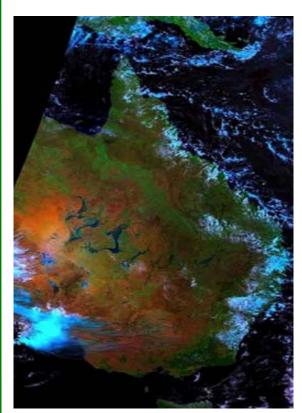**ALOS**

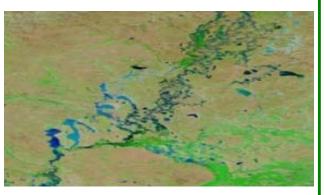*Using multi-temporal ALOS PALSAR to investigate flood dynamics in semi-arid wetlands: Murray Darling Basin, Australia.*

Tony Milne, Rachel Melrose
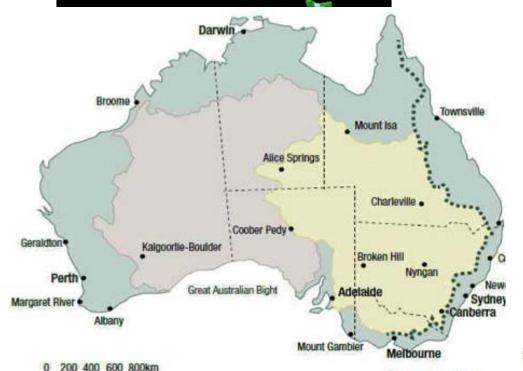
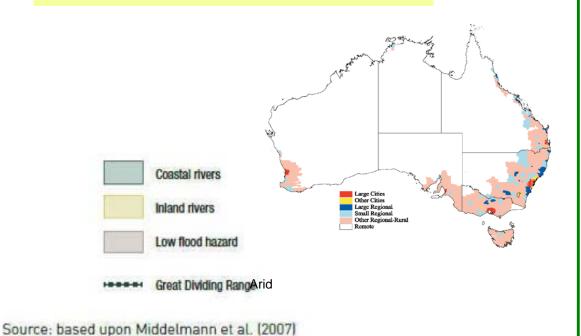*Paroo River Catchment*
March 14, 2010

UNSW
THE UNIVERSITY OF NEW SOUTH WALES
SYDNEY · CANBERRA · AUSTRALIA

HGC
HORIZON GEOSCIENCE CONSULTING

Science Team meeting #21 – Phase 3 Result Presentations
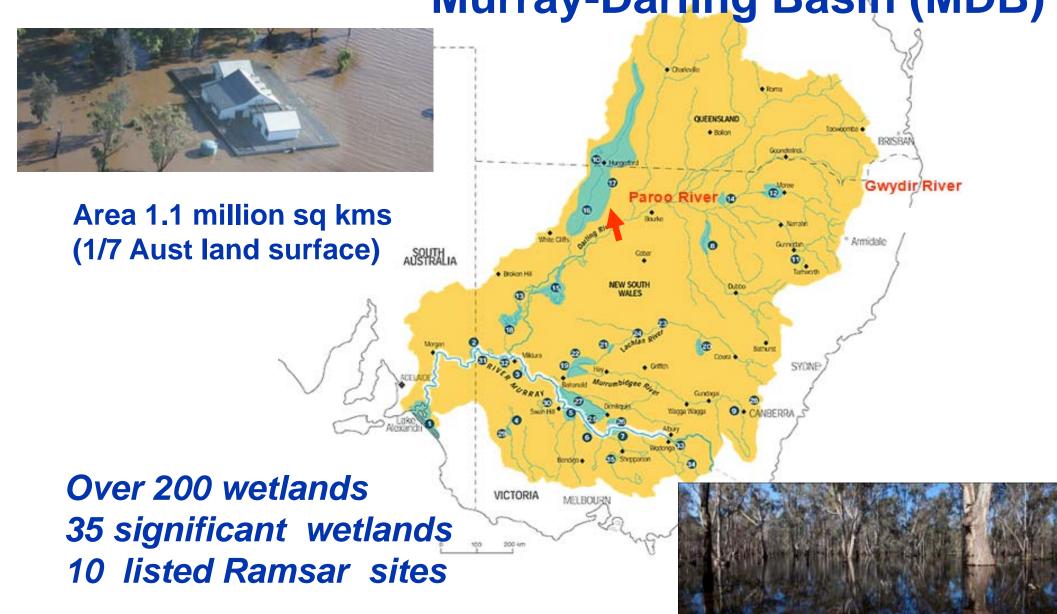Kyoto Research Park, Kyoto, Japan, December 3-4, 2014

Australia – Some Facts

- *Area 7,692,024 sq km*
- *Coastline 29,000 kms*
- *Population 22 million*
- *90% of population on eastern seaboard*

Coastal rivers
Inland rivers
Low flood hazard
Great Dividing Range

Arid

Large Cities
Other Cities
Large Regional
Small Regional
Other Regional-Rural
Remote

Source: based upon Middelmann et al. (2007)

Murray-Darling Basin (MDB)

Area 1.1 million sq kms
(1/7 Aust land surface)

Over 200 wetlands
35 significant wetlands
10 listed Ramsar sites
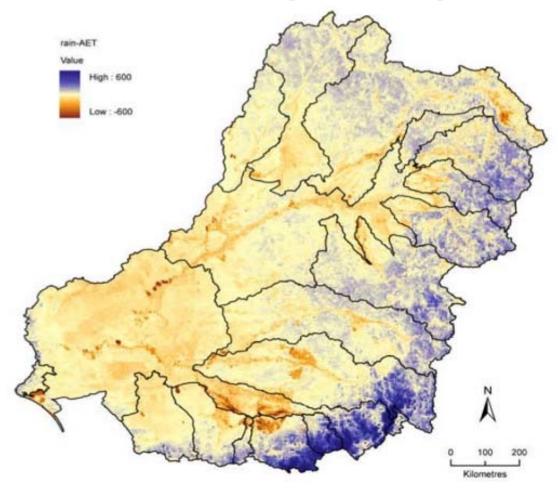
Estimated net water balance - rainfall minus actual evapotranspiration.

rain-AET
Value

High : 600

Low : -600

Blue indicates regions where runoff is generated, yellow no runoff, red/brown indicates standing water (Kirby et.al.,2008)

Project objectives

- **Use PALSAR for mapping and monitoring wetland distribution in the MDB arid zone**

