HYDRODYNAMIC MODELLING OF COMPOUND FLOOD DRIVERS IN ESTUARIES

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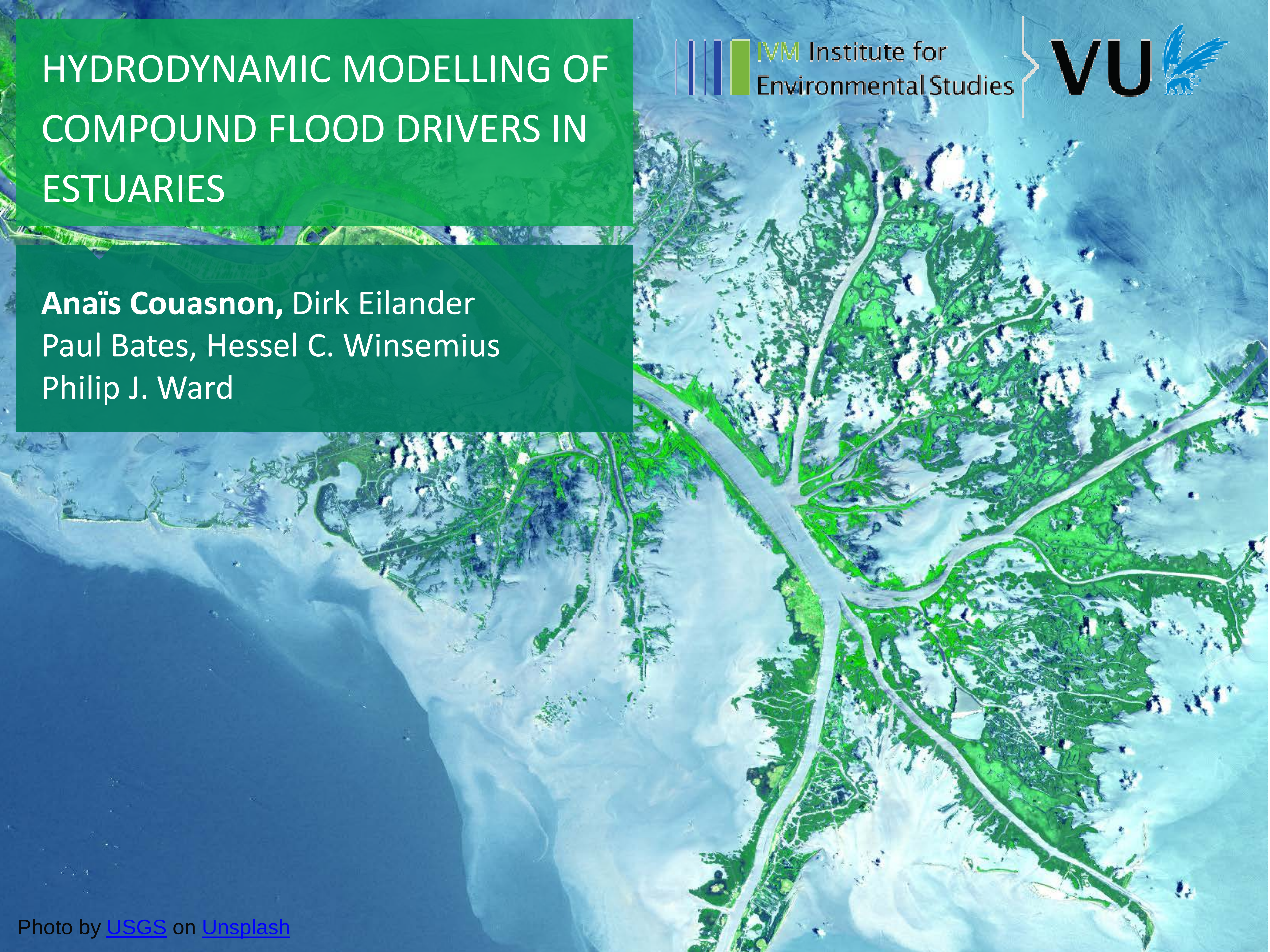

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Deltas and estuaries are prone to compound flooding (CF)

- In global flood models, flood drivers are usually modelled <u>separately</u> to determine coastal or riverine flood hazard.

