Project information

<table>
<thead>
<tr>
<th>Project full title</th>
<th>EuroSea: Improving and Integrating European Ocean Observing and Forecasting Systems for Sustainable use of the Oceans</th>
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<td>EuroSea</td>
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Deliverable information

<table>
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<tr>
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<tr>
<td>Deliverable title</td>
<td>Final report describing the demonstration and the user feedback at European sites</td>
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<tr>
<td>Description</td>
<td>Last 6-months optimisation and testing in cooperation with end users. Integration of new monitoring instrumentation and operational forecasts systems</td>
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<tr>
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<td>Lead beneficiary</td>
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<td>Lead authors</td>
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<td>Contributors</td>
<td>Oscar Ballesteros, José María García-Valdecasas, Pilar Gil, Fernando Manzano, Manuel Espino, Marc Mestres, María Liste, Javier Romo, Joaquim Cortes, Simon Williams, Marcos García Sotillo, Giovanni Coppini</td>
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<td>Comments</td>
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Table of contents

Executive summary ............................................................................................................................................ 2
1. Introduction ............................................................................................................................................... 2
2. Demonstrator general description ............................................................................................................ 4
   2.1. OSPAC Software ................................................................................................................................. 4
   2.2. High-resolution modelling component ............................................................................................. 6
   2.3. New instrumentation ........................................................................................................................ 7
3. Implementation methodology at two European sites ............................................................................ 10
   3.1. Barcelona pilot site .......................................................................................................................... 10
       New instrumentation in Barcelona ......................................................................................................... 10
       Operational models in Barcelona ........................................................................................................ 11
       OSPAC launch and configuration in Barcelona ........................................................................................ 12
   3.2. Taranto pilot site ............................................................................................................................. 14
       New instrumentation in Taranto ............................................................................................................. 14
       Operational models in Taranto .............................................................................................................. 16
       OSPAC launch and configuration in Taranto ........................................................................................... 16
4. Demonstration period ............................................................................................................................. 17
   4.1. Barcelona pilot site .......................................................................................................................... 17
       Summary Dashboard ............................................................................................................................... 18
       Real time in-situ data .............................................................................................................................. 19
       Forecast Points ....................................................................................................................................... 20
       Forecast Maps ......................................................................................................................................... 20
       Floating Debris ......................................................................................................................................... 21
       Alert Subscription and Thresholds Definition ........................................................................................ 22
       Optimisation and users' feedback ........................................................................................................... 23
   4.2. Taranto pilot site ............................................................................................................................. 28
       Real time in situ data ............................................................................................................................... 28
       Forecast points module .......................................................................................................................... 29
       Forecasts Maps module ........................................................................................................................ 29
       Optimisation and users' feedback ........................................................................................................... 30
Conclusions ...................................................................................................................................................... 31
References ....................................................................................................................................................... 34
Executive summary

The development and implementation of the OSPAC (Oceanographic Services for Ports and Cities) demonstrator in EuroSea Task 5.2 exemplifies the commitment to European innovation and integration of ocean observations and forecasts, facilitating a seamless connection between scientific advancements and the practical needs of end-users. The task combines the deployment of novel measurement equipment, advanced high-resolution coastal forecasts, and the design of tailored downstream services to address the specific requirements of port managers and urban planners, fostering efficient and informed decision-making in both maritime and city planning domains.

The demonstration of OSPAC in three pilot sites underscores its adaptability and effectiveness in diverse coastal settings, providing a tangible example of how EuroSea is bridging the gap between scientific research and the real-world applications essential for advancing the concept of "smart cities" and promoting sustainable practices in port management. The report describes the OSPAC demonstrator characteristics already operational for Barcelona and Taranto pilot sites and the positive feedback, as well as recommendations for future improvements, from end-users at Barcelona and Taranto ports and city councils, during the last 6 months of the project.

This collaborative effort showcases the EuroSea role in connecting scientists with end-users, creating a harmonious synergy between cutting-edge research and the practical tools needed to navigate the challenges of our evolving coastal environments.

1. Introduction

The development of oceano-meteorological downstream services and products tailored to meet the specific requirements of end-users and policy makers is paramount in addressing the increasing demands for accurate and actionable information in the dynamic realm of oceanography and meteorology. These downstream services play a crucial role in transforming raw observational and modelling data into valuable insights and user-friendly information that directly caters to the needs of diverse stakeholders. In a world where climate change and its associated impacts are becoming more evident, there is a growing recognition of the importance of informed decision-making in mitigating risks and adapting to changing environmental conditions. Oceano-meteorological downstream services bridge the gap between scientific knowledge and practical applications, providing decision-makers with timely and relevant information to formulate effective policies, respond to emergencies, and manage resources sustainably.

These services are instrumental in various sectors, including maritime operations, agriculture, disaster management, and environmental conservation. For example, accurate weather and ocean forecasting tailored to specific regions can optimize shipping routes, enhance fishing strategies, and minimize the impact of extreme weather events on coastal communities. Furthermore, policy makers rely on these downstream services to design and implement evidence-based policies that address environmental challenges and promote sustainable development. In essence, the development of oceano-meteorological downstream services aligns with the global imperative to harness scientific advancements for the benefit of society. By customizing data outputs to meet the distinct needs of end-users and policy makers, these services empower
decision-makers to navigate the complexities of our changing environment and foster a more resilient, sustainable, and informed society.

For port managers, the significance of developing oceanographic services cannot be overstated. The maritime industry, with its intricate logistics and dependency on weather conditions, relies heavily on accurate forecasting and real-time data. By tailoring downstream services to the specific needs of port operations, managers can optimize vessel scheduling, cargo handling, and overall port efficiency. Additionally, this precision aids in mitigating potential disruptions caused by adverse weather, ultimately enhancing safety and reducing economic losses.

Moreover, the integration of oceanographic information is pivotal in advancing the concept of "smart cities" through strengthened connections with nearby urban centers. Ports often serve as vital economic hubs, and their seamless integration with nearby cities is fundamental for holistic urban development. The availability of precise weather and oceanographic data enables city planners to design resilient infrastructure, plan for sustainable land use, and implement efficient transportation systems. This, in turn, contributes to the realization of smart city initiatives by fostering connectivity, optimizing resource utilization, and enhancing the overall quality of life for urban residents. The synergy between port management and nearby cities underscores the broader societal impact of oceanographic downstream services in shaping resilient, adaptive, and forward-thinking urban environments.

