BEeS

The LifeWatch ERIC Biodiversity & Ecosystem eScience Conference

Seville
22-24/05/23

Threats and challenges to biodiversity and ecosystem conservation from an eScience perspective

LifeWatch ERIC

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ciimar
Centro Interdisciplinar de Investigação Marinha e Ambiental

Herb stratum biomass estimation through ultra-high resolution UAS remote sensing

Summary

1. Objective
2. Study Area
3. Methodology
   I. Quadrats
   II. Vegetation indices
   III. Classification
4. Above Ground Biomass (AGB)
5. Validation
6. Further Research

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Looking from above, can we identify the biomass of a specific herb stratum plant community?

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Remote Sensing

- Satellites
- Airplanes
- Unoccupied Aircraft System
  - Multispectral Images
    - Red
    - Green
    - Blue
    - Edg
    - NIR
  - **Ultra-High resolution**
    - px size = 2.5 cm

Source: DJI Matrice 200 - dji.com
Micasense RedEdge MX - micasense.com

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Ultra-High Resolution Aerial Images

- Pixels < 2.5 cm
- Monitor herb stratum

Wetlands

Source: wetlands-initiative.org

Ultra-High Resolution Aerial Images

- Pixels < 2.5 cm
- Monitor herb stratum

Prairies

Source: BLM Wyoming

Ultra-High Resolution Aerial Images

- Pixels < 2.5 cm
- Monitor herb stratum

Intertidal Seagrass

Source: Nordlund, Lina & Torre-Castro

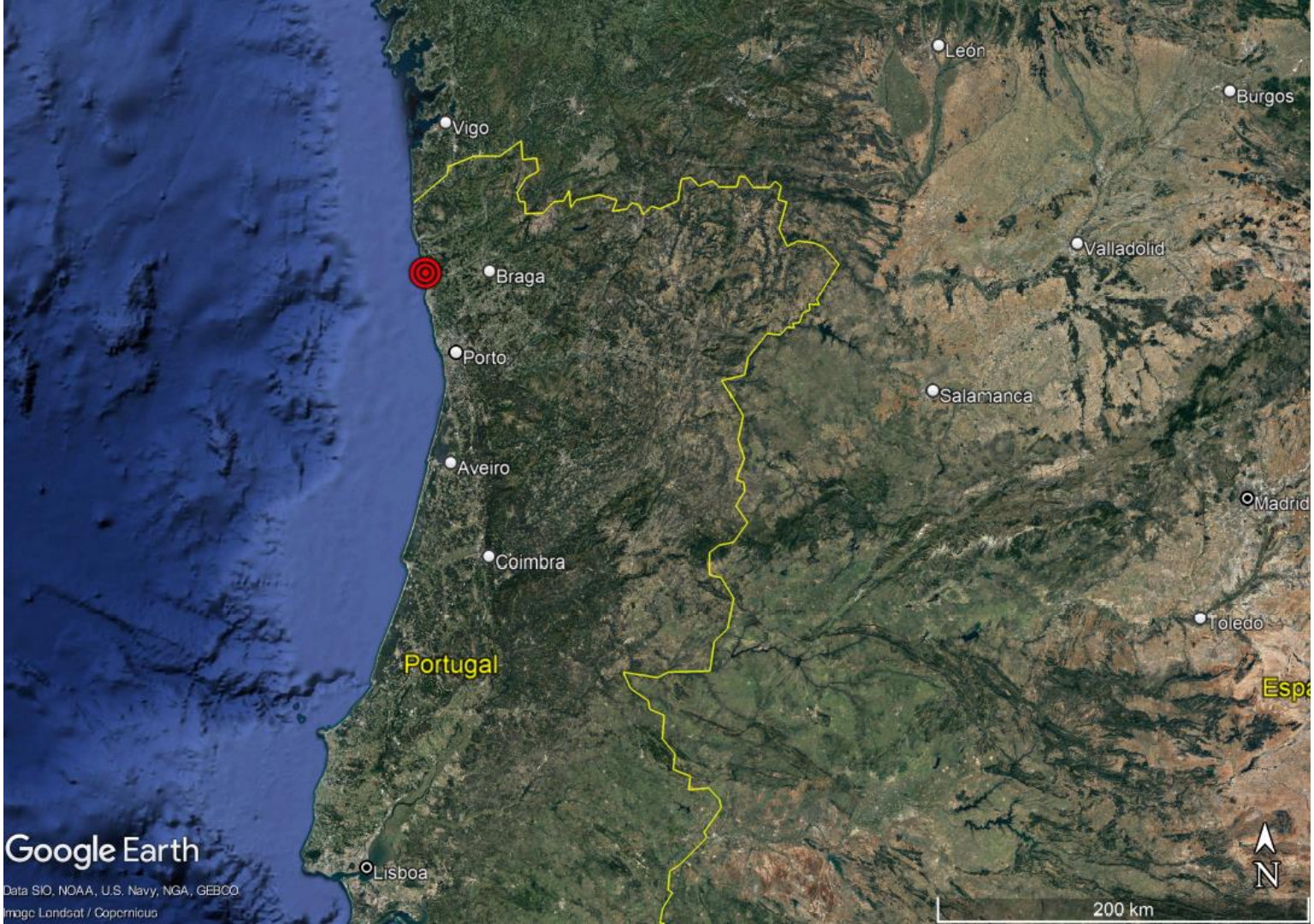
Ultra-High Resolution Aerial Images

- Pixels < 2.5 cm
- Monitor herb stratum

Dunes

Source: dynamicdunescapes.co.uk/


Protected landscape of Ofir littoral
Parque Natural do Litoral Norte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Vigo
Valladolid
Braga
Porto
Salamanca
Aveiro
Madrid
Coimbra
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Lisboa
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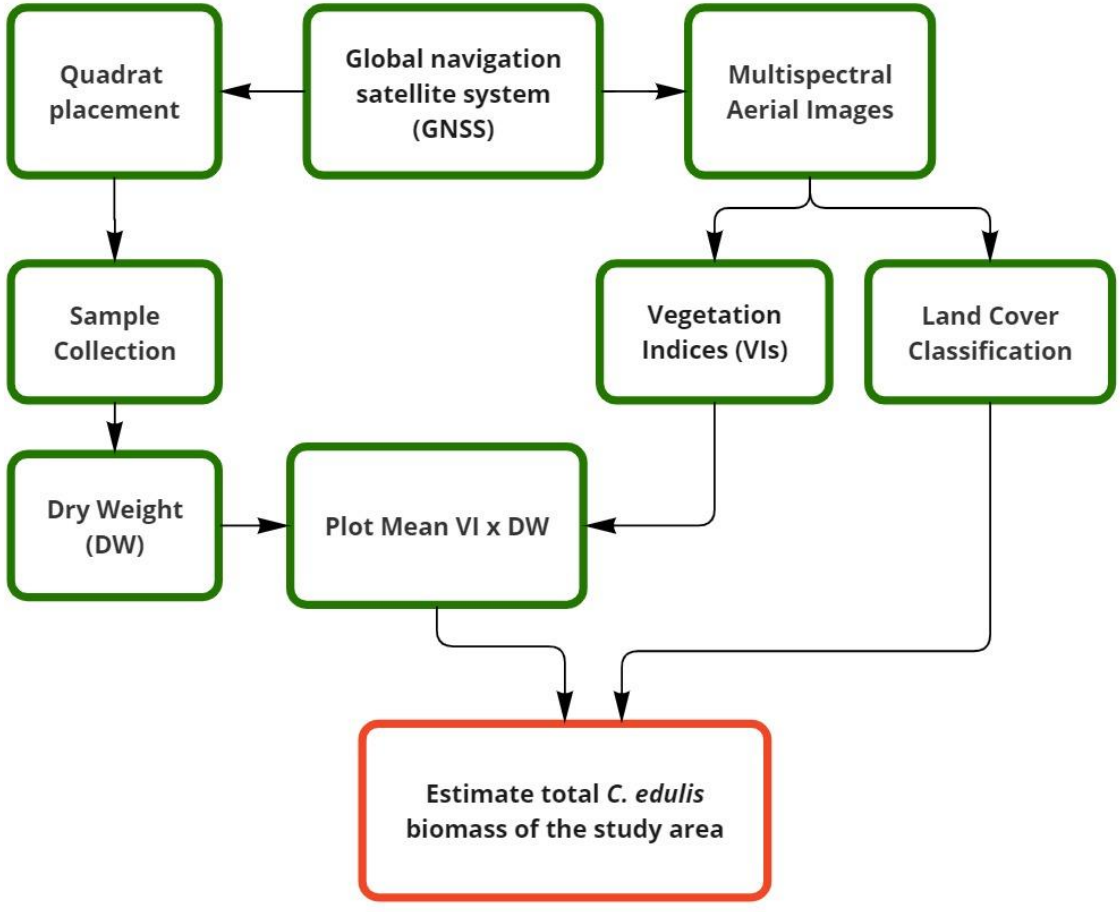
Image Landsat / Copernicus
N
200 km



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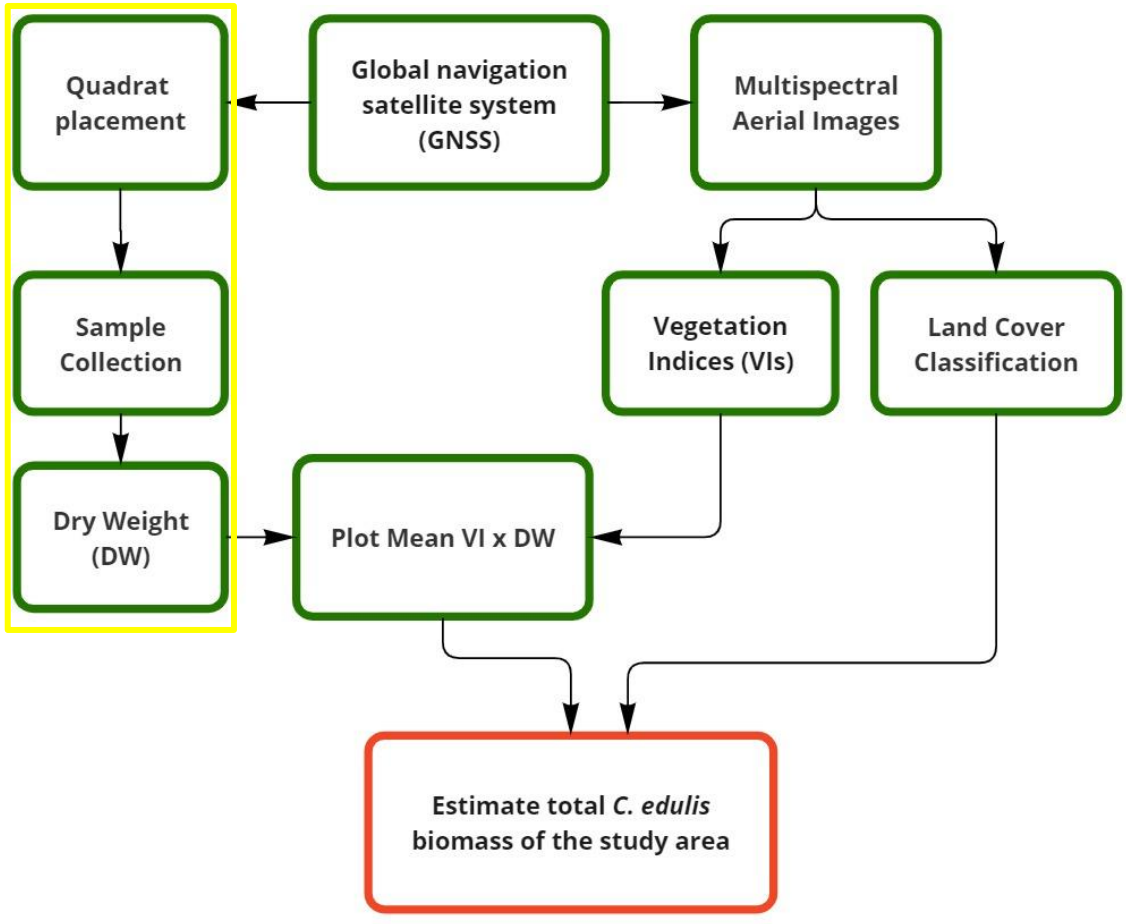

