Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2019-582-AC2, 2020


Hydrology and Earth System Sciences
Discussions

HESSD

Interactive comment

# *Interactive comment on* "Frequency and magnitude variability of Yalu River flooding: Numerical analyses for the last 1000 years" *by* Hui Sheng et al.

**Hui Sheng et al.**

jhgao@nju.edu.cn

Received and published: 21 April 2020

The manuscript offers a very interesting and comprehensive study of changes in flood magnitude and frequency over the last 1000 years in Yalu River, China.

Dear review: We greatly appreciate for your positive comments on our study. Your valuable suggestions are helpful for us to improve the manuscript. The manuscript has been carefully revised and point-by-point responses are listed as below.

Q1: The manuscript is overall well written but could be shortened by removing some redundancies. Some of the methodologies and results are unclear and must be better explained (see below).

Response: We appreciate for this important suggestion. Response to review's suggestion the methodologies are modified as follows:

1) The model description was simplified, and some details for rainfall event module and degree-day module in HYDROTREND were given which can help reader effectively understand how monthly-scale climate data downscaled to daily –scale (Line171-228 in revised manuscript).

2) The accuracy of the simulated precipitation and temperature from ECHOG outputs were clarified (Line232-246 and Line 25 in revised manuscript).

3) Why use the GEV distribution to calculate the return interval flood values, and How to estimate the parameters of the GEV were clarified (Line 304-317 and Line772 in revised manuscript).

Response to review's suggestion the results are modified as follows:

1): Model limitations induced by model assumptions, uncertainties of climate data input and simplistic anthropogenic impacts were clarified (Line 406-422 in revised manuscript).

2): The results for investigating factors controlling the flood frequency variability have been shortened. Meanwhile, the Section for qualitative study impact of climate change and human activities on flood frequency has been rewritten (Line 491-571 in revised manuscript).

Q2: I found it quite challenging to assess the robustness of the analysis given the limitations in the model and input data. The use of monthly precipitation with daily simulations based on probability distribution for flood analysis is problematic, and, to a lesser extent, the reliance on peak annual discharge results.

Response: Thank you for your professional comments. Different from the precise flood forecasting model system with high temporal and spatial resolution input boundary conditions (DEMs, climate data, anthropogenic activities, etc.) the model has limitations for simulating annual peak flows over the last 1000 years due to the uncertainties of input boundary conditions and model assumptions. In order to reduce the uncertainty of simulation results, monthly scale climate data from ECHO-G outputs were downscaled to daily scale based on rainfall event module and degree-day module in the model combining with Monte-Carlo technique. Meanwhile, different multi-rainfall patterns (total of nine categories: wet year-SMW, average year-SMW, and dry year-SMW) were applied to better simulate daily precipitation intensity and distribution in process of modeling. The GEV combined with the block maxima method was adopted to reduce the uncertainty of simulations through improving the quality of reconstructed samples. Furthermore, the bulk of the analysis for flood characteristics in special periods with different climate and human activities was conducted to mitigate the impacts of simplified boundary conditions.

This paper provides an attempt to: 1. improve the accuracy of design floods by expanding the samples of historical floods. 2. Investigate the impacts of climate change and human activities (deforestation and dams) on floods by comparing flood characteristics in different periods which have more significant differences in climate characteristics and human activities. How to further improve the limitations of the model (for example, input of spatially changing precipitations, higher resolution for climate data, DEMs and more complex of anthropogenic activities) is worth study in the future.

Q3: The model simplistic anthropogenic representation is also a confining factor. The authors are clearly aware of these limitations and effectively mitigated these limitations by framing the bulk of the analysis on differences between long time-periods. The authors need to more clearly and explicitly discuss these limitations early in the manuscript.

Response: We have followed your suggestion. In revised manuscript, the descriptions for model limitations and uncertainties, and how to reduce the uncertainties of simulations were added (Line 406-422 in revised manuscript).

Specific Comments:

Q4: Line 74 - 'become' can be removed

Response: Revised

Q5: The sentence starting in line 258 - Appendix A2 does not seem to show that.

Response: We have followed your suggestion. The related reference was added.

Q6: Section 3.4 - additional information will be helpful - how was it calculated? What values were used (Qpeak)?

Response: In revised manuscript, Appendix A4 and related descriptions have been added to clarify why use the GEV distribution to calculate the return interval flood values, and how to estimate the parameters of the GEV In this paper, the L-moments method for parameter estimation of the GEV was applied to study the flood frequency in the Yalu River based on simulated annual peak discharges in Yalu River, combined with the block maxima method (Line 304-317 in revised manuscript).

Q7: Section 4.1.1. - qualitative results are very limited which always raises suspicion unless clearly justified.

