



The Sand Motor: Building with Nature

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The struggle with water has marked the development, contours and character of a large part of the Netherlands. By intervening constantly, the Dutch have reduced the threat from both the sea and rivers. The last ‘Views and Experiences’ discussed the search for alternatives to control flood risks in the central river area and research into the effects of these alternatives. This article focuses on the EIA for an experiment, known as the ‘Sand Motor’, in which coastal erosion is combated by using the forces of nature. The NCEA advised on the terms of reference for the EIA and reviewed the quality of the EIA report when finished.

Introduction

At many places along the Dutch coast the sand which erodes into the sea, for instance during storms, is replenished every five years. One way of doing this is to pump sand onto the beach on an ongoing basis. This promotes dune accretion and reduces the risk of flooding. Regenerating and reinforcing the dunes provides a buffer against the rise in sea level due to climate change and guarantees the safety of the coast, also in the longer term. The Sand Motor Project examines how natural processes such as ocean currents and wind can be used to step up dune accretion along the coast, thus possibly reducing the need for human intervention. If this approach proves effective it could have a beneficial effect on coastal maintenance, reducing its frequency and consequently the disturbance to life on the sea bed. The method employed would also provide more scope for nature conservation and recreation. What’s more, the project could be appropriate for all countries dealing with densely populated coastal areas that are susceptible to coastal erosion and a rising sea level.

An EIA for this experiment is mandatory because of the potential adverse effects of large-scale sand extraction and nourishments on the natural environment. By addressing these effects and suggesting alternatives, the EIA supports optimization of the set-up of the experiment. A monitoring programme following the realization of the experiment has to demonstrate its eventual effectiveness.

Aim and design of the project

The basic idea behind the Sand Motor is that a large quantity of sand is deposited in one go at a single point off the coast, rather than depositing small quantities over a period of time at various points along the coast. Waves, currents and wind are then expected to distribute the sand, allowing the coast to regenerate naturally. The resulting dune accretion may serve various purposes, namely it may guarantee safety and create nature conservation and recreation facilities, the former being paramount.

The Sand Motor principle has not yet been put into practice on a large scale, so the project has the nature of a pilot scheme. Through this pilot knowledge will be acquired of new ways of anticipating climate change, and it will provide information on coastal maintenance methods that are supported by the natural environment and beneficial to it.

The project is a joint initiative of the province of South Holland, the Directorate-General for Public Works and Water Management, various ministries and municipalities, the Delfland Water Board and the South Holland Environmental Federation.

Siting

The Delfland coast, which is situated between the longitudinal embankment at the village of Hook of Holland and the mole at the village of Scheveningen (The Hague area), has been selected as the site of the pilot (see map). This part of the coast is suitable for various reasons: it is representative for large parts of the Dutch coast; it does not present an obstacle to nearby harbours, discharges from pumping stations or to other current plans or projects; and there is a substantial demand for additional space for nature conservation and recreation along this part of the coast.

To the north of the selected site is the dune area of Westduinpark, an urban park for the municipality of The Hague. To the south lies the only sizeable artificial dune area in the Netherlands, which also provides an important recreation area for residents of the municipality of Rotterdam. In between is a very narrow row of dunes. All the dunes along the Delfland coast are protected under the Nature Conservation Act.

Content of the EIA

The morphological developments have been predicted for two types of alternatives using quantitative models. Their environmental impacts have subsequently been charted. These alternatives involve (a) depositing large quantities of sand under water, on the foreshore, and (b) piling up sand to create an offshore island or peninsula, which can be used for recreation or develop into a nature reserve. The effects of various methods of sand extraction and of extraction at various sites or combinations of sites have also been compared. The amount of sand is the same in all cases, namely 20 million cubic metres.

It was decided to compare the economic and environmental effects of the alternatives under consideration with the situation at the time of construction. Some of the effects also occur when the Delfland coast is nourished in the normal way, so the effects would not be fully apparent if they were to be compared with the effects of regular maintenance. A distinction was also made between the effects

of sand extraction and the effects of the Sand Motor and its construction. As regards sand extraction the EIA looked at the effects on:

- The coast and the sea, e.g. changes in water quality and the morphology of the sea bed
- The natural environment, e.g. the development of biodiversity and quality of habitats
- Archaeological assets
- Activities such as fishing and shipping
- Energy consumption for construction and maintenance and the associated emissions.

As regards the Sand Motor and its construction the EIA looked at:

- Safety, based on e.g. the degree of dune accretion and the amount of coastal maintenance
- The development of the natural environment, based on indicators such as biodiversity and quality of habitats
- Spatial quality, based on indicators such as landscape quality, access to the dunes and the sea and effects on archaeological assets
- Activities, such as opportunities for existing and new forms of recreation
- Economic effects, e.g. the cost of construction and maintenance, or revenue from tourism
- Opportunities for research into coastal erosion and dune formation.

