | Resources | Data catalogue

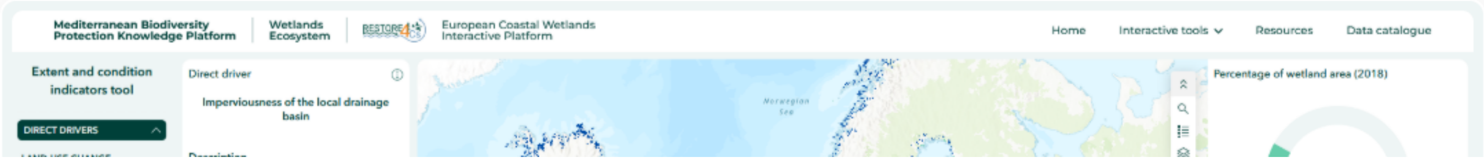
- Decision-support toolbox
  - Toolbox
- Data and indicators

European Coastal Wetlands Interactive Platform

Access interactive tools and spatial data to understand, monitor and support the conservation of coastal wetlands across Europe. From continent-wide insights to in-depth data from our six pilot sites, the platform is the Restore4Cs hub for evidence-based decision-making and research

Visit the RESTORE4Cs website for additional project information, news, events, results, etc., and stay connected and updated via social media

Explore the Interactive Platform



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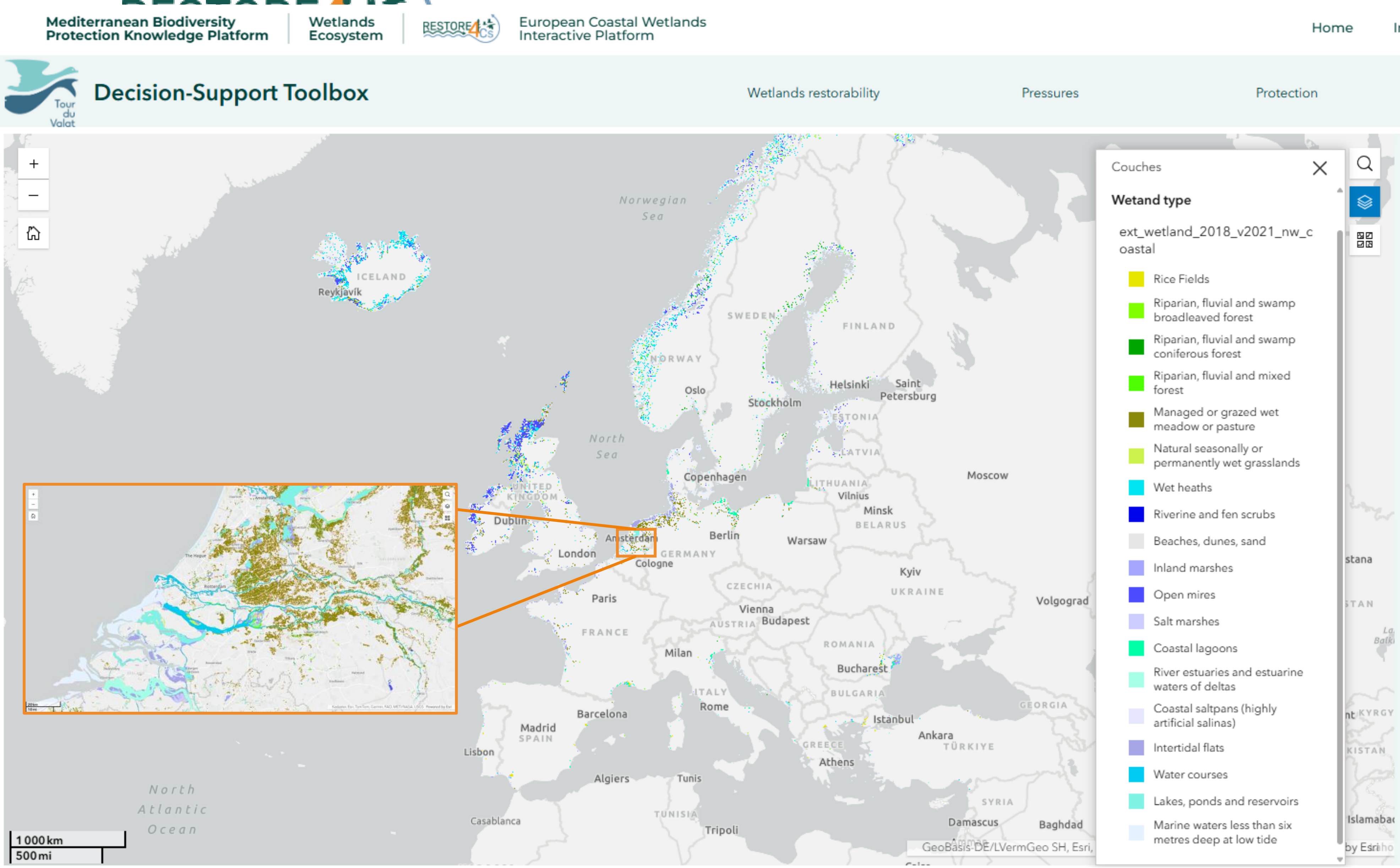
Decision-Support Toolbox (TdV)



Enables the identification and delineation of all European coastal wetlands, and their classification using a hybrid system combining CLC and Ramsar typologies

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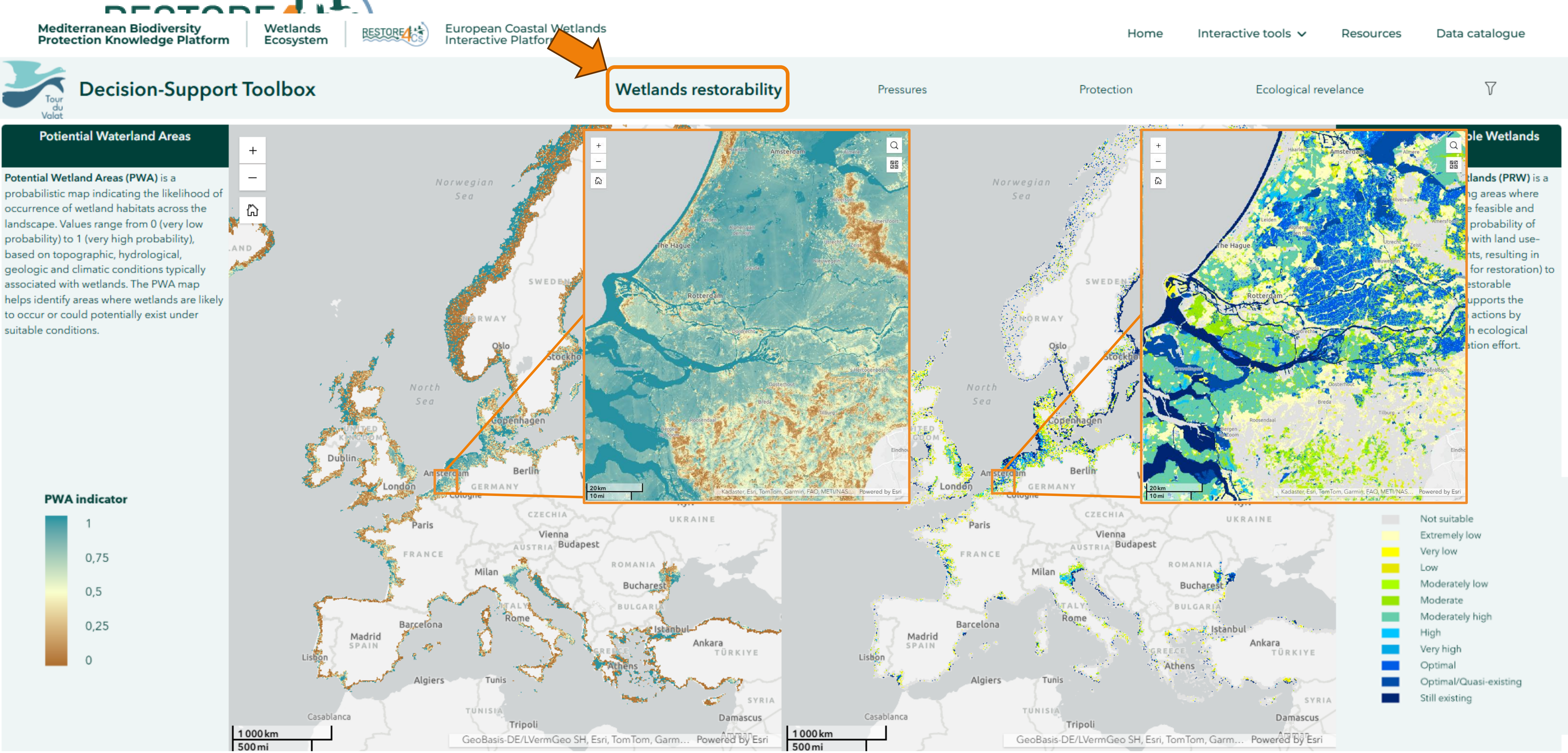

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Decision-Support Toolbox (TdV)

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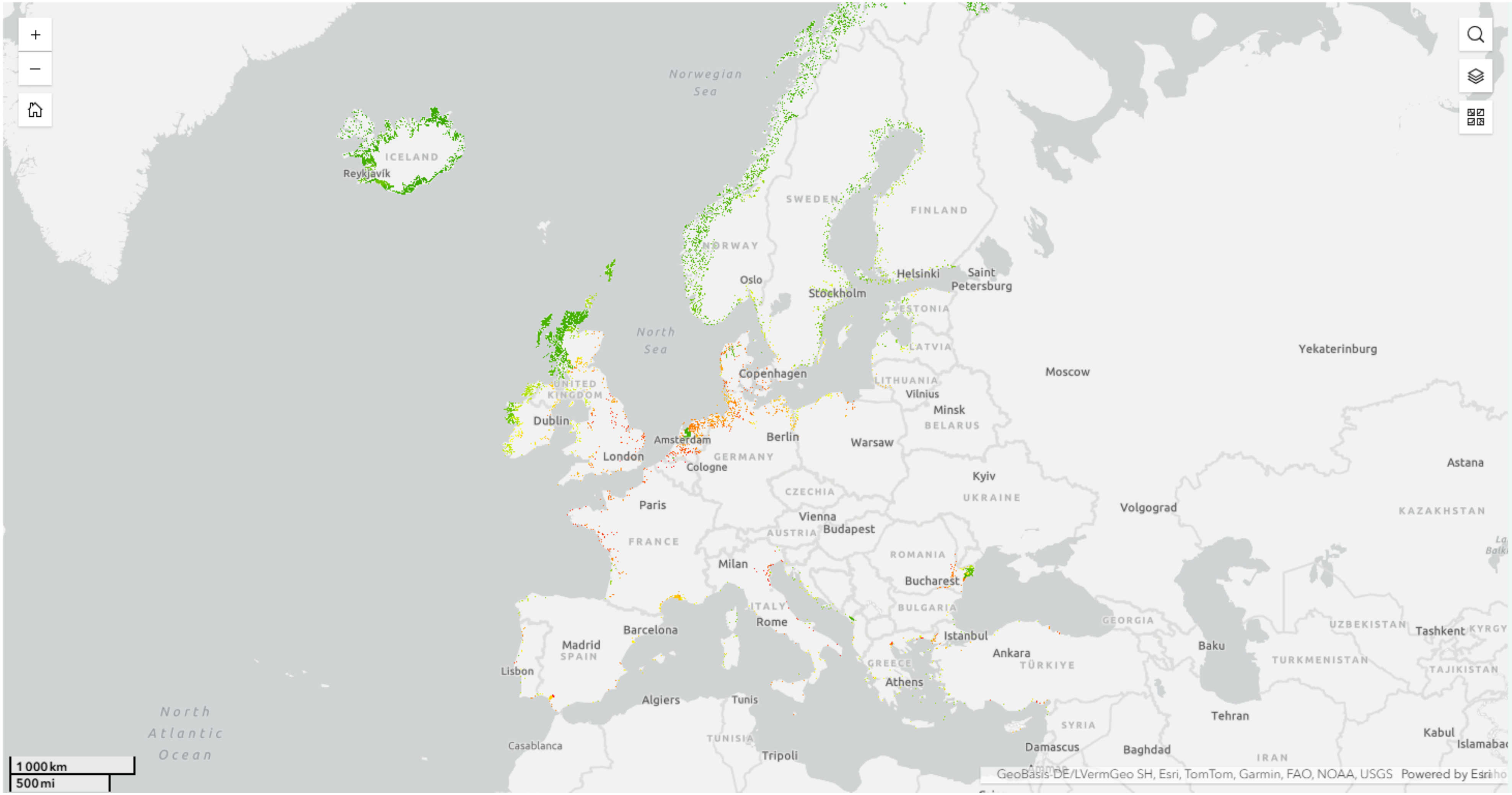
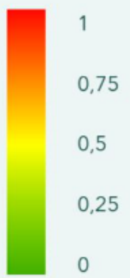
Decision-Support Toolbox

Wetlands restorability | **Pressures** | Protection | Ecological revelance



Pressures represent an estimate of the level of anthropogenic pressure affecting European coastal wetlands. The index is derived from a spatial analysis combining wetland habitat extent with surrounding agricultural and urban pressures at the sub-catchment scale, expressed as scores ranging from 0 (very low pressure) to 1 (very high pressure). Higher values indicate wetlands more exposed to human activities and potential degradation risks. This layer supports the identification of areas where conservation or restoration actions may be more urgent, or where pressures could limit restoration feasibility.



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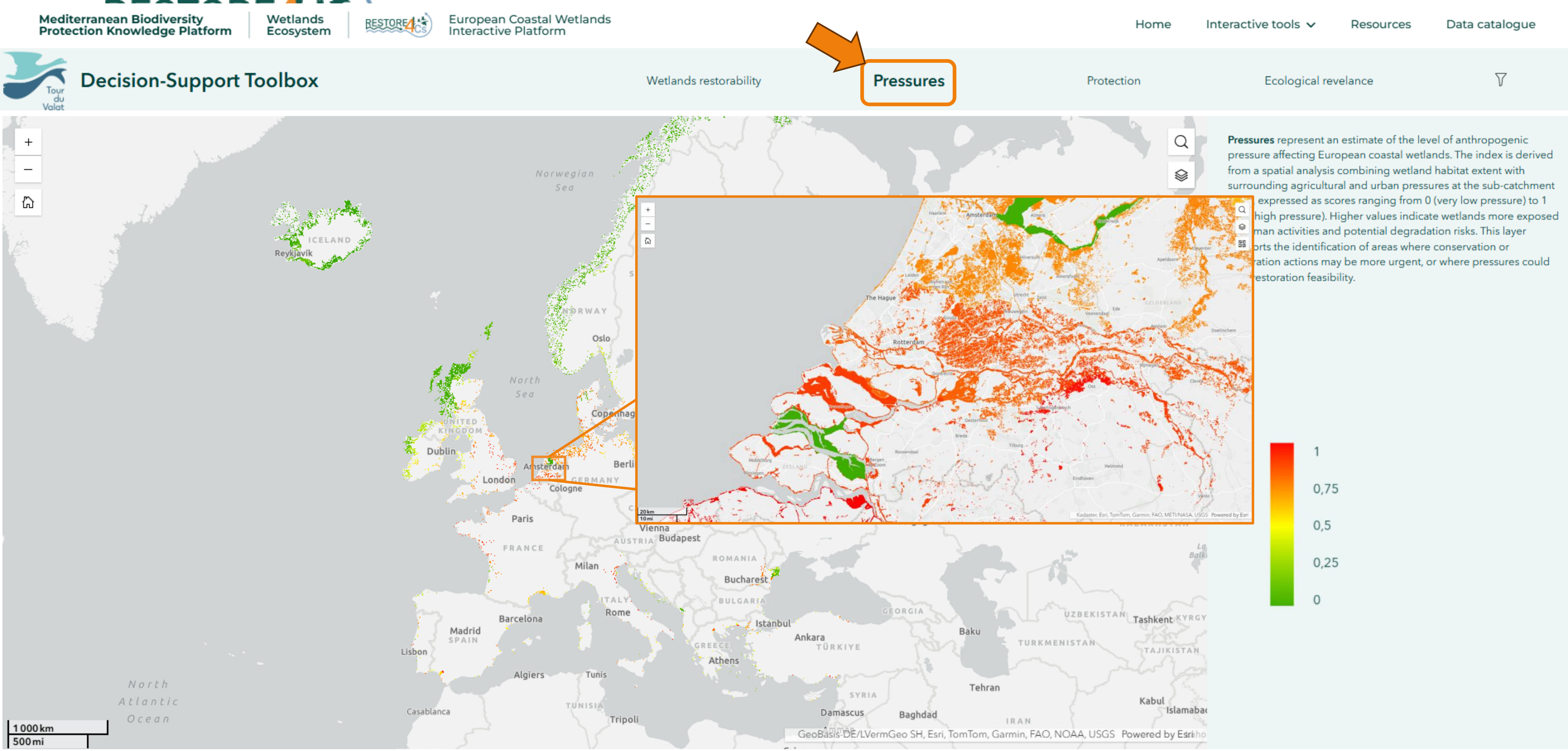
Decision-Support Toolbox (TdV)



