



Feedbacks between Fine-Grained Sediment Deposits and Bedforms in a Predominantly Sandy Seabed: Field Observations from the Southern North Sea

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Fine-grained sediments, i.e. clay and silt, play a key role in the ecological functioning of the southern North Sea. Additionally, when fine-grained sediments can influence the development of bedforms in two possible ways. First, the permeability of a sandy seabed strongly decreases, even at low mass fractions of fine-grained sediments. Second, at higher mass fractions, the bed may become cohesive, inhibiting the development of bedforms. Hence, it is of importance for the mobility of the bed of the southern North Sea how fine-grained sediments are spatially distributed in the surficial seabed layer. Unfortunately, their large-scale spatial distribution has hardly been studied. In this paper, we investigate how spatial patterns of fine-grained sediment in the surficial seabed layer of the southern North Sea are controlled by a combination of physical conditions and human activities.

To determine the spatial distribution of fine-grained sediments, we analysed the results of a monitoring programme that took place from 2006 to 2014 along the Dutch coast. For this monitoring programme, surficial seabed samples (upper 10 cm) were collected at 300 sampling stations on a (mostly) yearly basis. In total, up to 1800 seabed samples were collected with a boxcore on both the shoreface and inner shelf, with cross-shore distances ranging from 1 km to 50 km. Additionally, we used Sediment Profiling Imagery (SPI) on specific sites to qualitatively assess small-scale sediment distribution patterns.

We found that fine-grained sediments are heterogeneously distributed in the surficial seabed layer along the Dutch coast. Further than 20 km offshore, virtually no fine-grained sediments are found in the surficial seabed layer. Within 20 km of the shore, high mass fractions of fine-grained sediments are mainly found in three areas: (i) North and South of the Port of Rotterdam entrance; (ii) in the former tidal channels in front of closed estuaries in the Southern part of the coast and (iii) close to the shore, i.e. within 2 to 3 km of the shore. The presence of fine-grained sediments in the bed requires: a significant supply of fine-grained sediments and relatively calm hydrodynamic conditions. The supply can either be the result of natural processes or human activities. Calm hydrodynamic conditions should be interpreted relative to their direct environment. We identified such relatively calm conditions on different spatial scales. Using the boxcore data, we demonstrate this for the large spatial scales, for instance to identify fine-grained sediment deposits in the troughs of tidal ridges. The SPI data shows small-scale variations in fine-grained sediment fraction on ripple scales. Thus, bedforms on different scales play a key role in deposition and accumulation of fines.

We conclude that the presence of fine-grained sediments in the seabed depends on two requirements. The supply of fine-grained material determines whether it is likely to find fine-grained sediment in an area. Present bedforms determine the local accumulation of fine-grained sediments, resulting in a heterogeneous spatial pattern on different scales. Evidence for the influence of the fines on the bedforms is currently being explored.