MAASVLAKTE 2: A FIRST STEP TO LARGE SCALE SAND EXTRACTION

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ABSTRACT

In het Nederlands deel van de Noordzee wordt sinds decennia zand gewonnen. De hoeveelheden zijn toegenomen van 2 á 3 miljoen m³ in de jaren zeventig tot circa 25 miljoen m³ in de laatste jaren. Naast deze winning voor kustsuppletie en gebruik als ophoogzand op land wordt er zand gewonnen voor grote projecten. De grootste hiervan is de aanleg van Maasvlakte 2 waarvoor circa 300 miljoen m³ zeezand nodig is.

Het uitgangspunt bij zeezandwinning is altijd geweest om op een betaalbare manier zand te winnen, waarbij de effecten op natuur en ander gebruik van de zee zo gering mogelijk zijn. Door de schaalvergroting die in de loop der decennia is opgetreden is de aandacht voor de monitoring van deze effecten groter geworden. Voor de zandwinning voor Maasvlakte 2 wordt een zeer uitgebreid monitoringprogramma uitgevoerd.

Het is aannemelijk dat de zandwinning voor kustsuppletie de komende decennia sterk toe zal nemen vanwege de verwachte zeespiegelstijging. Om ook dan een goed en verantwoord gebruik van de zandvoorraad te kunnen maken is een zandwinstrategie geformuleerd, waarbij in de verschillende regio's verschillende uitgangspunten, zoals natuur of ruimtelijke planning, prioriteit kunnen krijgen.

De ervaring opgedaan met de grootschalige en diepe zandwinning voor Maasvlakte 2 is zeer waardevol voor de komende grootschalige zandwinningen.

THE MANAGEMENT OF MARINE SAND EXTRACTION IN THE NETHERLANDS

From the Netherlands Continental Shelf a considerable amount of marine sand is extracted. The last years an average of 26 million m³ per year is taken from the seabed for regular use. In general, half of the amount of this marine sand is used for coastal nourishment. The other half is used as fill sand on land. Nearly half of the fill sand used in the Netherlands is marine sand. Hardly any marine sand is used for industrial purposes like the fabrication of concrete. In the future a further increase of

extraction of marine sand is expected, especially for coastal nourishment to counteract the expected sea level rise due to global warming. In figure 1 the amounts are given till 2007. Later years show a much larger amount due to large scale projects as the enlargement of the Rotterdam harbour and a mega scale coastal nourishment in the Province of South-Holland.

