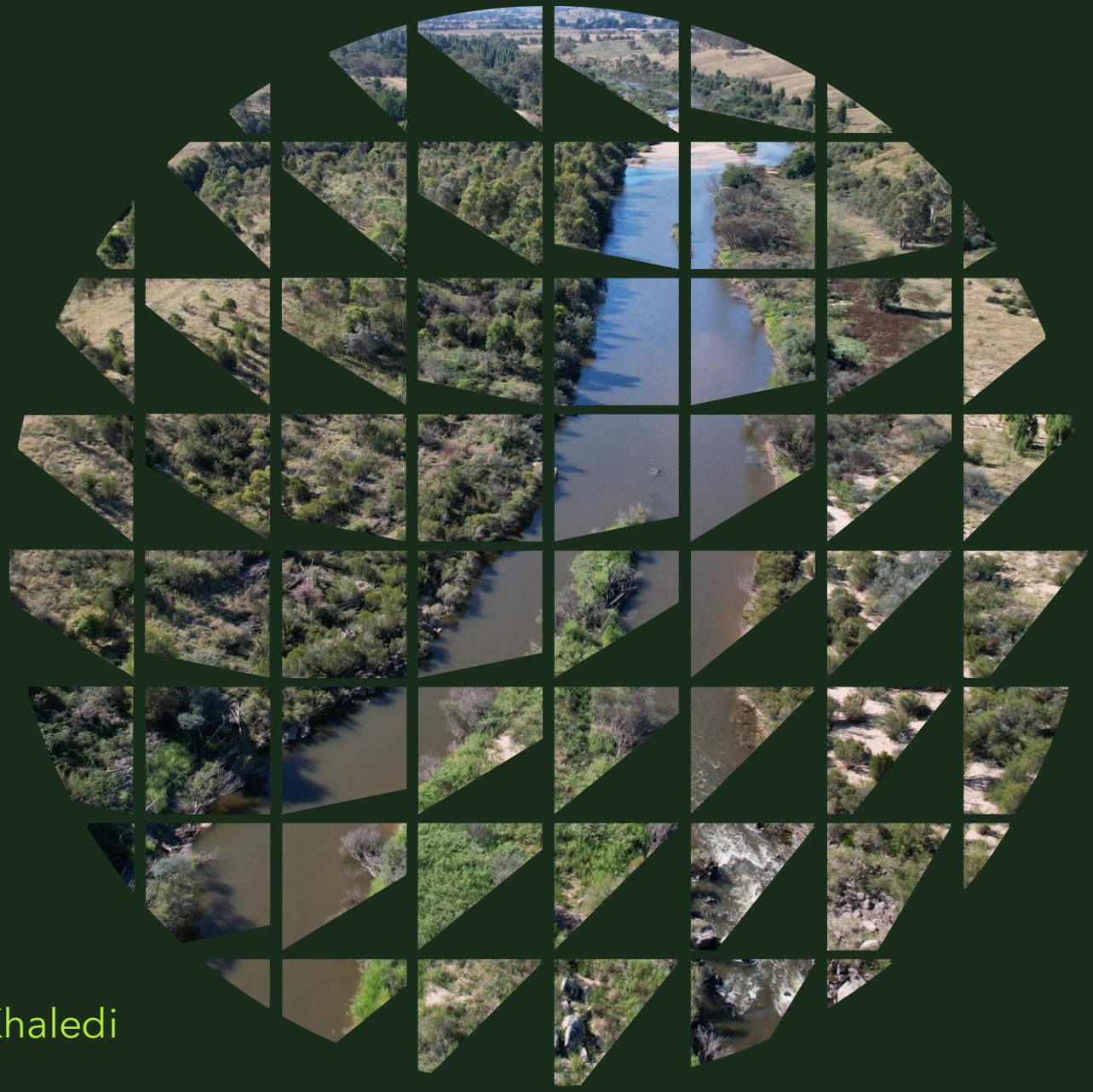
alluvium group | alluvium consulting



NEXT WATER 2025

Catchment health metrics toolbox

Petter Nyman, Paul Richards, Ben Gawne, Jabbar Khaledi

Outline

Catchment health - industry needs and our approach

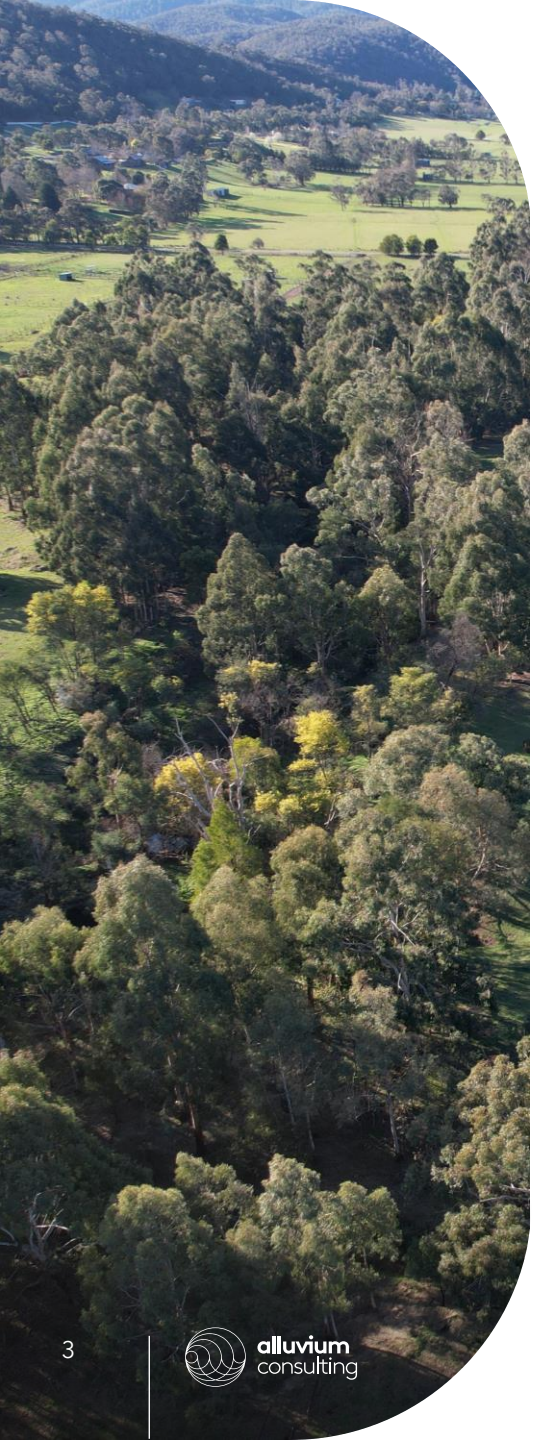
Developing a framework

Case study: Coliban Water

Conclusion and next steps

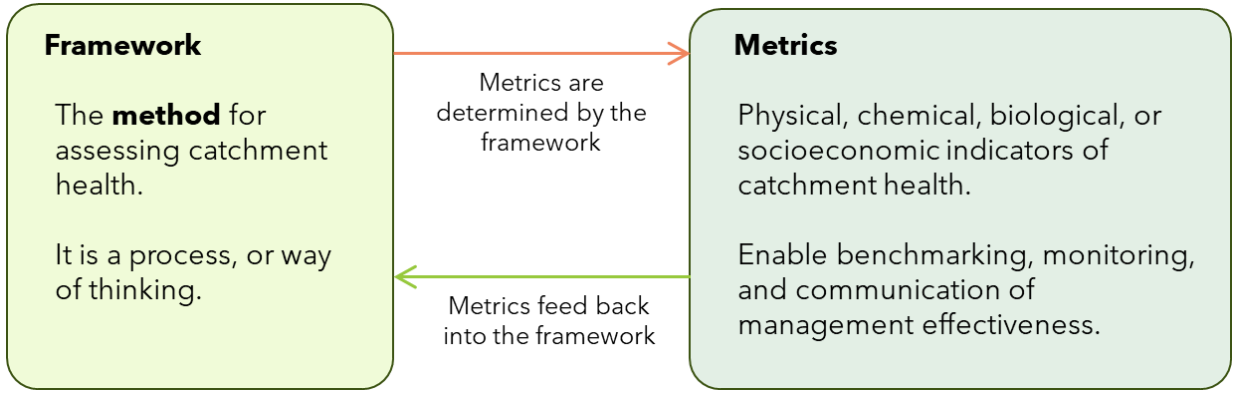
Acknowledgements:

Water RA Partners: WaterNSW, Water Corporation, Melbourne Water, Hunter Water, Coliban Water, Sydney Water, Wannon Water



What is catchment health and why is it a useful concept?

- A method or process for measuring the condition of a catchment
  - Condition defined to reflect specific management objectives:
    - ecosystem services, cultural values
    - biodiversity, conservation
- Useful concept to:
  - understand threats, connecting cause and effect in relation to management objectives
  - identify and prioritize management options,
  - benchmarking and tracking outcomes,
  - communicate amongst stakeholders.



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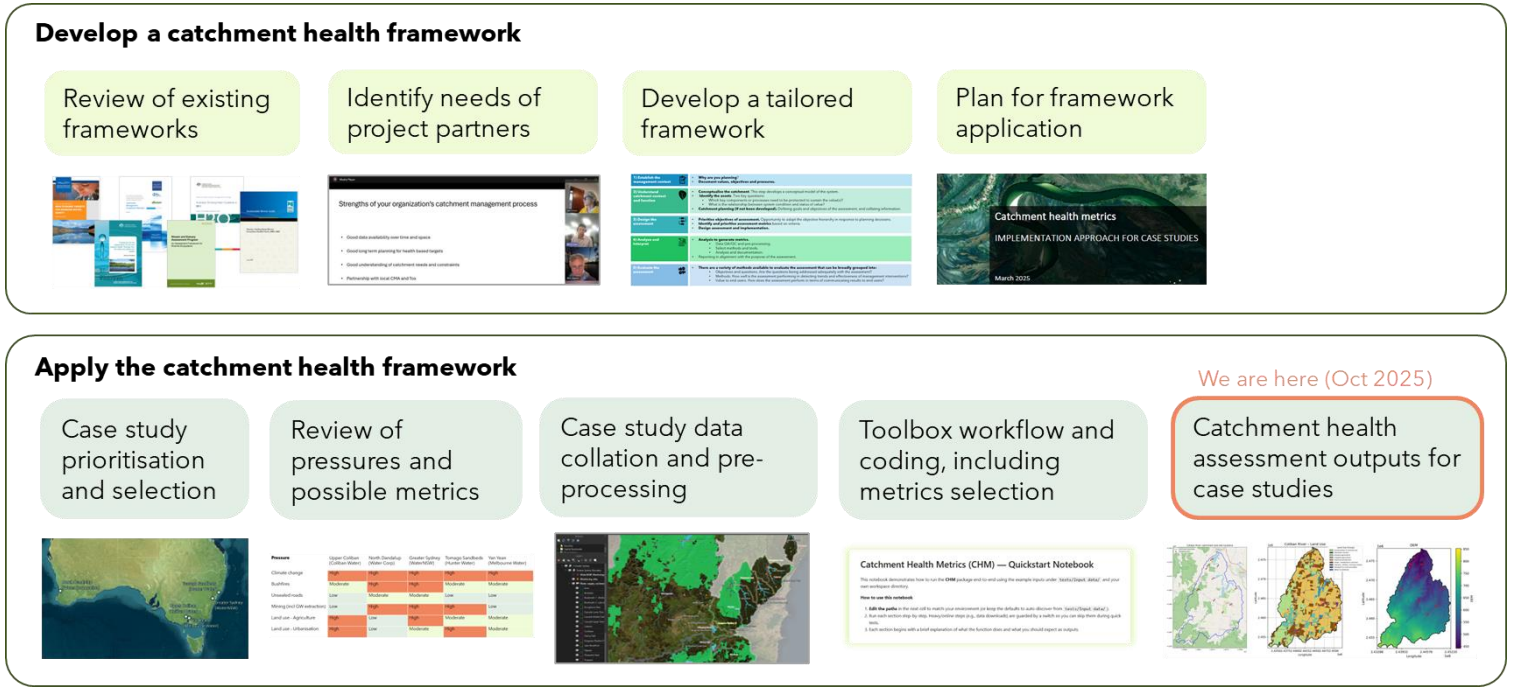
Aims and approach

Aim

- Support integrated catchment management through the development of a catchment health assessment framework
- Development of metrics to support the assessment framework

  - generic process and options that can be adapted by managers to their situation.
  - primary target group for catchment health assessment in the project is drinking water utilities.
  - complimentary and a value add to existing frameworks.



