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Predicting Himalayan glacial lake formation using SAR and optical datasets

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Glacier recession in high-Himalayan catchments leads to the formation of moraine-dammed lakes on many debris-covered glacier snouts. Such lakes are hazardous to communities and infrastructure downstream because of their potential to breach catastrophically. While the development of these lakes is known to begin as a series of ponds that subsequently coalesce into a larger lake, the controlling parameters on pond formation are not well understood. Using ERS-1 and ERS-2 Synthetic Aperture Radar (SAR) data and ASTER and SPOT-5 optical imagery, information relating to the dynamics and structure of Nepalese and Tibetan glaciers is presented. Specifically, glacier velocity data derived from interferometry show that glaciers where lakes are developing are virtually stagnant (displacements < 5 m a^{-1}) on their debris-covered snouts with maximum displacements at any point on the glacier as low as ~ 10 m a^{-1}. Further, elevation data derived from the SPOT-5 HRS sensor reveal that pond formation is prevalent in areas less than 2° from the glacier terminus, supporting previous work on Bhutanese glacier surface gradients. These analyses also reveal information regarding transverse glacier elevation variations. Integrating such datasets into a single analysis highlights those glaciers particularly vulnerable to lake development, on a forecast time-scale of the order of 30-years. The development and successful application of these techniques is particularly valuable given the political sensitivity and relative inaccessibility of the study areas. Such analyses can easily be adopted into current GIS-based methodologies for hazard assessments in high-mountain areas.