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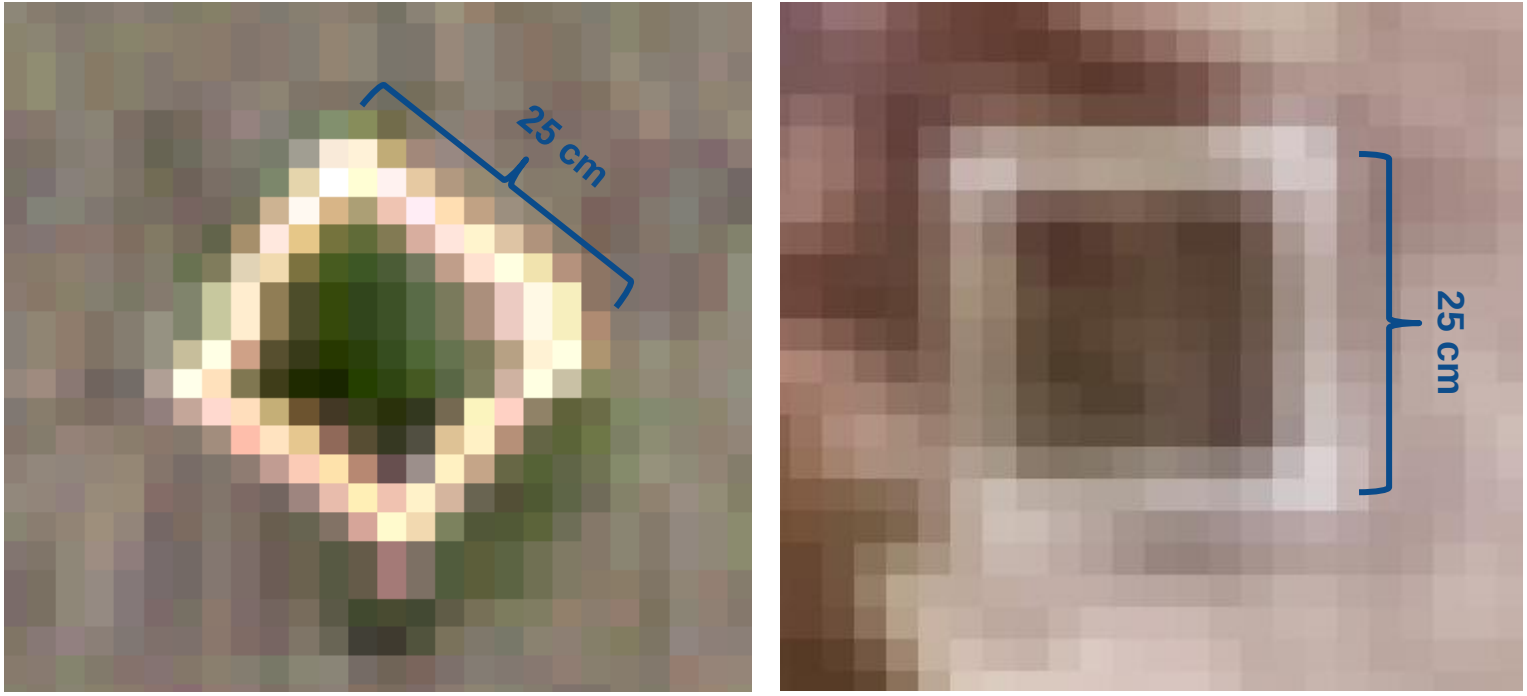

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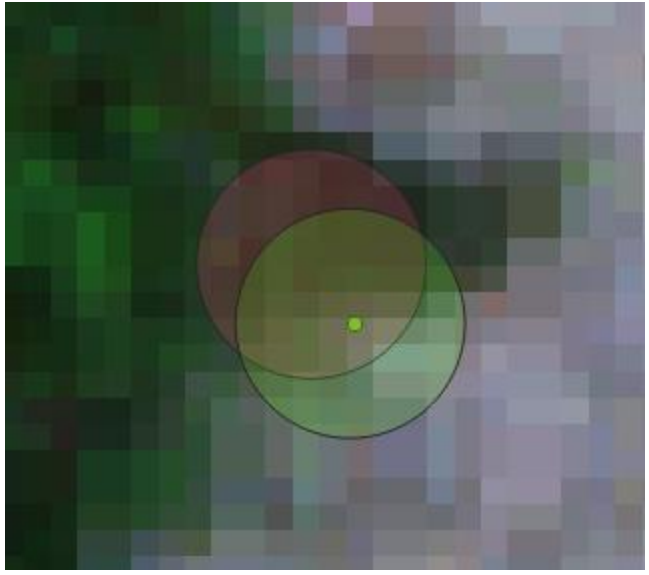
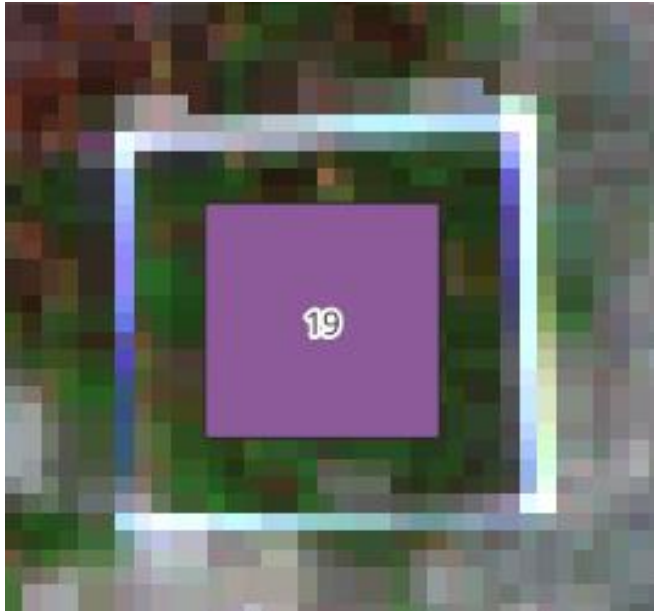
D = 20 cm