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Framework for assessing catchment health

Five key elements, designed to bring consistency into the assessments:

1) Establish the management context 	• **Why are you planning**? • **Document values, management objectives and pressures.**

2) Understand catchment context and function 	• **Conceptualise the catchment**. This step develops a conceptual model of the system.
	• **Identify the assets**. Two key questions:
	  • Which key components or processes need to be protected to sustain the value(s)?
	  • What is the relationship between system condition and status of value?
	• **Catchment planning (if not been developed).** Defining goals and objectives of the assessment, and collate information.

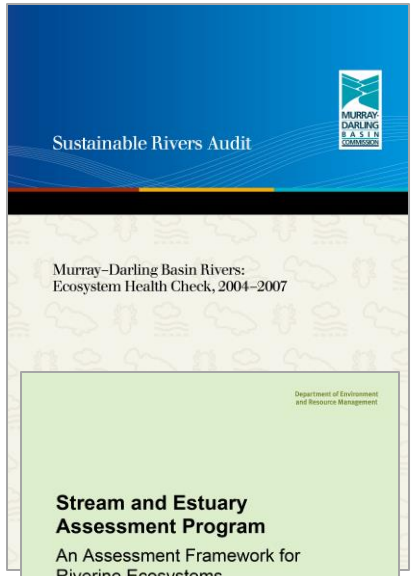
3) Design the assessment 	• **Prioritise objectives of assessment.** Opportunity to adapt the objective hierarchy in response to planning decisions. • **Identify and prioritise assessment metrics** based on criteria. • **Design assessment and implementation.**

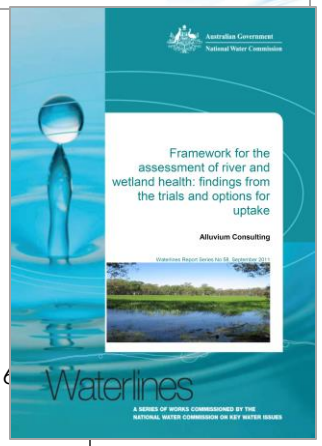
4) Analyse and interpret 	• **Analysis to generate metrics.**
	  • Data QA/QC and pre-processing.
	  • Select methods and tools.
	  • Analysis and documentation.
	• Reporting in alignment with the **purpose** of the assessment.

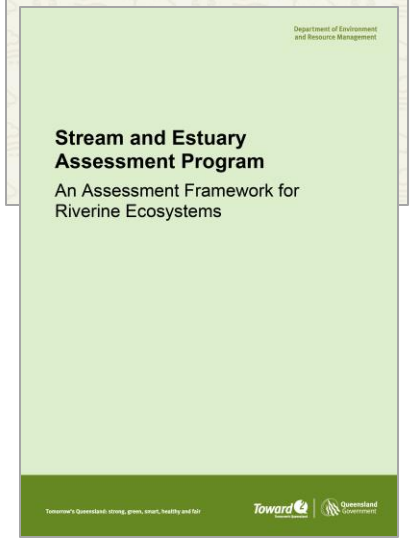
5) Evaluate the assessment 	• **There are a variety of methods available to evaluate the assessment that can be broadly grouped into:**
	  • Objectives and questions. Are the questions being addressed adequately with the assessment?
	  • Methods. How well is the assessment performing in detecting trends and effectiveness of management interventions?
	  • Value to end users. How does the assessment perform in terms of communicating results to end users?

Framework for assessing catchment health

- There are many different frameworks in use across Australia, developed in different management contexts and serving different purposes.
- We are focusing on the most universal value and objective amongst the partners – **provision of drinking water**.







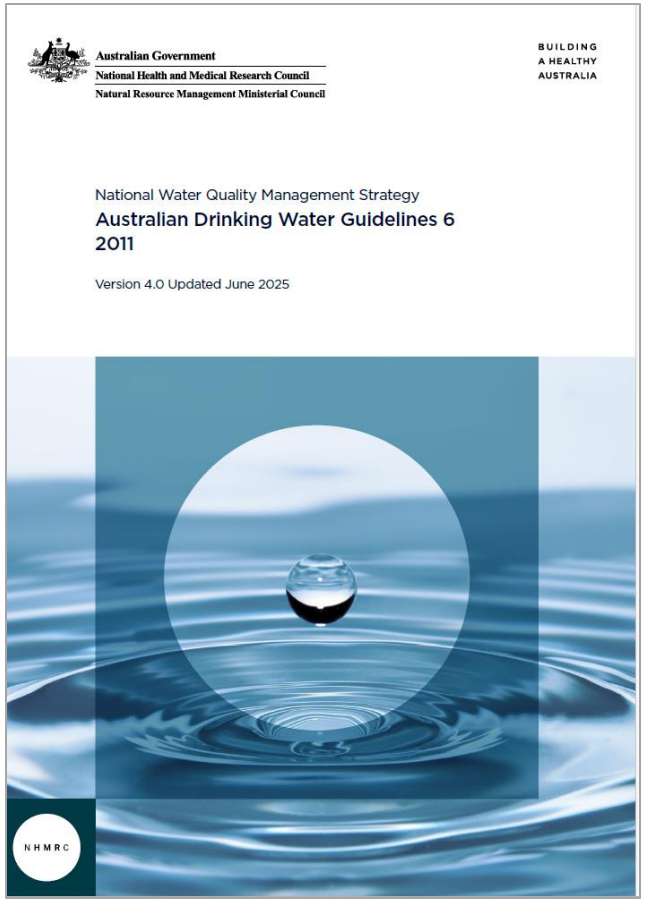
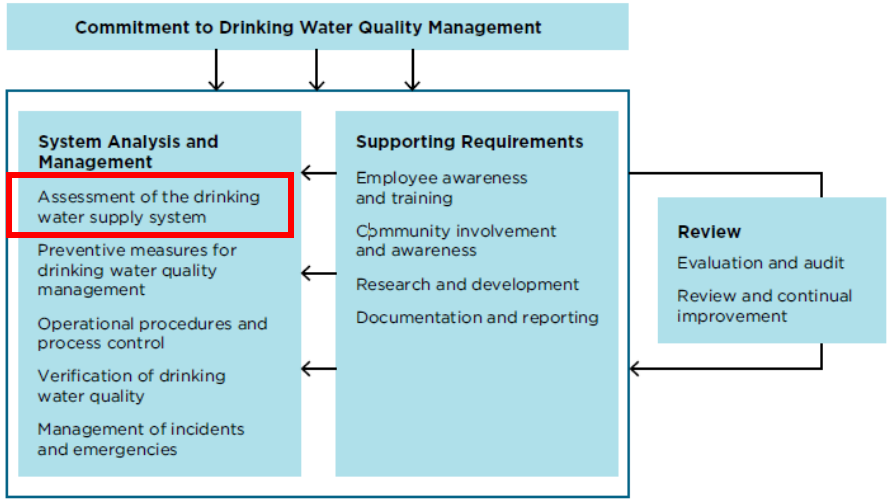


