



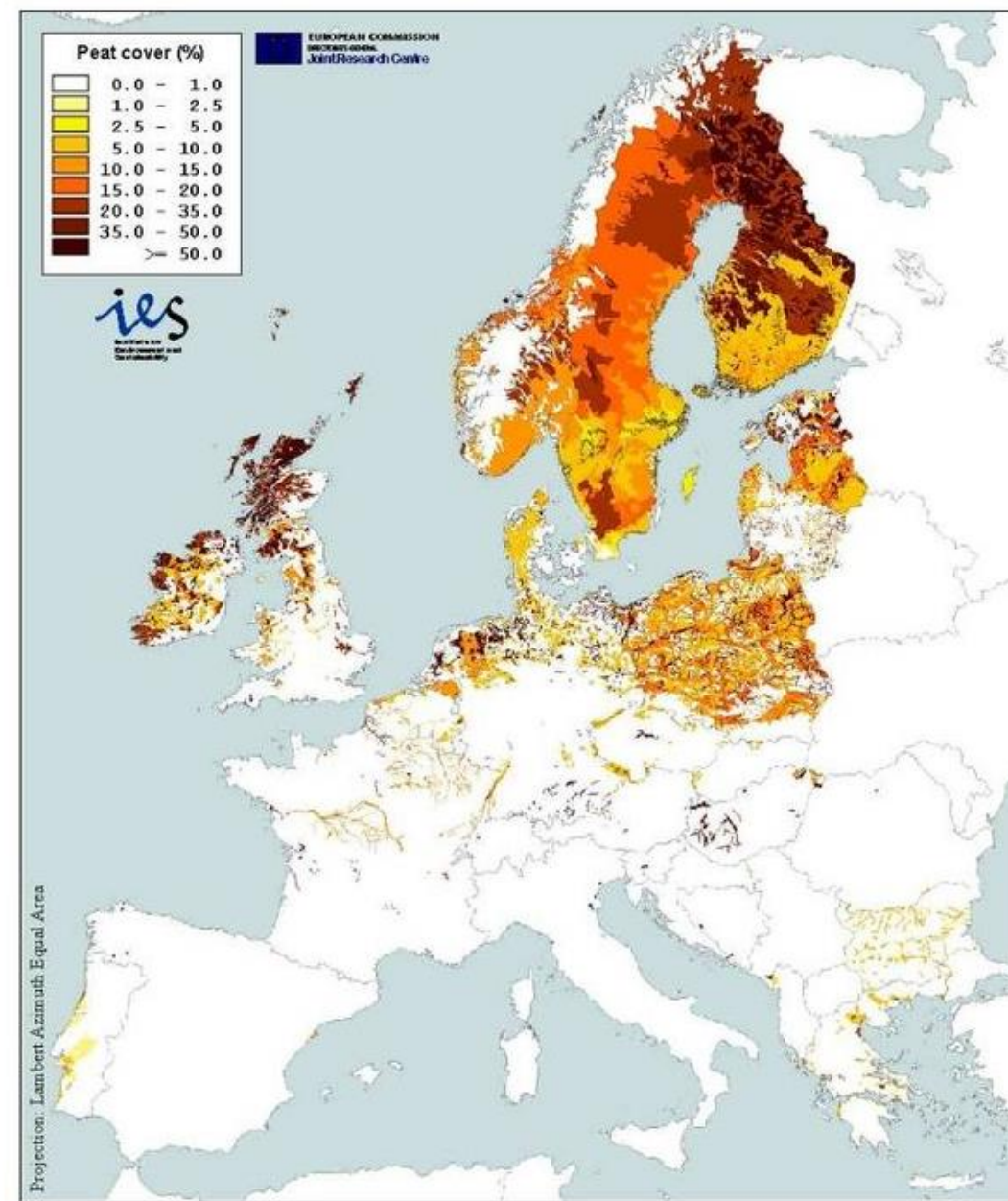
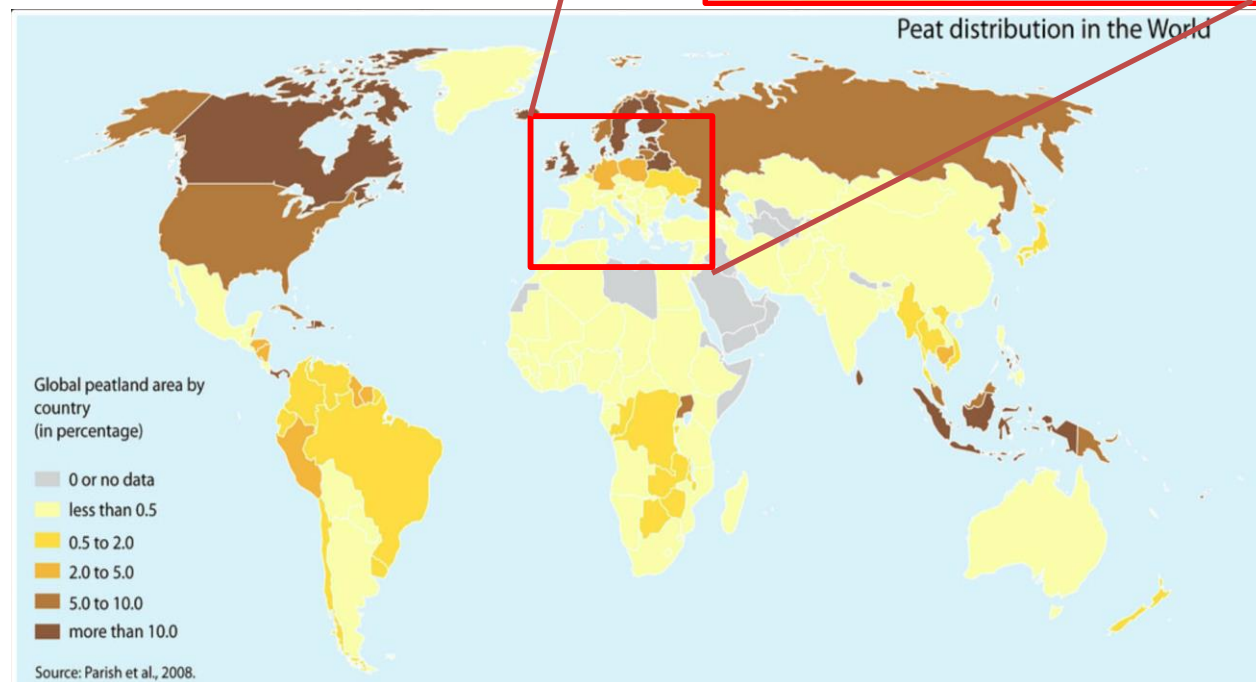
ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA
CAMPUS DI RAVENNA

Characterization of Alpine peatlands based on remote sensing of vegetation and water content

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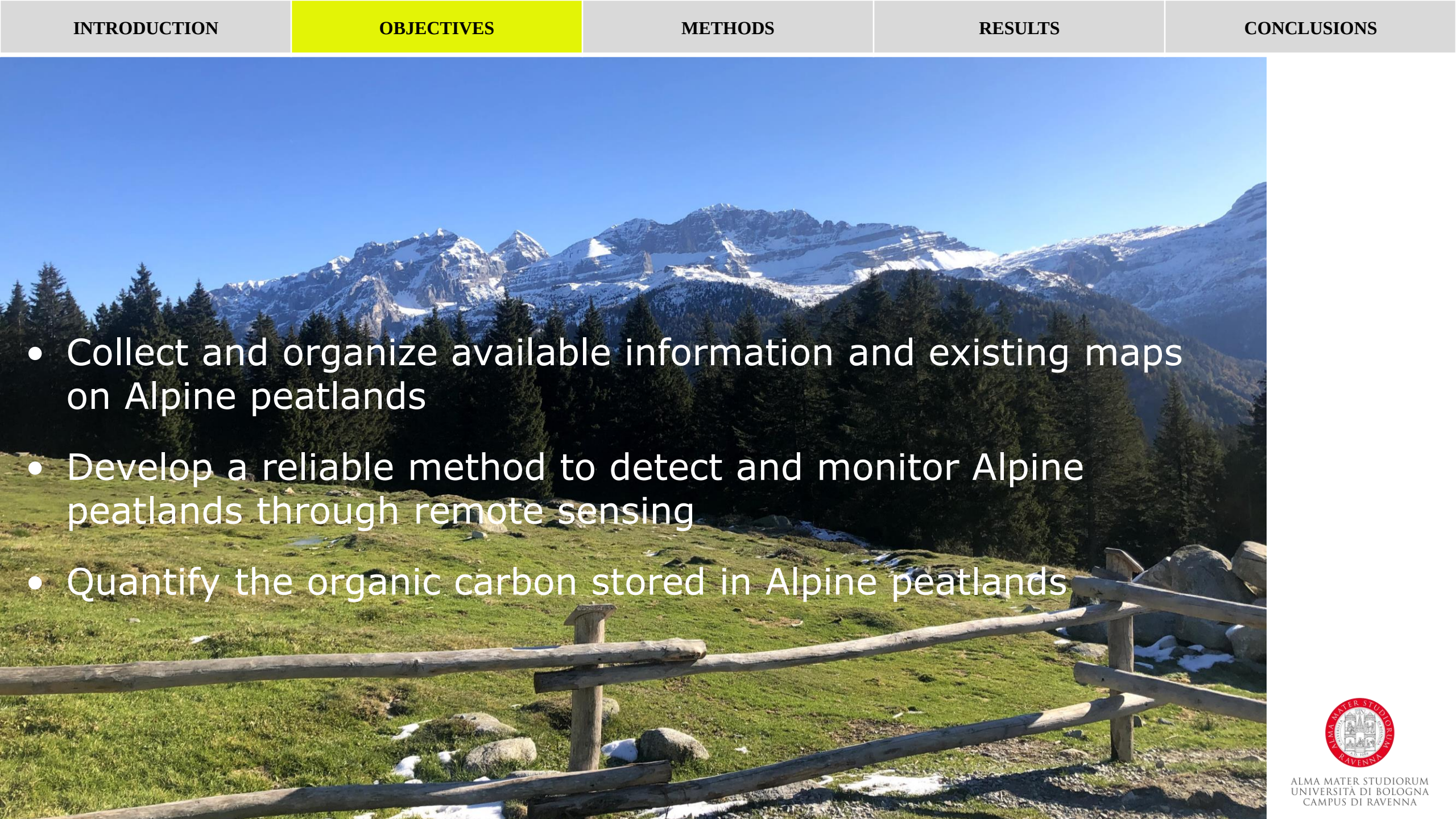
The presence of peatlands on the Alps is rarely included in global or EU maps.





