How the tides changed in the Schelde-estuary under influence of natural changes and human interference

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The Schelde-estuary

The Schelde-estuary has a length of 160 km and is located in Flanders (up-estuary, called "Zeeschelde") and the Netherlands (down-estuary, called "Westerschelde"). The estuary is characterized by a macro-tidal regime, ebb and flood currents, a longitudinal salinity gradient and important sediment transports, leading to important morphological changes.

Over the past centuries several human interferences have taken place in and along the estuary: starting with important poldering of areas along the estuary, dike-building, cutting-off of several bends, dredging works to guarantee the port accessibility and sand extraction for commercial reasons. Beside these human activities sea level change occurred and has caused changes in the morphology of the estuary and thus the tidal penetration in the estuary.

Tidal penetration

Due to the funnel shape of the estuary, the tidal range increases from the mouth of the estuary towards up-estuary. At the start of the 20th century, this maximum was located near Antwerp (KM 80), while at the end of the 20th century this maximum has increased (almost 1m) and is located more up-estuary (near Tielrode, KM 100). More up-estuary the tidal range decreases, mainly due to the smaller depth of the estuary resulting in damping.

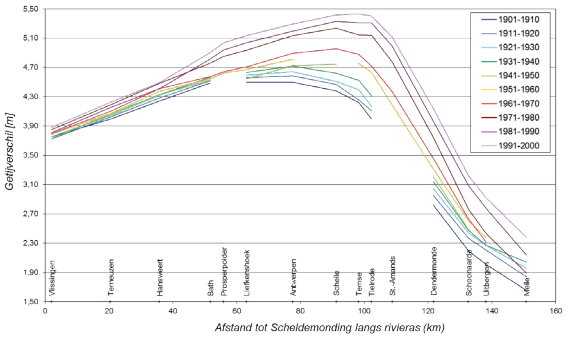

Figure 1: Tidal range along the estuary in the 20th century

In a recent study, the available water level data were analysed for the Schelde-estuary. The analysis of the Dutch stations was performed by Deltares, while Flanders Hydraulics Research performed the analysis for the Sea Scheldt. Figure 2 and 3 show the evolution of the mean high and low water level for Antwerp. It can be seen that the yearly averaged high water levels increase gradually over the period, while the low water levels show a rather sudden drop in the 1970's. For the high water level both sea level rise and the 18,6-year nodal cycle are found to be important in the changes of the water levels. These factors also influence the low water level, although the drop in the 1970's is related to the combination of different human interventions.

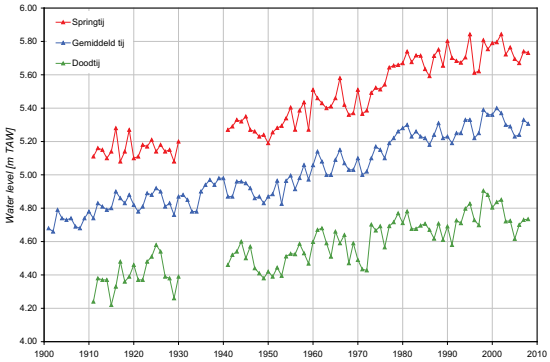

Figure 2: Evolution of high water levels in Antwerp

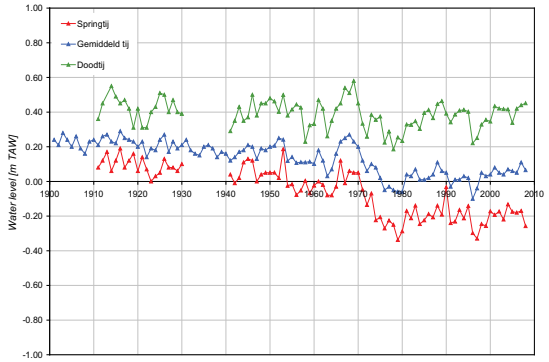

Figure 3: Evolution of low water levels in Antwerp

Research

Over the past years, a lot of research projects have tried to estimate the individual importance of each activity in the changes of water levels. State-of-the-art numerical models (1D and 2D) were used to quantify the effect of these activities. Up until know, it was not feasible to explain the changes in water level by adding the effect of individual activities. It is assumed that the effect of morphological changes (natural or activity-induced), is responsible for changes in the tidal penetration.

Acknowledgement

All the water level data have been measured and validated by the colleagues of the Hydrometry-department.

The research has been supported by the Maritime Access Division, within the scope of the LTV Research & Monitoring project.