

Interactive comment on “How streamflow has changed across Australia since 1950’s: evidence from the network of Hydrologic Reference Stations” by S. X. Zhang et al.

(Anonymous Referee #2, Received and published: 29 April 2016)

Authors' response to Referee #2

17 May 2016

S. X. Zhang et al.

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Response to review referee #2: Many thanks for the positive evaluation of our work. We highly appreciate your explicit comments and suggestions which will help to improve the submitted manuscript. Please find our response below to your comments, questions and suggestions. The referee’s comments are first recalled in *italics, blue colour font*, and then followed by our answer.

General comments

The overall impression of this paper is that it is very clear, well structured and interesting. The topic of temporal hydrologic change is highly relevant, and the quantitative data analysis of 222 stream gauges is comprehensive and previously unprecedented.

The paper presents a neat compilation of a large quantity of data and addresses relevant scientific questions within the scope of HESS – both regarding the issues of temporal hydrologic change, but also the central question regarding aggregation, compilation and presentation of large data quantities (daily discharge values for 222 stations for 45 years).

The presentation of the HRS web portal great! This is a valuable resource, which will be of great use for the international hydrological community. A paper such as “How streamflow has changed across Australia: :” will (apart from its research significance in other ways) have an additional value of helping more researches find the publicly available Australian discharge data.

The paper is written in a clear, concise and straightforward manner, answering most questions that arise. The title clearly reflects the contents of the paper. The language is (as far as I can judge) fluent and correct, the paper is generally very readable. The mathematical formulae, symbols, abbreviations, and units correctly are correctly defined and used. The length of the paper is exemplary short, but still comprehensive enough.

The abstract provides a concise and complete summary, although I’m slightly confused about the expression ‘living gauges’.

The scientific methods and assumptions are valid and clearly outlined, allowing reproduction (and traceability of results, as all data and used equations are publicly accessible).

The statistical methods are thoroughly explained, and the decision to have these equations in an appendix is wise. The amount and quality of supplementary material

is considered appropriate, and the figures and tables are generally in good shape, and are referred to accordingly.

In general, the number and quality of references seems appropriate for the topic, even though I think that a few more references regarding climate change could have been provided. Especially, I miss a reference to the most recent IPCC which would be of value here.

The scientific approach and the applied methods are valid and the results are to be sufficient to support the interpretations, and the substantial conclusions that are reached.

Answer

The authors would like to thank the referee for those positive evaluations of the manuscript and our work; and for the insightful comments on the data and method.

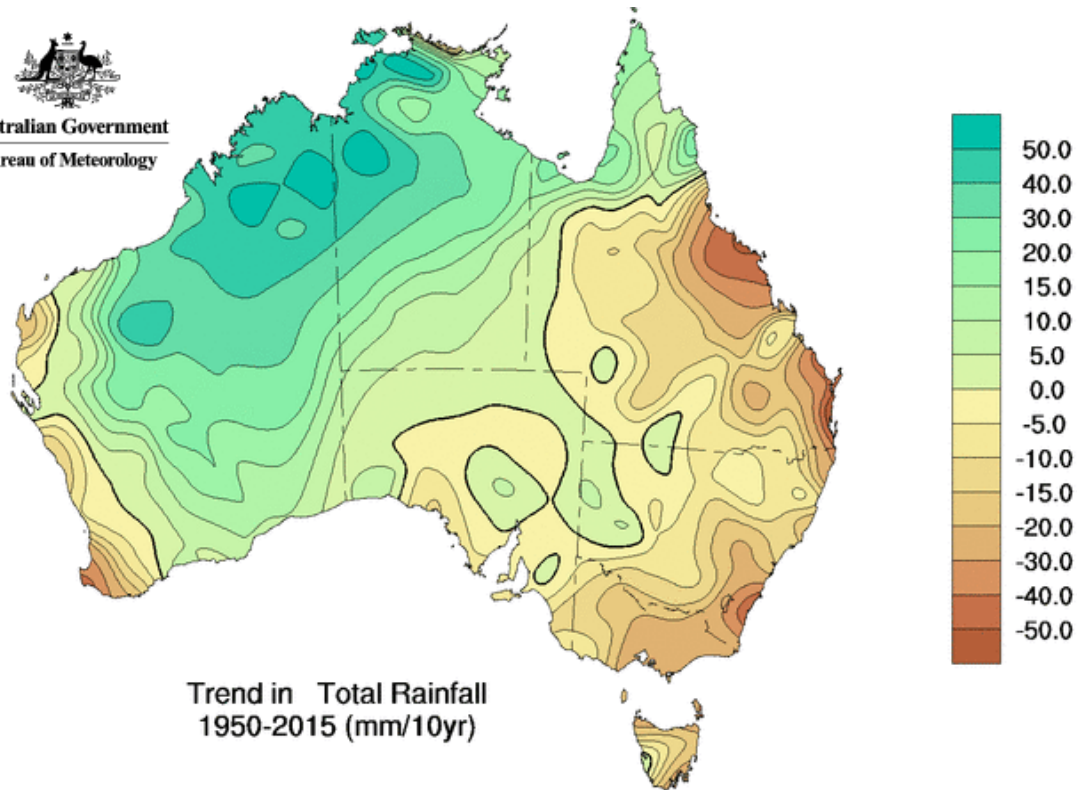
For the first question in general comments about ‘living gauges’: we have avoided using the expression ‘living gauges’, and specify its meaning more clearly to avoid confusion (it was changed to “critically important gauges”, at line 29 and line 93).

