Geo3-4306 Kust Hoekstra / Ruessink.

1. Waves and sediment transport under storm conditions

Figure 1.1 shows an instantaneous, 800-s time series of sea-surface-elevation as measured in about 3-m water depth in the inner surf zone during a severe storm. The variations on the time scale of about 15 s represent waves that propagate past the instrument location. At the time of the measurements, the significant wave height well seaward of the surf zone was about 7 m, the wave period was about 15 s, and the angle of incidence was 30° from shore normal. When the measurements were made, the beach was uniform in the alongshore direction and the cross-shore beach slope was 1:50. The median grain size diameter on the beach is 300 μm. The beach faces the Atlantic Ocean.

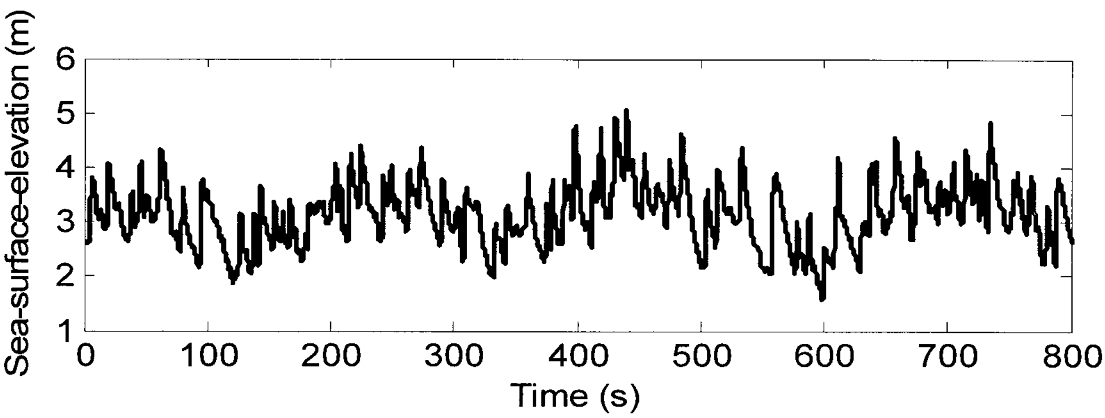

Figure 1.1 Time series of sea-surface-elevation

a) Are these offshore waves with a height of 7 m and a period of 15s likely to be sea waves or swell? Explain your answer.

b) Carefully examine the time series in Figure 1.1. Mention three characteristics of the sea/swell waves that corroborate the remark that the measurements were made in the inner surf zone. Briefly explain your answer.

c) As you can see in Figure 1.1, the sea-surface-elevation also fluctuates on the time scale of about 200 s. What are these fluctuations and how are they generated?

d) Discuss which hydrodynamic processes are likely to dominate the stirring and the subsequent cross-shore transport of sediment under the conditions shown in Figure 1.1.

2. Morphological evolution of a sandbar

Figure 2.1 shows a time-exposure image, collected by an Argus video camera at Surfers Paradise, Gold Coast, Queensland, Australia. This image was obtained by averaging over 600 separate images collected at 1 Hz. The image is thus a 10-minute time-averaged image. The most obvious feature in the image is a white, high-intensity band, indicated by the arrow. At the time the image was taken, the waves approach the beach from a shore-normal direction.

Figure 2.1 Time-exposure image of Surfers Paradise, Gold Coast, Australia

a) It is often assumed that the alongshore, high-intensity band marked by the arrow is indicative of the presence of a sandbar. Explain why this assumption is justified.

b) Classify the sandbar morphology marked by the arrow according to the beach-stage-model of Wright and Short (1984). Motivate your answer.

c) Lifeguards have indicated the immediate vicinity of location A to be very dangerous for tourists because of the presence of a rip current. Do you agree that there will be a rip current at location A? If yes, explain why. If no, provide an alternative current pattern for location A.

d) Shortly after the image in Figure 2.1 was taken, Surfers Paradise was hit by a storm that caused the sandbar to become alongshore uniform and then to migrate offshore by 50 m. Use the morphodynamic-system approach to outline why a sandbar will migrate offshore during a storm.