Within this context, the EuroSea demonstrator OSPAC (Oceanographic Services for Ports and Cities) has been developed and implemented in Task 5.2, for the three pilot sites presented in Figure 1, two in European waters, Barcelona (Spain) and Taranto (Italy), and another one in Buenaventura (Colombia). This report describes the operational implementation of the different elements of OSPAC in place in Barcelona and Taranto. A pre-operational first configuration of OSPAC for Buenaventura (Colombia), is already in place, despite several unforeseen delays related to the COVID-19 pandemic, the need to change the location of the non-European site in 2022 (originally planned to be Alexandria), and the delay of equipment installation due to several unexpected events.

The report is organized as follows: Section 2 provides a general overview of the different components of the demonstrator. Section 3 describes their implementation in operational mode and official launch for the two European pilot sites. Finally, section 4 displays examples of the services in place within OSPAC during the demonstration period, including an updated feedback from end-users.
2. Demonstrator general description

The demonstrator developed in EuroSea Task 5.2 is based on the OSPAC (Oceanographic Services for Ports and Cities) software, described in detail in Deliverable 5.5: Final version of the software running operationally for the demonstration¹; on the deployment of new measuring instruments installed in the framework of EuroSea, as described in Deliverable 5.9: Operational monitoring systems available at the three sites²; and on the implementation of high-resolution coastal and harbour scale models at three pilot sites (Deliverables 5.3: CMEMS downscaled circulation operational forecast system³ and 5.4: CMEMS downscaled wave operational forecast system⁴). The work is the result of the coordinated and collaborative work of scientists and engineers in Puertos del Estado (EPPE), the National Oceanography Centre (NOC), Nologin-Consulting, LIM-UPC, CMCC, the Port of Barcelona and the Port of Taranto.

2.1. OSPAC Software

OSPAC is a tool jointly developed by EPPE and Nologin that provides a comprehensive hub for meteorological and oceanographic indicators, through a suite of tools designed for effective management and decision support in harbours and coastal cities. The platform encompasses highly adaptable applications for visualizing and issuing alerts related to real-time measurements and forecasts of meteorological and oceanographic parameters, and it is accessible on both desktop and mobile devices. All these applications are managed by a common infrastructure, in which each pilot-site may have several Administrators and Users. Hence, OSPAC can be used by different types of stakeholders, each one with different requirements.

¹ https://doi.org/10.3289/eurosea_d5.5
² https://doi.org/10.3289/eurosea_d5.9
³ https://doi.org/10.3289/eurosea_d5.3
⁴ https://doi.org/10.3289/eurosea_d5.4
and access levels. The access to the tool (https://www.ospac.es) requires a user and password, that must be provided by the tool administrator at each port (Figure 2).

![OSPAC tool access](https://www.ospac.es)

Figure 2. OSPAC tool access, https://www.ospac.es

OSPAC software encloses the following main services:

- Visualize real-time met-ocean parameters (e.g. waves, sea level, wind, currents, temperature and salinity) coming from different in-situ stations (buoys, tidal stations, meteorological stations, etc.);
- Visualize met-ocean forecasts coming from high-resolution models developed within the framework of the EuroSea project at each pilot site.
- Create highly customizable warnings for any of the above-mentioned parameters, be it from real-time parameters or met-ocean forecasts. These warnings can be timely received by e-mail or SMS.
- Forecast floating debris Lagrangian trajectories, according to sources defined by the pilot-site Administrator. High resolution 3D circulation models are used as reference to estimate these Lagrangian trajectories.
- Oil-spill: it allows to generate a simulation of 72 hours to forecast the evolution of an oil spill, based on the use of the MEDSLIK-II model.

For this, the architecture of OSPAC can be considered divided in the following three main layers:

i. Visualization layer: It includes the interface that Users access to view and set-up the results of the different applications (i.e. alerts, forecasts, floating debris);
ii. Storage layer: It involves the database (EPPE PostgreSQL database system) that stores all the data needed to manage the app (real-time measurements, met-ocean forecasts);
iii. Interoperability layer: This layer manages the connections and data transfer between the database (storage layer) and the User app (visualization layer), via a Python-based web server.
2.2. High-resolution modelling component

Within the EuroSea project framework, the WP5 team has dedicated efforts to developing “state of the art” high resolution wave and 3D circulation models and implement them for operational forecasts in the 3 OSPAC pilot sites. A downscaling approach based on CMEMS-IBI and MED products has been employed for Barcelona and Taranto, respectively.

In Barcelona, the modelling setup for waves and currents is based on a double nesting approach on common regular grids with 350 m resolution in coastal waters and 70 m in Barcelona port domain. In Taranto, wave and currents models run in a common unstructured-grid implemented to cover the entire Gulf of Taranto, with primary emphasis and increased horizontal resolution (up to 20 m) directed towards the Taranto port and adjacent embayments. The use of a variable mesh approach ensures a seamless exchange and continuity of information across different scales, including sub-regional, coastal, and port areas. In both cases, coupling between waves and currents has been implemented as an improvement to previous modelling setups in the areas of study, for an improved representation of coastal interaction between different processes such as coastal sea level increase due to wave set-up, among others.

These models have been extensively validated with in situ observations by CMCC (for Taranto site) and LIM-UPC (for Barcelona), as described in detail in Deliverables 5.3: CMEMS downscaled circulation operational forecast system and 5.4: CMEMS downscaled wave operational forecast system. Comparisons with the CMEMS-IBI and MED parent solutions highlight the enhanced value of the coastal models. This improvement is attributed to the downscaling strategy, which involves a higher spatial resolution encompassing geometric features of coastal areas, specific input datasets, and parameterizations tailored for coastal scale processes. Overall, this approach contributes to a more realistic representation of ocean hydrodynamics at the coastal scale.

An overview of main characteristics of these modelling components of OSPAC for Taranto and Barcelona is shown in Table 1 (see D5.3 and D5.4 for more technical details).

<table>
<thead>
<tr>
<th></th>
<th>Barcelona</th>
<th>Taranto</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wave model</strong></td>
<td>SWAN nested in IBI-Waves-CMEMS</td>
<td>WAVEWATCH III, nested in Med-Waves-CMEMS</td>
</tr>
<tr>
<td><strong>Hydrodynamic model</strong></td>
<td>ROMS nested in CMEMS IBI-MFC</td>
<td>SHYFEM (3D finite element) nested in CMEMS MED-MFC</td>
</tr>
<tr>
<td><strong>Forcing</strong></td>
<td>AEMET (HIRLAM: 0.05 for +36h horizon, 0.16 for +72h horizon)</td>
<td>ECMWF (6.5 km resolution and 3h frequency)</td>
</tr>
<tr>
<td><strong>Coupling tool</strong></td>
<td>COAWST-MCT</td>
<td>External coupler which includes radiation stress and surface drag coefficient from waves to ocean, and currents and sea level from ocean to waves.</td>
</tr>
<tr>
<td><strong>Bathymetry</strong></td>
<td>EMODnet + Port Authority</td>
<td>EMODnet + Italian Navy Hydrographic Institute</td>
</tr>
</tbody>
</table>
### 2.3. New instrumentation

Novel multi-parametric equipment was installed at each pilot site, with a final configuration dependent on specific requirements agreed with local stakeholders. These include a prototype low maintenance tide gauge system developed by the NOC in Task 5.1.1, powered by renewable energy, dual sea level sensors and telemetry, and with the ability to monitor both land motion and sea level. A new technique known as GNSS Interferometric Reflectometry (GNSS-IR) is used to provide mean sea level and significant wave height whilst simultaneously measuring vertical land motion with a permanent GNSS (Global Navigation Satellite System) receiver. Real time data from the new equipment are integrated in OSPAC for providing real time alerts, model validation, and for monitoring oceano-meteorological conditions in support of port operations.

