Coastal protection strategy and the Sand Motor

SEA enabling Nature-based Solutions in strategic coastal adaptation

Case study



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Key message

The Netherlands coastal protection case shows how SEA can enable Nature-based Solutions (NbS) by creating strategic decision space before project choices are fixed. The SEA for the National Water Plan supported a shift towards adaptive sand nourishment using natural processes, later demonstrated through the Sand Motor: a large-scale Building with Nature pilot project combining coastal safety, dune development, recreation, nature and knowledge generation.

Case description

The Netherlands has a long history of managing flood risk along its low-lying coast. A significant part of the country depends on beaches, dunes, flood defences and continuous coastal maintenance for protection against the North Sea. Sea level rise, land subsidence and coastal erosion increase the long-term challenge of maintaining a safe, liveable and economically productive delta.

The Dutch National Water Plan 2009-2015 was prepared to guide national water policy and investments, including long-term coastal protection and marine spatial use. The plan was supported by a Strategic Environmental Assessment (SEA), which assessed strategic alternatives and their environmental implications before implementation choices were fixed. This case illustrates how SEA can help identify, assess, and embed Nature-based Solutions (NbS) at strategic planning level. It also shows how a strategic choice made in a national plan can create enabling conditions for subsequent project-level innovation, in this case the Sand Motor ('Zandmotor' in Dutch), one of the world's most widely recognised examples of Building with Nature for coastal protection.

Strategic planning context

The National Water Plan 2009-2015 set out the Dutch Government's approach to sustainable and climate-resilient water management. It formed part of a broader policy response to climate change and long-term flood safety, including the development of the Delta Programme. For the coastal zone, the central strategic issue was how the Netherlands could maintain and strengthen its coastal foundation under uncertain future sea level rise while also safeguarding environmental quality, spatial functions, recreation and nature.

The SEA for the draft National Water Plan compared different strategic alternatives for coastal management. Its purpose was not merely to assess the impacts of a predetermined intervention, but to provide environmental information early enough to influence strategic decision-making. The SEA therefore assessed the environmental effects of alternative policy choices and helped give environmental considerations a full place in decision-making.

Strategic alternatives assessed

The SEA considered different approaches to long-term coastal reinforcement. These alternatives represented fundamentally different choices about how the Dutch coast should respond to sea level rise, erosion and future flood risk.



Table 1 | Alternative approaches to long-term coastal reinforcement in the Netherlands.

Alternative	Description	SEA relevance
1. Landward reinforcement	Strengthening the coastal defence system from the landward side.	Could contribute to flood safety, but would place pressure on existing land uses, landscapes, agricultural areas and built environments. It would make limited use of natural coastal dynamics.
2. Seaward expansion through direct sand nourishment	Large-scale artificial seaward reinforcement by placing sand directly on beaches, nearshore areas and dune fronts.	Would create more space and improve flood protection, but would rely more strongly on engineered placement and less on natural redistribution processes.
3. Gradual seaward reinforcement through sand nourishment and natural processes	Sand nourishment in a way that allows waves, tides, currents and wind to redistribute sediment over time.	Most closely reflects Building with Nature by using sediment dynamics as part of the solution and supporting adaptive coastal management.

SEA findings and preferred strategic direction

The responsible Ministry preferred alternative 3. maintaining and strengthening the coast through sand nourishment while making maximum use of natural coastal processes. This direction aligned with the Dutch coastal policy principle of “soft where possible, hard where necessary”, under which sandy and adaptive measures are preferred where they can meet safety requirements.
The preferred alternative was also adaptive.

Instead of committing immediately to large-scale fixed infrastructure based on uncertain long-term sea level rise projections, the nourishment strategy made it possible to adjust the timing, location and volume of interventions in response to observed coastal development and future climate conditions. This flexibility is particularly relevant for NbS, which often evolve over time and require monitoring and adaptive management.

