camERa: a webcam network to improve the regional coastal early warning system in Emilia-Romagna (Italy)

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INTRODUCTION

In the north-western Adriatic, the Hydro-Meteo-Climate Service of the Regional Agency for Protection, Environment and Energy of the Emilia-Romagna Region (Arpae-SIMC) manages a daily coastal Early Warning System (EWS) based on an operational chain of meteo-marine forecasting models. Outputs from hydrodynamics and wave forecasting systems, forced with meteorological fields, are used as boundary conditions to a coastal morphodynamics model (XBeach) which provides hourly forecasts of index based maximum water levels for three days. These indexes are then compared against predefined thresholds with this information being part of a Decision Supporting System (DSS) in the decision-making process by regional authorities (Harley et al., 2016).

However, the validation of such a system is difficult due to the lack of in situ measurements which would provide data to check the performance of the model. Collecting data that accurately reflects the state of coastal environments is crucial for effective coastal management and the establishment of EWSs but this task is both challenging and costly. One way of overcoming the aforementioned limitations is through video monitoring techniques. Key parameters in the nearshore can be extracted from remotely sensed video (Holman and Stanley, 2007; Davidson et al., 2006) and include shoreline position, surface currents (Chickadel et al., 2003) and wave run-up.

Among the several video monitoring applications, one of the most common refers to the detection of the shoreline position using timex images and the wave run up along the beach. Furthermore, by installing a video monitoring system, it is also possible to analyze the evolution of the shoreline with high frequency in time and during stormy conditions, aiming not only to increase knowledge of local, significant processes, but also as a support system during such extreme weather events.

Recently, Arpae-SIMC has acquired a video monitoring system to overcome the limitation of model validation and to have more reliable monitoring during coastal storms, as well as to check the differences between pre- and post-storm conditions. In the longer run, the system can also provide important information on the definition of local thresholds for the storm impact indexes (which are currently the same for locations with same benchmark typology) as well as to provide invaluable information on the long term management and development of local guidelines and policies towards better coastal planning strategies.

This paper will present the design and the implementation of the webcam network installed along the Emilia-Romagna littoral, which aims to support coastal management and enhance the existing EWS infrastructure.

METHODOLOGY

In September 2023 Arpae has implemented a video monitoring system named camERa, with the aim to:

- provide continuous observation of the sea and coastal conditions;
- acquire georeferenced images at a rate of 2Hz ;
- produce shorelines position every half hour;
- produce timestacks to assess the wave run-up during extreme events.

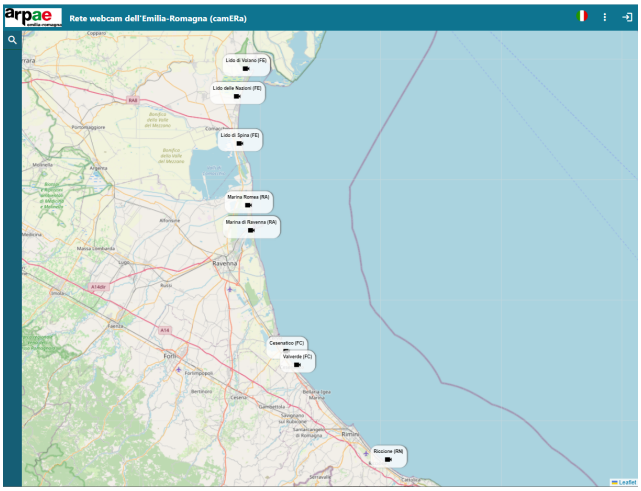

Figure 1 – Location of the video stations of the camERa network

The camera network is composed of 8 stations strategically located to ensure representation, alignment with the Regional Early Warning beach transects (Biolchi et al., 2022), and availability of suitable infrastructure, as

depicted in Figure 1.

The 8 video stations are installed along the coastline of the Emilia-Romagna (ER) Region extending approximately 110 km from north to south.

As mentioned above, the already implemented EWS based on coastal impact indicators follows an operational forecasting chain from weather forecasting systems to wave and hydrodynamics models and finally to morphodynamics components (based on XBeach). Model results, in terms of runup, are used to evaluate two "Storm Impact Indicators", varying from natural (SCW = Safe Corridor Width) and urbanized coastal areas (BWD = Building Waterline Distance) (Harley et al., 2016; Biolchi et al., 2022).

Currently, the XBeach-based EWS covers 12 monodimensional profiles along the regional coast, each profile consisting of a benchmark, with the distance between them and the maximum horizontal water excursion calculated for each forecasted time step. One of the main drawbacks is that the system has not been properly validated, as no waterline measurements were available at the time of implementation.

Figure 2 – Example of timestacks, timex and coastline for the Riccione site.

EXPECTED RESULTS

The operational images produced every half hour are timestacks, timex and snapshots, an example of which is shown for the Riccione site in Figure 2. Some significant storms will be presented and the coastal evolution (due to run-up and inundation extension), based on image processing, will be described following the methodology of Archetti and Gaeta (2012). For the selected storm events the run up forecasted values will be analyzed together with the maximum excursion measured by camERa in order to validate the system.

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