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Adaption strategies to the effect of climate change on a coastal area in Northwest Germany with different land management scenarios

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Coastal areas are highly vulnerable to the impact of climate change and handling is difficult. Adaption to two different situations has to be taken into account. On the one hand, increasing global sea level in combination with increased precipitation and higher storm surge frequency has to be handled. On the other hand, in summer periods due to the increase of temperature, enhanced evapotranspiration and an increase of salty seawater intrusion into groundwater have to be managed.
In this study we present different landuse management scenarios on a coastal area in Northwest Germany, East Frisia, and their effect on the hydrological response. Landuse is dominated by dairy farming and intensive crop farming. 30 percent of the area lies below sea level. A dense channel network in combination with several pumping stations allows permeant drainage. The soils are characterised by marsh soils and impermeable layers which prevent an interaction with the confined brackish aquifer. Observations in those areas indicate a high salinity with concentrations peaking during the summer period.
The landuse strategies include a scenario that the technological level of the management will be adapted to rainfall and sea level but without additional drainage from the hinterland to reduce salt water concentration. A second scenario includes the adaptation to increasing precipitation and the sea level with a polder system and wetland areas designated as potential buffer for winter storm surges and inland floods and as freshwater storage for dry summer periods.

Two scenarios use large polder areas in the future as potential buffer for winter storm surges and inland floods and as freshwater storage for dry summer periods, additional usage for nature conservation and as the storage of carbon sequestration or extensive farming are planned. Also, stakeholders have developed a system of several smaller polders in combination with an intensification of the water resource management, and this is used as a third landuse scenario.
A hydrological model that couples surface water and groundwater interactions is used. Several climate scenarios based on the IPCC emission scenarios are applied (A1B, A2 and B1 are used to cover an increase of future temperature between 1 and 3.5 K) in combination with three different heights of sea water level increase. Furthermore, the effectivity of the scenarios in respect to ecosystem services and economic efficiency are calculated.
The business as usual scenario is able to guaranty the current farming strategy by coastal defences and prevention of inundation, but the cost intensive pumping rates increase. Areas with subsurface preferential pathways for groundwater to the land surface have the potential to be affected by salinization of groundwater, soil and drainages, without coastal defences to be able to prevent that.
The large polder systems are able to buffer the increasing precipitation volumes to the price of losing 20 percent of the agriculture area and locally the creation of a completely different landscape. The polders are used effectively to store freshwater in summer periods and can actually also be used to prevent salinization.
The stakeholder scenario with small distributed polders have a comparable effect with the benefit of preserving the original landscape and higher acceptance by the local residents, but with higher cost for more elaborate water resources management and maintenance.