CHAPTER 4

Changes in salt-marsh area in the Netherlands Wadden Sea after 1600

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1. Introduction

The Danish, German and Dutch Wadden Sea harbours important areas of salt marsh (Dijkema *et al.* 1984). These marshes form a modest remainder of an extensive natural landscape of salt marshes, brackish marshes, peatland and lakes which existed till about 1000 years ago at the transition of Pleistocene deposits and coastal sea (Behre 1979, Griede & Roeleveld 1982, compare Beeftink 1975 for the southwest Netherlands estuaries). At that time, embankment of the already inhabited marshes was started. Later on, large recaptures by the sea were made in the embanked areas by flood disasters. In these flooded areas as well as in other areas outside the existing reclamations, sedimentation allowed growth of new foreland (e.g. Middelzee, Lauwerszee, Fivel, Dollard, Leybucht, Harlebucht, Jadebusen). During the last three to four centuries, the Wadden Sea became gradually smaller by successive reclamations of these newly accreted salt marshes for agricultural purposes. The continuing sedimentation produced new marshes, however.

Nowadays, the growth of salt marshes is much slower and occurs in the Wadden Sea mainly through artificial stimulation. The reclamations are on a larger scale than the accretion of the marshes (Verhoeven *et al.* 1980). After the flood disasters of 1953 in The Netherlands and 1963 in Germany coastal defence became more important, leading to embankment or filling of extensive parts of salt marshes and tidal flats. Notably higher salt marshes (Schleswich-Holstein) and sheltered bights (Nordstranderbucht, Meldorferbucht, Lauwerszee) disappeared. Such works have been executed for coastal defence, drainage of the hinterland and as a means for obtaining areas for freshwater reservoirs, recreation, military training, agriculture, better connections with the islands, etc.. The Jadebusen, Leybucht and Dollard remain, however.

Data on the area of embankments (Van Veen 1948, Drijver 1983) are no indication for the changes in salt-marsh area because of the ongoing salt-marsh growth. Therefore in this contribution reconstructions of the area of salt marsh have been made for some selected years. These can be based on the well documented history of embankments (e.g. Verhoeven 1976), supplemented with data from historical maps. Finally, an indicator value for the natural status of the salt-marsh area will be developed from these reconstructions.

2. Methods

For a historical reconstruction of the salt marshes in the Netherlands Wadden Sea data on embankments have been drawn from present-date ordnance-survey maps; Westenberg (1961) gives a detailed description of this method. Embankments have been used as a basis for the reconstruction of salt marshes in selected years (Fig. 1). For the rest all identifiable details on salt marshes

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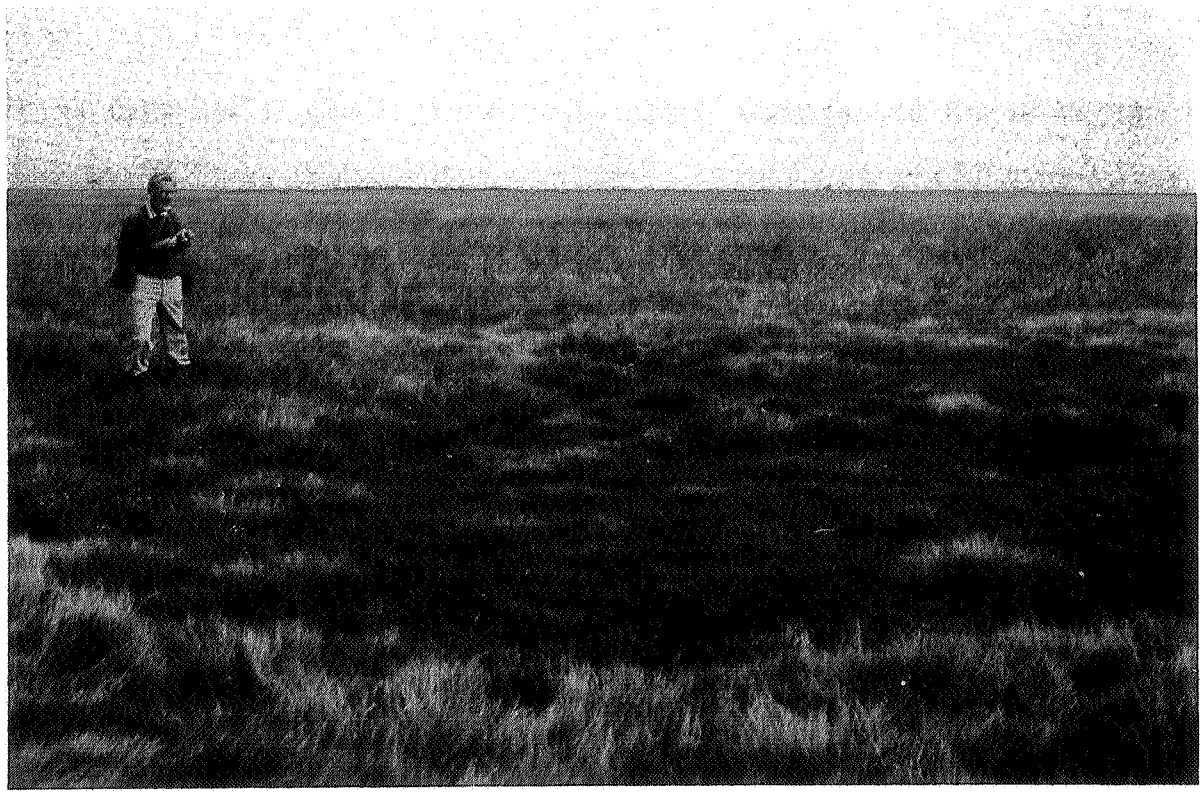

