Use of ALOS PALSAR for Regional Mapping and Monitoring of Mangroves

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Overview

- The Japanese Space Exploration Agency (JAXA) Kyoto and Carbon (K&C) Initiative
- Spaceborne L-band SAR
  - JERS-1 SAR and ALOS PALSAR
- Classification of mangroves
  - Extent and structure
- Detection of change
  - River dynamics
  - Direct clearance
  - Coastal erosion and accretion
  - Climate and sea level fluctuation
- Contribution to JAXA's Global Mangrove Watch.

The Japanese Space Exploration Agency Kyoto and Carbon (K&C) Initiative

- Established to support explicit and implicit data and information needs raised by:
  - International environmental Conventions
  - Carbon Cycle Science
  - Conservation of the environment
- Led and coordinated by EORC JAXA
  - Undertaken by an international Science Team
- Focuses primarily on defining and optimizing provision of data products and validated thematic information derived from *in-situ* and satellite sensor data
  - Phased Array L-band Synthetic Aperture Radar (PALSAR) on-board the Advanced Land Observing Satellite (ALOS) (2007-2010)
  - The Japanese Earth Resources Satellite (JERS-1) SAR (1992-1998)

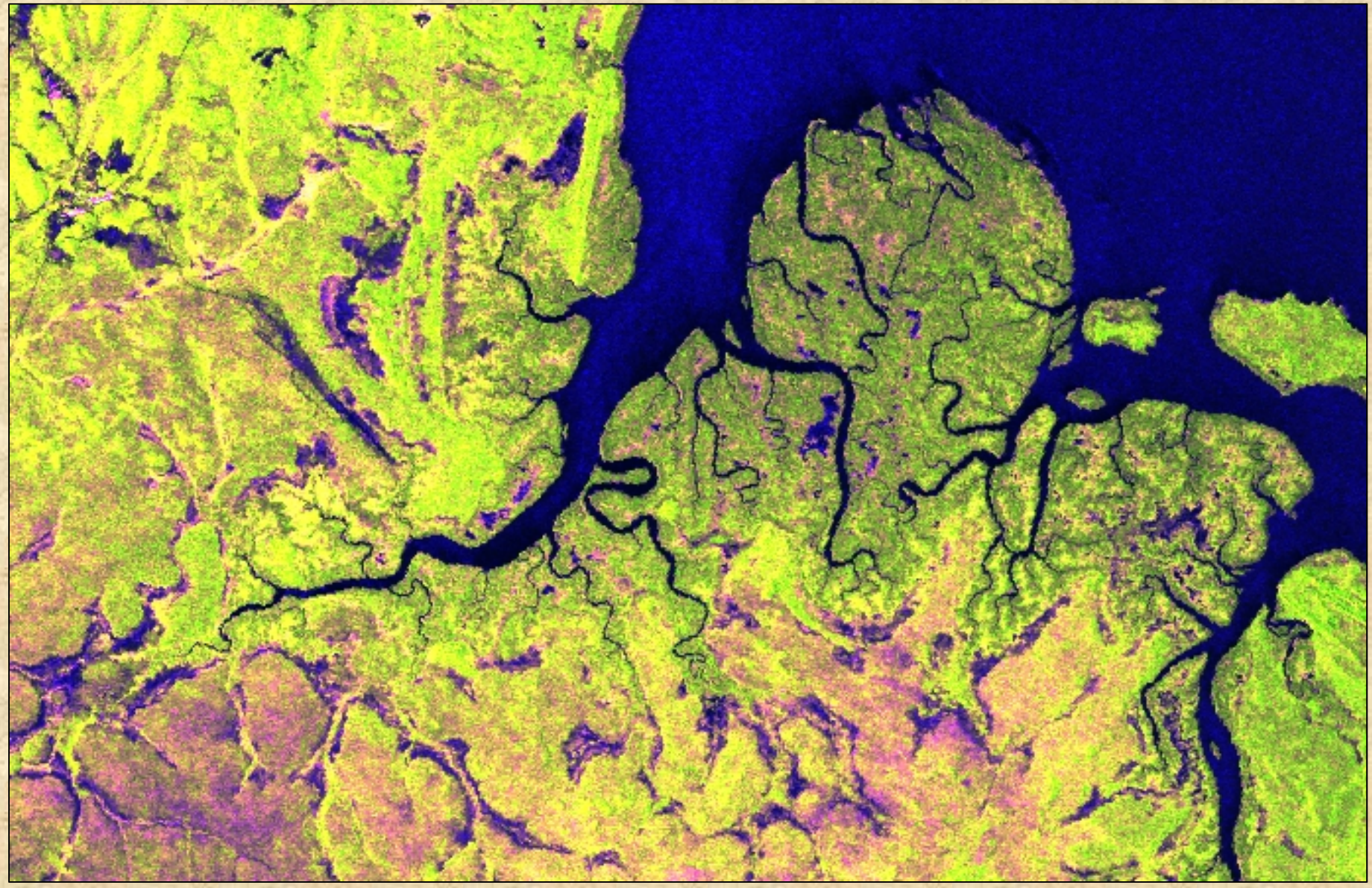
JAXA L-band SAR

- JERS-1 SAR (1992-1998)
  - L-band HH
- ALOS PALSAR (2007-2010)
  - L-band HH and HV (FBD)
  - L-band HH (FBS) and fully polarimetric (PLR)
- ALOS-2 SAR (Planned launch, 2013)

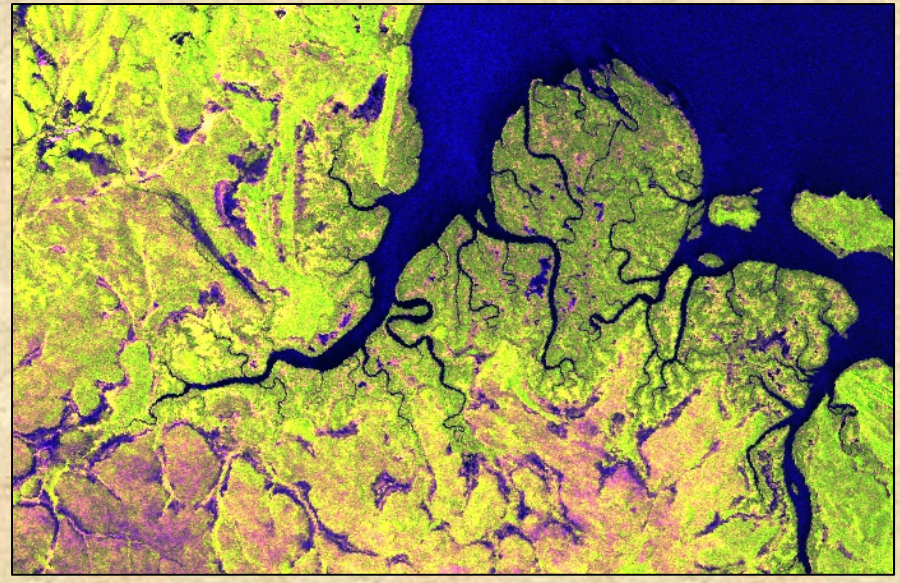
The USGS/NASA Global Mangrove Dataset

Giri, C., Ochieng, E., Tieszen, L.I., Shu, Z., Singh, A., Loveland, T. and Duke, N. Status and Distribution of mangrove forests of the world using earth observation satellite data. *Global Ecology and Biogeography*, 20(1), 154-159.

L-band SAR: Mapping Mangrove Extent



Mangrove Extent



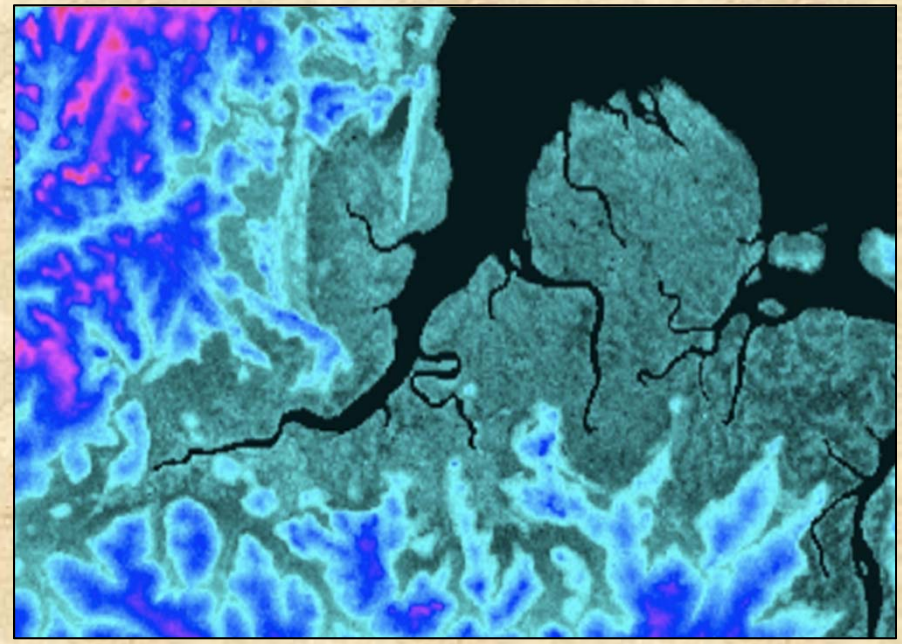
- ALOS PALSAR
  - Difficulty in mapping mangrove extent when adjoining other vegetation

- Landsat FPC
  - Provides clear differentiation of mangrove and non-mangrove areas

Mangrove Extent

Texture: Maximum Entropy
(Forest/Mangrove)

Minimum HV
Maximum area of water

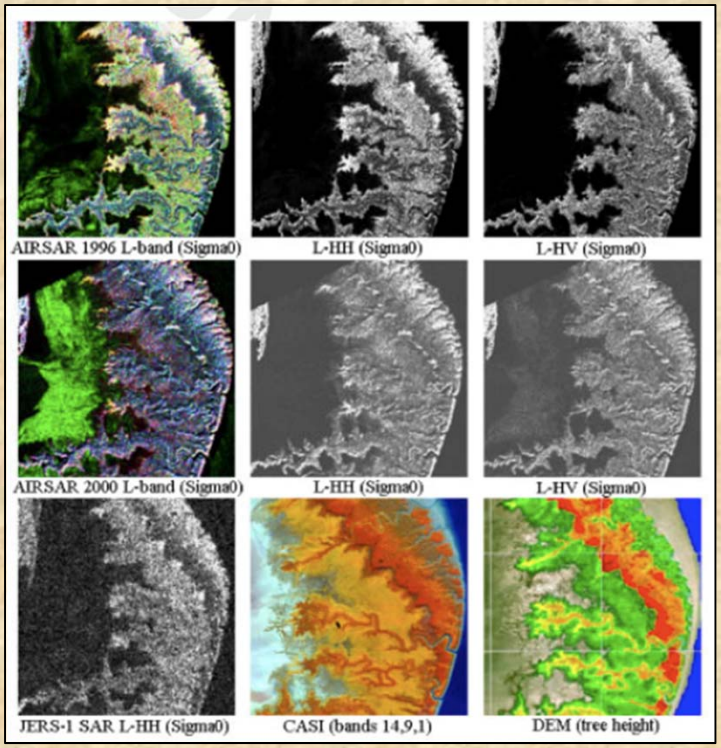


Mangrove Structure

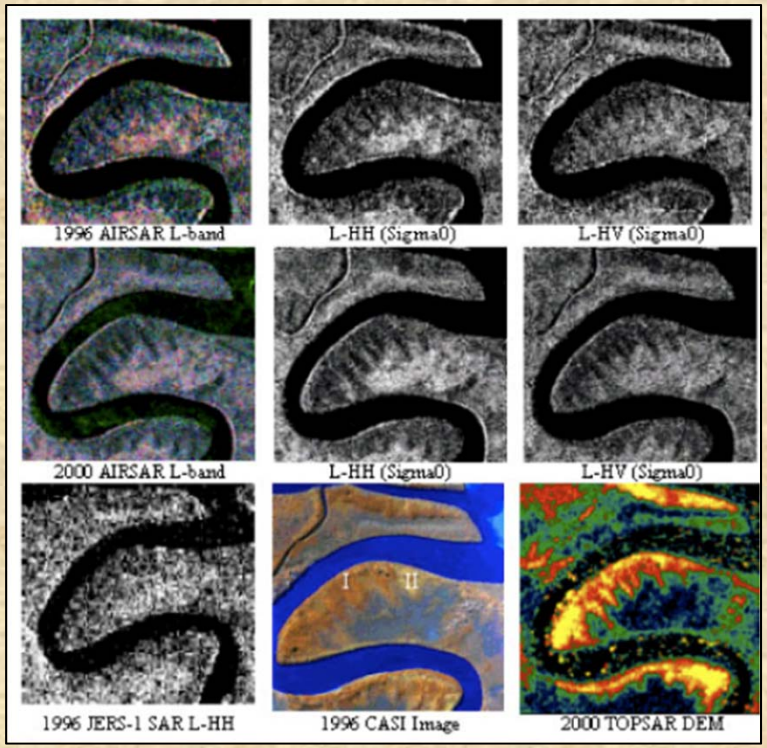
- SRTM or Tandem X
  - Focuses classification on low-lying coastal areas
  - Subsequently useful for retrieval of mangrove canopy height
    - Height retrieval more successful in larger, contiguous areas of closed canopy forest
- Landsat FPC
  - Related to cover
  - Assists in retrieval of height
  - Australia only.