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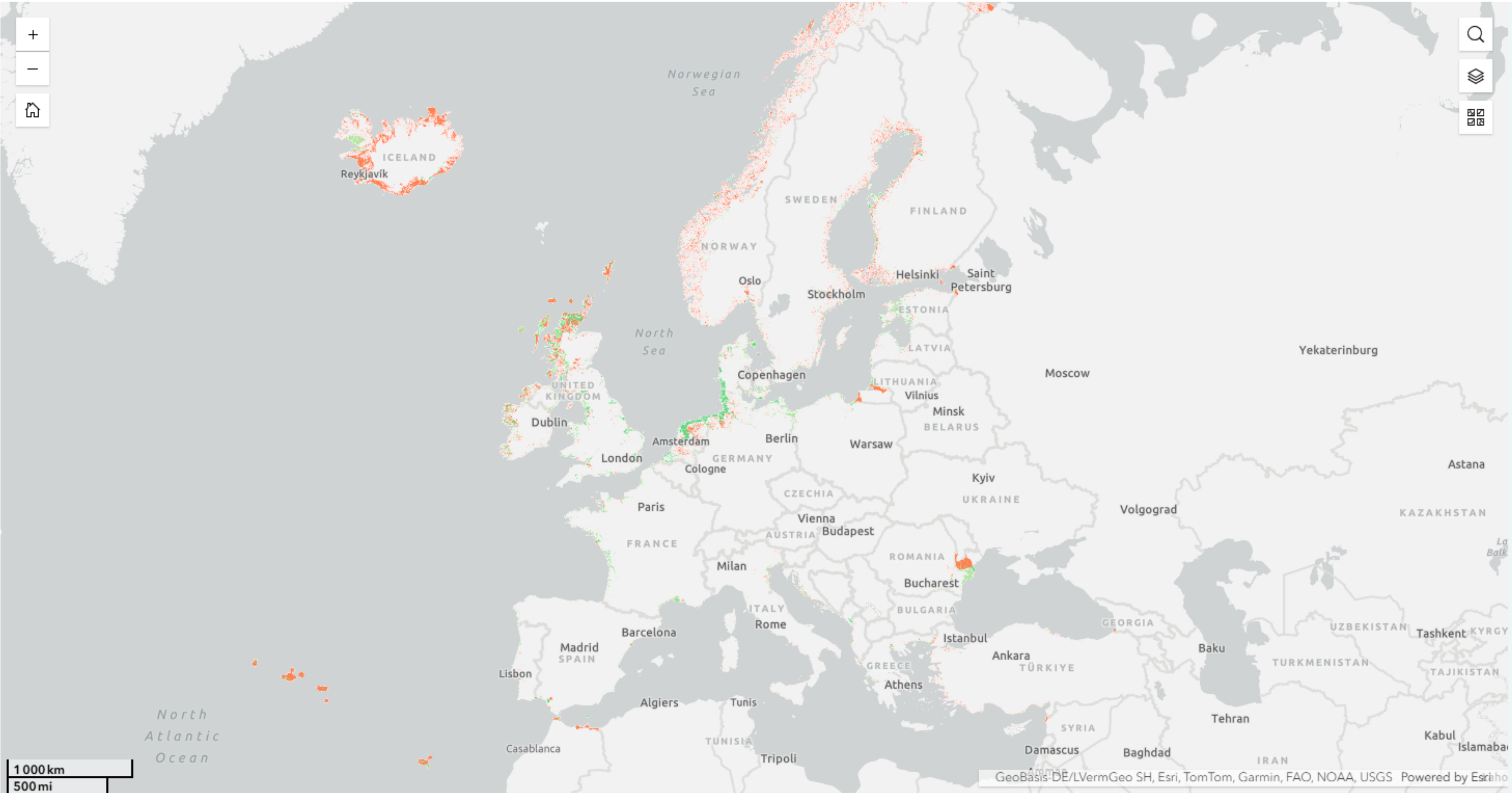
Decision-Support Toolbox (TdV)

Mediterranean Biodiversity Protection Knowledge Platform | Wetlands Ecosystem | European Coastal Wetlands Interactive Platform

Home · Interactive tools · Resources · Data catalogue

Decision-Support Toolbox

Wetlands restorability · Pressures · **Protection** · Ecological revelance



Protection describes the protection status of European coastal wetlands based on the spatial overlap between wetland extent and protected areas, including different protection levels. Values reflect the degree to which wetlands benefit from formal conservation frameworks, from unprotected areas to habitats under higher levels of protection. This layer provides context for restoration planning by highlighting wetlands already covered by conservation measures as well as areas where protection gaps may remain.

Protection level

- Highly protected
- Protected
- Not Protected

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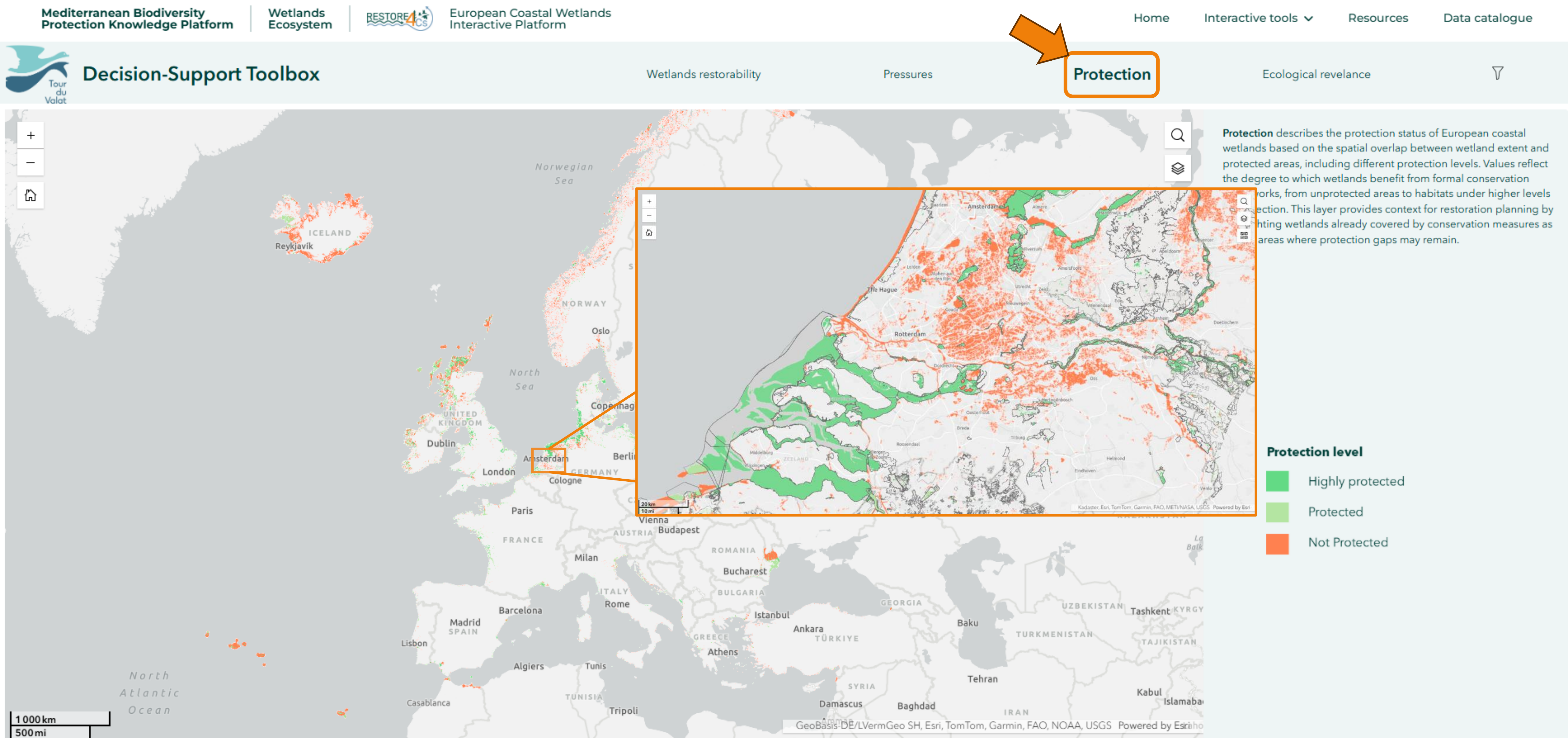
Decision-Support Toolbox (TdV)



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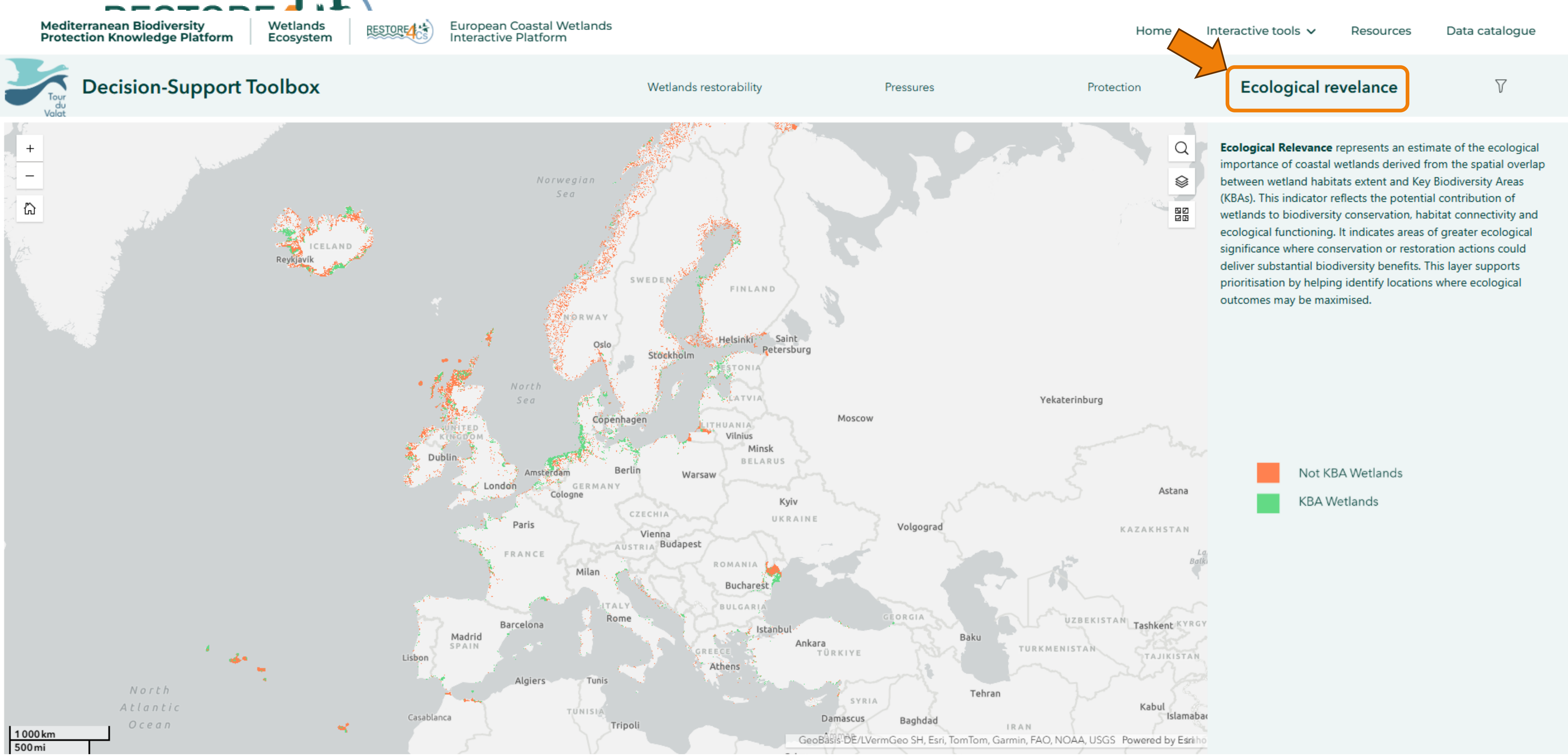

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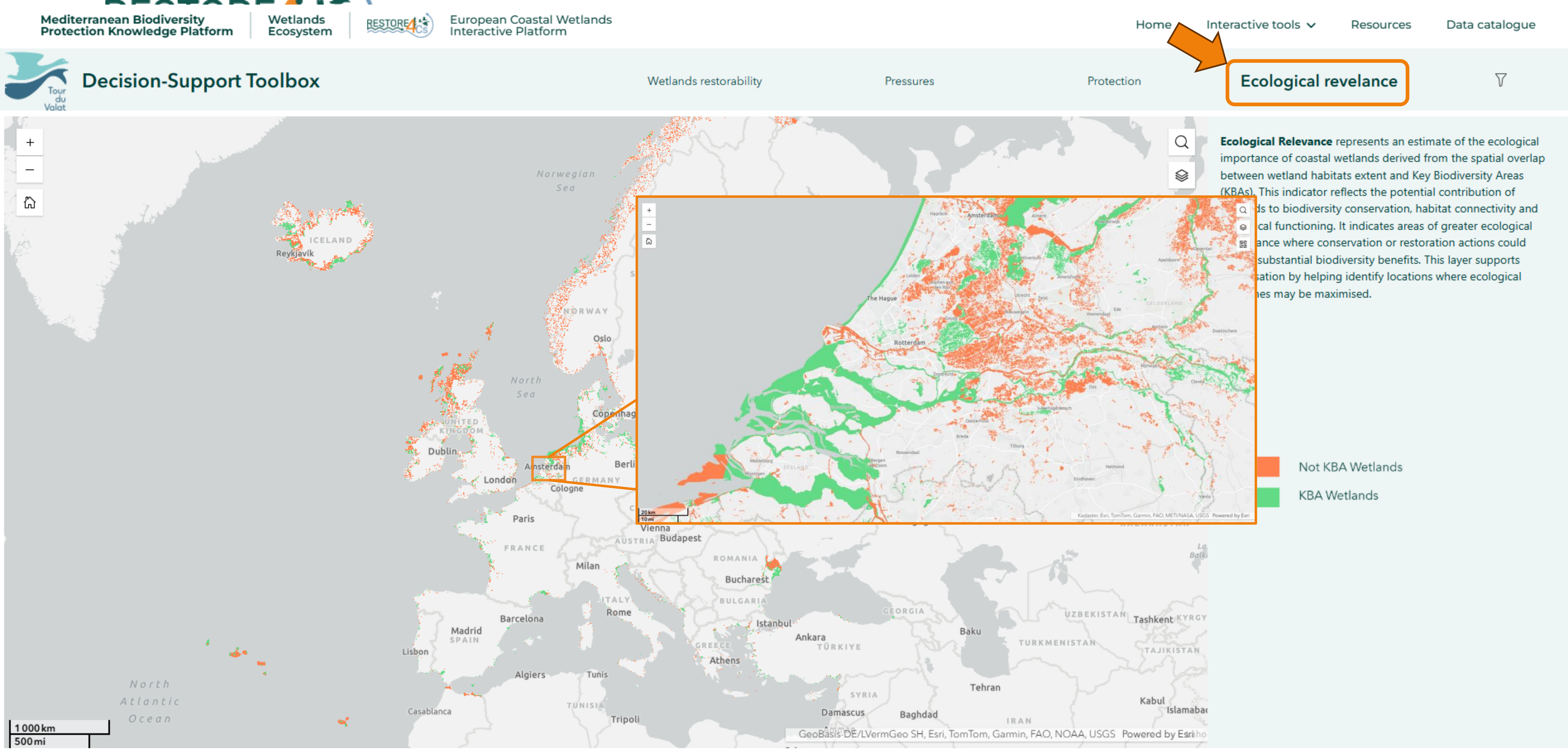

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Both the **Interactive Online Platform** and the **Decision-Support Toolbox** are available here:

https://biodiversity.uma.es/knowledge-platform/wetlands-ecosystem/interactive-tools/european-coastal-wetlands-interactive-platform/

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Q & A - 5 MINUTES

Restoration for the future WETLANDS www.alfawetlands.eu

RESTORE4Cs

rewet

WET HORIZONS

Improving the information available for the management of natural areas and ecological restoration to make them resilient to climate change

Jaime Ribalaygua Batalla
Fundación para la Investigación del Clima
Climate Research Foundation
www.ficlima.org
jrb@ficlima.org

foresteCCO

FORtaleciendo la RESTauración Ecológica
y la infraestructura verde para la adaptación
de especies forestales al Cambio ClimáticO

Strengthening ecological restoration and green infrastructure for the adaptation of forest species to climate change