Figure 2.1 Framework for management of drinking water quality

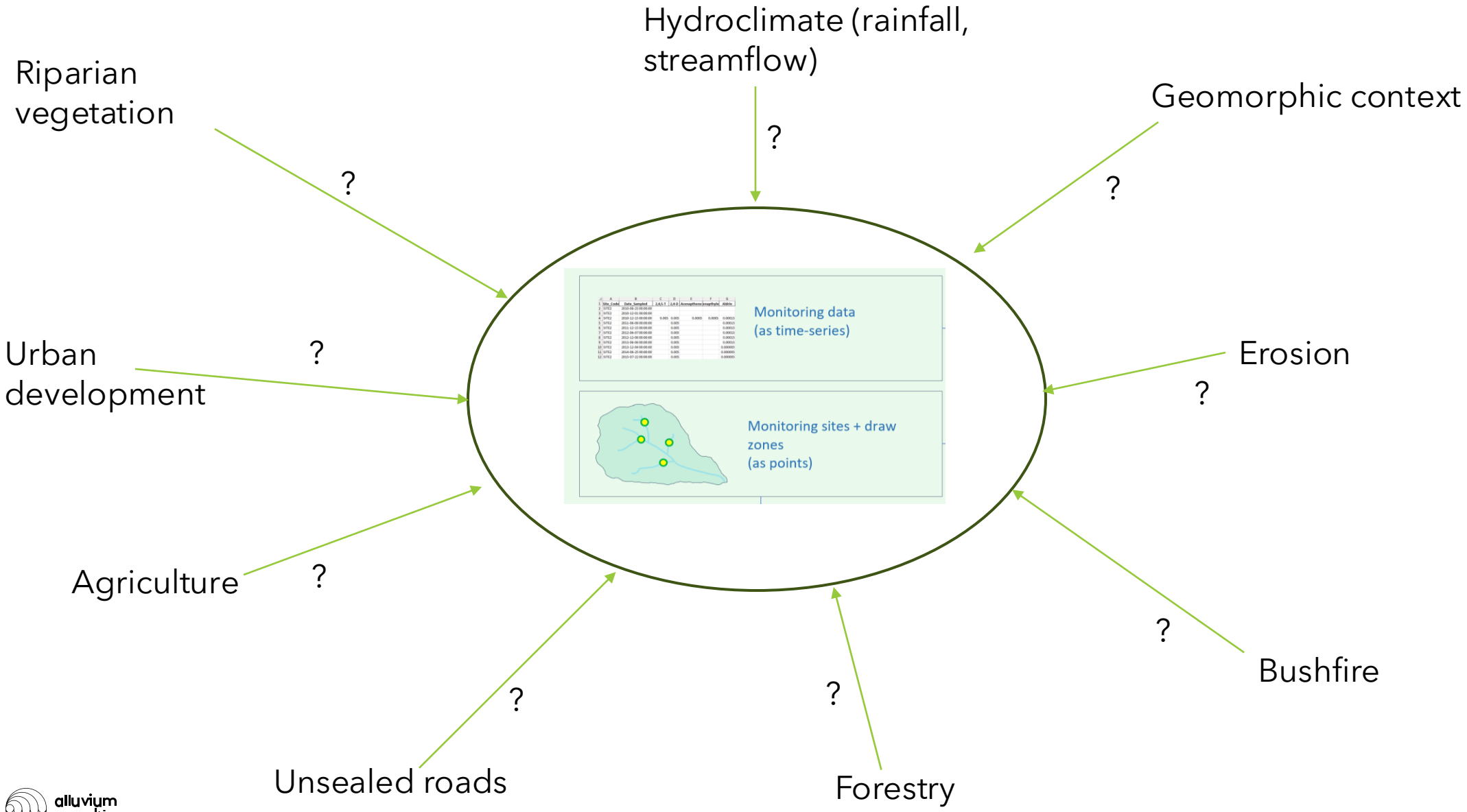


A1.2 Water supply system analysis

Table A1.1 Key characteristics of the drinking water supply system

Catchments	
• Geology and soils	• Nature and intensity of development and land-use activities:
• Topography and drainage patterns (hydrology)	– agricultural, dairy and animal husbandry
• Streams and rivers	– land clearing
• Meteorology and weather patterns (climatic and seasonal variations)	– forestry
• Riparian conditions	– mining
• Vegetative cover	– industrial
• General catchment and river health	– rural and urban development / residential
• Wildlife (e.g. native and feral animals)	– sewage treatment works and septic tanks
• Historical contaminated sites	– recreational activity
• Competing water uses	• Intermittent or seasonal use practices
• Land irrigation practices	• Future planning activities
	• Development and planning restrictions

A catchment health metrics toolbox



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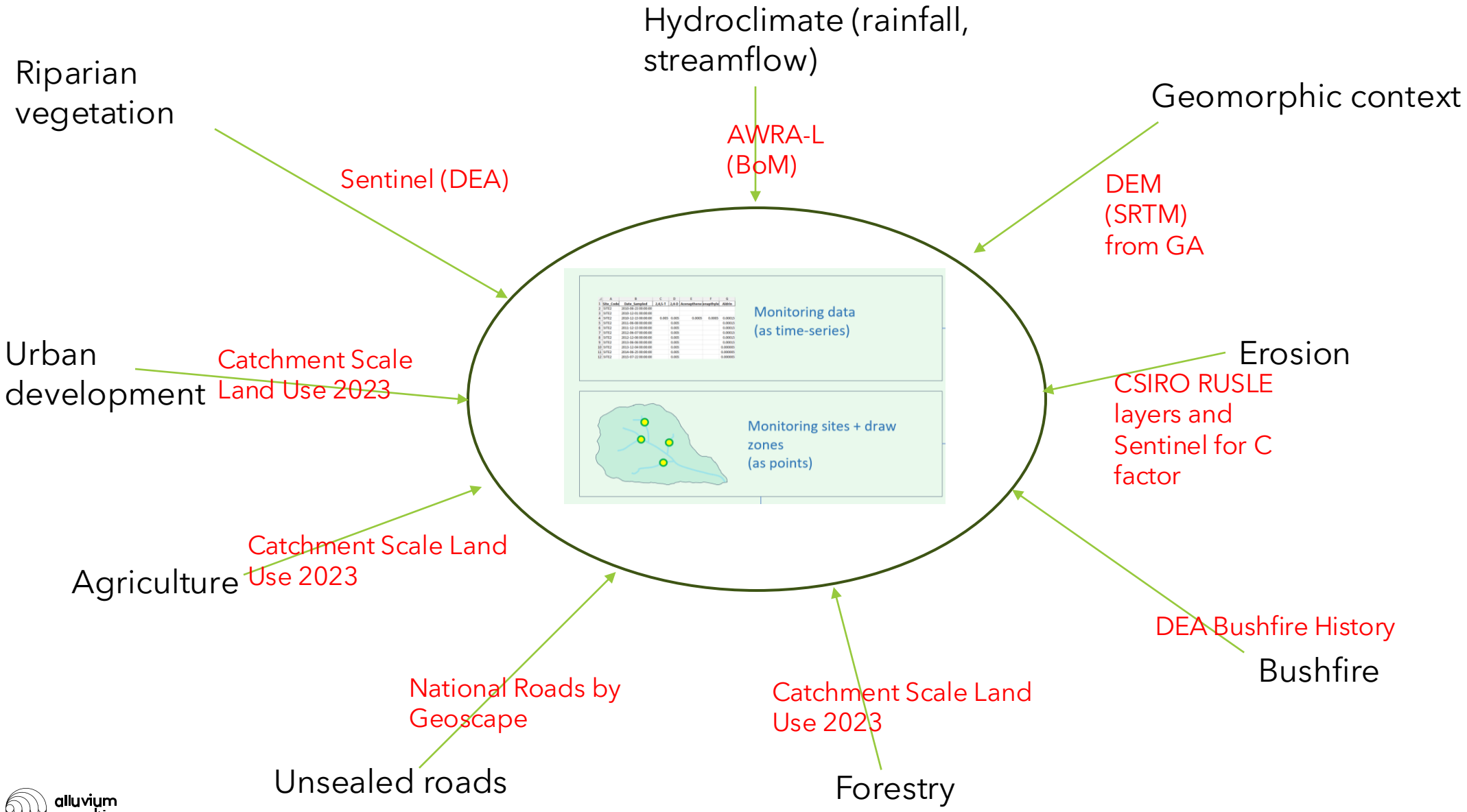
A catchment health metrics toolbox



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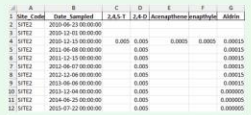
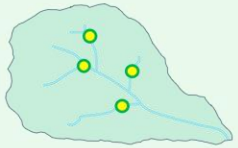
A catchment health metrics toolbox

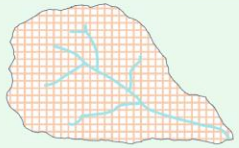
Inputs



Monitoring data
(as time-series)



Monitoring sites + draw zones
(as points)



Open-source pressures data
(as rasters – including rasterised vector data)

Catchment (as polygon)

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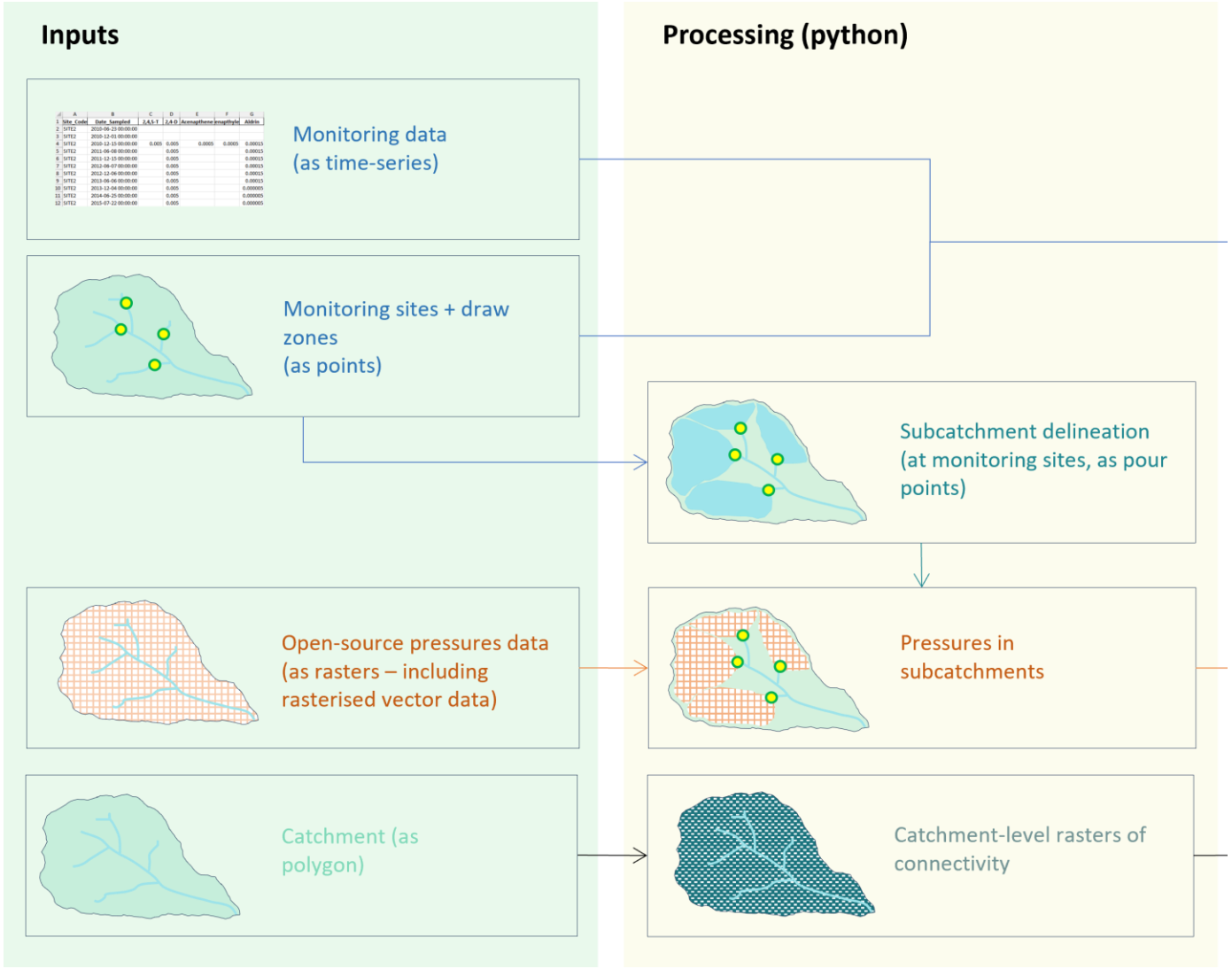
A catchment health metrics toolbox



