User-driven applications and tools for Climate-Informed Maritime Spatial Planning and integrated seascape management, towards a resilient & inclusive Blue Economy

D4.1 – Preliminary Report on design and implementation of each platform component

WP4 – OCEANIDS user-driven tools & applications

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1 Executive Summary

This Work Package, WP4, entitled “OCEANIDS user-driven tools & applications” led by Resilience Guard (RG), will create a comprehensive platform aiming to provide decision-makers with the necessary tools and information to facilitate better integration of urban and maritime spatial planning with climate adaptation planning (CAP). It comprises three distinct, yet interconnected, parts: (a) The Climate Change-Hazard and Risk-Decision-Support System (CC-HR-DSS) (Task 4.1 “Climate Change (CC) risk and hazard risk assessment platform for regional stakeholders” led by RG); (b) the integrated Earth Observation (EO) and spatial data platform (EO-P) (Task 4.2 “Integrated EO and spatial data platform – A single access window for spatially-enabled data” led by OHB); (c) the Oceanids Decision Support Platform (O-DSP) (Task 4.3 “The OCEANIDS Decision Support Platform (O-DSP): A Decision Support Platform for CI-MSP in Coastal regions” led by Geosystems Hellas [GSH]).

The O-DSP embedded within this platform plays a crucial role in enabling decision-makers to make informed choices regarding climate adaptation strategies and spatial planning. By leveraging data from the integrated EO and spatial data platform, as well as climate risk assessments from the CC-HR-DSS, valuable insights will be provided into the potential impacts of climate change (CC) on coastal regions.

Through the integration of urban and maritime spatial planning with CAP, decision-makers can develop more resilient strategies that take into account the dynamic nature of coastal environments and the associated risks. This holistic approach fosters better coordination and cooperation among various stakeholders involved in coastal management, ultimately leading to more effective decision-making processes and enhanced resilience in the face of climate change.

This document is intended to give a detailed overview of the deliverable “D4.1 Preliminary Report on design and implementation of each platform component modules” led by RG. This deliverable is in line with Milestone 3 (MS3), "Start of design and implementation of each platform component". The deliverable represents a short report containing a brief description of each platform component, their interconnectivity, schematic representations, mock-ups and workflows, as well as some expected results.

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Table 1: List of Acronyms/Abbreviations

Acronym Abbreviation	Explanation
AI	Artificial Intelligence
API	Application Programming Interface
ARIO	Adaptive Regional Input-Output
BC	Business Continuity
CAP	Climate Adaptation Planning
CC	Climate Change
CC-HR-DSS	Climate Change-Hazard and Risk-Decision-Support System
CI	Critical Infrastructure
DSS	Decision Support System
EO	Earth Observation
EO-P	Earth Observation Platform
FR	Functional Requirement
GA	Grant Agreement
GSH	Geosystems Hellas
GUI	Graphical User Interface
IM	Intensity Measure
JSON	JavaScript Object Notation
LSTM	LongShort-Term Memory
MAF	Mean Annual Frequency
MS	Milestone
NFR	Non-Functional Requirement
ODC	OCEANIDS Data Cubes
O-DSP	OCEANIDS Decision Support Platform
O-DSS	OCEANIDS Decision Support System
OHB	OHB Digital Services
RG	Resilience Guard GmbH
SaaS	Software-as-a-Service
SES	Stochastic Event Sets
UML	Unified Modeling Language
UR	User Requirement
VDT	Vendor Dependence Table
WCS	Web Coverage Service
WFS	Web Feature Service
WMS	Web Map Service
WMTS	Web Map Tile Service
WP	Work Package

2 Introduction

Coastal regions are often characterised by strategic socio-economic assets (i.e., linked to tourism, fisheries, harbours, and shipyards). This makes coasts particularly sensitive to CC impacts, which primarily expose infrastructure and local population. Human activities are also responsible for additional pressures on coastal ecosystems, often generating more immediate impacts than those expected from CC by aggravating existing vulnerabilities. The need for CC adaptation in coastal areas is evident and is predicted to become progressively more significant over time due to the grim long-term forecasts of climate variables. Coastal area adaptation strategies should be iterative and dynamic, due to the evolving dynamics of coastal territorial systems. Furthermore, CC adaptation measures should consider local ecology, economy, society, politics, and technology. Therefore, the definition of CAP must consider specific local socio-economic contexts. The OCEANIDS project aims to develop the tools and applications that enable a more resilient and inclusive society in coastal regions via better-informed and integrated seascape management. The central concept is to collect, harmonize, and curate existing climate data services, making data accessible, reusable, and interoperable for developing local adaptation strategies.

The role of WP4 "OCEANIDS user-driven tools & applications development" is to develop a comprehensive risk and hazard assessment platform that integrates CC hazard data with risk assessment, utilizing EO and spatial data. This platform is designed to function as an integral component of a Multi-Level Governance Platform tailored for coastal regions. It will serve as a Decision Support System (DSS) to enhance the integration of Urban and Maritime Spatial Planning with CAP, ultimately facilitating more informed and effective decision-making.

WP4 consists of the following tasks:

- **Task 4.1: Climate Change (CC) risk and hazard risk assessment platform for regional stakeholders (Leader: RG; Contributors: ICCS) [M9-M28]**
- Task 4.2: Integrated EO and spatial data platform – A single access window for spatially-enabled data (Leader: OHB; Contributors: ICCS, CDP) [M9-M28]
- Task 4.3: The OCEANIDS Decision Support Platform (O-DSP): A Decision Support Platform for CI-MSP in Coastal regions (Leader: GSH; Contributors: ICCS, CDP, USE, WTOC, RG) [M13-M31]

This document is the report presenting the Design and Implementation of Each Platform Component developed under WP4. It is in fact, one of the outputs of **Task 4.1**, based on the GA (Grant Agreement) and represents the first deliverable of WP4. Moreover, this report is in line with the already submitted deliverable **D1.4** "Report on technical requirements for the core technology modules" where several initial requirements are documented. The following sub-sections present the scope and objectives, as well as the structure of the document.

2.1 Scope and Objective of the deliverable

The main objective of deliverable D4.1 “Preliminary Report on Design and Implementation of each Platform Component” is to provide an overview of the technological solutions developed under WP4 in the early stages of the OCEANIDS project. As WP4 starts on M9 and extends to M31, it was crucial to initiate the discussions and activities agreed upon by the technological partners to avoid any confusion as the project moves forward. This preliminary report is a result of meetings and discussions among the WP4 Task leaders, aiming to finalise, as detailed as possible, the interconnection between the WP4 components, not only internally in this WP but also externally with the other WPs.

2.2 Project Workflow - Connection with other WPs

In **Figure 1**, the OCEANIDS overall Project Workflow and the connections among the WPs are depicted. WP1 serving as the main WP of the overall project management, plays a pivotal role in managing all activities conducted under the other WPs. WP4 as one of the main Technical WPs, is connected directly to WP3 which acts as the main data-providing task offering the main repository of the data acquired within the OCEANIDS project. WP2 serves as the primary source and the baseline analysis of needs and problems through extensive stakeholder engagement. The collected information is then fed into WP3 and WP4, where all the technological modules and platforms are developed, aiming to provide the CC-HR-DSS, the integrated EO and spatial data platform as well as, the final DSS, in order to facilitate decision makers. All the developed solutions are fed into WP5, which is the WP responsible for the demonstration and validation of the developed solutions.

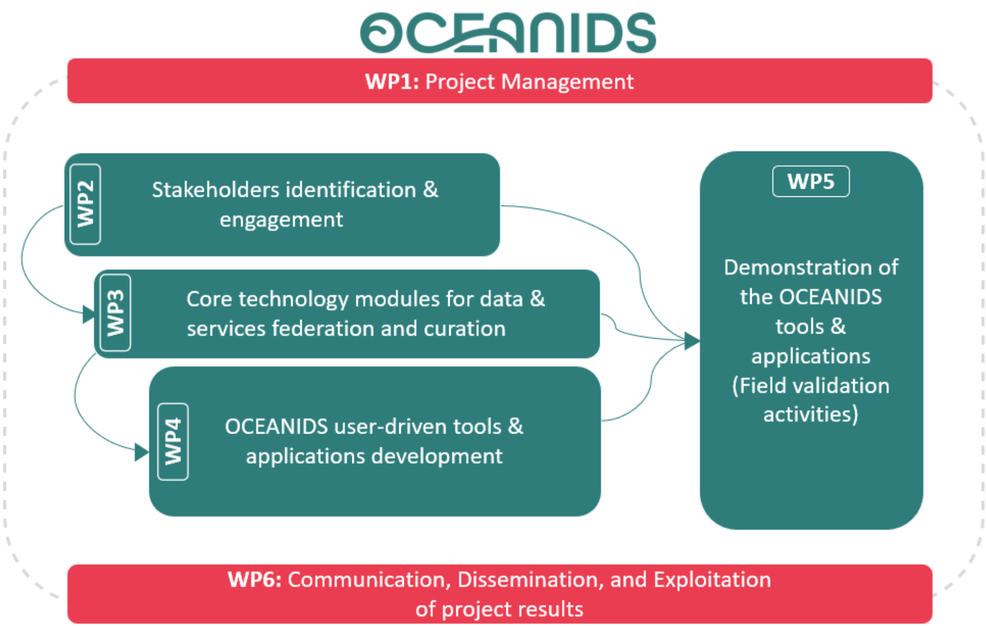


Figure 1: OCEANID’S WP structure workflow

2.3 Structure of the Deliverable

This document consists of the following chapters:

- **Chapter 1** includes the Executive summary
- **Chapter 2** presents the introduction, main scope and structure of the deliverable
- **Chapter 3** introduces the components of WP4
- **Chapter 4** presents the Climate Change (CC) risk and hazard risk assessment platform (CC-HR-DSS)
- **Chapter 5** presents the Integrated EO and spatial data platform (EO-P)
- **Chapter 6** presents the OCEANIDS Decision Support Platform (O-DSP)
- **Chapter 7** presents the interconnection between the three components and the design of the Platform (mock-ups)
- **Chapter 8** summarises the conclusions of the deliverable
- **Chapter 9** includes the References of the deliverable

3 WP4 Components

In this section, the interconnection among the WP4 components will be outlined within the context of this preliminary report. The WP4 components are these identified in the 3 Tasks of WP4; the **CC-HR-DSS, EO-P** and **O-DSP** serve as the final outputs of the OCEANIDS project. The responsible partners will be RG, OHB and GSH, respectively. More specifically, the activities that will be implemented are described as follows:

RG will be responsible for the development of the **CC-HR-DSS** within the context of WP4, in Task 4.1. This aims to develop a system enabling regional stakeholders to understand the effect of various planning options in response to CC scenarios, particularly focusing on quantifying the impact in coastal areas. The task will result in the design and implementation of a risk assessment platform serving as a DSS for multi-hazard planning and response. The outcomes will inform further platform development and contribute to decision-making processes regarding CC impacts.

OHB within the context of WP4 and Task 4.2, will be responsible for the creation and deployment strategy of the integrated EO and spatial platform, **EO-P,** following the definitions and specifications for new EO data services from Task 3.2. The platform will provide comprehensive access to spatially enabled data for decision-making support via a single-access user-oriented graphical user interface (GUI), and further for expert usage, via APIs following OGC standards.
Related responsibilities encompass the following aspects:

- Implementation of the platform into a cloud-based solution
- Access to EO and spatial data (e.g., time series, historical data, near real-time data) via a user-friendly GUI
- Technical access to the same data via APIs for expert users and developers
- Cloud Framework independent integration of the solution, while ensuring scalability
- Assure periodic and on-demand workflows via carefully chosen platform components, incorporating high-security standards through established authentication and authorization principles
- Provision of processed EO Data assessing CC and environmental impact on coastal regions. This will encompass the integration of the EO processing component and the respective New EO data services
- Developing an elaborate plan for the platform's architecture and the User Interface design

GSH will be responsible for the design and implementation of the **O-DSP** running in the backend, in direct contact with the CC-HR-DSS, and within the context of WP4, in Task 4.3. This includes the integration of Climate Data and the integration with the Climate Data Store[1], following a methodological approach, ensuring that each component interacts with the inputs from the other OCEANIDS platforms, in collaboration with Task 3.5 and the CREODIAS Platform. GSH aims to give special attention to the overall design, by incorporating relevant feedback mechanisms, recommendation engines, and decision-support tools. The ultimate objective is to facilitate an optimal decision-making process within the context of OCEANIDS.

