River-ocean interactions: Building a new morphodynamic delta model

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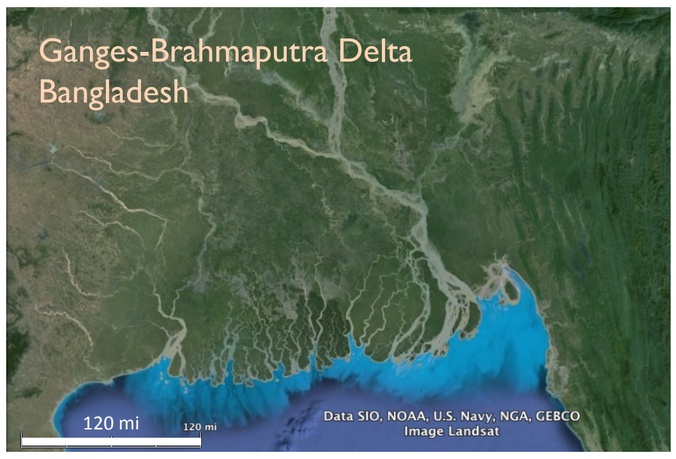


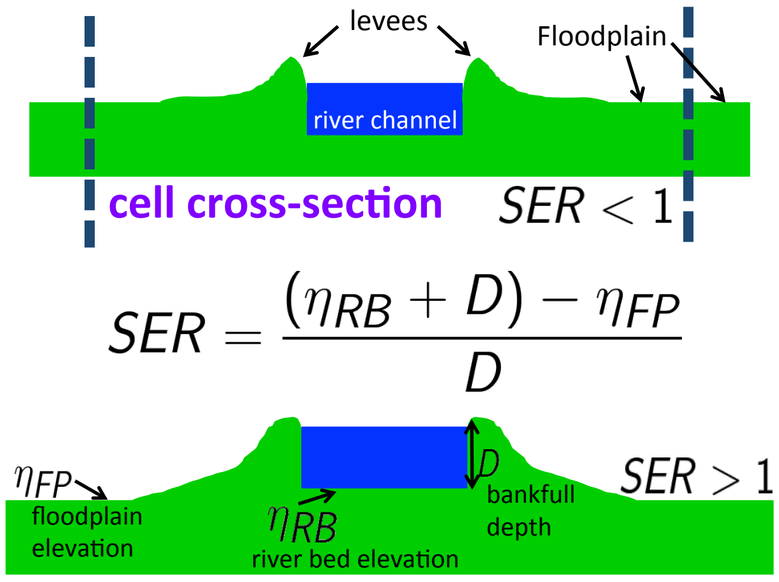
Motivation & Research Questions

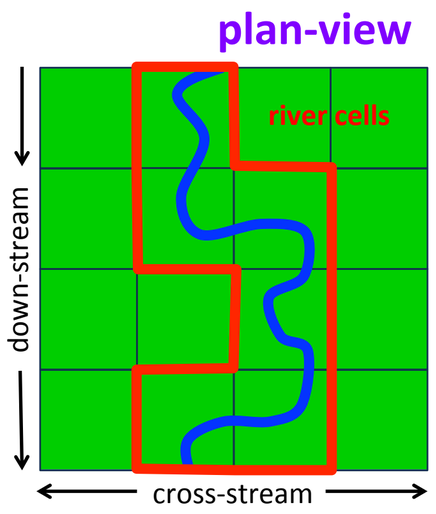
- Deltas are flat & fertile → densely populated
- Important for agriculture, resources, and transportation
- Inhabitants increasingly susceptible to natural disasters
- Humans have:
  - Decreased sediment supply (e.g. dams)
  - Altered river course (e.g. channelization, levees)
- Rate of relative sea-level rise (RSLR) increases → aggradation & backfilling increase (morphodynamic backwater) → avulsions more frequent

How will increasing rates of RSLR and anthropogenic manipulations affect delta morphodynamics?

