Forest Mapping and Parameter Estimation with PALSAR

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and
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FCT - Information Priorities

- Forest from Non-forest
- Intact Forests from Degraded Forests
- Regrowth and Afforestation
- Map Change to Time series
- Biomass to Carbon

"Recent methods of estimating emissions due to land use change are dependent on multiplying very uncertain estimates of deforested area by equally uncertain estimates of mean biomass of these areas" ***(ESA Biomass,2009)***

REDD Reporting Level

Validation

Primary RS

“Hotspot”

Sensor resolution	Examples of current sensors	Utility for monitoring	Cost
Very high (<5m)	IKONOS, QuickBird	Validation over small areas of results from coarser resolution analysis	Very high
High (10-60m)	Landsat, SPOT HRV, AWiFs LISS III, CBERS	Primary tool to identify deforestation	Low/medium (historical) to medium/high (recent)
Medium (250-1000m)	MODIS, SPOT Vegetation	Consistent global annual monitoring to identify large clearings (>10-20 ha) and locate “hotspots” for further analysis with high resolution	Low or free

Tier 3

Tier 2

Tier 1

DeFries, Achard et.al, 2006

Intact Forest Landscapes (ITF)definitions

- Unbroken expanse of natural ecosystems within areas of forest extent, without signs of significant human activity and having an area of at least 500 km2 (*Potapov. et.al,)*

- Landscapes greater than or equal to 500km2 internally undivided by infrastructure and with a minimum linear dimension no smaller that 10km

- Territory within a forest zone which contains forest and non-forest ecosystems minimally disturbed by human economic activity, within an area of at least 500km2.

IFT is described and defined by a spatial dimension

Peter Potapov 1, Aleksey Yaroshenko 2, Svetlana Turubanova 2, Maxim Dubinin 3, Lars Laestadius 4,Christoph Thies 5, Dmitry Aksenov 6, Aleksey Egorov 2, Yelena Yesipova 6, Igor Glushkov 6, Mikhail Karpachevskiy 7, Anna Kostikova 6, Alexander Manisha 6, Ekaterina Tsybikova 6, andIlona Zhuravleva 2

Mapping the World's Intact Forest Landscapes by Remote Sensing

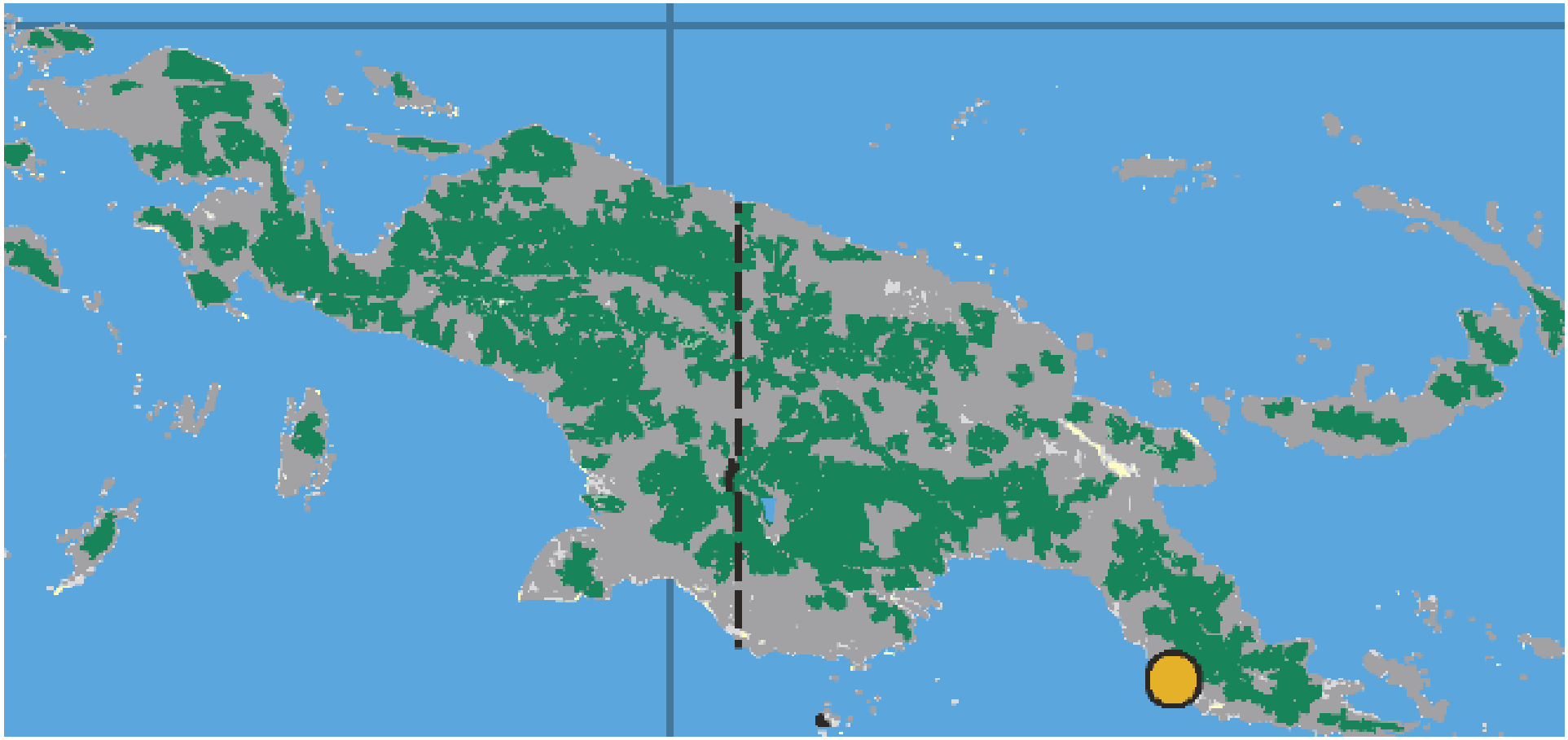
Ecology and Society 13(2): 51, 2008

[online] URL: http://www.ecologyandsociety.org/vol13/iss2/art51/

1 Geographic Information Science Center of Excellence, South Dakota State University, 2 Greenpeace Russia, 3 Dept. of Forest Ecology & Management, University of Wisconsin-Madison, 4 World Resources Institute, 5 Greenpeace International, 6 Transparent World, 7 Biodiversity Conservation Center

Polygons = Intact forests (ex Greenpeace)


Hanoi
Hong Kong
Yangon
Manila
Bangkok
Singapore
Jakarta
Port Moresby
Intact Forest Landscapes
Closed forests
Open forests, woodlands and savannas
Other Forest and Tree Cover Area*
Closed forests
Open forests, woodlands and savannas

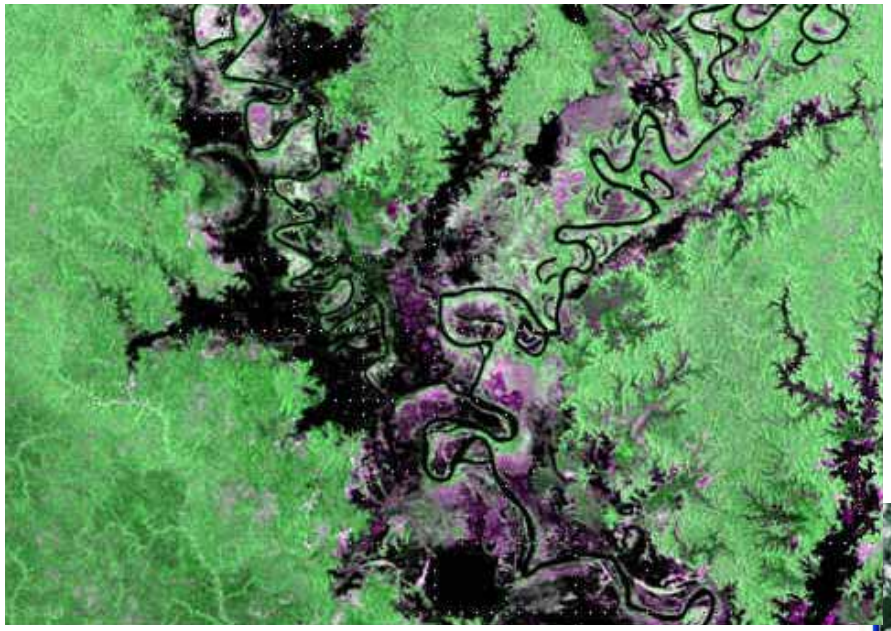


www.rinya.maff.go.jp/faw2002/12%20Mr.%20Dambis%20Kaip.pdf

http://wbcarbonfinance.org/docs/PNG_R-PIN_07-31-08.pdf

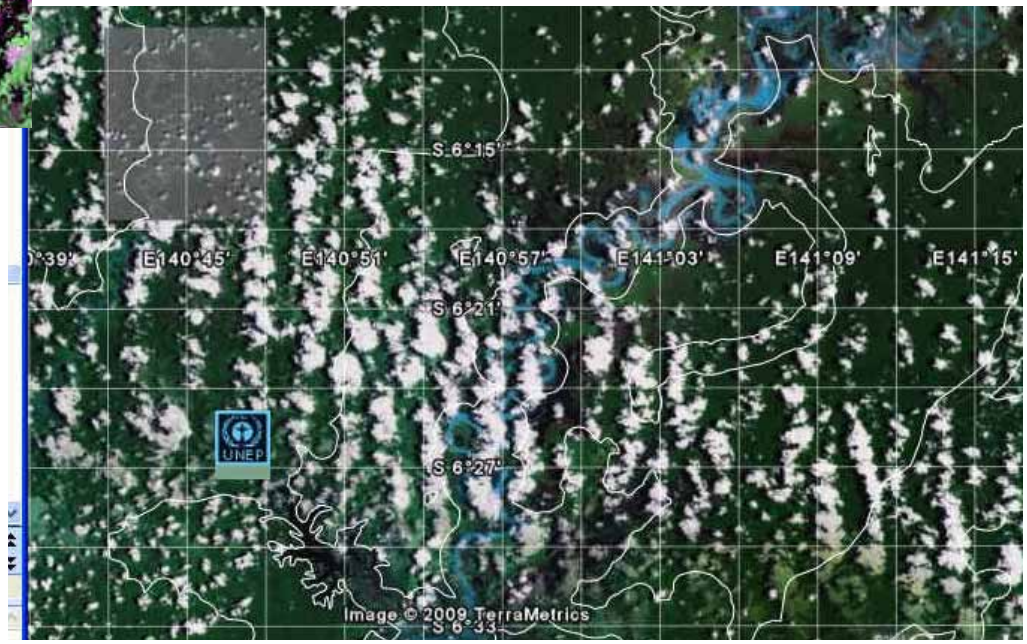
http://www.wrm.org.uy/deforestation/Oceania/Papua.html

