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Coastal erosion vulnerability estimations by coupling field data and hydrodynamic modeling

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Wind generated waves are a dominant factor of coastal zone evolution as they induce nearshore sediment movement. Significant sediment transport and the associated morphological changes of the coastal zone are related, mainly, to storm events.

In this study, the effects of a severe storm event, associated with the Etesian winds, that took place from the 24th to 30th of July at Gouves beach (north coast of Crete) were monitored ([1], [2]) and subsequently simulated, with the use of the Delft3D model, in order to provide necessary data for estimating beach vulnerability. Beach vulnerability to erosion was estimated by the BVI method ([3]), which has the ability to refer to smaller sectors of an individual beach.

The interaction between waves and currents, which is required for the computation of the BVI, was obtained by the coupling of two models included in Delft3D: the Delft3D - FLOW, for the hydrodynamic computations and the sediment transport processes; and the Delft3D - WAVE, for the computation of the wave field. Boundary conditions were derived from the field data, assuming a JONSWAP spectrum. Additionally, 3 observation points were used for the monitoring of the computed quantities as a function of time. Their positions coincide with those of the three Valeport Autonomous Benthic Recorders, which were deployed at water depths of 2.60m, 3.95m and 5.62m during the field measurements.

The outputs of the simulation fit well with the measured data, leading to accurate forecasted results regarding the morphodynamic conditions of the study area. Bottom changes occur mainly during the first peak of the event. The model slightly overestimates the significant wave height, the current velocity in the nearshore area and the suspended sediment concentration near the bed at the observation points. Furthermore, the model predicts a shoreward increase of sediment concentration at the observation points, with the value of accumulation at the second observation point being smaller that the value at the observation point positioned farther offshore. This is related to the location and movement of the breaker zone. However, in general, the results of the simulation are very close to the measurements, and the underwater bars formed during the erosional and depositional phases of the storm event are represented with adequate accuracy.

The overall BVI values show a relatively high vulnerability of the beach, even though the nearshore sediment transport rates do not seem to be significant, varying from low to moderate for both the long- and cross – shore constituents. Hence, it is concluded that the extremely high values of wave run up, indicating that the wave action affects the whole subaerial part of the beach, are responsible for the high vulnerability of the Gouves beach.

References

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