Response to Reviewer #2

General comments

R1. In general it's clear that the authors improved the original manuscript (https://doi.org/10.5194/hess-2021-5). They did improved the flow of the storyline and the analysis of the control catchment. The manuscript has appropriate objectives and gives insight in the change in hydrological processes caused by the combination of land use and climate changes.

Response: Thanks very much for your great efforts to assess our manuscript. We have studied your and reviewers' comments carefully and will make corrections/revisions as suggested. In the following, we have detailed how these comments (in black) are raised and our responses (in deep sky blue).

R2. Although the assumptions and fallowing conclusions are constructively fine and according to the applied methods, the arguments (especially in the abstract and conclusion) are not very clear. Although some comparative values per method are presented, for a reader it is not clear where the conclusions are based on.

Response: Thanks for bringing this to our attention. More specific descriptions about where the conclusions are based on will be mentioned in the mew manuscript.

Abstract:

Multiyear drought has been proved to cause non-stationary rainfall-runoff relationship. But whether this change can occur in catchments that have also experienced vegetation change and whether it invalidates the most widely used methods (the paired-catchment method (PCM), the time-trend method (TTM), and the sensitivity-based method (SBM)) for estimating impacts of vegetation change on runoff is still unknown and rarely discussed. In the Red Hill experimental catchment in Australia, which has experienced a 10-year multiyear drought (2000 – 2009) and afforestation, inconsistent results of the three methods were obtained. Estimated afforestation impacts were 32.8%, 93.5%, and 76.1% of total runoff changes by the PCM, TTM and SBM, respectively when the longer available observed record (1990 – 2015) was used in this study. In addition to afforestation, it is further found that multiyear drought which cannot be ignored has led to the non-stationary rainfall-runoff relationship. The runoff coefficient decreased by 87.8% and 63.3%, respectively, during the drought period in Red Hill and Kileys Run catchment. For the TTM and SBM, the paradigm and the calculations show that traditional application did not further differentiate different drivers (i.e. multiyear drought and vegetation change) of non-stationary rainfall-runoff relationship, which led to significant overestimation of afforestation effects (93.5% and 76.1%). However, for the PCM, the result (32.8%) is relatively correct because the runoff data of the control catchment offsets the common impacts on the two catchments, that is, multiyear drought and climate variability. Further, a new framework was proposed here to separate the effects of three factors on runoff changes including vegetation change, climate variability and hydroclimatic non-stationarity (i.e. multiyear drought). Based on the new framework, the percentage runoff reduction of the control catchment induced by multiyear drought is -45%. Impacts of afforestation, multiyear drought and climate variability on runoff of the treated catchment (Red Hill) were 32.8%, 54.7% and 23.9%, respectively, and impacts of multiyear drought and climate variability on runoff of the control catchment (Kileys Run) were 87.2%% and 12.8%, respectively. With the new framework, impacts of afforestation on runoff were 38.8% (93.5%−54.7%) and 21.4% (76.1%−54.7%) using the TTM and SBM, respectively, agreeing well with that by the PCM (32.8%). This study not only proved that multiyear drought can induce non-stationary rainfall-runoff relationship using experimental observations, but also proposed a new framework to better separate the impact of vegetation change on runoff. More importantly, it is proved that non-stationarity induced by multiyear drought does not invalidate the PCM, and PCM is still the most reliable method when paired catchments both experienced climate-induced shift in rainfall-runoff relationship.

Specific comments

R3. The abstract ends with "paired-catchment method is proven to be still the most reliable method even the control catchment experienced climate-induced shift in rainfall-runoff relationship", but within the abstract no information on the control catchments are presented. I would suggest to give actual numbers so that the reader is able to draw this conclusion himself.

Response: Thanks for your suggestions. "The percentage runoff reduction of the control catchment induced by multiyear drought is −45%.", "Impacts of multiyear drought and climate variability on runoff of the control catchment (Kileys Run) were 87.2% and 12.8%, respectively." will be added in abstract section.

