No: NHESS-2021-218

JOURNAL: Natural Hazards and Earth System Sciences

MS TITLE: Comprehensive evaluation of hydrological drought and the effects of large reservoir on drought resistance in the Hun River basin, NE China

AUTHORS: F.T. Yang, S.P. Yue, X.D. Sheng

RESPONDENCE AUTHOR: Shupeng Yue (yuesp_123@163.com)

RESPONCES TO THE REVIEWERS' COMMENTS

We do appreciate all useful comments and suggestions on our manuscript.

The MS was thoroughly revised, against all revision comments from the editors and reviewers. We have taken this opportunity also to read through and tried to perfect the analysis details, discuss the results more comprehensively and pick up any minor grammar, wording or format problem and made corrections accordingly so that it strictly follows the Journal formatting requirements. Detailed corrections and revisions are listed below point by point. And, all the revisions have been addressed in the reply and highlighted in the manuscript with yellow background.

Reviewer # 1:

1. ***The methods section is missing SRI and SPI. They are well-known drought indices, but their application is not straightforward because it requires normalization of the probability distributions. What transformations were applied and how good were the results?***

[Authors' response]: We thank you for reminding us this importing. We have already added the introduction of SRI and SPI in the Methodology section in our revised manuscript (Page 4 line 20 to 30).

2. The definition of drought "severity" is not clear. On line 1 of page 5, it is stated that drought severity is the "run length", but run length is related to duration, not severity.

[Authors' response]: We gratefully appreciate for your comment. The drought severity is identified as the absolute value of the accumulated SRI during the drought duration. We have revised it in our revised manuscript (Page 6 line 8 to 9).

3. I have some trouble with the interpretation of the drought propagation time. It is stated that drought propagation time is the SPI time scale with the best correlation with the 1-month SRI. However, in the results section, the analyses are presented separately by months (Figure 7). I interpret these results as the correlation coefficient obtained between n-month SPI and 1-month SRI for the values of each month in successive years. However, the values of the correlation coefficients change from month to month. If we focus on relatively high correlation coefficients (over 0.5), the band is larger in some months than in other. How can it be that the drought propagation time in June is 2-6 months, in July and August increases to 3-12 months and in September it drops to 2 months? Am I missing anything? I would expect some discussion of this in terms of droughts, physical processes, and reservoir operation, not only in terms of numerical results from the statistical analysis.

[Authors' response]: We gratefully appreciate for your comment. The T_p was indicated by the month with the strongest correlation. In some months, the SPI time scale varies widely and the correlation is high, which leads to the drought propagation time in June is 2-6 months, in July and August increases to 3-12 months. However, the correlation is high for a large variety of SPI time scales in some months, which makes the identification of T_p values highly uncertain.

Therefor, in order to overcome this issue, the uncertainty of the correlation coefficients was calculated. And the T_p was expressed on SPI time scale with strong correlation and low uncertainty. We have revised it in our revised manuscript (Page 15 line 10 to 14). Meanwhile, the conclusions related to T_p have also been revised.
[Authors' response]: As suggested, we have added the discussion in terms of droughts, physical processes, and reservoir operation to further reveal the changes of T_p (Page 16 line 5 to 18 and Page 17 line 1 to 23).

4. I am also troubled by the discussion of the propagation time. The sentence in line 5 of page 16 states: "Considering the lack of data before the construction of the DHF reservoir..." How can you make an analysis of the effect of a reservoir if there are no control data without the reservoir? The authors are attributing the differences in the results obtained in the different stations to the reservoir. How can they be sure of this if there are no data prior to the construction of the reservoir? In fact, they even state that the reservoir "weakened the drought resistance upstream the DHF reservoir". I cannot imagine a way in which a reservoir may influence the threshold of rainfall deficit required to generate a drought of certain level in an upstream basin. This should be discussed. Could it be just variability in the data?
[Authors' response]: We gratefully appreciate for your comment. After our further discussion, we decided that it would be imprecise to attribute the differences in results obtained at different sites to reservoir construction. Indeed, it would be more convincing if we get a comparative assessment on the data before and after the construction of the reservoir. However, the data before the construction of DHF reservoir are lacking. Therefore, based on the calculation of drought propagation threshold for triggering different scenarios hydrological droughts, we discussed the drought resistance capacity of the basin and the influence of factors including the operation of Dahuofang reservoir on the drought resistance of the basin in section 4.4 (Page 19 line 5 to 6, Page 20 line 1 to 30 and Page 21 line 1 to 10).

