

Interactive comment on “Real-time monitoring of nitrate transport in deep vadose zone under a crop field – implications for groundwater protection” by T. Turkeltaub et al.

Anonymous Referee #2

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General Comments

I appreciate the opportunity to review this paper. The authors monitored the fate of nitrate in the vadose zone under an annual cropped field, which received applications of liquid dairy manure. The study was carried out for 6 years. The risk of nitrate contaminating groundwater from commercial fertilizer and organic sources is not new and has been well studied by many researchers, and therefore, this work does not add substantially in this area. However, the method used and that six years of data that were collected provides some level of novelty and strength, and may provide important regional relevance, though this is not indicated. The paper is generally well written; however, there are several places where the English is awkward and needs to be rephrased,

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excess words deleted, and/or 'tighten up'. The Introduction does not state a clear purpose/objective(s)/hypothesis. Significant improvement on the description of methods is required. Many questions were raised during the review. Also, method statements appeared in the Results and Discussion and should be removed. A better description of methods and added information will improve the basis for discussion points. The area that needs the most improvement is that much more and in-depth discussion is required.

Specific Comments

In the Introduction, for several points, many references are listed. If possible, please reduce to a fewer number and most relevant references.

L107-120 Delete. This paragraph describes methods and some general results. Replace with a paragraph stating why this particular study was conducted, its importance, and the main objectives (or hypotheses).

L138 Was this tillage fallow or chemical fallow? What was the surface condition during the fallow period?

L141 What time of the year was manure applied? At what application rate (L/ha)? Did the entire field receive manure each year, or was manure applied to only a portion of the field in a given year? Do you have nutrient content data for the manure? How long has manure been applied prior to the study period? Is there any indication that manure had been 'over applied' relative to crop requirements? For example, is plant-available P high or low in the top 15 cm of soil? These are very important details for the discussion.

L148-149 Move the first part of this sentence to Section 2.1. Replace the rest of the sentence with 'The field was instrumented with a VMS (Fig. 1).' State when the instrumentation was installed

L153 Is this 35 degree from vertical or from horizontal?

L154 Boreholes is plural, suggesting more than one borehole. However, there is no fur-

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ther indication if there was more than one borehole. Please make it clear on the number of boreholes/VMSs. Also state where the borehole(s) was(were) installed within the field. If only one borehole was used, the study would have been strengthened if more than one was installed. Provide statements on how representative the selected borehole site was of the field.

L165-168. Delete. This is redundant.

L171 How was water content monitored? Were the FTDRs connected to dataloggers? If so, what type and how were they powered?

L172 How was water samples collected and processed? Were the VSPs connected to tubing and the water pumped to the surface? How much water was collected per sampling? How were the water samples handled in the field (e.g., placed on ice) and transported to the lab? How were the samples stored/preserved prior to analysis? What parameters were analyzed and what methods were used (with references)? Indicate the time period water samples were collected (e.g., from 2009 to 2015).

L214-215 Delete the first sentence. It is a methods statement.

L230-234 Delete. Should be in the Methods section.

L235-237 Delete the first sentence. Redundant. Already stated in the Methods section.

L252-254 Was manure applied after the wheat crop in 2013? And if so, why was no NO₃ spike observed. It would be helpful to clearly state (and even show with an arrow in Fig. 3) when manure was last applied.

L255-257 This discussion needs to be expanded here. The quality and rates of the manure used at the site would be very helpful. Also the mechanism of how legumes contribute to the increase in nitrate should be discussed with references. Can specific information about the total residue biomass of the pea crop and the likely TN contribution be included?

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L269-272 The mechanism/progress should be expanded and further discussed with references.

L280 The isotope analysis needs to be mentioned and described in the Methods.

L284 Often nitrate is not considered as a conservative tracer, for example, compared to chloride. Provide further discussion in this paragraph, with references. Are there variations amount studies and soil types? How does your field site/soil type compare?

L293-296 Delete the first two sentences.

L299 What basis is the application rate considered “excessive”? There is no information provided to support this.

L302-304 Therefore, essentially most of the increased NO₃ remained with the vadose zone within the time frame of the study. Any speculation on when or how much of this NO₃ will enter the groundwater? Please provide discussion. What are the risks?

L308-314. Delete these two sentences. They are method statements.

L326. You state there was an “underestimation”. So why the difference? Please discuss.

L349-351 This statement is far too generalized. Under the conditions of the site, this is true. However, some important conditions for this site have not been described, such as the amount and quality of the manure applied. Are nutrients being over applied? But this may not be the case at other sites because of a host of factors. Therefore, this needs to be re-phrased along with further discussion. In areas that are at higher risk of groundwater contamination from nitrogen sources, particularly from manure, what mitigation options are potentially available? There should be some discussion around this. For example, apply manure based on crop requirements (e.g., see Olson et al. 2010. Canadian Journal of Soil Science 90; 619-635).

L354-360 The first two conclusion points are essentially the same thing. Please com-

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bine.

L363-364 Provide supporting discussion as to why nitrification and mineralization had little effect at this site. Discuss.

L368-371 This is not a methods paper. I assume this is a proven method to monitor leaching of contaminant and water content in the vadose zone. Instead, state what are potential mitigation options, future work required, other practical implications, etc. Is there a local/regional significance to this work?

L380-381 This implies more than one field. However, the Methods/Results suggests that only one field was used in the study. This adds more uncertainty on what was actually done in the study.

