



SOFT ENGINEERING VERSUS DYNAMIC APPROACH IN COASTAL DUNE MANAGEMENT:

A CASE STUDY ON THE NORTH SEA BARRIER ISLAND OF AMELAND, THE NETHERLANDS

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Background

Dunes act as flood defenses in coastal zones, protecting low-lying interior lands from flooding. To ensure coastal safety, insight is needed on how dunes develop under different types of management. The current study focuses on two types of coastal dune management: (1) a 'soft engineering' approach, in which sand fences are placed on the seaward side of foredunes, and (2) 'dynamic coastal management', with minimal or no dune maintenance (FIG. 1). The effects of these management styles on dune formation are examined for two adjacent coastal sections of the North Sea barrier island of Ameland, the Netherlands, where dynamic coastal management was introduced in 1995 and 1999, respectively. (FIG. 2)



Figure 1. View of a dune strip before (left) and after (right) introduction of dynamic coastal management. Upper photos show the situation near transect 20.2 looking to the west in 1995 (A) and 2002 (B). Photo A shows a 'white dunes' habitat with *Ammophila arenaria* (marram grass) on the seaward side and sand fences. Photo B shows the same location in 2002. Here we see embryonic shifting dunes grown with *A. arenaria* and *Elytrigia juncea* (sand couch) and 'grey dunes' in the hinterland. Lower photographs show details of the front of the foredune near transect 10.0 to the east with (C) and without (D) human intervention in the form of sand fence placement.

