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How ship wave action influences the sediment budget of a nature friendly bank protection in a confined, non-tidal waterway

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Failure of the concrete slab revetment resulted in progressive bank erosion along the Lys (Belgium), a confined, non-tidal waterway subject to heavy shipping traffic. In an attempt to reconcile both the technical and environmental requirements related to a river bank, restoration was carried out using a more ecologically sound, 'soft' engineering method. A nature friendly bank protection, consisting of off-bank timber piling in combination with (reed)vegetation in the shallow water zone behind, was installed.

As a consequence of this effort towards a more sustainable and ecological design of the waterway, sediment redistribution and transport processes are however altered distinctly. Being a waterway subject to heavy shipping traffic (on monthly average 1700 ship passages), hydrodynamic ship wave action on this open, semi-natural bank protection also induces sediment (re)suspension and acts as a main contributor to sediment transport (in normal weather conditions). In order to identify the relevant transport processes caused by ship-generated wave forcing, a field measurement campaign took place in April 2011. By measuring instantaneous water velocities, suspended sediment concentrations and wave hydrodynamics with a high temporal resolution, the effects on the sediment budget were quantified.

It is found that the driving forces for these processes are the ship's speed, its blockage coefficient and the distance of the sailing ship to the timber piling. Bottom shear stresses significantly increase to values up to 10 N/m^2 during a ship passage. Being much higher than the critical shear stress of 1.5 N/m^2 and lasting for several minutes, the fine as well as coarser fractions of bottom sediment are dislodged and (re)suspended. Wave height also correlates well with the amount of sediment suspension. The best predictor for bank erosion is the velocity at which the displaced water mass hits the river bank.

These experimental results indicate a reduced yet continuing erosion process in spite of the installation of the nature friendly bank protection. A dynamic sediment equilibrium, indispensable for optimal ecological conditions in the transitional zone between land and water while maintaining efficiently the goods traffic in the fairway, is not established.