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ANALYSIS OF THE IMPACT OF A PILOT ZONE FOR WAVE ENERGY CONVERSION OFFSHORE PORTUGAL

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ABSTRACT

The present study aims at studying the impact of energy absorption by wave farms on the nearshore wave climate. The study was applied to the Maritime Pilot Zone recently created by the Portuguese government to support the deployment of offshore wave energy prototypes and farms. This Zone is located off the west coast between the 30 m and 90 m bathymetric lines, with an area of 320 Km^2. The present study aims at establishing a methodology to analyse how the pilot zone will potentially affect the nearshore wave climate. In fact, the objective is to estimate the change of the wave characteristics (wave height and wave direction) at the nearshore when wave farms are deployed in the pilot zone. In this study the REFDIF model was adapted in order to model the energy extraction by wave farms.

KEY WORDS: Wave farms, wave energy extraction, Portuguese Pilot Zone; sea-wave propagation; numerical modeling.

INTRODUCTION

A Maritime Pilot Zone for wave energy extraction off the Portuguese coast was created by the Portuguese Government, to support the deployment of offshore wave energy prototypes and farms. This maritime zone is located at the West coast off S. Pedro de Muel, between 30 m and 90 m water depth, with an area of about 320 km^2. The Pilot Zone has been selected in an area with low environmental sensitivity. Global environment impacts are expected to be small in the initial phase where only a small number of devices will be deployed. Since environmental impacts are yet unknown, the main objective is to monitor and then to learn from field results, and ultimately to integrate the knowledge into Portuguese (and international) regulations (Huertas-Olivares, 2007).

For this pilot zone, several wave farms for wave energy exploration are planned. However, before the installation of those devices, it is recommended to consider and study several aspects: the number and position of those wave farms, the characteristics of the devices and the impact of the energy absorption by the wave farms on the nearshore wave field and morphodynamics.

In the present study a methodology for studying the effects of offshore wave farms in the nearshore wave climate is presented and the first results are discussed. This is a first step to assess the influence of wave farms on the dynamics of the surf zone and coastal circulation pattern. In fact, one wants to compare the wave characteristics (wave height and wave direction) at the nearshore for the present situation where no wave farms are installed (hence no wave energy absorption occurs) and the case where wave farms of up to 300 MW are present. Moreover, different configurations for the wave farms are considered in order to compare the effects on the nearshore wave field.

To implement this study, the following methodology was carried out:
- Definition of two configurations for the wave farms to be installed on the pilot zone, and its characteristics;
- Selection of representative offshore wave characteristics based upon the offshore wave regime, Capitão *et al*. (1998);
- Wave propagation calculations without and with the two wave farms configuration, for each incident wave condition;
- Assessment of the influence of the wave energy absorption by the wave energy devices in the near shore wave climate;

In more detail, two different configurations for the pilot zone are tested, respectively, with three and six wave farms, although with the same total installed power (202.5 MW), same alignment parallel to the wave crest with a total length of 16 km and spanning an area of 8.1 km^2. Two incident wave conditions were considered. These corresponded to the monthly minimum and maximum mean values, taken along the year. The wave energy absorption for each wave condition is based upon the technical specifications of the Pelamis wave energy device, as available from the website of the developer (*www.pelamiswave.com*), assuming 20 MW installed per km^2.

The REFDIF model (Dalrymple and Kirby, 1991) is used to simulate the propagation of sinusoidal waves of different amplitudes, periods and directions under the two described situations for different wave farms configurations and wave energy absorption conditions. To that purpose the model had to be adapted in order to simulate the energy absorption by the wave farms.