Análisis de vegetación y cartografía a gran escala con teledetección e inteligencia artificial

Análisis de parcelas de vegetación y cartografía a gran escala con inteligencia artificial y teledetección: aplicaciones en conservación de áreas protegidas

Una visión integrada orientada a las necesidades del usuario final

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Instituto Mixto de Investigación en Biodiversidad
IMIB | Universidad de Oviedo-CSIC-Principado de Asturias

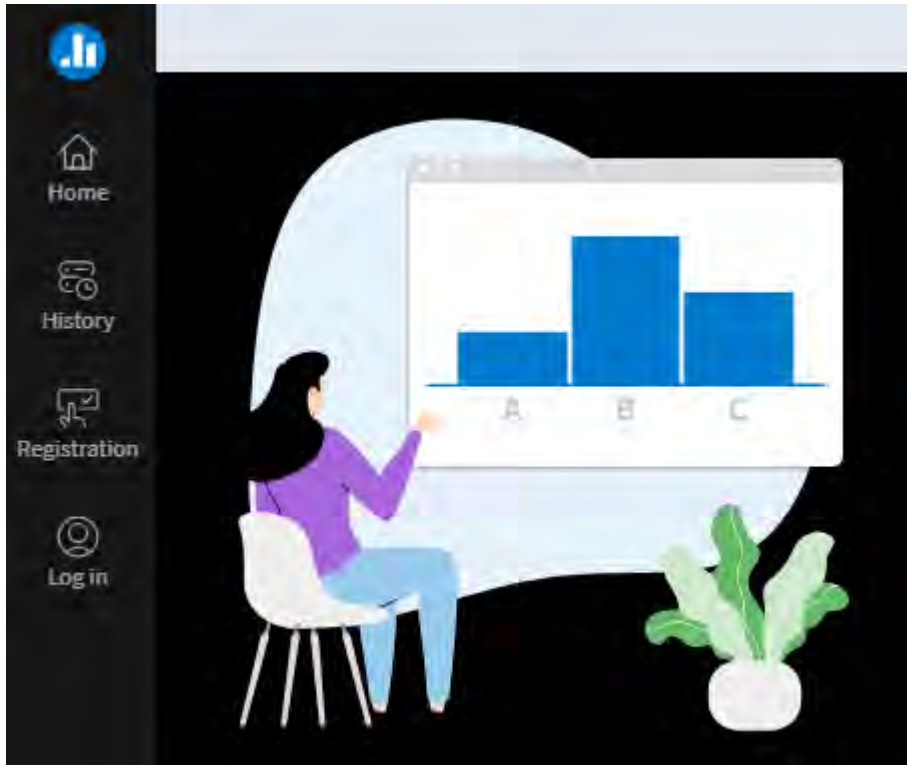
Tracy Hruska & Roger Norum

Socios/as de los proyectos Europeos **MOTIVATE y PAs**

Co-funded by the European Union

Gap analysis survey: encuesta de capacidades y necesidades

https://pollev.com/gonzalohernandez049



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Contenido

Colaboración a escala EU_

Capacidades y necesidades (gaps)

Por qué?

Cómo?

Proyecto MOTIVATE_

Cómo muestrear y validar información in-situ?

Proyecto CLMS Protected Areas_

Una metodología común a escala UE

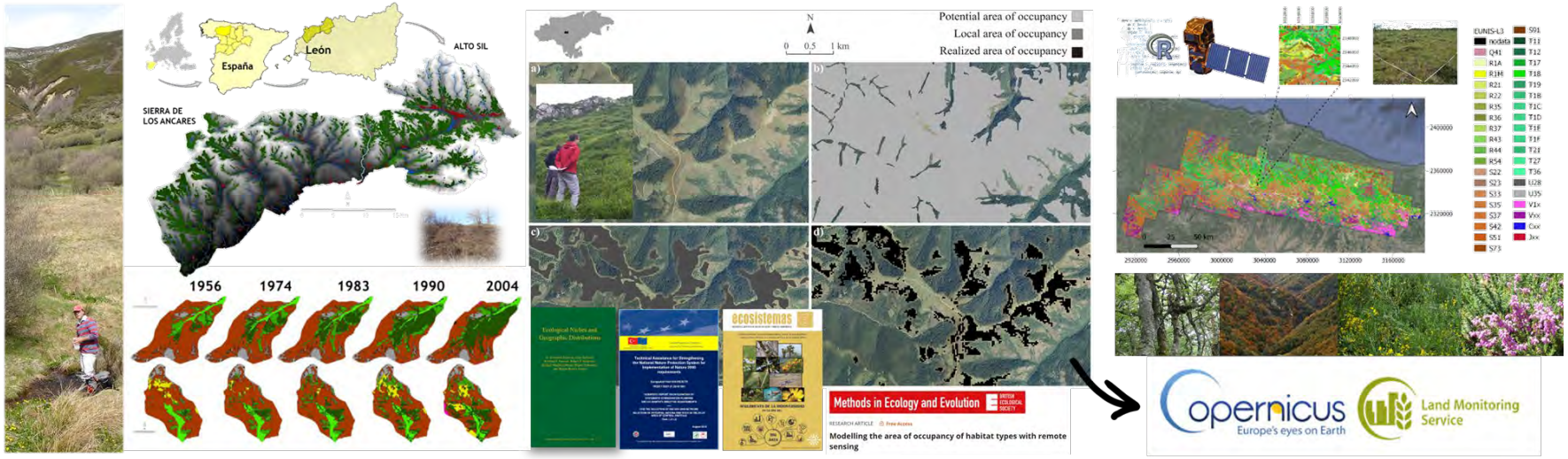
Copernicus user uptake

Dónde?

Línea de investigación: *RS-based vegetation mapping and monitoring*

Tres ejes en la línea de investigación:

- **Distribución y dinámica de poblaciones y comunidades vegetales** → a nivel de cambios en la composición y estructura a lo largo del tiempo, partiendo de un dato in-situ basado en criterio experto que analice, además, los efectos del uso del suelo y otras perturbaciones
- **Modelado ecológico y teledetección** → desarrollando modelos predictivos de la distribución de especies y comunidades, utilizando técnicas de aprendizaje automático y grandes bases de datos, incluidas imágenes de teledetección para monitoreo a gran escala. Desarrollo de indicadores y variables espectrales y biofísicas a través de índices de vegetación relativos a biomasa y productividad, humedad del suelo o índice de área foliar (LAI) **¡EBVs!**
- **Transferencia y gestión** → aplicación de los conocimientos adquiridos para la conservación de la biodiversidad vegetal y el manejo de ecosistemas, identificando áreas prioritarias para la conservación, evaluando el impacto de especies invasoras y desarrollando estrategias de adaptación y mitigación al cambio climático y los usos del suelo.



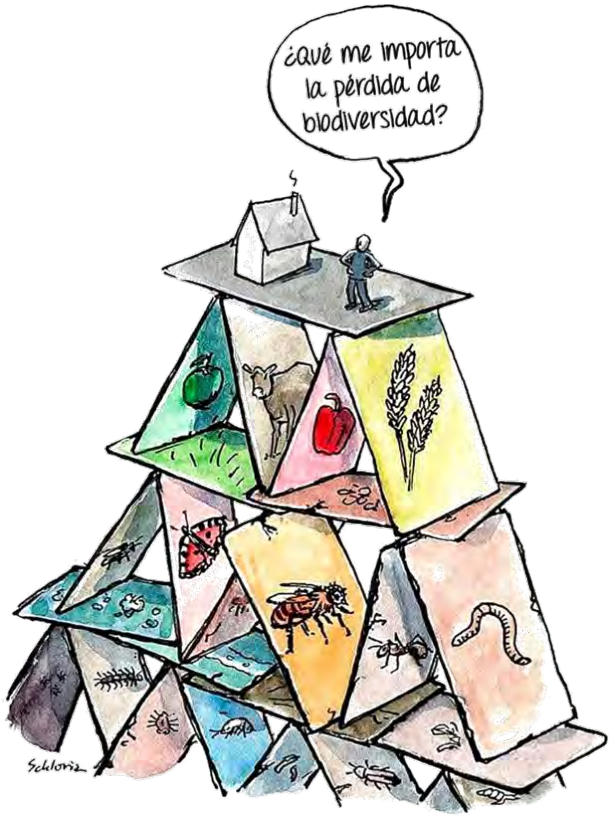
Del paisaje y la vegetación… hasta la multifuncionalidad ecosistémica: **el papel de la biodiversidad vegetal**

[1] Cavender-Bares, J., Gamon, J. A., & Townsend, P. A. (2020). ***Remote sensing of plant biodiversity*** (p. 581). Springer Nature.
[2] Cavender-Bares J et al. 2022. Nat Ecol Evol. 6(5):506-519
[3] Tosa M. et al. 2021. Frontiers in Ecol. and Evolution, 9, 698131.
[4] Reddy CS et al. 2021. Biodiversity and Conservation, 30, 1-14.
[5] Reddy CS et al. 2021. Biodiversity and Conservation, 30, 1-14

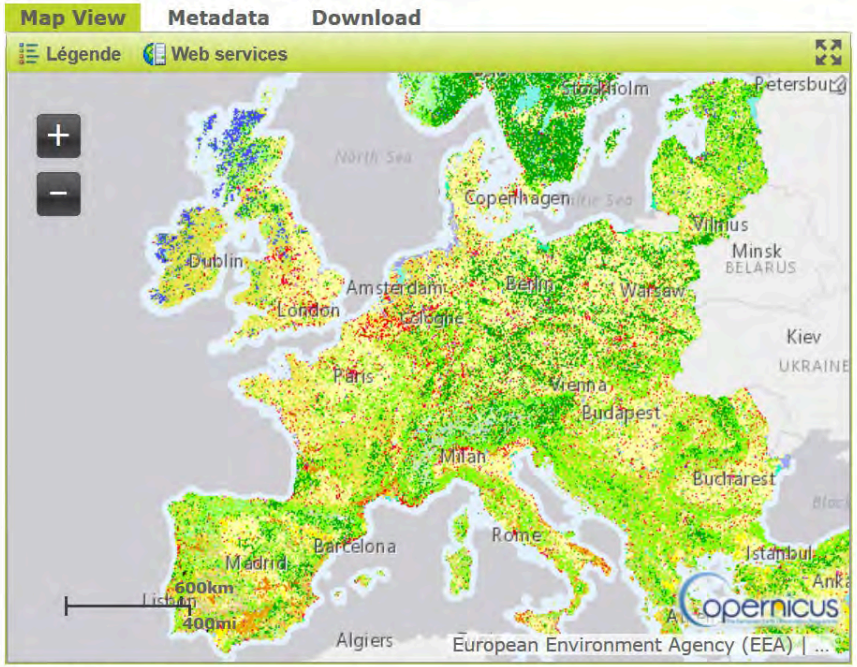
Paisajes heterogéneos

Sistemas dinámicos

Driving forces



ECOSYSTEM SERVICES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Rome
Madrid
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600km
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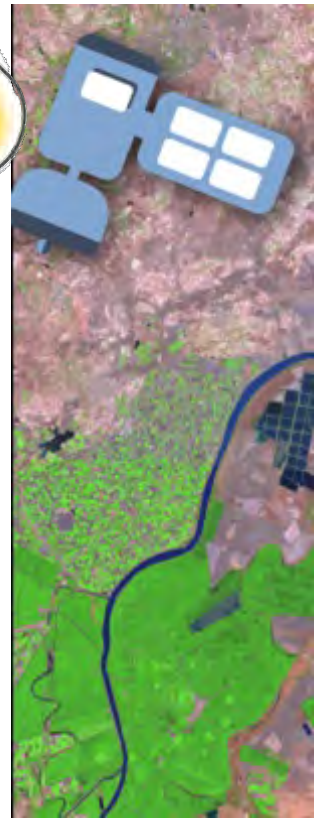
Copernicus
European Environment Agency (EEA) | ...

User corner


CO2
ECOSYSTEM SERVICES

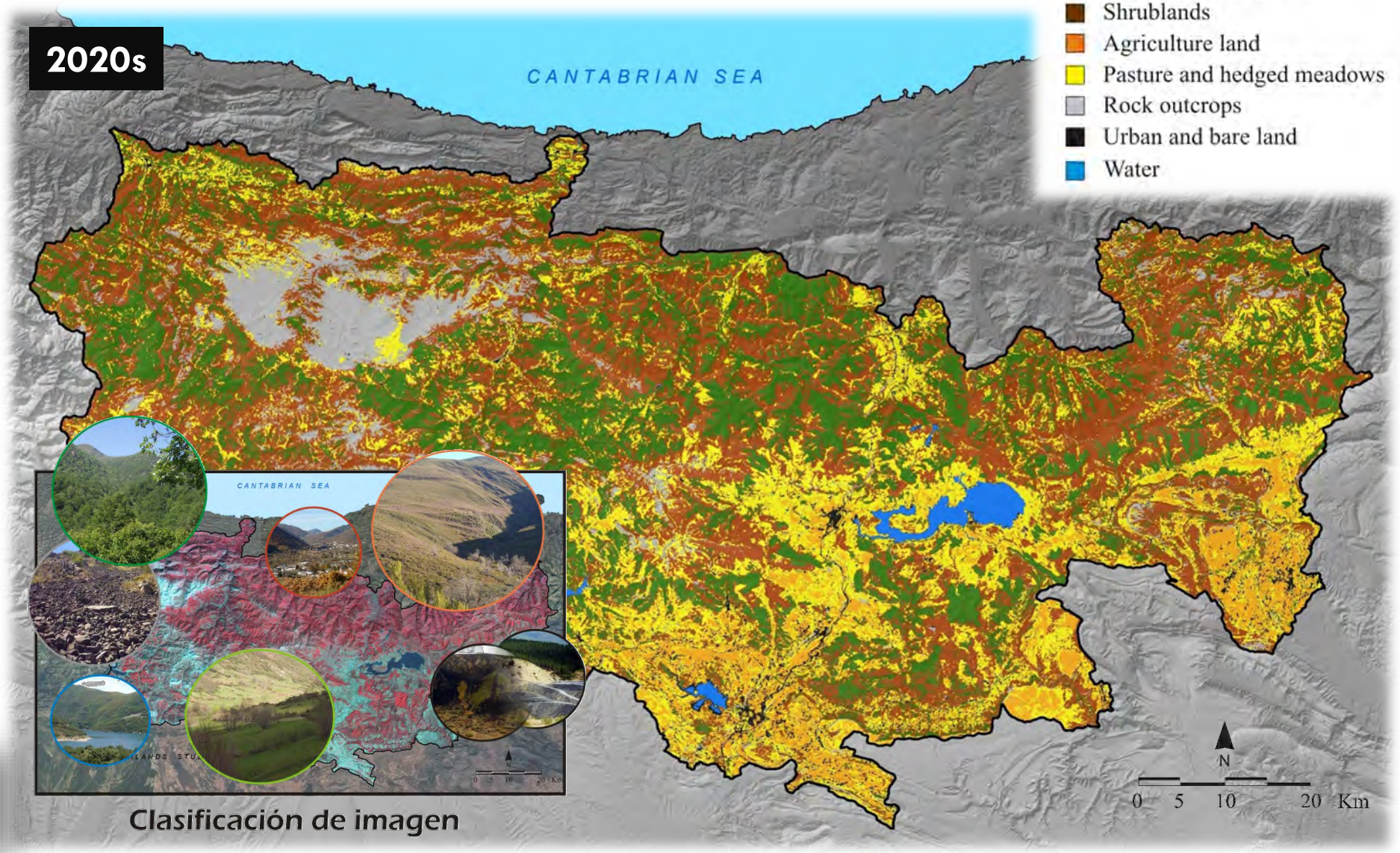
Podemos crear nuestros propios mapas



sentinel-2

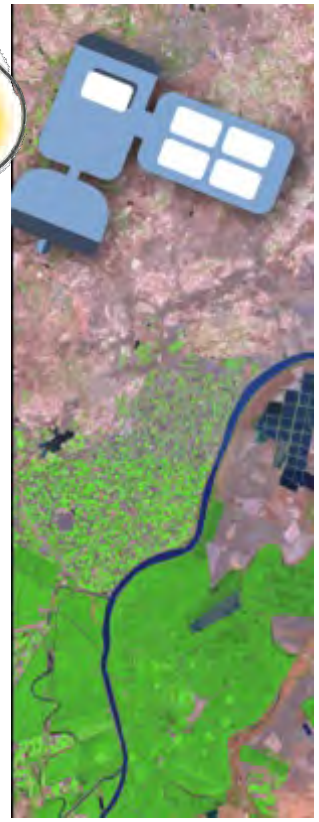
Hard classifiers. Accuracy >85%

2020s

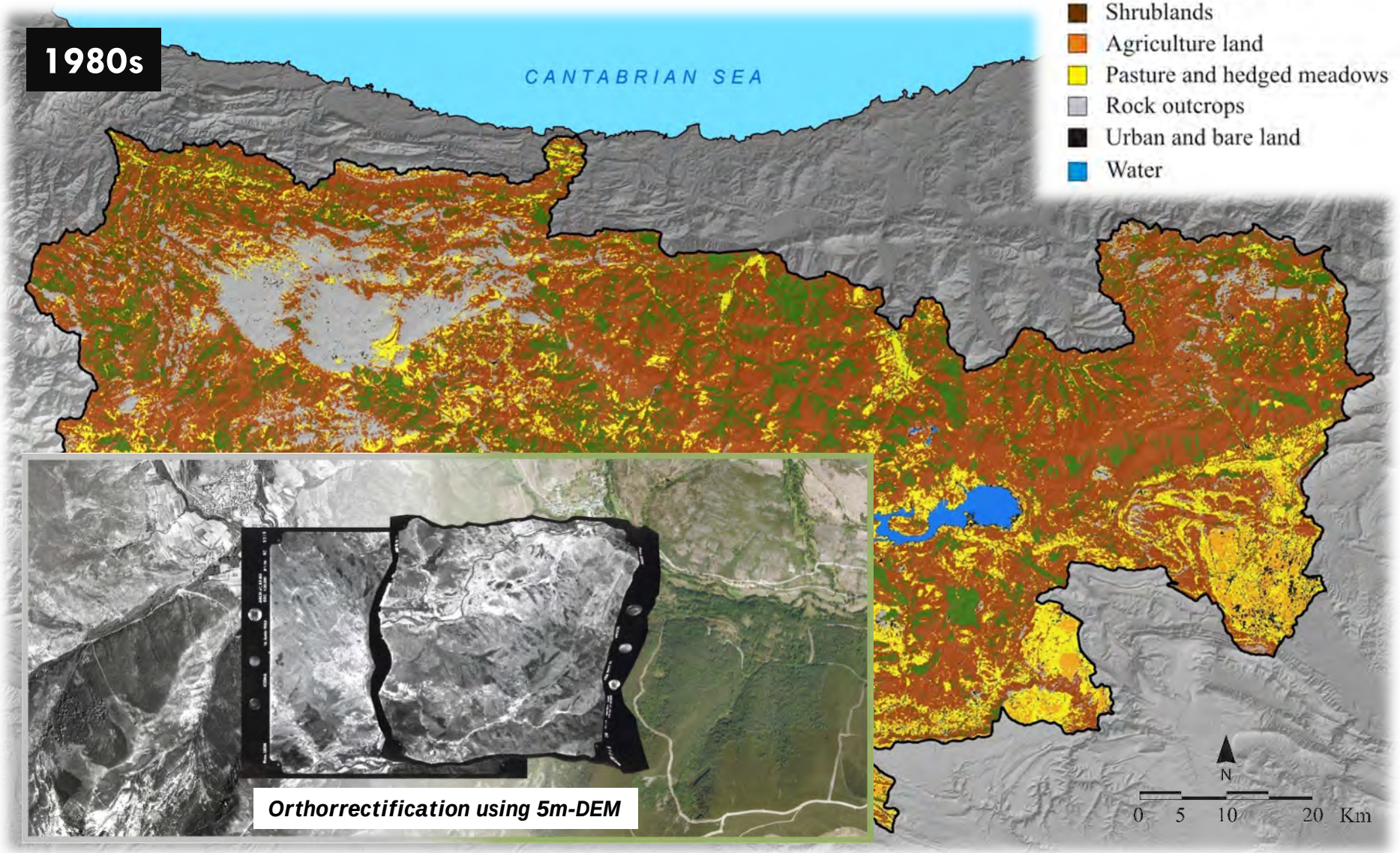


Clasificación de imagen

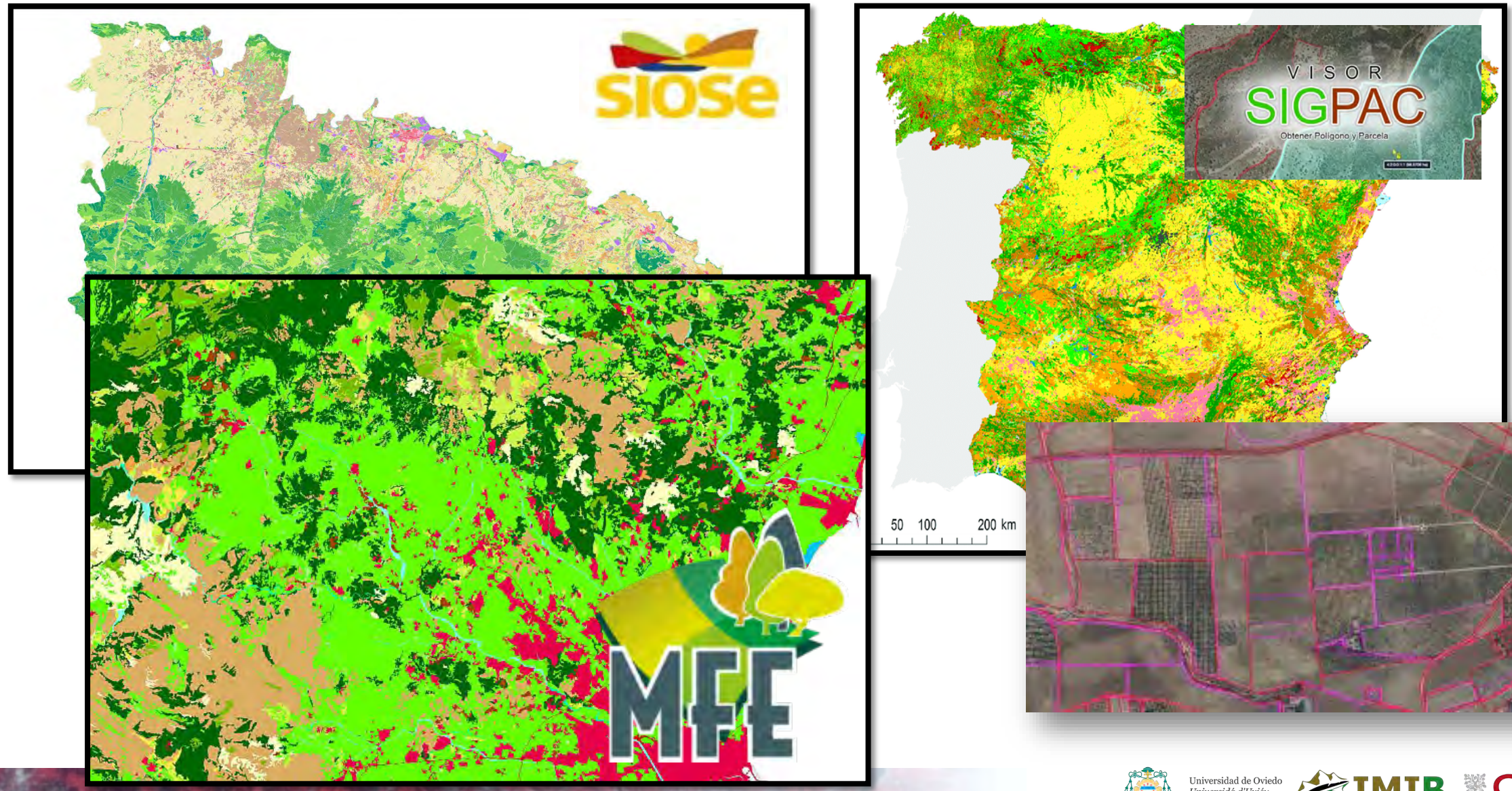
Podemos crear nuestros propios mapas



Collection of 1980 spectral signatures using old aerial imagery as ground data and RS-based time series analyses

