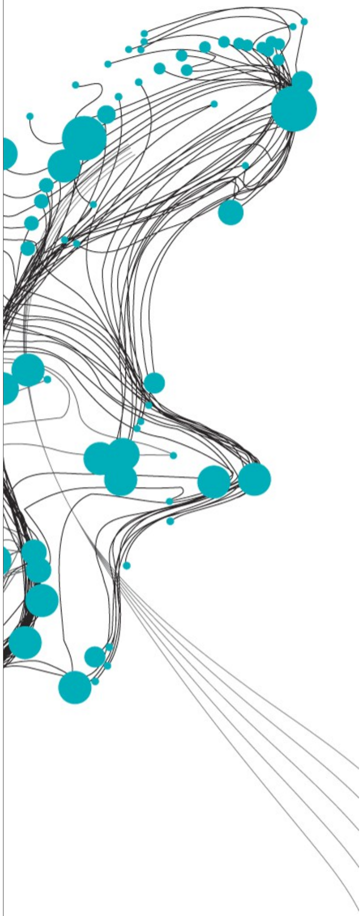
Hydrodynamic river modelling with D-Flow Flexible Mesh

Case study of the side channel at Afferden and Deest



Accurate predictions of water levels play an important role in the management of flood safety. Nowadays, it has become common practice to use multi-dimensional numerical hydrodynamic models for such purposes. Currently, WAQUA and Delft3D are standard tools in the Netherlands, which are based on a structured curvilinear grid. Drawbacks of the curvilinear grid approach are that staircase representation of closed boundaries is sometimes unavoidable, because grid cells are not aligned with flow direction and in the inner bends of meandering rivers, gridlines may become focussed to unnecessarily small grid cells. To improve on these issues, Deltares is developing the unstructured grid based hydrodynamic model D-Flow Flexible Mesh. By combining curvilinear and triangular grid cells, grid resolution can be increased at locations where it is most desired. In this study Flexible Mesh is tested and compared with WAQUA for the river Waal and the possibilities of the unstructured mesh of Flexible Mesh are applied on the side channel at Afferden and Deest, where the WAQUA grid is considered to be inaccurate.

In the first step of the study the Flexible Mesh model is compared to the calibrated WAQUA model for low and high discharges. For low discharges there is almost no difference in the water level, but for high discharges the water levels are higher and the discharges over the floodplain and in the side channel are smaller in the Flexible Mesh model. Two important sources for the differences between WAQUA and Flexible Mesh are; 1) a different formula for the Colebrook-White roughness which results in a larger friction and higher water levels and 2) the energy losses due to flow over weirs is modelled different resulting in higher water levels and lower discharges over the floodplain and in the side channel in Flexible Mesh. However, the numerical performance is quite comparable between Flexible Mesh and WAQUA.

In the second step local grid refinement is applied to the main channel of the Waal and to the side channel. The grid refinement of the main channel of the Waal didn't show clear effects between consecutive grid refinements. The grid refinement in the side channel resulted in larger discharges in the side channel and lower water levels. After the grid was refined four times, further refinement had very small effect, showing convergence of model results Figure 1. Further, grid refinement is more effective when the grid cells are aligned with the flow direction of the side channel to avoid staircase representation. For the case study grid refinement turned out to be useful until a four times refined grid, as for further grid refinements effects on model results are very small and computational time rapidly increases to meet model stability.

This study shows potential for application of D-Flow Flexible Mesh to model more accurate for complex geometries by applying local grid refinement.

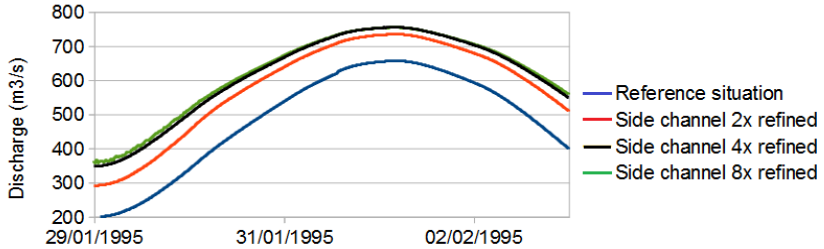


Figure 1: Discharges in side channel at Afferden and Deest for original and 2x, 4x and 8x refined grid, showing convergence of model results after a 4x refined grid.

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