R4. In my opinion it's a missed opportunity that the majority of input by the previous reviewers and especially the replies by the authors are not processed within this manuscript.

e. Response to reviewer 1 (https://doi.org/10.5194/hess-2021-5-AC1): "During 1988 the uppermost 50 ha of Red Hill was planted top. radiata, with the remaining 145 ha planted to p. radiata in April 1989. During 2003 the plantations in Red Hill catchment were thinned to remove pulpwood and to promote the growth of sawlogs in the remaining stands. During the prolonged drought period, no trees died in the treated catchment. The change of annual PET can be seen in Figure 8 (b) (Page 42). PET showed an insignificant (p-value>0.1) increasing trend of 3.5 mm year-1. PET initially decreased before 1996 and then increased after 1996. The mean annual PET during the period of 1990-1996, 1997-2009, 2010-2015 and 1997-2015 are 1168 mm, 1262 mm, 1186 mm and 1238 mm, respectively. Compared with the period of 1990-1996 and 2010-2015, the mean annual PET during the period of 1997-2009 (the prolonged drought occurred) increased by 94 mm and 76 mm, respectively. Compared with the period of 1990-1996, the mean annual PET during the period of 1997-2015 increased by 70 mm. It is consistent with the cognition that afforestation and drought can make PET increase."

e. reviewer 2 (https://doi.org/10.5194/hess-2021-5-AC2), which you may use in the introduction and/or discussion: "Considering the influence of prolonged drought on the rainfall-runoff relationship in the treated catchment, the result of the paired catchment method is closest to the real runoff change caused by vegetation change. Because the control catchment indirect eliminate the influence of prolonged drought and climate variability on the treated catchment under the assumption that the response of the two catchments to prolonged drought is similar. Interannual changes in watershed storage occur primarily in soil water and shallow groundwater, pools that are often hydrologically active at time scales shorter than 1 year (Sayama et al., 2011). Rice and Emanuel (2019) indicates that down-regulation of transpiration and inhibition of hydrologic connectivity by forest vegetation represent two important negative feedback processes that can avert large losses in soil water or plant-accessible groundwater during dry periods. In doing so, this feedback mechanism has the potential to reinforce steady-state (or near-steady-state) conditions in dry conditions. So, the sensitivity-based method may be less affected by the prolonged drought because it is used in the forest and the time scale of PET and P data used in this method is annual scale. Runoff changes calculated by the sensitivity-based method are induced by climate variability."

Response: We apologize for these oversights, and thanks very much for your reminder.

(1) More detailed information about the characteristics of paired catchments, data and the history of vegetation change treatment will be mentioned in section 2 in the revised manuscript.
(2) The analysis of changes in potential evapotranspiration and rainfall will be mentioned in section 5.1 in the revised manuscript.
(3) More specific analysis of the application of traditional methods will be added in section 5.1 in the revised manuscript.

R5. For some statements I suggest to add some additional more recent papers.

e. at line 33.

e. at lines 52-53 "in many catchments around the world" two papers are cited one from 1980 and one from 2005, may be implying that these methods are not used that often anymore?

Response: Thanks for your suggestions. Changes will be made as suggested. (see references below).

line 33:

Cavalcante, R. B. L., Pontes, P. R. M., Souza Filho, P. W. M., and Souza, E. B.: Opposite Effects of Climate and Land Use Changes on the Annual Water Balance in the Amazon Arc of Deforestation, Water Resour. Res., 55, 3092-3106, https//doi.org/10.1029/2019WR025083, 2019.

Kalisa, W., Igbawua, T., Henchiri, M., Ali, S., Zhang, S., Bai, Y., and Zhang, J.: Assessment of climate impact on vegetation dynamics over East Africa from 1982 to 2015, Sci. Rep.-UK, 9, 16865, https//doi.org/10.1038/s41598-019-53150-0, 2019.

