# The JAXA K&C Global Mangrove Watch
# A Coalition of Partners

Richard Lucas, Nathan Thomas, Takuya Itoh, Ake Rosenqvist, Peter Bunting, Femke Tonneijck, Lammert Hilarides, Niels Wielaard, Emma Asbridge

JAXA UNSW AUSTRALIA PRIFYSGOL ABERYSTWYTH UNIVERSITY UNEP WCMC Wetlands INTERNATIONAL SarVision

## K&C Phase 3 Deliverables –

## Datasets and thematic products

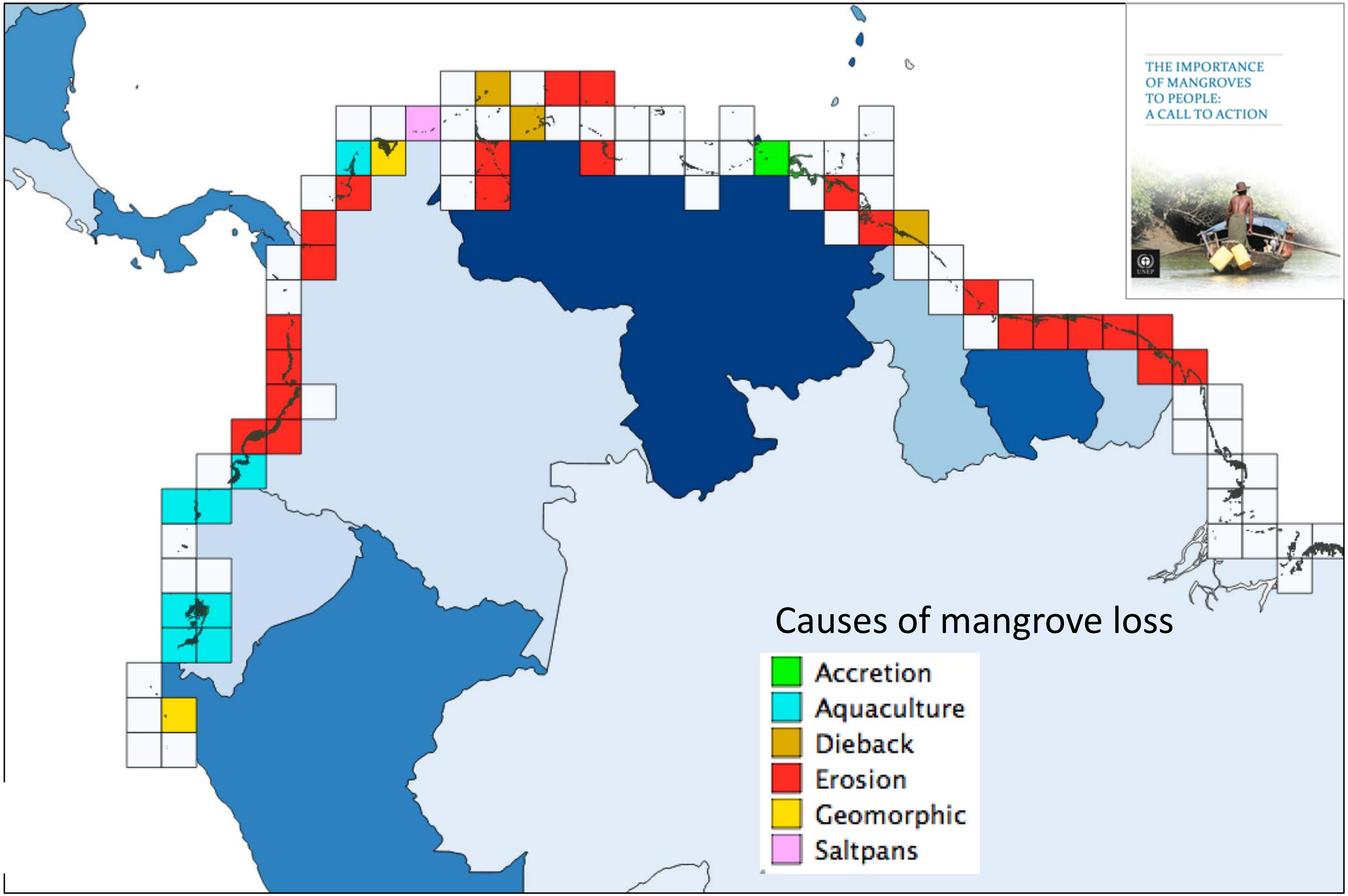
### 1. Completed and delivered to JAXA

- Methods for mapping and monitoring mangroves across their geographical range
    - Open source software (RSGISLib)
- Case studies showing the application and limitation of techniques developed.
- Publications supporting the development of the Global Mangrove Watch.

### 2. Completed but not yet delivered to JAXA

- Global assessment of mangrove change based on over 1000 tiles (composites of JERS-1 and ALOS PALSAR data from 2007 and 2010)

# Example: mapping causes of change South America (1996 – 2010)



## Publications relevant to mangroves

### 1. <u>Published</u>

- Thomas, N., Lucas, R.M., Itoh, T., Simard, M., Fatoyinbo, L., Bunting, P. and Rosenqvist, A. (2014). An approach to monitoring mangrove extents through time-series comparison of JERS-1 SAR and ALOS PALSAR data. Wetlands Ecology and Management doi 10.1007/s11273-014-9370-6.
- Lucas, R.M., Rebelo, L, Fatoyinbo, L., Rosenqvist, A., Itoh, T., Shimada, M., Simard, M., Souza-Filho, P.W., Thomas, N., Trettin, C., Accad, A., Carreiras, J. and Hilarides, L. (2014). Contribution of L-band SAR to Systematic Global Mangrove Monitoring. Freshwater and Marine Science, 65, 589-603
- UNEP. The importance of mangroves to people: A call to action.

### 2. <u>Submitted/in preparation</u>

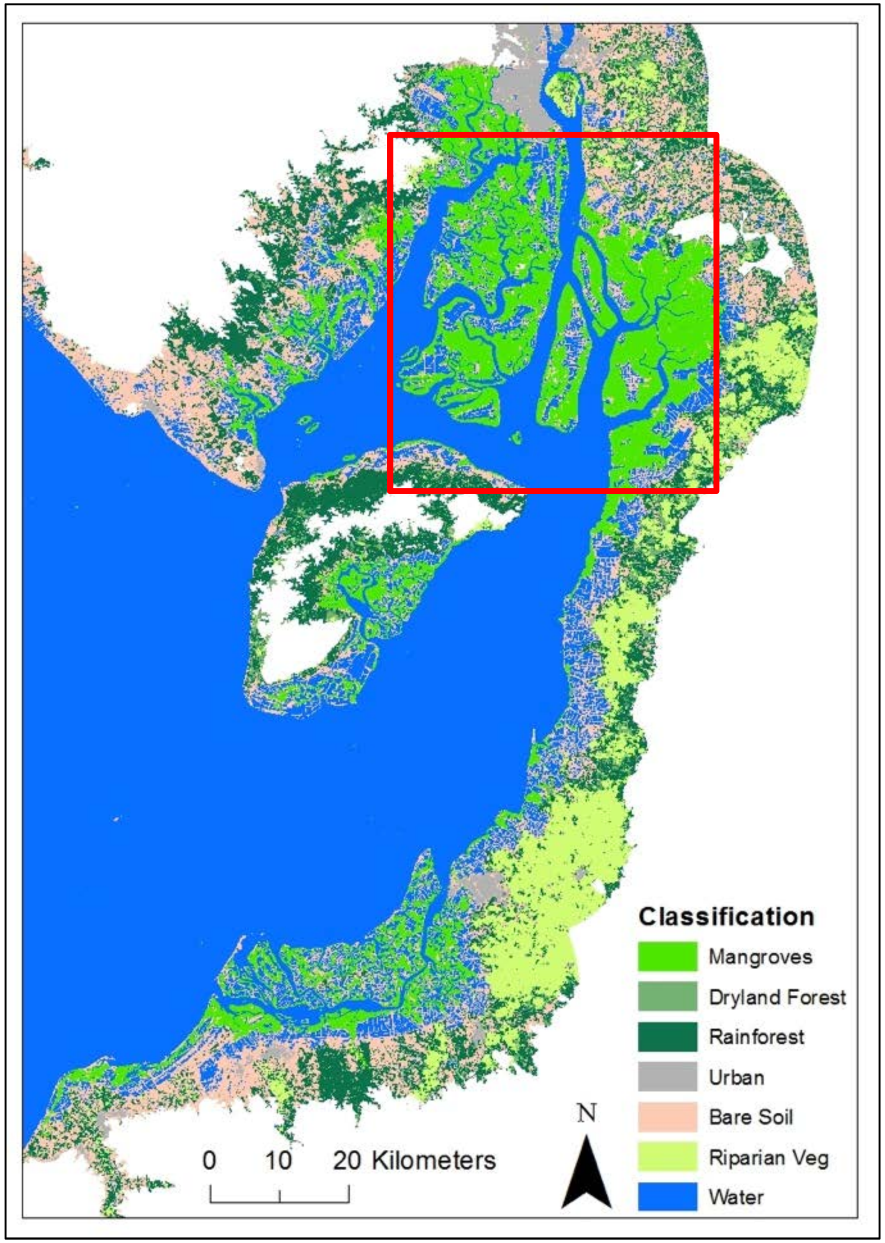
- Lucas, R.M. and various authors. (2014). The Wetlands Encyclopaedia. Wetland Methods, Volume 3, Springer.
- Lucas, R.M., Ashridge, E., Thomas, M., Rodríguez, M.T., Kamal, M., Kuenzer, C. and Lule, A. (2015) Chapter 4. Spatial Ecology of Mangroves. In: Mangrove Ecosystems: A Global Biogeographic Perspective – Structure, Function and Services.

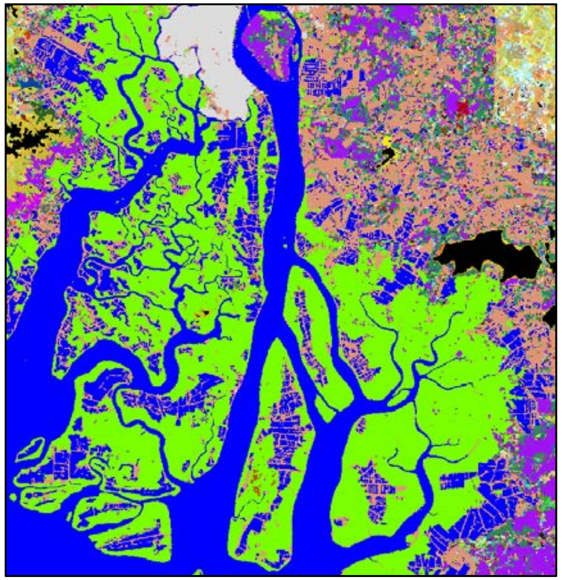
# The Basis of the Global Mangrove Watch Japanese L-band SAR

- JERS-1 Synthetic Aperture Radar (SAR)
  - Mid 1990s
  - Single polarisation (HH)
- ALOS PALSAR
  - 2007-2010
  - Dual polarisation (HH HV)
- ALOS-2 PALSAR-2
  - 2014 onwards
  - Dual polsarisation (HH and HV)
- Digital Elevation Data
  - Global SRTM (90m)
  - Regional SRTM (30 m)
  - Tandem X (10-90 m)
- Hansen *et al* 2013 Landsat Mosaic
  - (25 m spatial resolution)

West Sumatra colour composite ALOS PALSAR 2007: HH, HV, HH/HV

# Generation of Baseline Maps of Mangrove Extent, Guayaquil, Ecuador

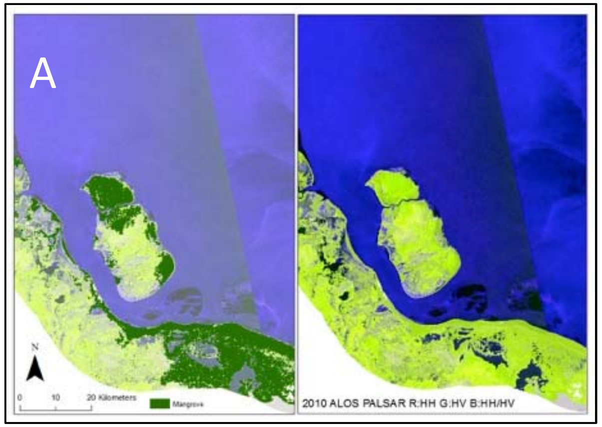


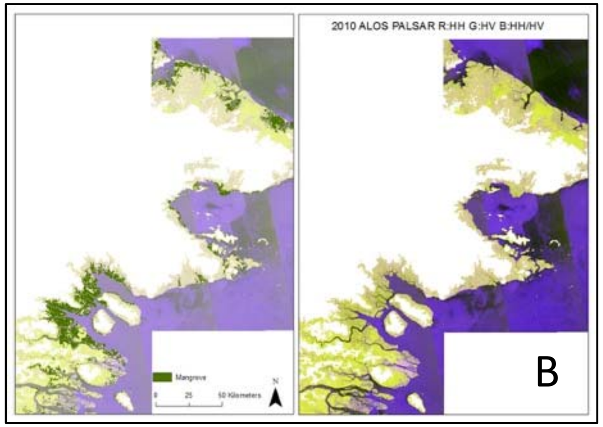



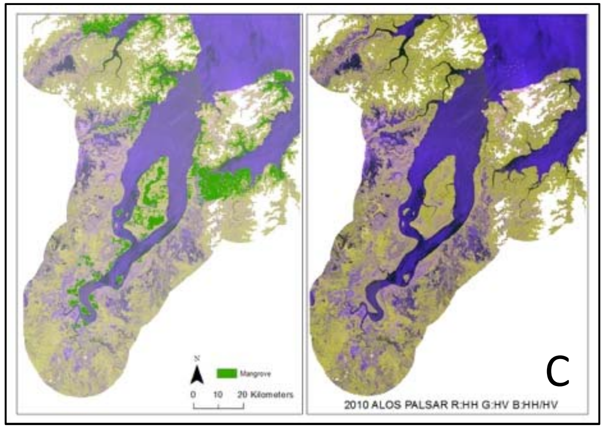
Mangrove Extent Classification

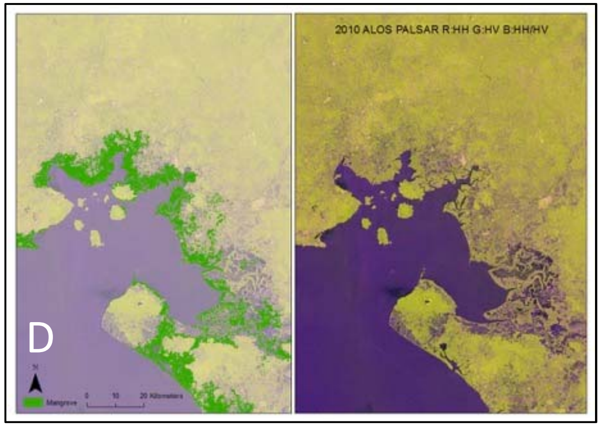
Accuracy of classification:
*90.4 % for mangroves*
*98.0 % for non-mangroves*

