6as Jornadas de Engenharia Hidrográfica
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Intertidal zone mapping using in-situ, local high-resolution and lower-resolution satellite remote sensing data

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SWUAV

COMPETE 2020
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REPÚBLICA PORTUGUESA
FCT Fundação para a Ciência e a Tecnologia
ciimar 20 anos
U.PORTO FACULDADE DE CIÊNCIAS UNIVERSIDADE DO PORTO

Objective

In the framework of the **SWUAV project**, which aims to map the intertidal zone in stretches of northern Portugal, based on UAV multispectral imagery we aimed to **assess how remote sensing data collected at different resolutions can be used for intertidal cover mapping**

→ *in-situ* ground truth

→ NDVI based on aerial photography UAV (multispectral)

→ NDVI based on aerial photography plane (RGB+NIR)

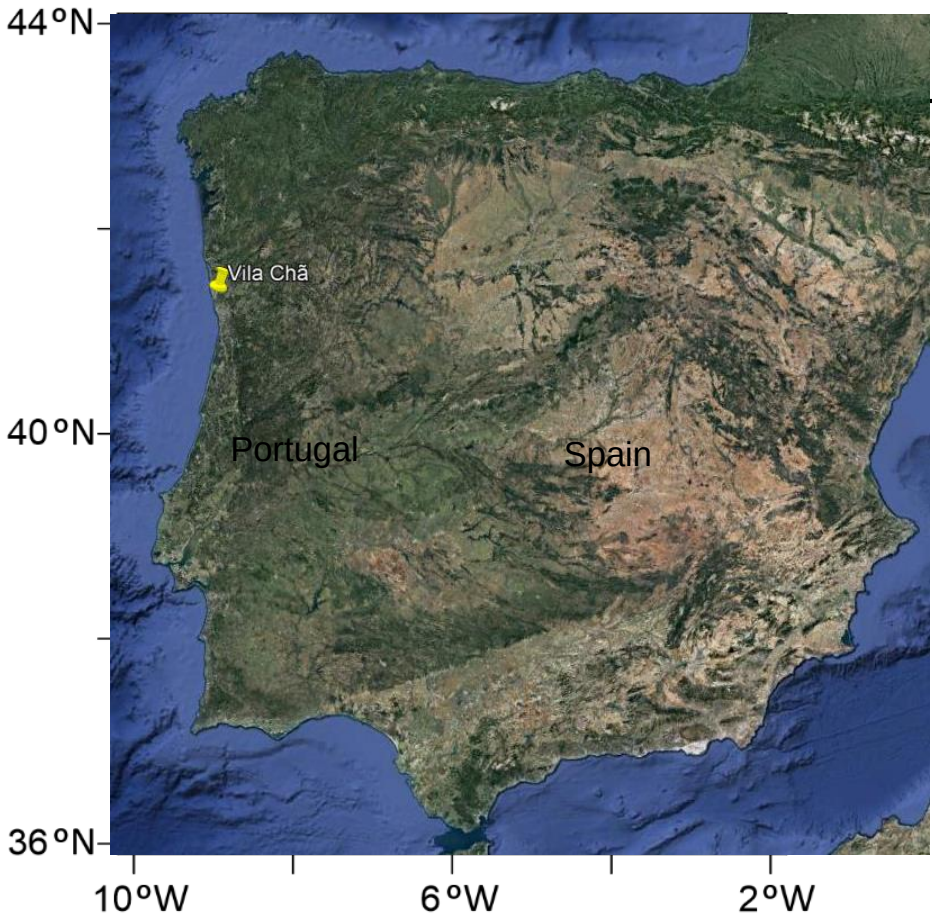
→ NDVI based on Sentinel 2 satellite data (multispectral)

Study site

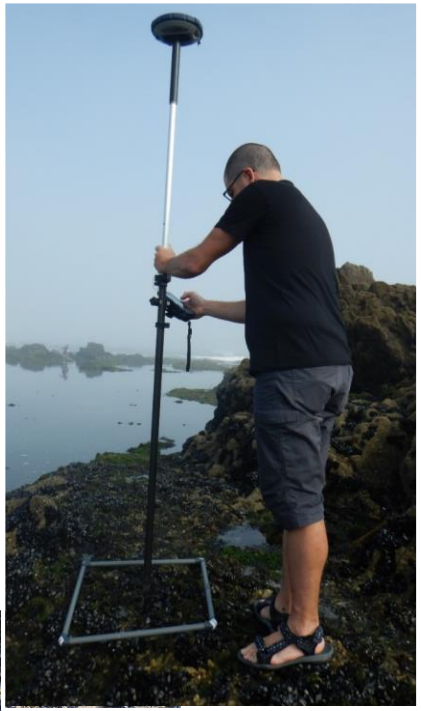
Vila Chã

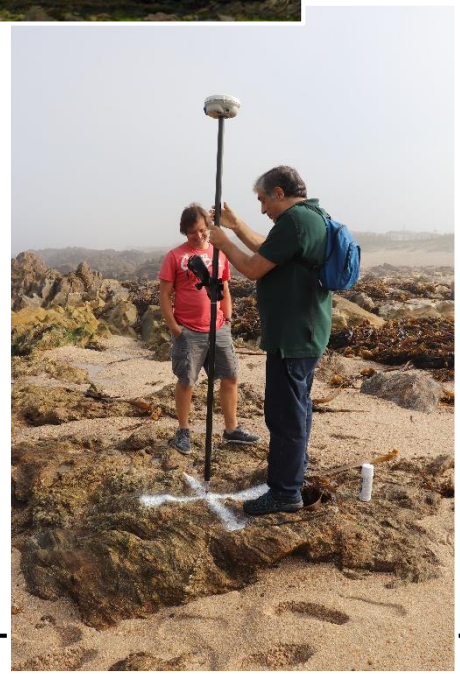
- area 4604 m²
- diversified cover:
  - sandy patches
  - rocky outcrops
  - Seaweed
  - Mussels
  - Barnacles
  - limpets

Airborne orthomosaic Nov. 2017



Ground truth (*in situ*)





Ground truth (*in situ*)