3. Development of tidal conditions in the estuary of the Western Scheldt (NL)

Paleogeographic developments in the Western Scheldt estuary are illustrated in Fig. 3.1; it shows the effect of both natural and man-induced developments inside the estuary. Meanwhile and over the same period tidal conditions in the Western Scheldt estuary have also changed; the modification in tidal range is demonstrated in Fig. 3.2 ; the diagram is based on tidal observations since 1650.

3a) What is the relation between the development of the tidal range and the morphological development of the estuary ? Explain the longitudinal change in tidal conditions inside the estuary. Motivate your answer.

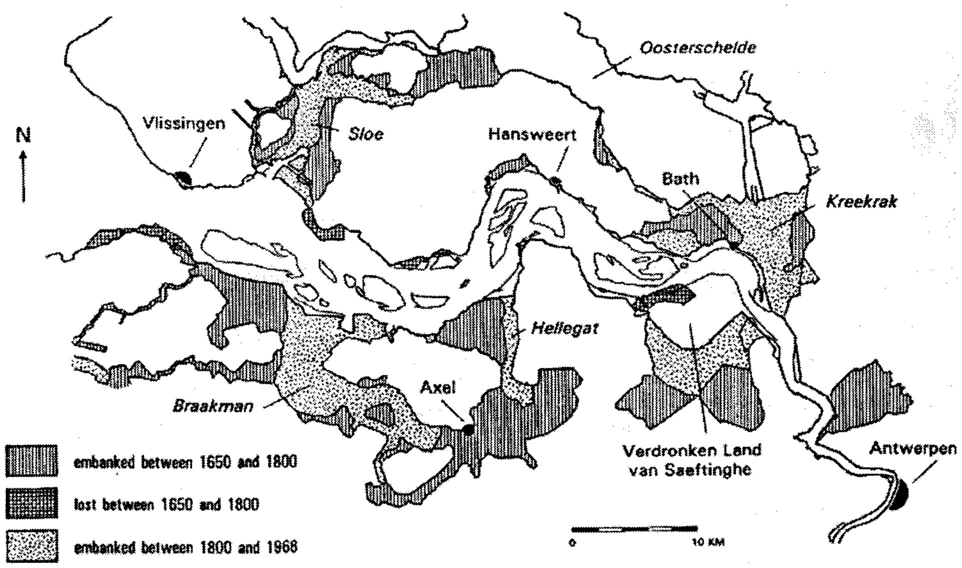

Fig. 3.1: Changes in intertidal morphology in the estuary of the Western Scheldt since 1650.

3b) What will happen with the time lag between the moment of high water at Vlissingen (almost at the mouth of the estuary) and the moment of high water at Antwerpen (about 75 km upstream in the estuary) in the same period ?

3c) What will happen with the tidal prism of the Western Scheldt and what kind of morphological feedback can be expected ?

3d) What is the effect of an increase in tidal range for the erosional and depositional processes that operate in salt marshes? Discuss both wave- and current-driven processes.

