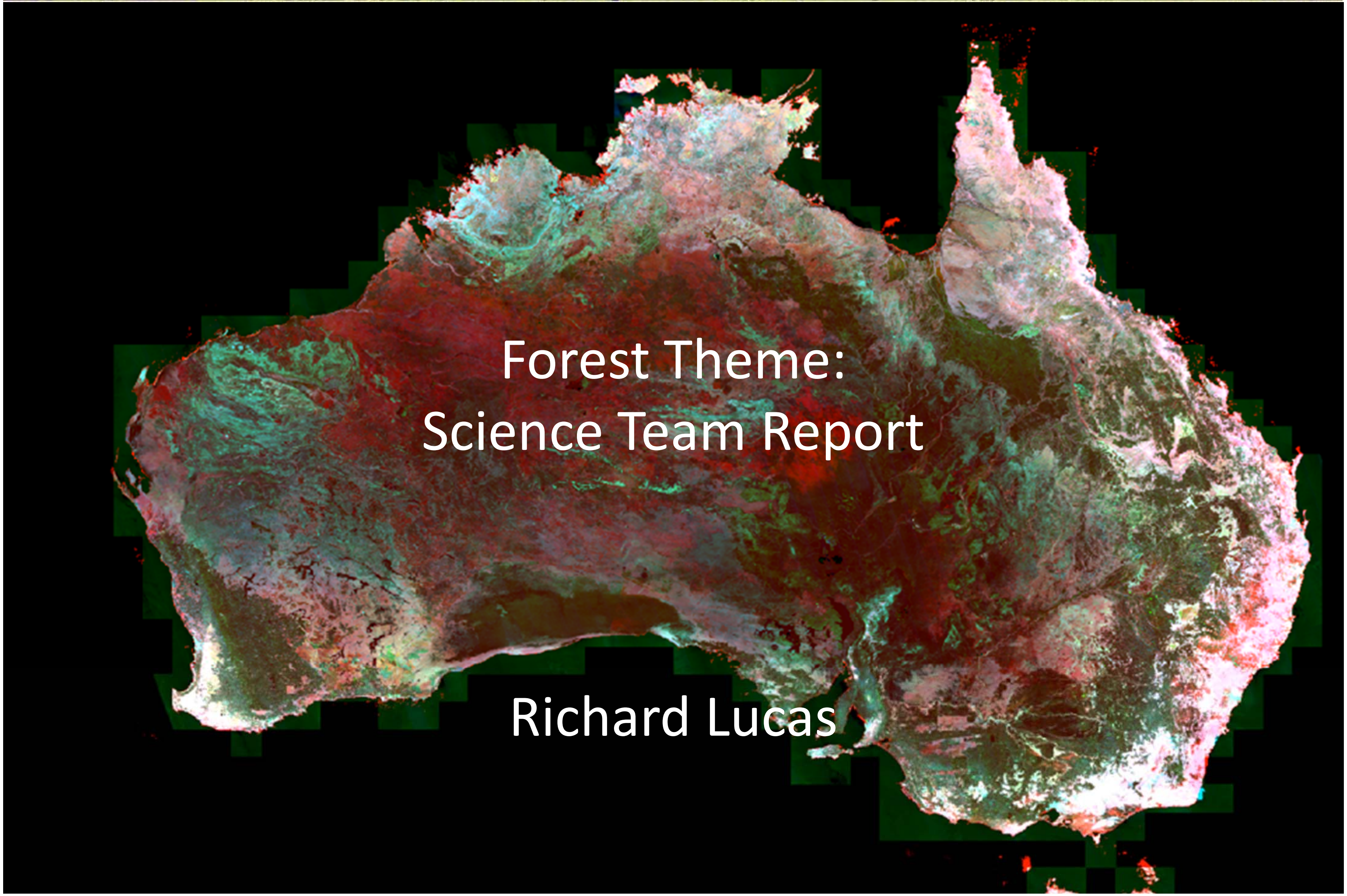
ALOS

K&C Initiative
An international science collaboration led by JAXA

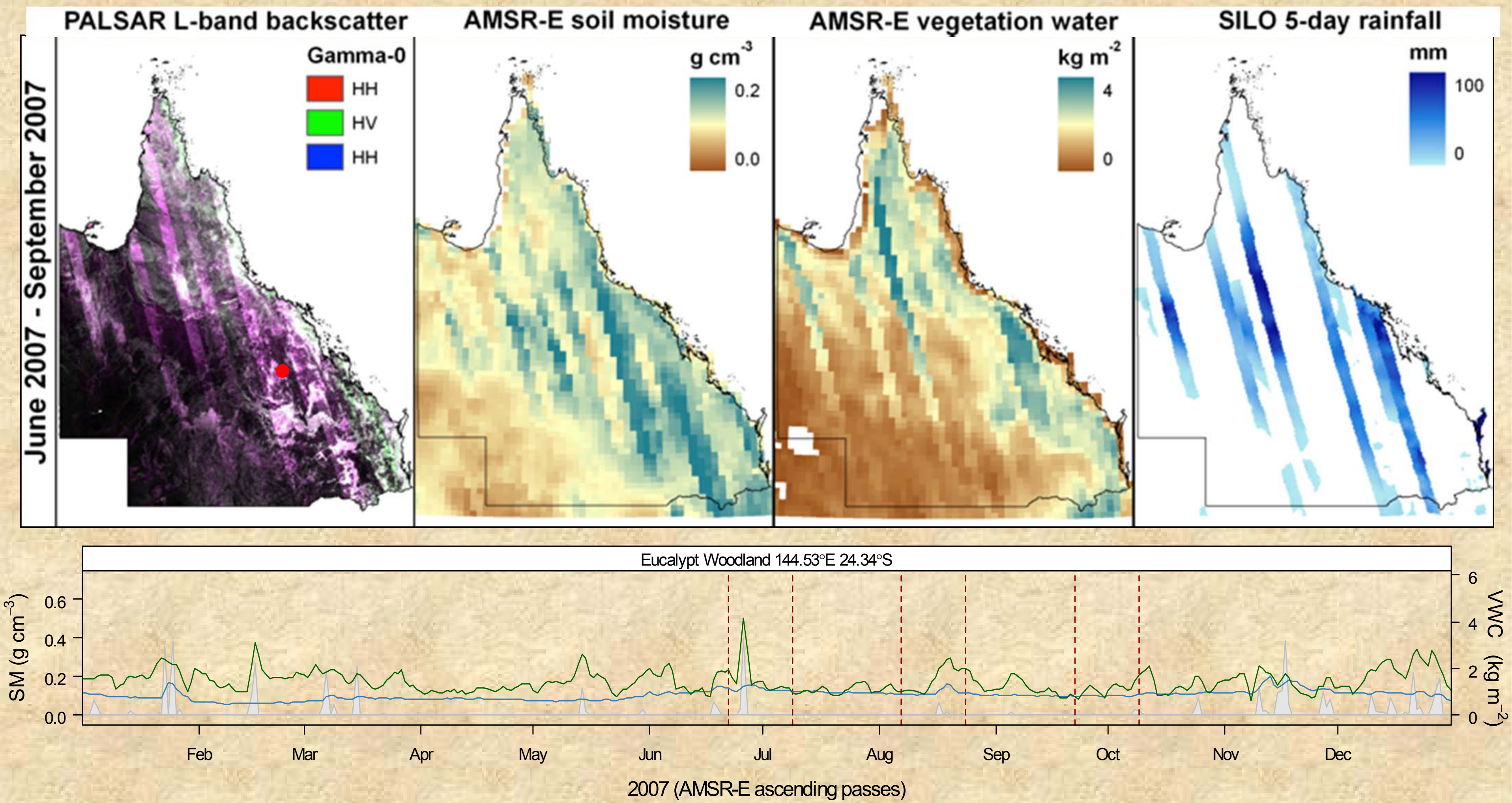


Forest Theme: Science Team Report

Richard Lucas

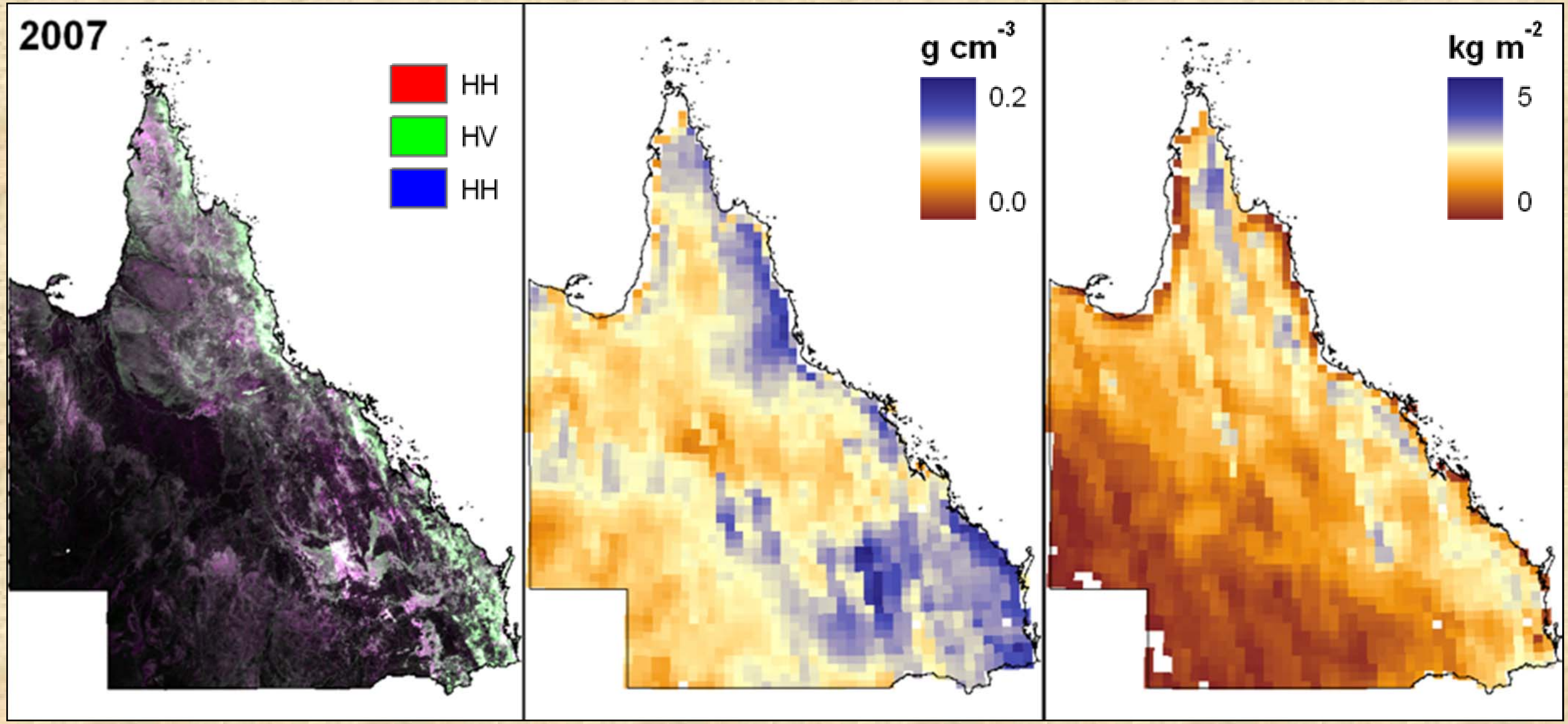
JAXA's Kyoto and Carbon (K&C) Initiative

Supporting development of regional mapping of forests and change
(Bur first understanding impacts of surface moisture)



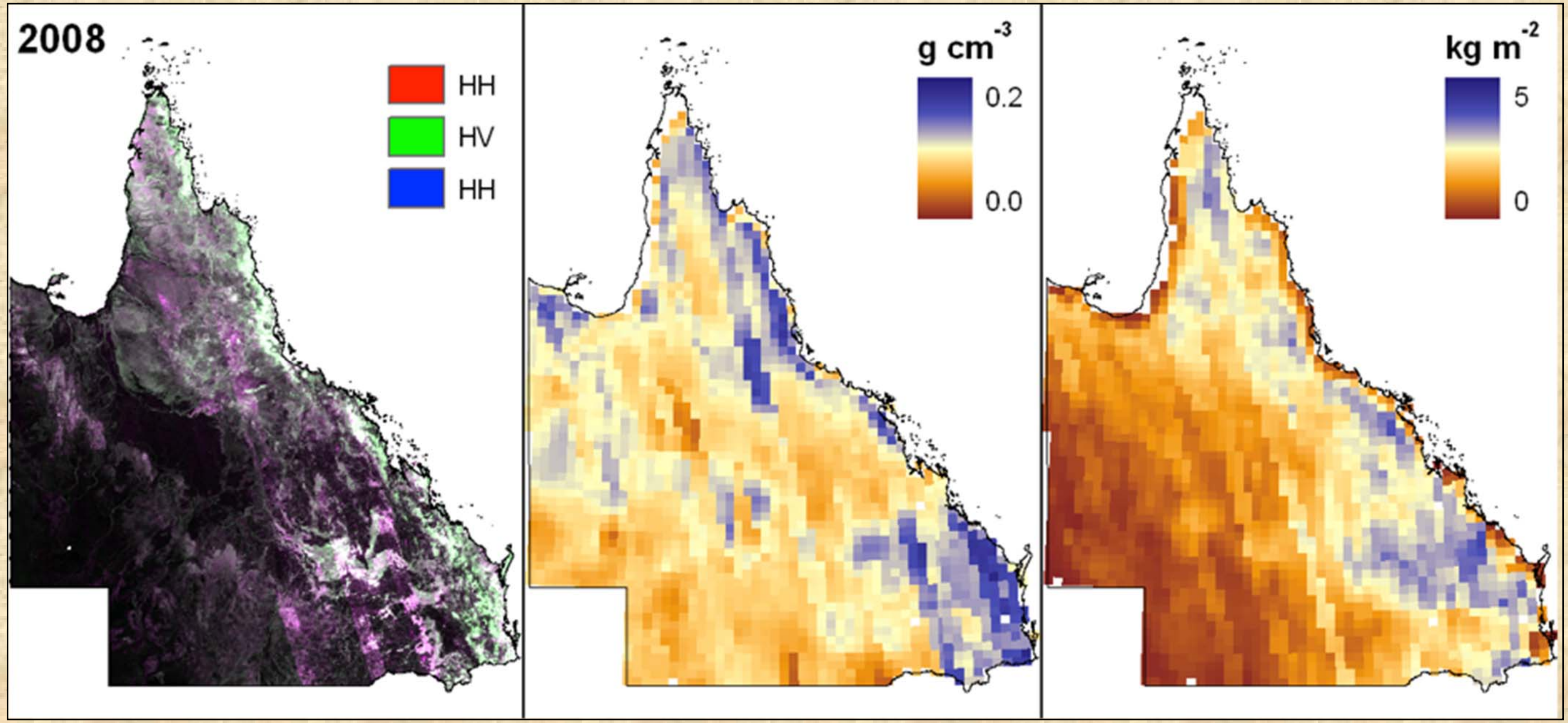
Generation of image mosaics

- Annual mosaics from 2007 to 2009
    - Three acquisitions per year
    - Used strip dates captured under driest conditions



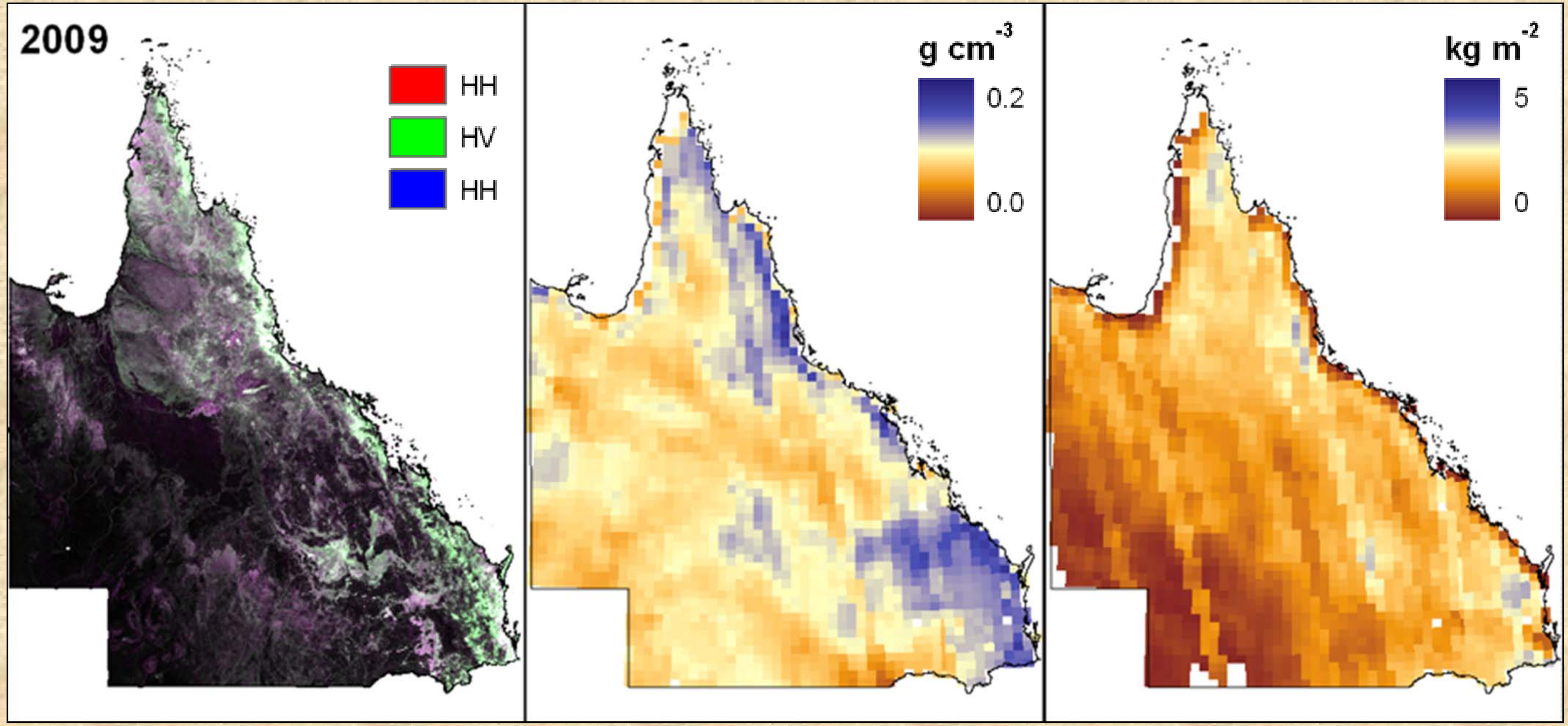
Generation of image mosaics

- Annual mosaics from 2007 to 2009
  - Three acquisitions per year
  - Used strip dates captured under driest conditions



Generation of image mosaics

- Annual mosaics from 2007 to 2009
  - Used strip dates captured under driest conditions
  - Mosaic for 2010 compromised by wet conditions



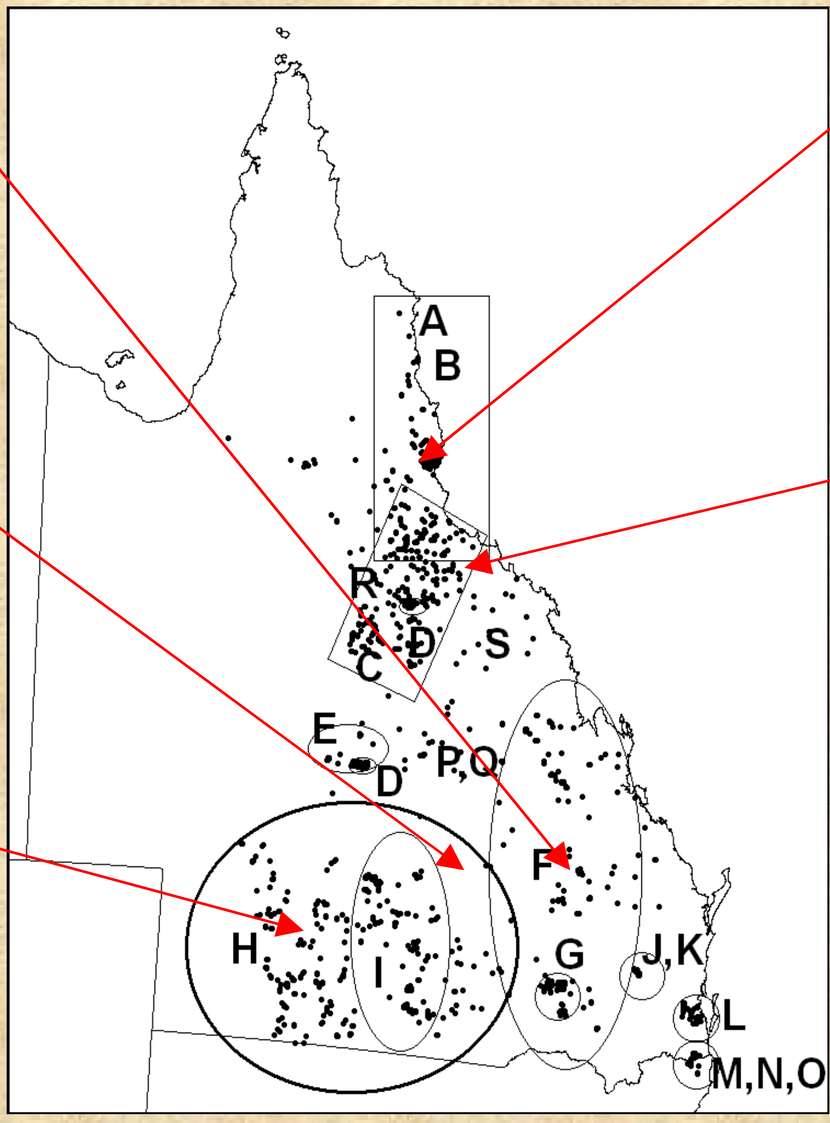
Ground truth data for estimating AGB

Brigalow Forest Regrowth

Open Callitris Forest

Low Acacia Woodland

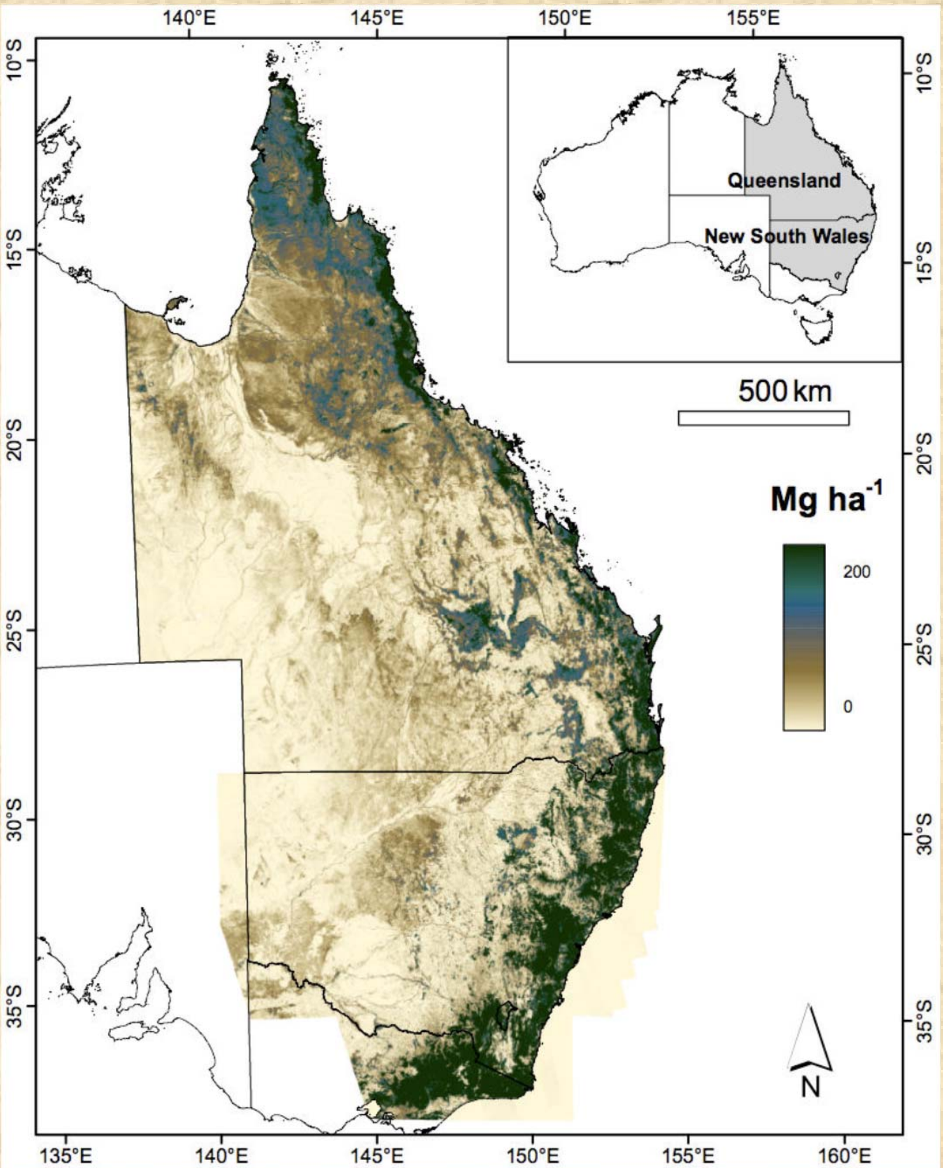
Biomass library - 1139 sites (2781 plots)



