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## Reply on RC3

Belizario A. Zárate Torres et al.

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Author comment on "GNSS and RPAS integration techniques for studying landslide dynamics: Application to the areas of Victoria and Colinas Lojanas, (Loja, Ecuador)" by Belizario A. Zárate Torres et al., Nat. Hazards Earth Syst. Sci. Discuss., <https://doi.org/10.5194/nhess-2021-32-AC1>, 2021

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### General comments:

The paper by Belizario et al. entitled "GNSS and RPAS integration techniques for studying landslide dynamics: Application to the areas of Victoria and Colinas Lojanas, (Loja, Ecuador)" presents the application of GNSS and RPAS techniques to study the landslide dynamics of two landslides that affected the Victoria and Colinas Lojanas sector of the city of Loja, Ecuador. The direction and velocity of landslide displacements were calculated by GNSS measurements, while orthophotos and DSMs were used to calculate horizontal and vertical displacements in a set of significant points throughout the study area.

Overall, this is an appropriate subject area for the NHSS journal, and the amount of data collected is very important from a risk monitoring and prevention perspective. However, this work should try to better develop the application of topographic techniques to the case of study where some innovative aspects or tools are missing. In addition, the methodology used is not effectively illustrated and lacks some aspects related to an accurate assessment of errors. I believe that this paper has great potential and interesting aspects that could be improved to make it more appealing to a reader but in its current state is not ready now to be published. It requires a substantial upgrading (major review), maybe assessing the limits and errors associated with the used topographic techniques and the comparison with other technologies in terms of landslide dynamics estimation. The text is unclear in some sections (requires English revision and often the terminology used is incorrect, especially regarding the photogrammetric process), difficult to follow for a reader and the structure of the text must be revised because some parts are not in their optimal location (see specific comments below). With some important improvements, this work can be interesting and useful for the scientific community.

Firstly, we would like to sincerely appreciate your comments and suggestions. This an advance of the response we are preparing after the closure of the open discussion.

We are rewriting the abstract and restructuring the sections to make the paper more easily for reading and understanding. We are also rewriting some parts of the methodology and the error assessment, as well as revising some tables and figures as you suggest.

Specific comments

Abstract: I suggest rewriting it to make it more attractive to the reader perhaps emphasizing the innovative aspect of this work and the usefulness of these results in terms of the mitigation of natural hazard problems.

**Answer: Modifications are being made to the abstract based on suggestions**

Introduction: this part should be underlined the innovative aspects of the work, motivated the choice of technologies used for the surveys, and highlighted the usefulness of the data obtained.

**Answer: Suggestion will be added in the manuscript introduction**

Methods:

A GoPro 3+ camera was used to carry out the SfM surveys, but it was not shown how the problems related to image distortion were solved given the use of a fisheye lens with a flight altitude very high.

**Answer: The fisheye function was not used for the present study, the wide mode was used. Capture mode specified in the manuscript.**

The study areas are quite large (around 6 and 2 ha) and 6 and 5 GCPs were used respectively, by what criteria were this number and GCP/CP ratio chosen? Is this number sufficient? (look at this paper: <https://doi.org/10.3390/rs10101606>

and <https://doi.org/10.1016/j.geomorph.2016.11.021>).

**Answer: Pepa et al (2016, 2019) carried out a study to evaluate the precision of a UAV-based monitoring system, in which a total of 5 GCPs are considered to monitor an area of 6.6 ha, the accuracies obtained are similar to those of the present study. Other studies cited in the text present similar errors and uncertainties. The geographical conditions given in said study are similar in the two study areas. Although studies suggest having a greater number of GCPs, the results obtained were considered relevant.**

Where are they located in the study area (a figure could be added about this)? Are the errors related to GCP and CP referred to the point cloud? and the errors related to DSM?

Because for the displacements monitoring, the points are extracted from DSMs in stable areas so the interpolation error should also be considered.

**We are considering your suggestions, and revising the figures and the tables to include this information. The control points were located on the ground with the utmost care in order to avoid location errors.**

Were the DoDs thresholded to account for the errors or do they represent raw differences?  
Line 180: why was a 3 m threshold chosen?

**Landslide evidence in the study area is related to subtle changes in the terrain elevation, usually lower than 3 m and even 1m. Thus to detect visually these changes, we saturate the palette in values higher than 3 m that is enough to observe the landslides evidence. The text has been to express better this idea.**

Technical corrections

**All technical corrections have been made according to the suggestions given.**