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Mangrove Mapping and Monitoring using Earth Observation Satellite Data

Chandra Giri, Ph. D.
U. S. Environmental Protection Agency

EPA United States Environmental Protection Agency

To manage the ecosystem on a sustainable manner, we need information on:

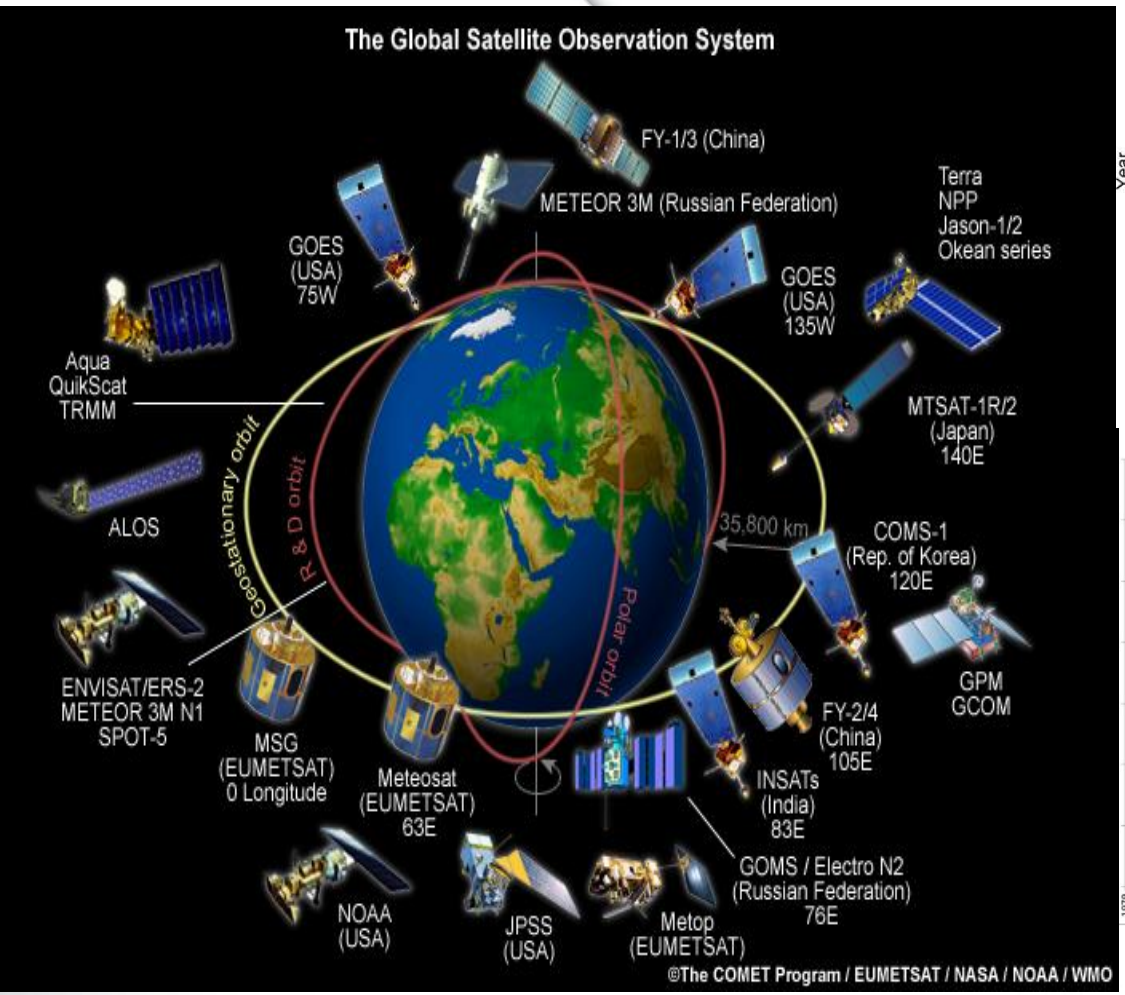
- Distribution
- Mangrove change (deforestation and regrowth/afforestation)
- Disturbances and recovery
- Health and Productivity
- Drivers of change
- Consequences of change
- Future projections

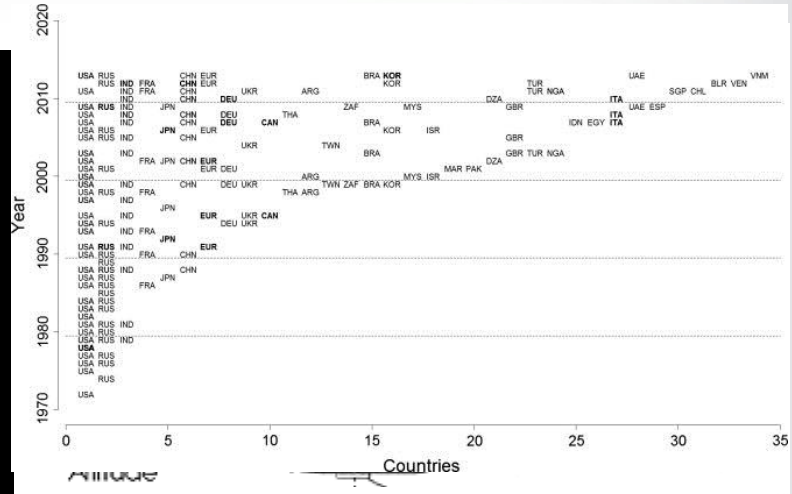
- From local to global scales

United States Environmental Protection Agency

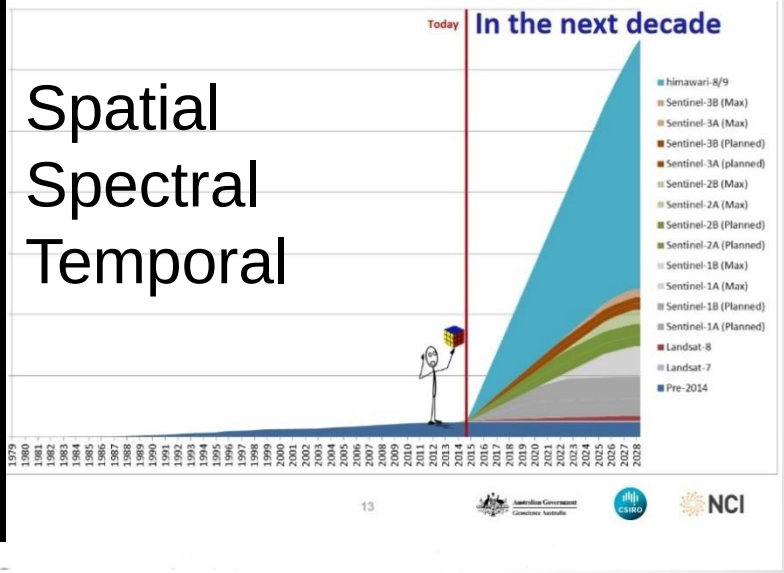
Remote Sensing Approach

Distinctive Signature





Spatial
Spectral
Temporal



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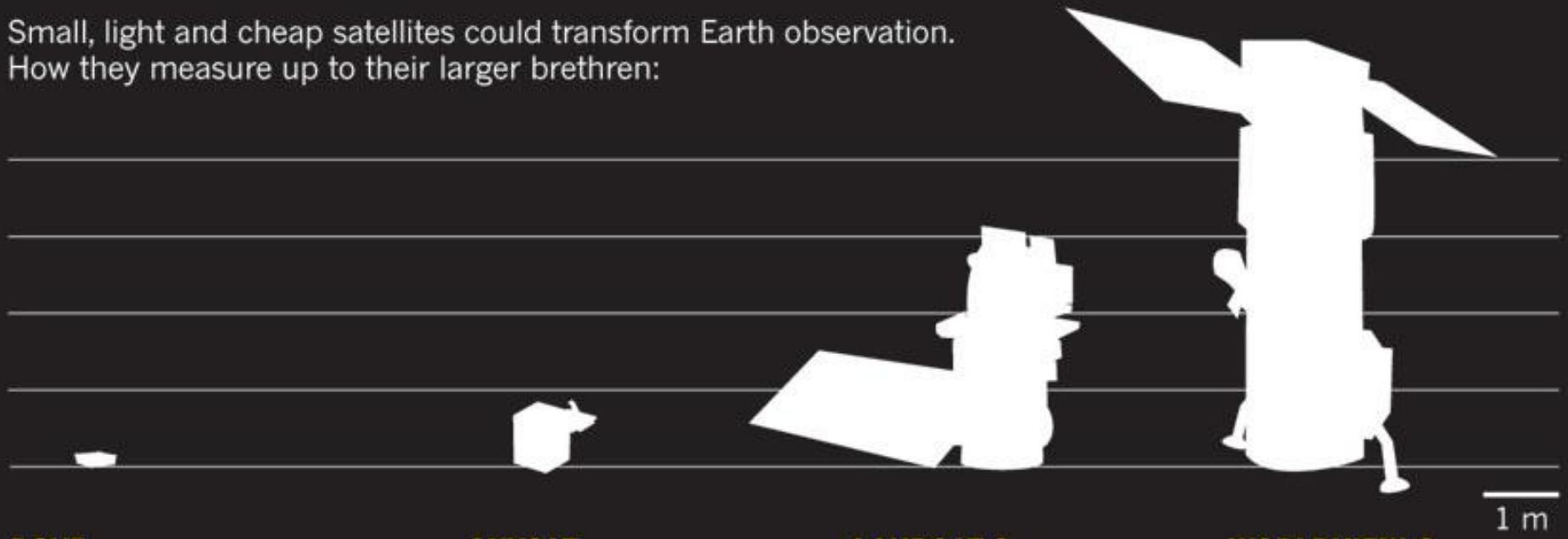
THE SWARM COMETH

