



Hydrodynamic modeling of glacial lake outburst flood (GLOF) and its impact on a Hydropower Station- A case study at the upper Alaknanda Basin, Central Himalaya

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ABSTRACT:

The existence of numerous lakes at the higher reaches of the Himalaya makes it a potential natural hazard, as it imposes a risk of glacial lake outburst flood (GLOF). A GLOF event may cause great loss of life and infrastructure in the low-lying areas. Hydrodynamic modeling of a natural earth dam failure helps us to understand the flow behavior of the sudden water discharge along a given river channel. Further, flood forecasting along the river channel would determine the water discharge of the dam failure event at a particular downstream point. In the present study, moraine failure using hydrodynamic modeling of the Satopanth Tal located in the Alaknanda basin, Central Himalaya is performed to estimate peak discharge at a point just downstream of the lake. Further, unsteady flow routing of the dam-break outflow discharge is performed along the river channel to estimate the peak discharge at a hydropower dam site located 21 km downstream of the lake. The simulation of the glacial lake failure has resulted in a flood event with a peak discharge of 486 m³/s at a distance of 5 m downstream of the dam. In addition, assuming the GLOF event has occurred at the same time of a 100-year return period flood, hydrograph routing has been carried out to understand its impact in the worst flood condition. The hydrograph routing of a 100-year return period flood along with the GLOF resulted in a flood with a peak discharge of 2406.14 m³/s which reached the dam site 15 minutes after the failure event. The volume of water for which the channel has been routed is determined using area-based scaling methods, where the area has been mapped using high-resolution DGPS points. The parameters such as Manning's roughness coefficient and slope has been derived using satellite-based raster surfaces. The results are validated using various empirical relations.

Keywords: Glacial lake outburst flood (GLOF), hydrodynamic modeling, Himalaya, Glacier Hazard