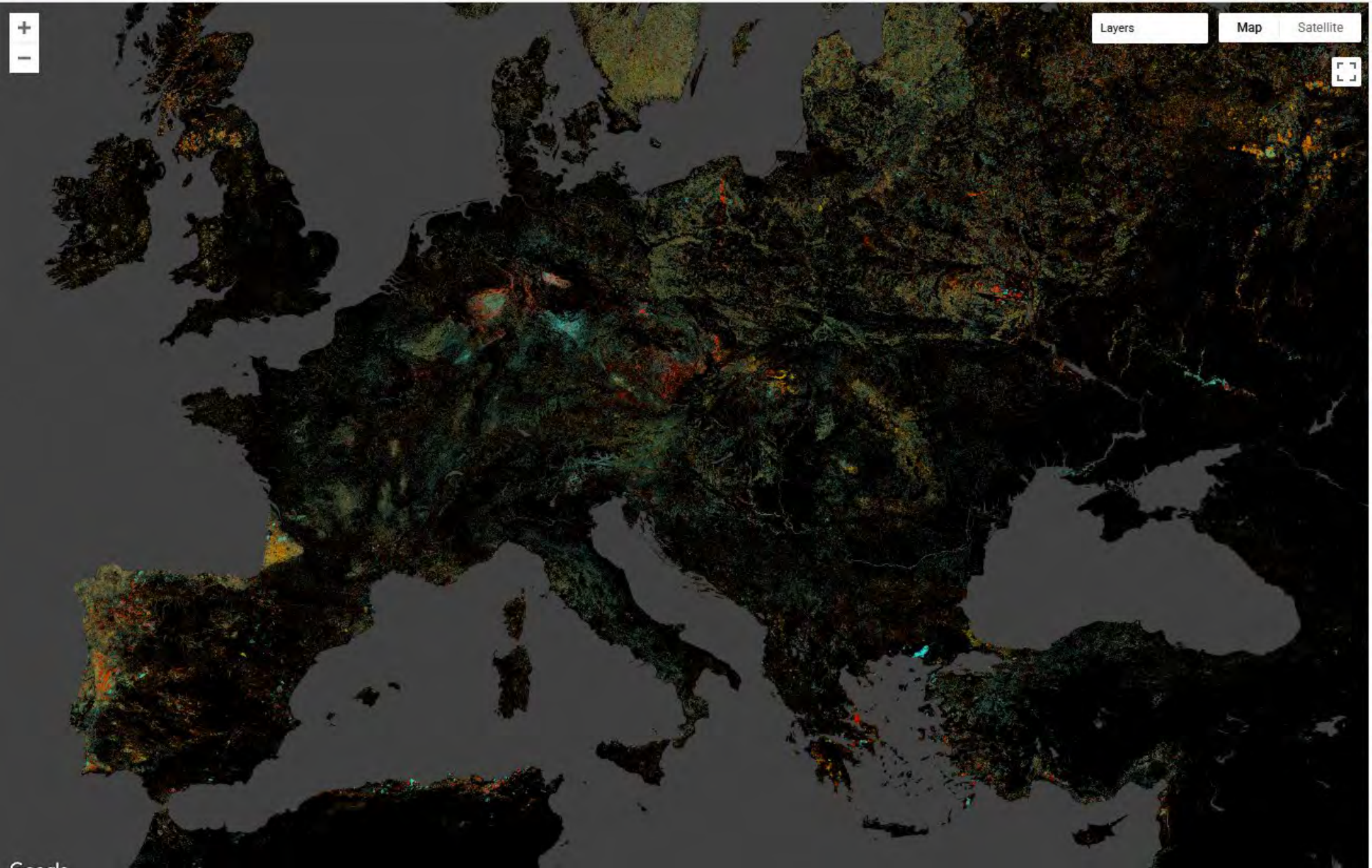


Gran cantidad de mapas...



Gran cantidad de mapas…

HABITAT MAPPING
In-situ data and remote sensing



Global Forest Change

Published by Hansen, Potapov, Moore, Hancher et al.

University of Maryland

Department of Geographical Sciences

Results from time-series analysis of Landsat images characterizing forest extent and change.

Trees are defined as vegetation taller than 5m in height and are expressed as a percentage per output grid cell as '2000 Percent Tree Cover'. 'Forest Cover Loss' is defined as a stand-replacement disturbance, or a change from a forest to non-forest state, during the period 2000–2023. 'Forest Cover Gain' is defined as the inverse of loss, or a non-forest to forest change entirely within the period 2000–2012. 'Forest Loss Year' is a disaggregation of total 'Forest Loss' to annual time scales.

Reference 2000 and 2023 imagery are median observations from a set of quality assessment-passed growing season observations.

To share location copy URL.

Download the data.

☑ Data Products

Forest Loss Year (2023 Highlight)

- 2023
- 2022
- :
- 2000
- No loss
- Water or no data

☐ Other Data Layers

2000 Percent Tree Cover

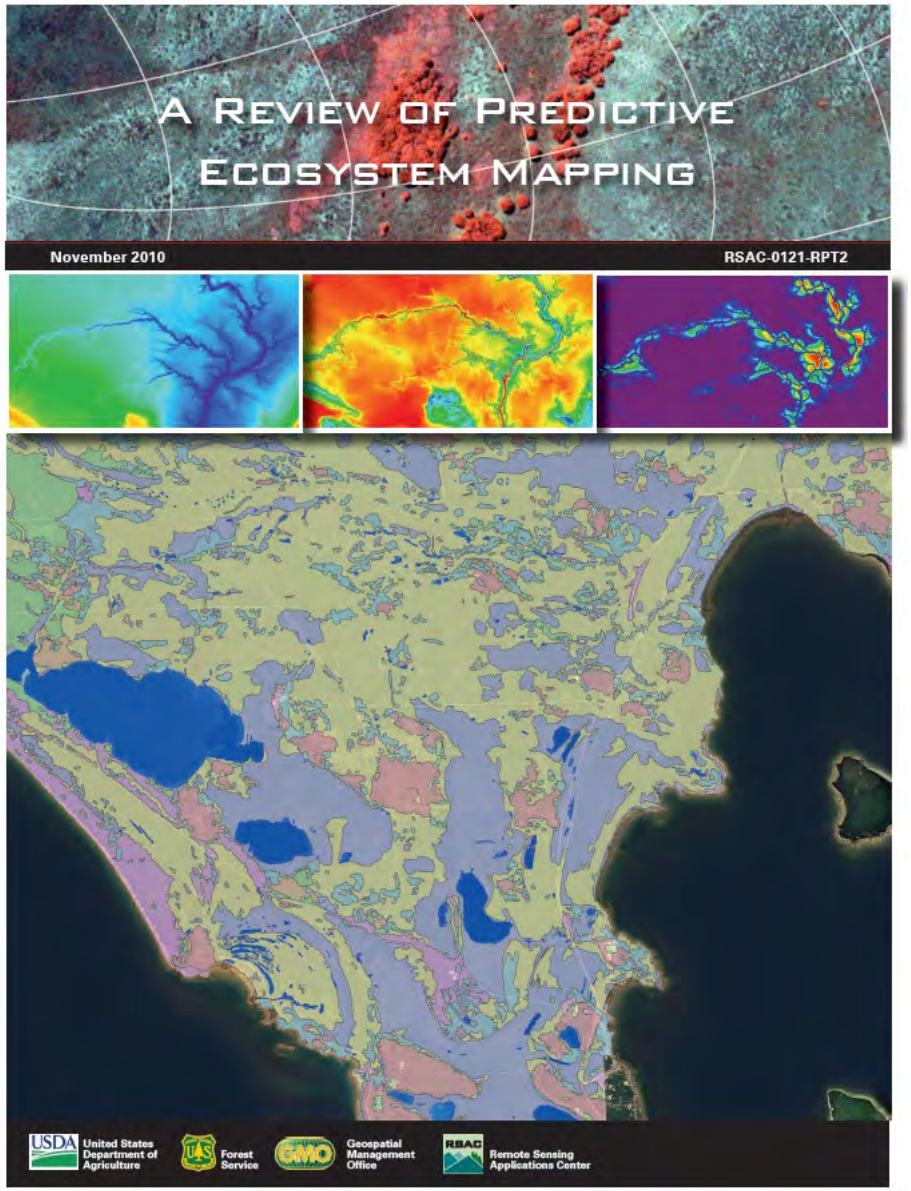
☐ Background Imagery

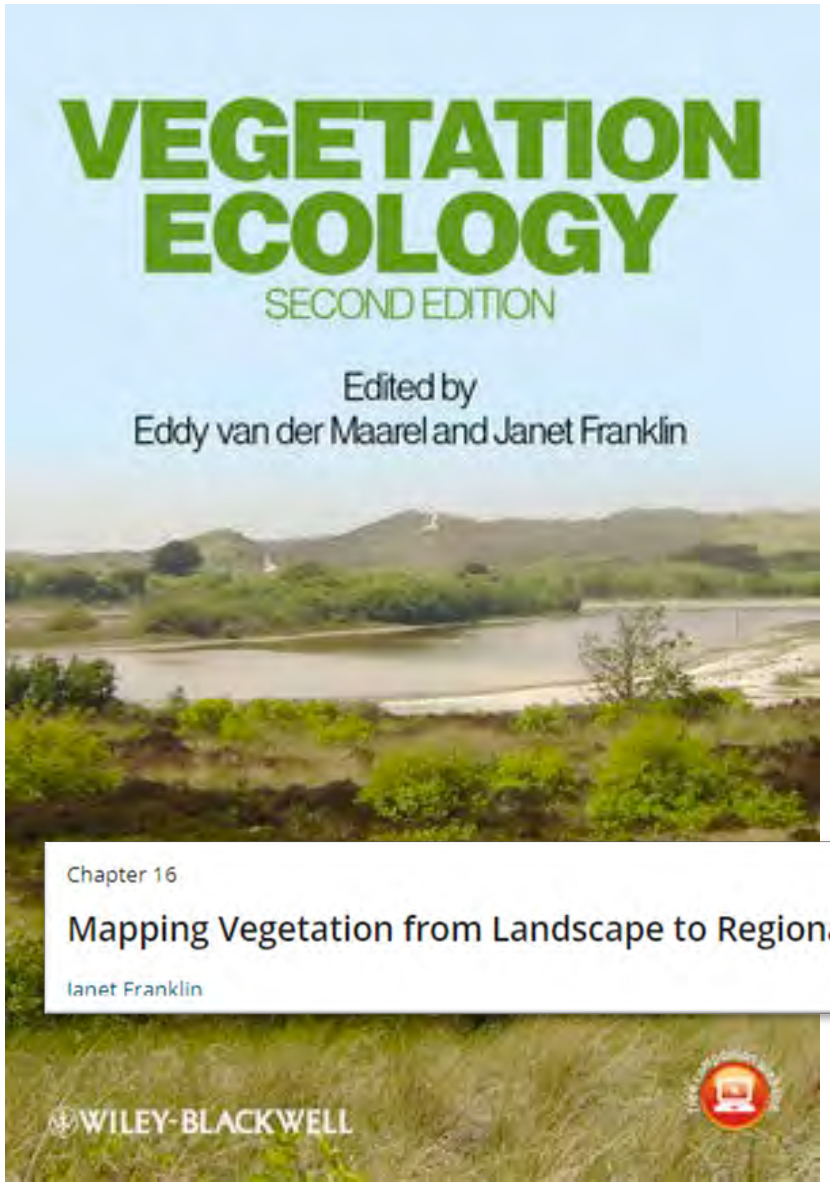
Year 2000 Bands 5/3/4

Example Locations

Wildfires in Canada

Biodiversidad vegetal: existe mucha información…

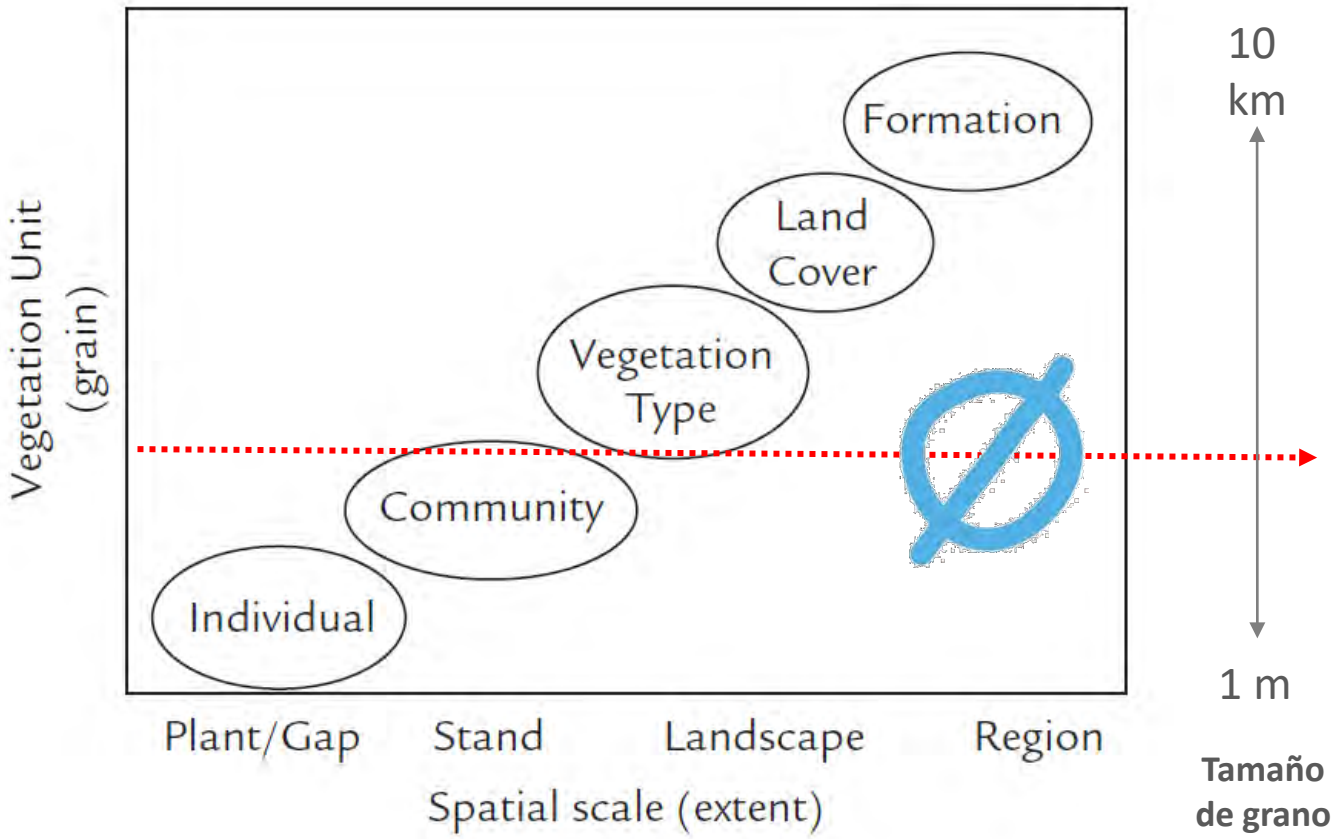


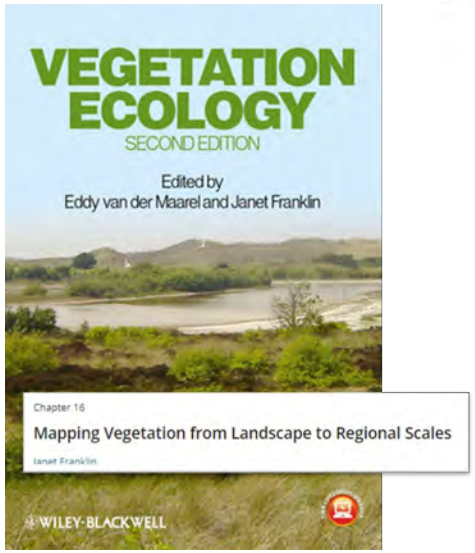


… pero:

¿cubren estos mapas todas nuestras necesidades?

Biodiversidad vegetal: necesidad de (más y mejor) información





Franklin (2013). Mapping Vegetation from Landscape to Regional Scales.
In: van der Maarel & Franklin (Ed.) Vegetation Ecology (pp. 486–508)

Carencia de mapas a gran escala con alta resolución espacial, temporal y tipológica (temática)

Metodologías comparables con base científica

Biodiversidad vegetal: necesidad de (más y diferente) información

European Environment Agency

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Indicators / Conservation status of habitats unde...

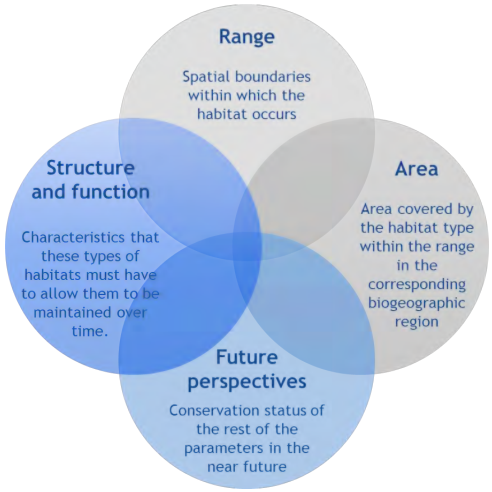
Conservation status of habitats under the EU Habitats Directive

At the EU level, only 15 % of habitat assessments have a good conservation status, with 81 % having poor or bad conservation status. Grasslands, dunes, and bog, mire and fen habitats show strong deteriorating trends, while forests have the most improving trends.

The EU is not on track to meet the 2020 target of improving the conservation status of EU protected species and habitats. At the EU Member State level, the majority of assessments indicate a low number of habitats with a good conservation status. Intensive agriculture, urban sprawl and pollution are the top reported pressures to habitats.

Published: 18 Nov 2021 13:16 – 25min read

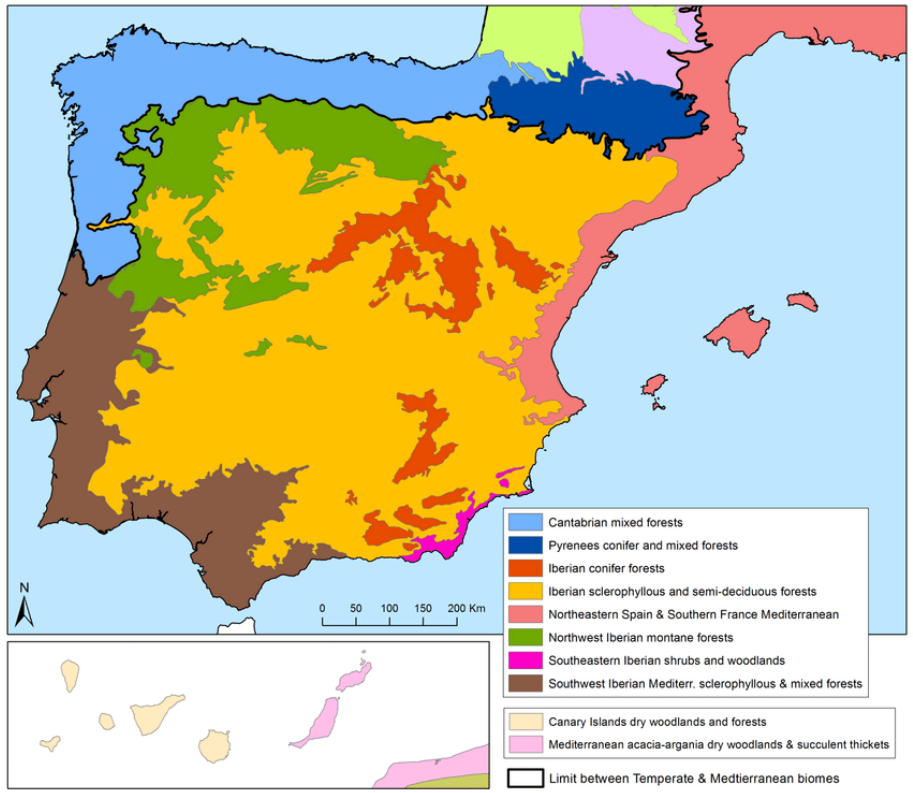
https://www.eea.europa.eu/ims/conservation-status-of-habitats-under

