

Response to RC1 Comments

Dear reviewer,

We highly appreciate your valuable comments and suggestions. It has greatly improved the quality of our manuscript.

We have made revisions point-by-point according to your comments and suggestions. In the revised manuscript, the newly added and altered sections are highlighted in red, to hopefully facilitate your review.

The answers for the suggestions and comments are as follows.

Q1: If possible, indicate the four community types (Type 1 - Type IV) in the Wuhan and Hongshan District map (Figure 2)

Authors' responses:

Thanks for your valuable suggestions. According to your suggestion. We've indicated the 11 communities in the Hongshan District map (Figure 2), as follows.

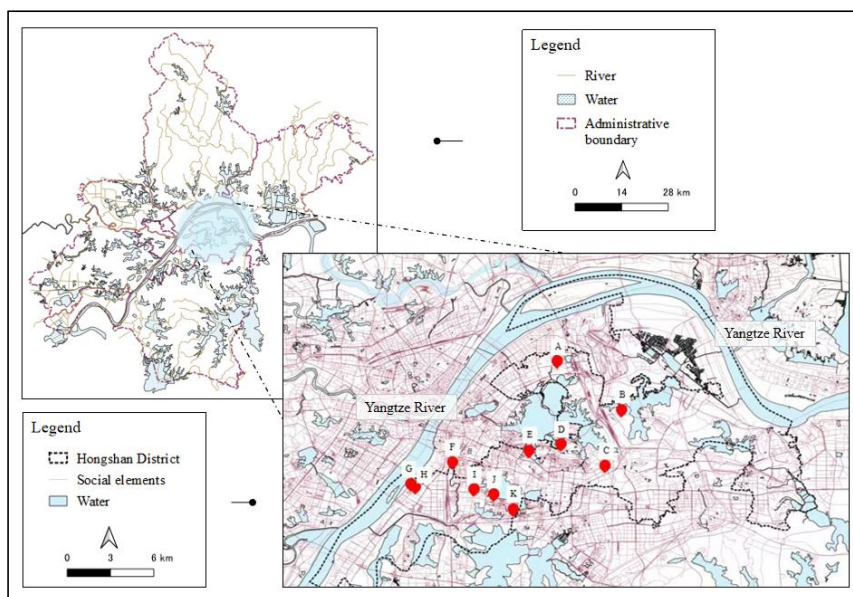


Figure 2. Geographical features and administrative boundaries of Wuhan City and Hongshan District. The points of A-K show the locations of the communities where the questionnaire surveys were conducted.

Q2: In the methods section, the authors should clarify how the data were “weighting” in this context. For example, are you weighting the survey data to be representative of the target community and for non-response bias or are you applying a weighting algorithm to give more importance to certain

measures of vulnerability?

Q3: Section 3.2 (Determination of weight): This section needs much more detail. Describe how you selected experts, the response rate, demographics of experts, methodology for eliciting ratings including the modality (in person, by phone/email, etc.), what prompts did you use, what scale did you provide, how did you define each of the 15 indicators for the experts, etc. If the AHP method you used followed a standard procedure, please at least include a citation. Define what first-level and second-level index means. Describe how you “check the consistency of the judgment matrix”. Include an interpretation of CR, CI, and RI for the reader.

Authors' responses:

Thank you very much for your comments. Firstly, we will explain the weighting part of the methodology. The empowerment of this study mainly adopts a combination of expert scoring method and Analytic Hierarchy Process. The calculation of the weight of this method is not based on research data, but on the scores given by the experts, that is different from methods such as principal component analysis and entropy method. After obtaining the weights of each indicator, combined with research data, the vulnerability of residents is calculated. Therefore, the purpose of weighting is to calculate vulnerability. Each weighting method has its advantages and disadvantages, and we have explained the reasons for choosing this method in the manuscript.

For consistency testing, generally, when the consistency ratio $CR < 0.1$, it is considered that the consistency of the judgment matrix is acceptable, otherwise it needs to be corrected. 0.1 is the best solution obtained by the original author (Saaty 1980) through multiple Monte Carlo simulations. As this step is a necessary step in the Analytic Hierarchy Process, we have added references according to your suggestions when making revisions to facilitate better understanding by readers.

