Blue Paths

Addressing Sustainability Transition Pathways in the Blue Economy

"*Ensemble*" Multi-criteria techniques for robust offshore wind planning in a MSP perspective

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II MED-MSP-CoP Webinar
MSP AND OFFSHORE WIND ENERGY
Monday 13th November 2023 11:00 – 12:15 CET

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About Blue-Paths

Hosted by: University of Girona, Department of Geography, Landscape Analysis & Management Group
Team: Daniel Depellegrin (Research Lead) + Carolina Marti Llambrich (Coordinator);
Duration: 2023-2025
Budget: 165,000€
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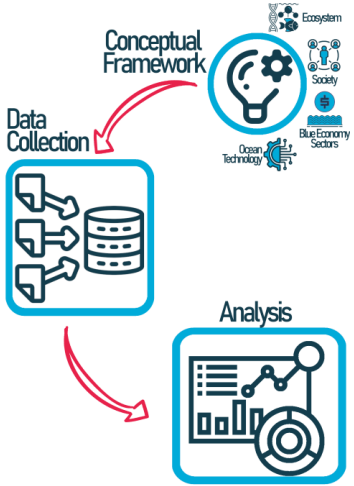


…to address the effects in terms of cost-benefits of pervasive ocean technologies deriving from different sectors of the Blue Economy on the marine SES through the development of a sustainability transition framework. The framework will be tested for the Spanish exclusive economic zone.

Spanish MSP Context

First Maritime Spatial Plan approved by Royal Decree 150/2023 (28 of February), approves Maritime Spatial Plans for five Demarcations.

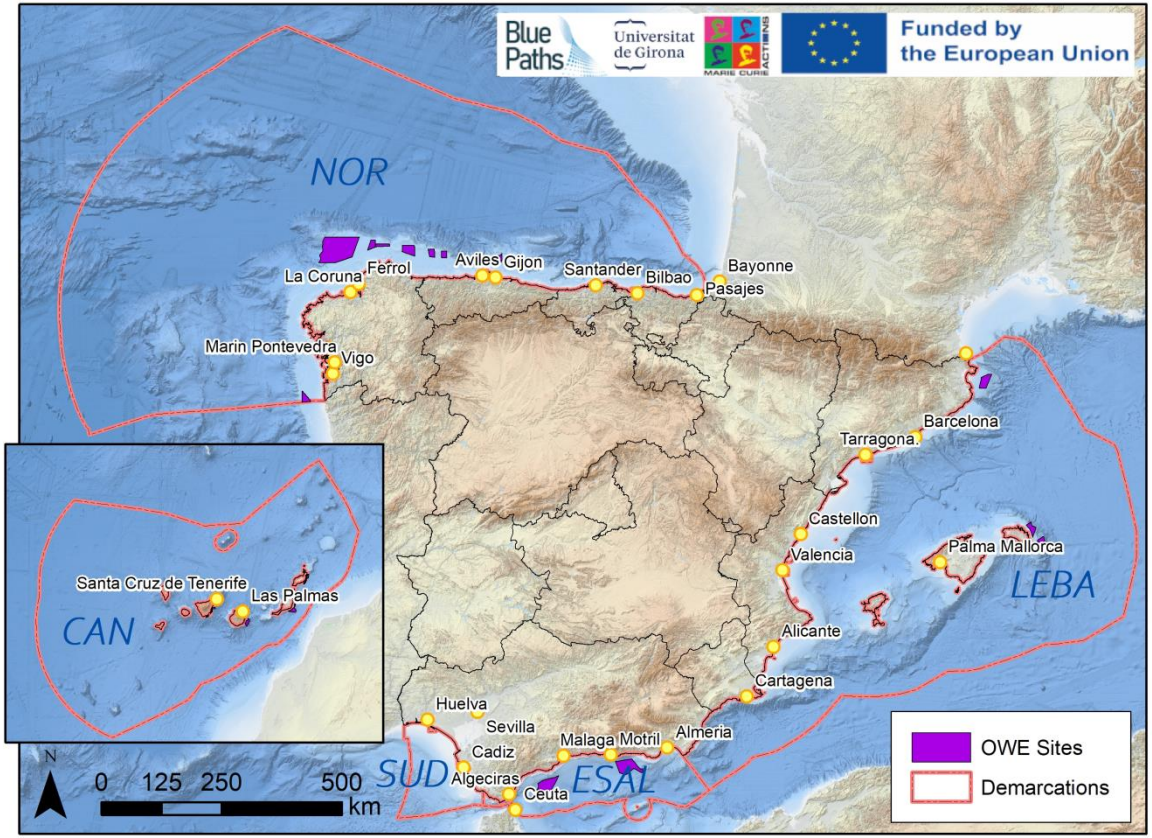
Overall Objective of the plan is to prioritize human activities and sustainable growth of maritime sectors compatible with MSP and a sustainable use of marine resources

