



score

D8.7-Tools to access and visualize SCORE data and outcomes release notes

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym / Abbreviation	Meaning / Full text
2D	2-dimensional
3D	3-dimensional
AI	Artificial intelligence
API	Application program interface
CCLL	Coastal City Living Lab
CRUD	Create, read, update, and delete
CSS	Cascading Style Sheets
CZML	Cesium markup language
DT	Digital Twin
DTEW	Digital Twin and Early Warning
DT-EWS	Digital twin-early warning support
EBA	Environmental-based approach/adaptation
EU	European Union
EW	Early Warning
EWSS	Early-warning support system
GeoJSON	Geographic JSON
GIS	Geographic Information System
gITF	Graphics language Transmission Format
GML	Generalised markup language
HTTP	Hypertext transfer protocol
ICT	Information and communication technologies
JSON	Javascript object notation
KML	Keyhole markup language
ML	Machine Learning
OGC	Open Geospatial Consortium
PSO	PowerSchedO
REST	REpresentational State Transfer
RPO	Research performing organizations
SCORE	Smart control of the climate resilience in European coastal cities
SIP	SCORE Information and communication technologies (ICT) platform





SME	Small-medium enterprise
SOS	Sensor observation service
STA	SensorThings API
WCS	Web coverage service
WFS	Web feature service
WMS	Web map service
WMTS	Web map tile service
WP	Work Package





BACKGROUND: ABOUT THE SCORE PROJECT

SCORE is a four-year EU-funded project aiming to increase climate resilience in European coastal cities.

The intensification of extreme weather events, coastal erosion and sea-level rise are major challenges to be urgently addressed by European coastal cities. The science behind these disruptive phenomena is complex, and advancing climate resilience requires progress in data acquisition, forecasting, and understanding of the potential risks and impacts for real-scenario interventions. The Ecosystem-Based Approach (EBA) supported by smart technologies has potential to increase climate resilience of European coastal cities; however, it is not yet adequately understood and coordinated at European level.

SCORE outlines a co-creation strategy, developed via a network of 10 coastal city 'living labs' (CCLs), to rapidly, equitably and sustainably enhance coastal city climate resilience through EBAs and sophisticated digital technologies.

The 10 coastal city living labs involved in the project are: Sligo and Dublin, Ireland; Barcelona/Vilanova i la Geltrú, Benidorm and Basque Country, Spain; Oeiras, Portugal; Massa, Italy; Piran, Slovenia; Gdansk, Poland; Samsun, Turkey.

SCORE will establish an integrated coastal zone management framework for strengthening EBA and smart coastal city policies, creating European leadership in coastal city climate change adaptation in line with The Paris Agreement. It will provide innovative platforms to empower stakeholders' deployment of EBAs to increase climate resilience, business opportunities and financial sustainability of coastal cities.

The SCORE interdisciplinary team consists of 28 world-leading organisations from academia, local authorities, RPOs, and SMEs encompassing a wide range of skills including environmental science and policy, climate modelling, citizen and social science, data management, coastal management and engineering, security and technological aspects of smart sensing research.

EXECUTIVE SUMMARY

This document is a deliverable of the SCORE project, funded under the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003534.

The aim of this document is to describe the development tools that are used to access and visualise the SCORE data and outcomes. That includes the software modules used in the frontend interface and user interface manual as a release notes. The document contains the release notes, which contains details on how to operate all the available modules and their applications. Thus, it describes the user functionalities, operation procedures and user guidance.

LINKS WITH OTHER PROJECT ACTIVITIES

This document takes inputs from all the available SCORE project deliverables D8.1 - GIS Based Digital Twin Platform functional requirements [1] and D8.2 - GIS Based Early Warning and Digital Twin Platform system architecture and design [2], SCORE D8.3 – GIS-Based Early Warning and Digital Twin Platform Interface Control Document [3], and SCORE D8.10 - Early Warning and Spatial Digital Twin Assessment Plan [4]. Whereas for the Early Warning System and digital Twin, platform details, D8.5 [5] has been considered. The sensor data for the SCORE platform will be considered from the sensor services in WP3, especially sections 3.1 [6] and 3.6 [7], with the deliverables SCORE D3.1





- Package of procedures for baseline characterization and projections, and SCORE D3.6 - User document for statistical analysis tools for urban-scale hazards and data samples.

The interface is built on the SCORE Information and communication technologies (ICT) platform (SIP) defined in SCORE project WP5, risk maps given by SCORE project WP6, and a list of Nature-based solutions (NBS) described in SCORE project WP7. While the outputs are applicable to SCORE WP8 system development, integration, deployment, validation, and assessment activities (project tasks T8.2, T8.3, T8.4, T8.5).





Table of Contents

1. Introduction	10
1.1. Scope of this report	10
1.2. System access and home page	11
1.2.1. Portal homepage	11
1.2.2. Data Access: Geospatial Catalogue Explorer	11
2. DT-EWS web user interface architecture.....	13
2.1. Web-based Geographic Information System (Web GIS)	13
2.2. User Scenario Evaluation (USE) interface	15
2.3. Early Warning Support Subsystem (EWSS)	15
3. Data Visualisation: Map Viewer	16
3.1. SCORE ICT Platform (SIP) Data	16
3.2. Hazard Maps	17
3.3. Flood Maps	18
3.4. User Scenario Evaluation (USE) Subsystem data	18
3.5. Early Warning Support Subsystem data	19
3.6. Official Sensor data (STA)	19
3.7. CCLLs and citizen science Activities Sensor Data	20
3.8. Data Stories	20
3.9. Sensor Explorer	21
4. User Scenario Evaluation interface.....	23
4.1. Scenarios EBAs editor	23
4.2. Scenarios Parameters Editor	25
4.3. Scenario Simulations Outputs	25
5. References	27





LIST OF FIGURES

Figure 1: SCORE DT_EWSS homepage	11
Figure 2: Catalogue explorer after login	12
Figure 3: User operation flow (as reported in D8.10)	14
Figure 4: SCORE DT-EWS system data catalogue	16
Figure 5: SCORE ICT platform SIP data	17
Figure 6: Visualisation of flooding (water depth) results computed with LISFLOOD for the CCLL of Massa area.	18
Figure 7: USE subsystem exploration and visualisation	19
Figure 8: Early warning flood damage explore and visualisation.....	20
Figure 9: Interactive data stories creation module	21
Figure 10: Sensor Network exploring and location of sensors on the map (sensor data can selected from the map).....	22
Figure 11 User scenario evaluation interface.....	23
Figure 12: List of EBA solutions for a User Scenario Evaluation in the USE interface.....	24
Figure 13: Flood scenario visualisation for Massa.....	26

LIST OF TABLES

Table 1: The main user modules for SCORE web-based GIS	10
Table 2: Access to SCORE ICT Platform (SIP)	12





1. Introduction

This document is a part of the technical deliverables of WP8 (Development of integrated early warning support system and spatial digital twin solution prototypes) of the SCORE project. The objective is to provide a release note for the results of the developed tools to access and visualize SCORE data. The report includes details about all the software modules release notes and user manual for accessing the data.

SCORE Digital Twin-Early Warning Support (DT-EWS) architecture system designed and implemented during the project will be discussed here. This DT-EWS innovative decision support system is developed for the municipalities to provide support in the design and implementation of measurements to mitigate and adapt to climate change. This digital model will allow to simulate the effects of actions (e.g., nature-based solutions) considering different possible climate threats and conditions.

1.1. Scope of this report

The report aims to document the DT-EWS system functionalities, design, implementation, and operational procedures for the end-user. For each developed version of the software, release notes will be created to list the updates since the previous version(s).

The SCORE Geographical Information System (GIS) based Early-Warning and Digital Twin Platform, that in the following will be termed as DT-EWS (digital twin-early warning support) system, is composed of two main subsystems: i) Early-Warning support (EWS) and the ii) User Scenario Evaluation (USE). These subsystems run independently based on the user requirements (See D 8.10).

The main user modules for the SCORE web GIS based system described in the report are listed in Table 1.

Table 1: The main user modules for SCORE web-based GIS

Module name	Function
Web interface homepage	How to access the web interface with a visible login module. What are the existing data? eLearning modules. Reports about Open Data. How to search for datasets by data category. The keywords search for datasets user reports.
Datasets/parameters	Entering the datasets -View how to filter datasets. How to download (export data option) datasets and outcomes. How to browse by data catalogues.
Visualization of Geo-Spatial Data	How to visualize geo-spatial data from a dataset resource. Download the maps. Print the maps.
Simulations	Create user EBAs. Run the simulations. Story editor.





1.2. System access and home page

The core architecture of the SCORE Digital Twin and Early Warning Support (DT-EWS) system is composed of two main parts strictly connected by each other. The first part is the DT-EWS backend system that involves the objects and logic that define digital twin system, and the second part is the frontend visualisation system. The current deliverable report is on how 'to access and visualize SCORE data', which is about the frontend visualisation system. The frontend interface is to communicate with the backend resources and capabilities introduced above via a HTTP request/response model and Open Geospatial Consortium (OGC)- communication protocols. The DT and EWS subsystems offer several web GIS functionalities for data visualisation based on open-source geospatial technologies.

1.2.1. Portal homepage

The DT-EWSS portal can be opened in the test environment available in this [link](#), and the homepage is as shown in Figure 1.