Alpine peatlands support a number of ecosystem services as for example water retention and mitigation of droughts and floods, water purification, water availability to wildlife, carbon sequestration and storage.



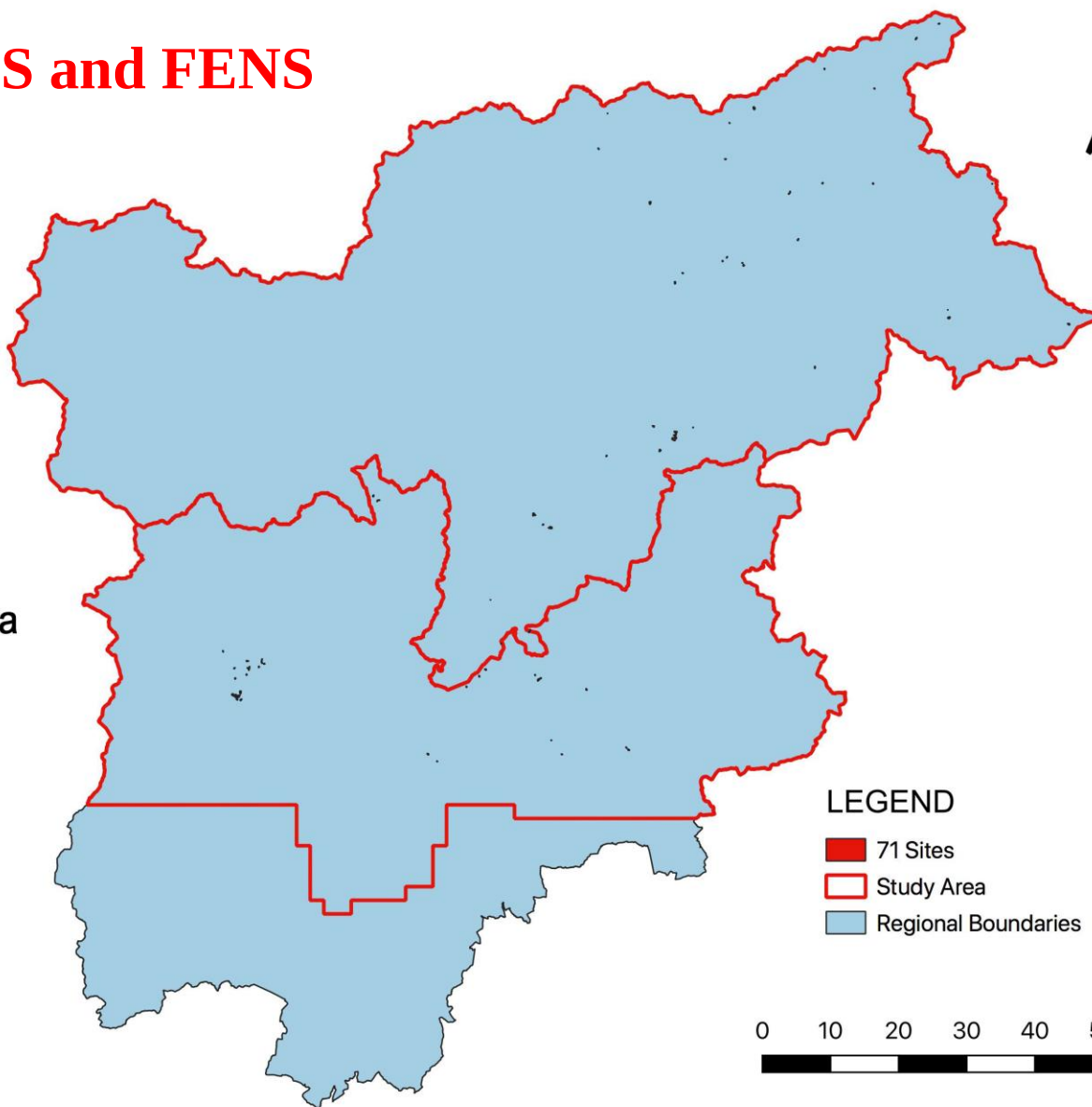
- 
- Collect and organize available information and existing maps on Alpine peatlands
 - Develop a reliable method to detect and monitor Alpine peatlands through remote sensing
 - Quantify the organic carbon stored in Alpine peatlands



71 BOGS and FENS

DATA SOURCES:

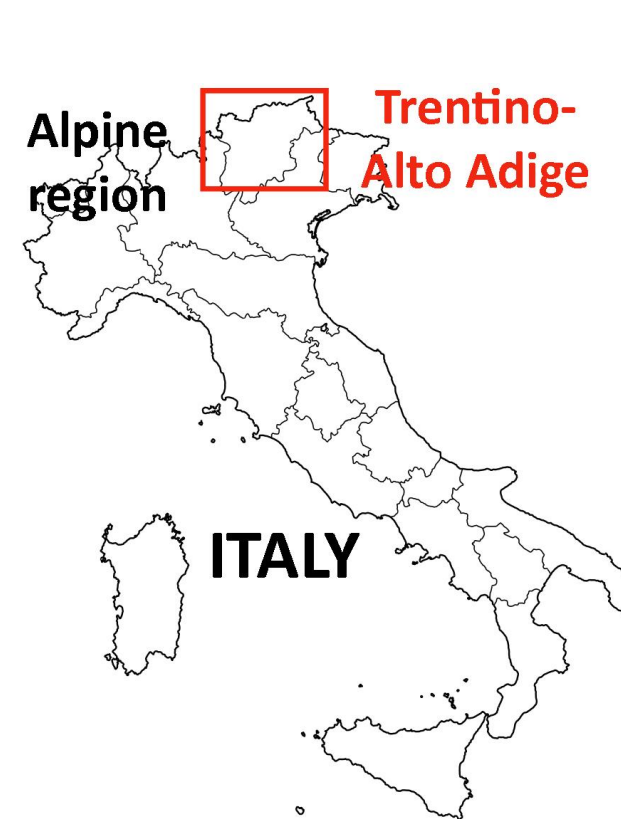
- Geocatalogue of the autonomous province of Bolzano;
- Natura 2000 sites;
- Vedrette di Ries-Aurina Nature Park;
- Corine Land Cover project;
- Previous studies.



