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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Open space suitability analysis for emergency shelter after an earthquake" *by* J. Anhorn and B. Khazai

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On behalf of my co-author, I wish to thank Referee #3 for the useful comments and the suggestions aiming at improving the proposed study.

1) The used earthquake scenario has been taken from the JICA and MOHA study in 2002; as stated on page 4276. The respective ground motion, seismicity and fault model used can be found there (JICA and MoHA, 2002). Unfortunately this study is the most recent published earthquake assessment for the Kathmandu valley. Out of three fault models used, the Mid Nepal Earthquake (Ms=8.0) would lead to MMI VIII within the valley. This is seen as the "worst case scenario" in terms of the modelled building damages and casualties. Since 2002 this model has also been used many times for

awareness and information campaigns by local and international organisations. Recent efforts to develop a new and open source earthquake risk assessment for Nepal exists by the Global Earthquake Model (GEM) Foundation.

2) For the purpose of this research paper, we did not compute any sensitivity analysis considering multiple earthquake scenarios. The paper focuses on the development of a decision support tool and uses the most recognised scenario known by decision makers in Nepal, which is the Mid-Nepal earthquake. Nevertheless and also in agreement with referee #1 it would certainly be a benefit if implemented on the ground.

3) No actual damage of the road network is accounted for in the capacitated accessibility measure. We acknowledge that this would be a great benefit for the study. For example modelling road blockage due to debris and damages as well as accessibility of building blocks in post disaster situation as it has been proposed by Caiado et al. (2011, 2012), Chang et al. (2012), or Franchin et al. (2006).

4) Unfortunately there are no recent data on building stock composition available for KMC. This poses a serious limitation which we accounted for assuming a linear increase without specifying details about replacements, upgrade or deterioration of building structures during the last years. The Nepalese Building Code (NBC) developed in 1994 was approved by the government only in 2003 and has never been implemented across the country. Most new buildings (private and public) do not comply with earthquake safety standards due to the lack of resources (enforcing governmental chapters, trained masons, financial resources. . .) despite various efforts (Dixit, 2009). The actual composition of the building stock therefore had to be derived using the simplistic linear upscaling.

5) The total OSSI is calculated as the multiplication of the suitability (qualitative) and accessibility (quantitative) measure. The logic behind this equation reads, that without being suitable at all, accessibility is irrelevant. As well as with a high pressure from the accessible surrounding, suitability is compromised.

I share the recommendation of the referee and would like to include the following paragraph (after the results section):

6 Limitations

The proposed methodology to investigate the suitability of open spaces is based on a few assumptions which need to be clearly communicated. Particularly if such tools are used for decision making processes:

- Population distribution varies across time and space within an urban area. We recommend to adjust this parameter to the best available model. Shelter needs (through earthquake risk and loss assessment) should be revised accordingly.

- Earthquake risk scenarios highly depend on detailed understanding of geophysical processes as well as knowledge about the elements at risk (critical infrastructure, buildings, etc.). In this case study we only considered one scenario. In a more ideal way cascading secondary effects as well as multiple scenarios could be integrated. Ongoing work at the Global Earthquake Model Foundation to develop a probabilistic seismic risk assessment for KMC will provide a better basis for producing a full set of physical damage scenarios. The number of these scenarios must be then greatly reduced to become manageable for shelter planning processes.

- The proposed methodology relies on detailed geospatial data which are prone to be outdated, fragmented and limited in detail. For this case study it is the best available dataset currently available.

- The road network is considered a full functional relational network not bearing in mind the potential failure/disruption of accessibility. Incorporating the robustness and redundancy of street networks into the overall suitability might advance the proposed method.

- The selected qualitative evaluation criteria their scoring and weighting should always be based on local experts, taking into account contextualized conditions. This also

applies to the potentially necessary incorporation of additional criteria.

- Peoples needs and preferences change over time. We only considered a limited number of factors influencing suitability for immediate shelter taking a mixed planner's and inhabitant's position in evaluating them. Medium and long term shelter may need different factors. The adjustment to such dynamic circumstances is what we understand as contextualization of models and is yet not part of the KMC case study.

Additional literature:

Caiado, G., Oliveira, C. S., Ferreira, M. A. and Sá, F.: Assessing Urban Road Network Seismic Vulnerability: An Integrated Approach, Indian Institute of Technology, Lisbon. [online] Available from: http://www.iitk.ac.in/nicee/wcee/article/WCEE2012_1105.pdf (Accessed 9 July 2014), 2012.

Chang, L., Elnashai, A. S. and Spencer, B. F.: Post-earthquake modelling of transportation networks, Structure and Infrastructure Engineering, 8(10), 893–911, doi:10.1080/15732479.2011.574810, 2012.

Dixit, A. M.: Challenges of Building Code Implementation in Nepal, in From Code to Practice: Challenges for Building Code Implementation And the Further Direction of Housing Earthquake Safety, edited by S. Ando, J. K. Subedi, and H. Nakamura, pp. 61–66, UNCRD. [online] Available from: http://www.preventionweb.net/files/10591_HESITokyoPapers.pdf (Accessed 13 May 2014), 2009.

Franchin, P., Lupoi, A. and Pinto, P. E.: On the Role of Road Networks in Reducing Human Losses After Earthquakes, Journal of Earthquake Engineering, 10(2), 195–206, doi:10.1080/13632460609350593, 2006.

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