Impact of vegetation control measures on the bedform of braided gravel-bed river

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Motivation

- Vegetation encroachment induces river morphology change and may reduce the bio-diversity in the fluvial system.
- Vegetation clearance can be promising measure in to restore river morphology and ecological system.
- This study aims to investigate the influence of vegetation clearance on river morphology.

Vegetation encroachment in the Satsunai River, Japan (https://mapps.gsi.go.jp/).

Modelling method

- Hydrodynamic: shallow water equations
- Bedload transport: Ashida-Michiue formula
- Bed elevation update: Exner equation
- Vegetation model: 1. establish on dry grids during specified period; 2. destruction by erosion and burial during floods.

Vegetation effect

- Vegetation effect on water flow

$$F_D = \frac{1}{2} C_D a_s U^2$$

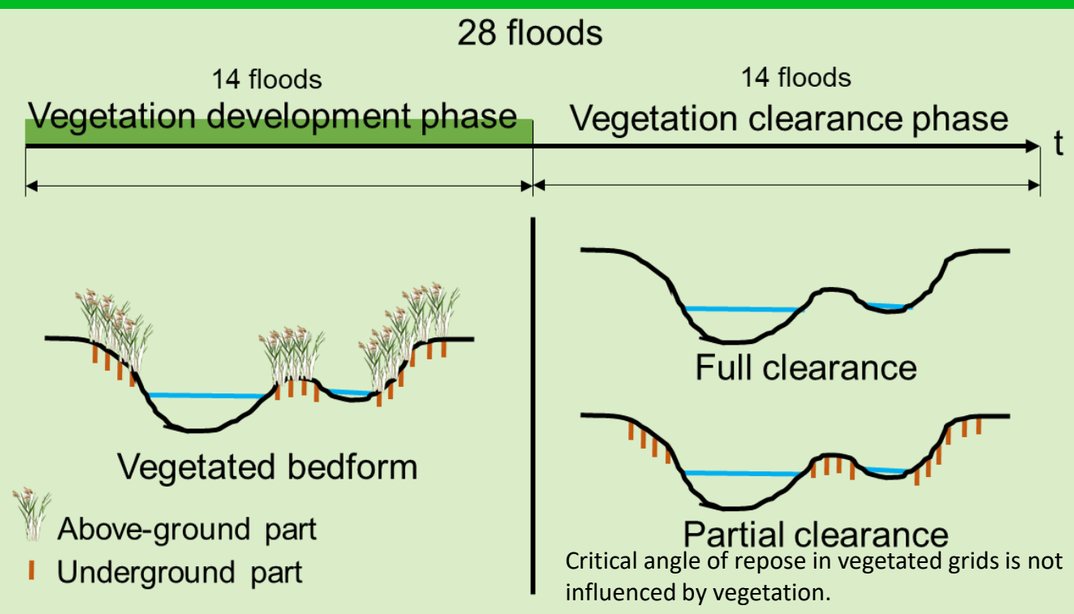
- Vegetation effect in stabilizing riverbed

$$\theta_c = (\theta_{cmax} - \theta_{cmin}) \frac{a_s}{a_{max}} + \theta_{cmin}$$

C_D is the drag coefficient, a_s is the vegetation density (m^{-1}), U is the depth averaged velocity, θ_c is the critical angle of repose of riverbed.

