REMOTE SENSING-BASED SPATIO-TEMPORAL ASSESSMENT OF SNOW COVER DYNAMICS IN THE KUHUMBUHIMAL GLACIER, NEPAL

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Abstract

Mountain glaciers are a specific component of the cryosphere, influencing hydrological and ecological processes and ecosystem stability. The snow cover of Mountain glaciers is rapidly changing due to climate change. However, studies of snow cover dynamics are limited for several Himalayan glaciers. Thus, this study aims to assess multi-temporal changes of snow cover and to examine the magnitude/direction of snow changes in the Kuhumbuhimal Glacier, Nepal (1995, 2002, 2011, 2018, 2020, 2024). The United States Geological Survey (USGS) was used to download Landsat satellite images for the considered years. Afterwards, the Normalized Difference Snow Index (NDSI) was computed using the green and shortwave infrared bands in ArcPro 3.6. The output images were classified into two classes, snow-covered and snow-free areas, based on respective threshold values. The areas of these classes were calculated for each year. Moreover, Mann-Kendall test and Sen's slope analyses were applied to examine the magnitude/direction of snow cover using R. The findings revealed that the areas of snow-free land were 9.9405 km^2 in 1995, 9.3942 km^2 in 2001, 12.1284 km^2 in 2011, 10.6479 km^2 in 2018, 12.1536 km^2 in 2020, and 11.4354 km^2 in 2024, respectively. The areas of snow cover were 5.913 km^2 in 1995, 6.4593 km^2 in 2001, 3.7251 km^2 in 2011, 5.202 km^2 in 2018, 3.6819 km^2 in 2020, 3.6819 km^2 in 2020, and 4.3821 km^2 in 2024, respectively. The trend analysis indicated a negative tendency, with Kendall's Tau values ranging from -0.20 to -0.60. Sen's slope values ranged from -0.0105 to -0.0196, further confirming a downward trend. Additionally, corresponding p-values were less than 0.05. These findings emphasized noticeable multi-temporal snow cover variation and the establishment of continuous glacier monitoring systems to detect temporal variations and quantify their magnitudes. This would directly contribute to ensuring downstream communities' livelihoods by reducing vulnerabilities to glacier-induced disasters.

Keywords: Geographic Information Systems, Normalized Difference Snow Index (NDSI), Remote Sensing, Snow Cover Dynamics