



UNDERSTANDING THE TIDES CRUCIAL FOR JOINT MANAGEMENT OF THE SCHELDT ESTUARY

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ABSTRACT

The Scheldt estuary is situated in the Netherlands and Flanders/Belgium. Both countries collaborate in policy, management and research, as laid down in a treaty of 2005. Preservation of the 'physical characteristics of the estuary' plays an important role in formulating objectives, but it is still debated 'what exactly should be preserved'. What exactly should be preserved' has a diversity over the various places, as both actual values and driving forces are different along sites. A management plan in such detail is not available.

Recent research has shown which role the tidal intrusion has in these discussions. Tidal intrusion as (an indicator of the) objective for future policy (i) reflects a long term development, (ii) can be linked to changes within the estuary itself, including sediment management and (iii) can be evaluated easily, as for practically all user-functions the increase in tidal amplification is regarded as negative. As a conclusion we pose that we need to accept that from science alone we cannot expect an unambiguous answer when preservation of the 'physical characteristics of the estuary' is fulfilled.

Keywords: Estuary, Tidal Amplification, Estuary Management, Delta Governance

1. INTRODUCTION

The Scheldt estuary plays a crucial role in the relationship between the Netherlands and Flanders/Belgium. Both countries require flood protection, need accessibility to large ports (Antwerpen, Gent, Terneuzen, Vlissingen) and value it as one of the few remaining natural estuaries in North West Europe.

2. JOINT ESTUARY MANAGEMENT

The condition for a sustainable and balanced policy was a joint 'target-view', laid down in a Long Term Vision on the Scheldt estuary. This vision-document was developed in cooperation between the two countries.. Decision making in the parliaments of the both countries was done by a treaty based on mainly two documents. The first was the Long Term Vision 2030, or LTV (Technical Scheldt Committee, 2001). The second was the 'Development Sketch', in Dutch: 'Ontwikkelingsschets 2010' or OS2010 (ProSes, 2005), that elaborated a set of measures needed to be started not later than 2010, accomplishing a first phase of the LTV towards the aspiration for 2030.

The Long Term Vision and the Development Sketch 2010 had a threefold objective: improvement of the three user-functions 'Safety, Accessibility and Naturalness', with 'preservation of the physical characteristics of the estuary' as precondition. Measures that were agreed on included amongst others a further deepening of the shipping fairway, nature restoration (mainly by giving more room to the estuary by depoldering) and a Safety plan for the Sea Scheldt (Sigma plan). It could be concluded that making a Long Term Vision and Development Sketch accelerated getting agreement and decision making for issues that had been highly controversial, like a further deepening of the shipping fairway. It was all part of an integrated plan for the development of the whole estuary.

Together with the treaty on the OS2010, two other treaties were prepared and signed (December, 2005). The 'Treaty on Cooperation in Policy and Management' included the agreement to do joint research and monitoring to support policy and management issues. Due to this treaty the Technical Scheldt Committee, a bilateral committee with high level civil servants, was given more powers and became the Flemish Dutch Scheldt Committee (www.vnsc.eu). Parts of the committee functioning were regular meetings and negotiations between the responsible ministers from both countries. A secretariat and a set of working groups were also established. In this framework estuarine managers and researchers of Flanders and Netherlands could cooperate intensively.

The Treaty provided a framework and assured budgets for applied research in both countries on the physical and ecological functioning of the Scheldt estuary, attuned to each other. As the guidance on the research was done by working groups under the VNSC, the relation with decision-making in estuary management was secured. Important decisions were now related to careful preparation of necessary permits and common conclusions on results of monitoring. A special

research program named ‘Safety and Accessibility’, lead to a joint understanding on the long term development of the estuary, its driving forces and how these were influenced by human interventions. It also provided an extensive description of how these large scale developments and driving forces were related to what could be observed on individual channels and intertidal areas (the so-called meso-scale).

The Treaty on Cooperation in Policy and Management was evaluated recently. It was a.o. concluded that the choice for an integrated, bilateral project organization proved to be successful. As one of the most important aspects of this cooperation the evaluation report mentions the ‘creation of a common knowledge base’ and the advice was given to ‘continue with investments in a common, scientifically grounded, knowledgebase, which can be the foundation for future decision-making’.

3. Results on tidal response in the research program ‘Safety and Accessibility’

The results of the research program have been described in a large set (32) of reports (available at <http://www.vnsc.eu/organisatie/werkgroepen/onderzoek-en-monitoring/rapporten-v-t.html>). As our objective is to describe the outcomes of research on tidal development with its influence on the setting of the agenda for policy and management, we focus on the two most relevant pictures.

