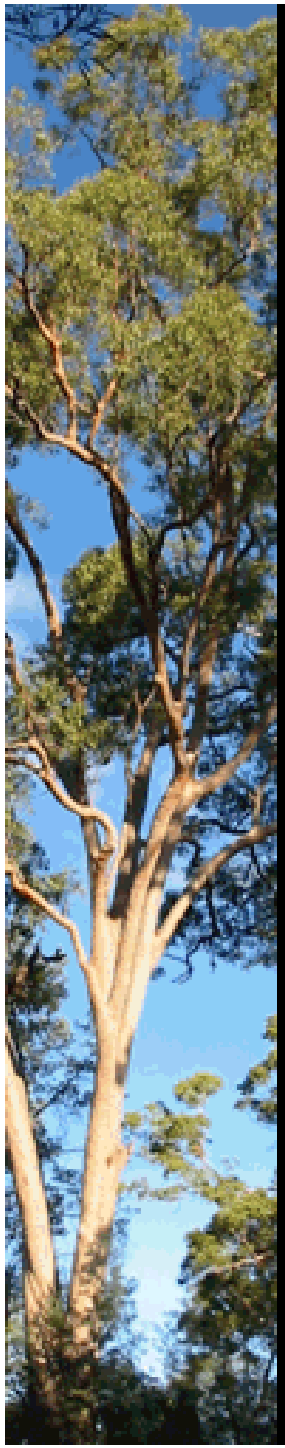


Forest Theme Results
Australia

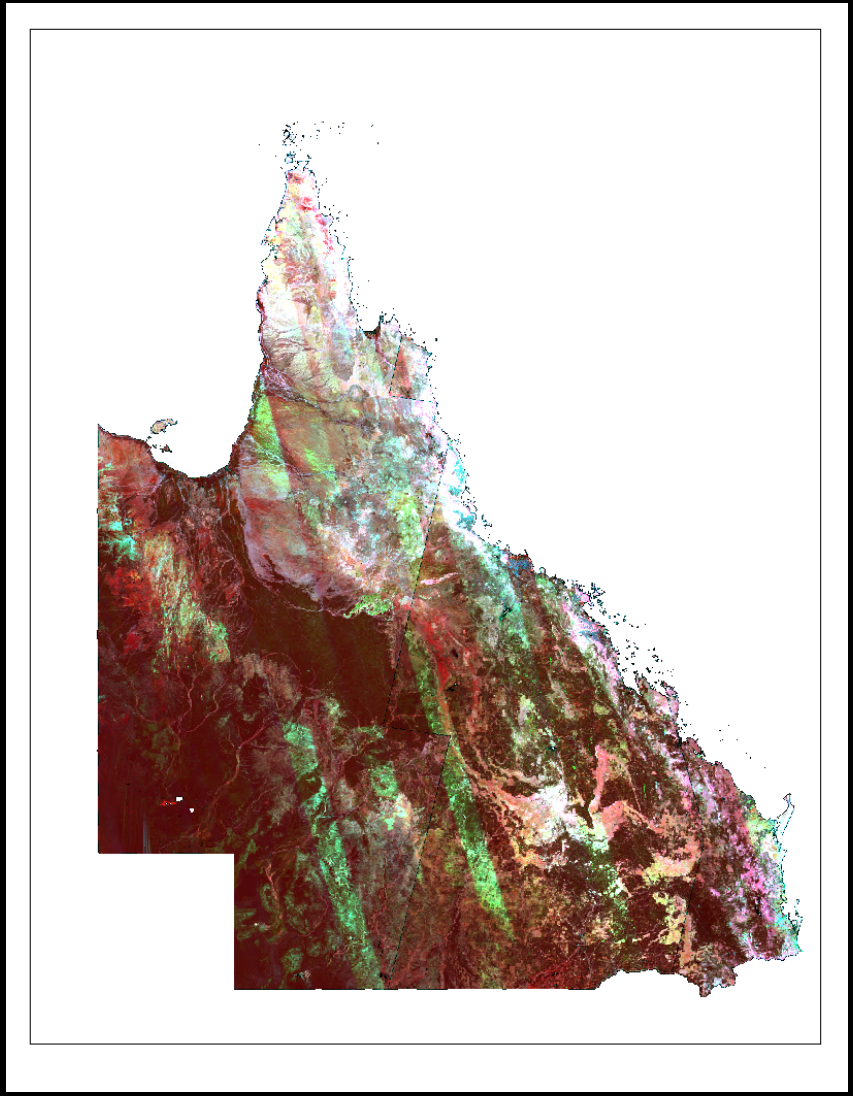
Richard Lucas

Institute of Geography and Earth Sciences, Aberystwyth University, Ceredigion, Aberystwyth, Wales, SY23 2EJ
(rml@aber.ac.uk)

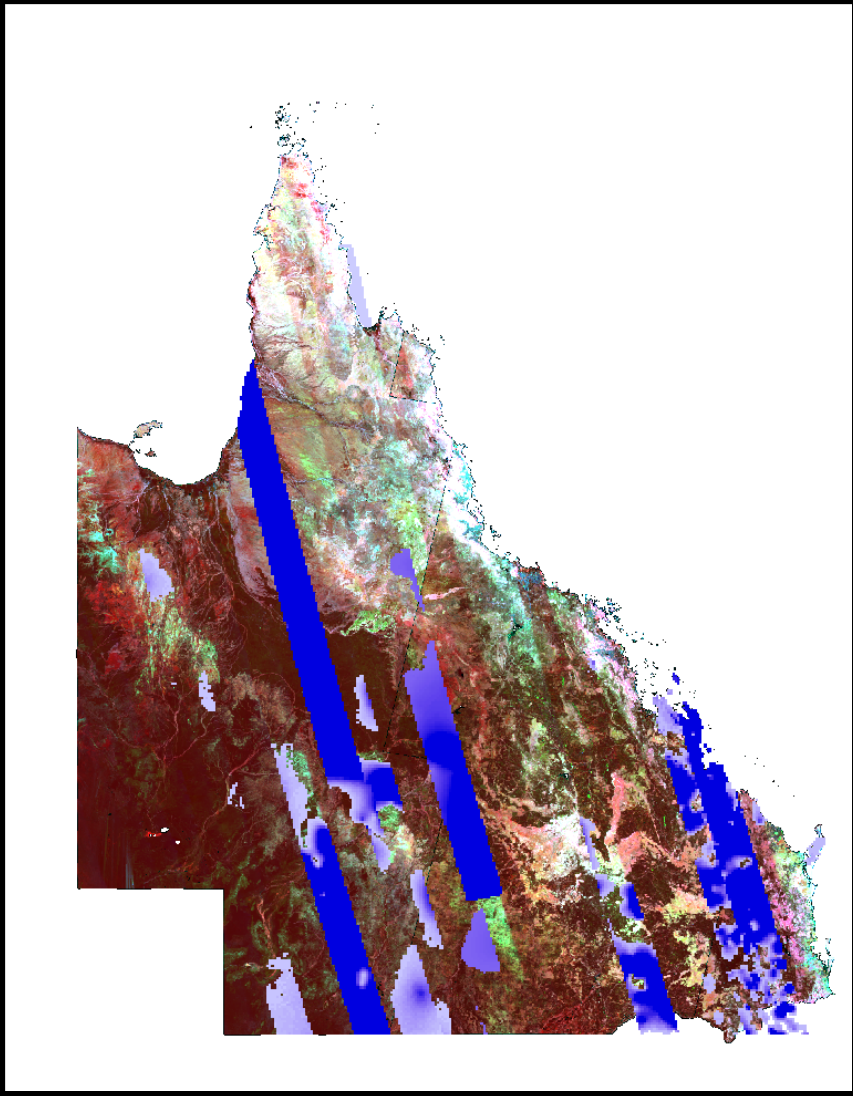
Overview

- Understanding variability in ALOS strips
  - Variations in brightness between image strips from different dates and also locations.
- Collation of additional datasets to refine algorithms for retrieving structure and biomass
  - Wide range of forest types (open versus closed)
  - Various states of regeneration and degradation
  - Requirement for calibration and validation of retrieval algorithms
- Regenerating forests
  - Variability in structural form and development of regrowth
  - New requirements based on recent moratorium on regrowth clearing (April, 2009)
- Development of retrieval algorithms
  - Particular focus on non-linear estimation with Mahta Moghaddam
  - NASA-funded DESDynI (Paul Siqueira, Bruce Chapman).

