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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Risk Zoning of Typhoon Disasters in Zhejiang Province, China" *by* Yi Lu et al.

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Dear Editor and the reviewer,

We do appreciate your constructive, thoughtful, careful, and helpful comments and suggestions. After careful discussions, calculations, and analyses, we finished the preparation of responses to you. The responses are structured in 3 sequence: (1) comments from Referees, (2) author's response, (3) author's changes in manuscript. If there are any new comments or suggestions, please let us know.

Best Regards

Yi Lu and the coauthors

Response to Reviewer 2

1. The English of the manuscript is need be improved.

Reply: Thanks for your comment. According to the suggestion, modifications include:

(1)The first half of Abstract has been rewritten.

(2)"Province" has been changed into "province".

(3)"Comprehensive Risk Index for Typhoon Disasters" has been changed into "Typhoon Disaster Comprehensive Risk Index".

(4)The second half of the last paragraph in Introduction has been rewritten.

(5)The structure of the paper has been changed. Considering that Section 2 is so thin and unbalanced to other sections, "2 Study Area" is merged into "3 Data and Methods" and then the Section numbers hereafter are changed.

(6)Analyses for the figures have been revised especially these for Figure 7.

(7)For grammar, all past tense have been changed into present tense.

(8)Other specific modifications can be seen in detail in the text with revision-tracing.

2. Extend data from 2012 to 2016?

Reply: Thanks very much for the suggestion. As county-level typhoon disaster data is so limited and it's hard to get new data, we can't extend data from 2012 to 2016.

3. The background of typhoon disaster over Zhejiang province must be introduced.

Reply: According to the suggestion, modifications include:

(1) In the last paragraph of "Introduction", a sentence "In this study, Zhejiang province, which is frequently affected by the strongest landfall typhoons (Ren et al., 2008) and experiences most serious typhoon disasters (Liu and Gu, 2002) in the mainland of China, is selected as the study area." has been added.

(2) The following two new references have been added:

Liu, T. J. and Gu, J. Q.: A statistical analysis of typhoon disasters in Zhejiang province, Journal of Catastrophology, 17 (4): 64-71, 2002. (in Chinese)

Ren, F. M., Wang, X. L., Chen, L. S., and Wang, Y. m.: Tropical cyclones landfalling on mainland China, Hainan and Taiwan and their correlations, Acta Meteorologica Sinica, 66 (2): 224-235, 2008. (in Chinese)

4. L74-75. Add reference about best track data from CMA.

Reply: Thanks for your suggestion. According to the suggestion, we have added references about best track data from CMA.

New references are added in L301.

Eunjeong, C. and Ying, M.: Comparison of three western North Pacific tropical cyclone best track datasets in seasonal context, Journal of the Meteorological Society of Japan, 89(3):211-224, 2009.

Li, S. H. and Hong, H. P.: Use of historical best track data to estimate typhoon wind hazard at selected sites in China, Natural Hazards, 76(2):1395-1414, 2015.

5. Describe more detail about the OSAT methods.

Reply: Thanks very much for the suggestion. According to the suggestion, we have added more detail about the OSAT method.

We add following sentences in L96 of section 3.2.1 before " Lu". "The OSAT method is a numerical technique to separate tropical cyclone induced precipitation from adjacent precipitation areas. Based on the structural analysis of precipitation field, it can be divided into different rain belts. Then, according to the distances between a TC center and these rain belts, typhoon center and each station, typhoon precipitation is distinguished."

6. L103: In this section, authors describe the methods of standardization. But corresponding variables are unknown.

Reply: Thanks for the comment. According to the comment, we have added introduction of corresponding variables.

We add following sentences at the end of L107 in section 3.2.3. "Z-score standardization is used for calculating intensity index of factors causing typhoon disasters. Both typhoon precipitation and typhoon maximum wind speed are standardized by this method. When calculating typhoon disaster comprehensive risk index (R), we use MINMAX standardization to standardize the intensity index of the factors causing typhoon disasters (I) and the population vulnerability index (SoVI)."