Results

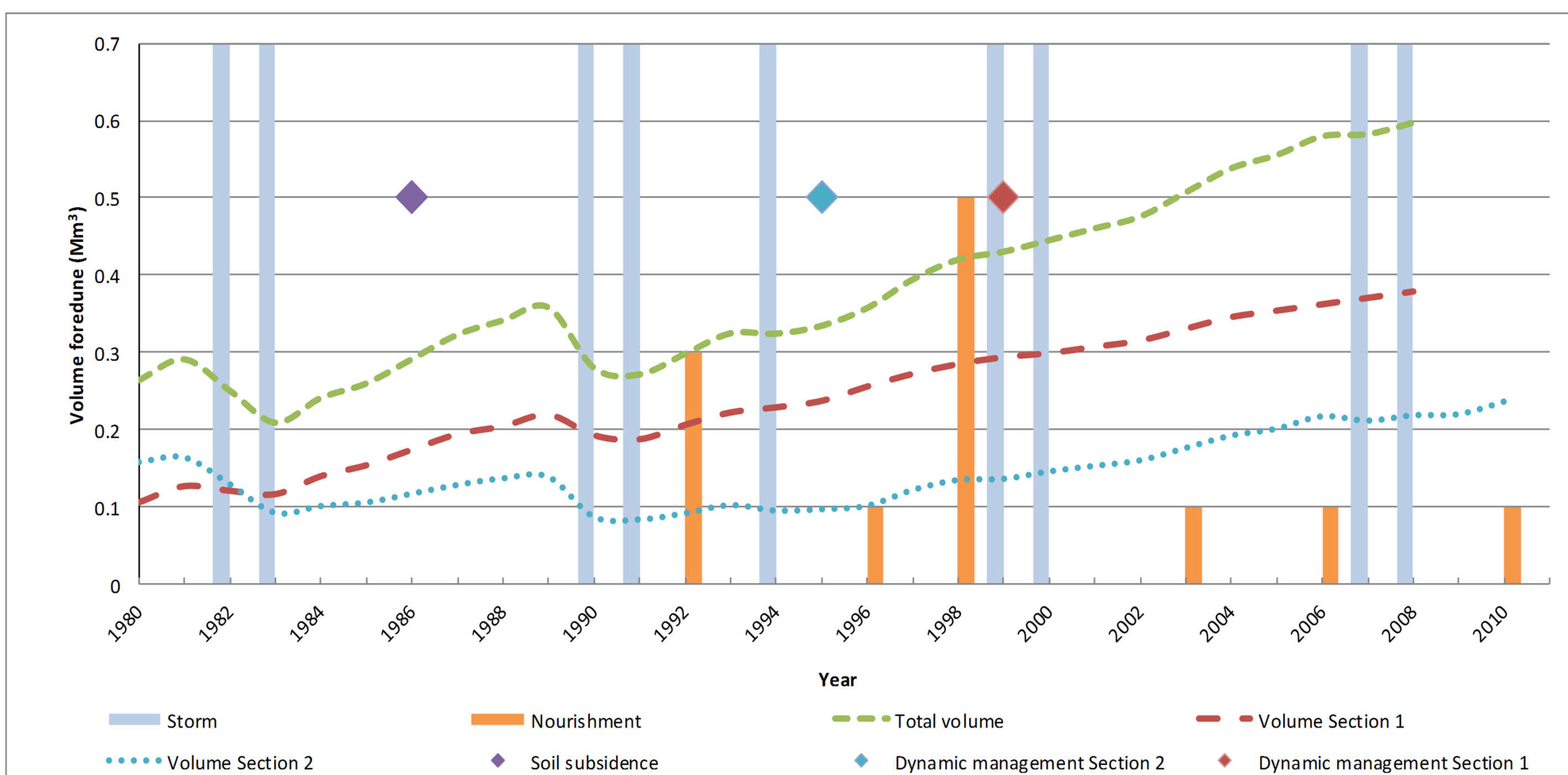


Figure 3 Total foredune volume (transects 19.6 to 21.6) and volumes of Section 1 and Section 2 between 1980 and 2010, with markers for high-water events (storm), beach nourishments on the north coast of Ameland, introduction of dynamic coastal management, and the start of soil subsidence.