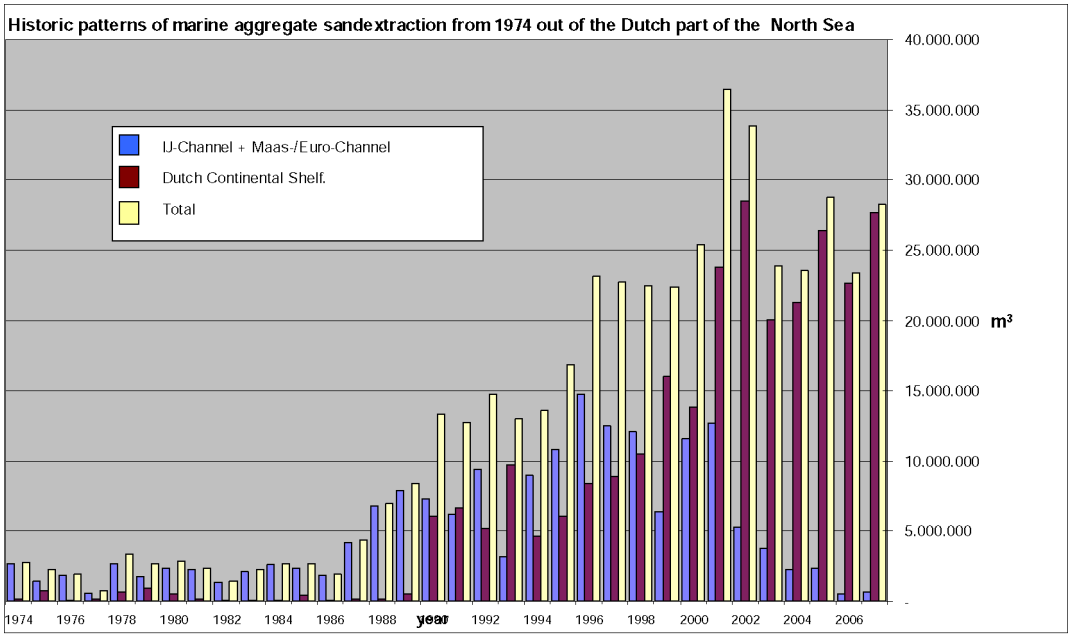

Figure 1: Historic pattern of marine sand extraction from 1974-2007 in the Dutch part of the North Sea.

The extraction of marine sand and gravel is subject to regulations to ensure recovery of benthic fauna and to avoid negative influence on coastal defence, nature areas and other uses of the sea. The ICES Guidelines for the Management of Extraction of Marine Sediments are taken into account. The most important restriction is that extraction is not allowed in areas along the coast where the water depth is less than 20 m, both for ecological as for coastal defence reasons. Therefore, landwards of the established NAP –20 m depth contour sand extraction is not allowed, except for some specific reasons, e.g. maintenance dredging. The established contour is given in coordinates and is a simplification of the real depth contour line. NAP is close to mean sea level.

Large scale and deep extractions are a great challenge for the managing authorities due to the ecological and morphological effects these may introduce. Due to the license procedures set out for large-scale extractions an EIA is required. Large scale is defined as an amount of more than 10 million m^3 or an area of more than 500 ha per license.

Some criteria for the extraction are given by the policy documents (e.g. The National Water Plan, 2009; BOR, 2010). After large scale extraction the sediments of the new seabed should not differ too much from the original sediments. The design of the pit must be so that the water exchange near the bottom of the pit is enough to be sure that there will be no oxygen depletion. This will allow the benthic fauna to recover. Besides minimising the effects on the ecosystem, there should be minimal influence on other uses of the sea.

MAASVLAKTE 2

For the enlargement of the harbour of Rotterdam land reclamation of 20 km² is needed. This new harbour area is called Maasvlakte 2. To construct the land reclamation an amount of about 290 million m³ of marine sand is needed for the outer contour, the southern part of the harbour area and the coastal defence in the first ten years. The most intensive sand extraction will take place in the first four years. In 2009 and 2010 a total amount of 169 million m² was extracted. For the second phase another 75 million m³ is needed for the northern part of the harbour area. The total amount is about fifteen times the present yearly amount of marine sand extraction in the Dutch part of the North Sea. A sand extraction of this large scale and this deep as for the Maasvlakte 2 project has never been carried out in the Dutch part of the North Sea. Therefore, the procedure around the formulation of the Environmental Impact Assessment (EIA), the license and the monitoring programme is executed with utmost carefulness (Stolk and Dijkshoorn, 2009).

For the coastal area, the enlargement of the Rotterdam harbour is a large intervention. The consequences of the reclamation and the sand extraction for nature and other activities at sea are described in detail in the EIA. For this EIA much research is done or earlier research results are re-examined.

For sand extraction the following themes are taken into account:

- *Coast and Sea*: morphology, geology, coastal defence, currents, nautical effects, etc.
- *Nature and Environment*: primary production, benthic fauna, fishes, birds, marine mammals, archaeological values, nature areas, emissions, energy, etc.
- *Other uses*: fishery, pipelines, cables, small scale sand extraction, etc.

The license for sand extraction focussed on demands on location of the extraction area, sand quality, designs of the sand pit, intensity of dredging, technique of dredging and monitoring and evaluation.