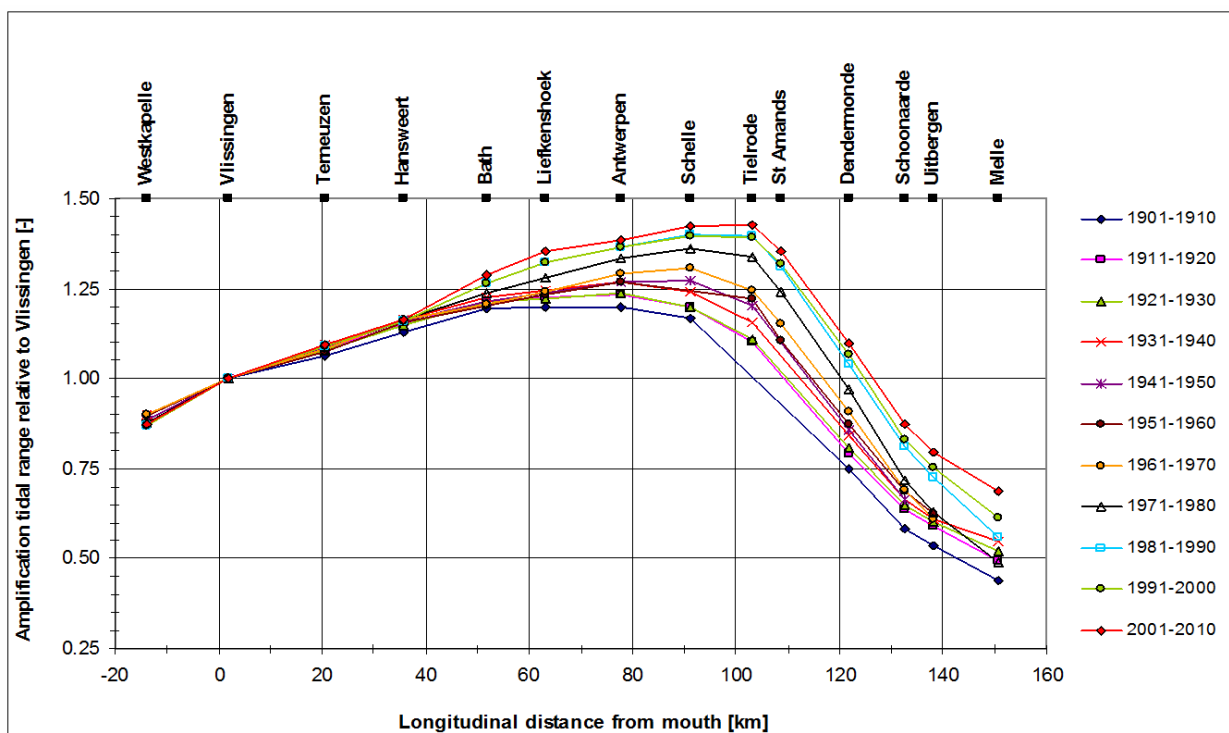


Figure 1: Historical evolution of the amplification of the tide along the Scheldt estuary

Figure 1 shows that the mean tidal range increases nowadays from about 3.8 m at Vlissingen to almost 5.5 m at Tielrode (20 km upstream of Antwerp). More upstream the tidal range decreases to some 2.3 m at Melle near the sluices of Gent. The figure also summarizes the tidal evolution during the last century. In upstream direction the tidal range continuously increased and at the same time the location with maximum amplification shifted in upstream direction over a length of some 40 km. The enhanced intrusion of the tide is even noticeable in Melle, where the tidal range increased with 1 m during the last 100 years.

Theory on estuarine processes predicts that the four most important factors determining tidal intrusion are (i) channel depth / cross section area, (ii) the funnel shape (convergence factor), (iii) the amount of intertidal area and (iv) bed friction. If the Scheldt estuary is evaluated with this in mind, the conclusion can be drawn that during centuries the strategy of reclaiming land and building embankments, played the major role. They made the estuary more funnel-shaped and reduced the amount of intertidal area. During the last half century, however, the channel depth was the most substantial factor, especially in the more eastern parts of the Western Scheldt and in the lower Sea Scheldt.

4. RELATION BETWEEN SEDIMENT BUDGETS AND AMPLIFICATION

Deepening and maintenance of the shipping fairway made the estuary relatively more deep, combined with sand mining and disposal strategies that bring sediment more downstream. Figure 2 illustrates that this was indeed the main cause of increased tidal intrusion from 1970 on. Detailed water level data from the tidal stations of Hansweert and Bath were combined with bathymetrical data. Water levels respond immediately to changes in bathymetry and by analyzing

amplification instead of tidal range we exclude the external effects at the boundaries of the estuary (sea level rise, 18.4 year nodal cycle, wind climate on the North Sea) largely.