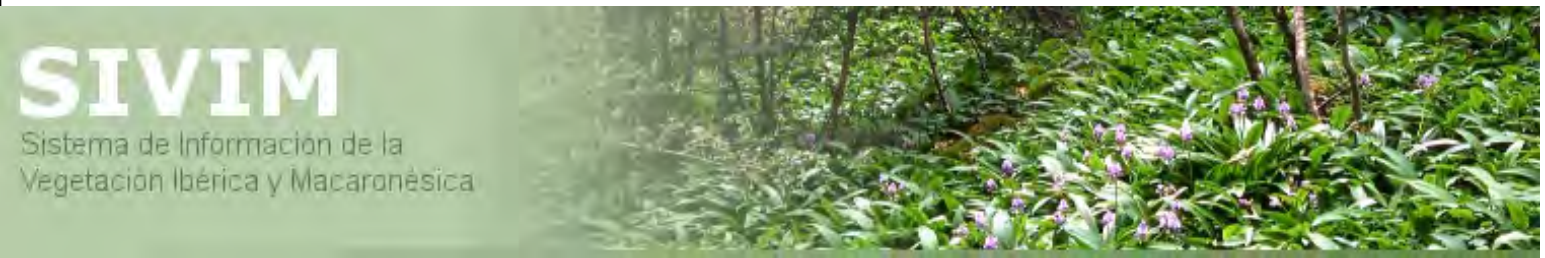


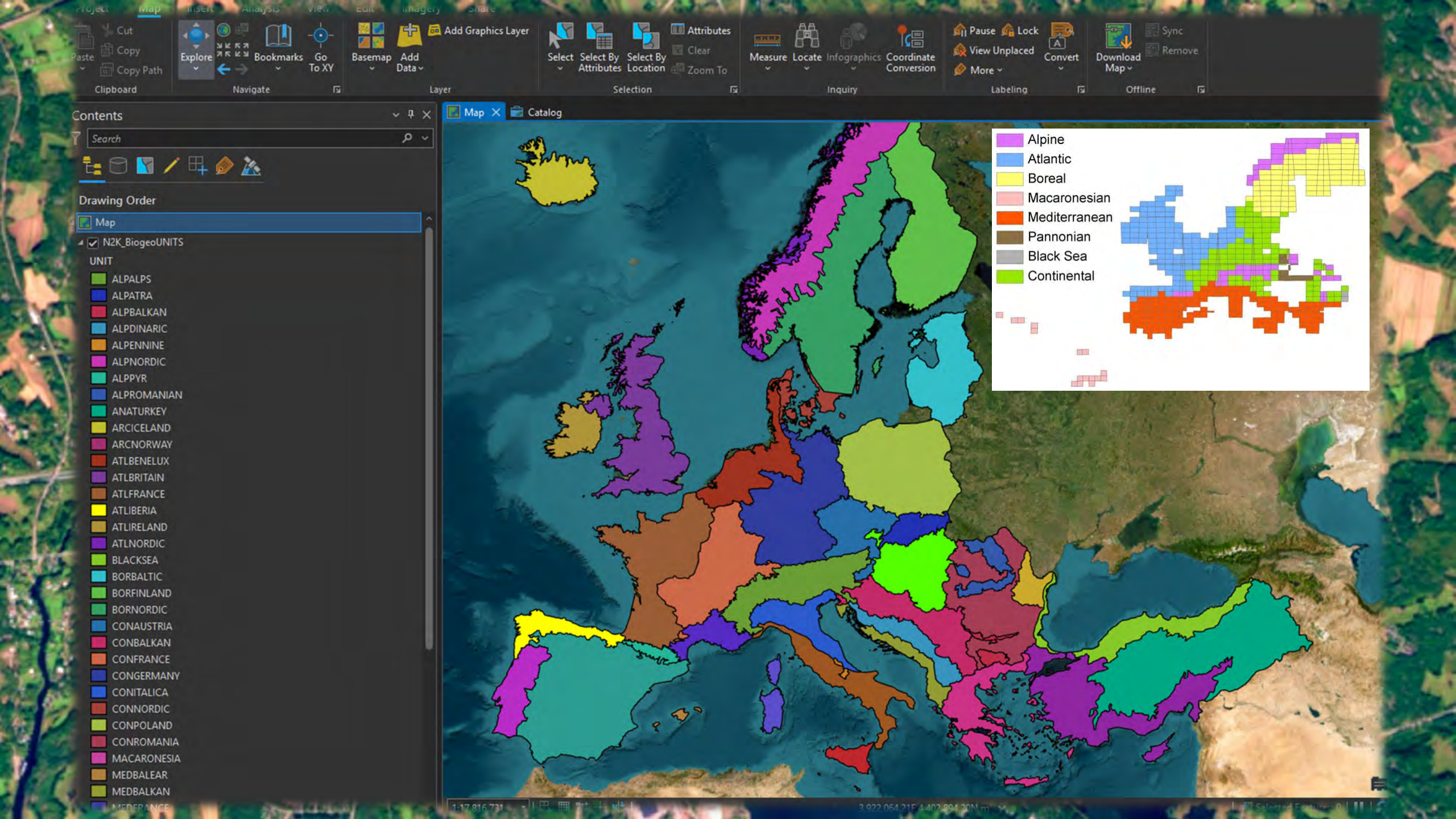
NATURA 2000

The Cantabrian Mixed Forests ecoregion

(= Cantabro-Atlantic province)
28,775 pardelas de muestreo
3,205 especies



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Add Data
Add Graphics Layer
Layer
Select
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Select By Location
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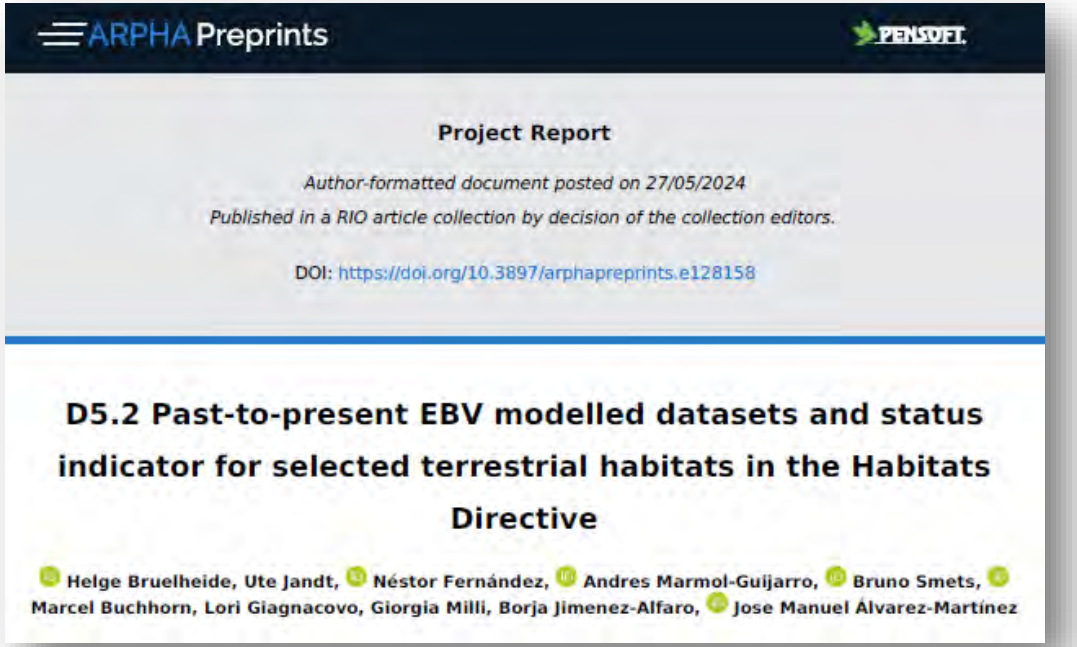
UNIT
ALPALPS
ALPATRA
ALPBALKAN
ALPDINARIC
ALPENNINE
ALPNORDIC
ALPPYR
ALPROMANIAN
ANATURKEY
ARCICELAND
ARCNORWAY
ATLBENELUX
ATLBRITAIN
ATLFRANCE
ATLIBERIA
ATLIRELAND
ATLNORDIC
BLACKSEA
BORBALTIC
BORFINLAND
BORNORDIC
CONAUSTRIA
CONBALKAN
CONFRANCE
CONGERMANY
CONITALICA
CONNORDIC
CONPOLAND
CONROMANIA
MACARONESIA
MEDBALEAR
MEDBALKAN
Map
Catalog
Alpine
Atlantic
Boreal
Macaronesian
Mediterranean
Pannonian
Black Sea
Continental

Desafíos actuales en el seguimiento de vegetación a gran escala

- Optimización de tiempo y recursos
- Consistencia metodológica
- Cobertura a gran escala con alta resolución
- Replicabilidad en el tiempo (monitoreo)
- Basado en datos de campo (GPS) y criterio experto
- Aprovechamiento de datos de teledetección



EUROPABON

Del dato in-situ al mapa (a la gestión) a gran escala

MAPAS:
Patrones y procesos **comparables** a múltiples escalas espaciotemporales

ESTADO DE CONSERVACIÓN:
Estructura, dinámica, función (+ tendencias)
Presiones e impactos

GESTIÓN Y POLÍTICA:
Conservación y restauración.
Multipropósito

EBOCC (UE)

EUROPABON

MOTIVATE

biodiversa+
European Biodiversity Partnership

EVEREST

SONATA

Funded by European Union

Protected Areas

European Environment Agency

opernicus
Europe's eyes on Earth

Land Monitoring Service

Universidad de Oviedo
Universidá d'Uviéu
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El primer paso en seguimiento
de la biodiversidad con RS/IA:
calidad en dato in-situ!

Macroecología Vegetal

Cómo?

Colaboración a escala EU_

Capacidades y gaps

Proyecto CLMS-Protected Areas_

Una metodología común a escala UE

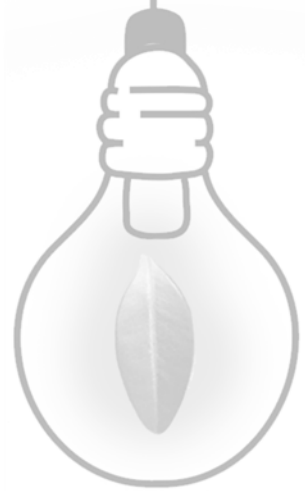
Copernicus user uptake

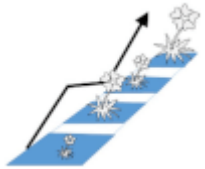
Proyecto MOTIVATE_

Cómo muestrear y validar información in-situ?

Por qué?

Dónde?





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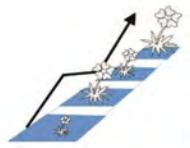

MOTIVATE, Monitoring of terrestrial habitats by integrating vegetation archive time series in Europe

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sPlot & **MOTIVATE** (EVA/ReSurvey)

WP3: Trends in habitat quality and ecosystem properties

First steps towards a remote-sensing-based monitoring of vegetation

Vegetation & Biodiversity Lab

Universidad de Oviedo

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IISTA Instituto Interuniversitario de Investigación del Sistema Tierra en Andalucía

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Our team

MOTIVATE, Monitoring of terrestrial habitats by integrating vegetation archive time series in Europe

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Vegetation & Biodiversity Lab

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IMIB

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Javier Martínez-López
Domingo Alcaraz Segura

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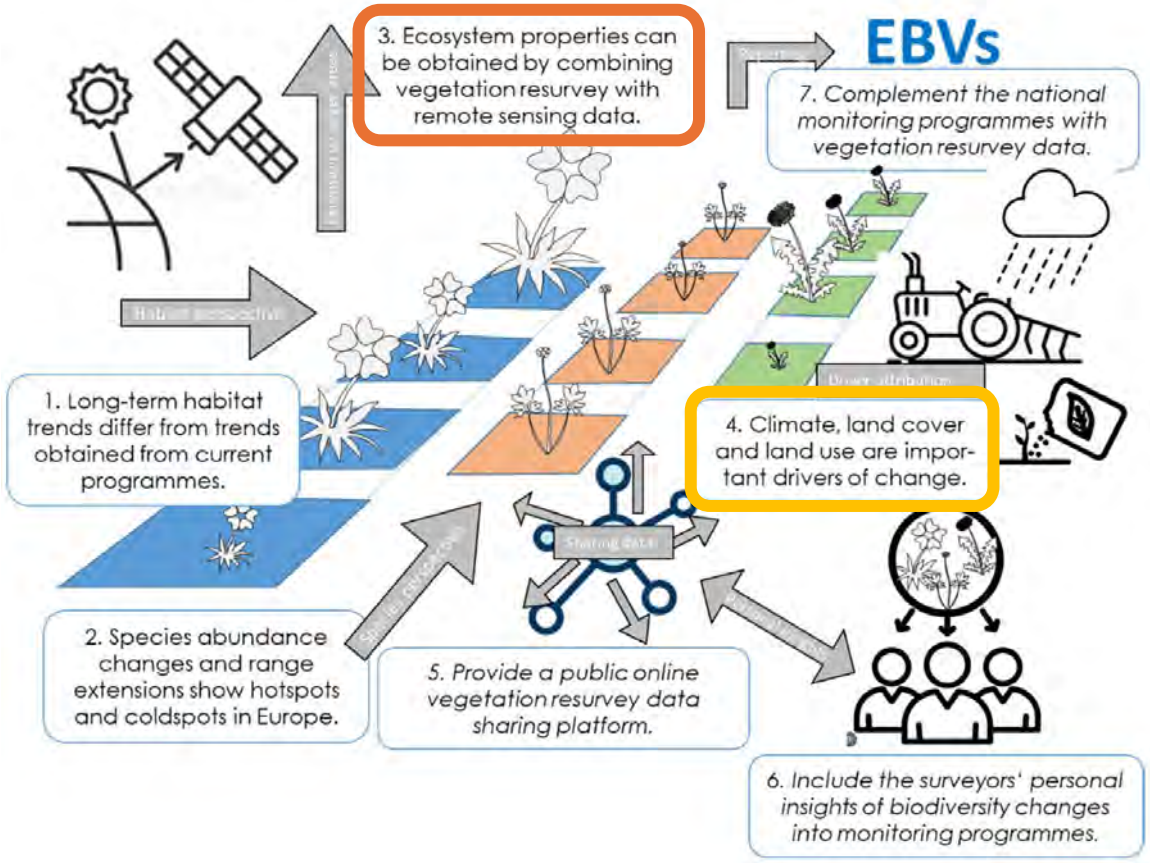
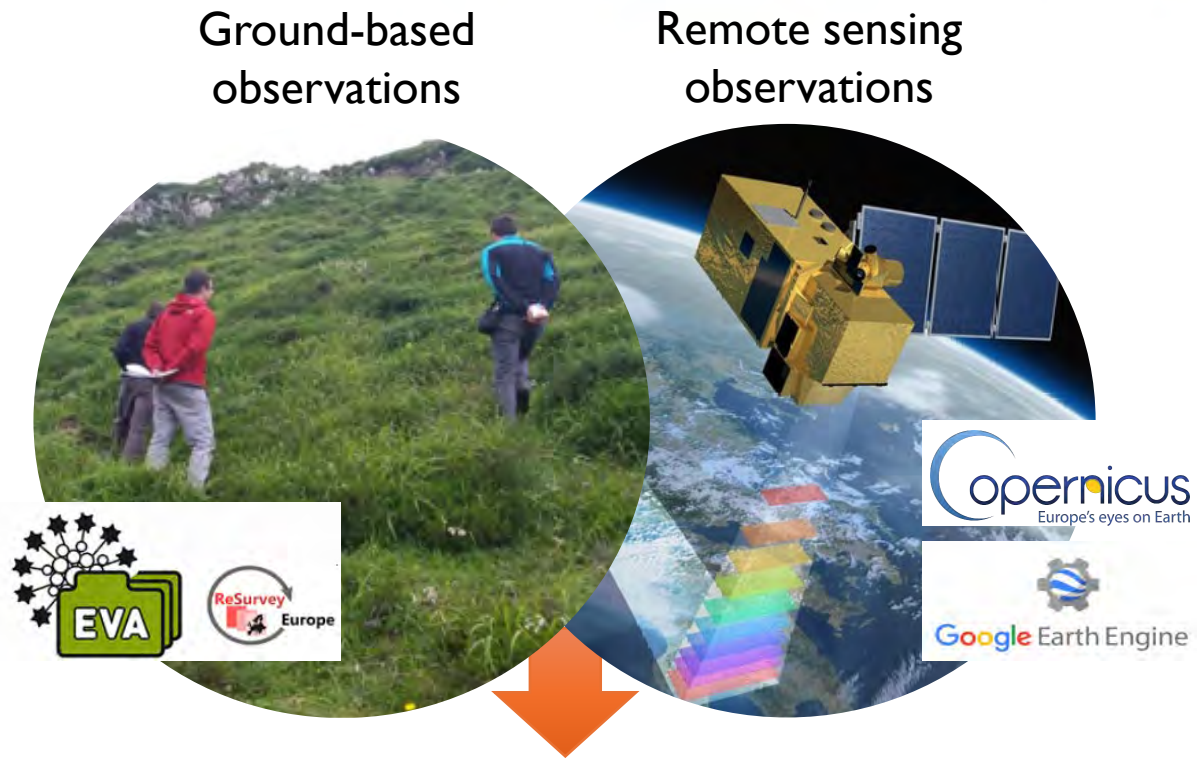
WP3: Trends in habitat quality and ecosystem properties

MOTIVATE, Monitoring of terrestrial habitats by integrating vegetation archive time series in Europe





Task 3.1 Mapping the geographic extent of resurveyed habitats with remote sensing

Task 3.2 Evaluating temporal trends in the productivity of resurveyed habitats

Task 3.3 Developing a remote-sensing framework for monitoring phenological changes

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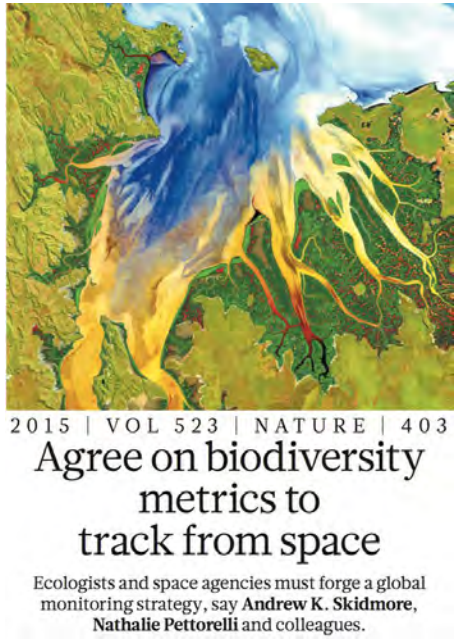
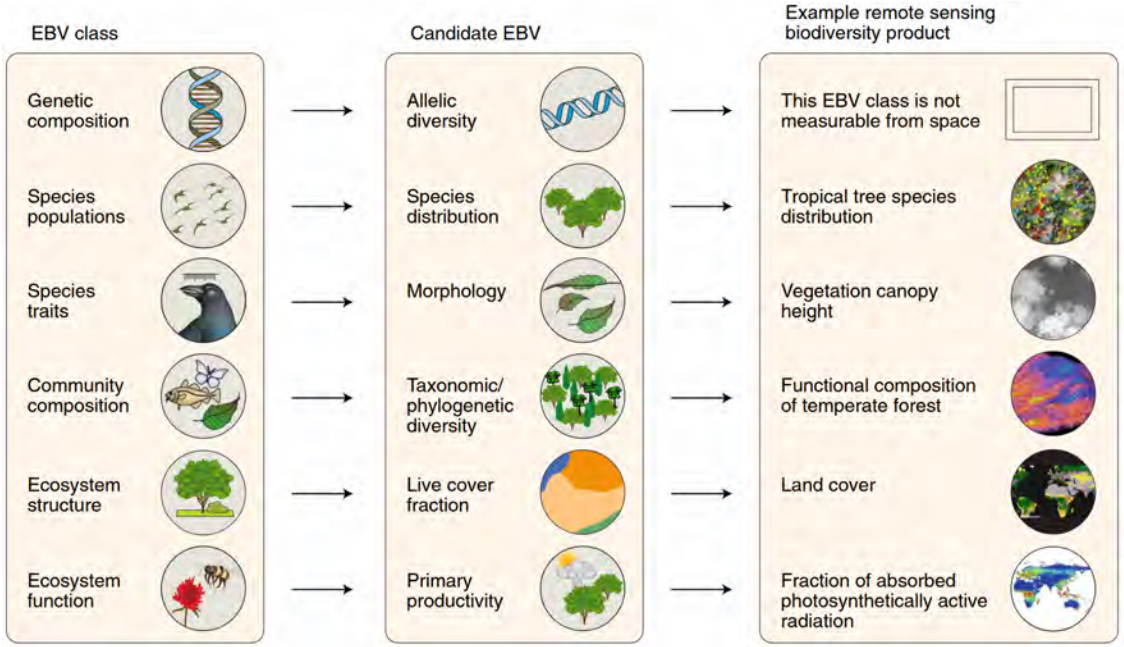
Why RS-based monitoring?

- Multiple spatial and temporal resolutions and cloud-computing facilities
- Identification of spatial and temporal patterns in ecosystem functioning
- Lower cost and effort than field campaigns
- Monitoring of Essential Biodiversity Variables (EBVs)
- Relevant for management





Skidmore et al., 2021, Nature Ecology & Evolution, 5(7), 896-906

ALWAYS coupled to HIGH QUALITY in-situ

EVA

ReSurvey Europe

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MOTIVATE WP3

Four steps towards a remote-sensing-based monitoring of vegetation

1. Vegetal biodiversity sampling **protocols (for survey and resurvey)**
2. **Validation** and relocation of vegetation plots
3. **Mapping** the distribution patterns / geographical extent of habitats
4. **Monitoring** of patterns observed and development of indicators of change

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MOTIVATE WP3 – 1. Sampling protocols

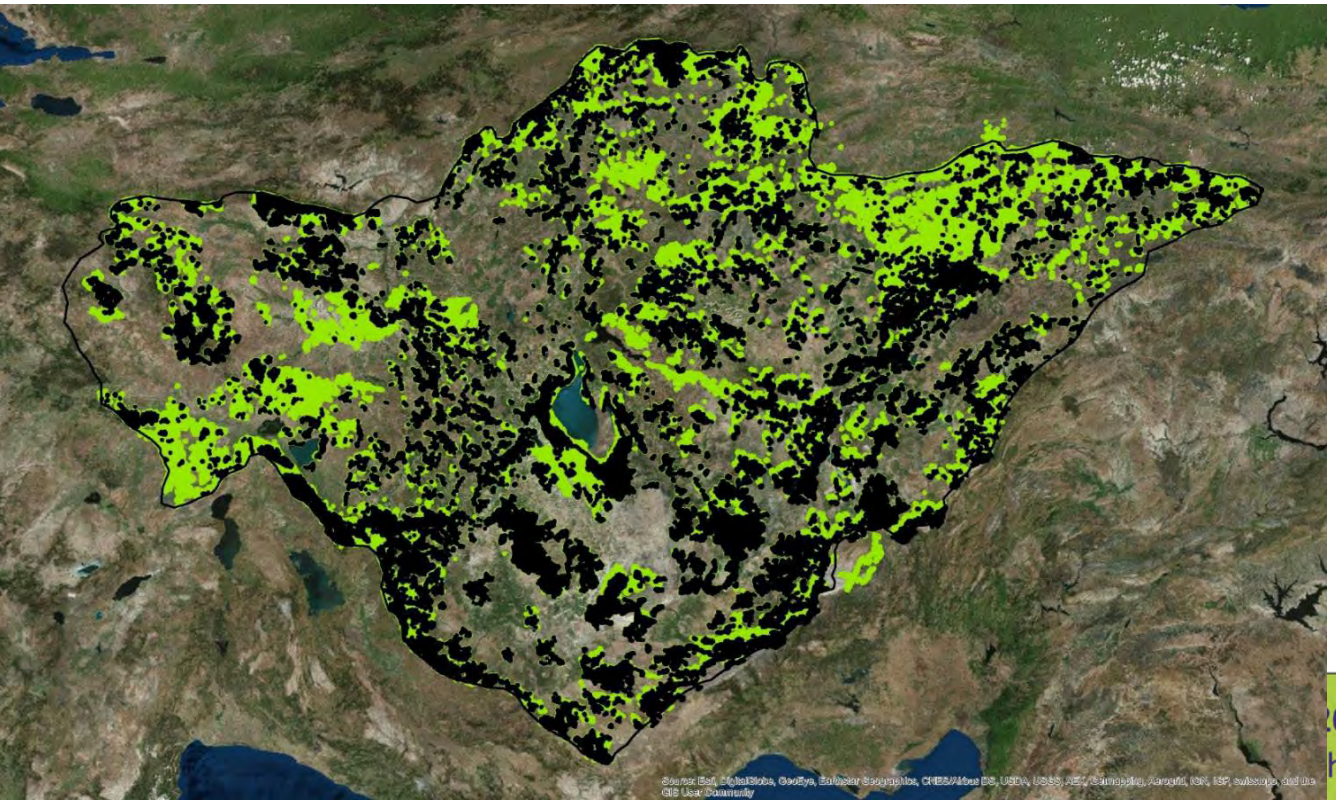
MOTIVATE, Monitoring of terrestrial habitats by integrating vegetation archive time series in Europe

