Time-domain wave propagation modelling for assessing the impact of WEC farms on the wave field and the local morphodynamics and sediment transport

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Ocean waves carry part of the energy transferred from the atmosphere to the sea surface over long distances. Some of this energy can be harvested using wave energy converters (WECs). The performance (energy extraction) of isolated WECs and WEC arrays is strongly dependent on: i) the dominant sea-state [1]; ii) its temporal and spatial variability; iii) the wave-structure interaction within the WEC array; and iv) on the local environmental features. The most common approach to estimate the power absorbed by WECs is considering bulk parameters to represent the directional wave spectrum [2,3]. This approximation is not entirely accurate, particularly at regions with complex and variable wave conditions [4]. Through the directional wave spectrum or the sea surface elevation is desirable for such cases. Both can be approached by employing numerical simulations. In the literature, the wave energy redistribution around WECs has been widely simulated using the spectral numerical model SWAN (Simulating WAves Nearshore) [5,6], where WECs are represented as obstacles [7]. However, the SWAN model cannot solve the evolution of individual waves nor wave-structure interactions. Consequently, the wave-induced velocity field is not resolved, and hence the sediment transport cannot be adequately estimated using this model. For that reason, using a phase-resolving model is more convenient. Different numerical models have been used to resolve the wave propagation and far-field wake effects by the presence of WEC arrays [8, 9].

In this work, we propose to use the MILDwave phase-resolving wave propagation model, developed at Ghent University [9, 10, 11], coupled with a wave-structure interaction solver to take into account the WEC performance and its effects on the near and far-field [12]. For the numerical simulations, the boundary and initial conditions will be determined to carry out test cases with different WEC array configurations and for different scenarios of incident wave conditions. Finally, with the results of MILDwave, it is intended to obtain the wave-induced velocity field, which will be used to solve the advection-diffusion equation to analyze the sediment transport and morphodynamics due to the presence of WECs.

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