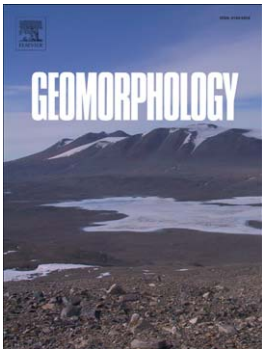

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Assessing linkages between spatial facies changes and dimensional variations of glaciers in the upper Indus Basin, western Himalaya

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Abstract

The present study provides an insight into the heterogeneous response of 45 glaciers in the Lidder and Sindh river basins, western Himalaya, and explores the linkages between glacier facies variability and changing glacier parameters. Results show that the region has undergone an overall deglaciation of ~12 ±1.5% (11.9 ±1.4 km^2) from 1996 to 2014. Fluctuations in the temperature and precipitation patterns seem to be the primary factor controlling the changes in glacier dimensions (R^2 > 0.82 in all cases). Glacier facies changes suggest depletion in snow-ice cover (~18 ±2.3%) and an increase in ice-mixed debris (~4 ±1.4%), supraglacial debris (~6 ±1.5%), and periglacial debris (~17 ±1.2%). These glacier facies transitions are possibly the result of ice-melting; however, its relative rate and elevation decides the nature of facies conversion. An increase in the proportion of supraglacial debris has led to the conversion of 11 clean glaciers to sparsely debris-covered glaciers and 5 sparsely debris-covered glaciers to debris-covered glaciers. The size of the glaciers greatly influenced the rate of conversion of glaciers, and glaciers <2 km^2 dominated the others in this regard. The small glaciers also experienced maximum shrinkage. Further, the glaciers with varying supraglacial debris cover respond differently, as sparsely debris-covered glaciers exhibit the highest rates of retreat (25 ±7.3 m/y), followed by clean (23.7 ±7.3 m/y) and debris-covered