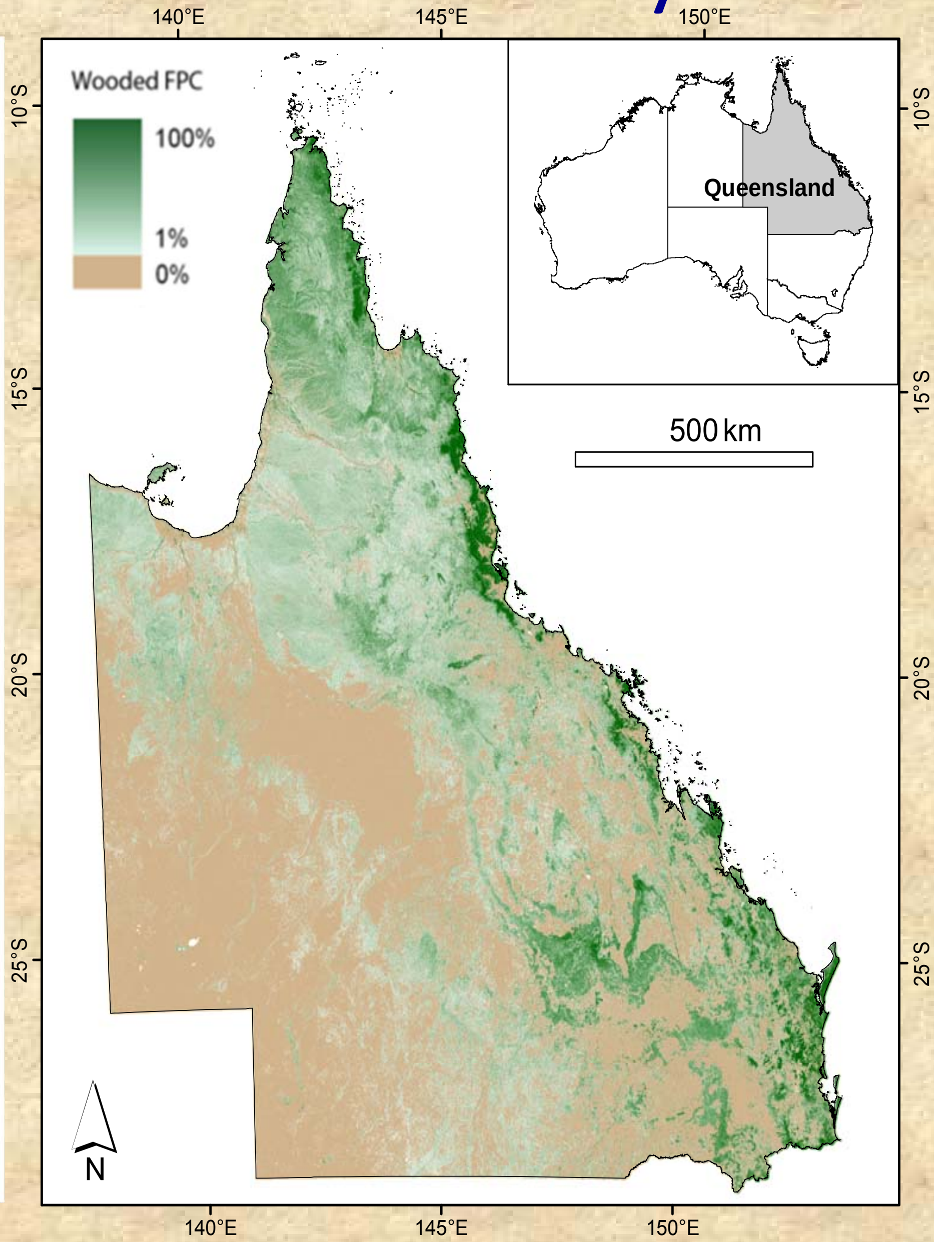
Tall Closed Rainforest

Eucalypt Woodland

Retrieval of AGB – ALOS PALSAR and beyond



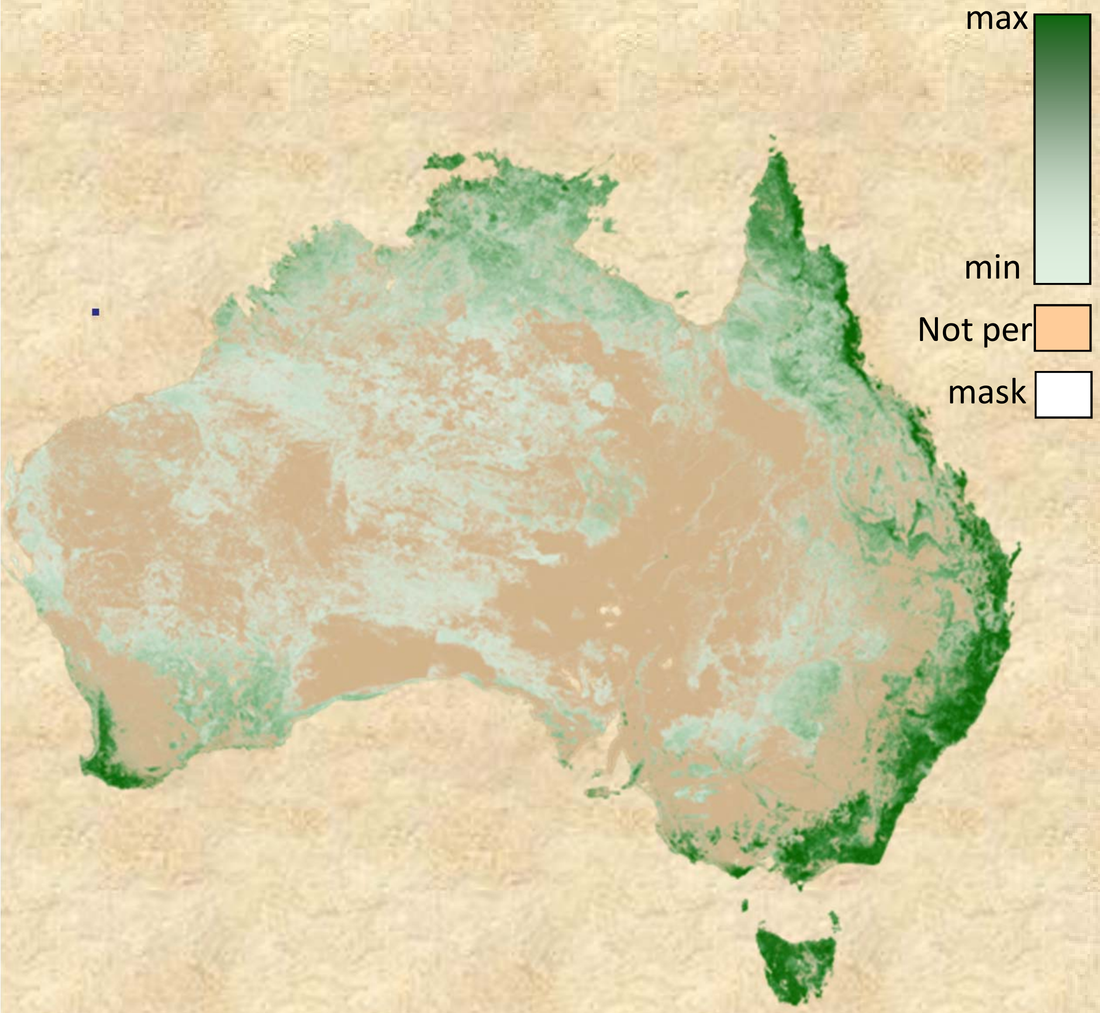
Above Ground Biomass, 50 m, 2009 (dry mosaic)

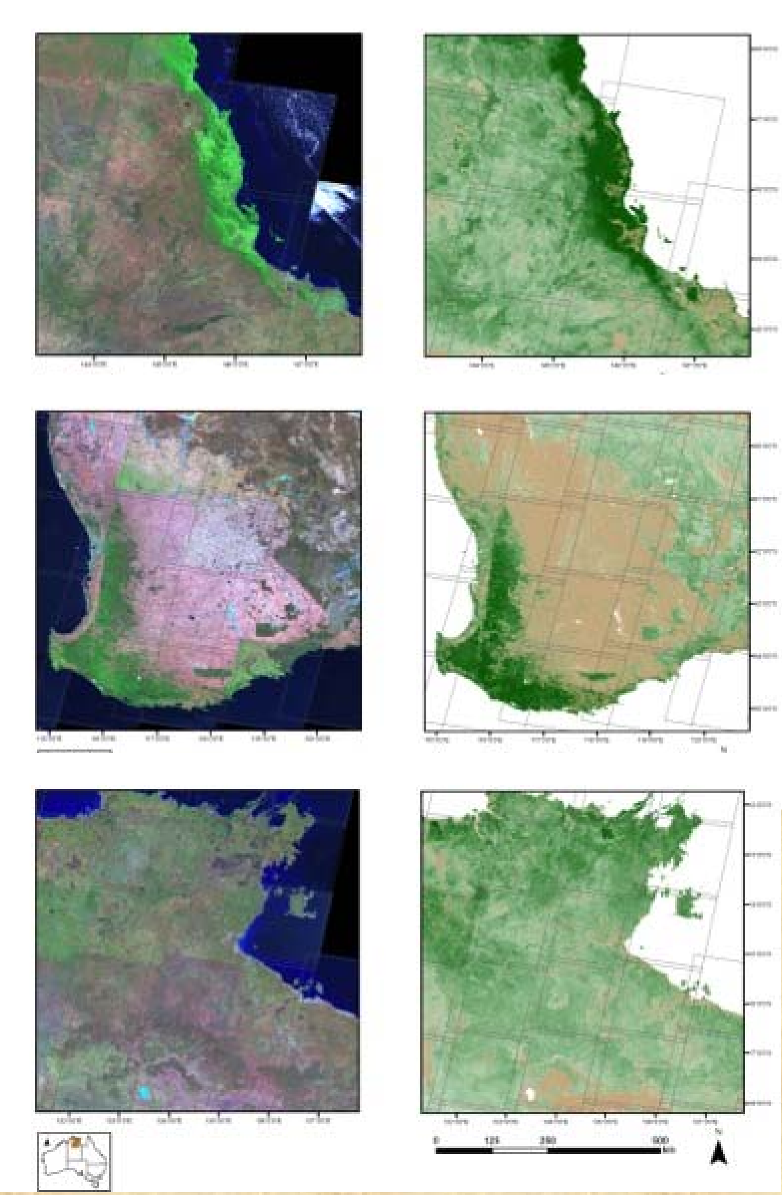


Landsat-derived FPC (25 m)

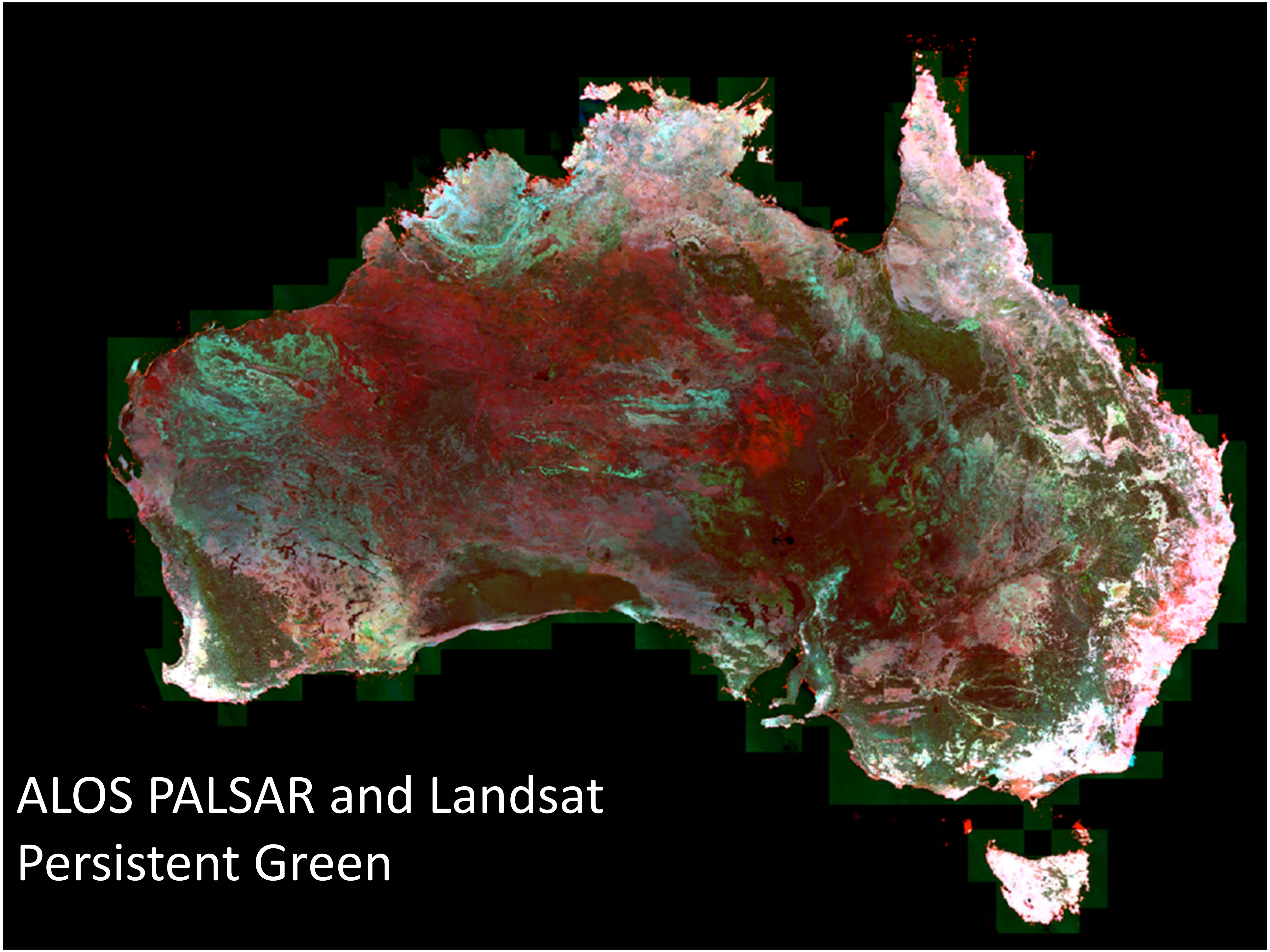
Persistent Green Fraction, Australia

Landsat-derived

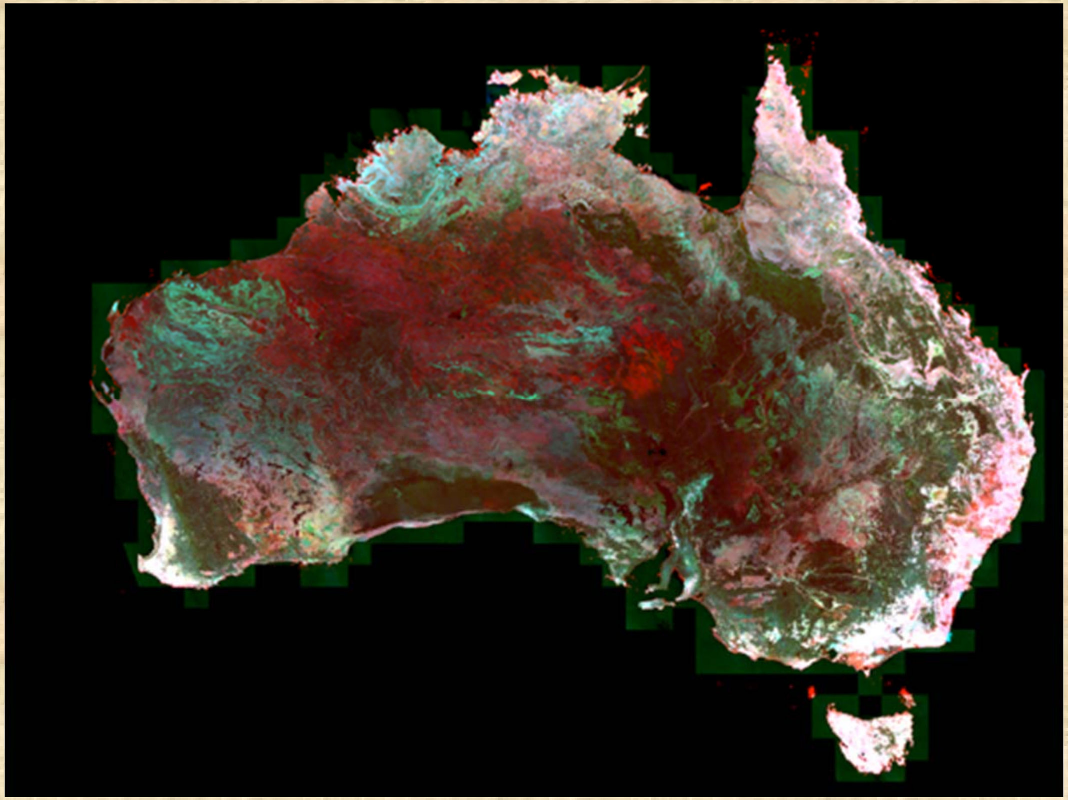


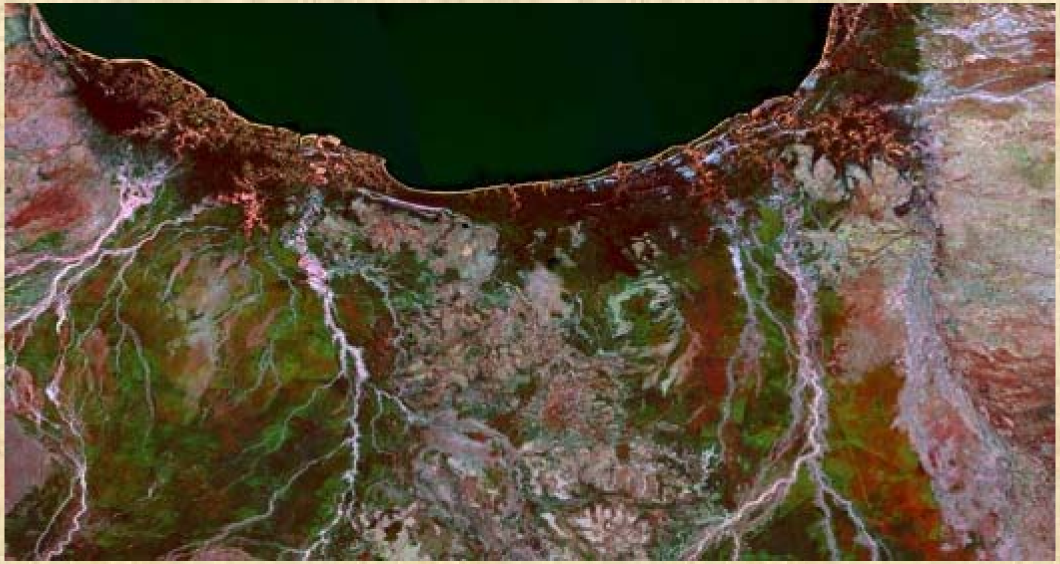


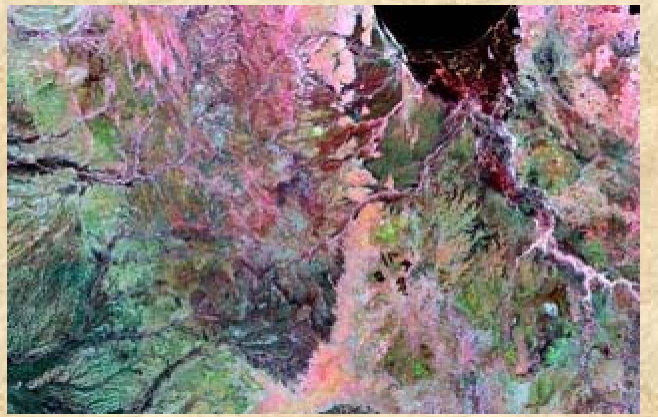
Landsat - spectral visible,
near infrared and shortwave infrared data

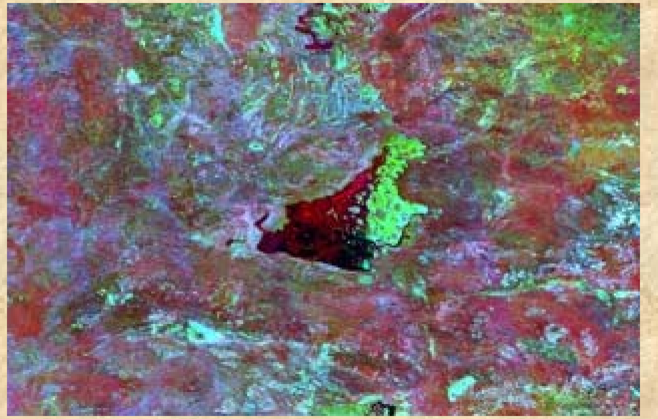

ALOS PALSAR and Landsat
Persistent Green

Potential for Ecosystem Classification



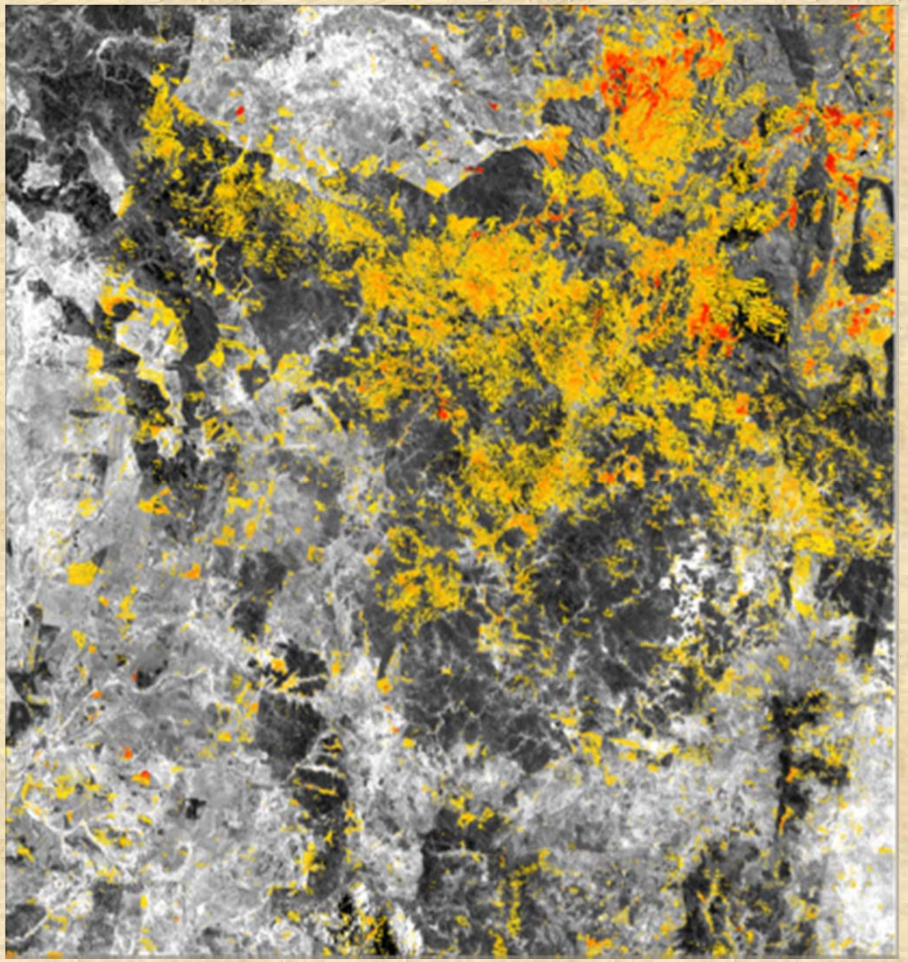






History of Natural Events

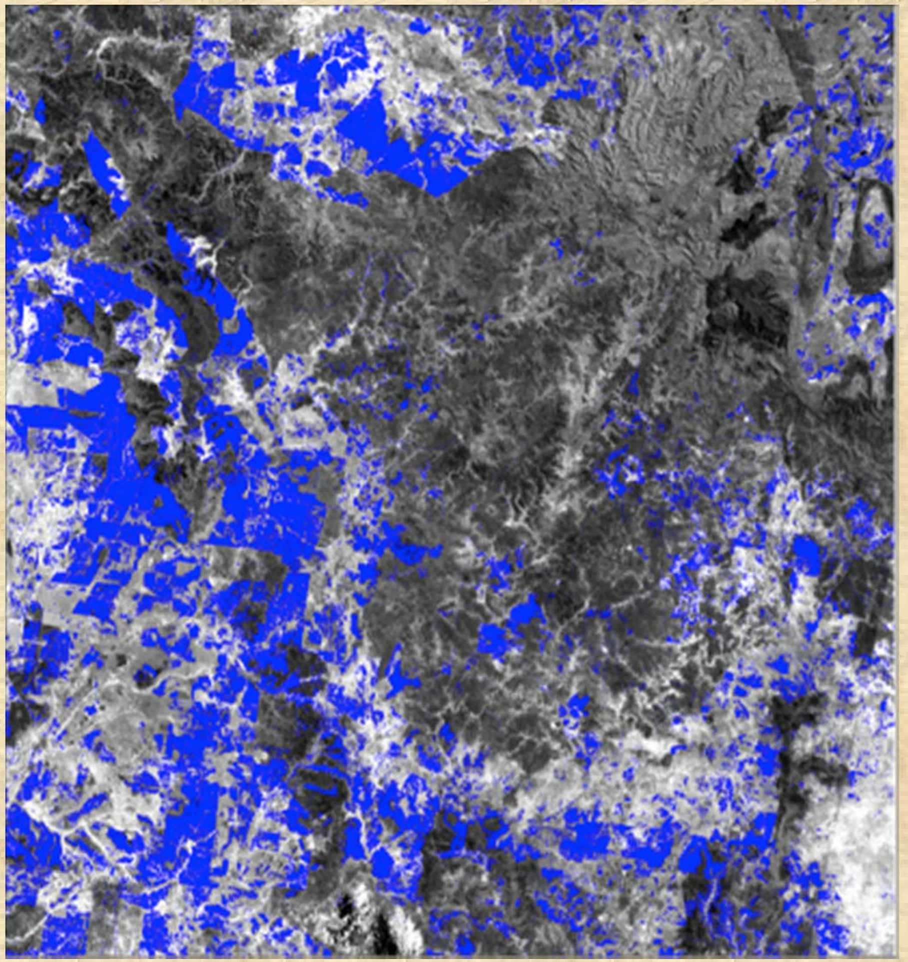
Landsat FPC and ALOS PALSAR L-band HH and HV (RGB)



Fire history (past 30 years) from Landsat time-series

History of Land Use

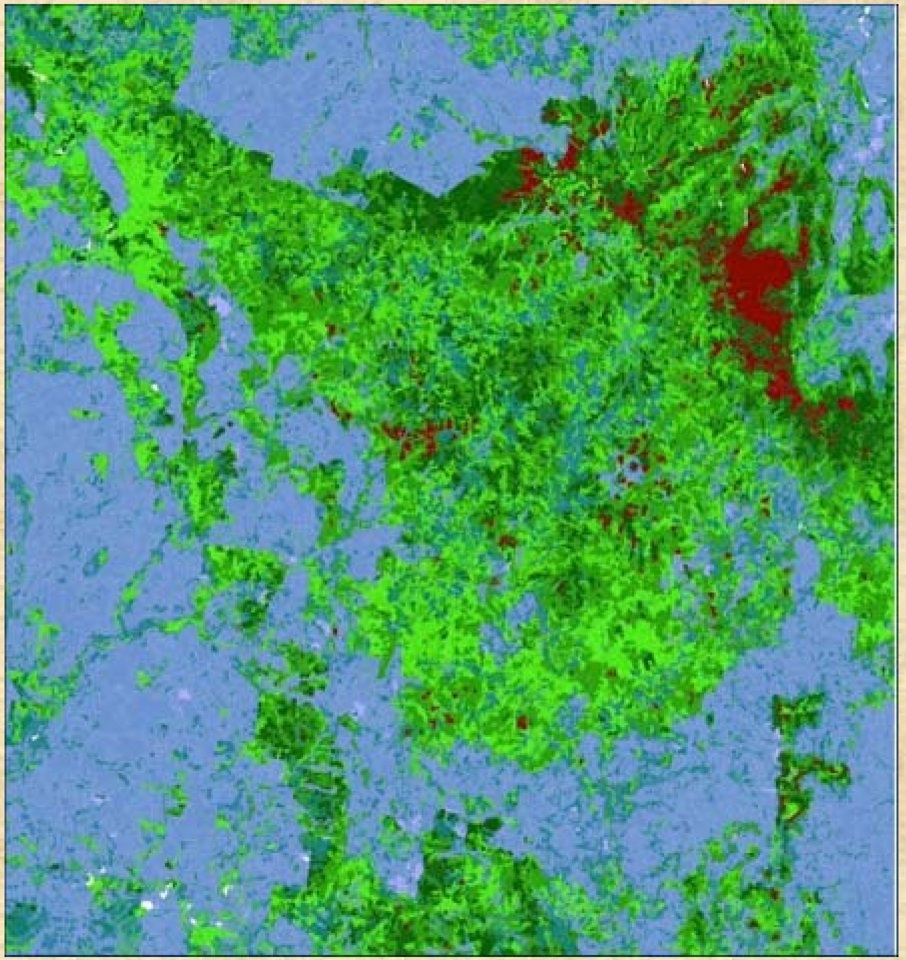
Landsat FPC and ALOS PALSAR L-band HH and HV (RGB)