The conceptual architecture of WP4's interconnected abovementioned components, including the users' actions and data flows, is illustrated in **Figure 2**. This diagram will be further analysed focusing on each component within the following sections.

[1] https://cds.climate.copernicus.eu/api-how-to

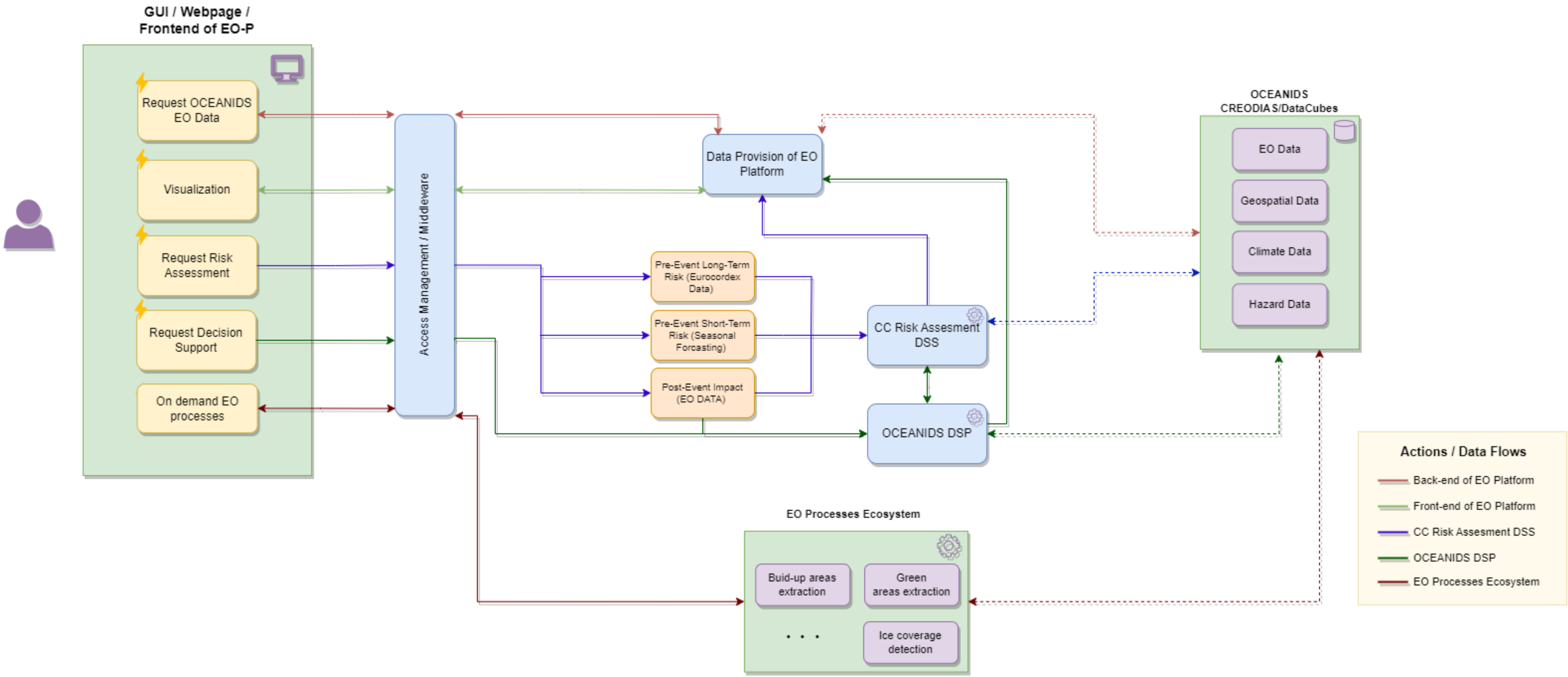


Figure 2: Conceptual architecture of WP4

4 Climate Change hazard and risk assessment DSS (CC-HR-DSS) for regional stakeholder

The first component of WP4, CC-HR-DSS represents a risk assessment platform serving as a DSS for multi-hazard planning and response. The outcomes will be used by the O-DSP and contribute to decision-making processes regarding CC impacts.
CC-HR-DSS will accommodate different types of datasets (e.g. hazard, assets, fragilities) and risk analysis algorithms. The platform will be interconnected with the frontend of the EO-P and O-DSP which will provide suitable user interface elements for scenario and data repository management, analysis workflows setup, intuitive result visualization and reporting.

4.1 OCEANIDS CC-HR-DSS conceptual framework

4.1.1 Direct and indirect losses

The potential impacts of climate extremes are well documented (Leal Filho, 2018; Semenov and Stratonovitch, 2010), encompassing a variety of direct and indirect effects. Direct impacts include damage to buildings, equipment, and inventories, as well as human injuries and fatalities. Economically, the direct costs of such events are typically assessed by insurance companies and involve the repair or replacement of damaged or destroyed assets (Hallegate, 2008). Indirect impacts, on the other hand, include off-site business interruptions, declines in property values, and stock market effects (Kaushalya et al., 2014). Coastal areas, in particular, which often house strategic socioeconomic assets related to tourism, fisheries, harbours, and shipyards, are especially vulnerable to CC impacts that primarily affect infrastructure and local populations. **Table 2** outlines specific assets vulnerable to various climate extremes considered in the OCEANIDS project.

Table 2: Assets vulnerable to various climate extremes

Assets	Possible sources of failure
Cranes	Affected by temperature fluctuations and high winds
Warehouses, Office buildings, Terminal buildings, Wharfs, Piers	Vulnerable to storm surges combined with sea level rise and flooding
Power substations	At risk from storm surge coupled with sea level rise
Storage tanks	Susceptible to storm surge coupled with sea level rise, wind, floods
Containers yards	Impacted by storm surges coupled with sea level rise, floods

Equipment	Sensitive to changes in temperature and humidity
Structures in seismic areas	Threatened by earthquakes

Regarding the indirect effects, a business-based quantitative methodology utilizing the Adaptive Regional Input-Output (ARIO) model of Hallegate (2008) will be used to simulate the socioeconomic effects.

The proposed socioeconomic model:

(a) introduces a simplified business taxonomy for distinct business sectors to represent individual businesses in coastal areas,

(b) defines three performance indices to quantify indirect economic losses due to disruptions in infrastructure, supply, and demand,

(c) employs Vendor Dependence Tables (VDTs) from Business Continuity (BC) to account for vendor disruptions and adaptive tourist/resident consumption behaviour, and (d) considers the effects of event occurrences during high or low seasons.

4.1.2 Strategic Framework

Enhancing community resilience through preparedness and adaptation is a cutting-edge approach to minimizing the direct and indirect costs of CC. This involves developing a strategic framework for bolstering the resilience of critical infrastructure (CI) across three timeframes: **long-term, short-term, and post-event.**

In the long term, there is no definite threat to account for per se. Instead, one employs the probabilistic assessment of hazard through CC modelling to generate numerous potential events of different frequency and magnitude, using available EO products to assess the potential impact on an event-by-event basis. Thus, only statistics of potential impact can be employed to quantify CC risk for the area in question, as performed by catastrophe modellers and the insurance/reinsurance industry. Herein, the focus shifts to transformative mitigation strategies, such as decentralizing and modularizing CI to better withstand unpredictable climates. Government support is crucial throughout, facilitated by technical codes, regulatory policies, innovation funding, and the inclusion of climate risks in public investment.

In short-term risk assessment, no event has taken place yet, but forecasting and early-warning systems indicate a high probability of such an occurrence within the next few hours or days. Since nothing has happened yet, EO cannot assist directly, only indirectly. Specifically, impact assessment models are employed based on already-processed EO data to help assess the extent of the consequences, determine the scale of mobilization needed, alert the stakeholders, and activate respective emergency response teams.

In the post-event phase, an extreme event has already occurred or is presently unfolding. Damages have already materialized and are potentially worsening over time. Thus, resilience focuses on implementing emergency plans (i.e., stop the “bleeding”) and adapting responses to facilitate efficient recovery (i.e., return to normal). Depending on the event type, the use of EO data to assess the extent of damages will be explored to ensure efforts are properly focused and waste is minimized.

Accordingly, the OCEANIDS risk assessment platform will operate in three modes concerning natural hazards: **long-term (pre-event)**, **short-term (pre-event)**, and **post-event**.

Per the preceding discussion, three corresponding different scales of application are implemented. In long-term mode, all potential scenarios are considered, clearly having the widest range of potential outcomes (highest uncertainty); in short-term mode, the forecast data appropriately constrain the scenarios, still leaving some uncertainty due to inherent forecasting variability; in the post-event operation the uncertainty is minimized as we are only considering one scenario, where the event has already occurred, or (at worst) a handful of matching pre-computed scenarios that best correspond to the characteristics of an event that is presently unfolding.

Where more than one scenario is considered, this typically concerns pre-computed virtual scenarios to enable near-real-time assessment. As the respective impact analyses are time-consuming and often require specialized software, they are best performed offline and pre-loaded to the system. This offline execution and storage of millions of results enable (a) rapid response estimates in milliseconds, compared to the hours typically required by models, and (b) the use of machine learning to quickly derive rational response, damage, and impact estimates, even for hazard scenarios beyond those initially predicted.

The framework will be implemented using an open-source code-based in Python, allowing the risk assessment platform to efficiently use pre-computed results to assess the risk of natural hazard events.

4.2 Long-term and Short-term Impact Assessment Tools

The OCEANIDS project aims to develop comprehensive tools for assessing the **long-term and short-term** impacts of seismic and weather-related hazards, incorporating the effects of CC. These tools will provide vital information for planning, mitigation, and response strategies.

The long-term impact assessment tool in OCEANIDS provides annualized consequences for seismic and weather-related hazards by incorporating the effects of CC. In the initial phase, all critical assets are identified, and their performance is assessed in terms of potential damage and losses. This involves modelling the critical assets and subjecting them to a series of analyses using recordings that represent the specific hazards they are vulnerable to. For seismic hazards, assets are analysed using a set of ground motion records that are carefully selected to match the site-specific seismic hazard. This ensures that the analysis accurately reflects the seismic risk specific to each asset's location. For weather-related hazards, assets exposed to factors such as moisture, precipitation, and temperature fluctuations are assessed using site-specific time-series data of relevant weather parameters. This comprehensive approach allows for a detailed assessment of each asset's vulnerability to these conditions.

Based on the analysis results, all potential scenarios for each asset are assessed and integrated with associated consequences such as cost and downtime. This integration provides a complete picture of the potential impacts, enabling a thorough evaluation of each asset's vulnerability. The results are then compiled into a comprehensive database, forming the OCEANIDS asset impact database, which stores the ensemble of consequence files for all assets and hazards affecting them.

Within the pre-event phase, stochastic event sets (SESs) are developed for all hazards threatening the assets (**Figure 3**). Each SES represents a possible realization of the hazard in the region of interest. For seismic hazards, an SES includes potential realizations of seismicity for a given site, as described by the site-specific seismic source model. Each SES comprises multiple Intensity Measure (IM) fields, representing potential realizations of the spatial distribution of IM values for the given hazard. These IM fields provide spatial correlation of intensity throughout a single event, allowing for the combination of compatible asset scenarios to estimate all potential damage and recovery realizations for the entire region of interest.

