

Interactive comment on “Irrigation return flow causing a nitrate hot spot and denitrification imprints in groundwater at Tinwald, New Zealand” by Michael Kilgour Stewart and Philippa Lauren Aitchison-Earl

Anonymous Referee #2

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This paper looks at the impact of irrigation return waters in areas of intensive agriculture on nitrate concentrations and considers more broadly how we track the sources of nitrate via dual isotopes. The study itself is scientifically sound although I struggled in places with the text. Some of the sections are not very clearly written and the structure could be improved. Specifically, both the introduction and discussion alternate between local and more global observations and the descriptions in parts of sections 4 & 5 are long.

A few clearer statements around the global importance of the work would also improve

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its impact.

I have made several comments below that I hope are useful in revising this paper.

Specific comments

Abstract. The abstract is well-written and intelligible without having to refer to the rest of the paper. Having said this, it could be improved by:

- 1) Adding a sentence at the start to outline the motivation for the study
- 2) Adding a few key values (there are a fair number of qualitative terms here – high, low, relatively etc). A few specific values would convey more meaning.

Introduction

The introduction sets the scene for the study. For a paper in an international journal such as HESS, it would be appropriate to add a few comments about how New Zealand compares to other intensive agricultural areas globally in terms of the scale of the problem. High nutrient loads are of global interest and this research will have broader interest, so some more comments here are warranted.

The structure could be improved as it alternates between general and area-specific statements. Try to group these more. Some of the description of the issues around Tinwald could be in section 2.

Lines 39-43. What the concentrations of nitrate in the groundwater and the river water?

Lines 44-48. This seems out of place in the description of the local setting. It would be better earlier where you discuss the general importance (especially as it refers to contaminants other than nitrate).

Lines 68-62. These references are a little dated. Can you point to some key recent studies, especially those that deal with the issues of irrigation return flows?

Background

As mentioned above, some of the detail from the introduction (eg the high nitrate, which is also covered in section 2.4) would be better here. This section is also long for the information it contains and probably it could be written more succinctly.

Lines 91-95 (and elsewhere). It would be preferable to use “residence times” not “ages”. Also, here and throughout suggest referring to the groundwater not the well (the well’s age is when it was installed, which is not what you mean).

Line 125. MAV not defined (I think that it is the maximum WHO limit for nitrate in drinking water?). Is this the best value to use or should the lower NZ limit be used?

Line 126-136. Adding values to the text would get the message across better (rather than the reader having to find them for their self).

Methods

Section 3.1 could use a few more details.

a) Somewhere, the screened intervals should be noted as geochemical data from long-screened production wells conveys different information to that from short-screened monitoring wells.

b) In Table 1, is the depth the mid-screen?

c) Were the wells purged or was sampling done from flowing wells?

d) The Comments on groundwater levels and river flows is not very clear.

Line 147. Field quality?

Lines 148-149. What are the criteria used for these groups?

Results

Section 4.1 is difficult to follow without some more details being reported in the text. At the moment, the reader has to keep looking at the data in the figures or tables to see what is being referred to (especially lines 186-192 and 193 to 200).

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Lines 217-223. You do not need the detail of the GMWL as it is well known. You could move the definition of the d excess to the methods.

Lines 220-243. The description of the stable isotopes could be shorter (and clearer). There is a lot of text here to explain a relatively simple concept that samples with isotopic compositions to the right of the MWL are evaporated.

Lines 243-250. There are probably a reasonable number of uncertainties in these calculations (having to estimate the initial isotopic composition of the rainfall that recharges the groundwater, understanding the precise impacts of evaporation etc). Do you have any ideas of how those impact these calculations?

Section 4.3. Again, this description is long in places and could be rationalised. The Raleigh equation (line 261) is reported later in the section - it might be better to report how the calculations were done in the methods which would let this section focus on the results (at the very least try to group the descriptions of the calculations and the outcomes more).

Section 5.1. Lines 330-364. Do you need all these calculations? It seems though the CI mass balance together with the isotopic enrichment defines the recharge % well enough (it is the basis of an often used recharge rate calculation after all). Could you start off with that and then report the results of the water mass balance as support? Also, the infiltration data look to be from a lysimeter, which may be less than total recharge (given that it is probably above the water table). Since you are interested in the chemistry of the recharging water it would be simpler to relate it to a recharge estimate based on the chemistry.

Section 5.2. The other aspect that is often ignored is that the source has to be there (regardless of the isotopic composition). The points made on lines 398-404 are correct but there are a fair few studies where the isotopic compositions point to stores that are not locally present. This more general discussion would be better in the conclusions.

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Lines 440-450. It is not clear whether these are general points or some things that may be related to your studies. If it is the latter, is there any evidence that they may apply? You make the point again in the next paragraph, so something to back it up would be good.

Conclusions

The conclusions are reasonably area specific; however, there are several general points made in the discussion. It is preferable to have the conclusions outline the more general points (after the area-specific conclusions) – then the reader who skips the details gets the message!

Appendix

I am not sure what the rationale is for where the equations are presented. At the moment they are scattered throughout the text and in an appendix. You could look at whether they would all be better in the appendix or split between the appendix and the methods.

Are the calculations in the Appendix the same as those from Gonfiantini (1986: Handbook of Environmental Isotope Geochemistry. Vol.2 the Terrestrial Environment. Elsevier, Amsterdam, 113-186) which are widely used?

Table 4. Standard deviations of the data would be useful

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