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K&C Phase 4 – Status report

Sustainable national forest monitoring using SAR and Optical data

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crc•si Spatially Enabling Australia and New Zealand

UNSW THE UNIVERSITY OF NEW SOUTH WALES

Science Team meeting #22
Tokyo, Japan, Feb 16-18, 2016

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Forestry demonstrator

- Robust, comparable & sustainable NFMS and carbon accounting demands accurate spatio-temporal information on forest cover
- A CRCSI developed approach will demonstrate the capabilities of C- and L-band SAR and optical data for forestry applications and potential suitability for country's MRV systems
  - Enable progression of a nation's effort in reducing emissions from deforestation and degradation (UNFCCC REDD+)
  - Relevant to K&C thematic drivers
    - Carbon cycle science, international conventions, environmental conservation
  - Support international initiatives, e.g., FAO FRA, GFOI
- Potential export of a robust, internationally comparable & sustainable NFMS service to stakeholders within/outside of Australia
- Change of study area: Tasmania, Australia
  - Formerly Greater Mekong sub-region (cancelled ADB project)

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Project background

- Collaborative SAR solutions UK and Australia
  - Building research capacity and capability
    - Australia is already a sophisticated user of Optical data; more limited use of SAR
    - Keen to enhance ground segment capabilities & act as regional EO data hub in Asia-Pacific
    - Presently lack large-scale SAR processing capability to exploit satellite SAR data
- Significant opportunity to promote & showcase SAR to Australian Government and value-adding industry (NRM/environ/ag sectors)
  - Increasing interest in SAR: reports, satellite launches, growth of service industry
- High potential for collaborative, global market development for SAR data and its associated value-adding services
- Lay the foundations for future export opportunities to the greater Asia-Pacific region

UK SPACE AGENCY

CATAPULT Satellite Applications

CSIRO

Australian Government
Geoscience Australia

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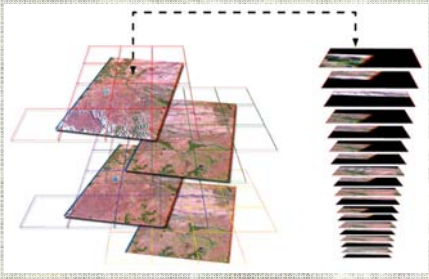
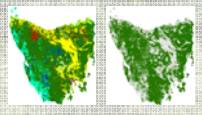
Overarching objectives

- Collaborative SAR solutions for commercial & academic needs
  - Establish a collaborative framework for UK/Australia R&D with a focus on SAR exploitation and application creation
    - Joint technological and scientific research and product innovation
- Demonstration projects in key thematic areas:
  - Forestry/MRV – Tasmania
  - Water resources monitoring – Menindee lakes, NSW
  - Crop monitoring and biomass estimation – WA/QLD



- Further development of infrastructure to manage and disseminate EO data
  - GA data cube, HPC facilities
- Create an ongoing data provision service from the UK to the newly created Australian infrastructure, and potentially export to other countries
- Create a sustainable value-adding service that supports operational programs

Anticipated image products

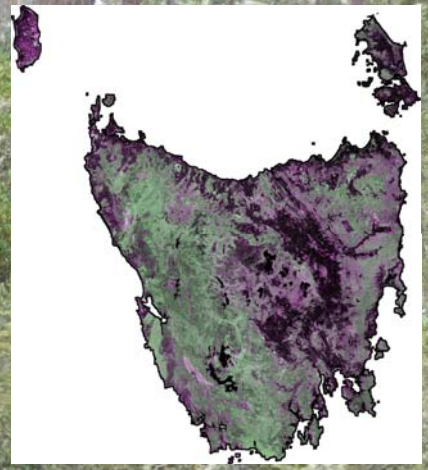
- Calibrated L-band SAR time-series 
  - Comparison of ALOS-1/2 mosaics generated using two processing streams
  - Demonstration of time-series processing capability in HPC environment
- Land use/land cover and forest/non-forest map products 
  - Derived from ALOS-2, Sentinel-1 and Landsat data (2015)
  - Assessment of interoperability and complementarity of multi-sensor data
- Trend metrics derived from time-series (ALOS-1/2, Radarsat-2/Sentinel-1) 
- Time-series forest cover change maps
  - Evaluation of Sentinel-1 performance (2014/15) 
- *Optional*
  - ALOS-2 biomass (Tasmania)
  - Integration of ALOS-2, Sentinel-1 and Landsat mosaics (Australia) 

