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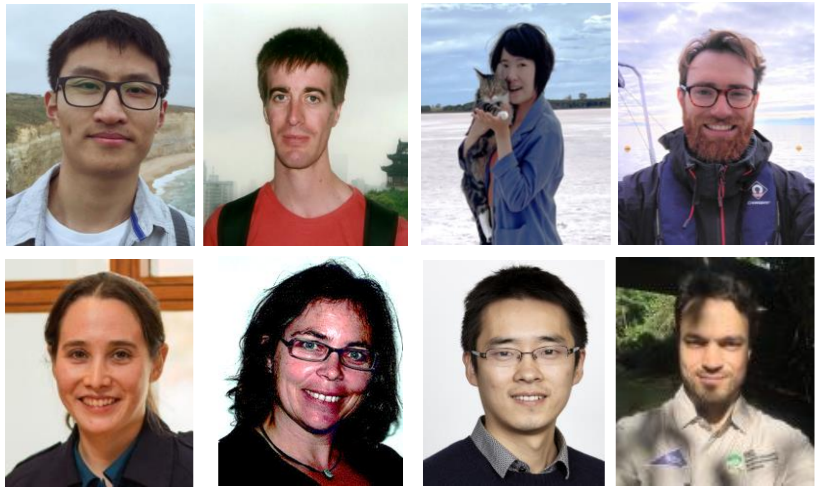
Controls on spatial variability in mean concentrations and export patterns of river chemistry: *a study across the Australian continent using a Bayesian approach*



Shuci Liu (Nanjing University of Information Science & Technology, China)
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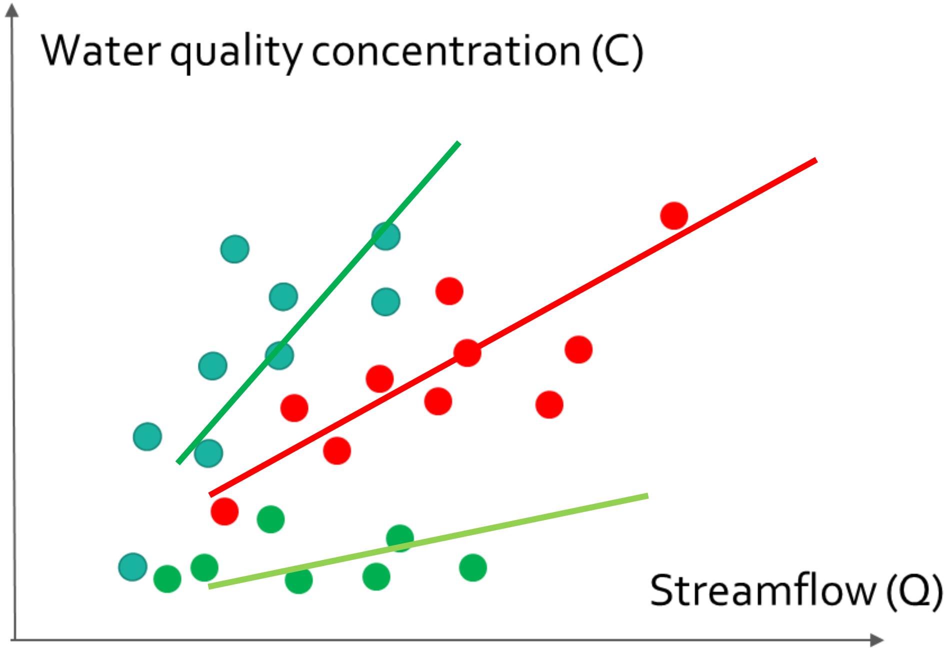
Danlu Guo (University of Melbourne, Australia)
Anna Lintern (Monash University, Australia)
Camille Minaudo (University of Barcelona, Spain)
Ulrike Bende-Michl (Bureau of Meteorology, Australia)
Kefeng Zhang (UNSW, Australia)
Clément Duvert (Charles Darwin University, Australia)