W. G. Beeftink in a salt marsh in Denmark, Møn. (Photograph: K. S. Dijkema, Texel)

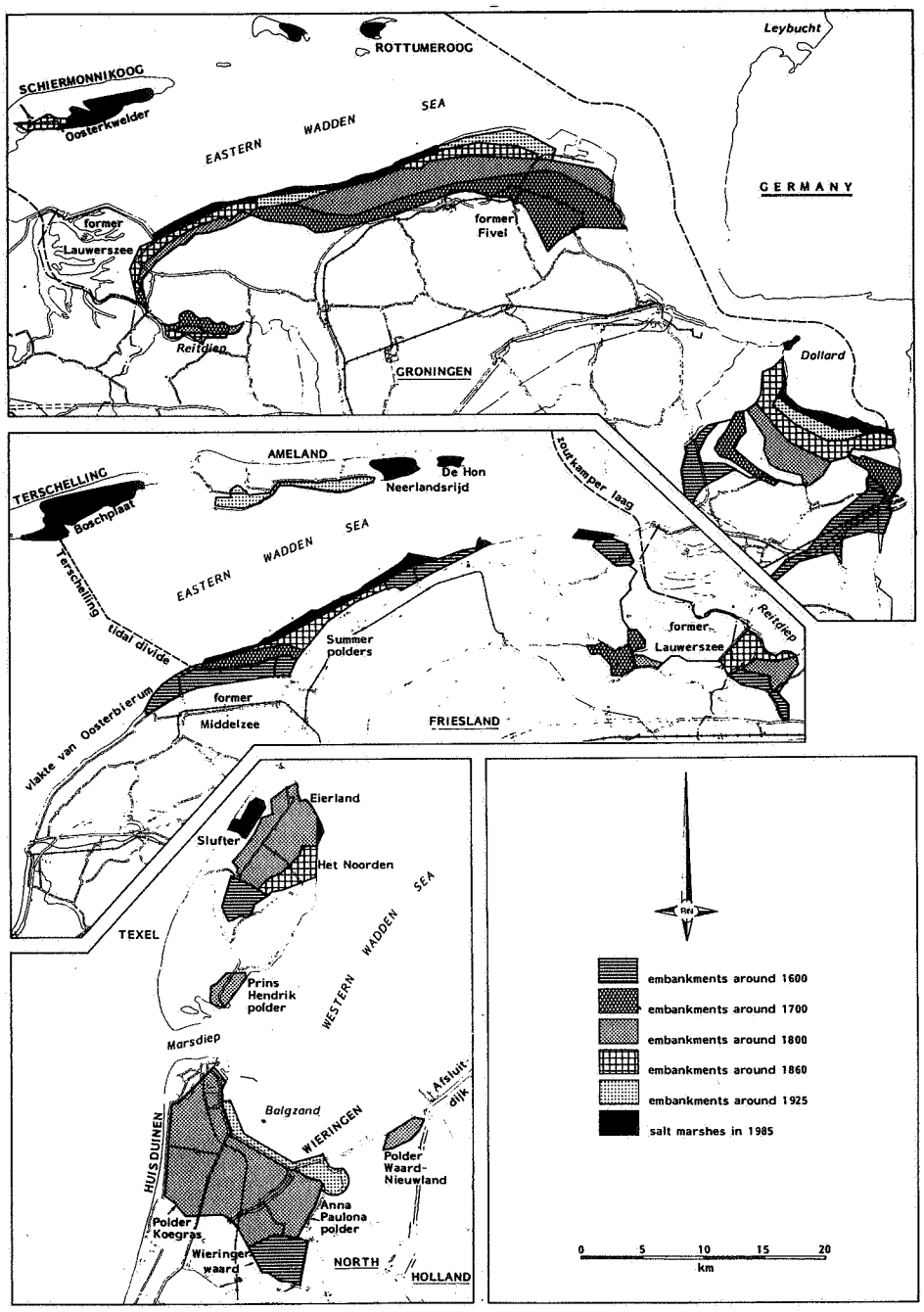

Fig. 1. Simplified map on changes in salt-marsh area in the Netherlands Wadden Sea. Embankments have been used as a basis for the reconstruction.

are added to prepare final maps for the selected years.

The written history of embankments and historical maps served as sources: for Texel Schoorl (1975) and Van Lare *et al.* (1980); for the North-Holland mainland Westenberg (1961); for Friesland the map of Brouwer & Eekhoff (1834) and the explanation of the soil map of the

Netherlands (Anon. 1981); for the Lauwerszee Tuinstra (1963); for Northeast Friesland and Groningen the book with historical maps of Vredenberg-Alink (1974); for Northeast Groningen the salt-marsh map of Sems (1630) and Roeleveld (1974); for the Dollard Stratingh & Venema (1855). From 1860 on, ordnance-survey maps have been used. The present salt marshes have been investigated and mapped by Dijkema (1983) and Dijkema *et al.* (1984).

The years for historical reconstructions of salt marshes have been chosen after 1600 because (1) for the period before 1600 hardly any maps are available and these maps are too inaccurate to identify salt marshes, and (2) moreover, till 1600 embankments and flood disasters alternated with each other (Van Veen 1948, Verhoeven 1976). After 1600 newly accreted salt marshes were embanked at regular intervals and large losses of land did not occur anymore. In general, the selected years 1600, 1700, 1800, and 1860 precede series of embankments. In 1860 the first ordnance-survey maps are available and the year 1925 precedes the start of large-scale stimulation of salt-marsh growth by man. Finally, the actual situation (1985) will be presented.