5. Finally, I was entirely lost with the presentation and discussion of the Bayesian network model to link cumulative precipitation deficit to hydrological droughts. What is the purpose of this analysis and why is a Bayesian model required? What is the utility of the conditional probability distributions shown in Figure 9? Are these distributions derived from the fitted models? What is their relationship with actual data and their usefulness? Please clarify all these questions.
[Authors' response]: We gratefully appreciate for your comment. Bayesian networks are directed acyclic graphs in which the nodes represent variables of interest and the links represent informational or causal dependencies among the variables. The strength of a dependency is represented by conditional probabilities that are attached to each cluster of parents-child nodes in the network.
Fig 3a shows the graphical model of Bayesian network. It describes the causal relationships among the cumulative precipitation deficit (CPD, mm), drought duration (D), severity (S) and hydrological drought levels (HDL) (Page 9 line 1 to 4). In this model, the drought duration and severity of each drought event are taken as the target, respectively, and the corresponding CPD is identified as the condition. The conditional probability of hydrological drought under different CPD conditions would be calculated. The conditional probability distribution in Figure 9 (present Figure 11) was obtained by fitting the conditional probability and CPD. Then, the CPD corresponding to the confidence level of 0.95 was identified to determine the drought propagation threshold for triggering hydrological drought events (Page 8 line 19 to 22).

6. Some of the figures need additional work or explanations. In Figure 1, I was not able to locate the stream gauge upstream of the reservoir (BKQ). The definition of severity is not clear in Figure 2. What are the bar charts that appear to the right of the plots in Figure 7?. Are these the PTMH?
[Authors' response]: We are very sorry for the mistakes in this manuscript and inconvenience they caused in your reading. The graphic error in the our revised manuscript has been corrected (Page 5 line 1 to 2).

[Authors' response]: We gratefully appreciate for your comment. The definition of drought intensity in Figure 2 has been more clearly defined (Page 6 line 17n to 18).

[Authors' response]: We gratefully appreciate for your comment. The bar chart that appears on the right of the chart in Figure 7 (present Figure 8) are the drought propagation time T_p for each month (Page 16 line 3 to 4).

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Reviewer # 2:

1. The description of the work in the abstract should be improved; in fact, while reading the abstract, the work appears to be only a case study application. On the contrary, I believe that the Authors are proposing a methodological framework to evaluate the impact of meteorological droughts in regulated river systems.

[Authors' response]: We gratefully appreciate for your valuable suggestion. As suggested, the description of the work in the abstract has been revised (Page 1 line 8 to 26).

2. (5) should be better explained, e.g. by adding a sketch. If this equation was previously used for the same scope, a reference should be added. I would also add a sketch describing depicting the general framework adopted here. A better description of the framework could help the reader understand the rationale behind the specific statistical tools implemented here.

[Authors' response]: We gratefully appreciate for your valuable suggestion. We have already added related references in our revised manuscript (Page 8 line 10 to 12). Meanwhile, we have added the schematic of determining the drought propagation threshold in Methodology section to make the presentation of methodology clearer (Page 9 line 1 to 4).

3. The CPD is used as condition to explain the occurrence of severity and duration of hydrological droughts; why using CPD and not meteorological drought characteristics estimated based on SPI (e.g. intensity, severity and duration of meteorological droughts)? This point is not very clear to me, and the same could be for a potential reader. Further, why using the 0.95 CPD quantile as a threshold for hydrological drought? Does it result for data analysis or from the hydrological response of the catchment?

[Authors' response]: We gratefully appreciate for your comment. As the discriminant standard, drought intensity and duration of meteorological droughts are relatively absolute and not convenient to monitor. Precipitation, the most basic hydrometeorological monitoring index, is easy to obtain and the results are intuitive and easy to apply. Therefor, the CPD is more suitable as condition to explain the occurrence of severity and duration of hydrological droughts.