Sectoral objectives identify areas of highest potential in each Demarcation AND monitor interactions with other human activities and nature

Spanish OWE Landscape in numbers…

19 sites in 4 planning demarcations
8 high potential areas in NOR - North Atlantic
6 high potential areas in CAN - Canary Islands
3 high potential areas in LEBA - Levantine-Balearic
2 high potential areas in ESAL - Straight-Alboran
0 high potential areas in SUR - South Atlantic

Space demands of high potential areas
0.45% of space demand for the Spanish EEZ
4.5% of sea space in the Straight-Alboran demarcation
0.24% of EEZ in North-Atlantic demarcation



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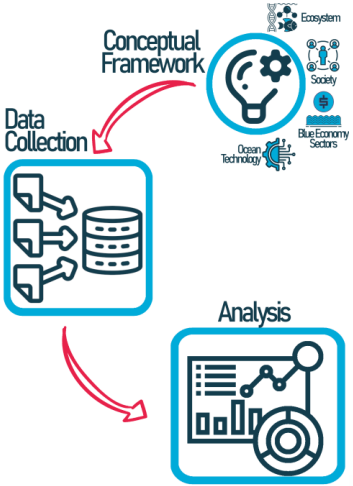
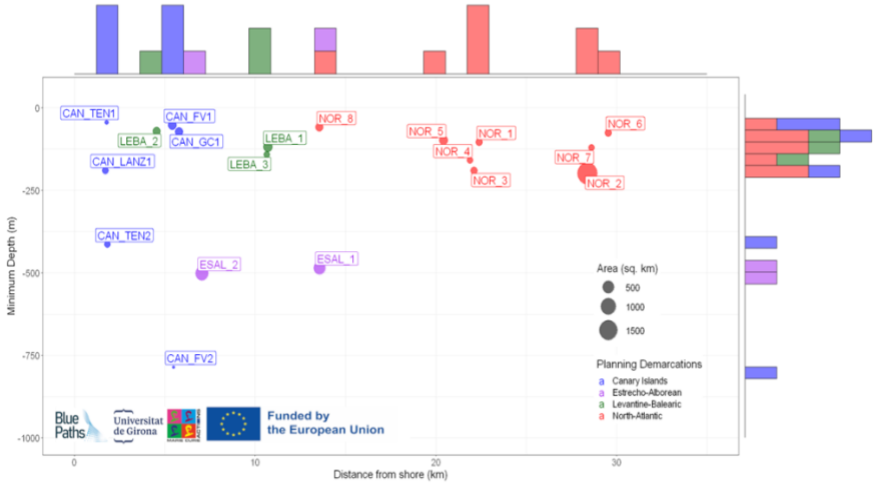
Research aim

The aim of the research is to propose a flexible methodology to address decision-making problems in ocean planning through the application of an **automated ensemble of Multi-Criteria algorithms** for ranking of optimal selection of Offshore Wind Energy arrays as proposed in the Spanish Maritime Spatial Plan published in February 2023.