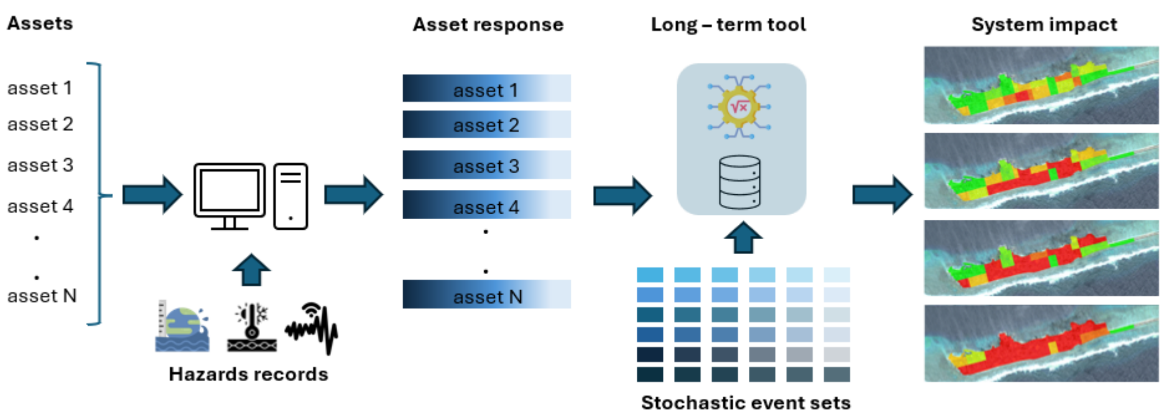


Figure 3: The long-term impact assessment workflow

The tool also calculates the risk assessment for portfolios of assets. For seismic hazards, it provides the mean annual frequency of exceedance (MAF) of various consequences, including the indirect and direct cost for entire portfolios, e.g. the number of buildings for each damage state (**Figure 4**). Corresponding hazard maps are also generated, facilitating a comprehensive understanding of the risks involved. This enables the computation of direct losses and the loss of functionality, allowing for the assessment of socioeconomic impacts based on the damage to different business sectors and accounting for indirect losses.

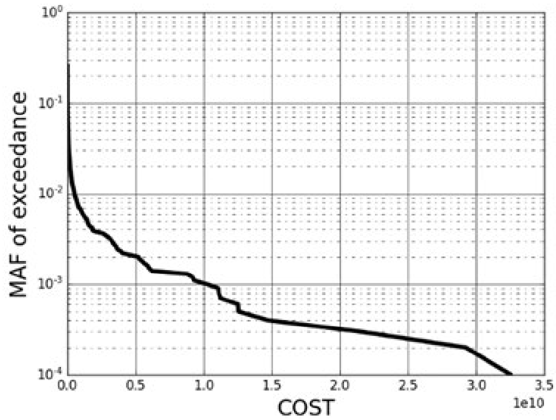


Figure 4: Exceedance-probability curve showing the MAF of exceeding given values of direct physical loss (i.e., cost to repair) for a portfolio of buildings.

For weather-related hazards, the tool uses climatic projections from various EURO-CORDEX scenarios to assess the relevant parameters, such as temperature and precipitation (**Figure 5**). The OCEANIDS project adopts the **EURO-CORDEX scenario 45**, indicative of an "average" (i.e., neither optimistic nor pessimistic) pathway of future CO_2 emissions, ensuring that the analyses incorporate the most accurate and up-to-date climate data.

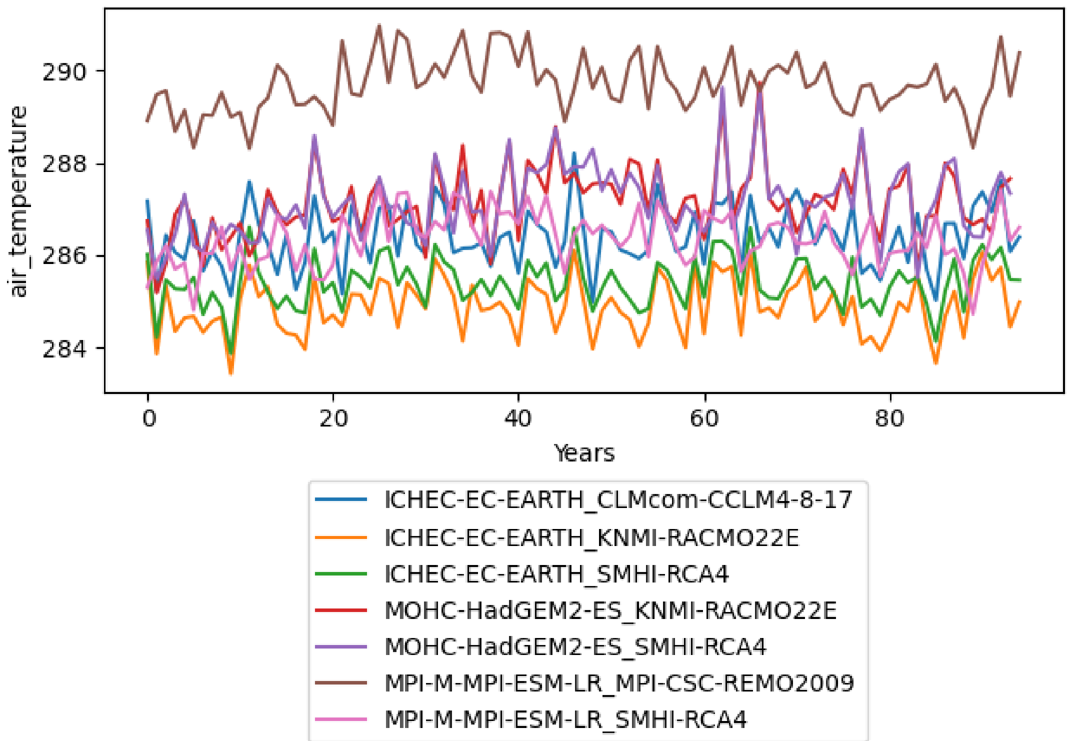


Figure 5: Example of results for predicted air temperature according to EURO-CORDEX scenario 45 for a single location in South Europe.

In addition to the long-term framework, OCEANIDS also includes a pre-event short-term operation mode, as presented in **Figure 6**. This mode utilizes climate projection and seasonal forecasting data, provided by **Task 3.4**, available monthly for the next 6 to 12 months. These predictions are inherently probabilistic, but they allow us to better focus the hazard estimates, helping reduce the range of potential events. This approach helps constrain the SESs, ensuring more precise and accurate predictions.

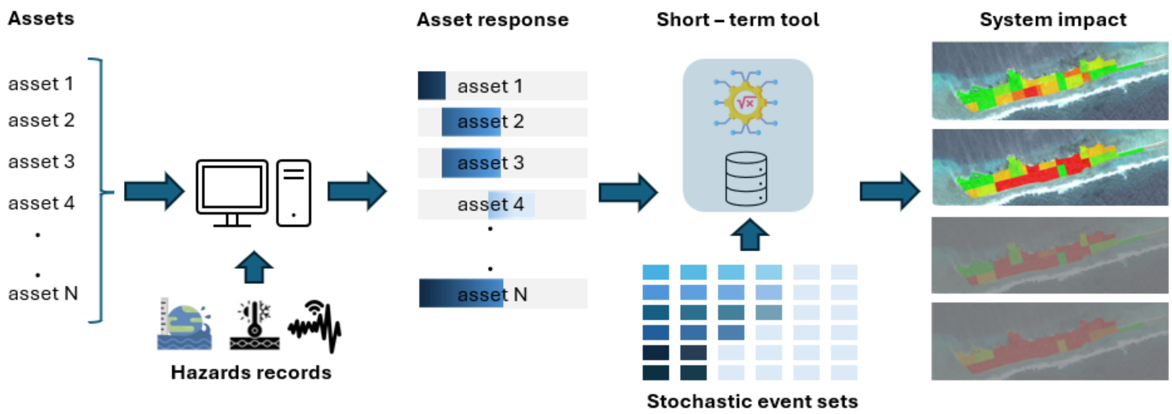


Figure 6: The short-term impact assessment workflow

4.3 Post-Event Impact Assessment Tool

The OCEANIDS **post-event** operation framework is presented in **Figure 7.** In this phase, EO data from Task 3.2 are used, that are processed right after the event occurs. The EO data may only provide hazard data (e.g. temperature, precipitation, water level), or it may also include direct impact data (e.g., flood extent, location and number of buildings damaged). In case only hazard data is available, which is often the case, the assets' fragility/vulnerability functions will be employed to deliver impact. Otherwise, direct EO impact information is by far more reliable.

The primary function of the post-event impact assessment tool is to allow users to evaluate the impacts of already-occurred or currently-unfolding hazardous events. When only hazard observations are available, this is achieved by combining pre-computed hazard scenarios, consequence realizations, and the exposure model specific to the area of interest. The tool uses pre-calculated hazard intensities, provided in the form of SES, as inputs for the **CC-HR-DSS**. This structured approach facilitates thorough and precise impact analyses in the absence of direct EO data, which is often not available for some days after an event.

A significant feature of the tool is its flexibility in scenario definition, which allows it to also operate as a what-if analysis tool. Users begin by specifying the parameters of their scenario of interest. The tool then retrieves events from a comprehensive site-specific database that meets these criteria. The pre-calculated intensity of the hazards is used as input in **CC-HR-DSS**, enabling users to select any event from the list and immediately assess its consequences on all critical assets.

The results generated by the tool are presented in clear and accessible formats, such as bar charts (e.g. **Figures 7,8**) and other visual aids. For instance, users can view the distribution of buildings across different damage states, providing a tangible understanding of the impact. This visualization helps stakeholders in making informed decisions regarding disaster response and infrastructure resilience.

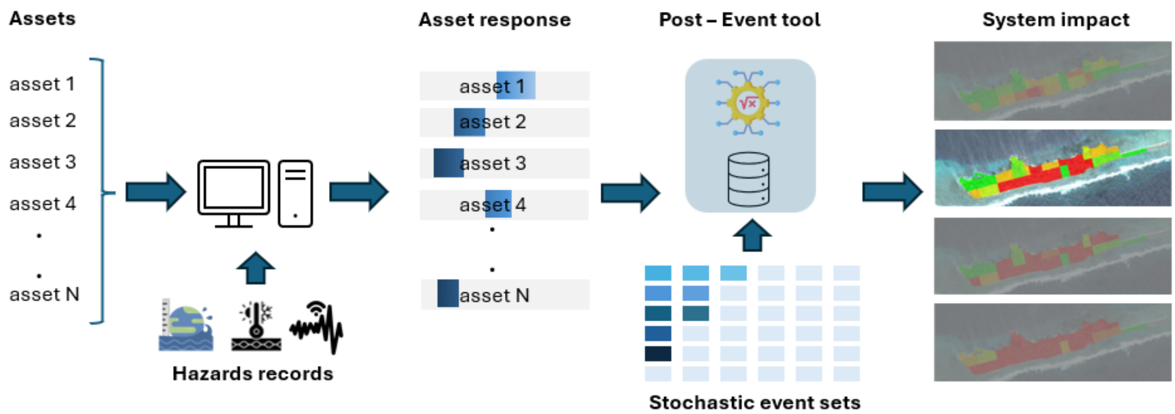
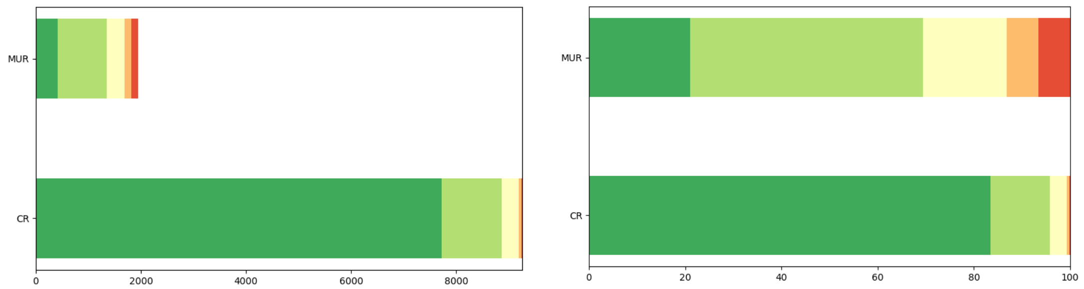


Figure 7: The post-event impact assessment workflow



(a) (b)

Figure 8: (a) Number of buildings per damage state and typology; (b) Percentage of buildings per damage state and typology.

