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Hydrology and Earth System Sciences Discussions

Interactive comment on "HESS Opinions "Hydrologists, bring out shovels and garden hoses and hit the dirt"" *by* M. G. Kleinhans et al.

Anonymous Referee #1

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I generally like this opinion paper and it definitely deserves publication in HESS. I applaud the authors for drawing attention to the under-rated scientific method of controlled experimentation in hydrology, and I agree with their statement that this complements the more traditional methods of data gathering and analysis and numerical modeling.

However, I think that the paper is too long and that the authors should do an effort to shorten it so that the paper keeps the focus on the main points. I also think they should give some attention to real-world 'experiments' in hydrology, of which there are many examples (tracer studies, covered catchments, irrigation experiments, etc). Even though these 'experiments' can be considered not true experiments (in the purist's mind), they do have great benefits and help us to advance our understanding of how

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water moves through the landscape.

What I miss most in this paper is some vision of what the grand challenges are in hydrology and how controlled experiments will allow us to address these grand challenges. What is the future of hydrology? They refer to the B2 Hillslope experiment currently under construction. This experiment is designed to address at least one of the grand challenges in hydrology: how does the critical zone evolve under different atmospheric forcings and what is the role of life in this evolution? The experiment views hydrologic systems (in this case a zer-order catchment) as open dynamic systems that process mass and energy fluxes, export entropy to the environment and in doing so create conditions to decrease entropy and thus allows for the emergence of surface and subsurface structure that alters the hydrological partitioning and the efficiency of mass and energy transport. What starts of as a simple homogenous system, we expect it to evolve into a strcutured more heterogeneous system due to physical and chemical processes that are driven by energy gradients across the system. Thermodynamic theory predicts that such open dynamic systems will evolve towards a state that is more efficient in processing the resulting fluxes, but so far we lack the theory to predict the direction of this evolution, especially when life starts interacting with the physical system. This is a grand challenge in hydrology as we are facing rapidly changing landscapes due to global warming and human interventions. Predicting water availability under these changing conditions needs to accept that the system itself is changing because of these man-induced environmental changes and thus that the existing knowledge of systems behaviour is insufficient. It is clear that interpreting the outcome of this experiment requires an inter-disciplinary aproach where all Earth sciences work together to develop new paradigms in hydrology (and all other Earth sciences).

It would be good to hear from these authors what they think the grand challenges are and how controlled experiments can help us addressing those.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 6, 6581, 2009.

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