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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Regional snow-avalanche detection using object-based image analysis of near-infrared aerial imagery" *by* Karolina Korzeniowska et al.

Anonymous Referee #1

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General comments:

The paper by K. Korzeniowska and co-workers describes a method for automatic avalanche detection based on object-based image analysis (OBIA) of near-infrared (NIR) aerial imagery. The paper starts with an introduction of the dangers and risks related to snow avalanches with some detailed information on human fatalities and damages to infrastructures (mostly focused on the case of Switzerland), and the need for further developments concerning the large-scale yet precise mapping of avalanche activity. Section 2 provides the reader with an overview of the existing studies on automatic detection of avalanche activity based on image processing. A very short section (current section 3) describes the study area and data, and already includes

some information on the methods. Section 4 is the detailed section on the methods. Section 5 shows the main results with a focus on the following points: the accuracy of the OBIA workflow proposed, including the influence of variables chosen -brightness, NDVI, NDWI, SD_NDWI- on accuracy, on the one hand, and the results on (i) topographic factors that influence avalanche activity, (ii) density of avalanches and (iii) classification in release, flow and run-out zone of detected avalanches on the other hand. Section 6 is a discussion on the advantages and drawbacks (points to be improved) regarding the method proposed. Finally, the last section concludes by mostly giving a summary of the main points discussed in section 6.

The paper presents an interesting method for detection of avalanche activity, which is based on object-based image analysis (OBIA) of near-infrared (NIR) aerial imagery. Given that NIR aerial images of good resolution are available, this method has the potential to cover large-scale mountainous areas including very remote areas. Furthermore, a statistical approach allows to distinguish between release, flow and run-out zones of the detected avalanches. One tricky yet important issue remains the distinction between single and multiple events. The OBIA workflow and the results presented in the paper are worth to be published in NHESS. However, the paper in its current form is not ready for publication. Some substantial revision is needed at least for two main reasons. First, I found that the sensitivity analysis of the method and outcomes to varying the different thresholds is lacking. The authors should pay attention to including such a sensitivity analysis when possible, and/or argue more on their choice regarding the thresholds of a number of parameters: see my specific comments below. Second, the authors should make an effort to improve the editing/structure of their manuscript that is sometimes quite hard to follow: short section versus another much longer section, announcement of outlines needed in the main introduction and the long section on "methods", etc. (see my comments regarding Editing/Structure of the paper and technical corrections).

Specific comments:

- section 1 (intro), page 2 (lines 20-21): Saying "..., focussing mainly on geographic coordinates, but rarely on any detailed information about their extent or area." appears too strong to me. I think the authors should qualify that statement. Traditional methods, such as photo-interpretation, the use of testimonies, photographs, etc, gives crucial information, and merging that information into one single platform (see for instance the paper by Irstea group, by Bourova et al. CRST 2016, as well as some references therein) is already an important and efficient step. Could you please revise this part of the text?

- section 2, page 3 (lines 23-25): Please could you argue a little bit on this 35 deg threshold? I believe such a limit should depend on the snow type and then influence the results of your automatic detection approach. Please could you comment on this point?

- section 2, page 4 (line 25): again, this threshold of 35 deg needs much more discussion. This angle should depend on the snow type. Either you show a sensitivity analysis of your detection to that threshold, or you give more physical arguments on this choice.

- section 4.1.1, page 6 (line 4): why this threshold of 6.25 square meters (the exponent 2 for the segment area is missing)? Could you please argue to make your choice less arbitrary? Did you conduct any sensitivity analysis of your method to varying that threshold? If yes, could you please include a thorough discussion on that analysis in the manuscript?

- section 4.1.2, page 6 (lines 13-16): the sentence is not clear to me, please revise. Could you please show a couple of examples of the cross-comparison between segment values and their visual representation in an image?

- end of section 4.1.2: could you please argue on this threshold of 62.2 square meters? Again: did you conduct any sensitivity analysis? Also I would suggest you show a square of that size on one figure (among figs a,b,c,d shown in Fig. 4 for instance). It

would be useful for the reader to materialize the physical size of that threshold onto the map, compared to avalanche extensions that are detected.

- section 4.1.4, page 7 (line 4): could you please explain why you are using/choosing those values for both brightness and NDVI thresholds? I would suggest you to show a sensitivity analysis to varying those thresholds. This seems to me a crucial point if you would like your method to be possibly extended to much larger scales or other mountainous areas.

- section 4.1.5, page 7 (lines 24-25 in brackets): why those thresholds? Could you show a sensitivity analysis to varying the thresholds? Brightness threshold is 2500 here, while it was 3000 a little earlier in the text (see previous comment too).

- section 5, page 8 (lines 17-22): this part discusses the problems/limits of the method. The reader would like to know how those problems/limits are sensitive to the choice of the different thresholds (see the specific comments above). Could you please strengthen the discussion on this point?

- section 5.3, page 9 (line 12): is the range 20-40 deg compatible with the threshold of 35 deg discussed in section 2?

Editing/Structure of the paper and Technical corrections (typings errors, etc.):

- Abstract (line 19): "... at three 4-km areas..." The exponent 2 for areas in square kilometres per square is missing?

- end of section 1 (intro), page 3 (lines 14-15): again, the exponent 2 is missing here. Please fix it.

- section 1: would be nice to terminate the section by announcing the detailed structure of the paper, with a short summary of each section (including explicit numbered reference to each section).

- section 2, page 3 (lines 23-25): the construction of the sentence is a bit weird... The

threshold of 35 deg is an assumption (a model input that stems from the DEM data) but not an outcome of the RAMMS model. Please revise the sentence.

- section 2, page 3 (line 27): "nadir?". Please fix this.

- section 3, page 5 (line 10): again, the exponent 2 is missing... PLEASE CHECK CAREFULLY the entire text regarding this issue, which is present in many parts of the manuscript.

- section 3 is very very short. Given the fact that it already includes some information on the methods, I would suggest that the authors include section 3 as a sub-section of section 4 "Methods".

- introduction of section 4: this part needs careful revision. Would be nice to put here an outline with explicit references to the sub-sections that follow (by using the numbering), as well as explicit reference to key figure 4. In its current form, I must say that section 4 is very difficult to read/follow.

- end of section 4.1.2, page 6 (line 19): typo... should be "then" instead of "than"

- section 5.4: I would suggest to replace "inset 1, Fig. 8" by "inset on Fig. 8a" and "inset 2 on Figure 8" by "inset on Fig 8b".

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