D5.3.2 “Pilot action final reports”

STRATEGIC PROJECT

FRAMESPORT

Framework initiative fostering the sustainable development of Adriatic small ports

Project Full Title	Framework initiative fostering the sustainable development of Adriatic small ports
Project Acronym	FRAMESPORT
Project ID	10253074
Project Website	https://www.italy-croatia.eu/web/framesport
Priority Axis	4 – Maritime Transport
Specific Objective	4.1
Work Package	5
Work Package title	INNOVATIVE TOOLS AND SERVICES BOOSTING STRATEGIC DEVELOPMENT OF SMALL PORTS
Deliverable Nr.	5.3.3
Status	Final
Partner in charge	PP13 - CMCC
Dissemination Level	Partnership

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1. Introduction

The pilot action "**3.3 - Harbour and navigational safety: development of a meteo-oceanographic forecasting system for sea shipping activities**" is focused on the macro-theme A “ICT applications and services development”.

In fact, small ports of Apulia Region, as other small ports worldwide, may suffer from the intense global competition that forces changes in the way all players in the international logistics chain, including ports, conduct business in the future. More and more innovative systems and new technologies are requested to support port infrastructure and increase specialisation. Additionally, environmental, safety, and security concerns are key aspects of ports management policy. In this way, the expected result of the pilot action "3.3 - Harbour and navigational safety: development of a meteo-oceanographic forecasting system for sea shipping activities" is the provision to the small ports of a set of innovative services for harbour and navigation safety, that will increase their competitiveness and tourism attractiveness.

2. Pilot action description

2.1.Aim of pilot action

The aim of the pilot action “**3.3 - Harbour and navigational safety: development of a meteo-oceanographic forecasting system for sea shipping activities**” is to improve safety conditions of harbours and navigation. It acts on the macro theme “ICT applications and services development”. The purpose is to develop a meteo-oceanographic forecasting system based on atmospheric forecasts and hydrodynamic forecasts and VISIR ship routing for sea shipping activities.

2.2.Start date - End date

October 2021 – March 2023

2.3.Achieved results

2.3.1

The modelling activities of the meteo-oceanographic forecasting for the pilot ports are finalized and the model is running operatively, as reported for port of Otranto, Trani and Vieste in Figure 1, Figure2 and Figure 3 respectively. For all cases the main variables provided by the systems are currents, salinity, temperature and waves. The models are available at https://otranto.cmcc.it/ for the port of Otranto and at https://soap.oceanity.eu/ for the ports of Vieste and Trani.

2.3.2

The ship routing system is based on a python software called VISIR (https://www.cmcc.it/models/visir). It is a numerical model for computing optimal maritime tracks, based on a graph-search method and uses dynamic meteo-oceanographic fields for computing optimal maritime tracks. The vessel's sea-keeping and emissions are based on mathematical models that take into account ocean currents, surface gravity waves and wind. The forecasts are used to identify the tracks that minimise distance, navigation time and CO2 emissions. The service is available at https://www.frame-visir.eu/. Two examples of the information provided are presented in Figure 4 (sailboat) and Figure 5 (motorboat).