Findings of the EIA report

The amount of dune accretion expected was quantified using models. The other effects were rated qualitatively on a seven-point scale. A complete overview of the findings for the alternatives considered is beyond the scope of this article. A few striking ones were:



- All the Sand Motor alternatives contribute to coastal reinforcement, albeit to different degrees and at different places. They would probably reduce the need for regular maintenance, but do not prevent it completely.
- When it comes to the natural environment, there is a complex interplay of positive and negative effects. The construction of the Sand Motor, for instance, would result in extensive disturbance to fauna and flora due to underwater noise, clouding and asphyxiation. This disturbance would occur in both the area where the sand is extracted and the area where it is deposited. On the other hand, the broad beaches and sandbanks created would provide new foraging opportunities for birdlife or resting places for seals, among other things.
- As the nature of the beach would be changed across a large area, the recreation opportunities there would also evolve. As regards recreationists, whose needs are met more and whose needs are met less would depend on such things as the nature of the land created: a peninsula with a lagoon off the coast would be attractive to swimmers, for example.
- Lastly, the study shows that the alternatives that involve creating an island or peninsula above sea level would be more expensive than those that involve a forshore nourishment: sand has to be pumped to create a piece of land, which is more costly than dropping sand from the underside of a ship sailing off the coast. On top of this, one-off nourishment is more expensive than spreading it out over a period of twenty years, which also spreads out the costs.

“More theoretical research would not reduce uncertainties.”

Independent quality review

Part of the Dutch EIA procedure is an independent quality review of the EIA report by the NCEA, which is mandatory by law when complex projects are concerned. In its advisory review the NCEA noted that the way in which the sand would be redistributed along the coast and thus influence dune accretion is subject to more and greater uncertainties than indicated in the EIA report. The NCEA took the view that the bandwidths for dune accretion are larger than predicted: in particular there is uncertainty as to the ratio between landward and seaward movement of sand and the relationship between beach width and the amount of dune accretion. More theoretical research would not reduce these uncertainties; one way to achieve this is, according to the NCEA, by setting up a robust, feasible research programme and creating suitable conditions for the implementation of this programme right from the start of the project.

The EIA procedure in brief

The EIA procedure started in January 2009 with the notification of intent, which outlined the aim and design of the project, the siting and the definition of possible alternatives. Based on this document, the public had six weeks to submit questions and views. The NCEA advised in March on the terms of reference of the EIA report, taking public submissions into account. NCEA's advice for the terms of reference, with some minor adjustment, was copied in full and approved in April 2009 by the competent authority, the Ministry of Transport and Public Works (today, the Ministry of Infrastructure and Environment). Broadly speaking, the NCEA asked attention for those aspects listed in the paragraph 'set up of the EIA'.

After completion of the study, in February 2010, the permit applications and the EIA report were made available for public inspection. At the same time the NCEA reviewed the EIA report. The NCEA took submissions of the public into account in its final advisory report, which was published in May. In September 2010 the permits and the competent authorities formal response to the submissions received were published. In November 2010 the permits were formally granted.

Result of submission: drainage facility installed to avoid negative effects

The impact on the hydrology of the dune area of depositing large quantities of sand could not be considered sufficiently in the EIA report. The hydro-morphology of the affected dune area is complex and there are some old areas of contamination. Sand nourishment could push up the groundwater level and shift the boundary between salt and fresh water, which could in turn affect the vegetation and the availability of drinking water extracted by the water company from the dune area. The effects of this may be intensified by the previous reinforcement of the Delfland coast. As a result of a submission by the water company additional research has been carried out and a drainage facility installed so as to avoid possible negative effects on groundwater level and flow. The need to take care of these potential effects can be regarded as a major lesson from the pilot.



The EIA report, however, paid only limited attention to the preliminary work for a research programme. The NCEA stressed that, if the targets are to be met, the feasibility of the research programme must be assured. The NCEA also recommended examining a number of potential negative effects on the natural environment of sand nourishments and extraction and seeking ways of mitigating these effects if necessary. Shellfish banks that provide food for some sea birds should be identified more effectively, for instance, so as to have better control over extraction and nourishments. The presence

and behaviour of marine mammals and the effect of underwater noise on them should also be carefully recorded at the start of the project. The lack of knowledge on both aspects could then be filled in based on this information.

