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Geoscientific Model Development Discussions

Interactive comment on "Simulating human impacts on global water resources using VIC-5" *by* Bram Droppers et al.

Anonymous Referee #2

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The manuscript describes in thorough details the integration of models that enhance VIC5 in the representation of anthropogenic activities. The represented human system models include sectoral water demand models, a generic reservoir operations model, and a water supply model. The authors present the overall performance of the model by evaluating the continental water withdrawals with other large-scale hydrology-river routing-water management models. The manuscript is very well structured and written, providing a great resource to support future papers that will likely focus on the analytics instead.

Below are recommendations to further support the individual modules that are being added – some require more details and citations. Another recommendation is about the evaluation of the model performance – only the water withdrawals are evaluated rather

than flow regulation and overall redistribution of water resources and performance of the model in meeting the sectoral demands. The clarifications , and evaluation, are needed in order for this paper to be cited in subsequent papers and support the future analytics.

About the models: Most of the models already exist, whether the hydrology model, the generic operating rules reservoir model, the water supply model, the sectoral water demand models. There is no significant novelty in those individual models. Some models would need to refer to existing models for evaluation:

- The sectoral demand models: (Huang et al., 2018) provides an evaluation of the different water demand models for different sectors. The set up and computed sectoral water demands would need to be further evaluated to support the sectoral water demand models in VIC5-WUR. Please note that the assumption for power plants to run at maximum capacity constantly is not realistic. Capacity factors (ratio of generation over maximum capacity) and generation portfolio are available through the EIA and IEA datasets, which could help improve this demand model, along with suggestions in the other models.

- Enhancement of reservoir releases based on storage levels. (Yassin et al., 2019) and (Rougé et al., 2019) provided a new reservoir operation formulation that modulates releases based on storage levels. While the manuscript is not a review of existing models, the proposed citations should help further support the "model enhancement and improvement" with respect to existing models. Appropriate figures and validation should be provided.

- (Nazemi & Wheater, 2015a, 2015b) provides an overview of existing challenges in large scale water management models. Those papers should be cited in the introduction to complement the authors identified challenges (the environmental flow) with other identified challenges.

- The supply models: The allocation of sectoral water demand to surface and groundwater systems as well as the sectoral return flow into the surface water system seems to be equivalent to (Voisin et al., 2017), which should then be cited. The description of how the supply is allocated to the different sectoral water demands needs to be specified in this manuscript. A missing description is how the priority is set between sectoral demands. For example , are thermo-electric plants getting their demand met first before domestic or irrigation demand? Is there any priority for supply allocation based on spatial location? Which grid cells can request water from a mainstream if the main channel is not within this grid cell? Was the Hanasaki et al. (2006) “dependence” database used? While authors indicate that it will be the subject of further research, what is the default implementation that was used in the presented simulations?

About the evaluation to support future studies;

- the introduction is missing a range of large scale studies where such a large scale water management model has been used with the VIC model, albeit not VIC5. While the proposed set up seems more complete, it seems that the paper should still cite those studies as they represent to a certain extent an earlier version of this integrated model (Voisin et al., 2017; Voisin et al., 2018; Zhou, Voisin, Leng, Huang, & Kraucunas, 2018)

- The overall evaluation of the model is limited to continental sectoral water withdrawals. The model is expected to be used in large scale water-energy-food nexus numerical experiments, yet there is no evaluation of the terrestrial water storage with respect to GRACE as performed in other equivalent models valuations, or in flow (Yassin et al., 2019), or in supply deficit metrics as “accounting for supply from unsustainable sources” (Döll et al., 2012) or as unmet demand (Voisin et al., 2013), which allows to evaluate the overall performance of the sectoral water management model.

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