Surface characteristics of debris-covered glacier tongues in the Khumbu Himalaya derived from remote sensing texture analysis

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The delineation of debris-covered glaciers remains a challenge in optical remote sensing, due to the similarity of the spectral signature of debris-covered ice to surrounding lateral moraines, making it difficult to apply standard semi-automated algorithms commonly used for clean ice delineation. Furthermore, supraglacial debris exhibits considerable spatial variability in its characteristics such as debris cover thickness, particle size, thermal resistance and thermal conductivity. These properties are needed in order to map the extent of debris cover and to estimate ice melt under the debris cover or at the surface.

In this study we evaluate the potential of texture analysis for detecting surface characteristics of debris-cover glacier tongues in the Khumbu Himalaya, using Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) and high-resolution Ikonos data. We focus on mapping supra-glacier lakes and exposed ice walls using texture analysis algorithms such as grey-level co-occurrence measures (GLCM), filtering, image segmentation, and particle boundaries. We compare the performance of various existing commercial software suitable for texture analysis such as ERDAS Objective, Aphelion, as well as public domain image display and analysis software used originally for medical analysis, notably Image SXM and ImageJ.

Preliminary results based on geostatistics and GLCM measures show differences in surface roughness of debris cover when compared to surrounding ice-free moraines. We expand on these results and aim at developing a quasi-automated algorithm for extracting surface features, which will be used as input in an energy balance model for estimating melting under debris cover as well as surface ice melt.