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Mapping and monitoring of landslide-dammed lakes using Sentinel-2 time series

A case study after the 2016 Kaikōura Earthquake in New Zealand

Lorena Abad[1]
Daniel Hölbling[1]
Raphael Spiekermann[2]
Zahra Dabiri[1]
Günther Prasicek[3,4]
Anne-Laure Argentin[3]

[1]Department of Geoinformatics - Z_GIS, University of Salzburg, 5020 Salzburg, Austria
[2]Manaaki Whenua - Landcare Research, Palmerston North 4442, New Zealand
[3]Department of Geography and Geology, University of Salzburg, 5020 Salzburg, Austria
[4]Center for Interdisciplinary Mountain Research, University of Lausanne, 1967 Bramois, Switzerland

Session NH6.1 – Live chat: Thu, 07 May, 14:00–15:45

Z_GIS UNIVERSITY of SALZBURG

Introduction

Motivation

Dammed lakes are a potential natural hazard due to flooding risk.

Monitoring landslide dams and their related lakes is important for disaster management.

Field measurements and observations provide detailed information but are time-consuming and expensive, mainly for large areas.

Aerial photographs and LiDAR data are valuable data sources, but time series for constant monitoring are hardly available.

Satellite remote sensing imagery, like Sentinel-2, has become essential to obtain a large overview of hardly accessible areas.

Objectives

Detect and map landslide-dammed lakes with Sentinel-2 imagery on Google Earth Engine (GEE).

Monitor dammed lake evolution in different time periods.

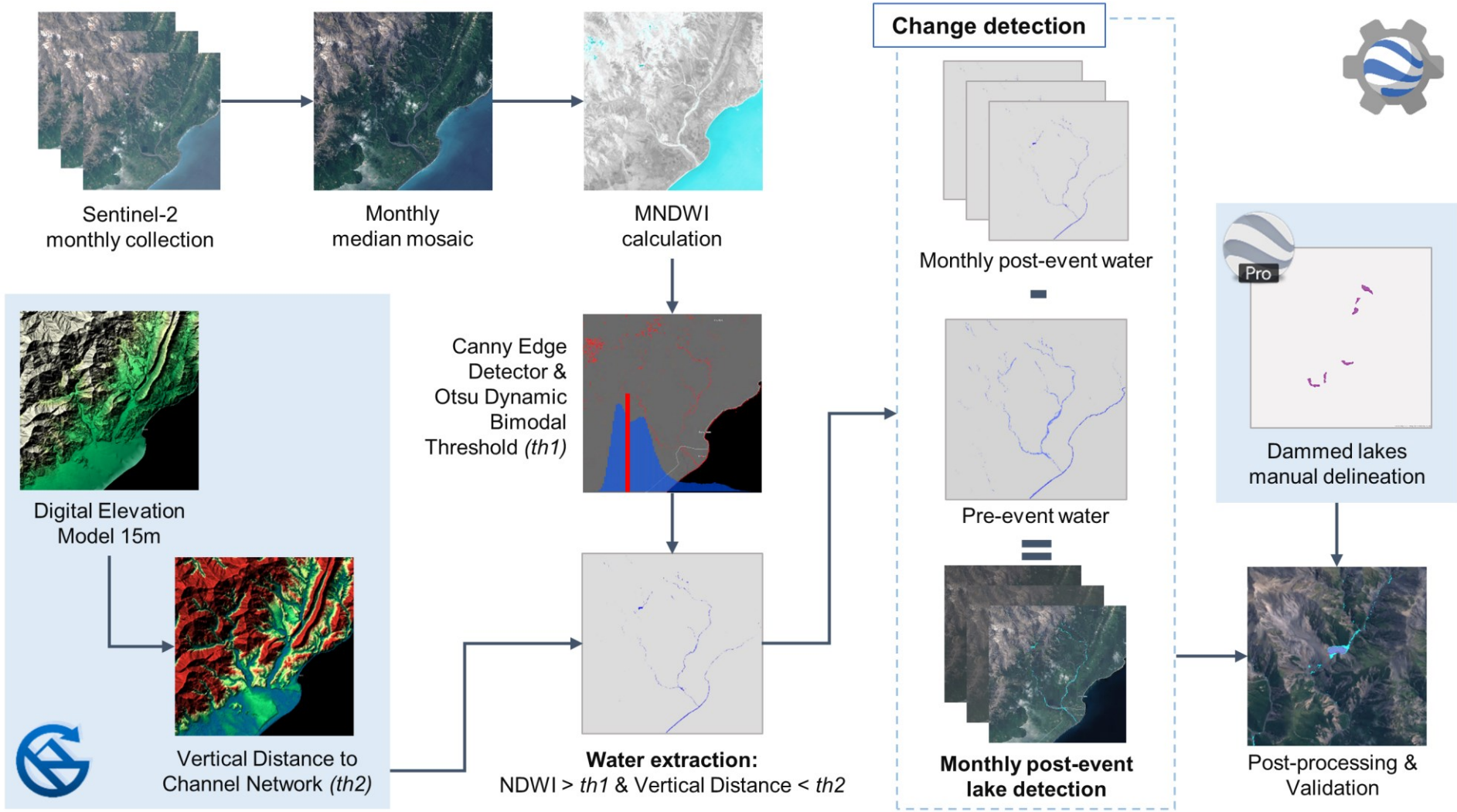
Apply the automated method for the 2016 Kaikōura earthquake in New Zealand.

