

EGU2020-6650

<https://doi.org/10.5194/egusphere-egu2020-6650>

EGU General Assembly 2020

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Spatial distribution of debris cover and its impacts in the Hunza River Basin

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Hunza River is an important tributary of the Indus River, which contributes ~12% of the total runoff in the upper Indus River. 25% of Hunza River basin is covered by glaciers. The Karakoram Highway (KKH) connecting Pakistan and China goes from the Khunjerab Pass and down to the Gilgit, which is an important section of the Pakistan-China Economic Corridor in the high mountains. Many glaciers in this region are extensively covered by supraglacial debris, which strongly influences glacier melting and its spatial pattern. Changes in these glaciers may threaten the stability of the highway subgrade through meltwater floods, unpredictable behaviors of glacier terminals as well as potential outburst floods of glacier lakes near glaciers. Therefore, predicting runoff, response to climate change and risk of outburst floods of debris-covered glaciers requires different treatment to that of clean glaciers in the Hunza River Basin. In this study, we estimate the thermal resistance of the debris layer for the whole basin based on ASTER images. Our results reveal that debris-covered glaciers account for 69% and 30% of the total number and area in the basin. Using a physically-based debris-cover effect assessment model, we find different debris-cover effects on different glaciers, with important implications for the morphology and evolution of glacier hydrological system and associated hazards.