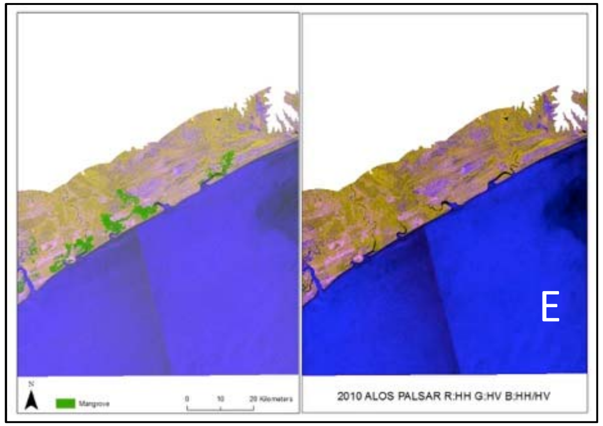
Landsat (2013) False colour Image (NIR, SWIR, RED)

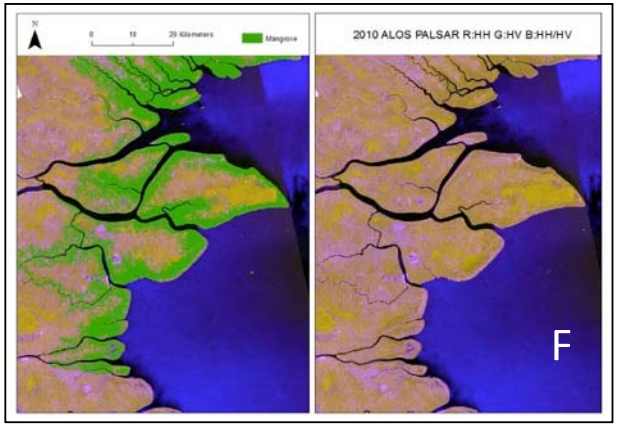


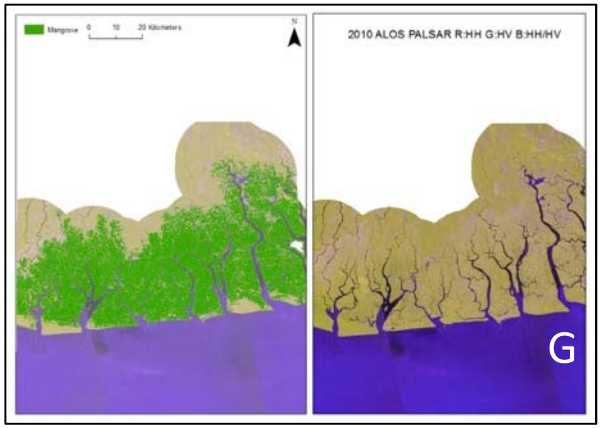



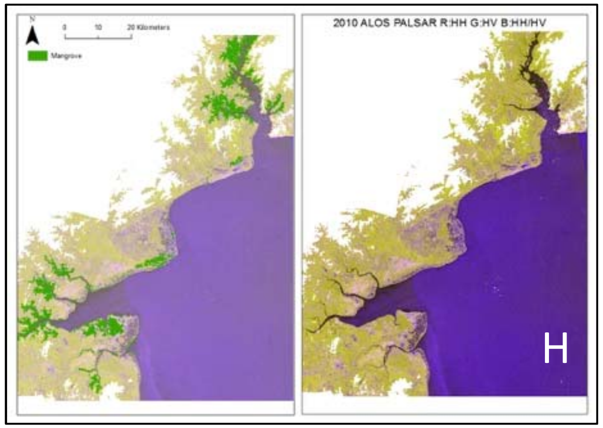



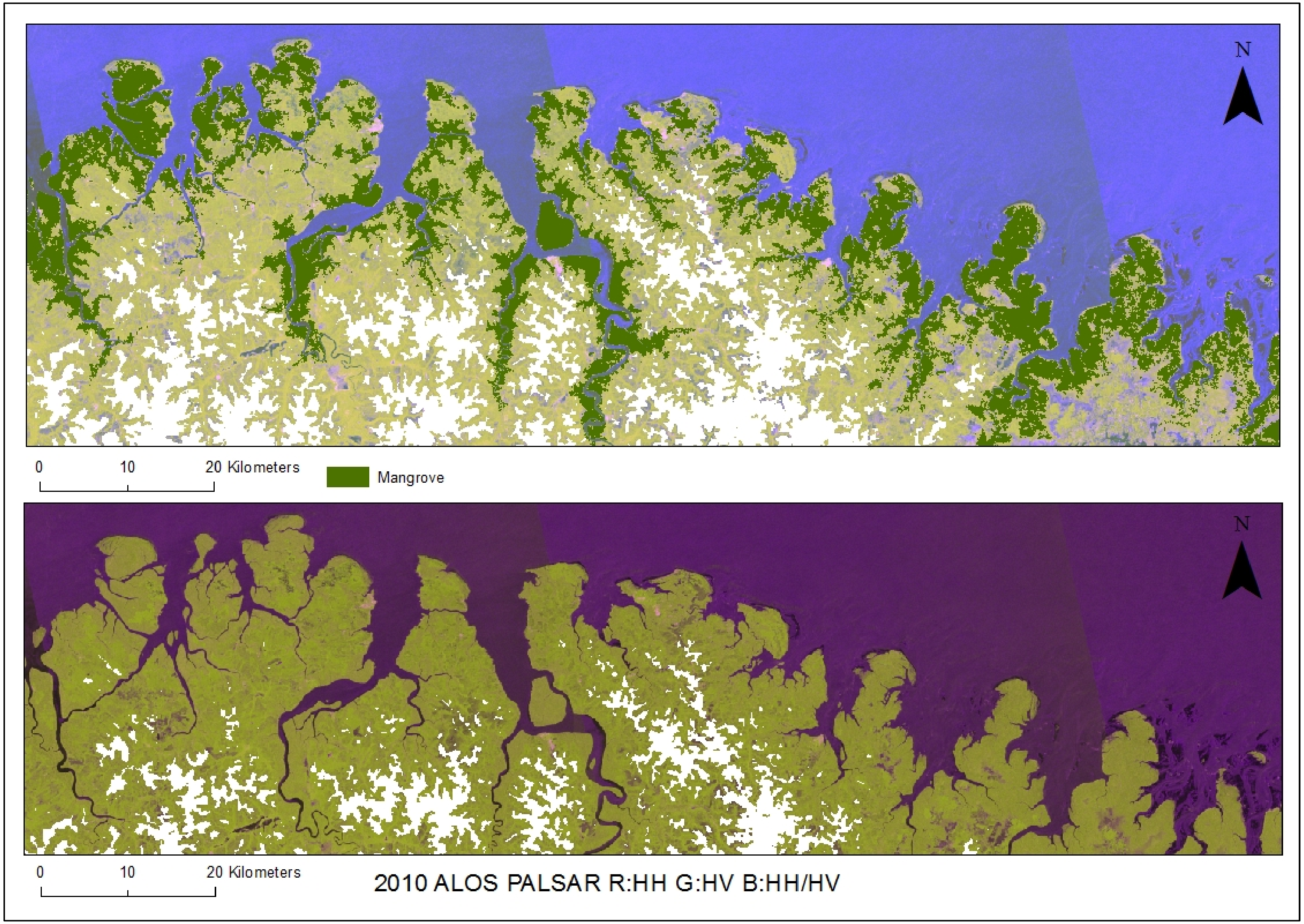



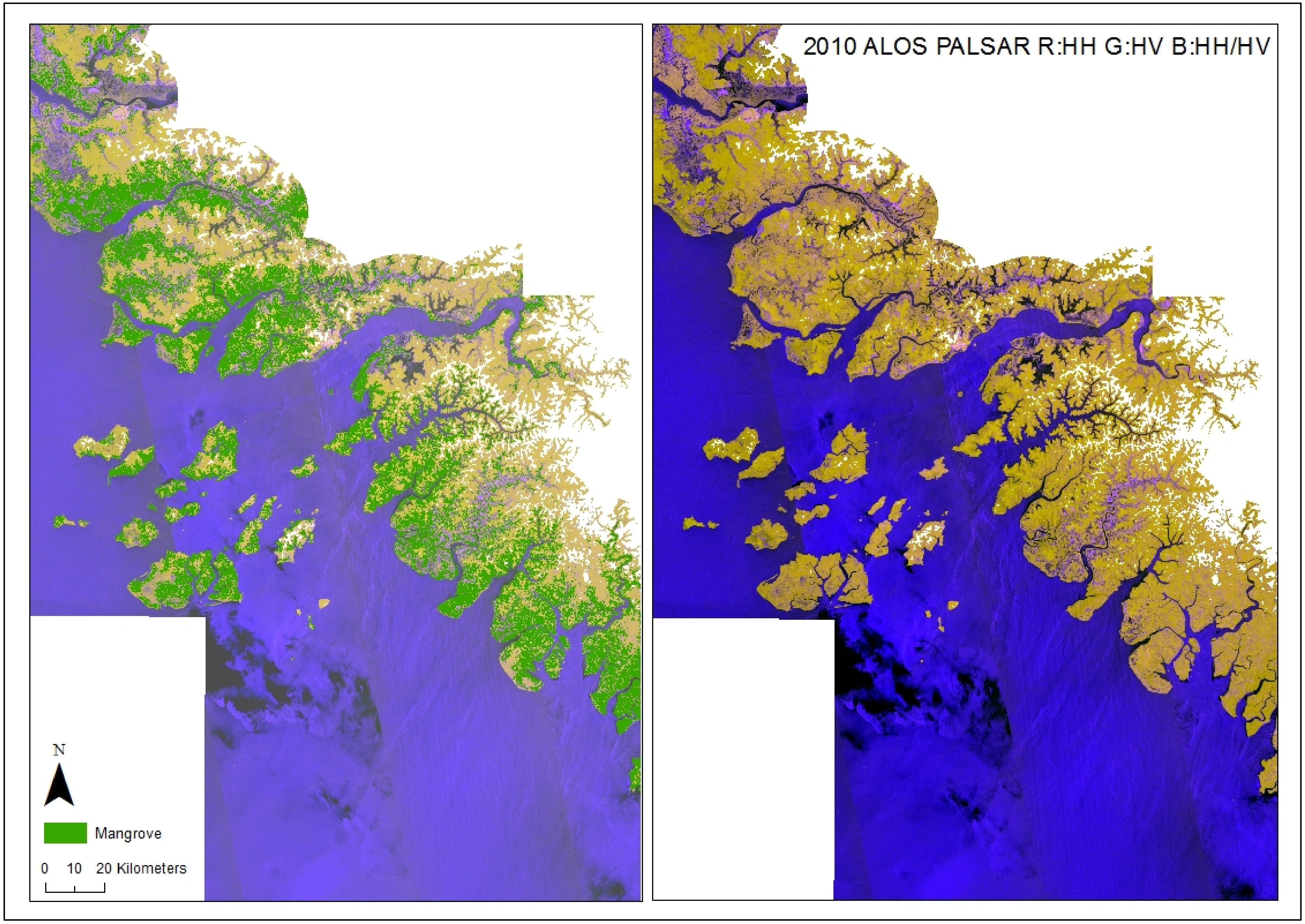

# BASELINE MAPS OF MANGROVE EXTENT

A: Amazon
B: Borneo
C: Brazil
D: Honduras
E: Mozambique
F: Sumatra
G: Nigeria
H: Kalimantan