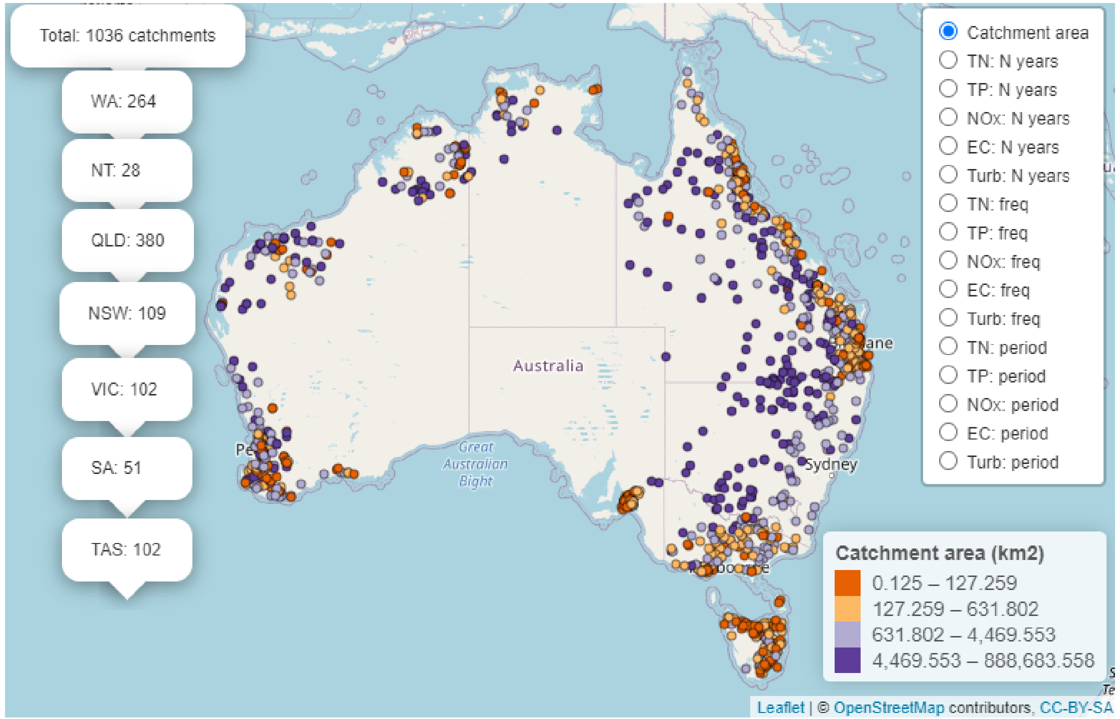
Background

Concentration-flow (C-Q) relationship



$$\log(C_{site,time}) = \alpha_{site} + \beta_{site}\log(Q_{site,time})$$

The Australian National Water Quality Dataset



Long-term stream water quality data were requested from **7 Australian state agencies that hold the data.**

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Research Questions

Overarching Question:
*How does Australian river water quality vary **over space** and **time**?*

Q1. What are the **links between climate zones and river water quality**?
https://doi.org/10.1002/hyp.14423

Hydrological Processes
RESEARCH ARTICLE | Full Access
The influence of climate on water chemistry states and dynamics in rivers across Australia
A. Lintern, S. Liu, C. Minaudo, R. Dupas, D. Guo, K. Zhang, U. Bende-Michl, C. Duvert
First published: 30 October 2021 | https://doi.org/10.1002/hyp.14423

Q2. How does the **flow regime** affect the export pattern?
https://doi.org/10.5194/hess-26-1-2022
*(*next presentation by Danlu Guo, EGU22-6847)*

https://doi.org/10.5194/hess-2021-353
Preprint. Discussion started: 8 July 2021
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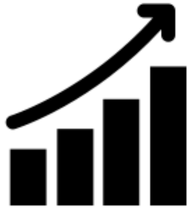
Hydrology and Earth System Sciences Discussions

Synthesizing the impacts of baseflow contribution on C-Q relationships across Australia using a Bayesian Hierarchical Model
Danlu Guo[1], Camille Minaudo[2], Anna Lintern[3], Ulrike Bende-Michl[4], Shuci Liu[1], Kefeng Zhang[5], Clément Duvert[6,7]

Q3. What are the key **landscape and climatic controls** that drive spatial differences in water quality?
https://doi.org/10.1002/essoar.10510878.1
*(*this presentation, EGU22-11003)*



Q4. How does water quality **vary across time**? (WIP)