Zhang, J., Zhang, Y., Sun, G., Song, C., Dannenberg, M. P., Li, J., Liu, N., Zhang, K., Zhang, Q., and Hao, L.: Vegetation greening weakened the capacity of water supply to China's South-to-North Water Diversion Project, Hydrol. Earth Syst. Sci., 25, 5623-5640, https//doi.org/10.5194/hess-25-5623-2021, 2021.

lines 52-53:

Stoof, C. R., Vervoort, R. W., Iwema, J., van den Elsen, E., Ferreira, A. J. D., and Ritsema, C. J.: Hydrological response of a small catchment burned by experimental fire, Hydrol. Earth Syst. Sci., 16, 267-285, https//doi.org/10.5194/hess-16-267-2012, 2012.

Graeber, D., Goyenola, G., Meerhoff, M., Zwirnmann, E., Ovesen, N. B., Glendell, M., Gelbrecht, J., Teixeira De Mello, F., Gonzάlez-Bergonzoni, I., Jeppesen, E., and Kronvang, B.: Interacting effects of climate and agriculture on fluvial DOM in temperate and subtropical catchments, Hydrol. Earth Syst. Sci., 19, 2377-2394, https//doi.org/10.5194/hess-19-2377-2015, 2015.

Van Loon, A. F., Rangecroft, S., Coxon, G., Breña Naranjo, J. A., Van Ogtrop, F., and Van Lanen, H. A. J.:

Using paired catchments to quantify the human influence on hydrological droughts, Hydrol. Earth Syst. Sci., 23, 1725-1739, https//doi.org/10.5194/hess-23-1725-2019, 2019.

R6. Lines 79-93: The data and location description are very brief. I suggest to give some more extended information. i.e. It can be seen that Kileys Run experienced a multiyear drought that lasted … with the period of the Millennium Drought", explain why? What is lowest amount of rainfall measured?

Response: Thanks for your advice. Changes will be made as suggested in the revised manuscript.

(1) Red Hill catchment (1.95 km^2) and Kileys Run catchment (1.35 km^2) were paired catchments located 23 km north-east of Tumut and 100 km west of Canberra in New South Wales, Australia (35.322°S, 149.137°E) (Figure 1). The catchments are adjacent, and the soil texture, the topographic characteristics, and climatic conditions are similar. The altitude of the two catchments ranges from 590 m to 835 m above sea level. The slope in the lower part of catchments is mostly gentle, and gradually increases towards the ridge in a convex form. Geology of Red Hill catchment is predominately Young granodiorite, while Kileys Run catchment is dominated by Alkali diorite. Valley floor, midslope yellow duplex, shallow red soils and upslope red duplex are four main soil types in the two catchments. Upslope red duplex soils has the highest saturated hydraulic conductivities and valley floor soils has the lowest saturated hydraulic conductivities (Major et al., 1998). The climate of the two catchments is temperate with highly variable and winter-dominated rainfall. In 1988, *P. radiata* was planted in the eastern quarter of Red Hill catchment (0.5 km^2), and the remainder (1.45 km^2) was planted in April 1989. By 1997, pine occupied 78% of Red Hill catchment. During the multiyear drought period, no trees died in the treated catchment. The neighbouring catchment (Kileys Run) was the control catchment, which has been maintained as a grazed pasture control (Webb and Kathuria, 2012).

(2) Daily rainfall and runoff from the two catchments were collected during the period of 1990–2015. The daily rainfall was measured by tipping bucket rain gauges had been located at catchment outlet and the daily runoff was measured by a flat-v style crump weir at a gauging station at the outlet of each catchment (Major et al., 1998). The measured daily rainfall and runoff were made by government agency and were collected by Dr. Lu Zhang from CSIRO Land and Water, Black Mountain, Canberra, Australia. Mean annual rainfall and mean annual runoff of Red Hill catchment were 817 mm and 75 mm, respectively, during the study period. Mean annual rainfall and runoff of Kileys Run catchment were 817 mm and 161 mm, respectively, over the same period. Monthly potential evapotranspiration records were obtained from the SILO Data (www.longpaddock.qld.gov.au/silo/point-data/). The daily data were only used for the analysis of flow duration curve. The monthly data were used for the PCM, TTM, the new framework and double mass curve. The annual data are used in the SBM. Figure 2 shows the change of rainfall anomaly (%) in Kileys Run and Red Hill catchment. Rainfall anomaly (%) is defined as the percentage deviation of annual rainfall to mean manual rainfall. It can be seen that the three-year moving average of the rainfall anomaly (the black line) is less than zero from 2000 to 2009. According to the method of determining the multiyear drought period proposed by Saft et al. (2015), two catchments experienced a multiyear drought that lasted 10 years from 2000 to 2009 and this coincided with the period of the Millennium Drought. The minimum and maximum measured annual rainfall from 1990 to 2015 are 388.6 mm and 1334.4 mm, respectively.

