# Final examination River Morphodynamics GEO3-4305, 2016

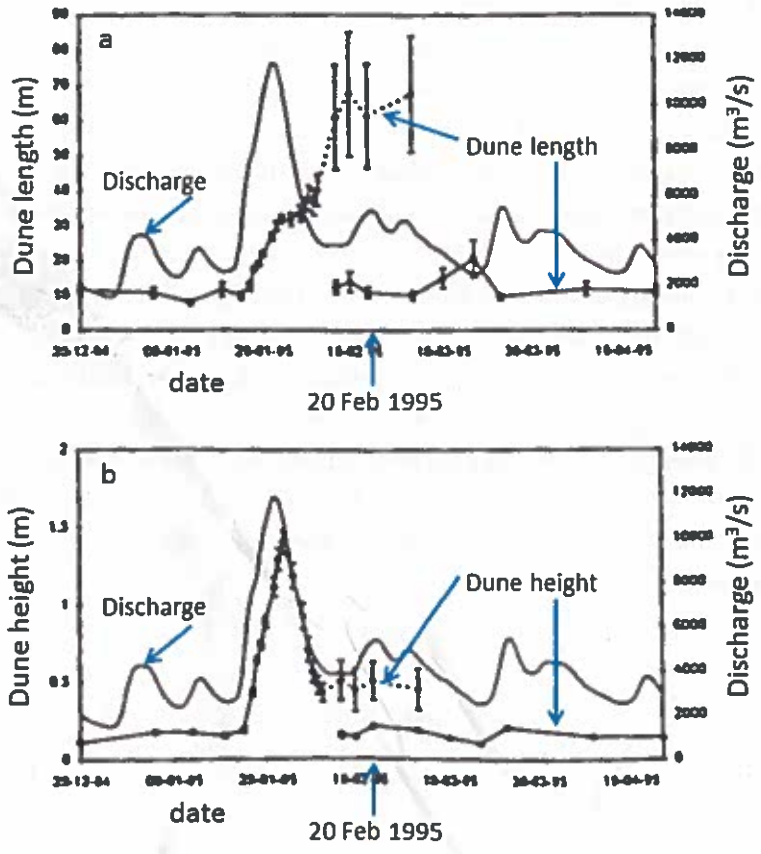
- Friday 15 April 2016, 09:00 – 12:00 hrs
- Answer questions in **English**, individual exam (no talking...)
- All course materials may be used except electronic equipment such as phones and computers.
- Adequate reasoning, good arguments and conciseness are more important than 'the correct answer somewhere in a flood of words'. All questions are weighed equally for the grade.
- The grade will be given for **no more than 5 pages** of normally written, readable text (and note that 2 pages can be sufficient).

## Question 1. Flood alert!

Over recent years, more and more money has become available to study bed forms in rivers. This is not only because these features are interesting from a scientific point of view, but also because flood risk managers want to know more about bed form dynamics and enhance the ability to predict their evolution.

a. Here the managers clearly have a point! But why? Why are flood risk managers so interested in the formation of bed forms?

b. The figure below shows the dune development in the Rhine. It shows dune length (Fig. a) and height (Fig. b) during a period of approximately 4 months. Looking at the figure, describe the type of conditions that are apparently necessary for the dunes to develop and explain why by referring to the bed form stability diagram of Van den Berg and Van Gelder (1993).



