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# Island-terminus evolution related to changing ebb-tidal-delta configuration: Texel, The Netherlands

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**Abstract**

Historical maps of southwest Texel and the adjacent ebb-tidal delta, supplemented with quartz OSL (Optically Stimulated Luminescence) ages of dune sand, span four centuries and show several links between coastal development and ebb-tidal-delta behavior. Updrift inlet migration governed recurved-spit formation, and changes in ebb-tidal-delta size and shape resulted in the formation of a bulge at the island terminus. Sustained updrift migration of the ebb-tidal delta resulted in a commensurate position shift of the bulge and eventually in flattening of the coastline. Regional coastal-management measures have had a strong influence on tidal-inlet and ebb-tidal-delta behavior, and therefore also on the changing shape of southwest Texel. Identification of relationships between ebb-tidal-delta behavior and changing barrier-terminus erosion-and-accretion patterns on a decadal to century time scale contributes to our understanding of coastal-system dynamics. Any barrier terminus with preserved sets of dune ridges holds a potential record on past ebb-tidal-delta orientations, which provide clues on past changes in tidal prisms and wave versus tide dominance. Under the current ebb-tidal-delta configuration, the entire westward-oriented coast of southwest Texel is too exposed for lasting accretion. Bulges resulting from future merger of shoals with the coast in this area will be eroded rapidly.


*Keywords:* barrier island; beach ridge; coastal processes; dune ridge; luminescence dating

## 1. Introduction

The updrift terminus (defined with respect to the longshore current, Fig. 1) of many barrier islands is characterized by recurved ridges developed in response to wave refraction around ebb-tidal-delta shoals at high tide and the associated divergence in the direction of local longshore sediment transport at a nodal point some distance from a tidal inlet (cf. Hubbard, 1975). Much of the wave energy that produces the sediment contribution to the ridges comes from refracted waves across the ebb

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Fig. 1. Location of the study area. On Texel, a dune belt (outlined and white) occupies the western fringe of the island. Other land areas, including Vlieland, are shown in white, without details. Elsewhere, dark gray tones denote tidal channels and light gray tones denote tidal flats and the shallow lake that was formerly the Zuider Sea.

delta at high tide, and the landward recurved part of the ridge is due to waves refracting through the main ebb channel at high tide. Sediment bypasses inlets in the form of large landward-migrating swash bars (FitzGerald, 1988). The size and morphology of the ebb-tidal delta control the location of swash-bar attachment. Generally, the distance between the inlet and the attachment location downdrift increases as (1) inlet size increases and (2) the downdrift skewness of the ebb-tidal delta increases. The latter condition produces humpbacked or bulbous barrier islands. The opposite ebb-tidal-delta arrangement produces straighter barrier islands (FitzGerald et al., 1984).

Variability in barrier-terminus shape has been studied for various barrier-island chains, so that at present, differences among individual barriers can be explained (cf. Hayes, 1979; FitzGerald et al., 1984). In any single barrier, similar variability occurs on a temporal level (cf. FitzGerald, 1984). To explain observed long-term changes through time, detailed island-terminus erosion-and-accretion patterns need to be linked to ebb-tidal-delta behavior. Such comparison requires accurate temporal records of both ebb-tidal-delta configuration and barrier-island shape. Here, we compare the development of the southwestern terminus of Texel and the behavior of the associated tidal inlet, Marsdiep, and its ebb-tidal delta. These two environments have been monitored frequently since the 16th century, for coastal-defense and navigation purposes. Historical maps and documents, the main source of information for this study, show that the island tip and the ebb-tidal delta have both changed