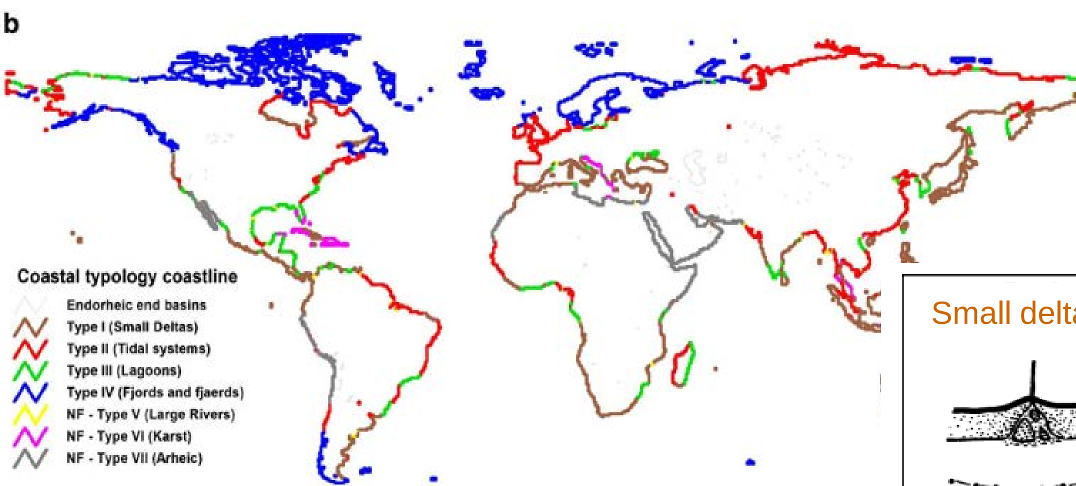
- Recently, Eilander et al. (2020) identified locations where both riverine and coastal flood drivers contribute to flooding, also referred to as compound flooding.

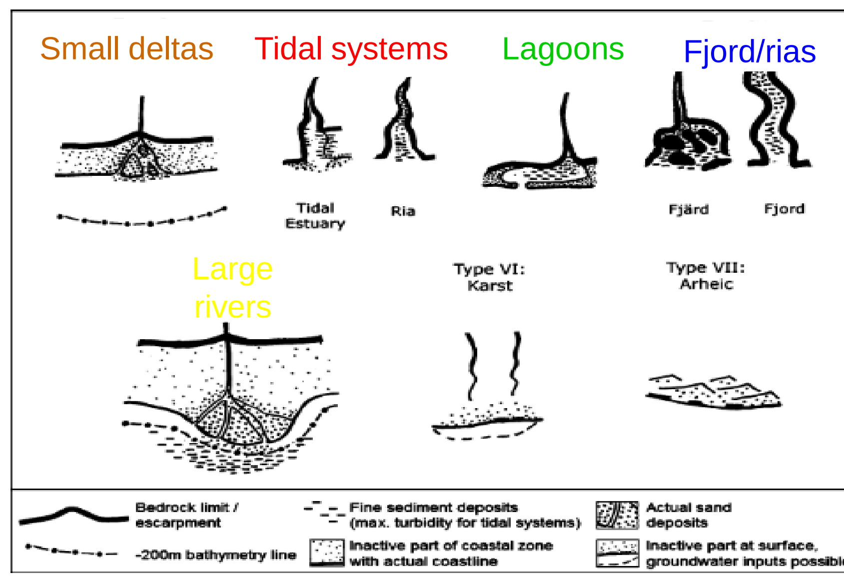
(Eilander et al 2020)

Environ. Res. Lett. in press
https://doi.org/10.1088/1748-9326/ab8ca6

Coastal environments are diverse

- But the representation of estuaries and deltas in global flood models remain <u>very simple if not absent</u> even though estuarine environments are diverse.





