The estimation of humification of exposed upland peat from HyMap and ASD spectra

J.M. McMorrow ¹
A. Al-Roichdi ¹
M.G. Evans ¹
M.E. Cutler ²

1. Upland Environments Research Unit (UpERU), School of Geography, University of Manchester
2. Department of Geography, University of Dundee
Research question

Can HyMap estimate the degree of humification of exposed upland peat?

- Are humification signals detectable for \textit{in situ}, wet HyMap spectra?
- Are they detectable in dry spectra?
- Which spectral indices of humification are significantly correlated to humification for both sets of spectra?
Structure

- Context
- Data and methods
- Analysis
- Conclusion
CONTEXT
Environmental significance

- Peat erosion causes loss of habitat, siltation of reservoirs and water discolouration
- Humification increases the probability of release of heavy metals into ground water (Bozkurt et al. 2001)
Study area

S. Pennines, Bleaklow plateau
Peat types

- Well humified, sapric
- Poorly humified, fibric

Context

McMorrow et al. Bruges ’04
DATA & METHOD
HyMap

- 3m and 5m spatial resolution
- ATREM atmospheric correction, pre-processed to apparent reflectance
- Ephemeris geometric correction
- Spectra extracted for peat sampling sites from 3m data

3m data: 12.5 x 1.3 km
Peat samples from 33 sites. Burned sites excluded from this analysis.

Lab analysis of
- Humification (transmission)
- Organic matter
- Particle size
- Moisture (for 18 concurrent with HyMap)

- GPS location
- Digital photos of surface
- ASD field radiometry
ASD contact probe

To investigate effect of water on spectra

- Further 34 retrospective surface samples from the same and different sites
- Humification recorded by colorimetry: transmission at 540 nm
- Peat air-dried. Wetted to saturation. Wet samples oven dried in stages
- Spectra recorded in lab with ASD in contact probe mode at 20 drying stages
- Mean of driest spectra for each sample were simulated to HyMap
Visual inspection of both spectra
  – in situ (wet) HyMap spectra
  – dry spectra simulated from ASD

Extraction of spectral indices
  – Gradient e.g. normalised difference index
  – Depth below continuum

Correlation of indices with
  – Transmission
  – Moisture content
ANALYSIS
**HyMap in situ, wet spectra**

Deep absorption at bands 52 (Trans r 0.638, water r 0.624), 63, 95: water + ligno-cellulose?

- **Bleaklow7, Head7**
  - Well humified
  - Low transmission

- **Hern1,2&3, yellow peat**
  - Poorly humified

**Well humified peat has steeper gradient of shoulders between bands 47 and 58 (Hy58-Hy47)/(Hy58+47)**

**Flatter between bands 68 and 82**

(\(\text{Hy82} - \text{Hy68}\) / \(\text{Hy82} + \text{Hy68}\))

And between 99 and 110

(\(\text{Hy110} - \text{Hy99}\) / \(\text{Hy110} + \text{Hy99}\))
Dry simulated HyMap spectra using ASD contact probe in lab

Shallow absorption at bands 63, 95: ligno-cellulose? None at band 52, but r 0.746

Prominent SWIR absorption features

Good separability in NIR and SWIR

Negative correlation of SWIR and NIR reflectance with transmission

Well humified peat still has steeper gradient of shoulders between bands 47 and 58 (Hy58-Hy47)/(Hy58+Hy47)

Flatter between bands 68 and 82, not significant (Hy82-Hy68) / (Hy82+Hy68)

Direction reversed, not significant for 99 and 110 (Hy110 - Hy99) / (Hy110 + Hy99)
Summary

- HyMap spectral indices provide a possible basis for estimating peat humification.

- Best indices of humification are those that have significant correlation in the same direction for wet and dry spectra:
  - Normalised gradient of NIR slope, especially between bands 47 and 58 (1123-1281 nm), -0.763, r -0.813
  - And bands 62 and 31 (873-1337 nm), -0.818, -0.640
  - Absorption feature at band 52 only present in wet spectra, but depth significantly correlated to transmission for both, r 0.638, 0.746
Summary (continued)

- Water masks other absorption features:
  - Those on right slope of water absorptions
  - SWIR features, e.g. Cellulose absorption index (CAI) at band 103 (2100 nm)

- Dry spectra retain absorption features at bands 63 and 95 (1400, 1950 nm), so also due to other components such as lignin and cellulose
Further work

- Indices characterising shape of absorption features, position of shoulders and max absorption
- 200 samples at different drying stages
- Upscaling effects: extraction of HyMap in situ spectra for all contact probe sampling sites
- Other measures of humification:
  - Transmission at 624 and 651 nm
  - Lignin-cellulose ratio
  - Carbon-nitrogen ratio
- Empirical Modelling of humification and moisture;
  - Multiple regression
  - Artificial neural networks ANN
- Classification of combined humification-moisture classes
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http://www.art.man.ac.uk/Geog/uperu/index.htm