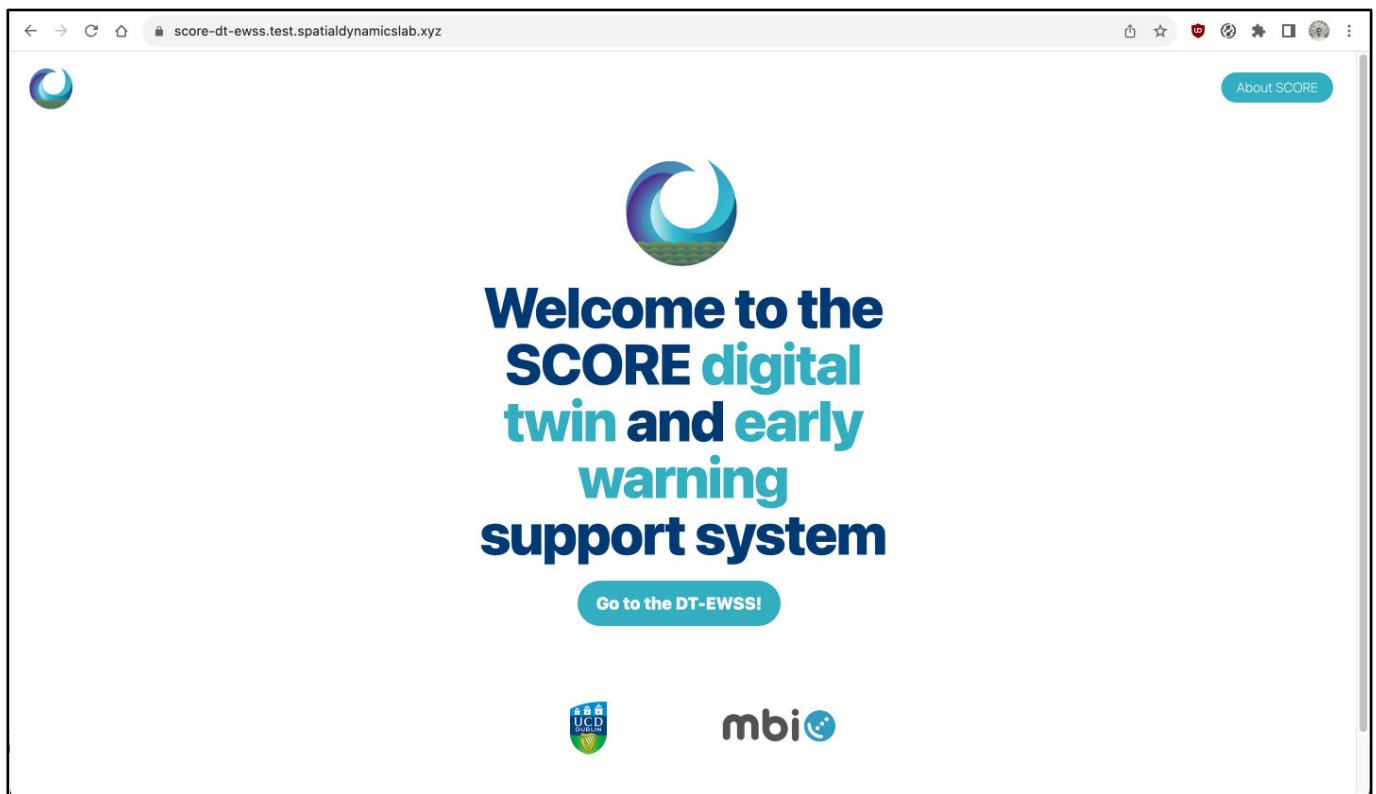


Figure 1: SCORE DT_EWSS homepage

1.2.2. Data Access: Geospatial Catalogue Explorer

To access the data in the SCORE ICT platform, one must login with a 'username (User ID)' and a 'password' on the SCORE DT-EWS web user interface. The catalogue can be explored once the login is successful. Once the login is successful, the user can see the login homepage, (shown in Figure 2). The system has multiple modules to search, explore, visualise the data and print or share them with map stories. This advanced system also helps users to upload the data layers to manage, simulate and visualise the outcomes.





Table 2: Access to SCORE ICT Platform (SIP)

SCORE ICT PLATFORM	
1	Log in: User ID + Password on a web-based interface.
2	Browse/Visualize official data (baseline DEM/DTM, hydrography, hazard maps, etc.)
3	Browse sensor distribution maps
4	Upload/Download/Edit official data
5	Browse the list of possible EBAs (possibly with a description)
6	Browse/Visualize simulation results
7	Download Simulation results
8	Log out

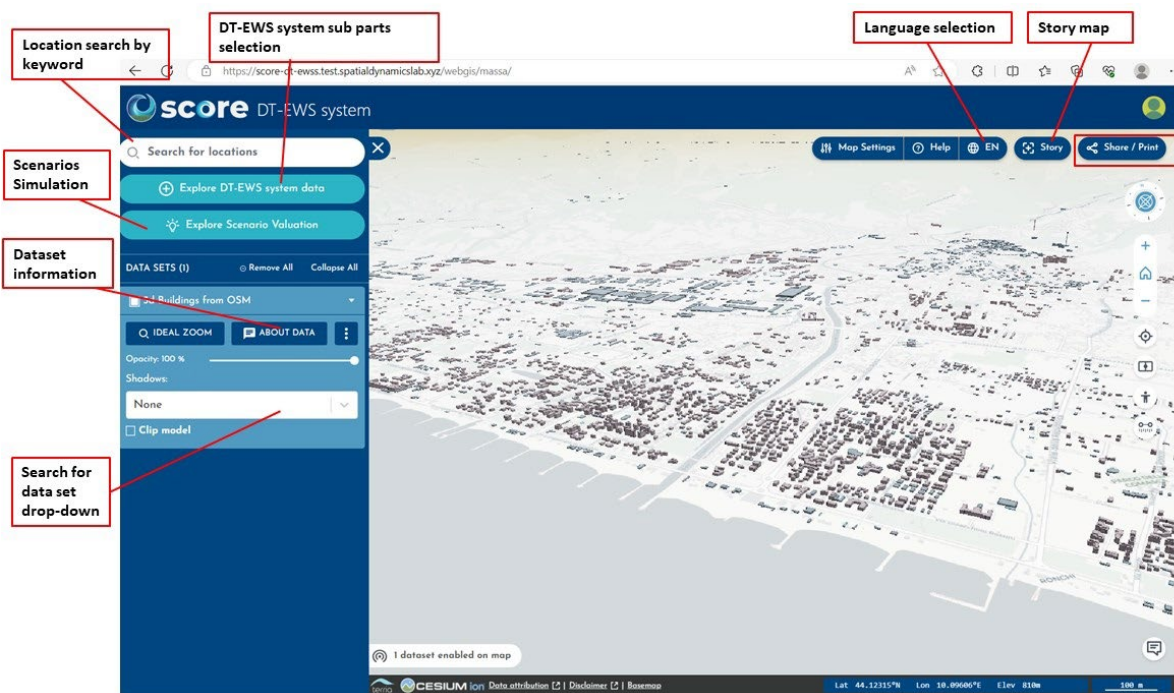


Figure 2: Catalogue explorer after login





2. DT-EWS web user interface architecture

The DT-EWS is an end-user accessibility web-interface that will make use of GIS-based techniques for data visualization with 2-Dimensional (2D) and 3-Dimensional (3D) support. The web user-interface majority of data are stored in the SCORE ICT platform (SIP) or will come from the live active sensor while monitoring. However, the end-user does not directly interact with SIP, instead via data service function using the REpresentational State Transfer (REST) application interfaces. Therefore, the interface here is the point of interaction between a user and the web application. The interface will manage to integrate different datasets from various sources from SCORE SIP WPs data and other publicly available sources of geospatial data providers such as Copernicus, to explore and map the layers.

The DT-EWS system was developed using a variety of technologies, including the Django web framework, CSS and Javascript libraries, and online GIS and web mapping tools. Django is a Python framework that works with the Unicorn and Nginx server technologies to control views, URL paths, and functions to pre-process the data coming from the backend to optimise the frontend data accessible. These functions help to enhance the web data access and visualisation with backend interactions.

The CSS and Javascript libraries enhance user functionalities by using the Tailwind CSS, Flowbite, JavaScript, and Axios and create an application user interface that can Create, Read, Update and Delete (CRUD) operations by communicating with the backend APIs. Flowbite Django UI complements Tailwind CSS by providing interactive UI components for Django-based web projects, Tailwind CSS simplifies front-end design, responsiveness, and styling. While REST API calls can be made straight from the browser with Axios' promise-based HTTP client when necessary. These libraries help in the 'User Scenario Evaluation (USE) interface' to manage the scenarios, particularly with the CRUD interface.

The web GIS and web mapping libraries include the industry standard methods such as The Open Geospatial Consortium (OGC) data formats, Web Map Services (WMS), Web Feature Service (WFS), and Web Map Tile Services (WMTS) standards for the geographic data access from the backend subsystems. The Web GIS uses the TerriaJS platform for exploring geospatial catalogues and visualising data. An open-source frontend javascript library 'React' is used for creating user interfaces based on components. While, for 2D interactive mapping and Cesium for 3D web-based geospatial visualisation, the TerriaJS framework smoothly integrates both technologies.

The DT-EWS Web User Interface uses a combination of these technologies to provide a strong, intuitive, and cutting-edge platform for enabling the best possible data management, geospatial visualisation, and user interaction. Further, the use of open-source platforms makes it more scalable and ensures the repetitive usability of the web app.

2.1. Web-based Geographic Information System (Web GIS)

The TerriaJS framework serves as the foundation for the Web GIS platform. The framework is chosen for its sophisticated capabilities in geospatial data analysis and visualisation and provides users with an advanced yet intuitive interface for accessing and visualising SCORE data and results. The system further ensures the user with a range of data (from geospatial, real-time sensor, and forecasted scenarios) accumulating continuously and managing 2D/3D map viewing facilities. The key features of this component are:





1. Data catalogue and integration
2. Interactive data exploration and visualisation
3. 3D/2D visualisation
4. Data sharing and collaboration

The geospatial catalogue explorer will allow users to see the multiple data sources and formats, forecasted scenarios and any other layers/maps available. While the interactive data exploration helps the users with tools to search and explore the available datasets and visualise them on map/layer format or charts and attribute tables. It further has the capability to edit the map styles with attribute data from maps, create stories and print the maps. The map viewer with 2D/3D visualisation capability integrates with the Cesium JavaScript library and WebGL for the full 3D earth image to analyse the data in a 3D or 2D map view. While creating a unique URL to access the Web GIS, the system helps the user to share the map view and data story.

