Response to Anonymous **Referee #1**

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

Main Comments

Q1 (Question 1): Their research is logically explained and convincible but needs great improve of writing style and grammar. The present writing style is poor and lower than international standard. I suggest the authors to have their manuscript edited by a native speaker in this field.

R1 (Response 1): Thank you for your comment. We will have our new manuscript edited by a native English speaker.

Q2: This manuscript needs more literature review and citing style is very poor. Many of sentences were explained without citing reference. Please add appropriate references when explaining about numbers, previous works (databased, information from website, etc.), and it is not commonly known.

R2: Thank you for your comment. In the new manuscript, we will add appropriate references and cite more literature following your advice. (Pp.10 L3)(Pp.3 L16) (Pp.2 L34)(Pp.10 L3)

Q3: Earthquake data: Is it possible to separate the data by period? You mentioned later about improvement of building preference. Data of each region shall be separated before and after the major change of building code. Then we can see how much such countermeasure could reduce the death toll.

R3: Thank you for your comment. We have tried to separate the data by period. However, it turned out that the results are not ideal. Separate the data into two datasets by period will result in fewer samples especially strong earthquakes with magnitude larger than 7.5. For example, 82 earthquake events occurred from 1990 to 2012 meet the criterion to establish vulnerability models for China while the magnitude of only one of them is larger than 7.5. Separate the data will make it more difficult to fit curves due to the lack of violent earthquake samples. In the discussion part of this paper, improvement of building preference was mentioned only to illustrate those countries with lower vulnerability of people to earthquake have relative higher seismic requirement for buildings and improve their national standers constantly. There is no point denying that separate the data of each region before and after the major change of building code and analyze the contribution of countermeasure in reducing the causalities quantitatively through comparison are good points. However, new and old buildings coexist in the form of different proportions in every region, which make the contribution of such countermeasure in reducing the causalities varies in different region. As a consequence, more detailed building stocks data is needed in order to implement the research points you have come up with.

Q4: Casualty data: I would suggest the authors to separate their casualty data to 1) death, 2) injure and 3) number of affected people (evacuee) as rescue and other early response activities are completely different for each item (details are shown in specific comments).

R4: Thank you for your comment. As details are shown in specific comments, we will respond this question in R6.

Specific comments

Q5: P1 L19: Need a reference to support that earthquake cause the largest death toll.

R5: Thank you for your comment. We will make the following revision and add a reference.

According to the report Poverty & Death: Disaster Mortality 1996-2015 (UNIDSR and CRED, 2016), 1.35 million people died in natural disasters from 1996 to 2015. Earthquakes caused 56% of these deaths. (Pp.1 L19-L21)

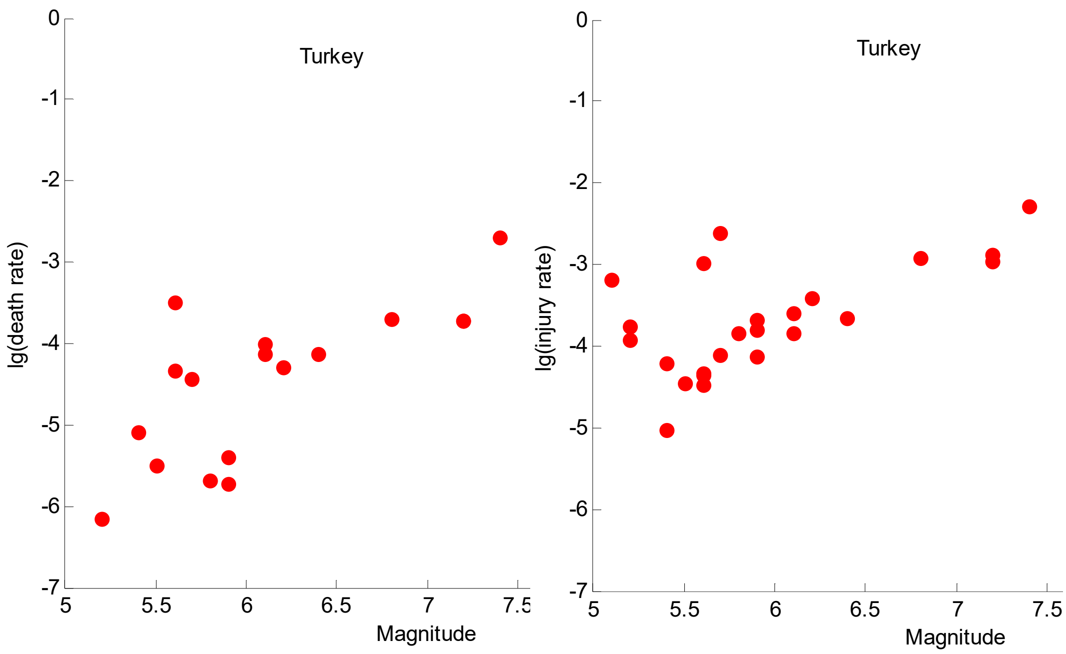
Reference:

UNISDR.,CRED.: Poverty & Death: Disaster Mortality 1996-2015, http://cred.be/sites/default/files/CRED_Disaster_ Mortality.pdf, 2016.

