Sources and Flows, Our Land and Water National Science Challenge

CLUES calibration: Can we use CLUES to estimate attenuation?

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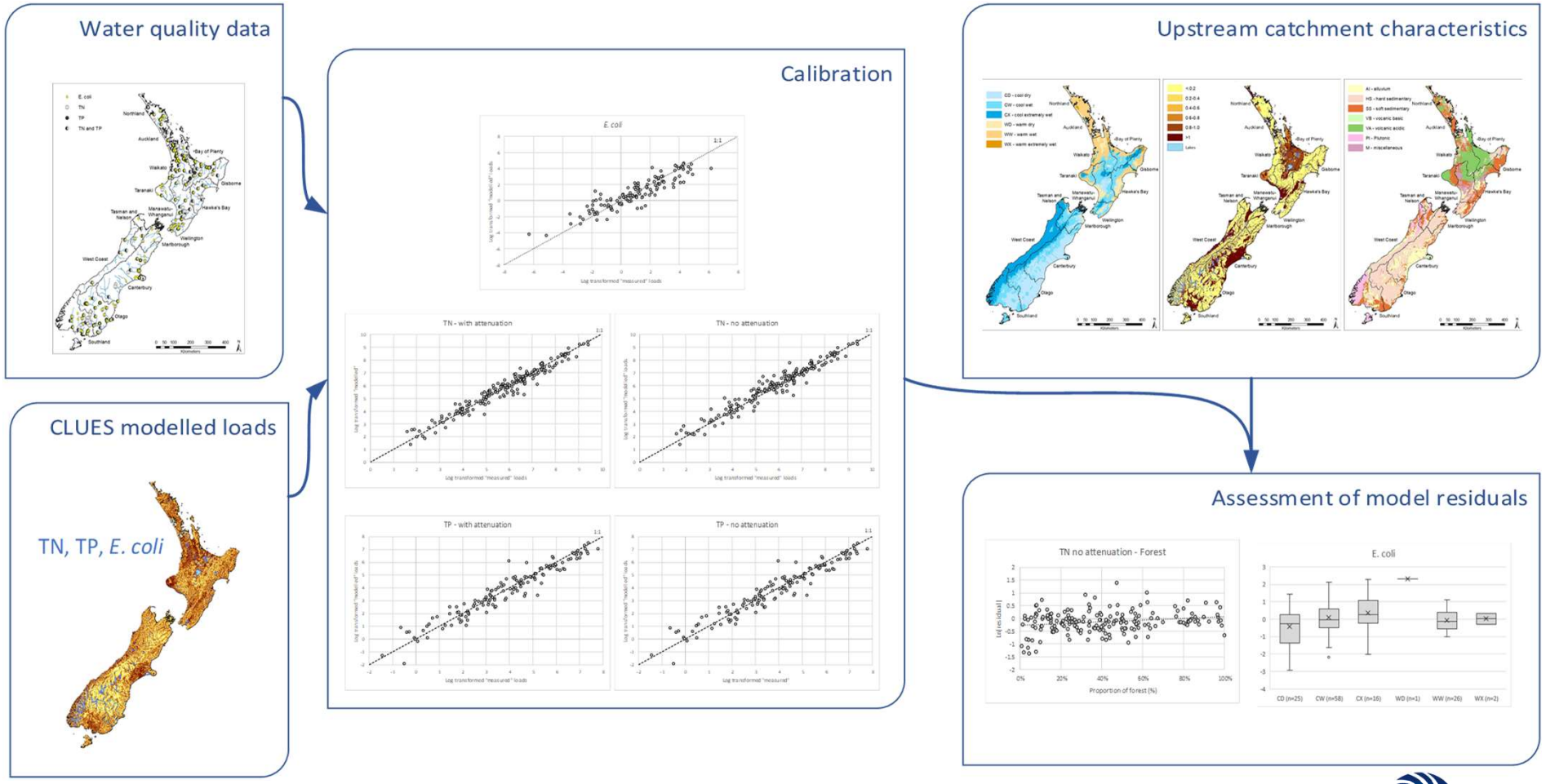
What we did…



