ABSTRACT: National Water Initiative Workshop: Allocating water and maintaining springs in the GAB, Alice Springs

TITLE: Mapping the spectral and spatial characteristics of GAB mound spring wetland vegetation: initial findings and exploration of an unsupervised PCA approach

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The research presented in this paper contributes to a larger project which will develop novel quantitative, robust and repeatable methods for assessing and monitoring the sensitivity of mound spring permanent wetland vegetation to water allocations using various forms of remote sensing. This paper presents preliminary results determining the capability of Principal Component Analysis (PCA) applied to hyperspectral data to map the extent and distribution of mound spring permanent wetland vegetation.

The Dalhousie Springs group has been selected as the focal site for preliminary study because it is the largest and most significant spring group within South Australia in terms of ecology, conservation importance and water allocation sensitivity. Moreover, the spatial extent of the spring vegetation features under investigation at Dalhousie are larger (up to tens of kilometres) than for the other key spring groups (from several to tens of metres). The extent, scale and diversity of wetlands at Dalhousie provide an ideal test-bed for image mapping methodologies (see Figure 1a and b).

(a) ***(b)***

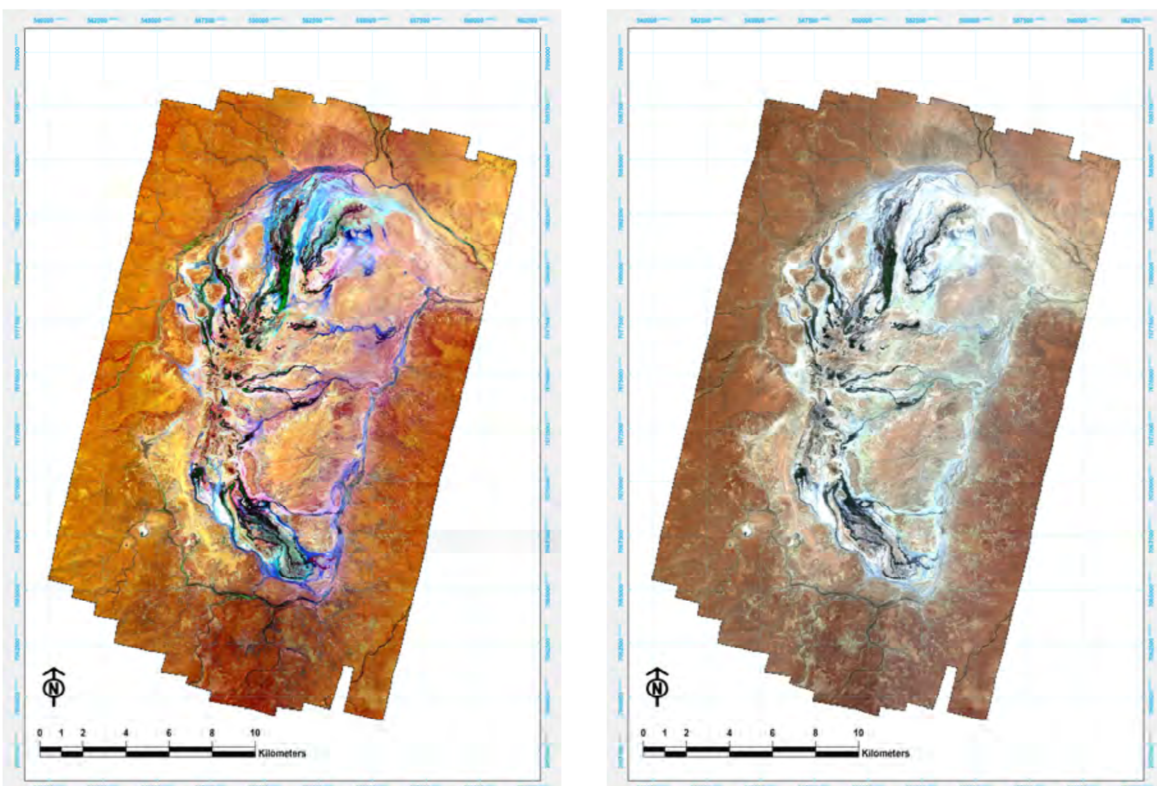


Figure 1: HyMap composite images of the Dalhousie spring group; (a) wavebands 7 (467 nm), 4 (891 nm), and 1 (2,207 nm) associated with the Landsat TM sensor and (b) true colour Red, Green, Blue.

