

Interactive comment on “Hydrologic impact of climate change on Murray Hotham catchment of Western Australia: a projection of rainfall-runoff for future water resources planning” by S. A. Islam et al.

Anonymous Referee #2

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The manuscript aims to assess the impact of climate change (CC) in rainfall and runoff from a catchment under two different CC future scenarios with and without CC mitigation action. A multi-scale (in space and time) assemblage of eleven Global Climate Models (GCMs) and a Hydrological model (LUCICAT) were used at first to construct future rainfall scenarios and then to predict catchment scale runoff as a result of the CC scenarios. The study was conducted in a large catchment in Western Australia (WA) with a strong spatial gradient (West-East) in mean annual rainfall inputs and land use changes. The site presents a wealth of data and strong spatial gradients across

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the catchment to investigate effect of CC on rainfall-runoff transformation. The authors used sound methods and made a great effort to prepare artwork with the relevant results. There is novelty in this work for publication but the authors failed to bring it up mainly due to lack of organization, identification of key results for discussion and the use of available information to the authors to show and discuss the effect of predicted future rainfall scenarios on catchment's runoff. General and specific comments for the authors to bring up the key findings and improve the current form of the manuscript for publication are presented below.

The Introduction section lacks of organization, excessive use of CC jargon and acronyms and too much focus on studies within Western Australia. The literature review is presented as a simple summary of previous work without a good connection to the objectives of this manuscript. To this reviewer surprise only one study in Australia (apart from those from WA) has been mentioned. It is hard to believe that no more work on CC impact on catchment hydrology has been conducted in Australian Eastern States. The objectives of the manuscript are well presented. This reviewer is concerned with the fact that the authors have already published some results (including Figure 2 presented here) in a conference paper and it is not possible to assess what is new in this manuscript. How different are they? The authors should respond to this issue.

The study site is not well described and lacks of soil information of relevance for the hydrological model (see specific comments below). The CC scenarios A2 and B1, the focus of the manuscript, are not fully presented to the readers until a later section on Data and methods. This should be presented up front. The Result and Discussion sections require more attention. First, there is an arbitrary selection of observed rainfall and runoff periods (at least not explained) as the historical time period is considered to be 1961-2000 with the 1981-2000 period called as recent. What happen with the data corresponding to 2000-2010? Is it also part of the recent climate? Secondly, lack of clarity and organization made it hard for the reader to follow. While the reader is

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directed to follow Fig. 7 and Fig. 9 for results, the authors present and describe results from Tables (5 and 6). Both Figures and Tables show the same results but presented in different units, why? The issue is found again towards the end of the manuscript as runoff quantities are presented in 'GL', 'percentage', and 'mm' and the base period for comparison and GCM assemblage changed from an initial period of 20 yrs (1961-1980) to a 10 yrs period (1961-1970) in Figure 13. Why? This issue needs to be addressed.

There is no critical discussion of results in this manuscript. Discussion should point out limitation of the approach, assumptions, and explain some of the remarkable and important results arrived by the authors. For example, Why is that a decrease of 23% in rainfall resulted in a 75% reduction in runoff? Where does the water go? The reader has not information on some of the key hydrological processes that may be responsible for the LUCICAT results. How is the air temperature changing for different CC scenarios accounted for by the hydrological model? Is the land use (particularly vegetation) changing for future scenarios? No supporting evidence for changes in hydrological processes for this catchment is presented for the discussion of the results. Why? The authors used a fully semi-distributed hydrological model accounting for internal storages, unsaturated-saturated zones and near stream hydrological elements and they clearly showed that LUCICAT captures runoff variability in space and time. The authors have sufficient detail and information to properly assess and explain what happened with runoff generation due to decreasing rainfall scenarios A2 and B1 but instead they have used previous research findings from no-representative catchments to support their findings (e.g. Silverstein et al. apply to 10% of the total catchment area of the Murray-Hotham catchment). Finally, the authors stated that "plausible causes" of runoff reduction for CC scenarios are rainfall amount, intensity, and absence of extreme events. This manuscript mainly showed that the reduction in rainfall amount impacted in runoff so Why is it a PLAUSIBLE cause? Please clarify. This reviewer considers that there is novelty in the work and the results are of importance not only for water resources planning in the area but also for water quality and stream ecology in the region and elsewhere. Publication is recommended after major revisions. The authors

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should consider the general and specific comments that follow.

