



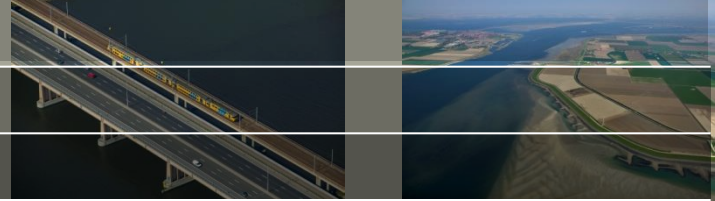
Impact assessment of coastal hazards due to typhoons in the Marshall Islands

by Kees Nederhoff & Alessio Giardino

Deltares, Unit Marine and Coastal Systems, The Netherlands

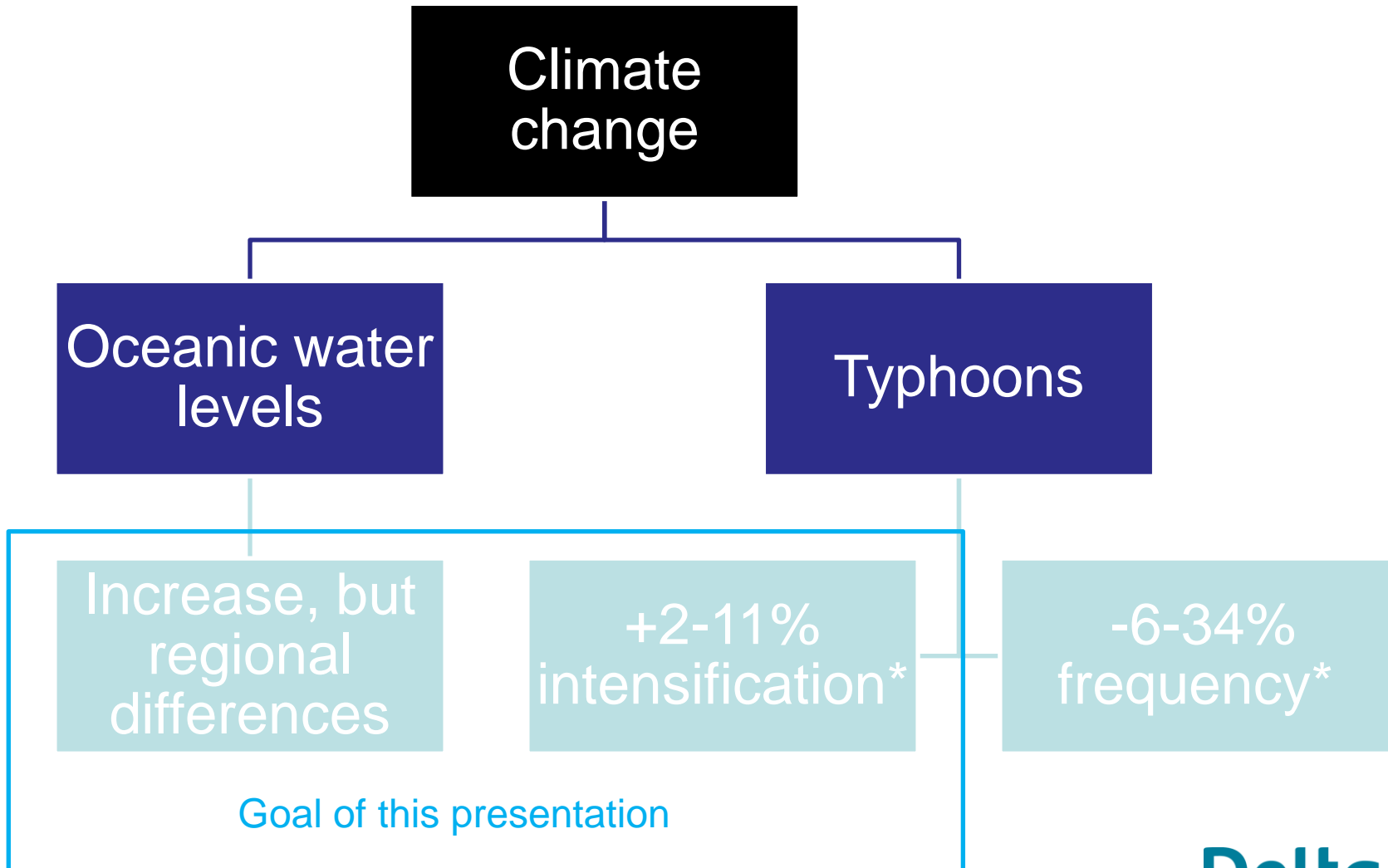
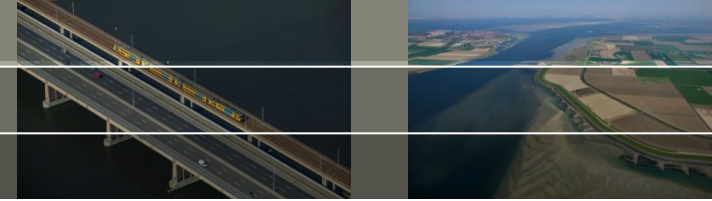
**American Meteorological Society's 30th Conference on Climate Variability
Session 1A: Changes in Extreme Weather (paper 1A.6)**

Content



1. **Introduction: background and case study**
2. **Deep water coastal hazards:** waves and storm surges
3. **Nearshore impacts:** atoll flooding
4. **Conclusion**

