Environmental Research Demonstration Strategy

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WavEC Offshore Renewables
28/11/2024

This Project is co-funded by the European Climate, Infrastructure and Environment Executive Agency (CINEA)

ENVIRONMENTAL RESEARCH DEMONSTRATION STRATEGY based on the **collection, processing, modelling, analysis and sharing of environmental data** collected in WE sites from different European countries where WECs are currently operating (Mutriku power plant and BIMEP in Spain, Aguçadoura in Portugal and SEMREV in France).

Monitoring (WP2):
(i) Underwater noise
(ii) Seafloor integrity
(iii) EMF
(iv) Fish communities

Modelling (WP3):
(i) Underwater noise
(ii) EMF
(iii) Marine dynamics

Sharing data (WP4):

MARENDATA

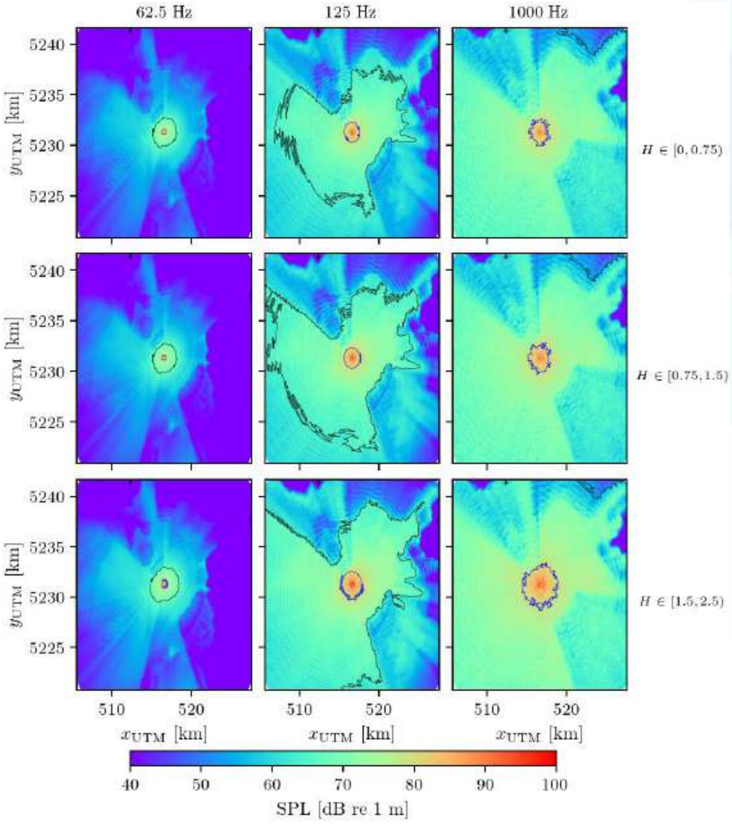
Device	Technology	Site	Location	Monitoring/Modelling
Mutriku Wave Power Plant	Oscillating Water Column	Mutriku, Spain	Onshore	• Acoustics
Penguin II (Wello)	"Point absorber" – Rotational Mass Resonator	BiMEP, Spain	Offshore	• Acoustics • EMF • Seafloor integrity • Fish communities • Marine dynamics
HiWave (CorPower Ocean)	Point absorber	Aguçadoura, Portugal	Offshore	
WAVEGEM (GEPS Techno)	Energy autonomous platform	SEM-REV, France	Offshore	• Acoustics • EMF (FLOATGEN) • Seafloor integrity

Acoustics

- Inputs for all test sites **modelling with good resolution**
  - Successful campaigns using three hydrophones at increasing distances from the WECs
  - Seasonality included by obtaining one year of data
  - Modelling at 62.5 Hz, 125 Hz, and 1 kHz

- **Acoustic disturbance area metrics computed**
  - Noise from WEC (blue contour) ranges between 1 and 3 km depending on wave height and season

- **Evaluation of noise impact on cetaceans**
  - The noise exceeding the cetaceans' hearing threshold is below the background noise
  - The area where LF cetaceans will hear the background noise (black contour) is much greater than the area where LF cetaceans will be affected purely by the WEC (blue contour)



Sound pressure level modelling at SEM-REV test site. Black contour encircles the area where noise is higher than LF cetaceans thresholds. Blue contour encircles the area where SPL > SPL_off

Acoustics

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H [m]	f [Hz]	Winter	Spring	Summer	Autumn
[0, 0.75]	62.5	2.2	1.9	1.7	1.8
	125	5.3	4.8	4.5	6.4
	1k	6.7	6.4	6.1	6.4
[0.75,1.5]	62.5	2.3	2	1.8	1.9
	125	5.6	5.2	4.8	5.1
	1k	6.7	6.5	6.2	6.5
[1.5, 2.5]	62.5	2.7	2.3	2.1	2.3
	125	6	5.6	5.3	5.5
	1k	6.9	6.7	6.4	6.7

