Coastal Morphodynamics Ge03-4306
30-01-'06

Question 1 Morphological evolution

Figure 1.1 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. The dot A marks the location of an instrument that measured the mean cross-shore and alongshore velocity.

Figure 1.1: Time-exposure image at Surfers Paradise, Gold Coast, Queensland, 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 (1983). Motivate your answer.

c) At the moment the image was collected, an instrument that measured mean cross-shore and alongshore velocity was located at position A. Estimate the dominant direction and magnitude of the current at point A. Explain your answer. Assume that offshore waves approach the shore with a zero angle between the wave rays and the shore normal.

d) Figure 1.2 shows the offshore wave height for a 3-week period at Surfers Paradise. The image in Figure 1.1 was taken at time = 0 days. How will the sandbar respond to the offshore wave series shown in Figure 1.2? Use the terminology of the Wright and Short (1983) model. At the Gold Coast waves with a height less than about 1.5 m can be considered as low-energetic waves.

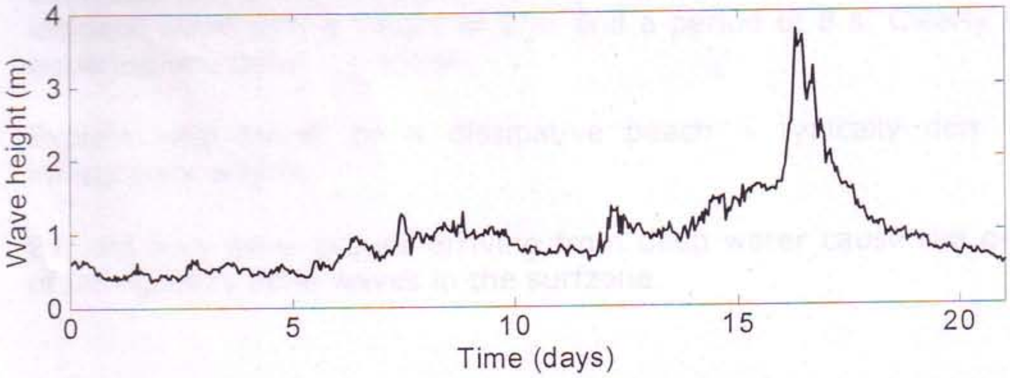


Figure 1.2: Wave height as a function of time. The image in Figure 1.1 was collected at time = 0 days.

e) The instrument at location A also measured during the storm at time = 17 days (wave height about 3.5 m). Provide an estimate of the direction and the magnitude of the mean *cross-shore* current at time = 17 days. Motivate your estimate.

Question 2 Shoreline hydrodynamics

a) During storms, the waterlevel on a beach is typically larger than the tidal water level offshore. Provide two mechanisms that may cause this larger waterlevel. Also briefly explain how these two mechanisms lead to the larger waterlevel.

b) Estimate the 2% exceedence run-up elevation on a 1:50 beach for an incident wave with a height of 2 m and a period of 8 s. Clearly state the equation you used. rekenen

c) Explain why swash on a dissipative beach is typically dominated by infragravity waves.

d) Explain how wave groups arriving from deep water cause the generation of infragravity edge waves in the surfzone.

Exams GEO3-4306 Coastal Morphodynamics

Question 3: Tides in the Persian Gulf

Tides are important in generating water level fluctuations and associated currents. Tidal conditions in the Persian Gulf, in particular based on the O_1 (fig. 3.1A) and M_2 (Fig 3.1B) tidal constituents are illustrated in Fig. 3.1 The Persian Gulf is characterized by mixed tidal conditions and both diurnal and semidiurnal components are important for the local tidal regime. Fig. 3.1 gives an overview of both cotidal and co-range lines. The Persian Gulf has the following geographical dimensions: its length is about 850 km, the width is on average 320 km and the mean depth is 50 m.

Q 3.1:

Explain the pattern of co-tidal and co-range lines for the O_1 and M_2 constituents in the basin. What are common aspects and what are the differences in behaviour of both tidal constituents ? What explains the differences ?