Barcelona monitoring requirements were defined in spring 2020 by representatives of the Port of Barcelona, Puertos del Estado and the NOC, while in Taranto these were agreed in February 2021 by representatives of the Port of Taranto, CMCC and the NOC. Final decisions on the type of sensors were taken depending on the availability of other permanent instrumentation in each port, and on the final monitoring location selected, based upon the local knowledge of the spatial impact of extreme wave conditions (with potential for causing damage to the sensors). The following requirements were agreed for both sites:

- High frequency sampling (1 min) and low latency of data transmission for sea level data to facilitate tsunami warning
- Atmospheric pressure observations to reduce the effects of atmospheric noise in tidal predictions
- Observations of wave activity outside the harbour area to support navigation (Barcelona), and at the coast and in the nearshore area (Taranto)
- Highly accurate observations of mean sea level and vertical land motion to understand the impacts of climate change
- Minimal maintenance requirements
- In Barcelona: warnings of potential lightning strikes in order to improve safe operations (and timely shutdowns) of a nearby energy centre (flammable liquid operations)

Tables 1 and 2 show the sensors and variables measured by the new instrumentation deployed in Barcelona and Taranto ports. Pictures and locations inside the ports are displayed in Figures 3 and 4. In Barcelona, a Thunderstorm Warning System from INGESCO Preivistorm was set up to identify possible lightning strikes. The system is strategically placed at a considerable distance from the energy centre at the port, providing ample time for early warnings. The Preivistorm system worked well for many months, but the power supply at the installation site became unstable in 2023 and suffered multiple failures. The WP5 team was reliant upon local stakeholders to visit the installation site to restart the dedicated laptop so that the data flow could be reinstated, but as of December 2023, this has not taken place and a solution cannot therefore be implemented without assistance of the Port Authority.
Table 1. Configuration of the novel multi-parametric equipment installed in Barcelona pilot site.

<table>
<thead>
<tr>
<th></th>
<th>YSI Waterlog Nile 502 radar (2)</th>
<th>Vaisala Barometer</th>
<th>PTB110 Barometer</th>
<th>Trimble GNSS</th>
<th>Alloy</th>
<th>Low cost Emild REACH M2 GNSS</th>
<th>InGesco Preivistorm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea level</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waves</td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atmospheric pressure</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Vertical land motion</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Lightning (electric field)</td>
<td></td>
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<td></td>
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</table>

Furthermore, an affordable GNSS antenna has been installed on a lighthouse located at the entrance of the harbour. This setup is designed to measure the Significant Wave Height (SWH) beyond the harbour wall. This is crucial as substantial swell waves outside the harbour can negatively affect navigation. The antenna collects 1-second samples of carrier phase, range, and signal-to-noise ratio. These data are then transmitted via a roaming SIM card at hourly intervals to the National Oceanography Centre (NOC) in the RINEX 3 format. Currently, these data are manually processed every few days using the IR technique mentioned above to generate hourly SWH estimates.

During a test period (June to August 2023), the results showed a strong agreement with those obtained from the offshore buoy operated by Puertos del Estado. There were plans to further refine this process to create a near-real-time SWH product to support the OSPAC tool in Autumn 2023. However, during the installation, local permissions were revoked to connect the affordable GNSS system to an existing array of batteries in the lighthouse. This meant that an additional 100W solar panel and 38Ah battery had to be sourced locally by the supporting Spanish company SIDMAR and during Autumn 2023 the system became unable to maintain power. Given the success of the trial period, the NOC staff will try to resolve this issue post-project with the agreement of the Port Authority, and EPPE will integrate the new technology wave data in real time in OSPAC as soon as the problem is solved.
Figure 3. Barcelona EuroSea equipment position, including the prototype low-cost tide gauge (TG) and GNSS station, composed of two Waterlog Nile sea level sensors, a permanent GNSS receiver and an atmospheric pressure sensor, and the low cost GNSS sensor on the lighthouse (secondary site).

Figure 4. Taranto EuroSea equipment position, including the prototype low-cost tide gauge (TG) and GNSS station, composed of a Waterlog Nile radar sensor, a MIROS sensor, a permanent GNSS receiver and an atmospheric pressure sensor.
Table 2. Configuration of the novel multi-parametric equipment installed in Taranto pilot site

<table>
<thead>
<tr>
<th></th>
<th>YSI Waterlog Nile 502 radar</th>
<th>MIROS SM140-N radar</th>
<th>Vaisala PTB110 Barometer</th>
<th>Trimble Alloy GNSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea level</td>
<td>√</td>
<td>√</td>
<td></td>
<td>√</td>
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<tr>
<td>Waves</td>
<td></td>
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<tr>
<td>Atmospheric pressure</td>
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<td>√</td>
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<tr>
<td>Vertical land motion</td>
<td></td>
<td></td>
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<td>√</td>
</tr>
</tbody>
</table>

3. Implementation methodology at two European sites

3.1. Barcelona pilot site

New instrumentation in Barcelona

Under Task 5.1.1, a solar-powered tide gauge (Figure 5) was installed in the Port of Barcelona in April 2023 and was equipped with dual high frequency sampling radar sea level sensors and a geodetic quality Global Navigation Satellite System (GNSS) receiver. The GNSS was enabled for monitoring vertical land motion and for monitoring sea level in a geocentric reference frame via the innovative GNSS Interferometric Reflectometry (GNSS-IR) technique. A barometer was also installed, alongside a low cost GNSS receiver for measuring significant wave height (SWH) outside the harbour wall via GNSS-IR. A Previstorm lighting detection system was also fitted close to the airport, providing sufficient distance from the port energy centre to allow advance notification of potential lightning strikes. Data logging equipment, solar panels, a battery array and dual data telemetry systems were also incorporated. This system has low maintenance requirements and low running costs to ensure the longevity of the gauge.

