Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2019-399-AC3, 2019
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Hydrology and Earth System Sciences
Discussions

Interactive comment on "HESS Opinions: The Myth of Groundwater Sustainability in Asia" *by* Franklin W. Schwartz et al.

Franklin W. Schwartz et al.

schwartz.11@osu.edu

Received and published: 20 October 2019

We are appreciative of the constructive comments and suggestions from all of the reviewers. Following here is our detailed response to comments of Reviewer #3. Dr. Fogg has made excellent points which are considered in our revision.

Reviewer#3 – Dr. Fogg

1. This Opinion paper is a well-written, sobering description of the ongoing crisis of groundwater mismanagement in Asia and prospects for changing course. Despite its negative bottom-line message that the crisis likely cannot be averted, I enjoyed reading the paper and believe the readership will find it interesting and thought provoking.

(response) We appreciate Dr. Fogg's comments here.

2. All of my edits and comments are marked directly in the PDF that is uploaded with this review.

(response) We examined Dr. Fogg's pdf that provided comments on specific phrasing, and more substantive ideas. We made appropriate modifications editorial and otherwise to the manuscript that reflected his suggestion in all instances.

3. My main comment is that the message - that it's highly unlikely for groundwater in Asia to ever be managed sustainably- is too negative. Granted, this is an opinion piece, and the authors are entitled to their opinion, but I think they might be missing an opportunity to provide more impetus for positive change. I worry that the negative message may do more to stifle groundwater management than to produce beneficial change, and all under the assumption that such change is impossible.

(response) Dr. Fogg's comment on the message being too negative is similar to that coming from Reviewer #2. We accepted both their points of view and responding by rewriting the conclusion to brighten it up as well as other parts of the paper. Most importantly we have deleted the idea of "planning for the worst". In other words, we leave the far future to the readers' imaginations without explicitly stating that sustainability won't happen. This has led to changes in the title to section 4 and the concluding paragraph and paragraphs describing research on adaptation. As we mention with specific following comments, we have added several sentences in the conclusion that specifically reflect Dr. Fogg's perspective (below).

Dr. Fogg made a comment before the conclusion that made the point that traditional MAR was a very good thing, rather than some incremental effort that we implied in our initial draft. The revision of the conclusion also put a much more positive "spin" on the MAR efforts in India and China.

4. For added perspective, consider the following:

(a) Any of the needed groundwater information infrastructure would be cheap relative

to the spending these countries are currently doing for construction and maintenance of surface water infrastructure (dams and conveyance). So if they realize they must have something, they can likely find the means to achieve it. One less dam project could free up enough funds for a national groundwater monitoring network. Thailand's Department of Groundwater (yes, there is such a thing) has been doing this nationally since the 1950-60s and hence has been more proactively managing groundwater.

(response) We have no disagreement with what Dr. Fogg has written here. The manuscript was confusing about what kind of infrastructure we were considering to be expensive. We were actually not thinking about informational infrastructure. The infrastructure we wrote about was that required to provide for new sources of water for MAR. Imported water, might, for example, require dams and canals. Using domestic wastewater in India as a source, would require adding, expanding and upgrading sanitary sewer systems, re-imagining the waste-water treatment facilities, MAR and making electric power more reliable. We have added clarification to the text on this point.

(b) The world may be entering a period of change with respect to groundwater management, although it may require considerable coaxing and crises to get there. Since widespread deployment of industrial scale groundwater pumping technologies some 70 yrs ago, very little effort has been devoted to recharging and managing groundwater. In essence, civilization has not yet begun to try to manage groundwater very much, mainly because it has not had to, mainly because of the vastness of most groundwater basin resources. But now that may be starting to change. See the discussion piece: (Trend magazine 2019). I agree - it is questionable whether such change can happen soon enough in Asia, and people should also start preparing for the worst.

(response) We did examine Dr. Fogg's paper in Trend Magazine. The conclusion was modified to reflect this view point through the addition of sentences and reference to Dr. Fogg's paper. This is written in the following section.

(c) One could argue that a big part of the problem is the lack of transparency of ground-

water systems, making the state of gw resources easier to ignore. There are technologies coming along that could change this significantly - e.g., low-cost wireless, real-time groundwater level monitoring networks connected to open-source web platforms to track fluctuations in groundwater levels (these may require cellular networks, which are already more extensive in parts of rural Asian than parts of rural America); and future

(response) This point is well taken. We also added words to suggest that monitoring could be a catalyst to increase understanding of the problem "There is, however, some hope that new technologies, may create sufficient visibility as to the severity of the groundwater problems to finally spur action (Fogg, 2019)."

We also add several sentences that made particular reference to real-time monitoring and GRACE follow-on mission as being examples of helpful new technologies.

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