(Dürr *et al.* 2011)

Estuaries and Coasts
https://doi-org.vu-nl.idm.oclc.org/10.1007/s12237-011-9381-y

Research objective

- At the local scale, the influence of various geophysical and catchment characteristics on compound flooding has been studied
  - (for eg: Van den Hurk (2015), Bevacqua et al. (2017), Couasnon et al. (2018), Serafin et al. (2019))

In this study, we aim to provide a broader perspective on these local findings and to investigate how compound flood hazard in estuaries is influenced by their various geophysical characteristics and the nature of their upstream river basins.

Methodology – overall framework

1- Define typology of coastal systems

- → Nb. of categories
- → Length of channel
- → Transversal cross-section
- → Longitudinal bed slope

2- Derive range of boundary conditions

- → Discharge hydrograph
- → Coastal hydrograph
- → Dependence

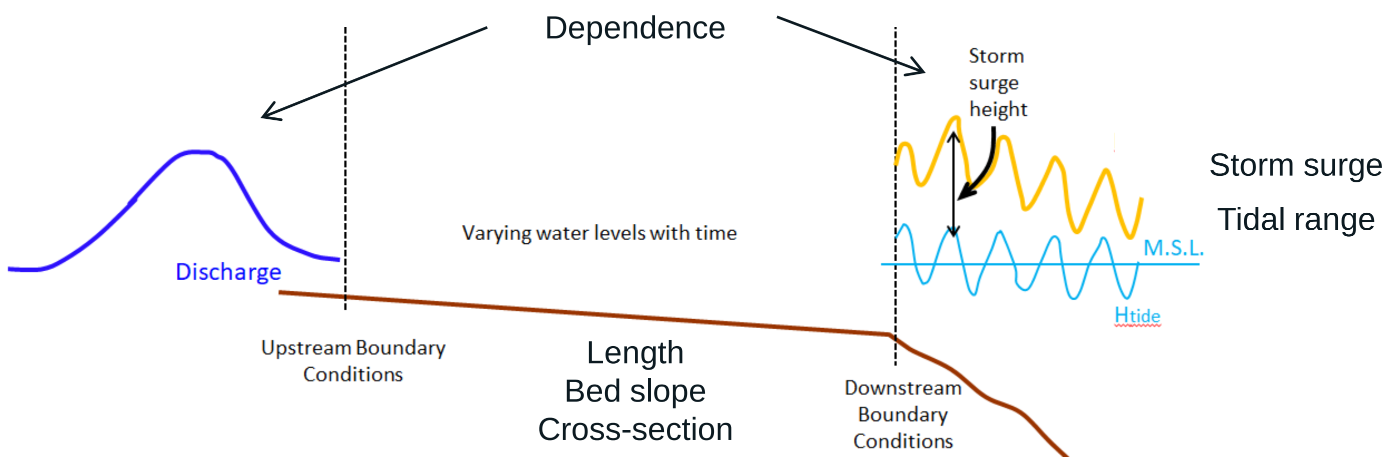
3- Quantify severity of compound flooding

- → Length of the "transition" zone (Bilskie and Hagen, 2018 - https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2018GL077524)

"The location within a river system where both riverine and coastal flood drivers significantly contribute to the water level is referred to as the transition zone"

Method

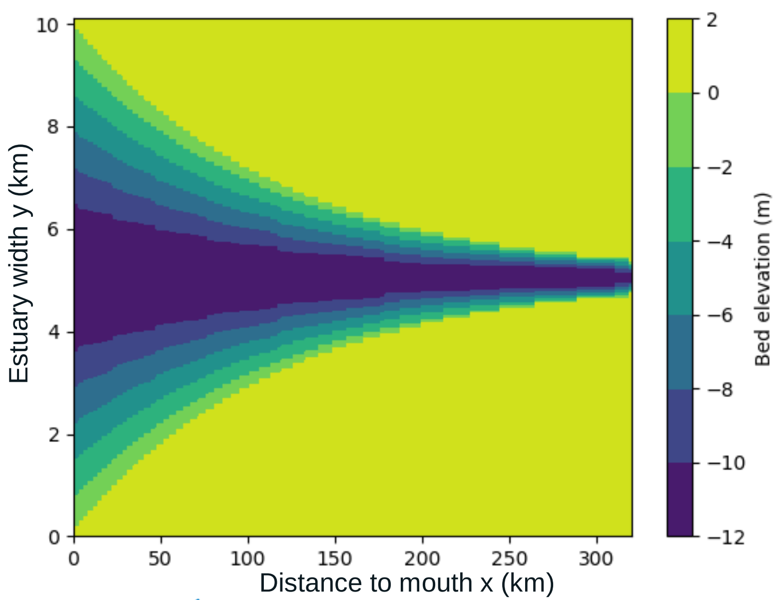
- We model estuaries as idealised estuaries since detailed estuary bathymetry datasets at the global scale do not exist. We use sets of non-dimensional laws to derive estuary shapes and profiles.

