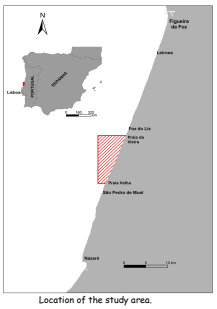
Medium-term evolution of a stretch of the Portuguese central coast based on analysis of aerial photographs and hydrographic surveys: First results

Abstract

A littoral stretch of 12 km, in the west coast of Portugal, has been submitted to anthropic pressure in the last decades. The morphology, wave climate, tidal regime, sediment budget and nearshore dynamics were characterised to support the interpretation the results obtained. A methodology that integrates data extracted from aerial photographs, a digital terrain model based on hydrographic surveys and results from nearshore processes based mathematical modelling was applied to classify the recent morphological evolution tendency of the coastal stretch, through the quantification of the variation of parameters that characterise the nearshore hydrodynamics and the backshore morphology. It was found an average retreat rate of the shoreline and vegetation line of 4.31 and 3.28 m.year-1, respectively. The comparison of the instantaneous positions of breaking line extracted from the aerial photographs with the breaking line obtained from numerical modelling of wave propagation confirms the advance of the surf zone over the emerged beach in during the period 1995-2003.



Location of the study area.

Illustration of the erosion occurred in the mid of the XX's century at Vieira beach (property of CCDRC, unknown author).

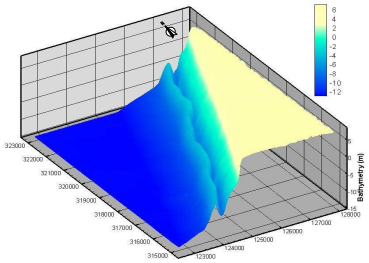
Method

A Geographic Information System (GIS) framework was applied to manipulate four aerial photographs, of 1995, 1996, 2002 and 2003, of the study area. This tool was used to georeference the sets of digitalised aerial photographs, to map lines that characterise the beach morphodynamics, to delineate a baseline and transects (distanced 500 m alongshore) and extract measurements between lines. The results were then integrated with results of nearshore processes based mathematical modelling of the study area.

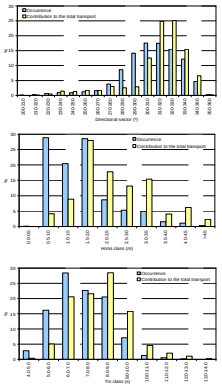
The lines that characterise the beach morphodynamics here considered were the breaking line, the shoreline and the vegetation line. The first two have high frequency changes, which depend mainly on the wave climate and the tidal level. However, since the beach backshore consists mainly of a dune system, the evolution of the vegetation line that corresponds to the position of the toe of the dune occurs at a lower frequency (order of months to years). The distances from the baseline to the shoreline and the vegetation line were measured along each transect, for each photograph. For each transect, a linear regression was applied to approximate the rate of change. These results were than used to evaluate the average evolution rate of both lines along the total study area. The evaluation of the evolution of the breaking line was performed based on the comparison of the instantaneous position of the breaking line extracted from the aerial photographs with the breaking line obtained from numerical modelling of wave propagation from offshore, were the wave measurements are registered (at a wave rider station moored at 92 m depth), to the shore. This analysis allows assessing the displacement of the surf zone.

Characterisation of the present coastal dynamics (integration of field surveys and numerical modelling)

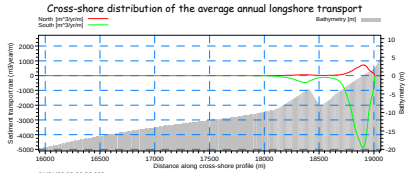
Alongshore submerged bar



Longshore sediment budget

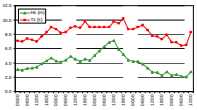


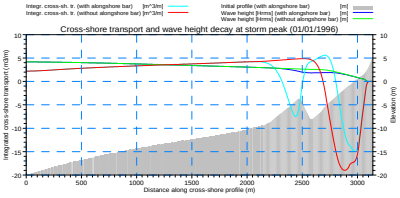
Cross-shore distribution of the average annual longshore transport

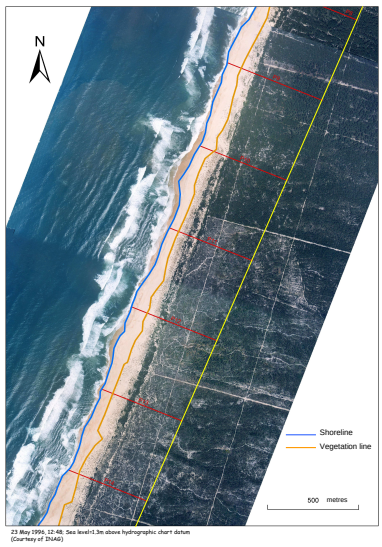


Cross-shore sand transport and wave decay during a storm episode

Wave height and period measured during a storm episode in January 1996.

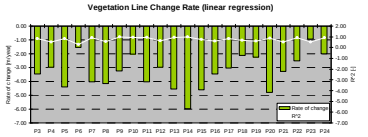




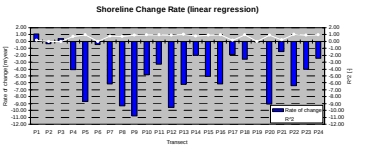


23 May 1996, 12:48. Sea level+1.3m above hydrographic chart datum (Courtesy of IHAG)

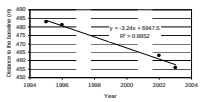
Vegetation Line Change Rate (linear regression)



Shoreline Change Rate (linear regression)



Transect P9



Discussion

The most basic requirement to apply this methodology, performed in a Geographic Information System (GIS) framework, to interpret medium-term evolution of lines that characterise the beach morphodynamics, is to be in the presence of a coastal region with uniform profile alongshore, because, with this 2-dimension method, 3-dimensional variations of the beach are not taken into account and, if they occur, can have a high influence on the plan form evolution. As already pointed out, with the exception of the first 1.5 km at North, the study area fulfils this requirement.

The biggest difficulty found was the georeferencing process of some aerial photographs that only include sea, a stretch of emerged beach and a relatively short extension of the dune system, covered with uniform vegetation. In this case, it was rather difficult selecting reliable georeferencing points. For these photographs, maximum errors of 15 m were observed.

Two other sources introduced error in this analysis. One, inherent to the methodology, is that not all the area is described with the same precision. Since the methodology is 2-dimensional, the error increases from zero at the georeferencing point to a maximum value (depending on characteristics of the photograph, like scale) proportionally to the radial distance. To decrease the effect of this error in the measurements, the georeferencing points were selected in the foredune, as close as possible to the vegetation line. The other source of error concerns the interpretation of the position of the lines, which in some cases is ambiguous and dependent on the GIS operator. To overcome this error only good sense was applied.

Authors

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