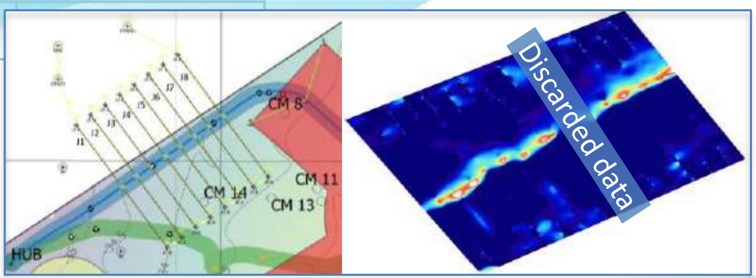
Acoustic disturbance distance (km) at SEM-REV

EMF

- Measurements using an AUV:
  - Cover **large areas**
  - Data acquisition at **constant hight above the seafloor**

- **Validation of the modelling tool** using the data acquired during the monitoring survey:
  - Monitoring data and modelling simulation return a flux density in the **same order of magnitude (nT)**

- For the three test sites the modelling tool allowed to **simulate scenarios, e.g., with the cables or devices operating at rated conditions**



SEMREV test site: Transects travelled by the AUV (left); Magnetic detection of the umbilical cable (right)

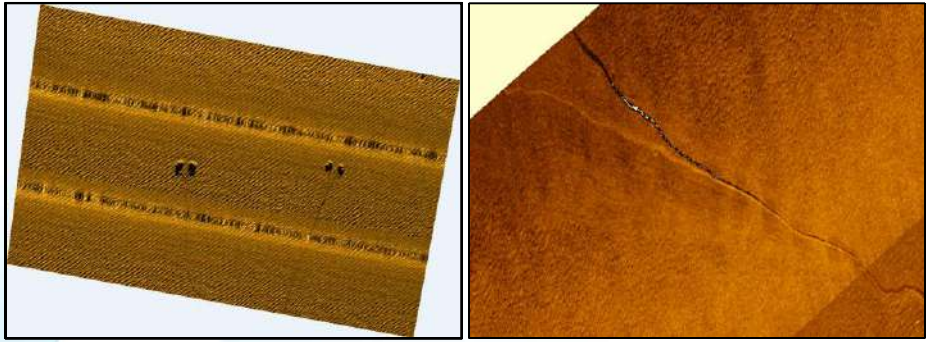
Test site	|B| 0.1 m	|B| 3 m	|E| 0.1 m	|E| 3 m
SEM-REV	22.2 μT	0.05 μT	758 μV.m^{-1}	44.0 μV.m^{-1}
BiMEP	9.5 μT	0.02 μT	342 μV.m^{-1}	20.8 μV.m^{-1}
Aguçadoura	10.4 μT	0.02 μT	341 μV.m^{-1}	18.4 μV.m^{-1}

Test site	|B| 0.1 m	|B| 3 m	|E| 0.1 m	|E| 3 m
SEM-REV	98 μT	0.2 μT	3084 μV.m^{-1}	174 μV.m^{-1}
BiMEP	152 μT	0.4 μT	5501 μV.m^{-1}	334 μV.m^{-1}
Aguçadoura	99 μT	0.2 μT	3232 μV.m^{-1}	175 μV.m^{-1}

Flux density |B| and Electric field|E| results from modelling at SEM-REV, BiMEP, and Aguçadoura test site at 0.1 m and 3 m from the cable surface at maximum device current (top) and maximum cable capacity (bottom)

Seafloor integrity

- Use of complementary techniques: **ROV and AUV-SSS**
  - Large area of seafloor morphology imaging using SSS
- Main results:
  - **Fauna attraction and refuge**
  - Changes in the seafloor morphology by sweeping action of mooring chains
    - Footprint affected by depth (reduced at the shallower site)
    - **Area affected <1% of the installation area**
    - Moorings kept in place: **uncertainty about the duration of the footprint**



Side-scan sonar imagery at BiMEP

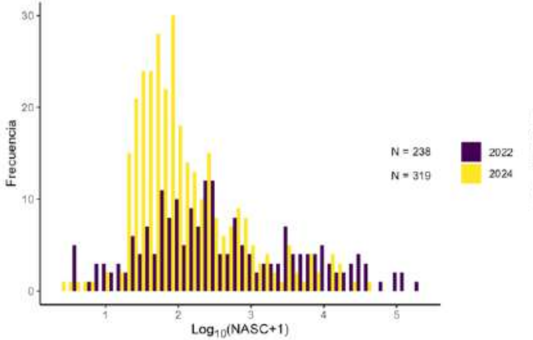
Attraction and refuge of marine fish at BiMEP

