

# ***Interactive comment on “Spatio-temporal controls of C-N-P dynamics across headwater catchments of a temperate agricultural region from public data analysis” by Stella Guillemot et al.***

## **Anonymous Referee #1**

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### General comments

This study jointly explores concentrations and concentration seasonality of nitrate, DOC and phosphate in the agricultural Brittany area, France. It provides an impressive database with surprisingly strong hydroclimatic gradients. Using different statistical methods the study try to explain the interplay human impact and given catchment conditions shaping the observed responses. This all is interesting for catchment scientists and water quality managers and suitable for HESS. While I like the general approach of the study I did not find it totally convincing. I see issues with the applied methodology as well as with the way the results are discussed. In terms of methods I don't clearly

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see the added value of the PCA and the GAM. Statements made from the PCA could have been made from simple correlation analysis as well. The GAM selects only catchments with a significant seasonality and discards chemostatic catchments. The basic findings could have maybe been also derived by simply describing seasonality indices and/ or a averaging of concentrations for each month of the year. Finally, the correlation analysis with the catchment variables should touch and discuss covariation among the predicting variables. This often hinders interpretation towards underlying processes. Concerning the discussion of the result I miss a synthesis that goes beyond the mere description of the patterns and the statement of interacting natural and anthropogenic drivers. What are implications for ecological water quality (stoichiometry!). What are implications for management and potential future development of these catchments? How does that embed into other research that address catchment scale water quality? This all does not have to be exhausting but would push the paper away from the more descriptive style to something that adds more scientific value. For details see my specific comments below.

## Specific comments

### Abstract

I would have expected some discussion part on the underlying processes here. You describe patterns but you do not discuss these. Why?

L23: "opposing pattern" would maybe fits better here.

### Introduction

L39: Mentioning headwater catchments here seems to be disconnected from the line of argumentation. Why is it relevant to look at headwaters? You mention that later - maybe start with that argument here.

L49: Other studies such as Zarnetske et al. (2018, 10.1029/2018gl080005) or Musolff et al. (2018, 10.1016/j.jhydrol.2018.09.011) indicate a dominance of topography and

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connected wetlands in terms of concentrations (not DOC quality).

L45-54: This exploration of human impacts on C, N and P concentration and spatial concentration variability is not totally convincing. I think some more words, a clear structure and a systematic evaluation of all three nutrients is needed. I miss a discussion on the spatial homogenization by agriculture that was discussed by Basu et al. (2010, 10.1029/2010gl045168) and Basu et al. (2011, 10.1029/2011wr010800).

L69: Why need the human pressure to be similar in headwater catchments to study them better?

L72: The reference (Agren) here has an unclear meaning. Does this study state the lack of seasonal analysis or also do not consider seasonality or consider as a rare case seasonality?

L78f: This hypotheses needs to be better worked out above - see my comment above (referring to L45-54).

L84: What are "relevant" time series?

L87: I suggest to leave out "potential" here. The causality of the correlation may be potentially hint to an underlying process.

## Material and Methods

Table 1: Catchment descriptors are not always self-explaining: What is the topographic index? Is elevation referring to the mean elevation? What is the "class" of dominant soil thickness?

eq 1: Did you considered the offset when the discharge gauge was not at the same position as the water quality station?

L172ff: Did I rightly understood that GAM considered month of the year as only variable? This is not fully clear from the text. Later on it looks like day of the year was the predicting variable.

L177: "Amplitude" of a trend is maybe not the right wording. "Slope" is totally fine.

L179: I don't understand this last sentence.

## Results

L212f: This is already a discussion of your result and should thus be part of the discussion section.

L213ff: All these statements could have been made from a correlation analysis of C10, C50 and C90 (among and between the three nutrients) only. I do not see the added value of the PCA - from my point of view it may be taken out.

L231f: Check this sentence. Better "fitted to XX DOC concentration time series"?

L232f: Can you quantify that? Is mean SI lower for the cases where GAM could not be fitted?

L241: Check this sentence. Discharge cannot have a seasonal concentration cycle.

L244: Does that refer to the comparison between all catchments? That is not clear here.

L245f: I am not sure were to see this gradient in Fig. 4. Is that referring to the right figure?

L257f: What does that stability means? That the pattern does not change between the years? This cannot be seen from the GAM averaging over all years. I am a bit lost here.

L288: You may give direction of the correlation with the hydrologic variables as well.

## Discussion

L304ff: Rather than directly with the interaction of N and C wouldn't it be better to first explain the individual spatial patterns?

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L313ff: But this argument would lead to high concentrations of both, C and N?

L324ff: Wouldn't Fovet et al. (2018, 10.1016/j.jhydrol.2018.02.040) provide a good mechanistical backup for the processes described here?

L334ff: You need some references for these statements.

L350ff: The study may benefit from a conceptual sketch of the two general types of catchments, its N and C sources and seasonal changes.

L400f: You may show and quantify this earlier on by the ratio of CVc and CVq as done in Thompson et al. (2011, 10.1029/2010wr009605).

## Conclusions

The conclusions restate the major findings, which is ok for me, but miss implications (e.g. for management) and an overarching synthesis on catchments functioning (in concert with previous studies on e.g. denitrification or solute mobilization from the Brittany [Kolbe et al. 2019, 10.1073/pnas.1816892116], the above mentioned Fovet et al. 2018).

## SI

Fig. S1: Panel b does not make sense without a legend. Typo in panel d legend name.

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