4.4 Proposed Socioeconomic Model

The proposed **socioeconomic model** is designed to assess cascading failures and business interruptions in coastal areas through a detailed aggregation method. This model categorizes businesses into distinct sectors, creating a simplified yet effective framework for analyzing economic impacts and disruptions.

The model utilizes a business taxonomy to classify individual businesses based on their sector, disregarding their spatial distribution. Instead, it aggregates businesses into nodes, each representing a specific sector. For example, the “Accommodation” sector includes all forms of short-term lodging, from large hotels to small bed and breakfasts. This aggregation allows for a broad yet precise analysis of sectoral impacts without the complexity of spatial data.

The business taxonomy adapts to the socioeconomic characteristics of the coastal area under study, which can vary significantly between communities. In tourism-heavy regions, sectors like “Food and Beverage” may be subdivided further to reflect the diverse nature of local businesses, such as bars, restaurants, and cafes. Conversely, in areas where sectors like “Manufacturing” or “Agriculture” play a lesser role, these may be aggregated into broader categories to simplify analysis. This flexibility ensures that the model accurately reflects the economic significance and operational diversity of different regions.

The resilience of critical infrastructure and lifeline services—such as transport, electricity, water, and sewage—is integral to the community’s performance during and after a disaster. The importance of these infrastructures varies depending on their location and the community's characteristics. For instance, marine or air transportation might be vital for isolated coastal islands, whereas land-based transportation might suffice for cities on continental landmasses. Additionally, businesses in developing countries, which often rely on more traditional methods and limited technology, might be less affected by power disruptions compared to those in more technologically advanced regions (Asgary et al., 2012).

The model’s adaptability to different socioeconomic environments enhances its utility across various coastal areas. By adjusting the business taxonomy and CI considerations according to local conditions, the model provides a tailored approach to understanding and mitigating the impacts of disasters. This adaptability supports more accurate predictions of economic disruptions and facilitates targeted resilience planning for diverse coastal communities.

5 Integrated EO and spatial data platform–A single access window for spatially-enabled data

5.1 Overview of the EO and spatial data platform (EO-P)

The primary objective of the integrated **EO-P** is to provide comprehensive access to spatially enabled data, thereby supporting decision-making in CC management, mitigation, and adaptation. It aims to be a powerful tool for stakeholders, providing essential data and insights to drive effective CC actions. The platform will be built based on the specifications for new EO data services from Task 3.2 and implemented as a cloud-based solution.

As the central component of the EO-P, a single-access-window will provide a user-friendly interface for easy access to a diverse range of information, data products, and metadata provided by the CC-HR-DSS, the O-DSP or the ODC/CREODIAS for CC-related decision making. Thereby, users will benefit from enhanced data accessibility and visualizations of all available datasets gathered and processed in the scope of OCEANIDS in an intuitive GUI. In relation to its integration with other WP4 components, the EO-P will handle the authentication and authorization of the platform users, allow users to request and specify risk assessments and decision support via interactive elements in the GUI and visualize results. The respective datasets will encompass risk assessments on various hazards from the CC-HR-DSS, mitigation and adaptation strategies from the DSS and the O-DSP, EO data products provided by the backend of the EO-P and further spatially enabled metadata data from the OCEANIDS database. Further, the EO-P will provide time series data, historical data, and near real-time data based on the stakeholders needs and respective use cases.

The cloud-based EO-P will be built of multiple components, which will interact via APIs among each other or with the interfaces of the CC-HR-DSS and the O-DSP. The backend components of the EO-P will tackle tasks such as the processing and provision of EO data and the new EO Data services specifically designed for assessing CC and environmental impacts in coastal regions. Dependent on the user needs this may include periodically or on-demand processing workflows and use-case-specific processing components and algorithms. Technically, the GA foresees the implementation of the processing ecosystem as a part of Task 4.3. However, it is more practical to visualize the processing workflows of the processing ecosystem within the scope of WP3 and its respective deliverables as the processing is detached from the workflow of the WP4 platforms.

Scalable resources for both storage and processing ensure that the platform can efficiently handle varying workloads and data volumes to maintain smooth operation and data retrieval. Furthermore, the EO-P will account for the access management of the OCEANIDS platform and adhere to stringent security measures, incorporating established authentication and authorization principles to safeguard data integrity and privacy or handle the rights of users.

A detailed plan for the platform’s architecture and user interface will be developed, incorporating feedback from stakeholder interviews and user interaction mock-ups to ensure high usability and user satisfaction. The results of the implementation will be elaborated upon in detail in **D4.3** ”Integrated EO and spatial data platform” including a description of the architecture design and development of the prototype with a brief report on its functionality.

5.2 Components of the EO-P

As some components of the backend and frontend of the EO-P are already depicted as individual components in the visualization of the overall WP4 workflow to enhance comprehension, this division is retained within this section. The mentioned user requirements (UR), as well as the non- and the functional requirements (NFR, FR) refer to the deliverable D1.4 “Report on technical requirements for the core technology modules”, which represent initial but central technical requirements for the platform components.

5.2.1 EO Processing Ecosystem/Component

The **EO Processing Ecosystem or Component** will be implemented based on the specifications for new EO data services from Task 3.2. Therefore, the workflow, interfaces, algorithms and outputs will be highly dependent on the assessment of current gaps between the stakeholders’ needs and existing applications and services available conducted within T2.2. Based on these outcomes, the EO Processing Ecosystem/Component will process EO data specific to users’ needs and provide information, data products, and necessary metadata for decision-making support in CC-related enhanced management, mitigation, and adaptation actions. Based on the scenario, the respective processing workflows may be on-demand or periodic and data may be stored in the ODC/CREODIAS.
As this component focuses on data processing, its respective processing workflow is highly connected with the components and workflows of WP3 and will therefore be initially presented within the deliverables of WP3. However, it should be mentioned, that dynamic processing of EO data could be triggered on demand via the GUI, if this will be a requirement due to a use case originating from the stakeholder needs. **Figure 9** depicts the part of the WP4 workflow regarding the on-demand trigger of the EO Processes Ecosystem. The Ecosystem will consist of at least two components, one for scheduling the processing (on demand via GUI or periodic) and at least one component that requests initial EO data from the CREODIAS platform, conduct the data processing with respect to users’ needs or identified gaps and will store the data back into the system of CREO. Details on the EO processing component(s) will be elaborated on in deliverables **D3.2** “Earth observation (EO) data services requirements & specifications” and **D4.3**.

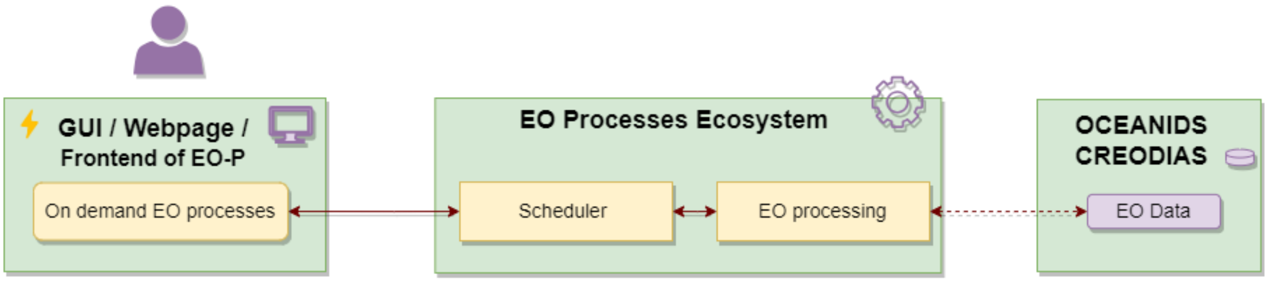


Figure 9: On-demand trigger of the EO Processes Ecosystem

5.2.2 Access Management Component/Middleware

The Authentication and Authorization layer will account for the functional requirements **FR-1, FR-2** and **FR-5** as well as the non-functional requirement **NFR-4** to verify user identities, enable multi-user support and control the user access to the systems resources. To follow common principles, protocols and highest security standards it is envisioned to develop a middleware layer incorporating a framework such as Keycloak[2]. Requests originating from the GUI are guided to the REST-API-based middleware, where the authentication is validated, and the requests are forwarded to the specific platforms. As all requests will pass the middleware layer it may be extended to monitor requests, user traffic and errors accounting for **FR-5** and **NFR-9** using frameworks such as APISIX[3] and Grafana[4].

5.2.3 Data Provision Component

The EO-P backend system will include a data provision component that provides data from the OCEANIDS data warehouse, managed by ODC/CREO, along with results from the CC-HR-DSS and O-DSP to the end user via the GUI of the OCEANIDS platform. It will enable functionalities such as the visualization in the GUI and provision of raw data of all outputs from the WP4 platforms, adhering to OGC standards[5]. The table below summarizes **the main functionalities of the GUI** in which the Data Provision Component will be involved.

---

[2] Keycloak
[3] Apache APISIX® -- Cloud-Native API Gateway
[4] Grafana: The open observability platform | Grafana Labs
[5] OGC API - Tiles - Open Geospatial Consortium

Table 3: The main functionalities of the GUI

Functionality	Requirements	Description
Search available datasets	**UR-2** Search Functionality **FR-6** API Support	Allows the user via the GUI or the CC-HR-DSS/O-DSP to browse available datasets and select from those via an API. Optional OGC standards for the implementation may be OGC API-Features, CSW or OGC candidate STAC[6,7].
Visualization of EO data (raster data)	**UR-4** Data Visualization **UR-6** Accessibility **FR-6** API Support	This component functionality will enable the GUI to visualize raster data from the data warehouse (ODC/CREODIAS) or on-demand processing in a user-friendly map interface. The implementation may adhere to OGC standards such as OGC API-Tiles, WMS or WMTS. Based on the user needs and requirements the implementation may provide customizable data views including layers, styles, and spatial reference system.
Visualization of O-DSP (and CC-HR-DSS) output	**UR-4** Data Visualization **UR-6** Accessibility **FR-6** API Support	The functionality of this component will enable the GUI to present vector data and metadata from CC-HR-DSS/O-DSP on an intuitive map interface. The implementation may follow OGC standards such as OGC API-Features, WFS, or the STAC specification as an OGC candidate.
Download of data	**FR-10** Data Export **FR-6** API Support	Allows the user to download data and metadata from the OCEANIDS platform. The implementation will be dependent on the use case, stakeholders' needs and respective data formats, but it may adhere to OGC standards such as OGC API-Features, WCS or WFS.
Custom Visualizations	**UR-4** Data Visualization **UR-6** Accessibility **FR-6** API Support	This functionality highly depends on the user's needs. For example, time series of a parameter and specific location could be extracted if required. If possible, these functionalities may adhere to OGC standards as well.

Different tools, libraries and APIs are under consideration for the implementation of these services. The EO-P will implement a selection from options such as TiTiler[8], Geoserver[9], pygeoapi[10], STAC-API[11] or other to account for data provision and handling adhering to OGC

[6] Bringing STAC into OGC - Open Geospatial Consortium
[7] STAC: SpatioTemporal Asset Catalogs (stacspec.org)
[8] TiTiler (developmentseed.org)
[9] GeoServer
[10] Home - pygeoapi
[11] stac-utils/stac-fastapi: STAC API implementation with FastAPI. (github.com)

standards from the table. For instance, TiTiler is a lightweight, modern, cloud-native and efficient image tiling server specifically tailored for cloud-optimized GeoTIFFs (COGs) that could account for a WMTS service providing tiles for map visualizations of EO and raster datasets in the GUI. However, the final decision on suitable tools is still pending, as the final selection depends on the technical specifications and requirements of WP3 and WP4 partners as data formats, interfaces, tools etc. Therefore, these requirements will be elaborated on in **D3.2** and the tools together with the respective components will be defined in **D4.3**.

5.2.4 Frontend of the EO-P

The EO-P will provide comprehensive access to all OCEANIDS users to support decision-making in CC management, mitigation, and adaptation via a user-friendly GUI. Its single-access window will allow users to interact with the backend components of the OCEANIDS platform, specify requests to the CC-HR-DSS or O-DSP and retrieve EO and spatial data.

