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Assessing the hydrologic-budget components based on field- and remote-sensing data of the Sutlej-Valley, western Himalaya.

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The Himalaya is the source of major Asian rivers, which provide drinking water and sustain agriculture, livestock, and electricity through hydropower for hundreds of million people in the Indo-Gangetic Plain. These rivers are fed by a combination of rainfall, snowfall, and glacial melting. Liquid precipitation mainly falls during the Indian Summer Monsoon season, whereas snowfall originates form winter westerlies. Due to the remoteness of the Himalaya mountains there exist little reliable information about spatiotemporal precipitation quantities. In addition, there is virtually no comprehensive understanding of glacial melting due to the lack of mass balancing. This knowledge, however, is crucial to understand and predict the consequences of climate change in this densely populated region.

In this study, we attempt to quantify the discharge components for the Sutlej River from 2001 to 2007. The Sutlej River ($\sim$55,000 km^2) is the third largest river draining the Himalaya by area and receives $\sim$50% of its annual moisture budget during winter precipitation. We combine remote-sensing data with ground measurements to calibrate and validate a hydrologic model to distinguish between the discharge components. Our distributed enhanced temperature index model captures runoff derived from rainfall, snow- and glacial melts and losses to evapotranspiration within 500x500 m grid cells. We utilize the MODerate Resolution Imaging Spectroradiometer (MODIS) on the Terra satellite to derive fractional snow cover, surface albedo, cloud cover, mean daily surface temperature, and evapotranspiration. Rainfall distribution is obtained by the Tropical Rainfall Measuring Mission (TRMM) product 2B31, which we scaled by 19 weather stations within the Sutlej catchment. We mapped glaciers by classifying snow- and cloudless Landsat ETM+ scenes and incorporated debris covered glacial tongues based on high-resolution imagery and morphological characteristics from Google Earth. We further computed global solar radiation based on a digital elevation model (SRTM) and validated it with ground data.

Our study models the Sutlej River as an entity and 7 sub catchments that have varying discharge contributions. In addition, our approach is able to quantify river discharge in previously ungauged sub-catchments of the Sutlej to estimate its hydroelectric power potential.