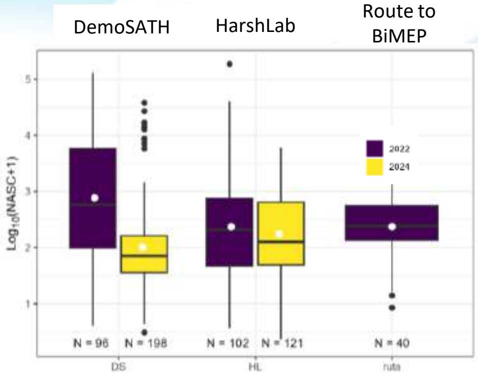
Fish communities

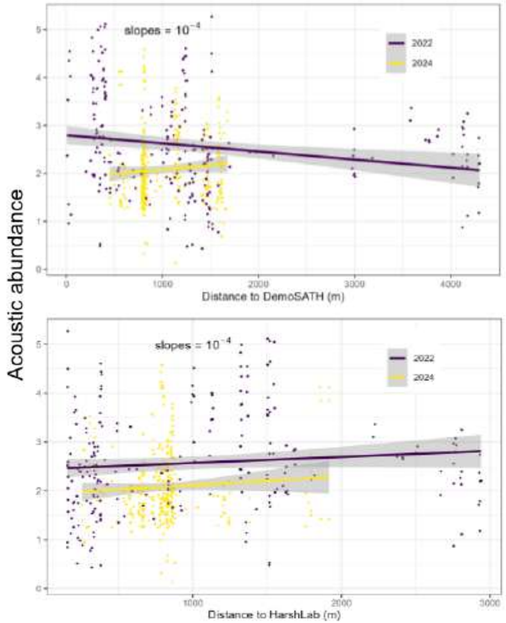
- **BiMEP test site**
  - ITSASDRONE:
    - Work remotely and autonomously
    - Cover large areas
  - Distribution of fish schools:

    ■ Detection of fish schools before installation of HarshLab and DemoSATH (2022)

    □ Estimation of abundance as a function of distance to the devices (2024)