R7. Lines 346-357, the paragraph about "Multiyear drought induced changes in the rainfall-runoff relationship" is short and doesn't discuss the subject. I suggest to compare your results with other locations where multiyear drought led to changes in the rainfall-runoff relationship.

Response: Thanks for your suggestions. Changes will be made as suggested in section 5.2.

It can be seen that multiyear drought has led to significant changes in rainfall-runoff relationship in Figure 4 and 5, which is similar to the significant downward shift of rainfall-runoff regression lines in basins in southeast Australia, the United States and China (Avanzi et al., 2020; Saft et al., 2015; Tian et al., 2018). In this study, the runoff coefficient decreased by 87.8% and 63.3% during the drought period in Red Hill and Kileys Run catchment, respectively. The latter is close to the decrease of runoff coefficient in Texas (Allen et al., 2011). The reason why the decrease of Red Hill is higher than that of Kileys Run may be that Red Hill is also affected by vegetation change (Saft et al., 2015). This will lead to more runoff reduction than predicted based on the rainfall-runoff relationship established in pre-drought period, and ignoring the impact of non-stationary change may cause large errors in the results (Zhao et al., 2010). Compared with the line during drought period, the rainfall-runoff regression line moved up after the drought due to heavy rainfall in 2010, but it did not completely return to the state before the drought. Peterson et al. (2021) suggested that these changes may be due to water loss from increased transpiration. Watersheds may thus have multiple states and a finite resilience to transient disturbances, and hydrological droughts can persist long after meteorological droughts.

R8. In this paragraph you do mention a change in physical processes (runoff, soil moisture and evapotranspiration?), but not really compared with studies elsewhere. Do you have any specific evidence available about changes processes?

Response: Thanks for your constructive comments. Changes will be made as suggested. More comparisons with studies elsewhere and descriptions of changes in annual lowest seven-day flow (it reflects the storage state of groundwater to a certain extent) will be added in section 5.2. Because only rainfall, runoff and potential evapotranspiration data can be obtained, the conjecture about the reasons is based on the analogy of similar catchments also affected by multiyear drought in Australia.

For precipitation input, inter-annual rainfall variability decreased and high rainfall years were missing during the drought period in Figure 2. Similar changes also occurred in 124 watersheds in Australia during the drought period (Saft et al., 2015). The reduction of rainfall input reduces runoff at the source. For runoff process, in Kileys Run and Red Hill catchment, rainfall primarily occurs in autumn and winter, less rainfall in autumn may result in lower antecedent soil moisture, which means more precipitation were used to replenish the soil water deficit in winter (Figure 7). The change of the monthly averages of rainfall and runoff is very similar to that of Murray Darling Basin, where rainfall-runoff relationship has changed caused by multiyear drought (Potter et al., 2010). As a result, the decrease of runoff began to increase in winter and the decrease of rainfall in spring further affected the runoff generation during the drought period, finally resulting in more runoff reduction than rainfall reduction. The decrease of GRACE satellite-observed average monthly terrestrial water storage and estimated groundwater storage in Murray–Darling Basin may support the above speculation about runoff reduction (van Dijk et al., 2013). The decline in groundwater levels may also be the reason for runoff reduction. Decline in precipitation usually results in a decline in groundwater levels (Peters et al., 2003), and may cause the connection between groundwater and surface water to be disrupted (Kinal and Stoneman, 2012). Brutsaert (2008) demonstrated that annual lowest seven-day flow can be used to indicate the change of ground water storage in the absence of observations of groundwater level. The annual lowest seven-day flow in Kileys Run catchment generally declined from 1990 to 1999, and was reduced to 0 from 2001 to 2010.

