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Simulation of a Storm Surge Event at the North Sea (Germany) Using a Fully Coupled Approach

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Tidal fluctuation and storm surge events lead to saltwater intrusion into a coastal aquifer. Tidal fluctuation causes dynamic boundary conditions of the seaside boundary, where submerged zones are of Dirichlet-type, and where aerial zones are of Neumann type. In a storm surge event, saltwater will flow on the land surface towards the inland and cover parts of the land surface. Saltwater will eventually infiltrate the unsaturated soil and percolate downwards towards the groundwater table.
To simulate that dynamic coastal flow system, a fully integrated approach based on the numerical "HydroGeoSphere" model is being developed, where the coastal zone is treated as a hydraulically coupled surface-subsurface system.
That new approach will allow simulation of: (i) surface flow, (ii) variably saturated, density-dependent groundwater flow, (iii) salt transport in the surface and in the subsurface, and (iv) water and salt interaction between surface and subsurface.
In the new approach, tide and storm surge events induce a time variant head that is applied to nodes of the surface domain thus tide or storm surge force will be applied to the system through surface domain. The hydraulic interaction between the surface domain and the subsurface domain simplify the flow and transport boundary conditions caused by tidal fluctuation and storm surge events. This newly proposed approach is the first conceptual model of a fully coupled surface-subsurface coastal flow domain. It allows simulation of tidal activity and storm surges at a heretofore impossible complexity.