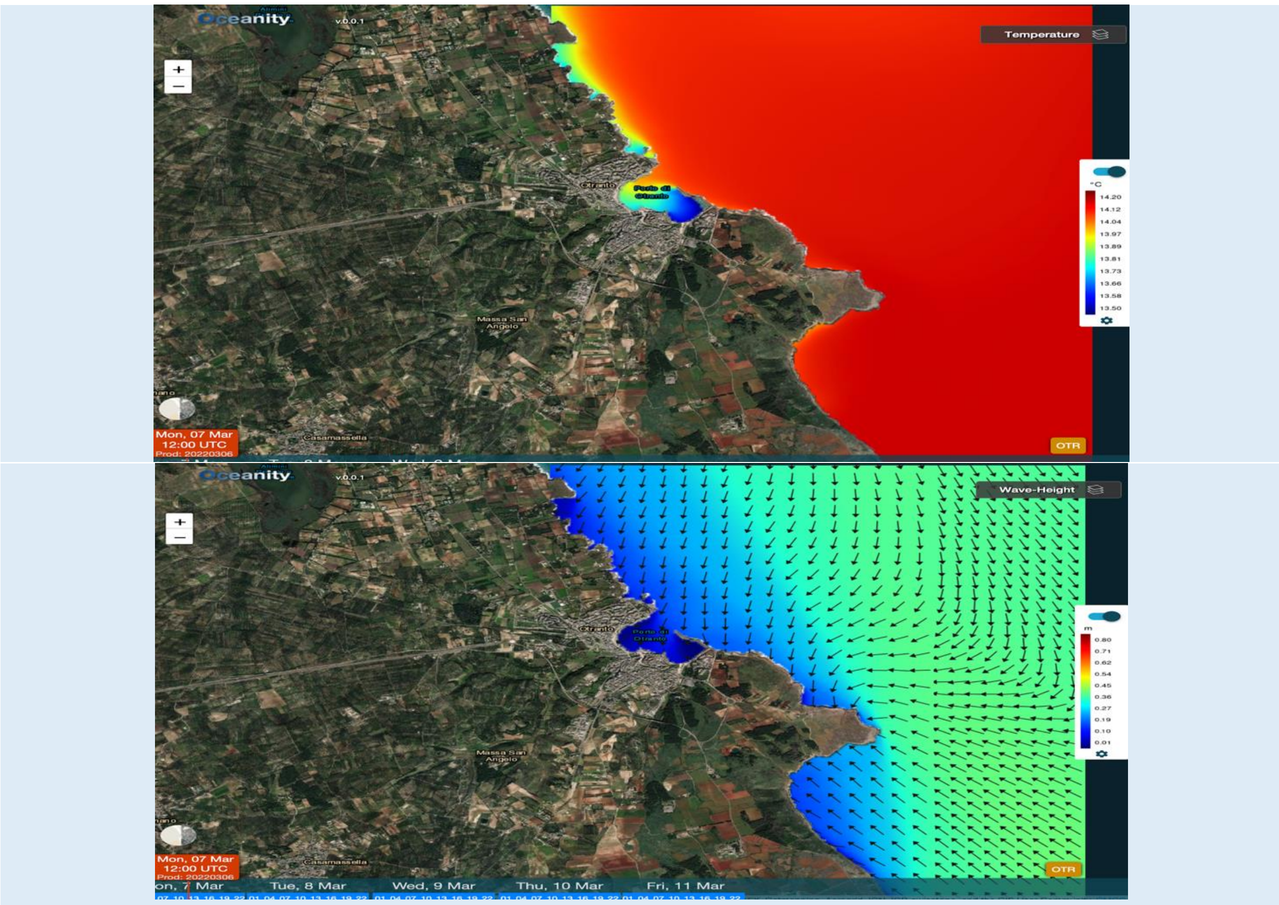
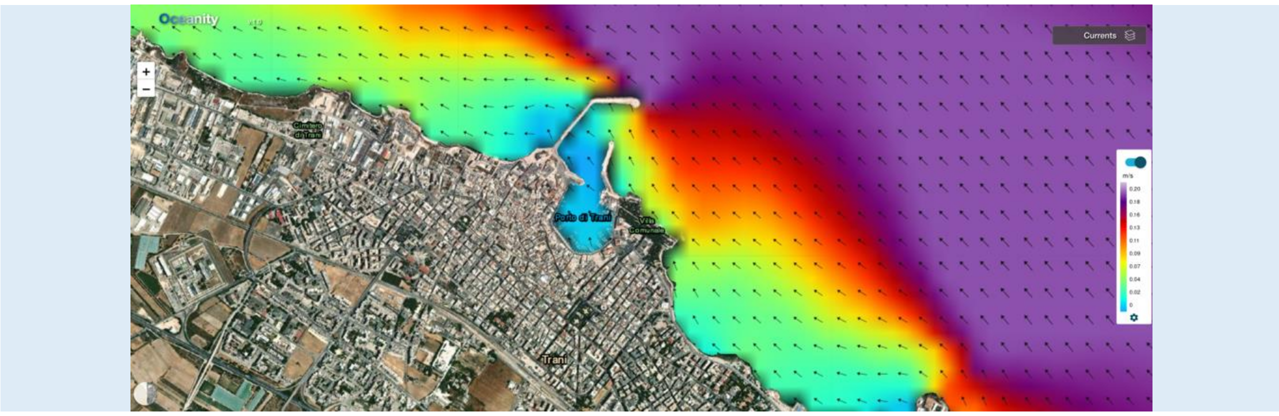


Figure 1 – Modelling results (currents, temperature and waves) for the Otranto port