- 4 cover types
- 3 training areas + 1 validation area for classification

Seaweed

Sand

Mussels and rock

Rock, barnacles and limpets

UAV remote sensing

high-resolution multispectral survey

- multirotor UAV, equipped with MicaSense RedEdge multispectral camera

high-resolution RGB orthophoto of the intertidal area (1.6-cm pixel)

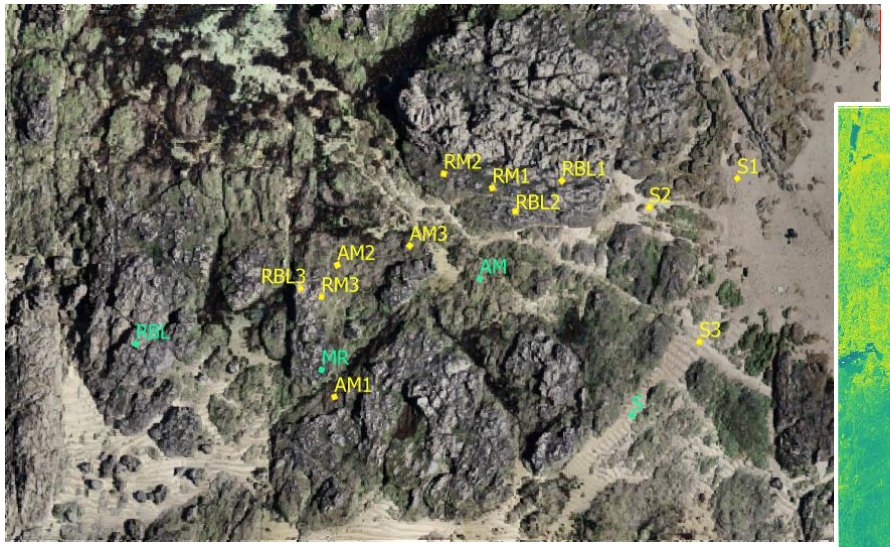
File suffix	Band Name	Center Wavelength (nm)	Bandwidth (nm)
1	Blue	475	32
2	Green	560	27
3	Red	668	14
5	Red Edge	717	12
4	Near IR	842	57

$$\mathrm{NDVI} = \frac{(\mathrm{NIR} - \mathrm{Red})}{(\mathrm{NIR} + \mathrm{Red})}$$

Normalized difference vegetation index

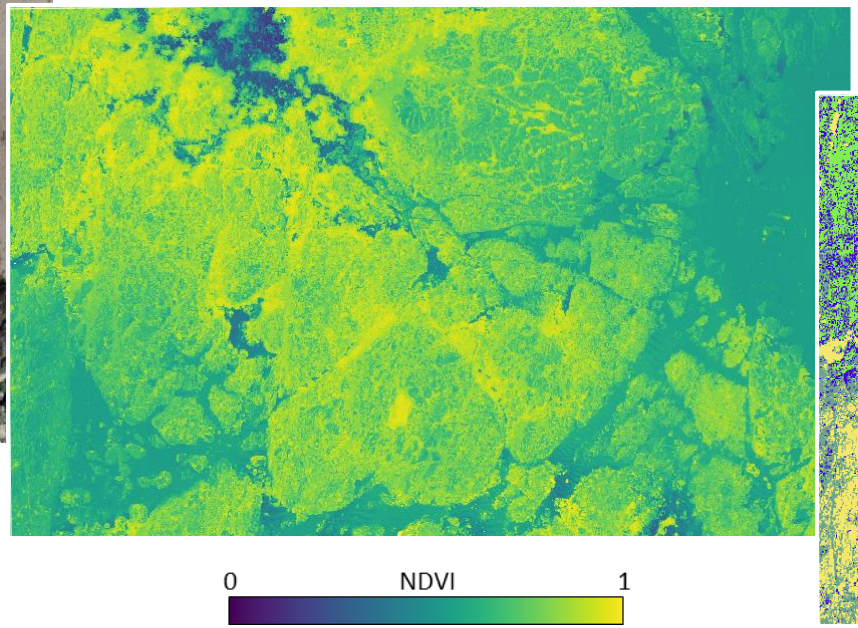
UAV cover classification

Orthomosaic 19 May 2019, **GSD 1.6 cm**



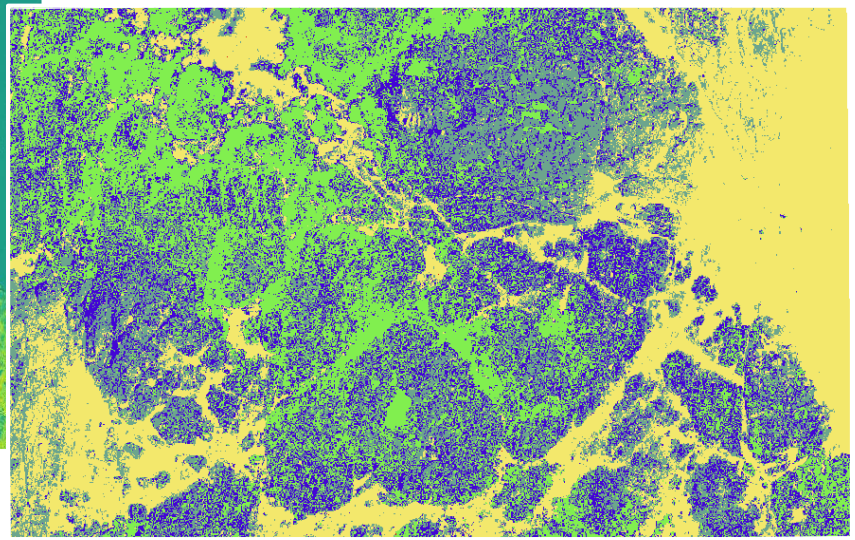
with in-situ surveyed cover-class squares (ground truth)