The graph in the top panel shows that in the last forty years periods of increasing amplification alternated with periods that do not show amplification. A first period of increasing amplification ends around 1980. A second period with increasing amplification starts in the middle of the 1990's and lasts almost one decade. The first period coincides with the first (and largest) deepening of the shipping fairway. The second period starts when the disposal strategy was changed and large volumes of dredged sediments from the eastern part of the estuary were transported to the western part. At the same time sand mining activities were transferred to the Hansweert-Bath area, leading to a further depletion of sediment budgets. Finally a second deepening started in 1997.

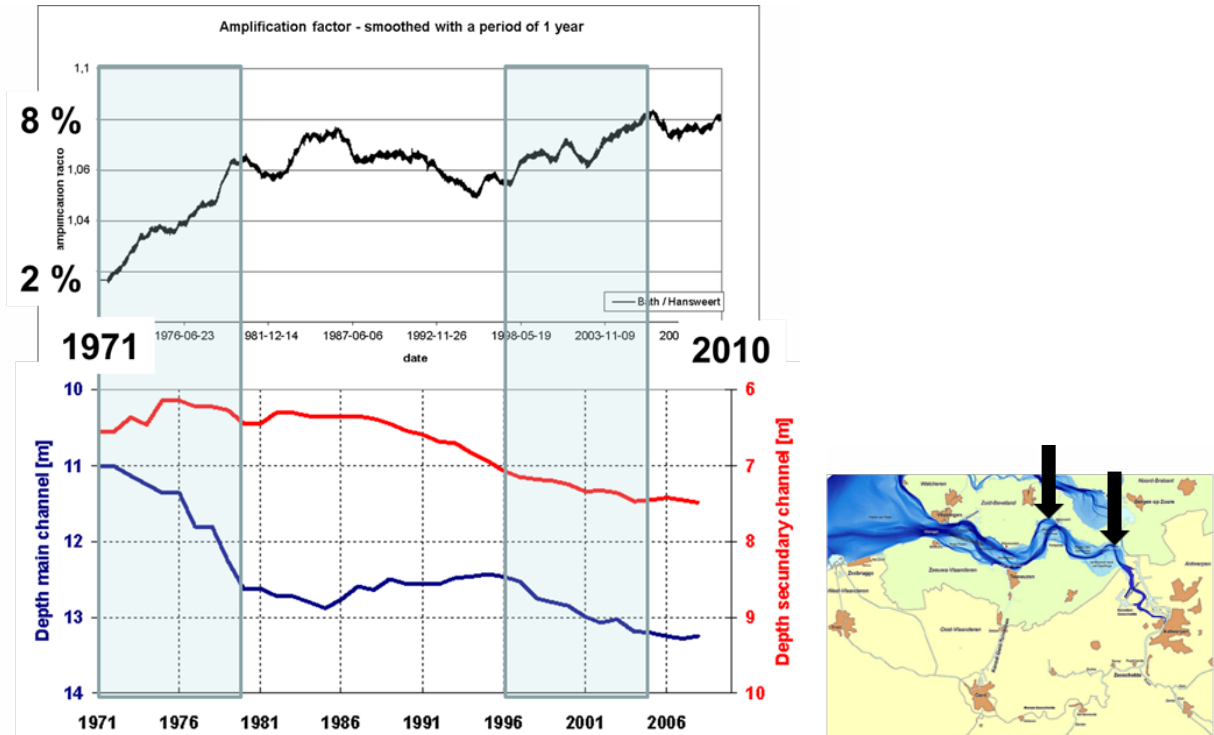


Figure 2: Tidal amplification (top panel) in section Hansweert-Bath and channel depth relative to NAP (Dutch ordnance datum) of the main (blue line) and secondary channels (red line) in the same section (down panel); Scheldt estuary and gauging stations in right panel.

5. THE GROWING ROLE OF TIDAL AMPLIFICATION IN MANAGEMENT OBJECTIVES FOR THE SCHELDT ESTUARY

Within the VNSC it was understood that the tidal regime has strong impacts on safety against flooding, accessibility and ecological values. More tidal intrusion increases the boundary conditions for design of flood protection works, due to higher water levels and changes in the 'foreshore'. The navigability depends on the levels of low water, the deformation of the tidal wave resulting in faster wave propagation and dangerous local cross-currents (during spring tide). The ecological values of the Scheldt estuary are strongly related to the available habitat area, gradients between these and small scale patterns, although the local situations differ strongly, depending a.o. on geometry and historical evolution etc. Finally, increased tidal intrusion may be one of the main factors that has caused a regime shift in comparable estuaries (e.g. the Lower Ems River) with properties that leads to huge import of fine sediments and hyperturbid conditions.