Field spectroradiometry reflectance measurements were acquired in March 2009 to ground truth airborne hyperspectral imagery, to aid in understanding the spectral heterogeneity within an area matched by the spatial resolution of the hyperspectral sensor and to provide a spectral library of mound spring vegetation species and substrate. Field spectroradiometry reflectance measurements were acquired of the visible to shortwave infrared wavelength range (350-2,500 ***nm***), in conjunction with a botanical survey, for wetland vegetation species, arid land vegetation species and adjacent soil substrate (travertine, vertical leakage and soils) (refer to Figure 2a, b and c). The field spectra were acquired employing a reliable and repeatable protocol ensuring reflectance spectra were representative of the surrounding landscape and vegetation coverage and type at the GAB spring group level. The field spectral reflectance measurements were acquired near simultaneously with airborne HyMap hyperspectral imagery (approx. 3 m spatial resolution), digital aerial photography and very high resolution (VHR) QuickBird satellite imagery (sub-metre spatial resolution) for the exemplar spring group at Dalhousie. The field spectroradiometry data possess a spectral range comparable to the HyMap imagery.

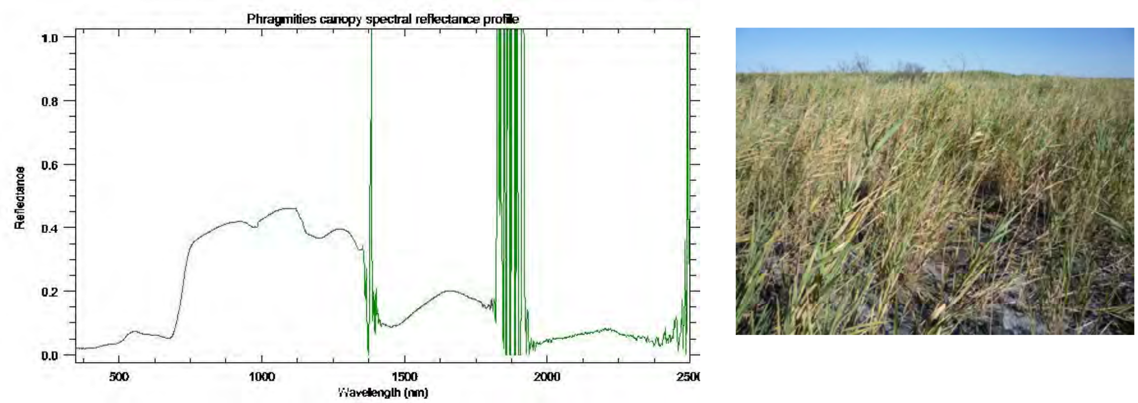
Principal Components Analysis (PCA) is being conducted on the field spectra to determine the spectral separability, at key wavelengths conveying the most variation within the spectra, between the following components/variables: (i) photosynthetic (permanent wetland) and non-photosynthetic vegetation (arid); (ii) ephemeral and green wetland vegetation; (iii) within species variability of permanent wetland vegetation; (iv) wetland vegetation with underlying water and wetland vegetation with no underlying water; and (v) invasive species, i.e., date palms and Phragmities, from native wetland species.

A similar PCA approach is being conducted on the HyMap imagery analysing the same components/variables as the field spectroradiometer data. It is intended that PCA of the HyMap imagery will be compared with PCA from the field spectroradiometer data to determine if spectral separability between the components/variables analysed for the field spectroradiometry data is also evident in the HyMap imagery. Differences between the two data sets may indicate influences associated with the spatial heterogeneity within the 3 x 3m pixels of the HyMap imagery. Moreover, the spectral heterogeneity within a HyMap pixel is also associated with fractional coverage of the vegetation species and substrate within the pixel. Species coverage information derived from the botanical survey, employing 9 x 9 m plots, is being investigated to establish relationships between plant cover and hyperspectral image response.

