Foredunes and sand dykes in the Netherlands

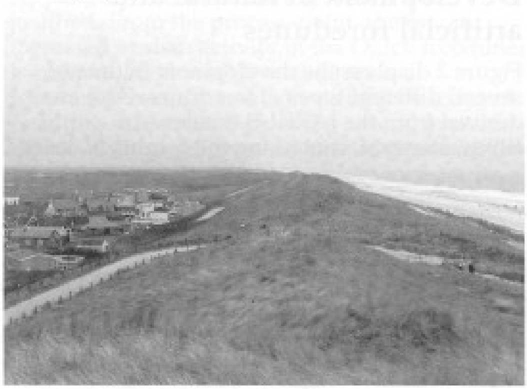
By Bas Arens

A large part of the Netherlands is protected from the sea by dune areas, extending in width from a single dune ridge to about six kilometres. Approximately 250 km of foredunes form a natural barrier against the sea. Because of this important function, foredunes in the Netherlands have been influenced by man for centuries, which in many places has resulted in strong contrasts between (artificial) foredunes and the adjacent (natural) dune landscape. In general, management aims to reduce erosion by wind and to stimulate sand deposition, mostly by erection of sand fences and planting of marram grass. Locally, irregular slopes or blowouts are smoothed, for practical purposes (planting) or to reduce the eroding capacity of the wind. In case of a regressive foredune, the dune shape is often artificially reconstructed, to maintain a minimum safety standard. Consequently, the morphology of foredunes has gradually evolved to often straight structures without any dynamic features like blowouts. Possibly, this also has influenced the biotic diversity in the foredunes (plant and wildlife).

Foredune types

In a natural system, foredunes develop at the transition between land and sea, characterised by dynamic processes; their appearance may change at a time scale of days, either due to erosion (marine or aeolian), or by deposition during import of sand with onshore winds. In an human influenced system, the foredune is an often static, more or less artificial sand dyke, changing only due to dune erosion during storm surges and subsequent management activities. Both examples of natural and artificial foredunes can be found along the Dutch coast, but fully natural foredunes are rare (approximately 8%). At relatively short distances, large differences in shape can be observed, like for example near Callantsoog (Figure 1a), near Groote Keeten, about 7 km to the North (1b) and on the eastern side of the Wadden island of Schiermonnikoog (1c). The foredune near Callantsoog is static, it is clear that its maintenance is essential for the safety of the polderland behind (situated below mean sea level). Although the origin of this ridge is natural, presently it has the characteristics of an artificial sand dyke. The foredune near Groote Keeten is very dynamic and progressive. In this case there is no need for strict management. There is a large import of sand, and although some blowouts have formed, erosive features are restricted to the frontal zone of the foredune, and landward losses of sand are negligible. The input of fresh sand results in a vital marram grass vegetation, which contributes to the foredunes stability. The foredune at the eastern side of Schiermonnikoog used to be a

Figure 1. Examples of foredune types in the Netherlands; a. Strictly controlled foredune near Callantsoog; b. Dynamic and naturally developing foredune near Groote Keeten; c. Remnants of a former 'stuif-dyke', eastern Schiermonnikoog. (photo: Bas Arens)

