Hydrology and Earth System Sciences Discussions

Hydrol. Earth Syst. Sci. Discuss., referee comment RC1
https://doi.org/10.5194/hess-2022-199-RC1, 2022

Comment on hess-2022-199

Anonymous Referee #1

Referee comment on "Regional significance of historical trends and step changes in Australian streamflow" by Gnanathikkam Amirthanathan et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-199-RC1, 2022

Summary:

Reviewer comment: This manuscript uses statistical tests to show the historical trend of the streamflow in Australian, which is intriguing. The results would be useful for the future study to learn how climate change, evapotranspiration, rainfall pattern or other factors affect the streamflow pattern.

Author response: *We thank the reviewer for their appreciation and acknowledgement of the results of our paper. We will address all the comments by the reviewer as described below.*

Major Comments:

Reviewer comment: For several statistical tests, the 0.1 of P value were used. Nowadays, many research use p value of 0.05, could you give us more detail or explanation why 0.1 has been used.

Author response*: We thank the reviewer for asking for an explanation of using p values of 0.10 instead of 0.05. While a p value of 0.05 or less would be preferable for a strong statistical significance test, a p value of 0.1 has also been commonly used for similar studies (e.g. Sagarika, et al., 2014). Further, in our previous paper, published on the Australian Hydrologic Reference Stations, for all the flow variables, a p value of 0.1 was used except for the annual total flow, where p values of 0.01, 0.05 and 0.10 was considered (Zhang, et al,.2016). In this paper, we decided to use p value of 0.1 for all the analyses, considering the brevity, consistency and content and size of the manuscript.*

Reviewer comment: Line 675, "abrupt shift in streamflows across water year", it would be better to show how abrupt percentage is based on the region (spatial) and year (year), like in Table.

***Author Response**: This is an interesting suggestion and we have investigated this further. We have calculated the % change in annual total volume (average of the number of catchments within a division), as shown in the table below. The result presented in the table is for the editor/reviewer benefit only and we do not intend to include it in the paper for two reasons. First, when the mean change in streamflow is presented in this way, it may suggest that the change represents the whole region (division), however in reality the change is only on those HRS stations where a change was detected. Second, the respective year of a detected step change (for a specific station) varies, so it can be misleading to refer to a given mean step change, as this will have occurred over several years, and is not as abrupt as suggested.*

Table X. Annual total volume shifts in different drainage divisions

Drainage division	Drainage division	Water-year		
		% Shift		Median year of shift**
		Mean drop(-)/rise(+)	Std. deviation	
I	Northeast Coast (10/66)*	-45%	8%	1990
II	Southeast Coast (83/138)*	-49%	13%	1992
III	Tasmanian (9/25)*	-33%	10%	1986
IV	Murray-Darling (96/133)*	-54%	16%	1996
V	South Australia Gulf (5/3)*	-52%	9%	1997
VI	Southwest Coast (32/50)*	-54%	11%	2000
VII	Indian Ocean (1/10)*	-85%	--	2000
VIII	Timor Sea (12/21)*	77%	21%	1996
IX	Gulf of Carpentaria (1/10)*	120%	--	1998
X	Lake Eyre (1/4)*	-89%	--	2003
XI	North Western Plateau (0/2)*	--	--	--
XII	South Western Plateau	--	--	--

Note: ( ) refers to (number of sites with sig. shift/total number of sites in the division). These %change only represent the average of the sites and do not represent the basin.*
*** The median year of shift is given for sites with significant shifts and the year of shift varied within each drainage divisions.*

Reviewer comment: How does the long drought or extreme event affect the statistical test, like linear trend? E.g. after the long drought years, will it become increasing trend?

Author Response: *We thank the reviewer for this question. However, we used Theil–Sen estimator to compute the trend of the slope, which is generally insensitive to outliers. Therefore, this estimation of trend slope is not affected by extreme events (outliers). However, the level of statistical significance derived from performing MK test may be impacted due to extremes. Investigating the effect of long drought and extreme events on the statistical tests is an interesting and intriguing question and needs further investigation, which we consider out of scope of this paper.*

Reviewer comment: I recommend have a table or paragraph to show the raw data format like time interval, and explain how to deal with the raw data (take out extreme abnormal data, delete zero value). This is really important input for the following statistical tests.

