National Environmental Science Program

Marine and Coastal

PROJECT 5.11

Detecting long-term trends in water quality at key Great Barrier Reef basins

Water quality trends in river catchments draining to the Great Barrier Reef: an analysis of ~40 years of data

Summary

Long-term data from seven key rivers of the Great Barrier Reef catchment area show encouraging declines in dissolved inorganic nitrogen (DIN) and/or suspended sediment (SS) concentrations. While some trends appear to be associated with improved fertiliser management and catchment condition, attributing these declines solely to land use management is difficult. Incomplete data on management investments, together with mixed upstream land uses and climate and hydrological variability, make it hard to link the observed patterns to specific causes.

Context

Poor water quality runoff from catchments adjacent to the Great Barrier Reef (GBR) contributes to problems such as macroalgae on coral reefs, coral stress, reduced water clarity, and seagrass loss. Governments have invested millions of dollars in land management programs since 2003 to reduce these impacts. A critical question now being asked is: **Are river water quality concentrations improving over time?**

Approach

- This study compiled long-term water quality datasets from nine river monitoring sites across the GBR catchment[1], covering 18-37 years. Sites represent ~66% of the GBR catchment area, spanning wet and dry tropical climates, small (~400 km^2) to very large (~140,000 km^2) basins, and mixed land uses (grazing, sugarcane, rainforest, regulated rivers).
- This study analysed trends in DIN and SS concentrations and applied Generalised Additive Mixed Models (GAMMs) to handle irregular sampling and data gaps, and account for flow effects, seasonality and autocorrelation.
- This is one of the first studies in the GBR to assess both long-term (~linear) trends and episodic (non-linear) changes in river water quality concentrations.

[1] Queensland Government GBR Catchment Loads Monitoring Program sites augmented with historical project data collated by James et al. (2025).

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Key findings

Most sites show improving water quality concentrations.

- **DIN:** Seven of nine sites show significant long-term decreases in DIN (North & South Johnstone, Tully Gorge, Tully at Euramo, Herbert, Burdekin and Pioneer). One site (Barratta Ck) shows a strong increasing trend, linked to the introduction and expansion of sugarcane in the early to mid-1990s. One site (Fitzroy) shows no clear long-term trend.
- **SS:** Seven of nine sites show significant long-term decreases (North Johnstone, Tully Gorge, Herbert, Barratta, Burdekin, Pioneer and Fitzroy). One site (Tully at Euramo) shows a weak increasing trend. One site (South Johnstone) shows no clear long-term trend.

Non-linear (episodic) trends occur everywhere.

- All sites showed significant non-linear patterns. These episodic changes often align with climate variability (wet/dry cycles, cyclones), changes in catchment land use and reductions in synthetic nitrogen fertiliser application.
- Key implication: Simple linear trends over multiple decades can obscure important changes over shorter periods i.e. within five or ten years. These episodic changes are relevant to understanding key drivers in changing water quality.

Absolute concentrations still matter.

- Even when trends are improving, some rivers still have high absolute concentrations, especially for sediment. Trends must therefore be interpreted in the context of concentration levels, not just percentage change.

Long term monitoring is essential.

- Long term monitoring is essential, but its value depends on alignment with land management practice data to translate observations into credible evidence for management decisions.

What are the drivers that explain these trends?

- **Declining DIN trends** broadly align with reduced nitrogen fertiliser application in several catchments. Confidence in attribution is higher where monitoring sites capture a large proportion of cropped land, such as Tully at Euramo and Herbert at John Row. However, interpretation can be confounded by climate-driven flow variability, water storages and instream processing, and interactions between sediment and nitrogen.
- **Declines in suspended sediment** were largest in the Burdekin, Tully Gorge, Herbert and Pioneer. Particularly for the large dry tropical catchments, declines in SS are strongly influenced by wet–dry climate cycles. The observed declines may reflect a combination of legacy effects of historic land use (mining, forestry), dams, improved grazing land condition, changes in erosion sources over time, and floodplain storage.
- It remains challenging to attribute trends to specific remediation actions, particularly at large spatial scales where climate signals dominate.

Next steps

To better evaluate progress toward Reef 2050 Targets there is a need to (i): integrate concentration trends with streamflow to assess load trends; (ii) examine trends under different flow conditions (baseflow vs events); (iii) incorporate additional management data, such as fertiliser histories and remediation inventories; (iv) link changes in streamflow concentrations/loads with inshore marine water quality data; (v) assess if the current reductions in DIN and SS concentrations are ecologically sustainable or if further reductions are required to maintain marine health.

Further information

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FRONT: Burdekin River after heavy rainfall in 2019. Credit: Matthew Curnock. BACK: Erroding riverbank. Credit: Matthew Curnock.

Journal article: James, C., Kuhnert, P., Lewis, S., Bartley, R., Lawrence, E., Strauss, J., Mann, R., Turner, R., Bainbridge, Z. 2026. Water quality trends in river catchments draining to the Great Barrier Reef: an analysis of ~40 years of data. *Journal of Environmental Management*. https://doi.org/10.1016/j.jenvman.2026.130359.

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