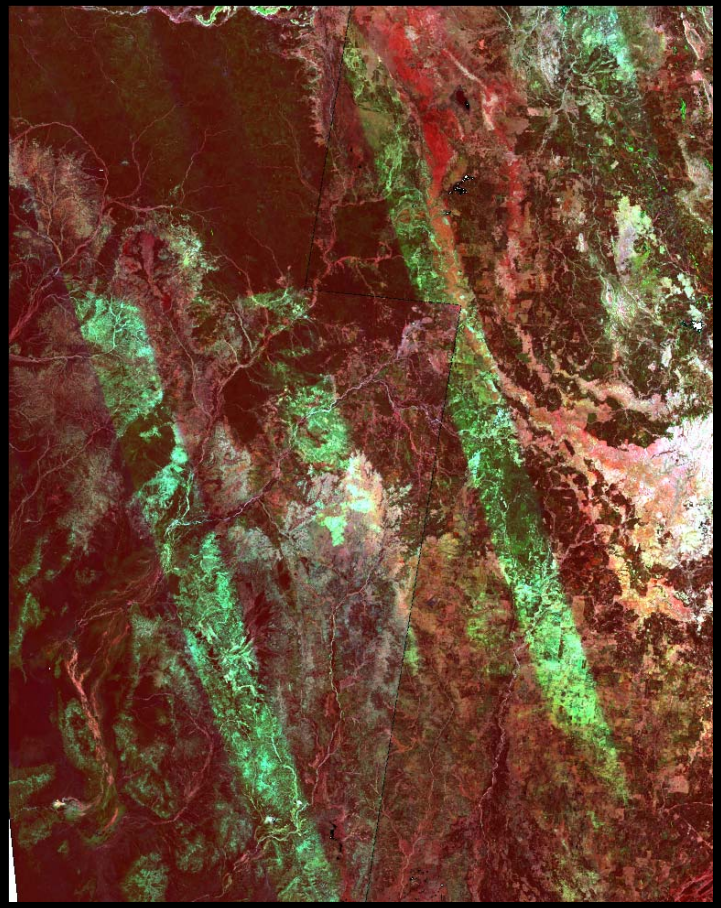
Understanding Variability in Strips

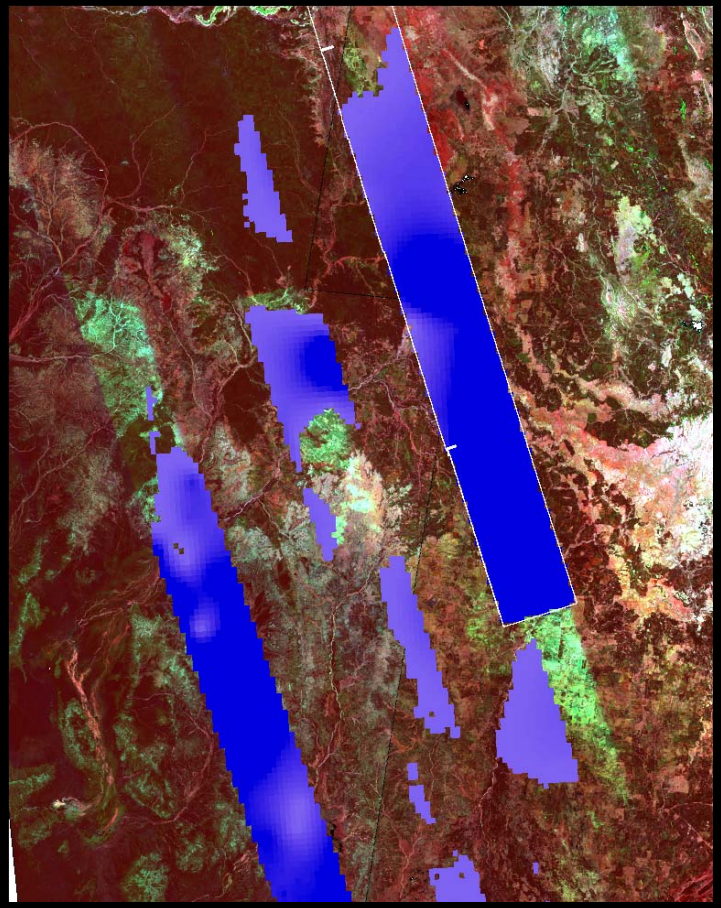


Landsat FPC / ALOS PALSAR mosaic



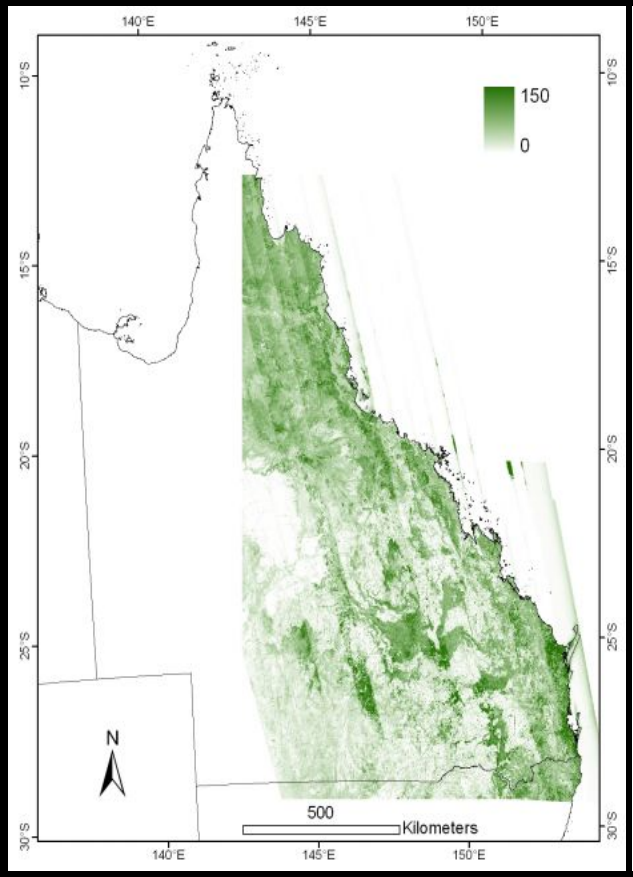
Rainfall surfaces (day of acquisition)



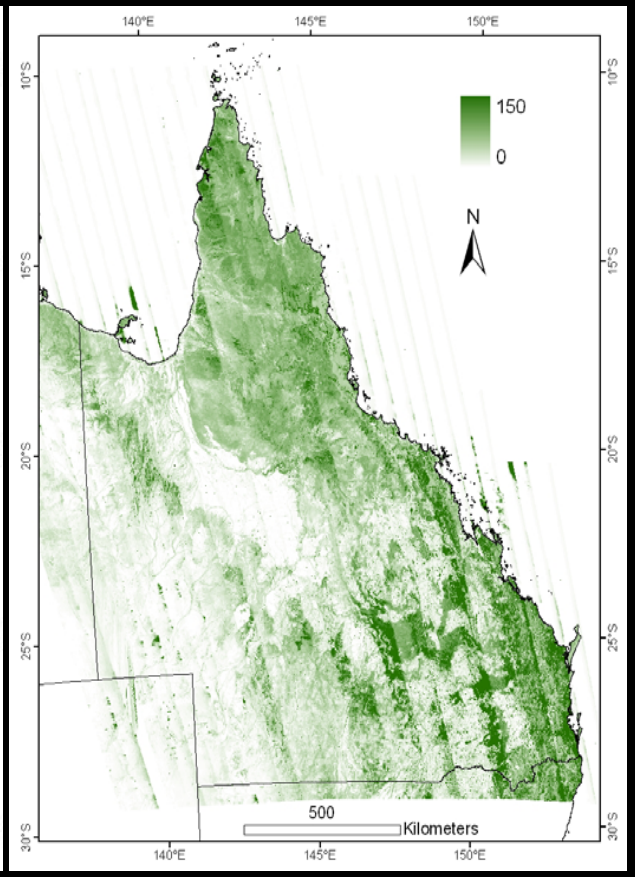


- **Suggests that:**
  - **In wetter environments (e.g., boreal, tropical zones), soil and vegetation continually has a high moisture content and hence enhanced backscatter.**
  - **In dryer environments (e.g., wooded savannas) with high rates of evaporation, backscatter is lower.**
  - **May contribute to differences in relationships observed between open (typical to dryer environments) and closed (wetter environments)**
  - **Consideration of rainfall amount and soil moisture retention important when formulating generic equations.**

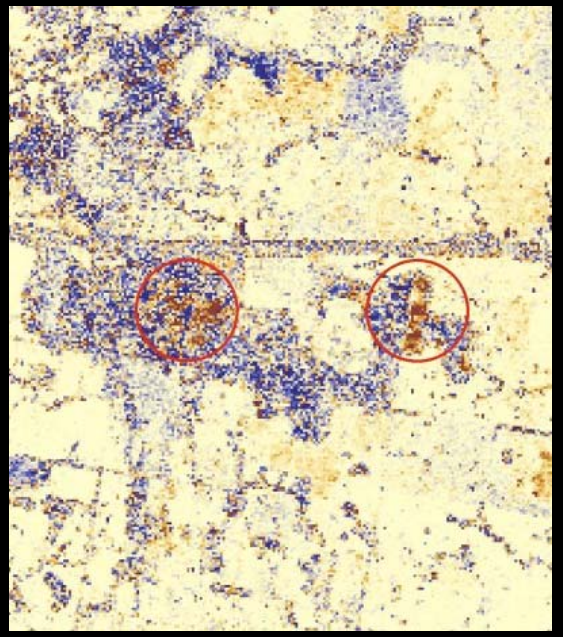
Implications for Biomass Change Detection



