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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Quantifying the nutrient flux within a lowland karstic catchment" *by* T. McCormack et al.

Anonymous Referee #2

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SUMMARY

The manuscript presents a quantification of the nutrient flux within a lowland karst catchment in western Ireland over a three year period. Hydrochemical insights of the catchment are gained due to testing of water samples from rivers, ephemeral lakes (turloughs), boreholes and springs at monthly intervals. A hydrological model was used to estimate the derived nutrient loading. The authors interpret that nitrogen reductions within the turloughs during stable flooded periods are caused by denitrification processes.

GENERAL REMARKS

In general, the research topic of the manuscript fits very well with the scope of this

journal. The manuscript contains a suitable number of illustrations and one informative table. Formally, the manuscript is well written, but the structure of the manuscript makes it hard to follow. It should be noticed that some of the findings/very similar illustrations have been previously published in McCormack et al., 2014, and Gill et al., 2013. In my opinion, the most critical issues of the manuscript are a) the sampling frequency of one month in a karst terrain, b) in relation to the sampling frequency the validation of the model, c) the final interpretations that were made based on the available dataset:

a) the sampling frequency of one month in a karst terrain

Temporal high-resolution monitoring has proofed that in karst systems significant chances in nutrient transport often occurs in a time frame of hours to days (e.g. Lloyd et al., 2016; Mellander et al., 2013; Pu et al., 2011). The authors state that 'Monthly sampling of turloughs was deemed to be adequate to characterize the system as water is typically retained in the turloughs for long periods. However, for the rivers, monthly sampling only offers a snapshot of concentrations at the time of sampling. ' (P 10243, line 5). Personally, I do not agree that the assumption 'monthly sampling of turloughs is adequate enough' can be made without any evidence. For example, if you look at the fluctuating stages over time (Fig. 4) (or the changes in the mean volume of the turloughs over time in Fig. 7 – or Fig. 14 in Gill et al., 2013, for the changes of the turlough water levels in the previous years) than it is more than likely that due to monthly sampling intervals a lot of significant concentration changes of the nutrients (due to dilution or mobilisation processes) are missed. The question is how reliable the temporal resolution is regarding the interpretations made in the manuscript. A higher frequency of sampling over time or e.g. the use of passive diffusion bags that are recording mean values of nutrient concentrations would be more reliable.

b) in relation to the sampling frequency the validation of the model

In Fig. 9 (and in the manuscript itself) the validation of the model with the field data is missing. It should have been easy to plot the simulation plots together with the real nutrient concentrations. I also doubt that the model input of the river (SA1) in Fig. 8 is realistic in relation to the time chosen. The shape looks familiar as proven in a lot of studies, but the time frame is unusual (e.g. steady increase of concentration for approx. 1 month) (e.g. compare with Bende-Michl et al., 2013, or Schwientek et al., 2012). In Gill et al., 2013, there are 'final calibrated model results for Owneshree river section' for the area shown which also leads to the interpretation that the concentration input signal should be different. In general, the question remains: Could one sample once a month representative enough for the continuous, modelled curve?

c) the interpretations that were made based on the available dataset

In general, the author's choice of the graphic depictions of the available dataset makes it complicated to follow the author's interpretations in the text. As example: âĂć Page 10244, line 5-8 (in relation to Fig. 7): 'These spikes could be due to the increased sensitivity of the turloughs to their river inputs during dry periods. During these periods, the turloughs have less capacity to dilute any incoming nutrient plumes and so spikes in nutrient concentrations should be expected'. The interpretation would be more qualitative if the precipitation dataset would be included in Fig.7. âĂć Page 10233, line 22-24: 'The peak in P in July 2012 (Fig. 6) (which was also seen to a lesser extent in the other two rivers) occurs during forestry fertilization season of April- August (Teagasc, 2015) and coincides with a period of heavy rainfall.' It would have been great to have seen the precipitation data for this area plotted in Fig. 6 to be able to verify this thesis with real data.

One main interpretation of the study is (page 10222, line 17-22) 'Denitrification during stable flooded periods (typically 3-4 months per year) was deemed to be the main process reducing nitrogen concentrations within the turloughs whereas phosphorus loss it thought to occur mostly via sedimentation and subsequent soil deposition. The results from this study suggest that, in stable conditions, ephemeral lakes can impart considerable nutrient losses on a karst groundwater system.' One example for denitrification

is shown in Fig. 10. First of all, it should be recognized that the amplitude of Total N between Point A and B is very low (max. 0.5 mg/l). In addition, there is a sampling interval of one month in a karst catchment (see my previous comment to 'a) the sampling frequency of one month in a karst terrain'). And in general, I miss error bars in the diagram that show the expected accuracy of the method chosen for the analysis of TN. In my opinion, all these facts lead to a high uncertainty of the interpretation.

SPECIFIC REMARKS

Page 10223, line 20-23: Give information about the extension of the EU Water Framework Directive.

Page 10225-10226 (2 Area description and background): I miss references that support the statements e.g. have there been performed some tracer tests (or a geophysical survey), previously?

Page 10226, line 15: 'Fig. 2c' should be 'Fig. 2a'

Page 10228, line 13: Tell the reader how far away the synoptic weather stations of Met Éireann are to the catchment. Notice the hourly rainfall and evapotranspiration data is not presented to the reader in the following text/illustrations.

Table 1: Add the time frame in the legend.

Fig. 1: First of all, check the scale of your figure as the scale shown does not fit with the scale of the map already published by Gill et al., 2013, (Fig. 1). Secondly, check your text at page 10225 and your figure and adapt to one another. For example: Page 10225, line 3-4: 'The eastern portion of the catchment is dominated by the Slieve Aughty Mountains and underlain by Devonian Sandstone (Fig.1)' The Mountains cannot be recognized in the illustration by the reader as they are not marked and the Devonian Sandstone is presented as 'Old Red Sandstone' in the illustration which makes it hard for the reader to follow. As second example, in the following passage it is written that 'The western portion of the catchment is mostly flat und underlain by

pure carboniferous limestone'. In contrast, in the legend are four limestones mentioned without any geological time frame information. In addition, check the legend of your figure: 1) Add information of the geological time frame. 2) Describe the white area of the map (add to the legend) – I assume it is the sea. 3) Is it correct that the rivers are not continuous (e.g. Clonteen River)? 4) Add your symbols for the rain and river gauges - which you have used in the map - to the legend. 5) Some information about the topography in the illustration would help.

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