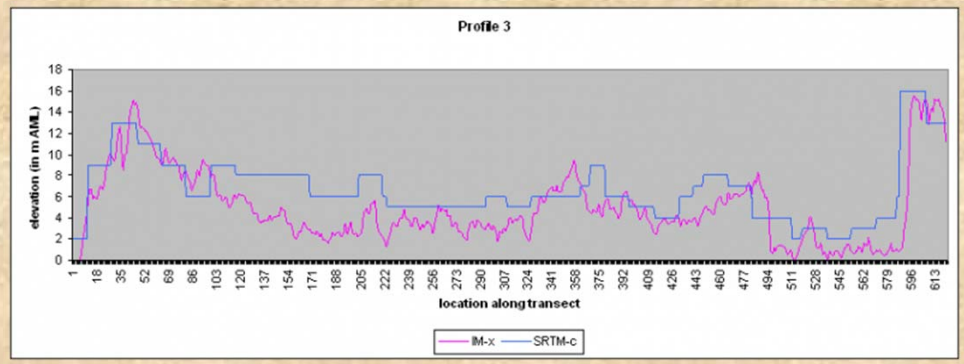
Airborne Observations of Mangrove

Kakadu National Park, NT



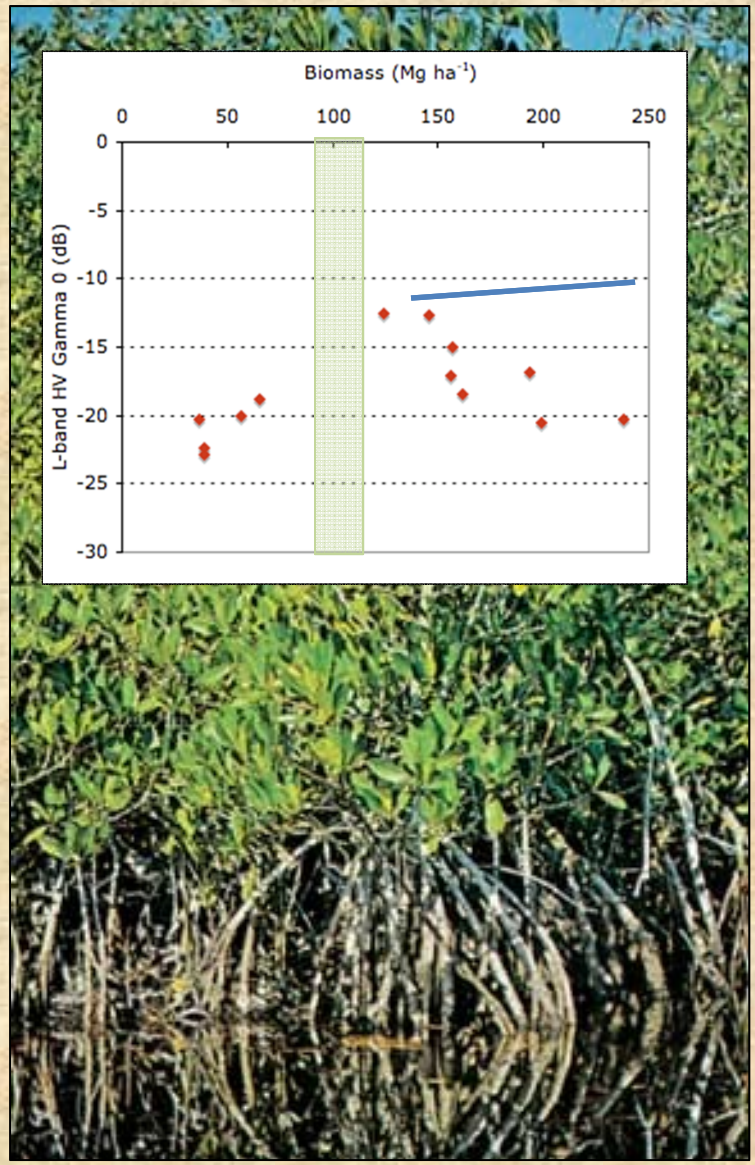
Daintree National Park, QLD





Comparison of NEXTMAP Intermap and SRTM DEMs, Belize Mangroves

Approach to classifying mangroves

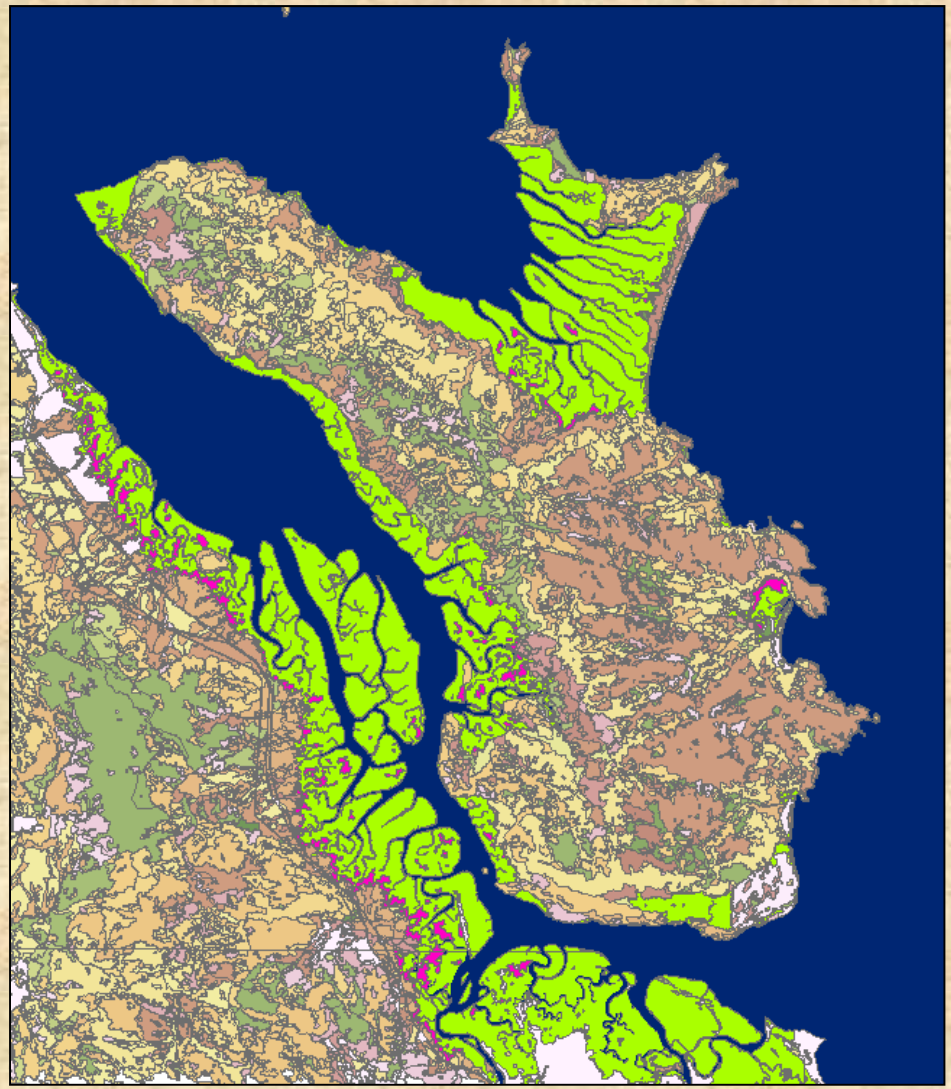


- Define extent of mangroves
  - Existing data layers
  - Landsat FPC
  - Direct classification based on ALOS
- Separate ‘low’ from ‘high’ mangroves
  - SRTM, Tandem-X
  - Definition of height locally variable (e.g.., 10 m)
- Separate high mangroves with/without prop root systems
- Assign all remaining objects to ‘low mangroves’
- Assign biomass classes (e.g., using relationships with L-band HV; upward & downward trends)

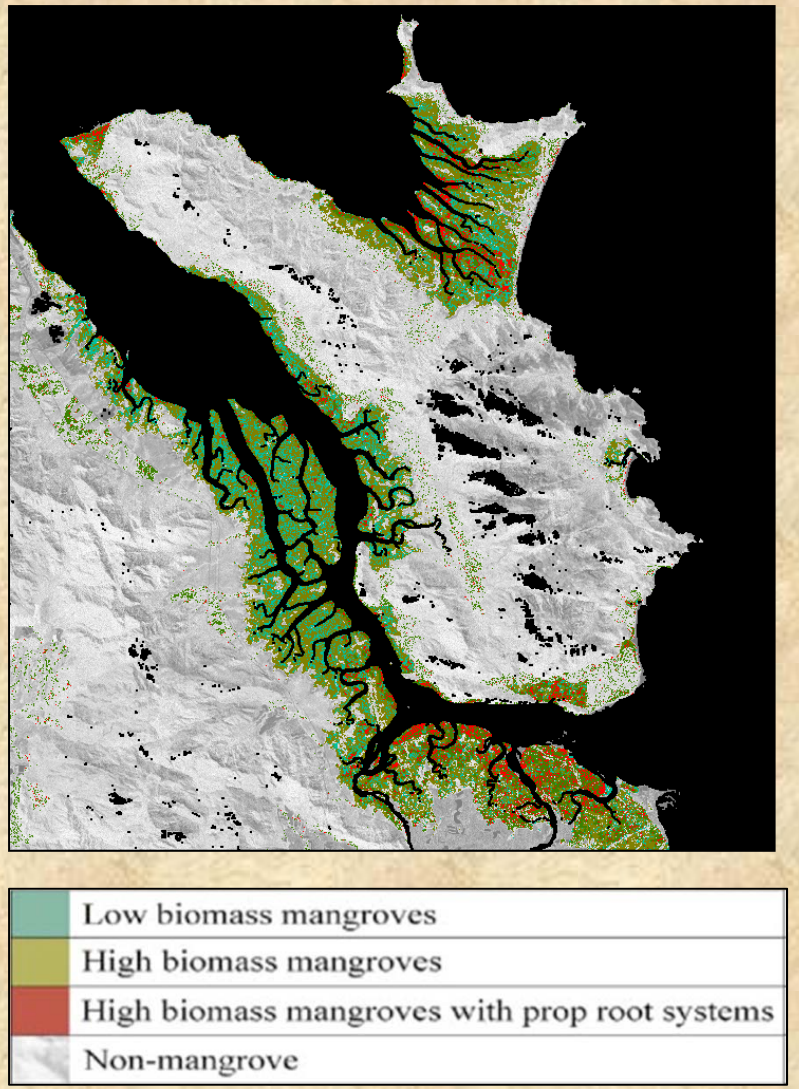
Example of Mangrove Classification

Hinchenbrook Island, Queensland, Australia

Queensland RE Mapping



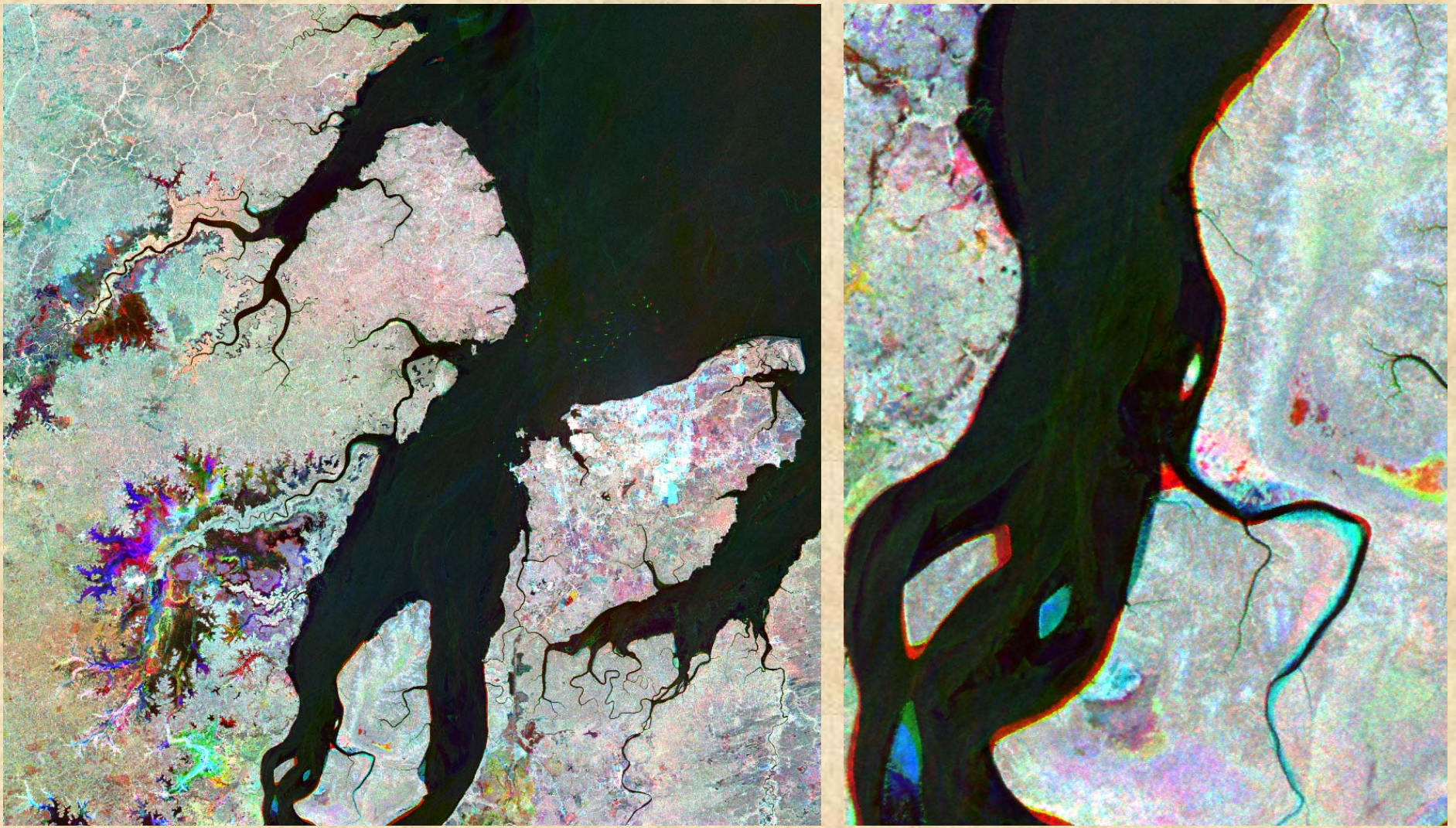
Structural classification



Change Detection using L-band SAR

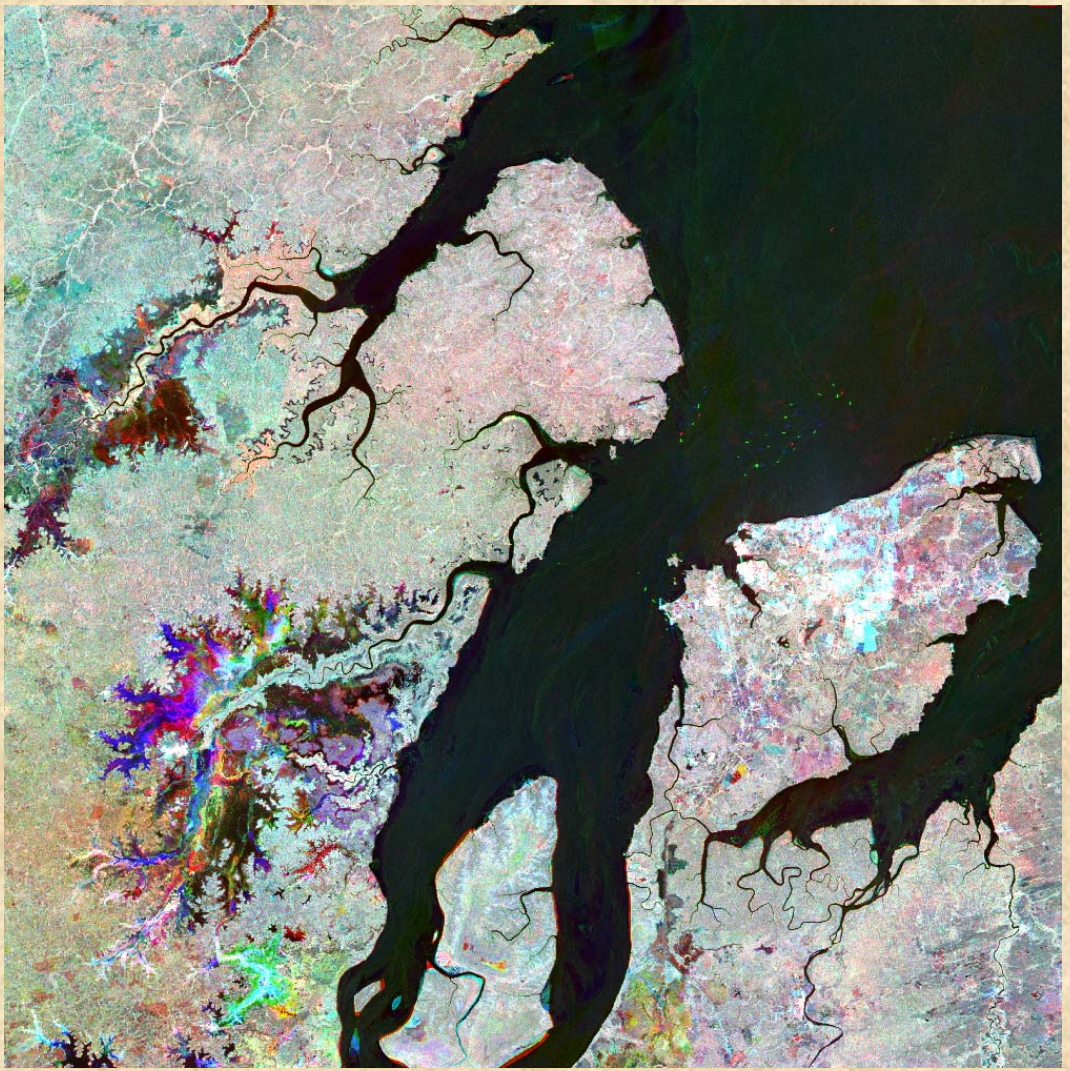
- Changes in River Dynamics
  - South east Asia
- Human-induced change
  - Perak, Malaysia
- Coastal erosion and accretion
  - French Guyana
- Response to climate and sea level fluctuation
  - Gulf of Carpentaria, Northern Australia

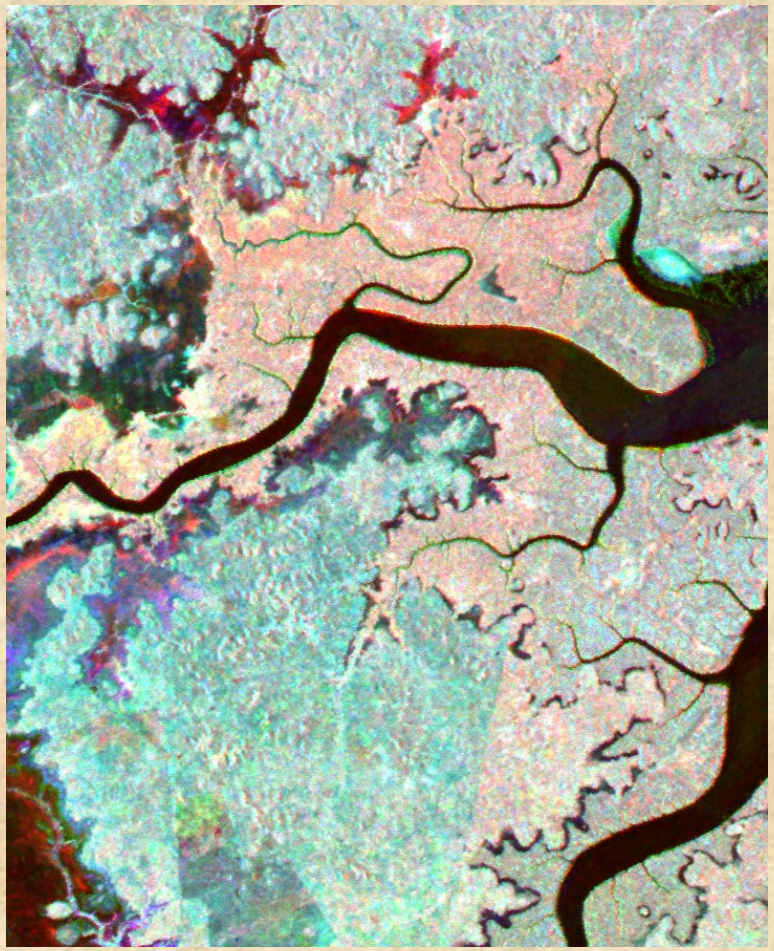
Changes in Mangroves, river channels, SE Asia.



