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Dependence of ripple dimensions on cohesive and non-cohesive bed properties in the intertidal Dee Estuary

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There is a need to better understand the effects of cohesive and mixed sediments on coastal processes, to improve sediment transport models for the management of coastal erosion, siltation of navigation channels and habitat change. Although reasonable sediment transport predictors are available for pure sands, it still is not the case for mixed cohesive and non-cohesive sediments. Existing predictors mostly relate ripple dimensions to hydrodynamic conditions and median sediment grain diameter, assuming a narrow unimodal particle size distribution. Properties typical of mixed conditions, such as composition and cohesion for example, are not usually taken into account. This presents severe shortcomings to predictors' abilities. Indeed, laboratory experiments using mixed cohesive sediments have shown that bedform dimensions decrease with increasing bed mud content. In the field, one may expect current predictors to match data for well-sorted sands closely, but poorly for mixed sediments.

Our work is part of the COHBED project and aims to: (1) examine, in field conditions, if ripple dimensions are significantly different for mixed cohesive sediment beds compared to beds with pure sand; (2) compare the field data with laboratory results that showed reduced ripple length due to cohesive mud content; and (3) assess the performance of a selection of ripple predictors for mixed sediment data.

The COHBED project was set up to undertake laboratory experiments and fieldwork to study how physical and biological processes influence bedform development in a mixed cohesive-cohesionless sediment environment. As part of COHBED, a suite of instruments was deployed on tidal flats in the Dee Estuary (on the NW coast of England), collecting co-located measurements of the hydrodynamics, suspended sediment properties and bed morphology. The instruments occupied three sites collecting data over different bed compositions during a two week period (21 May to 4 June 2013). One site was located above a sandy bed, and the two others were above mixed beds of different mud content. The tide covered a full cycle from neaps to neaps and the weather provided onshore and offshore winds of varying strength. Bedform measurements were taken every half an hour using an Acoustic Ripple Profiler (ARP) that covered an area of about two square metres. Dynamic measurements of tides and waves were made using an Acoustic Doppler Velocimeter (ADV) at 8 Hz. Bed samples were taken when the tidal flats dried out at low tide and a sediment trap collected suspended load near the bed. In the presentation, comparisons of the sites will be made from measurements of the proportion of mud and biological sediment binders at each site and the ripple dimensions for different hydrodynamic conditions.

Key words: bed morphology, current ripple, mixed sediment, cohesion, hydrodynamics, observations, tidal flat, estuary, Dee