lorenacristina.abadcrespo@sbg.ac.at

Methodology

The lake detection method applied on GEE can be summarized in 4 basic steps:

1. Monthly mosaic and MNDWI calculation from Sentinel-2 imagery.
2. Monthly water extraction [1] based on vertical distance to the channel network and NDWI thresholding.
3. Differencing change detection of water layers using pre- and post-event mosaics.
4. Post-processing and validation of detected dammed-lakes.



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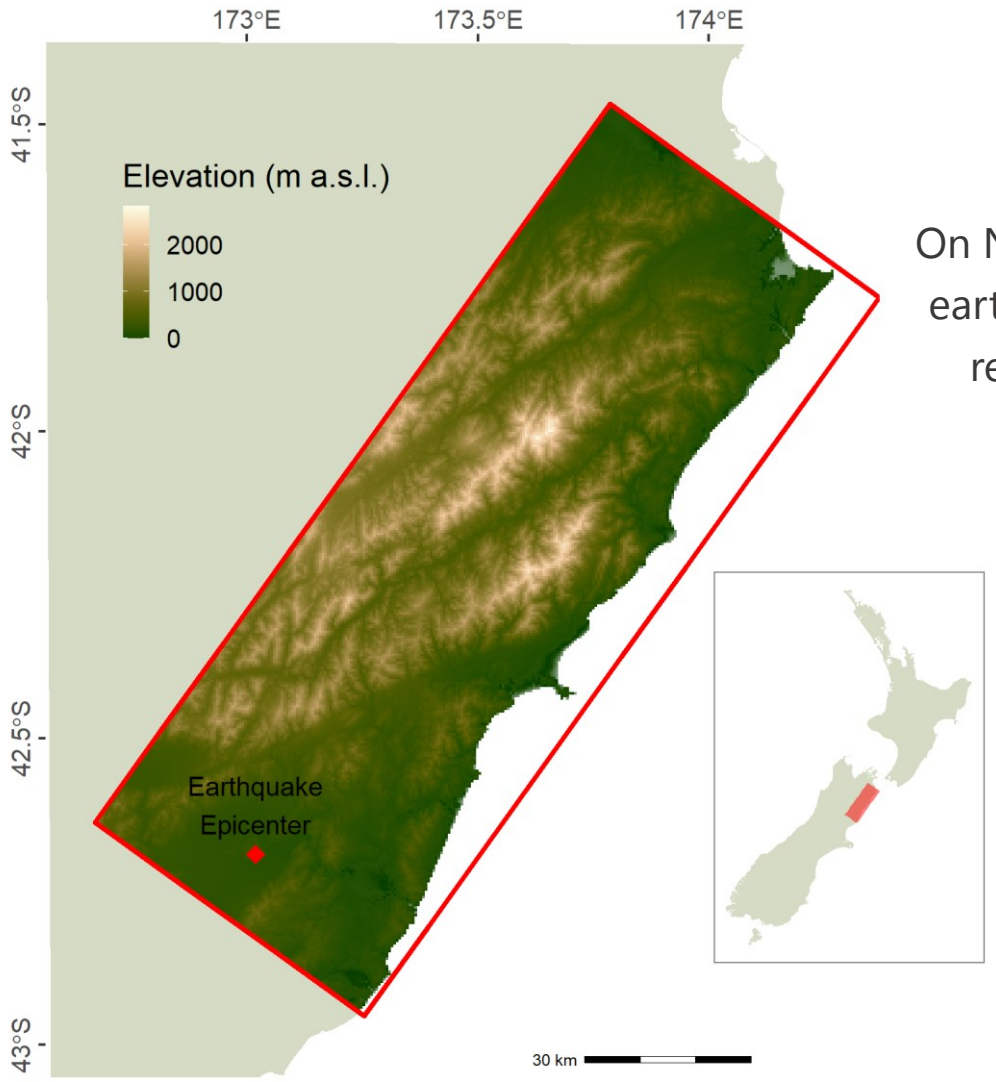
Case study background



