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Hyperspectral grassland and erosion monitoring by UAV in the Italian Alps

Recent research in the Alps finds that decreased management of grasslands is correlated to increased soil erosion. These developments also cause changes to the dominant grassland vegetation. Different types of vegetation have been shown to be distinguishable by hyperspectral cameras. However, these cameras, mounted to aeroplanes and satellites, are expensive, inflexible in their use and have a relatively low ground resolution. Newly developed, cheaper, miniaturized hyperspectral cameras, have a more detailed ground resolution and can be deployed more flexible when mounted to Unmanned Aerial Vehicles (UAVs). This thesis explores whether these, UAV based, cameras can be used to detect differences between highly similar grassland vegetation of managed and unmanaged grasslands. Classification maps derived from hyperspectral images can be used for the mapping of alpine grasslands types and can support erosion mitigation projects by locating areas with vegetation which is more susceptible to erosion.

A field study was undertaken at an erosion hotspot near the Schlüter lodge, located in the Dolomite mountain range within the Italian Alps, in order to evaluate the accuracy of the UAV based hyperspectral camera. Measurements taken on the ground were compared to those of a high precision reference measuring device (Spectrometer). The study also evaluated whether the image quality of such an approach is high enough, and the grassland types are separable when using a image classification algorithm. Analysis of the hyperspectral data shows that grassland types could be distinguished by the new lightweight hyperspectral camera. However, the aerial image created by stitching together UAV images (orthomosaic) displayed unsatisfactory precision and accuracy. These errors stem from a partial sensor malfunction and unstable lighting conditions throughout the flight. The malfunction caused the Near Infra Red NIR wavelength to be recorded incorrectly, which is highly relevant when analysing vegetation. The resulting classification of the grassland classes was of low accuracy. This is partly due to the low precision orthomosaic as well as due to class definitions, that were not suited for image classification. Nevertheless, when inspecting the image data, the grassland vegetation surrounding the erosion areas, was found to display a distinct pattern. This indicates that a better classification can be obtained by using a different approach to selecting classes. Identifying grassland with a higher erosion is possible by selecting classes based on a prior analysis of the orthomosaic. Furthermore, it was found that the vegetation around the erosion spots displays less vegetation species diversity compared to areas without erosion. This potential connection between species diversity and erosion risk requires further research. This research could be aided by aerial images, which have previously been used to detect different levels of species diversity. The research shows the potential of using UAV based camera classification methods for mapping grasslands in the Alps. The method is complicated and not without challenges but it is cheaper and faster than manual surveying of alpine areas. The increase in number and intensity of extreme weather events due to climate change will likely also increase the amount of erosion and landslides in the Alps. Therefore, it is important to reduce, limit and prevent alpine erosion, as it causes damage to the surrounding landscape, settlements and also puts the local population at risk. Locating grassland areas with high erosion risk helps to focus prevention and mitigation efforts on the most relevant areas and is therefore of great value.

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

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