Sand engine quells the coast's hunger for sand

« former article | content | next article »

Category: Science

An artificial peninsula at Ter Heijde is designed to feed the coast with sediment. Scientists are investigating whether this kind of sand engine could be the Netherlands' answer to rising sea levels.
Thomas van Dijk

At the foot of the dunes in the coastal resort of Ter Heijde, Matthieu de Schipper and Sierd de Vries carefully cross the sand in their four-wheel drive vehicle. The dunes here have recently been reinforced. Neat lines of beach grass protrude from the sand at intervals of some 30 cm. "Pretty different to what you get with the sand engine," says De Schipper. Through the other window he points to where we are heading: a massive hook-shaped expanse of sand extending 1 km out to sea. "The waves, sea current and wind are creating all kinds of gullies and bays around the sand engine. It's wonderful to let nature do her work."
"Building with nature" has now become the watchword for hydraulic engineering. It's also the theme of the PhD research that De Schipper and his colleague, De Vries, are working on. The two researchers from the faculty of Civil Engineering and Geosciences (CEG) are regular visitors to this peninsula. "We come to count the grains of sand," De Schipper jokes.
This sand engine provides the hydraulic engineers with a superb testing ground. Last year, dredging companies Van Oord and Boskalis used trailer suction hopper dredgers to deposit 21.5 million cubic metres of sand here. In the coming years, the sand will be carried by currents and waves in a primarily northerly direction, compensating for the loss of sand along the coast up to Scheveningen. Some of the sand will be blown into the dunes, reinforcing the coastline.
Using GPS equipment on board the vehicle, the researchers measure the sand engine's movements on a monthly basis. A staff member from the Delft spin-off company Shore Monitoring also uses a jet ski equipped with sonar technology to investigate the soil morphology up to the edge of the coastline. The researchers share their findings with Deltares and Imares Wageningen UR. These two research institutes have been commissioned by the Directorate-General for Public Works and Water Management (Rijkswaterstaat or RWS) to closely monitor the sand engine and the currents and ecology around it over the next ten years.
The peninsula will gradually disappear. Just a few months after its completion, there are already signs of changes. Sand deposits have increased the size of the bay, a kind of lagoon on the inside of the hook. Already an ideal site for kite surfing, it will eventually form a suitable habitat for rare plants, such as salicornia and searocket. The sand engine will gradually transform into something completely different - most likely a system of sandbanks.

Experiment
"It's part of a major experiment that RWS is conducting into alternative methods of sand replenishment," says De Vries. Since 1990, RWS has been commissioning the annual replenishment of 12 million cubic metres of sand along the whole of the Dutch coast, alongside the beach, on the beach itself or in the dunes. The aim is to counteract coastal

erosion – or to quell the coast's hunger for sand, in a manner of speaking. Before the project started, the Netherlands had been gradually eroding for centuries, a result of rising sea levels and soil subsidence.
"The problem is that these sand replenishments from deeper parts of the North Sea are expensive and disrupt the marine ecology," continues De Vries. "We're using the sand engine to see if it's possible to use a single large-scale replenishment in one location in order to protect an entire section of the coastline over a much longer period."
A preliminary study conducted by Deltares suggests that the sand engine will have been completely reabsorbed into its surroundings in about 20 years' time. At a cost of € 50 million, the sand engine works out to be much cheaper than the series of smaller replenishments that would have been necessary over that same period.
According to hydraulic engineer, Professor Marcel Stive (CEG), who played a major role in the realisation of the sand engine, the project offers valuable prospects for research. He believes there will need to be a significant increase in sand replenishment in the coming years, making it extremely important to gain experience of new, larger-scale techniques.
The Delta Commission 2008, of which Prof. Stive was a member, recommended that the annual volume of sand replenishment be increased to 20 million cubic metres in order to stifle the Dutch coast's hunger for sand. A proactive approach, enabling the coast to grow in the next century, might even require 85 million cubic metres of sand.
There may even soon be a series of sand engines along the coast. In an interview in this edition of Delft Outlook ('Nature always lends a hand', page 16) Prof. Stive explores that possibility.

