Imperial College London

F1

Implementation of an open source numerical model (XBeach) to predict the influence of wave grouping on beach profile evolution

ALEXANDER DOUGLAS MARR **supervised by Dr Jose Alsina**

Department of Civil and Environmental Engineering, Imperial College London

INTRODUCTION

Grouping of waves has an important effect on the characteristics of beach profiles. A key focus here is the generation of Low Frequency waves by wave groups, which appear to influence the way in which beaches evolve.

An open source numerical model, XBeach, was used to reproduce a set of wave flume tests conducted by Alsina et al., (2014). The way in which XBeach reproduced the experiments was studied and an assessment was made of whether the model could predict and give an insight into the influence of wave grouping.

BACKGROUND

Low Frequency waves

Low frequency (LF) waves are wave components of much lower amplitude and longer period than commonly observed surface gravity waves. Their properties show strong correlations to those of local wave groups, implying that wave groups are key to their generation. Figure 1 shows a typical LF wave bound to a wave group.

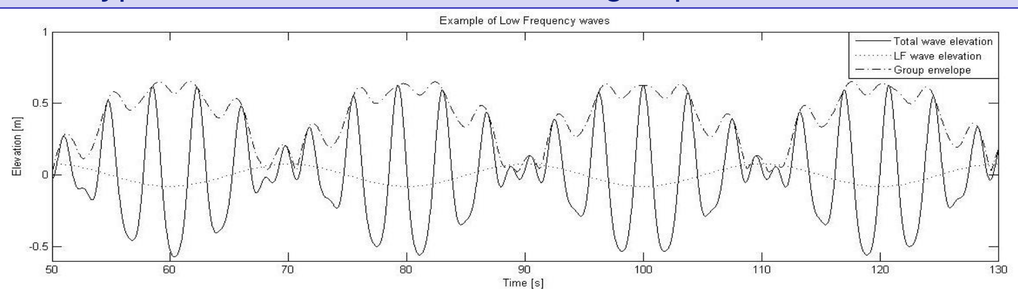

Figure 1

Nearshore bars

The main morphological feature of interest to this study are nearshore sand bars. They can be defined as areas where sediment has accumulated relative to an initial “undisturbed” beach profile, illustrated in Figure 2. Their behaviour is governed by the balance between onshore and offshore sediment fluxes. LF waves may have an important net contribution in tipping the balance between opposing fluxes.

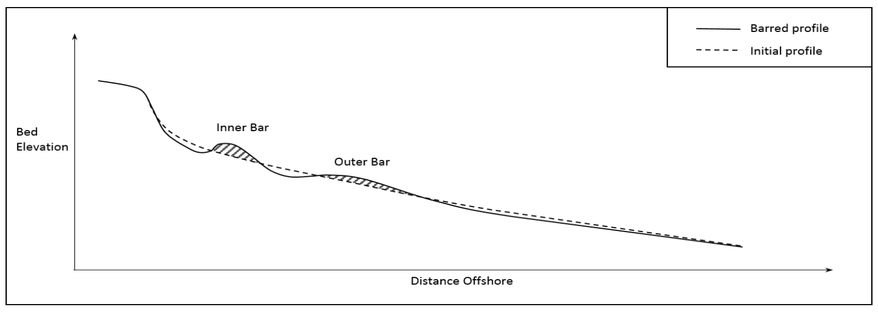

Figure 2

METHODOLOGY

The XBeach software was used to simulate two flume experiments where a simple beach profile was subjected to different wave conditions for a total of 240 minutes. The wave conditions had the same energy content and characteristic wave heights, but travelled with different group periods – one of 15s (Case BE1) and the other of 27s (Case BE4), such that any differences between the two resulting beach profiles would arise as a result of the wave grouping. Hydrodynamic and morphological outputs from XBeach were compared to those from the original experiments to assess the accuracy of the model.

ACKNOWLEDGEMENTS

Thanks to Dr Jose Alsina for supervising and guiding me through this project, providing help, advice and ideas and an great insight into this fascinating field.