Q6: P1 L22-28: I think you should better separate death and injure in the data. You cannot reduce number of deaths if they were killed already but you can reduce number of deaths from number of injuries if rescue activity can be sent very soon using your quick assessment method.

R6: Thank you for your comment. At the beginning of our research, we had the same ideas just as yours. However, we didn't separate death and injury due to the following reasons and the explanations will be added in the Discussion part of the new manuscript.

There are two reasons that the casualty rate (the ratio of the sum of deaths and injuries to the total number of people living in the earthquake-affected region) was adopted as an indicator. First, in the preliminary study, the correlation of earthquake magnitude and death rate and the correlation of earthquake magnitude and injury rate were investigated. This work showed that the correlation of the earthquake magnitude and death rate was less significant. For example, as is illustrated in magnitude-fatalities and magnitude-casualties scatter plots from Turkey (Fig. 5), the points are more clustered in Fig. 5(b). This is because the death toll caused by an earthquake is affected by many other factors, including the rescue efficiency, the distance to the nearest hospital and medical level. However, the number of people injured in earthquakes is not affected by these factors. In other words, compared with the linkage between deaths/physical exposure and magnitude, the linkage between injuries/physical exposure is substantially more significant. Therefore, the sum of deaths and injuries to physical exposure was used as a casualty indicator because the dead are also injured. Second, the 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.7 L23- Pp.8 L5)



(a) Magnitude-fatalities scatter plots (b) Magnitude-casualties scatter plots

Figure 5 Magnitude-fatalities/casualties scatter plots for Turkey

Q7: P2 L11: Jaiswal and Wald (2010) is not in reference list.

R7: Thank you for your comment. The literature you mentioned is *An Empirical Model for Global Earthquake Fatality Estimation* and it's in reference list (P10 L27-L28 of previous manuscript).

Q8: P3 L1-5: Need a reference to support about the 'shallow earthquakes', list of earthquakes from USGS, as well as CRED (not in reference list).

R8: Thank you for your comment. We will add detailed statistics to support about the 'shallow earthquakes' and add references following your suggestions.

According to Measuring the Size of an Earthquake (Spence et al., 1989), earthquakes occurring at a depth of less than 70 km are classified as shallow-focus earthquakes. In the list of earthquakes from the USGS, in 2016, 41 earthquakes above magnitude 6 occurred in Asia. Among those Asian earthquakes, 71% of them had a focal depth of less than 70 km (USGS, 2016). (Pp.3 L1-L4)

Reference:

Spence, W., Sipkin, S. A., and Choy, G. L.: Measuring the size of an earthquake, Earthquakes and Volcanoes, 21, 58, 1989.

USGS.: World earthquakes with magnitude above 6 in 2016, https:// earth quake. usgs.gov/earth quakes/browse/m6-world.php? year=2016, 2016.

Q9: P3 Data: In some great events associated with tsunami (2004) Indian Ocean and 2011 Great East (Japan), how can you separate only deaths from the earthquake? This work used different kind of data from many sources. Please create two or more tables summarizing three sources in 2.1 and other sources in 2.2. Did you use day or night time population data? How it affects to the accuracy of your proposed model?

R9: Thank you for your comment. Earthquakes can trigger other disasters which can cause more casualties. It's difficult to set casualties caused by shaking-related-collapse apart from those caused by other disasters in reality. In those databases from which we collected earthquake events, casualties of two types are not separated either. As a matter of fact, we consider it's unnecessary to separate the data. Earthquakes with large magnitude will induce other disasters inevitably, for example, the 2008 Wenchuan Earthquake and the 2011 Great East Japan Earthquake. As is often the case, earthquakes with lager magnitude will trigger other disasters that more influential and more fatal. The positive correlation between them has the same direction with the correlation between magnitude and causality rate. So we didn't separate the data.

We compiled earthquake data from three different data sources and population data were collected from one data source. In the new manuscript, the following tables will be added to summarize data sources. (Pp.14)

Table 1. Sources of earthquake data

No.	Data Source	Prepared By	Records	Approach
1	Emergency Events Database	CRED	356	Website of EM-DAT
2	Disaster Archive	ADRC	57	Website of ADRC
	GLIDE database	ADRC		Website of GLIDE
3	Google Earth	Google	408	Website of Google Earth
	Web news search	News website	5	Online collection

Table 2. Type of population distribution data(Spence et al., 1989)

No.	Data Version	Years Covered	Data Type	Resolution	Prepared By	Approach
1	GPWv3	1990 1995	Raster	2.5 arc-minutes	SEDAC- Hosted by CIESIN at Columbia University	Website of SEDAC
2	GPWv4	2000 2005 2010 2015 2020		30 arc-seconds		

The population data we used was created mainly from census. At present, we haven't found population data separated by time. The accuracy of our model will be benefited from the existence of such dataset. As we all know, population distribution in day and night is different at relatively small spatial resolution. Besides, people's response and the resulting casualties are also different. If we have population distribution data of day and night respectively, we will separate the earthquake data by time of the day and fit models for both day and night.