Response: The descriptions for this section are insufficient in original manuscript, which led to the confusion. This section has been rewritten in response to review's suggestions. Response to this comment, this section has been revised as follow:

4.4.1 Qualitative flooding frequency analysis in response to basin changes

Line 492-525: Simulated annual peak discharge including impacts of climate change and human activities were thresholding processed (over threshold for 1 and otherwise 0) based on design floods level of different flood return intervals over the past 1000 years, and the same process was adopted for annual rainfall based on the standard of extreme rainfall events (strong rainfall in wet years greater 942 mm yr-1) in the Yalu River, as shown in Appendix A1. Generated time series datasets were conducted by using a wavelet analysis to qualitatively investigate the dominant controls on flood frequency variability for the Yalu River over the past 1000 years (Fig. 9). The wavelet results showed that during 1130–1190, 1280–1340, 1520–1580, and 1880–1940, the occurrence frequencies of floods exceeding the 50-years return period standard were much higher than those of other periods, and related extreme rainfall events also showed similar trends (Fig. 9). The occurrence frequency of floods over the 50–year standard during 1000–1450 was close to LIA (1450–1840), similar to the intensity and frequency of extreme rainfall events. In contrast, occurrence frequencies of floods over the 20–year and 10-year standards during 1000–1450 were much higher than that of the LIA, which was more related to the variations of multi-year average precipitation (Fig. 9). Compare with LIA, occurrence frequencies of floods over 50 years during 1841–1940 rapidly increased, and occurrence frequencies of floods over 10–years was basically at the same level in response to the significant increasing intensity and frequency of extreme rainfall events and similar average annual rainfall (Fig. 9). Our results demonstrate that the frequency and intensity of extreme precipitation caused by climate change have a dominant control on the frequencies of large floods (100-year, 50-year). However, medium and small-magnitude floods (20-year, 10-year, and 5-year) are more closely linked to long-term climatic trends of warming and humidity (Figs. 2 and 9).

As shown by Fig. 9, the occurrence frequencies of floods over different return interval standards rapidly decreased after 1940 due to the construction of cascading reservoirs, despite the increasing frequency and intensity of extreme precipitation events in response to climate change and anthropogenic impacts. The results demonstrate that the construction of reservoirs can effectively reduce flood disasters for the Yalu River basin despite having little effect on the long-term runoff to the sea (Sheng et al., 2019); additionally, the declines of occurrence frequencies for medium- and small-magnitude floods (20 year, 10 year) predominated over those of large floods (50 year) due to the construction of flood retention dams.

Q8: Figures 3 and 4 - consider changing the x axis title from 'item' to 'ranked yearly peak flow'. It may be worthwhile trying to explain or at least speculate about years in which the simulated and observed Qpeak strongly diverge.

Response: We have followed your suggestion to make changes for figures. The descriptions for simulated and observed Qpeak strongly diverge and its impacts for investigating frequencies of floods were given in revised manuscript. The Table1(in original manuscript) for comparison between observed and simulated return interval peak discharges for the period 1958–2012 in Yalu River were replaced by Appendix A4 in new manuscript. The picture can not only clarify why GEV was used to estimate design floods, but also explain the accuracy of the simulation results for flood frequency analysis.

Q9: Line 351 and later - 'frequencies of immense floods of 22.0%...' it is not clear to me what 22% means in this context! It is crucial that the authors clarify this as it is one of the main quantitative metrics used in the manuscript.

Response: The terms of 'Frequencies of immense floods of 22.0%' means the numbers of recorded immense floods per 100 years was 22. Inaccuracy of descriptions caused confusion of readers, and this section and related Table have been revised in the new manuscript.

Q10: Line 407 - 'observed' - I think 'estimated' is more appropriate.

Response: Revised.

Q11: Lines 421-422 - this seems to be a bit too specific an explanation given the model's limited anthropogenic representation.

Response: We have followed your suggestion.

Q12: Figure 8 and associated text - the figure needs to be better explained. It is not at all clear what it is showing.

Response: This section and caption of this figure have been revised in new manuscript.

Q13: Figure 9 and associated text - the figure is not immediately clear and could benefit from an explanation on how to interpret it. The results drawn from it are not at all apparent e.g. line 473, 479 & 487.

Response: The figure and captions have been revised. In order to clearly show the impact of climate change and human activities (deforestation and dams) on magnitude of design floods, new table has been added.

Q14: Line 500 - 'flood magnitudes' - Figure 10 title is % frequency of floods - is it magnitude or frequency?