Clearance history (past 30 years) from Landsat time-series

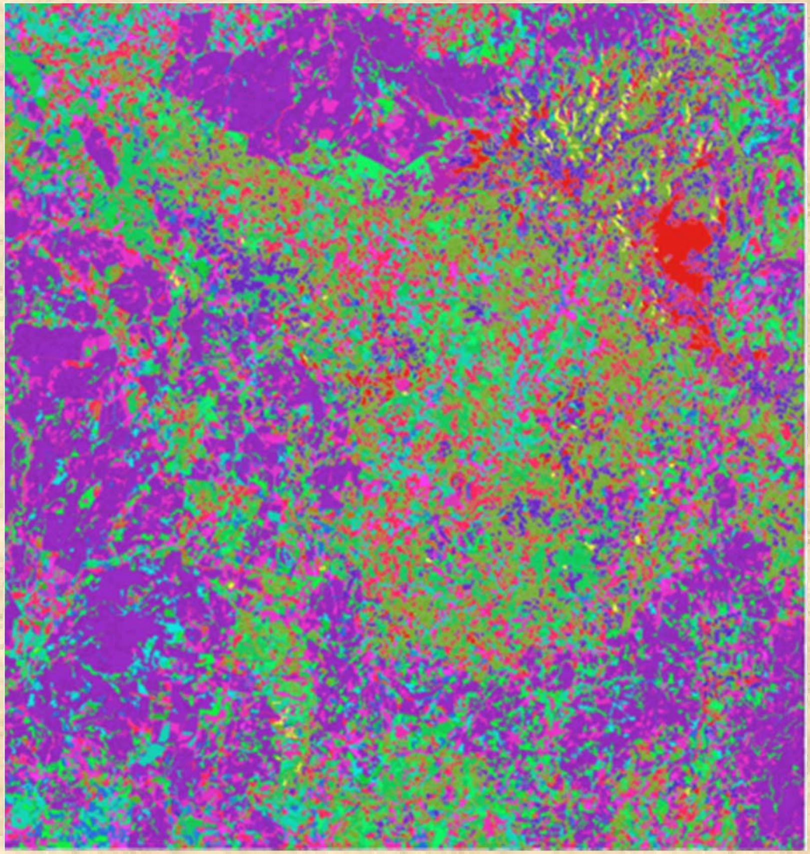
Forest Structure

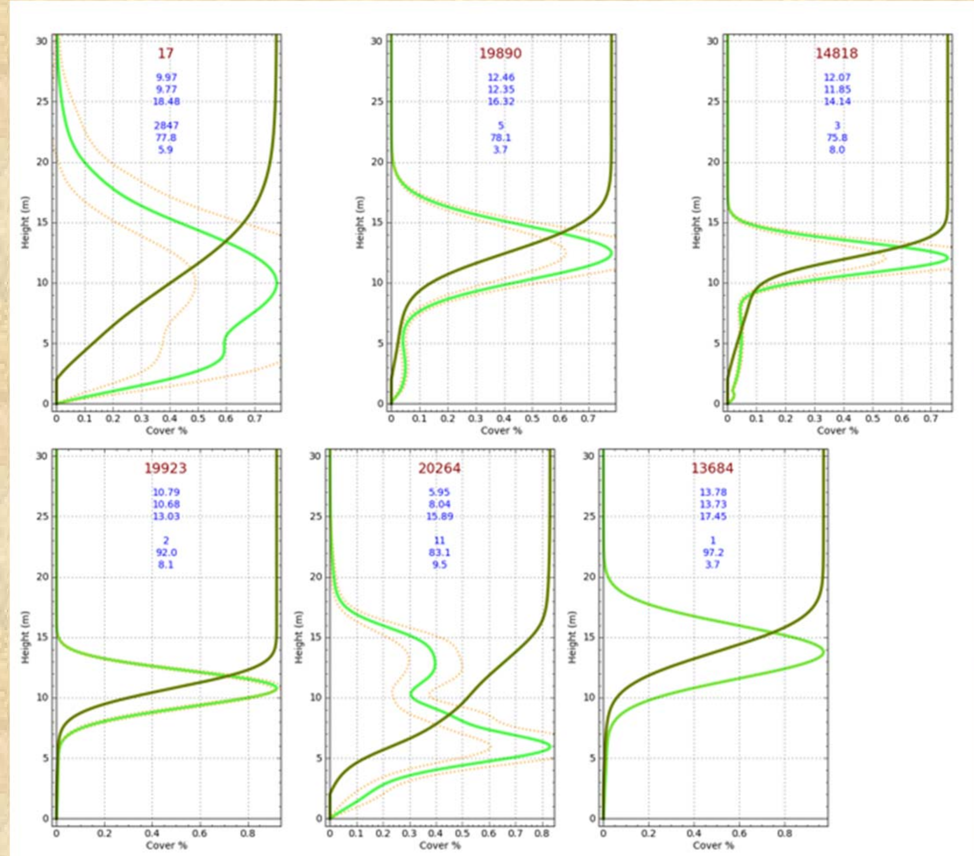
ICESat GLAS/
Segmentation of L-band and
Landsat FPC



Forest Stand Height

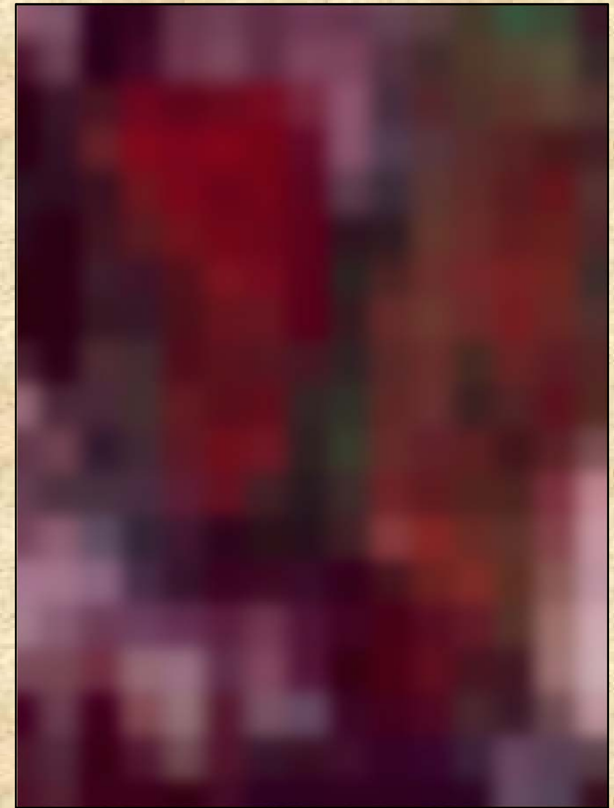
Structural Classification based on Landsat FPC, ALOS PALSAR L-band HH and HV and ICESat.





- Segmentation based on FPC and L-band HH/HV (40 classes)
- Similar vertical vegetation profiles for each class (e.g., 17)

Composites of Landsat FPC, L-band HH and HV

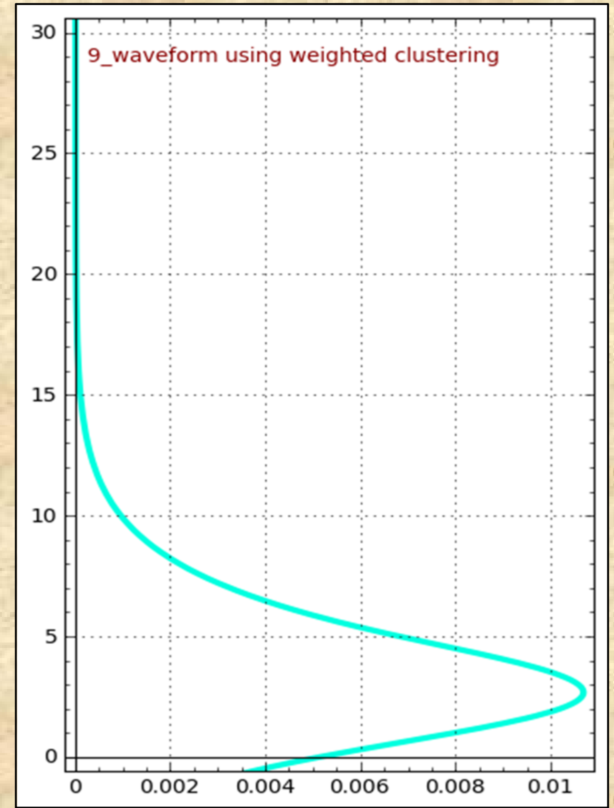


Early Regrowth

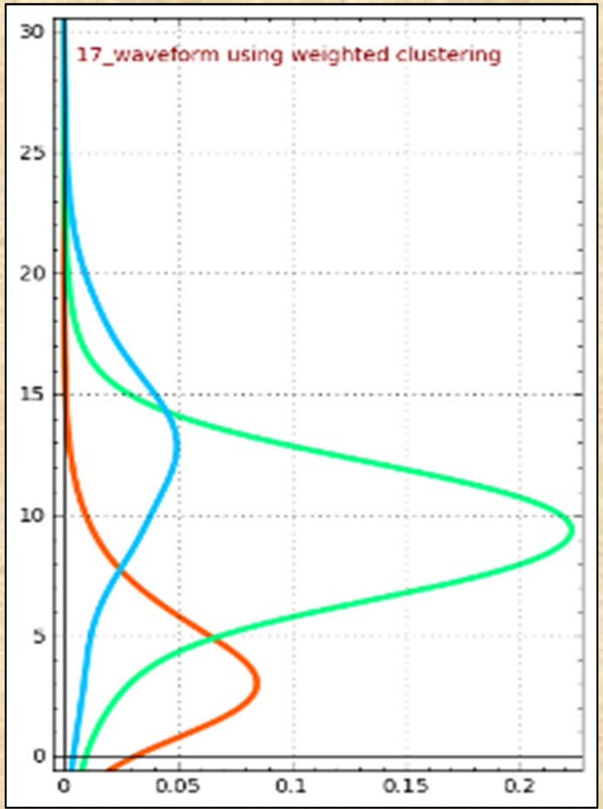
Recovery from fire

Mature pine

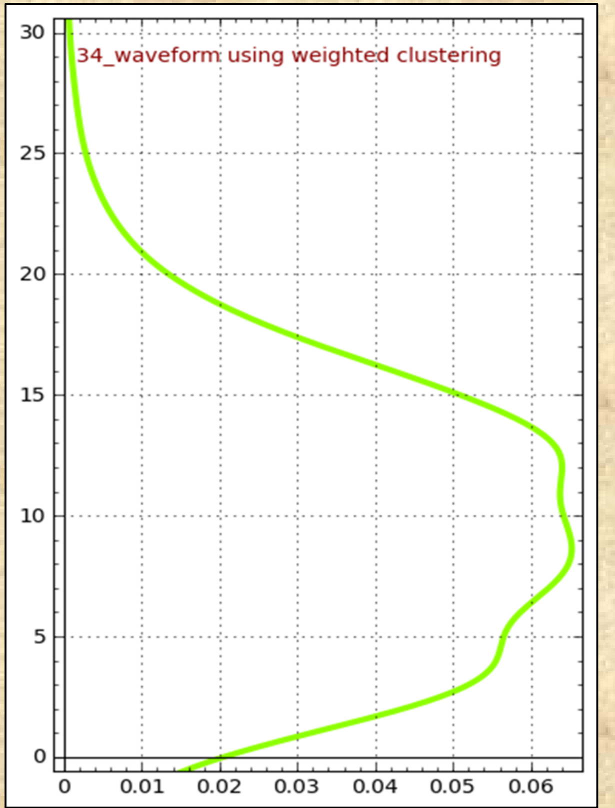
ICESAT Profiles, Injune



Early Regrowth

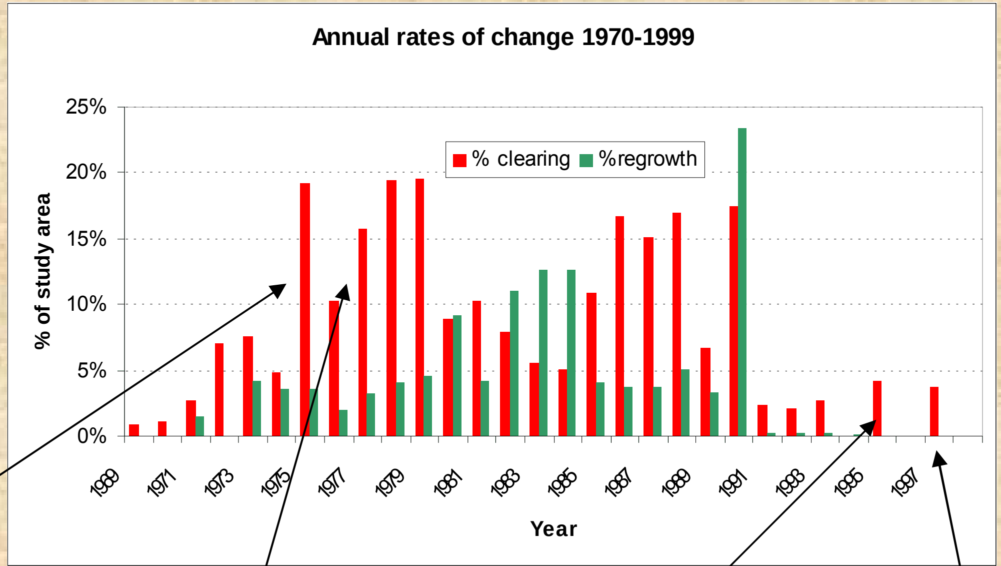


Recovery from fire



Mature pine

Assessing forest disturbance dynamics using Landsat time-series and LiDAR vertical profiles



Current state

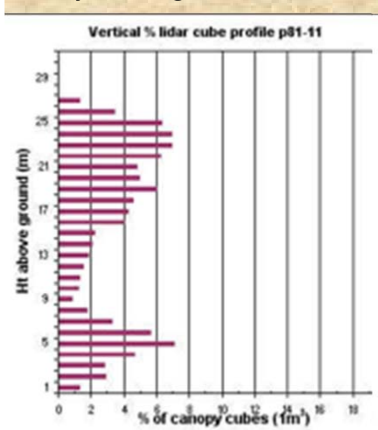
Only ever grazed

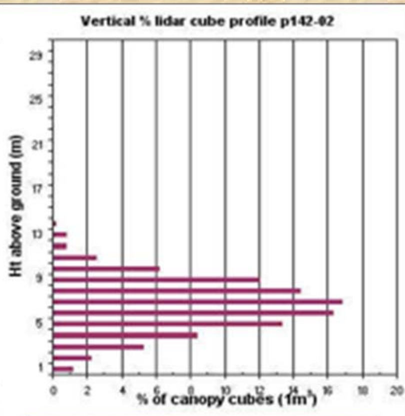
Chained 1970's

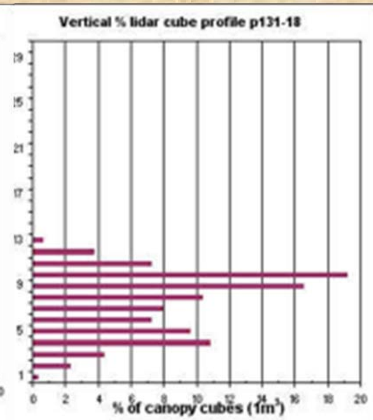
Stem Injected 1970's

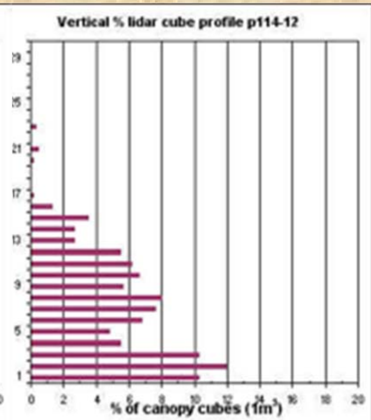
Logged 1995

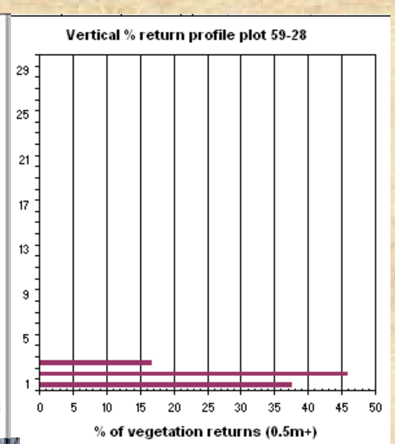
Chained 1997

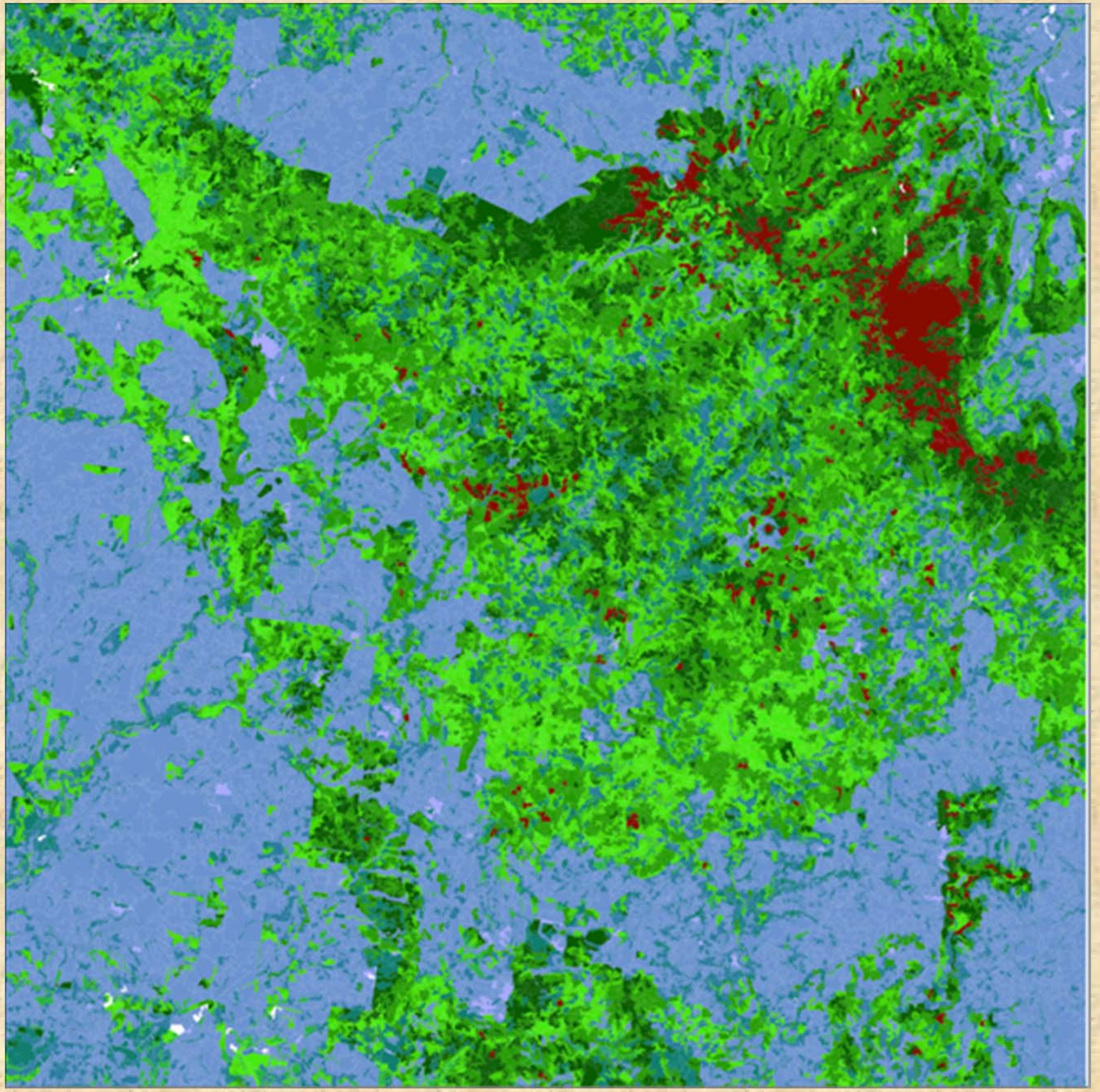




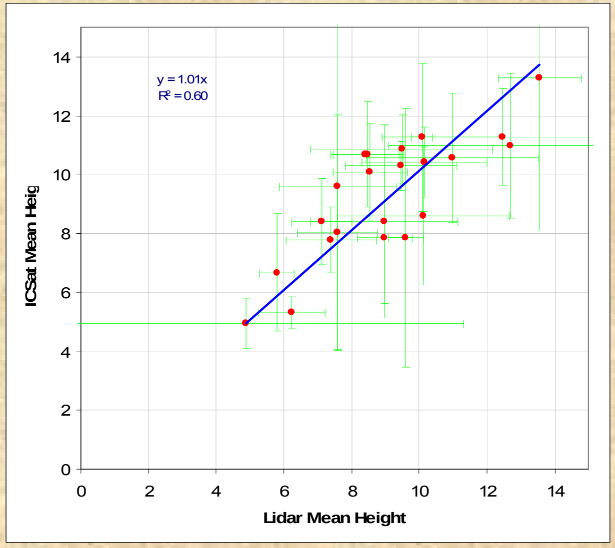




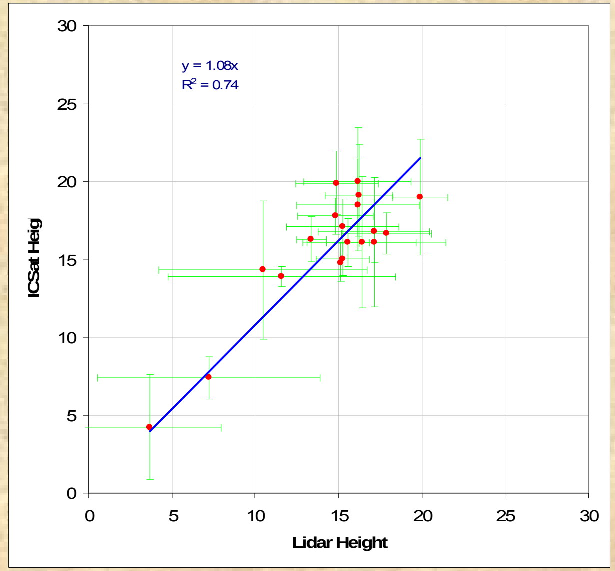




ICESat-derived height map

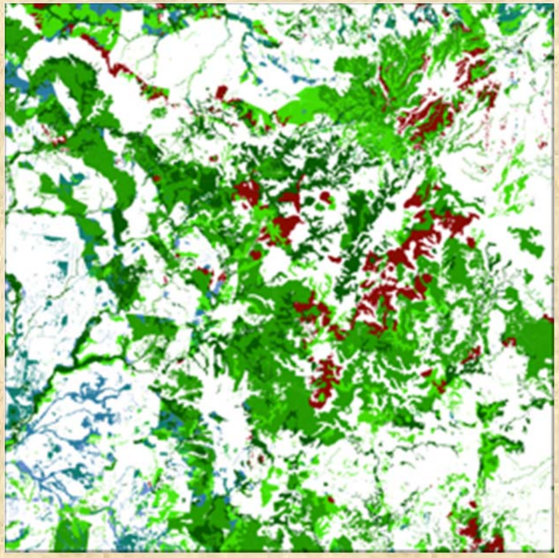


Comparison with ICESAT

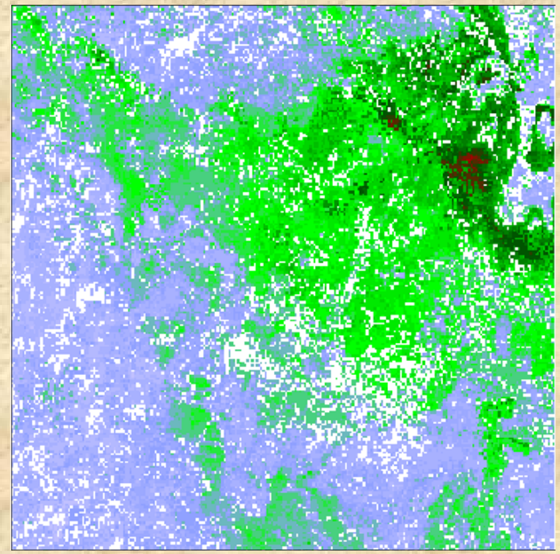


Comparison with airborne LiDAR

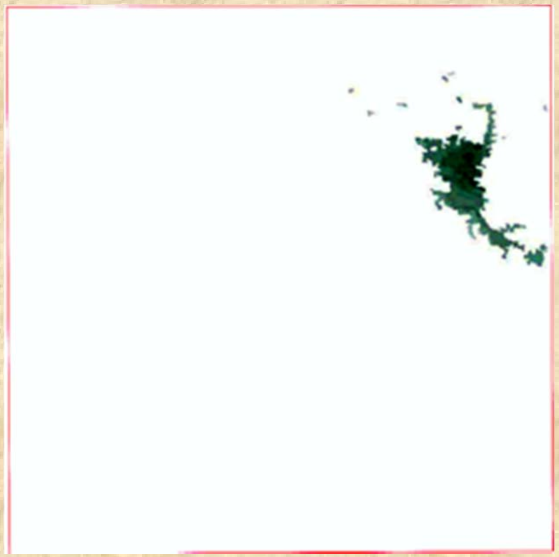
Comparison of ICESAT Height Products



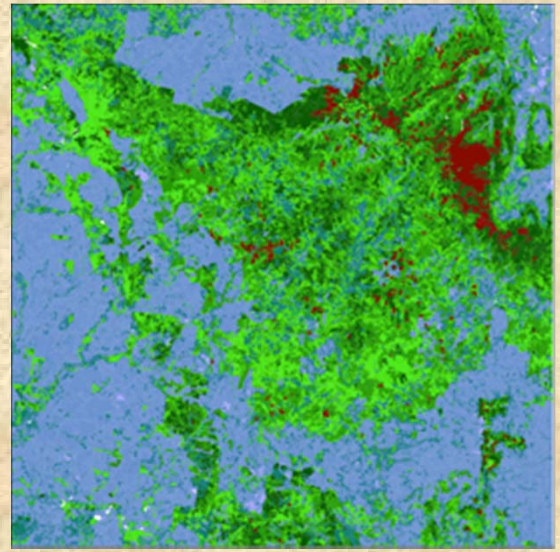
Based on Regional Ecosystems



Simard (2012)