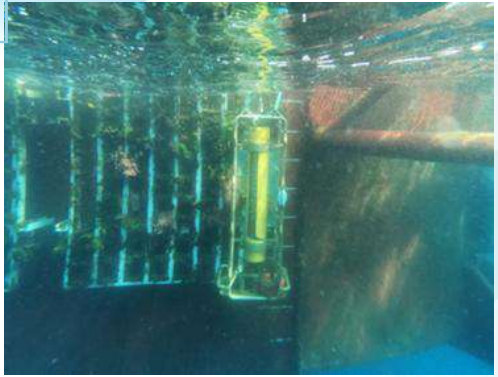
$r < -0.19$
$p < 0.05$

$r < 0.10$
$p > 0.05$

AZTI's ASV ITSASDRONE

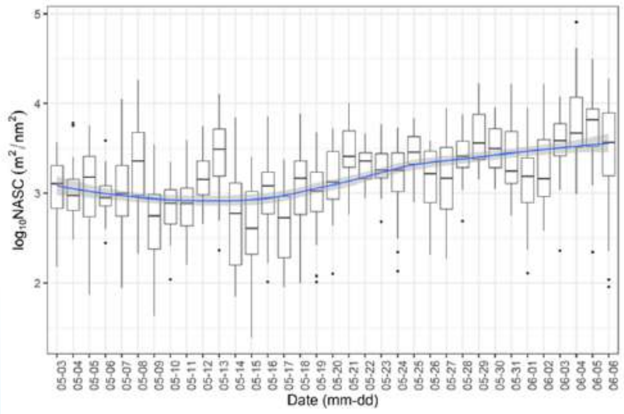
Tecnalia's HarshLab

SAITEC's DemoSATH

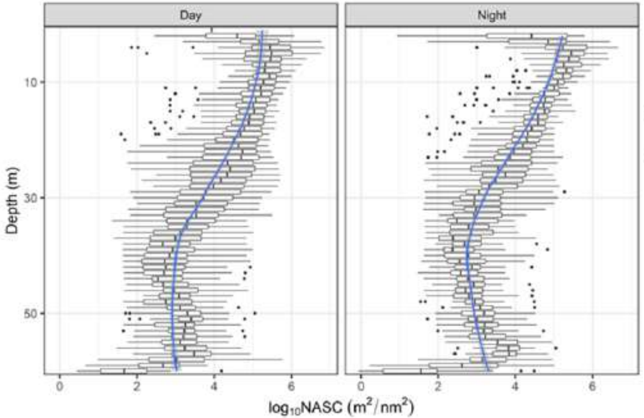


Fish communities

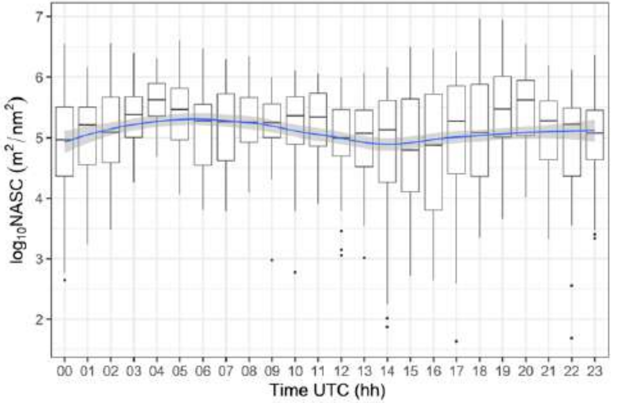
- **BiMEP test site**
  - WBAT:
    - Stationary echosounder anchored to HarshLab
    - 1 month data
    - Study temporal variation of fish communities



Increase of abundance with increase of radiance

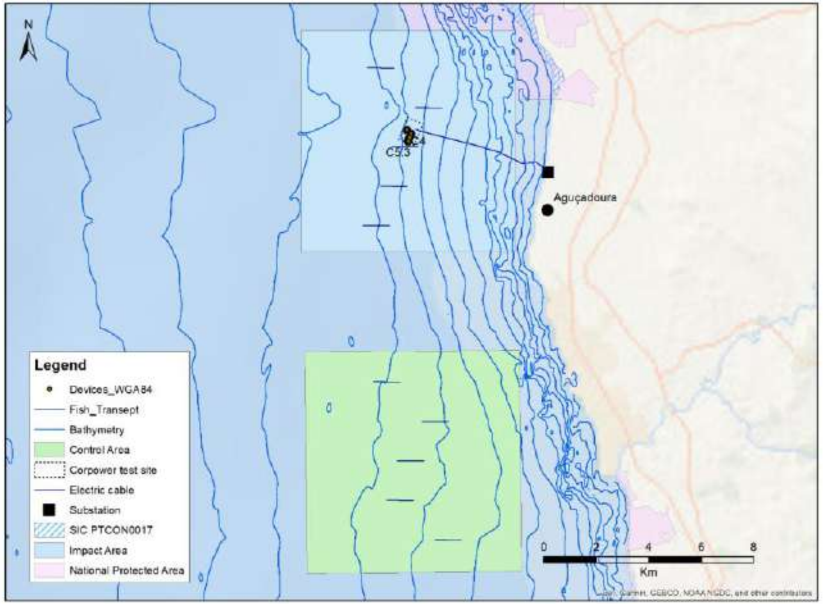


Greater acoustic abundance in the first few meters of the water column, the lowest observed around 40 m depth



No clear diurnal cycle was observed

Fish communities



- **Aguçadoura test site**
  - 2 Baseline surveys – July and November 2024
  - "Impact" and "Control" areas
  - Trawling and pots (in transects)
  - Data processing and analysis ongoing

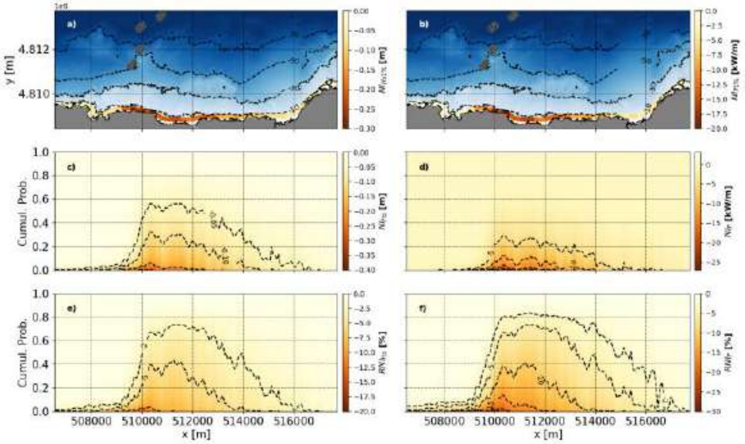
	Impact Area	Control Area
Total fish taxa	10	**14**
Total invertebrate taxa	5	**24**
Total algal taxa	**8**	0
Total taxa	23	**38**

