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An attempt to detect sedimentary materials grain size using texture analysis of FCIR orthophotos

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Grain size is one of the main factors controlling the ground (surface) temperature, and thus the permafrost occurrence in mountain areas. Its automatic detection may thus help to improve the distribution models of the phenomenon.

The physical properties of the ground surface can be detected by performing image texture analysis. As texture is usually defined as the spatial variation of the gray values in an image or the variation of its spectral radiance, texture operators can provide useful information about the spatial variation of the ground surface characteristics.

For this study false-color infrared (FCIR) orthophotos were used (0.25 meters resolution). These five channels (PAN, NIR, R, G, B) images were recorded with airborne digital sensor (ADS) digital cameras by the Swiss federal office of topography (swisstopo). They cover two test sites located in the Western Valais Alps (Switzerland).

In a preliminary step some regions of interest were delineated. Hydrography network, glaciers and human infrastructures (buildings, roads, etc.) were masked from FCIR images by extraction from a primary surfaces map (swisstopo). Vegetation was distinguished and extracted thanks to the Normalized Difference of Vegetation Index (NDVI), calculated with the NIR and Red bands. Finally, the resulting dataset was only composed by mineral-covered surfaces. In a second step, we computed a Principal Component Analysis (PCA) in order to find the combination of bands that contain most spectral information. Various texture operators such tonal features (mean, variance, skewness and kurtosis of gray levels) as well as texture features computed from gray level co-occurrence matrices (entropy, homogeneity, energy, etc.) were performed on the first principal component using different moving windows (3x3, 5x5, 7x7, 9x9).

The grain size classification was lately performed on a new dataset whose variables correspond to the various combinations of moving window sizes and the corresponding operator. A generalization boundary dividing coarse from fine sedimentary materials was computed using supervised machine learning algorithms. These techniques, which allow dealing with large sets of data, required some so-called training samples (labelled examples) in order to identify the best function which produced the most effective classification. Therefore, the resulting map of the grain size was based on previously mapped portion of the study site in which the grain size was known.

In further researches, detected grain size will be adopted as an explaining variable governing the presence or the absence of alpine permafrost in order to model the spatial distribution of this phenomenon at a site scale (tens of meters).