Small, light and cheap satellites could transform Earth observation.
How they measure up to their larger brethren:



DOVE	SKYSAT	LANDSAT 8	WORLDVIEW-3
Operator: Planet Labs	Skybox Imaging	NASA	DigitalGlobe
Number of satellites*: 32	24	N/A	N/A
Weight: ~5 kg	~100 kg	2,071 kg†	2,800 kg
Instruments: Optical and near-infrared spectral bands	Optical and near-infrared spectral bands	Multiple spectral bands	Multiple spectral bands
Spatial resolution: 3–5 m	~1 m	15–100 m‡	0.3–30 m‡

*When fully operational † Without instruments ‡ Depending on spectral frequency

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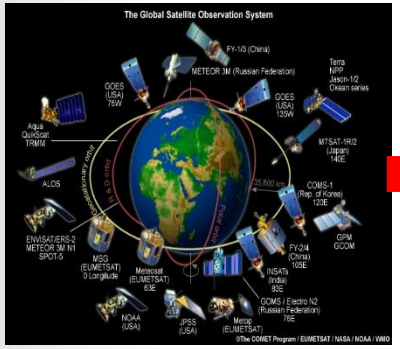
Low Cost Sensor Technology

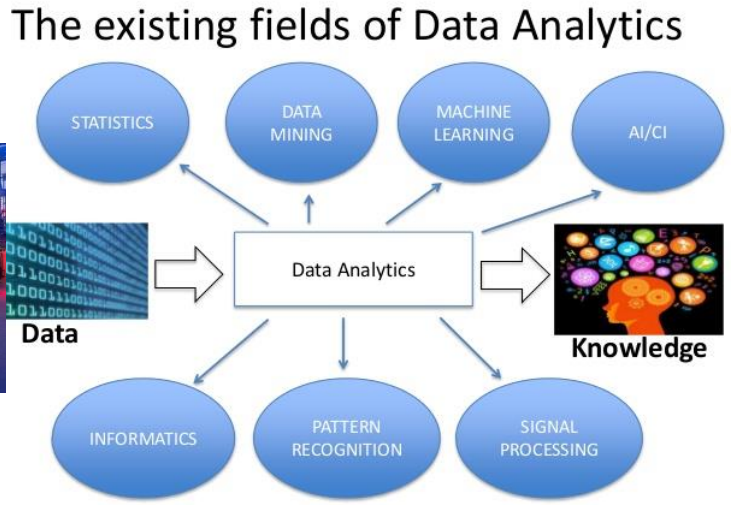
AirCasting App

AirCasting Air Monitor

Citizen Science

Drone Technology