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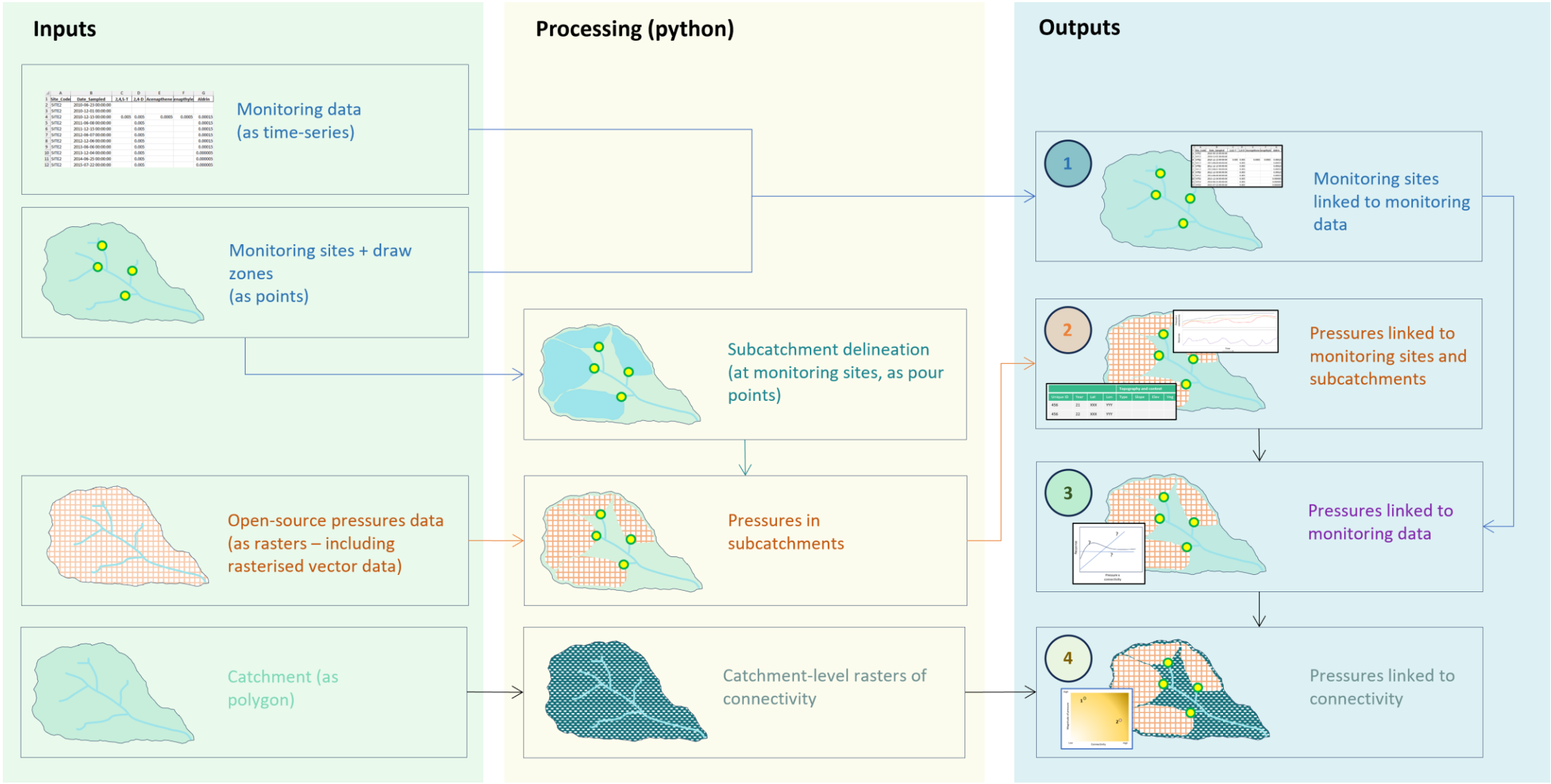
A catchment health metrics toolbox



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Toolbox as a Python library

A python package for assessing catchment health that links information on monitoring, pressures, and connectivity.

Catchment Health Metrics (CHM)

CHM is a Python library for assessing **catchment health**.
It automates the retrieval and processing of topography, hydroclimate, vegetation, bushfire, road, and land use datasets for a given catchment boundary.
From these datasets it generates groundwater and surface connectivity metrics (e.g., **Topographic Wetness Index (TWI)**, **Sediment Delivery Ratio (SDR)**) and uses them to create **risk profiles** for vegetation (NDVI), bushfire, roads, and land use (e.g., plantation forests, mining, industry, transport, residential, irrigation, cropping, and horticulture).

The package is built with a **src/** layout for clean packaging and development with `pip install -e .`.
It is tailored for **Australian conditions and datasets** (e.g., GA DEM, AWRA-L, DEA/AGCD) but the structure is flexible for adaptation elsewhere.

Features

- **Topography**: DEM acquisition (GA WCS) and generation of slope, aspect, TPI, TRI, LS factor
- **Connectivity**: Flow accumulation, SDR, TWI, sediment connectivity indices
- **Vegetation & C-factor**: NDVI time series, C-factor derivation, summaries
- **RUSLE & SDR-RUSLE**: Daily and annual erosion/sediment delivery estimates
- **Hydroclimate**: Precipitation and temperature (AWAP/AGCD), runoff, ET, and soil moisture (AWRA-L, historical & projections)
- **Bushfire**: Historical fire severity integration
- **Roads**: National roads dataset and connectivity overlay
- **Land Use (2023)**: Summaries for plantation forestry, mining, industry, cropping, horticulture, and more
- **Pipelines**: Chain modules for reproducible end-to-end workflows

Catchment Health Metrics (CHM) — Quickstart Notebook

This notebook demonstrates how to run the **CHM** package end-to-end using the example inputs under `tests/Input data/` and your own workspace directory.

How to use this notebook

1. **Edit the paths** in the next cell to match your environment (or keep the defaults to auto-discover from `tests/Input data/`).
2. Run each section step-by-step. Heavy/online steps (e.g., data downloads) are guarded by a switch so you can skip them during quick tests.
3. Each secti…u should expect as outputs.

This is an automated report for Coliban River catchment health condition

Coliban River

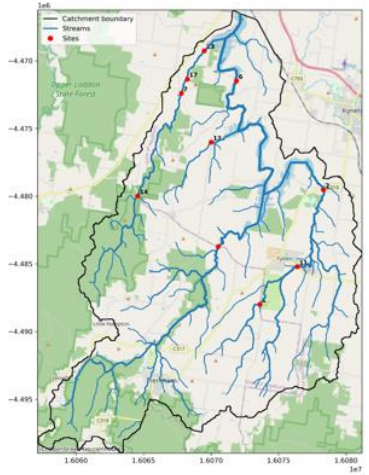

Figure 1. Coliban River and the location of sites.

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Case study: Upper Coliban

Management context

Overview

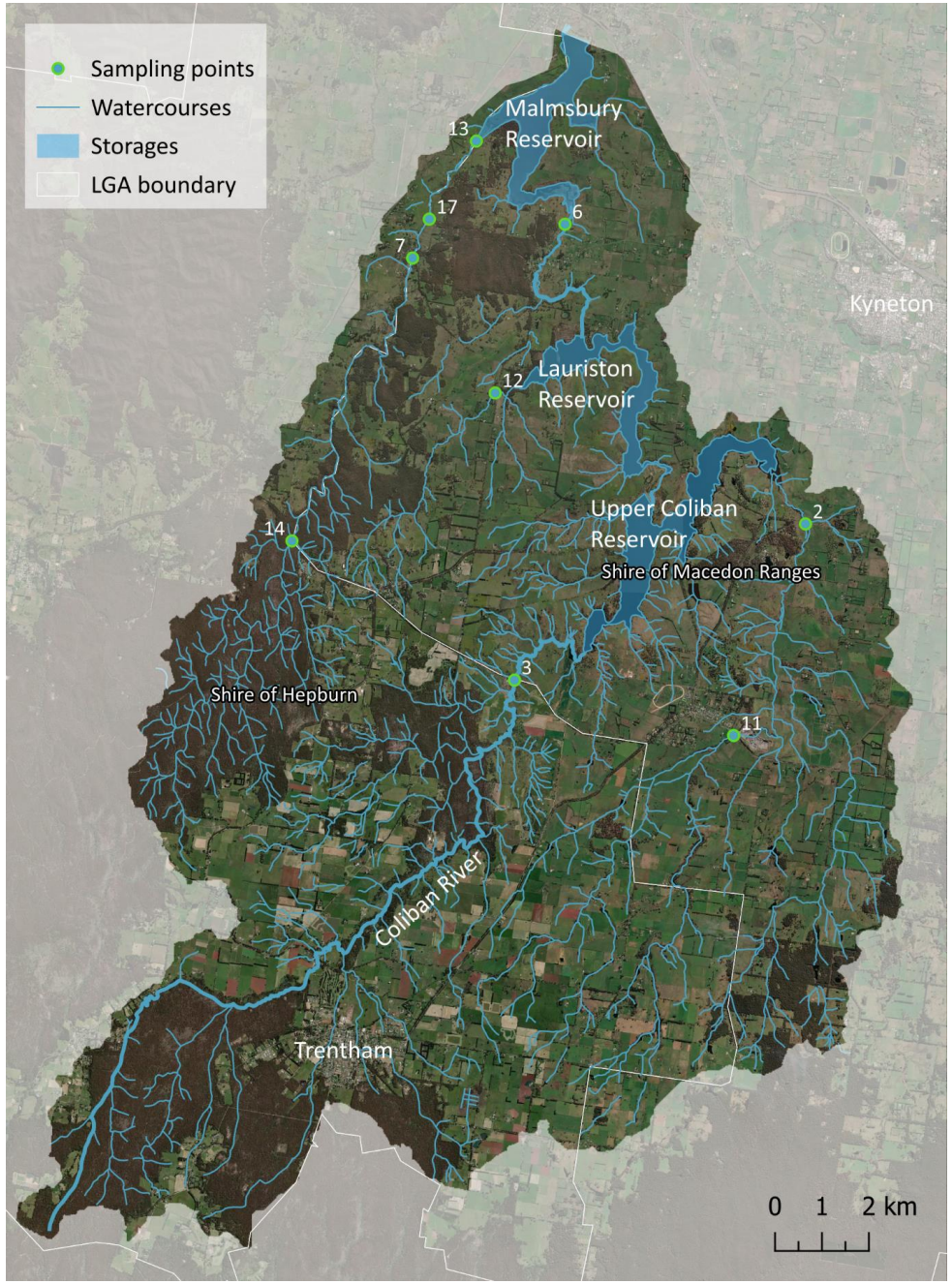
- The second largest catchment of five case studies.
- The southernmost catchment of the Coliban River - at the southern extent of the Murray-Darling Basin.
- Three agencies working collaboratively to:

Protect the Coliban River and its long-term water supply.

Improve habitat connectivity.

Maintain sustainable land use practices.

Further build cultural and lifestyle (recreational) values.



