Re: Manuscript reference No. nhessd-3-1473-2015

Dear Dr. Fausto Guzzetti,

Thank you very much for your supervision of the reviewing process of the manuscript (Ref. No. nhessd-3-1473-2015). We appreciate the reviewers' careful, conscientious, and broad knowledge on the relevant research fields, since they have given us a number of beneficial suggestions. These comments are insightful and enabled us to greatly improve the manuscript.

Based on the comments we received, a rewrite with recommended modifications has been performed. For the convenience of reviewers, all the amendments are highlighted in red in the revised manuscript. The following pages contain a point-by-point response to each of the reviewers' comments.

We hope that the manuscript revisions and our accompanying responses will be sufficient to make our manuscript suitable for publication.

We shall look forward to hearing from you at your earliest convenience.

Yours sincerely,

Jinghai Xu

Responses to the comments of Referee #1

General comments:

1. The manuscript describes the validation of a procedure aimed at estimating the human loss due to earthquakes in China. The manuscript also focuses on how the availability of good dasymetric maps of population and building area allows to improve the speed, accuracy and positioning of loss estimation. The method is based on two of phases. In the first one, depending on the different level of expected earthquake intensity, a set of pre-calculated maps of loss are built. The second phase concerns the time period immediately after an event: a new map is defined, where the intensity is modeled exploiting information on the magnitude and the epicenter location of the real earthquake. The loss is then conveniently calculated, given the estimated intensities, querying the pre-calculated set of maps of loss. The method is validated using 4 different earthquakes and proves to work enough well though it is not able to predict the loss due to other types of geological phenomena triggered by the earthquakes (e.g. the landslides).

   The paper doesn't present new data or concepts but the method is, as far as I know, interesting and relevant within the scope of NHESS.

   While the method is described enough clearly there is an important element that is not discussed enough. The method is based on the dasymetric map concept but in the manuscript there is not a clear description of the procedure adopted for the creation of the dasymetric maps of the buildings and population. I believe that the revised version of the paper should include, at least, a section where the production of these maps is described. This is important also for the reproducibility of the method.

Response: we added a new section 3.2 to provide more details about the exposure data (population) production. But we still want to control the length of this section for two reasons:

(1) This manuscript is the result of two large research projects. The work on producing the exposure data was done by other scholars of the project group and has been published in three papers (although they are in Chinese).

Han, Z. H., Li Z. Q., Chen, Z. T., and Ding, W. X.: Population, housing statistics data spatialization research in the application of rapid earthquake loss assessment: a case of Yiliang earthquake, Seismology and Geology, 35, 894–906, 2013. (in Chinese)

Chen, Z. T., Li, Z. Q., Ding, W.X. and Han, Z. H.: Study of Spatial Population Distribution in Earthquake Disaster Reduction—A Case Study of 2007 Ning'er Earthquake, Technology for Earthquake Disaster Prevention, 7: 273-284, 2012. (in Chinese)

Jiang, D., Yang, X. H., Wang, N. B. and Liu, H. H.: Study on Spatial Distribution of Population based on Remote Sensing and GIS, Advance in Earth Sciences, 17, 734-738, 2002. (in Chinese)

(2) Even if a reader is not able to read the papers listed above about the production method of the exposure data used in our paper, he/she can still reproduce the two-phase disaster estimation method. Because, there are many studies on related data production methods can give good references (such as, Jia et al. (2014), Alahmadi et al. (2013), and Thieken et al. (2006)). Meanwhile, some globe exposure dasymetric data are available, for example the LANDSCAN data (http://web.ornl.gov/sci/landscan/), which has global coverage. It is free for the USA government departments and may be free for research institutions after application.

Jia, P., Qiu, Y.L., and Gaughan, E. A.: A fine-scale spatial population distribution on the high-resolution gridded population surface and application in Alachua County, Florida, Applied Geography, 50, 99–107, 2014.

Alahmadi, M., Atkinson, P., and Martin, D.: Estimating the spatial distribution of the population of Riyadh, Saudi Arabia using remotely sensed built land cover and height data, Comput. Environ. Urban, 41, 167–176, 2013.

Thieken A. H., Muller M., Kleist L., Seifert I., Borst D., and Werner U.: Regionalisation of asset values for risk analyses, Nat. Hazard. Earth Sys. Sci., 6, 167–178, 2006.

2. The abstract is enough complete but the title could be improved.

Response: we have changed the title. The new title is "*A quick earthquake disaster loss assessment method supported by dasymetric data for emergency response in China*".

3. The font sizes of the texts inside the figures seems too much small.

Response: We have enlarged the font size inside the figures.