Remote Sensing

Data Analytics

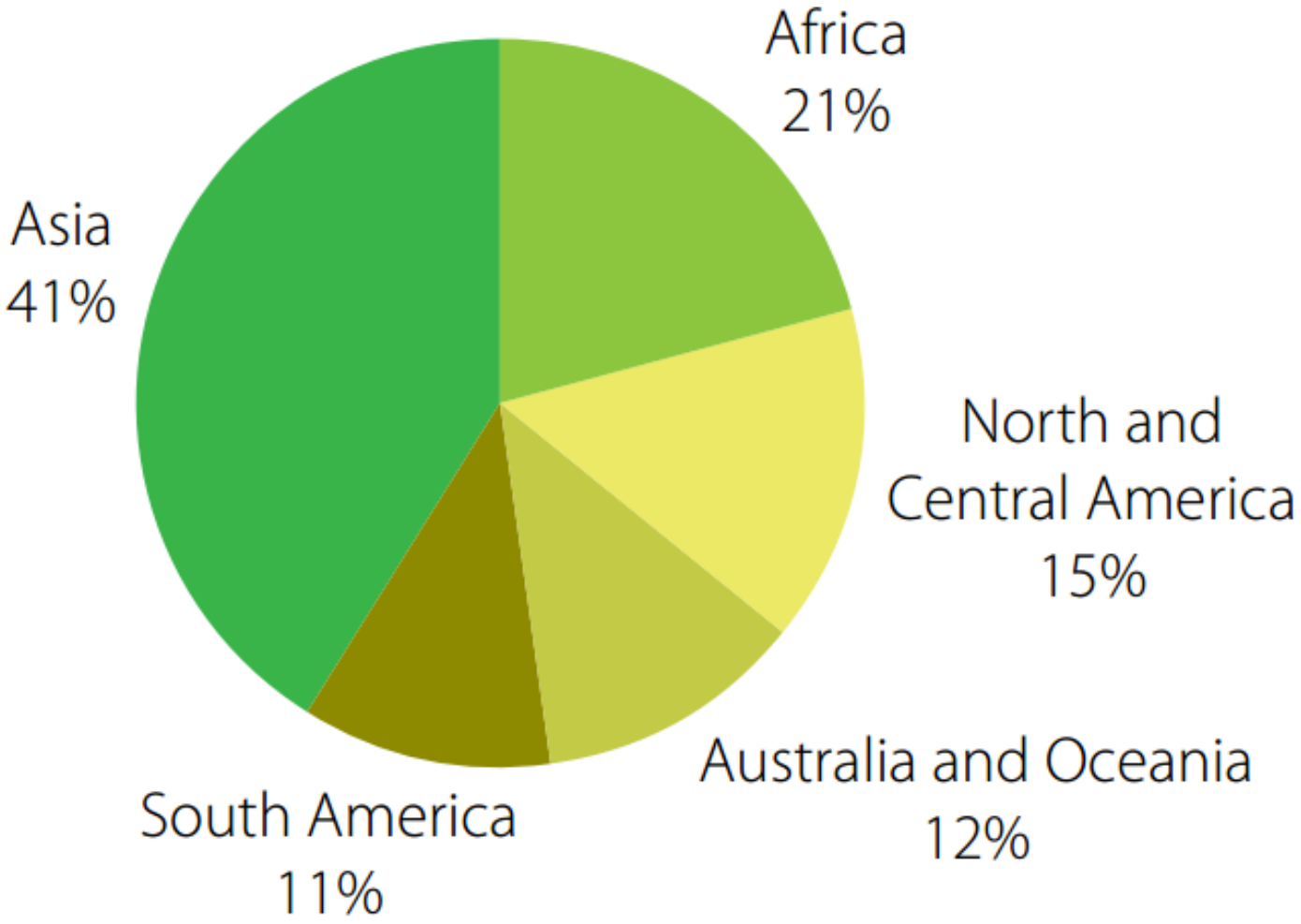
Sensors

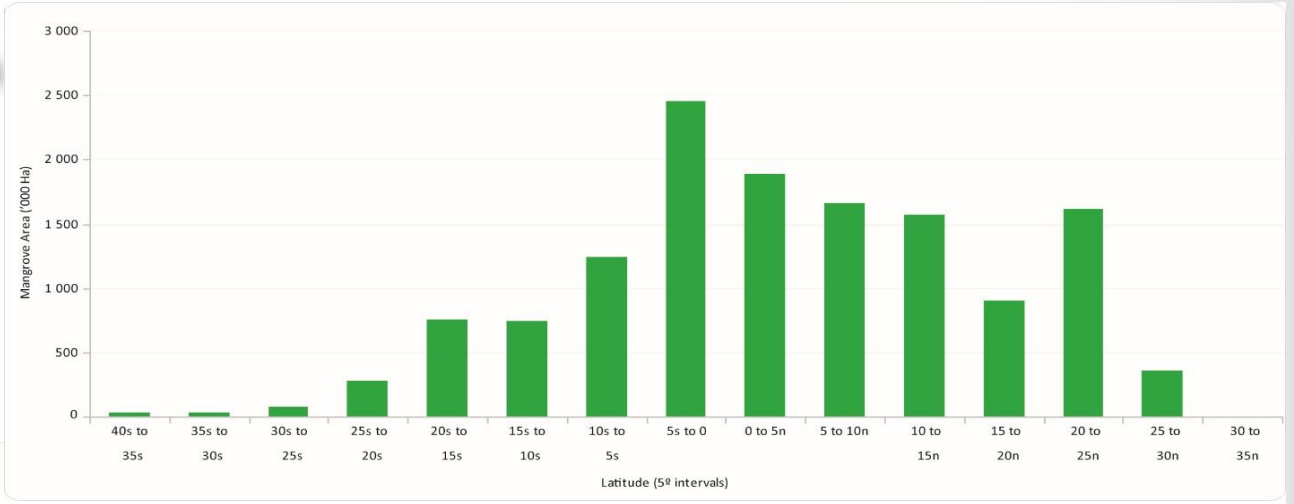
Citizen Science

Cloud

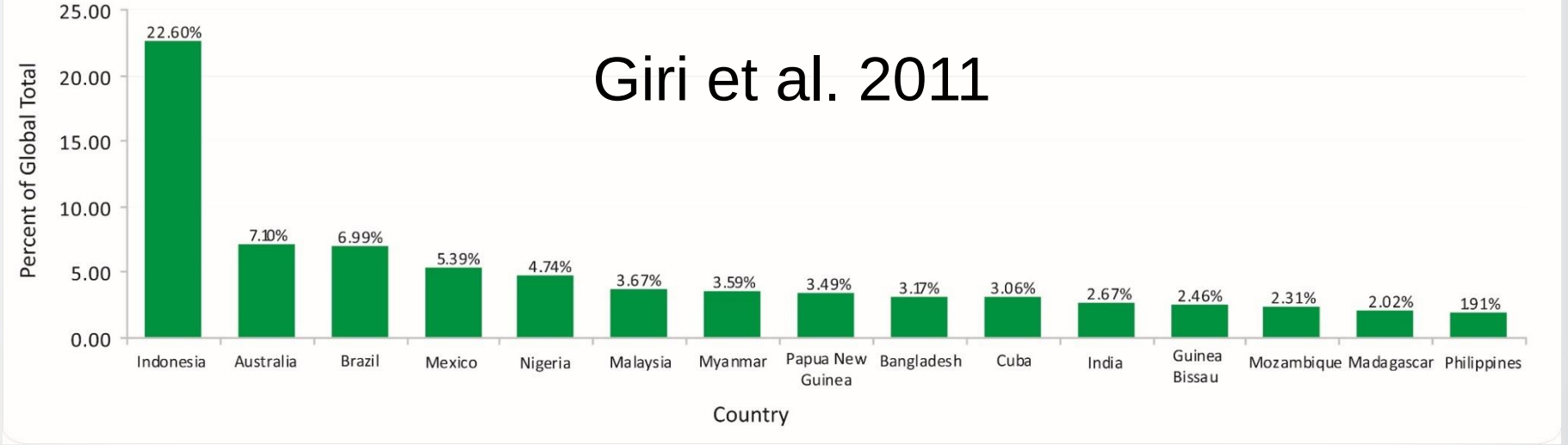
- Google Earth Engine (GEE)
- Amazon Web Services (AWS)

most comprehensive, globally consistent and highest resolution (30 m) global mangrove database ever created (Giri et al. 2011)


Africa
21%
Asia
41%
North and
Central America
15%
Australia and Oceania
12%
South America
11%

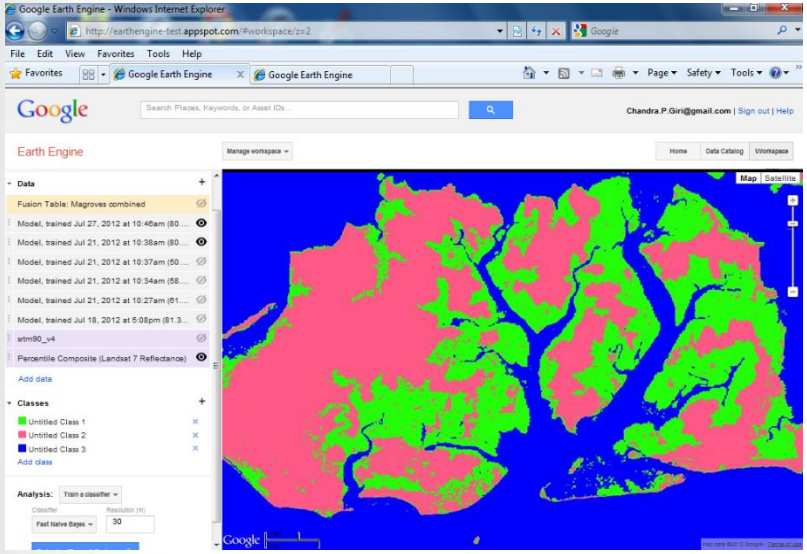


Giri et al. 2011



Free Data Availability

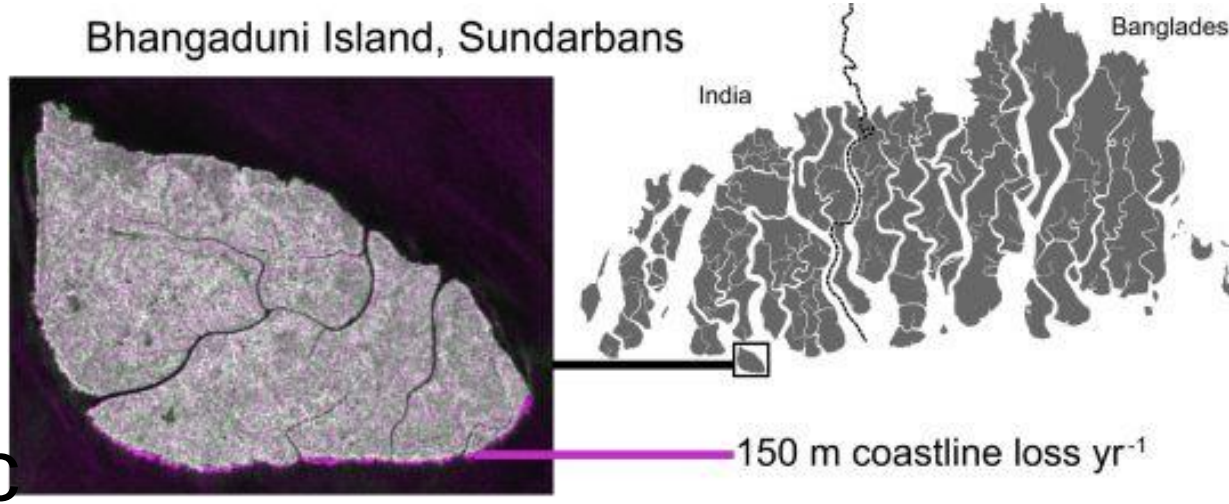
Google Earth Engine

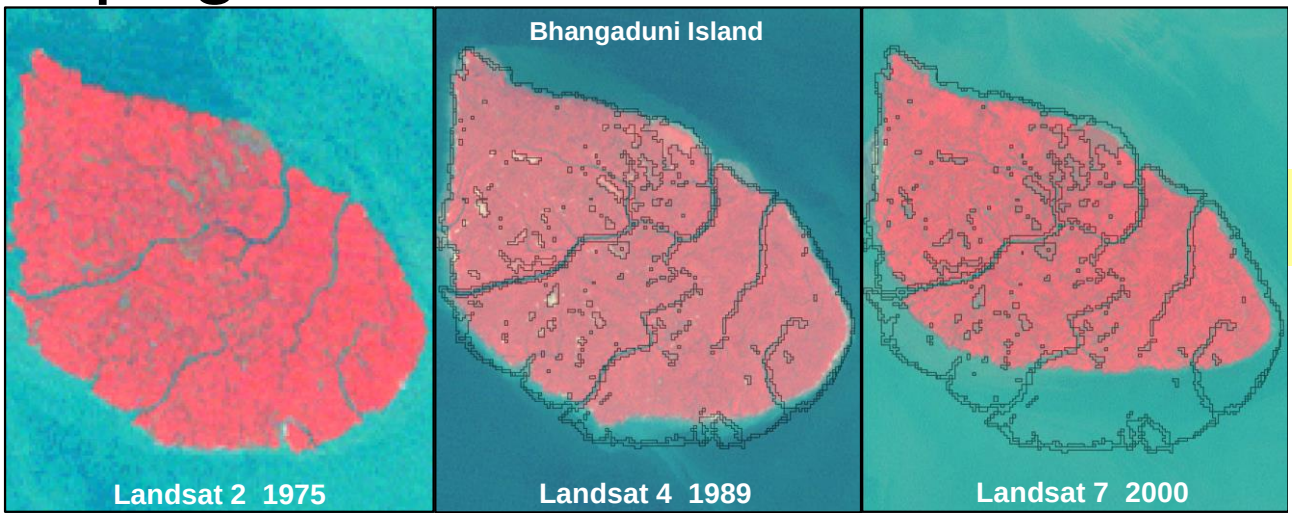


1. http://gridnairobi.unep.org/chm/africa_programme/
2. ftp://na.unep.net/UNEP/mangroves
3. Global Forest Watch
4. UNEP WCMC
5. CIESIN/Columbia University

