MODELLING OF BEACH STATE VARIABILITY

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INTRODUCTION

Beach morphological states evolve over different time scales in relation to waves and antecedent beach characteristics. There are various forms of beach state which include dissipative, reflective, and intermediate. The aim of this work is to develop a new empirical model that can recognize beach state variability when beaches respond to varying wave climates without having the need to use computationally expensive process-based numerical model.

METHODOLOGY

To create a database from which an empirical beach state variability model may be developed, a processed based morphodynamic numerical model Xbeach (Roelvink et al.,2010) was used in 1D (beach profile) mode. The model was first validated against a set of large-scale experimental data acquired from Canal d'Investigació i Experimentació Mańtima (CIEM) at the University Politècnica de Catalunya (UPC) in Barcelona, Spain (Eichentopf et al.,2019). The model was used to simulate morphodynamic change of beaches with a widely varying sediment characteristics and slopes from a large number of incident wave conditions. Different parameters were examined, but particular focus was put on describing the response of the nearshore berm formation and shoreline change. Hence, the Dean parameter, $\Omega = H_s / (W_s T)$, (Wright and Short,1984) was used, where (H_s) wave height, (W_s) sediment fall velocity, and (T) wave period. Ω incorporates both wave characteristics and sediment characteristics and is related to different morphological states of the beach.

RESULTS

The numerical simulations described above provided information on which to test and develop empirical formulations to determine the berm crest, its location with respect to shoreline, berm height, berm length and shoreline change, given to incident wave conditions. The empirical equation for berm height is given in Equation (1)

$$(Bh/h)^{0.5}(h/L) \backslash Tan\beta = 0.0387\ \Omega^{1.261} \quad (1)$$

where (Bh) is the berm height, (h) water depth, (h/L) ratio of the water depth at specific location to the wavelength at that same location and ($Tan\beta$) slope. This formula had a goodness-of-fit of 0.8, as measured by R^2

The empirical formulations were validated against beach profile measurements from three sites around the world, which are distinctly different in terms of beach characteristics and incident wave conditions.

Figure 1 shows the empirical model for berm height and the comparison with field data. The results demonstrate the empirical model is able to capture the beach change at dissipative (< 6) and intermediate (1 < 6) states.

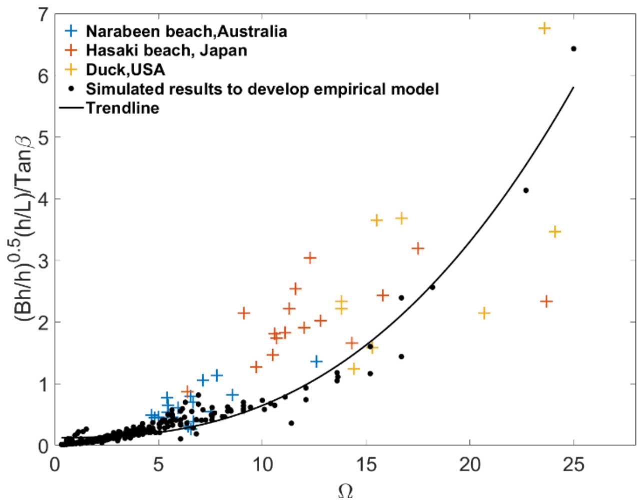

Figure 1. Non-dimensional berm height vs Ω and comparison of field data against the empirical formulation.

The full paper will describe numerical model setup and validation, the full set of empirical relationships between incident waves and a set of beach change indicators, include further validation of the model against reflective beaches and describe how those empirical relationships can be used to determine variability of a given beach under different wave conditions. Merits and the limitations of the models will be discussed.

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