Geophysical Research Abstracts
Vol. 19, EGU2017-10711, 2017
EGU General Assembly 2017

The role of bio-physical cohesive substrates on sediment winnowing and bedform development

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Existing sediment transport and bedform size predictions for natural open-channel flows in many environments are seriously impeded by a lack of process-based knowledge concerning the dynamics of complex bed sediment mixtures comprising cohesionless sand and biologically-active cohesive muds. A series of flume experiments (14 experimental runs) with different substrate mixtures of sand-clay-EPS (Extracellular Polymeric Substance) are combined with a detailed estuarine field survey (Dee estuary, NW England) to investigate the development of bedform morphologies and characteristics of suspended sediment over bio-physical cohesive substrates.

The experimental results indicate that winnowing and sediment sorting can occur pervasively in bio-physical cohesive sediment - flow systems. Importantly however, the evolution of the bed and bedform dynamics, and hence turbulence production, is significantly reduced as bed substrate cohesivity increases. The estuarine subtidal zone survey also revealed that the bio-physical cohesion provided by both the clay and microorganism fractions in the bed plays a significant role in controlling the interactions between bed substrate and sediment suspension, deposition and bedform generation. The work will be presented here concludes by outlining the need to extend and revisit the effects of cohesivity in morphodynamic systems and the sets of parameters presently used in numerical modelling, particularly in the context of the impact of climate change on estuarine and coastal systems.