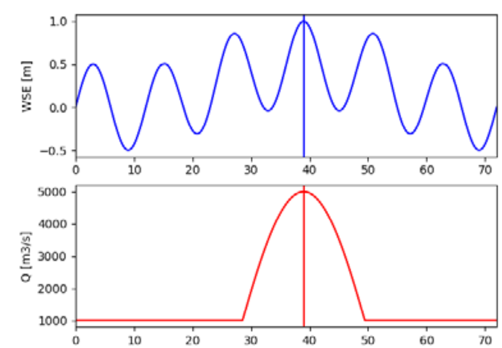


- We use the LISFLOOP-FP model to model riverine-coastal interactions
  - > Quasi-linearized 1D shallow-water equations (advection term is neglected)

Example result for one estuary (1/3)

Scenario description	Coastal boundary condition	Riverine boundary condition	Label in next figures
Reference	Tide	Q_{mean}	'ref'
Coastal driver only	H_{max} + Tide	Q_{mean}	'surge'
Riverine driver only	Tide	Q_{max}	'discharge'
Both drivers	H_{max} + Tide	Q_{max}	'tide_surge_discharge'



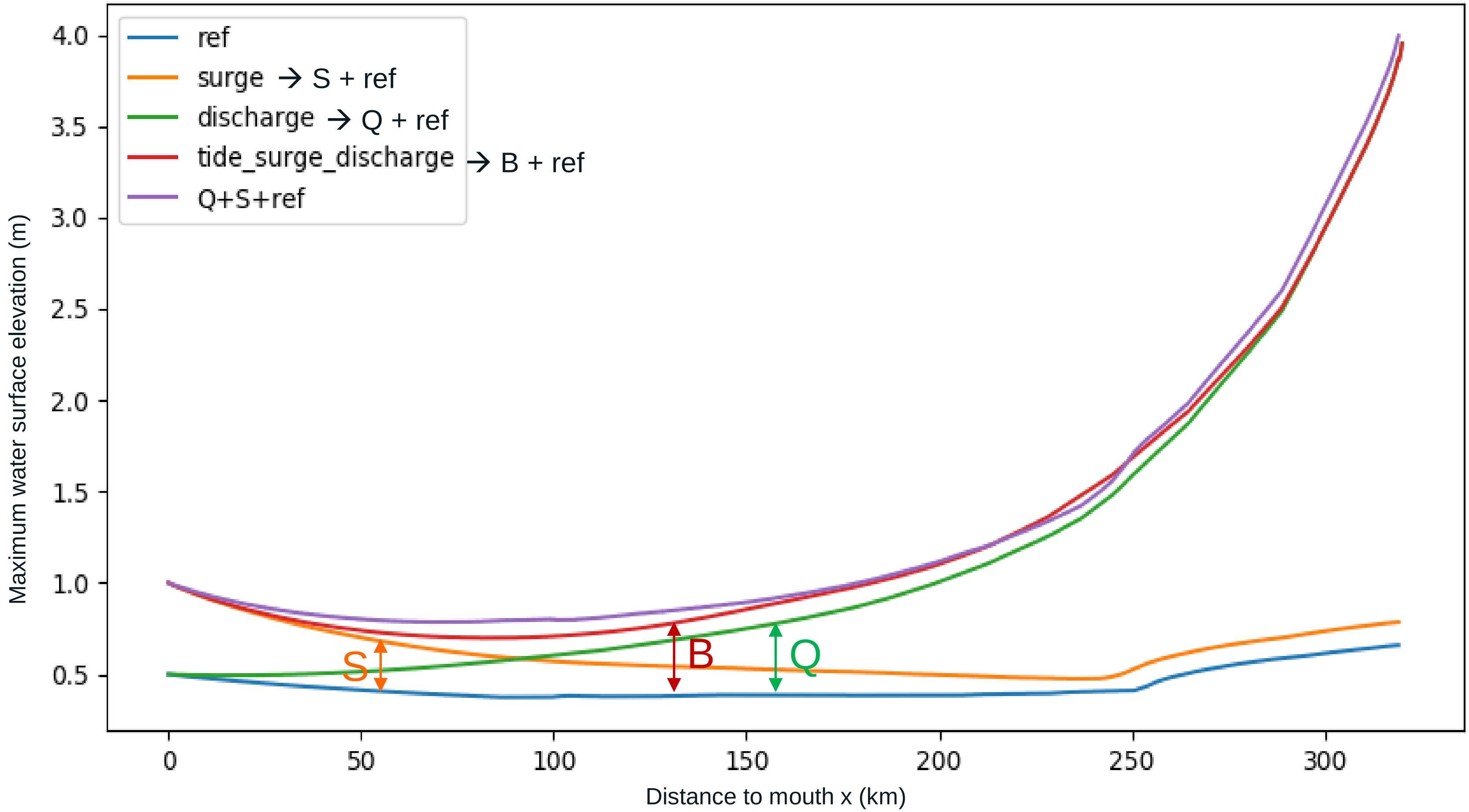


H_{max} + Tide

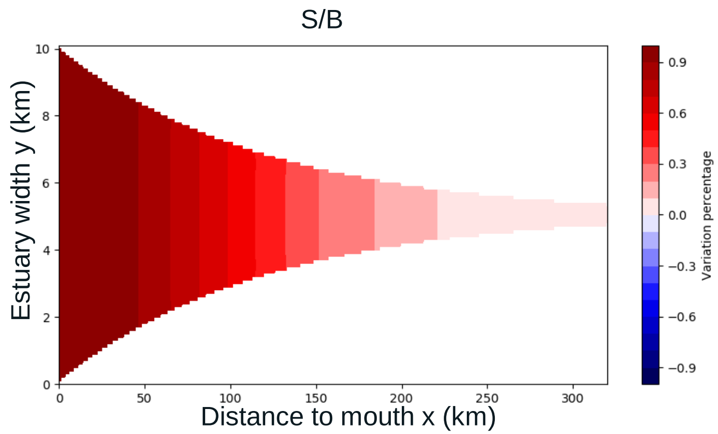
Q_{max}

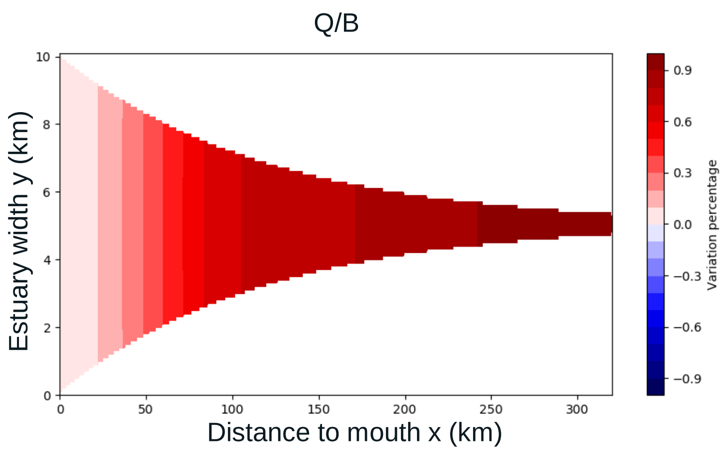
VU

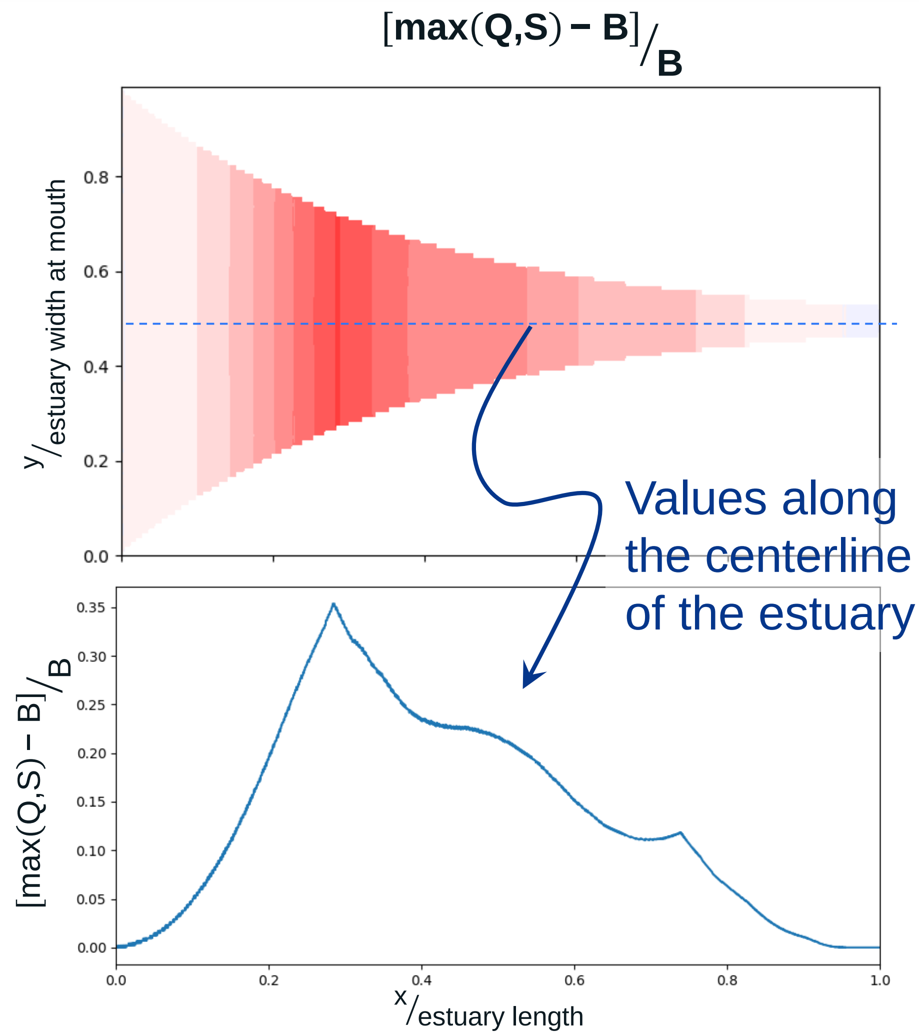
Example result for one estuary (2/3)



Example result for one estuary (3/3)