Study area: **9,600 km²**

On Nov. 14th, 2016, a **7.8 M_W** earthquake hit the Kaikōura region in New Zealand.

Over **10,000 co-seismic landslides** affected the area[2].

Approx. **200 landslide-dammed lakes** were formed.

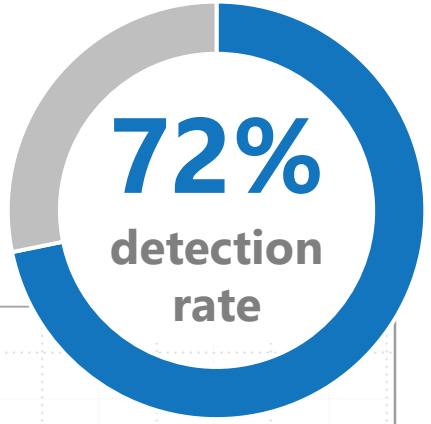
Lake formed at the Leader river dam. Ph. A.-L. Argentin, Jan. 2019

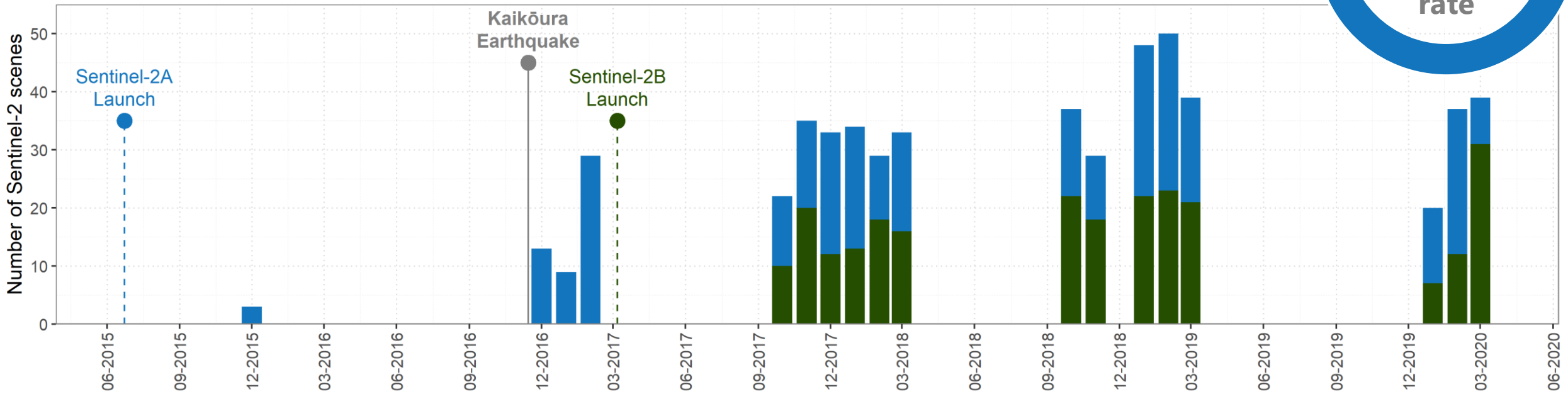
lorenacristina.abadcrespo@sbg.ac.at

Method application and validation

One pre-event and **17** post-event monthly mosaics were composed on GEE, selecting scenes with cloud coverage below 30%. The analysis considered imagery from October to March. A mosaic was used for analysis when the study area was completely covered. The launch of Sentinel-2B increased the number of available scenes significantly.

