IH cantabria
INSTITUTO DE HIDRAULICA AMBIENTAL
UNIVERSIDAD DE CANTABRIA

Modelling the Area of Occurrence of habitat types with remote sensing.

Applications for habitat mapping and tracking of conservation status. Some practical examples at a regional scale

iHabitat

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GOBIERNO DE ESPAÑA · MINISTERIO DE AGRICULTURA Y PESCA, ALIMENTACIÓN Y MEDIO AMBIENTE

IEPNB

Copernicus

SEMINARIO: CARTOGRAFIA DE LOS HABITATS ESPAÑOLES

FUNDACIÓN IH · UC UNIVERSIDAD DE CANTABRIA

IHCantabria - Copernicus Academy Network and FPA

European Commission Networks: Copernicus Relays and Copernicus Academy. Objective: to contribute on spreading awareness and knowledge about Copernicus across and outside the EU.

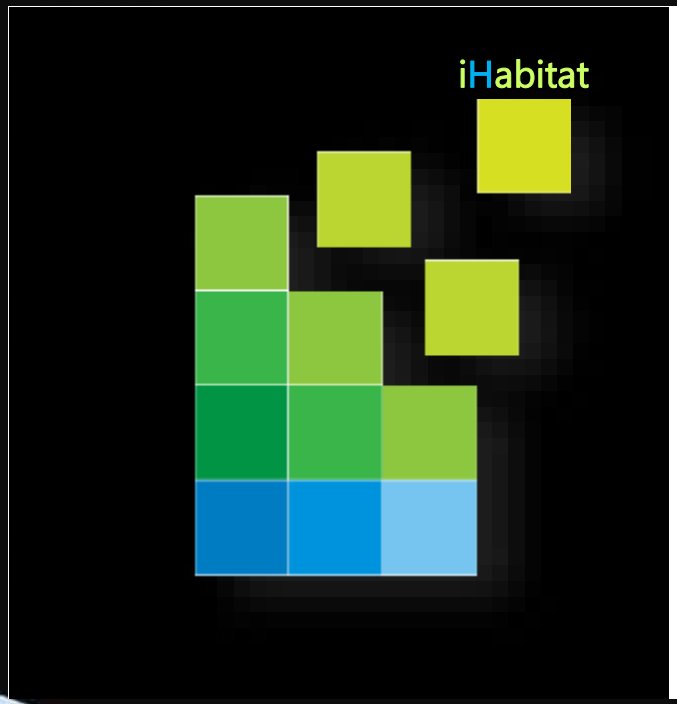
The Copernicus Academy will support the Commission in bridging the gap between skills and data use in new sectors, fostering the development of interdisciplinary masters and educational classes, skills boosting programmes for vocational training, industry-university traineeships and the **creation of spin-offs**.

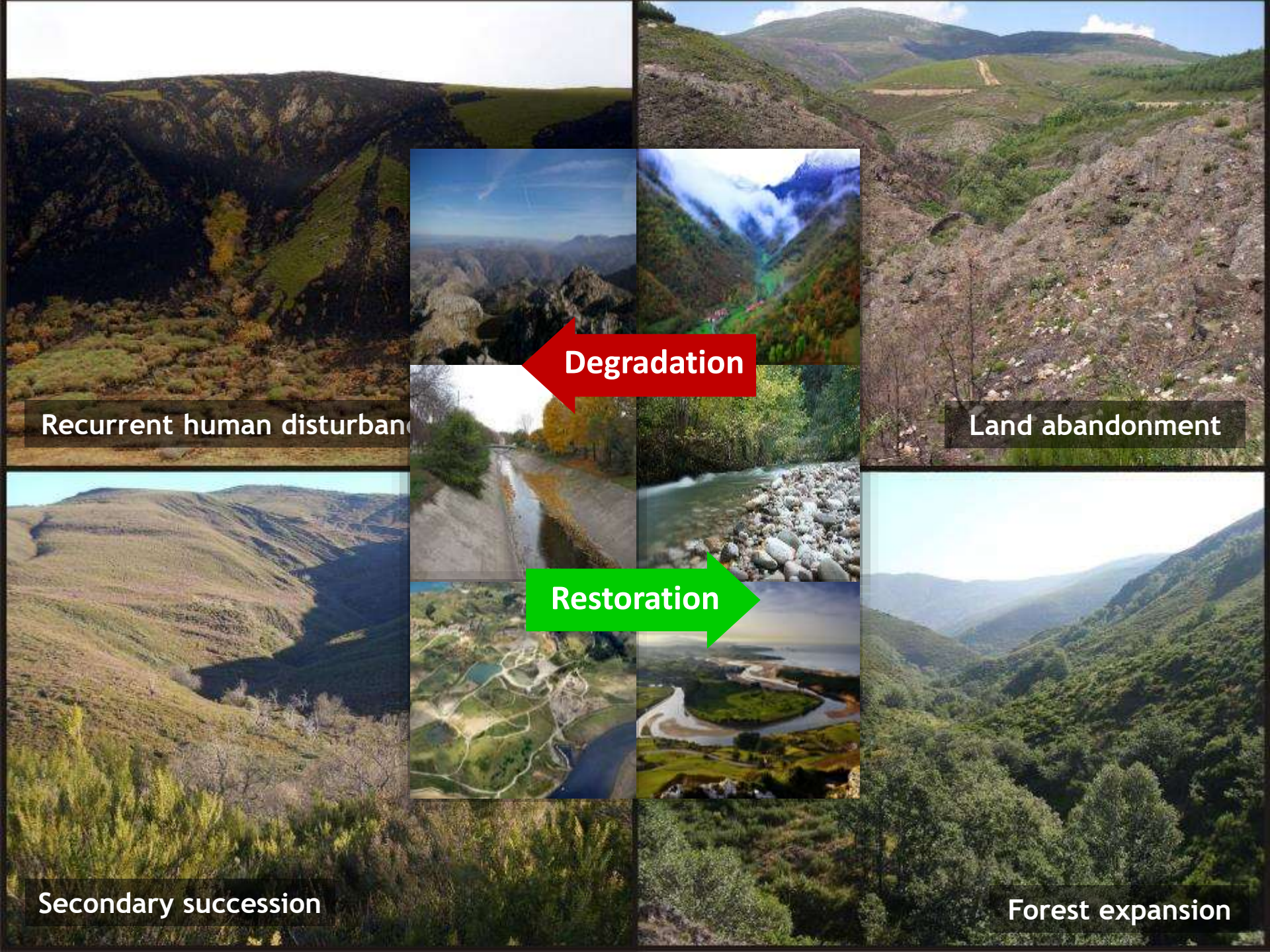
ATHENEA: Integral marine hydrocarbon spill prevention and Management System

SAILING: 2017 World Cup Series Final & 2014 ISAF Sailing World Championships

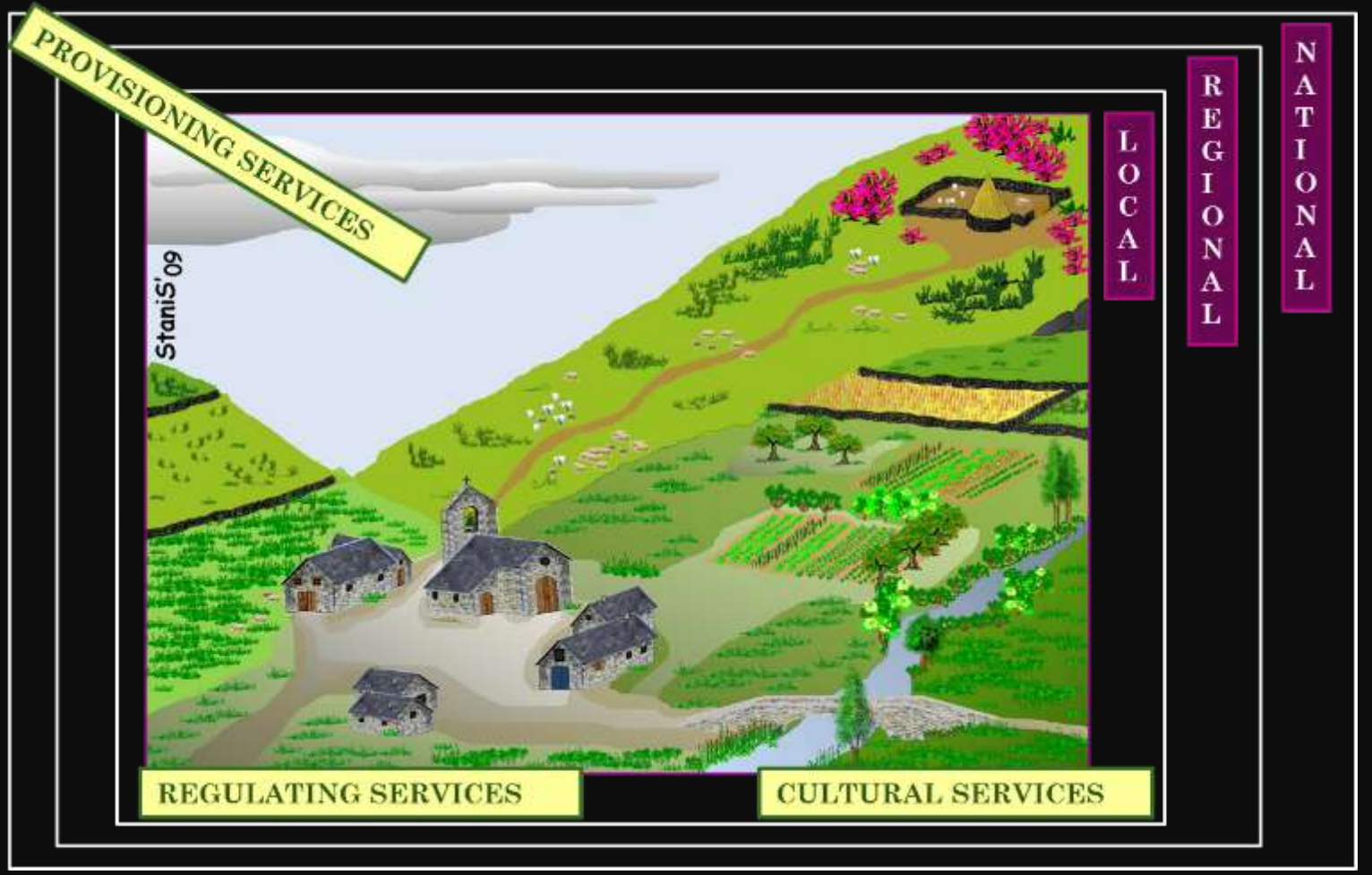
TRL+: Expert Management System to test marine energy technology in deepwaters.

SODIN: Flood Damage Operational System




Recurrent human disturban
Land abandonment
Degradation
Restoration
Secondary succession
Forest expansion

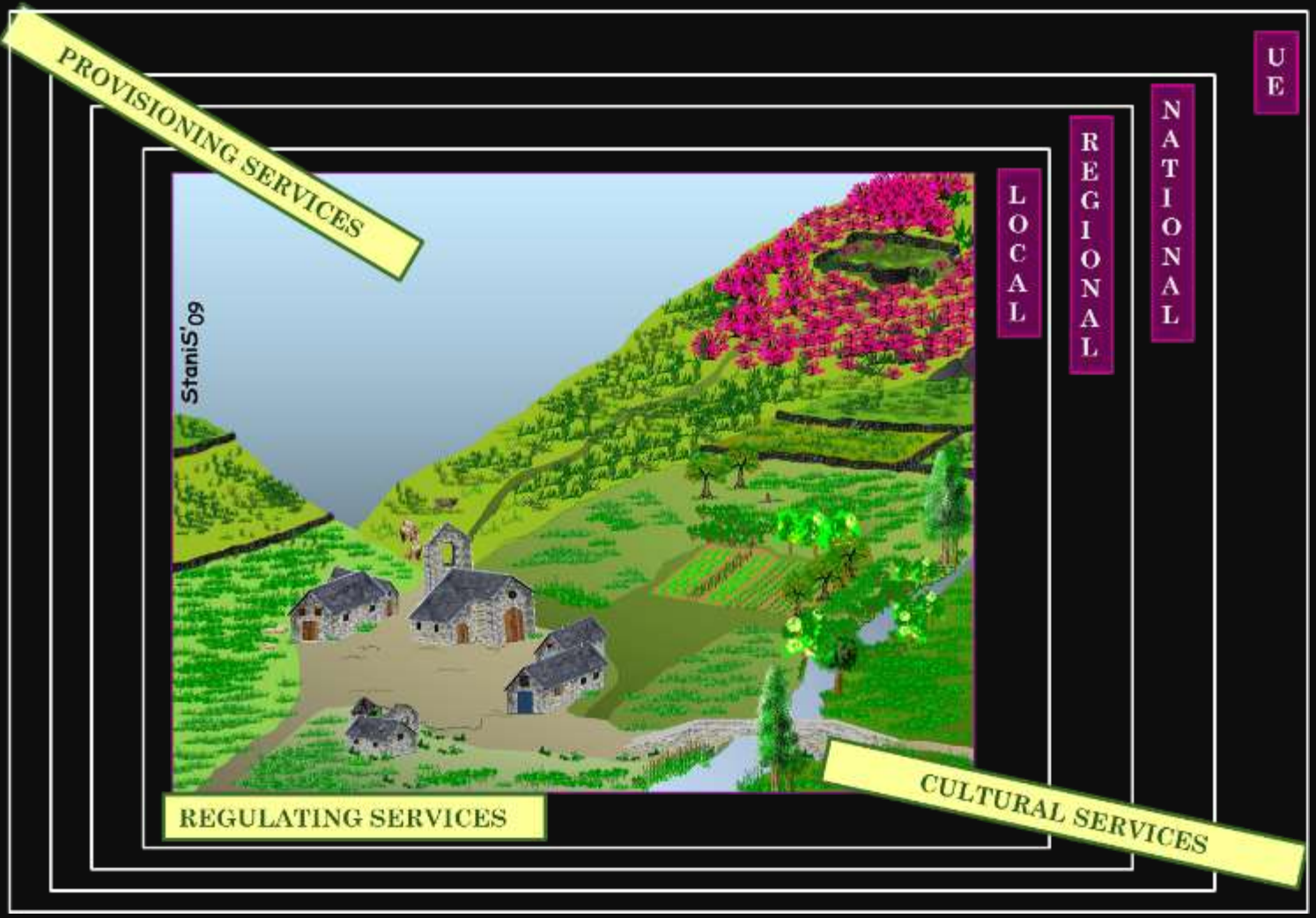
Heathland landscape1950



Morán-Ordónez et al. (2013) *Ecosystems*

ECOSYSTEM SERVICES

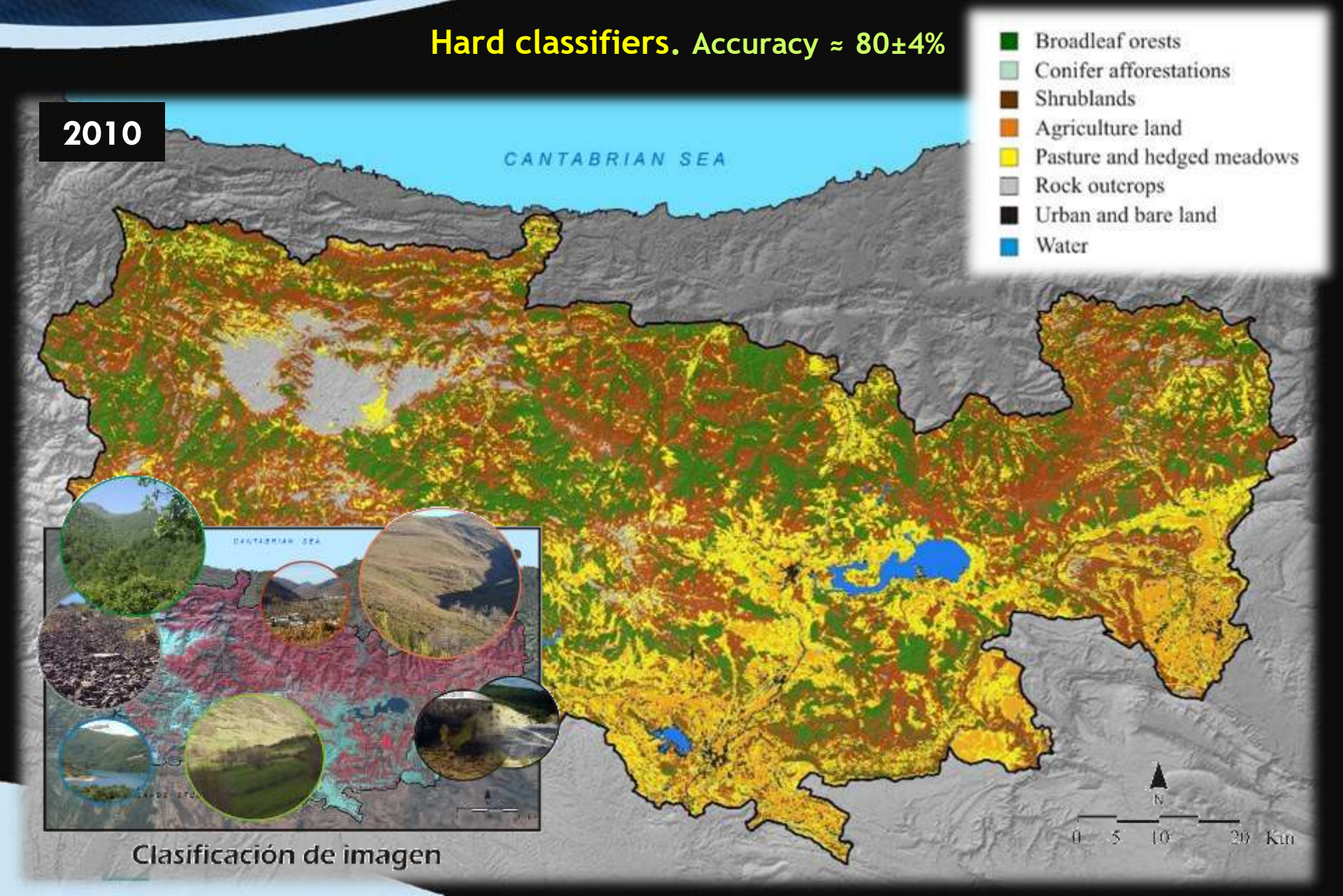
Heathland landscape2010



Morán-Ordónez et al. (2013) *Ecosystems*

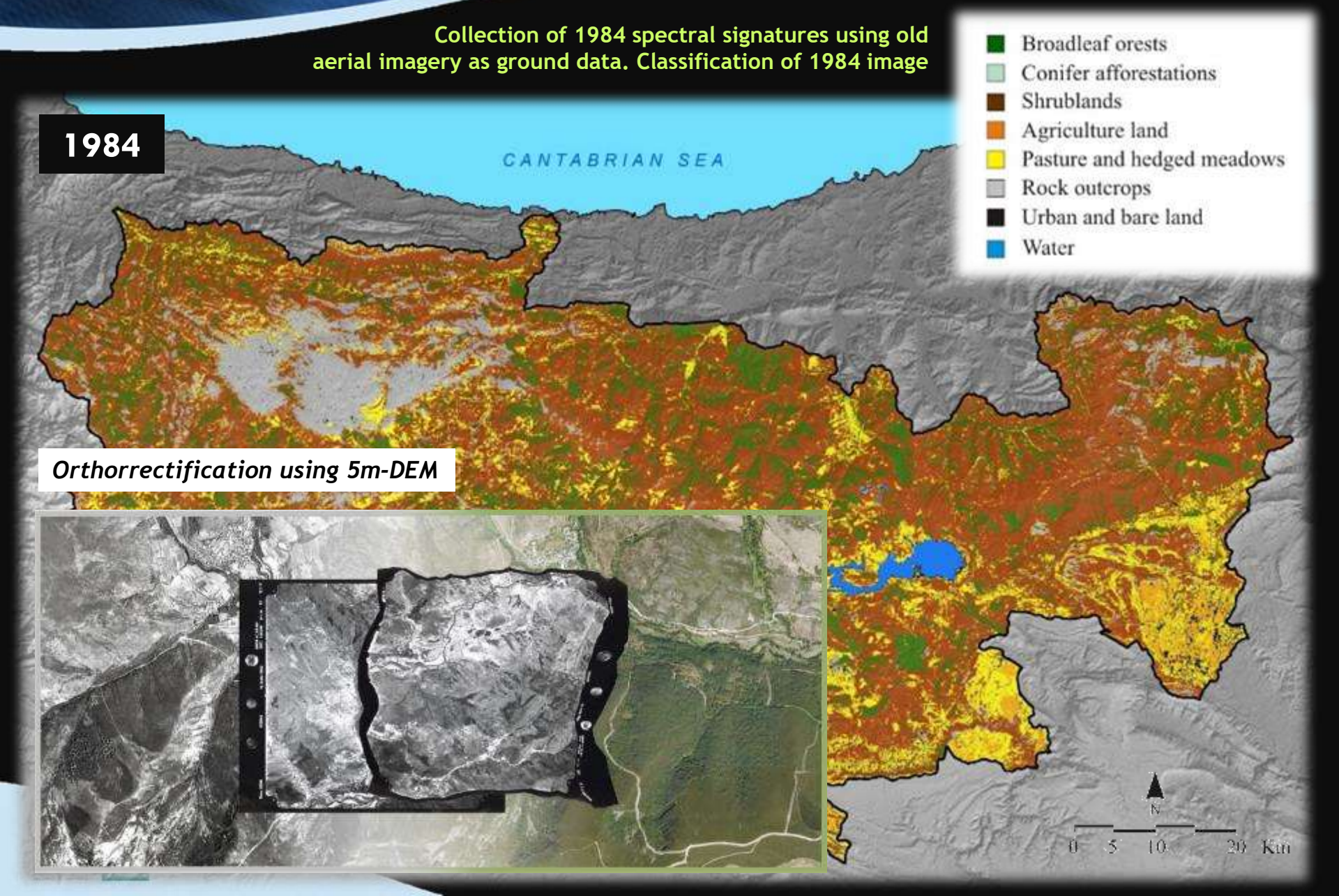
LANDSCAPE DYNAMICS

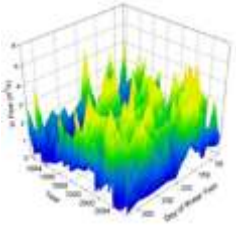
Hard classifiers. Accuracy ≈ 80±4%

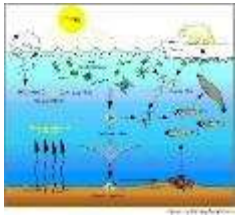


LANDSCAPE DYNAMICS

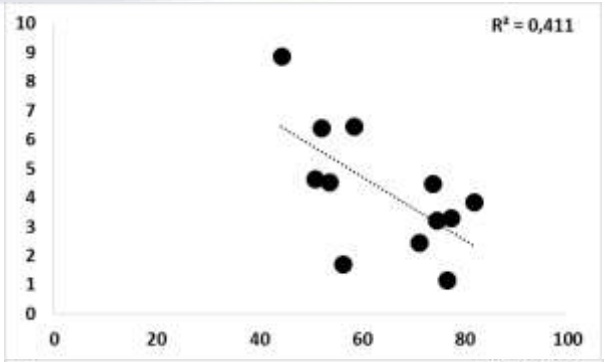
Collection of 1984 spectral signatures using old aerial imagery as ground data. Classification of 1984 image



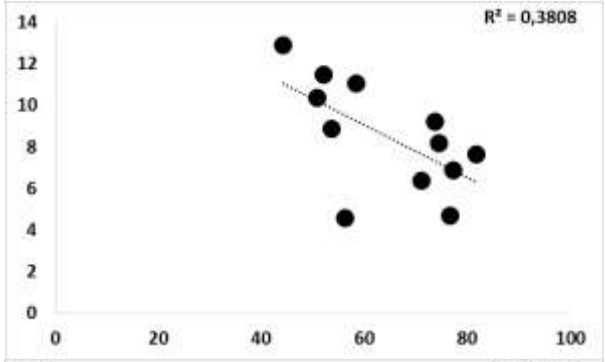




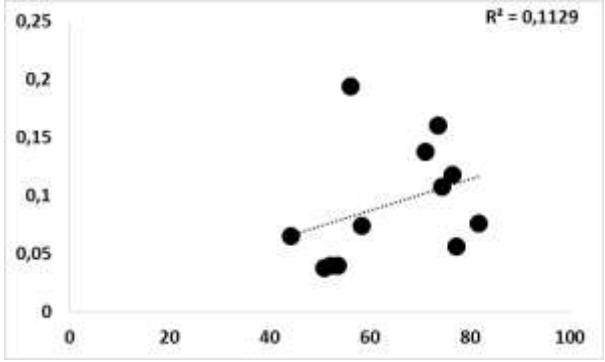
FRE9



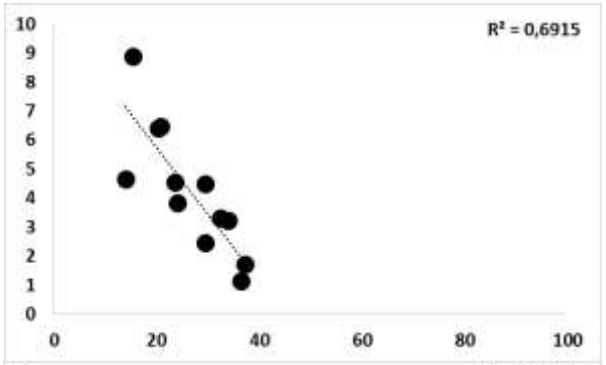
Mean3DayFlowMaxs

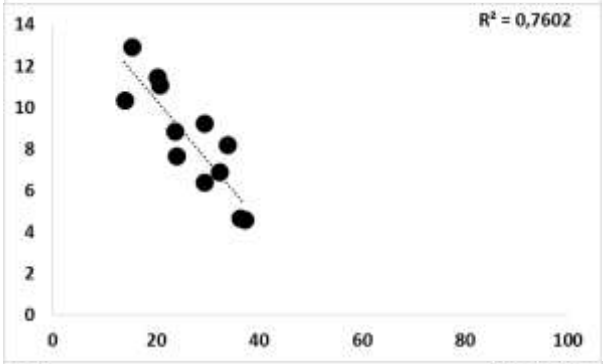


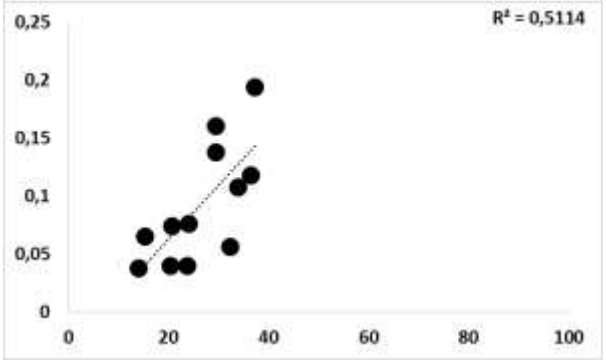
BFI



Average probability of forest presence in 2009







Increase in probability of forest presence from 1984 to 2009

Forest and Hydro

Macro. Algae Fish Metab.

LANDSCAPE DYNAMICS

Human driving forces and ecosystem services. Ecosystem monitoring

Land abandonement, rewilding

Human land use, disturbances

Álvarez-Martínez et al. ***Journal of Ecology*** *(2014)*

Álvarez-Martínez et al. ***Diversity and Distributions*** *(2014)*

- Water and soil fluxes
- Biodiversity patterns
- BGI & ES policy schemes

COPERNICUS PROGRAMME

Copernicus is served by a set of dedicated satellites (the Sentinel families) and contributing missions (existing commercial and public satellites). The Sentinel satellites are specifically designed to meet the needs of the Copernicus services and their users. Since the launch of Sentinel-1A in 2014, the European Union set in motion a process to place a constellation of almost 20 more satellites in orbit before 2030.

Copernicus also collects information from in situ systems such as ground stations, which deliver data acquired by a multitude of sensors on the ground, at sea or in the air.

Through **satellite** and **in situ observations**, the services deliver near-real-time data on a global level which can also be used for local and regional needs, to help us **better understand our planet and sustainably manage the environment** we live in

satellite and **in situ observations**

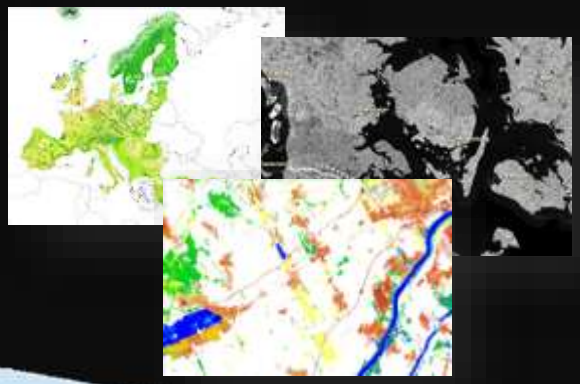
Copernicus

Land Monitoring Service

The Copernicus land monitoring service provides geographical information on land cover and on variables related, for instance, to the vegetation state or the water cycle. It supports applications in a variety of domains such as spatial planning, forest and water management, agriculture and food security, etc.

It consists of three main components:

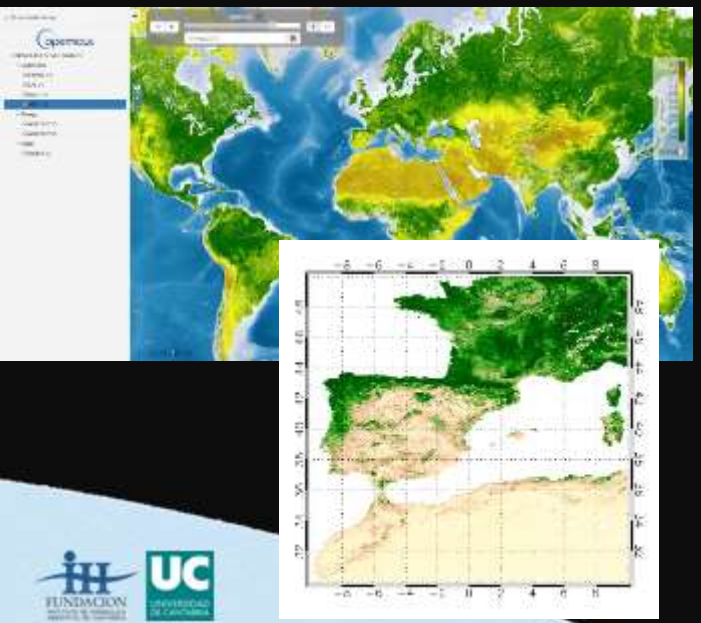
1. Global component
2. Pan-European
3. A local component

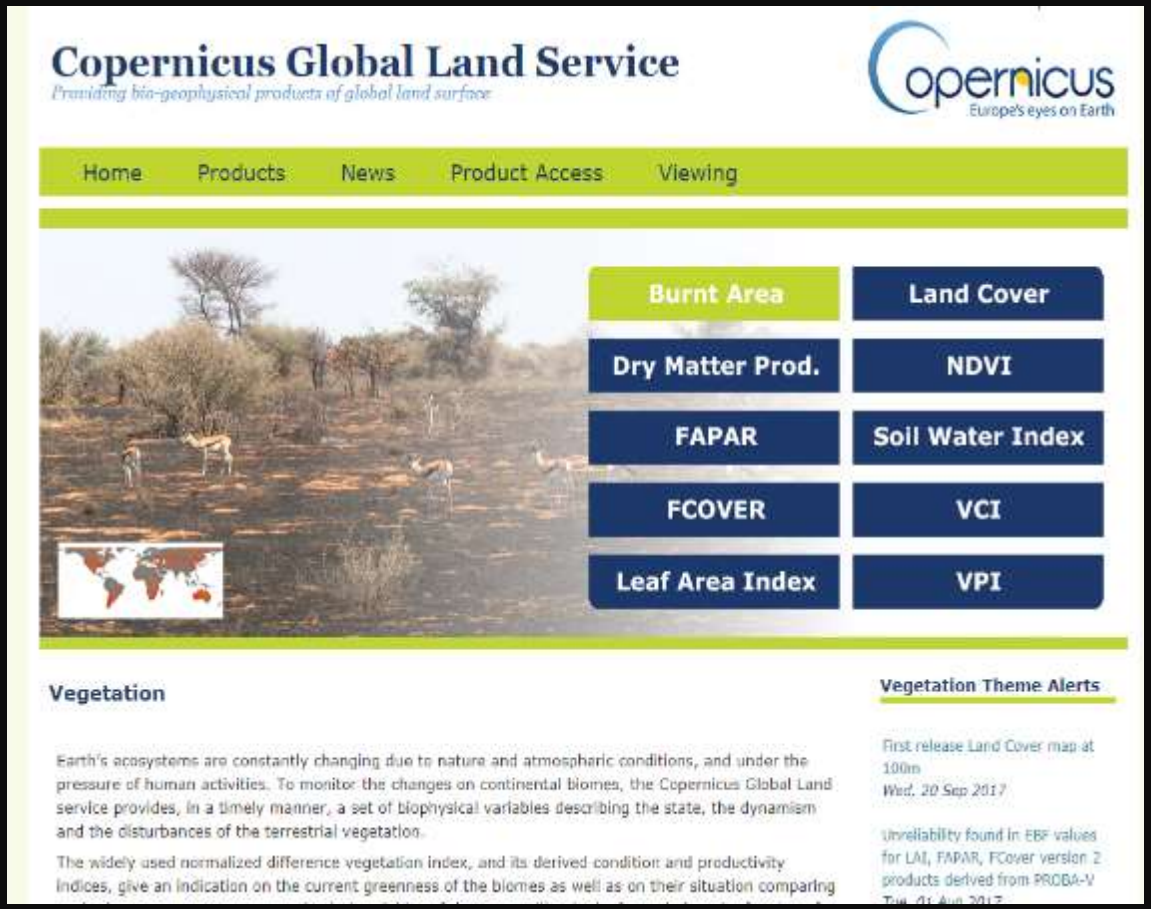


GLOBAL COMPONENT

Coordinated by the European Commission DG Joint Research Centre (JRC)

It produces **data a global scale** (i.e. worldwide), describing the state of vegetation (e.g. LAI, fraction of green vegetation cover, vegetation condition index), the energy budget (e.g. albedo, land surface temperature, top of canopy reflectance) and the water cycle (e.g. soil water bodies).





PAN-EUROPEAN COMPONENT

Coordinated by the European Environment Agency (EEA):

- CORINE Land Cover data, LU/LC satellite image mosaics
- High Resolution Layers, HRL
- Reference Data
- Related Pan-European products

CLC 1990, 2000, 2006 and 2012. 44 LC7LU vector-based classes. Land-change layer, LULCC.

HRL are raster-based datasets describing impervious surfaces forest, (semi-) natural grasslands, wetlands, and permanent water bodies of 39 countries.

SIOSE: Sistema de Información sobre Ocupación del Suelo de España (CNIG)
CLC (CORINE): CoORdination of INformation of the Environment (EEA)

CLC, SIOSE: Vectorial format, i.e. *homogeneous* land cover patches…

LOCAL COMPONENT

Urban Atlas. EU regional policy justifies the production and maintenance of detailed LULC information over major EU city areas. The Urban Atlas provides pan-European comparable LULC data covering a number of Functional Urban Areas (FUA). In 2012, an additional layer (Street Tree Layer - STL) was produced for a selection of FUAs

Riparian Zones. The next local component addresses LULC in areas along rivers, i.e. the riparian zones. The rationale for this local component is provided by the need to monitor biodiversity at European level, amongst other in the framework of improving the “green” and “blue” infrastructures in the European Union.

Natura 2000 (N2K). The aim of the first N2K project was to assess whether these sites are effectively preserved and to monitor the decline of 5 grassland habitat types as important hotspots at the EU level.

The local component is coordinated by the European Environment Agency and aims to provide **specific and more detailed information** that is complementary to the information obtained through the Pan-European component. It focuses on "hotspots" which are prone to specific environmental challenges and problems. It is based on very high resolution imagery (2,5 x 2,5 m pixels) in combination with other available datasets (high and medium resolution images) over the pan-European area. The local component provides detailed land cover and land use information over major European cities, riparian landscapes and Natura 2000 areas, all important for EU policy

NATURA 2000 (N2K)

Natura 2000 (an EU-wide network of nature protection areas established under the 1992 Habitats Directive) is the centerpiece of EU nature & biodiversity policy. The aim of the network is to assure the long-term survival of Europe's most valuable and threatened species and habitats.
A selection of N2K grassland-rich sites (5 grassland habitats types 6210, 6240, 6250, 6510 and 6520, including a 2km buffer and covering approx. 160.000 km2) sites was mapped in order to assess their actual area, their condition and their development over time.

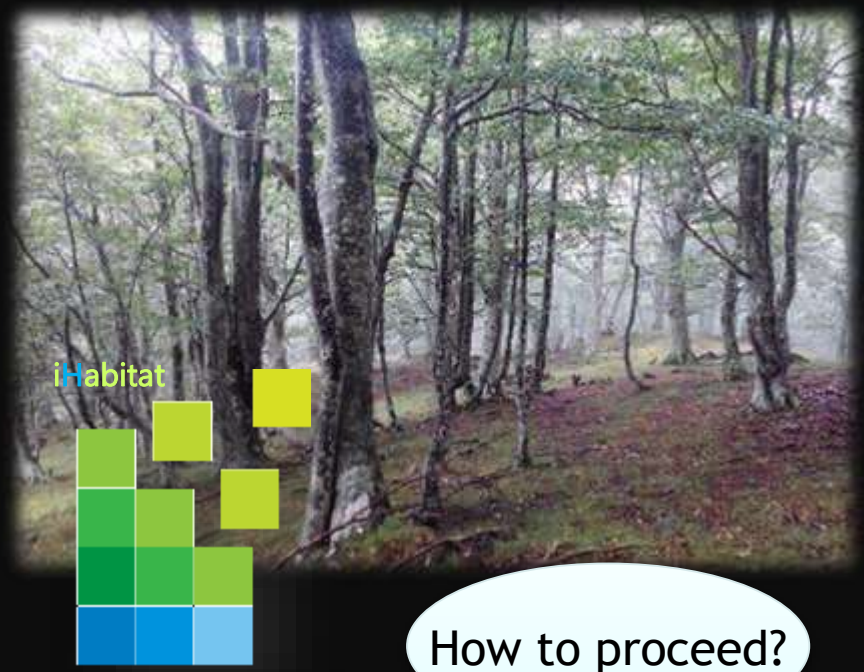
The sites were analysed for the 2006 and 2012 reference years and a change analysis was performed. The mapping also included a 2km buffer zone where an analysis of pressures and threats was conducted. The analysis focused on a selection of grassland (semi-natural/species rich) habitat types.

The inclusion of the remaining grassland-rich N2K sites not selected in the current exercise will be implemented in 2017-2018 and an extension to other habitat types is also foreseen and under discussion.

NATURA 2000 (N2K)

Habitat types are defined as **"terrestrial or aquatic ecosystems distinguished by geographic, abiotic and biotic features"** (Evans 2006; Commission 2013)

Europe → **Vegetation communities** of interest for conservation → Hábitats Directive[1]



Hábitats Directive[1] → SCI → Declared → SAC → **Management Plan**

Hábitats Directive[1] → **Sexennial Report of Conservation Status**

Annex I
1. Habitat mapping
2. Conservation Status
3. Management Plan

New: June 2018

How to proceed?

UE Directives → A need for a standardized methodology

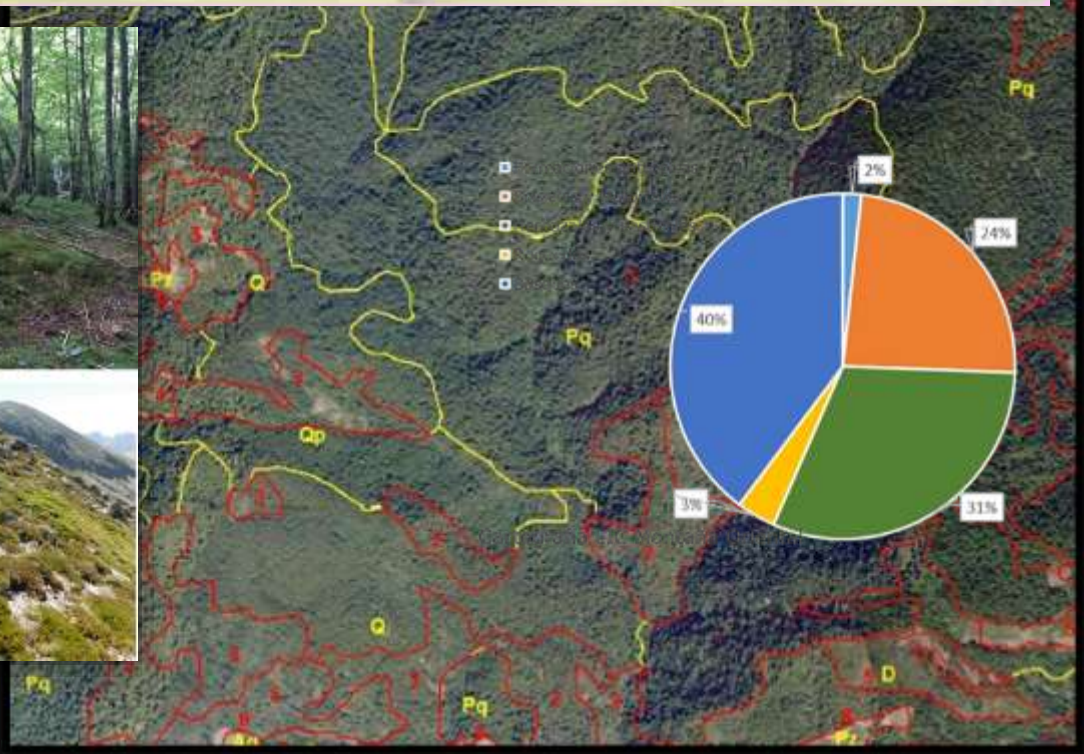
Council Directive 92/43 / EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora

Traditionally: visual & field interpretation

F4.22

EUNIS (level 1): Heathland, scrub and tundra
EUNIS (level 2): Temperate shrub heathland
EUNIS (level 3): Dry heaths
EUNIS (level 4): Sub-Atlantic [Calluna] - [Genista] heaths F4.22

HABITATS DIRECTIVE ANNEX I: 4030-EU dry heathlands



€; Vectorial format, i.e. *homogeneous* land cover patches…

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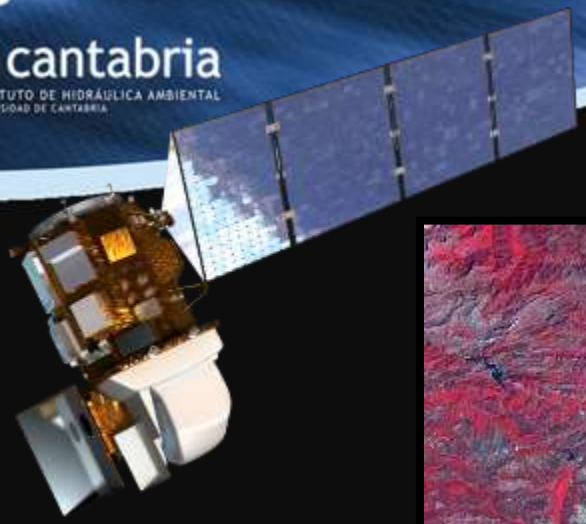
HABITAT MODELLING

Mapping *vegetation* from digital data

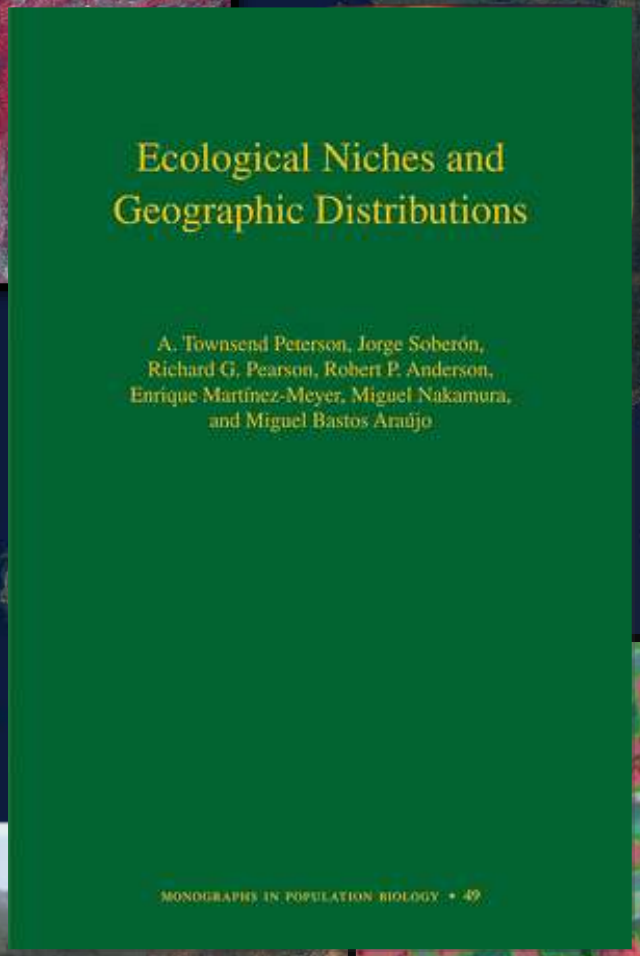


Remote Sensing (RS)

Satellite imagery:
Landsat8 OLI – MVC, 30m

LiDAR data: derived variables, 5 to 30m

+ Environmental limiting factors: interpolation to pixel resolution (5-30m)



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NATURA 2000 SITES IN CANTABRIA

NATURA 2000

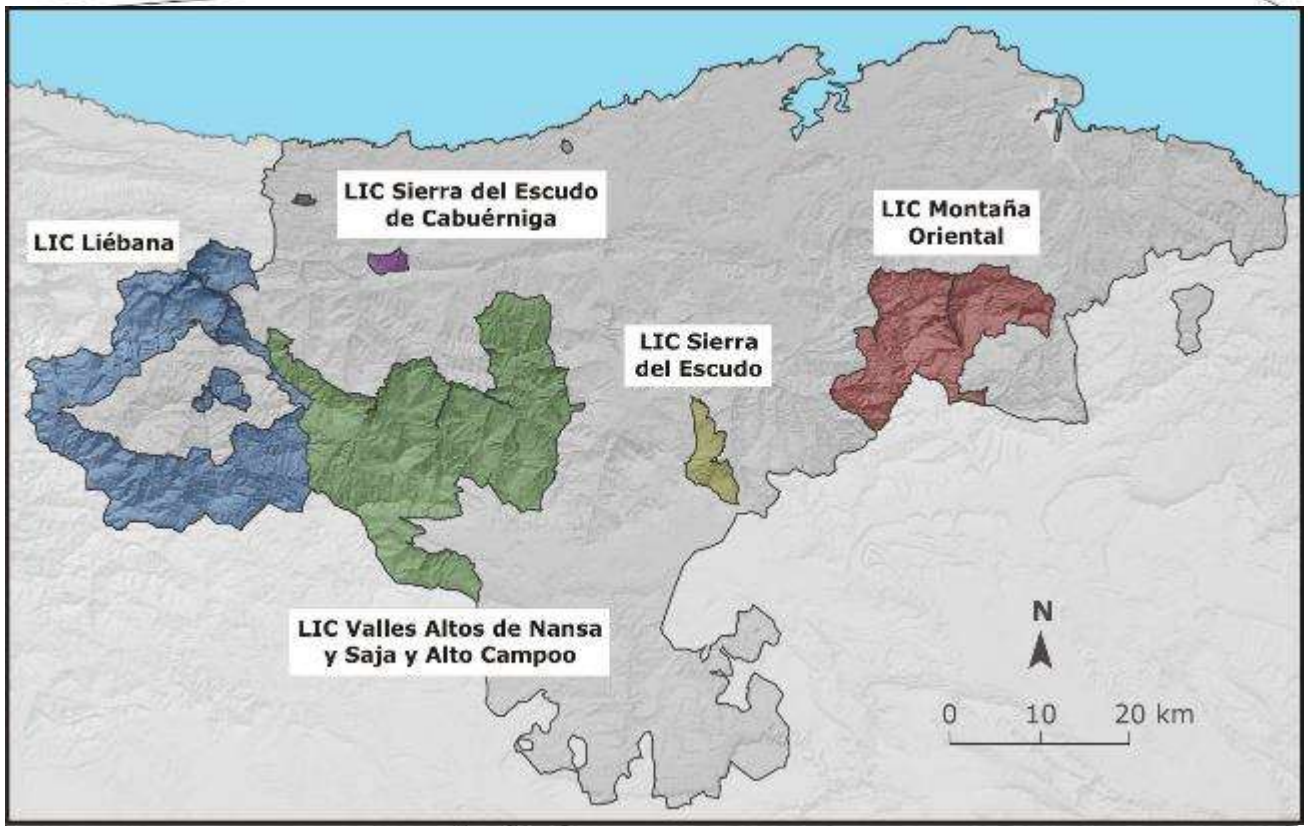
Management plan

Annex I

1. Habitat mapping (41→24)
2. Conservation Status
3. Management Plan-Local actions

Mapping broad-scale vegetation patterns in complex mountainous territories

Habitat maps using modelling techniques in SCI→SAC of Natura 2000 Network in Cantabria (NW Spain)
26% of Cantabria



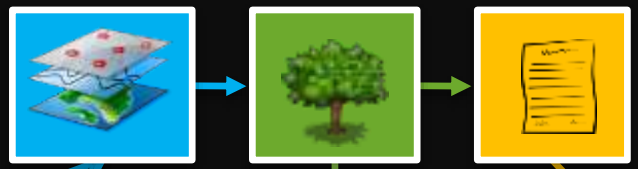
GENERAL METHODOLOGY

HABITAT MAPPING

STATE OF CONSERVATION

MANAGEMENT PLANS

GENERAL METHODOLOGY



MODELLING

MAPS

INDICATORS

Reference values

OBJECTIVES

ACTIONS

Management

Conservation

INDICATORS

Extension

Vulnerability

Structure and Function

HABITAT MAPPING

HABITAT MAPPING

There exist a real reduction of **local AOO** into **realized AOO** when modelling habitat distribution with remote sensing data across landscape continuum and ecotone areas

Methods in Ecology and Evolution
BRITISH ECOLOGICAL SOCIETY

Modelling the area of occupancy of habitat types with remote sensing

Journal:	*Methods in Ecology and Evolution*
Manuscript ID	MEE-17-04-367.R1
Manuscript Type:	Research Article
Date Submitted by the Author:	n/a
Complete List of Authors:	Alvarez-Martínez, Jose; Environmental Hydraulics Institute IH Cantabria, Dept. of Science and Technology of Water and the Environment Jiménez-Alfaro, Borja; German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig Barquín, José ; Environmental Hydraulics Institute IH Cantabria Ondiviela, Bárbara; Environmental Hydraulics Institute IH Cantabria Recio, María; Environmental Hydraulics Institute IH Cantabria Silió-Calzada, Ana; Environmental Hydraulics Institute IH Cantabria Juanes, José Antonio; Environmental Hydraulics Institute IH Cantabria
Keywords:	GIS < Population Ecology, Sampling < Population Ecology, Modelling (Community Ecology) < Community Ecology, Diversity < Community Ecology, Monitoring (Community Ecology) < Community Ecology, Species interactions < Community Ecology, Habitats < Conservation
	1. A current challenge of biodiversity and conservation is the estimation of the spatial extent of habitat types across broad territories. In the absence of fine-resolution maps, predictive modelling helps in assessing the spatial distribution of vegetation cover. However, such approaches are still uncommon in regional planning and management. Here, we present a framework for mapping the area of occupancy (AOO) of habitat types that allows highly suitable estimates at different scales.

