Earth Surf. Dynam. Discuss.,
https://doi.org/10.5194/esurf-2017-38-RC1, 2017

Earth Surface Dynamics Discussions

Interactive comment on "3D topographic monitoring of earth surface deformation using multitemporal UAV photography" *by* François Clapuyt et al.

Anonymous Referee #1

Received and published: 8 July 2017

This manuscript reports on the performance of UAV derived topography processed using SfM photogrammetry for the purpose of monitoring active slope processes in the foothills of the Swiss Central Alps. The manuscript is clearly written, well structured, and effectively documents the work undertaken by the authors. In this work, the authors apply COSI-Corr, M3C2 (Lague et al., 2013) and the GCD ArcGIS plugin (Wheaton et al., 2010) to report on the horizontal and 3D displacements, and sediment budget of the landslide complex. In my opinion, the combination of these three analyses provide a really robust characterisation of the short-term (inter-annual) dynamics of the earthflow investigated. Overall, I believe the manuscript could be suitable for publication, but the authors need to consider the main contribution of this work given: (1) the large body

of UAV and SfM research already published in Physical Geography facing academic journals; and (2) the now frequent use of UAVs for hillslope monitoring by geotechnical consultants. Specifically I think the following questions need to be addressed before this work is formally accepted for publication: In what ways does the 'performance of UAV for monitoring ground surface displacements' need further investigation? How does this work build on from the work of Lucieer et al. (2014) [Progress in Physical Geography] who also used multi-temporal UAV imagery and SfM to report on surface change, and displacement (using COSI-Corr) associated with landsliding? Is the value of this work related to the fact that it is a SfM case study or should the scientific findings regarding hillslope failure be more prominent in the manuscript? In places, the work would benefit from citing a wider range of up-to-date UAV and SfM articles, especially those pertaining to the application of UAVs to hillslope failure. This year alone a large number of highly relevant manuscripts have been published and should be acknowledged and discussed in the manuscript. This will allow the contribution/novelty of this research, beyond representing another potential 'application of SfM' case study, to be better communicated to practitioners within this rapidly developing area of remote sensing.

Some specific comments:

P1. Lines 25-26: SfM for multitemporal analysis is not in its early stages. There is now a vast body of research that addresses this topic.

P7. Lines 3-5: I see you did not survey the entire earthflow in 2013 and 2015? Is this not problematic for your assessment of the hillslopes sediment budget?

P3. Lines 19-26: How did you classify the different morphogenetic units? Please provide more detail on the geomorphological mapping in this research with reference to the approach undertaken to classify this particular hillslope failure (e.g. with reference to key geomorphological mapping literature). This information should be provided in the methods section. You could also, for example, use digitised morphogenetic zones

to produce a more detailed breakdown of geomorphological change using the 'budget segregation' feature in the ArcGIS GCD plugin provided by Wheaton et al. (2010).

P5. Lines 18-27: Did you use a multi-rotor or fixed wing aerial platform? What was the approximate distance between the camera and the surface of interest during image acquisition? Please add this detail and ensure all details pertaining to the camera settings are provided in the main body or appendix in line with the recommendations of O'Connor et al. (2017) [Progress in Physical Geography].

P6. Lines 25-28: Please provide more information on the errors associated with each raster surface used for differencing (beyond what is presented in section 3.1). The propagated error values used to threshold the DoD need to be presented alongside your results and in Table 5. What is the uncertainty (in $\pm$ m3) associated with the estimates of erosion, deposition and the net volume of difference? How did you arrive at the minimum, best and maximum estimates – are they linked to your detection limits? Were these based on difference values used to threshold the DoDs? Did you use spot height checkpoints to derive propagated error values? You need to more clearly communicate these aspects in the manuscript.

P9 Lines 25-26: You suggest that your study "confirms that the SfM algorithm in itself is robust and can be applied to convert raw image datasets into very-high resolution 3D point clouds." This is rather obvious and has been documented and addressed in great detail in a vast number of published manuscripts. I think you might need to reconsider what the main findings of your work actually are – perhaps the scientific findings are more interesting than the methodological ones?

P9 Line 30-onwards: Is it worth commenting on the application of ground-control here and any influence control measurement may have had on the resulting pattern of morphological change? For example, did you have any issues placing GCPs on problematic terrain and did this impact your GCP spacing (suggested 25m spacing on P5. Line 25)? Does the GCP distribution weaken confidence in any of your findings? As I am

certain you are aware, the application of GCPs is a time-intensive process that is important for reducing uncertainty in topography surveys. These themes (amongst other aspects of the SfM workflow) have recently been addressed by the work of James et al. (2017) via articles published in the journals ESPL and Geomorphology. On inaccessible and unstable terrain ground control cannot always be applied for practical/safety reasons (e.g. volcanic terrain). There has been some discussion about the potential for using direct georeferencing based UAV-SfM workflows in hazardous terrain (e.g. Carbonneau and Dietrich, 2017, ESPL). I think you would benefit from acknowledging these approaches/methodological papers when discussing the merits of the UAV-SfM approach for monitoring earthflows in this manuscript. In summary, the latest SfM findings need to be better integrated into this manuscript.

P10 Lines 1-4: The regulatory framework for RPAS/UAV operation is rapidly evolving in many countries. Are you able to briefly highlight any specific considerations (with reference to support materials) pertinent to your work in Switzerland? I am sure this information will be beneficial to geoscientists/geomorphologists planning future work in Switzerland.

Table 1: It would be great to see the GCPs plotted in a figure so the reader can assess GCP distribution and the impacts it may have had on the quality of the surface reconstruction for each survey.

Technical corrections:

P2. Line 4: 'is' change to 'are'?

P4. Line 12: "auttaumn" change to autumn?

P5. Line 23: Change to "better capture complex 3D structures"?

P10 Line 5: Title for the next section is duplicated in the main body of section 4.1.

Interactive comment on Earth Surf. Dynam. Discuss., https://doi.org/10.5194/esurf-2017-38,

2017.

C5