Anonymous Referee #2

Dear Reviewer:

The authors thank you for the insightful and constructive comments. We have revised the paper to take into account these comments and incorporate your suggestions.
Authors' response is shown in italics, and new text is highlighted in red.

The reviewer's general comments:

This article computes a household level social vulnerability index (HSVI) for eleven villages in Henan Province, China. The study is mixed-methods, as the authors use a combination of expert and lay judgment for variable selection, a household level survey as a primary data collection tool, and a principle components analysis (PCA) for the purposes of data reduction. While the development of a household level social vulnerability index is a novel contribution to the literature because of the lack of household focus within vulnerability indicators literature, the article has several conceptual and methodological shortcomings that must be resolved prior to publication.

The reviewer's comment 1:
First, the manuscript does not fully explain the theoretical value of constructing an index at the household level, nor do the authors identify an audience for the application of their findings. Demonstrating the novelty and utility of a household level index is of paramount importance, since this focus is what makes the study innovative. Is there a reason why households are more appropriate than the prefecture, county, or township levels in the Henan, China, context? What information might the household SoVI communicate that higher levels would not? Who specifically would find this information useful? Simply stating that "the household is the basic unit of social organization" and pointing out the lack of focus on household vulnerability is not enough. Is the interest in examining vulnerability at the household level purely theoretical, or does an initiative by a local government, the central government, or a non-governmental entity provide the basis for the household focus? Perhaps the household focus is more appropriate considering the autonomy of rural, farming households in this region? As written, the article leaves the reader to speculate. Hence, the authors should clarify the context and provide evidence to show the theoretical or practical value of a household level index.

The authors' response:
We have revised the section and emphasized the theoretical and practical value of a household level index. The added texts were marked in red.
All these studies provide a good understanding of the social vulnerability to natural hazards. However, these studies focused on contributing to theoretical research or empirical study at national or regional scales (Garbutt et al., 2015; Zhou et al., 2014; Cutter and Finch, 2008; Cutter et al., 2013). The studies at the household level are very limited. Hence, studying and developing a household level social vulnerability index to flood hazards is an important contribution to examine social vulnerability to natural hazards, because it can provide a new perspective from

individual house level in compare to using national or regional levels. Social vulnerability research at national or regional scales is macroscopical, where the results provide some macroscopical rather than specific and detailed information. For decision making purpose, while studying at national or regional levels is useful for the government to make macrodecision, it is difficult to help the government or household to make operational coping strategies. For example, examining social vulnerability at household level provides details about why households' social vulnerability is at high, low or moderate level. Then the households can take corresponding strategies to reduce their social vulnerability and improve their resilience to natural hazards accordingly. Meanwhile, the results can also be used by the government to make more specific decision-making. Rural areas are one of the most important flood hazard-prone areas (Eakin and Bojorquez-Tapia, 2008; Ghimire et al., 2010), and more than six hundred million people live in a rural area in China. Therefore, understanding the social vulnerability at rural household level is crucial for both rural households and local governments to prepare, mitigate and response to natural hazards (Ghimire et al., 2010; Linnekamp et al., 2011).

The reviewer's comment 2:

Second, there are several gaps in data collection and analysis that need to be addressed:

(1) The abstract states that a principle components analysis (PCA) was performed to calculate the weights of the eight input factors. The manuscript should include the results from this PCA (i.e., component names, percent variance explained, loading scores, and details on rotations and eigenvalues cutoffs). Furthermore, PCA is a data reduction technique to decrease the number of factors being considered and simplify analysis by identifying patterns in multivariate data. A table of variables considered prior to the PCA run would make the process more transparent.

The authors' response:

As indicated by this reviewer, PCA is used to determine the weights of the input factors. As stated in the paper [(P6731, line 9-10. The principles, steps and advantages of using PCA to determinate index weight was detailed in Qu (2012)]. To clarify, we have added the procedures and results from PCA in Appendix 2.

We also used another methods to select the indicators in our study [P6730, line 17-19. One is the discussions with experts from different fields (geography, hydrology, sociology and risk management) *and local farmers (Ghimire et al., 2010), and another is to obtain indicators from the existing literature (Cutter et al., 2003; Werg et al., 2013; Linnekamp et al., 2011)].*

P6731, line 9-11.

