Response to Reviewer 1

We thank the reviewer for their helpful suggestions and have responded to each of their comments below.

Abstract

L5, "triggering events". You can specify the type of event

We will change this to "triggering earthquakes"

L6 "ARIA", specify the acronym

Thank you for identifying this. We are renaming this method based on comments from the other reviewer so this will be changed to "co-event coherence loss method"

L10 "useful landslide density", I would say landslide mapping
We used landslide density so that readers do not expect individual mapped landslides, which is the most common output from mapping landslides using optical satellite imagery.

Introduction

L22 "could have been much longer had the earthquake occurred during Nepal's monsoon season", check this
This statement is supported by Robinson et al. 2019, which is referenced earlier in the same sentence

L30 "reliability of global empirical rainfall-triggered landslide susceptibility maps", the scale itself is a limitation

The spatial scale of the empirical models may be a disadvantage for some applications, but immediately after the earthquake, low resolution information over a large spatial scale is useful for giving an overview of severely impacted areas to emergency response coordinators (Discussed in Williams et al. *NHESS*. 2018). Although our analysis is carried out at a slightly higher resolution than these empirical models (200 x 220 m pixels as opposed to 1 km^2, which is used by Nowicki-Jessee), the improvement in resolution in this study is fairly limited.

We have added a sentence on the resolution of the empirical models "The outputs of these models have a comparatively low spatial resolution (around 1 km^2 in the case of Nowicki Jessee et al. 2018), but can be used to provide an overview of the most severely impacted areas."

L31 "style of landsliding,", I would say landslide type
We have changed this to "type of landslides".

L41 there are thousands of published paper in this field. I think the reference list can be extended, see some recent examples: _Dai, K., Li, Z., Tomás, R., Liu, G., Yu, B., Wang, X., ... & Stockamp, J. (2016). Monitoring activity at the Daguangbao mega-landslide (China) using Sentinel-1 TOPS time series interferometry. Remote Sensing of Environment, 186, 501-513. _Solari, L., Del Soldato, M., Raspini, F., Barra, A., Bianchini, S., Confuorto, P., ... & Crosetto, M. (2020). Review of Satellite Interferometry for Landslide Detection in Italy. Remote Sensing, 12(8), 1351. _Aslan, G., Foumelis, M., Raucoules, D., De Michele, M., Bernardie, S., & Cakir, Z. (2020). Landslide Mapping and Monitoring Using Persistent Scatterer Interferometry (PSI) Technique in the French Alps. Remote Sensing, 12(8), 1305. _Reyes-Carmona, C., Barra, A., Galve, J. P., Monserrat, O., Pérez-Peña, J. V., Mateos, R. M., ... & Azañón, J. M. (2020). Sentinel-1 DInSAR for Monitoring Active Landslides in Critical Infrastructures: The Case of the Rules Reservoir (Southern Spain). Remote Sensing, 12(5), 809. _Hu, X., Bürgmann, R., Lu, Z., Handwerger, A. L., Wang, T., & Miao, R. (2019). Mobility, thickness, and hydraulic diffusivity of the slowâˇARˇmoving Monroe landslide in California revealed by LâˇARˇ band satellite radar interferometry. Journal of Geophysical Research: Solid Earth, 124(7), 7504-7518.

Thank you, these have now been added to the list of references at L41.

Satellite radar coherence for change detection

L68 “method”–> technique

Thank you. We have changed this in the text.

L77 any reference for the boxcar method?

This is the most common method of calculating coherence, I have altered the text to make this clearer and added some examples of texts that use this method.

Proposed new text: “The ensemble is chosen so that the pixels used in the calculation are expected to be similar. In a “boxcar” method, it is assumed that pixels immediately adjacent to and centred on the target pixel are similar to it (e.g. Hansen, 2001; Yun et al. 2015).”

Case studies

L131 “landslides were triggered by the earthquake”, the occurrence of a typhoon the day before is certainly a trigger as well.

We agree that the typhoon the day before the earthquake will have caused widespread pore-pressure increase across the study area and that this may have played an important role in the initiation of some of the observed landslides. However, the landslides have been widely attributed to the earthquake as the primary trigger, with debate over the role of rainfall being focussed on the extent to which it pre-conditioned the slopes for failure (e.g. Osanai et al., 2019; Wang et al., 2019; Yamagishi and Yamazaki, 2018; Zhang et al., 2019). We are interested in this event because of the close sequencing of intense rain and shaking rather than as a test of our ability to distinguish the different triggers. We propose to remove reference to the earthquake as the trigger since this is unnecessary and replace that sentence with the following text:

Proposed new text : “…with the advantage that because the typhoon and earthquake occurred one day apart, and aerial imagery of the triggered landslides was acquired immediately afterwards, we know more precisely when the landslides occurred (Yamagishi and Yamazaki, 2018).”

