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ES ENVIRONMENTAL

Environmental Risk Assessment tool for Wave Energy Converters

WEC-ERA tool

Ibon Galparsoro Iza
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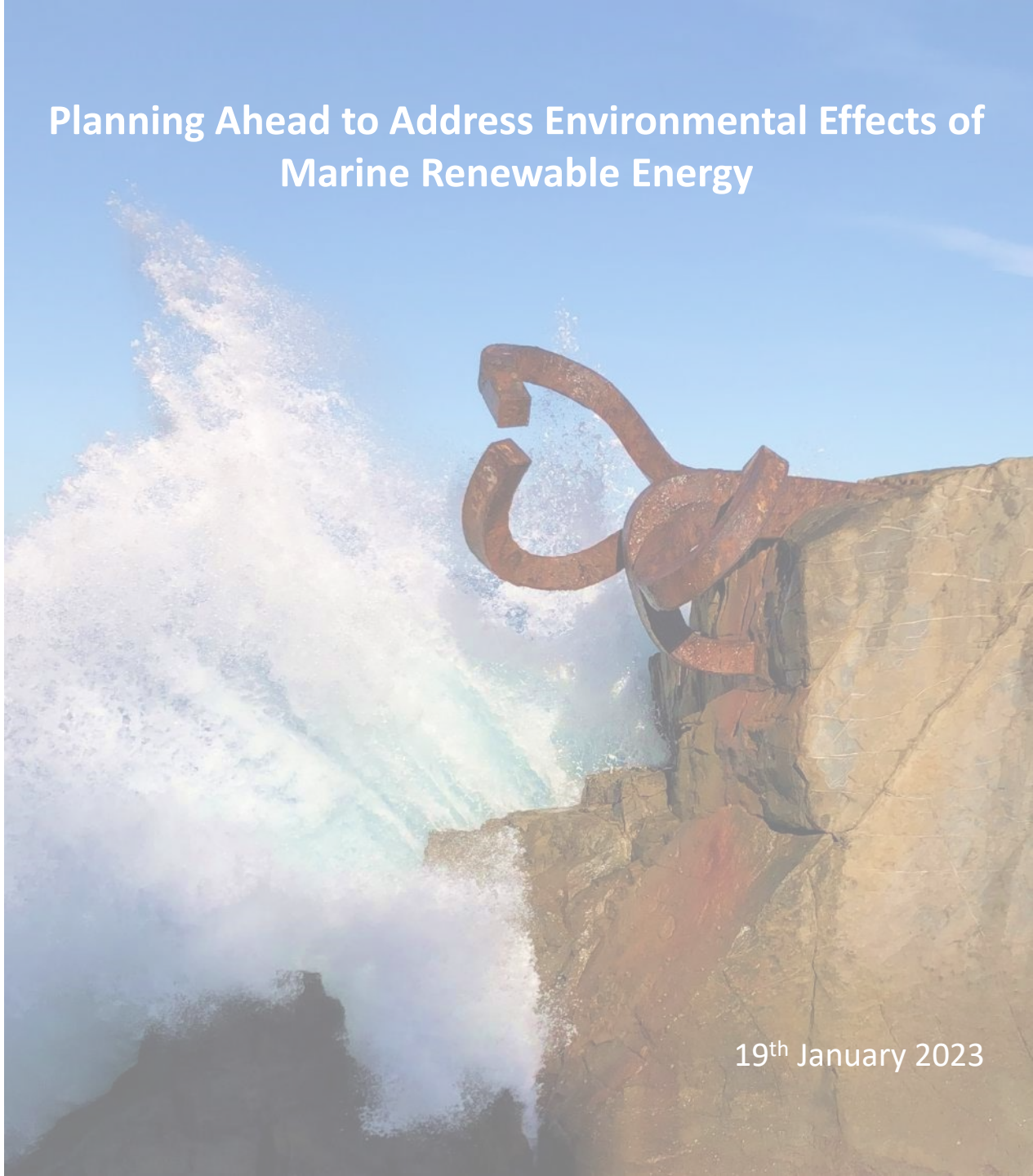


Context

While the technological development of Wave Energy Converters is progressing fast, there are some non-technological barriers that could hinder the development of the wave energy sector:

(i) the **early phase of development** of these technologies, and associated to that,

