Review of mitigation modelling and assumptions for Otago Regional Council

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Report for Otago Regional Council

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1. Assessment

Otago Regional Council provide four reports (Mackey, 2022; Marapara, 2022; ORC, 2022; Sise et al., 2022) that together outline a means to assess how much losses of nitrogen and phosphorus will be reduced by the application of diverse mitigation strategies across Freshwater Management Units (FMUs). The impacts and suitability of each mitigation practice will vary spatially because of differences in climate, land use, soil, and topography. Thus, the methodology that has been applied contains an explicit focus on developing a regional-scale approach that is consistent yet allows for spatial flexibility. This body of work will inform limit-setting activity for freshwater assets across the region, particularly speaking to the environmental outcomes and feasibility accruing to options of different intensity.

The primary objective of this summary is to present an overall assessment of the approach and assumptions used in the proposed programme of work, to draw together the individual comments that I have made on each of the four reports.

I believe that the methodology outlined in the four reports is fit for purpose and robust. Water-quality management issues are difficult due to address due to strong value conflicts, significant uncertainty, and transient dynamics (Alford and Head, 2017). In this context, it can be appealing to invest significantly in data collection, monitoring, and modelling to assess the impacts of future actions (Doole, 2022). However, the biophysical and social complexity of the systems involved, including their interaction, poses a strong constraint to accurate forecasts. Instead, it is crucial to match model complexity to the quality and quantity of data, as well as carefully considering the available resources, principally data, expertise funding, and time (Doole and Pannell, 2013). The methodology described in the four reports provided by Otago Regional Council are notable for their pragmatic application of this approach.

Several features of this method are:

1. The cost of generating information is greatly reduced through placing heavy dependence on the credible, relevant data generated by the Our Land and Water (OLW) National Science Challenge (McDowell et al., 2021; Monaghan et al., 2021a, b; Srinivasan et al., 2021).

2. A benefit of working with OLW data is that it has been generated with and for principal agricultural sectors (McDowell et al., 2021). Thus, it helps to improve data quality and build engagement with farmers.

3. A combination of expert opinion (McDowell et al., 2021; Monaghan et al., 2021a, b) and modelling data (Srinivasan et al., 2021; Sise et al., 2022) is utilised to address significant data scarcity.

4. The use of a typology approach (McDowell et al., 2021; Monaghan et al., 2021a, b) provides an efficient means of representing diversity within and across land uses but without modelling entire farm populations (Doole and Pannell, 2012).

5. Attenuation is mentioned, but not studied explicitly. This recognises the paucity of data concerning to what happens to nutrients between their loss from farms and subsequent delivery to waterways.

6. The OLW approach assumes diversity and realism in levels of uptake, both now and in the future (McDowell et al., 2021; Monaghan et al., 2021a, b). Further, ORC (2022) and Sise et al. (2022) note key barriers to diffusion, such as cost and complexity. Diffusion level and how this relates to the individual features of each mitigation or bundles of them is central to determining water-quality improvements arising from policy, but is seldom modelled explicitly (Doole et al., 2019).

7. The reports describe the variation between land uses and FMUs in terms of areal cover, nitrogen leaching, and phosphorus loss very well (Sise et al., 2022).

8. The breadth of data generated by Overseer in Sise et al. (2022) is magnified through changing key assumptions (e.g., soil types, drainage class). This is a cost-effective and pragmatic means of generating greater data diversity.

9. Diverse point estimates for baseline leaching loads have been presented in Insert 2 of Marapara (2022). These are based on Drewry (2018), Monaghan (expert opinion), and Srinivasan et al. (2021). These align with expectations, are very credible, and appear as an appropriate compendium of baseline nutrient losses across diverse land uses and soil types in the Otago region.

10. The use of point estimates in Marapara (2022) is a sound strategy (Doole and Pannell, 2011) to address uncertainty accruing to the maximum level of nutrient loss. An analysis of the ranges from Srinivasan et al. (2021) presented in Marapara (2022) highlights that the assumed distributions are very symmetric, unlike the log-normal distributions (which possess long right-hand tails) that are characteristic of nutrient losses (Doole, 2020).

Nevertheless, some areas of potential improvement are evident. These are:

1. The nature of the framework and how each element sits together with others took a while to emerge. This suggests a clearer, overarching description of the methodology—including concise diagram(s)—is likely justified.

2. There is an absence of a clearly-defined current or business-as-usual (BAU) scenario. For example, Mackey (2022, p. 8) states that, “The Good Management Practice (GMP) Scenario broadly corresponds to the 2015 measures described in Monaghan et al (2021b) and assumes all of these are fully implemented (as in McDowell 2021a). This will be an improvement on the current state in Otago…”. This suggests that GMP is not an adequate description of the current state. This is a critical gap in the analysis that I think requires further thought. Ideally, it would require work with agricultural consultants to identify existing levels of mitigation uptake across the FMUs.