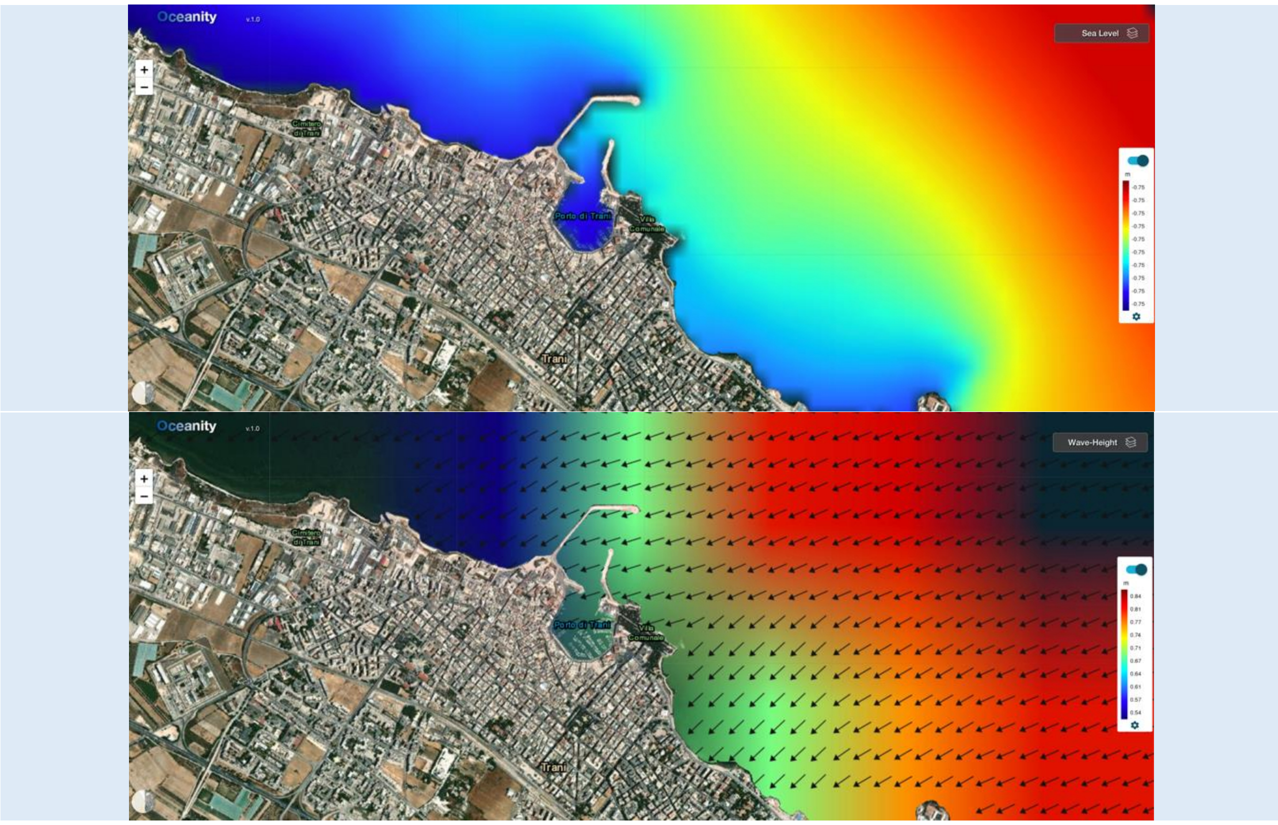
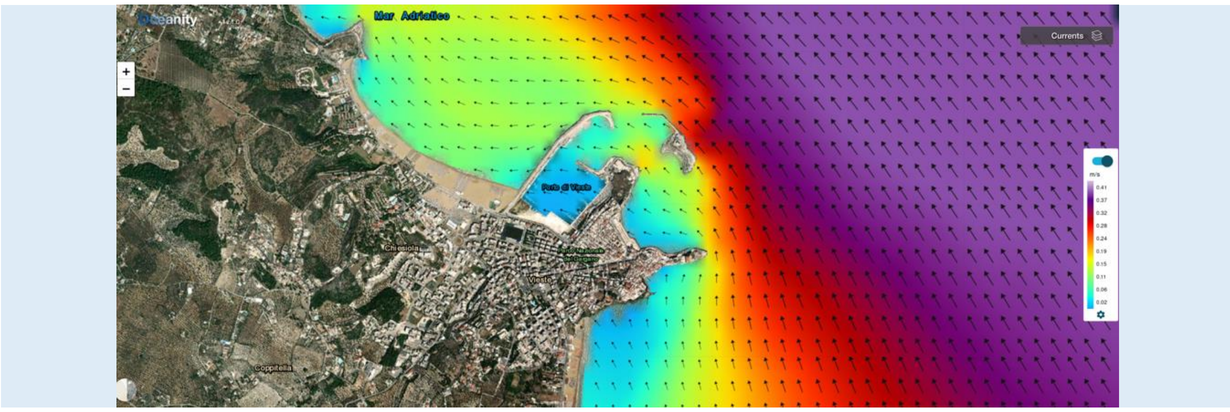