2007



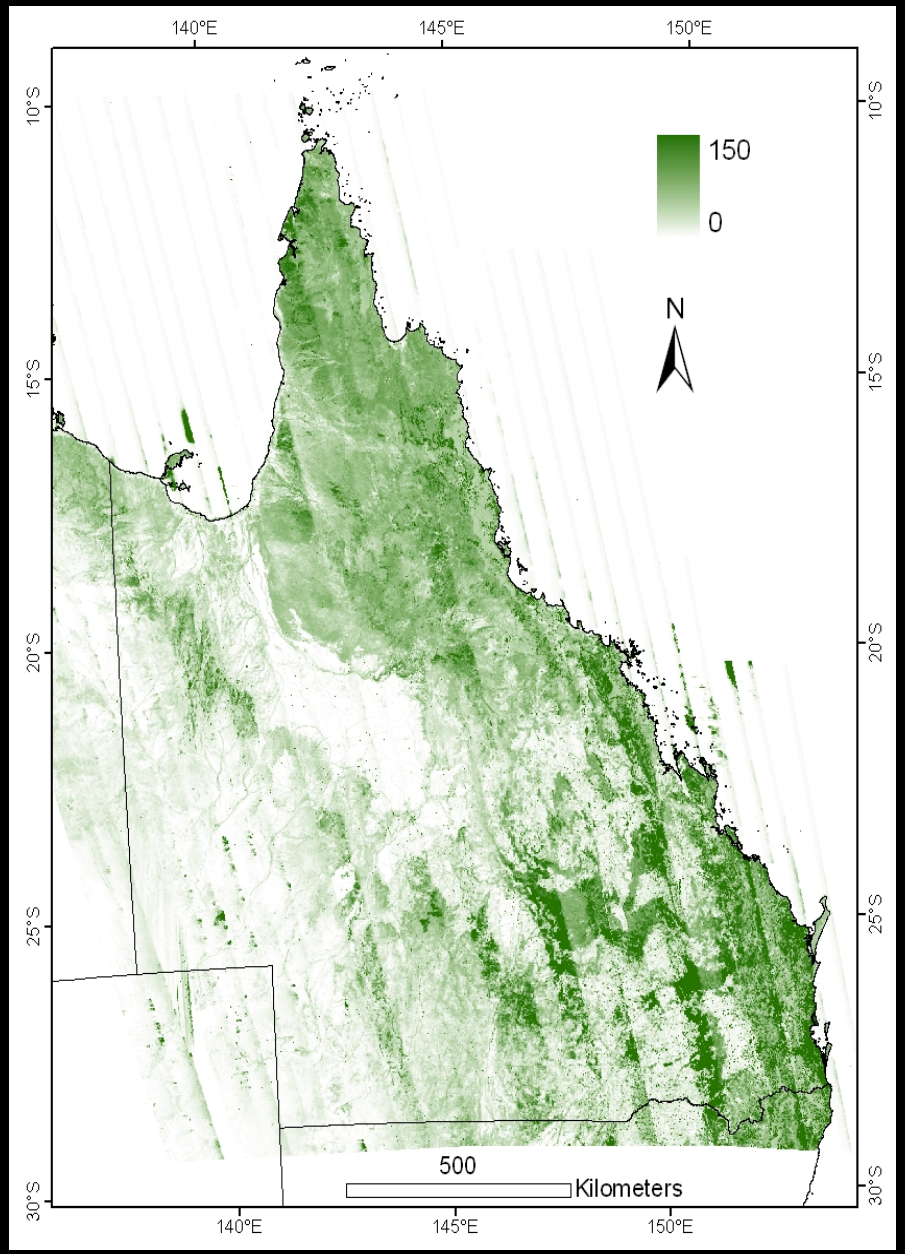
2008

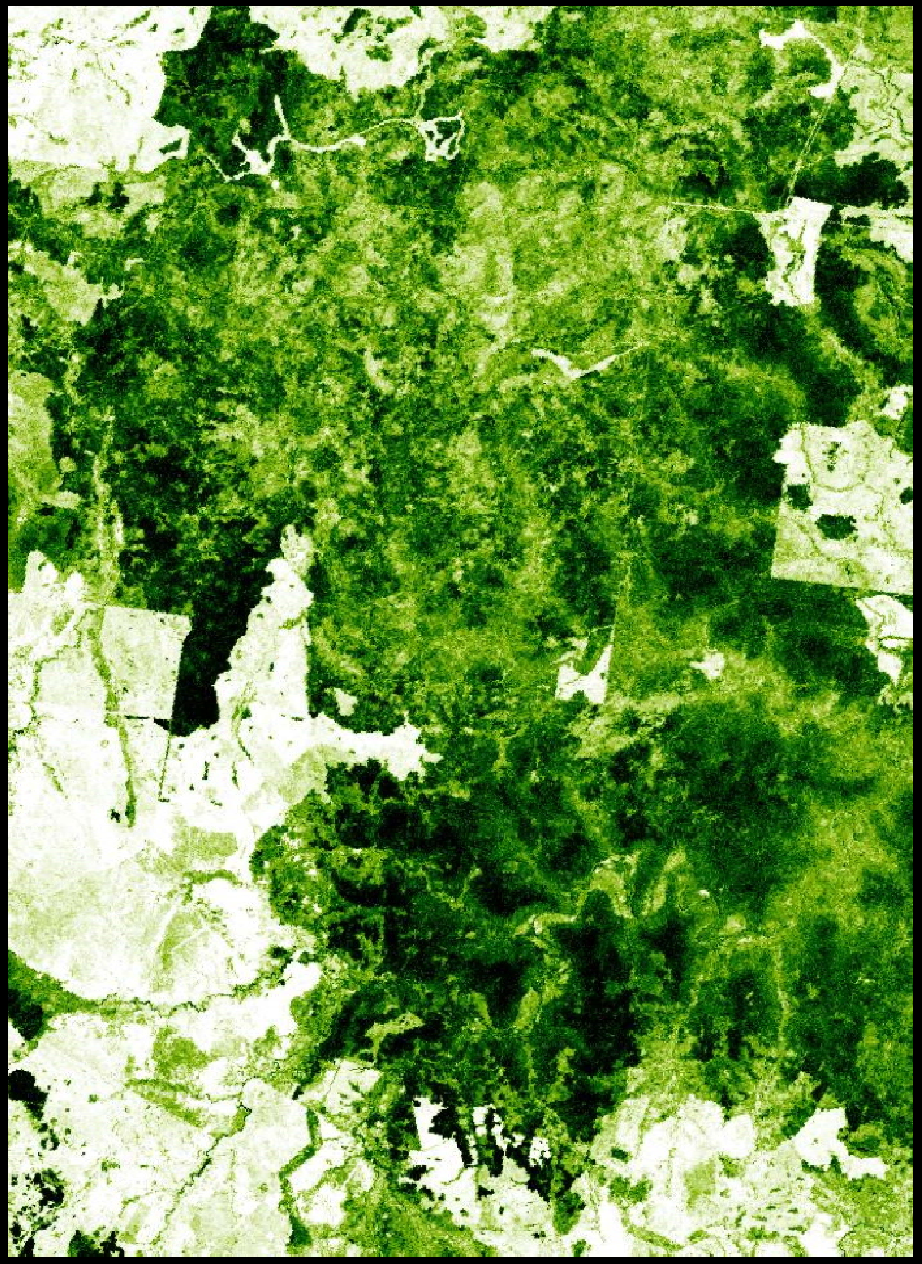


Biomass losses in red, gains in blue

- Requirement for consistency in backscatter within and between data to allow biomass change to be detected and quantified.

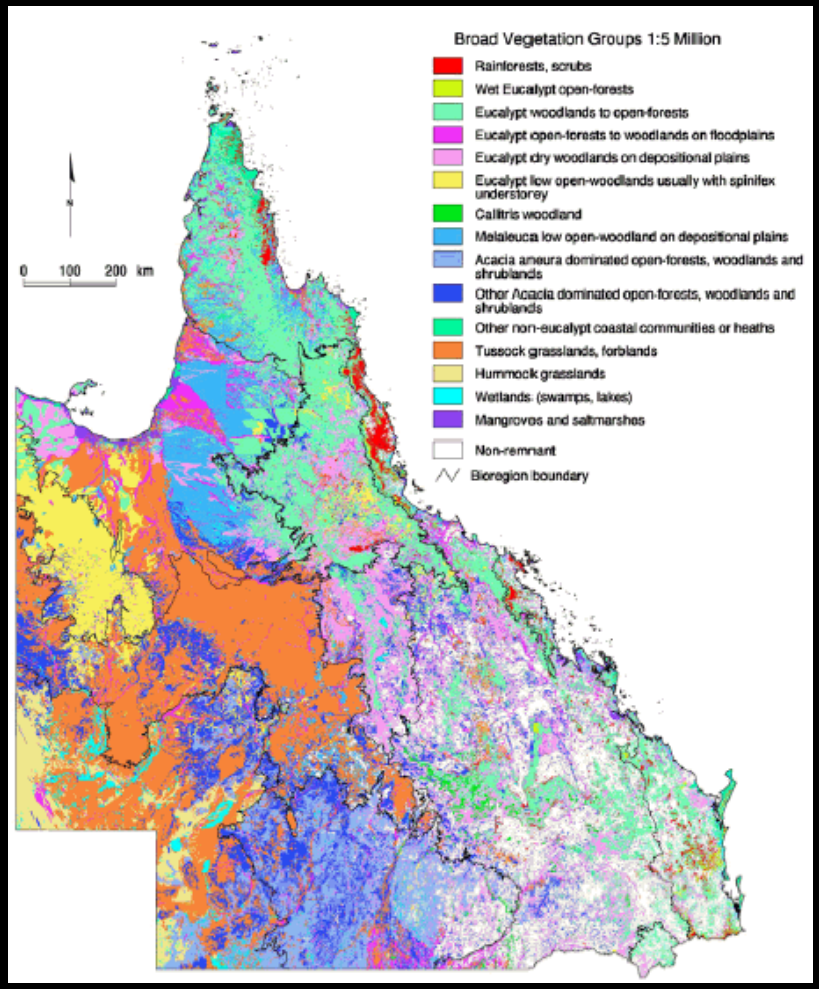
Revision of biomass estimates based on ALOS PALSAR data