[Authors' response]: The use of 0.95 CPD quantile as the threshold of hydrological drought was based on the relevant references and was the result of data analysis (Page 8 line 20 to 22). (https://doi.org/10.1016/j.scitotenv.2020.136502; https://doi.org/10.1016/j.jhydrol2020.125738)

4. What about drought frequency? It is mentioned at line 17 of page 9, yet not defined or investigated.

[Authors' response]: We gratefully appreciate for your comment. "Drought frequency" in this case refers to the number of droughts identified based on run theory, and we've changed the "drought frequency" to "drought events" in our revised manuscript (Page 12 line 5 to 6).

5. Section 4.2. What do you mean by "periodicity"? Do you mean frequency or probability?

[Authors' response]: We gratefully appreciate for your comment. The "periodicity" means the occurrence frequency of hydrological drought, and the periodicity was analyzed by calculating the return period in this study (Page 13 line 1 to 2).

6. At SY and XJWP stations, the correlation is very high for a large variety of SPI time scales; this makes the identification of PTMH values highly uncertain. This affects the conclusions drawn from figure 8; to overcome this issue I suggest to include in figure 8 the PTMH uncertainty bounds. This is the only major issue that should be addressed by the Authors.

[Authors' response]: We gratefully appreciate for your valuable suggestion. As suggested, the uncertainty of the correlation coefficient between the monthly SRI and the multi-time SPI has been calculated. The T_p was indicated by the month with strong correlation and low uncertainty (Page 15 line 10 to 14). Figure 8 and 9 have been replotted due to the changes of T_p values in some months (Page 16 line 4 and Page 18 line 1). Meanwhile, the conclusions related to T_p have also been revised.

7. *For clarity, in Figure 9 I suggest to use the same x-axis range for all D or S panels.*

[Authors' response]: We appreciate for your valuable comment. As suggested, we have used the same x-axis range for all D or S panels in Figure 9 (present Figure 11) in our revised manuscript (Page 19 line 2 to 4).

8. There are some typos in the text; I warmly suggest to revise the English language.

[Authors' response]: We are very sorry for the mistakes in this manuscript and inconvenience they caused in your reading. The manuscript has been thoroughly revised and edited by a native speaker, so we hope it can meet the journal's standard. Thanks so much for your useful comments.

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Reviewer # 3:

1. ***Improvement of structure of the manuscript, good definition of the objectives and clear presentation of the methodologies used. The above presentation should be so detailed as to help the reader.***

[Authors' response]: We gratefully appreciate for your valuable suggestion. We rewrote the section of Introduction, stating the main research questions addressed in the work and referencing the authors that have tackled these questions before, summarizing their results and identifying the gaps to be filled by this work (Page 2 to 3). Meanwhile, the SRI and SPI (Page 4 line 20 to 30), trend analysis (Page 5 line 4 to 9) and the schematic of determining the drought propagation threshold (Page 9 line 1 to 4) were added in Methodology section to make the presentation of methodology clearer.

2. Linguistic improvement of the text.

[Authors' response]: We are very sorry for the mistakes in this manuscript and inconvenience they caused in your reading. The manuscript has been thoroughly revised and edited by a native speaker, so we hope it can meet the journal's standard. Thanks so much for your useful comments.

3. Correction of errors that should be avoided:

(3a) BKQ station is not presented in Figure 1.

[Authors' response]: We are very sorry for the mistakes in this manuscript and inconvenience they caused in your reading. The graphic error in the original manuscript has been corrected (Page 5 line 1 to 2).

(3b) page 3, lines 17-18, change 'agricultural irrigation' to "irrigation".

[Authors' response]: We gratefully appreciate for your valuable suggestion. As suggested, we have changed 'agricultural irrigation' to "irrigation" (Page 4 line 8 to 9).

(3c) page 3, line 27, change 'tyson polygon' to 'Thiessen polygon'.

[Authors' response]: We gratefully appreciate for your valuable suggestion. As suggested, we have changed 'tyson

polygon' to 'Thiessen polygon' in our revised manuscript (Page 4 line 16 to 18).