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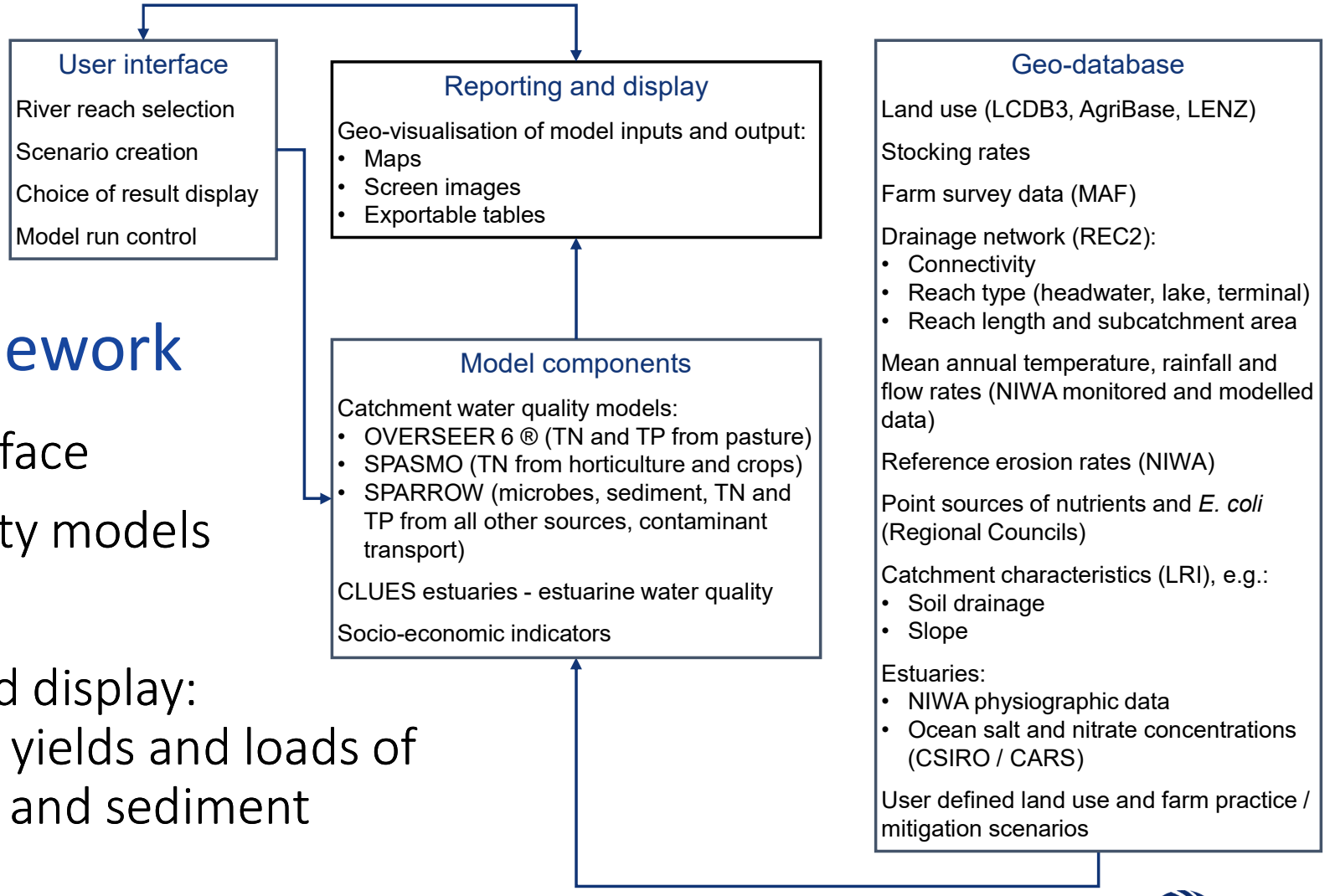
CLUES: Catchment Land Use for Environmental Sustainability

- System for assessing effects of land use and farm practices
- Steady state (annual timestep)
- Catchment scale
- Purpose:
- How does land use affect water quality?
- What if land use were to change?
- What are the spatial patterns of water quality?
- How and where can we mitigate the impacts of land use?

CLUES framework

- ArcMap interface
- 3 water quality models
- Geodatabase
- Reporting and display:
  Mean annual yields and loads of
  TN, TP, *E. coli* and sediment



Attenuation

- Required for setting load limits
- Attenuation processes vary spatially and by contaminant
- Estimated as difference between:
- generated loads and loads reaching the stream network (surface losses); or
- up- and downstream instream loads (stream and lake attenuation).

