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Spatial effects on salinisation processes in a coastal wetland area

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In this study we present the influence of environmental changes on a coastal area which is at risk of salinisation through the subsurface. The study site is located at the estuary of the river Ems at the German North Sea coast. 30 % of the pasture-dominated landscape is below sea level and requires permanent water management. The low permeable soils prevent a significant interaction with the salty perched aquifer. But through geological faults of old paleo-channels, a connection to the surface water body exists which considerably decreases water quality. Observations in those areas show a high salinity with concentrations peaking during the summer period. We expect that under climate change the area will be more affected by dry summer periods and wetter winter periods.
To analyse the effect of climate change on the study site, we choose a bottom up strategy. We simulate the hydrological dynamics of the catchment with a spatially explicit model approach. The estimated soil moistures and hydraulic heads are used as boundary conditions in a second step to calculate the local effect on salinisation on the plot scale. Because of the complex geology only predictions for areas with known layering are performed.
The models are calibrated and validated based on observations. Finally, the validated model setups are used to investigate different climate scenarios covering a temperature rise between 1 and 3.5 K with different meteorological and sea level time series. To take changes in land management into account, we develop different scenarios of landuse strategies to avoid inundation during winter and salinisation during summer. Therefore, different types of polder systems are investigated. One of the scenarios of landuse strategies assumes the technological level of management will be adapted to rainfall and sea level.
The scenario technological level of the land management is able to prevent low lying areas from inundation. But during summer salinisation and during winter cost-intensive pumping rates increase. Our results suggest that a decentralised polder system on the one hand successfully prevents salinisation, while on the other hand leads to a loss of 20 % of agricultural land and completely changes the appearance of the landscape.
In summary it can be said that under climate change the presented study site will lose areas for agricultural use by salinisation or by conversion to polder areas. The stakeholders have to evaluate which landuse changes will have the largest benefit and is less expensive.