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Comment on hess-2021-170

Grey Nearing

Community comment on "If a Rainfall-Runoff Model was a Hydrologist" by John Ewen and Greg Martin O'Donnell, Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-170-CC1, 2021

Review by Grey Nearing

Summary of Review:

It's always exciting to see people thinking about hydrology in new ways, and I was initially excited to receive this paper to review. However, after reading it carefully my opinion is that there is little new in this paper, either technically or philosophically. While I appreciate the effort to reframe some of the historical arguments into a new synthesis, I found the synthesis unnecessarily convoluted and the paper generally difficult to read. The idea of "Knowledge Documents" or "Knowledge Tables" is interesting at first glance (it is always a good idea to document all assumptions), however I cannot see what this adds over standard practices for documenting models, model development, and scientific experiments. Additionally, the model presented in this paper performed poorly relative to the benchmark model.

It seems unnecessarily difficult and cumbersome to document everything in "everyday English" as the authors suggest (line 130 and elsewhere). There is a reason why we use equations, plots, technical language and jargon, and diagrams to convey information in scientific documents, and I neither want to read nor write papers where everything that is "assumed known" (table 2) must be expressed in everyday english and/or in table format. I do not see in this paper any suggestion about how the current style of technical writing fails - good papers and technical reports already are expected to document all assumptions.

To be blunt, it's a big ask to change the way we do technical writing, and this paper does not approach the problem with any theory or evidence to support that suggestion. There is a science (and history) of technical writing (e.g., [1, 2]), and this paper makes suggestions that belong in that area of study without acknowledging the existence of that discipline, adopting any of the practices of analysis from that discipline, or even citing any papers from that discipline. I am also not an expert in the theory of technical writing, but given that this is the main focus of the paper I guess it should play a central role.

I have several major concerns with the philosophy of modeling outlined in this paper, and could go through the article paragraph by paragraph to highlight why I think that many of the ideas developed here are either redundant or, in certain cases, counter-productive.

But I hesitate to spend too much time going through these concerns in detail because I don't see a path to publication given the reasons summarized above. If there is some disagreement between reviewers, I will create a more detailed account of my concerns throughout the paper.

General Concerns:

I will try to respond briefly to the main points of the paper (without deconstructing the philosophical discussion in the paper). The paper is written in a way that makes it difficult to understand what the authors intend to be their primary contributions, so the points below reflect my best attempt at extracting the main points.

- The paper introduces a concept of a "Modeled Hydrologist" to help contextualize certain difficulties in developing complex systems models.

The "Modeled Hydrologist" concept appears to be the similar to what has previously been called the "perceptual" and/or "conceptual" parts of hydrological modeling [3, 4]. I'm not sure what anthropomorphizing these concepts, or the model itself, adds to the discussion. It is already well known and widely discussed that models are collections of approximations and assumptions, and there are numerous papers in the hydrology literature that explicitly recognize and discuss this [e.g., 5]. I am having trouble seeing any new ideas here, or any explanation about what is missing from previous "philosophy of modeling" work.

- The paper argues to use "Knowledge Documentation" to "document comprehensively what is assumed known, so that "the ignorance can be deduced when necessary."

This comment reiterates my main concern from the review summary above. I do not think that the argument to use "knowledge documents" is well thought out. Documenting all assumptions and methods is the purpose of standard technical writing in science. The format and customs around this ~300 year old culture and practice about how to construct scientific documents, document assumptions, and allow reproducibility is mature and, in my opinion, very effective when done correctly. What is missing from this? Why focus on plain English statements? Why not use the standard set of tools that scientists use to perform exactly this job (e.g., equations, figures, plots, tables, etc.)? All of these things contain knowledge or information in any meaningful sense. Equations especially are used to formally document assumptions and are often much more efficient and precise than written text.

My opinion is that by encouraging framing assumptions in everyday english, we will encourage sloppy and imprecise thinking. To be perfectly frank, it would be difficult for me to think of a suggestion about how to change scientific writing that I would disagree with more strongly than this one. Our goal should be to move *away from* plain language descriptions toward more formal, mathematical descriptions of all assumptions.

Further, the knowledge tables in this paper (e.g., Table 6) do not contain enough information to recreate the model and experiment. Not only are they difficult to read and to synthesize, they are incomplete. If the model were described in the traditional way, it would be much easier to understand and reproduce. Maybe I'm just not used to these tables, but it would be much easier both to see and understand your assumptions and also to recreate your model structure if you just used equations like normal papers do.

A counter argument for the position I've outlined is that it might be easier for artificial intelligence or natural language processing systems to extract conceptual or semantic

information from knowledge tables like the ones used here, rather than from the narrative style text that is more common in scientific writing. This is an interesting thought, however if this were a goal - however that is not the goal here. If we were to formally adapt scientific writing practices to be more accessible to NLP and automated text readers, I would like to see the problem addressed (theoretically and empirically) from that perspective.

- The paper outlines a new model that is used as an example of applying the Modeled Hydrologist concept to guide and/or document model development.

The new model performs poorly against the benchmark. What is the advantage of this new model vs. existing models? What are the use cases for a model like this? Is the only reason for creating this new model to provide an example for the "knowledge table" procedure? If so, it seems artificial. In general, the model itself is not something that I can see any hydrologist using or being interested in for any practical or intellectual reason, and publishing a new model to illustrate a new philosophy would be interesting if it worked and if it demonstrated some particular value to the new philosophy, but here it didn't work and the authors did not make a convincing argument about how or why the new philosophy gave us something that standard scientific writing would not.

[1] O Hara, F. M. "A brief history of technical communication." A*NNUAL CONFERENCE-SOCIETY FOR TECHNICAL COMMUNICATION*. Vol. 48. UNKNOWN, 2001.

[2] Todd, Jeff. "Teaching the history of technical communication: A lesson with Franklin and Hoover." *Journal of technical writing and communication* 33.1 (2003): 65-81.

[3] Beven, Keith. "Spatially distributed modeling: Conceptual approach to runoff prediction." *Recent Advances in the Modeling of Hydrologic Systems*. Springer, Dordrecht, 1991. 373-387.

[4] Gupta, Hoshin V., et al. "Towards a comprehensive assessment of model structural adequacy." *Water Resources Research* 48.8 (2012).

[5] Gupta, Hoshin V., and Grey S. Nearing. "Debates—The future of hydrological sciences: A (common) path forward? Using models and data to learn: A systems theoretic perspective on the future of hydrological science." *Water Resources Research* 50.6 (2014): 5351-5359.