Background



*: Knutson et al. (2010) in Nature Geoscience

Case study*: Ebeye on the Marshall Islands



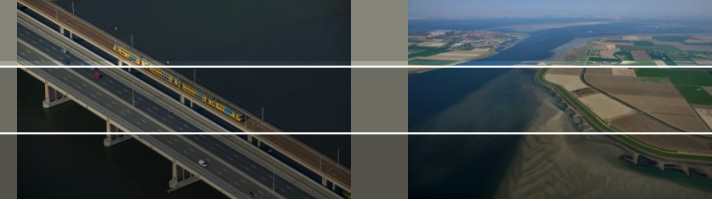
Geographical location of the Republic of the Marshall Islands (RMI)



Aerial view of the islands of Ebeye

*: case study is described in more detail in Giardino et al. (submitted) in Climate Change

Methodology:



Atmospheric
hazards



Coastal
hazards



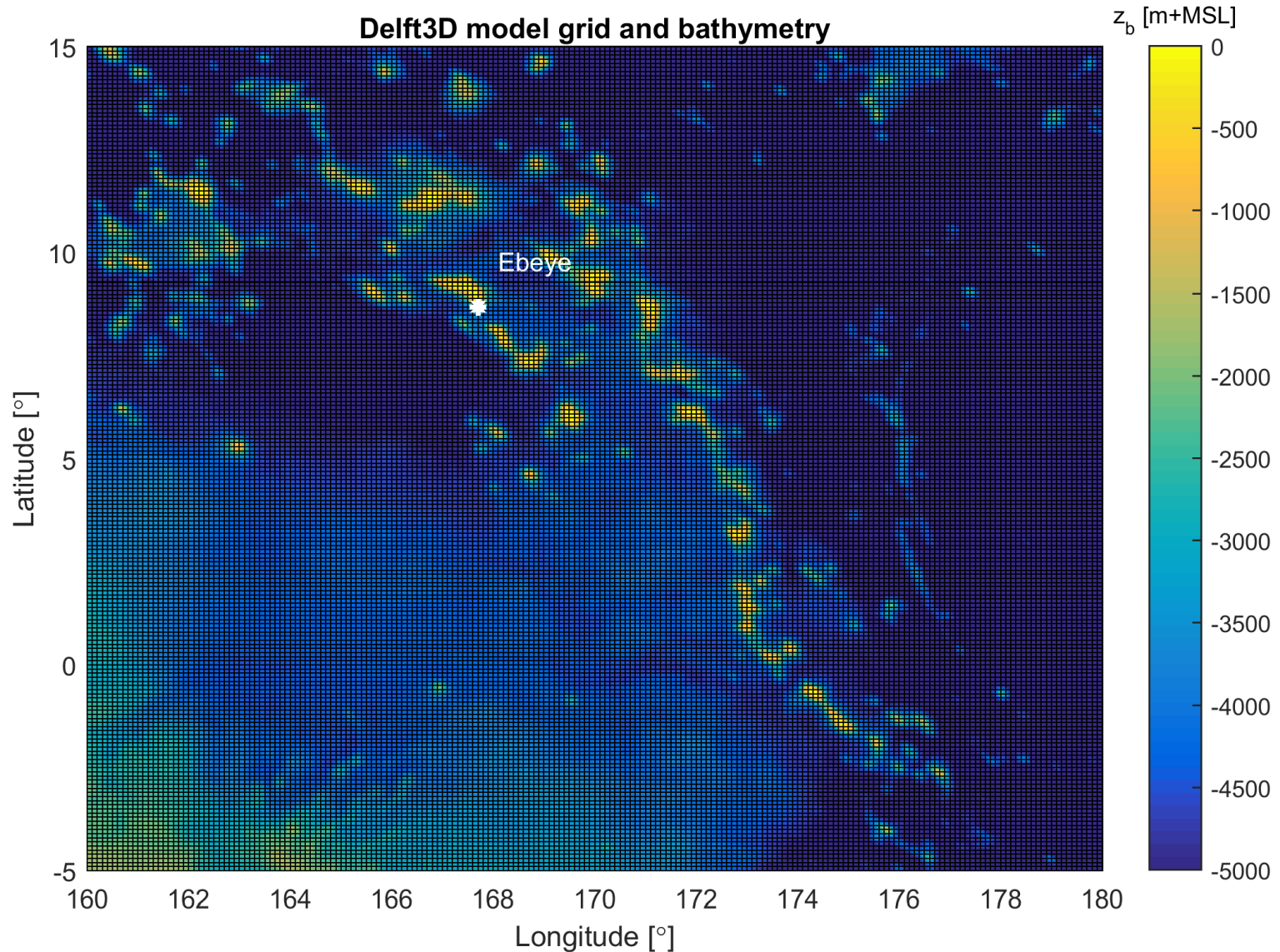
Impacts

Parametric radial profiles: Holland et al., 2010
Additional relationships: Nederhoff et al. (submitted)*