- **Swimming crab** (*Polybius henslowii*) **in all the samples and with great abundance** (especially in the Impact area)
- **Frequent fish:**
  - **Pouting** (*Trisopteus* spp.) mostly **in the Control area**
  - **Wedge sole** (*Dicologlossa cuneata*) **and Triglids** (e.g., *Chelidonichthys* spp.) mostly **in the Impact area**
  - **Dragonet** (*Callionymus lyra*) **in both areas**
- **Rare fish** (present in 1 sample)**:**
  - **Atlantic bonito** (*Sarda sarda*), **Megrim sole** (*Lepidorhombus whiffiagonis*) **and Thornback ray** (*Raja clavata*) **in the Impact area**
  - **Comber** (*Serranus cabrilla*) and **Black seabream** (*Spondyliosoma cantharus*) **in the Control area**

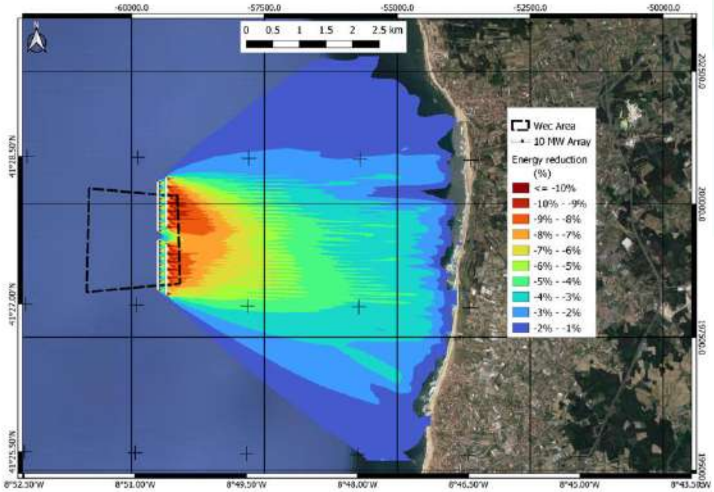
Marine dynamics

- **BiMEP**
  - Methods used in WESE **validated and compared with *in situ* data**
    - Models are stable and robust under different grid sizes
  - **Hybrid and Dynamic Statistical Downscaling** tested
    - HSD suitable for probabilistic wave farm coastal impact studies
  - **Little effects of the wave farm in Hs and coastline** (owing to the distance to shore)
    - Shoreline changes <5m and heterogeneous along the beach

- **Aguçadoura**
  - Shadowing effect gradually diminishes ashore, with the reduction nearshore being less than 2%
  - **WEC farm would not influence the sediment transport ashore or similar processes**