SCORE web-based GIS services are intended to facilitate the process of how to organise, manage and obtain geospatial data to mainly support risk analysis, EBAs analysis and monitoring the active sensor data for different variables for early warning awareness services. The mapping of spatial data objects and their relationships between natural or anthropogenic interventions, climate change and adaptation as well as providing the Ecosystem based approach policies for the coastal communities along ten coastal cities of the project. As most of the data are spatial, GIS can be used for the identification of hazards and visualising them with risk maps. In addition, the web-GIS interface services showcase the potential hazards and their associated risks or damages, assisting in the generation of decision-making reports for implementing preventative measures. The software modules description can be seen in D8.6. The flowchart for the web interface is as shown in Figure 3.

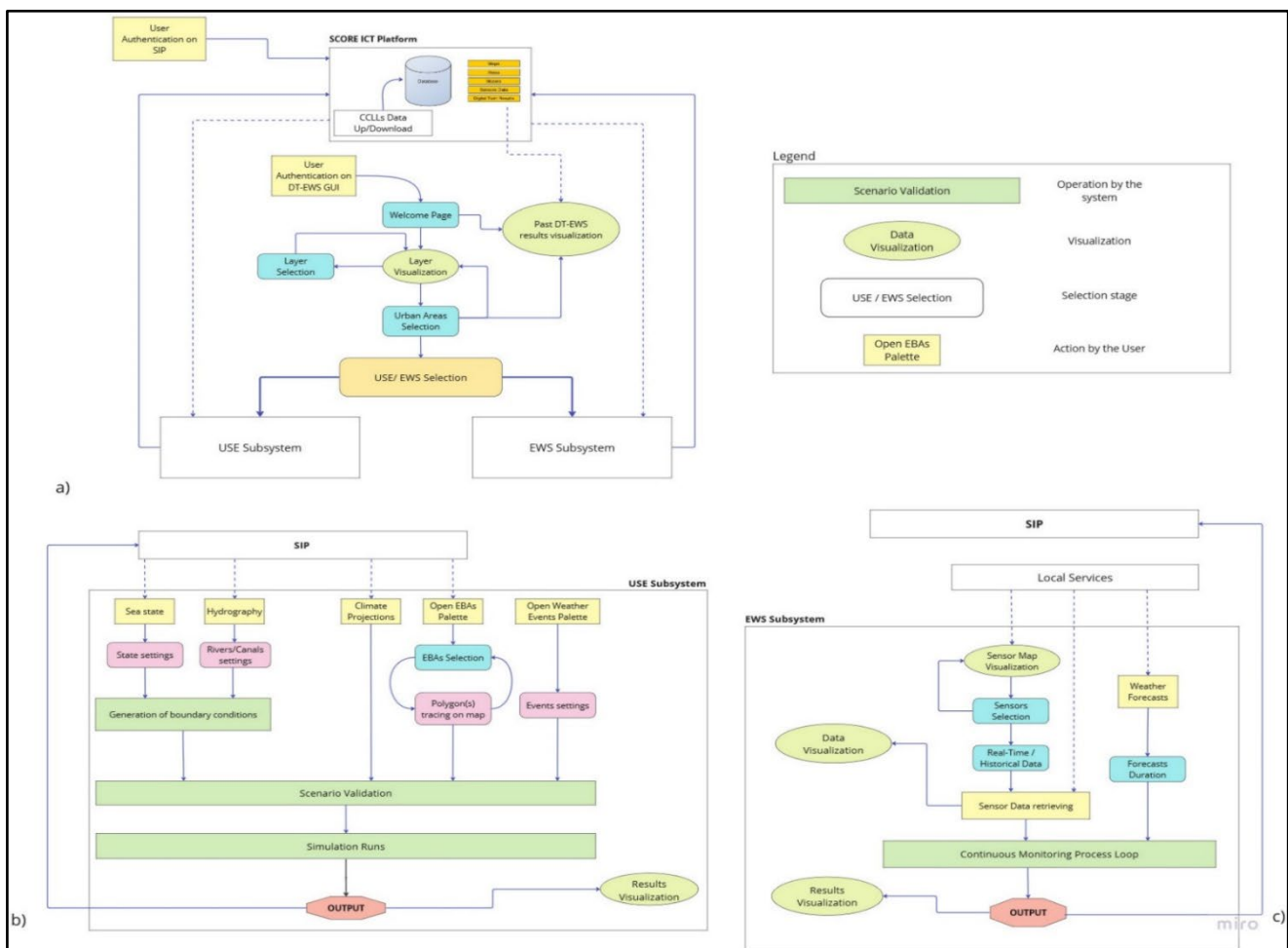


Figure 3: User operation flow (as reported in D8.10)





2.2. User Scenario Evaluation (USE) interface

Within the DT-EWS Web User Interface, the USE Interface is created to facilitate effective scenario management. The interface focuses on the management and assessment of the user created scenarios. The CRUD interface in the USE enables the user to create, read, update and delete the scenarios, by facilitating the dynamic data inputs as simulation parameters and Ecosystem-based Adaptation solutions creation using the web map digitalization and editing. Further, scenario evaluation and simulation output integration can be performed using the USE digital-twin backend model and can be directly linked to the Web GIS component to visualize the analysis data. The interface further has options to print or share the outputs.

2.3. Early Warning Support Subsystem (EWSS)

The objective of EWSS is to study the real-world data and create simulations to provide early warnings of coastal risks such as floods, sea level, storms etc. The EWSS scheme goes through a process flow for every run. The system goes through three primary steps:

1. Data aggregator (Active Sensor data and forecast data)
2. Cluster of data (with precomputed scenarios, historical scenarios)
3. Interpolator (to integrate and manage the events corresponding to different scenarios)

The system uses Artificial Intelligence (AI) / Machine Language (ML) algorithms that take the data from active sensors, weather forecasts and historical data to provide the scenarios for possible hazard information with maps. The process accumulates the input using the ML approach, such as feature selection strategies or dimensionality reduction algorithms and validated historical data and then classified using the real-time scenarios along with the existing precomputed scenarios in the library. The above ML based approach then compares the past scenarios with the observations and forecasts the occurrence of any damage (or risk) due to any extreme event. The probability occurrence predicted will be for multiple scenarios and an early warning is generated with probable decisions to adapt to or reduce the risks at socio and economic levels. The users can receive these early warnings to prepare for, while all these warnings will be stored in the repository for future predictions. The aim for the EWSS is to identify an extreme event right away from the current scenario that has been seen but is not intended to estimate how likely the event occurs. Therefore, the synthetic scenarios will not be considered for the actual historical events. For this SCORE EWS-DT platform, the downscaled models from WP3 (D3.6) will be considered.





3. Data Visualisation: Map Viewer

The data visualisation comes under the frontend part of the DT-EWS and is based on three web mapping technologies, Leaflet for 2D interactive mapping, CesiumJS for 3D geospatial visualisation, and TerriaJS as a web GIS development framework (See D 8.3). The geospatial data formats such as Geographic Javascript Object Notation (GeoJSON), Generalised Markup Language (GML), and Keyhole Markup Language (KML) will be accessible by end users through a web-based interface, for vector data, Graphics language Transmission Format (gTIF) and Cesium Markup Language (CZML) for 3D models, GeoTIFF for raster data, etc. Further, The Open Geospatial Consortium (OGC) web services such as Web Map Service (WMS) etc, are also available.

SCORE DT-EWS system data can be explored from the login page. The main parts of this system have three primary data contributors, they are i) SCORE ICT platform, ii) User Scenario Evaluation subsystem data and iii) Early Warning Support subsystem data. Any other datasets can be seen in other geospatial data, whereas a user can add the layers for their study area, which are only visible to the login user. Figure 4 shows, the DT-EWS system data interface in the portal.