Figure 2 – Modelling results (currents, sea level and waves) for the Trani port



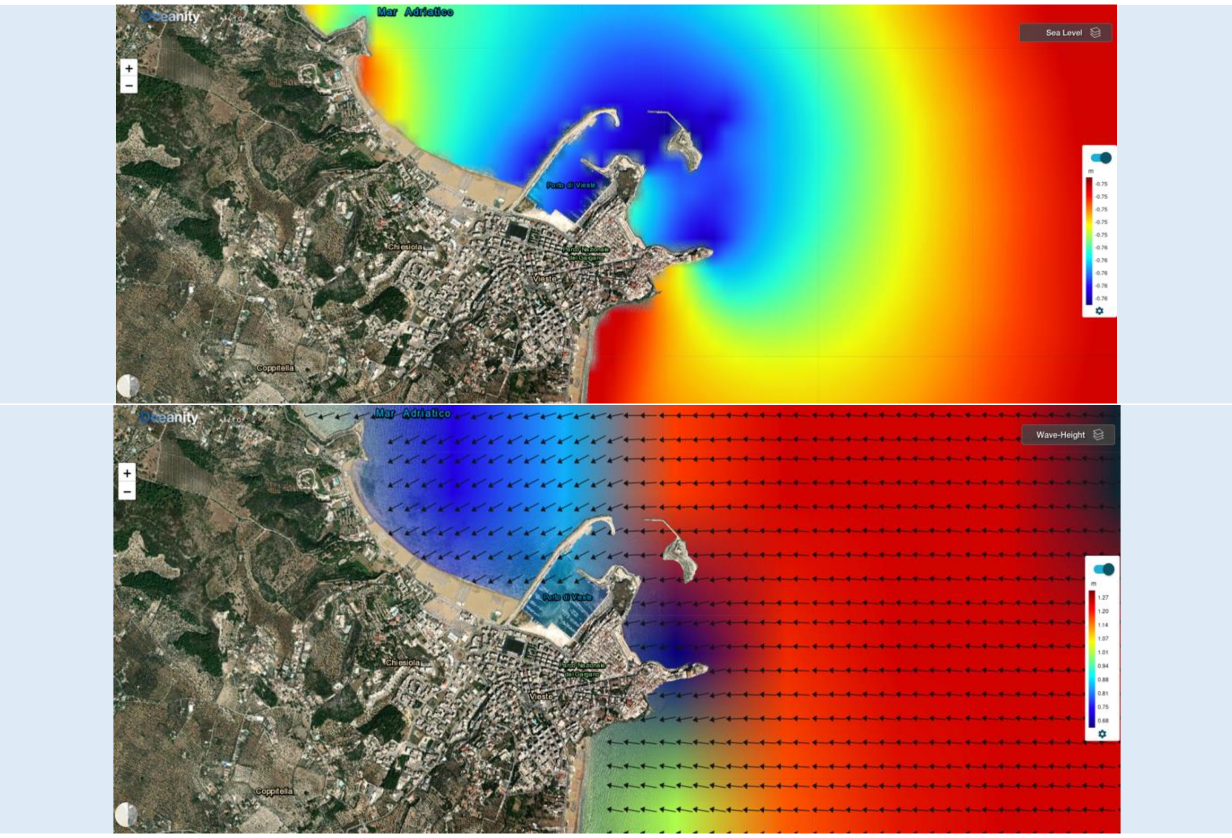


Figure 3 - Modelling results (currents, sea level