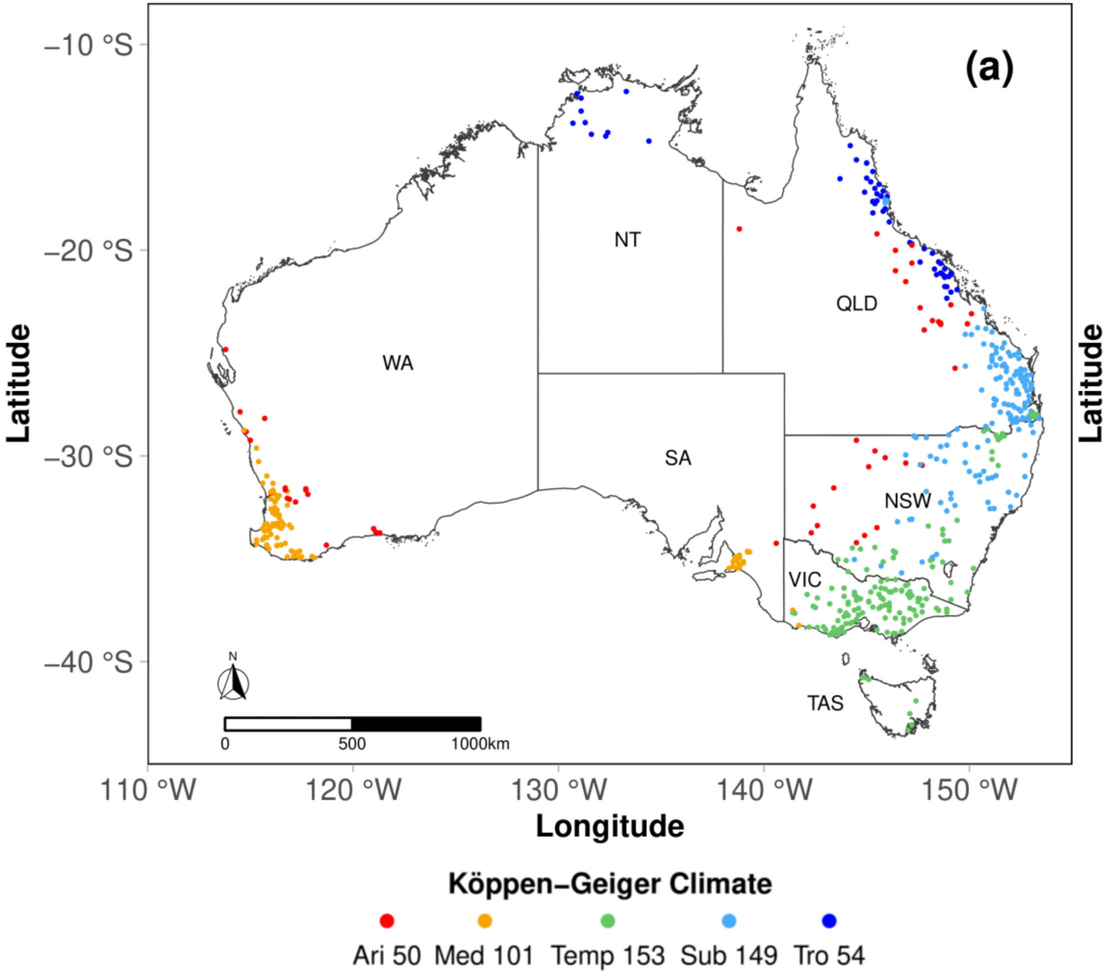
南京信息工程大学
Nanjing University of Information Science & Technology

Data used for this study – water quality

- **WQ Constituents selection:**

1. *Electrical conductivity (EC)*
2. *Total phosphorus (TP)*
3. *Soluble reactive phosphorus (SRP)*
4. *Total suspended solids (TSS)*
5. *Sum of nitrate and nitrite (NO_x)*
6. *Total nitrogen (TN)*

- **Catchment selection:** 1) >10 years WQ samples; 2) >50 C–Q pairs
- **A total of 507 catchments were selected across 6 constituents**



