Reply to Reviewer #1 Comments

We thank the Reviewer for taking time to review the manuscript. The helpful and constructive comments put us in an excellent position to further improve the paper. The text below contains our response in a point-by-point format. To clearly distinguish reviewer comments from our responses, the reviewer comments are indented.

> *General comments:*
> The paper by Gudino-Elizondo et al. entitled "Rapid assessment of urban mega-gully and landslide events with Structure-from-Motion techniques validates link to water resources infrastructure failures" analyzed the effectiveness of SfM photogrammetric techniques for rapid erosion assessment following water resources infrastructure failures (WRIF) events that affected the Urban development in Tijuana, Mexico. The study monitored for a five-year period three hazardous mass-movement events including two mega-gullies and one landslide and evaluate the significance of WRIF events with respect to mass movement hazards and sediment budgets at neighborhood- and watershed scales.
> Overall, this is an appropriate subject area for NHESS journal, and the amount of data collected is very important from a risk monitoring and prevention perspective. However, this work should try to better illustrate the application of the photogrammetric technique to the case of study, adding some aspects related to data post-processing and error assessment. I believe that this paper has great potential and interesting aspects that could be improved to make it more appealing to a reader. It requires an upgrading, maybe assessing the limits and errors associated with the used topographic techniques and the comparison with other technologies and studies in terms of gullies and landslides monitoring. With some improvements, this work can be interesting and useful for the scientific community.

We thank the reviewer for remarking on the importance of this work and its fit within the NHESS journal. We also thank the reviewer for the general suggestions to improve the paper. Based on your feedback and also the feedback from Reviewer #2, we have developed a four-part plan to improve the paper: (1) we will clarify our on focus on "abrupt" earth surface hazards which occur over a time scale of hours within the periphery of expanding urban areas and as a result of the combined effects of rainfall and water resources infrastructure failure (WRIFs), (2) we will emphasize that rapid-response SfM-photogrammetry is a promising approach to document these abrupt hazard events, and we will add more information about post-processing data including errors and uncertainties as recommended by the Reviewer, (3) we will add more contextual information (e.g., history of development, climate, presence of unpaved roads) around our observations to enable a richer interpretation of these important data as recommended by Reviewer 2, and (4) we will report the ways in which this work informs our understanding about the triggers and processes that are responsible for these "abrupt" hazards.

We especially regret that our original submission did not clearly explain our interest in "abrupt" events, i.e., mega-gullies and landslides that evolve over a matter of hours. This is a very important detail for justifying the importance and timeliness of rapid-response SfM-photogrammetry to document abrupt mega-gullies and landslides. This detail also bears on the originality of our contribution: to our knowledge, this is the first study to provide documentation of abrupt mega-gullies from a combination of rainfall and WRIFs, and only the second study to document abrupt landslides from a combination of rainfall and WRIFs. Since abrupt earth surface hazards in urban areas pose major safety and damage risks, with little opportunity for early warning and emergency response, primary data documenting these events and reporting their triggers is a very important responsibility of the scientific community.

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 WRIF hazard problems.
- 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.

We agree that the abstract and introduction can be improved, and we are prepared to do so upon direction from the editor to prepare a revision. In particular, we now recognize the need to address the oversight we made in the first version of the paper with respect to defining our problem of interest as "abrupt" earth surface hazards that demand a rapid-response approach for documentation purposes. Moreover, we will also explain to the reader that these abrupt events appear to be triggered by a combination of WRIFs and rainfall events. In the case of mega gullies, we can describe a two stage triggering mechanism: stage 1 involves the formation of a gully network in an unpaved road produced by surface runoff, which then exposes a pressurized water main that was constructed under the road. In stage 2, the water supply pipe breaks under its own weight and unleashes a high velocity water jet that creates a mega-gully. In the case of landslides, we will use existing literature (e.g., the landslide handbook by Highland and Bobrowsky, 2008) to explain that abrupt, rotational slides of soil are a common type of landslides in arid urban areas. We can also explain that these events are generally triggered by an overburden of weight: leaks in water mains are capable of saturating soils and increasing weight, which create conditions favorable to a slide during a rainfall event. Hence, both rainfall and WRIFs contribute to both types of events.

Specific comments

- Methods:
    1. 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.

2. Where are GCPs/ECPs located in the study area (a figure could be added about this)? Are the errors related to ECPs referred to the DSMs? and the errors related to point cloud?
3. Are the difference of DSM (DoDs) thresholded to account for the errors or do they represent raw differences?
4. It would be useful to add more information about the SfM workflow, in particular, the post-processing of the point cloud (e.g. filtering, errors) through to the DSMs.
5. Has the problem of co-registration of point clouds been considered in making multi-temporal DSMs?

We thank the reviewer for offering these five "specific comments" to improve the presentation of our methods. We can address these points, respectively, as follows:

(1) We used a non-distorted lens on the UAV mounted camera, and regret that this was not made clear.
(2) We are prepared to create a figure showing the location of GCPs and ECPs and to expand the discussion of errors.
(3) We reported raw differences in the manuscript, but we can easily revise the paper to include the RMSE for the DoDs and point clouds, respectively.
(4) We would be pleased to provide a more detailed description of the workflow.
(5) Yes. We compared elevation profiles in stable areas and no significant changes were observed (<7 cm). We also reported in the manuscript that co-registration errors were negligible.

Discussion

Misses an in-depth analysis on the problems and errors caused by the technologies used, how to improve these aspects, and a comparison with other works using the same techniques.

We agree that the discussion could be expanded to reflect on the technology, and we are prepared to pursue this recommendation upon revision of the paper.

Technical corrections

Figure 1: It would be better to put someplace names in the background to better identify the position of the catchment because it is not clear where it is located. Or put an image with its location on a larger scale next to it.
Table 1: Use UAV or UAS, not both because it is confusing for the reader.
Table 1: I would avoid entering "RMSE of ECPs" here, which should be reported in the results.
Line 123: "the difference DSM" > it is better to use the acronym DoD, which is widely used in this context of multi-temporal surveys.
Lines 175 and 180: I think the reference should be to Figure 2d.

Figure 2: What is the purpose of Figure 2c? is not explained in the manuscript.
Figure 2: here and in other captions the word DEM is used instead of DSM. In order to be consistent in the manuscript, it is good to specify the type of digital model used and always indicate it in the text.
Lines 191 and 194: should be moved to the discussion section.
Figure 3: It is not clear what the blue stars refer to. A legend is needed.
Line 221: the citation of Figure 4d, I don't think is located in the correct place and it is still not clear what the blue star in the figure refers to.
Line 228: after 'DSM' perhaps Figure 4b should be mentioned?
Line 234: Figure 4a should be mentioned before the others (Figure 4b, c, d) in the text. Remember that order matters.
Table 2: is not very clear. A better division between data measured in the field and estimated by the model would be better (not by indicating simple asterisks).
Table 3: sediment units are missing in columns 2 and 3.
Line 379: here the word DEM is used instead of DSM. It is better to choose which term to use throughout the manuscript.

We thank the reviewer carefully reviewing the paper and identifying each of these opportunities to improve the paper. We are prepared to address all of these suggestions with the preparation of a revision.