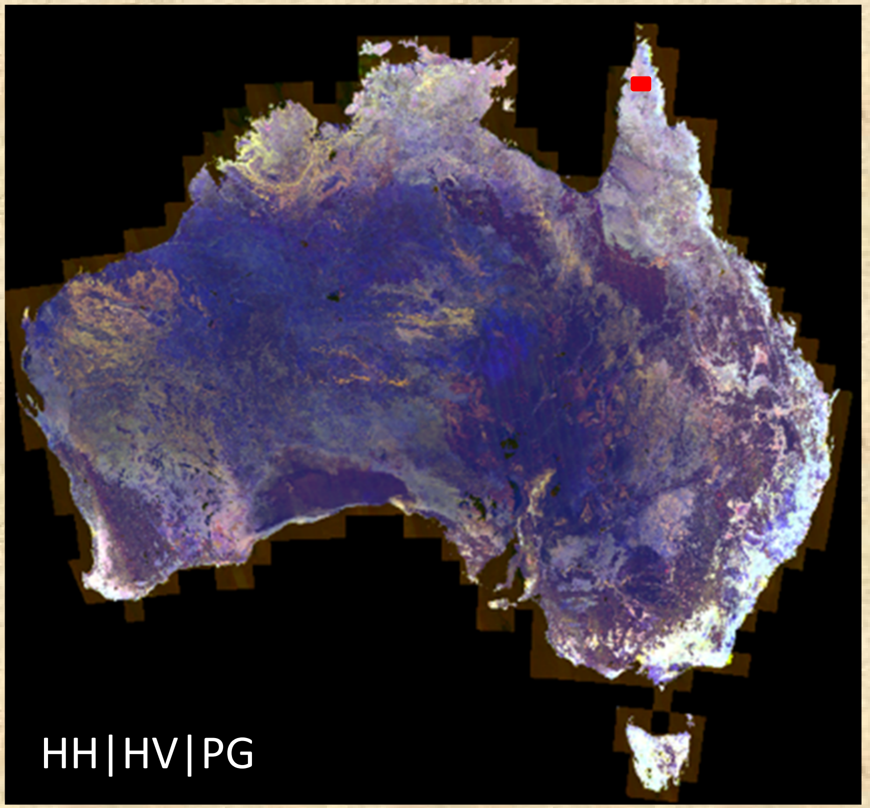


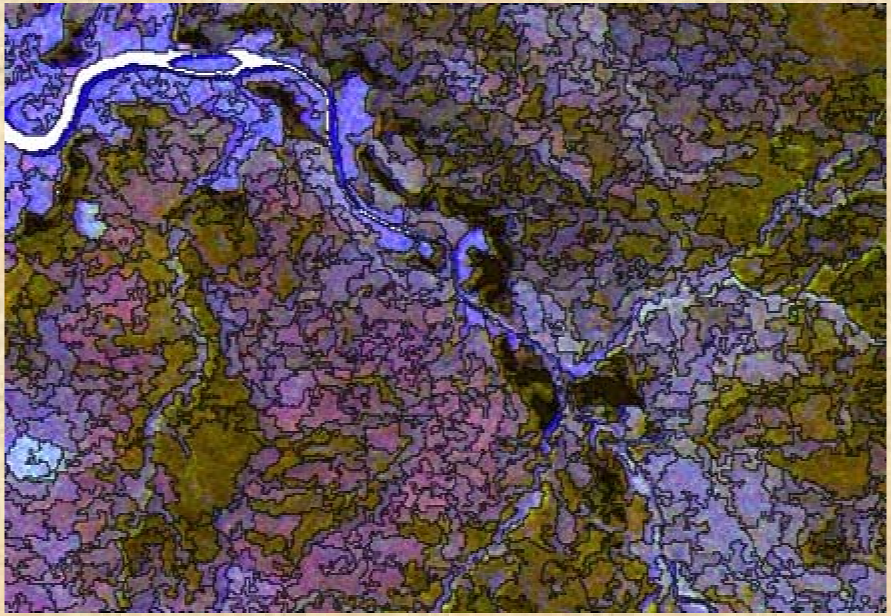
Lefsky et al. (2010)



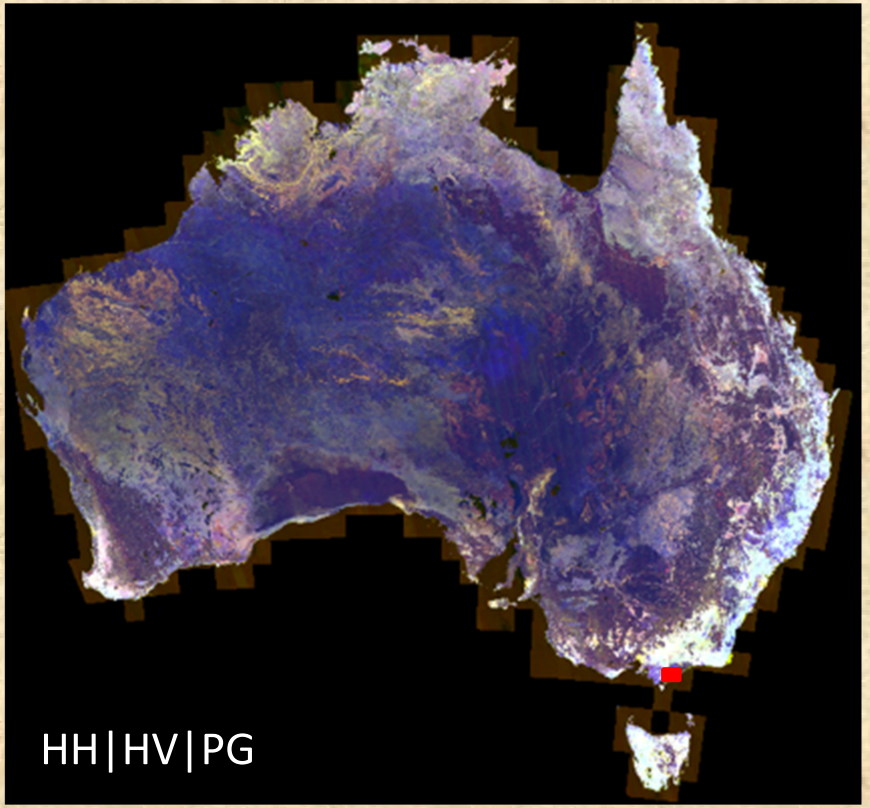
National Segmentation

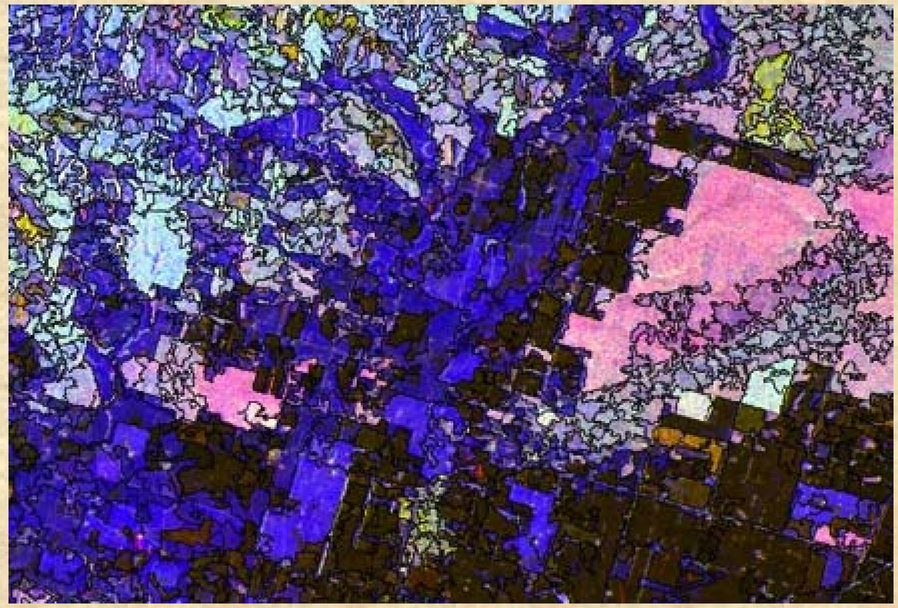
Northern Qld



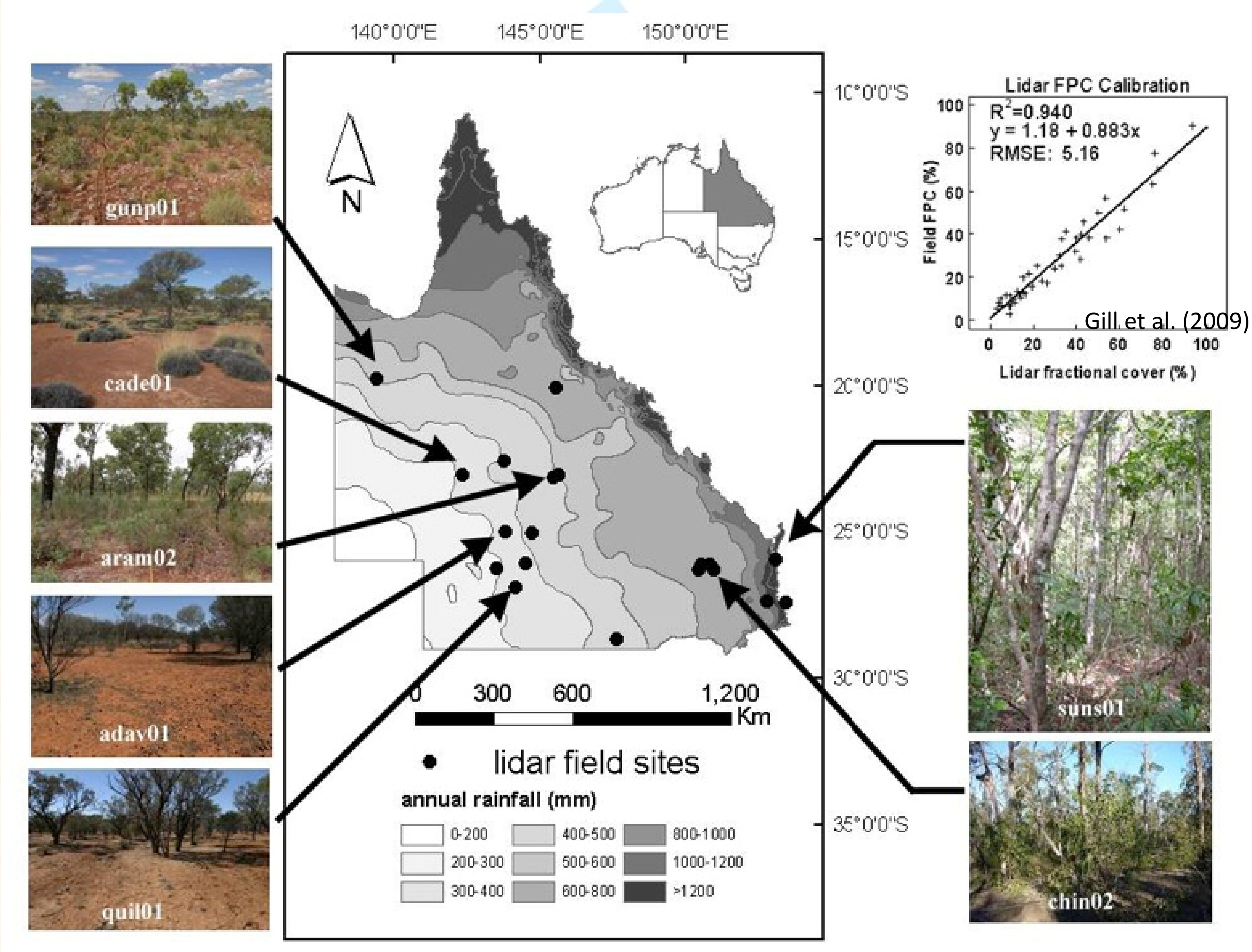


National Segmentation
Southern Vic



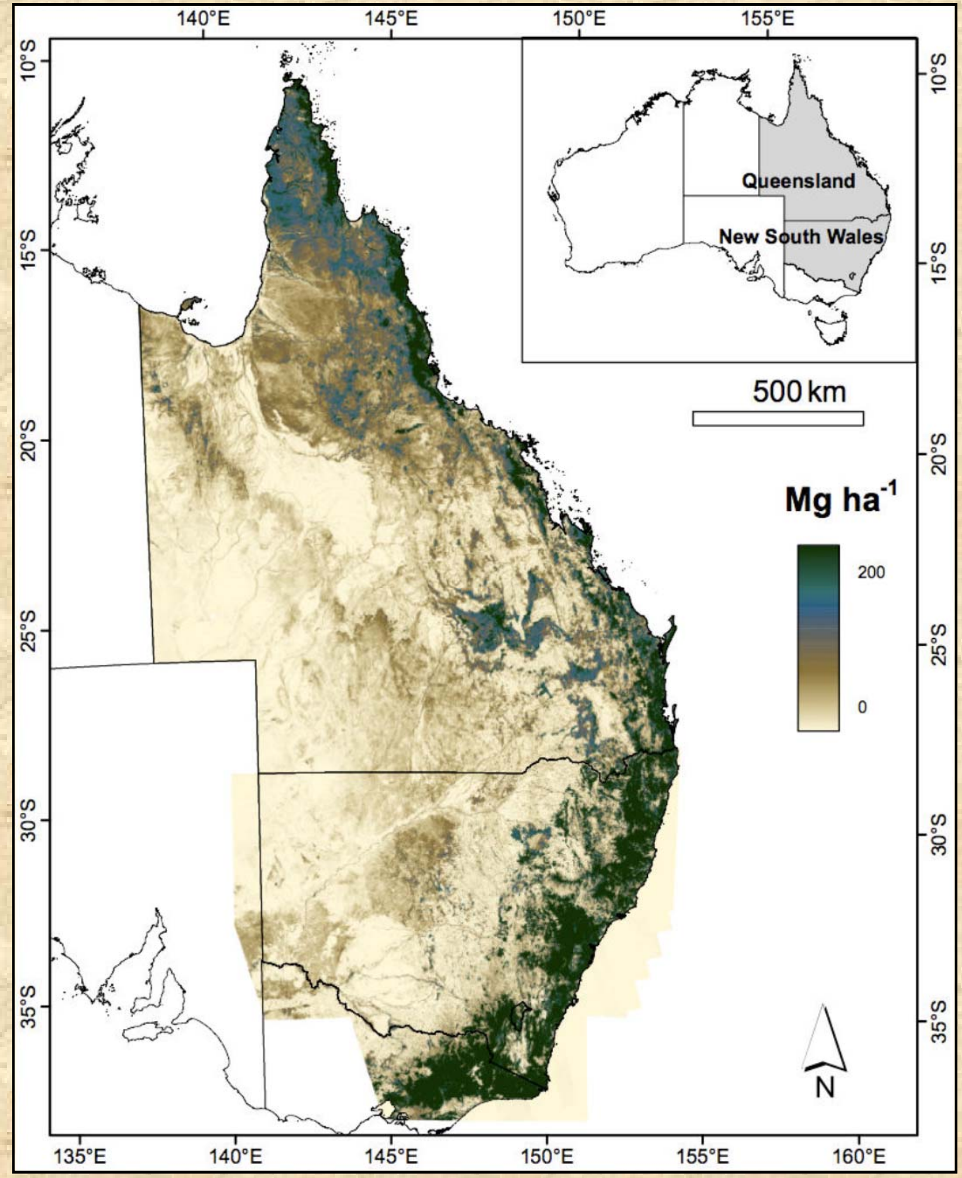


Scaling from LiDAR to SAR



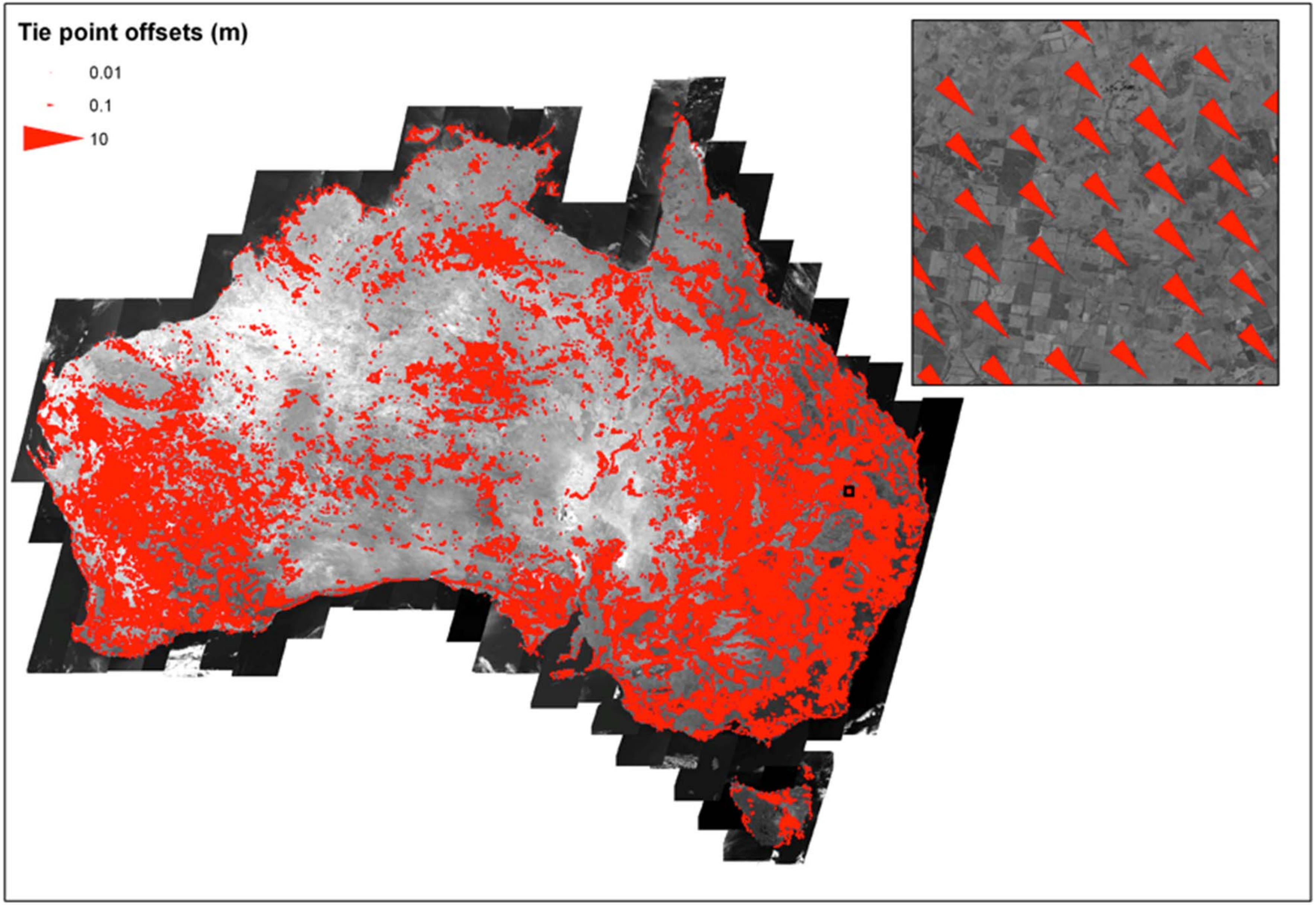
SPDLib (Bunting et al.,. 2012; open source software supporting visualisation and processing of LiDAR data

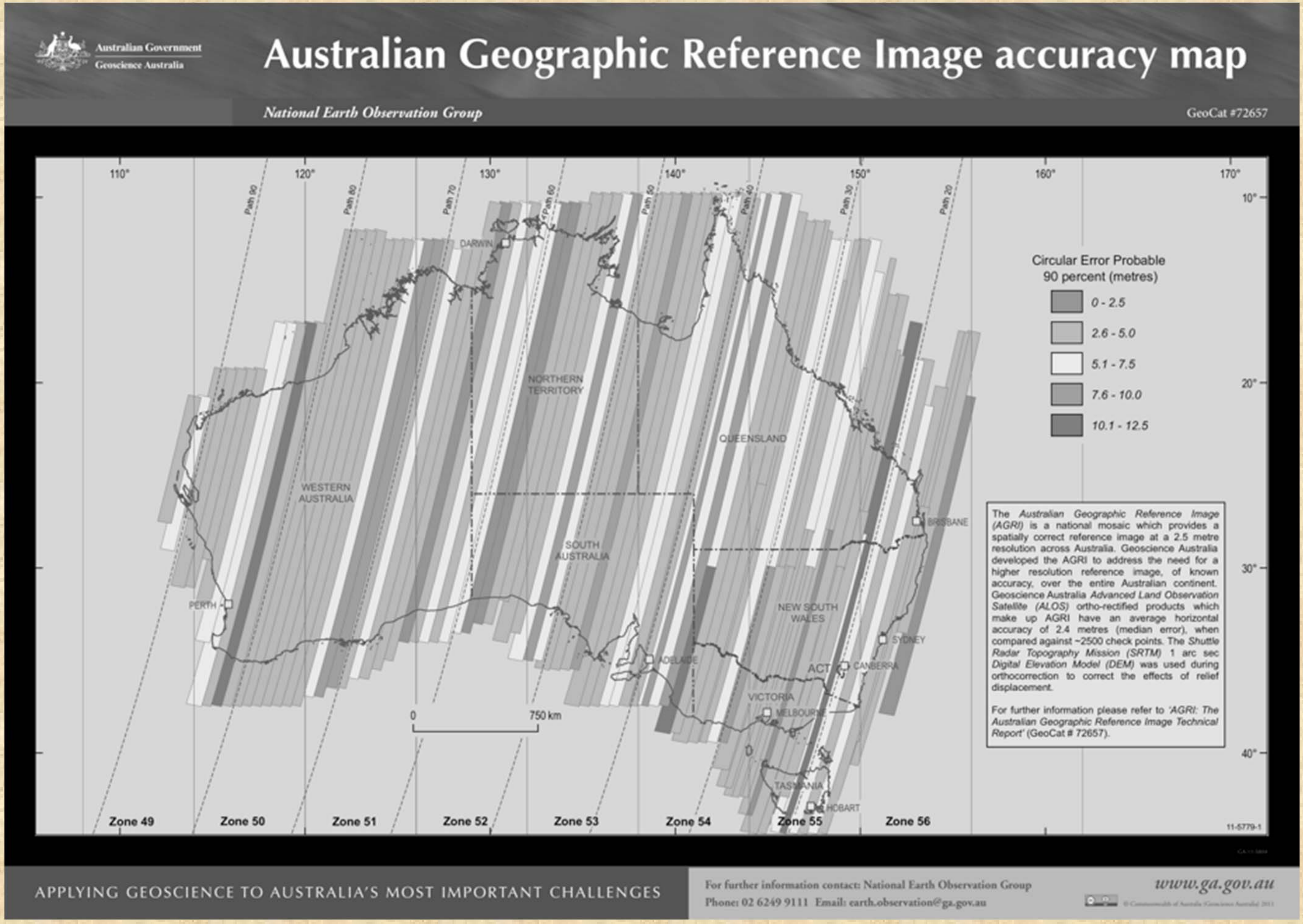
Biomass Mapping Australia



- Integration of ALOS PALSAR, Landsat Persistent Cover and ICESAT
- Consideration of different forest growth stages, ecosystems and structural formations (e.g., mangroves, flooded forests)

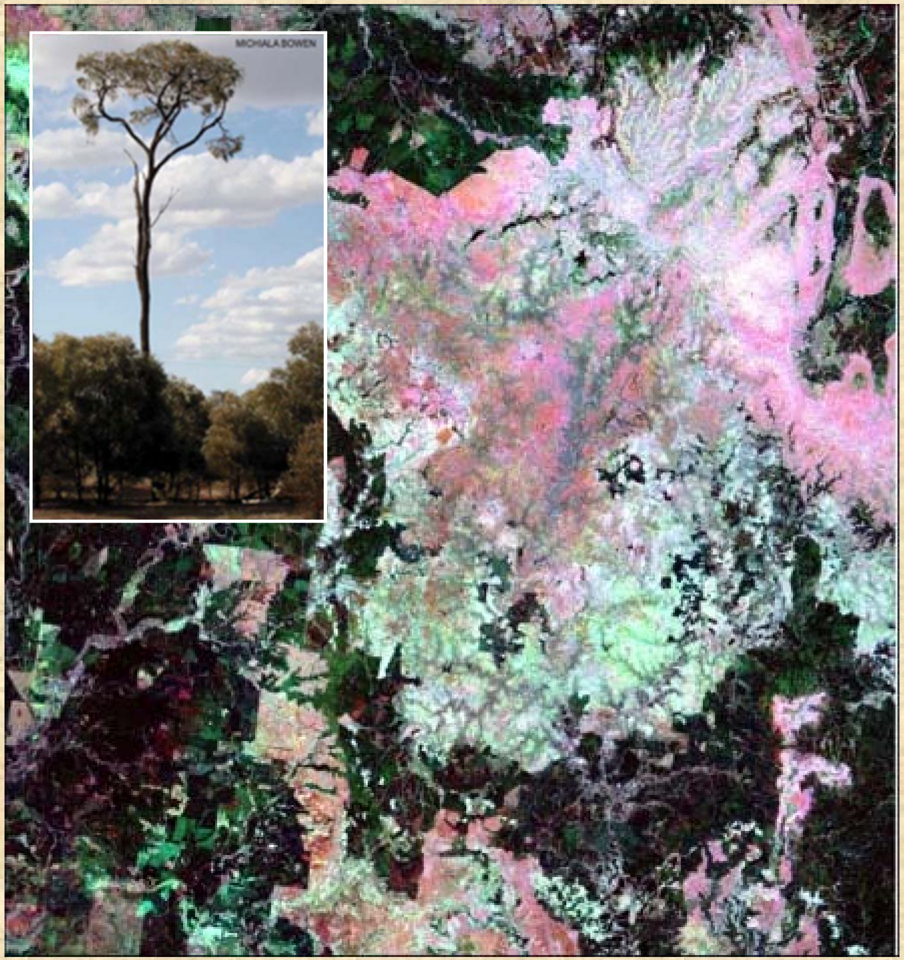
Tie Point Generation: ALOS PALSAR and Landsat Panchromatic



