

Landslide25_09**Assessing the Impacts of Landslides on Hydrological Structure and Vegetation in the Swiss Municipality of Blatten**

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SUMMARY

Approximately 50% of Switzerland's territory is covered by natural hazard maps. About 6% of residential buildings are in zones at risk from events such as landslides, collapses, rockfalls, avalanches, floods, and debris flows. One of the major cause of these disasters is climate change, including temperature shifts and glacial flooding. Around 20% of the population is at flood risk, about 7% live in landslide-prone areas, and one-third of all jobs are located in areas exposed to natural disaster risks.

This article examines satellite monitoring of the consequences of the Birch Glacier landslide, triggered by previous rockfalls from the summit of Kleines Nesthorn, which occurred on May 28, 2025.

The authors analyzed satellite images of the territory within the settlement of Blatten, including changes to the course of the Lonza River. Based on satellite data, a complete destruction of the Lonza riverbed was identified. The dynamics of an uncontrolled lake inundating the settlement were analyzed, as its potential dam failure poses a flood risk downstream. The information obtained by the authors may be useful for further analysis of the ecosystem condition, planning recovery efforts, implementing flood prevention measures, and most importantly – for creating risk zone maps.

Introduction

On May 28, 2025, a landslide occurred in the Swiss village of Blatten. The cause of the landslide was the collapse of the Birch Glacier, triggered by previous rockfalls from the summit of Kleines Nesthorn. As a result of the landslide, approximately 90% of the settlement of Blatten was destroyed, including 130 structures. The total volume of the landslide is estimated to be about 10 million cubic meters, and the seismic waves from the event were equivalent to an earthquake with a magnitude of 3.1 (Shostak, 2025; McIlveen, 2025). As a result of the landslide, debris from the mountain rocks blocked part of the Lonza River's channel, leading to the formation of a lake in the valley of the village of Blatten, which is flooding the village. There is a risk that if the dam breaks, the flood will inundate the settlements located downstream. It is worth noting that the landslide was an anticipated event, and therefore the residents of Blatten were evacuated on May 19 (SRF, 2025). One person died as a result of the landslide (Antarctic Glaciers, 2025). Research on forests, snow, landslides, debris flows, rockfalls, and avalanches in Switzerland is conducted by the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) (Swiss Federal Institute for Forest, Snow and Landscape Research WSL, n.d.). Swiss Federal Institute for Forest, Snow and Landscape Research – Institute for Snow and Avalanche Research (SLF) (WSL Institute for Snow and Avalanche Research SLF, n.d.) It provides statistical data on fatal landslides from October 1, 2002, to September 30, 2022. The interactive map and data include the location, date, human involvement, and the avalanche hazard level on the day of the event. According to WSL, 6–8% of Switzerland's territory is considered unstable—mostly the Alps and foothills—where landslides and collapses frequently occur. Approximately 7% of the population lives in areas at risk of avalanches, landslides, or rockfalls (SWI swissinfo.ch, 2023).

The article presents data on monitoring the consequences of the landslide in the Swiss village of Blatten, which occurred on May 28, 2025, using remote sensing methods. The authors analyzed seven Sentinel-2 satellite images of the area from May 18 to June 29, 2025. For monitoring, interpretation, and processing of the Sentinel-2 images, the authors used the free Copernicus Browser applications (The Copernicus Data Space Ecosystem Browser, n.d.) and Google Earth Engine (GEE) (Google Earth Engine (n.d.)).

Method

To monitor the impact of geodynamic processes on the hydrological structure and vegetation of areas near the village of Blatten in Switzerland, Sentinel-2 satellite images with a resolution of 10 meters were automatically interpreted using the Google Earth Engine (GEE) (Google Earth Engine (n.d.)). In the GEE application, scripts were developed for the automated detection of vegetation cover changes, assessment of river degradation, and monitoring of changes in water surface area. Using the calculation of the NDVI (Normalized Difference Vegetation Index), the authors' script utilized Sentinel-2 images with bands B8 – Near Infrared (NIR, approximately 842 nm) and B4 – Red (approximately 665 nm). The following formula was used to assess vegetation degradation:

$$NDVI = \frac{B8 - B4}{B8 + B4} \quad (1)$$

For the automated assessment of river degradation and monitoring changes in water surface area, the NDWI (Normalized Difference Water Index) was calculated. For the NDWI calculation in the authors' script, Sentinel-2 images with bands B3 (Green band) with a central wavelength of ~560 nm and B8:

$$NDWI = \frac{B3 - B8}{B3 + B8} \quad (2)$$

An automatic calculation of the water surface pixel area within the study area was performed for each date (pixel size 10 m²). The change areas were calculated in hectares and presented on cartographic materials.

