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Hydrology and Earth System Sciences
Discussions

Interactive comment on "High-resolution monitoring of catchment nutrient response to the end of the 2011–2012 drought in England, captured by the demonstration test catchments" *by* F. N. Outram et al.

Anonymous Referee #1

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Outram et al. describe research on concentration responses of stream nitrogen and phosphorus species to a drought-ending, extreme rainfall event that spanned three agricultural catchments of the UK Demonstration Test Catchments program. The authors have investigated high-frequency data from sensors using flow/solute duration curves and hysteresis analysis. They have discussed flushing patterns that control the variation of nutrient responses and why patterns vary among nitrate, ammonium, TP, and TRP. A strength of the manuscript is the explicit linkage of monitoring data, environmental policy, and management directives/strategies – the authors clearly and nicely

set forth and discuss this framework. Beyond that, the manuscript is grammatically well-written. The topic area is appropriate for HESS.

While I feel that the overall message is well crafted and the topic has merit, I am highly critical of several aspects of the manuscript and feel that major revisions are necessary before it may be further considered for publication. Substantial revisions are needed to address: 1) how sensor data were validated, operated, and QA/QC'ed; 2) content on hydrological flowpaths that is not directly supported by any strong evidence or cited, relevant literature; and 3) manuscript organization.

1) Validation and QA/QC information for sensor data: No information is presented to verify how sensors for streamflow or solute concentrations were calibrated, operated, validated, or assessed. In these types of studies, stream stage or flow is typically measured (e.g. readings from staff gages or measurements with flow meters) to validate calculated values of stream discharge from stage height monitoring; and grab water samples must be analyzed using benchtop instruments and standard methods to calibrate and validate sensor data. Furthermore, these validation measurements are typically done with regularity to span flow conditions. While the authors mention stream flow measurements with Doppler flow meters at two (of three) of the sites, there is no mention of how this information was used or how frequent measurements were made. And, I am especially concerned about the lack of descriptions of validation and maintenance methods for nutrient sensors. Without validation for each catchment and descriptions of QA/QC procedures, the data are unpublishable.

2) Discussions of hydrological flowpaths have not been supported by data: My contention here is that the authors have over interpreted hysteresis loops and that any resulting attribution of stream concentration variation to inputs from particular flowpaths (e.g. overland, shallow, near-surface, deep) is both completely unsubstantiated and unnecessary to the focus of the manuscript. It has been shown that identical hyteresis patterns may arise from various mixing processes (Chanat, J. G., K. C. Rice, and G. M. Hornberger (2002), Consistency of patterns in concentration-discharge plots, Wa-

ter Resour. Res., 38(8), 1147, doi:10.1029/2001WR000971). Consequently, mixing from distinct hydrological flowpaths cannot be deciphered from hysteresis patterns unless there is additional supporting information such as concentrations measured along various flowpaths and evidence that shows when water may have been flowing along those flowpaths. The authors have presented no such supporting information. In short, the analysis and interpretation regarding flowpaths are not credible. Since most of this interpretation appears in the results (see my criticism of this organization in the next comment), exclusion of this topic would have little effect on the strengths of the discussion section as it had been written.

3) Manuscript organization: Many sentences or paragraphs in the manuscript need to be moved to proper locations. All methods need to be consolidated in the methods section. For example, the calculation of the hysteresis index is a method, not a result. Interpretations (if supported by data) that currently appear in the results need to be moved to the discussion section. See line-by-line comments below for many examples. In addition, the authors should scrutinize the entire manuscript and remove superfluous details. For example, details on storm tracks and characteristics are irrelevant to the interpretation of stream flow and nutrient concentration patterns. See the line-by-line comments for more examples.

One other thing stands out: The authors make the point that the drought-ending event is unprecedented in magnitude and spatial coverage, which leads me to ask: If the event is so anomalous, what is the value of study? One way to address that question and bolster the relevance of the findings to science, policy, and management would be to discuss how these types of events may be more common in the future, if indeed that is consistent with projections of future climate for the region.

Title: There are far many more nutrients than N and P. The particular nutrients of this study need to be listed in the title. Also, shouldn't "Demonstration Test Catchments" be written with capitalization in the title?

15121.19-24: This sentence is nearly identical to the following sentence. Repetitious information should be removed.

