

## Onset of calving at supra-glacial lakes on debris-covered glaciers in the Nepal Himalayas

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Several glacial lakes is expanding rapidly at the terminus of debris-covered glacier in the Nepal and Bhutan Himalayas. In this study, we discussed on the glacial lake expansion processes using field observed data and numerical calculations.

Field surveys of supra-glacial ponds on debris-covered glaciers in Nepal Himalayas clarify that ice cliff calving occurs when the wave fetch exceeds 80 m. Thermal undercutting is important for calving processes at a lacustrine glacial lake. Therefore, sub-aqueous ice melt rates during the melting and freezing seasons are estimated under simple geomorphologic conditions. In particular, we focus on the differences among valley wind-driven water currents in various fetches during the melting season. Results of our calculations demonstrate that the sub-aqueous ice melt rate exceeds that of the ice cliff melt when the fetch is more than 30 meters and water temperature 2-4 degrees. Calculations suggest that calving can occur by the formation of a waterline notch due to thermal undercutting which is accelerated with the expanding water surface by currents driven by valley winds.