## Engineering: Building with Nature MOOC

## Key aspects of a solution

## Case 4: Coastal Protection

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| General Information on the solution | |
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| **Title** | Kust op Kracht (in Dutch) – A Fortified Coast |
| **Abstract** | A broad seaward extension was selected as Building with Nature solution with nature and recreational features in addition to increased safety from flooding |
| **Location** | Hondsbossche Pettermer Zeewering, North Holland, The Netherlands |
| **Date** | Finished in 2015 |
| **Main problem owner** | Dutch Ministry of Infrastructure and Environment, their operational arm Rijkswaterstaat, and the district water board Hollands Noorderkwartier |
| **Companies & Partners** | Van Oord (50%), Boskalis (50%), Ecoshape, Province of North Holland |
| **Costs** | The project costs cover Design, Construct and Maintain for 20 years. The project costs amount to 230 million euros. |
| **Project details** | • 20 year maintenance phase (commenced January 2016)<br>• 35.5 million m³ of sand nourishment<br>• 9 km long project site, 7km central section 1km on each side<br>• 640,000 m² of marram grass planted<br>• 3-km-long nature reserve with a damp dune valley<br>• 1.5 km of beach with a lagoon<br>• 25-metre-high panorama dune<br>• willow-slip sand drift screens<br>http://www.vanoord.com/activities/reinforcing-dutch-coastline |
| **Safety level** | 1:10 000 per year |

## Additional Information on the design problem

**Calculations:**

A. Broad seaward extension: 8 to 10 km @ 2500 $m^3/m \sim 25$ million $m^3$ sand in total

B. Cross shore losses: 8 to 10 km x 10 $m^3/m/yr \sim 0,1$ million $m^3$ sand /yr

C. Longshore losses: 0, 4 million $m^3$ sand /yr

D. Margin for sea level rise, uncertainty/storms: 5 million $m^3$ sand in total

Requisite volume of sand over 10 years:

A + B.10 years + C.10 years +D = 25 million $m^3$ sand +(0,1 million $m^3$ sand /yr x 10yr)+( 0, 4 million $m^3$ sand /yr x 10yr)+ 5 million $m^3$ sand = **35 million $m^3$ sand**

Sand buffers placed on the **foreshore**, beaches, and dunes, particularly on the sides of the seaward extension where the longshore transport gradients are highest