Mapping seagrass meadows and assessing blue carbon stocks using Sentinel-2 satellite imagery: A case study in the Canary Islands, Spain

Jorge Veiras-Yanes [1]*, Laura Martín-García [2], Enrique Casas [1], Manuel Arbelo [1]

1 Departamento de Física, Universidad de La Laguna, 38200 San Cristóbal de La Laguna, Spain.

2 Instituto Español de Oceanografía-CSIC, The Canary Islands, Spain.

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Seagrass Ecosystems: An Overview

- They capture carbon up to 35 times faster than tropical rainforests. [1]

In situ monitoring	Remote sensing
Expensive	Potentially free
Time-consuming	Efficient
Limited by extent	Unlimited

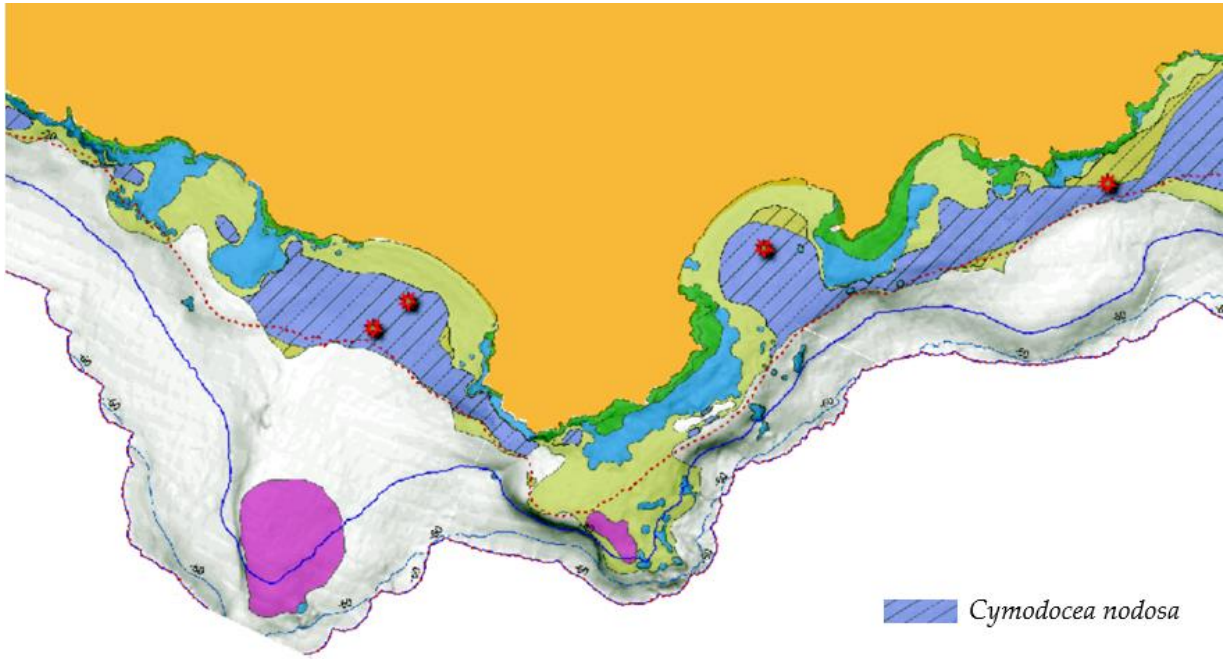
Cymodocea nodosa. Extracted from [2]

- Objective: evaluate the ability of Sentinel-2 imagery to map seagrass meadows.

