WESE

WAVE ENERGY IN SOUTHERN EUROPE

DELIVERABLE 2.7
Guidelines on EMF, noise, and seabed integrity monitoring planning for wave energy devices

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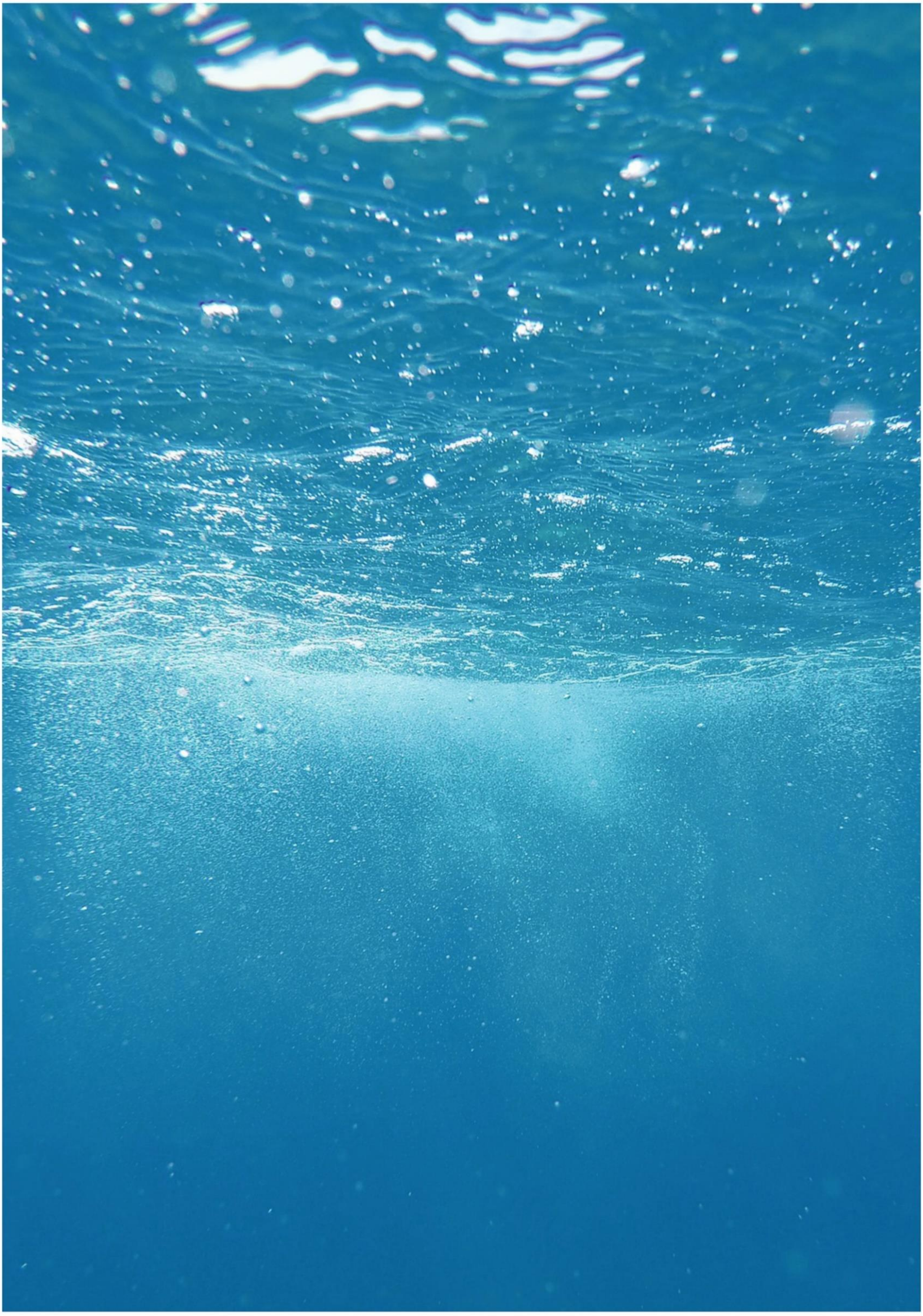

WP 2

Deliverable 2.7 Guidelines on EMF, noise, and seabed integrity monitoring planning for wave energy devices