- **Analyse pattern of flood flows, duration and recession of surface water**

- **Assess vegetation, soil and animal response to periodic flooding**

- **Investigate the effect of environmental flows in semi-arid landscapes**
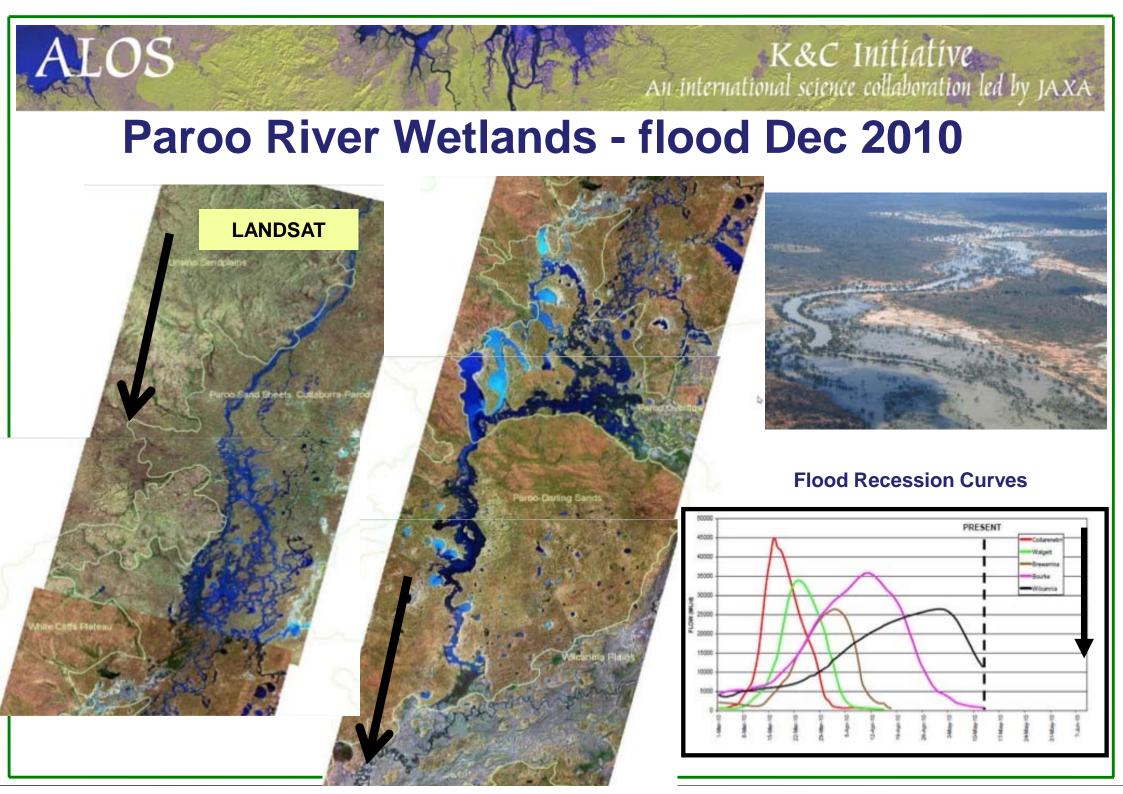
MDBA   Program   Objectives

- The establishment of baseline data for rivers and wetlands in the MDB to identify priorities for conservation action and rehabilitation under the International RAMSAR Convention

- To improve estimates of habitat availability for wetland dependent species and to identify species or habitats that require conservation.

- To evaluate the carrying capacity of the land for agriculture and potential carbon storage

- To perform flood risk mapping for flood mitigation and Government emergency response

Paroo River Wetlands

- **The Paroo catchment cover 7,400,224 hectares. The river is over 600 km long.**

- **Channel type comprise braided channels, waterholes, swamps, claypans, mound springs, shallow freshwater lakes and salt lakes.**

- **There are two internationally recognised RAMSAR sites along the Paroo River and numerous sites in the catchments designated in the *Directory of Important Wetlands in Australia*.**

Why the "Paroo River" ?

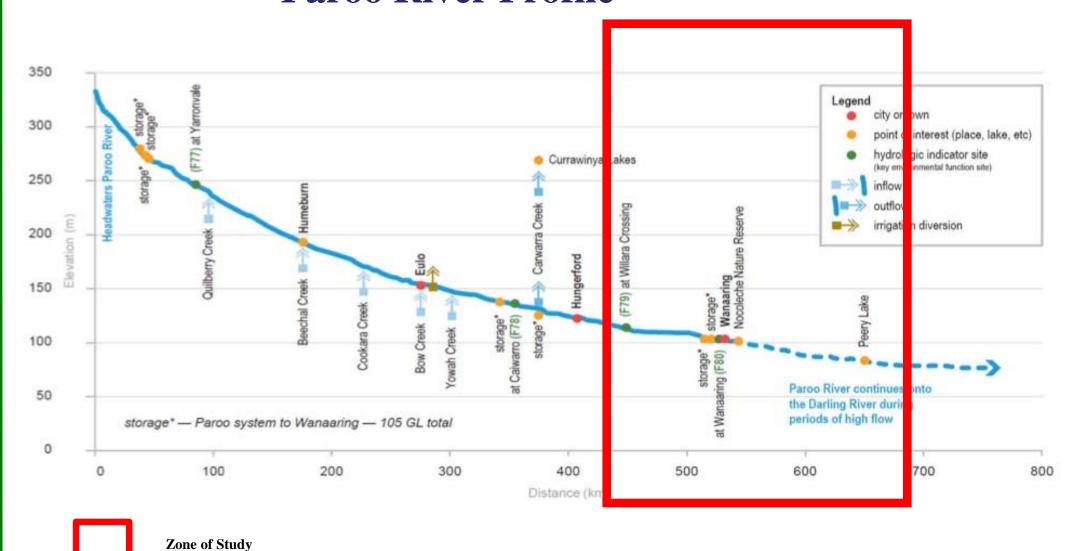- **Paroo - last largely free-flowing river in the Murray Darling Basin**

- **Internationally recognised RAMSAR sites**

- **Wetlands of high ecological significance**

- **Joint agreement between QLD and NSW governments to protect Paroo river**

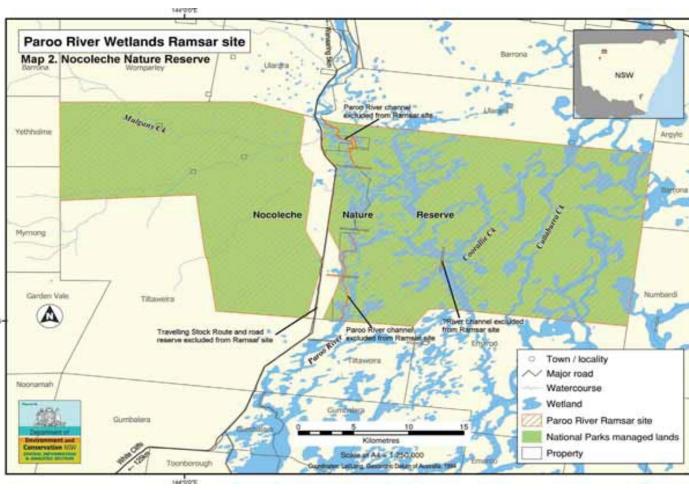- **Ephemeral nature of wetlands – vulnerable to regulation**

