

Interactive
Comment

Interactive comment on “Assessment of excess N₂ and groundwater N₂O emission factors of nitrate-contaminated aquifers in northern Germany” by D. Weymann et al.

D. Weymann et al.

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The comments are repeated here and our responses are inserted after each comment. We numbered the comments according to our responses. Responses are marked with R (number).

1. I could not understand well on the difference of denitrification potential and process between the 4 aquifers. This problem might be related to lack of information on the study aquifers like as geology, groundwater residence time, groundwater chemistry etc...

R (1): We completely agree that geology, groundwater residence time and groundwater chemistry are important for the assessment of denitrification potential or process

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rates. However, this was not the point we focussed on. We had not the intention to determine denitrification potentials. The aim of our paper is to evaluate and present an improved concept for the N₂O emission factor and to report estimates of this factor for different sites. To our opinion, presentation and discussion of data connected with geology, groundwater residence time and groundwater chemistry are hardly essential for the concept of emission factors we present in the manuscript and would lengthen it substantially. Therefore, we gave references in section 2.1 where information about geology, groundwater residence time and groundwater chemistry of the study sites are available. To emphasize that point, we add these references to the headline of Table 1. Furthermore and following the comment of reviewer 4, we modified the title of the manuscript in order to better underline the main aim of our study (N₂O emission factors from groundwater and improvement of the existing concept for evaluating these factors using the NO₃-approach).

2. Page 1268, line 3: What is the meaning of the additional samples? Is it no matter to do sampling from the tap?

R (2): In Fuhrberg, the majority of samples were collected routinely from 6 multilevel sampling wells with a peristaltic pump. Maximal sampling depth at each well was 10 m below the soil surface. In contrast, a few samples of raw water (5 per sampling event) were collected from the drinking water well of the waterworks in order to take more samples with RP close to 1 and high excess N₂ into account. The sampling depth here was 30 m (this information was added) and the samples were collected from a tap. Because of these differences compared to the routinely collected majority of samples from the multilevel sampling wells we denote the raw water samples as 'additional' ones. To our opinion, sampling from the tap was valid. The raw water was sampled from a continuously pumped groundwater stream like the other samples and not from a water tank. We add this information in the text (section 2.2)

3. Page 1270, line 4: Misspelled word (Boehlke = Böhlke)

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R (3): We corrected the spelling.

4. Page 1276, lines 18-26: The authors need to show the data of hydrostatic pressure or hydraulic potential of the shallow and deep groundwater.

R (4): Following reviewer 3, we add the depth of the groundwater table for the sites in table 1. Because metres of water column above a sampling depth is the only parameter affecting hydrostatic pressure (Phyd), Phyd can be derived from sampling depth. Due to comment (7) and (8) and to reviewer 4, we add a figure in the revised version (Fig. 1), which contains sampling depths of the investigated aquifers and therefore permits determination of Phyd. Furthermore, we modified the text of the section (lines 18-26): line 19: "in part" was deleted; line 25/26: the sentence was separated in two parts and references were added (Heaton et al., 1983; Dunkle et al., 1993, Böhlke et al., 1995).

5. Page 1278, lines 6-7: It would be better to provide the information of groundwater residence time at the study aquifers.

R (5): Robust results for groundwater residence time for all the sites are not available in detail. We deleted the sub-clause in line 5 in order to prevent misunderstanding of the term "residence time";.

6. Page 1278, lines 21-25: I would expect that also the organic carbon content effects on the N₂O emission from the aquifer.

R (6): There is no doubt that organic carbon is an important regulating factor for heterotrophic denitrification, but the content (which would be easy to measure) is of less importance. Rather, quality of organic carbon and its availability for denitrifying microorganisms is the key point governing denitrification. Unfortunately, this point is difficult to comprise and would need a lot of additional analyses. Thus, we did not incorporate organic carbon as a regulating factor for (heterotrophic) denitrification and N₂O accumulation.

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7. Table 1: The authors need to show more detailed information about the each study aquifers like as geology, material components, hydraulic conductivity, hydraulic potential of groundwater etc... It would be better to show the pH and DO with the each sampling depth (not overall). The authors have not stated clearly about the reason why pH and DO varies between the 4 aquifers. I would believe that it would relate to the difference of material components of the aquifers. Especially, the content of electron donor such as organic carbon and sulfides is important for the evaluation of denitrification potential.

R (7): Detailed information about the study aquifers like as geology, material components, hydraulic conductivity, hydraulic potential of groundwater etc.: Please see R (1). For the content of electron donors such as organic carbon and sulfides, please see R (6). Our comment on the importance of quality of organic carbon is also applicable to reduced sulfur compounds like sulfides.

8. Table 2: Same as Table 1, it would be better to show the concentrations of excess N₂, N₂O, NO₃⁻, NO₃(t₀)- and RP with the each sampling depth.

R (8): See R(4) please. A figure with excess N₂, N₂O- and NO₃ concentrations (measured parameters) depending on sampling depth was added.

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