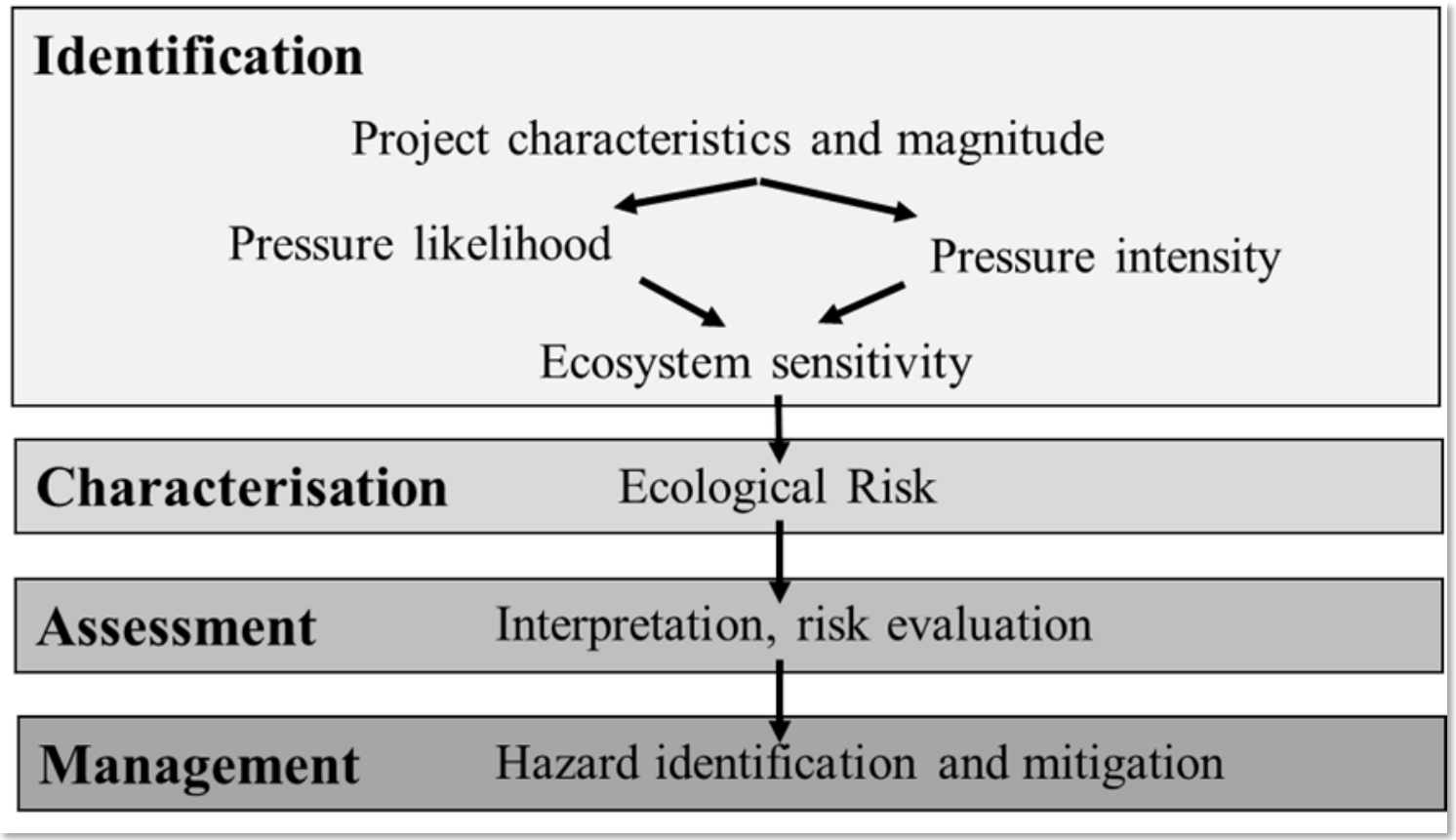
(ii) the **environmental risk and uncertainties** regarding the potential environmental impacts produced by Wave Energy Converters farms[6-8].

(iii) the **need for space** and Marine Spatial Planning (MSP) to overcome the potential competition and conflicts between wave energy industry and other marine sectors[4],

(iv) the **consenting process**, which is still generally regarded as a non-technological barrier caused by the complexity and the lack of dedicated legal frameworks[5], and

(v) the fact that they have been considered **uneconomical**[3],

Ecological Risk Assessment



A process to evaluate the **likelihood** (probability) of adverse **ecological effects** that may occur as a result of exposure to one or more **stressors** related to human activities.

Ecological Risk Assessment

Quantitatively or qualitatively determine the probability that an ecosystem indicator will reach or remain in an undesirable state

Full ecosystem elements

Based on list of pressures, ecosystem elements and indicators of the European Marine Strategy Framework Directive

- 16 pressure types (stressors)
- 27 ecosystem elements (receptors)

Ecological Risk Assessment

Wave Energy Converters

Few experiences (testing sites)
→ limited number of devices

Diverse technologies

↓

Expert consultation

WEC-ERA tool

7,776 risk indicators (16 pressures x 27 ecosystem elements x 3 technologies x 3 life-cycle phases x 2 (likelihood and magnitude of impacts))

432 indicators of sensitivity of ecosystem elements to pressures (16 x 27)

Difficult to use due to the amount of data

Development of an online free access web app tool for the assessment of ecological risks of wave energy projects

WEC-ERA tool

https://aztidata.es/wec-era

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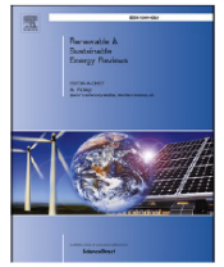
Detailded description of the expert consultation process

Analysis performed and tool development

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser



A new framework and tool for ecological risk assessment of wave energy converters projects

I. Galparsoro [a,*], M. Korta [a], I. Subirana [b,c], Á. Borja [a,d], I. Menchaca [a], O. Solaun [a], I. Muxika [a], G. Iglesias [e,f], J. Bald [a]

