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21st century projections of glacier mass balance, extent and volume for the Chandra Basin using downscaled CMIP5 data and a glacier geometry model

Sayli A. Tawde (1), Anil V. Kulkarni (2), Govindasamy Bala (1,2,3)

(1) Centre for Atmpsheric and Oceanic Sciences, Indian Institute of Science, Bangalore, India, (2) Divecha Centre for Climate Change, Indian Institute of Science, Bangalore, India, (3) Interdisciplinary Centre for Water Research, Indian Institute of Science, Bangalore, India

Himalayan glaciers are a major source of water for a large population in Asia. Warming in the mountain regions can lead to changes in snow-rain fraction, seasonality of snow-ice melt, an increase in glacier mass loss, consequently glacier retreat and formation of glacial lakes. Therefore, it is important to assess the potential changes in climate, glacier mass balance and volume in the future. In the present study, we estimate the changes in glacier mass, area and volume by the end of century under different Representative Concentration Pathway (RCP) scenarios for glaciers in the entire Chandra Basin in the western Himalaya. We have used downscaled (25km resolution) data from 21 climate models from the NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP), an improved AAR-mass balance method and a glacier geometry model (Δh parameterization). The ensemble mean of NEX data shows an increase in surface air temperature of 2.7 (RCP 4.5) to 6.1°C (RCP 8.5) near the Chandra basin by the end of the 21st century. Basin-wide mass loss is projected to accelerate from the present mass balance of -0.48 m w.e.(1995) to -0.75 m w.e. (2050) and -1.00 m w.e. (2090) in the RCP 8.5 scenario. Reduction in the total glacierized basin area is projected to be from 47% (RCP 4.5) to 55% (RCP 8.5) by the end of century. Our estimates also suggest that 56% (RCP 4.5) to 66% (RCP 8.5) of the total ice volume of basin could be lost by the end of century. However, the volume reduction could be as high as 92% when only the low-altitude (4-5 km a.s.l.) small (0.5-2 km2) glaciers in the basin are considered. The geometric response of glaciers is predicted to be rapid in the initial decades and is reduced by the end of century. Our study highlights the likely severe impacts to water resources in the Himalaya if CO_2 emissions follow the high-emission scenario of RCP8.5.