and waves) for the Vieste port

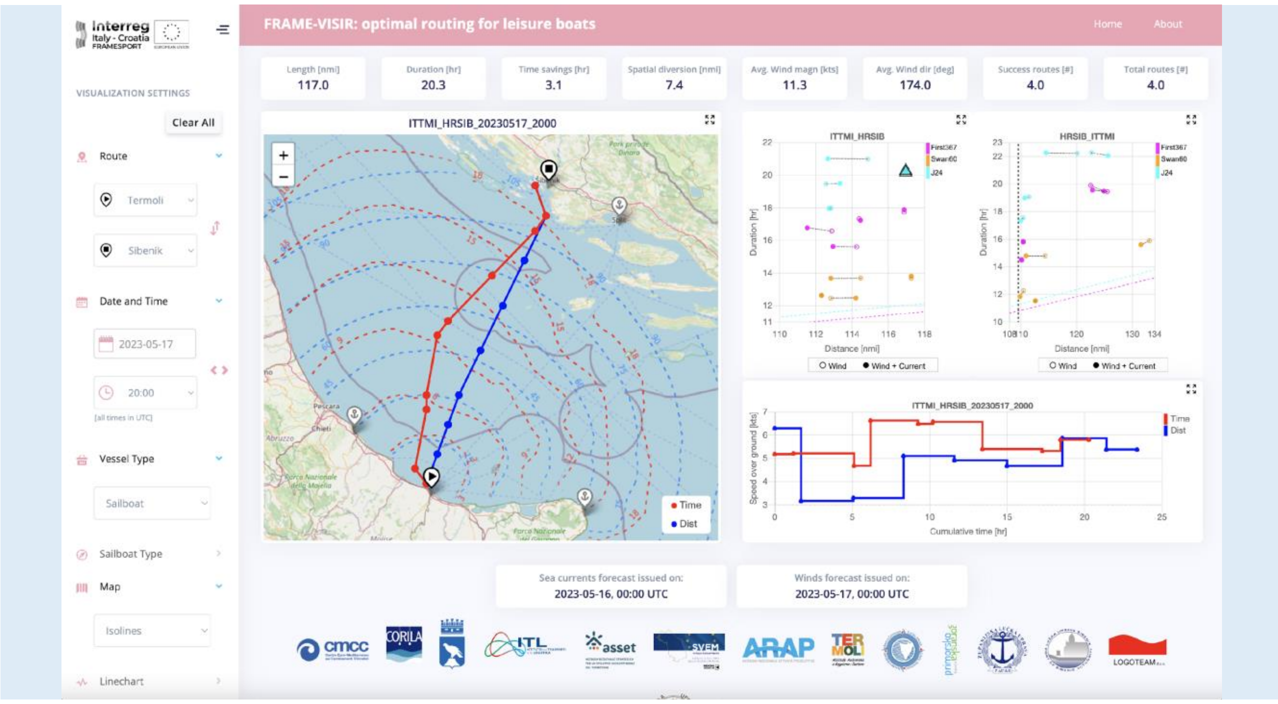


Figure 4 – VISIR least-time route from Termoli to Sibenik on 17-05-2023 at 20:00 for a J24 sailboat