1. RELIABLE OCCURRENCE DATA

Código DH	Modelling?	Nº Puntos	Sesgo?	Observaciones	Campo
3110	NO			Habitats fluviales (MDT 5 metros)	
3260	NO			Habitats fluviales (MDT 5 metros)	
3270	NO			Habitats fluviales (MDT 5 metros)	
3280	NO			Habitats fluviales (MDT 5 metros)	
4010	No en Cantabria				
4020	SI	105	Sí. Sin puntos en la zona oriental	Buscar puntos oriente	**SI**
4030	SI	465	No	OK	
4060	SI	220	No. Puntos localizados pero en su á	OK	
4090	SI	347	No	OK	
5120	SI	25	Sí. Sólo Picos Europa	Necesario eliminar sesgo y aumentar número de puntos	**SI**
6110	NO	0		Buscar hábitat	**SI**
6140	No en Cantabria				
6160	SI	9	Sí. Solo en Saja-Nansa	Necesario eliminar sesgo y aumentar número de puntos	**SI**
6170	SI	87	No	OK	
6210	SI	90	No	OK	
6220	NO	0		Buscar hábitat	**SI**
6230	SI	101	No	OK	
6410	NO	0		Buscar hábitat	**SI**
6420	SI	10	No	Aumentar número de puntos	**SI**
6430	NO	0		Buscar hábitat	**SI**
6510	SI	143	No	OK	
6520	No en Cantabria				
7110	NO			Turberas. Cartografía de campo	
7130	NO			Turberas. Cartografía de campo	
7140	NO			Turberas. Cartografía de campo	
7150	NO			Turberas. Cartografía de campo	
7220	NO			Turberas. Cartografía de campo	
7230	NO			Turberas. Cartografía de campo	
8130	SI	139	Si	Buscar puntos centro y oriente	**SI**
8210	SI	106	No	OK	
8220	SI	11		Aumentar número de puntos	**SI**
8230	NO	0		Buscar hábitat	**SI**
8240	No en Cantabria				
8310	NO			Cuevas no explotadas turisticamente. No modelar	
9120	SI	413	No	OK	
9150	SI	241	Si	Buscar puntos zona centro y oriente	**SI**
9160	No en Cantabria				
9180	SI	89	No. Puntos localizados pero en su á	OK	
91E0	SI	411	No	OK	
9230	SI	164	No	OK	
9240	SI	32	No	OK	
9260	SI	108	No	OK	
92A0	SI	19	No	Aumentar número de puntos	**SI**
9330	SI	10	No. Puntos localizados pero en su á	Aumentar número de puntos	**SI**
9340	SI	83	No	OK	
9380	SI	53	No	OK	
9580	No en Cantabria				

41 habitats of special interest in Nature 2000 network in Cantabria

24 data modelled (1st phase) **17: no data**

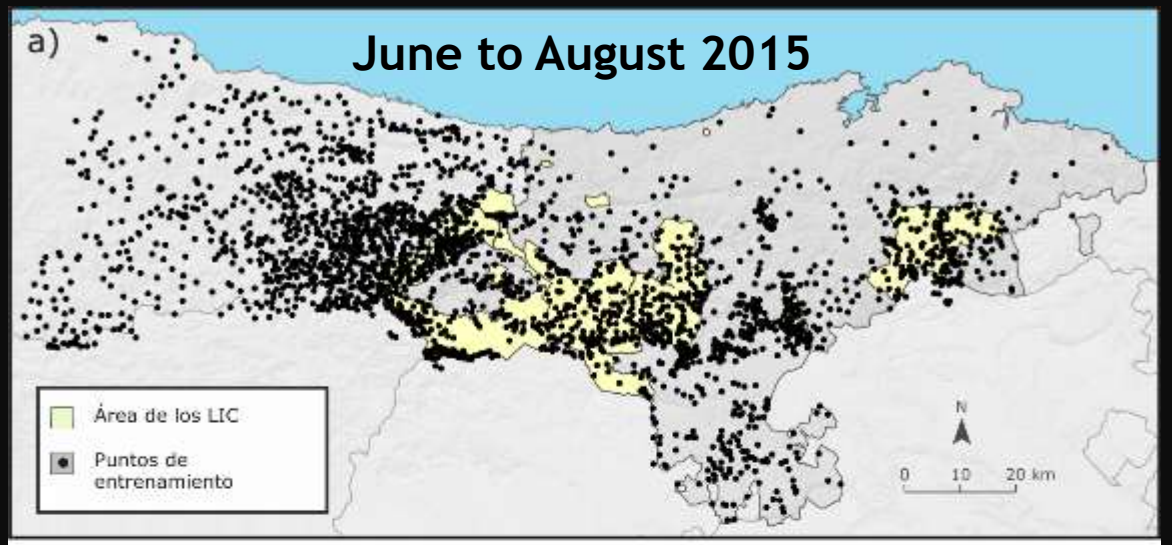
1. RELIABLE OCCURRENCE DATA

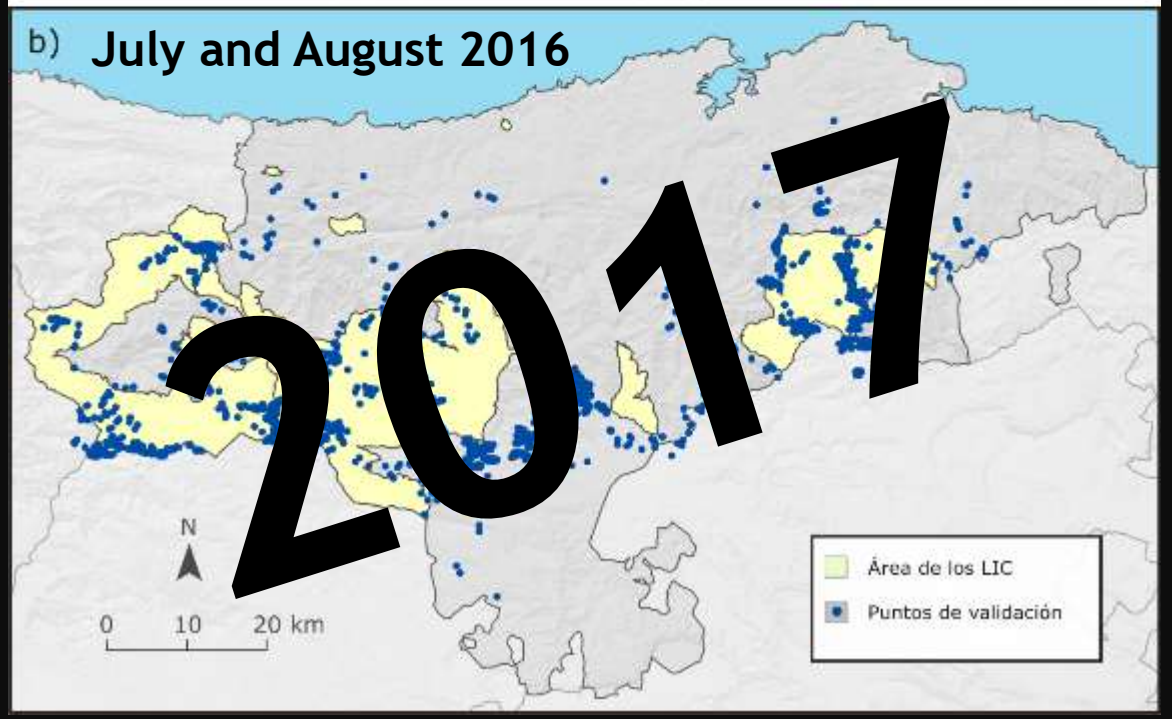
INDEPENDENT
training and testing data

Different experts
Different locations

TRAINING:
Vegetation maps with field checking

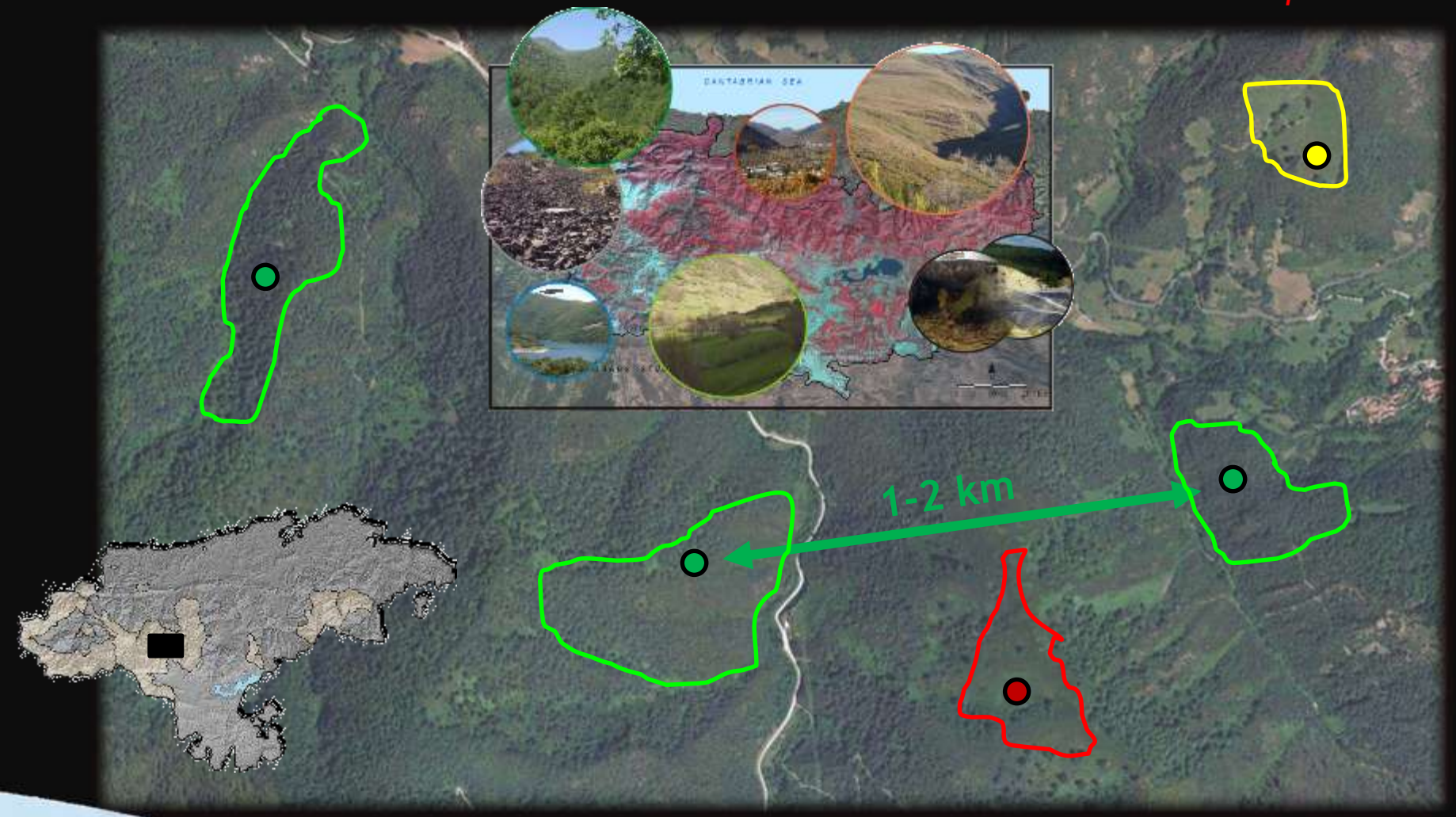
TESTING:
Field surveys





1. SUITABLE OCCURRENCE DATA

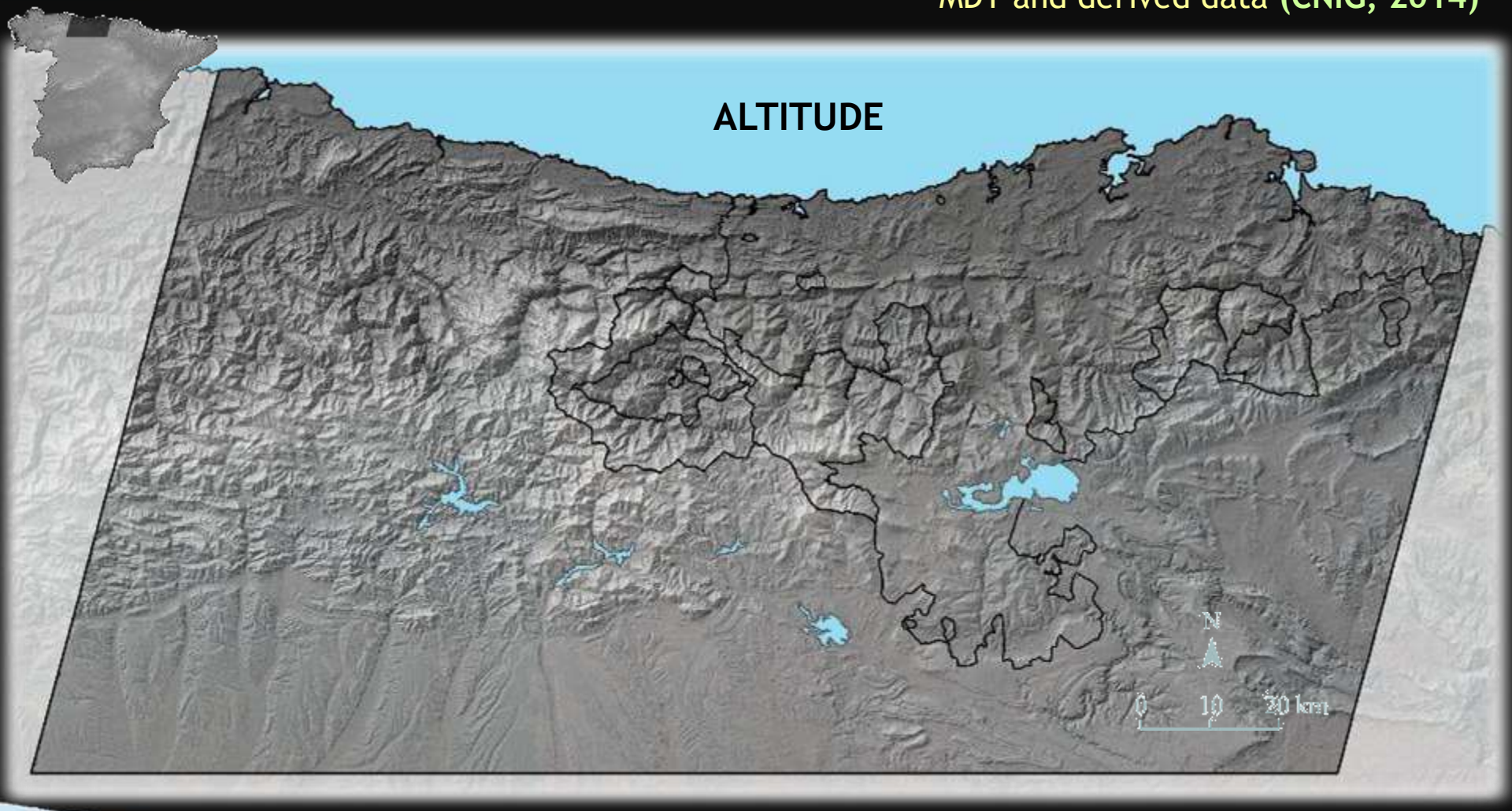
Some habitat have god data obtained from vegetation maps
Others needed additional fieldwork for a *complete* survey



FIELD DATA NEED TO BE HIGHLY ACCURATE

2. ENVIRONMENTAL PREDICTORS

ABIOTIC LIMITING FACTORS
MDT and derived data **(CNIG, 2014)**



All layers were resampled from **5-m to 30-m of spatial resolution** and coregistered with Landsat imagery at the pixel level and extent

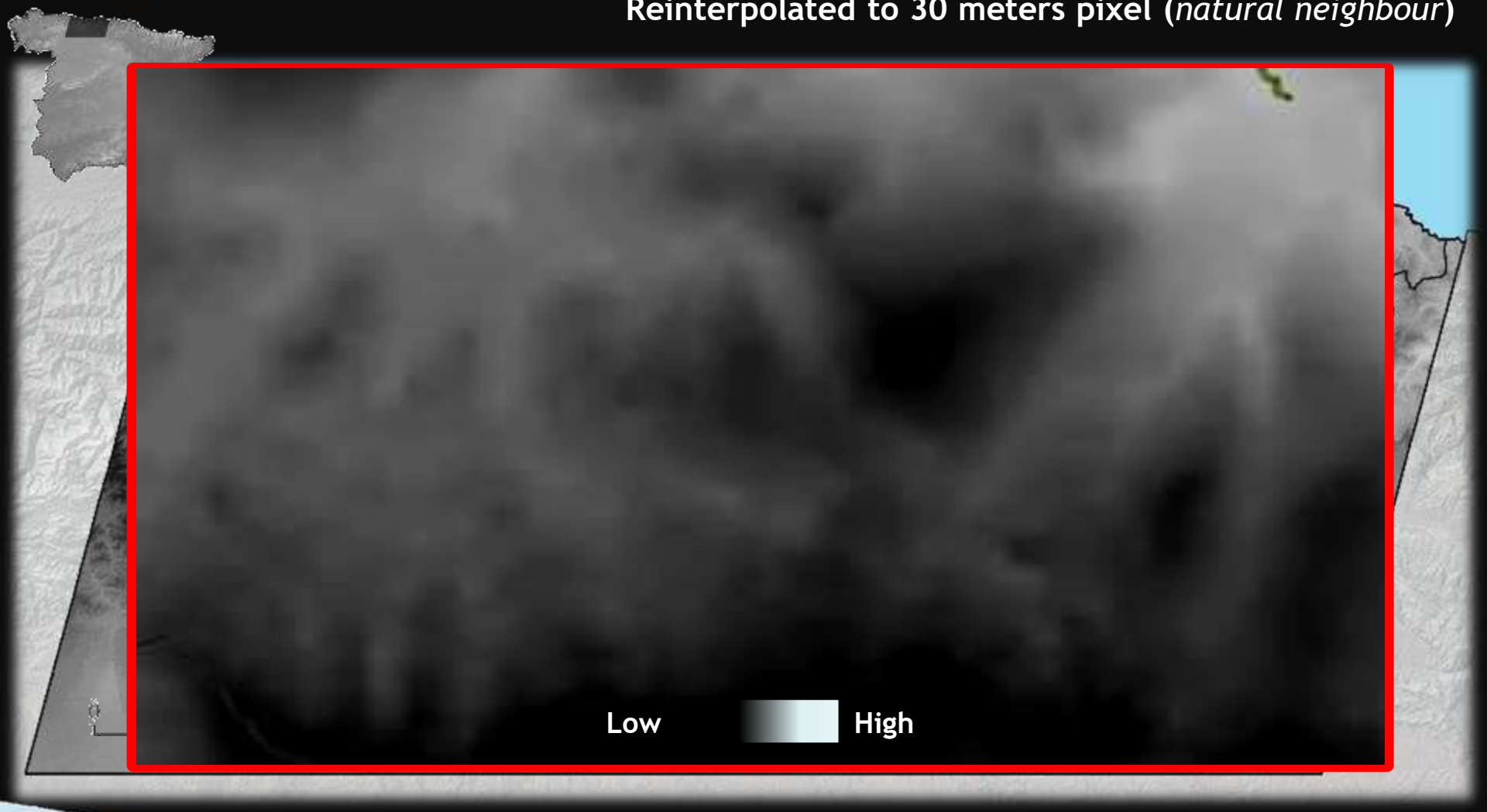
2. ENVIRONMENTAL PREDICTORS

ABIOTIC LIMITING FACTORS
MDT and derived data (CNIG, 2014)

All layers were resampled from 5-m to 30-m of spatial resolution and coregistered with Landsat imagery at the pixel level and extent

2. ENVIRONMENTAL PREDICTORS

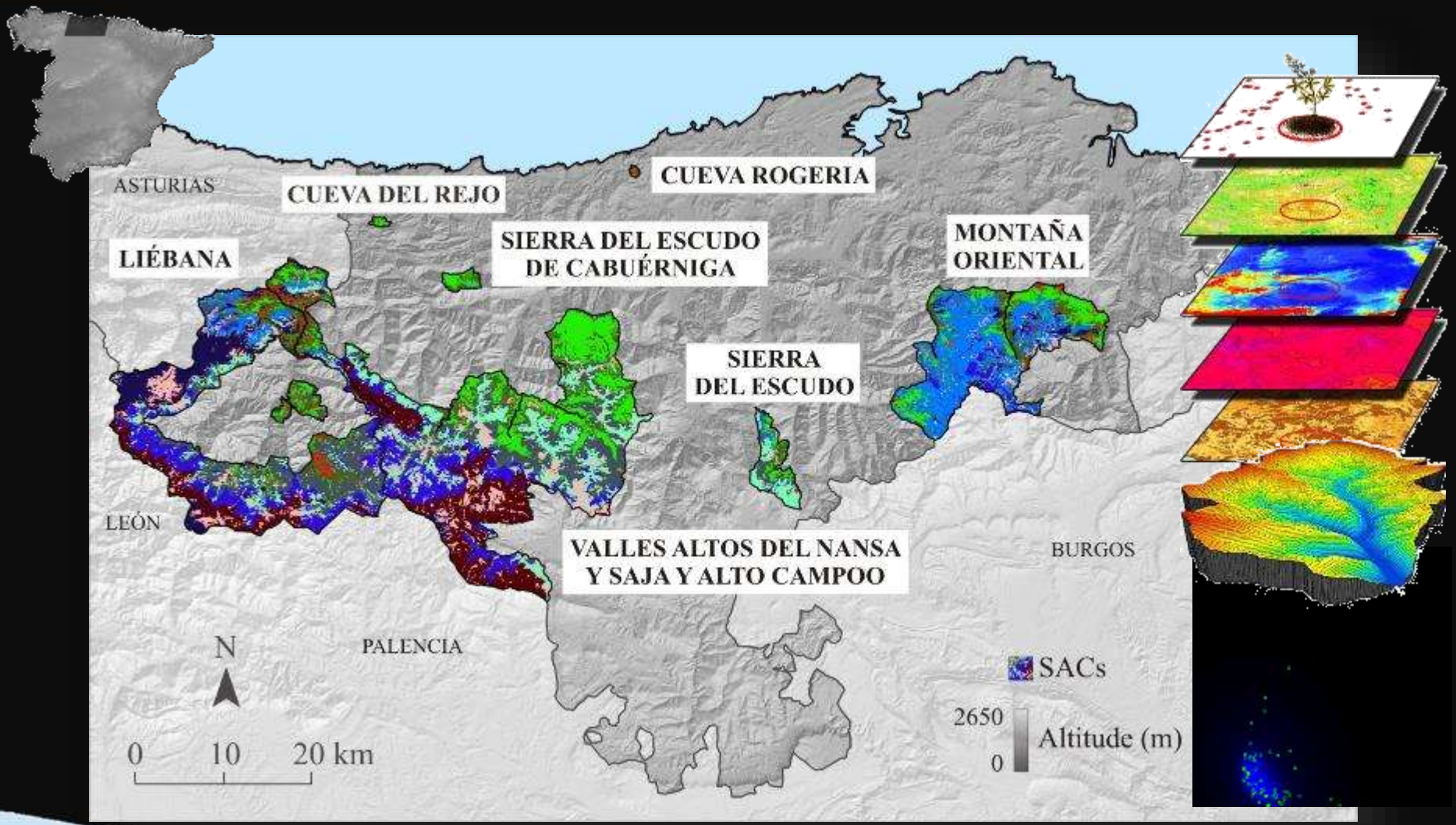
CLIMATIC VARIABLES : 200 meters (Ninyerola, 2005)
Reinterpolated to 30 meters pixel (*natural neighbour*)



Temperature, precipitation: max. Mean, min; seasonal and annual

2. ENVIRONMENTAL PREDICTORS

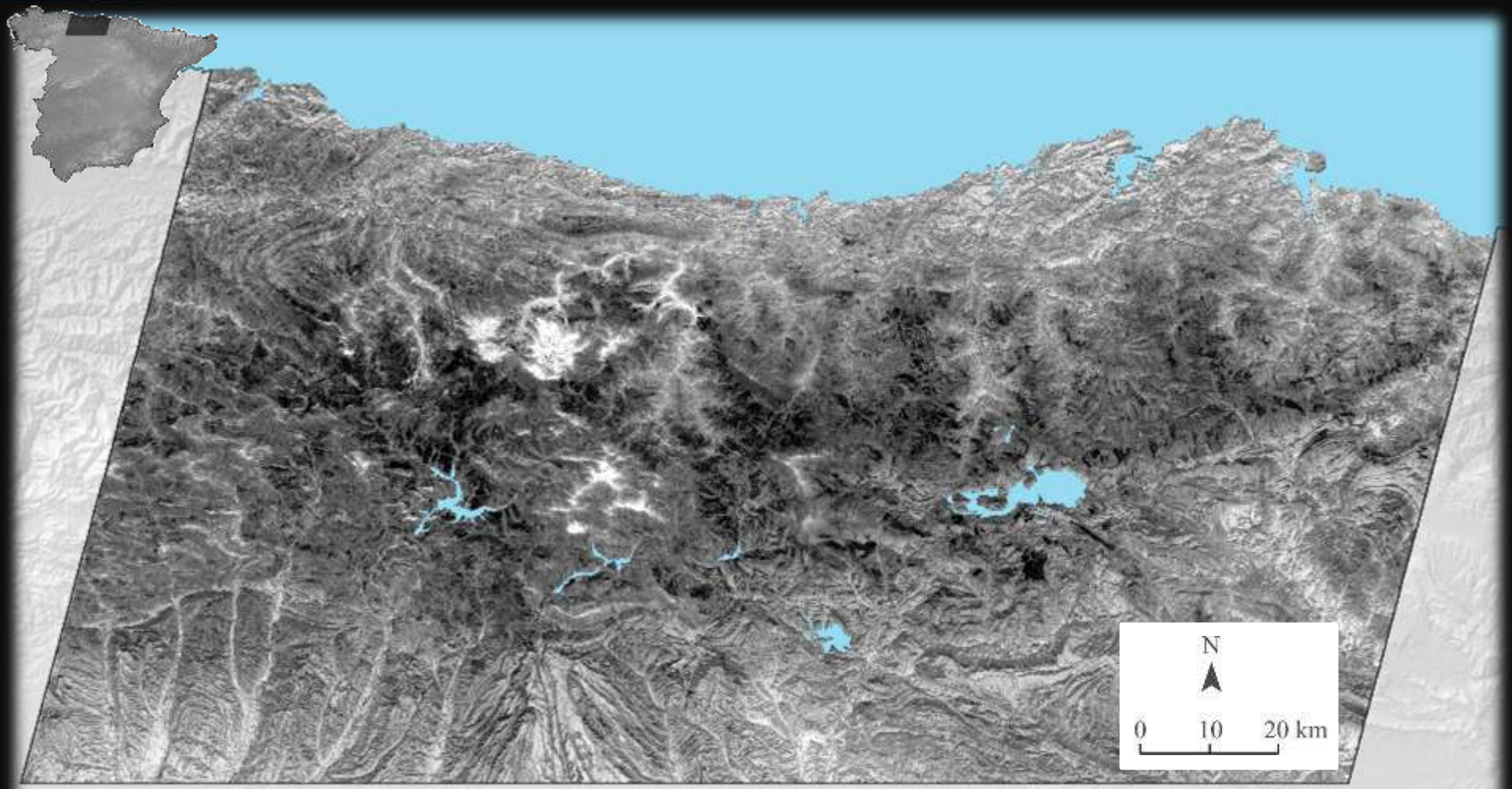
Digital soil mapping



A complete sampling of 10 different homogeneous environments + unsampled areas + target habitat types

2. ENVIRONMENTAL PREDICTORS

pH



Low High

2. ENVIRONMENTAL PREDICTORS

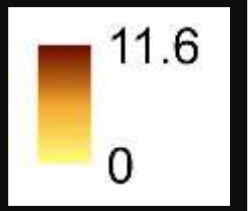
TEXTURE: % of sand of the topsoil (silt, clay)

Low High

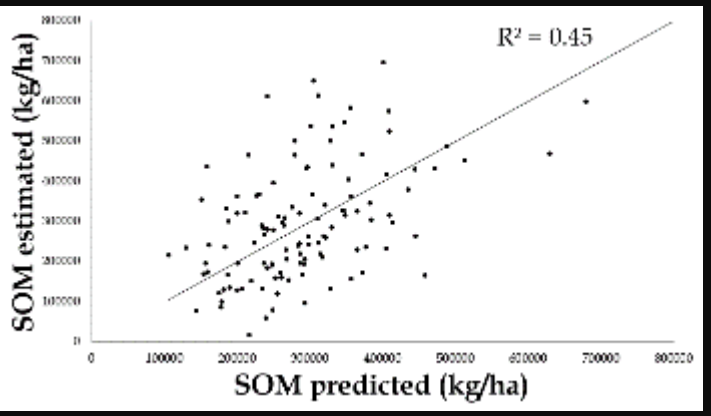
2. ENVIRONMENTAL PREDICTORS

SOIL PROPERTIES

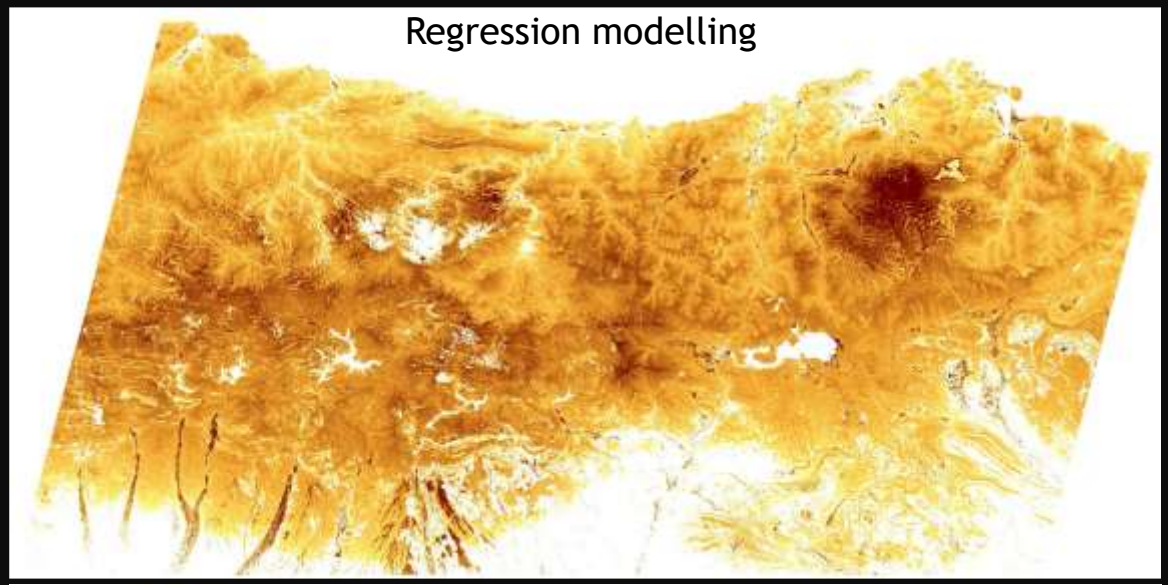
SOM
TEXTURE
pH
DEPTH



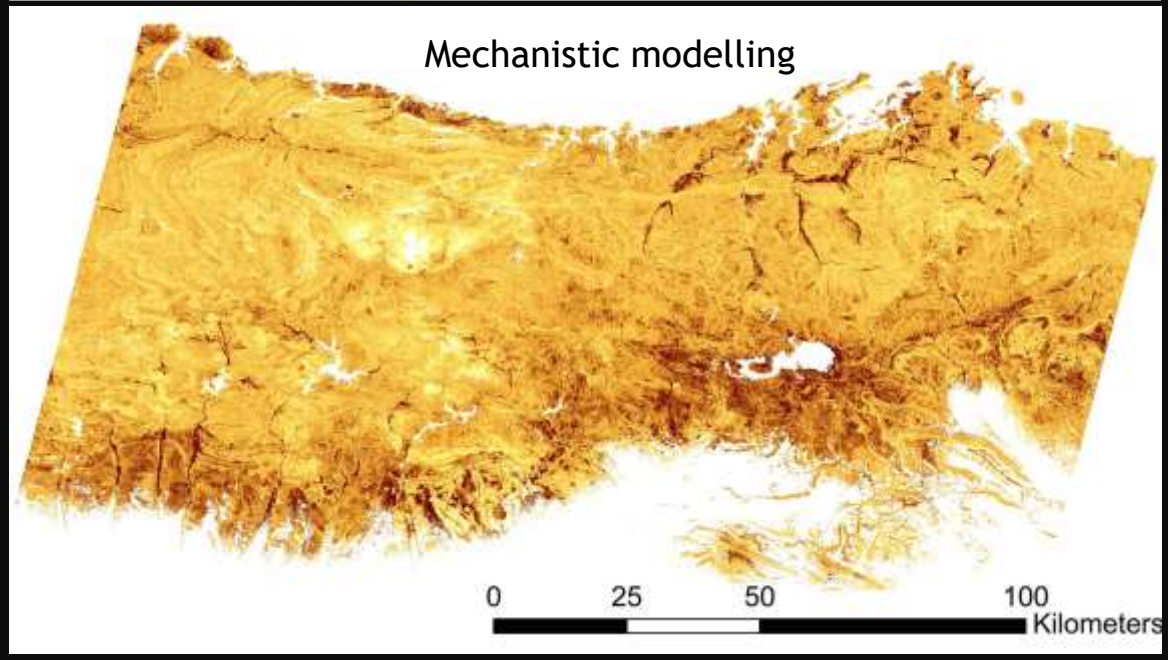
DIGITAL SOIL MAPPING



Regression modelling



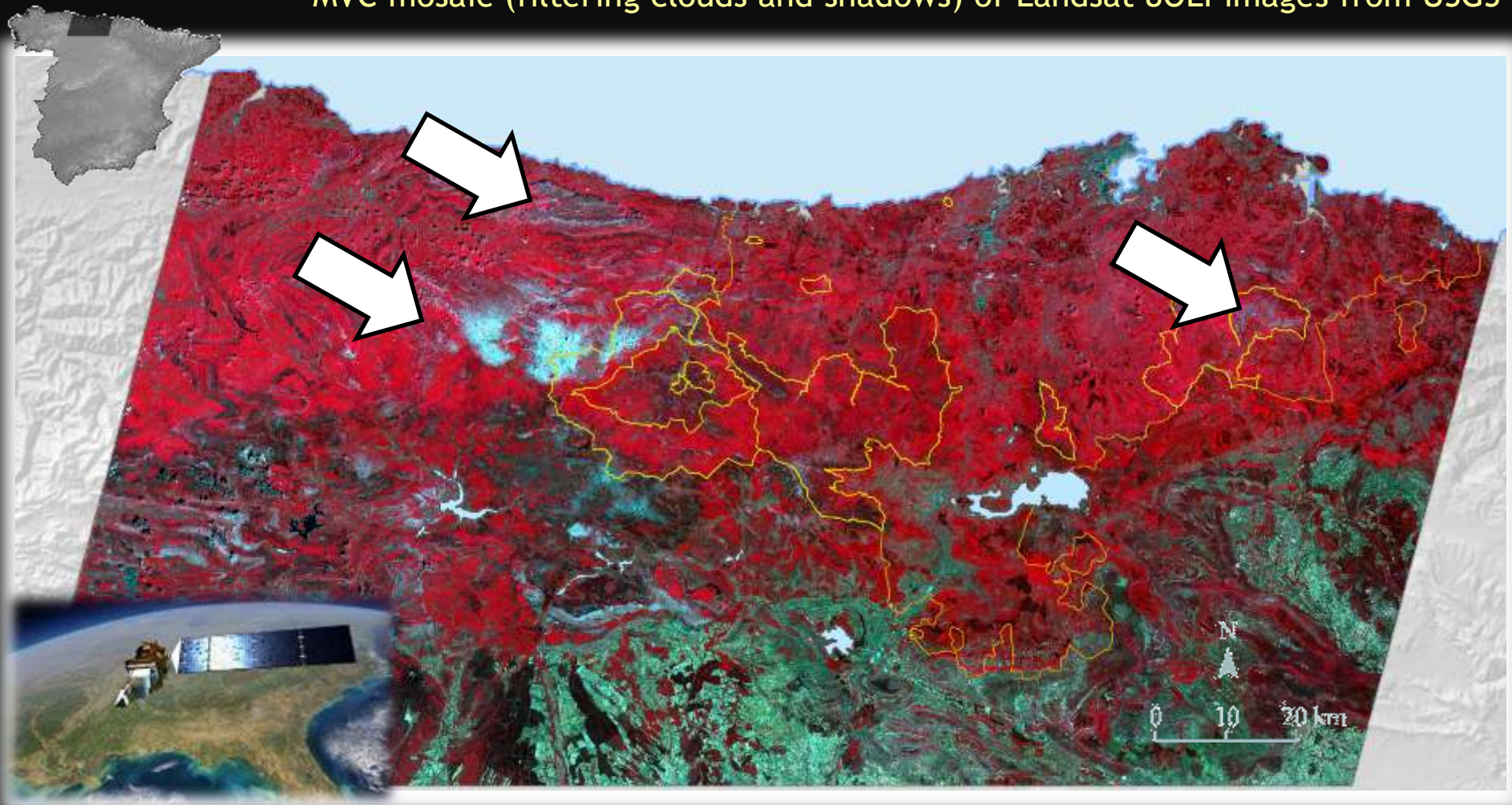
Mechanistic modelling



2. RS-BASED PREDICTORS

SPECTRAL INFORMATION (LANDSAT IMAGERY)

MVC mosaic (filtering clouds and shadows) of Landsat 8OLI images from USGS

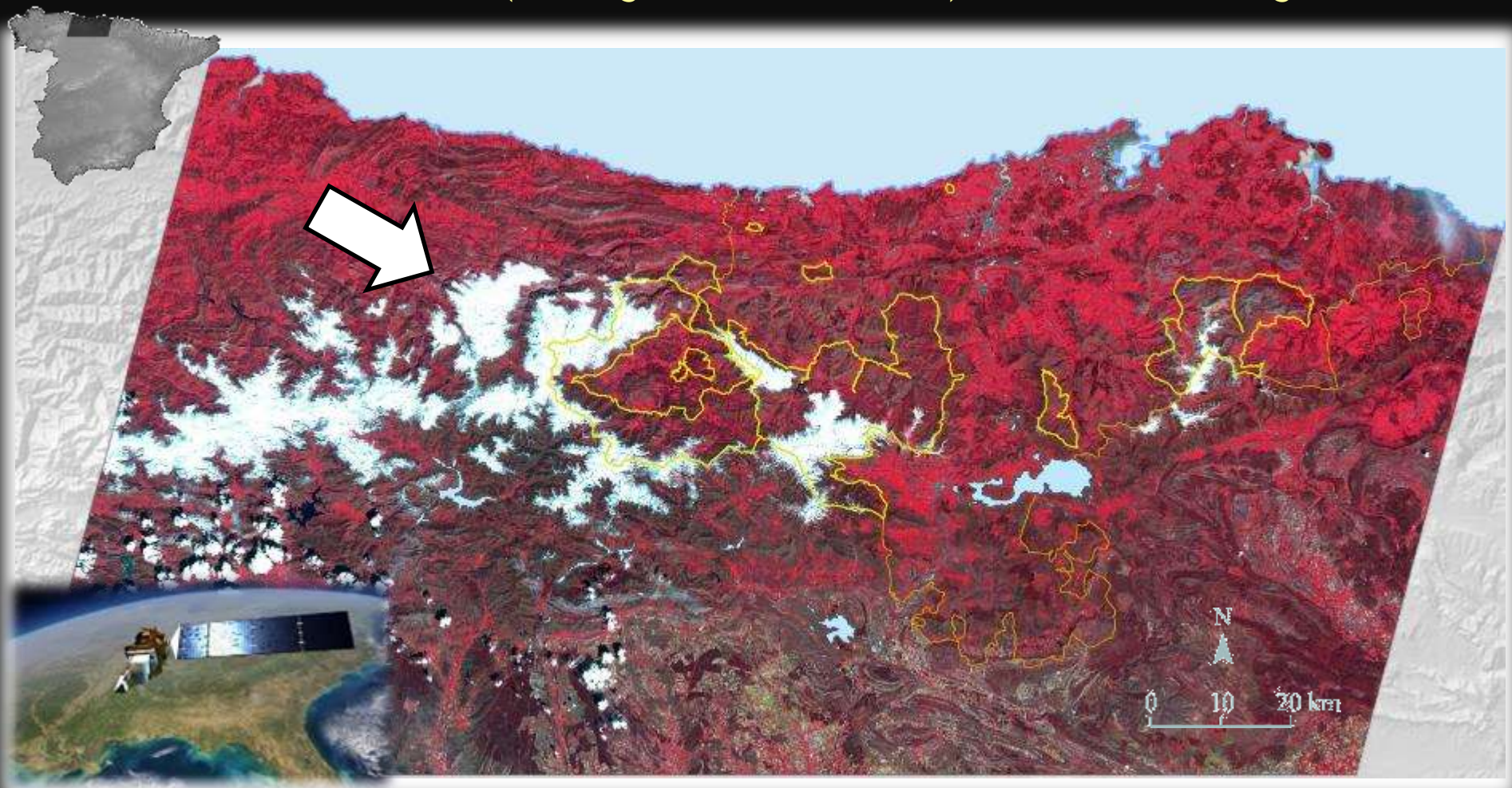


Landsat scene 202/30 (path/row) in pseudocolor RGB543
JUNE

2. RS-BASED PREDICTORS

SPECTRAL INFORMATION (LANDSAT IMAGERY)

MVC mosaic (filtering clouds and shadows) of Landsat 8OLI images from USGS



Landsat scene 202/30 (path/row) in pseudocolor RGB543
MARCH

2. RS-BASED PREDICTORS

SPECTRAL INFORMATION (LANDSAT IMAGERY)

MVC mosaic (filtering clouds and shadows) of Landsat 8OLI images from USGS

NORMALIZATION

CORRECTIONS:
Radiometric
Atmospheric
Topographic*

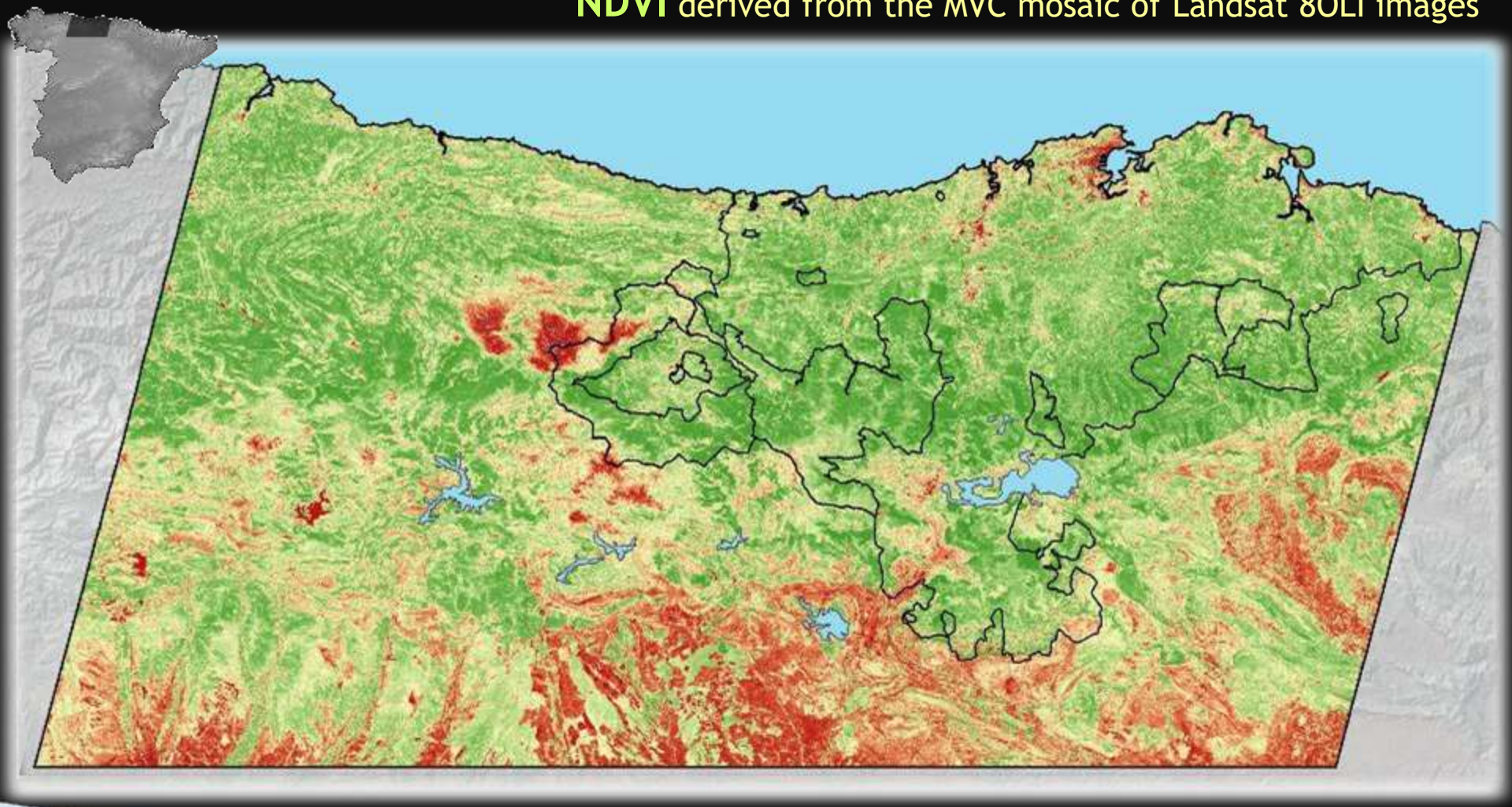
Sensitivity Analyses
submitted

Landsat scene 202/30 (path/row) in pseudocolor RGB543
We created a MVC mosaic for filtering clouds and shadows, We lost(*) the possibility of including phenology in calibration

2. RS-BASED PREDICTORS

SPECTRAL INFORMATION (LANVEGETATION INDICES)

NDVI derived from the MVC mosaic of Landsat 8OLI images

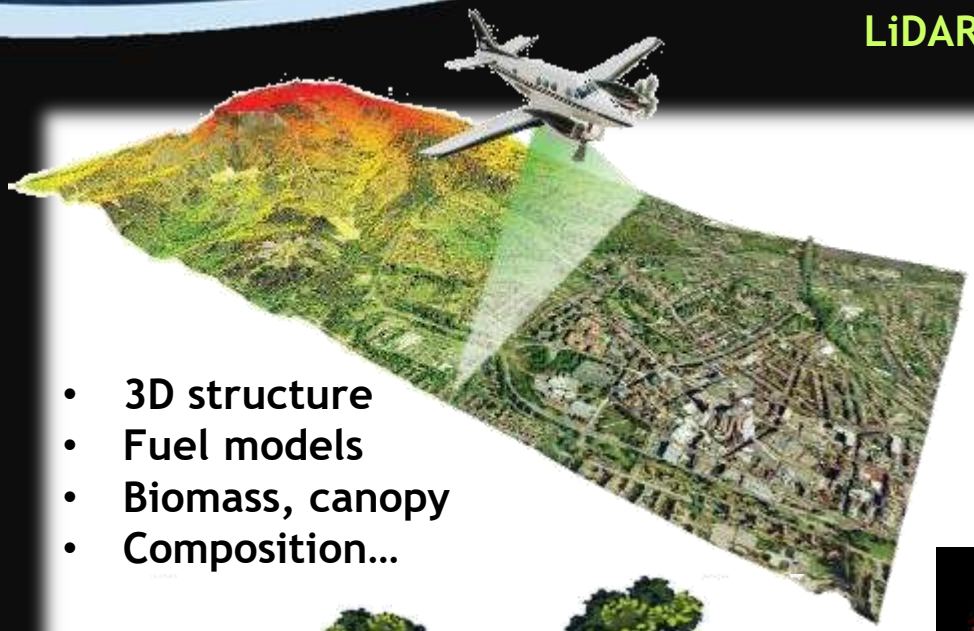


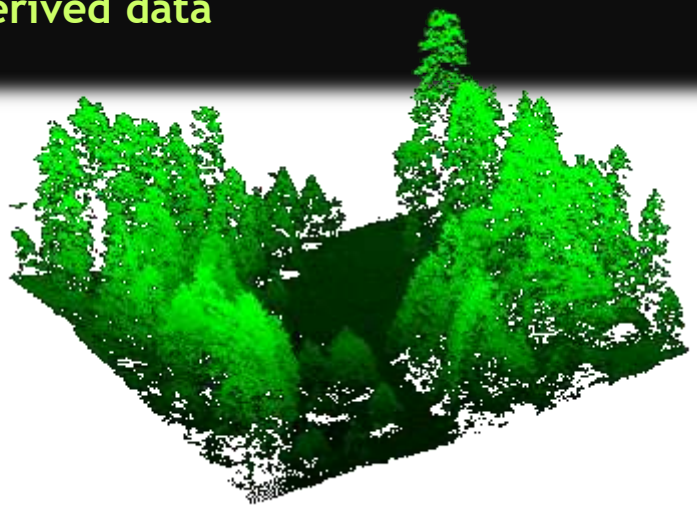
Landsat scene 202/30 (path/row)

NDVI derived from the MVC mosaic - the single image free of shadow and snow effects with information for the whole area

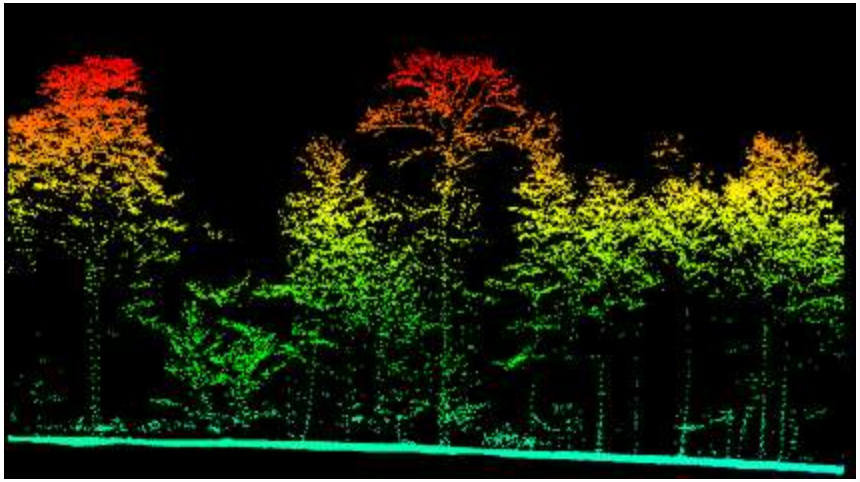
2. RS-BASED PREDICTORS

LiDAR derived data





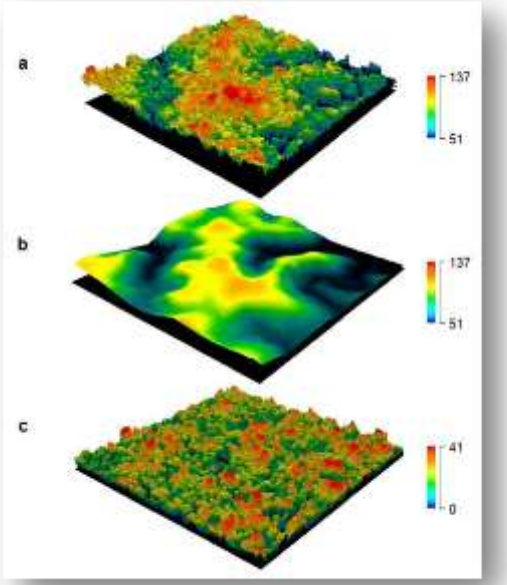
- 3D structure
- Fuel models
- Biomass, canopy
- Composition…

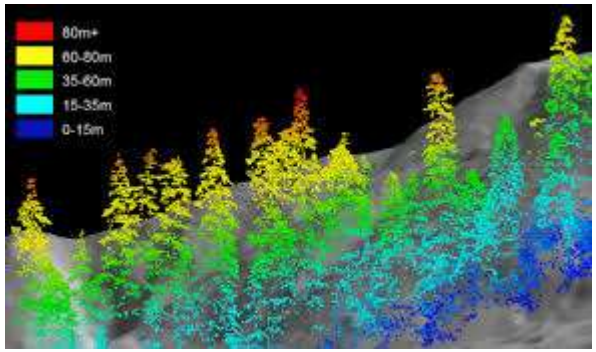


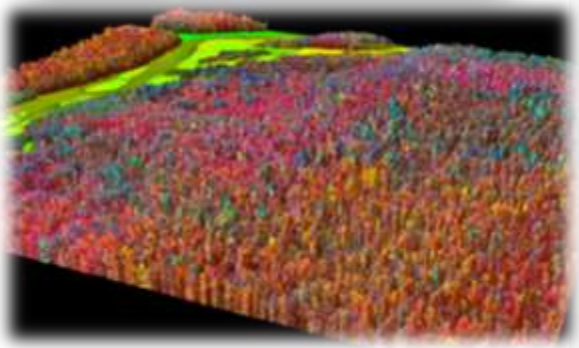
LiDAR PNOA: 0.5 p/m2 .Vegetation<0.5m=NoData

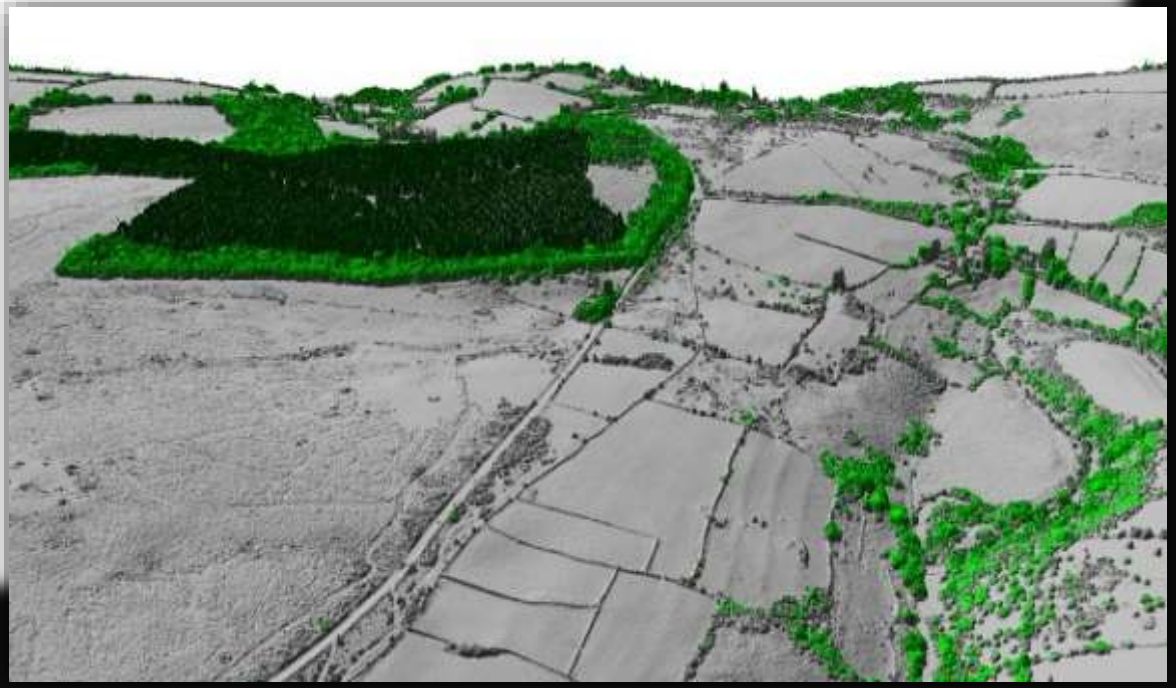
2. RS-BASED PREDICTORS

MFE25, IFN4 Ministery







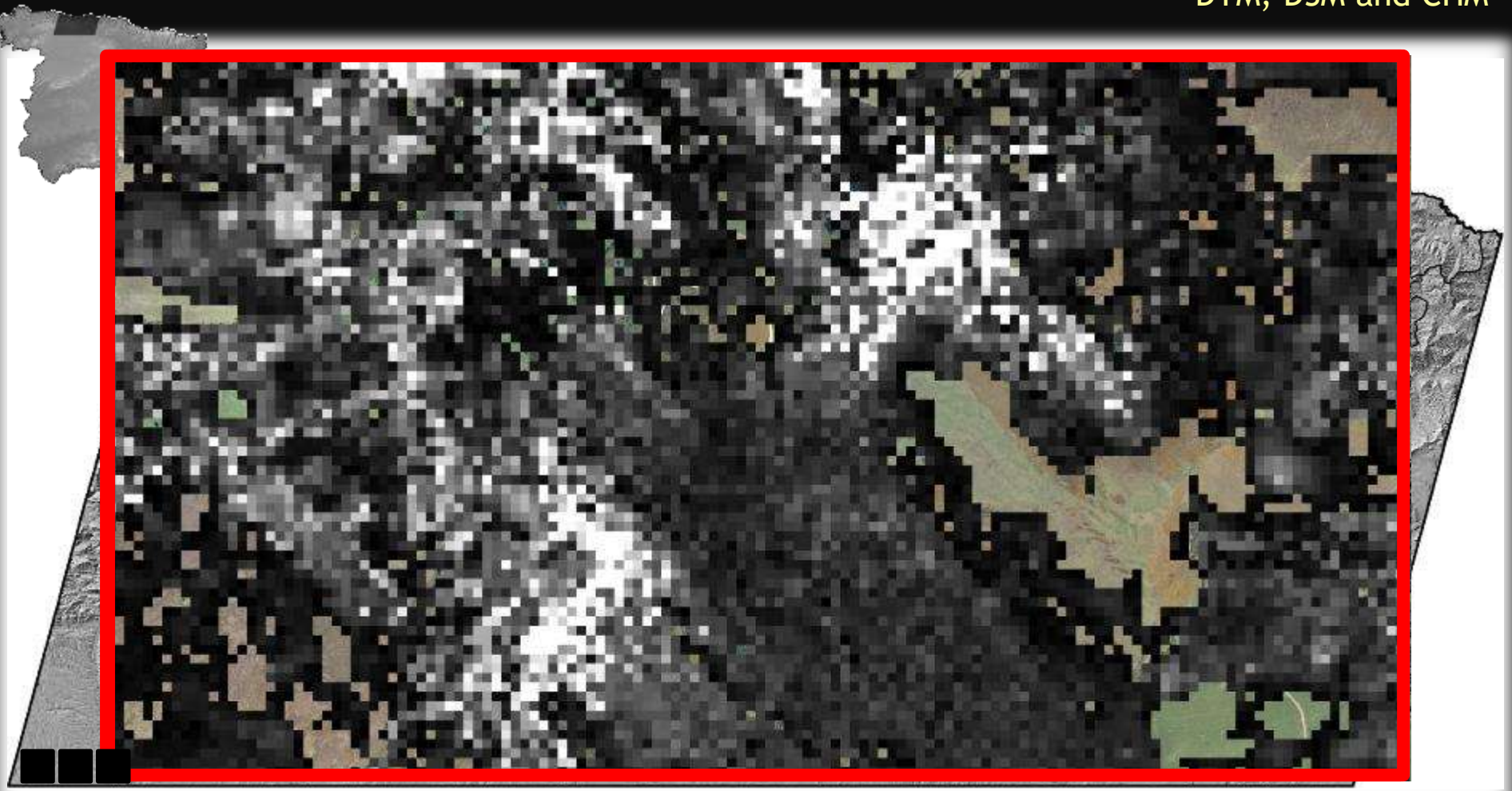


LiDAR PNOA: 0.5 p/m2 .Vegetation<0.5m=NoData

2. RS-BASED PREDICTORS

VEGETATION STRUCTURE (LiDAR derived data) (CNIG 2015)

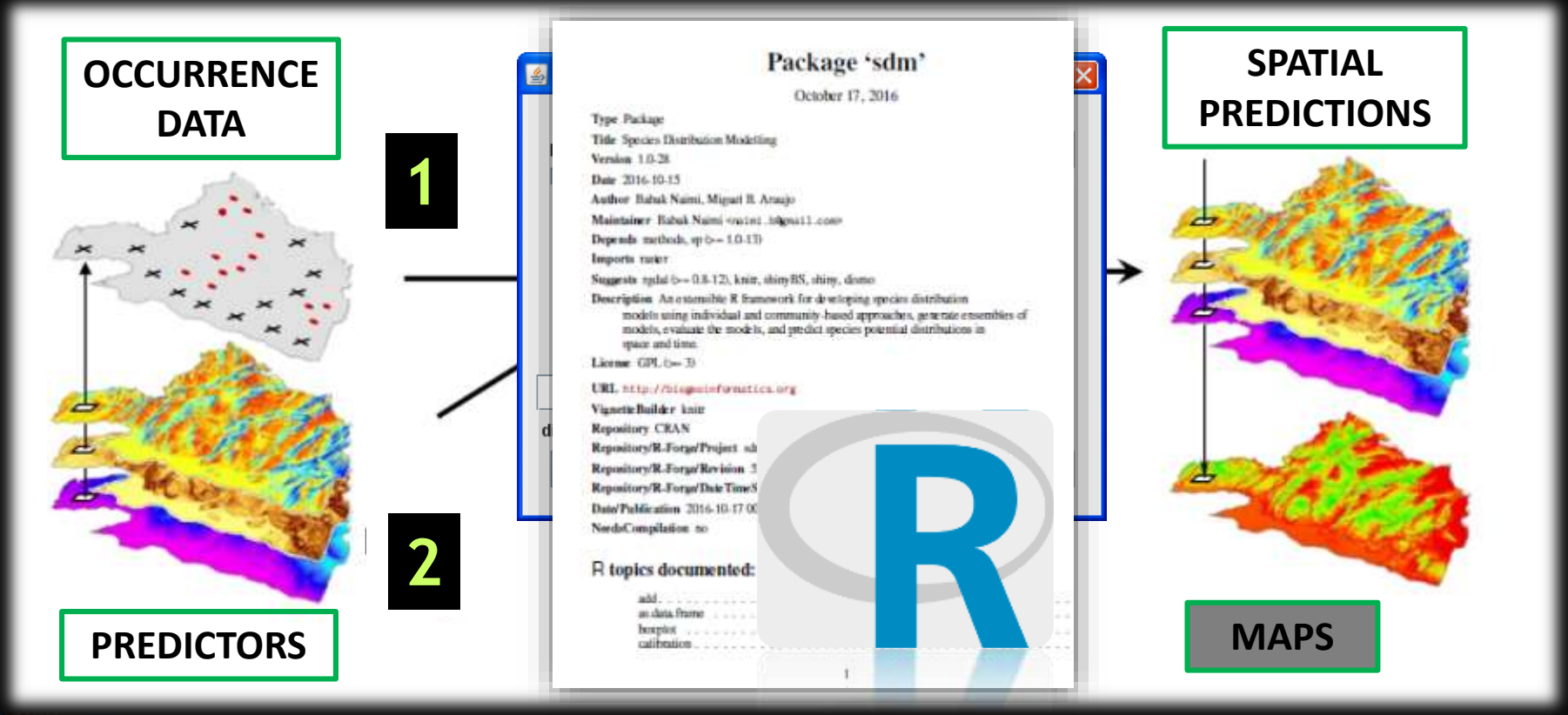
DTM, DSM and CHM



0 100

Predictive modelling bsed on remote sensing

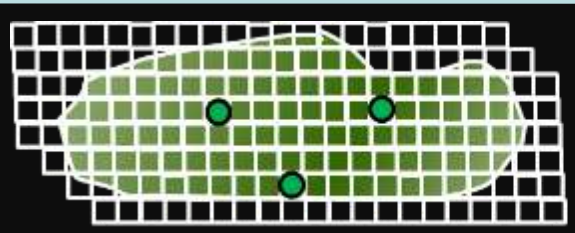
3. A **statistical method or modelling algorithm** for habitat mapping that relates occurrence data and the process-based environmental and RS predictors

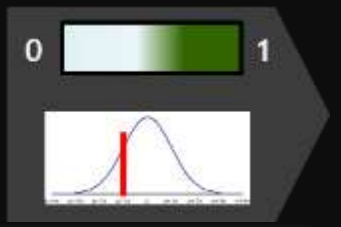


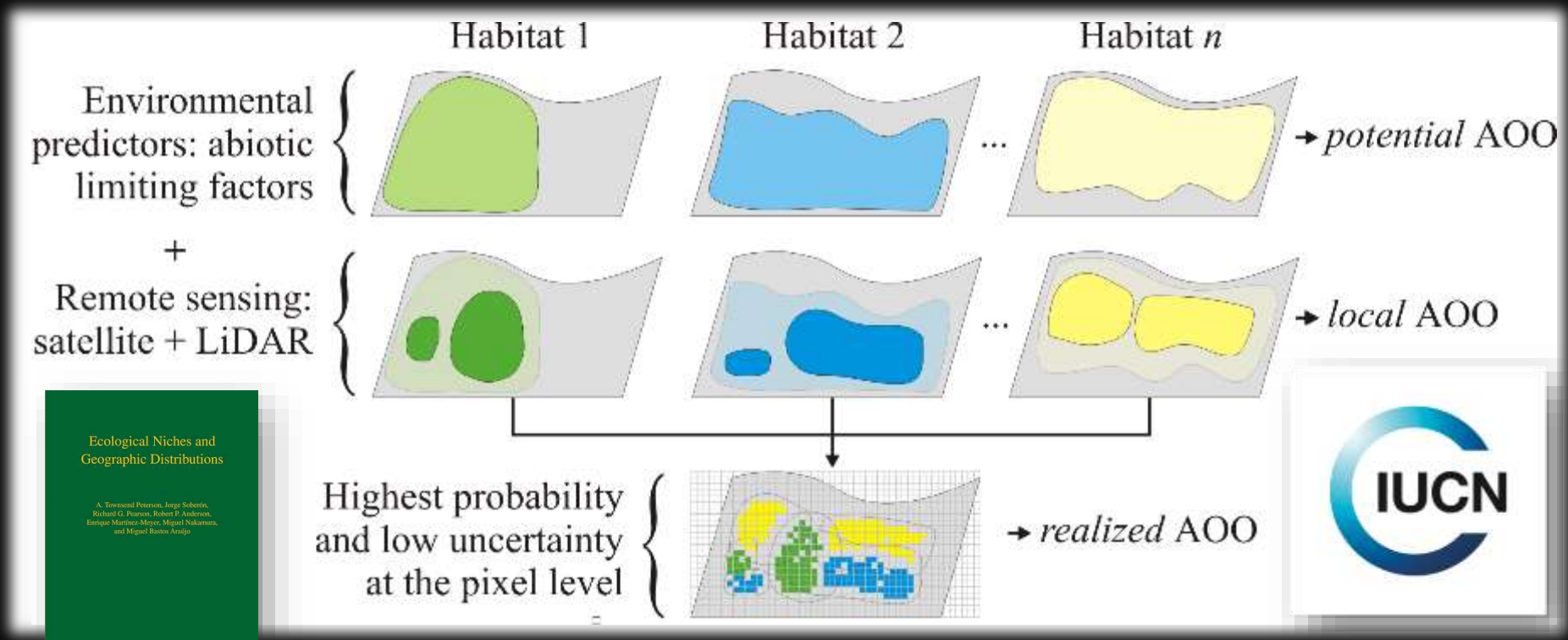
General approach: **Environmental niche modeling, Species Distribution models (SDM)**
Applied to habitats: **Predictive vegetation mapping, Community Distribution Models**

MODELLING RESULTS

Which maps do we create from the models?