New data streams from this tide gauge consisted of:

- 1 min averages of sea level from dual radar sensors transmitted at 1 min intervals to the EPPE ftp site (enoc.puertos.es) for incorporation into the OSPAC software. The same data transmitted every 6
mins via a free Meteosat satellite communications system to the Global Telecommunications System (GTS) from where they are accessed by the IOC Sea Level Station Monitoring Facility (IOC SLSMF).

- 6 min samples of atmospheric pressure transmitted via a KPN roaming SIM card at 1 min intervals (i.e. the barometer reading will be constant for 6 transmissions) to the EPPE ftp site (enoc.puertos.es) for incorporation into the OSPAC software. The same 6 min samples of atmospheric pressure transmitted via a free Meteosat satellite communications system to the Global Telecommunications System (GTS) from where they are accessed by the IOC SLSMF.

- Previstorm data (consisting of 1 sec samples of electrical field activity, V/m) transmitted direct to the port authority and at 1 min intervals to the EPPE ftp site (enoc.puertos.es) for incorporation into the OSPAC software.

- RINEX 3 data files from the Trimble Alloy GNSS receiver transmitted every 15 mins to the NOC via FTP. They contain observations of carrier phase and range, plus signal-to-noise ratio at 5 sec intervals from each satellite that is in view of the receiver. On a daily basis, the 15 min files are combined to produce a daily file of 30 second vertical land motion data which is sent via ftp to the SONEL data portal (GPS Barcelona Tide Gauge 2 (sonel.org), SONEL station code 4586, IGS site reference BCTG). The 15 min data files are additionally used in near real-time via the interferometric reflectometry (IR) technique, to produce sea level heights at 15-minute intervals. The latency is around 1 hour. These data are transmitted to the EPPE ftp site (enoc.puertos.es) for incorporation into the OSPAC software.

- 1 sec samples of carrier phase and range, plus signal-to-noise ratio are transmitted from a low cost GNSS at hourly intervals to the NOC in the form of RINEX 3 data. These were initially processed manually every few days during a calibration phase, using the IR technique, to produce hourly estimates of SWH outside the harbour wall.

Once the stations were installed and transmitting correct data, EPPE team developed specific scripts for automatic downloading and insertion into EPPE PostGreSQL database the new real-time data streams and corresponding metadata, including the definition/creation and configuration of the new instrumentation according to EPPE in situ data formats and requirements.

Operational models in Barcelona

A 3D hydrodynamic tool using the Coupled Ocean-Atmosphere-Wave-Sediment Transport (COAWST; Warner et al., 2010) modelling system has been developed by LIM-UPC for the Barcelona pilot site. The system uses the Model Coupling Toolkit (MCT) to integrate and exchange forecast variables between the Regional Ocean Modelling System (ROMS: Haidvogel et al., 2008; Shchepetkin and McWilliams, 2009; described in Deliverables D5.3 and D5.11) and the Simulating Waves Nearshore wave model (SWAN; described in Deliverables D5.4 and D5.11), focusing on detailed physical interactions between waves and currents (described in detail in Deliverable 5.4).

The COAWST modelling system uses the MCT to allow communication between models via the Message Passing Interface (Jacob et al., 2005). In the coupling process, the ROMS model receives the surface and bottom wave direction, height, length, period, fractional break, energy dissipation and bottom orbital velocity from the SWAN model. At the same time, the ROMS model provides bathymetry, bottom elevation, sea surface height and depth-averaged currents to the SWAN model.

As part of the system, the numerical simulations were carried out on a coupled, two-nested grid configuration. The coarse grid covers a part of the Catalan coast with a spatial resolution of 350m. Nested
within the coastal grid with a scale factor of 5 is the port grid with a spatial resolution of the order of 70m. Two grids were simulated simultaneously as a nested coupled application: two-way ocean refinement and one-way wave refinement with fully coupled exchange between two grids for the fields of water levels, currents, bathymetry and bottom roughness from the ocean to the wave model; and wave dissipation, height, length, direction, surface and bottom periods and bottom orbital velocities from the wave to the ocean model (described in detail in Deliverable D5.4).

The bathymetry was constructed using a combination of data from EMODnet5 and specific high-resolution sources provided by local authorities. Copernicus products have driven these high-resolution simulations; the simulations were forced with atmospheric data of winds, pressure, air temperature, relative humidity, precipitation and heat fluxes from CMEMS-IBI. At the sea surface, the models were forced with high-frequency wind stress, atmospheric pressure, and surface water and heat fluxes derived from the forecast services of the Spanish Meteorological Agency (AEMET).

The results of the described methodology were validated by measurements provided by a field campaign led by LIM-UPC work team between March and April 2022, during which a severe storm called CELIA was recorded, as well as some other large storms with high values of significant wave height. All these data were compared with modelled results, showing good agreement with in-situ observations (described in detail in Deliverable 5.46). Validation during the demonstration period (last 6 months of the project), including novel equipment deployed in EuroSea is included in Deliverable 5.11: Scientific model validation report during the demonstration period6.

An operational chain of this modelling component was developed and implemented by EPPE team at its HPC system, for operational integration of the forecasts, with a +72h forecast horizon, in OSPAC tool. Originally based on OSPAC-V1 version of the modelling component developed by LIM-UPC, an update to operations of OSPAC-V2 version including the coupling tool (Deliverable 5.3) was completed in 2023. The operational scripts are launched every day between 5:00 and 10:00 GMT and include downloading and pre-processing of the meteorological forcing from the Spanish Met Office (AEMET), downloading and pre-processing of the ocean and waves parent solutions (currents and wave variables) from the CMEMS IBI regional forecasting system, running of the COAWST modelling system, and post-processing of the models results. Time series (forecasts) at relevant grid points selected by the port and city users are extracted and inserted in EPPE PostgreSQL database, for their display in OSPAC. Netcdf files with the model fields are stored and freely distributed online7, and transformed to tile maps also displayed in OSPAC (see Section 4).

OSPAC launch and configuration in Barcelona

OSPAC software was implemented in EPPE in pre-operational mode, and configured for the port and city of Barcelona, in early 2022, originally displaying in situ observations from EPPE permanent networks and OSPAC-V1 version of the high-resolution model developed by LIM-UPC (Deliverable 5.37). The service was later transferred to operational mode by EPPE team, and entered a demonstration phase at Barcelona on 26 October 2022, as an on-line launch for the Administrators of the Barcelona pilot site (Barcelona Harbour and

5 https://www.emodnet-bathymetry.eu/
6 https://doi.org/10.3289/eurosea_d5.11
7 https://portuscopia.puertos.es/
Barcelona City Council). Since then, it has been disseminated at a series of international events, e.g. at the World Ocean Council 2022 in October 2022 where Susana Pérez-Rubio (EPPE) and Manuel García-León (Nologin Consulting) were keynote speakers at session "SMART Ocean-SMART Industries: Ocean and Climate Data Collection from Vessels, Platforms and Cables during the UN Decade of Ocean Science and Beyond".

