Do marshes attenuate storm surges?

A numerical study on the effects of marsh geometry and marsh size on storm surge reduction rates

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➢ Introduction

Sea level rise and increasing storminess force us to seek for sustainable strategies to protect coasts and estuaries against flood risks from storm surges. Large wetlands or marshes may provide for a sustainable solution, but it is still unknown how marsh size and geometry affect storm surge attenuation. A hydrodynamic model of the Saeftinghe marsh *(Fig. 1 & 2)* is set up in TELEMAC-2D and validated against water level observations by *Stark et al. (2015).* Morphological scenarios are simulated to assess the impact of marsh size and geometry on storm surge attenuation.

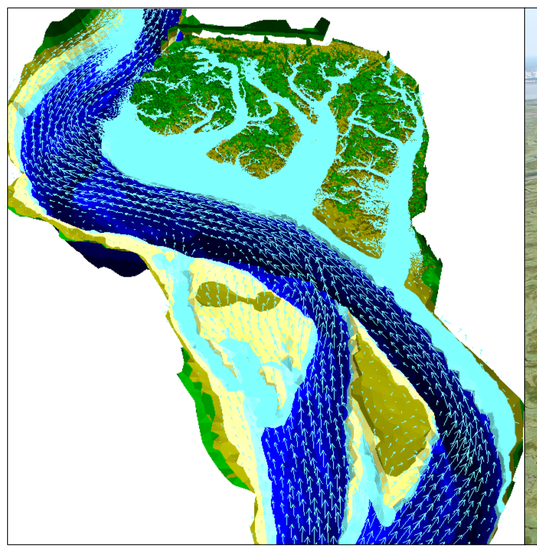


Figure 1: Hydrodynamic model

Figure 2: Saeftinghe marsh

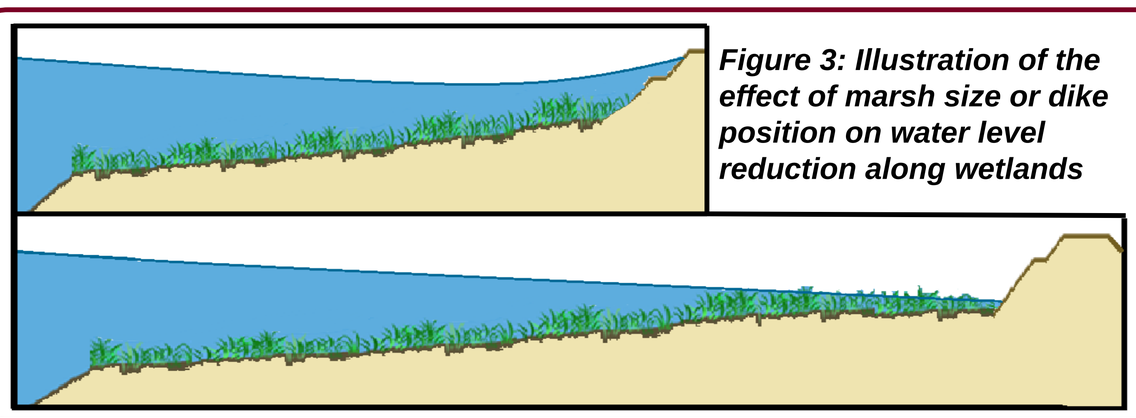


Figure 3: Illustration of the effect of marsh size or dike position on water level reduction along wetlands

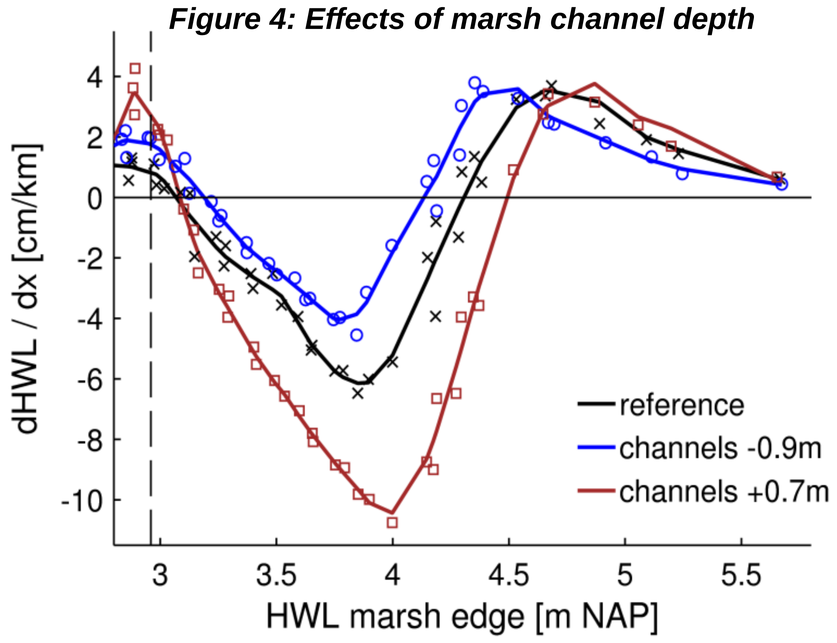
➢ Effects of marsh size

Attenuation rates can be minimized due to blockage of the tidal wave against dikes or other structures confining the marsh size *(*illustrated in *Fig. 3)*, sometimes even leading to amplification for larger storm surges *(Fig. 4 & 5)*.

