

Dynamic maps of flooding of the urban surface determined

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INTRODUCTION

The dynamic maps of flooding of the urban surface determined is a web application that allows to georeference the floodings in the urban surface of the city of Venice. This web application will be used to visualize and interrogate data regarding the sea level, the tidal forecast level and the flooding forecast.

CHAPTER 1 - The dynamic maps of flooding

The Web App collects and shows data regarding the flooding in the urban surface of the city and has been developed to specifically visualize and share the following information:

1. The height of the water column present on the public footway at the given instant by referring to reference to the observed tidal level;
2. The height of the water column present on the public footway at the given instant in reference to the forecasted tidal level;
3. The time course of flooding recorded in real time;
4. The time course of the forecasted flooding;
5. The location of the sections of the footway with walkability guaranteed by the city's system of footbridges and their availability in relation to the observed tidal level and the expected tidal level in the given instant;
6. In relation to the observed and predicted tide level, possible routes to get dry footing from one point in the city to another chosen by the users.

Source of information and data availability

The STREAM Web App takes advantage of the work done in the STREAM project about flood risk management but also re-use previously available data for the City of Venice and already ongoing real time forecast services.

The streets surface elevations data are available from a high resolution lidar survey data already owned by City of Venice. The contours available were processed to create a composite Digital elevation Model (DEM) with horizontal resolution of 1 meter and vertical resolution of 5 centimeters.

CHAPTER 2 - The maps application

The STREAM Web App is an online application for production of knowledge in urban areas of Venice, developed within the STREAM Project, mainly focused on supporting flooding forecasting and tiles forecasting on quantitative and geospatial level.

Overall architecture

The development was carried out inside a Django Framework (version 3.0.06). A vector tile server, Martin, was used to compact and make more efficient the map rendering of the vector tiles containing the geographic data on the client-side application. To define origin and destination in the routing process was used the geocoder Nominatim, a software tool that converts human-readable location descriptions, such as addresses or place names, into geographic coordinates (latitude and longitude) or vice versa. It enables the translation between textual location information and precise spatial data, allowing applications to associate specific locations with their corresponding coordinates on the Earth's surface. The graphical user interface (GUI) was implemented using the REACT library, specifically using MATERIAL-UI components for faster and easier web development. The map was integrated and customized using MapLibre, an open-source JavaScript library. The chart was implemented with EChart React, a JavaScript library that combines the functionality of ECharts, a popular data visualization library, with the flexibility and ease of use of React. It provides React components that wrap the ECharts library, enabling developers to easily integrate interactive and dynamic charts into their React applications. The final layout of the new App was customized according to the visual identity of the STREAM project.