Thanks also to Manuel Garcia-Leon of the Universitat Politècnica de Catalunya (UPC), Barcelona, for his tips on how to use XBeach, without which this project would have struggled to get off the ground.

REFERENCES

Alsina, J., Caceres, I., van der Zanden, J., Ribberink, J., Baldock,T. (2014) Large Scale Experiments On Beach Evolution Induced By Bichromatic Wave Groups With Varying Group Period. *Coastal Engineering Proceedings.* 1 (34)

Ruessink, B. G., Houwman, K. T. & Hoekstra, P. (1998) The systematic contribution of transporting mechanisms to the cross-shore sediment transport in water depths of 3 to 9 m. *Marine Geology.* 152 (4), 295-324.

RESULTS

Morphological change

Figures 3 and 4 show the change in beach profile for cases BE1 and BE4 respectively. Both show the model predicting the formation of a bar, but the characteristics of this do not match the experiment profile in either case.

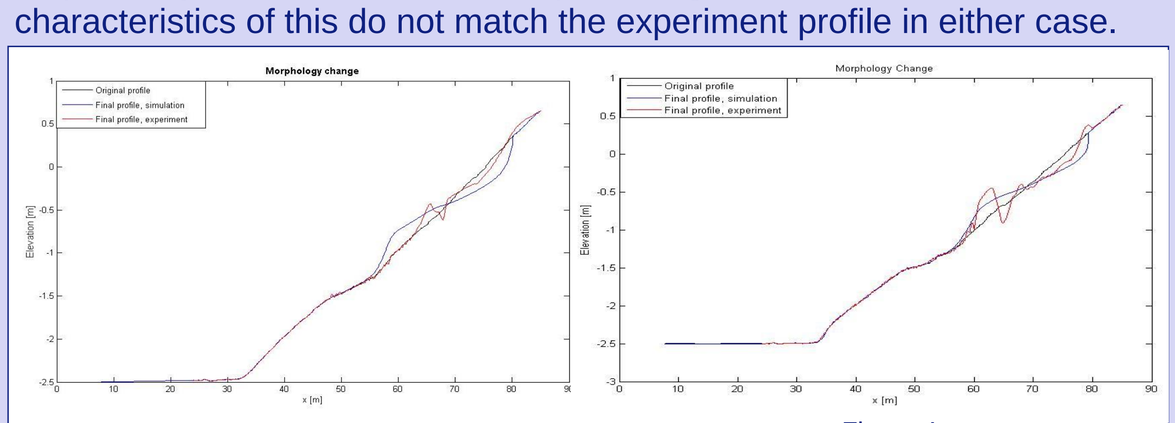

Figure 3 Figure 4

Figures 5 and 6 show how the distance of the bar from the shore over the course of the simulation for cases BE1 and BE4 respectively. The model fails to show the bar reaching an equilibrium position, contrary to the experiment.