FUNDING

GOBIERNO DE ESPAÑA

VICEPRESIDENCIA TERCERA DEL GOBIERNO

MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA Y EL RETO DEMOGRÁFICO

Fundación Biodiversidad

Plan de Recuperación, Transformación y Resiliencia

Financiado por la Unión Europea

NextGenerationEU

COORDINATION AND PARTNERS

fic fundación para la investigación del clima

INIA

Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria

CSIC

Consejo Superior de Investigaciones Científicas

UAM

Universidad Autónoma de Madrid

FUNDACIÓN INTERNACIONAL PARA LA RESTAURACIÓN DE ECOSISTEMAS

FiRe

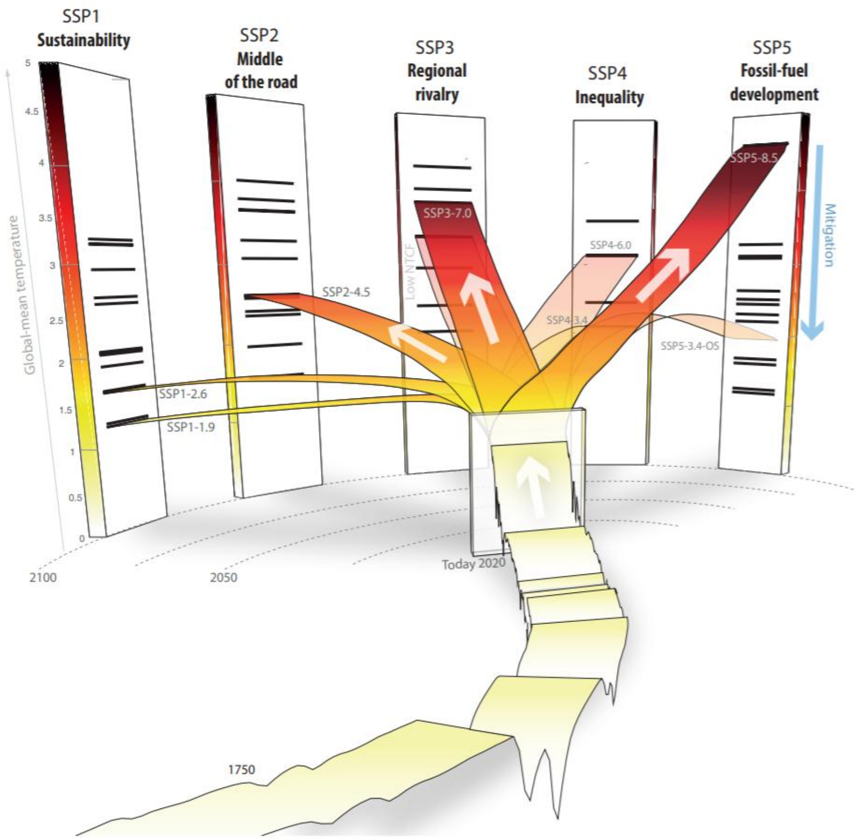
Main objective

To produce a web GIS platform which provides information on future suitability of plant species at a local scale

This information can be used by managers to select species which are resilient to future climate in each point

Key idea 1: climate future ➔ uncertainty

CMPI6 MODELS	Resolution	Responsible Centre	References
BCC-CSM2-MR	1,125º x 1,121º	Beijing Climate Center (BCC), China Meteorological Administration, China.	Wu, T. et al. (2019)
CanESM5	2,812º x 2,790º	Canadian Centre for Climate Modeling and Analysis (CC-CMA), Canadá.	Swart, N.C. et al. (2019)
CNRM-ESM2-1	1,406º x 1,401º	CNRM (Centre National de Recherches Meteorologiques), Meteo-France, Francia.	Seferian, R. (2019)
EC-EARTH3	0,703º x 0,702º	EC-EARTH Consortium	EC-Earth Consortium. (2019)
GFDL-ESM4	1,250º x 1,000º	National Oceanic and Atmospheric Administration (NOAA), E.E.U.U.	Krasting, J.P. et al. (2018)
MPI-ESM1-2-HR	0,938º x 0,935º	Max-Planck Institute for Meteorology (MPI-M), Germany.	Von Storch, J. et al. (2017)
MRI-ESM2-0	1,125º x 1,121º	Meteorological Research Institute (MRI), Japan.	Yukimoto, S. et al. (2019)
UKESM1-0-LL	1,875º x 1,250º	Uk Met Office, Hadley Centre, United Kingdom	Good, P. et al. (2019)
NorESM2-MM	1,250º x 0,942º	Norwegian Climate Centre (NCC), Norway.	Bentsen, M. et al. (2019)
ACCESS-ESM1-5	1,875º x 1,250º	Australian Community Climate and Earth System Simulator (ACCESS), Australia	Ziehn, T. et al. (2019)

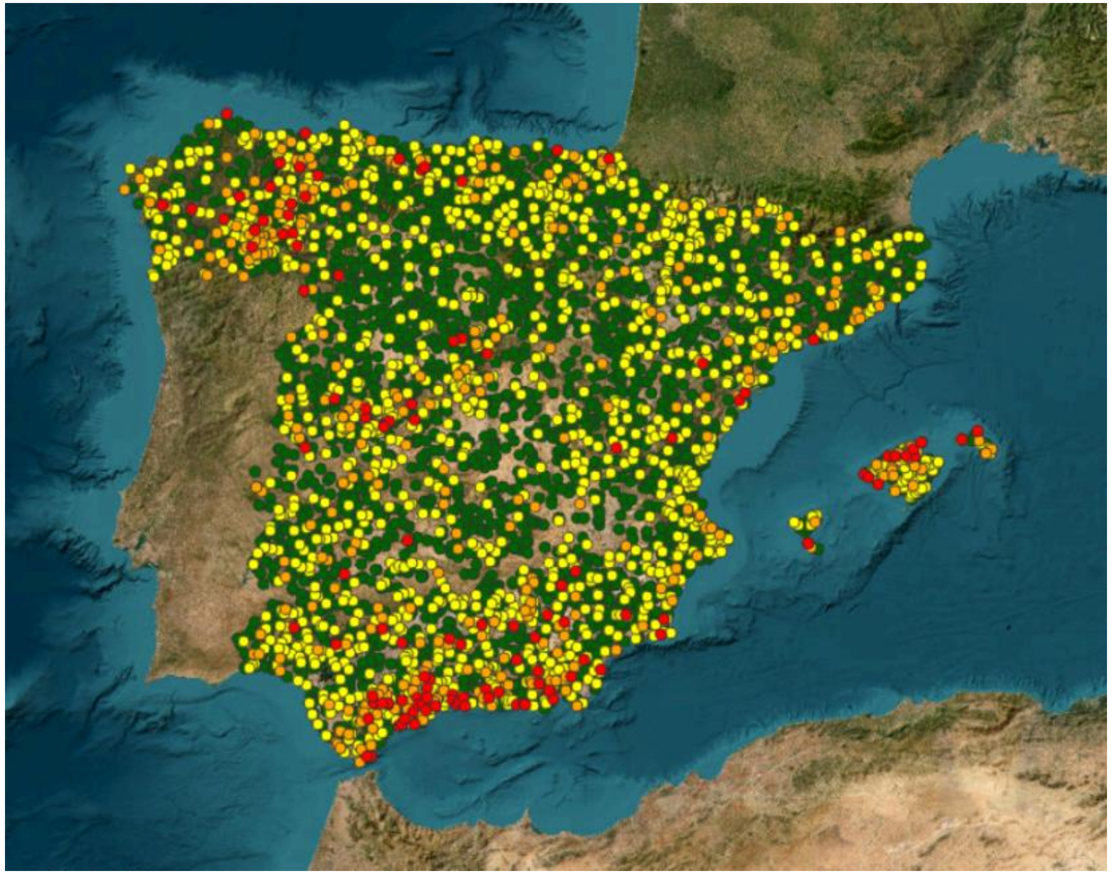


10 Global Climate Models x 4 Shared Socioeconomic Pathways

=

40 future projections !!

Key idea 1: climate future ➔ uncertainty

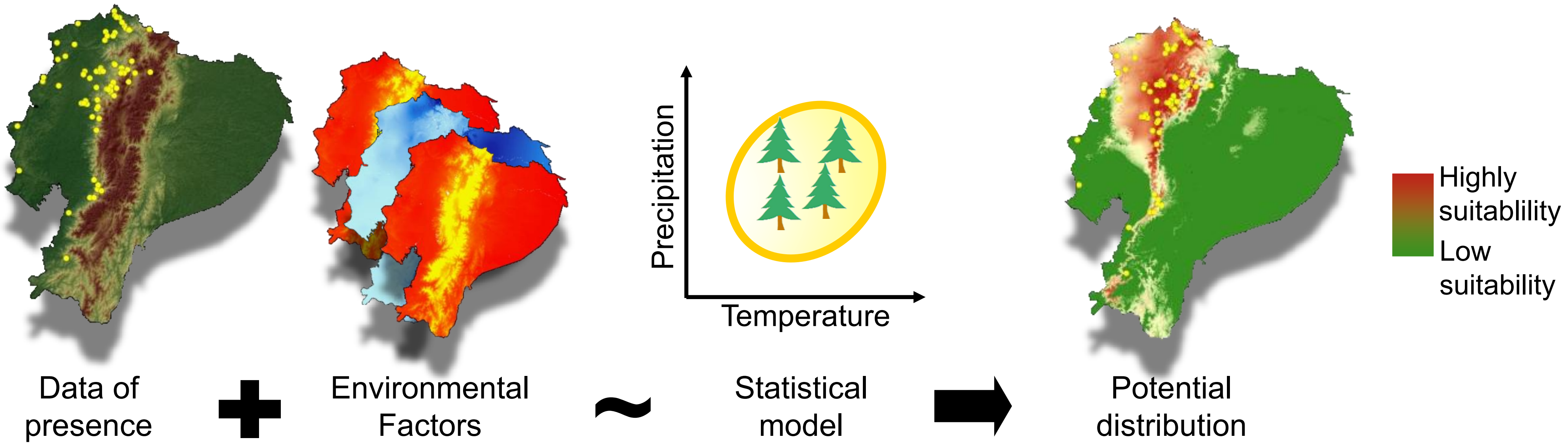


Grid of approx. 700 m x 900 m

Key idea 2: improvements in Species Distribution Models

Species distribution models

Ecological niche models, species distribution models (SDMs), etc.



Mateo, R.G. *et al.* 2011. Revista Chilena de Historia Natural

Key idea 2: improvements in Species Distribution Models

Cod	Descripción	Cod	Descripción
BIO01	Temperatura media anual	BIO14	Precipitación del mes más seco
BIO02	Rango diurno de temperaturas (media mensual (max temp - min temp))	BIO15	Estacionalidad en la precipitación (Coeficiente de variación)
BIO03	Isotermalidad: Relación entre el rango de temperaturas entre el día y la noche y entre el verano e invierno (BIO02/BIO07) (* 100)	BIO16	Precipitación del trimestre más húmedo
BIO04	Estacionalidad en la temperatura (desviación estándar*100)	BIO17	Precipitación del trimestre más seco
BIO05	Temperatura máxima del mes más cálido	BIO18	Precipitación del trimestre caliente
BIO06	Temperatura mínima del mes más frío	BIO19	Precipitación del trimestre más frío
BIO07	Rango de temperatura anual (BIO05-BIO06)		
BIO08	Temperatura media del trimestre húmedo		
BIO09	Temperatura media del trimestre seco		
BIO10	Temperatura media del trimestre más cálido		
BIO11	Temperatura media del trimestre más frío		
BIO12	Precipitación anual		
BIO13	Precipitación del mes más húmedo		

IMPORTANT!

The first 19 variables are from WorldClim, but it was necessary to modify some of them to avoid abrupt spatial and temporal discontinuities that prevent their use.

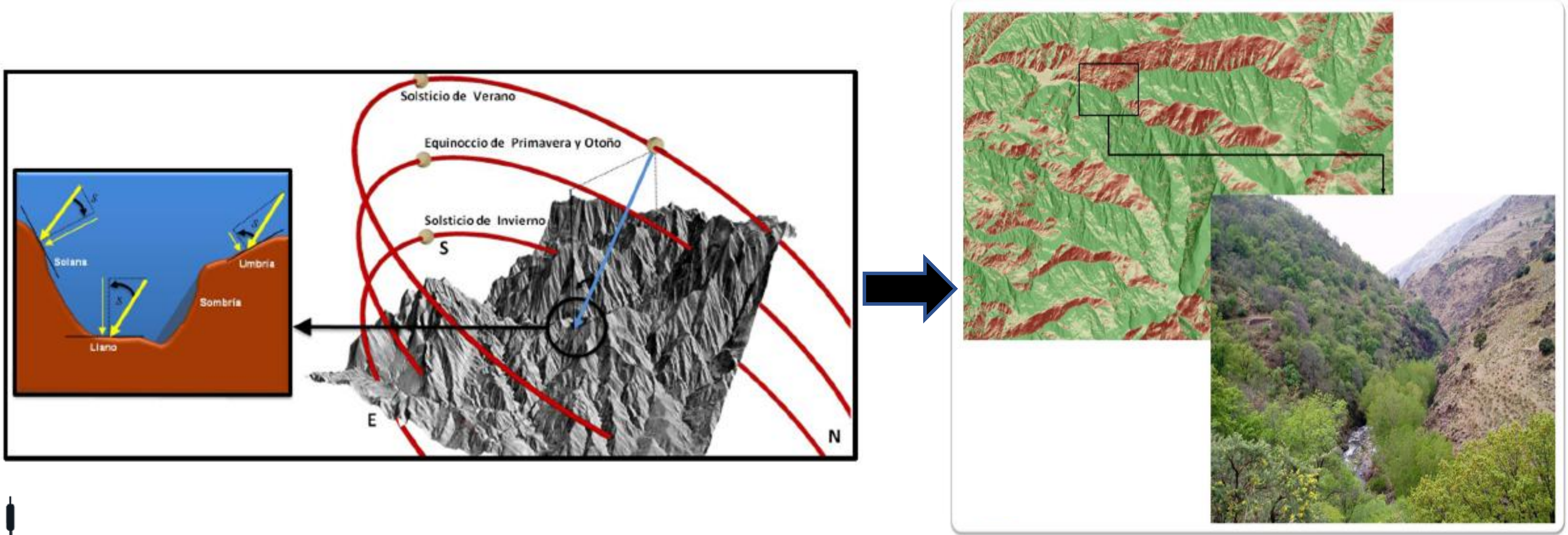
Be careful, do not use the original formulation of those variables from WorlClim, as it incorporates severe problems that greatly reduce the reliability of subsequent modelling.

BIO08 (Mean temperature of the wettest quarter):

	Trimestre húmedo	T de SON	T de MAM	BIO08
Present climate	Sep-Oct-Nov	15ºC	19ºC	15ºC
Future climate	Mar-Apr-May	17ºC	21ºC	21ºC

Key idea 2: improvements in Species Distribution Models

High-resolution Penman-Monteith reference evapotranspiration (ETo), incorporating the effect of topography on solar radiation

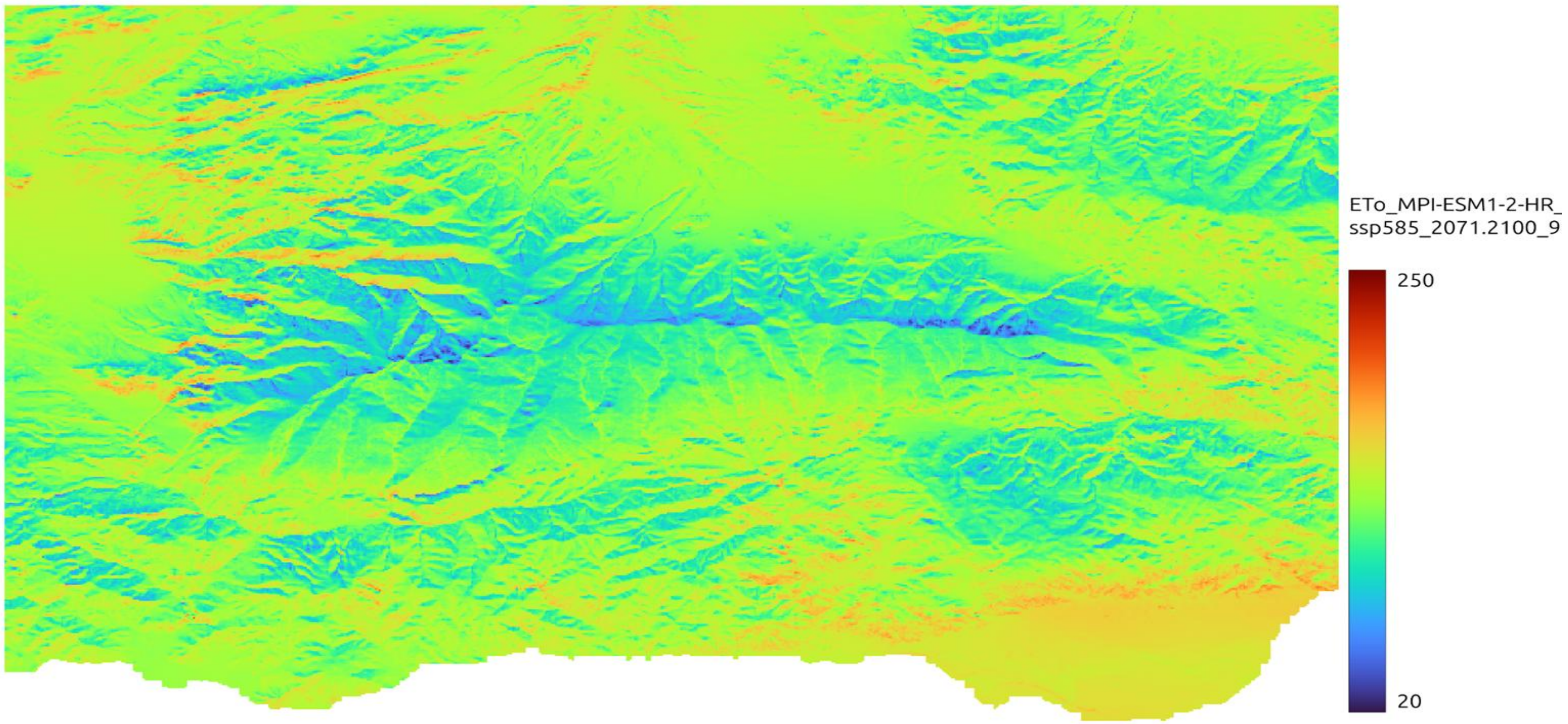


Key idea 2: improvements in Species Distribution Models

High-resolution Penman-Monteith reference evapotranspiration (ETo), incorporating the effect of topography on solar radiation