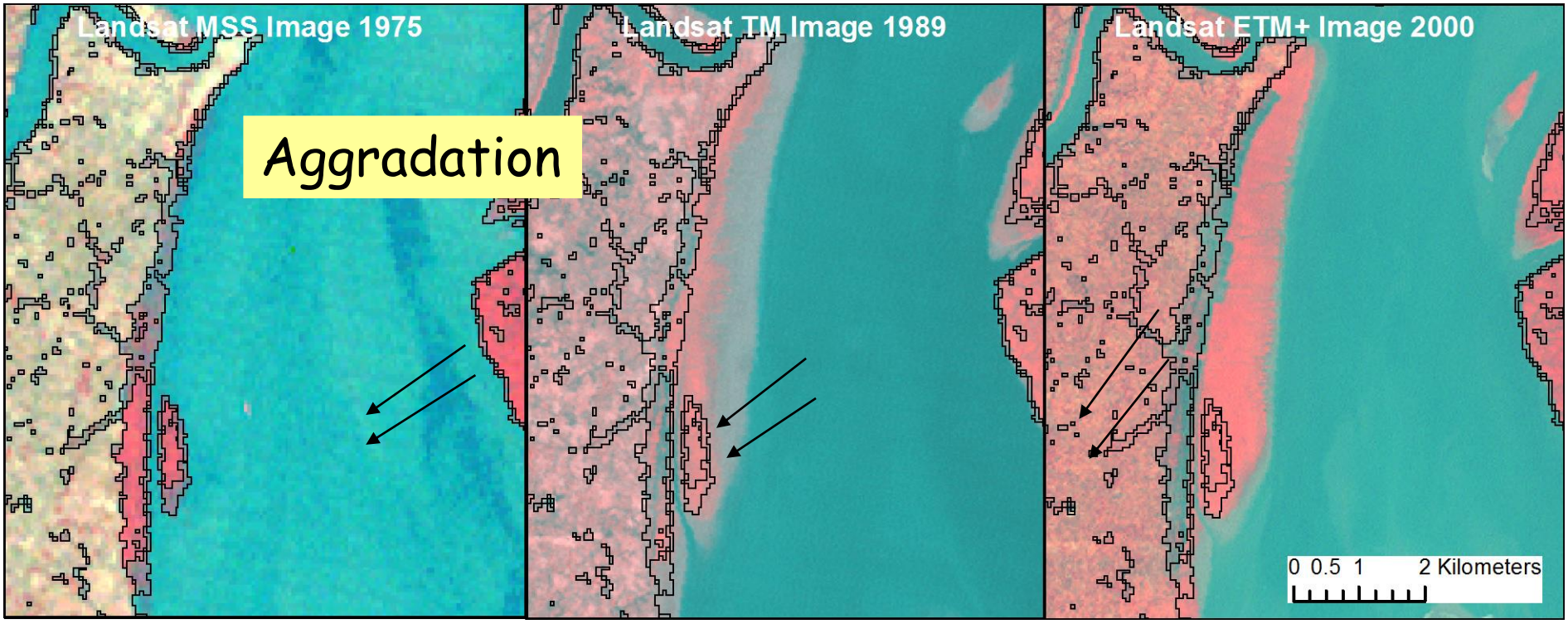
Mangrove Change

- Natural
- Anthropogenic

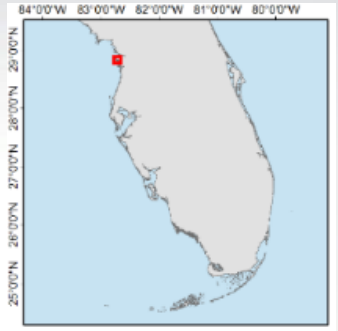




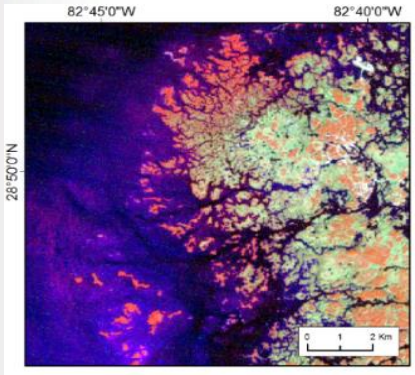
Erosion


Landsat MSS Image 1975
Landsat TM Image 1989
Landsat ETM+ Image 2000
Aggradation
0 0.5 1 2 Kilometers

