Relative efficiency of beach and shoreface nourishments

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1. Introduction

A large part of the Netherlands is protected against flooding by large sand dunes along the coastline. Both natural and anthropogenic forces influence the geometry and sand volumes in the cross-shore profiles along the Dutch coast. As a consequence, these volumes influence the safety levels against storm events and structural erosion.

The central hypothesis underlying this study (Vuik et al. 2012), states that changes in safety levels are forced by three external pressure factors: a long-term trend (e.g. due to the presence of jetties), a variable storminess, and the nourishment programme of the Dutch government.

The main objective of the study is to analyse the effectiveness of beach and shoreface nourishments in maintaining and/or improving safety levels along the Holland coast.

2. Use of indicators

The effects of nourishments have been evaluated using a number of coastal indicators, derived from the JARKUS profiles. Profiles are measured yearly, starting from 1965, with a long-shore interval of 250 m. Three safety level indicators have been calculated for each transect:

- The dune foot position,
- The Momentary Coastline position (MCL),
- The failure probability, based on probabilistic dune erosion calculations with PC-Ring (Van Balen et al. 2012).

For every transect, two indicators have been considered, describing the storminess in the period between two JARKUS measurements:

- The yearly maximum water level;
- The year-averaged wave energy H_s^2.

3. External pressure factors

The central hypothesis can be expressed by the following equation:

$$\frac{\Delta I}{\Delta t} = L + f(S) + g(N), \quad (1)$$

which states that changes in a safety indicator I at a certain JARKUS transect are the results of a long-term trend L, a certain function f of the variable storminess S and another function g of the nourishment volumes N.

First, the **long-term trend** L has been determined by linear regression on the time series $I(t)$ over the period 1965-1990, since before 1990 the Holland coast was only subjected to local and limited nourishment.

For the same period, the relation between **storminess** and changes in safety level has been investigated. After subtracting the long-term trend from the data, a linear relation has been assumed:

$$\frac{\Delta I}{\Delta t} - L = a \cdot S + b . \quad (2)$$

The result is e.g. an average additional retreat of the dune foot position, given a certain difference in maximum water level between two years.

After correction for the constant long-term trend and the effect of variable storminess, the effectiveness of **nourishments** has been determined for all available data (1965-2010) by means of the linear relation:

$$\frac{\Delta I}{\Delta t} - L - (a \cdot S + b) = p \cdot N . \quad (3)$$

The slope p expresses the relations between the cumulated nourishment volume over a certain period and the change in the indicator over the same period. This slope has been determined separately for beach and shoreface nourishments, to discriminate the relative effects of the two types of nourishments. (Figure 1).
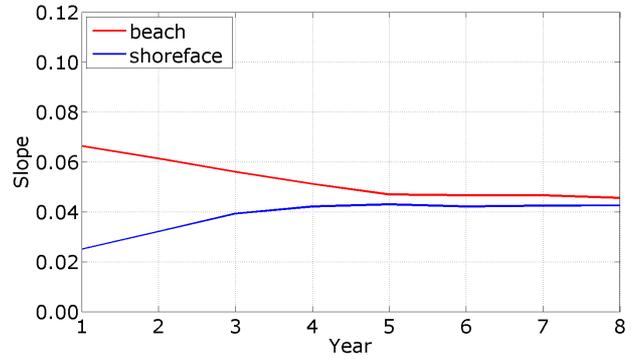

Figure 1: Effect of beach and shoreface nourishments [m^3/m] on change in MCL-position [m] after 1-8 years

4. Conclusions

The main conclusions following from the study are:

- On average, the effect of nourishments on safety levels is much larger than the effect of storminess and long-term trends.
- The effect of beach nourishments decreases, and the effect of shoreface nourishments increases in time. Although depending on the exact location, it can be seen that on average after 5 years the two effects are comparable.

The study supports management choices regarding nourishment types and volumes, given a certain flood protection objective.

References

Van Balen, W., Vuik, V. and Van Vuren, S. (2012), Pro-babilistic assessment of safety against dune retreat along the Northern-Holland coast, *NCK proc. 2012*.

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