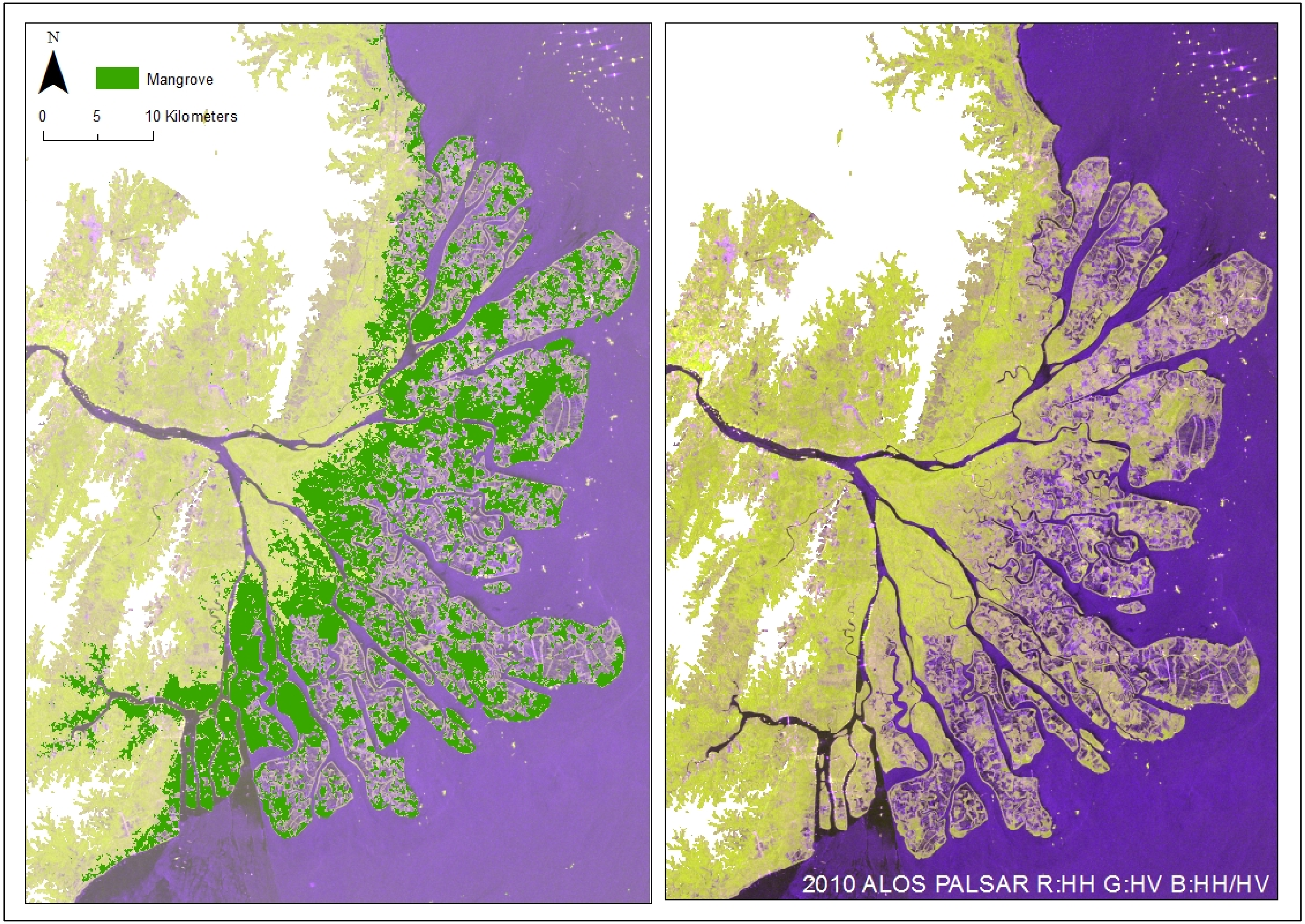
# Bragantina Zone, Brazil



# Guinea Bissau



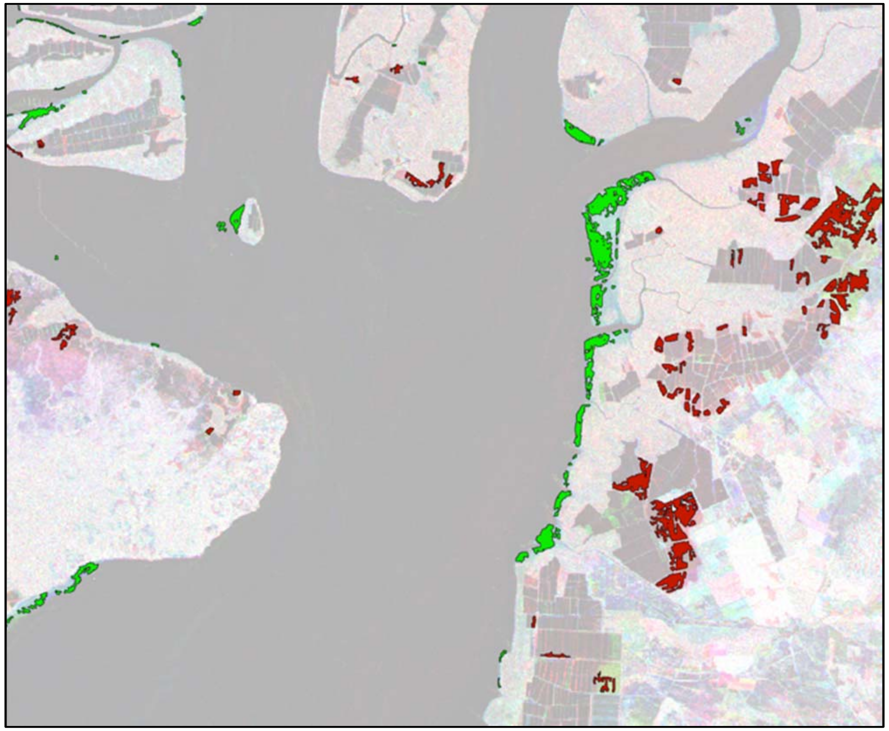
# East Kalimantan



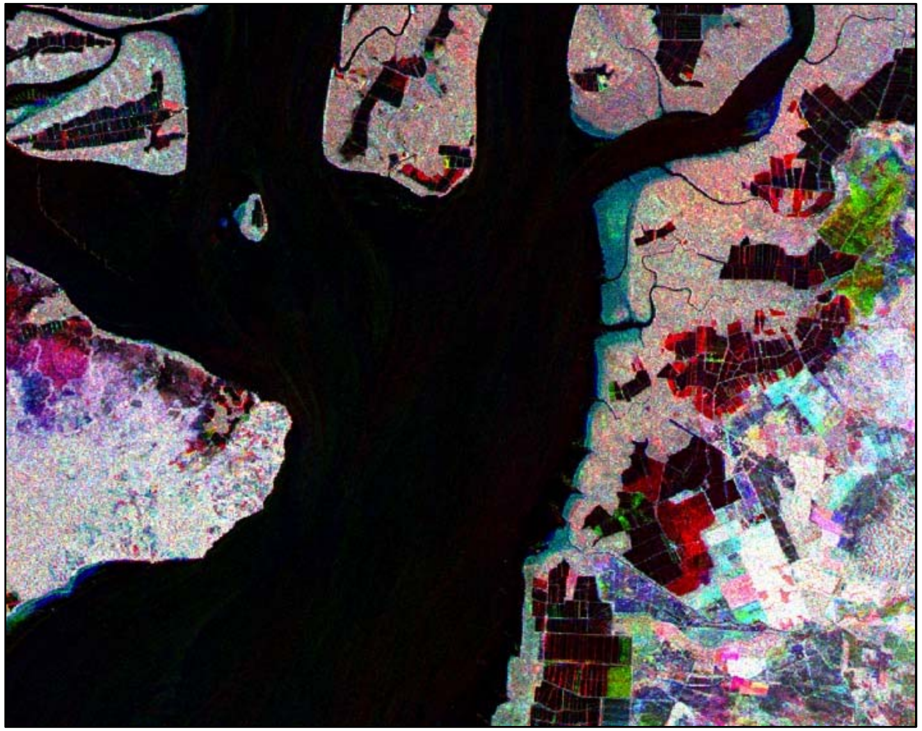
# Mapping Mangrove Loss East Kalimantan, Indonesia

- Loss of mangrove in red; between 1996 (JERS-1) and 2010 (ALOS PALSAR)
- Difficulty in establishing the boundary between mangrove and non-mangrove forests in complex landscapes.

# Detection of Change: 1996-2010



Mangrove advance and loss (1996-2010) overlain on a time-series colour composite Image (R: JERS-1 96 HH, G: ALOS 07 HH, B: ALOS 10 HH)



Time-series colour composite Image (R: JERS-1 96 HH, G: ALOS 07 HH, B: ALOS 10 HH)

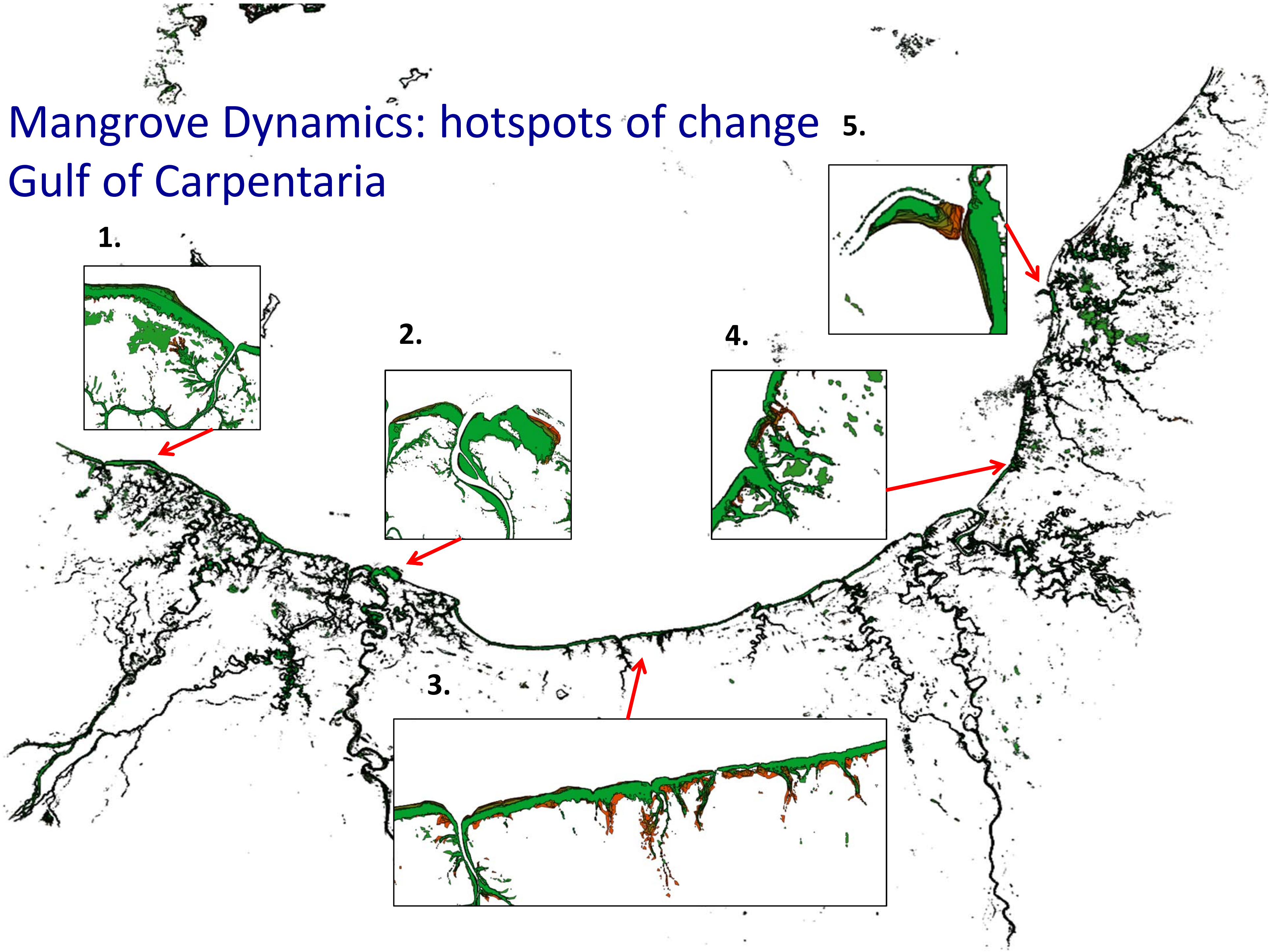
# Time-series comparison of JERS-1 SAR, ALOS PALSAR and ALOS-2 PALSAR-2 data

Nigeria

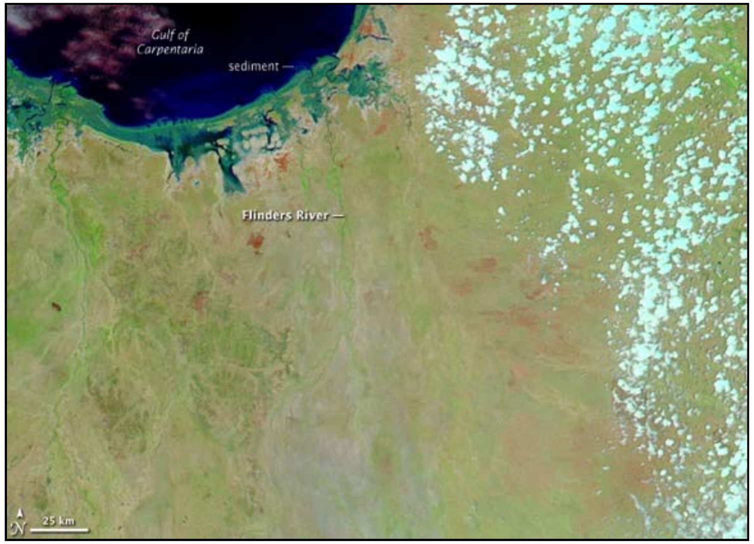
San Luis, Brazil

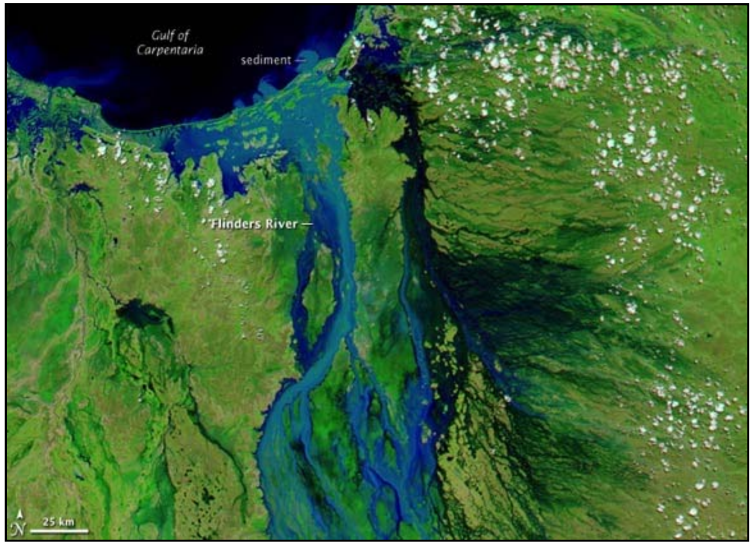
Blue: Gain, Red: Loss (between mid 1990s and 2014)

