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INSTITUTO DE HIDRÁULICA AMBIENTAL
UNIVERSIDAD DE CANTABRIA

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Developing support for monitoring and reporting of GHG emissions and removals from land use land use change and forestry

LULUCF

Copernicus for agri-environmental applications

Session3: Copernicus for Climate Change: monitoring land use and land changes

Thursday, 17th October 2019

MINISTERIO DE CIENCIA, INNOVACIÓN Y UNIVERSIDADES · CDTI Centro para el Desarrollo Tecnológico Industrial · GOBIERNO DE ESPAÑA MINISTERIO DE AGRICULTURA, PESCA Y ALIMENTACIÓN · GOBIERNO DE ESPAÑA MINISTERIO DE FOMENTO · INSTITUTO GEOGRÁFICO NACIONAL

Sensagri · VNIVERSITAT DE VALÈNCIA · IPL IMAGE PROCESSING LABORATORY · Copernicus · GOBIERNO DE ESPAÑA MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA

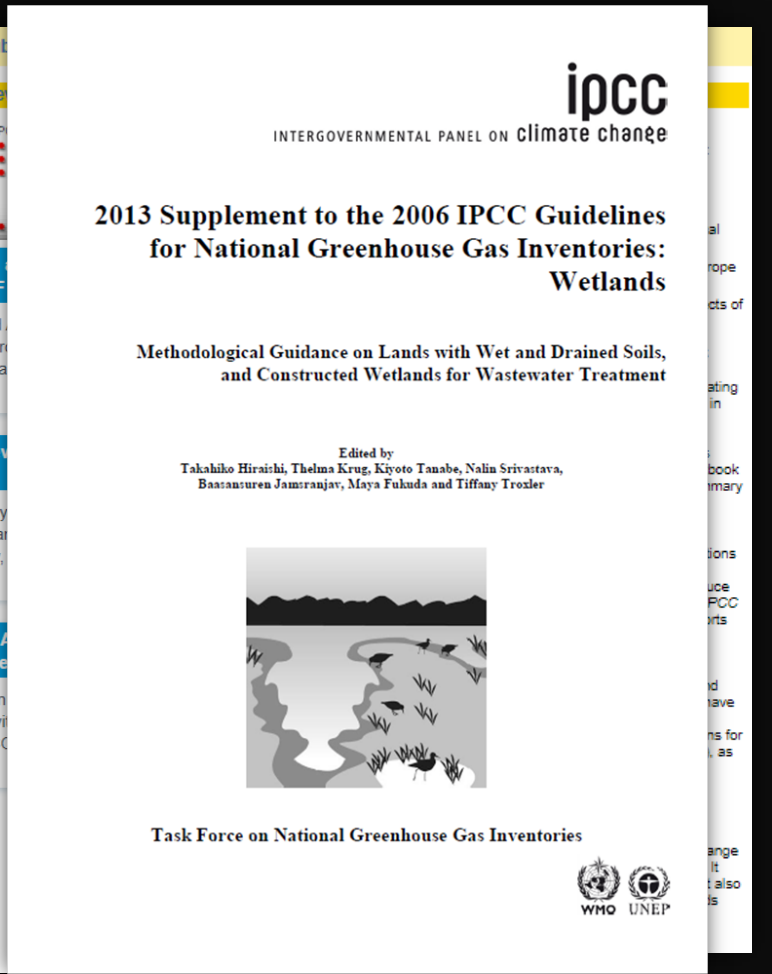
REPORTING OF THE LULUCF SECTOR

Human activities impact terrestrial sinks through **land use, land-use change and forestry (LULUCF)** activities, therefore the exchange of CO_2 (carbon cycle) between terrestrial biosphere system and the atmosphere is altered. To monitor and report GHG emissions and removals from LULUCF, relevant Commission Regulations are EU 2018/841, EU 2018/1999 and the current one EU 525/2013. They include mechanism for monitoring and reporting GHG emm.

However, the reporting is inconsistent across EU MS
with different methods and data sources being employed

https://unfccc.int/topics/land-use/workstreams/land-use--land-use-change-and-forestry-lulucf

Background	**Harvested Wood Products**	**Land Use, Land-Use Change and Forestry**	**Reporting of the LULUCF sector by Parties Inclu**	**Reporting of LULUCF**
Background Activities in the LULUCF sector can provide a relatively cost-...	SBSTA 20 to SBSTA 24 At SBSTA 20 (FCCC/SBSTA/2004/6, paragraphs 20-22), the...	Background Forests, through growth of trees and an increase in soil carbon,...	Background Article 4 of the United Nations Framework Convention on Climate...	Background the Kyoto Pr change in ca
Reporting on LULUCF activities under the Ky	**Other LULUCF Issues (Forest degradation an**	**LULUCF - Recent Developments**	**LULUCF- Developments at past COP and SB sessions**	**Recent dev**
A. Definitions, modalities, rules and guidelines for LULUCF activities...	COP 7 invited the IPCC to undertake methodological work and prepare reports on...	Recent developments The secretariat incorporated these tables of the common...	COP 10, SB 20 and SB 21 A. Reporting LULUCF activities under the Kyoto...	The CMP, by Land use, la and forestry,
LULUCF - Developments at past COP and SB	**The numerical value for forest management un**	**Harvested Wood Products**	**Harvested Wood Products, SBSTA 4-19**	**LULUCF - A and Refore**
COP 9, SB 18 and 19 A. LULUCF inventory under the Convention COP 9 (...	The government of Italy requested the COP/MOP at its first session (FCCC/KP/CMP...	Background The carbon cycle is affected when forests are harvested. CO2...	SBSTA 4 to SBSTA 19 An approach for estimating the net CO2 emissions from...	Afforestation project activi CDM The CC
LULUCF project activities under the clean	**LULUCF - Developments at past COP and SB**	**LULUCF - Developments at past COP and SB**	**LULUCF - Developments at past COP and SB**	
SBSTA 16 (FCCC/SBSTA/2002/6, paragraphs 33(a)–(c)) initiated the discussions...	COP 11, COP/MOP 1, SB 22 and 23 A. Methodological issues related to LULUCF 1...	Marrakesh Accords and COP 7 COP 7 (Marrakesh, October/November 2001)...	From COP 4 to COP 6 COP 4 (Buenos Aires, November 1998) decided to...	



SPATIAL DATASETS

SIOSE

CORINE Land Cover

https://land.copernicus.eu/user-corner/technical-library/upcoming-product-clc

Land Monitoring

Towards CLC+

Conceptual design and product outlines

Geoff Smith
EIONET Action Group EAGLE Land Monitoring in Europe

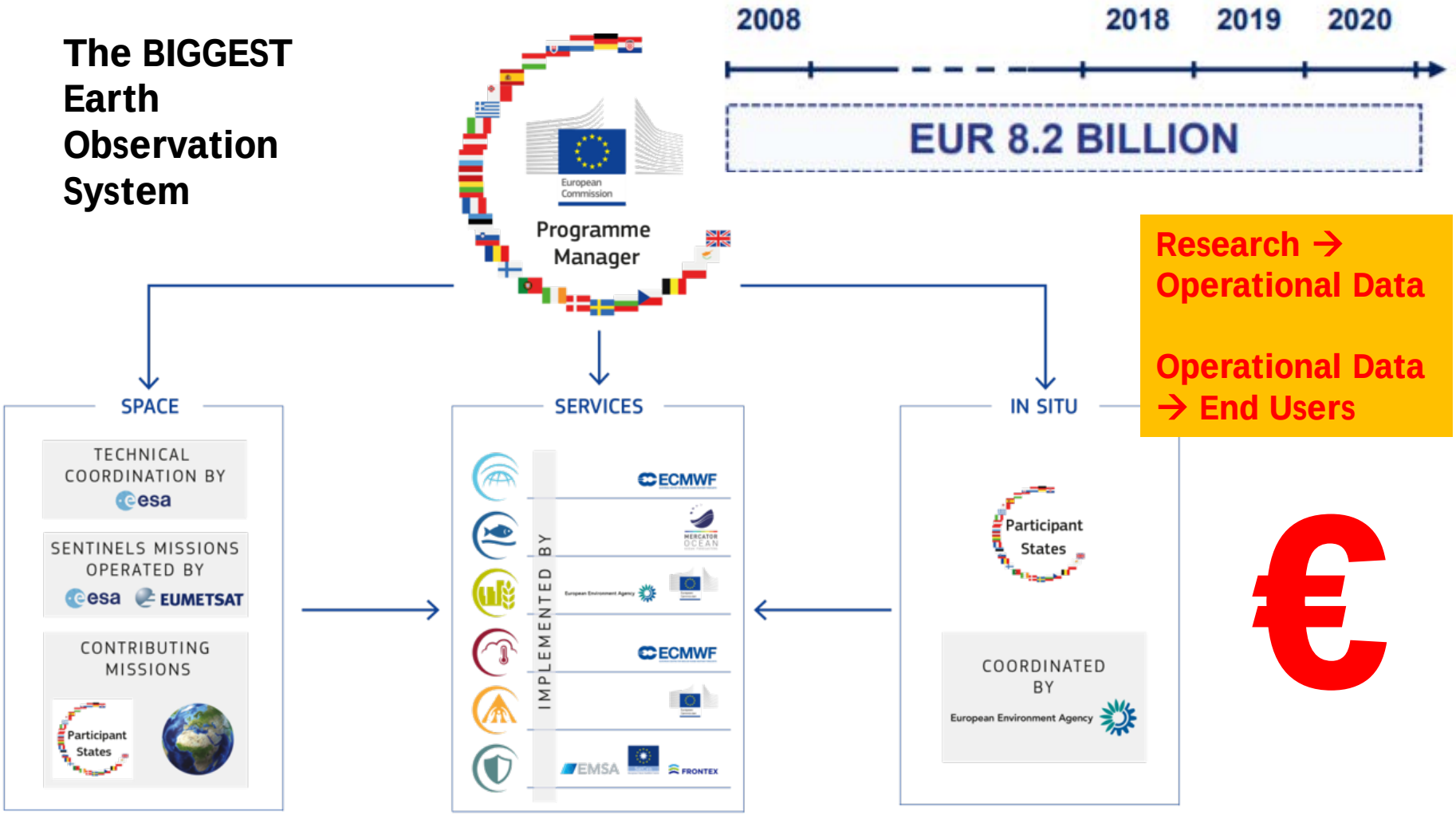
Copernicus | European Commission | European Environment Agency