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Indicator Database

Cost-Benefit Analysis of variables

Benefit = Ideal solution - outcomes to be maximized (e.g. distance from coast, tech capacity, install, cap)

Cost = Anti-ideal solution - outcomes to be minimized (e.g. ecological risk, collision risk, fishery)

22 indicators based on literature
Application of indicators for each 19 OWE sites defined in the Spanish MSP

Ecological

C- Ecological risk to marine habitats, fish, mammals, birds (*Index*)

C- Nature Protection *(% of overlap)*

Social

B - Distance from Coast (km)

C- Population (inhabitants)

C- Number of beaches (n)

B- Coastal urbanization (%)

C- Restricted/Prohibited areas (%)

C- Fishing effort Coast (*fishing hours*)

Economic

C- Distance to ports (*km*)

C- Distance to substation (*km*)

C- Constrains (*presence of shipping, MPAs, military areas*)

C- Collision risk (*index*)

B- Area (sq km)

Technical/Spatial

C- Strom frequency Coast (%

B- Technical Capacity (*index*)

B- Average wind speed (m/s)

B- Multi-Use potential with Aquaculture (*aquaculture companies*)

C- Depth (meters)

B- Substrate type (suitability)

C- Slope (*percentage*)

B- Installation Capacity (MW/sq km)

C- Telecomm Cables (*km*)

IUCN EMODnet protected planet

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Copernicus Land Monitoring Service

CEDEX CENTRO DE ESTUDIOS Y EXPERIMENTACIÓN DE OBRAS PÚBLICAS

Global Fishing Watch entsoe EMODnet

ESMAP Energy Sector Management Assistance Program

EMODnet

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GLOBAL WIND ATLAS
GLOBAL SOLAR ATLAS | ENERGYDATA.INFO

Example (1): Constrained areas

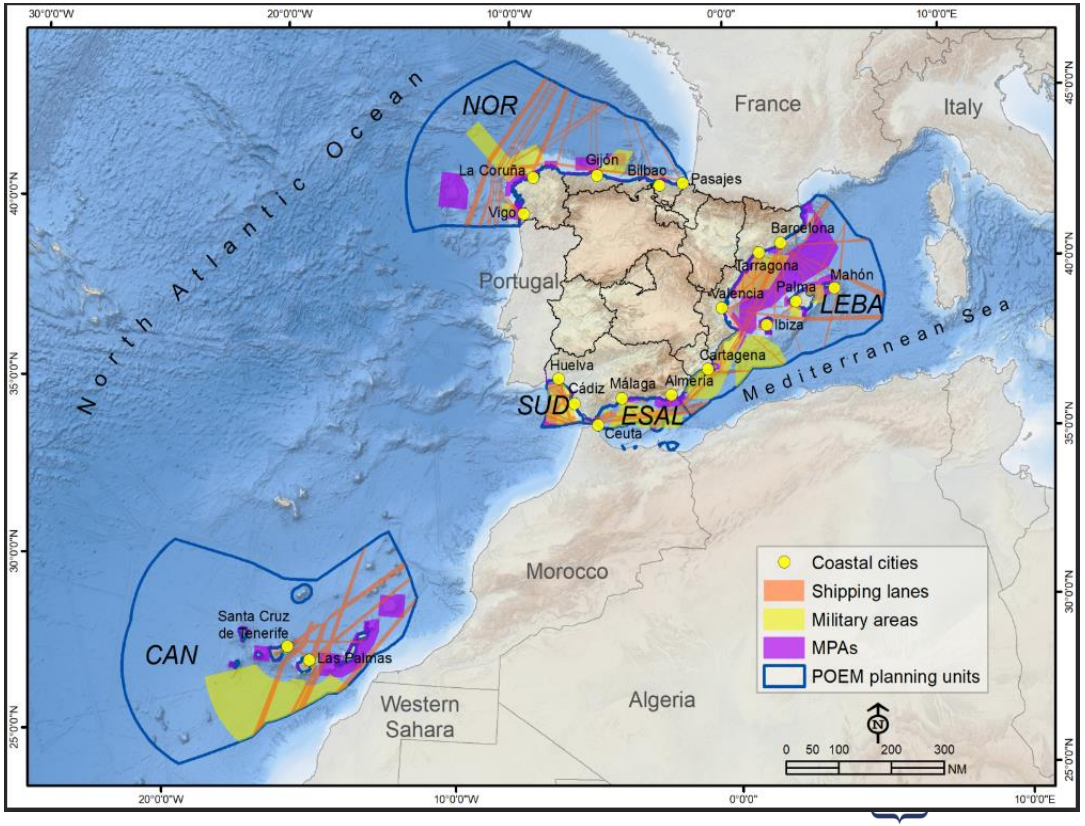
Economic

C- Constrains (*presence of shipping, MPAs, military areas*)

protected planet

EMODnet
European Marine Observation and Data Network

1. Military areas
2. Main shipping lanes
3. Protected areas



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Example (2): Ecological risk