For the expert scoring method, the explanation in the manuscript is indeed not detailed enough, and we have made modifications: Specifically, using snowball sampling, we firstly invited ten experts who are out of our research group from three countries (China, Japan, and Indonesia) through email, including local people with disaster experience, local scholars with disaster experience, and/or researchers on related issues in sociology and geography. By sending Table 2 (including explanations for each indicator) in a word file and specifying the steps for scoring 15 variables related to social vulnerability according to the degree of importance (very important=5, more important=4, generally important=3, less important=2, not important=1), we received feedback via email from all experts. There were no other prompts and the expert response rate was 100%.

Q4: Page 9, lines 27-31: This main idea of paragraph is ambiguous. Are the authors arguing that migrants are de-stabilizing the adaptive capacity of a community or are the authors highlighting the reduced adaptive capacity of migrant individuals?

Authors' responses:

Thank you very much for your comments. For page 9, lines 27-31 in the original manuscript, after our discussion, we think that it is not very helpful in explaining the content of this section, so we have deleted it.

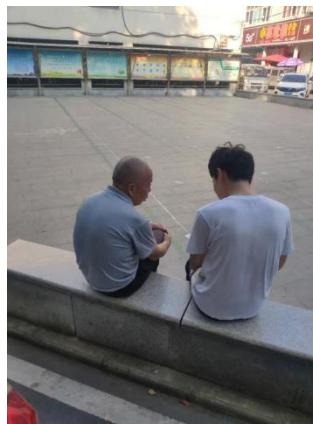
Q5: Section 3.3. (Data collection and analysis): This section is lacking in important details needed to evaluate the quality of the data generated from the survey. The authors should describe how they determined a minimum sample size, how they constructed a sampling frame, and if they stratified communities based on demographic characteristics (e.g., migrant status). The authors should also include a description of the survey questions used to assess social vulnerability factors, how the survey was administered to respondents, and the refusal/non-response rate? The authors do not indicate that the survey data was weighting to account for demographic differences and/or non-response. The lack of weighting seriously undermines the generalizability and validity of the survey data. Without any indication that the data collected are representative of the underlying community, it is inadvisable to extrapolate the results beyond the sample of individuals included.

Authors' responses:

Thanks for your valuable suggestions.

About data collection, we have supplemented it based on your suggestion. Selecting the sampling method, it was taken into account that many urban migrants, especially low-skilled and low-secured representatives of migrant workers, were not fully included in the official urban population list. Therefore, we adopted the method of quota sampling to determine the sample size of each community based on the official data, and the preliminary research and interview data. Then, the required quantity for each community is determined in advance through mutual control quota analysis of the age, gender and household registration characteristics of the surveyed samples, and then distributed face-to-face until the target quantity is collected (Please see the pictures below).

The classification of the four types of communities is based on the official records, socio-economic data, the landscape of the community, and the determination of the number of different types of communities is also based on the preliminary research information. However, due to some communities not being allowed to enter during the research process, a total of 599 questionnaires were obtained from 11 communities.



Q6: Section 3.2 (lines 24-26, Calculation of Final Weight): This section requires much more detail. I don't understand what the authors are referring to in Step 2 (final weight) if Step 3 describes how they

calculated the final weight.

Authors' responses:

Thank you very much for your comments. We are sorry for our mistake. In fact, steps 2 and 3 are one step, just in order to get more scientific results, we take the Arithmetic average, Geometric average, and Eigenvalue to calculate the weights, and then regard the average as the final weight of each indicator. We have made revisions in the manuscript.

(1) Use the judgment matrix to calculate the weight of each indicator (including the first-level and second-level indices), and check the consistency of the judgment matrix.

In the consistency test (Saaty 1980; Lane and Verdini 1989; Lin et al. 2013), the random consistency

ratio in the judgment matrix is $CR = \frac{CI}{RI}$ ¹

And the results of CR in all the matrices are less than 0.10.

(2) The final weight of each indicator was then calculated. To obtain a more scientific result, we used the arithmetic average, geometric average, and eigenvalue to calculate the weights, and then regarded the average as the final weight of each indicator (Table 3).

Q7: Figure 5: This figure is difficult to visually interpret. I suggest using a more simplified chart to display the distribution of each of these dimensions separately.

Q8: Figure 6: Trend lines for each plot in scatter plot matrix would help with interpretation.