For validation, the detected lakes for December 2016 were overlapped with lakes delineated manually on Google Earth Pro for the imagery available immediately after the earthquake. **28** out of **39** lakes were successfully detected with the automated method. Undetected lakes are due to topographic shadows on highly mountainous terrain.





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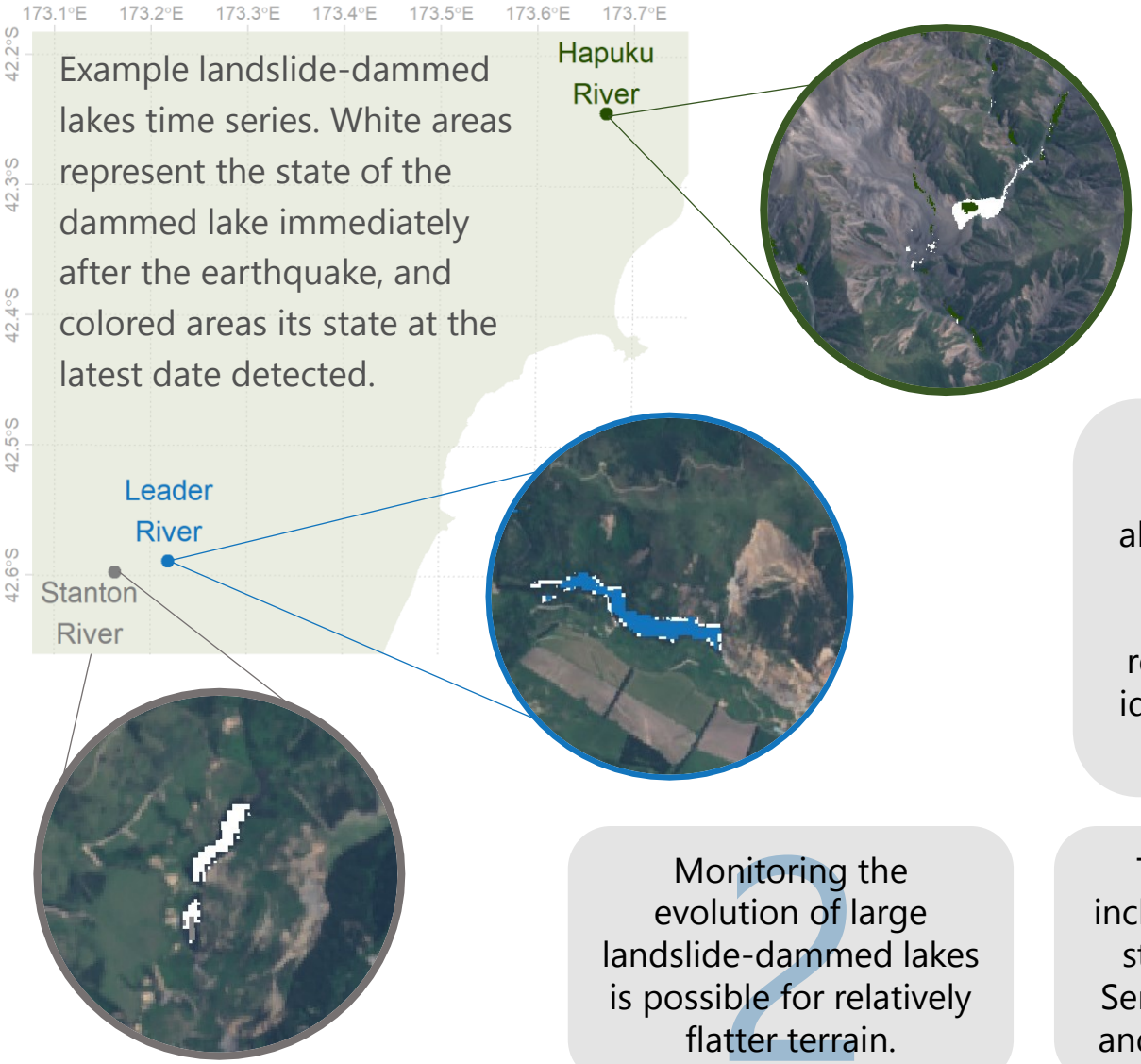
Results