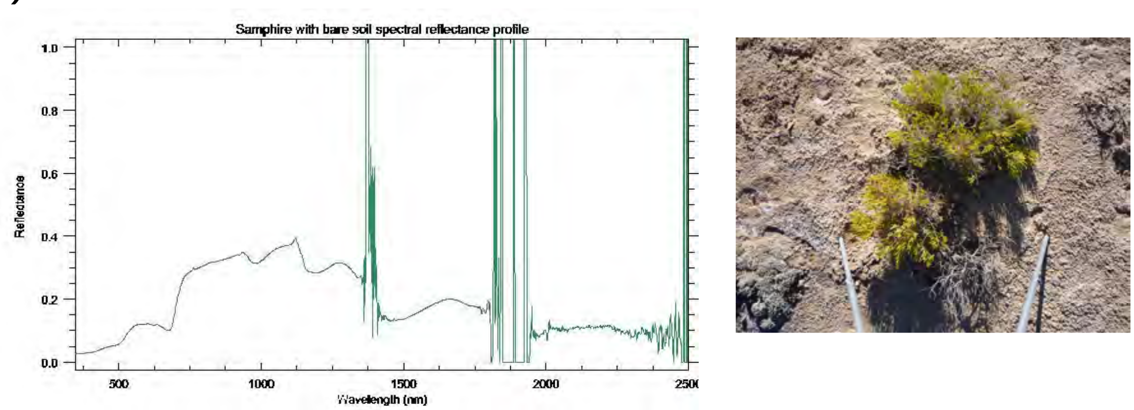
A georeferenced spectral library database of the field spectroradiometer ground reflectance measurements is also being developed to aid in the scaling of the PCA approach from plant to canopy level (relating plant fractional coverage of vegetation species within a HyMap pixel) with the HyMap imagery, as well as to enable repeatability of field methods, and aid in data post-processing.

The VHR QuickBird imagery and digital aerial photography are being employed for several purposes: (i) aiding in identification of test plots from botanical survey and field spectroradiometer data in the HyMap imagery; (ii) image to image geocorrection to improve the geolocation accuracy of the digital aerial photography at Dalhousie; and (iii) to aid in validating the HyMap PCA results. Currently under investigation is the possibility of deriving a digital elevation model (DEM) from the digital aerial photography: this would enable more advanced analyses of the imagery by enabling associations of species distribution with spring elevation, slope and aspect to be developed. Moreover, the use of a DEM at a selected site would offer potential for synergies between other sub-components of the project, e.g., linking spring flow rates with spring wetland extent and associations with species distributions (flora and fauna). Future research will also investigate the capability of object-oriented image approaches (image segmentation) applied to the VHR QuickBird imagery and digital aerial photography for mapping mound spring wetland vegetation.

(a)



(b)



(c)

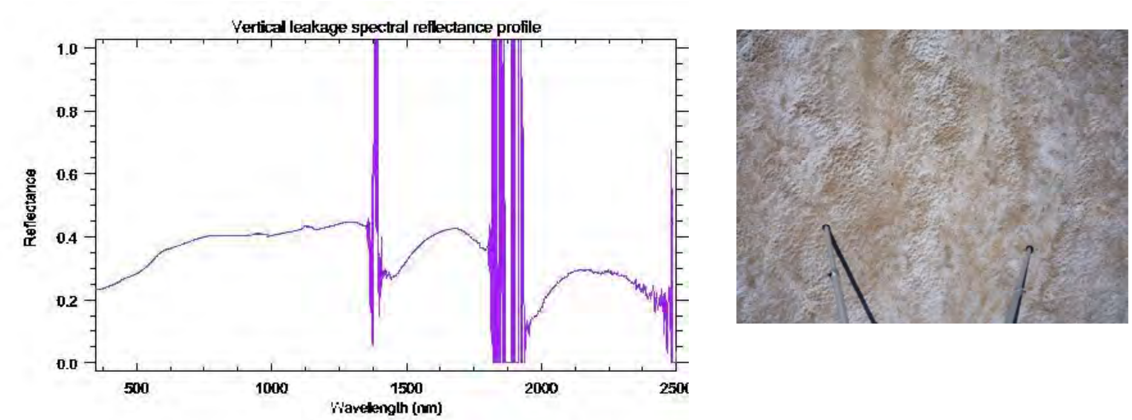


Figure 2: Selected field spectra and associated photographs of mound spring wetland vegetation, surrounding arid land vegetation and substrate: (a) ; (b) ; and (c) vertical leakage.

Preliminary results of the PCA analyses of the field spectroradiometer data and HyMap imagery will be presented at the workshop. An outline of future work and an illustration of potential synergies of the remote sensing sub-programme with other sub-programmes within the project will also be provided.