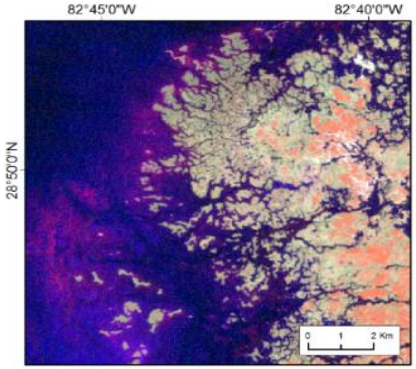
Winter Freeze: damage & recovery



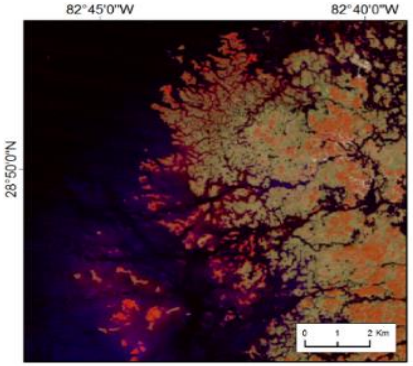
1982



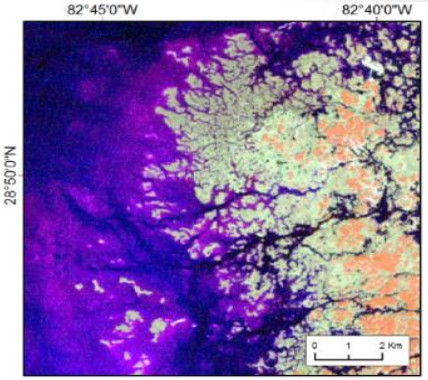
1984

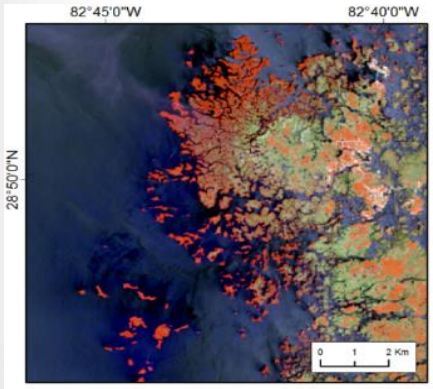


1988

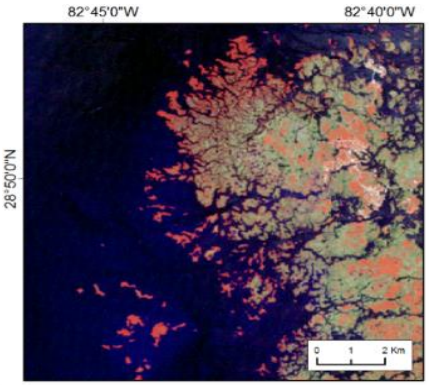


1990

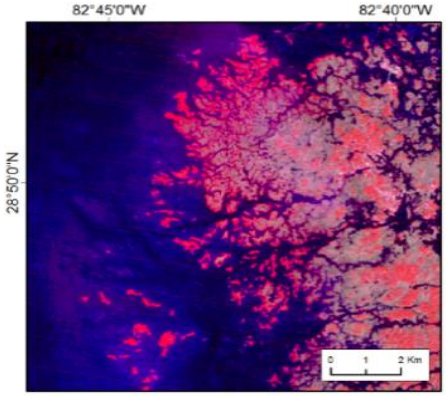




