# A Storm Surge Management System for the German Coast

## RISC - Risk Information System Coast


Nicole von Lieberman
Dr.-Ing.
Research Associate
nicole@fi.uni-hannover.de

Stephan Mai
Dipl.-Phys. Dipl.-Ing.
Research Associate
smai@fi.uni-hannover.de

Claus Zimmermann
Prof. Dr.-Ing.
Director
Fellow ASCE
zi@fi.uni-hannover.de

Franzius-Institut for Hydraulic, Waterways and Coastal Engineering,
University of Hannover, Nienburger Str. 4, 30167 Hannover, Germany


### Motivation

The anticipated accelerated sea-level rise requires an improved storm surge management in order to maintain safety of the hinterland with reasonable costs. An improvement can be achieved by storm surge management systems including

- a detailed description of the coastal defense system and its elements like dikes, storm surge barriers, sluices, locks, forelands, summer dikes, and tidal flats (Fig. 2)
- a collection of load parameters like statistics of tidal water levels and currents as well as wind and wave conditions (Fig. 3)
- a data base of the usage of the hinterland
- a data base of the economic values of hinterland areas (Fig. 4)
- maps of flood zones (Fig. 4)
- spatial distributions of losses in case of flooding (Fig. 5)
- maps of risk zones (Fig. 6)

This poster gives an example of the management system RISC for the German North Sea coast near the two harbors Bremerhaven and Wilhelmshaven (Fig. 1) with its characteristics:

- tidal range = appr. 3.50 m above German datum (MSL)
- maximum storm surge level = appr. 5.20 m above German datum (MSL)
- large tidal flats of appr. 10 km to 15 km width
- two estuaries "Jade" and "Weser"

### Methodology

In order to introduce a quantitative approach into storm surge management risk analysis is used. Within this concept the safety of coastal defenses is assessed by

**Risk = Failure probability of coastal defenses x Loss in case of failure**

**R [EURO/a] = p [1/a] x C [EURO]**

The probability of failure is calculated

- using statistics of load parameters
- assuming typical failure modes like wave overtopping at dikes
- taking into account uncertainties like statistic errors or simplifications within numerical models

The calculation of loss is based on

- the maximum possible loss, i. e. the total economic value of the hinterland
- the area flooded in case of failure of coastal defenses
- the inundation depth being a measure for the degree of damage

**Loss = Maximum Loss x degree of Damage**

**C [EURO] = C [EURO] x $\varphi_{(d)}$ [%]**

### Models

Because of the lack of data on the long-term wave statistics and on the flooding process numerical models were applied. The long-term wave statistic was derived applying the model SWAN (Shallow Waves Nearshore)

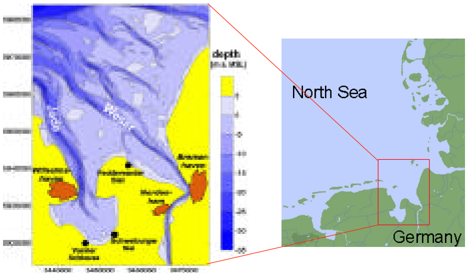
- for different conditions of water level and wind
- and transforming the joint probability distribution of water level and wind to a probability distribution of wave parameters

The flooding process was described using the model MIKE21-HD

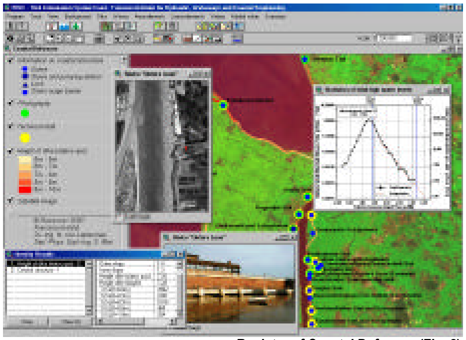
- for different historical storm surge events (1962, 1976, 1996)
- for different locations of failures
- for different failure modes (failure of dikes, storm surge barriers, etc.)

### Results

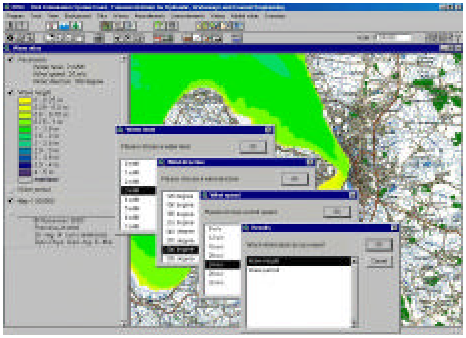
The storm surge management system RISC was developed using the platform of the Geographical Information System ARC/VIEW with expanded capabilities programmed in AVENUE. It also provides various alternatives of precautions like heightening of dikes and design of polders. It therefore can help decision-makers and stakeholders in planning future coastal defenses on the basis of a constant risk for the coastal hinterland leading to an optimal allocation of investments.



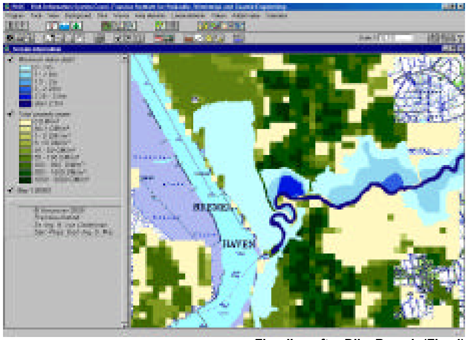

Area under Investigation (Fig. 1)



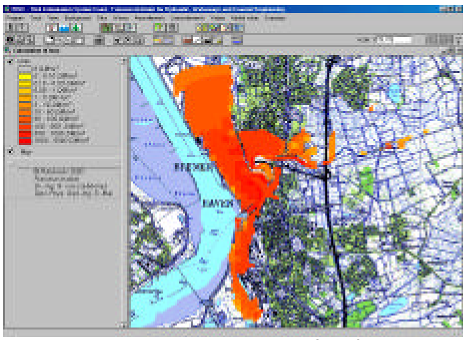
Register of Coastal Defenses (Fig. 2)



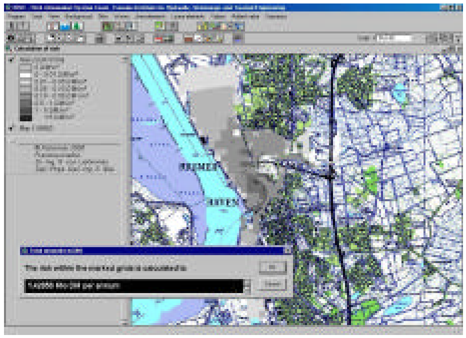
Wave Atlas (Fig. 3)



Flooding after Dike Breach (Fig. 4)



Losses in Case of Flooding (Fig. 5)



Risk due to Storm Surges (Fig. 6)