E_{GNSS} = 2.5 cm

E_{image} = 3.5 cm



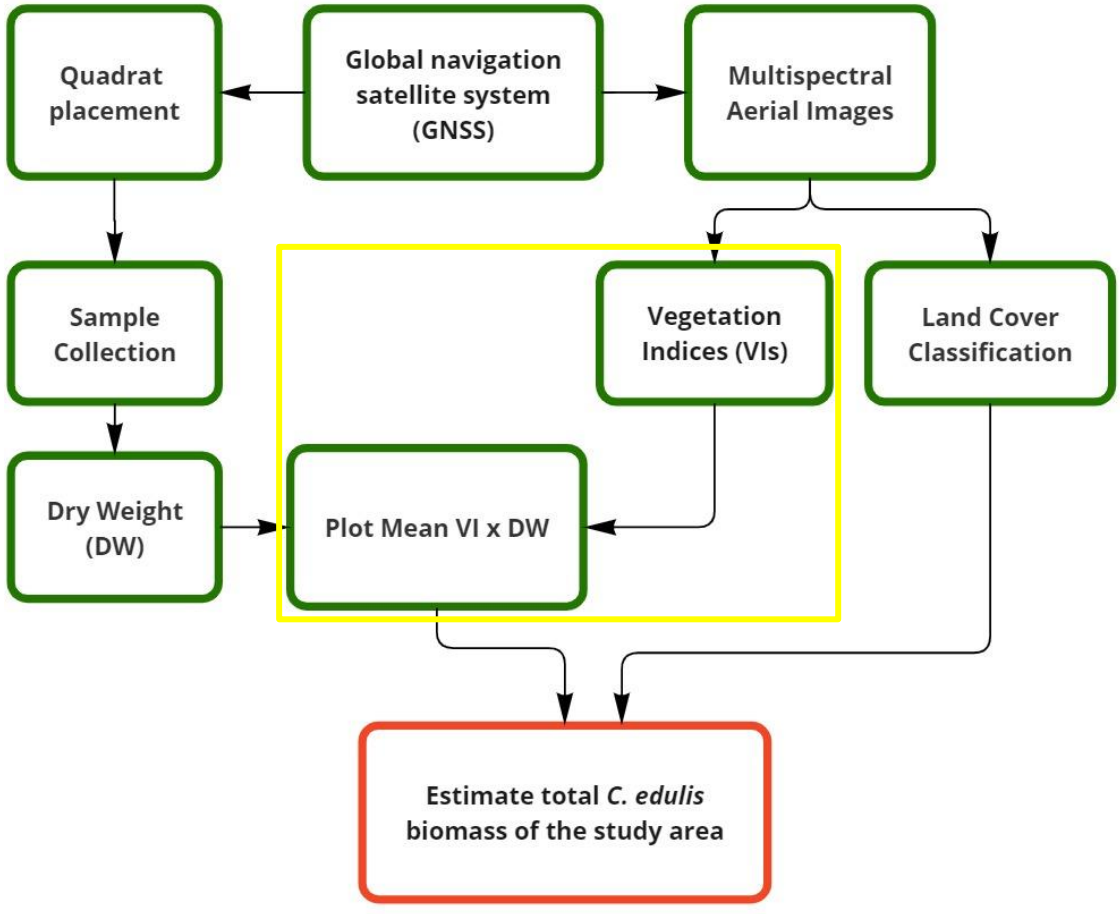
L1 = 50 cm
L2 = 30 cm



30 Samples

Samples parts separation
- Green
- Brown

Dried and weighed



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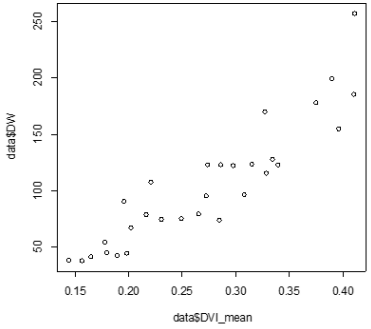
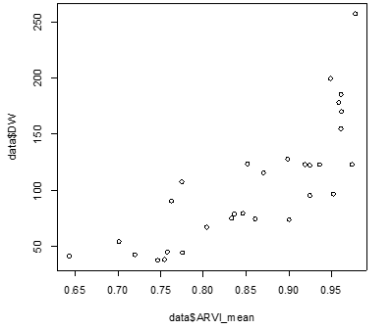
Vegetation Indices

Index	Formula
Atmospherically Resistant Vegetation Index (ARVI)	$\frac{NIR-(Red-Blu)}{NIR+(Red-Blu)}$
Green Chlorophyll Index (CLG)	$\frac{NIR}{Red}-1$
Chlorophyll Vegetation Index (CVI)	$\frac{NIR\times Red}{Gre^2}$
Difference Vegetation Index (DVI)	$NIR-Red$
Green Difference Vegetation Index (GDVI)	$NIR-Gre$
Enhanced Normalized Difference Vegetation Index (ENDVI)	$\frac{(NIR-Gre)-2Red}{(NIR-Gre)+2Red}$
Excess Green (ExG)	$2Gre-Red-Blu$
Excess Red (ExR)	$1.4Red-Gre$
Green Normalized Difference Vegetation Index (GNDVI)	$\frac{NIR-Gre}{NIR+Gre}$
Modified Green Red Vegetation Index (MGRVI)	$\frac{Gre^2-Red^2}{Gre^2+Red^2}$
Normalized Difference Red Edge Index (NDREI)	$\frac{NIR-RDG}{NIR+RDG}$
Normalized Difference Vegetation Index (NDVI)	$\frac{NIR-Red}{NIR+Red}$
Photochemical Reflectance Index (PRI)	$\frac{Gre-Blu}{Gre+Blu}$
RB	$\lvert Red-Blu\rvert$
Renormalized Difference Vegetation Index (RDVI)	$\frac{NIR-Red}{\sqrt{NIR+Red}}$
Ratio Vegetation Index (RVI)	$\frac{Red}{NIR}$