ENHANCING MONITORING

COPERNICUS USER UPTAKE

Engaging with public authorities, the private sector and civil society

The BIGGEST Earth Observation System



Research → Operational Data

Operational Data → End Users

€

Copernicus Market report – Feb 2019

COPERNICUS USER UPTAKE

Engaging with public authorities, the private sector and civil society

In its 2016 Communication on a European Space Strategy (COM 2016 705 final) the "Commission's aim is to optimise the benefits that space brings to society and the wider EU economy. Achieving this means boosting demand among public and private users, facilitating access to and use of space data, and stimulating the development and use of innovative downstream applications. It also means ensuring the continuity and user-driven development of EU space programmes"

A principal element of achieving this aim is to enhance user uptake of Copernicus data and services. **The Commission has defined a User Uptake Strategy**, identifying objectives, key principles and 16 specific actions to implement user uptake measures in the framework of Copernicus and **CUP Network**.

The FPCUP (Framework Partnership Agreement "Copernicus User Uptake") consortium has scoped the actions to be implemented in an Action Plan, which is an Annex to the FPA between Commission and the Consortium.

Home > Opportunities > For public authorities > Framework partnership Agreement

Framework Partnership Agreement on Copernicus User Uptake (FPCUP)
Supplementary Work Programme 2019

Copernicus Hackathon

Tenders and Grants

Framework partnership Agreement

Copernicus

2017 MARKS THE BIRTH OF THREE NEW USER COPERNICUS UPTAKE TOOLS

Copernicus Relays

Copernicus Academy

Copernicus Support Office

Copernicus User Uptake Network: traditional partners such as existing thematic or geographic networks and industry, and new entities such as the Copernicus Contact Points and the Copernicus Academy

Acciones IHCantabria:

- 2018:
  - Tier 1: courses in the fields anagement (Ecc
  - **Tier**
  - Ti mic Growth
-
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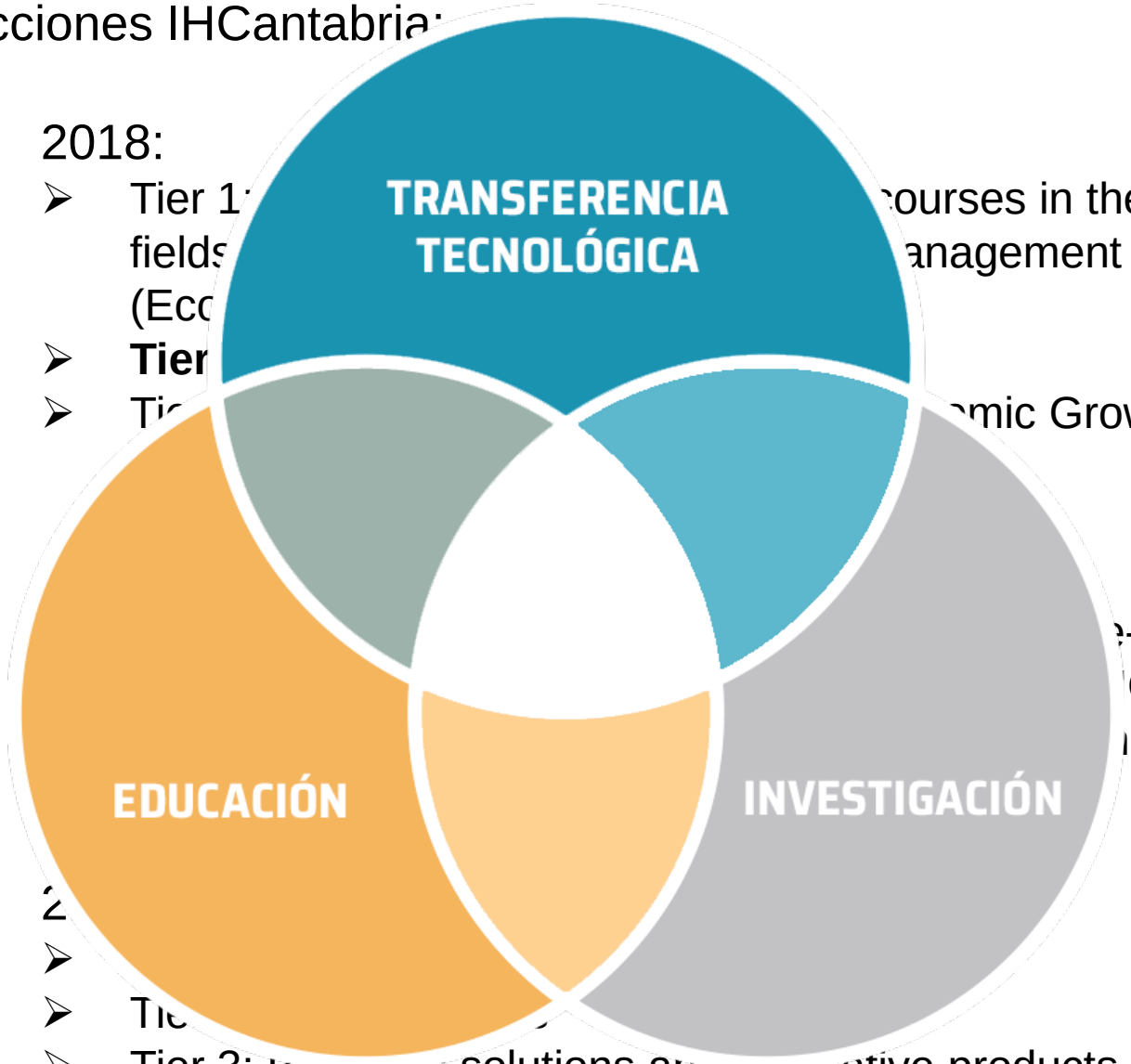
  - Tie
  - Tier 3: Bussines solutions and innovative products



FPA-CUP PURPOSE AND SCOPE

Engaging with public authorities, the private sector and civil society

This Action Plan describes five types of activities to be implemented:

1. National and multi-national information and training events, including workshops conducted by national institutions;
2. Building an active dialogue with actors in these measures regarding their needs;
3. Developing downstream applications and services, both for public institutions or companies with a need for EO-services;
4. Piloting downstream applications and services for public institutions in different Member States or Copernicus Participating States;
5. Promoting national and multi-national innovative actions.

Actions in FPCUP Work Programmes are generally named according to YEAR-TIER-NUMBER, e.g. 2019-3-03.

Global actions, including European cross-border user uptake and international user uptake (Tier 2)
The action of this Supplementary WP is under Tier 2 including European cross-borders user uptake and international user uptake activities.

Action Title		Partner
Tier 2: Global actions (1 additional Action)		
2019-2-49	Developing support for monitoring and reporting of GHG emissions and removals from land use, land use change and forestry	FMI, IGiK, SYKE, SRTI-BAS, CUNI, CBK PAN, Castra, IHCantabria, NUIM

THE ACTION 2019-2-49

Developing support for monitoring and reporting of GHG emissions and removals from land use, land use change and forestry (LULUCF). The objectives of the current Action are:

1. to examine existing reporting systems in the Member States (MS) while developing supports for monitoring and reporting of GHG emissions and removals from land use, land use change and forestry (LULUCF);
2. to propose developing a pan-European system for collectively estimating the change in carbon stocks and resulting GHG emissions and removals from land use, land use change and forestry;
3. to carry out a pilot study on the emerging methods for developing these estimates, building largely on Copernicus data and services such as CLC+ components and Sentinel imagery, with the aim of capitalizing LULUCF Monitoring on existing pan-EU data sets;
4. to evaluate these integrated national estimates at selected test regions using long-term time series of maps derived from satellite data.

Spatial Datasets + Methodology for unifying LULUCF spatial data

MITECO meetings – real needs – Copernicus solutions – Advisory group:

Success case studies

IMPLEMENTATION IN SPAIN

Three main axes:

1. **validation** of the National Emissions Inventory, i.e. time series of changes validated through RS data;
2. more **specificity** in the LULC types of interest (forests, grasslands, croplands, wetlands) by using Spatial Datasets available at the regional, national and EU levels (e.g. CLC +, IFN4 and MFE25 or specific analyses derived from projects or monitoring programs);
3. **Monitoring** and update of the LULC database since 2016 using S2 and auxiliary data.