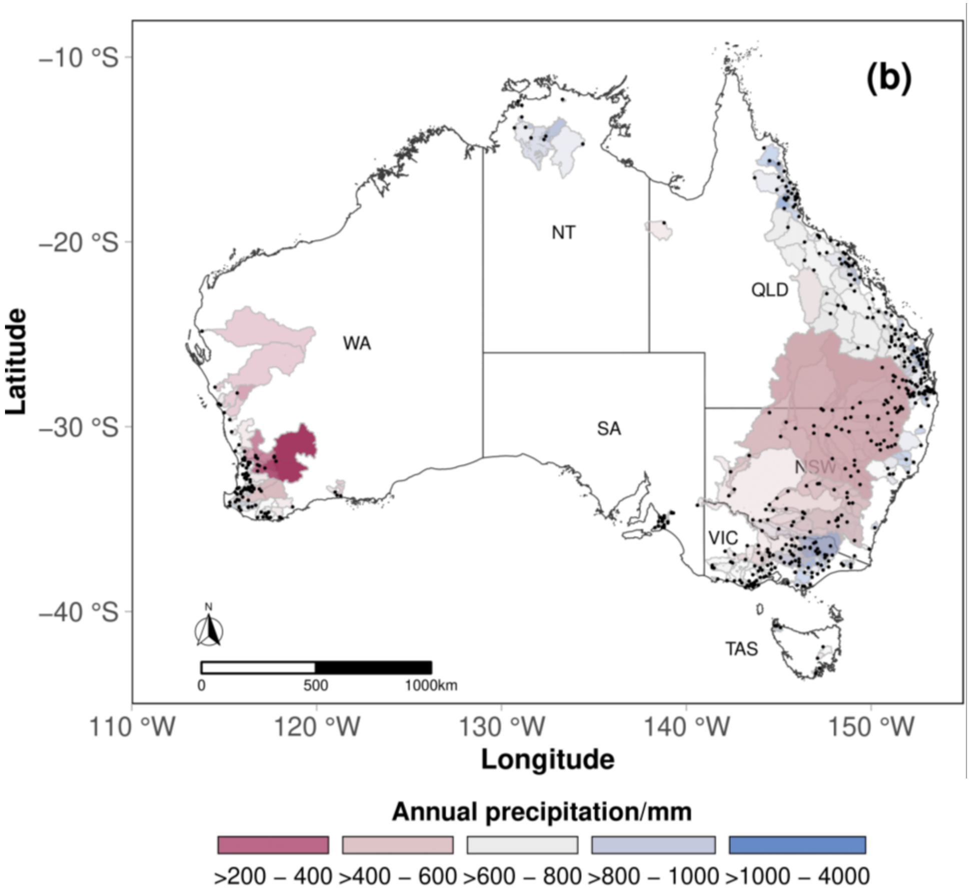
Locations of 507 selected catchments across five major climate zones

Data used for this study – catchment characteristics

- **Catchment characteristics selection:**

1. *Topography*
2. *Climate*
3. *Land use*
4. *Land cover*
5. *Soil*
6. *Hydrology*

- **A total of 26 catchment characteristics selected**



Spatial pattern of catchment annual precipitation

Method

- a **Bayesian variable selection (BVS) approach** to identify the key catchment characteristics affecting spatial variability (C mean) and export patterns (*C*–*Q* slope)
- a **Bayesian Hierarchical modelling approach** to quantify the effect of climate