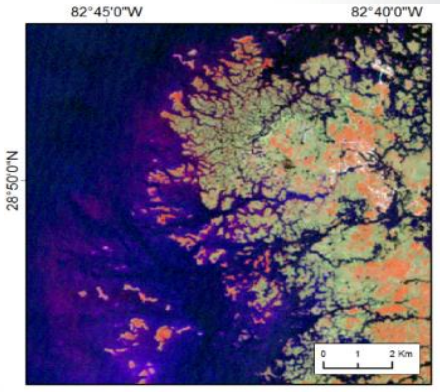
2014



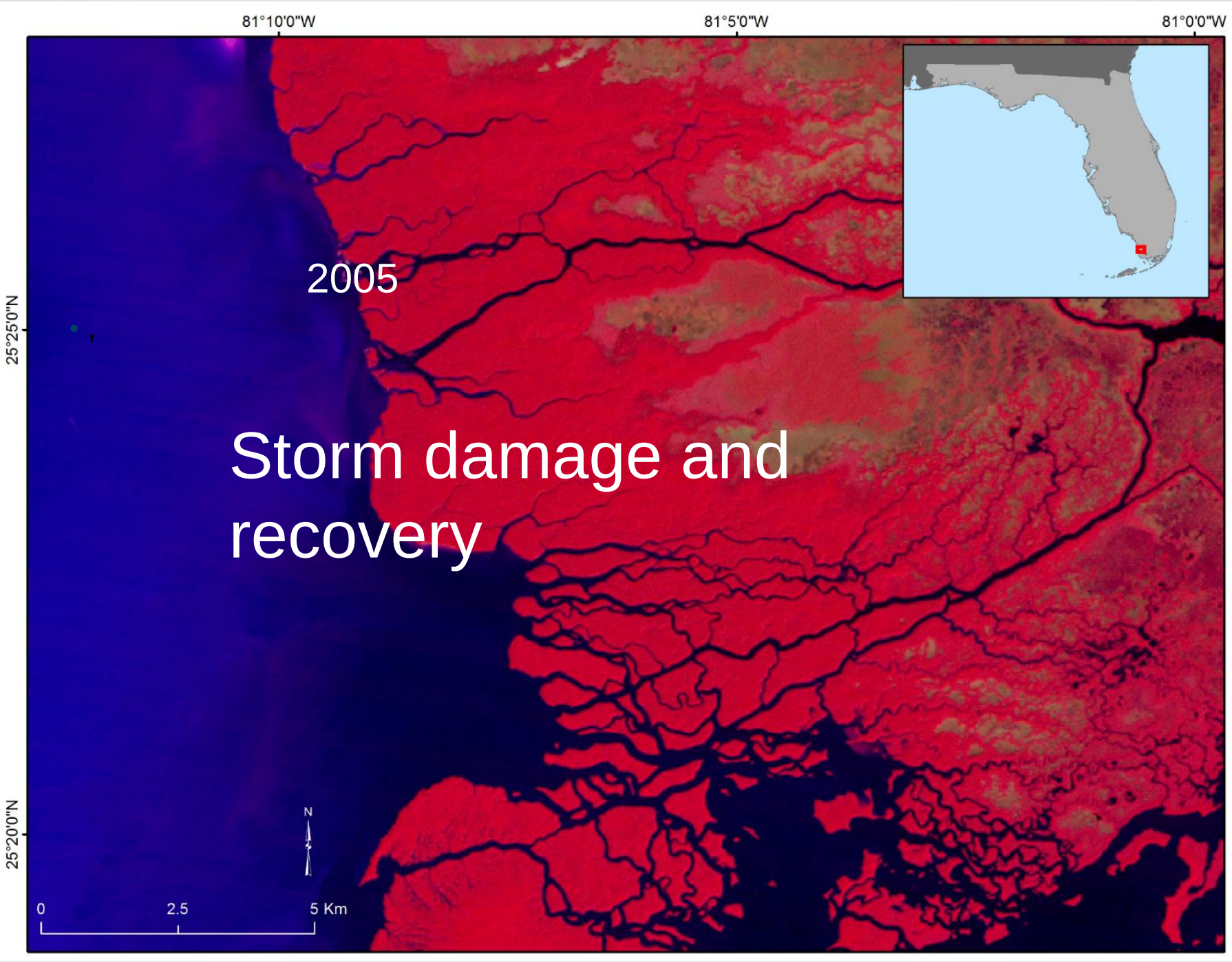
2010

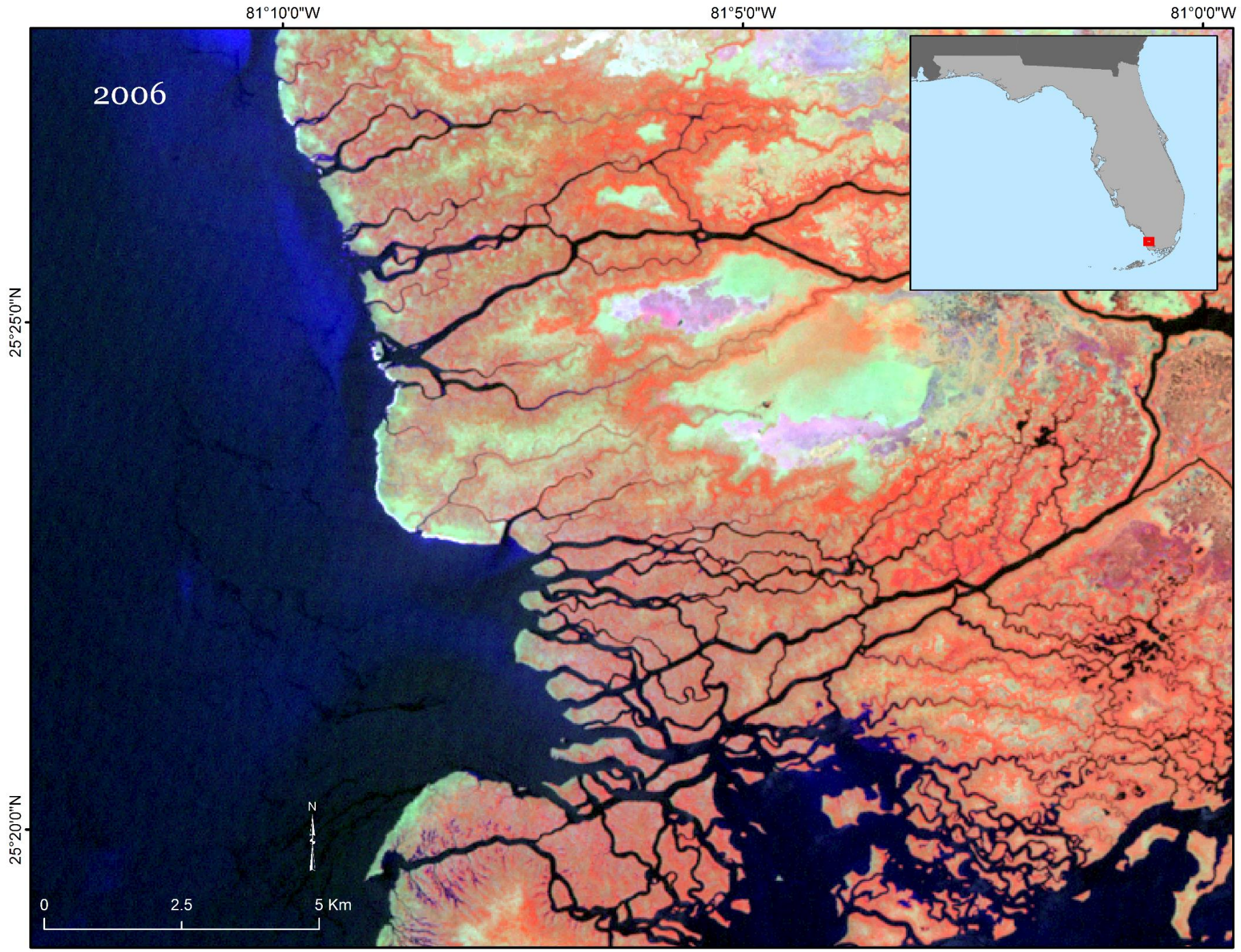


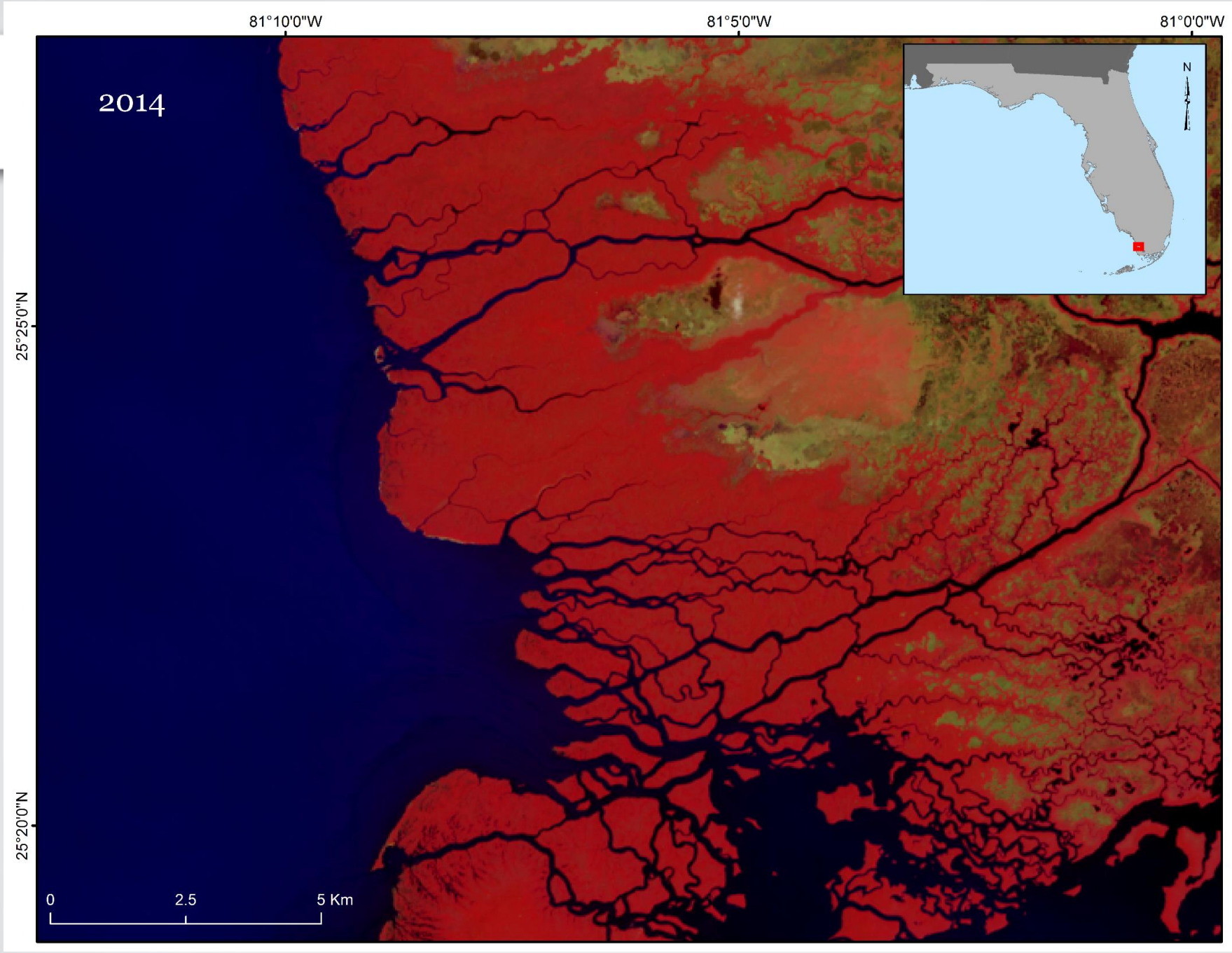
2008



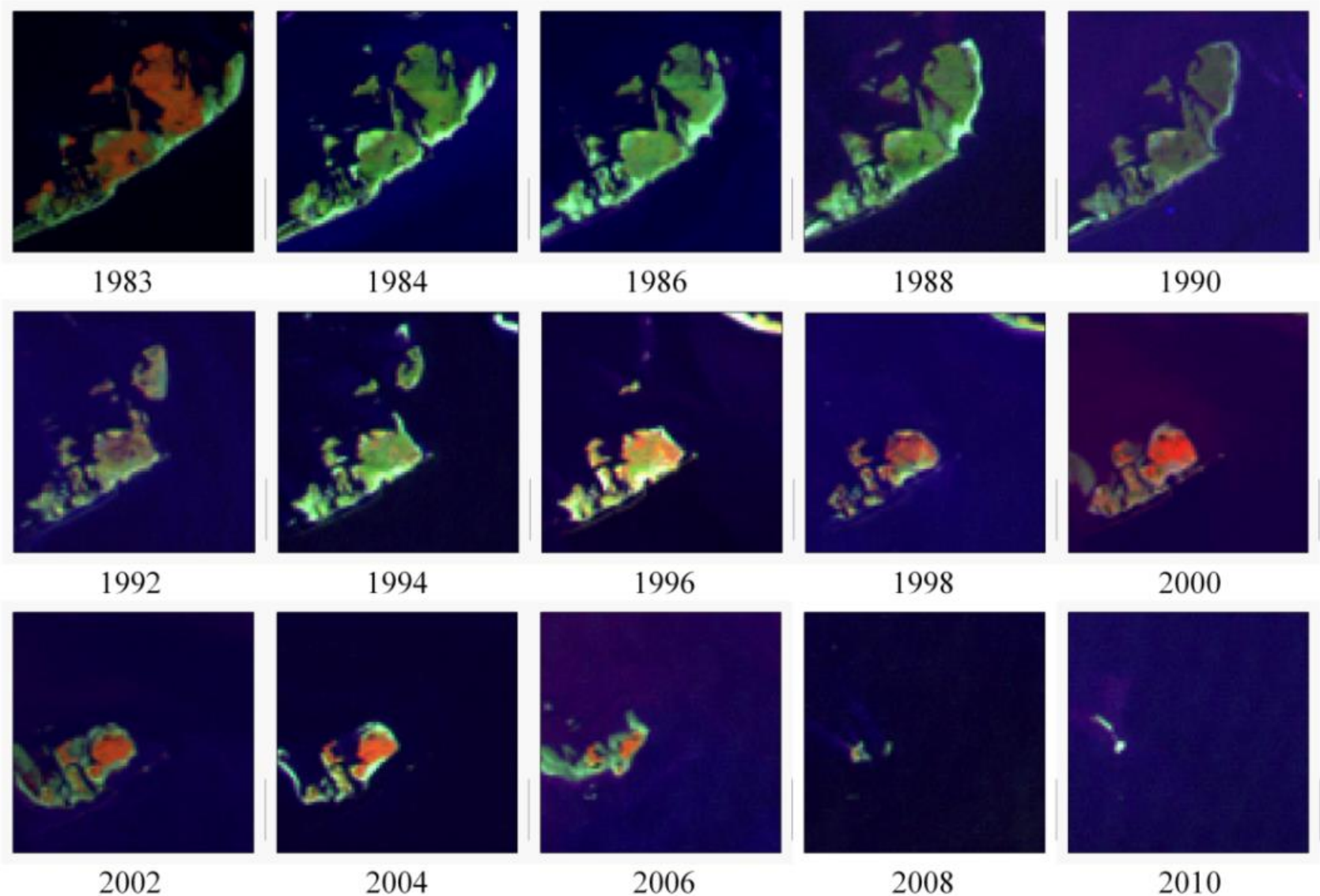
1995


81°10'0"W
81°5'0"W
81°0'0"W
25°25'0"N
25°20'0"N
2005
Storm damage and recovery
N
0
2.5
5 Km