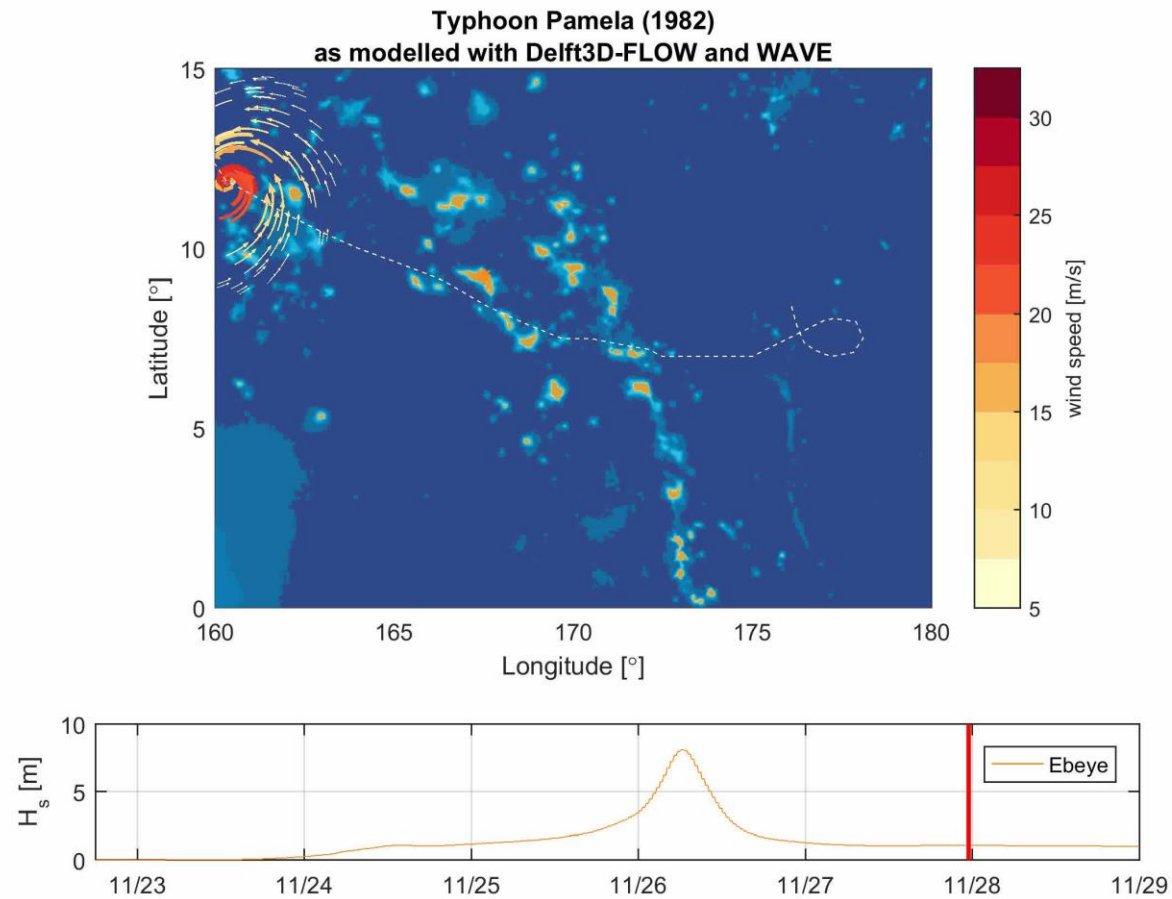
Delft3D-FLOW and WAVE model
forced by parametric wind and pressure field