Some web-pages of interest

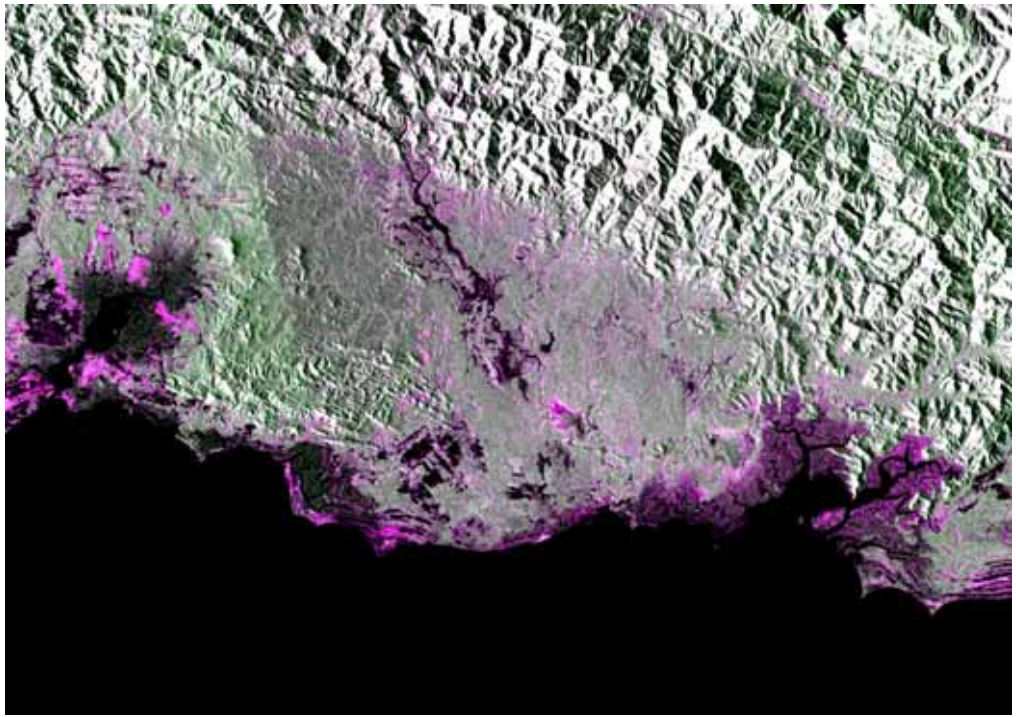


PALSAR

Shape Files on Google

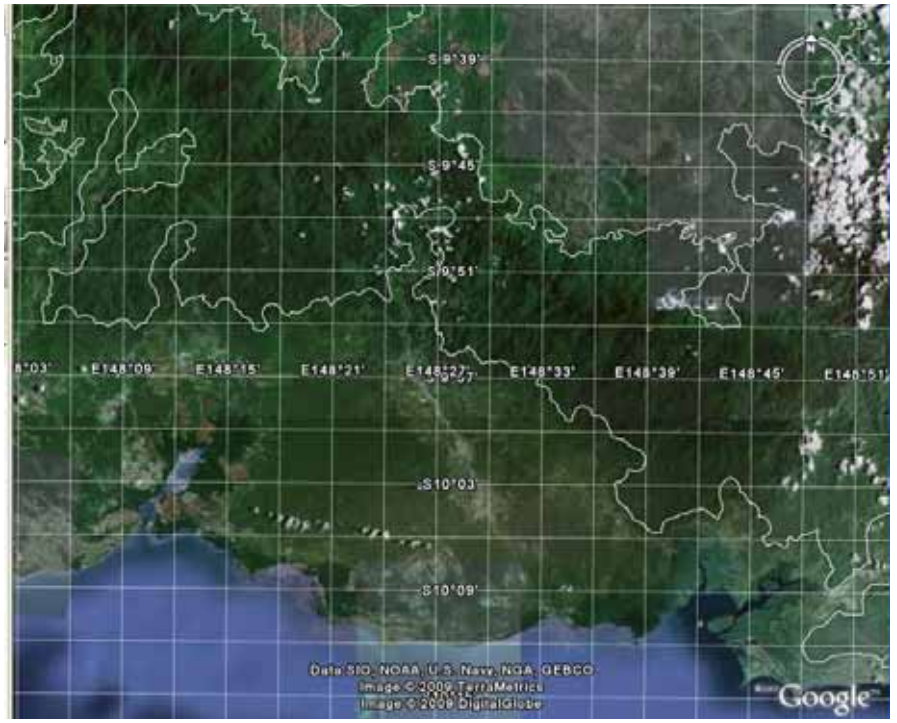


Fly River Floodplain, PNG

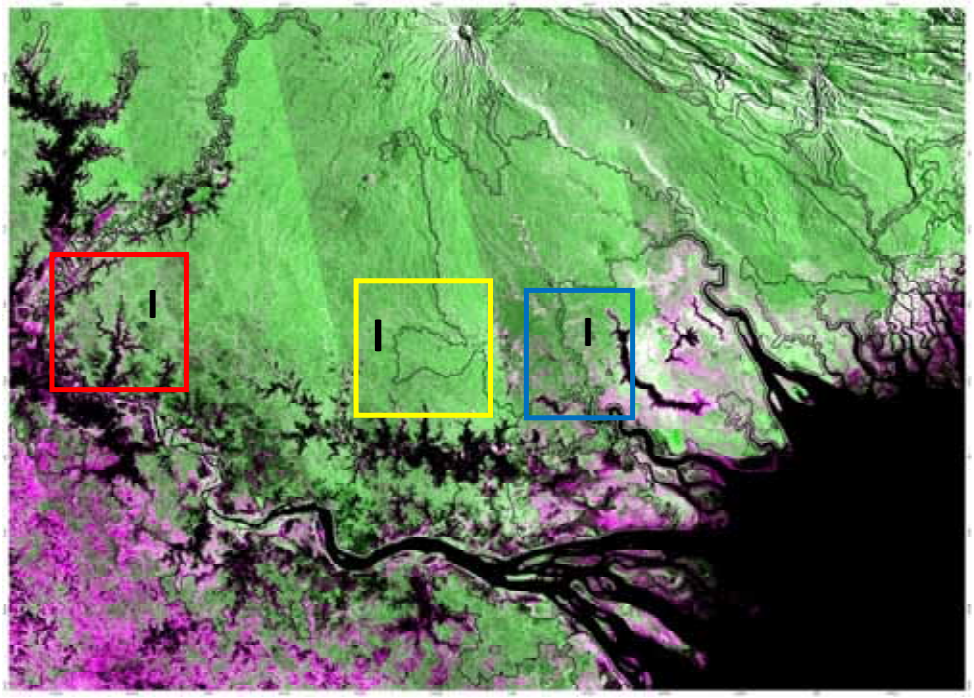


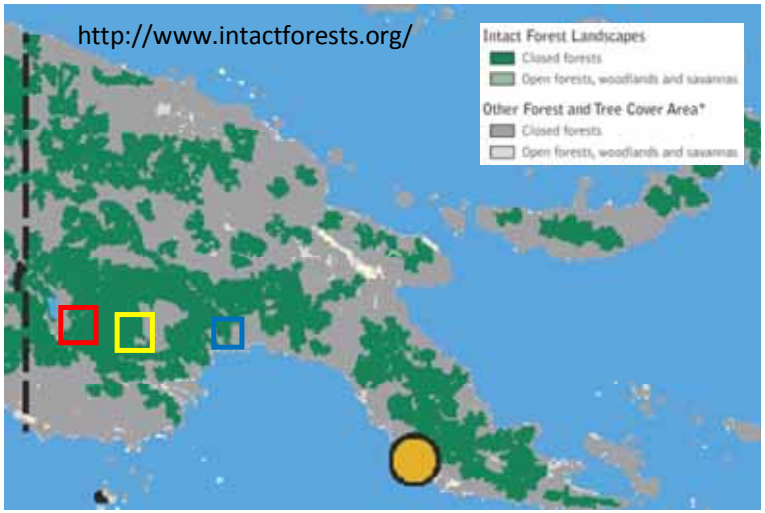
PALSAR

Shape Files on Google

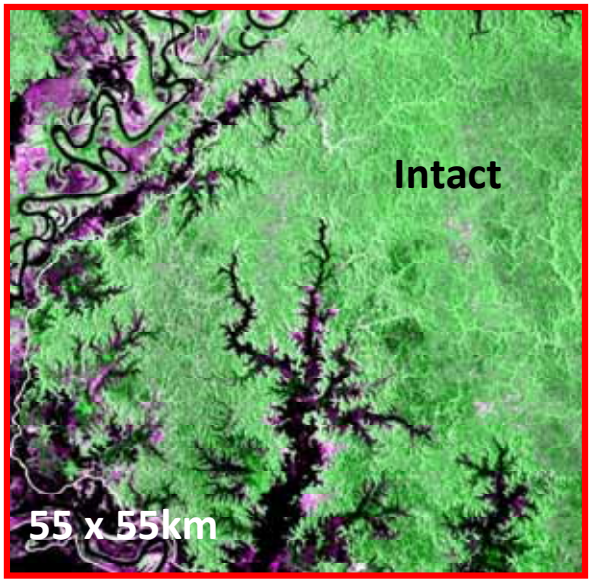


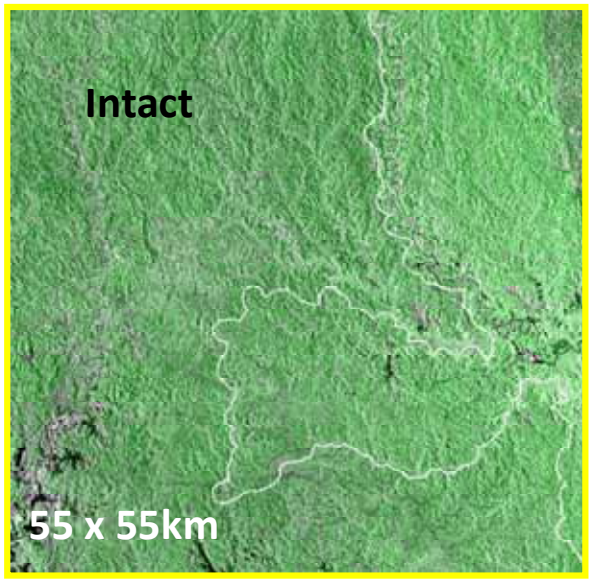
Kupiano-
CentralEastern Province PNG

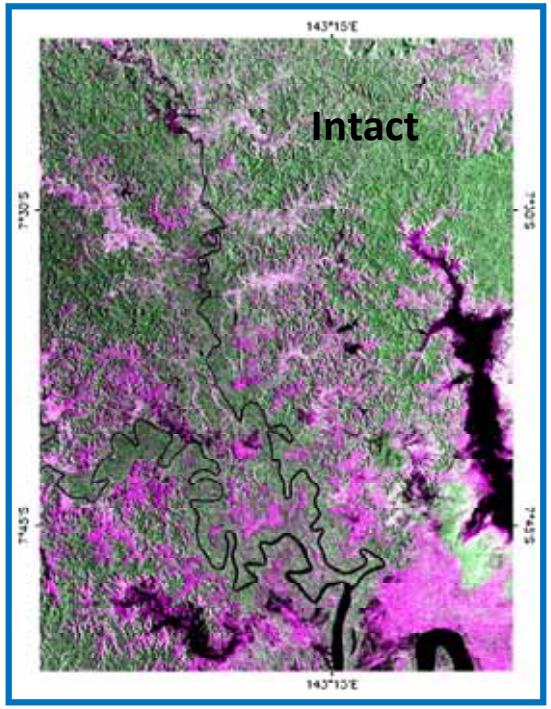


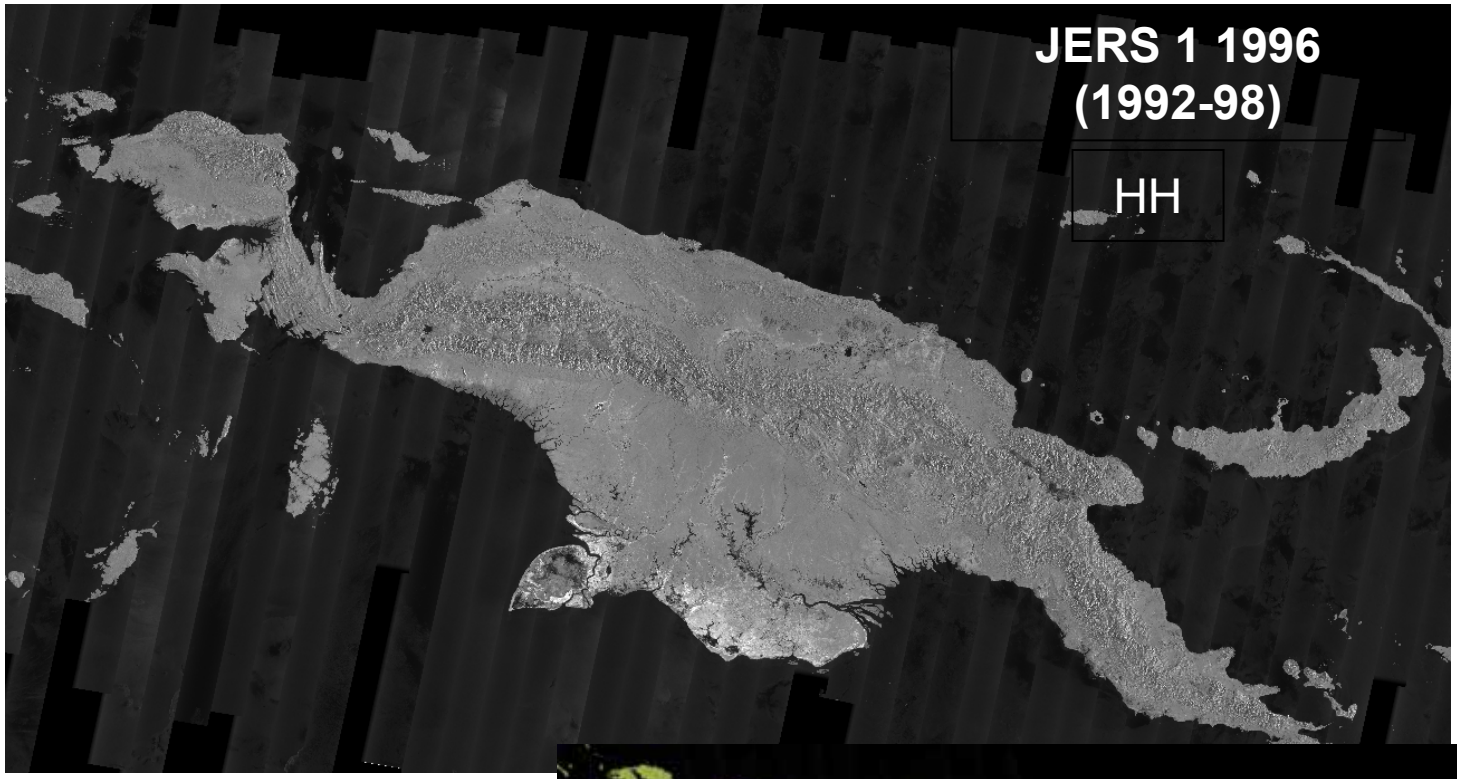


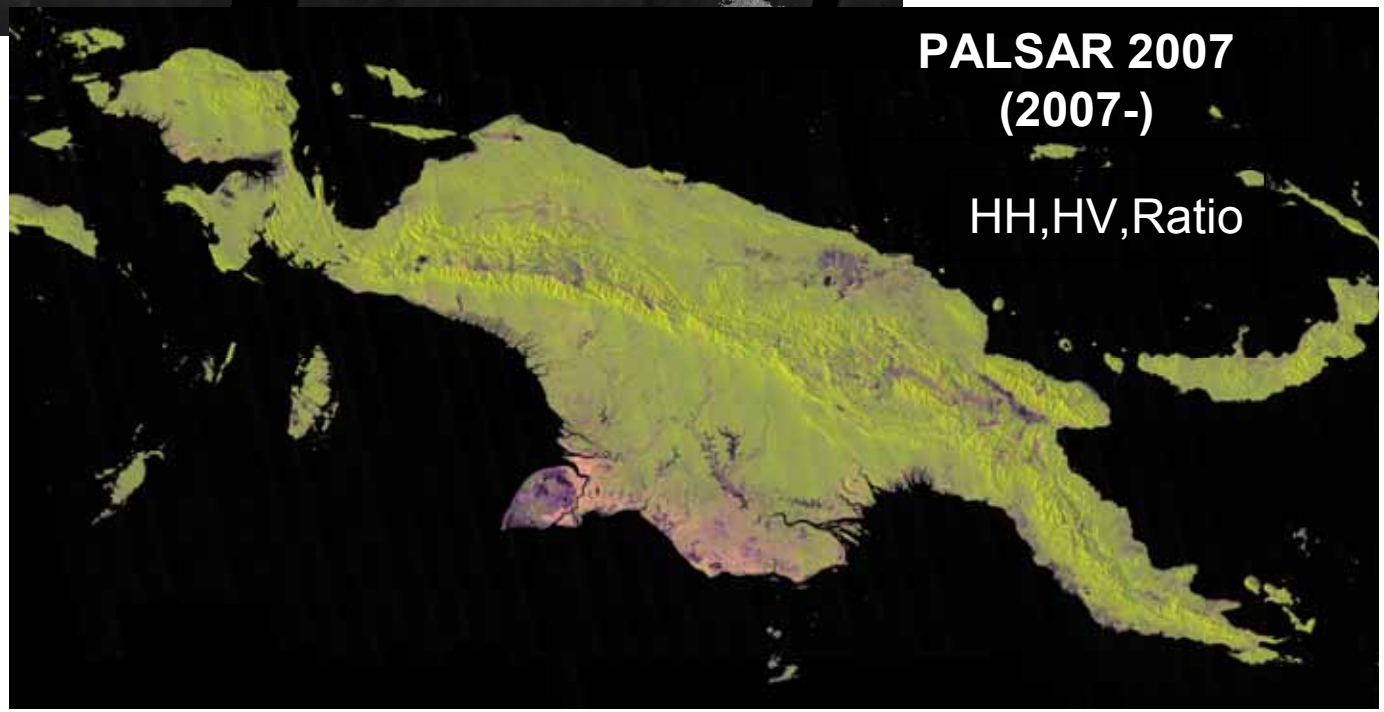
PALSAR - forest classification











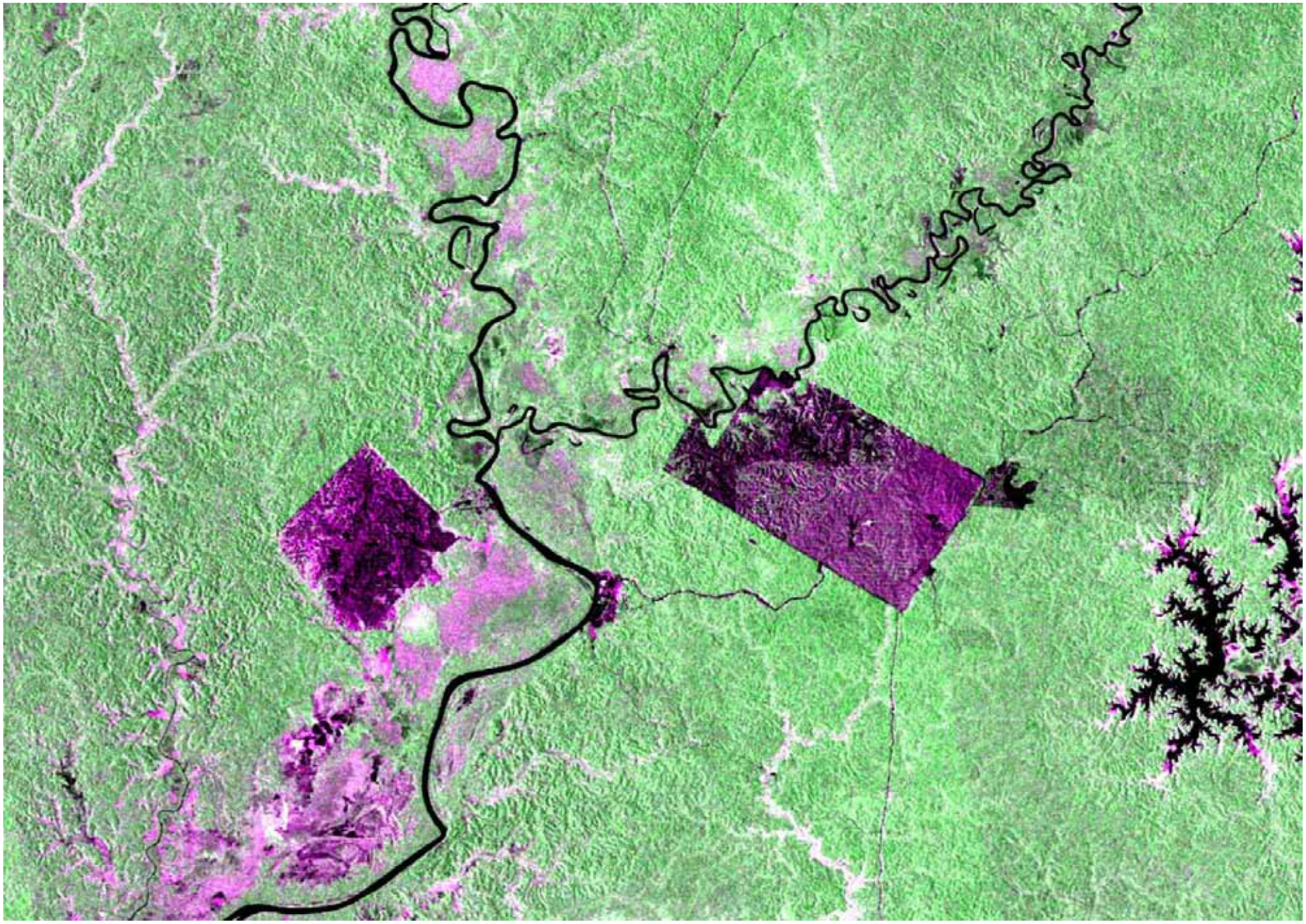
PALSAR Change Detection and Time Series

Direct approaches to detect forest degradation

Highly Detectable	Detection limited & increasing data/effort	Detection very limited
