Washover System Development

Reconstructing the morphological development of washover systems on mesotidal barrier islands

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Abstract

Overwash is considered an important process on micro-tidal barrier islands for large-scale morphological changes, but insignificant on mesotidal islands. However, we demonstrate its importance on mesotidal barrier islands, where it leads to the development of large washover systems. Aerial photographs spanning 80 years, LIDAR-data and beach profiles have been analysed and hydrodynamic modelling as well as fieldwork are performed. Here we focus on the morphological behaviour of washover systems on a decadal time scale on Schiermonnikoog.

In general overwash is highly episodic (frequency ≤ 5/year), but occurs for decades at the same locations, resulting in distinct morphological units, called washover systems. Most of the Dutch barrier islands show multiple washover systems, with a longshore spacing of several hundred meters.

In the earliest development stage washover channels are present between dune complexes and a delta is formed in the back-barrier basin. With time the elevation increases, overwash frequency decreases and dunes and washover systems expand northward.

The shape of the systems becomes triangular, with cross-shore length >> width and deposits no longer reach the back-barrier basin. Washover throat width (opening between flanking dunes) decreases when beach width increases and the systems can even close when aeolian deposition is high. Many systems though re-open after storm events and are remarkably stable.

Washover systems from ground view

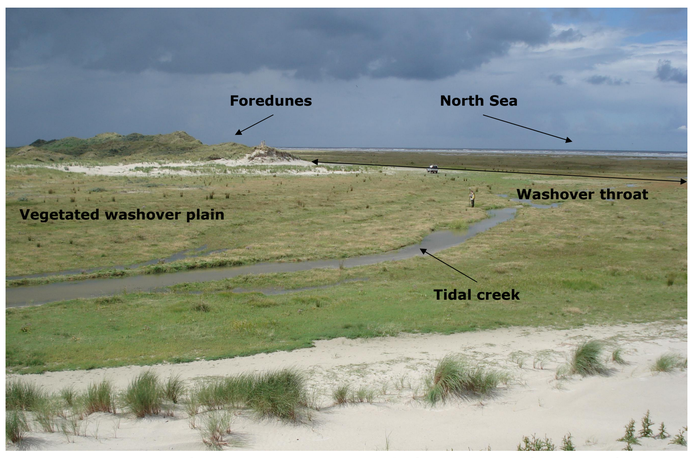

Figure 1: A washover system on Schiermonnikoog. The washover plain has become vegetated and a tidal creek is incised. The picture is taken during spring tide, only then the water in the tidal creek reaches the foredune area. On both sides of the plain, against the foredunes (on the fore- and background) recent storm deposits are visible, which are now being spread out over the area.

Figure 2: Unflooded washover system on Schiermonnikoog near km10. Only aeolian processes play a role during normal water levels. Microbial mats and vegetation can cover large parts of the system, reducing the amount of sediment transport.

Figure 3: Flooded, active washover system during the 9 november 2007 storm. Water depths reached 1.5-2m in the washover throat and erosion of the dunes at both sides was severe.

Washover systems from a bird's view

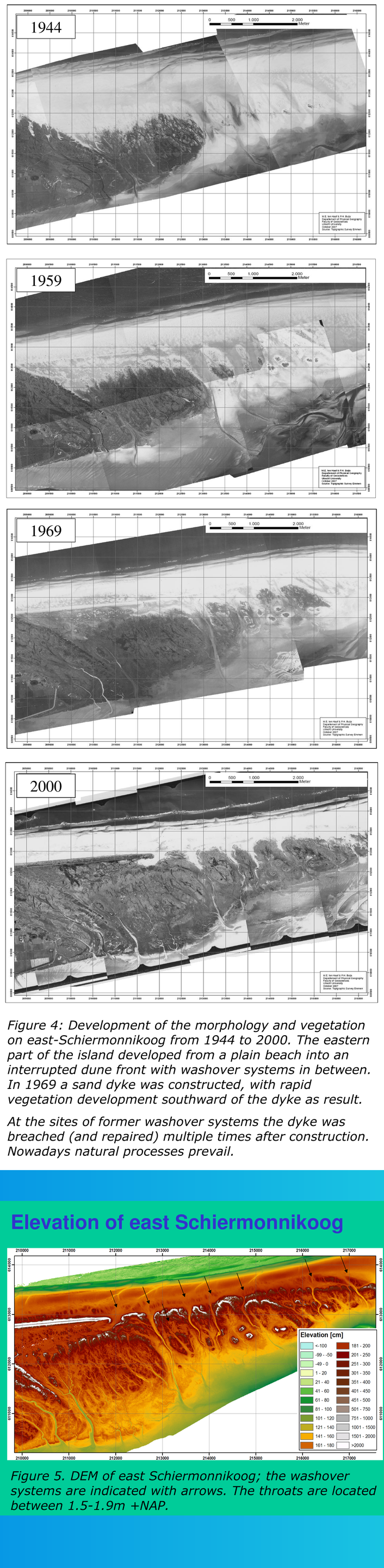

Figure 4: Development of the morphology and vegetation on east-Schiermonnikoog from 1944 to 2000. The eastern part of the island developed from a plain beach into an interrupted dune front with washover systems in between. In 1969 a sand dyke was constructed, with rapid vegetation development southward of the dyke as result.

At the sites of former washover systems the dyke was breached (and repaired) multiple times after construction. Nowadays natural processes prevail.

Elevation of east Schiermonnikoog

Figure 5. DEM of east Schiermonnikoog; the washover systems are indicated with arrows. The throats are located between 1.5-1.9m +NAP.

