XXXVIII Convegno Nazionale
di Idraulica e Costruzioni Idrauliche

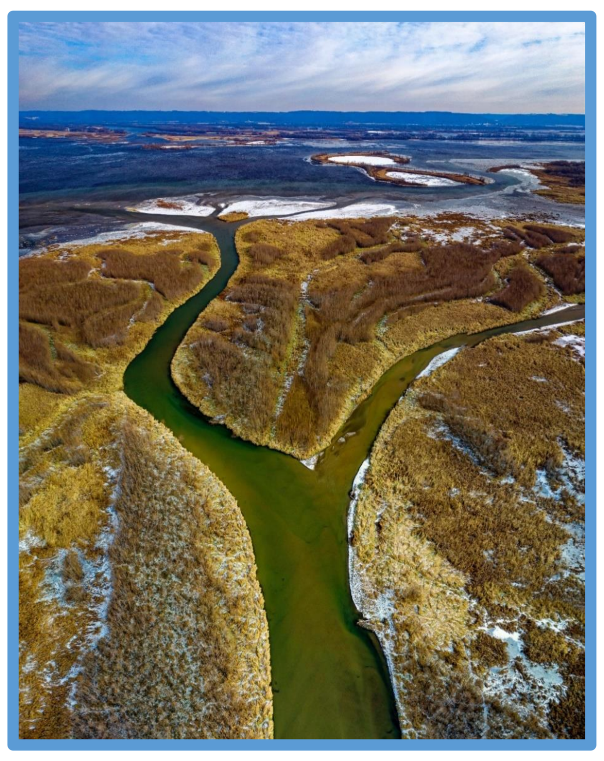
SETTEMBRE 2022 | REGGIO CALABRIA

NUMERICAL INVESTIGATION OF TIDAL FORCING ON THE STABILITY OF BIFURCATIONS

Lorenzo Durante [1]*, Michele Bolla Pittaluga [1] & Nicoletta Tambroni [1]

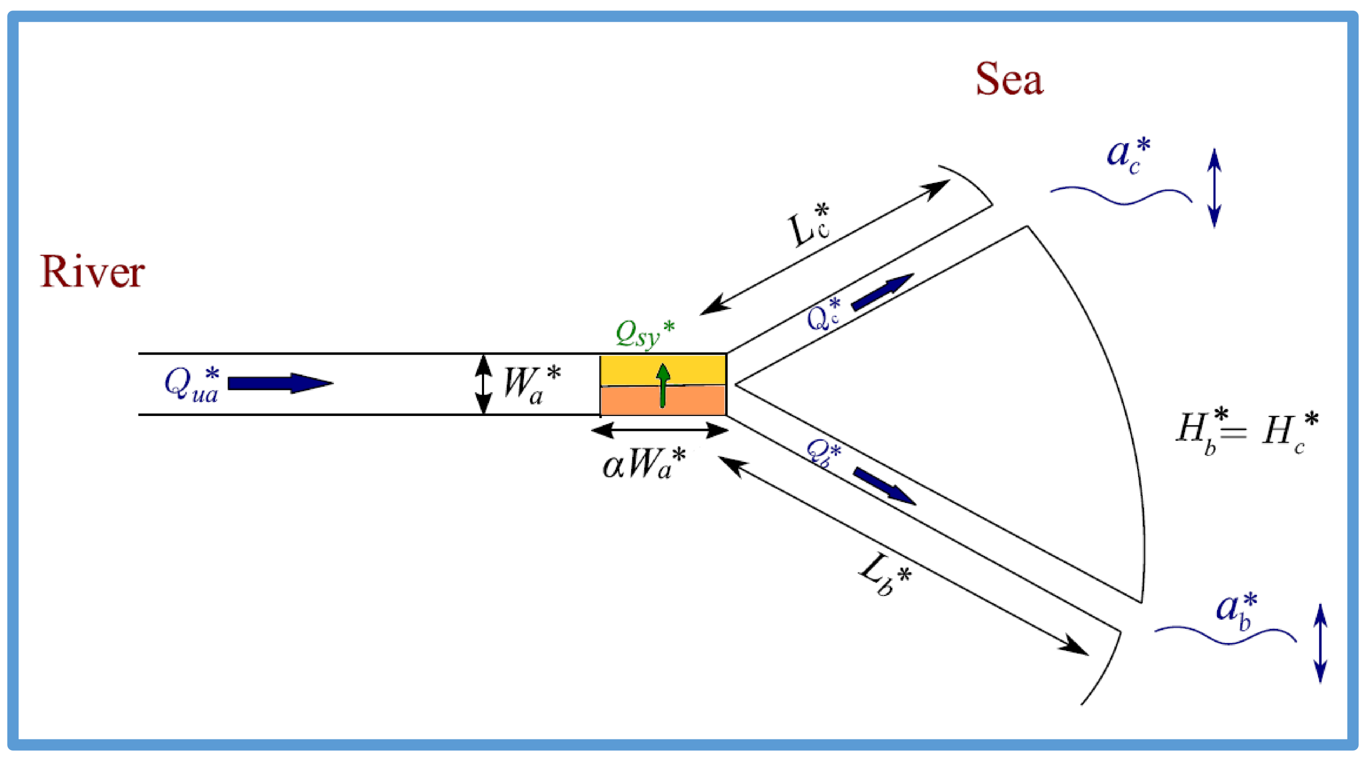
(1) Dipartimento di Ingegneria Civile, Chimica e Ambientale, Università di Genova (Genova)