LEGEND

- 71 Sites
- Study Area
- Regional Boundaries

0 10 20 30 40 50 km



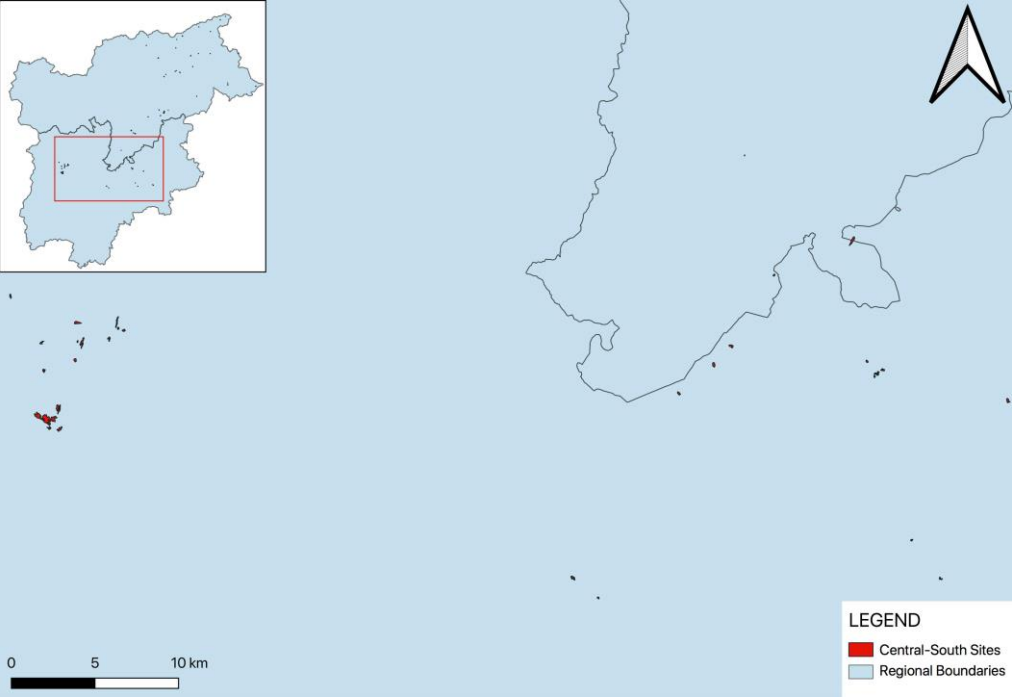
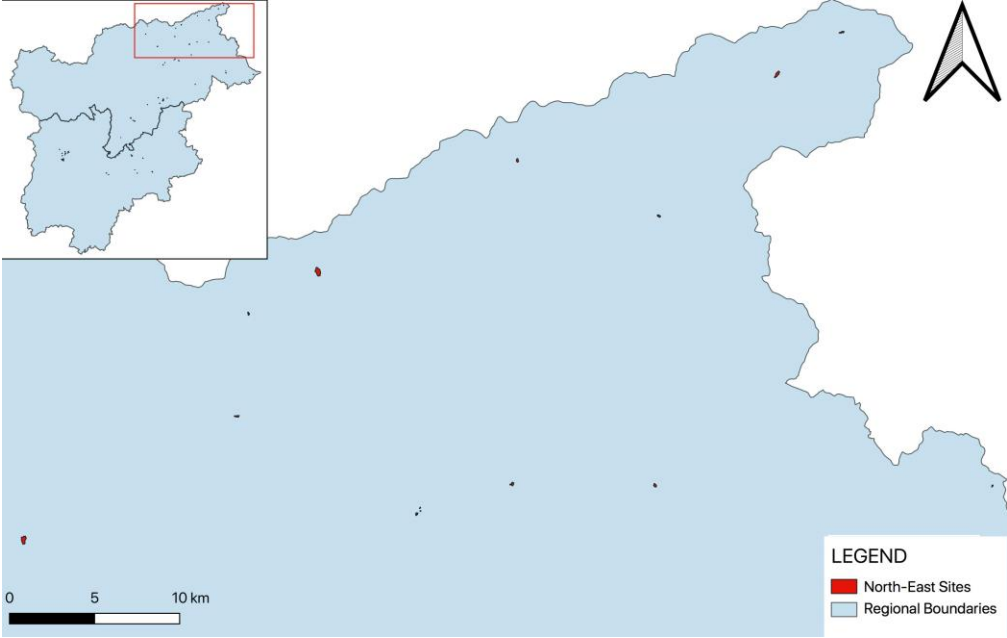
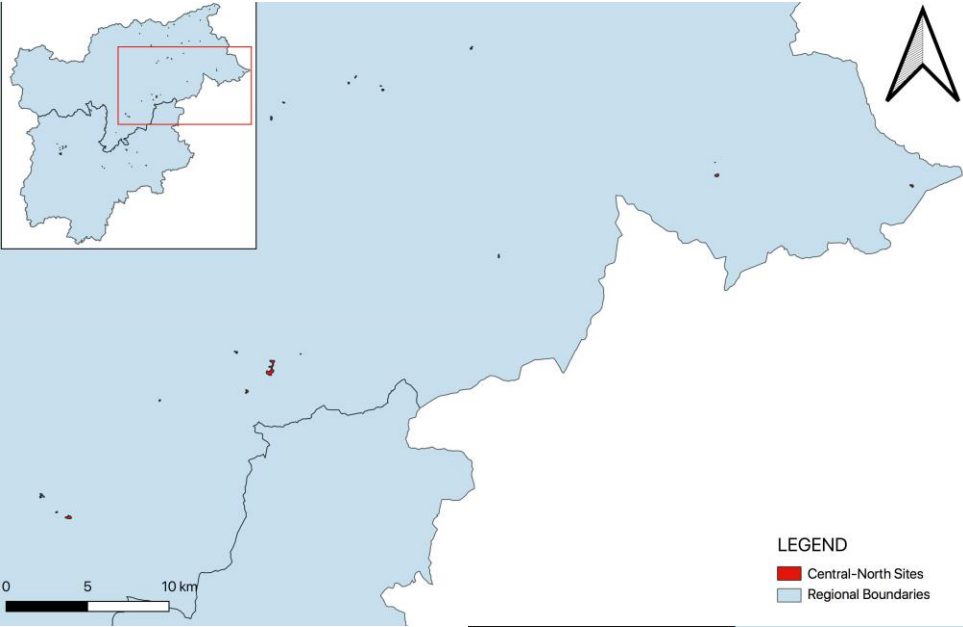
INTRODUCTION

OBJECTIVES

METHODS

RESULTS

CONCLUSIONS



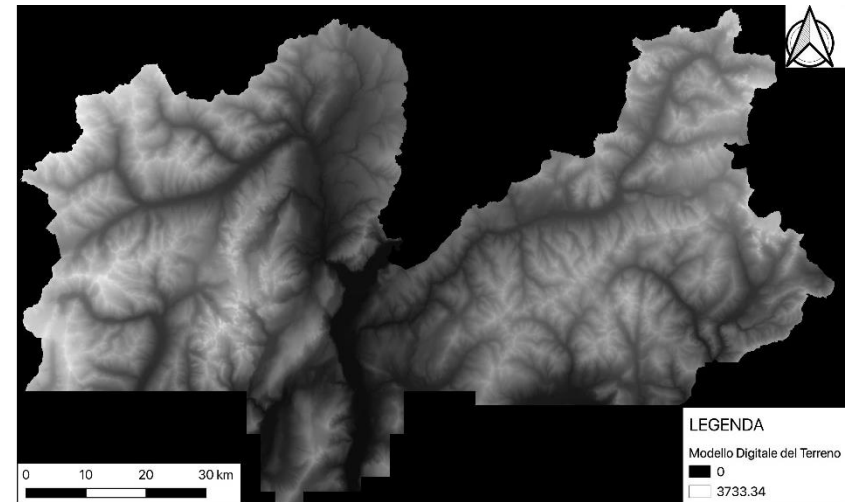
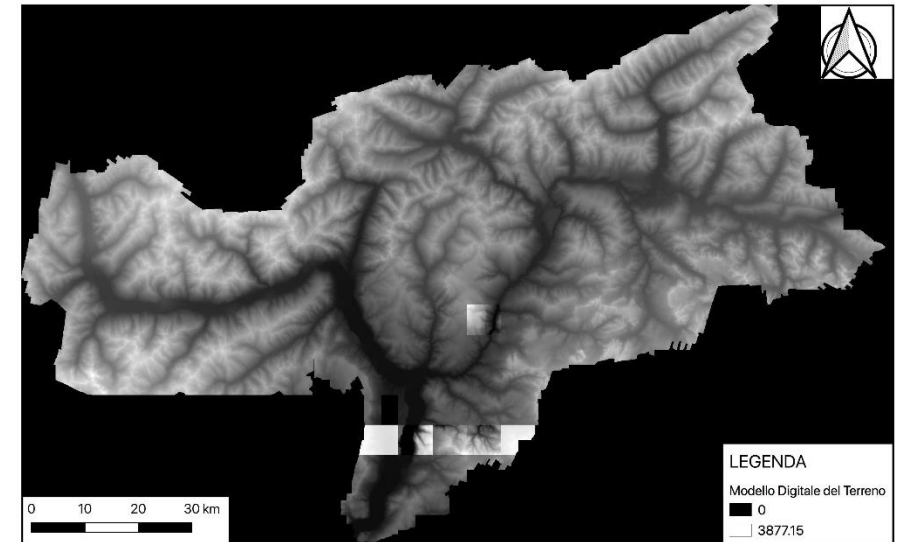
2m resolution Digital Terrain Model (DTM)