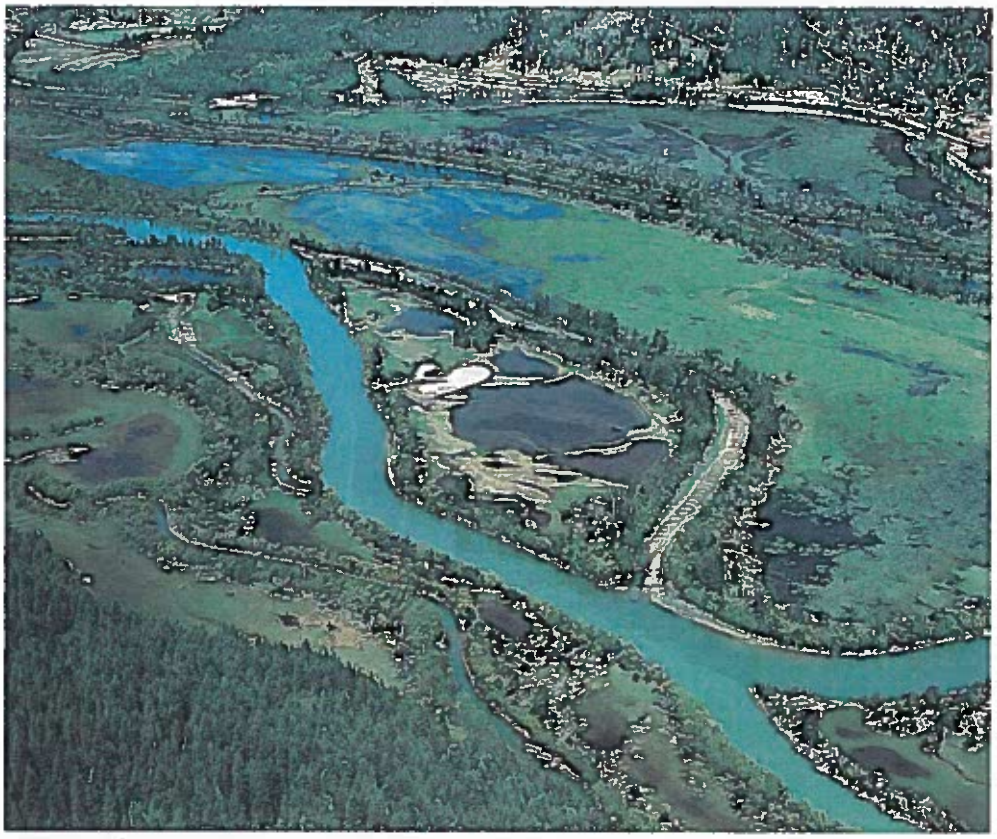
c. As you know, simple dune size predictors are mostly dependent on water depth. Now let's assume that water depth follows discharge without a delay. What problems will you encounter when using these simple predictors? Argue which predictions will be more accurate: those of dune length or dune height?
d. Let's draw! Make a sketch of the bedforms (side view) that are present on 20 February 1995.

Now we consider two modern measures in river management to reduce the risks of flooding. To judge the suitability of certain measures we have to be able to predict the change in water levels, both upstream and downstream.

e. Consider a reach of a river with a floodplain where vegetation is allowed to develop naturally. During a flood, the floodplain is covered in about 1-2 m water. Does the vegetation affect water level upstream of the forested area, downstream, or both? Why?
f. Near a populated area a retention basin is designed with an overflow weir at the side of the channel. This is an area which is allowed to flood during an extreme discharge event, and which is so large (yet shallow - remember, this is floodplain of the past) that it can contain enough water to top off the discharge peak. Does this retention basin affect upstream water level, downstream level or both? Why?
g. What effects on bed level change do you expect just upstream and downstream of the retention basin inlet?

## Question 2. It's all about the vegetation!

a. Let's first go far back in time... what type of river patterns do you think were predominantly present before the arrival of widespread vegetation on the continents, about half a billion years ago. Provide some arguments.
b. The photograph below shows a reach of the Columbia River, an anastomising river in a valley in Canada. Describe at least two mechanisms of how vegetation controls the development of river flood plain elevations and indicate how this can be seen in the photograph.
c. The bed of the channels is composed of sand, but this sand is hardly seen in the form of bars in aerial photographs during bankfull conditions. Explain whether there are sand bars, and what key variable needs to be different in a river for the sand bars to emerge.
d. Suppose we would remove our artificial levees ('river dikes') along the Rhine in The Netherlands, such that Rhine water entering the delta at the apex (Dutch-German border) can in principle flow everywhere over the delta from the apex downward when discharge is higher than bankfull, depending of course on local elevation and gradient. Discuss what would be the effect on (i) the trapping of overbank sediment by the delta floodplain when compared to the present-day situation; (ii) the main channel sediment transport and morphological development. If you need to make assumptions for your answer, make clear what these are.



## Question 3. Remeandering a small river: two contrasting views!

A local water management authority in northern Switzerland assigned a project to a Dutch company to renaturalise a small and steep gravel bed river of about 1 m deep (averaged over the width) and 30 m wide. At present the river is straight (canalized) and the banks are protected but the region used to have many gravel rivers with sparse vegetation. The most important aim of the project is to improve ecological value and water quality, and the ideal method to determine the success is by monitoring whether certain key species (plants, invertebrates, fish) are returning to this area. You are asked as independent morphologist to evaluate aspects of the design of the company.

a. The company proposes to dig a meandering channel of 1 m deep and 10 m wide in the present valley floor, reasoning that this is the best way to create spatial variation in water depth and flow velocity required for the biota, and that this will create more room for floodplain vegetation. Are they correct? Explain.
b. The local tourism office, however, would rather have a wider and shallower river as found more generally in this region, and because such a river would allow wading and fishing. Furthermore, a shallow fast-flowing river would allow for spectacular canoeing. Is such a shallow and wide river possible in principle in this case? And would canoeing be possible? Explain.