Public justification (visible to the public if the article is accepted and published):

Dear authors,

There are still some comments about this version. Please have a look and revise accordingly.

Regards,

Handling editor

Response: Thank you very much for the careful review and constructive comments of handling editor and all the reviewers. We revised this manuscript substantially and provided the point-by-point responses to all the comments and suggestions of reviewers accordingly. All the revisions were highlighted using track changes and blue words in the manuscript.

Report #2

Mayor comments

First, there is room for improvement in the redaction of the paper. Specially, each time the authors describe figures. They should focus on commenting on the findings from these figures more than mentioning the numbers present in the figure. These numbers can easily be added as an appendix or supplement information because the important part is the interpretation and analysis of the figures.

Response: Thank you very much for your constructive comments. The Results section was revised following your comments to clearly present the main findings and their interpretations of figures (see Lines 274–290, 307, 312, 407–429, 468–474, 480–516 and 535 in the manuscript with track changes). The introductions of numbers showed in figures were moved to the appendix or supplement (see Lines 684–695 in the manuscript with track changes and Text S1 in the supplement).

Second, I would recommend checking the interpretation of the influence of different factors in the overall response class. In some cases, it does not sound reasonable that factors with zero influence (0.0%), when analyzed locally, would have a high influence when they are considered combined. It could be just the deterioration of the most important factor when it is combined with very bad factors.

Response: We were very sorry that the unclear introduction of constrained rank analysis method which resulted in the misunderstandings of the individual and interactive contributions of control factor categories.

The constrained rank analysis was widely adopted to quantify the direct and interactive effects of multiple explanatory matrix on a response matrix. In our study, the individual contributions of meteorological, land cover and catchment categories were calculated by the partial rank analysis. This analysis was implemented by involving a certain control factor category as the independent matrix and the effects of other control factor categories were held constant. The percentage of constrained variance to the total variance of dependent variable matrix was considered as the individual contribution of involved control factor category on total variabilities of flood event classes. Furthermore, the entire rank analysis was also implemented by involving all the control factors as the independent variable matrix, and the variance percentage explained by independent variable matrix was considered as the entire contribution of all the control factors or categories.

If the sum of all the individual contributions was less than the entire contribution of all the factors, the interactive effects existed among the control factors and the difference between the summed and entire contributions was the interactive contribution (see the figure below). Therefore, the total contribution of a certain control factor category was its individual contribution plus the interactive contribution, which you mentioned. The individual and interactive contributions are not comparable. In the manuscript, the combined contribution was revised to the interactive contribution, and the entire, individual and interactive contributions of every control factor categories were presented, and the total contribution of every control factor categories were not presented.

The method introduction was revised as follows: *"Additionally, because of multiple control factor categories considered, two constrained rank analyses are implemented, namely entire and partial analyses. The entire analysis is implemented by involving all the control factors as the independent variable matrix, and the variance percentage explained by independent variable matrix to the total variance of dependent variable matrix is considered as the entire contribution of all the control factors or categories on total variabilities of flood event classes. The partial analyses of individual control factor categories are also implemented by involving a certain control factor category as the independent matrix and the effects of other control factor categories are held constant. The percentage of constrained variance is considered as the individual contribution of involved control factor category. The meteorological, land cover and catchment categories are adopted for the analysis individually, and their individual contributions are determined. If the sum of all the individual contributions is less than the entire contribution of all the factors, the interactive effects exist among* *the control factors and the difference between the summed and entire contributions is the interactive contribution (Legendre and Anderson, 1999; Zhang et al., 2016).*" (see Lines 243–259 in the manuscript with track changes)

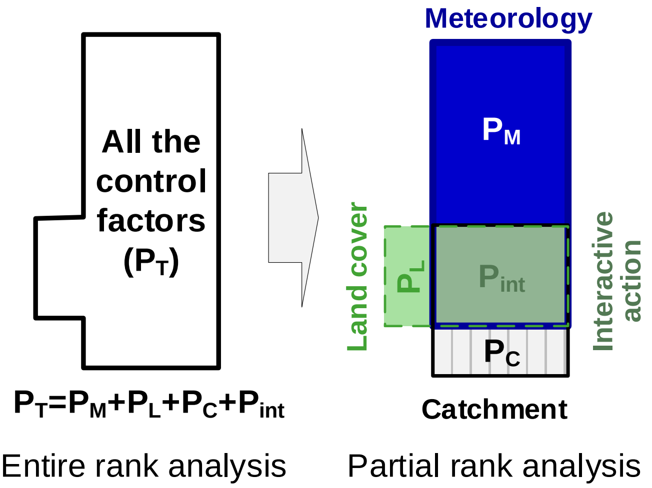


Figure. Entire contribution of all the control factors by the entire rank analysis, individual and interactive contributions of factor categories by the partial rank analysis

Minor comments.

Line 48. That is not assumed, decades of hydrological studies prove that. In fact, your results show the same.

Response: The sentence was revised to "*The deductive approach mainly focuses on the similarity of environmental factors which control flood events,……*" (see Line 48 in the manuscript with track changes).

Line 62. What do you mean by the hard clustering method? You should describe this classification of soft and hard before you describe the methods.