Results

An assessment of the landslide’s impact on vegetation was carried out. According to the Sentinel-2 satellite image dated May 30, 2025, in the Copernicus Browser (*The Copernicus Data Space Ecosystem Browser, n.d.*) The area affected by the landslide in the village of Blatten and the surrounding territory was determined to be about 2 km². The landslide stopped approximately 350 meters from the village of Eisten, and about 2.8 linear kilometers of the Lonza River were buried under debris (*Figure 1*).



Figure 1 Measurement in the Copernicus Browser application (*The Copernicus Data Space Ecosystem Browser, n.d.*) based on the Sentinel-2 satellite image dated May 30, 2025.

To assess vegetation degradation, the authors performed an analysis and comparison of two Sentinel-2 images: before the landslide on May 18, 2025, and after the landslide on May 30, 2025. Vegetation degradation was assessed through monitoring the NDVI index, which was calculated for the dates before (May 18, 2025) and after (May 30, 2025) the landslide using formula (1). The satellite image from May 30, 2025, shows complete soil degradation (*Figure 2*). The created mask indicating an NDVI decrease greater than 0.1 serves as a measure of vegetation degradation.



Figure 2 Assessment of vegetation degradation.

An assessment of the landslide’s impact on the hydrological structure of the Lonza River was carried out. As a result of the landslide, the Lonza River was blocked by a dam, forming an uncontrolled lake that rapidly expanded. In the article, the authors conducted monitoring of changes in the water surface area of the uncontrolled lake. A script was developed in the Google Earth Engine (GEE) application for the automatic detection of changes in the lake area (*Google Earth Engine, n.d.*). The detection of the water surface after the landslide was performed by calculating the NDWI index using formula (2) based on Sentinel-2 satellite images. The authors analyzed water masks created with NDWI thresholds ranging from 0.15 to 0.3 and decided to define the water surface using a threshold of $NDWI \geq 0.2$ to account for shallow, polluted, and shaded water. The image from May 30, 2025, shows a decrease in open water area, indicating

partial or, as in this case, complete blockage of the Lonza River channel (*Figure 2, 3a*). The monitoring will then determine the dynamics of changes in the area of the uncontrolled lake for the study dates when Sentinel-2 satellite images were available: May 18, May 30, June 9, June 12, June 17, June 19, and June 29, 2025. As a result of the analysis of the satellite images for the study dates in the GEE application (*Google Earth Engine (n.d.)*) the following data were obtained: a sharp increase in the flooded area in the eastern part of the landslide was observed, where the area of the uncontrolled lake on the June 12, 2025 image amounted to approximately 10.77 hectares (*Figure 3 b, Table 1, Figure 4*). After June 12, 2025, the river channel begins to gradually form, and the area of the uncontrolled lake changes but without sharp fluctuations (*Table 1, Figure 4, 5*).

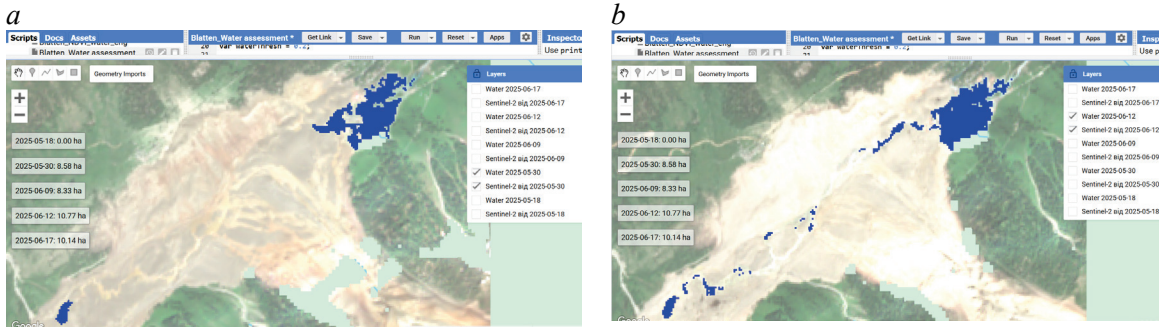


Figure 3 Determination of the flooded area on May 30, 2025, and June 12, 2025.

