Meandering channel dynamics in highly cohesive sediment on an intertidal mud flat

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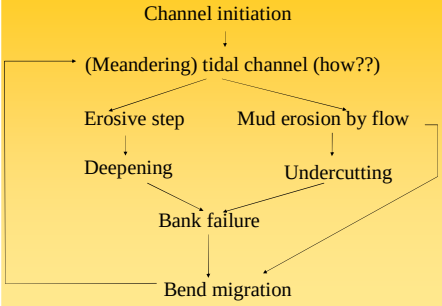
Research Questions

- How do meandering channels form and behave in a cohesive bed?
- How can the channel deepening and bend migration be predicted for these channels?

Main processes



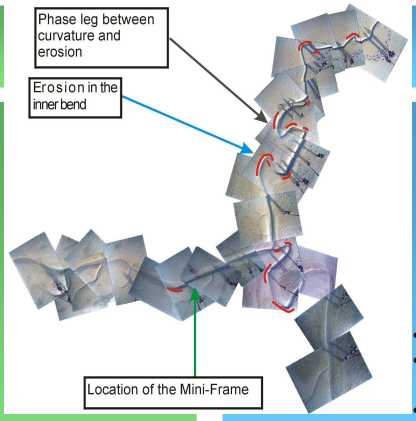
Conclusions

- Vortices in sharp bends results in highly localized bank erosion;
- sharp bends successfully parameterised in meander simulation model
- Succesive erosive steps deepen the channel;
- process well reproduced in laboratory flume and celerity well modelled

EROSIVE STEP MIGRATION

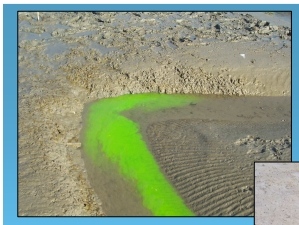
Field

- Deepening channels
- Cyclic and solitary steps
- Migration rate O(10^{-6}) m/s



SHARP MEANDER BENDS

Field



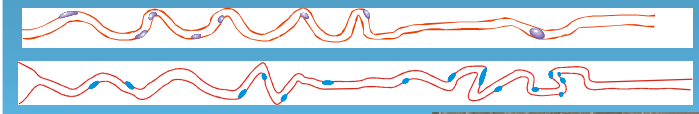
- 2 vortices per bend
- Flow impinges on outer bank
- Phase lag between erosion and curvature
- Small erosion rate
- Erosion by bank collapse

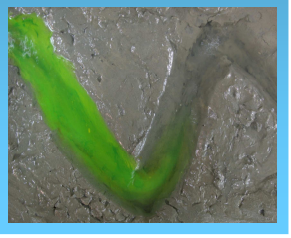
Flume

- Steps easily recreated in flume
- Both cyclic as solitary steps
- Migration rate O(10^{-6}) m/s for natural sediment
- Migration rate O(10^{-5}) m/s for sand/mud mixture

Flume

Locations of erosion in pre-formed channels:

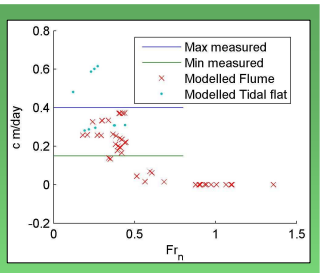


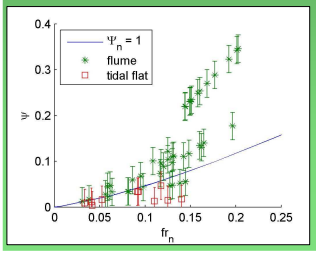


- 2 vortices
- Localised incision of channel
- Bank erosion where flow impinges
- Small erosion rate

Model

- Izumi-Parker stability analysis
- Calculated Migration rate O(10^{-6}) m/s
- Same order as measured values





- Above line - migration infinite upstream
- Below line - migration is limited
- Observations comfirm prediction

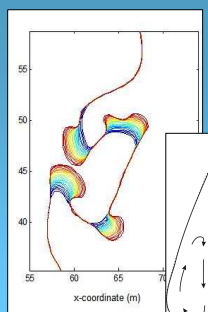
Model

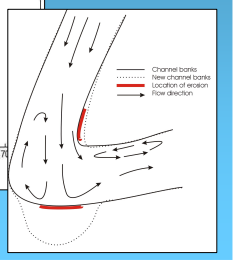
- **Meander migration model** of Ikeda *et al*. (1981) computes bend migration by:

$$\xi = Eu_{bank}$$

where u_{bank} is the excess flow velocity at the outer bank, which is related to the bend curvature.

- Parameterisation for sharp bends:
  1) Additional phase lag between curvature and bank flow velocity
  2) Critical flow velocity for bank erosion
- Modelled locations of bend erosion agree with observations
- Very slow process





References:
Ikeda, S., G. Parker, and K. Sawai (1981). Bend theory of river meanders. Part 1. Linear development. *J. of Fluid Mechanics 112*, 363–377.
Izumi, N. and G. Parker (2000). Linear stability analysis of channel inception: downstream-driven theory. *J. of Fluid Mechanics 419*, 239–262.

Acknowledgements
NWO grant ALW-VENI-863.04.016 to MK