Response: The hard and soft clustering methods were referred from Olden et al. (2012). A hard clustering method assumes that the flood events can be divided into non-overlapping clusters with well-defined boundaries of all the clusters, while a soft clustering method assumes that the flood events can belong to different clusters simultaneously with a certain degree of membership, whose boundaries were vague. All of these explanations were given in the introductions of tree and non-tree clustering methods. Thus, the hard and soft clustering methods were removed from the manuscript to avoid the repeat introductions. (see Lines 62 and 70 in the manuscript with track changes)

The sentence was also revised to "*The class boundaries of flood response metrics are vague, and the flood event classes are mainly based on the class membership degree deduced from sufficient of heterogeneous flood events*" (see Lines 72–74 in the manuscript with track changes).

Reference

Olden, J. D., Kennard, M. J., and Pusey, B. J.: A framework for hydrologic classification with a review of methodologies and applications in ecohydrology, Ecohydrology, 5, 503–518, https://doi.org/10.1002/eco.251, 2012.

Line 77. This is subjective. Currently, there are many libraries and tools available, so it is hard to mention that one is easier than the other.

Response: This sentence was removed accordingly (see Lines 78–79 in the manuscript with track changes).

Line 122. How much greater? How does that affect your results?

Response: This sentence was revised to "*The densities of flood events and gauges in the Southern China (i.e., Huaihe, Yangtze, Southeast and Pearl River Basins) were 1.25–11.01 times and 2.94–9.15 times greater than those in the Northern China (i.e., Songliao and Yellow River Basins) because of the higher occurrences of flood events*" (see Lines 125–128 in the manuscript with track changes).

The densities of flood events and gauges did not affect the results because all the results were specified in the individual headstream catchments, and the major river basins just showed the geographic locations of these catchments, which were revised as follows: *"There were 53 events at four stations, 104 events at four stations, 215 events at 13 stations, 844 events at 38 stations, 90 events at five stations, and 140 events at four stations in the upper tributaries of the Songliao River Basin (i.e., Songhua and Wusuli Rivers), Yellow River Basin (i.e., Huangshui, Jinghe and Yiluo Rivers), Huaihe River Basin (i.e., Northern and Southern tributaries), Yangtze River Basin (i.e., Hanjiang, Wujiang, Dongtinglake, Poyanglake, and lower Yangtze River), Southeast River Basin (i.e., Qiantang and Jinjiang Rivers) and Pearl River Basin (i.e., Beijing, Xijiang and Dongjiang Rivers), respectively."* (see Lines 118–125 in the manuscript with track changes).

Line 135- 138. This paragraph is not clear. Rewrite it.

Response: This sentence was revised to "*The geographic information system (GIS) data contained the digital elevation model, and the land cover data series in six periods (i.e., 1990, 1995, 2000, 2005, 2010 and 2015) whose spatial resolution is 30 m×30 m. The GIS data were downloaded* *from the Data Center of Resources and Environmental Science, Chinese Academy of Sciences, and were adopted to extract catchment attributes and area percentages of individual land cover types.*" (see Lines 140–145 in the manuscript with track changes).

Line 138-140. That a hydrological model predicts well doesn't mean your inputs are right. The parameters in the model can correct problems or biases in the inputs. Moreover, you should mention how good was the model.

Response: We agreed with you about the predictions of hydrological model. The data sources of control factors and interpolation methods were introduced clearly to show their reliability.

"*The daily meteorological variables were interpolated to the catchment by the inverse distance weighting method, which is one of commonly-used meteorological interpolation methods (Ahrens, 2006; Tan et al., 2021).* " (see Lines 138–140 in the manuscript with track changes).

"*All these data sources for control factor calculations had been widely used to represent the meteorological and underlying surface conditions in China for hydrometeorological change detection and causal analysis, hydrological modelling, and so on (Zhang et al., 2020; Du et al., 2022; Zhang et al., 2024).*" (see Lines 145–149 in the manuscript with track changes).

Reference

Ahrens, B.: Distance in spatial interpolation of daily rain gauge data, Hydrol. Earth Syst. Sci., 10, 197–208, https://doi.org/10.5194/hess-10-197-2006, 2006.

Du, Y., Wang, D., Zhu, J., Lin, Z. and Zhong, Y.: Intercomparison of multiple high-resolution precipitation products over China: Climatology and extremes, Atmos. Res., 278, 106342, https://doi.org/10.1016/j.atmosres.2022.106342, 2022.

Tan, J., Xie, X., Zuo, J., Xing, X., Liu, B., Xia, Q., and Zhang, Y.: Coupling random forest and inverse distance weighting to generate climate surfaces of precipitation and temperature with multiple-covariates, J. Hydrol., 598, 126270, https://doi.org/10.1016/j.jhydrol.2021.126270, 2021.

Zhang, Y., Ren, Y., Ren, G. and Wang, G.: Precipitation trends over mainland China from 1961–2016 after removal of measurement biases, J. Geophys. Res.: Atmos., 125(11), e2019JD031728, https://doi.org/10.1029/2019JD031728, 2020.

Line 150-153. You are mentioning the same information that is already in the table.

Response: This sentence was revised to "*Therefore, nine metrics are used to fully characterize the response of flood events (Table 1).*" (see Lines 159–162 in the manuscript with track changes).

