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EVALUATING THE COST-EFFECTIVENESS OF COMBINATIONS OF INTERCEPTIVE MITIGATIONS

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Introduction

New Zealand's agricultural sector aims to minimize nutrient, sediment, and microbe runoff into water bodies while sustaining productivity and economic viability. While in-field farming practices help prevent contaminant losses, additional edge-of-field and flow path mitigation options can intercept and further reduce diffuse contaminant runoff into surface waters. However, interceptive mitigation practices have a substantial cost relative to farm operating profit, so it is important to deploy them strategically. The optimal combination and scale of mitigations will depend on the specific farm system and hydrological landscape. To assist land managers in identifying appropriate portfolios of mitigations, we extend previous research by doing quantitative economic modelling of diffuse pollution mitigation practices for a typical New Zealand dairy farm and hydrological landscape.

Methods

The mitigations considered comprised grass filters, planted riparian buffers, constructed wetlands, woodchip bioreactors, filamentous algal nutrient scrubbers (FANS), sediment traps, and detainment bund*s* (Figure 1). Where available we assumed these mitigations were constructed in accordance with recent guidance (Paterson *et al.*, 2020; Christianson *et al.*, 2021; McKergow *et al.*, 2022; Tanner *et al.*, 2022). In contrast to previous analyses that provide estimates for mitigation costs, we also consider variability. We construct cost distributions from case studies where multiple sources are available, and develop detailed cost models where data is limited.

For modelling the interception potential of these mitigations, we utilised the framework proposed by Tanner *et al.* (2023), extending it to incorporate quantitative estimates of the proportion of N, P, and sediment transported by each hydrological flow path, using farm typology losses from Monaghan et al. (2021).

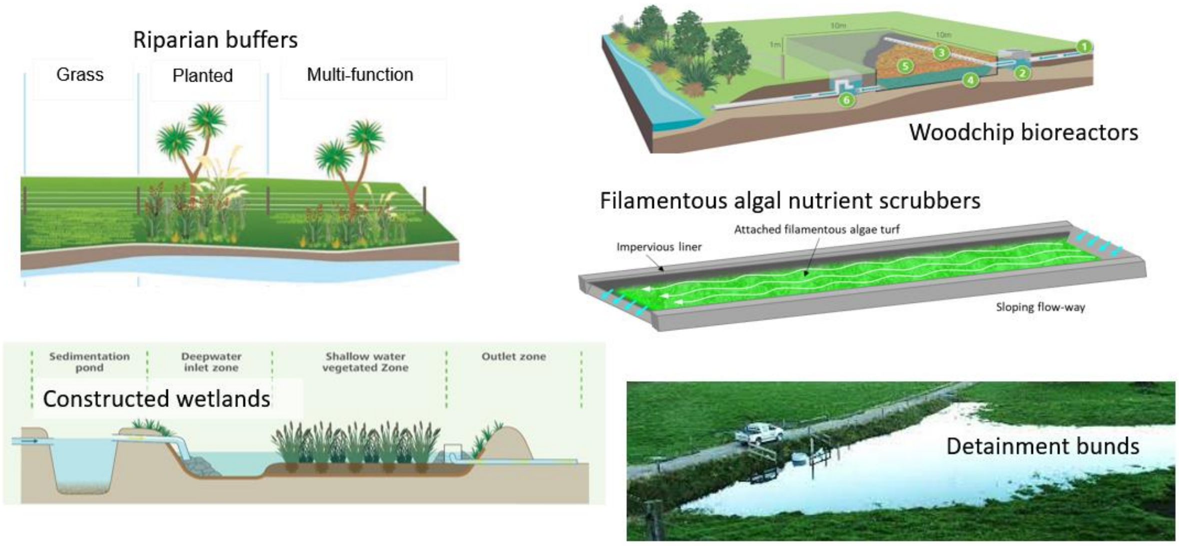

Figure 1: The five interceptive mitigations we evaluated.