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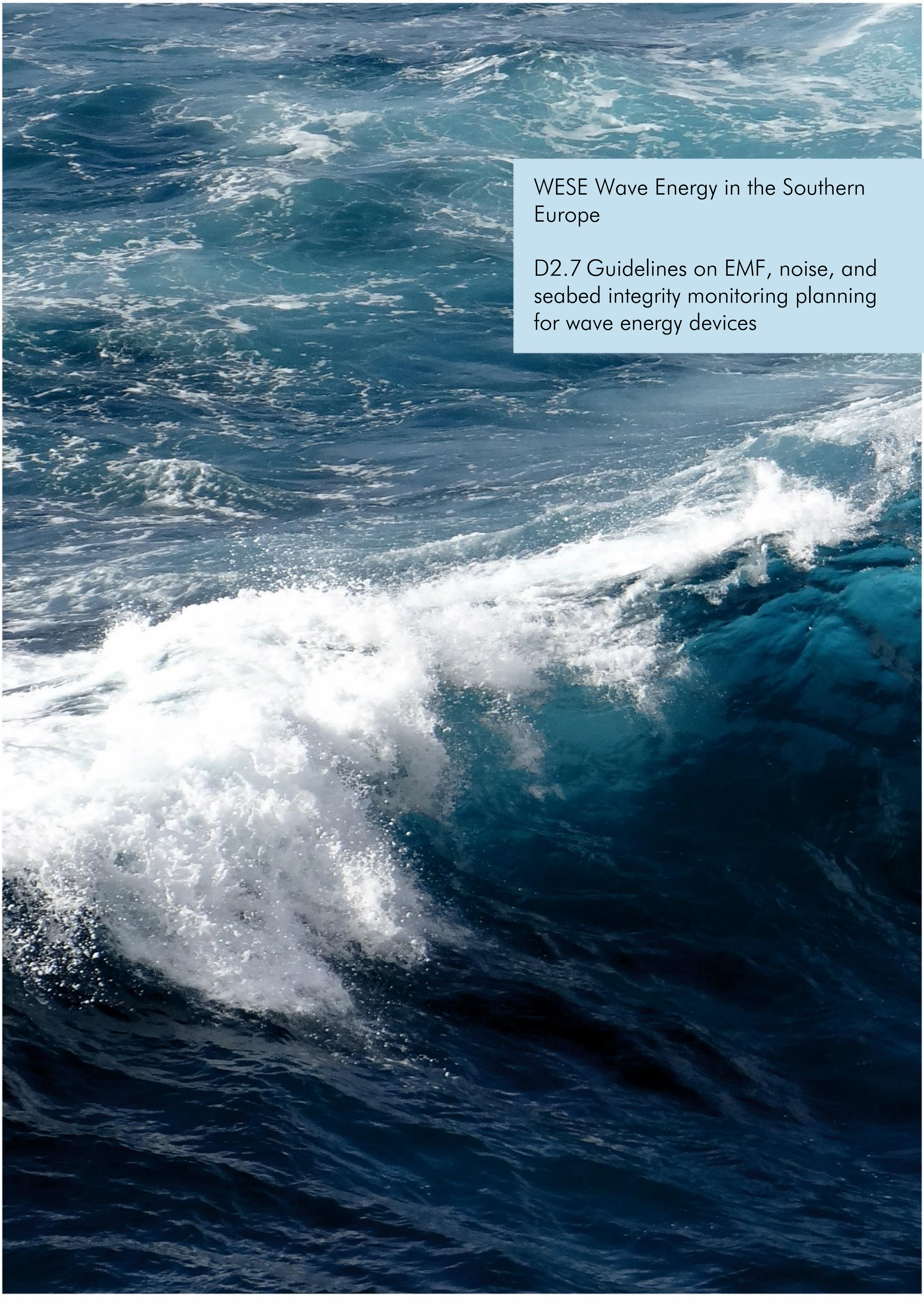

WESE Wave Energy in the Southern Europe

D2.7 Guidelines on EMF, noise, and seabed integrity monitoring planning for wave energy devices

