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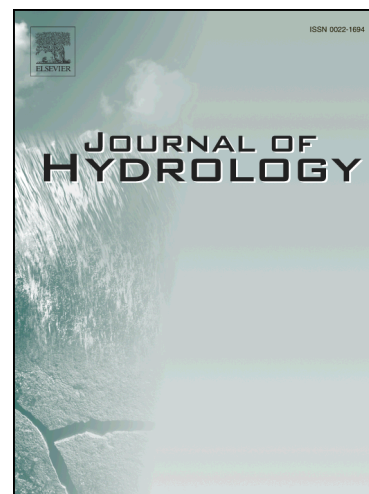
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Glacier recession and glacial lake outburst flood studies in Zanskar basin, western Himalaya

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Abstract

Glacier recession and formation of glacial lakes along with outburst flood hazards are increasing in response to changing climate in the Himalayan region. This study describes evolution of Dalung and Padam glaciers and their associated lakes employing multi-temporal datasets of Landsat (MSS, TM, ETM+), Indian Remote Sensing LISS-III, Google EarthTM, ASTER GDEM and Survey of India topographic maps. The Dalung Glacier (DG) and Lake (DL) are present in Suru River catchment whereas the Padam Glacier (PG) and Lake (PL) are present in Tsarap River catchment of Zanskar basin, western Himalaya. From 1962-2015; the DG and PG have shrunk at different rates. The DG has shrunk by $2.6 \pm 0.56 \text{ km}^2$ ($19.2 \pm 4.1\%$) at a rate of $0.05 \pm 0.01 \text{ km}^2 \text{ a}^{-1}$ whereas, the PG has shrunk by $3.4 \pm 0.65 \text{ km}^2$ ($12.7 \pm 2.4\%$) at a rate of $0.06 \pm 0.01 \text{ km}^2 \text{ a}^{-1}$. The frontal recession was recorded as $1.240 \pm 0.02 \text{ km}$ ($15.7 \pm 2.0\%$) at a rate of $20 \pm 0.4 \text{ m a}^{-1}$ for DG and $2.690 \pm 0.5 \text{ m}$ ($21.3 \pm 2.1\%$) at a rate of $50.7 \pm 0.1 \text{ m a}^{-1}$ for PG. Consequently, the proglacial glacial lakes have formed indicating an expansion of $0.28 \pm 0.05 \text{ km}^2$ (DL) and $0.41 \pm 0.008 \text{ km}^2$ (PL) during 1990-2015. Using integrated criteria of standard indices for the identification of potentially dangerous glacial lakes (PDGLs), the lakes were found to be vulnerable and have a potential to cause breaching in the coming years. In order to provide inputs for the emergency action plan, one dimensional MIKE 11 Model was used to generate the peak flood hydrographs at the lake and other vulnerable sites downstream. Highest peak discharge of $3361.7 \text{ m}^3 \text{ s}^{-1}$ (DL) and $4,210.3 \text{ m}^3 \text{ s}^{-1}$ (PL) were estimated at the lake sites which has reduced to $1520.9 \text{ m}^3 \text{ s}^{-1}$ and $1,722.4 \text{ m}^3 \text{ s}^{-1}$ respectively at the outlet sites. The reduced discharge at downstream sites still bears the potential to create dangerous flood hazards.

Key words: Zanskar, Dalung, Padam, Glacier Retreat, GLOF, Mike 11.

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