

Evaluation of the potential of applying CASI/SWIR for characterising and discriminating semi-natural vegetation in upland Wales



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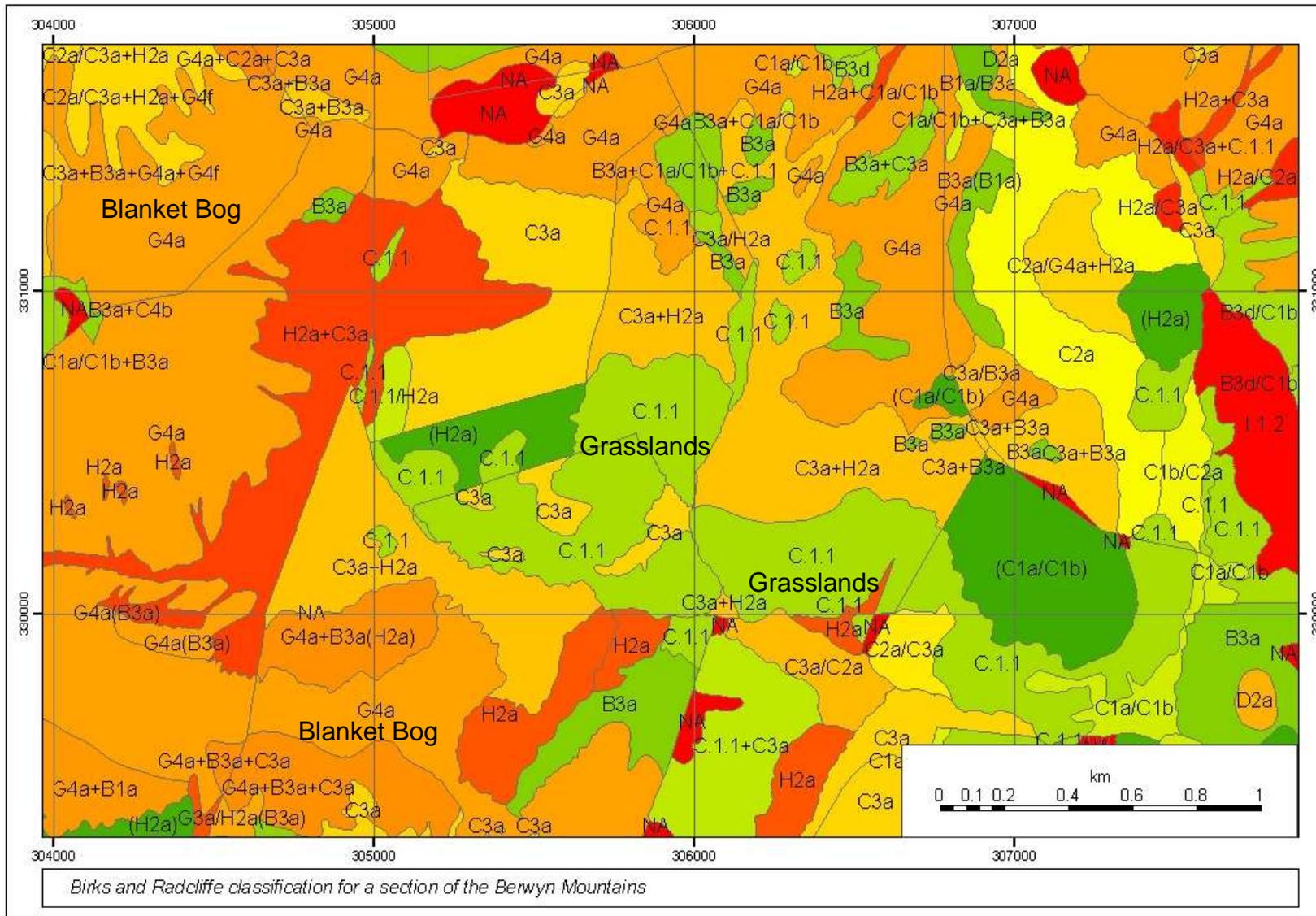
Wales, UK

Background

- The Countryside Rights of Way Act (2000) gives new rights of access to certain categories of open and common land
- Subject to mapping and consultation, access will be granted to open country, defined as mountain, moor, heath and down, and registered common land in England and Wales
- The Countryside Council for Wales (CCW) is charged with the delivery of the outputs for Wales
- The first set of outputs involved creating preliminary boundaries of open country from a number of existing data sources including Phase 1 Survey (1990), Upland Survey (1980) and Common Land Maps (1993)
- The new right of access will commence on a regional basis, beginning in Summer 2004



Background – Existing classification



Spaceborne Objectives

Spaceborne
Objectives

Assess the potential of Earth Observation (EO) data to aid the discrimination and mapping of semi-natural vegetation (mountain, moor heath and down) from intensively farmed and developed land

To evaluate the applicability, repeatability and accuracy of developed methods in discriminating semi-natural vegetation from intensively farmed land throughout Wales

To critically evaluate the potential of EO data as a mechanism for the revision of Open Access Land

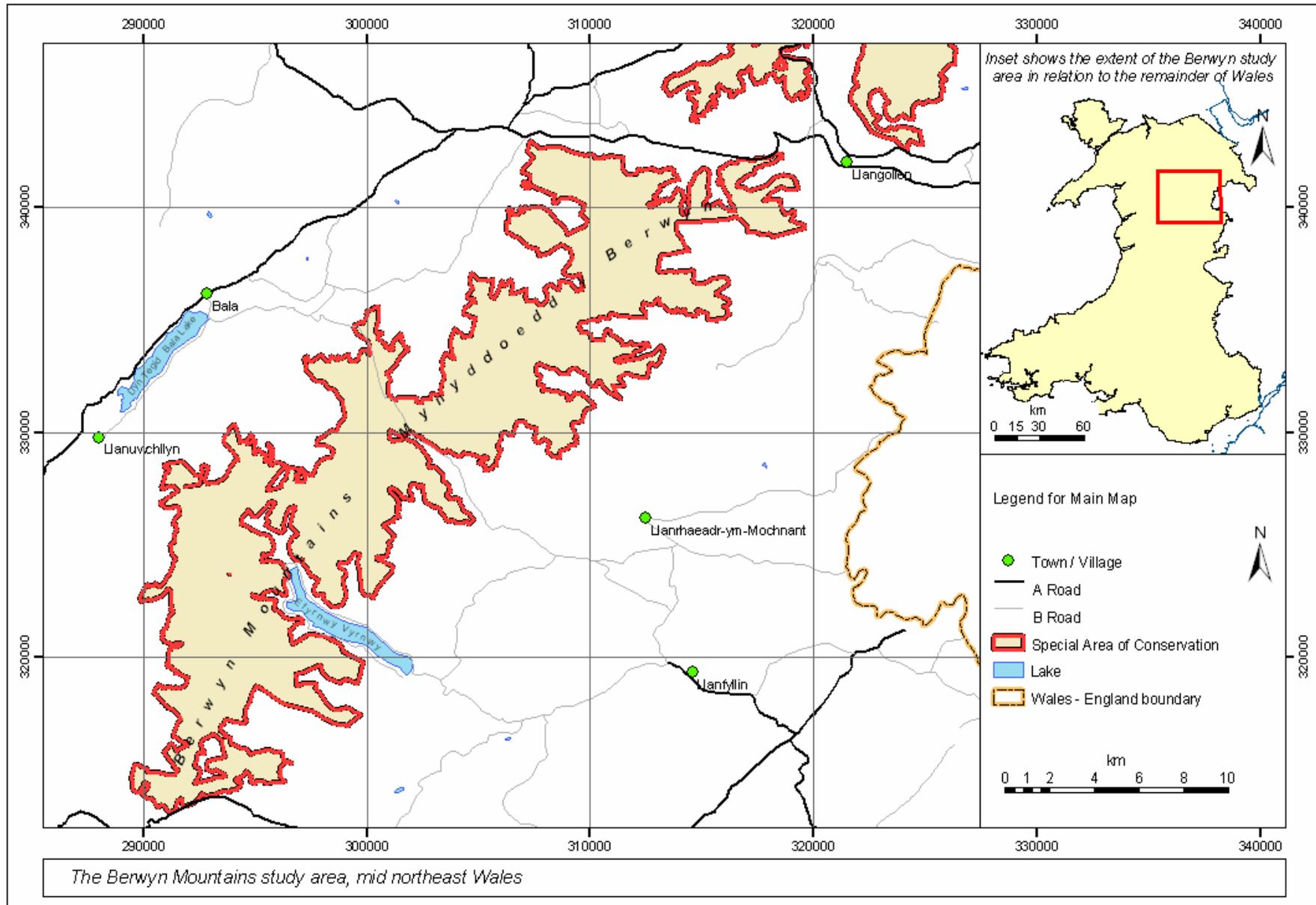
Vegetation categories

1	Woodland and Scrub							Bracken
2	Woodland						Scrub	Bracken
3	Broad-leaved		Coniferous		Mixed		Scrub	Bracken
4	Semi-natural	Plantation	Semi-natural	Plantation	Semi-natural	Plantation	Scrub	Bracken
1	Grassland and marsh							
2	Improved grassland	Semi-improved and Improved grassland						
3	Improved grassland	Acid grassland		Neutral grassland		Calcareous grassland		Marshy
4	Improved grassland	Semi-improved	Unimproved	Semi-improved	Unimproved	Semi-improved	Unimproved	Grassland
1	Tall herb			Heathland				
2	Tall herb			Dwarf shrub heath			Lichen/ Bryophyte heath	Montane heath / dwarf herb
3	Upland cliff ledge	Other		Dry heath		Wet heath	Lichen/ Bryophyte heath	Montane heath / dwarf herb
4	Upland cliff ledge	Ruderal	Non-ruderal	Acid heath	Basic heath	Wet heath	Lichen/ Bryophyte heath	Montane heath / dwarf herb