In addition, specific user feedback has been gathered (see next Section 4).

The OSPAC service has been opened to the public since the hard-launch event held at Barcelona in March 2023. Besides this launch, the service has been disseminated at the following events:

- Hard launch (27 March 2023): Begoña Pérez Gómez, Susana Pérez and Manuel García León. On-site launch at Barcelona harbour. Since the soft launch, the designated administrators can register any interested user to the already available modules.
- User feedback survey (April & May 2023): On-line survey for gathering feedback from the users (see results in the next Section 4).
- PredictOnTime: First Workshop on Observing and Predicting the Global Coastal Ocean (May 2023): On Friday, 12 May 2023 (10:30 – 10:45), Susana Pérez Rubio and Begoña Pérez Gómez (Puertos del Estado, EPPE) gave an on-line contribution called “OSPAC: Oceanographic services of ports and cities”.  
- Ocean Race Genoa 2023 - Ocean Data Week, EuroSea event: Towards a user-focused, interdisciplinary, and responsive European ocean observing and forecasting system: Jun 28 2023: Begoña Pérez Gómez: “From operational oceanographic services along the Spanish coast to EuroSea OSPAC tool”.

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8 https://www.sustainableoceansummit.org/sos-program/
9 https://predictontime.org/workshop-11-13-may-2023
At the date of publication of this report, the OSPAC application in Barcelona pilot site had 43 registered users, two of them with the role of OSPAC administrators, i.e. responsible for managing the application, which includes tasks such as granting access to new users, defining thresholds and activating alerts.

<table>
<thead>
<tr>
<th>OSPAC Barcelona</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Users</strong></td>
</tr>
<tr>
<td>43</td>
</tr>
</tbody>
</table>

### 3.2. Taranto pilot site

**New instrumentation in Taranto**

In June 2023 a solar-powered tide gauge was installed in the Port of Taranto (Figure 7) equipped with dual sea level sensors (1 conventional radar sensor, plus a MIROS wave monitoring radar sensor), a Global Navigation Satellite System (GNSS) receiver enabled for monitoring vertical land motion, plus sea level and wave monitoring via Interferometric Reflectometry (GNSS-IR)), a barometer, data logging equipment, solar panels, a battery array and dual data telemetry systems. This system has low maintenance requirements and low running costs to ensure the longevity of the gauge.
This system supplied the following observational data streams:

- 1 min averages of sea level from the conventional radar sensor transmitted at 1 min intervals to the EPPE ftp site (enoc.puertos.es) for incorporation into the OSPAC software. The same data transmitted every 6 mins via a free Meteosat satellite communications system to the Global Telecommunications System (GTS) from where they are accessed by the IOC Sea Level Station Monitoring Facility (IOC SLSMF).

- Wave parameters from the MIROS RangeFinder computed every 20 minutes from spectral analysis of the 2Hz raw data and transmitted every 20 min to the EPPE ftp site (enoc.puertos.es) where the following key parameters are isolated for incorporation into the OSPAC software:
  - Water level (m)
  - $H_m0$ (significant wave height (m))
  - $H_{max}$ (maximum wave height (m))
  - $T_{m02}$ (mean zero up-crossing period (s))
  - $T_p$ (primary wave peak period (s))

- 6 min samples of atmospheric pressure transmitted at 1 min intervals (i.e. the barometer reading will be constant for 6 transmissions) to the EPPE ftp site (enoc.puertos.es) for incorporation into the OSPAC software. The same 6 min samples of atmospheric pressure transmitted via a free Meteosat satellite communications system to the Global Telecommunications System (GTS) from where they are accessed by the IOCSLSMF.

- RINEX 3 data files from the Trimble Alloy GNSS receiver transmitted every 15 mins to the NOC via FTP. They contain observations of carrier phase and range, plus signal-to-noise ratio at 5 sec intervals from each satellite that is in view of the receiver. On a daily basis, the 15 min files are combined to produce a daily file of 30 second vertical land motion data which is sent via ftp to the SONEL data portal (GPS Taranto tide gauge (sonel.org), SONEL station code 4587, IGS site reference TRTG). The 15 min data files are additionally used in near real-time via the interferometric reflectometry (IR) technique, to produce sea level heights at 15-minute intervals and hourly estimates of SWH across the nearshore area with a latency of around 1 hour. These data are transmitted to the EPPE ftp site (enoc.puertos.es) for incorporation into the OSPAC software.
Operational models in Taranto
CMCC developed an integrated very high-resolution modelling framework based on unstructured-grid approach for 3D hydrodynamic and waves. The modelling framework is able to investigate in past and short-term forecasting mode the coastal and port coastal water dynamics of Taranto. The modelling tool, described in detail into deliverables D5.3 and D5.4, uses the two state-of-art models which are SHYFEM for the hydrodynamics and WW3 for the waves. The interaction between the two models is done via an external coupler which includes radiation stress and surface drag coefficient from waves to ocean, and currents and sea level from ocean to waves. The two models run over the same unstructured grid, with variable resolution from 3km in open ocean to 100m overall the coastal waters of the Taranto Gulf and 20m in the Taranto Seas and surrounding areas.

The operational chain was built by CMCC for the EUROSEA framework, and it is capable every day to provide 3-days of forecasts with hourly frequency. The outputs have been delivered both in unstructured (native) format and regridded format to serve downstream services (e.g. tool for visualization) and applications. The ocean fields released on the daily basis are 3D currents, temperature and salinity, and sea level. The forecast is prepared and runs automatically. The operational chain is activated as soon as the atmospheric forcings are available. The technical procedures (Fig. 12b) through scripts and codes for computing the forecast fields can be summarized in the pre-processing of input data, model run and post-processing of the output model. The operational suit, described in detail also in D5.3, runs every day in CMCC HPC system. The NetCDF files containing the ocean fields are then sent by sftp every day to EPPE, where an additional post-processing and format transformation script allows the generation of the tiles maps displayed in OSPAC, as well as the extraction of the relevant grid points to be stored in EPPE PostGreSQL database.

OSPAC launch and configuration in Taranto
OSPAC software was implemented and configurated for Taranto in EPPE, in pre-operational mode, in February 2023. At that time, the new EuroSea tide gauge was not installed yet, so only the outputs from the CMCC modelling system were available in this first configuration of OSPAC for Taranto pilot site. The service was later transferred to operational mode by EPPE team, and open to the general public in June 2023, when the demonstration period started. Soon after, thanks to the installation of the new EuroSea sensors by the NOC (end of June), the observations data streams started to enter EPPE ftp site in real time. These data are automatically inserted in EPPE PostgreSQL database for display in OSPAC nowadays.