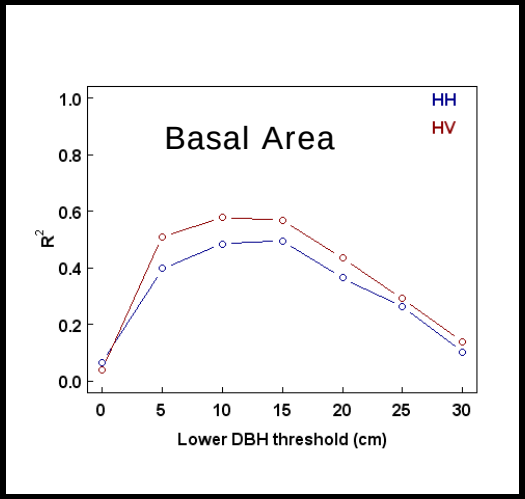


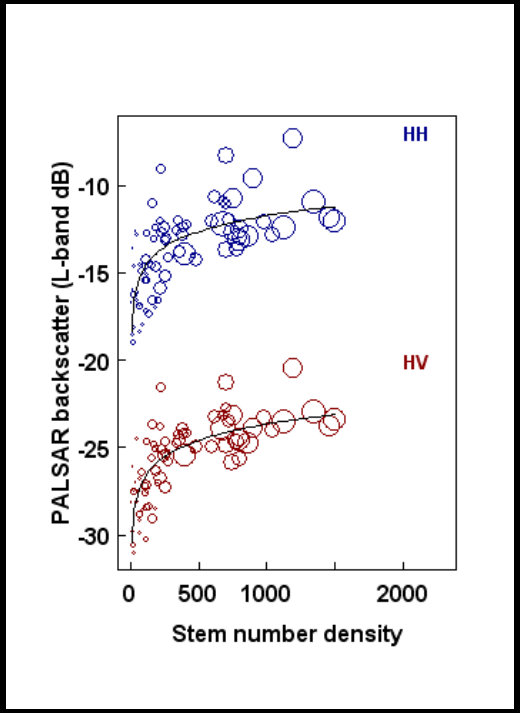
Vegetation Distributions, Queensland

Major vegetation group	Area Pre-European (km^2)	Area (circa 1997) (km^2)	% of total Extent remaining
Eucalypt woodlands	473,272	367,293	77.6
Tussock grasslands	294,662	282,547	95.9
Eucalypt open woodlands	165,065	134,421	81.4
Acacia shrublands	104,368	100,660	96.4
Hummock grasslands	92,009	91,809	99.8
Acacia forests and woodlands	182,089	91,534	50.3
Chenopod shrubs, samphire shrubs and forblands	82,070	81,944	99.8
Melaleuca forests and woodlands	72,173	70,014	97
Other forests and woodlands	49,692	49,266	99.1
Acacia open woodlands	39,861	36,734	92.2
Eucalypt open forests	62,646	35,150	56.1
Tropical eucalypt woodlands/grasslands	20,684	20,653	99.9
Rainforest and vine thickets	30,055	19,558	65.1
Other shrublands	16,780	16,419	97.8
Mangroves, tidal mudflats, samphires and bare areas, claypans, sand, rock, salt lakes, lagoons, lakes	15,442	15,143	98.1
Other grasslands, herblands, sedgelands and rushlands	4,963	4,771	96.1
Callitris forests and woodlands	5,601	4,134	73.8
Casuarina forests and woodlands	11,951	1,545	12.9
Heath	633	470	74.2
Low closed forests and closed shrublands	449	445	99.1
Eucalypt tall open forests	3,976	429	10.8
Eucalypt low open forests	111	111	100
Mallee woodland and shrublands	14	14	100



Differences in SAR-biomass relationships by forest type

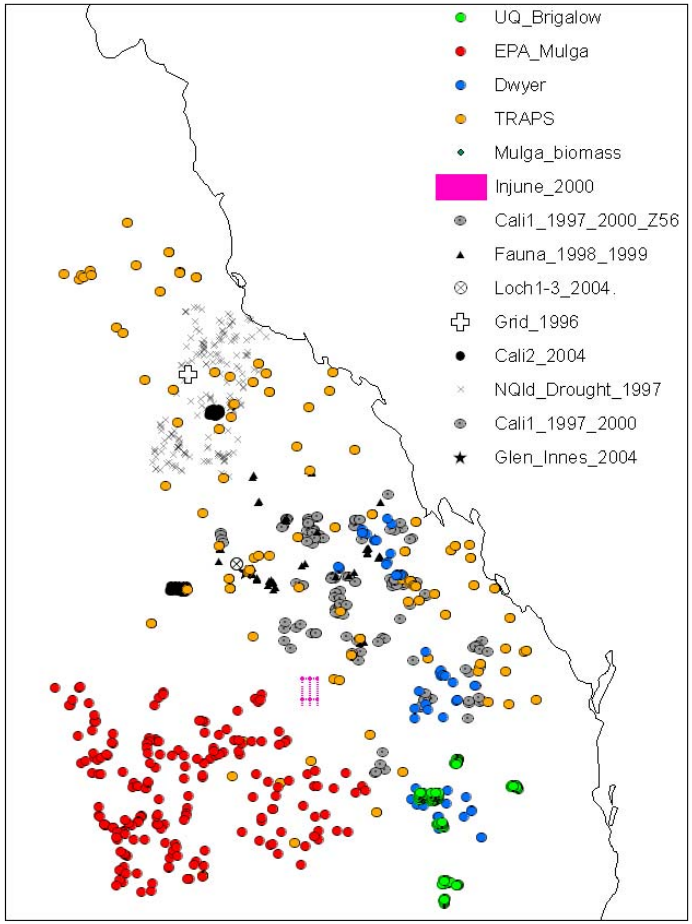




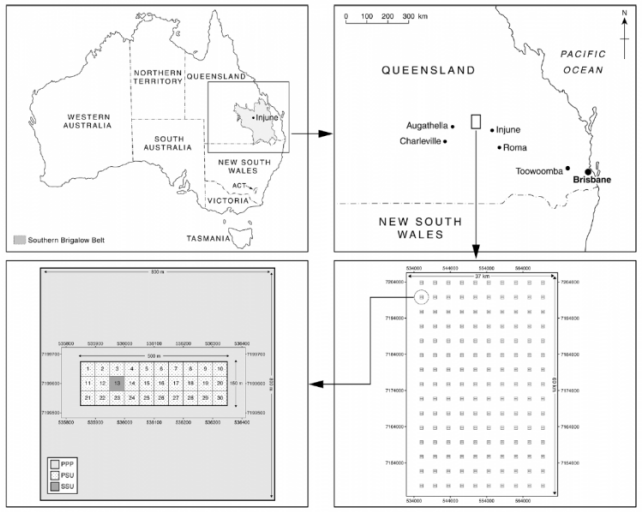
- **Differences in γ^o identified between open forests, closed forests and mangroves**
- **Attributable in part to structural differences**
  - **In open forests, less L-band interaction with smaller stems.**
  - **Noticeable increase in strength of empirical relationship when only stems above a certain size class are observed.**
  - **Not all biomass detected with lower frequency SAR (applies largely to open forests)**

Field-based estimates of biomass, structure and species

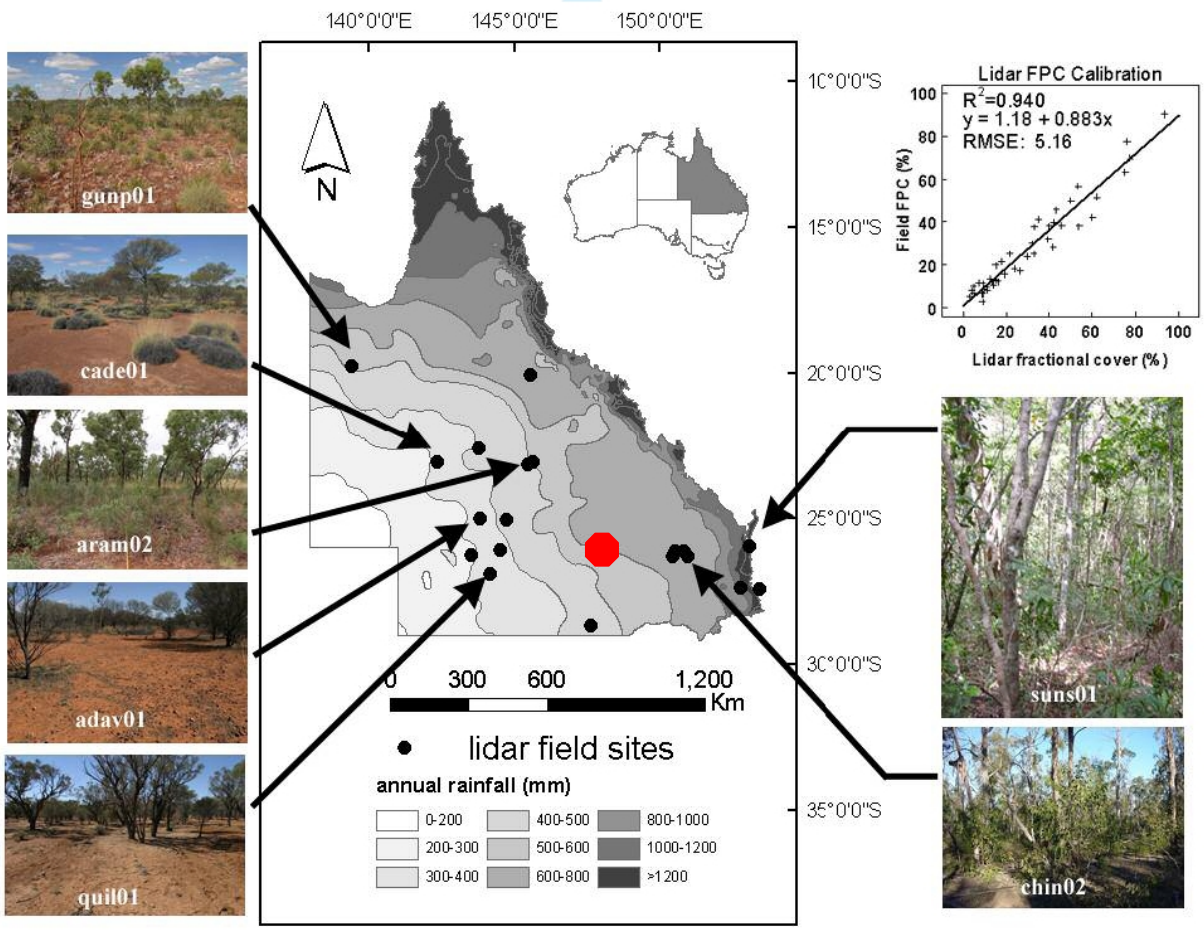
- Pre and post-2006
- Biomass estimated using species-specific and generic allometric equations
- Provides estimates of trunk and branch biomass
- Additional datasets include:
  - Closed forest
    - Wet Tropics
    - Border Ranges
    - Brisbane Forest
- Over 800 independent measures of biomass across a range of forest structural types and regeneration/degradation stages