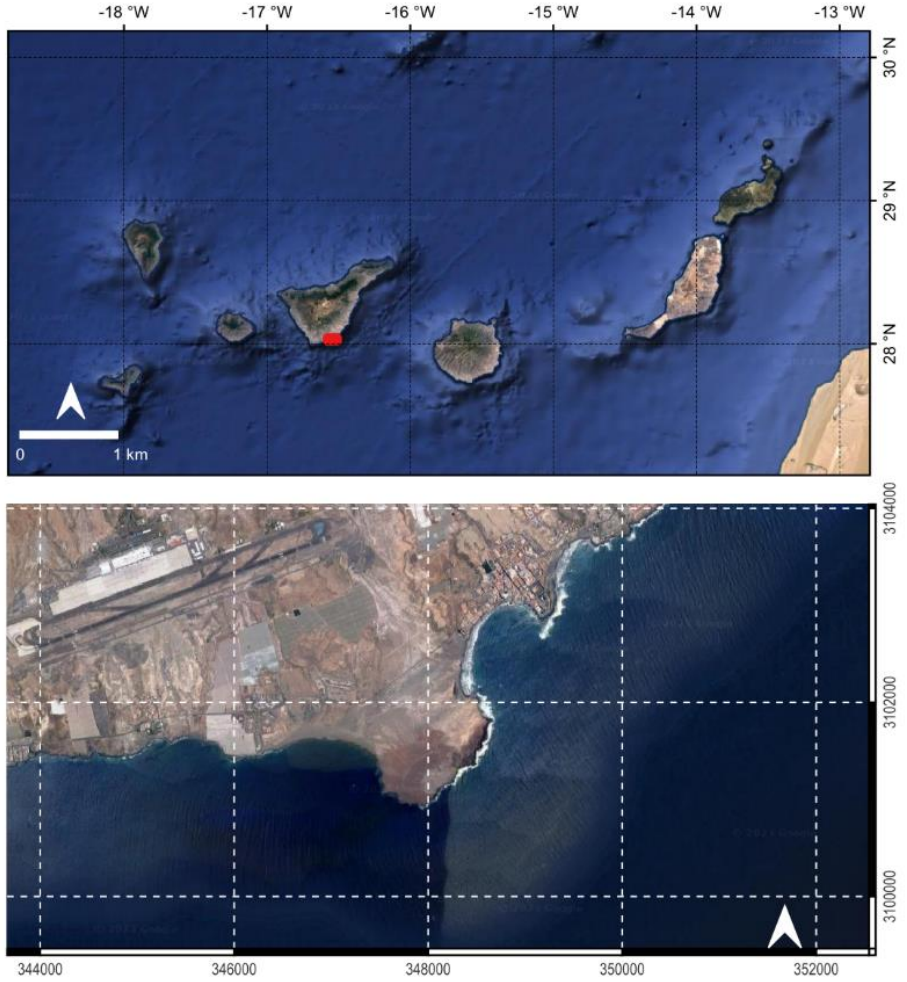
[1] Mcleod, E., Chmura, G. L., Bouillon, S., Salm, R., Björk, M., Duarte, C. M., Lovelock, C. E., Schlesinger, W. H., & Silliman, B. R. A blueprint for blue carbon: toward an improved understanding of the role of vegetated coastal habitats in sequestering CO2. Frontiers in Ecology and the Environment 2011, 9, 552-560. https://doi.org/10.1890/110004

[2] Seba (Cymodocea nodosa) – Canal del Área de Tecnología Educativa. (n.d.). https://www3.gobiernodecanarias.org/medusa/mediateca/ecoescuela/?attachment_id=6305

Materials and methods



Field data from 2016. Extracted from [3]



Level-1C image from 27 October 2022.

[3] Monterroso O., Rodríguez M., Pérez O., Ramos E., Álvarez O., Cruces L., Ruiz M., Miguel A., González M. Memoria final del estudio “Cartografía de Cymodocea nodosa en Tenerife y La Gomera”. Viceconsejería de Medio Ambiente del Gobierno de Canarias. Dirección General de Protección de la Naturaleza. Cima -Informe Técnico 2018, 164 pp

Image pre-processing

- Atmospheric correction: Sen2Cor

  - Aerosol Optical Thickness → AUX_CAMSFO
  - Water vapour column
  - Ozone layer

  AUX_ECMWF

  AUX_CAMSFO, AUX_ECMWF → European Centre for Medium-Range Weather Forecasts data

- Land mask: Threshold value of 0.1 in the NIR band (Band 8)

- Sunglint correction: Sen2Coral → Hedley's method [4]

- Deep water mask: Bathymetry data [3]

[4] Hedley, J., Harborne, A. R., & Mumby, P. J. Technical note: Simple and robust removal of sun glint for mapping shallow- water benthos. International Journal of Remote Sensing 2005, 26, 2107-2112. https://doi.org/10.1080/01431160500034086

Image pre-processing

- Water column correction: Lyzenga's method [5]