Determination of index weights. The principle component analysis (PCA) and expert scoring method were used to determinate the weights of each indicator. After the weights were obtained from the PCA, twenty experts from different fields (geography, hydrology, sociology and risk management) were invited to evaluate and adjust the results in order to make the weights be more suitable for the local situations. The principles, steps and advantages of using PCA to determinate index weight were detailed in Qu (2012). The procedure is also shown in Appendix 2.

Appendix 2. Procedures and results using Principle Component Analysis (PCA) to determine the weights of indicators

There are 4 steps to calculate the weights of indicators using PCA with the help of SPSS software. The first step is KMO test (Kaiser-Meyer-Olkin). The KMO value higher than 0.5 demostrates that the sampling data are suitable to perform PCA (Lolli and Di Girolamo, 2015). The KMO value, performed on indicators variables in "Appendix 1 The standard data and assessment results" is 0.757, which indicates that it is suitable to perform PCA.

The second step is to caculate initial eigenvalues and rotated eigenvalues of the PCA, including total, Variance (%) and Cumulative (%). The value of cumulative (%) should be equal or higer than 80%, which demostrates that the inofrmation of the extracted principle components could cover most of the information of the initial indictors. Table A1 shows the initial eigenvalues and rotated eigenvalues of the PCA performed on the indicator variables in Appendix 1.

Table A1. Initial eigenvalues and rotated eigenvalues of PCA performed on the indicator variables in Appendix 1

Component	Initial Eigenvalues			Rotated eigenvalues		
	Total	Variance (%)	Cumulative (%)	Total	Variance (%)	Cumulative (%)
1	3.33	41.6	41.6	2.39	29.8	29.8
2	1.28	16.0	57.5	1.49	18.6	48.4
3	1.02	12.8	70.3	1.41	17.7	66.1
4	0.77	9.7	80.0	1.11	13.9	80.0
5	0.62	7.8	87.8			
6	0.42	5.3	93.1			
7	0.32	4.0	97.1			
8	0.23	2.9	100.0			

The third step is to caculate the values of rotated component matrix (Table A2).

Table A2. Rotated Component Matrix

	Component			
	1	2	3	4
FS	0.87	0.22	0.01	0.09
DR	0.17	0.05	0.08	0.93
IR	0.07	0.88	0.09	0.12
RPW	0.37	0.76	0.00	-0.07
PCI	0.86	0.22	0.18	0.11
AHI	0.65	0.15	0.51	0.13
VPC	0.52	-0.03	0.53	-0.42
HRT	0.09	0.06	0.91	0.09

Extraction Method: Principal component analysis.
Rotation Method: Varimax with Kaiser Normalization.

The forth step is to caculate the weights of each indicator. The weight of the *i*th indicator (w_i) can be expressed by

$$w_i = \frac{\sum_{j=1}^{k}\left(\frac{a_{ij}}{\sqrt{\lambda_j}} \times v_j\right)}{\sum_{i=1}^{n}\left[\sum_{j=1}^{k}\left(\frac{a_{ij}}{\sqrt{\lambda_j}} \times v_j\right)\right]} \qquad i=1,2\ldots8,\ j=1,2,3,4 \qquad (4)$$

Where, a_{ij} is the value of the ith indicator at the jth rotated principle component, λ_j and v_j are the values of total and variance (%) at the jth rotated principle component, respectively.
Then the weights of all indicators can be obtained using formula (4) as follows
$w=[w_1, w_2,\ldots w_8]=[0.14, 0.12, 0.12, 0.12, 0.16, 0.16, 0.08, 0.11]$
In order to make the results more suitable for the local situations, twenty experts from different fields (geography, hydrology, sociology and risk management) were invited to evaluate and adjust the weights. Finally, the weights listed in Table 1 were used in this paper.

Lolli, S., and Di Girolamo, P.: Principal component analysis approach to evaluate instrument performances in developing a cost-effective reliable instrument network for atmospheric measurements, J. Atmos. Ocean. Tech, 32, 1642-1649, 2015.

