Modelling the impact of dams and exotic vegetation in New Zealand braided rivers

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Exotic vegetation in New Zealand rivers



Geomorphic effects of vegetation

- Increased hydraulic drag:
- Focuses flow into channels
- Determines sediment deposition in vegetated areas
- Increased bed stability due to roots:
- Reduces sediment mobility
- Strengthens banks, reduces bank erodibility



Promotes transition from braiding towards wandering / single-thread styles





Modelling vegetation effects on morphology

Novel «ingredients»:

- Bank erosion module [Stecca ٠ *et al.*, 2017]
- Vegetation module [inspired ٠ to: Bertoldi et al., 2014]

algorithms in morphodynamic modeling

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Water Resources Research

RESEARCH ARTICLE

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morphology modeling in rivers is a new field.

Coupled vegetation and

Model realism and reliability?

- The model contains rule-based parameterisations.
- Literature guidance on how to set parameters for real-world applications is lacking.
- Results are extremely sensitive to vegetation parameterisation.

How to guarantee realism and reliability?

Calibration – validation approach using two contrasting test cases





Waitaki Dam

Lake Pukaki

Lower Waitaki River

- 3 large natural headwater lakes
- Hydropower dams (WPS)
- Damped flood regime
- Slightly less steep (0.355%)
- Extensive vegetation
- 1 or 2 main braids



Waimakariri River

- No significant lakes
- Frequent floods and freshes
- Steeper slope (0.50%)
- Fairway largely clear of vegetation
- Multiple active braids

Discharge records





Calibration of vegetation growth timescale – Waimakariri



Validation of vegetation growth timescale – Waitaki

 $T_v = 12$ years

Recorded hydrograph: with dams



1 Jan 1936 0:00



Contrasting the Waitaki and Waimakariri Rivers – $T_v = 12$ y

- Identical vegetation parameterisation $(T_v = 12 \text{ years})$
- Different flow regime
- Different slope



Year

• The calibrated model can correctly reproduce the different response of the two rivers



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Study of the impact of the WPS on vegetation – Waitaki

 T_v = 12 years (calibrated model)

Natural - reconstructed hydrograph: NO DAMS





Study of the impact of the WPS on vegetation – Waitaki



The WPS has an impact on observed vegetation encroachment (100 m unvegetated width loss, avg. 1992-2020); but

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This impact is small: vegetation encroachment and transition towards a single-thead style would have happened anyway



onclusions

- New Zealand braided rivers are increasingly affected by exotic vegetation.
- We have built a physics-based model capable of predicting vegetation-driven morphological change.
- Determining reliable and realistic parameterisation for reproducing real-world cases is challenging.
- We use a robust calibration-validation approach on two contrasting river cases to calibrate the model.
- The calibrated model can be used to identify the role of different stressors.
- The Waitaki Power Scheme appears to have a minor influence on observed vegetation encroachment in the Waitaki River according to model results.



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Waimakariri 1940-44

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Waimakariri Present







Waitaki 2001

1997