

## ***Interactive comment on* “Brief communication: Roads and landslides in Nepal: How development affects risk” by Brian G. McAdoo et al.**

### **Anonymous Referee #1**

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This is a very short piece that looks at the spatial distribution of landslides triggered both by the 2015 Gorkha earthquake in Nepal and (presumably) by monsoon rainfall, and asks whether their locations are random or are correlated with distance from a road network. The links between landsliding and rural roads in Nepal have been addressed extensively in the past, both from physical and social science perspectives, and my first comment on the manuscript is that the authors need to clarify the novel contribution that they are making. The motivation for the manuscript is essentially a single clause in line 44 (‘To better understand the link between geologic hazards and development, we examine...’), and I think that the manuscript would be greatly improved if they can explain, with a bit more care, why exactly they have done this and what specific niche or gap in understanding they are trying to fill. There is a good recent review of

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road access and landsliding in the Himalayas that may help the authors to frame this: Hearn and Shakya (2017) Engineering challenges for sustainable road access in the Himalayas, Quarterly Journal of Engineering Geology and Hydrogeology 50, 69-80. I was also surprised that no mention was made of the Rural Access Programme, and the authors might want to have a look at a 2003 report on landslides and the RAP (<http://rapnepal.com/report-publication/landslide-risk-assessment-rural-sector>).

Addressing this concern need not add much text to the manuscript, but to me it should be done before this can be accepted for publication.

More specific comments and technical corrections, tied to line numbers in the text:

line 45: there's a word missing after 'landslides'

50-53: this sentence is key to understanding what the authors have focused on, but it is worded awkwardly – can they clarify what they are trying to achieve?

54: Roback et al. (2017 Geomorphology) mapped over 24,000 coseismic landslides – did the authors use the same data set? If not, is the landslide data set documented in Gnyawali and Adhikari 2017? Given that that latter reference appears to be in an edited book that some readers may not have access to, a bit more information on the coseismic landslide data set would be helpful. And it's a bit confusing to refer to landsliding as being controlled by 'rupture location' – what does that mean?

57-59: does this correlation imply causation? Let me put this another way: if the coseismic landslides were dominantly in bedrock, then why does it matter what soil type is found at the surface? Could this correlation be instead due to some other factor (e.g., steeper hillslope gradients associated with inner gorges along the major river valleys)? I think the authors need to clarify the proportion of their landslides that involve bedrock (as opposed to occurring within the regolith), or otherwise justify their use of this correlation in framing their work.

64: the authors could clarify that they are referring here to the magnitude-frequency

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distribution, not the spatial distribution. And how many Monte Carlo simulations were done?

65: there's a potential problem here if the landslide areas don't match the size of the hillslope where they have been randomly placed, and if the hillslope sizes vary in some systematic (non-random way). It's hard to know whether this is an issue or not, because the reader isn't shown the distribution of landslide sizes.

66: it's not clear from the text here whether the buffers are incremental or cumulative. Fig 2 makes it seem as though they are cumulative, but that's never explained clearly in either the text or the caption. And the Openstreetmap data set for Sindhupalchok is quite detailed – which roads were included? Did the authors include footpaths as well or just 'engineered' roads?

70: there's a word missing after 'random'

73: I suggest cutting 'recent' as the time scale over which these landslides have occurred is not known (or at least is not given to the reader). There's no detail on how these landslides were mapped and the time period over which they occurred. Were they mapped from imagery or aerial photos, or some other method? Line 74 says that their 'area distribution' (= magnitude-frequency distribution?) is 'not too dissimilar' to that of the coseismic landslide data set, but that doesn't mean very much to the reader.

78: it's not clear from the text how both the coseismic and rainfall-triggered landslide data sets were used. Were both used to generate the fine lines on Fig 2? If so, which is which? I'd suggest differentiating them somehow – perhaps with solid and dashed lines – because the reader has not been shown the mag-freq distributions and so can't judge for themselves whether or not these really are drawn from similar distributions.

81: what do the authors mean by 'predictably'? Can they give an idea of what they'd expect? For example, if the landslide locations were truly random and the numbers in Fig 2 were cumulative, then you'd expect a linear increase in distance from the road.

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Neither the rainfall or coseismic data sets seem to yield a relationship that is truly linear. I also wondered about weighting the data by landslide area, but that's probably a step too far for a brief communication.

86: Fig 1 lacks any coordinate grid, and panel A really needs some annotation (e.g., Bahrabise, Chaku, Kodari) to help orient the reader. The text 'to Kathmandu' and 'to China' can be cut – the latter especially because it is placed in China.

91: this text makes it sound like the buffers are incremental rather than cumulative, but that wouldn't fit with what the figure shows.

95: 'landslides'

107-109: there is another query here between correlation and causation. The authors have shown an apparently non-random association between rainfall-triggered (but not coseismic) landslides and road locations. To ascribe this solely to road construction, they would want to eliminate the possibility that roads are correlated with topography that is susceptible to landsliding. In other words, can they show more clearly that it's the presence of the road that is the causative factor?

131-133: this sentence is awkward and confusingly worded – can the authors clarify this (perhaps by separating the statistics)?

141-147: these conclusions have little to do with the analysis that the authors have shown, and introduce a few ideas (green solutions, 'environmentally sound interventions') that have not previously been discussed. I think it would be better to keep the conclusions focused on the novel contribution that the authors have made (thus linking back to their motivation in the introduction), and perhaps move coverage of green solutions to the discussion if it is relevant. Along those lines, I'd again ask them to consider the balance between bedrock and shallow landslides in their data sets – green solutions might be relevant for the latter but are unlikely to make a substantive difference to risk from the former.

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200: the Petley et al. (2007) paper, while definitely relevant for what the authors are trying to do, isn't cited as far as I could see.

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