How? Vegetation **Sampling** across environmental gradients

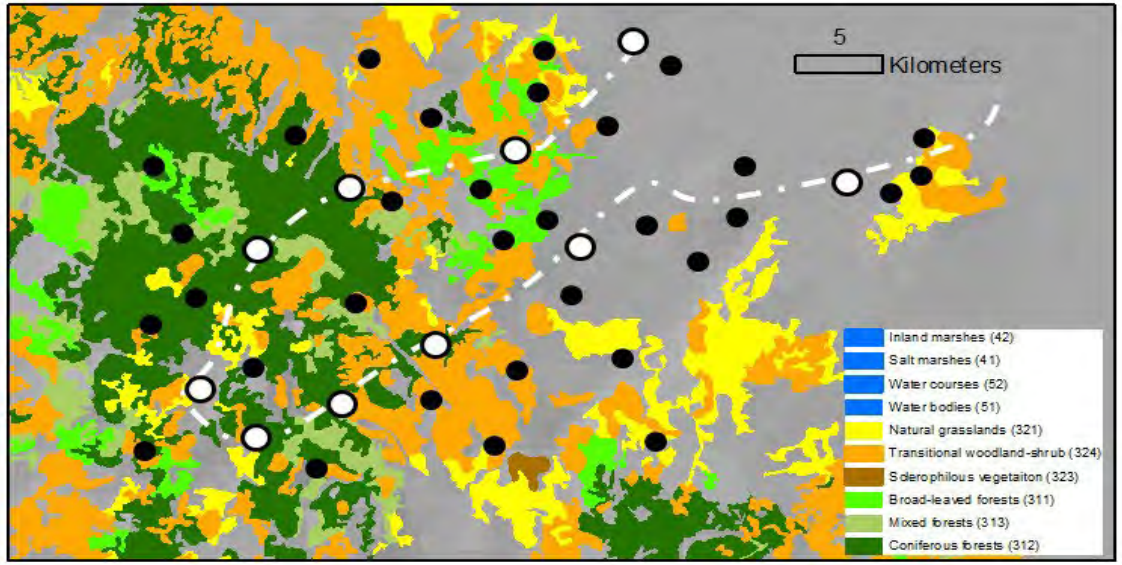
Training in habitat identification and sampling
(tablet system)
22 field workers

Systematic field surveys
(two seasons, 2017-2018)

60,000 GPS points
170,000 Map points



○ **GPS points** ● **Map points**



2023-2 "Biodiversa+ 2022"
hange for science and society

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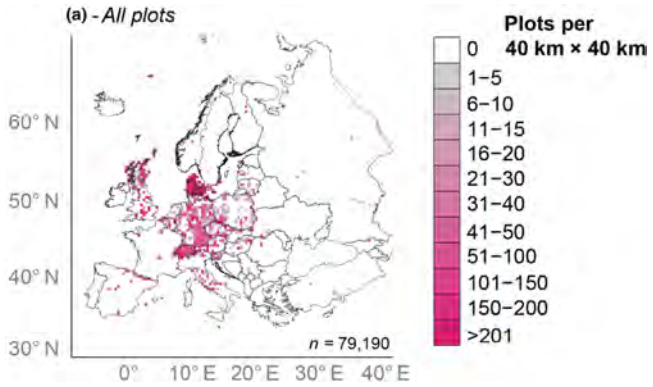
MOTIVATE WP3 – 1. Sampling protocols

MOTIVATE, Monitoring of terrestrial habitats by integrating vegetation archive time series in Europe

How? Vegetation **ReSampling** across environmental gradients

ReSurvey Europe



Knollová et al., 2024, Journal of Vegetation Science, 35, e13235

MOTIVATE producirá un protocolo detallado y estandarizado de (re)muestreos de vegetación, así como un documento con los requerimientos mínimos a cumplir a la hora de usar estos (re)muestreos para el monitoreo de vegetación a gran escala en Europa, con una visión integradora de trabajos locales

Muestreo inicial: características generales

- Único hábitat / todos o varios hábitats dentro de un área
- Referencia florística utilizada
- ¿Qué medir? Abundancia… ¿Cómo? (% / categorías de %). Idealmente todas las especies (plantas vasculares, briófitos y líquenes)

Muestreo inicial: detalles de las parcelas

- Forma: rectangular / cuadrada? Área recomendada?
- Localización: estacas (metálicas / plástico / madera) o imanes + GPS diferencial en dos esquinas diagonales
- Delimitación de la parcela al hacer el muestreo: cinta métrica / cuerda
- Anotar período fenológico, manejo, uso del suelo, perturbaciones, topografía…
- Esfuerzo de muestreo (tiempo y número de personas)
- Incluir varias fotos de cada parcela

Remuestreos

- Con el diseño anterior se debería garantizar la relocalización de la parcela
- En caso de incertidumbre en la relocalización (e.g. pérdida de marcas), seleccionar las coordenadas más probables
- Se pueden remuestrear dos parcelas: una en la localización más probable y otra en la vegetación más similar
- Intentar coincidencia topográfica, fenológica…
- Remuestreo con / sin la lista de especies del muestreo previo
- Remuestrear todas las parcelas, aunque haya cambio en el uso del suelo
- Si es posible, implicar a las mismas personas que realizaron el muestreo previo (en campo o asesoramiento general)

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MOTIVATE WP3 – 2. Validation

MOTIVATE, Monitoring of terrestrial habitats by integrating vegetation archive time series in Europe

CSIC IMIB

How? Metrics based on 3 remotely-sensed EBV families:

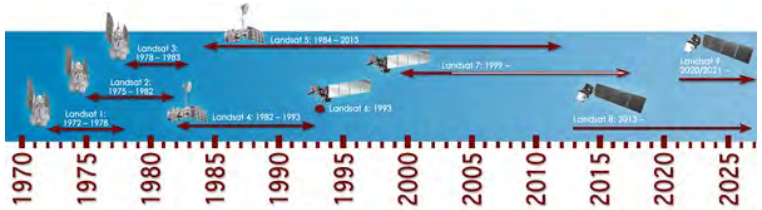
Ecosystem primary productivity: maximum NDVI in July

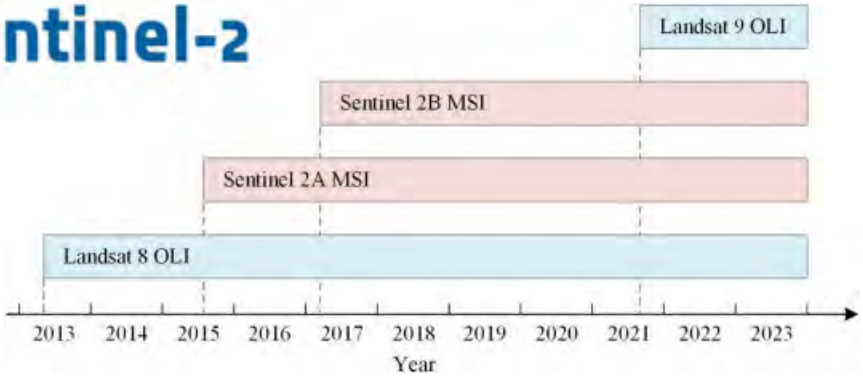
Ecosystem phenology: difference in NDVI (beginning-max-end of growing season)

Ecosystem structure: canopy height

Landsat 8

sentinel-2





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MOTIVATE WP3 – 2. Validation

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CSIC IMIB

How? Evaluate distribution of EBVs for each EUNIS habitat type across biogeographical regions
Define EBV-based ranges of membership to each habitat type

Received: 14 December 2019 | Revised: 10 June 2020 | Accepted: 17 July 2020
DOI: 10.1111/avsc.12519
VEGETATION SURVEY
Applied Vegetation Science IAVS

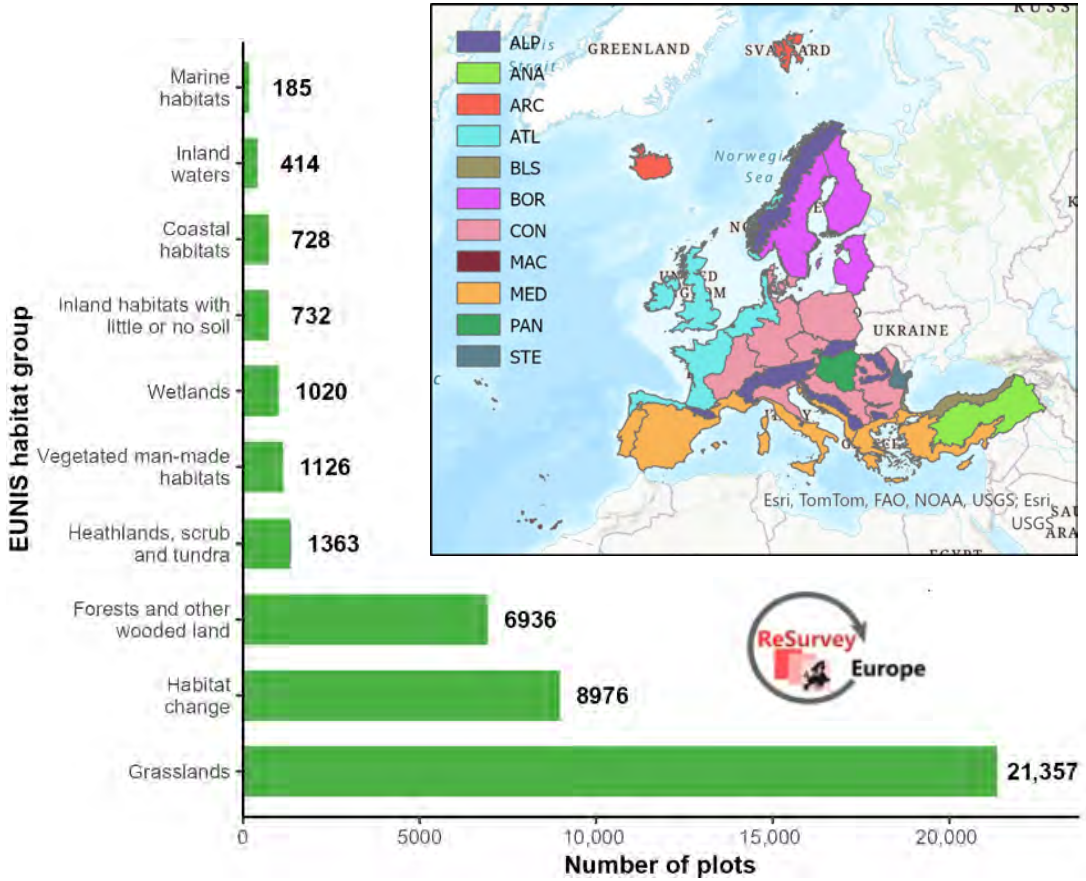
EUNIS Habitat Classification: Expert system, characteristic species combinations and distribution maps of European habitats

Milan Chytrý[1] | Lubomír Tichý[1] | Stephan M. Hennekens[2] | Ilona Knollová[1]

Received: 11 June 2020 | Revised: 17 December 2020 | Accepted: 22 December 2020
DOI: 10.1111/avsc.12562
METHODS IN VEGETATION SCIENCE
Applied Vegetation Science IAVS

Implementing the formal language of the vegetation classification expert systems (ESy) in the statistical computing environment R

Helge Bruelheide[1,2] | Lubomír Tichý[3] | Milan Chytrý[3] | Florian Jansen[4]



Knollová et al., 2024, Journal of Vegetation Science, 35, e13235

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MOTIVATE WP3 – 2. Validation

MOTIVATE, Monitoring of terrestrial habitats by integrating vegetation archive time series in Europe

How?

Ecosystem primary productivity:

- Maximum NDVI in July
- Above-ground biomass (3 m)

sentinel-2

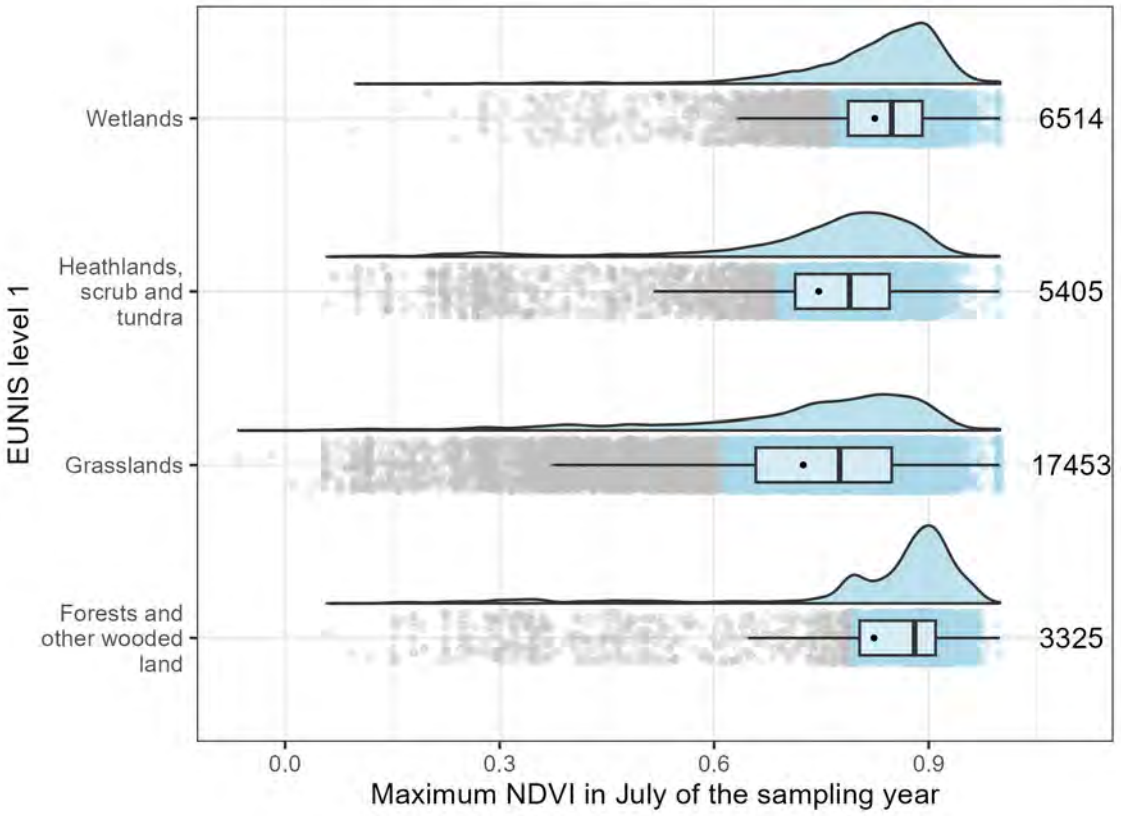
NASA • USGS LANDSAT NINE KSC • GSFC • EROS

SCIENCE ADVANCES | RESEARCH ARTICLE

ECOLOGY

The overlooked contribution of trees outside forests to tree cover and woody biomass across Europe

Siyu Liu[1]*, Martin Brandt[1]*, Thomas Nord-Larsen[1], Jerome Chave[2], Florian Reiner[1], Nico Lang[3], Xiaoye Tong[1], Philippe Ciais[4], Christian Igel[3], Adrian Pascual[5], Juan Guerra-Hernandez[6], Sizhuo Li[1], Maurice Mugabowindekwe[1], Sassan Saatchi[7], Yuemin Yue[8], Zhengchao Chen[9], Rasmus Fensholt[1]



WORK IN PROGRESS

Landsat data missing for some regions!

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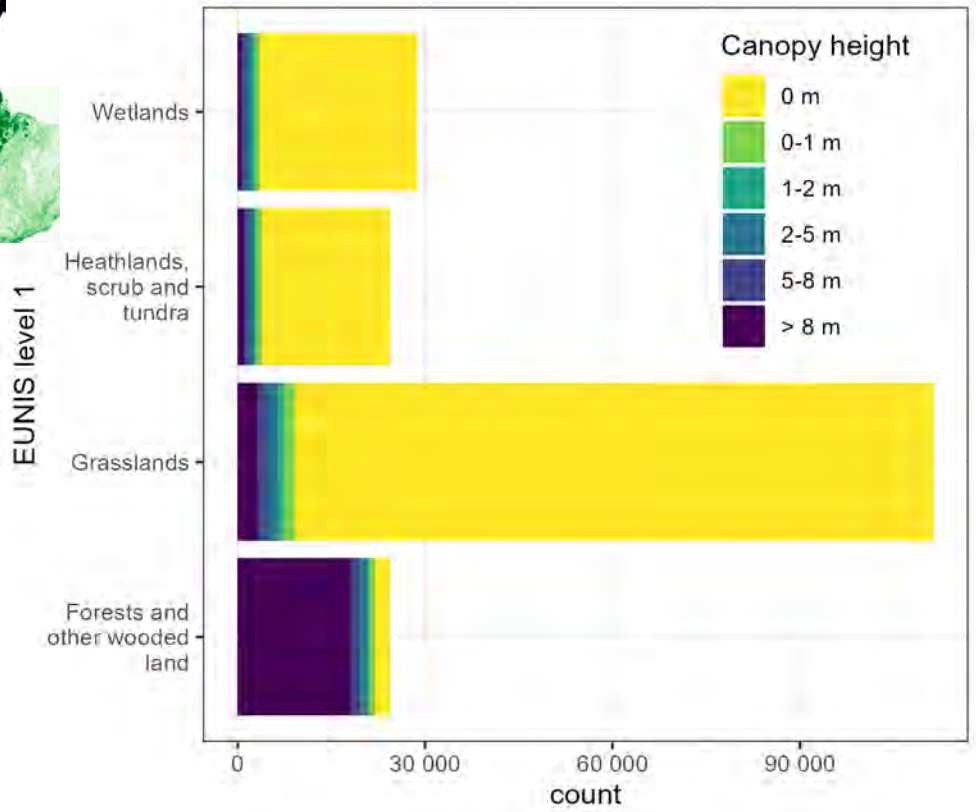
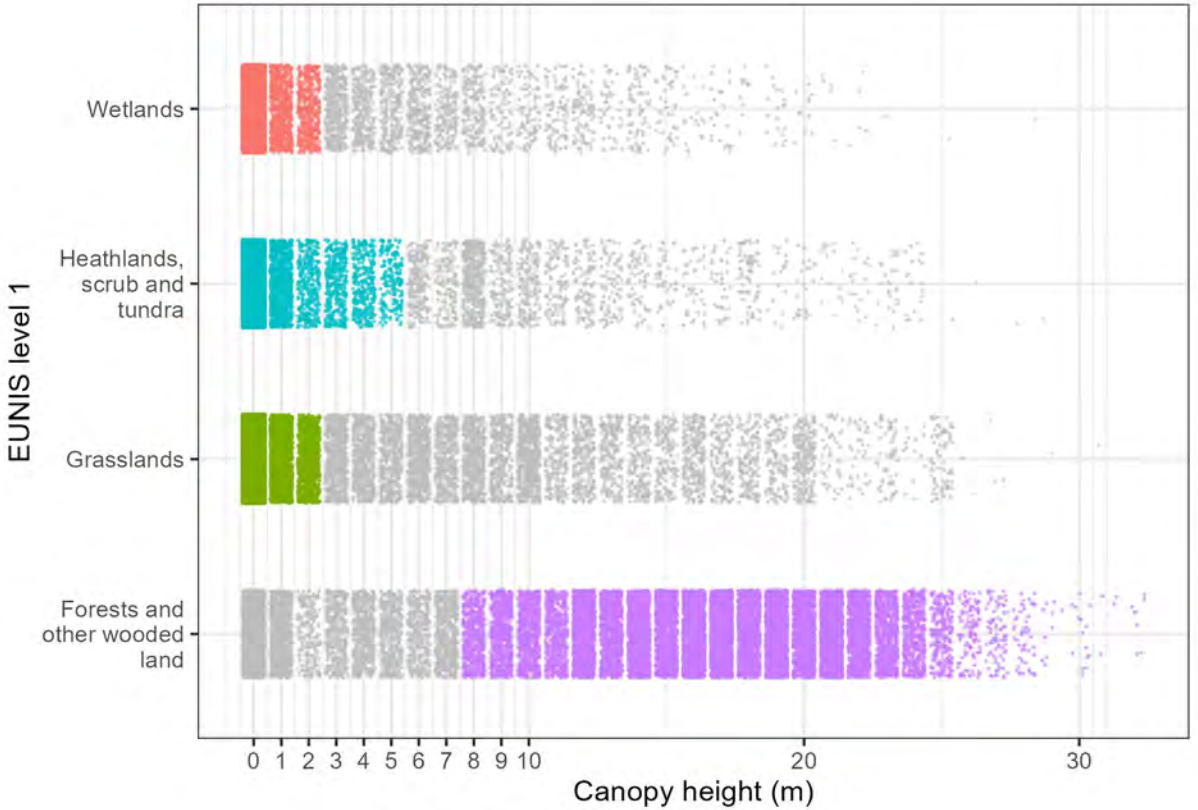
MOTIVATE WP3 – 2. Validation

MOTIVATE, Monitoring of terrestrial habitats by integrating vegetation archive time series in Europe

How?

