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# Deep learning approach to automatically identify avalanches in optical SPOT 6/7 imagery

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Spatially dense and continuous information on avalanche occurrences is crucial for numerous safety related applications such as avalanche warning, hazard zoning, hazard mitigation measures, forestry, risk management and numerical simulations. As such information is collected in a non-systematic way by observers in the field, there is, especially in situations with high avalanche danger, a strong bias towards avalanches in proximity to accessible infrastructure. In recent years research has shown that remote sensing is capable of mapping avalanches and complementing those existing databases over large areas (e.g. Bühler et al., 2019; Hafner et al., 2021).

After manually mapping avalanches in previous work, we have recently adapted a DeepLabV3+ , a fully convolutional neural network (CNN), to automatically identify avalanches in optical SPOT 6/7 data. We used the 24'778 manually annotated avalanche polygons and split them into geographically disjoint regions for training, validating and testing. We achieved an average probability of detection (POD) of 0.610, positive predictive value (PPV) of 0.668 and an F1 score of 0.625 in our test areas (Hafner et al., 2022). In order to understand the current standard to which we could compare those results to, we conducted a reproducibility experiment where we asked experts to identify all visible avalanches in a test region. Our subsequent analysis showed that our model performance is in the same range as manual annotations from different experts.

The ability to automatically, and therefore in a timely manner, identify avalanches from optical satellite imagery is an important step forward in complementing existing databases and providing data for different applications. More complete and less biased avalanche datasets are an important precondition to improve e.g. the avalanche warning, increasing the safety in Alpine Regions.

## REFERENCES

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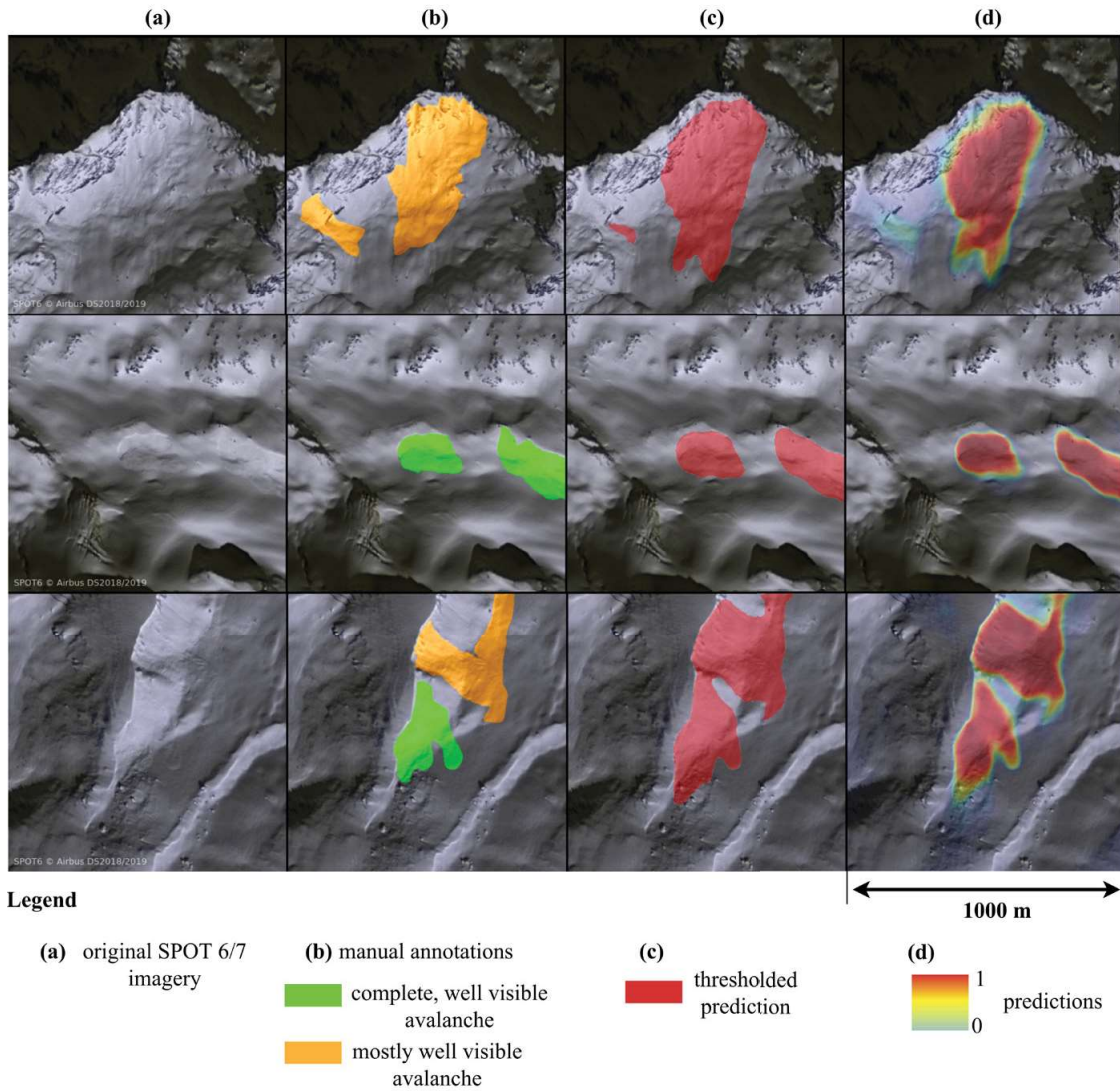


Figure 1. Comparison of results for three patches: (a) the original SPOT 6/7 image, (b) the manually mapped annotations used as reference, (c) the predictions thresholded at 0.5, and (d) the predicted avalanche probability (SPOT 6 data © Airbus DS 2018).