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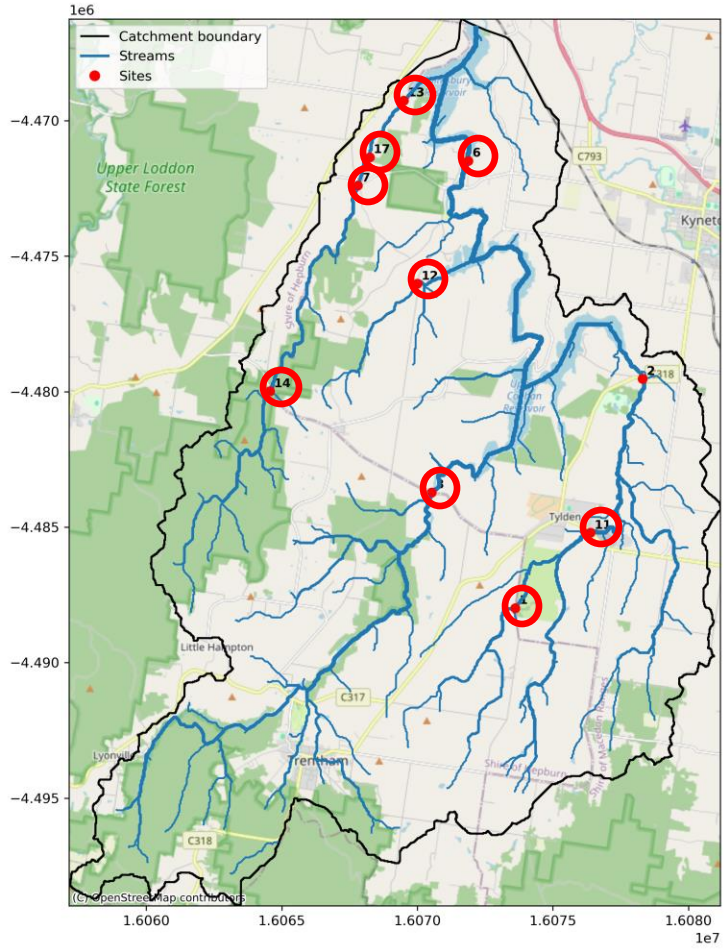
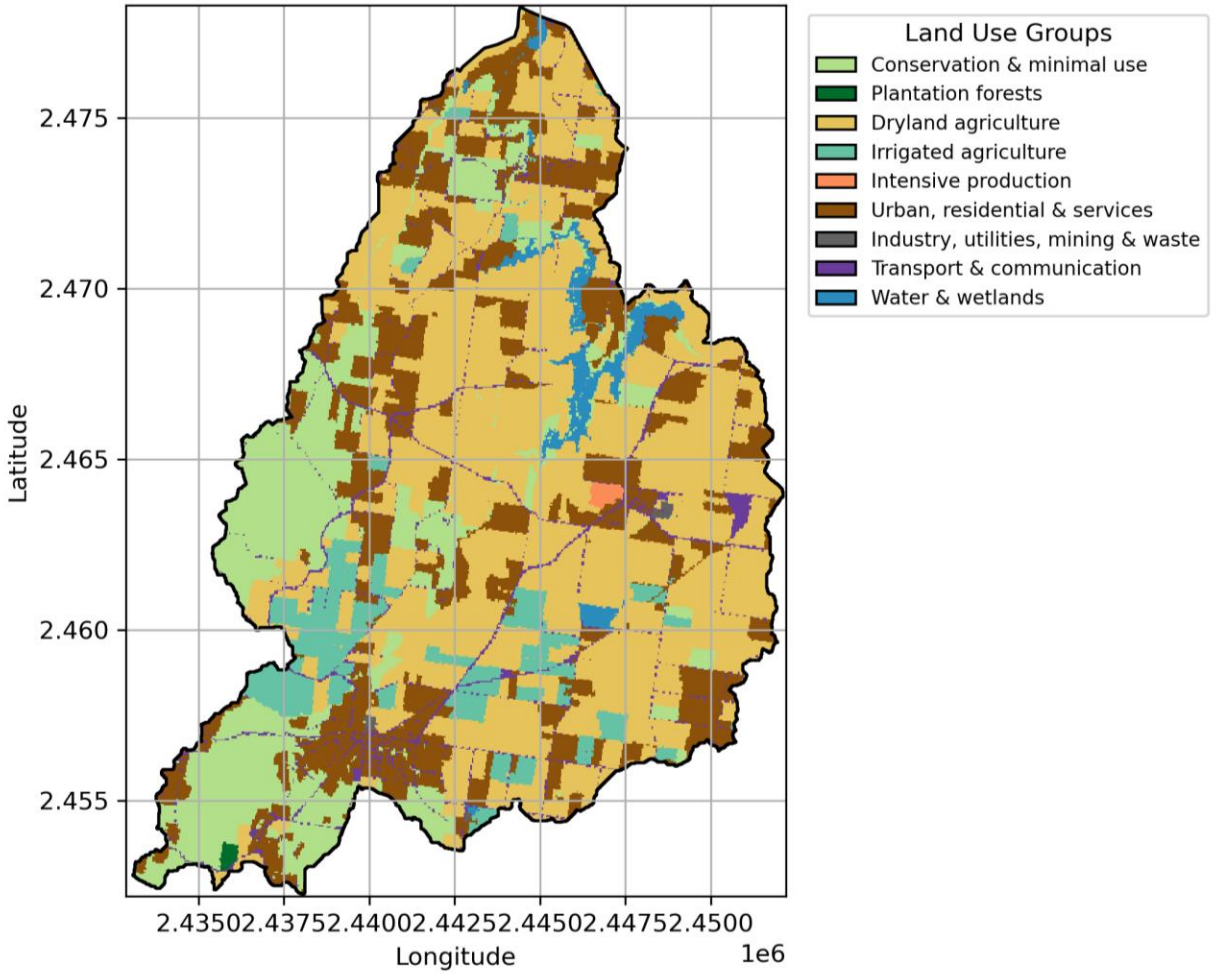
Toolbox outputs: Catchment context

Catchment and land use





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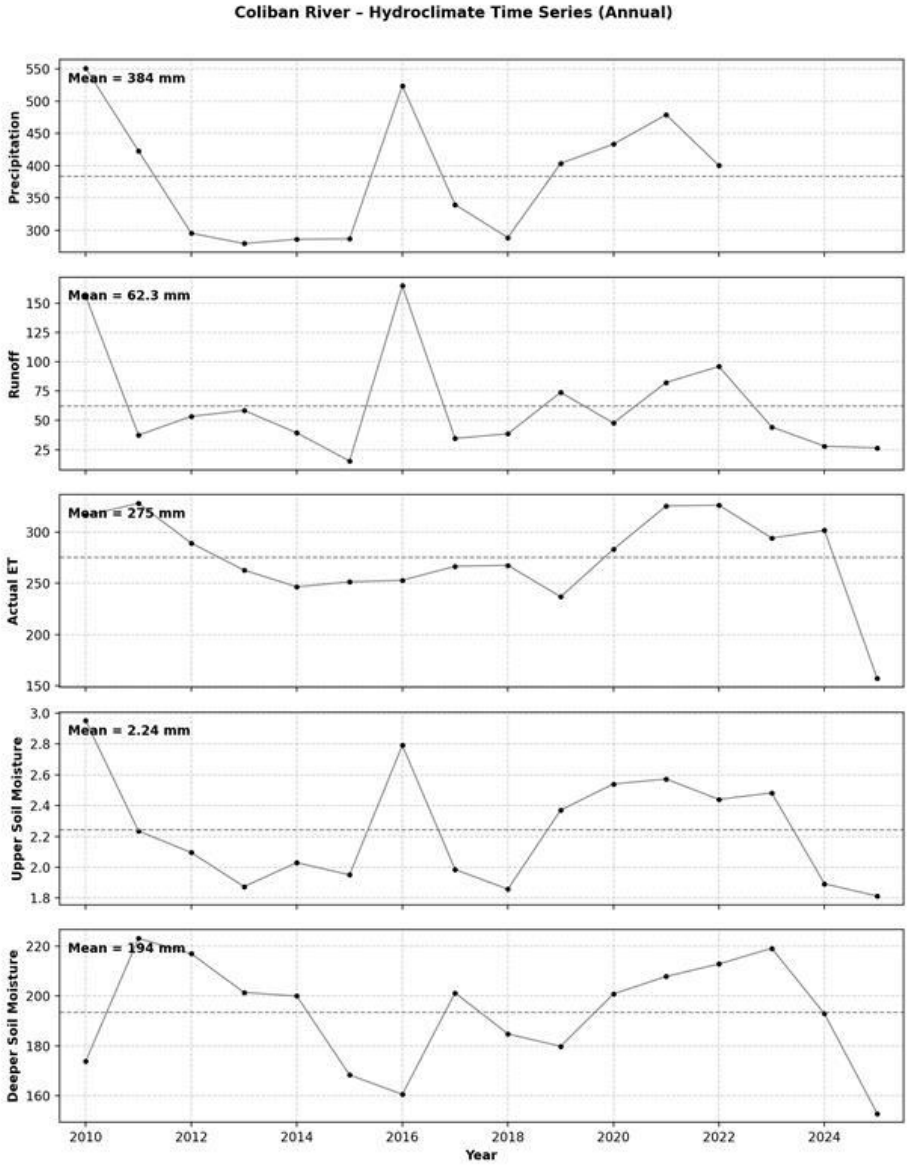
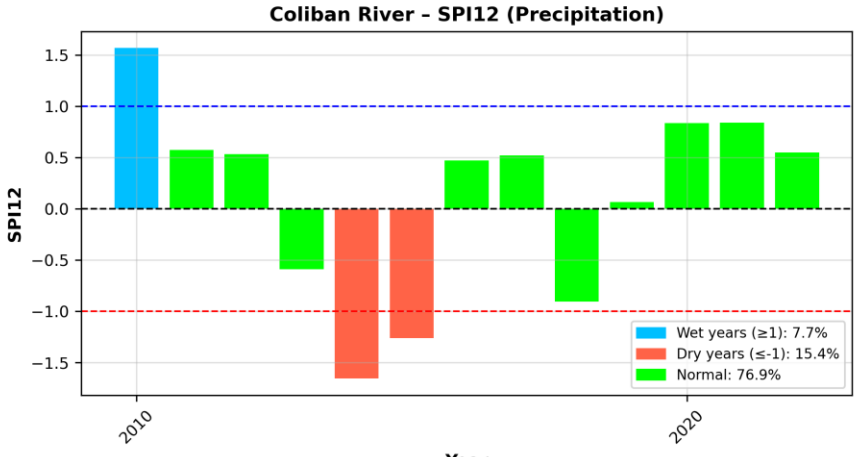
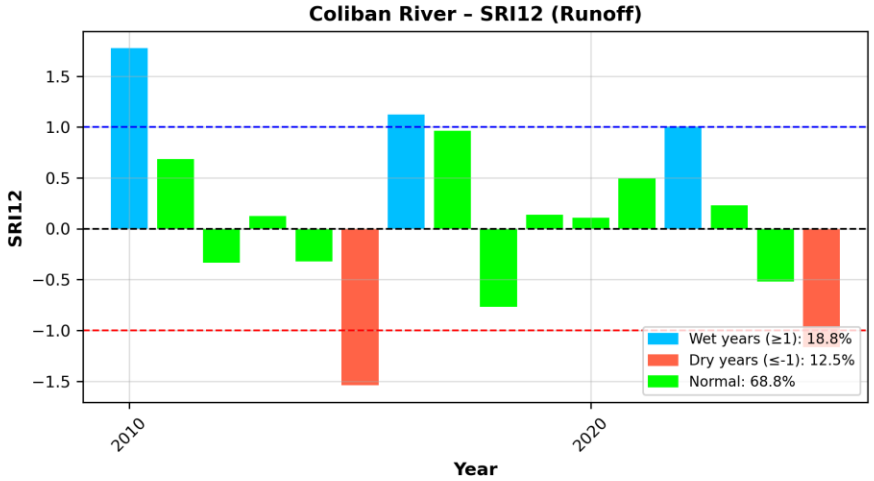
Toolbox outputs: Catchment context

