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Potential of dNDVI-method for landslide detection in Norway

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The Norwegian mass movements database contains over 33,000 registered snow avalanche and landslide events from the past 500 years and is used as an input for The Norwegian Landslide Early Warning System (LEWS). However, the usability of the database is limited by factors including a spatial bias towards transport systems and incomplete or missing information on landslide characteristics (including precise date, time or location). This has serious consequences for the definition of triggering thresholds. Sentinel-2 optical satellite data, with its frequent return period in Norway (up to three days) and relatively high resolution (10 m), could provide an alternative source of data on landslide occurrence to supplement ground-based observations and improve the information in the database.

This study examined the potential for using Sentinel-2 data to detect landslides with two approaches, using (i) a national-, and (ii) a local-survey. Both used the change in the vegetation index (denoted dNDVI) between pre- and post-event images, to identify a loss of vegetation as an indicator of landslide occurrence. Firstly, 30 well-documented landslides with a minimum volume of 1000m^3 were extracted from the national database. The selected landslides occurred across all Norway between 2015 to 2017. They were searched for in Sentinel 2 images to give insight into how factors including season, slope angle, aspect ratio, land cover, landslide size influenced landslide detection using the dNDVI-method. Secondly, the same approach was applied to the Jølster area in Western Norway, where an extreme short intense rainfall event in the summer of 2019 (30 July 2019) triggered multiple landslides. For Jølster, landslides were mapped and then verified by field and helicopter observations.

For the national survey, the season was found to have the greatest effect on detectability. For spring and summer events the percentage of landslides detected was 70-75%, while for winter and autumn this dropped to 14-20%. The main reasons for non-detection were clouds, shadows, snow, and lack of green vegetation. The average acquisition window for detected events was 43.3 days. The Jølster case study represented ideal conditions for using the dNDVI-method, with a five-day acquisition window (almost cloud-free images available from two days pre-, three days post-event), low shadow, and green summer vegetation. The mapping process produced an inventory of 99 events, giving a significant increase from the 14 events registered in the database.

The results indicate that the dNDVI-method has good potential for landslide detection in late-spring and summer in Norway, however, it is not recommended later in autumn and winter. We

believe that the dNDVI-method provides an option for gaining more information on the size and location of landslides, which at the present, are only registered as points in the database. For the Jølster case, this method showed a great improvement with respect to the current practice, both in terms of an increased number of landslides and spatial distribution. This suggests good potential for improving inventories of landslides, necessary in landslide hazard analyses and definition of landslide thresholds.

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