(2) In terms of the indicator selection, it is unclear who participated in the process. What do the authors mean by "multidisciplinary specialists?" How many individuals (specialists and farmers) were involved in indicator selection? Was this process carried out systematically through a series of semi-structured interviews, surveys, or focus groups? The reader lacks detail at this juncture.

The authors' response:
Some farmers and some experts from different fields including geography, hydrology, sociology and risk management participated in the process. "multidisciplinary specialists" means the experts from different research fields, we have changed it in the paper. We have added the number of specialists and farmers who participated in the process. We have also added the method used in this part.

Based on the exisitng literature (Cutter et al., 2003; Werg et al., 2013; Linnekamp et al.,2011) and interactive discussions with 30 local farmers and 20 experts from different study fields (geography, hydrology, sociology and risk management), and using the semi-structured interviews method (Harrell and Bradley, 2009), eight indicators were identified to assess the social vulnerability at household level to flood hazards.

Harrell, M. C., and Bradley, M. A.: Data collection methods. Semi-structured interviews and focus groups, Rand National Ddfense Research Inst. Santa Monica CA, 2009.

(3) How were local households sampled? Section 3.3 states that 100 households were selected based on local officials' advice. Without further details on selection, this procedure hardly seems systematic or repeatable.

The authors' response:

We explained the criteria to choose these households as our survey targets, and the criteria were marked in red.

The requirement for participants was that they could answer a questionnaire and have been affected by a flood disaster. One hundred households were chosen according to the local officials' sugestions.The criterias to choose survey targets were: 1) the household had been affected by flood hazard, 2) The flood hazards had resulted in property danage or loss of life, 3) the family characteristics should be as different as possible, and 4) the residences in the households were able to understand and answer a questionnaire clearly. All the 100 copies of the questionnaire were collected on the spot, and 6 copies were eliminated due to the inconsistent and incomplete answers.

(4) Section 4.2, lines 15-17, make reference to interviews about locals' flood risk perceptions. The reader lacks details on when and how these interviews were conducted.

The authors' response:

In section 4.2, lines 15-17, we did not refer to locals' flood risk perceptions. We just explained the methods and strategies to reduce social vulnerability at country, region or river basin levels in previous literatures. The purposes are 1) emphasizing the previous researches scales mainly focus on macroscopical scales and be lack of household scale, and 2) switching to our research, i.e. how to reduce social vulnerability at household scale.

(5) What is participatory rural appraisal (PRA), and how was this method integrated in the study? The authors reference PRA but do not cite any literature on this method or discuss its procedural steps.

The authors' response:

Thank you. We have added two references, which contain detailed procedural steps about PRA method.

Two methods, participatory rural apprasial (PRA) and household survey, were used to gather the data. The PRA method was used to gather some supporting information (Chambers, 1994; Cornwall and Pratt, 2011), such as their socioeconomic status, attitutes to flood hazards. Household survey (individual interviews) was used to collect the quantitative data of social vulnerability indicators (Ghimire et al., 2010).

Chambers, R.: Participatory rural appraisal (PRA): analysis of experience, World Development, 22, 1253-1268, 1994.

Cornwall, A., and Pratt, G.: The use and abuse of participatory rural appraisal: reflections from practice, Agr. Hum. Values, 28, 263-272, 2011.

The reviewer's comment:

Below are a few minor corrections:

(1) Page 6736, Section 4.1, lines 7-10: The text incorrectly states that the two Cutter et al. studies tested the validity of SoVI during Hurricane Katrina. A 2010 study by these authors did apply SoVI to the New Orleans context, but their social vulnerability index has been used as a descriptive algorithm, not as a validation tool.

The authors' response:

We will remove the following sentence marked in red in order to make the description more accurate.