• Deforestation • Forest fragmentation • Recent slash-and-burn agriculture • Major canopy fires • Major roads • Conversion to three monocultures • Hydroelectric dams and other forms of flood disturbances • Large-scale mining	• Selective logging • Forest surface fires • A range of edge-effects • Old-slash-and-burn agriculture • Small scale mining • Unpaved secondary roads (6-20-m wide) • Selective thinning of canopy trees	• Harvesting of most non-timber plants products • Old-mechanized selective logging • Narrow sub-canopy roads (<6-m wide) • Understory thinning and clear cutting • Invasion of exotic species

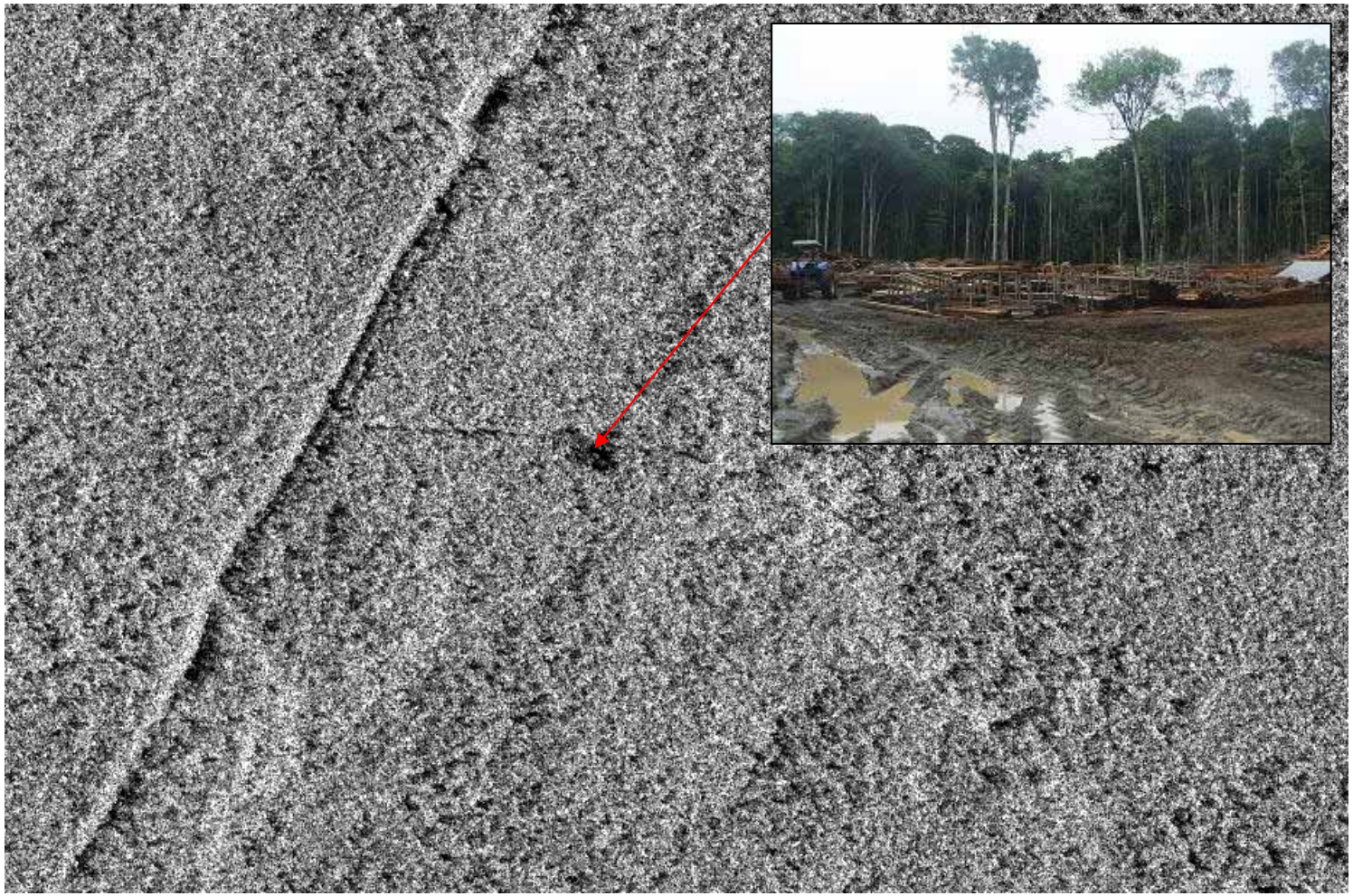
(using Landsat-type observations)

Peres et al., (2006) TREE

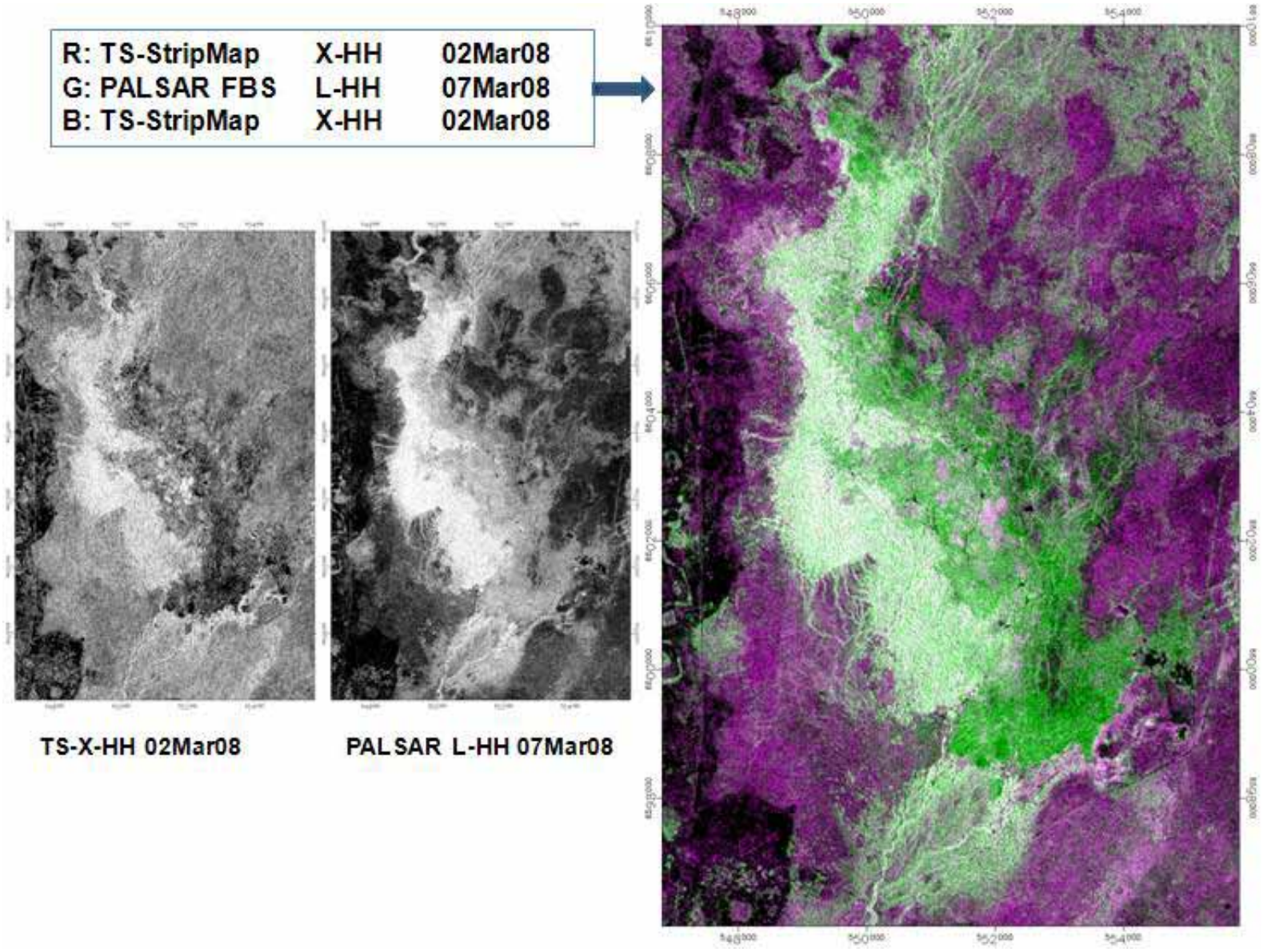


Iran Jaya - resolution not known 100-200m **HH:HV:HH (RGB)**

logging monitoring



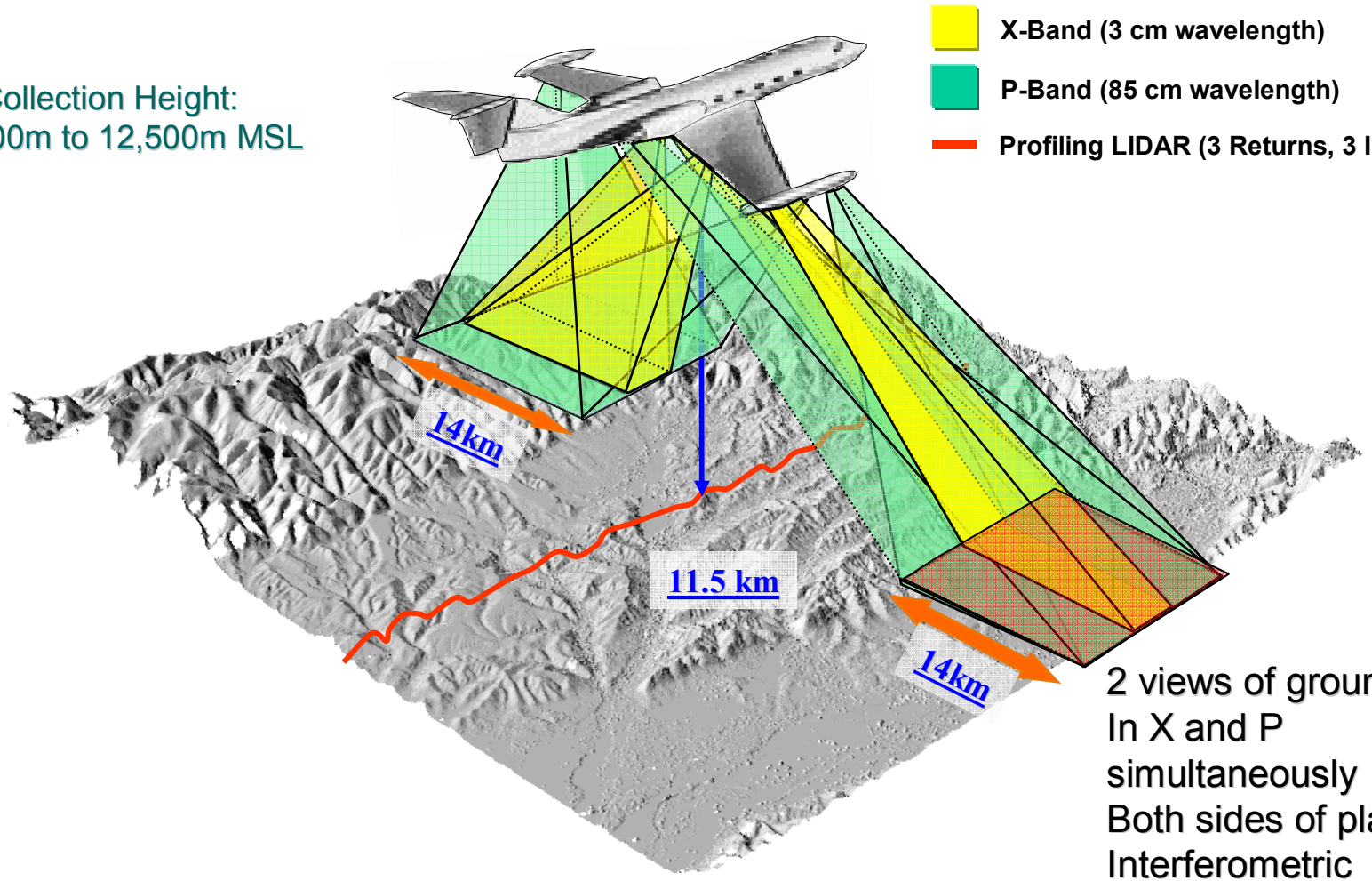
TerraSAR-X Spotlight mode – 1 m



Integration of L-band PALSAR and X-band TerraSAR-X data for discrimination of wetlands. Macquarie Marshes, (Milne and Tapley, 2008)