XBeach model
Forced by waves and water levels from Delft3D

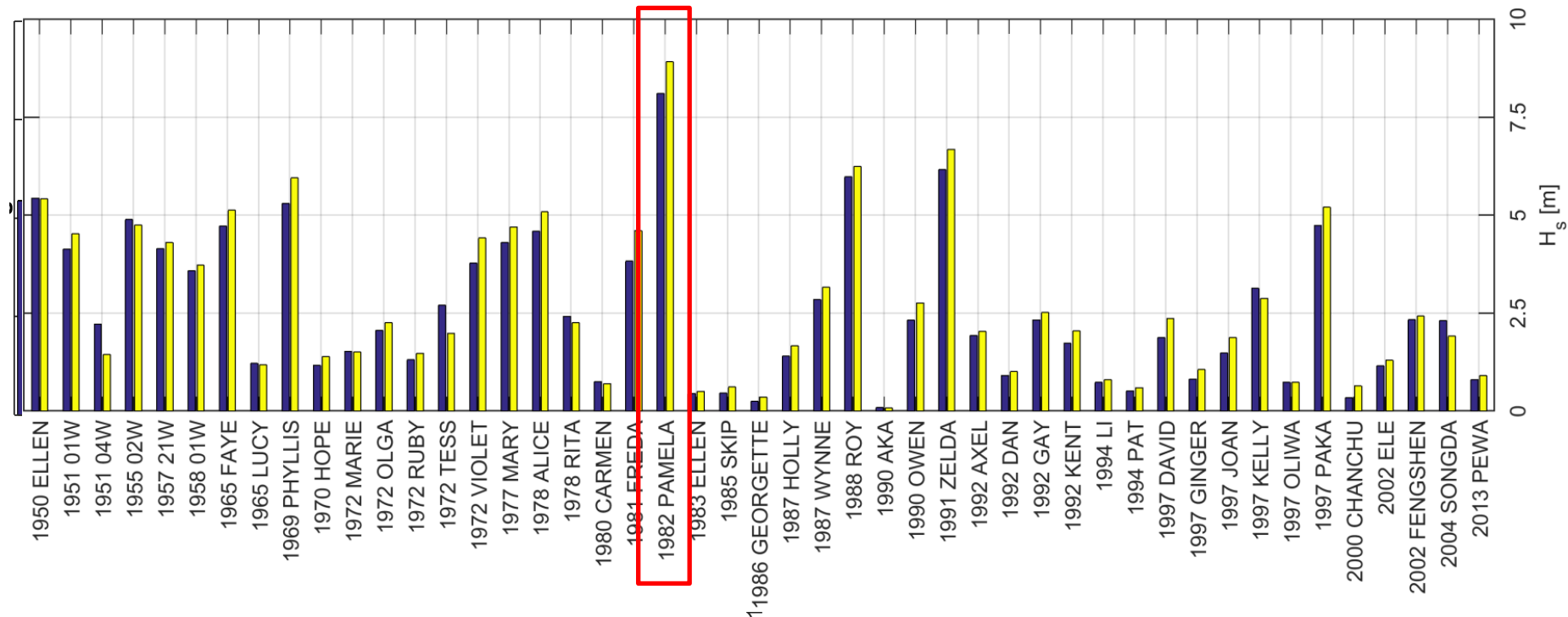
Delft3D FLOW-WAVE model: setup



Delft3D FLOW-WAVE model: results

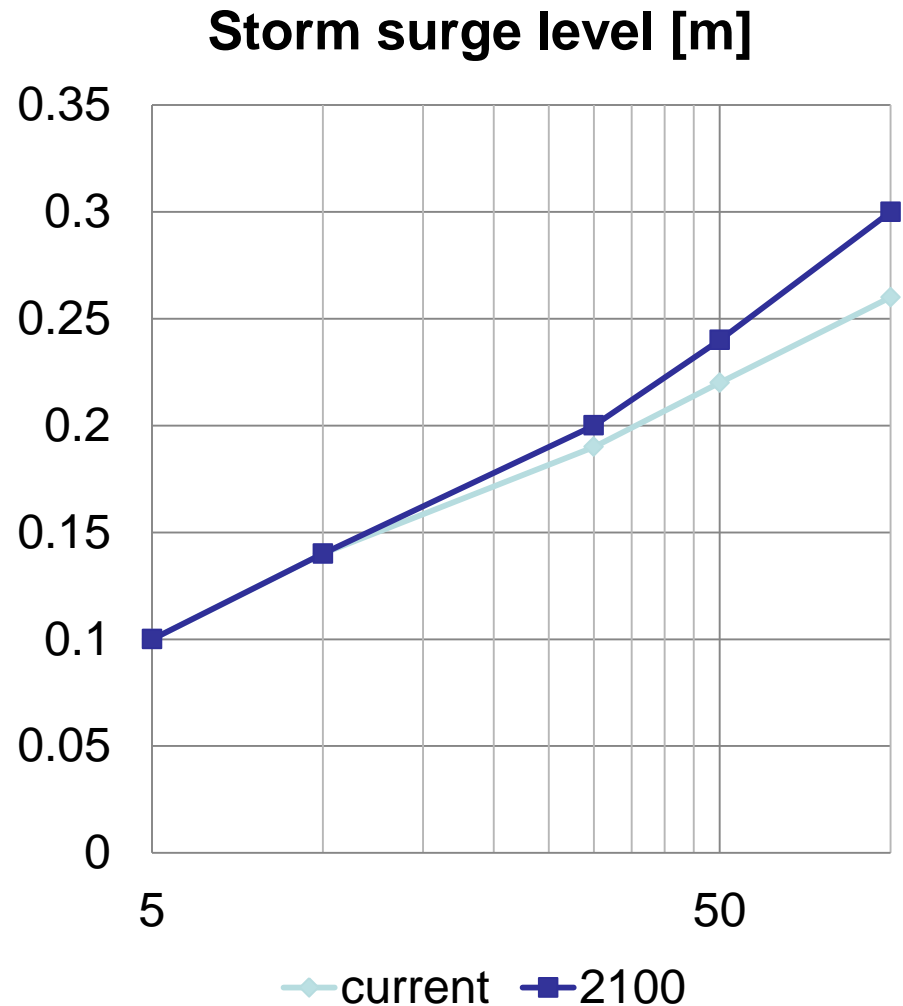
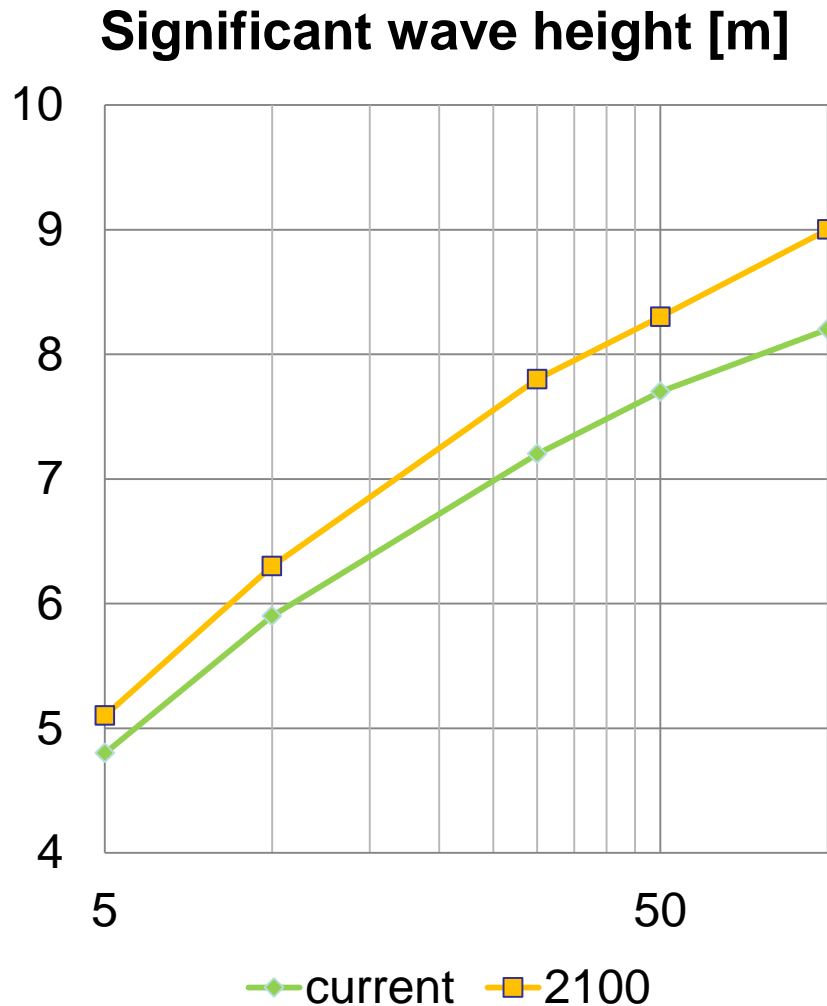