4. Previous works are correctly cited but at least in one case, the corresponding manuscript is not immediately available from the web. The overall presentation of the manuscript is easy to understand and the length is adequate.

Response: Some of references are in Chinese, especially research reports and Chinese technical rules. We have marked them in the reference list now.

5. Though I'm not a native English speaker, I think that the language is not enough good and fluent.

Response: We have carefully checked the English again. As non-native English speakers, we make great endeavors on English expression of this manuscript.

After the first formal version of the manuscript finished, we paid a British company for the manuscript proof-reading service (**the documentation is attached at the last page of this letter**). Then we invited a USA native scholar (Assocate Professor Scott Miles at Western Washington University) to revise the manuscript from the professional perspective (earthquake engineering). After this procedure, we then submitted it to the NHESS.

Currently, we invite a Chinese scholar (Assistant Professor Wenxia Tang at Central China Normal University) who earned MS and Ph.D. degrees in Canada to help us revise the manuscript again from GIS perspective.

This manuscript is about the inter-discipline research in GIS and earthquake engineering. We try to make the expression of this manuscript easy to be understood by the professionals from both fields.

Specific comments:

6. In the paper the authors frequently use the phrase: "km grid format". This can be rephrased simply to "raster format" or to "raster format having a resolution of ...". This is particularly true if they have used a geographical projection and a resolution of 30".

   As the authors say the equivalence of 30" to 1 km is not true for all the latitudes. More in general it could be technically interesting to know exactly the type of projection adopted for the maps and the project in general.

Response: We still prefer to use "km grid" based on the following reasons:

(1) 'Grid' is a kind of raster format data, but more specific compared to 'raster', usually used for raster data whose pixels are square in GIS. The disaster exposure data have a pixel size of a square in the length of 30".

(2) It is true that "km" is just a nominal length, the length of 30" is about 1 *km* only at the equator. Strictly speaking, the length and width of the pixel are not equal after projection (although both of them are 30"). That also means it should not be the grid. However, in Chinese GIS and earthquake engineering communities, people generally name these data in km grid format. We also noticed that similar expression is used in international refereed journal papers (e.g., *Jia, P., Qiu, Y.L., and Gaughan, E. A.: A fine-scale spatial population distribution on the high-resolution gridded population surface and application in Alachua County, Florida, Applied Geography, 50, 99–107, 2014.*).

    Compared to general GIS applications, no special requirements or rules is needed on the selection of projection type for the exposure data. For example, in China, we will use Gauss-Kruger projection if the map is for local use (small area, large map scale), and Albers projection will be used if the map is for nationwide use (larger territory, small map scale). Thus, Albers projection is used for this study.

7. p1476 r20: Here the authors cite a former work but there is no reference and it is not possible, for a reader, to know how the dasymetric maps have been created. This is fundamental also for the reproducibility of the method.
   p1479 r26. Again, it is not clear which method and data the authors have used to create the dasymetric maps.

Response: We have extended section 3 of the manuscript and a detailed description has been added about the exposure data production.

8. p1479 r17: As above. Moreover the figure 7 is not discussed enough and it is not easy to understand for a reader.

Response: More discussions have been added in section 5.2.

9. p1483 r2: it is not clear what the j stands for.

Response: Thank you for pointing this out and we have added it in the manuscript. It refers the damage degree, which ranges from "no damage" to "collapse" as shown in table 2.

10. p1485 r3-6: I understand the concept but it is not completely clear. I think the authors should rephrase with something as: "1) The DPM tables have been associated with the vector map of the earthquake zoning of China. 2) The vector map has been then converted to a raster map where the cells values depend on the DPM tables. The raster resolution is the same of the exposure maps"

Response: We have rewritten this paragraph according to your suggestions. Thank you.

11. p1485 r3 and r8 : I'm not sure that "gridding" is the most convenient word. I suggest "vector-to-raster conversion"

Response: We retain the use of "gridding" for consistency with the response 6.

12. p1485 r10-13: I understand but it is not clearly written. Please rephrase.

Response: We have rephrased it.

13. P1485 r18: Here ND is directly proportional to f_t but, according to table 4, f_t is inversely proportional to the earthquake intensity. Is it normal? Unfortunately I wasn't able to check reading the manuscript of Ma and Xie (2000) since it is not available online.

Response: The reference Ma and Xie (2000) is available at Chinese National Knowledge Infrastructure (CNKI, http://www.cnki.net/), but it is in Chinese. Table 4 is adapted from their study. According to their study, ft decreases as earthquake intensity increases. When earthquake intensity increases, the ratio between people death in daytime and people death at nighttime increases (the death population caused by an earthquake in the daytime and nighttime tend to be equal in large earthquake intensity). The ft value is normalized as 1 in daytime, so the ft value decrease in large intensity at nighttime.