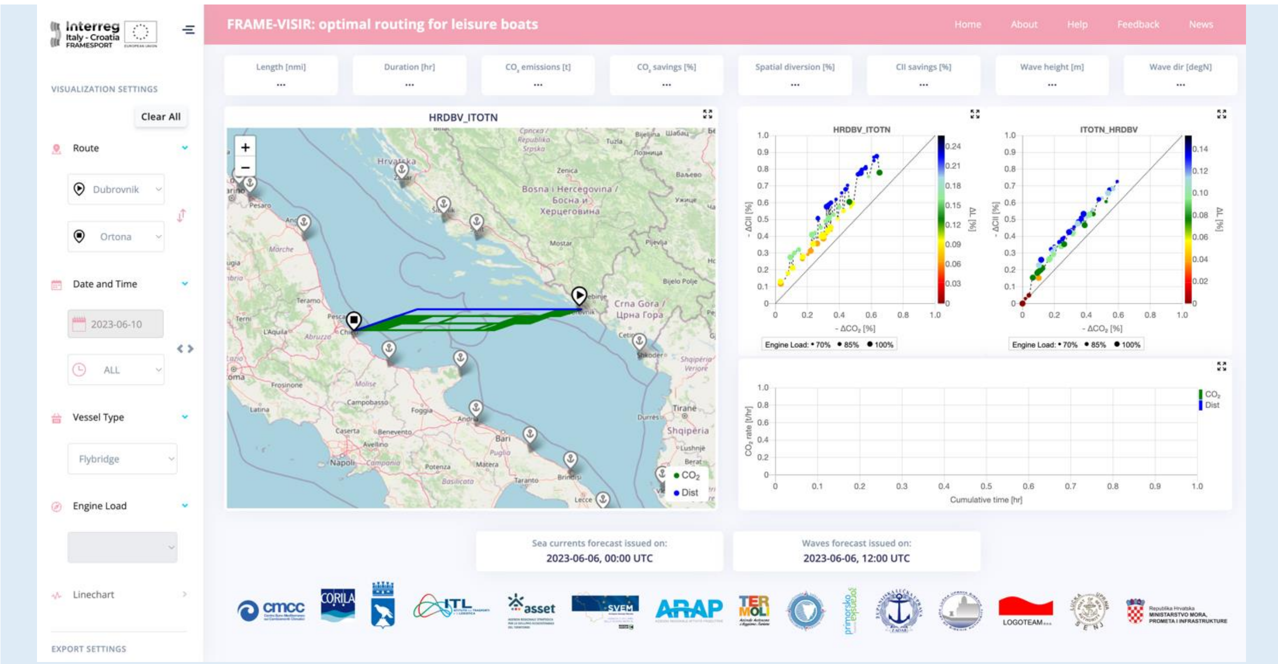


Figure 5 – VISIR least-CO2 routes from Dubrovnik to Ortina between 10-06-2023 amd 14-06-2023 for Flybridge motorboat

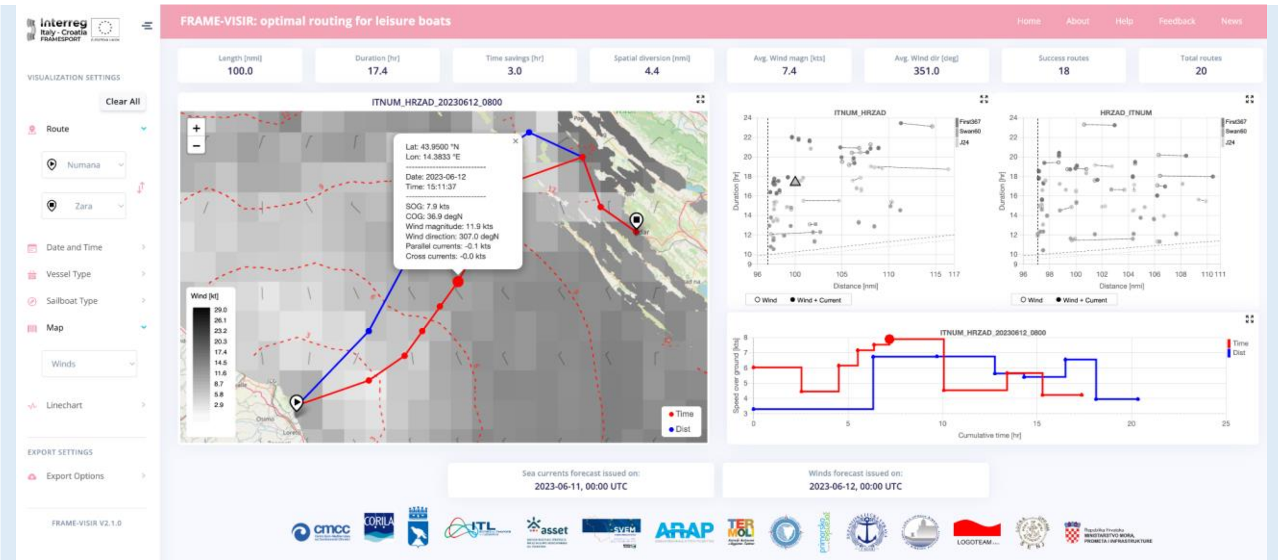


Figure 6 – Wind condition along VISIR least-time route from Numana to Zadar on 12-06-2023 at 08:00 for a First 36.7 sailboat