Authors' responses:

Thank you very much for your valuable suggestions. We attempted to add trend lines to Figure 6, but the effect was not good and did not help explain this figure. Therefore, we have added an explanation to Figure 4-6 to help readers better understand the information they are intended to show, as follows:

¹ Consistency ratio (CR); Consistency index (CI); Random consistency index (RI)

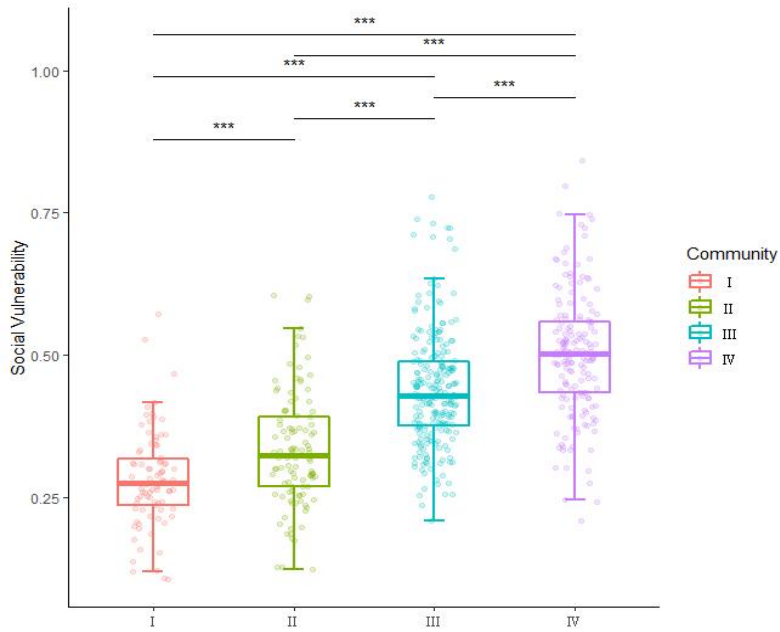


Figure 4. Social Vulnerability Box Plot of 4 type communities. The boxplot is used to represent the central location and distribution range of vulnerability data for the four types of communities, and to compare them. The four colors represented in the legend represent four different community types, each consisting of multiple communities (see Table 1). There is a line in the middle of the box, representing the median of the data; The top and bottom of the box are respectively the upper quartile (Q3) and the lower quartile (Q1) of the data; The top and bottom lines represent the maximum and minimum values of the group of data, respectively. Some points distributed outside represent outlier in the data. This figure can not only show the distribution, outlier, fluctuation and stability of each type of community vulnerability, but also compare the difference of distribution and value of different types of community vulnerability. *Note:* $p < .01^{***}$ ($= .000$)