Deep water coastal hazards: current and future

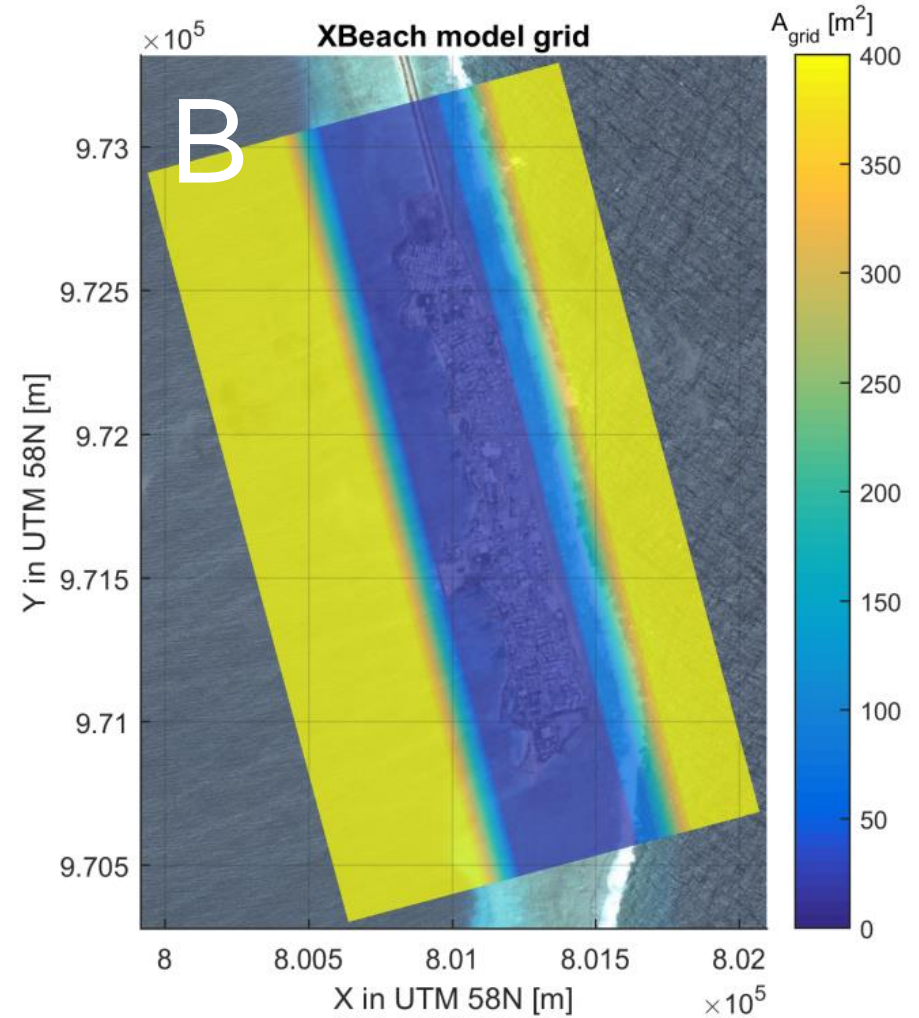
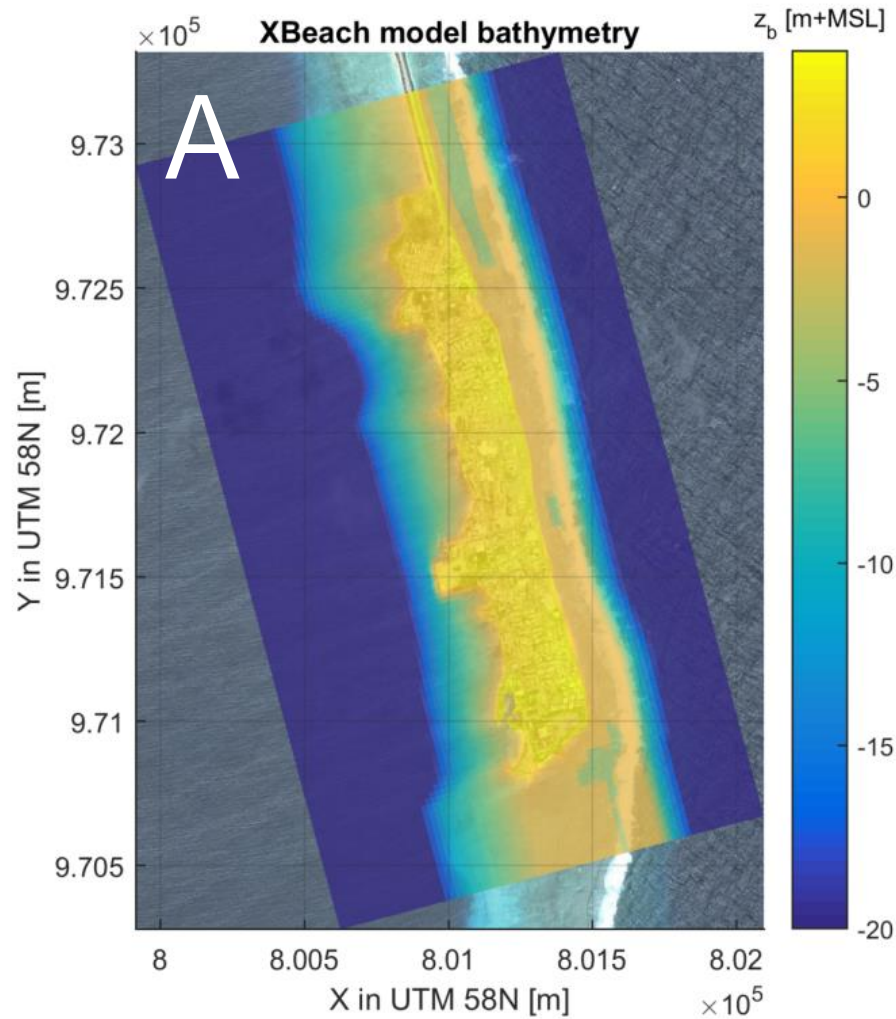
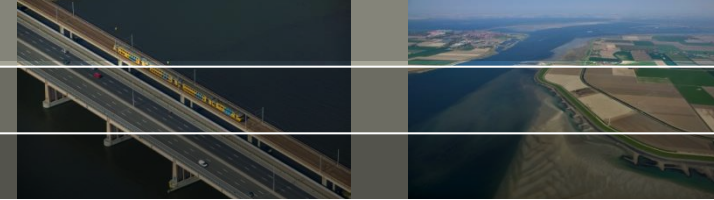