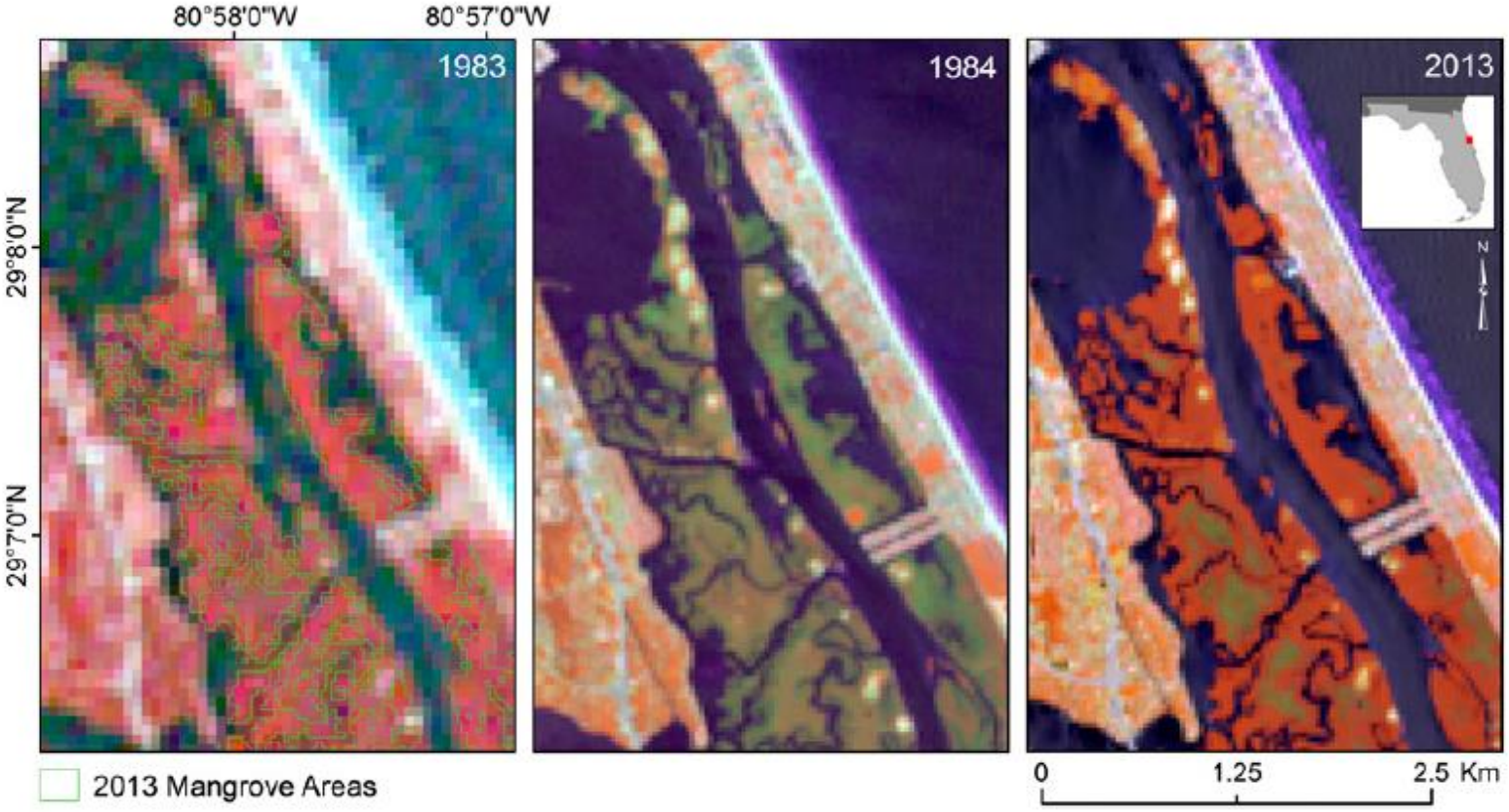

81°10'0"W
81°5'0"W
81°0'0"W
2006
25°25'0"N
25°20'0"N
N
0
2.5
5 Km


81°10'0"W
81°5'0"W
81°0'0"W
25°25'0"N
25°20'0"N
2014
N
0
2.5
5 Km

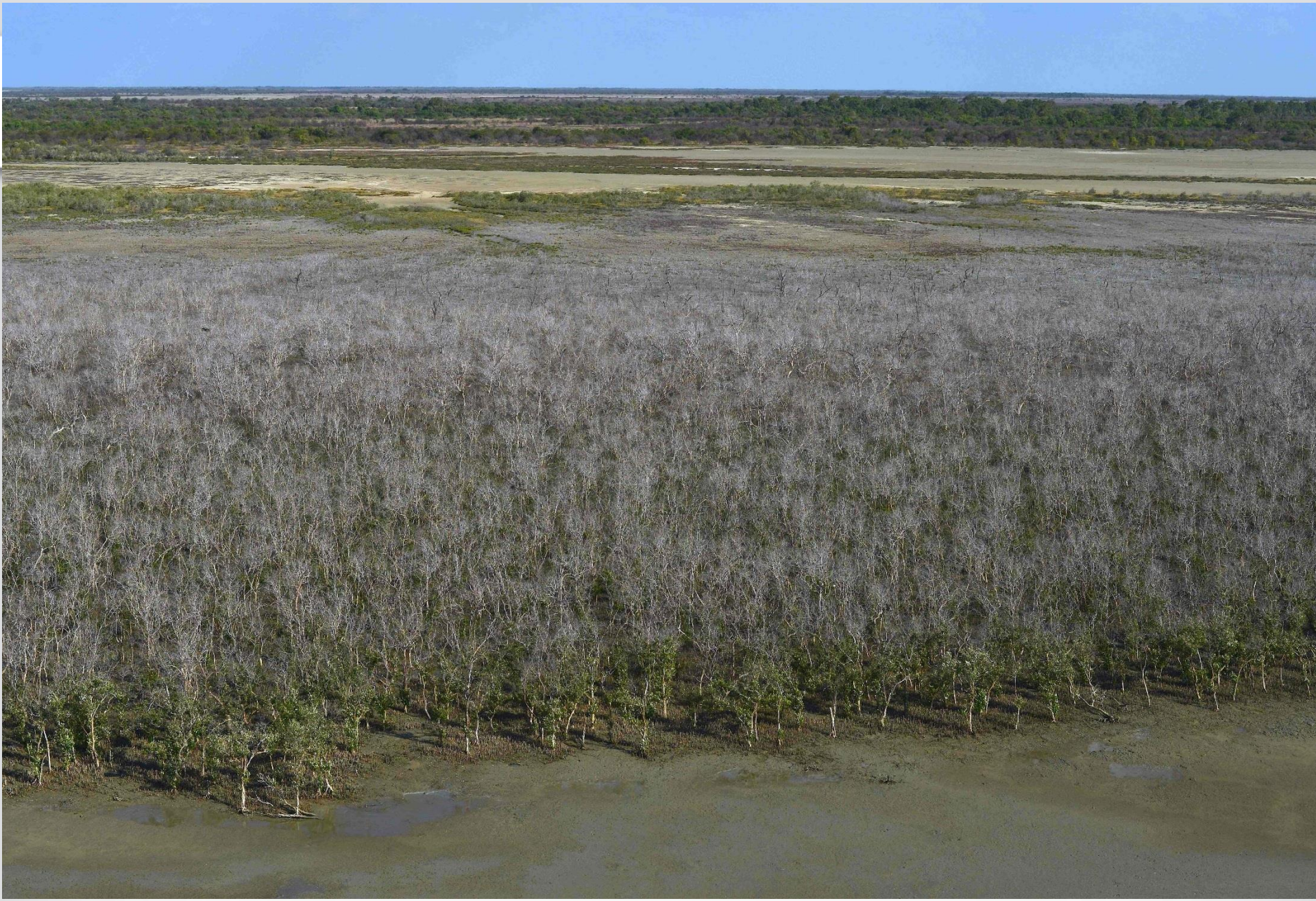
Timbalier Island, USA

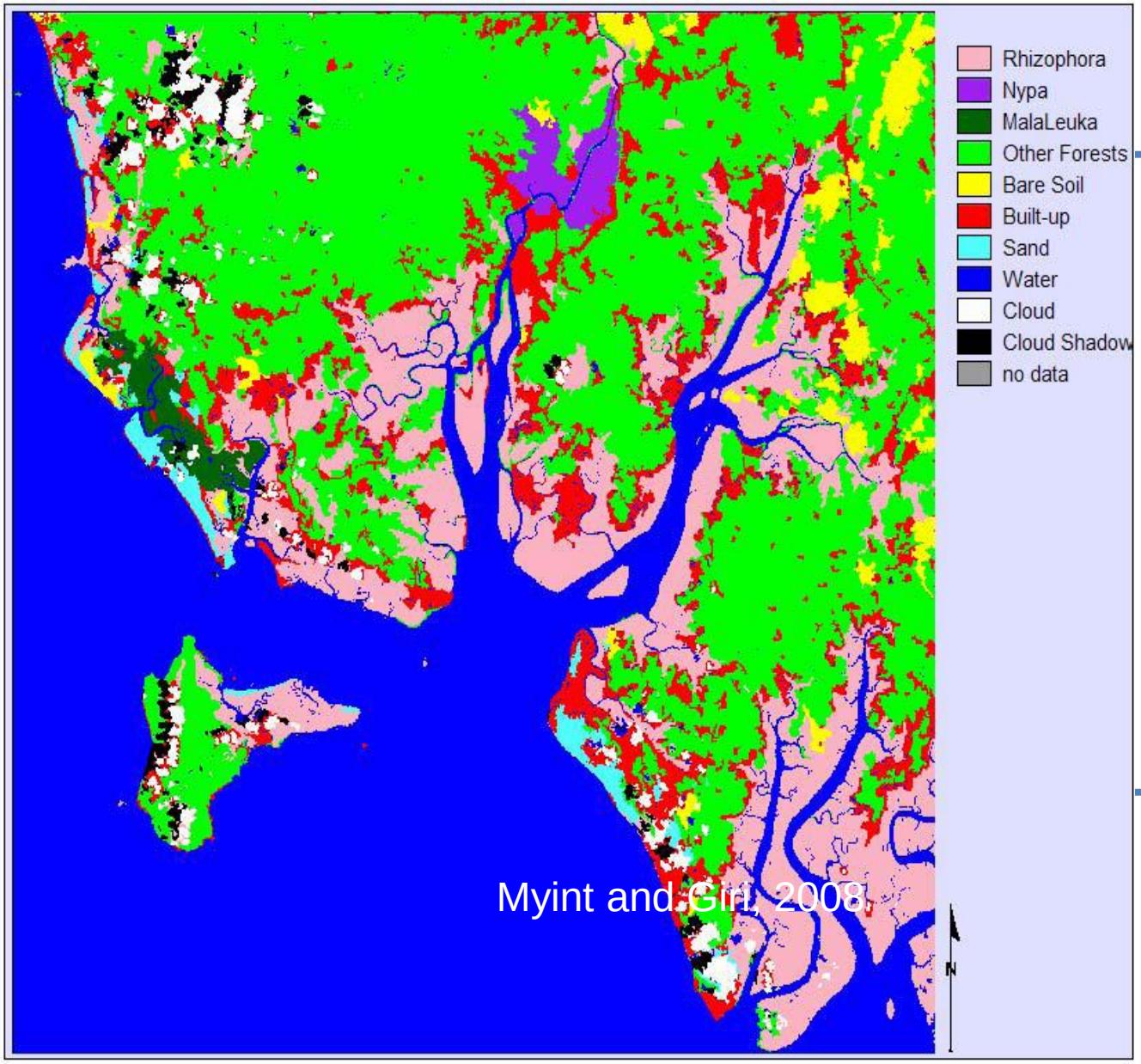


Mangrove Expanding?



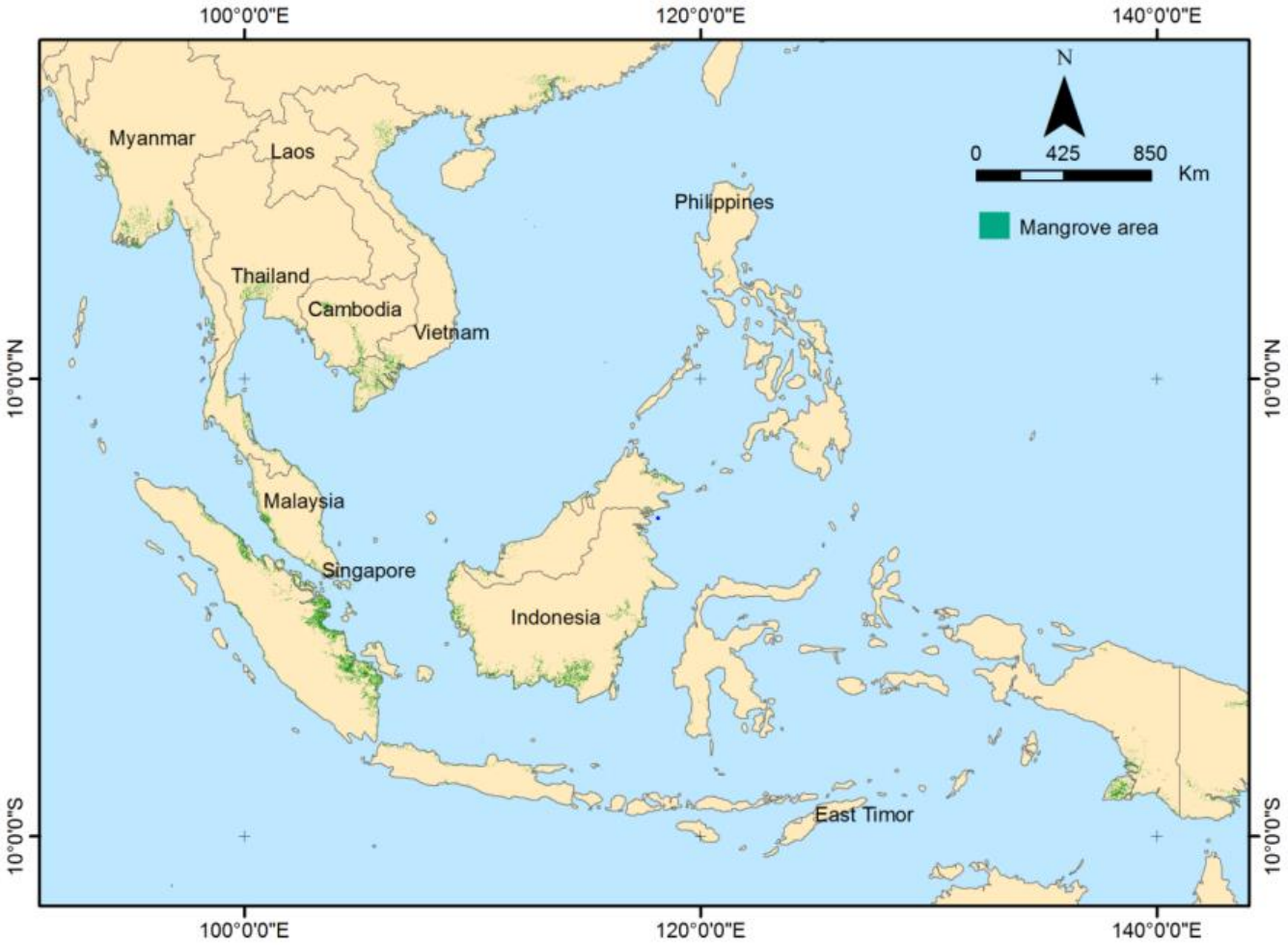
