Temporal bed level variations in the Yangtze tidal flats

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1. Introduction

The Yangtze River is one of the largest rivers in the world and the longest one in Asia. Its estuary forms an important entrance for shipping, but is also a key ecological system. Especially the inter-tidal flats are valuable habitats. The health and integrity of the estuarine tidal flat are however under pressure due to anthropogenic influences upstream (e.g. the Three Gorges Dam) and in the estuary (navigation works). The processes responsible for the dynamics of tidal flats are still not fully understood. Although it is clear that tides, river run-off and waves steer the sediment transport, the full non-linear interaction needs further research. In this paper, the seasonal variation of the bed level is analysed, using a data set of tides, wind and river run-off.

2. Site and Data

A unique long term data set (2 years) is available, including: daily observation of bed level, SSC and mean grain size of surface sediment at a fixed site on Nanhui tidal flat near Luchaogang. This data set is complemented with hourly water levels reconstructed from the available tidal constituents and daily river discharges measured at Datong Station, the tidal limit of the Yangtze River. Recent wave data are not available for this region. Therefore a wave simulation with SWAN is carried out for the period considered. The model could be calibrated with data from 1982, 2005 and 2006. As far as the authors know, no long term wave data has been presented yet for the Yangtze Estuary.

3. Analysis

A seasonal cycle is identified in the bed level signal, with an accretion phase from February till May, an degradation phase from June till October, and a dynamic equilibrium phase from November till January.

A similar variation was found during the same period at a near-by site. There are some deviations, which can be attributed to smaller scale spatial variation. It can however be assumed that the measured bed level variation is representative for the flat and does not reflect local patchiness. Despite the exposure of the site to waves, no direct seasonal correlation was found between wave forcing and bed level variation, especially as no clear seasonal cycle in wave height was found. This does however not imply that waves are not important for the bed level variation. Waves do contribute to the erosion.

A seasonal variation is found in the suspended sediment concentrations. High concentrations are found during increasing bed levels, and low values are found for decreasing bed levels. This variation coincides with concentration measurements offshore. It implies that the seasonal variation of the tidal flats is dominated by the variation in off-shore source and not so much due to variation of the local forcing.

The seasonal variation in bed level is also correlated with the variation in mean grain size. Increasing bed level is accompanied by fining of the sediment, implying the deposition of fine material. During decreasing bed levels, the sediment slightly coarsened. Stratification is present as if the bed level is lower than approximately 270 cm MSL, the grain size increases significantly for silty material to fine sand.

In addition to the seasonal variation, a clear fortnightly fluctuation is deduced from wavelet analysis during the period of increasing bed level. During spring tides, more sediment is transported onto the tidal flats.

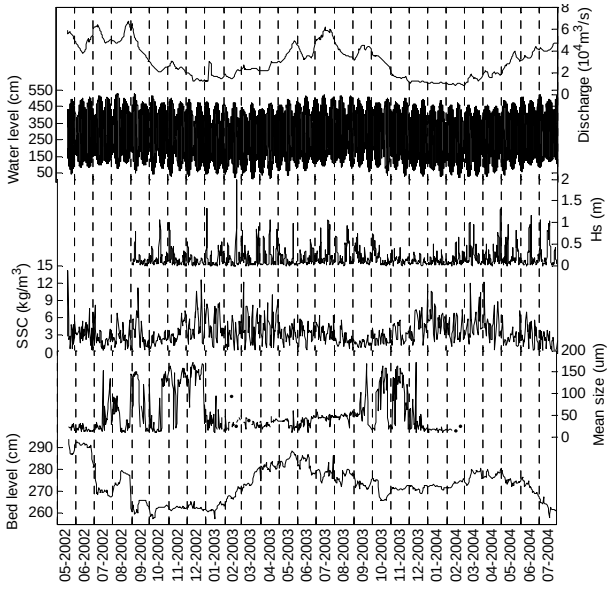

Figure 1: Time series of river discharge, water level, significant wave height, SSC, mean size and bed level.

4. Conclusion

A unique data set for bed level and concentration variations on tidal flats is combined with data for discharge, water level and (modelled) waves. In contrary to the expectations, the seasonal variations could not be attributed to seasonal variation in wave forcing. Seasonal variation in the offshore source is a more likely candidate. This implies that processes that influence this offshore concentration will affect the development of the tidal flats.

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