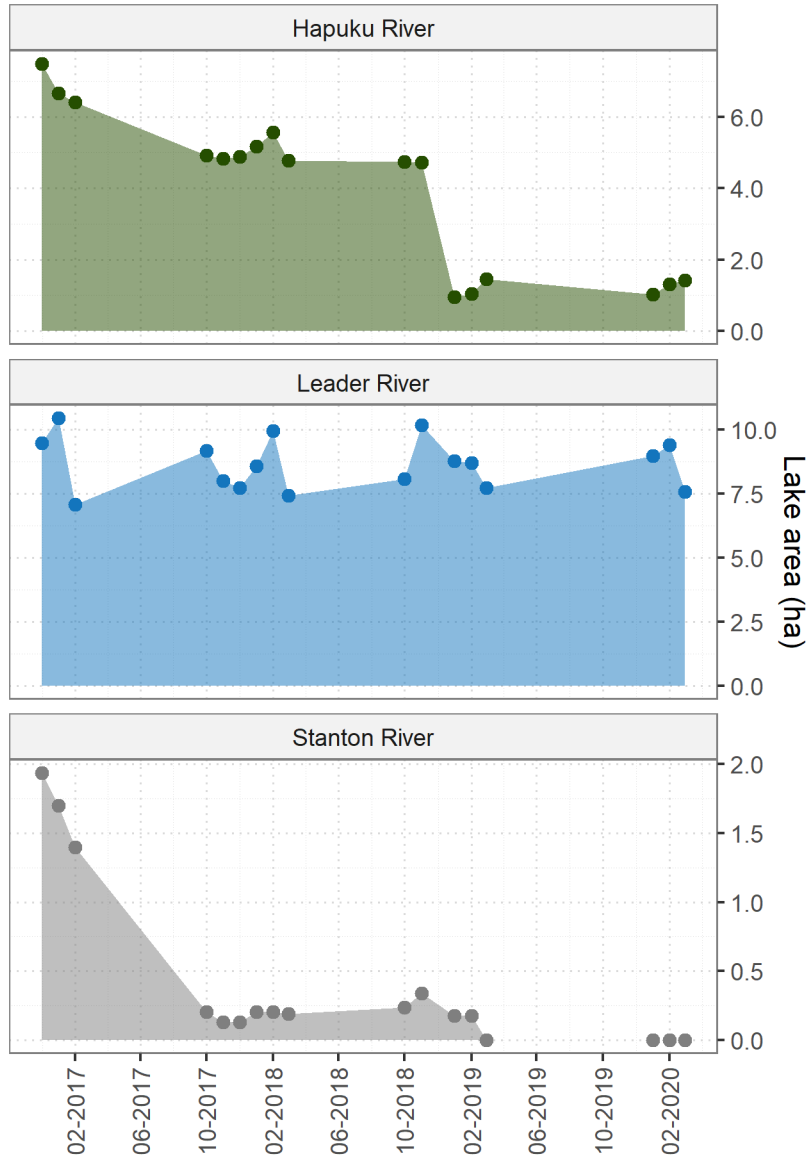
Example landslide-dammed lakes time series. White areas represent the state of the dammed lake immediately after the earthquake, and colored areas its state at the latest date detected.

Key findings:

1 The fast computing capabilities of GEE allowed a comprehensive mapping of landslide-dammed lakes in large regions, which eases the identification of potential risk areas at a glance.

2 Monitoring the evolution of large landslide-dammed lakes is possible for relatively flatter terrain.

3 The methods limitation include smaller sized lakes in steep terrains, due to the Sentinel-2 spatial resolution and topographical shadows.



lorenacristina.abadcrespo@sbg.ac.at

Thank you!

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References

[1] Donchyts, G. *et al.* (2016) 'A 30 m resolution surface water mask including estimation of positional and thematic differences using Landsat 8, SRTM and OpenStreetMap: A case study in the Murray-Darling basin, Australia', *Remote Sensing*, 8(5). doi: 10.3390/rs8050386.

[2] Dellow, S. *et al.* (2017) 'Landslides caused by the Mw7. 8 Kaikoura Earthquake and the Immediate Response', *Bulletin of the New Zealand Society for Earthquake Engineering*, 50(2), pp. 106–116. doi: 10.5459/bnzsee.50.2.106-116.

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lorenacristina.abadcrespo@sbg.ac.at