UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Département des sciences de la Terre

ELSTE
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UNIL | Université de Lausanne

Master in Earth Sciences

by

LEWANDOWSKI Linus

Exploring the possibilities of high-resolution spectral imaging to investigate rockfall source areas.

Under the supervision of:

Dr, DERRON Marc-Henri

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1. Abstract

Weathering reduces rock strength, consequently the stability of a cliff depends crucially on its weathering degree. Simultaneously, other parameters are altered as well, among which is surface color. By investigating surface color, conclusions can be drawn about weathering degree. Inherently, the direct investigation of outcrops imposes danger to the investigator and should ideally be avoided. For that purpose, a novel technique was tested to evaluate weathering degree remotely. Spectral imaging with a hyperspectral camera (spectral resolution: 204 bands in the range of 400-1000 nm) was performed on rock outcrops exhibiting different surface colors. Spectral analysis was used to identify wavelength ranges (bands), in which different surface colors can be distinguished. Based on these findings, bandpass filters were combined with a modified high-resolution "full spectrum" camera (one broad band, 300-1200 nm), substituting spectral for spatial resolution. The novelty of the technique required the development of a workflow for data preprocessing including demosaicing, corrections, noise reduction, registration, and removal of external influences. Subsequent analysis showed that it is possible with high-resolution spectral imaging to enhance contrast in outcrops and facilitate visual distinction between weathering degrees. Classification of image content based on either spectral angle mapping or band ratios is feasible as well as calculation of percentages of classes and mapping potential rockfalls source zones. The main benefit is the eliminated necessity to access the outcrop, improving safety and reducing time-cost significantly. By that, large-scale studies on the mountain- or catchment-scale are enabled. Datasets of potential rockfall source zones could complement the existing, well established rockfall propagation models and support rockfall hazard assessment. Prospectively, the combination of the presented approach with a remote sensing technique aimed at geometry could provide a powerful tool to investigate both weathering degree and fractures and therefore a global value for rock mass condition.