NDVI



Classification supervised

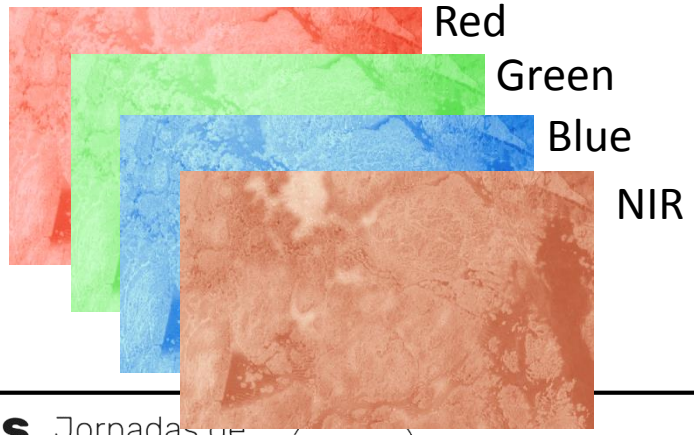
QGIS Semi-automatic Classification plugin



Plane-based RS

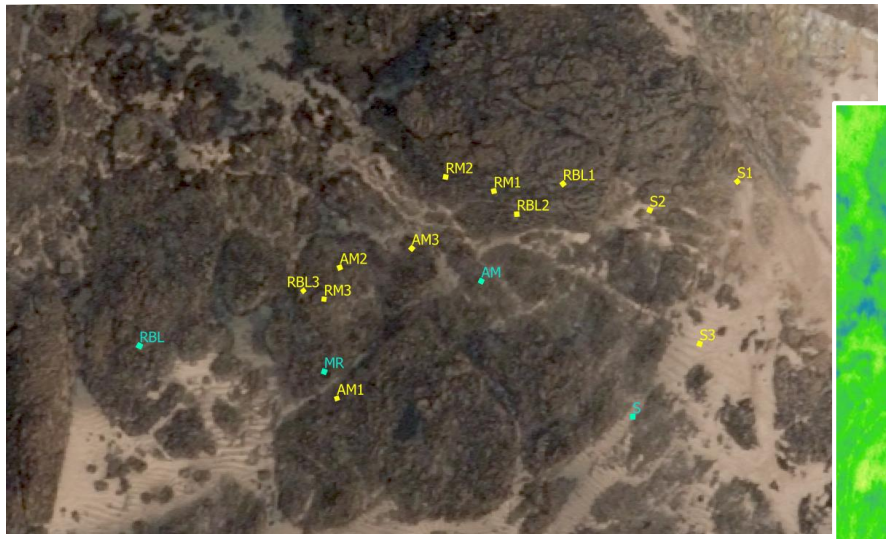
high-resolution RGB+NIR survey

- high-resolution digital photogrammetric camera (9420×14430 pixels)
- overlapping photos (80%)
- 1900 m flight height
- 12.5 cm GSD



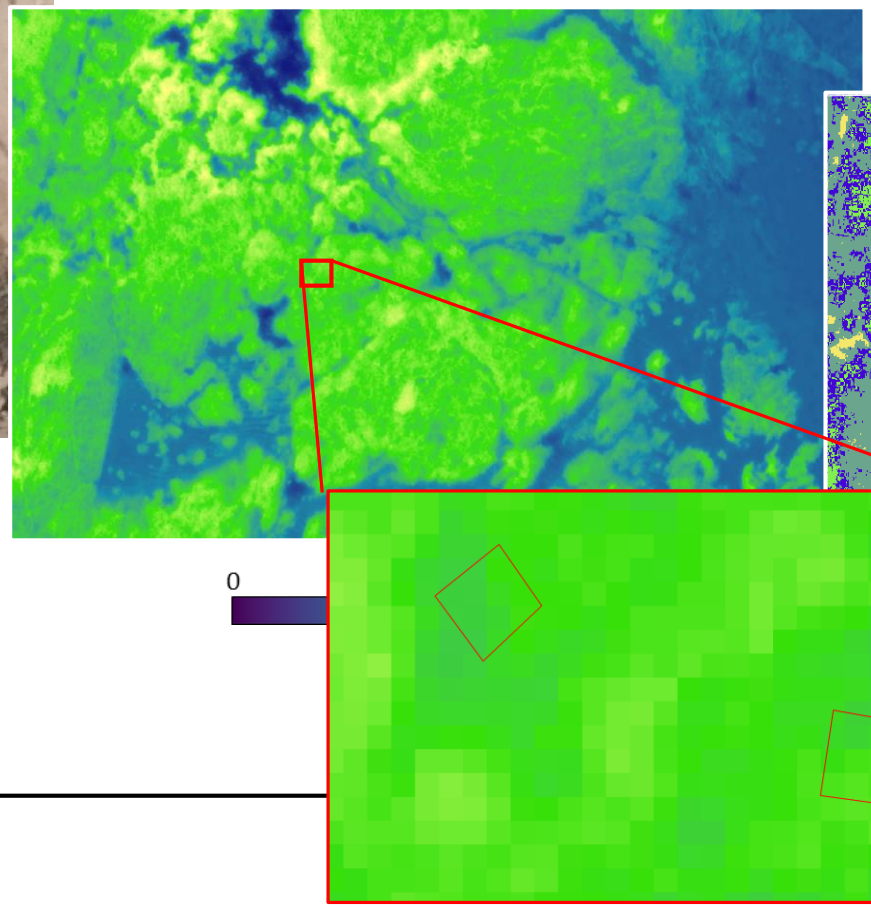
Plane-based RS

Orthophoto May 2019, **GSD 12.5 cm**



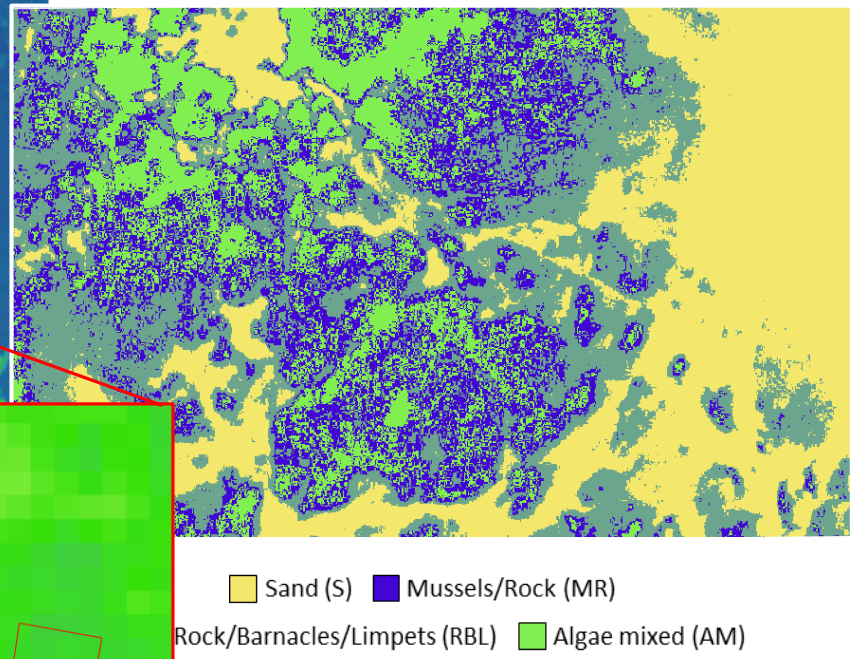
with in-situ surveyed cover-class squares (ground truth)

