Case study 65. Sandscaping

Author: Jaap Flikweert

Main driver: Improved defences, recreation, trial of a new approach

Project stage: various potential sites in the UK ranging from pre-feasibility to detailed design/Environmental Impact Assessment

Photo 1: Pilot Zandmotor on the Dutch coast (source: Royal HaskoningDHV; accessed 6 February 2017)

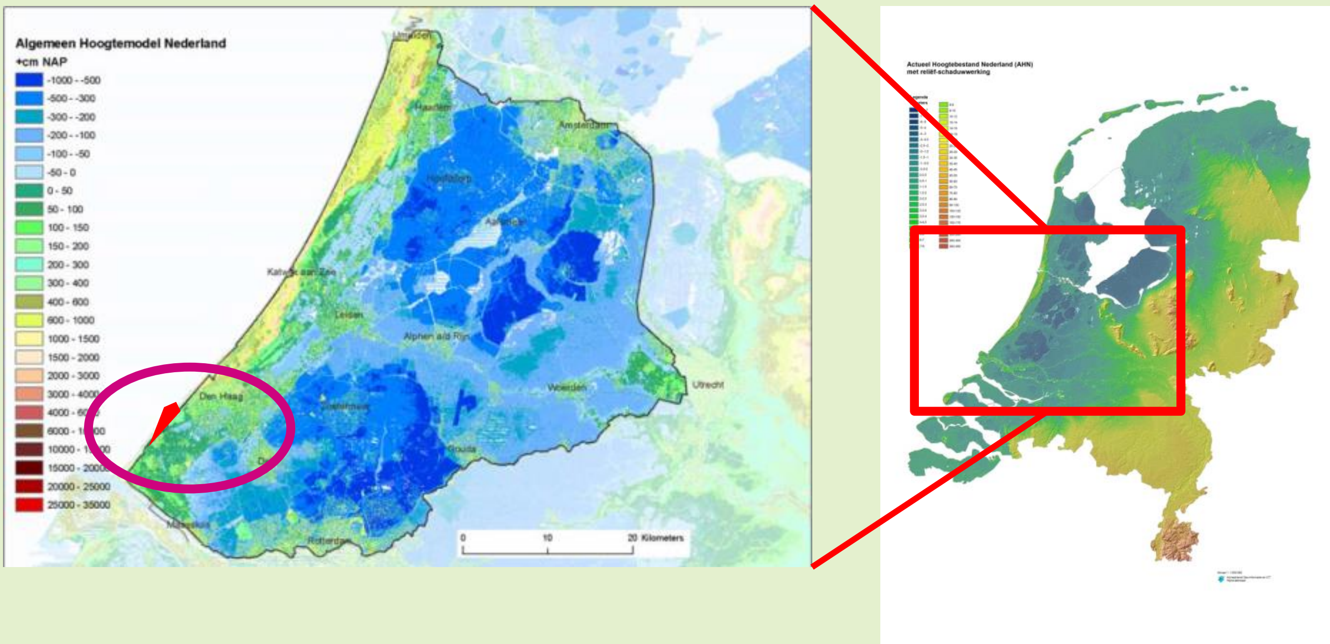
Project summary:

Sandscaping is an innovative coastal management approach, inspired by the Dutch Zandmotor (Sand Engine) (Photo 1 and Map 1)). It involves placing a large volume of sediment to benefit one location, designing it so that natural processes move the sediment to other places where it is needed. In the right place and if designed well, the large volume and concentrated placement can reduce costs, while the scale and dynamic nature can generate benefits for amenity, tourism and habitats.

A partnership of organisations has been exploring the implementation of Sandscaping in the UK. There is a long list of high potential sites currently being developed with local partners (Map 2).

Key facts:

The Dutch Zandmotor is a nourishment of 21.5 million m^3, intended to last for 20 years. Monitoring over the first 5 years shows it is likely to function longer, up to 30 years. Economies of scale reduced the cost per m^3 by about 50% from normal scale nourishments. In addition, the Zandmotor has become the most popular location for kite surfing in the Netherlands.



Map 1: Zandmotor in the Netherlands

Map 2: High potential locations identified for England and Wales (source: Jaap Flikweert, Royal HaskoningDHV)

1. Contact details

Contact details	
Name:	Jaap Flikweert (Royal HaskoningDHV)
Lead organisation:	Royal HaskoningDHV
Partners:	The Crown Estate, Van Oord, HR Wallingford, Arup
e-mail address:	jaap.flikweert@rhdhv.com

2. Location and coastal/estuarine water body description

Coastal/estuarine water body summary	
National Grid Reference:	Various potential locations in England and Wales
Town, County, Country:	Various potential locations in England and Wales
Regional Flood and Coastal Committee (RFCC) region:	Potential locations in each coastal RFCC region
Transitional and coastal water body size (km^2):	Netherlands Zandmotor ~2km^2 UK examples typically likely to be smaller
Transitional and coastal water body and location:	Various
Water Framework Directive water body reference:	Various
Land use, geology, substrate, tidal range:	Coastal zone Typically sand or shingle Varying tidal range

3. Background summary of the coastal/estuarine water body

This section deals primarily with the Netherlands Zandmotor, with comments about how this compares with a typical UK situation.