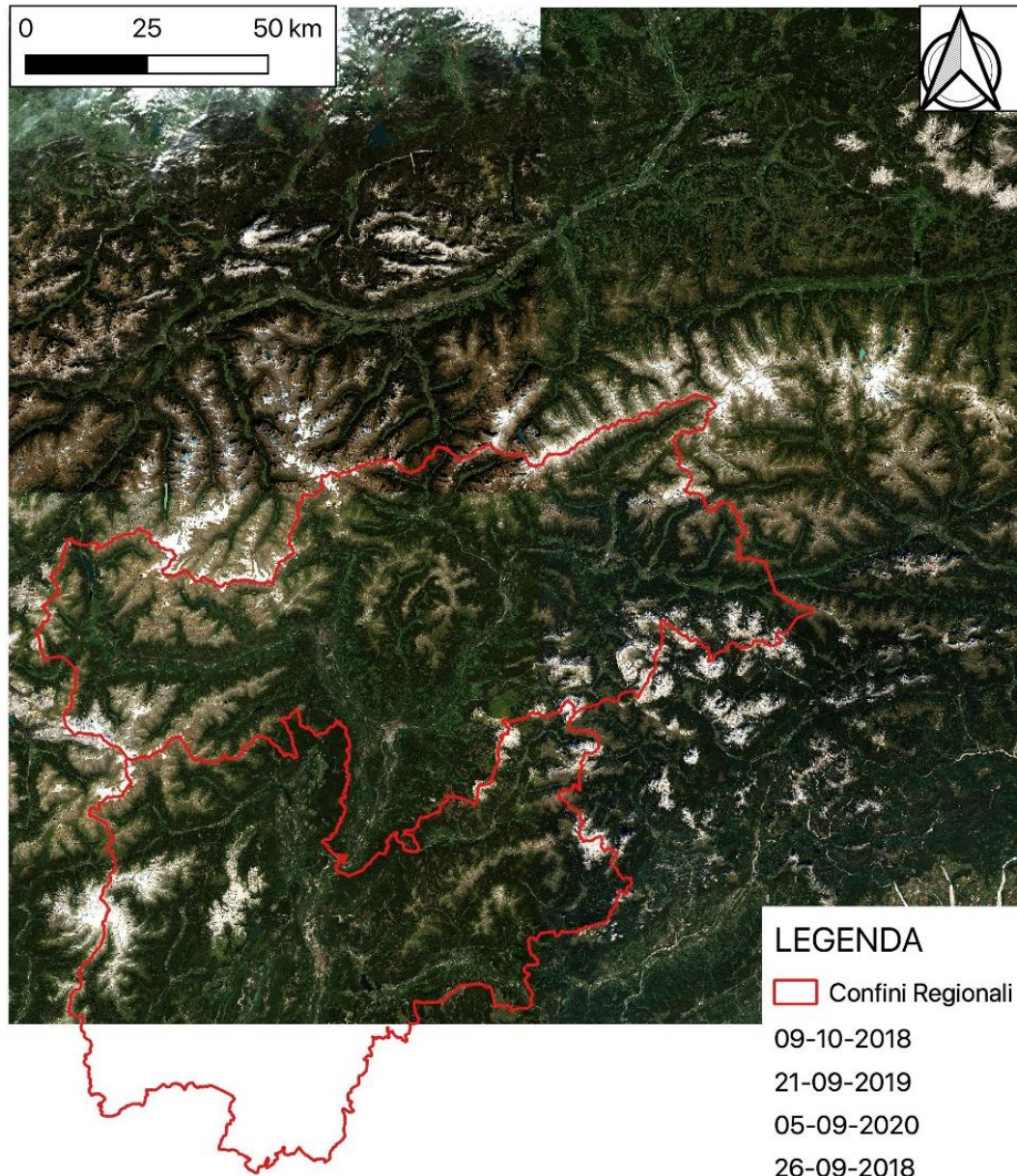


Statistics on the slope of the 71 sites:
average slope = 8.4°
 $2 \cdot \text{st dev} = 14.66^{\circ}$



Creation of a MASK to exclude steep surfaces:
areas with slope $> 25^{\circ}$ excluded from analyses





Four Sentinel-2 level 2A images (2018-2020)
(low cloud and snow cover)