https://doi.org/10.1016/j.rser.2021.111539

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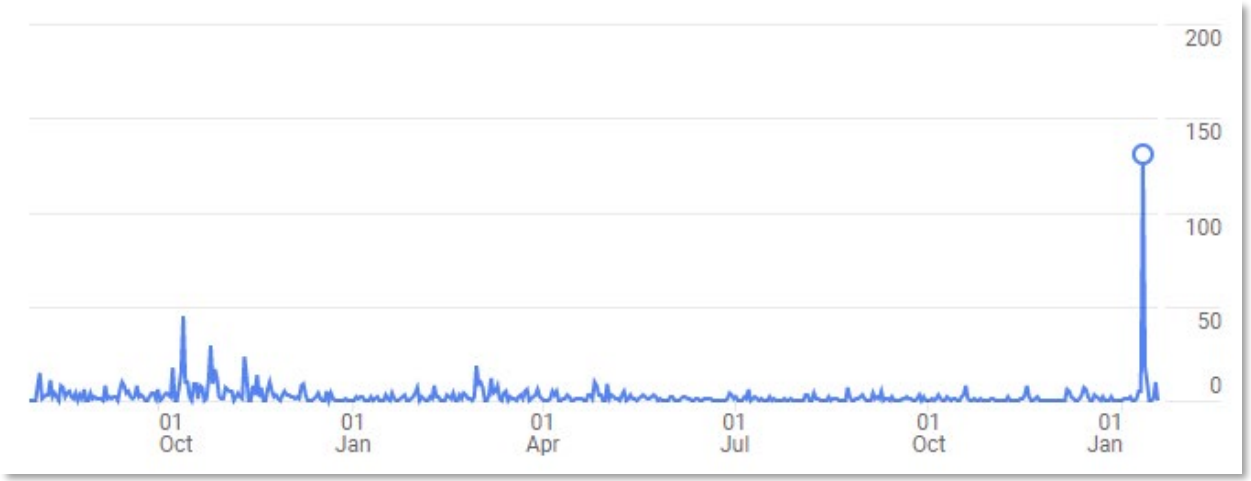
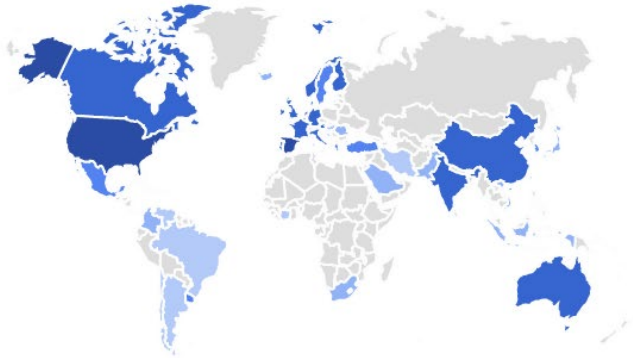
Launched: 1st August 2021
Users: 914



48 countries



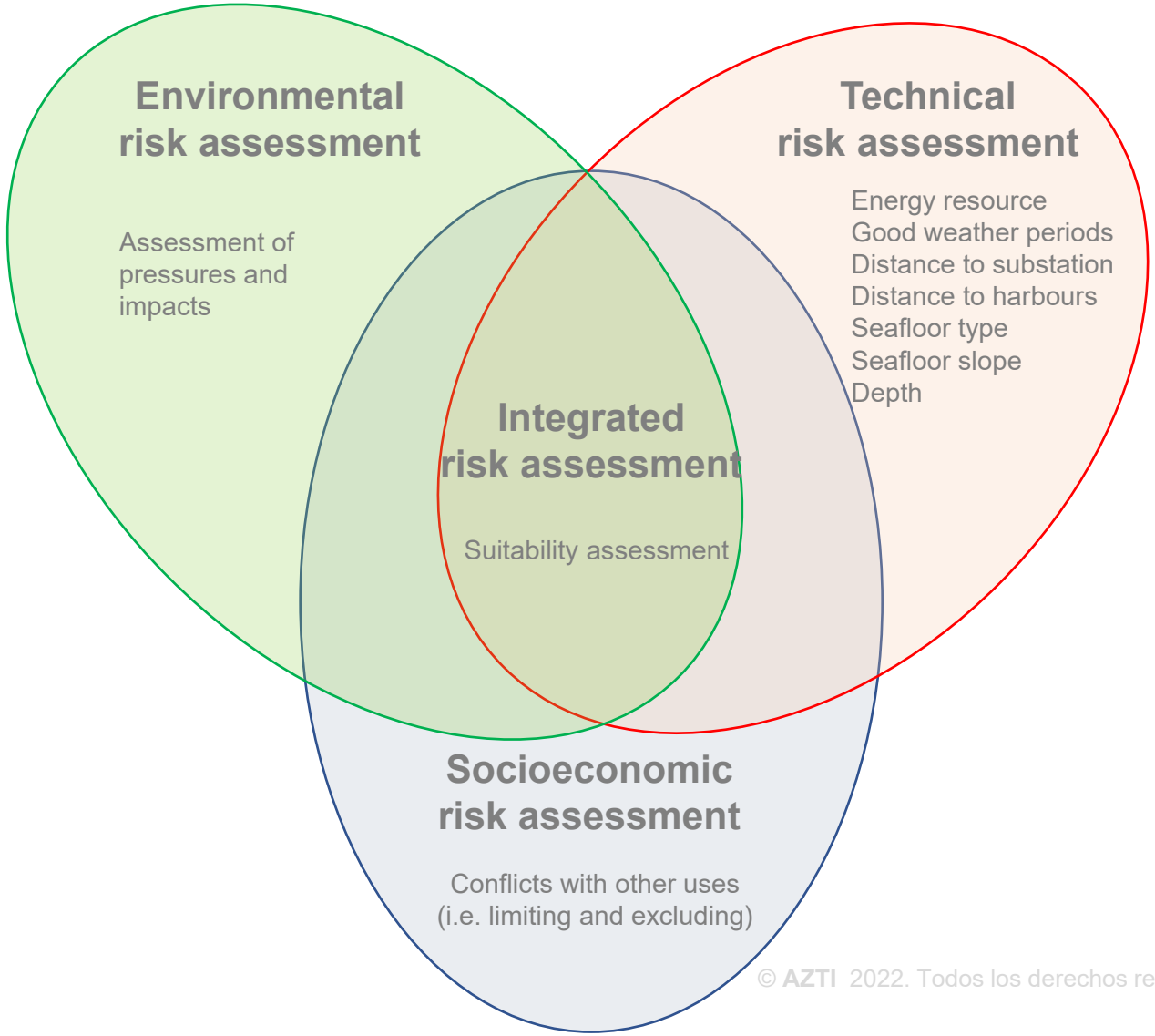
COUNTRY	USERS
United States	300
Spain	189
United Kingdom	65
Netherlands	60
Finland	54
France	43
Portugal	22

Source: Google Analytics
Date: 18/01/2023

Development of decision support tools

Site identification of the most suitable areas for the development and deploying of energy production projects