NDVI



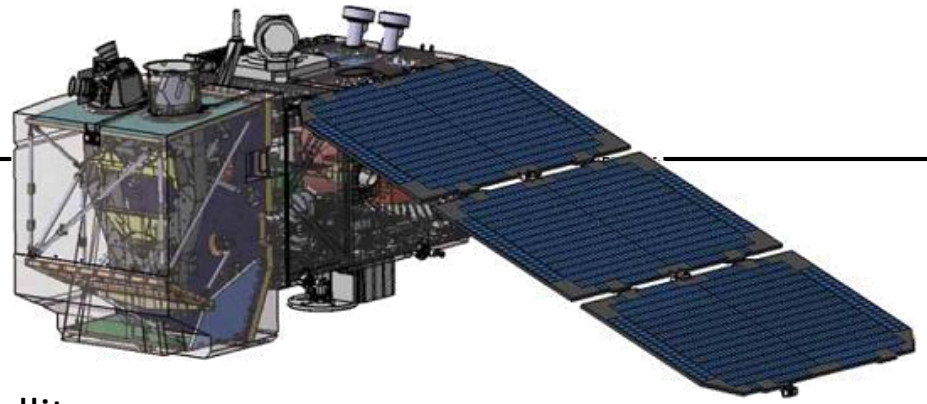
Classification supervised

QGIS Semi-automatic Classification plugin



Satellite RS

Sentinel 2



- Constellation of two polar-orbiting satellites:
  Sentinel 2A (23 June 2015)
  Sentinel 2B (7 March 2017)
- Swath width: 290 km
- Revisit time: 5 days with 2 satellites
- 13 spectral bands: four bands at 10 m spatial resolution

Band 4 = Red
Band 8 = NIR

Table 1: Wavelengths and Bandwidths of the 3 Spatial Resolutions of the MSI instruments

Spatial Resolution (m)	Band Number	S2A		S2B	
		Central Wavelength (nm)	Bandwidth (nm)	Central Wavelength (nm)	Bandwidth (nm)
10	2	492.4	66	492.1	66
	3	559.8	36	559.0	36
	4	664.6	31	664.9	31
	8	832.8	106	832.9	106
20	5	704.1	15	703.8	16
	6	740.5	15	739.1	15
	7	782.8	20	779.7	20
	8a	864.7	21	864.0	22
	11	1613.7	91	1610.4	94
	12	2202.4	175	2185.7	185
60	1	442.7	21	442.2	21
	9	945.1	20	943.2	21
	10	1373.5	31	1376.9	30