On old maps pioneer vegetation has not been drawn. It was not embanked in the past (except for some known examples, mainly in the province of North Holland). Therefore, pioneer vegetation has not been included in the reconstruction of salt marshes, and therefore it has been excluded from the estimations of the present salt-marsh area as well.

The areas have been determined with a planimeter. As the development, the morphological structure, the soil composition, the vegetation and the history of embankments of the island and mainland salt marshes show considerable differences, they have been treated separately. Also the western and eastern Wadden Sea have been distinguished, because west of the Terschelling tidal divide the conditions for salt-marsh formation are less favourable. In this study the former Zuiderzee has not been included. The boundary is formed by the Afsluitdijk, the southern border of Wieringen and the landward borders of the polders Wieringerwaard, Anna Paulowna, and Koegras.

3. Changes in salt-marsh area in the western Wadden Sea

The salt-marsh areas for the years 1600, 1700, 1800, 1860, 1925, and 1985 are shown in Fig. 2. Mainland salt marshes in the western Wadden Sea hardly covered any area in this period. Island salt marshes, on the contrary, grew to a considerable area of 88.5 km^2 in the 18th century. This was caused by the shelter of man-made sand-dikes (Koegras in the province of North Holland in 1610 and Eierland on the island of Texel in 1629). In 1817 and 1835 respectively, these areas were fully embanked, after which the salt-marsh area was minimized (Fig. 2).

