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Numerical model testing of green DRR solutions by dune reconstruction at a rapidly eroding coast in the Adriatic Sea

Paolo Ciavola, Tomas Fernandez-Montblanc, and Enrico Duo
University of Ferrara, Physics & Earth Sciences, Ferrara, Italy (cvp@unife.it)

In the current scenario of climate change, high water levels during storms threaten coastal landscapes that have a low elevation. Naturally coastal dunes and their vegetation provide the first line of protection. At eroding coastlines their reconstruction offers the opportunity to build dynamic coastal defences. In order to properly design a re-vegetated dune, modeling must be undertaken to identify the optimal dune height and width able to withstand the effect of an exceptional storm. The primary role of the plants is to modify the velocity profile of the flow above them: this implies to introduce in the model credible values of the drag coefficient that also reflect the spatial distribution of the different plant species and the density of stems.

Numerical tests using the hydro-morphodynamic model XBeach were undertaken to design and evaluate the effectiveness of dune reconstruction and revegetation as a Disaster Risk Reduction (DRR) measure at a rapidly eroding coastline in Bellocchio (Northern Adriatic sea). The work was developed as a part of the EU FP7-RISC-KIT project, which elected the site as the pilot case study after selection of a number of highly exposed hotspots (Armaroli and Duo, 2017). A detailed digital elevation model was produced merging a topographic Lidar, a nearshore bathymetric Lidar and a multibeam bathymetric survey for the offshore part. The storm selected to test the efficiency of the natured-based DRR occurred on 5-6 of February 2015, with a maximum offshore significant wave height of 4.66 m and a peak water level of 1.2 m above MSL. These conditions approximately correspond to a return period of 50 years. The two-dimensional domain extends 3000 m alongshore and 3600 m cross-shore. The resolution ranges from 18m alongshore and 21m cross-shore at the offshore open boundary at (10 depth) to 1m cross-shore and 8m alongshore in the area where the dune is located. The dune was built mimicking the current dune, enlarging it and increasing its crest according to the typical dune systems present in the region. The dune revegetation encompasses different species accounting for their distribution in the local dune systems. Two vegetation settings were considered, one with the current stem density and one doubling it. Two indicators were chosen to assess performance, respectively the Maximum Water Volume (MWV) for flooding and the sediment volume variation (SVV) for erosion.

The indicators highlight the high DRR efficiency. The results show a reduction of inundation with the re-constructed dune, which is still breached and overtopped at some points. If the vegetation is reconstructed on the dune there is a considerable decrease of inundation. Minimum changes are observed between normal and high density of vegetation for the reduction of MWV. The high-density vegetation set-up provides instead the most efficient solution for SVV reduction.

REFERENCES

Armaroli, Duo (2017): Validation of the coastal storm risk assessment framework along the Emilia-Romagna coast. Coastal Engineering, ELSEVIER,http://dx.doi.org/10.1016/j.coastaleng.2017.08.014