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RESPONSES TO REVIEWER #1's COMMENTS

We are grateful to Reviewer #1 for his/her insightful review. The provided comments have contributed substantially to improving the paper. According to them, we have made significant efforts to revise the manuscript, with the details explained as follows:

Point #1
COMMENT:
only one error in the equation I could find (line 331, the dot normally indicating placement of index "l" should not be there)

RESPONSE: We are thankful for the reviewer's carefulness, and have corrected this part as follows:

> Figure 1 show the locations of these three gauging stations based on the daily stream flow data

Point #2
COMMENT:
a question on whether all those significant digits are actually warranted in Tables 2-6 and in Figures 10-13.

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RESPONSE: We appreciate the reviewer's comment. The digits in Tables 2-3 and Figures 10-13 are rounded in Excel, and the digits in Tables 4-6 are generated by the Design-Experts. All those significant digits can be warranted.

Point #3
COMMENT:
Figure 1 could be expanded I would argue to explicitly indicate copulas, etc and provide a few more details on the framework.

RESPONSE: We are grateful for the reviewer's suggestion. Firstly, we rename the full-subsampling factorial copula method to iterative factorial copula, which is more concise. Also, the full-subsampling factorial analysis is renamed as iterative factorial analysis. Also, we have provided more details for Figure 1 as follows:

> Figure 1 illustrates the framework of the proposed IFC approach. The framework consists of four modules: (i) selection of marginal distributions, (ii) identification of copulas, (iii) parameter uncertainty quantification, (iv) parameter interaction and sensitivity analysis. In IFC, modules (i) and (ii) are proposed to construct the most appropriate copula-based hydrologic risk model. In detail, a number of distributions, such as Gamma, generalized extreme value (GEV), lognormal (LN), Pearson type III (P III), and log-Pearson type III (LP III) distributions, are usually employed to describe the probabilistic features of individual random variables (e.g. flood peak and volume). Also, in order to quantify the dependence structures of correlated random variables, many copula functions have been proposed, such as Gaussian copula, Student t copula, Archimedean copula family (e.g. Clayton, Gumbel, Frank and Joe copulas). In

the current study, the indices of root mean square errors (RMSE) and Akaike information criterion (AIC) will be employed to identify the most appropriate model for hydrologic risk inference. Module (iii) quantifies parameter uncertainties in marginal distributions and copulas. Modules (iv) would be the core part of our study to identify the main sources of uncertainties in multivariate risk inference by the proposed iterative factorial analysis (IFA) approach.

Point #4

COMMENT:

The two watersheds selected are not very different but you find discrepancies between which copulas perform best on which stations (lines 409 to 412) for predicting flood peak and volume, and different copulas are chosen to characterize uncertainty in the risks for each station (line 414-416). The authors are using data driven methods that have no explicit consideration for causal mechanisms (as with most data driven methods) but surely the differences in copulas selected are caused by physical differences in the watersheds. Can the authors please explain these discrepancies in terms of physical watershed characteristics (or perhaps make the case for why the differences cannot be ascribed to physical differences)?

RESPONSE: We are thankful for the reviewer's suggestion. We have added discussion for this issue in Section 5.1 as follows:

5.1. Differences for the Hydrologic Risk Models at Different Stations

Different copula functions are applied for different stations, which are chosen based on the indices of RMSE and AIC. However, the selection of copula models at different stations may also be related with some key characteristics of the drainage areas for those stations. The Gumbel copula will be applied for the Zhangjiashan station. It can reflect strong correlation at high values. However, the Joe copula, which is adopted for the Xianyang station, can reflect stronger right tail positive dependence. Both the Xianyang and Zhangjiashan stations have similar drainage areas. The Xianyang station controls a drainage area of 46,480 km^2 (Xu et al., 2016), while the Zhangjiashan station has a drainage area of 45,412 km^2 (Sun et al., 2019). Nevertheless, the major reason that lead to different copula functions for these two stations may be due to the elevation features for those two drainage areas. The drainage area of Zhangjiashan station is located in the central part of Loess Plateau of China and thus the major part of this drainage area is a mountainous region. In comparison, even thought a large part of the drainage area of Xianyang station is also located in the mountainous region, the Xianyang station also controls a significant part of the Guanzhong Plain, as indicated in the red part of Figure 2. Consequently, the flood hydrograph at Zhangjiashan station may be sharp while the flood hydrograph at Xianyang station is relatively flat and show a stronger right tail dependence among flood peak and volume. In fact, the value of Kendall's tau between peak and volume for the top ten floods at Zhangjiashan station is 0.33 while such a value of Kendall's tau at Xianyang station is 0.6. These facts may explain the Gumbel copula is applicable for Zhangjiashan station while the Joe copula is applied for Xianyang station.

Point #4

COMMENT:
Please detail what part of the analyses is watershed specific and thus, what analysis should each user conduct each time and for every station they wish to understand prediction uncertainty and parameter interaction with the outcomes of their analyses; or conversely, what can they simply adopt from the Tables and Figures for their watersheds

RESPONSE: We are grateful for the reviewer's suggestion. This study aims to propose a reliable uncertainty partition method for multivariate risk inference. Based on this method, the decision maker can track the major sources for the uncertainties in the risk inferences. The proposed method can be applied for different watersheds. We have highlight the usefulness of our study in conclusions as follows:

> The proposed method has been applied for flood risk inferences at two gauge stations in Wei River basin. The results indicate that uncertainties in the parameters of the copula-based model would lead to noticeable uncertainties in the resulting risk inferences, especially for the joint flood risk in AND. noticeable uncertainties exist in the predictive joint RP of AND even for a small flood event. However, the results from IFA suggested that those uncertainties in risk inferences may mainly be attributed to the uncertainties in shape parameter in GEV distribution and the parameter of sdlog in LN for both the two stations. In comparison, the parameter uncertainty in the copula function would not pose an obvious effect on the resulting uncertainty in risk inferences. Such results indicate that, at least that the Wei River basin, the decision makers need to well estimate the values or quantify the uncertainties for the shape parameter in GEV distribution and sdlog in the LN distribution, in order to obtain reliable risk inferences. For other catchments, the proposed IFC method can be adopted to reveal the major sources for uncertainties in risk inferences and then provide potential pathways to get reliable risk inferences.