- Key elements
- Spatially explicit
- Management, Strategic Environmental Assessment, decision making, consenting, MSP

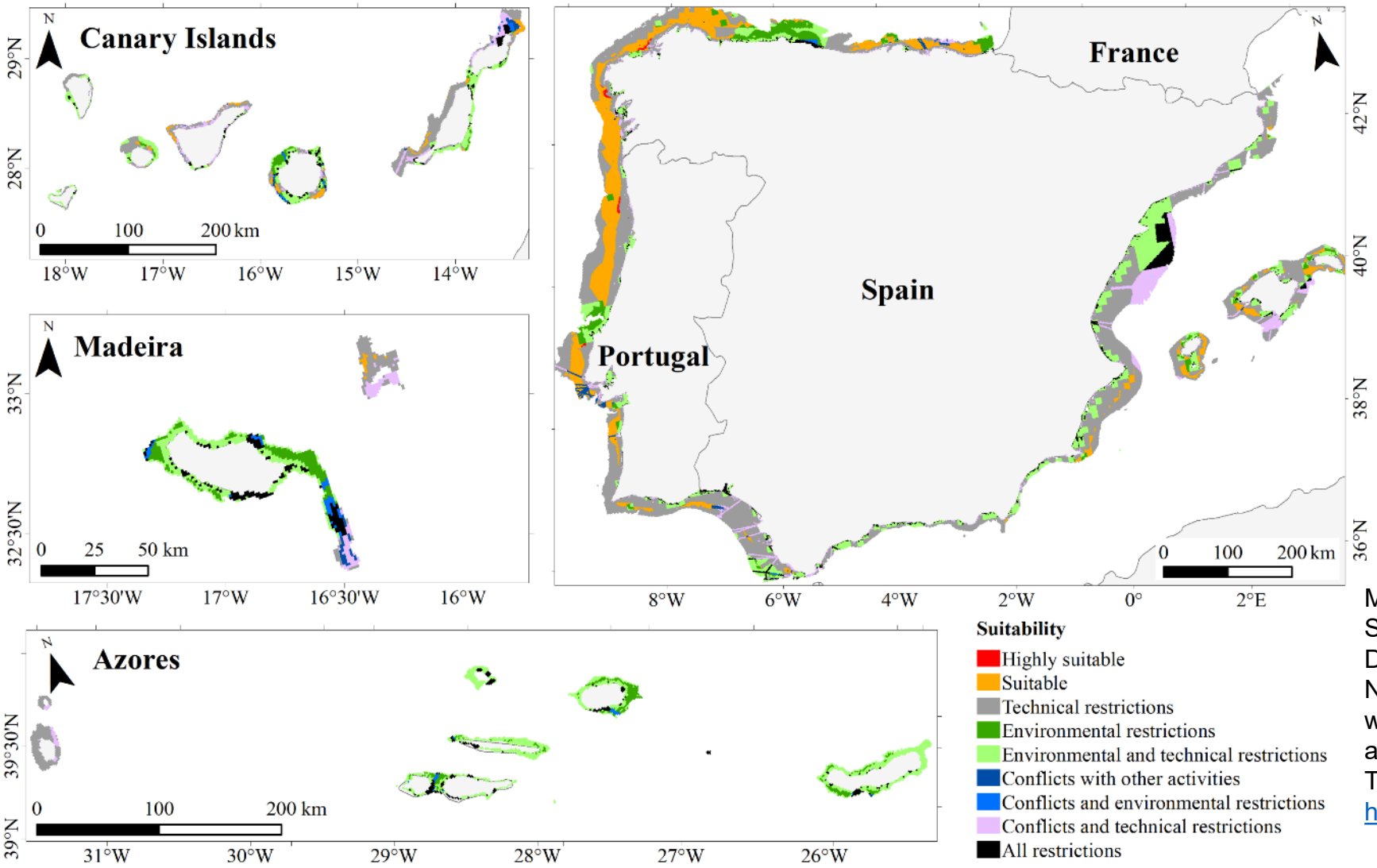


Development of decision support tools

- Decision support tool: Identification of suitable areas for offshore energy projects
- Inteface between complex models and GIS layers
- Free access, publicly available
- Software licenses are not needed

https://aztidata.es/vapem

Development of decision support tools



Maldonado, A. D., I. Galparsoro, G. Mandiola, I. de Santiago, R. Garnier, S. Pouso, Á. Borja, I. Menchaca, D. Marina, L. Zubiate, J. Bald, 2022. A Bayesian Network model to identify suitable areas for offshore wave energy farms, in the framework of ecosystem approach to marine spatial planning. Science of The Total Environment, 838: 156037 https://doi.org/10.1016/j.scitotenv.2022.156037

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Ecological Risk Assessment

Not intended to question the expectations of offshore energy production as a source of clean and renewable energy.

State-of-the-art scientific knowledge regarding the ecological consequences that the expansion of this sector could cause at local and, in some cases, also at regional scale → adoption of measures.

Environmental impacts must be evaluated on project-by-project basis as these are site-specific.

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Scientific contribution

Produce models and tools with a scientific basis that could be useful for all interested parties (managers, policy-makers, industry, maritime sectors and society).

Make them free and publicly available.

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Recommendations

Reduce uncertainties on ecological risks based on data aquired in monitoring programmes of testing sites

Promote transparency and sharing of data and information from existing monitoring programmes of operational farms (transfer value for new projects)

Periodical updates (empirical information, technical reports, databases, scientific publications)

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Thank you very much!

