A deterministic combination of numerical and physical models for coastal waves

Numerical and physical modelling are the two main tools available for predicting the influence of water waves on coastlines and structures placed in the near-shore environment. Numerical models can cover large areas at the correct scale, but are limited in their ability to capture strong nonlinearities, wave breaking, splash, mixing, and other such complicated physics. Physical models naturally include the real physics (at the model scale), but are limited by the physical size of the facility and must contend with the fact that different physical effects scale differently. An integrated use of numerical and physical modelling hence provides an attractive alternative to the use of either tool on its own. The goal of this project has been to develop a deterministically combined numerical/physical model where the physical wave tank is enclosed in a much larger computational domain, and the two models communicate via a multi-flap wave generator placed along one boundary of the physical model. Previous work in this regard has typically been by means of a one-way transfer of stochastic information based on linear theory, which precludes the transfer of important phase and nonlinear information. A new ad hoc unified wave generation method has been developed which combines the theories of nonlinear shallow water generation and linear deep water generation. The numerical model used is the Mike21BW model developed at DHI - Water & Environment. The theory is tested in a wave flume (2-D waves) and in a 3-D wave basin and is generally successful. The method is also tested with the numerical model replaced by a fully nonlinear periodic wave theory (Stream Function Theory) and it turns out to be far superior to existing wave generation techniques in its ability to generate highly nonlinear periodic waves of constant form.