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

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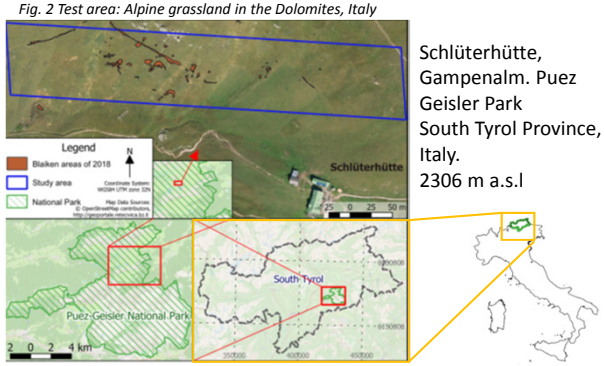
1 Introduction

Fig. 1 Blaiken erosion

Blaiken are **bare soil** patches (of **2-8 m in diameter**) resulting from sheet-landslide events occurring at slopes on high **alpine grasslands** and usually believed to be triggered by nival, human or animal activity.

Grassland around blaiken erosion has been shown to display specific vegetation species unlike vegetation in afflicted areas. These differences in **vegetation** are likely to display different **spectral signatures** which in turn could be used **to categorize** it into vegetation **susceptible to erosion** and vegetation **less susceptible to erosion**.

Fig. 2 Test area: Alpine grassland in the Dolomites, Italy



Schlüterhütte,
Gampenalm. Puez Geisler Park
South Tyrol Province, Italy.
2306 m a.s.l

2 Method

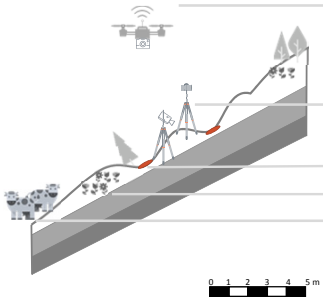


Fig. 3 Close range sensing method

<u>Proximal sensing</u>: UAV + optical sensors for retrieving DSM, orthomosaic and spectral maps for distribution of species in 3 ha area with 3 cm ground resolution.

<u>Ground sensing</u>: Optical instrumentation for visual identification, spectral images [leaf resolution - mm pixel] and spectroradiometry, for full spectral analysis [300-2500 nm]. Species classification

<u>Sub-plots</u>: To define representative spots in the area from which an exhaustive species classification will be performed.

<u>Species vegetation classification</u>: To identify main species in eroded and non-eroded areas. Density, distribution, composition. (sub-plots)

<u>Land use and management</u>: to understand main activities that affect the area (talks with farmer)

3 Preliminary results

Vegetation Areas	A1	A2	A3	B	C1	D1	D2	D3	E1	E2	E3	F1	G1	H1	H2	H3	occ.	max	avg	pear. corr.
Plant Species																				
Nardus stricta	33	33	20	33	33	20	0	0	0	0	12.5	20	0	20	20	33	11	33	17.3	0.42
Festuca sp	0	0	0	0	0	50	33	4	0	0	33	0	0	0	1.5	0	5	50	7.6	-0.19
Geranium sylvaticum	0	0	0	0	1.5	12.5	50	33	0	0	0	0	0	4	7.5	4	7	50	7.0	-0.26
Leontodon helveticus	4	4	4	20	0	0	0	0	0	12.5	4	0	33	1.5	1.5	7.5	10	33	5.8	0.00
Arnica montana	12.5	20	12.5	7.5	0	0	0	0	0	0	12.5	0	0	0	7.5	0	6	20	4.5	0.68
Alchemilla sp	0	0	0	0	0	0	0	33	0	0	0	33	0	0	0	0	2	33	4.1	-0.23
Liguisticum mutellina	4	0	0	7.5	0	0	0	0	0	0	20	12.5	0	12.5	1.5	4	7	20	3.9	-0.19
Poa	0	0	7.5	4	50	0	0	0	0	0	0	0	0	0	0	0	3	50	3.8	-0.14
Horminum pyrenaicum	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	1	50	3.1	-0.15
Number of Plantypes	10	8	14	9	11	7	4	6	5	7	11	6	9	15	15	10	Correlation between distance and number of plantypes: 0.3875122			
Distance from Blaiken in m	61.6	47.3	74.9	15.8	3.3	22.1	6.4	12.9	10.0	1.9	9.9	6.9	20.6	19.6	17.9	23.5				

For each species, the percentage of the ground cover of the plot is given using the following categories: + (0.5%); 0.5% (<1%); 1.5%(<2%); 4% (<5%); 7.5 (<9%); 12.5 (15%); 20% (25%); 33% (<40%); 50% (<60%); 80% (<100). "sp" after the species name means only the Genus but not the exact species could be identified.

Table 1. Species distribution analysis

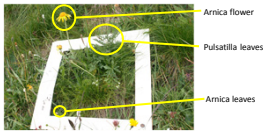


Fig 4. Sub-plot visual identification

- Ecology study for homogenous vegetation patterns and land cover/use in test area
- Creation of representative sub-plots
- Ecologists represented the correct vegetation type and vegetation group (table 1)

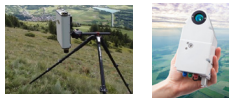


Fig. 5 SV1024i & Rikola camera. Hyperspectral instrumentation

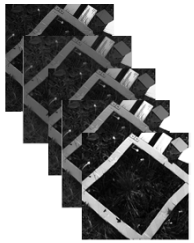


Fig. 6 Hyperspectral cubes for sub-plots

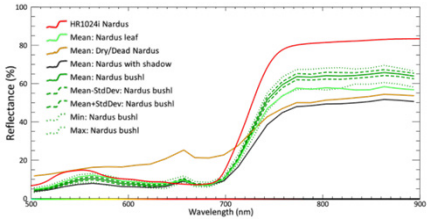


Fig. 7 Hyperspectral signature for single species

- Ground hypersectral technique with combined instrumentation demonstrated the possibility to identify key species (future analysis: soils)
- Aerial hyperspectral data acquisition permitted simple vegetation analysis with NDRE and PCA

Fig. 8 UAV-based Normalised Vegetation Red Edge index (NDRE) - vegetation vitality

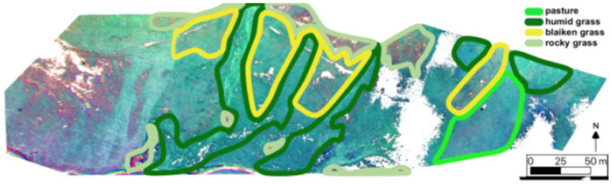


Fig. 9 Principal Component Analysis (PCA) and NDRE for basic classification

4 Conclusions

1) **UAV**–based products are good option for **monitoring *blaiken*** erosion (**high spatial resolution**)

\+ 2) Very simple **vegetation classification** (**NDRE** and **PCA** based on **hyperspectral** techniques)

3) **NDRE** revealed **low vegetation vitality** values around blaiken areas (**indicative** of **future erosion** areas)

\- 1) **UAV**–based **platforms** are **highly affected** by many conditions **in complex terrains** (weather, elevation, slope)

2) **Hyperspectral** techniques **using UAVs** require **stable conditions** and **very good knowledge** on the methods (calibration, light conditions, sample collection)

3) UAV-based **Hyper/multi spectral requires high elaborate processing**, time consuming and **correction methods**.

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