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Effect of sea-level rise on coastal aquifers in East Anglia, UK: a modelling approach

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Sea level in the East of England is predicted to rise 77 cm by the 2080s under a high greenhouse gas emissions scenario. This increase in sea level will lead to a higher saltwater head at the coastal boundary and enhanced saltwater intrusion into a regionally important sand and gravel (Crag) aquifer in East Anglia, UK, that is connected to ecologically important drained coastal freshwater areas. With the purpose of providing future scenarios of saltwater intrusion, models for the 1970s baseline and three different periods (2020s, 2050s and 2080s) were simulated in the Crag aquifer using Visual MODFLOW with the SEAWAT engine. The basic models apply a coastal drain with a high elevation relative to an inland drain in the low-lying coastal catchment. The basic model for the 2080s simulation is shown as the worst case of saltwater intrusion, where the saltwater interface (1000 mg/L) migrates about 2.6 km inland. Two mitigation strategies are tested: (1) changing the coastal drain level relative to the inland drain level; and (2) employing a scavenger well between the coastal drain and the coastline. The simulation of reducing the coastal drain elevation relative to the inland level could prevent saltwater from reaching the inland marsh area, although the coastal marshland would be sacrificed, where the coastal drain concentration is simulated to exceed 10,000 mg/L by the 2080s. In the case of employing a scavenger well, the chloride concentration in the inland drain could be reduced to around half, from 607 mg/L to 354 mg/L, by applying a pumping rate of 10 L/s. A combination of the two strategies is simulated to test whether the inland and coastal marshland can be protected. However, this goal is not achieved even with a high applied pumping rate, with the coastal drain concentration still almost 8000 mg/L. Further research is needed to investigate approaches to preventing drained coastal marshland from saltwater intrusion under the influence of climate change.