Ecological

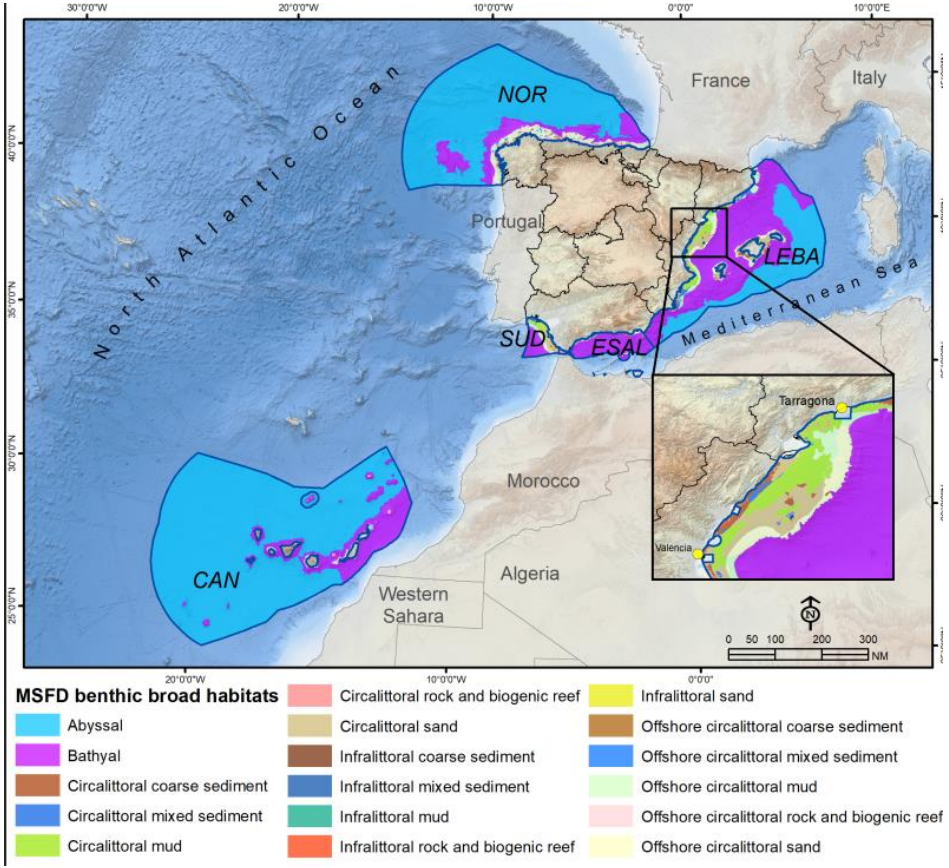
C- Ecological risk to marine habitats, fish, mammals, birds (*Index*)

Data source

IUCN

EMODnet
European Marine Observation and Data Network

A - Distribution of marine mammals
B - Fish species
C - Birds
D - MSFD Marine habitats