At the date of publication of this report, the OSPAC application in Taranto pilot site had 21 registered users, two of them with the role of OSPAC administrators, i.e. responsible for managing the application, which includes tasks such as granting access to new users, defining thresholds and activating alerts.

Table 4. Number of registered users in OSPAC for Barcelona pilot site. Information updated on 14 December 2023

<table>
<thead>
<tr>
<th>Users</th>
<th>Administrators</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>2</td>
</tr>
</tbody>
</table>
4. Demonstration period

4.1. Barcelona pilot site

OSPAC-Barcelona has been open to the public since the hard-launch event in April 2023. Several snapshots below display examples of the different modules and downstream services included in this tool, based on the models and instrumentation deployment described in Section 3. A detailed description of the OSPAC tool, its modules and services as well as user capabilities is available in Deliverable D5.5: Final version of the software running operationally for the demonstration.

The application for Barcelona site has 3 different views, each of them focused on a type of user who may be interested in an area, i.e.:

- Port view, intended for Port Authority users or companies that provide services in the port of Barcelona, as well as general users.
- City view, intended for City Council users or any user or companies involved in urban management, as well as general users.
- Coastal view, in which all the tools can be viewed in a larger area, of possible interest to users who carry out coastal activities in the environment beyond the strictly port or municipal area (water quality, fish farming, maritime navigation, renewable energies, etc.).

In each of these views the area shown, zoom levels and applications displayed are tailored to the region covered by OSPAC, as can be seen in Figure 8.
Summary Dashboard

This summary allows users to consult, on the same page and in a very simplified way, the basic information on the met-ocean variables available at Barcelona, both for the latest data measured in real time and those forecasted for the coming days (see Figure 9).
Real time in-situ data
This application displays the latest met-ocean in-situ data transmitted in real time available at Barcelona. Different icons on the map help to identify each station. When clicking on icons, a floating window shows the latest information from all parameters at each station. From that window users can open interactive time-series plots and download latest data files. At all times the information displayed is adjusted to each user’s configuration in terms of units and thresholds defined for each parameter (Figure 10).
Forecast Points
This module allows users to check the met-ocean forecast data (from numerical models) in the form of time-series for the next 72 hours at Barcelona. This information is shown in a set of locations (points on the map) that have been identified as relevant in coordination with the Barcelona Port Authority. Two different icons are used to distinguish different type of data: anchor icon provides access to forecasted sea level data while dot icons will show waves, currents and/or wind data. When clicking on icons, a floating window showing the expected daily extremes for each parameter will open. From that window users can open interactive time-series plots showing the latest forecast data available. At all times the information displayed is adjusted to each user’s configuration in terms of parameters units and thresholds (Figure 11).

Forecast Maps
In this module the prediction information derived from numerical models is provided using animated maps. These maps have a control menu that allows users to move forward, rewind, stop, start or pause the animation. Maps are updated when a new forecast cycle is available (Figure 12).
Floating Debris

The aim of this module is to forecast floating debris trajectories derived from high resolution circulation models at specific points that were defined by Barcelona Port Authority. Trajectories are daily updated as soon as a new forecast cycle is available (Figure 13).
Figure 13. Snapshot of the Floating debris module for Barcelona (port view) taken in December 2023. Forecasted floating debris trajectories derived from the currents are shown. Dots represent the source origin of the floating debris that are defined by the Administrator of OSPAC. The solid lines are the lagrangian trajectories forecast at different points inside/outside the Barcelona harbour.

Alert Subscription and Thresholds Definition
Users can define their own thresholds for each variable displayed in OSPAC, for one or several points of interest, or use the pre-defined thresholds defined by the administrator. They can also subscribe to specific real time/forecast points to receive default or tailor-made warnings by e-mail or sms (Figure 14).
Figure 14. a) User-defined thresholds can be implemented in the real time or forecasts graphs, example shown for defining thresholds for sea level from EuroSea Tide Gauge (radar1) station; b) example of graph displaying thresholds for significant wave height forecast graph (yellow and red lines); c) example of email with yellow alert from wind data of Barcelona meteorological station integrated in OSPAC; d) example of email with yellow alert from wind data forecasted at a specific model point in Barcelona.

Optimisation and users’ feedback
Three weeks after the hard launch (April 2023), there was sent an on-line survey to all the users requesting their feedback. This survey was answered by 16 users (47% of the users in May 2023) and it was held in Spanish to boost participation. Most relevant results can be found below. The survey questions and answers have been accordingly translated into English. The survey began with a set of questions to characterize the end-user profile (Figure 15).
There were three clusters of end-users (Figure 15): (i) those devoted to Harbour management and industrial operations (red), (ii) those focused on Urban and Environmental management (green), (iii) and a relevant share from Research and Education sectors (purple).

Close to 87% found OSPAC quite useful or very useful for their activities. Hence, there is a high degree of acceptance of the tool. The users concluded that the app provides support for a wide range of activities. As additional comments that justify this qualification of the service (directly translated from the users’ responses):

"Good example of potential applications"; "Very easy to customise and it allows alert set-up"; "Example of operational service for the civil engineering, environmental, naval and oceanic students. Support to the research work at the coastal areas included at OSPAC"; "The data provided by OSPAC will be useful for showing results and open new research lines"; "All-in-one several applications"; "It allows to plan daily operations in a fast way"; "Accurate wave forecast"; "Easy to query information"; "Very useful for emergencies, it contains both measurements and models”.

Half of the users (50%) access to OSPAC at least once per week. Despite that the users expose that OSPAC is useful for their daily activities, there is still a minority (close to 10%) that accesses this platform at a daily basis. The users expect to check the application with more frequency in case of extraordinary episodes, such as storm events or oil-spill accidents. The modules that are more used are “near-real time monitoring”, “forecast maps and points” and “warning system” (Figure 16). The added-values services (e.g. oil-spill and floating debris), as mentioned before, are more suitable for specific events that happen episodically.
A relevant share of users would prefer on-line training (44%) rather than on-site courses (25%). Note that 20% of the users would not require further training, but 30% recommend updating the documentation and the existing manuals.

There is a growing demand for new modules and most end-user have requested more than one module. There is a high demand for water quality modules (75%) and urban flooding (70%). Overtopping and air quality (44%) also have gained particular attention (Figure 17).
In general, the users are well satisfied with the OSPAC tool (more than 80% of the users rated 4/5 out of 5), Figure 18. This evaluation comes reinforced by the comments summarised in Table 5, that include direct translation of the justification made by the users.