BANDS resampled to 10 m

Band 2 - Blue

Band 3 - Green

Band 4 - Red

Band 5 - Vegetation Red Edge

Band 6 - Vegetation Red Edge

Band 7 - Vegetation Red Edge

Band 8 - NIR

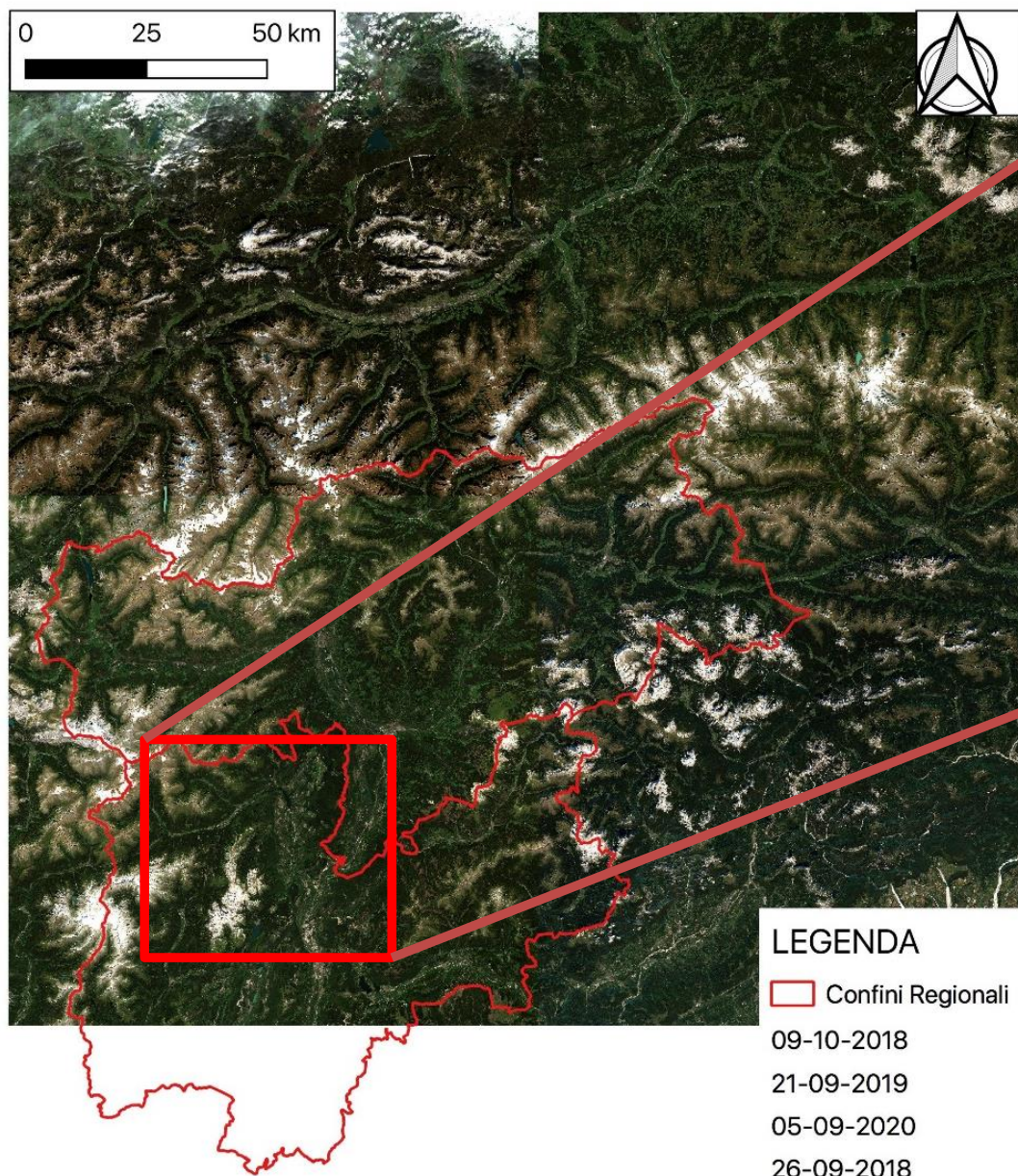
Band 8A – Vegetation Red Edge

Band 11 - SWIR

Band 12 - SWIR

Images downloaded from the
Copernicus Open Access Hub

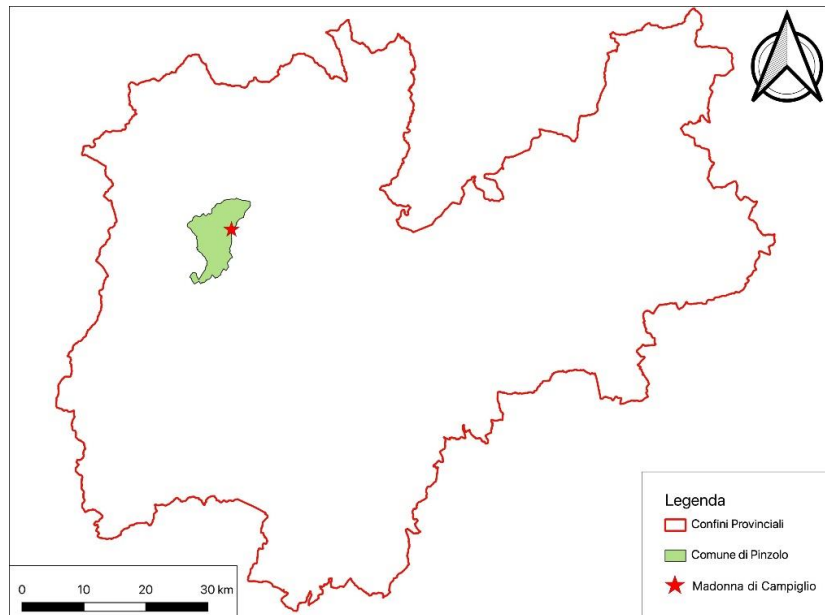




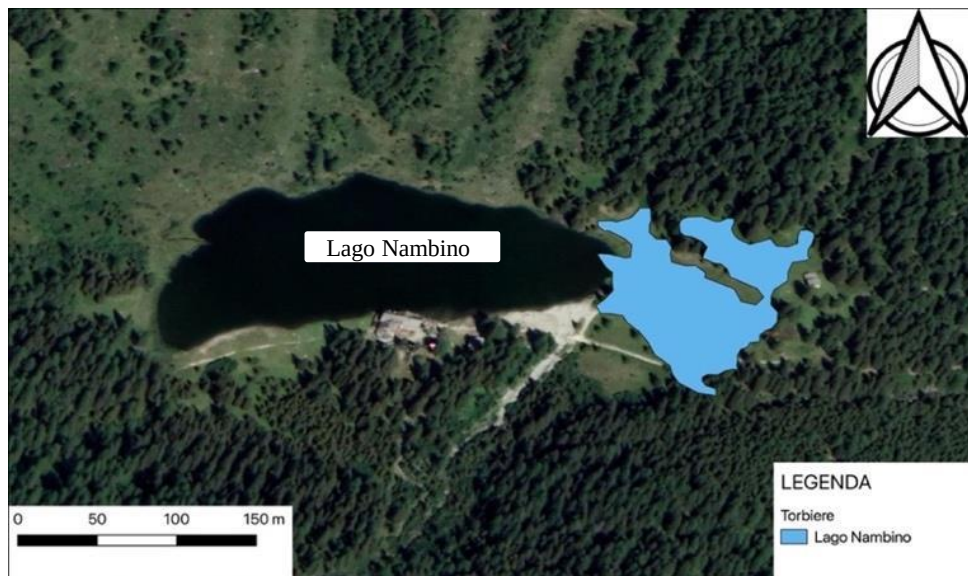
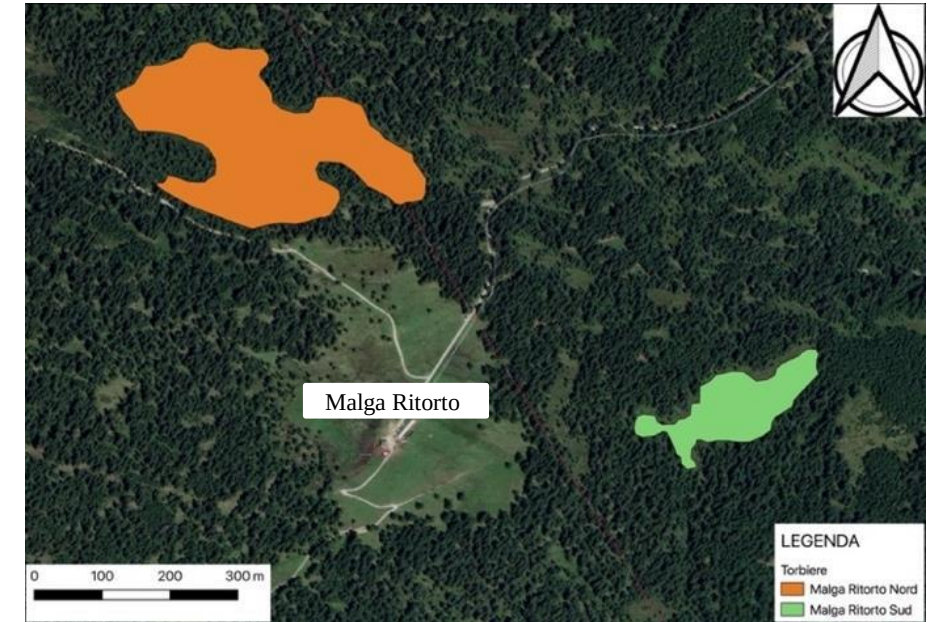
Random Forest supervised classification:

- 12 classes (water, forest, snow, grass, rock, bare soil, 4 types of crops, urban and PEATLANDS)
- 600 trees