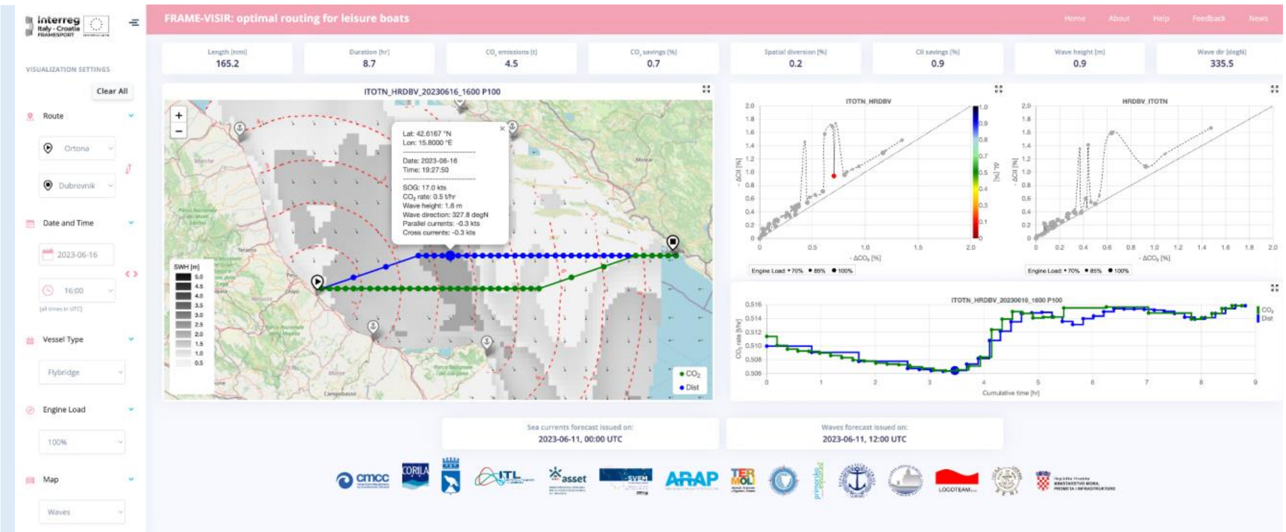


Figure 7 – Wave condition along VISIR least-CO2 route from Ortona to Dubrovnik on 16-06-2023 at 16:00 for Flybridge motorboat

2.4. Description of activities carried out

2.4.1 Coastal meteo-ocean modelling

Numerical forecasting models have been developed and kept operational, in order to provide information on the hydrodynamic-thermodynamic fields, from the open sea to the scale of ports of Apulia. The OPA division of the CMCC, starting from the forecasting system on a regional scale with a space of about 4km, called MFS (Mediterranean Forecasting System resolved, kept operational and with distribution of products from within the European Copernicus-CMEMS https://marine.copernicus.eu/) worked on the development on a sub-regional and coastal scale of a very high spatial resolution modelling system in MFS. Specifically, the CMCC-OPA has enhanced the hydrodynamic forecasting system, from the sub-regional scale to the Apulian coastal scale called SANIFS (Southern Adriatic Northern Ionian Coast Forecasting System, http://sanifs.cmcc.it/) and has developed the new systems SOAP and Otranto. The models are available at https://otranto.cmcc.it/ for the port of Otranto and at https://soap.oceanity.eu/ for the ports of Vieste and Trani. The prediction system is based on the deterministic finite element numerical model with an unstructured grid SHYFEM (Shallow water HYdrodynamics Finite Element Model). The SANIFS, SOAP and Otranto domains includes the South Adriatic and North Ionian seas and the relevant ports with a horizontal grid with variable resolution from 3000m in the open sea to 100m along the eastern Italian coasts (Puglia, Basilicata, and Calabria) and even at higher resolutions (up to 30 m) int the relevant ports. The vertical resolution has an uneven grid characterised by 99 levels. The model is initialised and nested in the MFS prediction system, forced to the boundary conditions by MFS and OTPS (OSU Tidal Prediction Software, code capable of providing the tide signal) and forced to the surface by the ECMWF fields. The complete set up of the model will be implemented in terms of: (i) initial conditions: temperature, salinity, sea level, currents (from MFS); (ii) surface boundary conditions: dew point at 2m, air temperature at 2m, wind speed at 10m, atmospheric pressure, cloud cover and total precipitation (from ECMWF); (iii) open boundary conditions: currents, temperature and salinity (from MFS), sea level (from MFS and OTPS); (iv) climatology of river flows. Meteorological forecasts are available on the website https://ecmwf.oceanity.eu The website provides wind, atm pressure at sea level, cloud cover, precipitation, and air temperature for the areas of interest.

2.4.2 Optimal routing

The development of the VISIR-2 model has been extended from the previous version, as described in the jmse_2021 publication, to include the ability to simulate and analyse sailboat behaviour. This enhancement required external expertise from the University of Geneva (UNIGE) to contribute to the development of several units within the model, including three sailboats and one motorboat.

