# SALTWATER ENTRAINMENT FROM BATHYMETRIC DEPRESSIONS: A CFD ANALYSIS FROM A LABORATORY CAVITY TO A SCOUR HOLE IN THE HARINGVLIET ESTUARY

Saltwater intrusion, especially in semi-closed estuaries such as the Haringvliet, poses threats to freshwater availability. Proper sluice management helps in maintaining water balance but determining the saltwater entrainment from the scour holes is needed to reduce saltwater intrusion. This is important considering climate change's worsening effects on freshwater availability. Despite existing studies on flushing saltwater from cavities, there is an existing knowledge gap in quantifying the saltwater entrainment rate from real-life scour holes. The primary research question focused on accurately predicting saltwater entrainment rates from cavities using CFD modelling in both lab and real-world scales using the commercial software Star CCM+. To understand the entrainment of saltwater in cavities, a systematic methodology was implemented. A lab scale model was first developed, referencing the physical model by Debler and Armfield (1997). Though Kirkpatrick et al. (2012) had earlier developed a validated model using a computationally demanding Large Eddy Simulation (LES), the current study pursued a less resource-intensive approach. Findings revealed that model choices such as meshing size and choice of Schmidt number had a significant role in the performance of the model. The field scale model of the Haringvliet scour hole showed a good agreement with the field observations, unlike what was observed for the lab scale model, which had more varied success. Finally, the study recommends further research on saltwater intrusion, broader data validation, and exploration of other software like OpenFOAM which allows for a higher degree of modelling control.

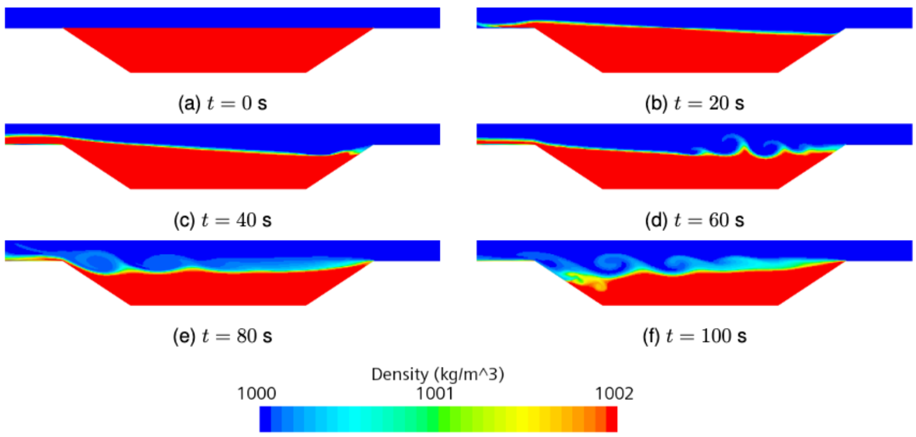


*Figure 1*: Temporal evolution of saltwater entrainment and interfacial mixing using Detached Eddy Simulation. a) shows the initial condition where saltwater and freshwater are distinctly separated; b-c) show the elevation of the saltwater interface at the downstream edge of the cavity due to the flow initiation resulting in a slope of the pycnocline against the flow direction; d-f) Kelvin-Helmholtz instabilities formation and changes in the pycnocline slope.

Debler, W., & Armfield, S. W. (1997). The purging of saline water from rectangular and trapezoidal cavities by an overflow of turbulent sweet water. Journal of Hydraulic Research, 35(1), 43–62. https://doi.org/10.1080/00221689709498643

Kirkpatrick, M. P., Armfield, S. W., & Williamson, N. (2012). Shear driven purging of negatively buoyant fluid from trapezoidal depressions and cavities. Physics of Fluids, 24(2), 025106. https://doi.org/10.1063/1.3680861

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