The evaluation of the Treaty on Cooperation in Policy and Management led to an 'Agenda for the Future', describing the issues that need to be dealt with in order to reach the long term objectives. In this agenda there is much attention to 'tidal amplification'. The scientifically grounded conclusions on the development of the tide were probably crucial in getting this on top of the joint political agenda. When the 2005-treaty was evaluated the 'window of opportunity' occurred in which Ministers of both countries needed to take a position on this.

Taking tidal intrusion as (an indicator of the) objective for future policy is attractive for various reasons:

- It reflects a long term development;
- The tidal response changes immediately after changes in the bathymetry / geometry;
- Especially tidal amplification can be linked to changes within the estuary itself;
- For practically all user-functions the increase in tidal amplification is regarded as negative;
- (Part of) the amplification in the past can be linked to human interferences, suggesting that measures must be available to stop or counteract the developments.

6. DILEMMA'S WHEN FORMULATING SEDIMENT STRATEGIES AIMING AT COUNTERACTING TIDAL INTRUSION

The amplification of tidal intrusion in the past suggests that measures must be available to counteract developments. There are, unfortunately, no easy options. Changing the large-scale shape of the estuary would require large interventions or reforming many polders back to estuarine area. The most feasible option seems to be the wise use of dredged material by strategic sediment management. Figures 1 and 2 demonstrate that the most recent amplifications were caused by sediment management as well.

The most prominent challenge for better sediment management is probably in the Sea Scheldt, which has hardly disposal sites for sandy material. The one that is available is kept open by sand mining, implying slowly decreasing sand budgets and probably increasing average cross-sectional area. Also in the more upstream parts of the Western Scheldt preserving or adding sediment to decrease tidal amplification must be done with respect to the shipping demands. There is hardly any space in the main channel upstream Hansweert, hence only secondary channels are available. Disposal in these channels could lead to a (further) shift in the balance between main and secondary channel and is nowadays regarded as a contribution to a gradual change to a one-channel system. This phenomenon induced a different disposal and sand mining strategy in the period 1997 – 2007 (approximately). This was already discussed at figure 2, which shows the profound effects of it on the average depth of the secondary channels between Hansweert and Bath. More tidal intrusion was the side effect, not foreseen at that moment.

There is therefore a large dilemma in weighing various aspects when formulating a sediment strategy, even from a perspective of naturalness and sustainability alone. To complicate it further: the extra costs of a different sediment strategy will probably not easily be accepted, with only the long term changes in the tide to convince decision makers and society. To get to real 'Integrated sediment management' measures must also contribute to (ecosystem) services, both today as in the next decades. At the Dutch coast, for example, the policy of nourishing yearly 12 million m³ is combined with the short term needs, for instance near coastal towns. In the Scheldt estuary these comparable demands on smaller timescales could be the reduction of the costs of safety measures or the creation of ecologically valuable areas. The latter refers to the recent disposals near shoals that are aimed at creating low-dynamic intertidal areas. These, however, do not directly contribute to a decrease of average channel depth.

The Long Term Vision states that preservation of the 'physical characteristics of the estuary' is a prerequisite. One decade later it is still debated 'what exactly should be preserved'. A management plan in such detail is missing. It can, for instance, also be argued that, especially on the long term, a one channel system does not necessarily imply low ecological values. Many other estuaries with one channel have important ecological values, as long as there is 'enough space between the embankments' for the accompanying intertidal areas. Note that for instance in the Ems estuary a change to a one-channel-system, from Eemshaven to Delfzijl, due to siltation Bocht van Watum, is currently not seen as an important management issue.

As a conclusion we pose that we need to accept that from science alone we cannot expect an unambiguous answer when preservation of the 'physical characteristics of the estuary' is fulfilled. It certainly is not meaningful to try to reason towards a 'pristine state' of the estuary or take the 1950's or 1970's as a reference. The choices that have been made on embankments and the situation of ports are an undeniable part of our history. The Scheldt estuary is and will be a modified estuary with safety and accessibility as leading user functions.

The best way forward is to keep on working on specifications of the demands of user functions and agree with stakeholders on a management plan that really defines 'what exactly should be preserved'. This will, undoubtedly, show a diversity along the various places, as both actual values and driving forces are different along sites. To develop such a plan, continuous investments in knowledge of the tides, the morphology and the local hydrodynamics are needed. In this way we may create a way of working that really deserves the name 'Integrated estuary sediment management'.

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