Author Response: *We thank the reviewer for asking the details of data quality control process used in this study. Most of the gauging stations, included in the Hydrologic Reference Stations, are of high quality, with generally less than 5% missing data across the entire record. A quality-assurance, quality control (QA/QC) process was applied to observed time-series of daily streamflow from each gauging station. This process identified and removed erroneous data values such as negative and outliers, and periods of long linear interpolation. The process of detection and removal was automated and then checked manually. The website (http://www.bom.gov.au/water/hrs/references.shtml :Hydrologic Reference Stations update 2020) has details about this process. However, we will add a few sentences referring to this information available in the website.*

Reviewer comment: Climate change could make extreme events more often, but it could be possible that the average yearly precipitation will not change. In this case, it might have increasing trend for the wet season, decreasing trend for the dry season and no trend for the annual basis. Do you find any station having this similar situation?

Author Response: *We thank the reviewer of this interesting hypothesis and question. It is possible that seasonal and annual streamflow data from some stations may show these trends. However, we have not analysed data to test this hypothesis and this warrants further research. We consider this to be out of scope for this paper. However, we will add a short discussion of this issue in Section 5.3 and identify it as future research (Section 5.4).*

Minor Comments:

Reviewer comment: Line 39, please add reference to support the statement

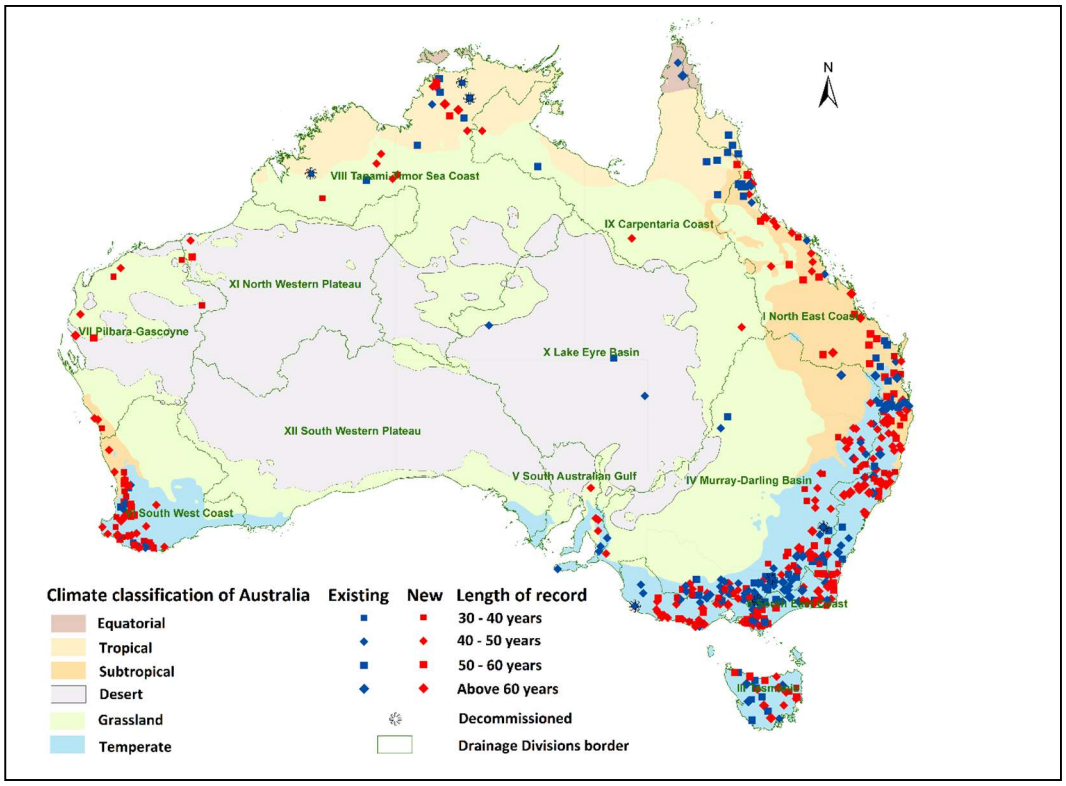
Author Response: *We thank the reviewer for noting this point. We will include a new reference (Bureau of Meteorology, 2022).*

Reviewer comment: Line156, 23,2846 km separator is wrong. It should be corrected to

Author Response: *Apology for the typo error, will be fixed > 232,846*

Reviewer comment: Figure 1, north arrow is missing

Author Response: *Apology of the omission, it is now fixed, please see below. The updated figure will be included in the manuscript.*



Reviewer comment: Line 409, how do you convert GL/year to mm/year:

Author Response: *We used a formula to convert GL to mm > 1 GL/year = (1000/A) mm/year; where A = catchment area in km^2. We will mention this in the manuscript.*

Reviewer comment: In section 4.2, the authors mention the Figure 3 (*Table 3*) several times. Did you mean by Figure 5 (*Table 5*)?