Line 166-167. I think you do not need to mention what a dimension reduction is.

Response: This sentence was deleted accordingly, and the next sentence was revised to "*principal component analysis is used to transform the high dimensional metrics into a few principal components (PCA) based on the orthogonal transform.*" (see Lines 176–179 in the manuscript with track changes).

Line 183-188. You can send this information to the appendix.

Response: It was revised accordingly.

"Appendix A:

All the multivariable statistical analyses are implemented using R software (version 3.1.1) (R Development Core Team, 2010), involving the `aov`*,* `cor` *and* `princomp` *functions in stats Package (version 4.1.3) for independence test, linear correlation test and principal component analysis, respectively (Mardia et al., 1979), the* `hcluster` *function in amap Package (version 0.8-18) for hierarchical cluster analysis (Antoine and Sylvain, 2006), the* `clara` *function in cluster Package (version 2.1.3) for k-medoids cluster analysis (Kaufman and Rousseeuw, 1990), the* `NbClust` *function in NbClust Package (version 3.0.1) for the optimal class number determination and classification performance assessment (Charrad et al., 2014). The Monte Carlo permutation test are implemented using the* `envfit`*,* `decorana`*,* `rda`*,* `cca`*,* `permutest` *functions in the vegan Package (version 2.5-7) of R software (version 3.1.1) (ter Braak, 1986; R Development Core Team, 2010)."* (see Lines 675–683 in the manuscript with track changes).

Line 199. SPEI is a drought index. You did not use an aridity index. Please change the term.

Response: The aridity index was replaced by the drought index in the whole manuscript (see Lines 22, 209, 225, 213, 412, 458, 495, 500, 523, 526, 529, 539, 603, 605, 606, 626 and 667 in the manuscript with track changes).

Line 237. How can you conclude about catchment factors if they are not dynamic?

Response: The catchment factors are excluded for the effect analysis of control factors on variability of flood event classes in the individual catchments (i.e., distributed analysis) because they are not dynamic. However, they are included for the effect analysis in the entire regions because they are different among individual catchments (i.e., lumped analysis).

We were sorry about the misunderstanding, and revised these sentences to "*All the meteorological and physio-geographical factors are included for the lumped analysis, while the catchment attributes are excluded for the distributed analysis because they are not dynamic in the individual catchments.*" (see Lines 264–266 in the manuscript with track changes).

Line 247. You have to reference the table you are describing. Moreover, Try to add a hydrological meaning to the component, such as you did with PC 4 and 5.

Response: The paragraph and table 3 were revised to remove the repeated information of table and add the hydrological meaning of individual components catchment factors.

"By the principal component analysis, five independent PCAs are found with the total cumulative variance of 85.7%, all of which are selected in our study (Table 3). The first PCA is related with magnitude, variability and rates of changes with the explained variances of 33.3%. The second PCA is related with magnitude, variability and peak number with the explained variances of 17.0%. The third–fifth PCAs are mainly related with flood event duration, beginning time of flood event and flood peak timing with the explained variances of 16.0%, 10.8% and 8.6%, respectively.

Table 3. Loads coefficients of flood response metrics in the selected PCAs and their explained variances

Components	*Variances (%)*	*Main hydrological metrics and their coefficients*	*Hydrological meanings*
PCA1	*33.3*	Q_{pk} (0.97), R (0.61), RQ_r (0.84) and RQ_d (0.84)	*Flood magnitude and rates of changes*
PCA2	*17.0*	R (0.51), CV (-0.47), T_{pk} (0.56) and N_{pk} (0.77)	*Flood magnitude, variability and peak number*
PCA3	*16.0*	T_{drn} (0.84)	*Flood event duration*
PCA4	*10.8*	T_{bgn} (0.92)	*Beginning time of flood event*
PCA5	*8.6*	T_{pk} (0.64)	*Flood peak timing*

" (see Lines 274–290 in the manuscript with track changes).

Line 258-266. This information should go in the appendix or supplement information because it only supports the selection of the number of clusters.

Response: The selection of cluster number is an important content of this study. We preferred to remove this paragraph into the appendix.

"Furthermore, the optimal classification of all the 1446 flood events are determined by comparing the classification performance between the hierarchical and k-medoids clustering methods. The five clusters using the k-medoids clustering method are optimum for further analysis in our study (Figure B1 in the Appendix B)." (see Lines 285–287 in the manuscript with track changes).

"Appendix B:

The optimal classification method and cluster number are determined by comparing the classification performance between the hierarchical and k-medoids clustering methods among individual cluster numbers. Figure B1 shows that the optimal criteria number is the largest when the cluster number is five (i.e., 22.7% of total) for the k-medoids clustering method. The optimal criteria are the CCC, TrCovW, Silhouette, Ratkowsky and PtBiserial with the values of -2.98, 1.39×10^{15}, 4.12 ×10^{6}, 0.20, 0.29 and 0.39, respectively. Therefore, the five clusters using the k-medoids clustering method are optimum for further analysis in our study. The flood event numbers in the individual classes are 347, 306, 195, *375 and 223, accounting for 24.0%, 21.2%, 13.5%, 25.9% and 15.4% of total events, respectively."* (see Lines 684–695 in the manuscript with track changes).