BIO41	Evapotranspiración anual
BIO42	Evapotranspiración del mes más seco
BIO43	Evapotranspiración del mes más húmedo o lluvioso
BIO44	Evapotranspiración del mes más cálido
BIO45	Evapotranspiración del mes más frío
BIO46	Estacionalidad de la evapotranspiración. Diferencia entre la ETo más alta - la ETo mínima

These variables justify working at such high spatial resolution



Key idea 2: improvements in Species Distribution Models

BIO01	Temperatura media anual	BIO14	Precipitación del mes más seco
BIO02	Rango diurno de temperaturas (media mensual (max temp - min temp))	BIO15	Estacionalidad en la precipitación (Coeficiente de variación)
BIO03	Isotermalidad: Relación entre el rango de temperaturas entre el día y la noche y entre el verano e invierno (BIO02/BIO07) (* 100)	BIO16	Precipitación del trimestre más húmedo
BIO04	Estacionalidad en la temperatura (desviación estándar*100)	BIO17	Precipitación del trimestre más seco
BIO05	Temperatura máxima del mes más cálido	BIO18	Precipitación del trimestre caliente
BIO06	Temperatura mínima del mes más frío	BIO19	Precipitación del trimestre más frío
BIO07	Rango de temperatura anual (BIO05-BIO06)	BIO41	Evapotranspiración anual
BIO08	Temperatura media del trimestre húmedo	BIO42	Evapotranspiración del mes más seco
BIO09	Temperatura media del trimestre seco	BIO43	Evapotranspiración del mes más húmedo o lluvioso
BIO10	Temperatura media del trimestre más cálido	BIO44	Evapotranspiración del mes más cálido
BIO11	Temperatura media del trimestre más frío	BIO45	Evapotranspiración del mes más frío
BIO12	Precipitación anual	BIO46	Estacionalidad de la evapotranspiración. Diferencia entre la ETo más alta - la ETo mínima
BIO13	Precipitación del mes más húmedo		

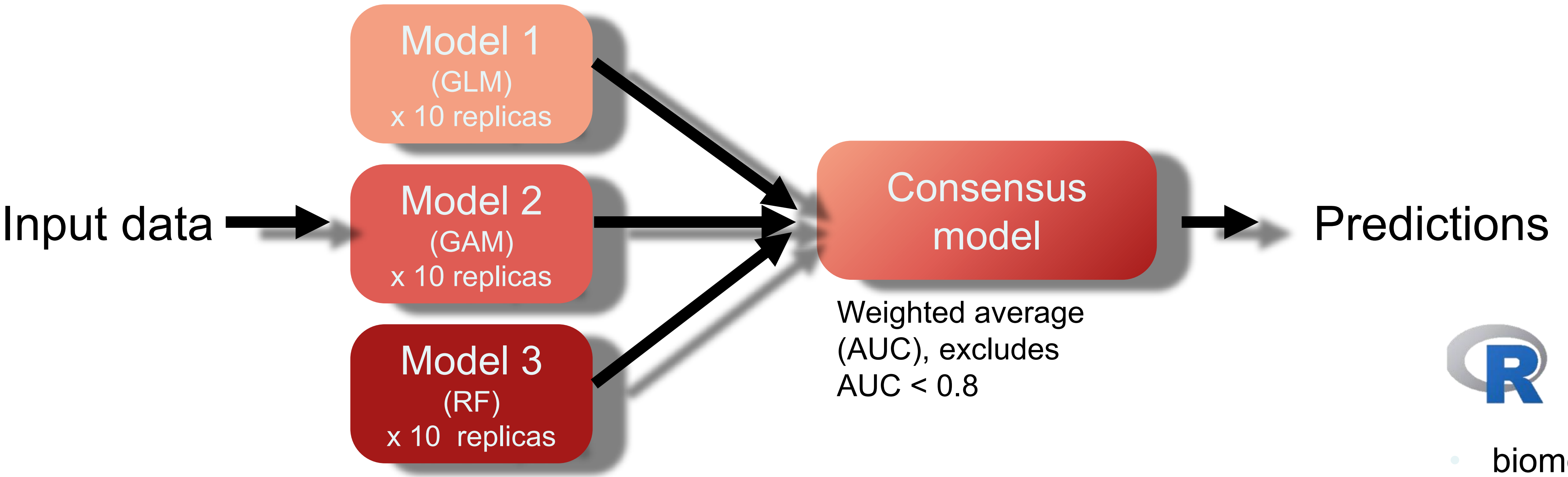
NIT	Nitrógeno en suelo (cg/kg)
SOC	Carbono Orgánico del Suelo (dg/kg)
SAND	Arena en suelo (g/kg)
PH	pH (ph*10)

Fuente: SoilGrids (www.soilgrids.org)

Key idea 2: improvements in Species Distribution Models

Consensus models

More robust, reliable and stable



- biomod2
- terra

Mateo, R.G. *et al*. 2010. *Diversity and distributions*

Mateo, R.G. *et al*. 2012. *PLoS ONE*

Key idea 3: need for validation

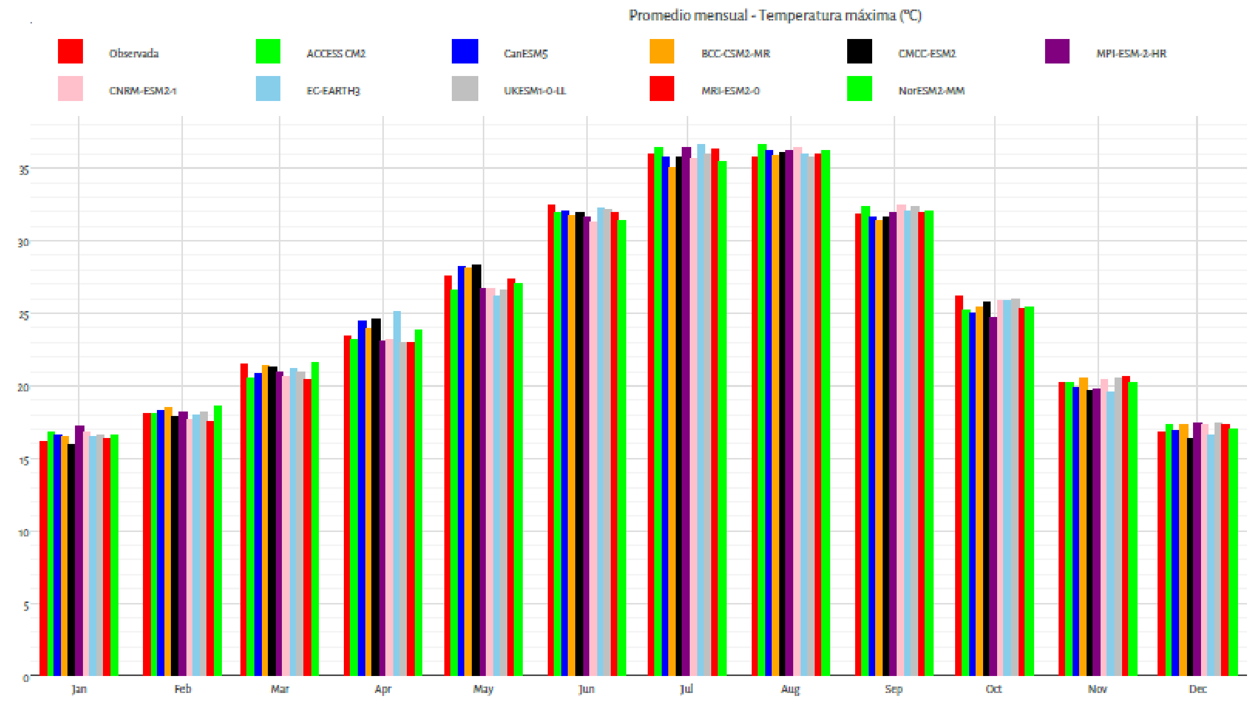
foresteCCO

Informe de validación de modelos para temperatura

13-11-2025 18:03
Página 1/ 4

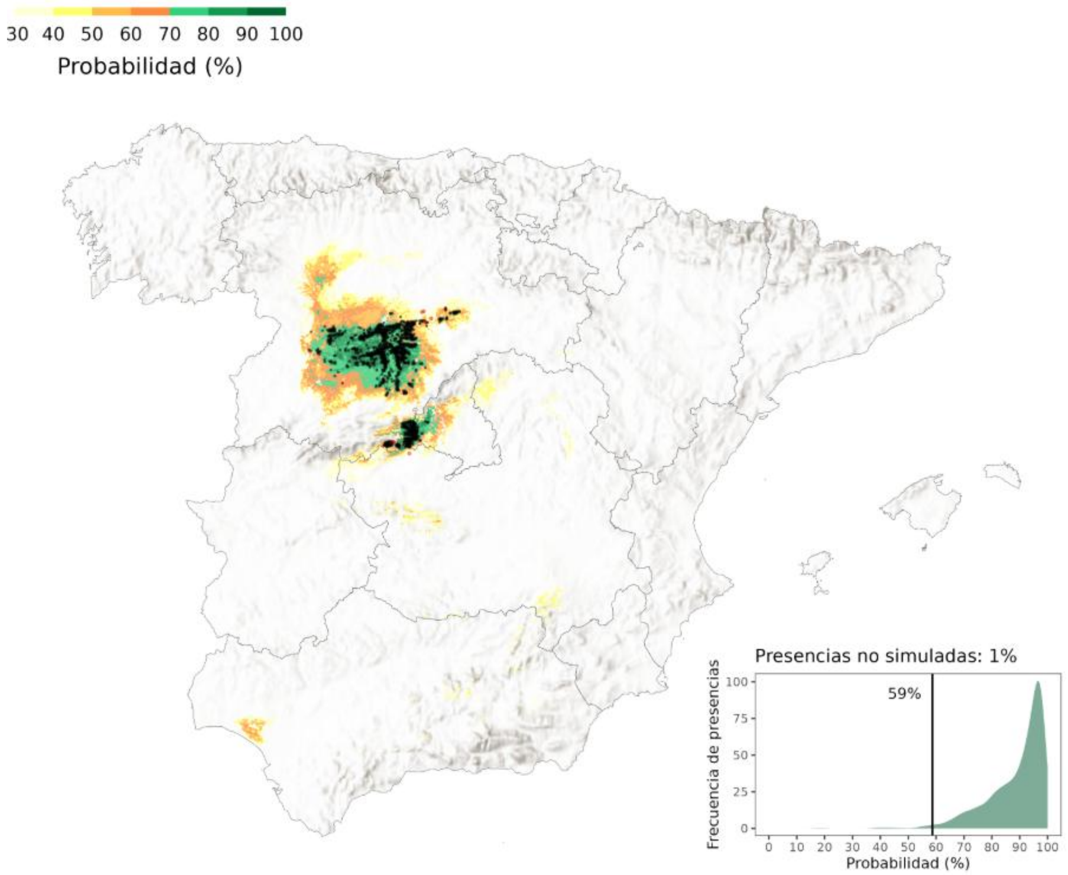
5783 - Sevilla, Aeropuerto (37.418677 -5.878042) msnm: 29

Temperatura máxima observada - promedio mensual (°C):

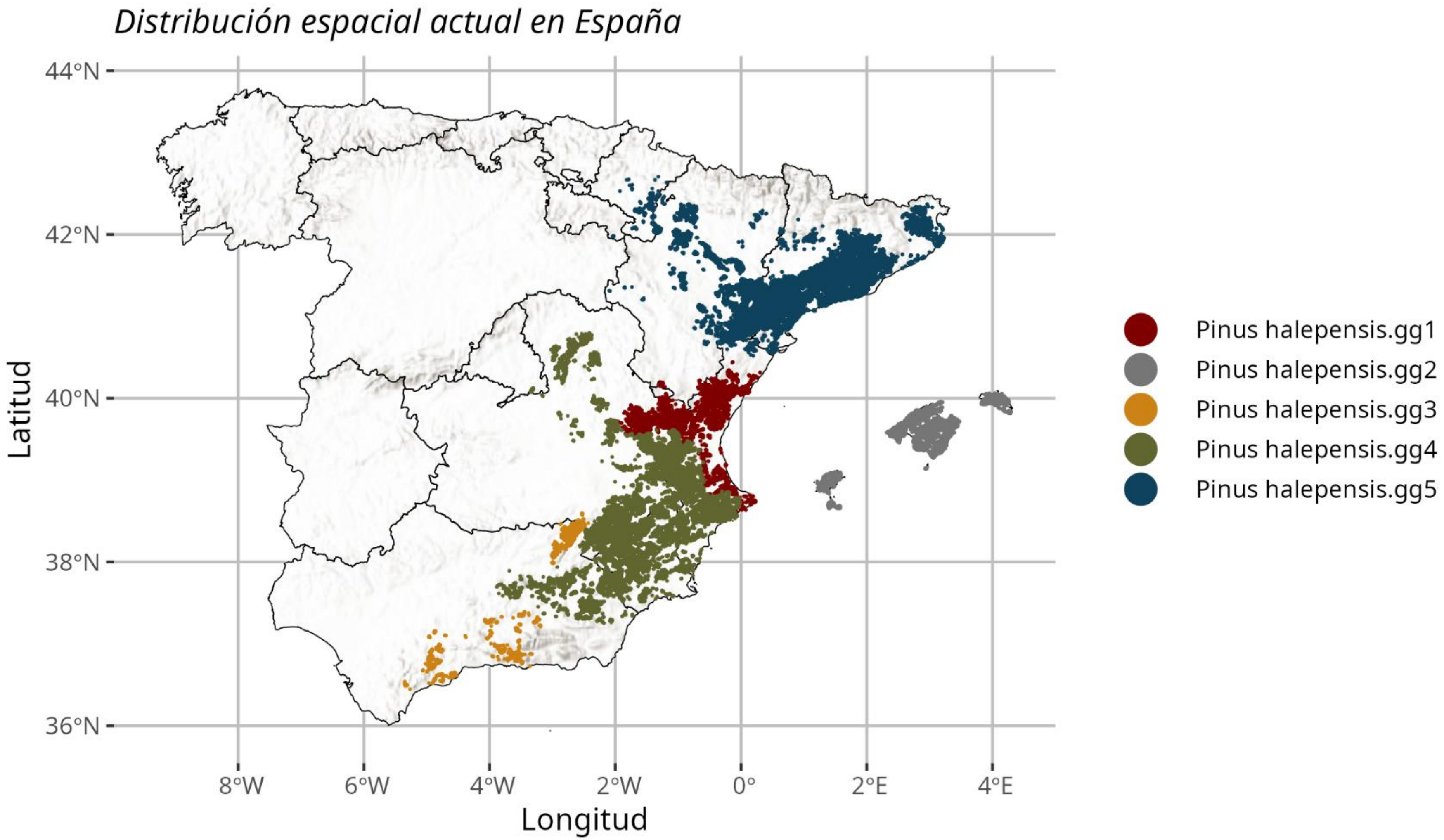


Pinus pinea gg1

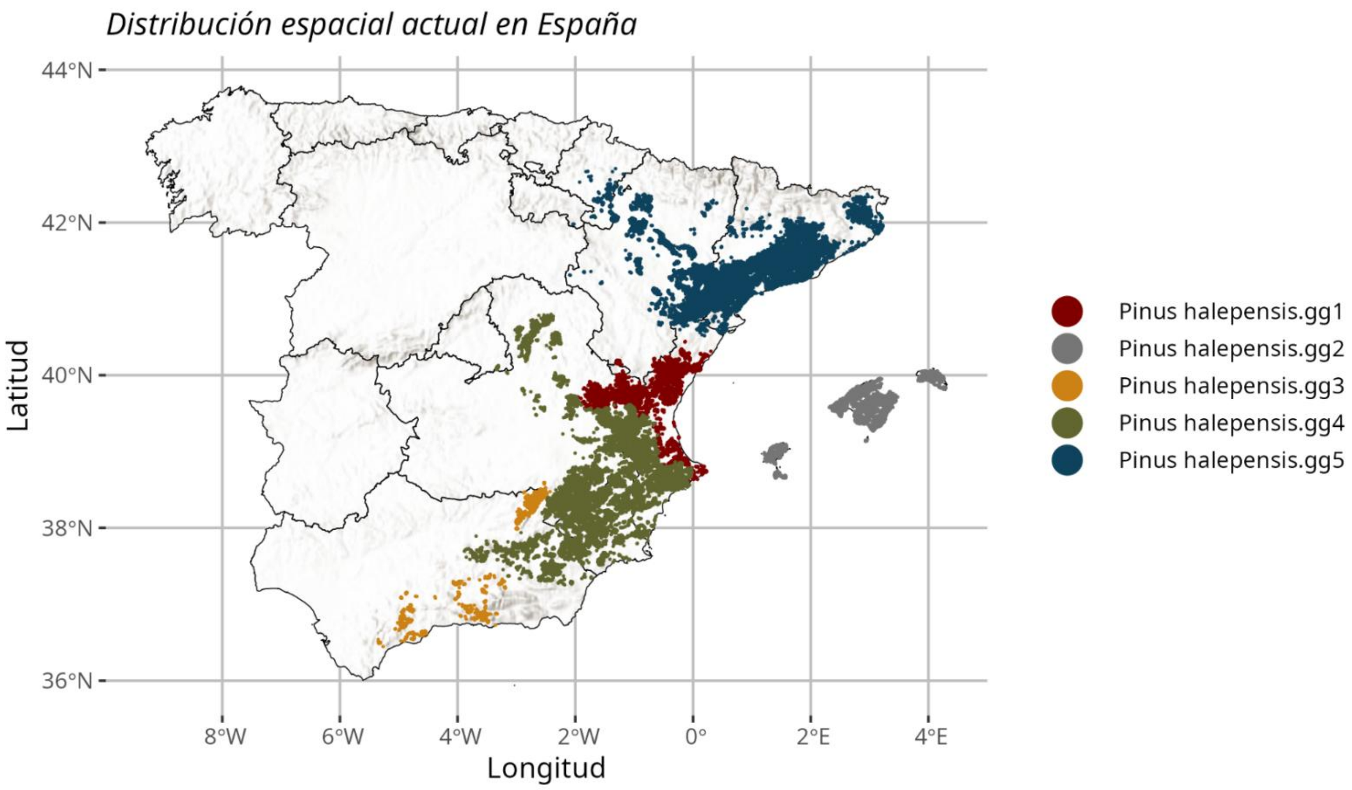
Modelo de probabilidad de idoneidad de hábitat actual y la presencia **coincidente** o **no coincidente** con el modelo

