Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2018-475-RC2, 2018

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Decadal trajectories of nitrate input and output in three nested catchments along a land use gradient" *by* Sophie Ehrhardt et al.

Anonymous Referee #2

Received and published: 23 November 2018

General comments: The manuscript addresses the important issue of legacy stores of nutrients, which may prevent mitigation actions that reduce the inputs from having immediate effects on stream water quality. I like the date drive approach to investigate the travel times of nitrate. The paper shows that 85% of the N input is retained within the catchment. The investigation about the fate of this lost N is not very convincing and inconclusive. Based on data on inputs and outputs alone, the authors cannot proof whether the N is retained in the soil, whether it is traveling along long flow paths, or whether it is denitrified. The authors try to give answers based on literature, but this is not very convincing. A weak point of the paper is that the entire soil and groundwater system is addressed as a black box. This is a bit strange given the focus on the

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paper on N –stores and travel times in soil and groundwater. Including data on e.g. groundwater heads and flow-paths and concentration depth profiles for N could provide more certainty about the fate of the lost N.

Specific comments:

Title: Consider to leave out 'decadal'. I don't understand why you would only be looking at decadal trajectories

Abstract: The abstract is rather long. Especially the description of the results (from "We show. . ."). Consider to start a new paragraph here to make the structure more clear. The conclusion statement is a bit weak. Management should both address longer term and short term N-loads. How does this change water quality management in practice?

Introduction: From P3L4 until P4L22 the introduction reads like a description and a justification of the methods that you apply. It remains unclear what is not yet known from the existing scientific literature, why that is important, and what new science this paper brings. In P4L20 you state that "data-driven studies focused either solely on N-budgeting and legacy estimation or on TTs." What data-driven studies do you mean here? Why is this a problem / what problem do you solve by combining these? The referencing to Van Meter and Basu is quite excessive P2L11-12: here you state that the agricultural nitrogen input is still high since the 1980's. It did decrease in most EU member states since the '80s as a result of the introduction of manure legislation, didn't it? P2L26: "The evaluation of measures. . ." What evaluation of measures. This sentence is a bit hard to follow.

P5L18: why is the region vulnerable to climate change? P6L3: it's not clear where the 2 WWTP's are located. Can you add them to your map? P6L8: how much are agriculture and WWTP's (and other sources) contributing in %? Figure 1: the stream is not very clear on this map. P7L5 :"artificially drained" Do you mean drained by open ditches or by subsurface tube drains? How much has subsurface tube drainage? Table 1: The fraction artificially drained (last row) is much lower downstream. I would expect

more artificial drainage in the downstream part of the catchment as this is usually the wetter part of the catchment. Is there a reason why there is less artificial drainage needed in the downstream part? P8L30 "...we do not account for wastewater fluxes at this point..." Why is this legitimate? Is the wastewater N flux negligible? Figure 2 and 3: shouldn't these figures be presented in the results section? Figure 2c: It seems like the NO3 concentration is 0 around 2007 and at the end of the graph. Please check this. There also seems to be a regime-shift in this plot just before 2000. What happened? P11L6: "flow-normalized concentrations" It is not clear here why you need flow normalization. Consider to bring forward the end of the paragraph. Why would you want to take out the impact of variable flow conditions? P11L9: I don't understand how you interpolate the bi-weekly/monthly data. "...using a flexible statistical representation for every day of the discharge record". P13L14: "purple line"→purple dashed line P13L21: "peaked 1980" → peaked in 1980 Table 2: It is hard to connect the numbers for the LFS and HSF contributions in the text (<10%, 33%) with this table. It would be better not to give the cumulative contributions, so for HFS: 21, 69, 10. P15L11: I don't understand "...besides the statistical evaluation of the time series" P16L6-15: During the measurement period the catchment will partly export N-inputs from before 1970/76. This could be seen as the legacy of the period before the measurement period. The missing N described here adds to the legacy from before 1970/76. P18L6: why are these TTs for all seasons taken together not presented? Figure7b1: The concentrations seem to drop here, before the input drops. How is this possible? Figuret7c1: The higher concentrations in summer and fall during the peak around 1990 are surprising. This would indicate that the concentrations in deep groundwater with long travel times to surface water are higher than the concentrations in shallow groundwater with short travel times. Is this groundwater N that infiltrated in the midstream catchment and seeps up in the downstream catchment? Figure 7a2-c2: add a legend. P20L9: refer to figure 7a2. P20L7-P21L17: This text in combination with figure 7 is quite a hard puzzle. P22L1: "was difficult" → "was impossible" P22L1-2: Degradation of organic matter may play a role. P22L17-20: I don't understand why "steeper terrain suggests

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a deeper infiltration" and "leaching of NO3 from a wider depth range than flat terrains". I would expect the opposite; deeper infiltration and leaching from a wider depth range in flat terrains. Of course, this depends on the geology. P22L26:"to for an" → "for an" P23L9-10: "Hence,...output" I think that this conclusion that denitrification is weakly supported by the previous text. Groundwater quality measurements would be very useful here. P23L16: why did Kuhr et al exclude denitrification? P24L4-9: from this paragraph and especially the last 2 sentences it seems like it is not important whether the legacy store is growing or the denitrification capacity is used, however on P22L23-25 you stated that this difference is important. Figure 8: This figure does not make any sense to me. P25L3-5: I don't think that you can make this assumption; the flow contributions from a certain depth can vary a lot due to interannual variability P26L3: You can also argue that groundwater seeping up is more important in the downstream catchment. This would mean more discharge of relatively old water.

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