Line 272. What do you mean by "variations are the same among the different classes"? Class 3 is statistically different than others.

Response: It means that "*the distributions of both total flood volume (R) and maximum flood peak (Qpk) are the same among different classes. That is to say, the metric values are the largest in Class 3, followed by Classes 5, 2, 1 and 4.*" (see Lines 304–306 in the manuscript with track changes).

Line 274. You do not need this level of description in a paragraph.

Response: The value ranges of individual classes were removed from the manuscript because all of these values had been presented in the table (see Lines 307 and 312 in the manuscript with track changes).

Line 291-297. I am not sure if the description you mention in this paragraph comes only from Fig. 3 or if you really need Fig 4 to conclude that. If Fig 4 is only supporting this description, my suggestion is to move it to the appendix.

Response: Thank you very much for your comments. The description of Classes 1–5 in this paragraph was based on Figures 3 and 4. Figure 4 showed the hydrographs of individual flood event classes and their duration frequencies, which were beneficial to support the descriptions of individual flood event classes. Thus, we preferred to keep this figure in this section, and the explanation of Figure 4 was also given to explain the description.

"*According to the metric distributions (Figure 2), and hydrographs and duration frequencies (Figure 3) of individual flood event classes, we can conclude that……*" (see Lines 325–326 in the manuscript with track changes).

Line 310. You should be more specific when you mention basins because your data does not cover the entire basin (e.g. upper, lower, headwater basin, etc).

Response: The locations of Classes 1–5 were specified to the tributaries of the main river basins. The revisions were given as follows:

"*The spatial distributions of individual classes are showed in Figures 4 and S1, and Table S5 in the Supplement. The moderately fast flood event class (i.e., Class 1) is mainly in the upper Dongjiang River of the Pearl River Basin, Poyanglake and Dongtinglake tributaries of Yangtze River Basin, accounting* *for 37.1% (52/140) and 29.7% (251/844) of total events in the main river basins, respectively. Specifically, Class 1 is dominant at the Yanling (54.5%, 18/33) and Tongtang (50.0%, 14/28) stations in the Dongtinglake tributaries, the Shanggao (52.6%, 10/19) station in the Poyanglake tributaries, and the Hezikou (47.2%, 42/89) station in the Dongjiang River. The highly fast flood event class (i.e., Class 2) is mainly in the upper Beijing River of the Pearl River Basin, and Dongtinglake tributaries of Yangtze River Basin, accounting for 31.4% (44/140) and 22.5% (190/844) of total events in the main river basins, respectively. Class 2 is particularly dominant at the Xiaogulu (80.0%, 24/30) station in the Beijiang River, and the Tangdukou (57.6%, 19/33) station in the Dongtinglake tributaries. The highly slow and multipeak flood event class (i.e., Class 3) is mainly in the upper Jinjiang, Qiantang and Minjiang Rivers in the Southeast River Basin, accounting for 42.2% (38/90) of total events, particularly at the Longshan (69.6%, 16/23) station in the Jinjiang River. The slightly fast flood event class (i.e., Class 4) is mainly in the upper Huangshui, Jinghe and Yiluo Rivers of the Yellow River Basin, and upper Songhua and Wusuli Rivers of the Songliao River Basins, accounting for 64.4% (67/104) and 60.4% (32/53) of total events in the main river basins, respectively. This class is dominant at the Qiaotou (77.3%, 17/22) station in the Huangshui River, the Huating (63.6%, 7/11) station in the Jinghe River and the Luanchuan (69.2%, 27/39) station in the Yiluo River, the Jingyu (69.2%, 9/13) and Dongfeng (64.3%, 9/14) stations in the Songhua River, and the Muling (58.3%, 7/12) station in the Wusuli River. The moderately slow flood event class (i.e., Class 5) is mainly in the southern tributaries of Huaihe River Basin, accounting for 47.4% (102/215) of total events, particularly at the Beimiaoji (100%, 12/12) and Qilin (70.0%, 7/10) stations.*" (see Lines 344–364 in the manuscript with track changes)

Line 317. What do you mean by obvious?

Response: This sentence was revised to "*This class is dominant at……*". (see Line 358 in the manuscript with track changes)

Figure 5. If you are going to talk about average behavior by basin, Figure 5 should show a pie chart on top of each basin. From the gauge description in the current figure is almost impossible to follow your conclusions. Another option is to have a pie chart on the left panel and the gauge locations on the right.

Response: Thank you very much for your suggestion. This figure was revised carefully as follow (see Line 370 in the manuscript with track changes).