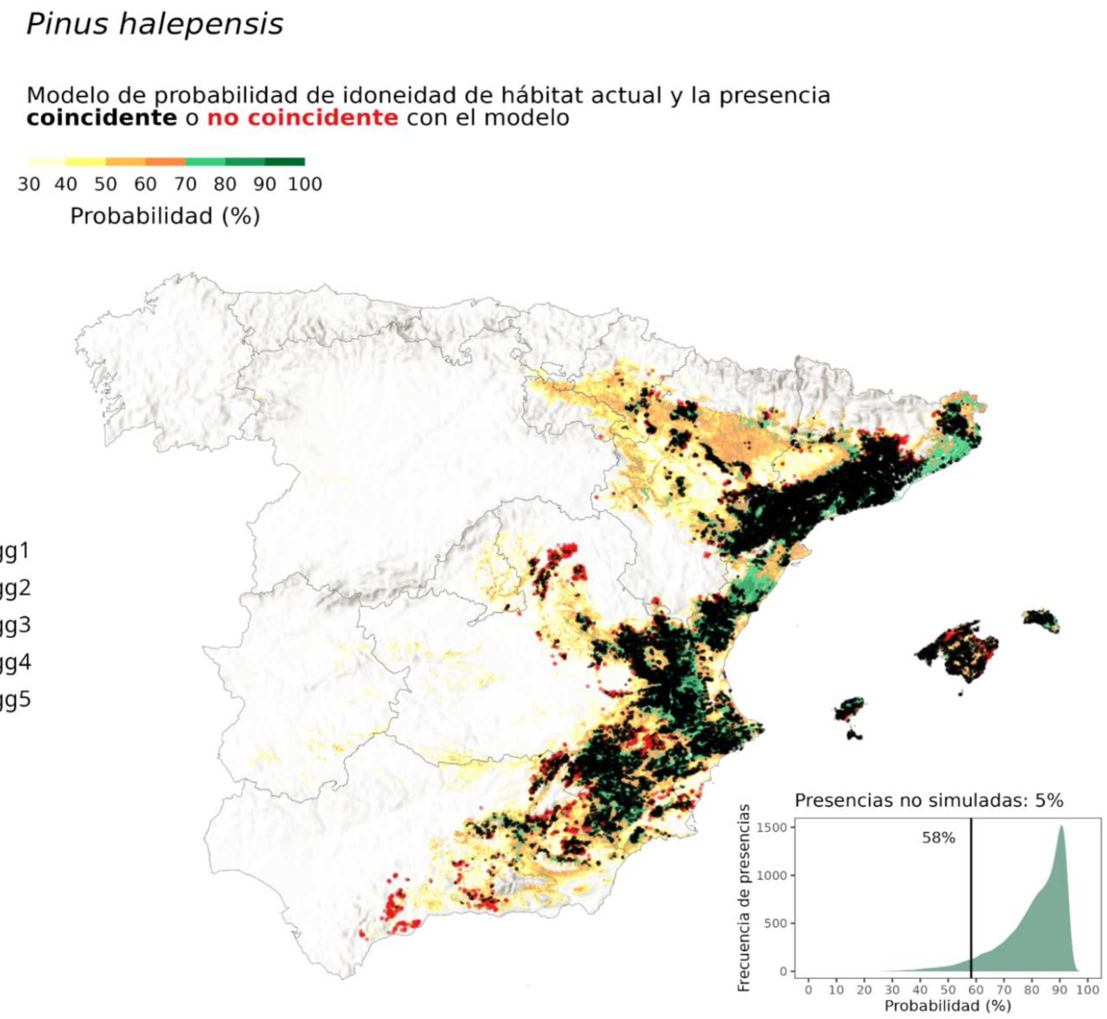


Key idea 4: use of ecological-genetic groups

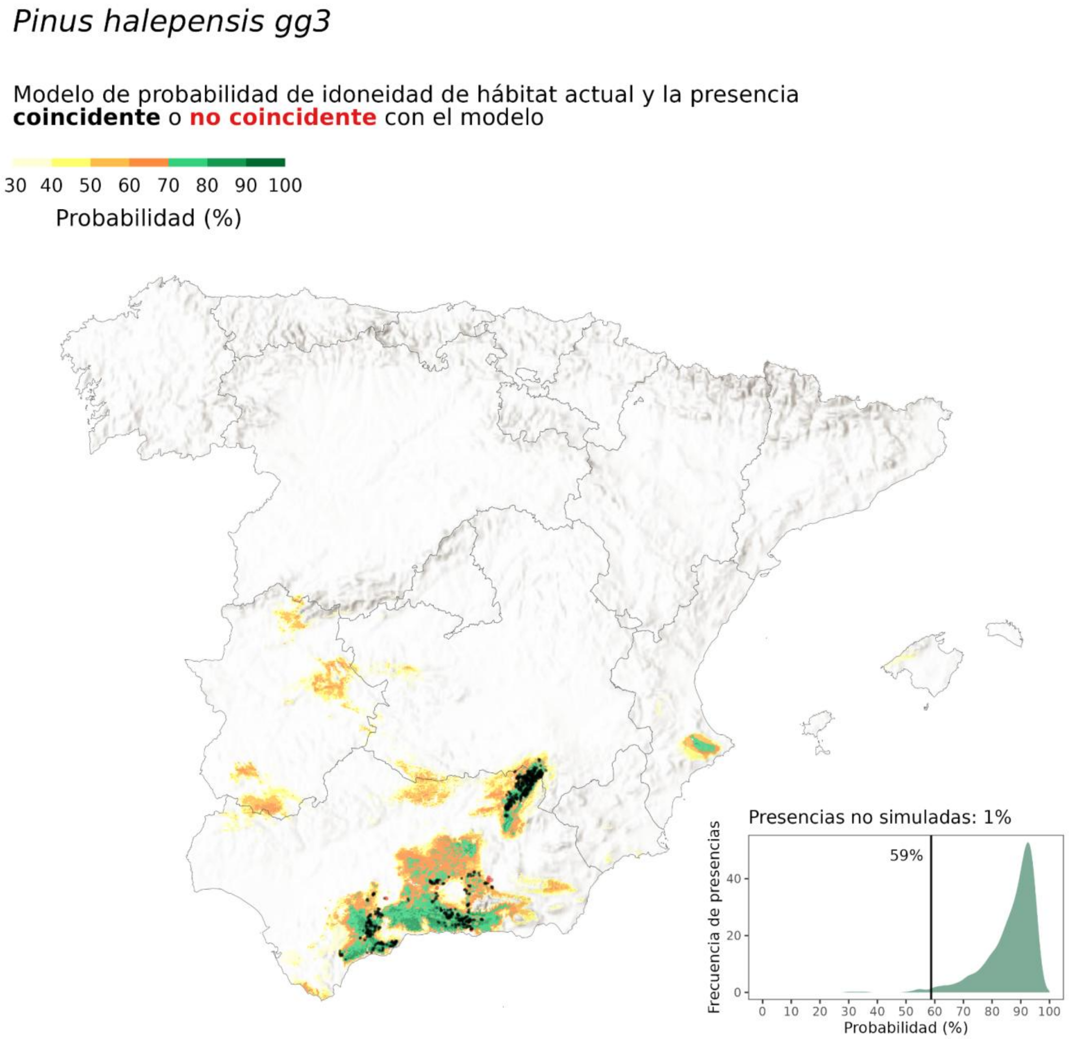


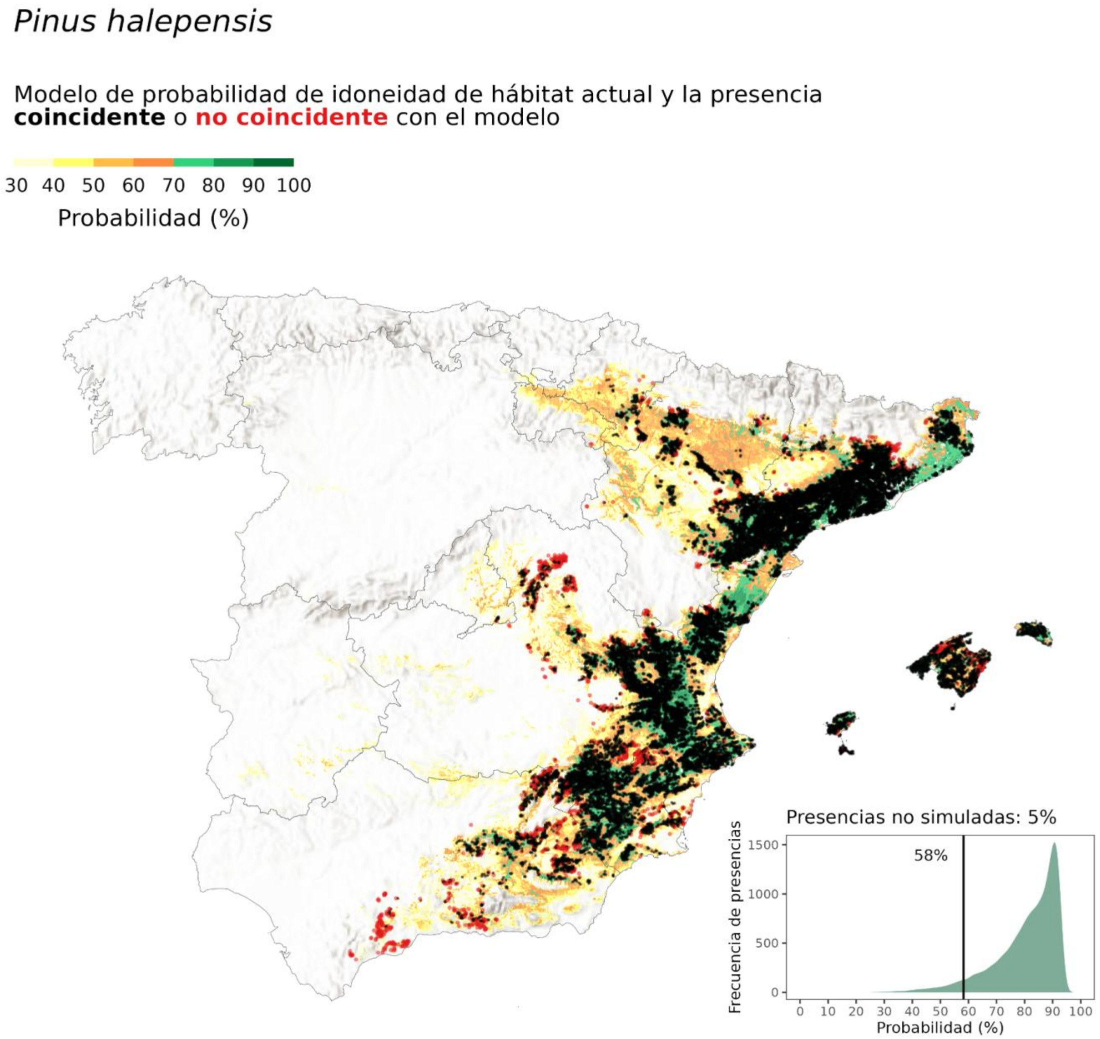
Key idea 4: use of ecological-genetic groups





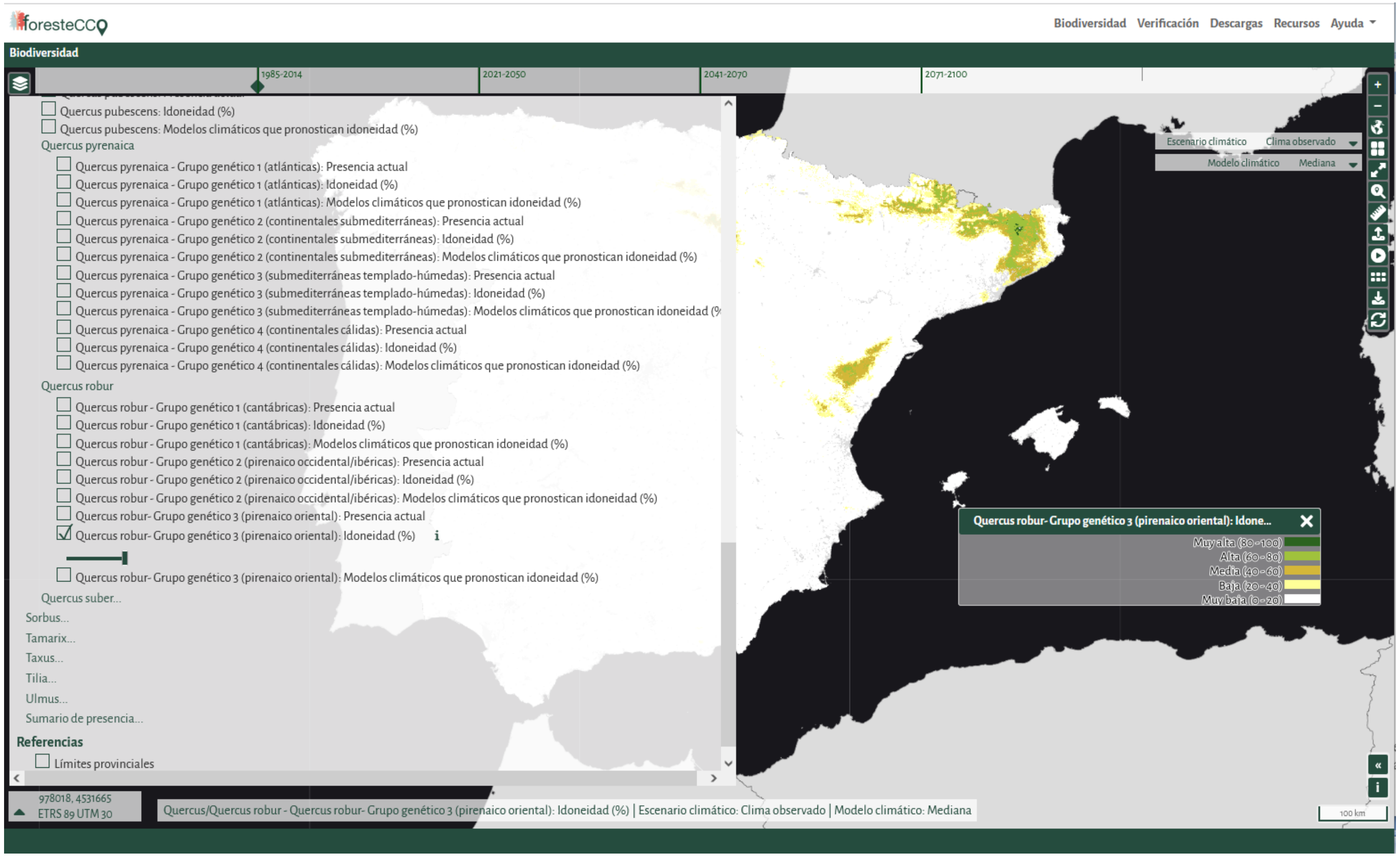
Key idea 4: use of ecological-genetic groups