First step: River & floodplain module

- **To be coupled with Sedflux**, a basin-filling model that generates 3D stratigraphy at large space and time scales (Hutton and Syvistki, 2008)
- **Steepest-descent methodology** (following Jerolmack and Paola, 2007) will replace probabilistic channel avulsion approach
- **River avulsions** triggered by **normalized super-elevation ratio (SER)** (Mohrig et al., 2000), **unsuccessful if not shorter** than previous path
- **Floodplain deposition** = blanket & crevasse splay (after 'failed' avulsion)

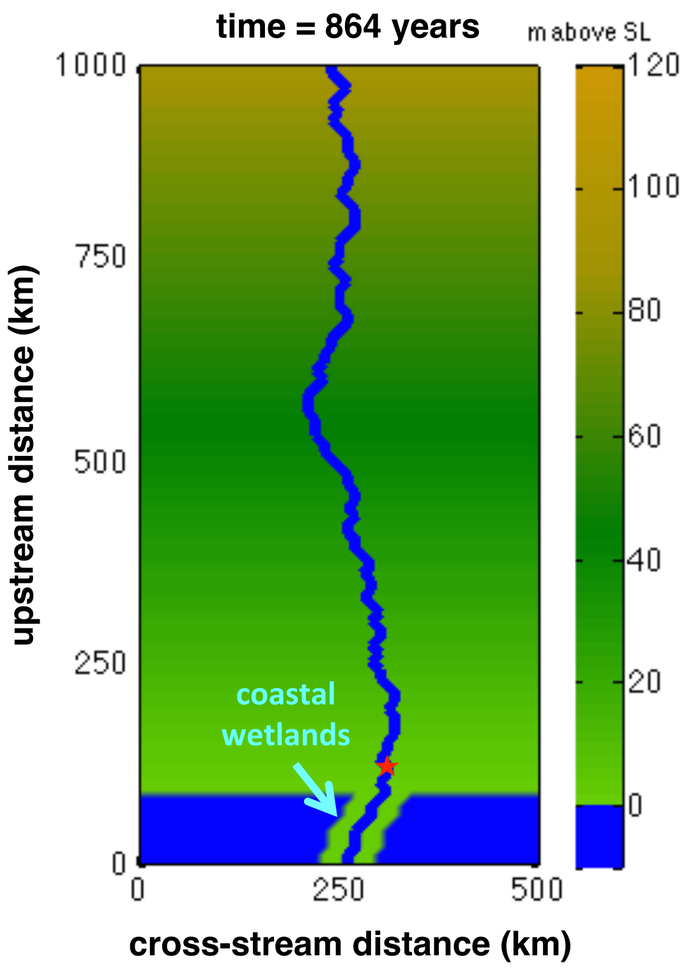


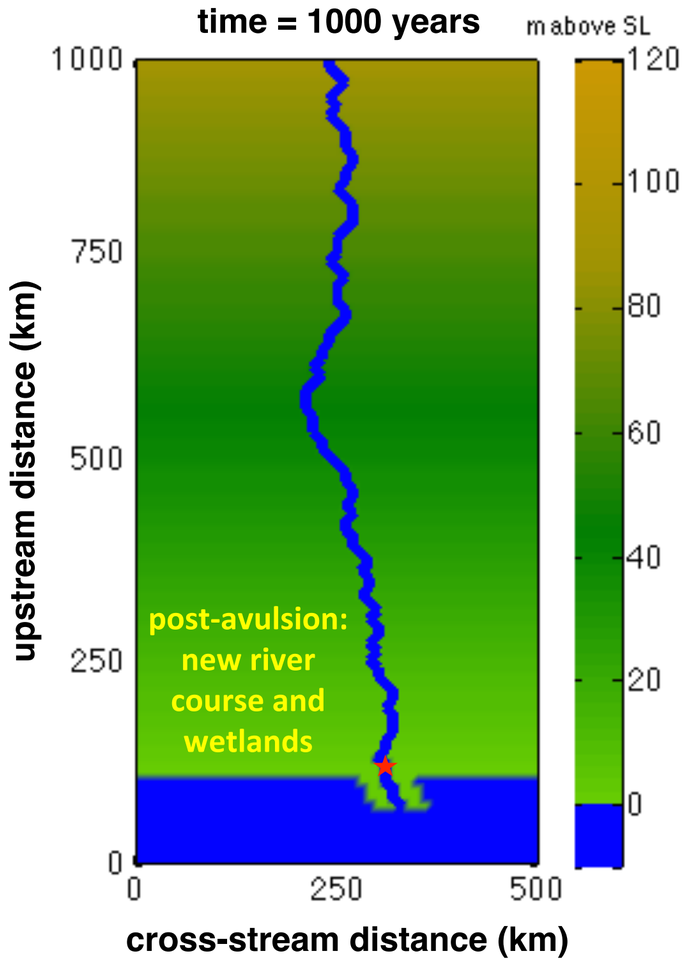


Preliminary (Uncoupled) Results

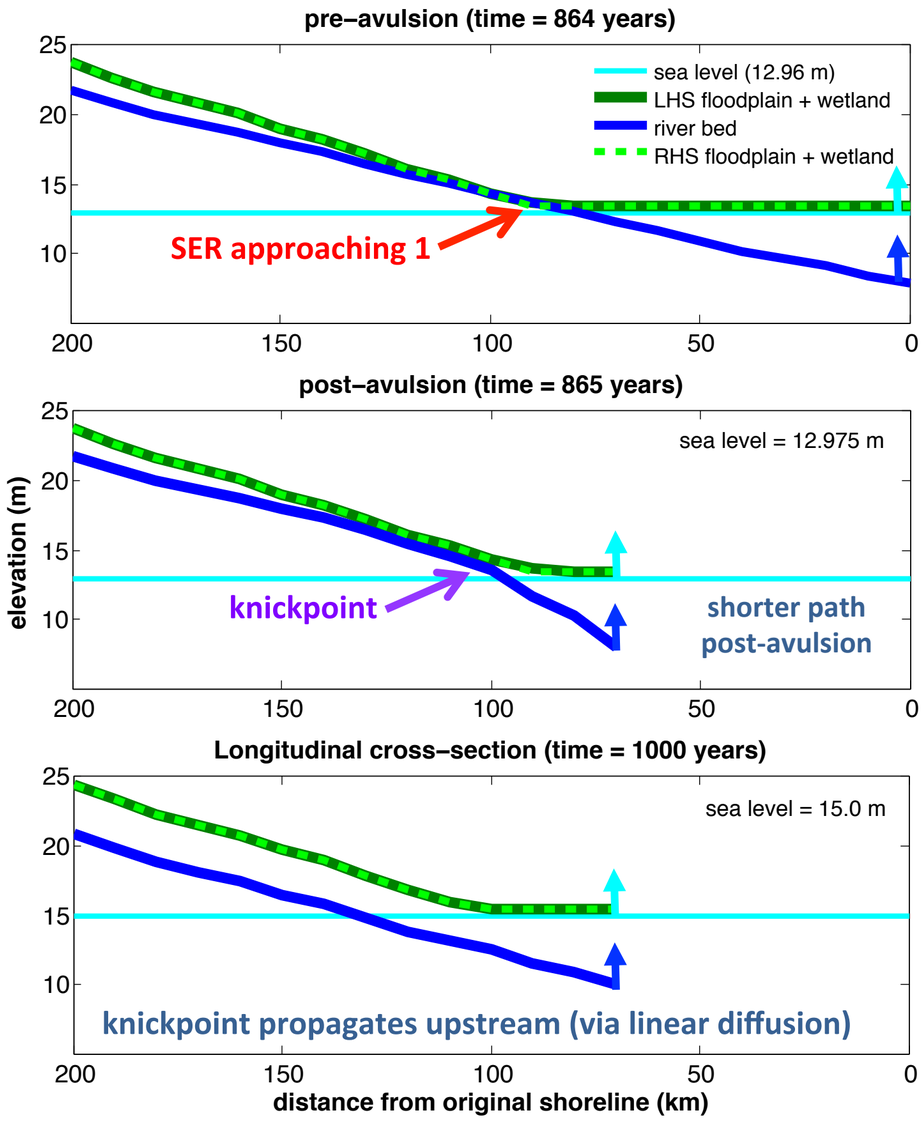
Default Parameters: cell size = 10 km; slope = 0.0001;
RSLR = 10 mm/yr; *no channel lengthening*