7. Introduce the method of calculating probability of typhoon rainstorms.

Reply: Thanks very much for the suggestion. According to the suggestion, we have added a definition of "typhoon rainstorm" and "typhoon torrential rainstorm". In section 4.1, we did some research about risk of typhoon rainstorm. Typhoon rainstorm in this study means daily typhoon precipitation over 50mm, and typhoon torrential rainstorm means daily typhoon precipitation over 100mm. The probability is the annual possibility of the occurrence of typhoon rainstorms. The probability denominator is the total number of years, and the numerator is the annual frequency of typhoon precipitation. When a station has experienced typhoon precipitation in one year, the numerator increases by one.

We add following sentences at the end of L133 before "Based on". "Typhoon rainstorm in this study means daily typhoon precipitation over 50mm, and typhoon torrential rainstorm means daily typhoon precipitation over 100mm. The probability is the annual possibility of the occurrence of typhoon rainstorms. "

8. L148: Do you sure about "over six sites"?

Reply: Thanks for your question. We feel sorry for that it is a translation error. This

should be referred to Typhoon wind over 6 grade ($\geq$10.8 m/s). Figure 6 shows average duration (days) of typhoon winds at each station in Zhejiang province from 1980 to 2014. We have modified L148. L148 is modified as follows. "The average duration (days) of typhoon winds (over 6 grade) is calculated in Zhejiang province (Figure 6). "

9. Durations of data in different parts are different. Could durations of different kinds of data are uniformed?

Reply: Thanks for the comment. In the original paper, we used three durations of data, including typhoon precipitation during 1960 - 2013, typhoon wind during 1980 - 2014, and typhoon disaster data during 2004 - 2012. According to the suggestion, durations of daily precipitation and wind have been uniformed with 1980–2014. Duration of typhoon disaster data remains unchanged. Detailed reasons are as follows.

(1)First of all, because of limited access to county-level typhoon disaster data, we have only obtained data during 2004 to 2012 from National Climate Center. So all analyses of intensity index of factors causing typhoon disasters are during 2004 to 2012, which remains unchanged. However, this duration is short for risk analyses of typhoon precipitation and typhoon wind. Therefore, longer time-series data are needed.

(2)We feel sorry for that it is a expression mistake to say "The statistics showed a rapid increase in the number of automated wind measurement stations from 1980" in L77. As Lu et al. (2016) mentioned, considering the homogeneity and continuity of wind data, we use daily wind data during 1980 - 2014 to to identify typhoon wind.

(3)Considering the consistency between wind and precipitation data, 1980 to 2014 is selected as the period of study. In addition, the OSAT method need to identify typhoon wind and precipitation from wide range rain belts (please see detail in section 2.2.1), so 2419 stations of precipitation data and 2479 stations of wind data over the mainland of China are used, which all contained 71 stations corresponding to counties in Zhejiang province.

According to the suggestion, modifications include:

(1) The introduction of daily precipitation and wind data in section "2.1.1 Typhoon, Precipitation and Wind Data" are rewrote as follow. "Daily precipitation data for 2479 stations and daily wind data for 2419 stations during the time period 1960 - 2014 over the mainland of China are obtained from National Meteorological Information Center. The maximum wind speed is given as the maximum of 10-minute mean. In this paper, two time periods of precipitation and wind data are used. Because of limited access to county-level typhoon disaster data, we have only obtained data during 2004 to 2012. So when calculating intensity index of factors causing typhoon disasters, time period of typhoon precipitation and typhoon wind are the same as typhoon disasters, which is 2004 - 2012. For risk analyses of typhoon precipitation and typhoon wind (please see detail in sections 3.1 and 3.2), suppose future probability is the same as historical probability, we then select the period of 1980 – 2014. As Lu et al. (2016) mentioned, considering the homogeneity of wind data, we use the period of 1980 - 2014 for wind analysis. To ensure the consistency between wind and precipitation data, 1980 - 2014 is selected as the period. In addition, the OSAT method need to identify typhoon wind and precipitation from a wider range than Zhejiang province (please see detail in section 2.2.1), so 2419 stations of precipitation data and 2479 stations of wind data over the mainland of China are used, which all contained 71 stations corresponding to counties in Zhejiang province."