Page 6736, Section 4.1, lines 7-12:

A comparison between the assessment results and a post-event situations is a feasible method to test the validity of selected indicators and their weights. For example, Cutter tested the validity of the SoVI during Hurricane Katrina (Cutter et al., 2003; Cutter and Finch, 2008). In this study, we calculated the correlation coefficient between socres of household social vulnerability and the casualties of each household in a storm flood in July 2010. The results showed that the correlation coefficient was significant at 0.05 significance level (r = 0.748), which indicated that the selected social vulnerability indicators and their weights were valid.

(2) Page 6736, Section 4.1, lines 10-14: Correlation between the HSVI and casualty numbers from a recent flood is offered as a means to validate the current index. The calculated Pearson's r of 0.248 establishes only a weak positive relationship, not validation. The authors should consider rewording this.

The authors' response:

The value of r should be 0.748. We have made a spelling mistake. We have changed it. Thanks for catching this.

(3) Page 6732, Section 3.2, lines 19-23: The eight indicators are organized into two groups: family characteristics and what seem to be coping abilities. An additional sentence or two explaining this two-type distinction would be helpful. As written it is unclear why there is a need for these two categories.

The authors' response:

Good suggestion. Now we think it is unnecessary to divide them into two groups. Lines 18-22 have been deleted.

(4) Table 1: In reference to the hazard training, in what types of training did residents participate? Please clarify in the text.

(5) Table 1: It is also unclear which indicators came from expert judgment and which came from outside literature consulted.

The authors' response to (4) and (5):

The types of training mainly include listening to lectures and participating in emergency exercise. We have added them (marked in red) into Table 1.
The indicators of "the ratio of perennial working in other places" and "access to hazard-related information" came from expert and existing literature. We had marked them in table 1.

Hazard-related training	0.14	Times to take part in hazard-related training for last 5 years	No=0; One time=0.5; Two or more times=1	The knowledge, attitudes and behaviours to disasters can be improved by attending training (listening to lectures and participating in emergency exercise.). So, the more times to attend, the lower the SV.

The indicators of "the ratio of perennial working in other places" and "access to hazard-related information" came from experts and exisiting references (Cutter et al., 2003; Werg et al., 2013; Linnekamp et al.,2011).

(6) Table 2: A tiered bar graph showing the proportion of high, moderate, and low HSVI with the 'n' superimposed on top of each category would be easier to interpret.

The authors' response:
We have changed the table 2 into the form of bar graph.

