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SEMINAR

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Debris Covered Glaciers in High Mountain Asia

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Abstract:

Debris-covered glaciers, common in High Mountain Asia (HMA), are the focus of novel observational and modelling efforts, since their role seems crucial to understand current and future glacier mass changes and water resources. Despite major advances in understanding specific processes, how debris impacts glacier response to climate at the regional and global scale remains controversial, and limited to insights from either large-scale satellite studies or local in situ studies. This apparent scale gap makes generalisations about main processes and patterns of changes difficult, and has given rise to large uncertainties in their future. Despite the insulating effect of debris, recent remote sensing studies have failed to find diminished rates of thinning compared to bare ice ones, in contrast with point scale observations that have documented reduced melt below a few cms. Until recently, the distribution and overall extent of debris globally was unknown.

Here, I present key recent advances in understanding debris-covered glaciers at multiple scales. Supra-glacial cliffs and ponds can act as local hot spots for melt, conveying atmospheric energy into the glacier ice. I show that their effect goes beyond the local scale as they can impact the mass balance of debris-covered glaciers considerably, accounting for up to 60% of total losses, based on the first catchment scale estimates of their role in enhancing glacier mass losses. I also consider their distribution in space and time, and discuss mechanisms that explain their formation and survival across the large climatic and geomorphological gradient of HMA. I present the first inventory of debris cover for HMA together with estimates of debris changes over the satellite era and assessment of debris potential expansion. Using this new inventory, I show that debris-covered glaciers along HMA exhibit different sizes, debris covers, slopes and altitudinal ranges, and analyse the corresponding characteristics of cliffs and ponds. I assess melt enhancement factors to account for the increased melt at these features, which can be used in regional modelling efforts. I conclude by highlighting key unknowns and avenues of future research and provide a perspective on how the major problems are being currently tackled.

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