Figure 2 shows the area of which sand extraction for Maasvlakte 2 is allowed. This area is on both sides of the Euro/Maasgeul, the approaching channel to the Rotterdam harbour. From this area of 60 km² only 15 km² is needed for the actual extraction. Most of the sand will be extracted from the area south of the Euro/Maaschannel. In principle, the extraction starts in the eastern part and extends westwards. Within the allowed area south of the Euro/Maaschannel, a subarea is appointed where sand extraction is not allowed due to a high percentage of mud. When the sand is extracted from areas where the seabed contain little mud the effects of the overflow on the ecology of the coastal zone, like primary production, eye catching fishes, birds and benthic fauna (and the fauna that feed on them), are limited. Therefore, areas that contain too much mud or even clay layers are excluded from extraction, as is the case in this subarea. To limit the yearly amount of overflow the intensity of the extraction is limited to 150 million m³ per year.

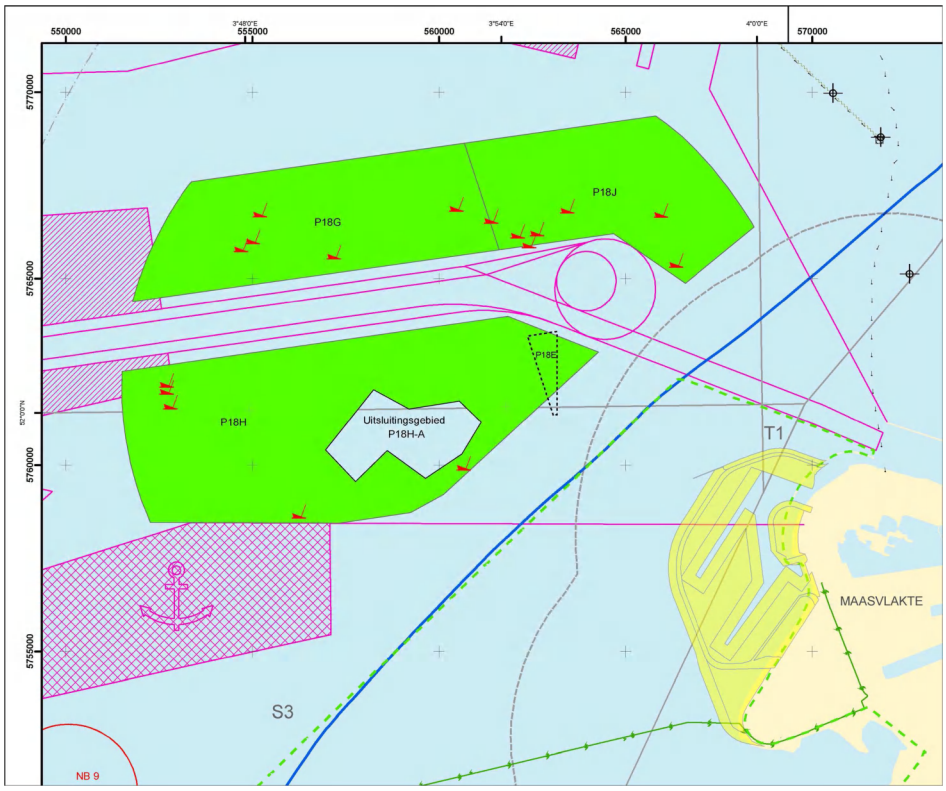

Figure 2: Sand extraction area. West of 'Maasvlakte' the new harbour area Maasvlakte 2 is shown. Northwest of Maasvlakte 2 are the extraction areas north (P18P/P18J) and south (P18H) of the approaching channel to the harbour. In the southern part the sub area were extraction is not allowed is indicated as P18H-A. The Nature 2000 area Voordelta is indicated by the dotted green line.

The direct elimination of benthic fauna can be decreased by the construction of extraction pits deeper than the usual depth of 2 m beneath the seabed. A larger extraction depth leads to less disruption by the hopper dredgers. The extraction pits will have a depth between 10 to 20 m below the original sea bed. To avoid a further deepening of the pits the orientation of the pits should be not on a positive angle of 15-35° with the dominant tidal current. The pit must be designed with slopes of less than 1:7. This enables the oxygen rich seawater to reach the bottom of the pit and for the benthic fauna to recolonize within a few years.