1. LULUCF technicians from the Ministry
2. Advisory Research Group (Research centres and private companies)

Success case studies

NATURA 2000

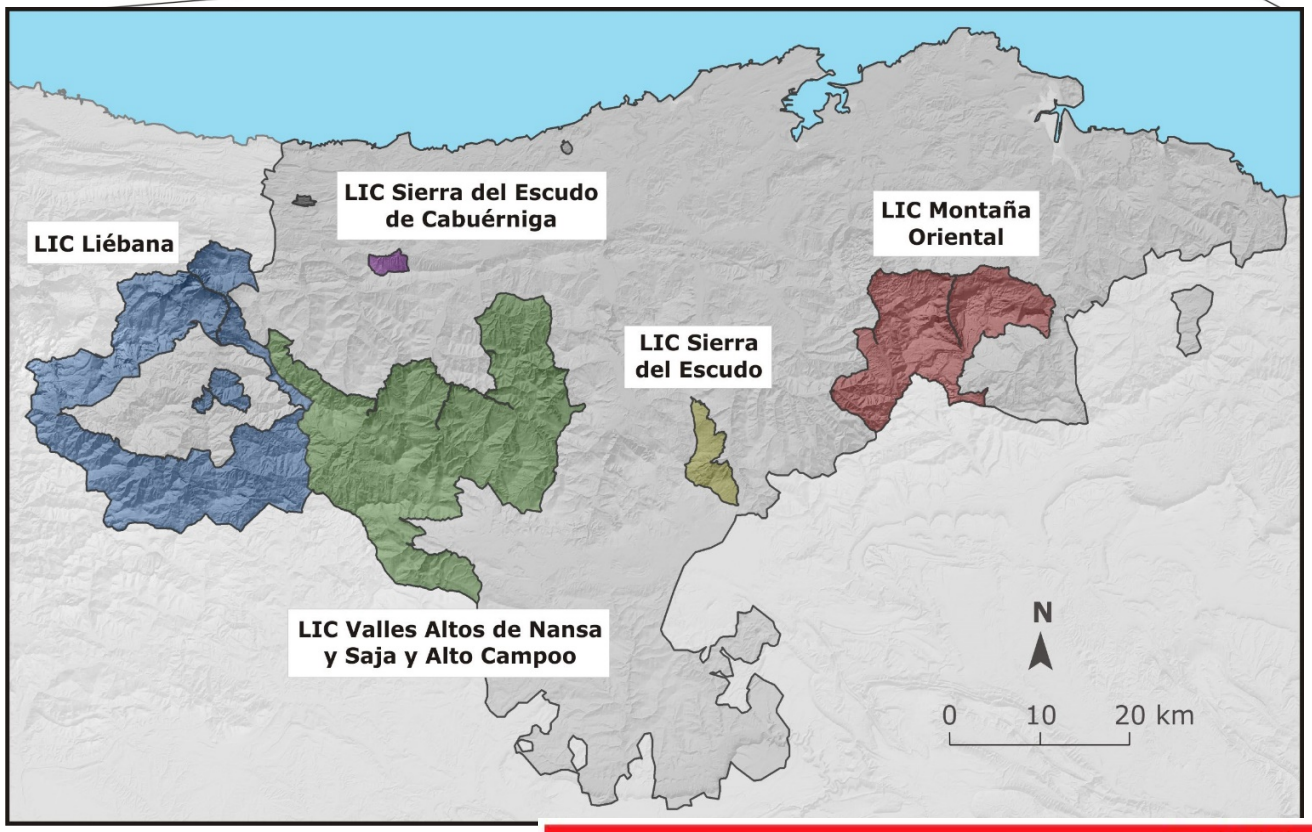
Management plan

Annex I

1. Spatial distribution
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. 25 hábitats...



Álvarez-Martínez et al, 2017

Methods in Ecology and Evolution
BRITISH ECOLOGICAL SOCIETY

LC TYPOLOGIES (habitats)

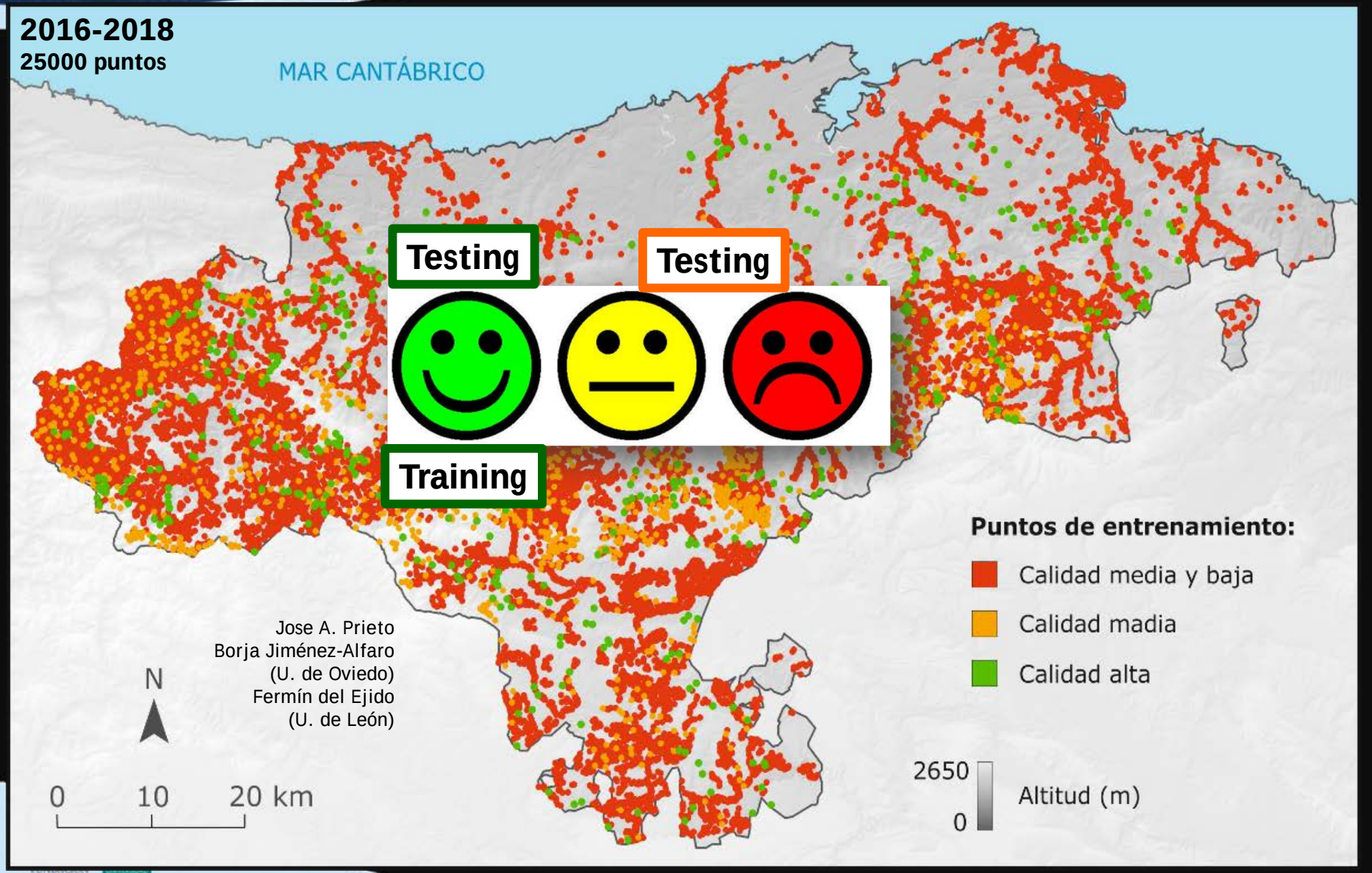
>100 EUNIS 3-5 level habitat types

Borja Jiménez-Alfaro
(U. de Oviedo)

EUNIS typologies in Cantabria

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

TRAINING DATA



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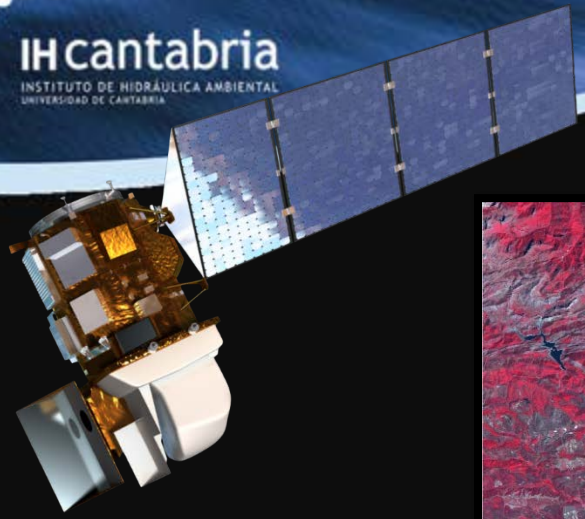
PREDICTOR LAYERS