Fine sand
Deltares and Imares have their work cut out for the next few years. In three years' time, the institutes must publish an interim report. "Before then, we'll be conducting a huge number of measurements," says Arjen Luijendijk of Deltares.
The predictions included in the environmental impact report (EIR) involve a number of uncertain factors.
"The EIR was based on a theoretical situation in which the sand has a uniform grain size," says Luijendijk. "In reality, these sizes vary. The effect of these variations has yet to be seen."
The fact that the sand engine also contains fine sand could explain why it seems to be working more quickly than expected.
At the northern tip of the sand engine, new sandbars have formed very rapidly, suspended like drips from a nose. Every minor storm has led to the formation of a new 'drip'. Luijendijk believes that the explanation for this is that, during the initial phase, all the fine sand is in motion.
Another major uncertainty affecting the models is the effect of dune formation on the sand engine. "The vegetation could prevent the sand from moving about, leaving the sand engine in place for longer than planned," says Luijendijk. Could severe storms perhaps also have a major impact on the sand engine?
The recently graduated hydraulic engineer, Timon Pekkeriet, is using models to predict the effect of the kinds of storms that only occur once every 20, 100 or even 1000 years.
There is little likelihood of a storm of the latter type hitting the sand engine in the next 20 years, but even if it does happen, the expected consequences would appear to be slight. "The combined effect of small storms is much more important than that of a single heavy storm," says Pekkeriet, who completed his research at Deltares.
So this leaves the effect of all the small storms combined. "In one year, you may have ten storms and in another as many as 50," says Pekkeriet. "This will certainly affect the way in which the sand engine works and the models should take greater account of these

fluctuations."
However, Luijendijk has few concerns about this. "If you look at things over the longer term, the effects of all the storms average out," he says.

Not ideal

Of course, the researchers will also need to monitor how much sand is actually distributed along the coast. They calculate that around 10 to 20 percent will flow away to greater depths. This is why the renowned hydraulic engineer, Dr Ronald Waterman, a former Liberal member of the Provincial Council of Zuid-Holland and a TU Delft alumnus, has his doubts about the use of sand engines.
Waterman would prefer to recreate a 17th-century coastline ("by way of approximation"). For Zuid-Holland, this would be a hollow curved coastline running from the northern breakwater of Hook of Holland to the extended southern breakwater of Scheveningen.
"In terms of land reclamation in Zuid-Holland, we aim to achieve a flexible, dynamic, hollow coastline that is in balance," says Waterman. "In the long run, sand engines will achieve that, but it's not what they're designed for. They do not have the ideal shape for that purpose."
Together with Czech engineer Honzo Svašek, Waterman pioneered the principle of 'Building with Nature'. The fact that he has such doubts about the use of sand engines may therefore come as a surprise.
Indeed, in a report dating from 1980, he already mentioned the need to extend the coastal strip. In his plans, dams and dikes largely make way for beaches and dunes.
Waterman has had a hand in a whole series of coastal extensions between the Slufterdam and Maasvlakte 2 in the south and Seaport Marina IJmuiden in the north. A family of coastal extensions that have all resulted in a boost for nature, according to Waterman.
Waterman does admit that the sand engine is an "interesting member of the family. It's interesting, because as well as increasing safety and boosting nature and recreation, it also offers numerous possibilities for research. And it could be put in place relatively cheaply because the trailer suction hopper dredgers were already in the area, working on Maasvlakte 2. It's for those reasons that I gave it my support. But in certain cases, I'd prefer to deposit the sand directly where it's needed, for example if port extensions are required."
In Waterman's view, if 85 million cubic metres of sand need to be replenished every year, this does not necessarily call for a whole series of sand engines along the coastline.
Ecologist Dr Martin Baptist, from Imares, does believe this would be a good idea. If the volume of sand replenishment required in the future increases significantly, sand engines will need to be used, or else it will prove disastrous for marine life, he argues.

Marine animals

"Although a sand engine has a major effect locally, the advantage is that it leaves the natural world in the wider environment undisturbed for 20 years," Baptist says. "If, on the other hand, you regularly replenish sand at numerous points along the coast, marine life doesn't have time to recover. It takes between four to six years for the soil community to recover in places where sand is disrupted.
"Another disadvantage of sand replenishment done in the traditional way is that it makes the coast steeper. This reduces the habitat for marine life in shallow waters."
Baptist is leading Imares's research into the marine ecology around the sand engine. At late 2011 his institute took more than 200 samples of sand from around the peninsula. The marine life taken from these samples (including countless worms, shellfish and crustaceans) is being preserved and will be counted over the course of this year. This process will then be repeated annually.
The key question is whether the animals can cope with the flow of sand originating from the

sand engine. “As long as they’re not covered by too much sand, they can still crawl up to the surface,” Baptist explains. “If the sand moves as the models predict, it shouldn’t be a problem.”

There is another reason for Baptist’s enthusiasm for sand engines: “Possibly these will serve as nurseries for flatfish. The lagoons are particularly interesting in this respect. We’re researching the ideal conditions for flatfish fry, such as the sediment content, depth and grain size of the sand, and how we can shape the sand engines to create these conditions.”

On the sand engine, the small expedition from TU Delft is now being subjected to a thorough sandblasting. Barely audible in the howling wind, De Vries draws the others’ attention to a boat full of ecologists about 100 metres out from the beach. “We’re working on this project with a lot of different disciplines,” says De Vries. “That’s the great thing about it.”