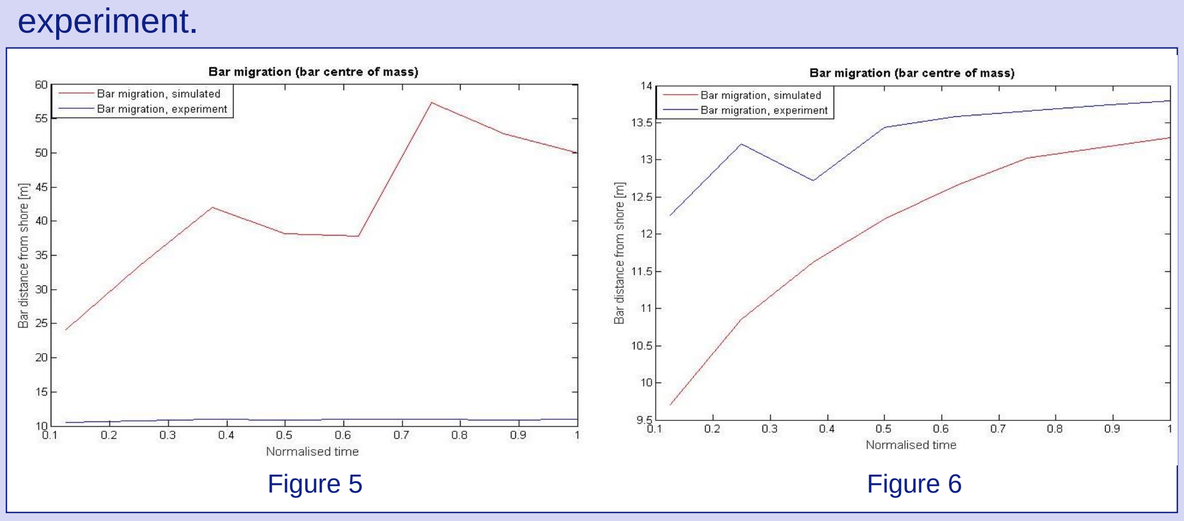

Figure 5 Figure 6

Hydrodynamics

Figures 7 and 8 show the RMS wave heights for cases BE1 and BE4 respectively. Both the overall wave heights and those of the LF waves are shown. It seems that for both cases the model underestimates the shoaling of waves near the breaking region, and the growth of the LF wave height approaching the shore.

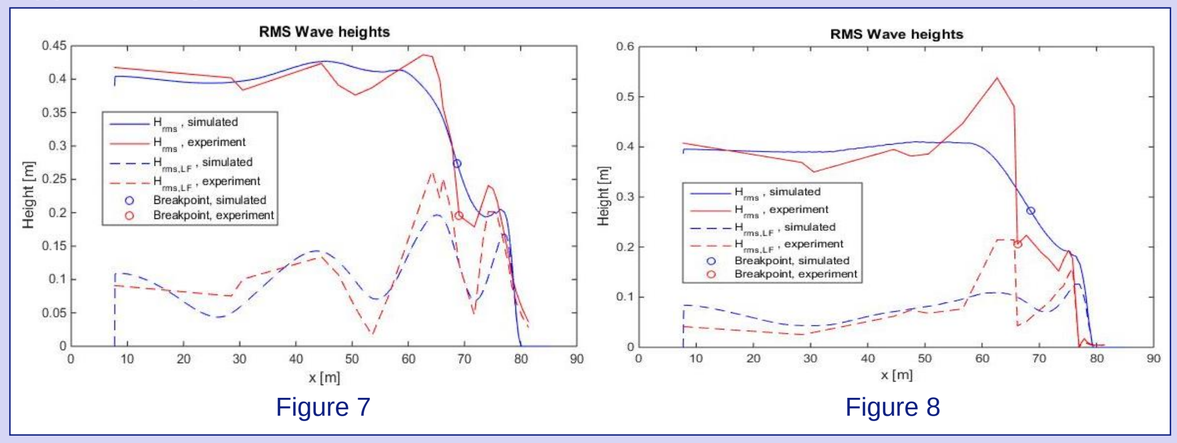

Figure 7 Figure 8

Discussion

The way that Xbeach is underestimating overall shoaling and the growth of LF waves could arise from a poor modelling of the interaction between the LF waves and the short waves generating them, possibly because the model is accurate up to the second order, which may be insufficient as waves become increasingly non-linear in nature. It has been suggested that the onshore sediment flux increases with wave asymmetry (Ruessink et al., 1998). Underestimation of shoaling could be linked to an underestimation of this effect, which could lead to an overall dominance of offshore transport, producing the greater erosion and offshore migration predicted by the model.

Conclusion

XBeach did not seem to be able to accurately predict the influence of wave grouping on beach profile evolution. It is possible that results may be improved with thorough tuning of certain model parameters, or use of different theoretical formulations. As XBeach is constantly evolving, due to its open-source nature, there is plenty of scope for improvement of the model.