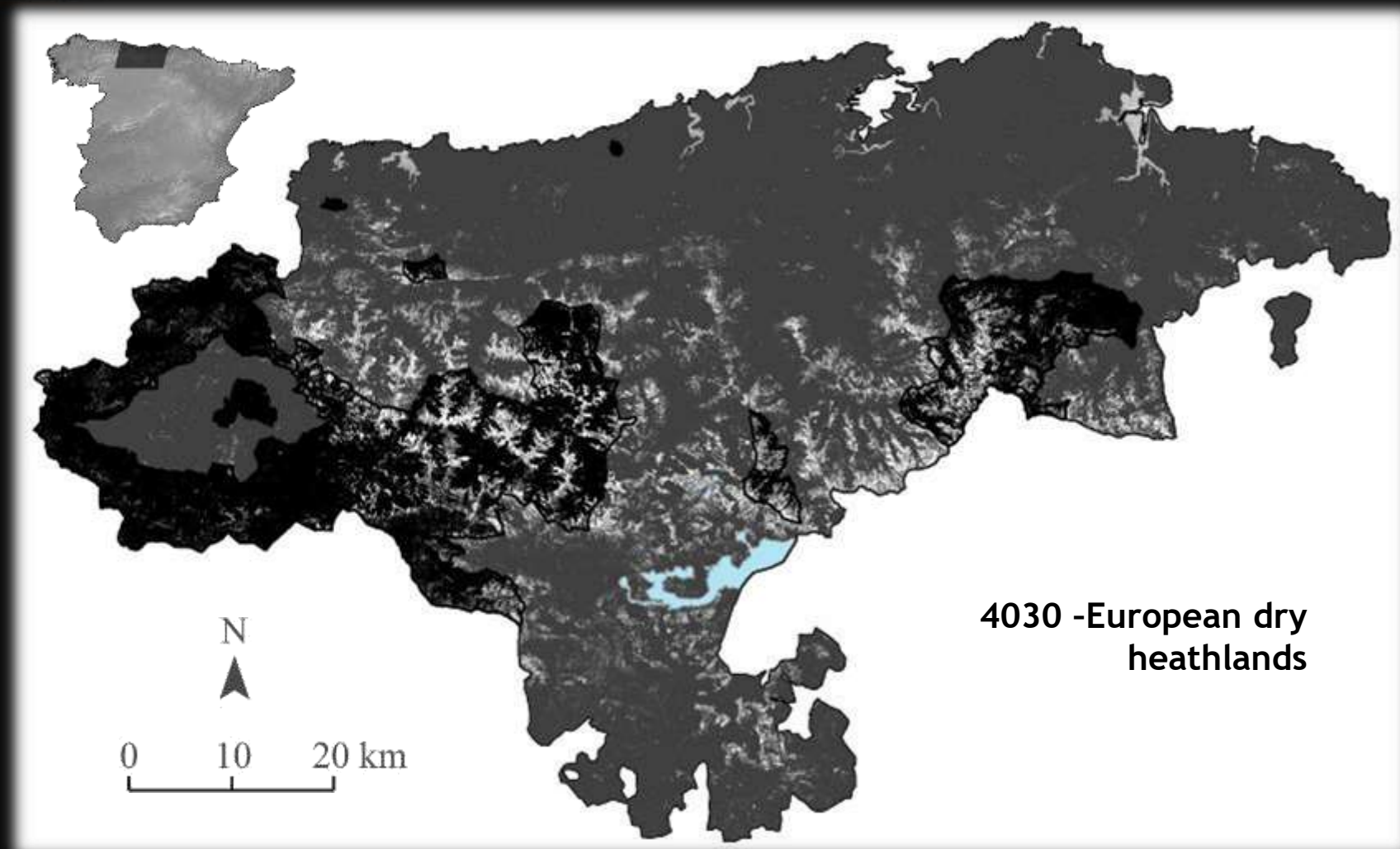
Concept of *Area Of Occupancy* (*AOO*)

Potential area of occupancy: the areas with suitable environmental conditions for a given habitat type, predicted or estimated at any spatial scale.

Local area of occupancy: subset of the potential AOO where a given habitat type is most likely to occur by considering structural or functional properties of the landscape matrix.

Realized area of occupancy: a subset of the local AOO where a given habitat type is more likely to occur than any other habitat type in the landscape matrix.

AREA OF OCCUPANCY



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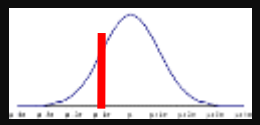
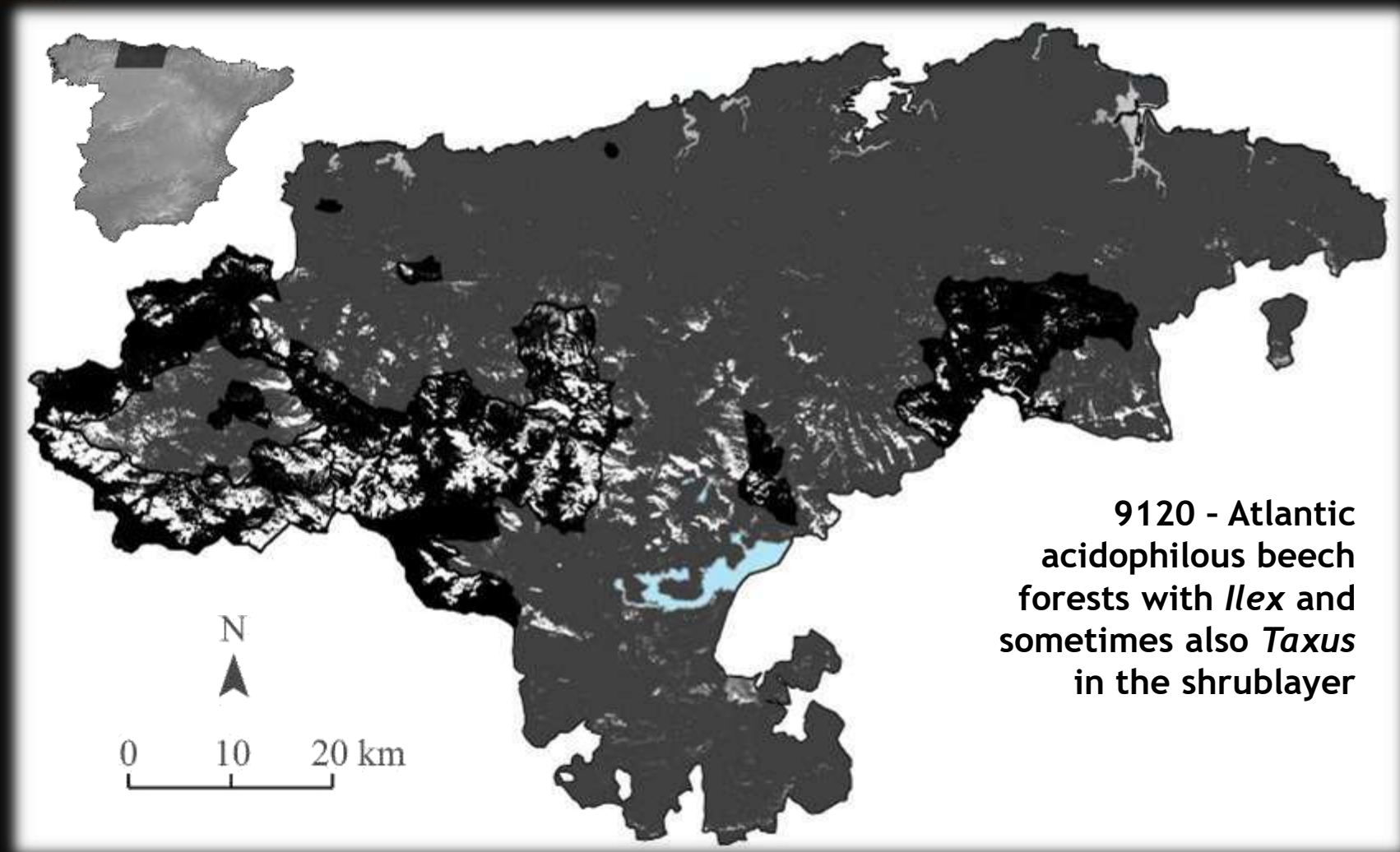
AREA OF OCCUPANCY

E 1:50 000



0 1

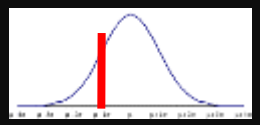
AREA OF OCCUPANCY



9120 – Atlantic acidophilous beech forests with *Ilex* and sometimes also *Taxus* in the shrublayer

AREA OF OCCUPANCY

E 1:25 000



0 1

AREA OF OCCUPANCY

9120 Atlantic acidophilous beech forests with Ilex and sometimes Taxus in the shrublayer

E 1:25 000

DOMINANCE + UNCERTAINTY 50%

VEGETATION MAP

Automatic and objective: depends on the models

E 1:50 000

GIS overlay and processing of habitat maps.

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VEGETATION MAP

Automatic and objective: depends on the models

FID	Shape *	TESELA	COD2000	AREA	PORCsi	4030	4060	4090	5120	6160	6170	6210	6230	6510
0	Polygon	1	ES1300021	8.56	58.04	57.74	0	0	0.28	0	0	0	0	0
1	Polygon	2	ES1300021	10.3	48.16	47.62	0	0.2	0.19	0	0	0	0.16	0
2	Polygon	3	ES1300021	6.17	68.12	67.29	0	0	0	0	0	0	0	0
3	Polygon	4	ES1300021	13.74	66.03	65.03	0	1	0	0	0	0	0	0
4	Polygon	5	ES1300021	19.16	49.39	46.58	0	0	1.95	0	0	0	0.15	0
5	Polygon	6	ES1300021	782.63	48.06	46.29	0.01	0.39	0.17	0	0	0.39	0.6	0
6	Polygon	7	ES1300021	6.3	46.46	44.64	0	0.12	0.33	0	0	0	0.29	0
7	Polygon	8	ES1300021	14.19	52.61	52	0	0.61	0	0	0	0	0	0
8	Polygon	9	ES1300021	7.28	77.79	75.9	0	1.89	0	0	0	0	0	0
9	Polygon	10	ES1300021	6.31	52.9	51.83	0	0.76	0	0	0	0	0.31	0
10	Polygon	11	ES1300021	29.67	26.2	21.49	0	0.24	4.16	0	0	0	0.15	0
11	Polygon	12	ES1300021	12.15	46.09	27.41	0	0	0.19	0	0	0	13.15	0
12	Polygon	13	ES1300021	6.04	28.43	28.3	0	0	0	0	0	0	0	0
13	Polygon	14	ES1300021	15.88	32	16.26	0	0	8.22	0	0	0	7.41	0
14	Polygon	15	ES1300021	9.73	53.7	49.2	0	4.36	0.15	0	0	0	0	0
15	Polygon	16	ES1300001	12.14	19.19	15.47	0	0	3.65	0	0	0	0	0
16	Polygon	17	ES1300021	6.39	58.18	56.59	0	1.59	0	0	0	0	0	0
17	Polygon	18	ES1300001	66.35	56.47	50.88	0	3.64	0	0	0	0	0	0.81
18	Polygon	19	ES1300001	13.43	39.5	30.07	0	0	9.03	0	0	0	0.33	0
19	Polygon	20	ES1300001	32.38	17.77	16.54	0	0.06	0	0	1.11	0	0	0
20	Polygon	21	ES1300001	13.33	12.2	9.45	0	0	0	0	0	0	0	2.7
21	Polygon	22	ES1300001	31.71	36.24	36.13	0	0.04	0	0	0	0	0.04	0
22	Polygon	23	ES1300021	105.27	72.78	71.85	0.05	0.16	0.71	0	0	0	0	0
23	Polygon	24	ES1300021	15.47	55.52	54.4	0	0.72	0	0	0	0	0	0
24	Polygon	25	ES1300021	23.09	18.2	16.37	0	1.83	0	0	0	0	0	0

E 1:25 000

% of occupation of each habitat and NO habitat

MAPS VALIDATION

Field surveys for independent test data collection: 1000

MAPS VALIDATION

CONFUSION MATRIX

Cross-validation of *local* AOO (vegetation) maps with TESTING data

Life form	Predicted	Testing points (obtained from expert fieldwork)																									User's accuracy	Commission error
		4030	4060	4090	5120	6160	6170	6210	6230 *	6510	8130	8210	8220	8230	9120	9150	9160	91E0 *	9230	9240	9260	92A0	9330	9340	9380	N		
Shrublands	4030	64		1	2			4							1												72	89%	11%
	4060	1	35		1				8		1		3														49	71%	29%
	4090	11	6	29			1	4	3	1		1						1	1						1	59	49%	51%
	5120	4			14																					18	78%	22%
Pastures	6160					10					6			2												18	56%	44%
	6170						1							1												2	50%	50%
	6210	3		14				24		4		2														47	51%	49%
	6230 *								21					3												24	88%	13%
	6510	3		2						26						1			1							33	79%	21%
Rock outcrops	8130						1				5	1														7	71%	29%
	8210										1	15													2	18	83%	17%
	8220		1			1							4	3												9	44%	56%
	8230					1					1		1	2												5	40%	60%
Forests	9120														45	2			6							53	85%	15%
	9150												1		9	9										19	47%	53%
	9160									4	3	1			2	7	15	1	2					2		37	41%	59%
	91E0 *									2					1		2		1							6	0%	100%
	9230	1													13		4		41		1			1		61	67%	33%
	9240														1				1					1		3	0%	100%
	9260																				1					1	100%	0%
	92A0																									0	0%	0%
	9330																						2			2	100%	0%
	9340											1			3				1				2	29		36	81%	19%
	9380														1											1	0%	100%
	n	87	42	46	17	11	3	32	32	37	17	21	9	11	78	19	21	2	54	0	2	0	4	35	1	580		
	Producer's accuracy	74%	83%	63%	82%	83%	33%	75%	66%	70%	29%	71%	44%	18%	58%	47%	71%	0%	76%	0%	50%	0%	50%	83%	0%		392	
	Omission error	26%	17%	37%	18%	17%	67%	25%	34%	30%	71%	29%	56%	82%	42%	53%	29%	100%	24%	0%	50%	0%	50%	17%	100%			67.59%

INDEPENDENT FIELD CHECKED DATA

24 habitat types

67.59% of overall accuracy

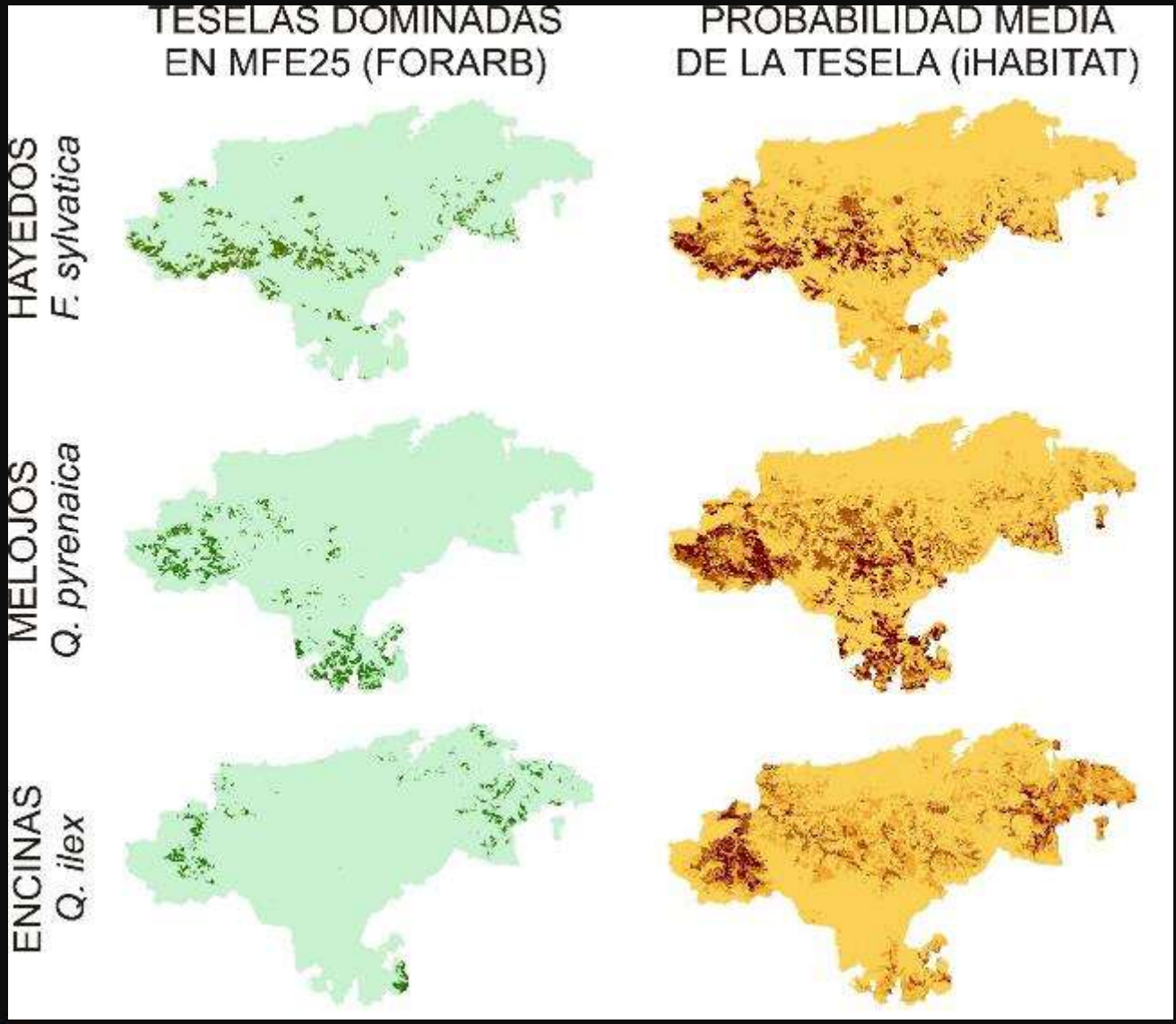
MAPS VALIDATION

FORESTRY MAP OF SPAIN MFE25-IFN4

INDEPENDENT DATA

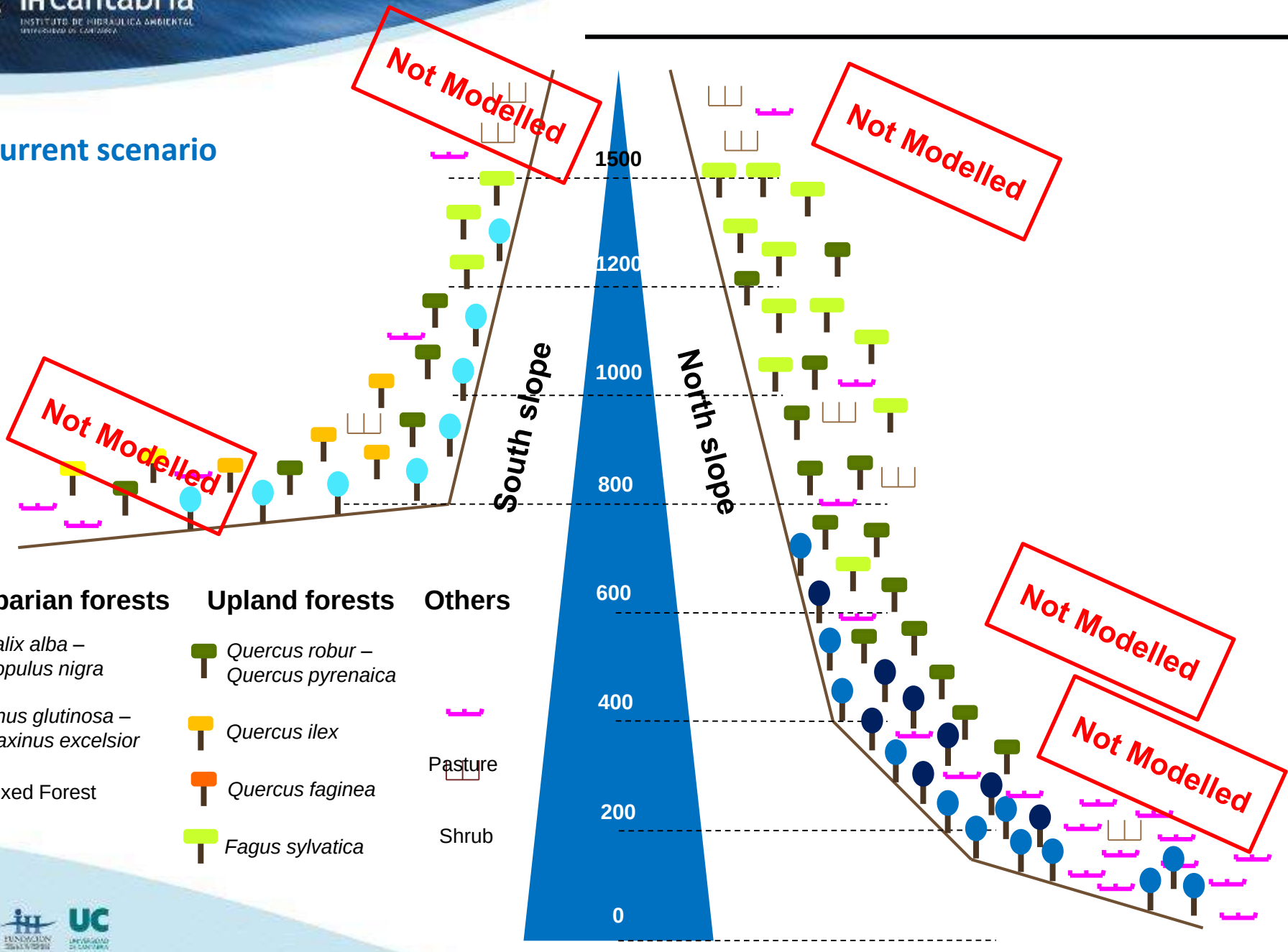
24 habitat types
80% of overall accuracy

with FCC>90%



BUT… THE OTHER HABITAT TYPES?

Current scenario



CONSERVATION STATUS

INDICATORS

Extension

Estructure and Function

Vulnerability

REFERENCE VALUES

EXTENSION

Local AOO

Realized AOO

E 1:25 000

INDICATOR: 83%

EXTENSION

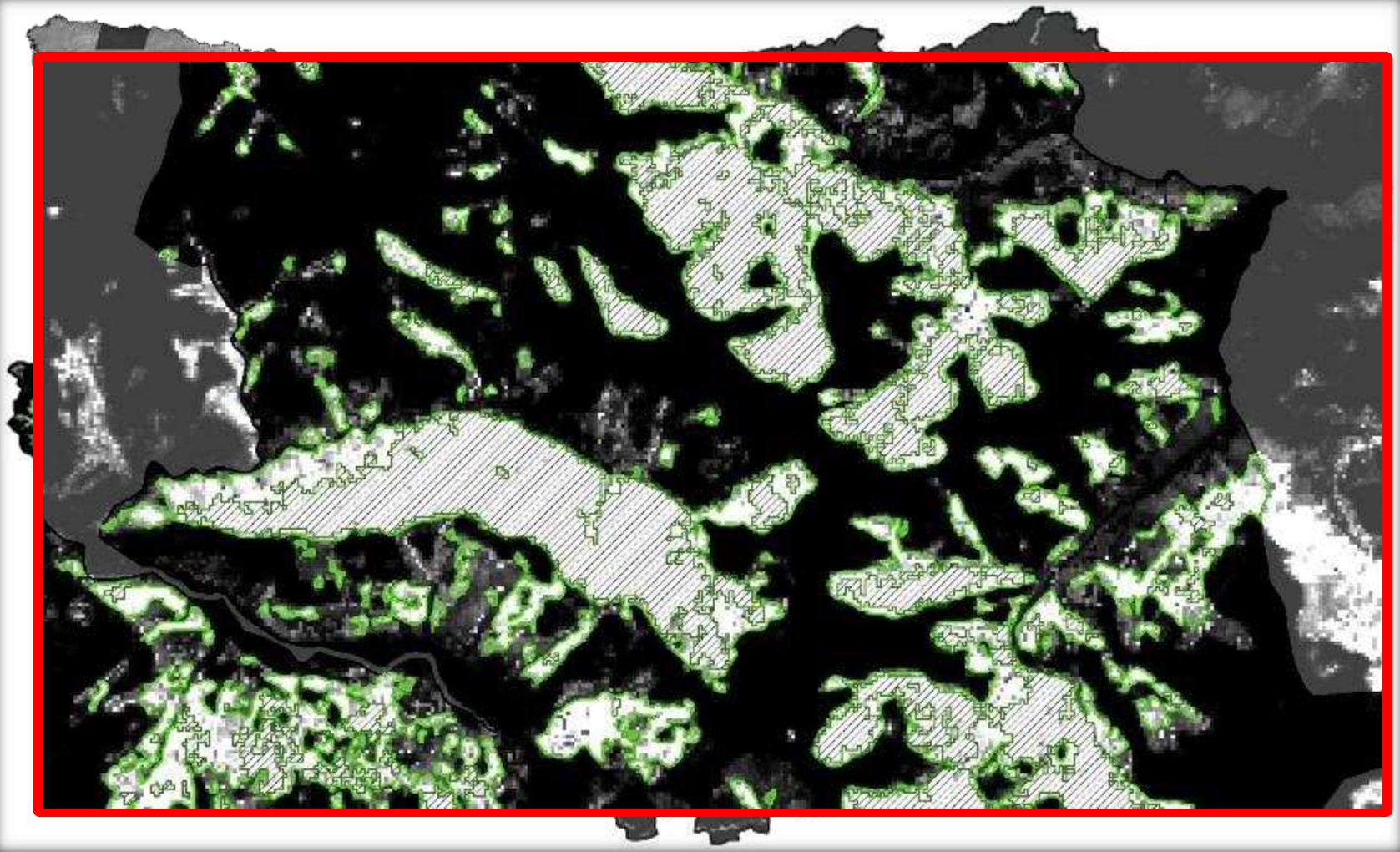
REFERENCE VALUES

	Physiognomic unit	Conservation Status	
		✓ **Favourable**	✗ **Unfavourable**
Habitat extension	Forest	Realized AOO > **60%** of Local AOO	Realized AOO < **60%** of Local AOO
	Shrubland	Realized AOO > **20%** of Local AOO	Realized AOO < **20%** of Local AOO
	Grassland	Realized AOO > **15%** of Local AOO	Realized AOO < **15%** of Local AOO
	Rock outcrops	Realized AOO > **5%** of Local AOO	Realized AOO < **5%** of Local AOO

Reference values are context dependent
When there is not information available, status is UNKNOWN

ESTRUCTURE AND COMPOSITION

Occurrence probability 0 1



E 1:25 000

INDICATOR: 87%
REF. VALUE: 80% y 65%

ESTRUCTURE AND FUNCTION

REFERENCE VALUES

	Physiognomic unit	Conservation Status	
		✓ Favourable	✗ Unfavourable
Habitat index of estructure and function	Forest and rock outcrops	Habitat suitability for local AOO > **80%** than habitat suitability for realized AOO	Habitat suitability for local AOO < **80%** than habitat suitability for realized AOO
	Shrubland and grassland	Habitat suitability for local AOO > **65%** than habitat suitability for realized AOO	Habitat suitability for local AOO < **65%** than habitat suitability for realized AOO

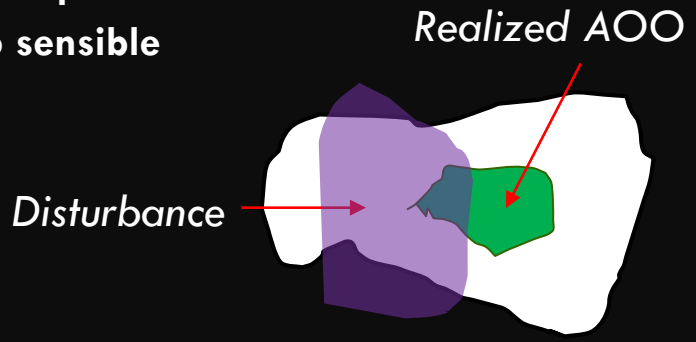
Reference values are context dependent
When there is not information available, status is UNKNOWN

VULNERABILITY

Anthropic pressures for each habitat type. GIS processing

1° **Identification**
- **Pressures**
- **Sensibility**
  1. High → very sensible
  2. medium → sensible
  3. Low → unresponsive
  4. Null → no sensible

2° **Delimitation of the area of affection**



3° **Signification assessmeent**
1. High
2. Medium
3. Low

4° **% habitat afffected** — ONLY for high and medium signification of affection

5° **Valoration**
- **Vulnerable** — In Risk: > 40% realized AOO affected ✗
- **No Vulnerable** — No Risk : < 40% realized AOO affected ✓

VULNERABILITY

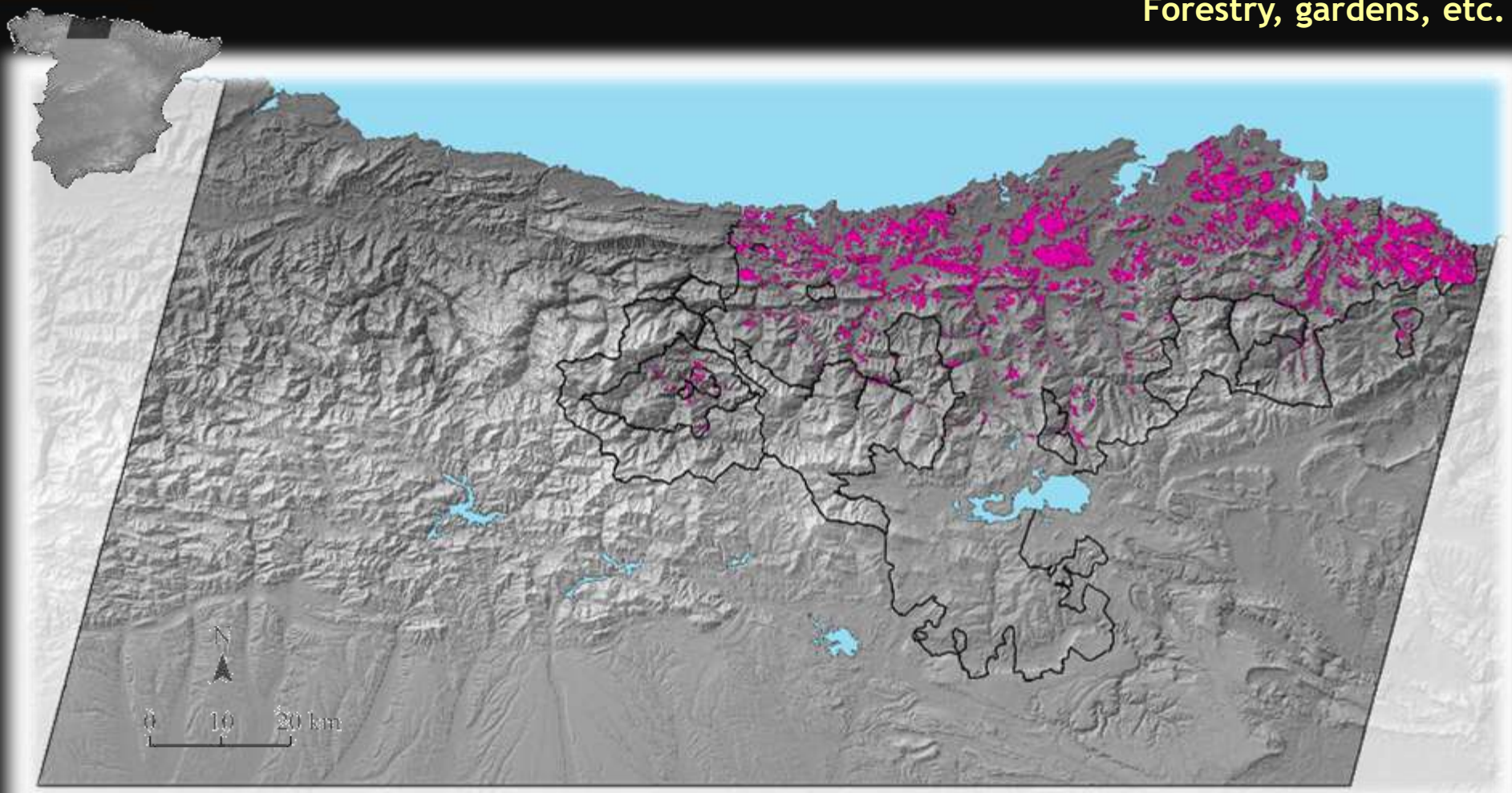
FIRE RISK

Model calibrated with topoclimatic factors and land use and land cover

Probability of occurrence and reccurrence 0 5

VULNERABILITY

Alien species
Forestry, gardens, etc.



Occurrence

CONSERVATION STATUS

Conservation status

How to measure it?

Extension	Structure and function	Vulnerability	
Favourable →	Favourable →	No vulnerable →	Conservation status Favourable ✓
	Vulnerable →		Conservation status Favourable in Risk ✗
Unfavourable →			Conservation status Unfavourable ✗
Unfavourable →			Conservation status Unfavourable ✗

INDICATORS AND REFERENCE VALUES obtained from mapping

CONSERVATION STATUS

Indicators of EXTENSION, STRUCTURE, COMPOSITION

The conservation status derives from the crossing of the metrics obtained from the different mapping and assessment thresholds established for each indicator separately:

INDICATORS THRESHOLDS

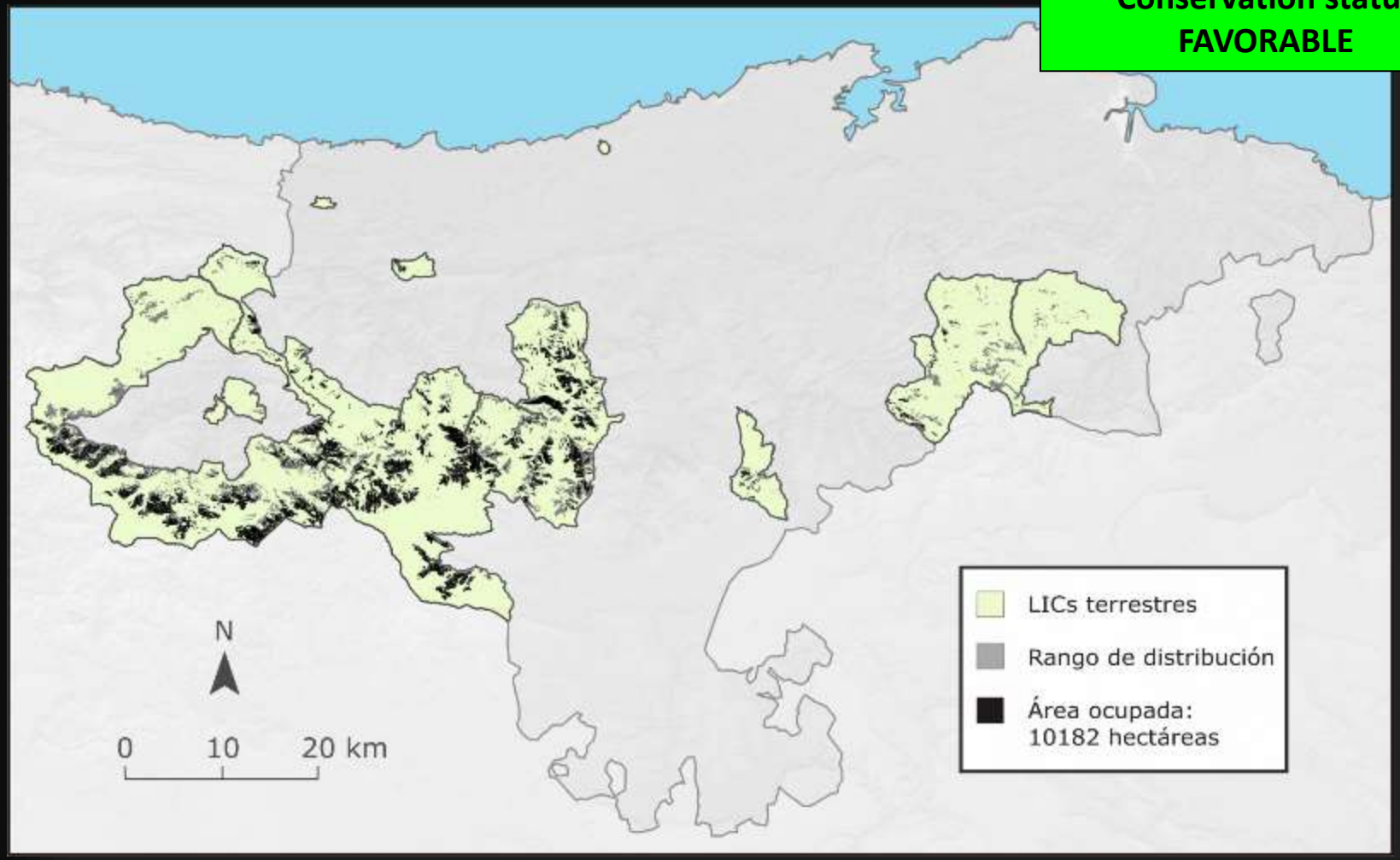
9 + 2

13

Hábitat	Hábitat	Extensión	Estructura y composición	Vulnerabilidad	Estado de conservación	do de rvación
	3110	Desconocido	Desconocido	Desconocido	Desconocido	
	4020*	Desconocido	Desconocido	Desconocido	Desconocido	
4030	4030	Favorable	Favorable	No vulnerable	Favorable	orable
4060	4060	Favorable	Favorable	No vulnerable	Favorable	orable
4090	4090	Favorable	Favorable	No vulnerable	Favorable	orable
5120	5120	Favorable	Favorable	No vulnerable	Favorable	orable
	6140	Desconocido	Desconocido	Desconocido	Desconocido	
6160	6160	Favorable	Desfavorable	No vulnerable	Desfavorable	vorable
	6170	Favorable	Favorable	No vulnerable	Favorable	
6170	6210	Favorable	Favorable	Vulnerable	Favorable en riesgo	orable
6210	6220*	Desconocido	Desconocido	Desconocido	Desconocido	e en riesgo
6230*	6230*	Favorable	Desfavorable	No vulnerable	Desfavorable	vorable
	6430	Desconocido	Desconocido	Desconocido	Desconocido	
6510	6510	Favorable	Favorable	Vulnerable	Favorable en riesgo	e en riesgo
8130	7110*	Desconocido	Desconocido	Desconocido	Desconocido	vorable
8210	7140	Desconocido	Desconocido	Desconocido	Desconocido	
8220	7150	Desconocido	Desconocido	Desconocido	Desconocido	orable
8230	7220*	Desconocido	Desconocido	Desconocido	Desconocido	orable
	7230	Desconocido	Desconocido	Desconocido	Desconocido	orable
9120	8130	Favorable	Desfavorable	No vulnerable	Desfavorable	orable
9150	8210	Favorable	Favorable	No vulnerable	Favorable	vorable
9160	8220	Favorable	Favorable	No vulnerable	Favorable	vorable
91E0*	8230	Favorable	Favorable	No vulnerable	Favorable	vorable
	9120	Favorable	Favorable	No vulnerable	Favorable	vorable
9230	9150	Desfavorable	Desfavorable	Vulnerable	Desfavorable	vorable
9240	9160	Desfavorable	Desfavorable	Vulnerable	Desfavorable	vorable
9260	91E0*	Desfavorable	Desfavorable	Vulnerable	Desfavorable	vorable
92A0	9230	Desfavorable	Desfavorable	No vulnerable	Desfavorable	vorable
9330	9240	Desfavorable	Desfavorable	No vulnerable	Desfavorable	vorable
9340	9260	Desfavorable	Desfavorable	No vulnerable	Desfavorable	vorable
9380	92A0	Desfavorable	Desfavorable	No vulnerable	Desfavorable	vorable
	9330	Desfavorable	Desfavorable	Vulnerable	Desfavorable	vorable
	9340	Desfavorable	Desfavorable	Vulnerable	Desfavorable	vorable
	9380	Desfavorable	Desfavorable	Vulnerable	Desfavorable	vorable
	9580*	Desconocido	Desconocido	Desconocido	Desconocido	

CONSERVATION STATUS

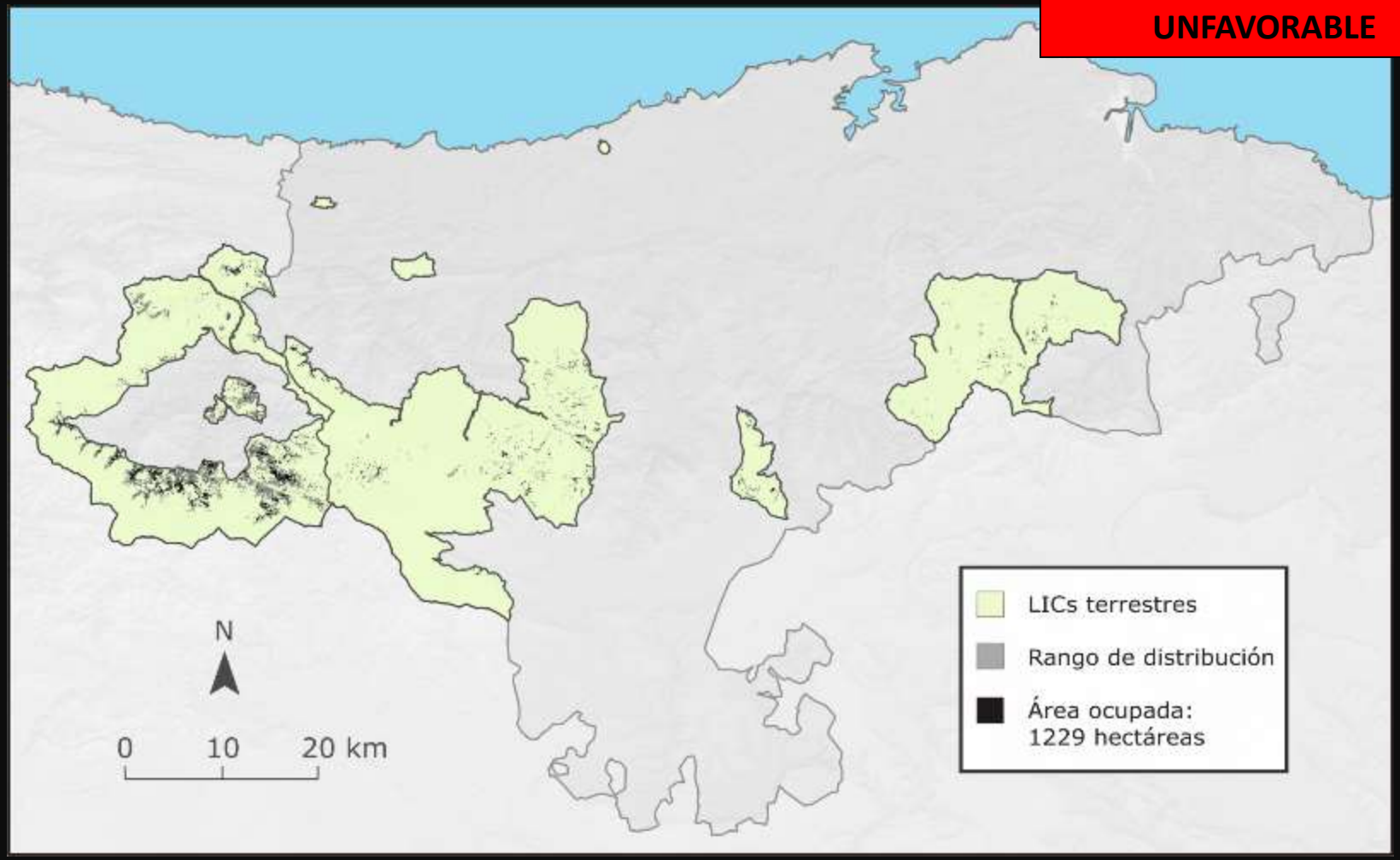
Conservation status FAVORABLE



9120 - Hayedos acidófilos atlánticos con sotobosque de *Ilex* y a veces de *Taxus*

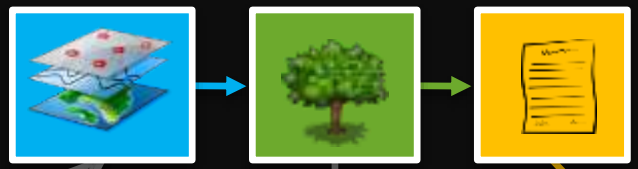
CONSERVATION STATUS

Conservation status
UNFAVORABLE



9140 - Robledales ibéricos de *Quercus faginea* y *Quercus canariensis*

GENERAL METHODOLOGY



MODELLING

MAPS

INDICATORS

Reference values

OBJECTIVES

ACTIONS

Management

Conservation

INDICATORS

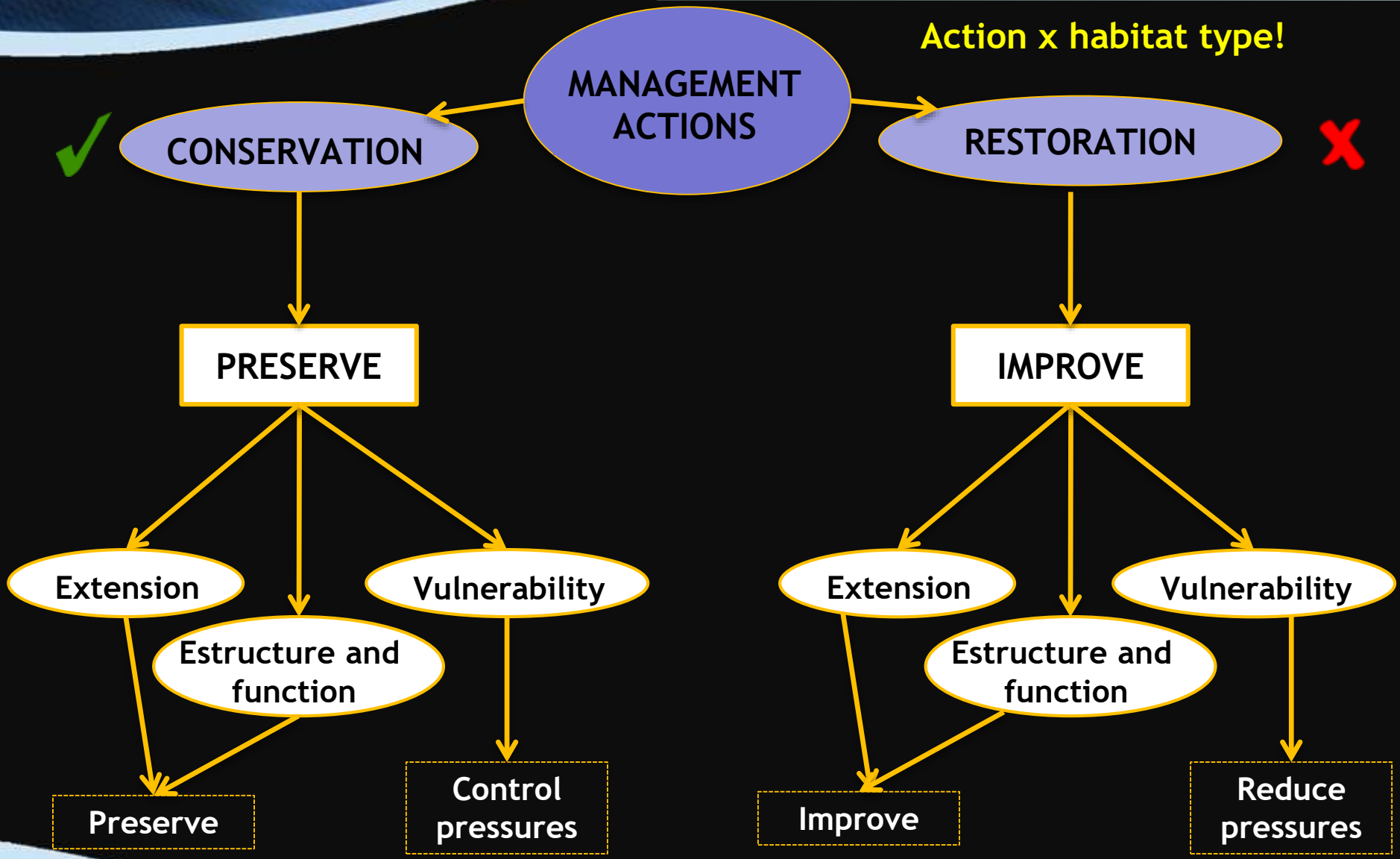
Extension

Vulnerability

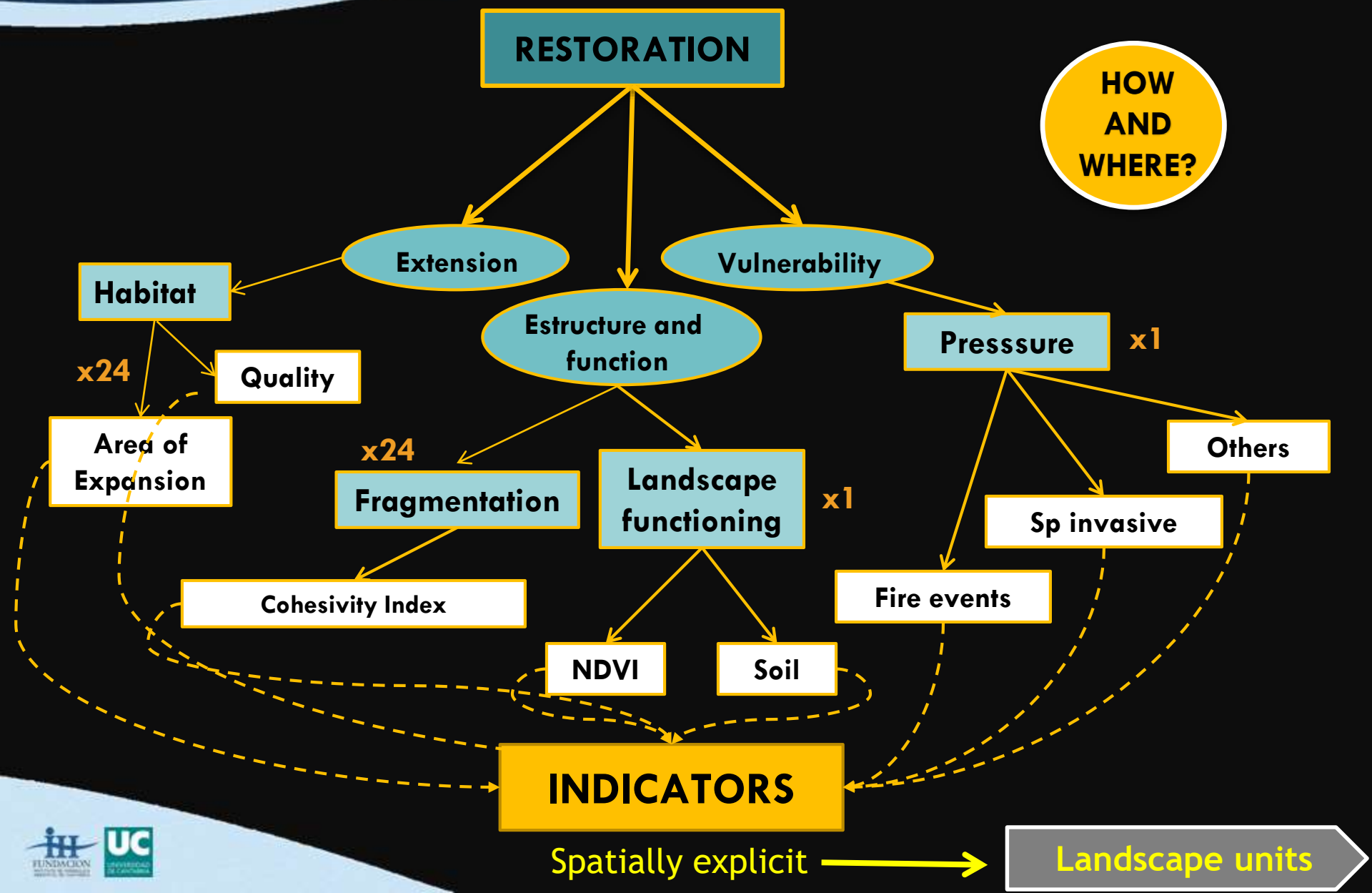
Structure and Composition

MANAGEMENT PLAN

Action x habitat type!