3. Scenario development remains unclear to me. The lack of a clearly-defined current state is mentioned in the previous point. Another is the presence of a GMP++ scenario that appears in Sise et al. (2022), but not in Mackey (2022). I think this reflects the need for a more-integrated description of the overall methodology. Indeed, there is a lot of moving parts in this workstream alone, and understanding how they all fit together takes some effort.

4. In Mackey (2022), the aggregation of diverse mitigations into different sets has been done differently across Abacus Bio (2021), McDowell et al. (2021), and Monaghan et al. (2021a). The addition of the classification of Abacus Bio (2021) to the more-aligned set of McDowell et al. (2021) and Monaghan et al. (2021a) is confusing and adds risk. I believe the use of a credible, integrated methodology is preferable over a combination of several, very-different approaches. This emphasises that the input of Abacus Bio (2021) should possibly be de-prioritised moving forward.

5. Overseer is assumed to be fit-for-purpose to assess the nitrogen and phosphorus losses from land use in Otago (Mackey, 2022; Sise et al., 2022). I believe that this requires additional justification, through a memo from experienced scientist(s) with strong credibility in this area, such as Richard McDowell and/or Ross Monaghan. This comment is motivated by the debate around this model that has followed the release of MFE/MPI (2021).

6. The ongoing role and value of sector engagement has not been broached in these documents. Industry involvement can bolster credibility, engagement, and trust. However, it is a double-edged sword, potentially increasing bias and/or tension in collaborative decision-making processes. It would be timely to discuss their input with clear decisions emerging around how they should be included in the future.

7. The workstream *appears* to be quite independent from that looking at economic and social impacts of water-quality improvement (Mackey, 2022).

I would note the cost, quality, and time risk associated with ongoing independence of the two work streams.

8. Adoption is a central feature of the four reports, but all discussions of cost therein are occurring independently of the economic assessment. This is a limitation because profit is a primary driver of the adoption of innovations to improve environmental outcomes (Pannell et al., 2006).

9. ORC (2022) provide an overview of many mitigation strategies according to a range of criteria. There could be a tighter relationship between these descriptions and the classification of mitigations in Mackey (2022).

10. ORC (2022) provides useful information, but the sources of information are limited. Key additional references are Doole (2016), Matheson et al. (2018), and references contained therein.

11. ORC (2022) provide specific estimates of cost and load reduction, based on previous studies. The scale of cost and the level of load reduction achieved are so specific to a farm system and farmer that it may be easier to specify changes in terms of low, medium, or high classifications. This follows similar work elsewhere, such as the Waikato Regional Council Farm Menus.

12. The description of each mitigation in ORC (2022) could benefit from a column based on complexity, which is a key driver of adoptability (Pannell et al., 2006).

13. Attenuation is not represented due to data scarcity. It is replaced by an assumption that nutrient losses to land and the amount delivered to waterways is linearly related. This assumption could be more strongly justified through a discussion of how attenuation rates may change at different loads.

14. Srinivasan et al. (2021) report estimated ranges for nutrient losses across a diverse range of soil types and rainfall/irrigation environments. Here, the

maximum ranges appear well below what is seen is practice [cf. Srinivasan et al. (2021) and Sise et al. (2022)]. Failing to consider higher-leaching farms will underestimate environmental benefits associated with a given percentage reduction in nitrogen. For example, if a given percentage reduction in nitrogen is modelled, as is being proposed, this quantum in kilogram terms is broadly different if the baseline nitrogen loss of the farm varies substantially. For illustration, a 10% reduction in nitrogen for a farm with baseline nitrogen (N) loss of 40 or 140 kg N/ha is 4 or 14 kg N/ha, respectively—a difference in excess of three times! It could also impact the estimation of abatement cost, given that farms with higher baseline losses often have greater potential to abate at lower cost, given options associated with improving nutrient-use efficiency (Doole and Pannell, 2012). Resolving such inefficiency can lead to higher profits and lower nitrogen loss; thus, it represents a win-win outcome on the farms where it is an option (Doole and Kingwell, 2015). Caution thereby needs to be exercised if the ranges stated by Srinivasan et al. (2021) are to be employed in the analysis.

15. The typology approach, its origin, and the sources of the information contained therein were not well explained in the draft report of Sise et al. (2022). This was adequately addressed in a revised version that I examined in December 2022, which was careful to include the citations that explain and justify this methodology (Monaghan et al., 2021a, b; Srinivasan et al., 2021).

Overall, the proposed approach provides an efficient, pragmatic, and robust means to estimate the impacts of different futures for water quality in the Otago region. I believe more clarity around scenarios is a key area for further work, as well as ensuring good integration with other workstreams in the programme.

2. References

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