Flight Characteristics

Collection Height:
10,000m to 12,500m MSL



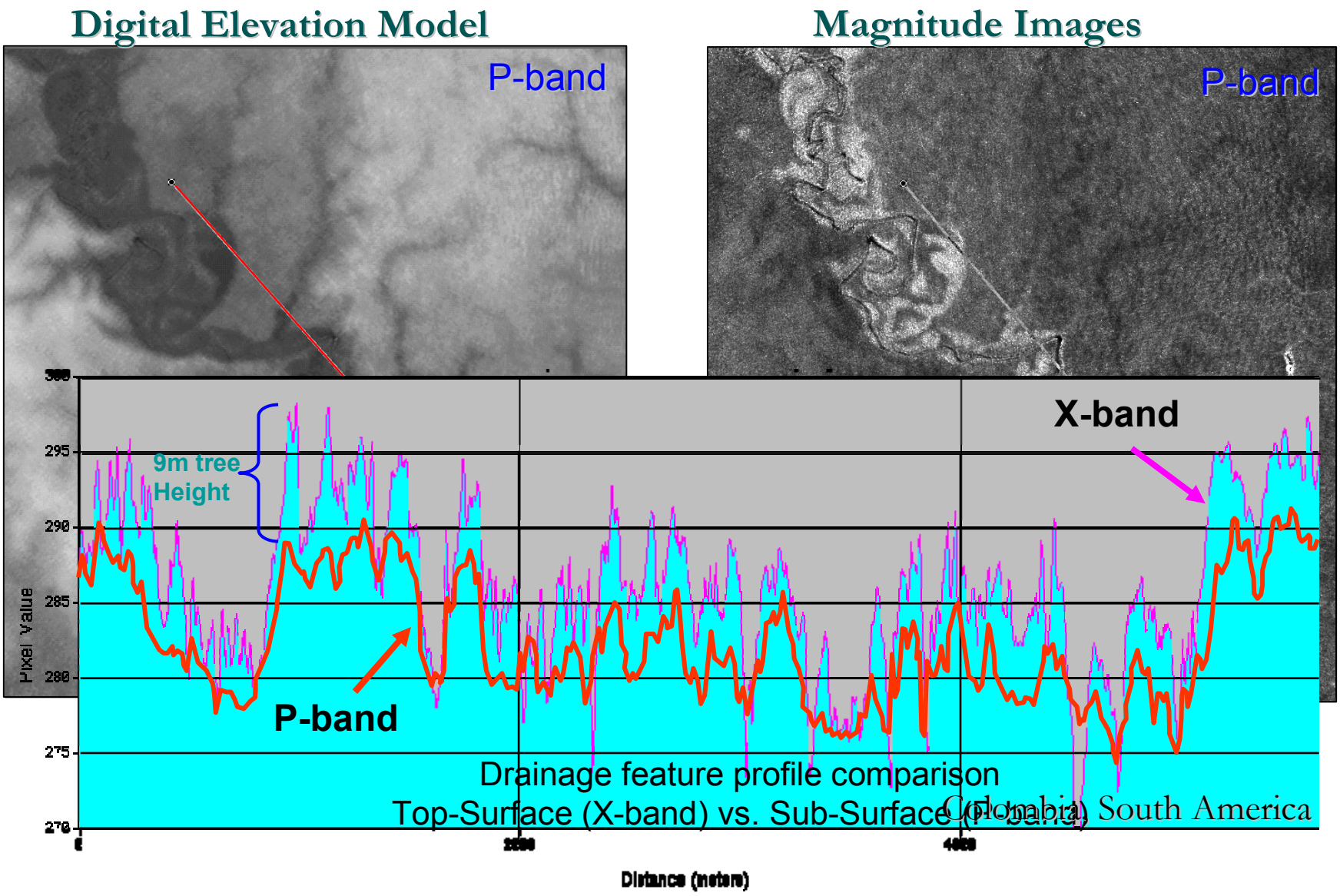
2 views of ground
In X and P
simultaneously
Both sides of plane
Interferometric

GeoSAR Product Characteristics

	X-band	P-band
DEM height accuracy		
Single swath	0.5-1.2 m (Relative)	1-3 m (Relative)
Mosaic	~1.0 m (Absolute)	1-4 m (Absolute)
DEM resolution	2.5 - 5 metres	2.5 - 5 metres
Planimetric Accuracy	1 m (Relative) < 2.5 m (Absolute)	2 m @ 5 km Altitude (Absolute) 4 m @ 10 km Altitude (Absolute)
Ground swath	12 -14 km on each side	12 -14 km on each side
Polarization	VV	HH and HV or VV and VH
Pixel Size	1.25 – 3m	1.25 – 5m

Multi-swath mosaicking and application of Lidar ground measurements results in considerable improvement over single-swath accuracy.

Airborne GeoSAR Xand P band



Airborne GeoSAR Xand P band

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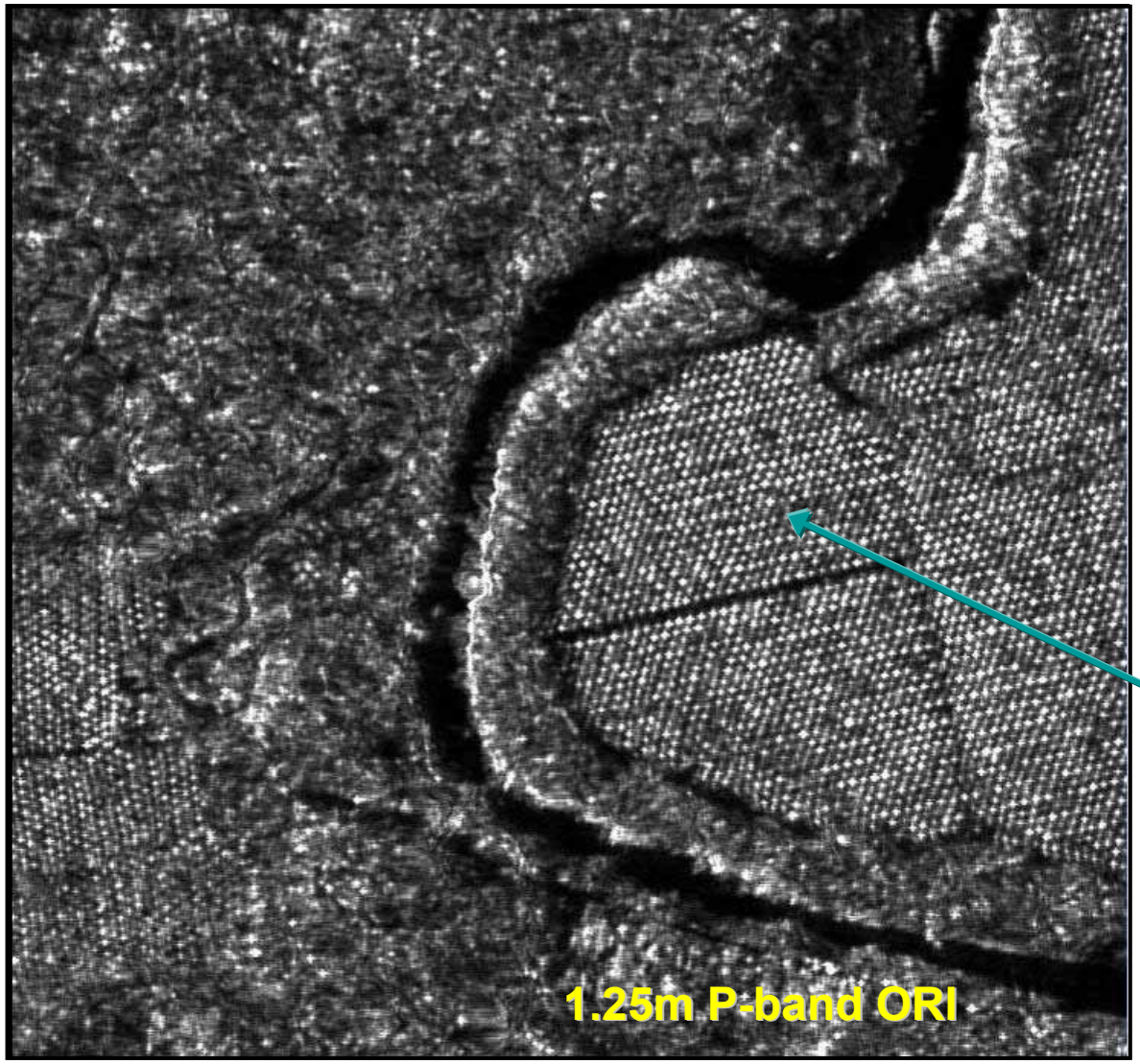


1.25m X- and P-band Radar Images

Orchards and trails, irrigation patters, drainages exposed in P-band

Capable of counting trees in orchards

Papua New Guinea

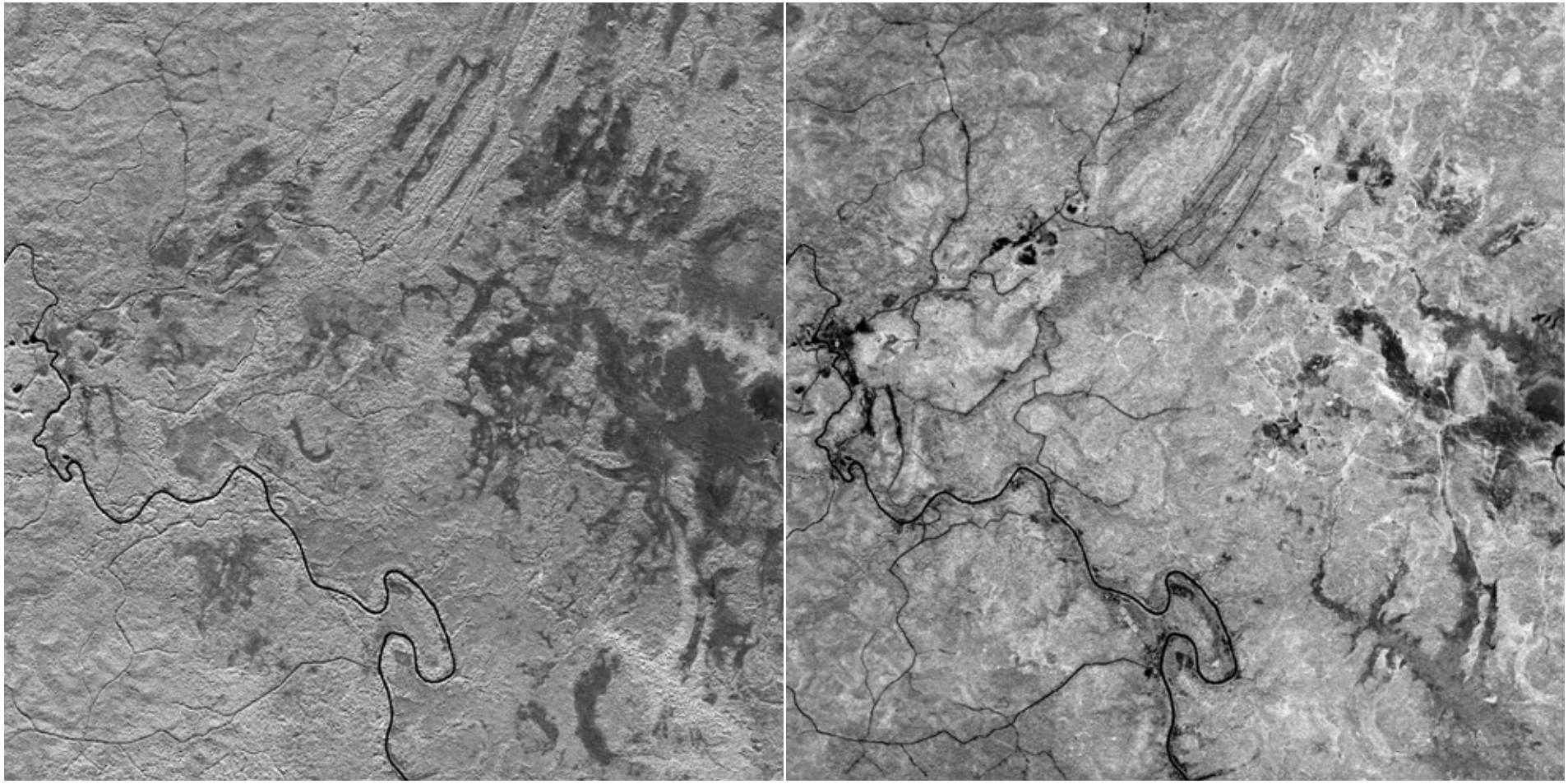
New Technologies for Radar Interferometry:

Automated Feature Extraction and Determination of Drainage Networks

CRC_SI Project 4.11

Participants: FUGRO – Earth Data International, DIGO and Horizon Geoscience, University of New South Wales. (Mark Williams, Ian Tapley and Tony Milne)

An Example of GeoSAR Biomass Estimation



- Left: X-band magnitude, right: P-band magnitude. The area is ~25,000ha. Data from Papua New Guinea collection