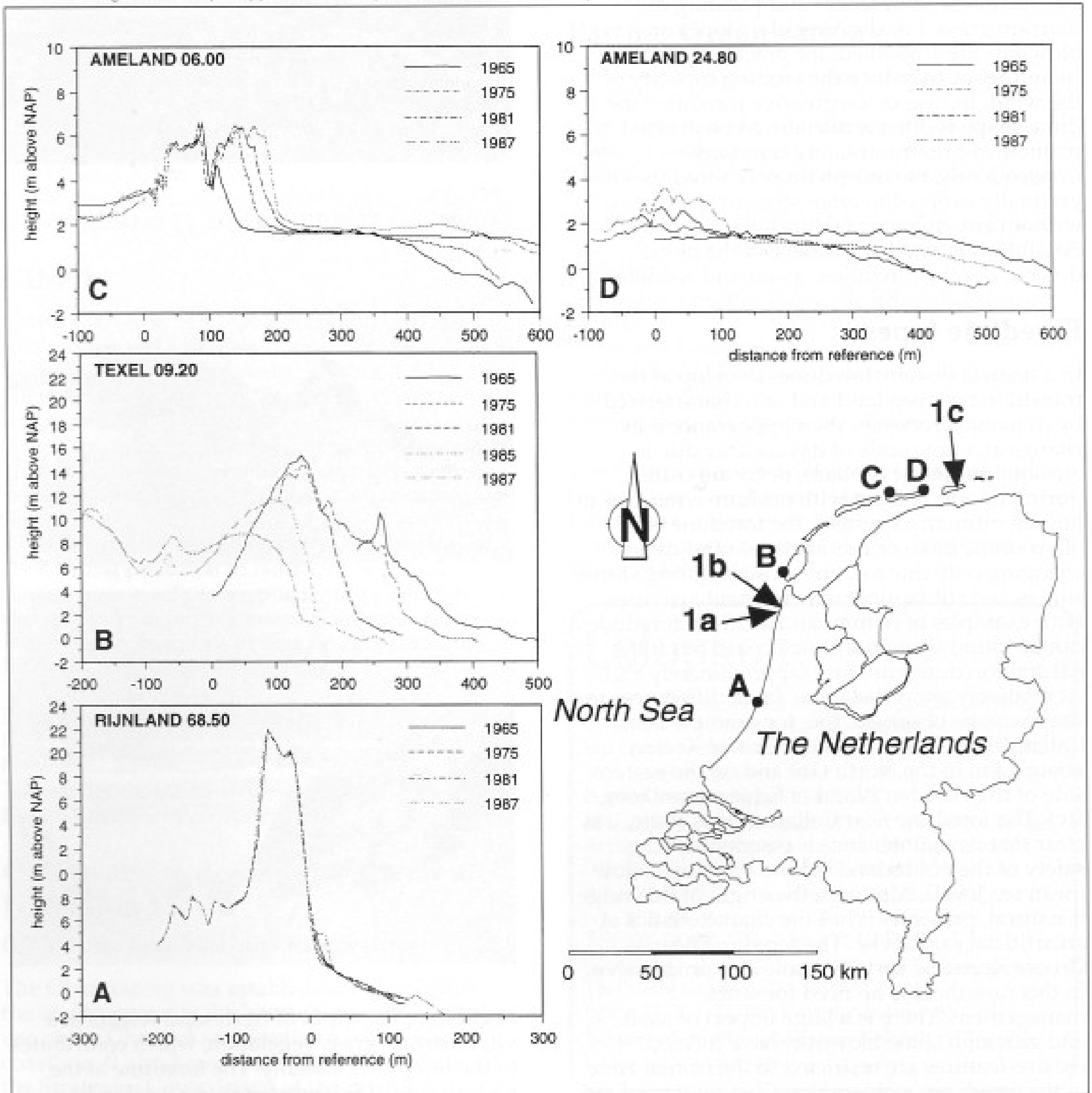


sand dyke created by sand fences, a so called 'stuif-dyke'. Nowadays it belongs to the most natural dune systems of the Netherlands. In a time span of about 10 years, several gaps in the foredunes evolved due to both wind and waves. Tidal inlets have formed, through which sea water intrudes during high water levels.

Development of natural and artificial foredunes

Figure 2 displays the development in time of several different types of foredunes. Data are derived from the JARKUS-database of Rijkswaterstaat, containing the heights of coastal cross sections, recorded yearly. Differences in foredune development are caused by differences in coastal dynamics, sediment budget, coastal orientation and management. Type A represents stable foredunes along the Mainland coast. The foredune is stabilised, mainly due to planting of marram grass; there are no changes in time, except for some recreational works on the beach. Type B represents a strongly erosive foredune on the island of Texel. In this case, both natural erosion and human activities (bulldozing and controlled aeolian removal in order to maintain a minimum sand volume) result in the landward displacement of the foredune. Types C and D represent accretionary systems. In C accretion is

Figure 2. Examples of foredune development JARKUS-database, Rijkswaterstaat. (The sea is to the right of the foredunes).



controlled by means of sand fences, resulting in a gradual seaward extension of the foredune. In D development is fully natural.

Dynamic dune management

For several reasons the interest in the restoration of natural dynamics in the dune environment has increased. First of all, consciousness has grown of the enormous nature potential of dune areas, national, but also in an European point of view. Secondly, as a consequence of economic recession, dune managers tend to restrict their activities to those areas that really need attention for safety reasons. Finally, it is recognised that aeolian reactivating of sand can be used as a measure against eutrophication and leads to an increased vitality of marram grass. For these reasons management is changing towards a so-called dynamic dune management, where foredune shape is determined by geomorphologic processes, without negative results for the sea defence function. For an optimal combination of functions there is a need for knowledge of natural processes.

Research for management

In order to optimise management, it is necessary to have insight in processes and dynamics of foredunes. Process measurements during 7 months on the island of Schiermonnikoog indicate that most of the dune development is realised in a short time period. Wind speeds of 10-15 m/s are most effective with respect to landward sand transport; during stronger winds, usually the beach is flooded, or transport is restricted due to heavy rains. During a period of moderate onshore winds, sand was deposited near the dune foot. Stronger winds finally eroded the dunefoot, and the formerly deposited sand was transported over the foredune. Transport mechanisms are strongly influenced by foredune morphology and vegetation. The pattern of vegetation controls the form of deposition, whereas the topography controls the rate of landward transport. Usually on foredunes with densely vegetated top and lee slope, landward transport of sand is limited. On Schiermonnikoog a densely vegetated seaward slope forced sediment in transport to be deposited in a narrow zone. Only small amounts of the sediment in transport reached the lee of the dune, which has negligible effects on topography.

Near Groote Keeten, Noord-Holland, sand imported from the beach was deposited in sheets, because of a steeper topography and lower vegetation density on the seaward slope. Sedimentation patterns were strongly related to wind speed and direction. Only during straight onshore winds, speed up was large enough for transport of substantial amounts of sediment over the top of the dune. However, also here the amounts of sand transported landward from the lee slope were small. Most of the transported sand is arrested by the (vegetated) foredune itself, landward losses are negligible.

Apparently, the fear of flying sand is not justified. From the process-point of view, an increased aeolian activity in the Dutch foredunes is permissible. In stable or progressive foredunes, management efforts may be reduced, resulting in a restoration of the natural system. Locally this might even benefit the vitality of the foredune vegetation, and therefore increase its resistance against wind erosion.

Bas Arens
Landscape and Environmental Research Group
(Department of Physical Geography and Soil Science)
University of Amsterdam
Amsterdam, The Netherlands.

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For further information

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