

Response to Anonymous Referee #1: Interactive comment on “Evaluating impacts of climate change on future water scarcity in an intensively managed semi-arid region using a coupled model of biophysical processes and water rights” by Bangshuai Han et al.

We are working on the manuscript revision, but we want to respond to the comments received. We would like to thank the referee for the helpful comments. Our point-to-point response to the reviewer’s comments is described as below.

Comments: The analysis is conducted starting from the outputs of 11 GCMs from CMIP5 run under RCP4.5 and RCP8.5 scenarios, which are bias-corrected and downscaled (by the authors or by others?)

Response: The GCMs were downscaled and bias-corrected to observed patterns in the Northwest U.S. by John T. Abatzoglou of University of Idaho (Abatzoglou, 2013). We cited this literature in the text (Line 249).

Comments: The manuscript need a deep reorganization. I suggest the following actions: 1) Section “2 – Methods” currently includes 6 sub-sections/sub-sub-sections, that are a mixture of models, data and study area description. Description of datasets is split among sections 2.1.2, 2.2, and 2.4, but datasets are not “methods”; description of models and methods is split among sections 2.1.1, 2.2 and 2.3; the study area is described in section 2.5, but again the study area is not a method. I suggest to reorganize the presentation putting together coherent information: e.g. merging the material disseminated in Section 2 into three Sections: “Methods/models”, “Study area”, “Dataset”.

Response: Thank you for the constructive suggestion for the reorganization. Our original intent was to focus more on the method, and just use the study area as an example. We tried to let readers focus more on the method itself instead of the study area as we believe this approach is applicable in many other regions. However, **we strongly agree that the organization led to confusions and appreciate the help with the reviewer.** We will reorganize the method section and split it into three sections in the revision as suggested by the reviewer: Methods/models, Study area, Dataset.

Comments:

2) Section “4.1 - Adopting stochastic weather generators with GCM output” (within Section 4 “Discussion”) is not a discussion! There is nothing new: it is a sequence of well-known and obvious considerations. It can be removed.

Response: Thank you for the suggestion. We will remove most part of this section, and reorganize the discussion to focus on one important piece that motivated our study: our method avoids deficiencies of using a single GCM or a simple mean of multiple GCMs that may lead to biased future projections, and avoids the deficiencies of limited number of GCMs that cannot provide enough reliable daily climate data for hydrologic models. Due to the wide application of using an individual GCM in daily hydrological/ecological modeling studies, we believe it is important to emphasize this and alert people to think about the issue.

Comments:

Section “4.3 - Future work” (within Section 4 “Discussion”), where they declare their plans for the future. It is not a discussion and I suggest to remove the section.

Response: Thank you for the suggestion. We will remove this part in the revision.

Comments:

4) As a general rule, I suggest the authors to avoid fragmentation of the information since it create confusion and the reader is lost. At the same time, be sure to give as soon as it is possible important information and complete explanation. E.g. I read in the Abstract that the study area is the Treasure Valley, but to discover where it is located I must read the first 19 pages, and even reading the whole paper I did not find the extension of the study area! This is an important information!

Response: Thank you very much for the suggestion. Again, our intention to focus more on the method might have led to the confusion. We will revise the manuscript throughout the make the organization more fluent and easy to read. Also, we will specifically point out that we have a companion paper published in HESS for readers to learn more about the study area (Han, Benner, Bolte, Vache, & Flores, 2017).

Comments:

5) “Socio-hydrological model” and “Socio-hydrological system”. In many part of the manuscript the authors claim they applied a socio-hydrological model/system. I did not find any part of the paper dealing with socio-hydrology, with the exception of Section “4.3 - Future work” (within Section 4 “Discussion”), where they declare that in the near future they will consider also the population and social aspects. I understand that the words “socio-hydrology” are nowadays appealing, but cannot be used in the context of the analysis and methods of this work. Remove any reference to “socio-hydrology”!

Response: Thank you very much for the suggestion. We apologize for not being able to clearly explain the social part of the model. It IS definitely a socio-hydrological model, as local water rights and management algorithms were built in. We elaborated the hydrological model in a companion paper (Han et al., 2017), and avoid repeating in this paper. However, we will add a few sentences in the method part in the revision, and also guide readers to our companion paper.

Comments:

Introduction. There is a long discussion on stochastic weather generators from page 5 to page 7. At the end of page 7 (line 149) the authors declare they have applied the WXGN model: I would have expected a reference here! Then in Section 2.1.1 (page 8) there is another list of references of stochastic weather generators and finally in page 9 it is declared the model used! This is another example of fragmentation. Please keep the state-of-the-art in the Introduction and then in the section “Methods” describe the used methods! This makes also clearer if the authors are using something developed by them or by others.