Paroo River Wetlands - flood Dec 2010

LANDSAT

Flood Recession Curves

Paroo River Profile

Catchment climate
Rainfall
Runoff

Warrego flows
Overflow into
Cuttaburra Creek

Paroo River flows

Local climate
Rainfall
Runoff

Hydrology
River flow magnitude
Antecedent conditions
Soil moisture profile
Evaporation

Geomorphology
Soil type
Topography, morphology
Sedimentation
Soil size and type
Erosion
Floodplain extent
Lakes, claypans, channels

Flooding and drying cycles

Habitat type
Substrate
Water column
Soil type
Inundation (extent, duration, frequency)
Water depth

Physicochemistry
Water quality (turbidity and salinity,
pH, nutrients)
Nutrient cycling
Carbon cycling
Oxidation–reduction
Soil chemistry

Distribution and abundance of biota
Flora (aquatic macrophytes, floodplain
eucalypts, lignum, grasses)
Fauna (birds, mammals, reptiles,
amphibians, invertebrates, fish,
diatoms)
Other biota
Biological processes
Reproduction, predation, competition,
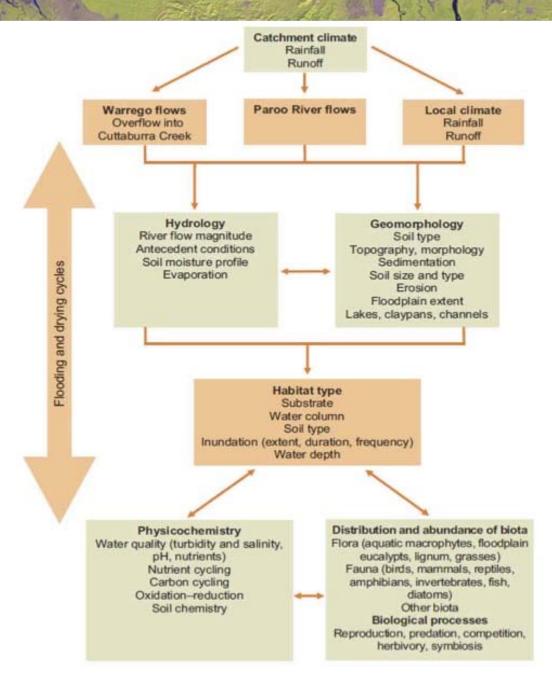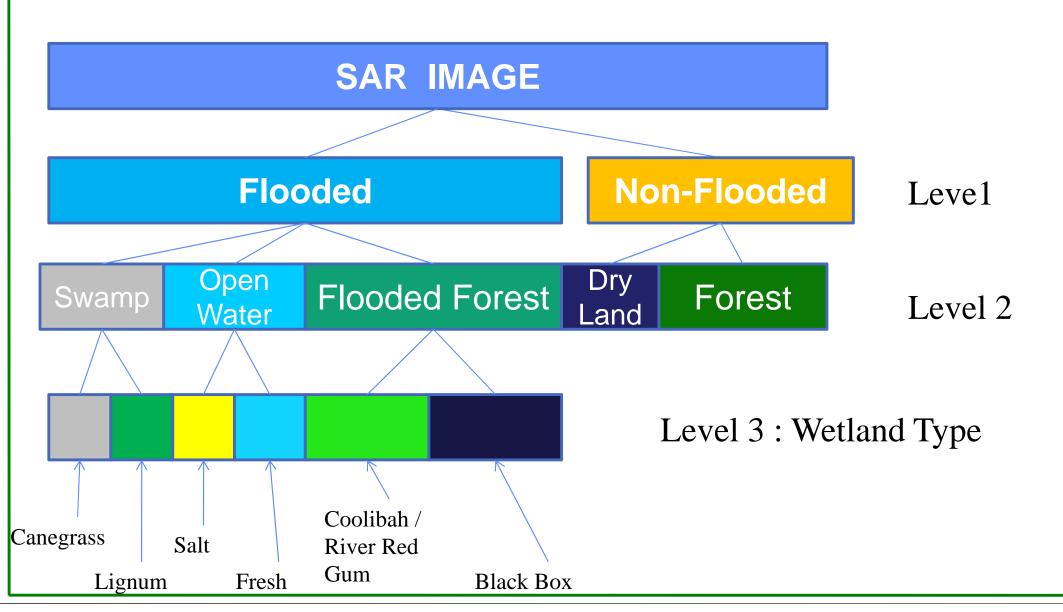herbivory, symbiosis

**Ecological Outcomes of Flow Regimes in the
Murray-Darling Basin Overton, I.C., Colloff, M.J., Doody, T.M., Henderson, B.
and Cuddy, S.M. (editors) 2009.**

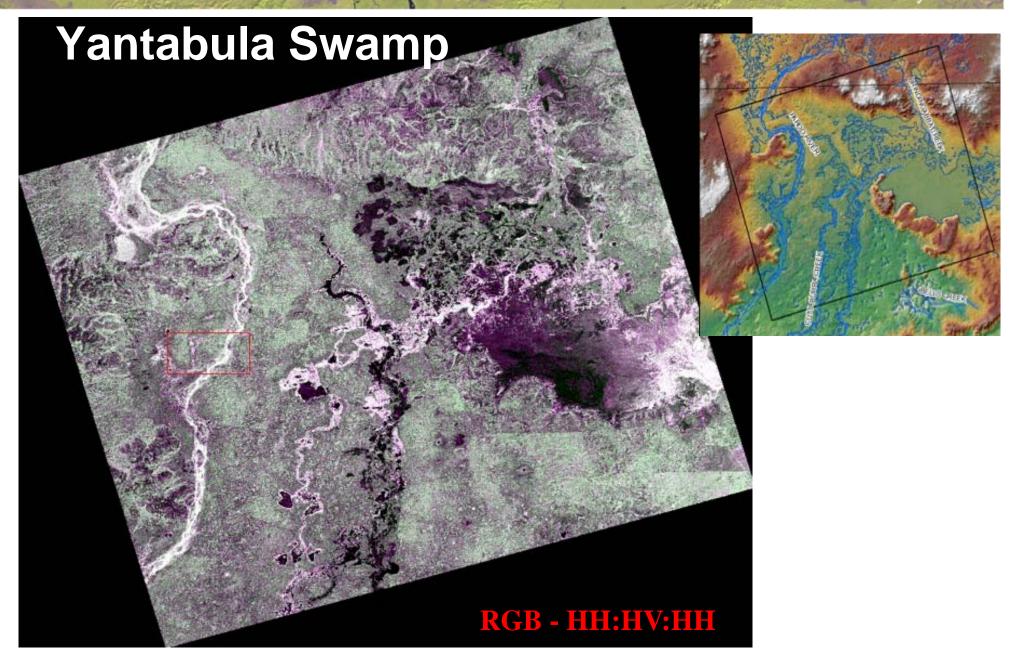# Morpho-ecological Mappingsemi-arid wetland typologies