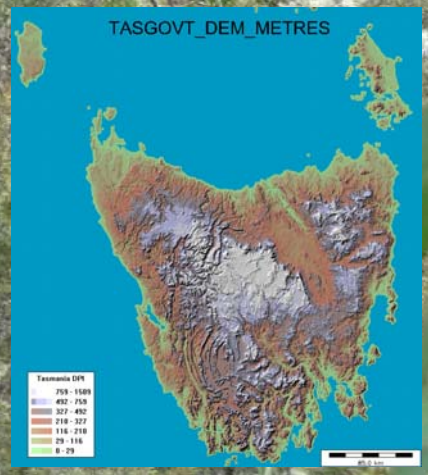
Other deliverables

- Summary report on SAR/Optical applications for forest information monitoring
  - Visual showcase and promotional material
- Roadmap for service exploitation
  - Determine next stages required in movement toward a marketable service
    - Conceptual design – data infrastructure and platform for generating products for NFMS
    - Identification of potential public and private stakeholders
- Scientific publications
- Conference presentations (e.g., ForestSat 2016, IGARSS 2017)

Data pre-processing

- Pre-processing of SAR Level 1 images to level compatible with Analysis Ready Data (ARD) concept
  - ALOS-1/2 PALSAR SLC Dual Pol
  - Sentinel-1 IW GRD
  - Airphoto interpreted DEM for Tasmania used in orthorectification
- Automated scripts calling libraries and functions from ESA SNAP Sentinel-1 Toolbox or Gamma software
- Co-registration accuracy assessment
  - Co-registration of L- and C-band SAR and Optical datasets
  - Comparison with previous ALOS PALSAR mosaics generated using SARscape
- Evolution of ARD concept and radar data cube





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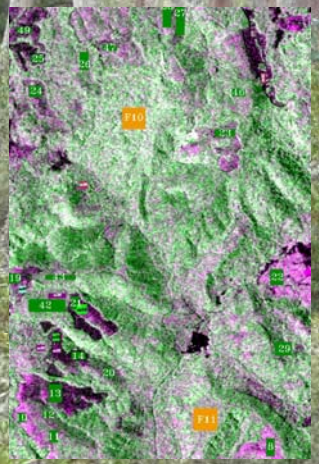
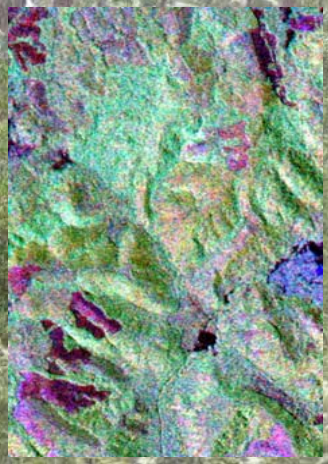
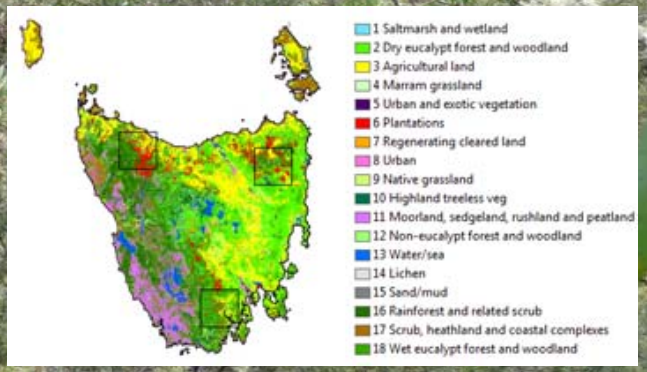
FCLU classification

- Object-based classification of forest cover/land use
  - Open source segmentation (RSGISLIB) – KMeans clustering
  - Feature extraction – spectral/texture/topographic
    - Assess separability of land covers in multi-sensor data
  - Tiling
  - Local training – TASVEG, field data, plantations layer
  - SVM classification (libsvm/imageSVM)
  - Mosaicking
  - Validation
- Scripts for streamlined/batch processing