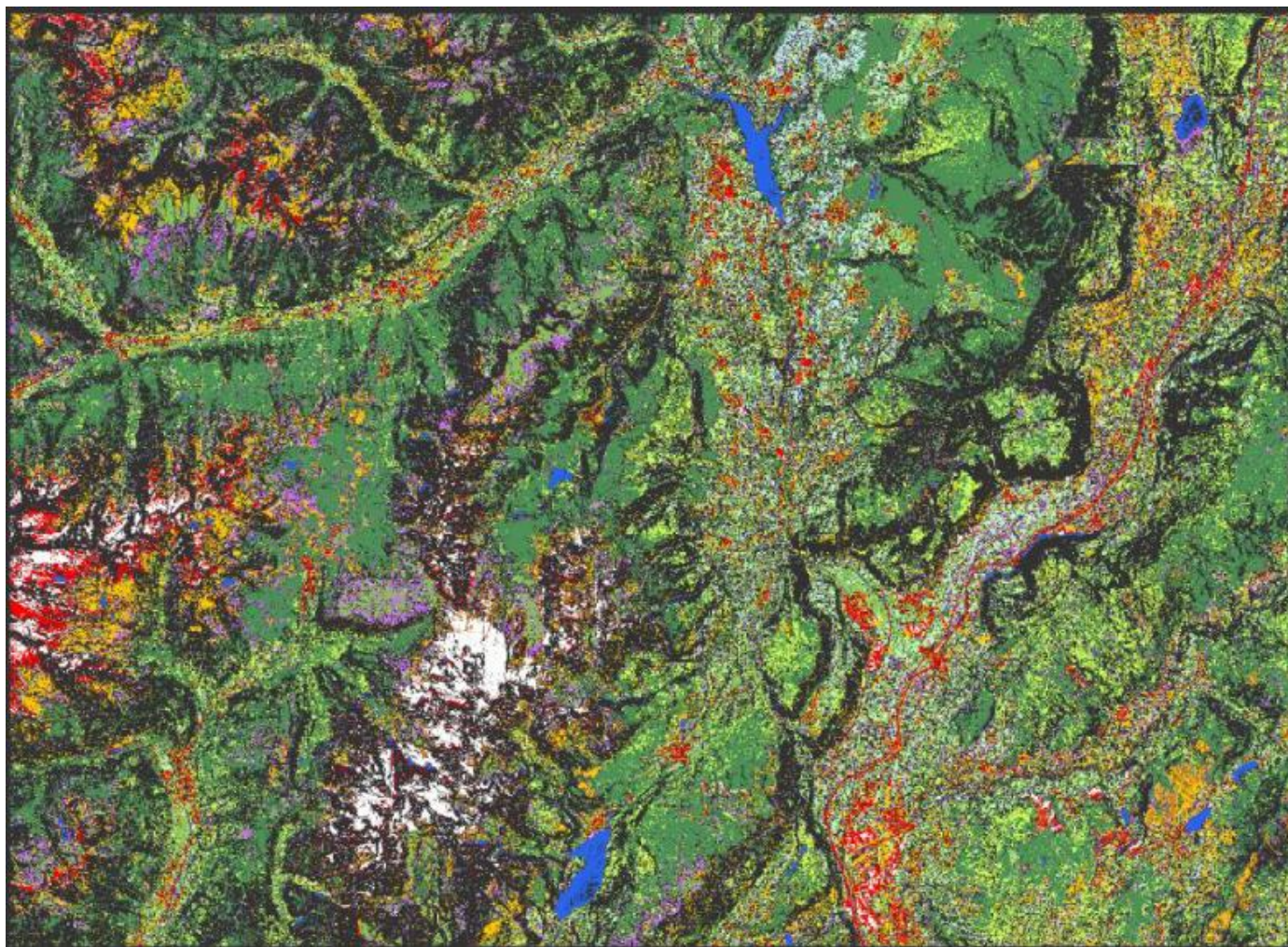




Field surveys:
3 locations
4 study sites
9 cores
17 samples



Classification results using 10 Sentinel-2 bands i.e. **10 bands**



No data

Water

Forest

MASK

Snow

Grass

Rock

Crop 1

Crop 2

Crop 3

Crop 4

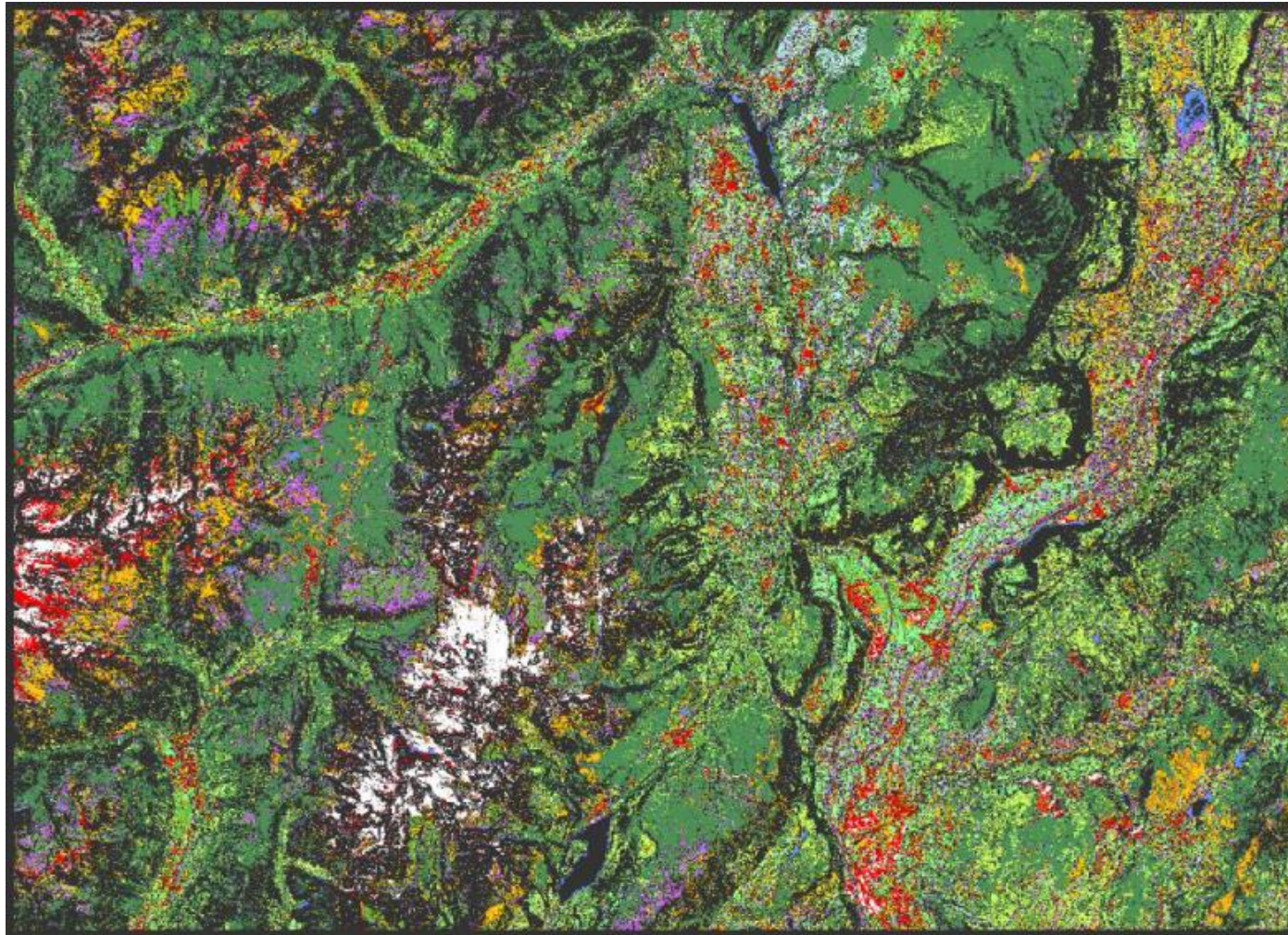
PEATLANDS

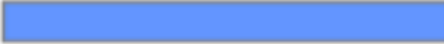
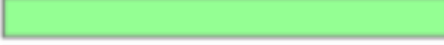
Urban

Colour	Value
	-1
	0
	1
	2
	3
	4
	5
	6
	7
	8
	9
	10
	11
	12

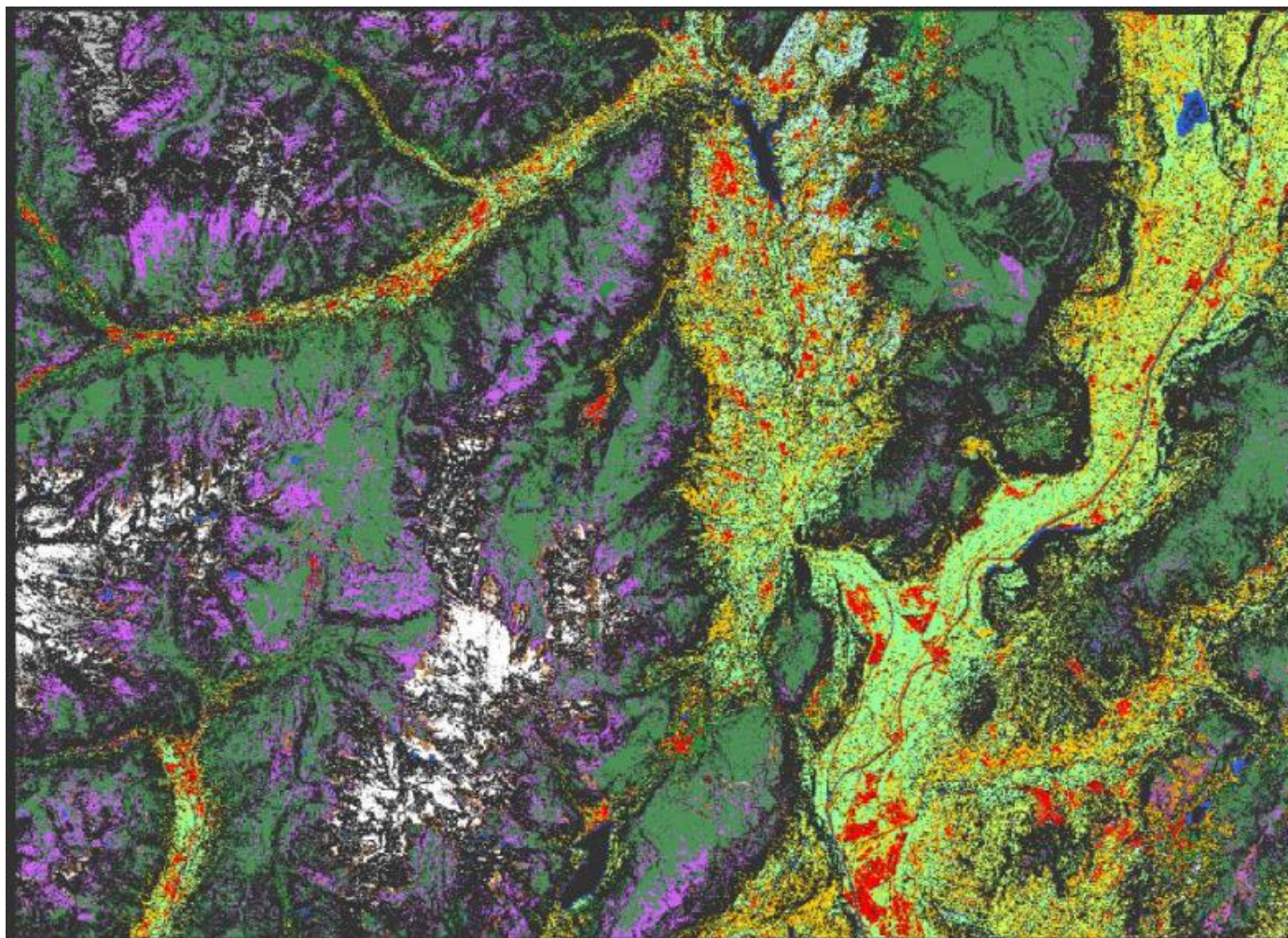


Classification results using 10 Sentinel-2 bands + slope i.e. **11 bands**



	Colour	Value
No data		-1
Water		0
Forest		1
MASK		2
Snow		3
Grass		4
Rock		5
Crop 1		6
Crop 2		7
Crop 3		8
Crop 4		9
PEATLANDS		10
Urban		11