Study site

- Berwyn Mountains, NE Wales

Study site



Study site

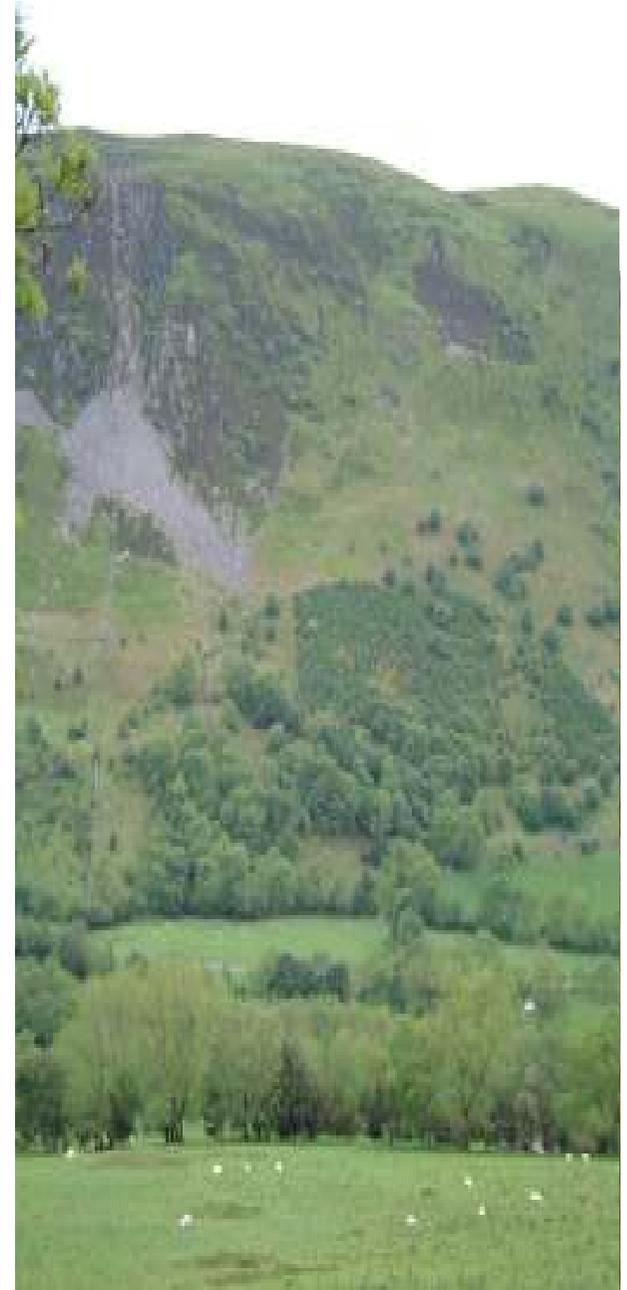
- Berwyn Mountains, NE Wales
- Long mountain massif, rising to >800m



- The north-east section forms a high ridge with a relatively continental climate, merging into an extensive area of plateau dominated by blanket-bog in the wetter, more oceanic climate to the south-west
- Site includes some of the most continental upland areas in Wales
- Has a full range of semi-natural habitats, and is characterized by transitions from intensive agriculture to heathlands, blanket bog and montane summit heaths

Study site - Ecological highlights

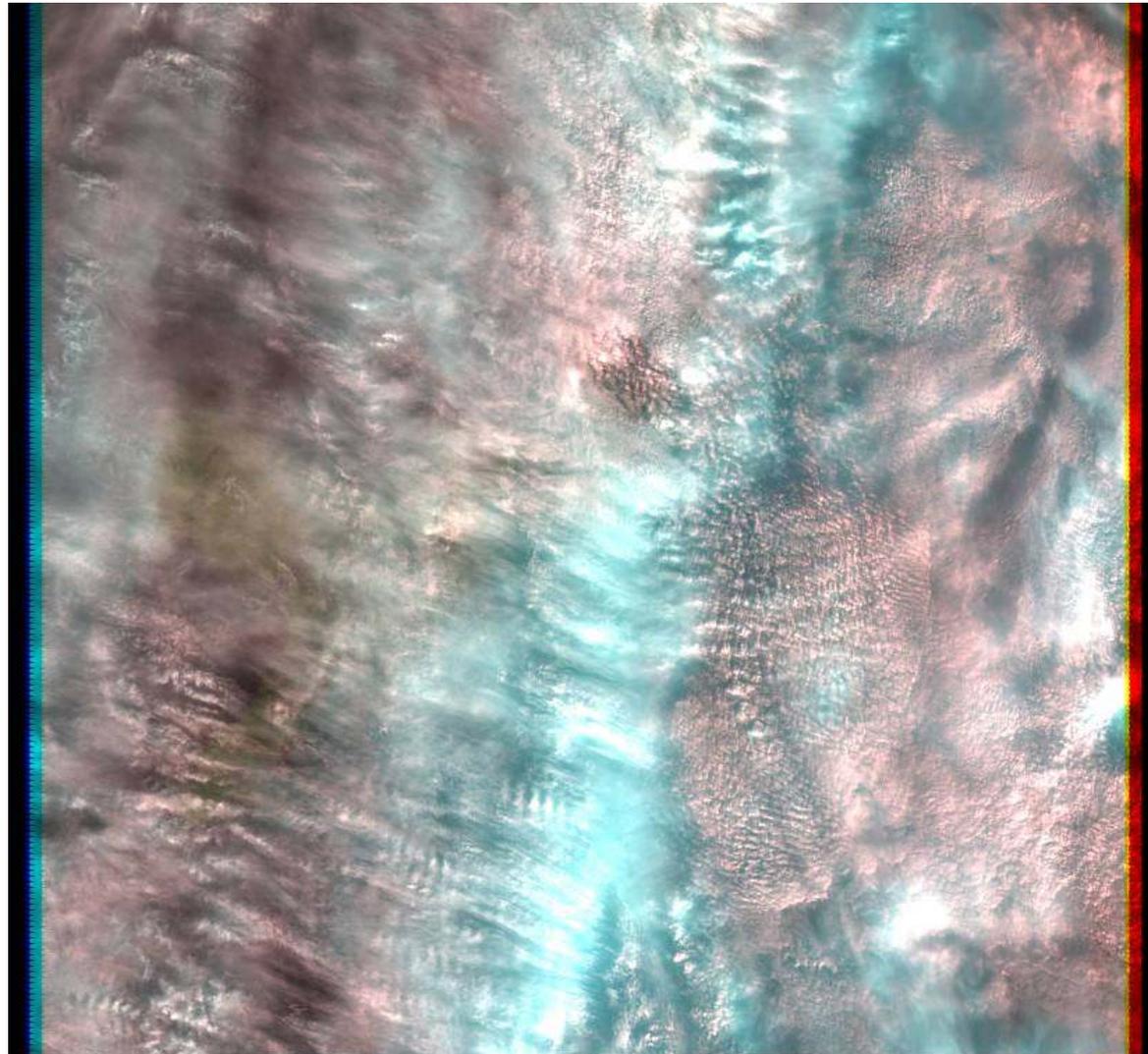
- The bogs are some of the most undisturbed in Wales and have notable populations of plants, such as *Rubus chamaemorus* (cloudberry) and *Andromeda polyfolia* (bog rosemary), some of which are close to their southern limit in the UK
- The montane area has small populations of arctic-alpine species, notably *Carex bigelowii* at its southermost station this far east. The MONARCH project (Harrison, Berry and Dawson 2001) predicted significant loss of climate space for both *Rubus chamaemorus* and *Andromeda polyfolia* , both of which are likely to become absent from Wales as a result of changes in both temperature and rainfall
- Berwyn is recognized as internationally important for its semi-natural habitats, including those outlined above, and is designated as a Special Area of Conservation (SAC) under the EU Habitats Directive