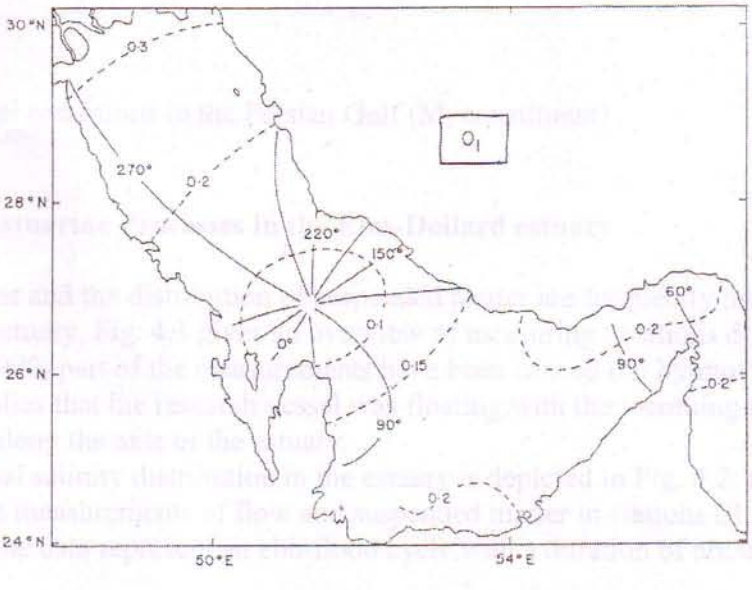


Fig. 3.1 A: Tidal conditions PersianGulf (O_1 tidal constituent)

Q 3.2

Purely based on tidal amplitudes, how should you characterize the tidal regime at a position 51° East and 26 – 27 ° N in the Persian Gulf; explain your answer.

Q 3.3

Which component is expected to result in tidal resonance (tidal co-oscillation) ? Provide arguments based on both theoretical considerations as well as information in both figures.

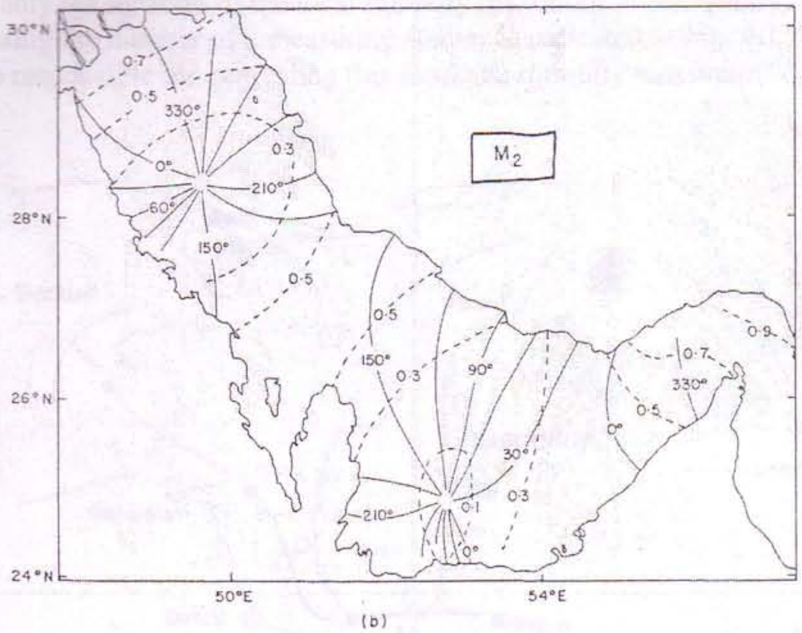


Fig. 3.1B: Tidal conditions in the Persian Gulf (M_2 constituent)

Question 4: Estuarine Processes in the Ems-Dollard estuary

Flow conditions and the distribution of suspended matter are frequently measured in the Ems-Dollard estuary. Fig. 4.1 gives an overview of measuring positions during a field campaign in 1990; part of the measurements have been carried out by moving boat method. It implies that the research vessel was floating with the incoming and outgoing water masses along the axis of the estuary.
The longitudinal salinity distribution in the estuary is depicted in Fig. 4.2; the figures 4.3 and 4.4 present measurements of flow and suspended matter in stations 01 and 06, respectively. The data represent an ebb-flood cycle with a duration of about 12 hours.