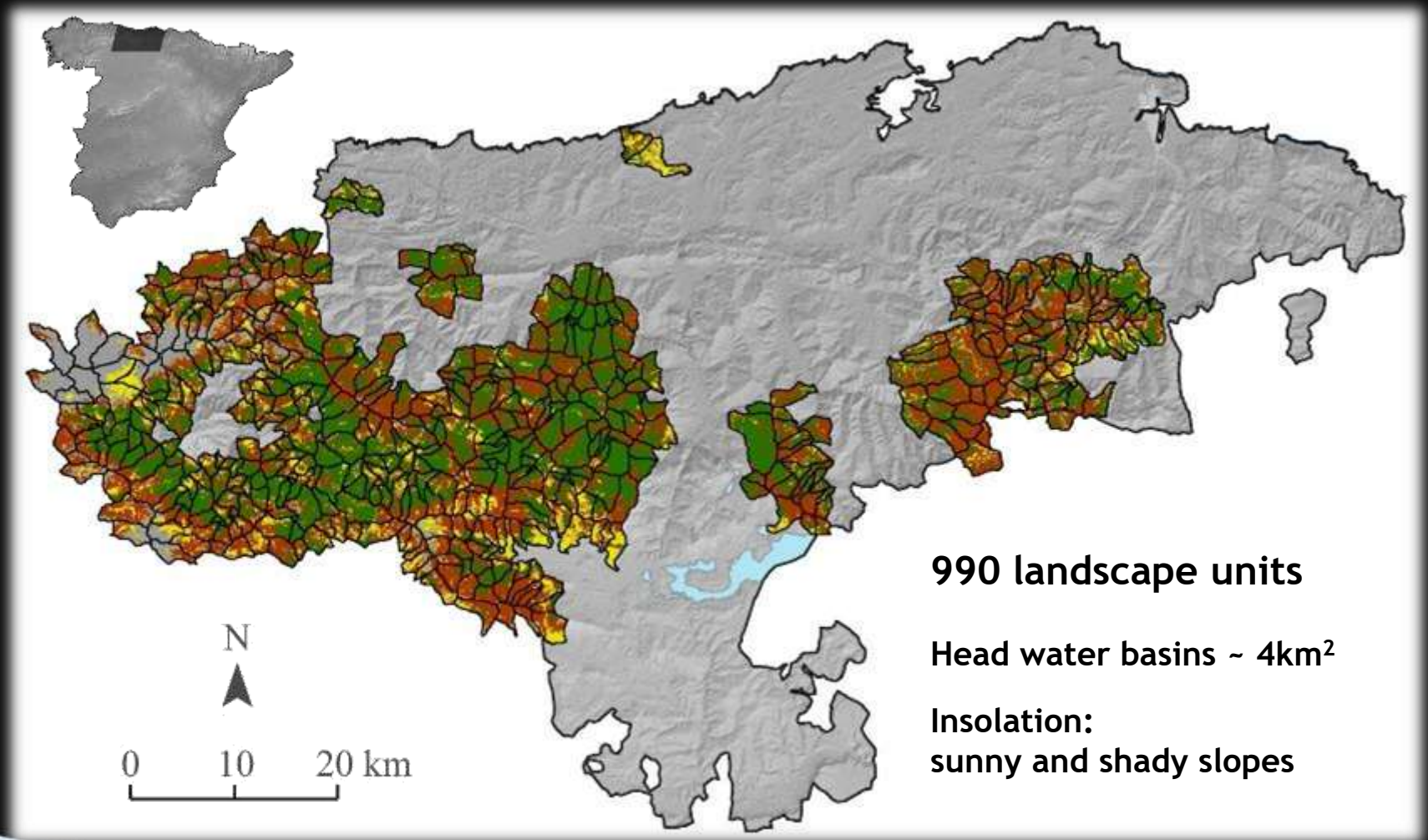


DEFINING MANAGEMENT ACTIONS



LANDSCAPE UNITS FOR MANAGEMENT

Homogeneous units (structure and composition) driven by environmental limiting factors (topography and climate)



990 landscape units

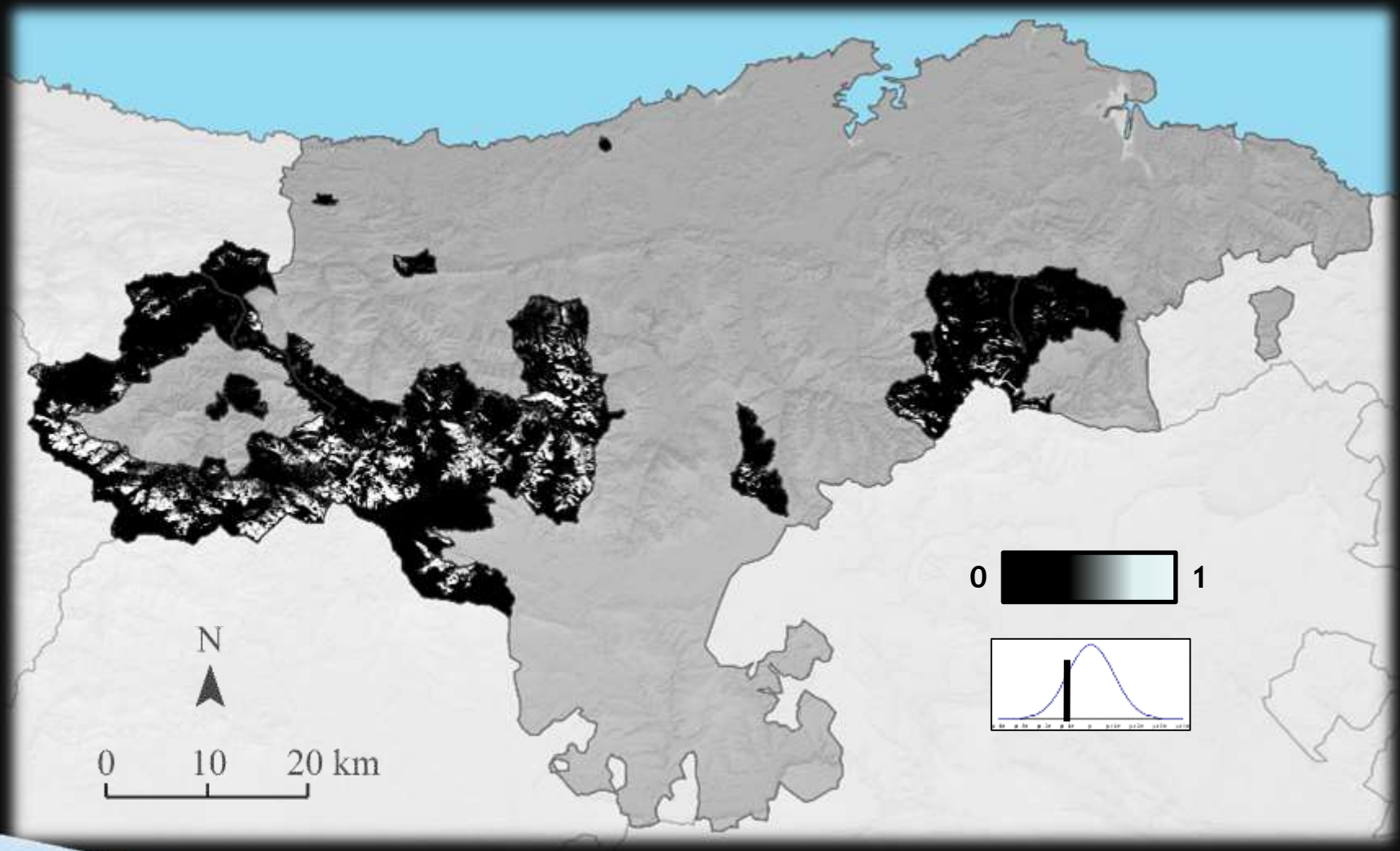
Head water basins ~ 4km^2

Insolation:
sunny and shady slopes

Álvarez-Martínez, J. M., et al (2014). Influence of land use and climate on recent forest expansion: a case study in the Eurosiberian–Mediterranean limit of north-west Spain, **Journal of Ecology**, 102, 905-919

MANAGEMENT ACTIONS

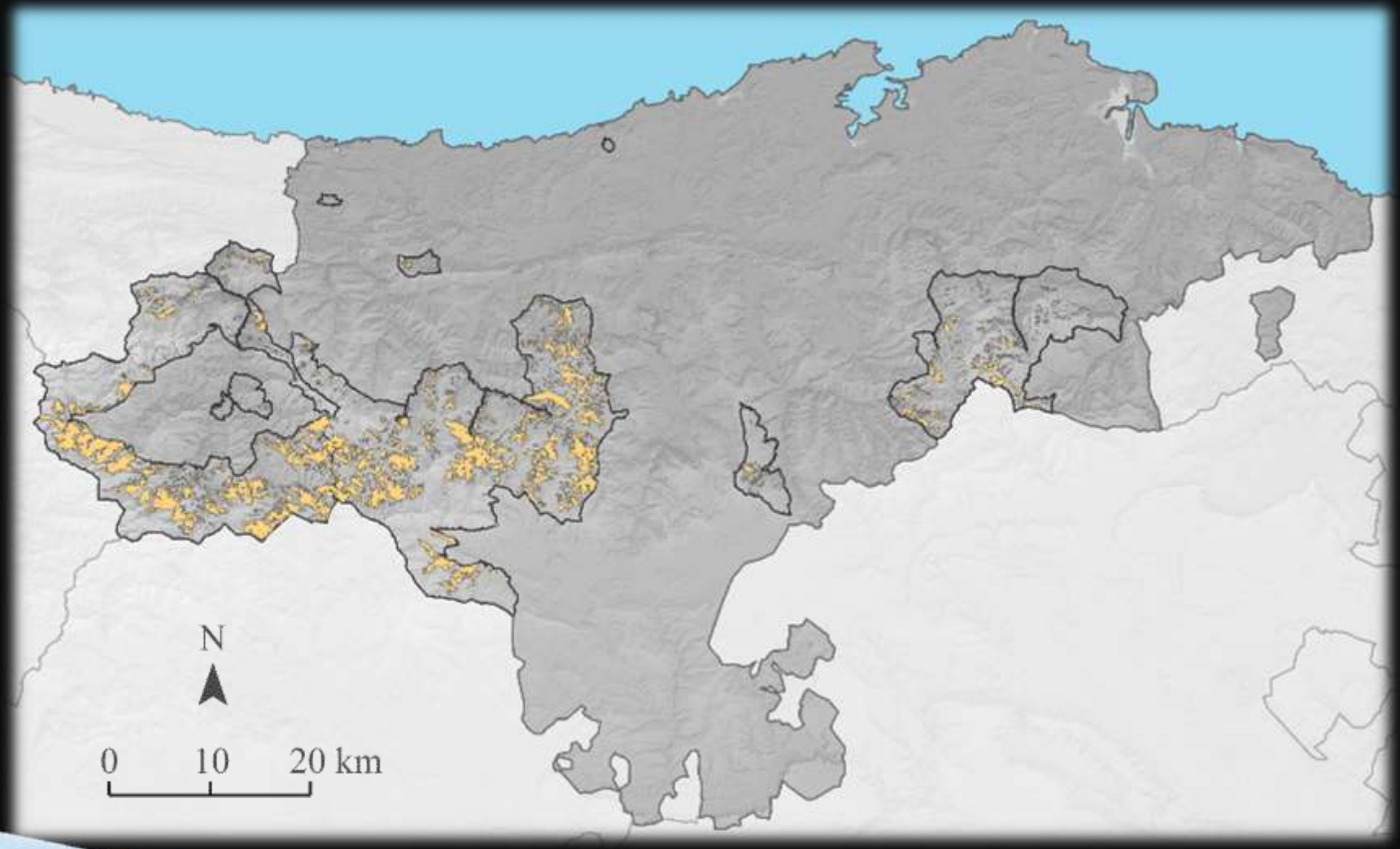
Probability RASTER



Habitat type 9120

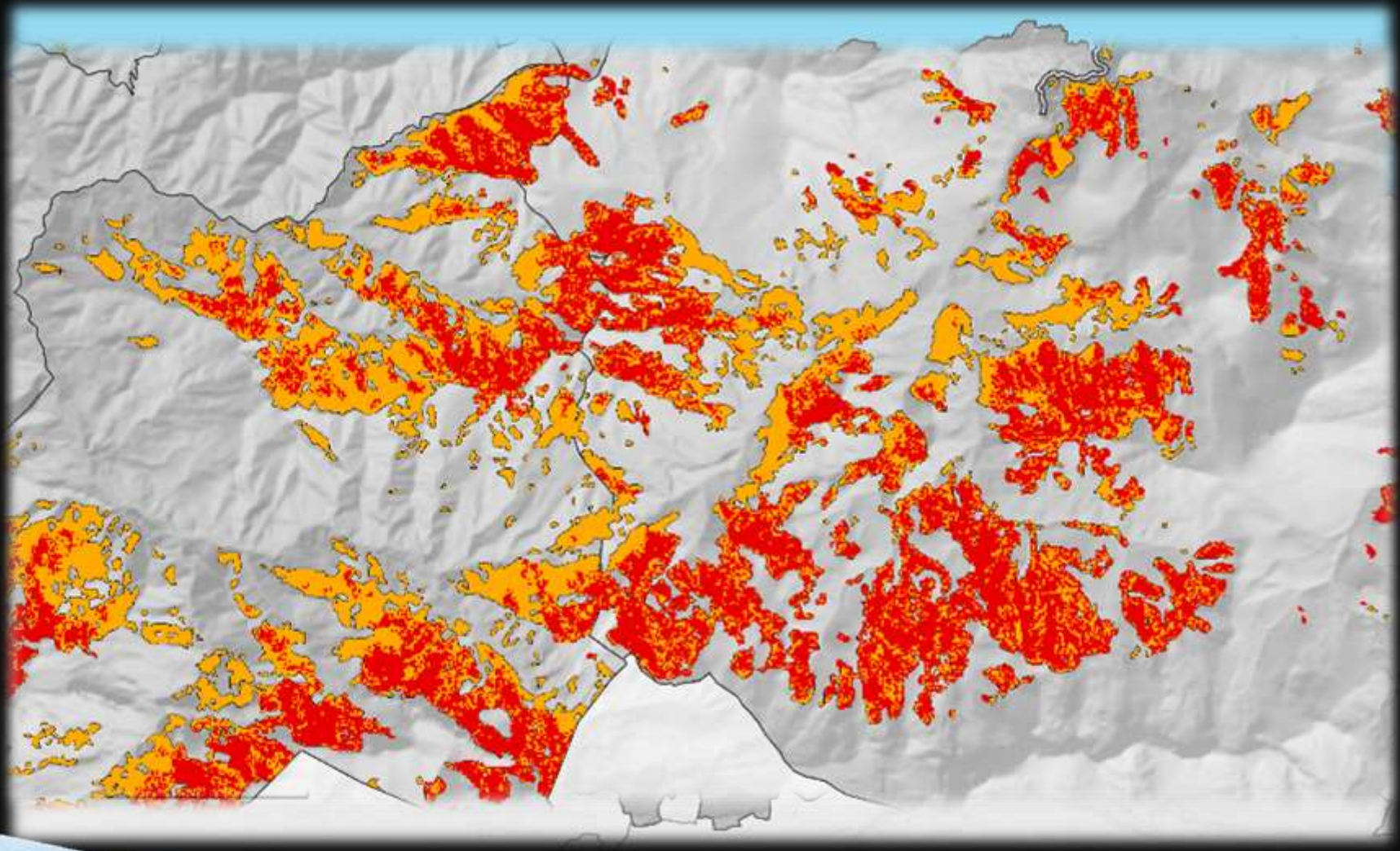
MANAGEMENT ACTIONS

Local AOO



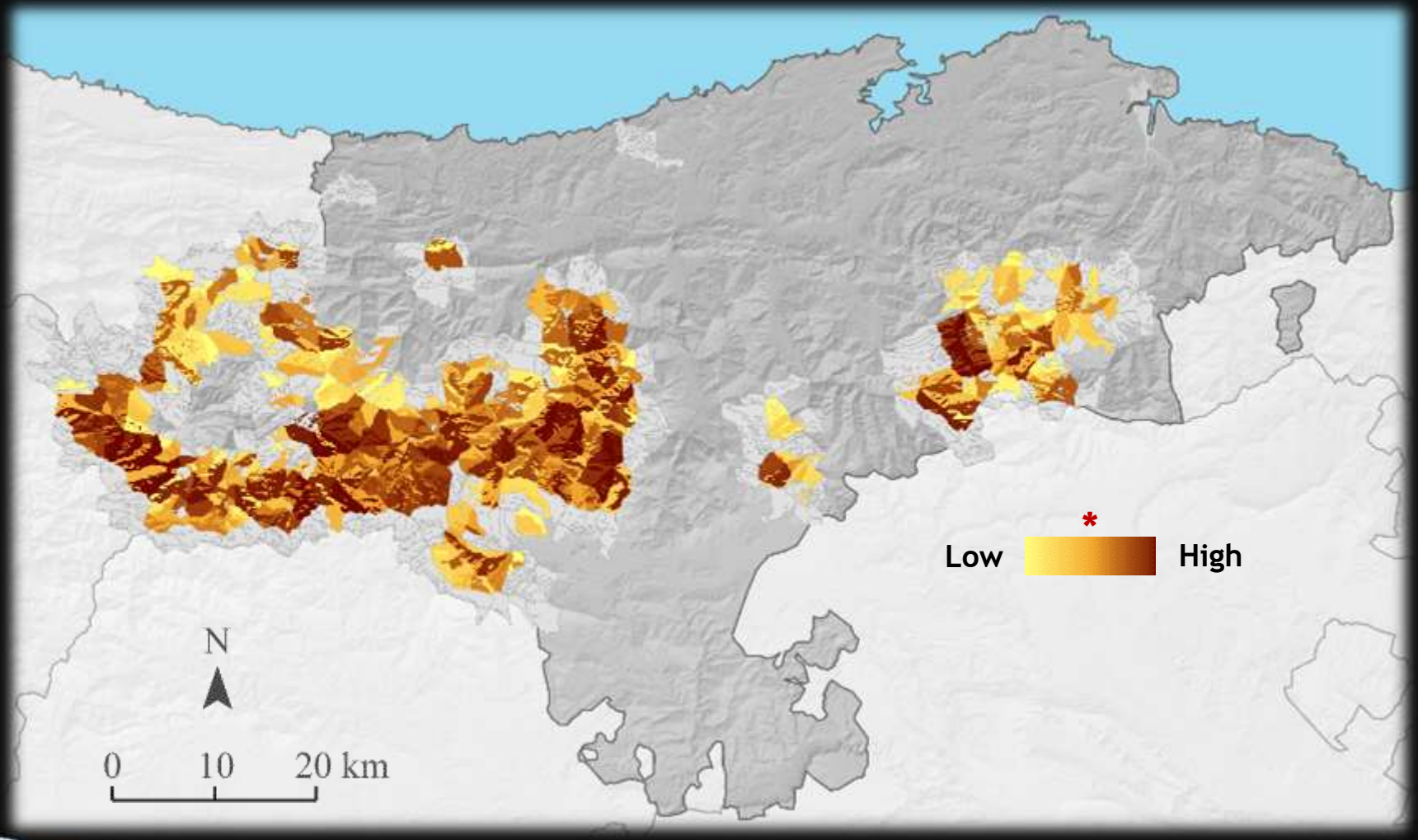
MANAGEMENT ACTIONS

Realized AOO



MANAGEMENT ACTIONS

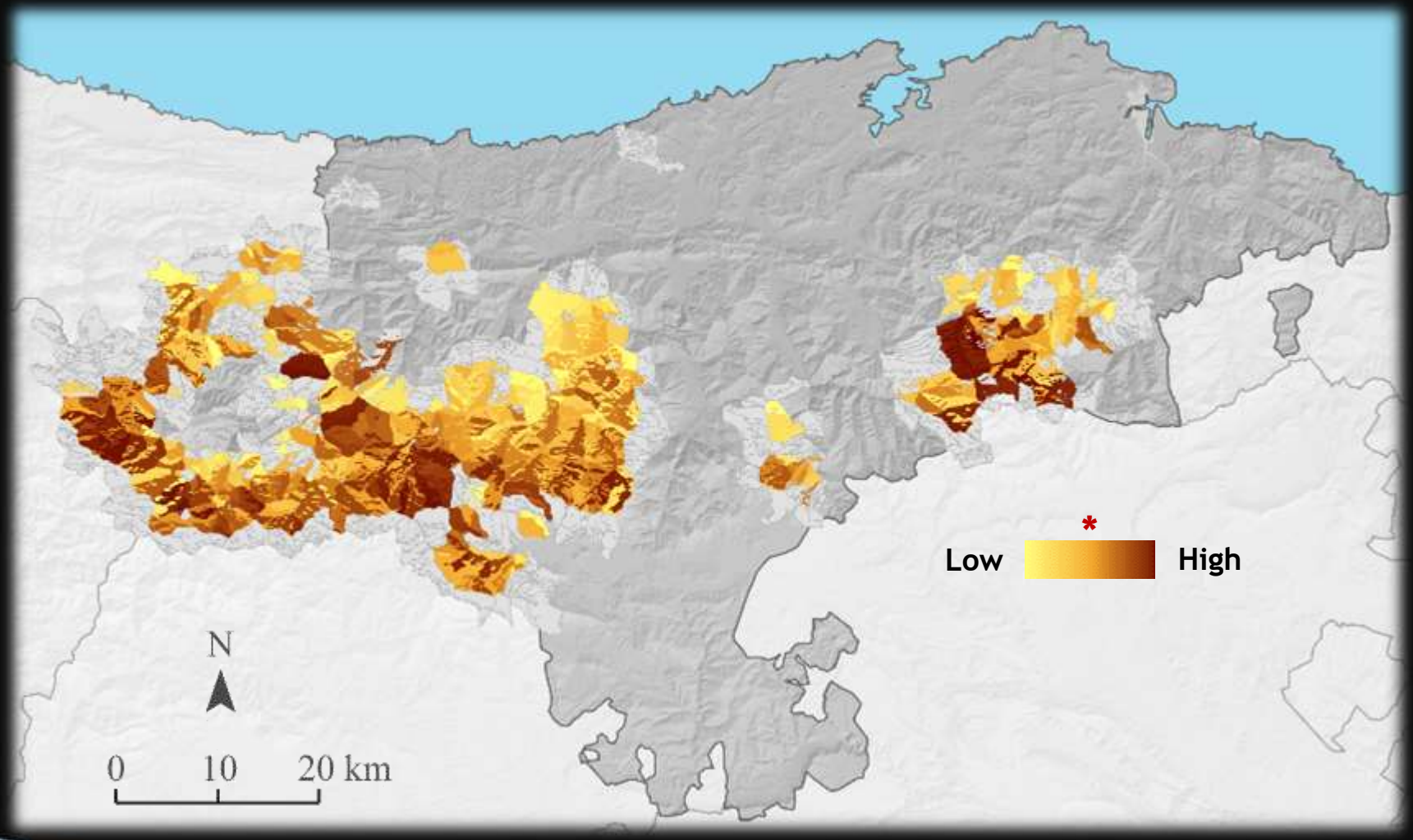
…easity generating specific INDICES for MANAGEMENT: QUANTITY of Area of expansion



* Unidades de medida estandarizadas par todos los índices
Ponderación y signo en su relación con cada hábitat

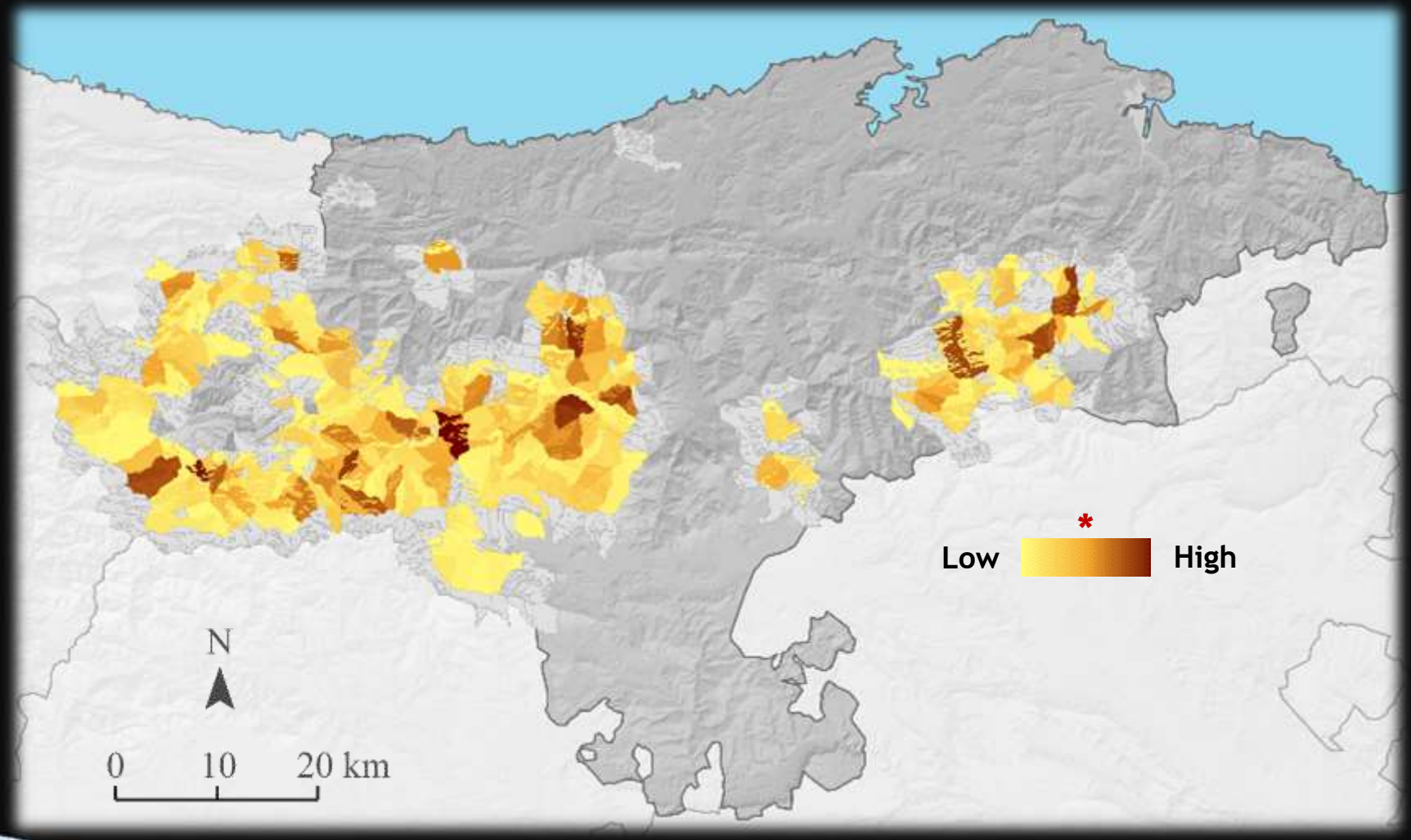
MANAGEMENT ACTIONS

QUALITY of Area of expansion



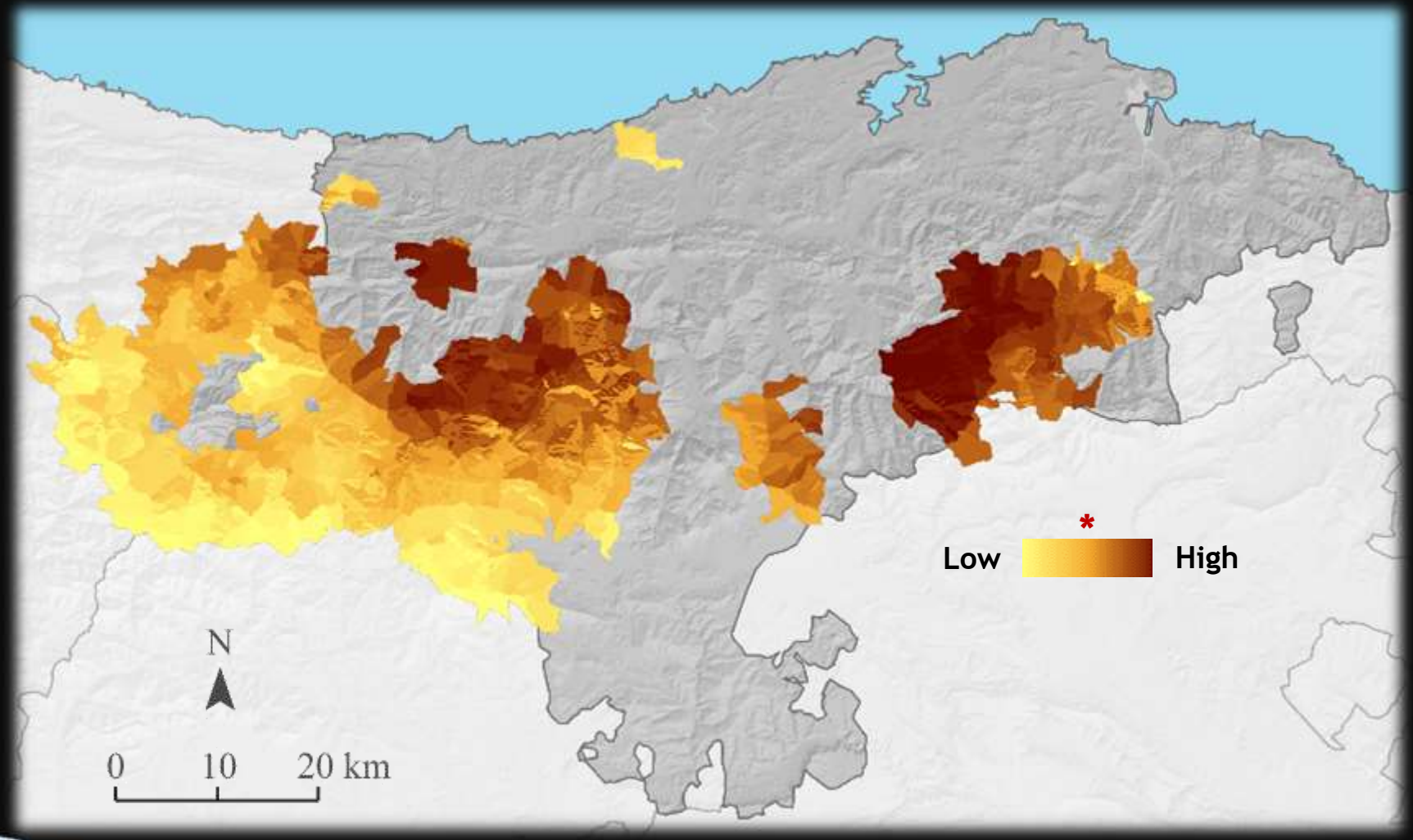
MANAGEMENT ACTIONS

FRAGMENTATION of Area of expansion (ej. number of patches)



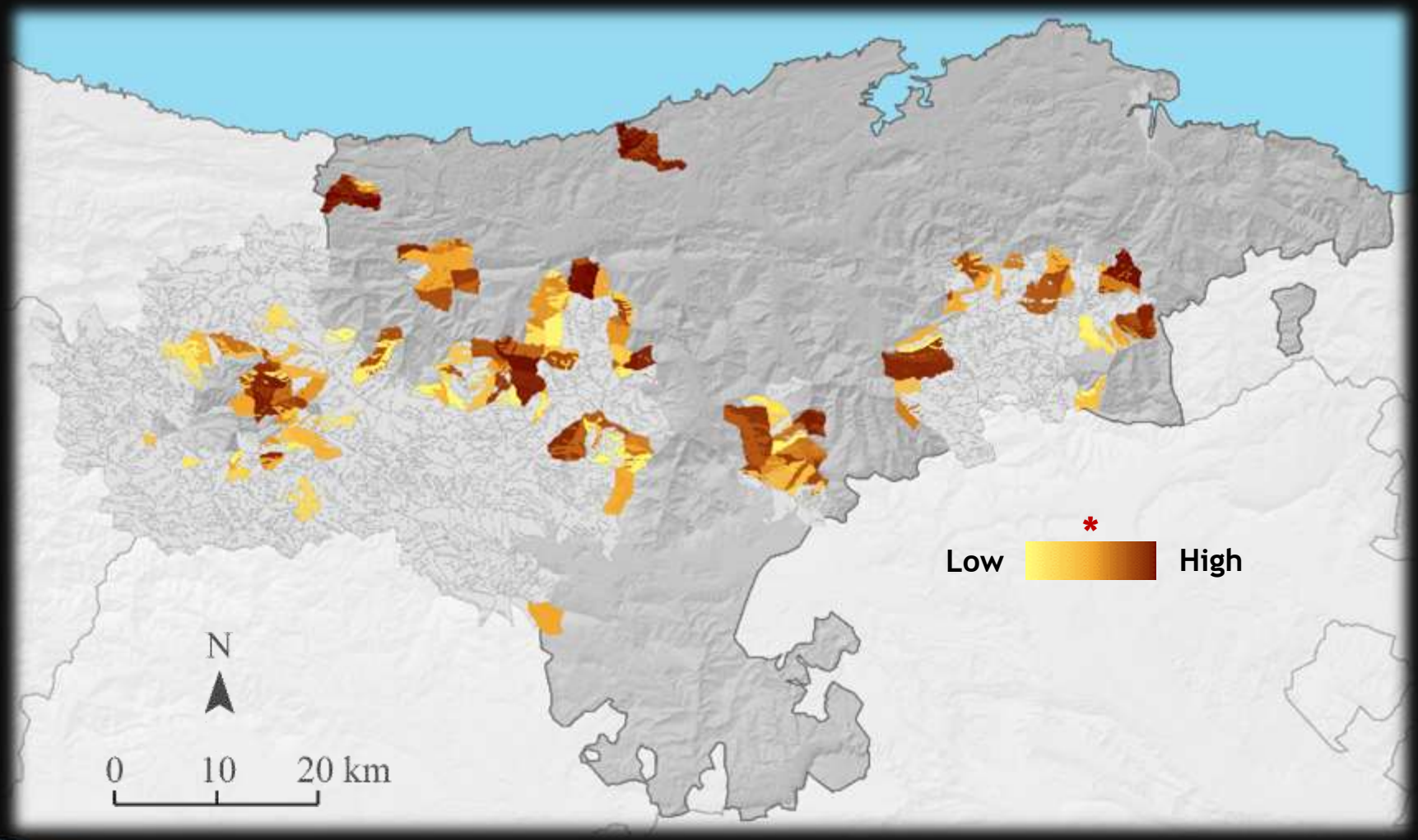
MANAGEMENT ACTIONS

FIRE RISK (for all landscape units)



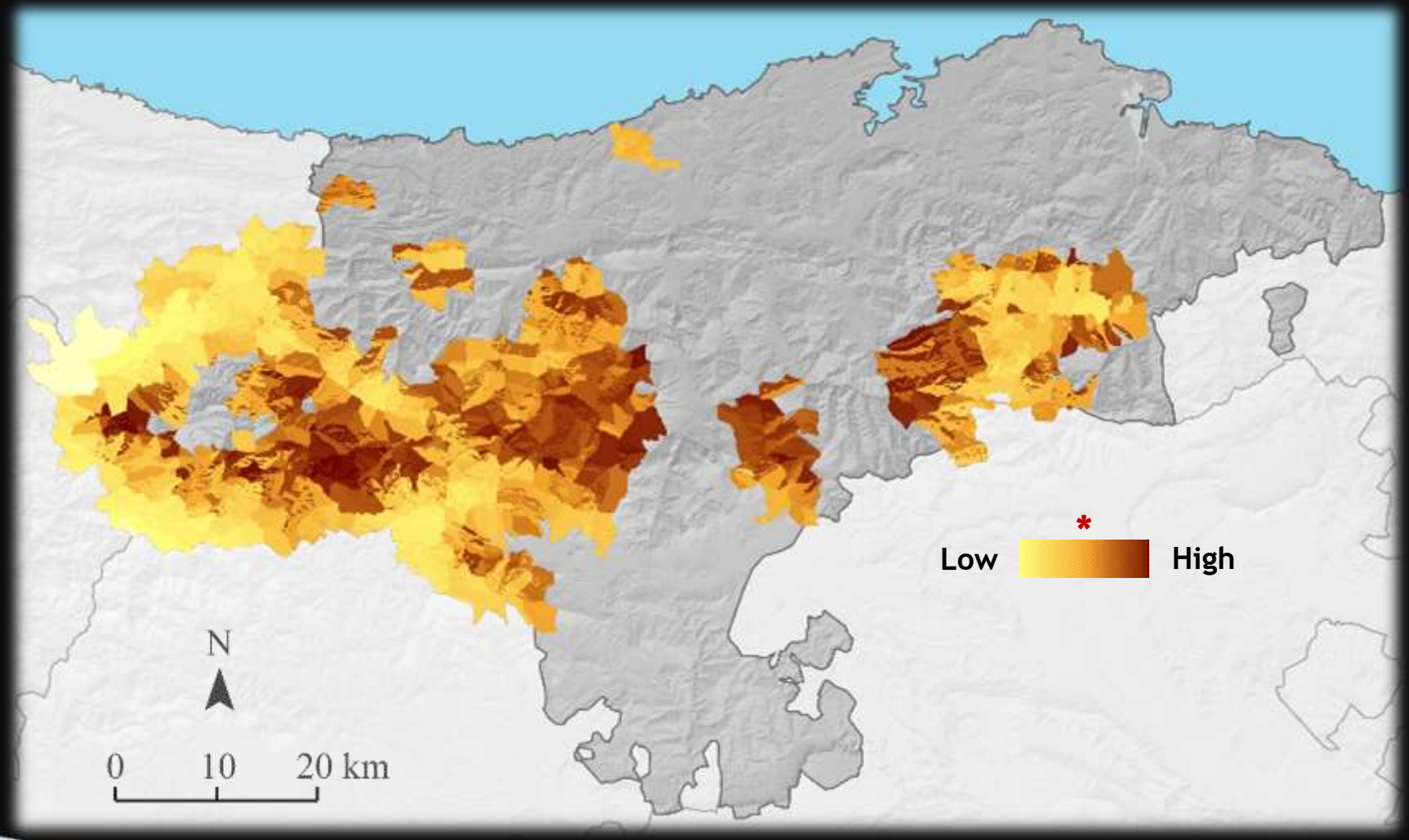
MANAGEMENT ACTIONS

ALIEN SPECIES (for all landscape units)



MANAGEMENT ACTIONS

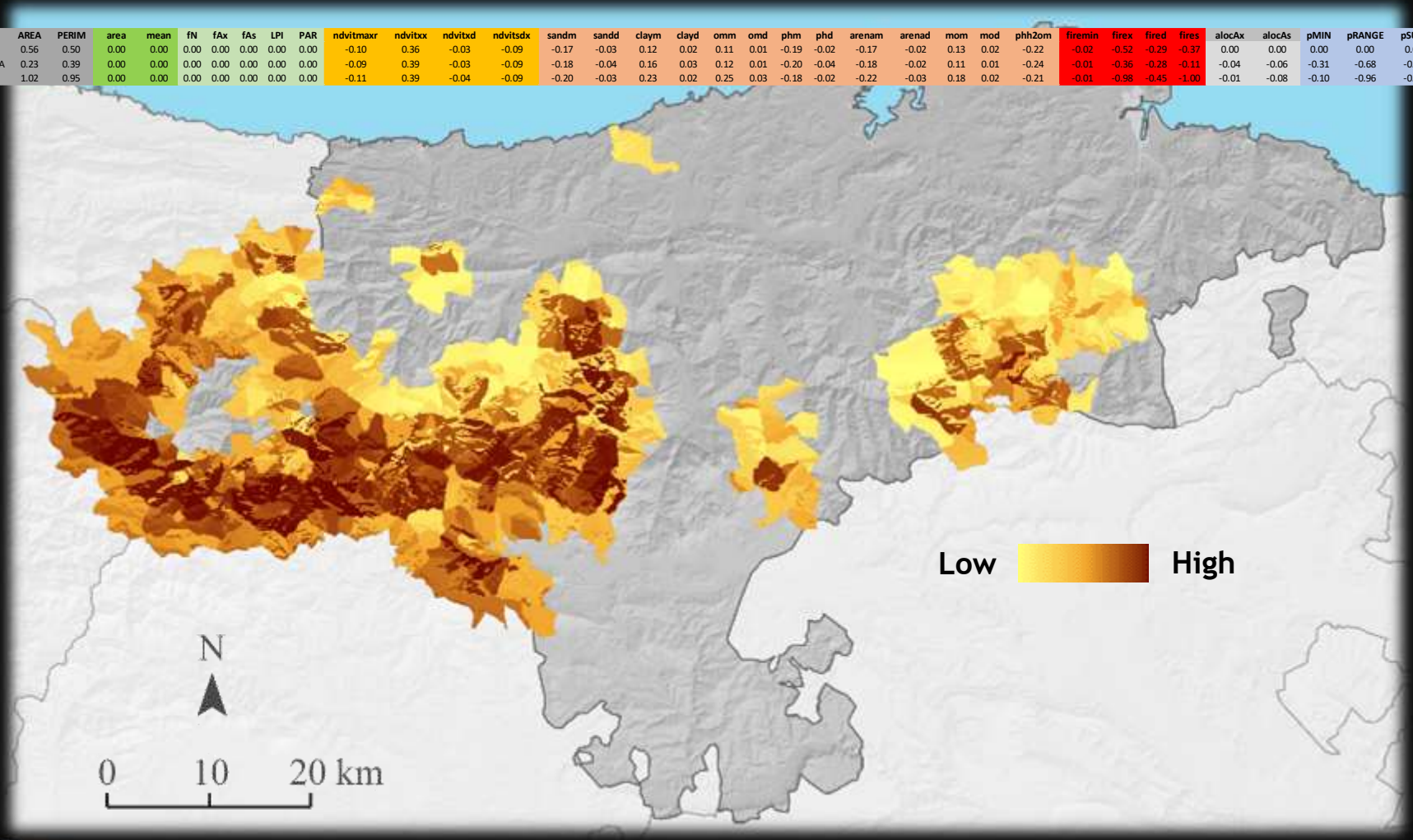
Primary production or NDVI through time (for all landscape units)



MANAGEMENT ACTIONS

PRIORITY INDEX (for all landscape units)

ID	LIC	AREA	PERIM	area	mean	fN	fAx	fAs	LPI	PAR	ndvitmaxr	ndvitxx	ndvitxd	ndvitsdx	sandm	sandd	claym	clayd	omm	omd	phm	phd	arenam	arenad	mom	mod	phh2om	firemin	firex	fired	fires	alocAx	alocAs	pMIN	pRANGE	pSUM	PRIORIZA
1	LIEBANA	0.56	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.10	0.36	-0.03	-0.09	-0.17	-0.03	0.12	0.02	0.11	0.01	-0.19	-0.02	-0.17	-0.02	0.13	0.02	-0.22	-0.02	-0.52	-0.29	-0.37	0.00	0.00	0.00	0.00	0.00	**-0.47**
2	CABUERNIGA	0.23	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.09	0.39	-0.03	-0.09	-0.18	-0.04	0.16	0.03	0.12	0.01	-0.20	-0.04	-0.18	-0.02	0.11	0.01	-0.24	-0.01	-0.36	-0.28	-0.11	-0.04	-0.06	-0.31	-0.68	-0.09	**-1.74**
3	ORIENTAL	1.02	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.11	0.39	-0.04	-0.09	-0.20	-0.03	0.23	0.02	0.25	0.03	-0.18	-0.02	-0.22	-0.03	0.18	0.02	-0.21	-0.01	-0.98	-0.45	-1.00	-0.01	-0.08	-0.10	-0.96	-0.26	**-3.24**

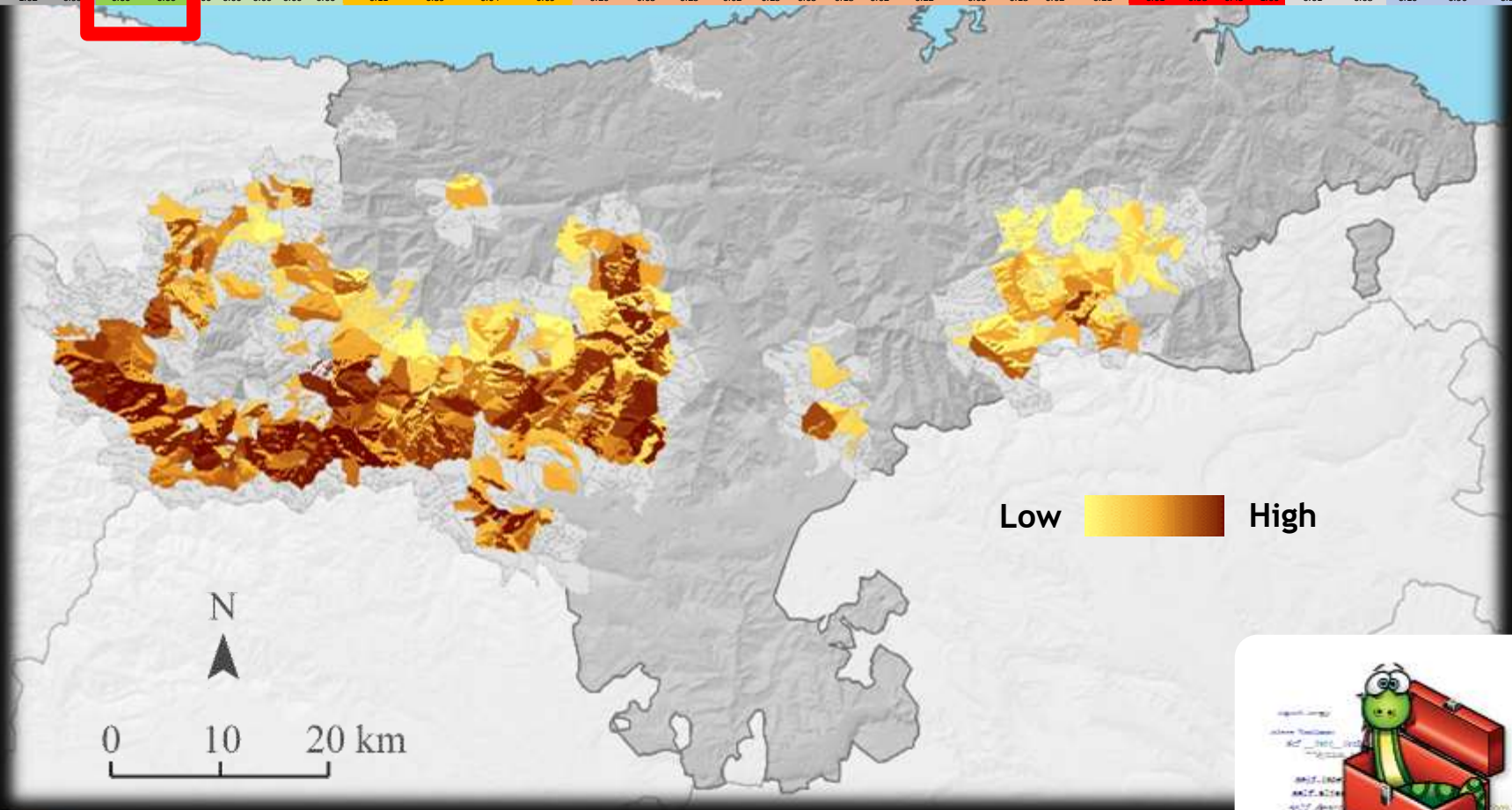


- Suma de todos los índices, normalizados con ponderación y signo
- Valores de *-n* a *+n*, siendo mayor la aptitud a mayor valor de *n*

MANAGEMENT ACTIONS

PRIORITY INDEX (for all landscape units)

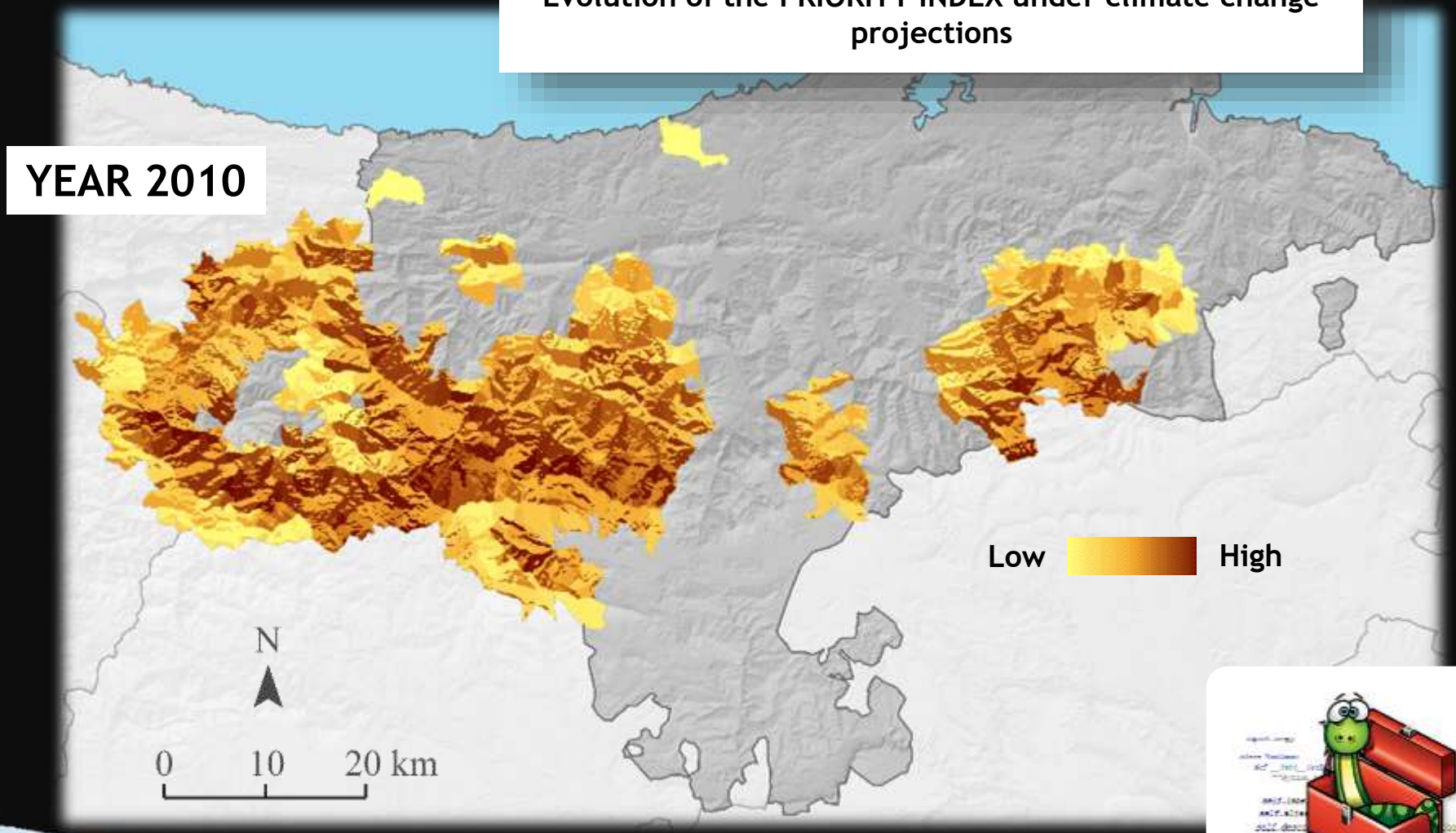
ID	LIC	AREA	PERI	area	mean	N	fAx	fAs	LPI	PAR	ndvitmaxr	ndvitxx	ndvitxd	ndvitsdx	sandm	sandd	claym	clayd	omm	omd	phm	phd	arenam	arenad	mom	mod	phh2om	firemin	firex	fired	fires	alocAx	alocAs	pMIN	pRANGE	pSUM	PRIORIZA
1	LIEBANA	0.56	0.5	0.00	0.00	00	0.00	0.00	0.00	0.00	-0.10	0.36	-0.03	-0.09	-0.17	-0.03	0.12	0.02	0.11	0.01	-0.19	-0.02	-0.17	-0.02	0.13	0.02	-0.22	-0.02	-0.52	-0.29	-0.37	0.00	0.00	0.00	0.00	0.00	**-0.47**
2	CABUERNIGA	0.23	0.3	0.00	0.00	00	0.00	0.00	0.00	0.00	-0.09	0.39	-0.03	-0.09	-0.18	-0.04	0.16	0.03	0.12	0.01	-0.20	-0.04	-0.18	-0.02	0.11	0.01	-0.24	-0.01	-0.36	-0.28	-0.11	-0.04	-0.06	-0.31	-0.68	-0.09	**-1.74**
3	ORIENTAL	1.02	0.9	0.00	0.00	00	0.00	0.00	0.00	0.00	-0.11	0.39	-0.04	-0.09	-0.20	-0.03	0.23	0.02	0.25	0.03	-0.18	-0.02	-0.22	-0.03	0.18	0.02	-0.21	-0.01	-0.98	-0.45	-1.00	-0.01	-0.08	-0.10	-0.96	-0.26	**-3.24**



"LEGO" format tool: expandable to any variable

MANAGEMENT ACTIONS

Evolution of the PRIORITY INDEX under climate change projections

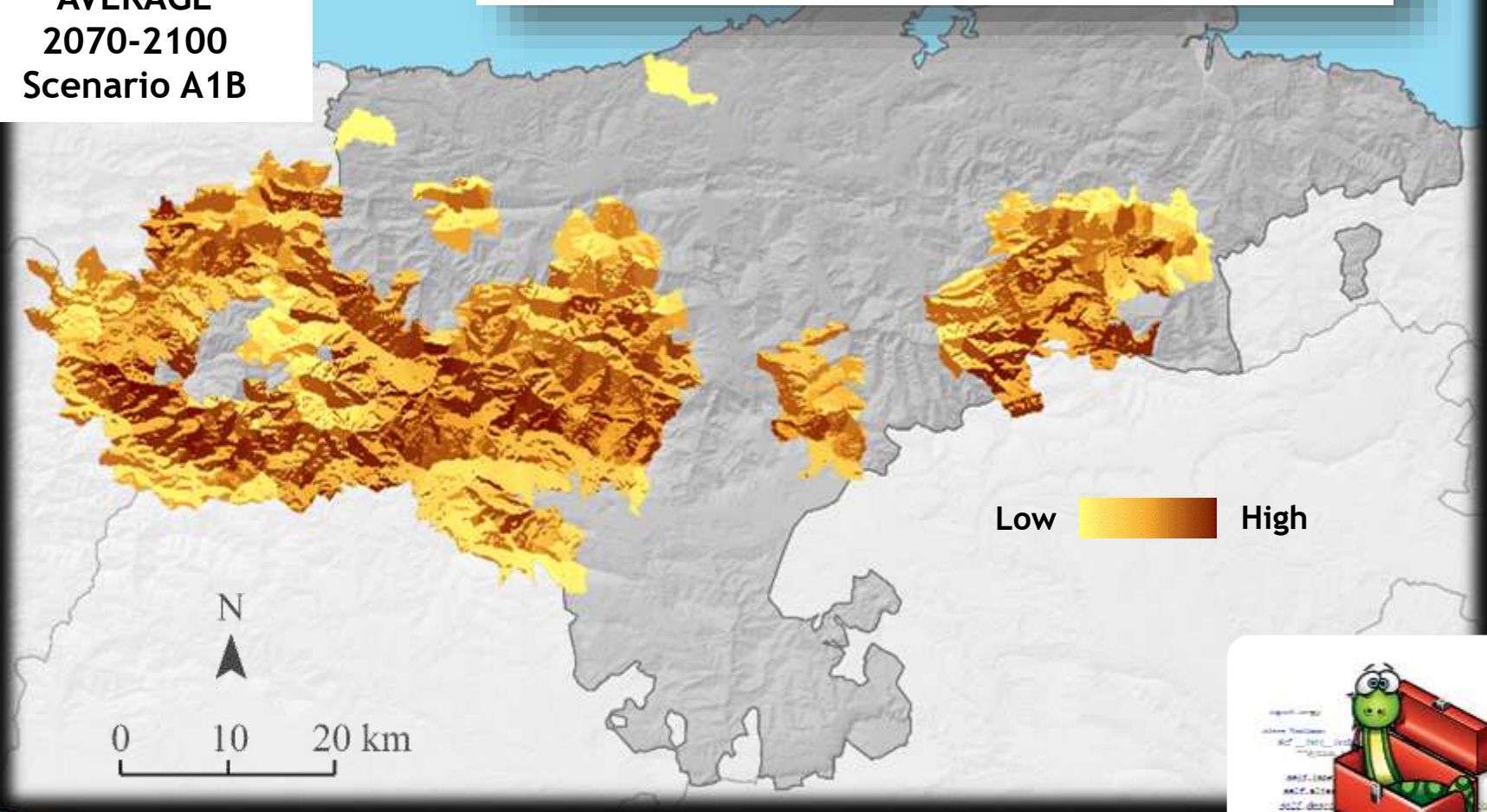


"LEGO" format tool: expandable to any variable

MANAGEMENT ACTIONS

Evolution of the PRIORITY INDEX under climate change projections

AVERAGE
2070-2100
Scenario A1B



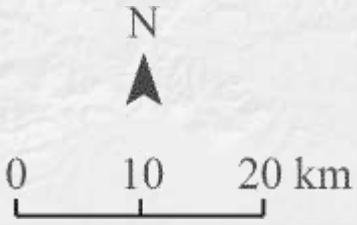
"LEGO" format tool: expandable to any variable