(3d) Although indexes SPI and SRI are well known, they should be more detailed (refer to normal standardization).
[Authors' response]: We thank you for reminding us this importing. We have already added the introduction of SRI and SPI in the Methodology section (Page 4 line 20 to 30).

(3e) page 5, line 4, '…, otherwise it is defined as no drought event (c).' According to table 1 when SRI is -1.0<SRI<=-0.5 there is Mild drought.
[Authors' response]: We gratefully appreciate for your comment. Combined with the actual situation of HRB, when SRI is less than -0.5 and greater than -1 only lasts for a month, it would hardly show drought, so it is not defined as a drought event in the process of drought identifying by using the run theory.

(3f) Figure 4, XWP change in XJWP.
[Authors' response]: We are very sorry for the mistakes in this manuscript. As suggested, we have changed 'XWP' to " XJWP" in Figure 4 (present Figure 5) (Page 12 line 1 to 2).

(3g) page 7, line 24, present in a figure the linear slope of SRI changed from -0.089/10a to 0.469/10a.
[Authors' response]: We thank you for reminding us this importing. As suggested, the linear slope change of SRI have been added to Figure 5 (Page 11 line 13).

(3h) page 9, line 6 and table 2 use the same value -0.83 or -0.84.
[Authors' response]: We are very sorry for the mistakes in this manuscript. After careful calculation and verification, the trend characteristic value *U* of DHF was -0.84, which has been corrected in our revised manuscript (Page 11 line 4 to 5).

(3i) page 11, lines 7-9, the values presented are out of the range of axes in the figure 6.
[Authors' response]: We are very sorry for the mistakes in this manuscript and inconvenience they caused in your reading. The error in Figure 6 (present Figure 7) has been corrected in our revised manuscript (Page 14 line 11 to 12).

(3j) page 9, line 23, 'the districts in the wast (XJWP)' change in 'the districts in the west (XJWP)'
[Authors' response]: We gratefully appreciate for your valuable suggestion. As suggested, we have changed 'the districts in the wast (XJWP)' change in 'the districts in the west (XJWP)' (Page 12 line 11 to 13).

(3k) page 12, line 12-13, '…PTMH ranged from 3 to 14 months, while the correlation coefficients were lower from late winter to early summer with PTMH ranged from 4 to 23 months at BKQ and DHF' the values are out of range in figure 7.
[Authors' response]: We are very sorry for the mistakes in this manuscript and inconvenience they caused in your reading. The error in Figure 7 (present Figure 8) has been corrected (Page 16 line 3 to 4). We feel sorry for our carelessness.

(3l) page 14, lines 3 and 4, 'Higher temperature in summer …. low PTMH of spring and winter' change to 'Higher temperature in summer …. long PTMH of spring and winter'
[Authors' response]: We gratefully appreciate for your valuable suggestion. As suggested, we have changed 'Higher temperature in summer …. low PTMH of spring and winter' change to 'Higher temperature in summer …. long PTMH of spring and winter' (Page 17 line 2 to 4).

4. Figure 9 was presented (page 16, lines 2 and 3) but it was not discussed.

[Authors' response]: We appreciate for your valuable comment. More description on the Figure 9 (present Figure 11) has been added in our revised manuscript (Page 18 line 14 to 19).

5. MAIN COMMENT. Page 16, lines 7-8: '…strengthened the drought resistance in the lower reaches of DHF reservoir while weakened the drought resistance in the upper reaches of DHF reservoir.' It is necessary to explain how the construction of the reservoir affected the upper reaches of DHF reservoir.

[Authors' response]: We gratefully appreciate for your comment. After our further discussion, we decided that it would be imprecise to attribute the differences in results obtained at different sites to reservoir construction. Indeed, it would be more convincing if we get a comparative assessment on the data before and after the construction of the reservoir. However, the data before the construction of DHF reservoir are lacking. Therefore, in this paper, based on the calculation of drought propagation threshold for triggering different scenarios hydrological droughts, we discussed the drought resistance capacity of the basin and the influence of factors including the operation of Dahuofang reservoir on the drought resistance of the basin (Page 20 line 1 to 30 and Page 21 line 1 to 10).