Satellite RS

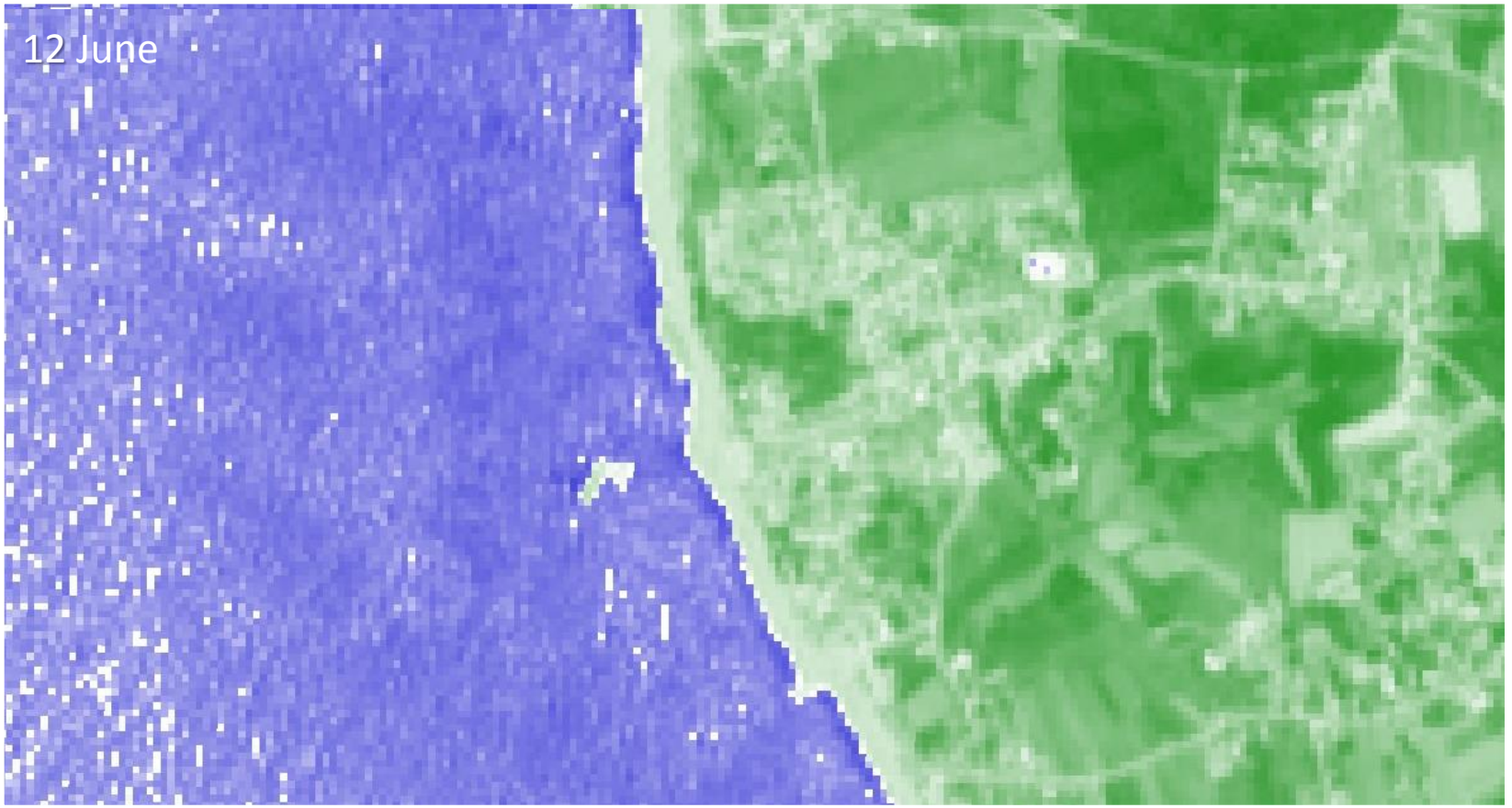
Data selection

based on:

— Image capture date

— Tide!

Sentinel-2 L2A images
NDWI (Normalized Difference Water Index)
Based on combination of Green and NIR bands
(B3 - B8)/(B3 + B8)



