Hydrol. Earth Syst. Sci. Discuss., 11, C3518–C3523, 2014
www.hydrol-earth-syst-sci-discuss.net/11/C3518/2014/

Hydrology and Earth System Sciences
Discussions

Interactive comment on "On inclusion of water resource management in Earth System models – Part 2: Representation of water supply and allocation and opportunities for improved modeling" *by* A. Nazemi and H. S. Wheater

Anonymous Referee #1

Received and published: 31 August 2014

General comments

The authors extensively reviewed earlier modeling efforts on human interventions to the natural water cycle. This is the second part of their double-featured paper focusing mainly on the formulations of reservoir operation and groundwater abstraction in global hydrological models. Based on literature review of more than 150 published reports, the authors summarized the background, history, achievements of modeling activities so far. They raised three major issues to be addressed and proposed a framework

for systematic improvement of representation on water resources management in the Earth System Models (ESMs).

Development of land surface models (LSMs) and global hydrological models (GHMs) that incorporate human activities has been carried out for more than a decade. Because the number of related publications has been growing rapidly, good review papers are required to overview them. This article effectively covers the influential publications available and suggests what should be done next. As far as I know, this is the first independent review article on this topic, which would be potentially important.

To be honest, it is difficult to comment on a review article. Apparently, there is no right or wrong way to select papers, structure the text, and conclude. Since this article is well prepared and quite informative, I don't have any strong comments. Below are my suggestions as a reader who has worked on this field for years. There are four major points.

First, although well surveyed, I found some errors in text which misrepresent some formulations or concepts of models (please see below for detail). It is quite challenging for non-developers, if not impossible, to describe models perfectly by only literature review. Here I would like to suggest the authors to make a simple survey of models: contact the main developers of major models and ask to check whether the descriptions on their models are correct.

Second, I found considerable overlaps in contents within this article. It could be attributed to its structure. Actually, the titles of chapters 2-4 read "Available representations of water sources in large-scale models", "Available representation of water allocation in large-scale models", and "Current large-scale modeling applications". In each section, both the reservoir operation and groundwater models are discussed citing the same papers repeatedly. I wonder the overlaps might be drastically reduced if the authors reorganize them into two sections, the reservoir operation and groundwater models.

Third, the objective of review is a bit unclear. As the title of this paper says, the authors may intend to make use of this review to develop an ESM including human activities based on an atmospheric model and conduct online simulations to study land-atmosphere interactions. If this is the case, the paper in the current form might pay too much attention to the application of offline simulations and too less to the problems inherent to ESMs and online simulation (low spatial resolution, biases in atmospheric and hydrological variables, small signal to noise ratio due to large internal variation, etc).

Fourth, the authors partly included discussion on water security in this paper, which confused me. Water security is largely a matter of socio-economic change, policy, institution, and governance, which is out of the scope of this paper. Above all, the review on this topic is insufficient.

I hope some of my comments are useful for revision.

Minor comments

P8303, L2, "focus mainly on measuring the annual difference between natural water availability and projected demand as an indicator of water scarcity": I'm wondering this part is of relevance to this review article. This paper basically focuses on the representation of human activities in numerical models rather than its application to water resources assessments. Indeed, dozens of high quality papers have been published on global water scarcity and security, which is largely missing in this article.

P8304, L19, "10% of the annual runoff": The number may be too small. 8000km3 of storage volume must be accounts for 20% of global annual runoff (approximately 40000 km3/yr).

P 8304, L16, "Available representations of water sources in large-scale models": The section includes a subsection "groundwater", while it excludes "surface water". I understand that river and lakes are "natural" processes and do not include explicit human

activity, but these are the most fundamental water sources.

P8307, L24, "often groundwater availability is assumed as unlimited local source": Please carefully revisit the original article. For example, Rost et al. (2008) devised a technical term "Nonlocal and nonrenewable blue water (NNBW)" and avoided assuming groundwater is unlimited source.