BiMEP

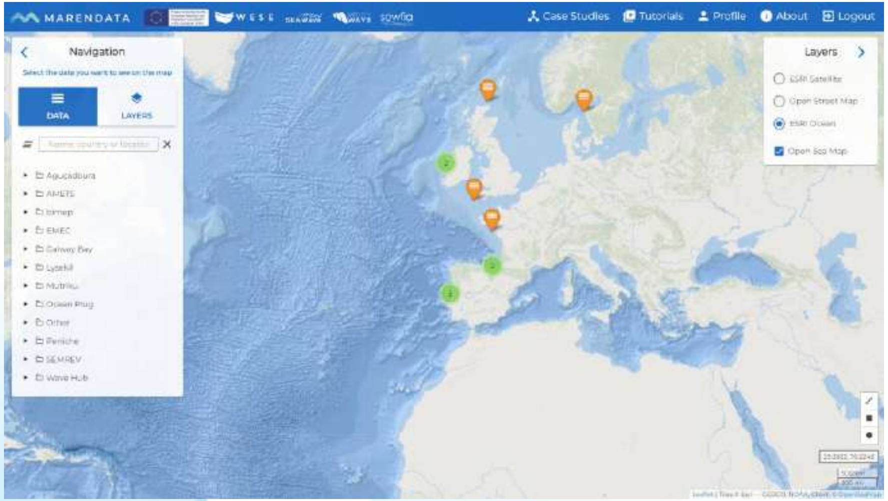


Aguçadoura

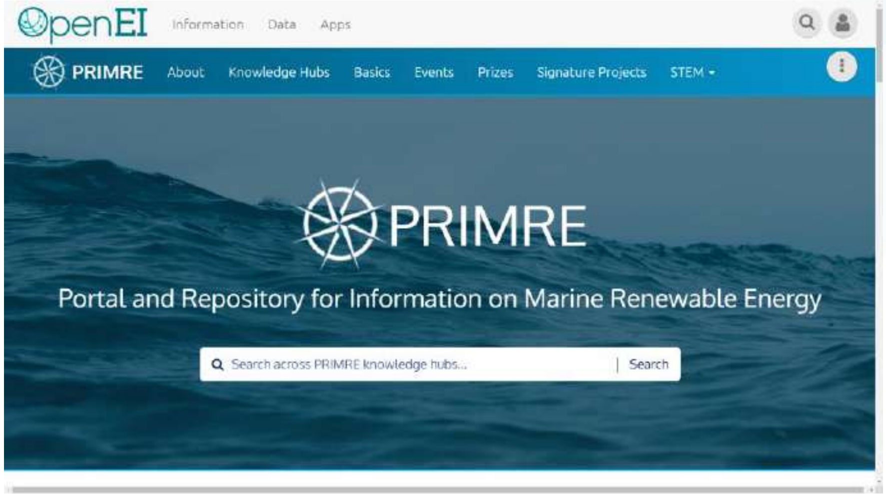
Data Sharing

- Field **data gathered during the project is being uploaded to MARENDATA**
- The platform already has **information gathered in previous EU projects** (WESE, SeaWAVE and SOWFIA)
- MARENDATA's data is **searchable in PRIMRE**

https://MARENDATA.EU



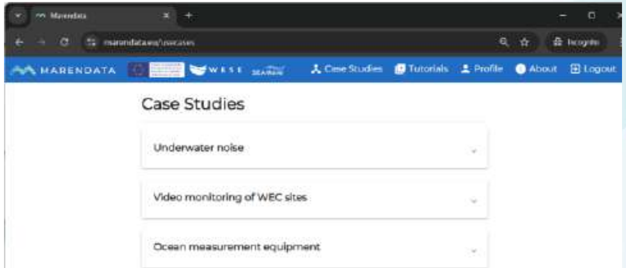
Indexed in PRIMRE (https://openei.org/wiki/PRIMRE)

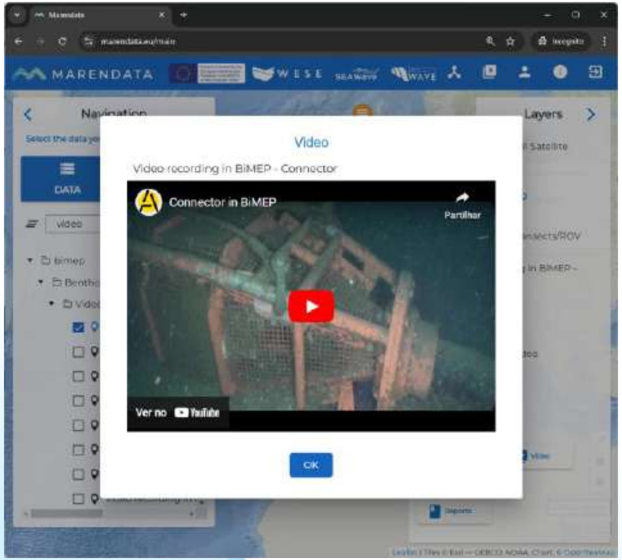


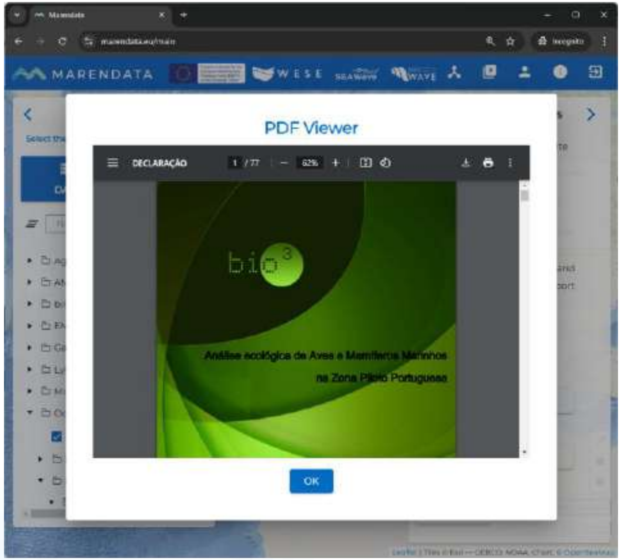
MARENDATA

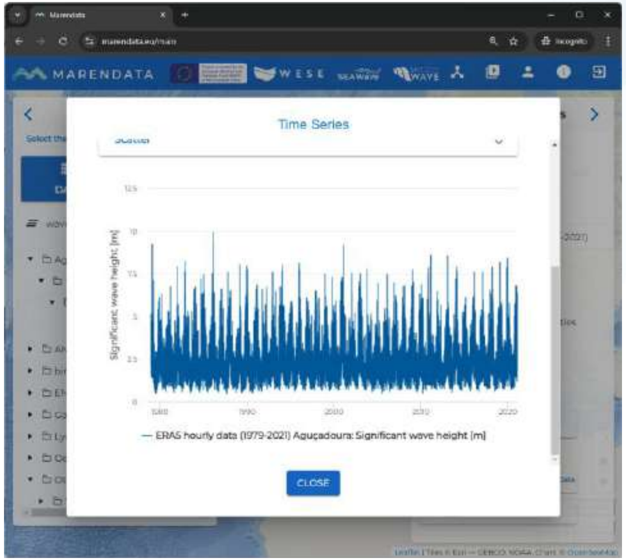
Data Sharing

- Supports multiple **data format types** (e.g., videos, .pdf, .csv, that can be visualised as charts)
- **User stories** to guide users on the platform and expand the functionalities



