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Offshore migration of coastal sand-bars
at Wanganui, New Zealand

A thesis presented in partial fulfilment
of the requirements for the degree of

Doctor of Philosophy

in

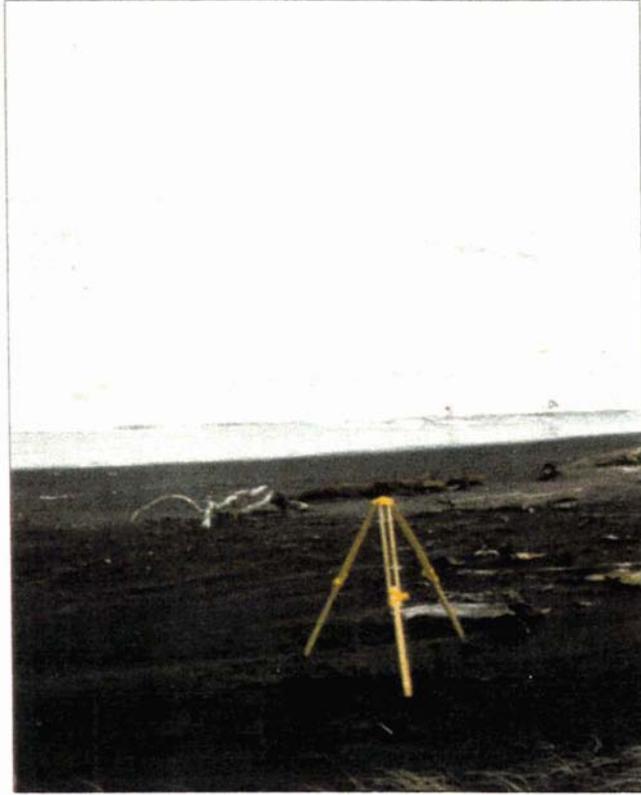
Geography

at

Massey University, Palmerston North,
New Zealand

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March 2000



The mystery of the universe, the layer upon layer of new meaning and new discovery, will never be revealed to those who do not look for it.

Veitch (1990)

ABSTRACT

Net offshore bar migration (NOM) refers to the systematic seaward migration of coastal sand-bars across the surf zone. These bars form near the shore-line and disappear in the outer surf zone. NOM behaviour is repetitive and has been described as cyclic. Over the past decade NOM has been recognised on the North Carolina coast, the Dutch coast and by the author on the west coast of the New Zealand North Island. The aim of this project is to elaborate on the behaviour and causative processes of NOM.

The New Zealand data used in this study comprise a 6.3 year bar-crest record from an approximately six kilometre long field site at Wanganui. These data were collected using aerial and terrestrial photography and supplemented with ground surveys. Image processing techniques were developed for photographic data abstraction and analysis. Published data from the other 'global' NOM sites were analysed and compared after data compatibility procedures had been developed and applied. The NOM cycles were quantified using parameters for NOM width (cross-shore migration distance), duration and rate, together with return period.

The global NOM sites are characterised by multiple sand-bars, the predominance of sea waves and a narrow band of storm strength wind and wave conditions. The longer-term (average cyclic) parameter values for the global data-set were as follows: NOM width ranged between 195 and 930 m; duration ranged between 1.2 and 13 years; NOM rate ranged between 35 and 196 m/yr, and NOM return period varied between 1.2 and 14.4 years. NOM characteristics for the global sites were found to be correlated with cross-shore slope, coastal orientation and extreme wave height.

The Wanganui bar-crest data were also analysed for shorter-term (within-cycle) bar behaviour. Cross-shore bar migrations had a bimodal frequency distribution. The group of larger migrations, termed 'episodic seaward jumps', significantly influenced the characteristics of individual NOM cycles. Episodic seaward jumps appear to be preceded by the degeneration of the adjacent seaward bar. Longshore non-synchronous variation in NOM characteristics were found to be mainly related to 'bar switching' (longshore bar realignment).

Based on the above results, a conceptual morphodynamic model for NOM was formulated. The model incorporates three main components: a drive mechanism; a morphodynamic modification mechanism; and a timing mechanism.

Net offshore bar migration is a significant mode of morphological behaviour within the surf zone. Its influence upon other aspects of coastal geomorphology such as shoreline change, and its relationship with existing 'beach-state' based models, require further investigation.

ACKNOWLEDGEMENTS

First I wish to thank my main supervisor, Dr Mike Shepherd, who introduced me to the fascinations of coastal geomorphology. My world quickly became a different place as the continuous and multi-scaled changes which characterise the coastal environment were revealed. I hope that I am also able to open the eyes of others to see the wonders of this world. Thanks Mike for your patience and help in dealing with the numerous obstacles I faced.

Professor Bob Kirk, now Pro-Vice Chancellor of Research at the University of Canterbury, played a vital role in keeping the project on track with his astute overview and insistence on coherence, clarity and adherence to the principles of scientific research - thanks Bob.

The project relied upon the imaging system VIPS, devised by Dr Don Bailey as part of his own PhD. I well remember wandering into Don's office with the Lippmann and Holman (1989) seminal paper on obtaining morphological bar-crest data from photographs and video, handing him the paper and then asking if he could do this sort of thing. In hindsight I realised this was a silly question to ask an engineer! Don willingly adapted his operating system to processing my surf zone photos and providing the bar-crest data for my subsequent geomorphological analysis. Don became a secondary supervisor and his advice concerning mathematics, statistics, physics and imaging were greatly appreciated. The National Institute of Water and Atmospheric Research (NIWA) subsequently commissioned Don to modify some of the algorithms for use in a national video-based automated coastal monitoring system.

Assistance with data and error analysis from Drs S. Ganesalingam and T. Moore of the Massey University Statistics Department is acknowledged.

I wish to thank Professor Rob Holman (Oregon State University) for the initial time-lapse photographic equipment and suggestions on how to go about developing techniques for its use. Thanks also to Drs Gerben Ruessink (Utrecht University) and Phil Osborne (Auckland University) for guidance on preparing papers for publication and to Professor Andy Short (Sydney University) for his instruction on coastal morphodynamics.

Funding and field support for the project came from many sources. I acknowledge with thanks the Massey University input: the Post Graduate Research Fund; the Massey University Research Fund; the Special Vice Chancellor Grant, and financial and equipment support from the Geography Department (now incorporated within the School of Global Studies).

Organisations in Wanganui were also very supportive. The Wanganui Port Company, the Wanganui District Council and the local NIWA office provided survey equipment and labour. The Wanganui Surf Lifesaving Club provided inflatable craft and highly skilled operators. Thanks to all of you - especially for braving winter days when conditions were marginal.

Finally, I wish to give special thanks to my parents who helped me develop an enquiring mind and acquire practical skills for problem solving, and also to my wife Susan and to my family and friends who for so long put up with me as I struggled through a project that, at times, seemed to have no end. You all supported me in so many ways - thank you.

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