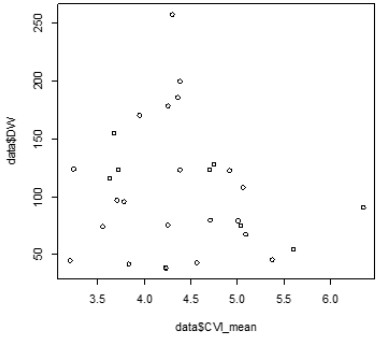
DVI



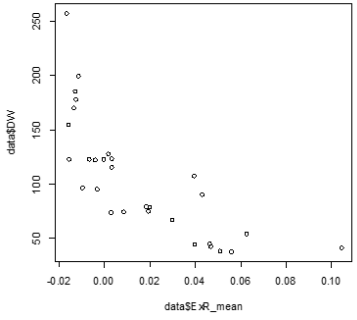
ARV



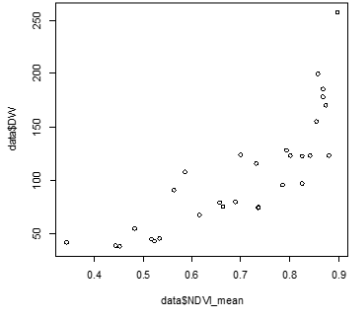
CVI



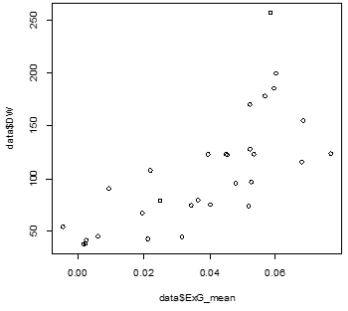
ExR



NDVI



ExG



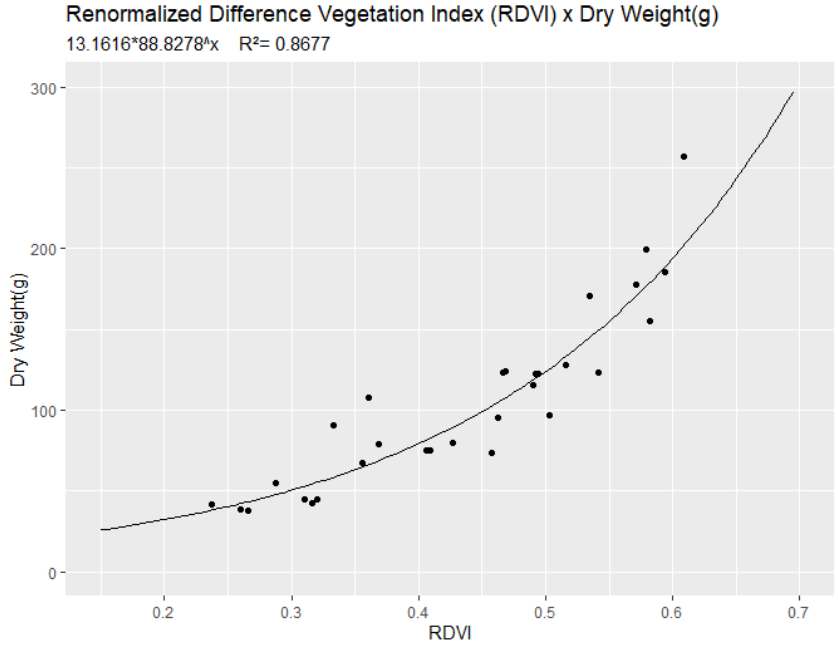
Regression models

$$y = a + bx$$

$$y = ab^x$$

$$y = ae^{xb}$$

Regression models

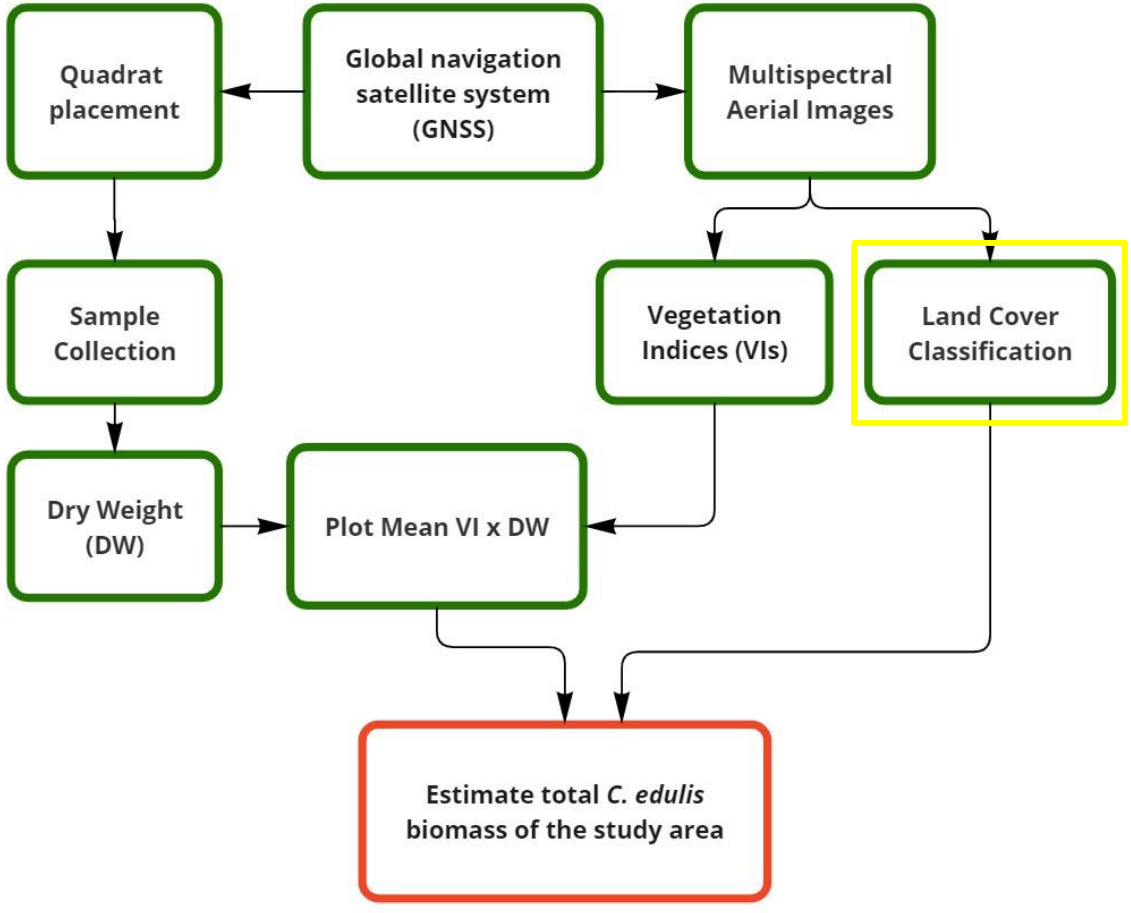