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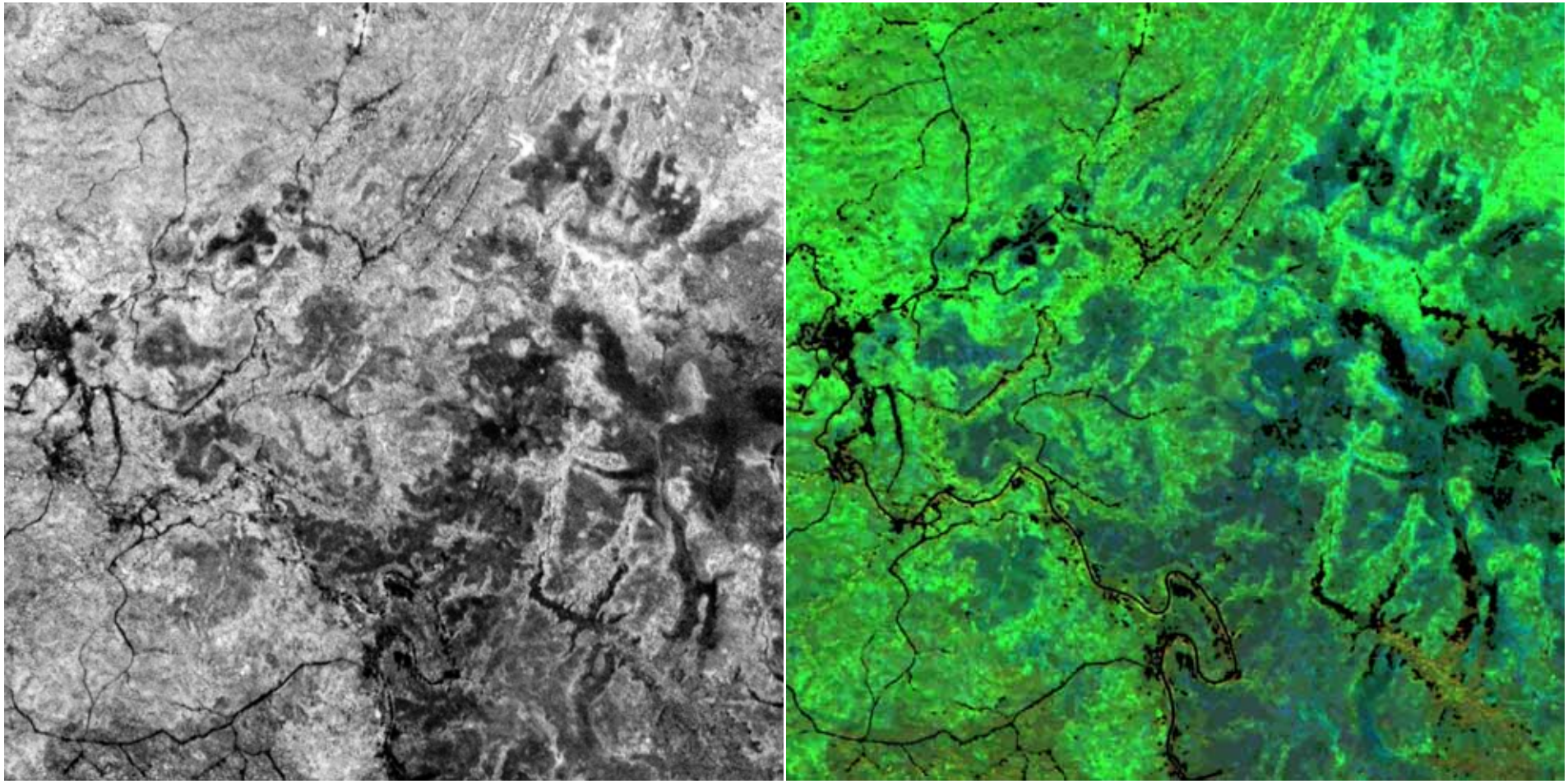
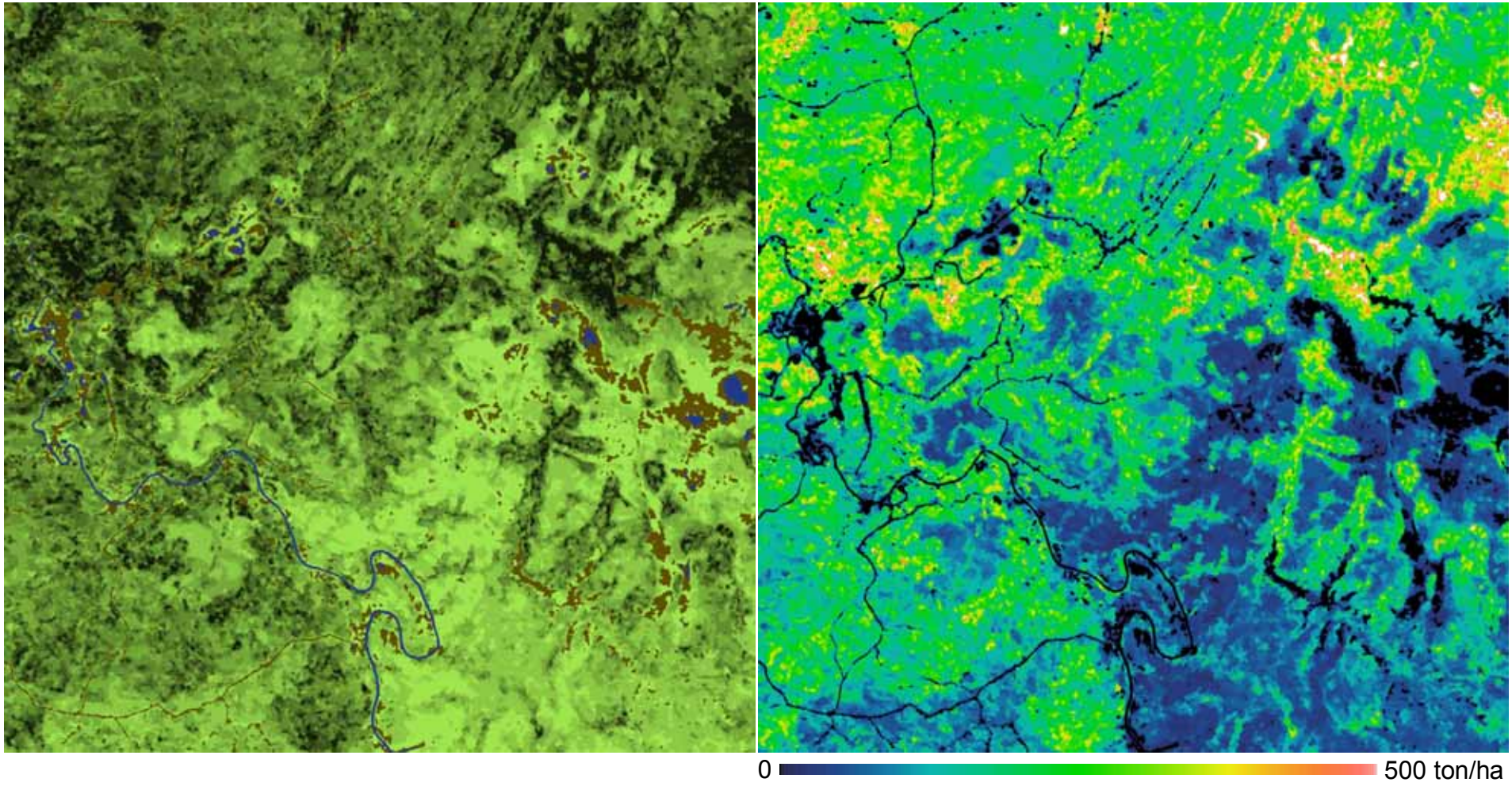


- Left: X-band - P-band interferometric height, h_{int}, is a surrogate vegetation height.
- Right: (R:X, G:h_{int}, B:P) for forested areas.

An Example of GeoSAR Biomass Estimation



- Left: Multi-channel data within segments is used to produce a terrain class map (dark green is high-biomass forest).
- Right: Multi-channel data within segments is used to produce a quantitative biomass estimate at high resolution.

(Mark L. Williams, 2009)

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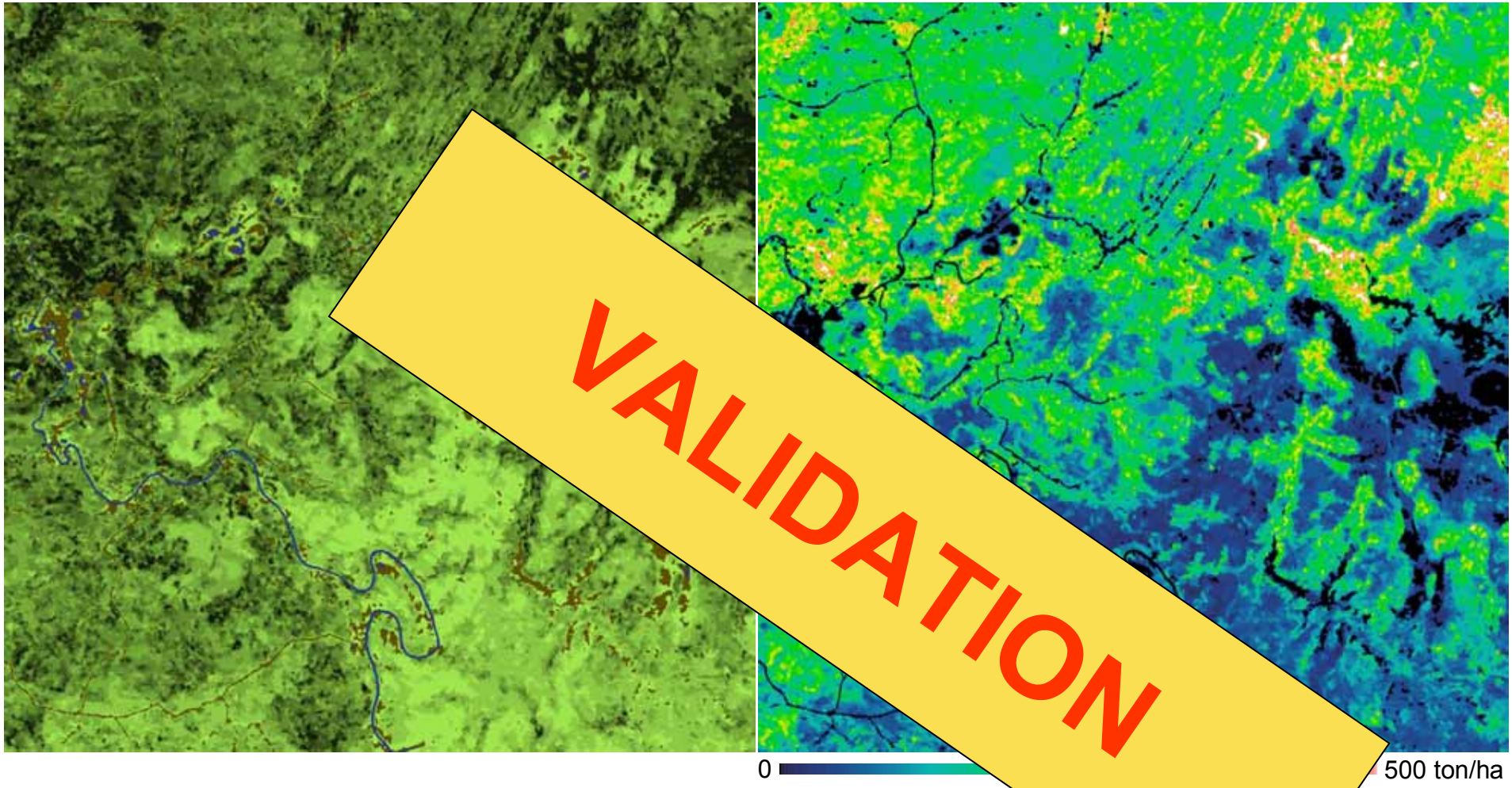

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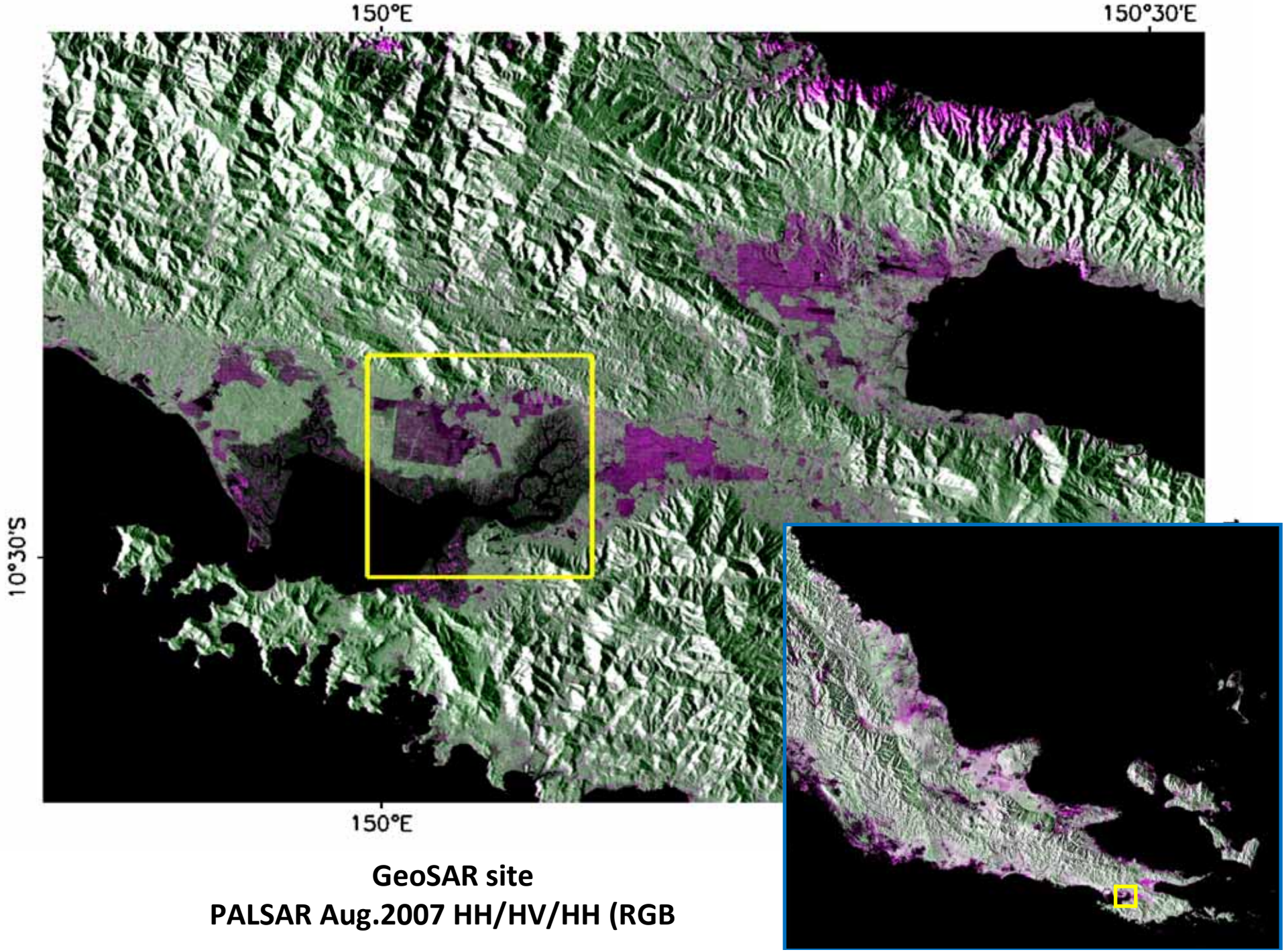