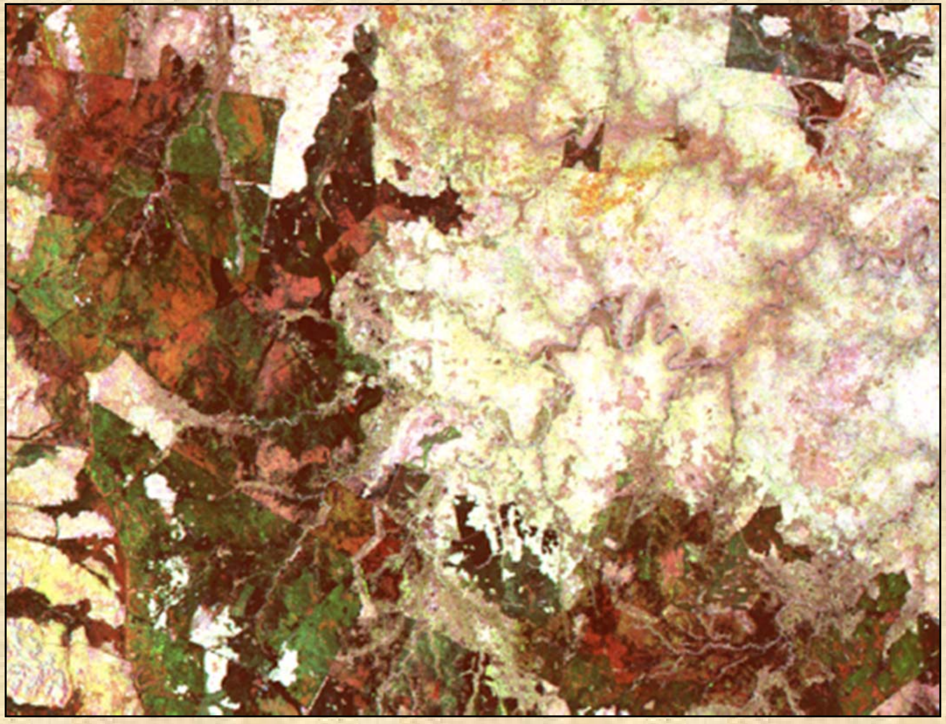


Australian Government
Geoscience Australia
Australian Geographic Reference Image accuracy map
National Earth Observation Group
GeoCat #72657
Circular Error Probable
90 percent (metres)
0 - 2.5
2.6 - 5.0
5.1 - 7.5
7.6 - 10.0
10.1 - 12.5
WESTERN AUSTRALIA
NORTHERN TERRITORY
SOUTH AUSTRALIA
QUEENSLAND
NEW SOUTH WALES
VICTORIA
TASMANIA
ACT
DARWIN
PERTH
ADELAIDE
BRISBANE
SYDNEY
CANBERRA
MELBOURNE
HOBART
Path 90
Path 80
Path 70
Path 60
Path 50
Path 40
Path 30
Path 20
110°
120°
130°
140°
150°
160°
170°
10°
20°
30°
40°
0
750 km
Zone 49
Zone 50
Zone 51
Zone 52
Zone 53
Zone 54
Zone 55
Zone 56
The Australian Geographic Reference Image (AGRI) is a national mosaic which provides a spatially correct reference image at a 2.5 metre resolution across Australia. Geoscience Australia developed the AGRI to address the need for a higher resolution reference image, of known accuracy, over the entire Australian continent. Geoscience Australia Advanced Land Observation Satellite (ALOS) ortho-rectified products which make up AGRI have an average horizontal accuracy of 2.4 metres (median error), when compared against ~2500 check points. The Shuttle Radar Topography Mission (SRTM) 1 arc sec Digital Elevation Model (DEM) was used during orthocorrection to correct the effects of relief displacement.
For further information please refer to 'AGRI: The Australian Geographic Reference Image Technical Report' (GeoCat # 72657).
11-5779-1
APPLYING GEOSCIENCE TO AUSTRALIA'S MOST IMPORTANT CHALLENGES
For further information contact: National Earth Observation Group
Phone: 02 6249 9111 Email: earth.observation@ga.gov.au
www.ga.gov.au

Forest Growth Stage Mapping

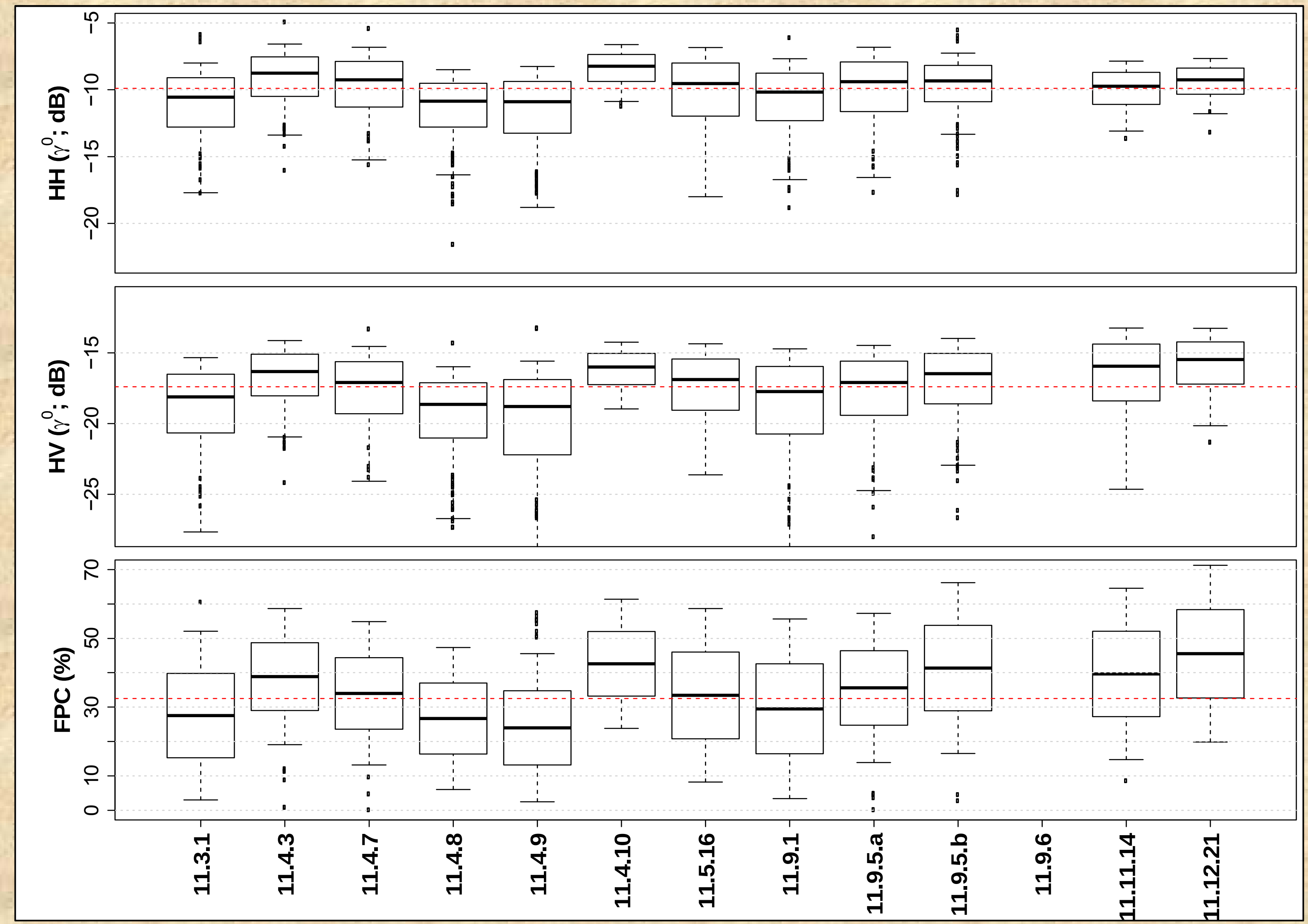


Landsat FPC and ALOS PALSAR
L-band HH and HV (RGB)



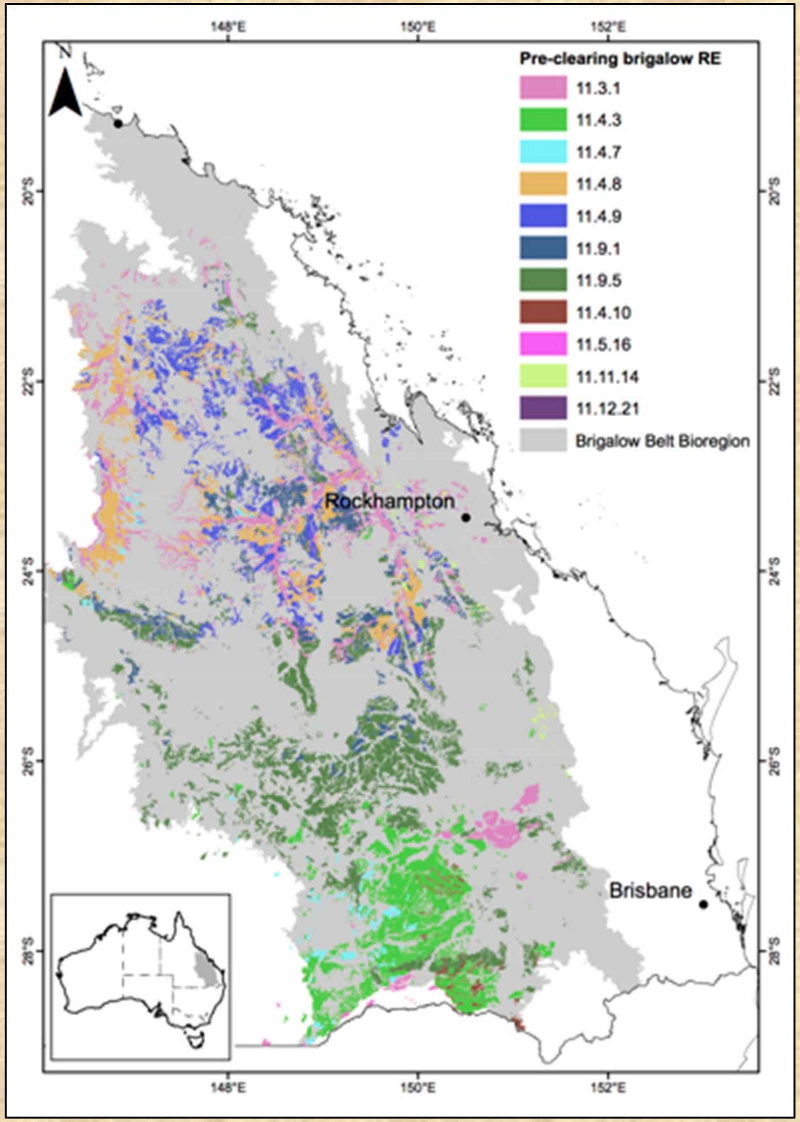
Differentiation of early regrowth
and remnant forest

Characteristics of Remnant (undisturbed forest):
Different Regional Ecosystems - Brigalow Belt Bioregion

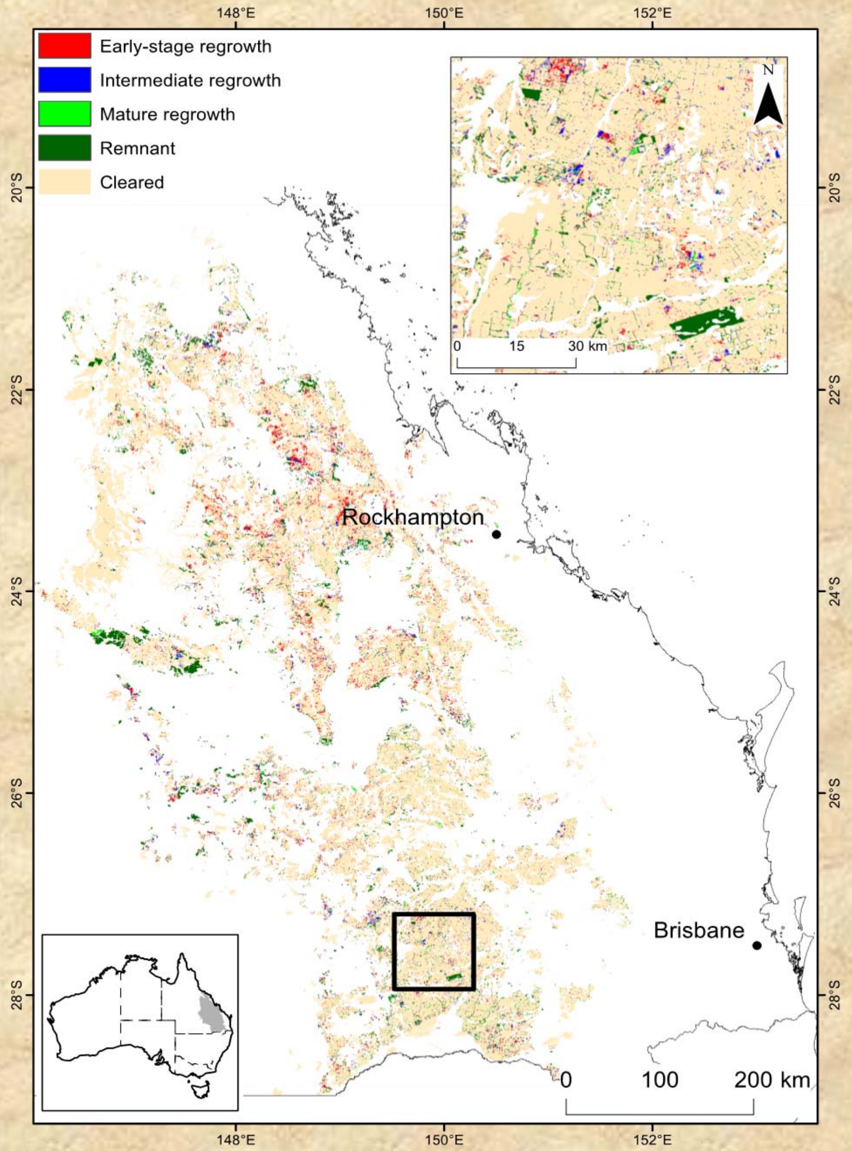


Regional Ecosystem

Integration of ALOS PALSAR and Landsat-derived FPC Forest Growth Stage: Brigalow Belt Bioregion



Regional Ecosystem Mapping



Growth stage map

Relevance to Policy: Addressing CBD Aichi Targets

Strategic goal A. Address the underlying causes of biodiversity loss

Target 1: By 2020, People are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.

Target 2: By 2020, biodiversity values are integrated into national and local development and poverty reduction strategies and planning processes and national accounts …

Target 3: By 2020, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed …….

Target 4: By 2020, Governments, business and stakeholders have plans for sustainable production and consumption and keep the impacts resource use within safe ecological limits.

Strategic goal B. Reduce the direct pressures on biodiversity and promote sustainable use

Target 5: By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.

Target 6: By 2020 all stocks managed and harvested sustainably, so that overfishing is avoided …….

Target 7: By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.

Target 8: By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.

Target 9: By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.

Target 10: By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.

Strategic goal C: To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity

Target 11: By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas are conserved through systems of protected areas……

Target 12: By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

Target 13: By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives is maintained,

Strategic goal D: Enhance the benefits to all from biodiversity and ecosystem services

Target 14: By 2020, ecosystems that provide essential services, including services are restored and safeguarded,

Target 15: By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems,

Target 16: By 2015, the Nagoya Protocol on Access and Benefits Sharing is in force and operational

Strategic goal E. Enhance implementation through participatory planning, knowledge management and capacity building

Target 17: By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated NBSAP.

Target 18: By 2020, the traditional knowledge, innovations and practices of indigenous and local communities and their customary use, are respected.

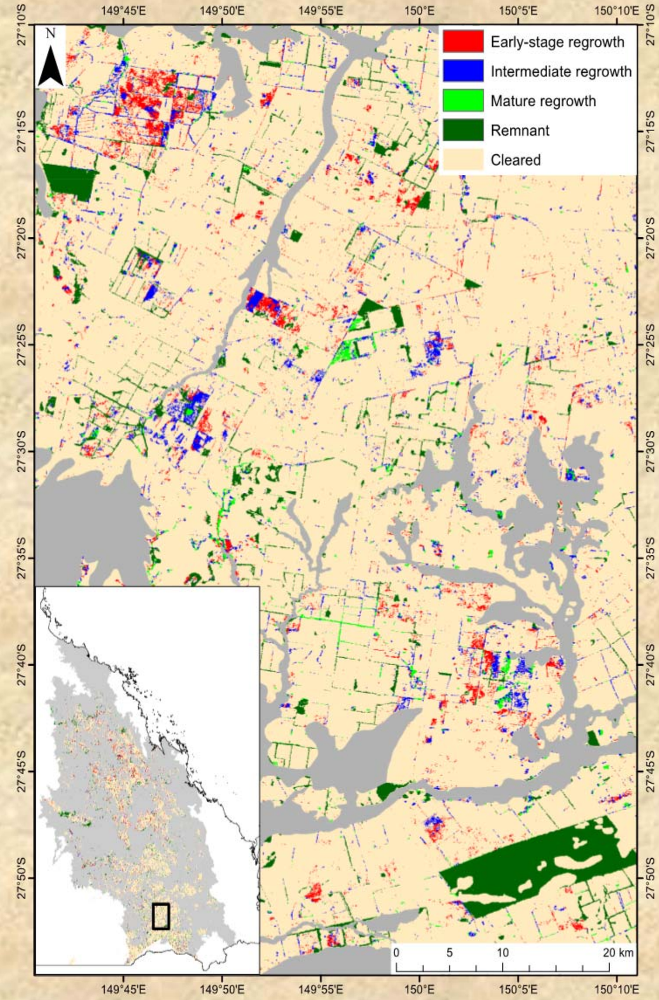
Target 19: By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.

Target 20: By 2020, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources,, should increase substantially .

Recovering the Endangered Brigalow Forest Ecosystems, Queensland, Australia



Relevance to Vegetation Management Acts, Australia



Regrowth classification

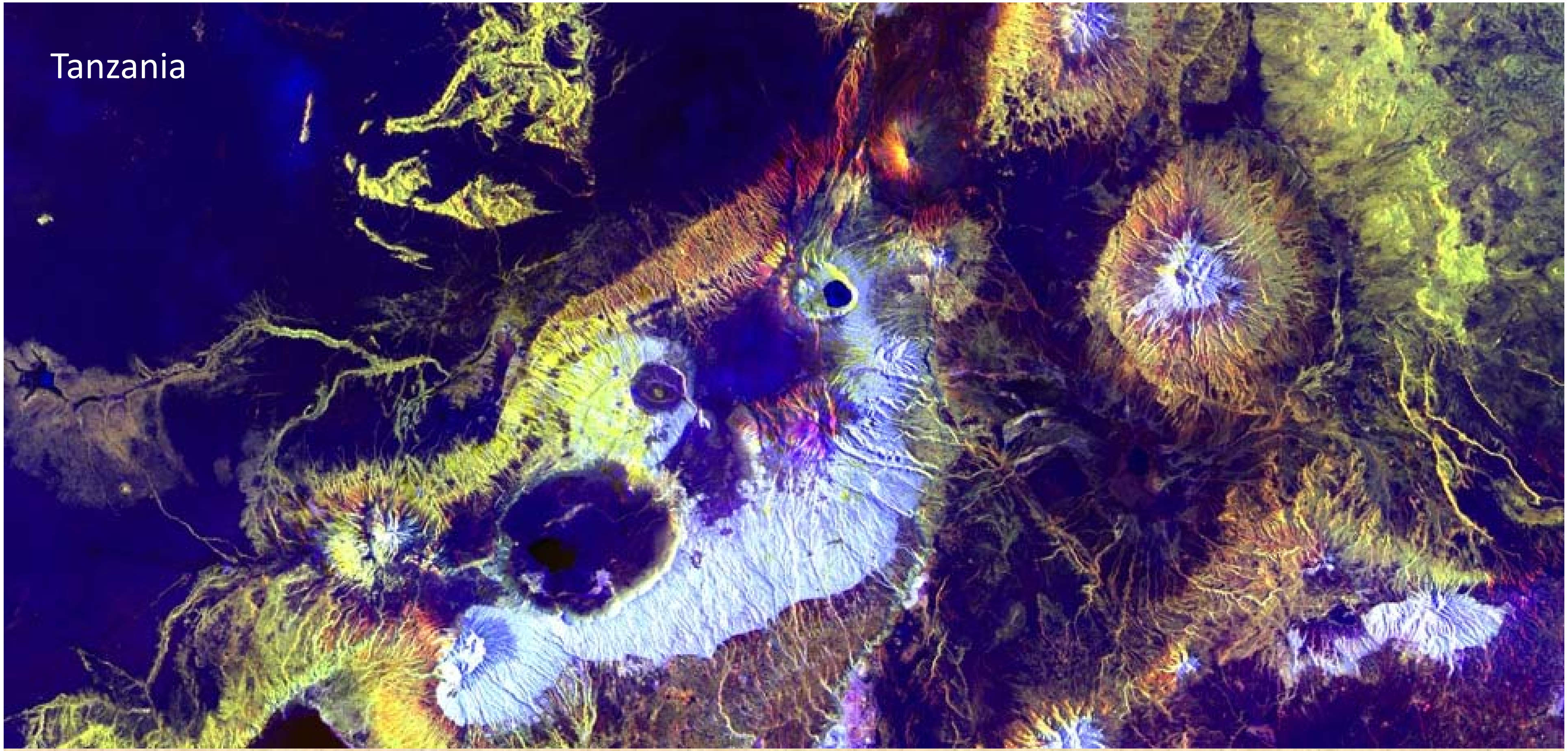
Essential Biodiversity Variables

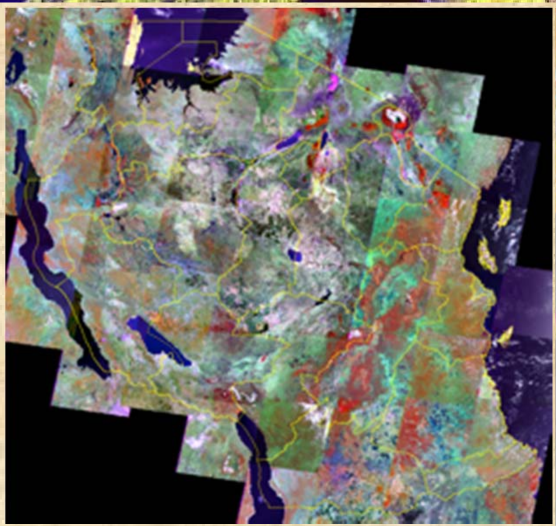
H. M. Pereira,[1*†] S. Ferrier,[2] M. Walters,[3] G. N. Geller,[4] R. H. G. Jongman,[5] R. J. Scholes,[3] M. W. Bruford,[6] N. Brummitt,[7] S. H. M. Butchart,[8] A. C. Cardoso,[9] N. C. Coops,[10] E. Dulloo,[11] D. P. Faith,[12] J. Freyhof,[13] R. D. Gregory,[14] C. Heip,[15] R. Höft,[16] G. Hurtt,[17] W. Jetz,[18] D. S. Karp,[19] M. A. McGeoch,[20] D. Obura,[21] Y. Onoda,[22] N. Pettorelli,[23] B. Reyers,[24] R. Sayre,[25] J. P. W. Scharlemann,[26,27] S. N. Stuart,[28] E. Turak,[29] M. Walpole,[26] M. Wegmann[30]

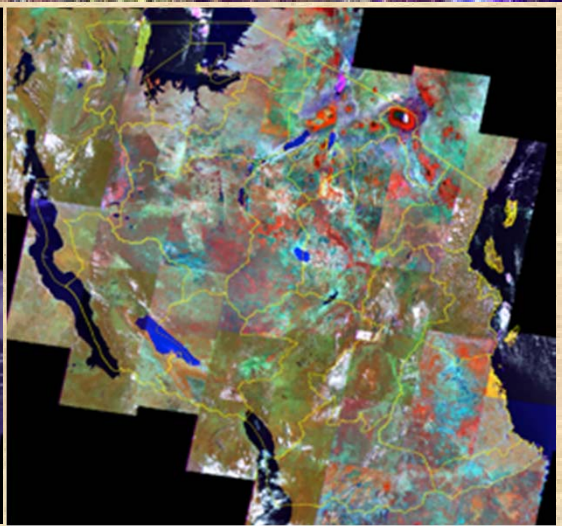
A global system of harmonized observations is needed to inform scientists and policy-makers.

Examples of candidate Essential Biodiversity Variables

EBV class	EBV examples	Measurement and scalability	Temporal sensitivity	Feasibility	Relevance for CBD targets and indicators (1,9)
Genetic composition	Allelic diversity	Genotypes of selected species (e.g., endangered, domesticated) at representative locations.	Generation time	Data available for many species and for several locations, but little global systematic sampling.	Targets: 12, 13. Indicators: Trends in genetic diversity of selected species and of domesticated animals and cultivated plants; RLI.
Species populations	Abundances and distributions	Counts or presence surveys for groups of species easy to monitor or important for ES, over an extensive network of sites, complemented with incidental data.	1 to >10 years	Standardized counts under way for some taxa but geographically restricted. Presence data collected for more taxa. Ongoing data integration efforts (Global Biodiversity Information Facility, Map of Life).	Targets: 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15. Indicators: LPI; WBI; RLI; population and extinction risk trends of target species, forest specialists in forests under restoration, and species that provide ES; trends in invasive alien species; trends in climatic impacts on populations.
Species traits	Phenology	Timing of leaf coloration by RS, with in situ validation.	1 year	Several ongoing initiatives (Phenological Eyes Network, PhenoCam, etc.)	Targets: 10, 15. Indicators: Trends in extent and rate of shifts of boundaries of vulnerable ecosystems.
Community composition	Taxonomic diversity	Consistent multitaxa surveys and metagenomics at select locations.	5 to >10 years	Ongoing at intensive monitoring sites (opportunities for expansion). Metagenomics and hyperspectral RS emerging.	Targets: 8, 10, 14. Indicators: Trends in condition and vulnerability of ecosystems; trends in climatic impacts on community composition.
Ecosystem structure	Habitat structure	RS of cover (or biomass) by height (or depth) globally or regionally.	1 to 5 years	Global terrestrial maps available with RS (e.g., Light Detection and Ranging). Marine and freshwater habitats mapped by combining RS and in situ data.	Targets: 5, 11, 14, 15. Indicators: Extent of forest and forest types; mangrove extent; seagrass extent; extent of habitats that provide carbon storage.
Ecosystem function	Nutrient retention	Nutrient output/input ratios measured at select locations. Combine with RS to model regionally.	1 year	Intensive monitoring sites exist for N saturation in acid-deposition areas and P retention in affected rivers.	Targets: 5, 8, 14. Indicators: Trends in delivery of multiple ES; trends in condition and vulnerability of ecosystems.