RDVI

$$\frac{NIR - RED}{\sqrt{NIR + RED}}$$

$R^2 = 0.87$

NRMSE = 0.09



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Landcover Classification

Randon Forest Algorithm and Sieve Filter

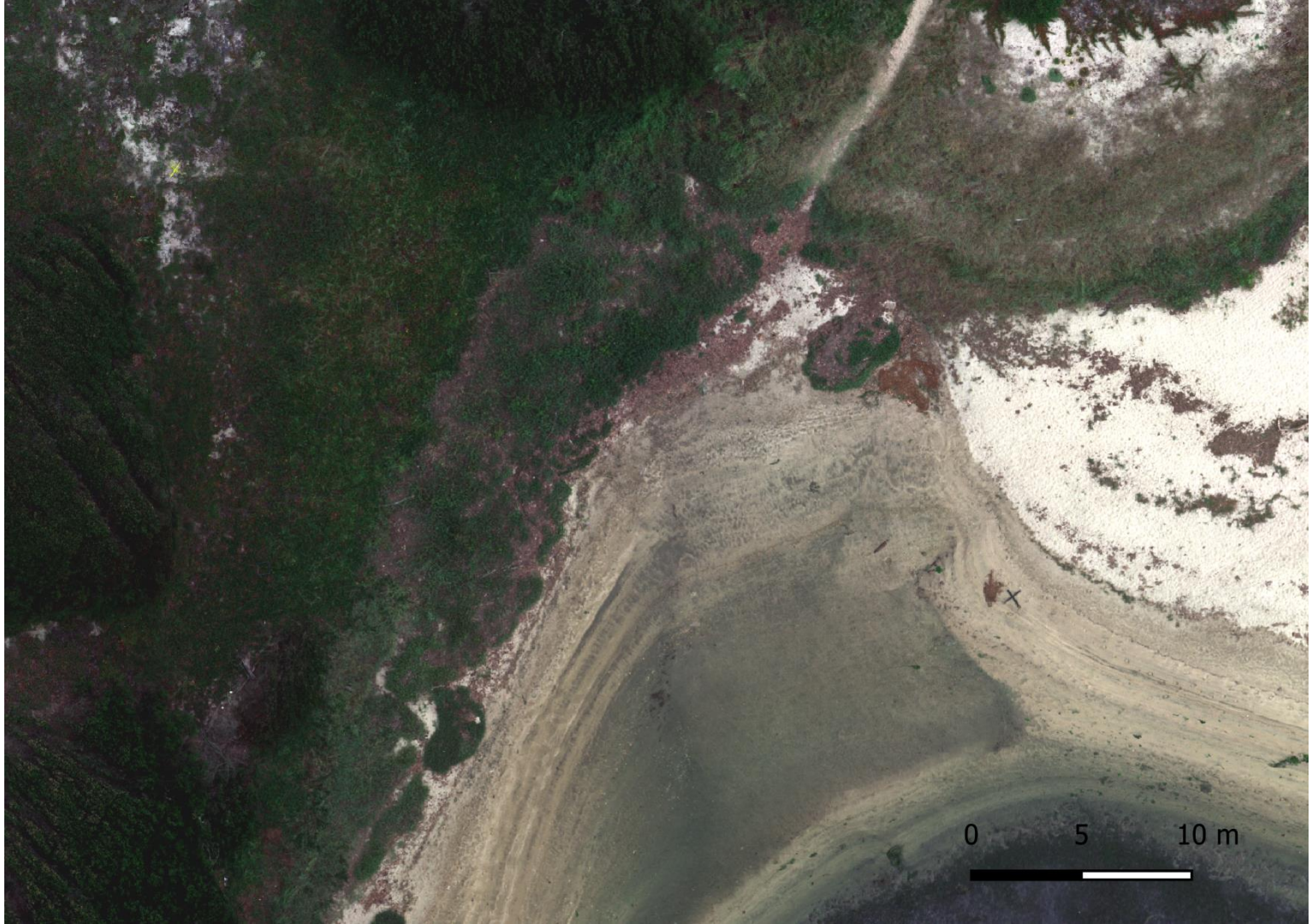
C. edulis User Accuracy = 0.80

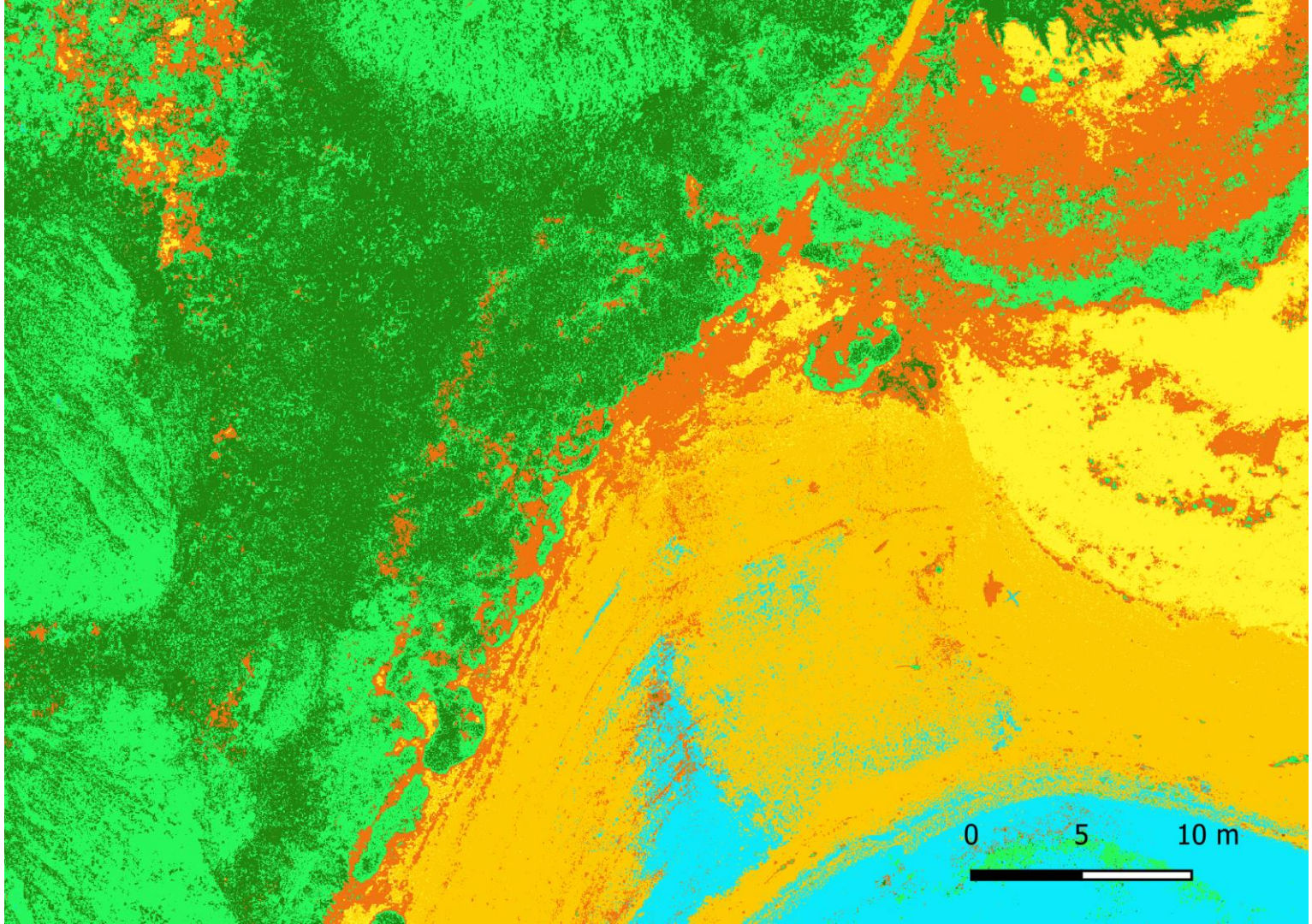
C. edulis Producer Accuracy = 0.91