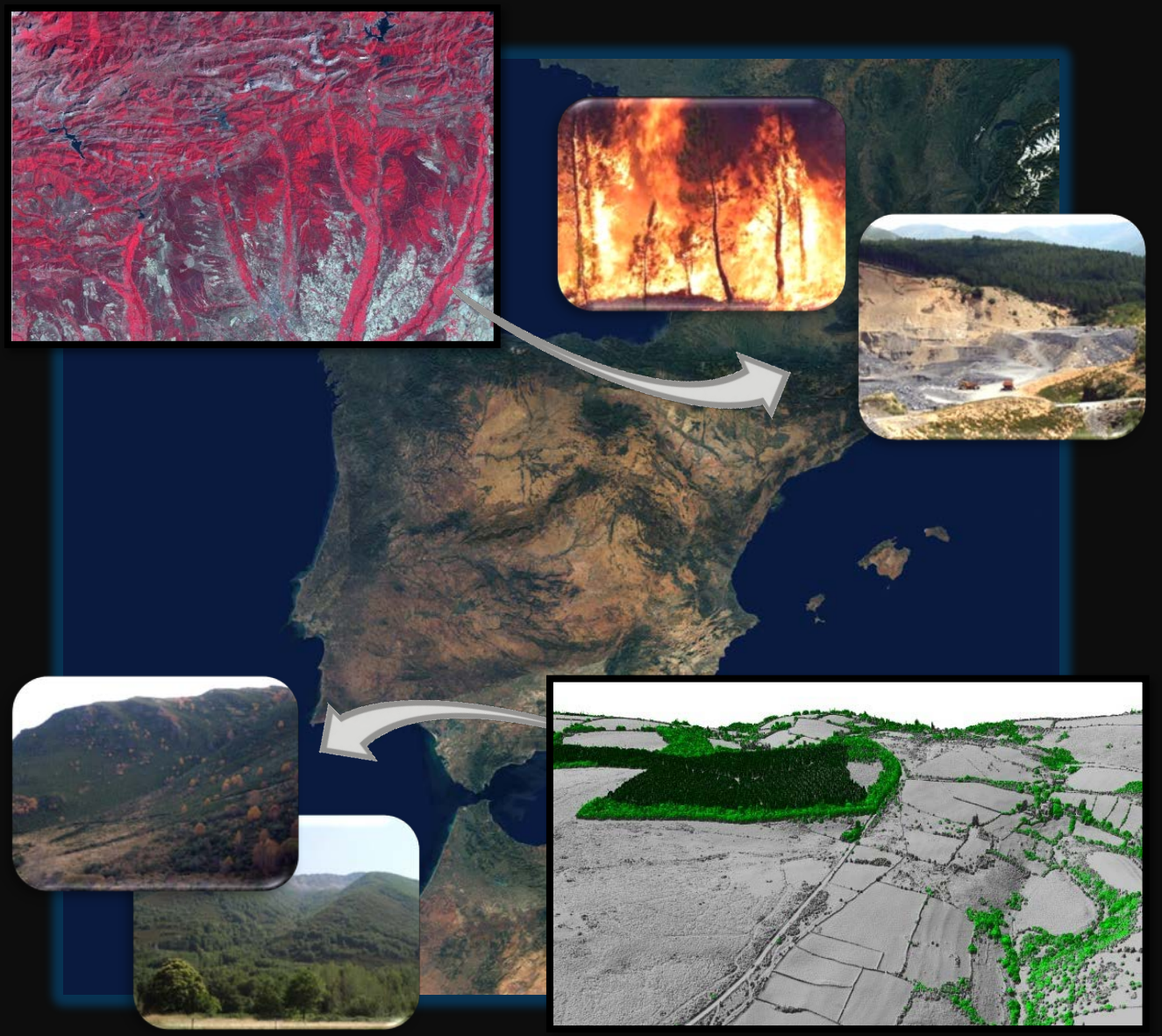
Remote Sensing (RS)

Satellite imagery:
Landsat 5TM and 8OLI 30m
Sentinel 2 A and B, 10-20m
DEIMOS-2, 4m

LiDAR derived data, 5-30m

ENV. LIMITING FACTORS

topography, climate, soil



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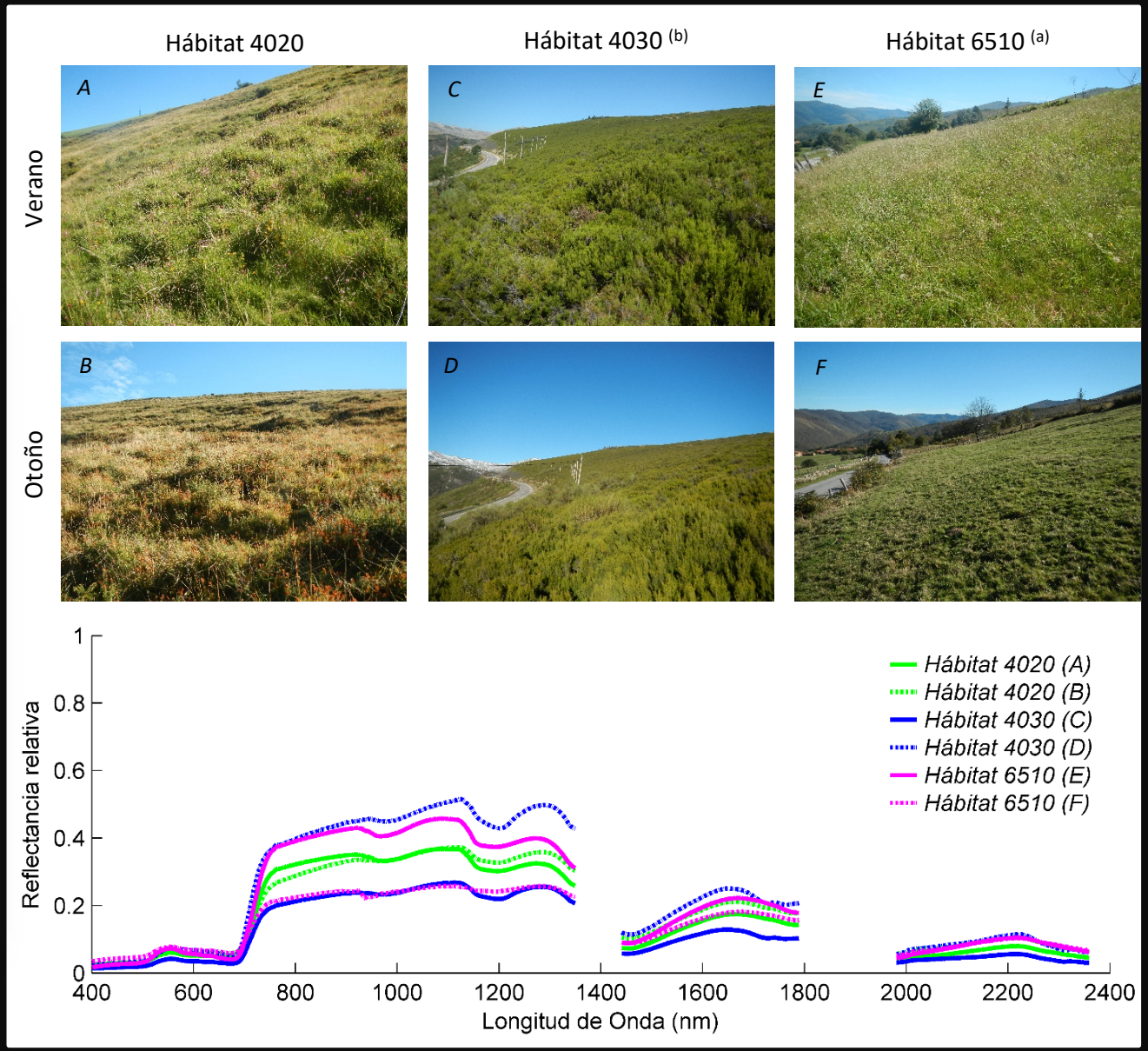
SPECTRAL SIGNATURES

Soectral library:
HABITAT TYPES
Pasture campaign
year 2020 (N2000)



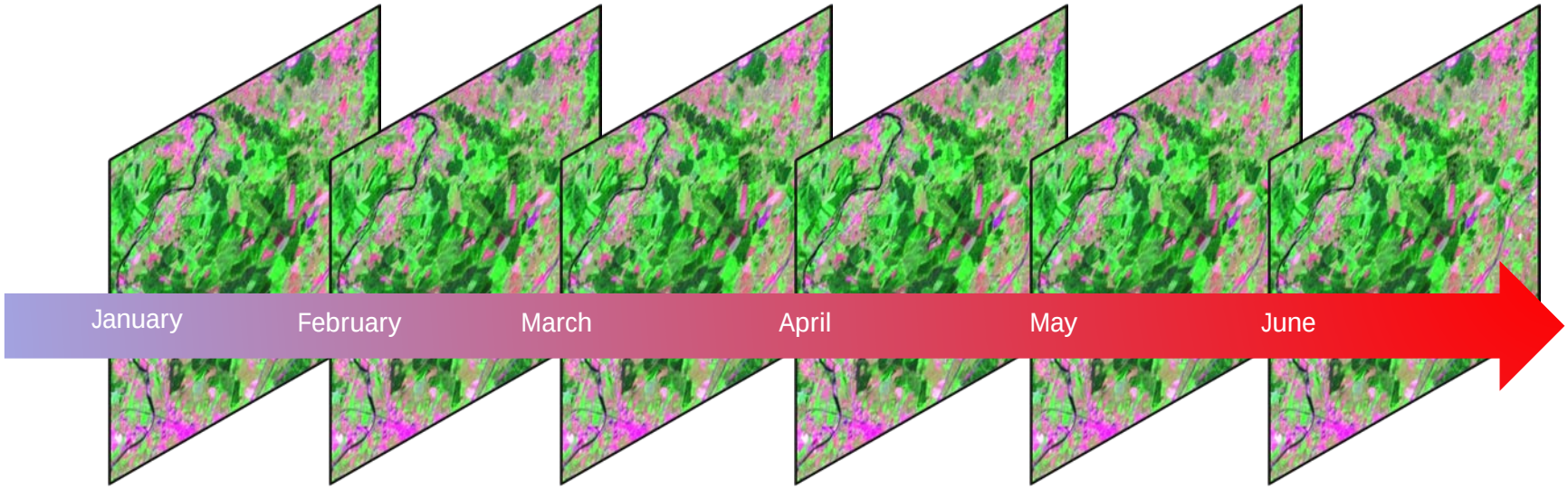
MONITORING LULC

Processing in real time of data series of imagery

Landsat, MODIS and Sentinel 2

Daily data for the 2000-present period.