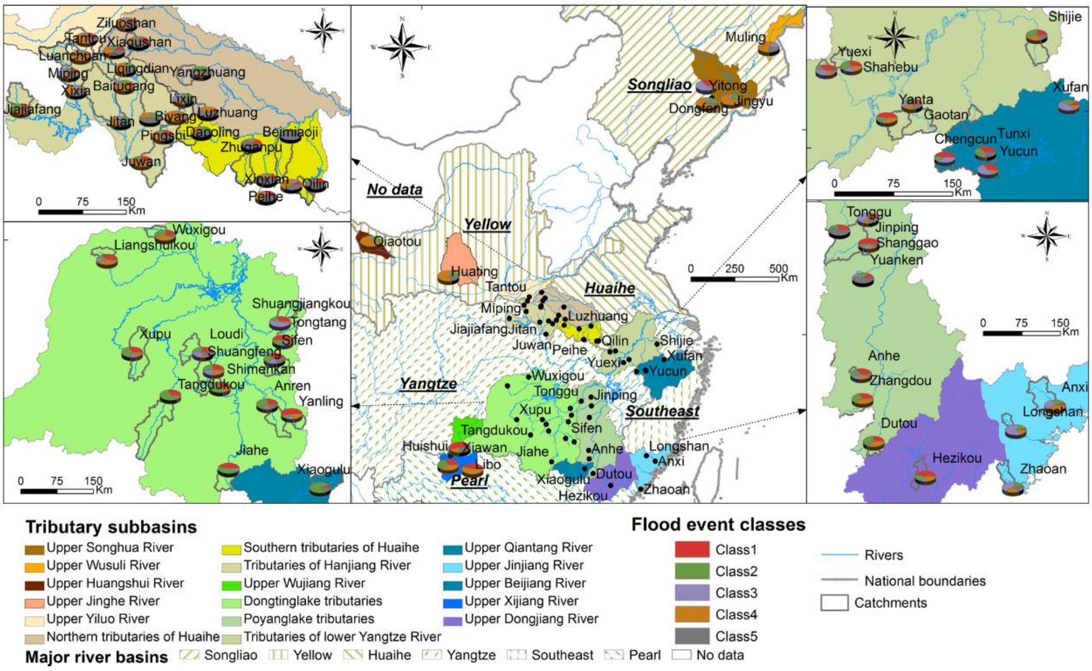


Figure 4. Spatial variabilities of individual flood event classes at headstream stations of major river basins

Line 326. When you talk about a subpanel of your figure, you should mention the subpanel in the text.

Response: The subpanels were mentioned accordingly (see Lines 371, 374, 377, 380, 388 and 396 in the manuscript with track changes).

Line 328. Be more specific about what part of the basin you are describing (same as Line 310).

Response: The interannual distributions of individual classes were presented specifically at station scales, which were given as follows.

"*However, the interannual distributions of individual classes are quite distinct at different stations, particularly in the upper Songhua and Wusuli Rivers of Songliao River Basin. At the headstream stations of Songliao River Basin (Figure 5b), the Class 4 is dominant with the annual mean percentage of 26.1±38.3% (n=32) though flood events are missed in several years due to the dry period. The dominance of Class 4 is the most considerable in 1996, 1998, 2002 and 2009 at the Muling station in the upper Wusuli River. At the headstream stations of Yellow River Basin (Figure 5c), the Class 4 is also dominant across the whole period with the annual mean percentage of 58.1±33.9% (n=67), particularly in 1994¬–1996, 1999 and 2007. The dominance of Class 4 is the most considerable in 1993–1995 and 2001–2004 at the Huating station in the upper Jinghe River. At the headstream stations of Huaihe River Basin (Figure 5d), the Class 5 gradually prevail with the annual mean percentage of 41.5±23.7% (n=102), particularly after 2007, whose percentage reaches 63.2±15.8% (n=79). The dominance of Class 5 is the* *most considerable in 2007-2014 at the Beimiaoji station in the southern tributaries. The event numbers of both Classes 1 and 2 gradually decrease, accounting for 33.1±24.4% (n=11) and 8.7±7.1% (n=5) of annual flood events in the period of 1993–1999 and 2011–2015 for the Class 1, respectively, and 20.3±20.9% (n=9) and 2.7±1.3% (n=1) in the period of 1993-1999 and 2011-2015 for the Class 2, respectively. The decrease in Classes 1 and 2 are remarkable at the Peihe station in the southern tributaries and the Ziluoshan station in the northern tributaries, respectively. The explanations are that the total precipitation amount and duration probably increase due to the climate change (Dong et al., 2011; Jin et al., 2024). At the headstream stations of Yangtze River Basin (Figure 5e), the Classes 1, 2 and 4 are dominant, accounting for 29.3±9.6% (n=251), 23.0±11.5% (n=197) and 21.1±7.0% (n=181) of annual mean flood events, respectively. Although the interannual changes of event numbers of Classes 1 (n=1–21), 2 (n=1–14) and 4 (n=1–16) are considerable, those of class percentages are relatively uniform except 2015. The class dominance is the most considerable in 1993, 1995–1997 and 1998 at the Yanling station in the Dongtinglake tributaries for Class 1, in 1993, 1994 and 1997 at the Dutou station in the Poyanglake tributaries for Class 2, in 1998, 2000, 2001, 2004, 2005, 2007, and 2010–2013 at the Biyang station in the tributaries of Hanjiang River for Class 4, respectively. At the headstream stations of Southeast River Basin (Figure 5f), the Class 3 gradually prevail after 2000 with the annual mean percentage of 46.2±32.5% (n=39), which is remarkable at the Longshan station in the upper Jinjiang River. At the headstream stations of Pearl River Basin (Figure 5g), the Class 1 is dominant with the annual mean percentage of 36.0±24.0% (n=52), but gradually shifts to Class 2 which accounts for 30.0±25.2% of annual mean flood events (n=40), particularly after 2008. The class dominance is the most considerable from 1993 to 2007 at the Hezikou station in the upper Dongjiang River for Class 1, and in 1993, 1994, 1996, 2005, 2006, and 2009–2011 at the Xiaogulu station in the upper Beijiang River for Class 2, respectively.*" (see Lines 372–400 in the manuscript with track changes)

Line 356. You should mention Table 4.