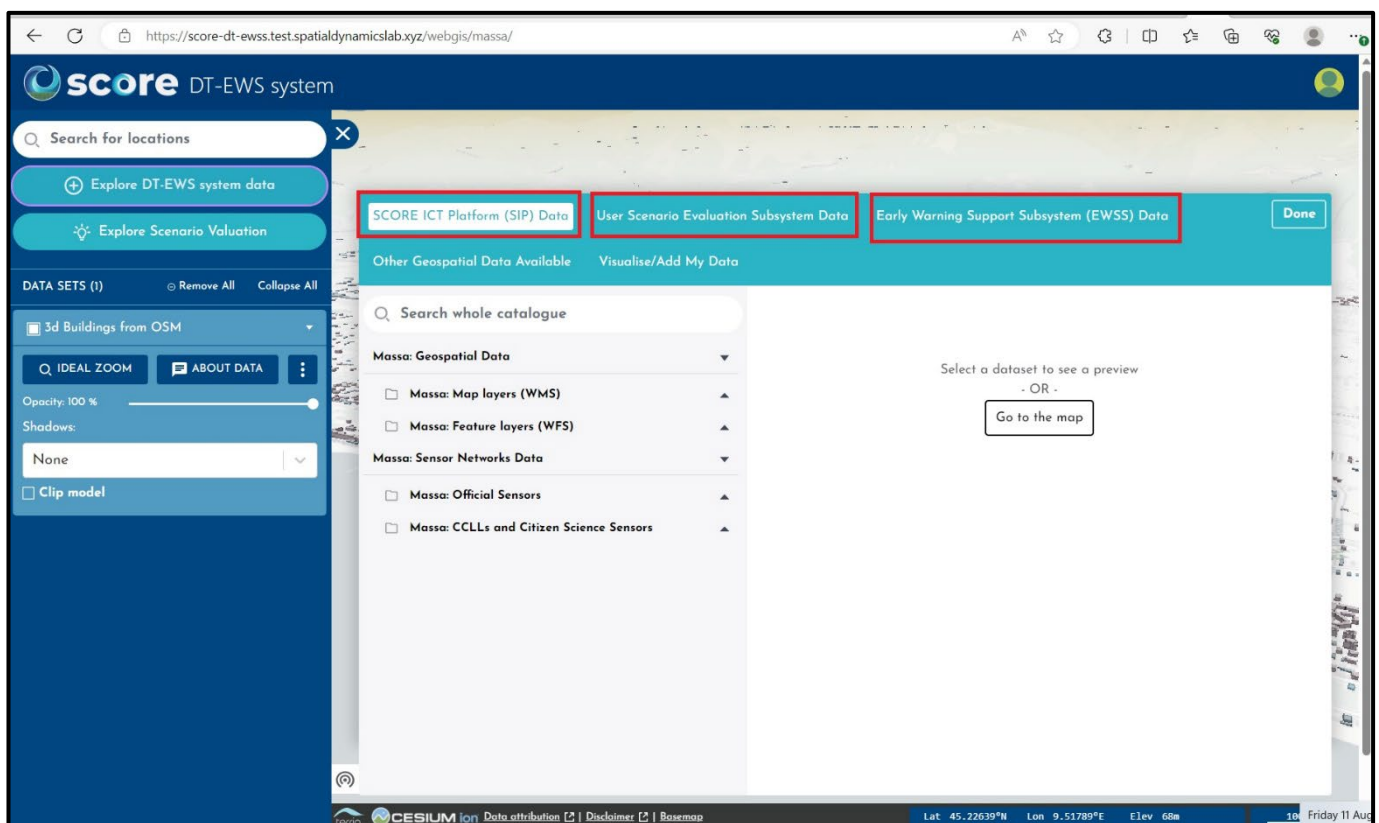


Figure 4: SCORE DT-EWS system data catalogue

3.1. SCORE ICT Platform (SIP) Data

SCORE ICT platform (SIP), featuring the SCORE database contains all the heterogeneous data and models generated from all the SCORE WPs. The platform is still under process, where the WPs outcomes all together will be employed to collect, store, and share the data that has been acquired or processed on different interfaces. The main advantage of the SIP platform is to store the long-term data of study areas and efficient use of the platform to analyse a diverse





range of parameters such as extreme events, sea level rise and coastal erosion to prepare more valid EBAs for the future. Thus, will provide DTS with continuous monitoring and develop a smart EWSS against extreme events.

The SCORE ICT platform (Figure 5) is collecting different datasets and makes them available all the relevant results of data processing by the DT and EWS subsystems. The platform will store the raw data coming, e.g., from meteorological models or historical records, from environmental risk maps, or raw data gathered by the already established environmental sensor networks, as well as by the low-cost sensors operated by citizens. The ICT-SIP interface is developed using the WP5, 'the exposure and vulnerability enabled maps provided by WP6, and the list of solutions or policies based on EBAs from WP7.

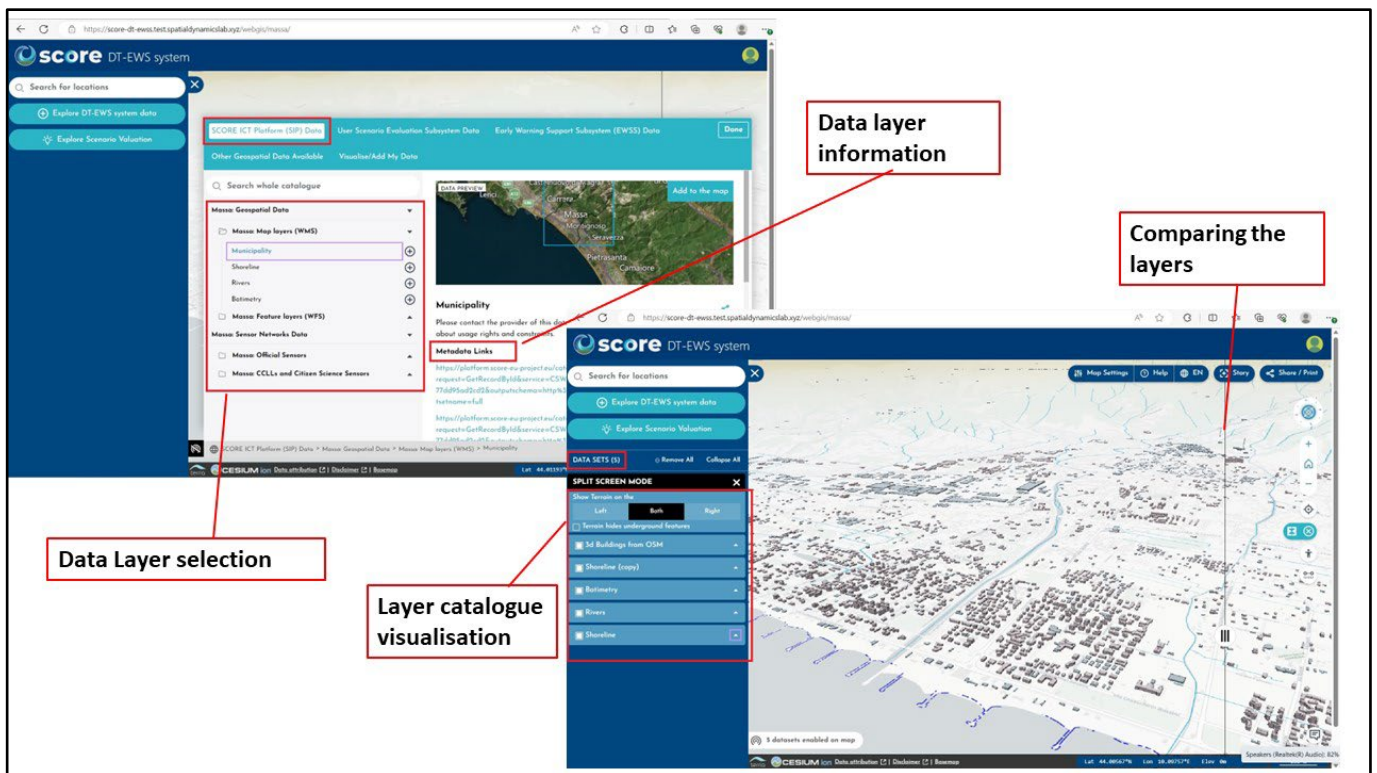


Figure 5: SCORE ICT platform SIP data

3.2. Hazard Maps

Data from sensors gathered will be accumulated continuously to develop the early warning hazard maps and policies. Additionally, forecasting and spatiotemporal analysis to build future scenario maps and hazard level maps can be made available for end-users provided with a few computational models for the DTEW along with sensor observations.

For early warnings and hazard levels of rising sea levels, coastal and land flooding, coastal storm surges, meteorological conditions, and environmental monitoring (such as heat islands, pollution, and riverbed condition), near-real-time observations must be processed. While, to monitor slower environmental processes or non-immediate hazards, such as coastal erosion, dunes displacement, or water distribution and quality, observations from official sensors must be combined with citizen sensing activities and reporting. WP4 will supply the sensor technology to be utilized by citizens and incorporated into the platform. The task further will involve D8.2, D8.3, as well as the results of T8.1 for the advancement of the Early Warning Support System and Digital Twin Platform components.

The web interface shall be able to simulate several events such as storms, rain, flood, storm-surge inundation etc., to analyse their effects on the coastal cities to get information about the risks and develop hazard maps.





3.3. Flood Maps

Assesses the land area covered by water in different water flooding scenarios can be studied with the SIP. LISFLOOD_FP hydraulic model shall be used to evaluate the time-series output layers in raster layer format with cells/grids. The resultant output (flooding distribution with water depth values) will be indicated on each cell/grid. The probability of occurrence of floods forecasted is then sent to EWSS to set up an early warning for the floods (with water depth values). The obtained raster layers for flooding are in GeoTiff format, therefore are ready to visualise immediately making it easier for the authorities and citizens to take up necessary actions.

Figure 6 shows the flooding water depth values for Massa (one of the CCLs), as a set of polygons showing the flooded area.

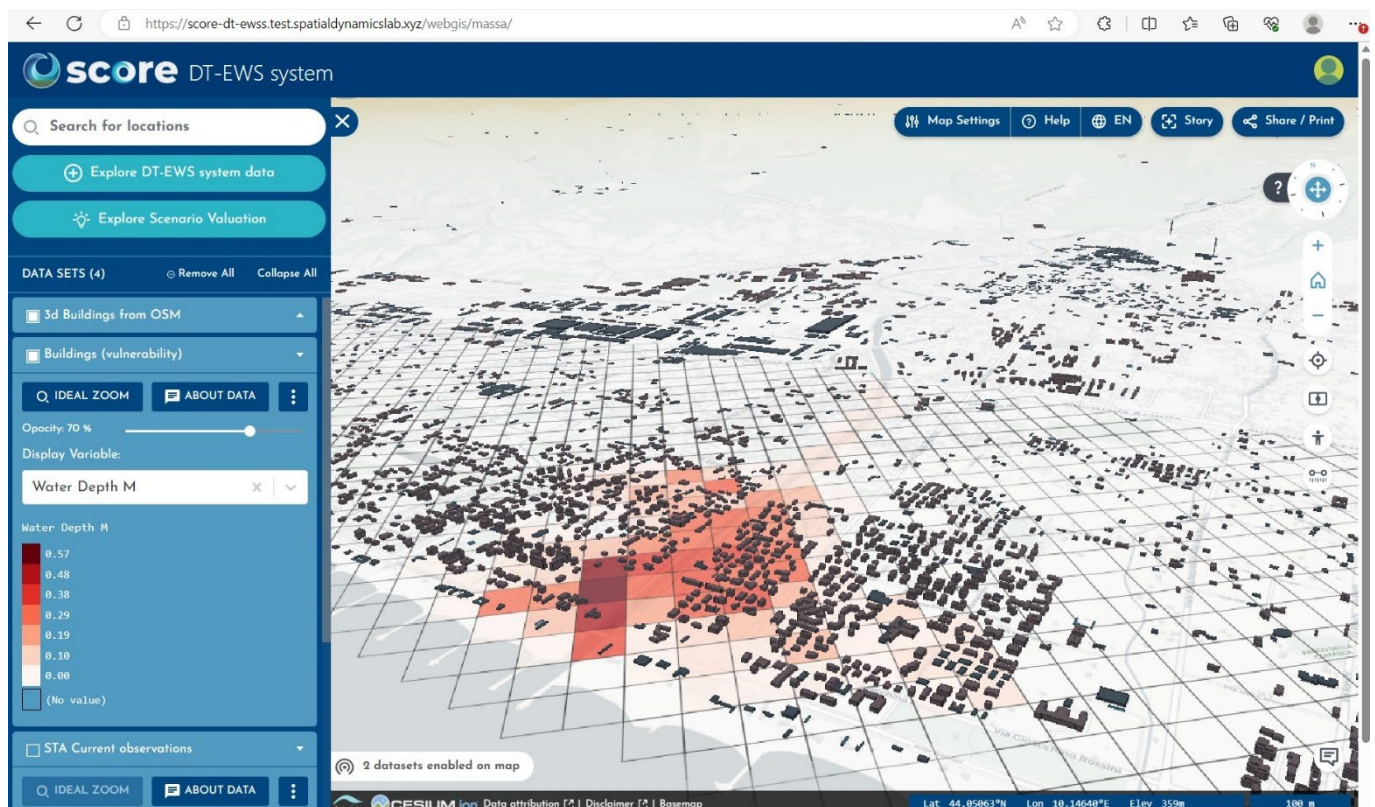


Figure 6: Visualisation of flooding (water depth) results computed with LISFLOOD for the CCL of Massa area.