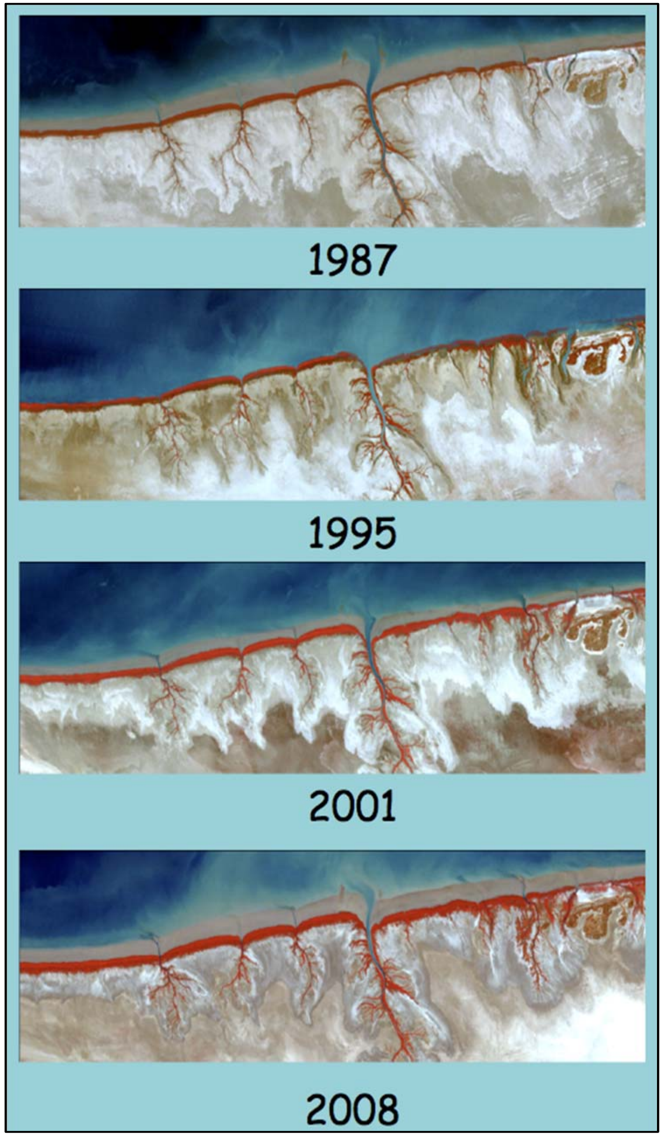
# Mangrove Dynamics: hotspots of change
# Gulf of Carpentaria



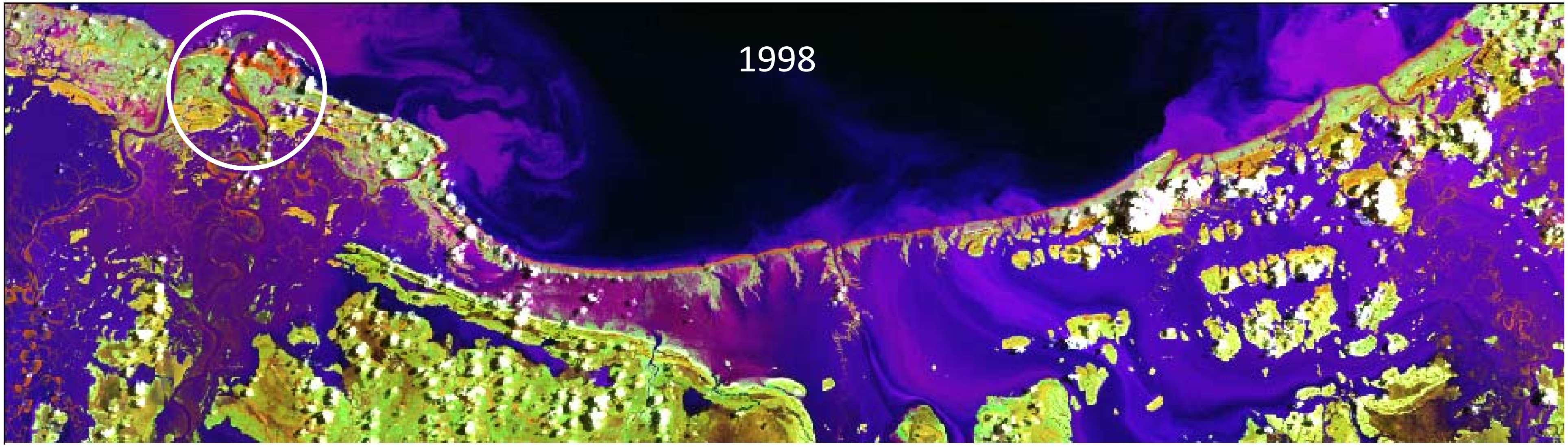
# Mangrove Change Dynamics:  Northern Australia



