The University
of Manchester

MANCHESTER
1824

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

Airborne
Hyperspectral
conference
8 Oct 2004,
Bruges

MANCHESTER
1824

Research question

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

- Are humification signals detectable for *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

The University of Manchester

CONTEXT

Airborne Hyperspectral conference 8 Oct 2004, Bruges

MANCHESTER 1824

The University of Manchester

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)

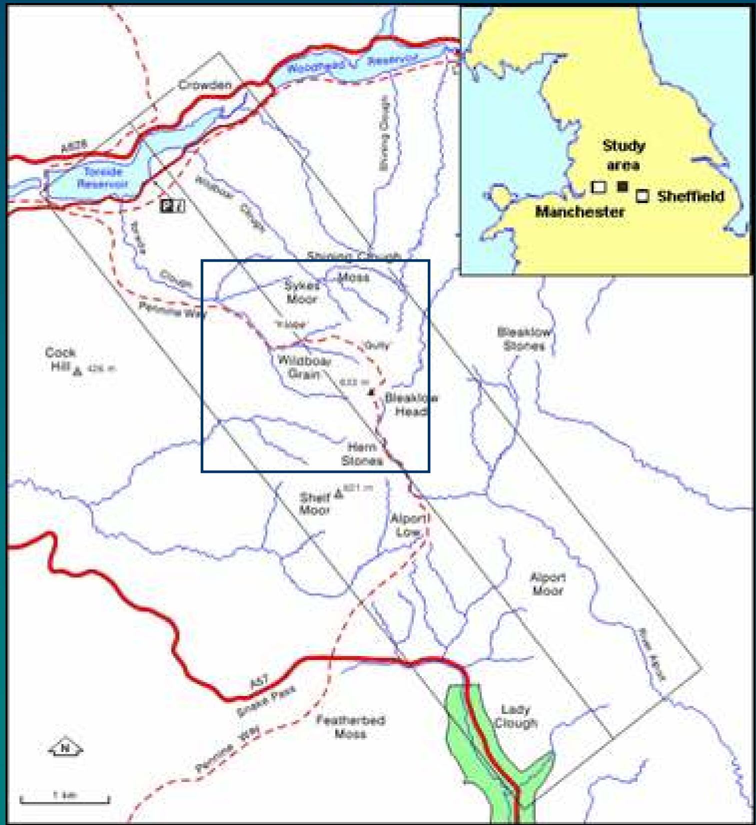
Context

McMorrow *et al.* *Bruges* ’04

The University of Manchester

Study area

S. Pennines, Bleaklow plateau



Context

McMorrow *et al.*
Bruges ’04

The University
of Manchester

Peat types

Well humified, sapric

Poorly humified, fibric

Context

McMorrow
et al.
Bruges '04

The University of Manchester

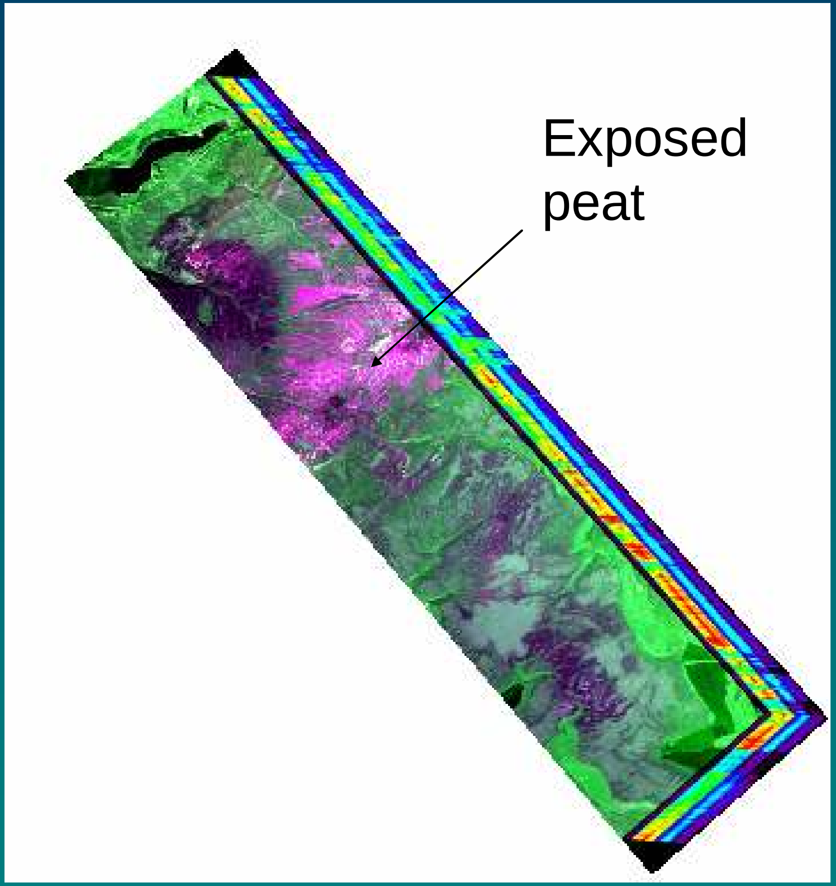
DATA & METHOD

Airborne Hyperspectral conference
8 Oct 2004, Bruges

The University of Manchester

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

Data & method

McMorrow *et al.* *Bruges* '04

The University of Manchester

MANCHESTER 1824

HyMap Field and lab data

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

- 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)

