Referee 2 (R2)	Comments from referee	Author’s response	Author’s change in manuscript
R2-1	The main difference in response is that the high rainfall site has the greatest mass flux of nitrate, and the greatest flux as a percentage of inputs, but lower concentrations. The low rainfall site has high concentrations but a lower mass flux. There may be differences in nitrate leaching due to cropping regime, but these are not systematically explored, just presented in a single figure. There is no discussion of how or whether the 3 sites could be generalised to tile-drained fields in general, which leaves the wider significance of the paper in doubt. Faced with these results, my instinct would be to try and fit a simple model to get a feel for the extent to which the results could be generalized rather than just being characteristic of these 3 fields.	The cropping were almost the same at the three fields. During the period 2001-2011 all three fields have been covered by corn (1 year) and spring barley (3 years). Winter wheat (2 years at Faardrup and Silstrup plus 3 years at Estrup). The remaining 4-5 years of the monitoring, however, long growing season crops (grass, beets, and rape) was less often grown at Estrup than at Faardrup and Silstrup. Nevertheless, the nitrate concentrations were lowest at Estrup having the highest precipitation, and highest at Faardrup having the lowest precipitation. For this reason, we do not find the choice of “crop”/”no crop” to be decisive for the degree of nitrate leaching (Figure 4 – periods with no colour indication represent bare soil/”no crop”, which are app. equally represented on the three fields). Even though Estrup has most autumn/winters crops, nitrate leaching occurred on average 243 days per year in period 2001-2011 (Table X2) and the leaching were evenly distributed over most of the year (Figure 6). At Faardrup and Silstrup, nitrate leaching occurred on average 88 and 86 days per year in 2001-2011.	***Abstract, Introduction, and paragraph 5:*** will more clearly address the influence of the cropping regimes on nitrate leaching especially the catch crops and their ability to reduce the nitrate leaching to drainage. ***Paragraph 4.4:*** The potential side effect of using catch crops will be addressed such as minimized percolation resulting in a lower groundwater recharge. It will be stated that the crop regimes at all three sites in 2001-2011 was without catch crops.
R2-2	It would be helpful if the authors would define some hypotheses which they could use their data to test. For instance, that nitrate loss from the lower rainfall site is dependent on a few large rainfall events whereas that from the high rainfall site occurs over the whole spectrum of rainfall intensities. This appears to be true from Fig. 6, but it needs to be quantified. Other hypotheses might be	The final paragraph in “Introduction” does not state clearly the aim of our study as indicated by the reviewer, why this needs a revision.	***Introduction:*** The aim will be revised in line with “To be able to optimize the use of N in agriculture and minimize the nitrate leaching to the aquatic environment, it is imperative to be able to identify a field’s natural ability to reduce nitrate. The aim of this study was twofold: (i) to provide detailed field-scale insight with regard to the impact of inherent conditions

	that that N loss is due to an interaction between rainfall and stage of crop growth, or N application date or rate, or the crop being grown. Are there differences between crops in N retention or release? The information is shown in Fig. 4, but needs to be quantified and preferably tested for differences statistically.		(air temperature, precipitation, and hydrogeological setting) and management (type of crops, crop development, amount and source of N, and time for application of N fertilisers) on nitrate transport to drainage obtained from long-term monitoring at three agricultural clayey till fields exposed to different climatic conditions; and (ii) to elaborate on the impact of such detailed insight on future N regulation and N management "on-field" and "out-of-field". Additional, the main conclusions of the paper by Gastal and Lemaire (2002). Journal of Experimental Botany 53:789-799: *Nitrate uptake of field crops as being highly variable within a single year and between crops and the dependence between N uptake and growth stage is very complex.* will be referred to and added to "References".
R2-3	The authors are right is saying that field-scale information is necessary for differentiation of N regulation, but they are missing an opportunity here to show how this information can be quantified and used for regulation. So I agree with Referee 1 that the authors need to show how to use their data for	The reviewer has a point. How the outcome of this study can be used in future legislation and as an initial guideline for whether it is possible to N regulate at field-scale or regional-scale is needed to be clearly described. We will revise the manuscript to address these important issues and additionally include new data presented in the attached Table X1 and X2, and in "Supplement" Figure SX.	The revised manuscript will include the following: ***<u>Abstract and final part of Introduction</u>*** will address these issues more clearly. ***<u>Paragraph 2.1:</u>*** The three fields

