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A new modelling concept for aeolian sediment transport on beaches

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This paper presents a new modelling concept for aeolian transport on beaches. Many research is invested in describing aeolian sediment transport for desert situations. Some of the principles of aeolian sediment transport in deserts are valid for application at the coastal zone but, where in deserts abundant sand is available for transport, in coastal situations sediment availability is limited. Sediment availability (or supply) is limited due to supply limiting factors such as moisture content of the bed, fetch effects and armouring of the surface.

We propose a new sediment transport concept where we quantify aeolian sediment transport while quantifying the sediment availability rather than the more conventional (Bagnold, 1954) wind driven transport capacity. The concept is illustrated using field data.

The field data is collected during a measurement campaign which has been designed to measure aeolian transport with special focus on sediment availability. Wind and sediment transport rates are measured on a beach for a period of 1 week. During this week onshore wind occurred allowing the analysis of aeolian transport across the beach towards the dunes. A total of 5 sediment transport gauges are dynamically placed over the cross section of the beach from locations in the intertidal zone (at low tide) until the dunefoot.

The observations show that the amount of aeolian transport is very much dependent on the tidal phase. Low tides correspond to large aeolian transport and high tides to significantly lower aeolian transport across the beach. Wind conditions during the experiment were relatively constant implying that the specific variability in time of the measured aeolian transport is caused by variability with respect to the source rather than variability in wind conditions.

Additional to this specific case, existing data of similar experiments (Arens, 1996) are analysed. Re-analysing this data, from experiments covering larger timespans, more evidence is found for source (or availability) related variability in measured aeolian transport rates.

The measurements support the concept of allowing a dominant role for sediment availability over wind driven transport capacity in sediment transport formulations. Moreover, these measurements allow for an initial formulation of a new sediment transport relation suitable for quantifying aeolian sediment transport on beaches. The new sediment transport formulation is fundamentally different from existing Bagnold type formulations but, shows large generic potential to quantify and predict aeolian sediment transport on beaches and other situations with limited sand supply.

References:
Bagnold, R., 1954. The physics of blown sand and desert dunes, 2nd Edition. Methuen, London.
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