Ecosystem structure





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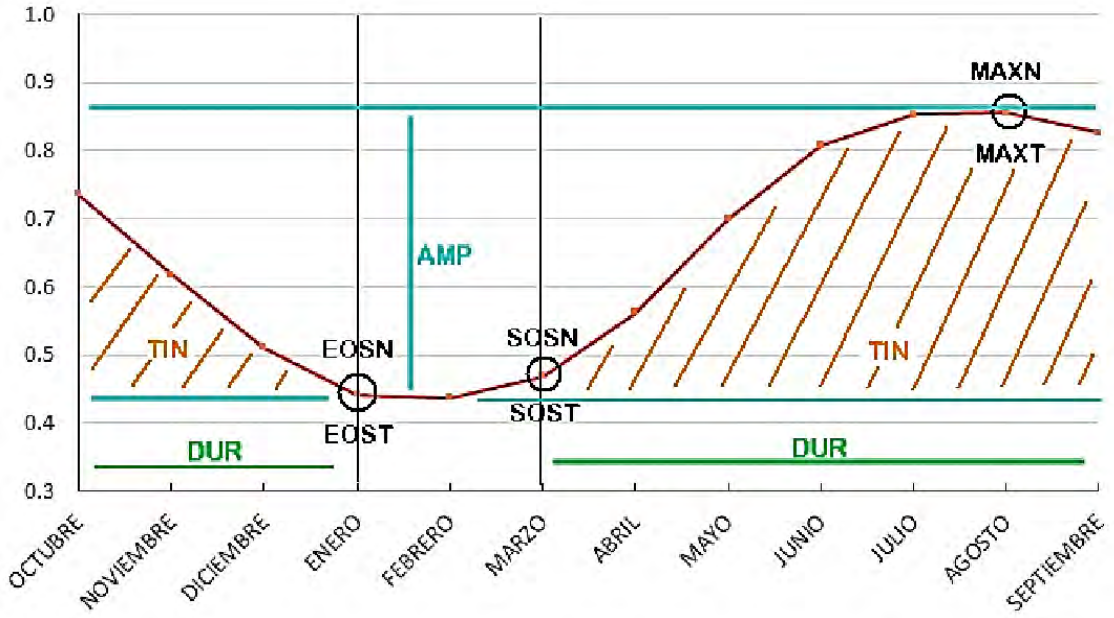
MOTIVATE WP3 – 2. Validation

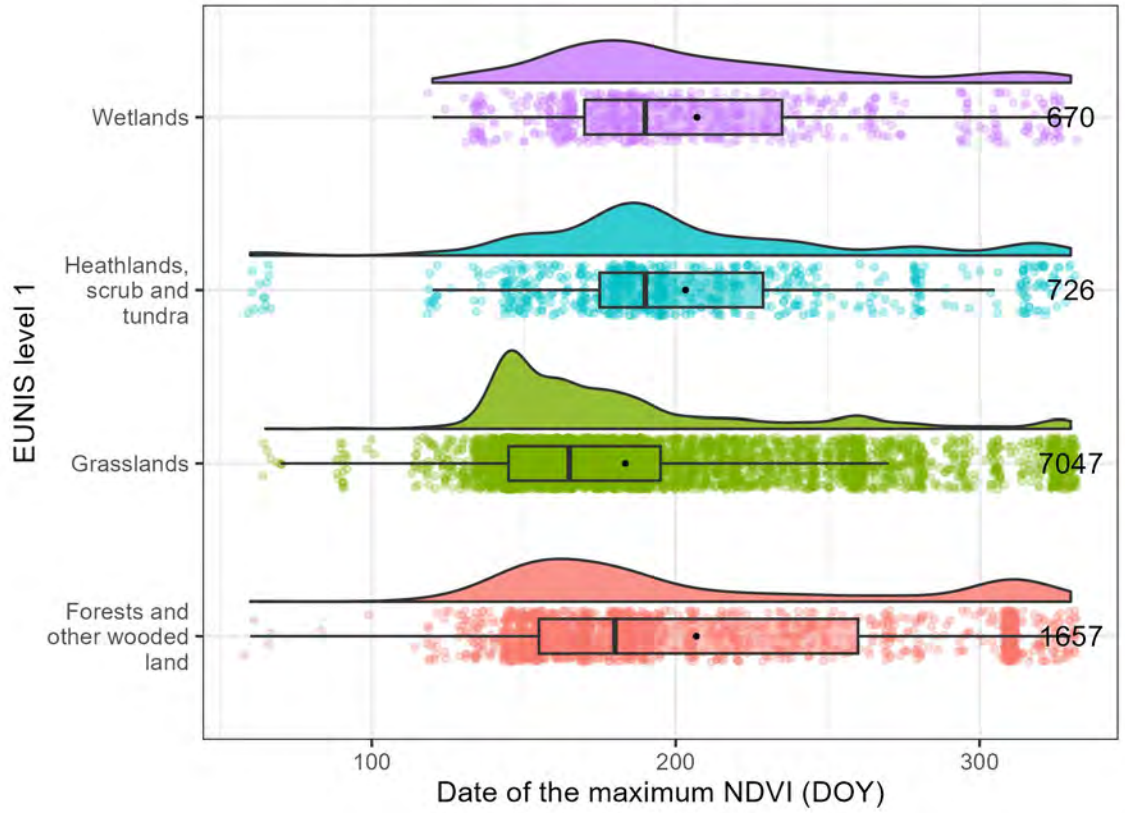
How?

Ecosystem phenology

sentinel-2

LANDSAT CELEBRATING 50 YEARS USGS





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MOTIVATE WP3 – 2. Validation

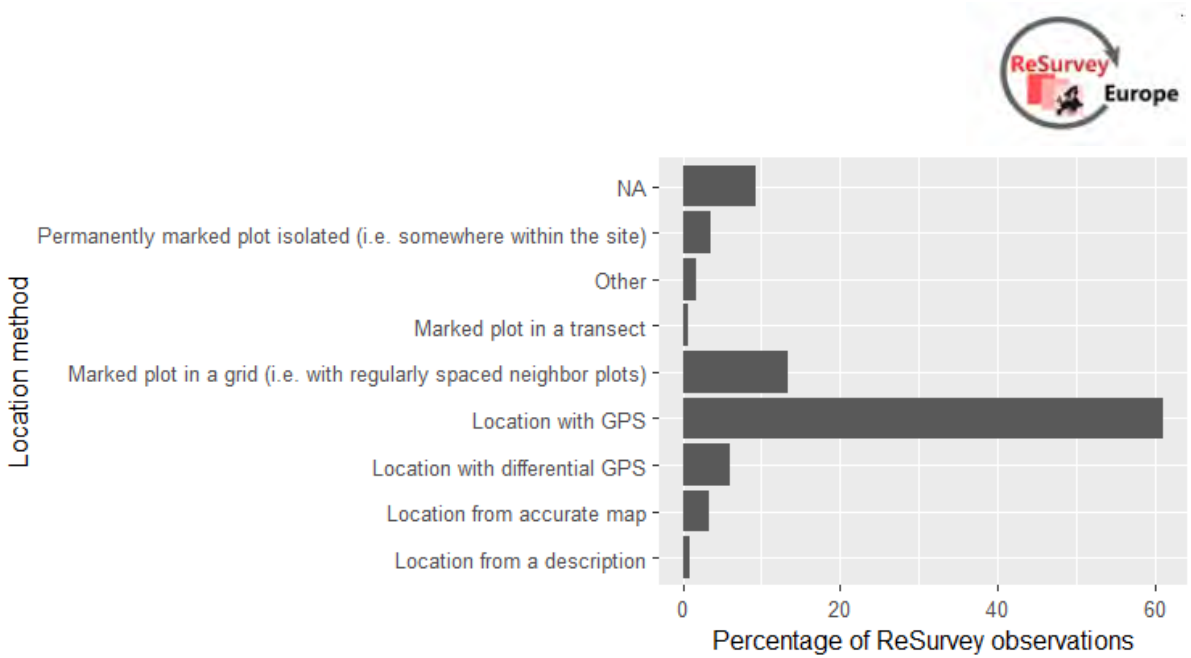
MOTIVATE, Monitoring of terrestrial habitats by integrating vegetation archive time series in Europe

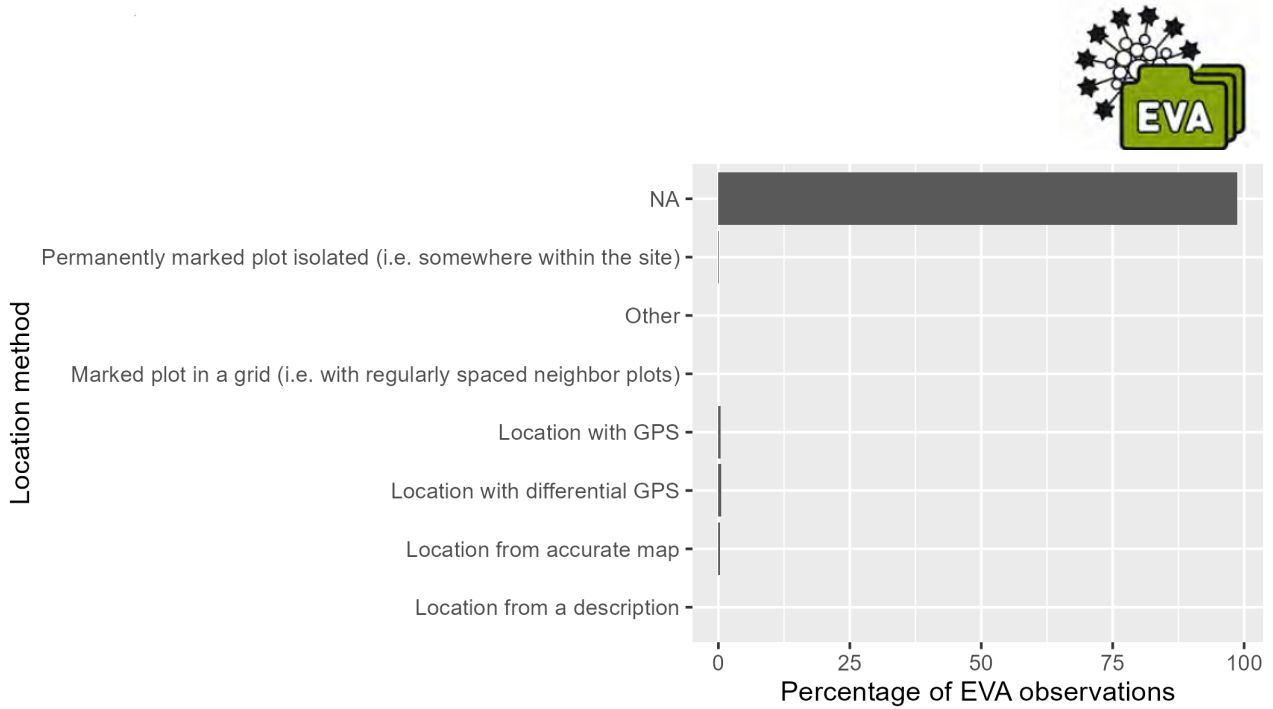
What next?

Defining ranges of membership for each EBV and habitat type and bioregion

Validation (and relocation, when needed) of all plots in ReSurvey

Same process for EVA and other vegetation datasets (maps or plots)





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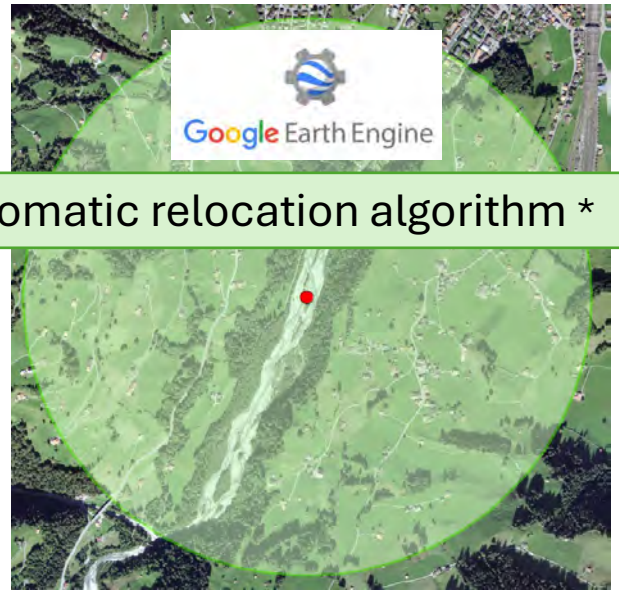
MOTIVATE WP3 – 2. Validation

MOTIVATE, Monitoring of terrestrial habitats by integrating vegetation archive time series in Europe

Where? Plot locations are correct if EBVs fall within the ranges of membership for the habitat type

If not, we **relocate** the plot (*sensitivity* analyses with many relocated plots)

EUNIS 1 = T
NDVI = 0.09
Canopy height = 0 m



Automatic relocation algorithm *

1-km buffer,
OR vegetation patch

Closest pixel(s) within ranges of membership

* Based on region growing seeding approach using e.g. Mahalanobis distances (GEE)

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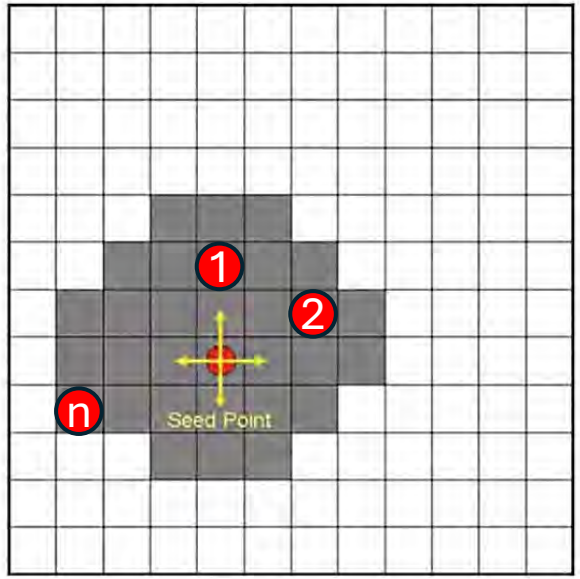
MOTIVATE WP3 – 2. Validation 2 steps,

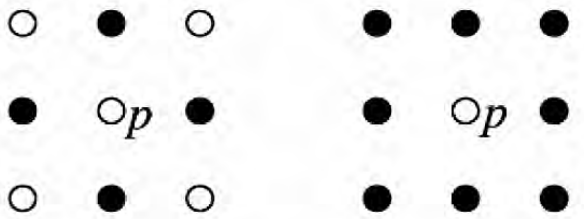
FIRST **identifying similar patterns** around plot locations (AOIs):

- Automatic identification (at the pixel level) of the habitat type identified in the **validated plot location** across patches of buffer areas, based on spectral similarity
- Mapping current distribution **patterns** of vegetation by aggregation of similar pixels until a certain (Mahalanobis) distance

European Environment Agency



1. Select a seed point/points
2. Define a growth criteria
3. Joint all voxels connected to the seed that follow the growth criteria
4. Stop when no adjacent voxel agree with the growth criteria



4-connectivity 8-connectivity

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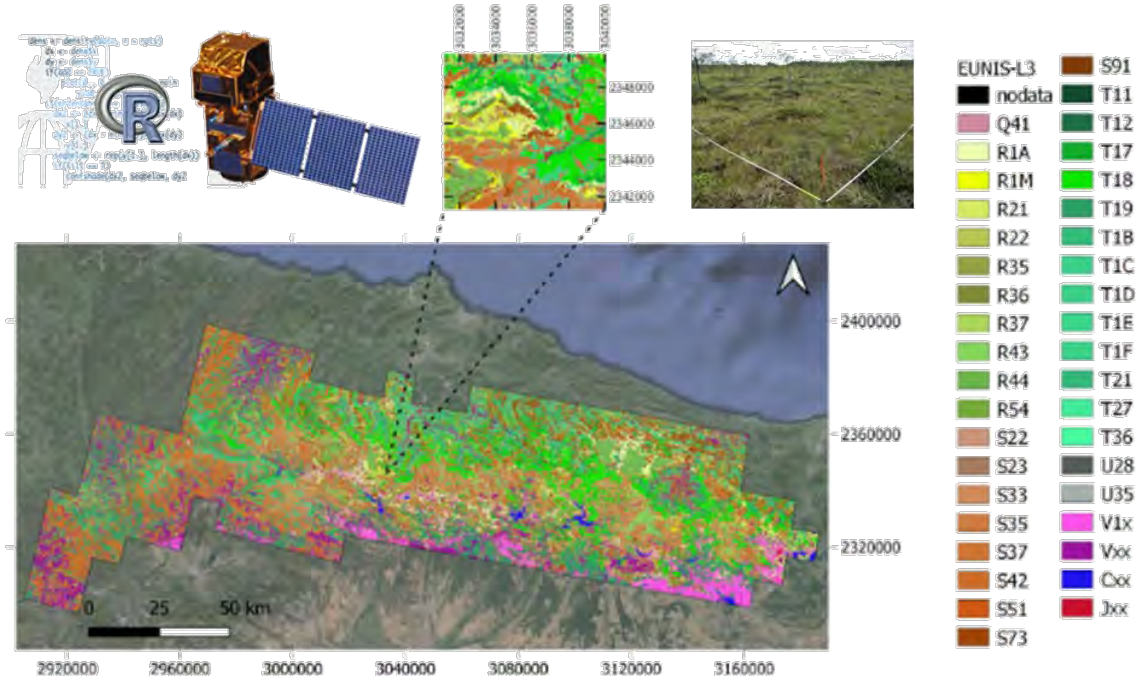
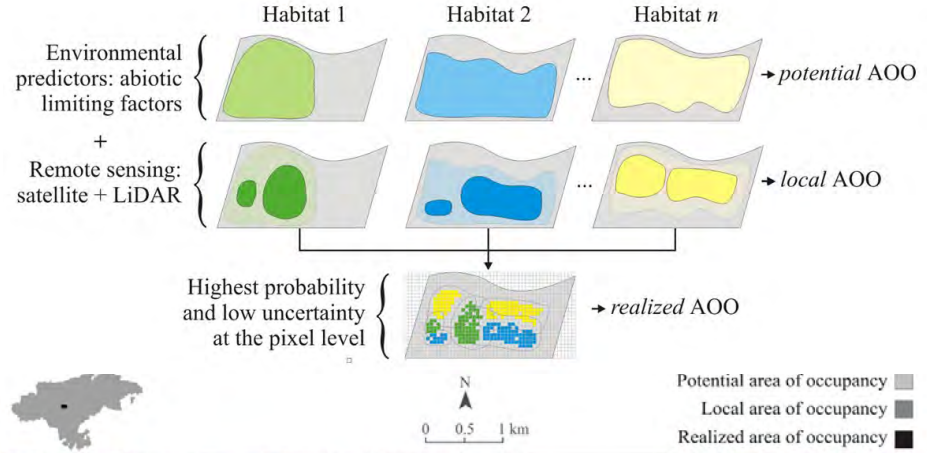
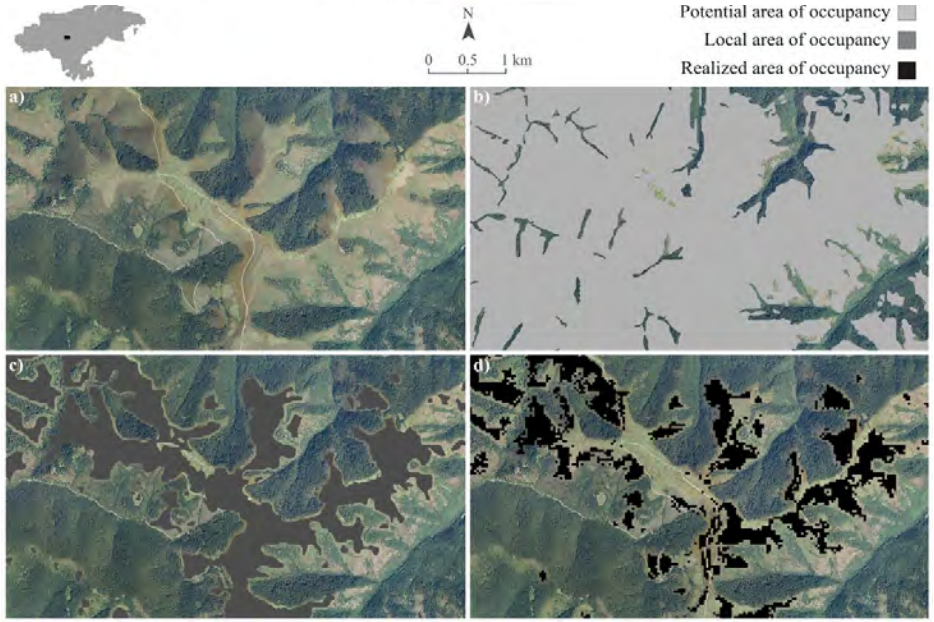
MOTIVATE WP3 – 3. Mapping

MOTIVATE, Monitoring of terrestrial habitats by integrating vegetation archive time series in Europe

SECOND **mapping the extent of habitat types** with AOIs **+** RS **+** ML/AI algorithms







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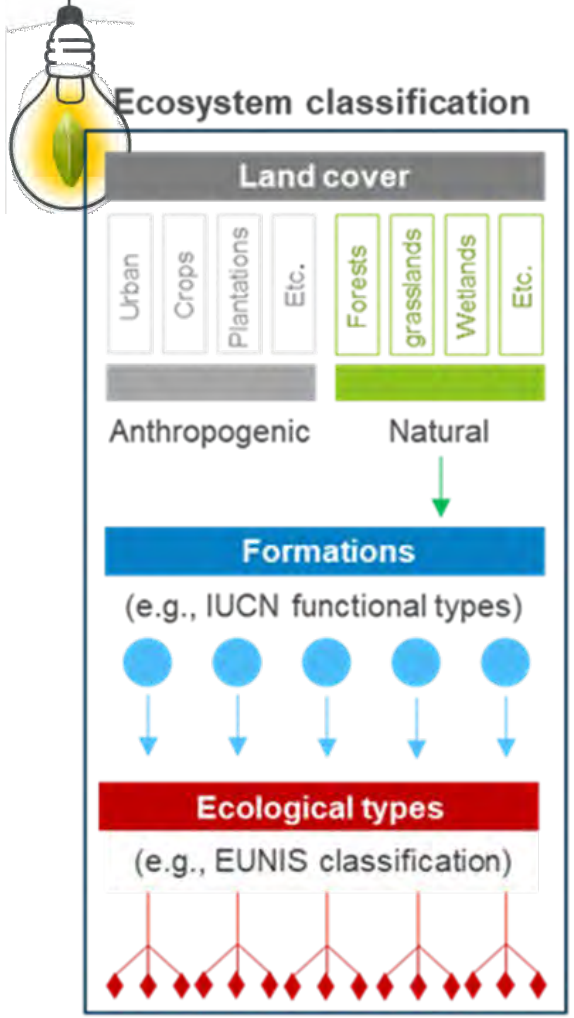
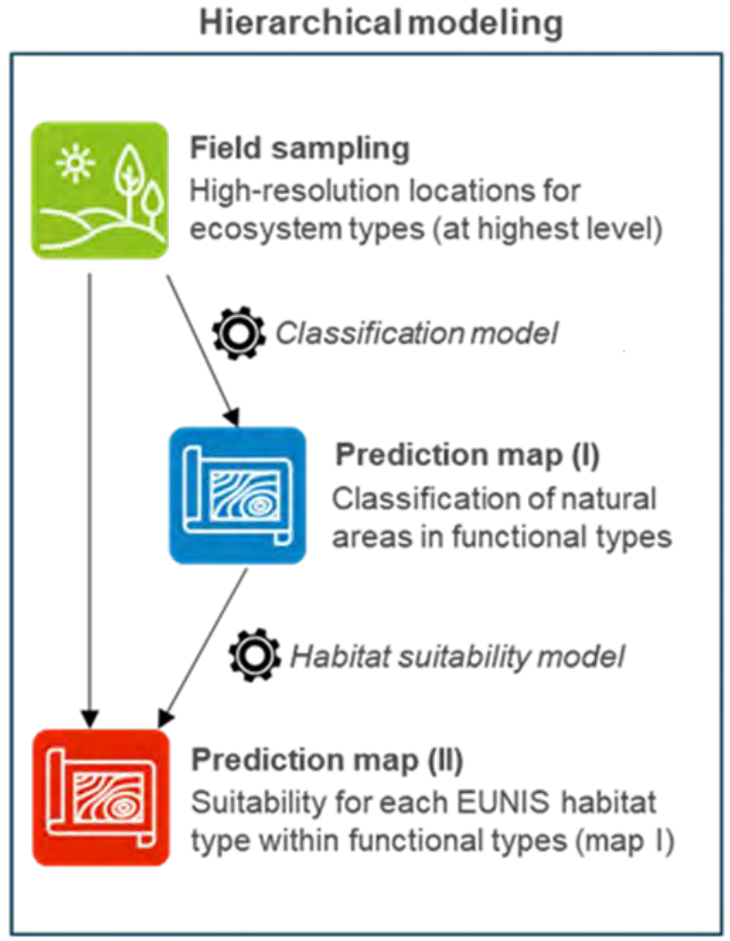
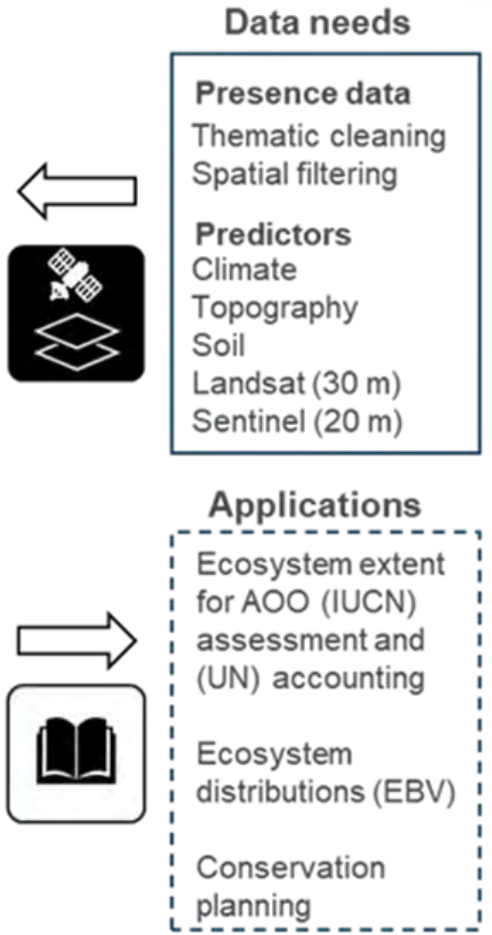
Un nuevo marco conceptual: AOO en un contexto jerárquico