GeoSAR site
PALSAR Aug.2007 HH/HV/HH (RGB

GeoSAR Data

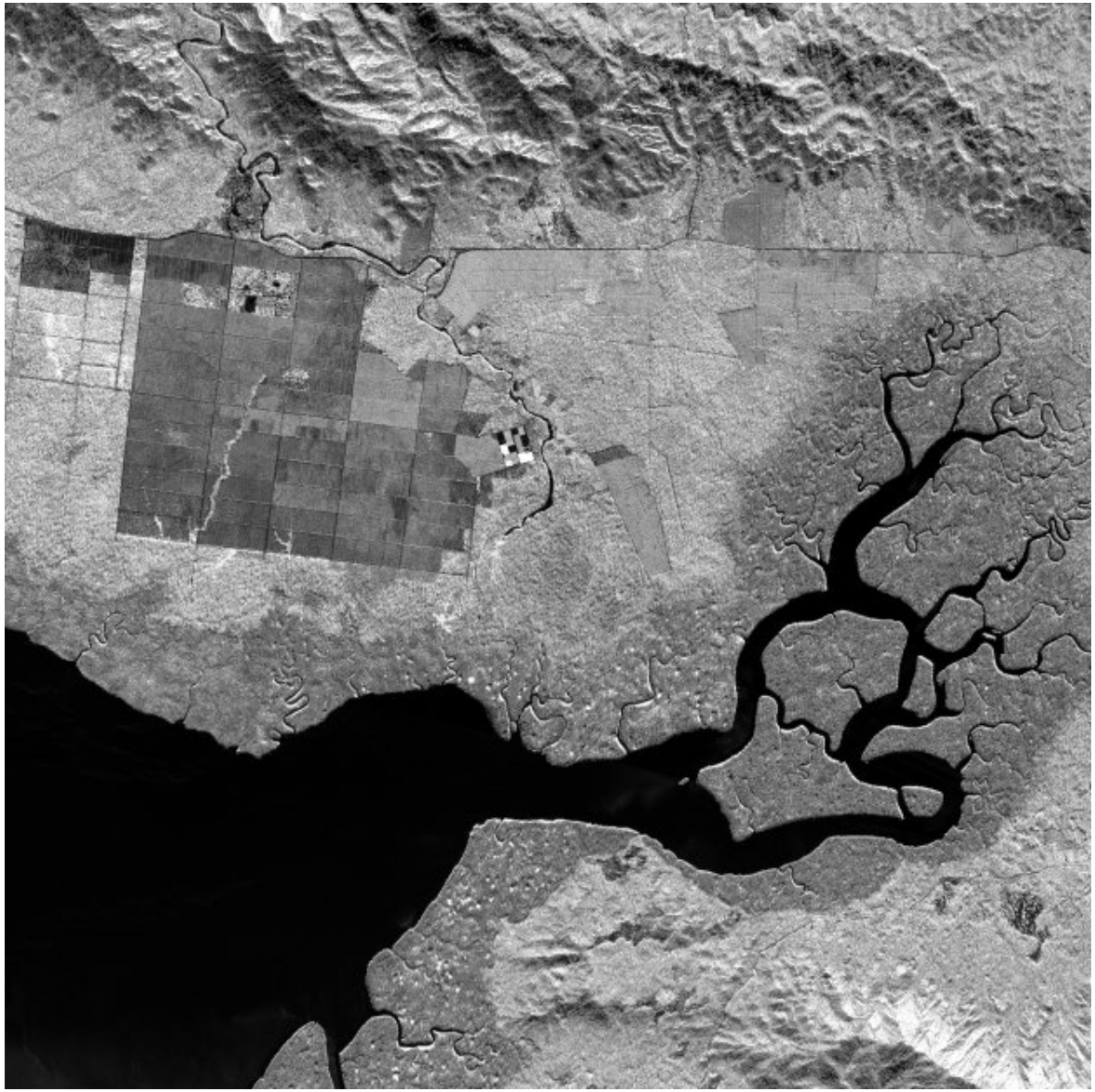
- P-band HH

  (1.25m posting, multi-looked to 12.5m)
- X-band VV

  (1.25m posting, multi-looked to 12.5m)
- P-band DEM

  (5m posting, averaged to 10m, re-sampled to 12.5m)
- X-band DEM

  (5m posting, averaged to 10m, re-sampled to 12.5m)



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- X-band VV

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- P-band DEM

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- X-band DEM

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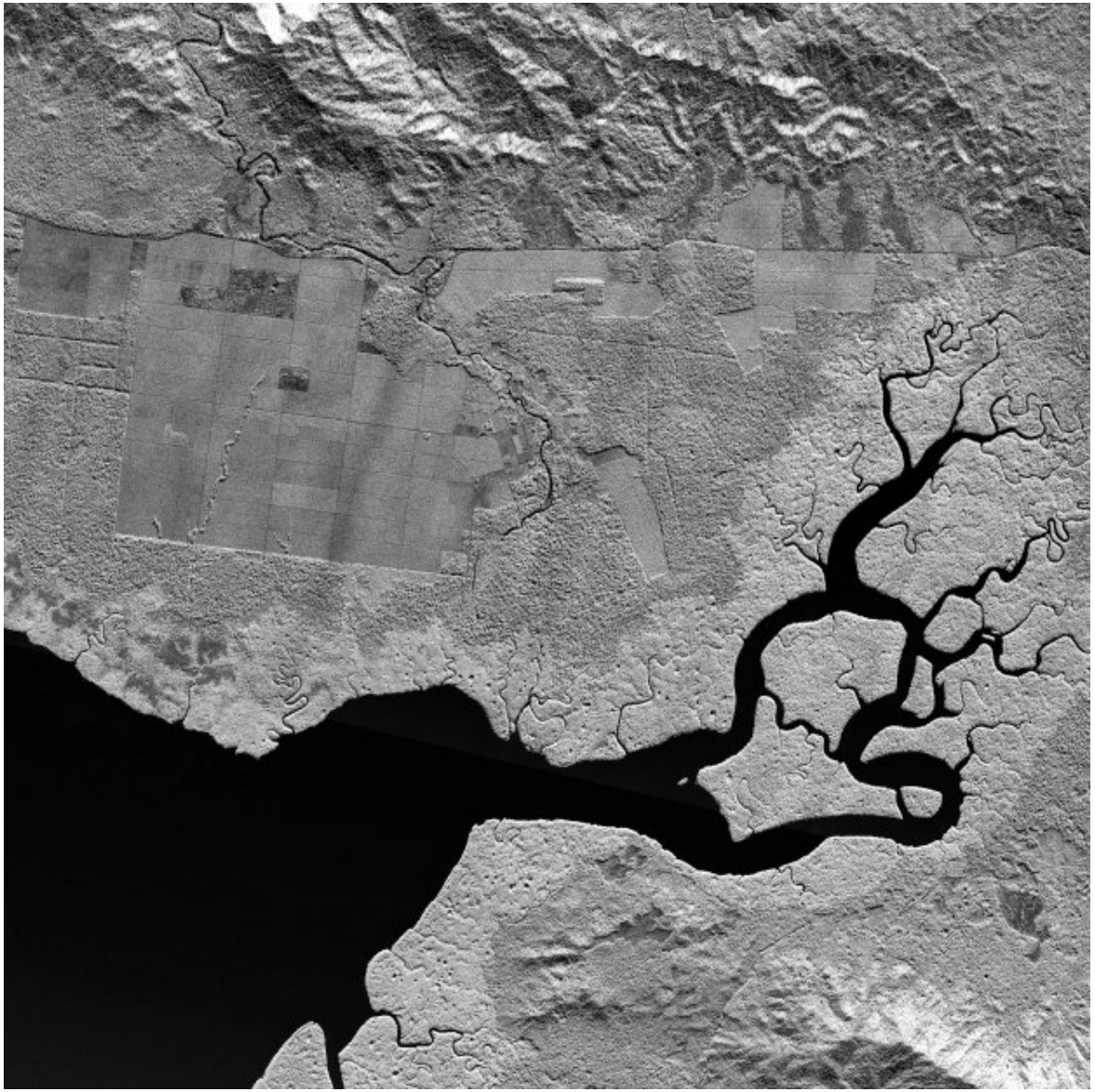

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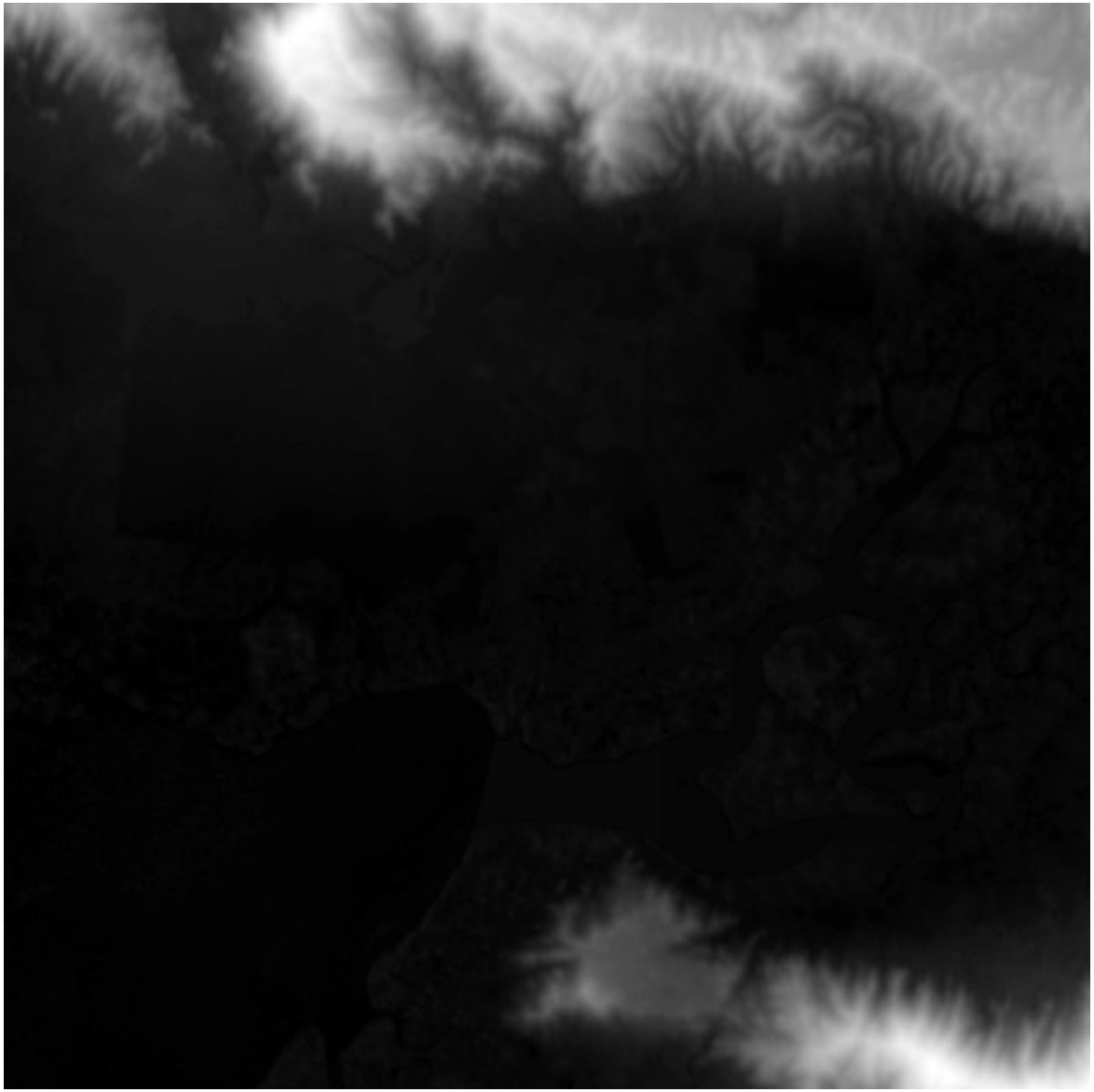