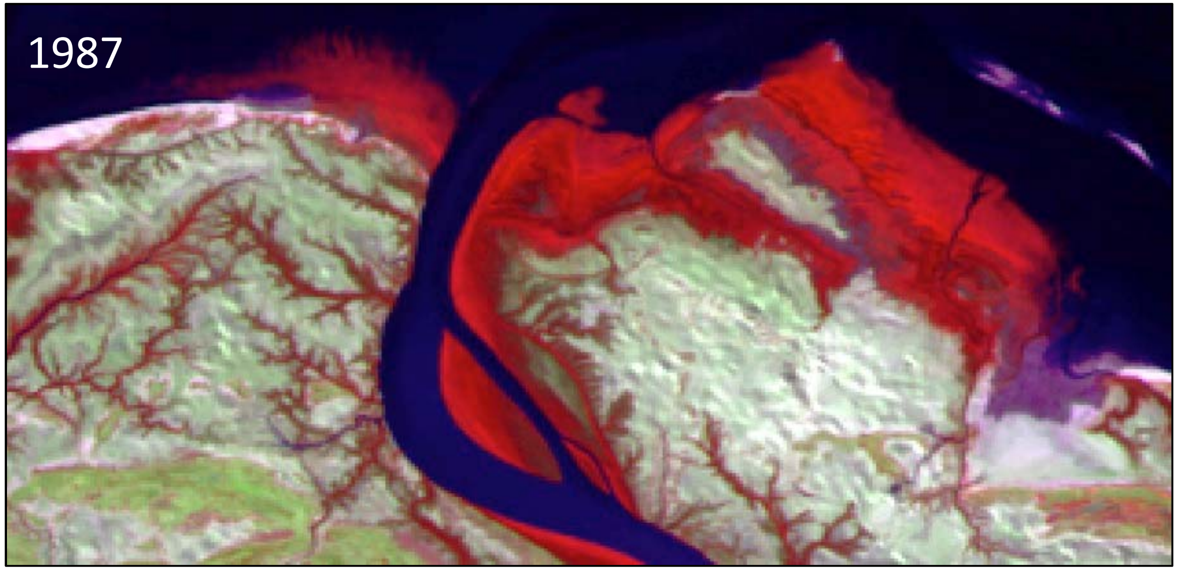



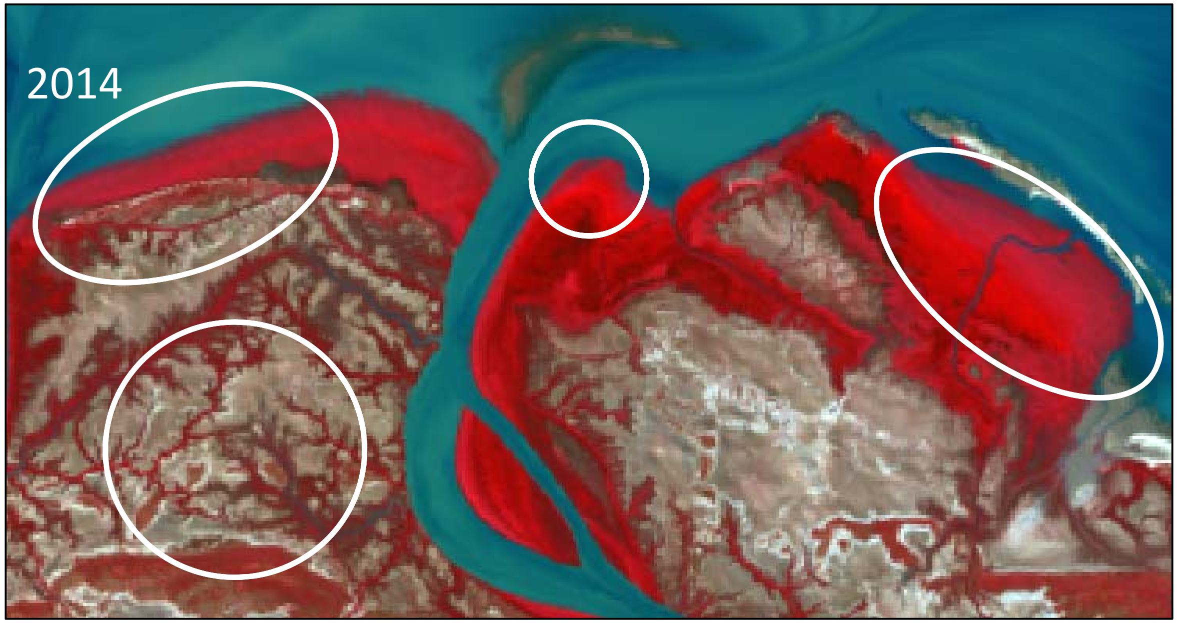



# Observations of the southern Gulf using Landsat sensor data

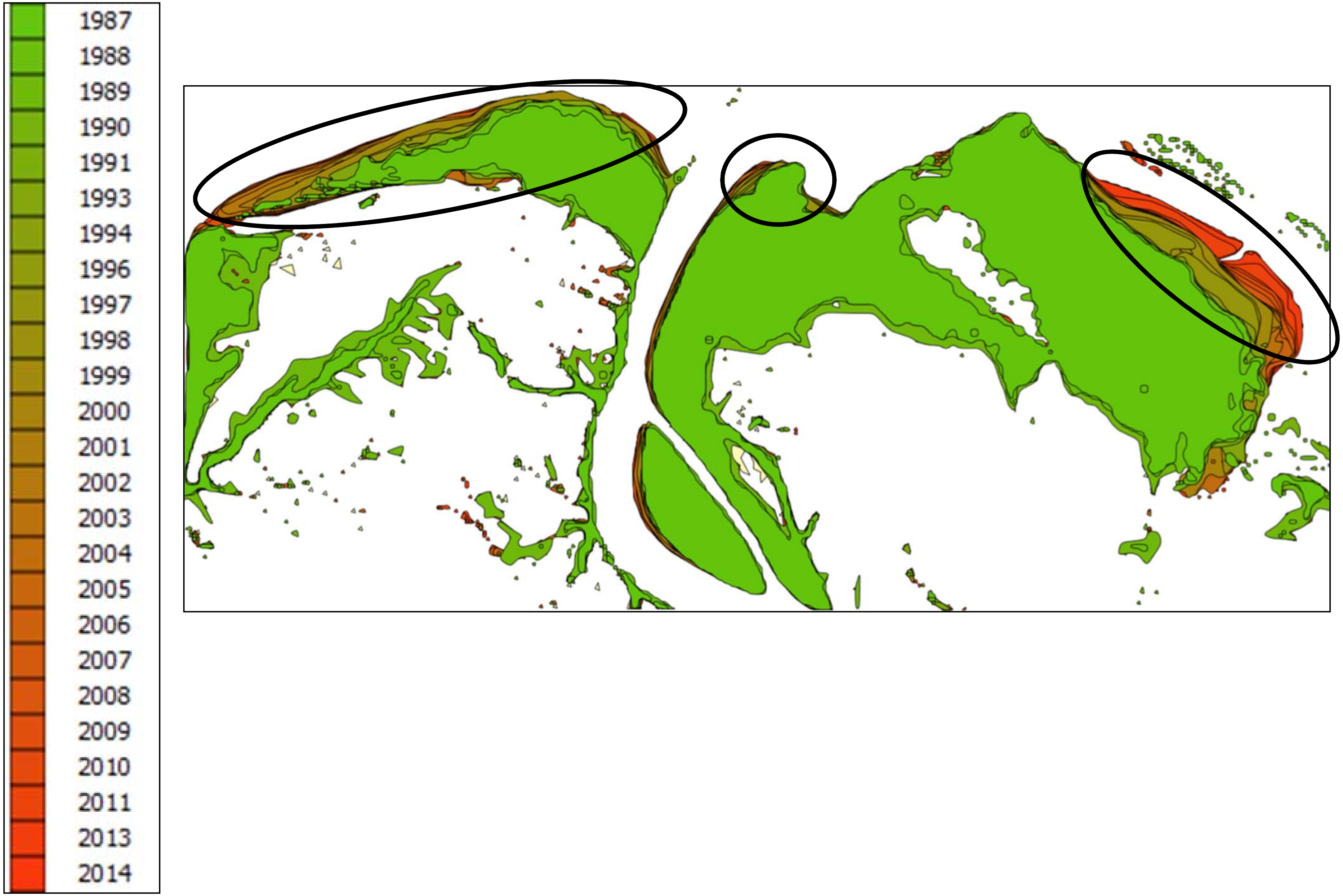



# Mangrove change, Leichardt River, Gulf of Carpentaria

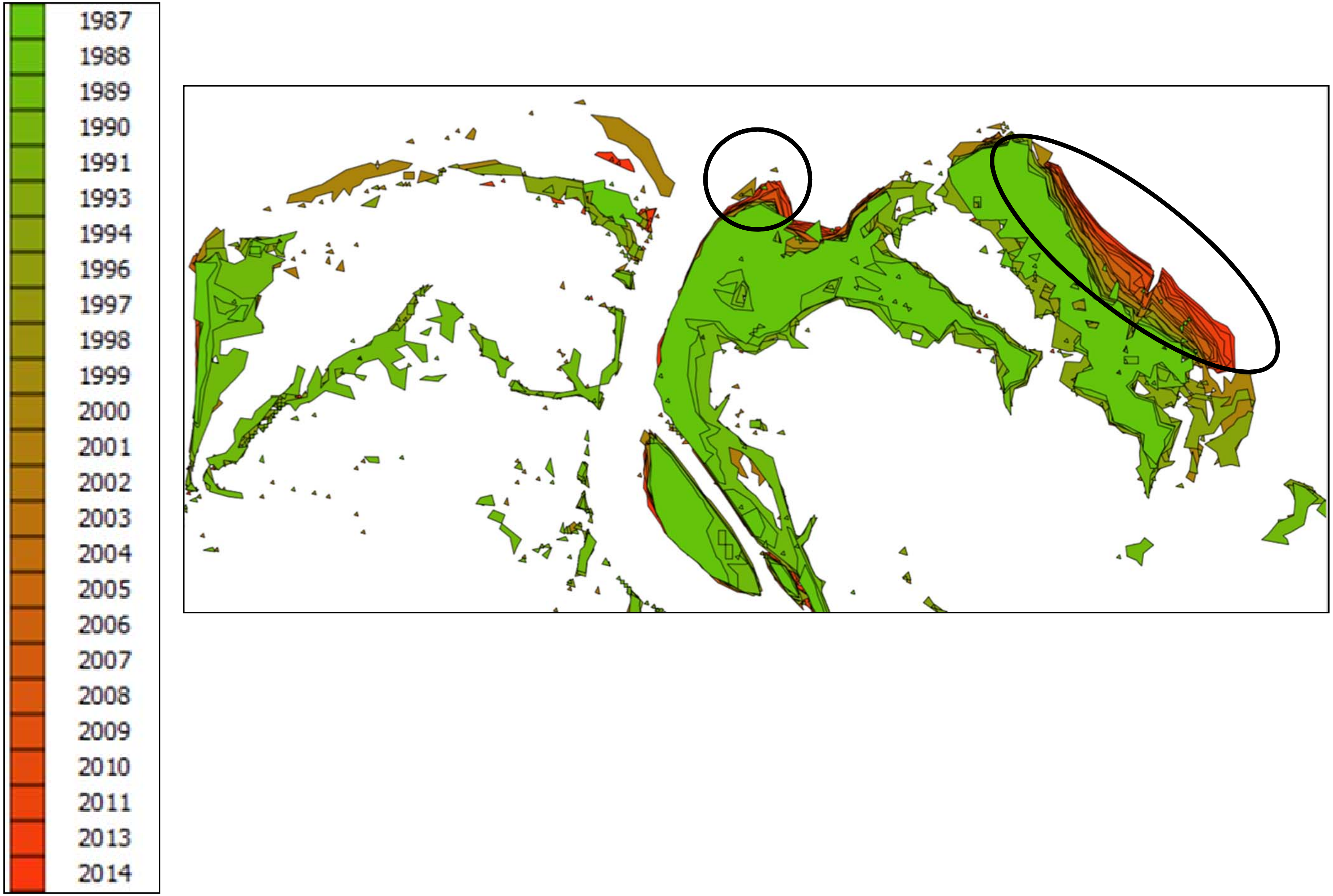


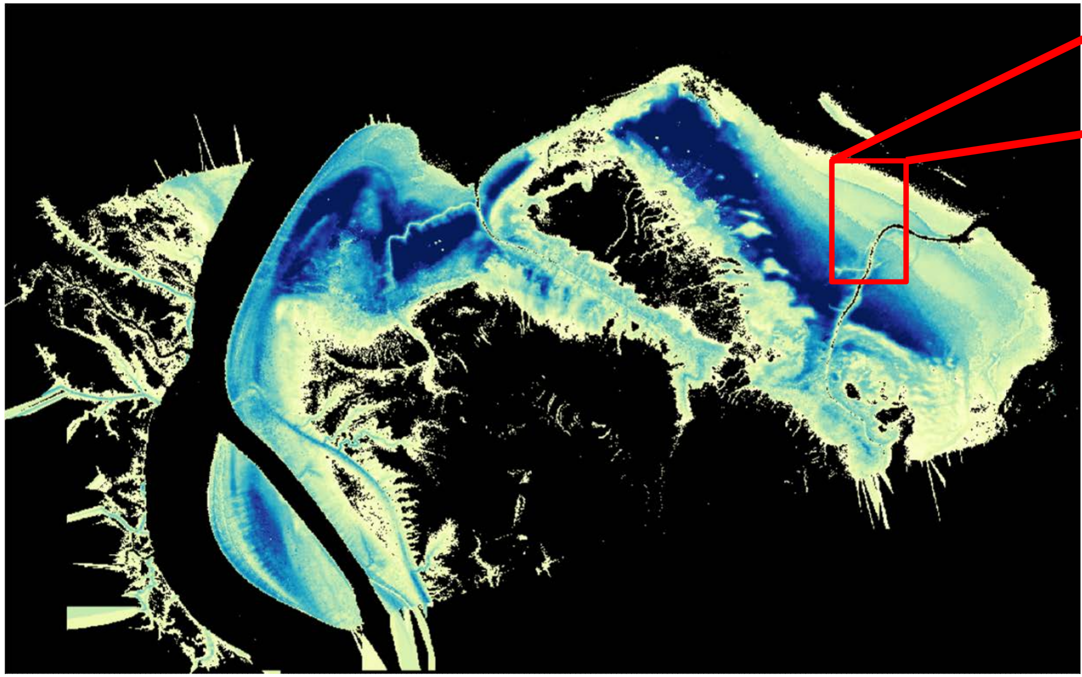



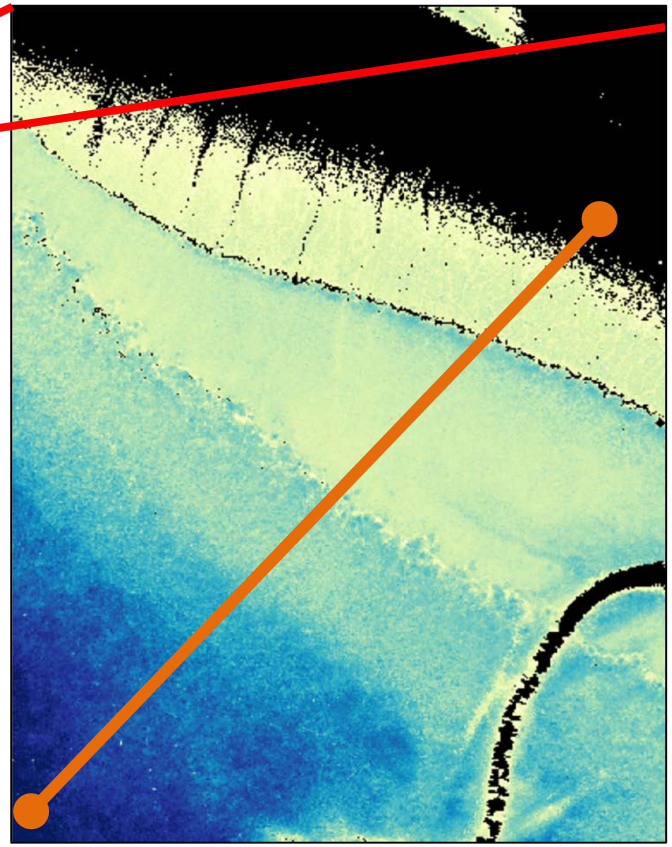
# Expansion of total mangrove area from 1987 to 2014



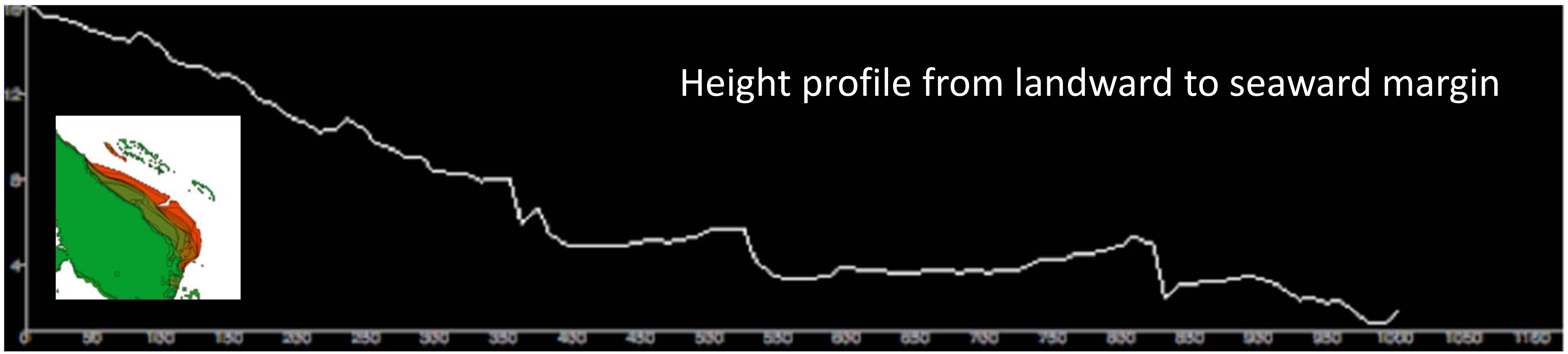
# Expansion of Rhizophora area from 1987 to 2014

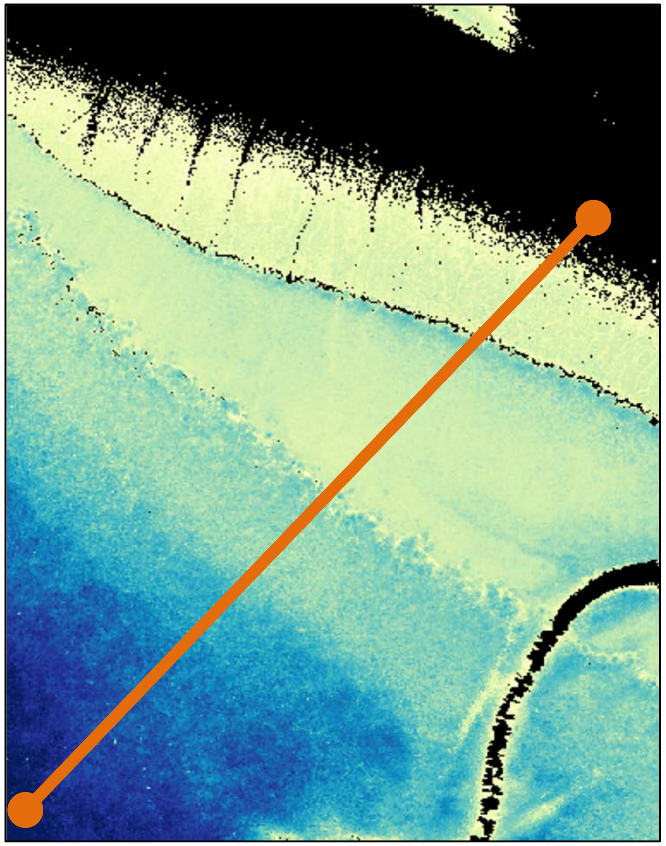


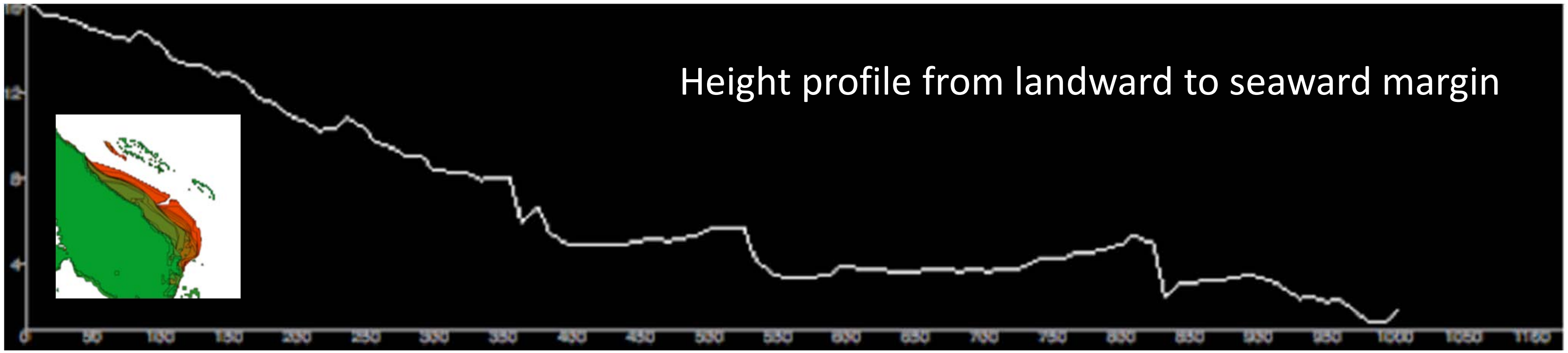




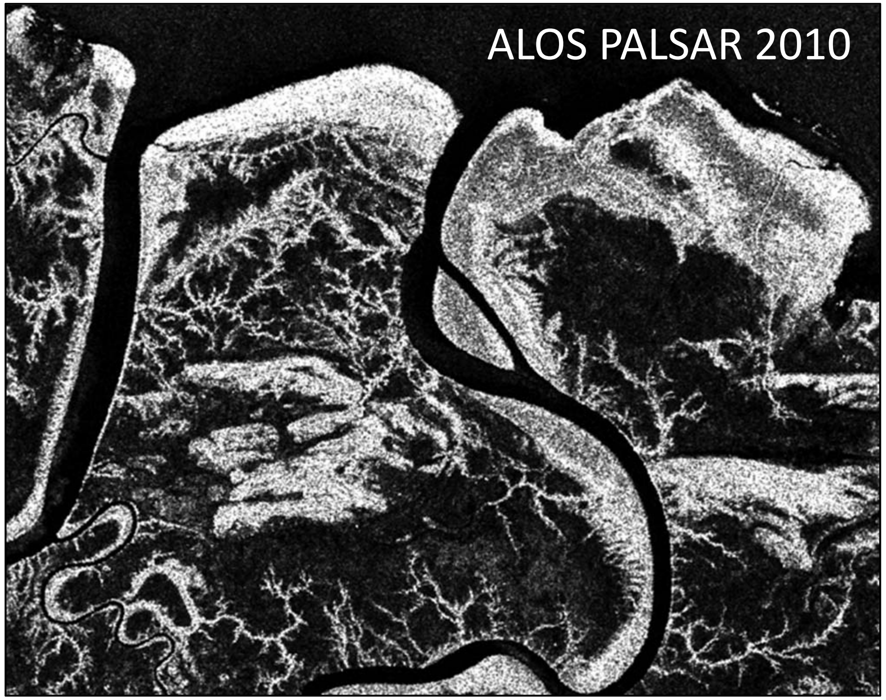
Seaward expansion -
Evident in LIDAR data

