Storm flood risk assessment and recommendations for a typical Wadden sea island, Langeoog - DE

1. Policy Objective & Theme

- ADAPTATION TO RISK: Managing impacts of climate change and safeguarding resilience of coasts/coastal systems
- ADAPTATION TO RISK: Integrating coherent strategies covering the risk-dimension (prevention to response) into planning and investment

2. Key Approaches

- Integration
- Socio-economic
- Technical

3. Experiences that can be exchanged

The way of producing an inventory and analysing most probable breaking points and calculating the most probable damage scenarios can be transferred to other Wadden sea islands. Many islands share common features: a ring of natural and technical storm flood defence measures, no permanent connection to the mainland, and if present a delicate natural freshwater source nourished by precipitation (though not all islands in the Wadden sea have such a natural freshwater source). However, risk management recommendations have to be based on each specific island conditions.

4. Overview of the case

At first an inventory of physical and socio-economic conditions as well as existing coastal defence measures in the Langeoog flood unit was compiled. From these data, the consequences of probable breaking points in the flood defence belt were calculated, and the related damage estimated. Recommendations for risk reduction and risk management were based on the risk assessment study.

5. Context and Objectives

a) Context

The case study area Langeoog is a Wadden sea island in the North Sea with an area of about 20 km2. It is a barrier island off the coast of the federal state Lower Saxony (Niedersachsen). The northern sea side coast is protected by dunes, while the Wadden sea side in the south is characterised by lowlands. About 2000 residents live in the village in the north-west of the island which covers an area of approximately 1.5 km2. Tourism is the main economic factor on the island with 179,000 guests and 1.5 million overnight stays. Part of the island belongs to the Wadden Sea National Park, access is restricted for conservation reasons. The island can be reached by ferries and with small aeroplanes. A road and a railway connect the harbour in the south with the village. Drinking water is extracted from the freshwater lens east of the village that is nourished by natural precipitation to the dunes and does not mix with the underlying heavier salt water. Flood protection is provided by the dunes and dykes around the lowlands. Dune erosion endangers the dunes' function as a natural flood protection barrier and the freshwater reservoir below them by the possible inflow of salt water. Therefore, the dunes are protected: any other usage besides coastal defence is prohibited by law, beach nourishment and dune strengthening are further measures. The Lower Saxony Dyke Act defines coastal defence elements, general design rules, legal obligations and regulations.

b) Objectives

The objectives were: assessment of the inventory of physical and socio-economic conditions as well as existing coastal defence measures in the Langeoog flood unit; estimation of the values, that are endangered by a flood (two probable scenarios); a state of the art risk assessment based on the modelled scenarios; development of recommendations for measures to reduce the risk of these specific cases and increase the safety standards according to them. The study ran from July 2002 to June 2005.

6. Implementation of the ICZM Approach (i.e. management, tools, resources)

a) Management

Lower Saxony Water Management and Coastal Defence Agency (NLWKN) was responsible for this study. It is the responsible entity for coastal protection in federal state Lower Saxony. External scientific experts supported the work: the University ofKiel / Department of Geography, Water Board of Oldenburg and East Frisia (Oldenburgisch-Ostfriesischer Wasserverband OOWV), and the Technical University Braunschweig / Institute for Environmental Geology (IUG).

b) ICZM tools

The weak points of the flood defences of the island were identified and probable impacts modelled to imply the scenarios in a risk analysis. The value of possible damage was calculated based on a hazard, vulnerability, and damage analysis. The scenarios were a dune breach or a dyke breach, respectively. The Hazard analysis was a one-dimensional numerical model which simulated beach and dune erosion, and the ProDeich model was used for a deterministic calculation of dyke failure. Risk elements in the study were buildings, vehicles, life stock etc. Estimated surge water levels were used to evaluate most probable flooding areas and the resulting water depths due to the specific scenarios. The small scale vulnerability analyses estimated the most probable damages to individual risk elements that a failure in the storm defences depending on the scenarios cause. Water propagation and depths are based on hydraulic calculations of water inflow at detected failure locations. The analysis was based on the MERK-project results that estimate values and damages. Thus, the probable damage for each risk element can be expressed as a monetary value. The effects on the freshwater supply by saltwater intrusion into the catchment area of the wells was calculated based on a numerical simulation; the vulnerability was estimated by experts and based on numerical models about salt concentration effects on the wells. The final risk analysis combines probability of the hazard analysis with the vulnerability of assets.

A workshop was held to discuss matters with external experts. Additionally, the preliminary and final results were discussed with the local administration and council on the island. Despite the lack of some fine scale data the study provides a decision-making tool for planning future reinforcements of the coastal defences, and to improve action plans in case of flooding based on the estimation of most probable damages that occur. This is a new approach to risk management, at least for Lower Saxony. It provides a list of priority measures that have to be tackled to ensure a rational risk management, and improves safety standards. The study can be used as a decision-making tool providing data and methods to refine future defence planning, detecting weak spots in the defence systems to be reinforced, and it gives input to adjust contingency plans for flood catastrophes.

7. Cost and resources

NLWKN secured national financing of €220,000 and a further €110,000 was provided by the ERDF to conduct the research.

8. Effectiveness (i.e. were the foreseen goals/objectives of the work reached?)

The risk assessment for Langeoog was the combination of an analysis of probable defence break points depending on hydrographic and morphological data with damage analysis in the likely flooded areas. The results were communicated to local experts and new recommendations for future flood risk management were provided. A part of the recommendation concerning freshwater safety was realised shortly after the work ended. Additionally, the detailed height information improved knowledge about best evacuation routes and the most endangered areas. However, some uncertainties prevail due to lack of a better data basis, and gaps in damage analysis. Still the modelled most probable risks were communicated to local experts, and recommendations for an improvement of risk management were developed.

9. Success and Fail factors

Some hydrographical data were relatively coarse (time series on water levels) or not available (wave climate). Some geo-technical parameters and the failure mode for dune erosion had to be estimated. Scenario definitions were necessary to determine resulting flooding, thus the number of breaches at the same time, their location, and dimension are the most important parameters. The flood simulation was based on calculations using a reservoir cascade model and a GIS description of the flooded area, leading to a rough scale of water depths and its impact on threatened objects. The damage evaluation has also some uncertainties, for example the evacuation rate, or the limited number of value categories, and the exclusion of many intangible risk categories. Short term morphological changes may lead to significant different results of the failure calculation. Further research is necessary to improve the reliability of data on which the models are based.

10. Unforeseen outcomes

The study results were presented to the local community to raise awareness. That led to the first consequences: around the end of the work the drinking water supplier had already realised the recommendations to protect the island's freshwater reservoir from saltwater inflow.

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13. Sources

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