The implementation will account for user requirements from D1.4 such as **UR-4** for data visualization, and **UR-5/UR-6** for usability and accessibility. Further, it may support **UR-12** of localization allowing the system to adapt to different languages and regions. Thereby, the frontend component will enhance the user's ability to visualize and interpret OCEANIDS data effectively. It enables users to easily enquire visualizations of EO and spatial data of their interest, request risk assessments and decision support, inspect visualizations of the related results and download datasets of interest directly for further and local usage. Therefore, the GUI will integrate various graphical elements such as menus, cursors, tabs, windows, and scroll bars, facilitating data handling, metadata extraction, and processing techniques even for non-experts. **Figure 10** illustrates the main interactions between the EO-P GUI with other interfaces and highlights some of the functionalities. The following subsections will provide an initial overview of these functionalities.

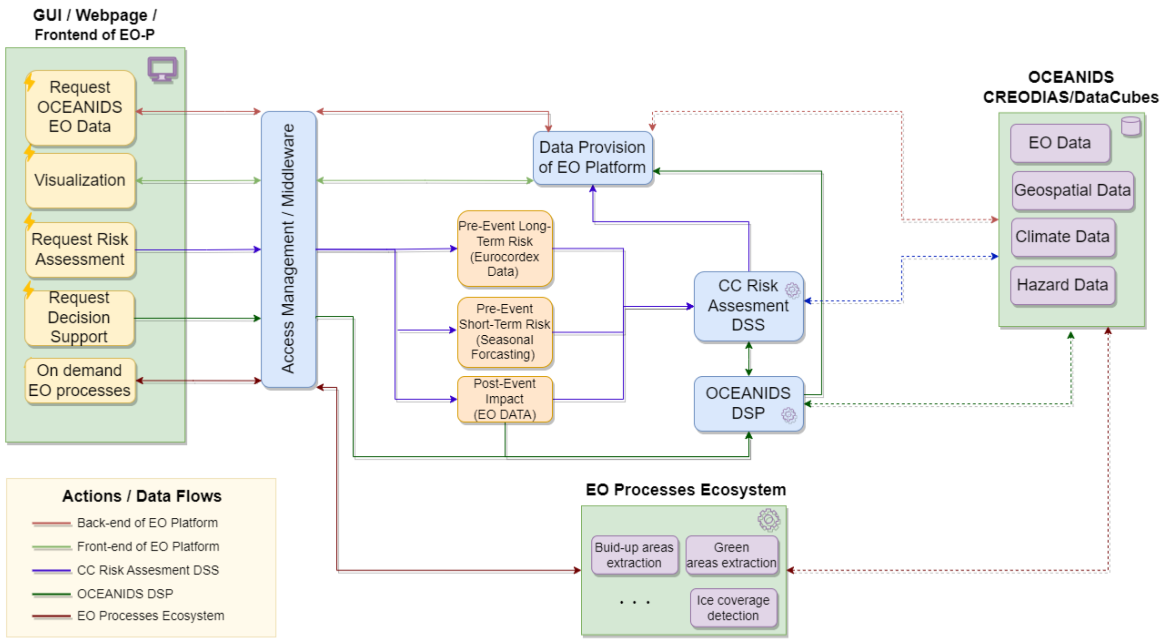


Figure 10: The main interactions between the EO-P GUI with other interfaces

5.3 Visualization of EO data

The visualization of EO data for decision-making support will be achieved through an **interactive map interface** designed to display data received from the EO-P backend. This map will visualize EO and spatial data utilizing services adhering to standards such as OGC API-Tiles, WMTS, WMS or OGC API-Features implemented in the Data Provision Component of the EO-P. As explained in section 5.2.3, the respective selection will depend on the required visualization functionalities.

The GUI will encompass options to customize the map display according to the users' interests and needs, allowing them to manipulate the map as needed. This may include functionalities such as zooming, panning, switching between different layers, adjusting opacity, and applying various filters to the data. To integrate these functionalities, the map interface will be built using geospatial mapping and visualization tools such as Leaflet[12], Mapbox[13] or OpenLayers[14] for interactive map development. Among others, the selection will be based on criteria such as their mapping capabilities, customization options, vector mapping ability simplicity or flexibility. The mapping tool itself will be embedded within an

[12] Leaflet - a JavaScript library for interactive maps (leafletjs.com)
[13] Mapbox | Maps, Navigation, Search, and Data
[14] OpenLayers - Welcome

Angular[15] framework, a powerful platform for building dynamic and robust web applications. Together, these technologies will enable a highly interactive and responsive map interface.

5.4 Download of EO and spatial data

The GUI of the EO-P enables users to directly download EO and spatial data as well as datasets from the CC-HR-DSS and O-DSP with functionalities tailored to the users' needs accounting for **FR-10** Data Export, providing a seamless and efficient data export process. Therefore, the GUI will offer the users options to specify the downloading process, ensuring high usability of the gathered results. These options may encompass selecting specific datasets, applying filters based on parameters such as time, geographic area, and data type, or previewing the data before downloading. This download functionality provides users with a straightforward method to access and locally utilize the essential data required for their analyses and decision-making processes. By enabling efficient data downloads, the EO Platform not only empowers users with access to critical data but also ensures that the system remains user-friendly and accessible, supporting a wide range of applications and use cases.

5.5 Requests for risk assessment, mitigation measures, adaptation actions and related visualisations

The GUI will enable users to interact with the CC-HR-DSS and O-DSP and initiate requests for risk assessment, mitigation measures and adaptation actions. Graphical elements such as buttons, checkboxes, drop-downs, switchers or sliders and the interactive map element will be used to choose between pilot areas and scenarios, to specify the request and related parameters and to start executions of risk assessments or DSS. All partners of WP4 will jointly define technical requirements for this specification to ensure seamless interaction between the GUI of the EO-P and the CC-HR-DSS and O-DSP. The specified requests will trigger processing workflows in the respective platforms.

The GUI of the EO-P will further take over the visualisation of the results originating from the CC-HR-DSS and O-DSP platforms. It will retrieve a response from the initial request and display the results in the interactive map element dependent on technical requirements from WP4 partners and user requirements of the stakeholders. The respective risk and recommendation results on specific assets from the CC-HR-DSS and O-DSP will be provided as vector data or more specifically polygons, in JSON format. These polygons will be

[15] Home • Angular

displayed on the map and offer further interaction capabilities, such as options to visualize metadata, statistics, charts, recommendation strategies and/or other information.

Furthermore, the GUI offers users the option to download all information directly from the interface. This integrated approach ensures that even non-experts can easily handle data, extract metadata, and process information, making informed decisions based on comprehensive visual and data-driven insights from all OCEANIDS platforms.

6 The OCEANIDS Decision Support Platform (O-DSP): A Decision Support Platform for CI-MSP in Coastal regions

6.1 Overview

The previously described components outline the objectives and methodological principles that will be followed for the development of the WP4 technological solutions. Fully in line with them, the introduction of the OCEANIDS Decision Support Platform (O-DSP) will follow. Its primary objective is to support operational optimisation for climate impacts, data and knowledge in coastal regions, particularly targeting port cities and local authorities.

The O-DSP represents a comprehensive and integrated toolset for coastal climate mitigation, fostering more efficient and consolidated decisions and strategies. This implementation shall provide a comprehensive overview of spatiotemporal changes, and the impact of CC on coastal management, accompanied by reliable recommendations towards the mitigation of the CC effects and coastal hazards' intensity. Through the provision of the end-users with an assessment of hazards in their respective region, the overall system will lead to efficient subsequent multi-scale planning addressing the needs of the coastal authorities and interested parties.

This platform shall secure and optimise ports, regional areas, and local authorities' operations on possible climate impacts in coastal regions. Its building components shall follow a methodological approach based on a well-structured UML (Unified Modeling Language) framework for the development of end-to-end services, that make them interoperable and easily accessible by other available tools and platforms, offering a holistic multiparametric solution for the efficient monitoring of the environmental and socioeconomic aspect of the coastal regions.

Aiming to satisfy the requirements defined by the end users, a unified user story will be considered, for the implementation of the O-DSP and its compatibility with the additional modules of the OCEANDIS project. Furthermore, special attention will be given to the computational execution time, precision/recall values for assessment, and security and privacy trust issues within the platform's architecture.

6.2 Components of O-DSP

Aiming to develop a novel decision support platform, individual decision-making tools and methodologies shall be combined and fused under Task 4.3 offering a robust and powerful software solution. The platform shall leverage the advantages of the AI (Artificial

Intelligence) models, such as the Long Short-Term Memory (LSTM) model for geospatial and data climate data fusion and enrichment through the spatial and time dimension. Utilising the outputs and the insight of the AI analysis along with a rich dataset of tangible and effective hazard mitigation measures/ recommendations, the platform shall be trained and be capable of providing reasonable and efficient recommendations to the end-user towards the mitigation of CC-driven hazards and their effects on the coastal regions. Moreover, through the support of relevant feedback mechanisms, the platform could automatically adjust and provide updated responses, tailored to user preferences. The overall concept includes the development of **(i)** Decision Support Tools (AI-featured), **(ii)** Recommendation engines, and **(iii)** Relevance Feedback mechanisms, aiming to enhance the European climate data services and climate data store through its operational functionalities and valuable results.

The methodological framework's sequence begins with the development of a **climate data acquisition ETL** (Extract, Transform, Load) pipeline on top of the data collected under WP3 and additional services that satisfy the O-DSP's special requirements e.g., climate, socioeconomic and built-up environment services. The collected and harmonized datacubes shall be utilised both for the training of AI models and for the data fusion and extraction of semantic information.

The outputs of this procedure will constitute valuable inputs to the **recommendation engine** that will be developed to provide recommendations tailored to the special needs and assets of each coastal region and be adjusted based on the intensity of the hazard and risk, offered by Task 4.1. The recommendation will be derived from a thorough literature review and refer to both general policies and physical interventions at the regional and local levels.

Additionally, **an advanced feedback mechanism** will be developed to parameterise the DSS based on user preferences and needs. The O-DSP shall be capable of receiving a list of parameters specified by the user, such as the cost level, the category of the interventions, the performance/area of effect, and other user preferences to adjust the results and focus on specific criteria and characteristics of the recommendations.

Moreover, the point of view of the **OCEANIDS's engaged/focus groups** could be considered as a high-importance parameter in the decision-making procedure. Hence, their inclusion into the O-DSP calculation engine will be examined as an input to the recommendation's component offering an extra parameterisation level. That feature will enable the end-users to design mitigation scenarios and new policy plans incorporating the perspective and the needs of the lower-level regional entities, following a **bottom-up decision-making approach.**

Implementing an **end-to-end software-as-a-service (SaaS) architecture** focused on the seamless interconnection and compatibility of the O-DSP with the other components of the OCEANIDS ecosystem, will offer a system which is also compliant and aligned with the external existing European services and climate data stores. Thus, the accessibility of the O-DSP output data will be facilitated through standardized APIs and data exchange protocols, ensuring interoperability with various European climate data services.

The user shall be able to invoke the OCEANIDS DSP either through the O-DSP API or the graphical interface of the EO Platform. Establishing a seamless interconnection with the EO Platform, their communication and data exchange shall provide a fully integrated system that uses JSON structures, as the common lightweight message-interchange language. Lastly, in order to develop the best practice solution, the integration of these services and data outputs into the OCEANIDS datacubes will be considered as an alternative, aiming to offer a unified interface under the OCEANIDS domain.

The following diagram in Figure 11, illustrates the **preliminary methodological pipeline** designed within the framework of this deliverable to showcase an initial approach for the development of O-DSP.