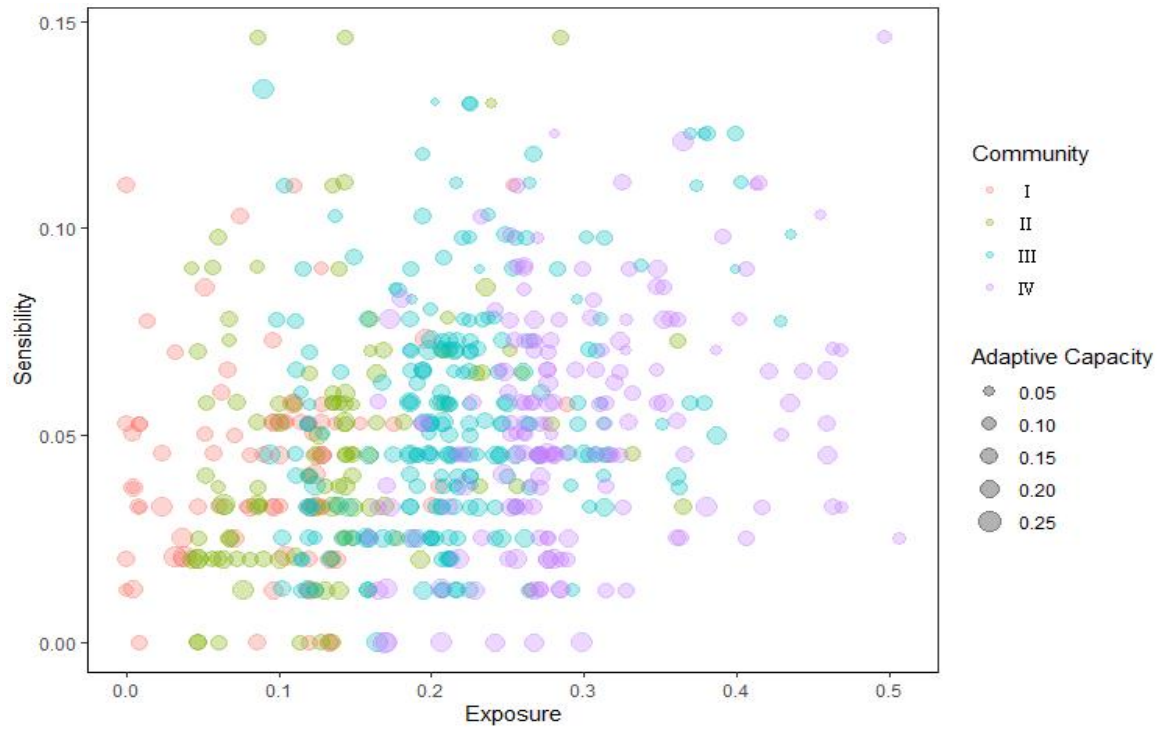


Figure 5. Exposure, sensitivity, and adaptive capacity of four types community. The bubble chart shows three variables (exposure, sensitivity, and adaptability) for four types of communities. Exposure and sensitivity correspond to values on the *X*-axis and *Y*-axis, respectively, and adaptability is represented by the size of the bubble. The four different colors in the legend represent four types of communities, and the dot size is used to explain the size of adaptability. Through Figure 5, not only can the overall exposure, sensitivity, and adaptability of the study area be displayed, but also the differences in exposure, sensitivity, and adaptability of different types of communities can be compared.

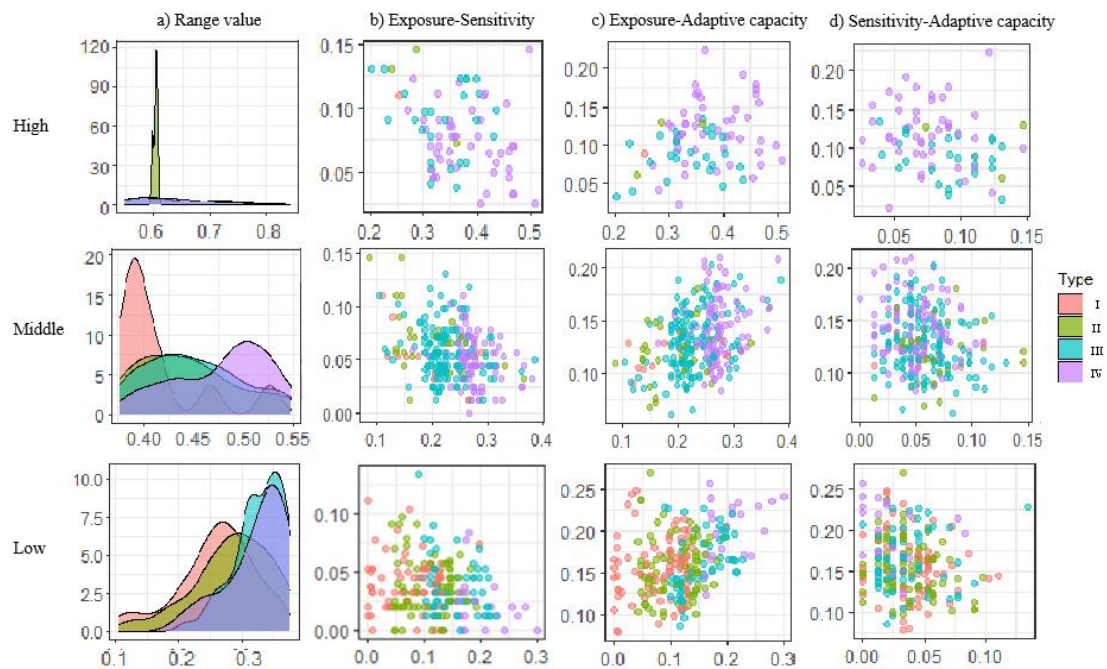


Figure 6. The distribution and characteristics of high, medium and low-level vulnerability. The figure

