

Coastal Protection of Lowlands: Are Alternative Strategies Purposeful for Changing Climate?

Hanz D. Niemeyer
Coastal Research Station of the Lower Saxon State Board for Ecology

Introduction

The lowlands at the southern North Sea Coast in Europe are protected by a line of dykes: The anticipation of an accelerated sea-level rise due to changing climate has risen the question if this strategy of keeping the line will still be appropriate or if alternatives should be taken seriously into consideration. Some alternatives to line protection are well known from the past: retreat, adaption and moving the protection line seaward.

The post-glacial sea-level rise at the southern North Sea inundated large areas leaving no alternatives to the coastal inhabitants than retreat. After the deceleration of sea-level rise and a remaining rather stable coastline settling in the fertile coastal lowlands became attractive: the settlers in these coastal areas erected artificial hills being sufficiently high to perform a safe haven for them during storm surges. One of the first references about these settlements is given by the Roman historian Plini who accompanied Roman military to the coastal lowlands at the southern North Sea coast. These hills have been heightened more than once in the course of centuries in order to meet the sea-level rise. The largest of these hills carried whole villages which are still well-known landmarks at the Frisian coast ranging from the Netherlands across Germany to Denmark. Early medieval storm surges eroded large areas creating large bays which have mostly been successfully reclaimed by the coastal inhabitants leading to the saying: God made the sea, the Frisian the coast.

Judging Alternatives

The presentation will mainly deal with the consequences of alternative strategies for coastal protection in the lowlands combining experience from history and state of the art methods like mathematical modeling of waves.

A **retreat** from the inhabited coastal areas would enforce the loss of enormous values. A resettlement of the coastal population in areas being safe from inundation due to storm surges without any protection would furthermore create a large burden for both individuals and society.

Adaption in the lowlands requires numerous protected islands with settlements and industry in the lowlands which is regarded more economical than the creation of extended artificial hills. The cost for this protection are at least as high as those for the dykes at the coast line. Furthermore infrastructure like e. g. roads or railways are more vulnerable to occurring storm surges.

Another alternatives which are discussed as alternative strategies are modifications of keeping the line: **Moving back** or **two lines**. Moving back is the construction of a new dyke line in a larger distance from the coastline with the aim to enforce a stronger attenuation of waves before attacking the dyke. Two lines is a combination of two

structures for coastal protection: most seaward one with the aim to act as a submerged breakwater during storm surges and in a certain distance another one being sufficiently high to keep storm surges levels and remaining wave run-up at bay. The effectiveness of both alternatives has been evaluated by aid of mathematical modeling which results will be presented.