A COUPLED MODELING SYSTEM TO EVALUATE THE ENVIRONMENTAL IMPACT OF THE MARINE ENERGY FARMS

Rusu Eugen,
Department of Mechanical Engineering, "Dunarea de Jos" University of Galati, 111 Domneasca St., 80008 Galati, Romania, e-mail: erusu@ugal.ro

The marine energy farms, especially those based on wave energy converters can have a significant impact related to the incoming waves. Depending on the type of the device, a percentage of the wave energy is dissipated, while also processes as reflection and diffraction are transforming the incoming wave trains inducing a down wave effect. From this perspective, depending on the direction and the intensity of the incoming waves, but also on the bathymetric features of the coastal environment, significant near field effects can be induced, effects that can propagate further to the far field and at the shoreline level, influencing the coastal dynamics.

In order to assess such effects, a new and complex computational environment, denoted as CSIAM (Computational System for Impact Assessment of the Marine energy farms), is going to be developed in the framework of the DREAM project. This tool is designed especially for the MRE (marine renewable energy) farms and would allow both studies of the near and far field effects of the MRE farms. This new computational platform is based on the development and upgrading of a previous tool designed by the leader of the DREAM project. This is the Interface for SWAN and Surf Models (ISSM), which is a combination between the SWAN spectral wave model, simulating the nearshore wave propagation and the Navy Standard Surf Model (denoted as Surf) that is used to evaluate in more details the nearshore processes, in particular the intensity of the longshore currents. Several improvements will be implemented in order to adapt better this platform for assessing the MRE impacts. First, various farm configurations can be graphically defined directly on the map of the target area. In relationship with the way how the transmission and reflection processes are considered in the model simulations some details are provided next.

Thus, the numerical model implemented can estimate wave transmission through a (line-) structure considering that the obstacle is narrow compared to the grid size, and this is also the case of most of the wave energy farms layouts. As regards wave's transmission, there are several mechanisms considered in numerical wave modelling and the numerical model can reasonably account for waves around an obstacle if the directional spectrum of incoming waves is not too narrow. In the present approach, two alternatives are provided. The first considers constant transmission coefficients that can be defined (and changed) according the wave energy converters considered and also to the intensity of the incoming waves. According to the second alternative the transmission of waves passing over an obstacle with a closed surface has been modelled using the expression of Goda et al. Depending on the nature of the obstacle, the reflected wave field can be more or less scattered. In the present work, the reflection over wave components was diffused in different directions. Furthermore, according to this approach in case the obstacle becomes flooded, its reflection and transmission properties change as a function of the relative freeboard, defined as the ratio of the difference in dam height and the water level by the (incident) significant wave height. Diffraction process is also highly important in such assessments related to the down wave impact of the wave energy farms. Diffraction produces the spreading of energy laterally and may yield smoother wave fields in the lee of the WEC arrays. At this point it has to be highlighted that spectral models do not give in general very accurate results for modeling diffraction in harbours or in front of reflecting obstacles. However, behind the breakwaters (or wave farm lines) of a down–wave beach, the results are considered to be enough reasonable. Furthermore, in order to increase the convergence of the diffraction computations, repeated convolution filtering for the wave field smoothing can be also considered as an extra measure. The model system implementation is ongoing and the research team of the DREAM project has gained a wide experience by implementing various versions of this computational environment in very different nearshore areas.

Keywords: marine energy farms, environmental impact, computational platform, waves, nearshore currents, near and far field effects

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