Response: Thank you very much for the suggestion. We will revise the introduction accordingly and go through the manuscript to avoid fragmentation.

Comments:

Section “2.1.2 – Climate change scenario design”. There is a lot of confusion here. Under CMIP5 the word “Historical” is used for GCMs runs in the historical period from 1850 to 2005 (then extended to 2012) forced by “observed” atmospheric composition changes. In line 207 I read: “1) Historical: This scenario group evaluates a 30-year historical period as a baseline”. Immediately I annotated “which period?”. Again I had

to read other two pages and move to Section 2.2 to understand that the authors use the words “historical scenario” to refer to a single station time series at the “Boise Air Terminal weather station from 1980 – 2014”. I suggest to avoid to create confusion using improperly the word “historical scenario”. The way it is presented in section 2.1.1 is misleading: “1) Historical : : :” in line 207, “2) RCP4.5 : : :” in line 209 and “3) RCP8.5” in line 215. Anybody with a basic knowledge of CMIP5 experiments will interpret the first scenario as a run with observed forcing that stops in 2005 (or 2012) and the RCP4.5/ RCP8.5 as run with prescribed radiative forcing starting in 2006 (or 2013) : : :.

Response: Thank you for the suggestion. We will change the name of the “Historical” scenario group to “Observations”, as those data were developed from local weather stations. Hopefully, this will avoid the confusion to readers.

Comments:

Clarify which 30-year period (line 207) is considered for observations and for RCP4.5/ RCP8.5 run. For observations there are contradicting information, e.g. see line 244 (1980-2014, i.e. 35 years), line 390 (1981-2014, i.e. 34 years). For RCP4.5/RCP8.5 it is not clarified.

Response: Thank you for pointing these out. We will clarify the simulation periods. The 30-year period is not accurate for 1981-2014. For RCP4.5/8.5, the period is from 2071-2100.

Comments:

Abstract: lines 28-30. “Three climate change scenario groups : : :”. Considered climate change scenarios are only 2: RCP4.5/ RCP8.5. This comment is also related to previous comment #7.

Response: Thank you for pointing these out. We will revise the wording.

Comments:

Line 237: “Latin Hypercube Sampling”. Put a reference.

Response: Thank you. Reference added.

Comments:

Line 238: “This data 210 sets : : :”. Apart for the language, why this “unusual” number? Only reading some other pages I was able to reconstruct where this number come from : : :

Response: This is another place we will revise to avoid fragmentation. The number of datasets created were explained later in lines 298-303. We will explain this earlier to make sure readers understand it.

Comments:

Line 251-253. Why making reference to 20 GCMs if only 11 are used? This create confusion, just refer to the 11 used.

Response: Thank you. Agreed.

Comments:

Line 268-272. There is no need to explain how to compute the 25th and 75th percentile in a sample. Specifically this is the Hazen plotting-position formula.

Response: Thank you. Agreed.

Comments:

Lines 287-288: “the LHS approach equally divides the range of each variable into M (here, M = 10) probable intervals”. LHS intervals must be “equally probable”. Equally dividing the range of each variable will produce intervals with different probability. The partition is usually made using the CDF and equally dividing the CDF co-domain (0,1).

Response: Thank you for raising up this concern. In our case, we specifically equally divided the range to ensure that values with relatively low probability of occurrence will be also sampled so that we do not ignore important climate change signals in limited number of simulations. This was mentioned in Line 291, but we will do a better job explaining it to the reader.

Comments:

Line 321. I would have expected to find a reference for HBV.

Response: Thank you. A citation will be added in the revision.

Comments:

Line 490 and following, Figure 6 and 7: “acre-feet”. Please use metric units! This is in general better, moreover HESS is an European journal. Why not using e.g. mm/yr as in Figure 8 and 9, which display the spatial distributions of the same variables?

Response: Thank you for the suggestion. We will convert all units into metric units.

Comments:

Caption of Figure 6: “: : . (Line figure. Show mean, and 85% and 15% range for each scenario group)”. I do not understand.

Response: Thank you for pointing this out. This was a misplaced sentence during manuscript preparation that was supposed to be removed.

Comments:

Legends of Figure 8 and 9 are not readable.

Response: We will re-draw these figures in the revision.

Citations:

Abatzoglou, J. T. (2013). Development of gridded surface meteorological data for ecological applications and modelling. *International Journal of Climatology*, 33(1), 121-131.

Han, B., Benner, S. G., Bolte, J. P., Vache, K. B., & Flores, A. N. (2017). Coupling biophysical processes and water rights to simulate spatially distributed water use in an intensively managed hydrologic system. *Hydrology and Earth System Sciences*, 21(7), 3671.