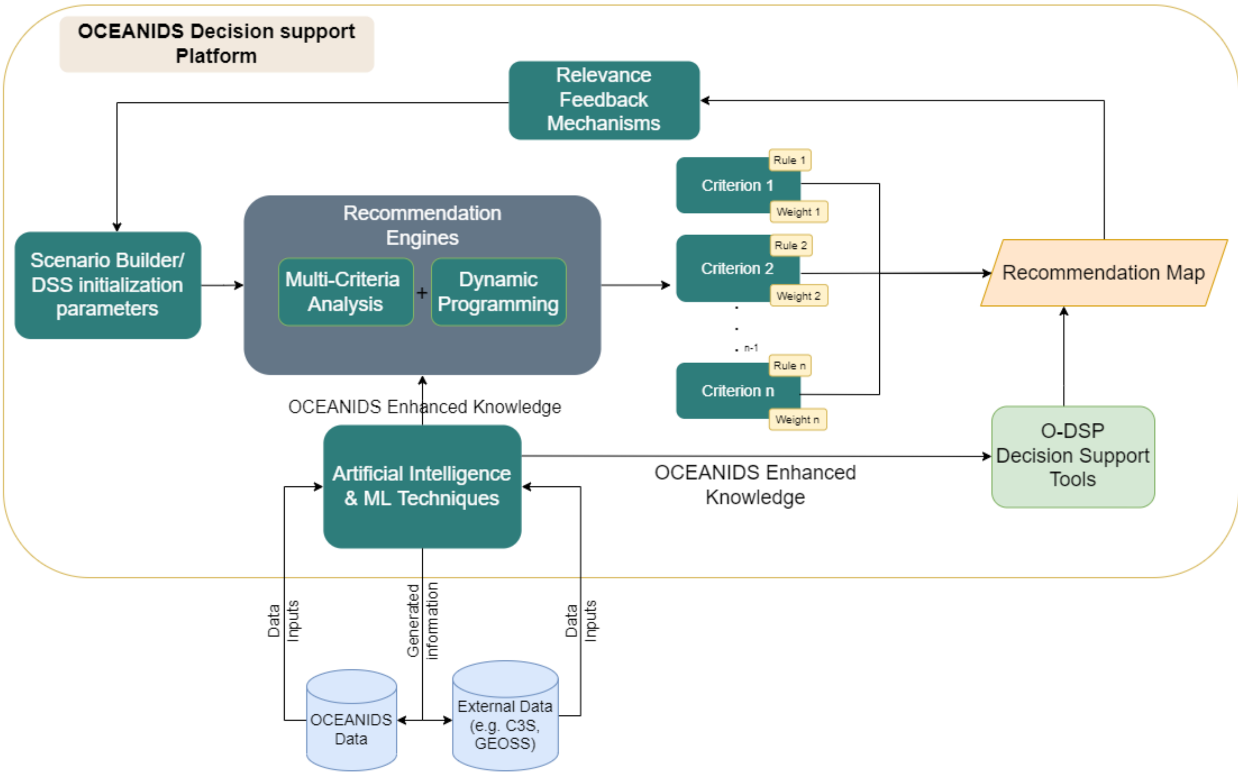


Figure 11: Preliminary methodological pipeline

7 Interconnection between the components and Platform visual design

The single-access window, EO Platform, developed by OHB under Task 4.2, shall serve as the main end-user interface depicting the results either developed or integrated throughout the OCEANIDS project. Therefore, the identification and assessment of the available best practices techniques and paradigms for the **interconnection between the components** of WP4 are pivotal during these initial steps.

7.1 Components Interconnectivity

The three individual components developed under WP4 shall be provided as stand-alone solutions, however, their interconnection and interchange of information are required in order to provide the optimal tool for successful coastal monitoring and decision-making.

The GUI of the **EO-P** will serve as the central access point for the users to interact with the OCEANIDS platform. After authentication and authorization, the user can choose from different functionalities. These encompass the visualization or download of datasets as well as sending requests for risk assessments or decision support to the **CC-HR-DSS** and **O-DSP** respectively or optionally trigger on-demand processing of EO data.

Regarding the connection between the WP4 platforms the EO-P provides specific functionalities and assumes the following main responsibilities:

- Access Management for OCEANIDS platform
- Allow the user to request risk assessments and decision support and specify the request via buttons, sliders, and check-boxes in the GUI
- Visualize EO and spatial data from the database ODC/CREODIAS
- Visualize results from CC-HR-DSS and O-DSP in the GUI
- The GUI allows the user to export and download data from the OCEANIDS platform according to the user's needs and preferences

Following that paradigm, the **user's experience** will be broken down into three main parts. The risk assessment, the mitigation measures/recommendations towards coastal resilience, and the mitigation scenario building. In combination with the provision and visualisation of EO data, the user will be empowered to assess the current state of an area of interest [Task 4.2 – OHB], understand the CC driver hazards and build its own mitigation scenarios based on the provided recommendations [Task 4.3 - GSH] and the intensity of risk [Task 4.1 – RG]. Additionally, the feedback mechanisms [Task 4.3 - GSH] shall be developed for the parameterisation of the O-DSP offering the ability to the user to adjust the calculation engine and receive recommendations tailored to its specific needs (e.g. cost, solutions category, performance, etc.).

Based on the abovementioned capabilities and developed functionalities of WP4 as a whole, the EO-P shall enable the following procedure:

1. The End-user selects a Coastal Pilot Site and one of the examined coastal hazards
2. It then selects scenario (covering "Pre-Event Long-Term Risk, Pre-Event Short-Term Risk, and Post-Event Impact"- specific names will be provided in a later stage based on selected Hazards)
3. The CC-HR-DSS generates the risk map of the current state (Baseline Assessment)
4. The EO data and processes are provided for visualization/export and execution respectively
5. Based on the risk map and the end-user's input parameters, the O-DSP triggers a properties-based analysis to highlight the areas that are capable of tangible recommendations/hazard mitigation measures
6. The end-user interacts with the feedback fields to adjust the O-DSP system to its preferences
7. The end-user selects the highlighted areas that wants to examine and then selects the recommendations that wants to consider
8. The CC-HR-DSS is triggered and generates a new risk map (new scenario) considering the selected recommendations/mitigation measures
9. New recommendations will be provided based on the new risk scores
10. The end-user will be able to proceed to the determination of additional scenarios

For optimal development and in order to facilitate the integration within the EO Platform, all the necessary data for map visualization, risk, recommendations, charts, etc., will be provided in a specific predetermined format ready for integration into the platform.

As part of the O-DSP, several functionalities are considered important for the visualisation, such as an execution button, some interactive map features to enable the visibility of the risk and the following recommendations, the weight adjustment fields for each selected recommendation (serving as user feedback) and the execution buttons showing the mitigation scenarios resulting from both the CC-HR-DSS and the O-DSP.

7.2 Preliminary Visual Design and Platform Mock-ups

Following the discussions with the technical partners and the OCEANIDS end-users' specific fields are considered for the initial parameterization of the hazard and risk assessment and the OCEANIDS DSSs, are:

- Pilot Areas
- Scenario dropdowns (covering Pre-Event Long-Term Risk, Pre-Event Short-Term Risk, and Post-Event Impact-- specific names will be provided in a later stage based on selected Hazards)

- List of checkboxes to indicate the existing resilience status of the pilot area allowing users to select which resilience measures are already implemented or note any experience with hazard-related events, and a risk assessment execution button
- Map visualisation of the provided results as polygons in JSON format, coloured based on their weight, values or scores – level of accuracy
- Tools like checkboxes, range bars or even switchers can be used to incorporate citizens' perspectives, categories, risk scores, and possible cost of the recommendations.

To visually complement the list of options to parameterize the hazard and risk assessment as well as the decision support request, some mock-ups of the GUI shown below, indicate how the end-users may specify their requests in the OCEANIDS platform. Additionally, it is indicated how EO or spatial data may be used for further support of the end-users. It should be mentioned that these mock-ups indicate the preliminary visual design and that the implemented platform, GUI and processes may vary from these initial mock-ups. For better clarity and understanding the mock-ups will apply to the potential risk of "heat" in the city of Malaga as an example. Note that this does not imply, that this risk will necessarily be elaborated on in the following manner by the O-DSP or that it suggests that "heat" is the primary challenge of Malaga in MSP or CAP.

The login to the OCEANIDS platform will be handled through an authentication and authorization framework such as KeyCloak (**Figure 12**):

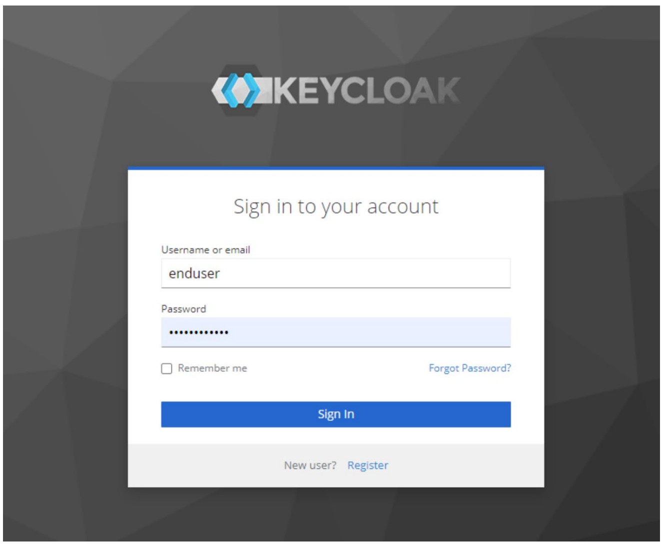


Figure 12: Login to the OCEANIDS platform

After signing in the end-users may select the pilot area and choose between the visualization and analysis of EO and spatial data or the option to specify requests for the risk assessment and decision support system (**Figure 13**):

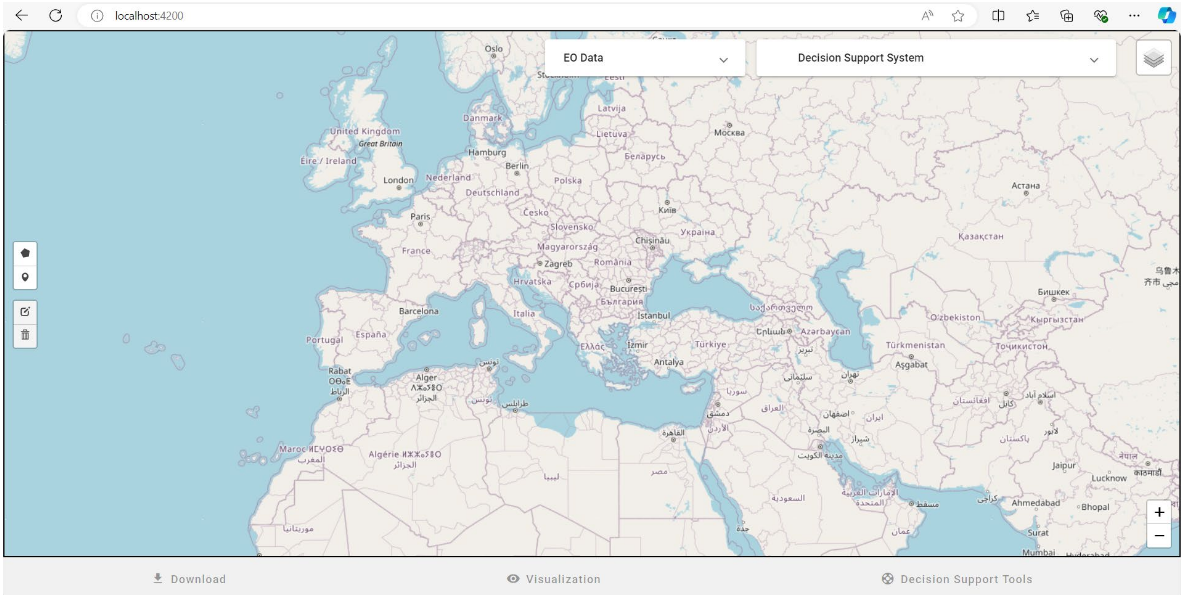


Figure 13: Selection of pilot area and request for decision support

Having selected and requested a risk assessment with specified potential options such as peril, scenario or return period in the DSS, polygons of sections in the pilot area will be displayed on the interactive map element colorized dependent on the respective risk scores to identify vulnerable aeras to the selected peril (**Figure 14**):