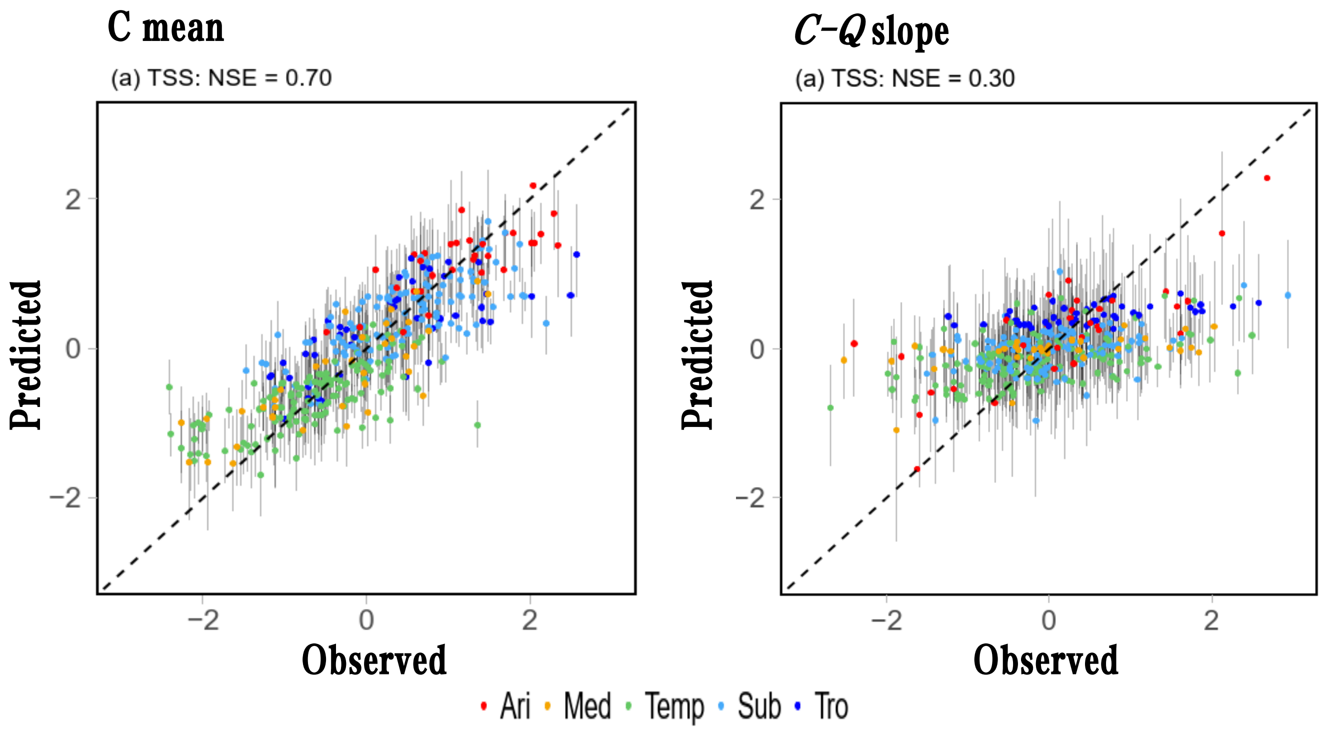
$$C_{site,climate} = \alpha + I \times \beta_{climate} \times CC_{site} + \ldots\ldots$$

Inclusion variable: relative importance

Coefficient: effect varying across climate zones

Result and discussion

Predictive performance



- Mean concentrations are more predictable
- Clearer climatic gradient in the mean concentration
- An increase in predictive performance for both C mean and *C–Q* slope when the effects of climate zones are incorporated explicitly using the Hierarchal BMA framework

