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Reviewer Comment on tc-2022-15

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Referee comment on "Snow Avalanche Frequency Estimation (SAFE): 32 years of monitoring remote avalanche depositional zones in high mountains of Afghanistan" by Arnaud Caiserman et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2022-15-RC1, 2022

The paper entitled "Snow Avalanche Frequency Estimation (SAFE): 32 years of remote hazard monitoring in Afghanistan" by Arnaud Caiserman et al. presents a Googel Earth Engine based analysis tool to map very large avalanche deposits in Afghanistan.

I acknowledge the innovative idea to apply optical satellite imagery to map avalanches and therefore generating avalanche information in data sparse regions. The presented approach could indeed help to improve avalanche cadasters in the future. However, there are several important flaws and problems with the presented approach that have to be clarified, improved and tested before this method is ready for publication and potential application:

- The state of the art is incomplete. Several publications, very relevant for this topic have to be considered and discussed. In particular the optical mapping with SPOT6 over the Swiss Alps is important (Bühler et al., 2019). But also, several mappings with Sentinel-1 are missing (Leinss et al., 2020; Karas et al., 2021; Vickers et al., 2016). Considering hazard indication mapping new developments allow for applications over very large areas (Maggioni and Gruber, 2003; Barbolini et al., 2011; Bühler et al., 2022) and was even already conducted in Afghanistan (Bühler et al., 2018). Therefore, the introduction has to be overworked including the relevant publications.
- It is essential to clearly communicate what can be expected from the presented approach in terms of accuracy and reliability. First of all, only very large avalanche **debris** can be mapped. Throughout the paper the authors should use this term and not the term avalanche to be clear. An avalanche consists of a release, a transition and a deposition zone. Only the deposition zone can be partially mapped. There are several problems for example if the avalanche debris is covered by soil / rock or wood (The NDSI is reduced and the deposit is not mapped as avalanche). There is now information on how many avalanches deposited onto one mapped deposit. Typically, this happens several times a year. In the river basins there is often complex terrain with a lot of cast shadow leading to missed avalanche debris. All these uncertainties lead to a very limited reliability of the presented approach. Therefore, it is not eligible to draw all the

statistics from the mapped debris as the authors do in the results. These statistics are strongly biased and not reliable. Applying them for hazard mapping or the planning of mitigation measures could be very dangerous.

- To assess the mentioned uncertainties and potential biases we recommend to test the algorithm with the most complete and accurate avalanche dataset mapped with SPOT6 imagery over the swiss Alps in 2018 and 2019 (Bühler et al., 2019; Hafner and Bühler, 2019) https://www.envidat.ch/dataset/spot6-avalanche-outlines-24-january-2018;https://www.envidat.ch/dataset/spot6-avalanche-outlines-16-january-2019. This exercise could bring clarity into very important questions and help to assess the potential of the presented approach.
- The snow avalanche size classification is totally flawed with respect to reality/ methodology. According to the definition of the EAWS (https://www.avalanches.org/standards/avalanche-size/#largeavalanche) size is mostly defined by volume, runout-length and destruction potential: so basically only avalanches larger than size 3 (large to extremely large) have potential to even reach those places where they are later detected with enough snow for it to remain until summer, Additionally, as the authors state they cannot separate single events, a size classification with the same classes as assigned to whole avalanches shortly after their release is nonsensical also as the area covered in gullies usually means a lot more volume than one would think. This makes methodologically no sense as well as everything derived from this (whether as category or as size).
- It is not clear why only Landsat is used. Sentinel-2 imagery would also be a big help for the presented approach (even though only available from 2015). What about the potential of other systems such as PLANET? This should be discussed.

Therfore I recommend a carful overworking of the manuscript an an extension of the validation as proposed.

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