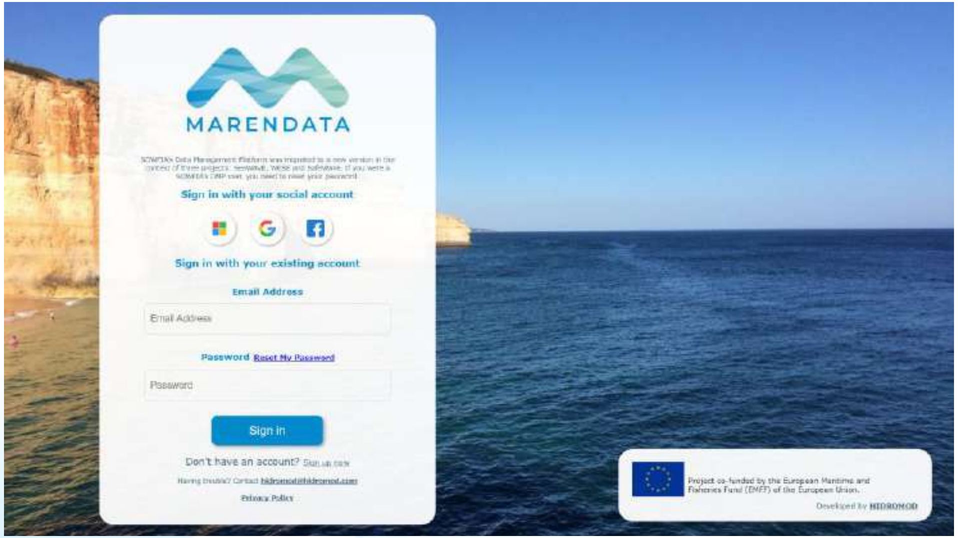


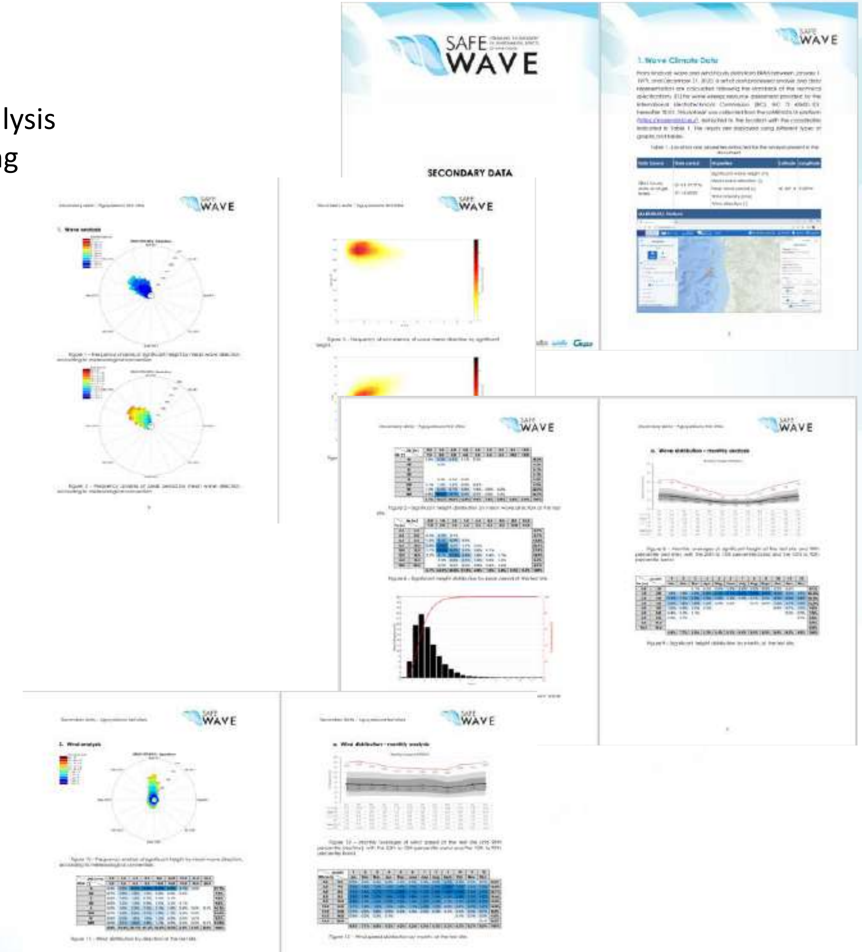




Data Sharing

- **Long-term wave and wind series** and report analysis
- Third party **identity providers**: log-in with existing Microsoft, Google, or Facebook accounts





