Bachelor Earth Sciences
Final exam of GEO3-4306 Coastal Morphodynamics

Date: January 30, 2013
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Please note the following:

- Before you start, carefully read the whole question.
- Answer each question on a separate piece of paper.
- Put your name and student number on each piece of paper.
- You may use the book by Masselink, Hughes & Knight, the readers by Hoekstra, and a calculator. The use of hand-outs, power-points, lecture notes, papers used during the course, and answers to papers and exercises is not allowed.

Question 1: Wave non-linearity in the nearshore zone

Fig. 1.1 shows two time series, labelled A and B, of the sea-surface elevation measured simultaneously at two different locations in a wave-dominated coastal setting. The bed slope is 1:15. The grain size at both locations is about 250 μm. Assume the sea bed to be flat (i.e., no ripples). The offshore significant wave height is 0.7 m. The peak period is 8 s.

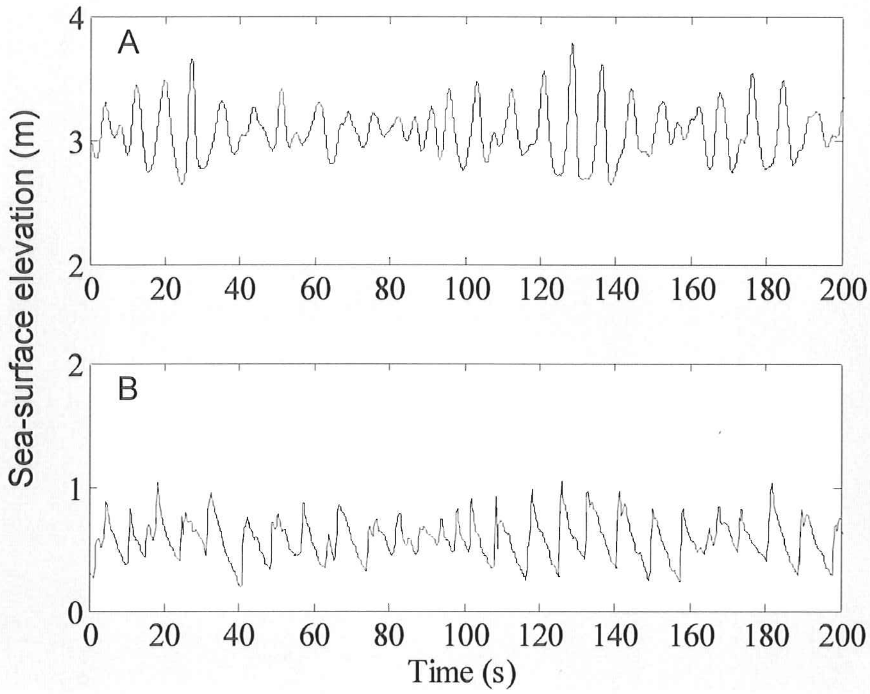

Fig. 1.1: Time series of sea-surface elevation at location A (top panel) and B (bottom panel). A sea-surface elevation of 0 corresponds to the sea bed.

a) Analyse both time series to determine in what parts of the nearshore zone the two time series were collected. Mention three distinct characteristics of the waves to support your answer.

b) Determine (= calculate) the dominant breaker type.

c) Make a motivated estimate of the wave period in the swash zone during the conditions shown in Fig. 1.1.

d) The wave-driven transport of sand at both locations was observed to be onshore directed. Explain why this was the case.

Question 2: Surf-zone circulation

Coastal scientists deployed an extensive array of instruments to measure surf-zone circulation in the nearshore zone. The bathymetry on one particular day is shown in Fig. 2.1. In this figure, X stands for cross-shore direction and Y for longshore direction. The contours indicate the bed elevation with respect to mean sea level (MSL), with negative meaning below MSL. The thick black line is the 0-m contour; the dashed line (-1 m MSL) is the location of the low-tide shoreline. Each black square is the location of an instrument that measured the mean cross-shore and the longshore velocity.

Fig. 2.2 shows the mean velocity vectors during a high tide. The offshore significant wave height was about 1.5 m and the peak period was approximately 15 s. The waves were shore-normally incident. There was no wind.

a) Classify the bathymetry in Fig. 2.1 according to the Australian beach model of Wright-and-Short (1984). Motivate your answer.

b) Explain the surf-zone circulation seen in Fig. 2.2.

c) Measurements were also taken at low tide. Motivate in what way the circulation at low tide would have differed from that at high tide. Wave conditions were the same as at high tide.

A storm arrived several days after the measurements of Fig. 2.2 were collected. The storm caused the offshore significant wave height to increase to 3.5 m. The peak period dropped to 8 s. The storm waves arrived at an angle with 30 degrees with respect to the shore-normal.

d) Explain why the peak period during the storm was lower than during the measurements prior to the storm.

e) Make a motivated guess of the evolution of the bathymetry during the storm.