C. edulis F1 Score = 0.85

Overall Accuracy = 0.89

Kappa = 0.87


0
5
10 m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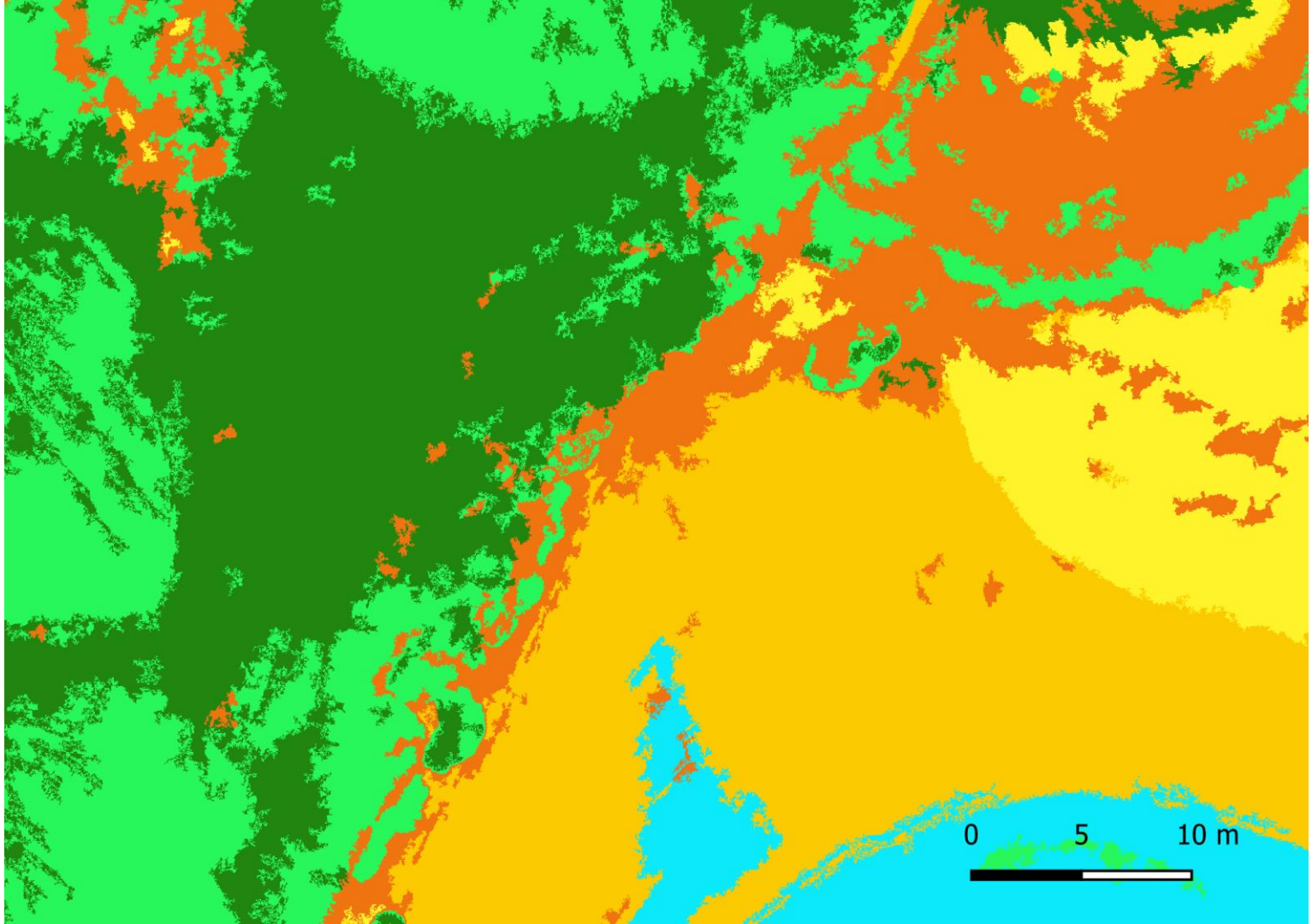
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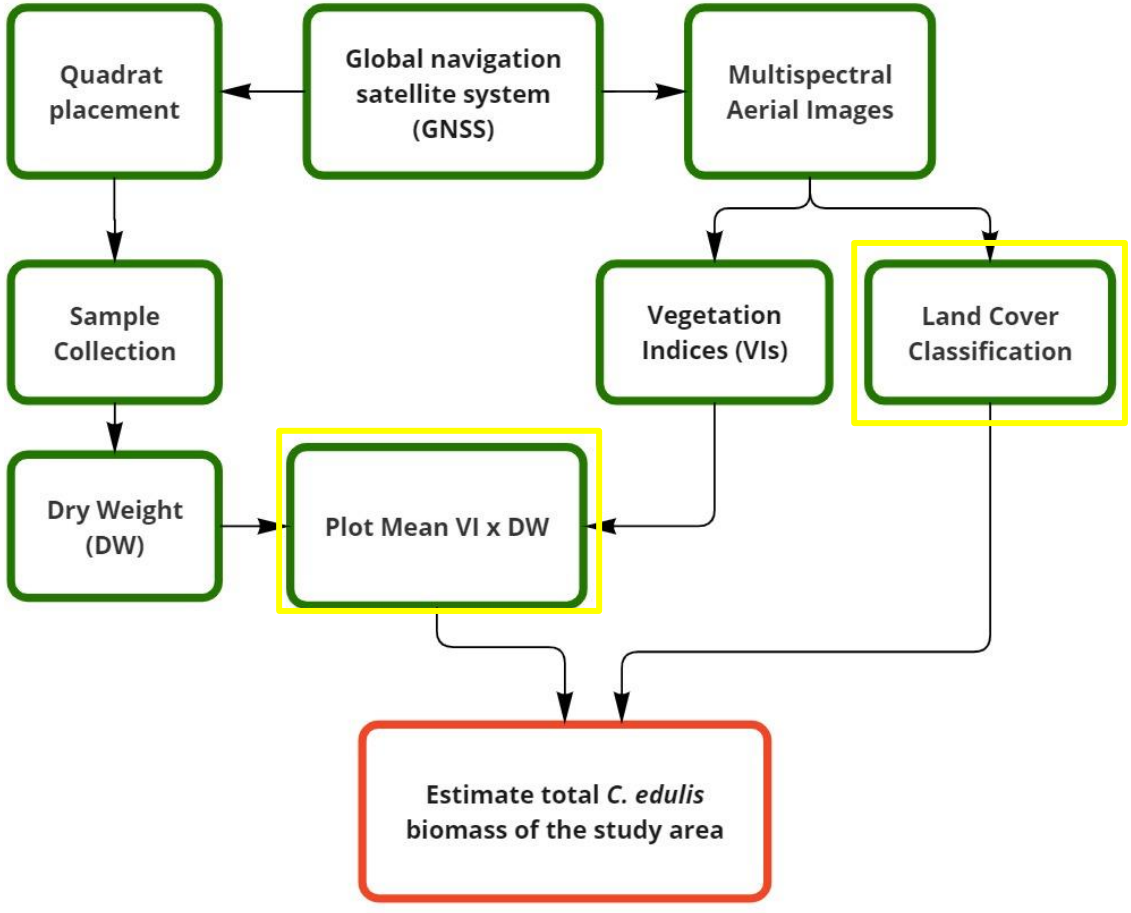

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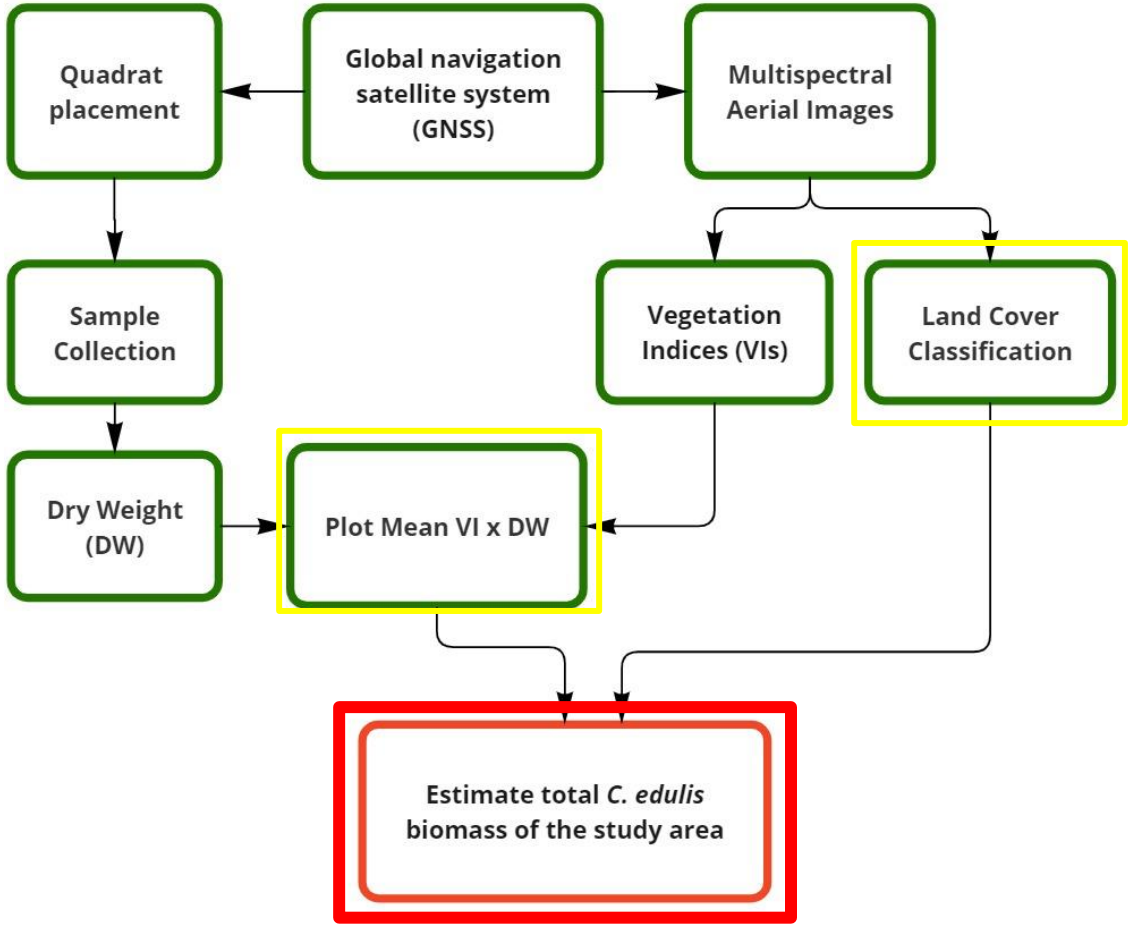