➢ Effects of marsh channel depth

Shallow marsh channels lead to higher attenuation rates along the channels, whereas deepening of the channels induces lower attenuation rates (*Fig. 4*).

Figure 4: Effects of marsh channel depth



➢ Effects of platform elevation

Only tides that inundate the platform are attenuated, while tides with peak water levels below the platform elevation are not attenuated or even amplified *(Fig. 5)*.

Figure 5: Effects of marsh platform elevation (indicated by dashed vertical lines)

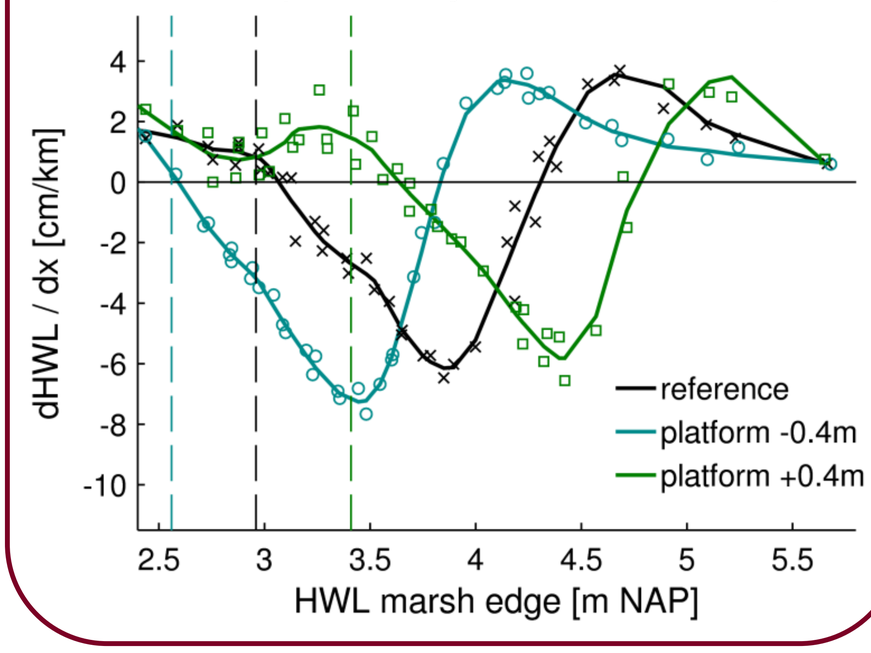
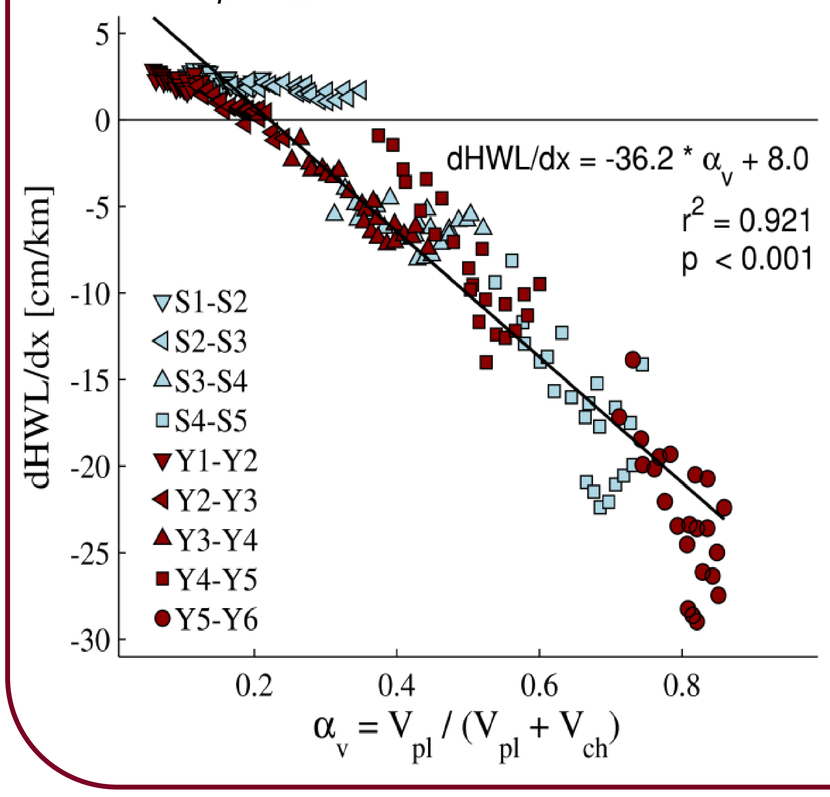


Figure 6: Peak water level reduction rates plotted against the ratio α_V between storage volume on the platform (V_{pl}) and total storage volume in the marsh ($V_{pl} + V_{ch}$)



➢ Predicting attenuation rates

Attenuation rates can be quantified with a relationship based on the ratio between the water volume on the marsh platform and the total water volume on the platform and in the channels *(Fig. 6)*:

- ***dHWL/dx = -36.2 * α_V + 8.0***
- with: ***$\alpha_V = V_{pl} / (V_{pl} + V_{ch})$***

The relationship is only valid if blockage does not affect flood wave propagation.

Reference:

Stark, J., Van Oyen, T., Meire, P. and Temmerman, S. (2015), Observations of tidal and storm surge attenuation in a large tidal marsh. Limnol. Oceanogr., 60: 1371–1381.

Funding source:

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