Data & method

McMorrow *et al.* *Bruges* '04

The University of Manchester

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

Data & method

McMorrow *et al.* *Bruges* '04

The University of Manchester

MANCHESTER 1824

Spectral indices & correlation

- 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

Data & method

The University of Manchester

ANALYSIS

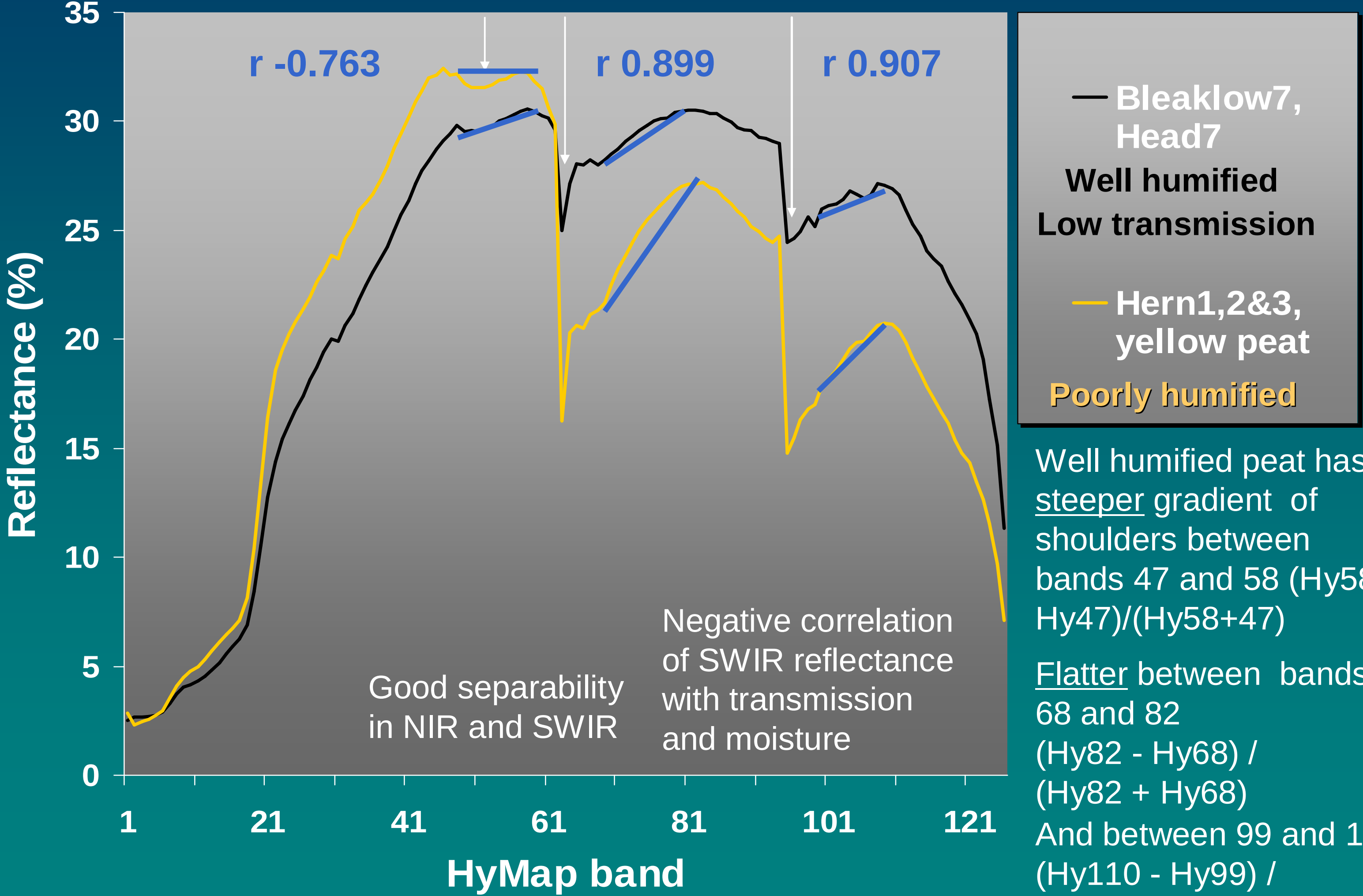
Airborne Hyperspectral conference
8 Oct 2004, Bruges

The University of Manchester

MANCHESTER 1824

HyMap *in situ*, wet spectra

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



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

<u>Flatter</u> between bands 68 and 82 (Hy82 - Hy68) / (Hy82 + Hy68)
And between 99 and 110 (Hy110 - Hy99) / (Hy110 + Hy99)

