

Hashemi et al. present a modeling study of potential climate change impacts on groundwater resources in an arid basin in Southern Iran. While, the methodology they employ is not new, the authors present results for an area that has not been previously studied. The results are relevant for regional planning purposes because the authors directly consider groundwater management practices in the basin. While I feel that this study would be of interest to the readers of HESS, in my opinion the manuscript need significant work before it will be ready for publication. The writing needs improvement and the presentation of the methods is incomplete. As a result, the paper can be hard to follow. Also, I think that the results and discussion need to be significantly expanded to thoroughly evaluate the findings. It's not clear to me from the results that there are significant climate impacts and I'm not convinced that the delta method is appropriate for making statements about future flood frequency. However, the authors still conclude that climate impacts will be 'serious' and that the 'number of floods might increase'. In my opinion, the conclusions should be reconsidered and the results section should be revised to more clearly support the conclusions.

Specific Comments

1. In find the title to be misleading because it implies that this paper will present a new modeling approach. However, the focus of this work is really climate change impacts to a specific basin and not validating a new method that can be applied to arid areas in general.
2. The distinction between the effects of management changes and climate change is not clear. I think the authors need to do a better job of isolating these two perturbations to their system and explicitly comparing the impacts of climate relative to changes in pumping and recharge areas.
3. In my opinion, section 2 needs to be rewritten. It is not clear to me whether the point is to summarize the primary groundwater impacts of climate change in arid environments (as the third paragraph and the title would suggest) or to summarize available modeling tools. If the point is to summarizing the findings of others, then this section should be organized around the types of impacts observed and the places people have seen them. Also, in addition to the studies that are discussed in detail, the authors should provide a summary of impacts and the physical mechanisms behind them. If the point is to review potential tools, then the discussion should contrast different modeling approaches and discuss the strengths and weaknesses of each approach in this type of environment. I think both discussions could add to the manuscript but it would be a good idea to split this section in two so that it is clear.
4. This study relies on a single GCM the Canadian Global Coupled Model. While I understand the need to keep the number of simulations manageable, I think the authors need to justify the choice of a single GCM more thoroughly. For example, how do the deltas derived from this model compare to the suite of CMIP3 projections? At a minimum, the authors need to expand on the discussion to explain that this is just one GCM and that there can be significant variability between GCMS.

5. There is no discussion of uncertainty in this paper. The authors present these results as their prediction for the future, but they do not address the fact that this is just one GCM. Ideally, the authors should compare multiple models. However, even if this is not feasible a more rigorous discussion should be added to address this point.
6. The use of the Baba-Arab station as a surrogate for the study area needs to be better justified. For example, is the precipitation equal for these basins?
7. Section 3.4 is hard to follow. I think it would be helpful if to start of with an outline of what data is needed and why before getting into the details. Also, I would consider moving the data discussion after the description of the modeling approach.
8. The spatial element of this work is really unclear to me. How many observation stations are there in the basin for precipitation and temperature? Is it assumed that the climate variables are constant over the domain? If not how do they vary spatially?
9. Section 4.2 also needs a better introduction. Rather than going back to the motivations for modeling and the potential climate change impacts, I think the authors should outline the approach that is taken here and the general goals for the modeling exercise. This would be a good point to reference Figure 3.
10. The models are not well described. I think there needs to be additional documentation on the equations used by the models, the assumptions that are made and the way information is passed back and forth. Also, the description of the domain is lacking any mention of total extent, spatial resolution and boundary conditions.
11. I am concerned about the statements made about future flood probability. The delta approach does not capture changes in weather patterns and drivers of extreme events. Of course, if you are scaling precipitation there is the potential for more rain events that cross a 'flood' threshold, but this is not the same as predicting an increased likelihood of extreme events. The authors conclude that, "more intense rainfall will occur in both future periods" (11815, 6). With this methodology I think you can conclude that it will be wetter in the future. However, you cannot say anything about how the precipitation will be distributed within storm events.
12. In my opinion, the results and discussion sections are weak and need to be significantly expanded. Essentially the results for the entire paper are presented in a single figure (Figure 7). There is no discussion of the differences between the climate change scenarios or quantitative comparison of climate change impacts and management scenarios. Also, Figure 7 only shows the first future period, there is no presentation of the second future period. The tables are helpful, but I think there could be additional graphical analysis of the differences between scenarios.
13. Throughout the paper it is noted that all of the groundwater recharge results from flooding. However, it is not clear how floods are simulated in the model. Does the inundated area and total recharge change with precipitation rate?

Technical Corrections

Abstract:

- 11798, 7: Define HBV
- 11798, 13: What do you mean by 'might increase'? Do you mean 'are projected to increase'?
- 11798, 3: Delete 'a' before 'proper'
- 11798, 15: This is confusing because in the last sentence you said that the number of floods will increase but here you are saying that there is no recharge impact?