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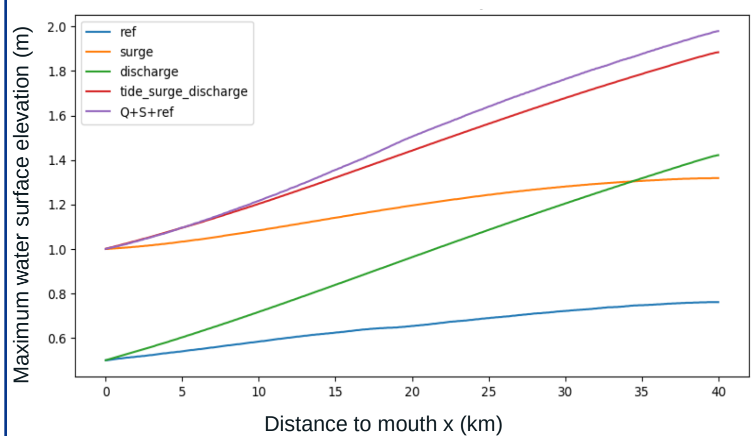
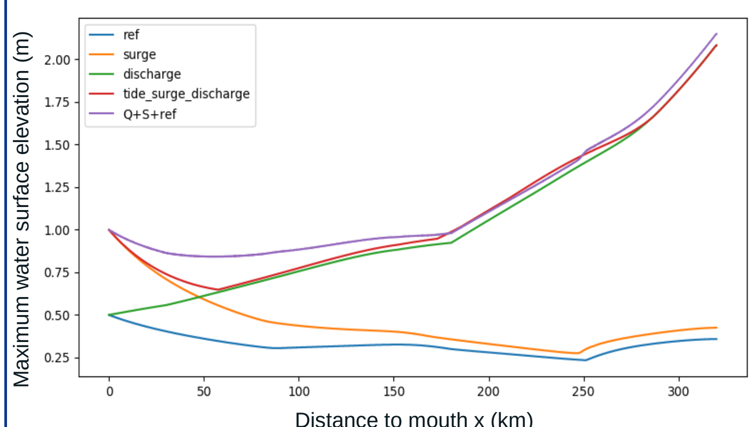
Comparison with other estuary shapes

Prismatic channel

X_{max} = 40 km

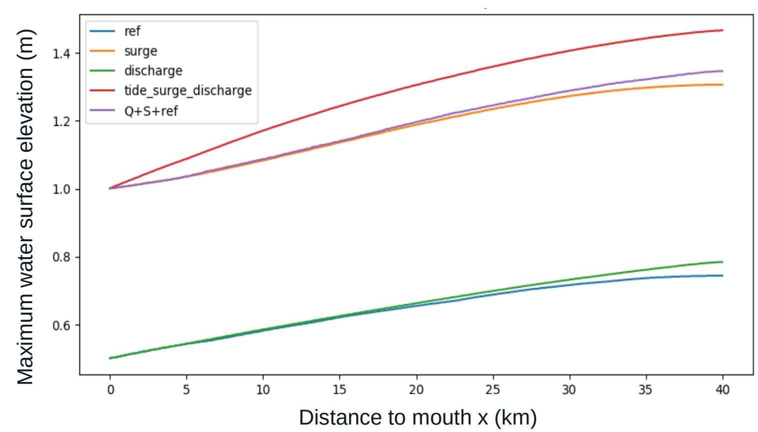


X_{max} = 300 km

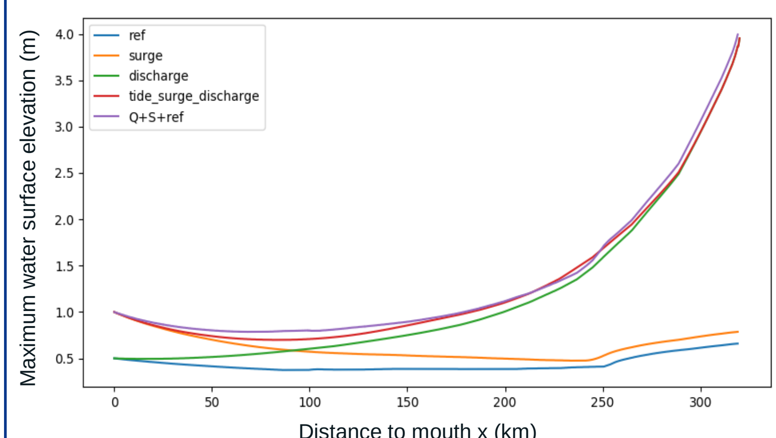


Strongly converging channel

X_{max} = 40 km



X_{max} = 300 km



Conclusion

- We use idealised estuary shapes to model interactions between riverine and coastal flood drivers.
- Coastal-riverine interactions in estuaries are highly non-linear.
- This implies that superimposing current riverine and coastal flood maps will not lead to an accurate representation of the flood hazard.
- The strength of these interactions vary depending on the estuary shape and length.

- Future efforts will focus on improving discharge and coastal hydrographs and include their temporal dependence. Any suggestions are welcome!