(2) The analyses in section "4.1 Risk of Typhoon Rainstorms" are modified. All time periods in this section have been changed to 1980 - 2014, with corresponding changes of calculations and pictures.

10. L178: What criterions are used in calculating precipitation or wind?

Reply: Thanks for the comment. If a typhoon disaster occurs and there is a corresponding typhoon wind or typhoon precipitation, it will be included in the sample.

11. L181: The distribution of sample sizes?

Reply: Good comment. The total valid disaster records of Zhejiang province from 2004 to 2012 are 421. To establish an intensity index of typhoon disaster-causing factors, we carry out CCA analysis. Taking the county as a unit, we select all the typhoons that affected the population, which means all records with an affected population greater than 0. The total precipitation and daily maximum wind speed during affected typhoons measured in each county are used. The total sample size is 322. Then, we do CCA analyses for all the typhoons that caused direct economic losses in the same way, and the total sample size is 404.

According to the suggestion, modifications include: (1) We add following sentences at L179 after "factors causing typhoon disasters". " The total sample size is 322. ". (2) We add following sentences at L182 before "(Table 1)". ", and the total sample size is 404.".

12. L194: the intensity index is calculated for each typhoons and each stations? And how get the distribution of intensity indices in figure 8?

Reply: Thanks for the comment. The intensity index is calculated for each typhoon at each station. Then we average all intensity indices at each station, and we can get the distribution of intensity indices in figure 8.

13. L199-L238. I am confused by the section 5.2. Each factor or component in factor 1 to factor7 in equation 2 or seven components in table 3 is a vector with 29 variables? Please describe more details about factors or components. The signs of vectors from PCA maybe opposite of real meaning. Do you do detail analysis on the relations of variables in a vector and between vectors? The equation 2 is must be evaluated carefully.

Reply: Thanks very much for the comments and suggestions.

(1) For the first question, component 1 to component 7 are vectors in table 3 with 29 variables. After performing PCA of the 29 variables, 7 components with eigenvalue

equal to or greater than 1 are extracted. (2) For the second question, 7 components are examined manually as to whether they increase (+) or decrease $(-)$ vulnerability and they are assigned a cardinality on that basis. Then the vulnerability index is produced by summing all the components using equal weighting, following the Chen (2013) approach.

To conveniently describe details about 7 components, we rename 29 variables (Table 2). After PCA, we obtain 7 components. The signs and contained variables of 7 components are shown in Table 3. We can see 6 components increase (+) vulnerability and a component decrease $(-)$ vulnerability. For example, the first component, which reflects the income of the population and the employment situation, is positive because the more property there is in an area, the higher the vulnerability to damage. The second component, which reflects education level of the population, is negative because if education level is higher, then the population's awareness of disaster prevention and reduction is greater and their vulnerability is lower.

According to the comments and suggestions, modifications include: (1) We rename the 29 variables in Table 2. Details of Table 2 can be seen in the supplement file. (2) We add contained variables of 7 components with different signs in Table 3. Details of Table 3 can be seen in the supplement file. (3) To distinguish the 7 components and 29 variables more clearly, we replace all "factor" with "component" in this section.

14. Could you find data of 29 variables in table 2 in early year? If the difference of population vulnerability between 2010 to early year is analyzed, the manuscript will to be more valuable.

Reply: Thanks for your thoughtful suggestion. The population data used in this paper is obtained from the sixth national population census of the Population Census Office of the National Bureau of Statistics of China and the 2010 statistical yearbooks of each city in Zhejiang province published by the cities' statistical bureaus. There exist many missing and abnormal records in the original data, which take a long time to be

processed. This article focuses on typhoon disaster risk zoning in Zhejiang province, so we didn't discuss the difference of population vulnerability between 2010 to early year. The variation of population vulnerability is an interesting topic. Maybe we can discuss it in future work.

Please also note the supplement to this comment:
https://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2018-14/nhess-2018-14-AC3-supplement.pdf

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