Nat. Hazards Earth Syst. Sci. Discuss., 3, C3041–C3043, 2016
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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Hazard interaction analysis for multi-hazard risk assessment: a systematic classification based on hazard-forming environment" *by* B. Liu et al.

B. Liu et al.

Y.L.Siu@Leeds.ac.uk

Received and published: 24 January 2016

We would like to thank the Anonymous Referee 2 for the careful review of the paper and his/her critical and helpful comments.

Reply to the specific comments:

1.In section 6.1, the authors state that "this method relies on extensive historical data which is often unavailable for some areas". Can the authors give some suggestions how to apply this conceptual Multi-Hazard Risk Assessment (MHRA) approach with limited data availability?

Re: As the commonly used method for hazard identification, historical data analysis relies on extensive historical data (at least 20 years) which is often unavailable for some areas. In this research, we proposed a new approach, which adopts stable factors to identify which kinds of natural hazards occur in a given area. Compared to historical hazard data, most data for stable factors are easy to collect, e.g. river basins, landform, hence stable factors for hazard identification can be used to solve data problems of existing methods. In the revised version, we have rewritten the second paragraph in section 6.1 to explain more.

2. I understand that the authors try to use Liu (2015) to support this hazard interaction classification system. However, authors did not provide information on how the Liu 2015 study on the Yangtze River Delta has been carried out (e.g. which major hazards are included, what are the classification of hazard interactions) and why Liu's study can be used for supporting this eveloped classification approach.

Re: Thank you for the constructive comment. We have added a new section entitled "A case study in China's Yangtze River Delta" after the section "Application in multi-hazard risk assessment". This new section depicts the use of the classification scheme within a multi-hazard risk assessment model to estimate potential loss caused by multiple hazards in China's Yangtze River Delta (YRD). There are three sub-sections in this section and they are:

1) Hazard identification: it is used to identify which kinds of natural hazards occur in the YRD and summarise the spatial distribution of these hazards based on the stable factors. The YRD is mainly influenced by typhoon, flood (slow riverine flood, fast riverine flood, coastal flood and pluvial flood) and landslide. According to the types of hazards in each assessment unit, the whole YRD area is divided into four zones.

2) Hazard interaction analysis: according to the trigger factors for various hazards in the YRD, the relationships among multiple hazards in the YRD were discussed in each zone. Then the exceedance probabilities of multiple hazards occurring with different

magnitudes were calculated based on the mathematical statistics approach with the change of trigger factors.

3) Multi-hazard risk assessment: Here, the YRD being struck by two consecutive typhoons (the most common multi-hazard scenario in the YRD) is taken as an example of this risk assessment. The first and second typhoons have an independent relationship. These two typhoons could induce various kinds of floods and landslides. Maximum daily rainfall and maximum daily wind speed in each typhoon were selected as trigger factors to construct the set of hazard-related indicators which represent the magnitudes of multiple hazards. With respect to losses, this case study takes the economic loss as an example, with Gross Domestic Product (GDP) in 2013 selected as the exposure indicator. The vulnerability-related indicators selected were: the number of mobile phone users per 10,000 people, doctors per 10,000 people, population density, GDP per km2, number of medical institutions per km2, percentage of population age >15 and < 65, percentage of male residents, and percentage employed. Based on the historical loss data form 1980 to 2012, the loss distribution influenced by multiple hazards with different exceedance probabilities was calculated. By adding this new section and its sub-sections in the revised version, we hope that the reviewer's concern is clarified and answered.

The revised version was uploaded in the form of a supplement.

Please also note the supplement to this comment:
http://www.nat-hazards-earth-syst-sci-discuss.net/3/C3041/2016/nhessd-3-C3041-2016-supplement.pdf

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Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 3, 7203, 2015.