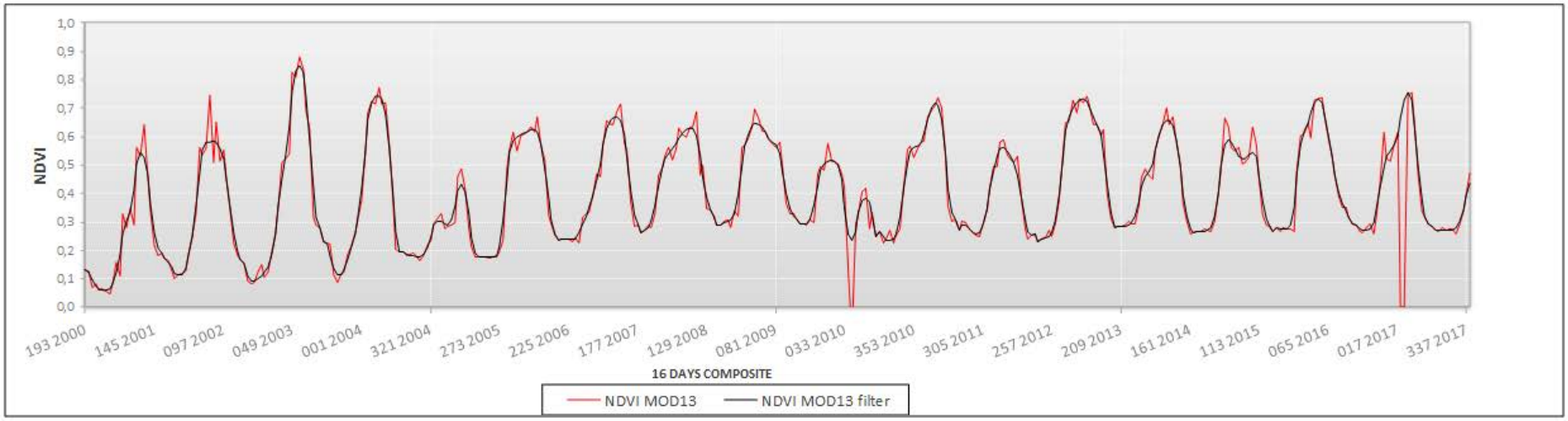
itd
medioambiente



MONITORING LULC

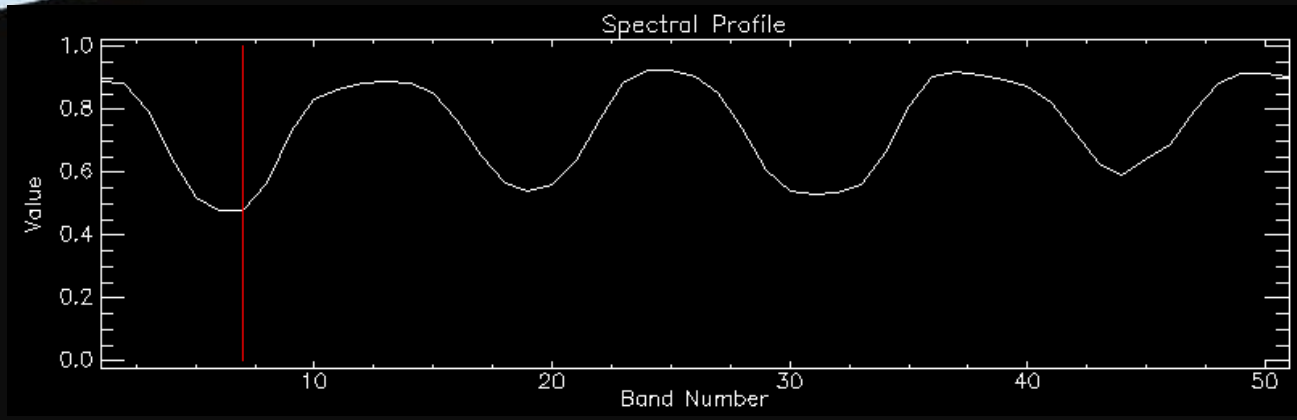
N2K PROTECTED AREA DOÑANA NATIONAL PARK (ANDALUSIA-SOUTHERN SPAIN)

TEMPORAL PROFILE

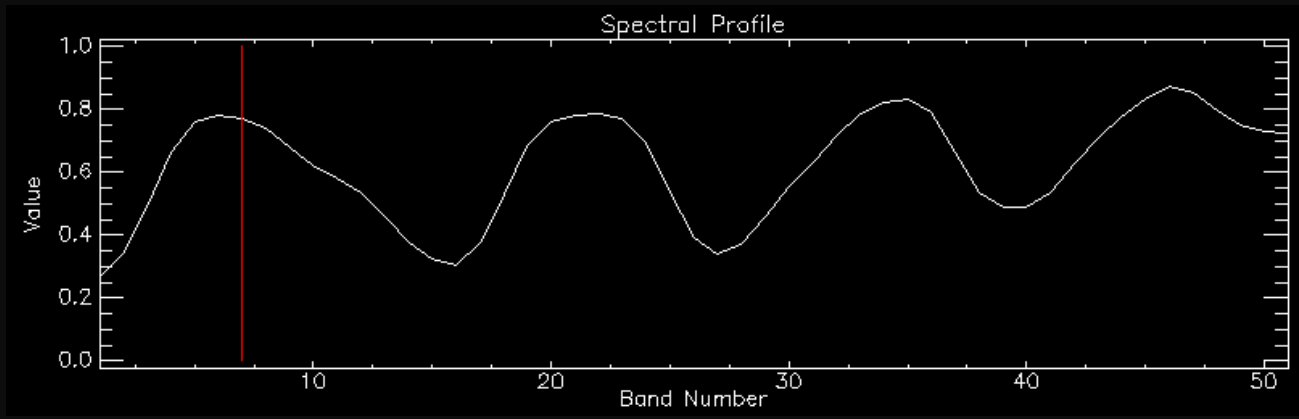


MONITORING LULC

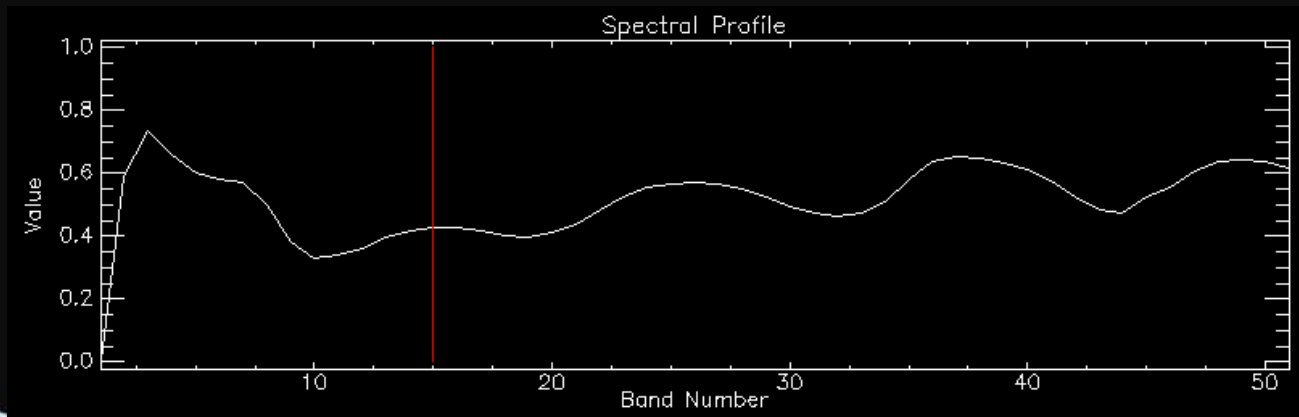
Beech forest,
Stable,
Climatic variation



Secondary succession
Grassland decrease
Higher minimums



Vetetation recovery
after fire

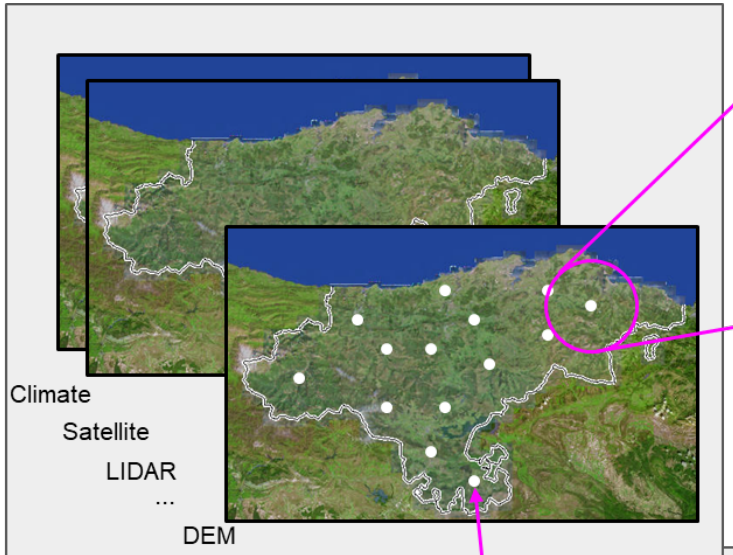


DEEP LEARNING PROCESSING

Deep learning

```
def define_model(self):
    input_shape = (self.channels, self.rows, self.columns,)
    mo = Sequential()
    mo.add(
        normalization.BatchNormalization(input_shape=input_shape, axis=1))
    mo.add(
        Conv2D(6, (1, 1), activation='relu', input_shape=input_shape))
    mo.add(MaxPooling2D((2, 2)))
    mo.add(Conv2D(12, (1, 1), activation='relu'))
    mo.add(MaxPooling2D((2, 2)))
    mo.add(Flatten())
    mo.add(Dense(self.eunis_types, activation='softmax'))
    mo.compile(loss='categorical_crossentropy',
               optimizer=keras.optimizers.Adam(),
               metrics=['acc', 'binary_accuracy'])
    return mo

def train(self, x_train, y_train, trained_model_path=None):
    x_train, y_train = self.reshape_matrices(x_train, y_train)
    file_name = None
    if trained_model_path is None:
        mo = self.define_model()
        mo.fit(x_train, y_train, epochs=100, batch_size=32, verbose=1)
        # Save trained model
        file_name = self.save_model_and_headers(mo)
    else:
        # load
        mo = load_model(trained_model_path)
    return mo, file_name
```