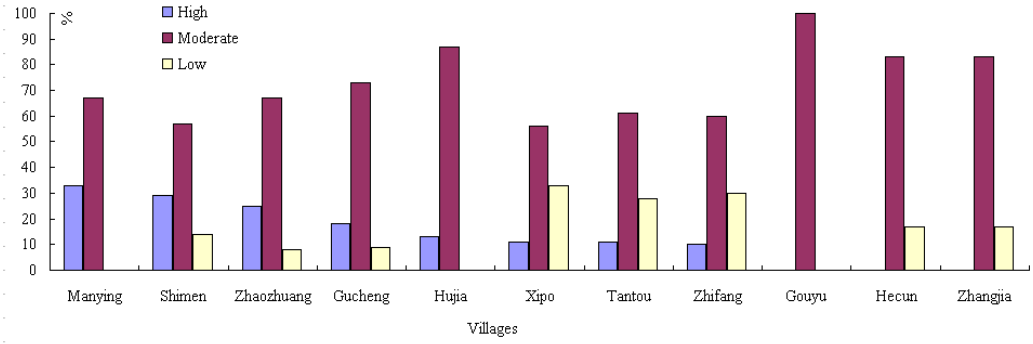
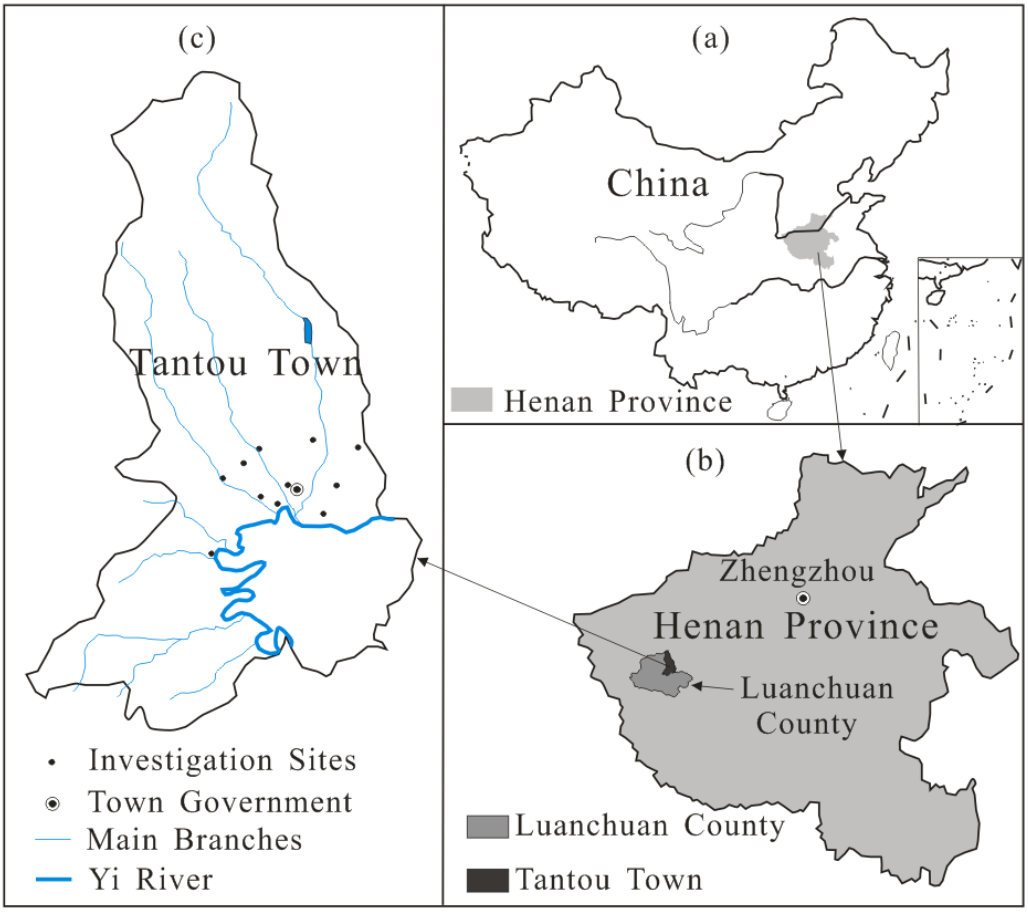


Fig. 2 Spatial distributions of household social vulnerability (%)

(7) Figure 1c should be remapped at a higher resolution to distinguish the symbol for town governments from the symbol for investigation sites. Labels on town names and water features would be helpful as well.

The authors' response:
We have remapped this figure as the following.



Spelling mistakes abound within the manuscript and are too numerous to list. Sentence structure and grammar are awkward in several locations: page 6730, line 17; page 6730, Section 2, line 5; page 6732, Section 3.2, lines 18-22 (deleted); page 6736, section 4.2, line 16-17.

Thank you. Changes have been made.

page 6730, line 17

The original sentence:

One is interactive discussions with multidisciplinary specialists and local farmers.

The revised sentence:

One method was to have discussions with experts in multiple disciplines and local farmers.

page 6730, Section 2, line 5

The original sentence:

The index-based assessment method was used here maily because (1) which can efectively reveal the spatial and temporal patterns, evolution of vulnerability to a natural hazard at diifferent scales.

The revised sentence:

The index-based assessment method was used in this paper because: (1) it can effectively reveal

the spatial and temporal patterns, as well as the evolution of vulnerability to a natural hazard at different scales.

page 6736, section 4.2, line 16-17.

The original sentence:

For example, there were 64.2% of the interviewed people thought that a flood did not occur in this region, and only 23.2% of the interviewed people often received trainings of hazard-related knowledge or evacuation skills.

The revised sentence:

For example, there were 64.2% of the people interviewed thought there was no occurrence of flood in this region, while there has been three times of flood catastrophes in the past fifty years (1953, 1975 and 2010). Only 23.2% of the people interviewed regularly received trainings pertain to hazard or evacuation.