Marine and Coastal

National Environmental Science Program

PROJECT 5.11

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

Trends in fertiliser use and efficiency in the Great Barrier Reef catchment area

Summary

A basin-scale compilation of synthetic nitrogen and phosphorus application from 1910 to 2024 shows considerable reductions for most river basins of the Great Barrier Reef (GBR) catchment area over the past one to two decades. This foundational dataset will help evaluate water quality trends and their drivers, and assess nutrient management, agricultural sustainability and regional planning. The study also highlights that the sugarcane industry has improved nutrient use efficiency while maintaining crop yields.

Context

Water quality runoff from rivers to the GBR contributes to problems such as overgrowth of macroalgae on coral reefs, coral stress, reduced water clarity, and seagrass loss. Since 2014, governments have invested millions of dollars in land management programs under the Reef 2050 Water Quality Improvement Plan to reduce these impacts. A critical question is: **have applications of synthetic nitrogen and phosphorus fertilisers reduced over time?**

Approach

- Compiled annual data on fertilised areas for seven crop groupings (sugarcane, bananas, cotton, fruit and nuts, vegetables, field crops and dairy pastures) for each basin of the GBR catchment area from 1990 to 2024.
- Compiled available nitrogen and phosphorus fertiliser application rates for each crop group.
- Applied a Monte Carlo statistical approach to reconstruct annual synthetic nitrogen and phosphorus fertiliser use for each GBR basin, accounting for uncertainty in both cropping area and fertiliser application rate.
- Produced an annual time series of nitrogen and phosphorus fertiliser use at basin and natural resource management (NRM) region scales from 1910 to 2024, by combining compiled data with the reconstructed data set of Pulsford (1996; see Figure 1).
- Confidence in the compiled dataset is highest at the NRM scale and in basins where N and P inputs are dominated by sugarcane, bananas and cotton, due to the availability of accurate average application rates over time.
- Additionally, compiled basin-scale data on mill mud application amounts, area and tonnes of sugarcane harvested.

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Key findings

Marked reductions in synthetic nitrogen and phosphorus fertiliser use have occurred across most basins over the past one to two decades (see Figure 1).

- Synthetic fertiliser use applied in sugarcane declined considerably between the 1990 and 2024 periods in the Wet Tropics, Mackay Whitsunday and Burnett Mary NRM regions. This decline reflects reduced fertiliser application rates in the Wet Tropics and Mackay Whitsunday NRM regions, and a marked reduction in sugarcane area alongside reduced application rates in the Burnett Mary NRM region.
- The expansion in areas of bananas in the Wet Tropics, cotton in the Fitzroy, and fruit and nuts (macadamias) in the Burnett Mary from 1990 to 2024, has led to increased contributions in the amounts of total nitrogen and phosphorus fertiliser applied.
- The reductions are attributed to a combination of improved farm management practices, increased knowledge extension to farmers, government regulation of fertiliser application rates, changes in land use and crop types, and rising fertiliser costs.

Soil additives such as mill mud increase the rates of total nitrogen and phosphorus applied.

- Mill mud and ash contribute up to 10% more nitrogen and 60% to 150% more phosphorus on top of synthetic fertiliser application at the farm scale.
- Key implication: Farm and paddock nitrogen and phosphorus budgets must account for additional sources such as mill mud, animal manure, and legume crops.

Long-term sugarcane yields have remained consistent over the past 50 years. Lower nitrogen application alongside stable yields demonstrates that nutrient use efficiency is the best it has been.

- Nutrient use efficiency in the Queensland sugarcane industry is the best it has been in 50 years, while the yields have remained consistent over this timeframe.
- Key implication: This achievement is a testament to the efforts of the Reef Plan program and farmers themselves through improved education and training, access to better equipment for applying fertilisers, enhanced extension support and regulation, and the willingness of some farmers to trial and adopt improved management practices.

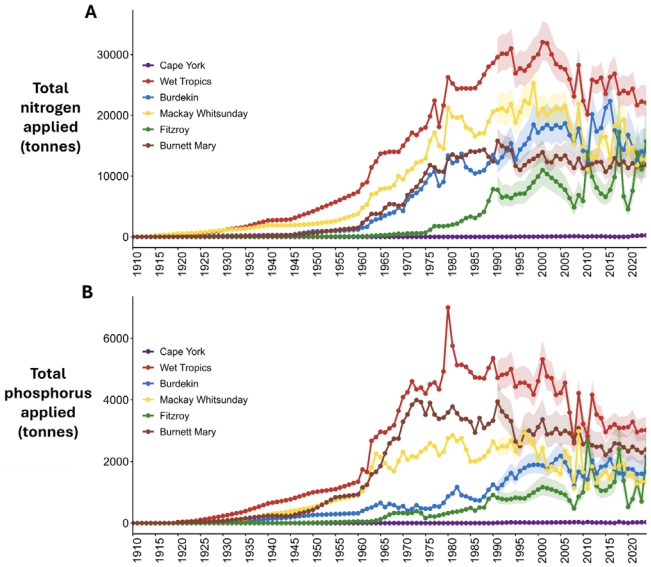

Figure 1: (A) Time series of synthetic nitrogen and (B) phosphorus fertiliser applied at the natural resource management region scale between 1910 and 2024. Data from 1910 to 1990 are derived from Pulsford (1996). Shaded 95% confidence intervals were based on Monte Carlo permutations to provide an estimate of uncertainty for the 1991 to 2024 period (this study).

Next steps

This study provides key evidence to evaluate and explain trends in water quality in GBR rivers. It supports modelling changes in nitrogen and phosphorus loads to the GBR lagoon. It also helps develop an annual repository of fertiliser application rates to track and benchmark trends over time.

Further information

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FRONT: Sugarcane agriculture. BACK: Flood plume front approaching Old Reef with Stanley and Darley beyond. Credit: Matthew Curnock.

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