Predicting geomorphic disturbance and stream channel change in urban watersheds

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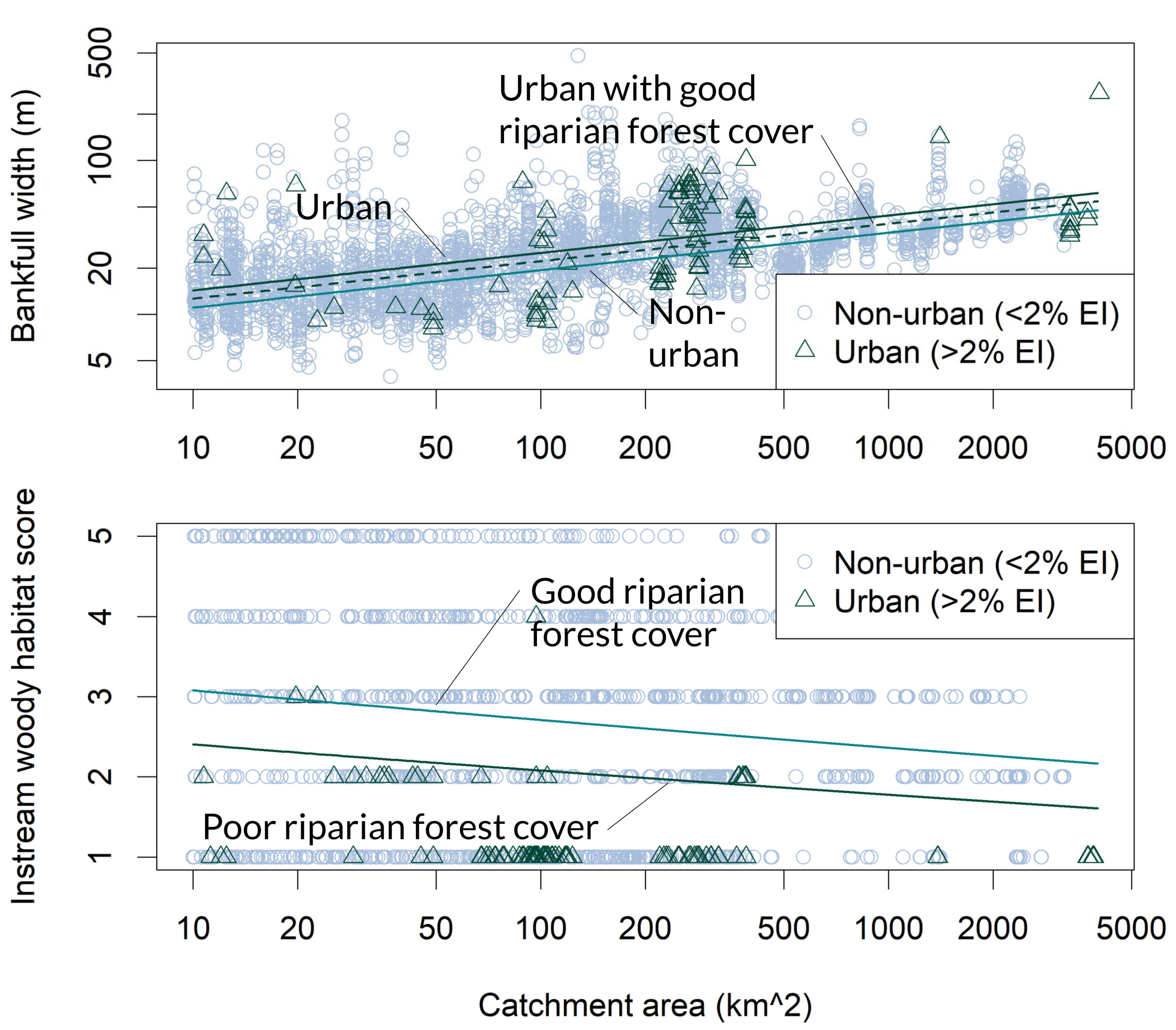
BACKGROUND: Urbanization enlarges and simplifies river channels, although there is currently no accepted model for the expected extent and severity of channel change given a set of watershed characteristics.

METHODS: Big data (LiDAR and regional datasets) allowed us to investigate region-wide patterns of urban stream geomorphic degradation. Using both linear models and data mining (boosted regression trees), we developed hydraulic geometry relationships between stream channel metrics (bankfull width, bankfull depth, instream woody habitat) and watershed characteristics (including effective imperviousness (EI) and riparian forest cover) across the city and suburbs of Melbourne, Australia.

