Rainfall-based estimation of fertiliser nitrogen inputs and their influence on stream nitrogen in Victorian catchments

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Abstract: Declining water quality in agricultural catchments, driven by excessive nitrogen (N) inputs, is a growing concern as it often leads to eutrophication and ecosystem degradation. Despite extensive research on nutrient transport, the relationship between catchment-scale N inputs and stream water quality remains poorly quantified due to the variability of N sources, which include synthetic fertilisers, livestock manure, wastewater effluent, atmospheric deposition, and biological nitrogen fixation (Galloway et al., 2004). Among these, agricultural fertiliser use is the dominant anthropogenic contributor to nitrate pollution in many regions.

This study presents a linear regression model using mean annual rainfall as a proxy to estimate fertiliser N inputs across four major agricultural land uses (mixed farming and grazing, dairy, non-dairy livestock, and cropping) in 59 diverse catchments in Victoria, Australia. These estimates, combined with N from crop-specific biological fixation (McKEE & Eyre, 2000) and a uniform atmospheric deposition rate (Adams et al., 2014), were used to assess the influence of N inputs on stream total nitrogen (TN) concentrations and exports, as detailed in Babatunde et al. (2025).

The model shows a positive correlation between average rainfall and fertiliser N input at the Catchment Management Authority (CMA) level (R^2 = 0.55–0.72), for each land use. At the catchment scale, analysis of combined N inputs reveals correlations between stream TN concentrations and total N inputs (R^2 = 0.72) as well as fertilizer N inputs (R^2 = 0.68), while TN exports correlate with total N inputs (R^2 = 0.47) and fertilizer N inputs (R^2 = 0.53). The proportion of catchment-scale N inputs exported varies from 1.4% to 26% (average 7%), influenced by agricultural land use and hydroclimatic factors. This is lower than global benchmarks (Galloway et al., 2004), likely due to regional climatic patterns and lower N inputs.

This parsimonious modelling approach provides stakeholders with a practical tool to estimate fertiliser N inputs in Victoria, as well as for other regions dominated by agricultural land uses, supporting targeted strategies to reduce N pollution and improve water quality, in line with the need for sustainable catchment management.

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