

Risk reduction by combining nature values with flood protection

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Multi-Functional Flood Defences: deliberately combining functions

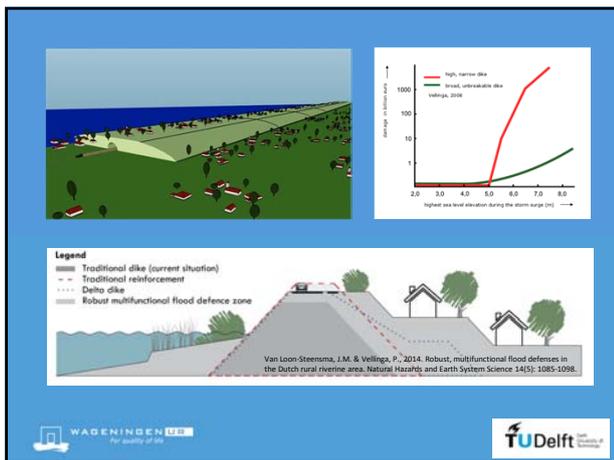
Due to the growing need for space, there is an increasing urge to effectively use the available room along coasts and rivers

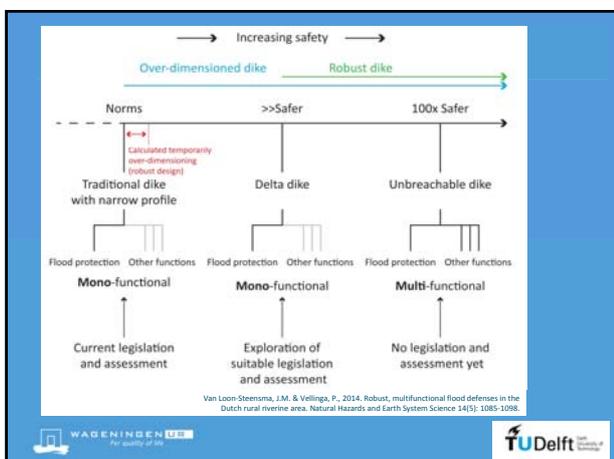


Ideas









Increasing interest for nature based solutions

e.g. advice Dutch **Delta Committee 2008** → recommended a tenfold increase in the flood safety level while also emphasizing the need for development of flood protection along with climate change and ecological processes



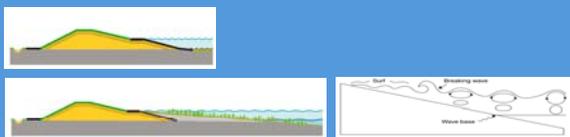
Dikes along the Wadden Sea coast



Salt marshes along the Wadden Sea coast



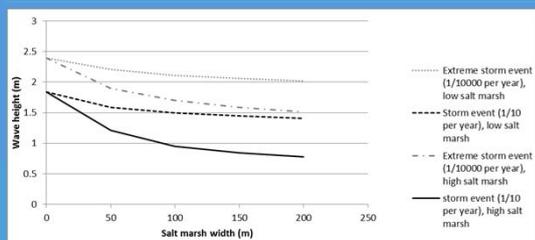
Wave damping by salt marshes



- slope of the coastal profile
- water depth above the salt marsh
- width of the salt marsh zone
- surface topography
- vegetation characteristics



Modelled wave height



Modelled wave height over a foreshore (1 m +NAP and 2.3 m +NAP) under extreme storm conditions (1/10 and 1/10,000 per year) (based on Venema et al., 2012).





Effects on risk for different situations

Situation	Effect on risk
Wave damping capacity of the present foreland explicitly taken into account in the flood defence design	In case of a tailored design the risk will increase due to the dynamic character of the salt-marsh foreland In case of a deliberately over dimensioned design that accounts for the dynamic character of the salt-marsh foreland than the risk will decrease
Wave damping capacity of present foreland not taken into account in the flood defence design	This will result in over dimensioning of the design and subsequently the risk will decrease
Effect of present foreland on exposure characteristics	No, or minor effect
Effect of present foreland on vulnerability of hinterland	No effect on risk




Risk under changing conditions

Situation	Cross-section flood defence system
a. Traditional dike covered with a layer of clay and grass and with a revetment of asphalt under current conditions	
b. Dike covered with a layer of clay and grass combined with a vegetated foreshore (multifunctional dike)	
c. Reinforced traditional dike under future conditions of sea-level rise (additional height and width to anticipate higher surge levels and higher waves and additional revetment)	
d. Reinforced dike under future conditions of sea-level rise (additional height and width to anticipate higher surge levels) and abundant sediment supply so that the elevation of the vegetated foreland can keep pace with sea level rise (so that wave height does not increase compared to current situation)	
e. Reinforced dike under future conditions of sea-level rise (additional height and width to anticipate higher surge levels and higher waves and additional revetment) when there is no supply of abundant sediment (which will result in erosion of the foreland)	




Management and Maintenance

- Integrating forelands into the flood defence system broaden the management scope of flood protection
- Adds ecosystem conservation and restoration measures
- Management of vegetation development

Still many questions






Conclusions and Recommendations

- By dissipating wave energy, a salt-marsh zone adjacent to an engineered dike reduces wave heights and subsequently buffers the loads on the dike.
- Comparison of risk reduction by a dike with and without an adjacent foreland gives an impression of the risk reducing capacity of this type of multifunctional flood defence.
- The size of the dike can be reduced if the wave damping capacity of the foreland is taken into account when designing the dike.
 - Tailored design: risk will increase due the dynamic character of the salt-marsh foreland
 - Deliberately over-dimensioned design, that accounts for the dynamic character of the salt-marsh foreland, the risk will decrease.
- A robust design, if the wave damping capacity of a present foreland is not taken into account in the flood defence design.



Thank you for
your attention



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