Theoretical Background

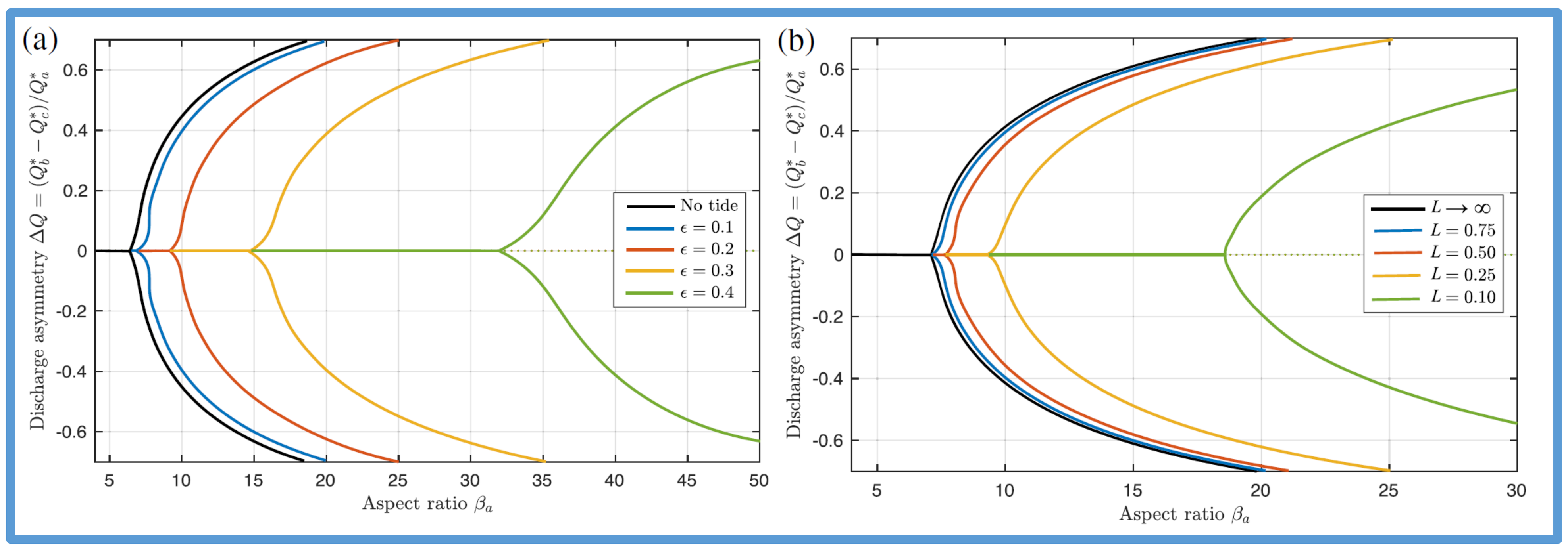


River bifurcation in Altura, US (Photo by Tom Fisk).

FROM NATURE TO MODELS



Scheme of the tidal bifurcation with notation.



Equilibrium diagrams for a tidal bifurcation with symmetrical downstream branch lengths for (a) different values of the tidal forcing ϵ (L=0.5) and (b) scaled channel lengths L (ϵ =0.2) (Ragno et al., 2020).

Unstable configurations (when $\beta_a > \beta_{cr}$) often result in the closure of one downstream branch, such that all the water flows in the other channel ($\Delta Q \rightarrow 1$).