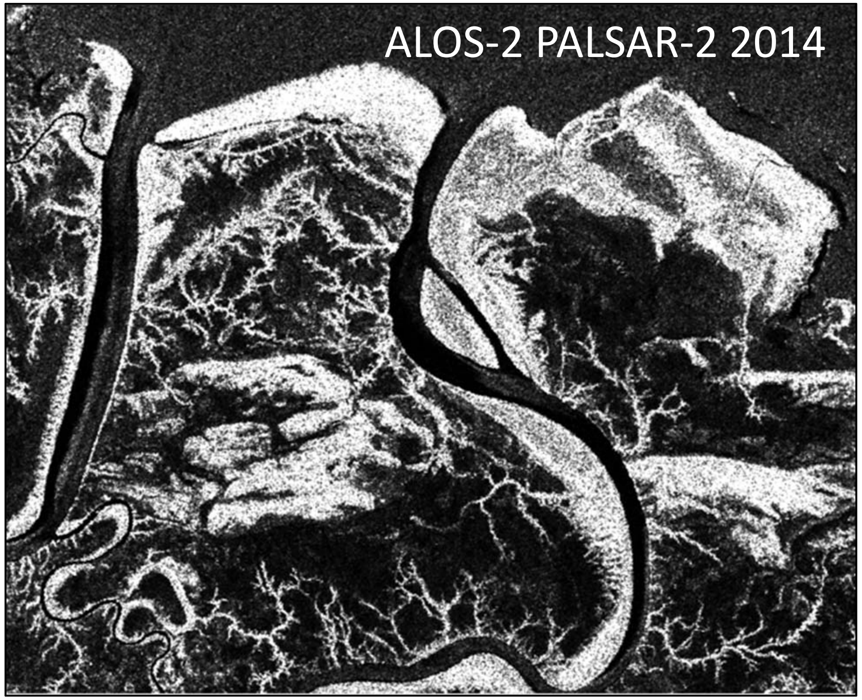


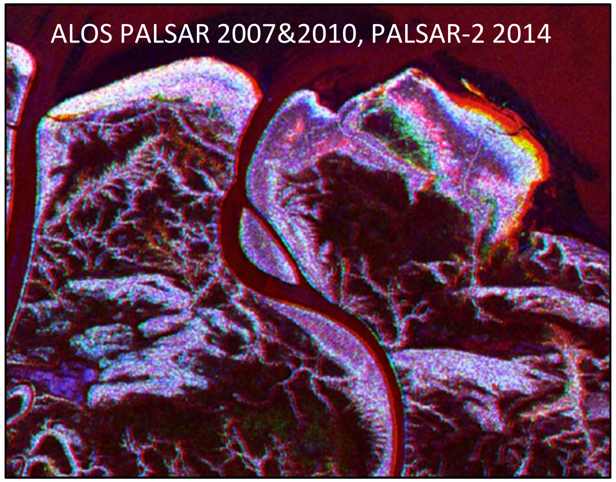



Height profile from landward to seaward margin

# Comparison of Mangrove extent and species composition



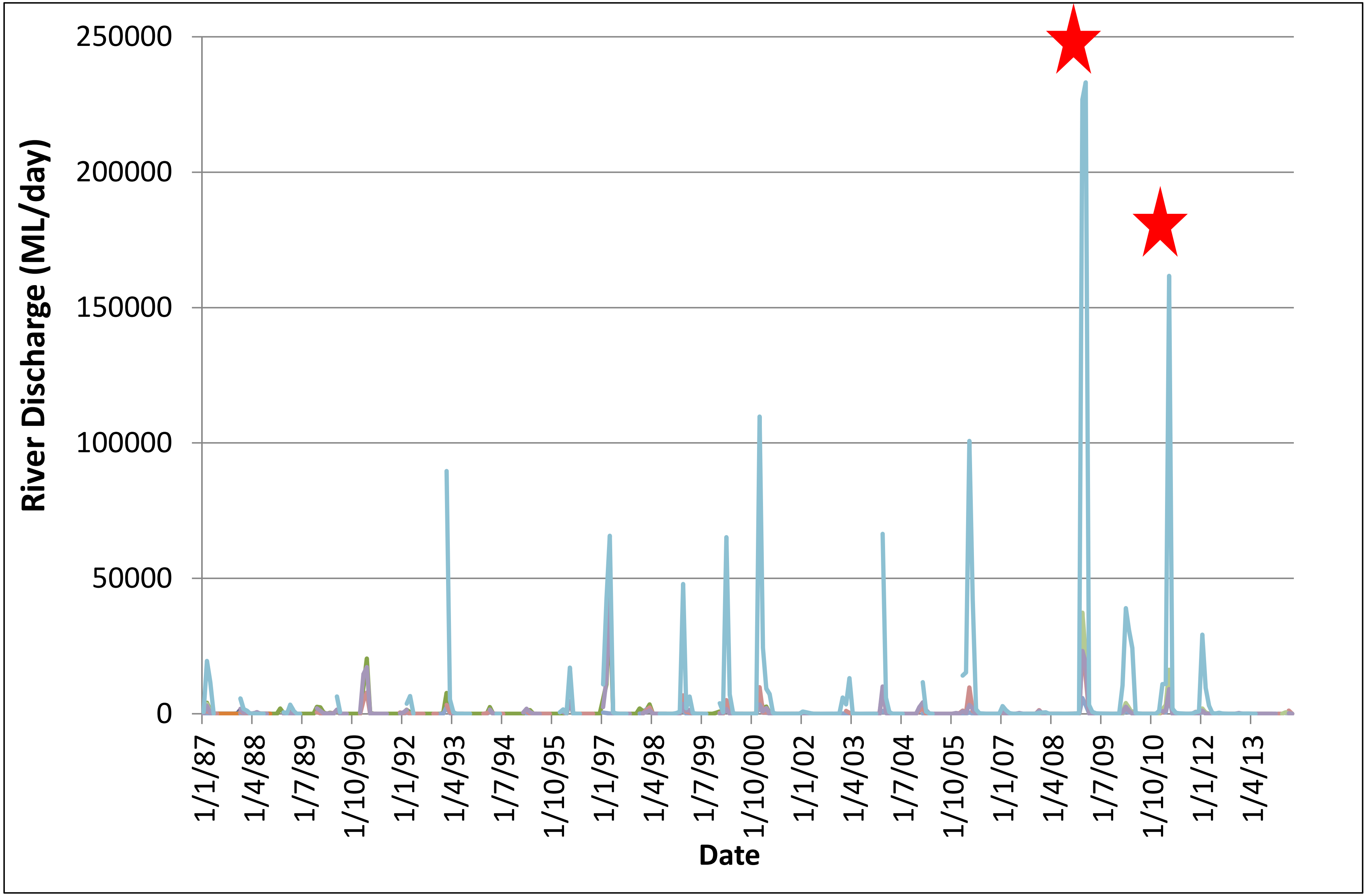




Seaward expansion (red) of mangroves as detected through time-series comparison of ALOS PALSAR and ALOS-2 PALSAR-2 data.

Note low areas of L-band backscatter within areas dominated *by Rhizophora stylosa.*

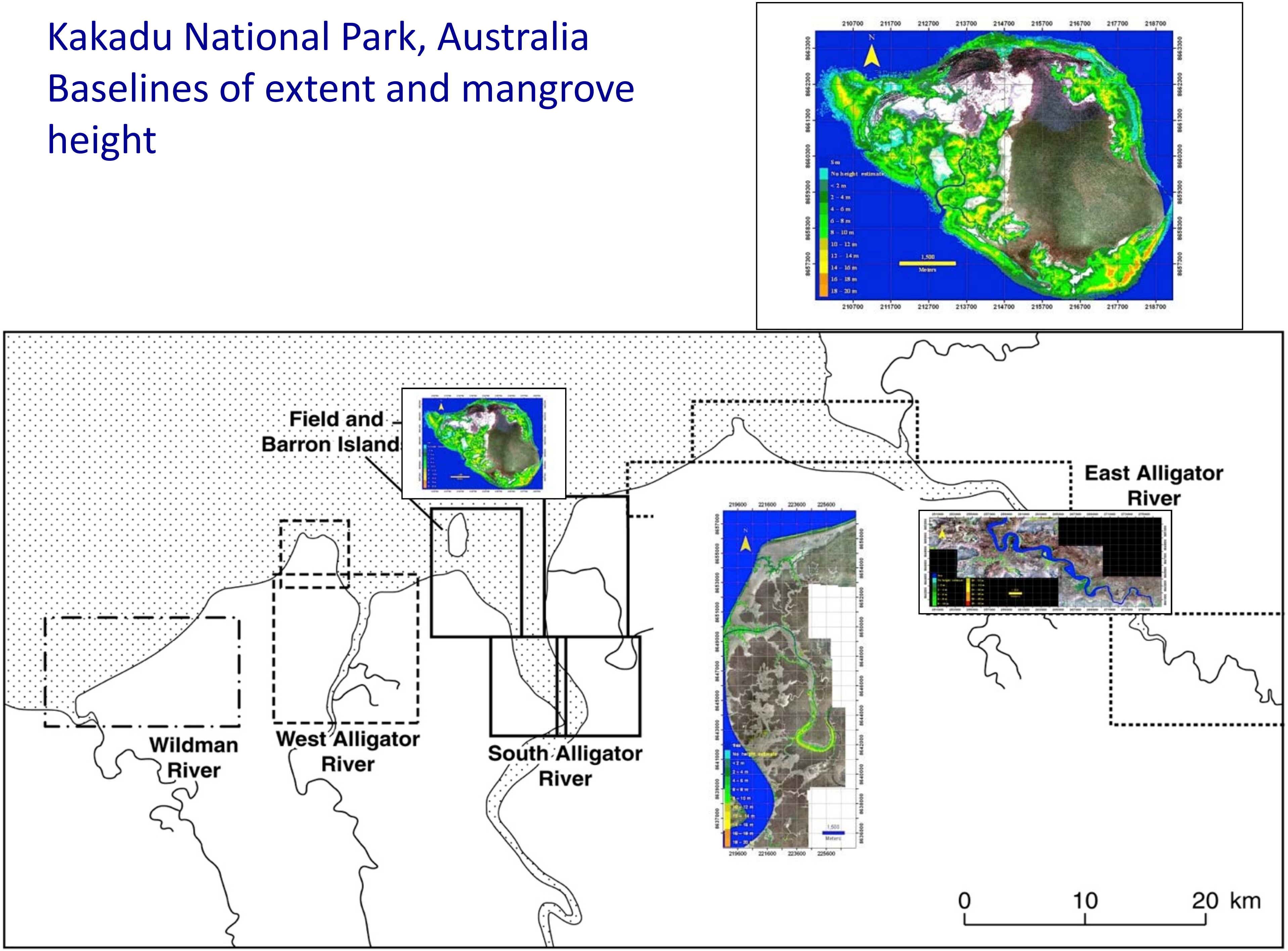
# River discharge in the Leichhardt catchment

