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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Impacts of climate change under CMIP5 RCP scenarios on the streamflow in the Dinder River and ecosystem habitats in Dinder National Park, Sudan" *by* A. K. Basheer et al.

Anonymous Referee #2

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General comments

This paper is about the impacts of climate change on streamflow and ecosystems in the Dinder River basin in Sudan. Output of two General Circulation Models (GCMs) for two representative concentration pathways (RCPs), partly with two downscaling methods and three periods are used as input into a hydrological model. Although the topic is interesting and relevant for this journal, the paper is moderately written and does not really include innovative aspects. Impacts of climate change on streamflow have been assessed numerous times in the literature including more advanced analysis meth-

ods and larger numbers of GCMs, scenarios and hydrological models. The impacts of streamflow changes on ecosystem habitats would be an interesting direction and addition to this, but is only considered in a qualitative and sometimes even speculative way. The methodological set-up is straightforward, but does not enable the assessment of climate change impacts on ecosystem habitats (or at least impacts on water bodies relevant for ecosystem habitats). Impacts are evaluated at the river basin scale through streamflows, but for instance 'Mayas' (wetlands) are not explicitly incorporated in the hydrological model nor evaluated regarding impacts of climate change while they are important for flora and fauna. Another aspect related to the methodological set-up is the way downscaling methods are compared. These methods are only compared for rainfall and not for temperature and are apparently implemented in a different way in the hydrological model (i.e. for one method observed rainfall is used for the 'current' climate and for the other method bias corrected GCM output is used). Many other specific comments can be found below. Furthermore, the English writing style and grammar is weak to moderate (including several typos); examples can be found in the section 'technical corrections'.

Specific comments

1. P10159, L4-6: It is not clear in this sentence which system/ phenomenon is affecting another system/ phenomenon.

2. P10159, L6-9: Why is the maximum temperature only important for the current climate (or past climate changes?) and precipitation for climate change?

3. P10160, L15: Can the authors please explain how measurements can be used to evaluate the effects of climate change on natural resources?

4. P10160, L29-P10161, L3: Why are most hydrological models unable to simulate effects of climate change on hydrology? There are numerous examples in the literature showing the opposite. And why has SWAT been selected as hydrological model in this study? The SWAT model includes many parameters for different HRUs and sub-basins

resulting in a large number of parameters to be calibrated. Given the limited data availability and possibly also quality in this area, one might wonder whether a more parsimonious model isn't more appropriate for their modelling purpose (i.e. assessing effects of climate change on (mainly monthly) streamflow).

5. P10161, L22: Methods are described in sections 2 and 3. This should be more properly organised.

6. P10162, L3-5: The unit for the annual average discharge is not convenient and appropriate. BCM is a unit for a volume and not a discharge. In order to compare with other hydrometeorological fluxes it would be better to express the annual average discharge in mm/year.

7. P10162, L6: Is the 65% decrease correct? When comparing 1.9 BCM with 0.35 BCM I would rather expect a decrease of 82%.

8. P10164, L8-18: Several issues regarding the data used for modelling with SWAT: Is a DEM resolution of 90 m sufficient for an accurate catchment delineation? How have the rainfall data been interpolated? What are the resolutions of the land use and soil data? Do you have a reference for the soil data?

9. P10164, L22-24: Why have these two GCMs been selected for this study? Did these GCMs show good results for this area in previous studies? The choice for these two GCMs seems to be arbitrary, and given the large differences in simulated climate between different GCMs, I would expect more than two GCMs to be used in this study.

10. P10164, L24-26: Why have these two RCP scenarios been selected? RCP 8.5 is a very extreme scenario, but is as important as the more probable RCP 4.5 scenario in this study (although probabilities cannot be assigned to these scenarios). Why not including the other two RCP scenarios as well (RCP 2.6 and RCP 6.0)?

11. L10165, L9: Which method for surface runoff estimation has been used?

12. L10165, L13-14: How optimal is the solution? Did you check whether you really

reached a certain global optimum? How many iterations have been carried out?

13. L10165, L14-15: Which objective function (R2 or NS) has been used as calibration criterion?

14. P10165, L17: Why has the CF method been applied to both temperature and precipitation and the QM method only to precipitation? It would have been also interesting to compare CF and QM results for temperature.