Q10: P6 L14: Please explain such criteria in detail to separate into six groups. World Bank website should be also listed in the reference.

R10: Thank you for your comment. We revised Table.1 of the manuscript and the following explanations will be added in the paragraph illustrating Table.1. The website of World bank will be added.

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)

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

Reference

Worldbank.: https://data.worldbank.org/, 2017.

Q11: Discussion: I would suggest split this section to some subsections, for example, 5.1 Iran, 5.2 Japan and Taiwan, etc. Then you can also explain about the benefit of building retrofit if your models were created by separating data period. How different between your results and USGS's method (Jaiswal et al., 2011) as well as this book? World Atlas of Natural Disaster Risk, Editors: Shi, Peijun, Kasperson, Roger (Eds.) http://www.springer.com/la/book/9783662454299 Human Casualties in Earthquakes, Progress in Modelling and Mitigation, Editors: Spence, Robin, So, Emily, Scawthorn, Charles (Eds.) http://www.springer.com/la/book/9783662454299

R11: Thank you for your comment. As responded in Main Comments, it's impossible to separate data by period.

The empirical model of PAGER (Jaiswal and Wald, 2010) predicts the probability of fatalities for various orders of magnitude while this paper predicts the range of casualties (the sum of deaths and injuries). To compare the USGS's results with QAMECA, we chose earthquake events from 2013 to 2016 and took the maximum probability of the number of fatalities from PAGER and made Table 6. Most of selected earthquake events are well predicted by both models and only a few events have deviations. The predictions of QAMECA for Japan and India are not as accurate as for China and Iran. In contrast, the results of PAGER are not accurate in China and Iran. In addition, both models do not have good accuracy in Indonesia, which means that further research is needed to develop a rapid casualty estimation model for Indonesia. (Pp.8 L6- L12)

In the *World Atlas of Natural Disaster Risk*, authors calculated expected annual earthquake mortality risk for countries worldwide. And the ranking order from high to low risk is: India, Indonesia, Pakistan, Bangladesh, China, Philippines, Myanmar, Iran, Afghanistan, Nepal, Kyrgyzstan, Turkey, Japan and Tajikistan. In this paper, the vulnerability of people to earthquakes from high to low is: Turkey, Iran, Afghanistan and neighboring countries (Pakistan, India, Nepal, Kyrgyzstan, Myanmar, Bangladesh, Tajikistan), China, Indonesia and Philippines, Japan and Taiwan. There are some discrepancies between the two ranking orders. For example, Turkey and Iran have the highest vulnerability in our paper while they are not countries with the highest mortality risk in the atlas. Besides, Afghanistan and seven other countries are in the same group in this paper while their mortality risks are quite different in the atlas. The differences exist mainly because indictor used in this paper is casualty while the atlas only focuses on fatality

Table 6 Comparison between the result of this paper and PAGER

Country	Magnitude	Actual number of casualties	Casualties range (results of QAMECA)	Actual number of fatalities	Fatalities range (results of PAGER)
Japan	6.3	32	32-5610	0	0-1
	6.7	45*	53-10387	0	0-1
	6.5	2853	61-11160	161*	10-100
	6.6	30*	38-7247	0	1-10
Taiwan	6.4	559	42-7286	35	0-1
Indonesia	6.1	2574*	1-159	42*	0-1
	6.5	32*	36-4749	0	0-1
	6.4	491	30-3576	104*	10-100
Philippines	7.2	1018	135-32706	222	100-1000
China	5.0	14	1-1818	0	0-1
	7.0	13680	1424-191118	196	100-1000
	6.6	1095	252-35022	94*	0-1
	5.9	47	3-520	3*	0-1
	6.1	43	46-6713	0	0-1
	6.5	3760	210-29446	617*	10-100
	6.6	325	98-13629	1	0-1
	6.3	59	24-3423	5*	0-1
	6.4	52	29-4194	20*	0-1
Afghanistan	5.7	159	36-1486	18*	0-1
	7.5	639	1113-331923	115	100-1000
	6.2	12	10-969	0	0-1
Pakistan	7.7	974	685-222598	522*	1000-10000
	7.5	2025	605-180573	280	100-1000
	6.6	46*	51-8142	5	0-1
Nepal	7.8	31212	3950-1330929	6659	1000-10000
India	5.8	60*	131-6495	1	1-10
	6.7	211*	308-53491	51*	100-1000

Iran	6.3	835	102-4362	35*	100-1000
	7.8	114*	512-37592	34	10-100
	5.6	52	17-357	7*	100-1000
	6.1	60	47-1741	0*	1-10

(* represents that prediction of model has considerable difference with actual value)