ALOS PALSAR HH 1996,
2007 and 2010 in RGB

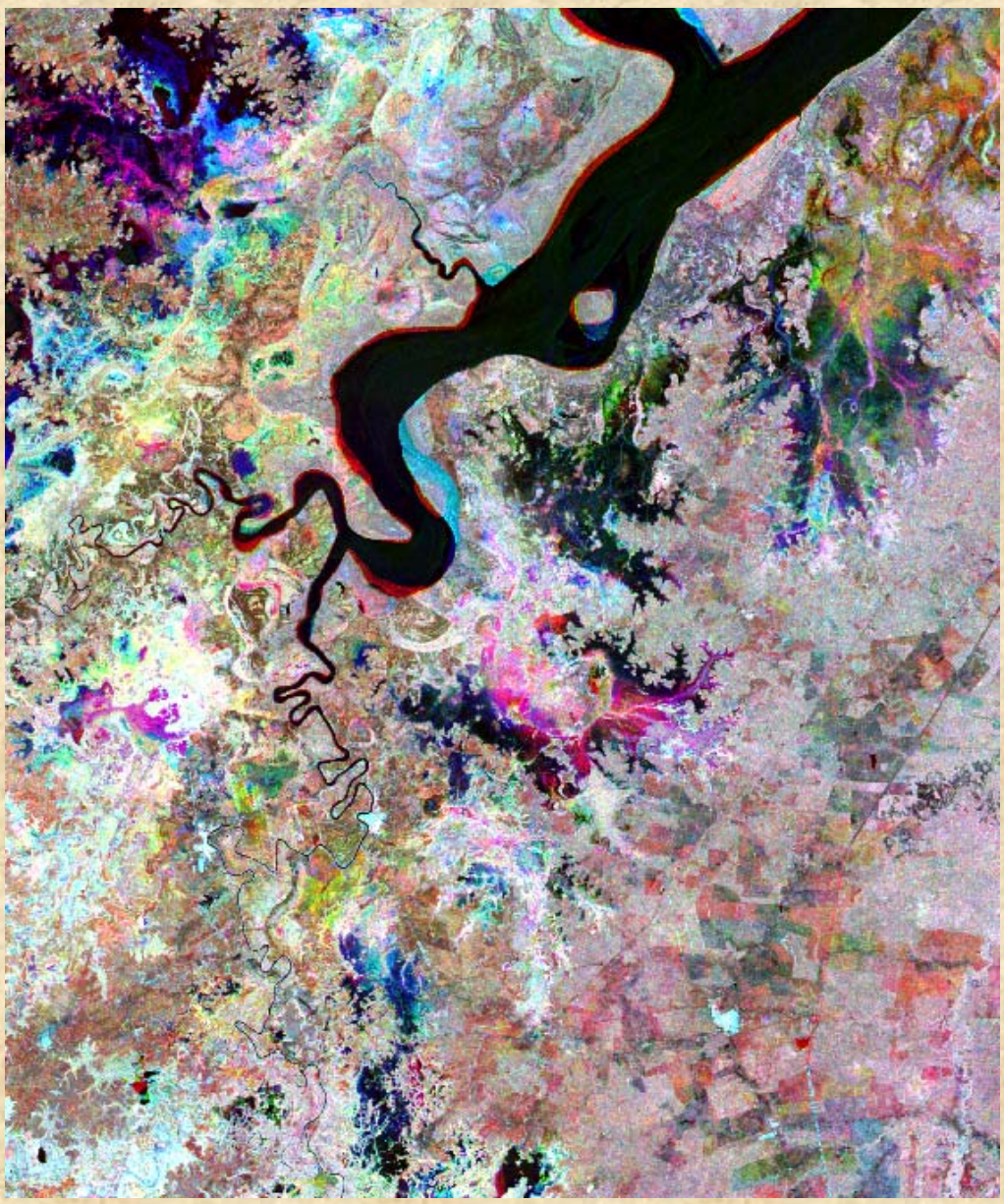
Stable mangroves, SE Asia.

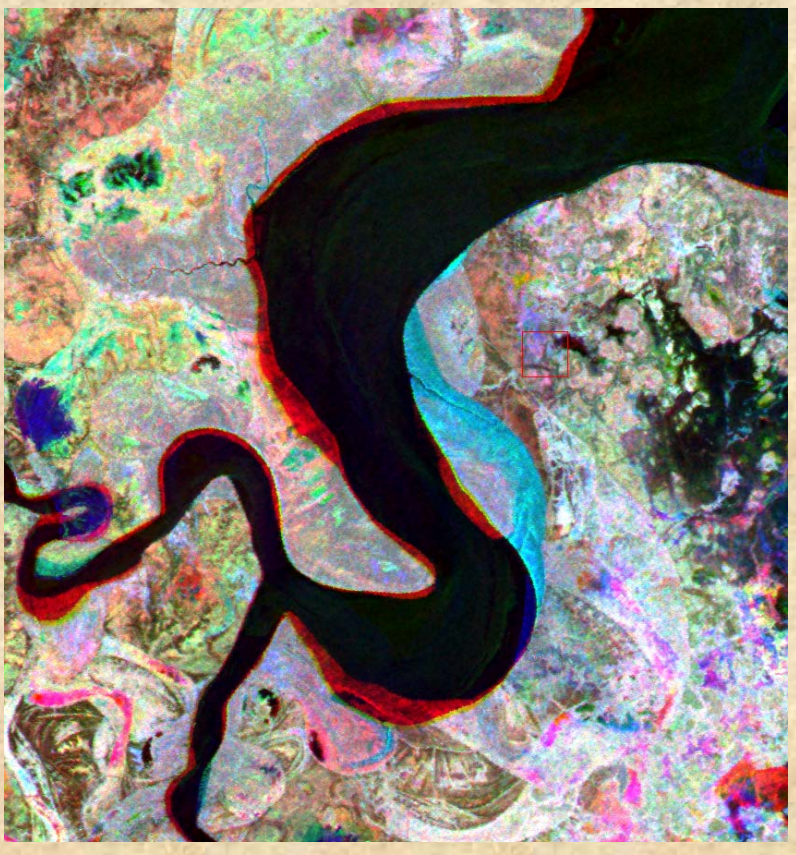




ALOS PALSAR HH 1996,
2007 and 2010 in RGB

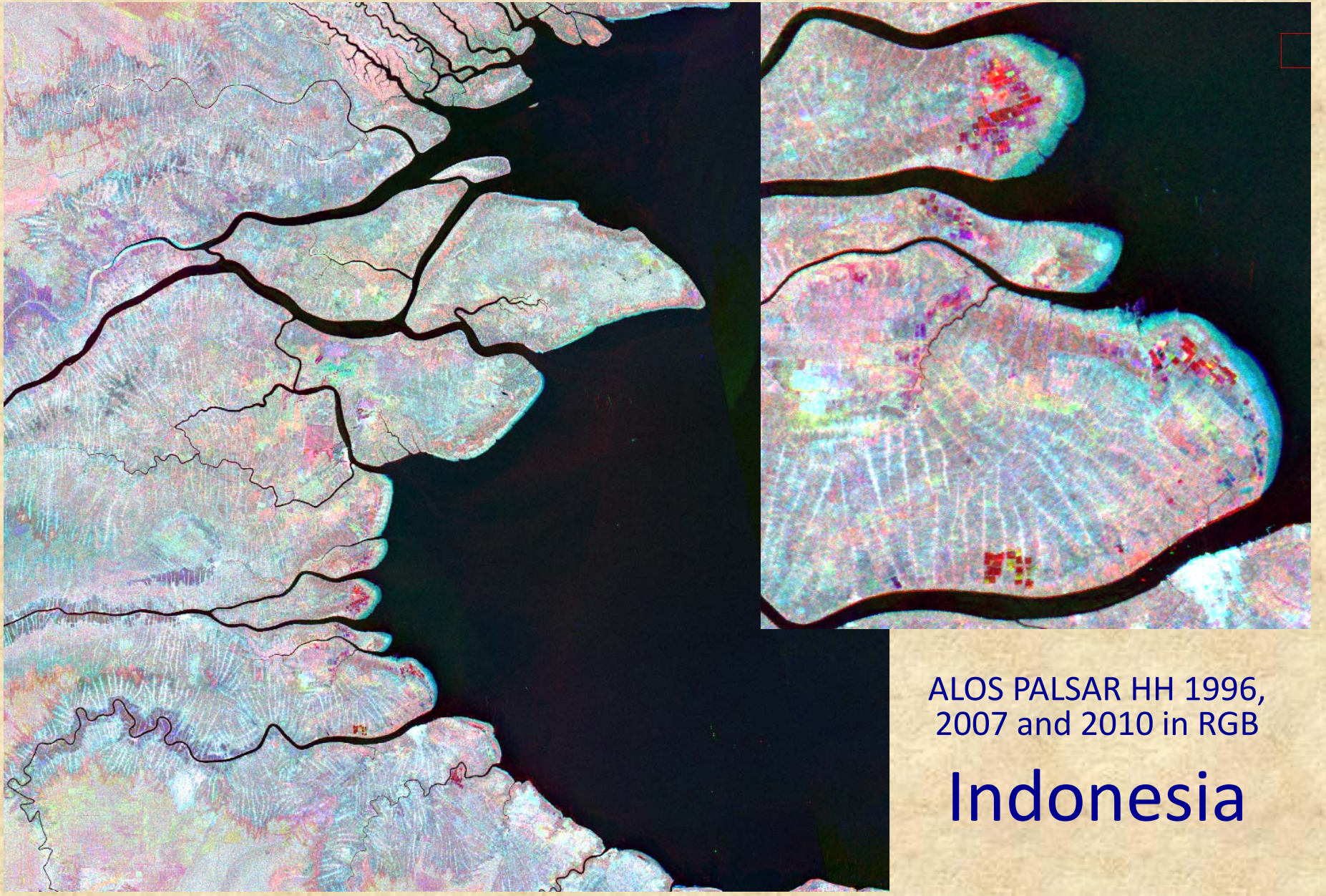
Changes in Mangroves along Estuary, Indonesia