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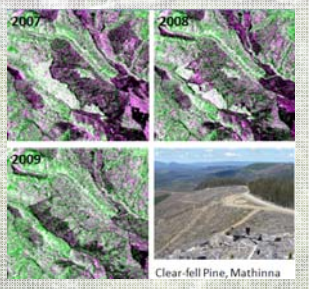
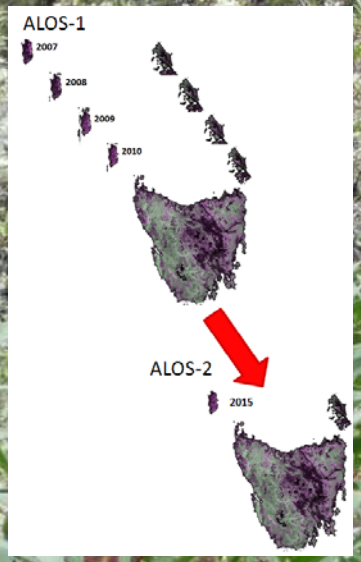
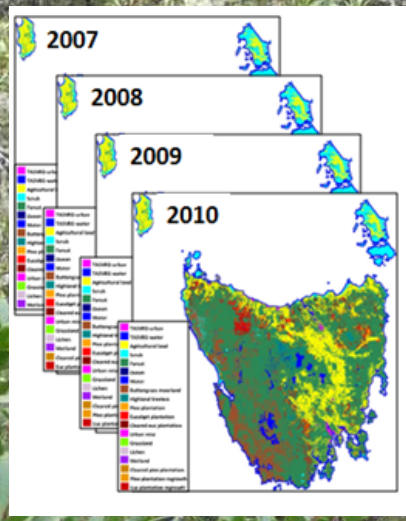
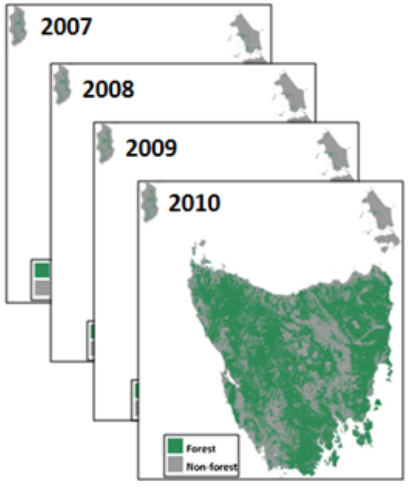
Forest cover trend metrics

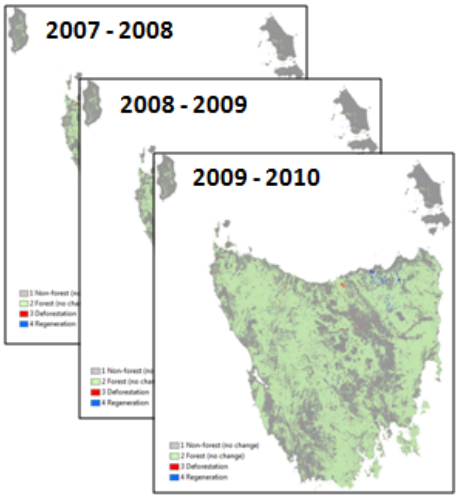
- Integrate with existing time-series and extract trend metrics
  - ALOS-1 PALSAR (2007-2010) -> ALOS-2 PALSAR-2 (2015)
  - Radarsat-2 (2009)-> Sentinel-1 (2015)
- Change analysis and thresholds to identify deforestation
  - Sentinel-1 TS over Warra: Oct 2014 – Dec 2015 (~14 images)











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Project milestones & data sharing

Year	Quarter	Task	Deliverable
2015	4	Inception workshop to scope WPs	
2016	1	Scope Forestry Demo	Forestry Demo work plan
		Collate and pre-process satellite data	Calibrated satellite data and mosaics
		Project meeting with UK-Australia partners	
	2	Trial FCLU mapping methodology	FCLU map products
		Interoperability studies	
		Roadmap for service exploitation	Summary report (Catapult internal*)
		Project meeting with UK-Australia partners	
	3	Streamline batch processing	Processing scripts
	4	Exploitation of dense TS Sentinel-1 data	Forest cover change maps
2017	1	Comparison of L-band SAR mosaics	Assessment report
	2	Change detection studies	Trend metrics
	3	Optional product generation	Image products
	4	Applications showcase on SAR/Optical data for forest monitoring	Summary report
2018	1	Draft publications	Publications
			Final project report to JAXA