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Rapid evolution of supra-glacial ponds on Hinku Glacier, eastern Nepal Himalaya: prospect for a larger lake development
Rapid evolution of supra-glacial ponds on Hinku Glacier, eastern Nepal Himalaya: prospect for a larger lake development

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An understanding of the recessional behavior of debris-covered glaciers, especially lake formation, is necessary for hazards assessment and mitigation because glacial lakes that form on them sometimes produce devastating glacier lake outburst floods (GLOFs) which are often several times bigger than normal climatic floods. Generally, a large glacial lake on a debris-covered glacier is formed by expansion and coalescing of supra-glacial ponds. Supra-glacial ponds existing on debris-covered glaciers at present are a precursor to a large glacial lake in the near future; however, not necessarily all supra-glacial ponds turn into a large lake. Glacier surface gradient in the ablation area, greatly dictates whether such ponds expand or coalesce to form a large lake. However, there are limited studies in the Nepal Himalaya on early recognition of potential sites for a large lake formation with scrutinizing lake expansion track and detailed topographic mapping of glacier surface. Objective of this paper is to present formation and growth of supra-glacial ponds on the debris-covered Hinku Glacier in the Nepal Himalaya from 1964 to 2010 and to recognize prospective sites and size for future lake development. We used Corona KH-4A (in 1964), Landsat TM5 (in 1992) and ALOS ANVIR-2 (in 2010) with spatial resolution 2.7-7.6 m, 30 m and 10 m respectively to map supra-glacial ponds for the years while ALOS PRISM data with spatial resolution 2.5 m (in 2006) to produce detailed topographic map with Leica Photogrammetric Suite. There was only one supra-glacial pond in 1964 and 1992 which rose to ten in 2010 with surface area of approx. 5,102, 5,818 and 183,972 m^2 for the respective years as revealed by the satellite data of the years. Rapid evolution of supra-glacial ponds (in numbers and surface areas) on the ablation area of the Hinku Glacier from 1992 to 2010 and spatial proximity of the ponds to coalescing suggest possibility of development of a larger glacial lake in the area. Detailed topographic maps, and subsequently derived digital elevation data and surface profiles of the glacier indicate that the glacier has very low surface gradient (less than or equal to 2 degree) at the terminus part about 3 km long and 0.4 km wide stretch, and has slightly higher surface gradient (2 to 5 degree) in the immediately up-glacier area for about 2.5 km long. After the upper 2.5 km stretch, there exists a rock cliff which separates 5.5 km long down-glacier area from further up-glacier area. Hence, our results suggest that the lowermost terminus part (approx. 3 x 0.4 km) of the glacier can be of highly possible sites to develop a larger lake while the upper stretch (approx. 2.5 x 0.4 km) also remains as potential sites to further lake expansion in later time.

キーワード: Supra-glacial pond, glacial lake development, debris-covered glacier, Hinku Glacier, Nepal Himalaya
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