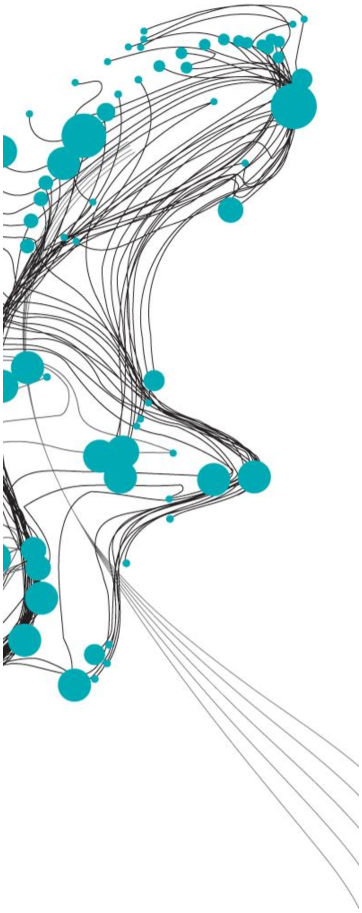
STORM SURGE MODELING IN A CLOSED AND SEMI-ENCLOSED BASIN

THE INFLUENCE OF BASIN TOPOGRAPHY AND WIND DIRECTION ON THE SET-UP ALONG THE COAST USING 1-DH AND 3-D FLOW MODELS



Destruction due to flooding, caused by severe storms, is a serious concern along coastal areas. The rise or set-up of the water level induced by a storm is called a storm surge. Improved understanding and accurate predictions of storm surges along the coast will help reducing the negative impacts of coastal disasters.

This study investigates the influence of the basin topography on the wind-driven response of large-scale coastal basins, measured in terms of the set-up at the coast, and paying particular attention to the role of the location of a topographic element, such as a shoal or a sand pit, relative to the wind direction. For this purpose, two different idealised process-based models have been used to simulate linearised hydrodynamics in closed and semi-enclosed rectangular basins driven by time-periodic wind forcing: (i) an analytical 1-DH flow model and (ii) the semi-analytical 3-D flow model of W.L. Chen et al. (2016). The frequency response, as obtained from these models, displays in particular resonance peaks, which we explain by linking them to the basin dimensions, the wind direction as well as the influence of the function, size and location of topographic elements. An example of such a combination of forcing and response in the frequency domain is shown in Figure 1 for a pit case at the rear end of the closed basin.

In general, it is found that adding topographic elements in front of the coast causes the resonance peaks to shift in the frequency domain, through their effect on local wave speed. Increasing bottom friction lowers the peaks. Furthermore, sensitivity analyses demonstrated that resonant frequencies strongly depend on the combination of basin topography and wind direction, particularly in shallow areas where bottom friction dominates the basin dynamics.

Subsequently, we illustrate how the frequency response is reflected in the time-dependent set-up generated by a single wind event. It turns out that the lower frequencies of the wind forcing input clearly dominate the behavior of the time-dependent set-up, relative to higher frequencies. This can be explained by the fact that due to the applied characteristics of a wind event, a large portion of the wind spectrum's energy is distributed over the lower frequencies of the spectrum. Moreover, this study demonstrates how to trigger optimal set-up behavior by modifying the basin topography for a given wind event with a certain wind speed, wind duration, ramp stage and most important, wind angle. Finally, Figure 2 shows the time-dependent set-up of the first case example (Figure 1) driven by a single wind event in the time domain.

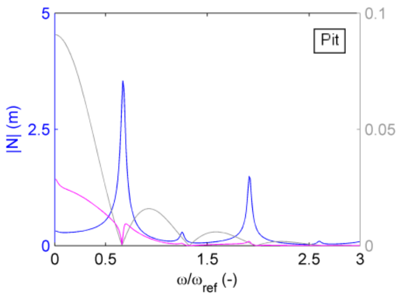


Figure 1: Spectral representation of the wind event (grey), response to periodic forcing (blue) and actual response (pink) of a pit case in the closed basin.

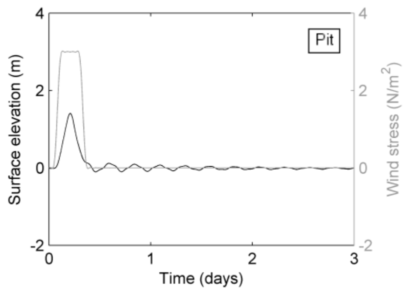


Figure 2: Temporal representation of both forcing (grey) and response (black) of the same case in Figure 1, where we have triggered a relatively low and calm set-up (black).

Chen, W.L., Roos, P.C., Schuttelaars, H.M., Kumar, M., Zitman, T.J. & Hulscher, S.J.M.H. (2016). Response of large scale coastal basins to wind forcing: influence of topography. Ocean Dynamics Vol. 66(4): pp. 549-565.

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