Author Response: *Thanks for this comment. We have closely looked at all refences (for both Tables and Figures) and found that Table 5 was wrongly refenced as Table 3 several times. We have now corrected this. However, we could not find Figure 3 or 5 mentioned wrongly.*

Reviewer comment: Line 706, where is the Figure 14?

Author Response: *Apology for the typo error. It should refer to Figure 10, this will be fixed.*

Comment on hess-2022-199

Nir Krakauer Referee #2

Referee comment on "Regional significance of historical trends and step changes in Australian streamflow" by Gnanathikkam Amirthanathan et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-199-RC2, 2022

Reviewer comment: This work presents trends in annual and seasonal mean streamflow since 1950 across an expanded Australia-wide network of reference gauges. It was found that streamflow has mostly decreased, which can be thought of as a step change in the 1990s, except for some areas in the far north that saw increasing streamflow. The authors highlight the widespread interannual persistence of streamflow anomalies in Australia, and make use of statistical trend tests that account for autocorrelation. This is a valuable contribution and in my view should be published, subject to minor revisions.

***Author Response**: We thank the reviewer for positive comments and finding our manuscript suitable for publication by HESS. We addressed all the comments by the reviewer as described below.*

Reviewer comment: There are a few unclear sentences, such as at line 383: "The main objective is to assess whether the number of locations with significant trends occur at a regional scale or not" and line 540: "It is least sensitive to outliers, and skewed distribution makes it most suitable for the analysis of streamflow data". These should be rephrased. In general, some proofreading is needed.

***Author Response:** We thank the reviewer for the comment. We will modify the text in line 383 (now line xx) as "The main objective is to assess whether a certain minimum number of locations with significant trends occur at a regional scale to make it field significant or not". We will also modify the text in line 540 as "As annual streamflow has a skewed distribution, and may have outliers, this non-parametric test, which is least sensitive to these characteristics, is well suited for change point detection".*

Reviewer comment: In general, some proofreading is needed.

***Author Response:** As suggested by the reviewer, we have undertaken proof reading of the entire manuscript and made editorial changes as required.*

Reviewer comment: The terminology "linear trend" is confusing at times (e.g. Section 3.1), as the MK test is for monotonic but not necessarily linear changes (including step changes).

***Author Response:** We thank the reviewer for noting this important observation. To avoid confusion, we have changed the title of Section "3.1 Linear Trend" to "3.1 Trend analyses".*

Reviewer comment: In Section 3.3, mention that the test for regional significance is actually conservative, as it is based on a null hypothesis of independent trends across stations, when the trends within a region are actually positively correlated.

Author Response: *We thank the reviewer for noting this point. We completely agree with the reviewer. We will include this information in Section 3.3, and modified the text accordingly.*

Reviewer comment: Check units -- e.g., at line 409, should it be 1.8 mm/year per year?

Author Response: *We will incorporate this change as ".. streamflow is 5.91 GL/year per year (1.8 mm/year per year)".*

Reviewer comment: In Section 5.3, mention the possible role of CO_2 increase in reducing vegetation evapotranspiration rate, which could increasing streamflow in certain climatic and geomorphic settings, offsetting the increased evaporation rate due to warming -- cf. for example my 2008 HESS paper "Mapping and attribution of change in streamflow in the coterminous United States".

Author Response: *We thank the reviewer for this suggestion. We will include this statement in Section 5.3 and cite the reference.*

Reviewer comment: In Section 5.4, consider mentioning that, given the decadal persistence in streamflow regimes, it will be useful to add the available information on streamflows before 1950 to a future analysis to better separate trends from oscillations.

Author Response: *We thank the reviewer for this important comment. We will include this statement in Section 5.4.*

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Conrad Wasko Community Comment #1

Referee comment on "Regional significance of historical trends and step changes in Australian streamflow" by Gnanathikkam Amirthanathan et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-199-CC1, 2022

Reviewer comment: As someone who has been using this world leading data set, I very much welcome this contribution. I enjoyed reading this manuscript and hope my suggestions are useful to the authors.