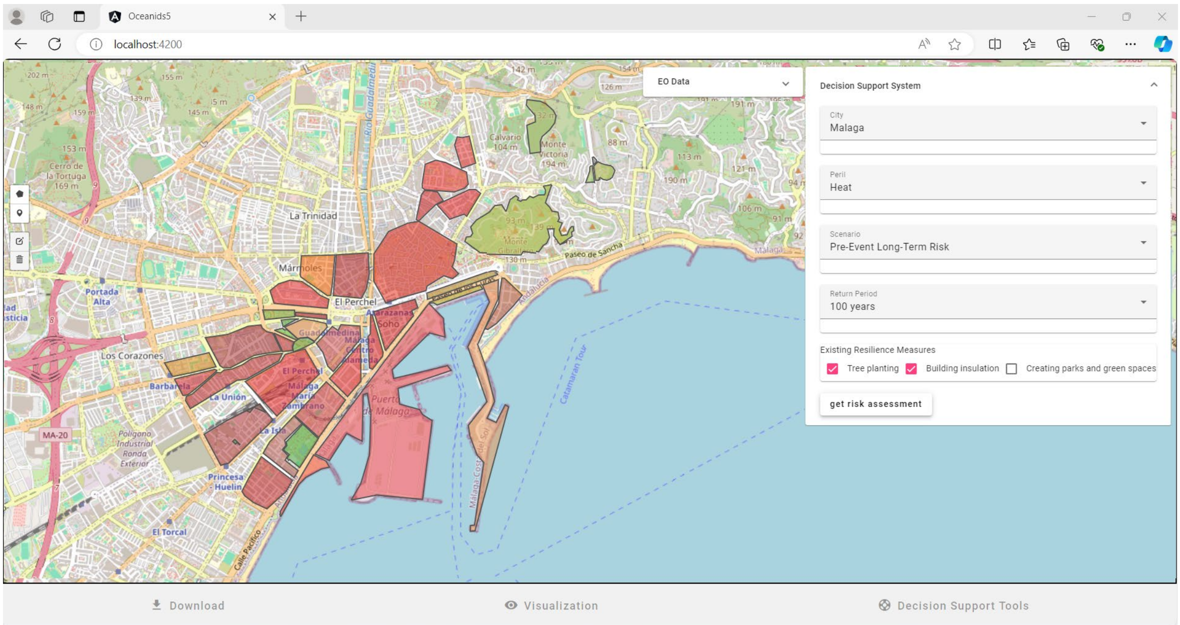


Figure 14: The potential hazards' options and the Interactive map

By clicking on or hover upon the risk polygons the user may select and get information about respective polygons, such as risk scores or other (**Figure 15**).

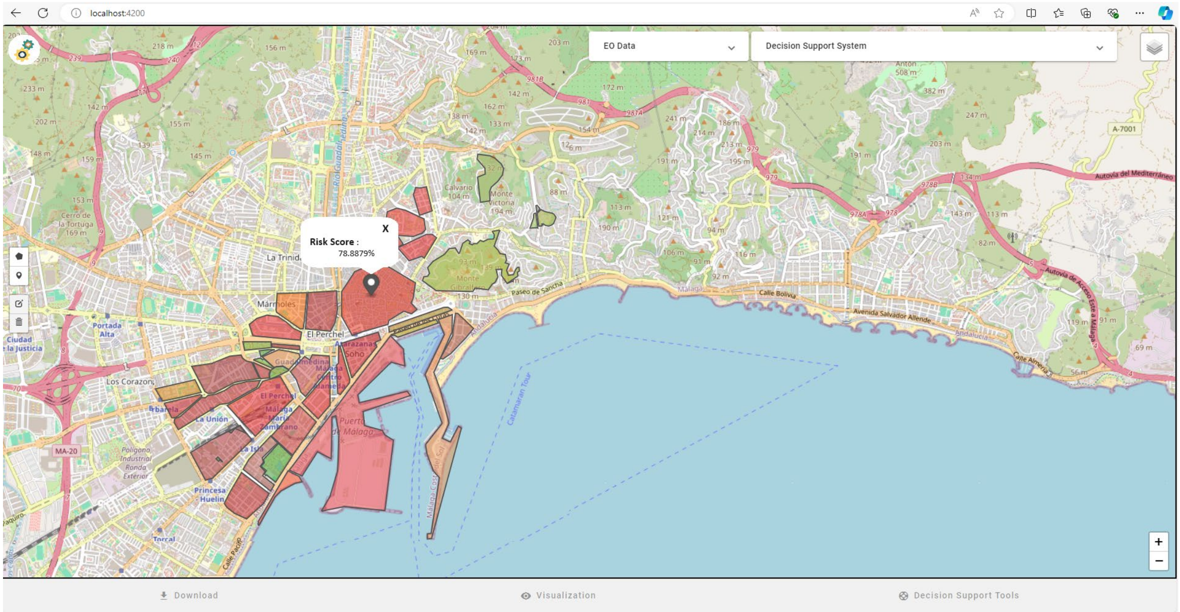


Figure 15: Risk scores on the selected polygons

Having selected a polygon, the user can open a toolbar to parameterize and execute a request for decision support. In this example this could be check-boxes for already existing resilience measures in that area or polygon, but the implemented solution will encompass additional elements (Figure 16). These will be defined by the WP4 partners and may encompass sliders, switchers, range bars or other dependent on the prior selections of the peril, scenario or other options.

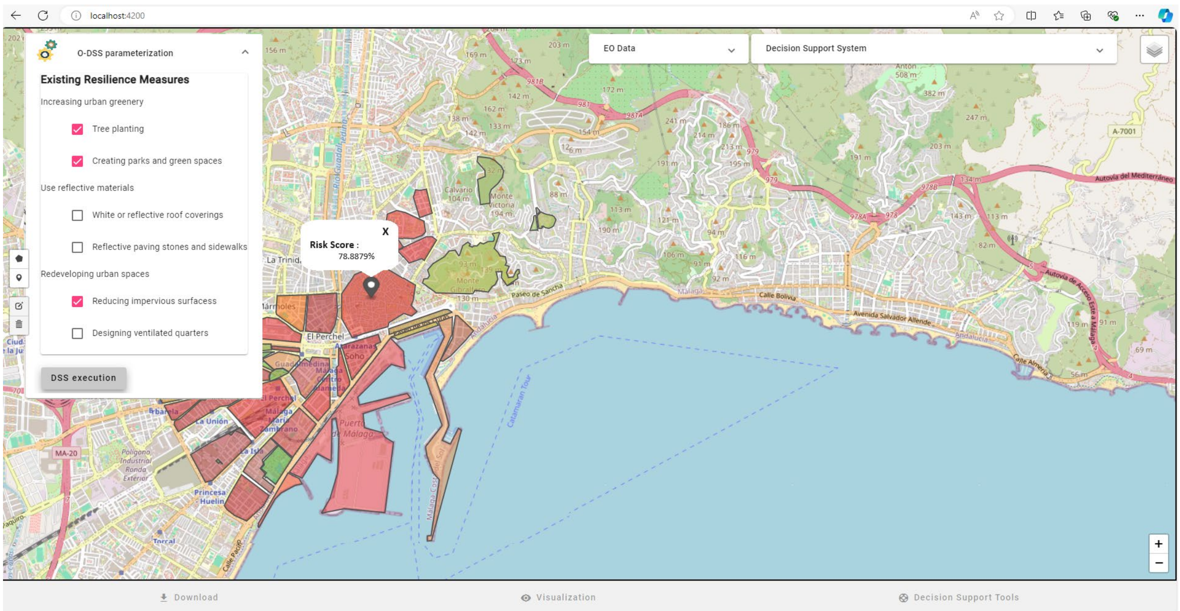
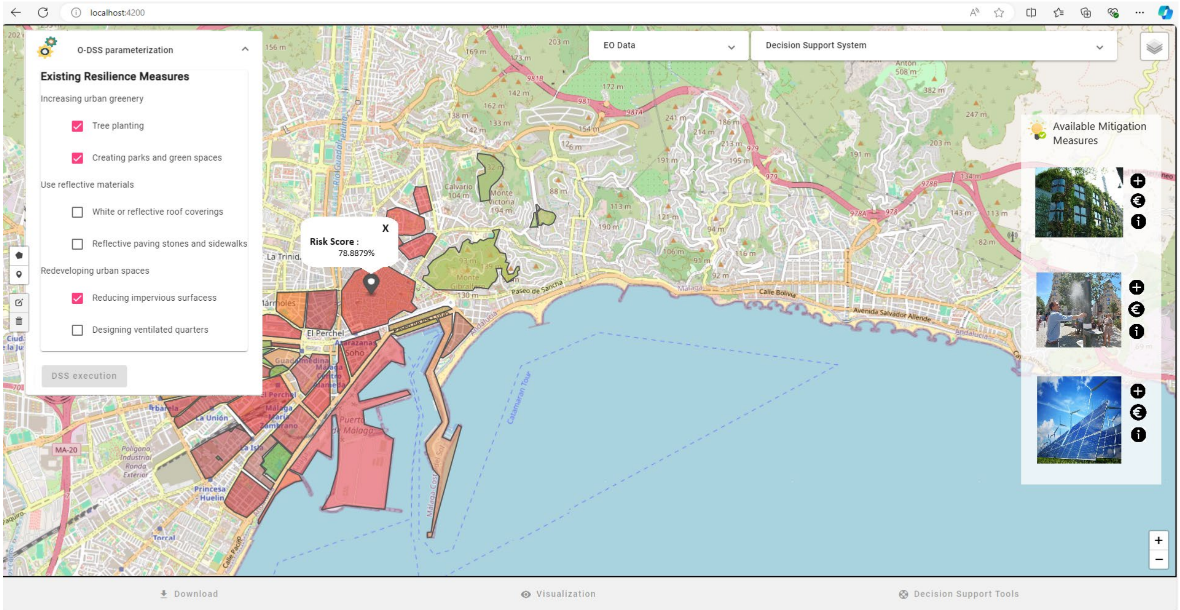
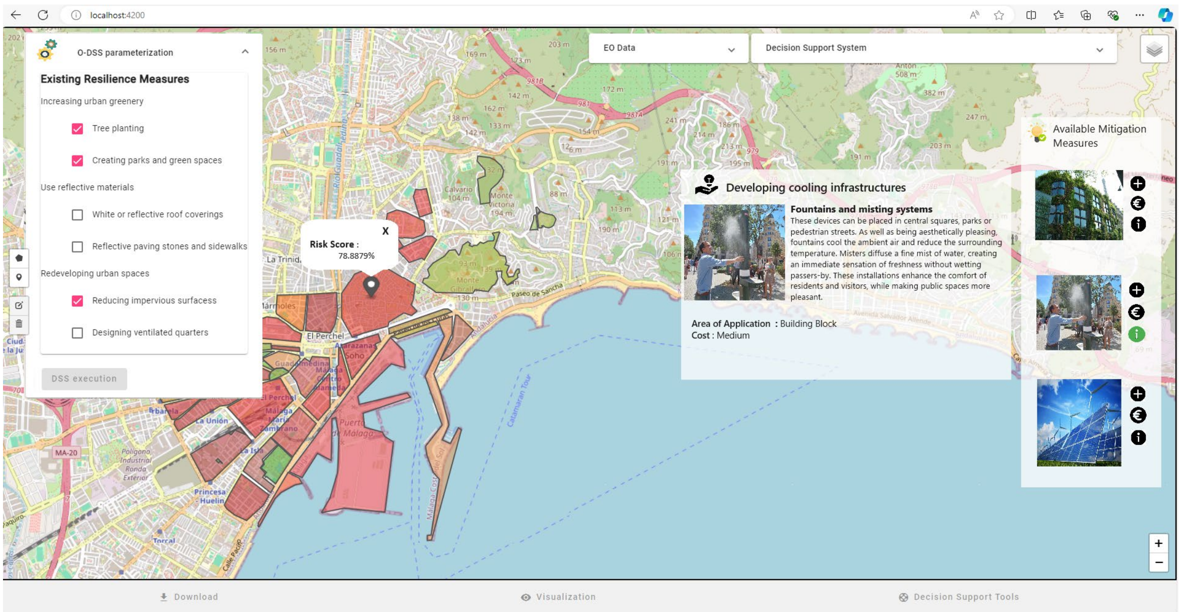


Figure 16: Parameterization and execution of request for decision support

After DSS execution, the response of the DSS will be visualized in the GUI. For example, this may include the visualization of suitable mitigation measures for the respective polygon in a separate interactive window together with detailed metadata and recommendations (Figure 17).



