A NEW CONCEP FOR AEOLIAN SEDIMENT TRANSPORT RATES ON BEACHES

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This paper presents a new concept for formulating aeolian transport with the aim of contributing to the predictive capabilities regarding dune development on the annual to decadal timescale.

Traditionally, aeolian sediment transport is modelled using Bagnold (1954) type formulations. Bagnold type formulations relate sediment transport to wind velocities to the 3rd power such as:

$$Q = C(U - U_t)^3$$

where Q is the sediment transport rate, C an empirical constant based on bed conditions such as grain size and moisture content, U the wind speed and U_t the threshold windspeed needed for transport. This approach assumes there is sufficient sediment supply to achieve transport limited conditions where a wind dependent transport capacity governs aeolian sediment transport rates.

At beaches, sediment transport systems are typically supply limited where the aeolian transport rates are very much influenced by the supply of sediment. This sediment supply is variable in time and dependent on beach geometry, surface sediment characteristics, surface moisture content.

We have conducted a field campaign to investigate the influence of wind speed and sediment supply on measured sediment transport rates. The experiment lasted for 3 days where wind speed and direction were measured together with sediment transport rates at several locations across the beach.

Figure 1 shows measured wind speeds, transports and tidal level. It is shown that variability in aeolian sediment transport rates does not correlate with variability in wind speed but does correlate very well with the measured tidal level. Therefore it is argued that sediment transport formulations based on the temporal variability of the supply are appropriate.

Figure 2 shows measurements of wind speed and sediment transport rates at three locations on the beach. Values are binned and averaged over a 30 minute interval. It is shown that the relation between wind speed and sediment transport rates is well represented fitting a linear curve.

Based on these and previous measurements we propose a sediment transport formulation for supply limited conditions:

$$Q_s = C_s(U - U_t)$$

where Q_s [m^3/s] is the sediment transport rate in a supply limited system, C_s [m^3/m] is a measure of supply in the direction of the wind, U [m/s] the wind velocity and U_t [m/s] the threshold velocity needed for transport.

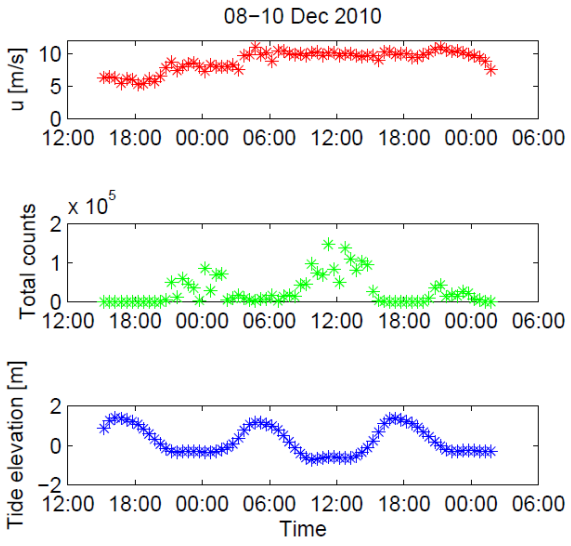

Figure 1. Overview of measurement results.

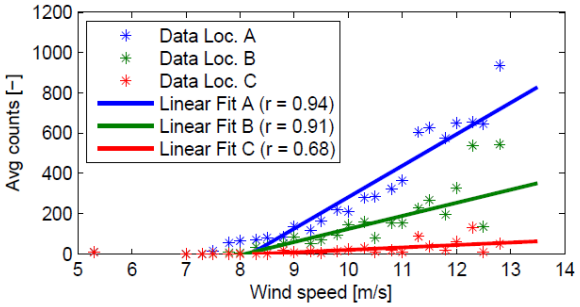

Figure 2. Fitted linear relationships between wind speed and sediment transport rates measured simultaneously (under similar wind forcing) at different locations.

The proposed concept allows for a temporal and spatial varying sediment supply where wind speed plays a less dominant role compared to the traditional Bagnold type relation. As a consequence, detailed calculations of wind conditions using CFD models can possibly be avoided.

Currently we derive supply using linear fits on measured data. Determining the supply in a generic way is needed for the concept to gain applicability for future applications,

REFERENCES

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