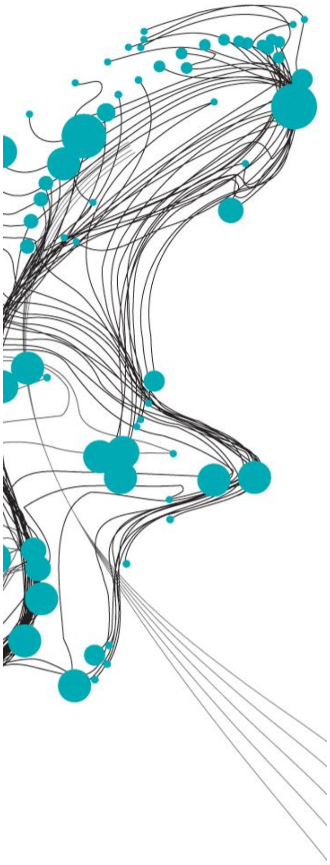

Assessing salinity dynamics with Delft3D Flexible Mesh due to lock modifications

Saltwater intrusion naturally occurs in the fresh-saline transition zone of freshwater basins and primarily exists because of the density differences. The Ghent-Terneuzen channel [GTC] is an example of a system where this phenomenon occurs, as daily operations of the three locks in the Terneuzen port result into a saltwater influx from the brackish Western Scheldt estuary. Managing salinity concentrations in the channel is of major importance, as salinization forms immediate hazards for agricultural water use, industrial water cooling systems and brackish seepage into fresh groundwater reserves.

Analysis of the waterway revealed that the maritime port is not conform modern standards. Plans have already been agreed and assessed to replace one of the existing locks with a large sea lock, fitting within the current port layout. An environmental impact assessment [EIA] had been carried out with the 1D numerical model SOBEK to estimate changes in the salinity dynamics, however considering the frequent occurrence of a salt wedge, the salt intrusion in the GTC has much more a 3D character. This study assesses the importance of density driven salinity transport in the GTC, therefore approximating the physical flow and transport processes at a detailed and realistic scale. A 3D numerical model was built, calibrated and validated with the new generation hydro software Delft3D Flexible Mesh [Delft3D FM] in order to assess the impact of the planned lock modification on the salinity dynamics in the GTC. The mutual fresh-saline lock exchange ratios were adopted from detailed numerical estimations in the EIA and implicitly imposed as exchange flows, using a complex vertical distribution of coupled sinks and sources.

On seasonal scale, the impacts of the lock modifications were assessed by three representative salt intrusion scenarios using historical inflow regimes. Longitudinal salt profiles were plotted to visualize the changes in the salinity dynamics. Examples are presented in Figure 1 and Figure 2, the salinity concentrations at the end of a dry summer for the present locks and after the planned modifications, respectively. The general conclusion is that the salinity concentrations will be affected over the full length of the channel, still the relative increase is estimated to be greater upstream. In winter, the salinity concentrations will approximately be twice as high and remain constant. In summer, salinity concentrations increase at least by a factor of 1.8 following the planned lock modifications. Therefore, it can be concluded that the current water quality standards are no longer achievable in the near future. The findings are consistent with the results of the EIA study. The vertical salinity distribution in the GTC will be almost unaffected as stratification in the domain remains more or less equal. By evaluation of the salinization patterns it became evident that as the salt wedge draws inland the gradual salinization of the entire water column follows quickly.

Because of the future increase in the salt intrusion and the density driven salinity transport, mitigating measures in the new lock will most likely be the best solution to manage salinity concentrations, but inherently the local users must be aware and adapt to a more brackish state of the GTC.

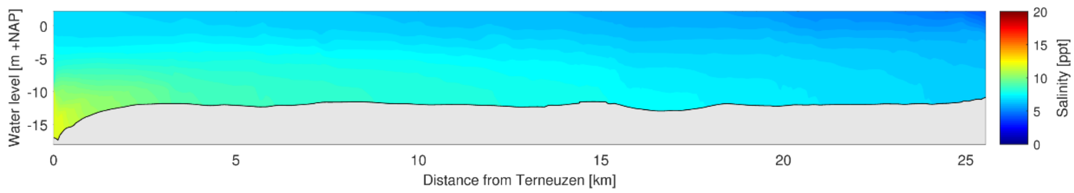

Figure 1. Longitudinal salt profile GTC, baseline scenario.

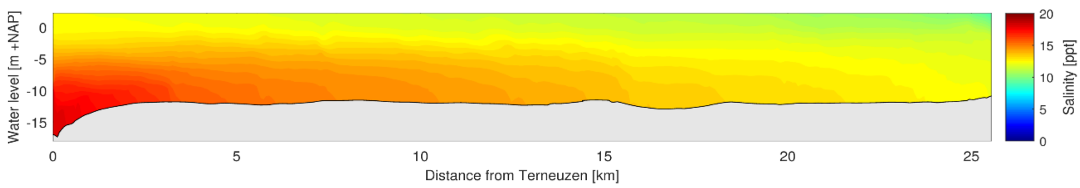

Figure 2. Longitudinal salt profile GTC, new lock scenario.

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