CONTENTS

1. WESE project synopsis

The Atlantic seaboard offers a vast marine renewable energy (MRE) resource which is still far from being exploited. These resources include offshore wind, wave and tidal. This industrial activity holds considerable potential for enhancing the diversity of energy sources, reducing greenhouse gas emissions and stimulating and diversifying the economies of coastal communities. Therefore, the ocean energy development is one of the main pillars of the EU Blue Growth strategy. While the technological development of devices is growing fast, their potential environmental effects are not well-known. In a new industry like MRE, and Wave Energy (WE) in particular, there may be interactions between devices and marine organisms or habitats that regulators or stakeholders perceive as risky. In many instances, this perception of risk is due to the high degree of uncertainty that results from a paucity of data collected in the ocean. However, the possibility of real risk to marine organisms or habitats cannot be ignored; the lack of data continues to confound our ability to differentiate between real and perceived risks. Due to the present and future demand for marine resources and space, human activities in the marine environment are expected to increase, which will produce higher pressures on marine ecosystems; as well as competition and conflicts among marine users. This context still continues to present challenges to permitting/consenting of commercial-scale development. Time-consuming procedures linked to uncertainty about project environmental impacts, the need to consult with numerous stakeholders and potential conflicts with other marine users appear to be the main obstacles to consenting WE projects. These are considered as non-technological barriers that could hinder the future development of WE in EU and Spain and Portugal in particular were, for instance, consenting approaches remain fragmented and sequential. Consequently, and in accordance with the Ocean Energy Strategic Roadmap published in November 20161, the main aim of the project consists on overcoming these non-technological barriers through the following specific objectives:

- Development of environmental monitoring around wave energy converters (WECs) operating at sea, to analyse, share and improve the knowledge of the positive and negative environmental pressures and impacts of these technologies and consequently a better knowledge of real risks.
- The resulting data collection will be used to apply and improve existing modelling tools and contribute to the overall understanding of potential cumulative pressures and impacts of larger scale, and future, wave energy deployments.

- Development of efficient guidance for planning and consenting procedures in Spain and Portugal for WE projects, to better inform decision-makers and managers on environmental real risks and reduce environmental consenting uncertainty of ocean WE introducing the Risk Based Approach suggested by the RiCORE, a Horizon 2020 project, which underline the difficulties for developers with an existing fragmented and sequential consenting approaches in these countries;
- Development and implementation of innovative maritime spatial planning (MSP) Decision Support Tools (DSTs) for Portugal and Spain for site selection of WE projects. The final objective of such tools will be the identification and selection of suitable areas for WE development, as well as to support decision makers and developers during the licensing process. These DSTs will consider previous findings (both environmental and legal, found in RiCORE) and the new knowledge acquired in WESE in order to support the development of the risk-based approach mentioned in iii);
- Development of a Data Sharing Platform that will serve data providers, developers and regulators. This includes the partners of the project. WESE Data Platform will be made of a number of ICT services in order to have: (i) a single web access point to relevant data (either produced within the project or by others); (ii) Generation of OGC compliant requests to access data via command line (advanced users); (iii) a dedicated cloud server to store frequently used data or data that may not fit in existing Data Portals; (iv) synchronized biological data and environmental parameters in order to feed models automatically.

2. Executive summary

Marine data are collected by different entities (institutes, governmental organizations, or private companies) using heterogeneous instruments and sensors installed in various observing platforms. However, apart from researchers' experience reported in technical reports and published papers worldwide, it seems that no specific guidelines are available concerning to the monitoring of the parameters covered by the WESE project, i.e., EMF, acoustics (noise), and seafloor integrity, around wave energy installations.

The data acquisition methodology (e.g., spatial and temporal frames, methods and equipment used) was planned to be as standardized and homogeneous as possible among devices and test sites and was developed considering recommendations from researchers and according to the specificities of the devices and their location. Details of the methodology and results can be consulted in Deliverable 2.1, Deliverable 2.2 for EMF, Deliverable 2.3 for underwater noise, and Deliverable 2.4 for seafloor integrity.

In the light of the results obtained and described in the above-mentioned deliverables a better understanding of EMF, acoustics, and seafloor integrity data collection, processing, validation, and reporting to allow comparison among sites was developed in Deliverable 2.6.

Thanks to this last exercise and the experience acquired, different lessons were learned for each environmental parameter. In the present Deliverable 2.7 we try to translate these lessons and experience into guidelines that could be of interest when consenting processes and environmental monitoring plans will be launched for installing wave energy device arrays or farms.

According to the experience and lessons learn during the monitoring campaigns in the WESE project, one of the main conclusions of D2.7 is the need to promote monitoring techniques based on autonomous remote sensing devices that are not dependant of sea conditions and able to cover properly the temporal and spatial resolution of the expected environmental impacts coming from wave energy harnessing devices.

3. Objectives

In the WESE project scope, Work Package (WP) 2 aims to collect, process, analyse and share environmental data collected in sites where Wave Energy Converters are operating in real sea conditions in Spanish and Portuguese coastal waters, representing different types of Wave Energy technology deployed onshore, nearshore, and offshore (Table 1).

Table 1. Wave Energy devices under study.