Integration of Airborne LiDAR



Injune
Flight configuration



Airborne LiDAR acquired in 2008/2009 in areas with fully polarimetric and FBD ALOS data.

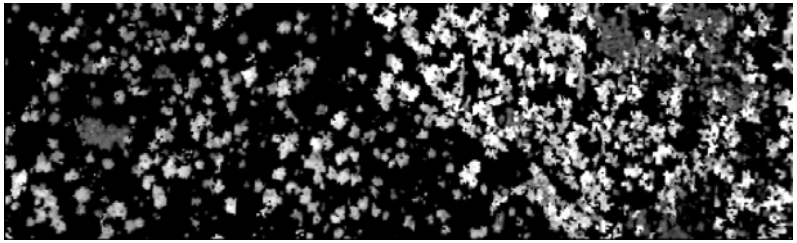
Repeat acquisitions over Injune (2000 and 2009)

19 other forest types images (2004 and 2008)

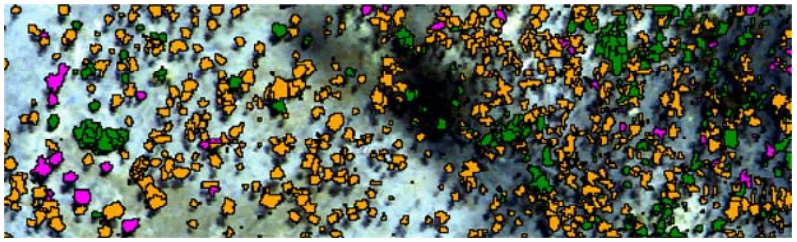
Other remote sensing (e.g., hyperspectral and terrestrial scanner data) acquired

Tree to Stand Level Products

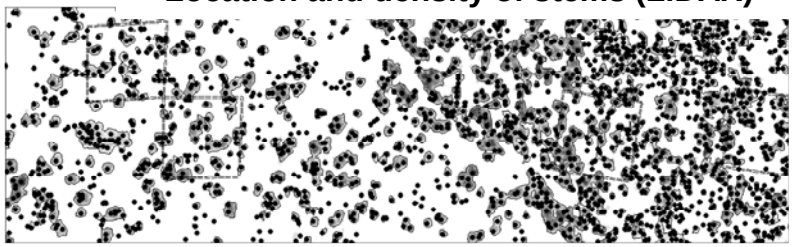
Tree height (LiDAR)



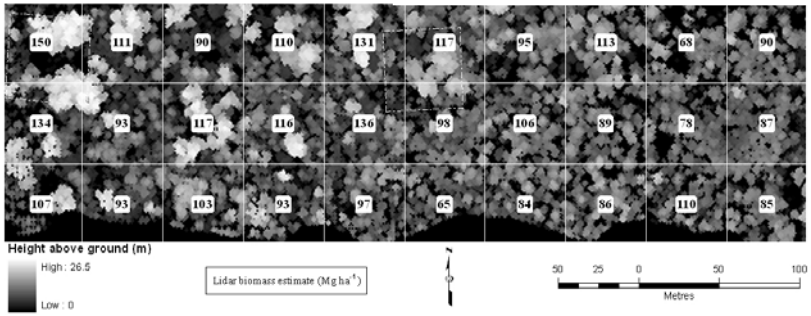
Species (Hyperspectral)

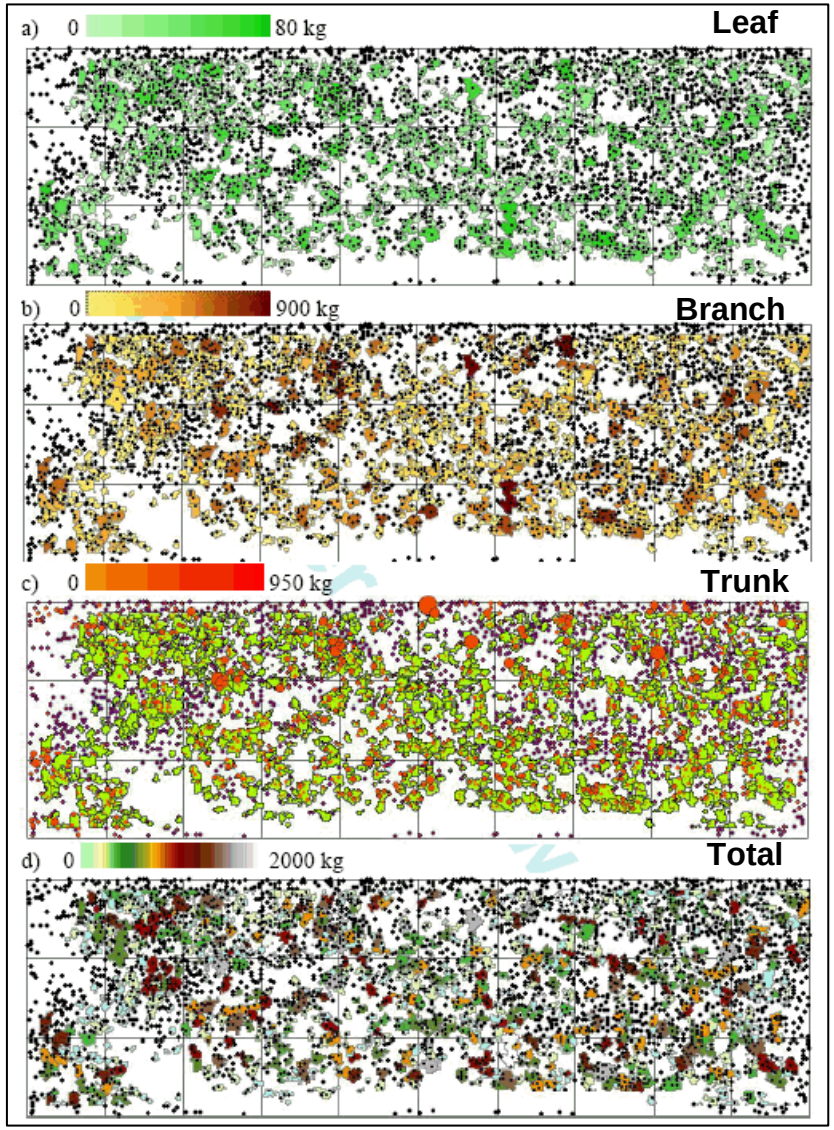


Location and density of stems (LiDAR)