Q 4.1

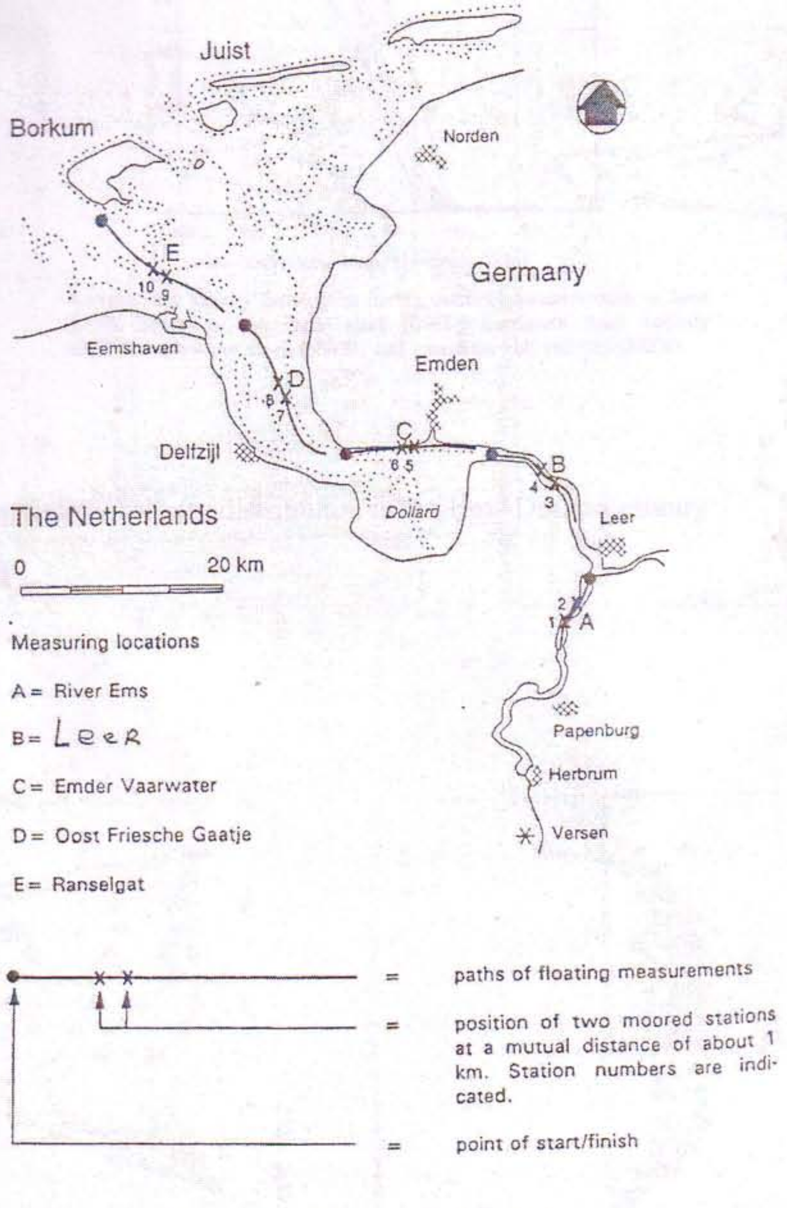
Explain the distribution of flow velocities in time. What is the difference in tidal flow conditions for both locations and what explains the difference ?

Q 4.2

Explain the concentrations in suspended matter as measured at station number 01. Are the maximum concentrations due to local erosion and resuspension or is advective transport (supply from other regions) a more dominant mechanism ? Motivate your answer.

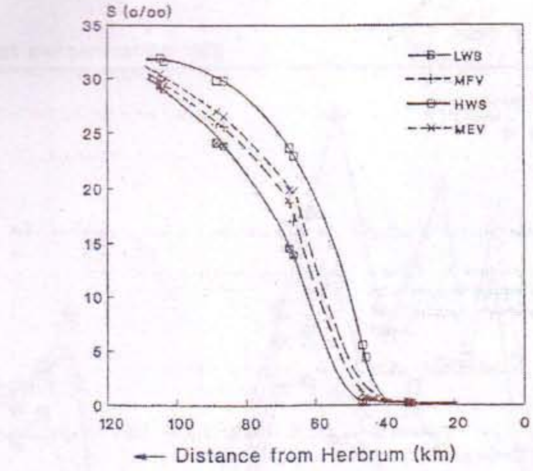
Q 4.3

What is probably the location of the local turbidity maximum in the estuary; indicate the position by using the number of a measuring station as indicated in Fig. 4.1. Which processes are responsible for generating this estuarine turbidity maximum?



