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UAV based hyperspectral grassland monitoring in an alpine shallow erosion area

Recent research in the Alps found that a reduction in grassland management is correlated to an increase in a certain type of shallow erosion areas called blaiken. This change also entails changes to the dominant grassland vegetation. New developments in hyperspectral technology have produced cameras which are sufficiently light for Unmanned Aerial Vehicles (UAVs). This thesis explores whether UAV mounted hyperspectral cameras (RIKOLA (SENOP Optronics, Lievestuore, Finnland)) can detect the spectral signatures of managed vs. blaiken-related unmanaged grasslands accurately, and whether their signatures are so distinct as to enable grassland classification on an aerial image. Accurate mapping of Alpine grasslands can guide erosion mitigation measures to manage grassland types that are more susceptible to erosion.

A field study was undertaken at a blaiken hotspot at the Schlüter lodge, located in the Dolomite mountain range within the Italian Alps, in order to evaluate the accuracy of the RIKOLA camera. Its spectral signatures taken on the ground were compared to those of a high precision spectroradiometer (Spectra Vista Corporation, Poughkeepsie, USA). The study also evaluates whether the spectral signatures of different grassland types were sufficiently unique and the quality of the Rikola images taken from the UAV system was high enough to permit the characterization of grassland types by a maximum likelihood classification algorithm.

The spectral separability analysis demonstrated that the spectral signatures of designated grassland classes separate in Rikola images taken on the ground. However, an orthomosaic created from aerial UAV-Rikola images displayed low precision and accuracy. These errors stem from unstable lighting conditions throughout the flight and the NIR sensor malfunction. The malfunction caused the NIR bands not to be recorded, a wavelength range which was shown to be highly relevant when separating grassland communities. A first classification of the grassland classes within the orthomosaic has a low accuracy, which is in part due to botanists' class definitions, that were unsuitable for spectral classification, as well as changing light conditions and the sensor failure. Nevertheless, when inspecting the spectrometer data and the orthomosaic image bands, the grassland surrounding the blaiken was found to have a distinct species composition and a distinct spectral signature, as shown by the spectral signature evaluation and spectral separability test. A better classification for identifying grassland with higher blaiken risk was found to be obtained by using a different selection of classes. The low accuracy of that map suggested that the Rikola UAV data does not fit the requirements to classify grasslands from a botanical point of view, despite the quality limitations of the UAV data aforementioned. Thus, the grassland classes should be based on prior spectral image analysis. Better weather conditions (overcast sky) during the flight should also enhance the classification as it reduces the influence of shadow artefacts in the image. Furthermore, species richness and NDRE (Normalised Difference Red Edge Index) values were found to be potentially connected to blaiken and erosion risk.

Keywords: Physical Geography, Ecosystem Analysis, Shallow Erosion, Blaiken, UAV, Hyperspectral Imaging, Alps, Grassland, Spectral Signatures

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