horizontally represents the distribution of high, medium, and low vulnerability populations in the four types of communities. Vertically, a) Range value is the nuclear density curve of the vulnerable population, with a higher peak indicating a more concentrated level of vulnerability (with smaller differences in vulnerability). Conversely, a lower peak indicating a more dispersed level of vulnerability (with larger differences in vulnerability). At the same time, the concentration range of its vulnerability values can be determined; b) Exposure-Sensitivity represents the correlation between the exposure and sensitivity of vulnerable populations in the four types of communities, with the *X*-axis indicating exposure and the *Y*-axis indicating sensitivity; c) Exposure-Adaptive Capacity represents the correlation between the exposure and adaptability of highly vulnerable populations in the four types of communities, with the *X*-axis indicating exposure and the *Y*-axis indicating adaptability; d) Sensitivity-Adaptive capacity represents the correlation between sensitivity and adaptability of vulnerable populations in the four types of communities, with the *X*-axis indicating sensitivity and the *Y*-axis indicating adaptability.

Q9: Table 5: It is more informative to show the percent of individuals in each community type that were high/mid/low vulnerability than the percent of individuals in each vulnerability category that lived in each community. For example, you show that 61% of high-vulnerability individuals lived in Type IV communities. However, only 27.6% of individuals who lived in Type IV communities are classified as high-vulnerability.

Q10: Page 17, lines 5-6: The authors state that, “The disparity in social vulnerability among inhabitants in various neighborhoods implies “residential segregation” in the metropolitan environments”. However, their previous statement appears to contradict this conclusion: “A previous study (Turner et al. 2003) found that not only do social vulnerabilities vary between societies, communities, and groups, but also among residents in the same area/community. We have verified that using quantitative analysis receives similar findings (see Figure 5).”

Authors' responses:

Thank you very much for your comments. The main purpose of Table 5 is to display the distribution of populations with different vulnerabilities (high, medium, and low) among the four communities, rather than to clarify the distribution of populations with high, medium, and low vulnerabilities in the same type of community. This can also support the phenomenon of residential segregation mentioned in lines 17 and 5-6. We want to compare the vulnerability of residents between different communities rather than those within the same type of community. In addition, the research results presented in 4.1 and 4.2 are from different perspectives. Figure 5 shows social vulnerability between societies, communities, and groups, but also among residents in the same area/community. This is similar to previous research results, so we mentioned the study by Turner et al. 2003.

Q11: Page 19, lines 20-21: I believe that the authors are implying that occupation, household registration, gender and debt cannot reflect the variations in individual social vulnerability because there are no natural quantitative hierarchies to these factors. If so, that argument should be made more explicit. However, I would argue that it would be informative to show the proportion of individuals within each vulnerability group that belong to a specific vulnerable group (e.g., percent of workers

employed in low-skill occupations, percent of individuals without household registration, etc.).

Authors' responses:

Thank you very much for your valuable suggestions. For Page 19, lines 20-21, we apologize for the unclear statement. What we actually want to express is that occupation, residence registration, gender and debt are categorical variables. Different from the continuous variables such as age and education in Table 6, their values cannot reflect individual vulnerability, so they cannot be put in Table 6. Then, we use Figure 7 to show the relationship between occupation, registered residence and vulnerability. In addition, the data results do not reflect the correlation between gender, debt and vulnerability, and it was not shown in the manuscript.

Q12: Page 20, lines 22-23: It is unclear the conclusion the authors present (“Although there are also some low-vulnerability individuals with the rural household registration, it can be argued that they are mainly engaged in state-owned enterprises, including public service units”). is supported by the survey data or if this is a hypothesis extrapolated by the authors.

Authors' responses:

Thank you very much for your comments. We found the results through data analysis of their occupational types, and we have made modifications to this sentence, as followed:

Although there are also some low-vulnerability individuals with the rural household registration, by analyzing their occupational types, it can be found that they are mainly engaged in state-owned enterprises, including public service units.

Q13: Page 16, line 20: The author indicate that communities of Type III have fewer scores than those of Type IV in terms of exposure and adaptive capacity, higher in sensitivity. I believe that they might have meant lower rather than fewer scores.

Authors' responses:

Thank you very much for your suggestion. Page 16, line 20 has been modified to lower scores.

