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Modelling the hydrodynamic and morphosedimentary response of an beach-headland system (Algarve, Southern Portugal)

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Future behaviour of beaches within a headland-beach system is of fundamental interest on coastal evolution since they act as a buffer between the waves' attack and the cliffs backing them. The beaches at the cliffs' foot anchored between headlands are space-limited environments to morphosedimentary processes. Additionally, headlands and shore platforms are natural barriers to the alongshore drift. Several attempts to develop numerical expressions to characterize the stability of headland-beach systems have been made based mainly on linear parameters. However, in the sandy areas occur volumetric variations of greater magnitude that changes in the shoreline position in a tidal cycle. This work aims to quantify the balance between the incoming and the lost sediment in two embayed beaches in order to improve knowledge of the sedimentary dynamics of such environments and therefore the evolution of coastal landscapes. The study area is the Algarve coastal karstic landscapes, which raises challenging questions on morphosedimentary processes because it has dozens of stacks and cavities both in the surf zone and in the nearshore that interfere with the littoral current patterns. The field campaigns were performed during spring tide conditions in February and March, 2011. The nearshore wave climate and the current's velocity and direction were measured using respectively a non-vented Level TROLL 700 Pressure Transducer (PT) and an autonomously deployable electro-magnetic current meter (EMCM) Infinity-EM with a data logger. The offshore wave data used was acquired through the Portuguese Hydrographic Institute (IH) at the Faro buoy, located 50 km southeast from the study area. The topographic surveys were performed for a total area of about 1500 m2 using two Global Navigation Satellite System receptors (GPS Trimble R6 and GPS Trimble 5800) in real-time kinematic mode (RTK) with differential global positioning system (DGPS) providing centimetric accuracy. The altimetric values ranged between -2 and +6 m (mean sea level-msl). The automatic determination of the spatial characteristics of the beach morphology results from the GIS tools. The wave and current post processing was made using the STWAVE and Bouss-2D model software. Our results showed that: (i) the shore orientation is the major factor for the height of the waves approaching the coast (considering the same offshore climate) and thus to the wave energy input to transport sediment, (ii) the shore platforms which extend up to -7 m (msl) determine a very irregular pattern of the shoaling waves and distance of the breaking point from the shoreline, (iii) as a consequence of (ii) the rip currents in the surf zone show a very complex pattern and the direction of the sedimentary transport can be opposite to the direction of the incoming waves, (iv) the pattern of the rip currents is highly variable depending on the water depth, (v) the results obtained for volumetric balances showed a negative balance (erosion higher than accretion) at the smaller embayed beach and a positive balance (accretion higher than erosion) at the larger one.
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