15121.16: The case for three different, small, unreplicated research catchments serving as representative "of a national scale" is not supported and this characterization does not seem to be relevant to the themes of the manuscript. Perhaps, the authors could write, "at several locations across the UK."

15124.17: The sentence starting on line 17 is superfluous. The entire paragraph could be modified/deleted to remove the tangential information about the consortium – that information is irrelevant to the presentation and interpretation of the data. If any of it is needed, it would be better suited for discussions, not the introduction.

15125.6: Here also, I am not convinced of the premise that three study sites are representative of a national scale.

15125.12: The air temperature information seems irrelevant.

15125.17 and onward: Much of this information is not introductory information and much of it would be better placed in the site description and methods sections.

15127.6: I have reason to believe that this sentence is incorrect. Given the information in following sentences, discharge was calculated, not measured. The authors should scrutinize this section to verify that measurements and calculations have been properly described.

15127.8: Since data were logged every 15 or 30 minutes, the monitoring was "fixed interval," not "continuous."

15127.11: Describe what the Doppler flow meters were used to measure.

15127: There was no mention of measurements to validate stream stage or chemistry sensors. This flaw is a considerable shortcoming that must be addressed. Without validation or a description of data QA/QC, the sensor data are NOT PUBLISHABLE.

Furthermore, the figures appear to show stream flow data that were calculated from uncorrected stage data that contained errors. For example, there are unexplained increases in stream flow without any rainfall and abnormal drops in stream flow that are not consistent with reasonable expectations of stream flow recession.

Section 2.3: While this information may be somewhat related, it is not necessary. The associated figure, especially, is not needed.

Section 3.1: The authors should consider removing information on meteorological conditions that are not directly relevant. For example, the mention of "low pressure systems and their associated fronts" really has no bearing on stream flow and solute responses to the storm, which are the foci of the manuscript. The same holds for "secondary depressions" and "unsettled conditions."

Section 3.1: Why haven't the authors described or plotted ammonium or TRP duration curves?

15129.19-29: Including the ranges of nutrient responses during events would be informative to readers.

15130.3: Does "underwent an extreme change" simply mean "showed considerably more variation in concentration than nitrate?" Again, providing concentration variation ranges would help.

15130.17-18: The authors have no way of elucidating specific hydrological flowpaths from flow duration curves or any other data that are presented in the manuscript. Overall, the topic area of hydrological flowpaths seems to be beyond the scope of interpretation unless the authors can reference other relevant studies on these catchments for the same events, or they present data that address flow and solute concentrations along those specific hydrological flowpaths. Also, this type of supposition, even if appropriately supported by data, belongs in the discussion section, not the results.

15132.18-19: The interpretations of sources and hydrological flowpaths belong in the

discussion section, but, similar to my previous comment, only if supported by actual documentation of flow and concentrations along those flowpaths.

15134.26/27-15135.7: These methods are inappropriately placed in the results sections.

Section 3.4.1: Interpretations, if supported by observations made in this study, need to be placed in the discussion section.

15135.13-14: No data have been presented on N profiles in soils. Therefore, the supposition is unsupported and hysteresis patterns alone are not sufficient to make definitive statements about specific areas from which N could be flushed. Any attribution to unmeasured sources or source areas is unfounded unless supported by solid evidence with presentation of the data in the manuscript.

15137.19: How is the citation relevant? To me the wording, "in surface soils immediately adjacent to the sampling location" implies some direct link between the citation and data collected for this study – something such as coordinated sampling or collocated sampling between two different studies. However, the citation is from 2010, and the drought mentioned in this study occurred 2011-2012. How relevant is the citation to the particular conditions during the drought and recovery from drought?

Figure 1: A larger font size is needed.

Figure 2: This figure is not needed.

Figure 3: Why does flow in Hampshire Avon increase during a period of no rainfall, between 11 and 16 April?

Figure 5: There appear to be irregularities in the stream flow data. Hampshire Avon: There are incomprehensible spikes in stream flow without rainfall and step shifts (a drop in particular) in streamflow between 30 Apr to May 1. Wensum: There is another incomprehensible drop in stream flow between 26 and 27 Apr. Why does stream flow oscillate during high flow between 29 and 30 Apr? These irregularities relate directly

to my concerns about the lack of a description of validation of sensor data.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 15119, 2013.