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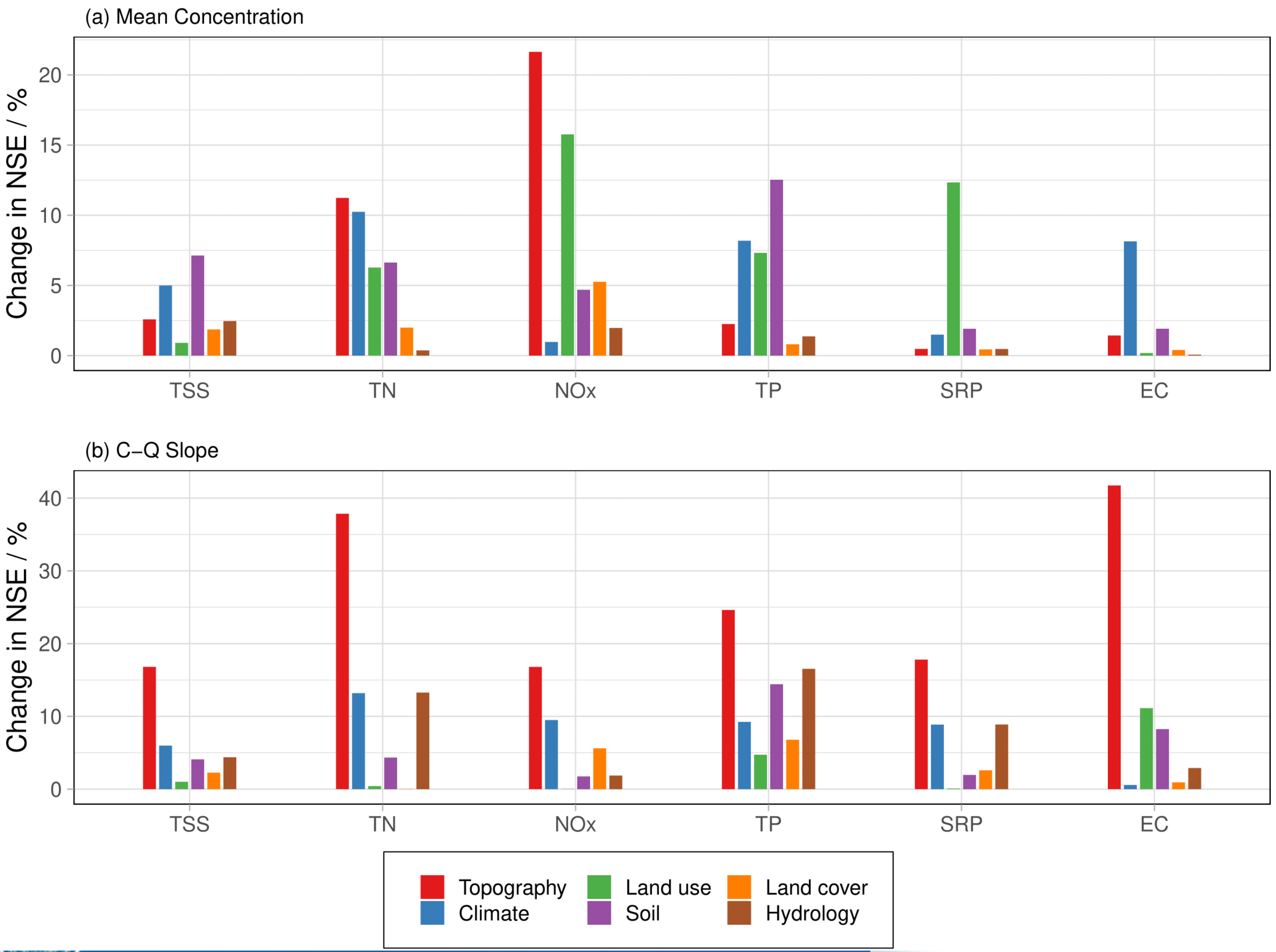
Result and discussion

Relative importance of catchment characteristics



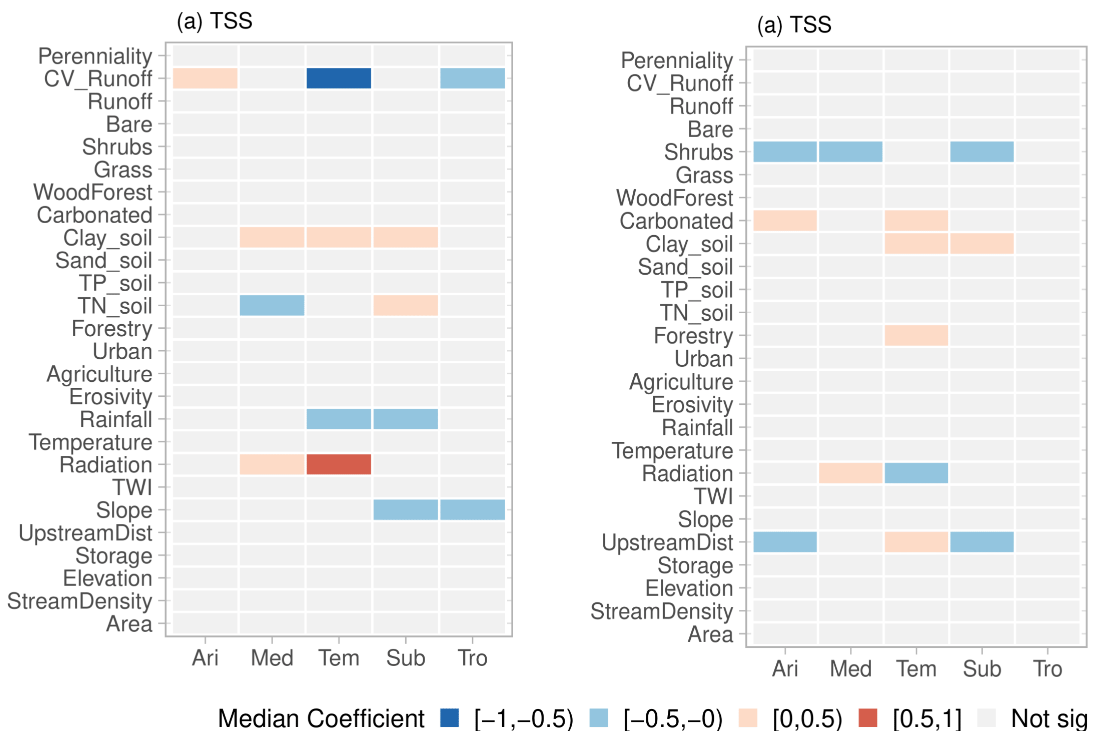
- Changes in NSE between the full model and 'leave one-category-out' analysis across individual constituents
- For C mean, different categories of catchment characteristics show varying effects.
- For *C–Q* slope, catchment topography is a strong driver for all constituents.