Monitoring and evaluation are required by the license to get an insight into the morphological and ecological effects of this large scale of deep sand extraction. Also, it is necessary to check if the actual effects are within the range expected in the EIA. An extensive monitoring programme is formulated in which the measurements, analyses and reporting are regulated. The monitoring is focussed on:

Bathymetry

To determine the effects on currents and sand transport and to estimate the influence on other constructions on the seabed, it is necessary to know the morphological behaviour of the sea bed, especially an eventually migration of the extraction pit, during and after extraction. Therefore, the

bathymetry of the extraction pits and surroundings will be determined using a multibeam echosounder.

Composition of the seabed

To determine if the seabed composition is comparable with the composition before the extraction, the seabed will be sampled with box cores for grain size analysis and mud content.

Suspended matter

A measuring programme that combines satellite measurements and ship-born measurements will be carried out along a broad area along the west coast of the Netherlands. The focus is on any increases in the amount of suspended matter due to sand extraction and on the patterns of suspended matter in the coastal area. The monitoring programme will also examine impacts on algae blossoms and benthic fauna, and from there on species higher in the food chain.

Benthic fauna

The influence of the extraction on benthic fauna in the vicinity of the pit and the recovery of the benthic fauna within the pits are studied by sampling in influenced areas and reference areas to determine biomass and species until total recovery is reached. It is expected that the benthic fauna will recover within 6 years.

Underwater noise

The underwater noise of the process of sand extraction, transport and dumping will be measured. The results of these measurements will be compared with existing knowledge on the effects of underwater noise on marine mammals to check if the worst case assumption as used in the EIA is valid.

Unexpected was the large amount of fossil bones from mammoths and other ice-age mammals that were found in the area. By the extraction activities the seabed is enriched with these bones, which are of high scientific interest.

DELTA COMMITTEE

The Government of the Netherlands requested an independent Committee of State (the Delta Committee) to give its advice on flood protection and flood risk management in the Netherlands for the next century (ICES-WGEXT, 2009).

The results of the Delta Committee were presented in September 2008. The committee's recommendations laid emphasis on development along with climate change. Their implementation will

allow the Netherlands to better adapt to the effects of climate change. To prepare the Netherlands to become climate proof, the Delta Committee drafted a Delta Programme.

In the advise account was made of a predicted regional sea level rise between 0.65 to 1.3 m by 2100 and from 2 to 4 m by 2200 (high-end estimates). Based on these predictions, recommendations were made to take sustainable measurements. The advice includes the use of marine sand for large scale nourishments to protect the Dutch coast. However, the implementations of this advice and the scale of the extractions involved needs serious environmental consideration.

Following the advice of the commission the annual volume of sand needed for coastal protection might increase up to a 85 million m^3 per year when the sea level rise is increased from 20 to 130 cm in 2100. This will result in vast extraction areas needed, possibly affecting the morphology in the coastal zone.

SAND EXTRACTION STRATEGY

To anticipate on an increase in sand extraction for coastal nourishments due to sea level rise, a new strategy on marine sand extraction is formulated (Zandwinstrategie, 2010) that aims at a regional approach from one or more of the following starting points:

- costs
- natural and ecological values
- environmental values
- resource management
- spatial planning

In the four regions offshore Delta, South-Holland, North-Holland and Wadden a different weight can be given to the different starting points.

First a number of scenarios are formulated for the need of marine sand in the next century. Figure 3 gives four scenario´s, ranging from 20 million m^3 per year to more than 100 million m^3 per year. The scenarios are based on assumptions for sea level rise and on the use of marine sand on land.

Studies on the availability of sand in the Dutch part of the North Sea have shown that in the area between the established NAP -20 m depth contour and the 12 miles boundary an amount of 20 billion m^3 sand is present within the first 5 m of the seabed and 40 billion m^3 within the first 12 m (Van Heteren and Doornenbal, 2009). Therefore, it can be stated that in general enough marine sand is

available in the offshore area. Nevertheless, it is important to know where how much sand resources are present and to which depth extraction can take place before e.g. a clay layer is reached. A resource-information model is developed for the coastal zone of the Netherlands Continental Shelf, between the 15 m depth contour and the 12 mile boundary. The model will allow an efficient and reproducible determination of sand quantity and quality. The resulting information system consists of a 3D model that can be queried to generate derivative 2D maps that contain information on the total and exploitable sand thicknesses for specific locations. From these thicknesses, volumes can be calculated. The reliability of the model, both laterally and vertically, is a function of data density and geological complexity. As a rule of thumb, the model and the 2D maps will be useful on national and regional scales. Thus, they are appropriate for strategic decision making but not for site studies (Maljers et al.,2010a; Maljers et al., 2010b).

