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Interactive comment on “Regional analysis of groundwater nitrate concentrations and trends in Denmark in regard to agricultural influence” by B. Hansen et al.

Anonymous Referee #2

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General comments

This paper addresses topics relevant for the scientific community involved in trend analysis. The authors use interesting approaches for looking at monitoring data and ways of combining these data with data derived from national inventories. The overall quality is good and presentation is clear.

Specific comments

Nitrate conservative compound?

On page 5324, line 25-26, the authors state ‘... because nitrate in oxic groundwa-

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ter can be regarded as a conservative compound directly comparable to the nitrate leached from the root zone when the age of the groundwater recharge is known.' That is, in my view, jumping to conclusions given the scale of the measurements used in this study. Even in phreatic 'oxic' groundwater micro or meso anoxic zones may be present that will result in a decrease of nitrate concentrations with depth because of denitrification. This denitrification might also occur in the unsaturated zone, probably in pockets that are temporarily saturated.

Temporal effects in map (special distribution)?

On page 5326, line 12-20 and page 5330, line 19-24, why do the authors use data from 1890 onwards (if this year is correct) to show the geographic distribution of nitrate in oxic groundwater. I assume that, like in many other EU countries, the nitrate problem has changed significantly over time. Are you now not looking in both space and time. In the extreme, the difference between east and west could have been entirely due to differences in time of sampling between this two regions in Denmark; east old data with low concentrations, west new data with high concentrations.

N surplus.

On pages 5328-5329 (N surplus apportionment), to me it seems a bit strange that surplus would only depend on livestock density and be independent of the ratio between grassland and arable land and differences in arable crops rotations between regions. In the extreme, I assume your model would predict a very low surplus in a region with only arable land and no livestock. In addition, the effect of surplus on nitrate concentration differs between arable land and grassland, that is, with the same surplus and same environmental conditions (soil type, groundwater level, weather conditions, etc.), nitrate concentration in groundwater of arable land will be higher than in groundwater of grassland.

Effect of N surplus on leaching.

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The authors define N surplus as N emission + N accumulation + N leaching (page 5328, line 22). From the point of view of nitrate concentration it seems to me, the surplus on the soil balance would be more of interest (N accumulation + N leaching). Especially when looking at long time series as specific measures might have been taken in Denmark as well to decrease the ammonia emission. In that case, the same N surplus (before and after introduction of ammonia emission reduction measures) would result in another soil balance surplus and thus in another level of N leaching. N denitrification is included in one of the other items?

The authors state that there is a comparable pattern between surplus and nitrate concentration (page 3731, line 20-22). However, as far as I recall, there are also differences in soil types between those regions and there may be differences in ratio of land use types (grassland versus arable land). Differences between soil types and land use will strongly influence the relationship between N surplus and nitrate in groundwater. (see also comment on using old data before)

Conclusion section.

To me it seems that a larger part of the text in the conclusion section of the paper would better fit into the introduction (sketch of the situation) and the results and discussion section (newly introduced data and references not provided before). The aim of this article is (page 3724, lines 28-29): "to better understand the geographic distribution of nitrate in groundwater and the evolution of nitrate trends in Denmark at different groundwater recharge ages by examining the influence from (1) regionally calculated N losses from agriculture and (2) the local amount of groundwater recharge." I would expect that the focus of the conclusion section would be on the key factors for distribution and trend. It is perhaps a simple question of reformulation and shortening of texts by moving text to the other sections, or call this section 'Discussion and conclusions'.

Numbers of analyses in different sections of the paper.

In section 2.3 (page 5326, line 18) a number of 3757 analyses sampled in the 1890-

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2010 period (really 1890?) is given (all types of wells). In section 2.4 (page 5327, line 16-20) a number of 46.800 analyses from 1500 sampling points is mentioned (period?), and a sub selection of 194 monitoring points with oxic groundwater (Danish Groundwater Monitoring Programme). In section 2.5 again another number is given (page 5328, line 6) 5321 analyses from 152 sampling points sampled from 1988-2009 (sub selection, oxic and CFC). (1) Why are there less analyses for all wells for a very long period (3757) than for 'only' the wells in the Danish Groundwater Monitoring Programme for a relative short period (1500 points with 46.800 analyses) (2) Is a sampling point the same as a monitoring point and is this the same as a well or is this a screen in a well (e.g. wells having more than one screen at different depths)?

Technical corrections

Figures 2 a-c are very small and, therefore, statements in paper are difficult to check.

Figure 3, in my view, too many lines / too much information, option to make separate figures for showing different levels of N surplus between geo-regions and for showing development of N surplus and nitrate concentration on national level.

Page 3731, line 8: 'high nitrate leaching from land use' => high nitrate leaching from agricultural land ' (?)

Page 3731, line 11: 'Denmark can be divided' => 'Denmark is divided' (reference) (?)

Page 3732, line 7-8, mowing => moving

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