For the second question in general comments, we have added a few more references regarding climate change, including:

(1) CSIRO and Bureau of Meteorology (2015) *Climate Change in Australia Information for Australia's Natural Resource Management Regions: Technical Report*. CSIRO and Bureau of Meteorology, Australia 222pp. <http://www.climatechangeinaustralia.gov.au/>

(2) Bureau of Meteorology (2016) Annual Climate Report 2015
http://www.bom.gov.au/climate/annual_sum/2015/Annual-Climate-Report-2015-LR.pdf

An example for that, adding a trend map of rainfall for discussion. The Figure below gives an example showing an updated summary of long-term rainfall trends (1950-2015). Changes in precipitation or other climate variables impact on the rainfall-runoff process directly, and indirectly causing changes in flora, relief and soil erosion. The identified trend patterns in annual total streamflow are spatially consistent with trends in annual total rainfall as shown in this Figure, where most of eastern and south-western Australia has experienced substantial rainfall declines since 1950; while north-western Australia has become wetter over this period. This similarity implies that hydrological variability is closely related with changes in rainfall patterns.



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(source: <http://www.bom.gov.au/climate/change/index.shtml#tabs=Tracker&tracker=trend-maps&tQ%5Bmap%5D=rain&tQ%5Barea%5D=aus&tQ%5Bseason%5D=0112&tQ%5Bperiod%5D=1950>)

Specific comments

My primary concern regards the limited reasoning regarding how the temporal change in streamflow is interrelated to a temporal change in precipitation.

The authors mention clearly that this is not within the scope of the study – which of course is fine. However, the dry period in the last decade in the south-eastern and south-western region is mentioned as a cause of some of the general downward trend. Although a thorough analysis is of course not viable within the scope of this paper, it would be nice to (if possible) have some discussion regarding the likeliness of this downward trend only being a consequence of the rainfall during a few dry years, or if the trend is likely to be consistent in the longer time perspective. Looking at table 2, at the years of the step change – 1996 is clearly the most dominating year (13 of 22!): an added reflection regarding the impacts of this (probably very non-normal) hydrological year would be interesting. How much impact does this “outlier year” have on the temporal trend? Would the same general pattern be seen even if it was to be omitted from the analysis? I do not request you to do the complete analysis of this issue, but some kind of (further) discussion on the topic could be useful.

Answer

Many thanks for the suggestion. We agree that this ought to be discussed. Though a thorough analysis is out of scope of this paper, we have added relevant literatures on climate (as mentioned above), and included discussion on relating the flow changes with rainfall, and more discussion on the finding of large numbers of 1996 step changes in southeast Australia linking to the millennium drought (SEACI, 2011,

The Millennium Drought and 2010/11 Floods, http://www.seaci.org/publications/documents/SEACI-2Reports/SEACI2_Factsheet2of4_WEB_110714.pdf).

Also, I believe that most data is available from the 1950's and onwards. However, I guess that longer time series should be available at least for some gauges. A comparison regarding an even more long-term time series would give additional weight to the results – although, this may be the subject of another study.

Answer

Yes, there are some stations which have longer time series but not many. More long-term time series will certainly give additional weight to the results, as you said, it will be an interesting point to be added for future study.

Line 152 – please also add the median time-series length.

Answer

The median time-series length (46.6 years) was added in this part.

Lines 206-208 – is any of this presented here? Or mainly as background info to the tables/figures?

Answer

These statistical data analyses in lines 204-208 were only mentioned here as background information for all types of graphic products in HRS web portal. For more details of other statistical data analyses that's not presented in this study, please check the information at the HRS website:

<http://www.bom.gov.au/water/hrs/>

Line 262 – shouldn't also land-use changes be mentioned in this context?

Answer

Thanks for pointing it out. We have added discussion on land use changes in this context.

One last comment: the fact that different hydrologic years are used for different stations (if I understand it correct) – will this have an impact on the results (lines 149-151)?

Answer

Water year or hydrologic year was used in this study, but it's not different for every station. Table 1 has listed the water year start month for each division, and they are in a more consistent way: for regions in the south part of Australia, water year starts at March or February; for regions in the north and central Australia, it starts at September or October. In this way, the analyses were more following the natural hydrologic pattern, and representing the results in a better way.

Technical corrections

There are hardly any technical corrections that need to be addressed in the paper. The authors have made a robust study, and compiled the data in a presentable and concise manner.

I am however not clear about what the authors mean by the concept of 'living gauges', neither in the abstract nor in the text (lines 29 and 93) – don't just normal gauges record and detect changes in hydrologic responses?

Answer

This has been addressed in the general comments above.

As not being very familiar with Australian geography, I would have appreciated (if possible

to do in an aesthetic manner) information regarding the names of the basins in figure 1 – perhaps by inserting the roman numerals from table 1 on the map?

Answer

We have modified Figure 1 in this way, by inserting the basin code (from I to XII) for each region. and readers can refer the basin names to Table1.

Also, table 2 seems to be of somewhat low resolution (the letters are blurry) – if possible, please improve this.

Answer

We have improved the quality of Table 2. Table 2 in the submitted manuscript was actually a graph (that's why the letters look blurry), as we had difficulties to inset the text table in a landscape layout. We have updated it in the revised version.

Figure 5 (and 6 and 8), please add Q_(appropriate index) in the text for clarity. Thanks for a good read, and congratulations on your thorough study! I'm looking forward to seeing more of this paper in the future!

Answer

We have added Q_(appropriate index) in the figures, for readers could easily refer to.

Thank you again for your valuable comments!