Controlling parameters

Fluvial case / *Tidal case*

Shields Parameter

$$\theta = \frac{q_{ua}^{*2}}{(s-1) g^* d_s^* C_a^2 D_{ua}^{*2}}$$

Aspect Ratio

$$\beta_a = \frac{W_a^2}{2 D_{ua}^*}$$

Dimensionless grain size

$$ds = \frac{ds^*}{D_{ua}^*}$$

Dimensionless tide parameter

$$\varepsilon = \frac{a^*}{D_{ua}^*}$$

Tidal amplitude / Uniform flow depth

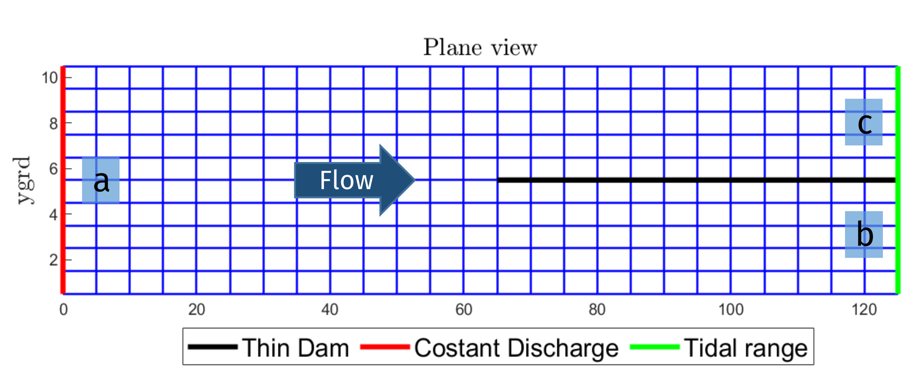
Dimensionless length

$$L = \frac{L_{b(c)}^*}{D_{ua}^*/S_a}$$

Branches length / Backwater length

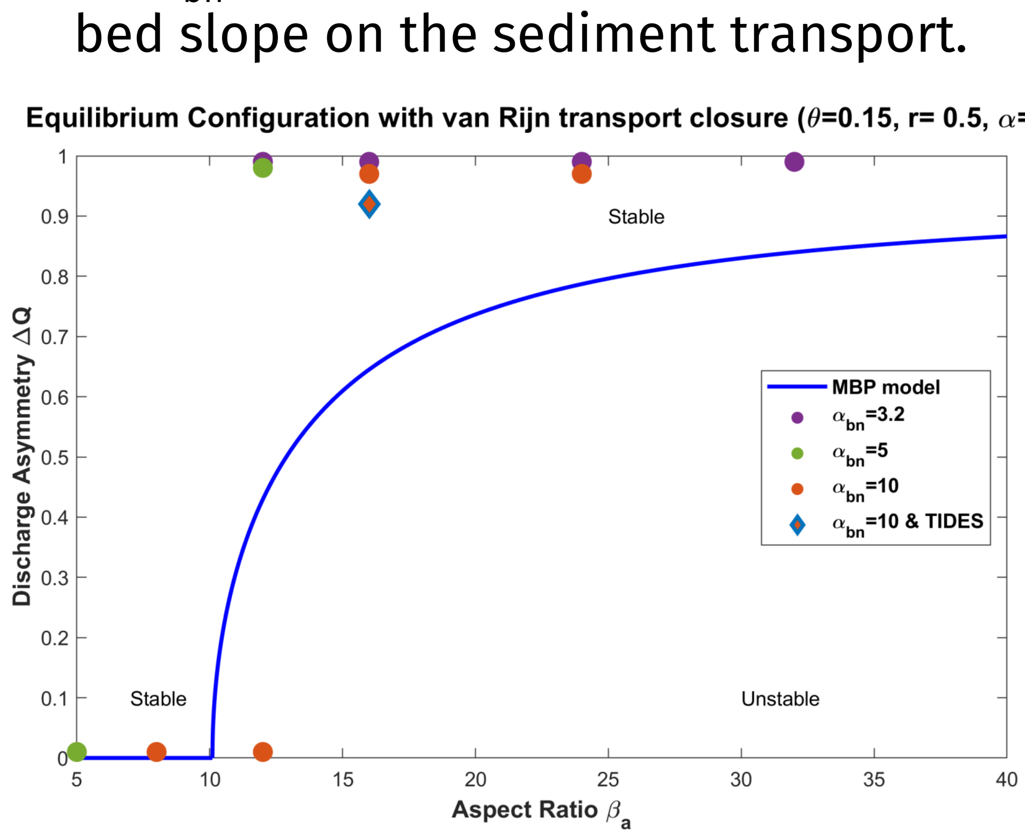
Numerical Modelling

Model validation



Representative sketch of the 2D computational grid of the model set-up in Delft3D.

The numerical results where compared to the theory of *Bolla Pittaluga et al. (2015)* for **pure riverine case** through, also, a sensitivity analysis on the parameter α_{bn} measuring the contribution of the transversal bed slope on the sediment transport.