P8308, L1, "Wada et al. (2014)": Döll et al. (2014) should be mentioned here as well.

P8310, L14, "Hanasaki et al. (2006) assumed that large reservoirs can supply all downstream demands within 1100km and with lower elevation": When the model of Hanasaki et al. (2006) estimates the monthly release of individual reservoirs, it only uses the information of water demand in downstream. Released water is not always sufficient to "supply the all downstream demands". This kind of details might be difficult to learn from literature review. Voluntary checking by model developers would substantially improve the accuracy.

P8310, L28, "Irrigation has often been given the highest priority": At least, Hanasaki et al. (2008a) gave priority to domestic and industrial water over irrigation in abstraction of water from river.

P8311, L3, "the deficit is typically shared proportionately to the demands": Because of the reason shown above, the proportion among water sectors is not shared at least in Hanasaki et al. (2008a, 2013a).

P8312, L7, "If the groundwater is considered as an infinite local source (Rost et al. 2008; Hanasaki et al. 2010. . .)": This is not the case for Rost et al. (2008) and Hanasaki et al. (2010). What they assumed infinite was Nonlocal Nonrenewable Blue Water (NNBW) which indicates water sources that are not explicitly represented in their models, namely, water diversion, glacier melting, desalination, and others.

P8319, L10, "Impacts assessment and water security studies": It is not very clear what kind of impacts on what are discussed here. For example, the reservoirs influence

not only the surface water/energy budget, but also sedimentation (e.g. Syvitsky et al., 2005), ecosystem (Vörösmarty et al., 2010). These issues are not mentioned here.

P8322, L23, "Computational complexities": Personally, I am not very much convinced by this sub-section. It is quite subjective to discuss what is computationally "complex" or "expensive". I am wondering whether this subsection is necessary.

P8326, L23, "implement the operation at finer temporal resolution (sub-hourly to few hours rather than daily and monthly)": I am wondering why such finer temporal resolution is needed. The atmospheric processes and reservoirs are primarily connected by the water surface of reservoirs. More specifically, the area and temperature of surface water, if I understood correctly. In most cases, both of them vary slowly, hence the reservoir operation in online modeling might not request such a fine temporal resolution. What I think more important here is that the river inflow to reservoirs by online simulation includes substantial bias compared to offline ones, particularly when it is not assimilated. A fundamental problem here seems to be how to represent reservoirs in a robust manner while the inflow simulation is highly unreliable. An old saying goes "garbage in garbage out".

Table 1, "Demand-supply dependency": upstream reads downstream.

Table 2, "Host model": H07 reads H08 (Hanasaki et al. 2008), and PCR-GLOBW reads PCR-GLOBWB (PCRaster Global Water Balance).

Table 2 "Discharge data": Does it show the validation data used in earlier studies? It is a bit confusing because many of studies simulated discharge by their models.

References

Döll, P., Müller Schmied, H., Schuh, C., Portmann, F. T., and Eicker, A.: Global-scale assessment of groundwater depletion and related groundwater abstractions: Combining hydrological modeling with information from well observations and GRACE satellites, Water Resour. Res., 50, 5698-5720, 10.1002/2014wr015595, 2014.

Syvitski, J. P. M., Vorosmarty, C. J., Kettner, A. J., and Green, P.: Impact of humans on the flux of terrestrial sediment to the global coastal ocean, Science, 308, 376-380, 2005.

Vörösmarty, C. J., McIntyre, P. B., Gessner, M. O., Dudgeon, D., Prusevich, A., Green, P., Glidden, S., Bunn, S. E., Sullivan, C. A., Reidy Liermann, C., and Davies, P. M.: Global threats to human water security and river biodiversity, Nature, 467, 555-561, http://www.nature.com/nature/journal/v467/n7315/abs/nature09440.html#supplementary-information, 2010.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 8299, 2014.