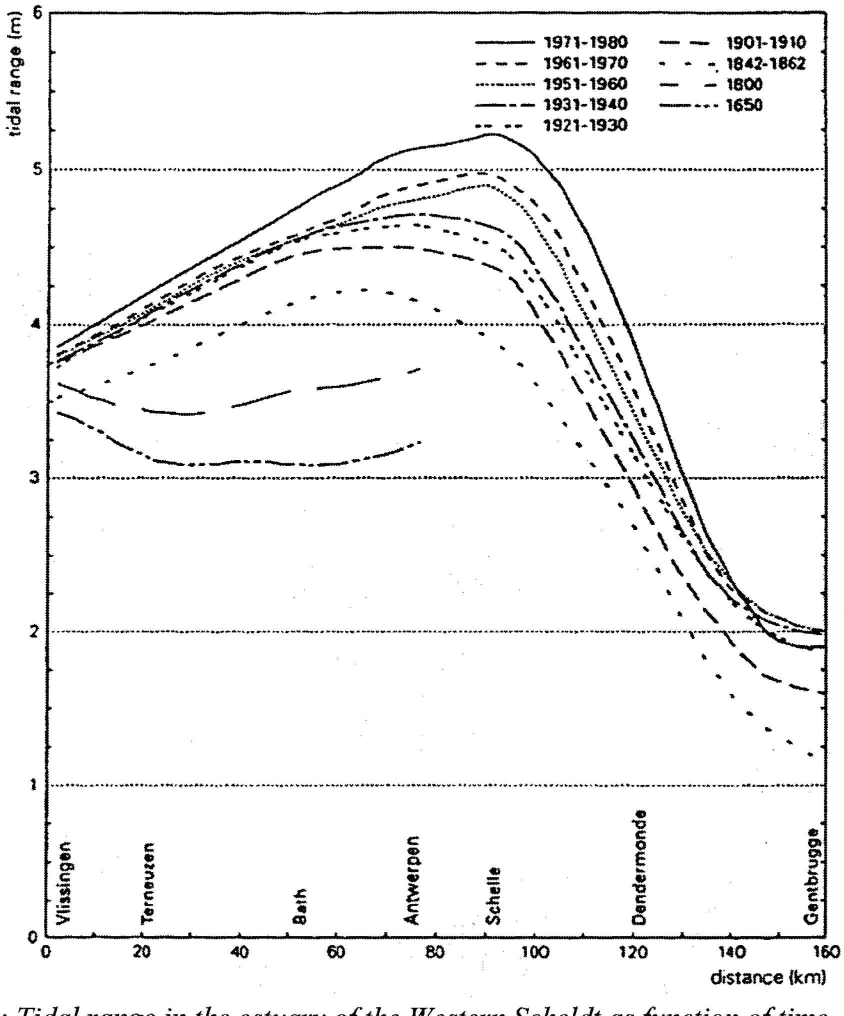

Fig. 3.2: Tidal range in the estuary of the Western Scheldt as function of time (developments since 1650) and location inside the estuary. The mouth of the estuary corresponds to km section 0 (close to Vlissingen).

4. Morphodynamics of a tidal inlet and estuarine system

The Edisto Inlet is located along the East coast of the USA. In the period 1853-1963/1978 the morphology of the system has changed considerably, as illustrated by the migration in coastlines of the islands at both sides of the inlet (Fig. 4.1) and the morphological changes in the ebb tidal delta (Fig. 4.2).

4a) What changes can be observed in the ebb tidal delta and how are these changes related to changes in the back barrier basin and the longshore sediment transport ? Explain your answer.

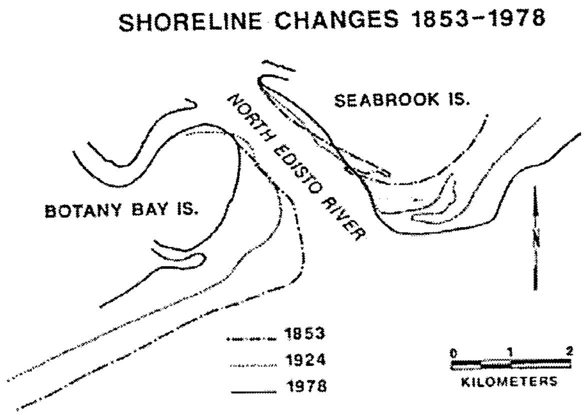

Fig. 4.1: Changes in coastline at Edisto Inlet (USA; 1853 – 1978)