	this purpose. The Abstract concludes that ". . .local hydrogeological conditions need to be taken into account in a differentiated regulation of agricultural fields. . .".		were selected to cover different types of clayey geology and climate (primarily expressed by the amount of annual net precipitation – see Figure SX in "Supplement"). The three study sites are representative for about 71% of the clayey areas in Denmark (Faardrup: 30 %, Silstrup: 30%, and Estrup 11%). ***<u>Paragraph 3.1:</u>*** A discussion of the daily average air temperatures (5 $^{\circ}$C for "biological zero", 10 $^{\circ}$C, and 15 $^{\circ}$C) at the time of drainage will be added. The data are presented in Table X2 and show that 49 %, 56 %, and 58 % of the drainage at Faardrup, Silstrup, and Estrup, respectively, took place at daily average temperatures above 5 $^{\circ}$C. The corresponding data for 10 $^{\circ}$C is 16 %, 12 %, and 22 %. ***<u>Paragraph 3.2:</u>*** A discussion of the number of days within the period 2001-2011 with drainage larger than 0 mm d^{-1} (Table X2) will be added. This number is 86, 88, and 243 days $year^{-1}$ at Faardrup, Silstrup and Estrup, respectively. ***<u>Paragraph 5:</u>*** The long-term simultaneous monitoring of many different parameters related to the

			inherent physical appearance of the fields (e.g., soil type, geology, precipitation, temperature and drainage) and the management of the fields (e.g., crop type, type of N fertilisers, agricultural practices) confirm that the three fields are different in terms of future water management. These data confirm that the outcome of on-field or out-of-field ("end of pipe", e.g. wetland and constructed wetland) actions may be different in fields of different hydrogeological settings and climatic conditions and we propose a regional conceptual model with three water management scenarios: *The Faardrup type* with low net precipitation, high concentration of nitrate, short-term intensity drainage at air temperatures often below 5 °C. The concentration of nitrate should be regulated on-field by the selection of crop type and the introduction of catch crops. Low reduction of nitrate out-of-field in wetland/constructed wetlands due to low temperature drainage. *The Silstrup type* with medium net

			precipitation, medium concentration of nitrate, short-term high intensity drainage at air temperatures often above 5 $^{\circ}$C. The concentration of nitrate should be regulated on-field by selection of crop type and introduction of catch crops. Medium reduction of nitrate out-of-field in wetland/constructed wetlands. *The Estrup type* with high net precipitation, low concentration of nitrate, long-term high intensity drainage at air temperatures above 5 $^{\circ}$C. The concentration of nitrate may be regulated on-field by the selection of crop type and the introduction of catch crops. Large reduction of nitrate out-of-field in wetland/constructed wetlands. The scenarios cover 71 % of the areas of Denmark dominated by clay. The remaining 29 % needs to be elaborated in the future.
R2-4	Would they say that it would be beneficial to restrict N applications on high (hydrologically-effective) rainfall sites in order to reduce N loads on rivers?	Good question - it is recommendable during growing season to split application of N on high rainfall fields like Estrup due to the very quick response in nitrate concentration in drainage caused by application of N fertilisers.	***<u>Paragraph 4.1:</u>*** This recommendation will be added.
R2-5	Or to restrict N application on low rainfall sites to reduce nitrate concentrations?	Profitable crop production at reduced input of N fertilisers may be very difficult in areas with low rainfall but the right choice of crops combined with growing of catch crops may be the solution for the optimal N management of	***<u>Paragraph 4.1:</u>*** This recommendation will be added.

