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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Developing a nutrient pollution model to assist policy makers by using a meso-scale Minimum Information Requirement (MIR) approach" *by* R. Adams et al.

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Note: for brevity, I shorten e.g. "page 10365, line 4" to "65-4".

HESS review aspects

1. Does the paper address relevant scientific questions within the scope of HESS?

Yes, a model which adequately simulates nutrient fluxes at the catchment scale would be valuable for both water managers and scientists.

2. Does the paper present novel concepts, ideas, tools, or data?

Yes, the model is new.

3. Are substantial conclusions reached?

Yes.

4. Are the scientific methods and assumptions valid and clearly outlined?

This could be improved. I would appreciate a clear objective and/or research questions in the introduction, to which the authors can refer in the conclusion. Also, the calibration procedure sounded a little like trial-and-error.

5. Are the results sufficient to support the interpretations and conclusions?

I am afraid not. The paper does not convince me that CRAFT adequately simulates either water or nutrient fluxes. In the way the results are presented now, it is hard for me to justify the conclusions that are reached. For example, it is hard to see how the points match in Figure 4. Zooming in to one year would give much more insight. Especially the dynamics of TP and SRP in Fig. 4 are not well captured by the model. In addition, the scatter plots in Figure 5 have a very low correlation. The predictive value of the model is therefore low. In addition (if I understand correctly), there is no model validation, but you only show the calibration results.

I am not a nutrient expert and therefore I cannot judge the valididty of some assumptions and simplifications you make. However, you should indicate clearly where assumptions are made, give arguments why these assumptions are valid, indicate in which cases they may not be valid and explain the consequences of these assumptions. For example, how realistic is it that flow from WWTPs is proportional to groundwater flow (73-13)? Why did you choose to schematize it in this way? What is the consequence for the applicability (for example if a water manager uses CRAFT to see what the effect is of a more effective WWTP, does it matter that the water quality of the whole groundwater store is altered)?

6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)?

Not completely. Nearly all model equations are given, but there is some additional information missing.
- There is no information on the used numerical discretization scheme. I assume it's explicit from the way the equations are documented.
- I assume the order of the equations is different in the model than in the paper (e.g. you have to compute Eq. 3 before you can compute Eq. 2).
- Eq. 4 and Eq. 5 depend on each other (computing SRZ(t) and PERC(t) using PERC(t) and SRZ(t) respectively), so I wonder if you obtain the values of SRZ(t) and PERC(t) iteratively or that one is in fact based on the value of the previous time step.

It would help if you could specify how and where the model could be obtained.

7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution?

The paper would improve if the authors add a paragraph on why it was necessary to develop this model while there are already water and nutrient models available, explaining the differences with well-known modelling concepts and the unique selling points of CRAFT. Explain why you developed a hydrological model as well, when there are many catchment-scale water balance models available.

8. Does the title clearly reflect the contents of the paper?

The word "developing" led (with me) to the expectation that the paper would contain a Section explaining the road to the final model concept and a detailed discussion on the choices you made and the consequences of those choices. The paper does contain a little of this, but I think it could be strengthened, especially in Section 2, where you explain the model, or as an additional Section before Section 2. I think it would be a good idea to include "CRAFT" in the title, such that in the future, people using the

model will be able to find the first paper in which the model is presented.

9. Does the abstract provide a concise and complete summary?

Yes, though I was puzzled at first where the R in MIR and F in CRAFT came from, but that can be solved quickly by adding "Requirement" and "Flux".

10. Is the overall presentation well structured and clear?

I am afraid I did not find it very clear. Some suggestions for improvement:
- Figure 1 could be a very important tool in explaining how the model works. Now, you have three figures in one: the boxes, the hillslope, and a schematization of the nutrient model (which is not clear to me). You can combine them to show how the water and nutrient flows are connected to the flowpaths. Add the missing model elements: (abbreviations of) the names of the separate stores, rainfall, evapotranspiration, internal model fluxes and model parameters. I also miss the cultivated layer in Figure 1.
- The introduction is rather long, with Subsections containing their own research questions. Maybe it helps to restrict the introduction to one problem description and one research question.
- The explanation of the model (Sec. 2) can be clarified.
- Figures 3–7 can be much improved, both in clarity and appearance (label sizes, boxes of different size and line thickness). As they are now, it is very hard to draw conclusions from them.
- The captions of Tables and Figures can be expanded to be more informative.