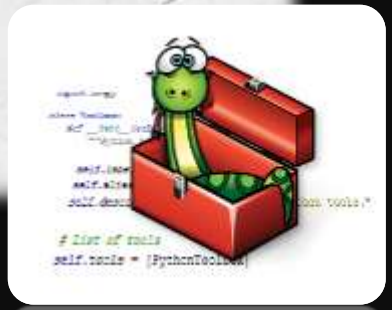
MANAGEMENT ACTIONS

Evolution of the PRIORITY INDEX under climate change projections

Difference PRESENT-FUTURE

	Media actual potencial	Media futura potencial	Valor F
9120	0.463	0.322	44,615***
9150	0.346	0.415	47,608*
9160	0.178	0.174	0.0167
9230	0.470	0.663	36,892***





"LEGO" format tool: expandable to any variable

MANAGEMENT PLANS

Implementation:
- Information available
- Funding mechanisms
- Concatenated management

Development:
- Conservation status
- Adaptative management

Trade-off:
- Systematic protocols
- Stakeholders
- BGI schemes and ES

HORIZON 2020
The EU Framework Programme for Research and Innovation
European Commission
opernicus
Europe's eyes on Earth

IH cantabria
INSTITUTO DE HIDRÁULICA AMBIENTAL
UNIVERSIDAD DE CANTABRIA

H2020

UMIB
Unidad Mixta de Investigación en Biodiversidad
(UO/CSIC/PA)

GOBIERNO DE ESPAÑA
MINISTERIO DE ECONOMÍA, INDUSTRIA Y COMPETITIVIDAD
CSIC

DUCCIO ROCCHINI
FONDAZIONE EDMUND MACH
CENTRO RICERCA e INNOVAZIONE

ALMA MATER STUDIORUM
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Alessandro Chiarucci
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Dipartimento di Scienze Biologiche, Geologiche e Ambientali
Settore scientifico disciplinare: BIO/03 BOTANICA AMBIENTALE E APPLICATA

WAGENINGEN
UNIVERSITY & RESEARCH

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ITD
Tecnosylva
Deimos

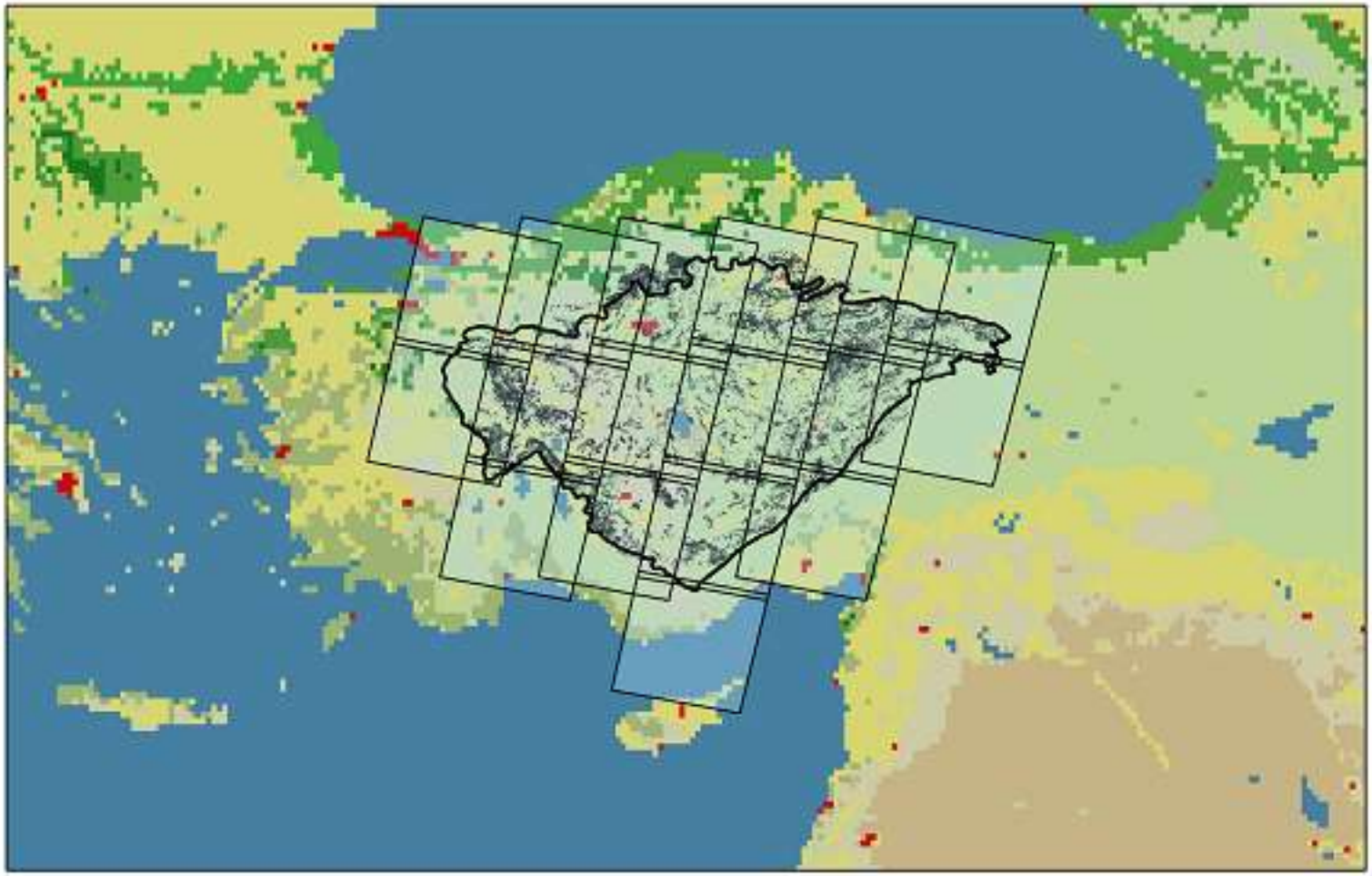
FUNDACIÓN IH
UC UNIVERSIDAD DE CANTABRIA

Landsat görüntüleri (path/row)

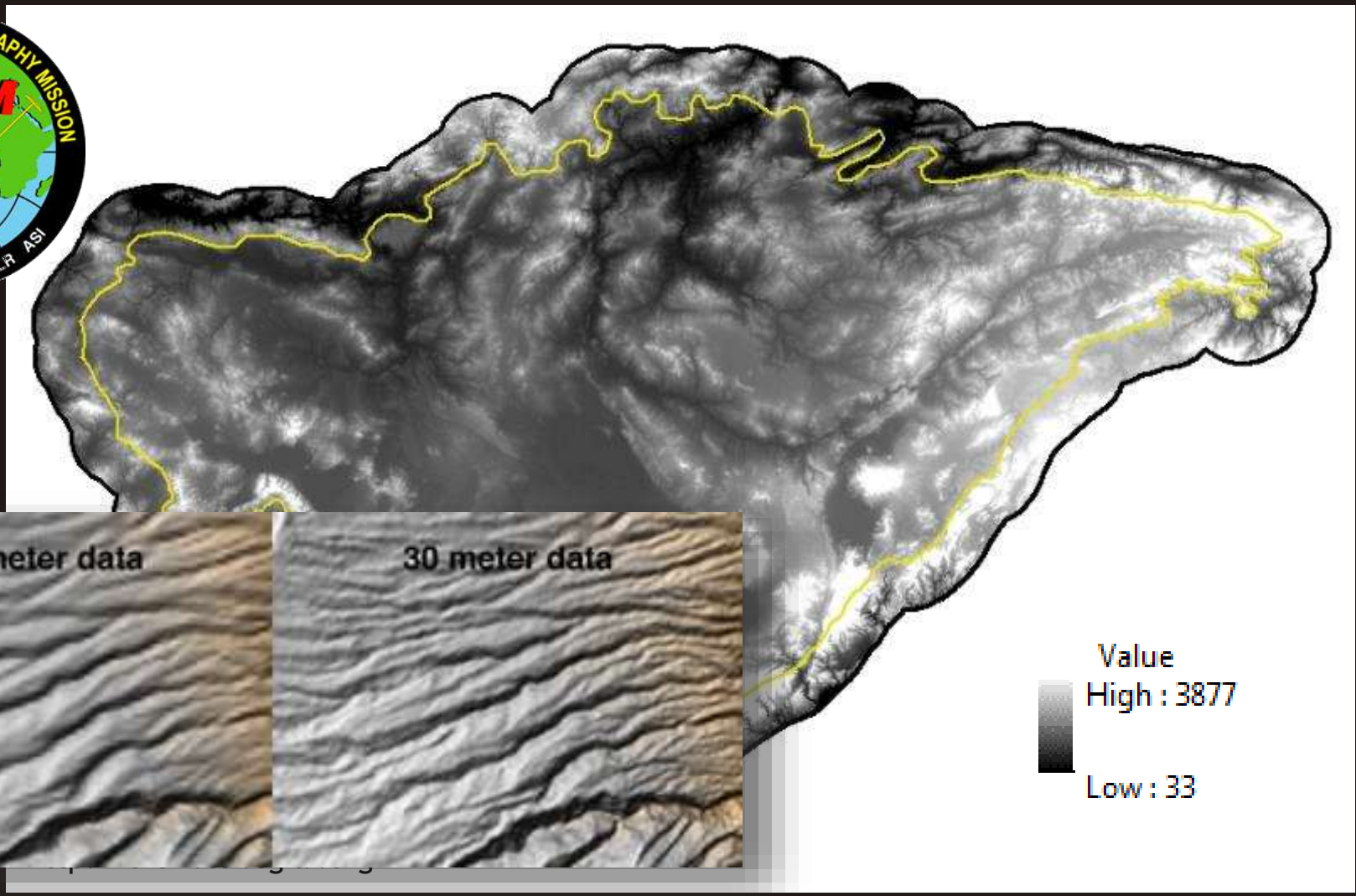
Görüntüler tüm çalışma alanını kapsıyor

CBS katmanlarının Landsat görüntülerinin 30 m konumsal çözünürlüğüne uyması gerek

17 Landsat görüntüsü

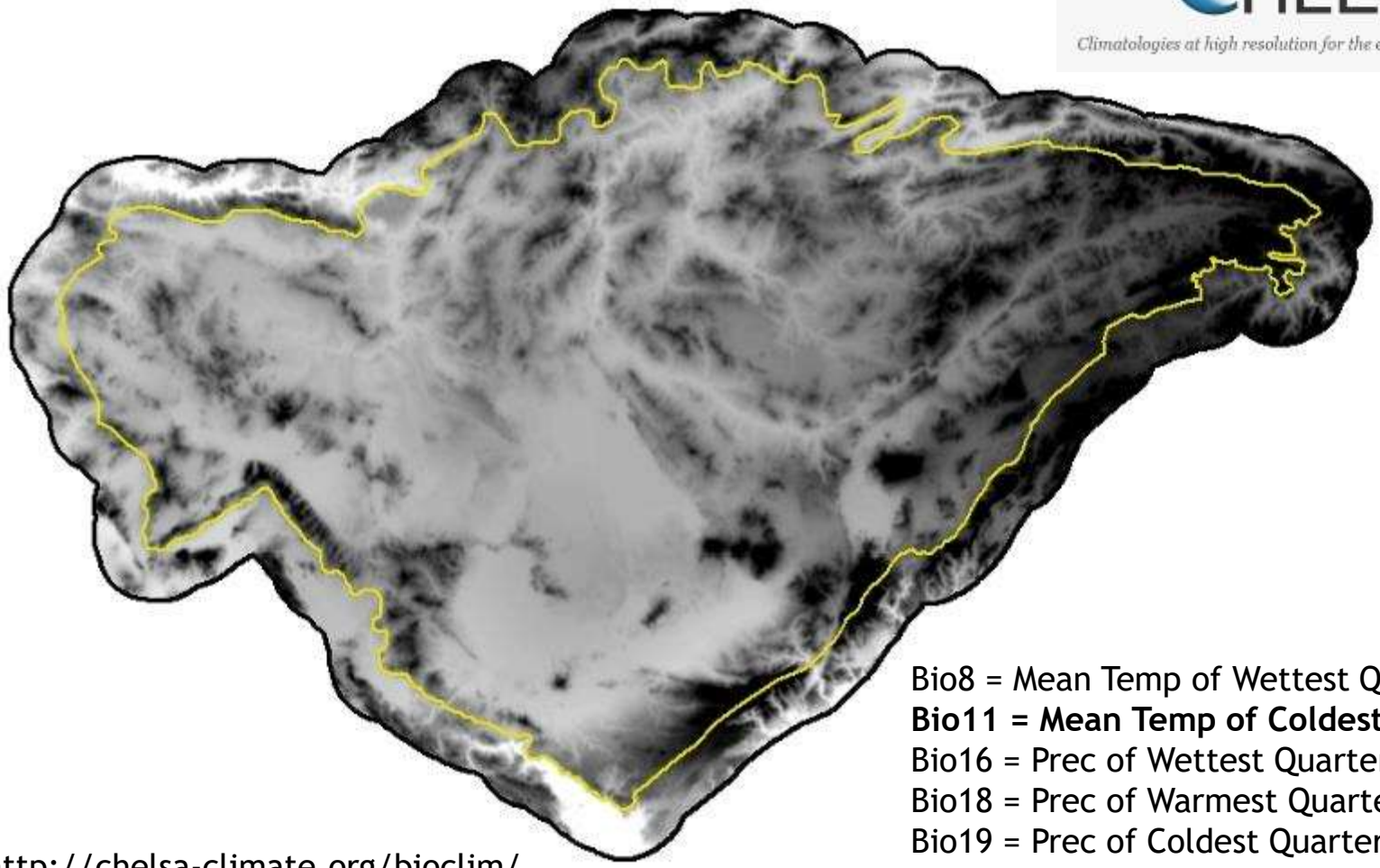


IRTIFA VE TÜREVLERI



30-m UZAMSAL ÇÖZÜNÜRLÜK

CHELSA
Climatologies at high resolution for the earth's land surface areas

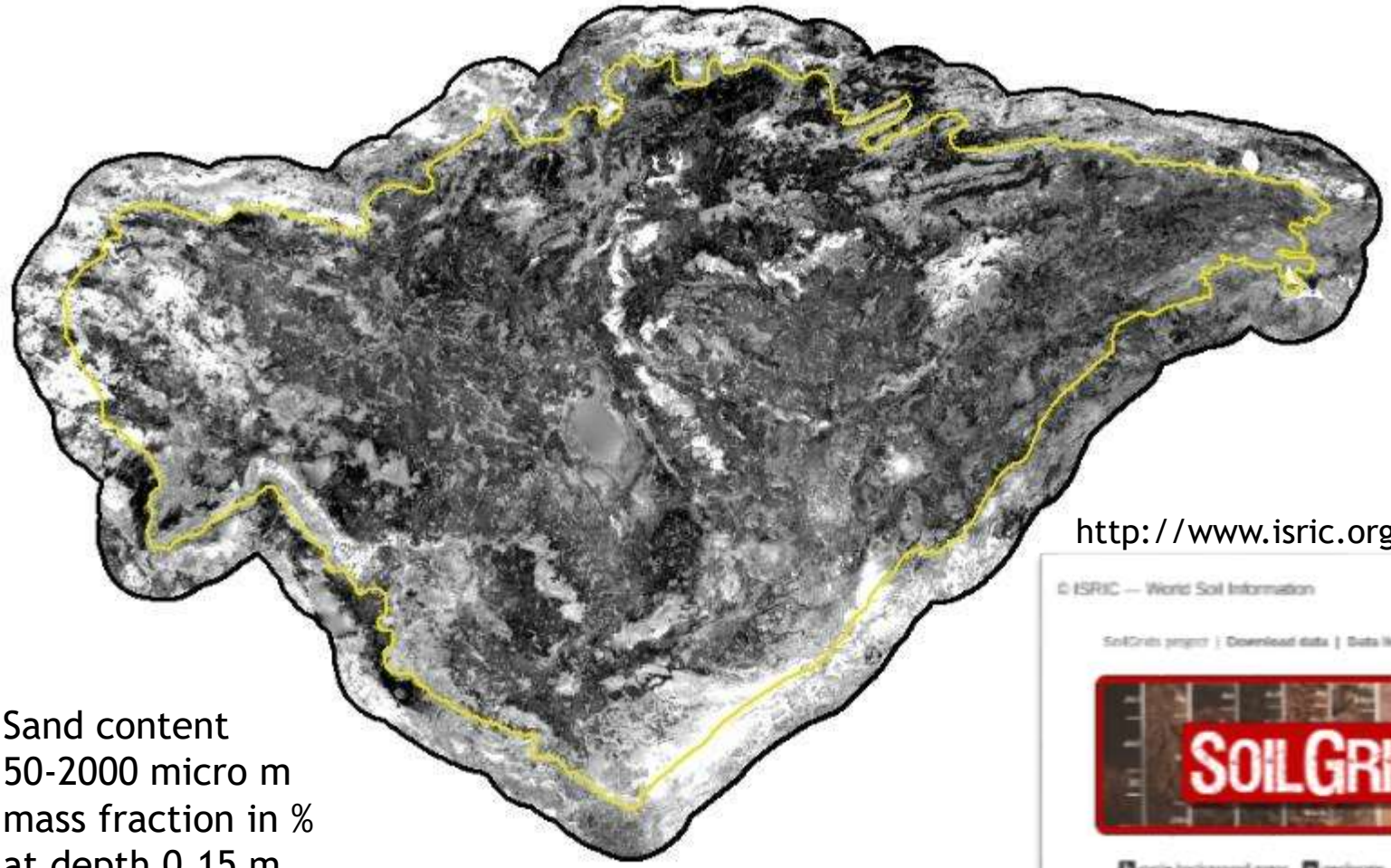


Bio8 = Mean Temp of Wettest Quarter
Bio11 = Mean Temp of Coldest Quarter
Bio16 = Prec of Wettest Quarter
Bio18 = Prec of Warmest Quarter
Bio19 = Prec of Coldest Quarter

http://chelsa-climate.org/bioclim/

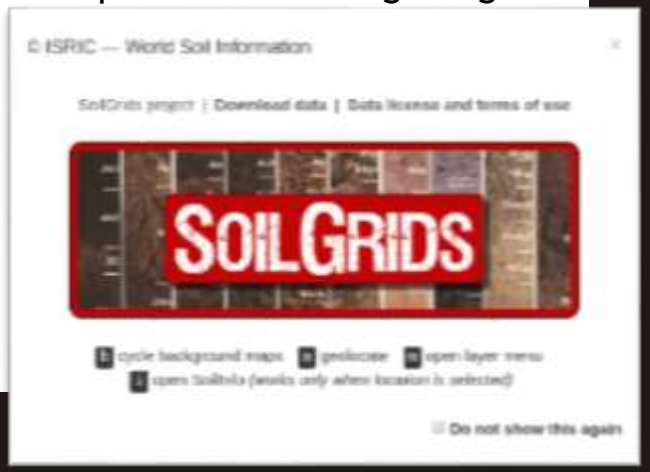
1000-m UZAMSAL ÇÖZÜNÜRLÜK → 30m

ZEMIN ÖZELLIKLERI



Sand content
50-2000 micro m
mass fraction in %
at depth 0.15 m

http://www.isric.org/soilgrids



250-m UZAMSAL ÇÖZÜNÜRLÜK → 30m

USGS ve ESA'dan daha yüksek güneş yükseltisi ve asgari bulut örtüsü

DOS3 yöntemi kullanarak TOA yansımalarından yüzey yansımaları (Song *ve ark*. 2001)

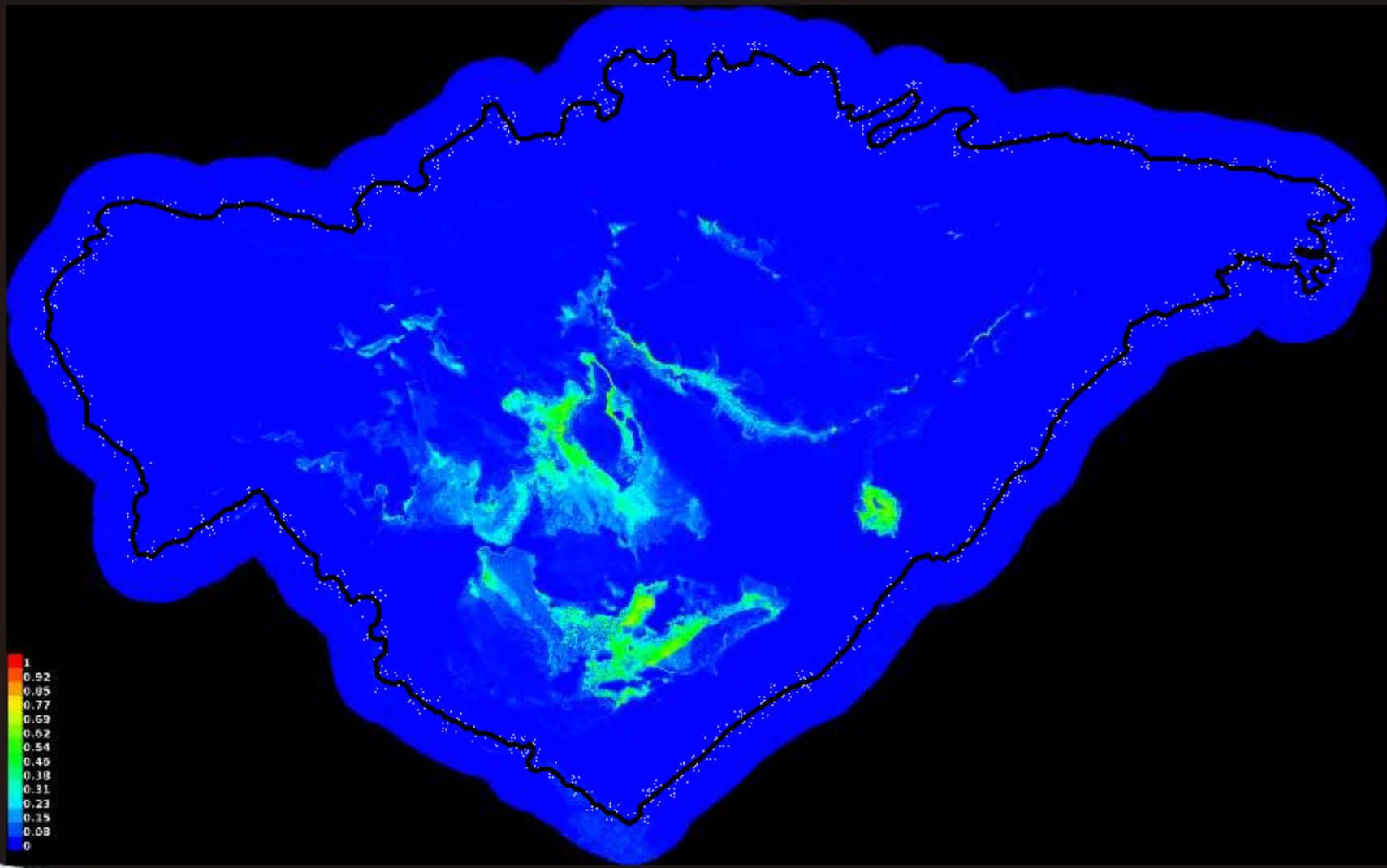
Teillet *et al. Teillet ve ark. (*1982)modeli kullanarak yüzey yansımasının topografik düzeltmesi

Sunuculardan gerçek zamanlı tüm görüntüleri almak için C++ olarak programlandı

Radyometrik normalleştirme

E62

Continental inland salt steppes



uygunluk

DOĞRULAMASI

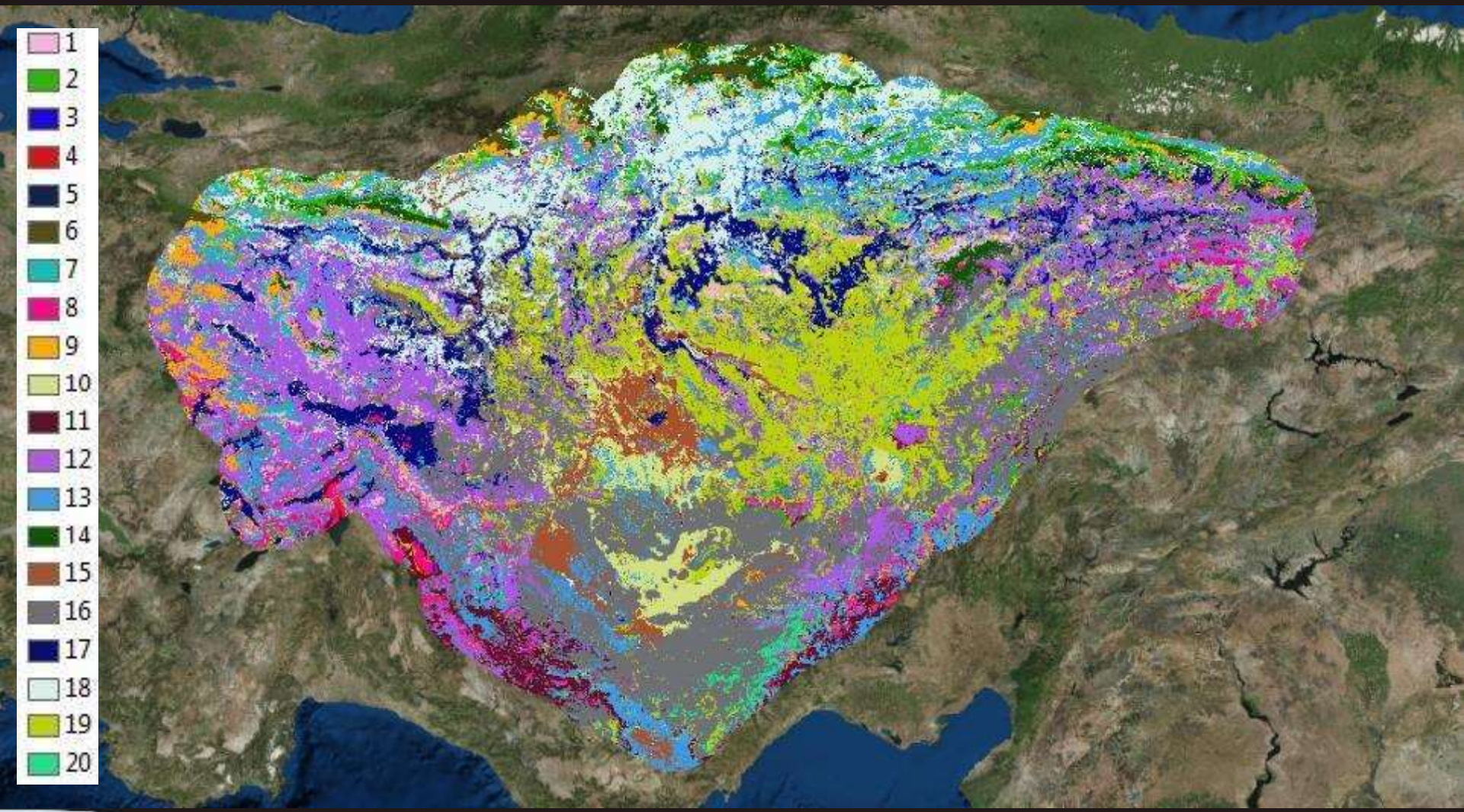
Olasılık [0-1]

	MAPS																																	
POINTS	D52	D61A	*D61B*	E11	*E12*	E12A	E12B	E12C	E12D	E12E	E12F	E43	E62	F31A	F31B	F52A	F52B	F53A	F53B	G11	G16	G17B	G17C	G17D	G17E	G19	G31A	G31C	G34	G35	G39	H26	*H32*	*XX*
D52	**0,15**	0,04	*0,00*	0,12	*0,39*	0,27	0,09	0,06	0,36	0,04	0,25	0,44	0,01	0,00	0,02	0,00	0,02	0,02	0,15	0,31	0,07	0,29	0,35	0,11	0,04	0,03	0,02	0,00	0,17	0,16	0,16	0,01	*0,00*	*0,41*
D61A	0,00	**0,57**	*0,00*	0,07	*0,26*	0,18	0,04	0,05	0,15	0,01	0,08	0,48	0,32	0,00	0,02	0,00	0,00	0,00	0,01	0,05	0,00	0,00	0,02	0,01	0,00	0,00	0,00	0,00	0,00	0,02	0,02	0,00	*0,00*	*0,33*
D61B	0,01	0,42	*0,00*	0,06	*0,19*	0,09	0,01	0,01	0,10	0,01	0,07	0,26	0,27	0,00	0,01	0,00	0,02	0,00	0,09	0,20	0,02	0,07	0,07	0,16	0,02	0,02	0,00	0,00	0,01	0,10	0,09	0,00	*0,00*	*0,23*
E11	0,01	0,01	*0,00*	**0,79**	*0,45*	0,37	0,25	0,12	0,34	0,06	0,21	0,51	0,07	0,00	0,07	0,00	0,00	0,00	0,05	0,15	0,00	0,07	0,13	0,08	0,00	0,00	0,00	0,00	0,01	0,10	0,14	0,05	*0,00*	*0,35*
E12A	0,01	0,01	*0,00*	0,16	*0,51*	**0,52**	0,03	0,04	0,36	0,18	0,38	0,47	0,01	0,00	0,05	0,00	0,04	0,00	0,13	0,12	0,04	0,12	0,23	0,07	0,02	0,04	0,08	0,00	0,04	0,19	0,28	0,07	*0,00*	*0,34*
E12B	0,01	0,02	*0,00*	0,31	*0,36*	0,18	**0,62**	0,15	0,25	0,01	0,17	0,49	0,02	0,01	0,00	0,00	0,00	0,00	0,02	0,10	0,02	0,05	0,09	0,04	0,00	0,00	0,00	0,00	0,01	0,01	0,07	0,00	*0,00*	*0,26*
E12C	0,00	0,02	*0,00*	0,05	*0,30*	0,14	0,13	**0,66**	0,20	0,00	0,14	0,45	0,00	0,03	0,01	0,00	0,00	0,00	0,01	0,05	0,04	0,07	0,10	0,06	0,00	0,00	0,00	0,00	0,04	0,03	0,04	0,00	*0,00*	*0,24*
E12D	0,01	0,01	*0,00*	0,23	*0,52*	0,44	0,06	0,09	**0,52**	0,06	0,43	0,52	0,01	0,00	0,02	0,00	0,01	0,00	0,09	0,14	0,02	0,15	0,26	0,11	0,02	0,02	0,02	0,00	0,04	0,15	0,19	0,01	*0,00*	*0,35*
E12E	0,01	0,01	*0,00*	0,10	*0,55*	0,58	0,00	0,01	0,28	**0,57**	0,46	0,44	0,00	0,00	0,03	0,00	0,10	0,01	0,15	0,12	0,07	0,12	0,20	0,02	0,05	0,07	0,15	0,00	0,02	0,21	0,33	0,08	*0,00*	*0,38*
E12F	0,01	0,01	*0,00*	0,16	*0,48*	0,41	0,06	0,06	0,39	0,12	**0,54**	0,46	0,01	0,01	0,04	0,00	0,05	0,01	0,12	0,14	0,04	0,14	0,23	0,06	0,02	0,03	0,07	0,00	0,02	0,15	0,25	0,08	*0,00*	*0,34*
E43	0,01	0,01	*0,00*	0,35	*0,51*	0,40	0,20	0,15	0,50	0,01	0,49	**0,59**	0,00	0,00	0,01	0,00	0,00	0,00	0,02	0,07	0,01	0,12	0,21	0,04	0,00	0,00	0,00	0,00	0,01	0,06	0,14	0,00	*0,00*	*0,35*
E62	0,00	0,24	*0,00*	0,05	*0,21*	0,13	0,02	0,01	0,11	0,00	0,05	0,46	**0,55**	0,00	0,00	0,00	0,00	0,00	0,00	0,03	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,00	*0,00*	*0,25*
F31A	0,00	0,00	*0,00*	0,00	*0,27*	0,10	0,13	0,09	0,17	0,00	0,19	0,24	0,00	**0,73**	0,01	0,00	0,00	0,00	0,01	0,01	0,48	0,02	0,06	0,07	0,00	0,00	0,00	0,11	0,16	0,05	0,03	0,00	*0,00*	*0,15*
F31B	0,04	0,01	*0,00*	0,36	*0,53*	0,54	0,01	0,07	0,32	0,22	0,22	0,46	0,00	0,00	**0,66**	0,01	0,06	0,04	0,48	0,48	0,01	0,12	0,39	0,06	0,01	0,05	0,02	0,00	0,01	0,40	0,44	0,20	*0,00*	*0,59*
F52A	0,15	0,03	*0,00*	0,63	*0,46*	0,27	0,01	0,03	0,40	0,16	0,01	0,50	0,02	0,00	0,36	**0,58**	0,57	0,35	0,25	0,71	0,02	0,07	0,26	0,01	0,01	0,21	0,02	0,00	0,01	0,36	0,34	0,25	*0,00*	*0,63*
F52B	0,04	0,07	*0,00*	0,35	*0,52*	0,46	0,01	0,01	0,50	0,27	0,38	0,44	0,01	0,00	0,23	0,03	**0,55**	0,15	0,45	0,69	0,02	0,43	0,49	0,07	0,09	0,13	0,08	0,00	0,02	0,43	0,44	0,10	*0,00*	*0,61*
F53A	0,08	0,05	*0,00*	0,19	*0,31*	0,22	0,00	0,01	0,21	0,10	0,14	0,37	0,01	0,00	0,14	0,35	0,58	**0,57**	0,43	0,68	0,02	0,20	0,34	0,04	0,01	0,21	0,07	0,00	0,03	0,32	0,33	0,20	*0,00*	*0,60*
F53B	0,02	0,00	*0,00*	0,11	*0,47*	0,43	0,03	0,03	0,37	0,09	0,40	0,37	0,00	0,00	0,16	0,00	0,04	0,01	**0,59**	0,33	0,05	0,28	0,41	0,21	0,01	0,16	0,11	0,00	0,16	0,30	0,38	0,08	*0,00*	*0,45*
G11	0,04	0,02	*0,00*	0,15	*0,37*	0,27	0,05	0,05	0,30	0,11	0,24	0,37	0,01	0,00	0,06	0,04	0,19	0,08	0,22	**0,60**	0,04	0,26	0,32	0,11	0,03	0,09	0,05	0,00	0,05	0,23	0,22	0,06	*0,00*	*0,38*
G16	0,00	0,00	*0,00*	0,00	*0,23*	0,09	0,04	0,03	0,21	0,02	0,21	0,17	0,00	0,08	0,01	0,00	0,02	0,00	0,03	0,07	**0,76**	0,20	0,25	0,12	0,00	0,01	0,00	0,00	0,20	0,19	0,05	0,00	*0,00*	*0,25*
G17B	0,02	0,00	*0,00*	0,10	*0,43*	0,35	0,02	0,04	0,39	0,16	0,36	0,35	0,00	0,00	0,04	0,00	0,10	0,01	0,26	0,40	0,11	**0,53**	0,50	0,17	0,14	0,10	0,11	0,00	0,12	0,31	0,34	0,05	*0,00*	*0,46*
G17C	0,02	0,00	*0,00*	0,14	*0,46*	0,40	0,04	0,06	0,43	0,09	0,36	0,38	0,00	0,00	0,03	0,00	0,05	0,01	0,25	0,37	0,09	0,40	**0,52**	0,21	0,03	0,06	0,04	0,00	0,20	0,30	0,33	0,02	*0,00*	*0,41*
G17D	0,01	0,00	*0,00*	0,18	*0,45*	0,32	0,09	0,08	0,45	0,02	0,32	0,36	0,00	0,01	0,02	0,00	0,00	0,01	0,26	0,37	0,11	0,35	0,41	**0,55**	0,00	0,10	0,01	0,00	0,15	0,17	0,21	0,00	*0,00*	*0,31*
G17E	0,01	0,00	*0,00*	0,04	*0,42*	0,39	0,00	0,01	0,40	0,19	0,34	0,26	0,00	0,00	0,04	0,00	0,07	0,00	0,19	0,35	0,11	0,49	0,47	0,03	**0,57**	0,17	0,34	0,00	0,02	0,37	0,50	0,03	*0,00*	*0,48*
G19	0,01	0,00	*0,00*	0,02	*0,39*	0,31	0,01	0,00	0,28	0,06	0,31	0,24	0,00	0,00	0,03	0,00	0,03	0,01	0,32	0,19	0,20	0,21	0,31	0,29	0,03	**0,56**	0,09	0,00	0,18	0,21	0,40	0,01	*0,00*	*0,26*
G31A	0,01	0,00	*0,00*	0,02	*0,42*	0,46	0,00	0,00	0,30	0,37	0,41	0,28	0,00	0,00	0,01	0,00	0,27	0,02	0,31	0,40	0,09	0,31	0,43	0,03	0,13	0,25	**0,51**	0,00	0,06	0,50	0,59	0,12	*0,00*	*0,47*
G31C	0,00	0,00	*0,00*	0,00	*0,11*	0,02	0,01	0,04	0,05	0,00	0,04	0,12	0,00	0,13	0,01	0,00	0,00	0,00	0,00	0,00	0,74	0,00	0,03	0,01	0,00	0,01	0,00	**0,62**	0,43	0,14	0,02	0,00	*0,00*	*0,18*
G34	0,02	0,00	*0,00*	0,01	*0,30*	0,25	0,02	0,01	0,22	0,01	0,21	0,23	0,00	0,01	0,00	0,00	0,00	0,01	0,15	0,16	0,34	0,16	0,39	0,11	0,00	0,03	0,01	0,00	**0,52**	0,22	0,31	0,00	*0,00*	*0,21*
G35	0,02	0,00	*0,00*	0,10	*0,40*	0,41	0,01	0,01	0,32	0,26	0,29	0,36	0,00	0,00	0,06	0,01	0,20	0,05	0,26	0,41	0,05	0,32	0,45	0,08	0,08	0,17	0,26	0,00	0,08	**0,53**	0,47	0,09	*0,00*	*0,51*
G39	0,03	0,00	*0,00*	0,21	*0,52*	0,53	0,02	0,01	0,41	0,20	0,49	0,43	0,00	0,00	0,19	0,02	0,13	0,04	0,35	0,32	0,04	0,29	0,42	0,06	0,03	0,12	0,14	0,00	0,06	0,38	**0,52**	0,20	*0,00*	*0,49*
H26	0,10	0,01	*0,00*	0,32	*0,54*	0,58	0,01	0,00	0,33	0,19	0,55	0,45	0,01	0,00	0,08	0,02	0,23	0,08	0,63	0,50	0,01	0,30	0,41	0,01	0,01	0,11	0,04	0,00	0,02	0,40	0,55	**0,63**	*0,00*	*0,57*
H32	0,04	0,00	*0,00*	0,37	*0,55*	0,58	0,00	0,00	0,43	0,25	0,42	0,45	0,00	0,00	0,37	0,00	0,10	0,03	0,43	0,33	0,00	0,27	0,36	0,01	0,03	0,06	0,05	0,00	0,00	0,35	0,49	0,36	*0,00*	*0,56*
XX	0,02	0,02	*0,00*	0,14	*0,44*	0,41	0,03	0,05	0,31	0,23	0,29	0,43	0,01	0,00	0,10	0,02	0,13	0,05	0,25	0,32	0,03	0,22	0,33	0,06	0,10	0,04	0,34	0,33	0,11	*0,00*	*0,53*			
Error X	0,02	0,03	0,00	0,16	0,40	0,33	0,04	0,04	0,31	0,11	0,28	0,38	0,01	0,01	0,09	0,02	0,09	0,03	0,20	0,27	0,09	0,19	0,00	0,07	0,22	0,27	0,07	0,00	0,39					

0.57

0.13

SONUÇLAR



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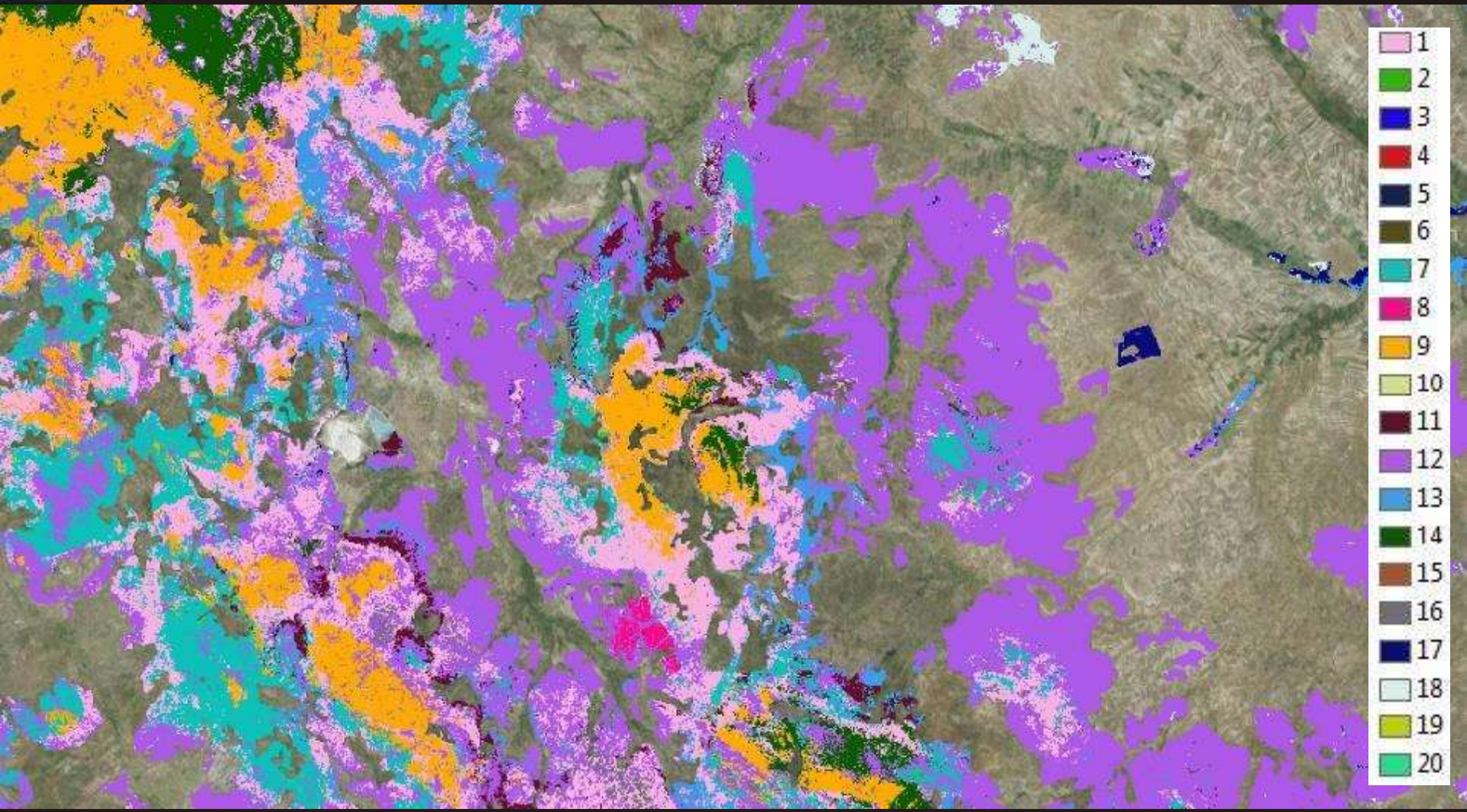

http://marxan.org/

MARXAN
conservation solutions

Marxan
Informing Conservation Decisions Globally

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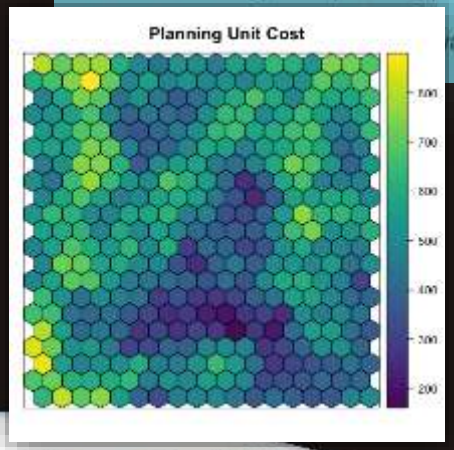
Marxan is a suite of tools designed to help decision makers find good solutions to conservation planning problems. This includes free software that can be used to solve several types of planning problems and extensive documentation and examples describing a framework for approaching conservation planning. Marxan is ...vation planning software and has been applied to hundreds of spatial conservation planning problems around the world.



CORE REFERENCES

In return for the free provision of Marxan, Marxan with Zones and Zonae Cogito, if you write about any of these three products, use them, or give a talk about them, please any or all of the three references below, along with any other relevant papers below. Access is provided wherever possible to online or .pdf versions of all these references.

For Marxan

Ball IR, HP Possingham and M Watts (2009) Marxan and relatives: Software for spatial conservation prioritisation. Chapter 14: Pages 185-195 in Spatial conservation prioritisation: Quantitative methods and computational tools. Eds Moilanen A, KA Wilson and HP Possingham. Oxford University Press, Oxford, UK.

For Marxan with Zones

Watts ME, IR Ball, RR Stewart, CJ Klein, K Wilson, C Steinback, R Lourival, L Kircher, and HP Possingham (2009) Marxan with Zones: software for optimal conservation based land- and sea-use zoning. Environmental Modelling & Software (2009), doi:10.1016/j.envsoft.2009.06.005. Electronic Preprint.pdf (367KB) - Final Published Version - Request Reprint

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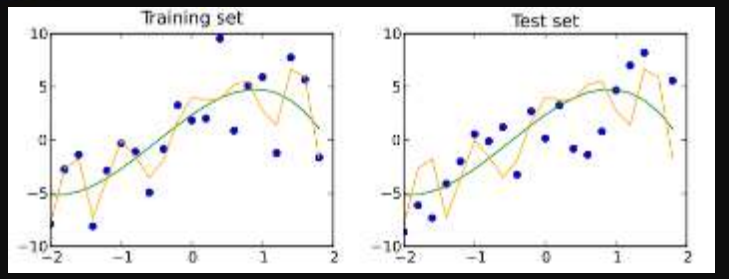
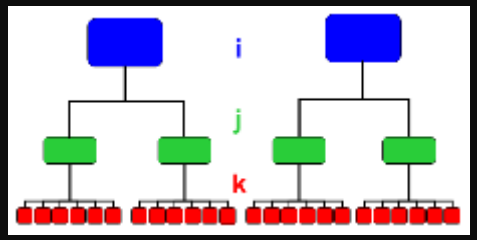


NATURA 2000

FURTHER WORK

opernicus
Europe's eyes on Earth

1. A reference list (classification) of habitat types of Spain
2. Sampling all habitats and all territory: MFE25, IFN4, field...
3. RS-based indicators of conservation status: Ministery, **H2020**
4. A database of new (improved) predictor layers
5. Hierarchical multi-modelling approach (SDM*; RF, BRT**)
6. Mapping all territory and all habitat types. SCP - Marxan
7. Collecting spectral signatures of complex vegetation type
8. Adaptive management strategies



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1. A REFERENCE LIST

EUNIS classification vegetation system → Annex I HD

European Environment Agency

Google Buscar

Search the catalogue NEW! A-Z Glossary

Topics Data and maps Indicators Publications Media About EEA The EEA is an agency of the European Union

EUNIS Home Species Habitat types Sites Global queries References About EUNIS

Welcome to EUNIS, the European Nature Information System

Find species, habitat types and protected sites across Europe

Species

Information about species in Europe, particularly species

Habitat types

Information about the EUNIS habitat classification and the

EUNIS Home Species Habitat types Sites Global queries References About EUNIS

Habitat Annex I Directive hierarchical view > FORESTS > Forests of Temperate Europe > Atlantic acidophilous beech forests with Ilex and sometimes also Taxus in the shrublayer (Quercion robori-petraeae or Ilici-Fagenion)

Atlantic acidophilous beech forests with Ilex and sometimes also Taxus in the shrublayer (Quercion robori-petraeae or Ilici-Fagenion)

Description (English)

Beech forests with *Ilex*, growing on acid soils, of the plain to montane levels under humid Atlantic climate. The acid substrate corresponds to alterations of acid rocks or to silt with silex more or less degraded or, to old alluvial deposits. The soils are of acid brown type, leaching or with an evolution towards podsol type. The humus is of moder to dysmoder type. These beech forests present different varieties:
a) sub-Atlantic beech-oak forests of the plains and hill levels with *Ilex aquifolium*
b) hyper-Atlantic beech-oak forests of the plains and hill levels with *Ilex* and *Taxus*, rich in epiphytes
c) pure beech forests or acidophilous beech-fir forests of the montane level, with *Ilex aquifolium* in the field layer.

Source: Interpretation Manual of European Union Habitats, version EUR 28 (2013)

Quick facts

EU Habitats Directive	**Annex I habitat type** (code **9120**)
EU conservation status *by biogeographical region*	Alpine - *Unfavourable-Inadequate* Atlantic - *Unfavourable-Inadequate* Continental - *Favourable* Mediterranean - *Unfavourable-Bad*
Habitat type	**Not priority**
Natura 2000 sites	**542** are designated for this habitat type

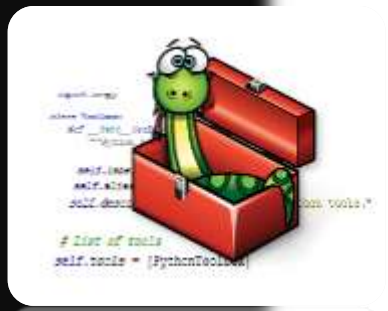
1. SAMPLING ALL TERRITORY

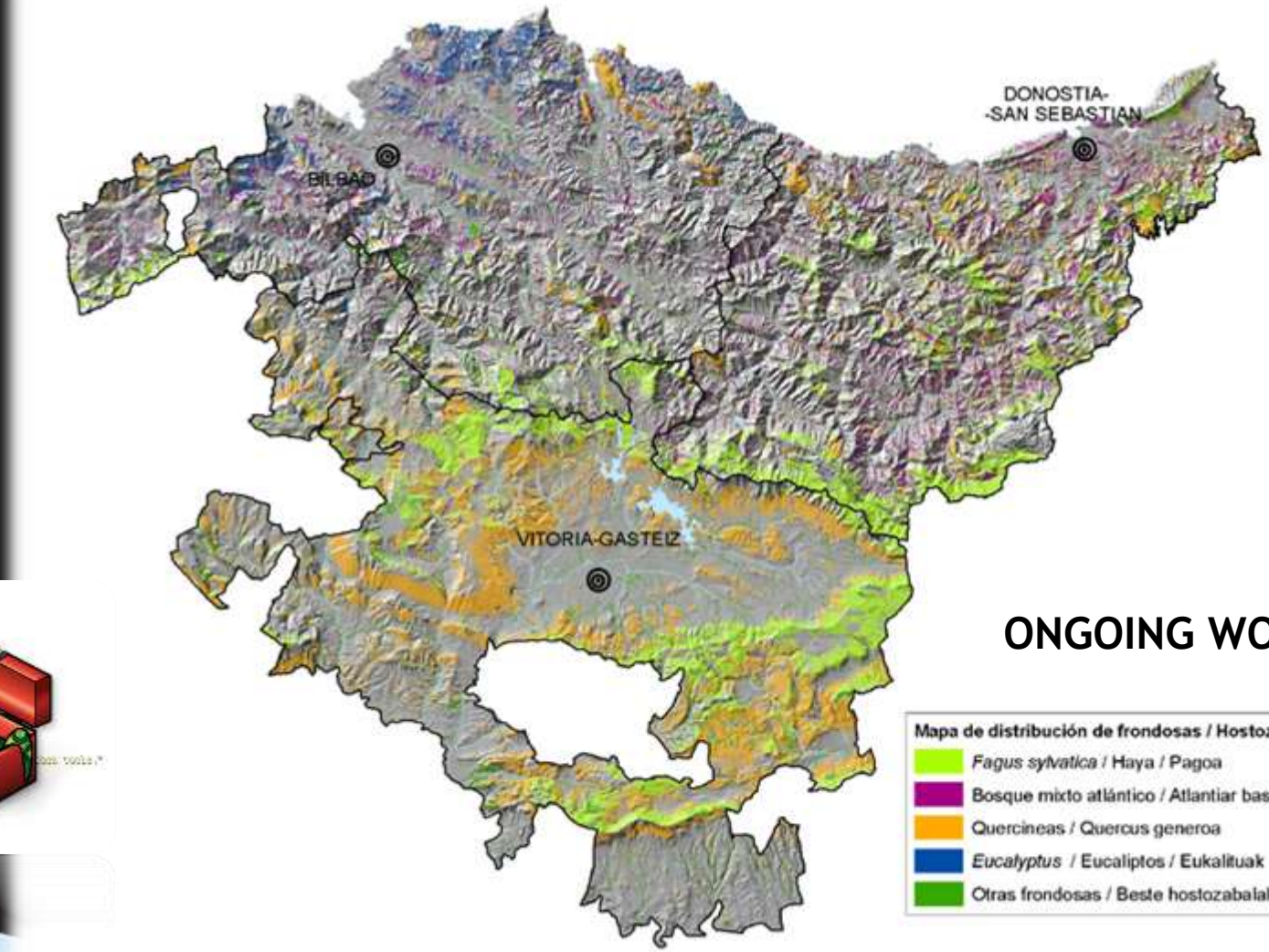
"Tablet System". H2020 Working Group of Turkey

Data for training models and conservation status indicators

PAÍS VASCO - EUNIS MAP

Habitat mapping for capacity bulding





ONGOING WORK...

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MAPPING LANDSCAPE CONTINUUM

A vegetation map with ALL habitat types (EUNIS)

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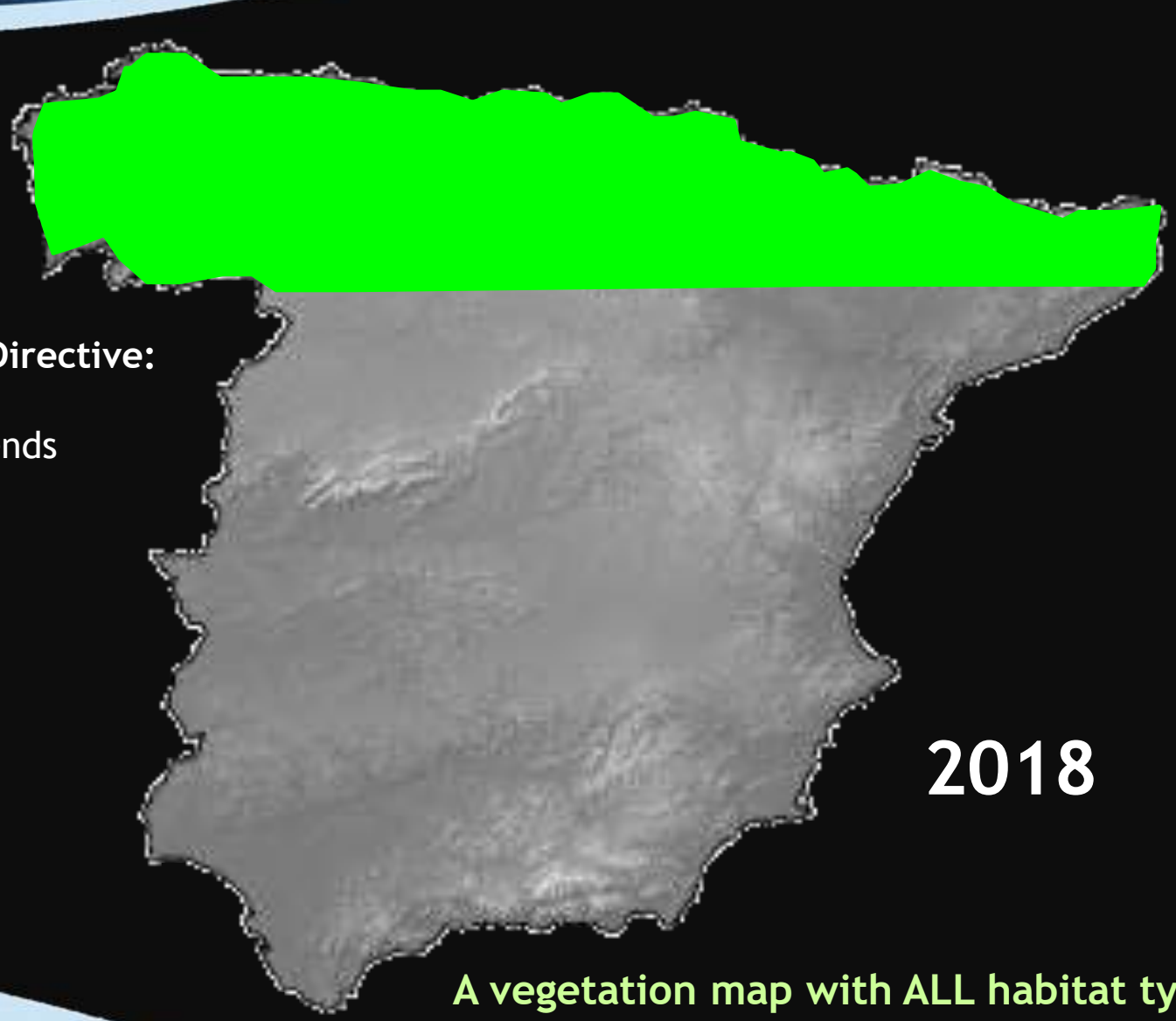
MAPPING LANDSCAPE CONTINUUM



Habitats Directive:
Rarity
Future trends
Etc.