Table 5. Compilation of the OSPAC strong/weak points mentioned by the users.

<table>
<thead>
<tr>
<th>Strong points</th>
<th>Weak points</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Intuitive tool</td>
<td>- Strongly focused on the harbours. Further assessment on the beaches.</td>
</tr>
<tr>
<td>- Integrates models and observations</td>
<td>- Heavily centred in physical variables, it will be nice to include water and air quality variables.</td>
</tr>
<tr>
<td>- Relevant at areas close to sewer outfalls</td>
<td>- It does not have a water quality module.</td>
</tr>
<tr>
<td>- Useful for daily operations at harbours</td>
<td>- A coastal flooding module will help to identify flooded areas.</td>
</tr>
<tr>
<td></td>
<td>- In case that environmental modules will be included, high potential for daily use.</td>
</tr>
</tbody>
</table>

Users also answered to their perception of the usability of the application as well as the simplicity and usefulness of each of the modules. The following conclusions can be drawn from the information gathered:

User Interface

Most of the users access OSPAC using personal computers or tablet. In general, user registration is found to be very easy (81%), and the user interface is quite appropriated (more than 50% of the users rated 4/5 or higher). The application has been rated as fast and highly customisable (4/5 out of 5).

As additional recommendations, the users requested: (i) to improve the user interface, (ii) to make it more intuitive and user-friendly; (iii) add more languages in the menu.
Real time measurements

The modules that have more users are the near-real time measurements and the forecast points. Also, they are the ones that require further revisit, as they keep updating with higher frequency (e.g. dependent of the sensor latency). Most users found the module as easy (80% of the answers are 4/5 out of 5). The variables that are more actively checked are waves (significant wave height, mean wave period and direction), sea level and atmosphere, whereas water temperature is only assessed by 20%.

As recommendations, the users added: (i) to include meteorological stations that are at the zone, but not available at OSPAC; (ii) to add the following new variables: rainfall, water oxygen, air quality (PM10), water quality (oxygen, turbidity).

Forecast maps and points module

The general satisfaction with the forecast points and maps is positive (53.3% are 4/5 out of 5). However, close to 40% of the users evaluated them as not easy or even difficult to interpret. Main checked variables include waves and wind (67%) and sea level (53%).

The users recommended to include the following issues: (i) add variables related to air and water quality, (ii) include new modules for wave agitation and rainfall rates, (iii) increase the forecast horizon (beyond the current 72 hours).

Alert module

The two previous modules (near-real-time monitoring and forecasts) are complemented with the alert module. There is a consensus that it is not as intuitive as these two previous modules (55% qualified the alert module’s easiness as 3/5 out of 5). Most users (close to 80%) are subscribed to waves and wind warnings and 60% of them have user-defined thresholds. However, only 25% have created user-defined alerts; whilst the remaining 75% use directly the alerts defined by the site administrator.

Most difficulties found for setting-up user-defined alerts highlight lack of clarity in the app for building alerts. As only 3 users filled this section of the survey, the numbers must be taken with caution. The specific comments on this section also requested further documentation on how to build alerts.

In addition, several users have pointed out the need for (i) including new variables, as atmospheric pressure and mean sea level, (ii) include alerts for flooding and erosion and (iii) include rainfall (e.g. compound events).

Oil-spill module

Most of the users of the oil-spill can visualize simulations, but only 2 of the Administrators answered the questions. Hence, the answers cannot be considered as representative of any trend. The module is easy to work with (62% considered the oil-spill as a 4/5 out of 5). As a drawback, the results are not that easy to interpret (close to 45% of the users evaluated 3/5 out of 5).

The administrators have tested the service both in forward and backward mode, but only one has used it for a real event. The veracity of the trajectories was found to be quite satisfactory.

Floating debris module

There is no clear consensus on how easy is to use the floating debris module. Each category has 2 votes, so it is complicated to obtain significant conclusions. Close to 75% of the users rated as 3/5 out of 5, though. Same problem happens with the interpretation of the results. The users requested (i) to improve the documentation and (ii) to use interfaces that are more user-friendly.
4.2. Taranto pilot site

OSPAC-Taranto has been open to the public since the hard-launch event in June 2023. Several snapshots below display examples of the different modules and downstream services included in this tool, based on the models and instrumentation deployment described in Section 3. A detailed description of the OSPAC tool, its modules and services as well as user capabilities is available in Deliverable D5.5.

The application for Taranto has 2 different views, each of them focused on a type of user who may be interested in an area, i.e.:

- Port view, intended for Port Authority users or companies that provide services in the port of Taranto, as well as general users.
- Coastal view, in which all the tools can be viewed in a larger area, which may be of interest to users who carry out coastal activities in the environment beyond the strictly port or municipal area (water quality, fish farming, maritime navigation, renewable energies, etc.).

**Real time in situ data**

This application displays the latest met-ocean in-situ data transmitted in real time available at Taranto. When clicking on station icon, a floating window show the latest information, all parameters of the station. From that window users can open interactive time-series plots and download latest data files. At all times the information displayed is adjusted to each user's configuration in terms of units and thresholds defined for each parameter (Figure 19).

![Figure 19. Snapshot of the Real-time module at Taranto taken on 17 December 2023. The monitoring floating window for the Taranto Radar 1 EuroSea tide gauge data is shown. On the upper-left sea the level time-series plot was superimposed; on the bottom-right, atmospheric pressure time-series plot was superimposed. Please note that sea level values are in safe level (green). Also note also that each station icon shows all its available parameters.](image-url)
Forecast points module
This module allows users to check the met-ocean forecast data (from numerical models) in the form of time-series for the next 72 hours at Taranto. This information is shown in a set of locations (points on the map), dot icons show waves and currents data. When clicking on icons, a floating window showing the expected daily extremes for each parameter will open. From that window users can open interactive time-series plots showing the latest forecast data available. At all times the information displayed is adjusted to each user’s configuration in terms of parameters units and thresholds (Figure 20).

Figure 20. Snapshot of the Forecast points module for Taranto (Coast view) taken on 17 December 2023. A floating window is shown for waves and currents at the closet position to the tide gauge. On the bottom-right side the forecasted surface currents time-series plot at that point is superimposed.

Forecasts Maps module
In this module the prediction information derived from numerical models is provided using animated maps. These maps have a control menu that allows users to move forward, rewind, stop, start or pause the animation. Maps are updated when a new forecast cycle is available (Figure 21).
Figure 21. Snapshot of the Forecast map module for Taranto (Coast and Port view) taken in December 2023. Above, forecasted surface currents at the Taranto harbour derived from a numerical model; the coloured areas denote the hourly-averaged surface current at the computational domain. Below, Significant wave height at Taranto harbour derived from numerical model.

