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Modelling changing hydrology in a coastal area under the influence of climatic change until 2100

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Climate change will have a much larger impact on coastal zones than on most inland areas, because seawater level rise and change in precipitation patterns may severely alter hydrological conditions, ecosystems and land use. The soils in such coastal areas are productive and population density can be high while diversity of ecosystems is large. Hence, these areas may be considered an important resource for agriculture, ecology and public. In the past the Dutch and German coastal areas have established a complex system consisting of drainage networks and pumping stations in order to permit land use. Our study site is located at the German North Sea coast, close to the estuary of the river Ems. Here, more than 1/3 of the area is below sea level meaning that permanent drainage and drainage management is required. Moreover, owing to its topographic setting, the area is vulnerable to climate change. Recent climate change projections point to an increase in magnitude and frequency of extreme climatologic conditions which will likely increase the impact even for two reasons:
(1) During winter periods, a combination of rising sea level, increasing occurrence probability of storm tides and higher volumes of precipitation are predicted.
(2) During summer periods, more frequent droughts are expected.
These changing conditions will challenge the water management of these areas.
To investigate the influence of climate change on the hydrological system, two model concepts on different spatial scales were established, to analyse hydrological processes on both small and large scale. A transect of the unsaturated zone crossing the study area is simulated using the model HydroGeoSphere in order to quantify salt water intrusions during the drier summer periods. Since the layered marsh geology is disturbed by peat and sand layers, this can promote preferential flow pathways for upcoming salt water and following salinisation of water, soils and ecosystems. During winter periods inundation processes will dominate. For this case, a model is applied covering the entire area, and is used to simulate transport from overtopped salt water and inundation owing to high tide and higher amount of drained water from the hinterland. Both models are driven by regional climate models based on an emission scenario assuming a temperature increase of 2°C and a sea level rising of 20, 50 or 100 cm. The uncertainty of both models is quantified.
The results provide an (first) estimate on the cost efficiency to protect the agriculturally used landscapes and the sensitive ecosystems from flooding or salinisation. Moreover, it can be tested if alternative management concepts can be feasible and economically interesting.