6. MAIN COMMENT. Page 16, lines 11-13: 'With the increase of hydrological drought level, ….at severe hydrological drought level'. It is not enough to make an observation; authors should try to explain why this happens.

[Authors' response]: We gratefully appreciate for your comment. After our further discussion, we decided that it would be imprecise to attribute the differences in results obtained at different sites to reservoir construction. Therefore, in this paper, based on the calculation of drought propagation threshold for triggering different scenarios hydrological droughts, we discussed the difference of drought resistance capacity of the four sub-basins and the influence of factors including the operation of Dahuofang reservoir on the drought resistance of the basin (Page 20 line 1 to 30 and Page 21 line 1 to 10).

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Reviewer # 4:

7. ***Page 2 Line 3 Hydrological drought refers to the condition when the water level of a river or aquifer is lower than normal. This is not true.***

[Authors' response]: We gratefully appreciate for your comment. We have revised the definition of hydrological drought after referring to relevant references (Page 2 line 6 to 8).

8. Page 2 line 7 the concept of drought resistance is not explained, it is not clear for me. No references are given. Any way I would think that it is not appropriate to compare the SRI severity for basins with different sizes. Severity should be scaled according to basin size.

[Authors' response]: We gratefully appreciate for your comment. I quite agree with you that the severity should be scaled according to basin size. In this paper, drought propagation threshold was applied to characterize drought resistance of watershed. We have added the explanation of the drought resistance in the manuscript (Page 21 line 3 to 5).

9. Page 2 Line 8 Run 8 Run theory, a time series analysis method. Here Yevjevitch 1980 should be cited as first reference.

[Authors' response]: We gratefully appreciate for your valuable suggestion. As suggested, we have already added this reference in the manuscript (Page 2 line 13 to 15).

10. Page 3 line 9 Authors need to mention the climate of the 3 studied sub regions DHF, SY, XJWP.

[Authors' response]: We gratefully appreciate for your valuable suggestion. The climate difference within the basin is weak. As suggested, we have added the description about the climate of the three sub-regions of DHF, SY and XJWP (Page 3 line 29 to 30).

11. Pqge 3 line 27 what is tison polygon method?

[Authors' response]: We are very sorry for the mistakes in this manuscript and inconvenience they caused in your reading. We have changed 'tyson polygon' to 'Thiessen polygon' (Page 4 line 16 to 18).

12. Page 5 line 6 the combination of droughts is important to mention in the abstract

[Authors' response]: We gratefully appreciate for your valuable suggestion. The combination of drought was introduced in chapter 3.3 (Page 6 line 13 to 16).

13. Page 5 line 19 it is not clear whether the dependency between drought duration and severity is for the same variable rainfall or runoff

[Authors' response]: We gratefully appreciate for your comment. The dependency structures of drought duration and severity were modeled based on references to the relevant literature (Page 7 line 3 to 4). (https://doi.org/10.1002/hyp.9233; https://doi.org/10.1016/j.jhydrol.2020.124751)

14. Page 5 line 11 why did authors selected these pdf?

[Authors' response]: We gratefully appreciate for your comment. The selection of these pdfs was based on references to the relevant literature (Page 6 line 19 to 21). (https://doi.org/10.1016/j.advwatres.2017.07.007; https://doi.org/10.1016/j.jhydrol.2020.124751)

15. Page 5 Line 21 RMSE and AIC do not seem adequate to measure the adequacy of Copula. Authors should use Kolmogorov Smirnov test or other tests based on Monte Carlo simulations and Cramer Von Mises statistics to check the copula model adequacy (See for example the paper of Genest et al 2011 https://arxiv.org/pdf/1102.2078.pdf)

[Authors' response]: We gratefully appreciate for your valuable suggestion. As suggested, we have added Kolmogorov Smirnov (K-S) test and Cramer Von Mises statistics (C-M) to check the copula model adequacy in the manuscript (Page 13 line 6 to 8 and Page 18 line 13 to 14).

16. ***Page 5 line 24 how did authors computed F (d,s)?***

[Authors' response]: We gratefully appreciate for your comment. F(d,s) is joint distribution function of drought duration and severity, which was calculated according to Equation 1 (Page 7 line 12).