11. Is the language fluent and precise?

Yes.

12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used?

Generally, yes. I found the table with abbreviations quite helpful (although some abbre-

viations were missing). One thing: what is QSCR in Eq. 1?

13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated?

Yes. See “specific/technical comments”.

14. Are the number and quality of references appropriate?

When the authors add a (short) discussion on existing water and nutrient models and the added value of CRAFT, the reference list will improve.

You may be interested in the work by Ype van der Velde, who has been looking at water quality from a water manager’s perspective as well:
- Y. van der Velde, G. H. de Rooij, and P. J. J. F. Torfs: Catchment-scale nonlinear groundwater-surface water interactions, in densely drained lowland catchments, Hydrol. Earth Syst. Sci., 13, 1867–1885, 2009, www.hydrol-earth-syst-sci.net/13/1867/2009/
- Y. van der Velde: Dynamics in groundwater and surface water quality: from field-scale measurements to catchment-scale models, PhD thesis, Wageningen University, 2011, http://edepot.wur.nl/159418

15. Is the amount and quality of supplementary material appropriate?

Adding the model code (or the model itself) as supplementary material would be helpful (if possible).

Specific comments

This model requires actual evapotranspiration data, as no evapotranspiration reduction procedure is included in the model itself (74-20). You should mention the consequences of this choice for practical applicability because only for a few catchment actual evapotranspiration data are available and/or give suggestions how to obtain it.

For the Frome catchment you used potential evapotranspiration (78-24). Can you justify that there is no evapotranspiration reduction? For example by comparing these results to other observations in the UK?

The water balance for the Frome catchment does not close: 1020 mm of precipitation annually minus 487 mm of discharge gives 533 mm. You mention a potential evapotranspiration of 465 mm and I can imagine that the actual evpotranspiration is less than that, but if we assume for now that ETpot=ETact, you still have 68 mm left. Can you explain where this water goes? Is the lower boundary well sealed?

What is the consequence of using an explicit scheme for model results, especially when using a daily time step?

71-5 - 71-13: “The CRAFT model ... their values.” It’s more logical to first explain the model itself and then how it’s programmed and which values you found for the parameters.

75-6: Why did you choose to keep SPLIT fixed and not depend on wetness (as in e.g. PDM model)?

76-14: Is the MAX-function in Eq. 10 necessary? As long as the slope of the relationship between flow and nutrient concentration is positive (I’m not a nutrient expert, so I don’t know if that’s realistic), it will always be above COFMIN.

79-4: Why did you not use the 3-5 gauges when they were available?

80-10: Is the correlation coefficient based on daily averages or instantaneous values?

80-18: “observed graphically”: can you give some more quantitative assessment?

85: Sec. 2.4.: How can a user determine how much parameter values should be changed to simulate a certain change in catchment functioning? I can imagine that you know that QUICK should become smaller when flowpaths become longer, but with how much should QUICK be reduced?

88-2: The seasonal cycle of groundwater level is a big driver for the seasonal dynamics of nitrate. When modelled groundwater goes up in winter and down in summer, you already capture a large part of the seasonal dynamics.

Technical corrections

67-23: “will show”: you don’t know that yet in the introduction.

69-6: Itemizing these research questions draws the attention, which is good. However, these are not the main research questions of the paper (If I understand correctly), so this attention may not be helpful here.

75-7: Write out both equations for subsurface flow. Introducing Qsub just to combine equations is a little confusing.

75-25: You could split Sec. 2.1 into 2.1.1. Water fluxes and 2.1.2 Nutrients.

77-6: Remove the outer brackets in the numerator.

77-23: Refer to Section 2.2.2 where you explain what kind of samples you took.

78-27 Replace the word “known” with e.g. “previously measured”, as you neven really know the ET.

83-13: Move Eq. 14 after “simulation i”

91-14 “as a” → “for”

91-18 “scenarios” → “scenario”

93-4: “uncertainty” → “uncertainty analysis”

Table 1: Why did you include both mean and median? They give the same information here.

Figure 2: Adding catchment boundaries and/or topographic map might be useful. I am

actually curious about the elevation range in the Frome catchment.

Good luck!
Claudia Brauer

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