Geophysical Research Abstracts
Vol. 21, EGU2019-15783, 2019
EGU General Assembly 2019

UAV-based hyperspectral techniques for monitoring shallow erosion in alpine pastures

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Shallow erosion processes often have negative impacts on mountain agriculture, natural hazards and landscape aesthetics. In the Alps, they are characterized by the displacement of vegetation together with unconsolidated material, resulting in a considerable loss of soil for affected slopes. Shallow erosion areas are present on steep grassland slopes from the montane to alpine elevation zone in affected areas with few square centimeters to some square meters, that difficult its monitoring with remote sensing methods. Since, alpine pastures and meadows are an essential element of the traditional cultural landscape with multiple socio-economic and ecological benefits (ecosystem services), they need to be protected from erosion and degradation.

In this work, we present an integrated strategy using ground and proximal sensing techniques using hyperspectral imagers for detecting shallow erosion areas in centimeter scale in alpine pastures, by characterizing different types of vegetation and soils to identify vulnerable areas using some known indicators. By one hand, the use of unmanned aerial platforms it is an excellent choice to overcome ground resolution scale, however, regular acquisitions (temporal scale) it is still a drawback for the full exploitation of these platforms due to local legislation and vulnerability to weather conditions. By the other, with the resolution improvement also increases data processing complexity, since such imagery includes several narrow bands that can be difficult to handle in real-time with reduced computational resources.

In this context, we used a dedicated ground spectroradiometer to identify the principal vegetation and soils species by identifying the most representative bands based on principal component algorithm. Then, we only processed those bands to reduce time and power computing processing. Finally, we obtain a hyperspectral mosaic by means of decorrelation stretch approach to identify affected and vulnerable areas for restoration purposes.

All data were collected on two high alpine mountain grassland sites in the Villnoess valley, Italy, during the vegetation period of 2018. UAV-based hyperspectral data -acquisition followed a pre-programmed flight plan in which the hyperspectral camera (Rikola) collected 28 bands. We perform data processing and correction steps for obtaining reflectance mosaics (dark current subtraction, conversion to radiance, adjustment of camera distortion, co-registration, mosaicking, georeferencing, topographic correction and conversion to reflectance). Ground spectral measurements collection took place on the same sites and on the same dates of the flight campaigns for ground truth validation and up-scaling integration.