Socioeconomic/historic context

Netherlands Zandmotor: Located in a very densely populated region made up of traditional coastal towns with some local tourism and a strong need for more natural space. See http://www.dezandmotor.nl/en/

In the UK (more than in the Netherlands), many coastal regions struggle with socioeconomic deprivation, creating a strong need for regeneration. In some cases, Shoreline Management Plans indicate that continued 'hold the line' is not sustainable, creating serious socioeconomic challenges.

Flood and coastal erosion risk management problem(s)

Netherlands Zandmotor

The Zandmotor is part of a dike ring with a 1 in 10,000 per year standard of protection, protecting the country's four largest cities and national airport. The area has been reinforced with regular beach nourishment since 1990s. The problem to be addressed is the concern that sea level rise could make the costs and environmental impacts of continued nourishment unacceptable, creating a strong national driver toward innovative solutions.

UK

The problems will be more local/regional; they can concern both cliff erosion and coastal flooding. Sandscaping is worth considering in frontages with active beach management or a need for renewal of existing hard defences.

Other environmental problems

Netherlands Zandmotor:

- Narrow dunes
- Uniform beach
- Limited potential under traditional management approaches
- Concerns about ongoing impact on habitats in dredging areas

UK

- Long-term depletion of sandy coastal zones – to an extent due to the construction of hard defences since 1950s which have stopped supply from eroding cliffs
- existing designations (habitat, geology) that need to be considered (in some locations)

4. Defining the problem(s) and developing the solution

What evidence is there to define the flood and coastal erosion risk management problem(s) and solution(s)

Netherlands Zandmotor

There has been very extensive and robust modelling over many years of the existing situation. The potential impact of sea level rise at national scale was assessed in the 2nd Delta Programme in the early 2000s. For the solution, relatively limited modelling was required due to an appreciation of experimental character. This was a very interesting process that convinced decision-makers, who were driven by political considerations and personalities, and by vision, much more than quantitative evidence (but within context that the solution was certain to provide at least the minimum required standard of protection, as this is non-negotiable in the Netherlands).

UK

The emphasis here is likely to be much more on quantitative evidence and a competitive business case. It will be less driven by national scale considerations and a drive toward innovation (although this could help somewhat).

What was the design rationale?

Netherlands Zandmotor

The aim was to design a nourishment scheme that will function for ~20 years while creating room for amenity and habitats, plus being is a suitable test case to develop knowledge about mega nourishments.

UK

A similar multi-purpose approach is intended in principle, but in practice this will vary according to the location, depending on objectives, ambitions, physical context and sources of funding. Examples considered thus far in the UK:

- design not only for a period of coastal protection at the nourishment site, but also in parallel for a beneficial impact on beaches downdrift
- design particular habitats to compensate for losses locally or elsewhere
- design dredging location to minimise costs and impacts
- design landscape and 'placemaking' for optimum value for tourism and recreation

Project summary	
Area of transitional and coastal water body or length benefiting from project:	Netherlands: ~2 km^2 (above water); neighbouring coastline: currently ~4km has been receiving sediment through natural processes UK typically smaller
Types of measures/interventions used (Working with Natural Processes and traditional):	Beach nourishment; use of natural processes to transport material to neighbouring frontages
Numbers of measures/interventions used (Working with Natural Processes and traditional):	Not applicable
Standard of protection for project as a whole:	Netherlands Zandmotor: support dunes to achieve 1 in 10,000 per year standard of protection UK: varies; similar 1 in 10,000 standard of protection being considered for critical infrastructure scheme, but typically down to 1 in 100 to 1 in 200 per year
Estimated number of properties protected:	Netherlands Zandmotor: part of dike ring that protects >1 million homes. UK: varying

How effective has the project been?

Netherlands Zandmotor

After 5 years, the Zandmotor is broadly behaving as expected, but more slowly in terms of both coastal processes and habitat generation. Current model predictions suggest that the required standard of protection will be provided for ~30 years (that is, 10 years longer than expected).

UK

Not yet implemented

5. Project construction

How were individual measures constructed?

Netherlands Zandmotor

Sediment was dredged from the seabed and placed on the shoreline by a combination of techniques (bottom dumping, rainbowing, pumping through pipes).