Until now two circumstances have hampered (new) accretion of salt marshes in the western Wadden Sea. First, embankments in former centuries have not been limited to salt marshes. Tidal flats have been included (66 km^2 in the 19th century: the Anna Paulowna polder, polder Waard-Nieuwland, Prins Hendrik polder and Het Noorden), a method which has only recently been applied in the other parts of the (Netherlands-German-Danish) Wadden Sea. Therefore hardly any high lying tidal flats at the edges, a starting-point for new salt-marsh formation, were left. Secondly, a tidal range smaller than 2 m gives the western Wadden Sea an almost microtidal character (Hayes 1975, 1979). Microtidal systems in general have less tidal flats and salt marshes than mesotidal systems like the eastern Wadden Sea. That is especially true for the mainland shore, where the shoreward margins of the flood deltas have not been filled in with sediment like in the eastern Wadden Sea. The enclosure of the Zuiderzee in 1932 caused a considerable increase in tidal range (Rietveld 1963), giving the western Wadden Sea a more mesotidal character. That has caused erosion of the existing (small) salt marshes, but in the long run an increased area of tidal flats and salt marshes may be expected. For this a supply of 10^9 m^3 sediment is needed in the Marsdiep tidal basin alone, which may take 100 to 200 years to accumulate (Eysink 1979). Large quantities of sand have already been deposited in the Afsluitdijk neighbourhood (Rietveld 1963) and also some areas in the province of North Holland (Balgzand) and Friesland

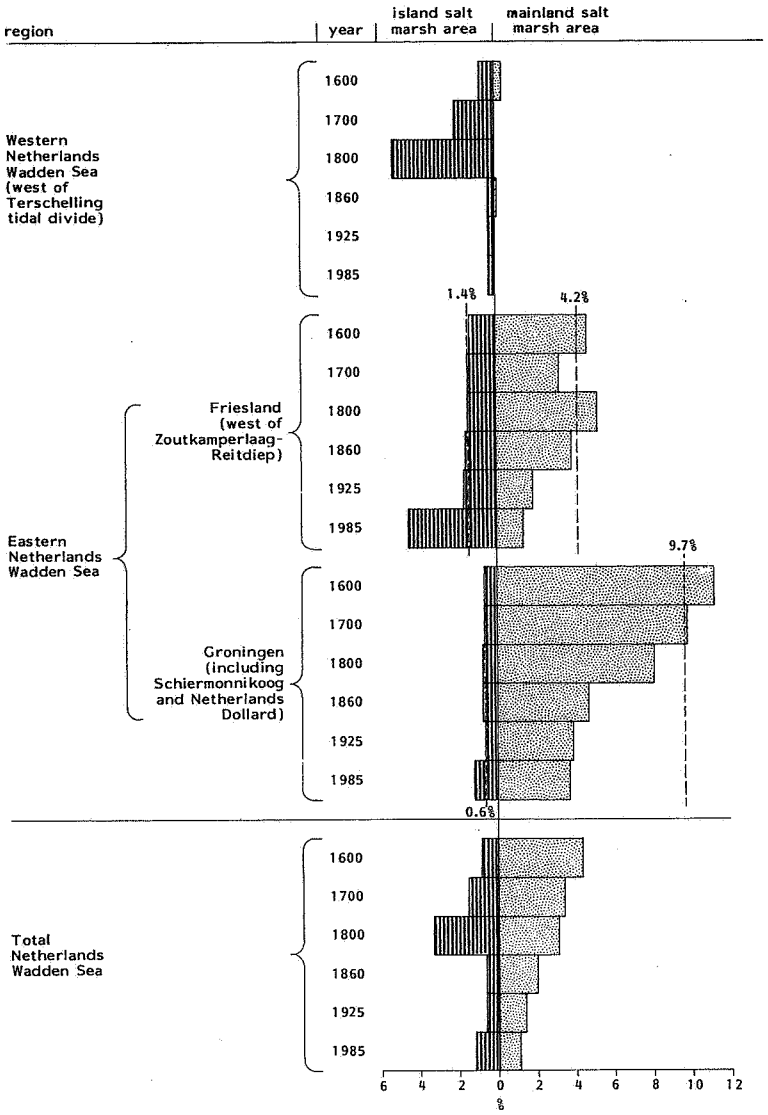

Fig. 3. Salt-marsh area in the Netherlands Wadden Sea after 1600, in % of the total tidal area. The former island Huisduinen has been included. Figures for 1985 including the Slufter on Texel, excluding summer polders (10.4 km^2) and mainland pioneer vegetation (about 5 km^2 for Friesland and 5 km^2 for Groningen). --- = mean salt-marsh % for the years 1600, 1700 and 1800.

the proportional share of salt marshes in their tidal basins can be used as an indicator value for the area of salt marshes in the Wadden Sea.