14. P1486 r3: What is the "map algorithm method"? Perhaps "map algebra"?

Response: Yes, it should be “map algebra”. Thank you for pointing out this mistake.

15. 1486 r3-5: Not clear. The authors say that “ND” depends on “RD” which in turn depends on “RB”. However RB was estimated, (section 4.1.3) using 100 maps, so now, IMHO. we should have 100*10 = 1000 maps.

Response: RB is the building collapse ratio, RB= area of all collapse buildings / area of all buildings (including all type buildings). Although RB is calculated in section 4.1.3, but it only has one value for a certain intensity. Then we have 1*10=10 layers on population loss.

16. P1487 r3-5: Which is the approach when an earthquake hits this dividing zone.

P1487 r8-12. I can’t understand.

Response: Form r3-12 describes the generation of theoretical isoseismal map based on epicentre location (longitude and latitude), magnitude (Ms). More descriptions have been added in the section 4.1.2.

17. P1487 r20-22 Please add more details. Not enough clear.

Response: we hope the added descriptions plus the response 16 will make it clear.

Technical corrections

18. P1489 r23: “it still not easy”, please add the missing "IS".

Response: Thank you. We have edited it.

19. Please check this references.
    In the text: Nadim et al 2003 (or 2004) ? Lin, 2011 (or Lin (et al.), 2011) (GB/T18208.4, 2005 (is not in the references list). In the references section: Dobson, J. E., Bright, E. A., Coleman, P. R., Durfee, R. C., and Worley, B. A.: LandScan: a global population database for estimating populations at risk, Photogramm. Eng. Rem. S., 66, 849–857, 2000 (not in the text)
    Whitman, R. V., Reed, J. W., and Hong, S. T.: Earthquake damage probability matrices, available at: www.iitk.ac.in/nicee/wcee/article/5_vol2_2531.pdf (last access: 20 November 2014), 1973 (not in the text)

Response: (Nadim et al, 2004) and (Lin et al, 2011) are in the references list.

Nadim, F., Moghtederi-zadeh, M., Lindholm, C., Anderson, A., Remseth, S., Bolourchi, M., Mokhtari, M., and Tvedt, E.: The Bam earthquake of 26 December 2003, B. Earthq. Eng., 2,119–153, 2004.

Lin, J., Cromley, R., and Zhang, C.: Using geographically weighted regression to solve the areal interpolation problem, Annals GIS, 17, 1–14, 2011.

GB/T18208.4, 2005 is updated with (GB/T19428-2003, 2003).

Other two references are in the text.

There may be some misunderstanding on the reference format. For example, in the text, we use (Dobson et al., 2000) and Whitman (1973) to cite corresponding references.

Responses to the comments of Referee #2

General comments

1. The quality of the presentation could be improved. In particular, the English should be thoroughly checked. Particular care should be devoted to ensuring the consistency of the acronyms (for instance, the term DPM (Damage Probability Matrix) is often susbstituted with DMP). The references should be checked as well for typos and inconsistencies.

Response: we have carefully checked the English expression again. More explanations are listed in the response 5 for referee #1.

2. Furthermore, the captions of the figures should contain a brief explanation of the content of the figures themselves.

Response: we have added a brief explanation for figure 1, for other figures the captions already have brief explanations.

Specific comments

3. the dasymetric approach, which is a core component of the paper, has not been properly described and discussed. What methodology has been followed for disaggregation?
   References should be provided and a clear explanation of the approach should be provided. The input data used to define the underlying exposure model is not clearly described.
   Moreover, the references points to papers available only in Chinese (to my knowledge), therefore would be useful either provide more useful references or describe in more details the data and used methodologies.

Response: We have added a new section 3.2 to provide detailed information about the exposure data production method. More explanations are listed in the response 1 for referee #1.

4. Generation of iso-seismals: how are the short and long axes of the ellipsoid computed? (i.e. how is the length of the rupture estimated?)

Response: More description have been added in section 4.2.1. The method used for the generation of iso-seismals excludes the estimation of rupture length.

5. The calibration of the DPMs included damage data from the earthquakes considered for validation of the proposed approach?

Response: The DPM introduced in the manuscript is the one widely used in China Earthquake Administration. It is deduced from historical earthquake disaster losses and analytic approaches. However, the disaster losses in the validation section are not included for its deduction.

6. For the 4 validation earthquakes, information about the expected and actual focal mechanism should be provided to assess the performance of the stage 1 of the coseismic assessment.

Response: Focal mechanism is out of the scope of this study. But the accuracy of isoseismals in stage 1 really has influence on the estimation. We have added more discussions about this issue in the section 5.2.