SEA key contributions

SEA contribution 1:

Creating early decision space for Nature-based Solutions

A key contribution of the SEA was that it enabled comparison between alternative coastal protection pathways before a specific project solution was locked in. This shifted the decision process from project-level mitigation towards strategic decision-making. The SEA made it possible to compare landward reinforcement, more engineered seaward expansion and nature-based nourishment strategies in terms of their environmental implications, spatial consequences and long-term adaptability. This is directly relevant for SEA practice. NbS are often disadvantaged when they are introduced late, after a conventional engineering solution has already been selected. In this case, the SEA created a decision space in which a nature-based coastal protection strategy could be assessed as a serious alternative at national planning level.

SEA contribution 2:

Supporting system-level understanding

The SEA helped frame the coast not only as a line of defence, but as a dynamic sediment, dune, ecological and socio-economic system. This system perspective is essential for NbS because their performance depends on natural processes such as sediment transport, hydrodynamics, dune formation and ecological succession. It also aligns with the Building with Nature approach described in the white paper, which starts from understanding the physical, ecological, socio-economic and governance context before identifying potential solutions.

By considering the coastal foundation, sediment availability, ecological values, recreation and flood safety in relation to each other, the SEA supported a more integrated understanding of the coastal system. This made it possible to identify sand nourishment using natural processes as a strategic solution rather than treating it only as a technical maintenance measure.

SEA contribution 3:

Moving from adverse-impact mitigation to positive value creation

The SEA also helped move the planning discussion beyond the mitigation of adverse impacts. Instead of asking only how negative environmental impacts could be reduced, the SEA identifying a coastal management pathway that could generate positive long-term value. Sand nourishment using natural processes could support flood safety while also contributing to dune development, landscape quality, recreation, habitat creation and climate adaptation.
This is an important lesson for SEA and NbS. When assessment is applied strategically, it can help identify solutions that provide multiple benefits rather than only reducing harm. In the Netherlands case, the SEA supported a planning logic in which coastal safety, nature, recreation, innovation and adaptability could be combined.

SEA contribution 4:

Creating a shared basis for stakeholder cooperation

The SEA formed part of the broader National Water Plan process and helped create a shared evidence base for discussion among public authorities and stakeholders involved in coastal management. While the SEA itself should not be presented as the only mechanism that brought stakeholders together, it contributed to a common strategic framework within which later cooperation could take place.
This became visible in the Sand Motor pilot project. The project required cooperation between 'Rijkswaterstaat', the Province of South Holland, municipalities, water authorities, universities, knowledge institutes and market parties. Rijkswater-staat identifies cooperation with the Province of South Holland, TU Delft, Free University of Amsterdam, knowledge institutes, market parties, University of Twente, Utrecht University and Wageningen University. A Province of South Holland source describes the Sand Motor as a catalyst for cooperation and notes that agreements were made with 15 stakeholders, including 'Rijkswaterstaat', municipalities, Dunea and the Delfland water authority, covering financing, implementation and management.
The case therefore shows how SEA-informed strategic planning can help create the enabling conditions for multi-actor collaboration during project preparation, implementation, monitoring and long-term management.

From strategic direction to implementation: **the Sand Motor**

The Sand Motor, or 'Zandmotor in Dutch', can be seen as a practical and innovative implementation of the strategic direction supported by the National Water Plan and its SEA. It was constructed in 2011 along the Delfland coast near Ter Heijde and Kijkduin.

Approximately 21.5 million m^3 of sand was placed in a large hook-shaped peninsula extending into the North Sea. Instead of repeatedly nourishing beaches every few years, the Sand Motor was designed so that wind, waves, tides and currents gradually redistribute the sand along the coast and into the dunes over time.

The project had three main policy objectives:

- to stimulate natural dune growth and contribute to long-term coastal safety;
- to create space and opportunities for nature and recreation;
- to generate knowledge and innovation on large-scale nourishment and Building with Nature approaches.

