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Hydrology and Earth System Sciences
Discussions

Interactive comment on "A review of methods for measuring groundwater–surface water exchange in braided rivers" *by* Katie Coluccio and Leanne Kaye Morgan

Anonymous Referee #2

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This paper provides a thorough literature review of papers describing methods to characterize groundwater-surface water (gw-sw) interaction in streams. The emphasis of the paper are studies in braided streams. Braided streams provide additional challenges for characterization, including ephemeral and low flows, heterogeneity, invasive species, and anthropogenic alteration as discussed in the paper.

The paper points out that relatively fewer studies of gw-sw exchange have been conducted in braided streams. This review paper pulls together a summary of many such studies. However, the paper lacks synthesis on several points. These issues should be addressed to strengthen the paper:

1. While the paper points out challenges in measuring gw-sw interaction, including a nice summary table by method, the challenges do not link up with the specific issues in braided rivers. In other words, the challenges would apply to all river types. For instance, the authors mention how heterogeneity makes it difficult to measure flow. While braided streams may be more heterogeneous (however that is defined), all streams would benefit from methods that address heterogeneity. I would have liked to see how the cross-sectional heterogeneity (in contrast to along reach) impacts measurement techniques. That said, Genereux's group has some papers illustrating both along-reach and cross section variation in streambed K, so even this aspect is not unique to braided rivers. The advantages and disadvantages sections list challenges that would apply to other stream types as well. The abstract and conclusions emphasize the need for multiple methods and consideration of scale in selecting methods, but again these recommendations apply to any river type. Without details about why a particular method works elsewhere but not on braided rivers, the paper lacks focus. It does not suffice to say a method is "more difficult" when it is difficult in a variety of river settings.

2. The paper provides a map of locations with braided streams, but does not justify why these locations are included and not others. The definition of what "concentrated" means in terms of distribution of braided streams is not provided. There is a list of braided streams in the US on https://commons.wikimedia.org/wiki/Category:Braided_rivers_in_the_United_States_by_stat which suggested that braided rivers are important in the US too, yet no sites there are listed. To list the map as a significant feature of the paper ("to the authors' knowledge, this is the first map of its kind") but provide no details on how the map was generated is frustrating to the reader.

3. The word "hyporheic" only appears in the abstract and end of the paper, not in the main body. This mention in the abstract should be removed since it is not a topic covered in the paper. It is probably better left to another paper as the issues in measuring

hyporheic flow differ significantly.

4. The modeling discussion is focused too much on MODFLOW. The description of MODFLOW packages can be found elsewhere and there are other models that incorporate groundwater-surface water interaction that could be discussed. For example, a recent special issue in Groundwater on integrated modeling included a paper on streambed heterogeneity. There is also a recent review paper on modeling gw-sw interaction in Reviews of Geophysics that provides a broader view. The abstract mentions the need for new approaches in modeling, but the paper does not provide sufficient direction to justify this as a conclusion of the paper. The conclusion the models need more data and more sensitivity analysis has been stated many times before.

5. I was surprised that fiber optic temperature systems (also known as DTS for distributed temperature systems) and geophysics were not discussed. These methods have been mentioned in other reviews and provide broader coverage which might benefit braided streams. I found it odd to bring up thermal imaging for the first time in the discussion section rather than in the review of methods, especially since it is mentioned in the abstract and it is one of the more promising techniques for heterogeneous systems. An example of the benefits of thermal imaging might provide an interesting figure.

6. On the topic of figures, the figures were lacking in illustrative examples of applications. There was a map, but the other figures were photos or diagrams and didn't show quantitative challenges or opportunities. In other words, I think it would help the readers' understanding to include data figures.

7. One place that the paper focuses on braided streams is the literature review of methods. The paper summarizes applications in braided streams and the table of methods lists braided stream citations. However, the literature summary sections of the paper are a bit dry. They list highlights of each paper one after another. I think some of these papers could be describing non-braided streams and the reader would

not know. This type of literature review needs to be briefer and provide synthesis of issues specific to the problem identified. In addition, a significant number of references (estimated 25% based on the first page of the bibliography) are not readily available literature but reports or theses (typically from NZ). Many readers will not have ready access and the focus on one region is not justified.

It can be difficult to meet the standards of a review article. In the end, I ask myself whether I would give this paper to colleagues to read, or just keep recommending Kalbus et al. or LaBaugh and Rosenberry as review papers on the topic. I do not think there is enough new material here for me to consider this paper to be an update on the earlier papers. If revising, I would recommend a very short review paper, which introduces Table 1 and gives the reader the reference list for readers to select topics on their own (rather than the one line summaries of each paper). The shorter paper also needs to provide the reader with an approach to braided streams that is distinctly different than other streams – this message will take additional synthesis and thus I would consider it to be a new paper rather than a resubmission. Hence, I am recommending rejection and significant redirection for any new submittal.

Some papers mentioned in the review:

Berg, S.J., Grosso, N.R., Sherrier, M.P., Mudrick, K., Ohr, M., Hwang, H.T., Park, Y.J., Callaghan, M.V., Frey, S.K. and Sudicky, E.A., 2019. Natural stimuli calibration with fining direction regularization in an integrated hydrologic model. Groundwater, 57(1), pp.21-35.

Genereux, D.P., Leahy, S., Mitasova, H., Kennedy, C.D. and Corbett, D.R., 2008. Spatial and temporal variability of streambed hydraulic conductivity in West Bear Creek, North Carolina, USA. Journal of Hydrology, 358(3-4), pp.332-353.

Brunner, P., Therrien, R., Renard, P., Simmons, C.T. and Franssen, H.J.H., 2017. Advances in understanding riverâĂŘgroundwater interactions. Reviews of Geophysics, 55(3), pp.818-854.

Not mentioned, but a classic that should be cited: Winter, TC, Harvey, JW, Franke, OL and Alley, WM. 1998 Ground water and surface water; a single resource. USGS Circular 1139

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