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Mapping the evolution of the Kaiwhata landslide and landslide-dammed lake in New Zealand using satellite image time series

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Landslides are serious natural hazards in the mountainous and hilly areas of New Zealand, where they frequently cause landscape changes and significant damage to people and infrastructure. Monitoring the evolution of landslides, associated landslide-dammed lakes, and their consequences is important for disaster risk management and can help to mitigate cascading hazards. The availability of time series satellite remote sensing data has facilitated more efficient mapping and monitoring of landslides and related hazard analysis.

By applying object-based image analysis (OBIA) and using Sentinel-2 satellite data from 2017 to 2021, complemented by PlanetScope data, we semi-automatically mapped the evolution of the Kaiwhata landslide and the associated landslide-dammed lake in the Wairarapa region in the south of New Zealand's North Island (cf. Pooladsaz et al., 2023). We mainly used spectral indices, such as the normalized difference vegetation index (NDVI) and the normalized difference water index (NDWI), with the support of digital elevation model (DEM) data acquired from the Land Information New Zealand (LINZ) and its derivatives, to classify the landslide and landslide-dammed lake areas. The DEM data helped to remove false classifications, even though the DEM shows the pre-landslide status of the terrain. The segmentation parameters were determined based on expert trial-and-error and visual assessment of the resulting image objects. The classification rules and parameters were developed continuously from the first image to the subsequent ones, following the evolution of the landslide and landslide-dammed lake. The knowledge-based OBIA mapping workflow was designed to be transferable to all the images. When applying the workflow to the other images, only minor modifications concerning the used layers and thresholds were needed. The semi-automated OBIA results were compared with the results of visual interpretation to assess the mapping accuracy.

Despite challenges such as cloud coverage and shadow effects during certain seasons, the spatial resolution of Sentinel-2 images was sufficient to accurately capture the landslide and landslide-dammed lake. The mapping results, which were also visualised as interactive three-dimensional (3D) models, revealed a gradual increase in the landslide area, with two major changes in June 2019 and November 2020. These major changes were followed by the formation of temporary landslide-dammed lakes along the Kaiwhata River (cf. Morgenstern et al., 2021), because the landslide reached the riverbed and blocked the stream. The use of OBIA and time series satellite

remote sensing data can provide valuable insights into the evolution of landslides and landslide-dammed lakes and allows for a more detailed assessment of their impacts.

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