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Example (3): Collision risk

Ecological

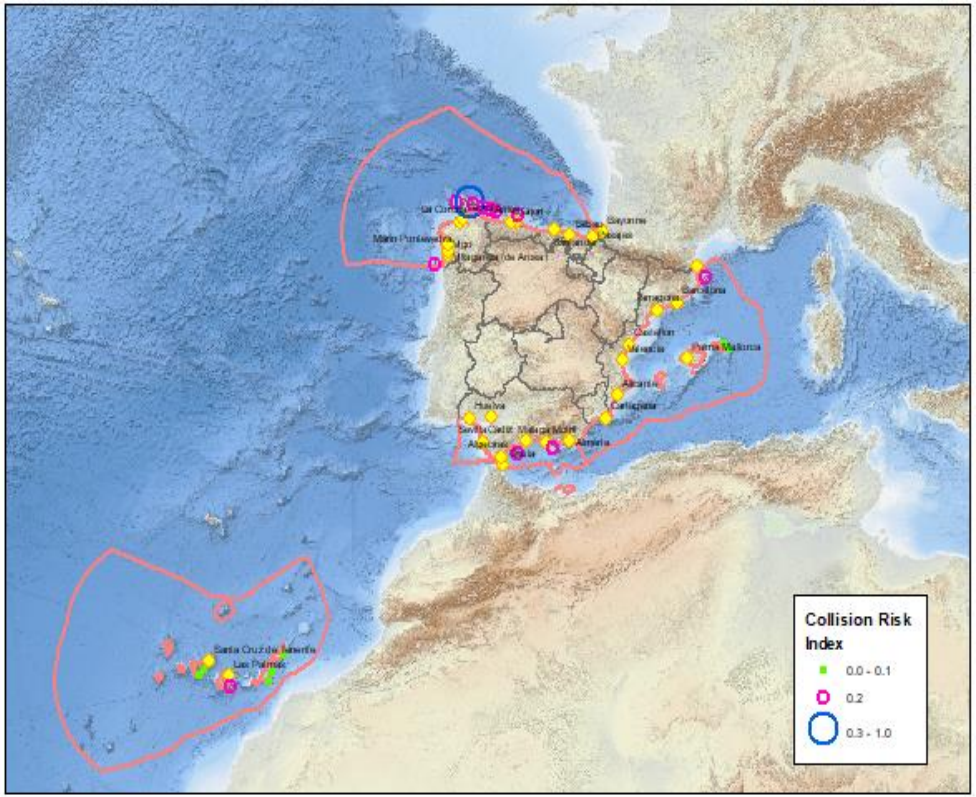
C- Ecological risk to marine habitats, fish, mammals, birds (*Index*)

Data source

EMODnet
European Marine Observation and Data Network

[Mean Vessel Density within 6482 m safety buffer from the OWE perimeter]. The maximum safety buffer identified in literature for OWE sites.

Source: MSP-Platform, 2022



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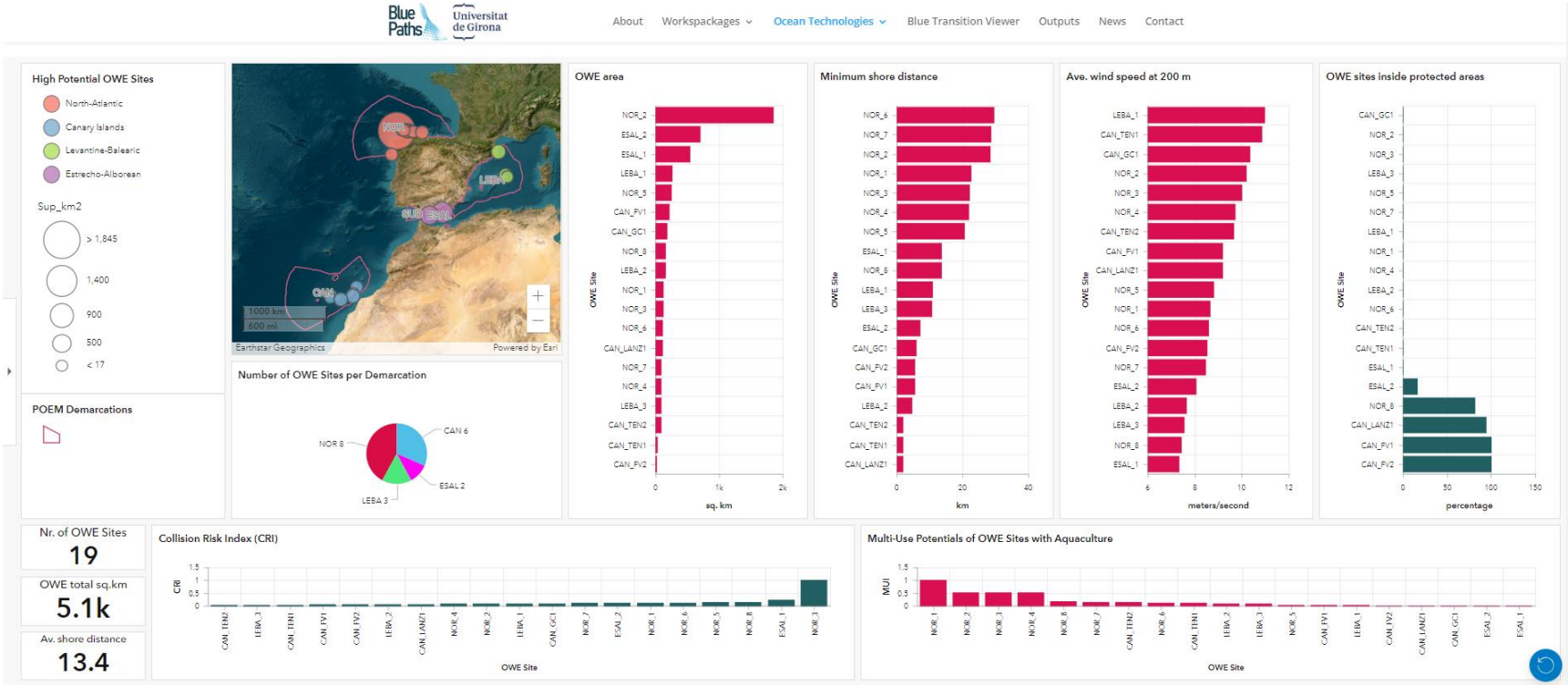
Indicator performance