Class Types

- **Commonly wet freshwater lakes**
- **Periodically-inundated floodplain freshwater lakes**
- **Periodically-inundated non-floodplain (depressional) freshwater lakes**
- **Floodplain freshwater swamps**
- **Non-floodplain (depressional) freshwater swamps**
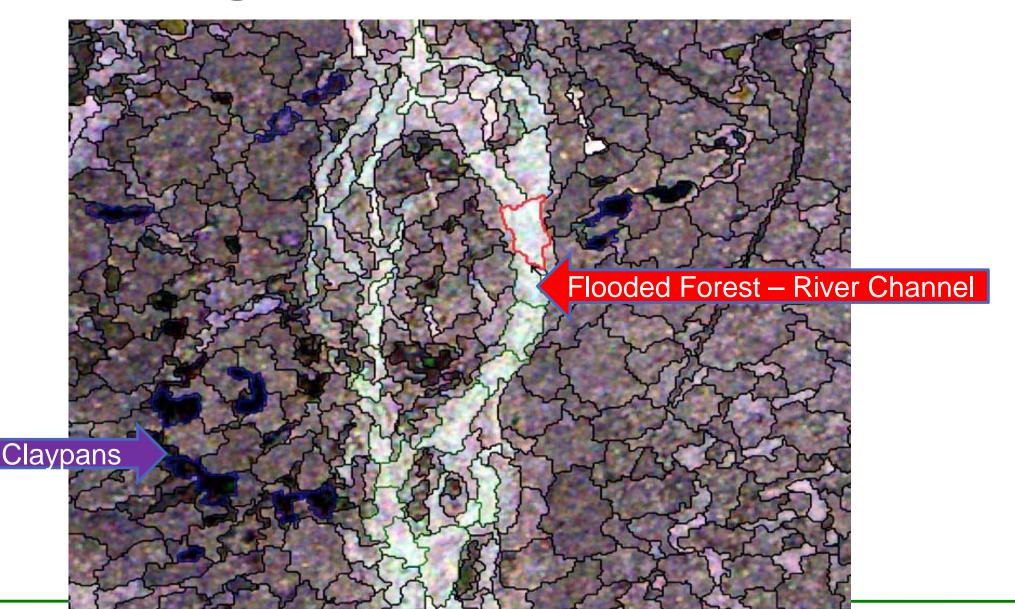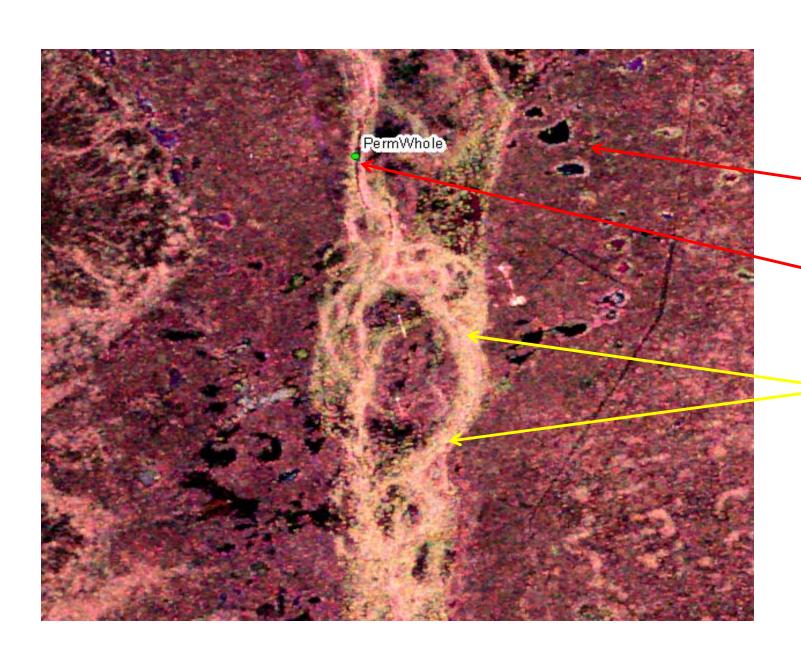- **Saline lakes**
- **Saline swamps**

Yantabula Swamp

RGB - HH:HV:HH

Segmented Floodplain
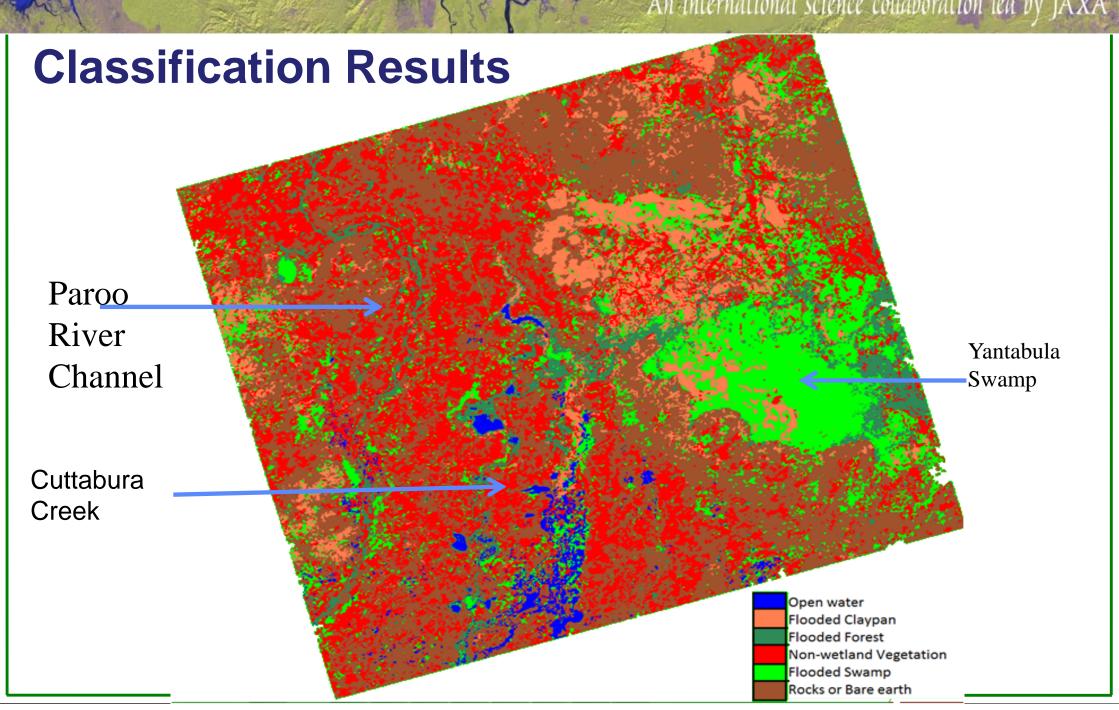
Flooded Forest – River Channel