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Funding projects

Wave Energy in Southern Europe (WESE) (Co-funded by the European Maritime and Fisheries Fund (EMFF); Agreement number EASME/EMFF/2017/1.2.1.1/02/SI2.787640)

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VAPEM project, funded by the Fisheries and Aquaculture Directorate of the Basque Government

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Project characteristics | Pressure assessment | Ecosystem elements sensitivity to pressures | Links between technologies, pressures and ecosystem elements

This window allows you to define the characteristics of the WEC project you are assessing

User input:

Indicate project characteristics:

Number of devices:
10

Consented total area (km^2):
10

Total installed production capacity (MW):
10

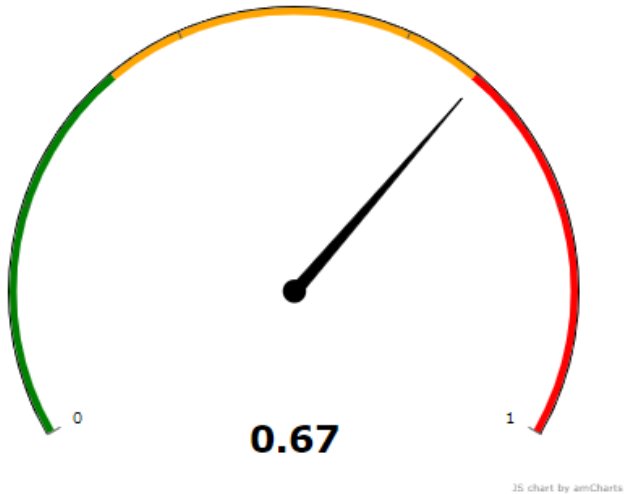
Project duration (years):
10

Sealed area per device (km^2):
1

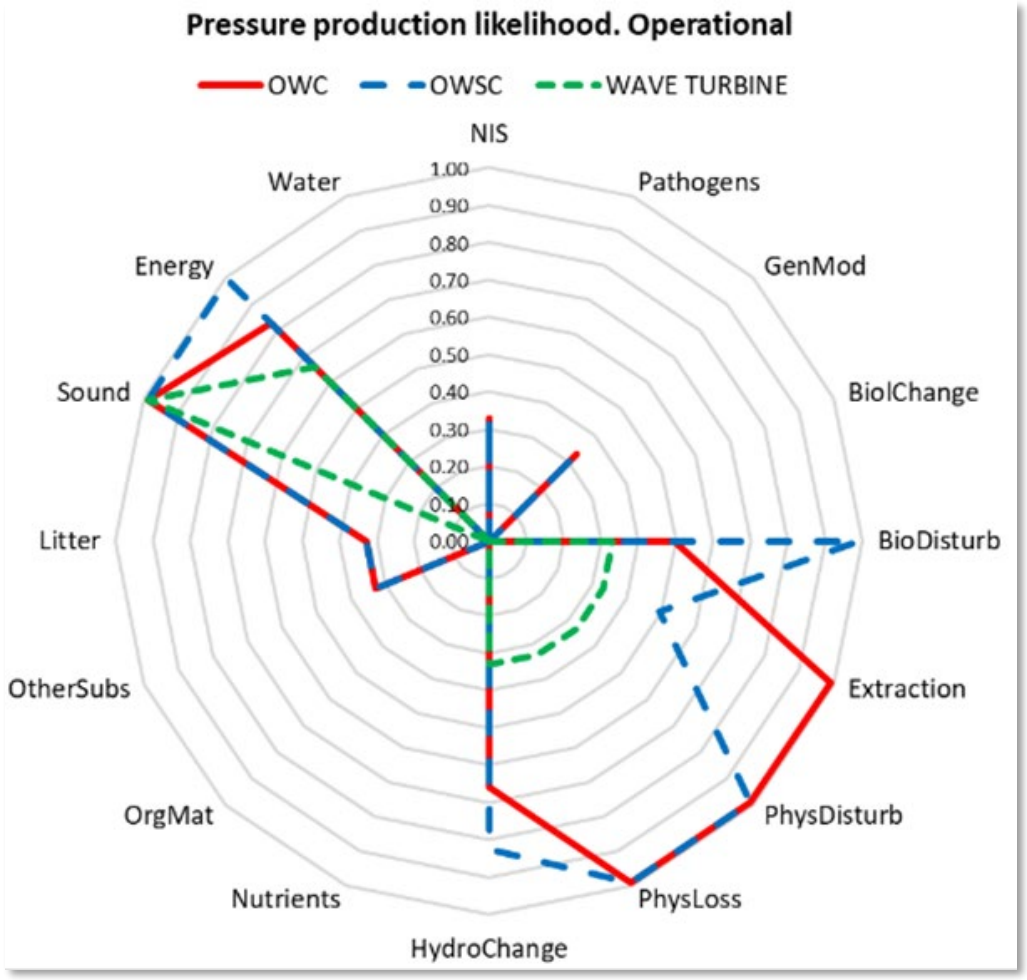
Proportion sealed/total area (%):
100

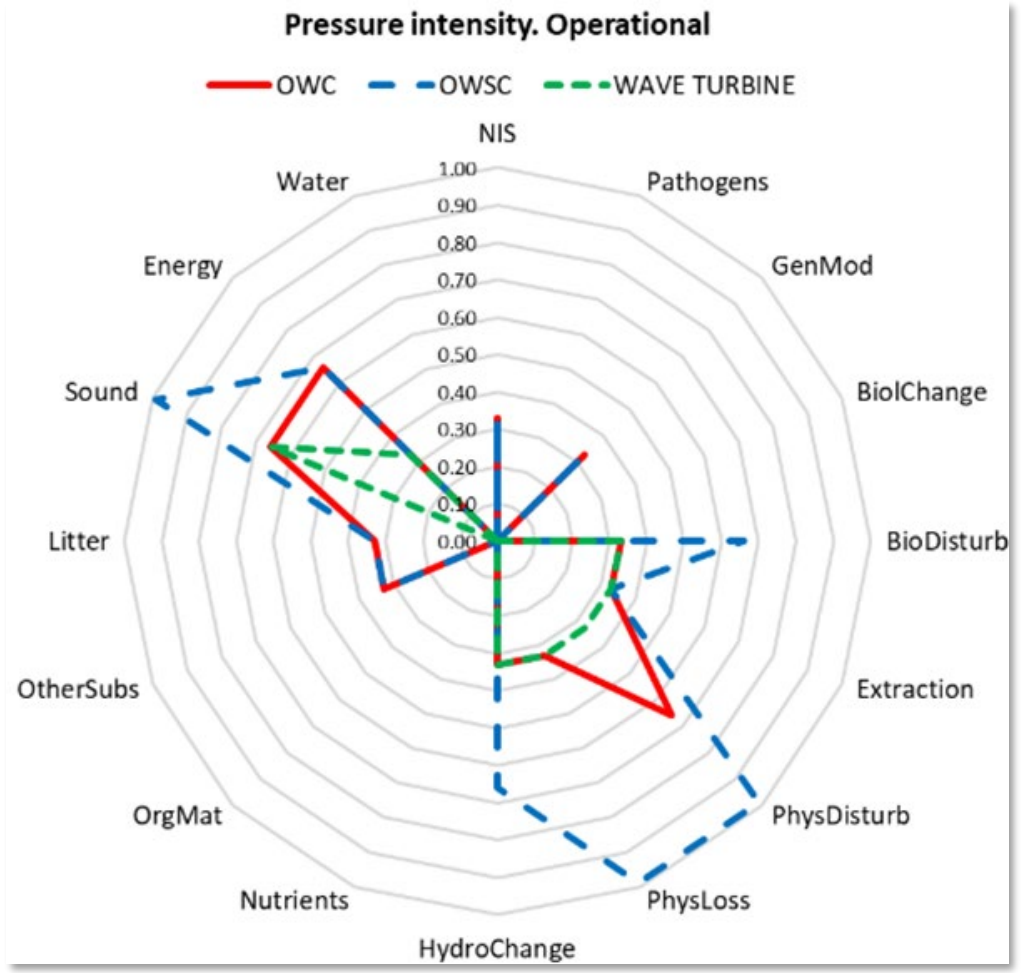
	Project dimension	Assessment
1	Number of devices	Medium
2	Occupied area	High
3	Total installed production capacity	Low
4	Project duration	Medium
5	Sealed area per device	Medium
6	Proportion sealed/total area	High

Project magnitude is:

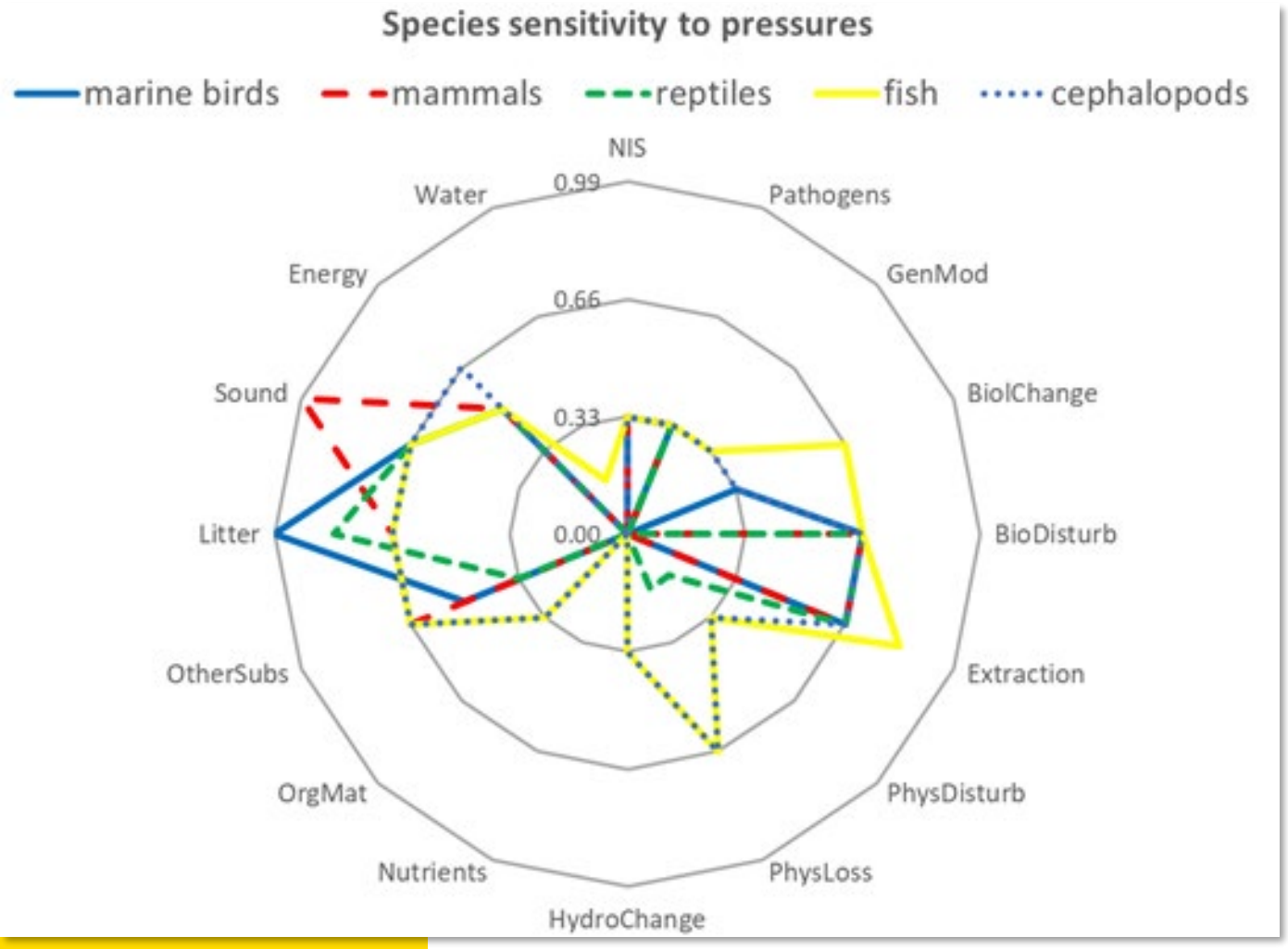


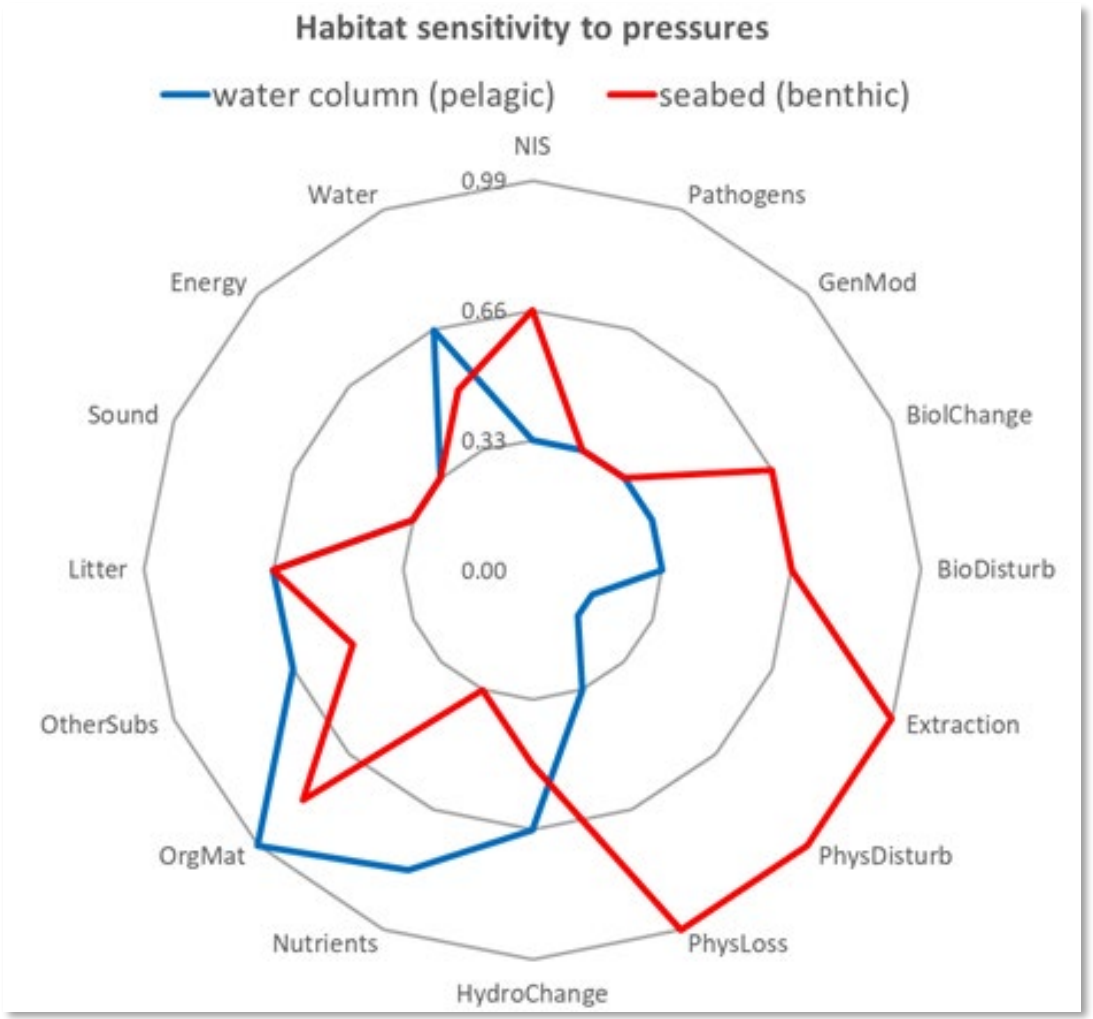
Ecological Risk Assessment





Ecological Risk Assessment





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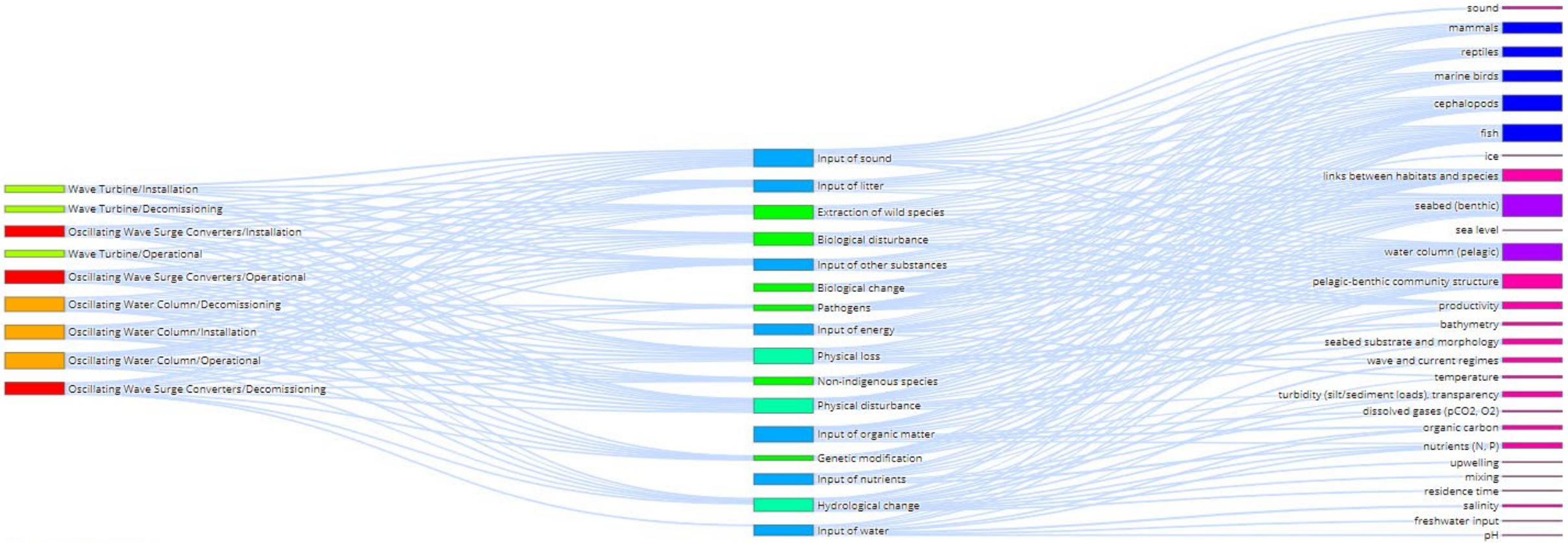
Project characteristics | Pressure assessment | Ecosystem elements sensitivity to pressures | **Links between technologies, pressures and ecosystem elements** | Ecological Risk Assessment table | ERA summary table

Sankey plot showing the frequency and magnitude of relationships between the wave energy technologies in their life cycle phases, pressures and ecosystem elements according to Marine Strategy Framework Directive.
The width of the nodes and lines are proportionally to the flow magnitude.
Click on the node to highlight the relationships. Direct relationships are highlighted in black while indirect relations in grey.

Clear selected node



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Project characteristics | Pressure assessment | Ecosystem elements sensitivity to pressures | Links between technologies, pressures and ecosystem elements | **Ecological Risk Assessment table** | ERA summary table

Risk matrix for each ecosystem element and pressure linked to the selected wave energy project characteristics.
Click on each pressure to order the ecosystem elements.

Ecosystem elements	NIS	Pathogens	GenMod	BiolChange	BioDisturb	Extraction	PhysDisturb	PhysLoss	HydroChange	OtherSubs	Litter	Sound	Energy
Marine birds	0.39	0.00	0.00	0.00	0.52	0.62	0.00	0.00	0.00	0.44	0.52	0.73	0.65
Mammals	0.39	0.00	0.00	0.00	0.52	0.62	0.00	0.00	0.00	0.47	0.47	0.81	0.65
Reptiles	0.00	0.00	0.00	0.00	0.52	0.62	0.52	0.44	0.00	0.39	0.50	0.73	0.65
Fish	0.39	0.00	0.39	0.00	0.52	0.65	0.62	0.62	0.47	0.47	0.47	0.73	0.65