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Mass estimation

$$DW_{area} = \sum_{1}^{n} DW_{green}(VI_n)$$

DW_{area} = Total DW of *C. edulis in the area*

DW_{green} = Dry weight of green parts for each pixel

VI_n = Vegetation index of each pixel of *C. edulis* class

Mass estimation

Relation between

- DW of green and brow parts of *C.edulis* - 3:1
- Dry Weight and Wet Weight of Green parts - 1:10
- Dry Weight and Wet Weight of Dry parts - 1:2

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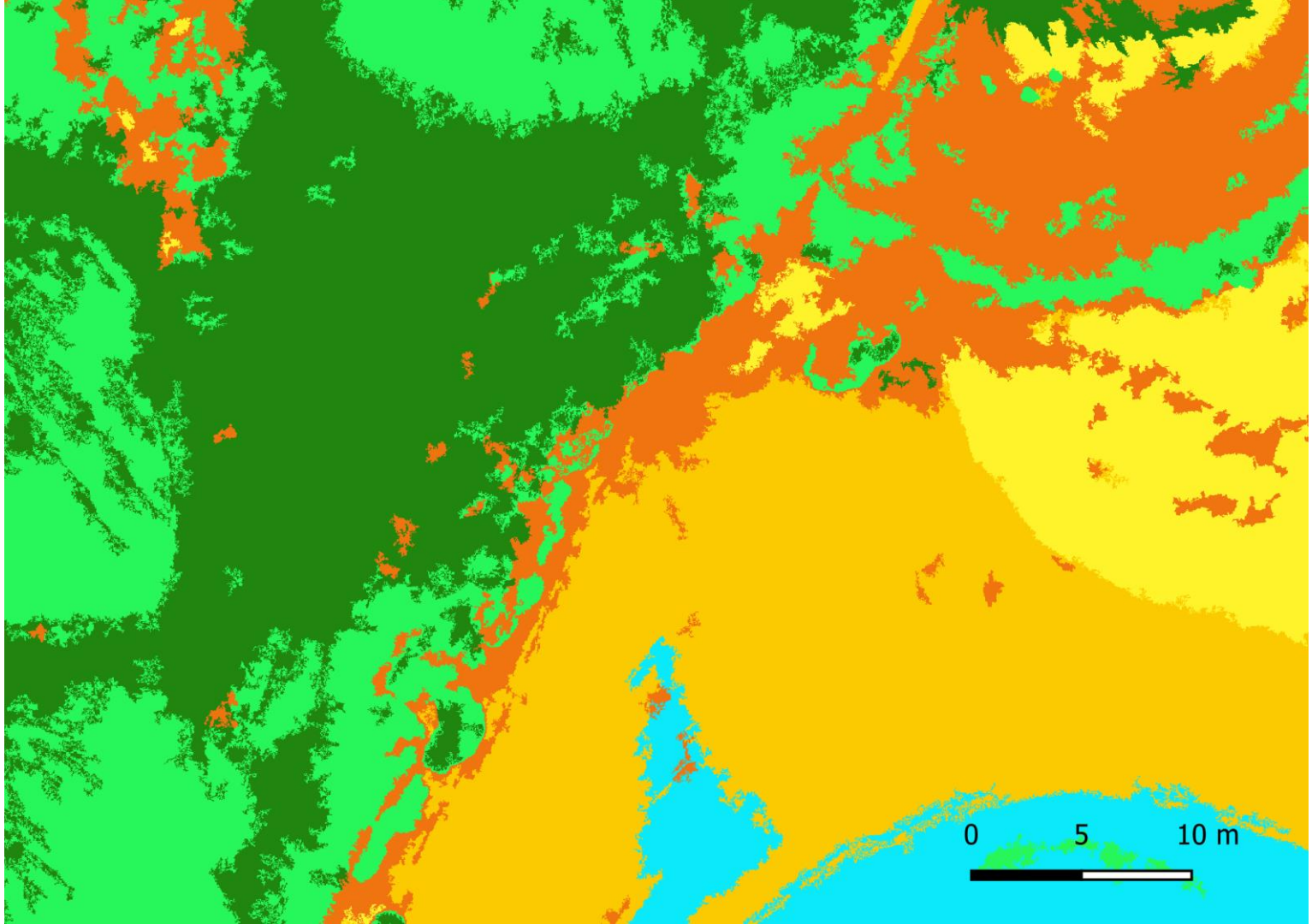
Validating Results

1) **Use some of the Region of Interest (ROI) as validation**
   I. 25 ROI as training, 5 ROI for validation
   II. 100% UA and PA fo *C. edulis*
2) **Use a k-fold cross validation**
   I. Lots of processing
   II. Migth still includes the 100% UA/PA result
3) **Create validation areas**
   I. Would be positioned tanking out the randomness of validation
   II. Sieve Filter could reduce its applicability
4) **Random Areas**


0
5
10 m

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Validating Results

1) ~~Use some of the Region of Interest as validation~~
2) ~~Use a k-fold cross validation~~
3) ~~Create validation areas~~
4) **Random Areas**
   - 600 Pixel size areas
   - 518 could be securely identified
     - 95% CI of 10% of the area

Further research

Can we reproduce the methodology with other species???

Can classification algorithms always differentiate a specific species from others?

Will the AGB x VI regression work with other species?

Is there any specificity of the plant that needs to be considered?

Can we monitor *C.edulis* by plane??

Remake all processes with Ground Sample Distance (pixel size) of 5 and 10 cm.

How much accuracy is lost?

Is it possible to monitor larger areas?

Thank you!

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Sandra Ramos
Advisor: Ana Bio

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Thank you! | www.lifewatch.eu/bees-2023