

MODELLING OF WAVE ATTENUATION INDUCED BY MULTI-PURPOSE FLOATING STRUCTURES

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INTRODUCTION

Multi-level forecastings concerning climate change reveal more and more the need for coastal protection against the rising sea level and storm events and their consequences. At the same time, the shrinking fossil fuels reserves and the increasing energy demand have enhanced the interest in sustainable and renewable energy sources, including wave energy. In order to extract a considerable amount of wave power, large numbers (tens) of Wave Energy Converters (abbreviated as WECs) will have to be arranged in farms using a particular geometrical layout. As a consequence of energy extraction, WEC farms create a region of reduced wave height downwave, referred to as *far-field effects*, influencing neighbouring activities in the sea, coastal ecosystems and even the coastline and the coastal defence conditions/parameters. The combination of the above leads to a realistic challenge: providing or enhancing coastal defences and, at the same time, satisfying the energy demand in coastal areas. Although WEC farm design requirements often refer to the idea of multi-purpose devices, there is only a small number of relevant studies available and primarily based on numerical and small scale physical modelling with typically <12 WECs.

THE FIRST EXPERIMENTS WITH LARGE WEC FARMS

In the research project WECwakes (Stratigaki et al. 2014), funded by the EU FP7 HYDRALAB IV programme, experiments have been performed in the Shallow Water Wave Basin (width x length: 35x25 m) of DHI, on large farms of floating devices. WEC farms of both rectilinear (Fig.1) and staggered configurations have been tested.



Fig. 1. View from behind the wave generator of 25 WECs.

This experimental set-up of 25 WEC units in a farm layout and placed in this large wave tank is at present the largest set-up of its kind, worldwide, studying important WEC farm effects that are also extrapolated to the nearshore wave climate. Float response (by displacement

meters), wave induced surge forces on the WECs (by load cells) and wave field modification (by wave gauges) have been measured simultaneously. A range of farm layout configurations and wave conditions are investigated (using regular, polychromatic, irregular long-crested and short-crested wind and swell waves). The floating devices have a 0.315 m diameter, D , and are limited to heave motion. WECwakes provides the first extended experimental database for validation of numerical models used for WEC farm modelling.

DISCUSSION ON RESULTS OF WAVE ATTENUATION

Wave field modifications are presented for unidirectional irregular waves (JONSWAP spectra, $H_{m0} = 0.104$ m, $T_p = 1.26$ s), for the resulting total wave field due to the diffracted wave field around the stationary structures and the radiated wave field caused by the oscillation of the floats. Up to 18.1% wave attenuation in the lee of the 25-WEC rectilinear farm is observed (and up to 20.8 % for the staggered farm). These wave attenuation results can be further used for estimating the coastline evolution due to the presence of a WEC farm, by applying traditional formulae, described in more detail in this paper.

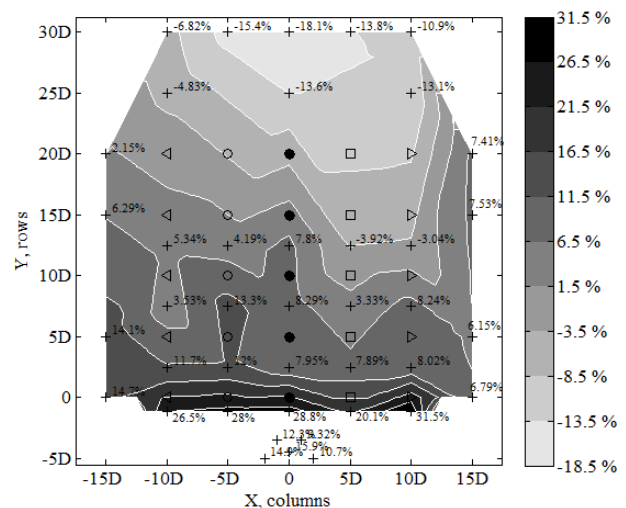


Fig. 2. Non-dimensional percentage of change of H_{m0} around 25 WECs ('triangle', 'circle' & 'square' symbols). showing their effect on the undisturbed wave field ('+' symbols: wave gauges). Through the WECs' "power take-off-system" the oscillation of the devices is damped.

REFERENCES

Stratigaki et al. (2014): Wave Basin Experiments with Large Wave Energy Converter Arrays to Study Interactions between the Converters and Effects on Other Users in the Sea & the Coastal Area. *Energies* 2014, vol. 7, pp. 701-734.