3.4. User Scenario Evaluation (USE) Subsystem data

The USE interface is a subsystem in the DT-EWS, and it allows users to perform simulations regarding weather-related factors, and *what-if* scenarios including climate change influenced long-term scenarios at the local level. For example, risk maps can be prepared for flood hazards and damage occurrence to buildings or road networks by quantifying different factors. With the help of Ecosystem Based Approaches (EBAs) and map visualizations, it can help policymakers and citizens to evaluate the risks and take the necessary adaptation measures. Further, the interface also helps to take any other possible actions to enhance coastal cities and their resilience against the risks through nature-based solutions (NBSs) or engineered solutions. For this purpose, the USE subsystem will take a range of datasets such as sea/ocean conditions, hydrographic, weather and climate data to generate the EBA polygons for any coastal location with multiple scenario simulation runs. Figure 7 shows the USE subsystem.



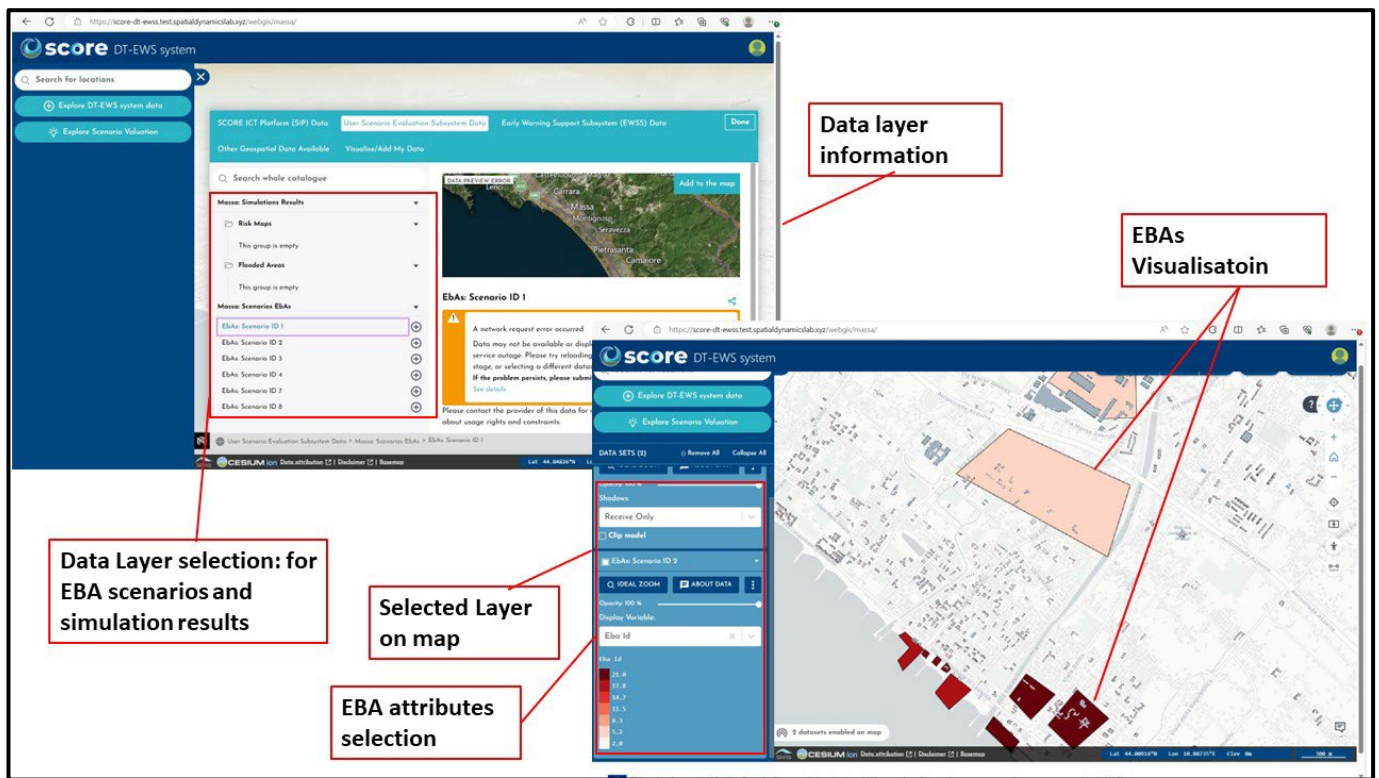


Figure 7: USE subsystem exploration and visualisation

3.5. Early Warning Support Subsystem data

The EWSS inputs for the simulations can be taken from models such as storm surge models/hydraulic models, for example, LISFLOOD-FP model is chosen for flood assessment. The scenarios are created in the same way as for the USE subsystem. This hydraulic model computes the time-series of flood events, from which the subsystem runs the scenarios, and develops maps in raster format. The output maps evaluate the flood level (water depth), or damaged area or elements such as buildings/roads due to floods (Figure 8).

The output raster files (in GeoTIFF format), and the damage layers (GeoJSON format) are then directly exported to early warning repository to visualise for different stakeholders, such as the decision-making authorities, citizens and other stakeholders.

3.6. Official Sensor data (STA)

The OGC STA (SensorThings API) servers are available mostly to connect and get data directly from CCLLs sensor networks. A STA and SOS (Sensor observation service) web service will be able to handle the sensors that are available to the DTEW in the SCORE SIP interface. The location of the sensors will be retrieved and shown on the map view using the OGC SOS 'DescribeSensor' operation and the OGC STA Thing and Location endpoints connected to the available sensors data. The user can explore the available active sensors on the map as well with map locations. The OGC STA facilitates DTEW technical development by providing access to current sensor observations using a REST API and (Geo)JSON encoding for data delivery to the user. The active sensors data will be fed into the network continuously for early warning support maps.



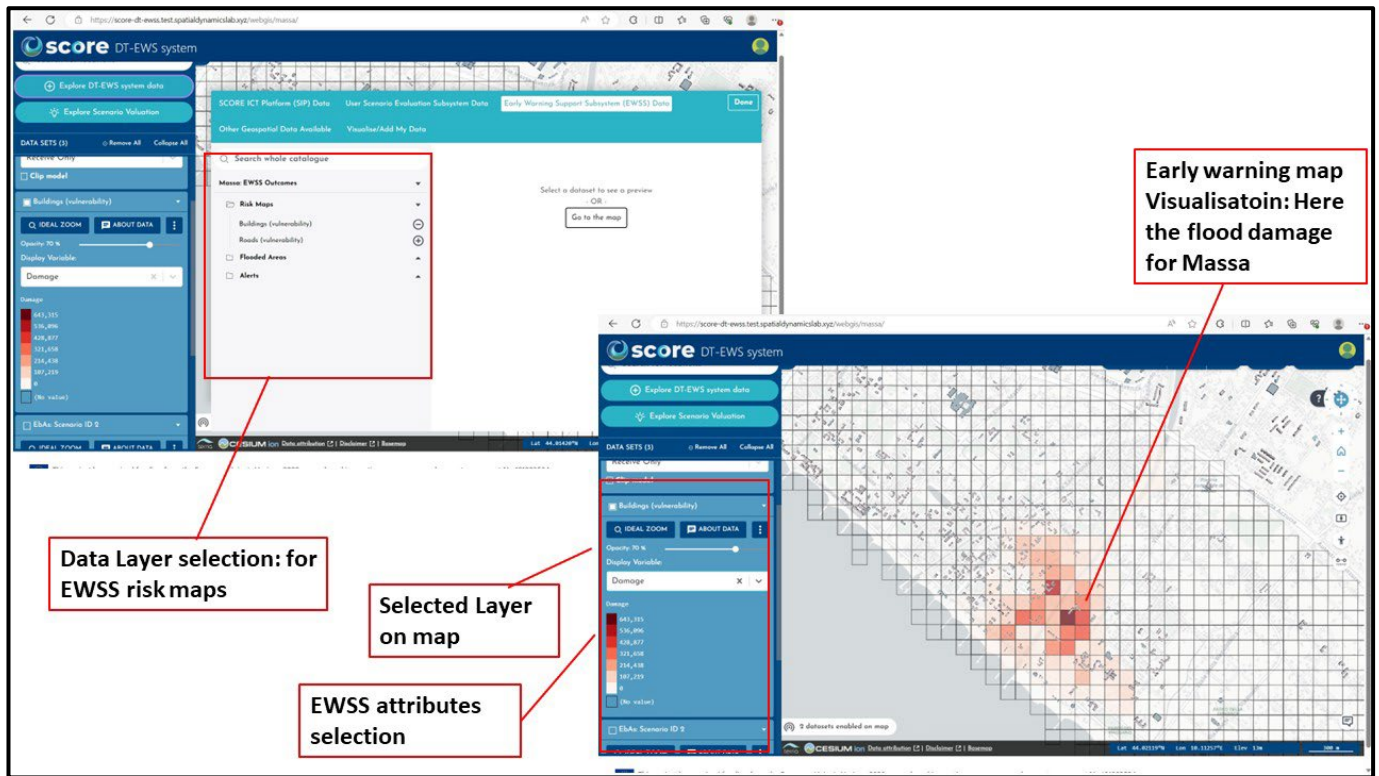


Figure 8: Early warning flood damage explore and visualisation.