Classification results using 10 Sentinel-2 bands + slope + DTM i.e. **12 bands**



No data

Water

Forest

MASK

Snow

Grass

Rock

Crop 1

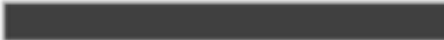
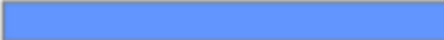
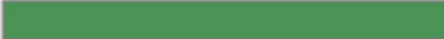
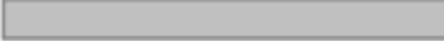
Crop 2

Crop 3

Crop 4

PEATLANDS

Urban

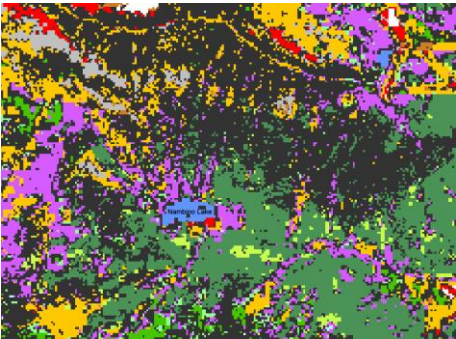
Colour	Value
	-1
	0
	1
	2
	3
	4
	5
	6
	7
	8
	9
	10
	11
	12



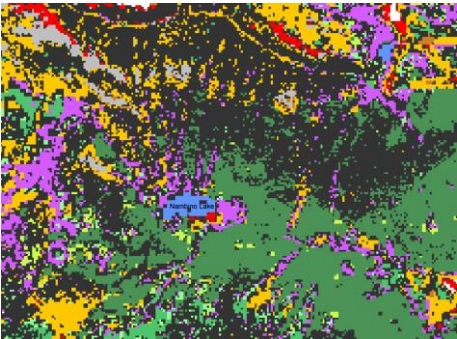
	RF 10 BANDS	RF 11 BANDS	RF 12 BANDS
OVERALL ACCURACY (%)	78	78	84
K COEFFICIENT	0.76	0.76	0.83
Producer's ACCURACY of PEATLANDS (%)	90	84	90
User's ACCURACY of PEATLANDS (%)	90	89	85

Overestimation of peatland sites

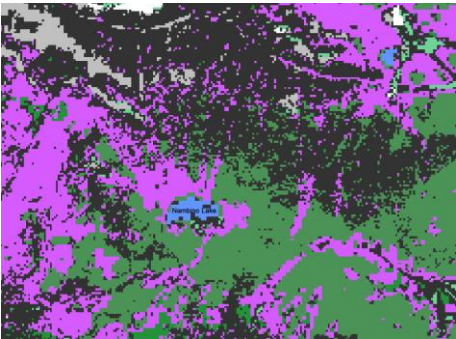
PEATLANDS



RF 10 bands



RF 11 bands



RF 12 bands



$$\text{Wetland index} = \text{NDVI} \cdot \text{NDWI} \cdot [(\text{NDVI} - \text{NDWI}) / (\text{NDVI} + \text{NDWI})]$$

