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Hydrology and Earth System Sciences
Discussions

Interactive comment on "HESS Opinions "Integration of groundwater and surface water research: an interdisciplinary problem?"" *by* R. Barthel

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The author is to be congratulated on insisting on a debate on the role of hydrologists in the (still) emerging discipline of integrating groundwater and surface water research. There are many good thoughts on why this has not worked out in the past. For those reasons I think the paper is worth publishing; it is a timely discussion, but, and allow me to state this in a provocative way, I also feel that it is 10 years too late. My main points of criticism are that; "integration is on the move – and there should be no point in making a distinction between groundwater and surface water hydrologists, it is old fashioned" and "integration is best done at the small scale".

First of all, it appears to me that the author thinks of surface water as rivers/streams

only. He thereby neglects open waters like lakes, coastal lagoons, and the sea. If these hydrological bodies were included in the discussion I think the conclusions/thoughts would be different in some aspects and remain the same in others. For example, it is my impression that groundwater and lake hydrologists have worked together for decades and most often it is not possible to distinguish who is who – it is the same researcher. Although the discussion paper sets water quality and ecology aside, I would like to mention that lake/groundwater hydrologists often work closely together with freshwater biologists and ecologist – so integration is perhaps better here and we can learn from this, not saying that integration is perfect as it is now. When it comes to the marine environment the situation probably resembles the problem that this paper addresses, i.e., here there is even more room for better integrating hydrological and marine research communities.

Second of all, I think that interdisciplinary research is "on the move", at least on the small scale. Here I am not sure I entirely agree with the author that "The smaller an area is the more likely it is that a non-integrative solution is sufficient". Beven argues in his text book (Beven, 2012, p. 155) that "If it has proven difficult to simulate the processes in very small catchments using this type of distributed models, how should that guide good practice in practical application of such models at larger scales?". The distributed models are exactly the kind of models that the author of this discussion paper refers to. One of Beven's own reflections on this is "that the predictions of such models will be uncertain, and consequently some effort should be made to assess and constrain that uncertainty". Inevitably, many flow processes will be lumped at the larger scale and the parameterization then uncertain. Which makes me think that the way to go is to secure interdisciplinary research at the local (small) scale to begin with? And this exactly what I see. There is more and more interdisciplinary research at the local scale between groundwater and surface water hydrologists (or groundwater hydrologists learning surface water hydrology or vice versa – maybe an even better approach?) and also involving geochemists, biologists, and ecologists. Exactly here I agree with the comment by the author that "scientists at all levels need to be educated

in interdisciplinary thinking" and "the growing number of inter disciplinary educational programs are a good start". I think this education should focus on local scale problems, where the right physics (and biogeochemistry) is taught.

Finally, a few other examples that integration is "on the move". On the integration side, this has been widely recognized recently amongst hydrologist, biologists/ecologists, and modelers as such (Smith et al., 2008). On the data side, Constantz et al. (2012) present new prototype monitoring stations for linking stream gauge data to well observations in order to study the coupling of stream and groundwater resources. It is also not entirely correct to say that base flow cannot be measured. Rosenberry and LaBaugh (2008) describe many methods such as seepage runs (flow accretion) or the use of seepage meters to actually quantify or measure directly how much groundwater exchanges with a river. On the modelling side, fully coupled models are in fact also used on the really large scale and not just the small scale. For instance, HydroGeoSphere has been used at the really large spatial and temporal scale (e.g. Lemieux et al., 2008), although maybe not integrating groundwater and surface water in the traditional sense. On the education side, it is true that many text books focus mainly on one topic; groundwater or surface water, and, typically for groundwater text books, will rather include chapters on groundwater quality and geochemistry, and not surface water. However, there are old and newer text books with a balanced coverage of both groundwater and surface water (and no water quality), for example undergraduate text books by Hornberger et al (1998) – Elements of physical hydrology (with a river corridor on the front) and by Hendrix (2012) – Introduction to physical hydrology (with a hydraulic jump on the front) and advanced/graduate books like Beven (2012) – Rainfall-runoff modelling.

In conclusion, the paper stimulates productive thoughts and is therefore a good opinion paper, where you can agree with some parts and disagree with other parts – this is the way it should be. To make it more readable I suggest taking out examples 4.1 and 4.2; I do not see why they are needed. For example, the example with recharge sounds to

me more like a simple sign convention and not a real problem. The hill slope case is in my opinion also not a good example. As far back as 1996, Hill (1996) recognized the important control between riparian zones and the "upland" or catchment and several other papers on similar issues have appeared since – so research on the "connection between groundwater and surface water" has not been "shallow" in my opinion.

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