

# Geospatial Early-Warning Indicators and Climate-Driven Dynamics of Thyanbo Glacial Lake, Nepal: A Remote-Sensing Based GLOF Assessment

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## SUMMARY

Rapid glacier melting in the Himalaya has caused many glacial lakes to grow quickly, increasing the danger of Glacial Lake Outburst Floods (GLOFs) that threaten nearby people and infrastructure. This study focuses on Thyanbo Glacial Lake in Solukhumbu, Nepal, which burst on 16 August 2024, displacing 135 people and damaging schools, health posts, hotels, and homes.

Sentinel-2 images from 2017 to 2024, DEM-based models, and NASA POWER climate data were used to study changes in the lake's area and volume. NDWI and MNDWI indices helped outline the water boundary, and DEM data provided accurate volume estimates. Manual digitization and pixel comparison were used for validation.

The results show that before the flood, the lake area increased by about 21%, and its volume grew by around 6.40%. These changes were linked to higher summer temperatures (up to 6.38 °C) and stronger monsoon rainfall. The lake reached its largest volume 16 days before the outburst, showing that satellite monitoring can provide early warning signals. After the flood, over 80% of the lake's water drained, and the shoreline was heavily eroded.

This study shows how remote sensing and GIS can be used to monitor risky glacial lakes. The findings can help improve early warning systems, guide safer land use, and support climate-resilient planning in mountain regions, contributing to Sustainable Development Goal 13: Climate Action

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