(a)



(b)

Figure 17 (a), (b): DSS results - mitigation measures together with recommendations

The user may include a selection of mitigation measures and re-run the risk assessment for the respective polygon taking these measures into account to assess the possible influence and efficacy of the proposed solutions (**Figure 18**). The polygon's new risk score may be directly visualized on the interactive map element (**Figure 19**):

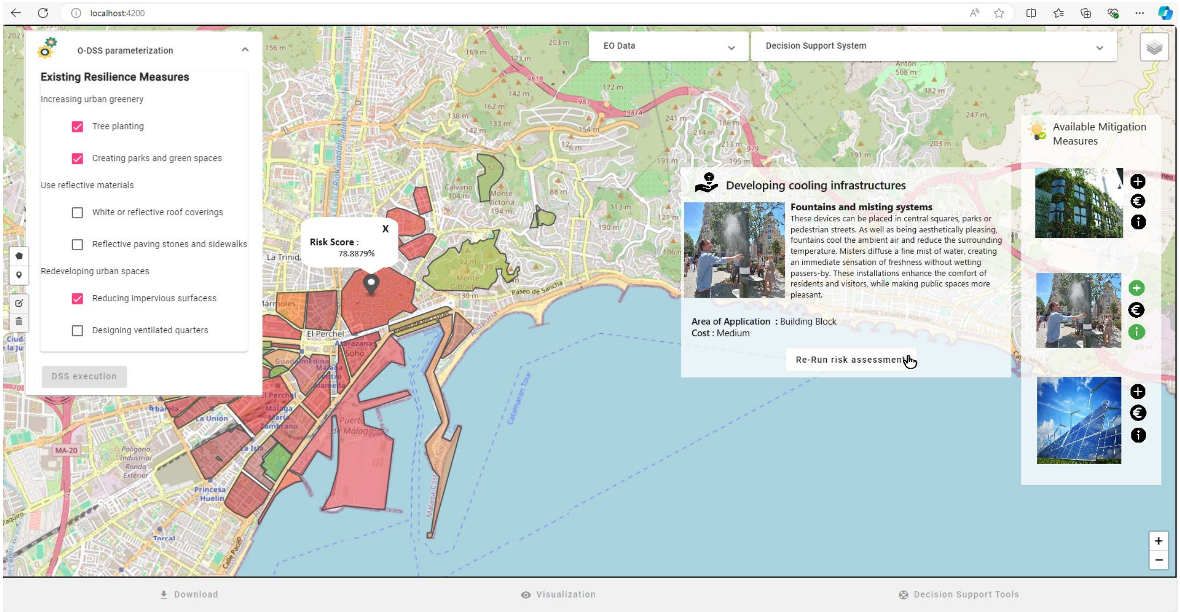


Figure 18: Re-running the risk assessment adopting the proposed measures

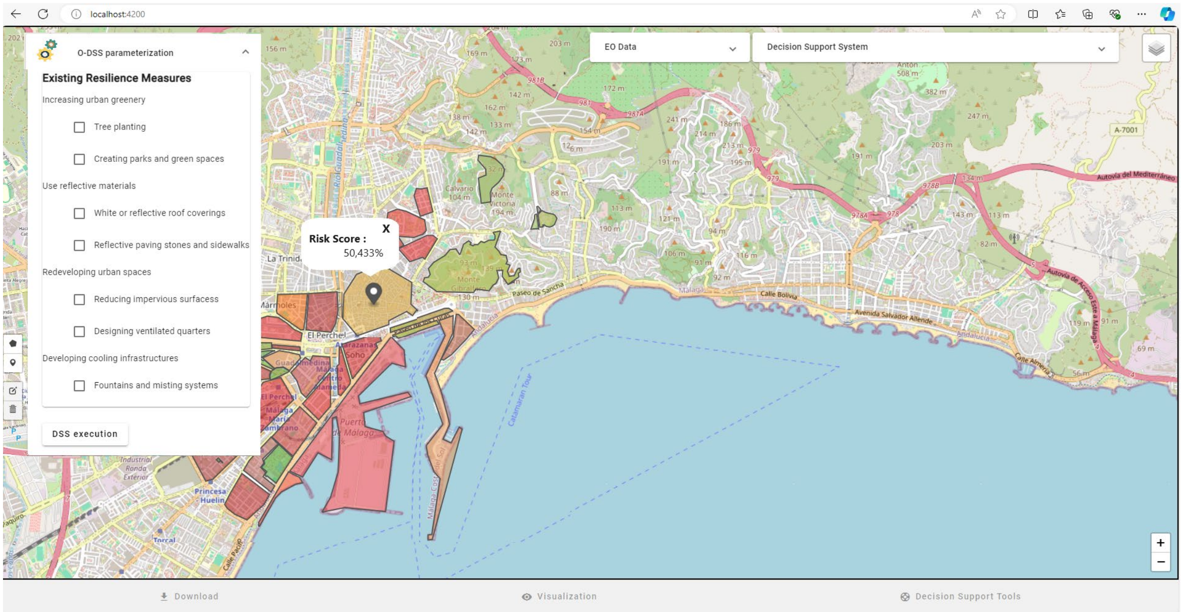
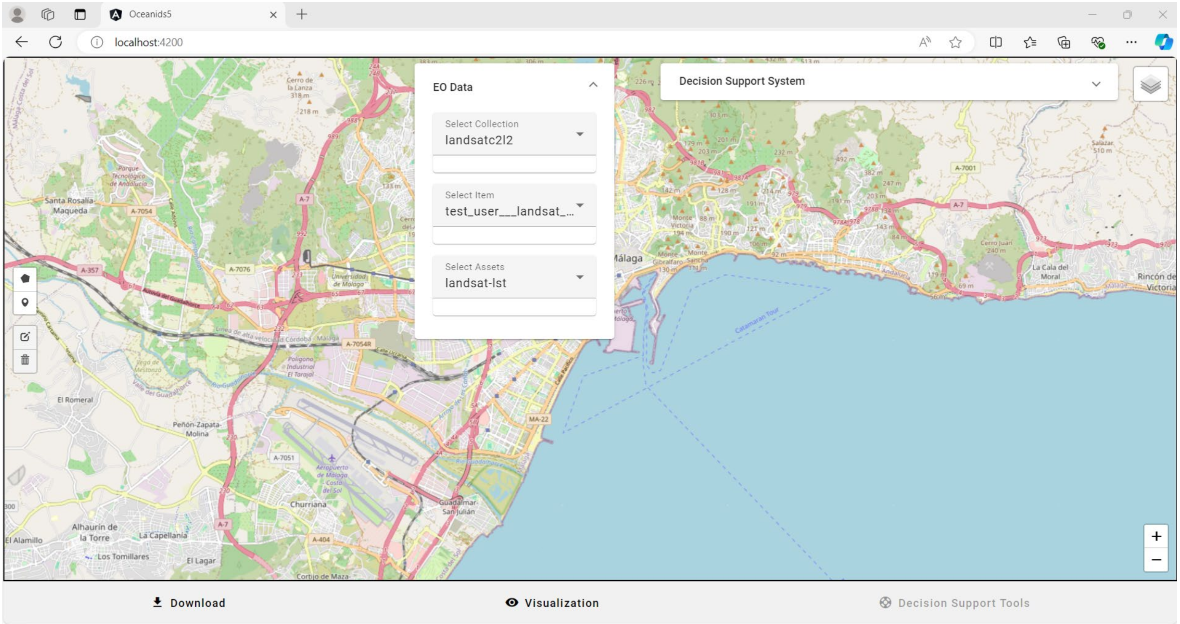
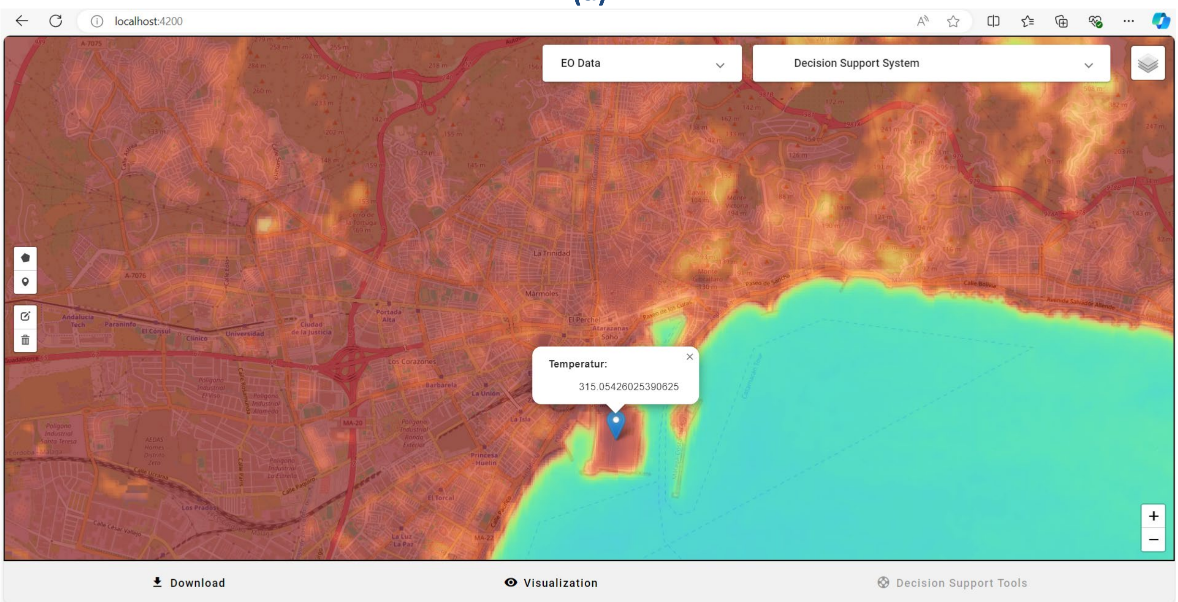


Figure 19: The risk score after re-running the risk assessment

To supplement the risk assessment and decision support, the user will be able to visualize EO and spatial data from the system (**Figure 20**). Regarding the example peril of heat, a suitable EO product could be the visualization of the latest thermal data to visualize areas of high surface temperatures. New EO Services, which will depend on the users' needs in the actual platform, could encompass for this example functionalities such as the identification of temperatures at specific locations, the classification of the hottest areas in the city (heat islands) or gathering time series of temperature data for specific locations.



(a)



(b)

Figure 20 (a), (b): Request and visualization of available EO and spatial data and functionality of retrieval of location-specific information

To conclude, the mock-ups are initial visual designs to serve as an input for further discussions with partners from all WPs, but especially with those from WP4 and the end users. Partners from WP4 will formulate requirements, that clearly determine the needed functionalities between the components of the platform and the needed graphical elements to specify requests to the DSS in the following deliverables.

8 Conclusions

This document presents an initial plan for the three separate components of WP4 and their interconnection. The CC-HR-DSS will accommodate different types of datasets (e.g. hazard, assets, fragilities) and risk analysis algorithms. O-DSP will provide a comprehensive overview of spatiotemporal changes, and the impact of CC on coastal management, accompanied by reliable recommendations towards the mitigation of the CC effects and coastal hazards' intensity. The EO-P will provide comprehensive access to spatially enabled data, thereby supporting decision-making in CC management, mitigation, and adaptation. Moreover, it will serve as the main end-user interface depicting the results either developed or integrated throughout the OCEANIDS project. Finally, the main functionalities of EO-P are discussed through the Preliminary Visual Design and Platform Mock-ups.

9 References

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