R9. In addition to that, add some references about global and local knowledge about land use changes and their effects, such as the infiltration trade-off hypothesis (i.e. Bruijnzeel, 1989) and regional water availability caused by tree restoration such as (i.e. Hoek van Dijke, et al. 2022).

Response: Thanks for your advice. Changes will be made as suggested. (see references below).

Bruijnzeel, L. A.: Forestaion and dry season flow in the tropics: a closer look, J. Trop. For. Sci., 1, 229-243, 1989.

Wang-Erlandsson, L., Fetzer, I., Keys, P. W., van der Ent, R. J., Savenije, H. H. G., and Gordon, L. J.: Remote land use impacts on river flows through atmospheric teleconnections, Hydrol. Earth Syst. Sci., 22, 4311-4328, https//doi.org/10.5194/hess-22-4311-2018, 2018.

Hoek Van Dijke, A. J., Herold, M., Mallick, K., Benedict, I., Machwitz, M., Schlerf, M., Pranindita, A., Theeuwen, J. J. E., Bastin, J., and Teuling, A. J.: Shifts in regional water availability due to global tree restoration, Nat. Geosci., 15, 363-368, https//doi.org/10.1038/s41561-022-00935-0, 2022.

R10. Lines 412-426, I suggest to re-introduce abbreviations.

Response: Thanks for your advice. Changes will be made as suggested. The words will be modified to "paired-catchment method (PCM)", "time-trend method (TTM)" and "ssensitivity-based method (SBM)"

R11. Lines 417-418, conclusion. Add numbers so the reader is able to "agree" with your conclusion.

Response: Thanks for your suggestions. "The runoff coefficient decreased by 87.8% and 63.3%, respectively, during the drought period in Red Hill and Kileys Run catchment.", "Estimated afforestation impacts were 32.8%, 93.5%, and 76.1% of total runoff changes by the PCM, TTM and SBM, respectively.", "Impacts of afforestation, multiyear drought, and climate variability on runoff of the treated catchment (Red Hill) were 32.8%, 54.7% and 23.9%, respectively. Impacts of multiyear drought and climate variability on runoff of the control catchment (Kileys Run) were 87.2%% and 12.8%, respectively." will be added in the revised manuscript.

Conclusion:

Through the study of the typical paired-catchment experimental site – Red Hill, we found that multiyear drought during 2000 – 2009 had altered the stationary rainfall-runoff relationship of both the treated and control catchment. The runoff coefficient decreased by 87.8% and 63.3%, respectively, during the drought period in Red Hill and Kileys Run catchment. The paired-catchment method (PCM) is not invalidated by the non-stationarity induced by multiyear drought because of the role of the control catchment. However, the essence of the time-trend method (TTM) and the sensitivity-based method (SBM) is to separate runoff changes caused by non-stationary (vegetation change or/and multiyear drought) and stationary (climate variability) changes in rainfall-runoff relationship, which makes the TTM and SBM significantly overestimate the impact of vegetation change on runoff. Estimated afforestation impacts were 32.8%, 93.5%, and 76.1% of total runoff changes by the PCM, TTM and SBM, respectively. On this basis, we propose a new framework by applying the TTM to the control catchment to quantify runoff changes caused by changes in rainfall-runoff relationship induced by multiyear drought. Impacts of afforestation, multiyear drought and climate variability on runoff of the treated catchment (Red Hill) were 32.8%, 54.7% and 23.9%, respectively. Impacts of multiyear drought and climate variability on runoff of the control catchment (Kileys Run) were 87.2%% and 12.8%, respectively. The contribution of vegetation change to runoff reduction using the three methods under the new framework become consistent (32.8%, 38.8%=93.5%−54.7% and 21.4%=76.1%−54.7%). We proved that the PCM is still a valid and fundamental method estimating the impact of vegetation change on runoff even paired catchments both experienced hydroclimatic non-stationarity in rainfall-runoff relationship under changing environments. This study provides a new way to quantify the impacts of vegetation change, climate variability and factors causing non-stationarity except vegetation change on runoff. The findings in this study not only gives insight in the change in hydrological processes caused by the combination of land use and climate changes, but also can help in developing strategies and management practices to ecological engineering under changing climate with frequent extremes in future.