Response: In the original manuscript, the ratio of the number of simulated flood peaks exceeding the standards to the statistical years is defined as 'frequency of flood occurrence', and designed floods of different recurrence intervals estimated by simulated annual peak discharges during 1000-2012 were applied for the standards. Distinguishing frequency of floods and 'frequency of flood occurrence' easily make reader confusions. Actually, the impacts of climate change and human activities on floods are able to clarify through discussing the changes of frequencies of floods or magnitudes of design floods. Therefore, we removed the Sections related to 'frequency of flood occurrence' to dispel confusions and redundancies.

Q15: Lines 538-542- is this based on the results or general assertion?

Response: It is general assertion based on previous researches (a change in global or regional climate patterns; hydrological characteristics of medium and small rivers) and conclusions of this paper. We would like to let the readers to know possible changing trend of floods in the future through this assertion. We are not to make conclusion without careful investigation and available data.

Q16: Line 544 and elsewhere - 'coupled' may be misleading in this context because it





Printer-friendly version

Discussion paper

implies that the two models are dynamically coupled where, to my understanding, the output of ECHO-G is used as input dataset to HYDROTREND (just like any other input dataset).

Response: We have followed this suggestion in the revised manuscript. We agree that ’coupled’ seems like to imply the interactions between two model systems, similar to a coupled model of waves and tides in the ocean. In this study output of ECHO-G is only used to as input dataset.

---

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2019-582, 2020.

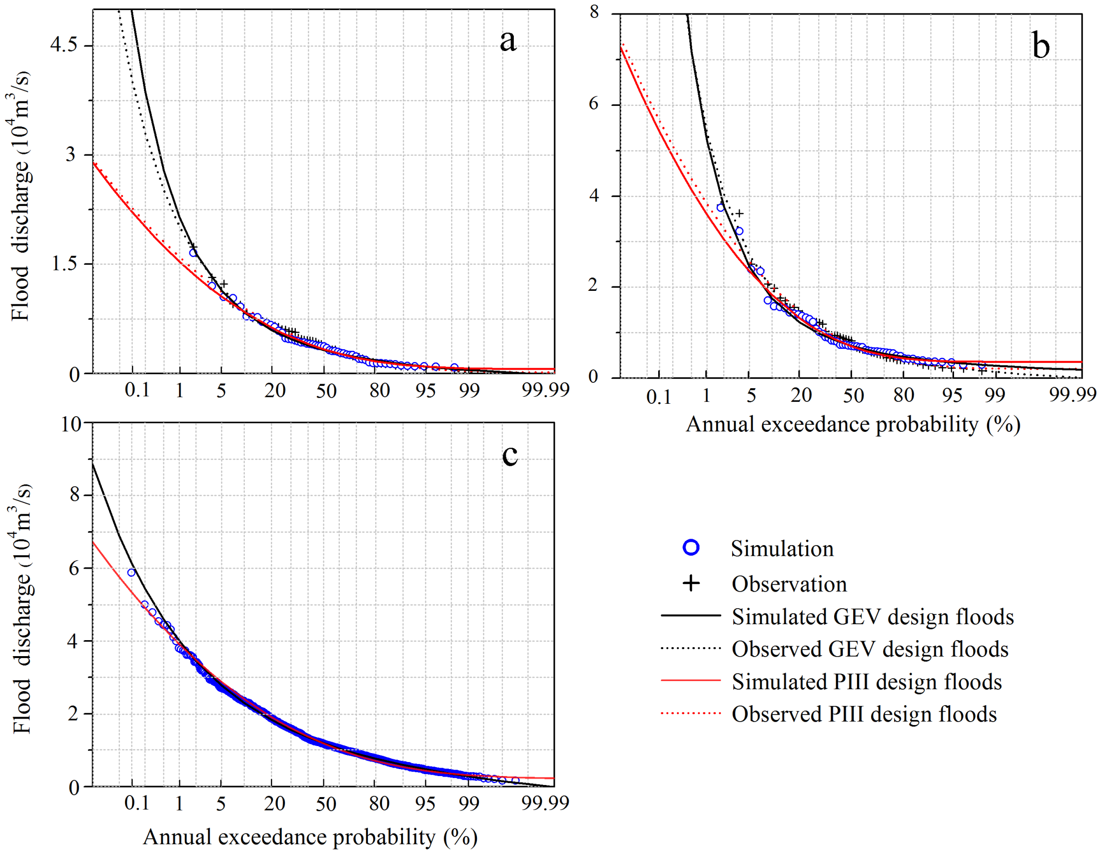


**Fig. 1.** Appendix A4. Comparison between the observed and simulated return interval peak discharges in the Ai River and Yalu River based on the GEV and P-III methods. The design floods for the period 1958–2012



Printer-friendly version

Discussion paper