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INTERNAL WAVE GENERATION IN NUMERICAL MODELS

Introduction

One of the most important ecological and economic issues related to coastal engineering is the protection of the coastal areas and the unique ecosystems and economic activities they host. Moreover, coastal areas around the world should be able to cope with new challenges caused by sea level rise and by more frequent and intense storms due to climate change, phenomena that require human's high attention.

Nowadays, numerical models are commonly used as engineering tools for the study of wave propagation and impact on coastal areas. Depending on the problem under investigation and the corresponding time and space scales, different numerical models are used. In the field of wave transformation in coastal areas, SWASH [1], which is a phase-resolving wave propagation model based on the nonlinear shallow water equations with added non-hydrostatic effects, has already reached a fairly mature stage [2].

Wave Generation

In order to simulate waves in the nearshore zone correctly, the generation and absorption of waves at the boundary of models need to be modelled accurately. In the SWASH model, waves are generated by prescribing the horizontal particle velocities normal to the boundary of the computational domain over the vertical direction. Additionally, to absorb and to prevent re-reflections in front of the numerical wave generator, a weakly reflective boundary condition is adopted in which the total velocity signal is a superposition of the incident velocity signal and a velocity signal of the reflected waves.

However, this method is weakly reflective for directional, dispersive waves since is based on the assumption that the reflected waves are:

- small amplitude waves
- shallow water waves
- propagating perpendicular to the boundary of the computational domain

On the other hand, models utilizing a sponge layer are very effective in absorbing reflected waves. However, this implies that with the use of a source function the waves have to be generated inside the computational domain instead of on the boundary. The purpose of this research is to deal with these issues and improve the performance of the generated wave fields.

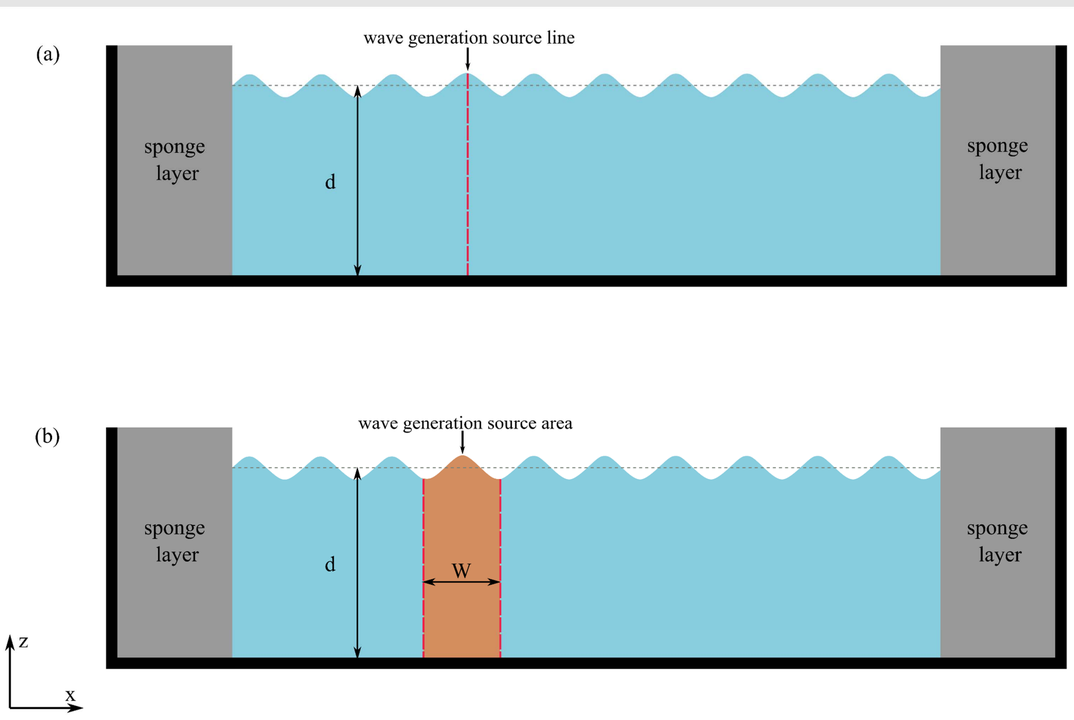

Figure 1. Definition sketch of the implemented internal wave generation methods (a) source term addition method and (b) spatially distributed source function.

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Research approach

In cases of directional and dispersive waves an internal wave generation technique can be applied to avoid re-reflections due to the weakly reflective wave generation boundary. Two different internal wave generation techniques have been developed and implemented in SWASH model.

- source term addition method proposed by Lee et al. [3] (Figure 1a)
- spatially distributed source function proposed by Wei et al. [4] (Figure 1b)

To demonstrate the strategic importance of the developed model for the generation of an accurate wave field over varying water depths, simulations are conducted for waves propagating over a shoal (Figure 2, Figure 3).