Introduction: Page 12028, Lines 12-13: Arbitrary past climate scenario selection (1961-1980), Why?

Page 12029, Line 9: Missing relevant research work on drying surface water catchments in SWWA region (e.g. Petrone et al. 2010). Line 13: Please clarify that Darling Range catchments are Surface water Supply scheme.

Page 12030, Line 11: What is IPCC AR4 data? Lines 19-20: What are MRI-CGCM2 and CCSR/NIES/FRCGC-MIROC under the SRES A2 scenarios? Line 25: This is the first time that the reader knows that the A2 and B2 are high and low emission scenarios. This sentence should be placed before the CC models' review.

Page 12031, Lines 15-16: More jargon as above. Please clarify. Line 24: Charles et al. (2007) was already mentioned in Line 13 as a study of the CC's impact.

Page 12032, Lines 5-6: Too much detail by naming rainfall stations. The readers do not have info at this point in the manuscript on the stations whereabouts. Lines 13-20: The aim of the study focused on investigating the climate change impact on rainfall and runoff for a particular catchment using 11 climate model data and two emission scenarios. It seems that the only difference to previous studies is on the use of 11 models to provide input for CC scenarios. Please bring up the novelty of the work here: Why is this catchment selected for the study? Is it due to data availability? Why is this catchment important? How representative is this catchment of the SWWA? What kind of water management issue affects this catchment?

Page 12033, Lines 10-17: Catchment description focused only on climate characteristics. There is no enough information in relation to soil types and depth, topography and land uses yet all of them of relevance to the hydrological model.

Section 3. Data and methods

Page 12033, Lines 22-23: The reader needs information on what emission scenarios

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of A2 and B1 are. Please clarify.

Page 12034, Lines 1-10: Finally, the authors have explained scenarios here but a brief explanation on A2 and B1 needs to be placed in a previous section. Lines 20-21: What is the valid reference for the LUCICAT Model? Why is Charles et al. reference used here? Please clarify.

Page 12035, Lines 5-6: Remove the word “widely”. Two applications of the model are not enough for the claim. This reviewer suggests the use of “successfully applied” or “developed for Western Australian catchments”.

Figure 2: Is it the same figure from Islam et al. manuscript? If yes permission from the publisher is required to use here, please check Journal requirements. Also, what do the authors mean by “LUCICAT observed rainfall as output” model? Is the model converting/interpolating the rainfall time series? Why do the authors need to calibrate again LUCICAT when using the climate data? Please clarify. Why does the historical data period go until year 2000? What happens with the data for 2000-2010 periods?

Section 4. Results and discussion Page 12037, Lines 6-19: The text is just a summary of what follows and it does not add any relevant information to the manuscript. Please remove. Line 21: Do you mean runoff Ratio? (Runoff divided by rainfall) A rate involves time reference. Lines 22-24: Similar issue with the use of historical climate data for period 1961-2000. Lines 21-25: Figure 3 shows annual flow (GL) but the text refers to ‘runoff rates’. Please modify text or figures accordingly for consistency.

Page 12038, Line 8: Where is the 5.5 % mean difference of annual flow criteria coming from? Lines 8-9: Table 1 should present the length of the records for each station. Line 15: Remove Fig. 5 but leave the text regarding the R-square values. Lines 17-19: The authors stated “..In addition to annual flow, the model was also calibrated for daily flow..”. This is confusing. How many calibrations were performed? LUCICAT runs on daily time-step and calibration is done for daily flows. Monthly and annual (additive response of the model) does not require any calibration. Is this correct? Please clarify.

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Page 12039, Line1: Again, issue with the consideration of time period for recent climate base on observed annual rainfall. Data up to 2010 is available and presented by the authors. Please clarify. Lines 19-21. Rewrite the sentence to avoid repetition of “part of the catchment”.

