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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Landslide dynamics and coupling revealed by L-band InSAR in central Georgia" *by* E. Nikolaeva et al.

Anonymous Referee #1

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This study characterises a landslide in Central Georgia, in terms of its spatial extent, decollement depth, rate of motion and potential triggers. The authors use a small set of radar interferograms (12 in total), LandSat imagery (6 images?), ASTER GDEM and field observations. This results in a detailed description of one landslide important to local hazard, which is likely to be of interest to practitioners and decision makers in Georgia.

I believe this work requires some changes before publication in Nat Hazards and Earth System Sciences.

Specific Points:

The most important points in order are:

1. I don't think that the authors have justified the use of Okada dislocation model. Muller and Martel (2000), cited at pg 4934, line 26, use a boundary element method for modelling translational landslides - not Okada as implied. The observations of horst and graben structures and description of the landslide itself made up of several smaller sliding blocks suggest significant internal deformation, not all elastic. A stronger case is needed to justify the use of the Okada dislocation, and if used, also some discussion of how deviations from elastic behaviour would affect the depth found for the decollement.

2. Title: I am not sure that the use of the "dynamics and coupling" in the title is appropriate, because a) the discussion of coupling with e.g. rainfall or earthquakes is inconclusive (page 4943, lines 13-15), b) the Okada modelling does not capture dynamics and c) the analysis of InSAR derived deformation over time is based on interferograms themselves rather than a time series, and does not properly account for noise in phase. This points should all be addressed and the title changed.

3. Although there are a couple of statements in the discussion and conclusions that refer to broader implications of this work for landslide hazard in Georgia, these ideas are not developed. This work could be strengthened by more detailed consideration of the history and potential future developments of this landslide, as well as a discussion of whether or not it is representative of landslide hazard in the region.

I have listed the other changes to be made before publication by line number below:

Abstract, line 15: what are the "important implications that are applicable elsewhere"? Is this a reference to earthquake triggering? If so, say so explicitly – also in the Conclusions at 24-26

Page 4926, line 35. Not clear what "conditionally" wet means?

Page 4927: Why are landslides "in Georgia in particular" likely to accelerate?

Page 4929, line 1. Exponent missing in number.

Page 4930, line 16. Word choice – "good conditions"?

Page 4931, line 16. Missing word?

3.2 InSAR. Were any tests done for DEM errors after topographic correction? E.g. at linear regression for baseline dependence? If there is significant topographic change due to long term sliding/mining activity, then current topography may differ from ASTER DEM, which will represent time-averaged topography since early in ASTER mission.

A time series analysis of InSAR data would also help conclusions about coupling and triggering. Perhaps the authors did not attempt this due to the low number of images available – but this should be at least be addressed in the text.

Page 4936. Some further information on the derivation of Equation 1 would make this easier to follow.

Page 4937, lines 5-12. The observations about nonlinear rate would be aided by time series analysis if possible. If not, then at least some discussion of the noise level in the phase data is still needed. Is the maximum difference, 5 cm, likely to be larger than e.g. atmospheric noise?

Figure 5. I struggle to see correlation between antithetic faults and displacement map described in the text. Could the trace of the faults be marked on?

The caption refers to a 'displacement map' derived from InSAR – derived how? Unit is cm/day, so shouldn't it be 'rate map'? Is this the average rate for all interferograms?

Page 4939 lines 25-28. What is the noise level and how was it estimated?

Page 4940 lines 20-24. How do these factors explain difference? Would they lead to under or overestimation in each method?

Page 4940 lines 17-20. The timeline is missing, and this is important information. When was the abandoned? When were houses damaged?

Page 4941 lines 7-12. On what basis were interferograms excluded from the analysis? Baseline threshold? Coherence threshold? This should be quantified and stated

explicity.

Page 4941 lines 21-23. More detail is needed here and this statement should be also be referenced. Could it be attributed pers.comm. ? What constitutes a "dramatic increase in landslide hazards"? This is rather imprecise.

The hazard context is not always very clear: how long has this landslide been taking place? Significant movement started since 1972 at least? How recent was onset? There are several statements in the Discussion that imply that it has been long-lived, but it would be useful if this question addressed directly at some point in the text.

Page 4942, lines 19-22. I don't see this in Figure 9. Also not clear what is meant by interferograms "tend to occur" as they have fairly long duration relative to a minimum point.

It would be good to have some discussion of how typical/atypical this area is relative to other landslides identified in Georgia with reference to volume, velocity or impact of mining?

Page 4943, lines 1-3 and 13-15. These statements seem to contradict each other. Is there increased velocity during periods with earthquakes? Figure 9 looks like it.

Page 4945, line 10 "conditionally faster"?

Page 4945, line 25-26 "the location and type of landslides in Georgia appear to vary in time". What does this mean? From where are conclusions drawn about Georgian landslides in general?

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 1, 4925, 2013.