Hydrodynamic modelling of flood impact of tidal marsh restoration in the Durme valley

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Partners: IMDC, Resource Analysis

Assignment:

In order to validate the impact of tidal marsh restoration of some polder areas along the Durme, a 2D hydrodynamic model is developed. Simulations show a quantitative picture of flood and flow phenomena, while also a qualitative impression on morphodynamics already can be formulated.

Scope of Services:

- Development of a fully 2D hydrodynamic MIKE21 model
- Calibration and validation of the numerical tool
- Visualization, analysis and synthesis of results

Technical Description:

Within the framework of the European funded 'FLOODSCAPE' programme a 2D numerical model of the Durme and its surrounding flood control areas is developed by means of Mike 21C. The development of the model consists of two stages: during the first stage the existing 1D model is extended to a 2D hydrodynamic model. Numerical simulation of a number of 'water'scenarios by means of this model allows a first qualitative impression of the flooding issues in the Durme valley. A second stage considers the morphodynamic aspects, validating the movement of sand and silt particles in a 2D water movement.

This part describes the development of a standard model for this 2D hydrodynamic simulation of the Durme. First only the main Durme riverbed between the dikes is modelled by setting up and calibrating the 2D model for the reference situation. A next stage includes the numerical simulation of a number of design scenarios for the Durme valley. The developed model provides a fairly good image of the general and local flow pattern in the Durme river for the different scenarios. Local current velocity and water depths already indicate where to expect erosion or sedimentation, providing a clear morphodynamic image based on the hydrodynamic scenario simulations as obtained.

View on the Durme, upstream the Mira bridge

The MIKE 21 hydrodynamic module simulates the water level variations and current velocity patterns in time (during the tide) and in space (for the entire Durme riverbed or part of it) by elaborating an implicit ending differential solution of the entire Saint-Venant equation in an irregular, curvilinear grid. The study area extends over the entire Durme river reach till the Dam in Lokeren. Near the Durme mouth a part of the Scheldt is included in the simulation model : upstream from the mouth till some hundred meter upstream from the Driegoten ferry and downstream from the mouth till just downstream from the flood control polder area in Tielrode.

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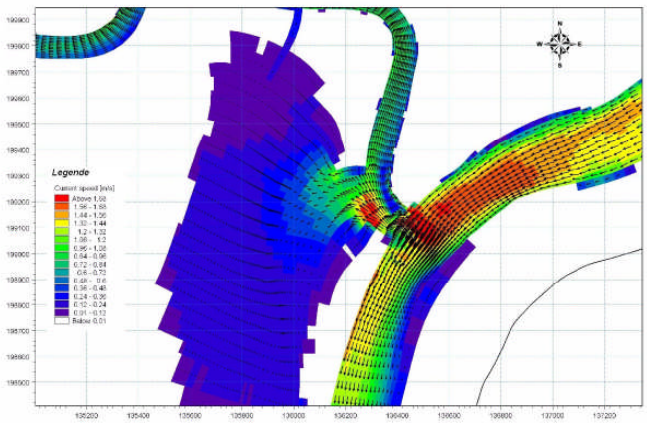
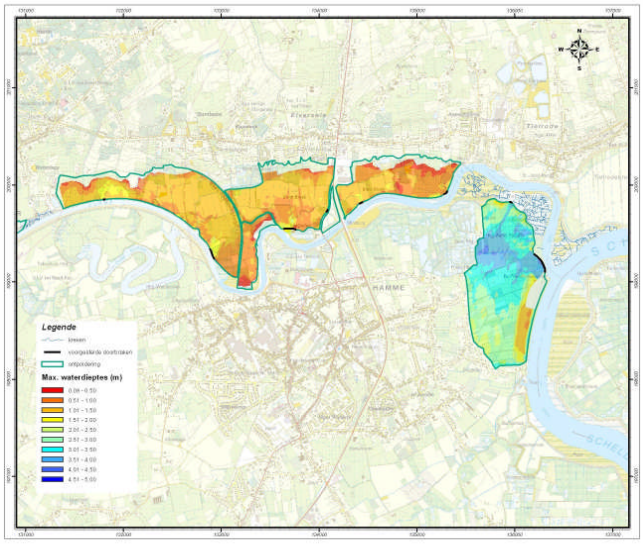
A series of calibration runs determines a set of parameters (roughness, eddy viscosity and dry/flood level) for the existing (reference) situation, which enables the 2D hydrodynamic model to simulate (both quantitatively and qualitatively) the actual discharge and corresponding water levels in the main river between the dikes. Also the comparison with the existing 1D model shows that the results of both models are similar. This reliable 2D model of the inner Durme (i.e. the main river reach between the dikes) is further used as a reference to simulate and visualize the changed flow pattern, as a result of the tidal marsh restoration of a number of areas outside the dike along the Durme. Since a limited part of the Scheldt is included in the standard model, it is clear that the prior conditions upstream and downstream from the Scheldt are influenced by linking the flood control polder areas. In order to determine these changing prior conditions the 1D model that includes the entire tide related Scheldt is used.

The following scenarios are calculated for three different types of tide (neap tide, spring tide and average tide):

- Tidal marsh restoration of the Bunt, Klein Broek, Groot Broek and Sombeekse Meersen. This is the most desirable scenario and was also calculated in the 1D model (Scenario 1).
- Tidal marsh restoration of the Bunt maintaining the salt marsh between the Bunt and the Durme (Scenario 2).
- Same as the first scenario but with eroded salt marsh next to the Bunt and near the Durme mouth (on the left bank of the Durme) (Scenario 3).



Detailed flow pattern around Durme mouth (with tidal marsh restoration of Bunt)



Flood levels in polder areas along the Durme river

Analysis of the hydrodynamic information obtained through the 2D model leads to the following conclusions:

- Because of the tidal marsh restoration along the Durme the current velocity increases along the left bank of the Durme near the Scheldt estuary. This leads to a possible erosion risk at the top of the salt marsh near the estuary.
- Tidal restoration of a number of areas along the Durme leads to a decrease of the water level in the upstream part of the Durme.
- In the most desirable alternative the current in the Scheldt, near the Durme mouth, is influenced till about the middle of the Scheldt. The flow direction at high tide in this area is clearly oriented toward the Durme mouth and the current velocity is considerably higher than in the existing situation. Low tide shows the same problem but in the reverse direction.
- The water velocity in the Durme increases downstream from the flooded valley areas. The differences with the existing situation increase the more areas upstream from the observed cross section are flooded. The peak velocity increases both at low and high tide.

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