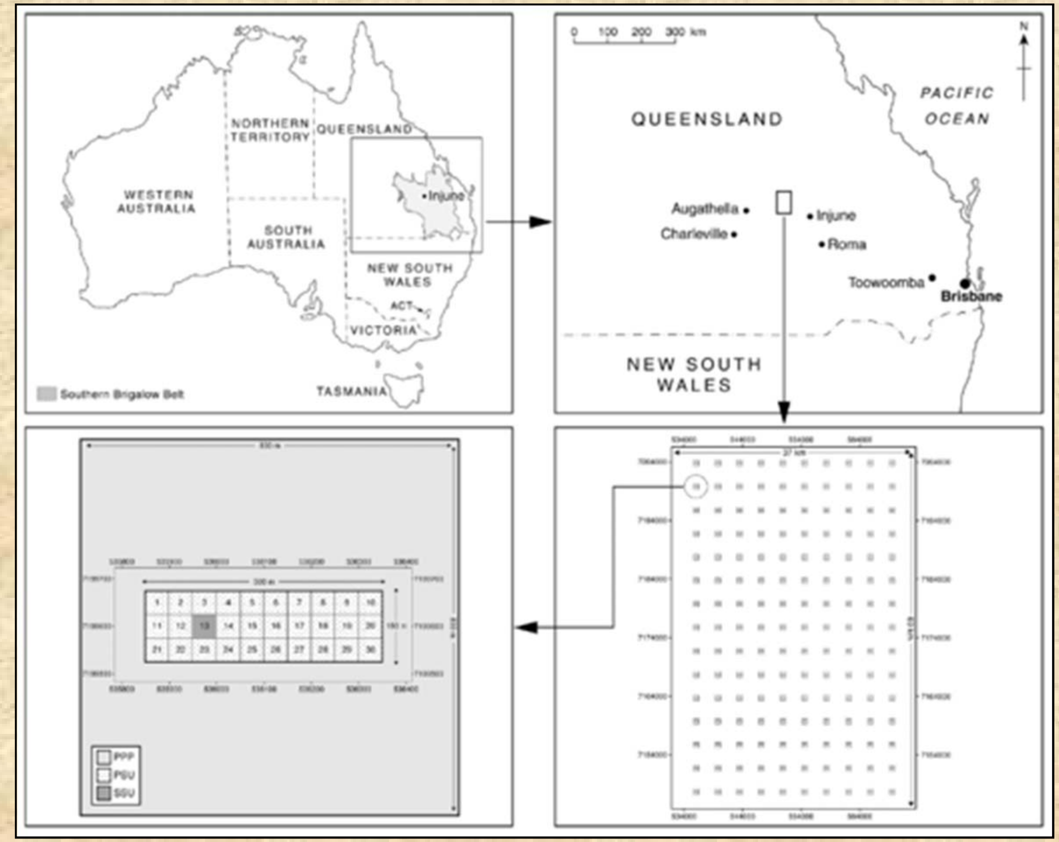


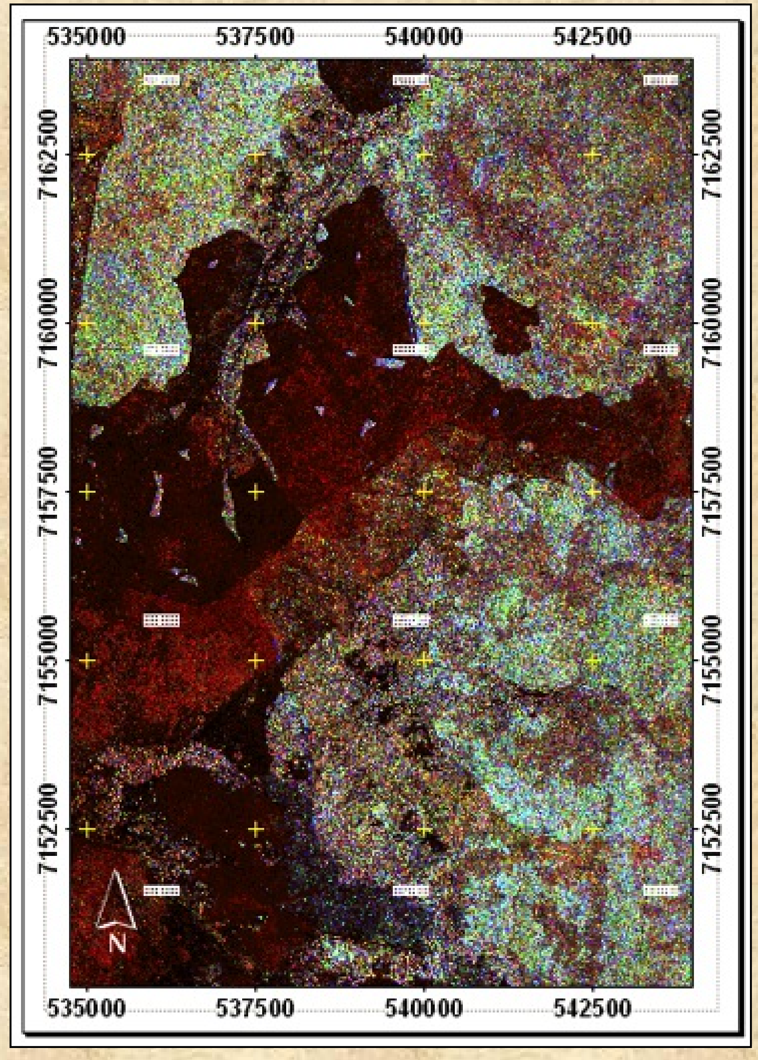


NDVI wet and dry and ALOS PALSAR HV
Capturing biomass and phenology

Dry and wet Landsat Mosaics, Tanzania
Rapideye mosaics for selected sites

The Injune Landscape Collaborative Project, Queensland, Australia

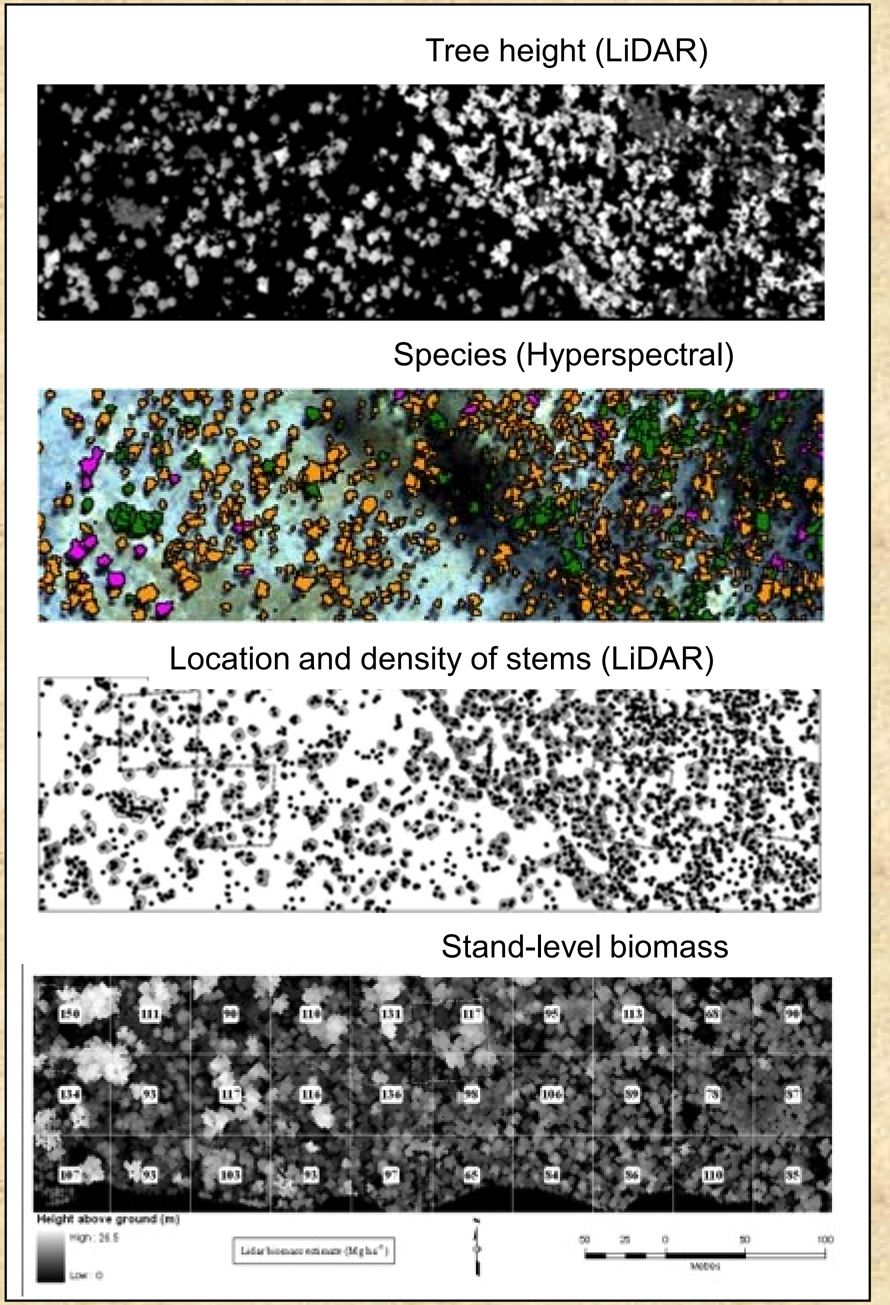


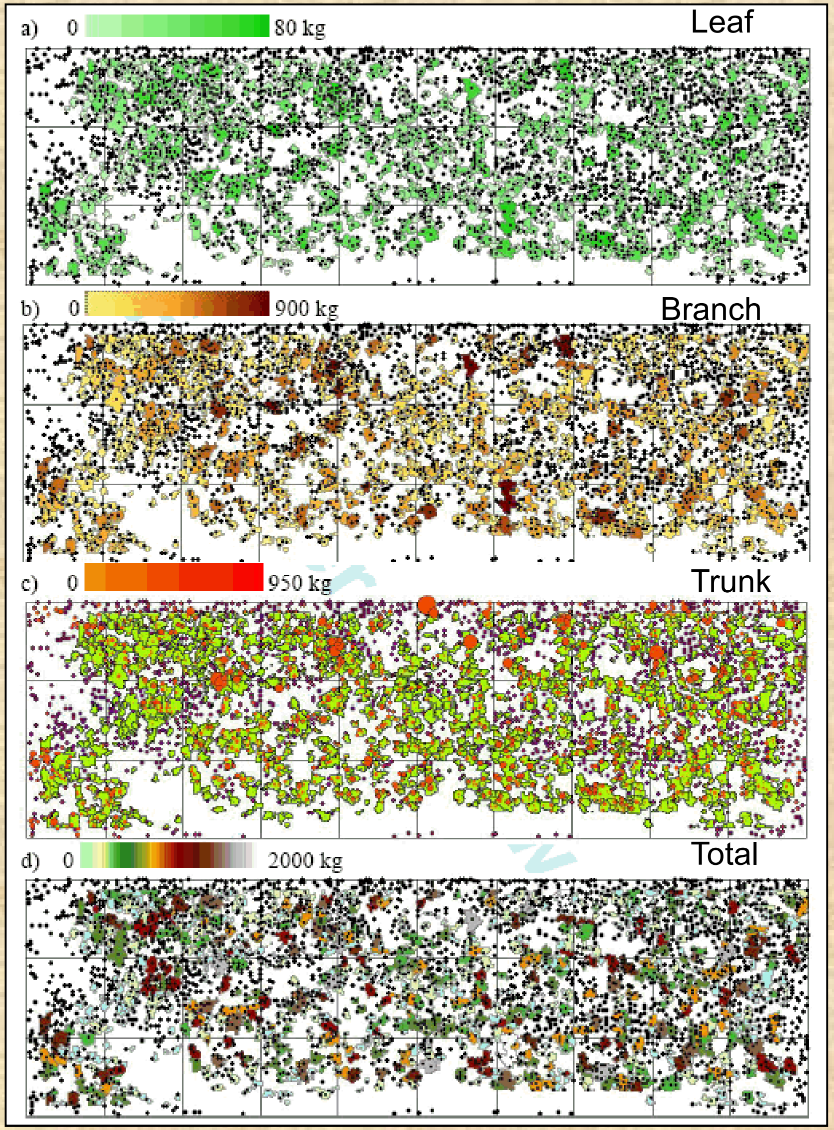


AIRSAR C, L and P-band

- Supporting statewide to national characterisation, mapping and monitoring of woody vegetation
  - At multiple scales using multi-sensor data
  - Algorithm and method development (e.g., retrieval of biomass, structure, species composition and change)
- Understanding ecosystem response to human-induced and natural change
  - Tree to landscape

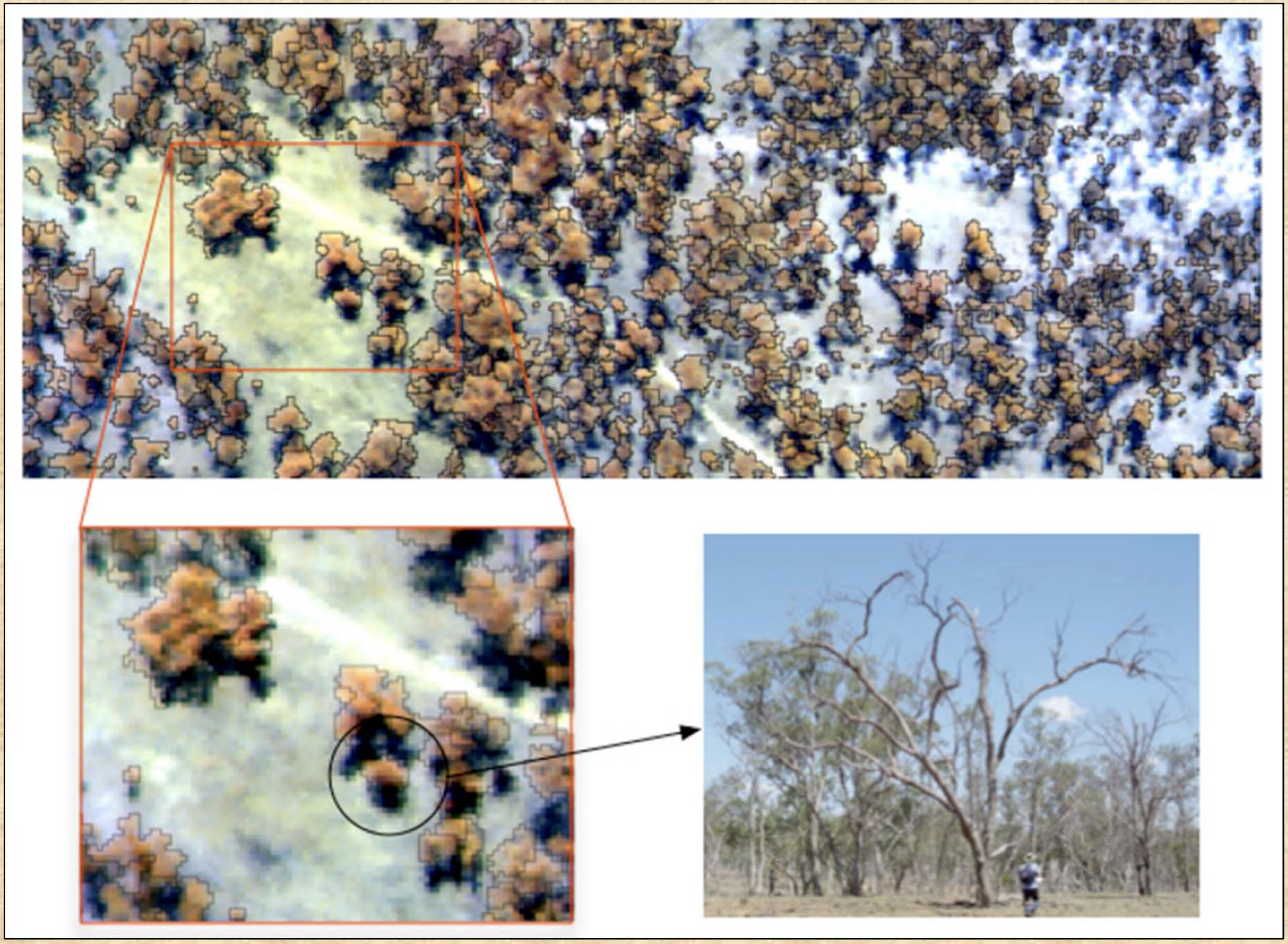
Tree to Stand Level Products





Integration of LiDAR and CASI

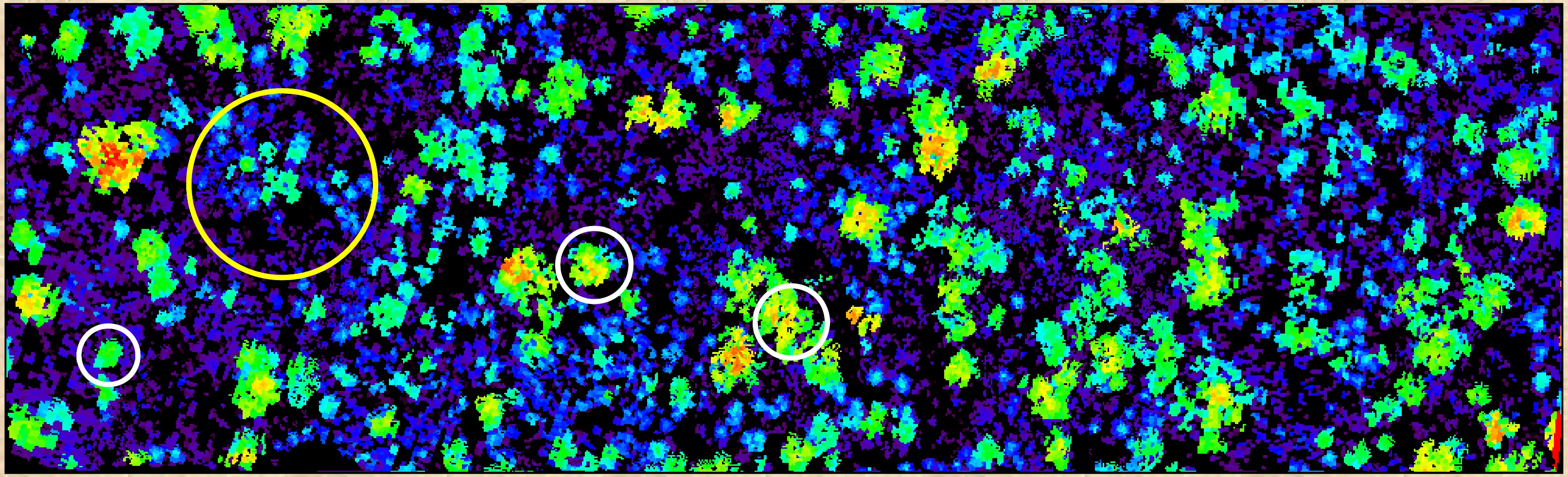
Environmental Change: Impacts of drought



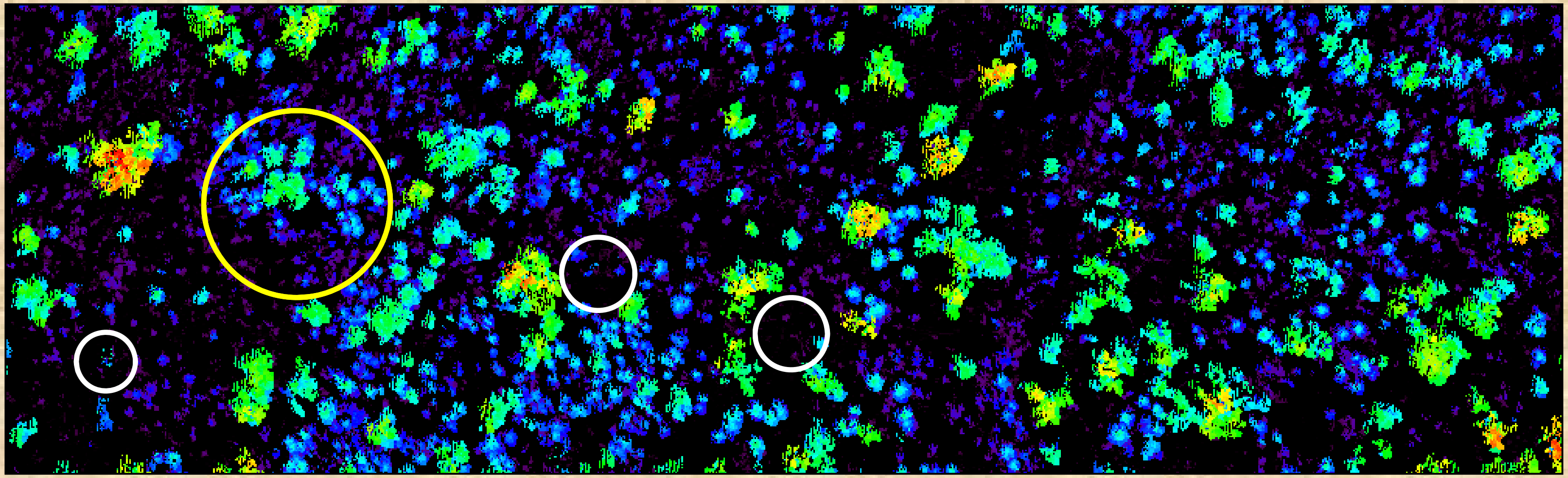
2000 2006

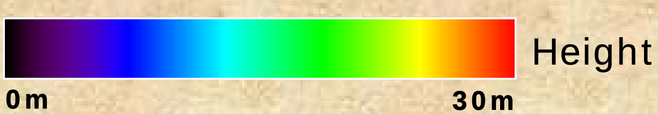
Tree mortality: Comparison of 2000 and 2009 LiDAR

August 2000 – Optech ALTM1020

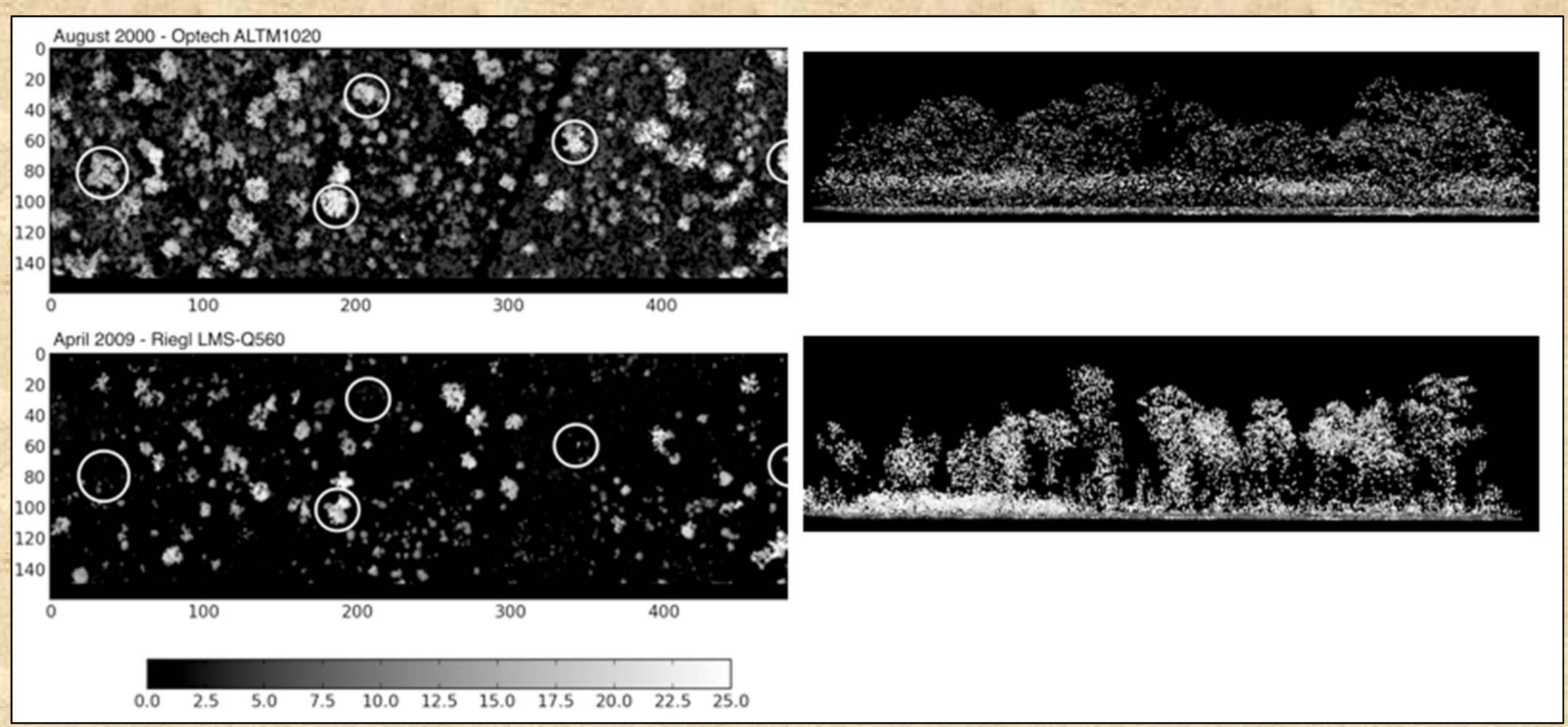


April 2009 – Riegl LMS-Q560

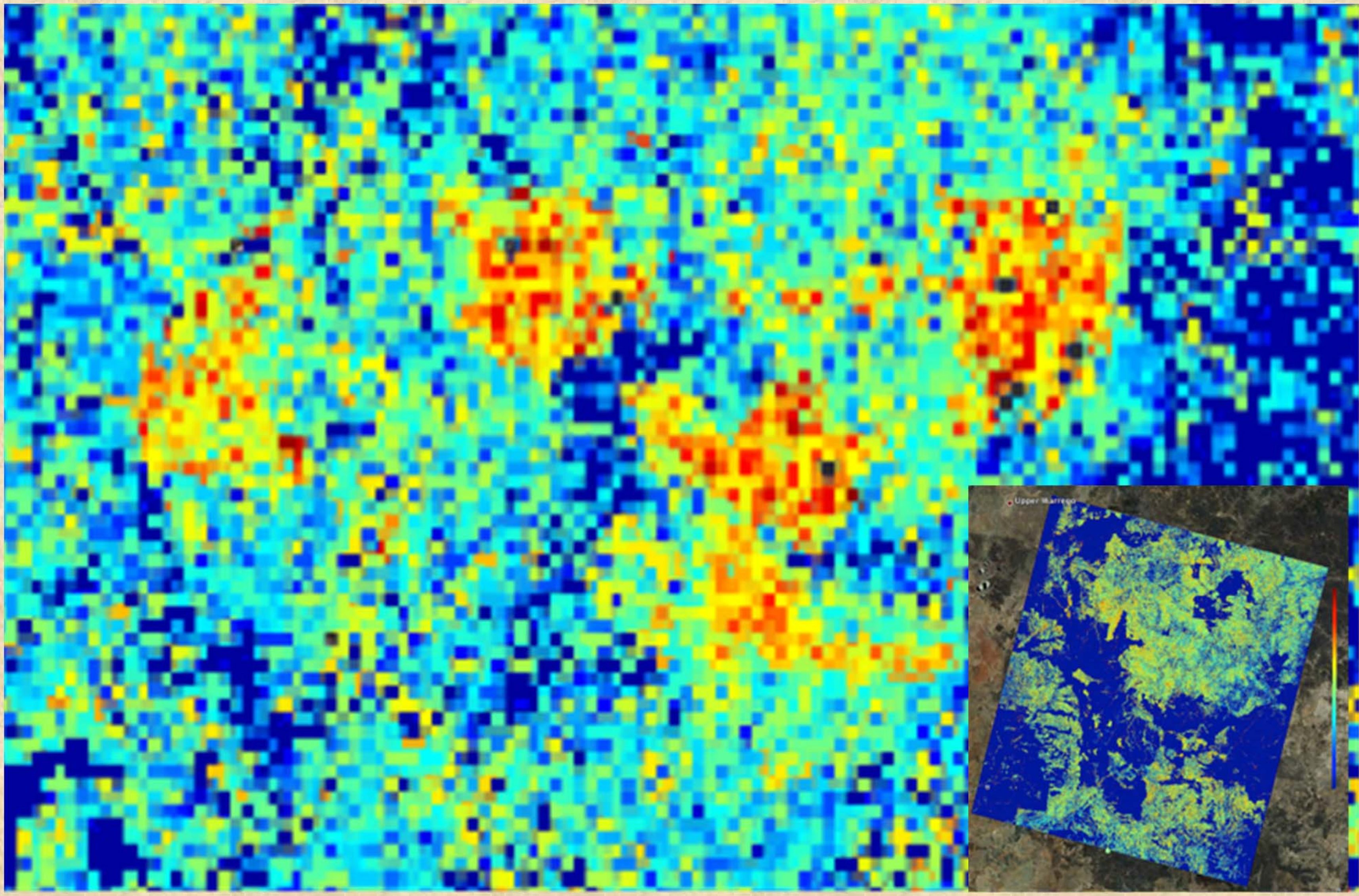




Tree mortality and loss of understorey through fire: Comparison of 2000 and 2009 LiDAR

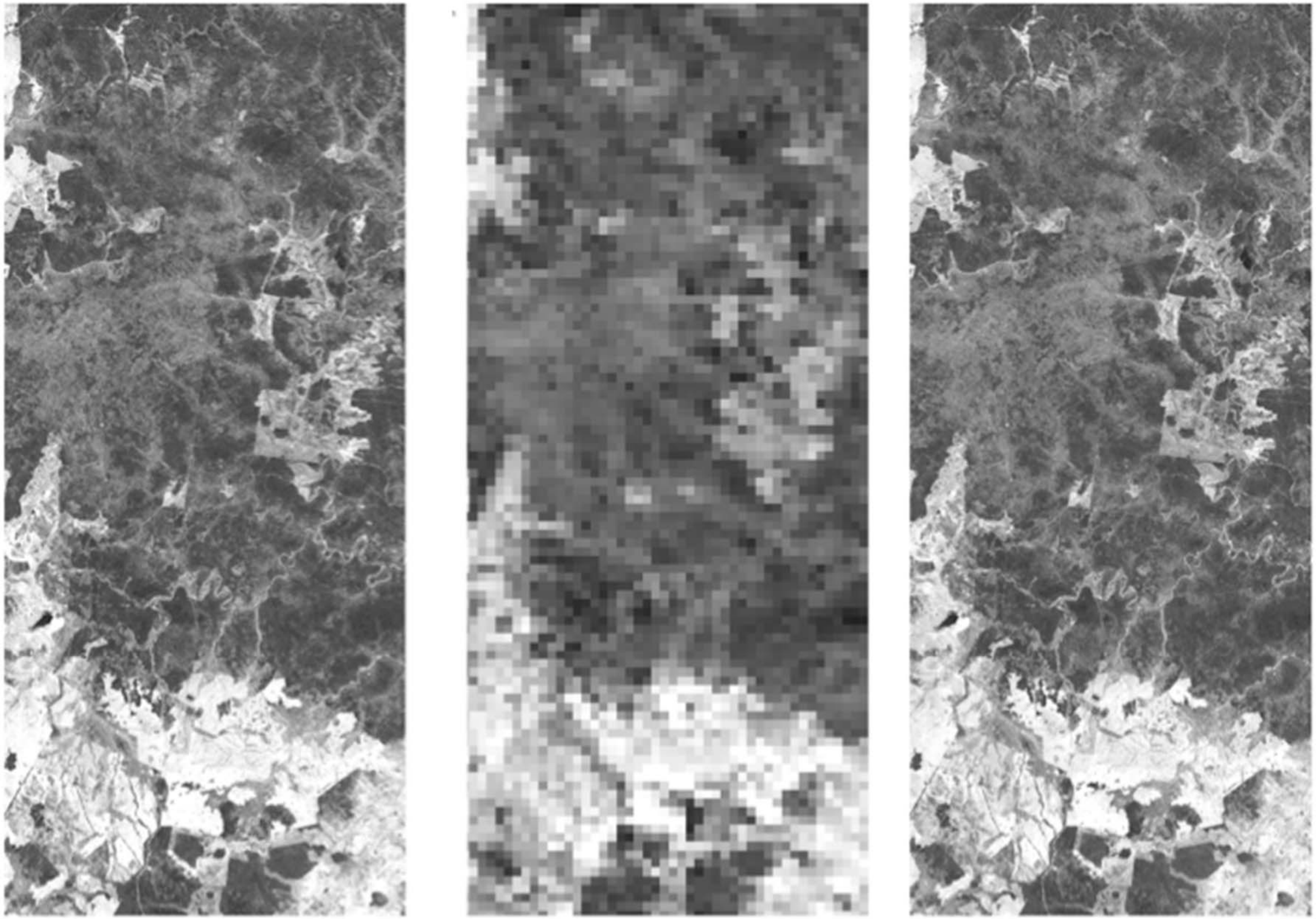


Forest Disturbance Monitoring: ALOS PALSAR Correlation (August – October, 2007)



Yang et al. (2012). Observation of vegetation vertical structure and disturbance using L-band InSAR over the Injune region in Australia. Remote Sensing of Environment, K&C Special Issue.