Author Response: *We thank the reviewer for positive comments and appreciation. Yes, your suggestions will definitely enrich the paper.*

Reviewer comment: Line 82 & 697: "However, it was not clear how these changes relate to change in rainfall", and "Further research is required to reveal the association of historical rainfall changes with observed streamflow". I would argue there is literature that addresses potential drivers, that is rainfall and secondly soil moisture (Wasko et al., 2021; Wasko and Nathan, 2019).

Author Response: *We thank the reviewer for the suggestions. We will elaborate the appropriate sections of the manuscript (Lines 82 and 697) and will include the references.*

Reviewer comment: Line 88: I agree but would note that another manuscript focussing on Australia found flood peak timing shifting alongside rainfall peak timing for frequent floods (Wasko et al.,2020).

Author Response: *We thank the reviewer for the observation. We will include this reference.*

Reviewer comment: Line 92: The following manuscript may be relevant (Gu et al., 2020)

Author Response: *Thanks for suggesting additional reference. We will modify the text and add it accordingly.*

Reviewer comment: Line 166: When I followed the link and clicked on "water year" I got the following definition: "1 July to 30 June." This is different from what was used in this manuscript.

Author Response: *We thank the reviewer for noticing the wrong link. We have defined the 'water year' according to the Hydrologic Reference Stations 'Glossary' (*http://www.bom.gov.au/water/hrs/glossary.shtml). *We have now fixed the link.*

Reviewer comment: Line 195: Why was only mean/total streamflow considered when previously a range of percentiles was examined (Zhang et al., 2016)?

***Author Response**: We thank the reviewer for noticing the differences. In this paper, our focus is trends (both linear and step changes) and regional significance of annual and seasonal streamflow. Other flow components and analyses are out of scope of the paper. We will elaborate the text in the scope and objective section (Lines 113-118) properly to make this clear.*

Reviewer comment: Line 230: The Pettit test is biased towards finding step changes in the centre of a time series (Mallakpour and Villarini, 2016) – though clearly the results presented here correspond well to drought periods.

***Author Response:** We thank the reviewer for the observation and we agree with the comment. We will mention this in the revised manuscript (Section 5.3 Attribution of trends) and cite the reference.*

Reviewer comment: Line 434: You mention the MK3 test was used for short term persistence, for consistency should you mention that the MK4 test was used for long term persistence?

***Author Response:** yes, we will modify the text accordingly.*

Reviewer comment: Line 468: Were the magnitude of the trends (on a site-by-site basis) presented or are they just discussed in text?

***Author Response:** Thanks for this question. We will include the magnitude of trends in Southern and Northern divisions in Section 4.1.1, with Fig. 4(a) and (b).*

Reviewer comment: Line 645: Does this mean non-bolded values in the table are decreasing? This could be stated here.

***Author Response:** We thank the reviewer for this question about clarity. Yes, non-bolded entries in the table indicate downward trend ($p<0.10$). We will modify the text accordingly to make this clear.*

Reviewer comment: Line 715: A recent paper (Peterson et al., 2021) and preprint (https://hess.copernicus.org/preprints/hess-2022-147/) suggest increased evapotranspiration per unit of precipitation as a driver.

***Author Response:** We thank the reviewer for suggesting two reference articles. We have now reviewed these articles, and will include this in the text.*

Editorial:

Reviewer comment: Line 102: The reference here is missing from the reference list and was published in 2019 (not 2020).

***Author Response:** We apologise for the omission; we have now fixed the error.*

Reviewer comment: Line 13: Insert "The" –> "The main objectives…"

Line 215: There are some additional spaces in this sentence.

Line 395: Missing 'l' in global.

Author Response: *Thanks for noticing the errors in Lines 13, 215 and 395, we have now fixed them in the revised manuscript.*

Reviewer comment: I am not sure Figure 8 adds much and it could possibly be omitted?

Author Response: *We thank the reviewer for the suggestion. This figure is simply to provide a typical example of how this information is presented. We will include a few sentences why the figure is useful to include in the paper.*

Reference

BoM (Bureau of Meteorology), 2022. Average annual, seasonal and monthly rainfall, Commonwealth of Australia. Accessed at: http://www.bom.gov.au/jsp/ncc/climate_averages/rainfall/index.jsp

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