

Interactive comment on “Proximate and ultimate controls on carbon and nutrient dynamics of small agricultural catchments” by Z. Thomas et al.

Anonymous Referee #3

Received and published: 17 January 2016

General comments

This manuscript examines the geological and land use controls on the concentrations of nutrients in freshwaters in three contrasting study catchments in north-western France. The manuscript draws on a 5-year water quality monitoring data set in both base flow and storm flow conditions, collected between April 1996 and August 2000. The paper is well structured and clearly written, however, I'm concerned whether the overall conclusions as they stand at the moment are sufficiently novel, as the different effect of physical controls and land use on water quality at a catchment scale has been demonstrated in a number of previous studies, including some high frequency long-term monitoring experiments (for example, see papers related to the Irish Agricultural Catchments Program but also many others). I would encourage the authors to clarify

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the novelty of their work in the introduction and conclusions.

Specific comments

Abstract

1. The authors refer to 'surface roughness' however this was not measured in this work and is not clearly defined – can you please clarify in methods how the difference in surface roughness was quantified between the three study catchments?
2. Although transient storage and residence time are mentioned in the abstract, these hydrological parameters are not examined later in the manuscript – perhaps some hydrograph analysis of this data set should be undertaken to support this statement?
3. 'Despite agricultural activity . . . the physical context (geology, topography, and land use)' – can you please clarify how does landuse differ from agricultural activity mentioned in the same paragraph, or restructure the sentence?

Methods

3.2 Catchment characteristics and experimental design – could the authors please also describe the soil types present in the three study catchments? This could help to inform the discussion of the observed water quality differences and likely soil biogeochemical processes impacting on nutrient availability and processing. Secondly, is it possible to estimate how the intensity of agricultural inputs differs between the three study catchments (ie input of organic and inorganic fertilisers, livestock stocking density etc.) as this may also help to explain the observed differences? Finally, did the authors consider calculating and comparing instantaneous nutrient loads, as well as concentrations?

3.3 Water quality analyses – can the authors clarify how was a discharge event defined? Can you please comment on the analytical precision and accuracy of laboratory analyses?

3.4 Spatial data and statistical analysis – can you please specify how was hedgerow

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density calculated? Please give a web page reference and scale for the geological map used. Can you please also include a soil map to illustrate the differences in soil types between the study catchments?

Results

3.1 Hydrological and land-use analysis – can you please comment on the land use in the riparian zone between the three study catchments – was this significantly different to explain some of the observed differences?

3.2 Effects of catchment characteristics on water chemistry - can you please present a table with the summary of water quality data for each catchment (determinands of interest, mean value, number of samples) in the supplementary information easy comparison? At the moment, it is difficult to understand the size of the dataset and how it captures the likely temporal variability in water quality. Similarly, to facilitate easy overview of the data, I suggest to reformat the Figures S2 and S3 to show discharge, rainfall and determinands of interest for each study catchment in a separate graph on a single page (so 3 graphs in total, one for each catchment). A table showing the factor loading scores on the PCA axes would also be beneficial – either in the main manuscript or in the supplementary material.

3.4 Inter-annual solute dynamics – please note line 9 is truncated, should end S-01.

Discussion

Sentence “We found that carbon and nutrient dynamics differed..” might be better reworded “We found that carbon and nutrient dynamics differed between the three study catchments both on an event and inter-annual temporal scales..”

4.1 Proximate and ultimate controls on water quality

Line 14 “buffering the catchment fluctuations in water chemistry” – can you please discuss what soil biogeochemical processes may be responsible for this buffering with reference to the soil types present in these three study catchments?

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Lines 4-5, page 15349 “the interactions between catchment context and human use have resulted in preferential agricultural development of schist catchments, which appear to be more prone to nutrient export”. Can you please clarify why these catchments may be more prone to nutrient export? - most likely due to higher soil nutrient content due to higher input of agricultural fertilisers. Have the authors considered whether point sources, such as rural septic tanks, can also be a source of pollution in these study catchments?

4.2 Controls on chemistry across scales

Line 22, page 15349 You refer to larger overall fluxes of NO₃⁻ but it is not clear from Figs. 3, 6 and 7 how these fluxes were quantified and there is no mention in the methods on how nutrient fluxes were calculated. In the paper, you consistently refer to concentrations, while a flux is the mass of nutrients exported over a given period of time.

4.3 Hedgerow density and vegetation effect on soil and shallow groundwater

You discuss the role of hedgerow density on NO₃⁻ mass balance at a larger scale. Line 3 suggests that soil beneath hedgerows may be relatively dry, you then go on to suggest that there may be enhanced removal or retention of NO₃⁻ by hedgerows. These two statements appear contradictory, as denitrification is more effective in anaerobic conditions in wet soils. Can it be that hedgerows are a surrogate for land use type and intensity (ie lower inorganic N fertiliser input), which then leads to lower NO₃⁻ losses from these headwater catchments?

Technical corrections

Fig. 2 – Did you consider discussing and comparing seasonal dynamics in nutrient concentrations? These may explain some of the observed differences between the three study catchments. Highest discharge in S-01 appears to be in the spring – presumably following snow melt?

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Fig. 4 - Can you please highlight the significant differences between nutrient concentrations in the three study catchments for easy comparison?

Fig. 5 – I found this figure difficult to work out – can you please indicate in which direction are discharge and elevation increasing? Why are elevation and chloride blue? Please note that the scale on axis 3 is obscured by the front edge of the cube. Can you please make the figure caption more explicit so that it explains the observed patterns to the reader, without the need to refer to the main body of the manuscript?

Fig. 8 – As for figure 5, can you please provide a more detailed description of the processes illustrated in this schematic in the figure caption. Why are there two hillslopes 1 and 2?

Interactive comment on Biogeosciences Discuss., 12, 15337, 2015.