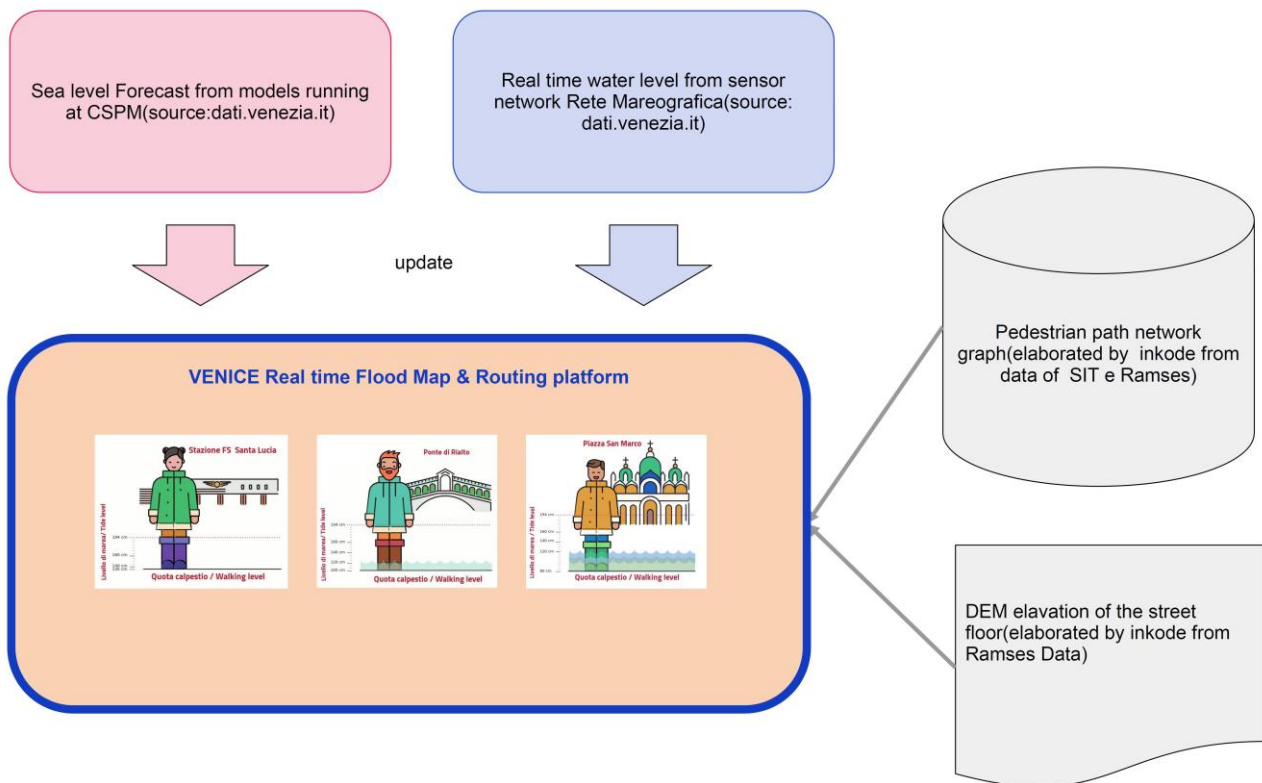


Fig. 1 Architecture components of the system and data flow

The components of architecture are illustrated on Fig. 1. High resolution elevation data for the street floors were already available from the Ramses project, a high resolution lidar survey of the city in 2011. The survey and data processing was conducted by Insula, a public company of the City of Venice. This data was processed to create a reusable elevation model in raster format.

Data harvesting

The geospatial data for the Venice streets network were given from SIT (Sistema Informativo Territoriale) using OSMnx, a Python package that allows to download geospatial data from OpenStreetMap and model, project, visualize, and analyze real-world street networks and any other geospatial geometries. The collected data were redesigned into a system of interconnected arcs and nodes using NetworkX, a Python package for the creation, manipulation, and study of the structure, dynamics, and functions of complex networks.

The real time sea levels data are collected through a semi-automatic harvesting procedure that uses periodic Celery tasks to query Open data website (dati.comune.venezia.it) and update the Web App. The forecasted tidal levels are published from Comune di Venezia on the Open data site, from these endpoints the forecast models are gathered into the Web App.

Using the Web App from Browser

In the Web App HomePage (Fig.2), besides the Navigation Bar, are visible the main components of the App.

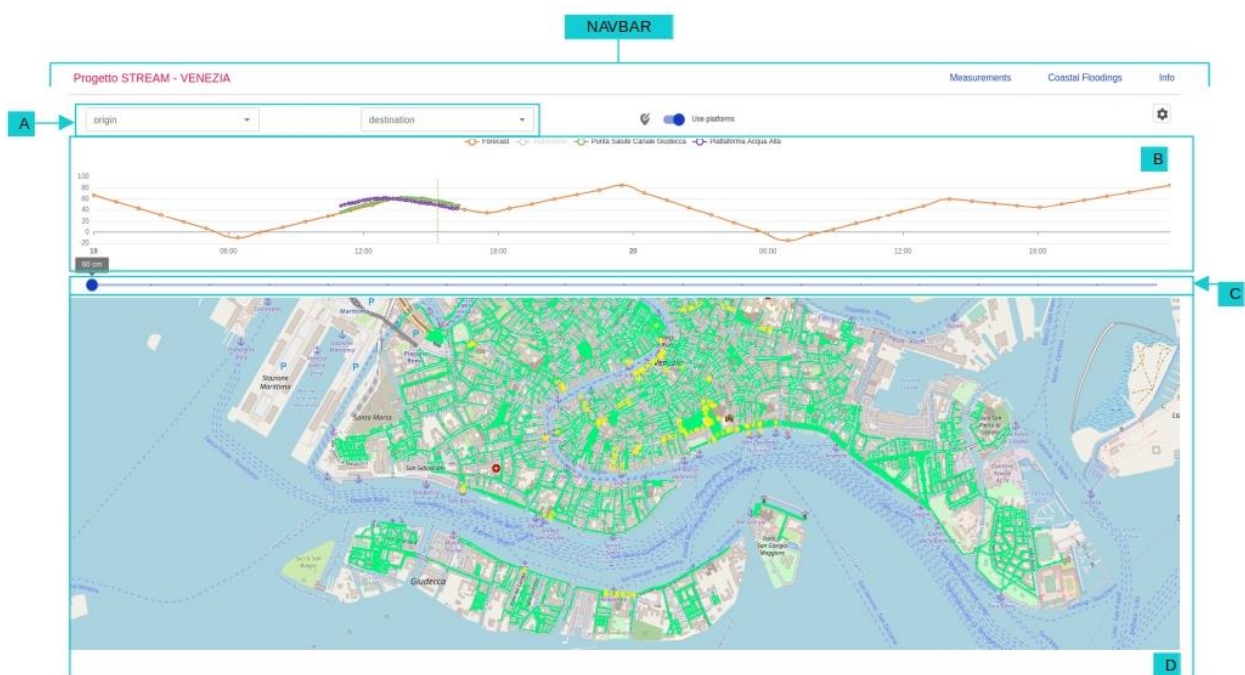


Fig. 2 HomePage with the component highlighted. Navigation Bar as NAVBAR, RoutingPanel (A), The ForecastChart (B), FloodingSlider (C) and Dynamic Map (D).

