Natural Hazards and Earth System Sciences Discussions

Nat. Hazards Earth Syst. Sci. Discuss., author comment AC1
https://doi.org/10.5194/nhess-2022-34-AC1, 2022

Reply on RC1

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Author comment on "Landslides caught on seismic networks and satellite radars" by Andrea Manconi and Alessandro C. Mondini, Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2022-34-AC1, 2022

The paper "Landslides caught on seismic networks and satellite radars" discusses the possibility to apply an integrated approach which combines broadband seismic data and satellite images for detecting landslides over large areas. To this aim, the approach was tested with a rock avalanche event occurred in Central Alps on 23rd August 2017.

GENERAL COMMENTS

I really appreciated the content of this paper, which is also fairly well-written. Although the proposed approach can be roughly summarized as a combination of two already-existing methodologies (i.e., Manconi et al., 2016 for seismic data processing and Mondini, 2017 for satellite imagery analysis), the manuscript presents several innovative elements which certainly fit with the aim of the Journal. However, before the article can be accepted for publication on NHESS, several aspects of the work must be improved to clarify the obtained results and substantiate the novelty of the proposed approach.

REPLY: We thank the reviewer #1 for this positive feedback. Here below we reply point by point to the comments and concerns.

SPECIFIC COMMENTS

1) Structure of the work: the authors should better distinguish the "Materials and methods" section and the "results" section. In the current form of the manuscript, there is a bit overlap between the sections (e.g., Table 1 should be included in Results)

REPLY: We will modify accordingly to avoid overlap between Methods and Results. Table 1 has been moved to the Results section.

2) Seismic data processing: the authors should better clarify "the step forward" of their approach with respect to the method employed by Swiss Seismological Service (SED) for detecting landslide phenomena. It seems that the identification of the candidate area is strongly related to an arbitrary constrained temporal window which, in turn, depends on the outcome of SED approach

REPLY: The step forward of our approach is the possibility to automatize the

processing pipeline, because the current SED procedure for the location of the mass movements is manual/visual and thus arbitrary. The temporal window selected for this demonstrative case is arbitrary. Our idea is to perform future evaluation on the continuous processing of seismic data in order to find the best parameters, to minimize false alarms and make a substantial evaluation of the potential implementation of such procedure. But this is beyond the scope of the current manuscript.

3) Analysis of the obtained results: the authors should perform a more in-depth analysis of the obtained results. At present, the "results" section is a bit lacking and several aspects are not investigated at all. Just two examples:

- six landquakes have been introduced in the first part of the work but, in practice, only LQ2 is considered (LQ5 and LQ6 are just partially addressed). Are the predicted volumes consistent with real ones?

REPLY: The volumes predicted with the empirical evaluation of the seismic waves are in agreement with the ones measured with LiDAR, we compared with the values published by Walter et al., 2019. The difficulty to evaluate the real accuracy of estimated volumes is that quantitative measurements are rare, and in most cases not performed after each single event.

- Are there other areas which show surface changes after satellite imagery analysis? If so, it would be important to investigate this point for better understanding the reliability of the proposed approach.

REPLY: Yes there are. In fact, the surface backscatter, so as measured in the microwave range by SAR images with fixed acquisition geometries, can experience several types of changes including: 1) changes due to a land cover change (e.g. from vegetation to bare soil, eventually caused by the occurrence of landslides), 2) changes in the soil moisture content (see dielectric constant) or soil roughness, and 3) a sort of random changes caused by the speckling-like effect that can affect wide portions of the single images in particular in vegetated areas. These changes can have intensities, sizes (area) and shapes quite different. In particular, landslides appear in the measures of backscatter changes as clusters of similar pixels (all dark or all light), with elongated shapes in a bulk of "salt-and-pepper noise". These elements potentially allow for an automatic or manual (interpretation) landslide recognition among other changes. In our case, LQ2 is very large compared to other changes for at least two reasons; 1) it's a big landslide, 2) there are no other significant changes around the cluster left by the landslide (quite a static situation except for the landslide occurrence). LQ5 is a much smaller event compared to LQ2 and left a sign which is quite clear (dark), elongated, but just a bit larger than the typical clustering of the salt and pepper noise, and smaller than other changes left by a dynamic evolution of the surrounding environment (see snow processes). In this case, the analysis of the area shows that the landslide segment is the largest in the "Bondo valley" but at least four other segments are relevant (in terms of area). The landslide can be recognised (for the moment manually) through the interpretation of the elongated shape and through its position (e.g. it is not in a flat area). As far as LQ6 is concerned, this episode probably determines a lower limit for the technique: in the "Bondo valley" there is a clear dark cluster, located in a position consistent with a landslide, but its shape is not elongated (the landslide is too small for the pixel size of the used image) and its size is comparable to the size of the bulk. LQ5 & LQ6 can be seen as red flags alerted by the procedure that need further investigation (optical, field survey, or higher SAR images resolution). Results and discussion have been changed accordingly:

In my opinion, the authors should rely on the material included in the supplementary files for improving the analysis of the obtained results

REPLY: Thanks for this suggestion. We have added additional plots on the Figure 4 to cope with this request.

4) I suggest to slightly modify the "Discussions" section in order to clarify strong points and shortcomings of the proposed approach. In my opinion, a table which summarizes these aspects would help in this regard

REPLY: Thanks for this suggestion, we have developed the table 3.

TECHNICAL CORRECTIONS

Caption Table 1: "have ML/MD" is repeated twice

REPLY: Thanks, corrected.

Figure 2: please add on the map the location of Piz Cengalo

REPLY: Thanks, added.