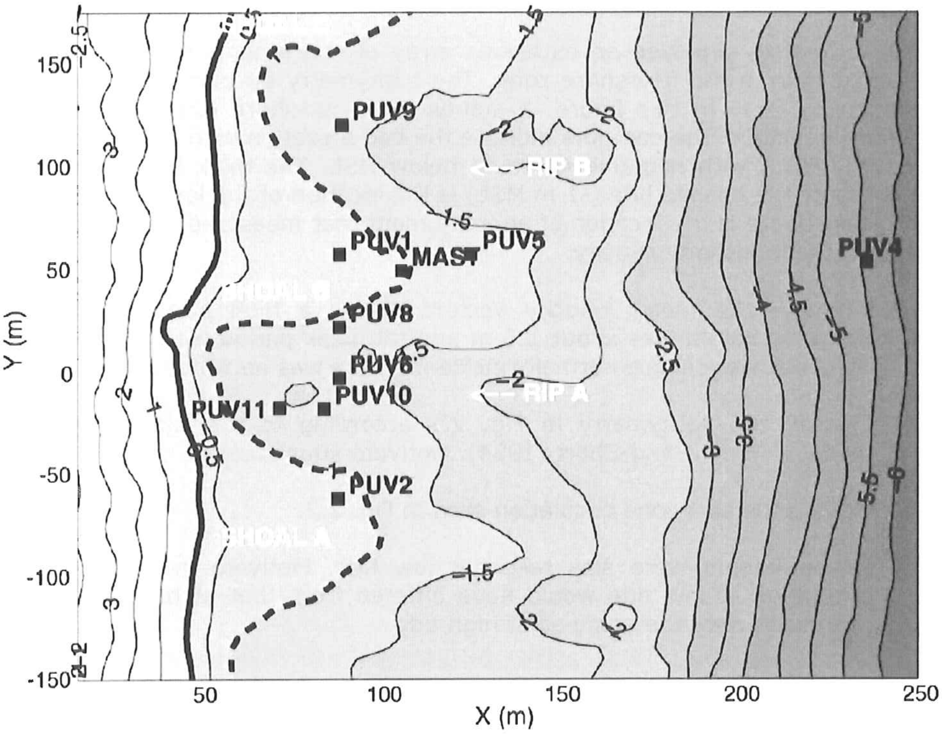

Fig. 2.1: Bathymetry (contours and colour shading) and instrument location (squares). X stands for cross-shore direction and Y for alongshore direction.

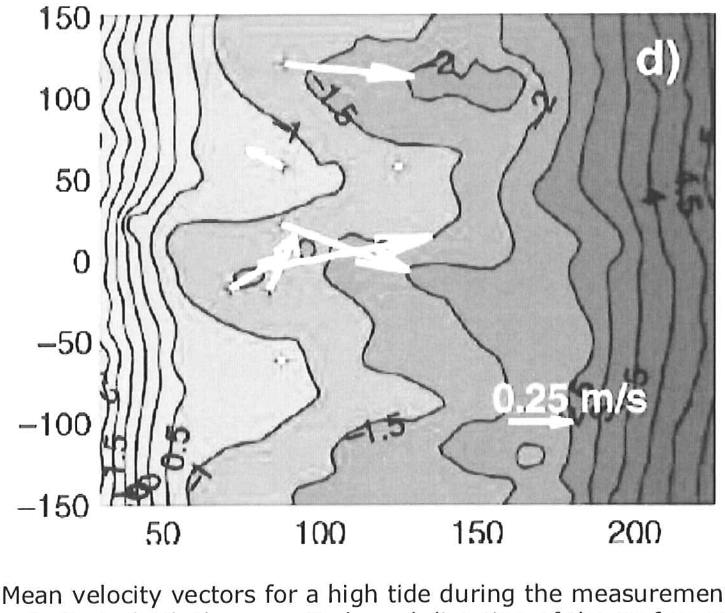

Fig. 2.2: Mean velocity vectors for a high tide during the measurement campaign. The arrows indicate both the magnitude and direction of the surf-zone circulation. The contours and colouring represent the bathymetry.