For the language expression you mentioned, we've already asked for professional grammar editing services. Please see the revised version.

Response to RC2 Comments

Dear reviewer,

We highly appreciate your valuable comments and suggestions. It has greatly improved the quality of our manuscript.

We have made revisions point-by-point according to your comments and suggestions. In the revised manuscript, the newly added and altered sections are highlighted in red, to hopefully facilitate your review.

The answers for the suggestions and comments are as follows.

Q1: Line 15: Vulnerability is a key concept for both disaster risk and climate change adaptation. By analyzing the potential factors causing losses, it is possible to predict the extent to which a disaster will impact society in the future (Vincent 2004). The author mentions “factors contributing to losses”; are they referring to the concept of “root causes of a disaster”? Further clarification of this matter is required.

Authors' responses:

Thank you very much for your comments.

This study suggests that the causes of disasters and disaster losses come from both natural hazards and social conditions/social factors. The degree of damage caused by disasters is influenced by factors such as the exposure, sensitivity, and resilience of the social system to hazards. Certain social groups in some circumstances are prone to be impacted towards hazards. Therefore, the factors that cause disaster losses we mentioned are not primarily focused on the hazard itself, but rather on the potential socio-factors that may cause damage in the hazard environment.

We have revised in the introduction section as follows:

Warming has become a predominant feature of the Earth's climate system resulting in changes in precipitation patterns and an increase in the frequency of extreme weather events such as heatwaves, droughts, forest fires, heavy rains, and floods. In recent years, extreme weather events have continued to affect vulnerable sections of society, leading to severe disaster losses worldwide. By analyzing the potential socio-factors that contribute to these losses, it is possible to predict the extent to which future disasters will impact society (Vincent 2004). To reduce disaster losses and improve disaster prevention capabilities, vulnerability has formed an important research since the 1960s. It has been studied in various programs such as in the International Biological Program (IBP), the International Geosphere-Biosphere Programme (IGBP), the International Human Dimensions Programme on Global Environmental Change (IHDP), and the Intergovernmental Panel on Climate Change (IPCC) (Zhang et al. 2008).

In urban areas, social vulnerability is primarily determined by the instability of the local society, especially in the context of rapid urbanization. The continuous increase in population mobility poses significant challenges to local infrastructure, the environment, and social structures. Socio-economic

inequalities among inhabitants manifest as a “mosaic” in the geographical space due to urban transformation. This “mosaic” results in social spatial isolation and leads to a redistribution of risk. Numerous studies on extreme events show that disastrous consequences are not only dependent on the hazard risk itself but are also closely related to physical environments, social structures, and demographic characteristics of a geographic location (Perrow 2007; Bolin 2007). If one place is physically exposed to a hazard risk, it will impact the population living there in uneven ways (Huang et al. 2020). Although urban population mobility itself does not lead to vulnerability (Donner and Rodriguez 2008), the population becomes marginalized when the market and/or government fail to provide adequate employment, water and sanitation facilities, housing, or medical services.

The result of population dynamics and diverse demands for locations, has led to a gradual decrease in the availability of safer lands, making it almost inevitable for human endeavors to be located in potentially dangerous places (Lavell 2003). For example, in Jakarta many migrants, Indonesia live in informal settlements called “Kampung” that are prone to flooding (Alzamil 2018). In Ghana’s capital, Accra 92 percent of migrants live in Old Fadama, a slum area that lacks tap water or sanitation facilities (Awumbila 2014). In China, the push to commercialize urban housing over the past 40 years of urbanization has widened disparities in living conditions. While existing old communities with poor living environments has not seen much improvement, the living quality in newly developed gated communities has significantly increased. This process has also created many marginal places, which are a hybrid of rural and urban systems characterized by high building density, unclear management rights and duties, and insufficient social infrastructure. People living in these areas bear the brunt of many urban disasters. The spatial and social differentiations in cities results in the formation of new socially vulnerable groups based on various types of local communities.

China is currently one of the most disaster-plagued countries in the world, experiencing various types of disasters. In recent years, the frequency, intensity, spatial scope, and duration of these disasters have further expanded. Rapid urbanization in China has led to land expansion and creation of different types of communities within and around the cities. This, coupled with the structural changes in population, economy, and society has made the society unstable. It is crucial to mitigate the impact of disasters on urban populations and communities, and case studies can provide the policy bases for disaster risk reduction. The main purpose of this study was to determine the degree of social vulnerability at the local level and identify the most vulnerable groups by focusing on the characteristics of social vulnerability within Chinese urban society from a micro perspective.