CHALLENGE: Define pool of indicators that can be applied across the different study areas

Ocean Technology Dashboards

Offshore Wind Energy (Test-) Demonstrator…

https://blue-paths.eu/ocean-technologies/offshore-wind-energy-demonstrator/



Blue-Paths on EMODnet

Blue-Paths Use Case on EMODnet
https://emodnet.ec.europa.eu/en/use-case/characterization-potential-spanish-offshore-wind-energy-landscape-through-emodnet-data

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Characterization of the potential Spanish offshore wind energy landscape through an EMODnet data-driven dynamic dashboard

23 Oct 2023

The user organisation

The research group in Landscape Analysis & Management of the Department of Geography of the University of Girona (Udg; Spain) is a leading research group in basic and applied research in regional planning and management. Its core research activities include management of coastal areas, ecological connectivity, landscape policy design, GIS-based modelling and remote sensing.

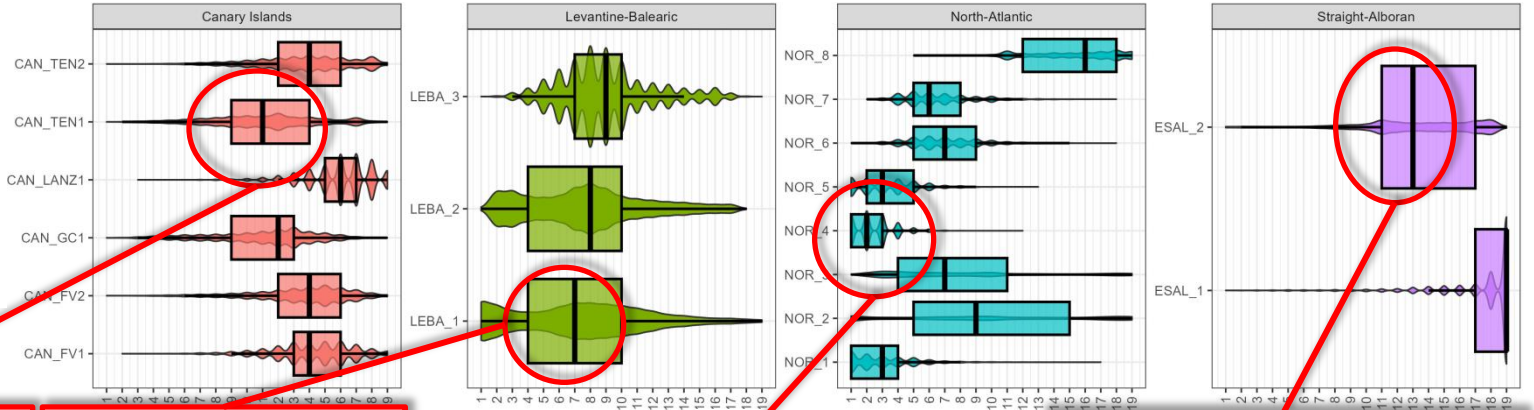
Challenges faced by the user