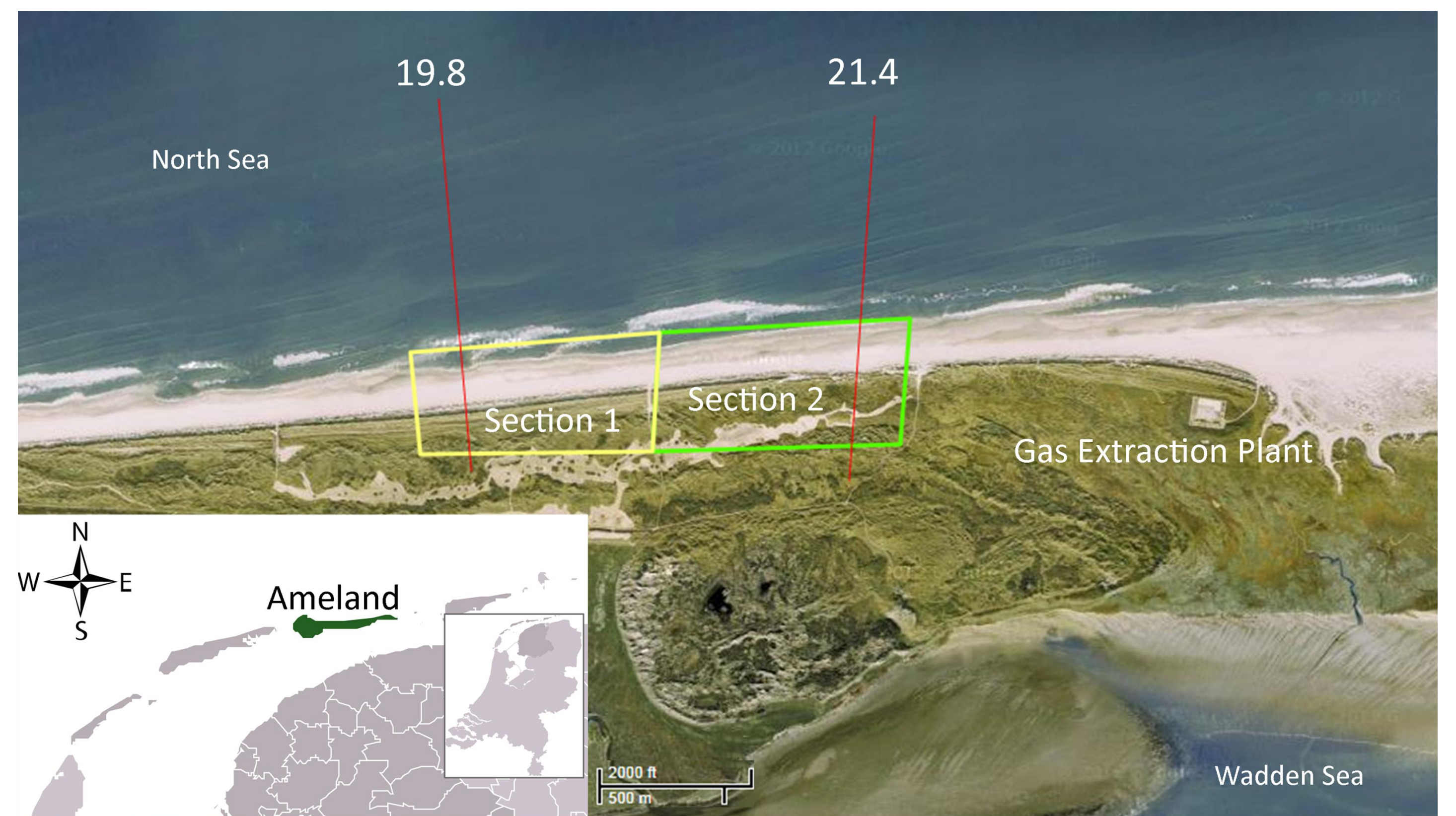


Figure 2 Location of the Dutch barrier island Ameland in relation to the Netherlands and the research area on the island's eastern end. 'Section 1' and 'Section 2' are the two research areas..

Methods

For each section, we analyzed cross-shore profile data from 1980 until 2010, deriving dune foot position, crest position, crest height, and foredune volume for each year and analyzing the situation before and after the change in management. We furthermore assessed the effect of the management regime on dune vegetation. Other factors that could influence dune development were also taken into account, such as beach width and shape, water levels, wave heights, and nourishments.

Results

Results show that implementation of dynamic coastal management did not directly affect the volume of the foredune. Growth was occasionally interrupted, coinciding with high-water events (FIG. 3). In periods between erosive storms, dune growth rates did not show a significant difference between management types ($p = 0.09$ and 0.32 for section 1 and 2 respectively). The main effect of the change was on vegetation development (Table 1).

Characteristic species	Section 1 (n = 10)			Section 2 (n = 10)		
	1995	1999	2002	1995	1999	2002
<i>Elytrigia juncea</i>	0	0	10	0	0	10
<i>Leymus arenarius</i>	0	1	10	0	1	7
<i>Cakile maritima</i>	2	2	10	2	5	10
<i>Ammophila arenaria</i>	10	10	10	10	10	10
<i>Sedum acre</i>	0	5	10	7	6	5
<i>Taraxacum</i> sect. <i>Erythrosperma</i>	5	7	9	4	4	5
<i>Cerastium semidecandrum</i>	5	10	10	0	1	5
<i>Calamagrostis epigejos</i>	10	10	7	6	5	2
Vitality of <i>Ammophila arenaria</i>	1	1	2	2	2	2
Number of vascular plant species	28	23	38	23	20	32

Table 1 Presence of characteristic plant species in Section 1 and Section 2. Values indicate number of plots where species were found (n = 10). The table shows the three years in which vegetation was monitored between 1995 and 2002.

Conclusions

- The introduction of dynamic coastal management appears to have been a positive step. It had no negative effect on the volume of the foredune, while it did enhance the foredune's natural quality. As long as the foredune volume continues to grow and nature profits from a dynamic coast, we recommend abstaining from nourishments on the island of Ameland east of transect 17.

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