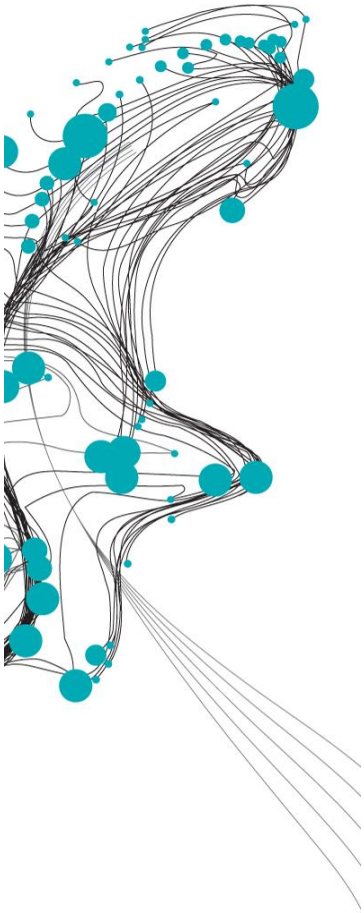
Modelling the influence of biological activity on fine sediment transport in the Dutch Wadden Sea.



A large number of benthic organisms have been observed in the Dutch Wadden Sea. The biological activity of these organisms has impact on the fine sediment dynamics. Previous numerical models have been confined to focus on individual or limited number of benthic organisms. Up to now, no serious attempts, by using complex model, conducted to model the influence of biological activity on horizontal sediment fluxes between North Sea and tidal basins as well as for bed composition for different basins and depth zones. In addition the effect of combined tidal forces and wind waves on mussel beds is not known. Therefore this research aims to investigate the biological activity on cohesive sediment for different spatial scales.

The numerical model of this research is 3-dimensional approach with 10 sigma layer in Delft3D, developed by Deltares for Dutch tidal basins. The sea bed consists of fluff and buffer layers. The biological activity was incorporated into the numerical model by adjusting physical parameters in the reference situation, which are the critical bed shear stress, erosion rates and settling velocity. The biostabilization influence is presented by *Diatoms*, leading to increase the critical bed shear stress τ_{cri} and decrease the erosion rate ε. While, the bioturbation influences by *Cerastoderma edule, Arenicola marina, Hydrobia ulvae, Macoma balthica* are responsible for lowering τ_{cri} and reduceε. Finally, *Mytilus edulis* has biodeposition influence that give rise to increase τ_{cri}, ε and settling velocity.

The outcomes of the biological activity are compared with the reference situation. The suspended sediment concentrations for stations in the study area have been increased due to the dominant influence of grazers with temporal and spatial variations; these variations were associated with the growth of *Diatoms* and water depth respectively. The buffer layer of the salt marsh and the upper-intertidal zone was regarded to be a sink for fine materials, while an increase in the storage could occur in the lower-intertidal and channel zones for the short term, depending on the effect of wind waves; moreover erosion in the buffer layer occurred always in subtidal zone. The shallow Borndiep basin was much affected by the biological activity than the deep basin, Marsdiep. In addition the biological activity resulted in reducing 25% of the horizontal fluxes from the North Sea to the tidal basins and 7% of the sedimentation to the bed layers; table 1 illustrates the influence on basins. Finally the influence of mussel beds on sedimentation was associated with water depth and could be significantly affected by wind waves (figure1).

Actually, calibration for the model is needed because the results overestimated the field measurements (figure 2). Finally this extended model highlight the promising usefulness of the biological activity in prediction more accurate results and promote the assessment of biological activity on the marine system.

Table 1. The difference in import fluxes from North Sea to tidal basins and sedimentation to bed layer with and without biological activity for tidal basins in the Dutch Wadden Sea over a 4 months study period.

Basin	Import flux in Reference model [Kilo ton]	Import flux in Extended model [Kilo ton]	Sedimentation in Reference model [Kilo ton]	Sedimentation in Extended model [Kilo ton]
Marsdiep	711	615	633	515
Vlie	834	748	1090	1100
Borndiep	495	128	899	640

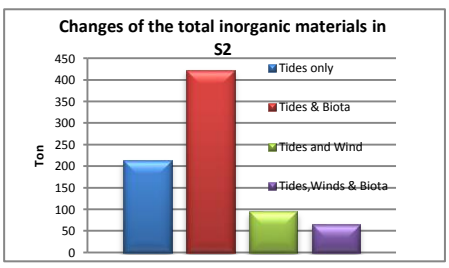


Figure 1: the accumulation of fine materials on the mussel beds in Marsdiep basin.

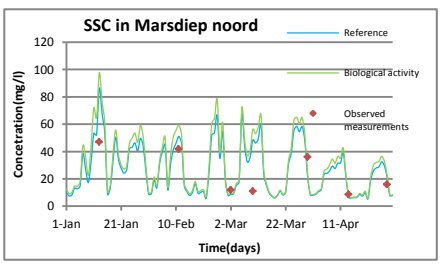


Figure 2: The suspended sediment concentration with the field measurements for Marsdiep station.

Name Student
Z.Bashir
Graduation Date:
1 April 2016

Graduation committee:
University of Twente
Prof.dr. S.J.M.H. Hulscher
Dr.ir. B.W. Borsje

Deltares
Drs. M. de Vries

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