17. Page 6 line 10 Did authors compute the Pearson correlation coef between SRI 1 month and SPI k months from k equal 1 to k equal 24?

[Authors' response]: We gratefully appreciate for your comment. We calculated the Pearson correlation coefficient between monthly SRI and SPI k months from k equal 1 to k equal 24 for each month from 1967 to 2019.

18. Page 6 Line 13 it is not clear how authors used Bayesian network BN. There is no graphical model. The causal influences among variables are not described. May authors add a graphical model? I understood that authors contribute to identify or fit the conditional probability which is known as parameter learning component in learning BN but the structure learning is missing. A reference to Pearl papers should be included for example https://ftp.cs.ucla.edu/pub/stat_ser/R246.pdf

[Authors' response]: We gratefully appreciate for your valuable suggestion. As suggested, we have added the graphical model of Bayesian network in the revised manuscript (Page 9 line 1 to 4). It describes the causal relationships among the cumulative precipitation deficit (CPD, mm), drought duration (D), severity (S) and hydrological drought levels (HDL). In this model, the drought duration and severity of each drought event are taken as the target, respectively, and the corresponding CPD is identified as the condition. The conditional probability of hydrological drought under different CPD conditions would be calculated.

The conditional probability distribution in Figure 11 was obtained by fitting the conditional probability and CPD. Then, the CPD corresponding to the confidence level of 0.95 was identified to determine the drought propagation threshold for triggering hydrological drought events.

19. Page 6 Line 21 Authors do not use the conventional words within BN which are nodes and parents, response variable y here hydrological drought with two components duration and severity and the feature variable x that characterizes y and which is here is rainfall deficit

[Authors' response]: We gratefully appreciate for your comment. As suggested, we have added in our revised manuscript (Page 8 line 7 to 10).

20. Page 7 line 21 what do authors mean by seasonal scale SRI? Is it SRI 3 months beginning in January; April etc…or is it SRI3 of 3 ;onth period beginning in January, then in February m then in March etc… ?

[Authors' response]: We gratefully appreciate for your comment. In this paper, the SRI-3 values in February, May, August and November were applied to describe the variations of hydrological drought in winter, spring, summer and autumn, respectively (Page 10 line 5 to 7).

21. Page 9 line 1 figure 4 what does mean heat map?

[Authors' response]: We gratefully appreciate for your comment. Indeed, Figure 4 (present Figure 5) shows temporal variation of hydrological drought at seasonal scales in the HRB from 1967 to 2019. we have modified the title of Figure 5 in our revised manuscript (Page 12 line 1 to 2).

22. Page 7 to 9 trend analysis should be first presented in methodology section and then in results section

[Authors' response]: We gratefully appreciate for your valuable suggestion. As suggested, we have added the introduction of trend analysis in the methodology section (Page 5 line 4 to 9).

23. Page 9 line 3 it is not clear whether the trend analysis is about SRI. It is not clear how are obtained the results of Table 2 . What are the series that are analyzed using M-K test?

[Authors' response]: We gratefully appreciate for your comment. In this paper, the SRI-3 and SRI-12 were applied to analyze the seasonal and annual variation trend of hydrological drought. The trend characteristic U values of M-K trend test of SRI-3 and SRI-12 was calculated to explore the temporal evolution characteristics of hydrological drought. Table 2 shows the calculation results of trend characteristic value U at seasonal and annual scales (Page 11 line 1 to 3).

24. Page 9 line 18 why do authors analyze 1 month SRI?

[Authors' response]: We gratefully appreciate for your comment. For hydrological drought, the change of hydrological regime can be sensitive and accurately captured by single time scale SRI. The multi-timescale SRI applies to describe the mean hydrological regime during the preceding few months. Therefore, three drought factors, namely drought frequency, duration and severity, were identified from the 1-month scale SRI sequence (Page 9 line 7 to 8).

25. Page 10 line 9 alpha equal 0.01 is problematic. Usually, we use 0.05. Other tests should be used.

[Authors' response]: We gratefully appreciate for your valuable suggestion. As suggested, K-S test ($\alpha = 0.05$) were applied to select the best-fit marginal distribution in our revised manuscript. Meanwhile, the RMSE test was added to select the best-fit marginal distribution (Page 13 line 3 to 5).