Satellite RS

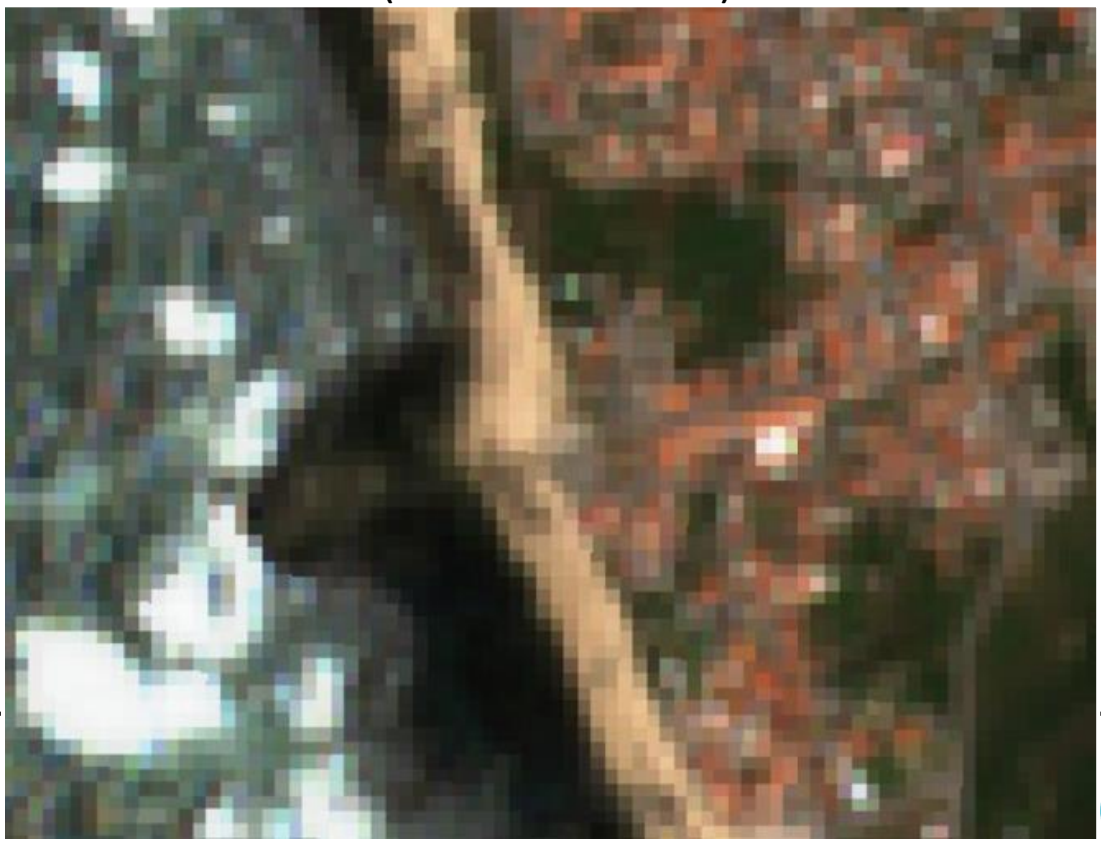
Selected Sentinel-2 images

18 May 2019

1 day before the UAV survey
2 h and 12 min after a (spring) low tide

7 June 2019

19 days after the UAV survey
58 min before a (less accentuated) low tide



Satellite RS

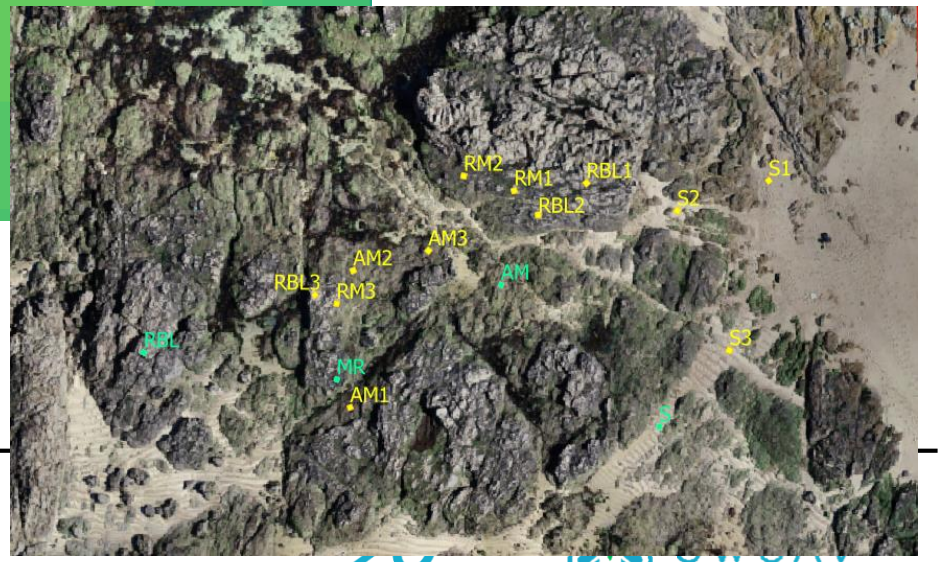
Selected Sentinel-2 images - NDVI

18 May 2019

7 June 2019

GSD 10 m

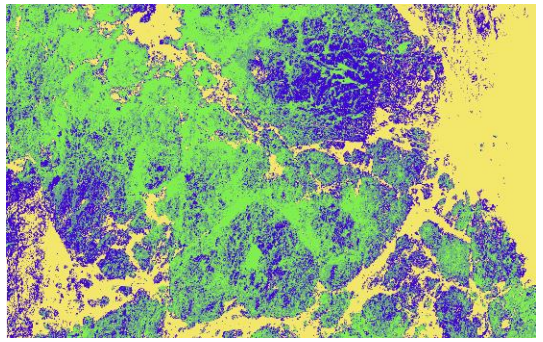
40 pixels 10×10m



⇒ **Cannot use**
0.5×0.5m training areas

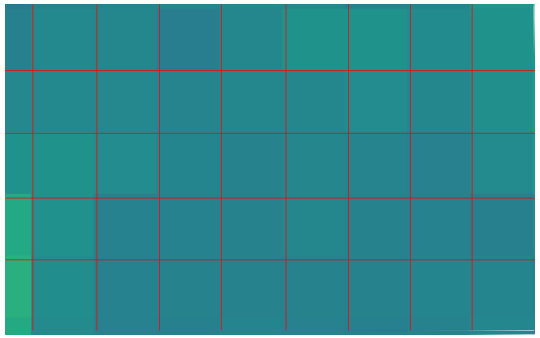
Satellite RS

Classification approach



19 May

18 May

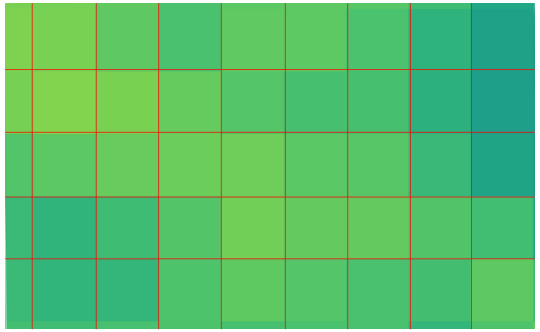


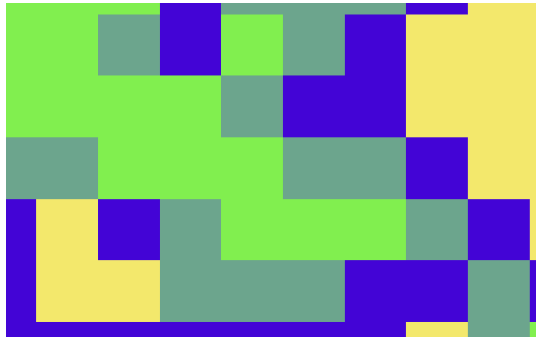
NDVI

training areas with best dominant UAV classification

satellite image classification

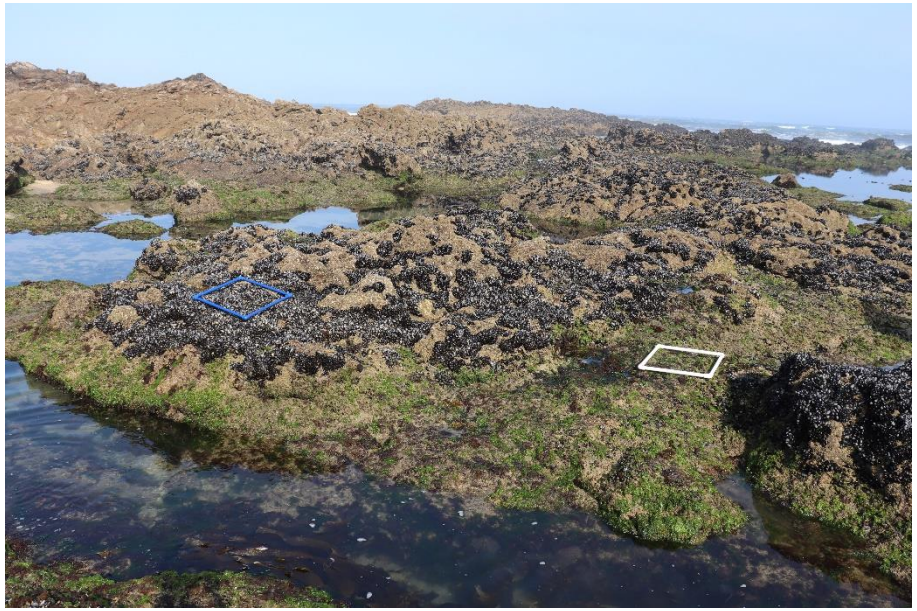
7 June

