

## Nature-based beaches and dunes for flood safety and nature; lessons from three large scale nourishment projects

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### 1. INTRODUCTION

Nature-based (man-made) coastal dunes are being constructed to deliver the diversity of functions that natural dunes provide: flood safety, high natural value, recreation opportunities, and (in some cases) freshwater resources. It is not straightforward, however, to design these dunes since the morphology and sand dynamics, sediment characteristics, vegetation developments, and groundwater dynamics are challenging to reproduce, and a small alteration can have a big effect on the eventual development and functioning of the dune landscape. Therefore, we find it essential to share our lessons on designing such nature-based coastal dunes based upon three case studies in the Netherlands: Spanjaards Duin, the Sand Motor, and the Hondsbossche Dunes. These are all man-made coastal dunes that were realized along the Dutch coast in 2009, 2011 and 2014 (respectively). They had different objectives ranging from high-quality nature development to flood safety and knowledge generation. Based upon these different objectives, the design principles used are also differed. Most importantly, all three locations were monitored for multiple years for their morphological, hydrological, and ecological developments. Not before have the insights from these three cases been combined to feed into design guidelines for nature-based coastal dunes.

	Case studies		
	Spanjaards Duin	Sand Motor	Hondsbossche Dunes
Year of construction	2009	2011	2014
Objective	Nature development (Natura 2000)	Long term coastal defense, nature recreation, knowledge development	Coastal defense
Design	Landscape was constructed including the dunes, which were planted. Interventions were made to steer the development	Peninsula was constructed without dunes, but with a lake and a lagoon. After construction, natural processes could freely shape the Sand Motor	The design was based upon delivering a specific flood risk reduction, creating multiple habitats and trapping sand to reduce dune sand dynamics

Table 1: Description of the case studies

### 2. APPROACH

In 2021 the International Guidelines on Natural and Nature-Based Features for Flood Risk Management (Bridges *et al.* 2021) were published. We use the key principles addressed in this guideline to analyze the three case studies. We use data and publications from the monitoring programs to compare the performances of the three case studies for flood defense and ecological functioning. Flood risk management objectives are often realized soon after the construction of NNBF, the ecological performance takes more time and is less predictable (Figure 1). We assess to what extent differences in the design and (adaptive) management approach of the case studies may have affected their

performance. Based on these results, we can draft lessons for future projects and the mainstreaming of beach and dune Natural and Nature-Based Features (NNBF).

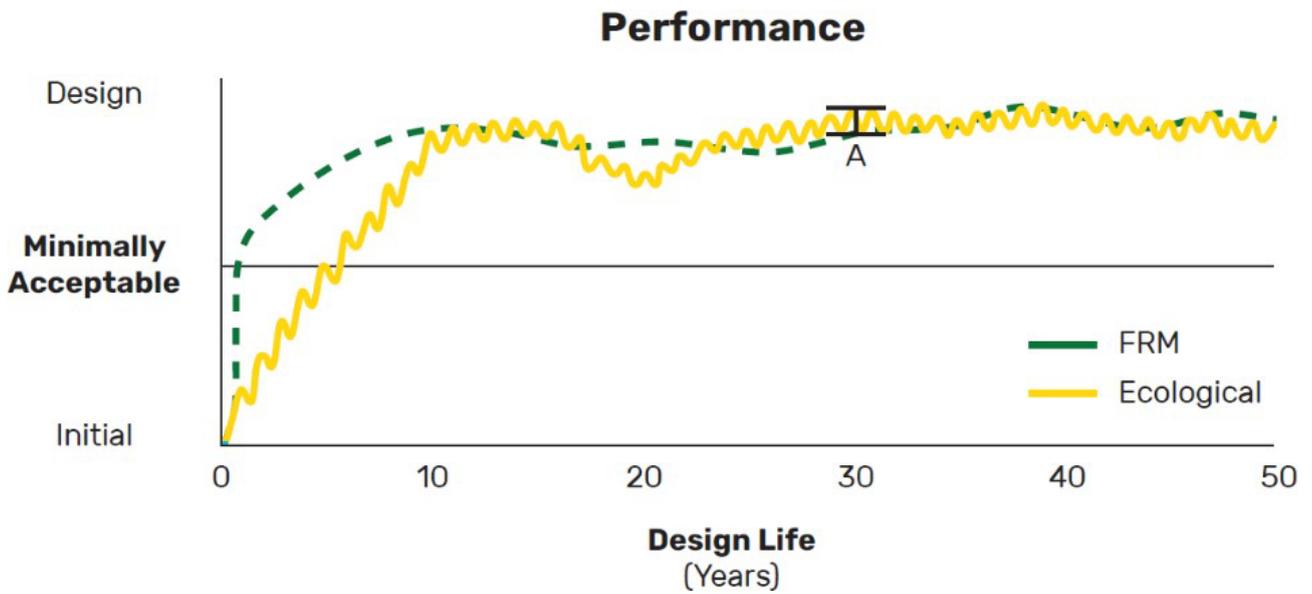


Figure 1: Conceptualized example of performance dynamics of a new NNBF. Green dashed line represents Flood Risk Management (FRM) performance and yellow solid line represents ecological performance. Value A represents typical seasonal variation in ecological performance (Bridges et al., 2021)

### 3. RESULTS

The results are not available yet and will be presented at the conference.

### 4. REFERENCE

Bridges, T. S., J. K. King, J. D. Simm, M. W. Beck, G. Collins, Q. Lodder, and R. K. Mohan, eds. 2021. International Guidelines on Natural and Nature-Based Features for Flood Risk Management. Vicksburg, MS: U.S. Army Engineer Research and Development Center.