Device	Technology	Site	Location
WaveRoller	Oscillating Wave Surge	Peniche, Portugal	Nearshore
MARMOK-A-5	Floating Oscillating Water Column	BiMEP, Spain	Offshore
Mutriku Wave Power Plant	Oscillating Water Column	Mutriku, Spain	Onshore

Earlier in the scope of Task 2.1, the environmental monitoring plans for electromagnetic fields (EMF), acoustics (noise), and seafloor integrity to be carried out around those devices were defined in Deliverable 2.1[1], and the results from the monitoring activities of each parameter were presented in Deliverable 2.2[2], Deliverable 2.3[3] and Deliverable 2.44, respectively.

Within WP2, the main objective of Task 2.6 and of the present report (Deliverable 2.7) is to translate into guidelines the **experience and lessons learnt** during the development and implementation of the common monitoring programmes exercise. This information could be of interest when consenting processes, and environmental monitoring plans will be launch for installing wave energy device arrays or farms.

[1] https://wese-project.weebly.com/uploads/1/2/3/5/123556957/wese_report_d2.1._monitoring_plans_for_noise_emf_and_seabed_integrity.pdf
[2] https://wese-project.weebly.com/uploads/1/2/3/5/123556957/d2.2_monitoring_of_electromagnetic_fields.pdf
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[4] https://wese-project.weebly.com/uploads/1/2/3/5/123556957/d2.4_monitoring_of_seafloor_integrity.pdf

4. Lessons learnt and guidelines

4.1 EMF monitoring

As explained in Deliverable 2.2 (Chainho and Bald, 2020), the EMF monitoring campaign in BIMEP was conducted by MAPPEM Geophysics team, using a towed instrumentation system that performed several transects perpendicular to the cable seabed location. The acquisition and processing methods relevant for this methodology are:

- Because the instrument is towed, the distance to the seabed needs to be continuously monitored and sampled simultaneously to the other signals, to guarantee the distance to the cable is properly estimated.
- According to Nyquist's criteria, the sample rate must be higher than at least two times the natural frequency of the grid – 2 x 50Hz – to allow for a proper capture of the signal of interest. Ideally, the sample rate should be higher to identify the harmonics, which could retain significant energy. For our campaign, the sample rate used was 2kHz.
- In post processing, a spectral analysis is essential to identify the amplitude of the signals of interest, around the fundamental frequency of the grid (50Hz) plus it's harmonics.

As concluded in Deliverable 2.2 (Chainho and Bald, 2020), no cable electromagnetic signature could be found. Several reasons could justify this which, along with the instrumentation distance to the seabed (around 5m in average), would return negligible EMF signal. It is worth mentioning that, according to the EMF model developed in Deliverable 3.1 (Chainho and Bald, 2021), this specific cable current and cable distance conditions would return a cable magnetic field in the sub-nano order of magnitude, which is hardly distinguishable from the ambient noise. At the same time, a strong 53Hz signal was visible in the spectrograms which could not be attributed to the cable EMF radiation as such deviation from the 50Hz would have tripped the electrical protections (the cause was attributed to the faulty generator on the campaign vessel). This signal could have masked any residual EMF radiated from the cable (Chainho and Bald, 2021).

Considering this experience, the following lessons and guidelines can be suggested:

- The EMF campaigns should be coordinated with the project developer, to guarantee the device is operating and a EMF signal can be detected.

- The campaigns should be conducted in sea-states which are relevant for WEC power production, so the EMF generated outside of the cable is distinguishable. Ideally, modelling estimations should be conducted to guarantee that the instrumentation range and accuracy can capture the EMF signals expected outside the cable.
- If it is not possible to operate the towed instrumentation in higher sea-states, e.g., due to vessel operability limitations, it should be considered a different methodology consisting of:
    - Sea-bottom instrumentation installed in two or more locations (no need to be simultaneous)
    - One of the instruments should be placed as close as possible to the cable surface, and its distance from the cable accurately measured whenever possible, and;
    - The duration of each campaign should allow to capture different WEC operation regimes, which is more realistic towards the end goal of measuring real-operation impact of EMF by the power cables.
    - Use autonomous platforms equipped with the appropriate sensors, such as AUVs. This way we can solve the problem of sea state conditions since this AUVs are able to work in hard conditions and can monitor as close as we want without the risk of entangling since they are not towed from surface.

4.2 Acoustics monitoring

As mentioned by Felis et al. (2021), two types of acoustic monitoring campaigns were carried out trough: (i) fixed stations for long term temporal monitoring but spatially limited to only one point of measurement and (ii) mobile measurements with larger spatial coverage but very limited temporal resolution (only one day of data).