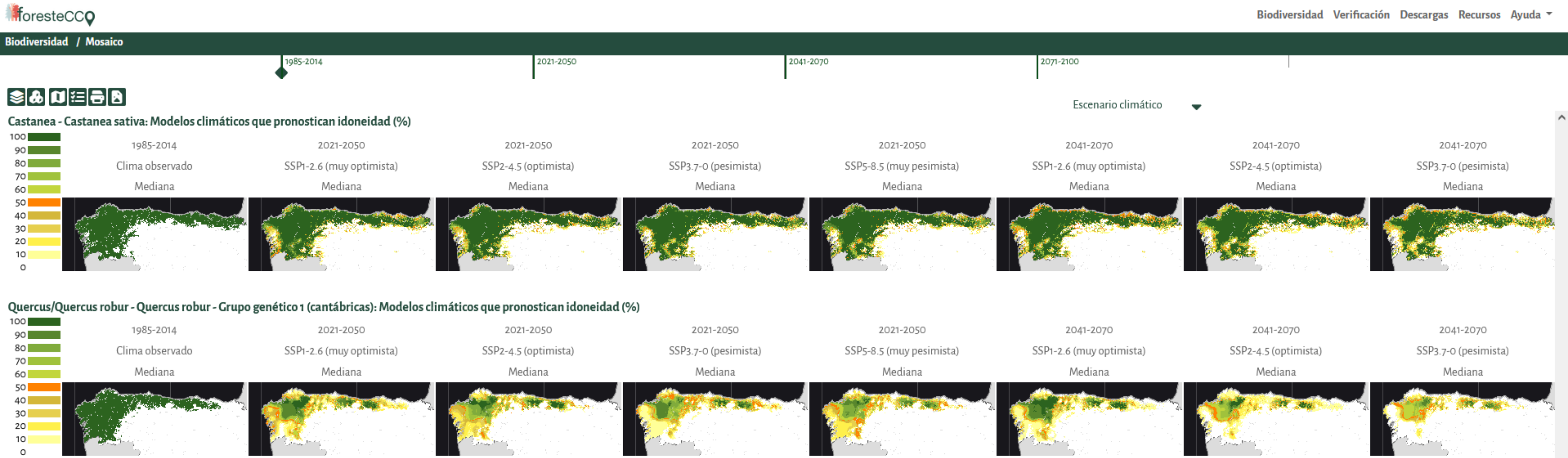
www.forestecco.org

www.forestecco.org



rewet

www.forestecco.org

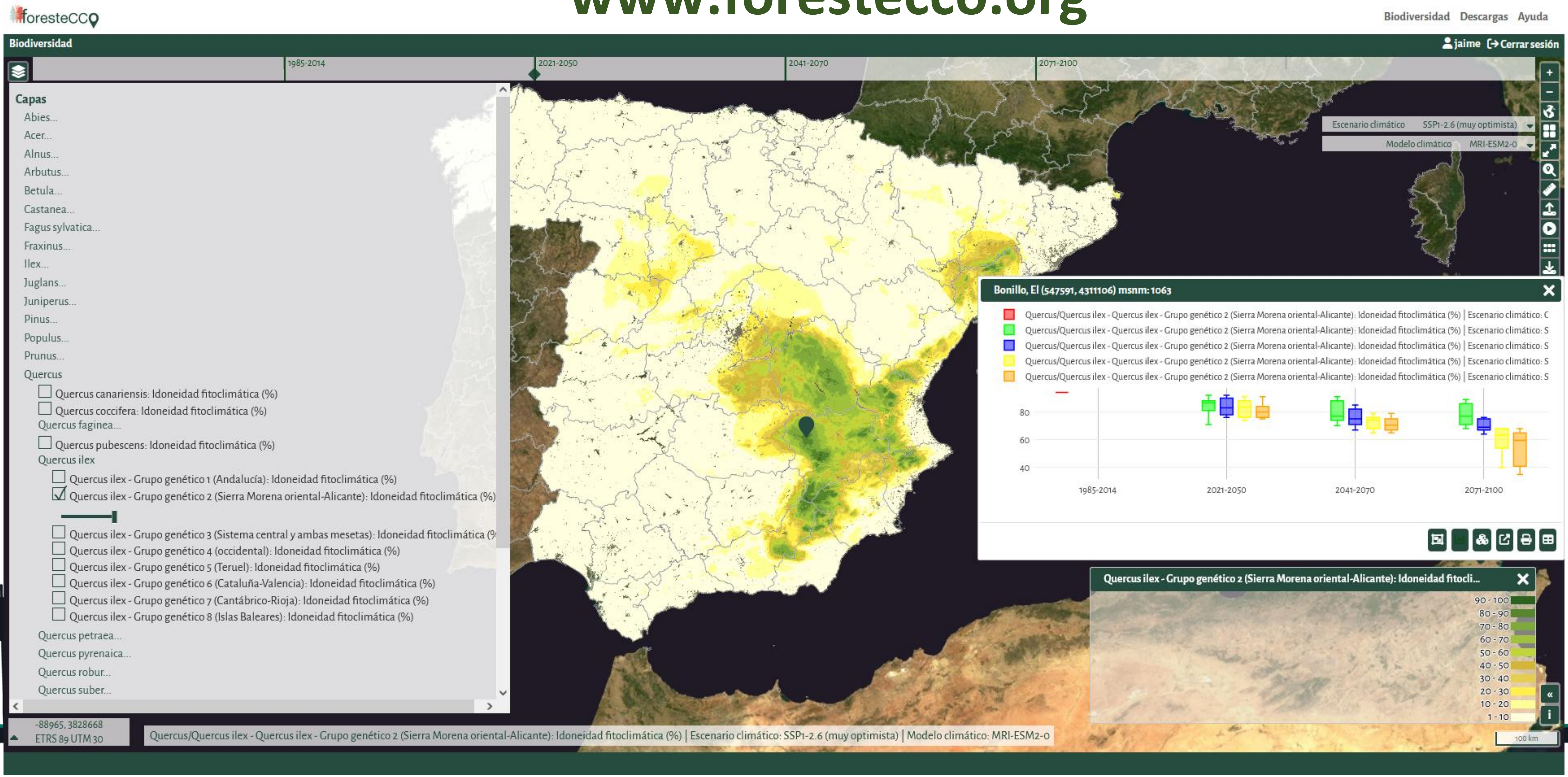


Hermandad de Campoo de Suso (393216, 4760493, 1378 msnm)

Presencias: Betula pendula, Fraxinus excelsior, Ilex aquifolium, Taxus baccata, Fagus sylvatica GG1

					2021/2050												2041/2070												2071/2100											
especie / grupo genético	∃	pc	ia		SSP1-2.6 muy optimista			SSP2-4.5 optimista			SSP3-7.0 pesimista			SSP5-8.5 muy pesimista			SSP1-2.6 muy optimista			SSP2-4.5 optimista			SSP3-7.0 pesimista			SSP5-8.5 muy pesimista			SSP1-2.6 muy optimista			SSP2-4.5 optimista			SSP3-7.0 pesimista			SSP5-8.5 muy pesimista		
Prunus avium	no	43	50	%mcpi		100			100			100			100			100			100			100			100			100			100			100			100	
				ip25 im ip75	55	57	59	56	58	59	57	58	59	55	57	60	56	59	60	57	60	62	60	62	64	62	63	65	55	59	61	60	61	65	63	64	67	61	63	65
Taxus baccata	sí	62	77	%mcpi		100			100			100			100			100			100			100			100			100			100			100			100	
				ip25 im ip75	79	80	81	78	79	82	79	79	81	79	79	81	78	79	81	77	78	81	77	79	80	77	79	80	78	78	81	77	78	81	74	75	77	70	71	76
Ilex aquifolium	sí	56	87	%mcpi		100			100			100			100			100			100			100			100			100			100			100			40	
				ip25 im ip75	74	76	80	77	78	81	74	77	80	75	78	80	73	78	81	74	75	79	73	74	76	75	75	77	73	75	79	70	72	76	63	65	73	52	55	61
Sorbus aria	no	51	63	%mcpi		100			100			100			100			100			100			100			100			100			100			80			40	
				ip25 im ip75	63	65	67	65	66	68	64	65	67	66	65	68	63	66	68	66	66	68	66	66	67	65	66	68	64	65	67	63	64	67	51	53	61	29	41	51
Populus tremula	no	52	50	%mcpi		100			100			100			100			90			100			100			90			100			100			70			50	
				ip25 im ip75	55	56	58	56	58	59	56	58	60	57	57	60	57	59	59	58	60	61	59	59	61	59	59	61	54	56	58	56	59	61	52	55	60	45	53	57
Sorbus aucuparia	no	55	79	%mcpi		100			100			100			100			100			100			100			100			100			100			70			30	
				ip25 im ip75	81	81	83	80	81	83	80	81	83	80	80	81	80	80	81	78	79	80	74	77	80	76	77	80	78	80	82	73	76	80	51	56	73	32	41	55
uercus pyrenaica - Grupo genético 2 (continentales submediterráne	no	61	47	%mcpi		80			90			90			100			80			100			100			100			90			100			80			50	
				ip25 im ip75	76	82	83	75	79	81	75	79	83	76	80	82	80	82	85	80	84	87	83	88	89	83	86	88	76	82	84	84	87	89	70	83	86	37	71	84
Pinus sylvestris - Grupo genético 1 (occidental)	no	66	65	%mcpi		50			70			70			50			90			90			70			70			50			70			50			40	
				ip25 im ip75	64	66	67	66	67	69	67	68	69	65	66	69	67	68	70	68	69	70	67	68	70	66	69	69	65	66	68	67	68	71	52	64	68	21	54	69
Quercus petraea - Grupo genético 1 (occidental)	no	55	80	%mcpi		70			90			80			80			80			70			60			60			60			50			30			0	
				ip25 im ip75	56	66	72	62	69	71	65	68	76	61	65	72	59	67	70	46	56	66	48	63	68	43	56	62	53	66	77	35	56	67	19	35	56	8	19	33
uercus petraea - Grupo genético 2 (vasco-navarro/sierras interiore	no	38	28	%mcpi		30			60			40			50			40			60			40			60			30			40			40			10	
				ip25 im ip75	20	26	47	22	39	45	25	34	41	28	40	49	25	34	53	33	40	47	29	36	43	31	43	56	20	25	38	33	36	48	17	25	40	9	19	31
Quercus pyrenaica - Grupo genético 1 (atlánticas)	no	64	29	%mcpi		10			20			10			20			30			40			60			50			40			70			60			50	
				ip25 im ip75	44	48	56	48	51	63	49	52	59	50	56	59	51	57	65	55	59	69	56	67	69	61	65	69	48	56	71	64	66	69	62	70	76	50	64	74
Alnus glutinosa	no	41	12	%mcpi		0			0			0			0			10			30			50			70			20			60			90			100	
				ip25 im ip75	17	18	26	19	21	30	18	21	32	22	25	29	21	27	31	26	30	42	30	40	47	37	44	47	22	26	40	38	44	51	51	57	63	55	58	66
Fagus sylvatica - Grupo genético 2 (Pirineos)	no	66	64	%mcpi		40			50			50			50			30			50			20			20			30			20			0			0	
				ip25 im ip75	54	60	70	63	66	68	59	67	70	63	66	69	55	62	67	56	63	68	56	59	64	52	54	63	50	55	65	51	57	63	25	36	44	14	19	33
Tilia platyphyllos	no	57	62	%mcpi		40			30			40			40			30			20			10			30			30			20			20			20	
				ip25 im ip75	46	47	60	48	52	59	47	53	61	48	53	58	46	52	61	46	49	55	47	50	54	47	51	58	43	47	60	46	49	54	37	48	56	33	42	51
Fagus sylvatica - Grupo genético 1 (Galicia)	sí	61	70	%mcpi		20			50			50			20			30			30			20			0			20			10			10			0	
				ip25 im ip75	21	43	58	24	53	73	27	50	70	28	42	46	16	45	61	22	28	62	21	36	46	27	30	45	17	31	47	19	29	38	7	26	38	4	11	19
Ulmus glabra	no	47	30	%mcpi		10			10			10			10			30			10			10			30			30			30			30			20	
				ip25 im ip75	31	36	42	35	38	43	35	39	42	35	41	45	35	37	47	40	42	44	39	42	43	39	42	50	36	38	45	40	40	46	40	43	46	38	42	46
Fraxinus excelsior	sí	72	50	%mcpi		0			0			0			10			0			0			0			20			10			20			40			40	
				ip25 im ip75	40	48	58	41	50	62	42	57	62	39	44	57	38	49	60	40	46	60	43	55	65	48	55	65	38	45	55	42	45	68	49	66	74	47	57	76
Castanea sativa	no	75	12	%mcpi		0			0			0			0			0			0			0			0			0			20			50			60	
				ip25 im ip75	19	25	34	19	23	42	19	27	35	22	26	37	24	38	46	30	37	58	32	48	66	42	56	67	24	35	53	46	60	73	63	74	82	74	79	81
Juniperus communis	no	54	32	%mcpi		0			10			10			0			0			0			10			10			0			30			10			0	
				ip25 im ip75	35	35	45	38	41	44	37	38	46	37	39	45	33	38	46	38	44	48	35	39	48	34	41	51	29	29	43	32	35	54	31	34	38	19	34	42
Arbutus unedo	no	48	7	%mcpi		0			0			0			0			0			0			0			0			0			0			20			40	
				ip25 im ip75	7	7	8	7	7	8	7	7	8	7	7	8	8	7	10	8	8	11	8	8	13	9	10	17	8	8	9	9	11	19	14	24	42	32	35	57
Betula pubescens	no	76	67	%mcpi		10			10			0			10			0			0			0			0			10			10			0			10	
				ip25 im ip75	63	65	70	60	64	69	62	63	67	59	63	68	59	61	67	58	60	64	56	62	66	50	61	69	54	66	74	54	62	68	44	61	69	29	45	59
				%mcpi		0			0			0			0			0			20			0			10			10			0			10			0	

www.forestecco.org



Thank you!!

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RESTORE4Cs

rewet

WET HORIZONS

WET HORIZONS

Wetlands in Action: Session 6
06/05/2026

servipeat

Decision support system in peatland rewetting

Mateusz Grygoruk, Marta Stachowicz

Dorota Mirosław-Świątek, Piotr Banaszuk, Philippe Ciais, Christian Fritz, Pouya Ghezelayagh, Tom Heuts, Agata Klimkowska, Marjon Hellegers, Liyang Liu, Paweł Osuch, Ojaswi Sumbh

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Spatial Multicriteria Analysis Tool

Alessandro Gimona, Fraser McFarlane, Ciaran Robb,
Ashish Dutta, Rebekka Artz

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Key questions guiding wetland restoration planning

WET HORIZONS

- How can peatlands be rewetted?
- How much will it cost?
- What environmental and economic benefits will we gain in return?
- Are there alternative solutions?
- What will happen at a larger scale?

Answering these questions is the starting point of the decision-making process.

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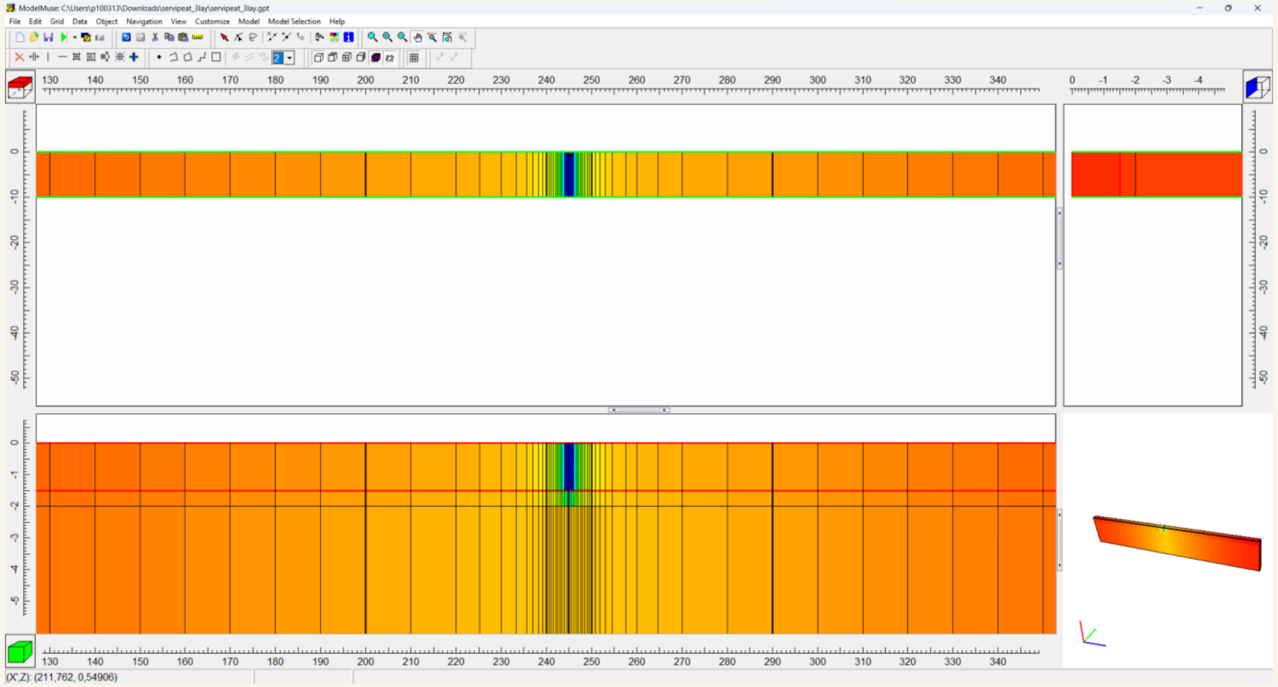
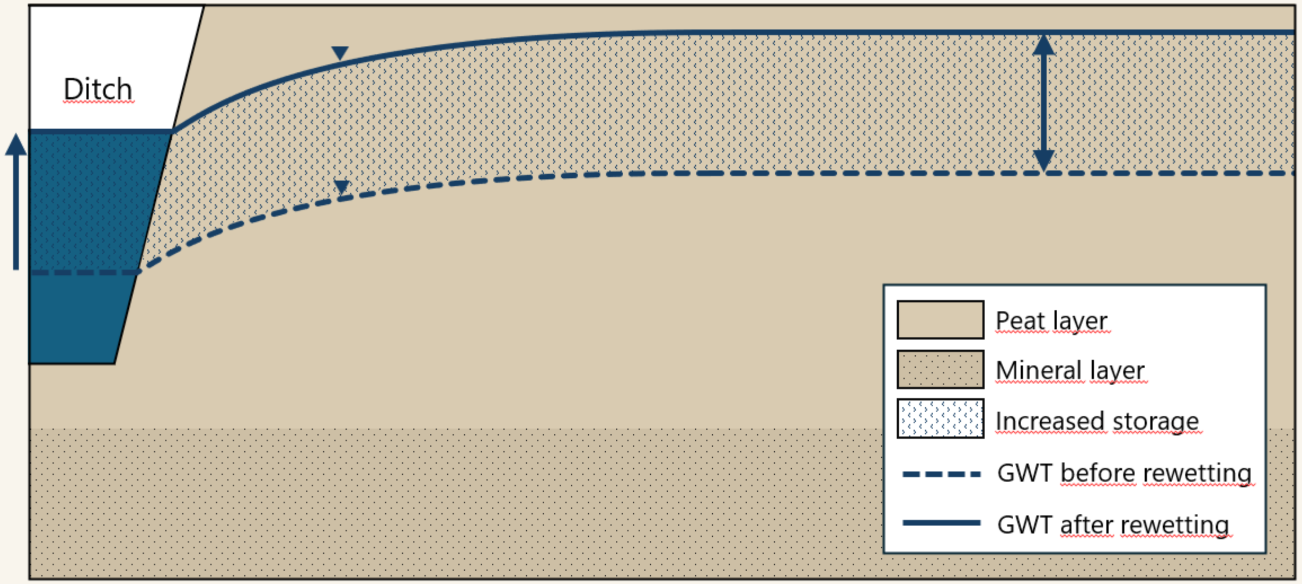
What is ServiPeat?