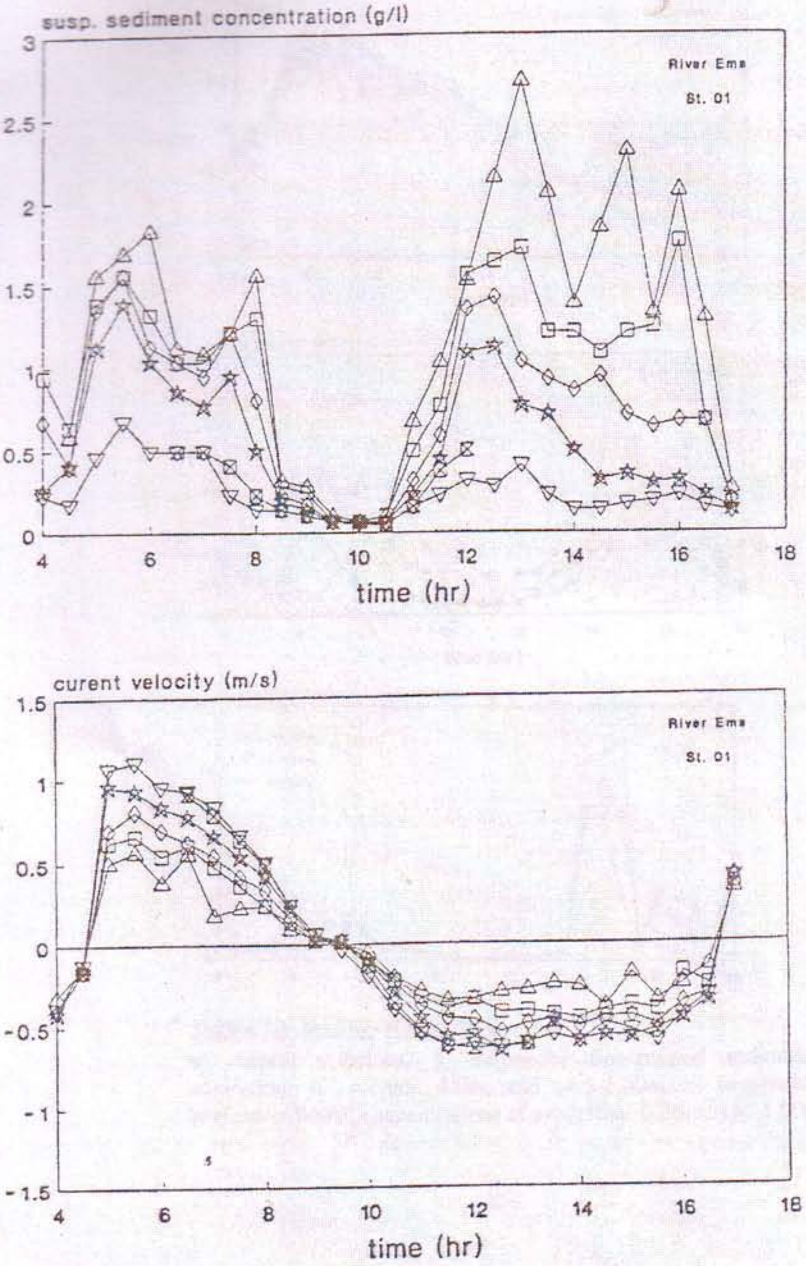
Locations of field measurements in the Ems Estuary.

Fig. 4.1: Location of field measurements in the Ems-Dollard estuary.



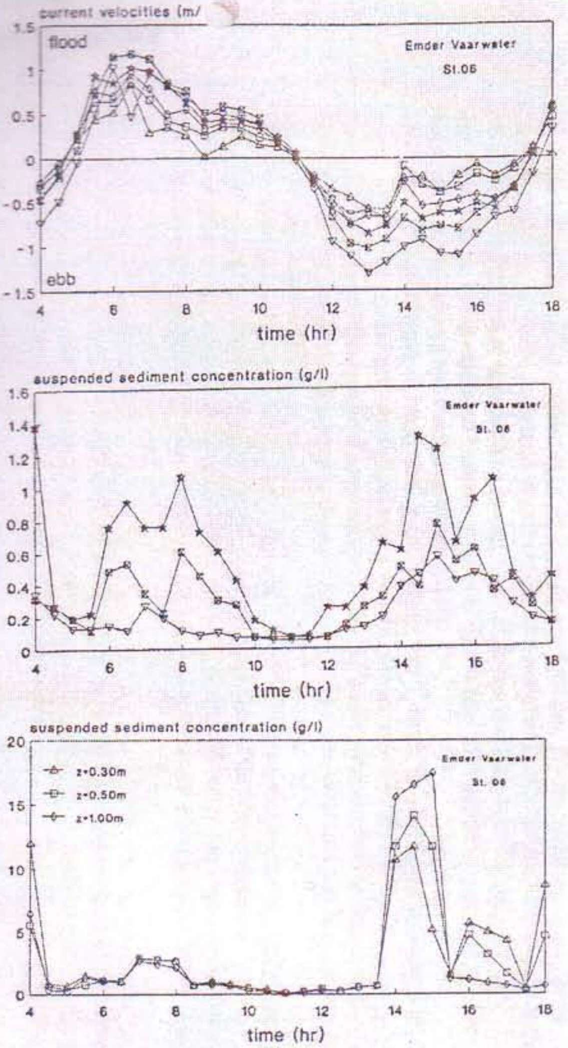
Longitudinal salinity distribution during the field measurements in June 1990. Results at low water slack (LWS), maximum flood velocity (MFV), high water slack (HWS), and maximum ebb velocity (MEV).

Fig. 4.2: Longitudinal salinity distribution in the Ems-Dollard estuary



. Station 01; location River Ems.
a) current velocities. b) suspended fine-grained sediment concentrations.

Fig. 4.3: Current velocities and suspended matter at station number 01



Station 06; location Emder Vaarwater.

a) current velocities. b) suspended fine-grained sediment concentrations at z=2.0m, 4.0m, and z=S-1.50m. c) suspended fine-grained sediment concentrations at z=0.30m, 0.50m, and 1.00m.

Fig.4.4: Current velocities and suspended matter in the Ems-Dollard estuary at location number 06