

## ***Interactive comment on “Assessment of ripple effect and spatial heterogeneity of total losses in the capital of China after a great catastrophe shocks” by Zhengtao Zhang et al.***

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The authors would like to thank the reviewer for your efforts on this manuscript and providing us with insightful comments and suggestions to improve the quality of this manuscript. The following responses have been prepared to address reviewers' comments in a point-by-point fashion. And the sentences in red are the corresponding revised parts in our manuscript. We also attach a copy of the revised manuscript with the Track Changes in the below of the responses. The paper conducts a hypothetical case by applying 2008 Wenchuan earthquake into Beijing. It integrates scenario analysis, Adaptive Regional Input-Output (ARIO) model and Inter-regional ripple effect (IRRE) model to assess both direct and indirect economic loss of this hypothetical

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earthquake in Beijing. Specifically, the proposed IRRE model allows to investigate the spatial heterogeneity of direct and indirect loss. The paper appears to be one of the few papers conducting scenario analysis based on real past catastrophe and applying it onto another region. In this respect, the paper has certain level of novelty and it provides strong evidence to support pre-disaster preparation by Chinese local governments. However, the paper is subject to a couple of limitations as follows: i) The paper utilizes an ARIO model to simulate the post-catastrophe economy in Beijing. However, some key parameters in the ARIO model requires more detailed explanation. For adaptation mechanisms, apart from overproduction capacity, how did you deal with imports? Price/quantity changes after floods? It's fine not to consider those factors as they can be very complicated, but the authors need to clearly state those parameters. Is those factors considered exogenously or endogenously? Response: Thanks for your comments. The comment includes three questions, so we intend to answer them separately. 1. For adaptation mechanisms, apart from overproduction capacity, how did you deal with imports? Response: this paper copes with the imports from three aspects: i) Input-Output (IO) Table: The ARIO model improves the traditional IO Table in such way: For the every production  $j$ , there is coefficient  $P_j$ ,  $P_j = (\text{Production} - \text{Export}) / (\text{Production} - \text{Export} + \text{Import})$ . The model multiplies the values of quadrant I and quadrant II of traditional IO table by coefficient  $P_j$ , creating a Local Input- Output table (LIO). The purpose is to remove the import part from the production and services of intermediate consumption/ inputs and final consumption, and to distinguish between sectors that produce goods and services that can be imported and those that produce goods and services that have to be locally produced. ii) setting substitutability of sectors: The model sets the substitutability of sectors based on the conditions that whether the sectors' productions and services can be imported from the outside of disaster-hit area. This study sets the manufacturing sectors (#3-#10), construction sector (#12) and Transportation, Post & Telecommunications (#13) cannot be substituted, other sectors' productions and services can be imported from the outside areas; iii) if a sectors can be substituted and its production capacity is insufficient during the

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reconstruction period, the import part is introduced. The imports amount depends on the relationship between demand and production, the parameter of import delay. The specific formula is as follows:

The sector  $j$  is the sector who consumes the goods or services produced by sector  $i$ ,  $TD(i)$  and  $Y(i)$  is the demand and production of sector  $i$ ,  $A$  is the intermediate consumption,  $\Delta t$  is the time step of model,  $\tau$  is the parameter of import delay, and the initial  $I(j)$  is the import of sector  $j$  at  $t$ th month during reconstruction period, which is decided by the ratio of the production of  $t$ th month and the production of pre-disaster. The formula is shown as follows:

2. Price/quantity changes after floods? Response: we think the floods the referee proposed is actually the earthquake. The Change in price in this study is calculated by the relationship between demand and production in the disaster aftermath. The ARIO model assumes that commodity prices respond linearly to the level of underproduction, and uses a single parameter of price inflation (parameter  $\xi$  in Table 2) for the whole economy in applying these prices. Therefore, the changes in prices do not strongly feed back into the simulation results. But these assumptions accord with the rescue policy of Chinese government after the catastrophe. The government will strictly control the changes in price, avoiding the serious inflation in the disaster aftermath.

3. Is those factors considered exogenously or endogenously? Response: According to the above description, the imports and prices are endogenously and the parameter of price inflation is exogenously. For the imports: the process for the imports data is based on the improved traditional IO table and the model itself; for the changes in prices, it's decided by the changes of demand and production. So the imports and prices are endogenously. For the price inflation, it depends on the condition of China's rescue policy. It changes with the different economic systems of disaster-hit areas. Therefore, it is exogenously. Please check the Page 10, Line 7 in the revised manuscript.

ii) The paper distributes the direct and indirect economic loss into specific districts