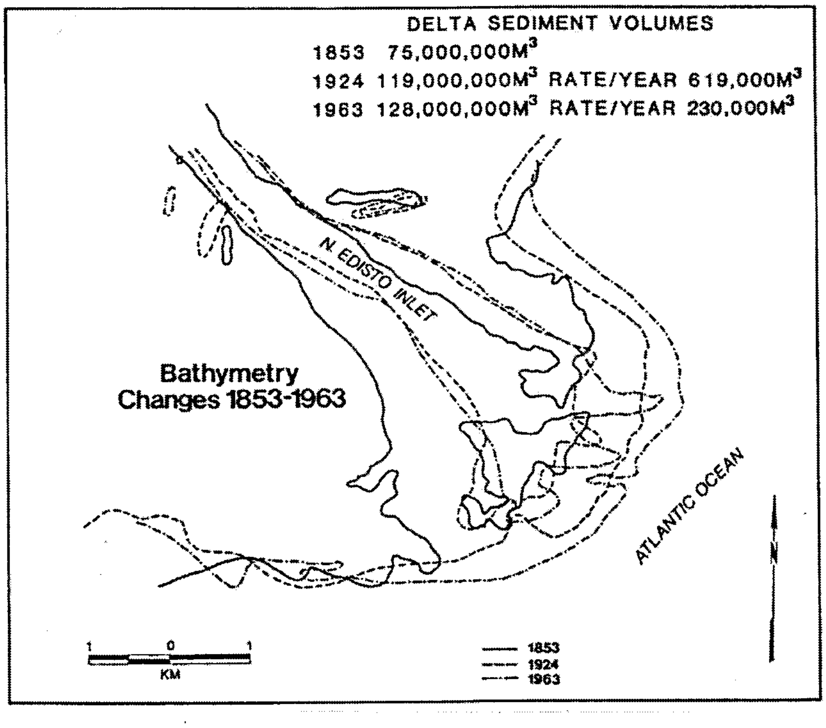

Fig. 4.2: Morphological changes in the ebb tidal delta of Edisto Inlet (1853-1963)

4b) What is the dominant direction of the longshore, wave-driven sediment transport (longshore drift) along the coast of the barrier islands ?

However, not only sand transport along the coast is relevant for the development of this coastal system, the Edisto river also supplies suspended sediment. River (out)flow and suspended sediment transport is depicted in Fig. 4.3. Measurements were carried out in the river mouth and include water depth, flow velocity and direction, salinity distribution, the Ri – number and the suspended sediment concentrations as function of height above the bed.

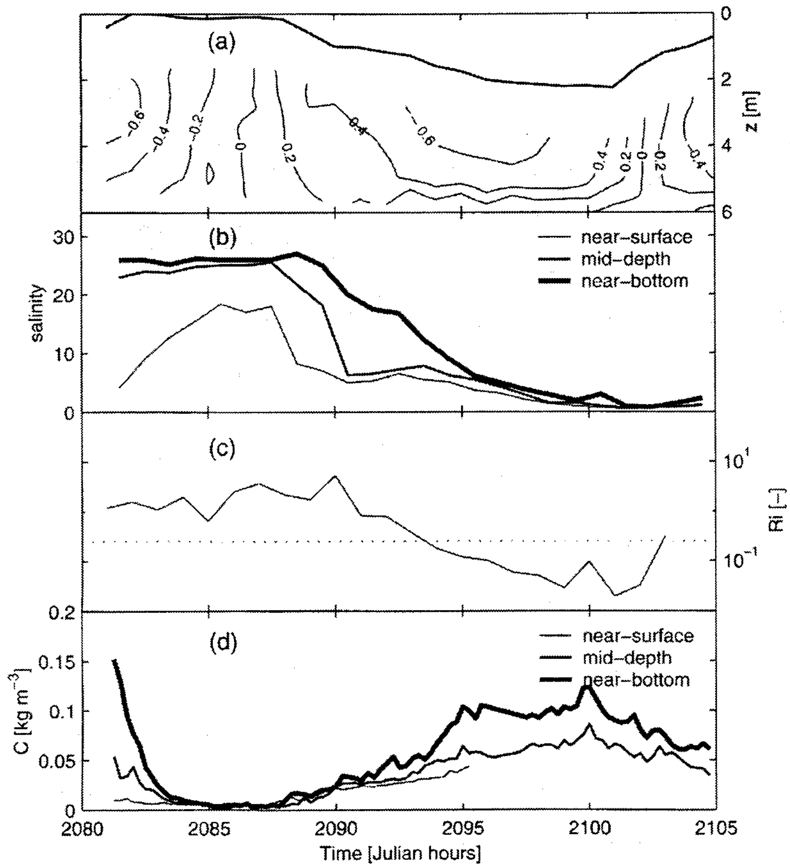

Fig. 4.3: Hydrodynamic and sediment transport conditions in the river mouth. It shows water levels and flow velocity (a, positive flow is in downstream direction), salinity distribution (b), Ri-number (c, dashed line Ri = 0.25) and suspended sediment concentration.

4c) Are tidal conditions in the river mouth a product of a progressive wave, a standing wave or a mixture of both ? Explain your answer.

4d) Explain the relations between the velocity, salinity and suspended load patterns measured at this location. How stable is the density stratification in the system ?