

Tidal marsh sedimentation in the Scheldt estuary: a field and modelling approach

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In the tidal marshes of the Scheldt estuary, deposition of suspended sediment takes place during tidal inundation. Tidal marsh sedimentation has an important effect on the functions of the estuary: (1) it is one of the most important controlling factors for changes in the estuarine ecosystem, (2) it can diminish sedimentation in the stream channel, which has to be maintained for intensive shipping, and (3) it reduces the role of tidal marshes as inundation areas, which can protect inhabited areas from flooding. In this research project, tidal marsh sedimentation is studied on the basis of field measurements and numerical modelling, on different spatial and temporal scales. Depending on the scale, different field methods and modelling approaches are used.

On the small scale, sedimentation patterns are studied with a high spatial and temporal resolution. Field studies are carried out at 3 small study sites (of ca. 30ha). On each study site, sediment deposition is measured at different locations within the marsh, using plastic sediment traps. These are replaced every 15 days after a spring-neap tidal cycle. The data show strong spatial variations, ranging from < 20 to > 1000g/m², during one spring-neap cycle. These variations are especially determined by the marsh topography. Young (low lying) marshes have higher sedimentation rates than old (high) marshes, due to higher and more frequent tidal inundations. The distance to the nearest tidal creek or the stream channel of the Scheldt River plays a secondary role on sediment delivery and deposition. Temporal variations between spring-neap cycles are affected by differences in inundation frequency and height. The higher the inundation height, the more suspended sediment is transported to and deposited on the marsh surface.

To model these small scale sedimentation patterns, a two-dimensional modelling approach is followed, which takes into account the complex interactions between marsh surface topography and the flow of water and sediment over the marsh surface. For that we will use two-dimensional finite element models and CFD modelling techniques. Model simulations will then be compared with the field measurements.

Tidal marsh sedimentation is also studied on the large scale. At 15 marsh locations, scattered along the Scheldt estuary, the sedimentation rate during the past 100 years is estimated on the basis of ²¹⁰Pb-dating of boring samples. Young marshes are characterised by initially high sedimentation rates. After an equilibrium level is attained, the sedimentation rate is much lower and is then expected to be controlled by the increase of mean high water levels and by the suspended sediment characteristics, which vary along the Scheldt estuary.

These large-scale sedimentation patterns can be modelled following a 1-dimensional modelling approach, based on long-term simulation of tidal marsh inundation and the solution of a simple mass balance equation over all these inundations. Preliminary modelling results are in good agreement with observed field data.

Keywords: tidal marshes; sediment deposition; numerical modelling; Scheldt estuary.