Page 12040, Lines 25-28: What follows is a description of spatial distribution of mean annual rainfall. This section should be presented in the catchment description (for example after the temporal distribution of rainfall).

Page 12041, Lines 10-11: Rewrite. High rainfall does not disappear “from the Figure” but from “the catchment area”. Lines 26-28. What does ‘ile’ stand for? Please clarify. What follows is also confusing as high rainfall (magnitude? or probability of exceedance?) is defined as > 50% ile. In a PAE plot high rainfall has the lower probability of exceedance (similar that Flood frequency analysis). Please clarify. The complete section needs improvement and better discussion for the differences between scenarios particularly for the Figure panels c-d and g-h.

Page 12042, Line 16: Missing verb in sentence (was observed). Similarly for Line 22. Line 20: Discussion about reduction in percentiles of annual runoff begins here without presenting those particular results. Fig. 10 is about annual flow in GL. Please modify accordingly.

Page 12043. This section is hard to follow and the reader is presented with flow quantities and percentiles and the use of short sentences which does not help to get the message across. Please rewrite.

Page 12044, Line 10: What do the authors mean by “some medium runoff areas falls into upper middle part”? Please clarify. Also, why did the authors change the units for runoff? This section now deals with runoff expressed in “mm” unlike previous sections (percentages and GL). Please be consistent with the units. Similar issue appears in Line 15 for rainfall amounts (reduction in percentage and in mm).

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Page 12045, Lines 3-5: Check grammar for missing verb.

Page 12046, Lines 8-15: The authors brought into consideration important research for SWWA in relation to storm pattern changes responsible for reduction in rainfall. Then, they speculate that plausible reasons of reduction in runoff could be the reduction in rainfall quantity.... WHAT! The whole manuscript is on how reduction in rainfall amount leads to reduction in runoff. Please clarify. Line 13. What do the authors refer to by using 'the ramification of these three events'? Please clarify. Lines 20-25: The Silberstein et al. work was conducted mostly in forested catchments of the SWWA which results are only relevant to the 10% of the total area for the Murray-Hotham catchment. It is not clear what the authors try to achieve by including this discussion here. Please clarify.

Page 12047, Line 4: Arbitrary change for the base time-period for comparison. Why? Please clarify. Line 7: What do the authors mean by reduction in time scale? Please modify sentence accordingly. Lines 14-15: The section focused on future projections so speculation on what caused the low runoff between 1980-1990 is not relevant here. Please modify. Lines 15-to end: This section presents the same results than a previous one but now on decadal time scale. What is the purpose? How and why is it relevant for water resources planning for this catchment? This needs to be clarified.

5. Conclusion.

Page 12049, Line 8: The authors assessed only the impact of CC on rainfall-runoff for Murray-Hotham. This reviewer argues that "water resources" have a much broader meaning.

Lines 11-13: This sentence is not a conclusion, is it? This section is just a summary or abstract of the work. Where are the conclusions of this work? Please rewrite it and clearly highlight what are the relevant findings of this work and its implications for future water management in the area. Can we use this knowledge elsewhere? How? How to overcome main obstacles in conducting this kind of research? Please modify the

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section.

Tables and Figures.

Table 3. There is no indication in the manuscript on what the errors on water balance and flow period indexes represent. A value of -0.07 for water balance, what does it mean? The same applies to EI. Please clarify in the manuscript or as a footnote in the table.

Figures 4 and 5 present the same data in different plots. Please remove Figure 5 as Figure 4 clearly shows good performance of the model and tracks the decline in runoff.

Figure 6. Panels a-d should be presented for the same year (e.g. 1988) for all catchments for comparison. Please modify for consistency.

Figure 8. It is ok but needs some changes to improve readability. Add the text "A2-Mid" and "B1-Mid" and A2-Late B1- Late. Also change the colour bar scale for panel k and scale from -40 to 0.

Figure 13. This figure really adds little to the manuscript. Why is the base period for comparison changed again (1961-1970)?

References. The list of references is too long, sixteen manuscripts on CC for Western Australia are listed. Please leave only the most important and relevant references for this work. Conferences proceedings that are not accessible to the readers should be removed.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 12027, 2013.

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