MOTIVATE, Monitoring of terrestrial habitats by integrating vegetation archive time series in Europe







nature

Proyectos Europeos IMIB

Jiménez-Alfaro & **Álvarez-Martínez JM** (In prep). 2025.
Mapping Ecosystem Extent for Large-Scale Conservation Planning

Project founded by the 2022-2023 Joint Call - **Biodivmon - PCI2023-2 "Biodiversa+ 2022"**

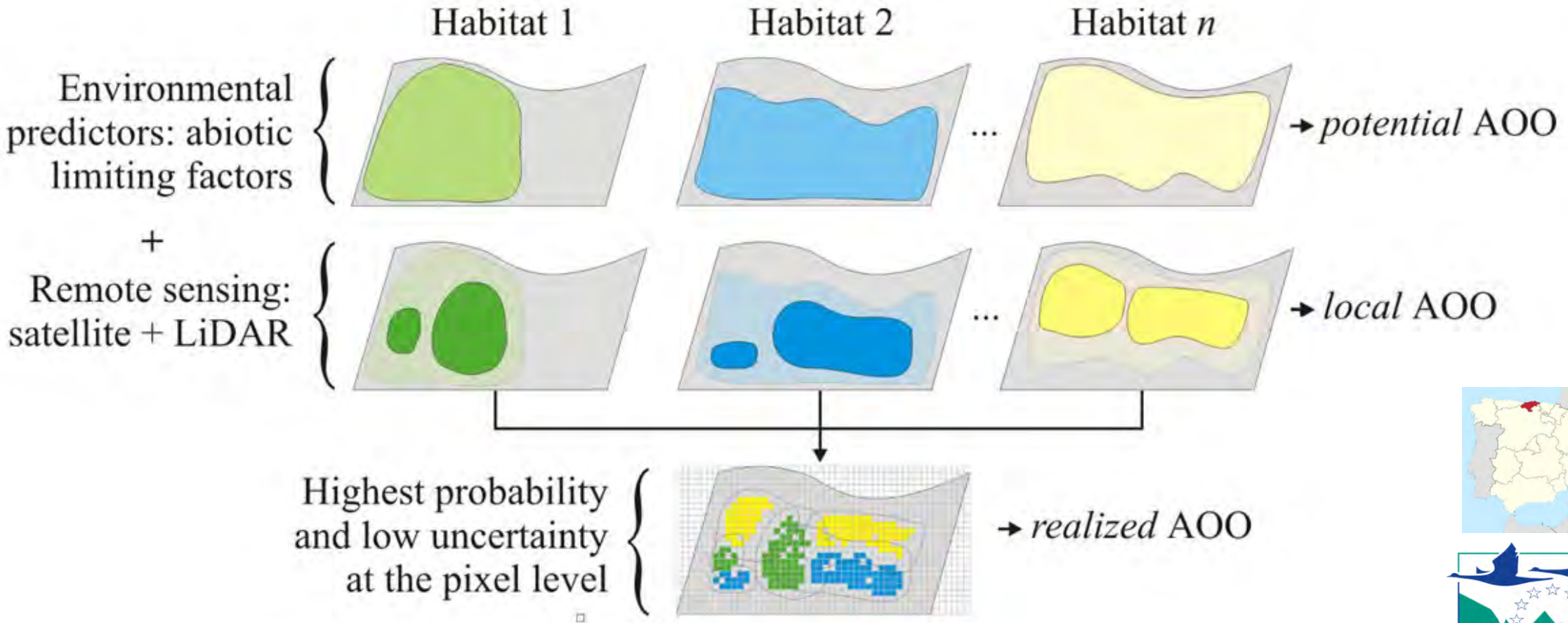
biodiversa+ IMIB CSIC

Un nuevo marco conceptual: AOO en un contexto jerárquico

Hábitats protegidos europeos
2000 puntos de campo (EUNIS)

Methods in Ecology and Evolution
BRITISH ECOLOGICAL SOCIETY
RESEARCH ARTICLE Free Access

Modelling the area of occupancy of habitat types with remote sensing



Álvarez-Martínez, Jiménez-Alfaro et al. (2018)
Methods in Ecology and Evolution 9: 580

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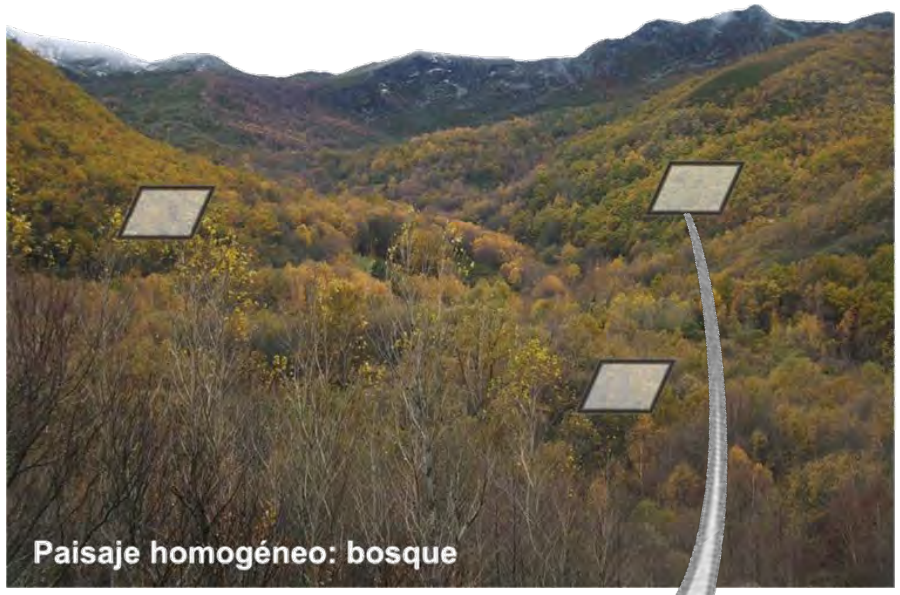
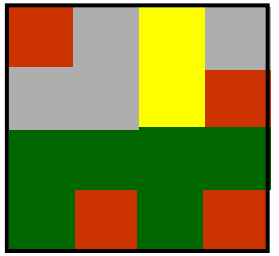
Un nuevo marco conceptual: AOO en un contexto jerárquico



Landsat 8 OLI (30 m)
Sentinel 2 MSI (10 m)
...



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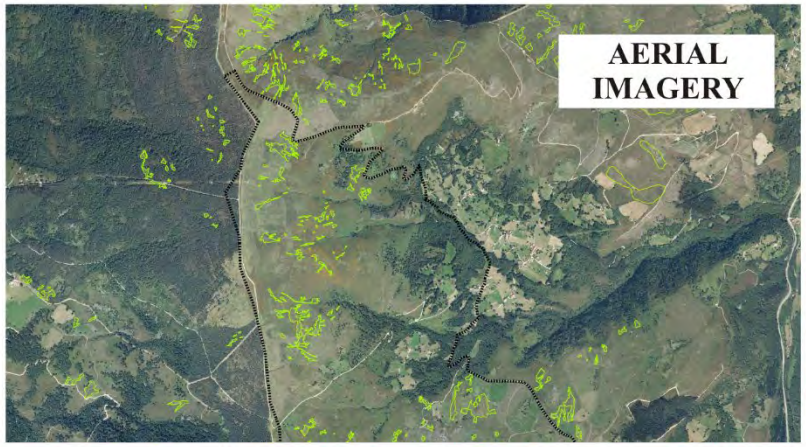
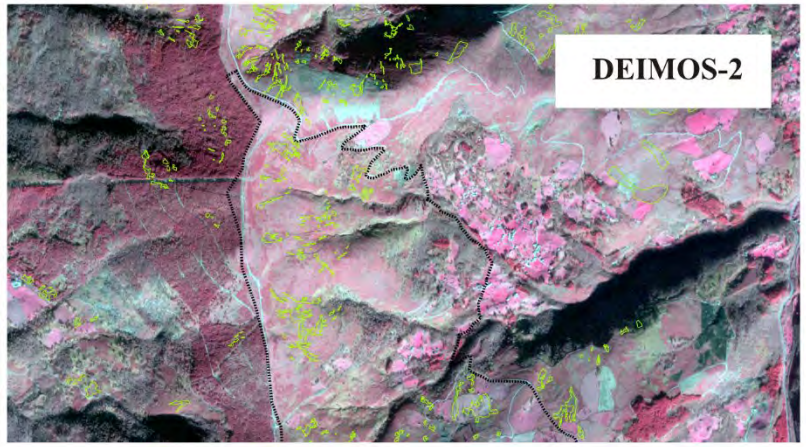
Mayor resolución en las imágenes: análisis de sensibilidad

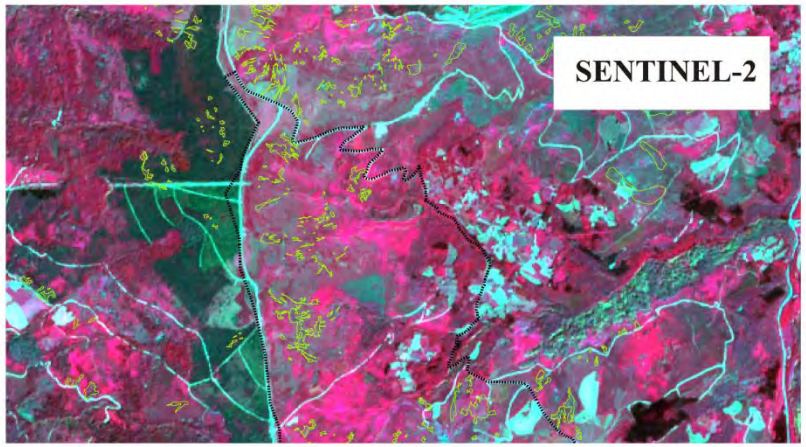
MOTIVATE, Monitoring of terrestrial habitats by integrating vegetation archive time series in Europe

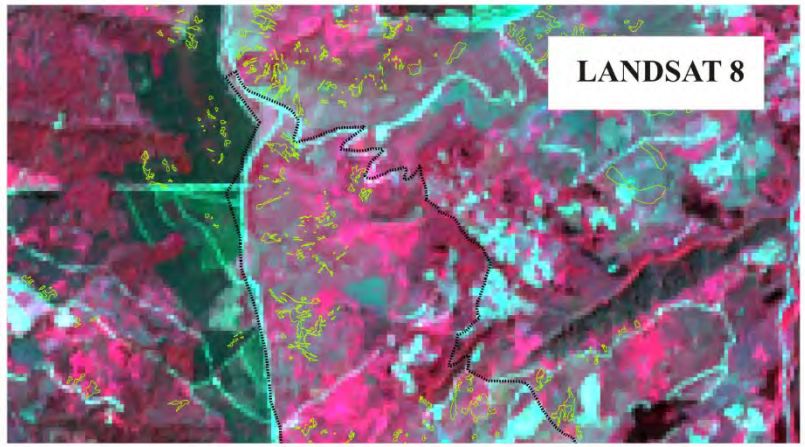
Special Area of Conservation limit

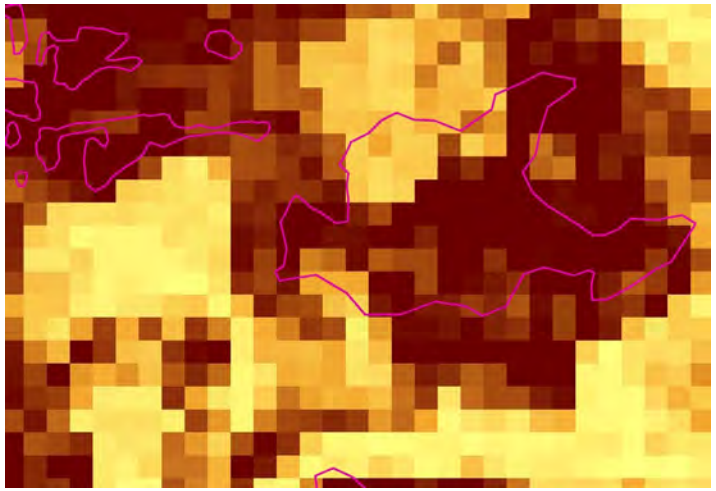
Peat and bogs habitat types

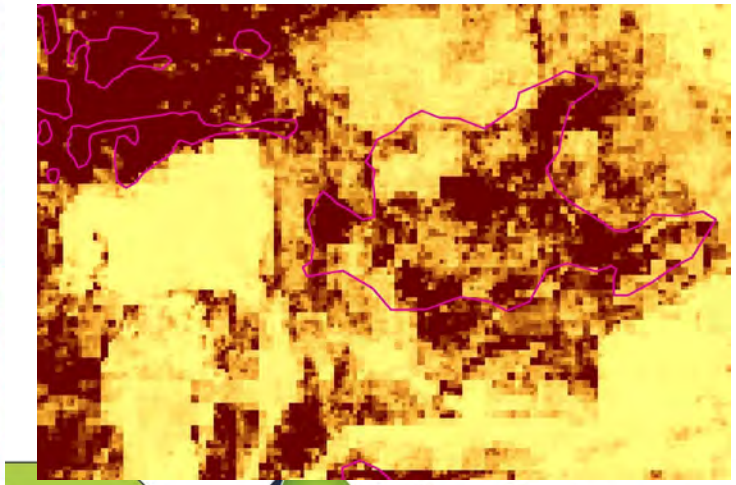












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ociety

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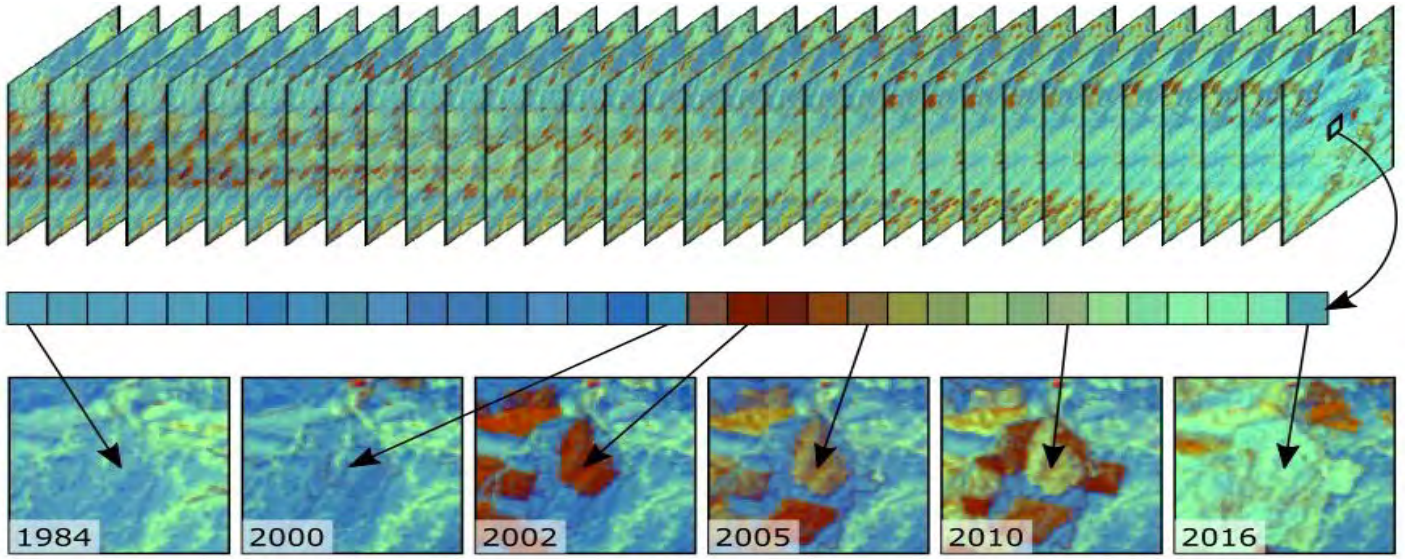
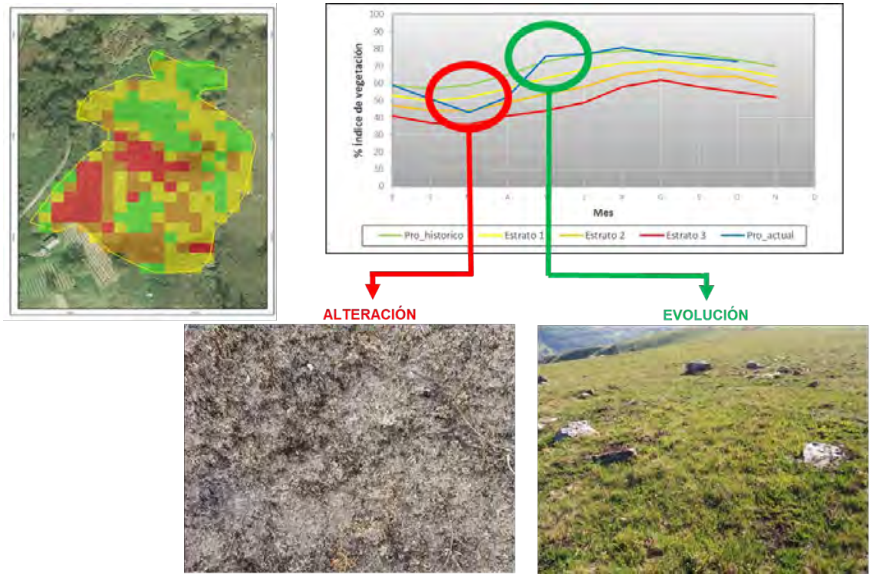
MOTIVATE WP3 – 4. Monitoring / Habitat patches

MOTIVATE, Monitoring of terrestrial habitats by integrating vegetation archive time series in Europe

Retrospective **monitoring** of current distributions and conservation status (extent and quality) during last decades

- Using **RS data** such as Sentinel-2 (from 2017-) and Landsat (since approx. 1985) in GEE (own pipeline)
- Using **indicators** (EBVs) of habitat extent, structure and functionality (same used for validation and mapping steps)
- Changes identified at the **pixel level** to reconstruct the extent (and quality) geographically and in vector attributes





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Biodiversidad vegetal: necesidad de información

Estructura

- Altura e indicadores derivados
- Área basal e indicadores derivados
- Diámetro a la altura del pecho e indicadores derivados
- Estructura vertical
- Clases de edad
- Estructura horizontal
- Volumen maderable con corteza específico
- Árboles grandes e indicadores derivados
- Rocosidad
- Materia orgánica
- Enhanced vegetation index (EVI)

Composición

- Cobertura vegetal e indicadores derivados
- Canopy relief ratio
- Densidad de árboles e indicadores derivados
- Riqueza de especies e indicadores derivados
- Abundancia de especies
- Distribución de especies
- Especies invasoras
- Morfología de especies

Función

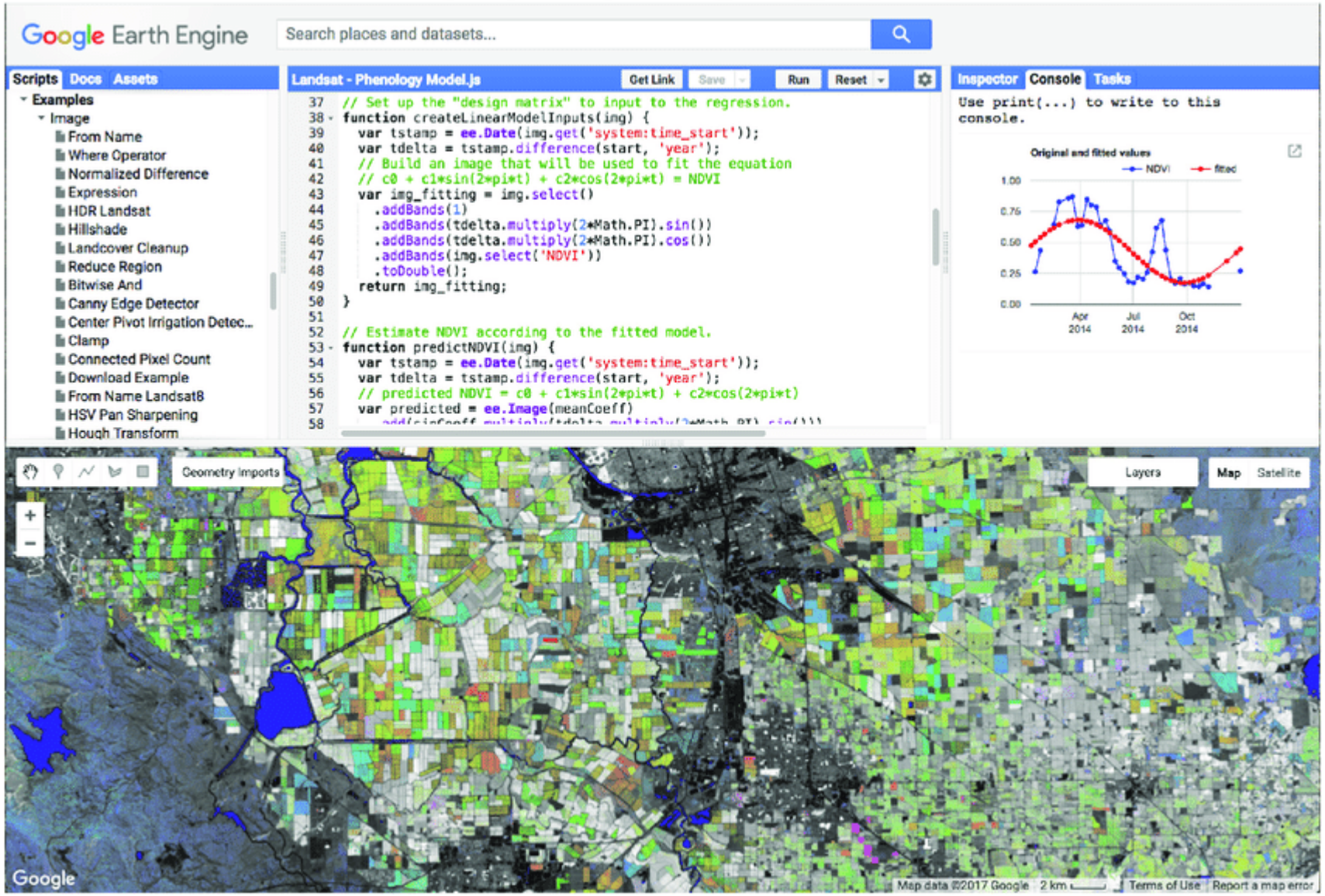
- Biomasa e indicadores derivados
- Producción primaria
- Crecimiento diametral e indicadores derivados
- Regeneración e indicadores derivados
- Madera muerta
- Diversidad funcional
- Fracción de la radiación fotosintéticamente activa (FAPAR)
- Fenología del ecosistema
- Producción de hojarasca

