Hyperspectral and Phenological Characterisation of Upland Heather Dominated Ecological Communities

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GEF loan 836 interim report

Introduction

Heather dominated uplands form a significant proportion of Scotland's land area, are of international importance for biodiversity conservation, are a hydrological buffer and are intimately linked to the global carbon cycle. Current management practices are considered to be causing the decline of these areas and climate change may be contributing. The extent and remoteness of upland moors makes manual survey problematic for monitoring ecological and phenological change. Remote sensing offers a complimentary approach. However, little is known of the detailed reflectance properties of heather or the influence of variations in key biophysical and biochemical parameters have on the spectral reflectance of heather canopies and it is not known whether heather stands can be classified and their spatial extent and standing biomass quantified by remote sensing.

The aims of this research are to improve scientific understanding of the detailed seasonal high spectral resolution reflectance properties of upland heather dominated vegetation assemblages with a view to develop remotely sensed inputs into complex moorland ecological models and to improve understanding of moorland vegetation phenology.

Data collection

Eight heather stand research plots with four age classes and in different three different ecological communities have been established on Smeath Hill, Renfrew Heights SSSI and SPA ($4^{o}42'18"$: $55^{o}51'37"$). Laboratory and field measurements of hyperspectral reflectance and the biophysical and biochemical variables influencing reflectance have been acquired from these heather age classes and ecological communities throughout the 2005 and 2006 growing.

Figure 1 Base station on prominent rock

During 2007 field measurements continued and a NERC ARSF campaign was flown with images for the Eagle/Hawk hyperspectral imaging system and the Wild RC-10 large format survey metric camera being acquired on 12th April 2007, 10thJuly 2007 and 29th August 2007. In addition, ground control points, to be used to verify geometric correction of the aerial images and map the extent of selected heather stands, was carried out on the 12th June 2007, with the aid of GEF staff, using a pair

off System 1230 receivers operated in RTK mode. A base station was established on a prominence that would be identifiable in the high spatial resolution aerial (Fig. 1) photographs and GPS control points were taken along the fence line of each of the eight individual research plots, along the Smeath Hill enclosure fence line (Fig. 2). In addition, control points were taken at a number of locations of features that would be identifiable in the ARSF acquired images and of artificial ground targets positioned to assist in atmospheric correction of images. In total 149 GPS control points were acquired covering the whole research site.

Figure 2 Research plot control points

Processing and analysis

After collection, the GPS was corrected by use of coefficients determined from the nearest OS Active Network station. Subsequently, the data's accuracy was verified by using 2 other, local Active Networks to determine correction coefficients and these applied to the data. It was found that the 3 corrected data sets were within 2cm of each other indicating an overall positional accuracy of 2cm.

As the first stage of the GPS data processing to check the geometric positional accuracy of RGB aerial images, purchased form a 3rd party during the planning stages of this research, the GPS control points they were overlaid and the image was found to be within 1 pixel (25cm) of the GPS control points (Fig. 3).

Figure 3 Research plot ground target GPS control points

The analogue aerial images, acquired by NERC ARSF, were scanned by Bluesky Ltd and digital images at 12.5cm and 25cm spatial resolution delivered during November and the hyperspectral image data was received from ARSF in March 2008. However, it was found that the July aerial data had been acquired under blanket cloud, hence there was too much spectral noise and a lack of contrast in both the hyperspectral and photographic the image data for them to be analysed, and 6 of the research plots and

the atmospheric correction ground control targets were obscured by cloud during the August flight

Subsequently, ARSF agreed to refly the research site and scheduled flights for July and August 2008, therefore, post processing and analysis of the image data was suspended, as senescence and phenology were primarily of interest, until the complete data set was available. However, inclement weather throughout the summer of 2008 rendered further survey flights pointless and another airborne survey will be attempted during summer 2009.

Conclusion

As the purpose of acquiring the GPS data was to validate the geometric correction and the spatial extent of heather stands determined from image analysis and as a full set of images is yet to be acquire this project is on going. It is proposed that the GPS data will be used for analysis during winter 2009 and, as a contingency, if ARSF data is not acquired during 2009, the research will proceed, albeit with more limited aims, through analysis of the one usable set of images and possibly by making use of the images acquired for the 3rd party.