1. Introduction:

- 11799, 9: Insert 'an' before 'increase'
- 11799, 13: 'no change or noticeable decrease and increase' is confusing, reword this sentence.
- 11799, 16: Delete 'The' before 'climate'
- 11799, 18: What 'economic situation' are you referring to? This is the first time economics are mentioned.
- 11800, 2-5: This is confusing. I do not understand how you 'apply projected recharge periods' to a hydrologic model. Do you mean you are only simulating these periods with they model? Also please define what a recharge period is before you discuss it.
- 11800, 7: Define 'ETP' before you use it.
- 11800, 7-9: I do not understand what this sentence is saying. In the previous sentence you say that groundwater impacts from climate should be indirect. However here you say that because of this you need integrated models? What 'above processes' are you referring to? Do you mean the hydrologic processes like runoff and ET or are you talking about climate processes?
- 11800, 12: 1% of what?
- 11800, 20: Should be 'flash floods' not 'flash flood'
- 11800, 27: What complex natural processes are you referring to? I found this discussion to be vague and I think that it would be improved by adding a paragraph to explicitly walk through the physical interactions and processes that you are alluding to.
- 11800, 28: The last sentence of this paragraph does not make sense. What do you mean by 'acquisition of land use changes'?

2. Review of climate change impacts on groundwater resources

- 11801, 7: Define 'GWL' before you use it.
- 11801, 23-24: Explain why this is the case.
- 11801, 25-26: Where did this study take place?
- 11802, 21: Cathy and ParFlow are two other examples of integrated models that should be included in this list.
- 11802, 26: 'the most substantial effect' compared to what?

- 11803, 1: I doubt that Klove et al. (2013) were the first to connect groundwater models with downscaled GCMs. The way this sentence is written it sounds like you are crediting them with pioneering this approach.
- 11803, 4: What do you mean by couple modeling and why is it appropriate?
- 11804, 1: Define 'local-scale'
- 11804, 5: Explain what you mean by 'coupled one-way'. What variables are being passed?

3. Description of the study site and observation data

- Figure 1 is not sufficient. I think you need a map that outlines the domain in addition to showing the location of all observations points, the recharge basin and the surface water bodies referred to in this section.
- 11805, 17: Define 'FWS' before you use it.
- 11805, 20-21: Reword 'which then the'
- 11805, 26-27: Over what period of operation did this decline occur?
- 11807, 15-7: I still don't know what you mean when you say that the 'GW recharge model only works with the flood periods'.
- 11807, 26: How are the aquiver hydraulic parameters estimated?

4. Methods

- 11808, 10-11: What do you mean when you say, "all future GCMs output data were assigned for the two twenty-year periods"?
- 11808, 18-19: This sentence is unclear. Are you saying that you will have 365 values for each of the 36 grid cells?
- 11808, 22: Where is this data collected and how many stations are there?
- Figure 3 needs improvement. I suggest having different shapes or shading to differentiate between, models/tools, datasets and actions.
- 11810, 11: 'intention' not 'intension'
- 11810, 14: Please explain GMS.
- 11810, 27: What is your definition of a 'flood event'?
- 11811, 2: What is the 'recharge parameter' and how exactly is it used?
- 11811, 6: reword 'recharge is taken place'
- 11811, 22: How is groundwater abstraction modeled in your setup?
- 11811, 27-28: What do you mean by 'in order to consider the efficiency of the system'?

5. Results

- 11812 19-20: This sentence is confusing, please reword.
- It is really hard to see the differences in Figure 4. Perhaps add the deltas to this figure.
- 11813, 16: Why are you reporting the temperature changes as percentages? I though the deltas for temperature were additive not multiplicative.

- 11816,1: From Figure 7 it looks like the starting water table levels for the future scenarios match the 1993 levels (~1143) not the 2010 levels. Is this correct?
- Figure 7: The titles should say recharge 'areas' not 'sources' to be consistent with the text.
- Figure 7: Where are these groundwater levels taken?
- 11816 27-28: This sentence is confusing, please clarify.

6. Discussion

- 11817, 6: What do you mean by 'mainly a one-way coupling'? What aspects of this are not one-way? This is something that could be made clear in a revised version of Figure 3.
- 11817, 14-15: What is the difference between a 'significant' increase and a 'slight' increase. Please clarify what you mean here.
- 11817, 19-20: I'm confused throughout this section on whether the climate impacts are serious or not. Earlier you say only slight, insignificant changes, but here you are saying serious. What classifies as a 'serious' impact? Also, I would like to point out that this is just one model so saying that xyz 'will' happen seems to be a bit of an oversell. I would prefer climate impacts 'are likely to' or 'are projected' to rather than 'will'.
- 11817, 21: 'events increase', not 'event increases'
- 11817, 25: Tables 1 and 2 should be introduced in the results section.
- 11818, 14-16: This is a jump. I would delete this sentence.
- 11819, 3-5: This needs to be explained in detail earlier in the paper.
- 11819,5: 'results' not 'result'
- 11819, 16-17: Are you saying that all of your results are wrong because you can't reflect changes in GWL from recharge with numerical modeling?
- 11819, 18: There was no discussion of the model calibration. How did you determine that you model is 'well calibrated'?

7. Summary and Conclusions

- It sounds from paragraph 2 like you are saying there are no significant climate impacts. However in the abstract you present increased flooding as one of your primary findings.