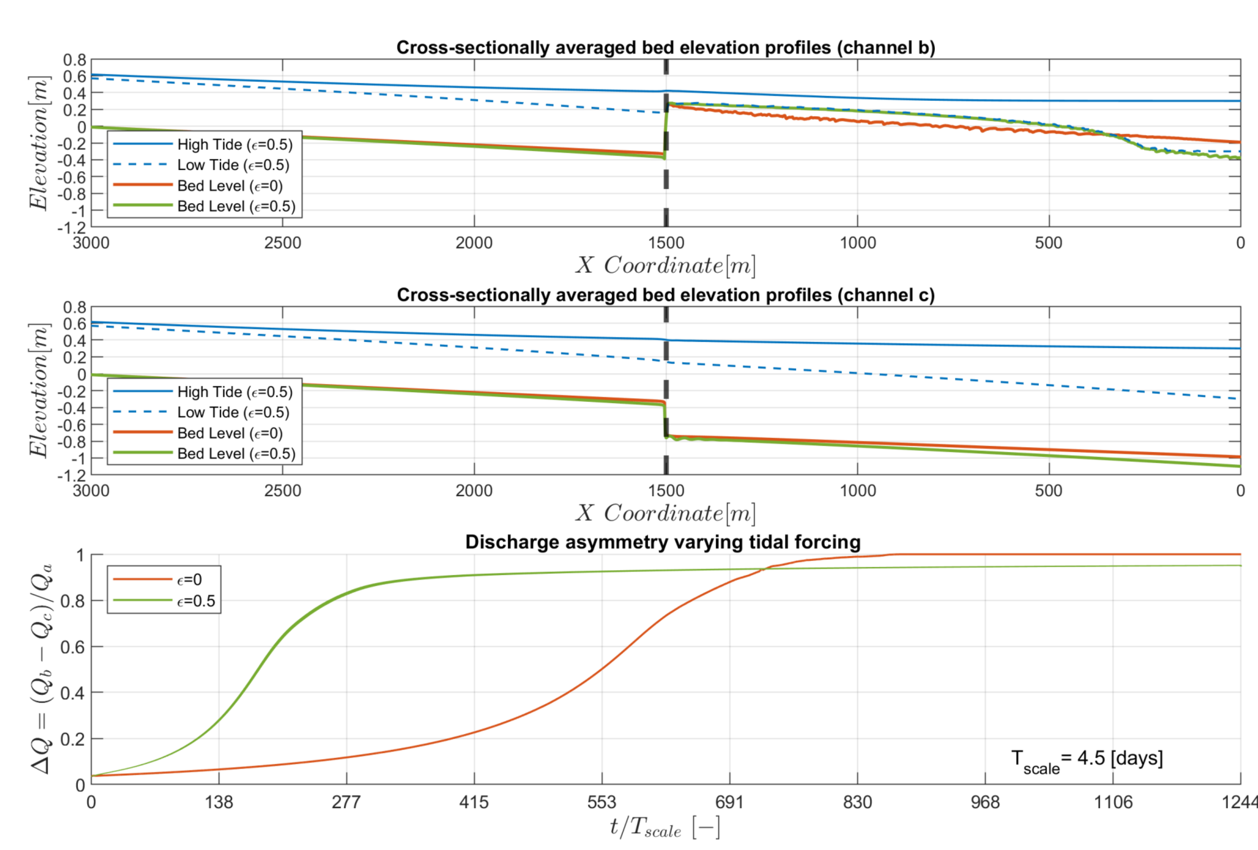
Numerical results, filled dots, are compared with analytical solution of Bolla Pittaluga et al. (2015), continuous line. The dot colours correspond to different values of the parameter α_{bn}.

Results are in a reasonable agreement with theoretical predictions.

Preliminary results of the tidal effect

The **tidal range** has a **stabilizing effect** on the system due to its erosive character, which is capable to keep morphodynamically active the branches. As found by *Ragno et al. (2020)*, the **stability increase** both with ε **increment** and L **reduction**.

Comparison between the equilibrium bottom profiles in the pure riverine (ϵ =0) and tidal (ϵ =0.5) cases:



Competing effect of an unstable pure riverine bifurcation versus the stabilizing effect of the tidal range (θ=0.15, β_a=16, ϵ =0.5, L=0.5).

In the present case results suggest, as in the theory, that the bifurcation node is too far from the sea to allow for tidal propagation significantly affecting the critical aspect ratio.

Università di Genova

Durante Lorenzo
lorenzo.durante@edu.unige.it

UniGe DICCA