

***Interactive comment on* “Global fatal landslide occurrence 2004 to 2016” by Melanie J. Froude and David N. Petley**

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We thank the reviewer for their comments and constructive suggestions in their review of manuscript number nhess-2018-49. Please find below the authors' replies (in italics) to these comments:

Summary: Overall this manuscript is well written, provides interesting findings reviewing over a decade of landslide reports and adds value to this topic within the landslide community. With minor revisions, I recommend this manuscript for publication. I do not see any major weaknesses in the methodology or evaluation methods and appreciate the insight provided in the discussion section regarding the challenge with anthropogenic modification of hillslopes in causing landslide fatalities; however the authors

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state in several places that human disturbance may be more detrimental to future landslide incidences than climate. I think a more accurate statement is that it may be more detrimental to future fatal landslides incidences, as the understanding of how climate may modulate change in extreme rainfall and how that may impact landsliding has not, to my knowledge, been robustly addressed. Please see specific comments below.

Line 106-7: How was the spatial precision determined? While this does not affect the analysis in the paper, it would be helpful to provide another sentence or a reference to how this precision was obtained for each report.

The description of the location of the landslide is extracted from each media report. Many entries provide the name of the village in which a landslide occurred, or the stretch of road affected. Some reports are less specific and simply include the broader administrative zone (e.g. state, county). All landslides are known to country level.

The spatial precision of each landslide report varies depending on the quality of reporting. When the landslide is reported in an administrative zone (village, city, stage), the administrative boundaries are used. For example, if the landslide occurred in the city of Kathmandu, then the administrative boundaries for Kathmandu define the spatial precision for the landslide report. These are extracted from the GADM database (2018). If the landslide occurred on a stretch of road network, then the stretch of road is mapped in GIS and a buffer applied to include slopes along the road. Some landslides can be identified in Google Earth imagery or Planet Labs imagery and these are individually mapped in GIS, so that the precise location of the landslide is known.

1-2 sentences will be added to the manuscript to provide more detail on the spatial precision.

Line 171: What precipitation data did you use in your analysis? *The rainfall data was from the Global Precipitation Climatology Centre data (Xie et al., 2013; GPCC, 2018). This is stated in the caption for Figure 5.*

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Line 195: I believe there is a word missing from the sentence that starts with “The season is bimodal: : :” possibly “with peaks in rainfall on either side of a midsummer: : :” *This sentence will be amended as follows.*

Original sentence: “The season is bimodal, with peaks in rainfall either side of a mid-summer drought, between late June to August (Magaña et al., 1999).”

Amended sentence: “The season is bimodal, with peaks in rainfall on either side of a midsummer drought, between late June to August (Magaña et al., 1999).”

Lines 240, 244, 247, 251: Should be changed to Figure 6, not Figure 7 *Typographical error: Line 240- “Fig 7c” to Fig 6c. Line 242- “Fig 7d” to Fig 6d. Line 244- “Fig 7c and 7d” to Fig 6c and 6d. Line 244- “Fig. 7e” to Fig 6e. Line 247- “Fig. 7f” to Fig 6f. Line 247- “Fig. 7g” to Fig 6g. Line 251- “Fig. 7f and 7g” to Fig 6f and 6g.*

Line 261: What is meant by the term unsettled weather?

I cite NOAA’s (2018) definition here for “unsettled”: “In meteorological use: A colloquial term used to describe a condition in the atmosphere conducive to precipitation. This term typically is associated with the passage of surface or upper level low pressure systems, fronts or other phenomenon when precipitation expected.”

Unsettled weather is associated with unstable air masses. Unstable atmospheric conditions occur when air in the lower levels of the atmosphere is warm (and/or humid) and rises, and continues to rise by being warmer than its surrounding environment. The rise of hot air leaves lower pressure regions, into which air from high pressure moves, heats and then rises. Conditions favouring this convection occur when sea surface temperatures are warmer. Not all low pressure systems may be large enough to be classified on the hurricane (or typhoon) scale, but these smaller systems, may still be associated with significant rainfall.

In the database, many landslides were triggered in hurricane prone regions, during hurricanes, by smaller low pressure systems.

