Response to Anonymous **Referee #2**

In this document, the underlined part is the revision that we will make for the new manuscript.

Main Comments

GENERAL COMMENTS

Modelling casualties caused by earthquakes is an essential contribution both to emergency management and planning. In particular, the rapid assessment of casualties after an earthquake is of great importance for post-disaster response interventions. Due to the large uncertainty in casualties estimates, this topic requires constant updating, in data and models, as it is addressed in this paper.

However, for several reasons, the paper would need major improvements to be acceptable for publication:

Q1 (Question 1): The paper is written in English language of poor quality and sometimes, it is difficult to distinguish throughout the text whether we are dealing with poor English or with not clearly stated concepts.

R1 (Response 1): Thank you for your comment. We will get our new manuscript edited by native English speaker of this field.

Q2: The title is not easy understand: "THE quick assessment model . . .. based on the VULNERABILITY OF EARTHQUAKE".: a. I suggest to substitute "The [...] model" by "A [...] model", since there is not a single model of casualties for Asia known by the readers. b. What does it mean the "vulnerability of earthquake"? Do earthquakes have vulnerability?

R2: Thank you for your comment. We will follow your advice and change the title of this paper as "A Quick Assessment Model of Earthquake Casualties in Asia". (Pp.1 L1)

Q3: It is recognized that the number of earthquake shaking deaths is closely related to the number of buildings collapse (So & Spence, 2012). On the other hand, the lack of detailed knowledge of the building stock in different regions of the world leads to the adoption of more simplified models for casualties' estimation, relating fatality rates, to exposed population and to shaking intensity levels. However, the authors fail to justify, early in their work, the adoption of such a simplified model. Besides, more than once, the authors refer to an "empirical relationship between the MAGNITUDE of an earthquake event and the CASUALTY RATE caused by it" (e.g. pp 1, line 10, or pp 3 line 15, pp. 5 line 10, etc.). The explanatory power of such a model should be very reduced, since the distance from the earthquake source to the affected population is not mentioned. However, latter it is possible to understand that another variable, the epicentre location, is also included in the model in order to estimate the "radius of the earthquake". The inaccurate description of the model proposed (casualty as a function of magnitude) should be avoided and corrected everywhere in the paper.

R3: Thank you for your comment. In the Introduction part of this paper, we missed some important background information. And we will add your advice into our new manuscript.

A previous study showed that the number of earthquake shaking deaths is closely related to the number of collapsed buildings (So and Spence, 2013). However, the lack of detailed knowledge of the building stock in different regions of the world leads to the adoption of more simplified models for casualty estimation. In this paper, a simplified empirical model relating earthquake magnitude and casualty rate was used. (Pp.3 L15-L19)

We agree with you that the distance from the epic center to the place where earthquake has impact on people will influence casualty rate. However, with focal depth of Asian earthquakes are about the same, this distance is also determined by earthquake magnitude. The higher the magnitude, the larger the distance. So we described our model as 'the empirical model between earthquake magnitude and the casualty rate caused by it'.

Reference:

So, E., and Spence, R.: Estimating shaking-induced casualties and building damage for global earthquake events: a proposed modelling approach, Bulletin of Earthquake Engineering, 11, 347-363, 10.1007/s10518-012-9373-8, 2013.

Q4: The Introduction of the manuscript is well organized according to a typical structure of a scientific paper, i.e., from general to the particular, providing the reader with a setting or context of the problem to be investigated, presenting more specific statements about the aspects of the problem already studied by other researchers, indicating the need for more investigation and giving the purpose/objectives of the study (Cargill and 'Connor, 2009). The research gaps the authors want to fill with the present study are (i) published international disaster casualty systems were not "developed specifically for Asian countries" and (ii) that those systems "would" provide a "discrepancy between simulated and actual intensity". Yet, the existence of that discrepancy is a hypothesis that was not really investigated and no solution for it was provided in the paper. It is not clear in the paper and it is highly unlikely that the formula used to determine the "range of earthquake affected area" (pp. 6, line 2) was specifically developed for Asian countries. Moreover, in page 7, lines 11 and 12, the authors criticise the accuracy of the method saying that "The radius obtained by this method might be too large." In conclusion, the authors did not present any advantage of using a very simplified model to estimate casualty rates instead of taking adequate attenuation laws of ground motions to evaluate intensity levels, damage and death tolls, as it is usually presented in literature.