Implementation and monitoring

The NCEA's advisory review and the submissions by the public have been incorporated in the implementation of the project and the design of the monitoring programme. Public submissions have also resulted in modifications to the

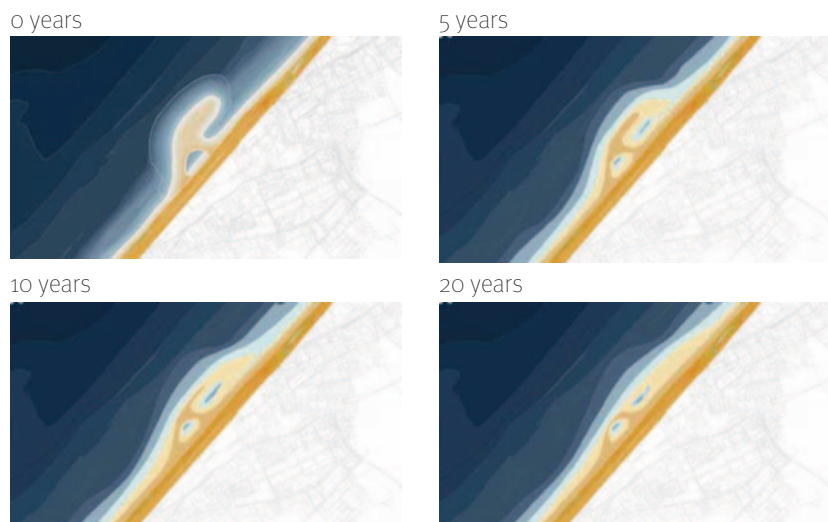
design of the project so as to avoid potential negative effects, such as the accumulation of silt deposits at the seaside resort of Kijkduin.

The Ministry of Transport, Public Works and Water Management and the province of South Holland decided in 2010 to create a peninsula with an area of 128 hectares. Although more expensive than other alternatives, this option has been selected because it will create an attractive temporary nature reserve and recreation area (see the predicted morphological developments of the peninsula in the figures below). It furthermore rated higher in the EIA report than some other alternatives in terms of dune accretion, safety and maintenance and opportunities for research into coastal erosion and accretion.

The peninsula was created between March and November 2011. The sand was extracted from an area approximately 10 kilometres from the coast. This one-off measure is expected to substantially reduce the amount of coastal maintenance required along the Delfland coast for at least the next twenty years. A strong monitoring program is of



Figure: Predicted morphological developments of the Sand Motor as an offshore peninsula.



crucial importance because of the pilot character of the project and the many uncertainties around, for example, the redistribution of sand. The monitoring of sand extraction takes place by joining forces with the national Monitoring and Evaluation Programme for sand nourishment, and it also takes the NCEA's recommendations on shellfish banks and seals into account. Meanwhile the research and monitoring programme to observe the effects of the Sand Motor has been developed and implemented, based on the EIA report and the NCEA's recommendations on the subject. The programme focuses mainly on whether this type of coastal maintenance is effective and what effects this intervention has on the environment. The programme is being carried out under the responsibility of the Directorate-General for Public Works and Water Management in close collaboration with the province of South Holland. It is funded in part by the European Regional Development Fund.

The depth and height of the area immediately surrounding the Sand Motor are measured at frequent intervals so as to monitor the movement of the sand. This is done using equipment mounted on jet skis and four-wheel-drive vehicles to measure the profile at various points from the toe of the dune up to a few hundred metres from the shore. In addition, the depth is measured twice a year by a ship, from Scheveningen to Hook of Holland, and an aircraft is used to measure the height of the dune area and the beach. Currents, waves and the development of the coastline are continuously monitored using monitoring buoys, a radar system and a video system in order to understand the movement of the sand. Flora and fauna are regularly sampled or counted under water, just outside the artificial peninsula, on the beach, in the sheltered area between the peninsula and the beach, and in the dune area behind the beach. The enormous change in the shoreline in front of the dune area is causing the amounts of salt and sand blowing into the dunes to change as well, thus influencing the development of the vegetation. These amounts are monitored at various points in the dunes using sand and salt collectors.

If undesirable developments do occur, intervention can be considered, e.g. a swimming ban if dangerous currents develop locally, depositing additional sand at places where there is excessive erosion or protecting vulnerable developing vegetation if the pressure from recreation is too great.

The development of the Sand Motor over the first five years is to be evaluated in 2016, focusing particularly on the effects and the aims of the Sand Motor in the long term. In the meantime scientists will be looking at the small-scale effects and processes.

In conclusion

The Sand Motor is now in place. The wind and waves are doing their work in spectacular fashion. Birdlife is finding its way to the area on a massive scale and pioneer plants, including one specimen of the rare Frosted Orache (*Atriplex laciniata*), have already appeared in summer 2011. As regards recreation, the Sand Motor has become a hot spot for kite and wind surfers. It may well be that nature conservation and recreation are benefiting more than was assumed at the time of the environmental impact assessment: monitoring and evaluation will show if this is the case. The EIA was mainly helpful in pinpointing the aspects dominantly affecting nature and the uncertainties in the process of dune accretion and thus in the outcome of the experiment. Those are the aspects which have to and will be looked at in the monitoring programme.

“A strong monitoring program is of crucial importance because of the pilot character of the project.”

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