A vegetation map with ALL habitat types (EUNIS)
for the whole biogeographical region

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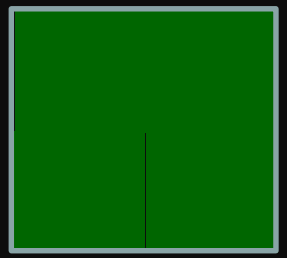
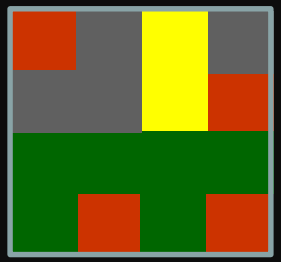
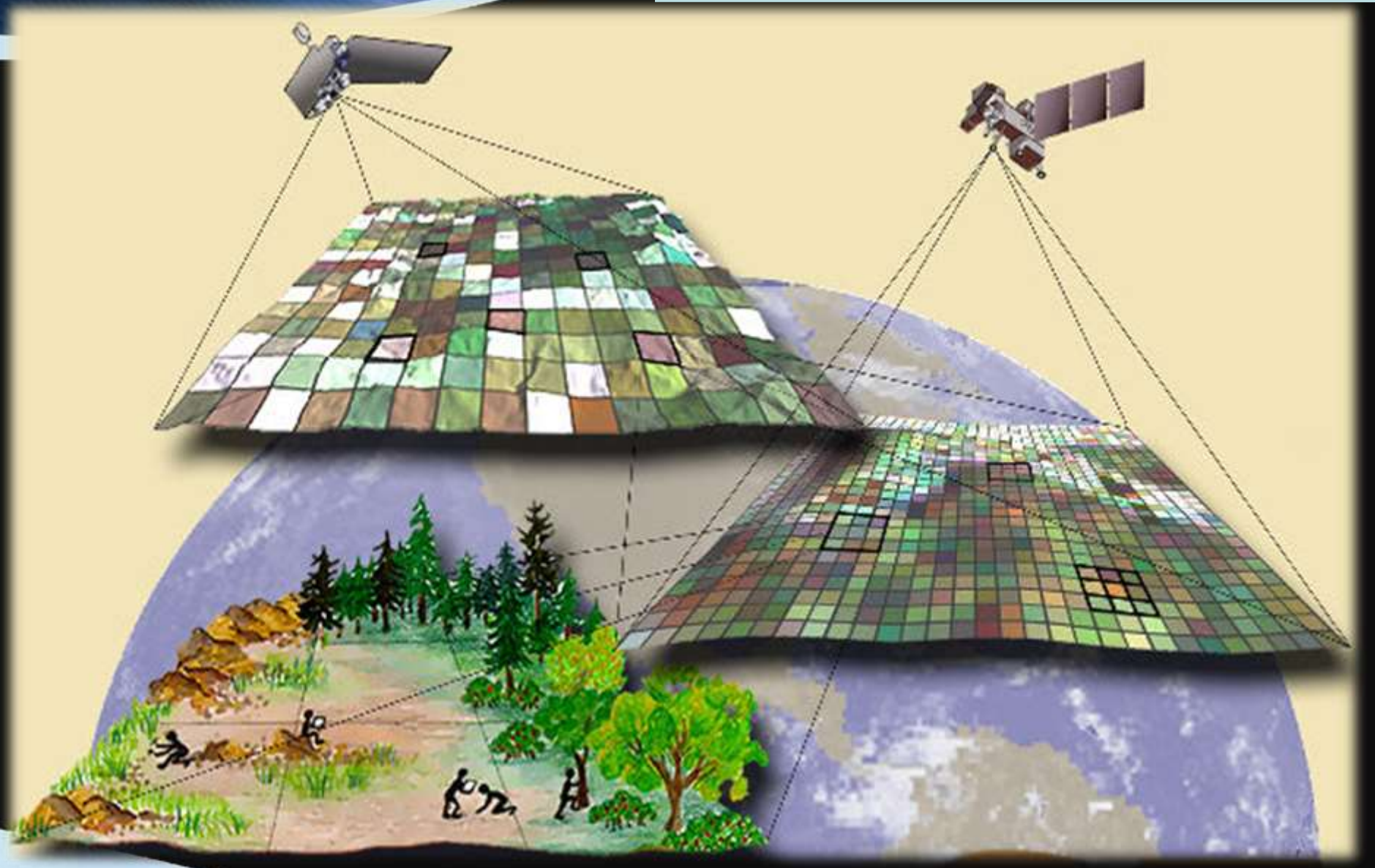
MULTISPECTRAL IMAGE



Landsat 8 OLI (30 m)



MULTISPECTRAL IMAGE



MULTISPECTRAL IMAGERY

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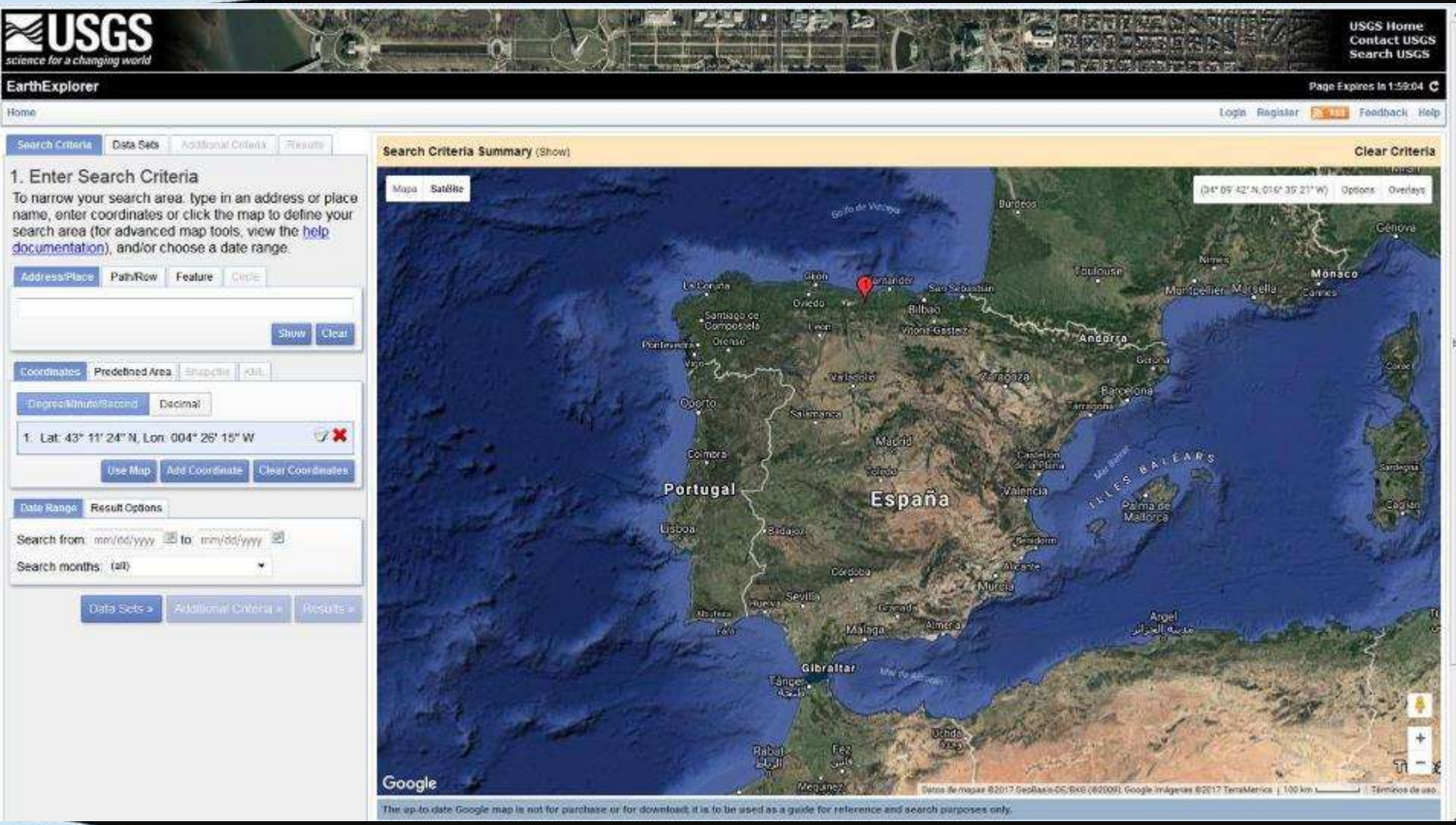
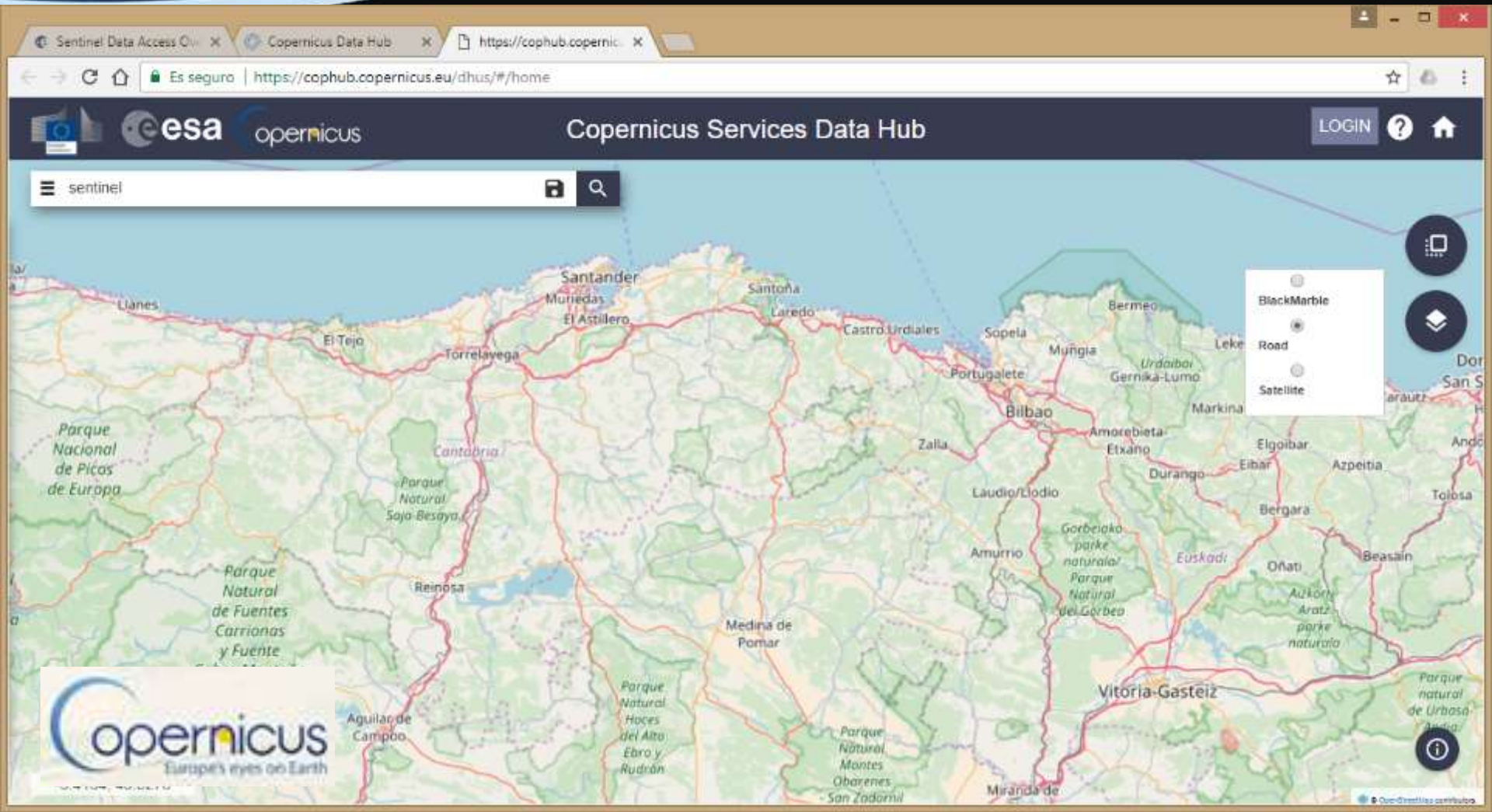
SATELLITE IMAGERY



Landsat-8 L1T At-Surface Reflectance Images from USGS EarthExplorer database: https://earthexplorer.usgs.gov/

SATELLITE IMAGERY



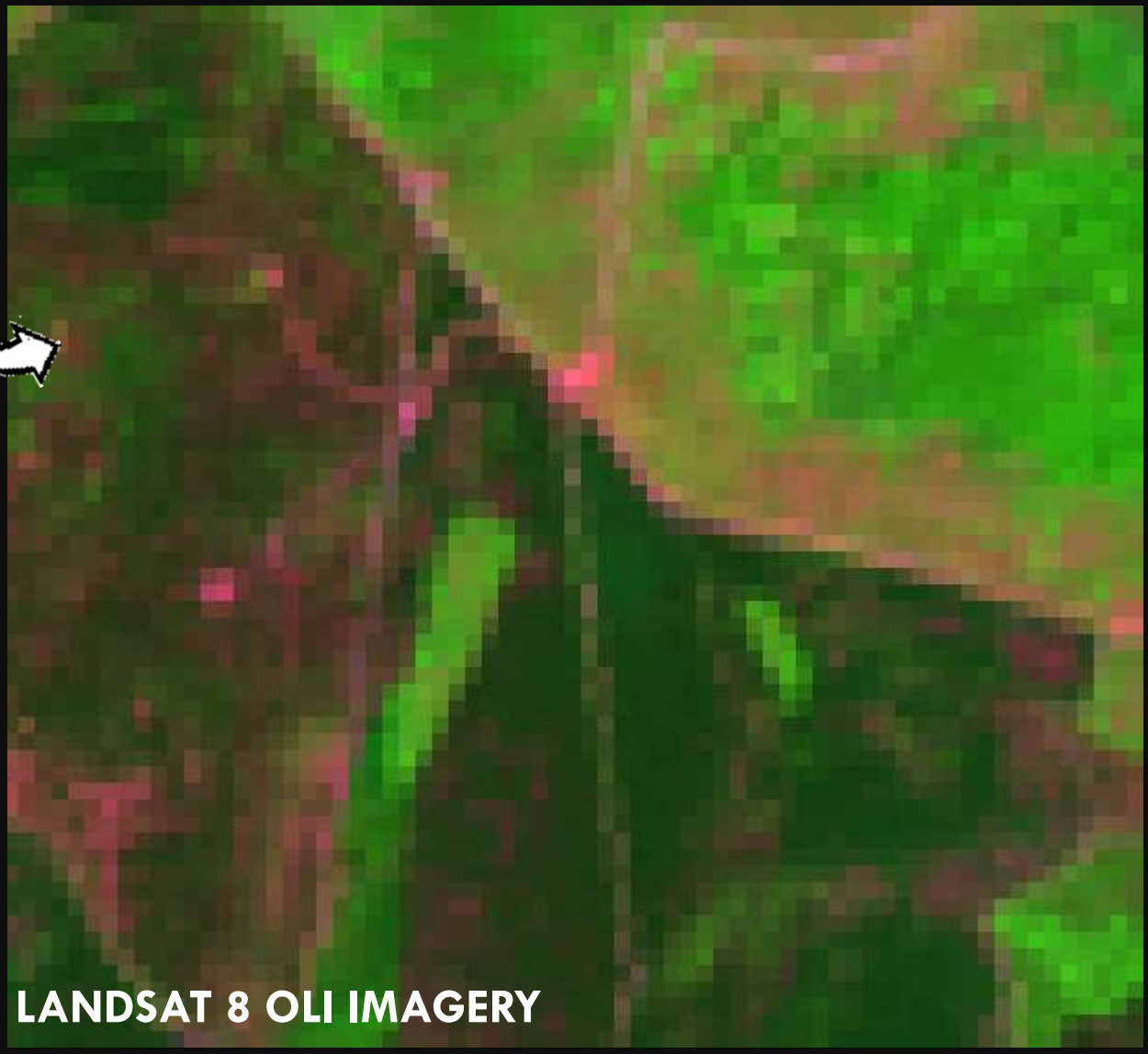
The Copernicus Services Data Hub provides a dedicated access to Sentinels user products.
https://cophub.copernicus.eu/dhus/#/home

NEW PREDICTOR LAYERS

Higher sun elevation and minimum cloud cover from USGS and ESA

Zoom

175_033
false_color_752
Reflect BOA
Roads detail



LANDSAT 8 OLI IMAGERY

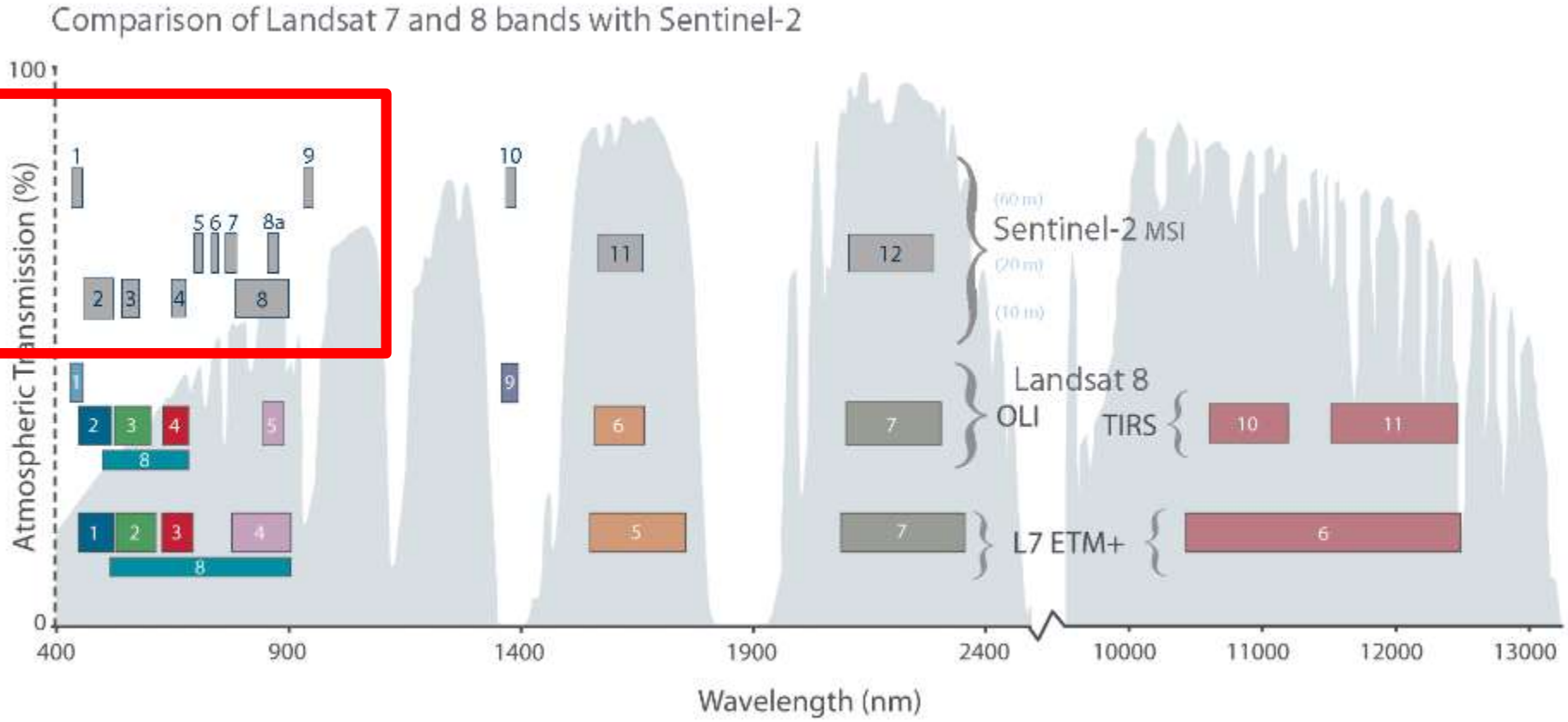
SATELLITE IMAGERY

Higher sun elevation and minimum cloud cover from ESA

Zoom

Sentinel_2A_1282
ReflecBOA_topo
Roads detail

SATELLITE IMAGERY



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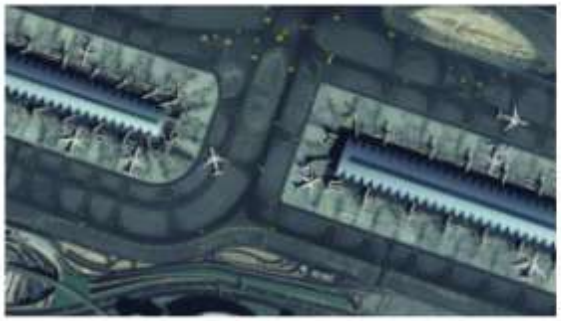
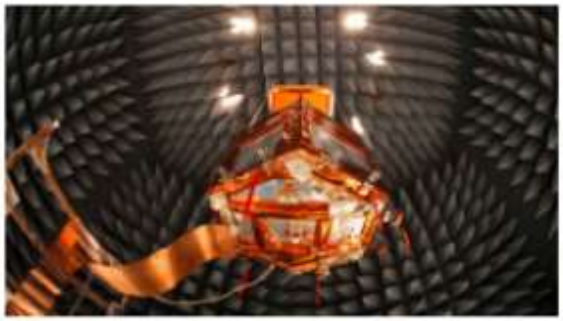
SATELLITE IMAGERY

VHR spatial resolution and RGB and NIR spectral data



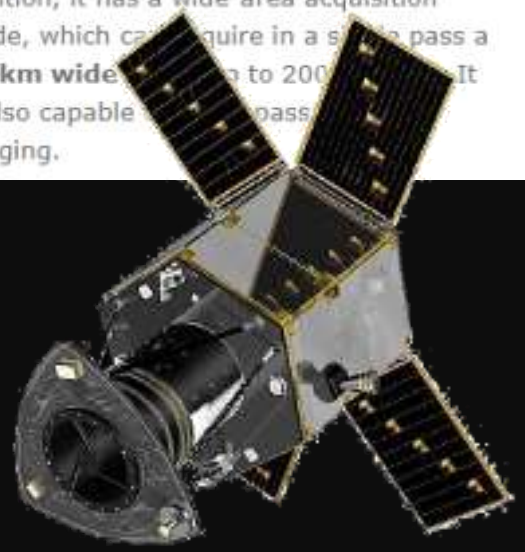
The **DEIMOS-2** provides 75-cm pan-sharpened imagery and 3-m multi-spectral images. Its multi-spectral capability includes 4 channels **(red, green, blue, NIR), plus the panchromatic band**. It is **the highest-resolution fully private satellite in Europe**, and one of the very few privately-owned submetric satellites in the world.



The **DEIMOS-2** satellite has been developed by **Elecnor Deimos** in collaboration with Satrec-I (Korea). The 300-kg satellite has been integrated in the 420 m2 clean room of Elecnor Deimos Satellite Systems premises in Puertollano (Spain). It has a lifetime of at least 7 years, and its mission has been designed to last more than 10.

The **DEIMOS-2** has a swath of **12 km**, and it is be able to acquire imagery in strip mode (up to 1500 km long), or in spot mode, shifting between various targets. In addition, it has a wide-area acquisition mode, which ca quire in a s pass a **24-km wide** to 200 It is also capable pass imaging.

deimosimaging
an urthecast company



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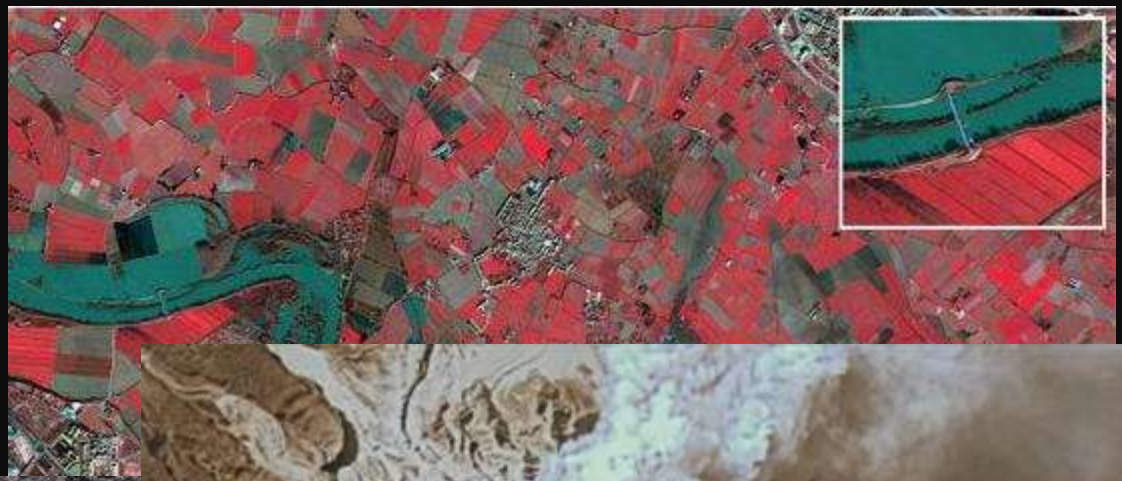
SATELLITE IMAGERY

VHR spatial resolution and RGB and NIR spectral data



deimos-2
very-high resolution, multispectral
75-cm pan-sharpened imagery

SATELLITE IMAGERY

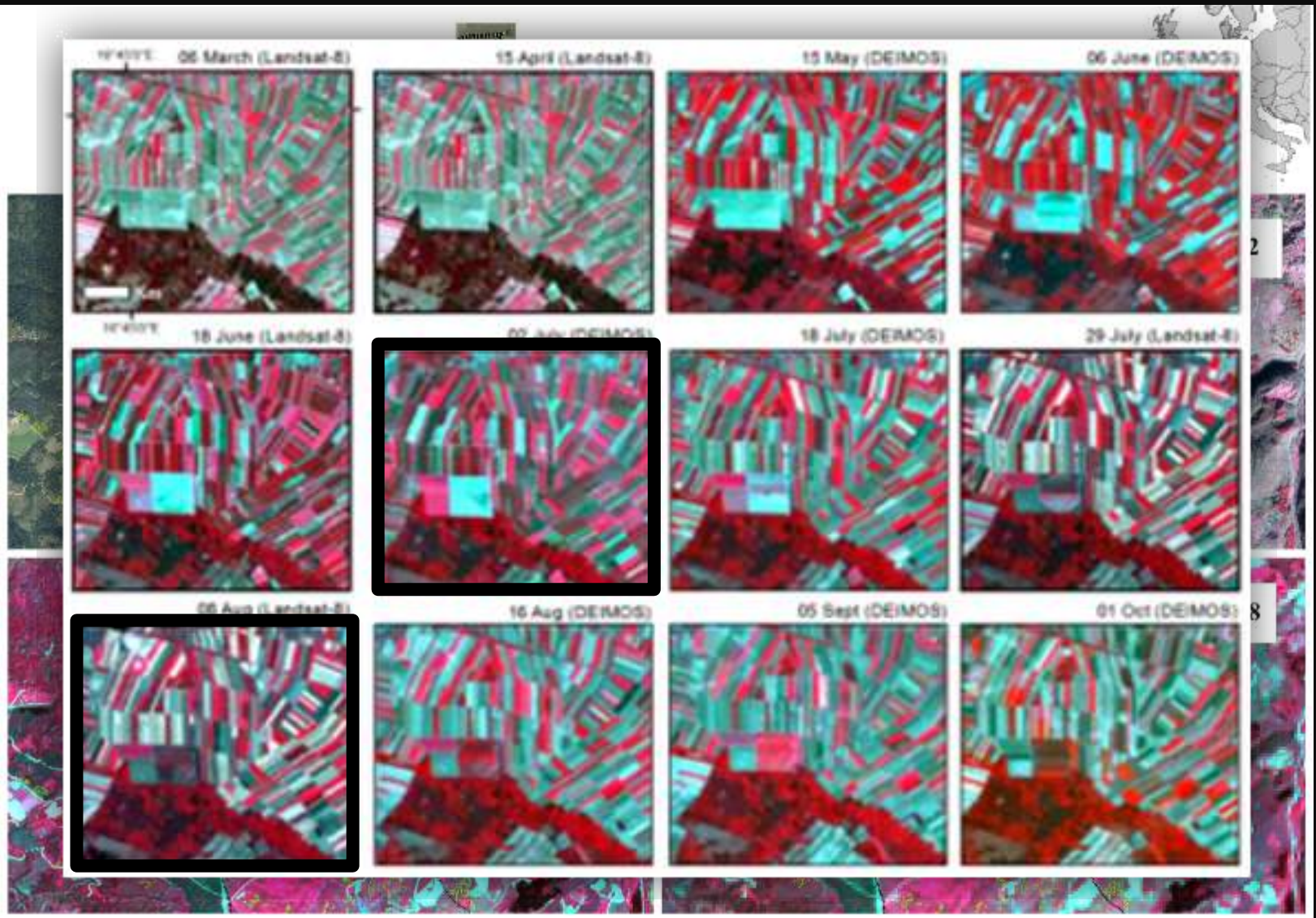
Local non-modelled habitat types: VHR imagery. DEIMOS-2 ***??

Landsat8
Sentinel2
Deimos2
Imagery

Temporal resolution (spring & summer)

All images together

Env. data



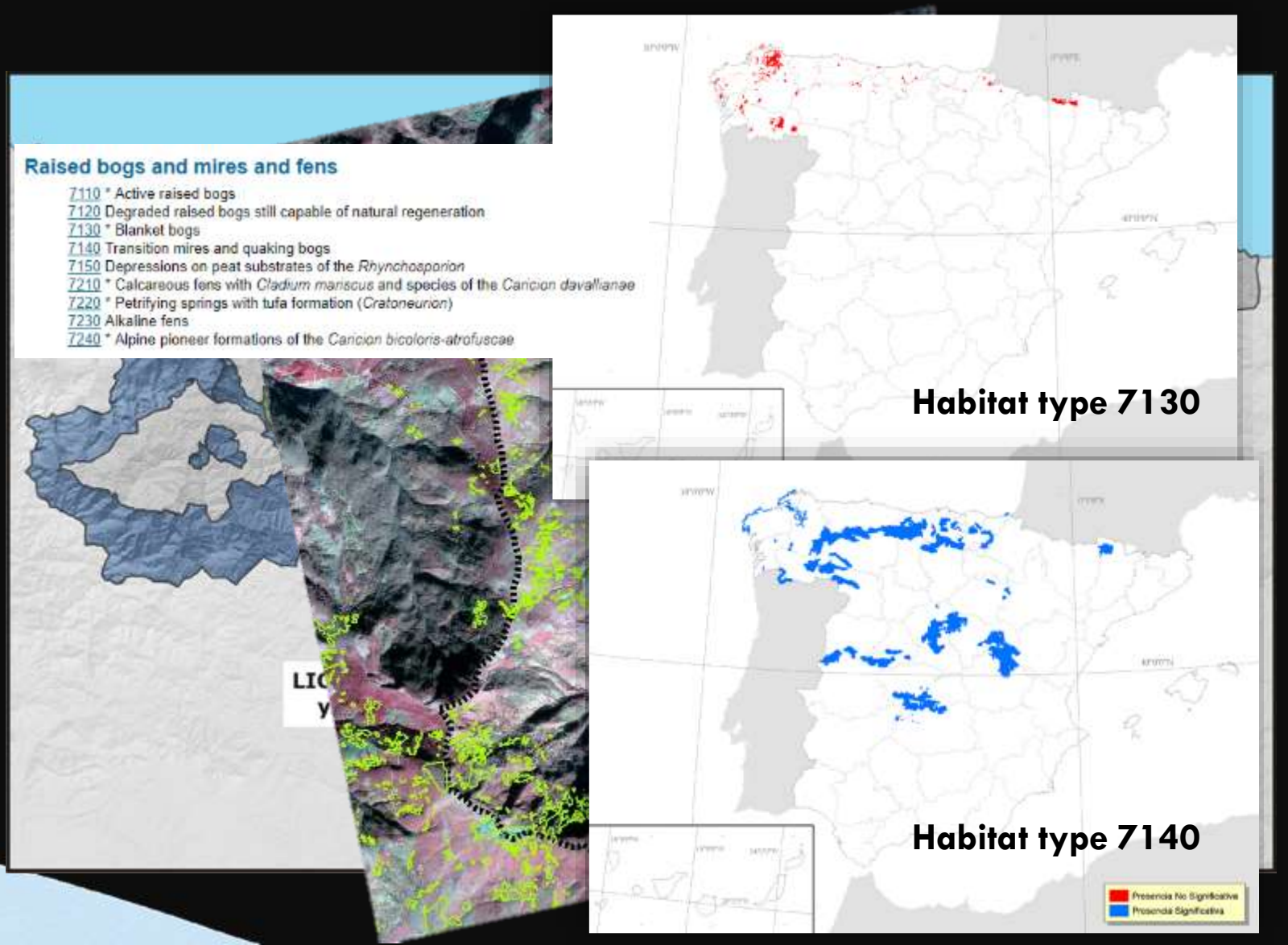
VEGETATION DATA

Study area: Sierra del Escudo (SAC Natura2000)

Vegetation maps derived from MFE25

Extensive survey for **peats and bogs** and lowland hay meadows (Autonomous Region)

Own **field campaing** in 2016, 2017

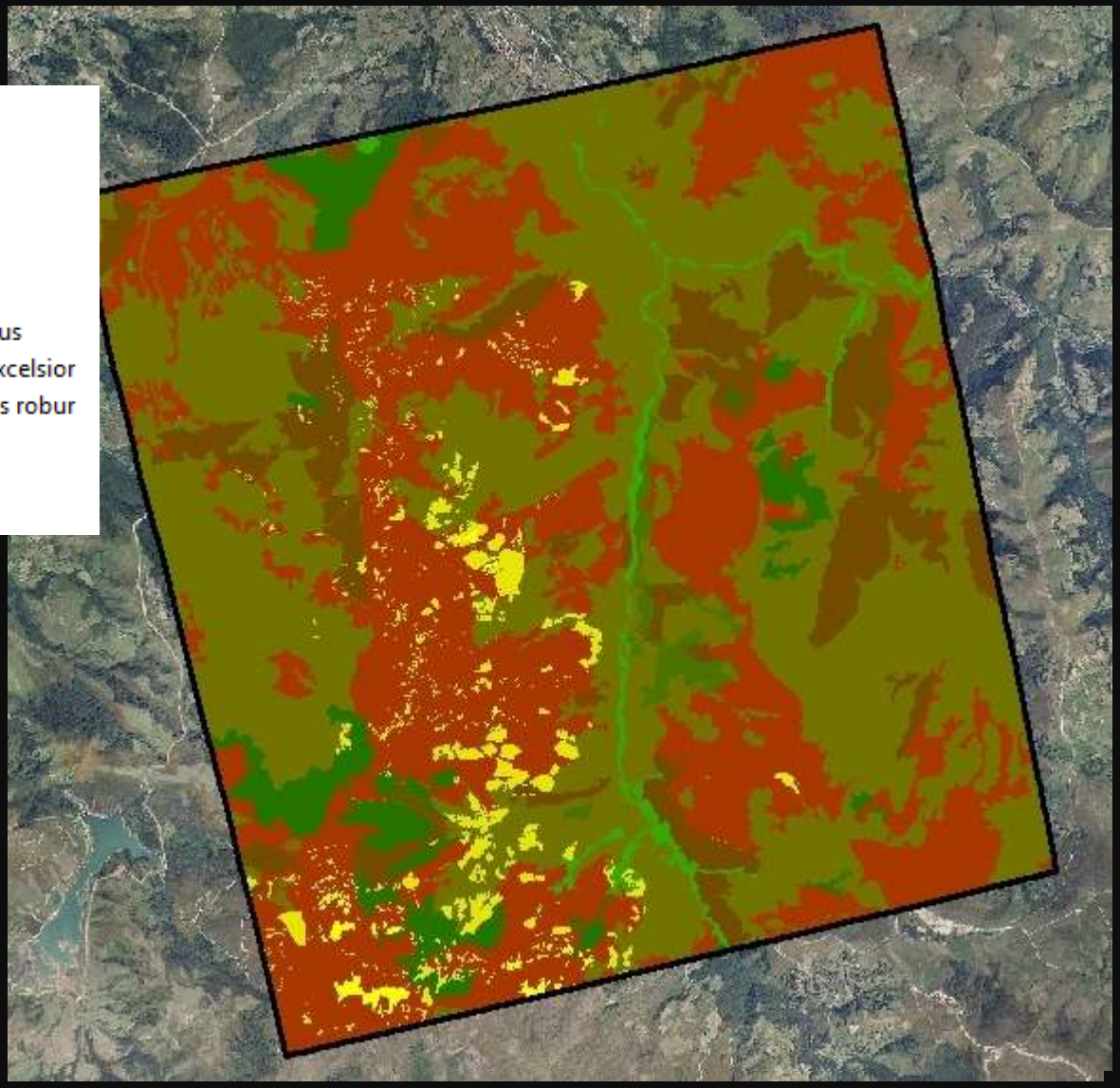


VEGETATION DATA

Study area: Sierra del Escudo (SAC Natura2000)

Vegetation (habitat) types:

- Oligotrophic waters
- European dry heaths
- Lowland hay meadows
- * Blanket bogs
- Transition mires and quaking bogs
- Undefined bog habitat type
- Atlantic acidophilous beech forests with Ilex and Taxus
- * Alluvial forests with Alnus glutinosa and Fraxinus excelsior
- Forests of Quercus pyrenaica y robledales de Quercus robur
- Forests of castanea sativa
- Other shrub habitat types (not Annex I)
- Other forest habita types (not Annex I)



Training data (n=250):
Bogs larger that 0.1ha of types 7130 and 7140

Centroid within polygon

VALIDATION

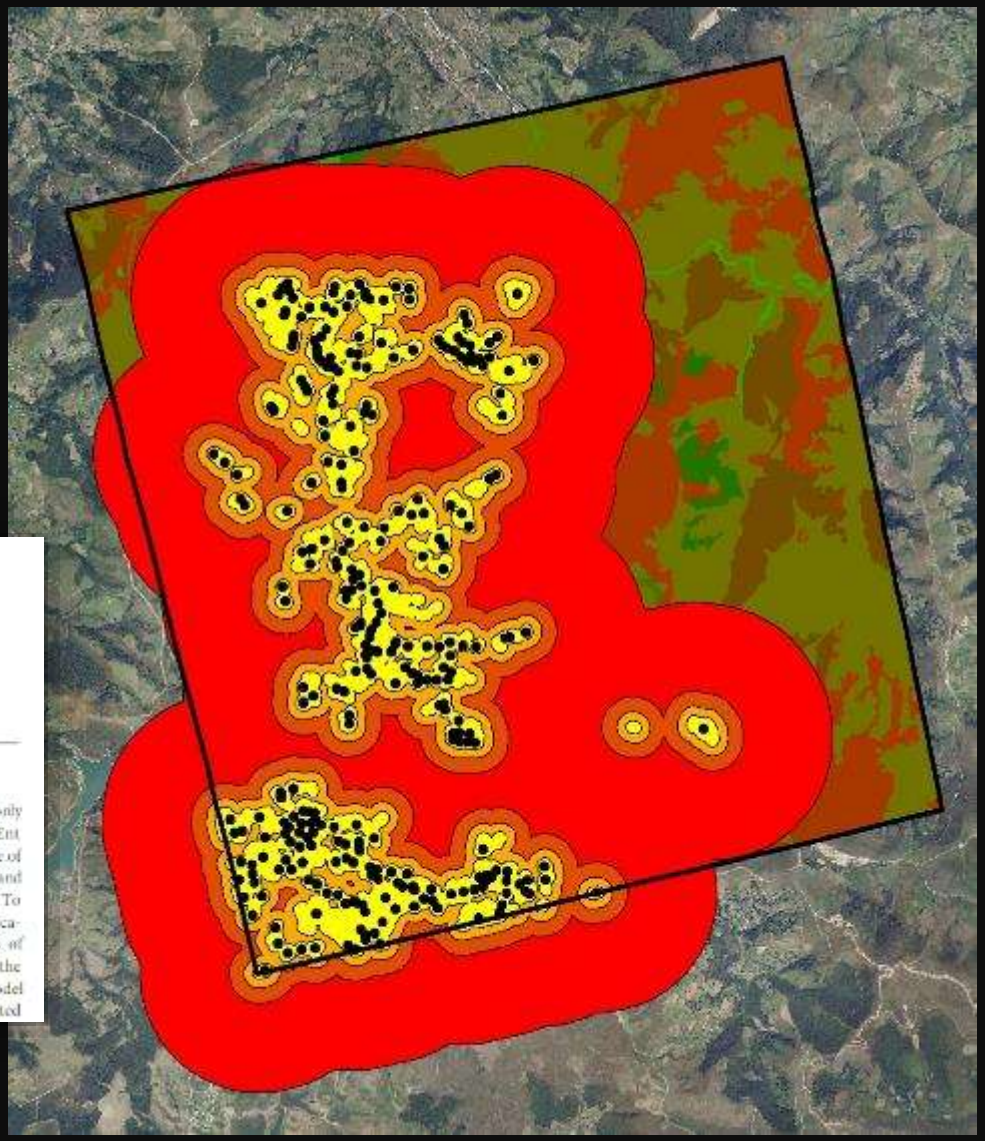
Study area: Sierra del Escudo (SAC Natura2000)

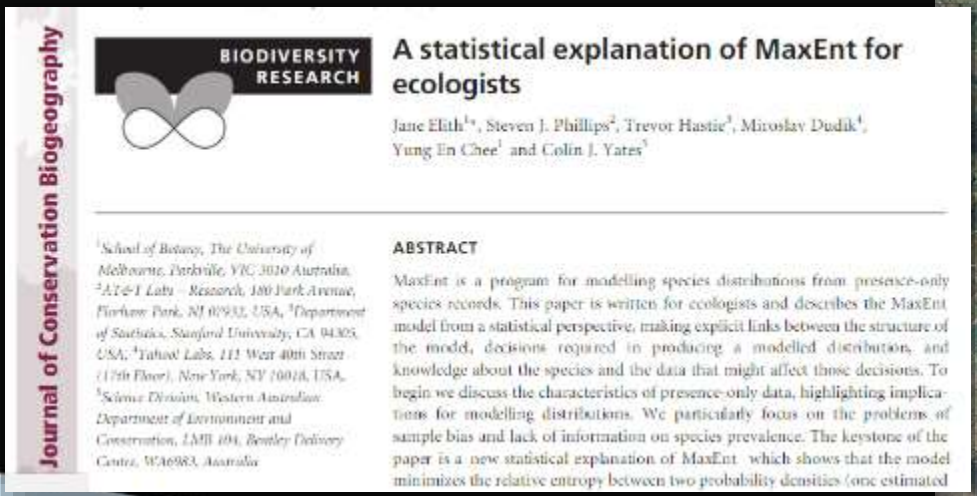
Validation: 3 levels,
- 250 meters
- 500 meters
- 2000 meters,

around selected bogs for training

Random points

spread out 50 meters, excluding training





Journal of Conservation Biogeography

BIODIVERSITY RESEARCH

A statistical explanation of MaxEnt for ecologists

Jane Elith[1]*, Steven J. Phillips[2], Trevor Hastie[3], Miroslav Dudík[4], Yung En Chee[1] and Colin J. Yates[5]

[1]School of Botany, The University of Melbourne, Parkville, VIC 3010 Australia, [2]AT&T Labs – Research, 180 Park Avenue, Florham Park, NJ 07932, USA, [3]Department of Statistics, Stanford University, CA 94305, USA, [4]Yahoo! Labs, 115 West 40th Street (17th Floor), New York, NY 10018, USA, [5]Science Division, Western Australian Department of Environment and Conservation, LMB 104, Bentley Delivery Centre, WA6983, Australia

ABSTRACT

MaxEnt is a program for modelling species distributions from presence-only species records. This paper is written for ecologists and describes the MaxEnt model from a statistical perspective, making explicit links between the structure of the model, decisions required in producing a modelled distribution, and knowledge about the species and the data that might affect those decisions. To begin we discuss the characteristics of presence-only data, highlighting implications for modelling distributions. We particularly focus on the problems of sample bias and lack of information on species prevalence. The keystone of the paper is a new statistical explanation of MaxEnt which shows that the model minimizes the relative entropy between two probability densities (one estimated

MULTI RESOLUTION MODELLING

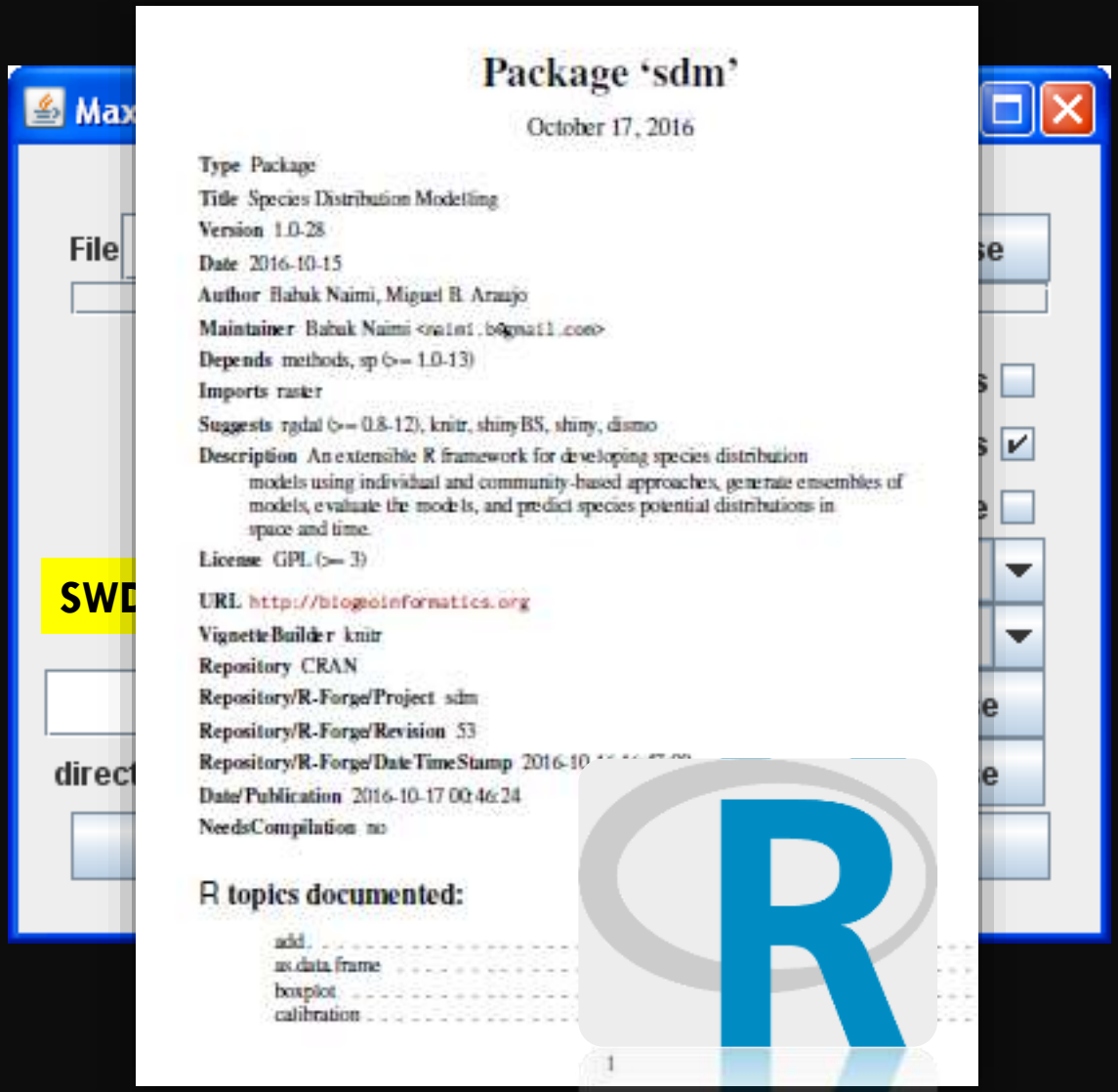
Modelling approaches: sensitivity analyses

MaxEnt:
SWD format
Tunning parameters

Phillips et al (2006)

SDM:
Multiple algorithms
Bootstraping for robust analyses

Naimi and Araújo (2016)



MODELLING RESULTS

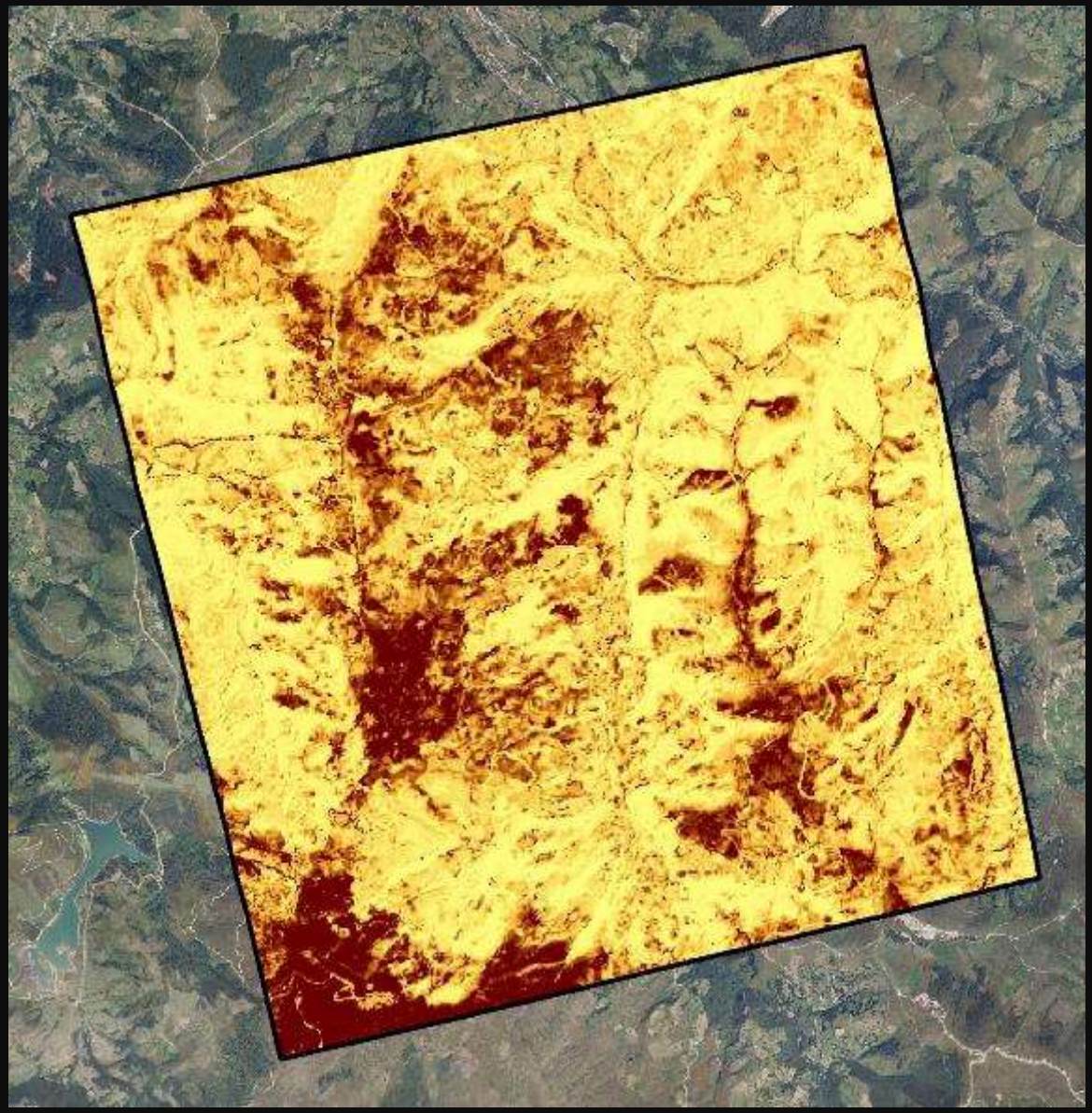
Landsat 8 MVC

Landsat8 x2

Sentinel2 x2

Deimos2 x2

+LiDAR +MDT



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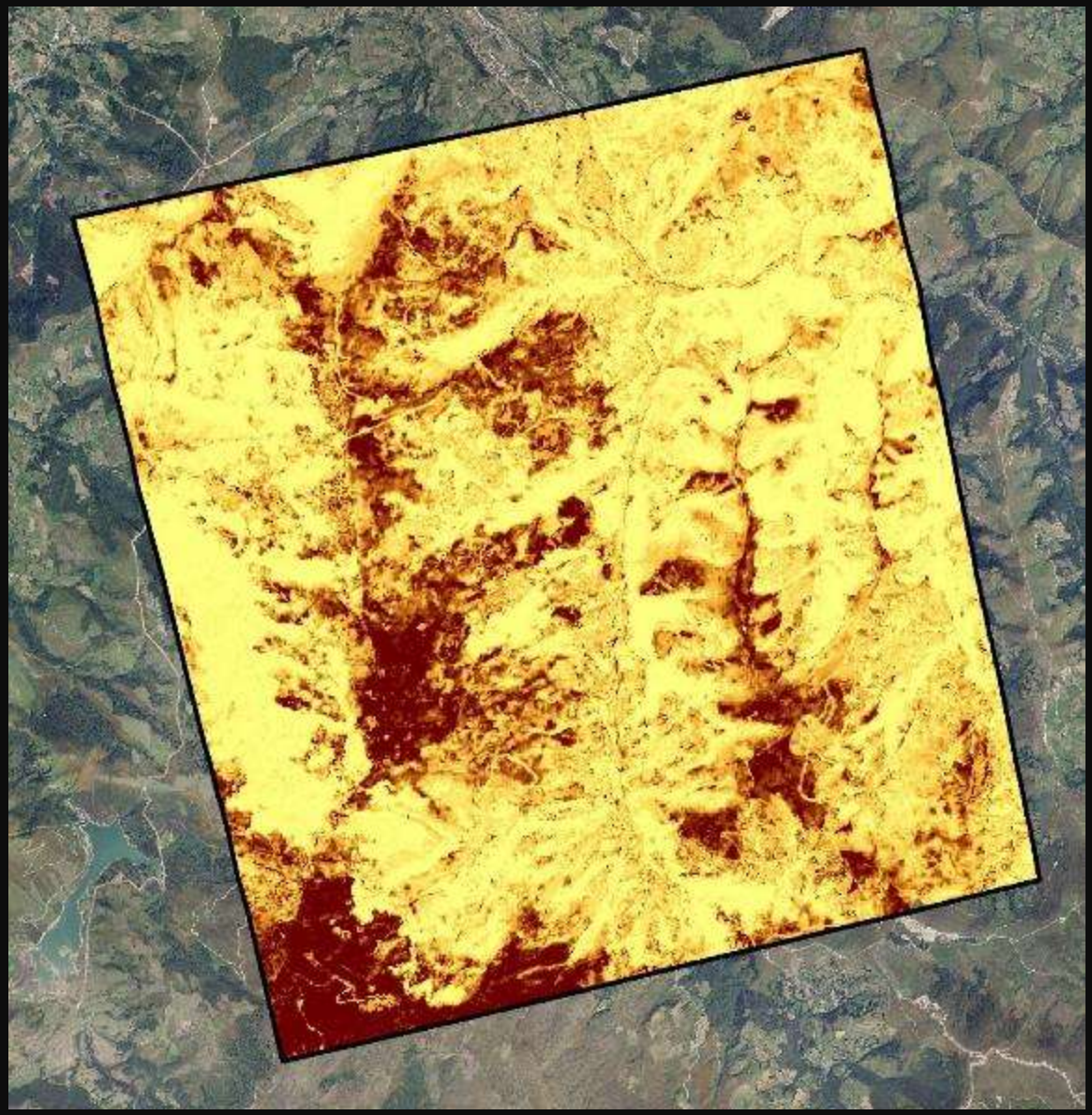