- Online, model-based decision support system in peatland rewetting
- It provides approximate estimates for:
  - recommended number of dams and their height in ditched peatlands in a rewetting scenario,
  - radius and area of rewetting influence,
  - expected outcomes of rewetting, including water retention gains, changes in GHG emissions, nutrient dynamics, potential changes in biodiversity and the indicative value of ecosystem services,
  - best management practices (no-regret measures).

Methods

- Hydrological module
  - Ditch hydraulics
  - Groundwater flow
- Biogeochemical module
  - Greenhouse gas emissions (CO_2, CH_4)
  - Nitrogen and phosphorus release
- Ecological module
  - Biodiversity
- Economy module
  - Ecosystem services





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User workflow

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Please select condition of your ditch

Good

Moderate

Poor

Please select hydrological type of your peatland

Ombrotrophic bog

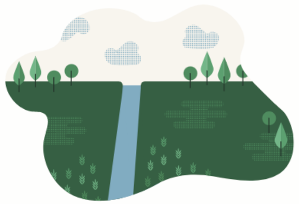
Transitional mire

Minerotrophic fen / Fluviogeneous mire

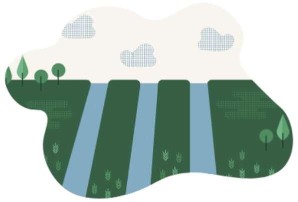
How many ditches are there in the system to be rewetted?

Please keep in mind that in case of a multiple-ditch system, the calculations represent conditions between two ditches and use the geometry of a single ditch only. If your peatland contains more ditches, you need to multiply the results accordingly to estimate the total effect for your system.

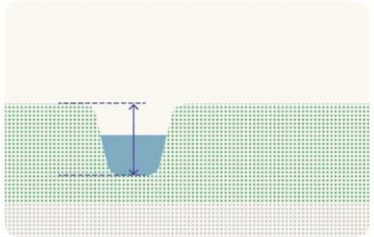
One



More than one



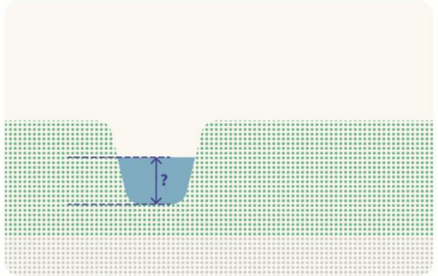
Depth of the ditch



Please specify the depth of the ditch (distance between the edge of the ditch and its bottom)

1 m

Please specify the depth of water in the ditch



0.6 m

Please specify the length of the ditch to be blocked

200 m

Please specify the pH of the peat in your peatland

4.5 -

Case study
Friesland, the Netherlands

Ditch condition	Peatland type	Ditch depth	Water depth in the ditch	Soil pH	Ditch length	Ditch spacing	Nr of ditches	Peat thickness	Land use
Good (well maintained)	Fen	1.5 m	0.5 m	6.3	300 m	100	10	2 m	Arable land

Weideveld et al, 2021
https://doi.org/10.5194/bg-18-3881-2021

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Results

In order to rewet the peatland it is required to design:

29
ditch blocks

1.0 m
elevation each

Radius of rewetting influence

Area of rewetting influence

13,380 m^2

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Results

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Costs:
11 600 EUR – wood dams

Benefits:
5559 EUR/year

By rewetting your peatland you could potentially gain:

4,541 m^3
of water storage

602.6 kg
Nitrogen
that could potentially be released after rewetting

5,559
€/year
Approximate total value of quantified ecosystem services gained through rewetting, which gives 4,155 EUR/ha/year

50.0 T
of CO_2
equivalent stored in the rewetted peat resulting from immediate cessation of emission from drained peat soil

106.2 kg
Phosphorus
of outwashed total reactive Phosphorus in first years from rewetting

+26 % vascular plants **+7 %** mosses **+8 %** birds
Relative increase in the number of species

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Other features

- Rewetting costs — See rewetting costs
- Trade-off analysis — Use as a reference for a trade-off analysis
- Report generation — Get report

Trade-off analysis

Please select condition of your ditch*

Land use*

Ditch depth
1.2 m

Required distance to the groundwater table in the middle of your peatland
15 cm

Cancel | Calculate

servipeat | WET HORIZONS

Report for: test

Transitional mire, more than one ditch, average distance between ditches: 150, water depth 0.5 m, peat pH 5.5, distance from the bottom of the ditch to the bottom of the peat layer 1 m, ditch length 200 m

Base scenario

Condition of the ditch: Good
Land use: Arable land
Depth of the ditch 1.2 m
Required distance to the groundwater table in the middle of the peatland 0.15 cm

In order to rewet the peatland it is required to design:
18 ditch blocks
0.5 m elevation each

By rewetting your peatland you could potentially gain:
689 m3 of water storage
58.3 kg of N-NO3
that could potentially be released after rewetting.

1106 EUR/year
Approximate total value of quantified ecosystem services gained through rewetting, which gives 369 EUR/ha/year.

4.1 T reduced emission of CO_2 eq.
11.6 kg of redox-sensitive P
released after rewetting
The amount of redox-sensitive P released after wetland rewetting is highly site-specific and quite reliable in Fe-rich wetlands. However, it fails in calcium-rich peatlands; see manual.

8.3% vascular plants
2.4% mosses
3.3% birds

No regret measures – best management practices
- Increase groundwater inflow, when appropriate

Disclaimer: The results generated by ServiPeat are indicative estimates only. Any implementation of rewetting measures should be supported by a comprehensive, site-specific hydrological and biogeochemical assessment.

generated 20.02.2026, 09:56:42

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Application of ServiPeat

- Preliminary planing and budgeting
- Preparation of funding applications
- Cost-benefit comparisons between rewetting scenarios
- Communicating potential rewetting outcomes
- Ex-ante assessment of peatland rewetting

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Spatial Multicriteria Analysis Tool

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- Designed to help users explore and combine multiple criteria raster layers in a simple multicriteria analysis (MCA) workflow.

The app allows you to:

- load raster datasets,
- inspect them visually,
- assign relative importance weights,
- and generate a final suitability surface
- for download and further use in GIS software

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The mapped data must represent criteria for a certain purpose, such as "restoration“ or “biodiversity importance”.

The app is intended as a decision-support tool.

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Handles data at various scales and extents

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Europe -0.5 degrees

Spatial MCA Tool

Select GeoTIFF Files

Browse server files

Set importance weights (MCA tab)

Importance weight for BirdMap_wgs84

0 — 0.5 — 1

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1

Importance weight for MossMap_wgs84

0 — 0.5 — 1

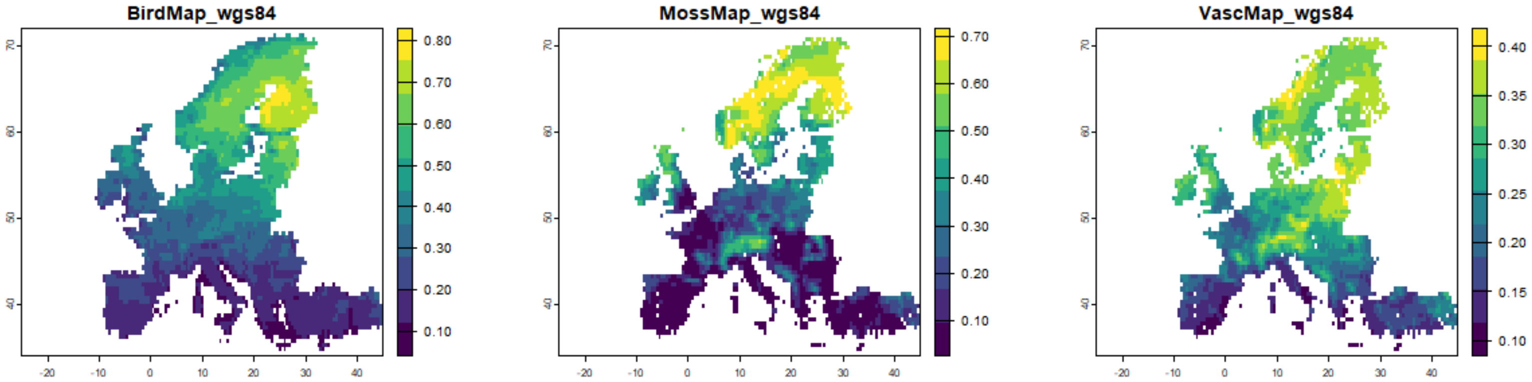
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1

Importance weight for VascMap_wgs84

0 — 0.5 — 1

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1

Introduction | Static Plots | Interactive Maps | Multicriteria Analysis



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N. Germany -100 m

WET HORIZONS

Spatial MCA Tool

Introduction | Static Plots | Interactive Maps | Multicriteria Analysis

Select GeoTIFF Files

Browse server files

Set importance weights (MCA tab)

Importance weight for 90m_germ - Copy (2)

0 — 0.5 — 1

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1

Importance weight for 90m_germ - Copy (3)

0 — 0.5 — 1

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1

Importance weight for 90m_germ - Copy

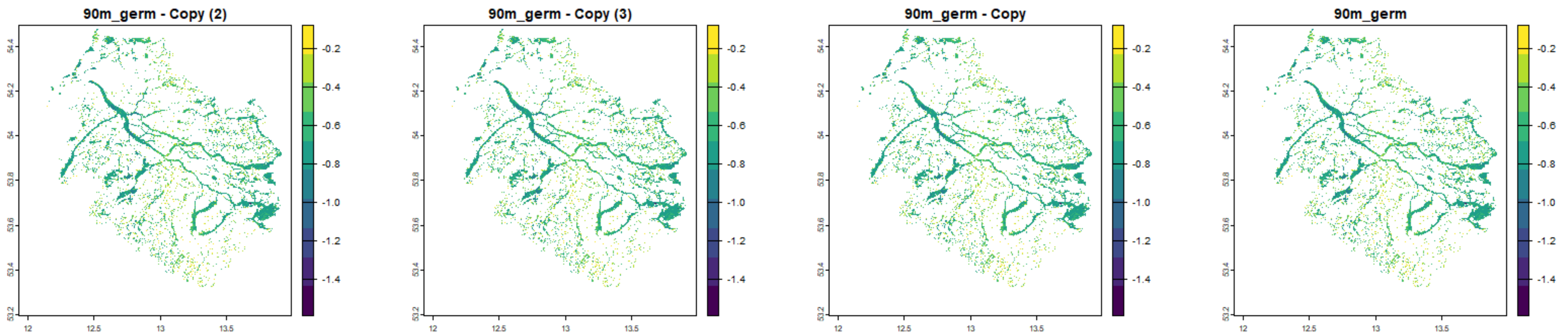
0 — 0.5 — 1

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1

Importance weight for 90m_germ

0 — 0.5 — 1

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1



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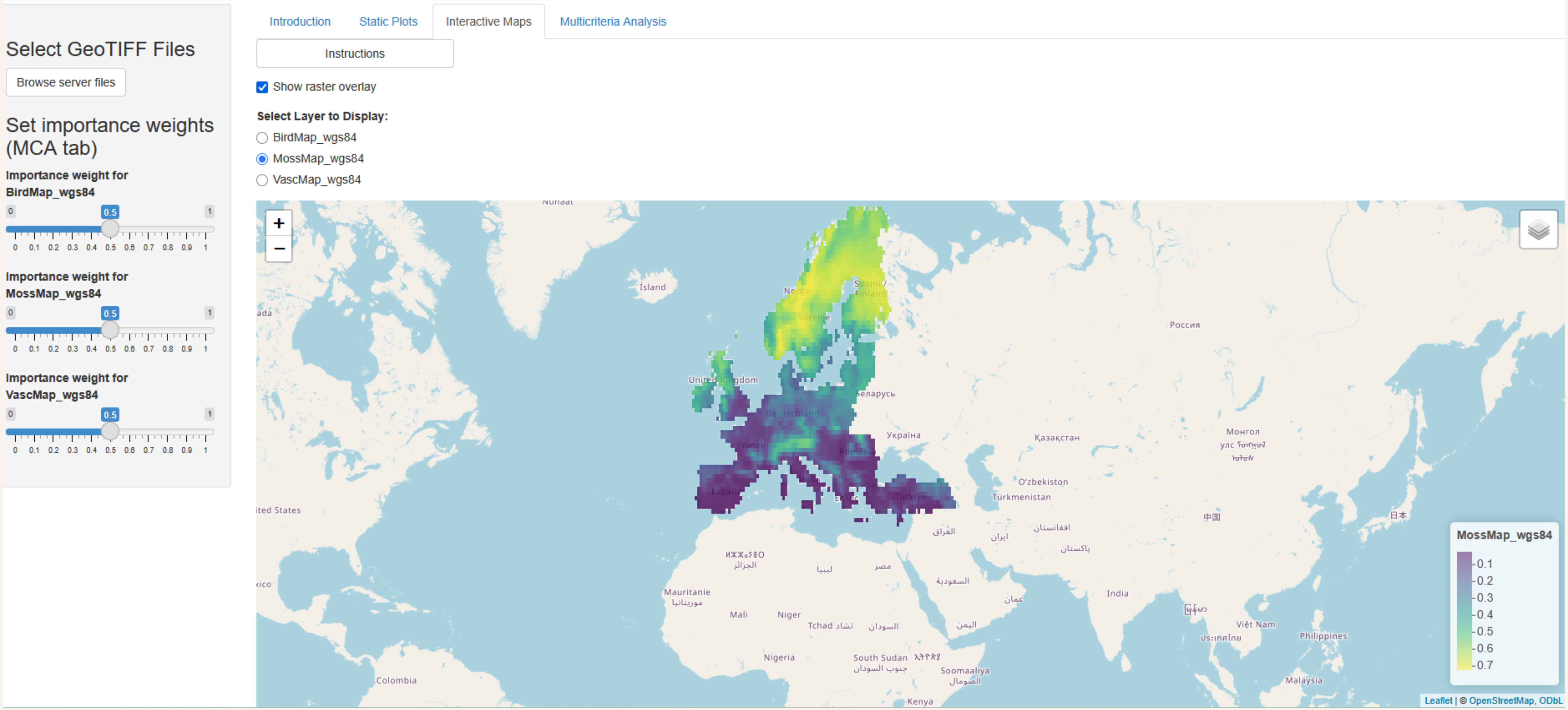
Inspecting criteria layers



