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Improving groundwater dynamics in new tidal marsh restoration projects: a modelling approach

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Abstract

Along estuaries and coasts, tidal marsh restoration projects are increasingly being executed on formerly embanked agricultural land to regain the ecosystem services provided by tidal wetlands. There are, however, more and more indications that restored tidal marshes do not deliver these ecosystem services to the same extent as natural tidal marshes. In particular, we found that marsh restoration on a compacted agricultural soil (which has a very low porosity and hydraulic conductivity) leads to reduced depth of groundwater level fluctuations, which may imply decreased soil-water interactions, reduced biogeochemical cycling and impaired vegetation development.

Using a modelling approach, we aim to determine design practices to optimize groundwater flow in new marsh restoration projects. A numerical groundwater model for a restored tidal marsh was set-up in HYDRUS, using a 2D vertical model domain representing a creek and marsh cross-section. The model enables variably saturated flow calculations in dual porosity media. Input parameters for the model were obtained by soil sampling from a restored marsh (Lippenbroek, Scheldt estuary, Belgium) and laboratory measurements of saturated hydraulic conductivity and soil water retention curves. Simulated results are in good agreement with *in situ* measured groundwater levels in monitoring wells. The resulting model was used to calculate fluxes of groundwater and solutes towards creeks in between tidal inundations and to run scenario analyses for different design options, including:

1. Soil amendments: As input for the model, we used soil hydraulic properties observed from a mesocosm experiment on soil amendments (ploughing and adding organic matter). The model showed that these soil treatments affect the depth of groundwater level fluctuations.

1. Creek excavation: Model scenarios with different interspacing between initial creeks, show that groundwater level fluctuations and fluxes towards creeks increase with increasing creek density.

Keywords

marsh restoration, groundwater flow, modelling, soil compaction