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A Precise and Efficient Methodology to Analyse the Shoreline Displacement Rate

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ABSTRACT

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The shoreline change rate is one of the most significant parameters in analysing sandy shore behaviour with time. This parameter can be monitored by means of low- and high-resolution survey methods, depending on the objectives of the monitoring programme. Survey efficiency is also very important for achieving high resolution in both space and time. Another important aspect is the precision and significance of the obtained results, not only from the survey method itself but also from the comparative analysis used to process the data from several surveys. The survey method and the processing algorithms are the basis of shoreline analysis. This paper presents an evaluation of two proposed high-resolution methods that are simultaneously highly accurate and very efficient. These methods are based on a global positioning system (GPS) in differential mode for surveying and on novel algorithms for assessing the spatial change rate of the shoreline. The most significant difference of the two presented survey systems is the physical support: whereas one uses a land vehicle (motor-quad) to delineate the shoreline in wide straight coastal stretches, the other considers an on-foot simplified version to survey small, more irregular stretches. The analysis of the error associated with the proposed methodologies is thoroughly described in this paper. In both modes of operation, system-inherent errors are within the centimetre level—in general lower than 0.05 m. Operation-specific errors can remain within the centimetre level, but if instrument handling is careless in the on-foot survey method, they can reach decimetre levels. If successive monitoring surveys are not carried out under similar field morphological conditions, when the frontal dune baseline is adopted as a shoreline indicator, rough errors can be introduced. Two case studies of the application of these methods, evaluating the shoreline evolution of two distinct coastal regions in Portugal, are presented.

ADDITIONAL INDEX WORDS: *GPS, coastal erosion, management, frontal dune baseline, frontal dune crestline.*

INTRODUCTION

Sandy shore erosion is of great concern to society in general, particularly in highly dynamic coastal stretches. In Portugal, for instance, about half of the political border is constituted by sandy shores, and local authorities must pay much attention to their evolution in time. Small-scale factors can be very important to the study of sandy shore erosion, giving relevance to analyses where high-resolution data, in both space and time, are processed. For example, in sandy shores landward limited by foredunes, storm events can induce foredune erosion. The alongshore distribution of foredune erosion zones is, in general, nonuniform and nonhomogeneous, with sections of the coast exhibiting significantly higher rates of erosion (Houser, Hapke, and Hamilton, 2008; List, Farris, and Sullivan, 2006). Characterising this distribution is very important because it provides sources of information to the local authorities necessary to prevent floods by foredune overwash and many other short- and long-term problems.

Sandy shore erosion is usually monitored by analysing the displacement of the shoreline in consecutive surveys. Until recently, and considering the classical geodetic techniques, the shoreline was mainly surveyed by considering sets of individual (and distanced) profiles drawn perpendicular to a reference lineation, such as the frontal dune baseline, observed by theodolites and total stations. The assumption is simple: At each point, the shoreline advances or retreats perpendicular to the main shoreline direction. This survey method is time-consuming, and in general a discrete shoreline representation is only allowed when the survey area has several kilometres

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