We thank the two anonymous referees for their comments on this paper. We have considered their comments and make the following responses (in blue), which will be incorporated into the final version of the paper.

Referee 1

1. First, there is no clear research question or hypothesis, which introduces the analysis and guides the reader through the manuscript: "In this study, the nutrient flux… was investigated…"; "Hence, the aim of this research was to investigate the nutrient flux within a series of such protected turloughs … whilst also examining the nutrient flux within the overall catchment surrounding them." These aims are very open and not specific enough to understand the concept and ideas behind this paper. The presented concepts of the different turlough systems could be used to generate such a conceptual frame for this study (and the study should focus on these systems alone).

Response

We agree now (in hindsight) with the assessment that the objective of the paper was poorly described and that focussing on the turlough systems is a better way to structure the paper. Hence, we will alter the text to refine the focus.

Currently the paper is structured as an investigation of the *turloughs* and the *catchment in general*. These two elements do not completely overlap which is probably why it appears somewhat disordered. The original intention of the paper was to answer the following question:

Are the temporary karst lakes of the Gort Lowlands subject to the same transformation processes as found in permanent lakes and do they impact the surrounding catchment. In other words, do the turloughs operate as sources or sinks of nutrients to the catchment?

As this objective was not clear in the original manuscript, the abstract, introduction, discussion & conclusions will be altered to focus on this issue.

Furthermore, based on the Referees' feedback of the manuscript, we feel that the paper has obviously done a poor job explaining the methodology and the purpose of each section. As such, we will include a new paragraph in the methodology to further clarify the objective, and steps taken in the study.

We also feel that the manuscript could be better served by a new title which could bring more focus to the surface-water groundwater interactions (i.e. the turloughs). For example:

Quantifying the Influence of Surface-water Groundwater interaction on nutrient flux in a lowland karst catchment

2. This unclear statement of research can be found throughout the manuscript. It took me quite a while to read the paper completely, though there was no clear lead to follow through the text. This means the paper needs to be restructured regarding clear objectives such as "…the mixing behaviour of different turlough systems". The chapters should not be structured according to the variables analysed within a chapter, but rather regarding the processes presented in a chapter.

Response

Again, we agree that the focus of the paper was unclear and the paper will be altered to fix this. However, regarding the suggestion to restructure the chapters by processes rather than variables, we are not sure whether that will help the clarity of the paper. As per comment 1, we do intend to refocus the paper to centre on the turlough processes and so feel that these alterations will address the unclear statement of research.

The processes themselves are separate for N and P. Thus any restructuring would still align the chapters separately for N and P. We thus feel that the structure of the paper is better served by treating them separately, rather than addressing the 'source or sink' in a combined N and P section in the conclusions.

3. Regarding the nutrient fluxes in the streams this paper did not shed enough light on governing processes. I suggest as treating them just as the upper boundary of the studied turlough-systems.

Response

This is a similar comment as made by Referee 2, and we agree that the monthly sampling in the rivers was not carried out at a fine enough resolution to enable a full characterisation of the nutrient loads in such flashy rivers draining the Old Red Sandstone Mountains. Thus the calculation of average loading rates, (and their mention in the discussion) will be removed. Instead, maximum observed loading rates, (i.e. upper boundaries) will be stated, but not used for further analysis.

However, the mean river concentrations will still be used as an input to the hypothetical model. This is deemed reasonable as the model does not require perfect observed data in order to convey the main concepts of the research.

4. I do not understand why the authors did not compare water level changes and concentration changes in the different turloughs quantitatively? There should be shown if +/-changes of water tables and concentrations are interlinked.

Response

The aim of this paper is to use the hydraulic conceptualisation of the turloughs (i.e. surcharge tanks & flow through systems, as shown in Figure 2) and to compare how nutrients would behave under such configurations using the model (to calculate conservative behaviour of the nutrients – i.e. pure dilution) compared to how nutrients behave in reality. In a surcharge tank turlough, once the turlough is flooded, the water remains unaltered and undiluted for the flooded period. This has been validated by various studies (see response to referee 2 comment 1). Thus, in such a surcharge tank turlough, the fact that concentrations are decreasing over time indicates that some losses/transformations are occurring.

These slow changes in concentration are certainly an indicator of some process occurring, but without more intensive studies, it is difficult to precisely associate these changing concentrations with a particular change in stage. The problem is that when a turlough stage increases, a volume of water with an unknown nutrient concentration has entered the turlough. This addition of water may increase or decrease the overall turlough nutrient concentration (and load) to a minor degree (or a

large degree if the turlough was relatively empty at the start). Thus, while we are confident that nutrient concentrations are dropping due to transformation processes, we cannot isolate the inflows/outflows. Thus the influence of dilution cannot be ruled out and so a quantitative calculation is implausible.

However, if a turlough can be sampled at the start and end of a long constant recession, then it is known that no new water is entering the turlough. In this scenario, dilution can be ruled out and thus any changes in concentration must be linked with transformation processes. Thus, complete quantitative analysis can be carried out over a long recession periods (such as January-February 2012), as has been analysed in the discussion section.