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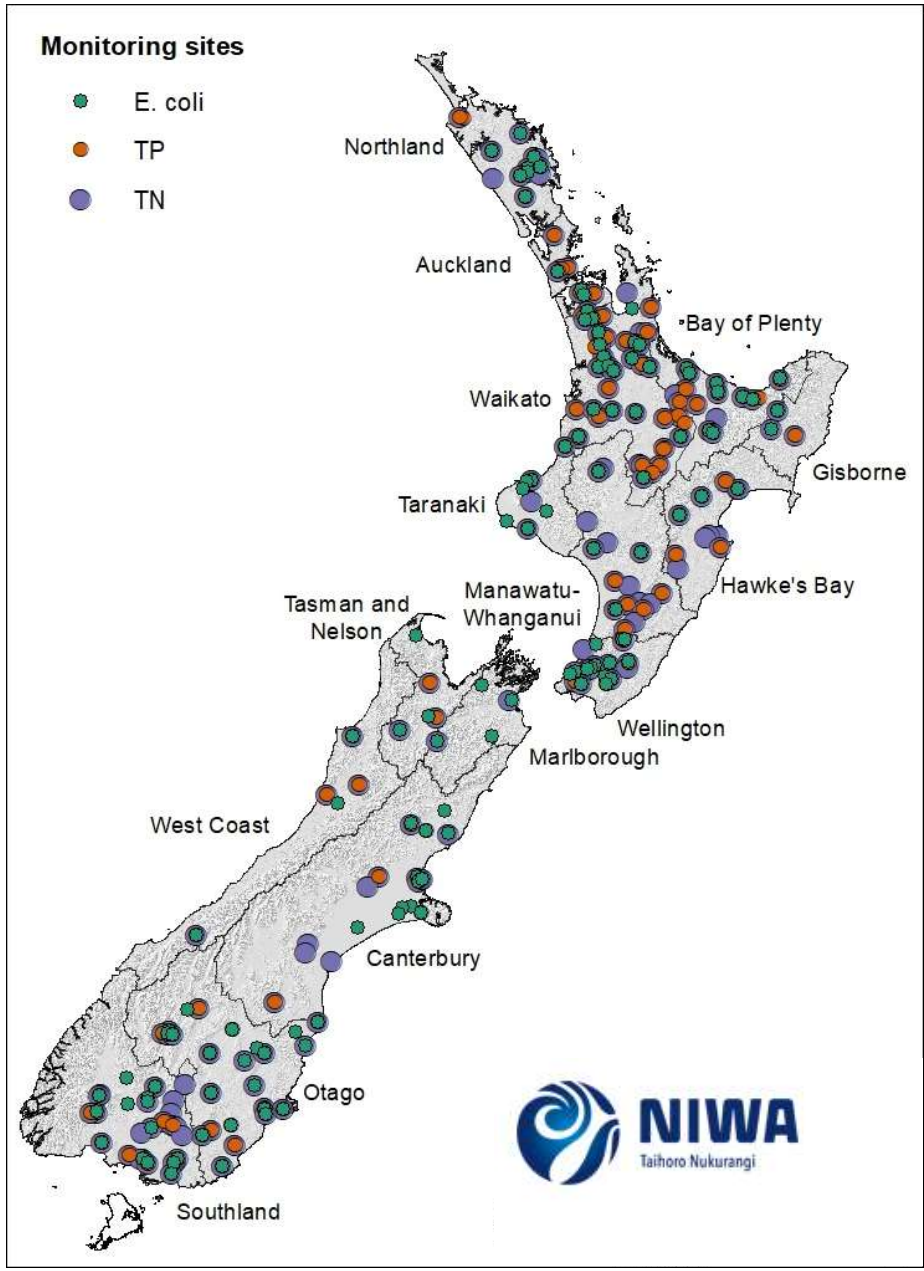
Issue: How reliable is CLUES for load estimation / attenuation?