6. A standard for the indicator value?

To use the proportional share of salt marshes as an indicator value in the Wadden Sea a standard is required which may be derived from the government policy for the Wadden Sea (Tripartite Werkgroep Beheer Waddenzee 1985). That policy aims at a Wadden Sea as natural as possible, in which all structures, plant species, and animal species natural for the Wadden Sea can survive, develop or recover. Also a rough balance between the geomorphological processes of accretion and erosion is needed. For salt marshes, this can be conceived as a rough balance between embankments and accretion, a

Table II. Indicator values for salt-marsh area in the eastern Netherlands Wadden Sea.

		Mean % salt marsh 1600—1800 (standard)	salt marsh 1985		difference	
			%	km²	%	km²
Friesland (Terschelling tidal divide-Zoutkamperlaag	islands	1.4	4.5	20.5	+3.1	+14.0
	mainland	4.2	1.4	6.1	−2.8	−12.7
Groningen (including Schiermoonikoog and Neth. Dollard)	islands	0.6	1.2	7.1	+0.6	+ 3.7
	mainland	9.7	3.7	23.0	−6.0	−37.1

situation which was found between 1600 and 1800. The proportional share of salt marshes between 1600 and 1800 (Fig. 3) is proposed as a standard. That value is rather stable and independent of the total Wadden Sea area. Based on that standard, the indicator value can be used as a criterion for the "naturalness" of the Wadden Sea.

Table II compares the present indicator values for the eastern Wadden Sea with the proposed standard. The island salt marshes are 18 km² larger than this standard due to recent sand dikes (section 4). The mainland salt marshes are 50 km² smaller, despite all attempts of salt-marsh stimulation.

For the western Wadden Sea, the present proportion of salt marsh area is extremely low. Island salt marshes have diminished from 12.7—88.5 km² in the period 1600-1800 to 4.0 km² nowadays (Fig. 2). Restoration cannot be expected in the near future because of embankment of all suitable areas. Although conditions for mainland salt marshes (nowadays hardly present) may improve in the long run (section 3), it is not realistic to select a standard for the proportional share of salt marshes in the western Wadden Sea.

7. Conclusions for the restoration of salt-marsh area

Because the rate of embankment has been faster than the accretion of new marshes, a prerequisite for the restoration of salt-marsh area has to be stopping all embankment till the indicator value has reached the standard.

A second condition for restoration of the salt-marsh area is to maintain a high incidence of man-made salt marsh formation in the eastern Wadden Sea until the natural processes will be able to take over. The accretion has been estimated between 37 ha (Bouwsema *et al.* 1986) and 75 ha (Eysink 1979) annually. By unaltered accretion the standard for the indicator value for the mainland salt marshes in the eastern Wadden Sea will be reached in 70—135 years. As salt-marsh accretion is assumed to proceed asymptotically, a period two times as long is not unlikely (Reineck 1980).

The proportional share of island salt marshes in the eastern Wadden Sea is above the standard, which has been caused by the construction of sand dikes. That may be regarded as some compensation for the losses on island salt marshes in the western Wadden Sea, where restoration is not possible. Island- and mainland salt marshes cannot replace each other, because of their large geomorphological and ecological differences. To maintain the large island salt marshes in the eastern Wadden Sea (Boschplaat, Neerlandsrijd, Oosterkwelder) the maintenance of sand dikes is necessary.

New large-scale construction of salt marshes does not fit into the present policy for the Wadden Sea. When the techniques are based on natural processes, they will succeed only slowly and locally. Moreover, restoration to a level close to the indicator value alone will not improve the disturbed balance between embankment and accretion.

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