# COASTLINE MODELLING FOR NOURISHMENT STRATEGY EVALUATION

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**Paper topic:** Beach nourishment

## 1. Introduction

A large part of the Dutch coastal zone consists of sandy beaches and dunes which are maintained with regular nourishments (Van Rijn, 1997). A policy called 'dynamic preservation' was adopted by the Dutch government in 1990, which preserves the coastline at its 1990 position by all means. This policy, however, results in a less dynamic coast, which is unfavorable for some coastal functions like recreation and nature values (Van Koningsveld and Mulder, 2004). It has therefore become desirable to come up with coastal maintenance strategies which include other functions than safety more prominently (NWP, 2009). Dedicated models are, however, needed to evaluate the impacts of these nourishment strategies. The models need to be very robust, fast and flexible. This research describes the applied modeling approach.

## 2. Typical Nourishment Strategies

Nourishment strategies for the Dutch coast were defined in cooperation with Rijkswaterstaat. Four strategies with different nourishment volumes, locations, methods and timing were defined, which had different targets with respect to the maintained coastal sections (e.g. only relevant locations for safety, necessary functions or the whole coastline) and allowance for sea level rise.

## 3. Modelling

The assessment of the long-term impacts of coastal nourishment policies for the Dutch coast requires the use of an aggregated modelling approach. A coastline model according to Pelnard-Considère (1956) was therefore adopted (see eq. 1), as it is fast and robust. The model was developed in a MATLAB environment to make it flexible and easy to adapt.

$$\frac{\partial y}{\partial t} = K\frac{\partial^2 y}{\partial x^2} + C \qquad (1)$$

Where y = cross-shore coastline position, x = alongshore position, t = time, K = diffusion parameter and C the parameter for source and sink terms.

The diffusion coefficient (K) and autonomous alongshore sediment transport were derived from transport computations with the UNIBEST-LT model for a large number of profile rays along the Dutch coast. The nourishment strategy can be included in the model through specification of a time-series of nourishments (i.e. properties like location, width and volume). Coastal structures like revetments and groynes can be included at specific locations along the coast. Additionally, an exchange with the dunes, lower foreshore and tidal basins was included. Interaction between the beach and the dunes is included in the model by means of a relation between beach width and aeolian transport rates (De Vries et al, 2012). The impact of sea level rise is included as a coastal retreat rate and the rate of offshore losses is related to the coastline position. Rates of sea level rise of 25 cm/century and 85 cm/century were evaluated with the model. The interaction with tidal basins consists of wave-driven sediment transport from the coast to the basin at the boundary

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(fixed coastline position) and sediment bypass from the ebb-delta to the coast. An ASMITA model was used to assess the impact of the strategies on the tidal basins.

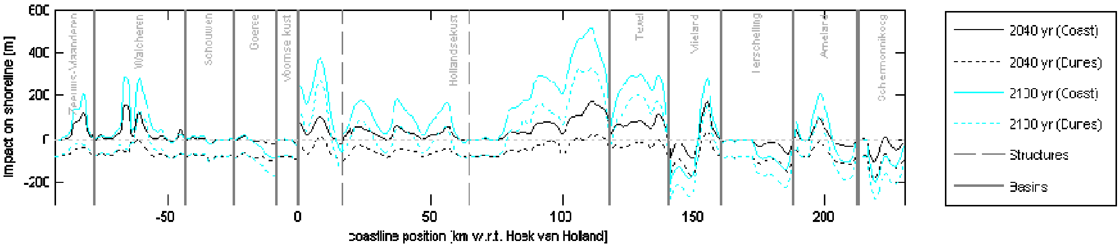


Figure 1. Example of the impact of nourishment strategy 1 for a scenario with current nourishment volumes

## 4. Evaluation on Coastal Indicators

The impact of coastal nourishment strategies on a number of coastal indicators (i.e. dyke ring safety, safety of structures, drinking water, recreation, costs and sand mining) was evaluated. Physical parameters like the average coastline position, dune foot position and beach width at relevant locations along the coast were used as a proxy for these coastal functions (see Figure 2).

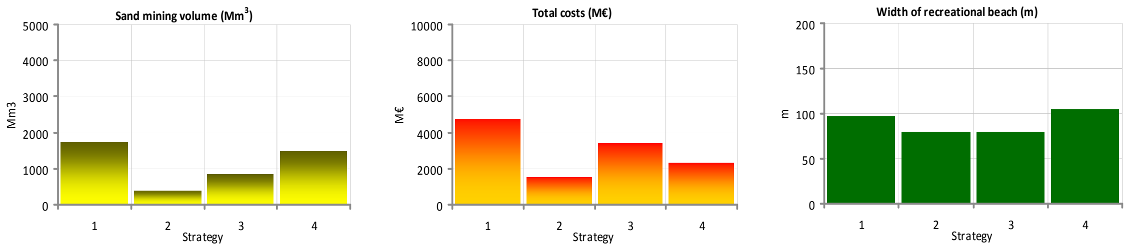


Figure 2. Example of the impact of the evaluation of the nourishment strategies on three coastal indicators

## 5. Conclusions

The conclusions with respect to the applied modeling approach are that coastline models (1) can be used effectively for the evaluation of coastal maintenance strategies, (2) allow for interaction with dunes, lower foreshore and tidal basins and (3) results can be used to evaluate a range of indicators for coastal functions. With respect to nourishment strategies it is concluded that (1) the current strategy can be sustained in the future (2) but other strategies can be more cost efficient.

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