

Cascade Hazards

What are cascade hazards?

Cascade hazards can occur when more than one hazard interact. Primary hazards (e.g. [avalanches and landslides](#)) can often trigger secondary hazards (e.g. [flooding and debris flows](#)). As a result, the impacts are extended further downstream ^{1,2}.

Cascade hazards are difficult to predict and even harder to model ⁴, therefore are not well understood ⁵.

FUN FACT: A recent study of rock and ice avalanches in High Mountain Asia found nearly half of the observed events (29/60) caused cascading ³.

Why are cascade hazards important?

As [glacial environments change in response to warming climates](#), the likelihood of cascade hazards increases. Generally, most risk management plans are tailored to a single hazard ⁶. However, where cascade hazards occur, the impacts can far exceed expectations of hazard mappers and response planners ⁷.

Thus, it is vital we study cascade hazards if future disasters are to be avoided.

Cascade hazard examples

Glacial lake cascades- The Changbaxia GLOF

Background

Glacial lakes are forming at higher elevations above existing lakes. As a result, the risk of cascade outburst has increased, whereby even a small volume release from a higher lake could trigger a larger volume release from a lower lake ⁸.

The Changbaxia GLOF



Figure 1: Aerial image showing the location of the three interacting glacial lakes, Chongbaxia Tsho, Chongbamang Tsho and Chongbayong Tsho. Photo credit: Google Earth 2024, annotated by Caroline Taylor.

This type of flood cascade was observed in 2001 in Eastern Himalaya.

Firstly, an ice avalanche into Chongbaxia Tsho (*the primary hazard*) triggered an outburst (*secondary hazard*) that cascaded into Chongbamang Tsho and Chongbayong Tsho beneath⁹.

Impacts of the outburst

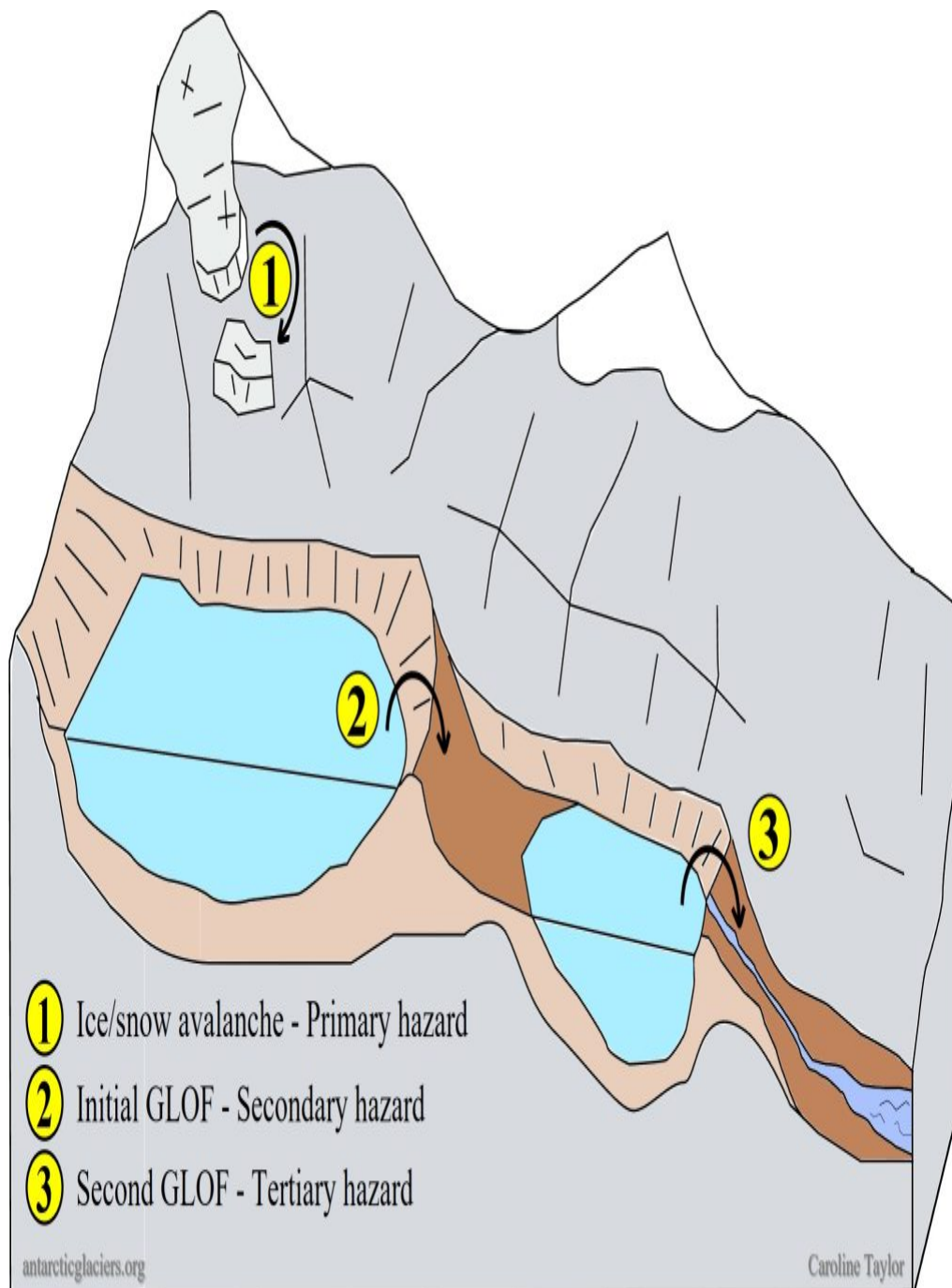


Figure 2: Schematic diagram to illustrate glacial lake cascade hazards. Firstly, the primary hazard (ice/snow avalanche in this example) triggers an outburst (the secondary hazard) from the first glacial lake Chongbaxia Tsho, secondly this cascades into the lower lake Chongbamang Tsho triggering a second, larger outburst (the tertiary hazard). Credit: Caroline Taylor.

In this case, the lower lying lakes **attenuated** the flood, storing ~96% of the flood volume and almost certainly reduced the downstream impacts of the GLOF.

Given that the flood was significantly reduced before it reached any downstream communities no fatalities are associated with the outburst⁹.

Landslide cascades- The Seti Flash Flood

Background



Figure 3: Aerial image to illustrate the origins of the rockfall in the Sabche Cirque. Photo credit: [Public domain, via Wikimedia Commons](#).

On May 5th, 2012, a rock slope failure occurred on Sabche Cirque in the Annapurna regions, Nepal (the *primary hazard*) (As shown above in Figure 3).

The mass descended 2km downslope.

Because of the vibrations, pressure and also the heat generated by colliding materials within the rockfall the mass movement caused the glacial ice to melt as it travelled.

This resulted in a huge flash flood along the Seti river (the *secondary hazard*).

Impacts

The flood inundated the town of Kharapani and continued downstream a further 10km, resulting in the **deaths of over 70 people** and causing widespread **destruction to agricultural land, infrastructure communication lines** ¹⁰.

Summary

To summarize, cascade hazards are likely to become more frequent in the coming decades, as the

climate warms and glacial environments adjust. As the number and area of glacial lakes increases at higher elevations closer to unstable slopes, the probability of mass movements triggering outbursts floods is greater, in addition to multi-lake cascades. More research is needed to fully understand these chain events.

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