Aerial and hyperspectral near-range spectrometry of *Puccinia psidii* (myrtle rust).

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Abstract:
Puccinia psidii (Fig. 1) is an invasive pathogen of global significance. Discovered in Brazil in 1884, it spread over Florida, Hawaii, Japan, China and finally reached Australia in 2010. Plant pathologists regard *P. psidii* (myrtle rust) as a threat to native Australian Myrtaceae-dominated ecosystems, and to industries depending on this plant family (e.g. Forestry and Tea Tree Oil). Typically, rust fungi have few host species, however myrtle rust has already infected over 300 native Australian Myrtaceae in four years, the number of infections rising (Makinson, 2014). Severe damage on two endemic rainforest species has been reported recently for the first time (Carnegie et al., 2015). Glen (2007) published a comprehensive review on *P. psidii* with a special focus on the vulnerability of Australian ecosystems. It is imperative that monitoring of plant communities and ecosystems are initiated to fully understand the long term impact of this devastating invasive pathogen.

Plant diseases like *P. psidii* alter the functioning and very often the phenotype of plants. Such changes cause plant stress and can be mirrored in varying plant's spectral reflectance which depend on the origin of stress (Jackson, 1986). Vegetation indices are well known to perform very accurately detecting unspecific stress, and have recently been advanced to detect even disease specific plant stress. Specific disease indices (SDIs) have been successfully applied to classify e.g. healthy and Cercospora leaf spot, sugar beet rust and powdery mildew infected leaves with high balanced classification accuracies (Mahlein et al., 2013). Apart from hyperspectral signatures and images, chlorophyll fluorescence, RGB and thermographic images are used to quantify plant diseases. Both thermographic and multispectral sensors can be mounted on unmanned aerial vehicles for repeated deployment for acquisition of high temporal resolution data at very high spatial resolution. Ground truth data is necessary to develop new SDIs and to support remote sensing systems like satellites for global scale monitoring.

Figure 1. A leaf of Rhodamnia rubescens infected with the exotic fungal pathogen Puccinia psidii. Usually seven days after inoculation the displayed egg yolk yellow pustules occur as a characteristic symptom. Such clearly visible symptoms are very suitable to be detected with hyperspectral sensors to develop specific vegetation indices.

My PhD project aims to combine near-range hyperspectral spectrometry and unmanned aerial systems to (i) identify specific hyperspectral signatures and features caused by the spectral reflection of *P. psidii* using a PSR+ 3500 portable spectroradiometer. Subsequently, I will use these features to (ii) develop SDIs that allow early detection and monitoring of rust invasion fronts of *P. psidii*. I plan to (iii) establish a severity ranking system for *P. psidii* infected plants by using drones and newly self-developed SDIs and also will (iv) incorporate the collection and analysis of thermal images to test their usefulness in comparison to specific vegetation indices. Field surveys on lemon myrtle plantations and the establishment of clean signatures with greenhouse experiments are planned for 2016.

In this contribution I will outline my future PhD topics and will highlight why *P. psidii* is a threat to Australian ecosystems. I am going to emphasize why unmanned aerial systems combined with spectral vegetation sensors are a very suitable method to tackle current problems regarding myrtle rust in Australia and present an outlook about how the UAS community could get involved in myrtle rust research.

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