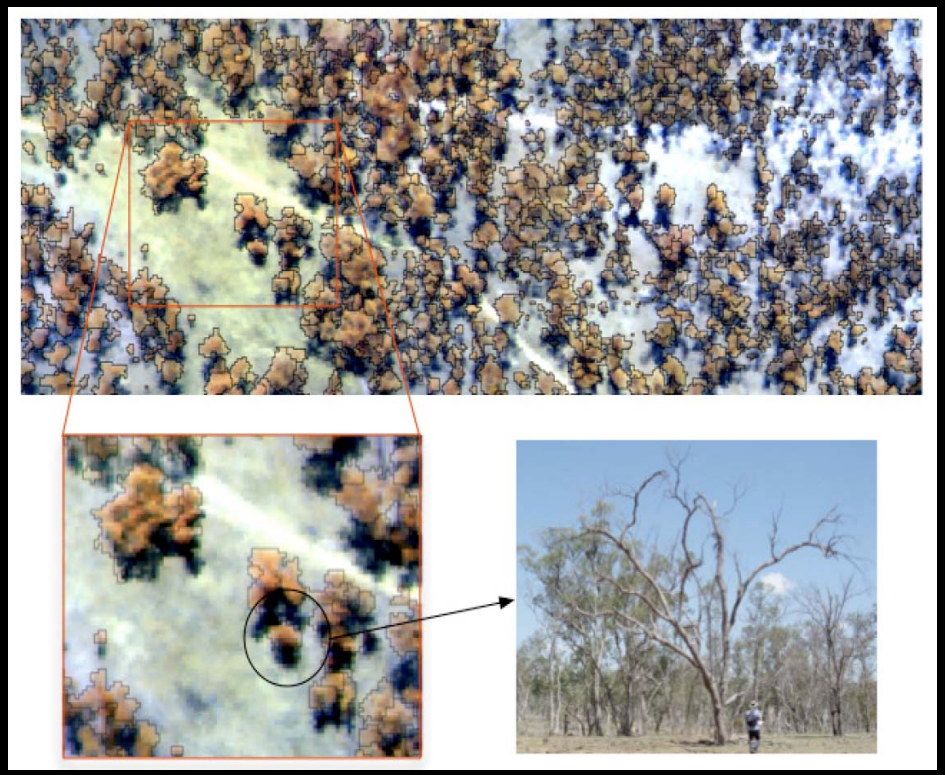


Stand-level biomass





Detection of Environmental Change



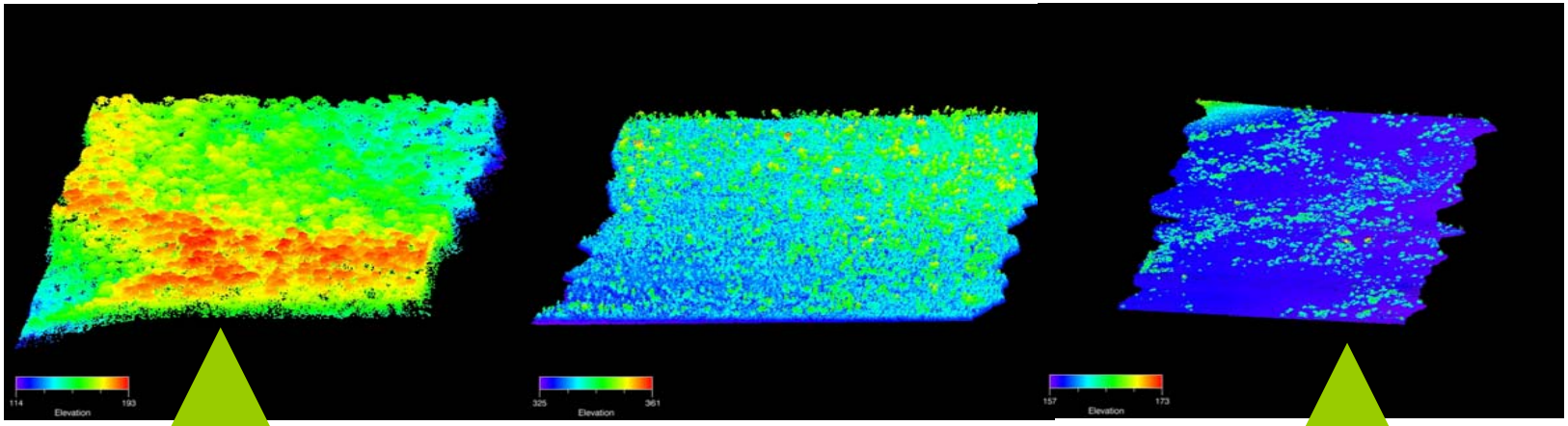
Drought impacts,
Injune, Queensland

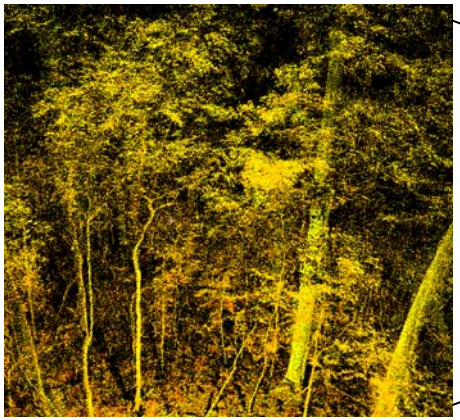
- Time-series comparison of LiDAR/optical data/products
  - 2000 (Injune)
  - 2004/5
  - 2008/9
- Time-series comparisons
  - JERS-1 SAR
  - ALOS PALSAR (2007 onwards)
  - Landsat-derived FPC
- Detection of:
  - Woody thickening
  - Forest degradation