ALOS PALSAR HH 1996,
2007 and 2010 in RGB

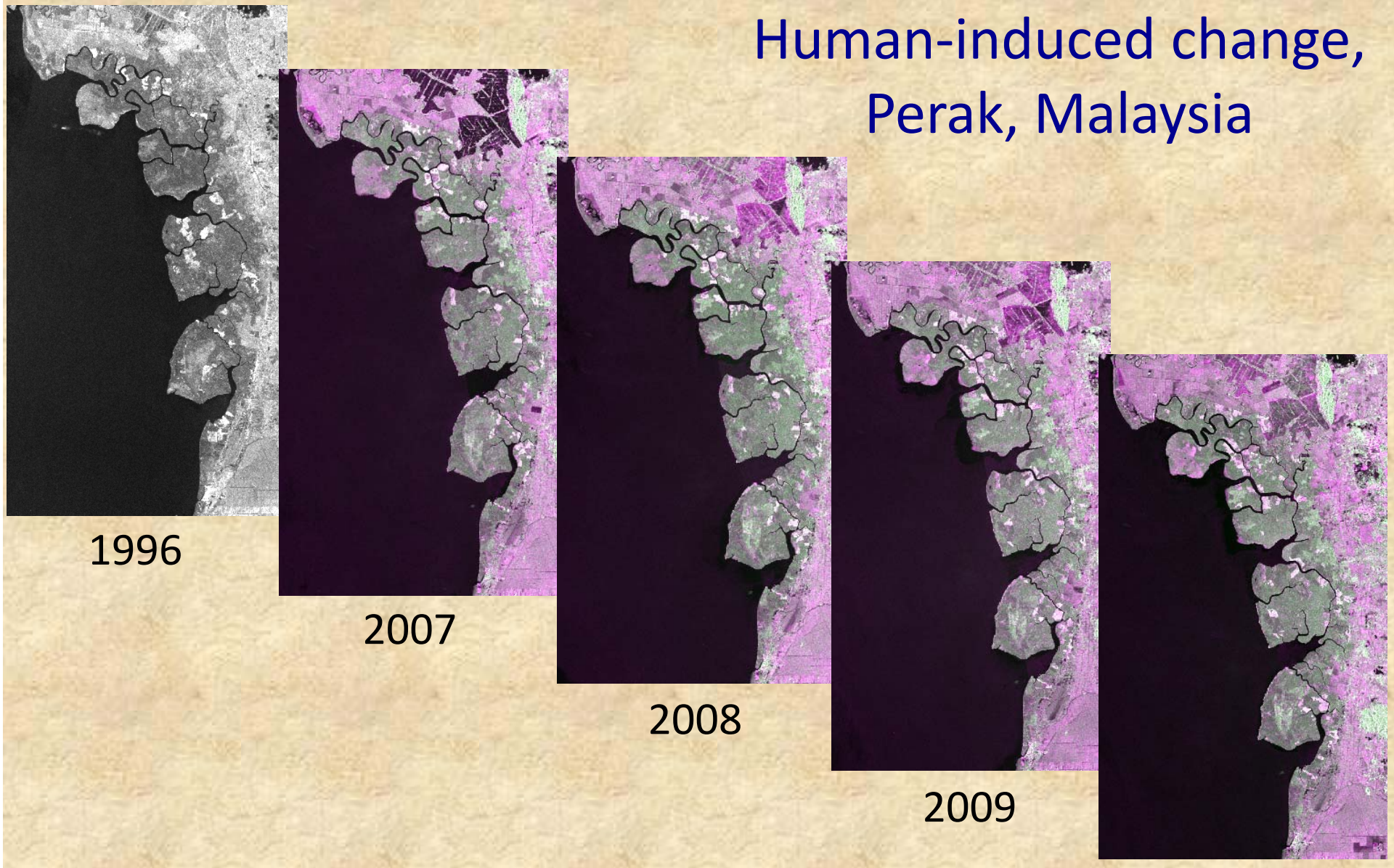
Anthropogenic change; seaward expansion



ALOS PALSAR HH 1996, 2007 and 2010 in RGB

Indonesia

Human-induced change, Perak, Malaysia



1996

2007

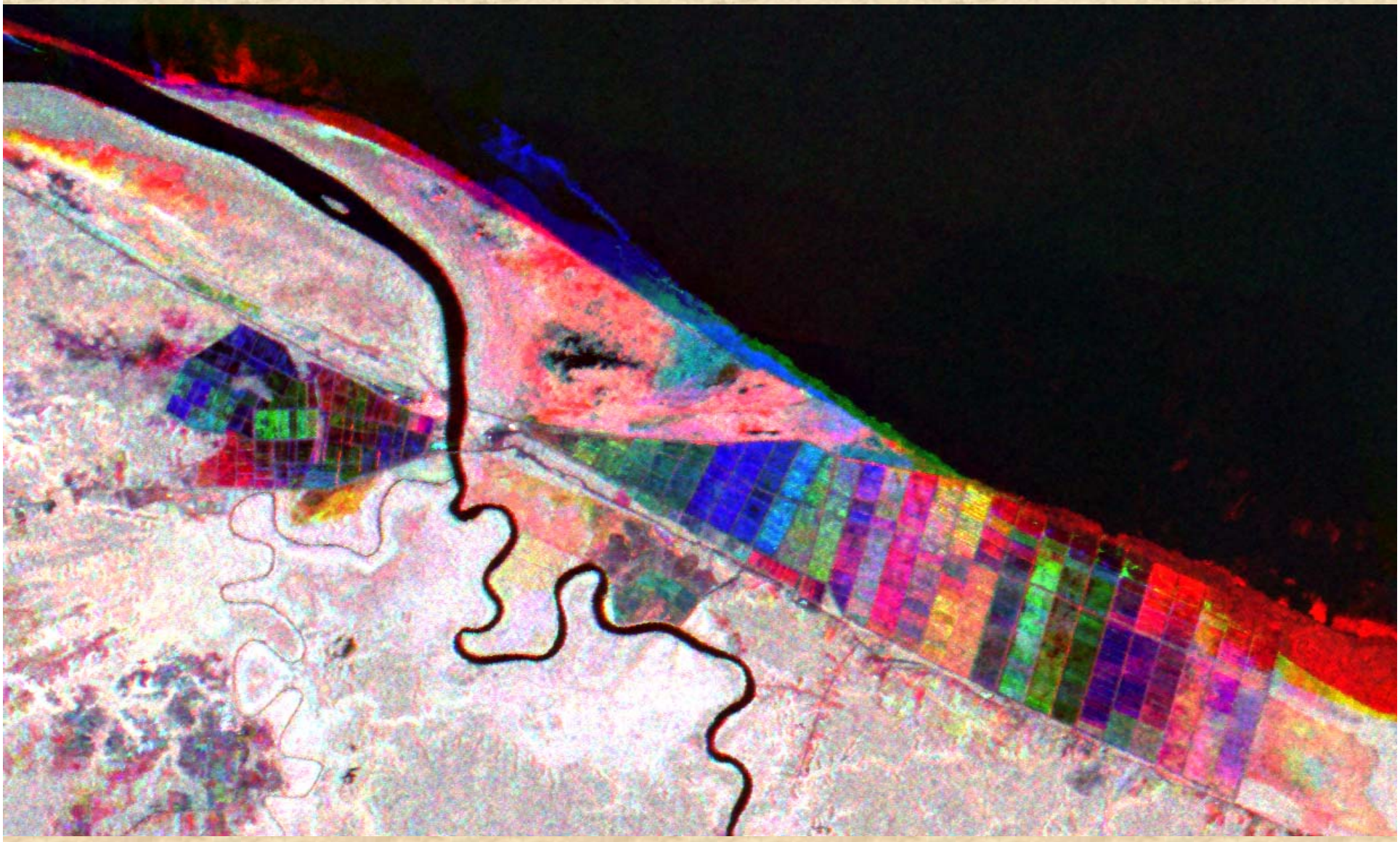
2008

2009

2010

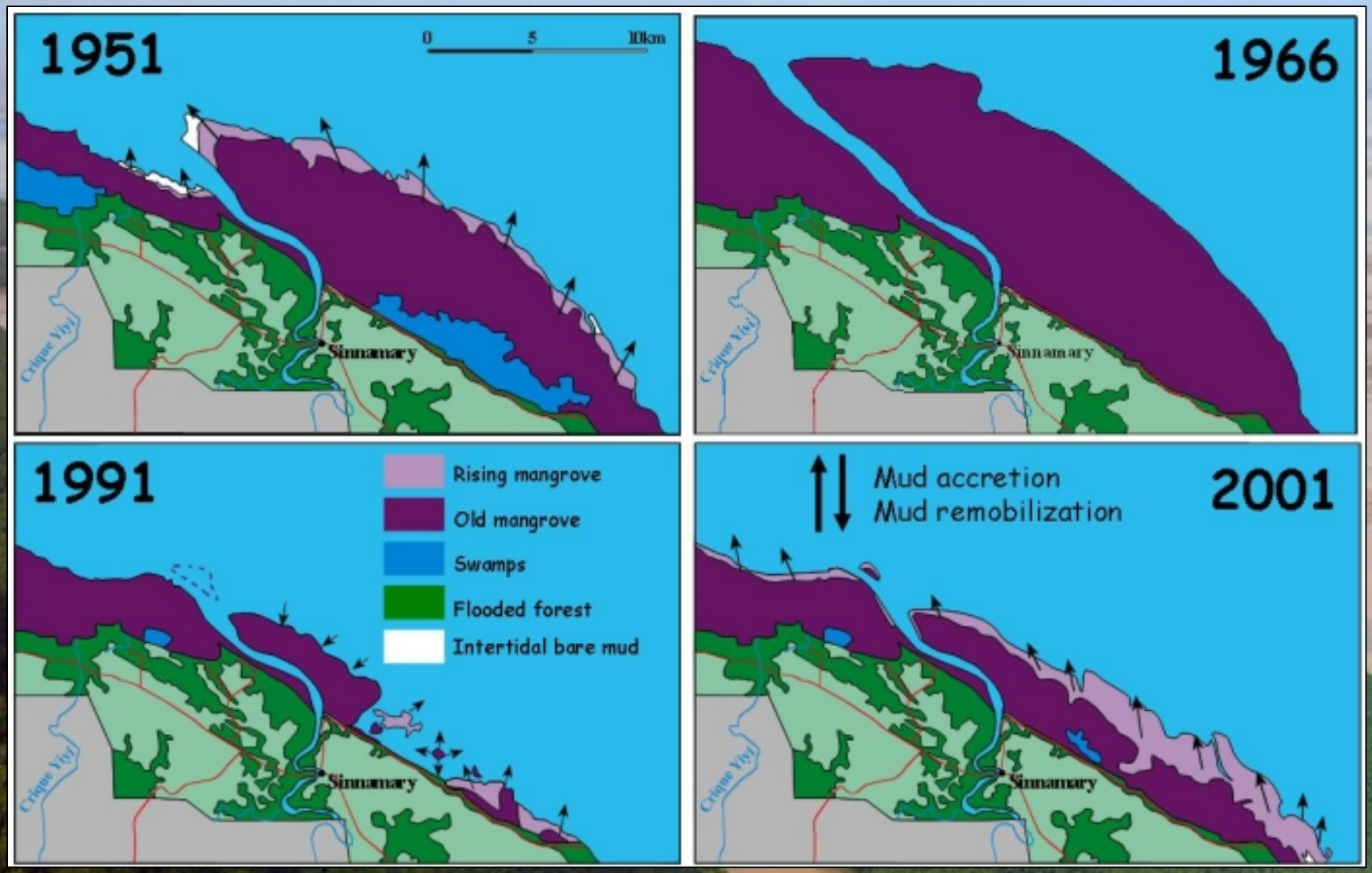
Mangrove Dynamics: Perak, Malaysia

Changes in mangroves and proximal environments, French Guiana

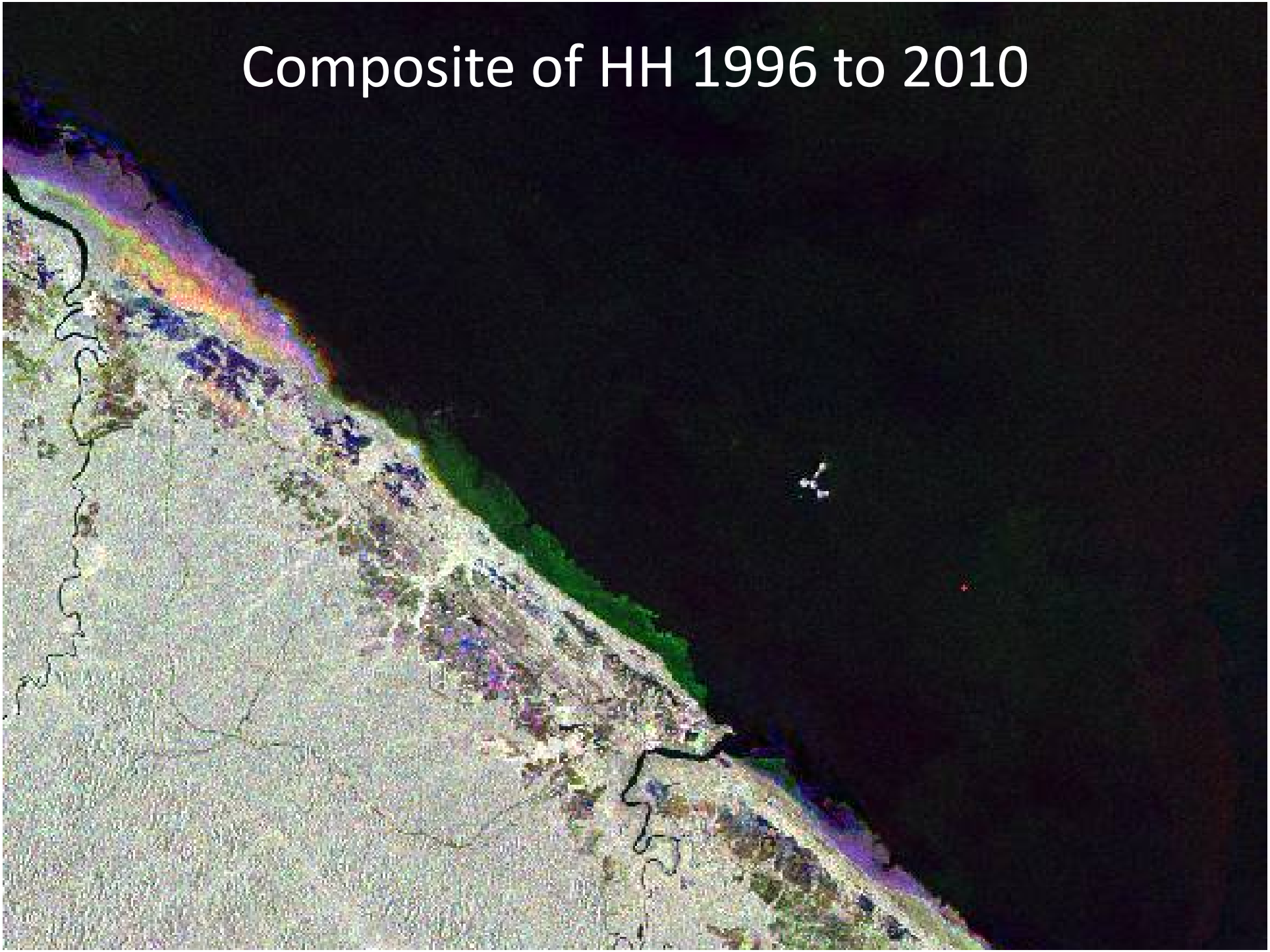


ALOS PALSAR HH 1996, 2007 and 2010 in RGB

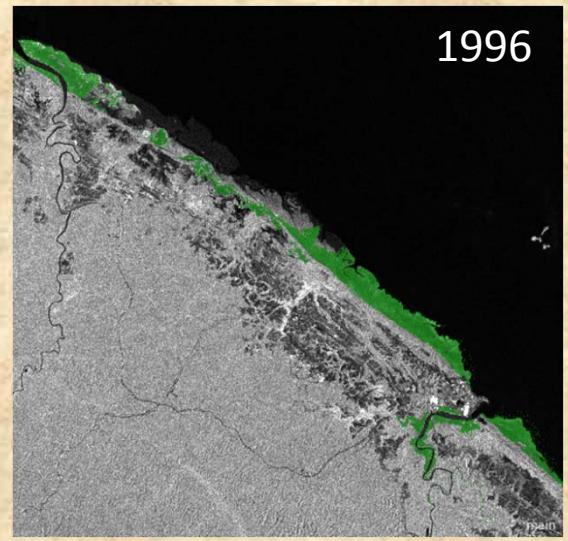
French Guiana: Changes associated with erosion and accretion of sediments

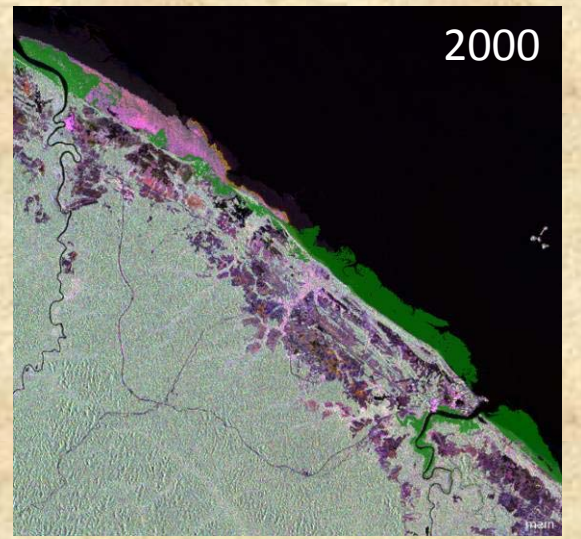


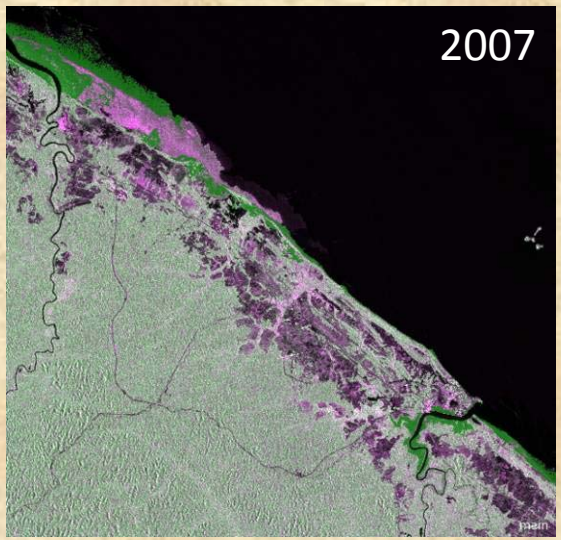
Composite of HH 1996 to 2010

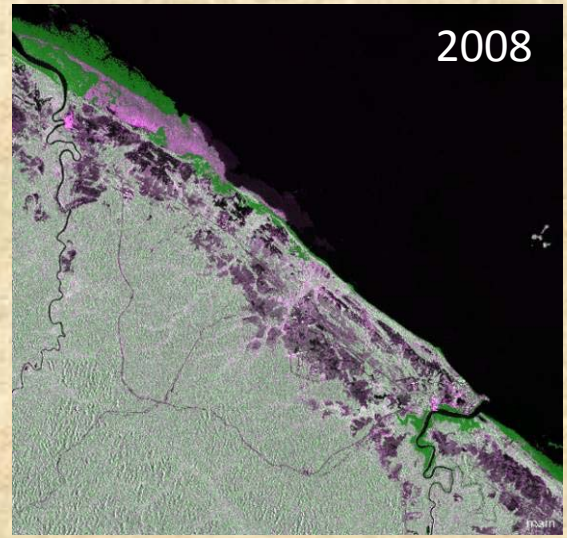


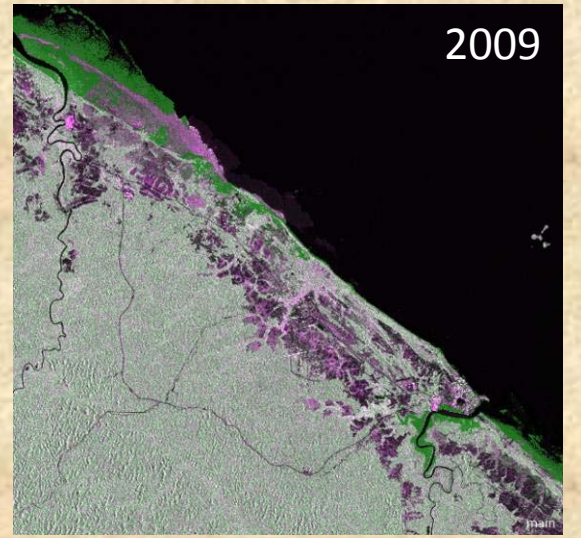
Changes in mangrove extent, French Guyana: 1996 to 2010 (N06W053)

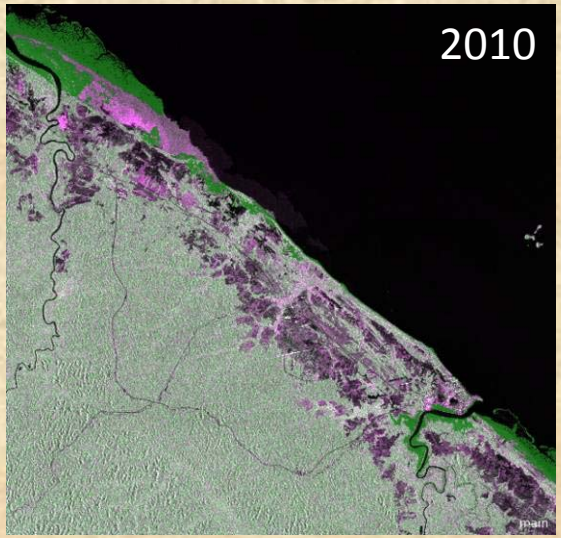












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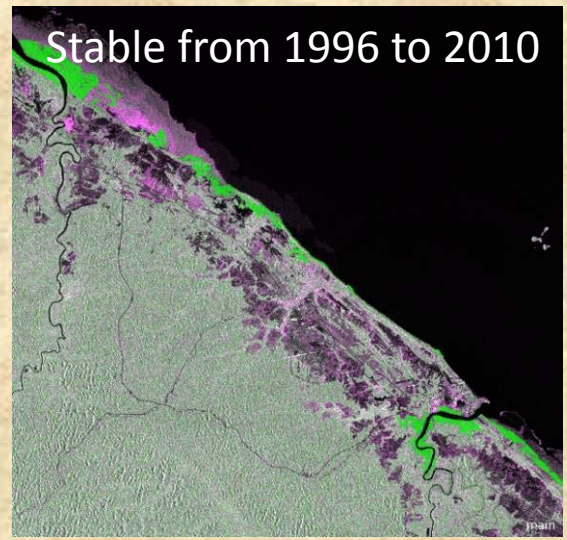
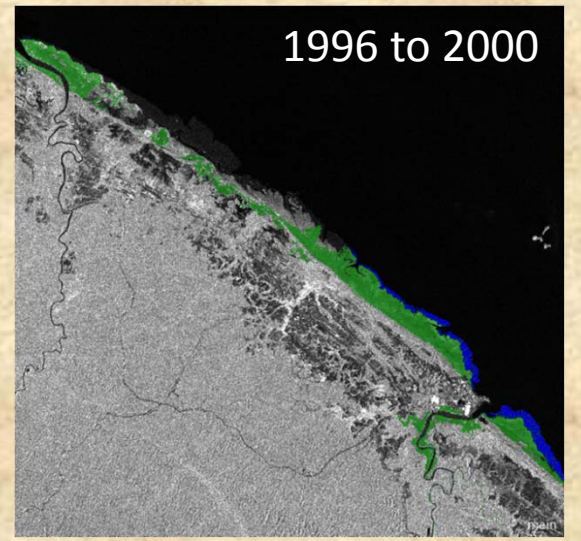
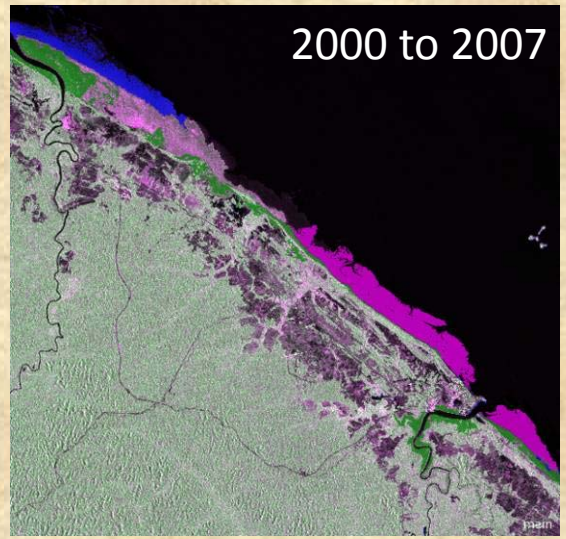
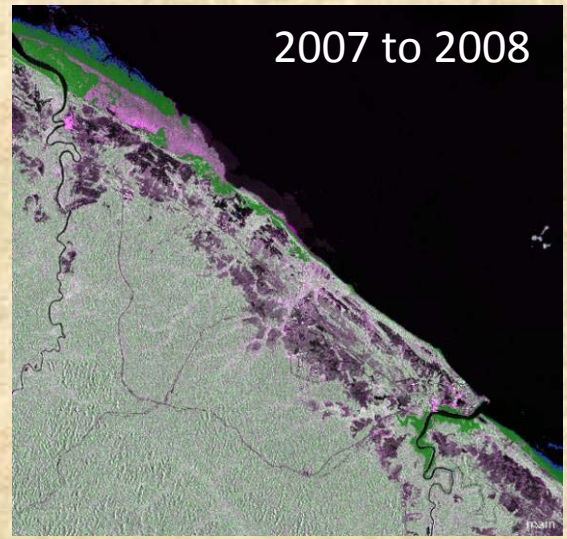
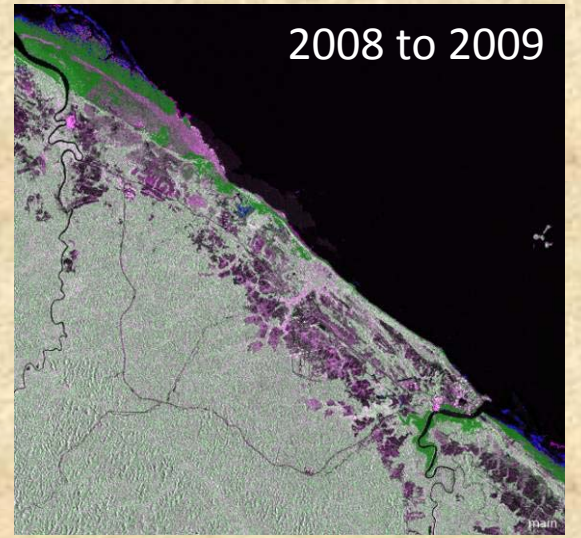
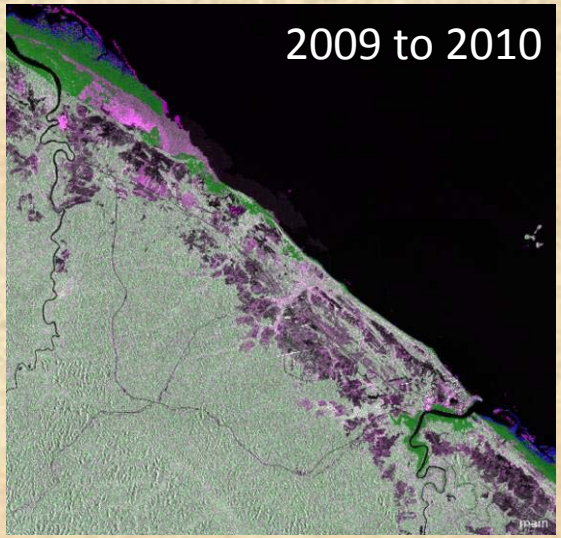




