Figure 1; Overview of the Dutch Delta and the estuaries that form the Voordelta, and major dams constructed as part of the Delta Plan (red dashed lines). The boundaries of the ebb-tidal deltas of the respective estuaries Haringvliet (1), Grevelingen (2), Eastern Scheldt (3) and Western Scheldt (4) are indicated with white lines. Depths are given in meters relative to NAP (Normaal Amsterdams Peil), the Dutch ordnance datum which is about present-day mean sea level. Note that the latter holds for all bathymetric maps in this paper.
Figure 2; The mouth of the Haringvliet and Brielse Maas estuaries in 1958. Brielse Maas had been dammed in 1950 and its former ebb-tidal delta had swiftly changed to the new hydraulic situation. In the Haringvliet ebb-tidal delta the major ebb channel Rak van Scheelhoek is situated along the shore of the island of Voorne. The ring-dike of the construction pit for the discharge sluices is situated in the middle part of the estuary. Directly south of it runs the channel Noord-Pampus which connects to the channel Slijkgat along the shore of the island of Goeree. In the north, seaward of the island of Roozenburg, the contours of major engineering works to be constructed in the years after 1958 are indicated with dashed lines. Depths are indicated in dm’s.
Figure 3; De Maas, the mouth of the rivers Rhine and Meuse, around 1850 A.D. The former estuary has been split in separate channels, Het Scheur in the northern part and De Nieuwe Maas in the south, by the formation of the island of Roozenburg. The main channel in the mouth, De Pit, has been forced to the south against the shore of the island of Voorne by the formation of the spit De Beer / Hoek van Holland. (from: Grote Historische Atlas van Nederland 1:50 000, vol. I West-Nederland 1839-1859. Wolters-Noordhoff Atlasproducties, Groningen, 1990).
Figure 4; Topography of the mouth of the Rhine-Meuse around 1850. It shows the location of the channels Het Scheur and Oude Maas, the shipping canal through Voorne (Voornse Kanaal, finished 1830) and the planned location for the Nieuwe Waterweg, to be dug through the spit De Beer/Hoek van Holland (started in 1869). (From: de Bruijn, 1949)
Figure 5; Morphology of the Haringvliet ebb-tidal delta including the mouth of the Brielse Maas in the north in 1849-1850. Note the spit De Beer that will be cut loose from the mainland of Holland by the digging of the Nieuwe Waterweg in 1869-1871. The contours of the Maasvlakte that was reclaimed between 1964 and 1976 are indicated with dashed lines. Depths are given in dm’s.
Figure 6; The morphology of the Haringvliet ebb-tidal delta in 1964. The Brielse Maas estuary has been closed off and its ebb-tidal delta has adapted to the new situation. The contour of the harbour extension Europoort is given. The contours of the Maasvlakte that was to be reclaimed in the following years are indicated. The channel pattern in the mouth of the Haringvliet has changed in reaction to the ongoing construction. Compare with the situation in 1958 in Fig. 2.
Figure 7; Aerial photograph of the mouth of the Brielse Maas and the shoreline of the island of Roozenburg in 1961. The channels in the ebb-tidal delta have rotated to a more or less north-south orientation. The shoal Westplaat has grown in surface area, has migrated shorewards and shows recurved spits at its southern tip. In front of the island of Voorne, a fan-like spit complex has formed. (From: Terwindt, 1964)
Figure 8; Aerial photographs of the island Roozenburg showing agricultural land and nature reserve De Beer at the coast before 1950 (top) and in 1960 (bottom) after construction of the Europoort harbour extension (from: van den Burg, 1989). In the top panel, the course of the blocked and subsequently reclaimed channel Het Scheur can still be recognized.
Figure 10: The sequence of interventions over the years 1955-1970 that are part of the damming of the Haringvliet estuary. This sequences includes building of the ring-dike for the construction pit of the discharge sluices in 1957, reconstruction of the Goeree shore between 1959 and 1966, removal of the ring-dike and dredging of the discharge channels from 1966 to 1968, closure of the Noord-Pampus channel in 1968 and, finally, blocking of the Rak van Scheelhoek channel in 1970.
Figure 11; Bathymetry of the Haringvliet ebb-tidal delta for (a) 1965 and (b) 2009 and (c) sedimentation-erosion plots and summaries of the volume changes of the Haringvliet mouth over the interval 1964-2009.
Figure 12; The morphological evolution of the Haringvliet ebb-tidal delta between 1957 and 2012. The course of respective channels are indicate with dashed lines.
Figure 13; The bathymetry of the Voordelta for the representative years (a) 1968 (based on Vaklodingen 1967-1969) and (b) 2010 (based on Vaklodingen 2009-2011). The morphological changes over this interval are shown by the sedimentation-erosion patterns in panel (c). Note that for Haringvliet the 2009 bathymetry was used, prior to construction of Maasvlakte2.
Figure 14; Cross-sections through the Haringvliet ebb-tidal delta showing the erosion of its shoreface, the formation and migration of the Hinderplaat, infilling of the tidal channels and the progradation of the spits and shoreline of Goeree between 1957 and 2012. Note that the sea is on the right-hand side in the cross-sections.
Figure 15; Overview of the bathymetry of the Grevelingen ebb-tidal delta for (a) 1964 and (b) 2010. The morphological changes over this interval are shown by the sedimentation-erosion pattern and the volume changes over this interval (b) and the cross-sections over the ebb-tidal delta (d).
Figure 16; General model for ebb-tidal delta evolution after a significant reduction in cross-shore flow, based on the evolution of the Haringvliet ebb-tidal delta between 1964 and 2006.
Figure 17: Sedimentation and erosion in the Haringvliet ebb-tidal delta between 1964 and 2012. The volume changes of the individual polygons are given in the tables.
Figure 18; Cumulative volume changes of the ebb-tidal deltas of Grevelingen and Haringvliet between 1964 and 2010. The red lines represent cumulative nourishment volumes (excluding dune nourishments).