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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

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in

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at

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New Zealand

Roger Duncan Shand

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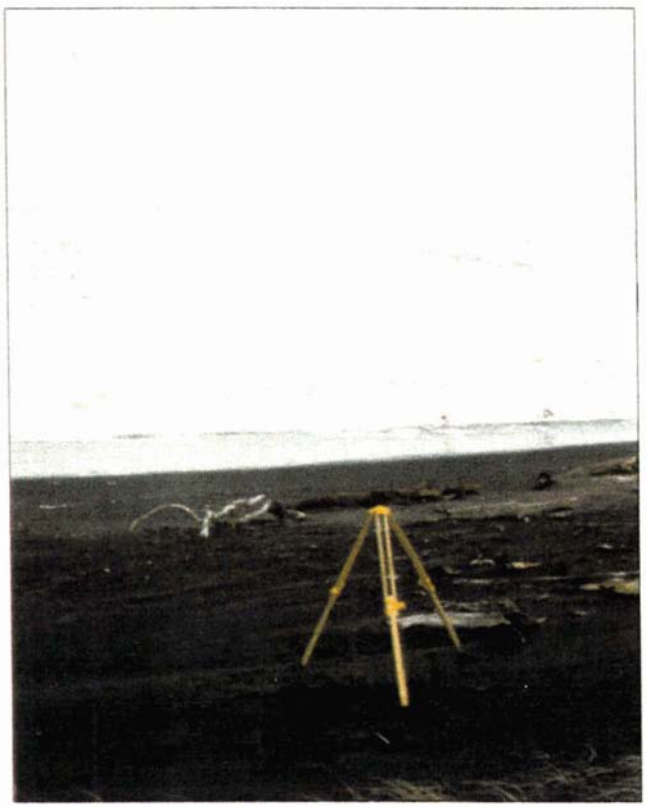

The mystery of the universe, the layer upon layer of new meaning and new discovery, will never be revealed to those who do not look for it.

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.

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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.

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