The project Blue-Paths - Addressing Sustainability Transition Pathways in the Blue Economy is funded by the EC (GA: 101062188) under the HORIZON – Marie Skłodowska-Curie Actions 2021 of the Horizon EU program. The fellowship is carried out at the University of Girona (Spain, Department of Geography). Blue-Paths aims to foster sustainable use of the marine socio-ecological systems (SES) through the development of an innovative Sustainable Transition Framework (STF), that will investigate the pathways of pervasive ocean technologies (OTs) transformations in the most important sectors of the Blue Economy e.g. Ocean Renewable Energy (ORE) Systems, coastal tourism, shipping, nature protection. The study area is the Spanish sea space.

1) Co-existence scenario

Planning AIM:
Prioritize OWE sites by balancing ecological-social-economic and technical/technological aspects
Indicators Pool: ALL

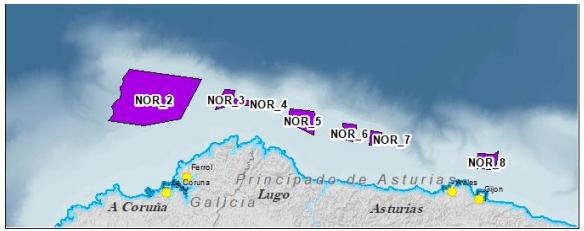
HPA for OW



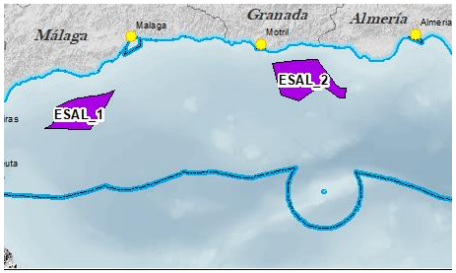
Rank (1 to 19)

1st Quartile: 9
Median: 11
3rd Quartile: 14

1st Quartile: 4
Median: 7
3rd Quartile: 10



1st Quartile: 1
Median: 2
3rd Quartile: 3



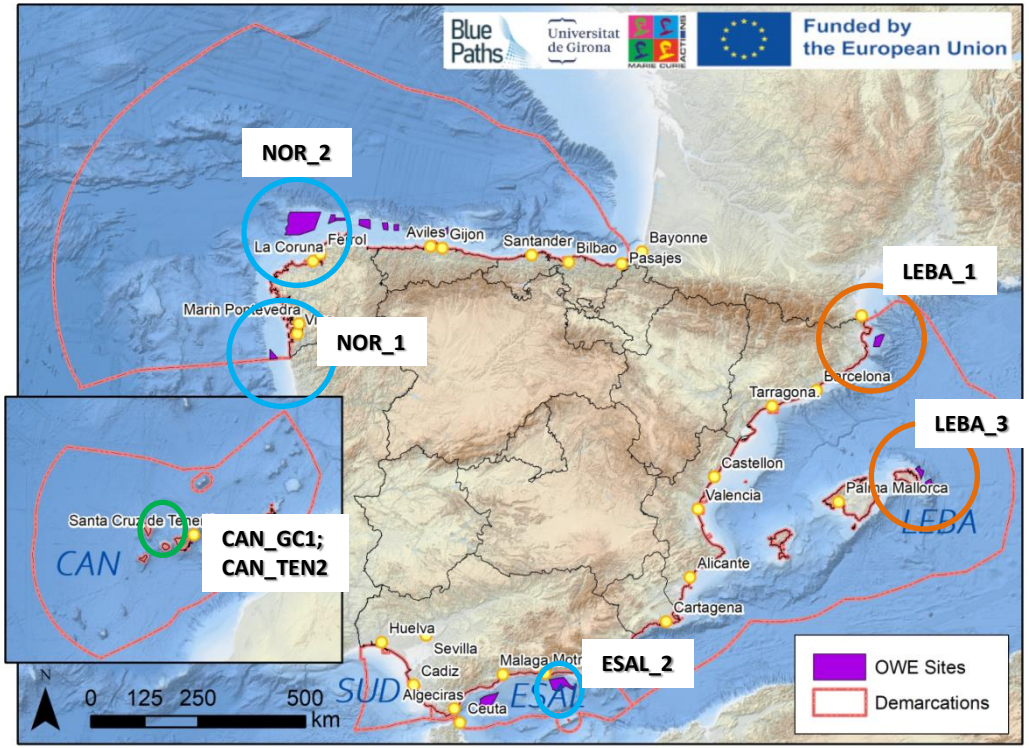
1st Quartile: 11
Median: 13
3rd Quartile: 17

