Wave forecast at the Tagus estuary by using the SWAN model

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ABSTRACT

The use of the SWAN model to forecast the parameters of wind-generated waves in the Tagus estuary is illustrated in this paper. In addition to sensitivity tests with that model for idealized wind fields and tide levels in the Tagus estuary, the paper contains a brief description of the wind regime close to a beach in the same estuary as well as of the wave characteristics forecast by the SWAN model for the most common weather conditions there. A comparison of the SWAN results to the wave parameters from wave records made in front of the same beach is also presented.

KEY WORDS: Estuarine beaches; numerical models; sea-wave propagation.

INTRODUCTION

Between Alcochete and Alfeite, on the left bank of the Tagus estuary, close to Lisbon, Portugal, there are sand beaches that are typically the result of the action of wind waves generated in the estuary. The genesis and the evolution of these beaches were studied by Freire (2003) and by Freire and Andrade (1999).

There is a research project going on now – BERNA – that aims at improving the tools for forecasting the medium and short-term evolution of this kind of beaches. For this there is the need to know both wind generated sea waves in restricted areas (such as the Tagus estuary) and their propagation across the estuary up to their breaking at beaches. Although, within the scope of that project, it is expected to couple a numerical model for wind wave generation with a numerical model for wave propagation, a first step consisted in checking the possibility of using one model only to solve the whole problem.

For this, the numerical model SWAN (Booij et al., 1999) was chosen. This model, which takes into account the wave generation, propagation, attenuation and non linear interactions between waves and currents phenomena, is a model that is usually employed in open coastal regions although not so often in enclosed regions, such as estuaries or lakes.

This paper aims at illustrating the use of the SWAN model in the forecast of wind generated waves at an enclosed region, namely at the Tagus estuary. The work consisted of the following steps:
- sensitivity tests with the SWAN model using idealized tide levels and wind fields, to identify the weather conditions that may cause sea states relevant to the Alfeite beach;
- characterization of the wind regime at Alfeite beach and, for the most common weather conditions, use of the SWAN model to characterize the sea waves in front of the Alfeite beach;
- simulation of the wind generated waves at the estuary at a selected date, July 21, 2005 by using the wind data from the Portuguese Meteorological Institute and comparison of the model results with the measurements taken at the same date in front of the Alfeite beach.

Vieira and Bernardino (2005) presented a similar study using the numerical model SWAN to forecast wind generated waves. However, their focus is on the Alfeite Naval base and not on the Alfeite beach. Therefore, their results cannot be directly used to compare with the ones presented in this paper.

The paper starts with a brief description of the numerical model SWAN along with a description of the study area and its wind regime. Then, the measurements made on July 21, 2005 are presented. Finally, the computations with the SWAN model are presented and the results obtained in front of the Alfeite beach are described and discussed.

THE NUMERICAL MODEL SWAN

The numerical model SWAN – acronym for Simulating WAVes Nearshore – computes sea-wave generation, propagation and dissipation based upon the equation for wave action conservation. This is a freeware program that is being continuously upgraded by the Delft University of Technology (The Netherlands). The main advantage of this development work is keeping the structure of both the input and output files, something that simplifies the transition to newer and more robust versions of the model whenever needed.

This model 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, bottom friction energy dissipation, wave blocking and reflection by opposing currents as well as wave transmission.