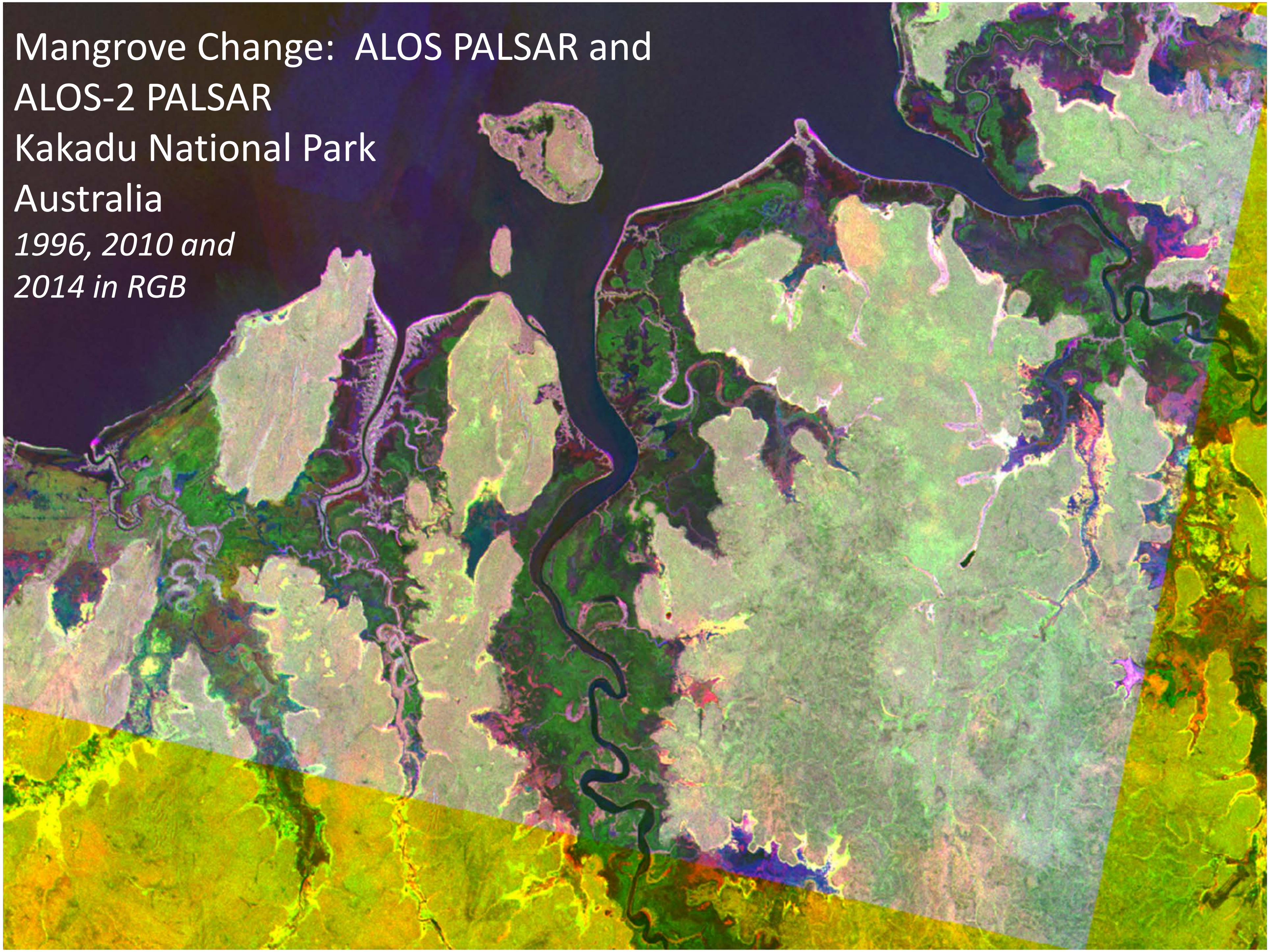


# Mangrove Dynamics, Gulf of Carpentaria

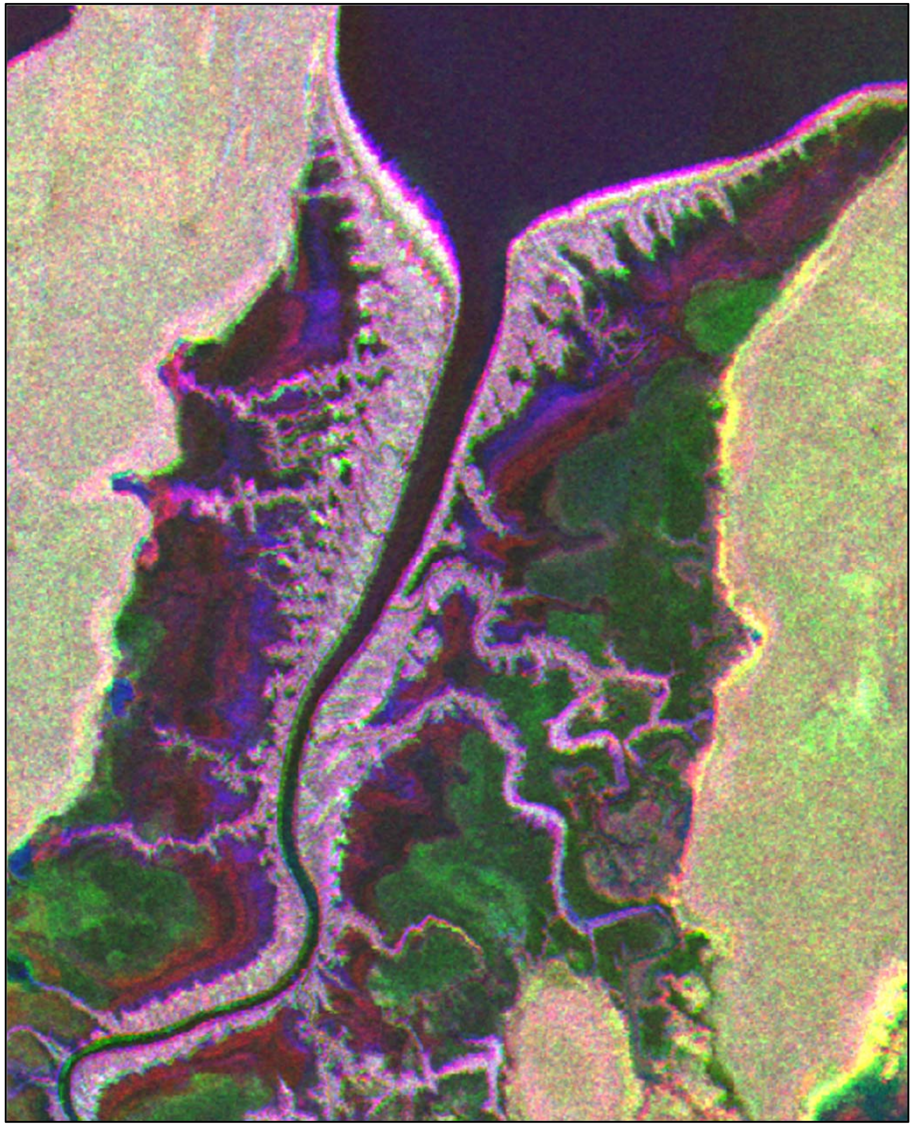
- In the Gulf, mangroves are extending seawards as a consequence of increased river discharge.
  - Analysis of lidar data indicates distinct height steps associated with colonisation of mangroves.
- Within the mangrove community, a transition from one species group to another also occurs.
- Mangroves are extending inland, with this attributable to increased flooding and potentially sea level rise.
- The changes observed in mangroves near the mouth of the Leichardt River are evident along most of the coast of the Gulf of Carpentaria.
- Changes are detectable through time-series comparison of ALOS PALSAR and ALOS-2 PALSAR-2 data.

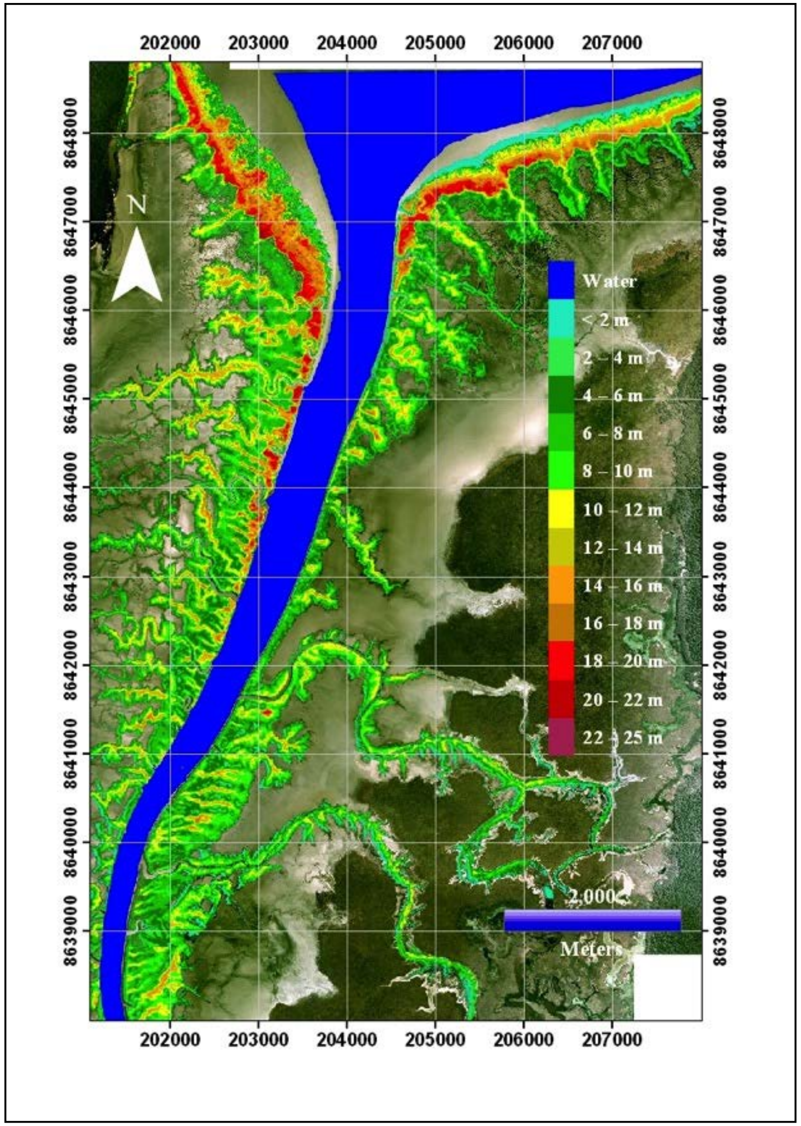
# Kakadu National Park, Australia
# Baselines of extent and mangrove height

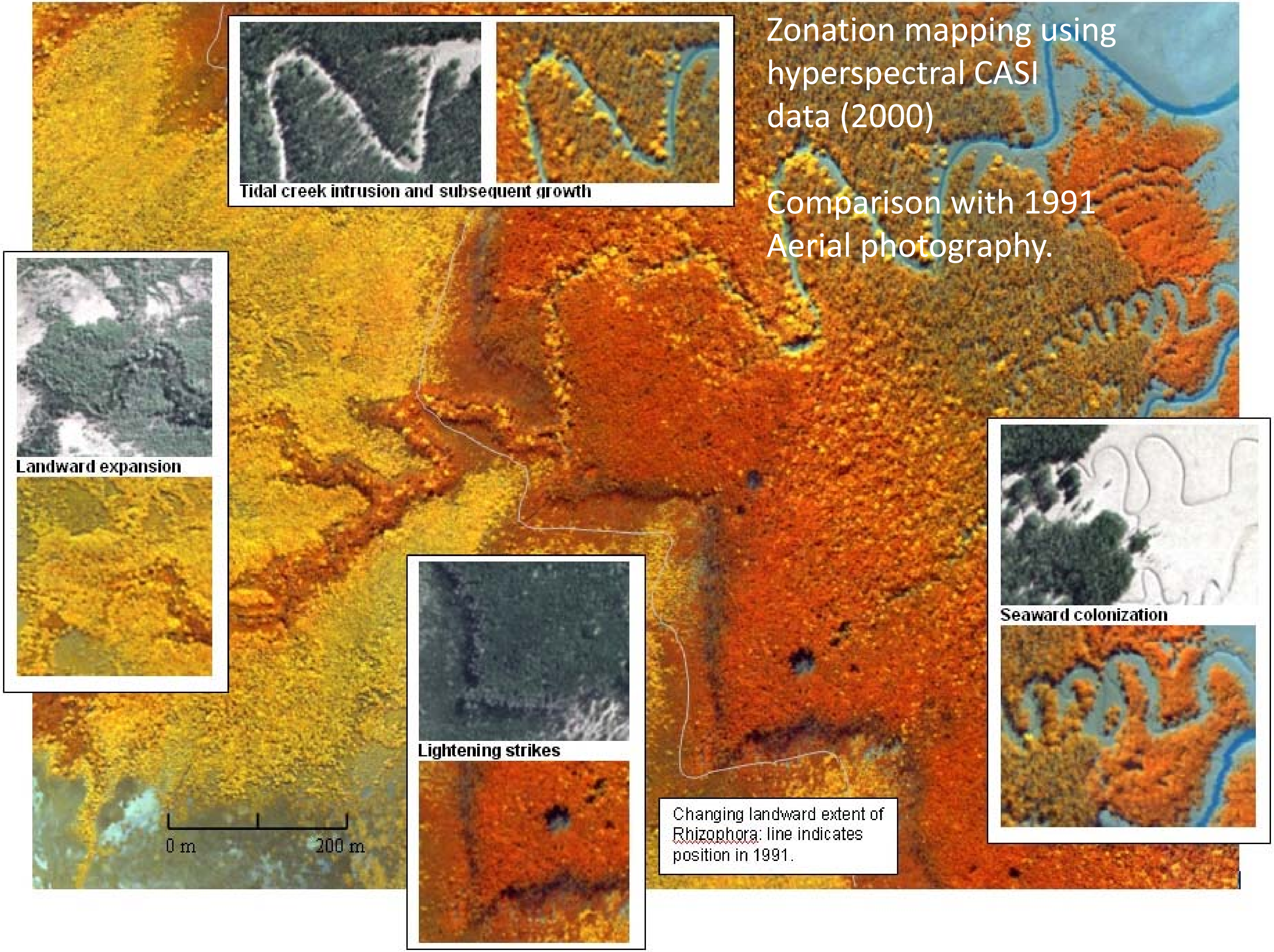



Mangrove Change: ALOS PALSAR and
ALOS-2 PALSAR
Kakadu National Park
Australia
*1996, 2010 and*
*2014 in RGB*

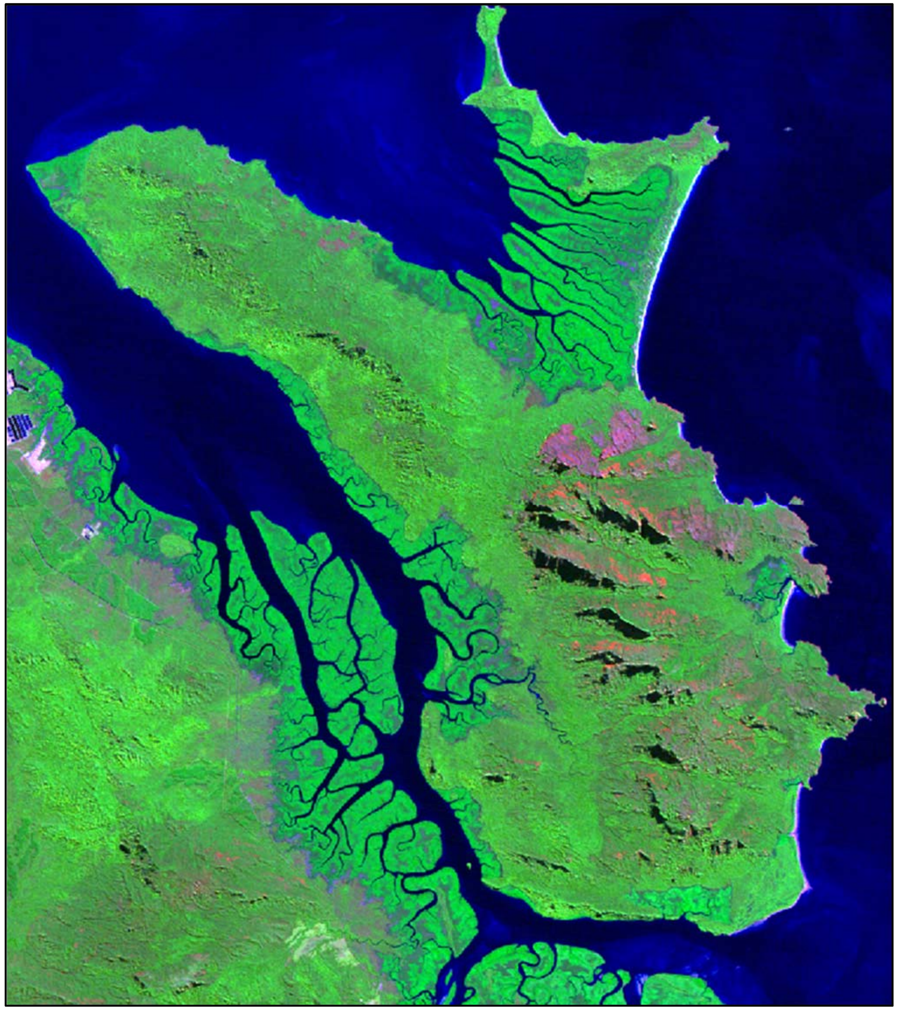
# Mangrove Change: ALOS PALSAR and ALOS-2 PALSAR, West Alligator River, Kakadu National Park