New Datasets for Interpreting ALOS PALSAR data

Airborne Laser Scanner data

Tropical rainforest | Wooded savanna | Low open woodland

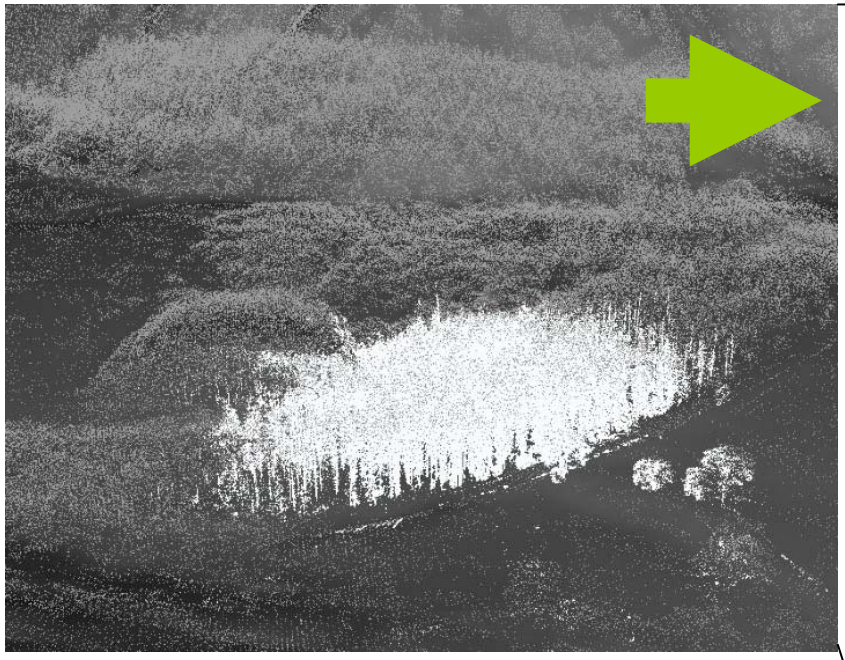




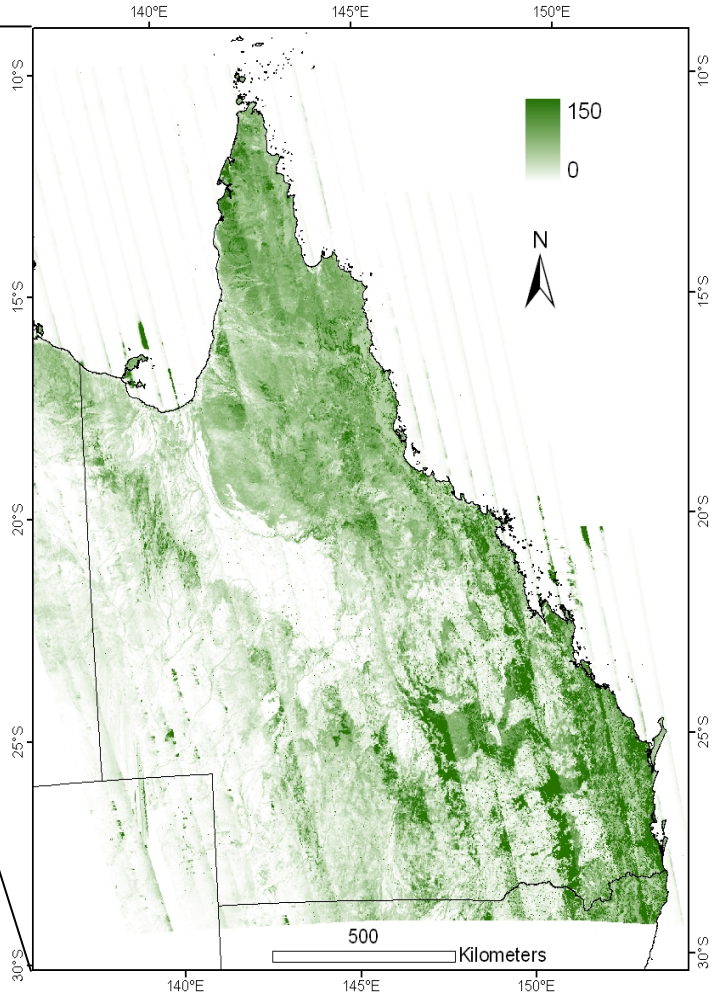
Terrestrial Laser Scanner

Field measures of structure / biomass

Scaling structural attributes and biomass

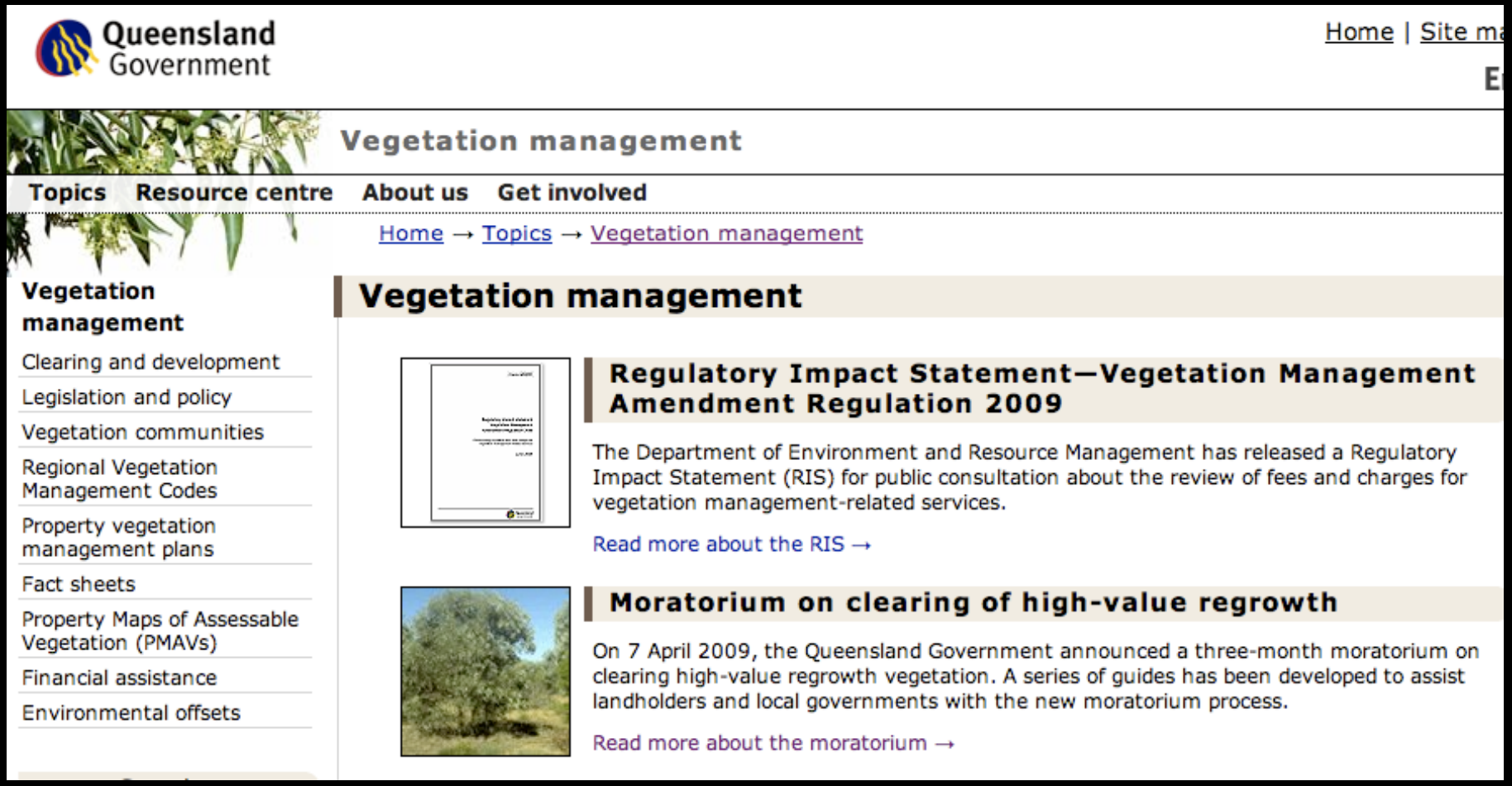


Retrieved estimates of biomass & structure (Airborne data)



Scaled using Spaceborne SAR (ALOS, BIOMASS?)

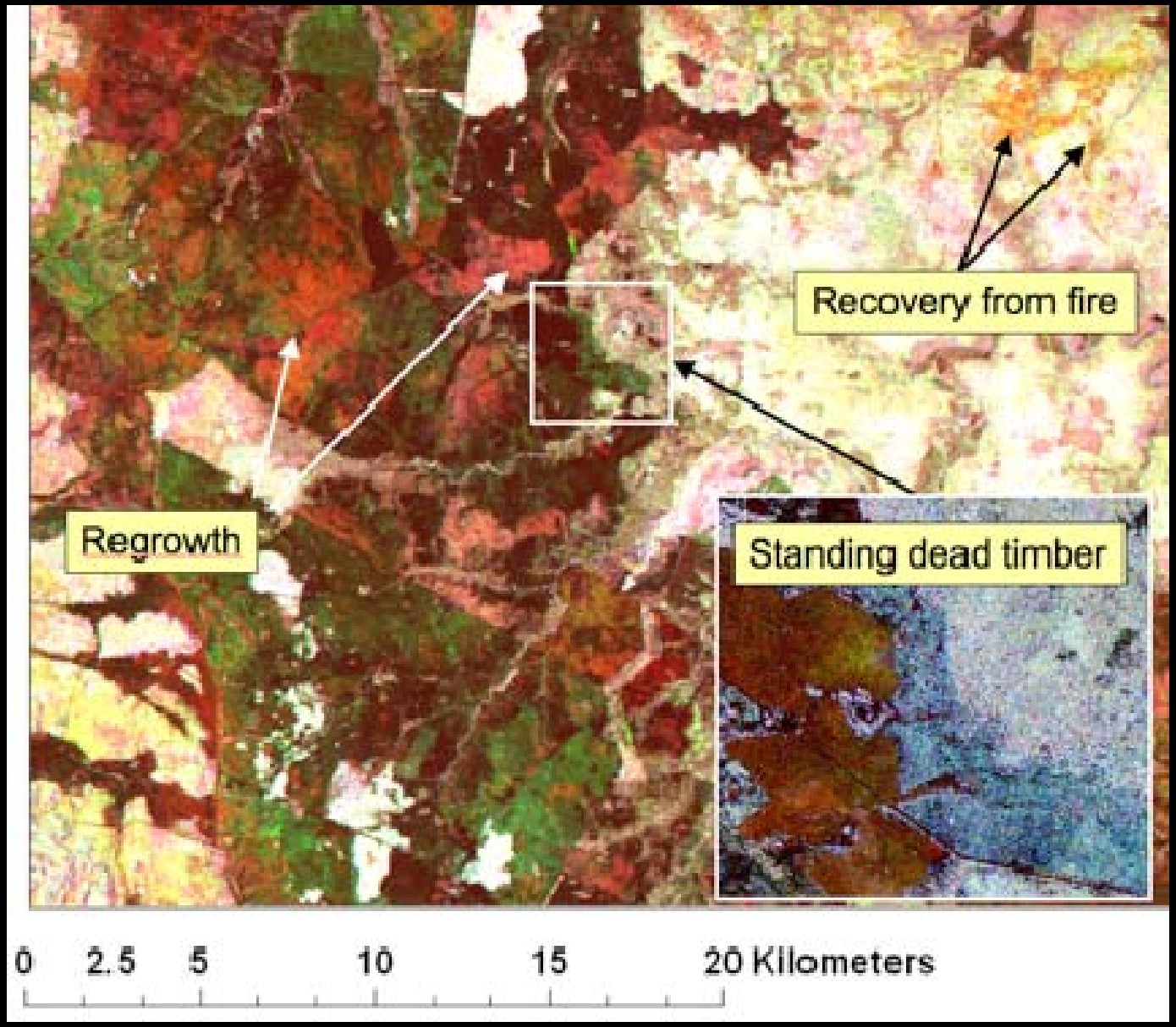
Queensland Moratorium on Regrowth Clearing



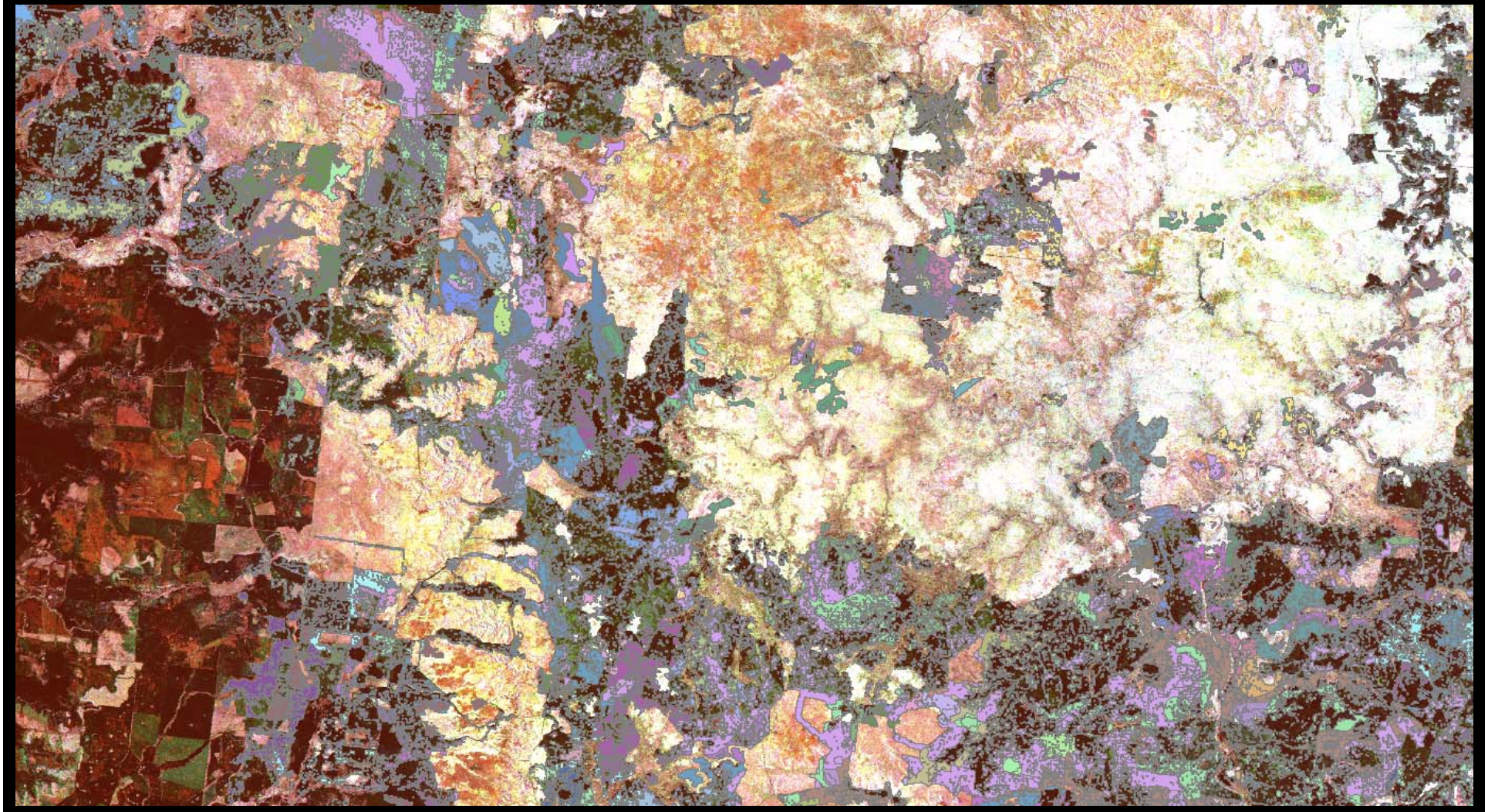
- **All native regrowth within 50 metres of a watercourse in the priority reef catchments and endangered regrowth vegetation in rural areas across the state on freehold and agricultural and grazing leasehold land is protected for a period of at least three months.**

