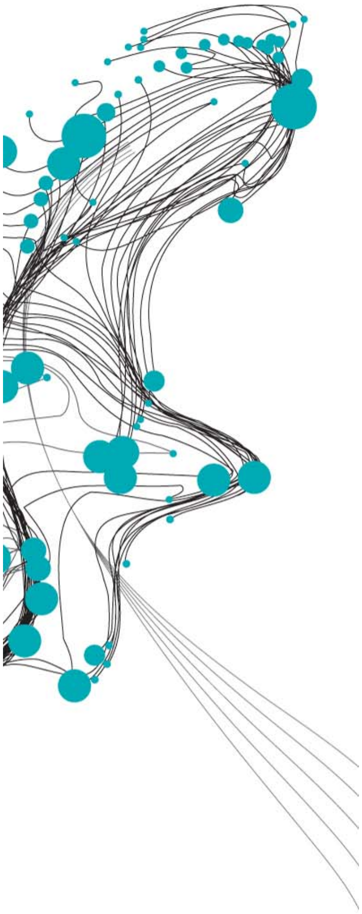
THE EFFECTS OF MULTIPLE RETENTION BASINS ON THE HYDRODYNAMICS IN CONVERGENT TIDAL CHANNELS



Retention basins are currently considered to be implemented in the Ems-Dollard estuary in order to reduce the tidal range, which has increased dramatically over the past decades. Since the effects are not yet well understood, the goal of this study is “*to explain the effects of multiple retention basins on the tidal dynamics of a convergent tidal channel by analysing the underlying physical mechanisms and to explore the effects of implementing the proposed plans of these basins in the Ems-Dollard estuary”.*

In order to accomplish this, an idealised hydrodynamic model is developed based on the cross-sectionally averaged shallow water equations. This model consists of adjacent convergent channel sections, while depth is allowed to vary in a stepwise manner between these sections. Secondary basins are represented as Helmholtz basins, i.e. basins with a certain area connected to the main channel by a short and narrow linear inlet channel. It appears that convergent channels can be classified as prismatic, subcritically convergent, critically convergent and supercritically convergent. Channels of this last class do not show waves any more, only an oscillatory behaviour.

The effects of retention basins are presented in terms of the amplitude gain at the channel head, which may show amplification, reduction, or no change at all. The results show that for a single basin in a convergent channel, which is placed increasingly farther away from the channel mouth, more amplitude reduction occurs. Moreover, for basins in supercritically convergent channels, amplification may only occur if placed near the channel mouth. Also in supercritically convergent channels, basins that placed in close proximity of each other will amplify each other's response.

The difference in results for various basin sizes is independent of channel convergence, a similar pattern for convergent channels is found as for prismatic channels. However, in the frictional case, `negative' (supercritically forced) basins can not be observed any more, whereas `large' basins shown an amplitude reduction at nearly all locations.

The mechanism that is responsible for the response of basins is overall similar to that in prismatic channels. Additional waves develop due to a volume transport through the inlet channel, which may trigger waves at either side of the vertex point. For supercritically convergent channels this is not the case, since no `real' waves can be distinguished in this regime.

The model has been calibrated according to historical water levels in order to test its applicability to real world estuaries. The result of the calibration shows that the model is overall well capable of predicting these water levels. However, the analysis of the proposed scenarios shows only some minor changes to the elevation amplitude. This contrasts results of other complex numerical studies, where significant amplitude reductions were achieved. Although there is a large difference between the models, this model is useful when exploring possible alternatives to current scenarios. Regarding the Ems River, placement of basins more towards the channel head shows a significant increase in amplitude reduction.

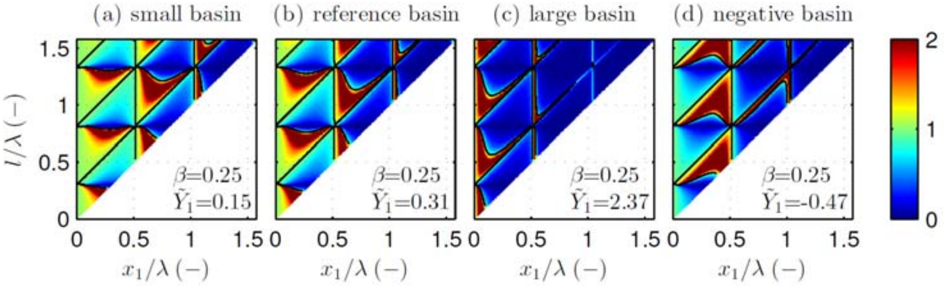


Figure 1: Amplitude gain for four different basins sizes in a convergent channel. A large basin shows a stronger response pattern, while a negative basin shows a reversed response pattern. The location of the basin is represented by x_1, the channel length by l. Parameter β represents the convergence (here mildly convergent), and the parameter $\hat{Y}_1$ represents the dimensionless basin admittance. Axes have been scaled against the shallow water wavelength λ (443 km).

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