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EGU2012-2769

Experimental Meandering: From braided towards meandering by the addition of cohesive floodplain material

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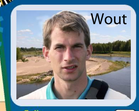
Research group River and delta morphodynamics



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Background

Braided rivers are relatively easily formed in the lab, whereas dynamic meandering rivers have never sustained beyond initial bend formation. Meandering rivers are generally single-thread and dynamic in the sense that their bends migrate through bank erosion. Bank erosion is equalled by floodplain formation on the other side of the channel. Despite numerous field and model studies, the necessary and formative conditions for meandering remain unclear until now.

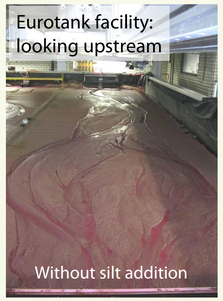
Example of a dynamic meandering river: Allier, France

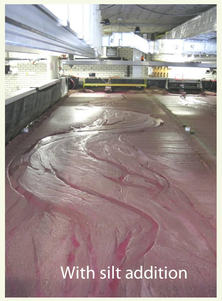
Objectives

To experimentally test:

1. **How floodplain formation causes braided or meandering river patterns.**
2. **How floodplain forms and how cohesion influences the occurrence of chute cutoffs and bend development.**

Experimental setup





To test the effect of cohesive fines on channel pattern development, we conducted two parallel experiments. To one of the experiments we added a fine silt fraction (white silica flour) in the sediment feed in a ratio of 1:4. During Q_{high} an extra amount of 0.5 L silt was added. The experiment ran for 120 hours.

Initial conditions

- Flume dimensions: 10 x 3 m
- Slope: 0.01 m/m
- Simple hydrograph: Q_{low} = 0.25 L/s for 2.5 hrs, Q_{high} = 0.5 L/s for 0.5 hr
- Initial bed material: poorly sorted sand

Continuous perturbation

- Inlet lateral amplitude: 30 cm
- Migration rate: 1 cm/hr

Measurements

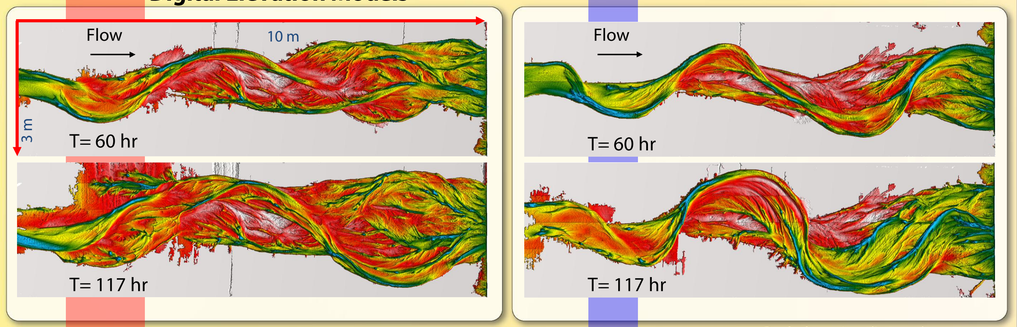
- Laser line scanner: Digital Elevation Models
- High-resolution camera: Silt distribution, Water depth, Grain-size distribution

Results

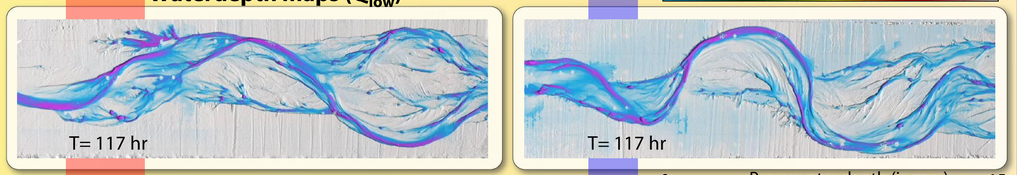
Braided river forms in the experiment **without** cohesive floodplain-filling material

Meandering river forms in the experiment **with** cohesive floodplain-filling material

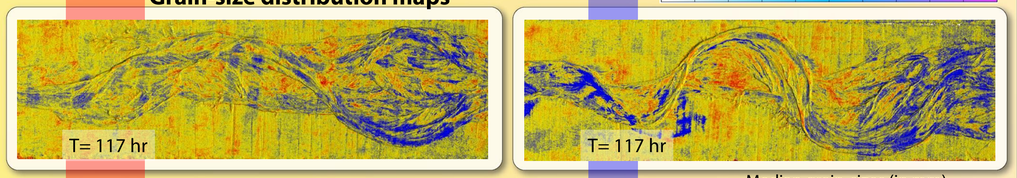
Digital Elevation Models



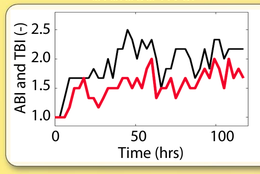
Waterdepth maps (Q_{low})



Grain-size distribution maps

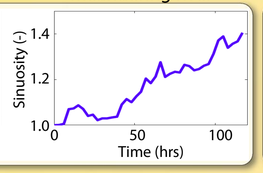


braiding index: braided river



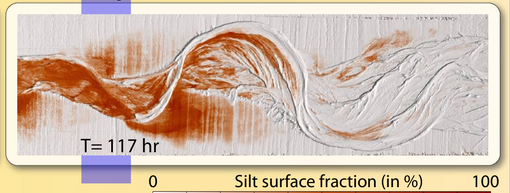
active braiding index >1.5

sinuosity: meandering river

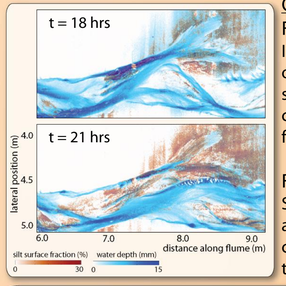


max = 1.4

Silica map



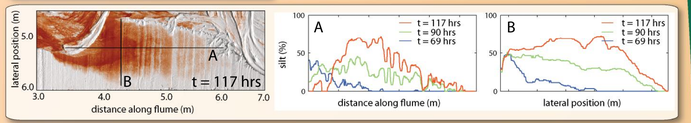
Floodplain styles



Outer bank deposits of silt:

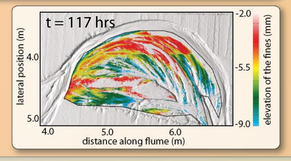
Flow strength > bank strength,
Incision of the outer bank caused the development of a crevasse splay with downstream sedimentation of the fines. When the crevasse channel is abandoned, the channel is filled with fines (Fig. left).

Flow strength < bank strength,
Sediment deposited on the outer bank and formed a Levee, where sand fraction was close to the channel and fines deposited downstream. Fines on the levee increased bank strength (Fig. below).



Inner bend deposits of silt:

Outer bank erosion by lateral migration of the channel is counterbalanced by formation of a point bar at the inner side. Fines deposited on the bar head lobes, scroll ridges and scroll swales increasing bank strength and reducing chute excavation (Fig. right).



Conclusions

- Without cohesive floodplain material a braided river forms.
- With cohesive floodplain material the channel developed to a meandering river.
- Cohesive material decreases bank erosion rate and chute excavation, so that the frequency of chute cutoffs decreases.
- Two different floodplain styles with cohesive material developed; outer bank deposits (crevasse splays and levees) and inner bend deposits (on the point bar).

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