Question 3: Sediment transport processes in the Ems-Dollard estuary

Hydrodynamic and suspended sediment transport measurements were carried out in the Ems-Dollard estuary to analyse mud transport phenomena. The location and morphology of the Ems-Dollard estuary in the north of the Netherlands is illustrated in Fig. 3.1. During one of these measurement campaigns, data were obtained on the particle size of suspended sediment (Fig. 3.2a), the flow velocities (Fig. 3.2b; the black lines represent lines of equal flow verlocity in m/s and flood currents are positive and ebb currents are negative) and the concentration of suspended matter (Fig. 3.2b; indicated by grey tones and given in mg/l). The total data set represents a complete flood-ebb cycle and the measurements were carried out in the main channel of the estuary.

a) Analyse and explain the temporal and spatial (=vertical) distribution of suspended matter (SSC: suspended sediment concentration) in the water column as function of time in the tidal cycle. Based on the observations: how can one classify this Ems-Dollard estuary?

b) Which factors are responsible for the change in floc size during the measurements? Explain their effect on floc sizes.

c) Is the position of the measuring station located landward, seaward or within the turbidity maximum (ETM)? Support your answer with arguments.

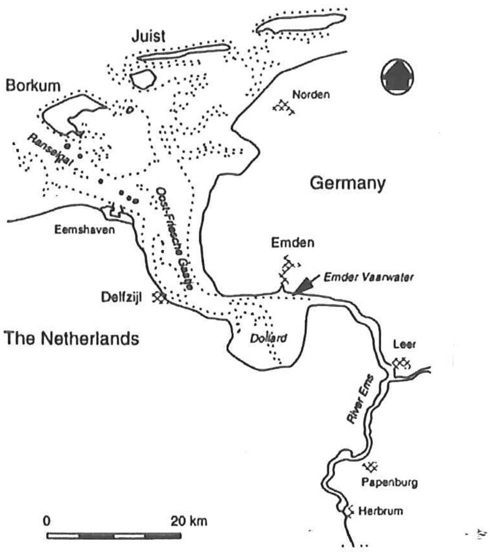

Fig. 3.1: The Ems-Dollard estuary at the boundary of the Netherlands and Germany

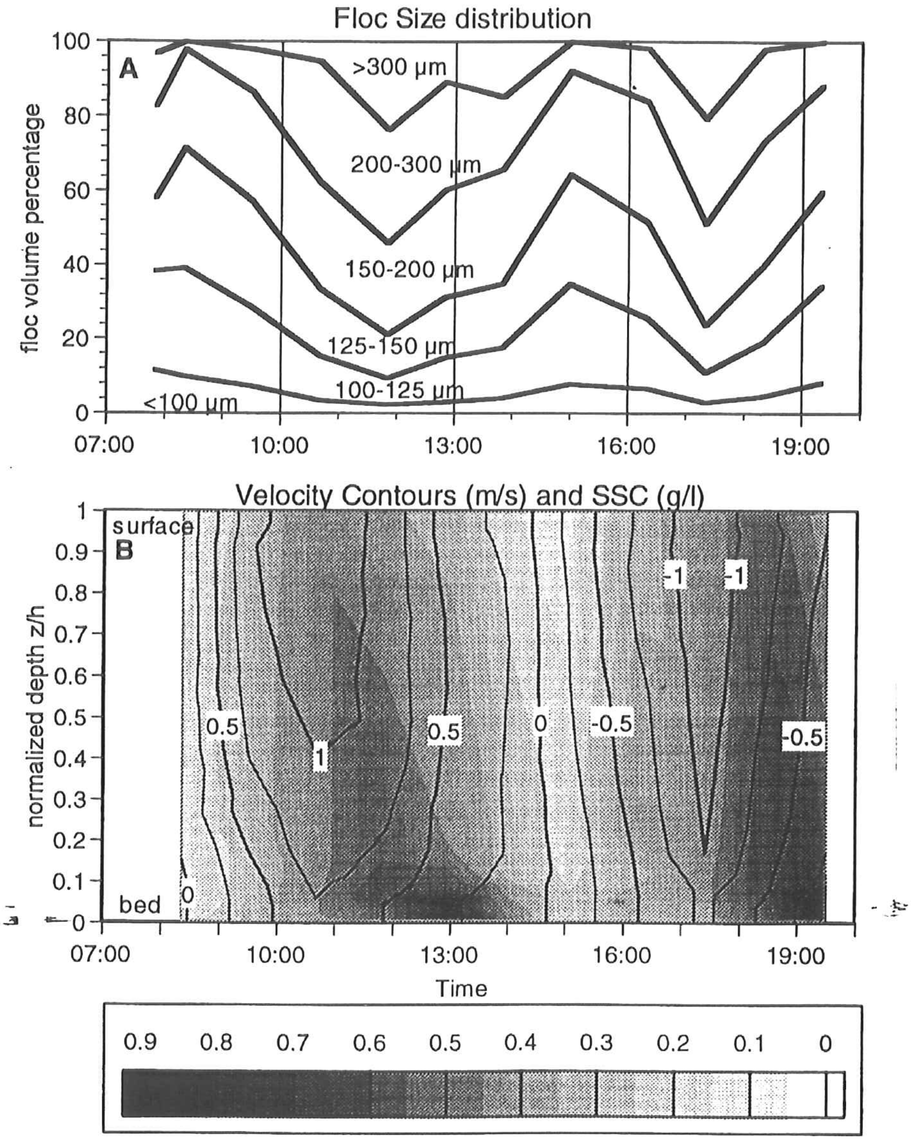

Fig. 3.2: Suspended sediment transport conditions: floc size (A), flow velocity (B) and suspended matter concentration.

