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Climate change and changing glacial landscape in Garhwal Himalaya, India

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Glaciers have reduced all over the world. Many scientists have attributed glacial recession to global warming. However, global warming does not tell anything about varying recession rates of glaciers in different parts of the world. Even in Nanda Devi Biosphere reserve area, the responses of glaciers in the form of retreating snouts to global warming are different. Many local factors such as local physiography, orientation, slope of bed rock, order of stream etc. have important influence on glaciers. Paucity of relevant information related to climatic conditions and glacier parameters renders glaciological studies very difficult. Observation close to glacial environment are rare and of very short duration. It is difficult to tell whether the glacial retreat is due to rise of temperature or decline of snowfall. Conclusive results about causative factors of glacial retreat are far from reach. However, there is no doubt about glaciers over the world have declined significantly. Glaciers are promising indicator of climate change. They have been receding rapidly in the Himalayan region over last few decades. Glacial retreat and mass loss have significant implications on fresh water supply, hydropower and other economic activities in Himalayan highland-lowland interactive system (Indo-Gangetic Plains). Therefore, continuous monitoring of Himalayan glaciers is immediately required. The snout, surface area, volume and elevation change of glacier of Himalaya were examined using Survey of India (SOI) topographical sheets and ASTER images together with intensive field investigation. Snout positions and other glacial feature e.g. moraine and glacial lakes were surveyed using GARMIN Etrex GPS in 2010. Two DEMs generated from SOI and ASTER data were compared for calculating change of volume and surface elevation of Milam, Dunagiri and Tipra glaciers. The study of Tipra glacier reveals that area of glacier decreased from 9.09 sq km (1962) to 8.54 sq km in 2004. The loss of glacial area is estimated to be about 0.55 sq km. The snout retreated about 288, 404 and 600 meters in right, central and left part of the glacier respectively during 1962 to 2010. The Dunagiri and Milam retreated about 60 and 1589 meters along central line respectively during 1962 to 2008 (Dunagiri) and 2009 (Milam). Altitudnal retreat of the snouts of Tipra, Dunagiri and Milam is about 60, 53 and 114 meters respectively. Presently, the snout is located at 3820, 4265 and 3622 meters above msl respectively. The range of elevation of Tipra glacier has significantly changed from 3760-5739 meters to 3820-5532 meters during 1962 to 2004 and the average width reduced by 10.39 meters. The snout retreat rate is of Tipra glacier is not much as it is heavily debris covered. Very low retreat rate of Dunagiri glacier is due to its higher snout position and low altitudnal range. Besides, the Tipra glacier appeared empty during field survey in lower ablation part with many longitudinal cracks and debris cover making its surface more vulnerable to collapse and it also suggests higher melting rate for this glacier.

Keywords: climate change, vulnerability, glaciers, snout retreat, Garhwal Himalaya, India