- Modeled 47 individual typhoons in Delft3D
- Climate change by 2100: 11% increased wind speeds + pressure drop
 - > Large typhoons result in highest waves
 - > Weaker typhoons do not necessarily result in high waves

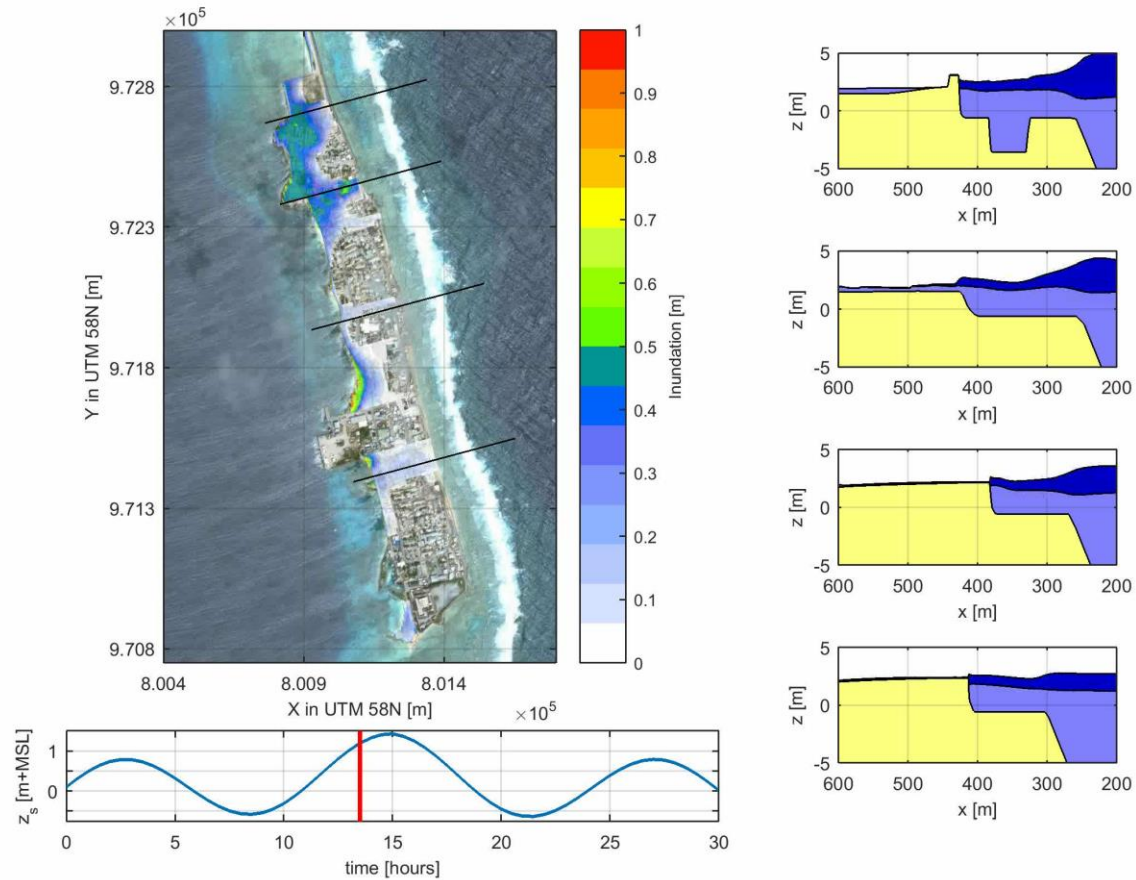
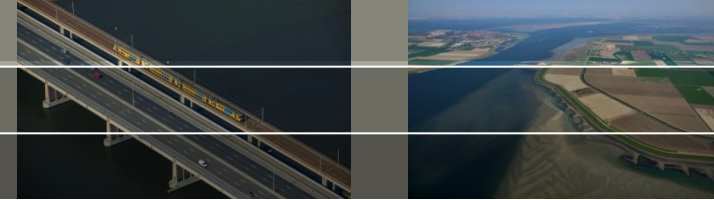
Deep water coastal hazards: current and future