Zonation mapping using hyperspectral CASI data (2000)
Comparison with 1991 Aerial photography.
Tidal creek intrusion and subsequent growth
Landward expansion
Lightening strikes
Seaward colonization
Changing landward extent of Rhizophora: line indicates position in 1991.
0 m
200 m

# Cyclone Damage, Hinchinbrook Island, Queensland, Australia

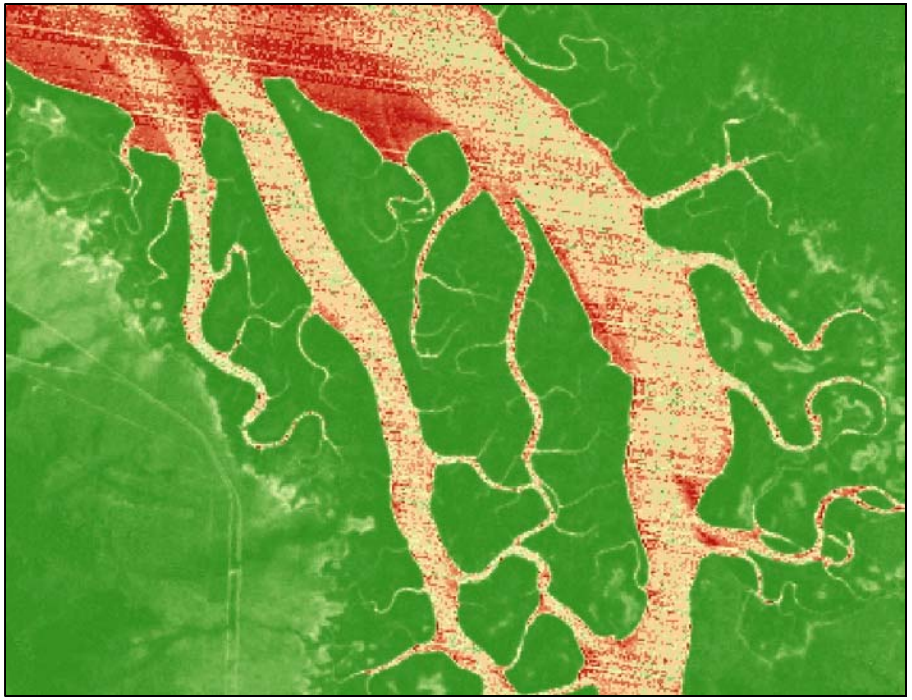


1st June, 2010

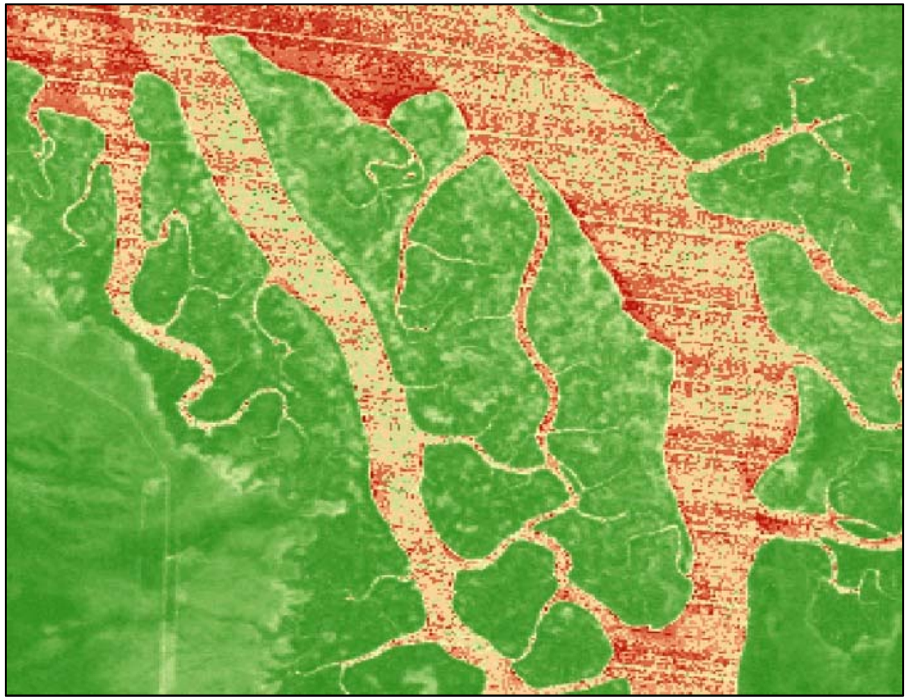
4th June, 2011

Landsat ETM+ data

# Loss of Foliage Material as observed by comparing Landsat-derived NDVI.



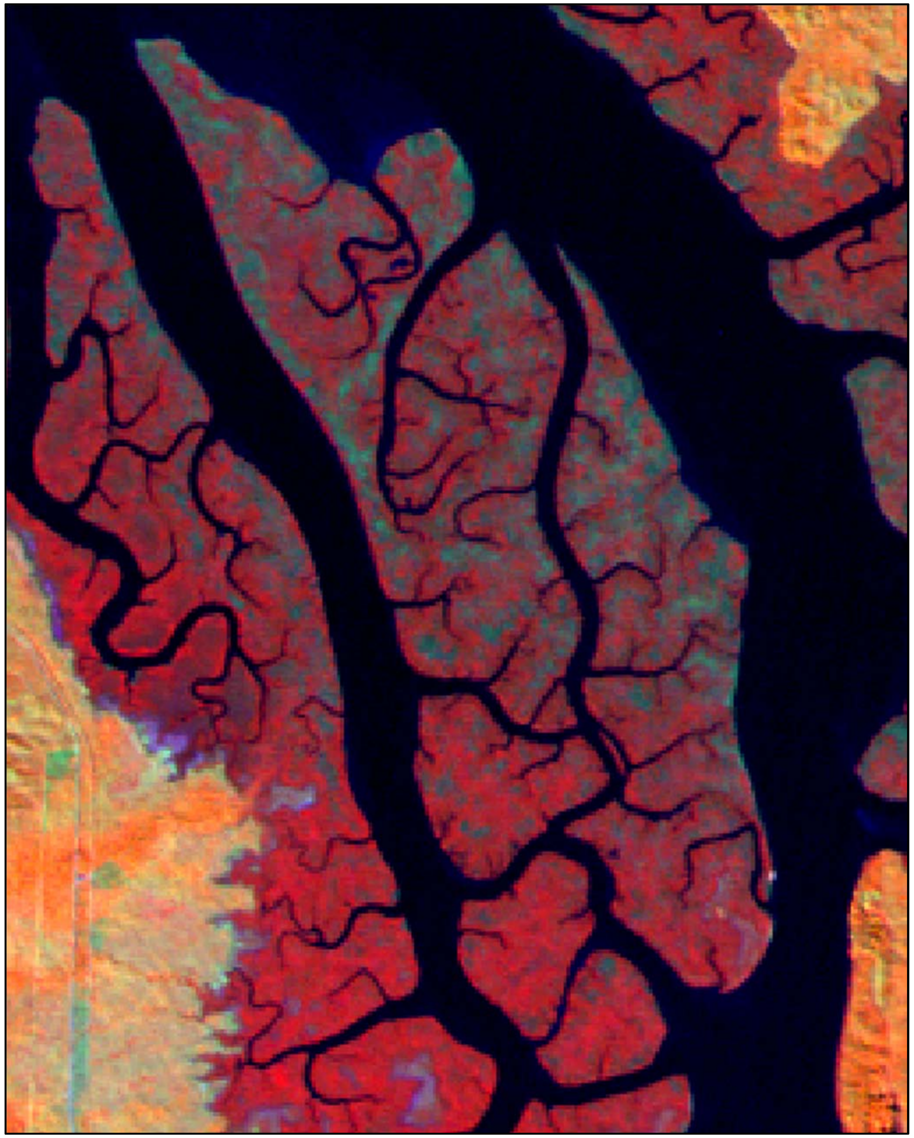
1st June, 2010



4th June, 2011

# Cyclone Damage, Cyclone Yasi

ALOS-2 PALSAR-2 (HH)

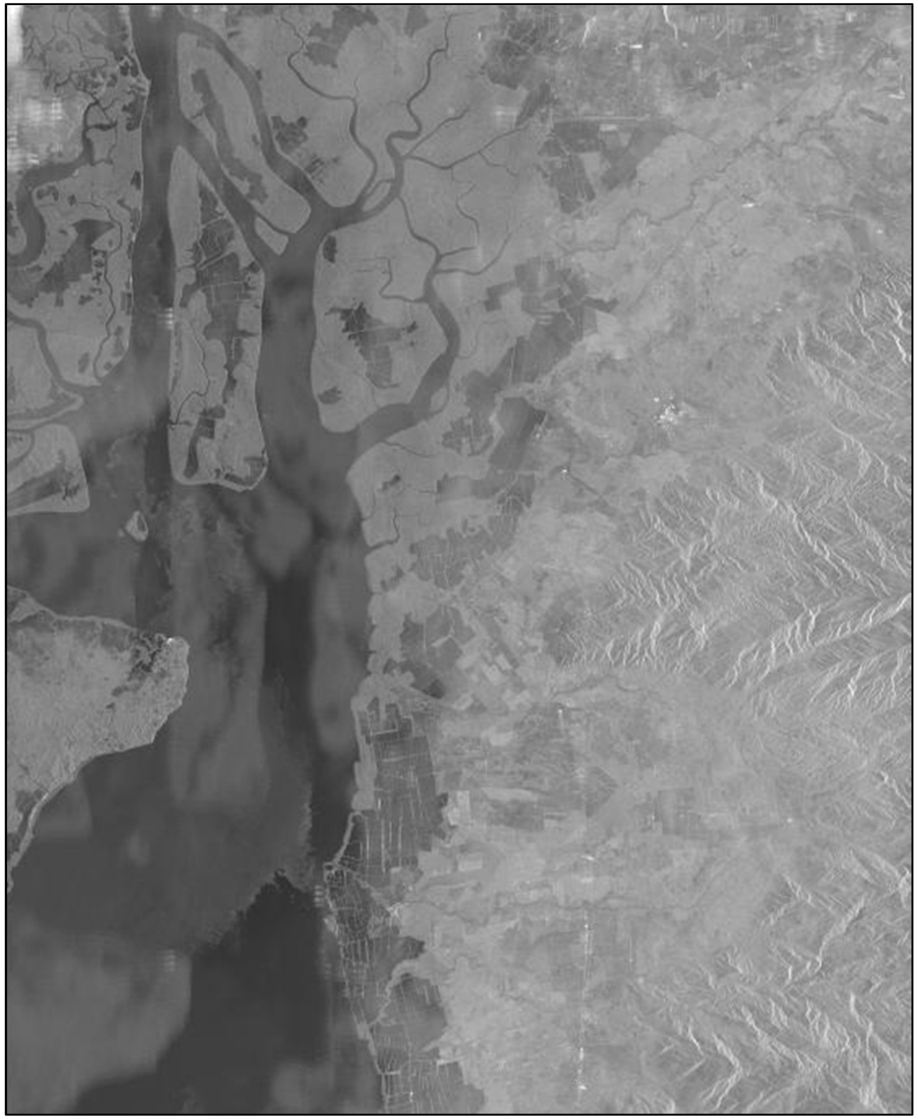


Landsat ETM+ (4,5,3 in RGB)

# Cyclone Damage, Hinchinbrook Island, Queensland, Australia

Windthrow of mangrove trees observed in Very High Resolution (VHR) imagery

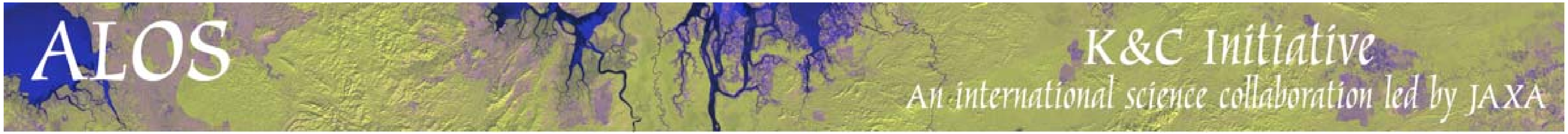
# Issues with ALOS-2 PALSAR data



- Shadowing in some images
  - HH polarisation.

# Who cares about mangroves?

- For many, there is no problem:
  - Most change seems to be movement out to sea so mangroves are expanding
  - Mangroves recover very quickly (e.g. Perak Province)
  - They occupy wastelands and are waiting to be exploited.
- However:
  - Many areas created from land previously occupied by mangroves can no longer support mangroves (e.g., aquaculture) and so these are gone ‘forever’
  - Clearance affects local populations in terms of fisheries and other products (e.g., timber)
  - Mangroves provide shoreline protection
  - Mangroves are a significant repository for biodiversity.
- The Global Mangrove Watch can inform on changes that are occurring, whether positive or negative, and therefore contribute to their long term conservation and sustainable use.




# The Global Mangrove Watch: The Way Forward

- Work with WCMC and Wetlands International to create a web interface
    - Initially showing image composites as $1^{o}$ x $1^{o}$ tiles (demonstration products)
    - Subsequently change maps
- Work with JAXA to provide options for the supply of change products for all mangrove areas.
    - Annual mapping of extent and changes in mangrove areas with particular focus on hotspot areas (as part of K&C 4)
- Work with WCMC and NASA JPL/GSPC to provide estimates of losses and gains in species and biomass.
- Key requirements:
    - Provision of JERS-1 SAR and ALOS-2 PALSAR-2 data for mangrove areas
- Respond to a proposed official launch of the GMW at the Ramsar CoP12 in June 2015