26. Page 10 line 11 it is not clear whether Table 3 is about precipitation data, this should be indicated in the title

[Authors' response]: We gratefully appreciate for your valuable suggestion. Table 3 shows the optimal marginal distribution function of drought characteristics (D, S and CPD). As suggested, we have indicated in the title of Table 3 in the revised manuscript (Page 13 line 9).

27. Page 10 discussion of the number of droughts. How did authors took into account the reservoir impacts on the runoff downstream ? Downstream stations SY and XJWP are affected by the reservoir operation . The comparison of the three hydrological stations does not hold because drought conditions in Downstream stations SY and XJWP are not due to natural variability but to both natural variability and storage decisions. This explains the seasonal characteristics discussed in Page 12 Line 8 and the results in Page 13 Line 7 and 8. However the comparison between DHF and BKQ holds. So in Fig. 7 c and d are not worth for comparison

[Authors' response]: We gratefully appreciate for your comment. Built in 1958, the reservoir has been in operation for many years, and its water supply plan has not changed much. In this paper, the data are from 1967 to 2019, and the hydrological drought under the operating state of the reservoir was studied.

Fig. 7 (present Fig. 8) shows the drought propagation duration T_p of four sub-basins under current conditions, which varies in different basins. Meanwhile, we have added the discussion in terms of droughts, physical processes, and reservoir operation to further reveal the changes of T_p (Page 16 line 5 to 18 and Page 17 line 1 to 23).

28. Page 11 Line 14 authors choose 0.5 as reflecting moderate drought, They should explain why 0,5 corresponds to moderate drought. (the mean is greater than the median corresponding to 0.5).

[Authors' response]: We gratefully appreciate for your comment. As suggested, we explain why 0.5 corresponds to moderate drought in our revised manuscript (Page 14 line 14 to 16).

29. Page 11 in Figure 6 and Table 5 why not representing results of station BKQ station?

[Authors' response]: We gratefully appreciate for your comment. Indeed, In this paper, the temporal and spatial variation and periodicity of hydrological drought were studied by dividing the basin into three sub-basins. However, for the analysis of drought propagation duration, the value of T_p in DHF, SY and XJWP showed great differences, so BKQ was introduced to verify whether this difference is mainly caused by the operation of the reservoir. Thus, the results of BKQ station were not represented in Figure 6 (present Figure 7) and Table 5.

30. Page 12 line 6 What is Poisson correlation coef?

[Authors' response]: We are very sorry for the mistakes in this manuscript and inconvenience they caused in your reading. We have changed 'Poisson correlation coefficient' to 'Pearson correlation coefficient ' (Page 15 line 14 to 15).

31. Page 14 Line 1 to 3. I would not agree with authors conclusions, the result of 4 months as propagation time in relation with an interdistance of 40 km is due to the fact that the reservoir exists. Otherwise I guess that the propagation time would be one month or less for such a distance

[Authors' response]: We gratefully appreciate for your comment. After our further discussion, we decided that it would be imprecise to attribute the differences in results obtained at different sites to reservoir construction. Indeed, it would be more convincing if we get a comparative assessment on the data before and after the construction of the reservoir. However, the data before the construction of DHF reservoir are lacking. Therefore, based on the calculation of drought propagation threshold for triggering different scenarios hydrological droughts, we discussed the drought resistance capacity of the basin and the influence of factors including the operation of Dahuofang reservoir on the drought resistance of the basin in section 4.4 (Page 20 line 1 to 30 and Page 21 line 1 to 10).

32. Page 14 the complexity of the situation (lines 7 to 17) argues in favor of drawing a Bayesian network BN scheme.

[Authors' response]: We gratefully appreciate for your comment. We are very sorry for the mistakes in this manuscript and inconvenience they caused in your reading. We have rewrote this section, stating the distribution of T_p in the four

sub-basins, summarizing their differences and discussing the reasons for the differences, making it more general and convenience to read (Page 16 line 5 to 18 and Page 17 line 1 to 23).