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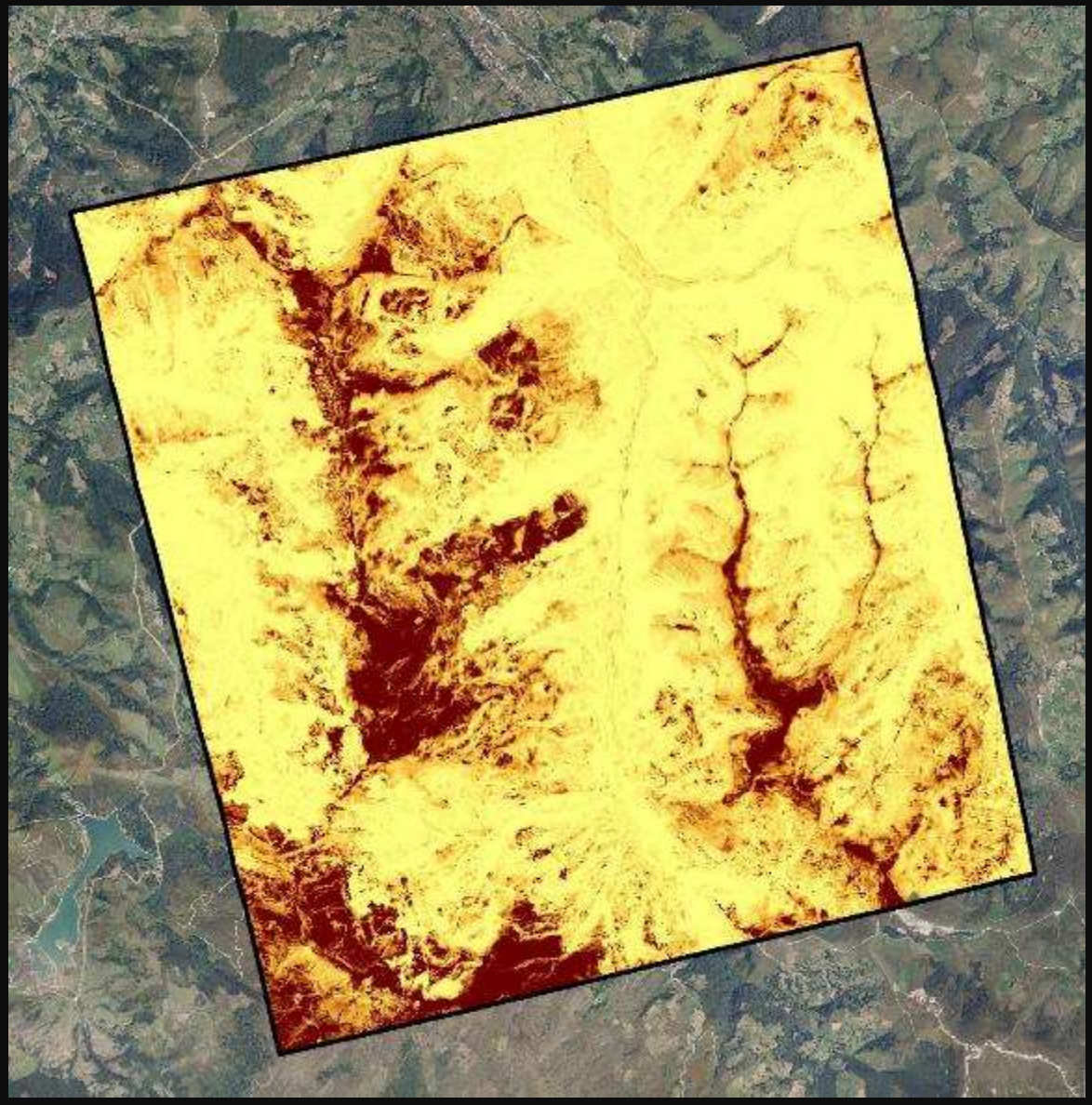

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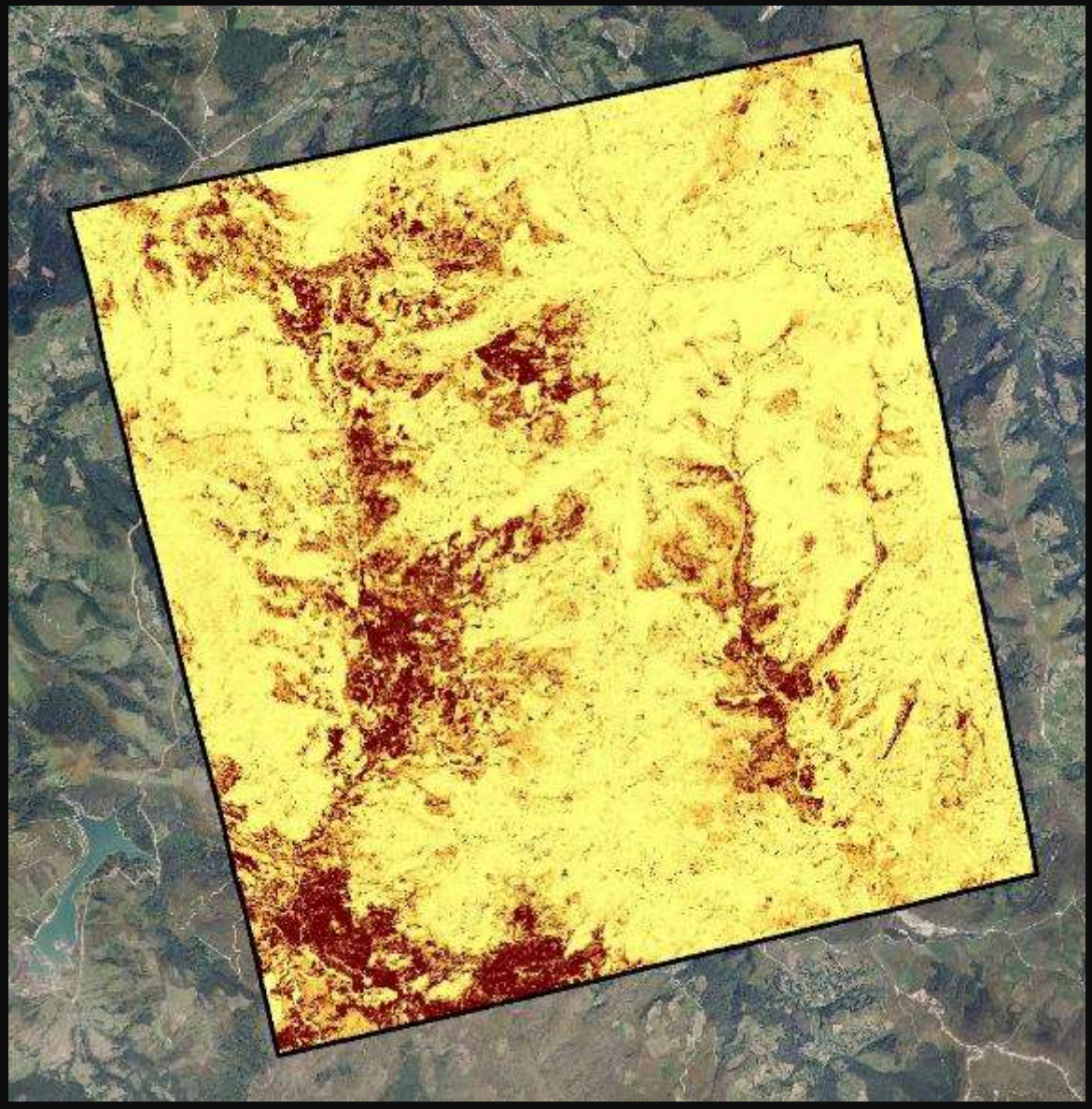

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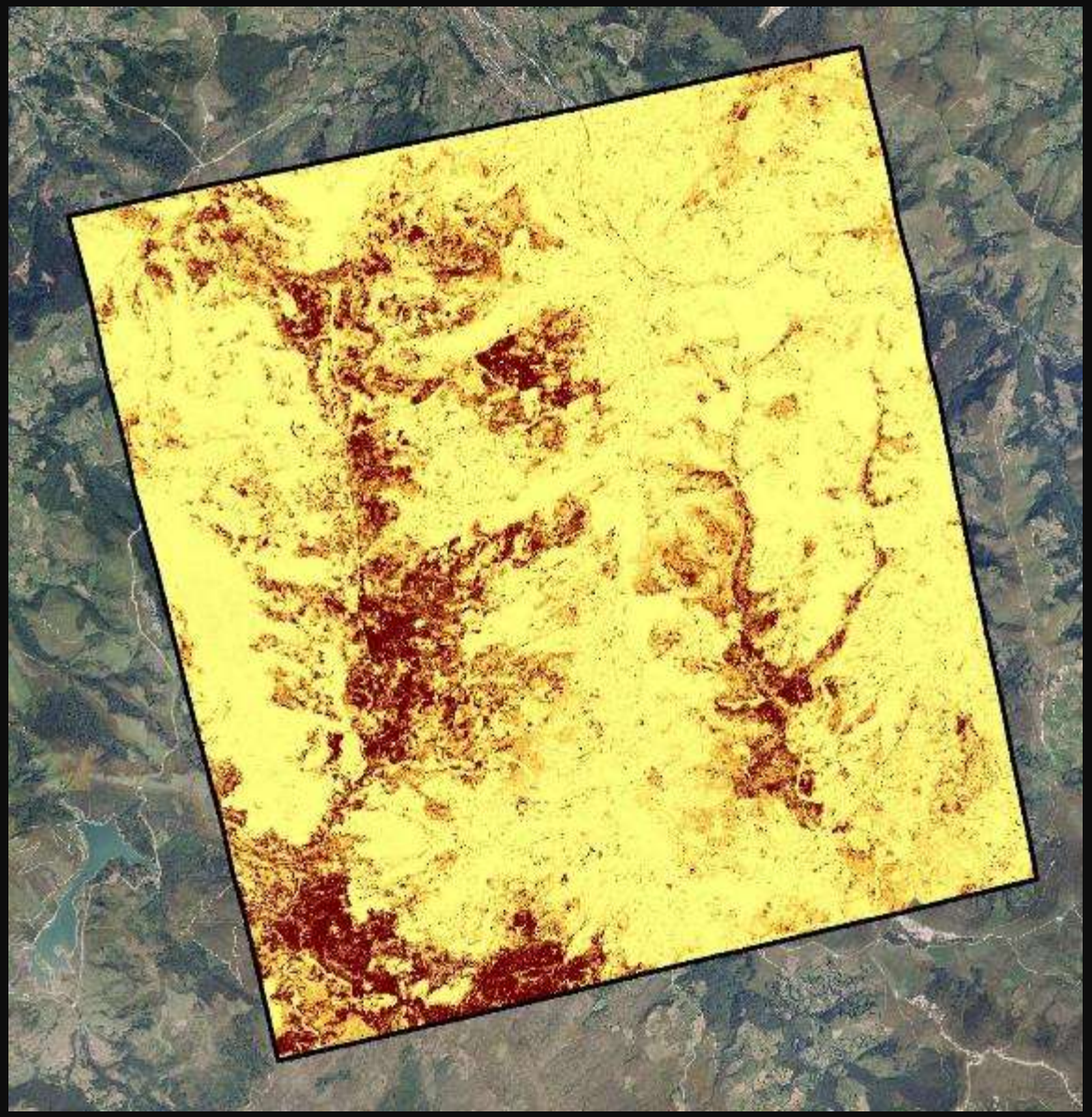

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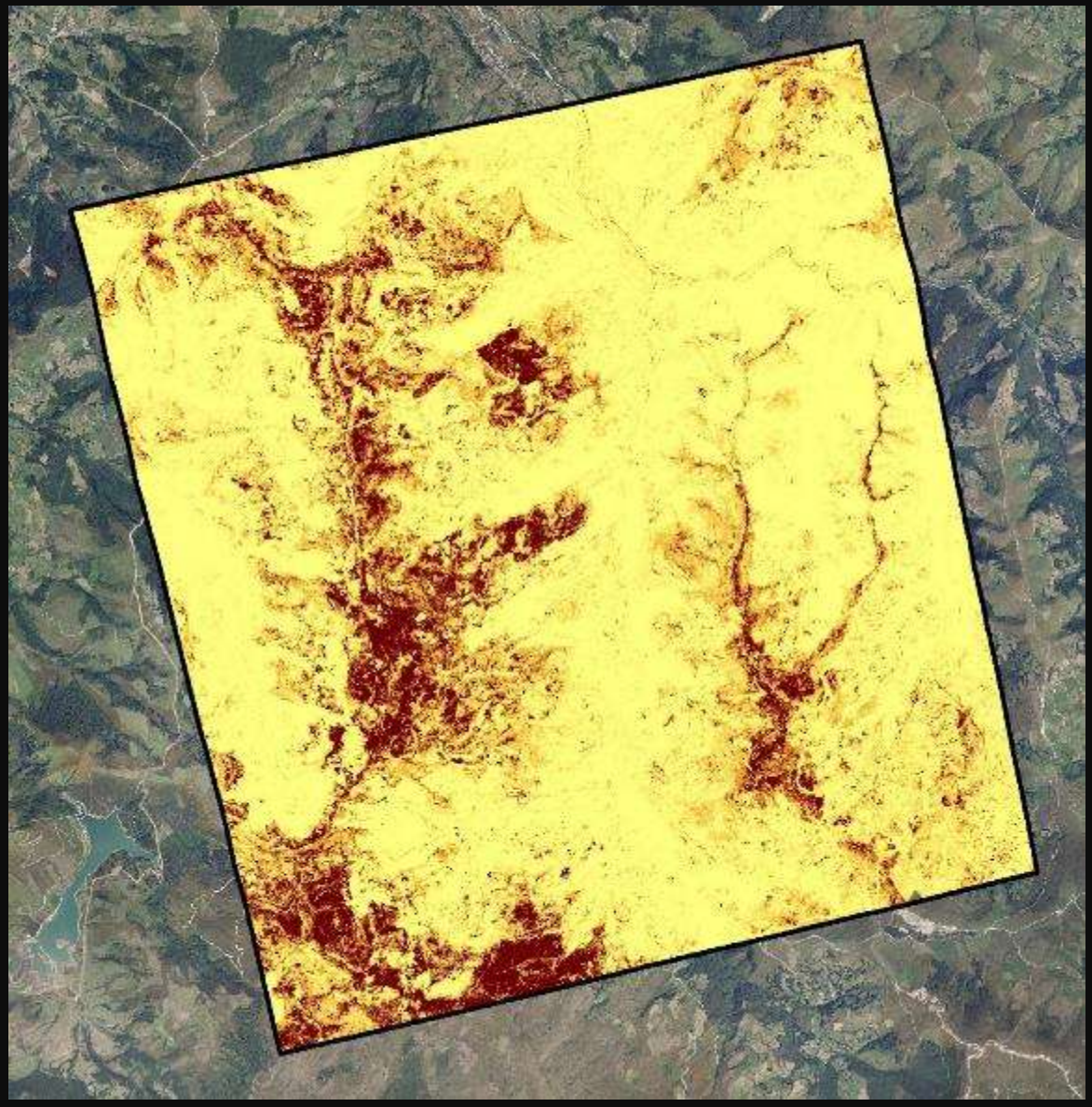

High suitability

Low suitability

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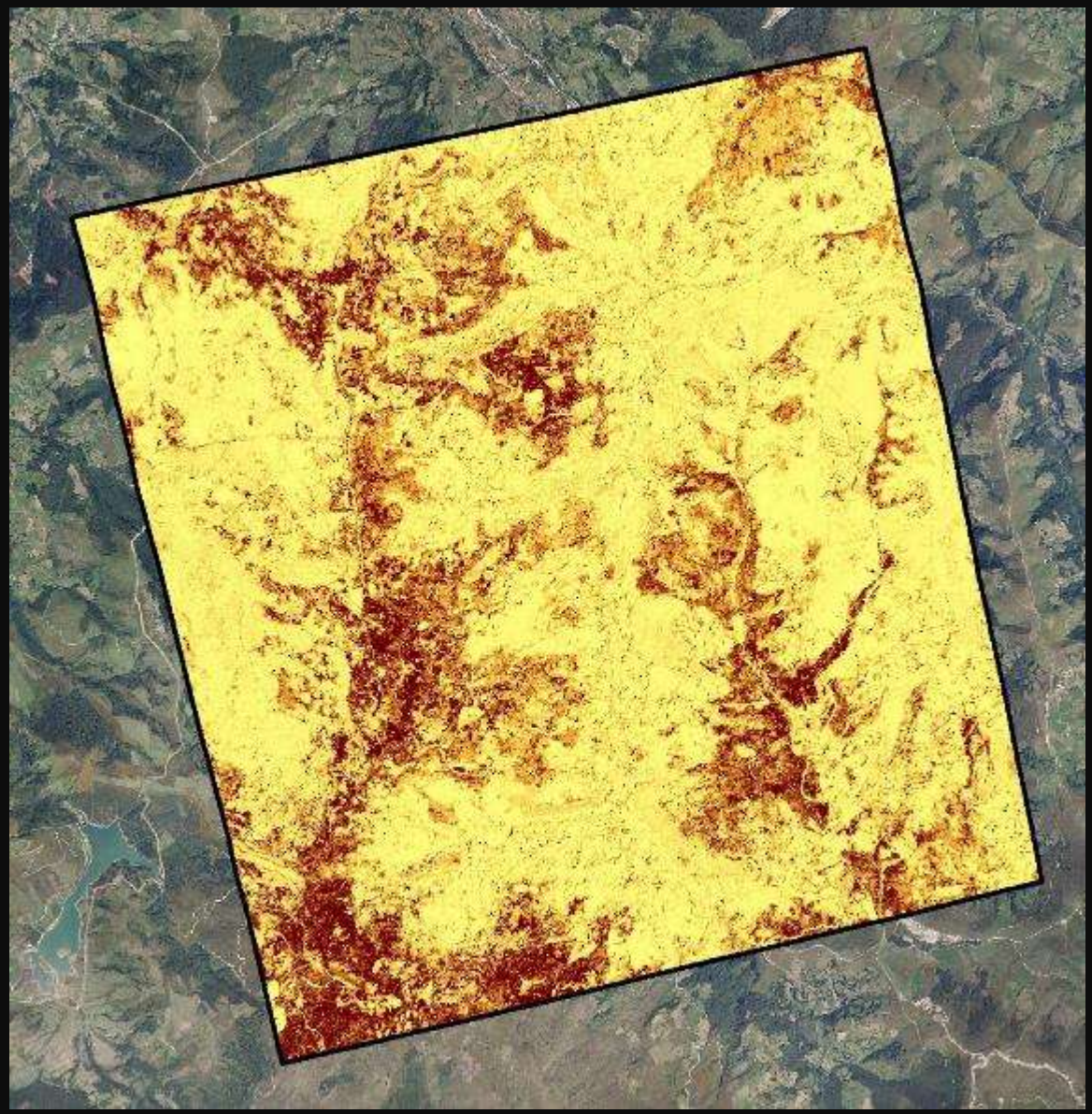

High suitability

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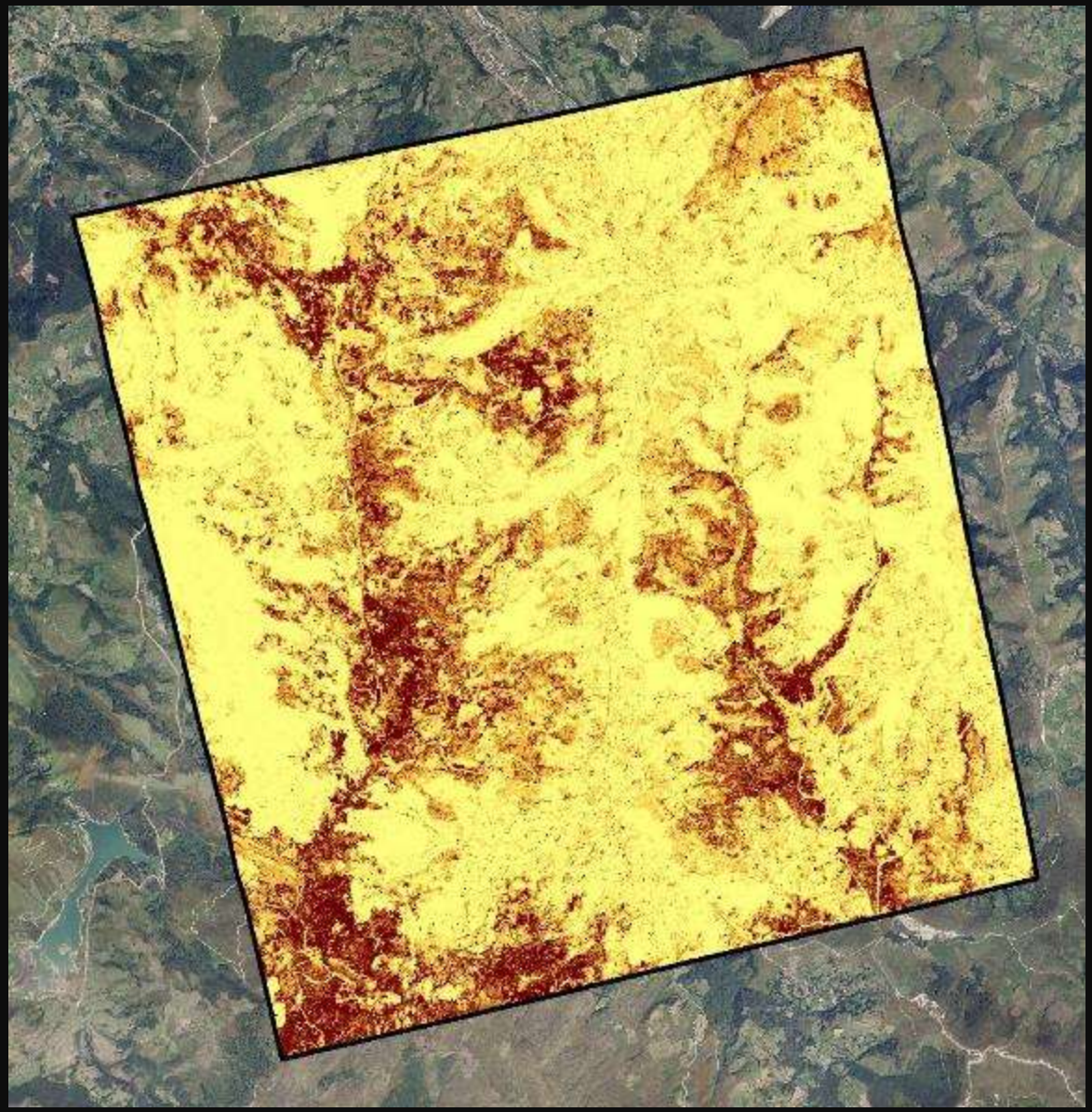

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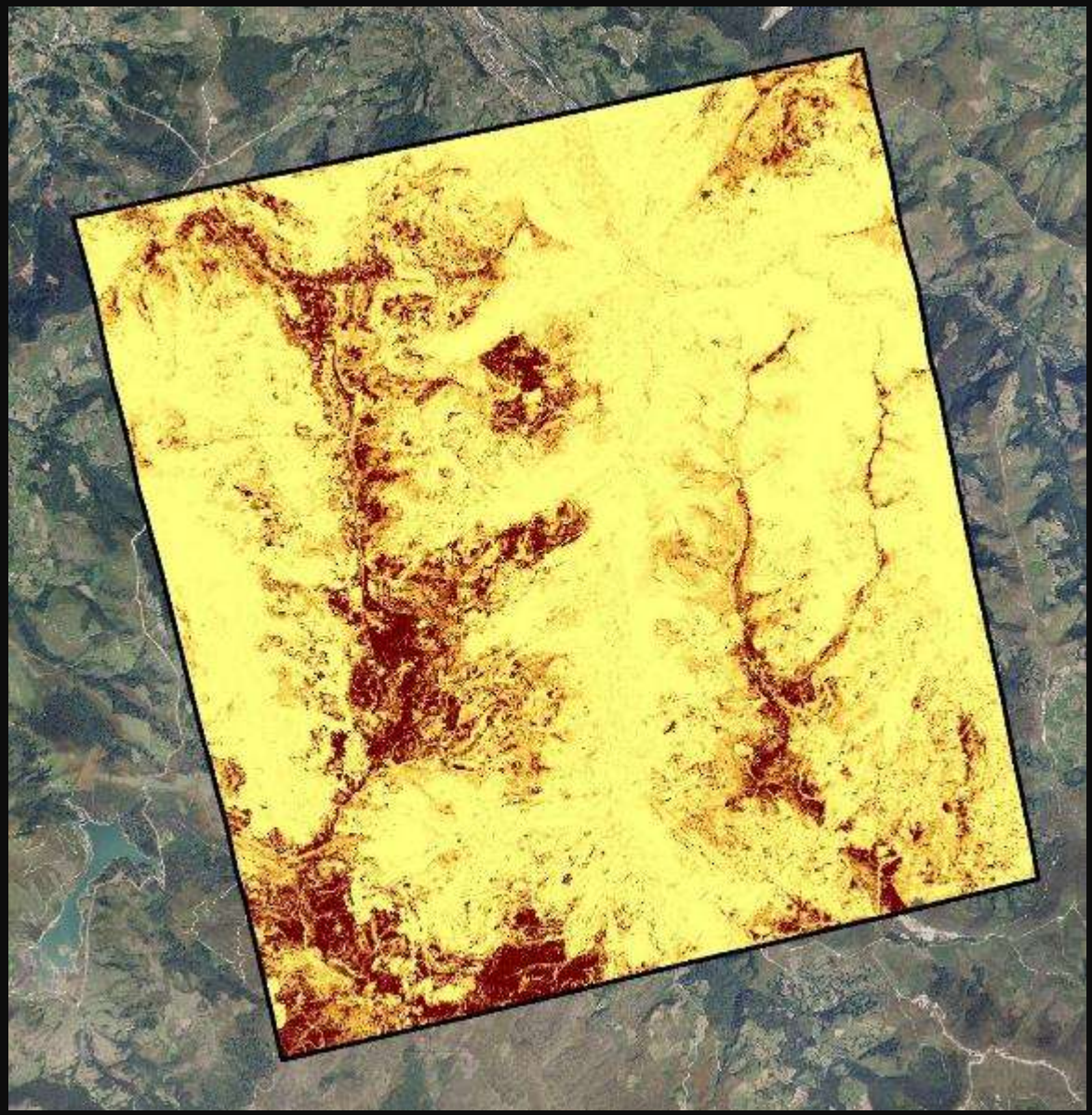

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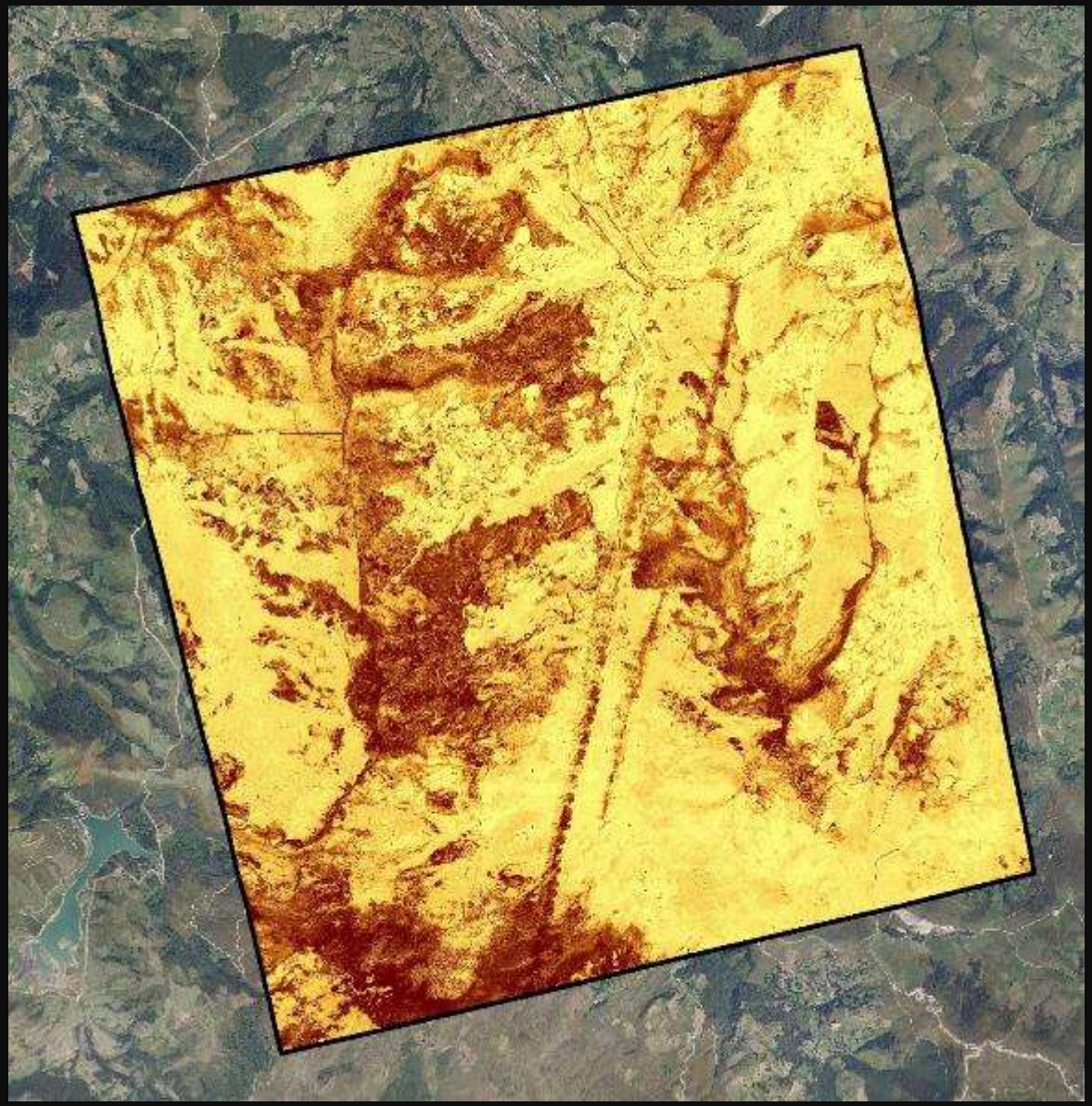

High suitability

Low suitability

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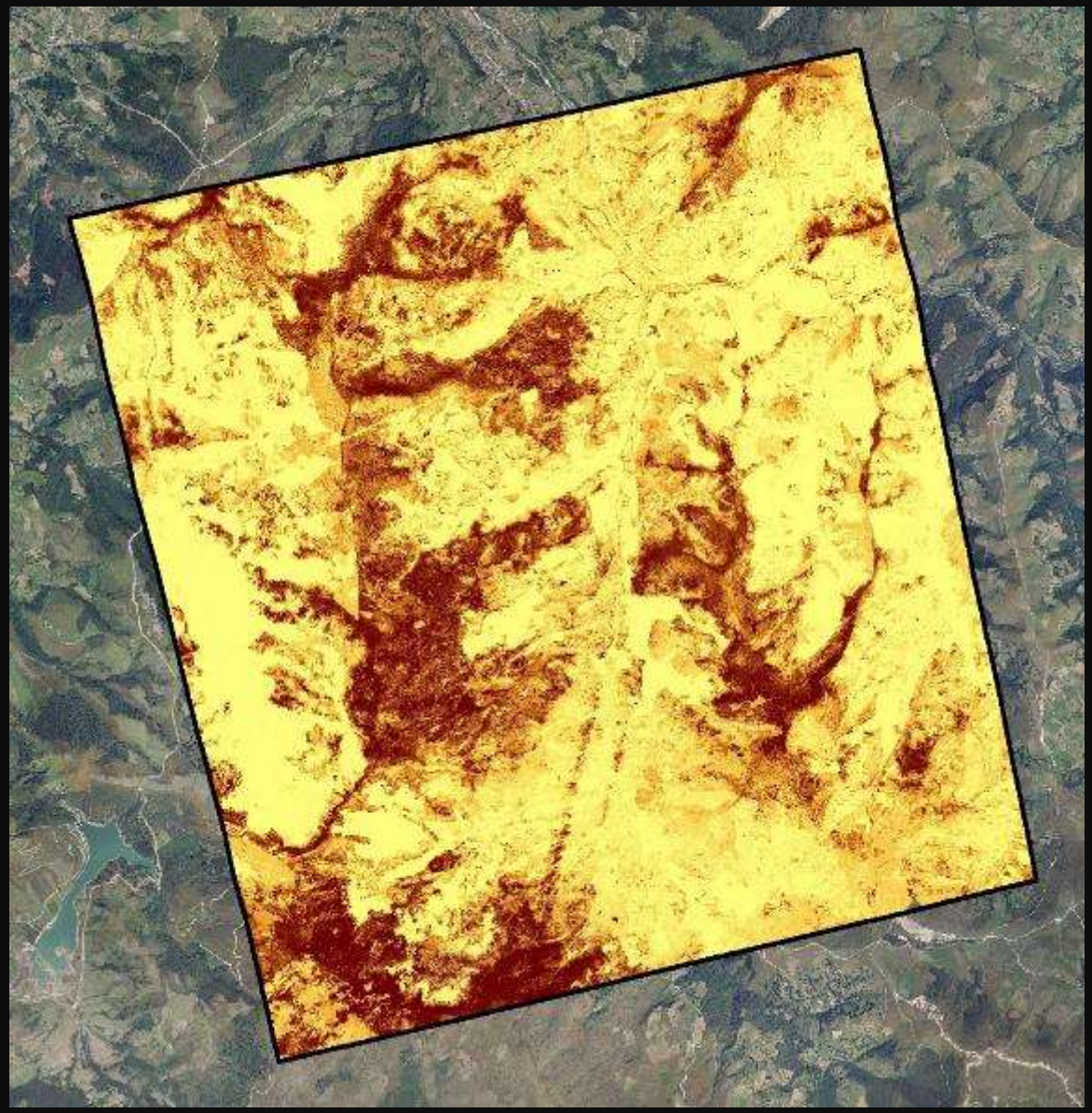

High suitability

Low suitability

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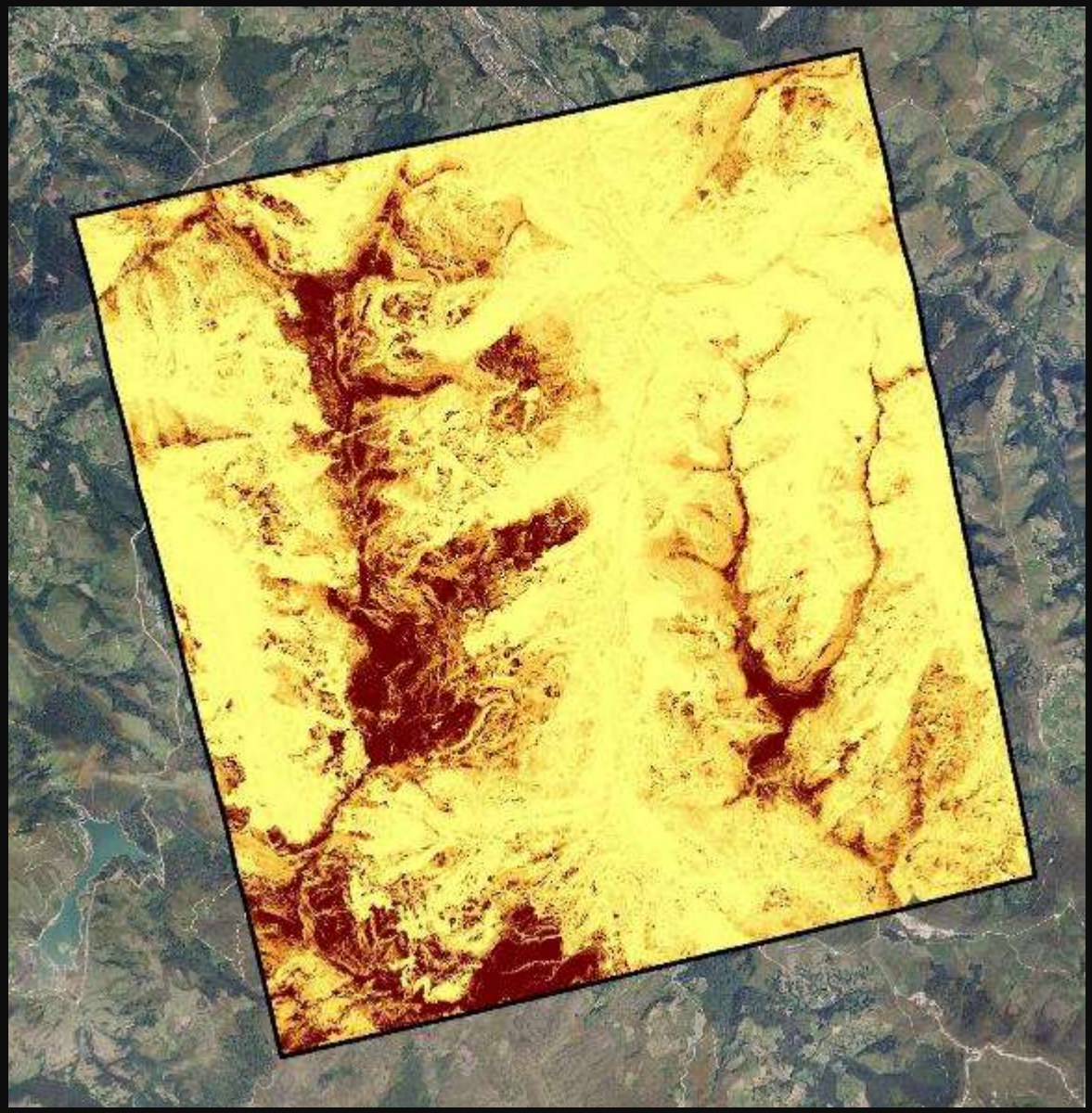

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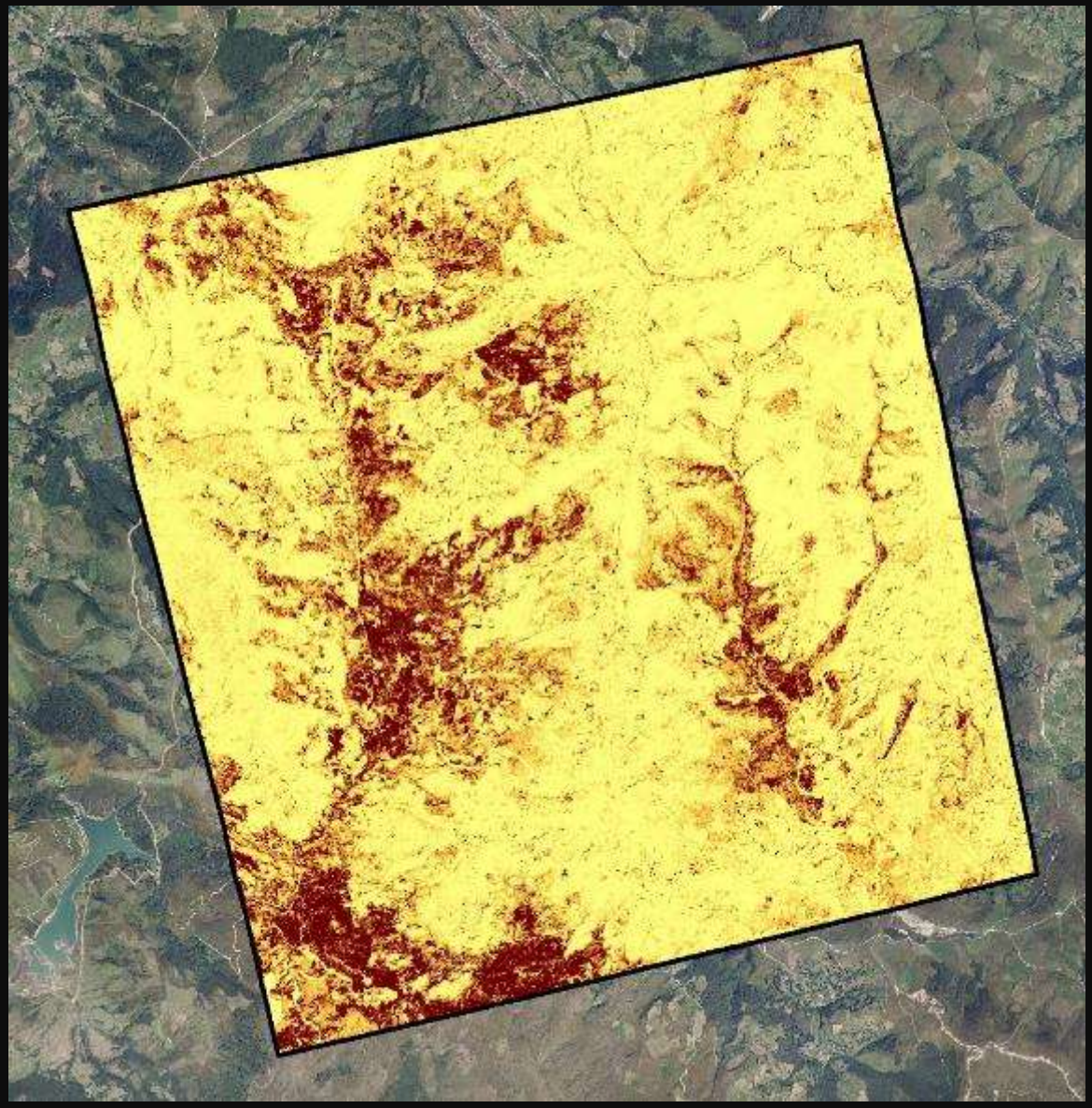

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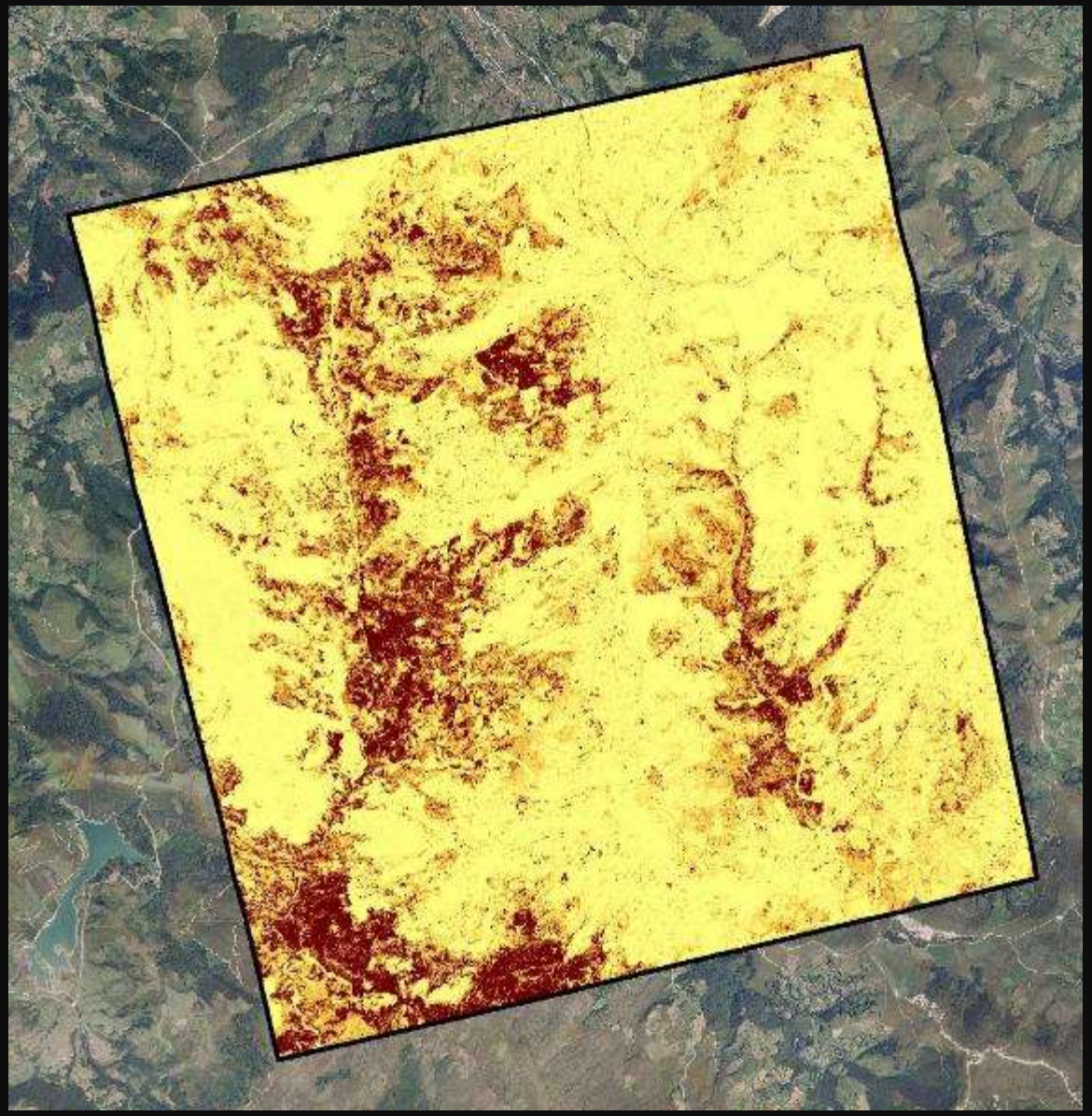

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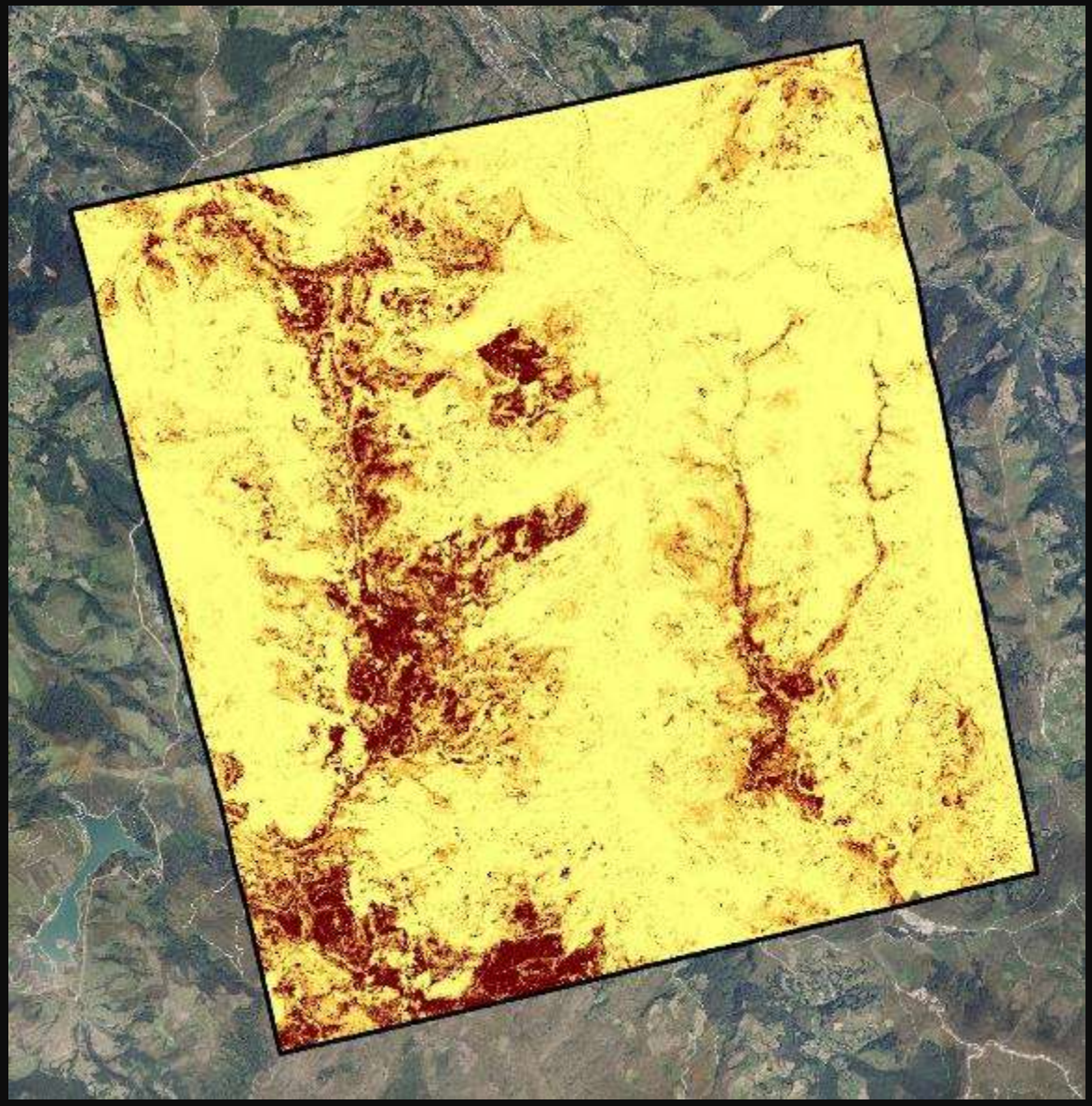


MODELLING RESULTS

HABITAT	*N*	Landsat x 1 (MVC)			Landsat x 2			Sentinel x 2			Deimos x 2			All x 2		
		M	M+L	M+L+E	M	M+L	M+L+E	M	M+L	M+L+E	M	M+L	M+L+E	M	M+L	M+L+E
7130	*73*	0.622	0.615	0.617	0.556	0.562	0.591	0.689	0.687	0.659	0.638	0.644	0.608	0.702	0.699	0.667
7140	*109*	0.519	0.522	0.544	0.540	0.543	0.564	0.592	0.604	0.596	0.579	0.571	0.590	0.637	0.647	0.645
7150	*1*	0.203	0.231	0.493	0.313	0.306	0.536	0.350	0.381	0.599	0.796	0.760	0.834	0.380	0.399	0.527
71XX	*113*	0.514	0.515	0.546	0.629	0.621	0.597	0.593	0.592	0.595	0.526	0.511	0.536	0.642	0.641	0.640
Bogs>0.1 ha	***296***	**0.541**	**0.541**	**0.563**	**0.577**	**0.576**	**0.583**	**0.616**	**0.619**	**0.611**	**0.574**	**0.567**	**0.575**	**0.654**	**0.657**	**0.648**
7130	*143*	0.571	0.567	0.545	0.471	0.479	0.493	0.542	0.540	0.518	0.583	0.590	0.537	0.538	0.534	0.508
7140	*289*	0.524	0.524	0.511	0.508	0.512	0.499	0.478	0.487	0.481	0.533	0.525	0.507	0.491	0.489	0.484
7150	*1*	0.203	0.231	0.493	0.313	0.306	0.536	0.350	0.381	0.599	0.796	0.760	0.834	0.380	0.399	0.527
71XX	*294*	0.423	0.421	0.439	0.528	0.523	0.473	0.428	0.426	0.418	0.479	0.459	0.456	0.424	0.421	0.423
All Bogs	***727***	**0.492**	**0.491**	**0.489**	**0.509**	**0.510**	**0.487**	**0.470**	**0.473**	**0.463**	**0.521**	**0.511**	**0.493**	**0.473**	**0.470**	**0.464**
0-250																
4030	*4431*	0.427	0.426	0.339	0.400	0.398	0.305	0.294	0.289	0.248	0.429	0.424	0.329	0.249	0.243	0.220
6510	*248*	0.282	0.256	0.237	0.164	0.149	0.148	0.115	0.107	0.114	0.285	0.239	0.223	0.099	0.088	0.093
9120	*349*	0.134	0.078	0.089	0.106	0.064	0.075	0.177	0.091	0.082	0.325	0.129	0.106	0.112	0.072	0.066
9190	*2*	0.046	0.061	0.015	0.020	0.038	0.006	0.017	0.010	0.001	0.584	0.354	0.055	0.009	0.009	0.002
9230	*549*	0.122	0.067	0.053	0.096	0.057	0.044	0.054	0.038	0.035	0.156	0.071	0.055	0.037	0.031	0.027
90X0	*537*	0.267	0.239	0.210	0.253	0.221	0.182	0.159	0.146	0.134	0.263	0.217	0.200	0.127	0.121	0.118
80XX	*504*	0.234	0.155	0.176	0.211	0.138	0.153	0.087	0.072	0.094	0.267	0.131	0.192	0.090	0.078	0.089
Other habitats	***6620***	**0.353**	**0.336**	**0.275**	**0.324**	**0.309**	**0.244**	**0.235**	**0.223**	**0.195**	**0.370**	**0.333**	**0.270**	**0.197**	**0.188**	**0.173**