3.7. CCLs and citizen science Activities Sensor Data

The deployment of sensors for the CCLs and citizen science activities is now underway. The objective is to collect data using low-cost sensors and raise the spatial resolution of the research area with citizens in order to encourage them to participate in adaptation policies. Once the sensors are linked to the module, the actively available sensor data can be monitored and simulated. These citizen science sensors will work in tandem with official sensors to study slow environmental processes like coastal erosion and water quality. Pebbles with sensor attachments are currently being considered for this activity, and the process is ongoing.

3.8. Data Stories

Data-stories are an interactive, that can be used as a web-based presentations that convey data-grounded narratives that build collaboration, influence stakeholders, and lead change. The stories shall be used to engage with the local communities. This will help convey the stories and facilitate stakeholders' comprehension of the data, changes, and decisions that need made. The end-user can create as many stories as possible for the stories (Figure 9).



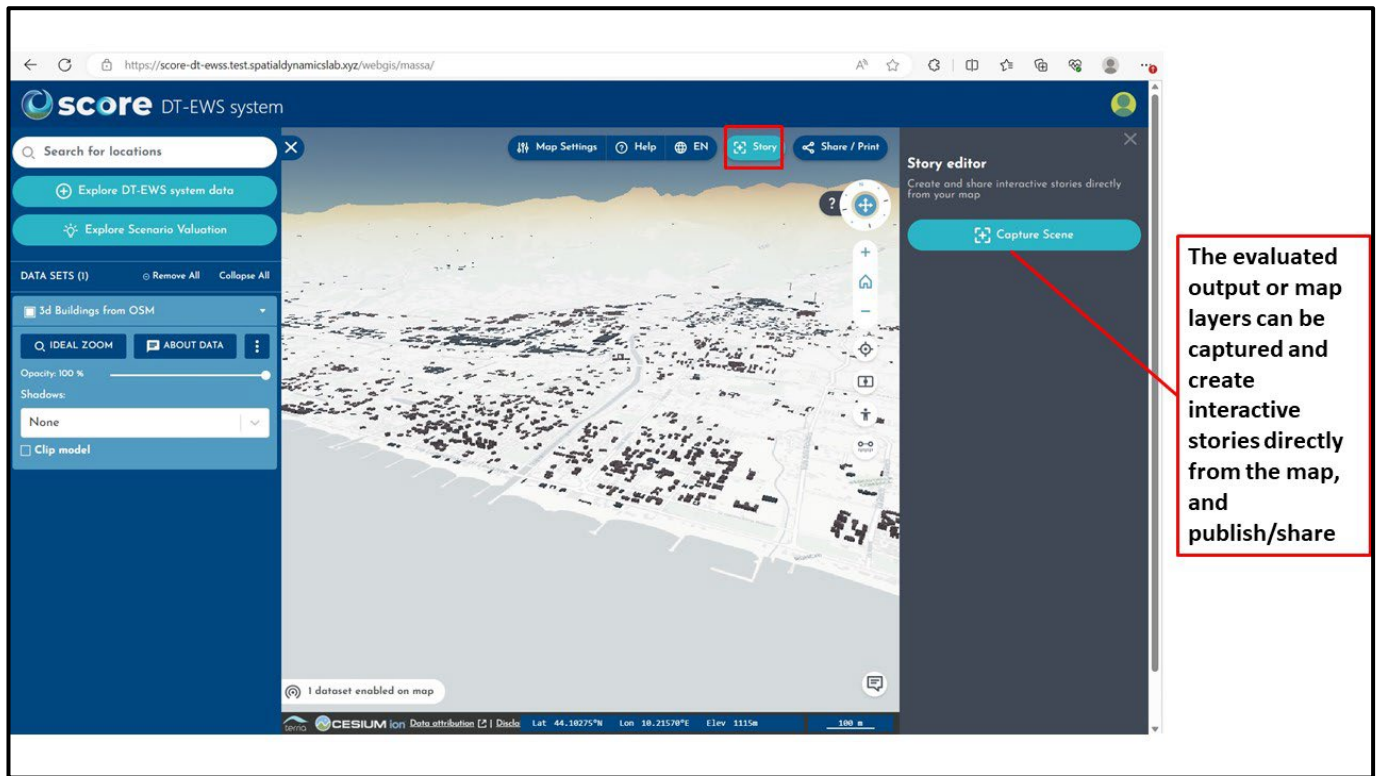
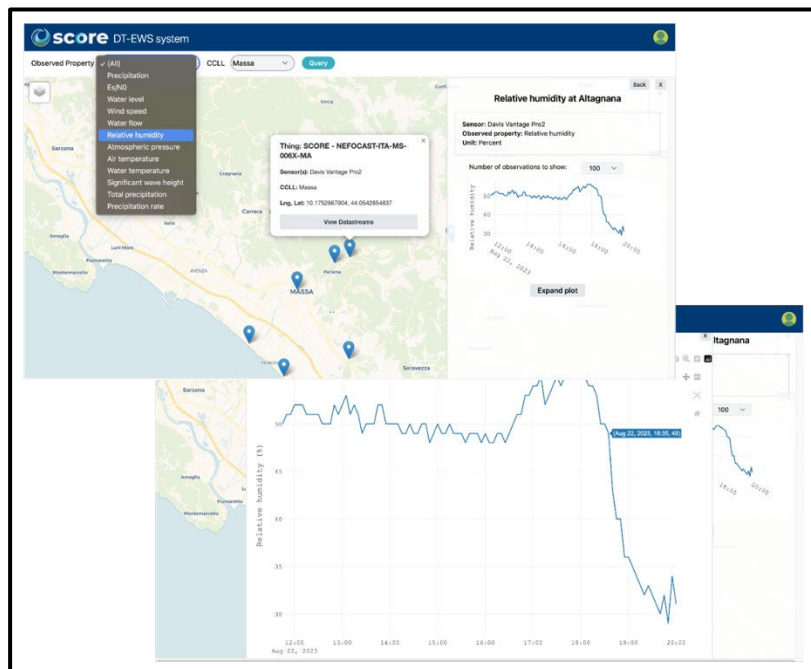


Figure 9: Interactive data stories creation module

3.9. Sensor Explorer

The sensors deployed on the ground will send the data continuously to the interface, where data is accumulated for further evaluation of EWS. Further, the developed EWS system can show the position of deployed sensors on the maps visually to explore them (Figure 10). The sensor explorer will be available in the coming version of EWS (Deliverable 8.8, Month 30 and Deliverable 8.9 Month 48)



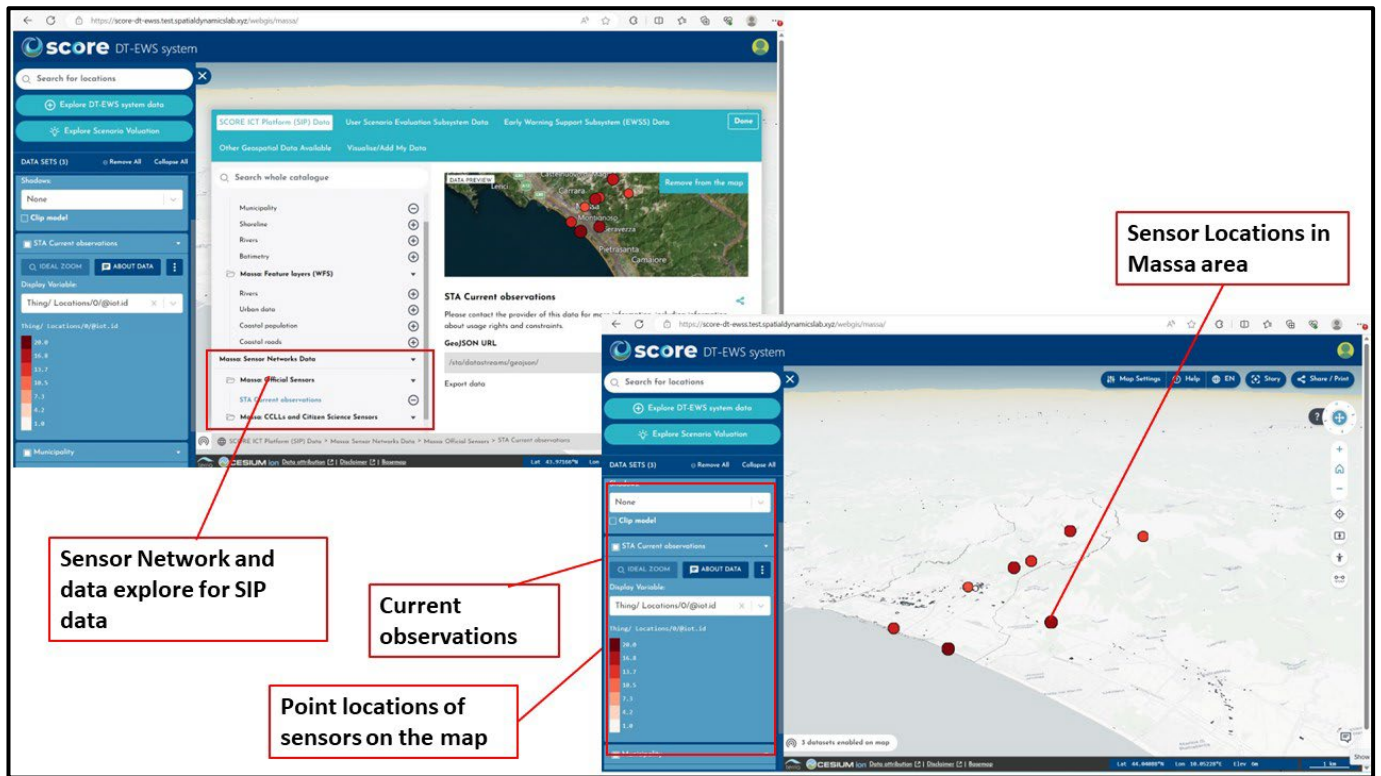


Figure 10: Sensor Network exploring and location of sensors on the map (sensor data can selected from the map)





4. User Scenario Evaluation interface

The PowerSchedO component (in the DT-EWS platform backend) is responsible for developing and running the city and environmental analysis and modelling scenarios, and then converting the results into useful data and insights for the DT-EWS web application, accessible through its USE interface. The USE interface component provides the necessary tools for the creation and configuration of simulation scenarios. User scenario evaluations can be run by employing historical or actively available datasets. Any scenario in the interface can be described using the factors, ID, Name, Description Baseline map ID, and List of ID of changes to the baseline map.