R12. Idem line 420.

Response: Thanks for your suggestions. The lines will be modified to "The contribution of vegetation change to runoff reduction using the three methods under the new framework become consistent (32.8%, 38.8%=93.5%−54.7% and 21.4%=76.1%−54.7%)."

Technical corrections

R13. Line 82, what about Red Hill?

Response: Thanks for bringing this to our attention and more information about Red Hill catchment will be mentioned in the new manuscript.

Geology of Red Hill catchment is predominately Young granodiorite, while Kileys Run catchment also has Young granodiorite but is dominated by Alkali diorite. The ridges and upper slopes of each catchment have predominantly given rise to red duplex soils that comprise dark brown organic loam and silty loam overlying light to medium reddish-brown clay. In Red Hill catchment lower slopes comprise sandy soils consisting of dark grey-brown organic loam/silty loam overlying grey-brown bleached and heavily cemented loamy silt grading to yellow-brown or grey-brown mottled medium-heavy clay at depths > 45 cm. This soil type is absent from Kileys Run catchment and mean saturated hydraulic conductivities were 42.84 cm/day, 11.12 cm/day and 6.62 cm/day at depths of 20–50 cm, 50–80 cm and 80–100 cm, respectively (Major et al., 1998).

R14. Line 87, it would be nice to apply your analysis with data up to 2020?

Response: Thanks for bringing this to our attention. Unfortunately, we do not have measured runoff and rainfall data up to 2020. We can obtain the annual grid rainfall from 1990 to 2020, the average value is 940.0 mm. Based on the analysis of the grid rainfall anomaly from 1980 to 2020 and from 1990 to

2020, the two series both experienced multiyear drought from 2001 to 2009 (Figure R1), which is consistent with the period of multiyear drought in the manuscript (the drought period is from 2000 to 2009). There is an alternate change of wet and dry after 2015, especially, a large negative rainfall anomaly (%) is existed after 2017. Therefore, the extended data may not greatly improve the results.

