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Sediment input to lee-side coastal foredunes: preliminary description of frequency and magnitude of potential transport events at Magilligan Strand, Northern Ireland

Irene Delgado-Fernandez (1), Derek Jackson (1), Andrew Cooper (1), Kevin Lynch (2), Andreas Baas (3), and Meiring Beyers (4)

(1) Centre for Coastal & Marine Research, School of Environmental Sciences, University of Ulster, Northern Ireland, BT52 1SA, (2) School of Geography and Archaeology, National University of Ireland Galway, University Road, Galway, Ireland, (3) Department of Geography, King's College London, London, UK, WC2R 2LS, (4) Klimaat Consulting & Innovation Inc., Guelph, Canada

Calculations of aeolian sediment input to coastal foredunes are essential for sediment budget calculations and prediction of foredune evolution, as well as many practical applications such dune rehabilitation and coastal restoration. However, predictions of aeolian sediment transport at a scale of weeks to months are tenuous which poses major difficulties in the building of appropriate frameworks for decision-making. Deterministic models of instantaneous sand transport are often combined with wind speed and direction collected from meteorological stations to calculate sand transport into the dunes, often providing quantities that disagree with observed values of deposition by several orders of magnitude. These types of discrepancies are one of the most recurrent questions in aeolian coastal research and preclude communication between scientists and managers.

Recent findings at Greenwich Dunes, Canada, suggest that the majority of sediment input to coastal foredunes is driven by a few wind events of medium frequency and magnitude. Key factors such as onshore winds over a minimum threshold for sand movement, fetch distance, moisture, and snow-ice cover regulate the frequency and magnitude of significant transport events. This site is representative of coastal areas with a predominant onshore wind regime, medium grain size, and relatively low, rounded dune crests. Research carried out at Magilligan Strand, Northern Ireland, suggests that key factors such as flow reversal under offshore wind conditions may play a primary role when tall-sharp dune crests and fine grain sizes are present. Furthermore, under particular conditions, post-storm recovery of a wave-scarped foredune may completely rely on reversed flows returning sediment to the dune toe.

This work summarises key aspects of offshore wind events that could be used for long-term prediction and explores the potential to calculate medium-term (weeks to months) aeolian sediment input to Magilligan dunes. This site has recently been the subject of detailed, short-term field and model airflow investigations to characterise offshore flow events and contains extensive records of a wind, sediment transport and topographic data over a number of time periods from September 2009 to April 2010. To supplement these data, hourly values of wind speed and direction, precipitation and temperature were also captured from an established coastal weather station located 1 km from the field site. Short-term experiments involving the location of anemometers at heights of 0.5 m over the beach surface aided in the determination of a minimum wind threshold for dry sand under which no sediment movement is likely to occur. This wind threshold was correlated with wind speed at the dune crest for a range of wind directions, which allowed isolation of potential transport periods associated both with onshore and offshore wind events. Tidal range was used as a proxy of beach width and fetch distance was calculated from wind direction and beach width for wind events with an onshore component. A simple procedure involving Bagnold's formula and underlying knowledge about the role played by onshore events was used to quantitatively predict sand input to the dunes. This was compared with sand accumulated over the same time period, by using two topographic surveys carried out with DGPS at the beginning (September 2009) and end (April 2010) of the study.

Preliminary results suggest that while onshore storms have very small probabilities of resulting in sediment input to the foredunes because of beach inundation and storm surge, strong offshore wind storms deliver significant quantities of sediment to the dunes in lee-side coast areas, especially when local sediment grain size is small.