Hydroclimate
from AWRA -L

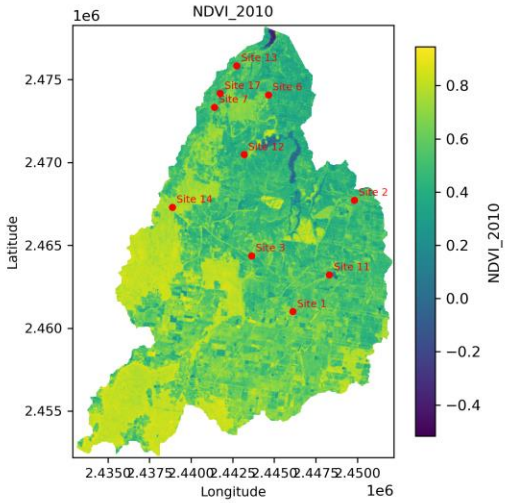


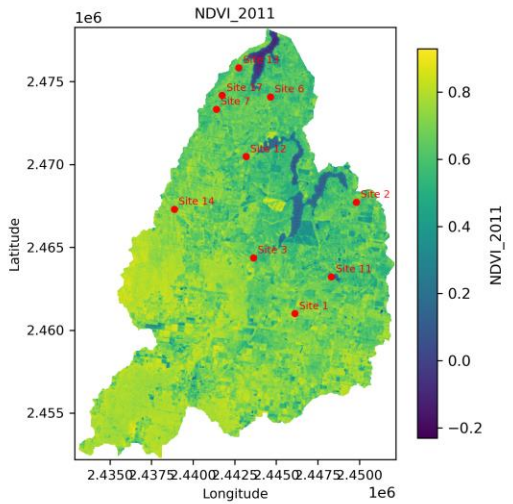


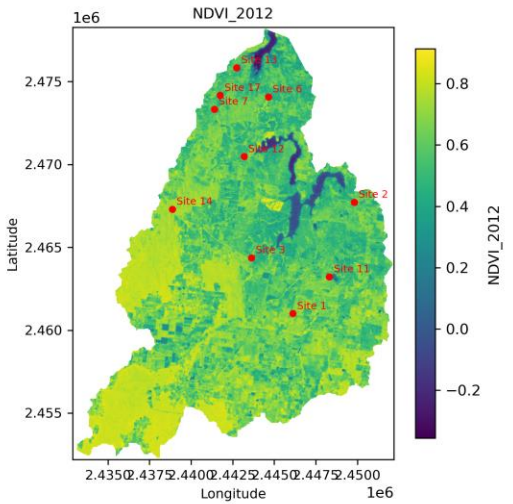


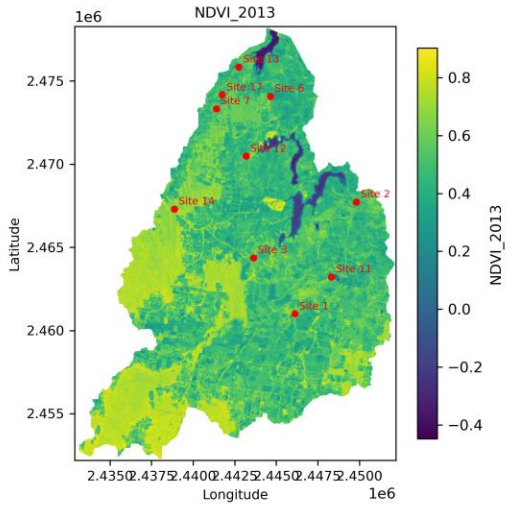
Toolbox outputs: Catchment context

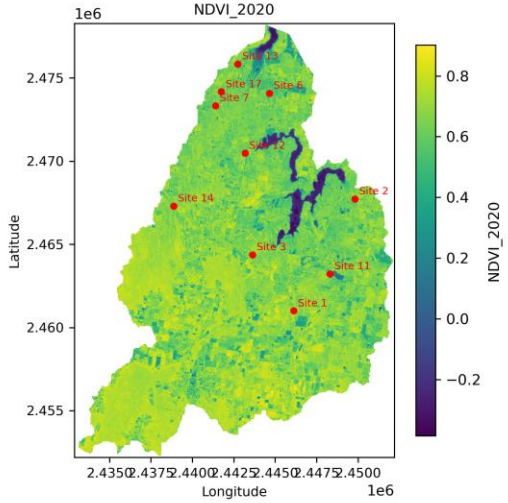
Vegetation

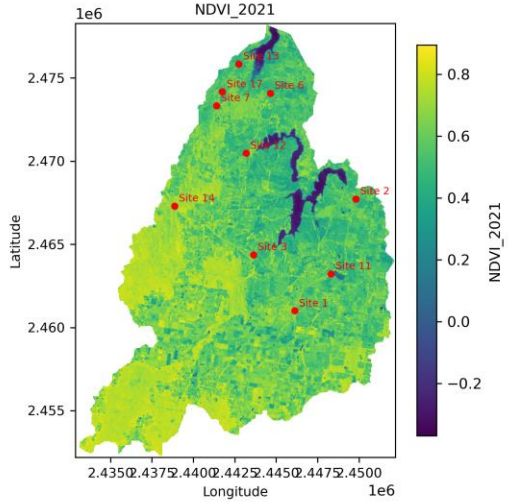


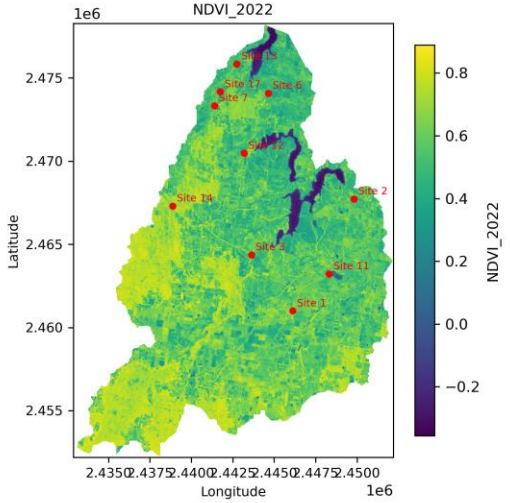


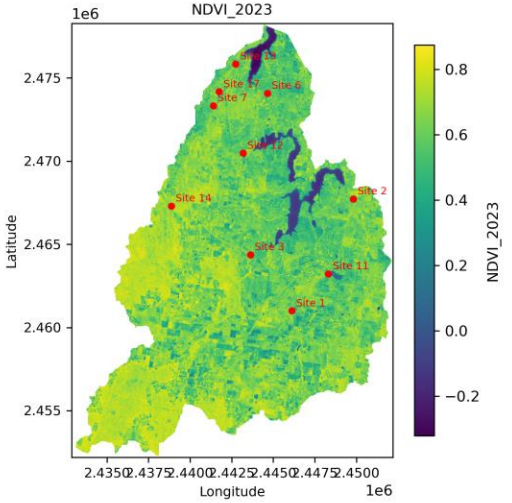






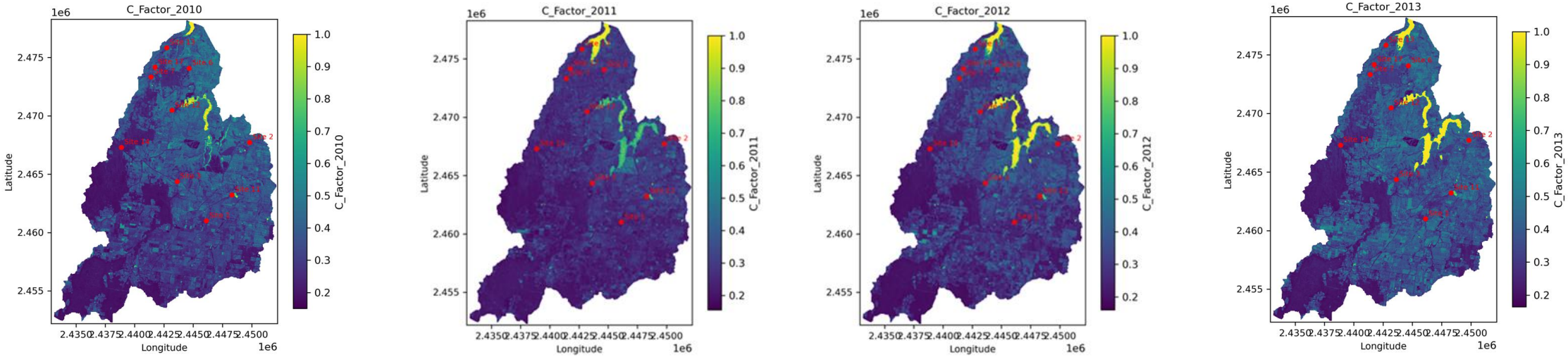






Toolbox outputs: Catchment context

Erosion



International Journal of Sediment Research 39 (2024) 83–99

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Original Research

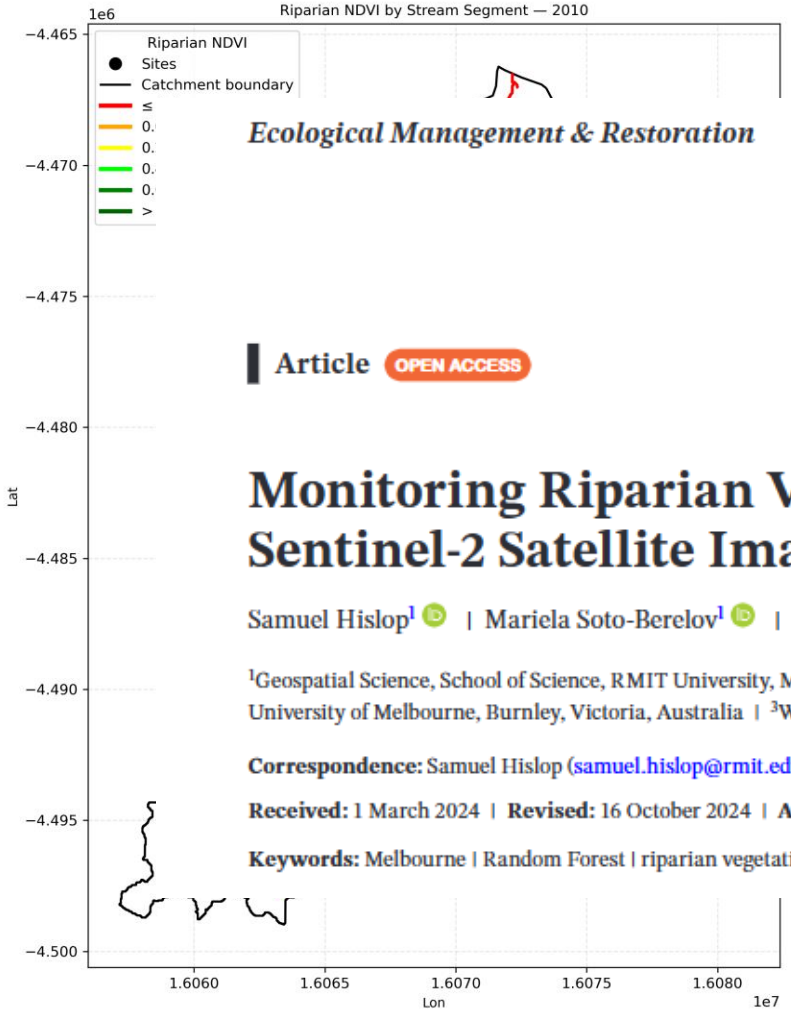
Spatiotemporal variability in the *C*-factor: An analysis using high resolution satellite imagery