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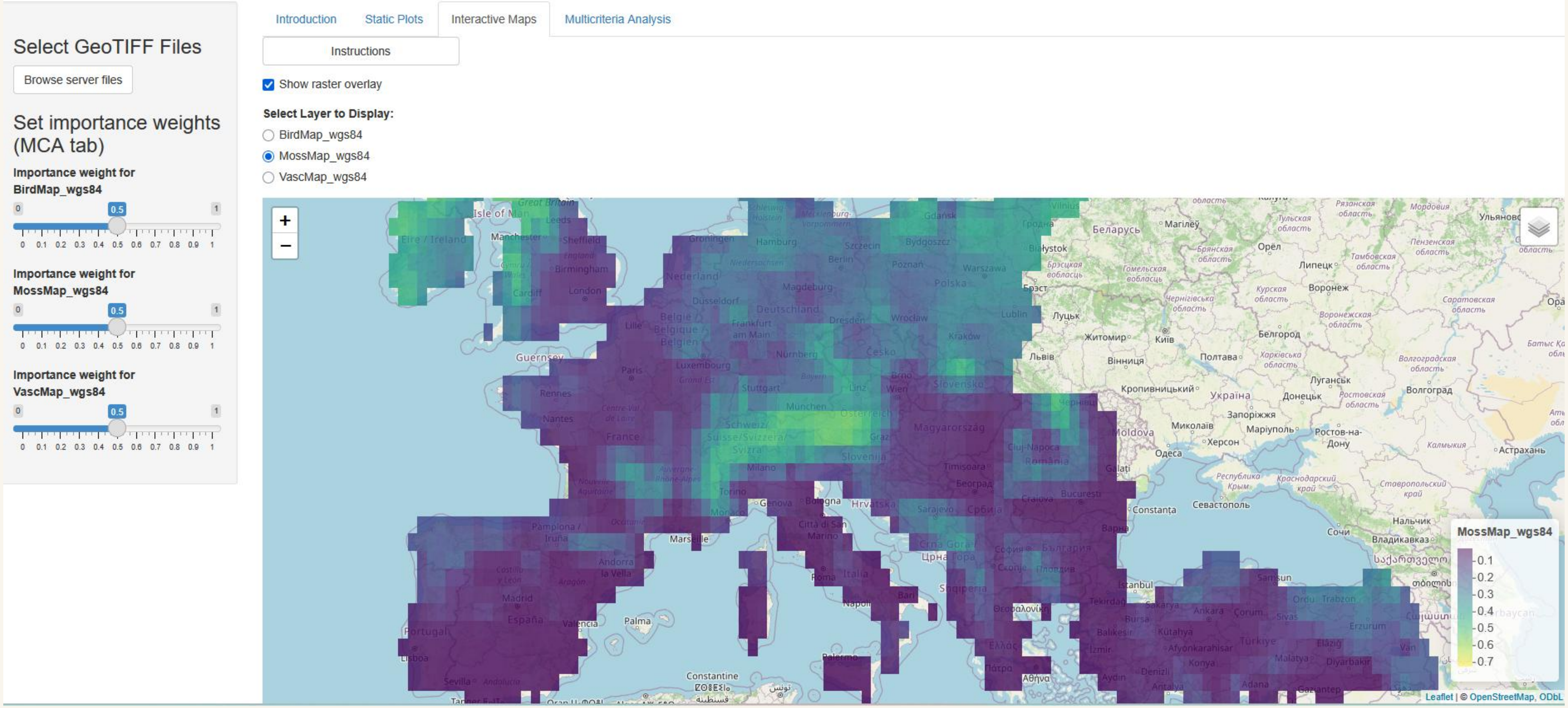
Zoom in

WET HORIZONS



Multicriteria analysis – linear weighted combination

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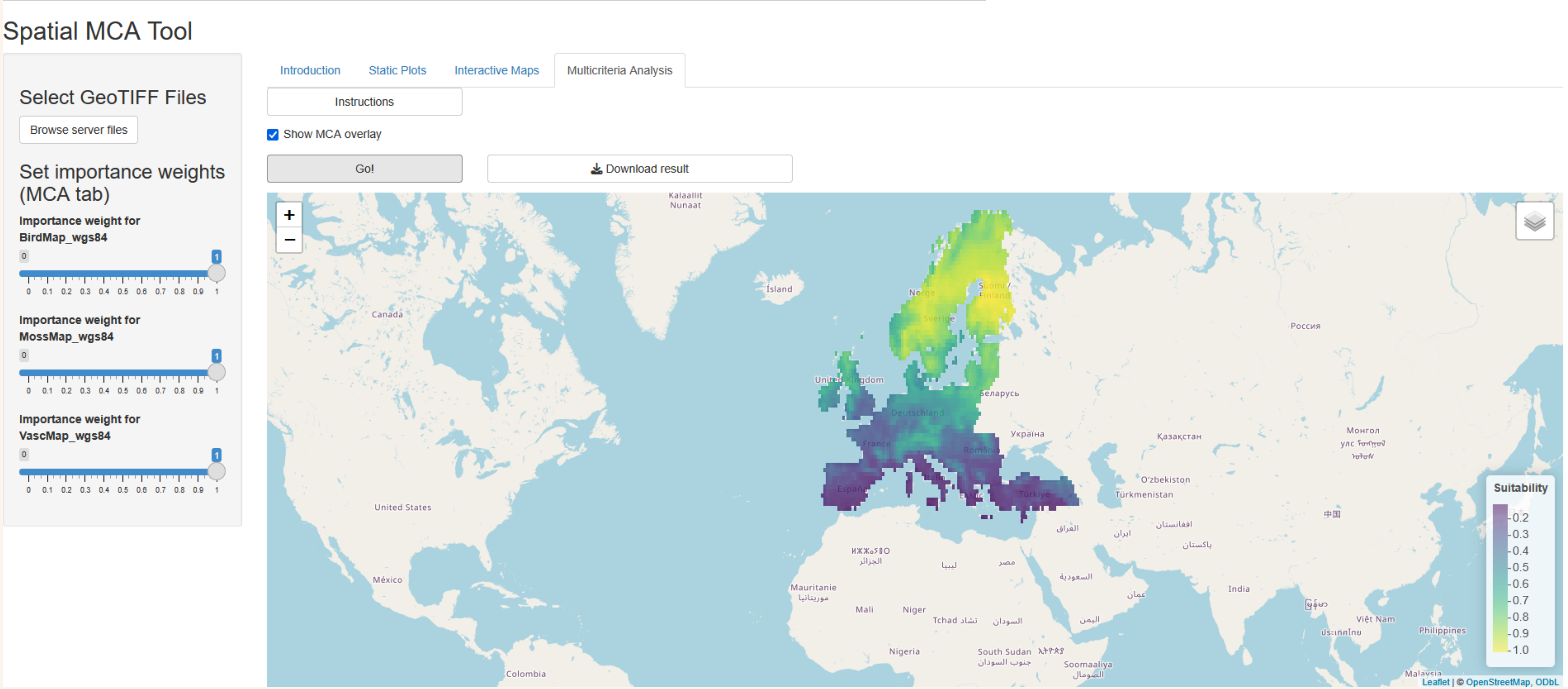

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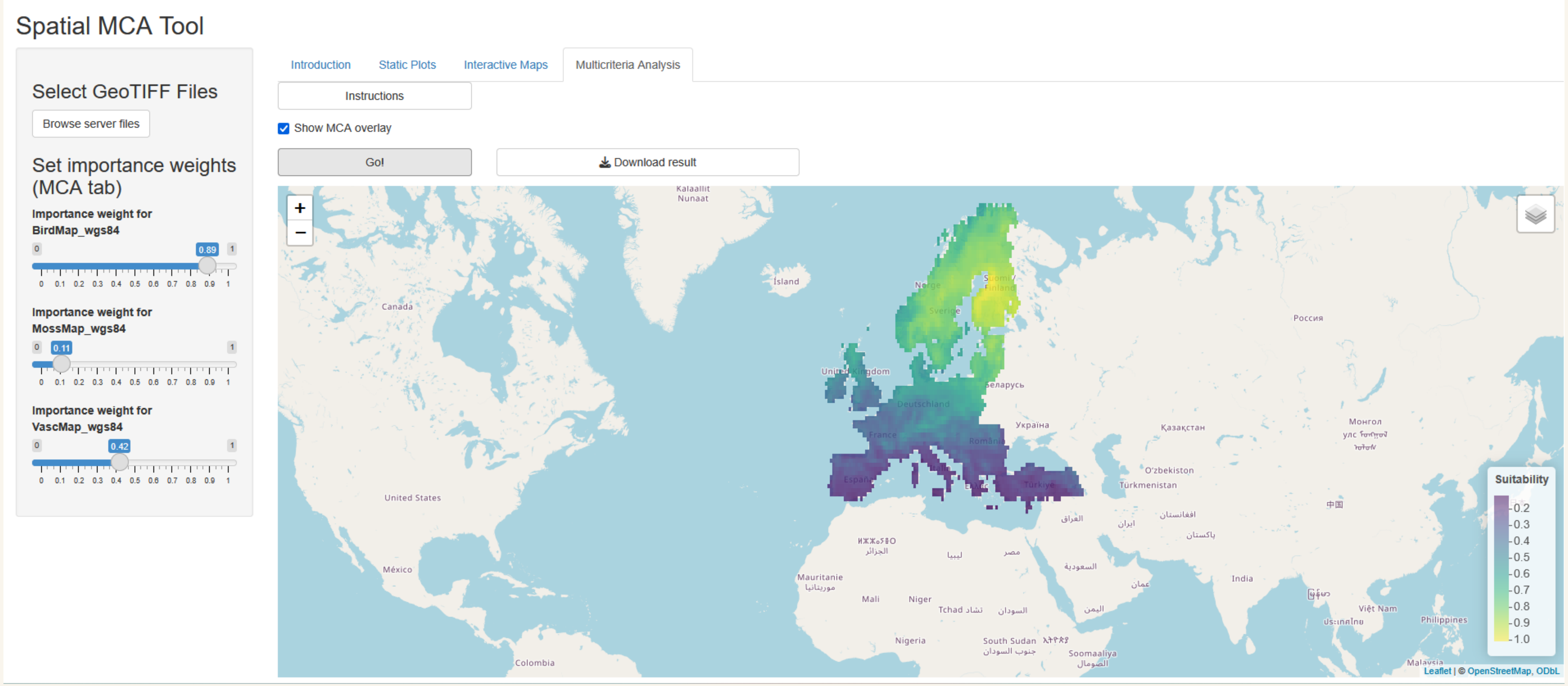
Live map update through sliders



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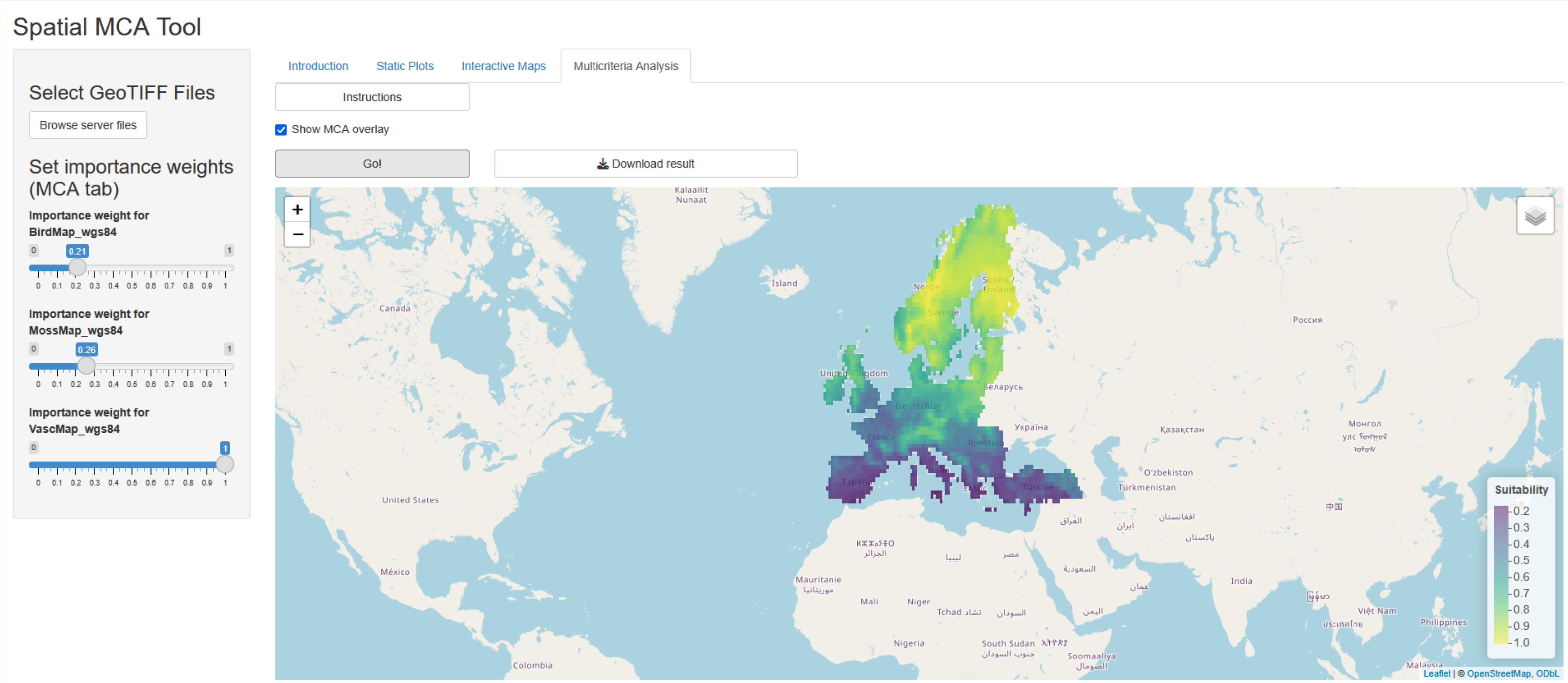

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Usual caveat

WET HORIZONS

The quality and interpretation of the results depend on the quality, consistency, and preparation of the input data. ☺

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Thank you for your attention!

WET HORIZONS

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This research was carried out in the framework of the European Union's Horizon Europe WET HORIZONS project, grant agreement no. 101056848

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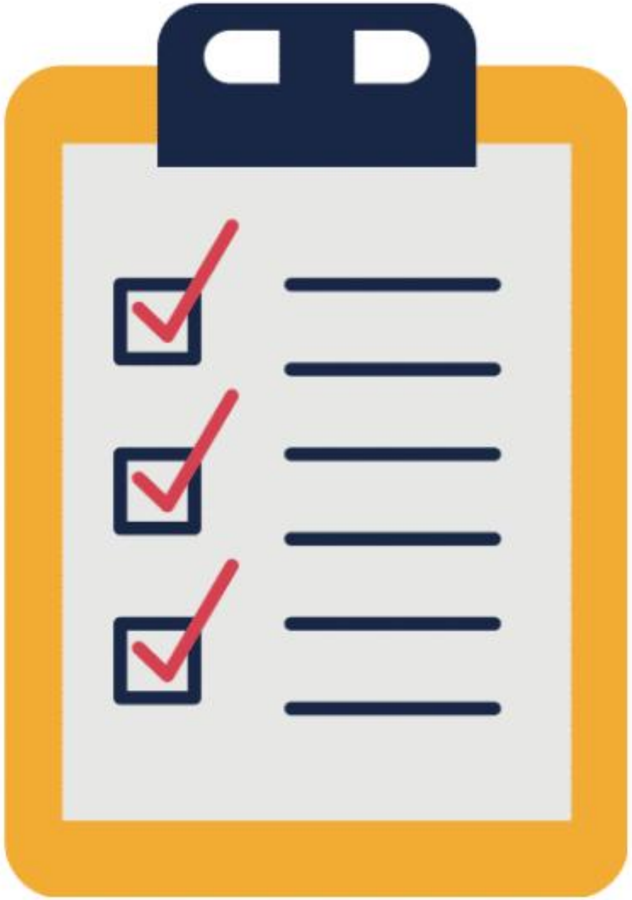
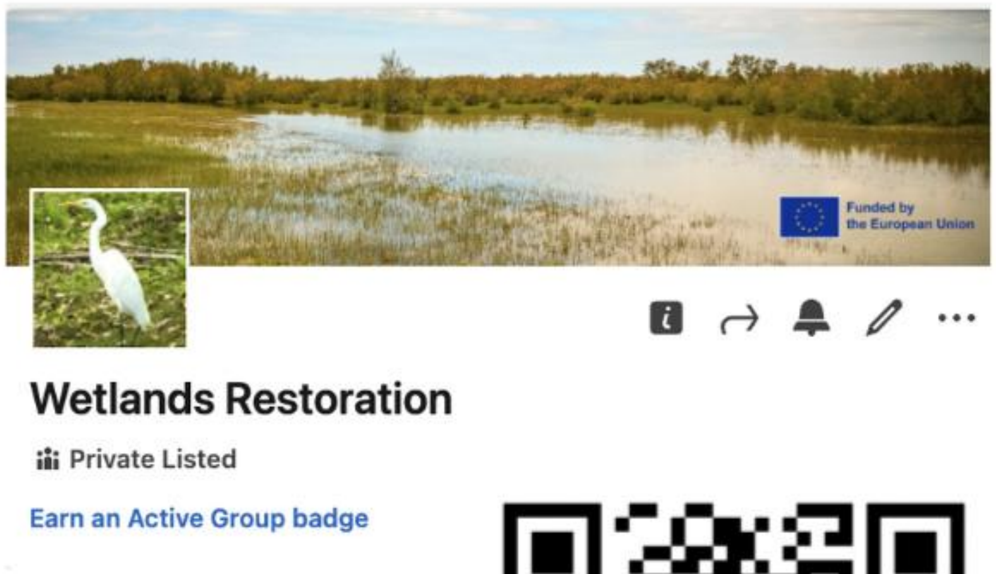
FINAL FEEDBACK QUESTIONNAIRE



[Join the LinkedIn Wetlands Restoration Group]



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