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Surface characteristics and evolution of debris covered glaciers

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Global climate change has led to increasing glacier retreat in most parts of the world. However, many heavily debris-covered glaciers have shown much smaller recession rates than their clean-ice neighbours. This can be attributed to the insulation effect of the supraglacial debris. Remote-sensing based investigations revealed that recent mass balances of debris-covered glaciers are equally negative. This fact is partly due to enhanced melting at supra-glacial lakes and ice cliffs but can also be caused by reduced mass flux. In this context, insufficient process understanding constitutes a major challenge for large scale glacier change assessment and modelling.

In this project, we aim at better understanding the evolution of glaciers in connection with changes in supra-glacial debris coverage. It is performed on Zmutt Glacier in Matter valley in Switzerland and on Gangotri Glacier in Garwhal Himalaya in India. Changes in glacier length, area, debris coverage, and surface elevation were compiled based on topographic maps, oblique photos, aerial and satellite orthoimages, digital terrain models (DTMs), and glacier monitoring data for a 50 (Gangotri) and 120 (Zmutt) year period, respectively. The subsequent analysis revealed that Zmutt Glacier has been in a slow but almost continuous retreating state since the end of the 19th century and showed a clear reduction in glacier area and volume. Similarly, Gangotri Glacier has retreated and, to a smaller degree, lost volume. However, the change in glacier length and area is clearly smaller than for other nearby, less debris-covered or debris-free glaciers. This fact is attributed to the larger debris-covered area that has steadily increased.

Further in the project, this data will serve as an important input and validation for the envisaged 3D flow modelling and, hence, will contribute to the understanding of the development of glaciers and debris-covered ice in a period of fast climatic changes.