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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Changes in ground deformation prior to and following a large urban landslide in La Paz, Bolivia revealed by advanced InSAR" *by* Nicholas J. Roberts et al.

Anonymous Referee #2

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This is a good, interesting paper. I enjoyed reading it. The authors clearly have good complementary expertise needed to show how advanced InSAR can provide very useful information on ground surface deformations affecting unstable and marginally stable slopes. The displacement data pre- and post-dating the occurrence of a well-documented large urban landslide are valuable and rather unique. The data analysis is original and shows the authors appreciate the complexity of slope/landslide deformation patterns, as well as the strength and limitations of InSAR.

Specific comments for the authors' consideration.

1) Data quality/relevance - The authors discuss some limitations of InSAR data and

mention that the quality of the post-failure InSAR results is expected to be lower than that obtained from the thinner stack of the pre-failure radar acquisitions. This is correct, but since you compare the InSAR results from two different periods, I think the issue of data quality deserves more attention. The precision of InSAR measurements depends also on the environmental conditions and the adopted coherence threshold (cf. Wasowski and Bovenga, 2014a,b). For instance, after the Feb 2011 failure, the topography of the slope has changed with respect to the reference SRTM DEM. Significant change for InSAR processing and sensitivity to displacement? Representative pre-failure and post-failure topographic sections of the landslide could help. Also, was the weather less rainy (dry) in the post-failure period with respect to the pre-failure time? Significant for the processing results? Fig 6b, which shows the distribution and average annual velocity of HDS (measurement points) for the pre-failure period, indicates some "noise" (especially southern part) in the data (areas where different velocity points are mixed together). Perhaps it would be useful to show a similar figure for the post-failure period. If not, to give an idea of the precision of the results obtained for the pre- and post-failure, you could consider estimating the mean velocity standard deviations for the two periods (cf. Wasowski and Bovenga, 2014a,b). Finally, we know the InSAR are relative in both time and space. You indicate the Master scene in the Supplement (for both pre- and post-failure stacks), but the location of a reference point (area) in space is not specified, unless I missed it. This could be relevant considering the generally marginal (changing?) stability of the land in the study area.

2) Interpretations and conclusions - I can follow you for the most part, but remain somewhat uncertain about the postulated broad significance of the observed post-failure creep acceleration (enhanced activity). One reason is that the quality/precision of pre- and post-failure measurements is not the same and perhaps difficult to assess (cf point above). Then, the conclusion regarding the post-failure creep acceleration is based just on this one specific case. On the basis of the literature review and their own data, Wasowski and Bovenga (2014a,b) indicated that InSAR seem to preferentially capture creep of deep slides, seasonal accelerations of large landslides and

post-failure ground instability (settlements, volumetric changes). For some deep landslides/materials, these settlements and volumetric changes can be significant. Could it be that these phenomena are (in part) responsible for the apparent enhanced activity or displacement acceleration measured in the 10-month post-failure period?

3) Figure S2. The precipitation record. . . - this figure is important and I suggest moving a possibly modified version from the Supplement to the main article. It could be good to extend the precipitation data to the entire 10-month post-failure period covered by InSAR data.

Minor issues: - Page 2, line 20 “coherence” – might want to explain or at least say interferometric coherence - Page 2, line 29 “over much of the landslide area” – this seems too optimistic if one looks and Figs 7 and 9. - Page 3, Line 13 “up to 50 km2”? Is this correct? - Page 8, Line 15 “($\sim$2.6 cm. . .)” – Shouldn’t it be 1.3 cm?

References

Wasowski J, Bovenga F (2014a) Investigating landslides and unstable slopes with satellite Multi Temporal Interferometry: current issues and future perspectives. Engineering Geology 174:103–138 http://dx.doi.org/10.1016/j.enggeo.2014.03.003

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