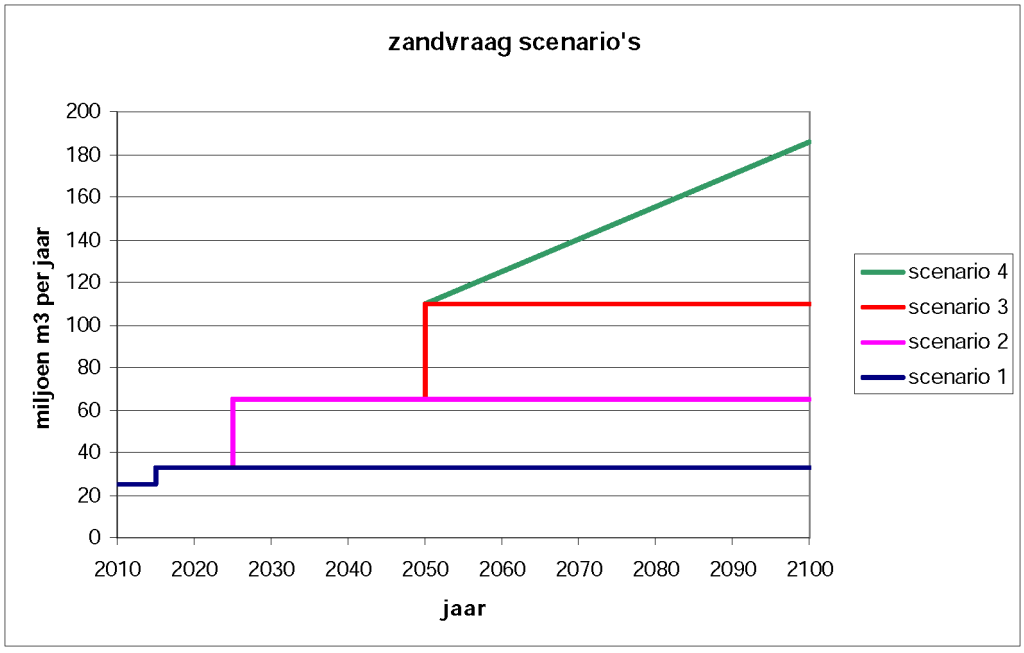

Figure 3: Scenarios for demand of marine sand.

When sea level rise goes on in the next centuries in a rate that is (much) higher than at present, the Dutch coast will be nourished by vast amounts of marine sand by the generations to come. In that case in the long term a very large trench will be developed by succeeding extractions. The effects of such a trench on morphology, sand transport, coastal sand balance and even on changes in the tidal system of the southern North Sea are studied (De Boer et al., 2010; De Boer et al, 2011; Van der Werf and Giardino, 2009; Van der Werf et al., 2010). The effects, even when the trench is deepened to 12 m are in the order of changes of a few cm in tidal amplitudes and a few cm/s in tidal currents at the coasts of the Southern Bight of the North Sea. Nevertheless, such small changes can have influence on sediment transport on the long term.

The implementation of the sand extraction strategy is focused on:

- legal an policy instruments needed for a more planned extraction of marine sand

- the need for knowledge of resources and quality of the sand
- integral managing of the monitoring on ecological and morphological effects of sand extraction
- sustainability and innovation
- management of extraction in the ecological important area of the Zeeuwse Banken

The Sand Extraction Strategy must lead to a sustainable and reasonably priced extraction of marine sand, with emphasis on the managing of the resource of marine sand and minimizing the effects on other functions of the marine area (including nature and other uses of the sea). The amounts of sand, the depth of extraction and the locations must be tuned in an optimal way in space and time to other functions and interests in the marine area.

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