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To improve clarity the authors amend “likely due to unsettled weather associated with the passage of large storms in the region.” with... likely due to unsettled weather associated with warm sea surface temperatures in the region.

Line 312: Suggest changing “which” to “that” and removing the comma

Agreed, this edit will be made.

Lines 439-441: Run on sentence, consider revising.

This sentence will be amended as follows:

Original sentence: “Future work bridging advances in climate science on regional impacts from ENSO diversity, with local patterns of landsliding, in acutely affected areas such as India, China and Nepal, will provide useful models for forecasting seasonal rainfall distribution and landslide impact.”

Amended sentence: “Increased understanding of the impact of ENSO diversity on regional climate, will improve models forecasting seasonal rainfall distribution and landslide impact. This is particularly important in acutely affected areas such as India, China and Nepal.”

Line 444: Consider adding “fatal” to the wording, “disturbance (land use change) may be more detrimental to future fatal landslides incidence: : .”

In this particular sentence, it is more appropriate to remain broad, as the studies referenced (line 444) consider landslide occurrence (number) rather than landslide impacts.

This paper does not aim to evaluate whether human disturbances or climate change may be more detrimental to landslide incidence. That question requires a longer time series of data (30 years) and we highlight this in the paper. The results of this study show that fatal landslides triggered by human activities are increasing (2004 to 2016). Specifically due to mining and construction.

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To improve clarity we will amend the following: Swap sentence line 442 “our analyses. . . hillcutting” and line 443 “human disturbance. . .2015)”. Add “fatal” before “landslide occurrence” line 442. Modify “in particular in relation to” with “driven by” line 443.

Line 453- 55: Suggest reworking sentence, it reads rather awkwardly

Original sentence: “Holcombe et al. (2016) emphasised that planning policy alone is not sufficient to control landslide risk in developing nations, because of the rapid and informal nature of construction, and low-income of residents, who cannot finance expert guidance when building their homes.”

Amended sentence: “Holcombe et al. (2016) emphasised that planning policy alone is not sufficient to control landslide risk in developing nations. This is due to the rapid and informal nature of construction, and low-income of residents, who cannot finance expert guidance when building their homes.”

Line 460-461: Sentence starting with “Several landslides were triggered: : :” is a repetitive sentence and is likely not needed here.

The sentence highlights a specific circumstance by which people are killed by hillcutting triggered landslides. This sentence should remain.

Line 461: Suggest omitting the word “simple” as often effective communication of risk by the government is not that simple.

Agreed, omit simple

Lines 471-476: Suggest reworking sentence, it reads rather awkwardly

Original sentence: “The dataset is a useful tool in identifying acutely landslide prone parts of the world and specific local drivers of landslide impact; thereby highlighting locations which would benefit from further development in early warning technology, landslide risk assessment and community capacity building; in support of the future directions of the International Consortium on Landslides (Alcantara- Ayala et al., 2017).”

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Amended sentence: “The dataset is a useful tool in identifying acutely landslide prone parts of the world and specific local drivers of landslide impact; thereby highlighting locations which would benefit from further development in early warning technology, landslide risk assessment and community capacity building. This is in support of the future directions of the International Consortium on Landslides (Alcantara- Ayala et al., 2017).”

Line 479 and other references: is it necessary to write AD prior to the years 2004 to 2016? I suggest removing as I am confident readers will not confuse it with events 4000 years ago.

The reference to AD will be removed

References

GADM (2018) <https://gadm.org/index.html>, accessed 25/4/18

NOAA (2018) <https://forecast.weather.gov/glossary.php?word=unsettled>, accessed 25/4/18

*Xie, P., Janowiak, J. E., Arkin, P. A., Adler, R., Gruber, A., Ferraro, R., Huffman, G. J. and Curtis, S.: GPCP Pentad Precipitation Analyses: An Experimental Dataset Based on Gauge Observations and Satellite Estimates, *J. Clim.*, 16(13), 2197–2214, doi:10.1175/2769.1, 2003.*

GPCC (2018) <https://www.esrl.noaa.gov/psd/data/gridded/data.gpcc.html>, accessed 25/4/18

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