To-SEAlert project. Main developments and results

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Mrs. Ana Catarina Zózimo [1], ***Mrs. Juana Fortes*** [1], ***Prof. João Alfredo Santos*** [2], ***Mrs. Liliana Pinheiro*** [1], ***Mrs. Rute Lemos*** [1], ***Mr. Rui Capitão*** [1], ***Mrs. Ana Fonseca*** [1], ***Mrs. Dora Roque*** [1], ***Dr. Rui Taborda*** [3], ***Prof. Ana Nobre Silva*** [4], ***Mrs. Vera Serrazina*** [1], ***Mr. João Craveiro*** [1], ***Mrs. Maria Teresa Reis*** [1], ***Dr. Umberto Andriolo*** [5], ***Dr. Jose Ferreira*** [6], ***Ms. Catarina Jóia Santos*** [7], ***Mr. Cláudio Duarte*** [8]

1. *Laboratório Nacional de Engenharia Civil (LNEC),* ***2.*** *ISEL - Instituto Superior de Engenharia de Lisboa, Instituto Politécnico de Lisboa,* ***3.*** *Instituto Dom Luiz, Faculdade de Ciências da Universidade de Lisboa; Departamento de Geologia, Faculdade de Ciências da Universidade de Lisboa,* ***4.*** *Instituto Dom Luiz, Faculdade de Ciências da Universidade de Lisboa e Departamento de Geologia, Faculdade de Ciências da Universidade de Lisboa,* ***5.*** *INESC Coimbra,* ***6.*** *MARE - Marine and Environmental Sciences Centre, Department of Environmental Sciences and Engineering, NOVA School of Science and Technology, NOVA University Lisbon,* ***7.*** *MARE - Marine and Environmental Sciences Centre, Department of Environmental Sciences and Engineering, NOVA School of Science and Technology, NOVA University Lisbon, Campus da Caparica, Caparica.,* ***8.*** *NOVA University Lisbon*

1. INTRODUCTION

The To-SEAlert project (Fortes et al., 2021) aims to include a set of tools/methodologies into the Early Warning System HIDRALERTA (Poseiro, 2019, Fortes et al., 2020, Pinheiro et al., 2020) to make it more efficient, reliable and robust. The project uses different tools to improve efficiency and reliability in the system, as well as to provide validation. The case studies are Costa da Caparica coastal area and Ericeira port, both on the West Portuguese Coast. This article describes the main developments and results obtained more recently.

2. MAIN DEVELOPMENTS AND RESULTS

The recent main developments and results are described below for each task.

T1 - Satellite image methodologies

Through the Copernicus program, it was possible to access a very high-resolution image from the Pleiades satellite, acquired over the area of interest during the storm on January 9, 2014. To compare the situation before and after Hercules storm, an image from the WorldView-2 satellite was acquired and subject to radiometric correction operations, namely sensor calibration and atmospheric correction, to obtain reflectance values at the top of the atmosphere, similar to those presented by the Pleiades image. The WorldView-2 image was also processed with the pan sharpening algorithm to obtain a very high-resolution multispectral image, equivalent to the Pleiades image. Wet sand zones were identified, that indicate the locations hit by water before image acquisition. The comparison of pre-event and post-event images showed changes in vegetation patches in a stretch close to the sea.

T2 - Video monitoring integration

Remote access to the video monitoring system was extended to Ericeira. One of the biggest challenges is the need to ensure the continued operation of these systems. For example, the precariousness of the building where the Ericeira camera is installed led, during a storm, to the breakdown of the IP camera. During the period in which the Ericeira camera was inoperative, a protocol was established with the NAVSAFETY project, which also has a camera (although in a different location) in the port of Ericeira. Currently, the collected data have been used for qualitative validation of the HIDRALERTA system alerts (Zózimo *et al.*, 2022).

In Costa da Caparica, the results analyzed to date revealed that no overtopping has occurred since the camera was installed. Algorithms to determine runup in the beach context and algorithms for the assessment of wave height have already been developed (Jóia Santos *et al.*, 2020; Andriolo *et al.*, 2020).

T3 - Physical Modeling

The tests on a 2D physical model of the port of Ericeira were carried out in LNEC's irregular wave flume (Santos

et al., 2021), to i) determine swash and overtopping in the quay area for various extreme sea wave conditions, including climate change scenarios; ii) obtain measurements of these quantities and of the characteristics of the sea wave along the channel and at the toe of the structure for validation of numerical models.
To measure the runup, the results of using a probe or a video-camera were compared to evaluate their performance and it was found that the use of video techniques is a very effective alternative, if good conditions of artificial light are guaranteed. As for overtopping, measurements were carried out by weighing the overtopped water (with a digital scale) and measuring the level inside the water reservoir. The two methods were in agreement when the overtopping is small. In the case of significant overtopping, the probe generates a signal with significant noise.
T4 - Numerical models
Several simulations were carried out to assess the performance of the SWASH numerical model in estimating the overtopping volumes in the section of the breakwater of the port of Ericeira which was tested in the 2D physical model (T3). The ability of the model to assess the extent of the flooded area on the back of the breakwater was also analyzed.
SWASH model was also applied on a prototype scale to two cross-shore profiles of the port of Ericeira. After calibrating the model for the two profiles (Manz *et al.*, 2022), five empirical expressions were deduced to determine the Manning coefficient. The automatic definition of the Manning coefficients, based on certain known variables, is essential in order to implement the SWASH model in the HIDRALERTA system. A qualitative validation of SWASH and NN_OVERTOPPING2 results was also performed (Zózimo *et al.*, 2022).
T5 - Risk assessment and emergency plans
To improve existing vulnerability and risk maps, meetings have already taken place with the Civil Protection of Almada, to include variables associated with Civil Protection (location of first aid stations, emergency corridors, among others). The preliminary Analytic Hierarchy Process (AHP) methodology was developed and adapted to be applied in the participatory sessions, which will serve to prioritize the different criteria of danger, exposure and vulnerability.
Surveys were also carried out using an unmanned aerial vehicle (also known as drone) to gather base information for the maps. These surveys resulted in the orthophotomap of the delimited area, as well as the corresponding digital surface model. The classification of land cover and land use for the port of Ericeira was also performed.
T6 - WebGIS Tool
The HIDRALERTA system prototype was updated for Costa da Caparica, to include the risk estimates through the Bayesian network based on the results obtained by the XBeach model in task T4 (Zózimo *et al.*, 2021).
The optimization of the HIDRALERTA system code has started in order to simplify the integration of future developments and the option to acquire the offshore agitation and wind data from the Copernicus service, in addition to the ECMWF service that has been in use so far. The development of the new Web platform with new features in terms of data analysis and user interactivity with the system is in its final stage.
A mobile application was also developed.
T7 - Test cases
The Ericeira prototype is under update to incorporate the SWASH model for the determination of overtopping and flooding. To-SEAlert prototype was updated for the coastal zone of Costa da Caparica, to contemplate the risk estimation through a Bayesian network based on the results obtained with the XBeach model. Ericeira and Costa da Caparica prototypes are currently under test and validation.

3. FUTURE WORK

As future work, it can be highlighted the continuation of the validation of alerts issued by Ericeira and Costa da Caparica prototypes, the finalization of the new web interface, the completion of the collection of basic information for the application of the AHP to the port of Ericeira and finally the application of AHP in Participatory Workshops in Costa da Caparica and Ericeira and respective adaptive scenarios.

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