Nabil Allataifeh [a], Ramesh Rudra [a], Prasad Daggupati [a, *], Jaskaran Dhiman [a], Pradeep Goel [b], Shiv Prasher [c]

[a] School of Engineering, University of Guelph, Guelph, Ontario, N1G 2W1, Canada
[b] Ontario Ministry of the Environment, Conservation and Parks, Etobicoke, Ontario, M9P 3V6, Canada
[c] Department of Bioresource Engineering, McGill University, Montreal, Quebec, H3A 0G4, Canada

Toolbox outputs: Catchment context

Changes in riparian vegetation



Ecological Management & Restoration

Article OPEN ACCESS

Monitoring Riparian Vegetation in Urban Areas With Sentinel-2 Satellite Imagery

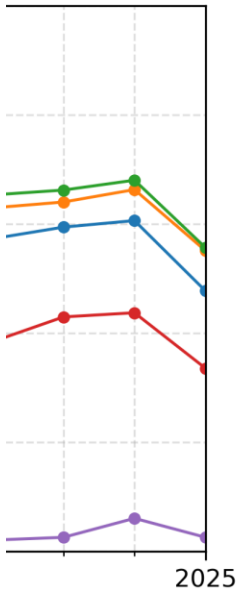
Samuel Hislop[1] | Mariela Soto-Berelov[1] | Sacha Jellinek[2,3] | Yung En Chee[2] | Simon Jones[1]

[1]Geospatial Science, School of Science, RMIT University, Melbourne, Victoria, Australia | [2]School of Agriculture, Food and Ecosystem Sciences, The University of Melbourne, Burnley, Victoria, Australia | [3]Waterways, Biodiversity & Environment, Melbourne Water, Melbourne, Victoria, Australia

Correspondence: Samuel Hislop (samuel.hislop@rmit.edu.au)

Received: 1 March 2024 | **Revised:** 16 October 2024 | **Accepted:** 11 December 2024

Keywords: Melbourne | Random Forest | riparian vegetation | satellite time series | vegetation condition



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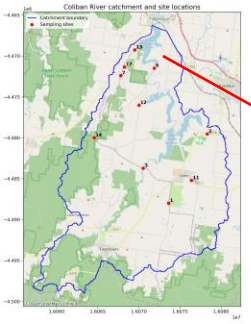
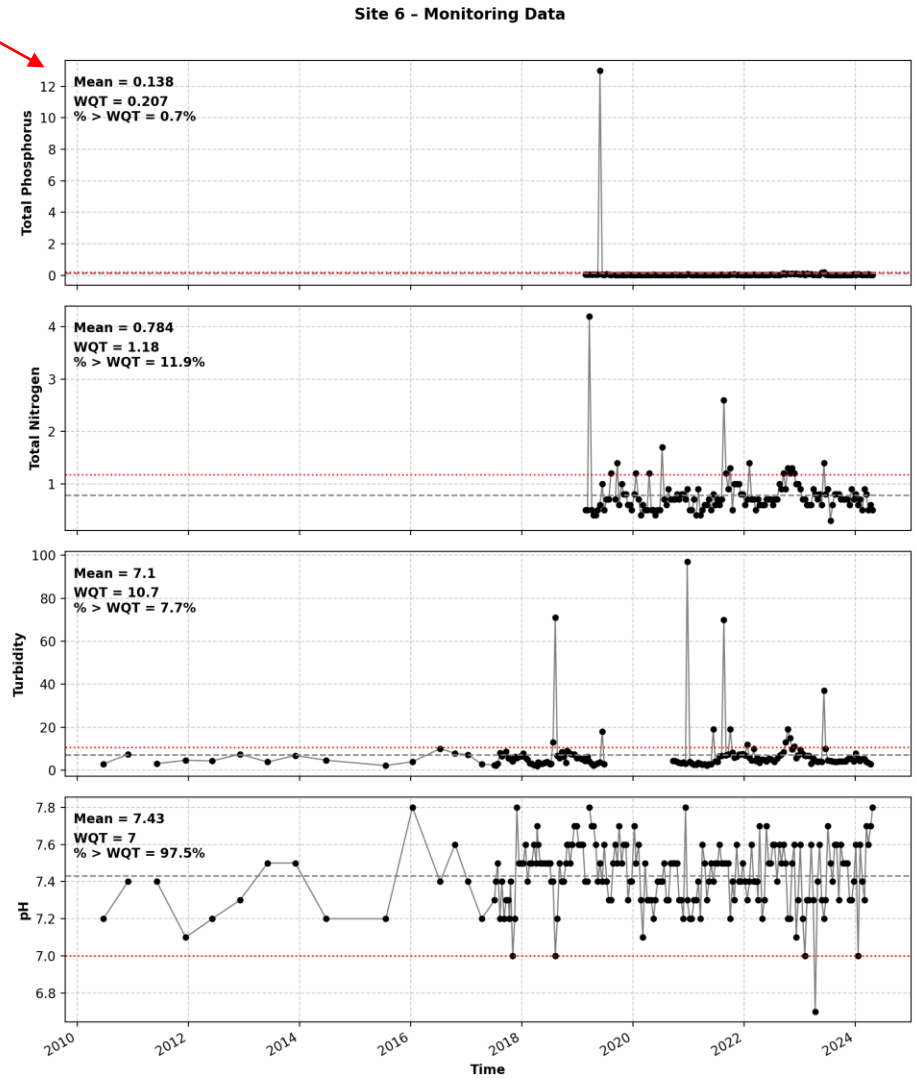
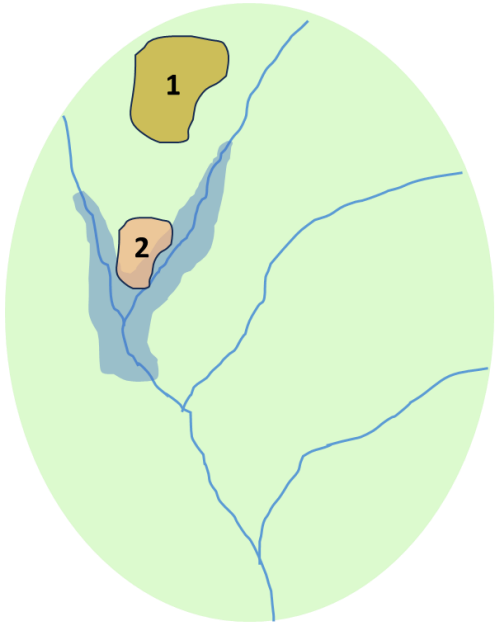
Toolbox outputs: Site-based assessments

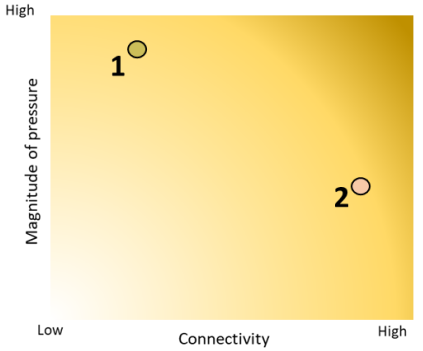
WQ monitoring





What is happening upstream of these monitoring locations?

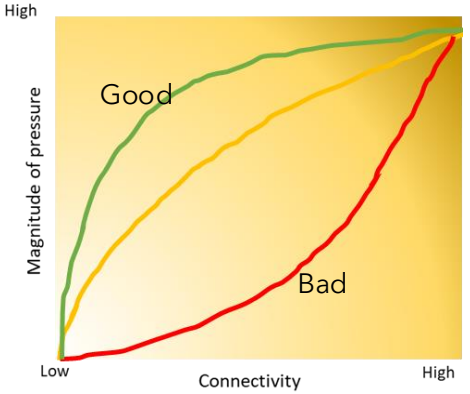




Connectivity

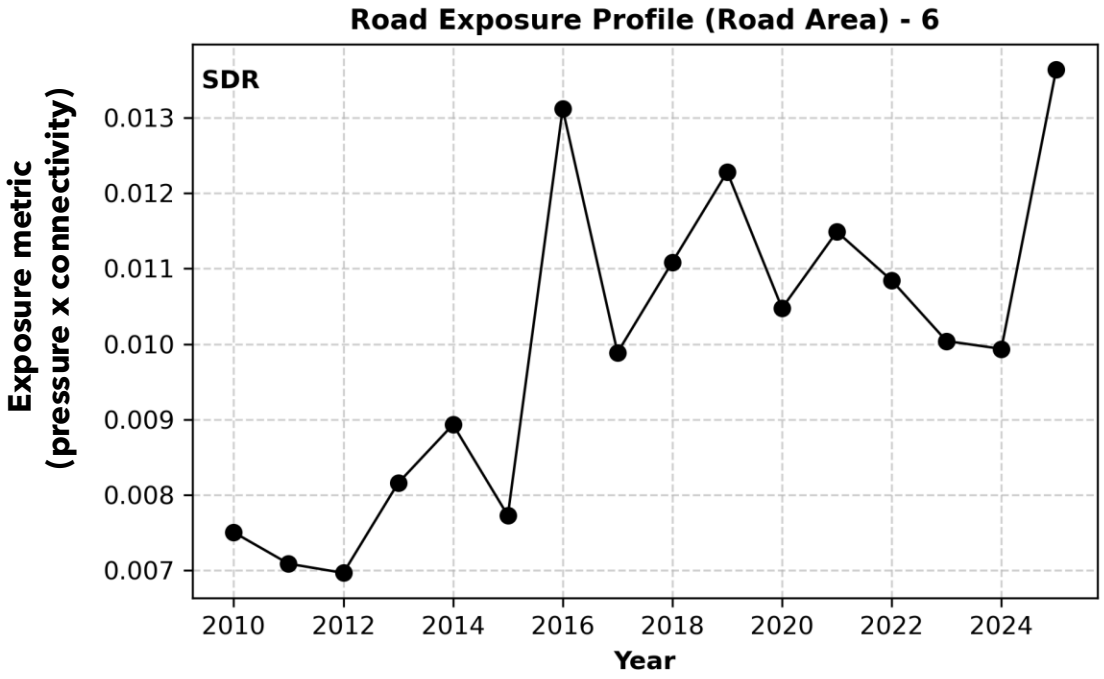
Pressure area (e.g., logging coupe)