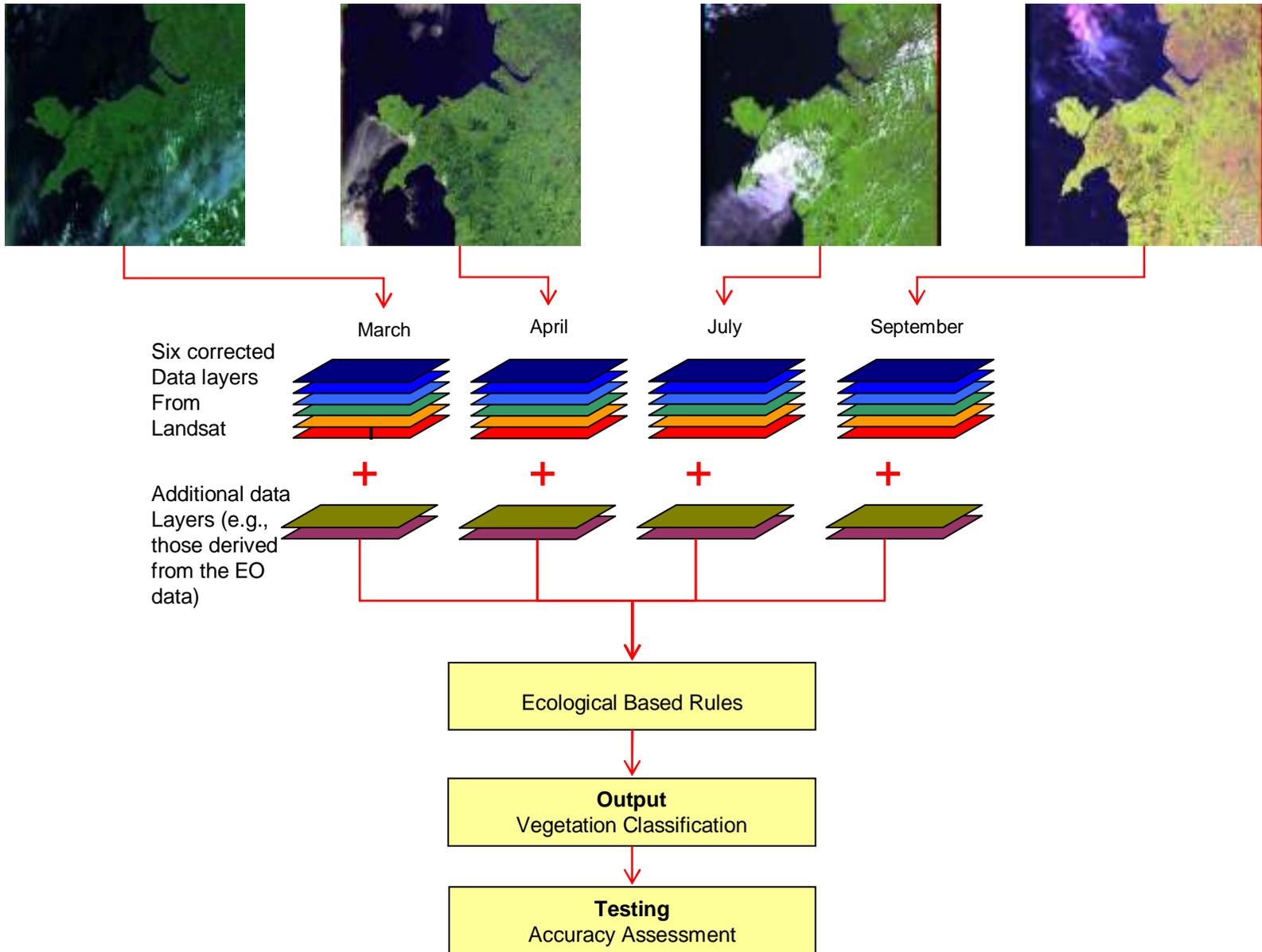
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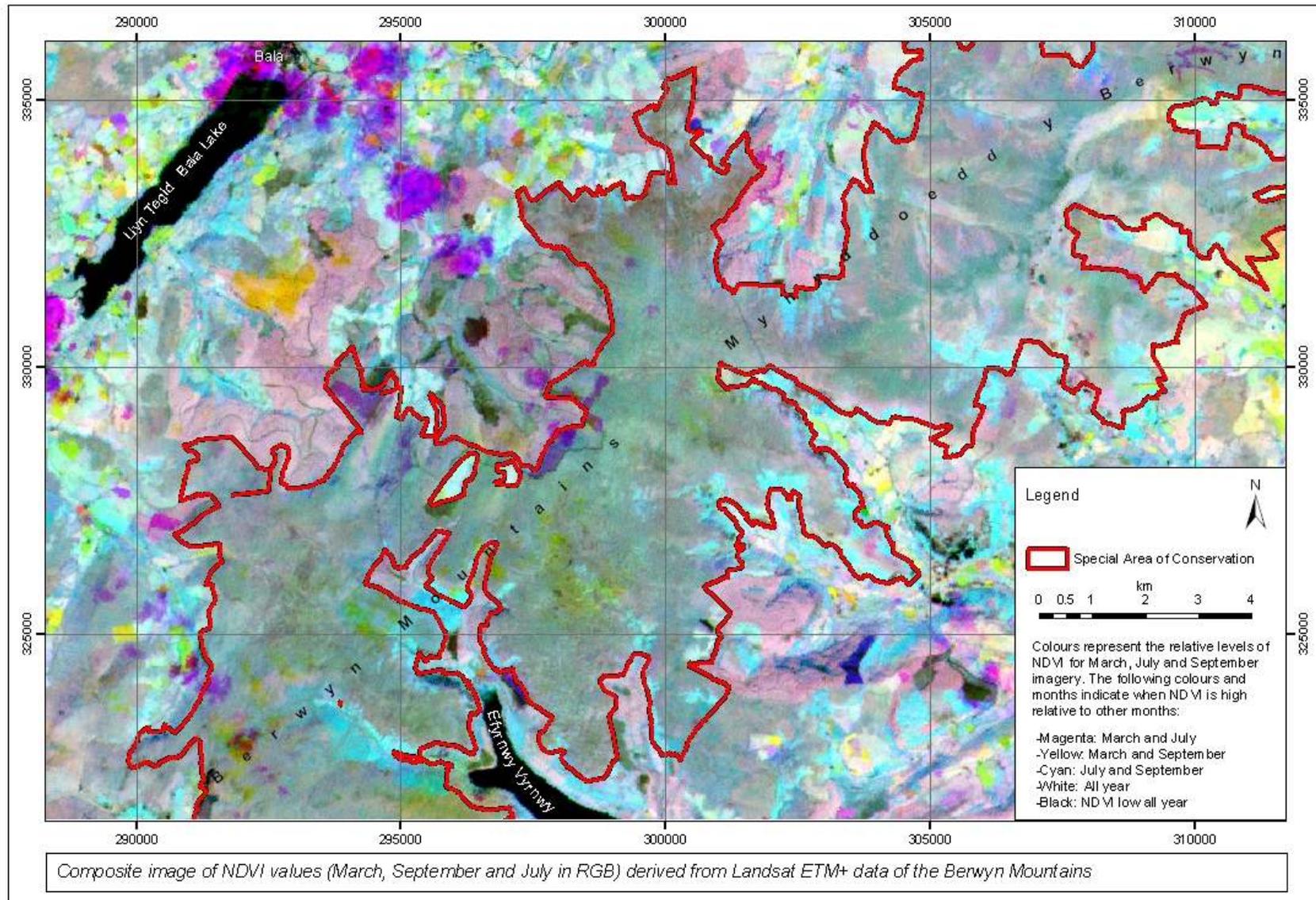
Usual conditions



