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The effect of Climate Change on Dune Erosion

Introduction

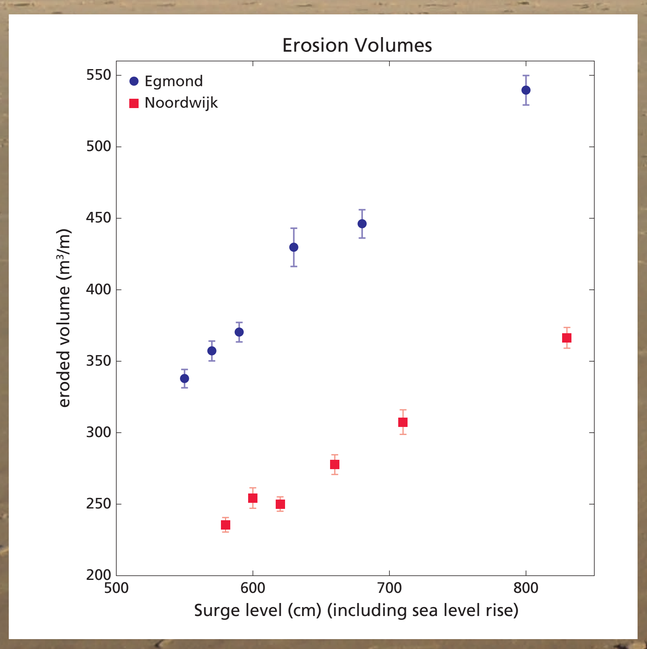
Coastal safety in the Netherlands is threatened by severe dune erosion when dunes are breached, resulting in flooding of the hinterland.
Dune erosion events are caused by storms in the North Sea basin, resulting in storm surge and large waves. Under climate change, the design wave height and period are expected to remain unaltered (de Winter et. al., 2012); However, the **wave direction** (de Winter et. al., 2013) and mean **sea level** are expected to change.
Here, we analyse from a coastal safety perspective, the effect of climate change on dune erosion in the Netherlands.

Methods

To analyse the effect of climate change on dune erosion, we used:

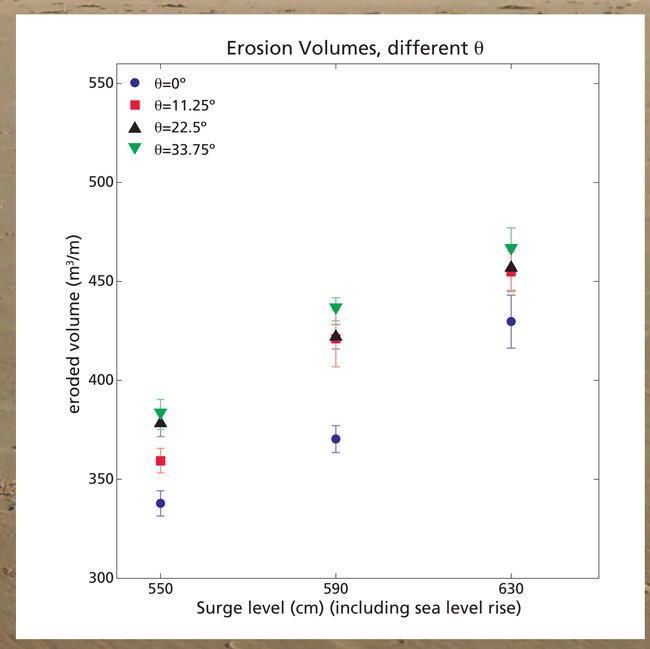
- A calibrated XBeach model in 2D area mode
- Representative profiles of Egmond and Noordwijk to create a homogenous alongshore topography.
- 1:10.000 y return condition
  - Egmond: surge 5.5m; H_s=9.55m; T_p =16.1s
  - Noordwijk: surge 5.8m; H_s=8.55m; T_p=14.3s
- Storm duration of 5 hours
- Sea level rise estimates of KNMI'14 and IPCC5 (ranging from 0 to 250cm)
- Different wave angles (shore normal to 33.75°)

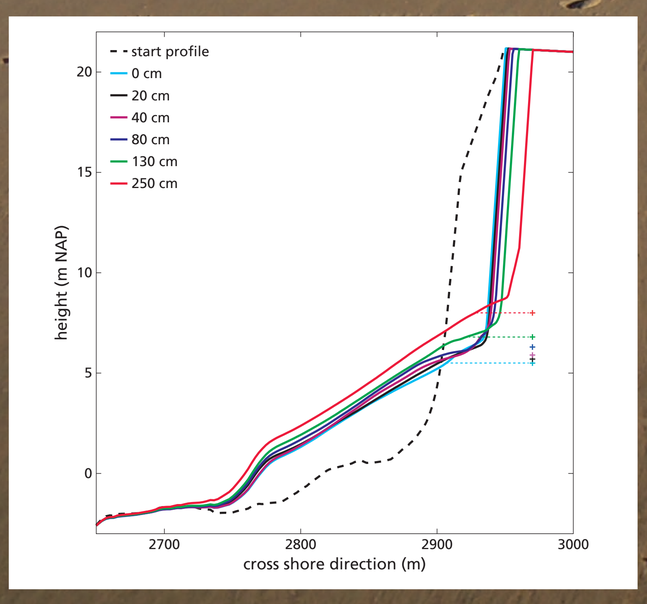
Results



Left: The amount of eroded volume in m^3/m, for Egmond and Noordwijk. Waves in Noordwijk are small compared to Egmond, resulting in smaller erosion volumes. Both locations show a linear relation between sea level rise and erosion volumes.

Right: Dune erosion in case of a sea level rise of 0, 40 and 80 cm and wave angles of 0°(shore normal) to 33.75°. A wave angle of 22.5° almost causes the same erosion volume as 40 cm sea level rise.





Pre and post storm dune profiles at Egmond. The offshore surge level (indicated by +) is lower than the bending point in the post-storm profiles

Conclusions

Our main conclusions are:

- A linear relation excists between sea level rise and erosion volumes
- Influence of wave angle are equally important as sea level rise
- Bending point post-storm profile is higher than offshore surge level

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