Presiones

- Incendios
- Efectos biológicos de inundaciones
- Fragmentación e indicadores derivados
- Indicadores de perturbación

Total indicadores: 32

Cálculo de indicadores de estrutura, funcionamento y cambios: GEE

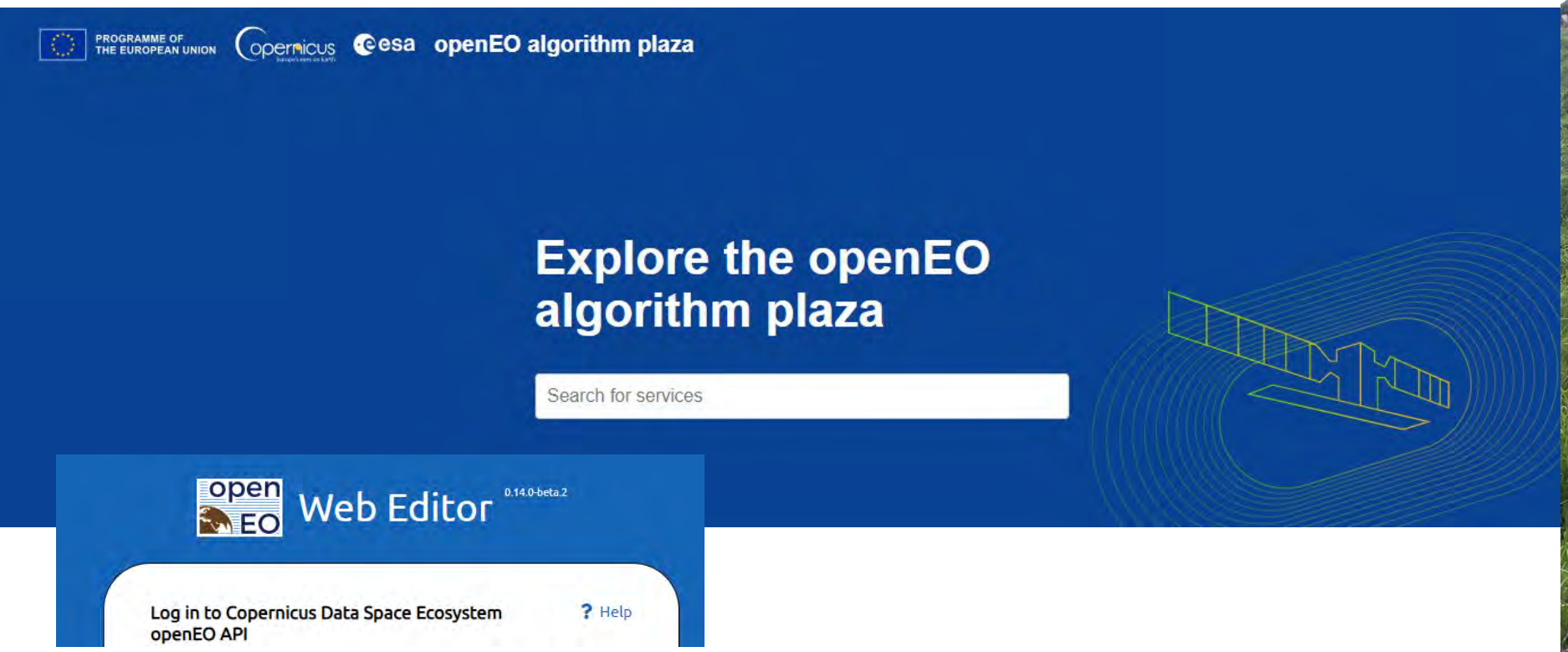


Google Earth Engine

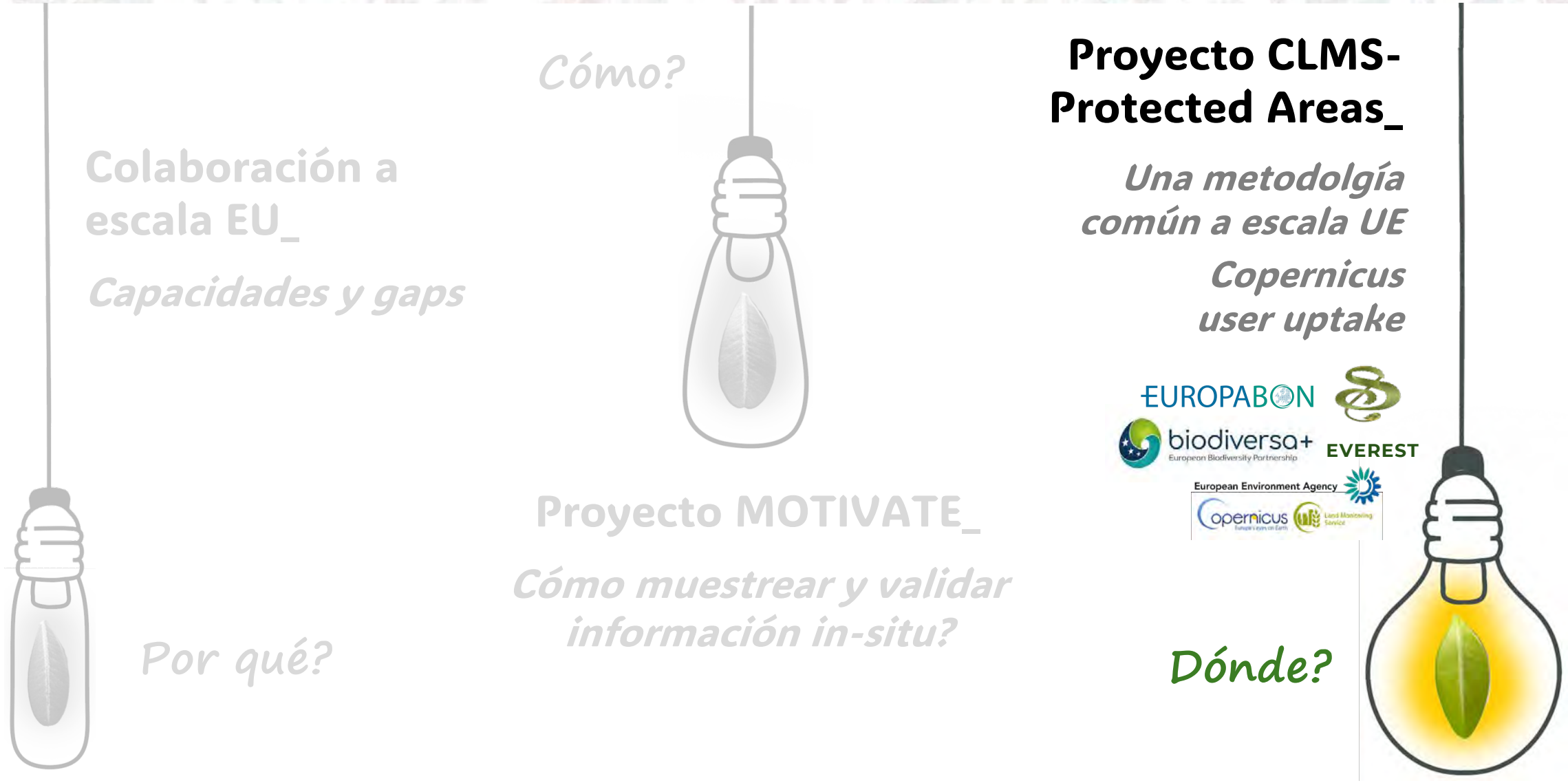
Google Cloud

Cálculo de indicadores de estrutura, funcionamento y cambios: openEO

Process graph will be stored as a service on the **marketplace** of CDSE (i.e., **openEO algorithm plaza**):



Macroecología Vegetal



Colaboración a escala EU_

Capacidades y gaps

Cómo?

Proyecto MOTIVATE_

Cómo muestrear y validar información in-situ?

Por qué?

Proyecto CLMS-Protected Areas_

Una metodolgía común a escala UE

Copernicus user uptake

Dónde?

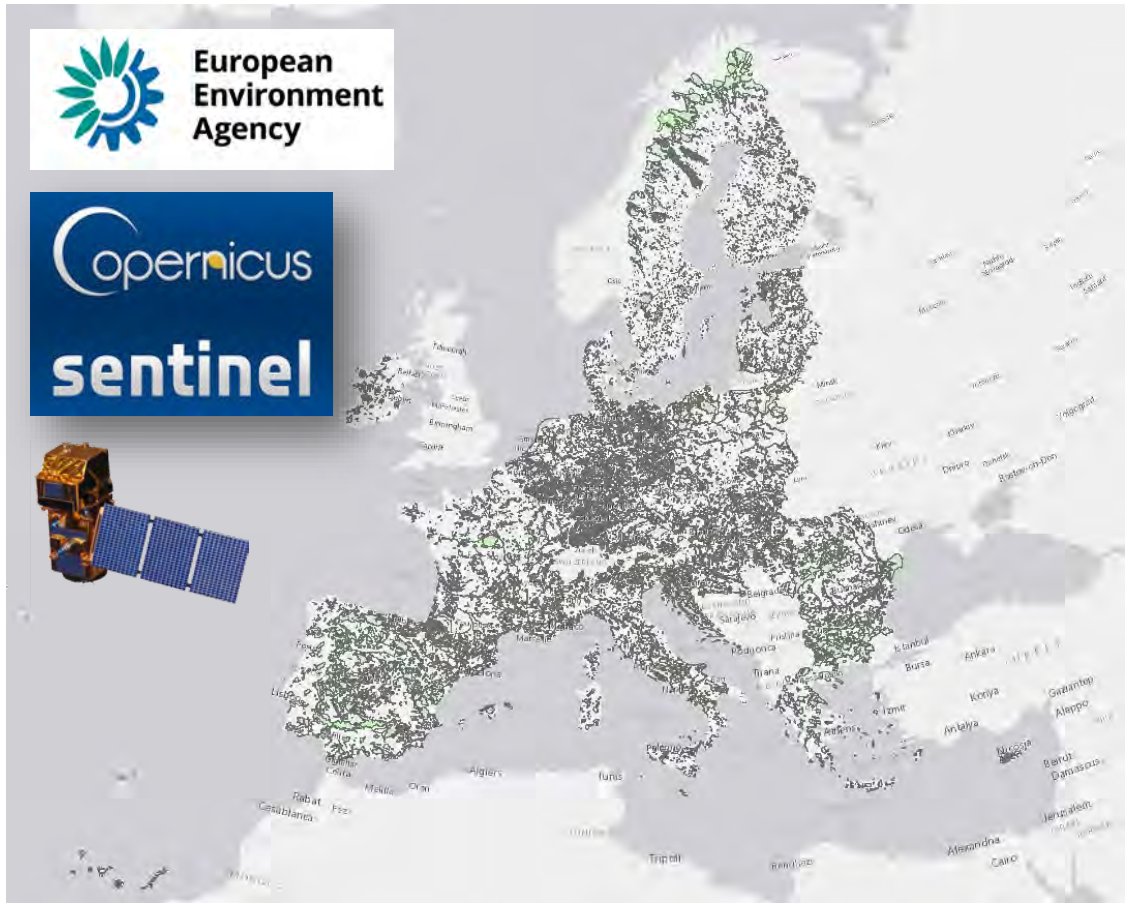
Mapas de hábitats: aplicación en toda Europa

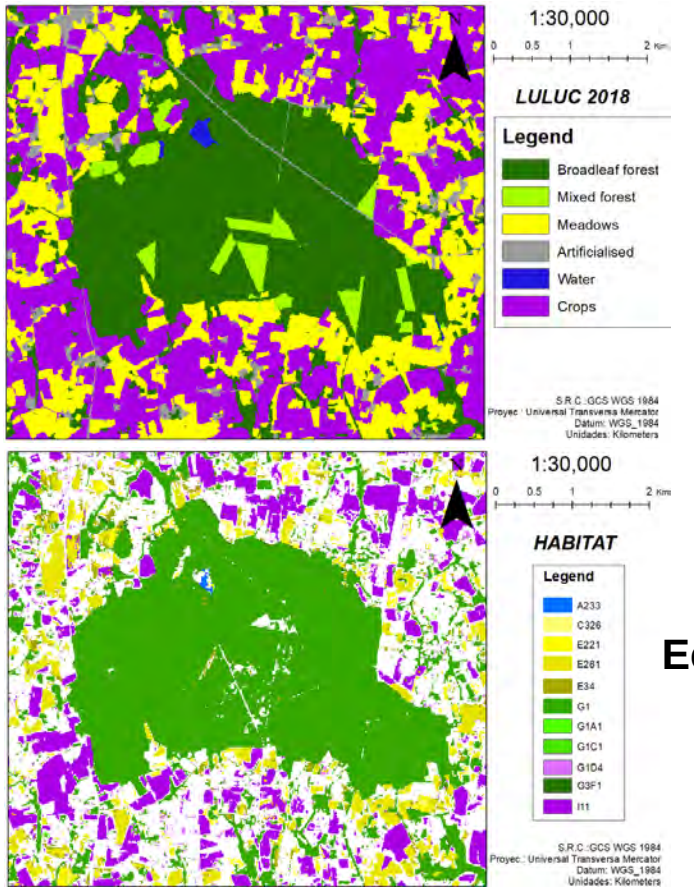
Protected Areas

European Environment Agency

Copernicus Europe's eyes on Earth

Land Monitoring Service





Land Cover classes (2025)

Ecosystem/Habitat types (2026)

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Mapas de hábitats: aplicación en toda Europa

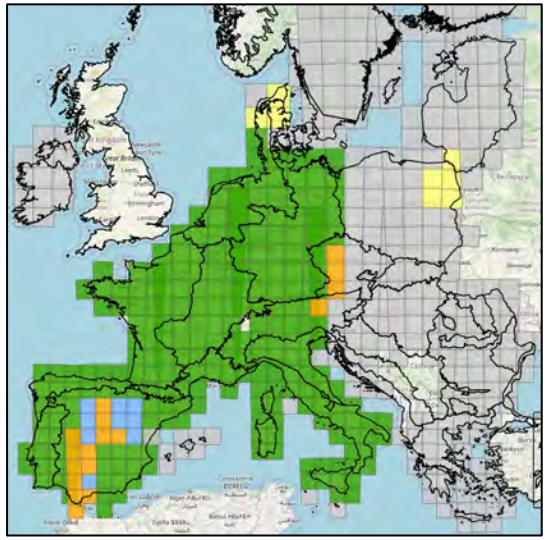
Protected Areas

European Environment Agency

Copernicus Europe's eyes on Earth | Land Monitoring Service

WORKFLOW

GEO BON | CEOS | esa



Samples vs S2SR Time series per class

Samples vs model uncertainty

ACTIVE LEARNING

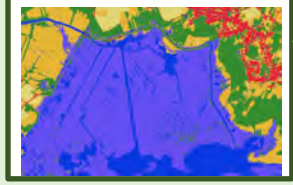
Information at bioregional level

Sentinel-2 Super Resolution Time Series Predictors NEW!

Training dataset NEW!

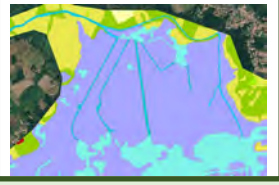
Deep Learning Model Training NEW!

Predictions

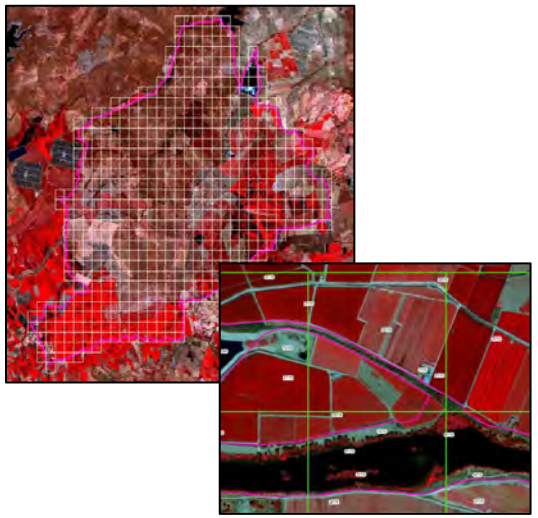


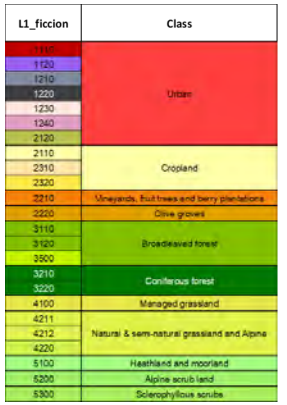
Post-processing NEW!