Technical Corrections

L23 Replace 'over a period of' with 'for'

L24 delete 'deep'

L25 delete 'sediment'

L45 add 'as' before NO₃, and (WHO, 2011) after NO₃. The reference is WHO 2011 4th edn.

L50 Units should be written exponentially mg L⁻¹. Applies throughout the paper.

L53 Change 'mechanism' to 'mechanisms'

L54 After the word 'specific', replace the rest of the sentence with 'practices used on agricultural land'

L57 Delete the colon

L57 Add the word 'analysis' after signature

L67 Replace 'evolve' with 'change'

L75 After 'Therefore,' add 'our understanding of'

L76 Replace 'impact' with 'effect'

L81 Replace 'water' with 'as a source for drinking water'

L83 Replace 'impact' with 'effect'

L85 Replace 'which' with 'that'

L86 Replace 'impact' with 'effect'

L86 Delete 'the' at the end of the line

L87 There is no Scanlon et al. 2002 in the list of references. Possibly this should be 2010.

L89 Replace 'over' with 'during'

L98 Replace 'domain' with 'zone'

L100 Replace 'setups' with 'settings'

L100 Delete the colon

L105 Replace 'impact' with 'effect'

L126 Delete 'located'

L129 add 'with' before 'an' near the end of the line

L131 change 'month' to 'months'

L138 delete the comma after 'Then'

L138-140 Delete 'with no additional irrigation' It has already been stated that this is a rainfed site.

L141 After harvest, the field was plowed with a . . . (described/name the implement).

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- L141 Delete 'crop'
- L142 Replace 'distribution' with 'application'
- L146 Delete 'setup'
- L153 Add a comma after 'uncased'
- L154 Replace 'multiple' with 'eight'
- L155 Replace the first two words (has a) with 'consisted of a'
- L156 Add 'a' before vadose-zone
- L156 Change 'ports' to 'port'
- L156 Change VSPs to VSP
- L160 Replace 'is' with 'was'
- L161 material (liquid two-component urethane), which solidified
- L162 Replace 'attachment' with 'good contact'
- L163 Replace 'to' with 'with'
- L186 Delete 'located'
- L191 Delete ', both'
- L192 In the list of reference, it appears as Van.
- L206 M/L3 is an odd unit. Does M represent mole? And you cannot have a cubic litre.
- L216 Replace 'indicated' with 'show'
- L217 Change 'contents' to 'content'
- L220 Replace 'significant' with 'larger'
- L226 Delete 'down'

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L228 Delete 'as well'

L237-238 Delete 'different scales and magnitudes of the'

L238-239 Change the first part of the sentence so it reads, The nitrate concentration time . . .

L240 After 'surface' add 'in 2011 and 2012'

L241 Replace ~ with 'about' Appears elsewhere in the manuscript.

L246 'with higher' and delete 'times'

L247 . . . then followed by a reduction . . .

L248 . . . scale in Fig. 3a, . . .

L249-250 . . . fluctuated near 600 mg/L. Then concentration increased to about 32000 mg/L . . .

L251 Replace 'tremendous' with 'relatively large'

L252 Delete the comma and change ~ to 'about'

L254 Delete 'the lower value of'

L258 . . . migration deeper into the vadose . . .

L259 Replace 'could' with 'can'

L259 Delete (Fig. 3)

L260 . . . of 2.7, 4.2, 9.5, and 15.6 m . . .

L260 Replace 'escalation' with 'increase'

L261 Change the comma to a semi-colon, add a comma after 'whereas' and delete m

L262 Replace 'significant' with 'major'

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L262 Delete 'during this period'

L263 Add a comma after 'period' and delete the comma after '2013'

L265 Replace 'on' with 'in'

L267 Delete 'domain is'

L268 Delete 'm down'

L269 Replace 'consists' with 'consisted'

L279-280 Delete this sentence Nitrogen . . . (Fig. 4).

L284 Replace 'like' with 'as'

L286 Replace the first half of the sentence. At the study site, measurements showed leaching and migration of a . . .

L296 Add '(Eq. 2)' after 'calculations'

L296 Replace 'a drastic' with 'an'

L297 . . . increase from 2009 to 2010, at the same time as NO₃ concentration increased in the upper . . .

L299 . . . cultivation of the pea crop and excessive . . .

L314 Delete 'Close examination of the' The results

L319 After 'model' add '(Eq. 1)'

L321 Replace 'found in' with 'applied to'

L324-326 Replace '~' with 'about'

L327 Replace 'over' with 'for'

L336-337 Delete the last part of the sentence after 'understood'

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L337 Replace 'Today's' with 'The'

L338 Replace 'might' with 'may'

L345 Replace 'which' with 'that'

L346 Replace 'by the distribution' with 'with'

L347 Replace 'impact' with 'effects'

L540 Delete the first footnote. It is not needed as the heading in the table already indicates this.

L546-549 Show Fig. 1c as a separate diagram. The diagram shows an observational well. There is no mention of this well in the methods or elsewhere in the paper. Please remove from the diagram. Show a distance scale in the diagram to indicate that the water table is about 18 m below the soil surface.

L551-552 Figure 2. Water-content (θ) at different depths in the vadose zone and daily rainfall for six consecutive years.

L554-556 Figure 3. Time series of observed (NO_3) concentrations in the vadose zone and daily rainfall for six consecutive years.

L561-562 entire vadose zone per year.

L564 Delete '(red circle)' and '(dashed blue line)' Figs. 2 and 3 The text in the these two figures seem to be stretched. Please re-size the figures.

Note: All of the citations in the list of references appeared in the text.

END

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