

Monitoring diseases by using Hyperspectral and Thermal techniques at two different spatial scales: A feasibility study in alpine regions

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1 Introduction

Cultural and traditional **alpine farming** have been **changed** enormously, mainly due to **anthropogenic** activities and **economic** factors. Some fields have been dramatically intensified by changing to **monoculture** in particular **apple orchards** and **vineyards**. In consequence, these activities allow practices of deforestation, the massive use of **fertilizers** and pesticides, the excessive use of machinery, grading, drainage among others. Additionally, human activity have impacted on weather by resulting on low rainfall or drought extended periods. The combination of these factors result that vegetation and species are more vulnerable to the **infestation** of **pests** and **diseases**.

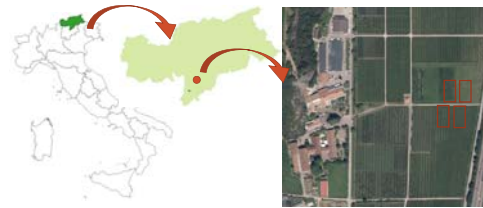


Fig. 1 Test area: Apple orchards fields – Laimburg research center, pre-alpine area, Laimburg, Italy (Lat.11.28769, Lon.46.38226)

On this **feasibility study**, we propose the **identification**, **mapping** and **classification** of individual trees affected by fungal species (alternaria) in apple orchards located in South Tyrol, Italy, based on hyperspectral and thermal imagery.

2 Method

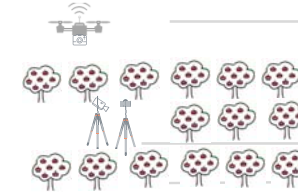


Fig. 2 Close range sensing method

Proximal sensing: UAV + optical sensors for retrieving DSM, orthomosaic and spectral maps to identify healthy and unhealthy individuals at 3 cm ground resolution.

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

Sub-plots: To define different conditions for future classification: healthy, unhealthy, chemically treated, bio-treated.

Land use and management: to understand main activities that affect the area

3 Preliminary results

We have conducted terrestrial surveys to identify (un)healthy individuals (trees). High spatial resolution scale consisted on terrestrial monitoring approaches based on the identification of trees and leaves, the collection of leaf spectral signature based on a dedicated spectroradiometer (300 to 2000 nm) and spectral imagery of individuals.



Fig. 3 Instrumentation: SV1024i spectroradiometer, Rikola Hyperspectral camera and FLIR Vu0 Pro, thermal camera.

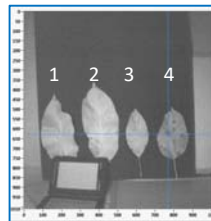


Fig. 5 (right) Hyperspectral datacube for affected tree and hyperspectral signature for different individuals at different grades of affection.

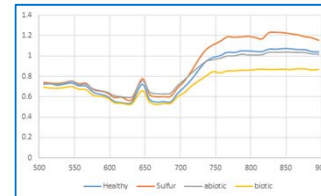


Fig. 4 (left) Hyperspectral data cube image with its spectral signature for different apple leaves (1) Healthy individual, (2) Sulfur treatment, (3) abiotic treatment and (4) biotic treatment

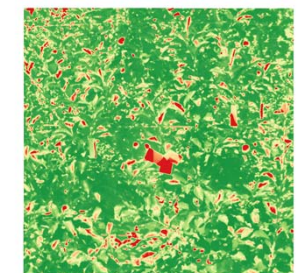
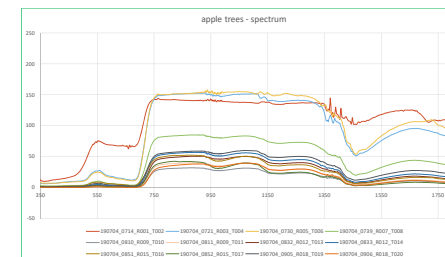
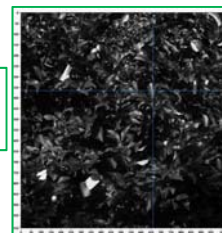


Fig. 6 Simple identification of the affection based on NDVI

4 Conclusions

- Unfortunately, due to the actual COVID-19 situation, we were not able to perform the **UAV**-flight during blooming period. Nevertheless ground hyperspectral imagery and spectroscopy demonstrate the potential to identify individuals affected by certain diseases.

- Simplified identification of pathogen is based on standard NDVI
- More complex indexes can be derived from the bands with high spectral differences such as the ones contained in the chlorophyll absorption (ca. 545nm). Red edge and water absorption bands provide best separation (700 and 1400 nm)