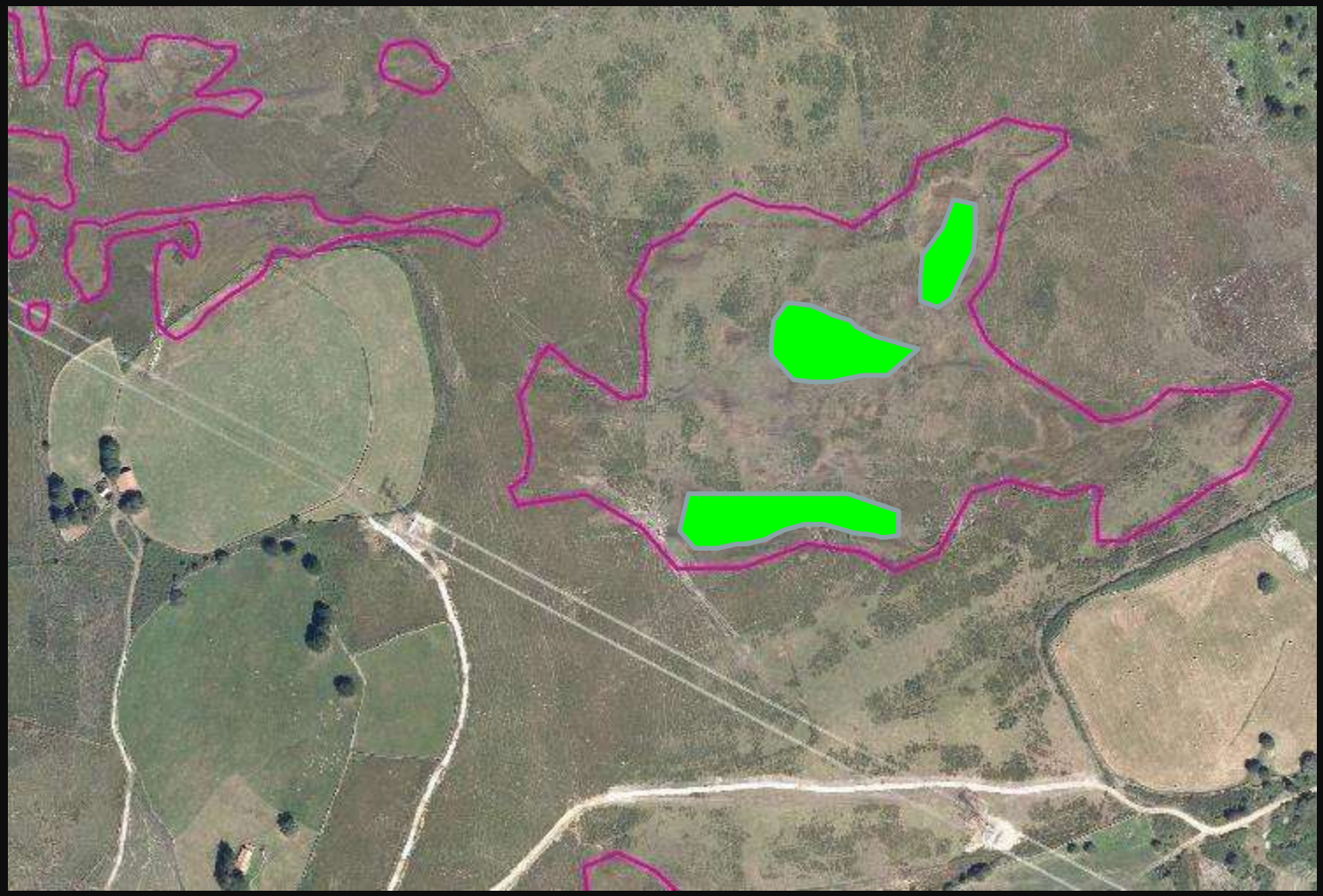
MODELLING RESULTS

MODELLING RESULTS

Landsat 8 MVC
Landsat8 x2
Sentinel2 x2
Deimos2 x2
+LiDAR +MDT

High suitability

Low suitability



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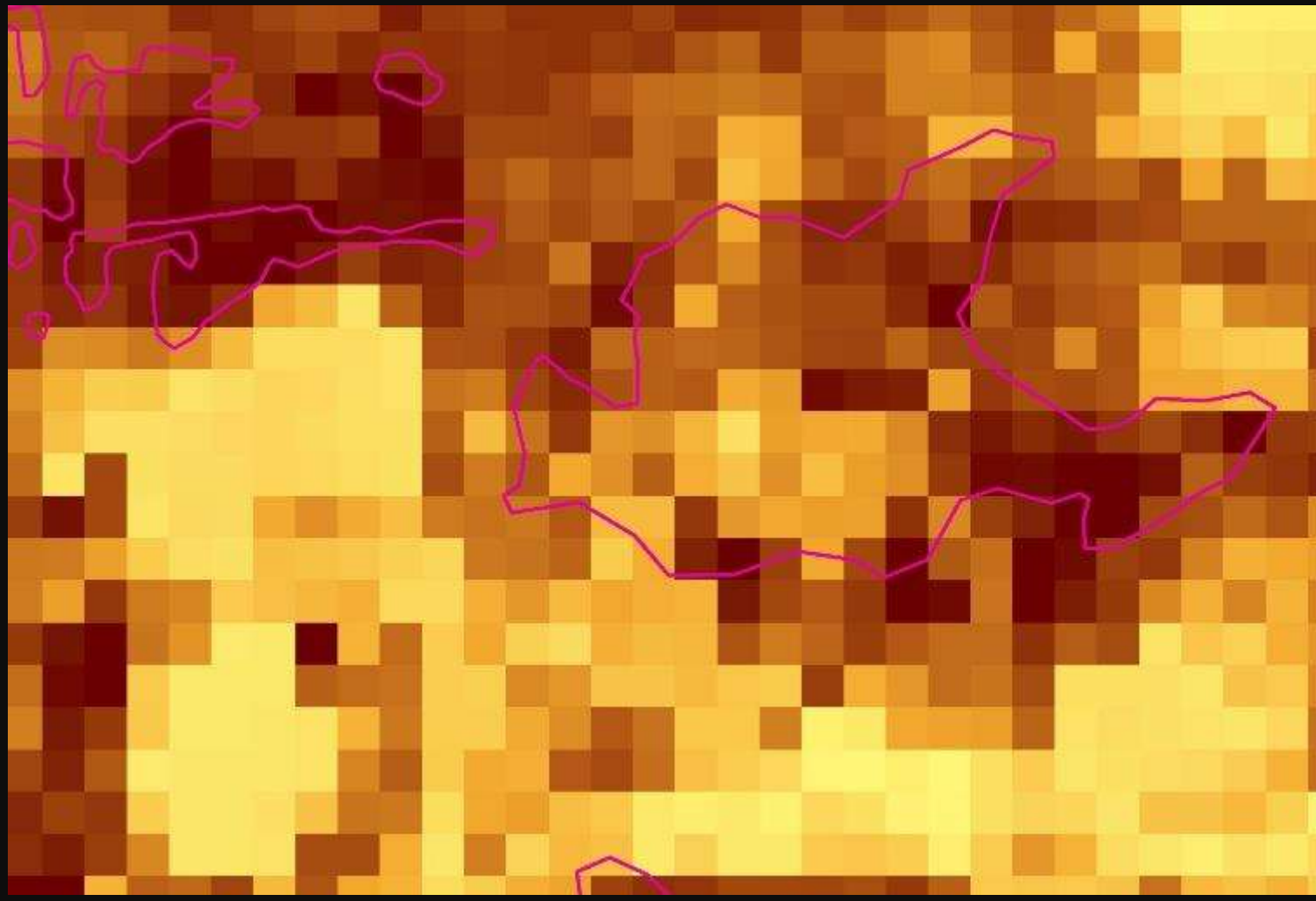

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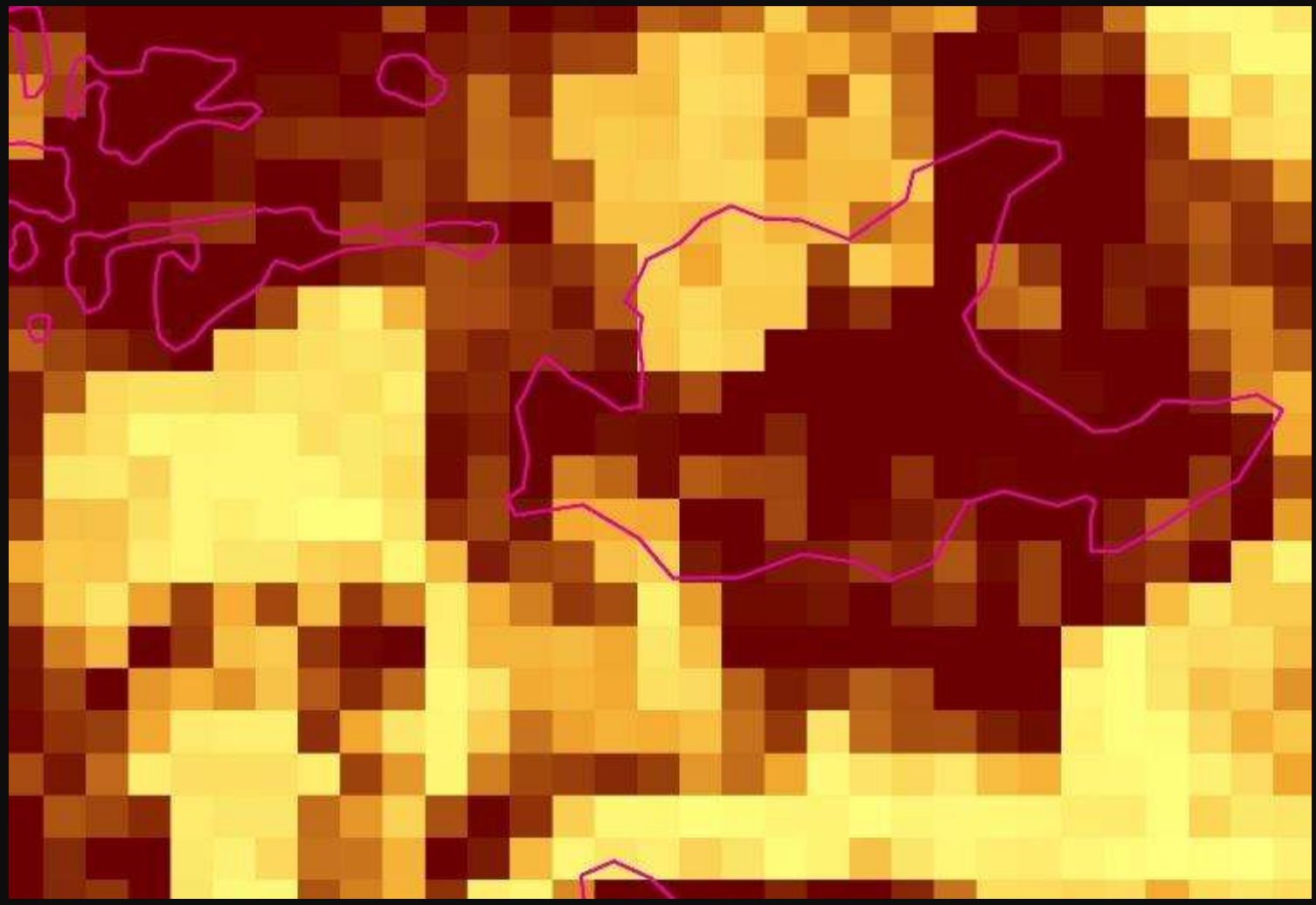

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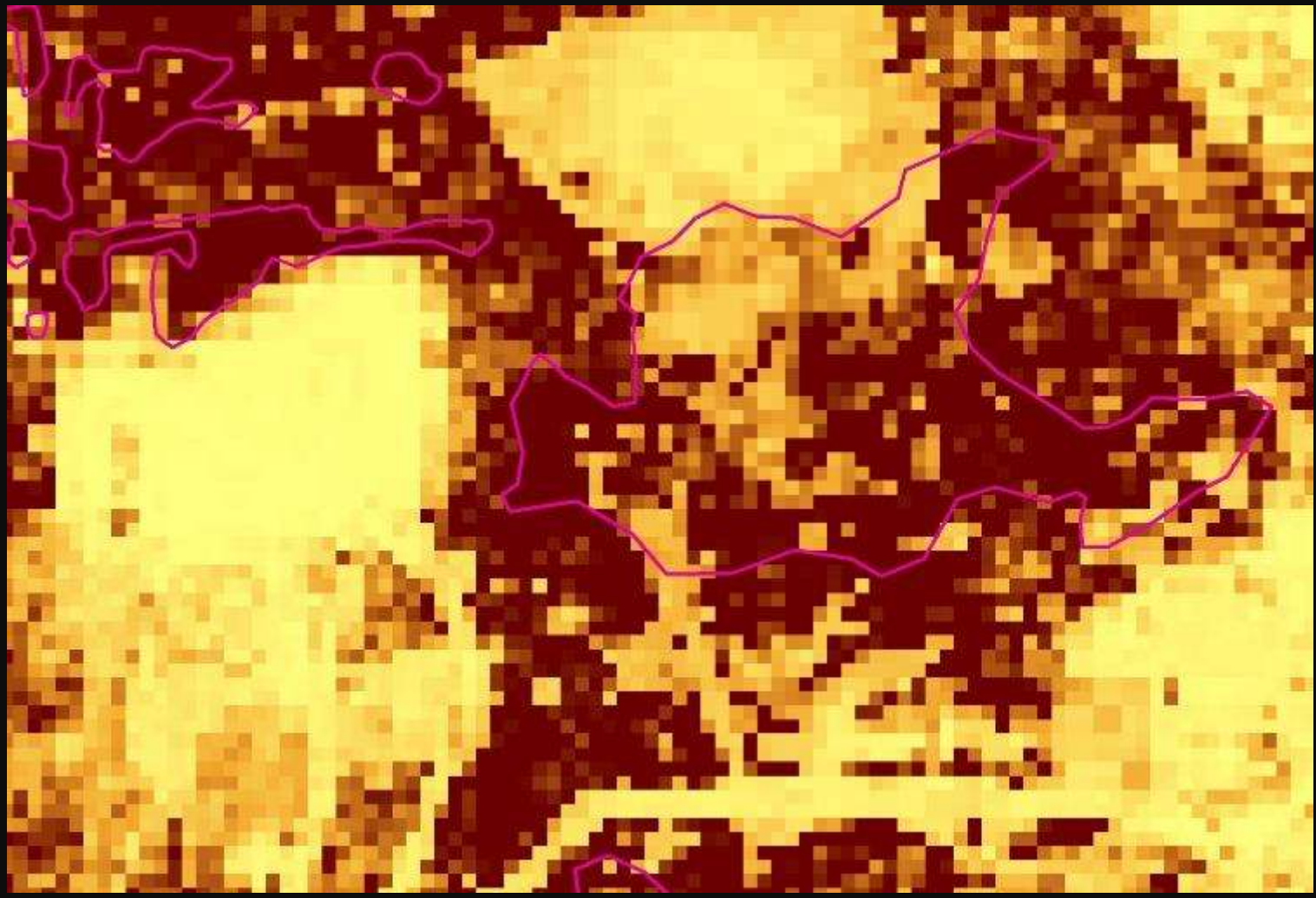

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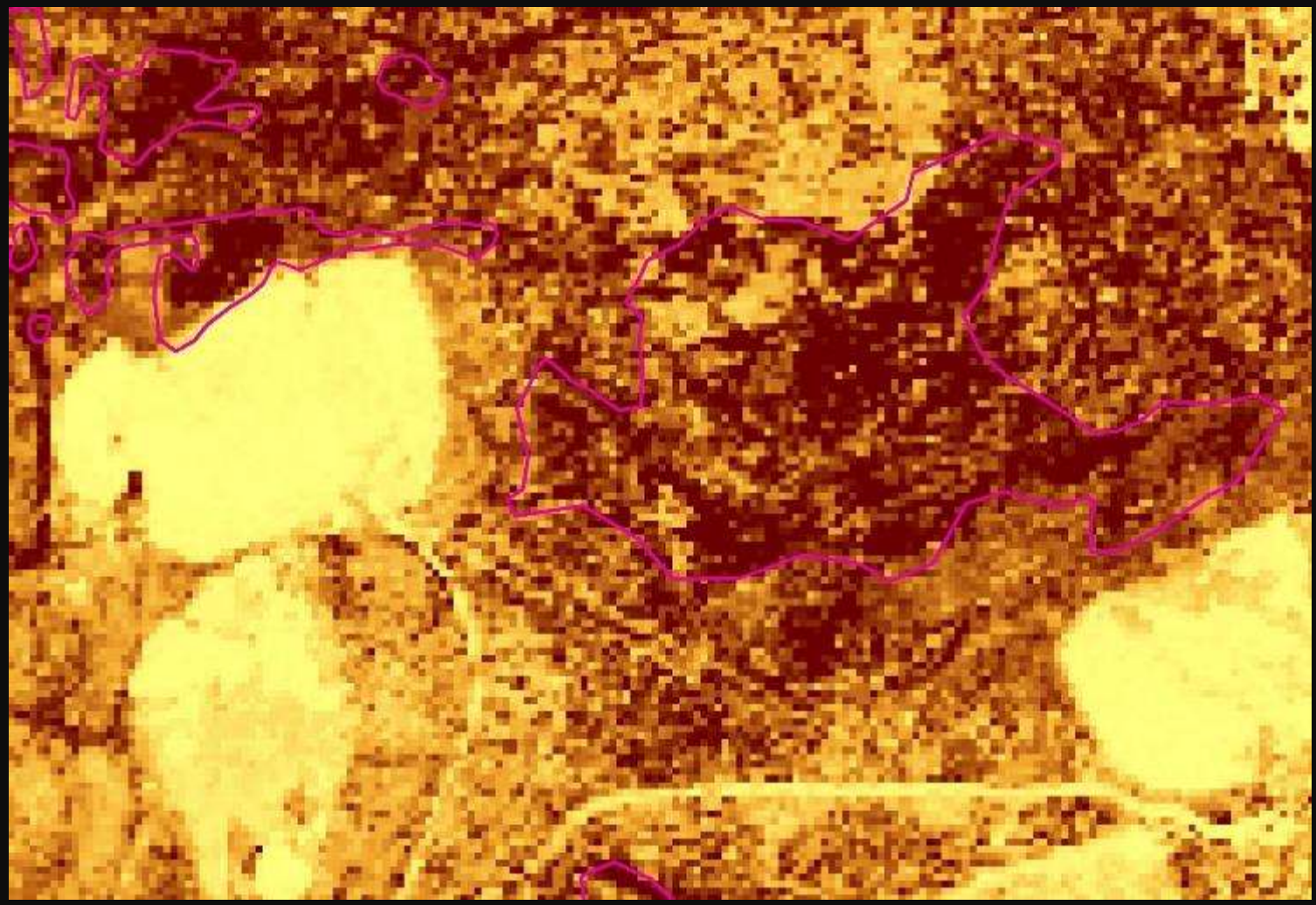

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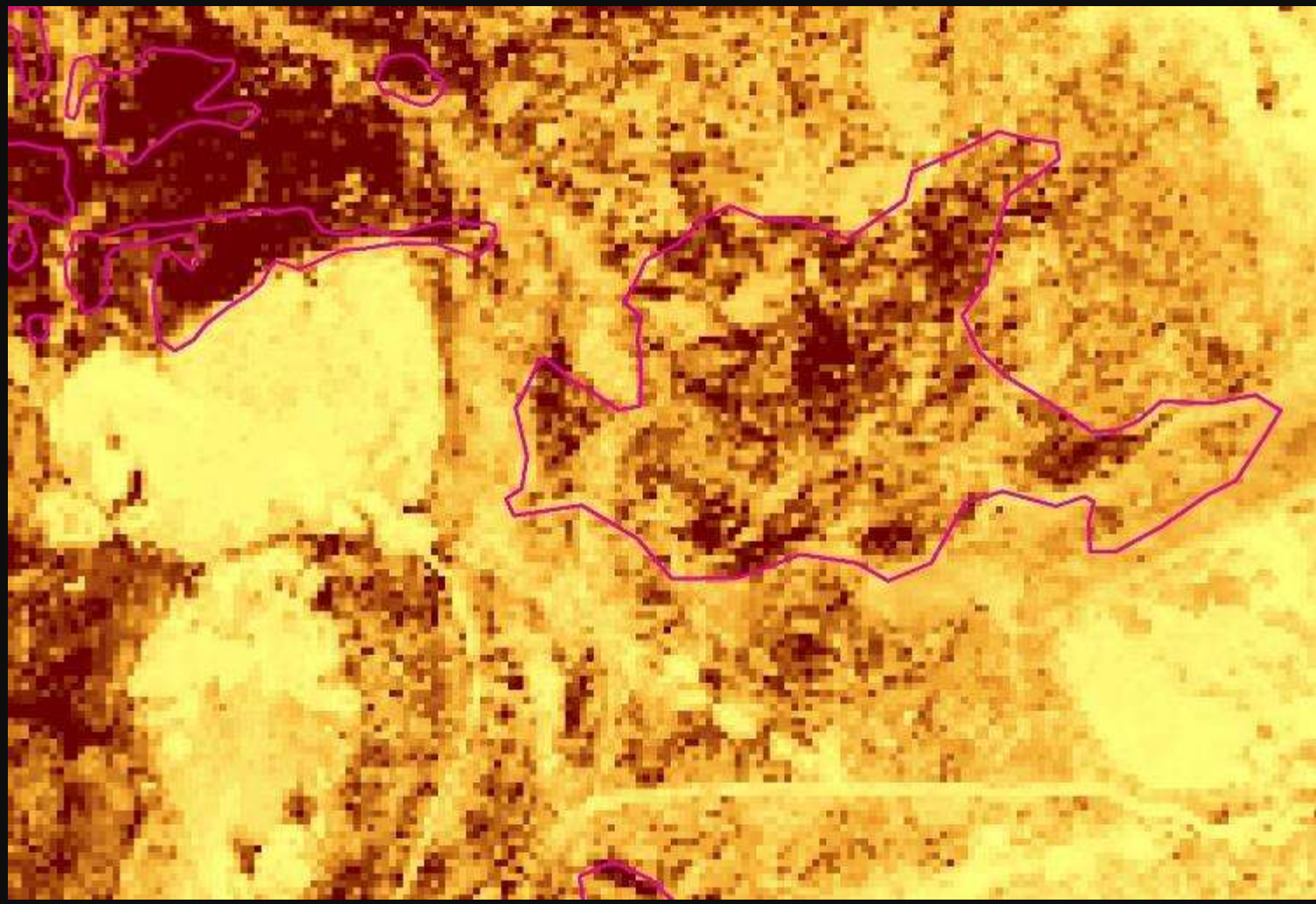
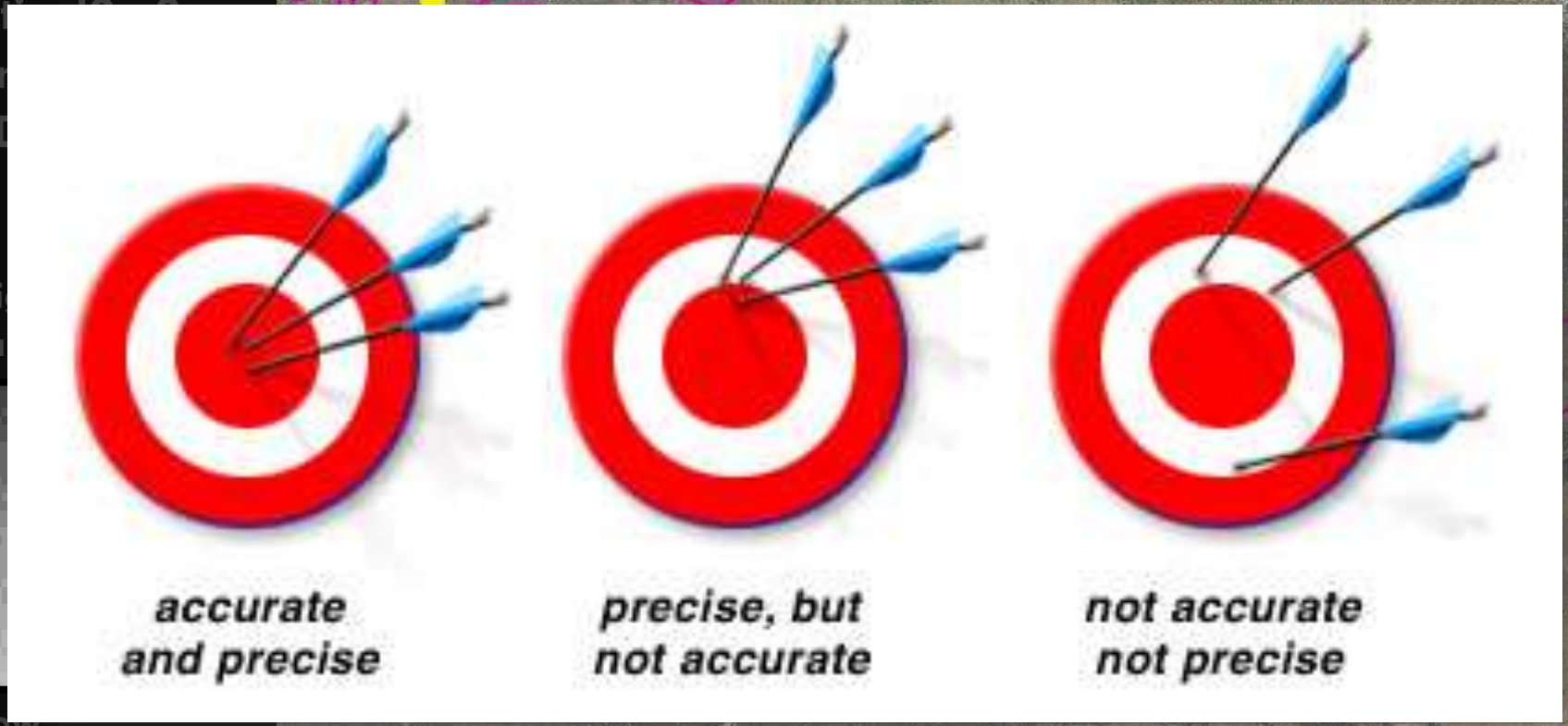


MODELLING RESULTS

Landsat 8 MVC
Landsat8 x2
Sent
Deir
+LiD

Hi
suita

Low
suitability



In complex (Mediterranean, High-Mountain) systems, we have to disentangle vegetation patterns and go beyond the mosaic by applying locally-tailored approaches for…

… understanding broad-scale vegetation patterns across space and through time.

- **Spatial resolution is very important, but minimum mapping unit (MMU) and VHR satellite data are not always correlative**

- **Spectral resolution looks highly important to match vegetation patterns across landscape gradients. Temporal resolution also improves the complex habitat maps obtained**

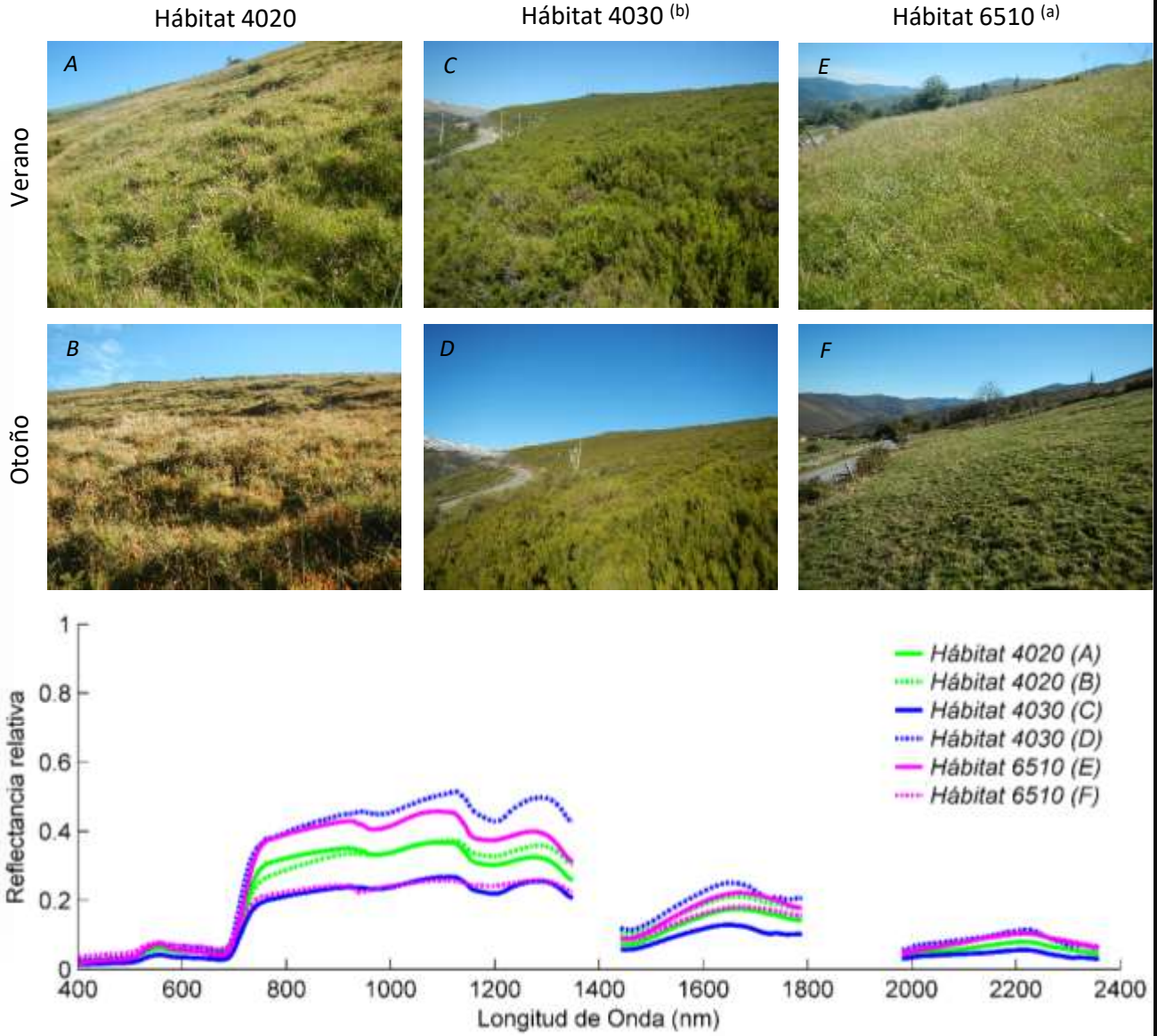
- **The accuracy of occurrence and predictor data for characterizing habitat types and the scale are mandatory**

SPECTRAL SIGNATURES

Hyperspectral meausrements

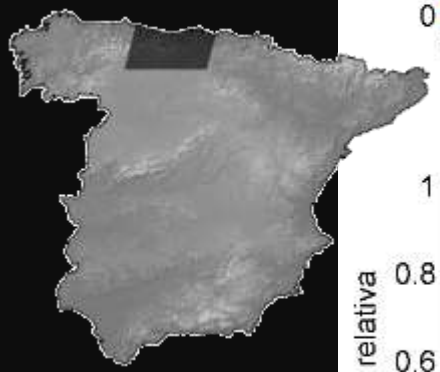
7. SPECTRAL SIGNATURES

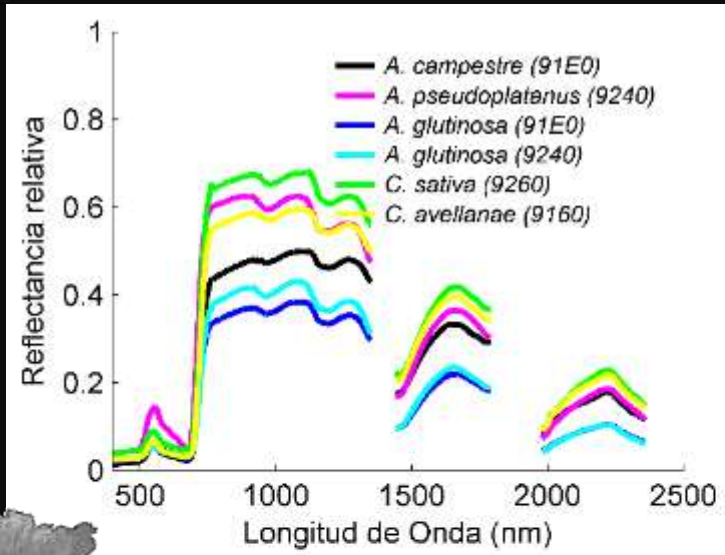
Habitat types

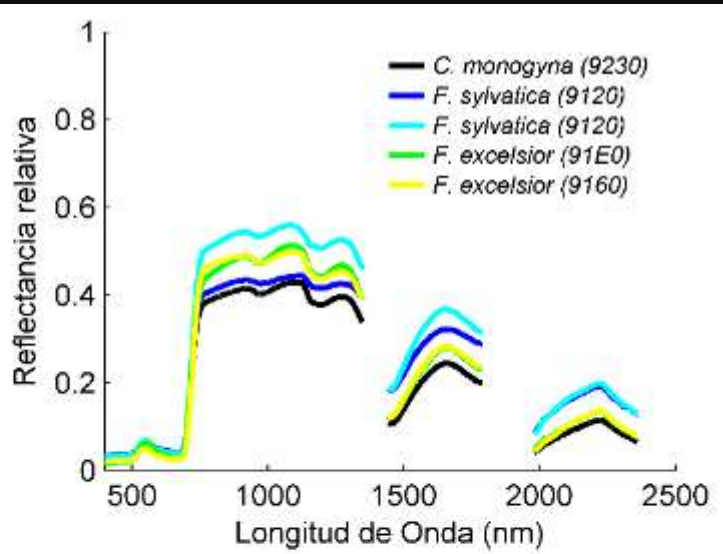


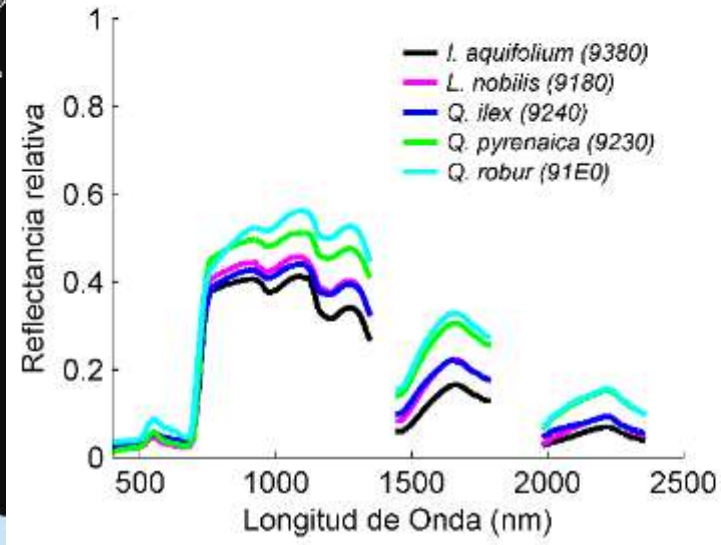
7. SPECTRAL SIGNATURES

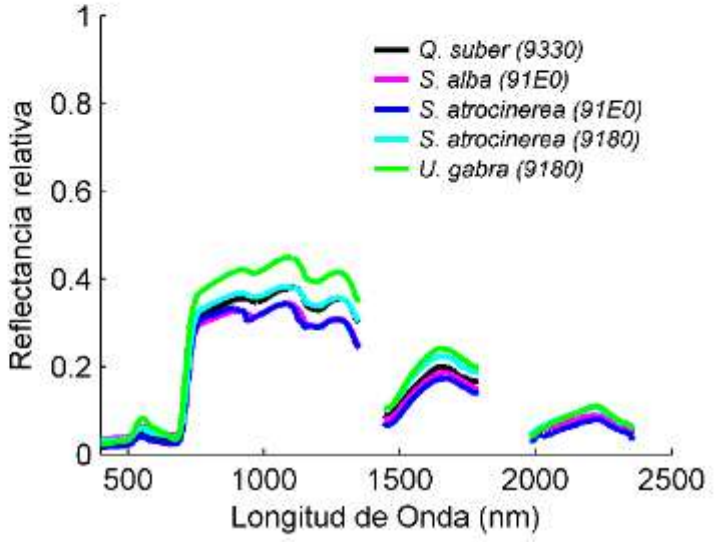
Spectral Library: SPECIES





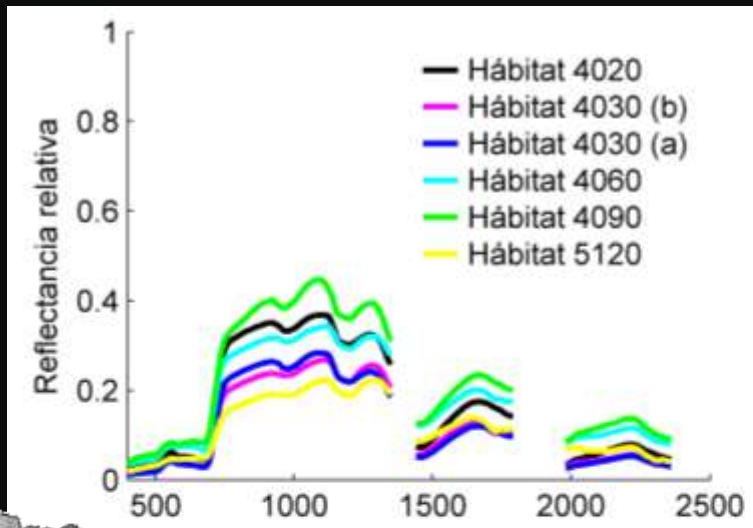


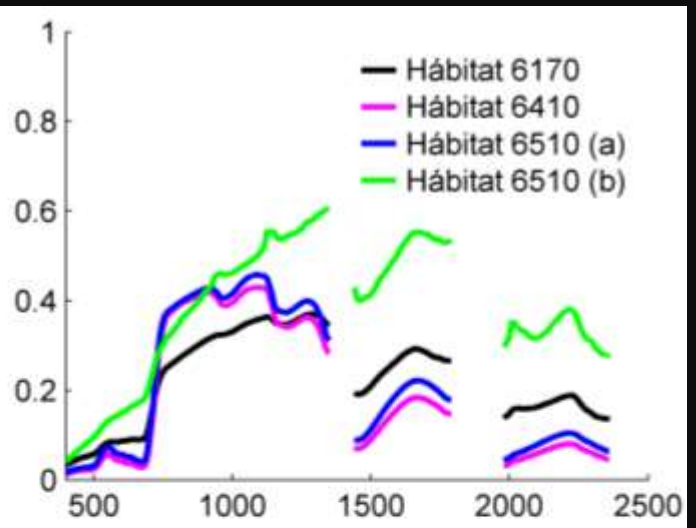


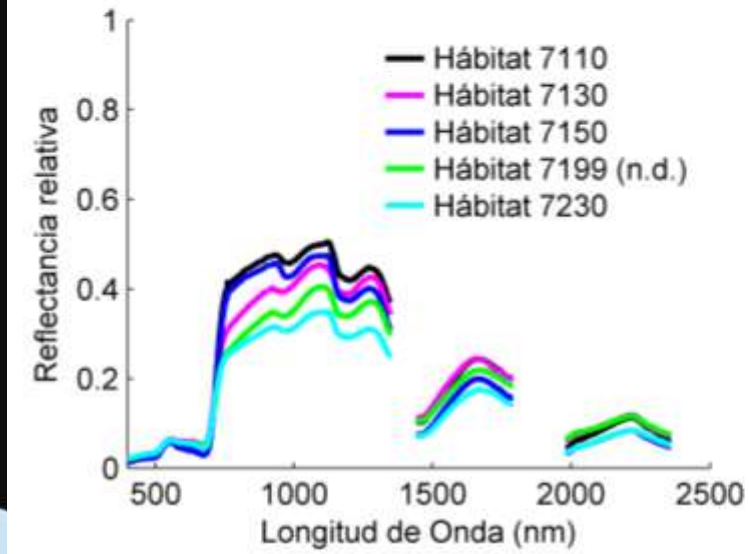


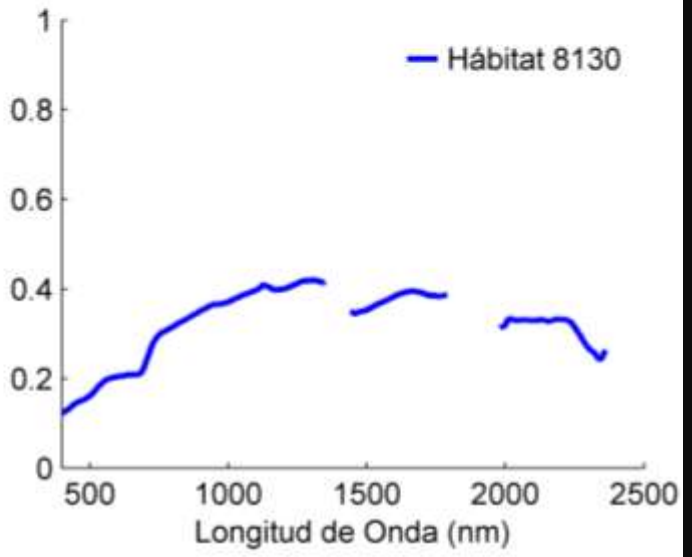
7. SPECTRAL SIGNATURES

Spectral Library: HABITATS



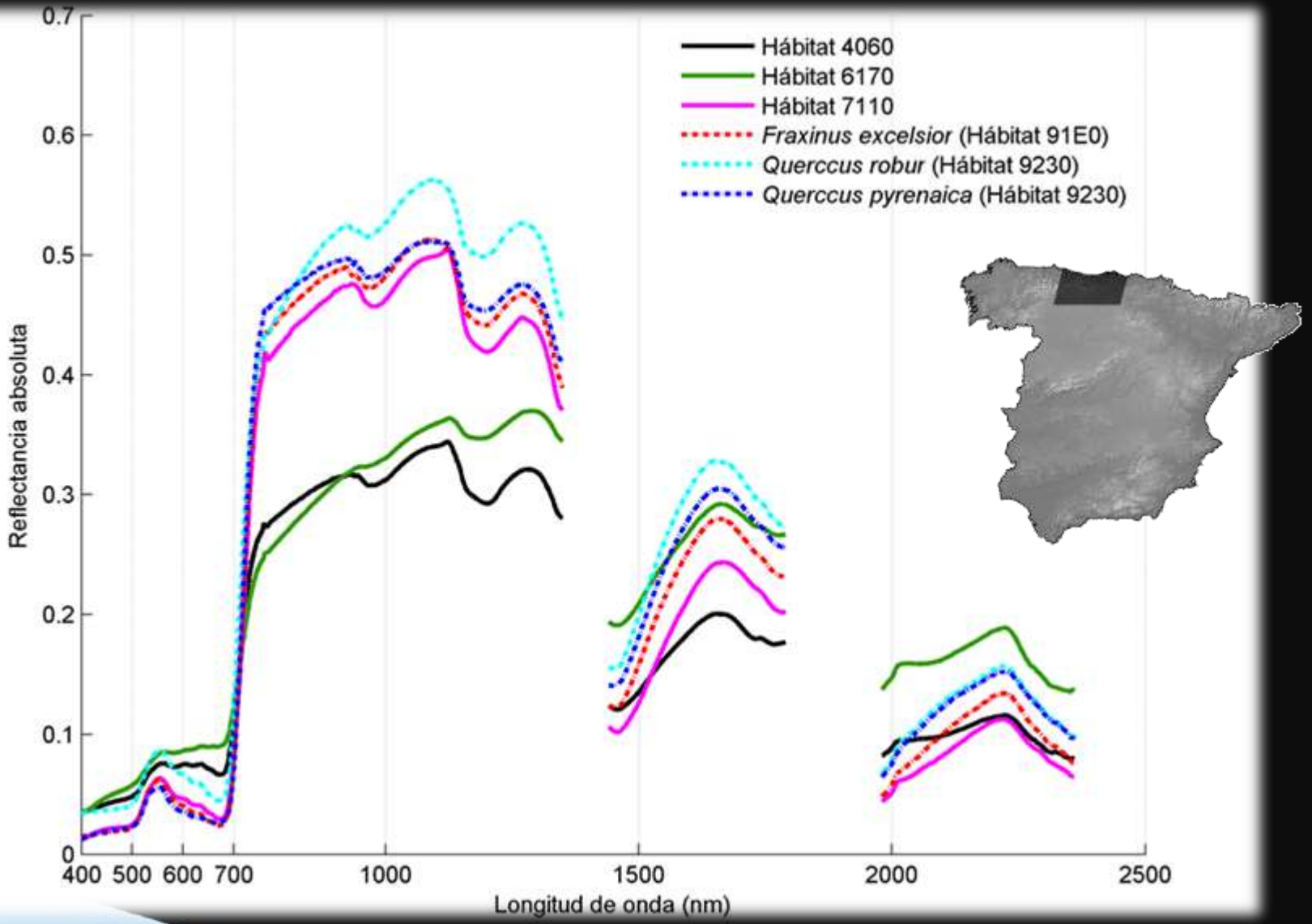






7. SPECTRAL SIGNATURES

Spectral library: A COMPARISON



7. SPECTRAL SIGNATURES

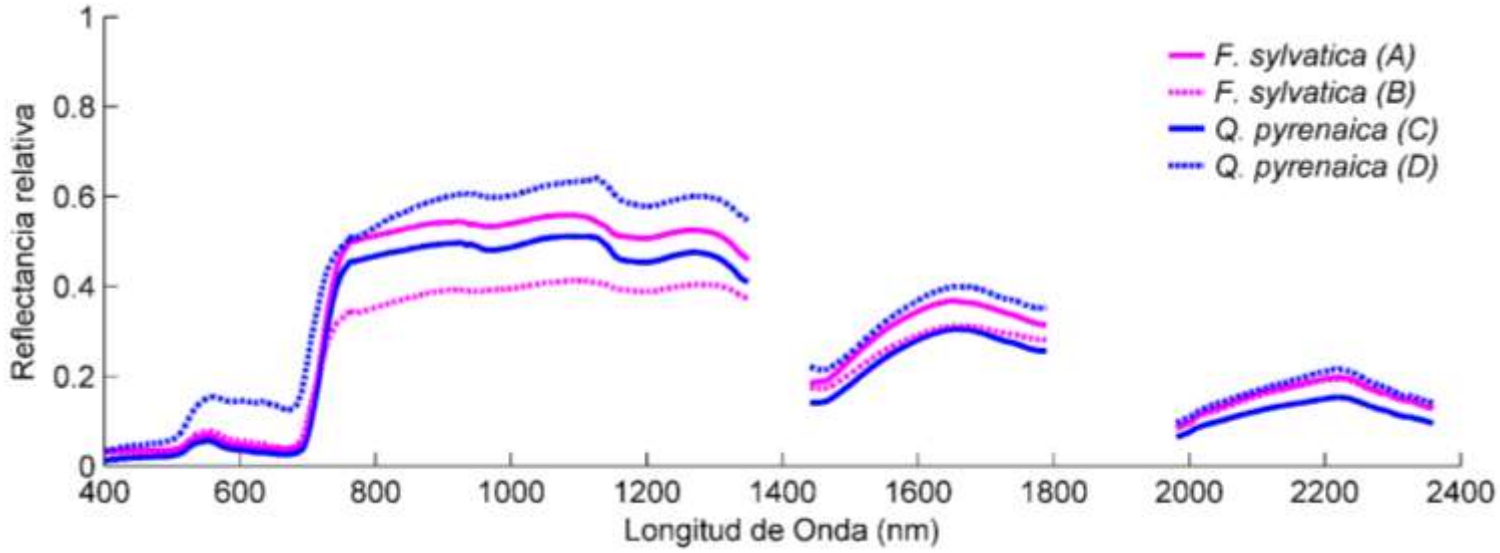
Spectral library: PHENOLOGY

Hábitat 9120 (*F. sylvatica*)

Verano → Otoño

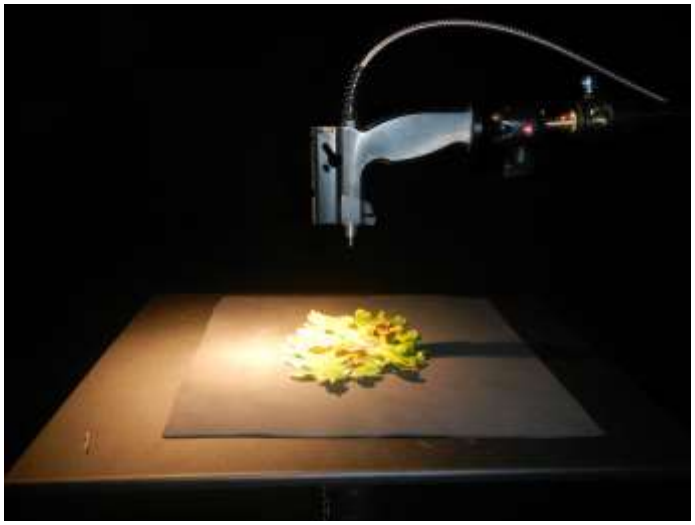
Hábitat 9230 (*Q. pirenaica*)

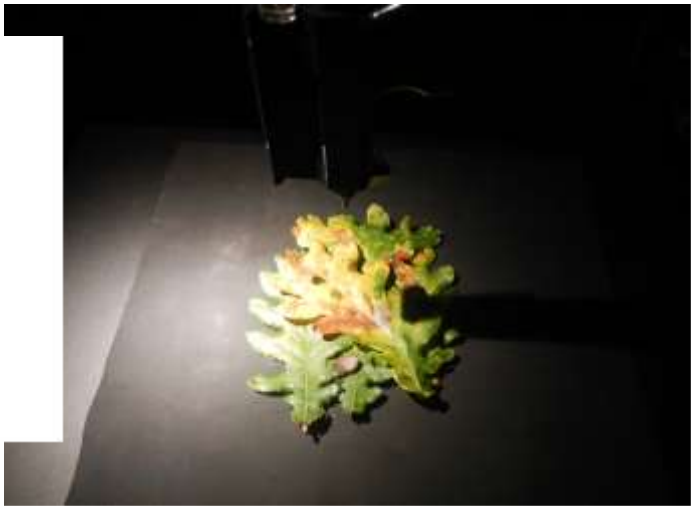
Verano → Otoño

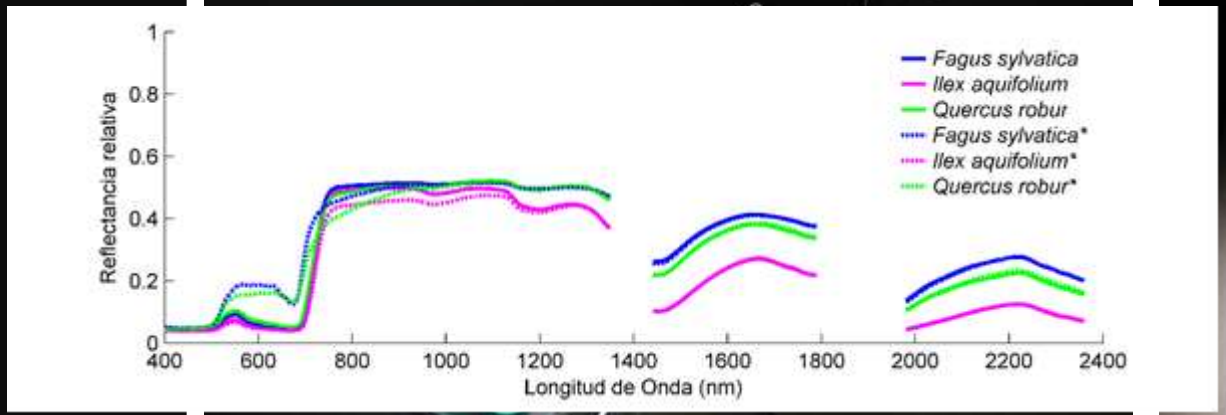


7. SPECTRAL SIGNATURES

Spectral library: LAB ANALYSES



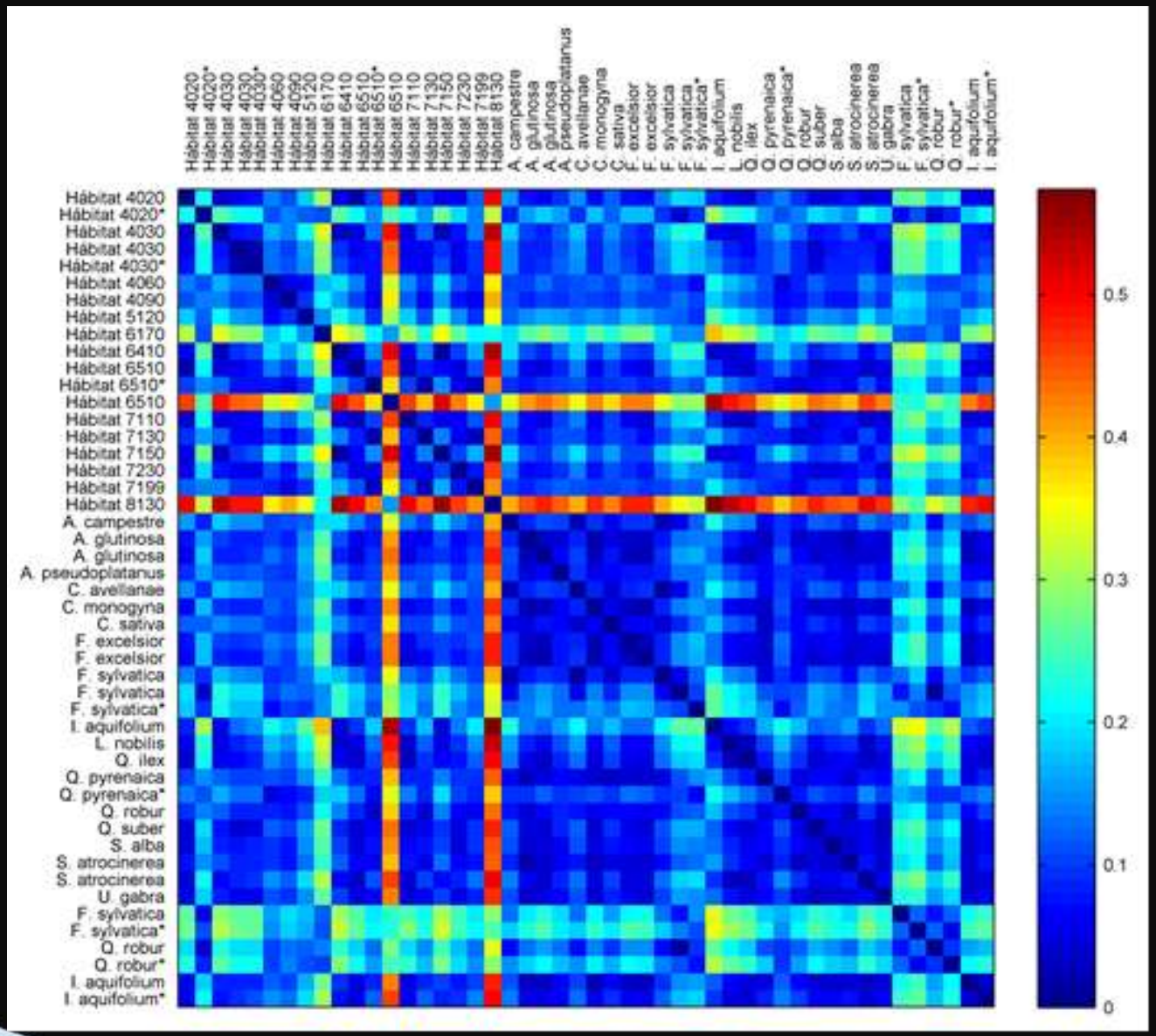




7. SPECTRAL SIGNATURES

Spectral library: PC ANALYSES

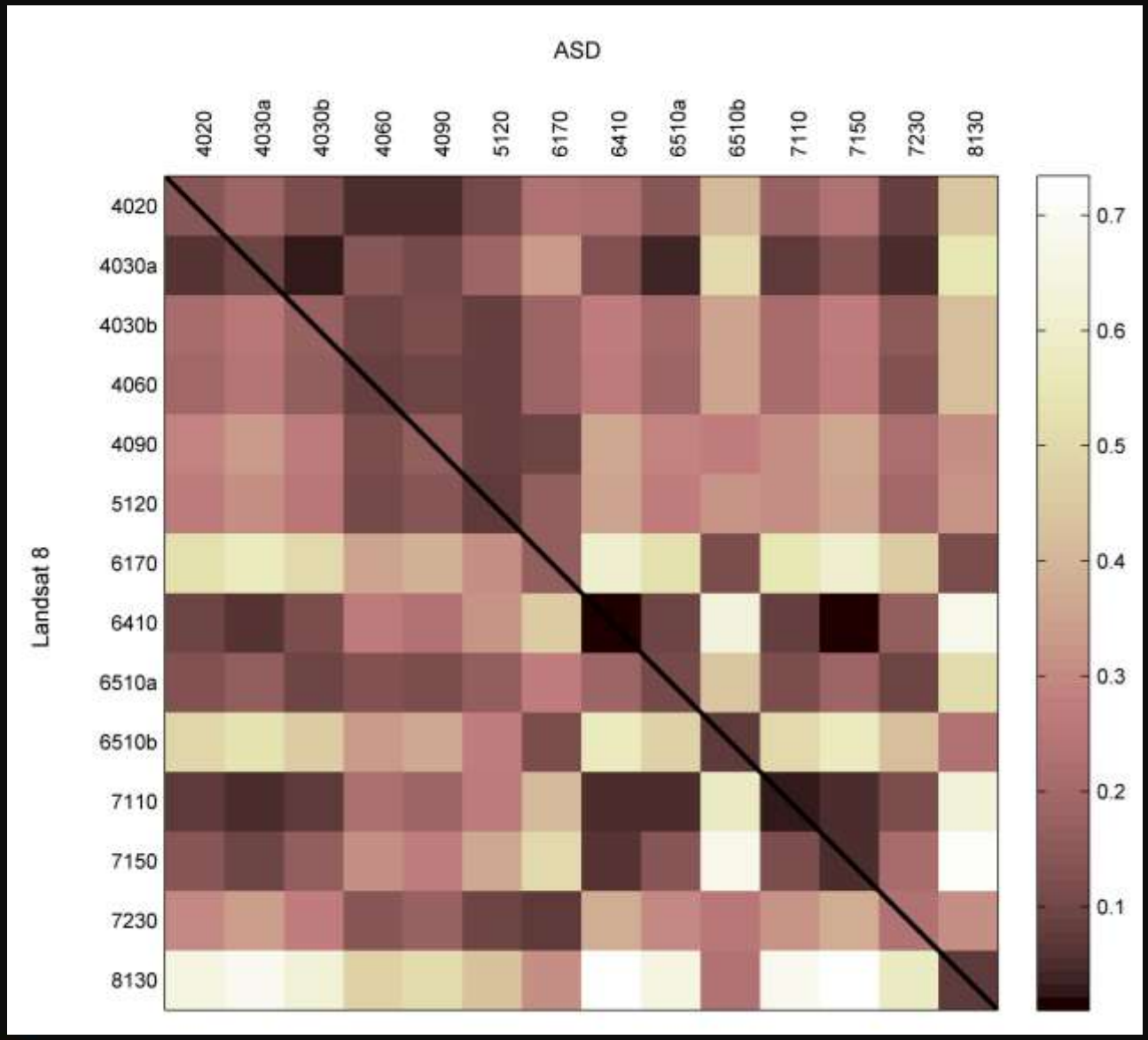
Matriz de similaridad espectral basada en el *Spectral Angle Mapper* (SAM). La escala de colores representa la diferencia angular en radianes. Una diferencia angular de 0 se corresponde con una similaridad del 100% y valores superiores, hasta un máximo de ∏/2, con una similaridad menor.



7. SPECTRAL SIGNATURES

Spectral library: PC ANALYSES

Matriz de similaridad espectral basada en el Spectral Angle Mapper (SAM) entre las firmas espectrales de los hábitats de tipo pastizal, matorral, turbera y rocosa obtenidas in situ (ASD) y de sensores remotos (Landsat 8). La escala de colores representa la diferencia angular en radianes. Una diferencia angular de 0 se corresponde con una similaridad del 100% y valores superiores, hasta un máximo de ∏/2, con una similaridad menor.



¡Gracias!

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