- The RoutingPanel (A) where it is possible to select the origin and destination of possible routes to get dry footing from one chosen point to another (usage example Fig.4).
- The ForecastChart (B) that displays the tide forecast, the astronomic forecast and the actual sea level measured on two stations from Venice Open data 'Punta salute Canale Giudecca' (inside the Venice Lagoon) and 'Piattaforma Acqua alta' (offshore). The x-axis reports the data time coverage and on the y-axis the unit of measure is displayed.

- The FloodingSlider (C) a slider selector that allows to select an hypothetical water column height level, that allows testing different flooding scenarios.
- the Dynamic Map (D) that shows in real time the changes applied by the wiring done by setting the components above (A, B, C).

Using the FloodingSlider (Fig.3) is possible to select the desired sea level forecast (F) and the map below changes according to the selection. In the different selected scenarios the green areas on the map represent the dry zones, the red represents the flooded areas and in yellow can be seen the footbridges. The option to use or not the footbridge platforms can be selected through the specific switch (E).



Fig. 3 HomePage: switch (E) to activate/deactivate usage of platforms during the routing calculation. Selection of specific height of sea level through the Slider (F).

Calculate route on dry pathways

In order to calculate dry-foot routes, four inputs are necessary: the desired sea level height for the scenario and the use (or not) of the footbridge platforms, the origin and the destination of the routing. The locations can be added by typing the address in the input form or pinning the markers straight on the Map (Fig.4).

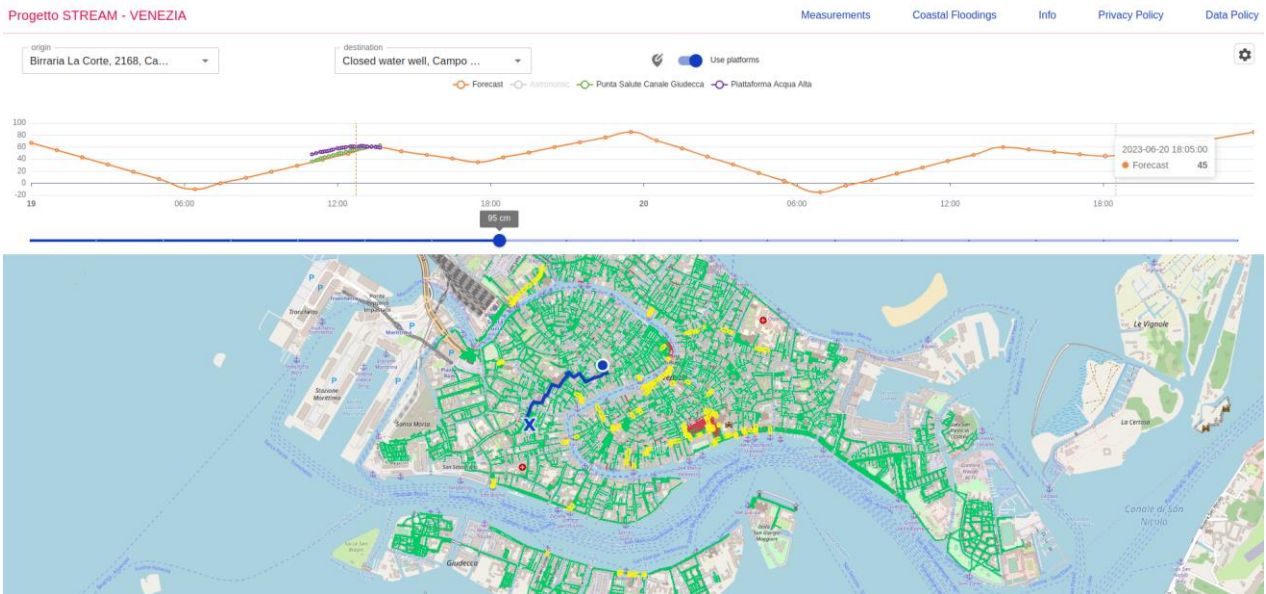


Fig. 4 HomePage: Example of routing pathway with active switch (E) for footbridge platforms usage and tide 95 cm height.

When all the parameters are set the routing is displayed on Map, if it is available a dry pathway according to the tide level and the streets' elevations.

Using the mobile Web App

The mobile version contains the same features of the Web App. From the interface (Fig.5) is possible to access all components of the App: the RoutingPanel, the ForecastChart, the FloodingSlider and the Dynamic Map.