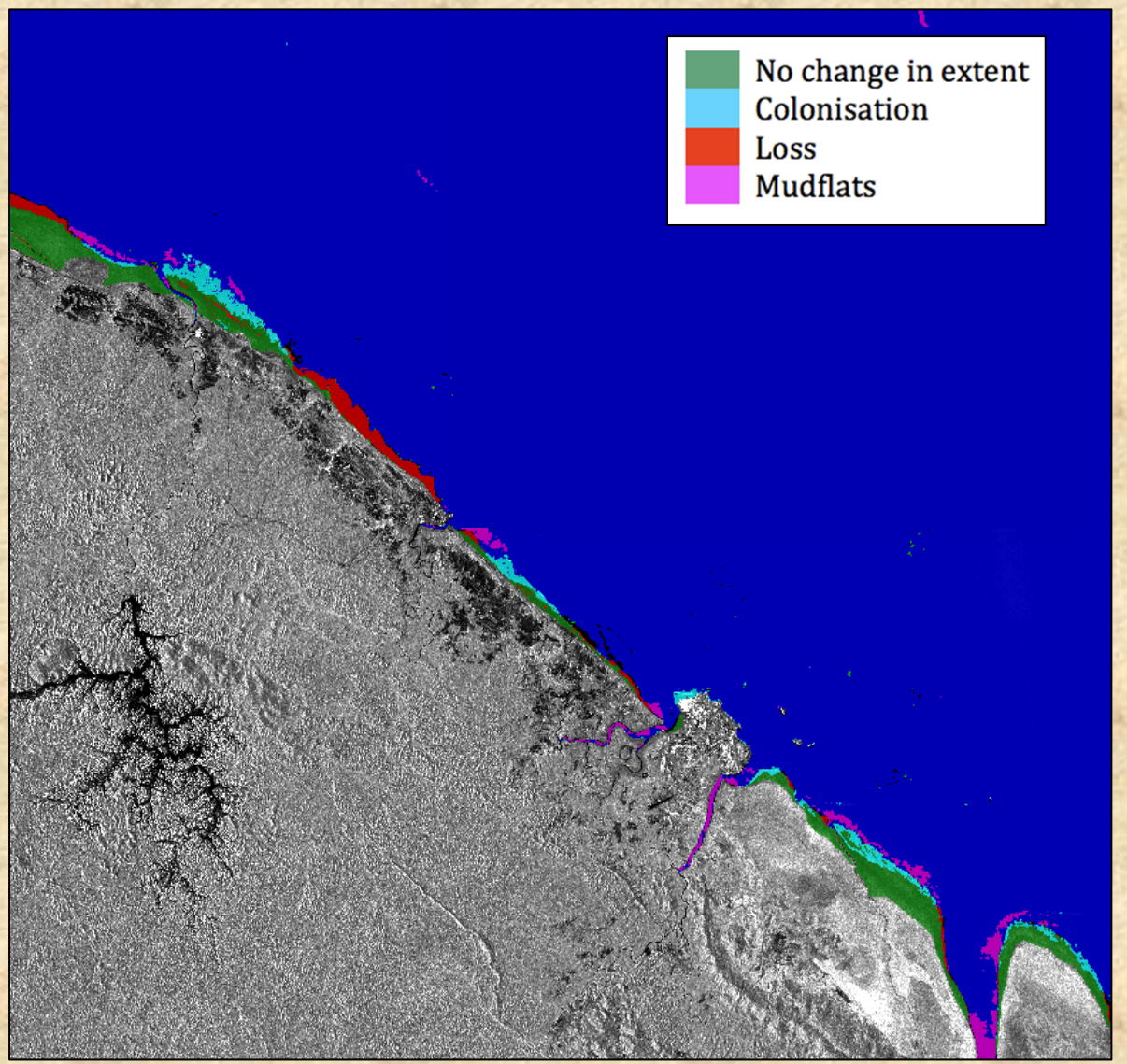


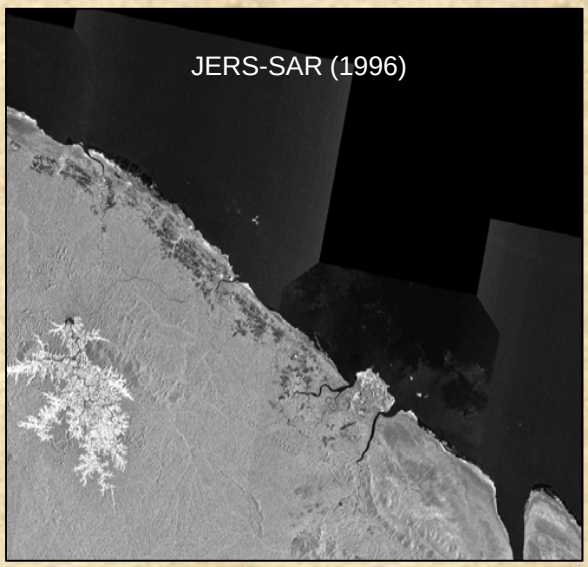


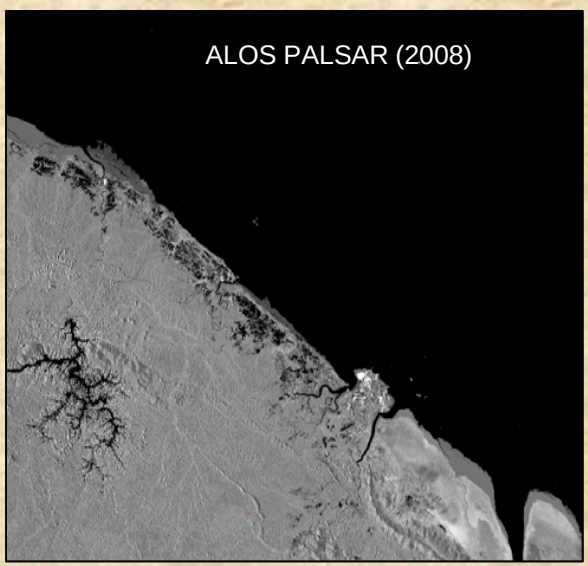




Classification of Change: JERS-1 SAR and ALOS PALSAR comparisons

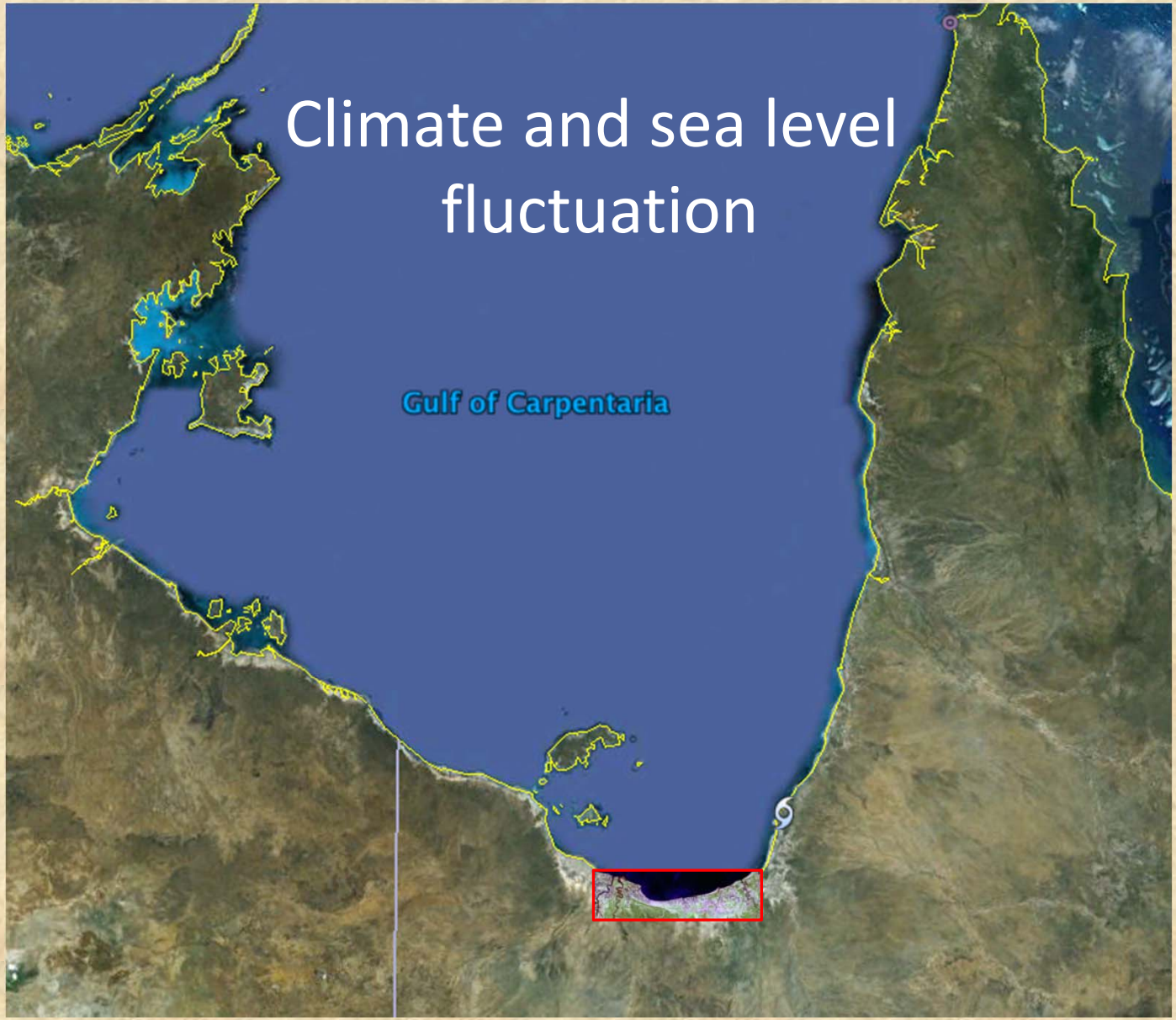






Changes in mangroves along the French Guiana coast (1996 to 2008)

Gulf of Carpentaria, Queensland, Australia



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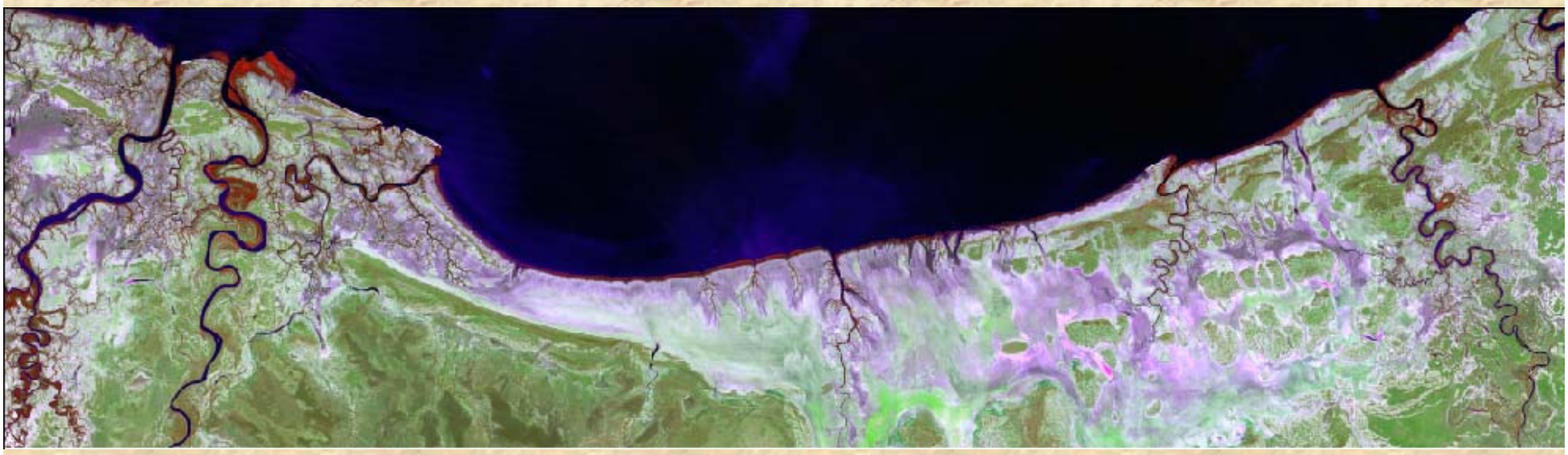
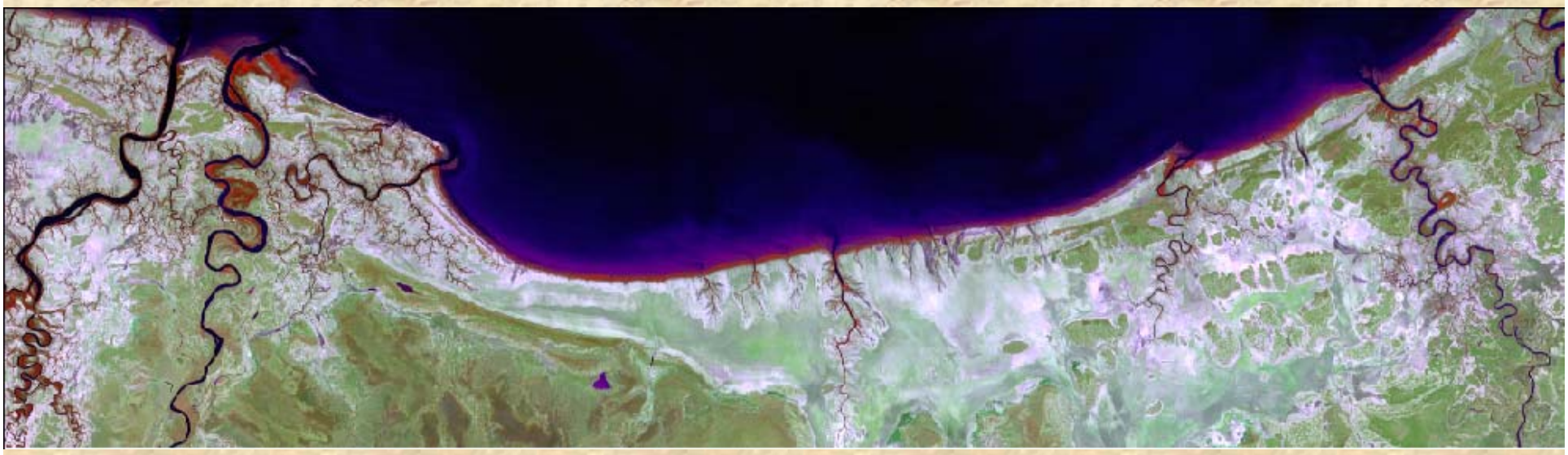