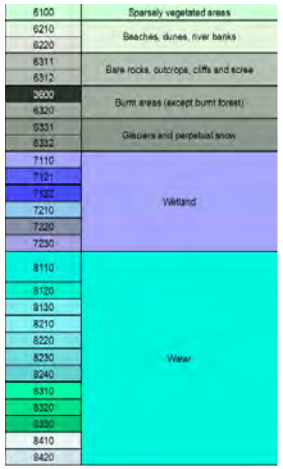
Manual refinement



Information at production unit of 50x50kms







Mapas de hábitats: aplicación en toda Europa

Protected Areas

European Environment Agency

Copernicus Europe's eyes on Earth

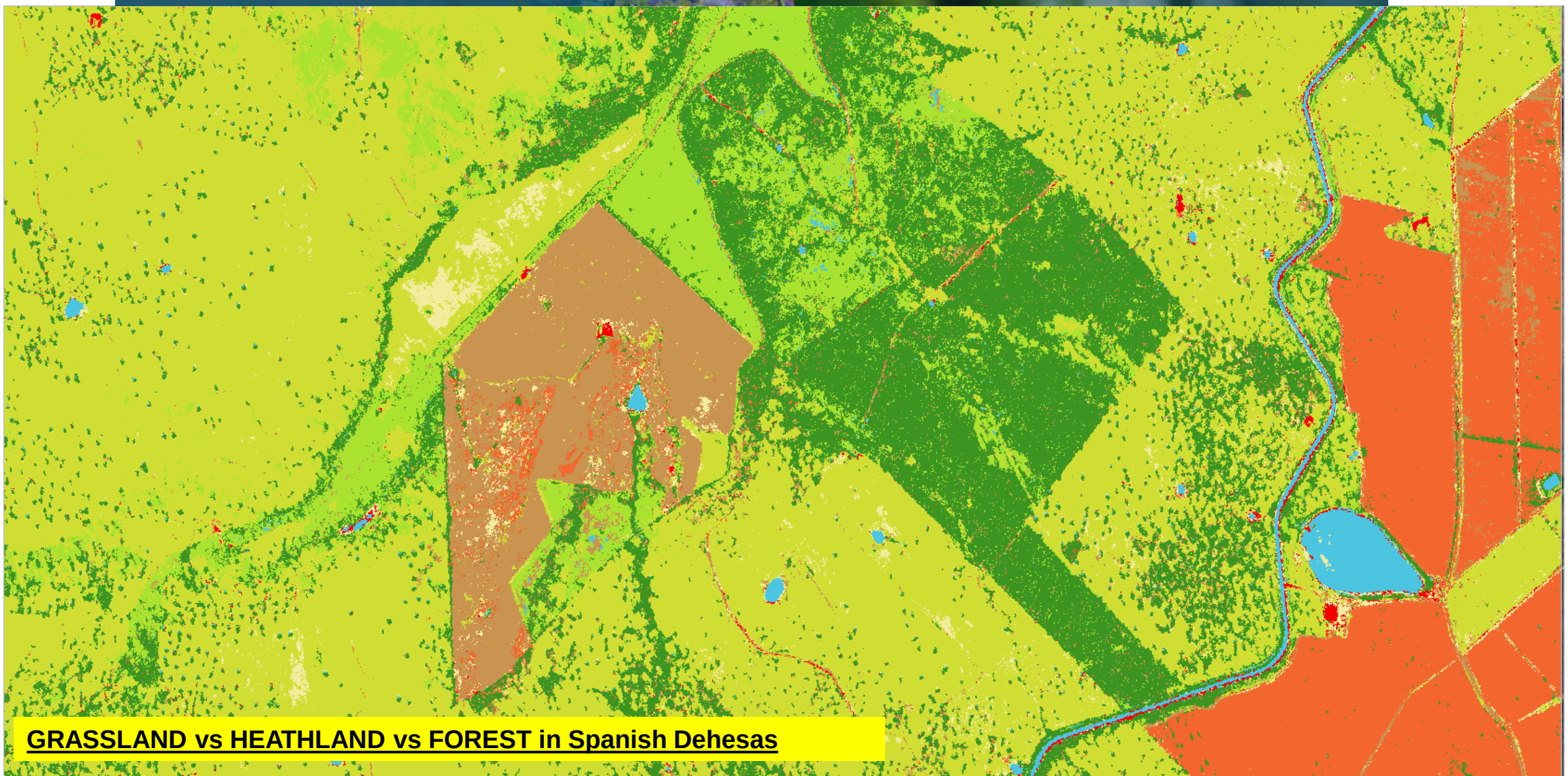
Land Monitoring Service

AUTOMATIC RESULT

GEO BON

CEOS

esa



GRASSLAND vs HEATHLAND vs FOREST in Spanish Dehesas

Mapas de hábitats: aplicación en toda Europa

Protected Areas

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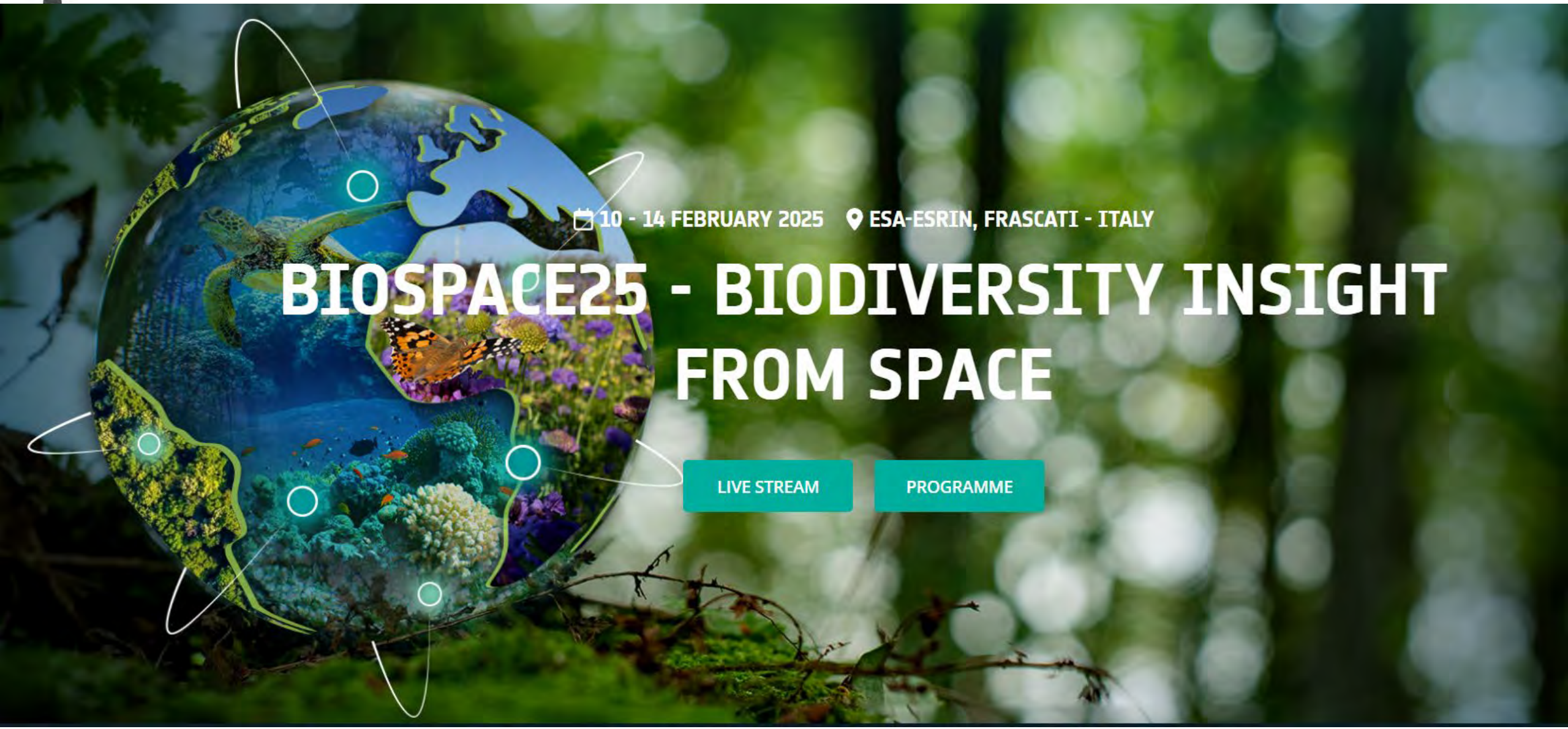
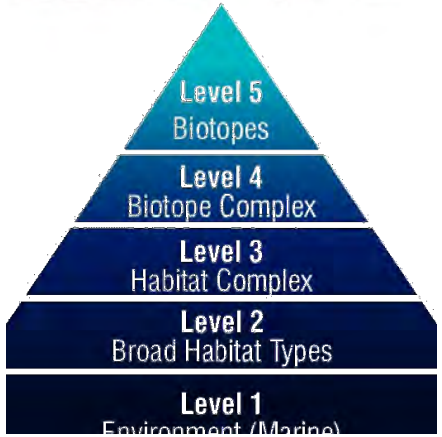
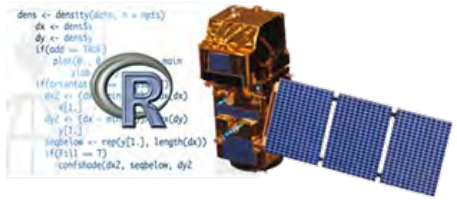


Necesidad de mapas de biodiversidad vegetal a gran escala (hábitats)





ID	EUNIS	N	Descripción
1	A2	103	Littoral sediment
2	A2.61	37	Seagrass beds on littoral sediments
3	C1	271	Surface standing waters
4	C2.2	169	Permanent non-tidal, fast, turbulent watercourses
5	D1.21	385	Hyperoceanic low-altitude blanket bogs, typically with dominant [Trichophorum]
6	E1.2	62	Perennial calcareous grassland and basic steppes
7	E1.263	227	Middle European [Brachypodium] semidry grasslands
8	E1.7	41	Closed non-Mediterranean dry acid and neutral grassland
9	E1.712	95	Sub-Atlantic [Nardus]-[Galium] grasslands
10	E1.721	131	Nemoral [Agrostis]-[Festuca] grasslands
11	E2.1	2430	Permanent mesotrophic pastures and aftermath-grazed meadows
12	E2.11	436	Unbroken pastures
13	E2.111	612	Ryegrass pastures
14	E2.112	171	Atlantic [Cynosurus]-[Centaurea] pastures
15	E2.2	328	Low and medium altitude hay meadows
16	E2.21	125	Atlantic hay meadows
17	E2.22	595	Sub-Atlantic lowland hay meadows
18	E5.31	40	Sub-Atlantic [Pteridium aquilinum] fields
19	F2.2	52	Evergreen alpine and subalpine heath and scrub
20	F2.231	73	Mountain [Juniperus nana] scrub
21	F3.13	31	Atlantic poor soil thickets
22	F3.17	125	[Corylus] thickets
23	F3.171	40	Atlantic and sub-Atlantic hazel thickets
24	F3.25	37	Piornales
25	F3.252	136	Northwestern Iberian [Genista florida] fields
26	F4.2	978	Dry heaths
27	F4.23	120	Atlantic [Erica]-[Ulex] heaths
28	F4.237	190	Cantabro-Pyrenean [Erica vagans]-[E. cinerea] heaths
29	F7.4	138	Hedgehog-heaths
30	F7.4451	834	Pyreneo-Cantabrian cushion-heaths
31	FA	46	Hedgerows
32	G1	40	Broadleaved deciduous Woodland
33	G1.21	252	Riverine [Fraxinus] - [Alnus] woodland, wet at high but not at low water
34	G1.2142	130	Pyreneo-Cantabrian alder galleries
35	G1.6	1343	[Fagus] woodland
36	G1.62	353	Atlantic acidophilous [Fagus] forests
37	G1.624	65	Pyreneo-Cantabrian acidophilous beech forests
38	G1.625	179	Western Cantabrian acidophilous beech forests
39	G1.64	247	Pyreneo-Cantabrian neutrophile [Fagus] forests

Seguimiento de hábitats y especies

Annex I Dir. Hábitats

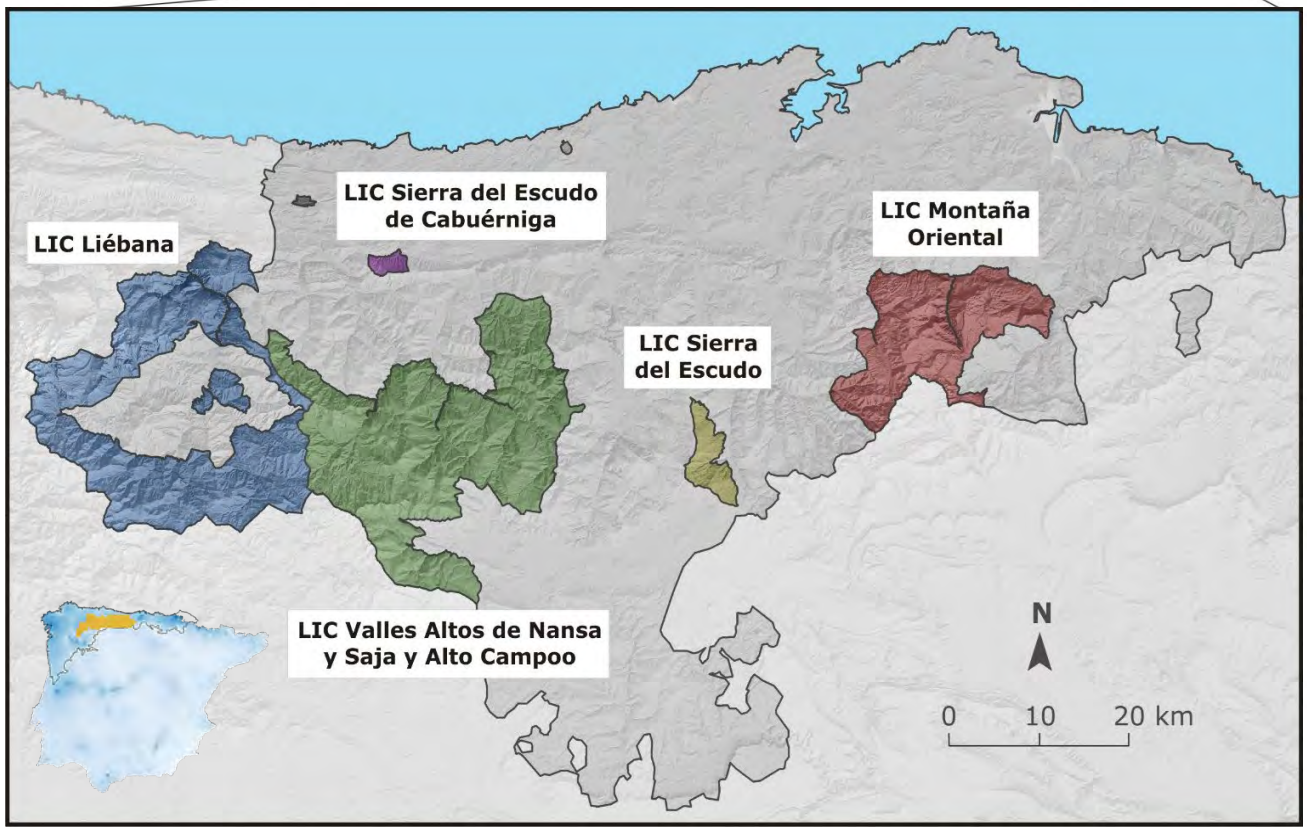
1. Distribución espacial y tendencia

2. Estructura, dinámica y función

3. Sistema de gestión, acciones RC

Cartografía de vegetación a gran escala (EUNIS) a lo largo del tiempo

Mapas de hábitats utilizando técnicas de modelado basadas en TD en la Red Natura 2000 en Cantabria (NO España)



Álvarez-Martínez et al, 2018

Methods in Ecology and Evolution

Necesidad de mapas de biodiversidad vegetal a gran escala (hábitats)

Natura 2000 Gerekliliklerinin Uygulanması İçin Ulusal Doğa Koruma Sisteminin Güçlendirilmesi Projesi

A pilot area to check the methodology for the selection of Natura 2000 sites in Turkey

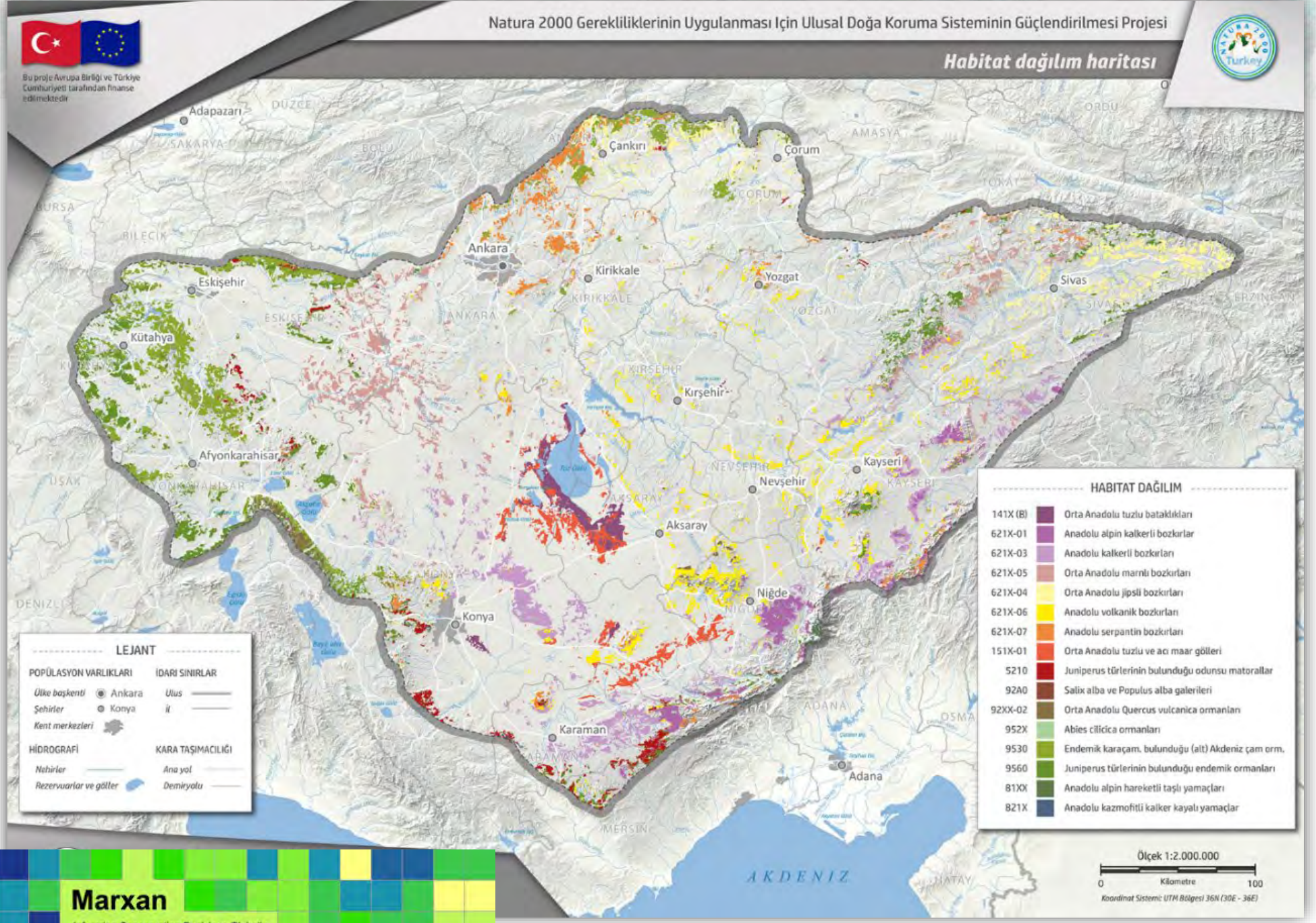
Diseño N2000

- 1. *Extent* de hábitats
- 2. Estado de conservación
- 3. Selección ZECs

Annex I, II

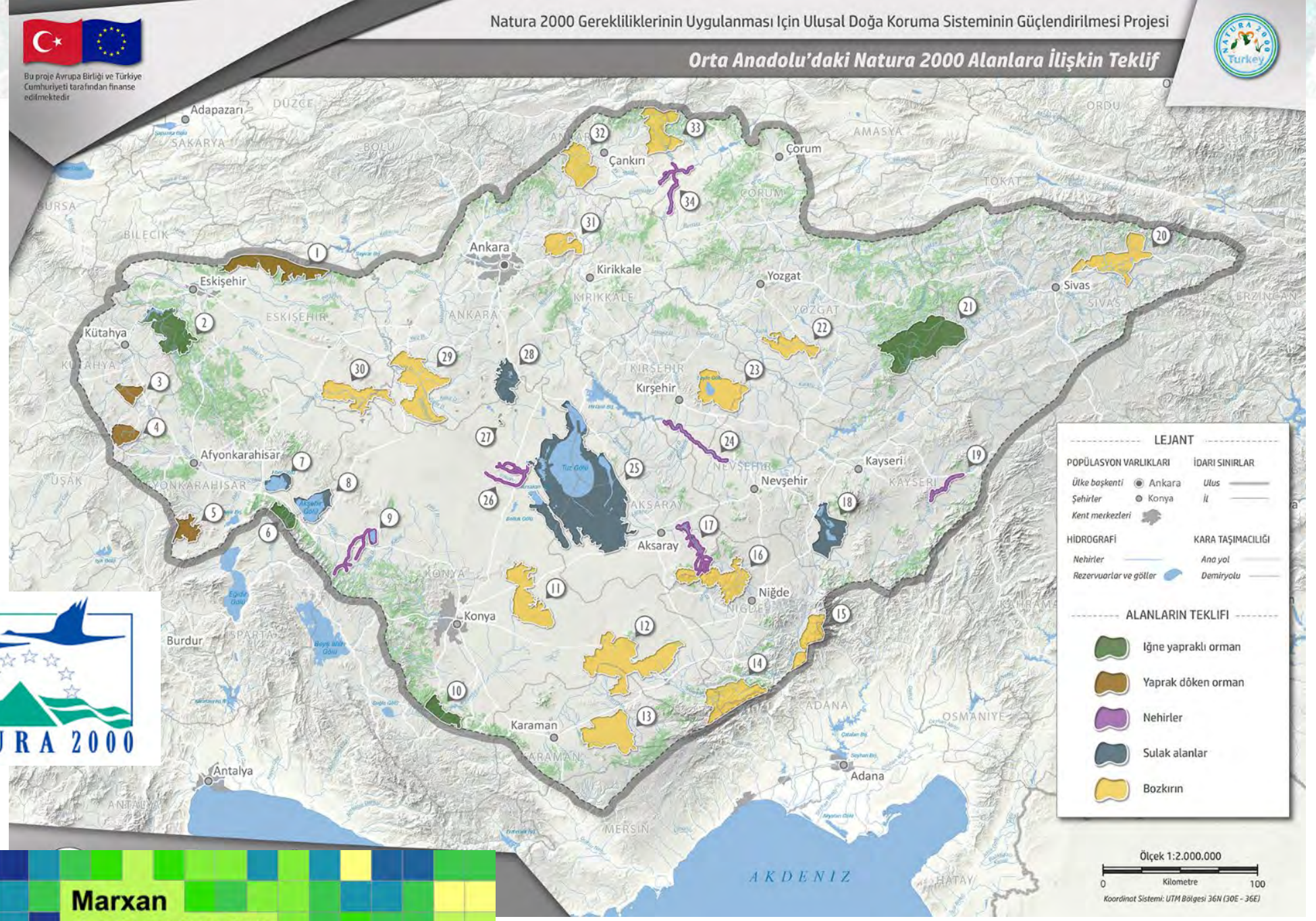
NATURA 2000

human dynamics



Marxan
Informing Conservation Decisions Globally

High resolution maps: 22 Habitats (Annex I) in Central Anatolia



NATURA 2000

Marxan
Informing Conservation Decisions Globally

Natura 2000 potential sites in Central Anatolia

Biodiversidad vegetal: modelado basado en teledetección

Mapas locales de vegetación

- Conservación
- Alta resolución espoacial
- Alto coste humano, económico y de tiempo

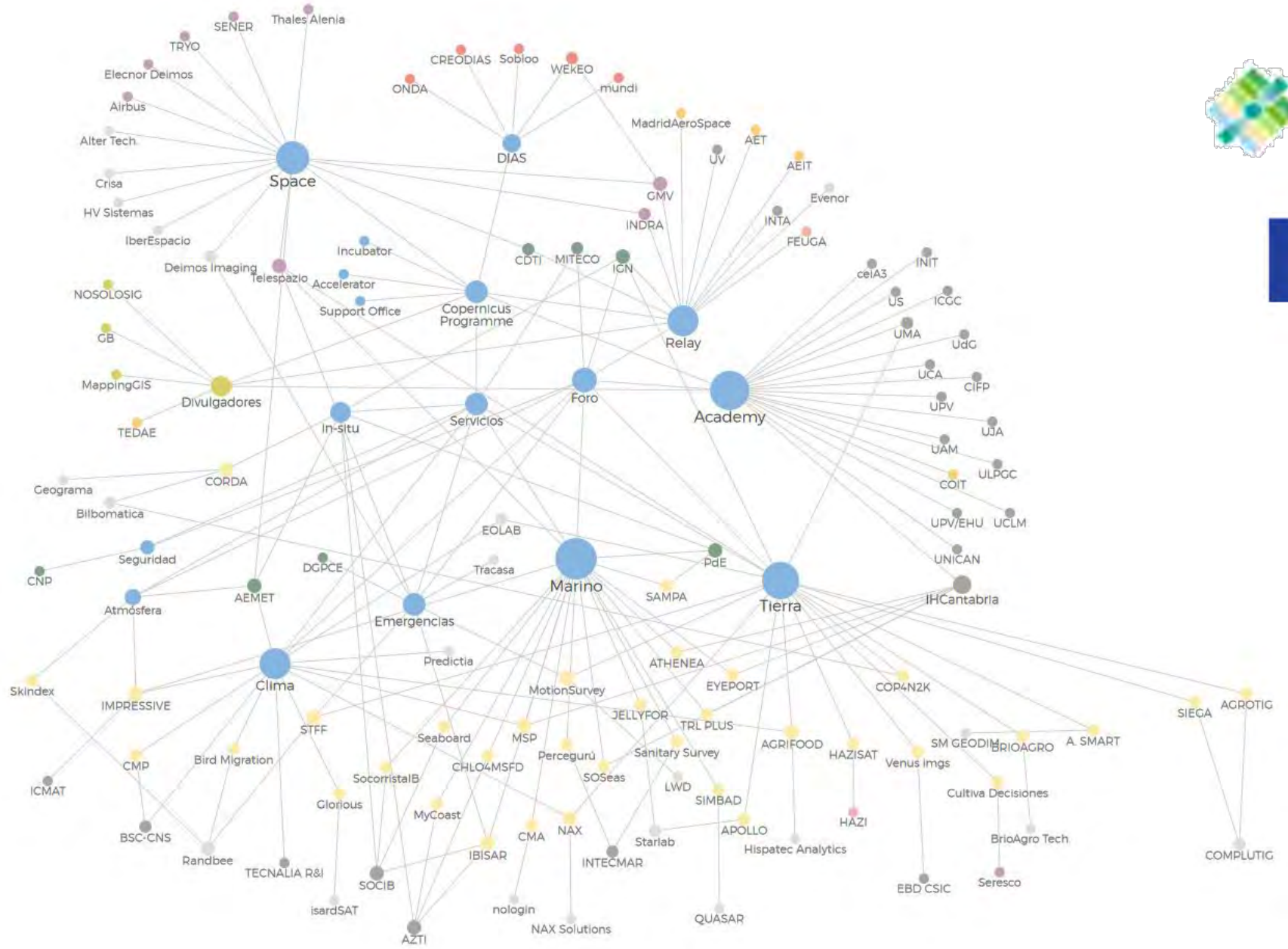
Modelización badasa en TD

- Enfoques basados en la ciencia
- Estudios a escala local y a gran escala
- Posibilidad de reproducir y ampliar

Mapeo probabilístico de la vegetación
para conservación a gran escala

permite optimizar los esfuerzos + datos disponibles

Hacia la **multifuncionalidad ecosistémica**: aplicación en toda España y Europa



APLICOP
IHCantabria


Preguntas