- SPASMO and OVERSEER pre-calibrated
- TN and TP from pasture
- TN from crops
- Surface losses implicit in loads provided to CLUES

- SPARROW calibrated nationally:
- Loads delivered to streams for TP from crops, TN and TP from forest and sediment and *E. coli* from all sources
- Contaminant routing and attenuation in lakes and rivers

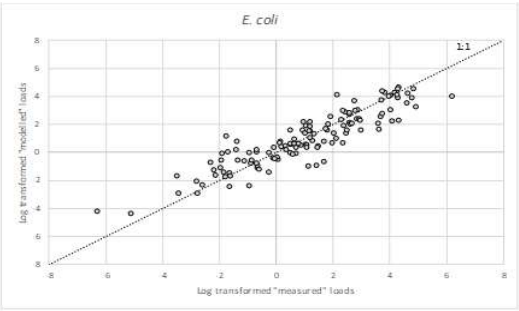
SPARROW calibration

- Minimize RMSE between modelled and "observed" loads
- Flow and water quality monitoring (Jan 2006 – Dec 2010) used to determine mean annual loads
- Sites suitability assessed on basis of rating curves

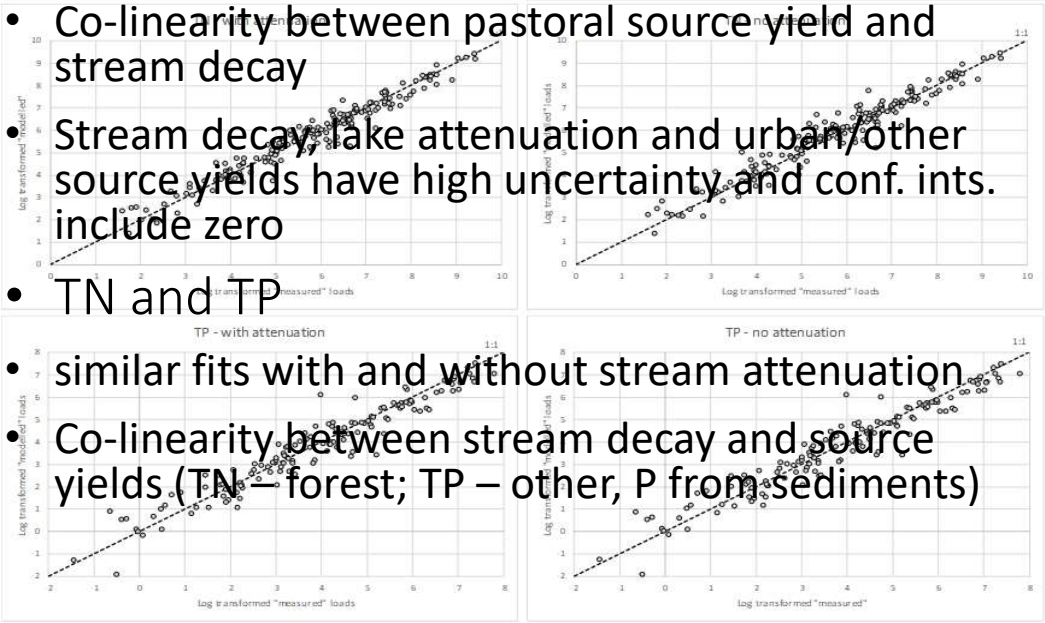


Calibration results

Calibration	Observations	RMSE	R^2	NSE
E. coli	128	1.001	0.82	0.82
TN with attenuation	183	0.395	0.95	0.95
TN with no attenuation	183	0.451	0.94	0.94
TP with attenuation	142	0.575	0.92	0.92
TP with no attenuation	142	0.575	0.92	0.92



- *E. coli*
- Co-linearity between pastoral source yield and stream decay
- Stream decay, lake attenuation and urban/other source yields have high uncertainty and conf. ints. include zero
- TN and TP
- similar fits with and without stream attenuation
- Co-linearity between stream decay and source yields (TN – forest; TP – other, P from sediments)