Gulf of Carpentaria, Queensland, Australia

1989

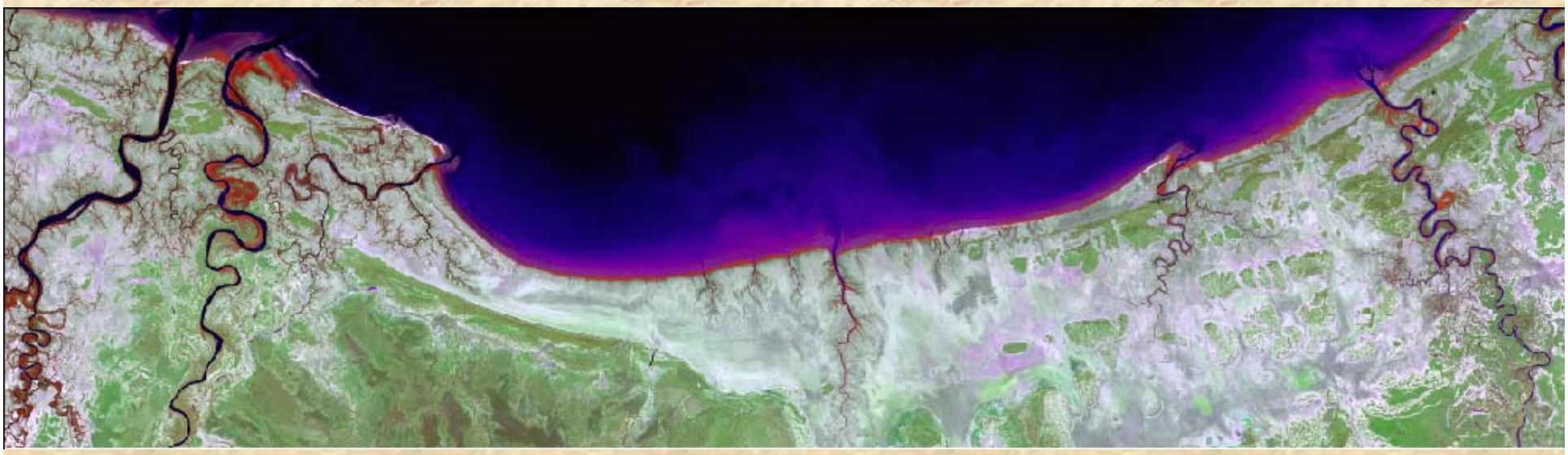


Gulf of Carpentaria, Queensland, Australia

1990

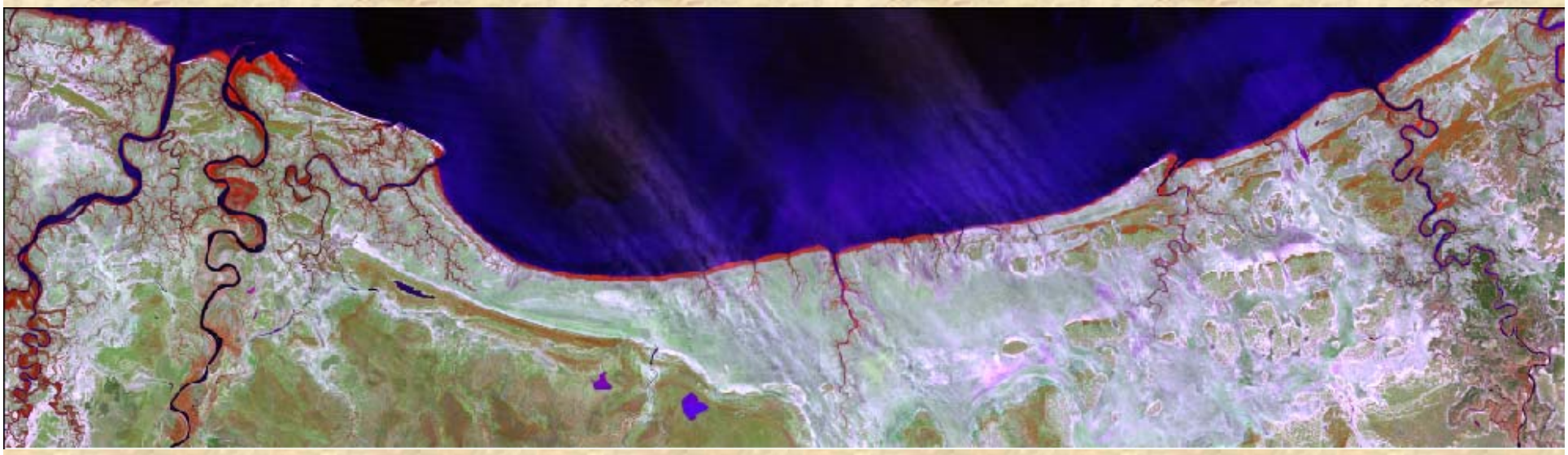
Gulf of Carpentaria, Queensland, Australia

1990



Gulf of Carpentaria, Queensland, Australia

1991

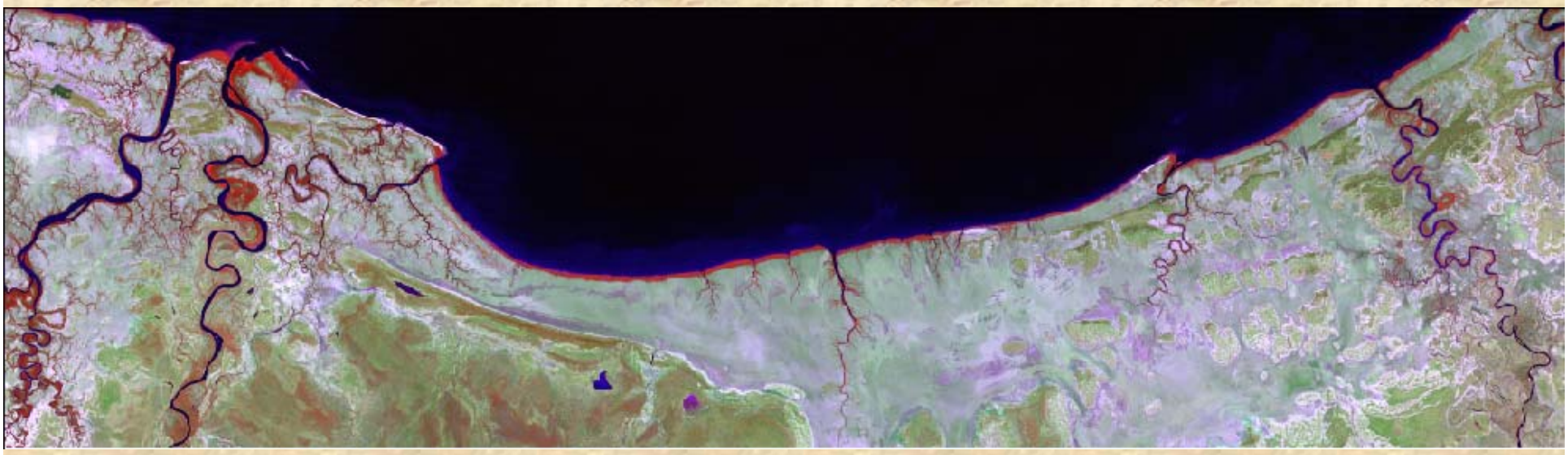


Gulf of Carpentaria, Queensland, Australia

1992

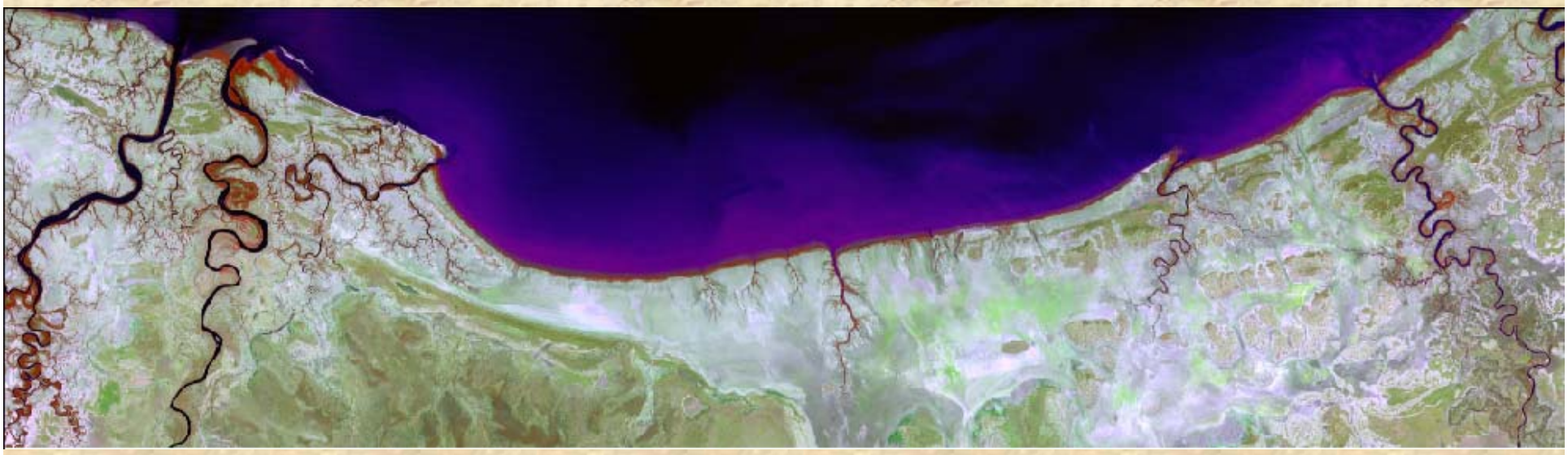
Gulf of Carpentaria, Queensland, Australia

1993



Gulf of Carpentaria, Queensland, Australia

1994

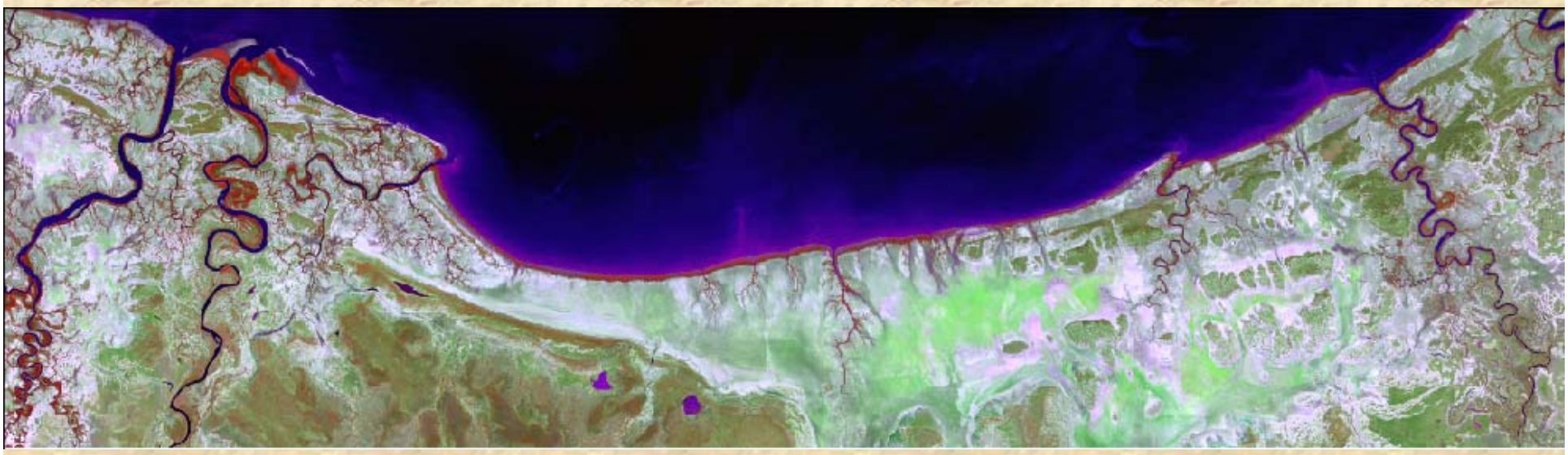


Gulf of Carpentaria, Queensland, Australia

1995

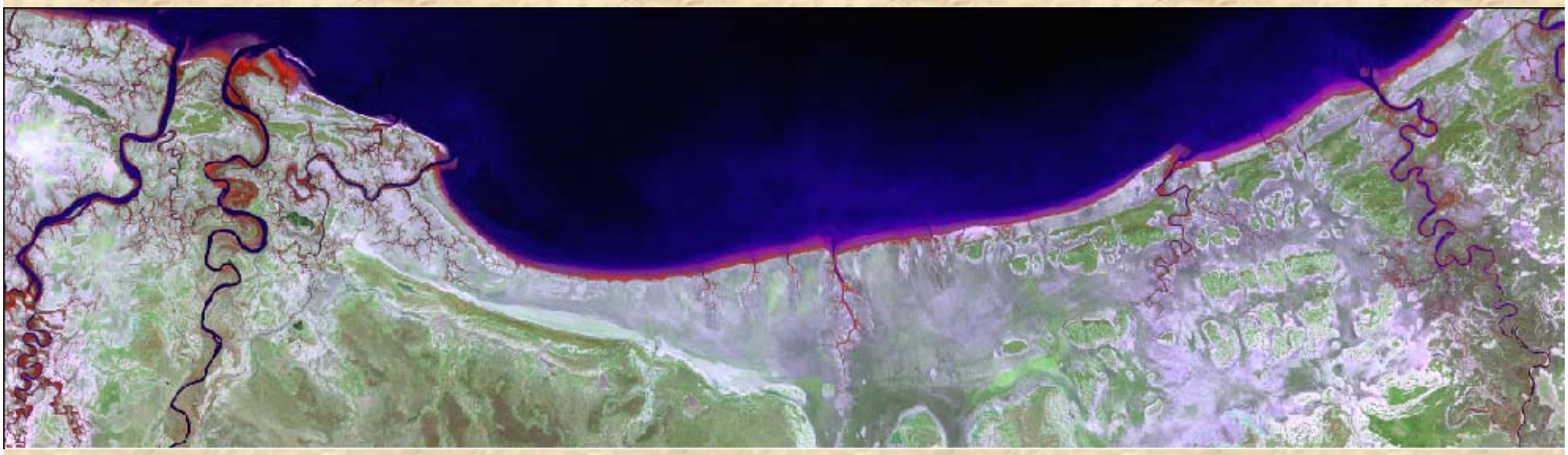
Gulf of Carpentaria, Queensland, Australia

1996



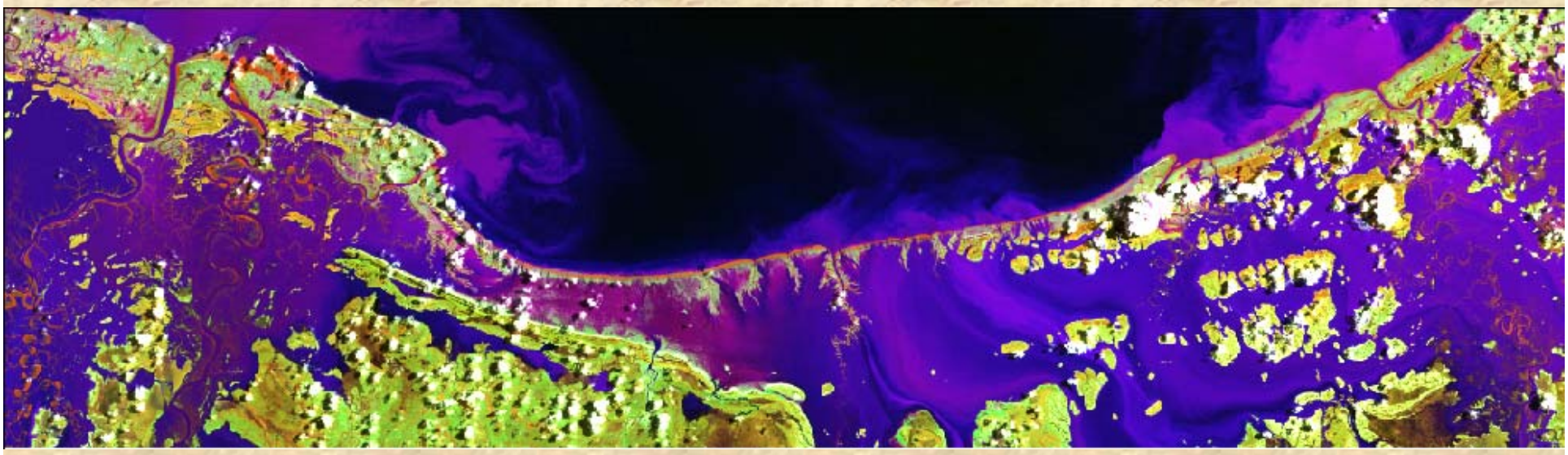
Gulf of Carpentaria, Queensland, Australia

