A bird’s eye view of Exmoor’s peatlands
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Why remotely sense peatlands?
• Hard to survey using traditional techniques
• RS = spatial information
• Many key indicators of peatland condition correlated to RS signal
  – Microtopography and vegetation pattern
    • LiDAR
  – Near surface moisture
    • Thermal imaging (TABI)

Why LiDAR? ➔ Morphology


LiDAR approach
• Can active remote sensing approaches (LiDAR), capture spatial variation in peatland structure?
• Does this offer a viable approach for condition monitoring?

Structural changes during degradation
• Microtope patterning and biodiversity lost
• Hummocks and hollows disappear
• Water table drops, gaseous C flux increases
• Shrub cover (Calluna / Erica) takes over
Previous work showed LiDAR could discriminate key peatland condition classes using surface vegetation patterns as a proxy for near surface moisture.

Exmoor is highly sloped...

- How well does LiDAR work as a monitoring tool on UPLAND blanket peats?

Processing challenge
- Extensive drainage
- Strong topographic signature underlying the LiDAR texture
- Vegetation communities
- *Molinea* dominated

Exmoor remote sensing datasets

- 50cm resolution aerial LiDAR Survey of Exmoor
- 2m resolution thermal imaging data (Tabi)
  - Collected early Summer 2010
- Fine resolution Terrestrial Laser Scanning (TLS) of selected sub-sites
  - Collected February 2011
- DGPS Surveys (accurate to 2 cm)
  - Collected February 2011
- Unmanned aerial vehicle survey (2 cm res photographs)
  - Collected March 2012

UoE experimental catchments

LiDAR signatures

- From a GIS perspective what features can be measured and mapped?

1. Presence of ditches and their relative width
2. Hidden archaeology
3. Thermal data – Tabi – what does it tell us?
4. Other work by the team
LiDAR – data challenge

• Large extent – 192 km²
• 192 data tiles
• First, mosaic
• Then, process!

Note – unprocessed LiDAR data look like this when zoomed in:

Blanket peatland coverage

Processing step 1: hillshade

• Qualitative technique to highlight features

Success of hillshade enhancement is strongly dependent on the topographic profile.

Hillshade analysis: digitising

Processing step 1: hillshade

Figure 5: Hillshade image produced from the LiDAR dataset (Tile 724 centred on 270496.242E, 143009.700N) using a solar elevation of 45 degrees and a solar azimuth of 185 degrees. This illustrates issues with shadowing that arise in areas of high relief when a single solar azimuth and elevation are used to create the hillshade image.
### Summary of linear feature mapping

<table>
<thead>
<tr>
<th>Width class</th>
<th>Description</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Very narrow, faint feature with 1-2 pixels defining its spatial width extent. May appear as a slightly broken line in the hillshade image.</td>
<td>4231</td>
</tr>
<tr>
<td>2</td>
<td>Slightly broader feature, more clearly represented, being 2-3 pixels wide.</td>
<td>1565</td>
</tr>
<tr>
<td>3</td>
<td>4-6 pixels wide with clearly delineated edges. Appears unbroken and is obvious even when the image is zoomed out to the scale of a single LiDAR tile.</td>
<td>988</td>
</tr>
<tr>
<td>4</td>
<td>Broad ditch-like feature spanning several pixels and with very clear structure.</td>
<td>278</td>
</tr>
<tr>
<td>5</td>
<td>Very wide feature, clear and distinct in the landscape, probably spanning a spatial width scale of &gt;10 pixels.</td>
<td>79</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>7141</td>
</tr>
</tbody>
</table>

### Linear feature mapping

#### Archaeological investigation

- Hillshade image with Southerly illumination
- Hillshade image with Northerly illumination
- An edge-detection image
  - Derived by passing a 7x7 pixel edge detection filter over the LiDAR, and thresholded to show extreme values
Summary

564 possible archaeological features (in addition to the 7141 linear features) mapped
What can TABI tell us?

- TABI = Thermal Airborne Broadband Imager
- Measures the ‘thermal emissivity’ of the land surface
  - How much thermal (long wavelength) radiation is being emitted from a substrate
- The higher the moisture content of an object, the greater its ability to absorb solar energy during the day, and hence, become a good emitter.
- Other factors can affect emissivity
  - Albedo (brightness) of an object (darker objects absorb more solar radiation and thus emit more thermal radiation)
  - Surface structure

Thermal imaging data

- High emissivity = wetter?
- Low emissivity = drier?

Inter-ditch areas show lower emissivity and hence are presumed to be drier. This is probably because the areas are receiving drainage from upstream areas.

Detrend using 11x11 low pass

Figure 31: raw Tabi data at Spooners with key features highlighted. Yellow-red = high emissivity (i.e. more water) and blue-green = low emissivity (i.e. less water).

Figure 32: Spooners raw Tabi data overlaid with linear feature vector from WFWI. Arrows highlight ditch features which appear to have a measurable effect on the Tabi emissivity values, indicating that these features must exceed the 2 m resolution of the Tabi and therefore be acting as significant conduits for water. Yellow-red = high emissivity (i.e. more water) and blue-green = low emissivity (i.e. less water).
Subtract from detrend - result

Note: blue/green pixels are now high emissivity i.e. wetter areas.

Field validation

Squares are location of channel surveyed using DGPS – arrows point to major pools

Tabi + LiDAR (Luscombe)

“This indicates repeated TABI can record immediate rewetting following restoration”

“LiDAR + Tabi combine to provide a useful indicator of relative wetness in peatland landscapes and how this relates to ecosystem structure.”

Other Work Undertaken...

1. Exploring vegetation height and pattern using LiDAR
2. Hydrological flow path mapping
3. UAV survey – preliminary results

Detrend LiDAR → vegetation height

Analysis of vegetation pattern

Aclands = 2.5 m  Spooners = 2 m

Consistent with Molinia vegetation cover (hummock pattern) at both sites. After restoration we expect this patterning to change.
LiDAR Vs TLS: validation

LiDAR Vs TLS

LiDAR Vs TLS

LiDAR Vs TLS

DGPS Validation

Flow accumulation models

Stream order mapping
Stream order vs. linear drains

UAV survey for fine scale mapping
March 2012: Working with QuestUAV to survey Exmoor’s peatlands
2 cm resolution data from Aclands and Spooners
Unprecedented detail!
The future...?

Thanks for listening!

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