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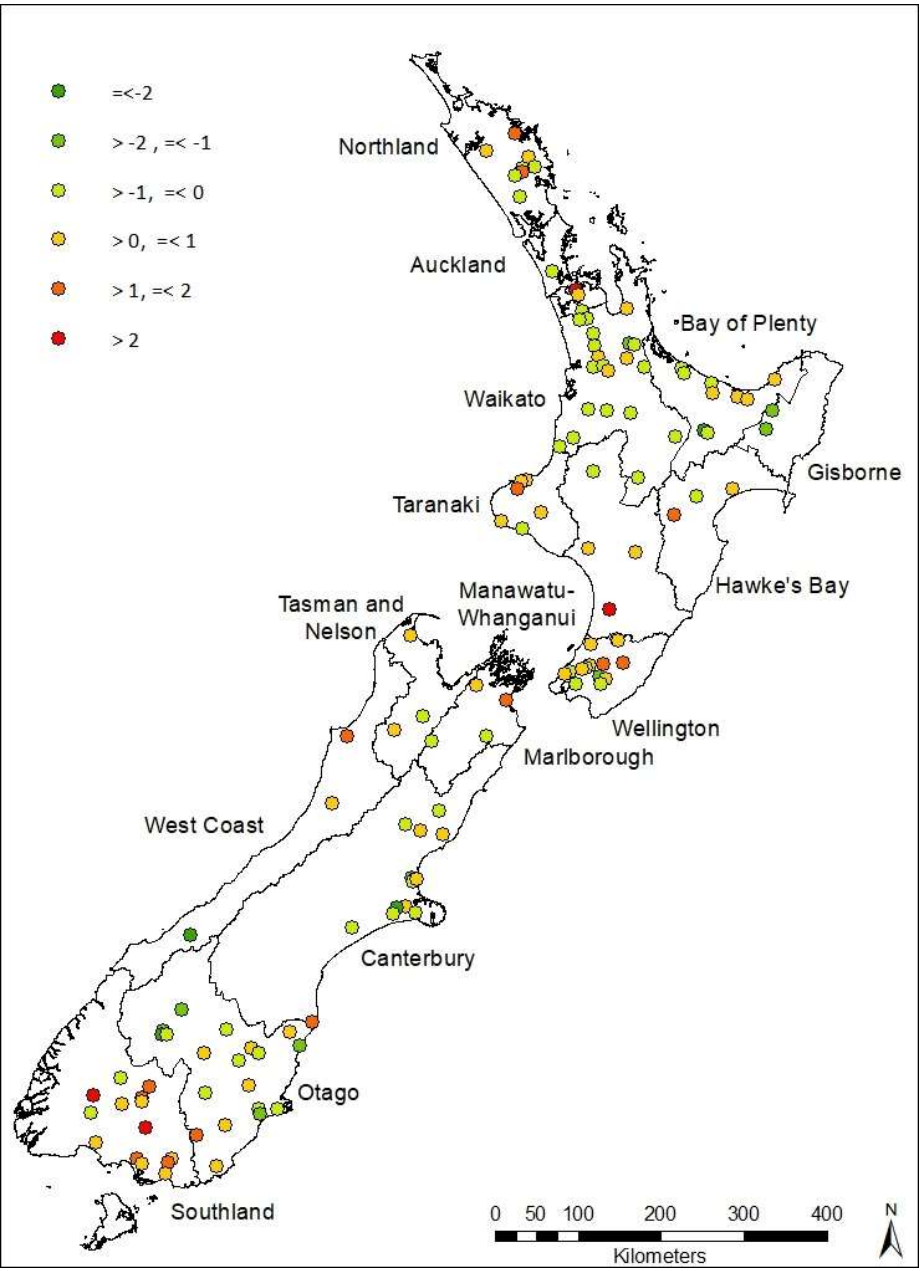

Residual analysis

- Identify systematic error
- Continuous variables:
- Regression analysis
- Slope, upstream land cover (percentages), soil drainage properties, baseflow index
- Discrete variables:
- Analysis of Variance (ANOVA), Tukey and Kruskal-Wallis tests
- Variables: region, land cover (dominant), network position, river environment classifications (geology, climate, source of flows)

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Residual results

- Regression found weak relationships for:
- *E. coli* (upstream proportion of deer, BFI)
- TN with attenuation (lat and long, upstream proportion of dairy, BFI)
- TN with no attenuation (lat, upstream proportions of dairy and forest, average slope)
- Statisistical tests found possible differences in distribution for:
- TN (region and climate class – may be related)
- Concern that most monitoring sites are on mid to high order streams

Conclusions

- CLUES gives reasonable load estimates of TN, TP and *E. coli* at the catchment scale
- No systematic bias in the model results were identified….

BUT

- CLUES cannot currently estimate stream or lake attenuation at the national level
- There are compensating errors in the parameters for source yields and attenuation
- Low order streams (sources) are not represented in the calibration data set

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Call to arms

To calculate attenuation, we need improved spatial representation of catchment characteristics in general and of lower order streams in particular.

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