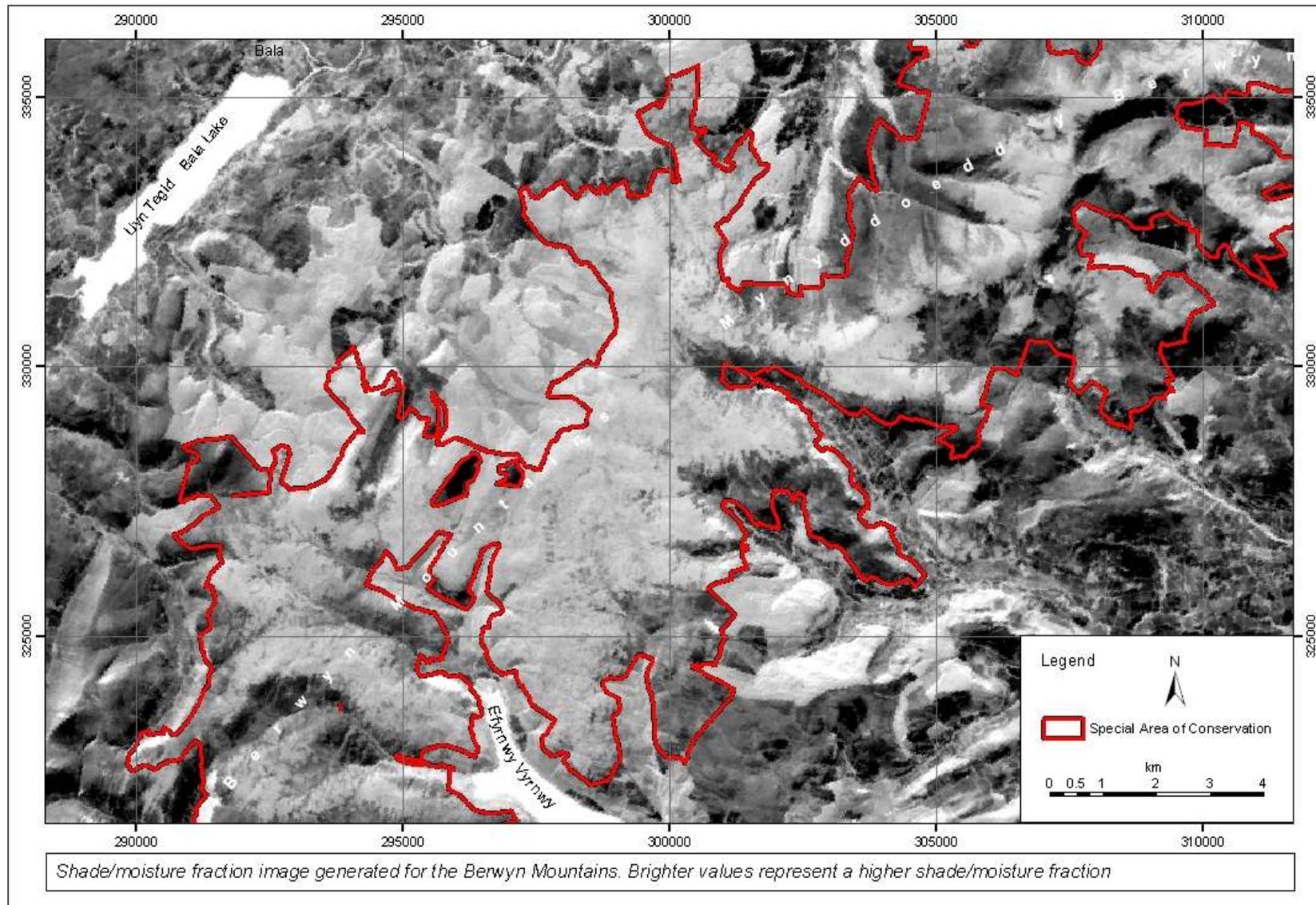
Methods - Time series analysis



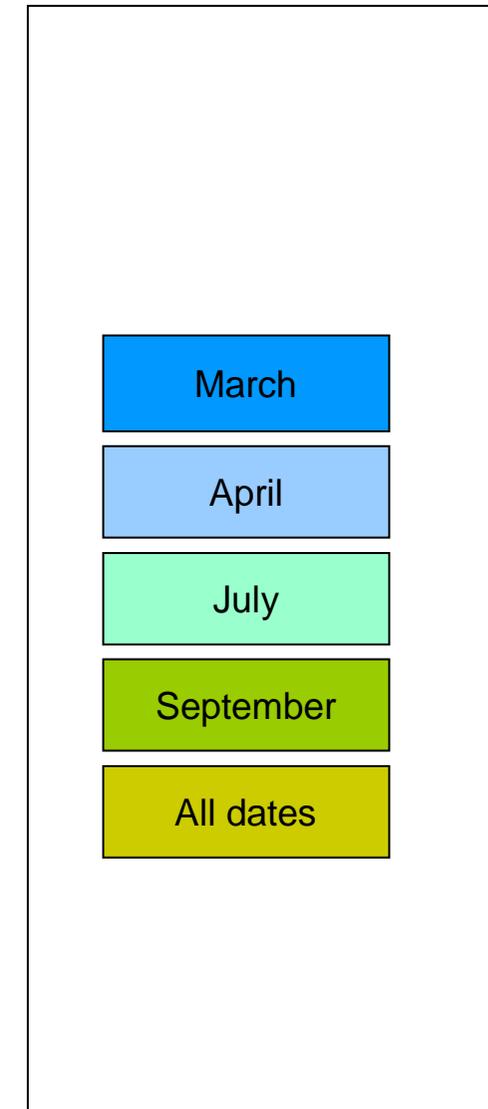
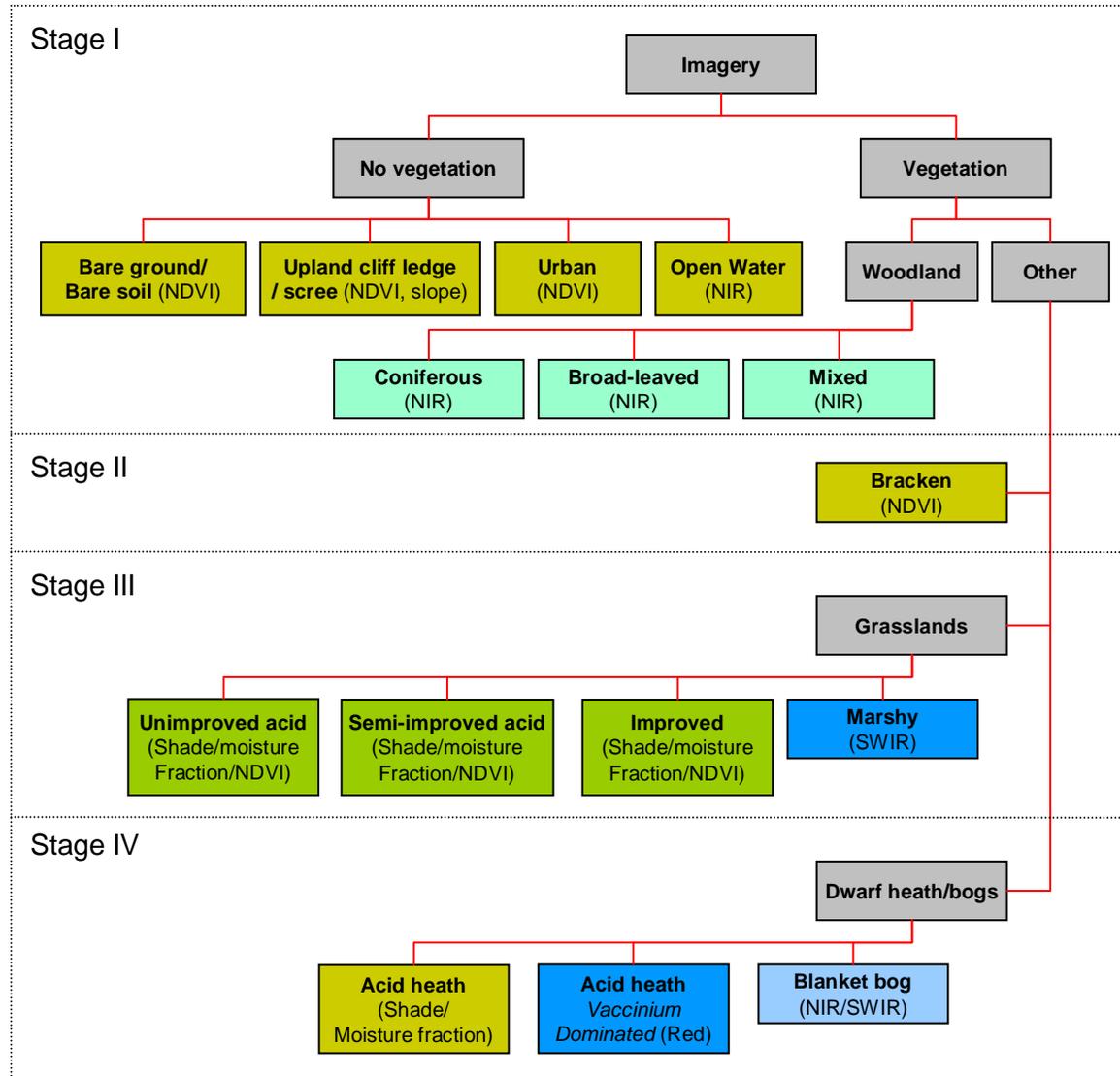
Methods - Time series analysis: NDVI



Methods - Time series analysis: NDVI



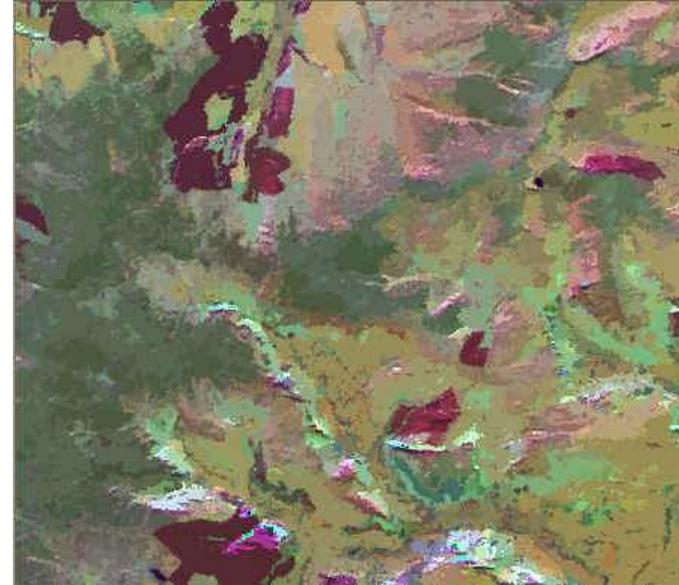
Methods – Classification based numerical decision rules



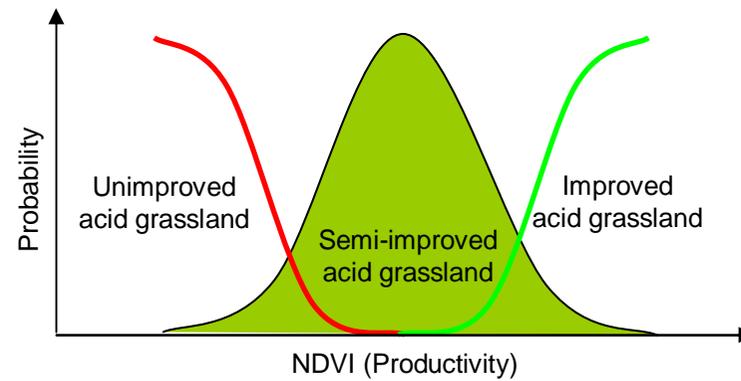
40 bands: 4 Landsat scenes + derived layers



Segmentation



Decision Based Rules e.g.