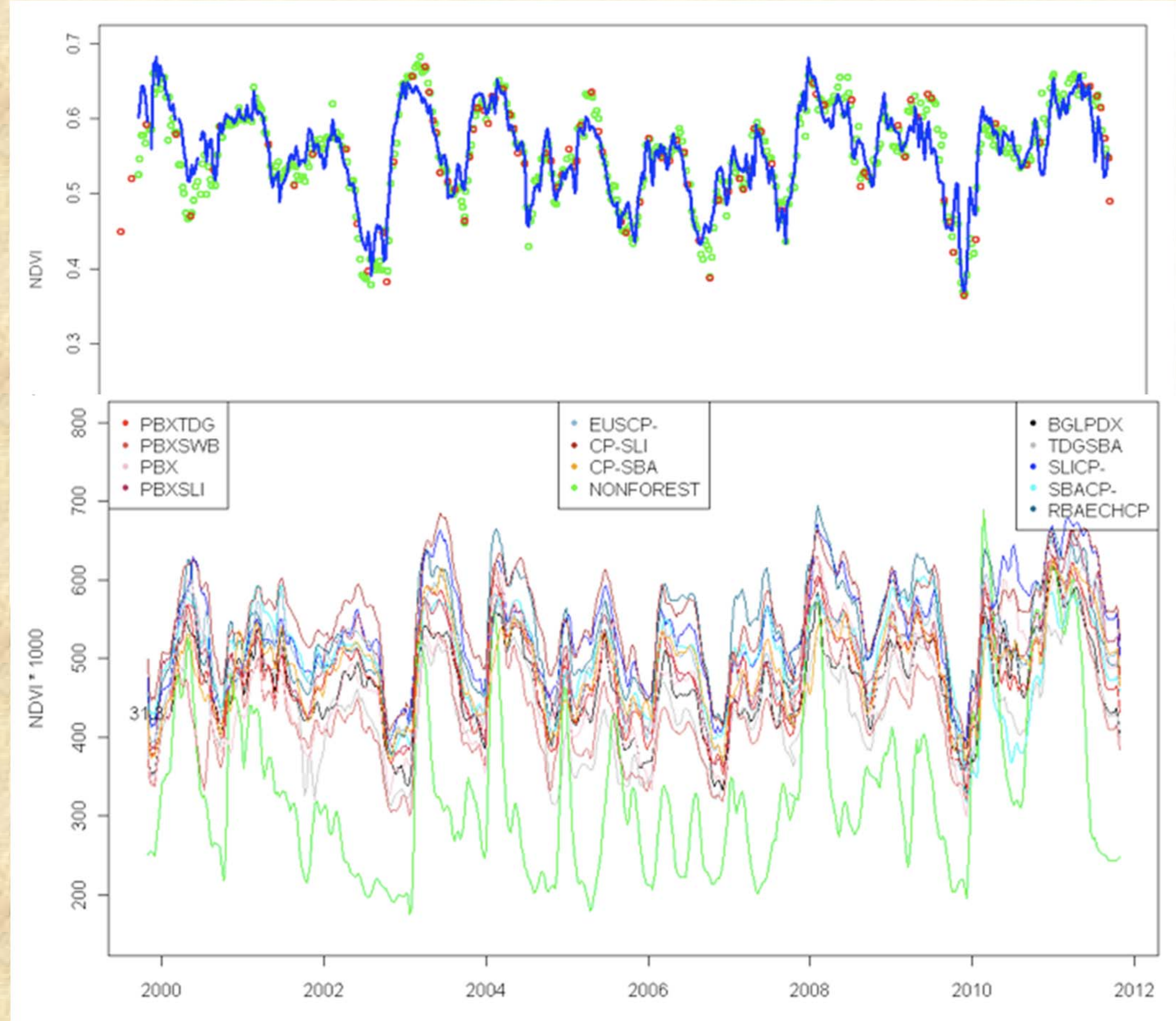
MODIS-Simulated Landsat sensor data



a) Landsat 5 - 20110707   b) MODIS - 20110712   c) STARFM - 20110712

Schmidt et al. (2012). Multi-resolution time series imagery for forest disturbance and regrowth monitoring in Queensland, Australia. Remote Sensing of Environment (in review)

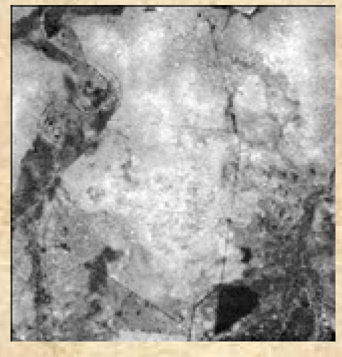
Vegetation Phenology: Stable Sites



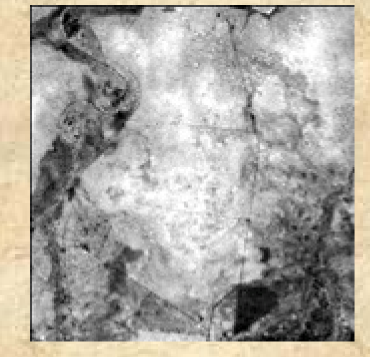
Hyper-temporal Landsat FPC (actual, simulated)

5th Aug 2007

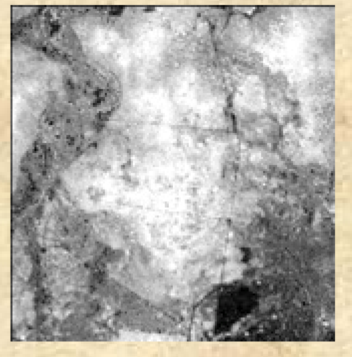
13th Aug 2007



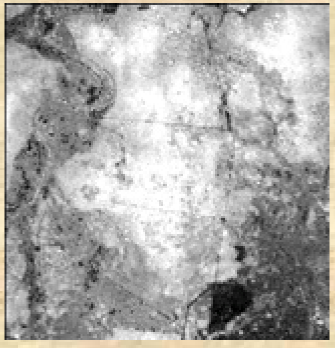
21st Aug 2007



21th Aug 2007

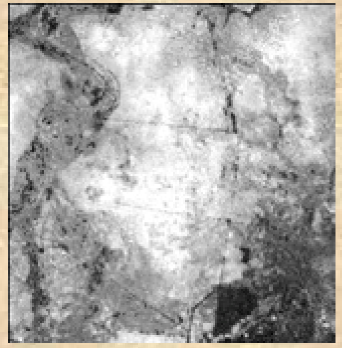


6th Sep 2007

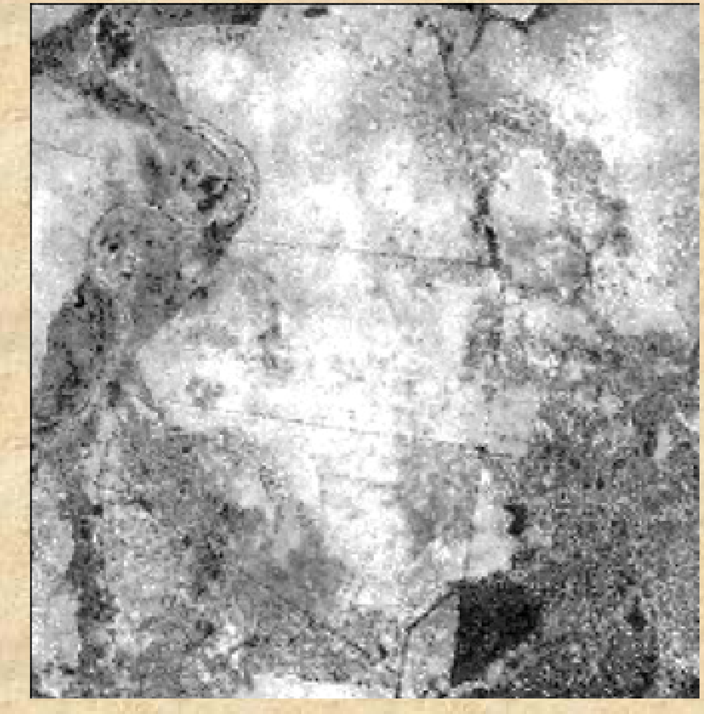


14th Sep 2007

22nd Sep 2007



30th Sep 2007

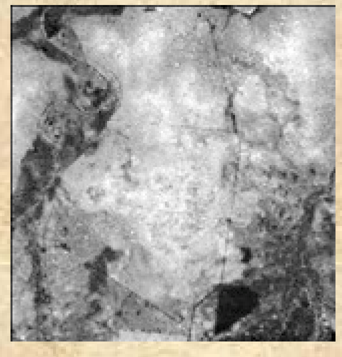


8th Oct 2007

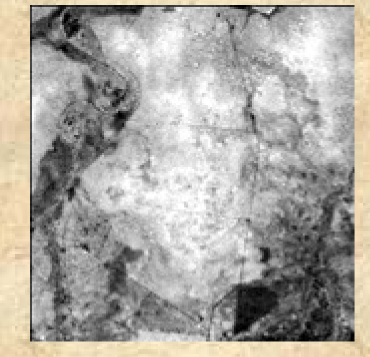
Hyper-temporal Landsat FPC (actual, simulated)

5th Aug 2007

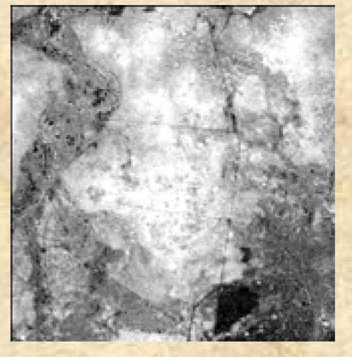
13th Aug 2007



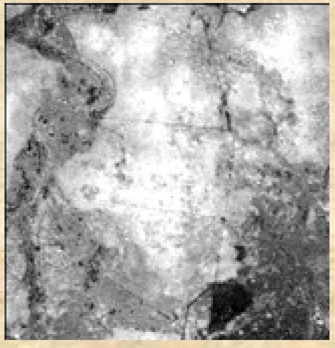
21st Aug 2007



21th Aug 2007

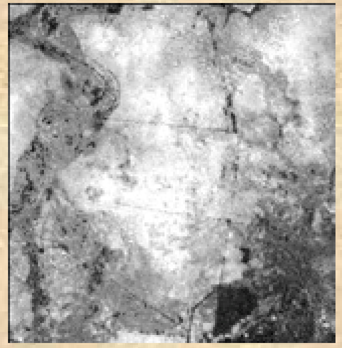


6th Sep 2007

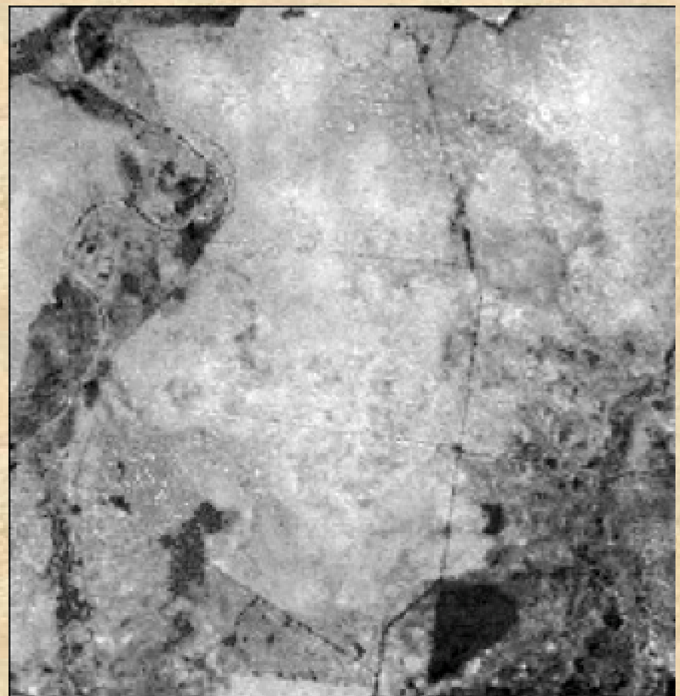


14th Sep 2007

22nd Sep 2007



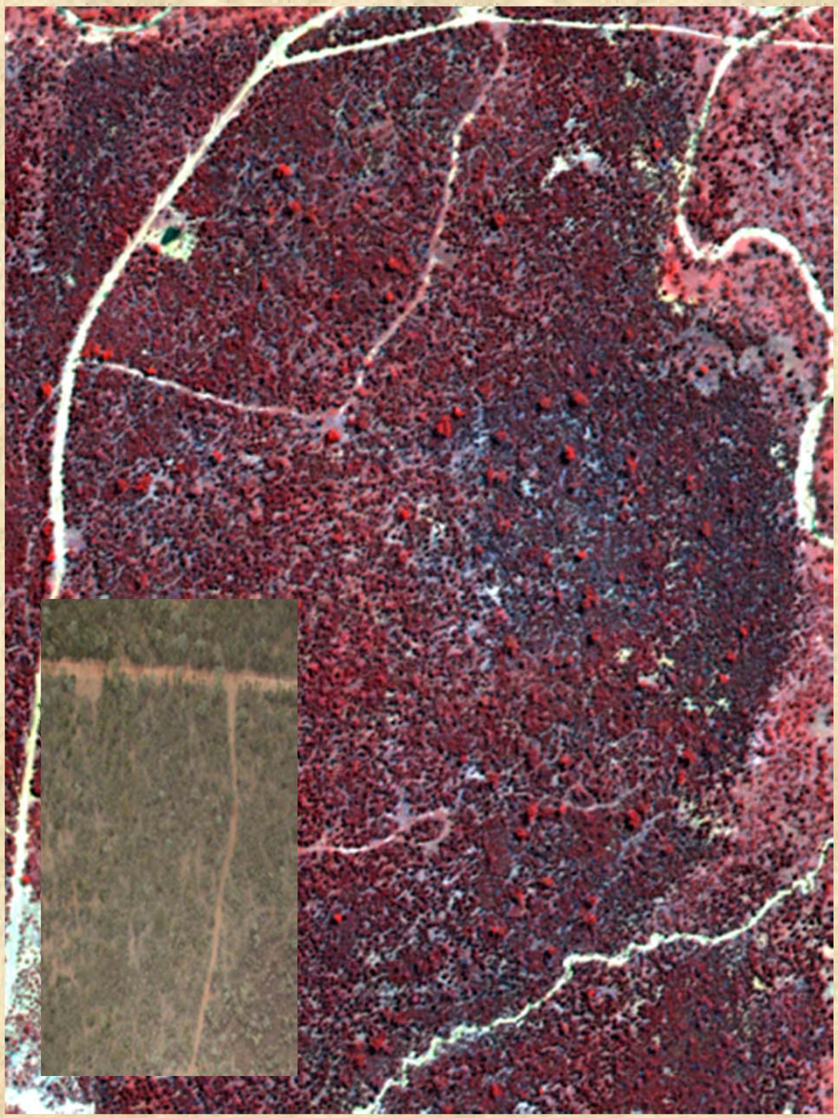
30th Sep 2007



5th Aug 2007

Time-series comparison of VHR data

Hyperspectral HYMAP (2000)

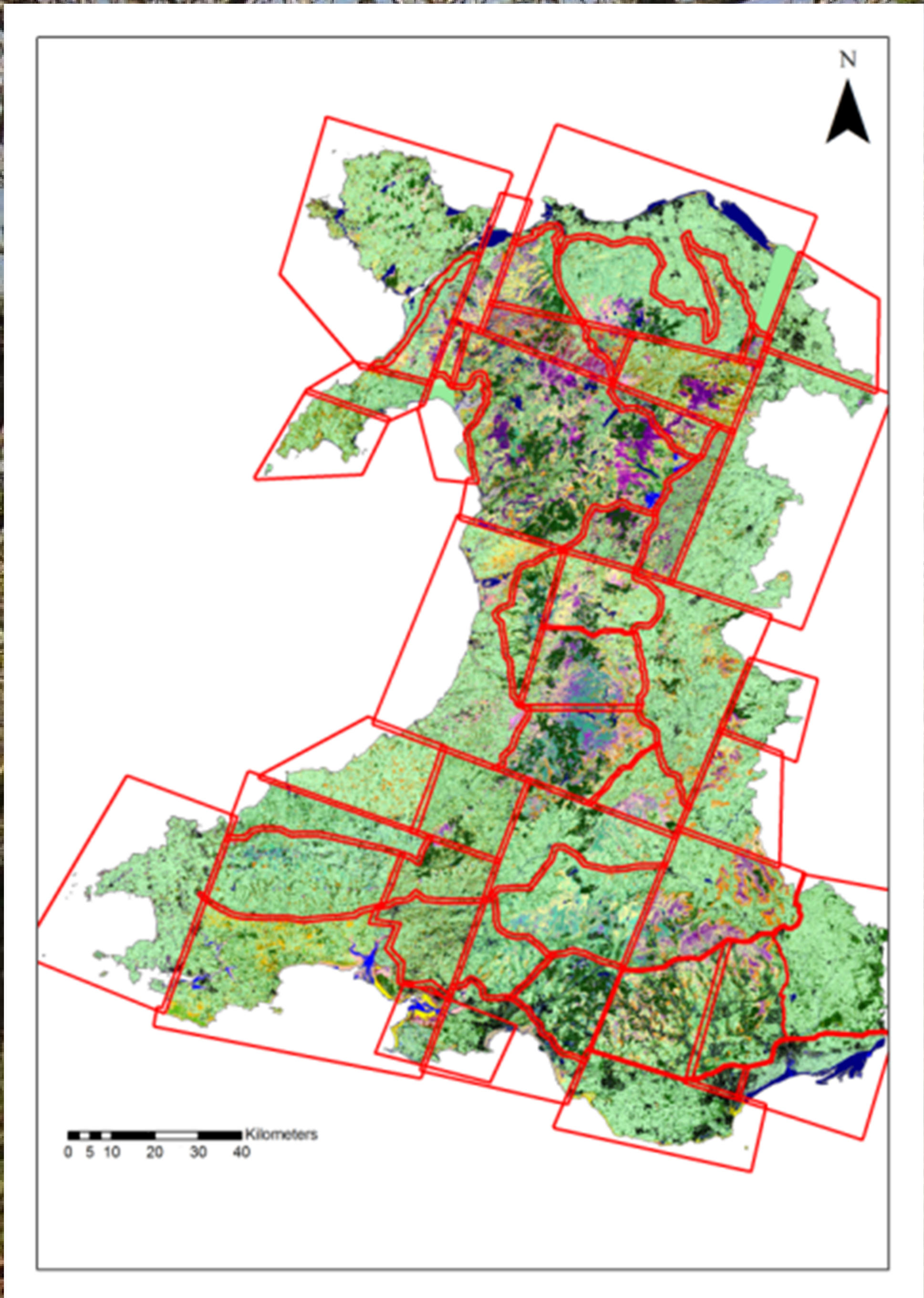


Worldview 2 (2010)

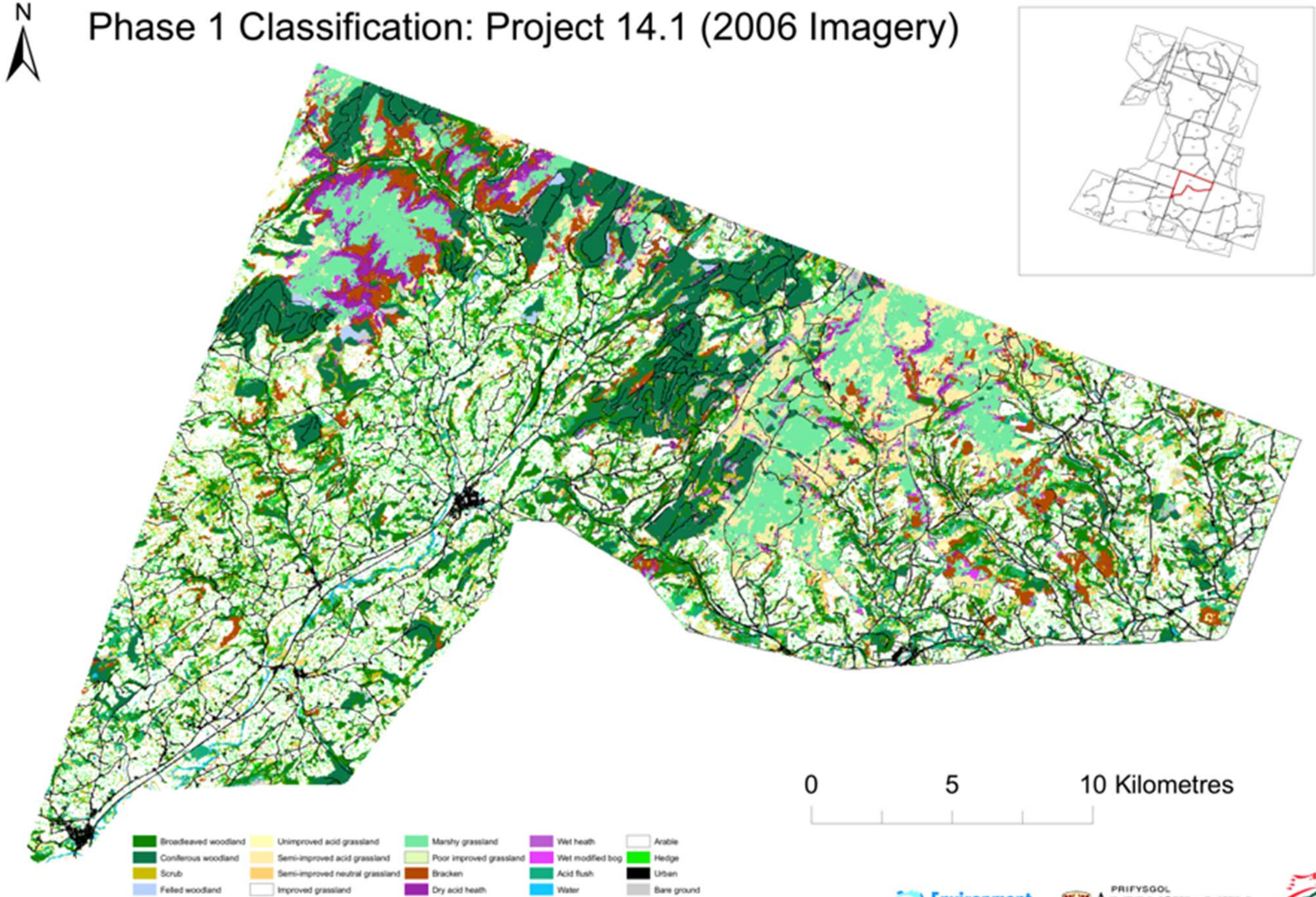
Key questions

- Are certain tree species removed in preference to others (e.g., through logging activities)?
- Is the composition of tree species within the regenerating forest communities a function of prior land use history (e.g., clearance mechanisms, time in pasture)?
- Do tree species respond differently to fire (e.g., as a function of intensity and frequency)?
- Are some tree species more susceptible to climatic fluctuation (e.g., drought, flooding)?
- Do changes in structure occur in response to events and processes (e.g., dieback of crowns) even though mortality of species does not occur?
- What are the observed changes in AGB as a function of processes such as woody thickening, tree dieback and fire?
  - Requirement for additional overflights

Land Cover Classification



Phase 1 Classification: Project 14.1 (2006 Imagery)

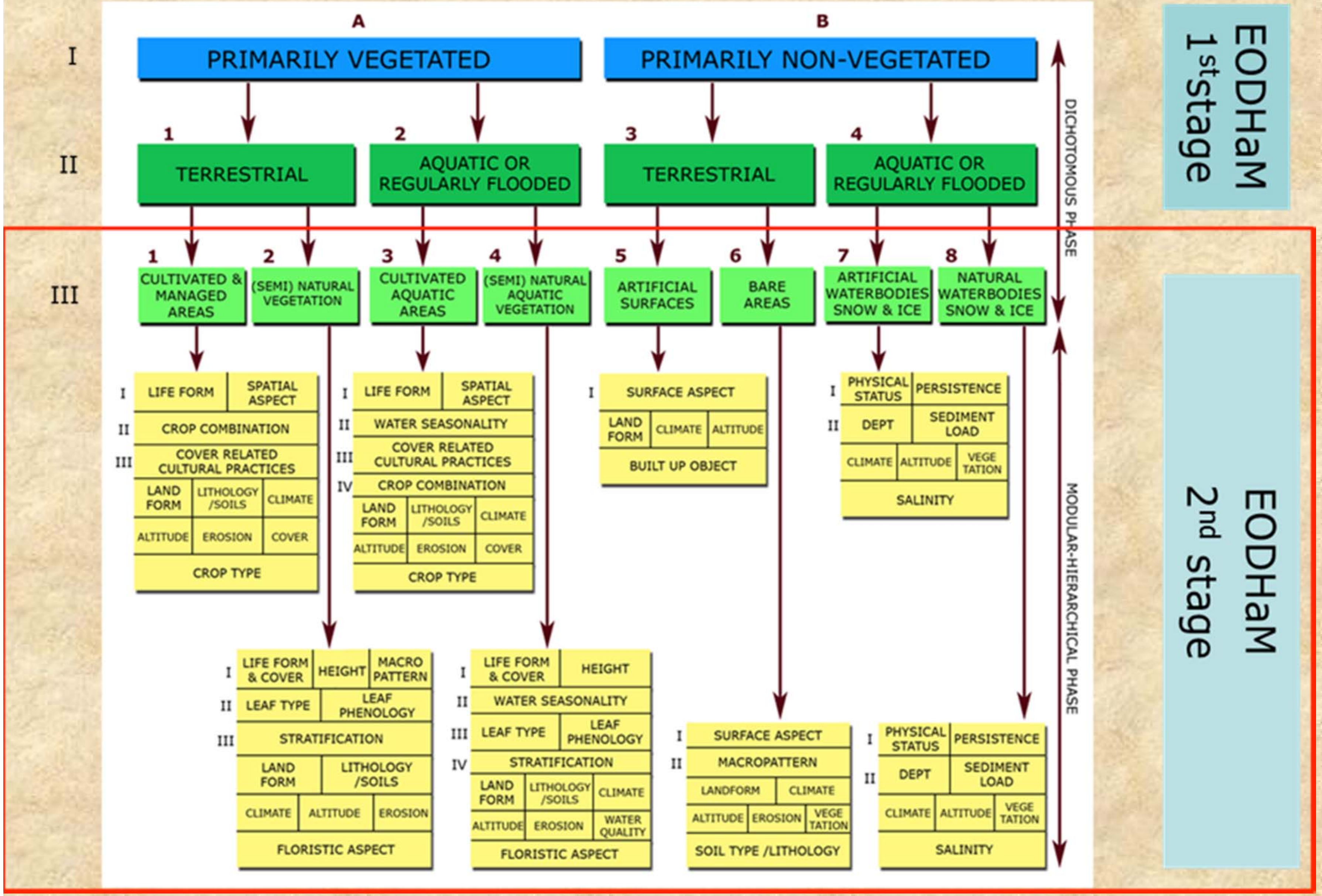


Environment SYSTEMS

PRIFYSGOL ABERYSTWYTH UNIVERSITY

This draft map has been produced by Environment Systems Limited using 2006 satellite imagery and eCognition software. Due to ongoing updates the validity of this map expires on 30/11/10.

