Response to Anonymous Referee #3

The paper “Coupling biophysical processes and water rights to simulate spatially distributed water use in an intensively managed hydrologic system” by Han et al. presents a modelling framework to integrate water rights allocation into a hydrologic model capture the spatial distribution of irrigation water diversion in semi-arid basins in Western US. Agricultural irrigation is the largest water consumption, but the socioeconomic and institutional factors affecting irrigation behavior are generally not well represented in hydrologic models. This paper provides an effort to better representing anthropogenic factors in biophysical models and will provide insights on how better water use regulation will support sustainability of water resources management. The paper is well written and the results are clearly presented. I would suggest a minor revision to the manuscript. Below are some specific comments:

Response: We appreciate the positive feedback from the reviewer, and are very happy to respond to the specific questions below.

In Line 292, how is water diversion water loss handled in the model? Is diversion water loss added to soil or groundwater or river near the diversion channel? Speaking of irrigation return flow, will the water loss be considered as return flow? Due to the significant amount of water loss (60% of diverted water), more details are needed. This would also provide important information about how irrigation efficiency will affect water allocation and stream flow.

Response: Water loss is a very complex issue related to seepage along the canals, evapotranspiration, direct flow back to streams etc. The model has no way to capture those details, nor do we have observational data to support the simulation of those water loss details. As such, we took a simple approach by assigning a lump-sum coefficient to reflect the whole water loss. The “lost” water is still applied to the irrigation land, so that it can either evaporates or infiltrates. Part of the infiltrated water will be routed to the stream based on the HBV model. In this way, we are able to capture the diversion rate from the stream correctly. As such, the actual spatial allocation rate in the farm land will be in a smaller scale than the simulation result as part of the water is lost along the canals before arriving at the farmlands. We will include the relevant information in our revision.

In Line 190, the land use and land cover in 2011 is used for the whole simulation. Does the irrigated crop area vary significantly during the simulation period?

Response: Thank you for pointing out this important issue. For this study, we temporarily used the 2011 land use data for the whole simulation. There is certainly land use change over the years, but for the 8-year simulation period, the change is not significant. Our next step is to project the future water use until 2100, and land use change will be a key factor to consider in the long run.

In Line 294 - Line 306, the irrigation requirements are satisfied based on the seniority of water rights. It would be interesting to see the model results on the allocated or unsatisfied water from different water rights seniority groups. For example, how much water is demanded and actually diverted for different water rights seniority groups? Will senior and junior water rights holders will be affected in wet/dry years? Since the model is unique in representing the water rights, how water is actually diverted to different water right seniority groups would provide important information for water resources management.

Response: Thank you. We totally agree. The water rights that are shut off or suspended are very important factors to inform stakeholders. In the current work, we are not able to fully capture those information, but we are trying to have more parameters summarized in our future work.

The unit of y axis in Figure 5 is misleading. The blue color is for discharge rate (mˆ3/s), while the red line is discharge volume (mˆ3). Is it possible to represent the simulated and observed irrigation water in a same unit?

Response: We apologize for this mistake. All the reviewers have pointed out this issue. We will address it in the revision.

The black dash line of Black Canyon Irrigation District in Figure 8 is difficult to capture. In addition, the average annual allocated irrigation water is some places are more than 1000 mm/yr, or even more than 1500 mm/yr. It seems to me the irrigation amount is quite big. Will farmers in these regions apply some much water in the fields?

Response: Thank you. We will change the way how the Black Canyon Irrigation District is reflected in the revision.
With regard to the allocation amount, the number is higher than actual value. The reason is that part of the “loss” water is applied to the farmland. This problem has been answered earlier above.

Farmers’ irrigation behaviors are affected by many factors, such as irrigation technology, insurance, farmer’s preference on profit/risk. Although these are beyond the scope of this study, the authors should briefly discuss it and cite some existing literature on how farmers’ behavior affect the hydrologic systems.

Response: Thank you. We will add discussions on the complexity of farmer’s decision making in the revision.