- **Large areas of regrowth are still unprotected**

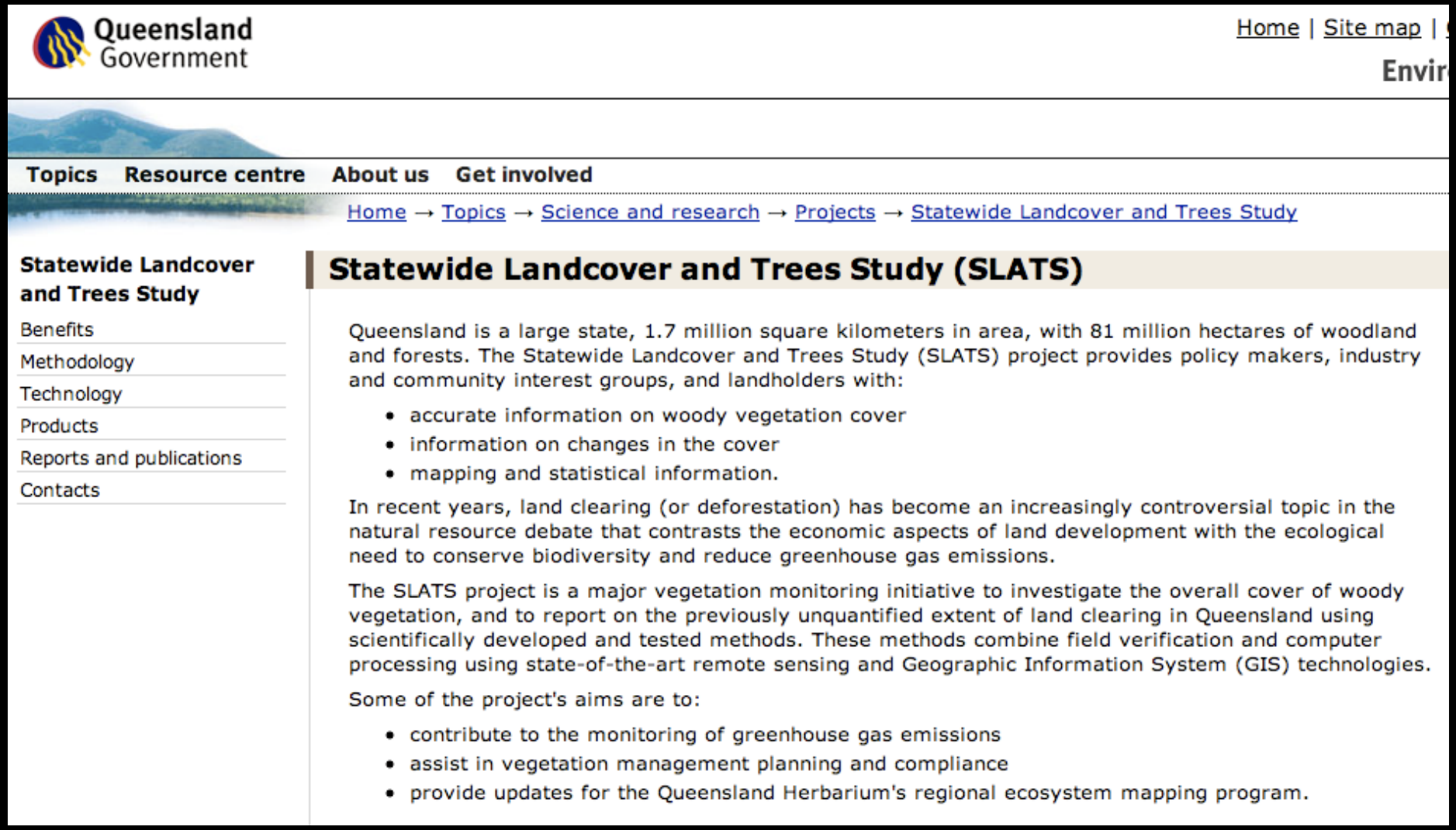
Forest Characterisation: Integration of ALOS PALSAR and Landsat FPC



Regional Ecosystem Mapping
Differentiating regrowth types

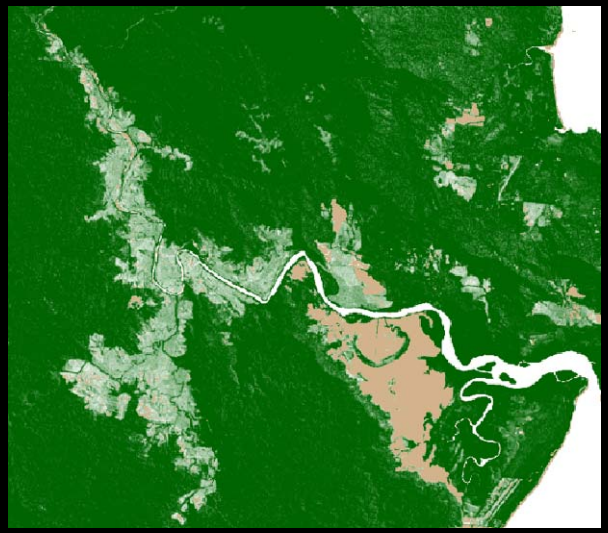


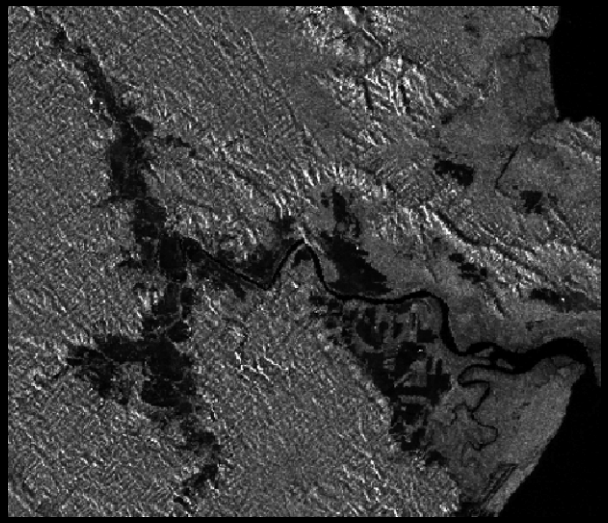
Forest cover mapping, Queensland, Australia



- **NSW are currently implementing a similar scheme**

Refinement of woody/non-woody vegetation maps, Queensland





- Landsat-derived FPC used to discrimination woody vegetation (10-12 % threshold)
- Confusion with pastures avoided using ALOS PALSAR

Overview

- Understanding variability in ALOS strips
  - Rainfall and retention of moisture in soil and vegetation
  - Requirement to select scenes acquired during periods of no or low rainfall.
- Collation of additional datasets to refine algorthms for retrieving biomass and structure
  - Over 800 field-based estimates of biomass and structure for refinement of algorithms
- Regenerating forests
  - ALOS provides unique opportunity to characterise the structure, biomass and growth stages of forests.
  - Potential to refine mapping of certain regrowth forms.
- Additional uses
  - Refinement of forest/non-forest maps in areas with herbaceous vegetation and where cloud cover presents observations from optical remote sensing data.
  - Non-linear estimation algorithm for retrieving biomass and structure
  - Support for NASA project

Acknowledgements

- Japanese Space Exploration Agency (JAXA) and the Kyoto and Carbon Initiative
- Electrical Engineering and Computer Science, the University of Michigan
- Definiens AG, Munich
- University of Adelaide
- Defence, Science and Technology Office (DSTO), Adelaide
- The University of Newcastle
- Queensland Department of Primary Industries (DPI) Tropical Beef Centre (TBC)
- Queensland University of Technology (QUT)
- School of Geosciences, University of Wollongong
- **School of Biological, Earth and Environmental Sciences (BEES), the University of New South Wales, Australia (UNSW).**
- **The Bureau of Rural Sciences (BRS)**
- **The Queensland Department of Natural Resources and Water (QDNRW)**
- **The School of Resources, Environment and Society (SRES), Australian National University (ANU), including the *WildCountry* Science Project**
- **The Cooperative Research Centre for Greenhouse Accounting (CRCGA)**
- **The Institute of Geography and Earth Sciences (IGES), University of Wales, Aberystwyth (UWA)**
- **Queensland Herbarium**
- **Queensland University**