R4: Thank you for your comment and introduction of the book about scientific writing. However, it seems that some misunderstandings exist due to our presentation style. The research gap we want to fill with the present study is only (i). As for (ii), we pointed out in P3 L12-13 of pervious manuscript that discrepancy between simulated and actual intensity exists. (Take the earthquake that hit Taiwan on 2nd of February as an example, intensity distribution of this earthquake simulated by USGS is very different from the final intensity map). So in our rapid assessment model, we gave up those intensity-simulation models and use a simplified model instead. As we pointed out in the Abstract and Conclusion parts, the two input parameters of QAMECA are magnitude and location of epicenter of an earthquake and earthquake casualties can be estimated immediately after earthquake has occurred, which means that we can't have a finer accuracy. We will point this out in the Conclusion part. We apologize again for make you confused due to our expression.

We only need to input two parameters, the earthquake magnitude and epicentre location, and then earthquake casualties can be estimated immediately after the earthquake has occurred. Although the accuracy of this method is limited in some ways, it is very simple and practical. (Pp.10 L11-L13)

Q5: The Asian Earthquake Database that was developed in this study has data on the "Death Toll"

and “Number of Injuries”, but the proposed casualty ratio model aggregates deaths and injuries. This simplification should be avoided or well justified.

R5: Thank you for your comment. The fields of death toll and number of injuries are indeed separate in our database. However, we consider thatthe aim of the model developed in this paper is to determine the level of emergency rescue within ten minutes after an earthquake has occurred, and the estimation of the casualty scale rather than the exact number of deaths and injuries is needed for this purpose. The estimation of the death toll is more complex and can be done later (for example, in one day after an earthquake has occurred) when rescue efficiency and rescue scale can be taken into consideration. (Pp.8 L1- L5)

Q6: The number of references is reduced, important references related to earthquake casualty estimation are missing.

R6: Thank you for your comment. In the new manuscript, we will add more references including(Koyama et al., 2011) (Pp.10 L3), (So and Spence, 2013) (Pp.3 L16), (Frolova et al., 2011) (Pp.2 L34)and(Ferreira et al., 2011) (Pp.10 L3).

Reference:

Koyama, M., Okada, S., and Ohta, Y.: Major Factors Controlling Earthquake Casualties as Revealed via a Diversified Questionnaire Survey in Ojiya City for the 2004 Mid-Niigata Earthquake, in: Human Casualties in Earthquakes: Progress in Modelling and Mitigation, edited by: Spence, R., So, E., and Scawthorn, C., Springer Netherlands, Dordrecht, 199-217, 2011.

So, E., and Spence, R.: Estimating shaking-induced casualties and building damage for global earthquake events: a proposed modelling approach, Bulletin of Earthquake Engineering, 11, 347-363, 10.1007/s10518-012-9373-8, 2013.

Frolova, N., Larionov, V., and Bonnin, J.: Earthquake Casualties Estimation in Emergency Mode, in: Human Casualties in Earthquakes: Progress in Modelling and Mitigation, edited by: Spence, R., So, E., and Scawthorn, C., Springer Netherlands, Dordrecht, 107-123, 2011.

Ferreira, M. A., Oliveira, C. S., and de Sá, F. M.: Estimating Human Losses in Earthquake Models: A Discussion, in: Human Casualties in Earthquakes: Progress in Modelling and Mitigation, edited by: Spence, R., So, E., and Scawthorn, C., Springer Netherlands, Dordrecht, 255-266, 2011.

SPECIFIC COMMENTS

Q7: Introduction, pp. 1 line 28: the authors claim that “rapid” earthquake casualty modelling is needed for the “vulnerability assessment of earthquake disaster”, however for such situation there is no urgency in estimating casualties and would be advisable to plan prevention strategies based on more reliable risk approaches, rather than on quick assessment estimates.

R7: Thank you for your comment. We are sorry to admit that we made a mistake in pp. 1 line 28. The following sentence is the corrected one.