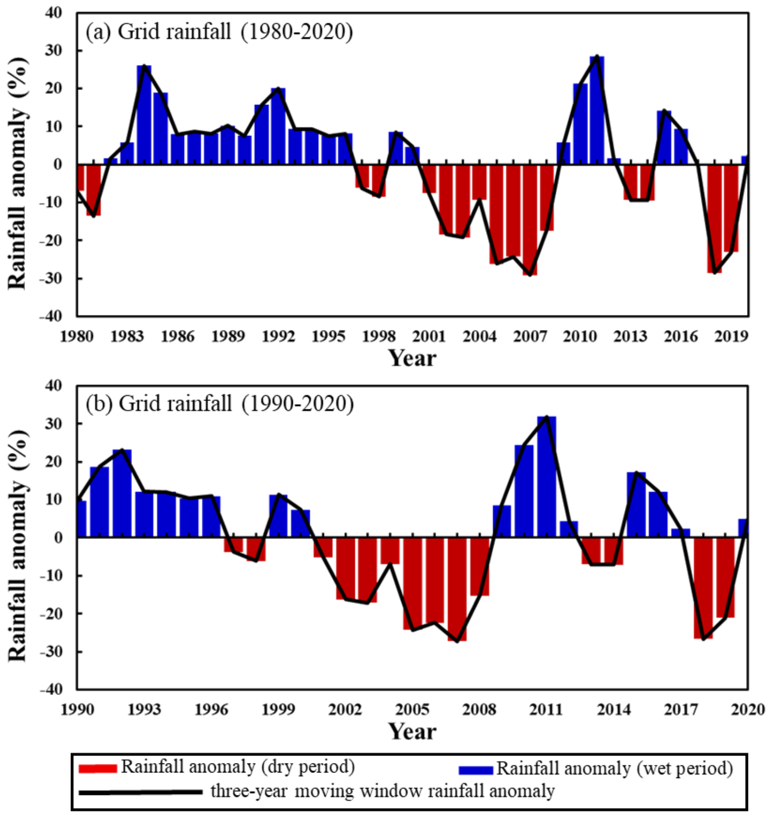

Figure R1 Rainfall anomaly (%) as a percentage of the mean annual rainfall of Kileys Run and Red Hill catchment. (a) Grid rainfall data (1980-2020); (b) Grid rainfall data (1990-2020). Red bars represent dry years and blue bars represent wet years. The black line represents the three-year moving average of the rainfall anomaly.

R15. Line 87, which method did you used to measure the runoff? Of where did you collected the data?

Response: Thanks for bringing this to our attention and the source of the data will be mentioned in the revised manuscript.

Runoff data were measured on site by government agency and were collected by Dr. Lu Zhang from CSIRO Land and Water, Black Mountain, Canberra, Australia. Observations were made at the outlet of each catchment, a gauging station was installed and began operation on 26 May, 1989. Daily runoff data are therefore available from June 1989 onwards. The gauging stations comprise a flat-v style crump weir at Red Hill and Kileys Run catchments. The rating curves (stage-discharge relationships) for Red Hill and Kileys Run catchment had been developed and tested by a series of velocity-area gauging and, as a result, the runoff data from those stations was considered reliable (Webb and Kathuria, 2012).

R16. Lines 88-89, add more information/background. You use daily rainfall and runoff, but monthly PET?

Response: Thanks for your advice. Changes will be made as suggested in section 2.

The daily rainfall and runoff data were measured on site by government agency and were collected by Dr. Lu Zhang from CSIRO Land and Water. The potential evapotranspiration (PET) data were monthly data from the SILO Data (www.longpaddock.qld.gov.au/silo/point-data/). The daily data were only used for the analysis of flow duration curve. The monthly data were used for the PCM, TTM, the new framework and double mass curve. The annual data were used in the SBM.

R17. Line 90, "figure 2 shows the rainfall anomaly that was calculated by the method proposed by", I suggest to describe the method (define anomaly). Which in this case is the annual percentage of rainfall being larger or less than the average rainfall.

Response: Thanks for your advice. Changes will be made as suggested in section 2.

Rainfall anomaly (%) is defined as the percentage deviation of annual rainfall to mean manual rainfall. The period of drought is determined by rainfall anomaly (%) smoothed with a three-year moving window. The method for determining the multiyear drought period is as follows (Saft et al., 2015):

The first year of the drought remains the start of the first three-year negative anomaly period;

The end year is set as the last year of this three year negative anomaly period (unless: if the last two years have slightly positive anomalies (but each <15% of the mean), in which case the end year is set to the first year of positive anomaly);

The length of dry periods must be not less than seven years;

The mean dry period anomaly must be less than −5%;

R18. Line 91-92, I suggest add to add the reference again.

Response: Thanks for your advice. Changes will be been made as suggested. (see references below).

van Dijk, A. I. J. M., Beck, H. E., Crosbie, R. S., de Jeu, R. A. M., Liu, Y. Y., Podger, G. M., Timbal, B., and Viney, N. R.: The Millennium Drought in southeast Australia (2001-2009): Natural and human causes and implications for water resources, ecosystems, economy, and society, Water Resour. Res., 49, 1040-1057, https//doi.org/10.1002/wrcr.20123, 2013.

Peterson, T. J., Saft, M., Peel, M. C., and John, A.: Watersheds may not recover from drought, Science, 372, 745-749, https//doi.org/10.1126/science.abd5085, 2021.

R19. Figures 3 – 5, and 7: used colours (combination of red and green) are not very suitable for colour blind readers (HESS - Submission (hydrology-and-earth-systemsciences.net))

Response: We apologize for these oversights. Figures 3 – 5, and 7 will be modified in the new manuscript.

R20. Lines 363-365, add reference?