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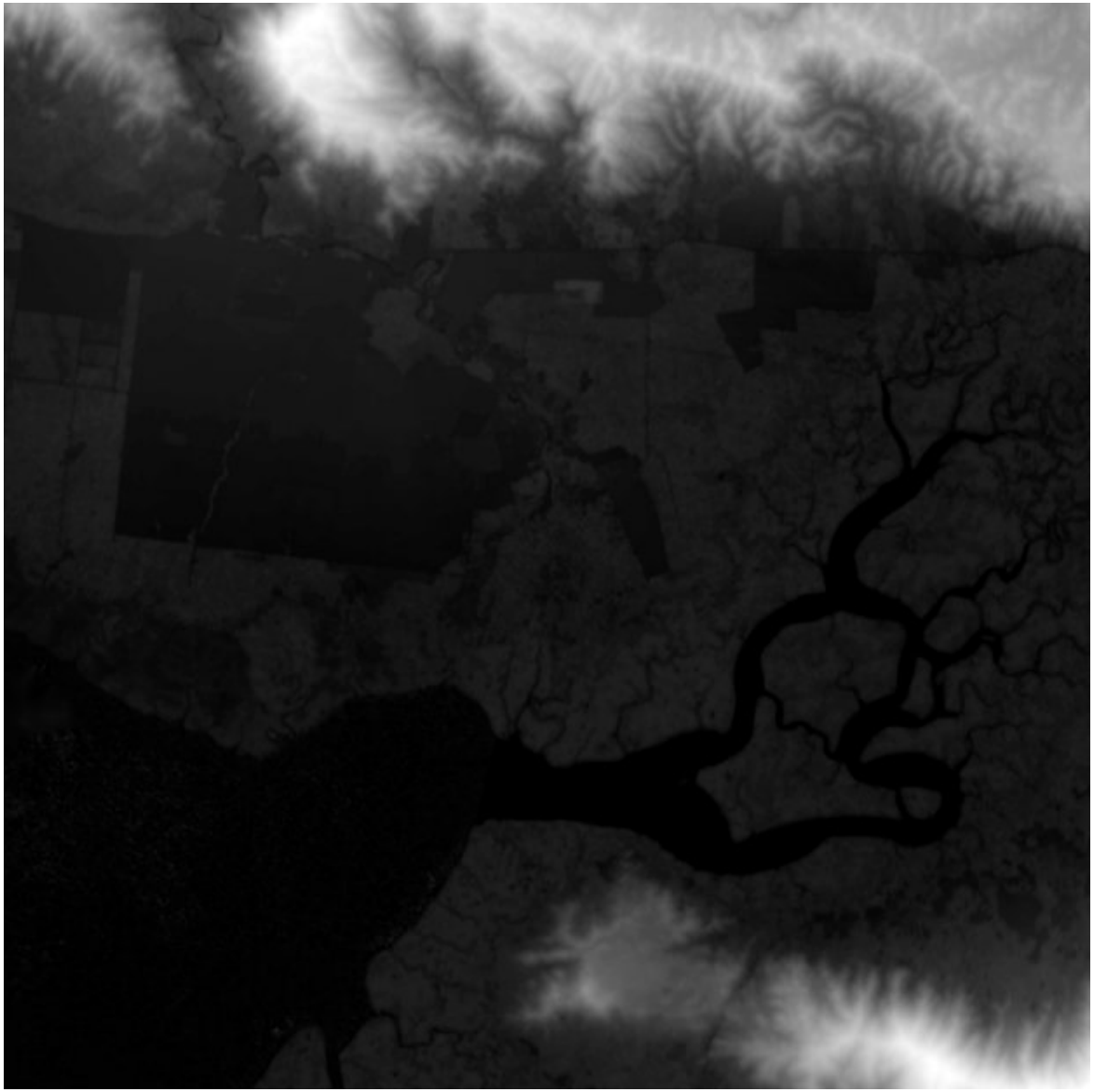
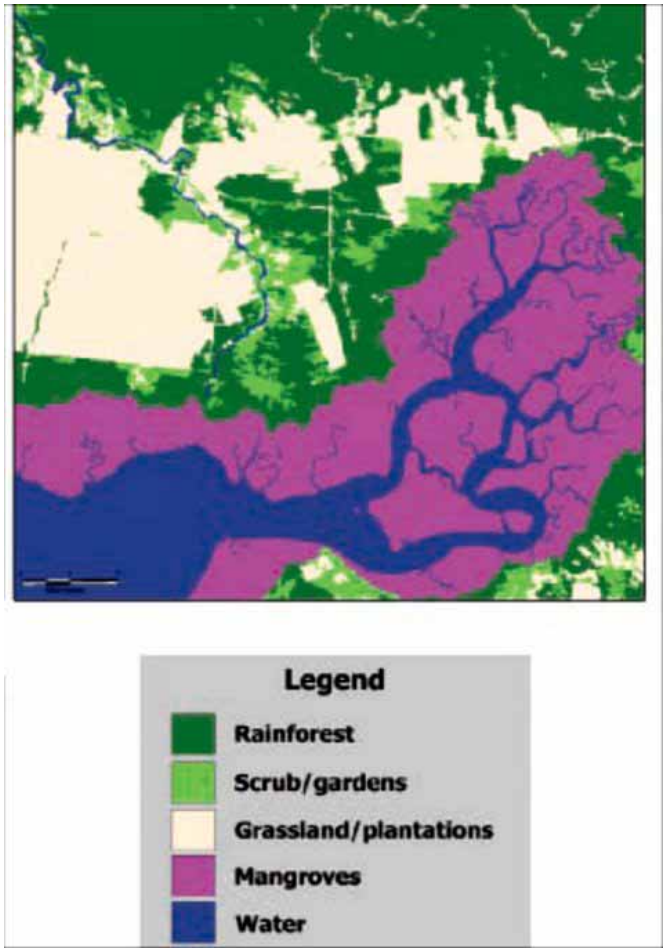
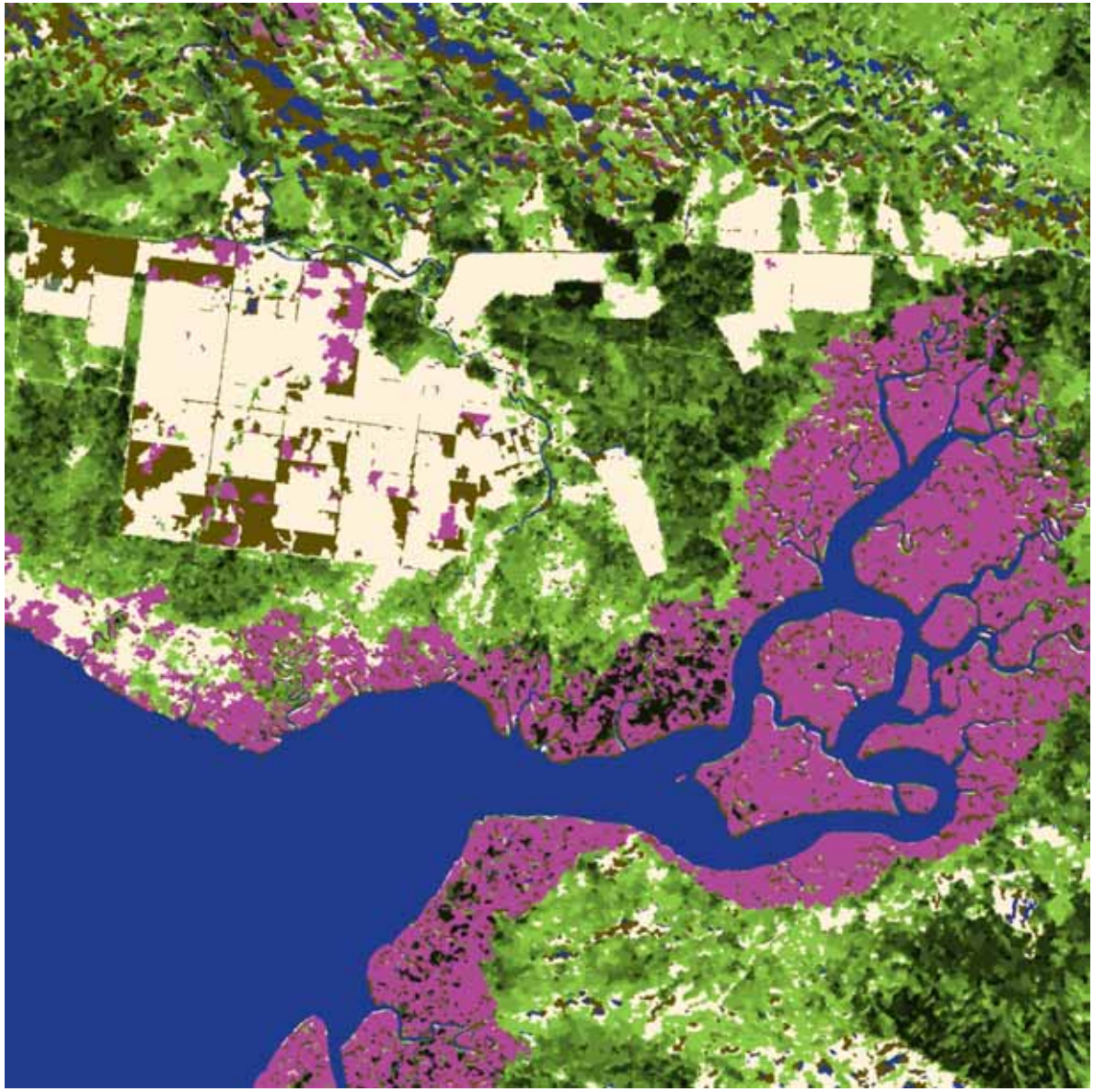


SPOT - GeoSAR Classification



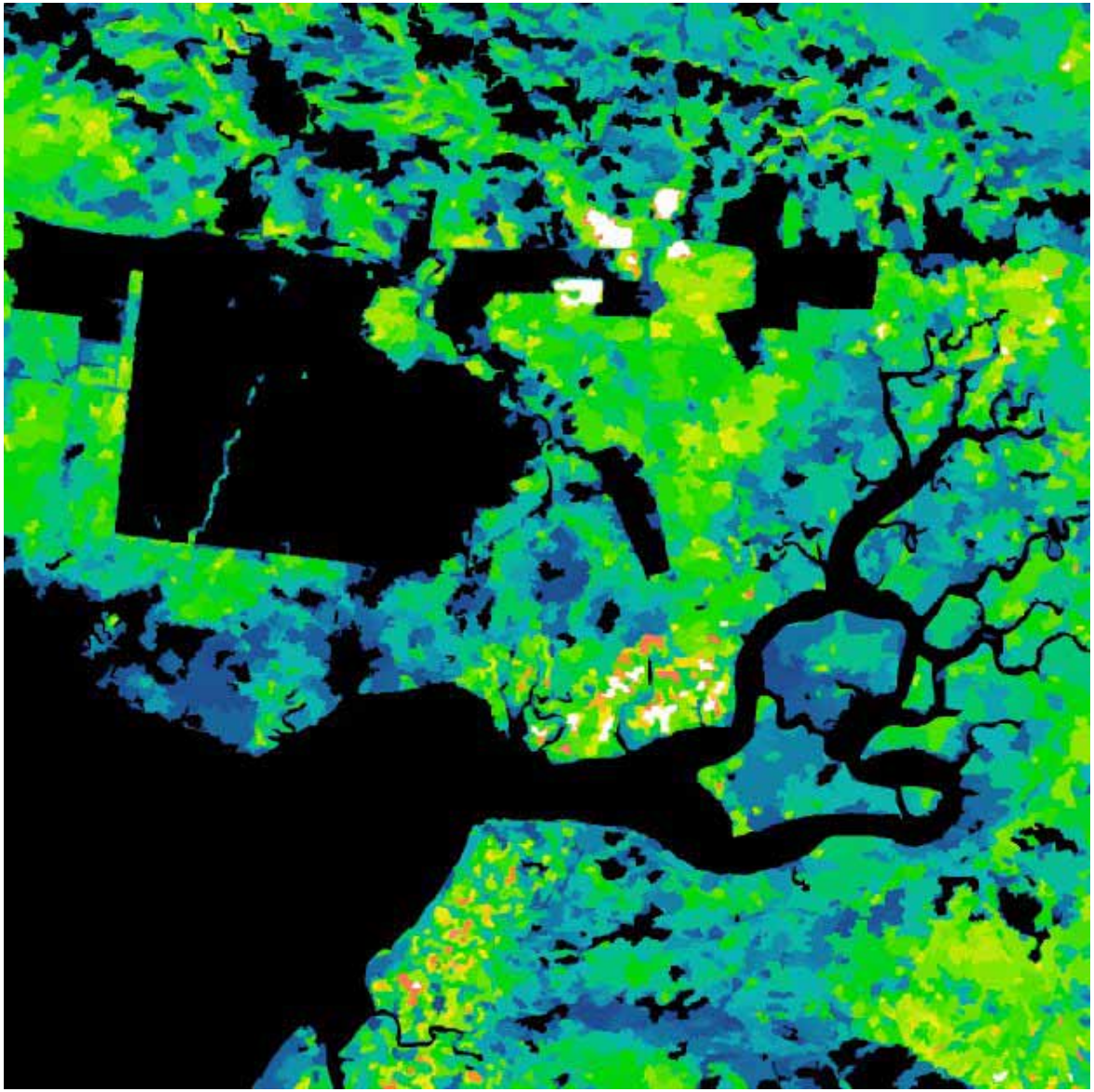


- Left: Terrain classified using SPOT5 data from 2002 [*The State of the Forests of Papua New Guinea*, P Shearman et al., University of Papua New Guinea, 2008].

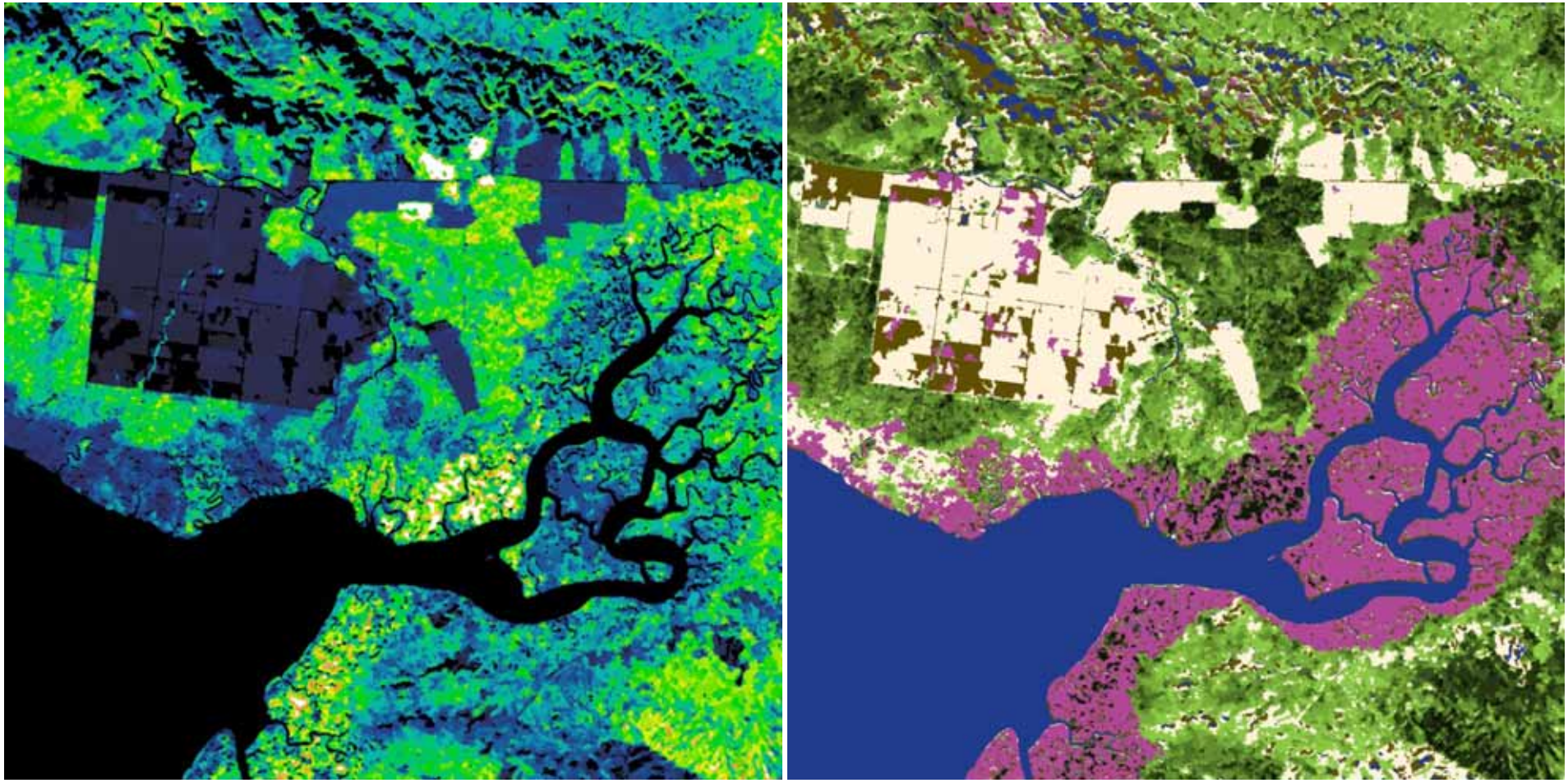
GeoSAR Classification / Biomass

- Quantitative tropical forest biomass map calculated using GeoSAR surrogate height mapping derived from Amazon ground data and SAR data (see Williams *et al*, IGARSS 2009)
- Biomass evaluated in forest and mangrove areas only.
- Shadowed areas misclassified in this image will be recovered from the opposing view data always available with GeoSAR.