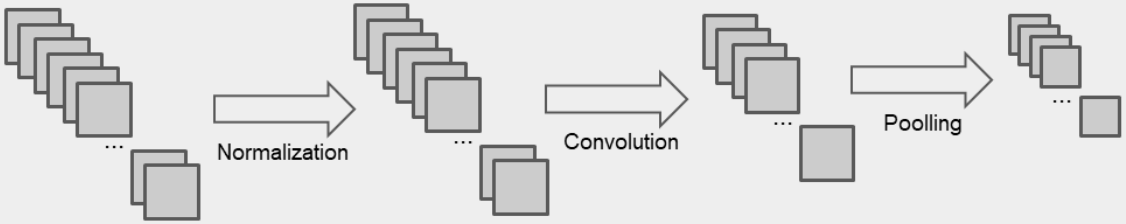
Predictor: 64 bands
Predictand: ~2500 samples of 15 EUNIS habitats

64 x 2500
sub images (11x11 pixels)

Data augmentation
with balancing

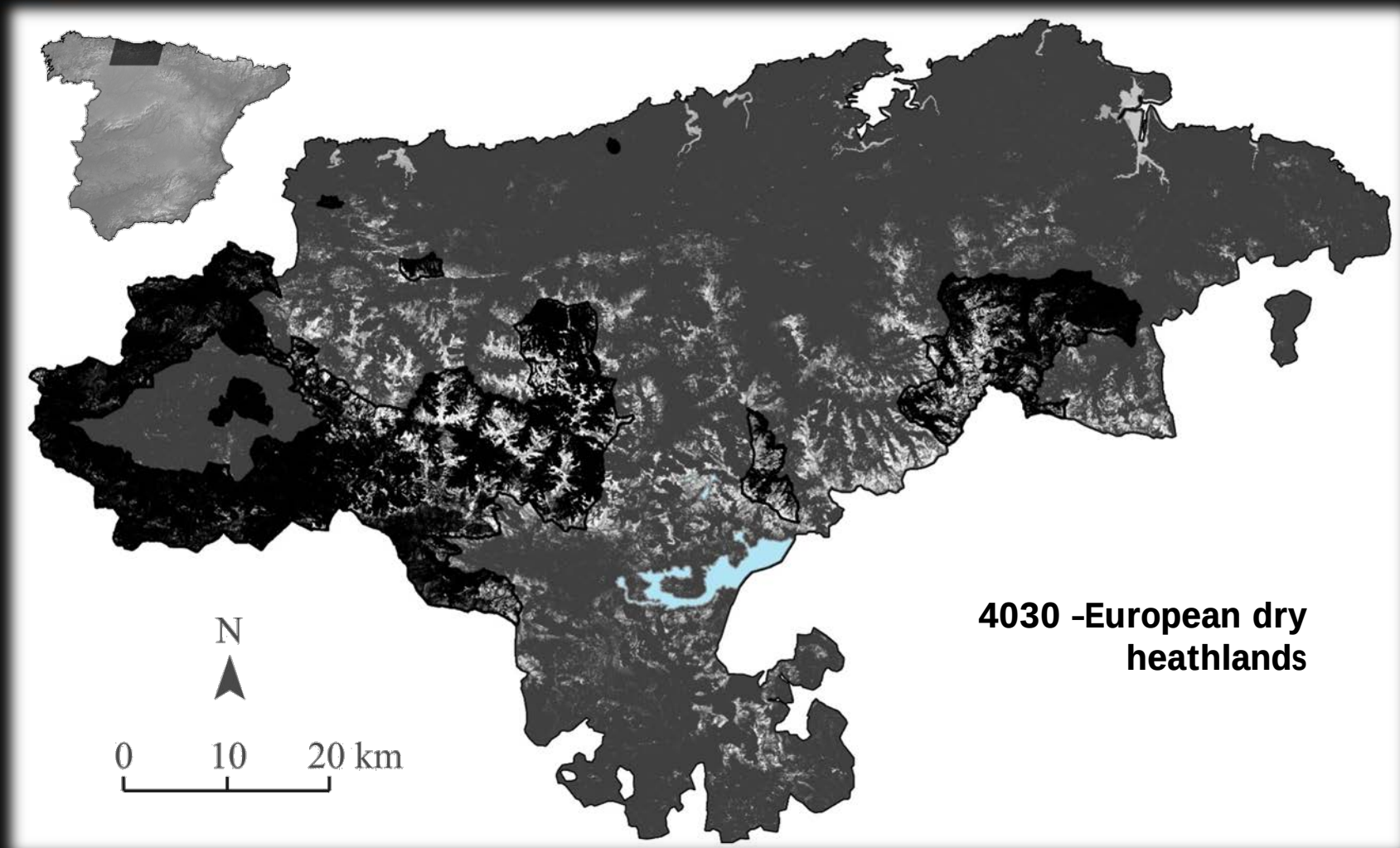
TensorFlow

Deep neural network



Deep learning is a class of machine learning algorithms that use a cascade of multiple layers of nonlinear processing units for feature extraction and transformation to learn about the feature to represent by using supervised or unsupervised appraches

AREA OF OCCUPANCY



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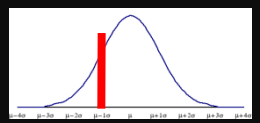
Local AOO



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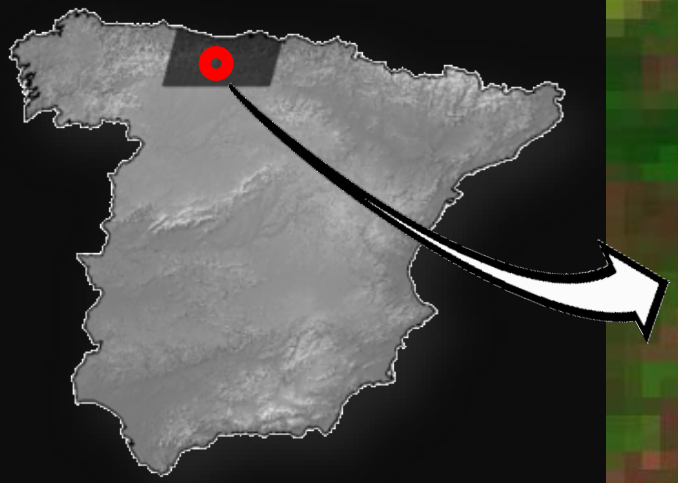
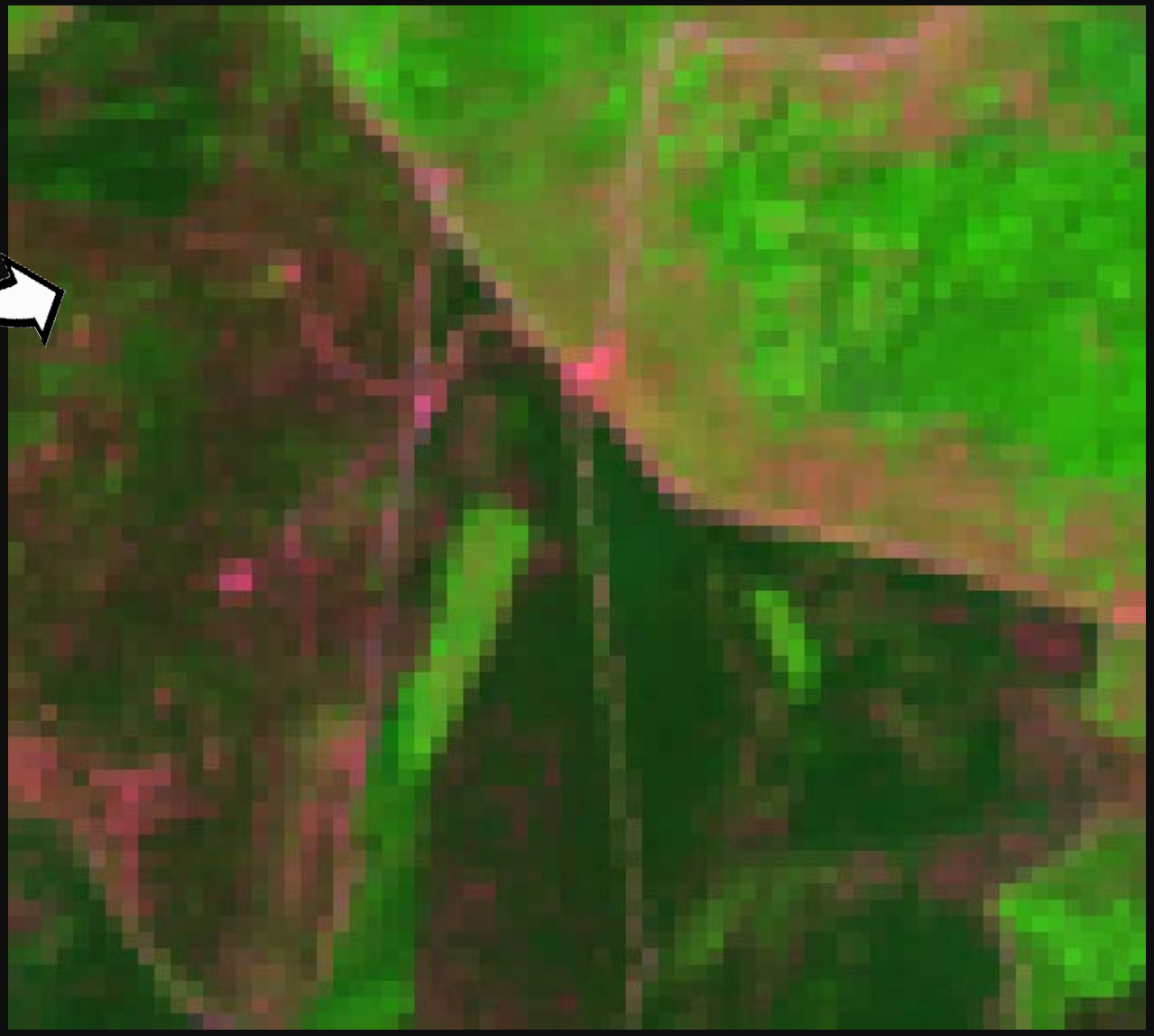
LANDSAT 8 OLI IMAGERY

