RELEVANCE OF VARYING COASTAL DEFENCE SYSTEMS ON FLOODING AND DAMAGE OF COASTAL AREAS

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Paper topic: Coastal risks and management, including climate changes

1. Introduction

The German Federal State Lower Saxony borders on its northern side the North Sea. Lower Saxony coastal lowlands have an extension of 6,600 km². This area is flood prone by storm surges and protected by primary flood defences with a total length of 610 km. In addition protection elements such as dike forelands and secondary dikes are present for significant stretches of the coastline (NLWKN, 2007). In combination with a primary dike, these elements form a coastal defence system of locally varying shape. The influence of different types of coastal defence systems on flooding of the hinterland and expected damages in case of failure of the primary dike, as well as damage and risk mitigation measures are investigated by the Lower Saxony Water Management, Coastal Defence and Nature Conservation Agency (NLWKN) in cooperation of RWTH Aachen University and Hamburg University of Technology within the joint applied research project HoRisK (Flooding Risk Management for Coastal Areas).

2. Main objectives and methods

Hydrodynamic flooding simulations and damage calculations in case of failure of a coastal defence system using a source-pathway-receptor approach are main focus of the subproject led by NLWKN. The structure of the coastal defence system along the Lower Saxony coastline as well as elevation distribution of the hinterland and the storage volume of polder areas is analysed and classified. Scenario based hydro-numerical simulations of failure of the primary dike are executed for selected schematic types of coastal defence systems and hinterland. The influence of different shape and location of secondary dikes as well as foreland height and width is investigated. Within the coastal area topographical elements such as drainage systems and break lines can influence characteristics of inundation significantly (Burg et al., 2008, Thorenz and Burg, 2008) and will be further investigated. Hydro-numerical 2D as well as combined 1D-2D-flooding simulations are applied.

The consequences of dike failure and the effects of different types of coastal defence elements investigated for typical sites along the Lower Saxony Coastline. Estimated damages will be evaluated by means of a GIS-tool using public statistical and land use data and integrated water depth-damage-functions based on the results of flood modelling. Based on these results will be used to investigate damage and risk mitigation options in a further project phase.

3. Influence of dike foreland

The coastal defence system in Lower Saxony consists of a combination of a primary dike with a foreland for 49% of the total dike line (Blum et al., 2011). Based on dike breach scenarios for schematic coastal defence systems, by hydrodynamic simulations is shown, that a foreland can reduce the inflow volume as well as the affected area significantly, depending on width and height. Compared to a defence system without a foreland, a foreland with an elevation of 1 m above mean

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high water level (MHW) can reduce the inflow water volume by 68 % for a schematic coastal defence system and by 74 % for a typical coastal site (Figure 1). The affected area is reduced by 59 % for the investigated coastal site. The effect of a foreland is facilitated in case of the existence of summer dikes with a crest height of 2 m above MHW, which can decrease the water volume by additional 12 %.

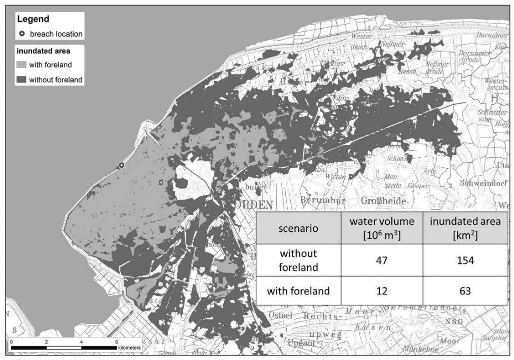

Figure 1. Influence of a dike foreland on inundation for the coastal area of the city of Norden.

4. Effects of secondary dikes

The effect of a secondary dike depends on the crest height as well as on the specific storage capacity of the polder bounded by the primary and secondary dike. The crest height is expressed as level below storm surge water level and the specific storage capacity as polder volume per meter of the primary dike. The specific storage capacity of the existing polders in Lower Saxony is low 2.000 m^3/m. Figure 2 shows, that a significant reduction of the water volume affecting the hinterland can only be achieved by higher specific storage capacities. In this case, also secondary dikes with a crest height of 1 m below storm surge level are effective.

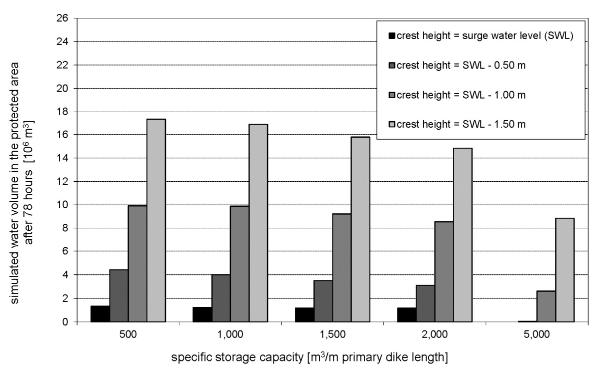

Figure 2. Influence of specific storage capacities and crest heights of secondary dikes on flooding volume

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