5. There is no proper comparison of modelling results and observations. The authors state first (p 16, l24) that they compare the modelling results to the field data. Whilst on p17,l22 they state that observations could not be compared directly to the modelling results. They even avoid plotting modelling results and observations together in one single Figure (this could be done by normalizing the concentrations). Nevertheless they draw conclusions from the modelling and the literature. This could have been done without any of the field data. In this context it is not clear to me, how the authors could identify denitrification processes within the data (the decrease of concentrations could be caused by mixing processes as well: slower inflow of GW with low nitrate concentrations into the turlough combined with faster outflow of "high" concentrated turlough water).The authors have to find a way to compare the information in the data with the information in the model.

Response

Due to the inadequacies of monthly sampling, it was not attempted to use the model for a direct observed-modelled comparison. Instead, the model was used to present a hypothetical scenario, in order to observe the conservative behaviour of a nutrient input under the specific karstic conduit network configuration (i.e. this characterises the changes in concentration expected from a pure hydrological dilution perspective). We have a lot of confidence in the network configurations of the karst system in this area which has been developed over several years of research and development resulting in the hydraulic model that we use. This is the reason why an observed-modelled comparison was originally not shown on the same plot. However, as the Referee points out, a comparison with normalised data would be beneficial. As such, the model concentrations and observed concentrations have been normalised and presented on the plot together (it should be noted that the modelled concentrations have been altered according to comments from Referee 2 as discussed later).

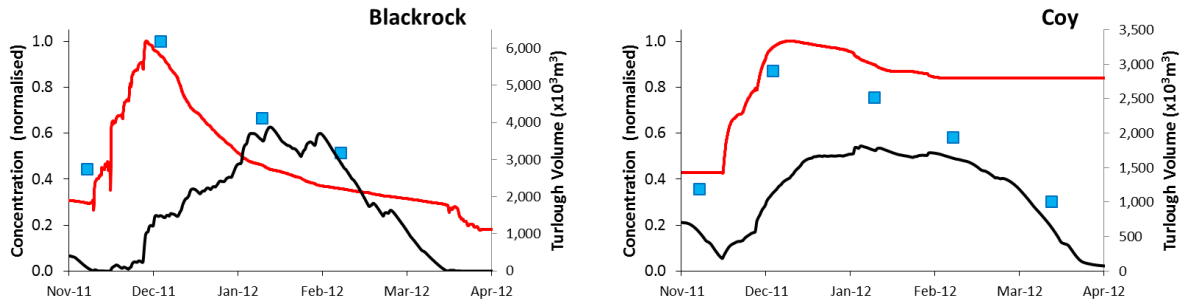

Figure A

With regards to identifying the processes in the turloughs, it is now clear that we had not explained the analysis well enough. The purpose of the observed-modelled comparison is to prove that processes are occurring (in the surcharge tank turloughs at least). Then the Discussion section elaborates on which process is causing the reduced concentrations.

For Blackrock and Coole turloughs, the mixing/dilution process that the Referee refers to is a likely reason for loss of nutrients as these turloughs are known to have a significant flow through component of their hydraulic regime. For the other surcharge tank-type turloughs however, there is a negligible flow-through component. Once the turlough fills, the water remains undiluted.

This can be confirmed by continuous Electrical Conductivity measurements taken at the only estavelle in Coy turlough over the 2012-2013 season (Figure B). These measurements, carried out as part of a PhD thesis (McCormack, 2014), show how constant the hydrochemical signal remains during flooded or recession periods. The only changes in EC are observed during flooding periods when the spring is in contact with new water. Thus, such constant, well mixed, behaviour in the turlough suggests that a process other than mixing/dilution is occurring. The likely process occurring in these turloughs is then discussed in the Discussion section of the paper.

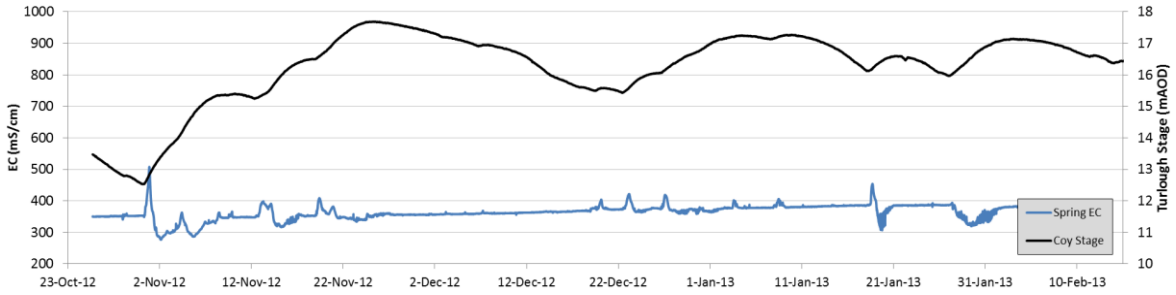

Figure B

References

McCormack, T. (2014). Quantifying Nutrient Dynamics through a Lowland Karst Network. PhD Thesis, Department of Civil, Structural and Environmental Engineering, University of Dublin, Trinity College, Ireland.