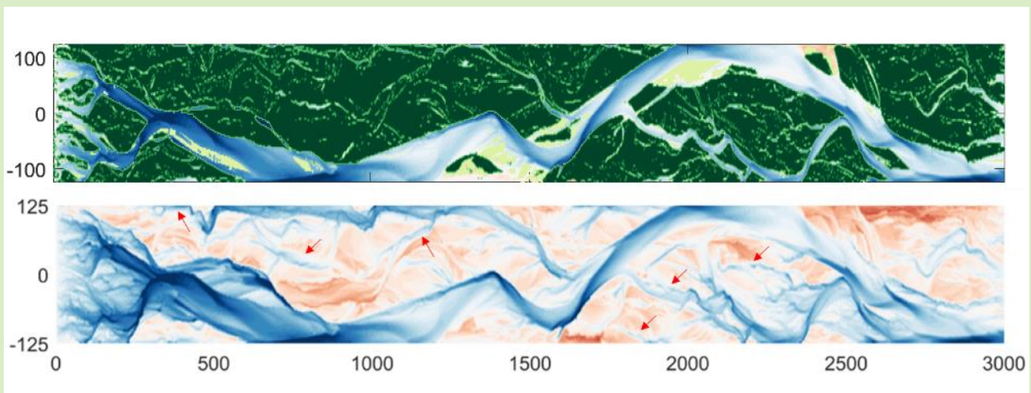
Simulation scenarios

- Simulation domain with a 3 km long straight channel with width equal to 250 m.
- Riverbed slope equal to 1/130.
- Two-level alternate hydrograph with maximum discharge equal to 200 m^3/s and 300 m^3/s.
- Sediment diameter is 25 mm.
- Reed type vegetation which have strong and weak resistance to flood disturbance.
- Two vegetation clearance method, i.e., full clearance and partial clearance.



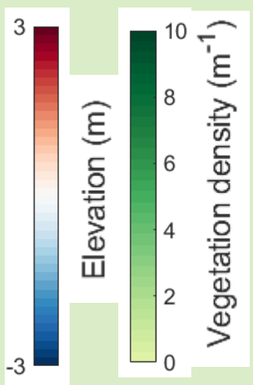
Schematic of two vegetation clearance scenarios applied in this study.

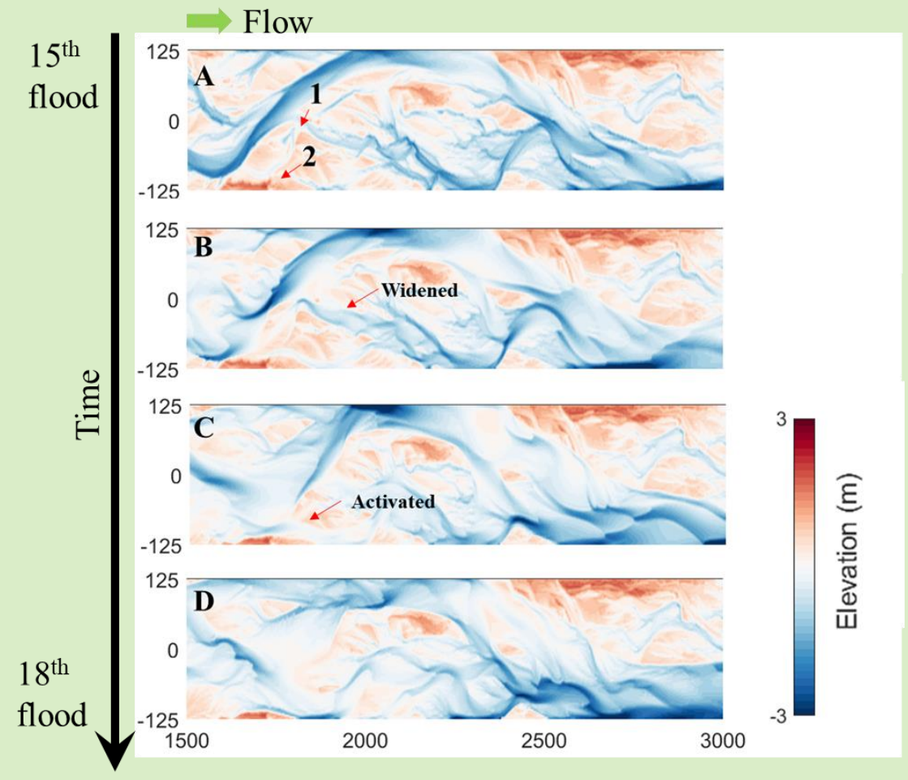
Results



Before vegetation clearance, river morphology transforms from braiding to single-thread due to vegetation growth.

After vegetation clearance, the river becomes braiding again, regardless of the vegetation clearance method.





Small channels on floodplain widen and reconnect to main channel after vegetation clearance. Results suggest increase connectivity between floodplain and channel can improve the effectiveness of vegetation clearance method.