Cephalopods	0.39	0.00	0.39	0.00	0.52	0.62	0.62	0.62	0.47	0.47	0.47	0.73	0.70
Water column (pelagic)	0.39	0.00	0.39	0.00	0.44	0.44	0.52	0.52	0.56	0.47	0.47	0.62	0.59
Seabed (benthic)	0.47	0.00	0.39	0.00	0.52	0.68	0.81	0.68	0.52	0.44	0.47	0.62	0.59
Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.59
Ice	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.59
Wave and current regimes	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.62	0.62	0.00	0.00	0.00	0.00
Upwelling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00
Mixing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00
Residence time	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00
Freshwater input	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sea level	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bathymetry	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.68	0.00	0.00	0.00	0.00	0.00
Turbidity/transparency	0.00	0.00	0.00	0.00	0.00	0.00	0.73	0.00	0.47	0.00	0.00	0.00	0.00
Sound	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.00
Seabed	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.68	0.47	0.00	0.00	0.00	0.00
Salinity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nutrients (N/P)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00
Organic carbon	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00
CO2/O2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
pH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Links habitats/species	0.39	0.00	0.39	0.00	0.52	0.62	0.62	0.62	0.00	0.39	0.00	0.62	0.59
Pelagic-benthic comm. struct.	0.47	0.00	0.39	0.00	0.44	0.52	0.73	0.62	0.47	0.39	0.00	0.62	0.59
Productivity	0.00	0.00	0.00	0.00	0.44	0.52	0.00	0.00	0.47	0.39	0.00	0.00	0.00

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Fish	0.39	0.00	0.39	0.00	0.52	0.65	0.62	0.62	0.47	0.47	0.47	0.73	0.65
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Temperature	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.59
Ice	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.59
Wave and current regimes	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.62	0.62	0.00	0.00	0.00	0.00
Upwelling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00
Mixing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00
Residence time	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00
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Bathymetry	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.68	0.00	0.00	0.00	0.00	0.00
Turbidity/transparency	0.00	0.00	0.00	0.00	0.00	0.00	0.73	0.00	0.47	0.00	0.00	0.00	0.00
Sound	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.00
Seabed	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.68	0.47	0.00	0.00	0.00	0.00
Salinity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nutrients (N/P)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00
Organic carbon	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00
CO2/O2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
pH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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Productivity	0.00	0.00	0.00	0.00	0.44	0.52	0.00	0.00	0.47	0.39	0.00	0.00	0.00

- Identification of highest risks for new projects
- Are the ecosystem element present in the project development location?
- Is there enough monitoring data on the ecosystem elements showing highest risk?
- Is the new project accounting for the ecosystem elements?
- Which is the uncertainty of the risk assessment and the potential environmental impact?
- Adoption of measures for risk retirement