Optimisation and users’ feedback

After the launch of the OSPAC tool the Taranto Port Authority was invited to use it and give feedback. During this period the Port Authority team used the tool and analysed the potentiality for specific applications and in general they were well satisfied with the OSPAC tool, considering OSPAC very useful for their activities. In particular they analysed both the real time data and the forecast modules.

The sea level data visualization is clear and is very useful the capacity to analyse the temporal series. The only issue is the necessity to improve the values with the right benchmark level, and the Taranto Port Authority will help in finding information useful to the target.
Regarding the forecast, both maps and points are very useful. The maps could be improved in the visualization of the waves, while for the other variables are very clear, it could be useful to integrate a scale bar. The points are the most useful module in the OSPAC tool: they allow to visualize the temporal series and the forecast in the following days, then with the application of the thresholds can give important information in order to operate on various activities in the harbour environment. It is possible to apply lower and higher thresholds both on sea level, waves and temperature on different points on the map. The Taranto Port Authority suggest integrating the capacity to add new points in the future. The direct visualization of the levels through the interface is very useful, as through the colour variation it is possible to create a kind of early warning system. It is also possible to insert email addresses to send alert communication if the thresholds set on the variables of interest are exceeded.

The Taranto colleagues think that this application can be used for planning harbour activities such as new infrastructures realization, dredging activities, maritime transport and navigation within the port basin.

They are using the OSPAC tool and are very satisfied. They believe that the tool provides support for a wide range of activities, for this reason they will involve other users who can assess the ability of the tool to provide useful data for different objectives. They will share the tool with the Ship Owners for transport safety but also with the mussel farming owners and managers who have many problems with temperature changes within the basins, so as to improve and optimize farming management.

Conclusions

The EuroSea demonstrator OSPAC (Oceanographic Services for Ports and Cities) has been successfully developed and implemented in operational mode at two European pilot sites: Barcelona (Spain) and Taranto (Italy). The work, developed in Task 5.2 of EuroSea project, required the collaborative effort of institutions in Spain, the UK and Italy, along with the involvement and active participation of local stakeholders and end-users in the ports and cities of Barcelona and Taranto.

Innovative equipment and advanced high-resolution modelling systems have been deployed/setup and validated and are now providing real time data and forecasts to OSPAC software integration package, thanks to the operational implementation at EPPE IT infrastructure. This includes the use of the new GNSS-IR technique, as a revolutionary solution for significant wave height and sea level measurements along the coast, and generation of forecasts based on wave-current coupled models for a better representation of coastal and local processes.

OSPAC current services can be summarized as: i) real time info on sea level, waves, atmospheric pressure and other in situ variables depending on the sensors available at each site (e.g. including currents, sea and air temperature, wind, etc); ii) forecast of waves, sea level, currents, water temperature and salinity, provided as 2-D maps and timeseries at selected grid points; iii) customized alerts based on user defined thresholds for real time observations and forecasts, of the variables mentioned above; and iv) special tools for tracking pollution, man over board or floating debris. The software can be easily configurated to include additional variables and information depending on the characteristics of operational models and equipment.

Local stakeholders and end users in the ports and cities of Barcelona and Taranto have had the opportunity to test this new tool developed in the framework of EuroSea, and feedback has been provided about advantages, disadvantages and potential future improvements.
The main outcomes from the OSPAC users’ survey at Barcelona pilot site can be summarised as:

- OSPAC is used by different end-user groups.
- OSPAC is found as a very useful tool for many users (they qualified the service as 4/5 out of 5).
- There is a higher demand for on-line training and tutorials, rather than for on-site training.
- There is a high demand for new modules on water quality and coastal flooding.
- The user registration and interface are considered as appropriate and customisable enough.
- The near-real-time and the forecast points & maps are the most used modules in OSPAC. Waves, sea level and atmospheric variables are the most relevant variables.
- Regarding monitoring and near-real-time data, some users have proposed air & water quality indicators, plus coastal run-off discharges.
- Most users are subscribed to wind and wave alerts. However, most of them rely on pre-defined alerts. Some users found setting-up alerts as difficult.
- The overall easiness of all modules (except floating debris) is close to 4/5 out of 5.
- The oil-spill is easy to use, but the results can be complicated to interpret and evaluate.
- There is no clear consensus about the floating debris. It is highly needed to update & improve the existing documentation.

The main outcomes from users from the Taranto Port Authority can be summarised as:

- OSPAC is used mainly for the forecasts.
- The forecasts points are the most used modules in OSPAC. Waves and sea level are the most relevant variables.
- The most useful module is the alert to be applied on the forecast points.
- OSPAC will be a very useful tool for different end-user groups.

In summary, the first demonstration period of OSPAC tool during the last months of the project has been successfully shared with our local stakeholders, thanks to the operational efficient implementation of models, in situ sensors and the OSPAC software. End-users seem satisfied with the actual implementation and foresee the potential support they could gain in the future.

Finally, OSPAC highlights the advantages of efforts to integrate in situ observations and forecasts for developing advanced tools providing relevant information and practical services, tailored to decision makers and/or general public interests. In addition, it showcases the benefit of linking the development of scientific products and innovative sensors with practical applications. The new tool has the potential to be applied at other sites in the world. In the frame of EuroSea, a pre-operational first configuration of OSPAC for Buenaventura (Colombia), is already in place, despite several unforeseen delays related to the COVID-19 pandemic, the need to change the location of the non-European site in 2022 (originally planned to be Alexandria), and the delay of equipment installation due to several unexpected events. OSPAC has already been configurated by EPPE in preoperational mode to display real-time sea level data from an existing tide gauge, and the tiles maps from Buenaventura modelling system developed by LIM/UPC. As an example of the on-going work regarding this third pilot site, Figures 22 and 23 show snapshots for the real time data and the sea surface temperature forecasts for Buenaventura coastal view.
Figure 22. Snapshot of the Real-time module taken in 22 December 2023 for Buenaventura. The monitoring floating window for the Buenaventura existing tide gauge is shown. On the bottom-left sea the level time-series plot was superimposed. Please note that sea level values are in safe level (green). Also note also that each station icon shows all its available parameters (only sea level in this case).

Figure 23. Snapshot of the Forecast map module for Buenaventura Coast view taken in December 2023. Forecasted sea surface temperature derived from a numerical model; the coloured areas denote the hourly-averaged sea surface temperature at the computational domain.

The operational implementation of the modelling component in EPPE, including integration of the new equipment when installed, will be completed in the following months in collaboration with local stakeholders from DIMAR (Colombia), the NOC and LIM/UPC.
References