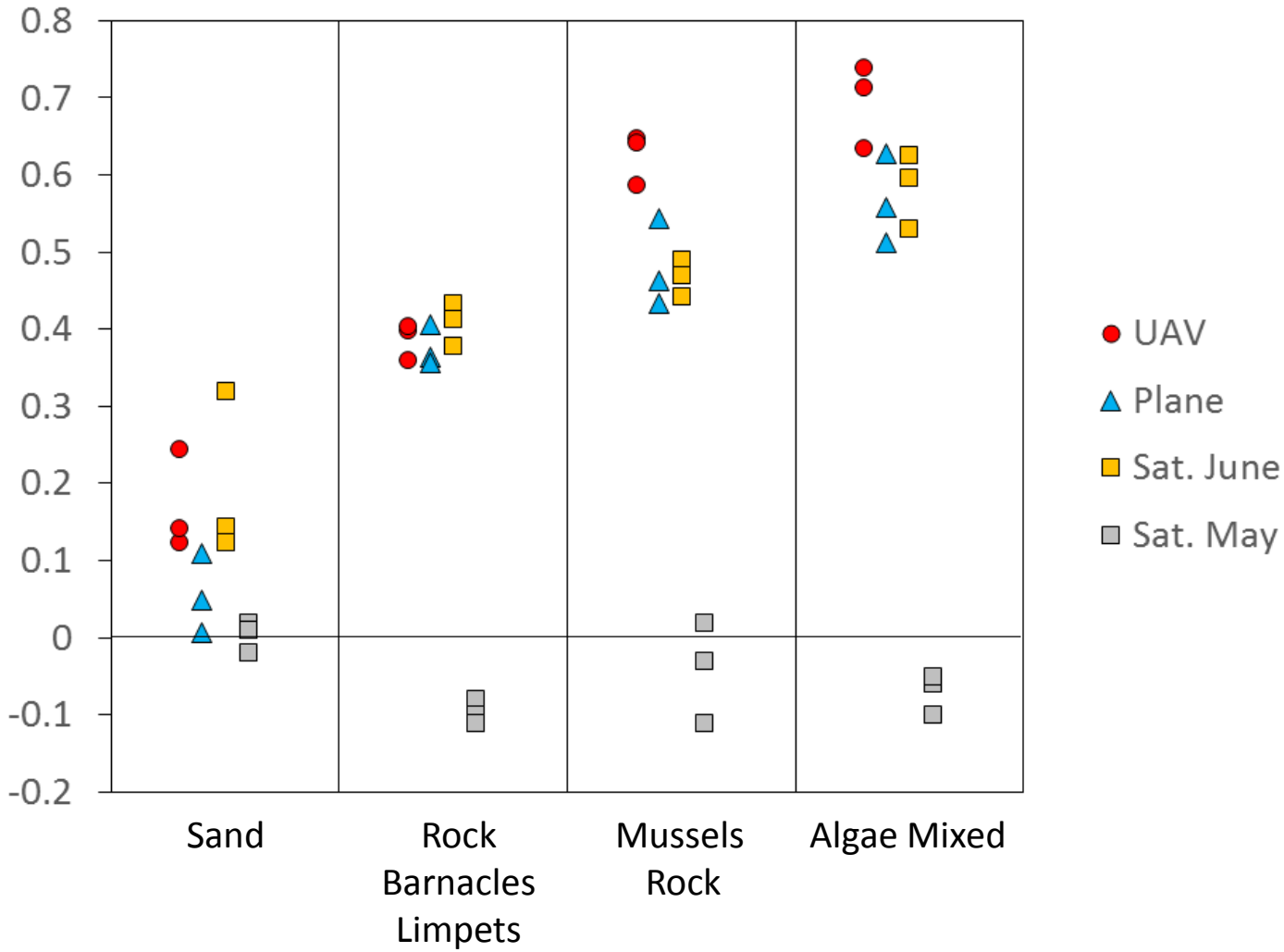




Comparison

Spectral signatures of training areas



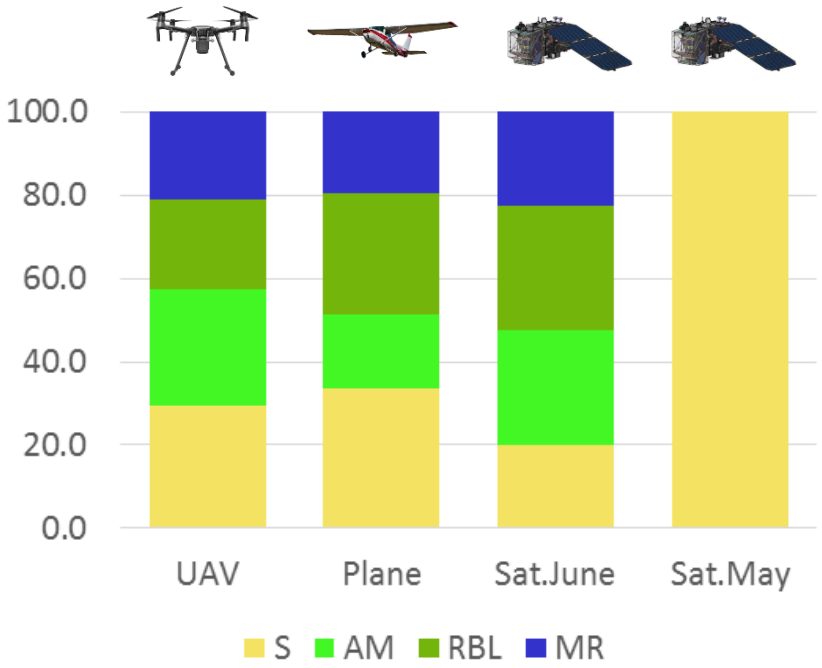


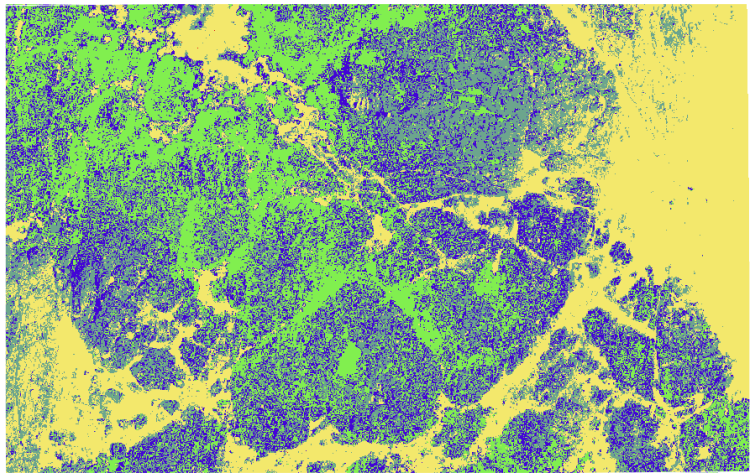
Comparison

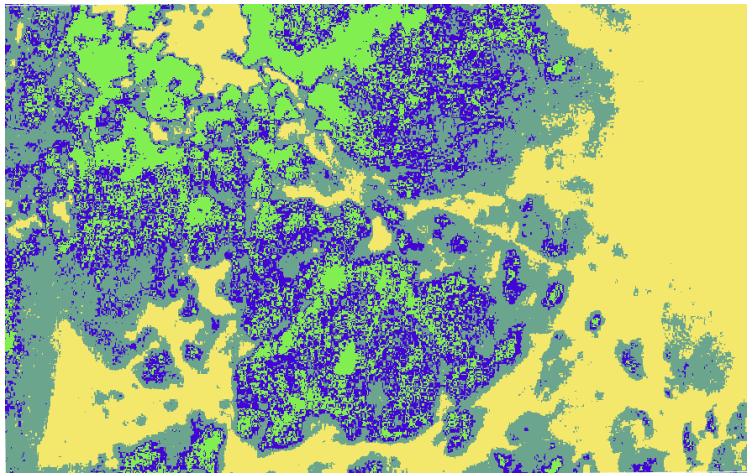
May

May

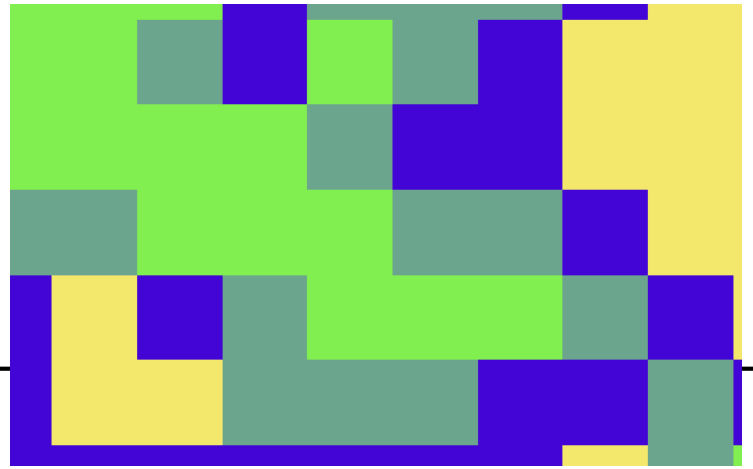
Classification maps & areas







June



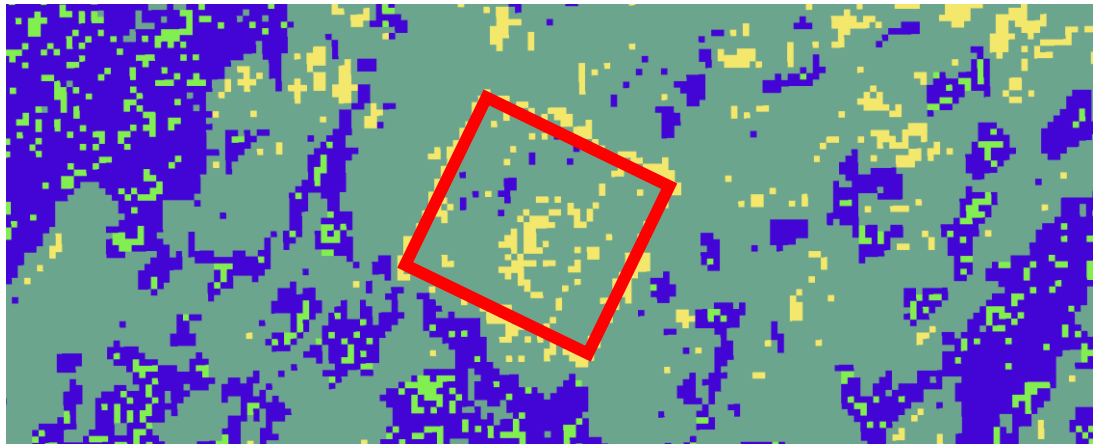
May

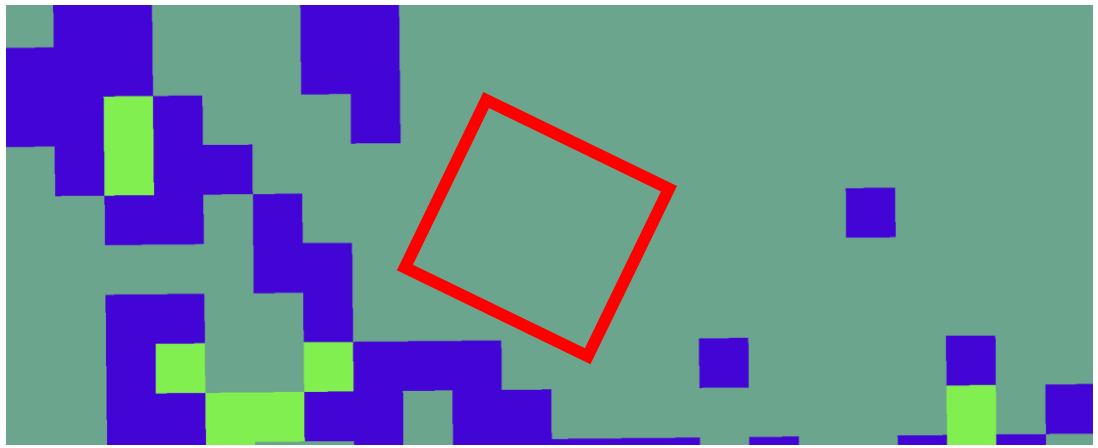
Comparison

Accuracy

User accuracy (%)


Sand	88.6	100.0
Rock/Barnacles/Limpets	87.0	100.0
Algae mixed	19.2	18.7
Mussels/Rock	20.8	19.2
Overall	**57.7**	**66.6**
$\hat{K}$	**0.43**	**0.55**





⇒ due to class-specific cover homogeneity/heterogeneity

⇒ due to more or less distinct class-specific spectral NDVI signature (e.g. the NDVI for S is particularly low)

⇒ shadow and glint effects?

Conclusion

- **Semi-automatic classification of NDVI** (based on two spectral bands) calibrated with *in-situ* observations, can produce useful intertidal cover maps
- **Unmanned aerial vehicles (UAV)** with high-resolution cameras are particularly useful for very detailed observation of small areas
- **Plane-based imagery** is less detailed but produces, in our case, quite similar results
- **Satellite imagery** may provide large-scale information for regional or larger areas, but is too coarse for small study areas
- Working at different scales, with information is upscaled from *in-situ* observations, to high-resolution UAV, plane-based and satellite imagery

  ⇒ **explore synergies** between different observation methods

  trade-offs: easiness, efficiency, extend, accuracy

Obrigada

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