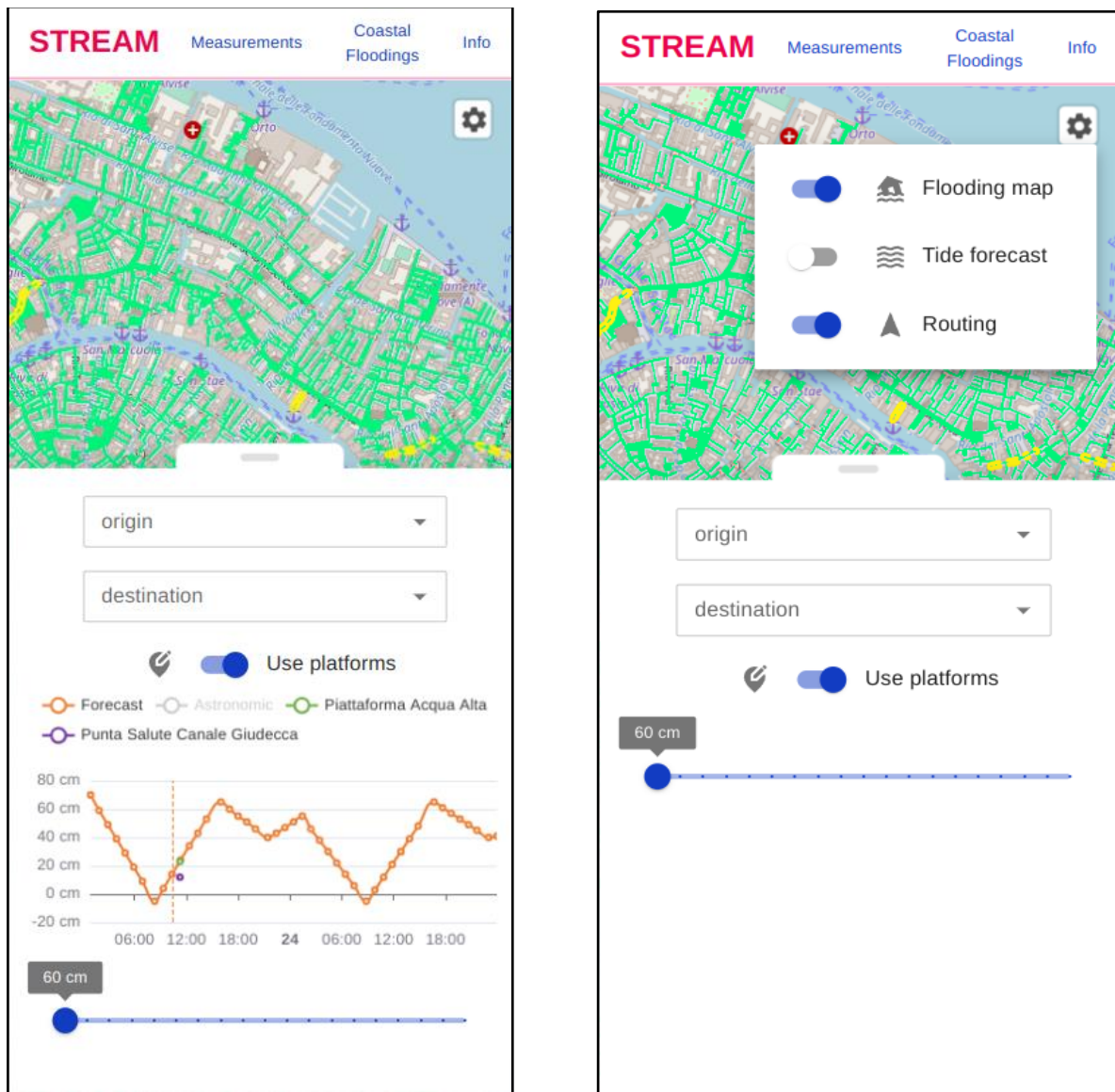


Fig. 5 On the left the default mobile version interface, on the right the same interface where the tide forecast chart is hidden from visualization.

The mobile version interface is customizable, using the gear icon button (Fig.5 right) in order to display or not a certain component or function.

- The main map will remain always available.
- The **Flooding Map** control will hide/unhide the section of interface with the slider that users can use to set up different levels of water level to calculate dry-foot routes. The map will open with the current water level based on real time data and it is possible to set up a different level based on the forecast graph shown on top of the page.

- The **Tide Forecast** control will hide/unhide the forecast and observation graph
- The **routing** control will hide/unhide the part of the interface used to set up origin and destination for route calculation.

CONCLUSION

The web app is publicly available at the website stream.seastorms.eu managed by City of Venice - Centro Previsione e Segnalazione Maree.