Response: The table was added accordingly (see Line 415 in the manuscript with track changes).

Line 362-376. Move to an appendix the description of the other classes. You should comment more than describe.

Response: The control factors and their contributions were presented in the Supplement (Text S1 and Figures S2–5 in the Supplement), and some explanations of the major control factors were also given in this paragraph. This paragraph was shortened as follows: *"According to the Monte Carlo permutation test between flood response matrix and control factor matrix in the individual catchments of Class 1, the total and mean precipitations, and drought index during the event (rpcp_dur=0.65–0.99, n=14; rpcp_av=0.70–0.97, n=7; rSPEI_dur=0.52–0.97, n=7) are the major control factors in 44.7% (17/38), 20% (1/5) and 25% (1/4) of total catchments of the Yangtze, Southeast and Pearl River Basins, respectively (Figure 6 and Table*

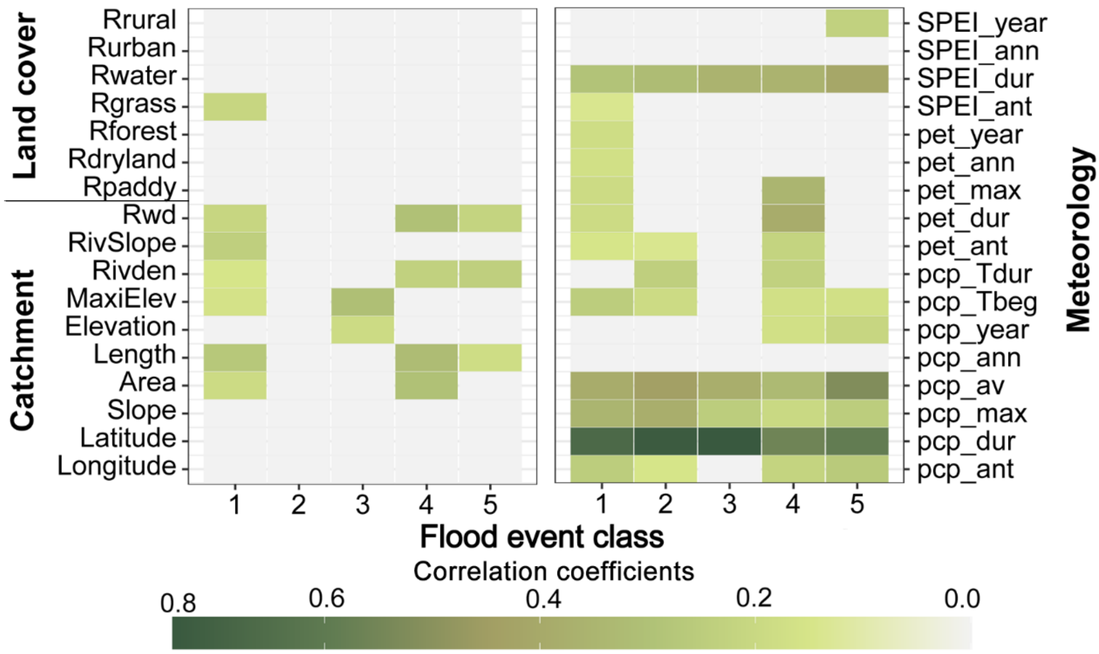
4). The contributions of control factors are statistically significant only in the Liangshuikou catchment of the Yangtze River Basin and Hezikou catchment of the Pearl River Basin. In the Liangshuikou catchment, 96.3% of temporal differences are explained, in which the meteorological and land cover categories explain 92.5% and 3.8%, respectively. In the Hezikou catchment, 66.7% of temporal differences are explained, in which the meteorological category and the interactive impact explain 49.4% and 17.3%, respectively. The major control factors and their contributions for the Classes 2–5 are also presented in Text S1 and Figures S2–5 of the Supplement. For all the classes, only the factors in the meteorological category are statistically significant, particularly the precipitation amount and intensity, and drought index during the events. The most control factors with statistical significances are in Class 1, followed by Classes 4, 5, 3 and 2. These control factors for individual classes are detected mainly in the catchments of Yangtze (Class 1), Yellow and Pearl (Class 4), Huaihe (Class 5), Southeast (Class 3) and Pearl (Class 2) River Basins, respectively. The explanations are that the precipitation amount and potential evapotranspiration during the event usually show remarkable differences among different events, which directly determine the spatial and temporal heterogeneities of flood generation process, and consequently flood event hydrograph, but the land covers usually show slow changes in the headstream catchments due to slight disturbances of human activities and climate changes." (see Lines 407–429 in the manuscript with track changes)

Line 392. Add in parentheses the name that appears in the figure for the grassland.

Figure 8. Add separation between land cover and catchment

Response: It was revised accordingly.