Question 4: The Mekong River delta in the South of Vietnam

The network of river channels of the Mekong delta is illustrated in Fig. 4.1. The river enters the South China Sea in a number of branches and is subject to fluvial as well as marine processes. Measurements of hydrodynamic conditions in the river mouth include water depth, flow velocity and direction, salinity distribution, the Ri – number and the suspended sediment concentrations as function of height above the bed. These data are presented in Fig. 4.2.

a) Are tidal conditions in the river mouth a product of a progressive wave, a standing wave or a mixture of both? How would you classify the tidal regime of the system? Explain and motivate your answer.

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

c) Based on the morphology of the river delta and the observed hydrodynamic processes: is this a fluvial-, tide- or wave-dominated delta system? Or is it a delta system with mixed conditions? Explain your answer.

d) The Mekong delta is very important for the cultivation of rice. Rice paddies are occupying the entire area; the cultivation system is supported by an extensive irrigation network. What are the hydrodynamic consequences and the effect on human settlements of this widespread irrigation system?

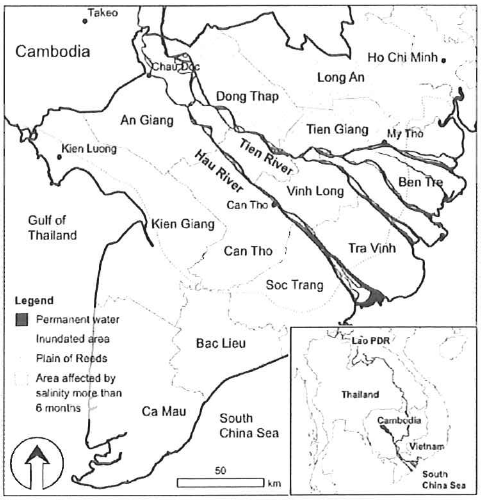

Fig. 4.1: The Mekong delta in the South of Vietnam.

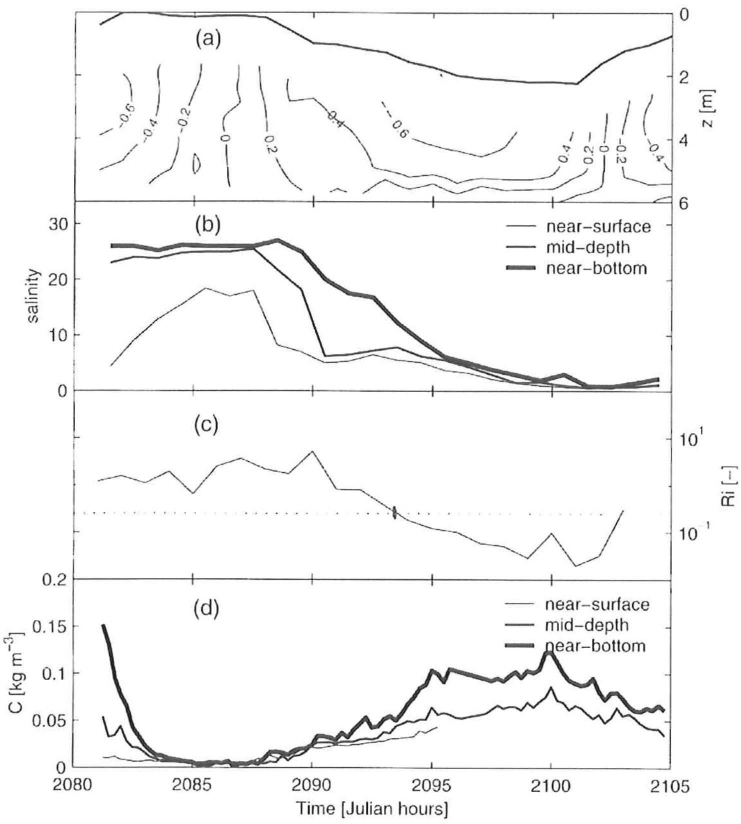

Fig. 4.2: Hydrodynamic and sediment transport conditions in the river mouth. It shows (a) water levels and flow velocity (positive flow is in downstream direction), (b) salinity distribution, (c) Ri-number (dashed line Ri = 0.25) and (d) suspended sediment concentration.