Response: Thanks for your advice. Changes will be made as suggested. (see references below).

Li, H., Zhang, Y., Vaze, J., and Wang, B.: Separating effects of vegetation change and climate variability

using hydrological modelling and sensitivity-based approaches, J. Hydrol., 420-421, 403-418, https//doi.org/10.1016/j.jhydrol.2011.12.033, 2012.

Dey, P., and Mishra, A.: Separating the impacts of climate change and human activities on streamflow: A review of methodologies and critical assumptions, J. Hydrol., 548, https//doi.org/10.1016/j.jhydrol.2017.03.014, 2017.

Zhang, L., Nan, Z., Wang, W., Ren, D., Zhao, Y., and Wu, X.: Separating climate change and human contributions to variations in streamflow and its components using eight time - trend methods, Hydrol. Process., 33, 383-394, https//doi.org/10.1002/hyp.13331, 2019.

R21. Line 372, add reference?

Response: Thanks for your advice. Changes will be made as suggested (see references below).

Xiao, Y., Xiao, Q., and Sun, X.: Ecological Risks Arising from the Impact of Large-scale Afforestation on the Regional Water Supply Balance in Southwest China, Sci. Rep.-UK, 10, 4150, https//doi.org/10.1038/s41598-020-61108-w, 2020.

Newman, B. D., Wilcox, B. P., Archer, S. R., Breshears, D. D., Dahm, C. N., Duffy, C. J., McDowell, N. G., Phillips, F. M., Scanlon, B. R., and Vivoni, E. R.: Ecohydrology of water-limited environments: A scientific vision, Water Resour. Res., 42, https//doi.org/https://doi.org/10.1029/2005WR004141, 2006.

Brodribb, T. J., Powers, J., Cochard, H., and Choat, B.: Hanging by a thread? Forests and drought, Science, 368, 261-266, https//doi.org/10.1126/science.aat7631, 2020.

R22. Figure 4, perhaps add cumulative rainfall and the separated periods.

Response: Thanks for your advice. Changes will be made as suggested in Figure 4.

The rainfall data used in the two catchments are the same. The measured cumulative rainfall shown in Figure R2 has two significant abrupt change points in October 1999 and March 2012. They are consistent with the beginning and end of multiyear drought (2000 – 2009).

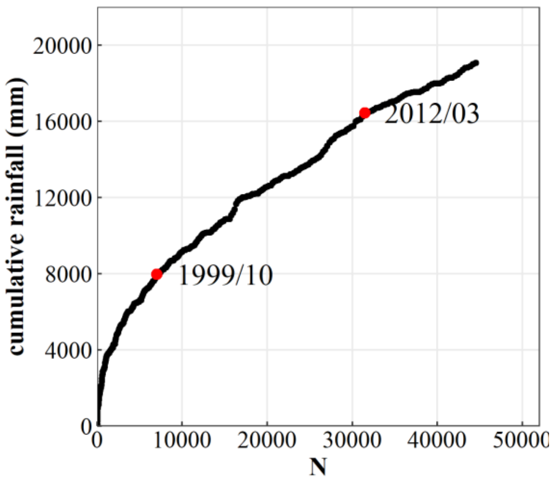

Figure R2 Double mass curve of monthly rainfall and N (cumulative sum of 1 to 312, 321=12 months/year × 26 years.

References:

Allen, P. M., Harmel, R. D., Dunbar, J. A., and Arnold, J. G.: Upland contribution of sediment and runoff during extreme drought: A study of the 1947–1956 drought in the Blackland Prairie, Texas, J. Hydrol., 407, 1-11, https//doi.org/https://doi.org/10.1016/j.jhydrol.2011.04.039, 2011.

Avanzi, F., Rungee, J., Maurer, T., Bales, R., Ma, Q., Glaser, S., and Conklin, M.: Climate elasticity of evapotranspiration shifts the water balance of Mediterranean climates during multi-year droughts, Hydrol. Earth Syst. Sci., 24, 4317-4337, https//doi.org/10.5194/hess-24-4317-2020, 2020.

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