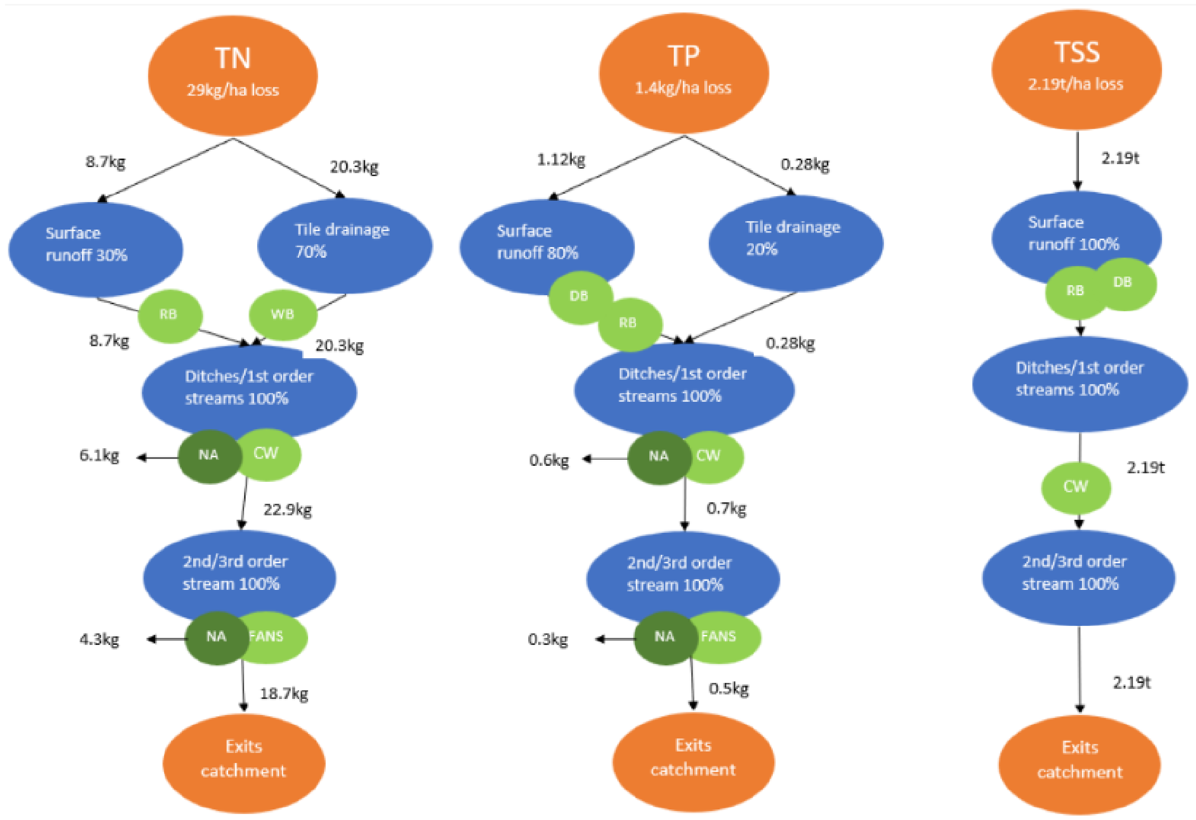

Figure 2: Illustration of modelled contaminant loads (orange), assumed flow pathways and estimated loads for TN, TP and TSS for a dairy farm in a flat Waikato landscape with low permeability soils. NA (dark green) shows where we account for natural attenuation. The proposed mitigations (light green) implemented at various locations are RB, Grass riparian buffers; WB, Woodchip bioreactor; CW, Constructed wetland; and FANS, Filamentous algal nutrient scrubbers.

Results and Discussion

We modelled the interception of nutrients and sediment in surface run-off, tile drainage, surface drains, and second and third-order streams at different locations in the landscape (Figure 2). The modelled variability in both cost and performance and confidence intervals for various combinations of mitigations and an overall abatement curve are shown for TN in Figure 3. This shows that woodchip buffers are the most cost-effective option for TN removal, followed by constructed wetlands and FANS. Overall Riparian Buffers are not particularly cost-effective for N reduction in this landscape type, because they do not intercept the dominant pathway for N, which is presumed instead to be mainly transported in subsurface tile drainage which largely short-circuits riparian buffers. For full results of the study including, see Matthews et al. (2024)

The results of this study show that achieving substantial reductions in nitrogen loads is likely to be the costliest and would require application of multiple mitigation systems at a cost of up to $1300/ha/y. However, targeting a 50% reduction in anthropogenic nitrogen would only cost around NZ$300/ha/y and also markedly reduce phosphorus and sediment loads. Specifically targeting phosphorus or sediment would require fewer mitigations and cost less than $200/ha yr, but only result in small reductions in nitrogen. The most cost-effective mix of mitigation systems will depend on landscape characteristics and water quality targets, which highlights the benefit of an adaptive multi-faceted approach to freshwater management.

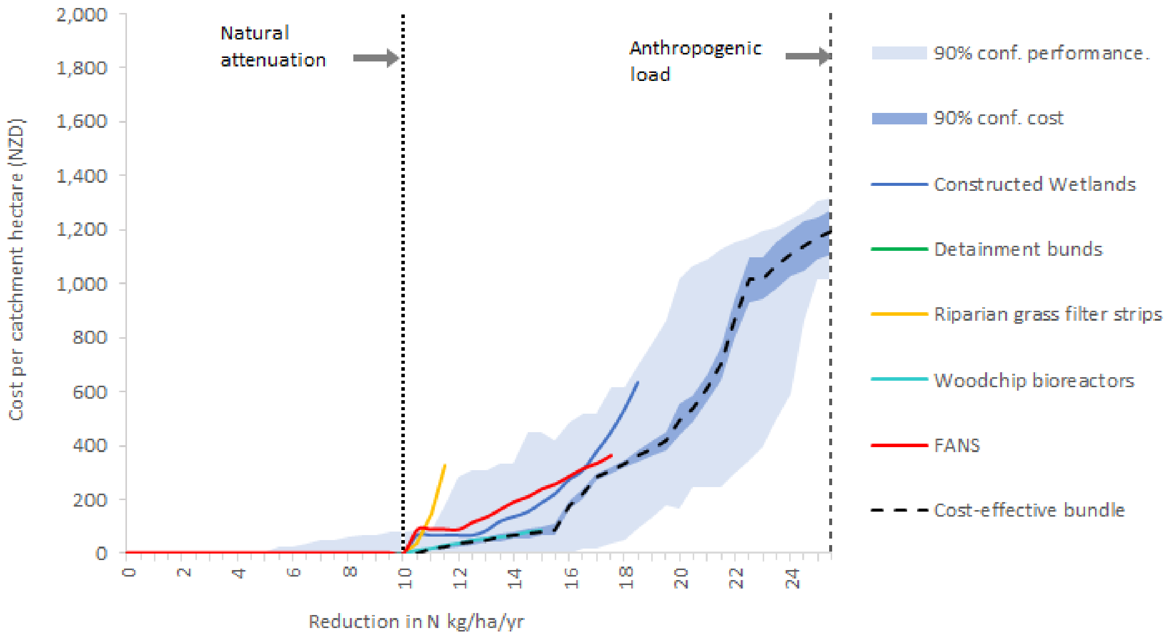

Figure 3. TN reduction costs for implementation of individual mitigations and the least-cost combination in a low gradient dairy catchment with low permeability soils

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