Methods – Decision rules: Bracken

Directional spectral properties of bracken

2269

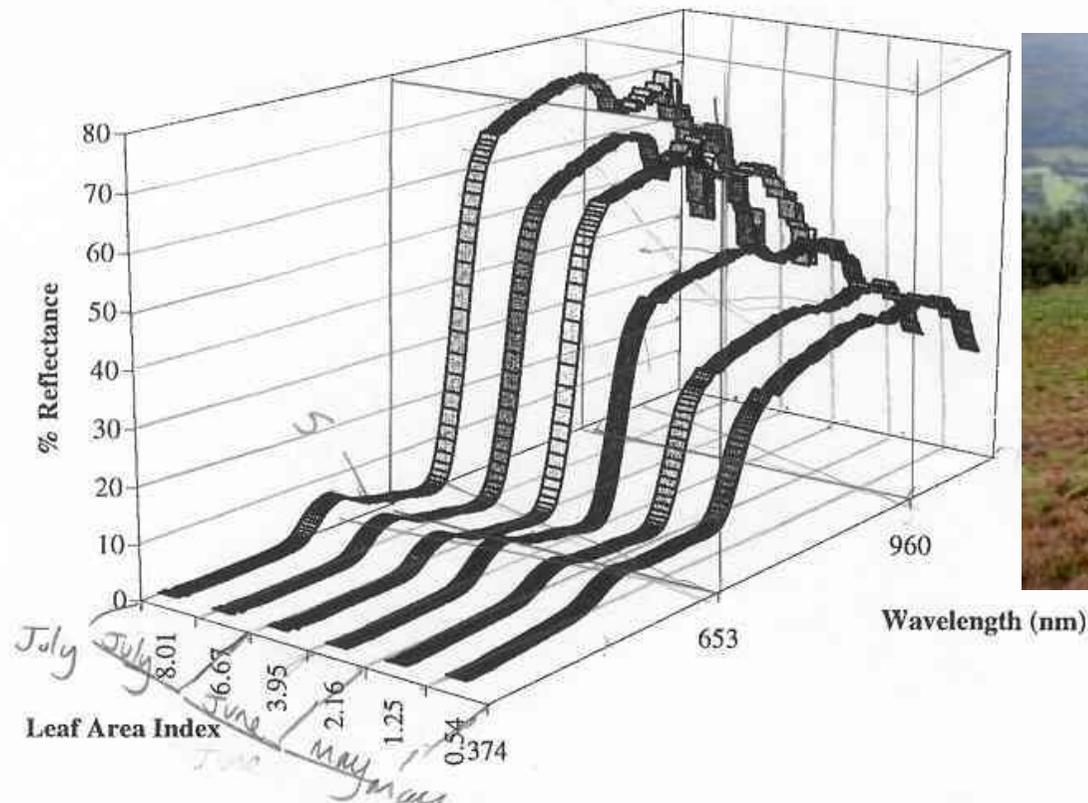
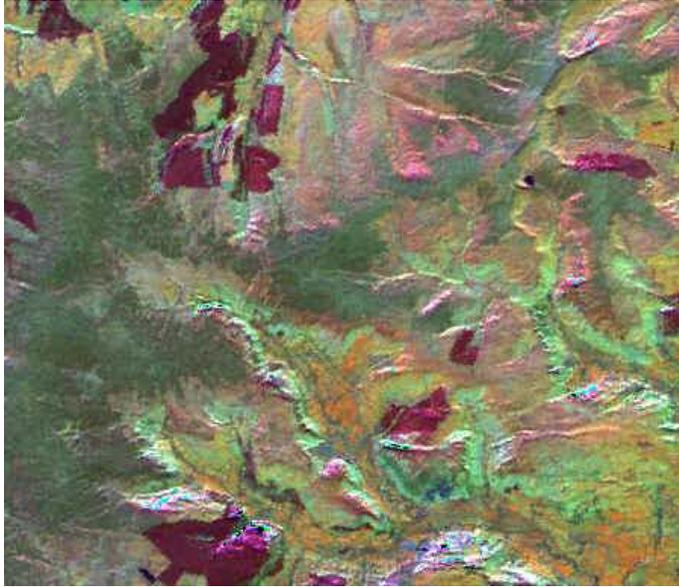
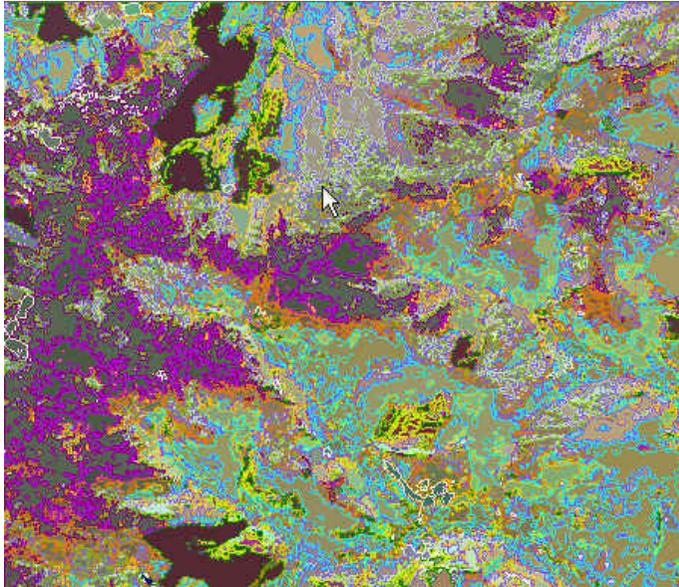
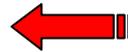
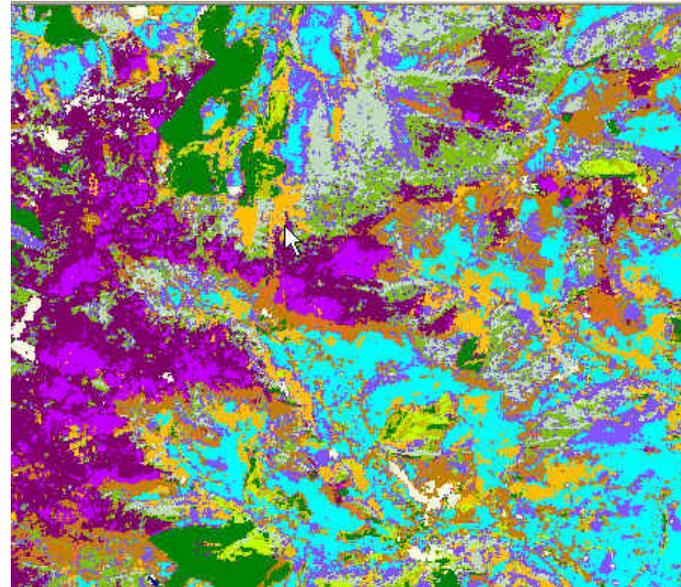
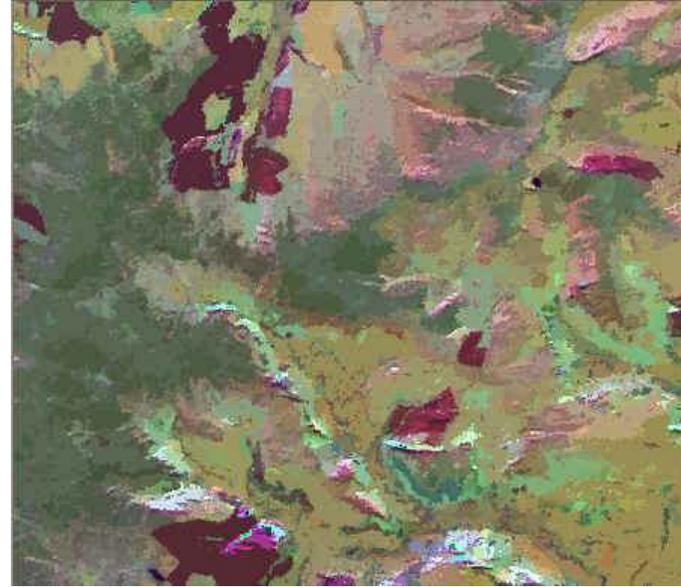


Figure 2. Spectral reflectance measured from nadir at various stages of bracken canopy development, as expressed through LAI.