"……particularly the precipitation amount and intensity (i.e., pcp_ant, pcp_dur, pcp_max, pcp_av, pcp_Tbeg, and pcp_Tdur), and the drought index during the events (SPEI_dur) with the correlation coefficients of 0.33¬–0.74, 0.20–0.38 and 0.29–0.41, respectively. The significant factor number in the catchment attribute category is less, which are mainly the mean catchment length (Length), river density (Rivden) and ratio of river width to depth (RivSlope) with the correlation coefficients of 0.18–0.32, 0.15–0.24 and 0.21–0.30, respectively. In the land cover category, only the grassland area ratio (Rgrass)……"(see Lines 457–462 and 465 in the manuscript with track changes)



Line 398-403. You are just describing the number of the figure. I think you should delete that or move to apprendix.

Response: The sentences were shortened, and the numbers of the figures were deleted.

"In the Class 1, the significant control factors are the precipitation, potential evapotranspiration and drought index in the antecedent seven days (i.e., pcp_ant, pet_ant and SPEI_ant) and during the events (i.e., pcp_dur, pcp_av, pcp_max, pcp_Tbeg, pet_dur, pet_max and SPEI_dur), and the potential evapotranspiration at the annual scale (i.e., pet_ann and pet_year) in the meteorological category, the area (Area), mean length (Length), maximum elevation (MaxiElev), river density (Rivden) and slope (RivSlope) and ratio of river width to depth (Rwd) in the catchment attribute category, and the grassland area ratio (Rglass) in the land cover category." (see Lines 468–474 in the manuscript with track changes)

Line 411-424. You are just describing the number of the figure. I think you should delete that or move to apprendix.

Response: The sentences were shortened, and the numbers of the figures were deleted.

"The significant control factors of Class 2 are mainly in the meteorological factor category, including precipitation and potential evapotranspiration in the antecedent seven days (i.e., pcp_ant and pet_ant), precipitation and drought index during the flood events (i.e., pcp_dur, pcp_av, pcp_max, pcp_Tbeg, pcp_Tdur and SPEI_dur). In the Class 3, the significant control factors are mainly the precipitation and drought index during the flood events (i.e., pcp_dur, pcp_av, pcp_max and SPEI_dur) and catchment elevation (i.e., Elevation and MaxiElev). In the Classes 4 and 5, most of the meteorological and catchment factors are significant. The specific factors are the precipitation and potential

evapotranspiration in the antecedent seven days and during the events (i.e., pcp_ant, pcp_dur, pcp_av, pcp_max, pcp_Tbeg, pcp_Tdur, pet_ant, pet_dur and pet_max), drought index during the events (i.e., SPEI_dur) and precipitation at the annual scale (i.e., pcp_year) for the meteorological factor category, and the catchment area (Area), mean length (Length), river density (Rivden) and ratio of river width to depth (Rwd) in the catchment attribute category for the Class 4, and precipitation factors (i.e., pcp_ant, pcp_dur, pcp_av, pcp_max, pcp_Tbeg and pcp_year), drought index during the events and at the annual scale (i.e., SPEI_dur and SPEI_year) for the meteorological factor category, and the catchment mean length (Length), river density (Rivden) and ratio of river width to depth (Rwd) in the catchment attribute category for the Class 5." (see Lines 480–504 in the manuscript with track changes)

Line 429. I am not convinced about the combined impact. The clearer situation is class 2. Catchment and land factors have zero importance by themselves. However, the combined effect is 23%. How can we be sure that the combined effect comes by the synergy of the three factors, if the combined effect is not higher than the meteorological effect by itself? Maybe the combined effect is just the effect of mixing a good factor with two awful factors, and for this reason, it is lower than the meteorological factor. Probably you should sum this combined factor only if it is higher than one of the factors.

Response: Thank you very much for your comments and we were very sorry that the unclear introduction of constrained rank analysis method resulted in the misunderstanding of the effect contributions of individual factor categories and their interactive contributions. We explained the methods in more details and revised the demonstration styles of all the contributions of Figure 8.

The constrained rank analysis was widely adopted to quantify the direct and interactive effects of multiple explanatory matrix on a response matrix. In our study, the individual contributions of meteorological, land cover and catchment categories were calculated by the partial rank analysis. This analysis was implemented by involving a certain control factor category as the independent matrix and the effects of other control factor categories were held constant. The percentage of constrained variance to the total variance of dependent variable matrix was considered as the individual contribution of involved control factor category on total variabilities of flood event classes. Furthermore, the entire rank analysis was also implemented by involving all the control factors as the independent variable matrix, and the variance percentage explained by independent variable matrix was considered as the entire contribution of all the control factors or categories.

If the sum of all the individual contributions was less than the entire contribution of all the factors, the interactive effects existed among the control factors and the difference between the summed and entire contributions was the interactive contribution (see the figure below). Therefore, the total contribution of a certain control factor category was its individual contribution plus the interactive contribution, which you mentioned. The individual and interactive contributions were not comparable. In the manuscript, the combined contribution was revised to the interactive contribution. The entire, individual and interactive contributions of every control factor categories were presented, and the total contribution of every control factor categories were not presented.