First, vulnerability assessments of earthquake disasters should be done well before the earthquake, and the construction of disaster prevention and reduction system should be strengthened in the regions with relatively high population vulnerability. Second, casualties should be estimated rapidly after the earthquake, and reasonable rescue measures should be deployed to carry out an effective rescue based on the estimated results. Although there are essential differences between these two angles, they are both needed to study earthquake casualties and loss modelling. (Pp.1 L25-L29)

Q8: The meaning of "radius R for earthquakes" (pp. 5, line 25) needs to be clarified.

R8: Thank you for your comment. The part "Radius R of earthquakes" refers to the quantative expression of earthquake influence range. To be more specific, it refers to the distance from the epic center to the point where earthquake has no effect on people beyond it. In order not to confuse with the definition of casualty rate, we revised "Radius R of earthquakes" as "Influence radius *IR* of earthquakes".

Based on the Bolt et al. (1977) study of strong earthquake records with different epicentral distances, (Pelling et al., 2004) developed the influence radius IR for earthquakes with different magnitudes *M*: (Pp.5 L28-L30)

Reference:

Bolt, B. A., Horn, W. L., Macdonald, G. A., and Scott, R. F.: Hazards from Earthquakes, in: Geological Hazards: Earthquakes - Tsunamis - Volcanoes - Avalanches - Landslides - Floods, Springer New York, New York, NY, 1-62, 1977.

Pelling, M., Maskrey, A., Ruiz, P., Hall, P., Peduzzi, P., Dao, Q.-H., Mouton, F., Herold, C., and Kluser, S.: Reducing Disaster Risk: a challenge for development, United Nations, New York, 978-92-1-126160-8, 2004.

Q9: Pp. 7, line 20, casualty rate is defined to the ratio between injuries and deaths, whereas in equation 1, the casualty ratio is defined as the sum of deaths and injuries to physical exposure. The definitions are not consistent and must be clarified.

R9: Thank you for your comment. In equation 1, the casualty rate is defined as the sum of deaths and injuries to physical exposure. In pp. 7, line 20, the author meant to express a new indictor "the ratio between the number of injuries and deaths", however, 'casualty rate' was mistakenly used here to define the indictor due to the poor presentation style. In order to make it clearer, we will make the following revision in our new manuscript.

This conclusion is consistent with the findings of Wyss and Trendafiloski (2011). Wyss et al. suggested that the ratio between deaths and injuries could be used as an index to measure the vulnerability of people to earthquakes. (Pp.8 L18- L20)

Reference:

Wyss, M., and Trendafiloski, G.: Trends in the Casualty Ratio of Injured to Fatalities in Earthquakes, in: Human Casualties in Earthquakes: Progress in Modelling and Mitigation, edited by: Spence, R., So, E., and Scawthorn, C., Springer Netherlands, Dordrecht, 267-274, 2011.

Q10: Pp.7 line 22: the authors state that "if the casualty rate is larger, it means that the seismic capacity is higher and the vulnerability of the population is smaller." If casualty rate is defined according to equation 1, I would expect the opposite of the author's statement, i.e., if the casualty rate is larger the vulnerability of the population is larger. Moreover, there is no definition on what seismic capacity is.

R10: Thank you for your comment. We are sorry to admit that it's our expression style that again causes your confusion. As the same with the last response, we revised the 'casualty rate' in pp.7 line 22 as "the ratio between deaths and injuries", which is totally different from the 'casualty rate' defined in equation 1.

To avoid unnecessary misunderstanding, we will delete the part related to 'seismic capacity'.

This conclusion is consistent with the findings of Wyss and Trendafiloski (2011). Wyss et al. suggested that the ratio between deaths and injuries could be used as an index to measure the vulnerability of people to earthquakes. If the ratio is smaller, it means that the vulnerability is the smaller. (Pp.8 L19-L21)

Q11: Pp. 7, lines 25 to 32 – The authors say that "Iran issued seismic codes for buildings, which require people to reinforce buildings with poor seismic performance". The authors describe the impact of two earthquakes after the codes being in force, but did not investigate whether code provisions were applied in practice.

R11: Thank you for your comment. What's known to all is that it takes some time from being introduced to be implemented for codes and standards of all kinds. Besides, the efficiency and results of implementation vary from region to region. As a consequence, we can't investigate whether code provisions were applied in practice in earthquake-stricken area. Now we get this information through research of other researchers. Sherafati and Sohrabi (2016) studied the performance of masonry walls during Kaki, Iran, Earthquake of April 9, 2013 and draw the conclusion that The masonry buildings that had followed the minimum code requirements performed very well without any serious damage. The engineered building constructed by confined walls could pass the event without any visible damages, while a neighboring non-engineered building had collapsed exhaustively. The literature is cited in Pp. 8, line 28.