Analysis

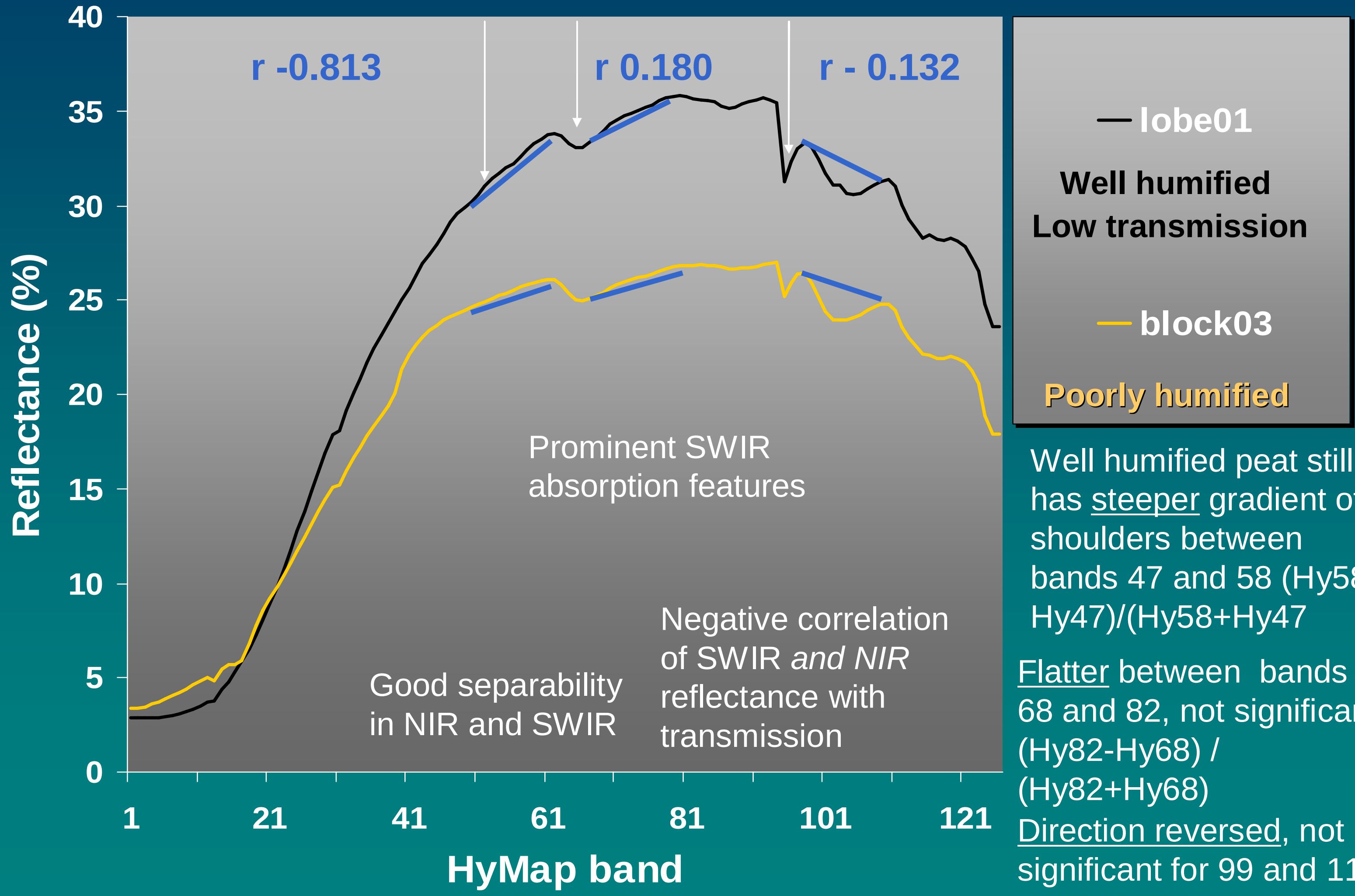
McMorrow *et al.* *Bruges* '04

The University of Manchester

MANCHESTER 1824

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



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)

Analysis

McMorrow *et al.* *Bruges* '04

The University of Manchester

CONCLUSION

Airborne Hyperspectral conference
8 Oct 2004, Bruges

The University of Manchester

MANCHESTER 1824

Summary

- HyMap spectral indices provide a possible basis for estimating peat humification
- Best indices of humification are those that have significant correlation in 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

The University of Manchester

MANCHESTER 1824

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

Acknowledgements

- BNSC/NERC: SHAC HyMap images
- NERC EPFS: ASD loan
- Moors for the Future: aerial photographs
- National Trust High Peak Estate and United Utilities: field access
- Manchester Geographical Society and the Faculty of Arts, University of Manchester: funding
- Syrian government: Amer Al-Riochdi’s Ph.D. studentship
- Postgraduates at Manchester: assistance with fieldwork

http://www.art.man.ac.uk/Geog/uperu/index.htm