Meta-ranking/Optimal ranking

Comparing ranks and provide Meta/Optimal Ranking to provide a rank out of multiple ranking methods

OWE Arrays	VIKOR	TOPSIS	MOORA	Optimal Rank
CAN_FV1	15	14	14	16
CAN_FV2	13	14	15	15
CAN_GC1	**8**	**12**	**13**	**13**
CAN_LANZ1	16	16	17	17
CAN_TEN1	11	9	13	14
CAN_TEN2	**13**	**12**	**15**	**12**
ESAL_1	18	19	19	18
ESAL_2	**2**	**12**	**15**	**13**
LEBA_1	**9**	**9**	**2**	**10**
LEBA_2	12	7	3	11
LEBA_3	**11**	**8**	**8**	**8**
NOR_1	**3**	**2**	**4**	**1**
NOR_2	**10**	**12**	**9**	**2**
NOR_3	4	11	8	3
NOR_4	2	2	3	7
NOR_5	2	3	4	4
NOR_6	7	6	7	6
NOR_7	6	6	7	5
NOR_8	18	16	12	9

Note: Medians for VIKOR, TOPSIS & MOORA



Method: ranks are medians; Cross-Entropy method with 500 iterations

Tradeoff analysis

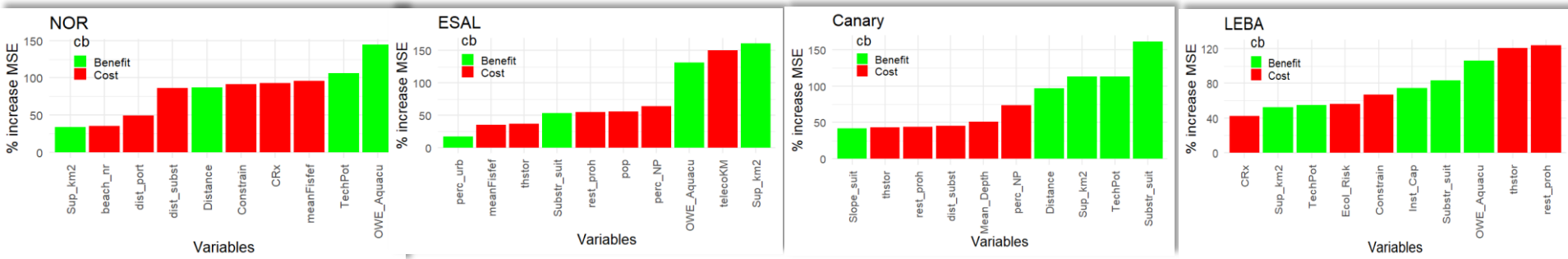
AIM: **Identify for each Planning demarcation the variables that create highest environmental, social and economic costs through machine learning techniques.**

Application of Machine Learning based technique to **define trade-offs:**

1. The importance of each variable in generating the rank from 1-19 for each high potential area for OWE
2. To identify what are the variables creating highest costs

Demarcation specific planning measures to reduce environmental, technical, social & economic costs

MSE = Mean Square Error



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Discussion & future research development

- More robust **and precise mechanism to address planning challenges**, such as potential future maritime activities
  - new aquaculture sites,
  - Biodiversity strategy 2030 objectives for locating new marine protected areas
  - Other new technologies
- **Automated character** of the instruments makes it more **flexible, scalable and customizable approach**.
- Addresses some **drawbacks of expert-based engagement in MC**
  - Understandings limited to maritime sectors,
  - conflict of interests,
  - limitation of number of participants
- In an **MSP development process** the methods should be used iteratively to inform about the **performance of a plan** (e.g. changes of the plan, intermediate/draft planning, iterations)
- FAIR principles **open data & code availability**
- **Future application** of the method also to other **European marine key technology** (vessel electrification, ocean clean up systems, ocean multi-use etc…)

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Thank You!

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