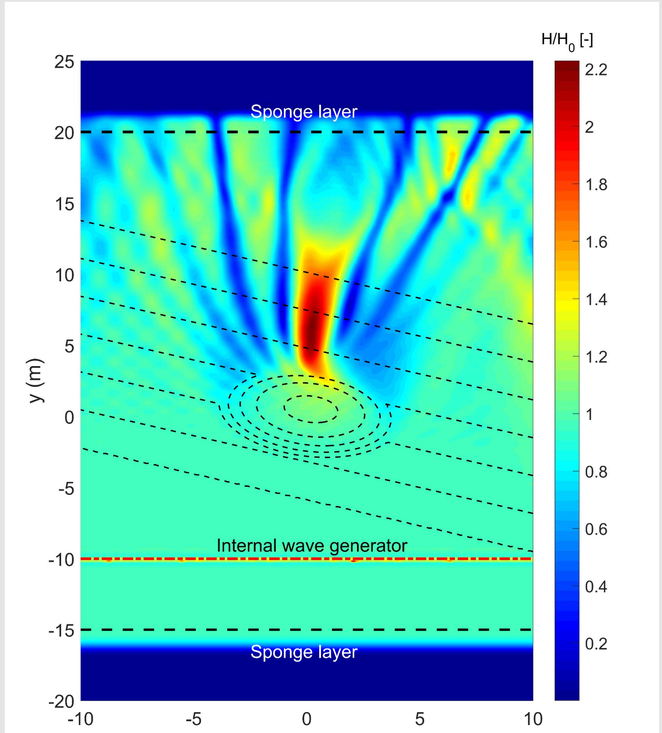

Figure 2. Normalised wave height distribution in the whole computational domain for the case of regular waves propagating over a shoal

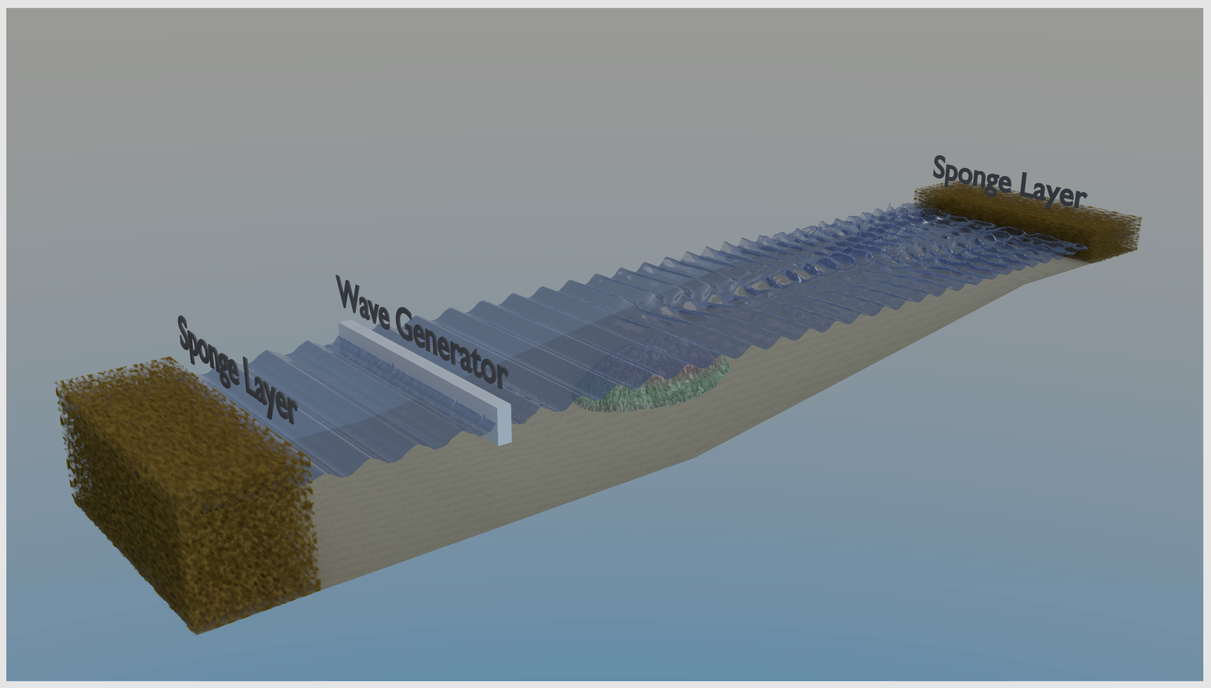

Figure 3. Regular waves propagating over a shoal

References

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