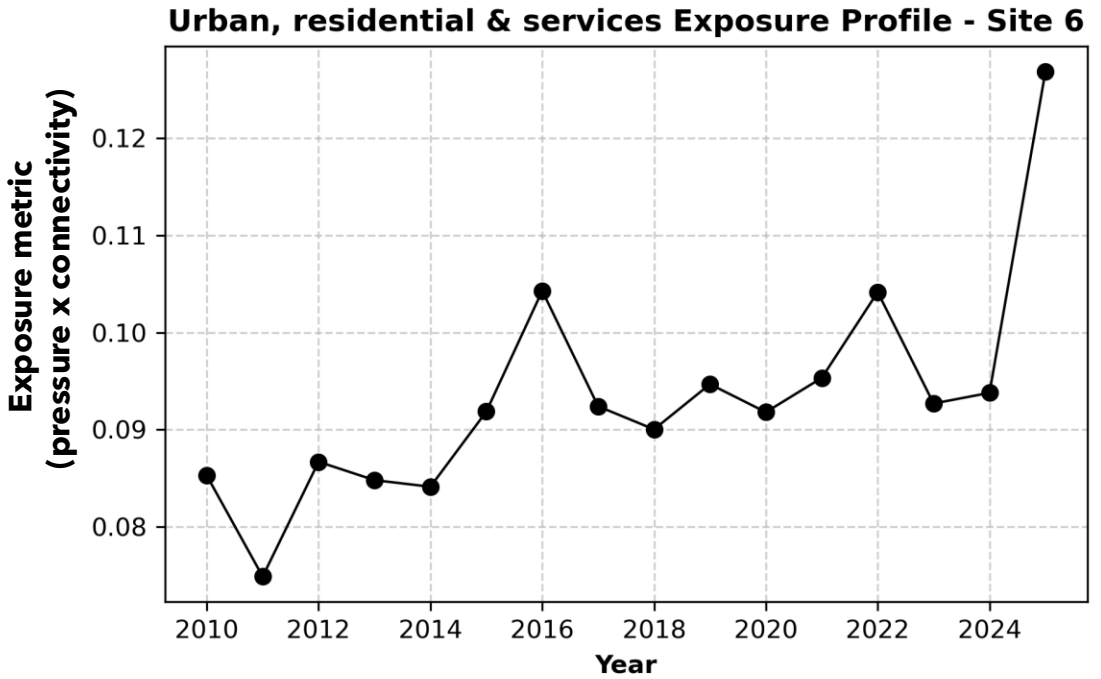
Exposure profiles



Toolbox outputs: Site-based assessments

Sub-catchments – mapping threats and erosion risk at Site 6





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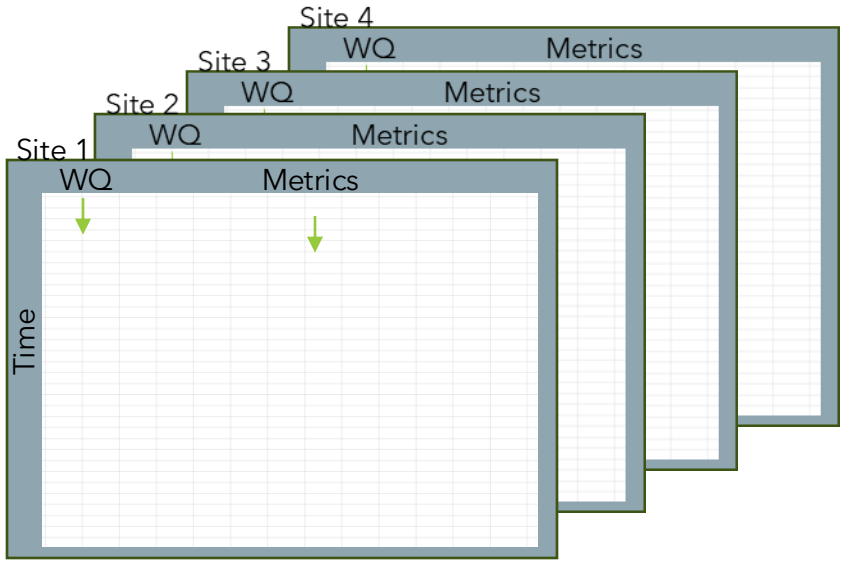
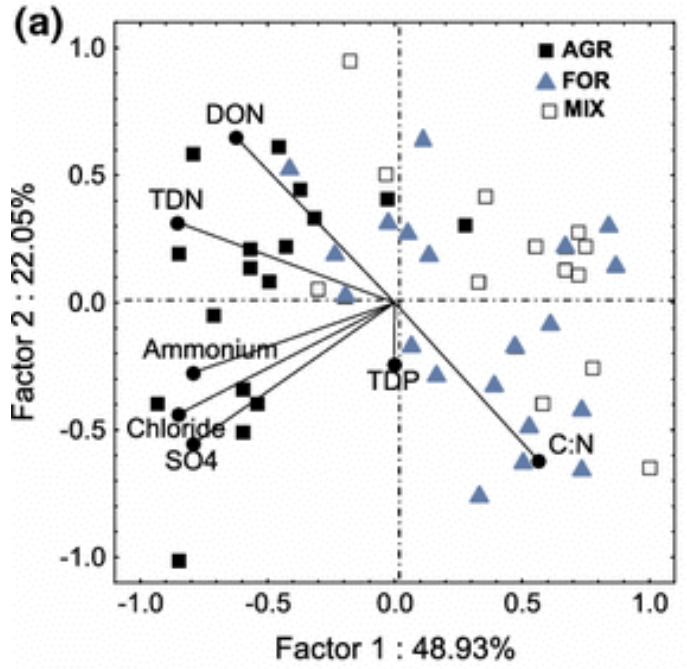
Toolbox outputs: Site-based assessments

- Opportunity to generate large database on WQ and pressures across many catchments
- Inform analysis into:
  - changes over time within and across catchments – regional insights, trends, benchmarking
  - performance of management interventions across catchments
  - relative contribution of different pressures to WQ – ordination, PCA





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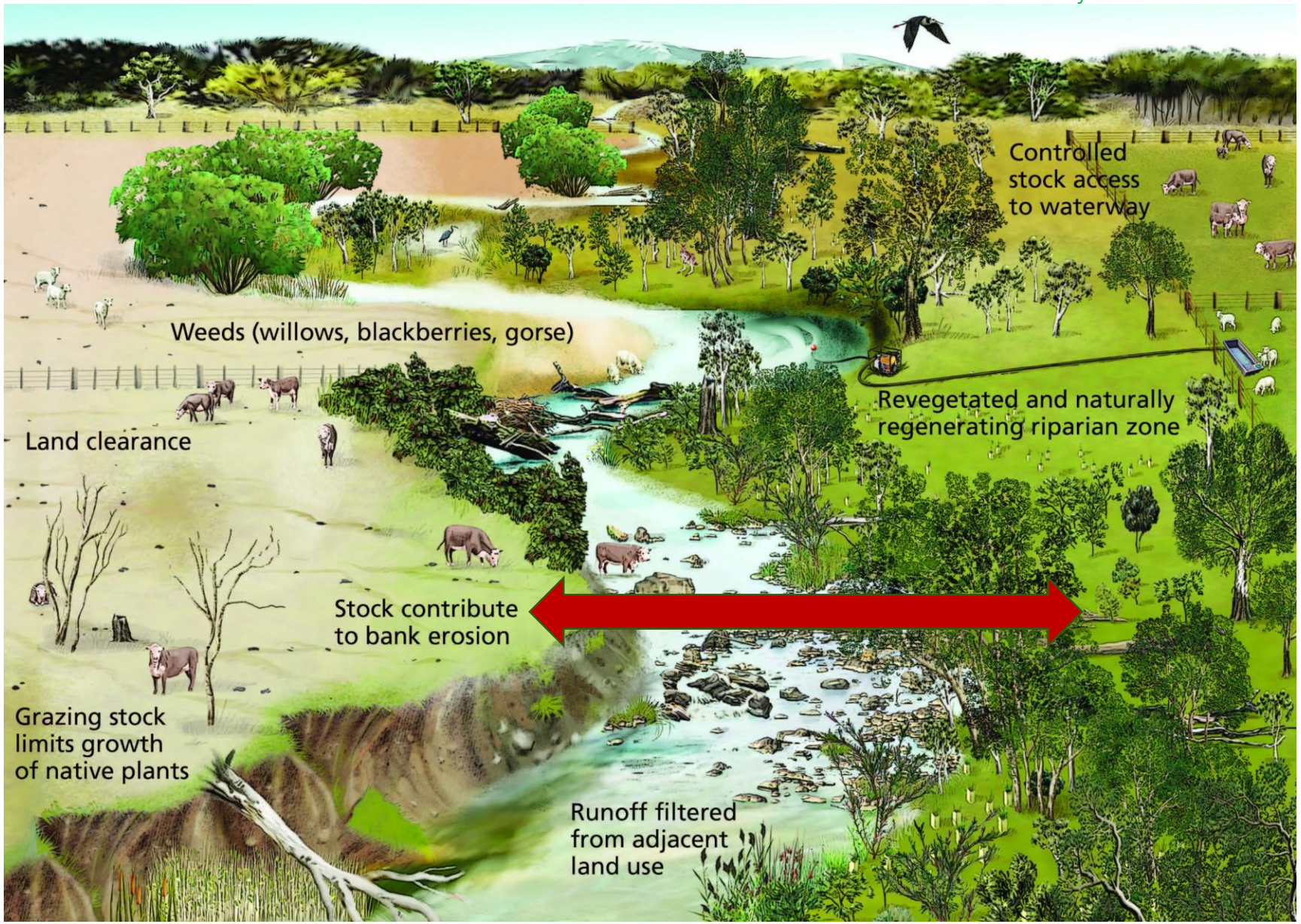
Conclusions

connect.coliban.com.au/healthy-coliban-catchment



Conclusions

- The industry has been lacking catchment assessment tools that make the most of open data and that is aligned with requirement under Drinking Water Guidelines
- The project has developed this framework, together with a toolbox to enable its implementation.
- The toolbox, which will be available as a Python library, is being applied to five case study catchments across Australia.
- New way of linking catchment data to water quality monitoring.

Next steps

- Further develop, evaluate, and finalise the assessment for each case study.
- Final reporting for the project – a toolbox manual and technical report.
- Training and adoption work with the project partners.
- Explore opportunities for further work in applying and developing the toolbox.
- A possible workshop at Ozwater'26 in May.

Thank you

Acknowledgements

This is WaterRA project 1140 and would not be possible without the support and participation of the project partners.

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