This paper aims to solve the following three questions:

What are the differences in vulnerabilities among different types of urban communities?

What types of mosaics are observed in urban areas? in other words, how are vulnerable populations distributed across communities and what are the underlying reasons for this distribution?

Who are the most vulnerable groups in the city, and what characteristics do they have?

Q2: Line 34: Social vulnerability is influenced by various factors beyond social and economic status. There are as well as political conditions that affect an individual’s or group’s position and power in society and additionally, people’s level of vulnerability may differ based on their life circumstances, age, and the time of year. Why the study did not consider the potential interactions between different social vulnerability indicators, which may affect the overall level of vulnerability?

Q3: Line 13: At the same time, the results also show that about 50% of urban registration holders are also at high and medium levels of social”. Despite the quantitative results, did the author

examine/documented urban social vulnerability from a more optimistic viewpoint, such as the innovative use of existing neighborhood groups for preparedness or the utilization of hazard and vulnerability mapping? Additionally, did the author investigate cases of excellent coordination between municipalities and NGOs/CBOs regarding improvements in risk communication or increased sensitivity to the needs of population, both legal and illegal?

Authors' responses:

Thank you very much for your comments.

The main purpose of this paper is to determine the degree of social vulnerability at the local level, and to identify the most vulnerable groups by focusing on the characteristics of social vulnerability within Chinese urban society from the micro perspective. Our research refers to the Hazards of Place Model of vulnerability (as developed by Cutter, 1996) in the USA context, and applied the model to identify the vulnerability of persons living in risk zones. Vulnerability is conceived of in this model as both the biophysical and the social, but within a specified geographic domain. The HOP model integrates prospective exposures and societal resilience with a special focus on specific locations or areas (Kasperson et al. 1995; Cutter et al. 2000). It emphasizes that hazards should be the product of a specific region operating at the level of natural and social structures, and the vulnerability of a specific society to hazards. In terms of model reference and indicator selection, subjectivity is inevitable, which is one of the limitations of this manuscript.

Q4: Why did the study not consider the potential role of cultural and social factors in shaping social vulnerability and disaster risk?

Q5: Did the author recognize any limitations of this study? If so, it may be advantageous to incorporate these limitations in the manuscript.

Authors' responses:

Thank you very much for your valuable suggestions.

The current research does have limitations, and we apologize for not emphasizing them before. We have made a statement in the conclusion section.

The current research provides collective vulnerability of community. It compares the differences in vulnerability between different communities. However, the community referred was limited to administrative institutions with Chinese characteristics (*Shequ*). Although it also includes geographical and social meanings to some extent, in the Chinese context it is more inclined to the administrative dominion. Therefore, the discussion is mainly considered according to the administrative jurisdiction and does not involve the discussion of social networks, or social capital. The second limitation is in indicator selection and weight determination. The selection of different indicators and the adoption of different methods to calculate weights will produce different vulnerability results. Since there is still a lack of unified standards in the academic community, this study, although the selection is based on previous studies, still cannot avoid adding some subjective judgments. Future studies should explore suitable methods for determining indicators and weights.

Technical corrections: Given the dynamic nature of vulnerability, it would be advantageous to delineate a timeline that specifically identifies periods of heightened vulnerability over the course of the year, particularly in relation to the influence of hazards. Such an approach would enable a more comprehensive appreciation of the “mosaic” of vulnerability within the research site.

Authors’ responses:

Thank you very much for your comments. We strongly agree that the vulnerability you proposed is dynamic, but this dynamic nature is difficult to measure using quantitative methods, especially the quantitative methods used in this study. We conducted a questionnaire survey in June and July 2021. Although summer is indeed the peak period for disasters in the studied area, the questionnaire did not require respondents to only answer the situation during this time period, making it difficult to conduct dynamic vulnerability analysis on the timeline. We believe that the impact of different time periods on residents’ vulnerability may have a greater impact on the exposure dimension. Your suggestion has indeed provided great insights, and we will continue paying attention to the temporal variation patterns of disaster occurrence time, frequency, intensity, and vulnerability in future research.