The collaboration with UNIGE allows for the incorporation of specialised knowledge in sailboat dynamics and performance.

In addition, efforts have been made to integrate seekeeping data provided by UNIGE into the VISIR-2 model. This includes the development of an interface that enables seamless integration and use of the seekeeping data within the model. By incorporating this data, the VISIR-2 model can more accurately account for the effects of sea conditions on sailboat behaviour and performance.

To make the VISIR-2 model operational, it has been deployed on a high performance computing (HPC) environment. This ensures that the model can handle the computational demands required for accurate and efficient simulations. Additionally, a dedicated web application (https://www.frame-visir.eu/) has been created to provide access to the results generated by the VISIR-2 model on the high-performance computing (HPC) platform. The webapp serves as a user-friendly interface that allows stakeholders to access and interpret the simulation results so that they can make informed decisions based on the results of the model.

The integration of the different components is a crucial step in the development process. It involves combining the different units and functionalities of the VISIR-2 model, as well as integrating the interface for seekeeping data and the webapp.

Testing plays a crucial role in ensuring the accuracy, reliability, and usability of the VISIR-2 model. Rigorous testing is conducted to validate the performance of the model and to identify and resolve any potential problems or discrepancies. In addition, comprehensive documentation is being prepared to provide clear instructions, guidelines, and insights into the VISIR-2 model, its components, and its use. This documentation enables users and stakeholders to understand and use the model effectively.

By following this systematic development approach, including external expertise, data integration, deployment, component integration, testing, and documentation, the VISIR-2 model is being enhanced to accurately simulate and analyse the behaviour and performance in an operational environment.

2.5.Actors/Beneficiaries/Stakeholders involvement

The implementation of the pilot action took place in different stages through the direct involvement of stakeholder such municipalities and coastal authorities. The three main ports of reference for the pilot are: Trani, Vieste and Otranto. However, other ports of the Apulia Region were invited to meetings and discussions.
Stakeholders were engaged in an online meeting on June 19, 2023, to introduce and collectively discuss the services to gather input, and stakeholders were able to learn about the features and

benefits of using the tool. In the same meeting also FRAMESPORT platform was presented, and feedback received.

2.6. Use of thematic equipment

No thematic equipment is needed for the development of the pilot. Computing facilities for the development of the service are already in house at CMCC, which has the full capability to develop the service. The only exception is an external expertise provided by UNIGE regarding vessel models.

2.7. Problems encountered

The COVID-19 pandemic has significantly impacted the ability to meet stakeholders and engage with small ports, making it challenging to reach end users. This has resulted in a shift towards remote communications and virtual meetings as the primary means of engagement.

Outreach to small ports, which are crucial for reaching end users, has been challenging.

The lack of in-person visits and interactions further exacerbates the difficulty in building relationships and understanding the unique needs and challenges faced by small ports and their respective end users.

3. Monitoring of activities

Indicator	Unit of measure	Target value	Achieved value	Time horizon for monitoring (July '21/ Feb. '22/ July '22)
Indicator 1 *Meetings with stakeholders*	*Number of participants*	*10-15*	*10*	*February/March 2022*
Indicator 2 *Development of meteo-oceanographic models and ship routing*	*Number models*	*4*	*4*	*July 2022*
Indicator 3 *Events*	*Number of events*	*1*	*1*	*March 2023*

4. Pilot action outcomes

We developed hyper-resolution (30m) ocean models, providing seamless circulation and wave modelling from the open sea to small harbours of the Adriatic Apulia areas.

A platform for optimal routing of sailboats in the Adriatic sea was developed: 5280 least-time routes among 21 small harbours and 3 vessels (a First-367, a J24, a Swan60FD) are computed daily, considering both the freshest ECMWF wind- and Copernicus sea current forecasts. Both cross-border and cabotage routes are provided. The effect of sea currents on both route duration and length is highlighted.

5. Conclusion

We developed a high resolution meteo-oceanographic model that covers the Adriatic Sea and provides information about currents, wave height and period, sea level, temperature and salinity up to 4 days in the future.

VISIR ship routing service allows it to investigate routes all over the Adriatic Sea. It is aimed at leisure boats, both sailboats and motorboats. It provides information about the meteorological and sea-state condition as well as the most relevant metrics, such as sailing distance, navigation time and CO_2 emissions. This tool may help users avoid extreme conditions by sailing for another destination or at different times.