(Mark L. Williams, 2009)



GeoSAR Biomass/ Classification



0 500 ton/ha

- Left: Quantitative biomass estimate at high resolution.
- Right: the same data is used to define a terrain class map

GeoSAR Biomass/ Classification

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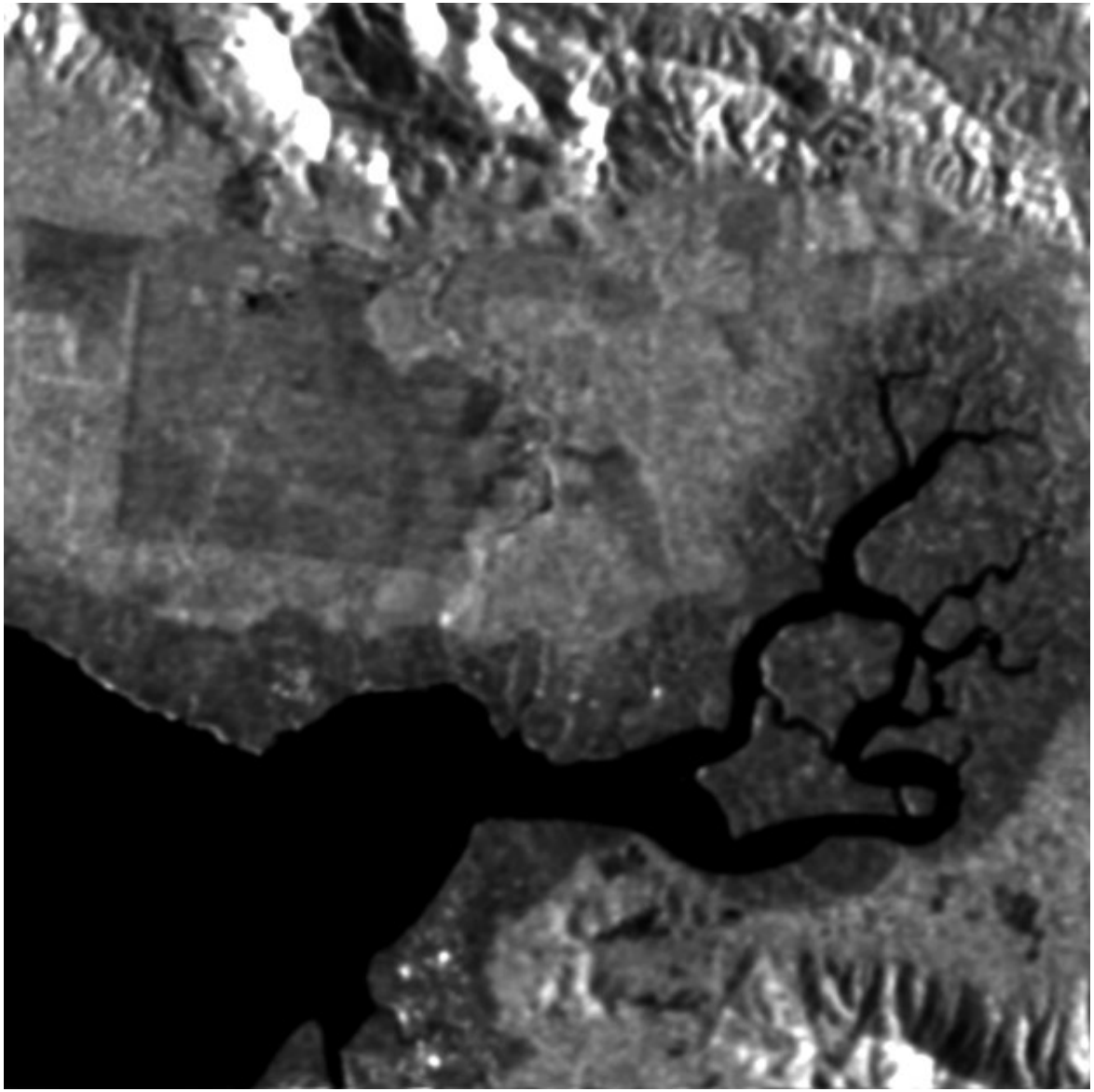
PALSAR Data

- L-band HH
  (50m posting, re-sampled to 12.5m)
- L-band HV
  (50m posting, re-sampled to 12.5m)

- PALSAR imagery is registered to GeoSAR imagery at the 12.5m posting.



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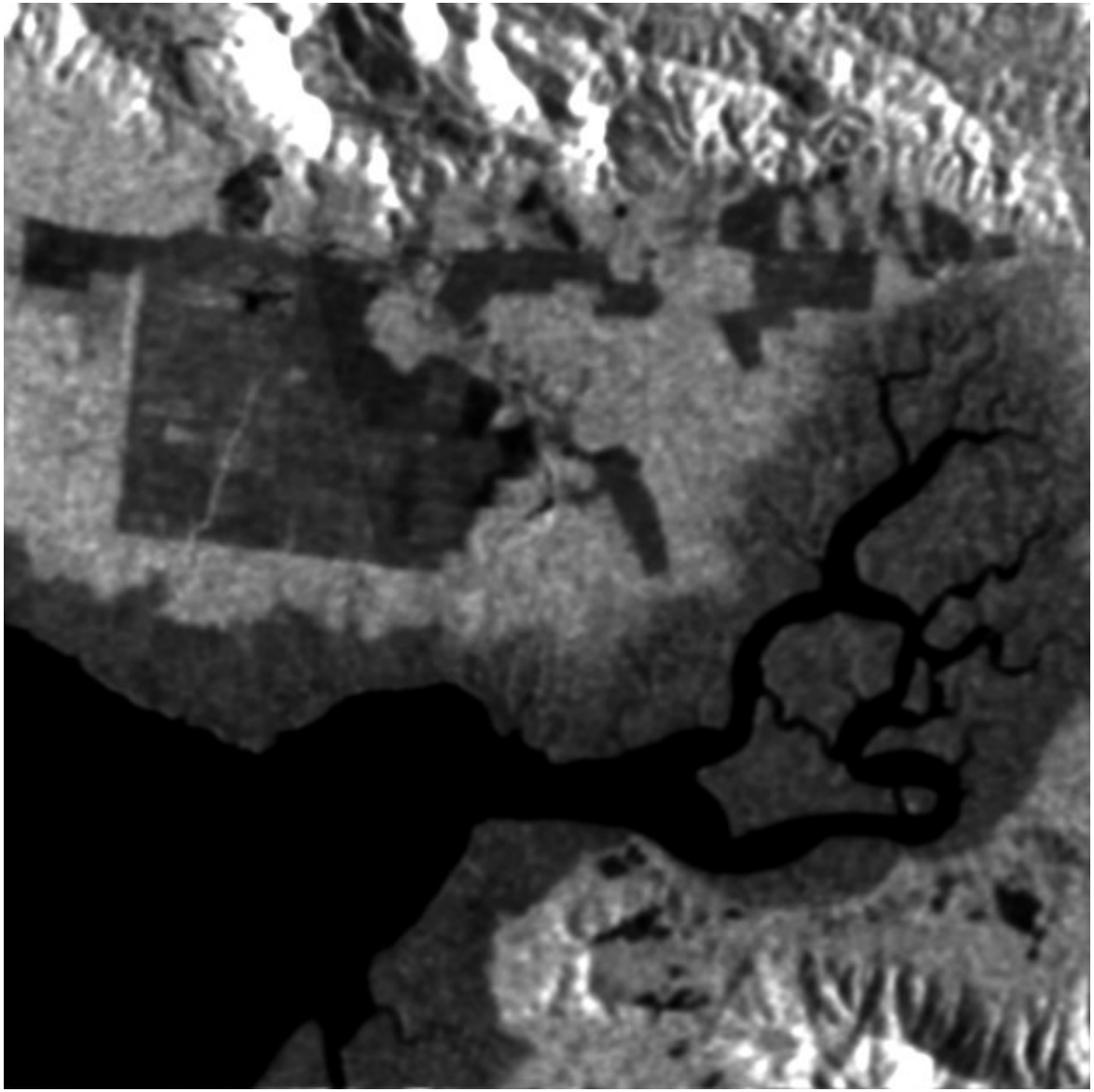

Joint Segmentation

- Combine X-P DEM difference with PHH and LHV magnitude data to form a span image.
- Segment the span image.

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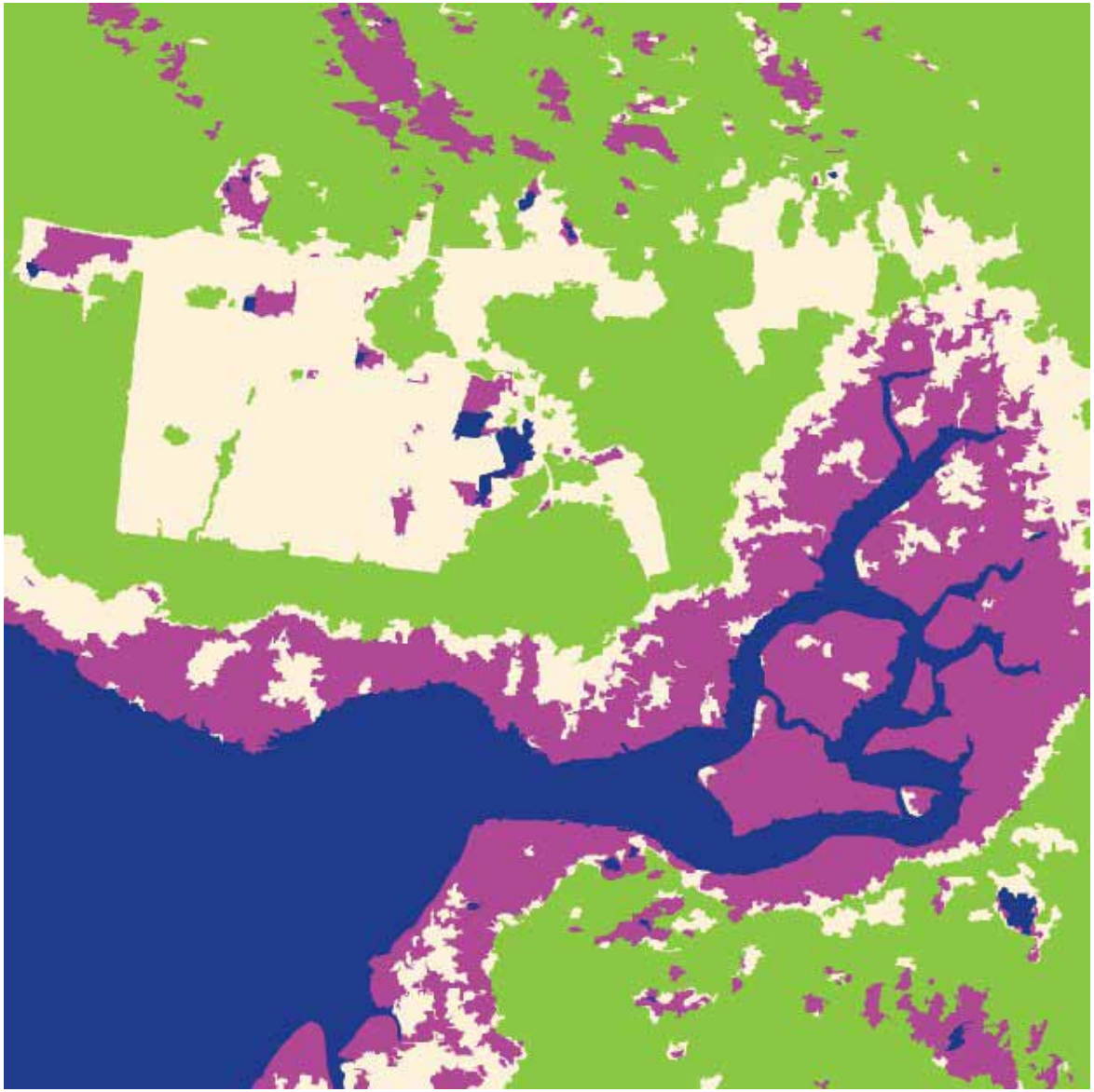
(Mark L. Williams, 2009)

PALSAR Classification

- Classification based on PALSAR data.
- Water
- Non-forest
- Forest
- Mangrove

- Shadowed areas misclassified in the PALSAR image may be resolved using contextual logic.



(Mark L. Williams, 2009)

Conclusion and Some other Issues

Both GeoSAR and PALSAR data can be used to classify forest (and mangrove) and non-forest classes.

Definite need to address the interface and integration of optical and SAR for information extraction and retrieval within both an operational and research environment.

‘Wall to wall’ or ‘stratified sampling’ approach to REDD or both?

How to benefit from collaboration with other organisations undertaking the same task (esp FAO GFR-2010).

Summary

- Both GeoSAR and PALSAR data can be used to classify forest (and mangrove) and non-forest classes.
- Only GeoSAR can be used to recover tropical forest biomass over the complete range of values using single-pass, dual-frequency, SAR interferometry.
- GeoSAR can map wide areas rapidly at high-spatial resolution.
- The combination of GeoSAR and PALSAR data should yield estimates of carbon gains and losses over time.
- PALSAR data alone can only be used to estimate areas of forest/non-forest change, and some re-growth, and will not yield quantitative estimates of biomass for regions with greater than 60 ton/ha.
- GeoSAR should permit estimation of tropical forest carbon content for high biomass regions (>500 ton/ha).