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Coastal structures and local morphodynamics changes identification using image classification algorithms – Stretch Esmoriz – Cortegaça, Portugal

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Coastal structures induce important impacts on the beaches and surf zone morphodynamic processes. Besides, they influence the refraction/diffraction patterns, limiting the development of long-shore currents, rips and rip feeder currents (Komar, 1998 and Short, 1999).

The Portuguese coastal zone has several coastal structures, build on an attempt to minimize the coastal erosion process (groins) or port development (breakwaters). In general they are significant length and large and shore-perpendicular. They cross the beach area extending throughout the surf zone, interfering with the long-shore sediment transport, carried by the drift currents, changing natural beaches to artificial enclosed ones. This interference could be characterized by downdrift erosion and updrift accretion, beach realignment due to the wave refraction/diffraction around the groins, and formation of rip currents. These currents are usually against consecutive groins and, in the central region between them, dependent on wave's obliquity, wave's height and groin spacing (Komar, 1998 and Short, 1999).

Several stretches of the Portuguese coast have modified their morphology and shape due to the presence of coastal structures, as happened in the stretch between Esmoriz and Cortegaça (length 5.5 km) is one of these places. Along this stretch two important urban settlements are located, which are protected by groins and a continuum revetment.

The local morphology between Esmoriz and Cortegaça was analyzed based on aerial image datasets (1996 and 2001), using two different methodologies. The first one consists in a visual analysis on a Geographical Information System environment and the second one a pixel based classification (supervised classification). The identification of hydrodynamic forms/patterns through image classification techniques was already tested with accurate results for the Portuguese northwest coast (Teodoro et. al, 2009).

The performance and accuracy of the supervised classification algorithms were evaluated in order to validate the visual interpretation performed. The supervised classification algorithm presents good performance, demonstrated by the results of the confusion matrix, Kappa coefficient and overall accuracy, especially for maximum likelihood algorithm. For example for 2001 aerial dataset the maximum likelihood algorithm present results of overall accuracy and of Kappa statistic of 95.64% and 0.96 respectively.

The performed analysis shows the groins' influence on the beach morphodynamics. The changes of long-shore sediment transport lead to the realignment of the coastline (e.g. coastal stretch between the two last groins). Groins may also have an important role on the formation of rip currents, especially if the wave's direction is oblique, wave's height and the groins are wide spaced (rip currents against both groins and central rips). These are characteristics of the studied area.

Using the non-dimensional embayment scaling parameter, for a typical surf zone gradient of 0.01, the degree of headland impact or embaymentisation can be predicted, Short (1999). For example, the non-dimensional embayment scaling parameter was calculated for 1996 and 2001 showing that the embayment, can be classified in general as transitional circulation type.

The type of circulation identified seems to be similar for every sector of these two image datasets. According to Short (1999), the transitional circulation occurs when the embayment size and shape begin to increasingly influence the surf zone circulation, by initially causing longshore currents to turn and flow seaward against each groin, while still maintaining some normal beach circulation away from the headlands. These facts can be observed in the two image datasets. Nevertheless, the pattern of rip currents stays identical, changing essentially the number of rip currents, from 1996 to 2001. Moreover, in some groins the refraction/diffraction pattern around

the groin head, seems to influence/induce the downdrift rip current. The rip currents have an important capacity of sediment transport in the offshore direction and, consequently, beach erosion.