Result and discussion

Contrasting catchment controls of mean concentrations and export patterns

C mean

C–Q slope



Effect of key catchment controls on C-mean (left) and *C–Q* slopes (right) across different climate zones

- **Key controls on mean concentrations and C–Q slopes vary across different constituents**
- **Topography controls connectivity between source to stream**
- **Soil controls the mobilisation of solutes and particulates**

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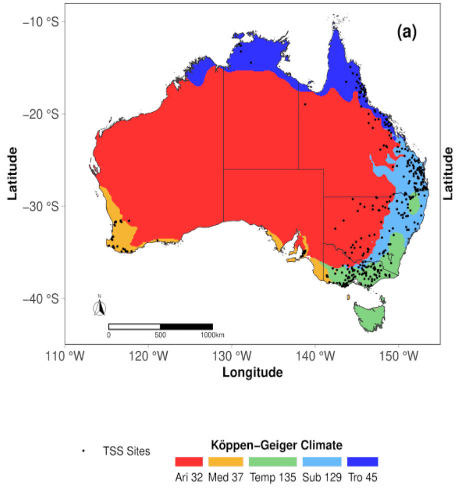
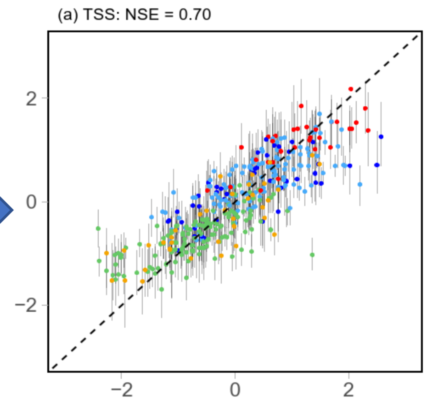
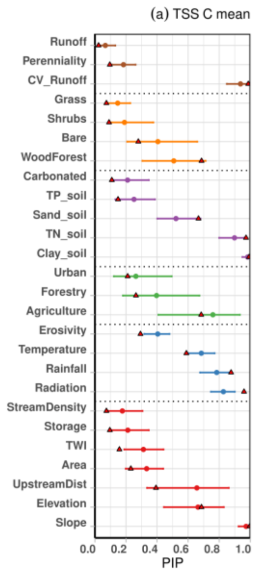
Take-home messages







- **Consideration of climate zones in a hierarchical modelling structure improves the predictability of both mean concentrations and *C–Q* slopes;**
- **Topography and soil are the most influential factors for mean concentrations; while topographic controls show strong effects on export patterns;**
- **The influence of catchment controls on mean concentrations/*C–Q* slopes vary across climates zones;**
- **Improved understanding of key controls on both means concentrations/*C–Q* slopes is likely to facilitate appropriate mitigation measures that can inform the design of varying levels of specific interventions.**

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Acknowledgment

- Australian Government agencies for supplying the water quality monitoring data and flow data:

- Professor Andrew Western from The University of Melbourne for providing suggestions on study design.

- Ms Natalie Kho for assistance in data pre-processing.

- The traditional owners of the waterways from where the water quality and flow data were collected.