Reference:

Sherafati, M. A., and Sohrabi, M. R.: Performance of Masonry Walls during Kaki, Iran, Earthquake of April 9, 2013, J Perform Constr Fac, 30, 2016.

Q12: Pp. 9 lines 6 to 10 – the justification to use a very simplified model should appear in the beginning of the paper.

R12: Thank you for your comment. Just like the response in general comment 3, we will add the following sentences at the beginning of the paper.

A previous study showed that the number of earthquake shaking deaths is closely related to the number of collapsed buildings (So and Spence, 2013). However, the lack of detailed knowledge of the building stock in different regions of the world leads to the adoption of more simplified models for casualty estimation. In this paper, a simplified empirical model relating earthquake magnitude and casualty rate was used. (Pp.3 L15-L19)

Reference:

So, E., and Spence, R.: Estimating shaking-induced casualties and building damage for global earthquake events: a proposed modelling approach, Bulletin of Earthquake Engineering, 11, 347-363, 10.1007/s10518-012-9373-8, 2013.

TECHNICAL CORRECTIONS

Q13: In page 5 the idea "is often in regions where shaking intensity reaches VI or greater that casualties occur" is repeated twice (lines 18 and 24).

R13: Thank you for pointing out this error. In the new manuscript, we will delete the repeated part.

Q14: In table 1 the values of the Per Capita GDP are not exactly equal to the values of GDP divided by the population.

R14: Thank you for comment. We revised Table 1 in the following form. As for the 'error' , we are sorry that we made you confused. The data of fields 'GDP' and 'Per Capita GDP' are from Worldbank and population of each country are calculated by GDP and Per Capita GDP. In order to make a clear presentation, the basic unit of population is 100 million. In other words, the values of the population are equal to the values of GDP divided by the Per Capita GDP.

Table 1.Basic information and classification of earthquake-prone countries in Asia

Group	Country (Region)	GDP (billion US$)	Per Capita GDP(US$)	Population (100million)	Per Capita GDP Range(US$)
I	Japan	4383	34523	1.27	20000-35000
	Taiwan	524	22288	0.24	
II	Indonesia	861	3346	2.57	2500-3500
	Philippines	293	2904	1.01	
III	China	11065	8069	13.71	8000-9000
IV	Afghanistan	20	594	0.34	500-2000
	Pakistan	271	1435	1.89	
	India	2112	1593	13.26	
	Nepal	213	743	2.87	
	Kyrgyzstan	7	1103	0.06	
	Tajikistan	8	926	0.09	
	Bangladesh	195	1212	1.61	
	Myanmar	63	1161	0.54	
V	Iran	393	5443	0.72	5000-6000
VI	Turkey	859	9126	0.94	9000-10000

Q15: The ranking order of the groups of countries in table 1, 2 and 3 is only explained in the discussion (pp. 7), whereas these tables are mentioned in the text quite earlier.

R15: Thank you for pointing out this error. We will add explanations about grouping criteria and ranking orders in the text.

In this paper, 15 earthquake-prone Asian countries were separated into six groups according to their per capita GDP, earthquake frequency and geographic position. First, we list a single country or region as a group if it has enough historical earthquake events to build a model. Second, countries with inadequate earthquake samples can be regionalized into a group with neighbouring countries that have similar per capita GDP. For example, China, Iran and Turkey were each listed as a single group, while countries with a per capita GDP less than 2000 dollars, including Pakistan, India, Nepal, Kyrgyzstan, Tajikistan, Bangladesh and Myanmar, were in the same group with Afghanistan. The ranking order of the six groups was determined by the vulnerability of people to earthquakes in each group, which will be explained in detail in the Discussion. (Pp.6 L16-L22)

Q16: Pp. 7, lines 15 to 18 – the authors mention “under 6” and “above 7.75”. The word magnitude is missing.

R16: Thank you for pointing out this error. We are very sorry for the omission. In the new manuscript, the word **magnitude** will be added. (Pp.8 L16, L17)