Table 1 Dynamics of the lake area

Date: 2025 year	Lake area, ha
18.05.	0
30.05.	8,58
09.06.	8,33
12.06.	10,77
17.06.	10,14
19.06.	10,95
29.06.	11,30

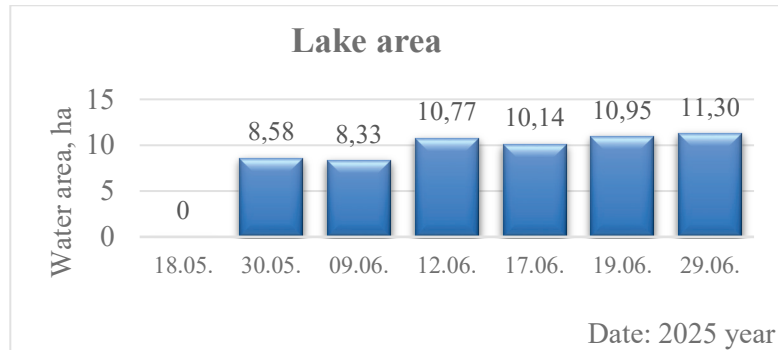


Figure 4. Dynamics of the water surface area of the uncontrolled lake.

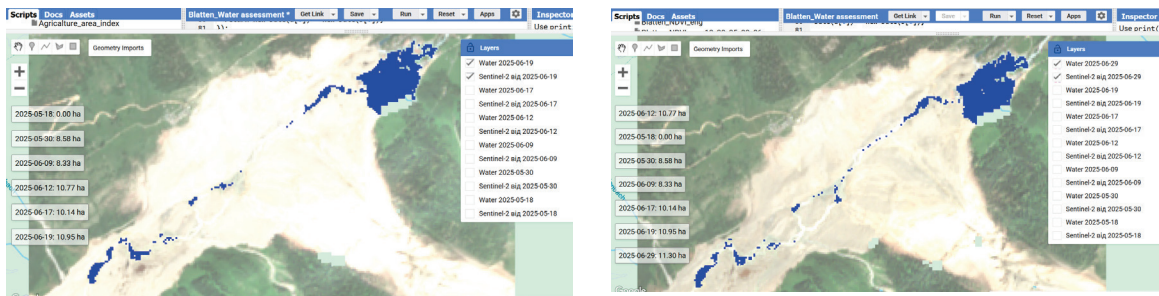


Figure 5 Determination of the water surface area on June 19 and June 29, 2025.

Table 1 and Figure 4 show the dynamics of the water surface area of the uncontrolled lake for the period from May 18 to June 29, 2025.

Conclusions

The obtained satellite indices make it possible to quantitatively and visually capture the impact of the landslide on the ecosystem within the village of Blatten. The authors established that significant degradation of vegetation cover occurred over large areas of Blatten and the surrounding territory. On the day of the landslide, a complete destruction of the Lonza River channel within the village was observed – specifically, a total disappearance of the water surface along the riverbed. The loss of water surface area was calculated by the authors of this study as the difference between observations on May 18 and May 30, 2025.

In the following days after the landslide, a sharp rise in the water level, the formation of an uncontrolled lake, and the flooding of the territory were observed. The authors conducted an assessment and monitoring of changes in the area of this uncontrolled lake over a period of one and a half months after the landslide. The maximum area of continuous open water of the uncontrolled lake was observed on June 12, 2025, amounting to approximately 10.8 hectares. After June 12, 2025, a slow reformation of the river channel was observed. A dam breach could lead to flooding of settlements downstream.

The cartographic materials and geospatial data presented by the authors may be useful for further analysis of the ecosystem condition, planning of recovery efforts, implementing flood prevention measures, and creating risk zone maps.

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