7. Page 17 line 5: According to the Authors "speed is more important than accuracy". This assertion is questionable and should be further motivated, or discussed. In general the common sense would suggest that a suitable tradeoff between speed and accuracy should be attained, but this information should come from the end-users and being closely related to the emergency response application.

Response: For earthquake emergency response, disaster loss estimation speed is more important than accuracy in China. This is acknowledged in the China Earthquake Administration (CEA). CEA is the government department who is directly responsible for the earthquake disaster emergency response. We address this issue in the introduction section, from first paragraph to the third paragraph:
"*Many real earthquake rescues have shown how prompt and correct decision-making about rescue countermeasures are crucial for success….*"

More explanation: The Chinese government needs to make quick disaster loss estimations for rescue decision making. 0-72 hours after an earthquake is crucial for emergency rescue, because people death will sharply increase after this period (it is known as "golden 72 hours"). Generally, it needs more than two days to prepare rescue materials, rescue troops and to send these materials and troops to the disaster area in China. The preparation and dispatch commands are based on the suggestions of the earthquake experts in the CEA. Thus, the time for earthquake experts to provide rescue suggestions should be no more than 1 hour after the earthquake. Currently, CEA needs almost ten minutes to collect information of earthquake three elements (earthquake magnitude, earthquake location, earthquake occurrence time), then disaster loss estimation will cost at least twenty minutes (generally 30-40 minutes). Time is also needed to get other information about the disaster area to prepare rescue suggestions, for example geological information, geographic information.

8. There is no discussion about the validity of the assumptions related to risk assessment, nor a discussion on the uncertainties in the different model components, in particular those used to implement the disaggregation.

Response: New discussion on uncertainties of the different model components have been added in section 5.2, i.e. the accuracy of isoseismal map and the disaggregation method.

9. The discussion on the validation would highly benefit from a modelling of the uncertainties. In particular, higher absolute errors to be expected in case where small number of fatalities is forecasted (cases E2 & E3). (that is, the aleatoric component plays a much greater role). Perhaps

a percent error could be used, or another type of relative difference. The case E4 should be discussed in more details separately, as indeed a significant difference between forecasted and actual estimate can be observed.

Response: we agree with the referee's perspective and use the eq. (1) to express the relative derivation between the estimation result and real result. However, we find it is not as straightforward as absolute derivation (shown in Table 1). Thus, we still keep the absolute derivation.

$$D_r = \left|\frac{Loss_{real} - Loss_{estimation}}{Loss_{real}}\right| \quad (1)$$

Where D_r represents relative derivation; $Loss_{real}$ is the real people loss caused by the earthquake disaster; $Loss_{estimation}$ is the estimated people loss in the earthquake disaster.

Table 1. Estimation accuracy of experimental cases

Performance	Estimation method	E1	E2	E3	E4
People loss estimation	No grid data support (traditional method)	170,739	31	68	237
	Grid data support (two phase method)	63,093	75	70	369
Real people loss		69,227	80	95	617
Absolute accuracy	No grid data support (traditional method)	246.7%	38.8%	71.6%	38.4%
	Grid data support (two phase method)	91.1%	93.8%	73.7%	59.8%
Relative accuracy	No grid data support (traditional method)	146.7%	61.2%	28.4%	61.6%
	Grid data support (two phase method)	8.9%	6.2%	26.3%	40.2%

We have added more discussions in section 5.2 on the possible reasons that cause the derivations as mentioned in response 8.

Field investigation result of case study E4 is now available from a new research report (*China Earthquake Administration: Report on earthquake disaster information service and emergency response decision-making support platform, Institute of Geology, China Earthquake Administration, Beijing, China, 412 pp., 2015. (in Chinese), whi*ch shows that one third of people losses are caused by the secondary geological hazards in the Ludian earthquake, and this result basically agree with the discussion on E4 in the manuscript.

10. Page 12 line 11: are the authors referring to the "seismic intensity with exceedance probability of 10% in 50 years"? Moreover, this is usually referred to as "hazard" and is only a proxy of "earthquake disaster risk", lacking the exposure and vulnerability information.

Response: Thank you for pointing this out. We have edited it.

11. Table 1: "Griddding damage possible matrixes". Does it refers to "Gridding Damage Probability Matrices"?

Response: Yes, we have edited it. Thank you.

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22 December 2014

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Document title:	**A dasymetric data supported earthquake disaster loss quick assessment method for emergency response in China**
Author(s):	**Jinghai Xu; Jiwen An; Gaozong Nie**
Format:	**British English**
Style guide:	**Natural Hazards and Earth System Sciences at http://www.natural-hazards-and-earth-system-sciences.net/home.html**
Particular comments:	**None**