General challenges

- **Lack of large-scale demonstration projects**
    - Lack of monitoring data useful to develop/improve/validate models
    - Lack of open-access data (private data)
- **Develop a monitoring plan** for different technologies deployed at different sites
    - Aligned with (e.g.) the EU MSFD
    - Aligned with industrial schedule
- **Share (and maintain) data publicly**

Acoustics

- **Equipment deployment:** Calm sea states needed
- **Acoustic temporal data resolution:** Some inputs used by the models (e.g., sound speed profile) are seasonal in nature
- **Lack of auxiliary information** (e.g., WEC operational data, sea states) **or low data resolution** (e.g., bathymetry, seawater temperature)
- **Lack of dedicated standards** (linked to general challenge n°1)

EMF

- **Data acquisition:** Monitoring during higher power production (= rough sea states)
- **Distance to the cables:** Natural burial is hard to quantify
- **Effects on animals** in the natural environment

Power (kW)	Max |B| (nT)
37.5	12.8

FLOATGEN – 2 MW

Seafloor integrity

- **Data acquisition** under strong hydrodynamic conditions
- **Estimate affected footprint** in highly hydrodynamic environments
- **Estimate effects on the benthic communities** (due to the methodology and time frame)

Fish communities

- **Data acquisition**: remotely and autonomously
- **Tunning and conditioning** a monitoring device for fish communities
- Fish sampling and data analysis dependent on constraints, e.g., presence of artefacts, comparability of sampling locations

Marine dynamics

- Reduce uncertainty regarding the methods used in WESE project
- Consolidate different downscaling strategies for this type of studies

Data Sharing

- Maintain data acquired in the project in an open repository
- Disseminate to a global audience

Acoustics

- **Acoustic source characterisation:** The many noise-generating mechanisms of the source are not considered
  - Use modelling software (e.g. COMSOL) to simulate the many noise-generating mechanisms of the source
- **Spatial data resolution:** Around 100 m
  - Increase spatial resolution through interpolation ML algorithms, integration of various datasets or self-acquired input data
- **Computational cost:** When introducing seasonality, problems are experienced in parallelization
  - Improve parallelization
- **Uncertainty in simulations:** Uncertainty was improved by placing three hydrophones
  - Use official guides (GUM) to obtain uncertainty in measurements

Acoustics

- **Validation of results and fine-tuning:** No validation of the results has been carried out
    - Validate the models through different measurements
- **Lack of info at high frequencies:** No modelling has been done for high frequencies
    - Use optimal models for high frequencies
- **Impact on marine organisms:** Obtain metrics for different marine organisms
- **MSFD standards falling short:** MSFD requirements for WECs are probably not enough for some cases
    - Use different standards (improve MSFD requirements?)

EMF

- Auxiliary data: know cables natural burial – use additional equipment (e.g., TSS)
- Measurements during high power production = strong sea states
    - Measurements offshore by fixed stations
    - Measurements onshore
- Validate the modelling tool with data from other test sites and devices
- Increase literature on EMF effects on marine organisms (different species and life stages, different distances/conditions to the source)

Seafloor integrity

- Detailed baseline surveys, identifying sensitive/important areas and habitats
    - ROV during operational phase, reducing costs and time, to monitor those areas/habitats
- Technologies to deal with video monitoring in turbid waters (underwater range-gated imaging system?)
    - Test AUVs equipped with video cameras?

Fish communities

- User-friendly & simplified navigation system
- Avoid overshooting
- Test ITSADRONE and monitor fish communities in other test sites
- Aguçadoura: Further baseline surveys (different seasons and years) and operational surveys
  - Establish trends, reduce uncertainty about natural variability, assess effects caused by the WE installation

Marine dynamics

- BIMEP
  - Test different technologies suitable for being implemented on the studied locations
- Aguçadoura
  - Use other models similar to SNL-SWAN
  - Adopt a statistical downscaling approach following the methodology described for the BiMEP case

SAFE WAVE
STREAMLINING THE ASSESSMENT OF ENVIRONMENTAL EFFECTS OF WAVE ENERGY

https://www.safewave-project.eu/

¡¡MANY THANKS FOR YOUR ATTENTION!!

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