Higher sun elevation and minimum cloud cover from USGS and ESA





Zoom

175_033
false_color_752
Reflect BOA
Roads detail

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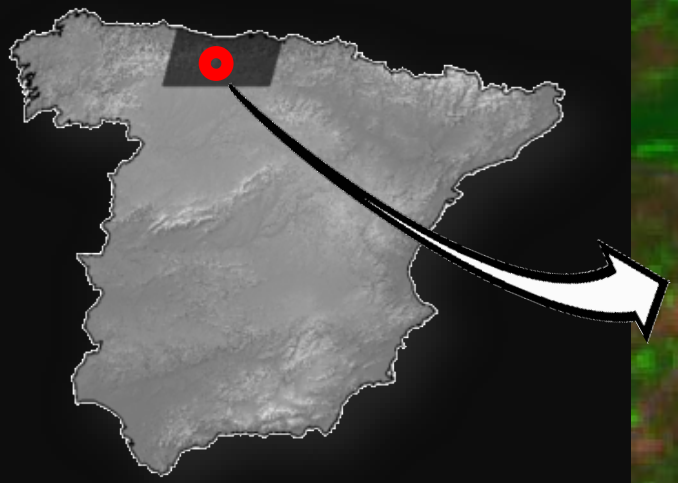
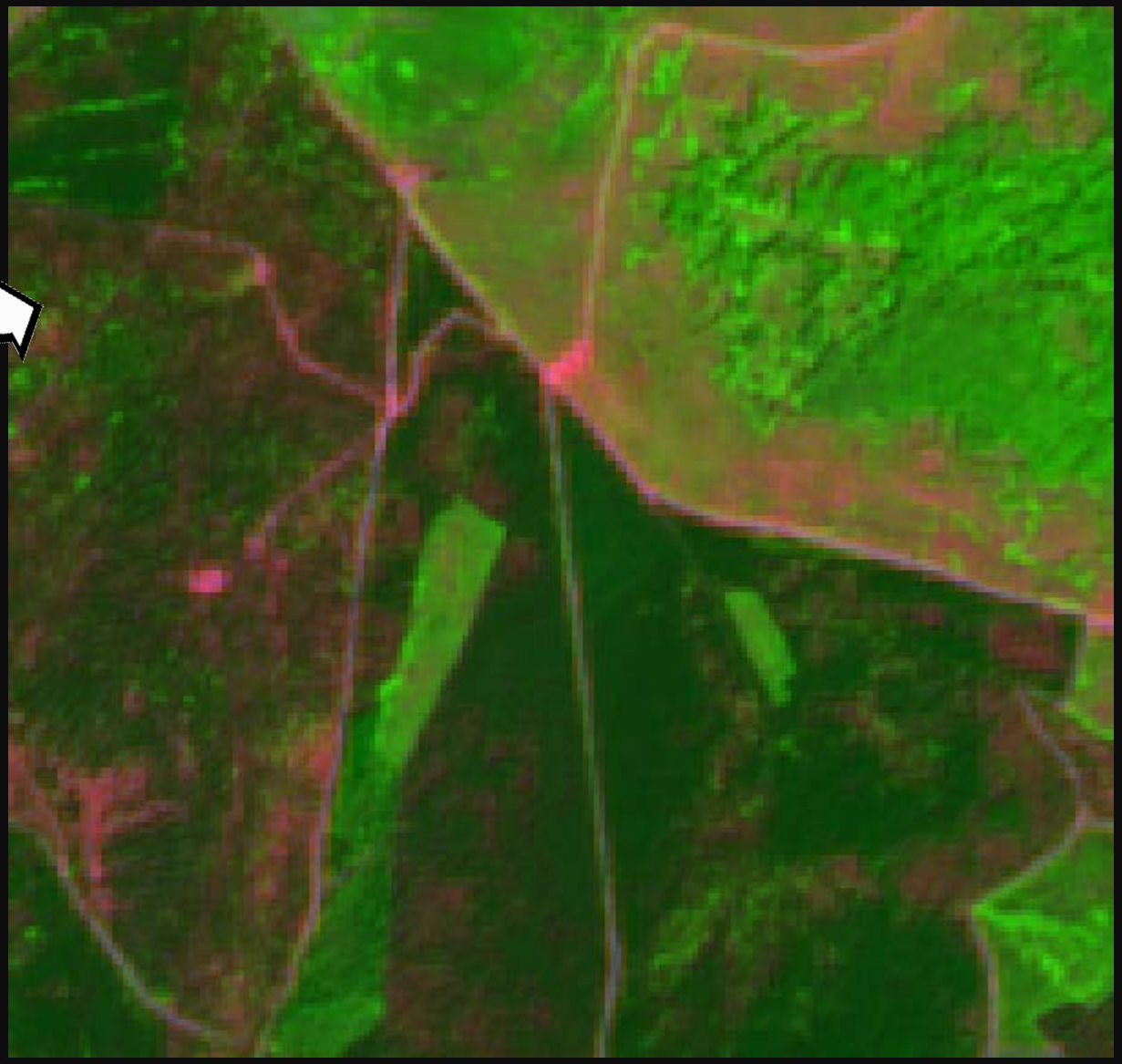
SENTINEL 2A IMAGERY

Higher sun elevation and minimum cloud cover from ESA





Zoom

Sentinel_2A_1282
ReflecBOA_topo
Roads detail

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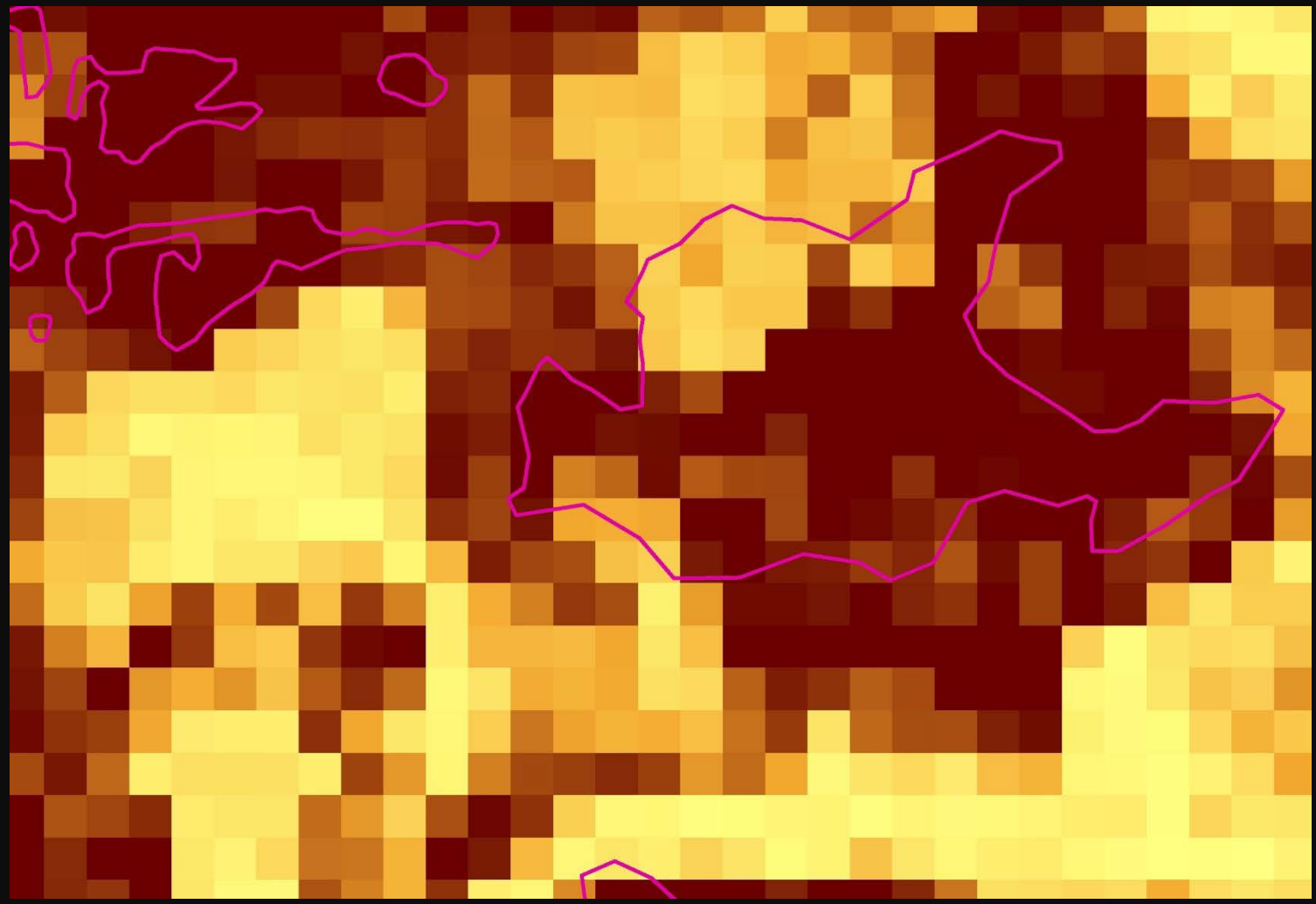
MODELLING RESULTS

