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Improving the determination of wave regimes in the TRANSFER methodology using the SWAN model

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ABSTRACT

The TRANSFER and MAR3G methodologies have been applied recently on a number of studies where the definition of wave regimes at locations is sought but no in-situ measured data are available. Those methodologies are based upon wave ray propagation models. However, these basic propagation models may be too simple to employ in more complex site areas. Therefore, in this paper, the implementation of a more complete wave propagation model (SWAN) into TRANSFER methodology is attempted and described. Results on the application of this improved methodology to two selected sites on the Portuguese coast will enable a better evaluation of its advantages and disadvantages to estimate the wave climate.

KEY WORDS: wave propagation; wave climate, SWAN model.

INTRODUCTION

The continental Portuguese coastal zone is characterized by a large number of sandy beaches, harbours and coastal works. The study of dynamics and sedimentary equilibrium of these beaches and the design and protection of harbours and coastal works, amongst others, in its vicinity depend significantly on the knowledge of the local sea wave regime characteristics. However, along the largest coast of Portugal, the west coast, only two buoys are at the moment in operation: at Leixões, in the north-western coast and at Sines, in the south-western coast.

As a consequence, the design and protection of harbours and coastal works at some site where no wave buoy has been deployed is usually compromised by the lack of wave data. Therefore, there is a need to employ some methodology to make up for this absence of wave data, and consequently to define the wave regime at the desired location. With this purpose, two methodologies have been successfully used at LNEC for a number of selected cases:

1) The TRANSFER methodology, Coli *et al*. (2002), consists in using the irregular wave model BACKTRACK-REFSPEC (BR), Covas and Pontes (1988), which is based on the linear wave ray theory, for transferring to offshore the wave data or regimes measured on a coastal buoy site where available data are sufficient to establish a convincing sea wave regime, followed by a new transfer from offshore to the coastal site(s), not too distant from the original site, where the wave regime(s) is(are) sought.

2) The MAR3G methodology uses the wind-wave MAR3G hindcast model, Pires and Carvalho (1996), along with the SAIREF wave ray propagation model, which uses meteorological data, i.e., the winds, on the area of interest.

Both methodologies use simple wave ray models to propagate the waves from offshore (or from the wind node) to inshore. This type of model accounts for the refraction phenomenon and has been successfully employed in several studies along the Portuguese coast, Capitão *et al.* (2006). However, they do not consider, on the wave propagation, phenomena like diffraction, wave breaking, harmonic generation or other nonlinear effects, which can be important.

The nonlinear numerical model SWAN (Booij *et al*., 1999) is able to propagate sea waves from offshore up to the shoreline and takes into account the major physical processes of wave refraction, diffraction and shoaling due to bottom depth variation and to the presence of currents. It also includes wind induced wave growth, wave breaking due to bottom variation and to whitecapping, energy dissipation by bottom friction, wave blocking and reflection by opposing currents as well as wave transmission.

In this paper, the SWAN model is included into the TRANSFER methodology to analyze the main differences on the results by considering a more complex model than the linear wave ray model BACKTRACK-REFSPEC (BR). Both original (using BR) and improved (using SWAN) TRANSFER methodologies are applied and compared in two selected sites on the Portuguese coast: Praia da Tocha (PDT) and Cabo Sardão (CBS), Fig. 1. Both sites where chosen due to their relative closeness to the Leixões (LXS) and Sines (SNS) deployment locations of directional wave buoys, Fig. 1.

The MAR3G methodology is also applied to the same locations. In this way, wave regimes computed using the three different methodologies will be compared at each of these locations, see Table 1.