UK

The sediment is also likely to come from the seabed – from licensed areas. Construction techniques will be similar, although there is likely to be less bottom dumping (as this requires larger scale or a deeper water scheme).

How long were measures designed to last?

Netherlands Zandmotor:

20 years – currently predicted to last 30 years

UK

This will be a case-by-case consideration or optimisation.

Were there any landowner or legal requirements which needed consideration?

Netherlands Zandmotor:

Limited as land owned by the state.

UK:

Case specific – land ownership by The Crown Estate and potentially various other public and private parties

National and international designations can play a role.

6. Funding

Completed for Netherlands Zandmotor only

Funding summary for Working with Natural Processes (WWNP)/Natural Flood Management (NFM) measures	
Year project was undertaken/completed:	2011
How was the project funded:	~85% national government (Rijkswaterstaat) ~15% province of Zuid-Holland
Total cash cost of project (£):	€70 million (~£60 million)
Overall cost and cost breakdown for WWNP/NFM measures (£):	€70 million This includes significant budget for monitoring as the project supports ~20 PhDs, reflecting the important piloting character of the project. No significant maintenance expected in the sense of nourishment until year 30. There are operational costs (public engagement, signage, inspection), but these are limited.
WWNP/NFM costs as a % of overall project costs:	100 % of these costs relate to WWNP/NFM
Unit breakdown of costs for WWNP/NFM measures:	€70 million per 21.5 million m^3 = ~€3.5 per m^3 This compares with typical rates of €7 per m^3 in the

	Netherlands and £10–15 per m^3 in the UK. This is largely the result of economies of scale (although specific market conditions also played a role). For the UK, there are strong indications that similar savings are possible, which could make beach nourishment a realistic and economically competitive option in many more locations.
Cost–benefit ratio (and timescale in years over which it has been estimated):	Not available for the Netherlands Zandmotor: flood and coastal management investments in the Netherlands are not based explicitly on benefit–cost ratio. In addition, the experimental nature of the project means that an uncertain return on investment was acceptable.

7. Wider benefits

Completed for Netherlands Zandmotor only

What wider benefits has the project achieved?

- Creation of habitats locally and in nearby dune areas – reduced disturbance of nourishment in dredging areas
- Regionally unique recreation and tourism (kite surfing, fossil hunting, nature walking)
- Extensive new knowledge of behaviour of mega nourishments, environmental impacts and benefits, socioeconomic impacts and governance of innovation
- General public acceptance of innovative solution and of a much more dynamic coast than before

How much habitat has been created, improved or restored?

- ~2km^2 (sandbank plus lagoon and lake), plus neighbouring beach and dune areas
- Dredging area (area unknown).

8. Maintenance, monitoring and adaptive management

Completed for Netherlands Zandmotor only

Are maintenance activities planned?

No significant maintenance expected in the sense of renourishment until year 30. There are operational costs (public engagement, signage, inspection) but these are limited.

Is the project being monitored?

Very extensive monitoring is being undertaken, reflecting the important piloting nature of the project. The project supports ~20 PhDs. It includes the so-called Argos mast with extensive monitoring equipment and has developed a range of innovative techniques for both physical and environmental monitoring (for example, the use of jet skis).

Has adaptive management been needed?

No adaptive management has been necessary for the primary function, but limited intervention has been needed to ensure swimmers' safety in the first years after placement.

9. Lessons learnt

Completed for Netherlands Zandmotor only

What was learnt and how could it be applied elsewhere?

Monitoring and research on the Netherlands Zandmotor is taking place with close co-operation with the research programme and management organisation to maximise learning for translation to UK projects. This concerns physical processes, modelling constraints and approaches, social, economic and environmental impacts and governance (that is, how are decisions made, roles and responsibilities).

10. Bibliography

DE SCHIPPER, M.A., DE VRIES, S., RUESSINK, G., DE ZEEUW, R.C., RUTTEN, J., VAN GELDER-MAAS, C. AND STIVE, M.J.F., 2016. Initial spreading of a mega feeder nourishment: observations of the Sand Engine pilot project. *Coastal Engineering*, 111, 23-38.

STIVE, M.J.F., DE SCHIPPER, M.A., LUIJENDIJK, A.P., AARNINKHOF, S.G.F., VAN GELDER-MAAS, C., VAN THIEL DE VRIES,J.S.M., DE VRIES, S., HENRIQUEZ, M., MARX, S. AND RANASINGHE, R., 2013. A new alternative to saving our beaches from sea-level rise: the Sand Engine. *Journal of Coastal Research,* 29 (5), 1001-1008.

Project background

This case study relates to project SC150005 'Working with Natural Flood Management: Evidence Directory'. It was commissioned by Defra and the Environment Agency's Joint Flood and Coastal Erosion Risk Management Research and Development Programme.