Claypans

Classification Results

Paroo River Channel

Yantabula Swamp

Cuttabura Creek

Legend:
- Open water
- Flooded Claypan
- Flooded Forest
- Non-wetland Vegetation
- Flooded Swamp
- Rocks or Bare earth

classes
- wet claypan
- dryland
- floodedforest
- openwater
- floodedswamp

Riverine Forest

Shrubland Swamp
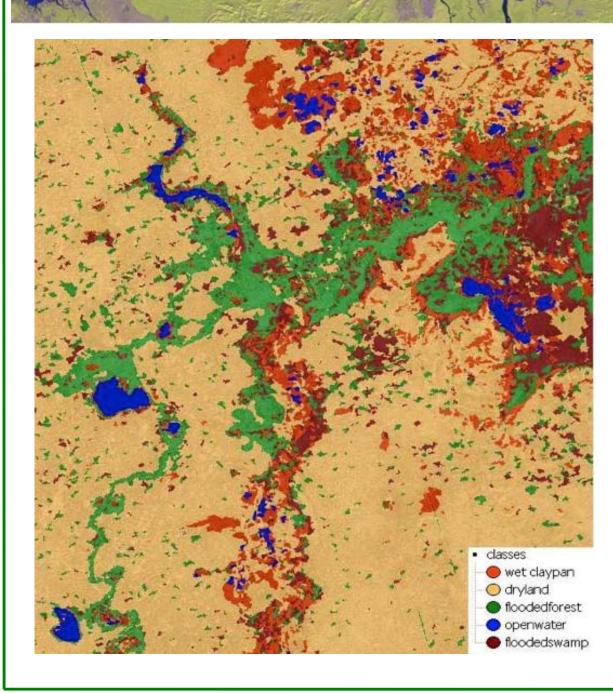
Flood Recession : Time series snapshot
water flow in Cuttaburra Creek ??

Time series: duration - permanence ?
Flow modelling potential: low relief - need Lidar DEM?

Conclusions

- ☐ **The successful inundation and broad wetland classification results using this imagery (>85% accuracy) illustrate the usefulness of using ALOS PALSAR data on its own for semi-arid wetland mapping.**

- ☐ **However, the 46 day repeat period was not adequate for characterizing all wetlands cover classes present in the study area as many are ephemeral in nature.**

- ☐ **The existence of the ALOS archive data as well as ALOS-2 and TanDEM-L satellite imagery, presents an ongoing opportunity to use L-band SAR to better understand flood recession patterns.**

- ☐ **In addition, we intend to further explore the use of optical data "interoperably" with radar to obtain a longer time-series of flood extent and frequency-magnitude events in order to better characterize semi-arid wetlands and "perenniality".**
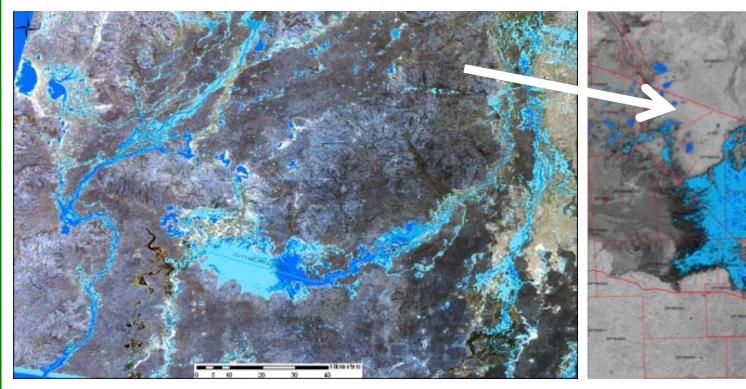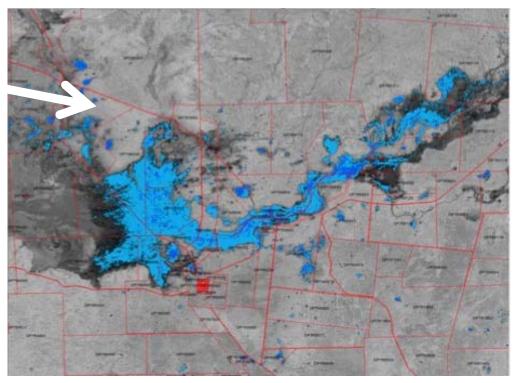
K&C Initiative
An international science collaboration led by JAXA

Australian Government
Geoscience Australia

Australian Flood Risk Information Portal

Legend

Water not detected.

Water detected in 1% of observations
(includes flooding and misclassified shadows).

Water detected in 5% of observations
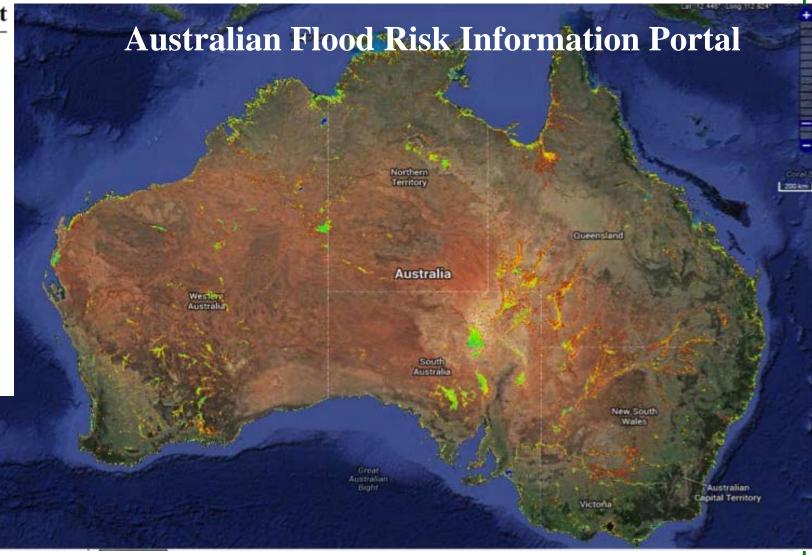(includes intermittant water bodies).

Water detected in 20% of observations
(includes water bodies that often dry out).

Water detected in 50% of observations.

Water detected in 80% of observations
(permanent water bodies).

Water detected always.

