AN EARLY WARNING SYSTEM FOR COASTAL RISKS ASSESSMENT

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1. Introduction

Storms impacting sandy coastal areas produce hazards such as erosion and overwash that, in turn, promote risk to life and property damage in occupied areas. Coastal damage and risks will increase in the future not only in association with climate change but also due to the growing human occupation in coastal areas (van Dongeren et al., 2018). Since the threatened coastal areas are often densely populated, there is a need to implement measures to prevent risks. One of such measures is the use of Early Warning Systems (EWS) that anticipate expected risks and, therefore, work as management tools to minimize or avoid disaster. This work presents the basis of an EWS prototype to alert about the potential consequences of overwash/overtopping and erosion induced by storms, in coastal areas.

2. Modelling and risk assessment

The EWS developed at EWCoast uses wave and water level data from available sources (e.g. global and regional forecast models) and existing or collected topo-bathymetric data as inputs for a model train. This model train includes SWAN for wave propagation and XBeach (Roelvink et al., 2009) for the impact assessment. XBeach is a process-based model employed to determine both coastal erosion and flooding and was calibrated against available data from previous storms. It is computationally demanding and, therefore, all possible storm events' combinations (i.e. tide, surge, wave parameters) have been previously modelled and stored at a Bayesian Network. This procedure ensures that the EWS is timely providing alerts up to 3 days before the occurrence.

Three Overwash/Overtopping EWS prototypes were built for Praia de Faro, Quarteira and Costa da Caparica, on the south and west coast of mainland Portugal. The overwash/overtopping was predicted by using XBeach in the non-hydrostatic mode, without considering morphological changes during the event. The model provides the mean overtopping discharge at defined points (e.g. roads, walkways) and the risk severity (four levels of risk) is evaluated for three coastal receptors: pedestrians, buildings and vehicles (Table 1), based on different intervals of mean overtopping discharge.

Table 1. Risk level definition used for the characterization of wave overtopping risks

Risk level	Pedestrians	Recreational facilities & buildings	Vehicles
No risk	No injuries or threats on individuals	No damage	Safe to drive any vehicle at any speed
Low risk	Minor injuries and caution with elderly and children	Minor damage to fittings, signs, posts, etc.	Light motorbikes or bicycles become unstable
Moderate risk	Dangerous for most people	Severe damage on non-structural elements (e.g. windows, doors)	Unsafe to drive and standard SEDAN cars become unstable
High risk	Very dangerous for all	Severe structural damage and building collapsing	Dangerous to drive standard passengers' cars and risk to all

An Erosion EWS was built for Praia de Faro. The coastal erosion induced by storms was predicted by using XBeach on the surfbeat mode and focusing on the possibility of

building/infrastructure collapsing due to sand removal. It also includes four levels of risk using the vertical erosion and distance to the target as proxies.

The EWS prototypes are part of the HIDRALERTA operational system (Fortes et al., 2020) with alerts being issued daily providing 72-hour forecasts with a 3-hour time step of wave characteristics and risk levels associated with the coastal receptors (see example in Figure 1).

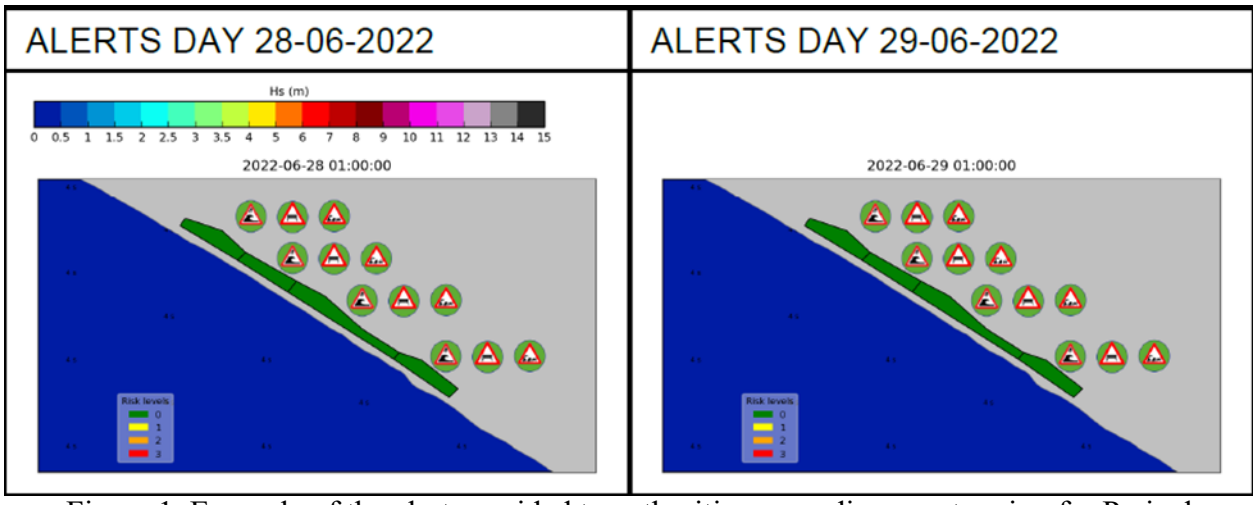

Figure 1. Example of the alert provided to authorities, regarding overtopping for Praia de Faro (4 sectors), for the 1 am of 28th and 29th June 2022

3. Conclusions

Three overwash/overtopping and one storm-induced erosion EWS prototypes were developed, tested, calibrated, and implemented. These systems are currently being validated against existing data and new storms. They aim to be the start of an expanded network of EWS prototypes for the Portuguese coast.

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References

Fortes, C.J.E.M., Reis, M.T., Pinheiro, L., Poseiro, P., Serrazina, V., Mendonça, A., Smithers, N., Santos, M.I., Barateiro, J., Azevedo, E.B., Salvador, M., Reis, F.V. 2020. The Hidralerta System: Application to the Ports of Madalena do Pico and São Roque do Pico, Azores. *Aquat. Ecosyst. Health Manag*. 23(4):398-406.

Roelvink, D., Reniers, A., van Dongeren, A., van Thiel de Vries, J., McCall, R. and Lescinski, J. 2009. Modelling storm impacts on beaches, dunes and barrier islands. *Coast. Eng*. 56:1133–1152.

van Dongeren, A., Ciavola, P., Martinez, G., Viavattene, C., Bogaard, T., Ferreira, O., Higgins R., McCall, R. 2018. Introduction to RISC-KIT: resilience-increasing strategies for coasts. *Coast. Eng*. 134:2–9.