To evaluate the scenarios, first click on the explore user scenario evaluation module (Figure 11), that opens the USE web-interface, which displays previously created scenarios as well as the option to create a new one. Using the Actions button/module on the right side, you can configure a scenario by entering its details or deleting a particular scenario.

NAME	DESCRIPTION	OWNER	ACTIONS
Coastal Erosion Exploration	Years of activity has worn down the coast. As river sediment discharge meets the eroding shores, which proves more effective in shoreline protection: engineered solutions like groynes or natural ones like dune restoration?	Bob	Configuration Delete
Heatwave Amidst Tourist Boom	As a summer heatwave descends upon a tourist-packed Marina di Massa, can urban green spaces sufficiently mitigate the increased temperature? And what's the impact of high water withdrawals from rivers on local hydrography?	Bob	Configuration Delete
Riverbed and Coastal Interactions	As sections of the River Frigido's bed deepen, the pace of water flow changes. Combined with the presence of infiltration ponds and dune restoration, how would this landscape influence flood reduction, groundwater recharge, and coastal defenses?	Bob	Configuration Delete
Scenario Massa 4	This environmental scenario simulation for climate change resilience in the city of Massa aims to assess and demonstrate the effectiveness of various environmentally based solutions implemented along the city's coastline. Massa, a coastal city facing the challenges of climate change and rising sea levels, seeks to enhance its resilience and protect its inhabitants and infrastructure.	Bob	Configuration Delete
Storm Tide & River Discharge Confluence	A potent autumn storm meets increased river discharge from the hinterland. How would Marina di Massa's coastline react, especially when tested against bio-swales and green infrastructure's potential flood prevention capabilities?	Bob	Configuration Delete

Figure 11 User scenario evaluation interface

4.1. Scenarios EBAs editor

The USE subsystem will be utilised for running simulations that enable what-if and long-term analyses on scenarios created by users as a combination of real, ground-truth data from the coastal city and hypothetical data, such as weather events, sea state, and a set of EBAs implemented in the study area.

Once a scenario is created by a user and open the Configuration option, we can see the detailed description of and scenario with all the EBAs and their description (Figure 12). Here users can add new EBAs from a palette with a range of EBAs types available and start digitising them on a map (Figures 13 & 14). Also, for each EBA created the Edit data





option is also available for updating its type from the palette and its description. With respect to two other options (Edit polygons and delete). The Edit polygons option allows the end-user to edit the geometries of a set of EBAs (Figure 13), that is, their geolocated polygons on a map. A user can select the time frame to be considered for a simulation. The minimum timeframe will be 15 min, and for the first version, the maximum will be 1 hour, whereas at present the server processing take 5 minutes for 1-hour simulations. However, this will be further improved in future versions, allowing simulations to be run for up to 10 days.

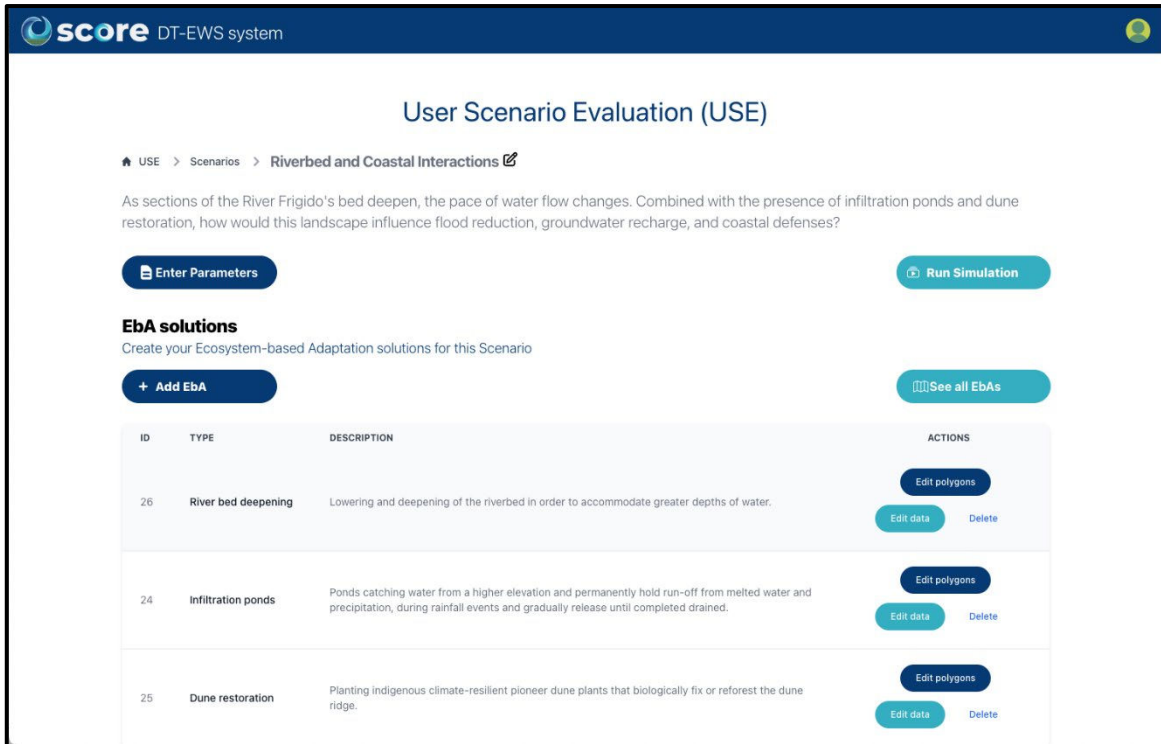


Figure 12: List of EBA solutions for a User Scenario Evaluation in the USE interface

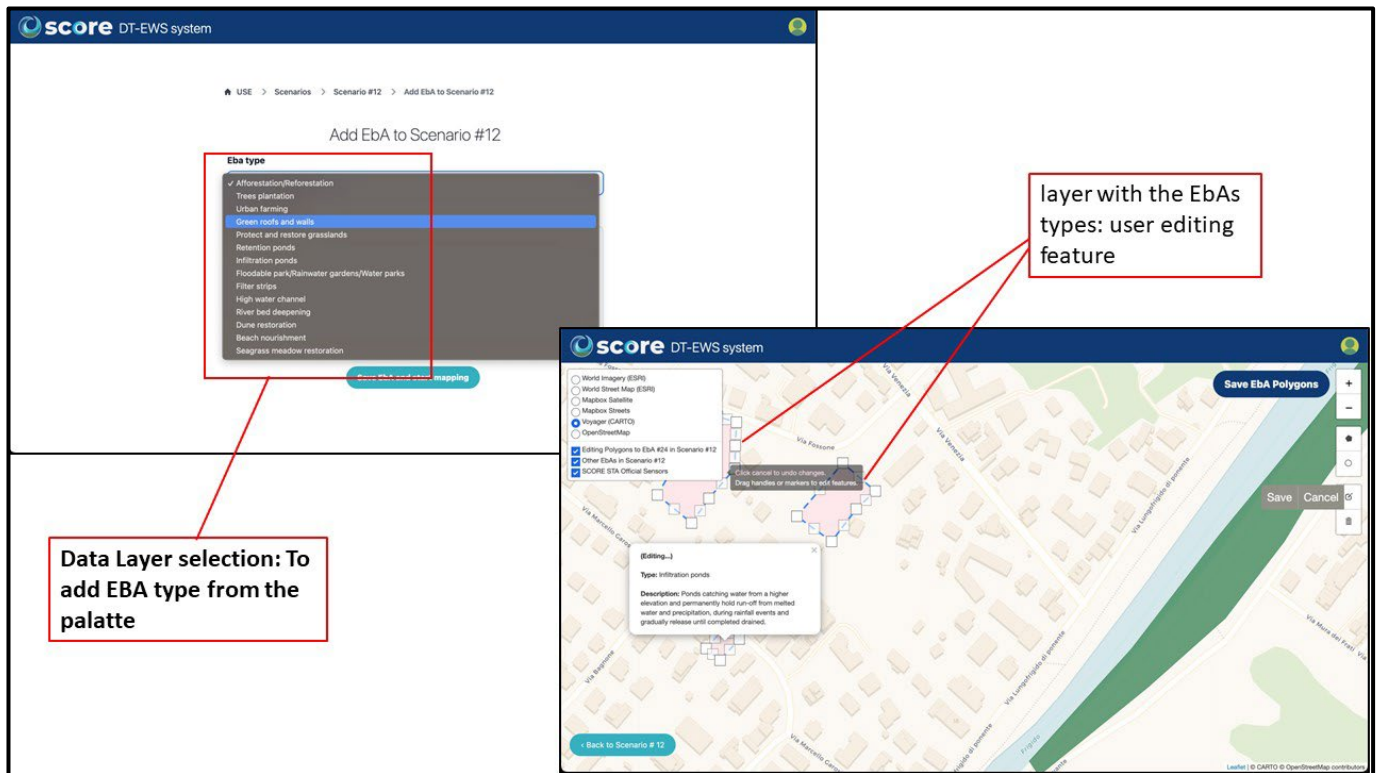


Figure 12: EBA type Palette and editing facilities on the EBA editor.