Generalised Systems for Land Cover and Habitat Classification



Classification of LCCS Levels 1-3

Initial Segmentation/Classification to LCCS Levels 1-3

4. Cultivated/managed vs Natural/semi-natural*

3. Artificial versus Natural (bare and water bodies)*

2. Terrestrial vs Aquatic*

1. Vegetated vs Non-vegetated*

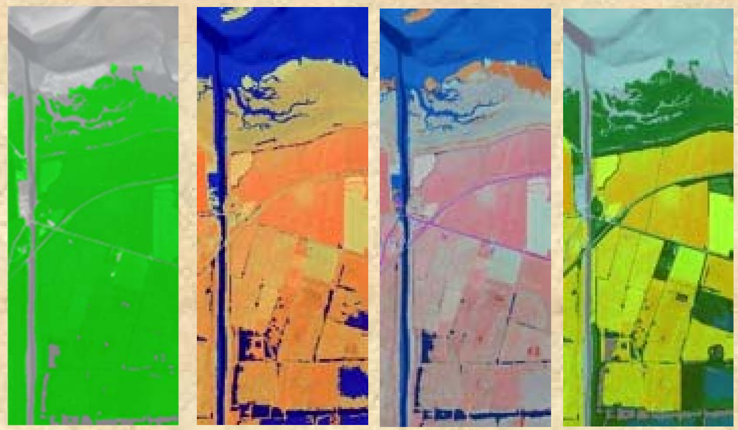
```python
#!/usr/bin/env python

import sys
from rios import rat
import numpy as np
import osgeo.gdal as gdal

WBI_PEAK_THRES = 1
WBI_POST_THRES = 1
GREENNESS_PEAK_THRES = 1
GREENNESS_POST_THRES = 1
NDVI_PEAK = 0.2
NDVI_POST = 0.2
```

2. Large objects (e.g., field boundaries)**

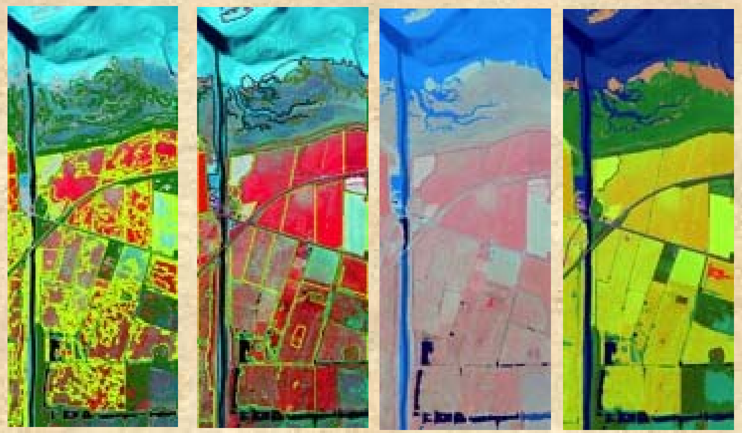
1. Water (flowing/standing; merged objects)**



Layers combined to generate LCCS Level 3 classification

*Layers above Level 1-3; deleted following generation of Layer 0: LCCS Level 1-3

**New layers inserted above Layer 0.



0. Level 1-3

0. Level 1-3

```python
def classifyLevel1FromImg(wbiPost, wbiPeak, psriPost, GreennessPeak, GreennessPost, Entropy, ndviPeak, ndviPost, BrightnessPost,
    BrightnessPeak, LengthWidthRatio):
    # Create Output Array
    l1P1 = np.empty_like(wbiPeak, dtype=np.dtype('a255'))
    l1P1[...] = "NA"
    # Urban
    l1P1 = np.where(np.logical_and(BrightnessPost > 0.56, BrightnessPeak > 0.56), "Urban", l1P1)
```

Classification beyond Level 3

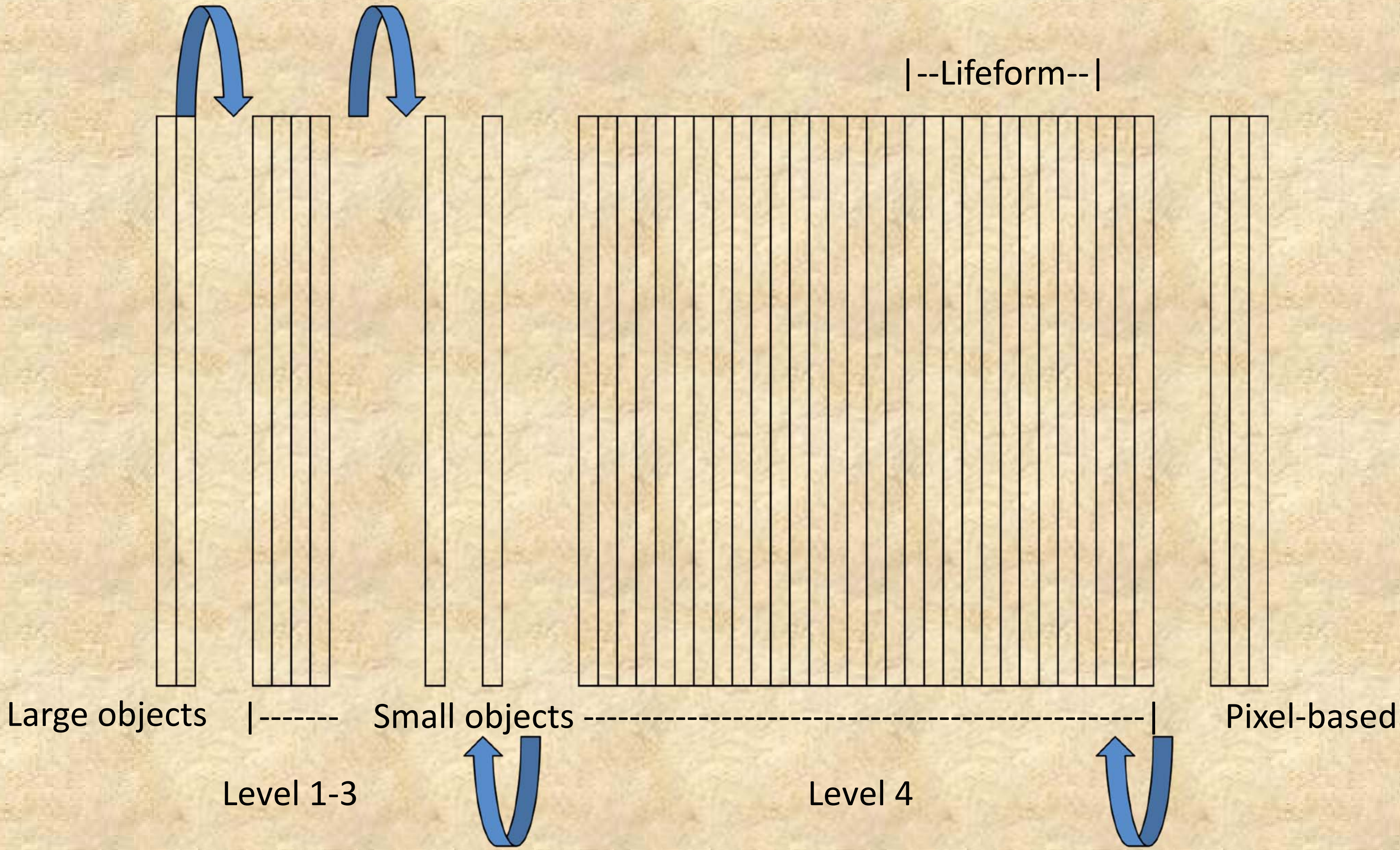
-1*. Lifeform Aquatic	-2. Water seasonality (nat)	-3. Crop lifeform	-4. Field Size	-5. Water seasonality (cul)
	-6. Cultural	-7. Crop. Combination		
-8. Artificial	-9. Surface aspect	-10. Urban density		
-11. Bare	-12. Surface aspect	-13. Material	-14. Macro-pattern	
-15. Water	-16. Physical status	-17. Dynamics	-18. Persistence	-19. Duration
	-20. Tidal	-21. Material	-22. Depth	-23. Sediment load
-24. Lifeform	-25. Cover (summer)	-26. Cover (winter)	-27. Height	-28. Leaf type
	-29. Phenology	-30. Distribution	-31. Stratification	

Temporary layers (pixel-based)

-32. Cover (summer)	-33. Cover (winter)	-34. -Phenology	-35. Materials

*Distance (in layers) below LCCS Classification level

Classification beyond Level 3
Raster Attribute Tables



Combining LCCS Codes

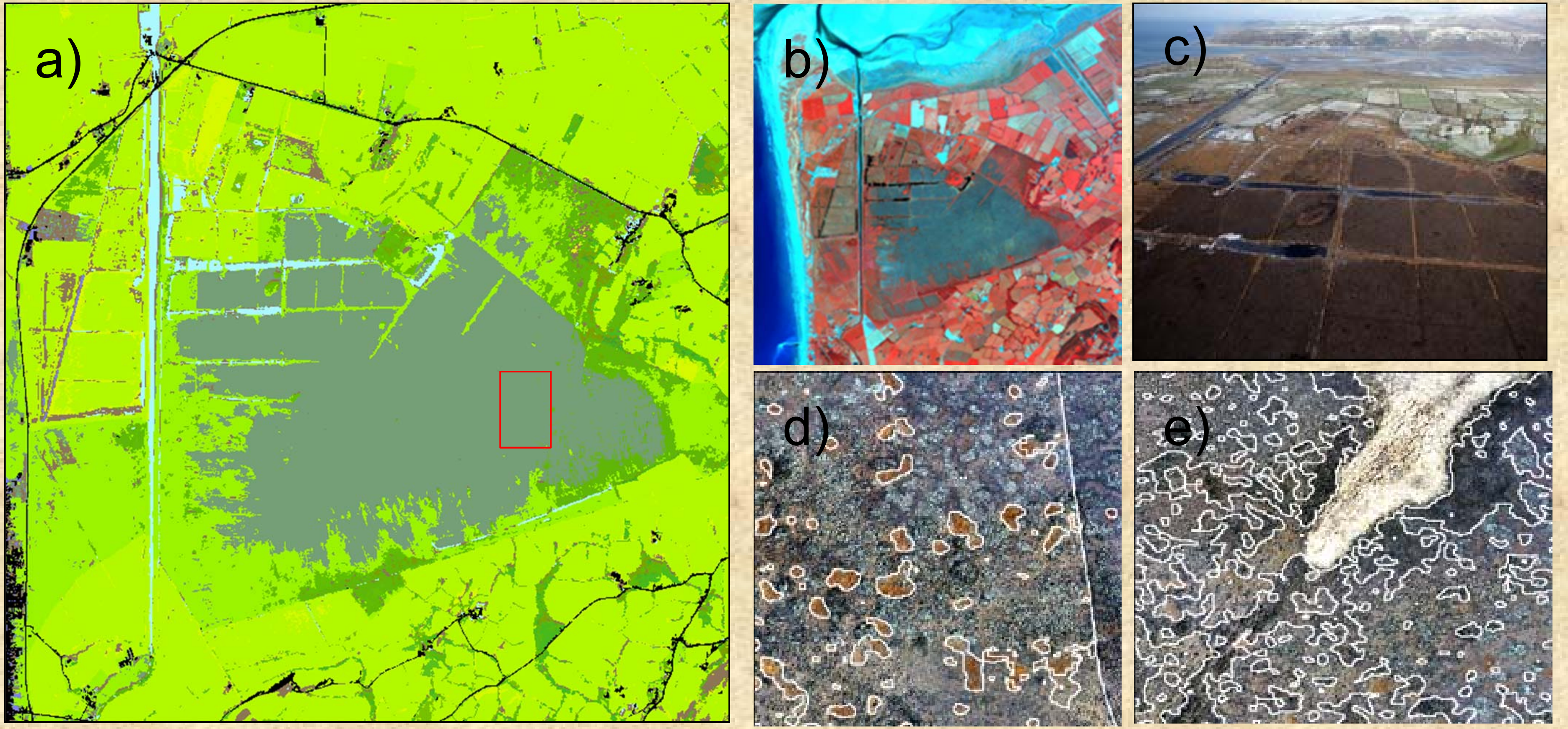
Supercatecory	Lifeform	Field Size	Cover	Cover Modifier	Leaf Type	Phenology	Phenology Mod	Height	Height Modifier	Surface Aspect	Surface Modifier	Physical Status	Persistence	Depth	LCCS code
A11	A1	B2	NA	NA	A7	A9	NA	NA	NA	NA	NA	NA	NA	NA	A11.A1.B2_A7.A9
A12	A1	NA	A11	A12	D1	E2	NA	NA	NA	NA	NA	NA	NA	NA	A12.A1.A11.D1.E2_A12
A12	A3	NA	A11	A12	D2	E2	NA	B3	B7	NA	NA	NA	NA	NA	A12.A3.A11.B3.D2.E2_A12.B7
A12	A6	NA	A10	NA	NA	E5	E6	B4	B13	NA	NA	NA	NA	NA	A12.A6.A10.B4.E5_B13.E6
A23	A1	B4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	A23.A1.B4
A24	A1	NA	A13	A15	D1	E2	NA	NA	NA	NA	NA	NA	NA	NA	A24.A1.A13.D1.E2_A15
B16	NA	NA	NA	NA	NA	NA	NA	NA	NA	A3	A8	NA	NA	NA	B16.A3_A8
B27	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	A1	B2	C2	B27.A1.B2.C2

Generation of LCCS descriptions

LCCS code	LCCS description
A11.A1.B2_A7.A9	Small sized field of Broadleaved Evergreen Tree crops
A12.A1.A11.D1.E2_A12	Broad-leaved Deciduous Open (40-65%) Woody vegetation
A12.A3.A11.B3.D2.E2_A12.B7	Needle-leaved Deciduous Open (40-65%) Low Trees
A12.A6.A10.B4.E5_B13.E6	Perennial Short Closed Graminoids
A23.A1.B4	Graminoid crops
A24.A1.A13.D1.E2_A15	Broadleaved Deciduous Open (15-40%) Woody vegetation on Flooded land
B16.A3_A8	Gravel, Stones and Boulders
B27.A1.B2.C2	Turbid Shallow Artificial waterbodies

LCCS Classes, Cors Fochno, Wales

LCCS Class Description	
Broadleaved Deciduous Closed Low Trees	Graminoid crops
Broadleaved Deciduous Closed Medium High Shrubland (thicket)	Graminoids on Flooded land
Broadleaved Deciduous Closed Medium Trees	Gravel, Stones and Boulders
Broadleaved Deciduous Closed Shrubland (thicket)	Large sized field of Broadleaved Deciduous Shrub crops
Broadleaved Deciduous Closed Woody vegetation	Large sized field of Broadleaved Deciduous Tree crops
Broadleaved Deciduous Low Trees on Flooded land	Large sized field of Broadleaved Evergreen Shrub crops
Broadleaved Deciduous Medium High Shrubland (thicket) on Flooded land	Large sized field of Broadleaved Evergreen Tree crops
Broadleaved Deciduous Medium Trees on Flooded land	Large sized field of Needleleaved Deciduous Shrub crops
Broadleaved Deciduous Open (15-40%) Low Trees on Flooded land	Large sized field of Needleleaved Deciduous Tree crops
Broadleaved Deciduous Open (15-40%) Medium High Shrubland (thicket) on Flooded land	Large sized field of Needleleaved Evergreen Tree crops
Broadleaved Deciduous Open (15-40%) Shrubland (thicket) on Flooded land	Medium sized field of Broadleaved Deciduous Tree crops
Broadleaved Deciduous Open (15-40%) Woody vegetation on Flooded land	Needleleaved Deciduous Closed Low Trees
Broadleaved Deciduous Open (40-65%) Low Trees	Needleleaved Deciduous Closed Medium High Shrubland (thicket)
Broadleaved Deciduous Open (40-65%) Low Trees on Flooded land	Needleleaved Deciduous Closed Medium Trees
Broadleaved Deciduous Open (40-65%) Medium High Shrubland (thicket)	Needleleaved Deciduous Closed Shrubland (thicket)
Broadleaved Deciduous Open (40-65%) Medium High Shrubland (thicket) on Flooded land	Needleleaved Deciduous Closed Woody vegetation
Broadleaved Deciduous Open (40-65%) Medium Trees	Needleleaved Deciduous Open (15-40%) Low Trees on Flooded land
Broadleaved Deciduous Open (40-65%) Medium Trees on Flooded land	Needleleaved Deciduous Open (15-40%) Medium Trees on Flooded land
Broadleaved Deciduous Open (40-65%) Shrubland (thicket)	Needleleaved Deciduous Open (15-40%) Woody vegetation on Flooded land
Broadleaved Deciduous Open (40-65%) Shrubland (thicket) on Flooded land	Needleleaved Deciduous Open (40-65%) Low Trees
Broadleaved Deciduous Open (40-65%) Woody vegetation	Needleleaved Deciduous Open (40-65%) Low Trees on Flooded land
Broadleaved Deciduous Open (40-65%) Woody vegetation on Flooded land	Needleleaved Deciduous Open (40-65%) Medium High Shrubland (thicket)
Broadleaved Deciduous Shrub crops	Needleleaved Deciduous Open (40-65%) Medium High
Broadleaved Deciduous Shrubland (thicket) on Flooded land	Needleleaved Deciduous Open (40-65%) Shrubland (thicket) on Flooded land
Broadleaved Deciduous Tree crops	Needleleaved Deciduous Open (40-65%) Woody vegetation
Broadleaved Deciduous Woody vegetation on Flooded land	Needleleaved Deciduous Open (40-65%) Woody vegetation on Flooded land
Broadleaved Evergreen Shrub crops	Needleleaved Deciduous Shrub crops
Broadleaved Evergreen Tree crops	



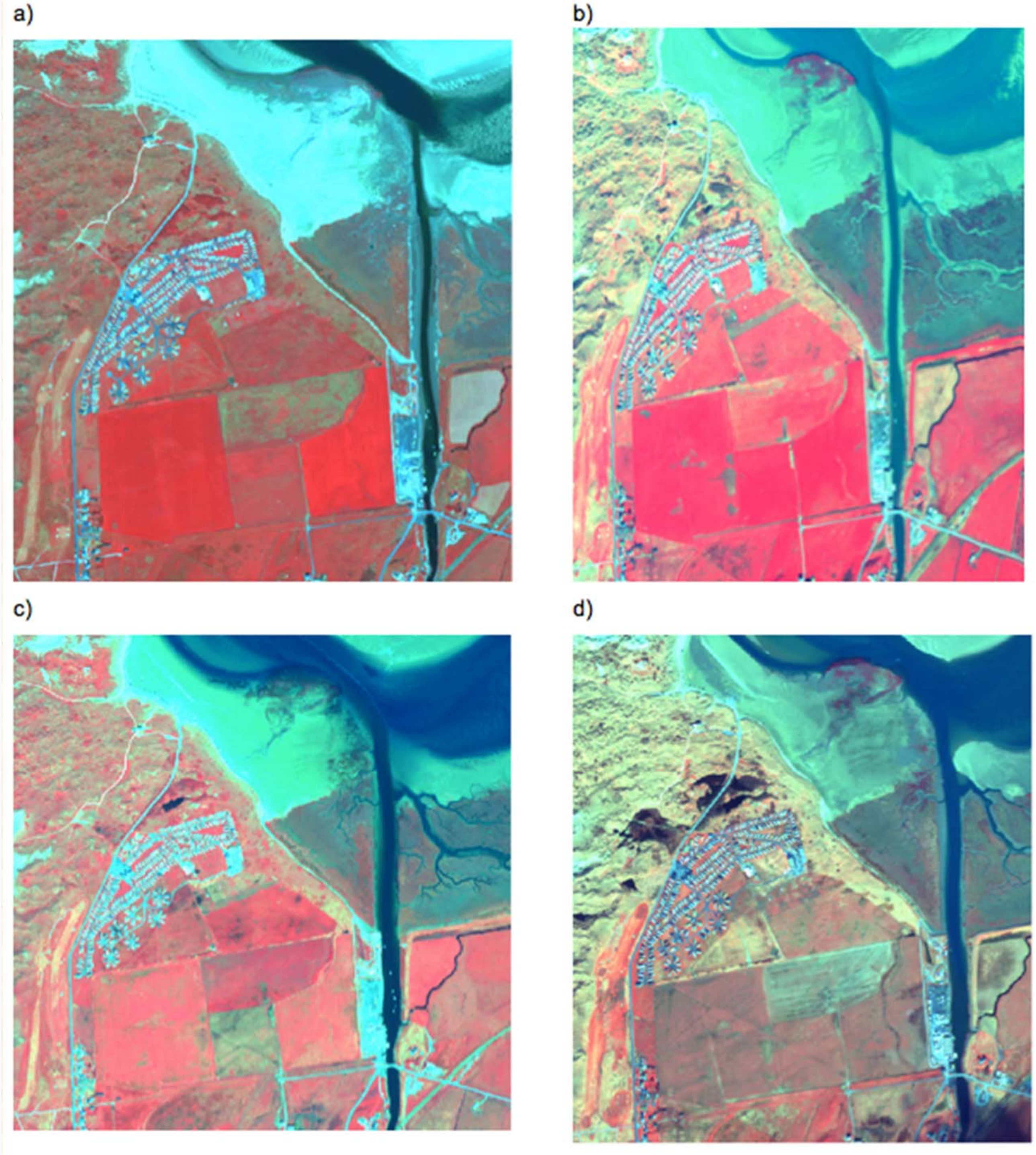
"a) Classification of General Habitat Categories, Cors Fochno, mid Wales, generated using b) multi-temporal Worldview data and showing the active raised bog (centre), surrounding agricultural (light green) and bare (primarily infrastructure) areas (brown/black), and semi-natural vegetation, including grasslands (mid green, adjacent to the bog) and forests (darker shades of green). A more detailed classification of c) the active raised bog (see red box; aerial photograph courtesy of Toby Driver, RCAHMW) shows the extent of d) Sphagnum (orange) and e) Calluna (dark grey) species overlain onto Unmanned Airborne System (UAS) imagery acquired in 2012.

Standardized land cover maps at local to global scales relevant to numerous activities (e.g., UN REDD, EU Habitats Directive etc.)

FAO LCCS Colour Scheme

A12	needleleaved	evergreen	high	Trees
			medium	
			low	
			high	Shrubs
			medium-high	
			medium	
			dwarf	
		deciduous	high	Trees
			medium	
			low	
			high	Shrubs
			medium-high	
			medium	
			dwarf	
	broadleaved	evergreen	high	Trees
			medium	
			low	
			high	Shrubs
			medium-high	
			medium	
			dwarf	
		deciduous	high	Trees
			medium	
			low	
			high	Shrubs
			medium-high	
			medium	
			dwarf	

A12	herbaceous	annual	high
			medium-high
			medium
			dwarf
		perrenial	high
			medium-high
			medium
			dwarf
	forbs	annual	high
			medium-high
			medium
			dwarf
		perrenial	high
			medium-high
			medium
			dwarf
	graminoids	annual	high
			medium-high
			medium
			dwarf
		perrenial	high
			medium-high
			medium
			dwarf
	lichens/mosses		
	lichens		
	mosses		



Changes in Water Extent

a) July 2011
b) March 2012
c) July 2012
d) April 2013

Changes in components of the LCCS class and hence LCCS class

Overview

- Progress towards generation of biomass and structural map for Australia based on integration of ALOS PALSAR, Landsat-derived persistent green and ICESAT GLAS.
  - Evaluation of contribution of each
- Regrowth mapping
  - Example for the Brigalow Belt Bioregion
  - Differentiation of regrowth stage, including early and remnant stage.
- Capacity for regional ecosystem mapping
- Land cover and habitat classification.
  - FAO LCCS
- Validation with reference to extensive airborne and ground data sets
  - LiDAR
  - Field measurements of biomass
- Datasets provided to and available to JAXA.
- All software open source and available to JAXA.
- Addresses carbon cycle science, conservation of biodiversity and contributions to international agreements (e.g. UNREDD).