1997



Gulf of Carpentaria, Queensland, Australia

1998

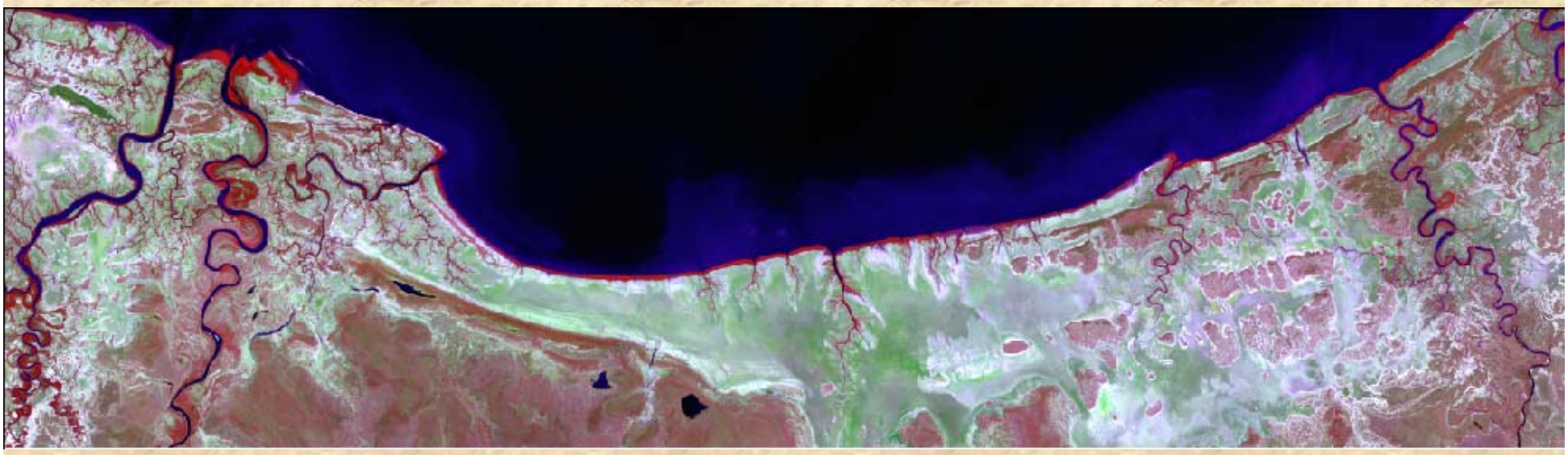


Gulf of Carpentaria, Queensland, Australia

1998

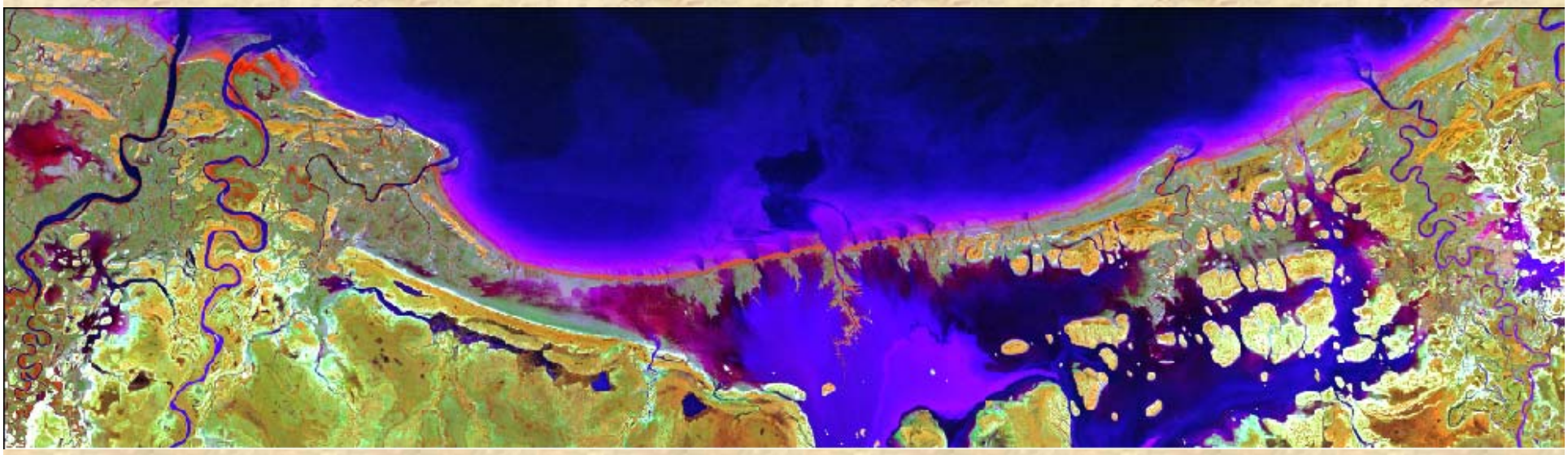
Gulf of Carpentaria, Queensland, Australia

1999



Gulf of Carpentaria, Queensland, Australia

2000

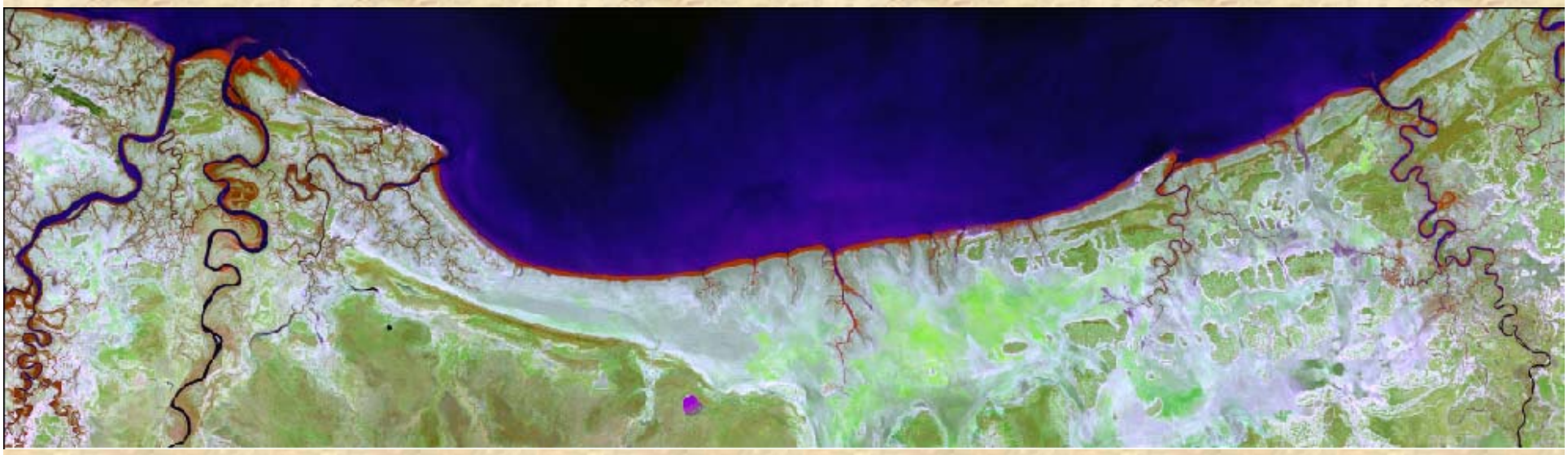


Gulf of Carpentaria, Queensland, Australia

2001

Gulf of Carpentaria, Queensland, Australia

2002



Gulf of Carpentaria, Queensland, Australia

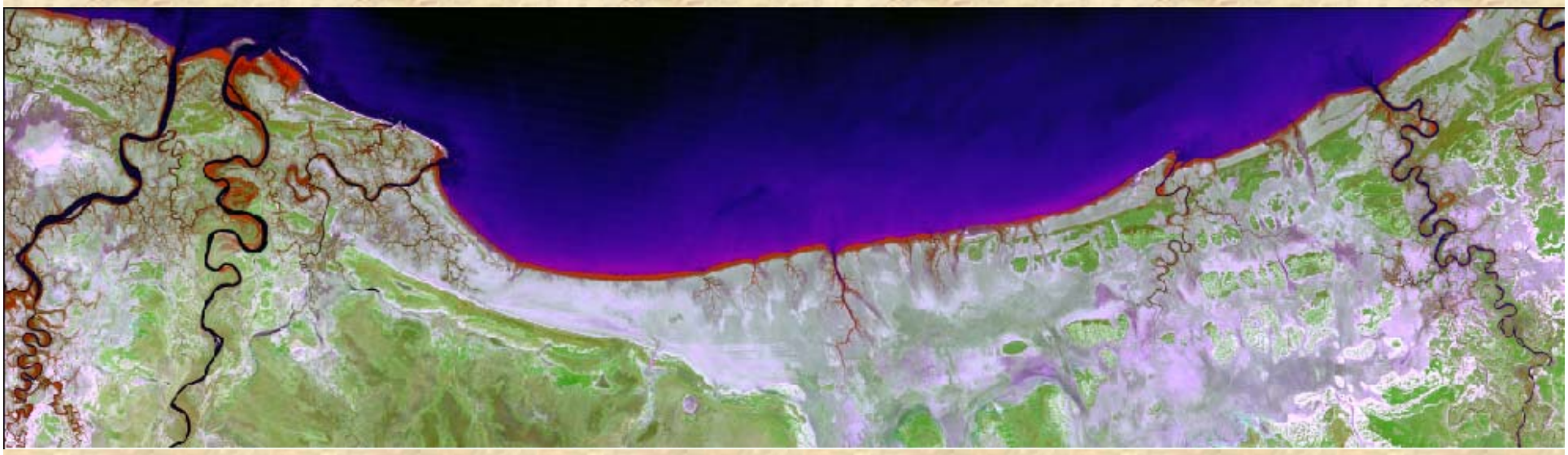
2003

Gulf of Carpentaria, Queensland, Australia

2004

Gulf of Carpentaria, Queensland, Australia

2005



Gulf of Carpentaria, Queensland, Australia

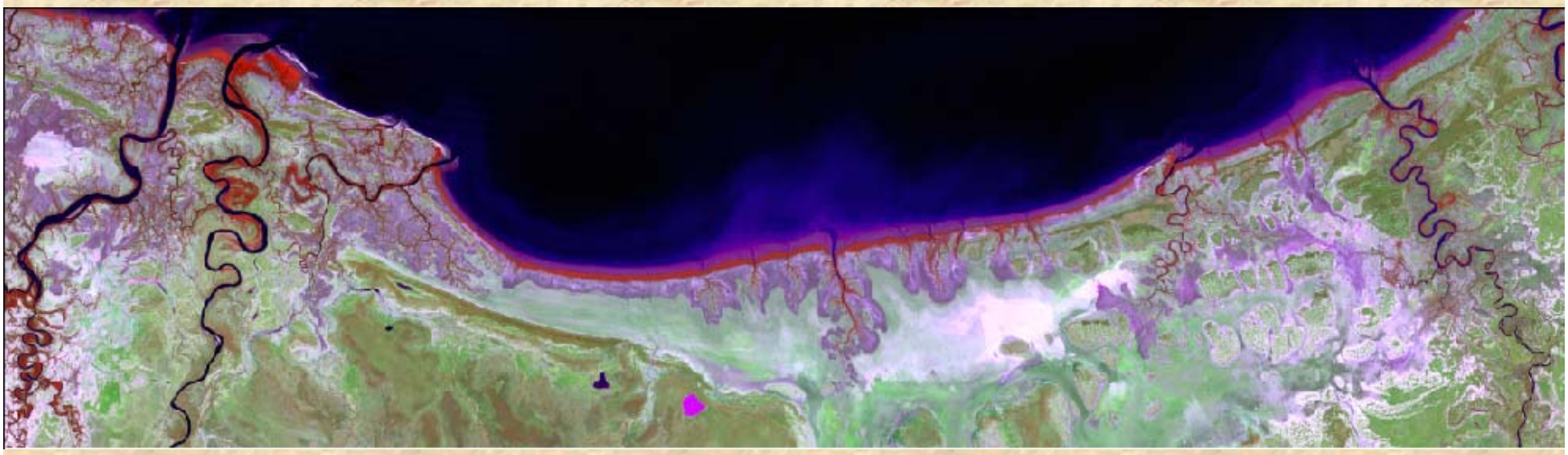
2006

Gulf of Carpentaria, Queensland, Australia

2007

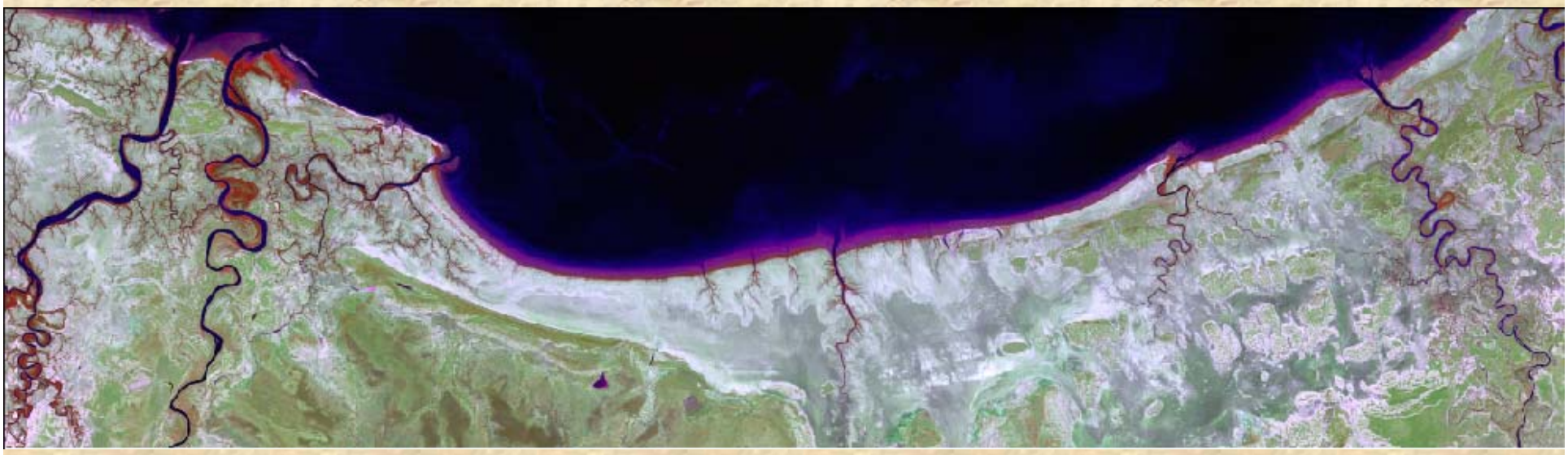
Gulf of Carpentaria, Queensland, Australia

2008



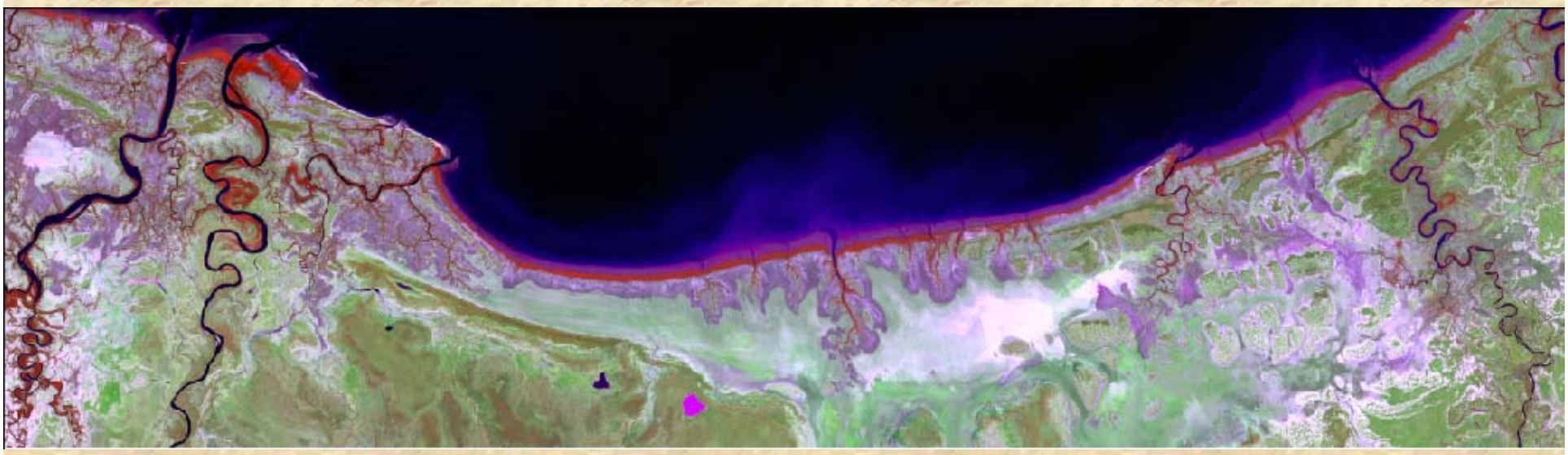
Gulf of Carpentaria, Queensland, Australia

