**Title**

Development of remotely sensed image velocimetry for large-scale free surface flows: Application to the flow through the Eastern Scheldt storm surge barrier

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**Abstract**

The Eastern Scheldt storm surge barrier (ES-SSB) is the largest hydraulic structure in the Netherlands. Its semi-open inlets allow for North Sea waters to enter and leave the Eastern Scheldt estuary with each tidal cycle, and can be closed during extreme storm events. The flow through the barrier is strongly contracted, and complex flow patterns emerge. Among characteristic flow features are the shallow jet and shallow mixing layer, generated as a result of large transverse shear stresses with horizontal lengths scales greatly exceeding the water depth. Large mean velocities in combination with the developing lateral non-uniformity of the flow between slack water and maximum flood gives rise to higher bed shear stresses. A bed protection up to a distance of about 600 m from the barrier is applied to stabilize the bed against increased hydraulic loading. Scour hole development adjacent to the applied bed protection was anticipated for, but expected equilibrium depths have not yet been reached. Reaching local depths of 60 m with respect to the water surface, these scour holes may on the long term be a threat to the stability of the barrier. Broekema (2020) concluded that during flow contraction, separation of flow near the bed of the scour hole is suppressed and high flow velocities in streamwise direction are found near the bed. Cyclic variations in lateral non-uniformity affect turbulence intensities and subsequent mixing of mass and momentum. Scour growth is therefore enhanced in two ways: i) velocities in the main flow remain high due to horizontal flow convergence, and ii) lateral velocity gradients are associated with larger turbulence intensities that are likely leading to larger bed shear stresses...