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Discussions

Interactive comment on "Probabilistic seismic hazard analysis using logic tree approach – Patna District (India)" *by* Panjamani Anbazhagan et al.

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General Comment: - Abstract In the article of "Probabilistic seismic hazard analysis using logic tree approach-Patna District (India)" (Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess 2018-328) studied by Anbazhagan et al., a popular tool called the logic tree approach is employed for seismic hazard analysis of Patna District, India. Despite being an extensive study, it is observed that the logic tree application needs to be more informative about the weighting factors of terminal branches and selection of attenuation equations. This discussion mainly aims to present some comments and criticisms for some clarifications of the logic tree application. Key words: Logic tree, weighting factors, seismic hazard analysis, attenuation equation. Due to its capability of combination of multiple models alternatively, the logic

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Discussion paper

tree approach employed in the article is of scientifically significance that practically offers a solution for the issues of the seismicity of the region (Patna District, India). However, the following technical points are the comments that could be queried for the application of logic tree approach in the study. Response: - The authors would like to thank the reviewer for his/her valuable time for reviewing the manuscript. The following are the detailed response to the comments. Comment 1: - In the logic tree approach, the seismic hazard analysis is carried out by the combination of models and/or parameters constructed with each terminal branch regarding with weighting factors. However, for construction of logic tree branches with the weightings of models, it appears that the criteria are lack and/or not clear in the article. They are the questions that what are the experimenter's (authors') concerns (issues) in practice and what are the expert's recommendations about the seismicity of the region. As a consequence, without accounting the weighting factors realistically, it is not possible to obtain a realistic result of seismic hazard analysis using the logic tree (Gullu and Iyisan, 2016). Response: - The questions that what are the experimenter's concerns in practice and what are the expert's recommendations about the seismicity of the region is also explained in the revised article. In the revised manuscript, the construction of logic tree and the weighting of the different branches of the logic tree has been explained at different places. Change in the manuscript: Patna district lies near to the seismically active Himalayan belt and on the deep deposits of the Indo-Gangetic basin (IGB). It is also surrounded by various active ridges as Monghyr-Saharsa Ridge Fault many active tectonic features such as Munger-Saharsa-Ridge Fault, and active faults such as East Patna Fault or West Patna Fault. These faults are acknowledged as transverse faults, and the occurrence of seismic events is due to stimulus of fluvial dynamics in the North Patna plains transverse faults (Valdiya1976; Dasguptaet al.1987). According to Banghar (1991) the East Patna Fault is one of the active faults in the study area and its interaction with Himalayan Frontal Thrust is characterized by a cluster of earthquakes. Dasgupta et al. (1993) accounted that all other faults between Motihari and Kishanganj city have the same possibility of seismic hazard as they form a part of related fault system. Comment 2: - One of the power utilities of the logic tree comes from its relatively less effort compared to the conventional seismic hazard methodologies. It is important to note that using the logic tree with the judged weighting factor requires a calculation effort that dramatically increases with increased branches (Bommer et al., 2005; Sabetta et al., 2005). Thus, in order for preventing the troubles from the increased branches during estimations, the branches with slight differences are strongly recommended to be avoided (Bommer et al., 2005). Hence, readers of the article should be informed whether the authors avoided from similar nodes in the logic tree branches. Again, this specifically requires presentation of selection criteria of weighting factors in detail. Response: - In the present study, the weight factor for different GMPEs has been calculated using the log likelihood values, which is explained in the manuscript. No such branch having with slight differences in weights have been observed in the present study. Change in the manuscript: It is necessary here to note that the experimenters performing for the seismic hazard assessment using weighting factor may lead to complication in the calculations with the inclusion of different branches. To prevent this trouble, Bommer et al. (2005) suggested avoiding using the branches having slightly differences between the options that it carries, in cases when those options result in very similar nodes. Therefore, when selecting the weighting factors in the logic tree in this study, the cases contrasting (or different) with each other as much as possible have been taken into consideration. Comment 3: - Past works (Sabetta et al. 2005; Scherbaum and Kühn, 2011) indicate that selection of attenuation models (i.e., ground motion prediction equations) is much important for seismic hazard analysis using the logic tree approach. Moreover, their selection for the seismic hazard assessment has a greater impact than expert's judgments for the weightings of the logic tree branches. In order to provide a consistency within a probabilistic framework, it is proposed (Scherbaum and Kühn, 2011) that the weight factors in attenuation equations are assigned in a sequential manner (such that if the first equation of three selected gains a weight of 0.6, then the remaining equations as sum must be 0.4). Consequently, the study in the article requires being more informative about how the authors assigned the weights of their selected attenuation equations into account of logic tree frame. Response: - We agreed with the reviewer, in the present study the weights have been assigned in the sequential manner. This has been already explained in the revised manuscript with proper references. Change in the manuscript: Scherbaum and Kühn (2011) showed the importance of weight treatments through the logic tree approach as probabilities instead of simply as generic quality measures of attenuation equations, which are subsequently normalized. They also indicated the risk of independently assigning of grades by different quality criteria, which could result in an apparent insensitivity to the weights. In order to provide the consistency with a probabilistic framework, they proposed assigning the weight factors in a sequential manner, which is used in the present study. Comment 4: - In the article, the authors perform seismic hazard estimations by Frankel approach as well as the logic tree. The logic tree estimations should principally show the whole terminal branches (i.e., combinations of all possible models), not sub-branches. However, the study is not convincing that how the authors can compare the logic tree's responses with the ones of its sub-branch of Frankel approach. This makes confusing about the estimation by Frankel approach whether it is estimated using sub-branches of logic tress or using its relevant formula. Response: - In the present study, the hazards values are calculated using the Frankel approach considering the four models proposed by Frankel (1995). Further the final map developed using Frankel (1995) has been weighted and combined with the areal seismic sources to calculate the hazard values using the zoneless approach.

Please also note the supplement to this comment:
https://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2018-328/nhess-2018-328-AC2-supplement.pdf

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