References

Osanai, N., Yamada, T., Hayashi, S.I., Kastura, S.Y., Furuichi, T., Yanai, S., Murakami, Y., Miyazaki, T., Tanioka, Y., Takiguchi, S. and Miyazaki, M., 2019. Characteristics of landslides caused by the 2018 Hokkaido Eastern Iburi Earthquake. *Landslides*, *16*(8), pp.1517-1528.

Wang, F., Fan, X., Yunus, A.P., Subramanian, S.S., Alonso-Rodriguez, A., Dai, L., Xu, Q. and Huang, R., 2019. Coseismic landslides triggered by the 2018 Hokkaido, Japan (M w 6.6), earthquake: spatial distribution, controlling factors, and possible failure mechanism. *Landslides*, *16*(8), pp.1551-1566.

Yamagishi, H. and Yamazaki, F., 2018. Landslides by the 2018 Hokkaido Iburi-Tobu Earthquake on September 6. *Landslides*, *15*(12), pp.2521-2524.

Zhang, S., Li, R., Wang, F. and Iio, A., 2019. Characteristics of landslides triggered by the 2018 Hokkaido Eastern Iburi earthquake, Northern Japan. *Landslides*, *16*(9), pp.1691-1708.

L140 and followings, what about the type of landslides that have been triggered?

We will add the following information at line 119

“Finally, the type of landslides triggered by our four case study earthquakes were typical of landslides triggered by earthquakes (Keefer, 1984). The majority of ground failures in the four earthquakes were slides. In Nepal, ground failures were primarily a mixture of slides and falls, with the exception of a large debris avalanche in the Langtang Valley. For all four earthquakes, failure surfaces were at shallow depths in most cases with a small number of exceptions (Collins and Jibson, 2015; Ferrario, 2019; Yamagishi and Yamazaki, 2018).”

Fig.1 is the inset in (c) Lombok 2? You should specify this in the caption

Thank you for pointing this out, we have added this information to the caption.

Landslide detection methods

L185 check the double “by a landslide”

Thank you, this has been fixed

Recommendations on data and methods

L379 and one day with images from ROSE-L

Thank you, I was not aware of this satellite and have added a reference to this misson.

Building damage

L398 do you have an estimate of the number/percentage of false positives due to the buildings? The same comment for the number of false positives due to wind or snow.

It is difficult to quantify the number of false positives resulting from a specific source as we do not threshold the classifiers in our analysis. However, we have tried to assess the impact of buildings by repeating the ROC analysis with urban areas masked based on the ESA CCI landcover map. We found very little change in ROC AUC (<0.02), as these land cover types make up a relatively small part of the study area.

Quantifying false positives in snow-covered areas is difficult, since these are also likely to be underrepresented in the landslide inventory generated from optical satellite imagery (Roback et al. 2018). Furthermore, the dependence of snow cover on season, elevation and climate means that any measure we obtain of false positives due to snow is unlikely to be applicable in future events.

Quantification of false positives due to wind damage is also difficult as there are no reliable validation data available for this. From visual inspection, it appeared that the signal was strongest for areas mapped as "evergreen needleleaf forest" but masking these areas did not noticeably improve ROC AUC (<0.02).

It is difficult to predict how these false positives might affect the applicability of SAR data to future events, as this will depend on the extent of urban development (in the case of building damage), the climate, elevation and season (in the case of snow) and on the occurrence of storms (in the case of wind damage). Therefore, while we note that these are potential causes of error, we do not think it is useful to try to quantify these further.

Rivers

You could mask the rivers. Since the single landslide is not the target of your approach, the detection of a single landslide dam should not be possible and the river-mask duable.

We agree this would be possible, but although we cannot map individual landslide dams, points where rivers pass through areas of high landslide density can be used to identify locations where a landslide dam is more probable (e.g. Robinson et al. *BSSA*, 2018) and therefore which are worthy of further investigation. Therefore, although we acknowledge that a landslide signal from SAR data is less reliable in a river than elsewhere, masking them would lead to a more confusing product where landslides are not allowed to intersect with rivers. Instead we suggest that rivers should be drawn over the coherence products. In response to the comments in this review and the following comment made by the other reviewer "Line 425 - You mention rivers giving false positives for the Bx-S method. Would it be possible to identify rivers by applying the Bx-S method to a pre-seismic coherence image (using the same pixel siblings) and then use that as a mask on your co-seismic landslide image? You could propose this if so.", we will add the following sentences at line 429:

"A variety of methods could be used to identify and remove rivers from our analysis (including using a pre-event Bx-S surface). However, since areas where landslides and rivers intersect are particularly hazardous due to the potential for landslide dams and associated flash flooding, we did not mask rivers in this study. We suggest that any product based on SAR coherence supplied to emergency response coordinators should have rivers overlaid. This would both mask false positives due to rivers and allow identification of locations where rivers pass through areas of intense landsliding."