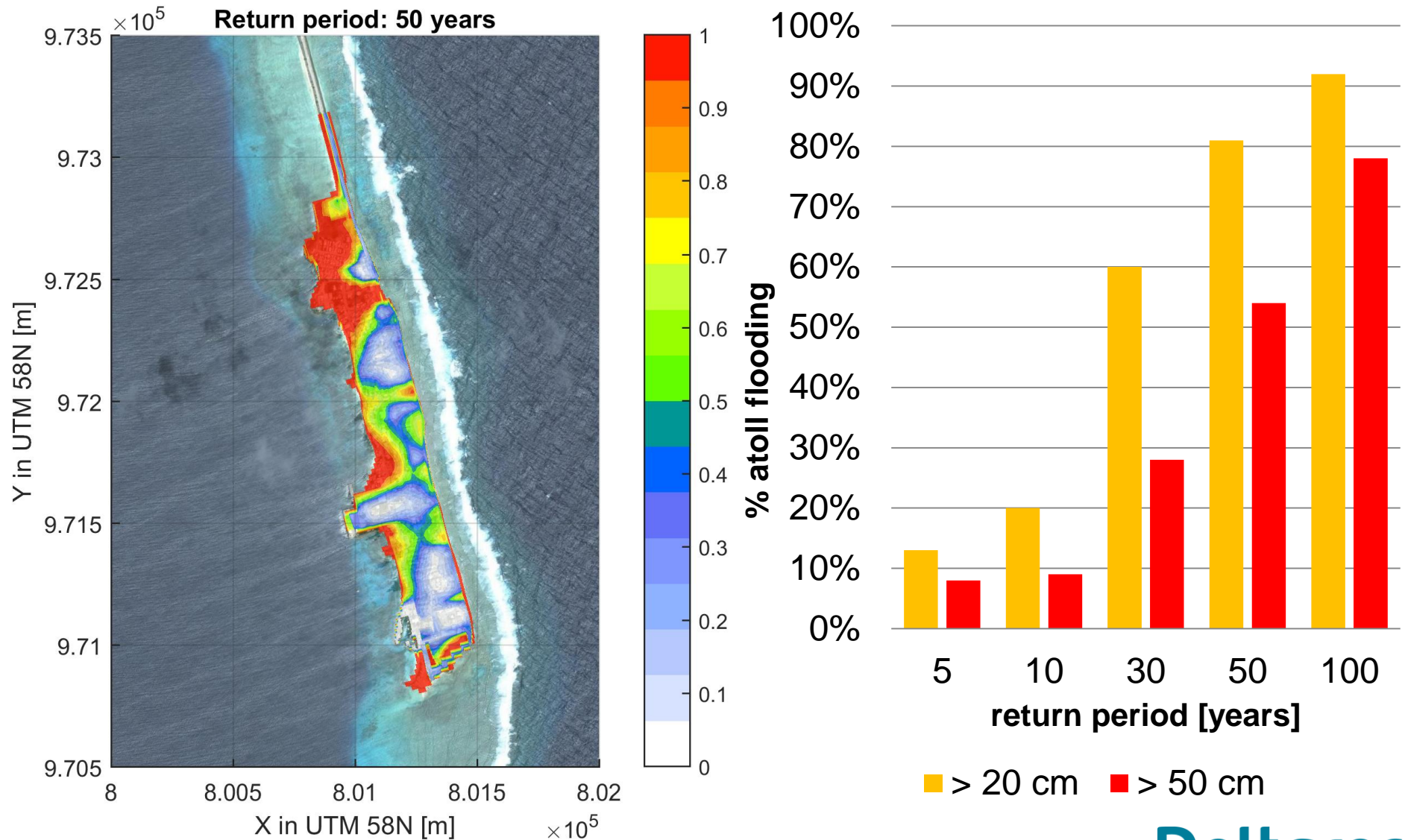
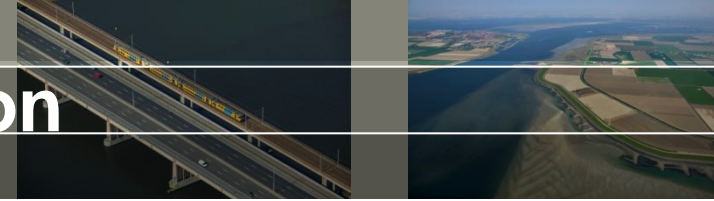
XBeach model: setup