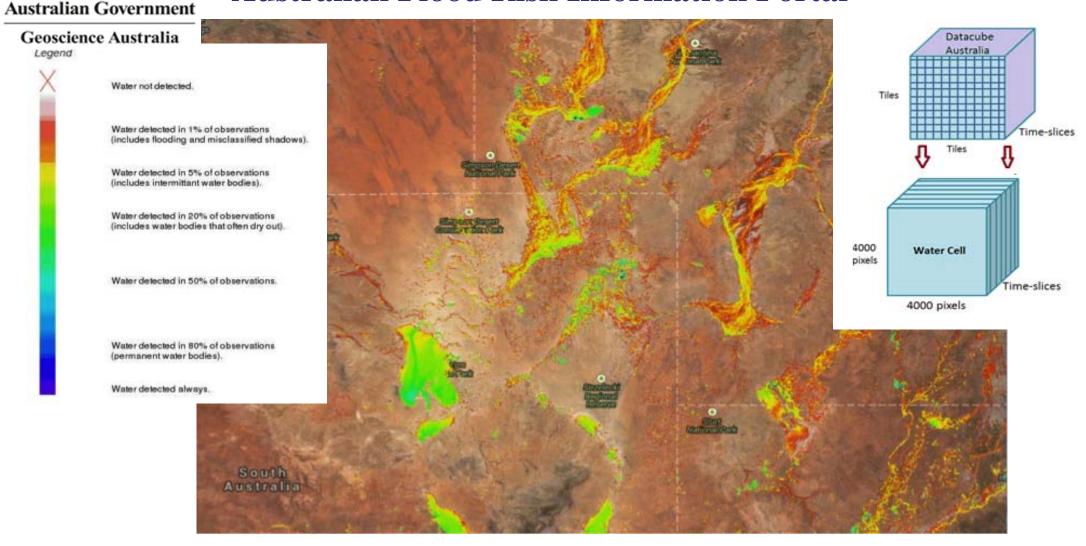http://www.ga.gov.au/scientific-topics/hazards/flood/australian-flood-risk- information-portal
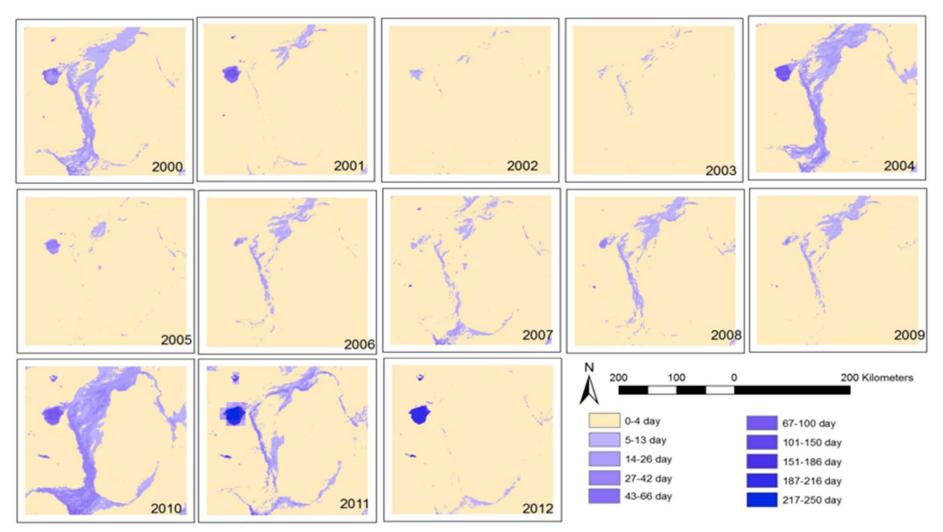
Australian Flood Risk Information Portal

Mapping annual inundation from MODIS daily images along the Cooper Creek 2000 to 2013
(Abdollah Jarihani, 2013)

Deliverables - Papers and reports

Reports

Milne A.K, Williams M, Mitchell A.L, Watt M, Robust imaging from space: satellite SAR . Consultant report provided to the SpacePolicy Unit, Department of Industry, Innovation, Science, Research and Tertiary Education. August 2012.

Phil Tickle, Mark Southwell, Anthea Mitchell and Kim Lowell, A Synthesis of Remote Sensing Capabilities with Specific Reference to the Business Needs of the Murray Darling Basin Authority (MDBA), CRCSI Report prepared for MDBA, 9th August, 2013.

Conference presentations and papers

Melrose, R. T. Kingsford, and A. K. Milne, "Using radar to detect flooding in arid wetlands and rivers". Proceedings of the International Geoscience and Remote Sensing Symposium, 22-27 July 2012, Munich, Germany, 2012.

Melrose, R. T,,"Mapping hydroperiod with L-band SAR time-series to identify permanent and ephemeral arid wetlands", Proceedings of the International Geoscience and Remote Sensing Symposium, Melbourne, Australia, July 2013,

Journal papers

A.L. Mitchell • A. K. Milne • I. Tapley Towards an operational SAR monitoring system for monitoring environmental flows in theMacquarie Marshes, Australia. Wetlands Ecology and Management,(in press Nov 2014.)

Deliverables - Papers and reports

Submitted/in preparation

R. T. Melrose, R. T. Kingsford, and A. K. Milne, "L-band SAR detection of inundation extent and identification of arid floodplain wetlands," submitted to Remote Sensing of Environment,

Others

"The Kokoda Track Conservation Initiative Remote Sensing Project". Report prepared on behalf of the Department of Environment and Conservation (DEC) Papua New Guinea (PNG),Horizon Geosience Consulting (HGC) and Cooperative Research Centre for Spatial Information, April 2013.

Completed and Delivered to JAXA

- ❑ Paroo- Flooding Maps
- ❑ Paroo- Land Cover of pilot areas.
- ❑ Paroo- Vegetation, Surveys and Reference materials.
- ❑ Paroo- MDB Ramsar Sites.
- ❑ Topographic Maps

Not yet Delivered

- ❑ Operational methods for monitoring the recession of floodwaters using ALOS PALSAR.

- ❑ Field data for accuracy assessment.

- ❑ Identification of ecologically significant wetland sites, in terms of the flood
  regime (timing, duration, extent of flooding) and vegetation characteristics in relation to their conservation value.