The Sand Motor was also subject to project-level Environmental Impact Assessment (EIA). The EIA assessed design alternatives, construction methods, sand extraction options and expected impacts on coastal morphology, ecology, recreation, water quality, air quality and noise. The EIA supported the permitting process for both the extraction of sand from the North Sea and the construction of the Sand Motor itself.



Results and learning

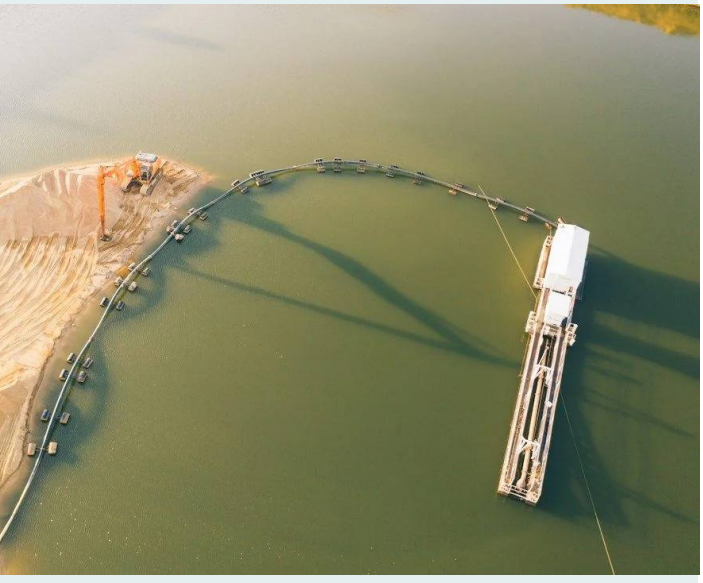
The Sand Motor has been extensively monitored. A 10-year evaluation covering the period 2011-2021 concluded that the project successfully contributed to natural dune growth and coastal maintenance while also generating important knowledge on large-scale nature-based coastal adaptation. Natural processes redistributed the nourished sand along the coast and into the dunes, confirming the feasibility of using mega-nourishment as an adaptive coastal management strategy.

The project also created recreational and ecological value. 'Rijkswaterstaat' notes that the Sand Motor created an attractive area for recreation and nature, while reducing the need for repeated disturbance of the seabed compared with more frequent smaller nourishments. The policy evaluation similarly emphasises that the project combined multiple policy goals, including coastal protection, knowledge and innovation, nature and recreation.

Table 2 | Lessons learned from the Sand Motor and their relevance to NbS

Lesson	Relevance to NbS
SEA can create early decision space for NbS	The SEA developed three alternative coastal protection pathways to be compared before project-level choices were made. One alternative was focusing on sand nourishment and natural-process-based coastal management. This was the most NbS supportive alternative and was selected as the preferred alternative.
SEA can support system-level understanding	The assessment treated the coast as a dynamic ecological and socio-economic system, rather than only as a line of defence. This aligns closely with the Building with Nature approach described in the whitepaper.
SEA can shift the focus from impact mitigation to positivevalue creation	By informing the National Water Plan, the SEA helped position nature-based sand nourishment within national coastal policy, creating a strategic framework for later implementation.
SEA can shift the focus from impact mitigation to positive value creation	The SEA-informed planning process contributed to a common strategic direction for coastal management. This helped create the conditions for later cooperation between public authorities, water managers, researchers and market parties in the Sand Motor pilot.
SESA can support adaptive management and learning	The preferred alternative strategy was flexible because nourishment volumes, locations and timing could be adjusted over time. The Sand Motor then provided a monitored pilot that generated evidence for durable future adaptive integrated coastal management, serving a variety of values.

Overall, this case demonstrates that SESA can act as an enabling mechanism for NbS when it is applied early enough to shape strategic government decisions. The Dutch experience shows that when NbS are assessed as part of long-term policy and planning, they can move from innovative pilot concepts to mainstream components of national climate adaptation and integrated coastal protection strategy.



Sources

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