where

$$\text{NDVI} = (\text{NIR} - \text{RED}) / (\text{NIR} + \text{RED})$$

$$\text{NDWI} = (\text{NIR} - \text{MIR}) / (\text{NIR} + \text{MIR})$$

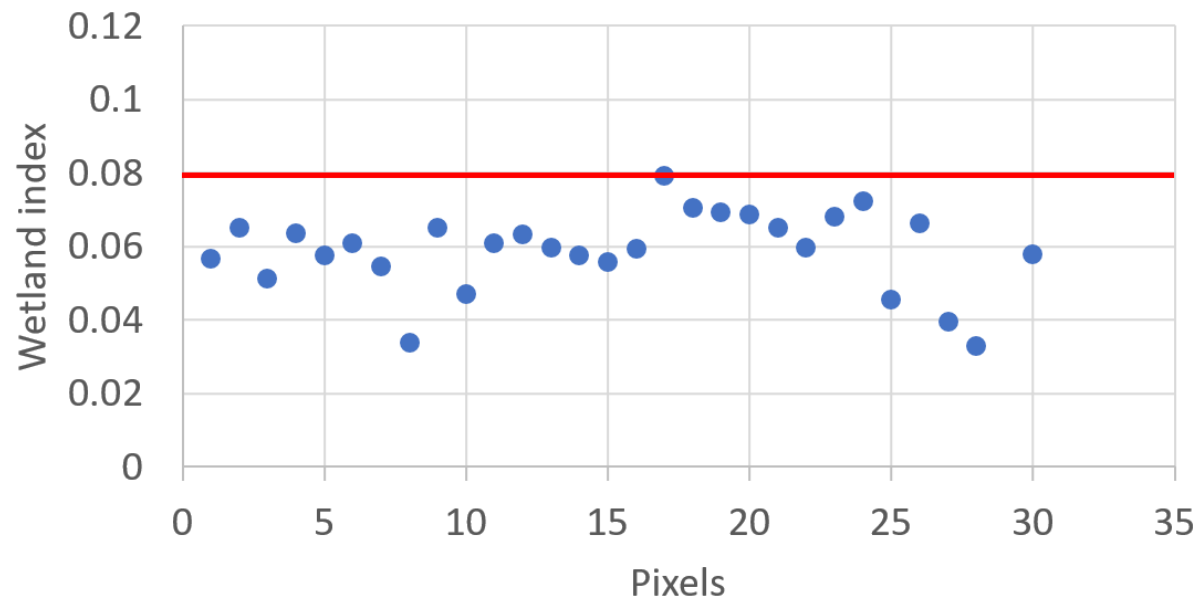
RED = Sentinel-2 band 4

NIR = Sentinel-2 band 8

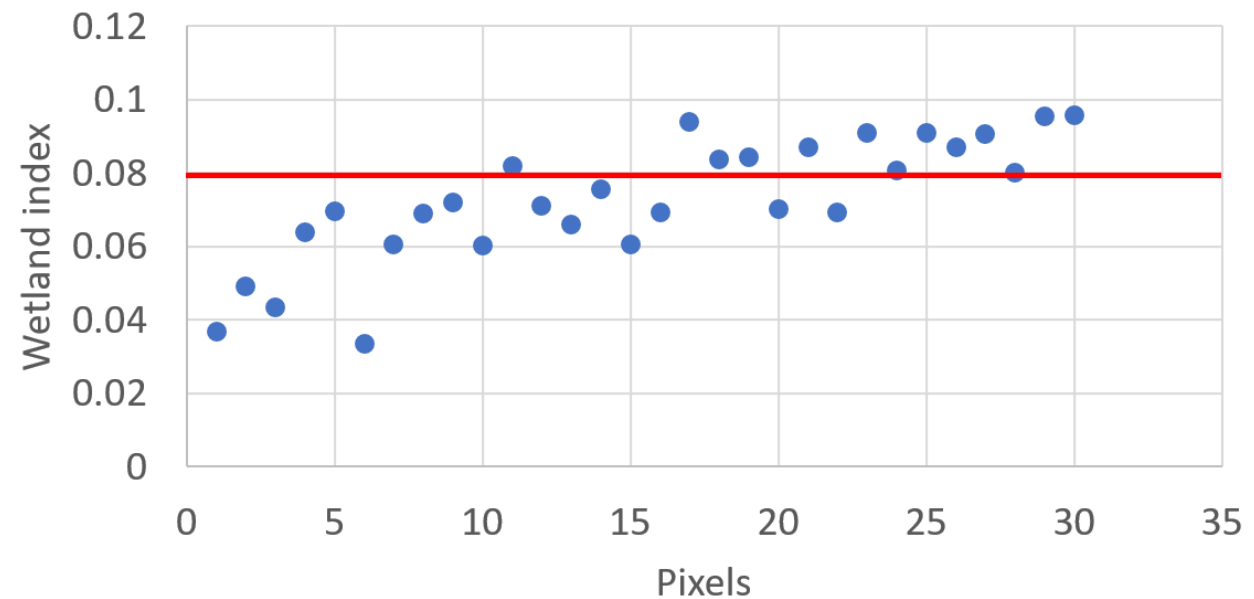
MIR = Sentinel-2 band 12

Wetland index threshold = 0.08

Wetland index of 30 pixels falling in peatlands



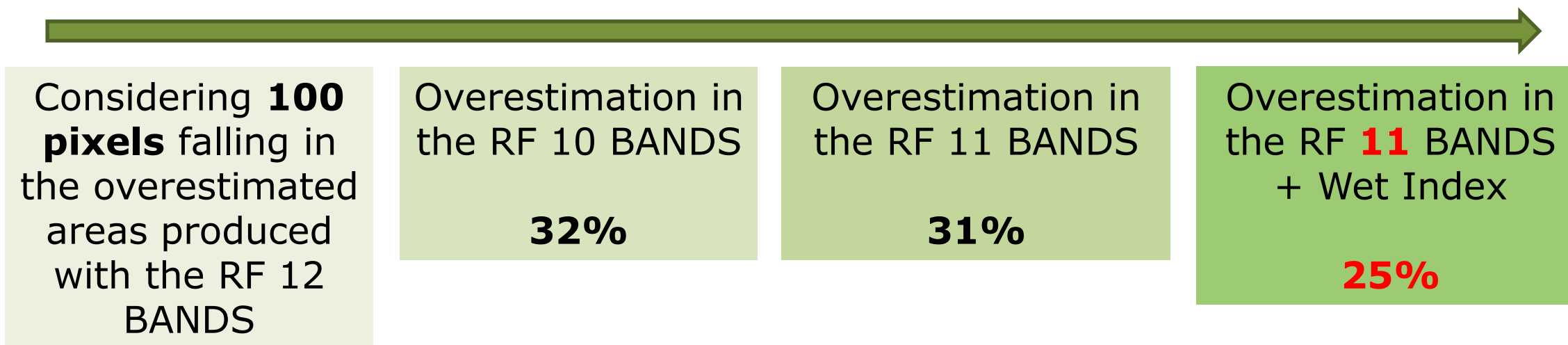
Wetland index of 30 pixels in overestimated areas

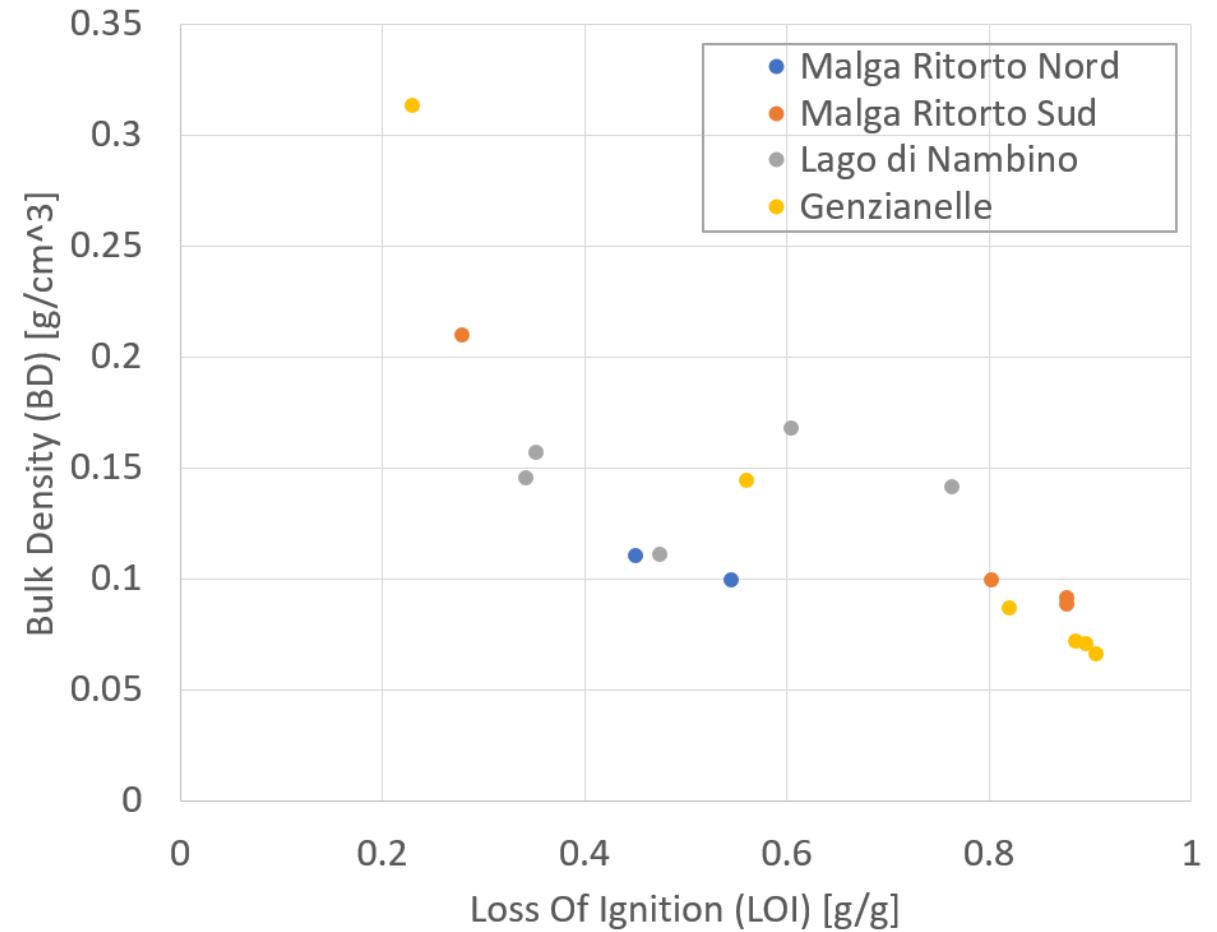
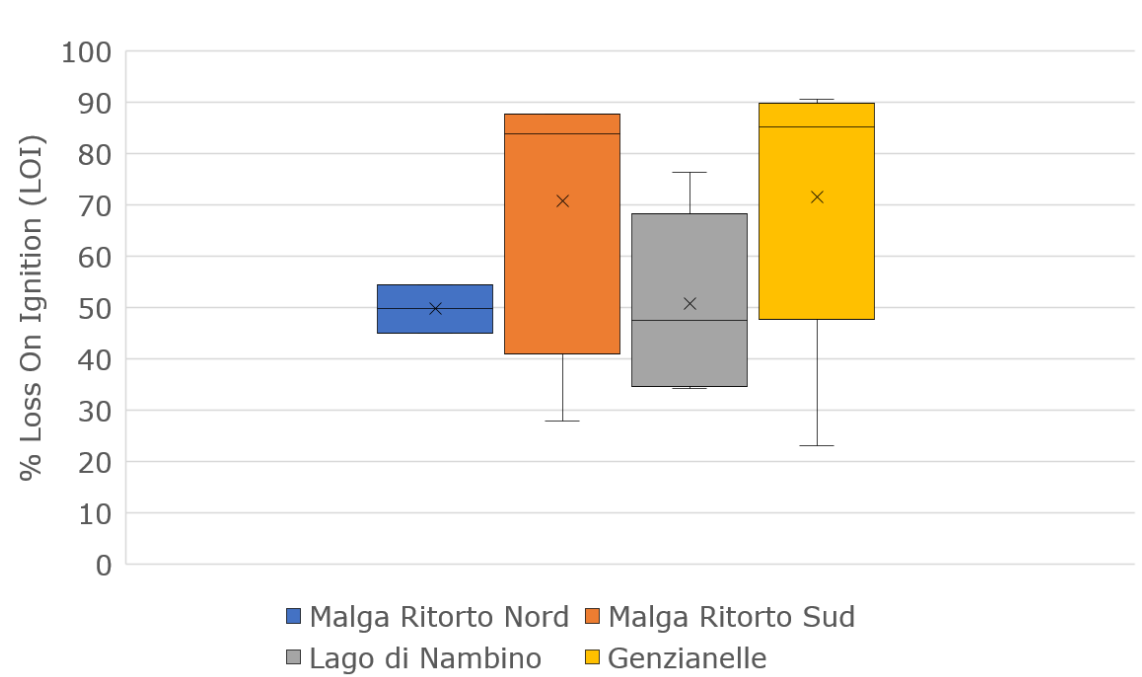


Does the producer accuracy decrease if we apply the threshold?

	RF 10 BANDS	RF 11 BANDS	RF 12 BANDS	RF 11 BANDS + Wet Index	RF 12 BANDS + Wet Index
Producer's ACCURACY of PEATLANDS (%)	90	84	90	84	86

Does the overestimation decrease?





Mean Organic Carbon Content by Soil Volume
0.0403 g/cm³



- Alps host hundreds of peatlands
- Remote sensing is a reliable and effective method for peatland detection and monitoring
- Random Forest applied to Sentinel-2 images allows high accuracy in the detection of actual peatlands, however the method overestimates their presence even if slope or elevation are included in the analyses
- A simple index based on NDVI and NDWI may reduce the overestimation
- Further analyses are needed in order to explore the use of other data sources with the objective of increasing the classification accuracy and further reduce the overestimation





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Thanks for reading !

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