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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Analysing post-earthquake landslide activity using multi-temporal landslide inventories near the epicentral area of the 2008 Wenchuan earthquake" *by* C. Tang et al.

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Dear referee

Please accept our special thanks due to your positive comments you have made on our manuscript.

In the following part both your comments and corresponding explanations are listed;

Your comment: The introduction section needs to be better structured, as different works appear somehow mixed up with the current one, while the objectives of this

new study with respect to previous works are not sufficiently remarked. In addition, references are needed after sentences both in lines 45-46 and 47-48. In line 53 the correct reference citation is Shieh et al., 2009.

Authors' explanation: We have done these corrections in the manuscript.

Your comment: In the study area section, including brief information on land cover would be helpful, especially as vegetation is later said to be used for landslide detection and classification purposes. In line 68, covers should be spelled as cover. The words area or study area could be removed in some instances to avoid too much redundancy.

Authors' explanation: We have done these corrections in the manuscript.

Your comment: As regards the methodology, very little is said about pre-processing of the remote sensing data used, which is relevant to produce a homogeneous multi-temporal dataset, especially in this case as different types and epochs of remote sensing data are used in a mountainous area. Also, given the several remote sensing image epochs used and the high number of landslides in the study area, some semi-automatic image change detection approach preceded by suitable image pre-processing may appear more appropriate than the single-epoch based stereo image interpretation technique used. In this respect, the authors should prove the advantages of their chosen technique over the above mentioned ones while providing more insight into it, especially to be able to find differences in landslide activity between the different image epochs and to detect new landslides. In addition, the issue of processing/analysing different spatial resolution images to produce comparable landslide inventory maps should be dealt with in the paper. Table 1 should inform also of the colour (multispectral) or panchromatic characteristics of the various imagery used. It would also be useful to mention which systems or informatics tools were used for landside digitizing and stereo visualisation.

Authors' explanation: The description of the pre-processing will be added. Erdas and Arcmap are used for producing the image dataset. The images were othorized with

the DEM in Erdas. Dozens of GCPs and hundreds of auto tie points were used to do the geometric calibration using Erdas Autosync Station. The Pleiades and worldview images have high geometric precision. The Spot images matches the other images well, however they have rather large geometric errors in the areas with high mountain tops and areas with very steep terrains. About 180 landslides were affected by the error and the mass movement traces with brighter tones and loss of vegetation can still be clearly seen. By comparing with the Pleiades and world view images, the problem of the geometric error can be minimized. Digitizing based on the co-seismic landslides also helps to minimize this error. The aerial photo has about 0.3 m shift in some of the areas compared with the other images. Thus after digitizing on this image, we manually corrected the landslide polygons' location based on the world view image, which covers all the interpretation area and has the highest geometric precision and spatial resolution among all the images.

We did not apply change detection in this research. The images are from different sensors, and having different spatial resolution and sun angle. These can disturb direct change detection considerably. The post-classification change detection seems more appropriate in this case. However the error from geometric effect cannot be eliminated, as the images from different sources and cannot match each other perfectly. Moreover the change detection in this case is actually detecting changes in vegetation, ignoring most of the mass movements on bare surfaces. We have tried to use OOA classification by e-Cognition software, and it turned out the classified landslide polygons were merged together and hard to be divided correctly as they sometimes could misguide the digitizers.

Your comment: Regarding landslide classification, a reference is needed on the scheme adopted as proposed by BGS (line 106), rather than on the works such classification is based on if not the same as them. The classification, especially as shown in Fig. 2, appears somehow inconsistent as some categories combine material and movement, whilst others refer only to movement. In this figure, the green line is miss-

ing in the legend and the type and date of the background images should be mentioned in the caption.

Authors' explanation: We used the BGS system as the basis. However due to the intensive ground shaking by the earthquake, some landslides with mixed movement types and liquefaction can be observed. None of the single landslide types can describes the mixed movement types well. They should be more belong to the "complex" type in the system used by BGS. Now we have added materials in the complex types, the green line's legend and the date of the images.

Your comment: It is arguable that Spot 5 imagery of 2009 at only 2.5 m resolution (i.e. panchromatic), mentioned in lines 269-270, can be reliably used to map and classify most small or very small landslides. Further justification on this should be provided.

Authors' explanation: As you mentioned, the 2.5m spot image taken in 2009 did cause some uncertainties in the related inventories. We mapped the 2009 inventory based on the co-seismic landslide inventory. New landslides and major changes were easy to be identified. The uncertainties were majorly in the small sized landslides. Any mass movement trace within the already existed small landslides was barely visible since the 2.5m pixels were not detailed enough. To minimize this kind of errors during mapping, we not only compared the two images of the two continues years related with the 2009 inventory, but also comparing them with the other high resolution images. As you said there should be descriptions about this issue and more information about pre-processing images.

Your comment: As for the controlling factors, rainfall is rather a triggering factor. It would be useful to show the relation between landslide activity changes and different classes/categories of topographic factors and lithology on a table.

Authors' explanation: Now the lines about rainfall has its own title, not belonging to the controlling factors. We'll try to make the table of landslide activity changes vs. lithology. It will be added if the result is significant. As for the topographic factors, our landslide

activity magnitude is qualified, and the value is stored in the whole polygons. .they are not suitable to be analyzed with the topographic factors and can result in false information if used, since a whole landslide polygon is marked as active even in reality only 10% of its area is active.

Your comment: The reference cited in line 139 is missing, as well as that cited in line 243. The year of the citation in line 182 must specify whether is a or b, as well of that cited in line 210, that in line 214, that in line 248, and the last one on Table 5. The sentence in lines 192-194 needs some rephrasing for clarity. The scale bar is missing in Fig. 11, while north arrows are missing in Fig. 2, 3, 4, 6, 7, 8, 9, and 11. Landslide inventory mapped should be replaced with landslide inventory map in captions of Fig. 6, 7, 8 and 9. In line 241 phenome should be replaced with phenomenon. Same for B with beta (as symbol) in Table 5 caption. Contrary to what is stated, the statement in lines 285-286 cannot be confirmed just from Fig. 7. In line 288, of should be replaced with or. In Table 6 all occurrences of The can be removed. The same applies to the caption after (1) and (2). The subject and verb in line 373 do not match. There is an extra parenthesis in line 377. Finally, the last comma in line 479 should be deleted, in line 504 either an should be inserted before early warning system or systems should be rather used, and the reference in line 576 must include spaces between words.

Authors' explanation: We have done these corrections in the manuscript.

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