$$DII_{ij} = ln(L_i) - \left[\left(\frac{k_i}{k_j}\right) ln(L_j)\right]$$

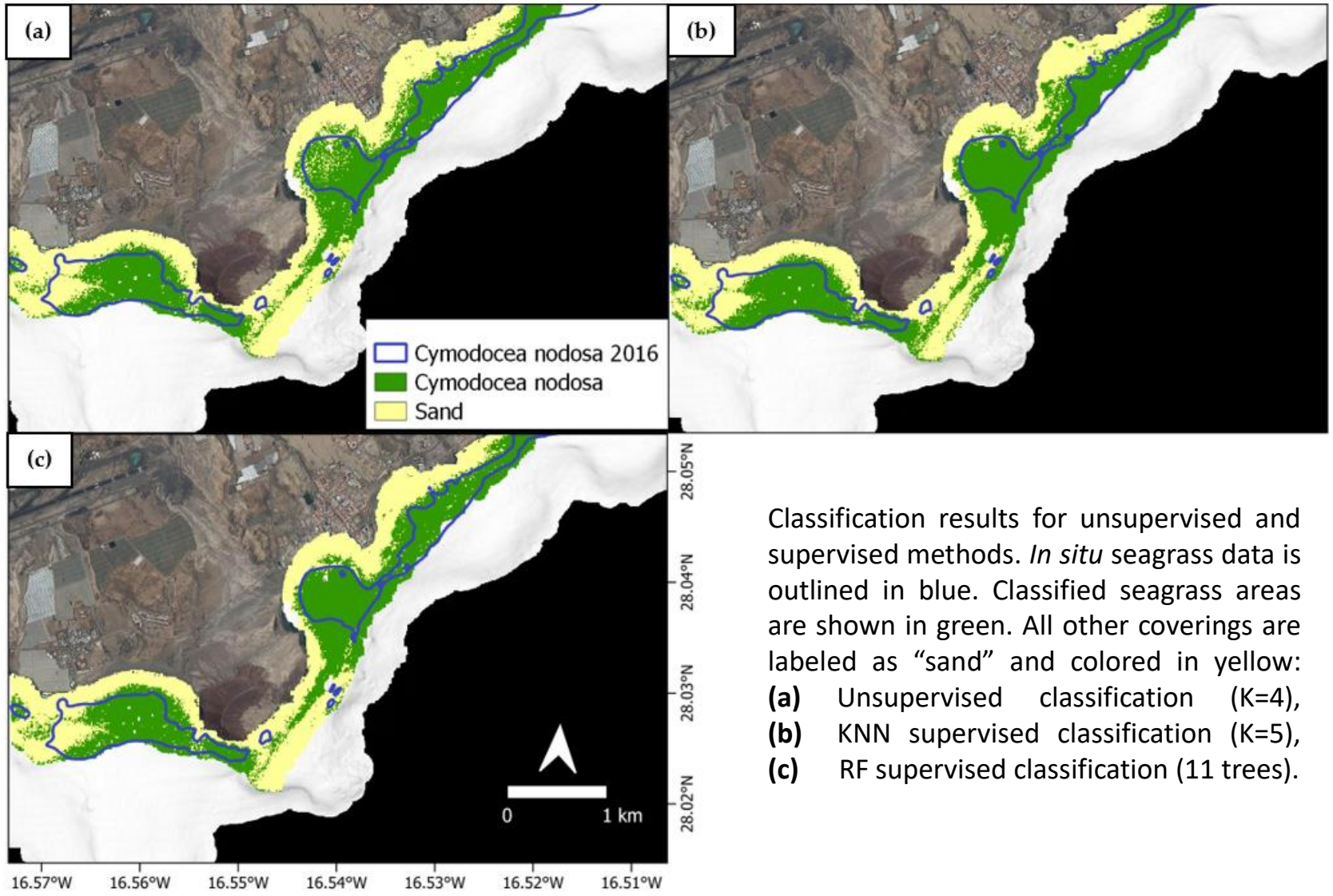
$$\frac{k_i}{k_j} = a + \sqrt{(a^2 + 1)}$$

$$a = \frac{\sigma_{ii} - \sigma_{jj}}{2\sigma_{ij}}$$

- i refers to a visible band, and j to another visible band (e.g., i=B2 and j=B3)

[5] Lyzenga, D. R. Remote sensing of bottom reflectance and water attenuation parameters in shallow water using aircraft and 187 Landsat data. International Journal of Remote Sensing 1981, 2, 71-82. https://doi.org/10.1080/01431168108948342

Classification results



Classification results for unsupervised and supervised methods. *In situ* seagrass data is outlined in blue. Classified seagrass areas are shown in green. All other coverings are labeled as "sand" and colored in yellow:
(a) Unsupervised classification (K=4),
(b) KNN supervised classification (K=5),
(c) RF supervised classification (11 trees).

(b) 245 ha highest seagrass extent

(c) 230 ha least seagrass extent

F1 scores for RF: 0.96 – 0.99

F1 scores for KNN and KDTree-KNN: 0.84 – 0.96

Blue carbon assessment

- Average seagrass area extent: 237±5 ha
- InVEST Coastal Blue Carbon model
- Carbon sequestered in our study area: 111,000±2,000 Mg of CO_2

Sector	Mg of CO2 emitted in 2019	Mg of CO2 emitted in 2020
Energy production and transformation	5,443,050	4,713,440
Industrial combustion plants	76,430	61,690
Not industrial combustion plants	224,020	185,100
Road transport	3,490,960	3,397,980
Other means of transport and machinery	8,140,270	5,494,840

[6] Observatorio de la Energía de Canarias - Emisiones. (s. f.) https://www3.gobiernodecanarias.org/ceic/energia/oecan/esta- 194 disticas-2/emisiones

Conclusion

- Valuable pre-processing method for similar studies.
- Highlights seagrasses’ key role in regional strategies to achieve net zero carbon emissions.

Thank you for you attention!

Any questions? Contact us at jveiras2001@gmail.com

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