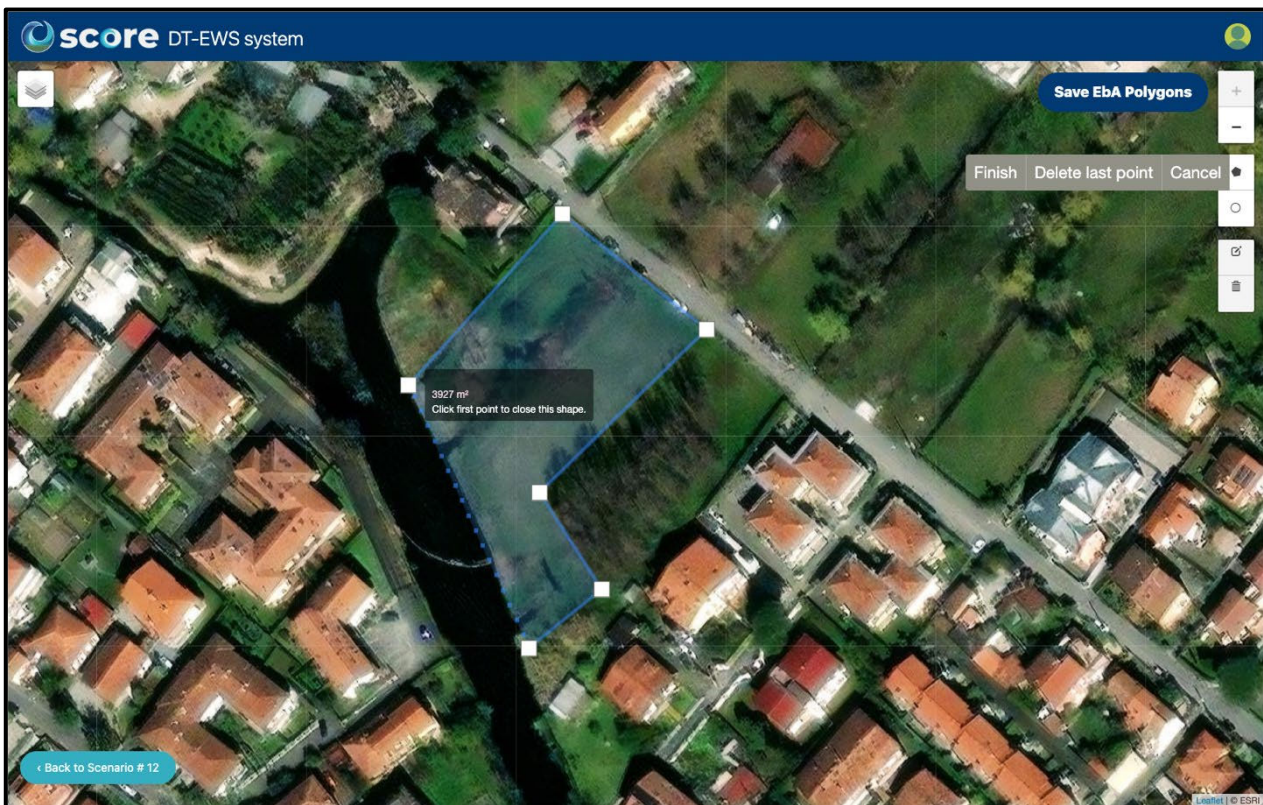


Figure 13: Adding and digitising the polygons of an EBA in the USE interface.

4.2. Scenarios Parameters Editor

Within the USE interface, the parameters for the simulation of a scenario can be entered or selected based on settings pre-set. After a user enters the Configuration of a specific scenario, there it is possible to Enter Parameters to be used for a digital twin-based simulation. The Parameters Editor view enables a user to input and select different settings as the duration of the simulation, and together with inputs based on timeslots or time intervals, introducing start and end times in minutes within the total simulation duration, the user can enter the settings for:

- the sea state with a list of categories with the available pre-sets representing the conditions of the coastal dynamics and the sea.
- the hydrographical conditions of the rivers and canals present within the CCLL simulation boundary, where specific river flow rates in m^3/s can be entered by the user, one by one in several defined timeslots. However, the user can also select input pre-sets based on historical data with different return times for the probability of a particular hydrologic event occurring with specific flow rate conditions. Also based on models of available future scenarios such as the RCP45 and the RCP85 scenarios that can generate potential impacts on river flow rates within the simulation limits.
- the weather conditions are based on a selection of pre-set weather events or based on the user specific inputs of rainfall rates in mm/h for a range of individual time intervals.

4.3. Scenario Simulations Outputs

Scenario simulations are useful in developing and creating future scenarios to identify future vulnerabilities or risks that occur due to climate and non-climate change. Once a scenario is created in the system, and edited where required, one can click on the 'run simulation' module to get the outputs. For example, to create a potential risk to the occurrence of flood and in identifying the impact of that event in-terms socio-economic





dynamics, output map projections shall be developed and shared with the stakeholders. The simulations can be analysed with the available either historical data or contextual geospatial data sets in the Web GIS. The interface also provides feedback and visualisation of information regarding the execution process, such as its time and status, as well as generated alerts and simulation results. Figure 14 shows the flood simulation output for Massa coastal area.

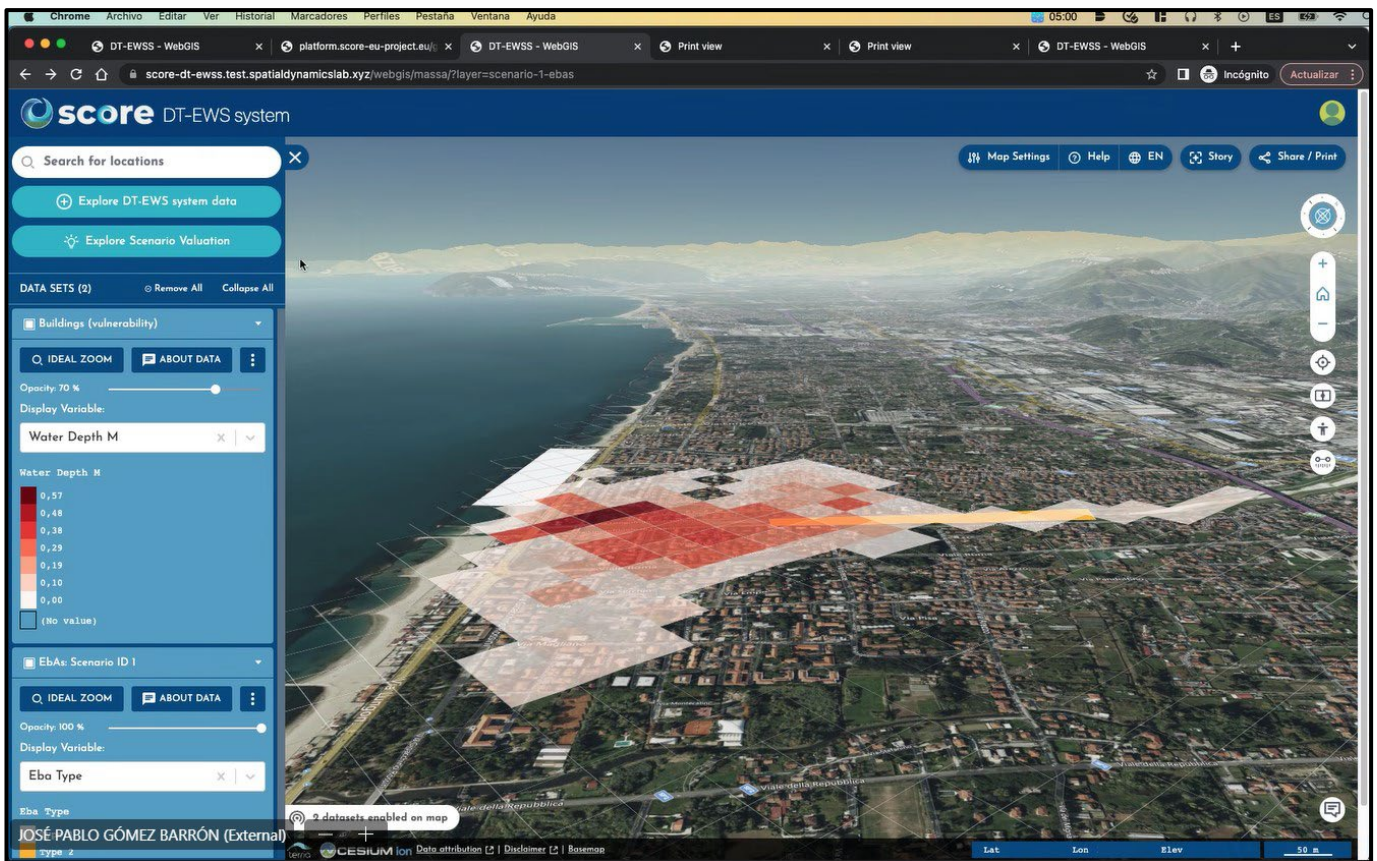


Figure 13: Flood scenario visualisation for Massa





5. References

- [1] SCORE D8.1 - GIS Based Early Warning and Digital Twin Platform functional requirements.
- [2] SCORE D8.2 - GIS Based Early Warning and Digital Twin Platform system architecture and design.
- [3] SCORE D8.3 - GIS-Based Early Warning and Digital Twin Platform Interface Control Document.
- [4] SCORE D8.10 - Early warning and spatial digital twin Assessment Plan
- [5] SCORE D8.5 - Early Warning and Digital Twin Platform release notes and user manual
- [6] SCORE D3.1 - Package of procedures for baseline characterization and projections
- [7] SCORE D3.6 - User document for statistical analysis tools for urban-scale hazards and data samples
- [8] SCORE D4.2 - Catalogue of lowcost sensors viable for citizen science activities
- [9] SCORE D4.3 - Citizen science DIY framework
- [10] SCORE D5.3 - SCORE ICT platform, 1st version
- [11] SCORE D5.4 – Application Programming Interface Middleware for Database Interfacing, 1st version
- [12] SCORE D7.1 - Synthesis of socioeconomic assessment methods, databases, and studies addressing EBAs and other adaptation strategies.
- [13] SCORE D7.2 – Methodological framework for the socio-economic assessment of adaptation measures to climate change