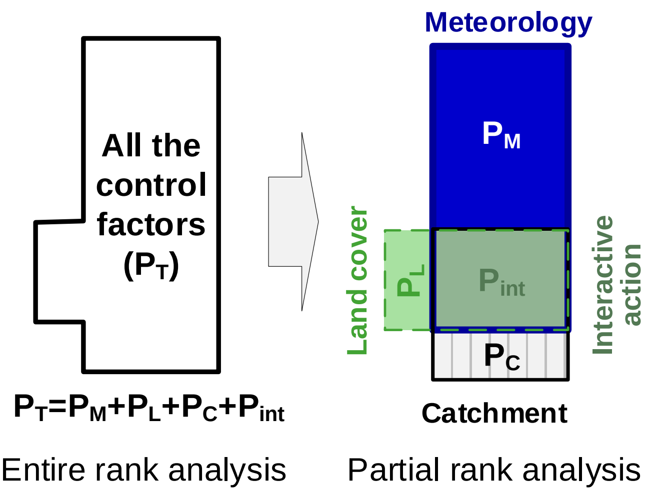


Figure. Entire contribution of all the control factors by the entire rank analysis, individual and interactive contributions of factor categories by the partial rank analysis

The method introduction was revised as follows: *"Additionally, because of multiple control factor categories considered, two constrained rank analyses are implemented, namely entire and partial analyses. The entire analysis is implemented by involving all the control factors as the independent variable matrix, and the variance percentage explained by independent variable matrix to the total variance of dependent variable matrix is considered as the entire contribution of all the control factors or categories on total variabilities of flood event classes. The partial analyses of individual control factor categories are also implemented by involving a certain control factor category as the independent matrix and the effects of other control factor categories are held constant. The percentage of constrained variance is considered as the individual contribution of involved control factor category. The meteorological, land cover and catchment categories are adopted for the analysis individually, and their individual contributions are determined. If the sum of all the individual contributions is less than the entire contribution of all the factors, the interactive effects exist among the control factors and the difference between the summed and entire contributions is the interactive* *contribution (Legendre and Anderson, 1999; Zhang et al., 2016).”* (see Lines 243–259 in the manuscript with track changes)

Furthermore, Figure 8 was revised to present the entire, individual and interactive contributions clearly and some data error was also revised as follows.

“For the entire contributions of all the control factors or categories, 73.3%, 85.4%, 65.9% and 65.7% of total spatial and temporal variabilities of flood events are significantly explained in the Classes 2–5, respectively (Figure 8b–e). For the individual contributions, the meteorological factor category explains the largest variabilities (i.e., 36.5%–50.5%), followed by the catchment attribute category (i.e., 5.1%–6.1%), and the land cover category explains the least variabilities, i.e., 0.0–2.4%. The interactive impacts of all the control factor categories also explain 17.5%–33.0% of total variabilities, particularly in the Class 3.” (see Lines 504–516 and 535 in the manuscript with track changes)

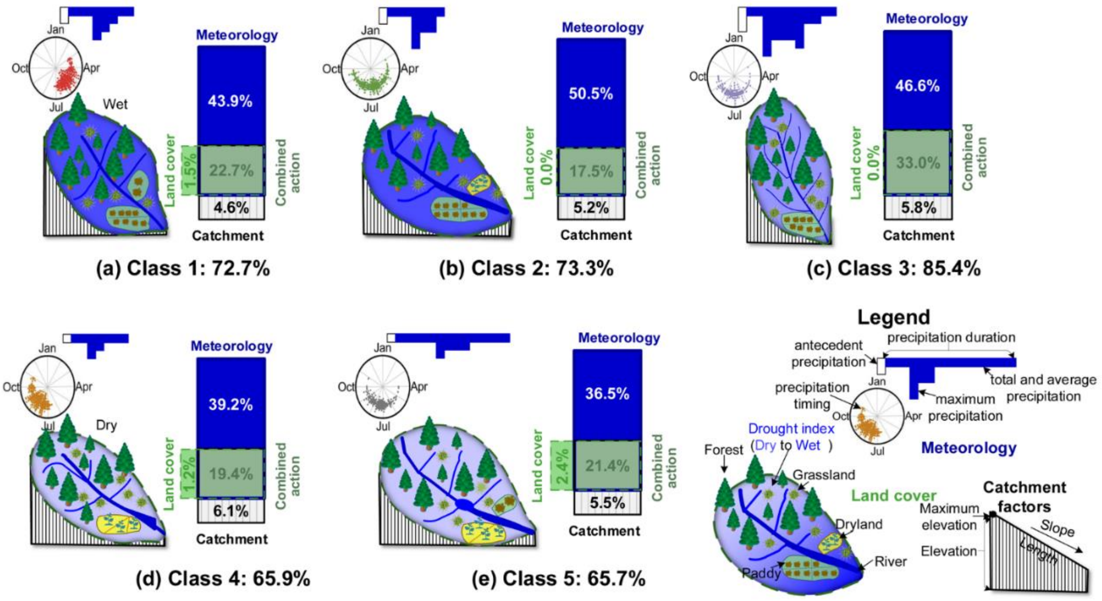


Figure 8. Entire, individual and interactive contributions of control factor categories on the spatial and temporal variabilities of flood event classes 1–5 (a–e)

Line 581. I don’t think that you can claim that your analysis is representative of the entire country. Be specific.

Response: It was revised to “……*at some headstream stations of China*” (see Line 669 in the manuscript with track changes).