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

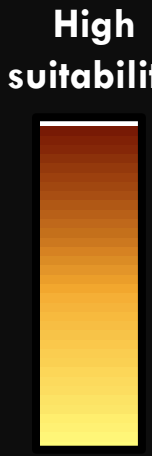


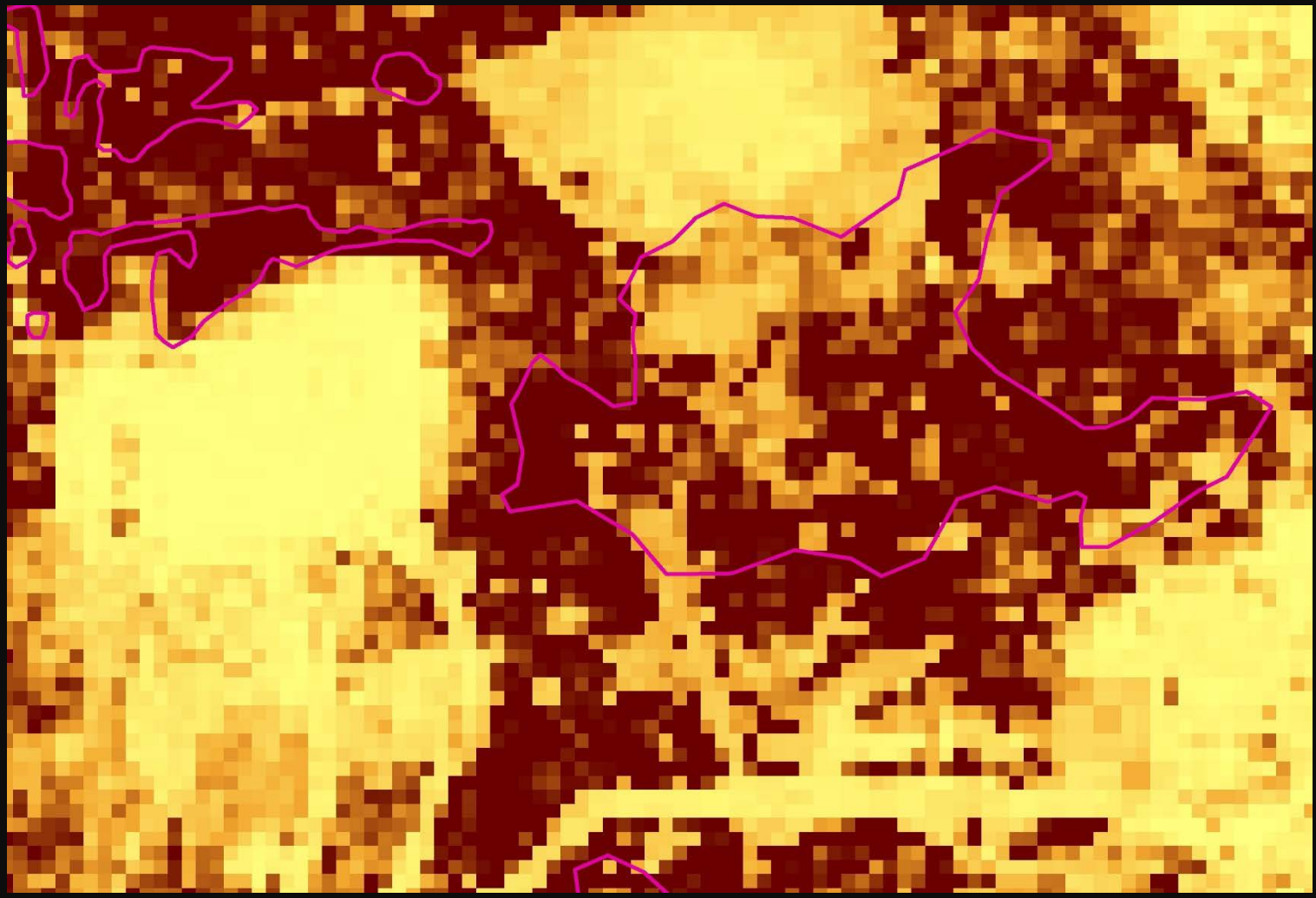
High suitability

Low suitability

MODELLING RESULTS

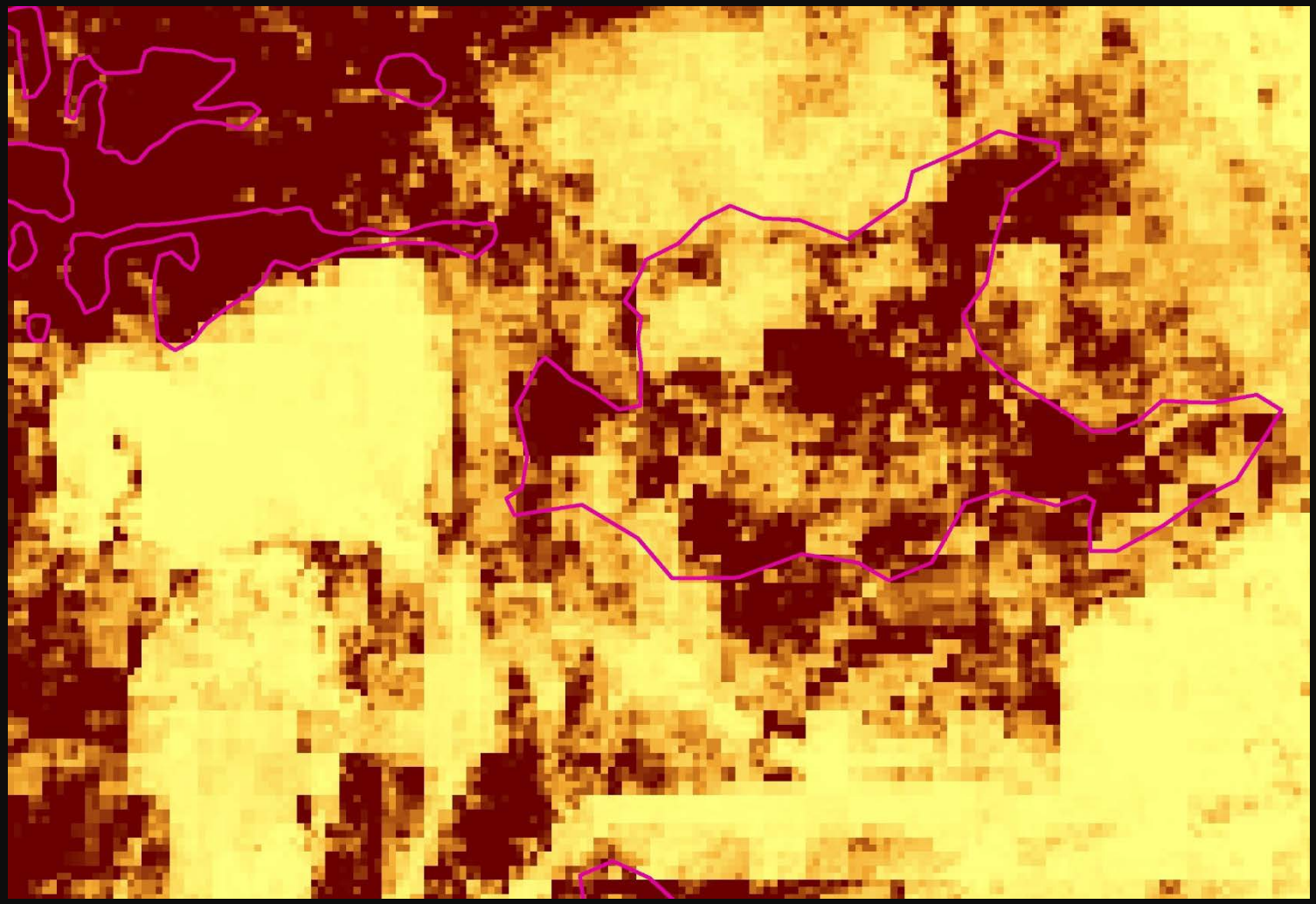
Landsat 8 MVC
Landsat8 x2
Sentinel2 x2
Deimos2 x2
+LiDAR +MDT





MODELLING RESULTS

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



High suitability

Low suitability

¡Gracias!

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