40 bands: 4 Landsat scenes + derived layers



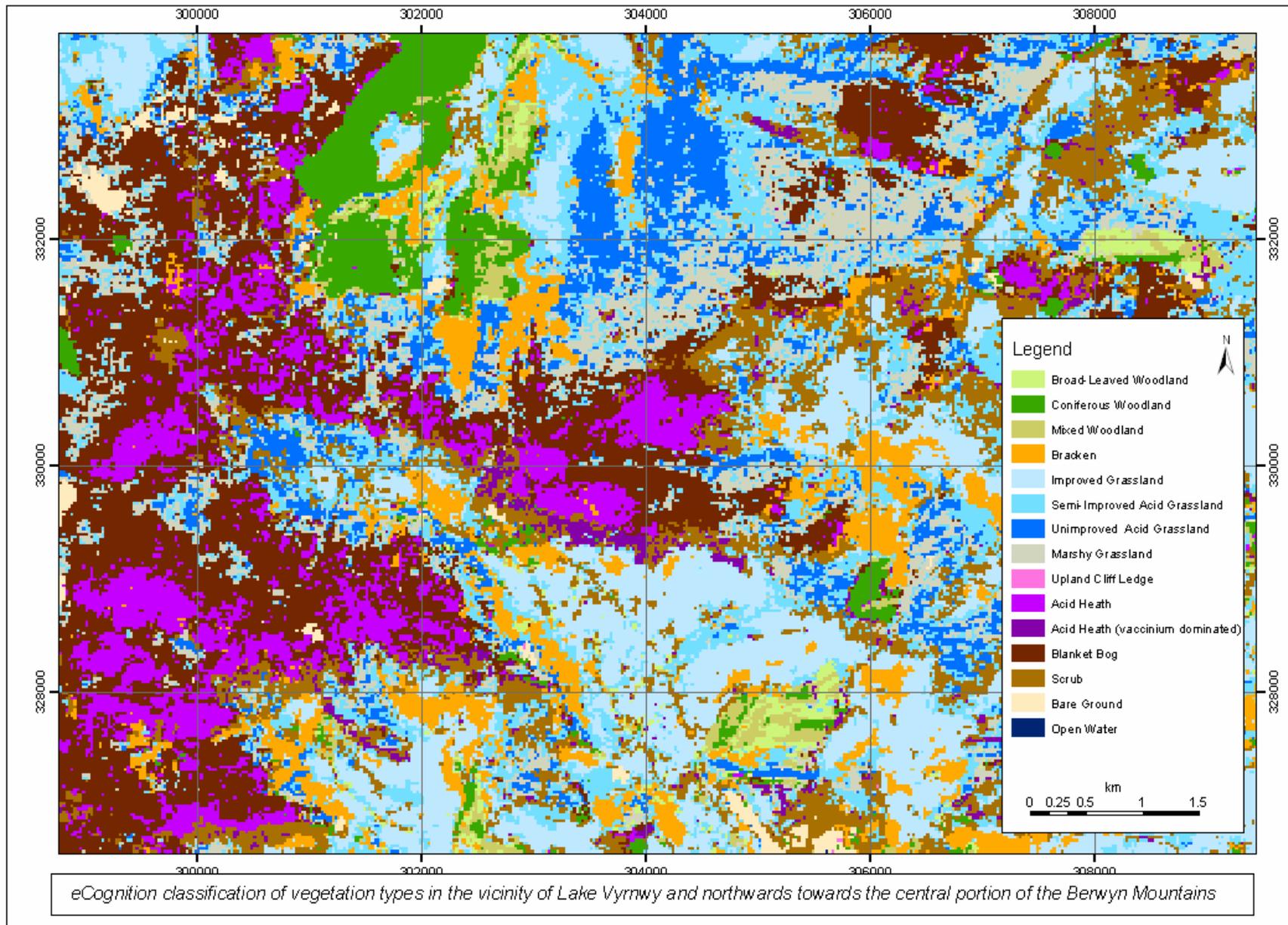
Segmentation



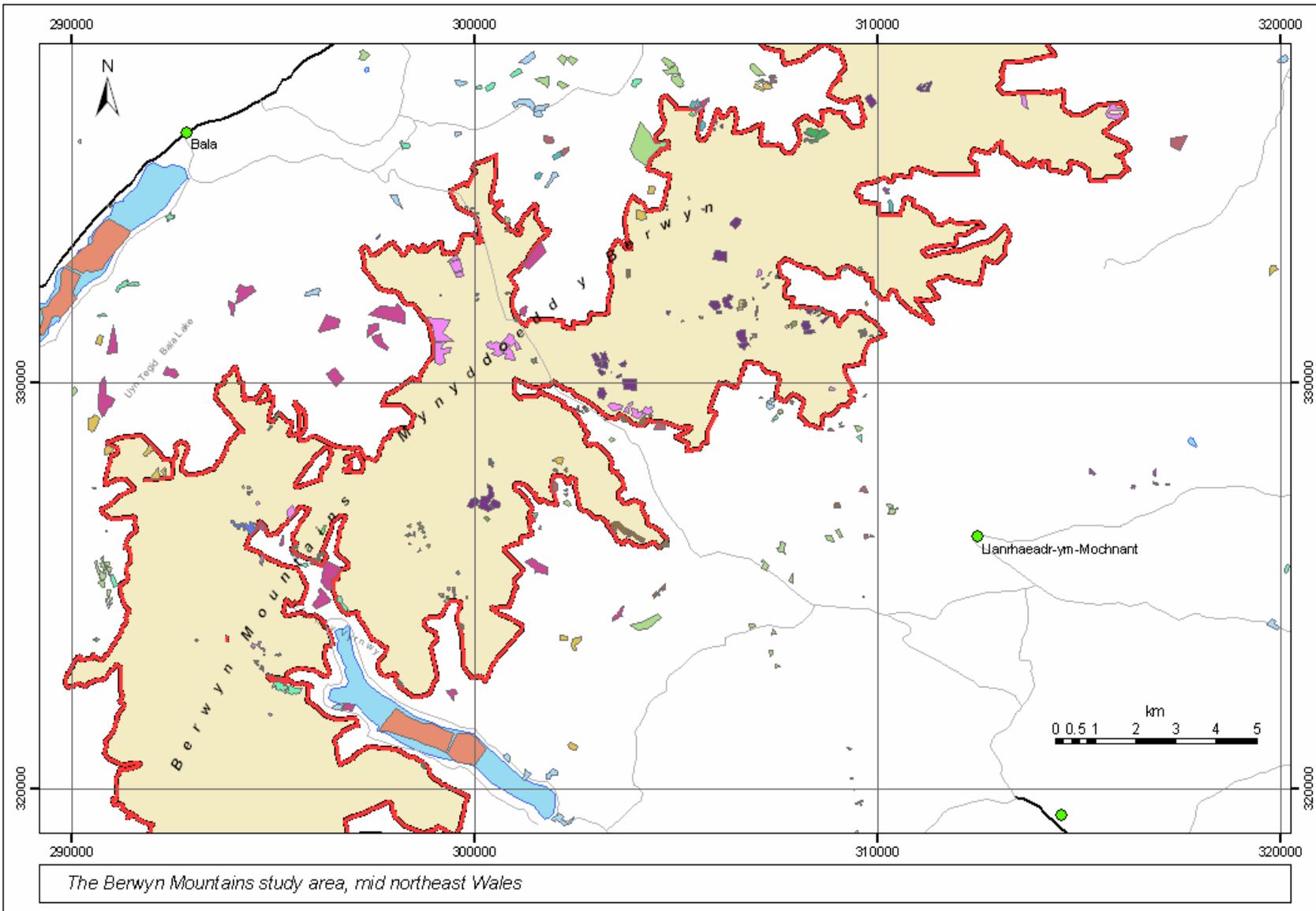
Vector output of classes

Decision Based Rules

Output - Classification



Accuracy ?



Accuracy ?

		Ground Truth														
		Broad-leaved	Conifers	Mixed woods	Scrub	Bracken	Improved grassland	SI	Un-I	Marshy grassland	Dry heath	Blanket bog	Bare ground	Open water	Total	User's accuracy (%)
Classification	Broad-leaved woodland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Coniferous woodland	7.1	122.1	9.3	0.4	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	139.2	87.7
	Mixed woodland	2.9	0.0	39.6	0.0	0.0	0.0	0.0	0.2	0.4	0.0	0.0	0.0	0.0	43.1	91.8
	Scrub	0.0	0.0	0.0	1.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	90.8
	Bracken	5.2	0.0	0.0	1.0	14.6	0.0	0.0	0.0	0.3	1.1	0.0	0.0	0.0	22.2	65.8
	Improved grassland	0.0	0.0	0.0	0.2	19.1	111.5	17.0	5.0	2.0	0.0	0.0	0.0	0.0	154.8	72.0
	Semi-improved grassland	1.1	0.0	0.0	0.0	2.5	5.4	15.1	3.7	0.7	1.4	2.8	0.1	0.0	32.7	46.1
	Unimproved acid grassland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.4	0.0	0.0	4.8	0.1	0.0	36.3	86.5
	Marshy grassland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.8	0.0	9.9	0.2	0.0	16.9	40.4
	Dry heath	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2	41.8	4.3	0.0	0.0	46.3	90.2
	Blanket bog	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	39.2	94.7	0.0	2.2	137.2	69.0
	Bare ground	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	3.7	0.0	6.6	56.0
	Open water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	136.1	136.1	100.0
	Total	16.3	122.1	48.8	3.5	36.5	116.8	32.1	40.6	11.4	86.4	116.4	4.1	138.3	773.5	
	Producer's accuracy (%)	0.0	100.0	81.0	54.0	40.0	95.4	47.0	77.3	59.8	48.3	81.3	89.2	98.4		

[1] Semi-Improved Acid grassland

[2] Unimproved Acid grassland

[3] Includes bare peat, scree and bare ground from deforestation

Airborne Objectives



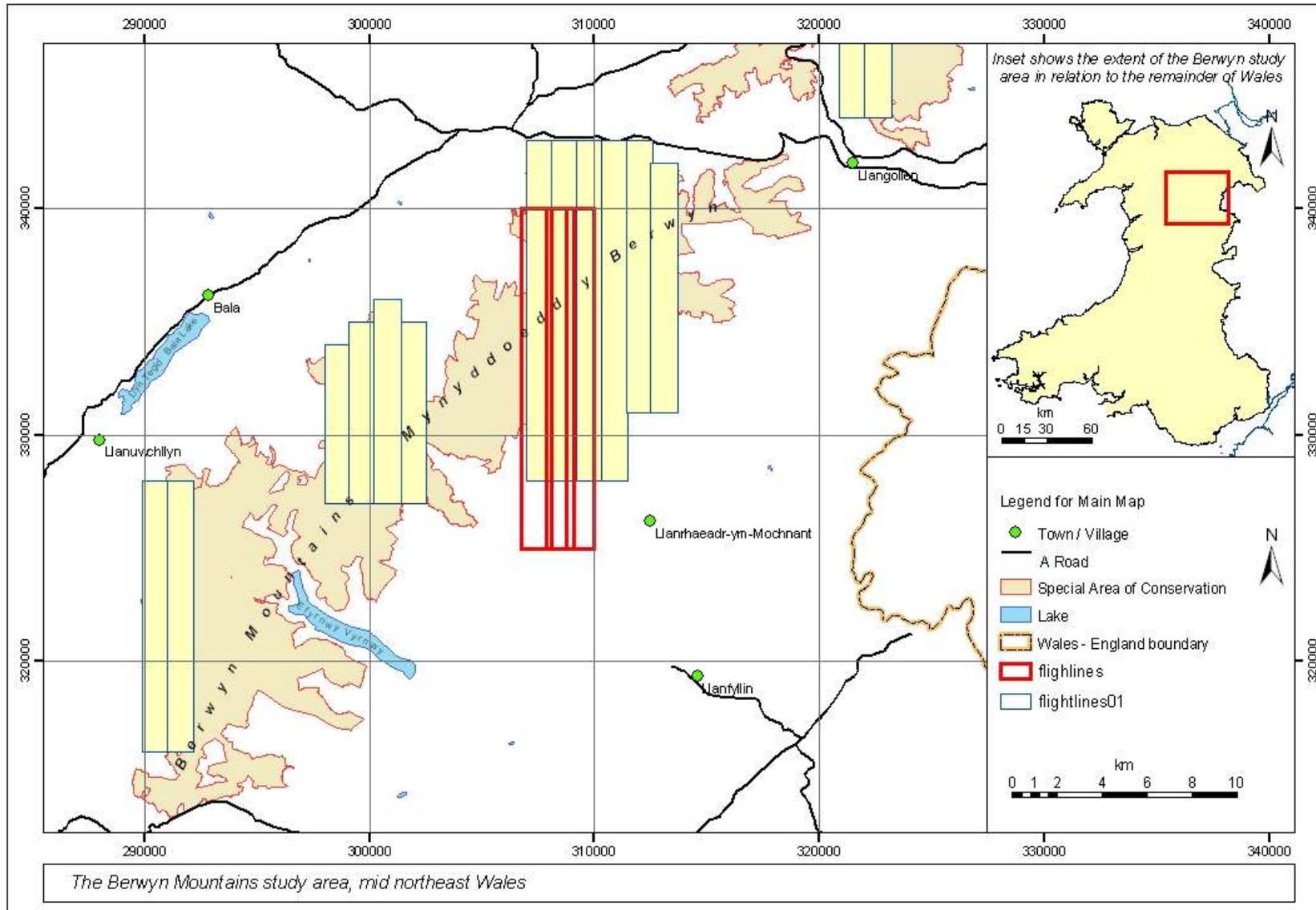
Airborne
Objectives

To evaluate the additional information provided by hyperspectral data that can be extracted to better characterise, discriminate and map species / communities associated with Level 4 vegetation types

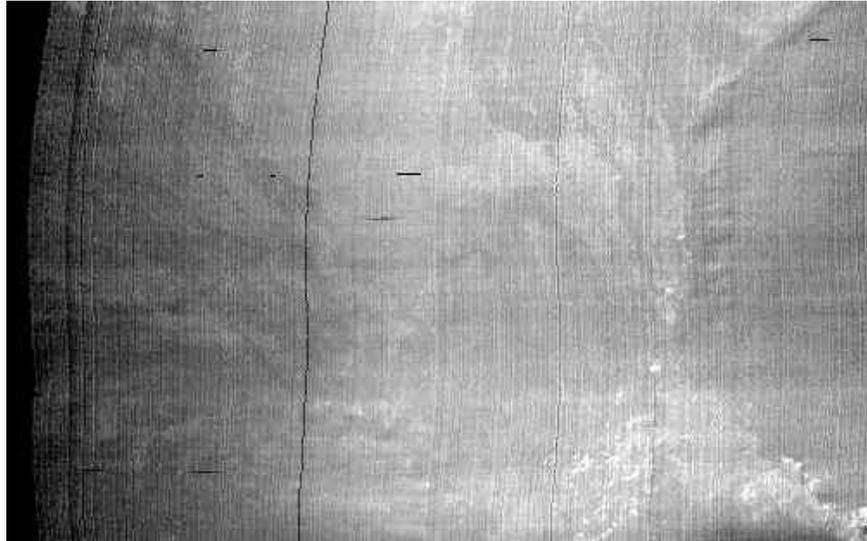
To identify whether observations in wavelength regions narrower than or different from those employed by current spaceborne optical sensors can provide better discrimination of upland species / communities

