

## CHARACTERISTICS OF INHOMOGENEOUS GLACIER AREA CHANGE IN BOLIVIAN ANDES

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The changing sizes of glaciers in the Bolivian Andes between 1987 and 2010 were determined using cloud-free Landsat Thematic Mapper (TM) images. A method of extracting glaciers was developed that uses the ratio of bands L4 and L5 computed from at-sensor radiance. A 30-m digital elevation model (DEM) derived from ASTER data helped to group the glaciers according to their catchments and slope orientations. Advanced Land Observing Satellite (ALOS) AVNIR-2 data were used to validate the method and identify glacier boundaries.

Glaciers in Bolivian Andes such as Condoriri, Tuni, and Huayna Potosi tended to be more affected by slope orientation, with their greatest area loss on wet-facing slopes. This phenomenon may be partly explained by analyzing meteorological conditions. Assuming that glacier melt occurred when the air temperature over glacier surfaces and incoming shortwave radiation values were both positive, this happened between 09:30 and 18:30 during dry season, whereas between 07:30 and 20:30 in the wet season. In both seasons, the time spans were shorter before noon and longer after noon. As a result, west-facing slopes received solar radiation for a longer span of time each day, which may partly explain why glacier shrank faster on west-facing slopes. Furthermore, incoming longwave radiation reached its peak value in afternoons, which may also have enhanced glacier melt by providing more energy. In addition, hill shade also showed strong influence on glacier melting.

Keywords: Glacier retreat, Slope orientation, Landsat, ALOS, Band ratio