The sea conditions during the mobile campaign were less than ideal, which compromised the obtained recordings. The monitoring in better sea conditions would guarantee the sampling campaign but would not guarantee the functioning of the device and thus the possibility of obtaining acoustic data from it.

Consequently:

- Temporal monitoring trough moored hydrophones is the most useful methodology. Greater temporal variability can be captured by sampling in different seasons. In order to solve the spatial resolution, three or more hydrophones can be moored at the same time. Since monitoring equipment's are close to the seafloor and far from the sea surface, they are not affected by bad sea conditions and the probability of survival is very high.

- Temporal resolution: 1-2 months seems enough.
- Hydrophones should be moored at distances not too far from the source; we recommend < 200 m from the devices.
- Sampling frequency should consider subsequent analyses and be as low as necessary to, e.g., reduce storage limitation of hydrophones and the amount of data to process.

4.3 Seafloor integrity monitoring

As it was explained in Deliverable 2.4 (Muxika et al., 2020) the seafloor integrity survey was undertaken using two different techniques: (i) a side-scan sonar towed from surface and (ii) a visual inspection with ROVs.

As it was noticed in Deliverable 2.4 (Muxika et al., 2020), the survey with the side-scan SONAR in BiMEP was conducted under less-than-ideal oceanographic conditions (1.5-2 m wave height), which limited the usefulness of the data acquired due to a lower resolution (as the SONAR was towed at a higher altitude in respect to the bottom) and to the artefacts caused by the tugs due to the swell. During the ROV surveys, several issues limited the usefulness of the data acquired. For instance, the positioning systems failed in the ROV.

Once at the laboratory, other issues need to be faced. The most important is the need of some expertise for the identification of filmed species. This could be straightforward when medium to large size common species are recorded but becomes problematic when very small or infrequent species are found. Moreover, the diversity of biological groups that could be filmed may require the participation of multiple experts in the assessment.

Considering this experience, the following lessons and guidelines can be suggested:

- While having a standardized monitoring protocol is relevant for data collection, the different environmental conditions at different sites (e.g., different wave heights and turbulence levels between BiMEP and Peniche) required adapting some of the approaches. For example, at Peniche were planned 5 transects covering the sections behind and in front of the WaveRoller device. This was not entirely possible owed to the strong winds and extreme turbulence inherent of the site which made very difficult to operate the ROV. Hence, besides partial transects (about 60-80 m each), imagery was also acquired by following structures of interest (moorings, electrical cable, device foundation) and when interesting features were observed in the area (e.g., biogenic reefs).

- Tracking of the ROV position is crucial for quantitative analysis. The imagery acquired by ROV allowed to estimate the area impacted at BiMEP, but not the level of affection.
- The ROV is a useful, non-destructive sampling technique, (i) it allows greater flexibility compared to divers as it is safer and allows deeper and longer dives to survey larger study areas, (ii) it allows greater flexibility compared to using more classical methods such as grabs or drop cameras, for similar reasons as mentioned above and considering that monitoring can focus a point of interest during the survey.
- While some specific adjustments in the monitoring approaches needed to be made, such adjustments together with the commonalities in the procedures implemented among sites allowed the acquisition of precious data to increase understanding on environmental impacts caused by Wave Energy installations. Nonetheless, we stress out the need for long-term monitoring, the lack of which not only difficult the determination of significant long-term environmental changes but also hampers the validation of models which many times serve as basis for impacts' evaluation.

5. Concluding remarks

According to the experience and lessons learnt during the monitoring campaigns in the WESE project, one of the main conclusions is the need to promote monitoring techniques based on autonomous remote sensing devices that are not dependant of the sea conditions and able to cover properly the temporal and spatial resolution of the expected environmental impacts coming from wave energy harnessing devices.

Consequently, we need to minimise or avoid any measurement undertaken from sea surface in a vessel, since the sea conditions that we need to detect signals coming from WECs will be most probably detected when sea conditions are bad and consequently with very limited capabilities to monitor.

For underwater acoustic, the mooring of more than one hydrophone in different locations for at least one month is one of the most promising methodology for underwater acoustic monitoring which has worked very well in the project.

For seafloor integrity, visual inspections with ROV is a useful, non-destructive sampling technique but need to be complemented with side-scan sonar images acquired through autonomous and remote sensing devices such as AUVs in order to avoid the limitations associated to sea conditions and be able to cover a larges spatial area.

For EMF, similar to seafloor integrity, remote sensing needs to be promoted through autonomous devices equipped with appropriate sensors such as AUVs. That way we can solve the problem of maintaining and appropriate proximity to cables and avoid the limitations associated to sea conditions.

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