XBeach model: results



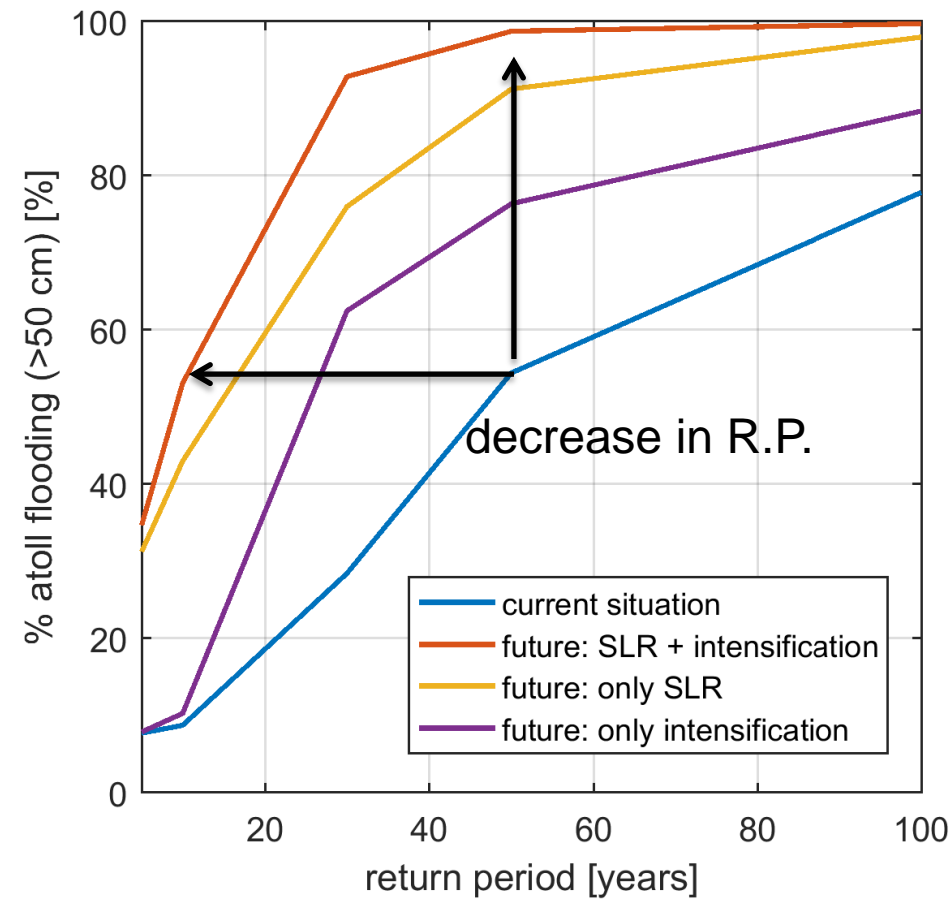
Atoll flooding: current situation



Atoll flooding: future (SLR + intensification)



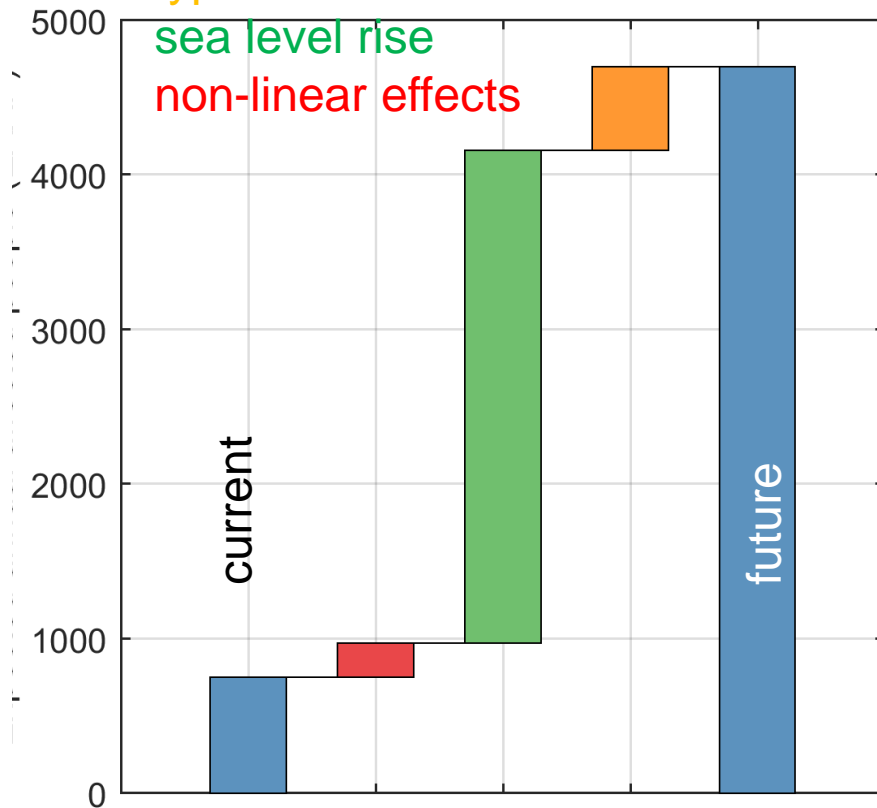
increase impact



typhoon intensification

sea level rise

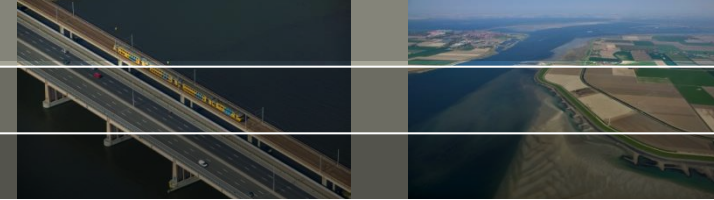
non-linear effects



$$EAAP = \int_p \sum A(p) \cdot dp \quad \text{with} \quad A(p) = \begin{cases} 0 & \text{if } hh \leq 20cm \\ 1 & \text{if } hh > 20cm \end{cases}$$

Deltares

Conclusions



- **Deep water coastal hazards:**
 - Extreme value analysis for 47 individual typhoons
 - Offshore wave heights: 4.8-8.2 meter (RP: 5 -100 years)
 - Climate change by 2100: 6-8% higher waves & surge
- **Impacts and social risk of typhoons on Ebeye**
 - Limited impact of more frequent typhoons (<10% atoll flooding)
 - Current social risk (EAAP) of +/- 750 people
 - Climate change by 2100: : 526% increase in social risk (4701 people)
 - Mainly due to increase of impact of more frequent typhoons
 - Large increase in social risk
 - 5% related to stronger typhoons
 - 82% related to sea level rise
 - 13% non-linear interactions