Conceptual model of island development

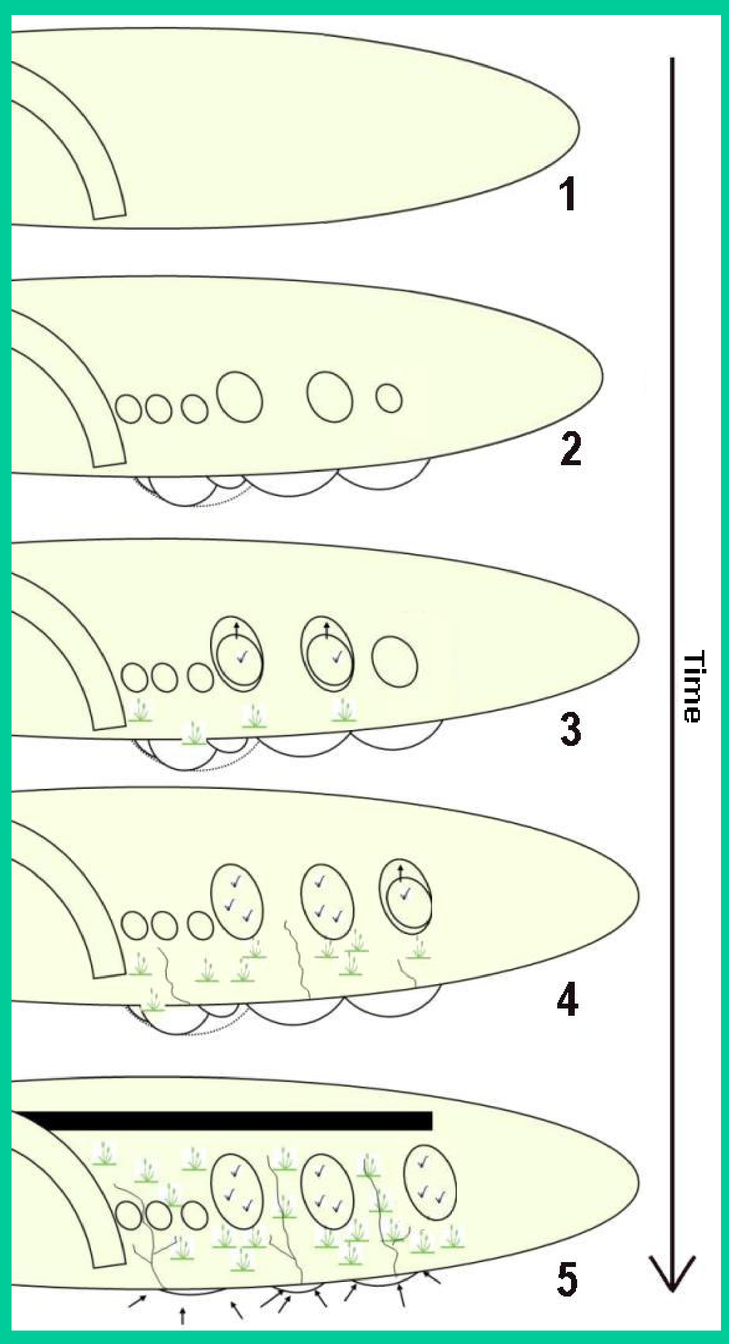

Figure 6. Schematic development of a washover system on an aggrading coast in five phases: 1) A plain beach at an islands' tail. 2) Dune forming when enough sand is available. Between dunes sand is transported during overwash that forms deltas in the Wadden Sea. 3) Vegetation arises in the sheltered parts and dunes expand seaward. 4) Further incision of creeks due to vegetation-expansion. 5) Humans closed off the systems with dykes, which can be breached at the historic locations of washover systems.

Processes influencing washover systems

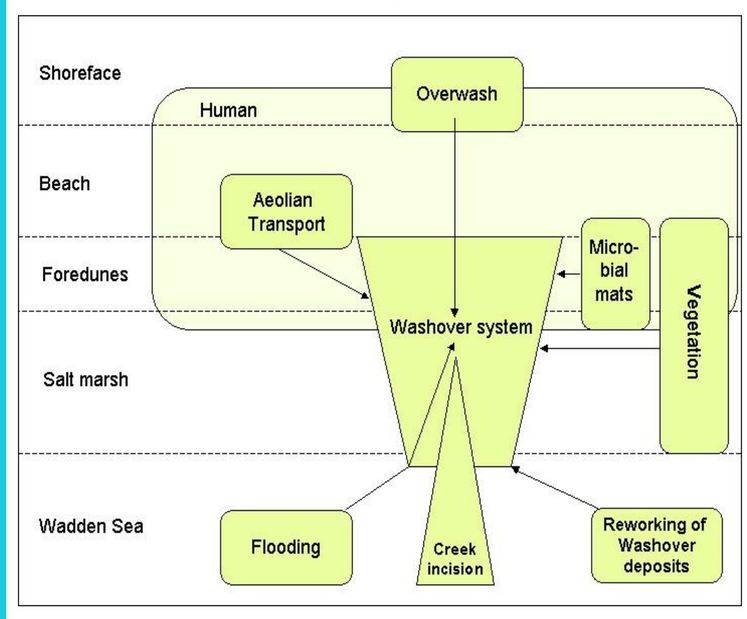

Figure 7. Conceptual model of processes influencing a washover system. The washover system is influenced by both processes acting from the North Sea (highly energetic) as well as from the backbarrier basin, the Wadden Sea (less energetic, but more persistent). Also, in situ processes are present, such as interactions with vegetation.

Acknowledgements

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