15. L10166, L7-15: Have these adjustments been applied at the basin scale or sub-basin scale?

16. P10167, L6: Has the same period (1961-1990) been used to set up the CDFs for the observed precipitation as for the GCM simulated precipitation?

17. P10168, L3-5: How many sub-basins and HRUs have used in the SWAT model? Did the authors attempt to minimize the number of HRUs given that the discharge data of only one gauging station have been used for calibration (resulting in over-parameterization problems)?

18. P10168, L12-13: There has been a lot of discussion in the literature on the meaning of particular NSE values (and values of other objective functions). NSE values cannot be compared between different catchments, since the natural variability (i.e. variance of observed discharge in denominator of NSE formula) is different in different catchments. Consequently, it is easier to obtain high values for NSE in catchments with a lot of variability in the discharge compared to catchments with less variability. The authors should therefore avoid subjective terms such as 'acceptable performance' for the modelling behaviour.

19. P10169, L7-8: Do the authors have any idea why the MPI model predicted larger temperature increases than the CCSM4 model?

20. P10169-10170: The enumeration of temperature and precipitation changes on these pages largely replicates the contents of Table 3-5. The authors should have

rather used this space to discuss and explain the differences between GCMs, periods and scenarios.

21. P10172, L6-11: How realistic are the streamflow changes? For instance from 1.8 to 99.1 m3/s?

22. P10172, L23-24: Why do any changes in rainfall result in relatively larger changes in streamflow? Do you have any hydrological or hydrometeorological explanation for this?

23. P10173, L8: The effect of uncertainty due to hydrological parameterization on the uncertainty in streamflow is not included in this paper. Apparently, only one (optimal) parameter set has been used for streamflow modelling.

24. P10173, L10: I would expect the analysis of past changes in climate and streamflow before the assessment of climate change and climate change impacts on streamflow.

25. P10174, L11-14: It is not clear in these sentences what is compare to what.

26. P10175, L17-23: Spatial differences in temperature and precipitation changes across the river basin have not been discussed yet, while one would expect such a discussion earlier in the paper (and not in a section about impacts of climate change on ecosystem habitats). Spatial differences in impacts on streamflow might also be interesting to discuss, although such results from the SWAT model have limited value given the lumped calibration and validation of the model. Additionally, changes in intensity and maximum precipitation values haven't been discussed as well.

27. P10176, L18-21: This reasoning/ these statements are not supported by results found in this study and therefore are speculative.

28. P10176, L29-P10177, L2: These results have also not been discussed earlier (while you would expect them to be discussed earlier).

29. P10191: Why isn't the simulated temperature by both models for the baseline period included in this figure? That would enable a better comparison.

30. P10192: Why are the authors showing time-series of annual rainfall? Wouldn't CDFs for the baseline and future period be more appropriate and useful?

31. P10194-10195: Monthly values (changes?) cannot be really observed in these figures. It would be more interesting to see changes in the average annual discharge cycle (on a monthly basis) instead of these multiple annual cycles without reference to the baseline period.

Technical corrections (P = page, L = line)

1. P10158, L3: Recharge of what?

2. P10158, L15: More sensitive compared to which variables?

3. P10160, L3: What is the meaning of "On the other hand" in this sentence?

4. P10161, L5: ". . .explored . . . alteration."; this sentence is not clear.

5. P10161, L16-21: What are the contents of section 3? And "section 6" should be replaced by "section 5".

6. P10162, L9: "Abdel Hameed and Eljack, 2003" (in text) or "Abdel Hameed and Eljack, 2013" (in references)?

7. P10163, L21: What is the difference between a continuous and long-term hydrological model?

8. P10167, L6: "Willems et al. (2012)" is not in the reference list.

9. P10170, L28: "insignificant difference" instead of "insignificant change"?

10. P10171, L17: "two downscaling approaches" instead of "tow downscaling approaches".

11. P10174, L7: “Keddy (2000)” is not in the reference list.

12. P10176, L3-L5: This sentence is not clear.

13. P10185-10186: Tables 3 and 4 can be combined.

14. P10187-10188: “Quantile method” instead of “Qunatile method”. These tables might also be combined to enable a better comparison.

15. P10189: What are the contents/ is the purpose of the map in the top-right corner?

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 10157, 2015.