RESULTS



KEY MESSAGES

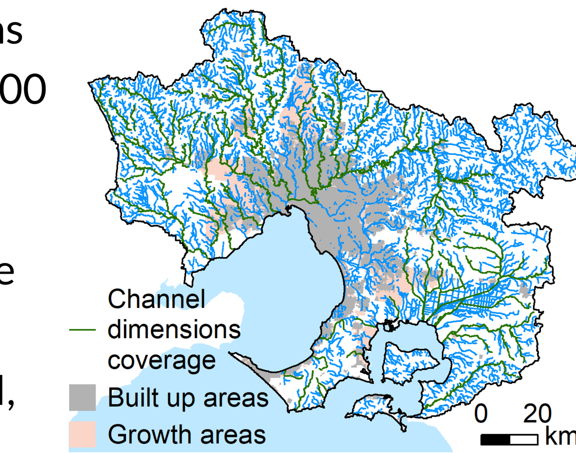
- Geomorphic channel degradation begins at very low levels of EI (1-2%)
- Maintaining riparian forest cover mitigates the impact of EI on channel dimensions and preserves instream woody habitat
- Remotely sensed big data is powerful but data quality is critical
- Our history of 'managing' streams makes it hard to differentiate direct channel alteration from geomorphic response

Noisy, big data demonstrates **channel enlargement** due to urbanization **at regional scales.**

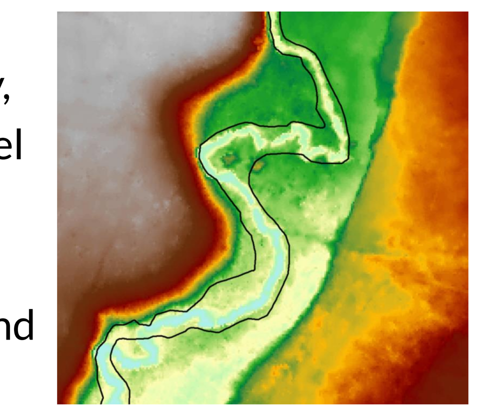
Maintaining **riparian forest cover mitigates channel enlargement as well** as providing **instream woody habitat.**

SCAN ME

THE DATASET

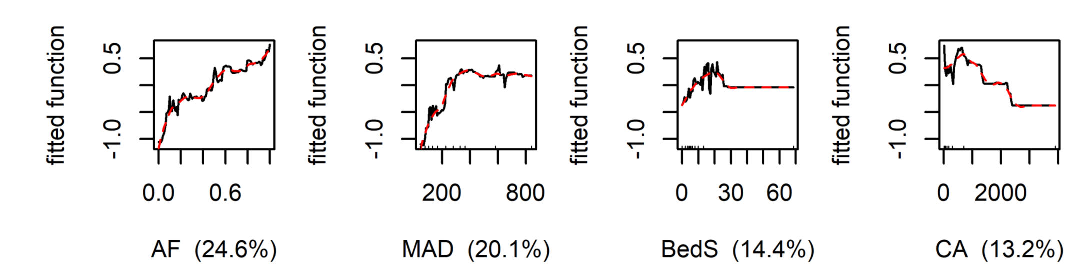


- Channel dimensions from LiDAR for 2,700 km stream length
- Instream woody habitat (IWH) score for 2,300 km
- Watershed data (EI, riparian forest, climate, geology) across whole region (10,400 km of streams)
- **Bias challenges:** urban ~ directly altered, urban ~ lower gradient, non-equal reach lengths
- **Future work:** equal reach lengths, reach connectivity, validate and extend channel dimension data
- Bankfull delineation is problematic, for humans and computers



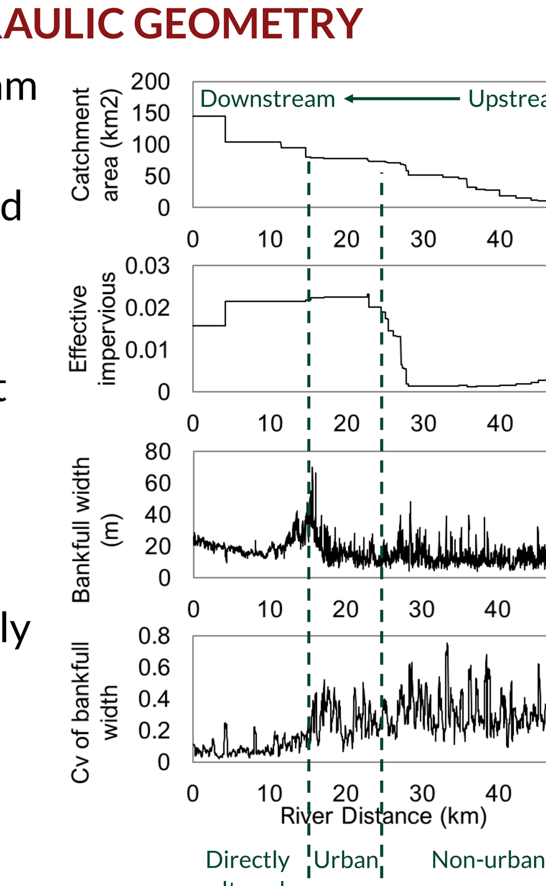
DATA MINING

- Width model: cross-validation R = 0.76, geology and watershed area were important predictors
- Depth model: CV R = 0.75, drainage area, water availability, and EI were important predictors
- IWH model: CV R = 0.85, riparian forest, water availability and bed slope were important predictors
- Example: partial dependence plots showing effect and relative contribution of each predictor variable to the best-fitted model for IWH:



DOWNSTREAM HYDRAULIC GEOMETRY

- Case study of a stream with forested upper watershed, urban mid watershed
- Width increases downstream, but not necessarily with EI
- Width variability lower in urban area, much lower in directly altered channels
- Indicates need for both regional and local approach



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