Plan-view: pre & post-avulsion



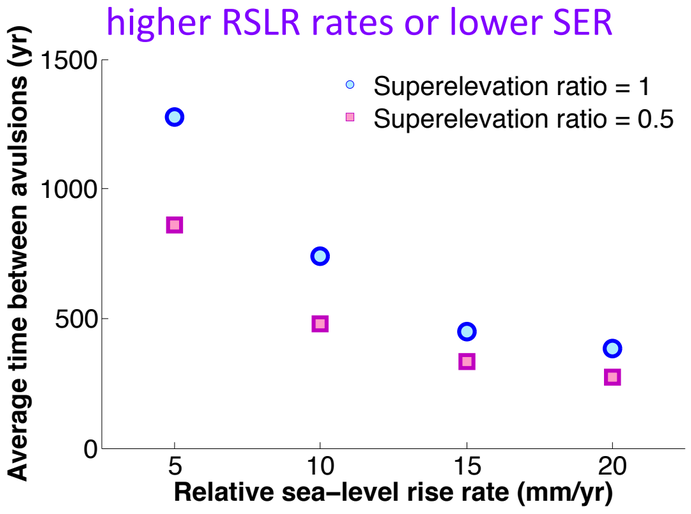


Longitudinal profile: pre & post-avulsion

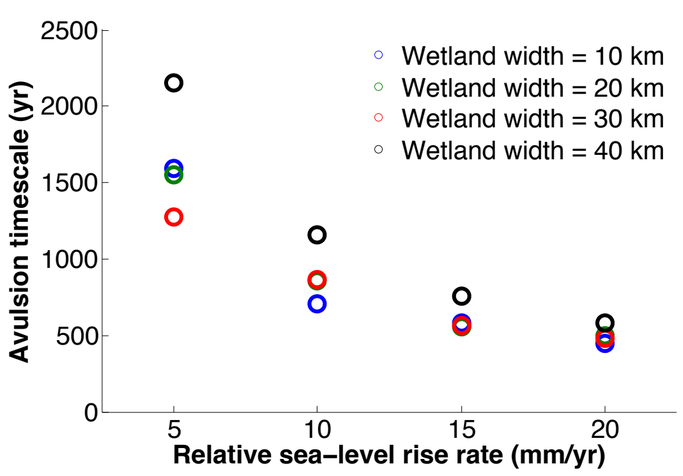


Avulsion timescales

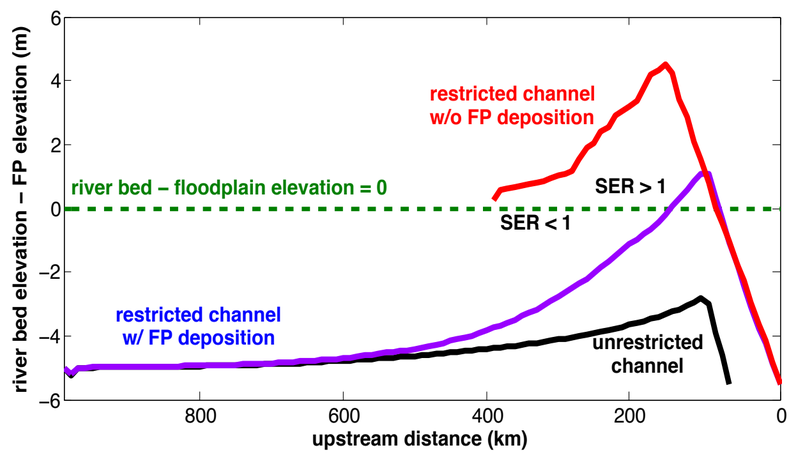
avulsion timescale decreases with higher RSLR rates or lower SER



narrow wetlands: avulsion trigger = SER
wide wetlands: trigger = shortest path



Anthropogenic manipulations



avulsions restricted: more vulnerable to floods upstream (river bed effectively higher)

Future Work

First step in a project to couple physical, ecological and human processes (couplings to include **Sedflux** as well as **coastal wetland**, **human dynamics**, **vegetation** and **coastline** modules).

The coupled model will be informed by field and laboratory observations.

Acknowledgements

NSF Geomorphology and Land-use Dynamics (EAR-13-24114) & the NSF Graduate Research Fellowship Program (DGF1106401) provided support.

References

Hutton, E. W., and **J. P. Syvitski (2008)**, Sedflux 2.0: An advanced process-response model that generates three-dimensional stratigraphy, Computers & Geosciences, 34(10), 1319– 1337.

Jerolmack, D. J., and **C. Paola (2007)**, Complexity in a cellular model of river avulsion, Geomorphology, 91(3), 259–270.

Mohrig, D., P. L. Heller, C. Paola, and **W. J. Lyons (2000)**, Interpreting avulsion process from ancient alluvial sequences: Guadalope-Matarranya system (northern Spain) and Wasatch Formation (western Colorado), Geological Society of America Bulletin, 112(12), 1787– 1803.