		such fields.	
R2-6	Or to restrict applications at certain times of year or under certain weather conditions?	According to the present legislation in Denmark, the application of N fertilisers is not allowed in autumn except for fields grown with winter rape and grass. On high rainfall fields like Estrup there may be an economical - and environmental - incentive to split up the application of N fertilisers and to avoid application during days/periods with risk of high rainfall intensities.	***<u>Paragraph 4.1:</u>*** This recommendation will be added.
R2-7	Should certain crops be avoided in some situations? Merely saying it needs to be done lacks credibility if not supported by data from the paper, and is not helpful to regulators.	Please see our answer to R2-1	Please see our answer to R2-1. The word “significant” will be removed from p. 653 l. 9.
R2-8	As well as taking the data analysis further, the authors need to consider how well the data support some of their conclusions. There is some discussion (e.g. p. 655 l.15) of how denitrification would be expected to be more effective at the wettest site (Estrup), yet this is the site with the lowest percentage nitrate retention. Why is this? Is there any evidence that denitrification is occurring at all (e.g. from the seasonal pattern of nitrate concentration, or in relation to temperature)? The authors need to take a more critical look at their data in general.	Based on the reviewer’s constructive question we have now evaluated on the degree of drainage in relation to different air temperature intervals (attached Table X2) and thereby the potential for denitrification both on-field and out-of-field.	***<u>Paragraph 4.5, 4.6, and 5:</u>*** This will be discussed in the two first paragraphs and summarized in paragraph 5.
R2-9	The Abstract is rather unclear and does not do the paper justice. In particular it is not obvious that the descriptions (A), (B), (C) in line 16 onwards represent the three fields referred to in line 11. Transport fluxes should have a time	The reviewer has a point. As stated in R2-3 the abstract will be revised.	The ***<u>Abstract</u>*** will be revised.

	dimension (kgN/ha.yr?) here and throughout the paper. The main results need to be stated more clearly, as well as the main differences between the sites (i.e. hydrologically-active rainfall).		
R2-10	644 l.12 Define Ap for those not familiar with this terminology	We agree	The definition of a Ap-horizon will be added
R2-11	p. 646 l.18 on. The nature of temperature variation at the sites is clear from Fig. 2, but this description of temperature ranges gives an impression that the temperature regime is more severe than it actually is. I would recommend using standard metrological statistics e.g. mean temperature, mean seasonal maximum and minimum temperatures etc. to characterise the temperature regime. A meteorologist would advise.	Regarding air temperature, we have chosen to focus on temperatures relevant in relation to the denitrification process. Information on air temperature span (min, max, and average) for each field is, however, still provided.	***Tabel 2:*** min, max, and average air temperatures for each of the three fields will be add. ***Figure 2:*** Will be deleted. ***Figure 5:*** The air temperature span (from min to max) above zero degree Celsius will be added.
R2-12	p.647 l.10, Fig. 3 etc. Water fluxes in m3/ ha.time would be better expressed in mm/time (1 m3/ha = 0.1 mm). This will be a more familiar unit for hydrologists, and they can then be compared directly with the precipitation, evaporation and runoff fluxes in Table 1, Fig.3 etc.	We had calculated water fluxes in mm/time and changed it according to the HESS-Manuscript preparation where it is stated that fluxes should be expressed as LT^{-1}	The dimension m^3 ha^{-1} will be change to mm day^{-1} in text, figures, and tables.
R2-13	p. 645 l.9 and p.648 l.8 Does “commercial N fertiliser” mean “inorganic N fertiliser”? Organic N fertilisers and even slurry are available commercially, so this distinction needs to be made.	We agree	We change commercial N fertiliser to inorganic N fertiliser in the text.
R2-14	p.667 Fig. 4 What is the crop in the white areas of the graph?	It is correct; an explanation for the white areas is missing.	A white box will be included in the legend with the explanation “Bare

			soil”.
R2-15	p. 642 l.11 Awkward phrase - suggest “. . .enhances crop yields on highly productive soils with poor natural drainage.”	We agree	The sentence will be revised.
R2-16	p. 646 l.3 “filtered” for “filtrated”	We agree	It will be changed.
R2-17	p. 648 l.4 and elsewhere. No need for a dash between “N” and “fertiliser”. “N fertiliser” is correct	We agree	The dash between N and fertiliser will be removed throughout the manuscript.
R2-18	p. 656 l.7 “primary” should be “primarily”	We agree	This will be changed.
R2-19	p.657 l.14 This reference (“Commission. . .”) is out of alphabetical order.	We agree	The references will be reorganized.
R2-20	p. 659 l.8 “Kladivko” should be “Kladikov” both here and where referred to in the text. p. 667	We disagree	The spelling is in accordance with the spelling given in the paper.
R2-21	Fig. 4 legend “BBCH” should be defined both here and in the text.	We agree	This will be added.