GFOI/GEO FCT Briefing Australia - Tasmania Status and Plans

Anthony K. Milne[1], Anthea L. Mitchell[1], Ian Tapley[2], Kim Lowell[3], Peter Caccetta[4], Eric Lehmann[4], Zheng-Shu Zhou[4], Mark Williams[5], and Alex Held[6]

[1]Cooperative Research Centre for Spatial Information (CRC-SI), School of BEES, University of New South Wales, Sydney

[2]CRC-SI Perth WA

[3]CRC-SI, Melbourne VIC

[4]CSIRO Division of Mathematics, Informatics and Statistics , Perth WA

[5]CRC-SI, Adelaide, SA

[6]CSIRO, Canberra, ACT

Science and Data Summit and National Demonstrators Summit

February 2013, Sydney - Australia
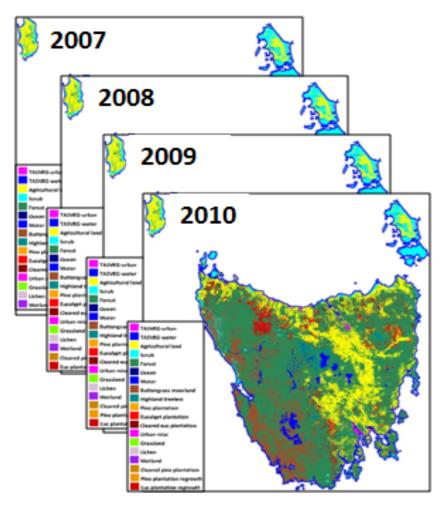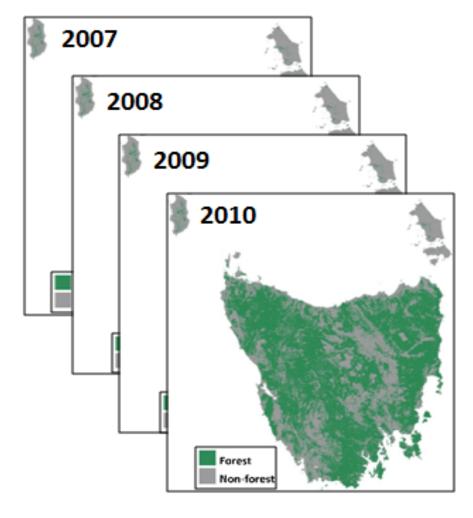
Horizon 1a Forest/Non-forest, Horizon 1b Land cover/land

Multi-temporal SAR-optical processing

Mathinna pilot study

Jointly processed data

Scenarios:

CPN1: Landsat 1972 – 2010

CPN2: Landsat 1972 – 2007, PALSAR 2008, Landsat 2009 – 2010
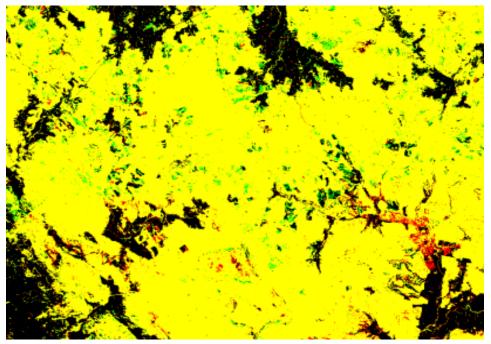
TASVEG agreement: 86.2 % (all-optical), 87.4 % (SAR-optical)

Main differences arise from:

☐ **Different thematic information afforded by SAR/optical**

☐ **Real on-ground change between dates (Jan Landsat, Oct PALSAR)**

☐ **Ben Lomond labelled as forest in all Landsat epochs, seen as spurious in 2008 PALSAR, so labelled as forest**

Comparison of CPN outputs:

Green: SAR-Landsat forest probabilities

Red: Landsat-only forest probabilities

Pixel-based agreement: 95.8 % (2008)

Technical Documentation

☐ **Generation of calibrated wall-to-wall SAR mosaics**

☐ **Processing strategies for forest & change mapping**

☐ **Verification assessment framework**

Training Material

☐ **Sample data sets**

☐ **Field observation strategies**

Sample Training Courses and Capacity Building
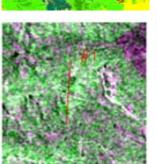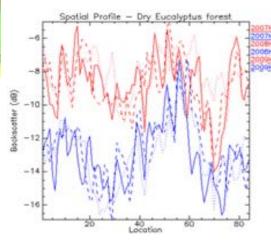
☐ **Forest Mapping, Forest Carbon and REDD+**

☐ **Forest Monitoring Using Radar**

Conference Papers and Presentations

Journal Publications
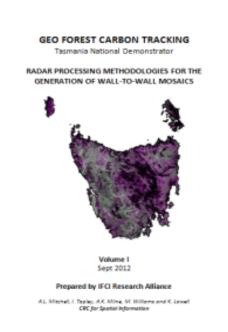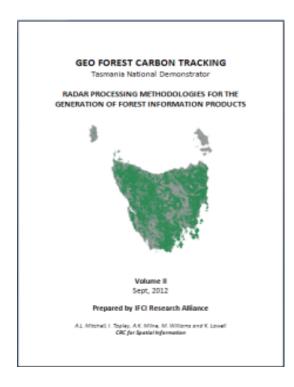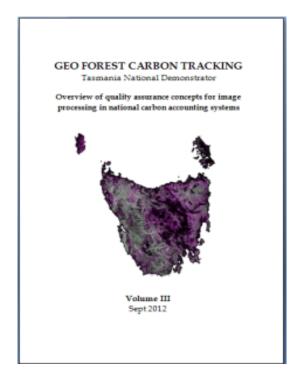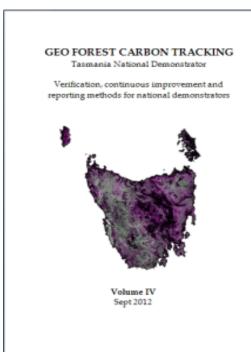
IFCI RA Technical Manuals

GEO FOREST CARBON TRACKING
Tasmania National Demonstrator

RADAR PROCESSING METHODOLOGIES FOR THE GENERATION OF WALL-TO-WALL MOSAICS

Volume I
Sept 2012

Prepared by IFCI Research Alliance

A.L. Mitchell, I. Tapley, A.K. Milne, M. Williams and K. Lowell
CRC for Spatial Information

GEO FOREST CARBON TRACKING
Tasmania National Demonstrator

RADAR PROCESSING METHODOLOGIES FOR THE GENERATION OF FOREST INFORMATION PRODUCTS

Volume II
Sept, 2012

Prepared by IFCI Research Alliance

A.L. Mitchell, I. Tapley, A.K. Milne, M. Williams and K. Lowell
CRC for Spatial Information

GEO FOREST CARBON TRACKING
Tasmania National Demonstrator

Overview of quality assurance concepts for image processing in national carbon accounting systems

Volume III
Sept 2012

GEO FOREST CARBON TRACKING
Tasmania National Demonstrator

Verification, continuous improvement and reporting methods for national demonstrators

Volume IV
Sept 2012

http://www.crcsi.com.au/Research/Radar-Research-Facility

SAR Processing

Mitchell, A.L., Williams, M., Tapley, I. and Milne, A.K. 2012. Interoperability of multi-frequency SAR data for forest information extraction in support of National MRV Systems. Proceedings: International Geoscience and Remote Sensing Symposium (IGARSS), Munich, Germany.

Milne, A.K., Mitchell, A.L., Williams, M., Tapley, I. and Kuntz, S. 2012. Sensor capabilities for deforestation and forest degradation. Proceedings: International Geoscience and Remote Sensing Symposium (IGARSS), Munich, Germany.

