Do marshes attenuate storm surges? Modelling the effects of marsh geometry and marsh size on storm surge reduction rates

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Restoration of tidal wetlands and marshes is starting to be implemented in addition to conventional coastal defense structures to protect coastal and estuarine areas from flood hazards. In this study, the capacity of tidal wetlands to attenuate peak water levels locally is assessed with a hydrodynamic model (TELEMAC-2D) for 'Het Verdronken Land van Saeftinghe', a 3000 ha intertidal marsh in The Netherlands. The model is validated against observed water level variations along a 4 km marsh channel. Scenario analyses are performed to study the effect of marsh geometry (platform and channel elevation) and marsh size (the position of the levees surrounding the marsh).

Model results indicate that peak water level reduction largely varies between individual flooding events and between different locations in the marsh. The marsh channel depth determines the maximum amount of peak water level reduction, with the highest attenuation rates for shallower marsh channels and lower attenuation rates for deeper channels. The elevation of the marsh platform has little effect on the maximum attenuation, but it determines which tides are attenuated. In particular, only tides that inundate the platform are attenuated, while undermarsh tides are not attenuated or even amplified. Furthermore, model scenarios with variable dike positions show that attenuation rates can be minimized by blockage and set up of water levels against dikes or other structures confining the marsh size. This blockage only affects peak water level attenuation across wetlands if the duration of the flood wave is long compared to the marsh size. Ultimately, a relationship is found between attenuation rates, local marsh geometry and the storm surge height for marshes covered with typical wetland grasses (*Spartina*, *Elymus* or *Scirpus* species).

The findings in this study may assist coastal managers in the optimization of the coastal protection function of tidal wetlands in combination with dikes.