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based on street-total capital ratio and street-total business income ratio, respectively. There are assumptions underlying here. Please state clearly about this. Response: Thanks for your suggestion. As is mentioned in the section 3.1, according to the core damage scope of 2008 Wenchuan earthquake and the uncertainty of seismic source location and the seismic intensity ranges, this study assumes the intensity of disaster damage is evenly distributed in the space of Beijing, gives the upper limit of the losses caused by the catastrophe. Based on the above assumption, the direct economic loss and indirect economic loss can be spread by the stock of fixed asset and the business income respectively. For the distribution of direct economic loss, the stock of fixed asset data are used in the SDN model. Except for the reason mentioned in the section 3.4 that the stock fixed asset belongs to the inventory change, there are two more reasons: i) the replacement costs of stock of fixed assets account for the most in the statistical components of direct economic loss; ii) the core idea of the feedback of the production capacity of economic system in the ARIO model is that production capacities of sectors decreases  $x\%$  when the stocks of fixed assets decreases  $x\%$  caused by the disaster. Therefore, the using the sectors' stocks of fixed asset not only accords with the statistical significance of direct economic loss, but also the simulated mechanism of ARIO model. For the distribution of indirect economic loss, the business income data are used in the IRRE model. Except for the reason mentioned in the section 3.5 that the business income is the flow data which is in line with the concept of "flow" of indirect economic loss, there is one more reason: in the earthquake disaster aftermath, the production reduction due to the limitation of production capacity, production bottleneck, and industrial linkage can be reflected in the business income of the affected year. The business income of a sector will be greatly affected if that sector suffers large indirect economic loss. Therefore, it's reasonable to use business income in the IRRE model. The part of this comment is similar to the third comment of RC1, so we answer these two comments together in the revised manuscript. The corresponding description is shown on the Page 11, Line 13 and Page 11, Line 21 and Page 12, Line 15.

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iii) The paper requires thorough language-editing, especially in section 4-Results of loss assessment. Some of the results are given mistakenly in 4.1, such as 'The indirect economic loss accounts for 41.5% of total loss, and almost the same as the indirect economic loss', 'The total loss has exceeded the 2.6% of BJ's GDP in 2008, and accounted for 3.6% of the national GDP of 2008.' Response: Thanks for your comment. We have already corrected the sentences and checked the section 4 again. "The indirect economic loss accounts for 41.5% of total loss, and almost the same as the indirect economic loss." on the Page 13, Line 10 is changed as "The indirect economic loss accounts for 41.5% of total loss, and is almost the same as the indirect economic loss." "The total loss has exceeded the 2.6% of BJ's GDP in 2008, and accounted for 3.6% of the national GDP of 2008." on Page 13, Line 12 is changed as "The total loss has exceeded the 2.6% of BJ's GDP in 2008, and accounts for 3.6% of the national GDP of 2008.". "...the decreasing value is up to 3.63%,..." on Page 13, Line 15 is changed as "the decreasing value was up to 3.63%,". "...therefore the economic impact caused by the catastrophe can seriously impede the sustainable development in the future (Table 4)" on Page 13, Line 16 is changed as "...therefore the economic impact caused by the catastrophe seriously impeded the sustainable development in the future (Table 4)". The term "100 CNY" on Page 14, Line 10 for example is changed as "USD 100". "BJ has a developed tertiary industry, accounting for 77.9% of the total GDP of the city, and affected by the population and commercial distribution," on Page 17, Line 8 is changed as "BJ has a developed tertiary industry, which accounts for 77.9% of the total GDP of the city. Affected by the population and commercial distribution," "Due to the severe damage of fixed assets of the secondary industry, seriously inadequate intermediate input, decrease of the demands of downstream industries, and decrease of production and increase of inventory of the secondary industry may be one of the major reasons to cause the increase of the indirect economic loss of the tertiary industry." on Page 18, Line 13 is changed as "i) the severe damage of fixed assets of the secondary industry leads to the seriously inadequate intermediate input, ii) the decrease of the demands of

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downstream industries leads to the decrease of production or the increase of inventory of the secondary industry may be the two major reasons to cause the increase of the indirect economic loss of the tertiary industry." Some words in the sentences "their industrial structure is also mainly dominated by the secondary industry, so the majority of total loss in this district are the losses of the secondary industry Therefore, industrial distribution and industrial structure are key elements for determining the size of indirect economic loss of a region. In the course of post-disaster recovery and reconstruction, government departments need to ..." on the Page 18, Line 23 is changed as "the industrial structure of this District is also mainly dominated by the secondary industry, so the majority of total losses in Shunyi District are the losses of the secondary industry. Therefore, industrial distribution and industrial structure are key elements for determining the size of indirect economic loss of a region. In the course of post-disaster recovery and reconstruction, government needs to ..." "...extend to the regions such as Changping District..." on the Page 20, Line 10 is changed as "...extended to the regions such as Changping District..." "...still have losses without showing much decrease along with the rescue effort improving," on the Page 20, Line 17 is changed as "...still suffer losses without showing much decrease along with the improving rescue effort," "under rescue scene C" is added on the Page 21, Line 2 "post-disaster affected areas\* under rescue scene C is reduced by 4,364 km<sup>2</sup>," for better understanding.

Please also note the supplement to this comment:

<http://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2016-354/nhess-2016-354-AC3-supplement.pdf>

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., doi:10.5194/nhess-2016-354, 2016.

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