To quantitatively compare the level of information that can be extracted from sensors observing at different spatial resolutions (and also times of the year) and to evaluate techniques for extraction of sub-pixel features

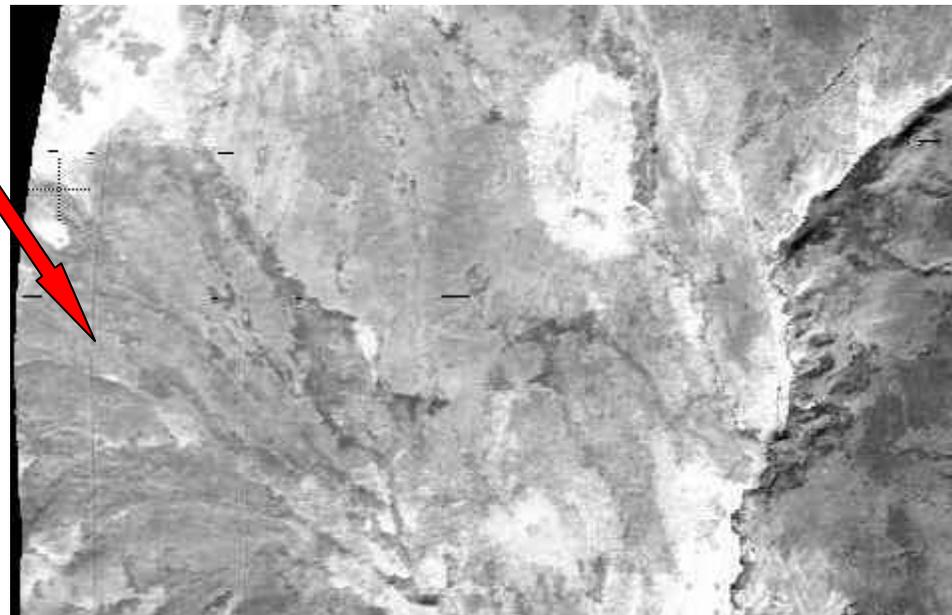
Airborne Objectives



Airborne - Problems SWIR

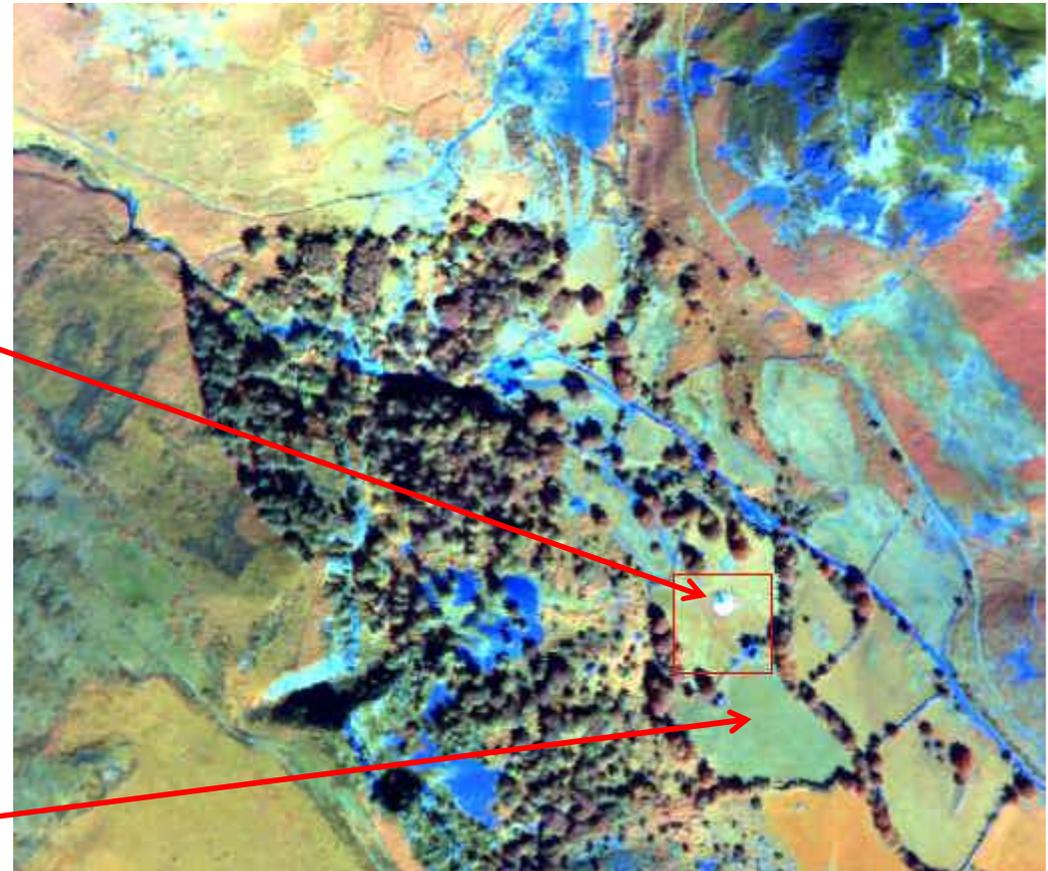
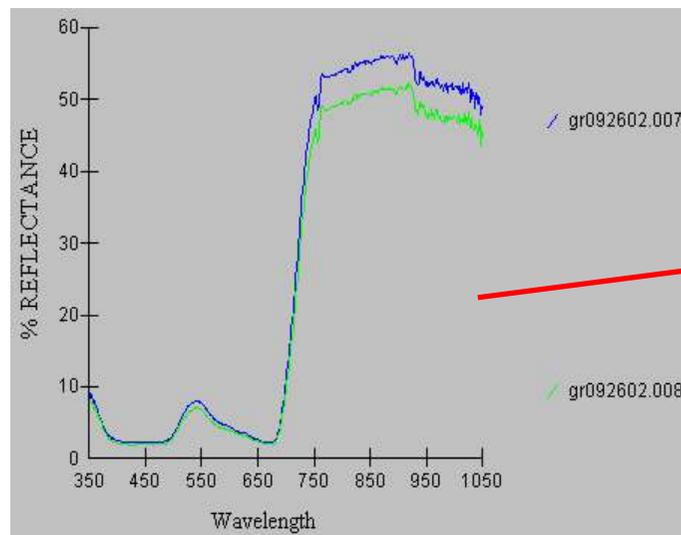
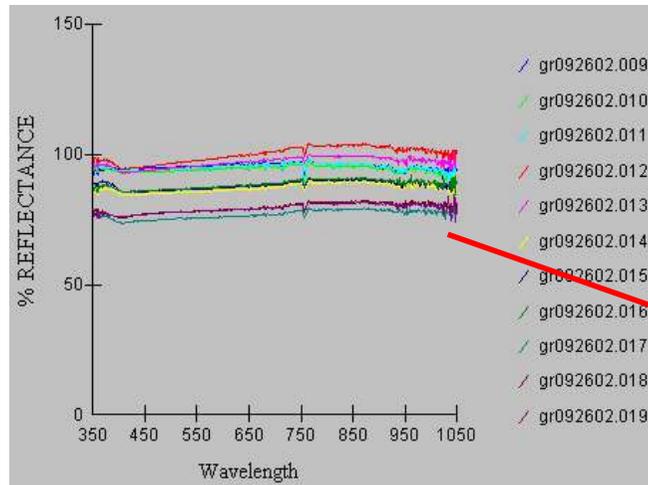


Band 94



Band 1

Airborne Ground calibration

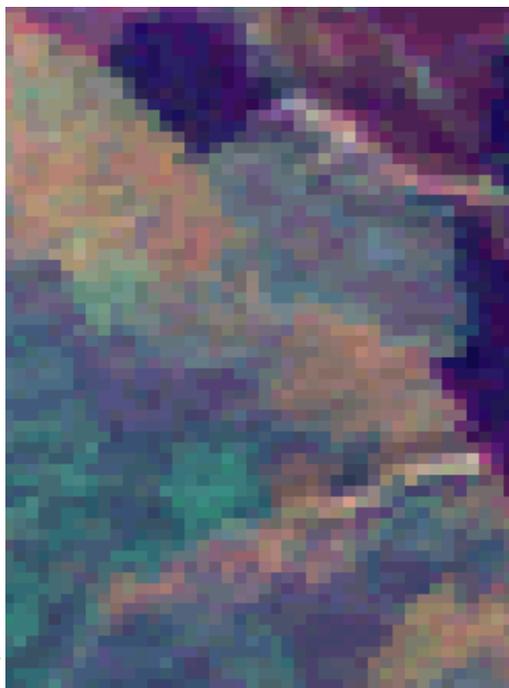


GER 1500
spectroradiometer
fitted with a fibre
optic and cosine
sensor

Airborne - CASI

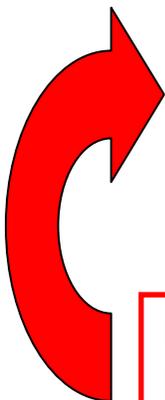
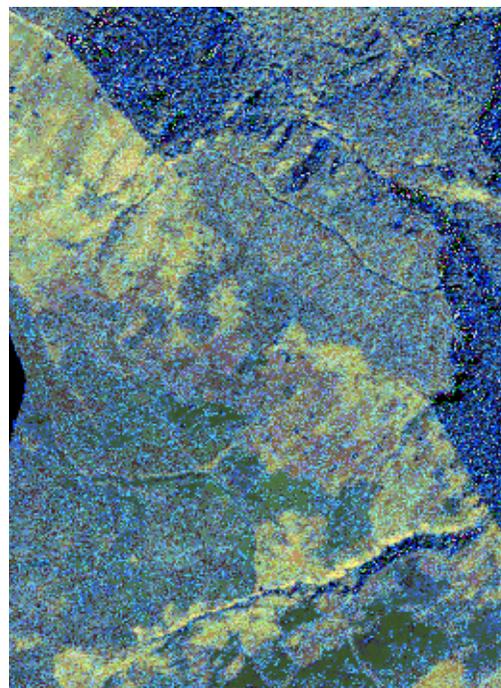
Landsat ETM+
image
(30 m spatial
resolution),