2009



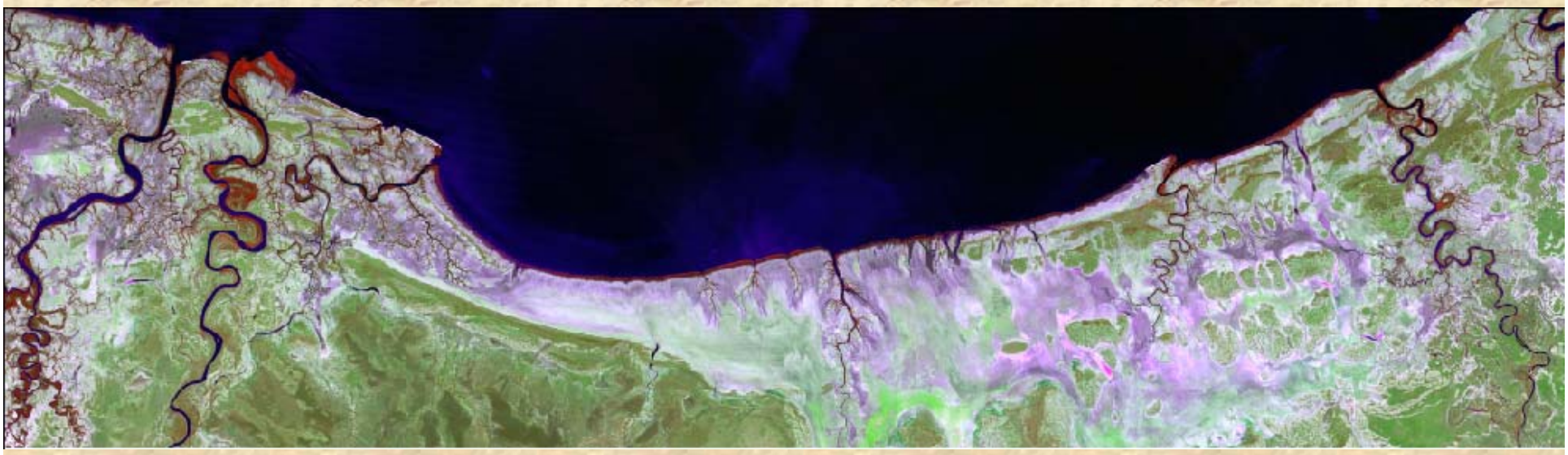
Gulf of Carpentaria, Queensland, Australia

2010



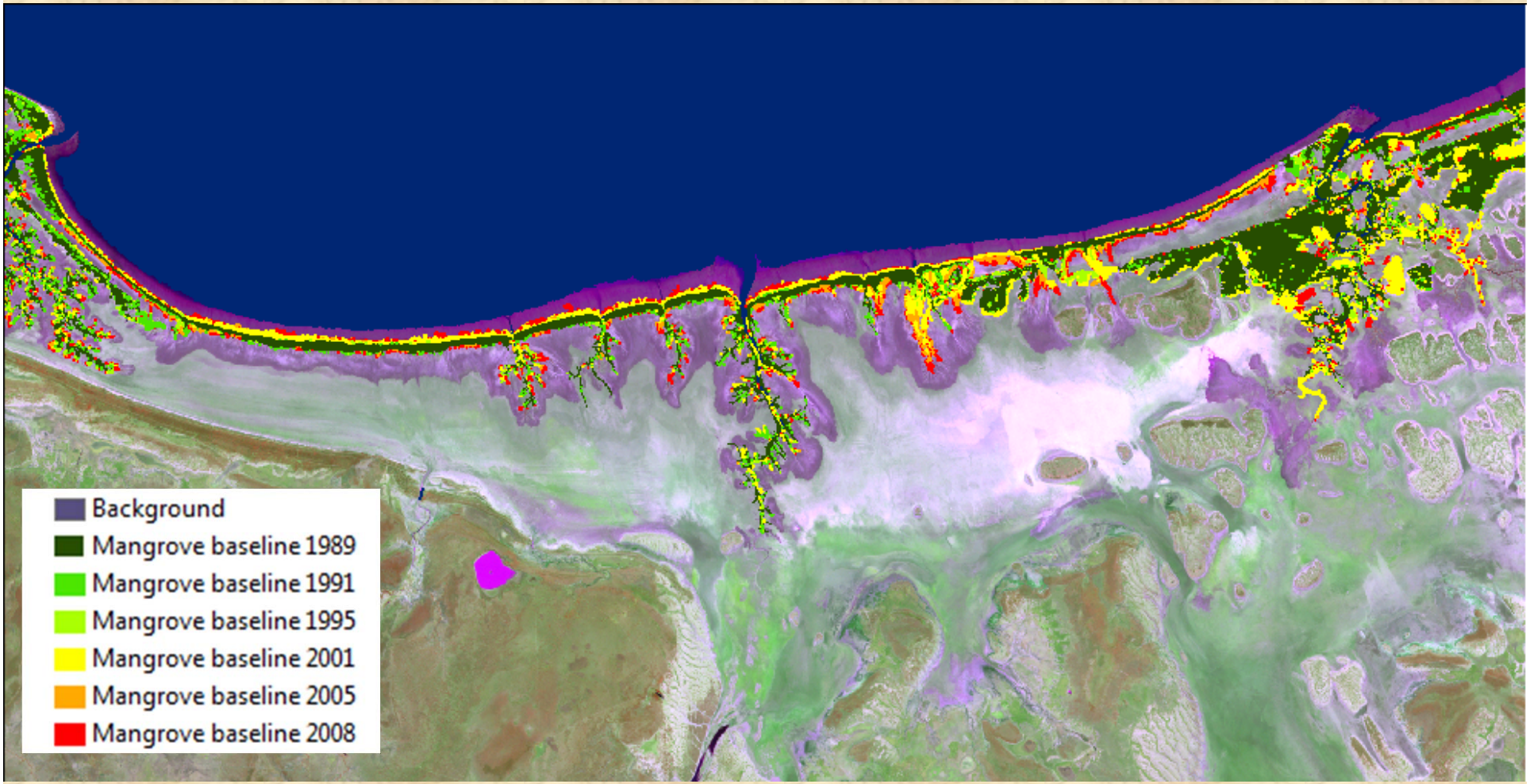
Gulf of Carpentaria, Queensland, Australia

1988



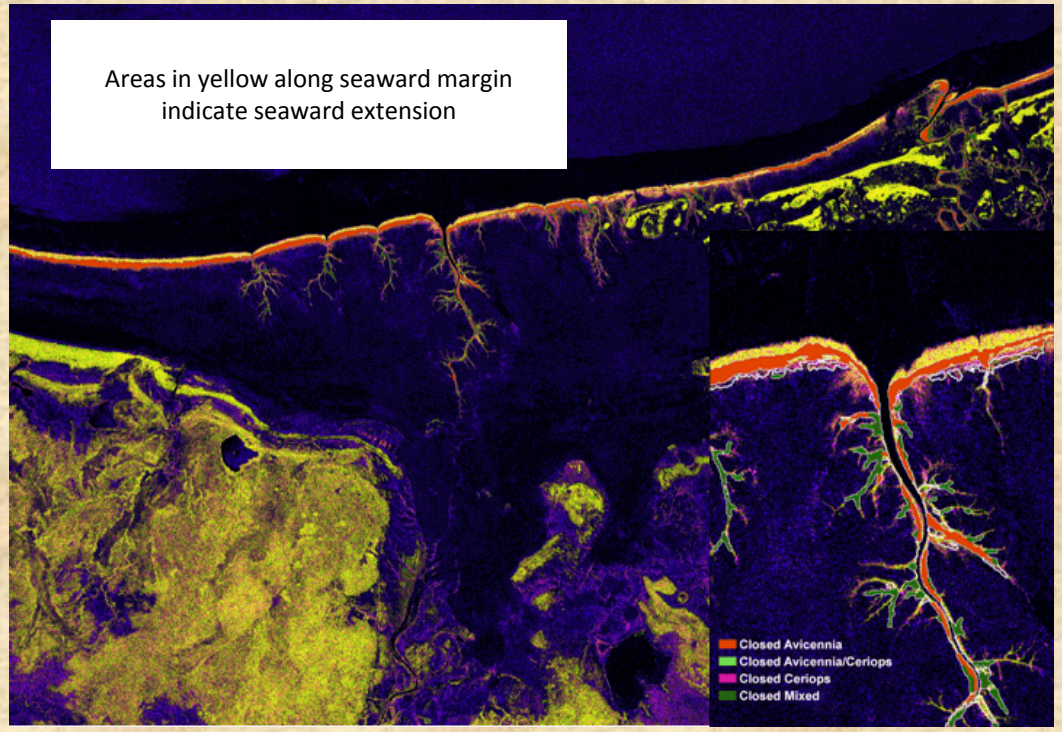
Gulf of Carpentaria, Queensland, Australia

Mangrove Change (1988-2010)

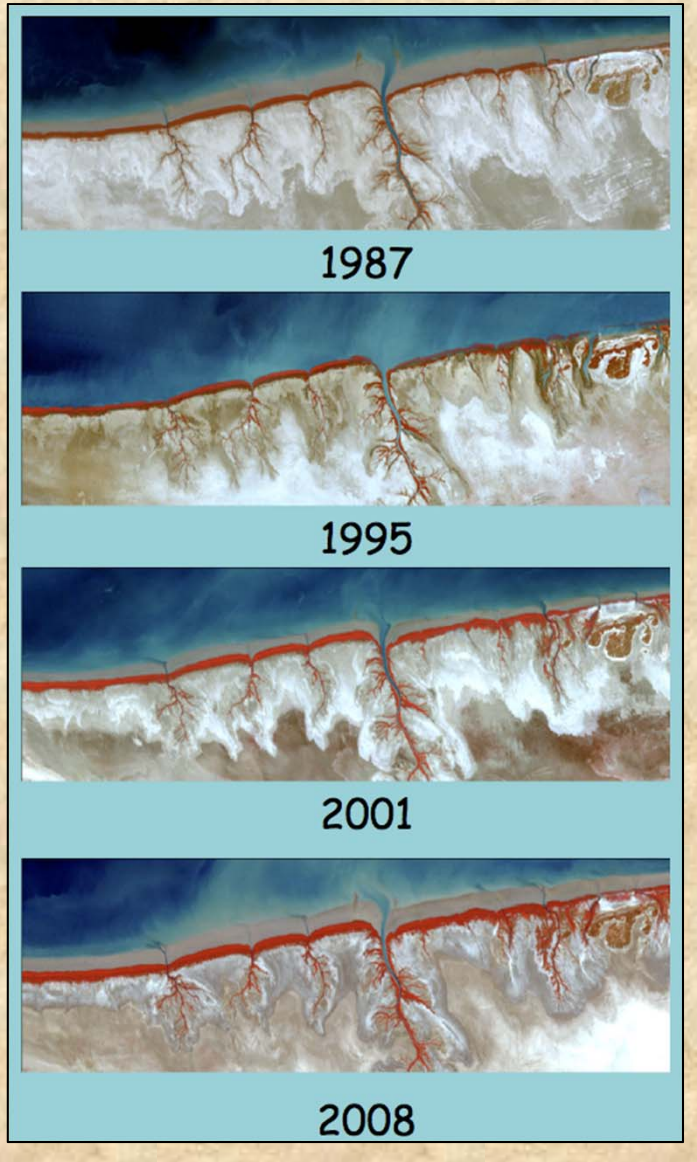


Gulf of Carpentaria, Queensland, Australia

Changes in Mangrove Extent, Northern Australia

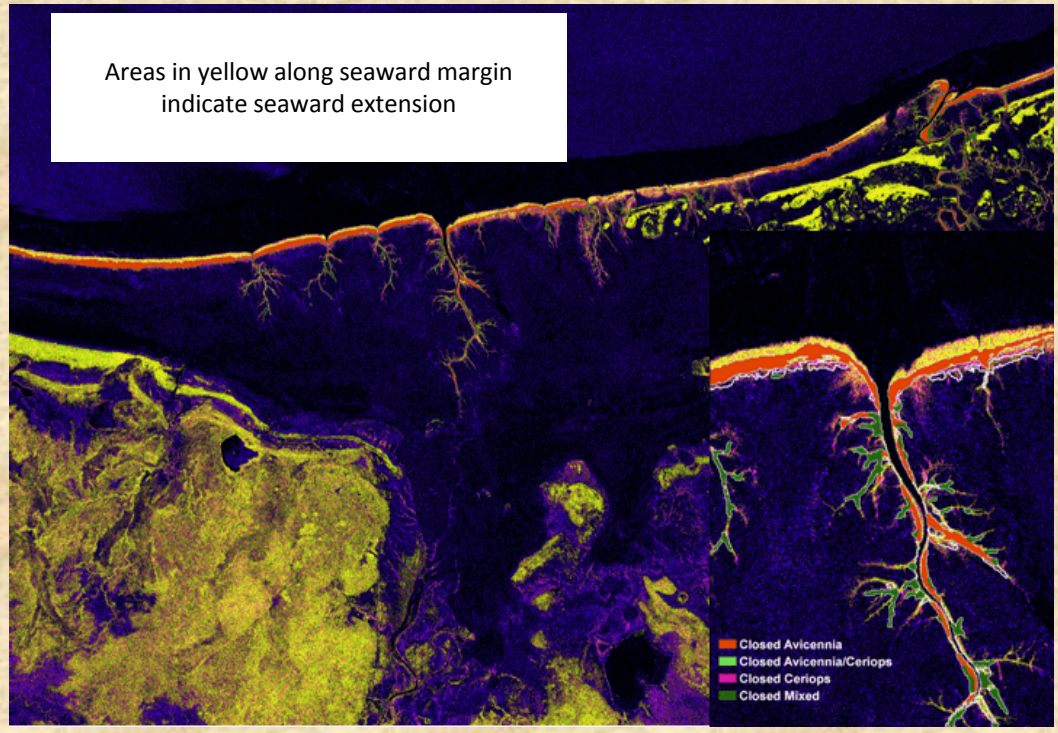


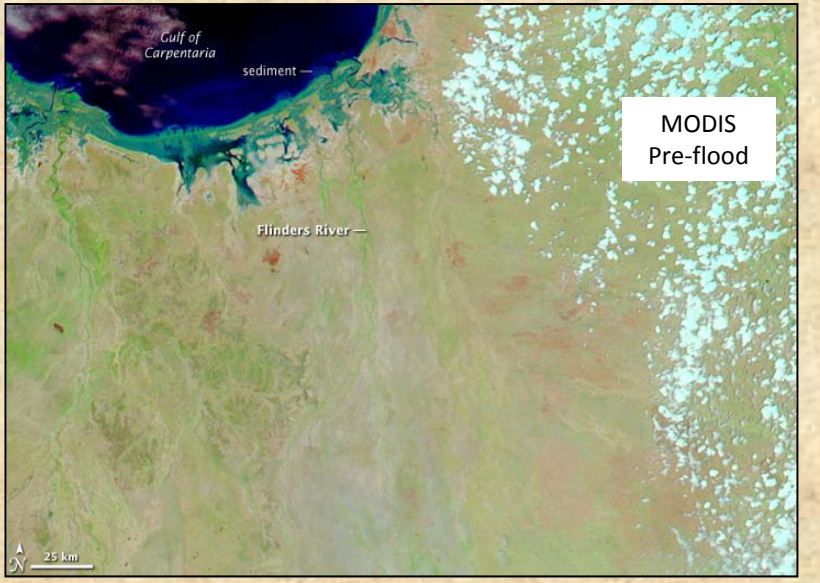
- Mapping from established baselines using ALOS PALSAR indicated relative general stability along Queensland coast
- Exception is the Gulf of Carpentaria
  - Significant seaward expansion
  - Some inland extension
- Associated with:
  - Extensive but periodic flooding and sediment discharge
  - Inland intrusion of sea water

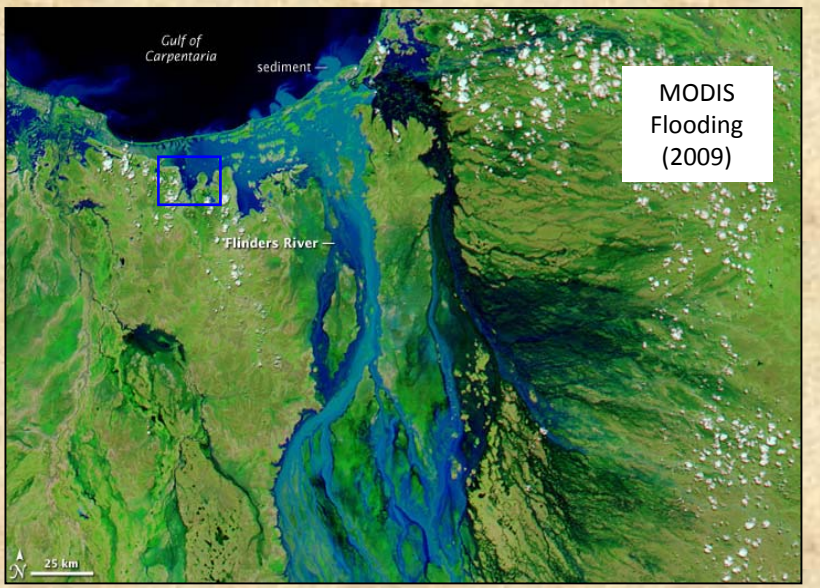


Changes in the extent of mangroves, as observed using time-series of Landsat sensor data

Changes in Mangrove Extent, Northern Australia







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Observations using time-series of L-band SAR data

- Significant changes in mangroves observed in coastal regions globally
  - Attributed to a combination of factors, including fluctuations in sea level, climatic variability, hydrological cycles, oceanic circulation and land use/cover change
- Potential link to land cover change (e.g., deforestation)
  - Increasing sediment loads
- Observations not yet effectively linked to drivers of change.
  - Need to understand and predict the likely impacts of future changes.

Contributions to JAXA's Global Mangrove Watch

Contributions to JAXA's Global Mangrove Watch

- Evaluating use of JERS-1 SAR and ALOS PALSAR data for:
  - Establishing a 1996 baseline of mangrove extent.
  - Quantifying change away from the baseline
  - Evaluating the use of existing Landsat-derived (with SRTM where available) baselines (Giri et al., 2011; Fatoyinbo et al., 2011) against which to detect change.
- Developing methods for:
  - Mapping mangrove change (losses and gains) and stable mangroves.
  - Retrieving mangrove structure and biomass.

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