Mitchell, A., Milne, T., Tapley, I., Lowell, K., Cacetta, P., Lehmann, E. and Zhou, Z-S., 2010. Wall-to-wall mapping of forest extent and change in Tasmania using ALOS PALSAR data. Proceedings: International Geoscience and Remote Sensing Symposium (IGARSS), July 25-30, Honolulu, Hawaii. Paper Number 2963. Presentation Code TU4.L03.2.

Mitchell, A.L., Williams, M.L. and Milne, A.K. 2011. Forest and forest changemapping using SAR data and a robust classification methodology. Proceedings: 32nd Asian Conference on Remote Sensing (ACRS), October, Taiwan.

Zhou, Z-S., Lehmann, E., Wu, X., Cacetta, P., Mitchell, A., Tapley, I., Lowell, K. and Milne, T. 2011. Practices of Terrain Slope Correction and Precise Registration of SAR Data for Forest Mapping and Carbon Tracking in Tasmania. Proceedings: 34th International Symposium on Remote Sensing of the Environment (ISRSE), April, Sydney, Australia.

Mitchell, A., Tapley, I., Milne, T. and Lowell, K., 2010. Forest Type Degradation Mapping in Tasmania using ALOS PALSAR Data, Abstract in Proceedings: 15th Australasian Remote Sensing and Photogrammetry Conference (ARSPC), Alice Springs, Australia. CD-ROM.

Interoperability

Lehmann, E., Caccetta, P., Zhou, Z-S., McNeill, S.J., Wu, X. and Mitchell, A.L. 2012. Joint processing of Landsat and ALOS PALSAR data for forest mapping and monitoring. *IEEE Transactions on Geoscience and Remote Sensing* (TGRS), Vol 50, 1: 55-67.

Lehmann, E., Zhou, Z.-S., Caccetta, P., Milne, T., Mitchell, A., Lowell, K. and Held, A., 2012. Forest mapping and monitoring in Tasmania using multi-temporal Landsat and ALOS PALSAR data. Proceedings: Proceedings: International Geoscience and Remote Sensing Symposium (IGARSS), Munich, Germany.

Lehmann, E., Caccetta, P., Zhou, Z-S., Wu, X., Mitchell, A., Tapley, I., Milne, T., Held, A., Lowell, K. and McNeill, S., 2011. Forest Discrimination Analysis of Combined LANDSAT and ALOS-PALSAR Data. Proceedings: 34th International Symposium on Remote Sensing of the Environment (ISRSE), April, Sydney, Australia.

Lehmann, E., Zhou, Z.-S., Caccetta, P., Mitchell, A., Milne, T., Lowell, K. and McNeill, S., 2011. Combined analysis of SAR and optical remote sensing data for forest mapping and monitoring. Proceedings: 7th International Symposium on Digital Earth. August, Perth, Australia.

Lowell, K., Mitchell, A., Tapley, I., Milne, A., Cacetta, P., Lehmann, E., Zhou, Z-S. and Held, A., 2011. Evaluating and characterising image classification interoperability. Proceedings: 34th International Symposium on Remote Sensing of the Environment, April, Sydney, Australia.

Mitchell, A., Milne, T., Tapley, I., Lowell, K., Caccetta, P., Lehmann, E. and Zhou, Z.-S. 2011. Interoperability of radar and optical data for forest information assessment. Proceedings: International Geoscience and Remote Sensing Symposium (IGARSS), July, Vancouver, Canada.

Zhou, Z-S., Lehmann, E. and Caccetta, P. 2010. The use of ALOS-PALSAR data associated with Landsat imagery for precise forest mapping: Tasmanian Pilot. Proceedings: 8th European Conference on Synthetic Aperture Radar (EUSAR), 7-10 June, Germany.

TAS ND Publications

Verification

Lowell, K., Held, A., Milne, T., Mitchell, A., Tapley, I., Caccetta, P., Lehmann, E. and Zhou, Z-S. 2012a. Accuracy Assessment for Maps of Single-date and Multi-temporal Interval/Ratio-Scale Vegetative Characteristics, and Nominal/Interval Multi-temporal Maps. International Journal of Geographical Information Science special issue on accuracy assessment (in revision).

Lowell, K., Held, A., Milne, T., Mitchell, A., Tapley, I., Caccetta, P., Lehmann, E. and Zhou, Z-S. 2012b. Accuracy assessment of multinomial land cover change maps using areal sample units. *Remote Sensing of the Environment* (in revision).

Lowell, K., Held, A., Milne, T., Mitchell, A., Tapley, I., Caccetta, P., Lehmann, E. and Zhou, Z. 2012c. Areal sample units for accuracy evaluation of single-date and multi-temporal image classifications. Proceedings: Accuracy 2012. Florianopolis, Brazil.

Lowell, K., Mitchell, A., Milne, T., Tapley, I., Held, A., Caccetta, P., Lehmann, E. and Zhou, Z-S. 2011. *Overview of Quality Assurance Concepts for Image Processing in National Carbon Accounting Systems.* Group on Earth Observations (GEO) Forest Carbon Tracking (FCT) Task. Document 6. 22 pp.

Lowell, K., Mitchell, A., Milne, T., Tapley, I., Held, A., Caccetta, P., Lehmann, E. and Zhou, Z-S. 2010. *Verification, Continuous Improvement and Reporting Methods for National Demonstrators*. Group on Earth Observations (GEO) Forest Carbon Tracking (FCT) Task. Document 9. 64 pp.

Other

Mitchell, A., Milne, T., Tapley, I., Lowell, K., Cacetta, P., Lehmann, E., Zhou, Z-S. and Held, A. 2011. Key Outcomes of the Tasmania National Demonstrator: A Project for the GEO Forest Carbon Tracking Task. Proceedings: 34th International Symposium on Remote Sensing of the Environment, April, Sydney, Australia.

Zhou, Z.-S., Cacetta, P., Lehmann, E., McNeill, S., Mitchell, A., Milne, T., Tapley, I. and Lowell, K. 2011. Dual polarised entropy/alpha decomposition and coherence optimisation for improved forest biomass mapping. Proceedings: International Geoscience and Remote Sensing Symposium (IGARSS) 2011. July, Vancouver, Canada.

Deliverables

GEO –Global Forest Observation Initiative   TASMANIA National Demonstrator

❑ **Field data - photographs and site descriptions**

❑ **PALSAR mosaics: 2007-2010**

❑ **PALSAR derived land cover and forest/non-forest maps 2007-2010**

❑ **Landsat Tas mosaics 2007-2010**

❑ **TASVEG data**

❑ **Documents - papers and IFCI manuals**

ALOS

K&C Initiative
An international science collaboration led by JAXA

Thank You

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