Berwyn
Mountains
(2nd Sep '02)



CASI image
(1.8 m spatial
resolution),

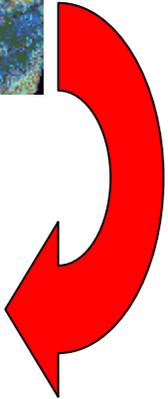
Berwyn
Mountains
(11th Sep '02)



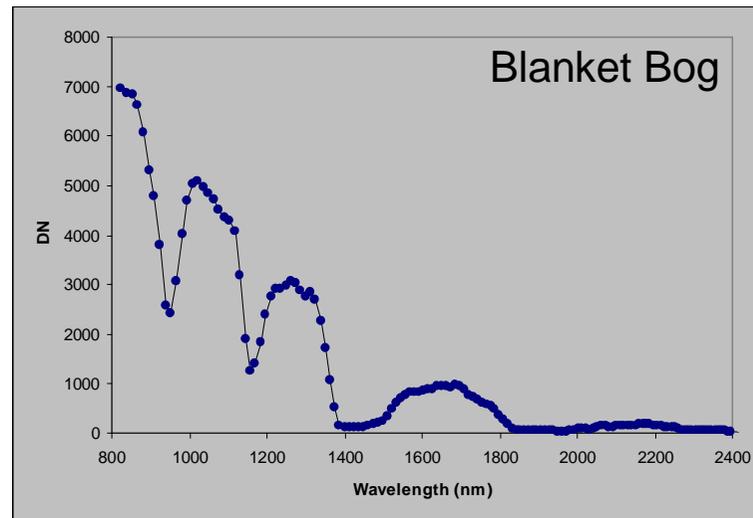
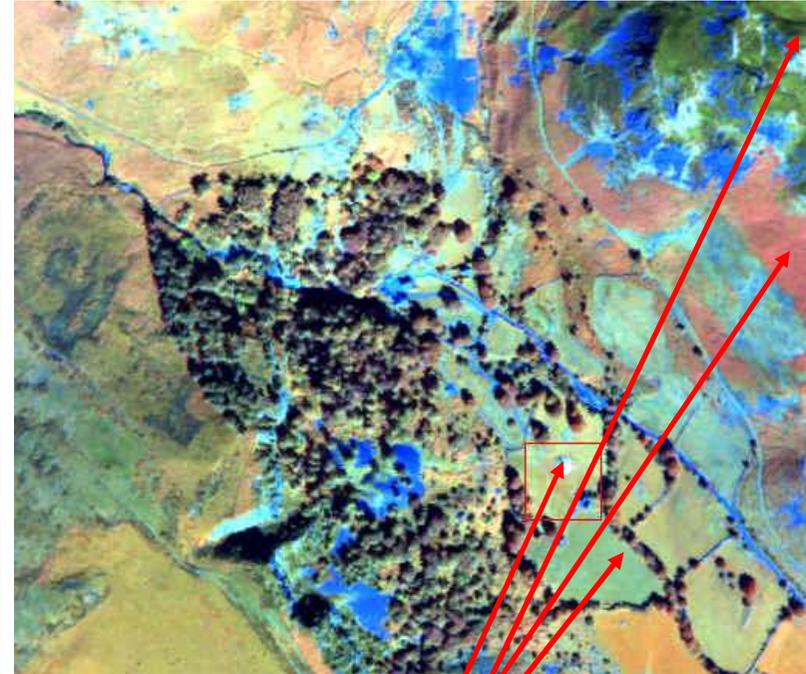
Feed into Decision
Based Rules



Spectral info.

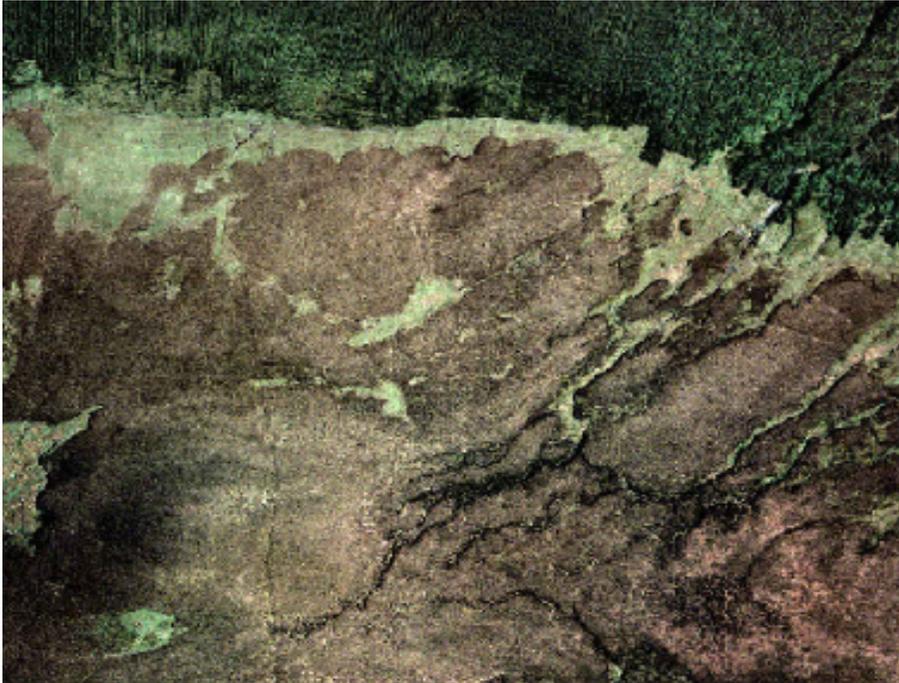


Airborne

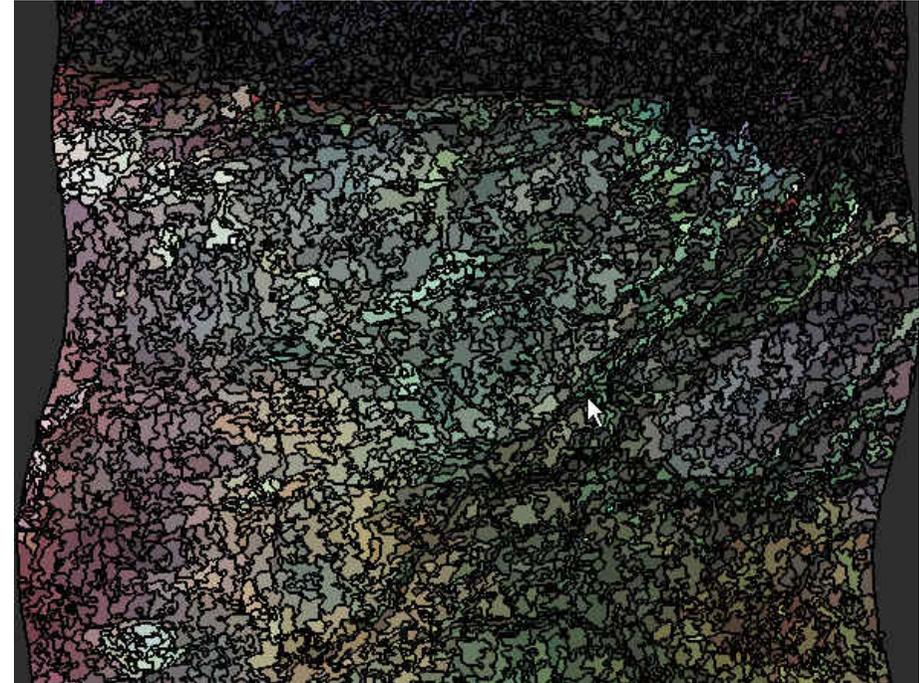


Airborne - CASI: Blanket bogs

Segmentation



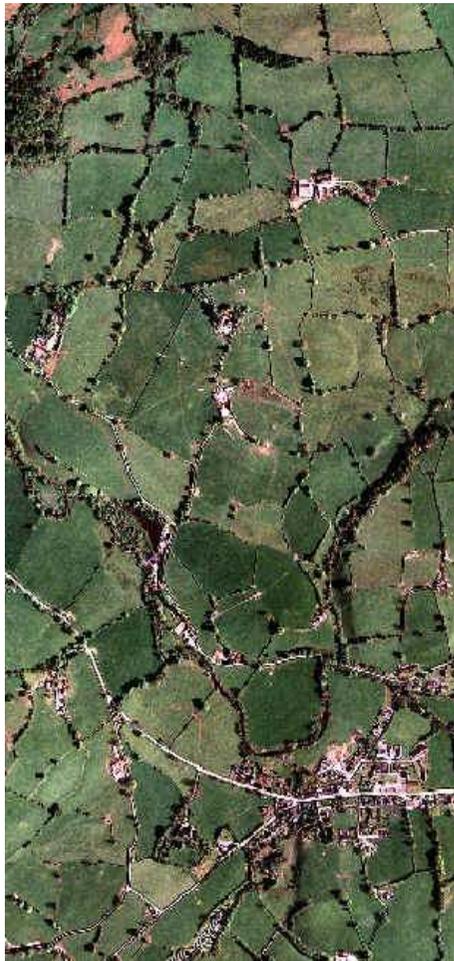
Aerial Photography
(GetMapping)



CASI image
Berwyn Mountains (11th September, 2002)

Airborne

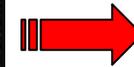
CASI: NDVI for differentiating improved, semi and unimproved grasslands



Aerial Photography
(GetMapping)



CASI image - NDVI
Berwyn Mountains (11th September, 2002)



Segmentation

Concluding Remarks

- The acquisition of these datasets provides a unique opportunity to evaluate the varying dimensions (spatial, spectral and temporal) of optical / hyperspectral and also radar remote sensing data for discriminating, characterising and mapping vegetation communities and land covers and assessing landscape dynamics
- Integration of these datasets is anticipated to lead to a better understanding of the benefits of using remotely sensed data of a spatial and spectral resolution finer than most current spaceborne sensors
- The levels of information contained within the respective datasets are also likely to be better understood, thereby assisting CCW to assess the future use of these data for ecological monitoring and associated requirements