Giri and Long (2014)





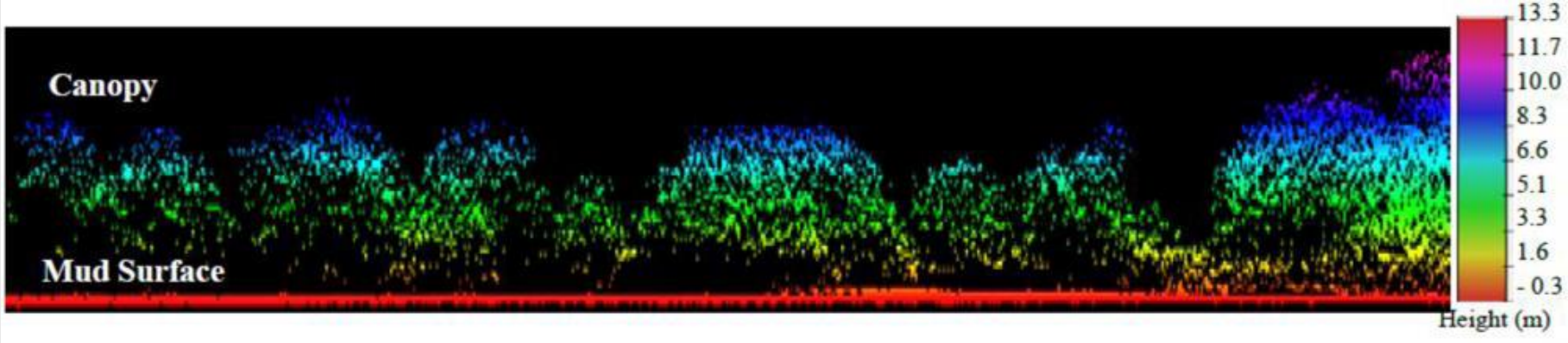
Myint and Giri, 2008

- object-oriented approach with lacunarity-transformed bands is more accurate (overallaccuracy 94.2%; kappa coefficient = 0.91) than traditional per-pixel classifiers (overall accuracy 62.8%; and kappa coefficient = 0.57).



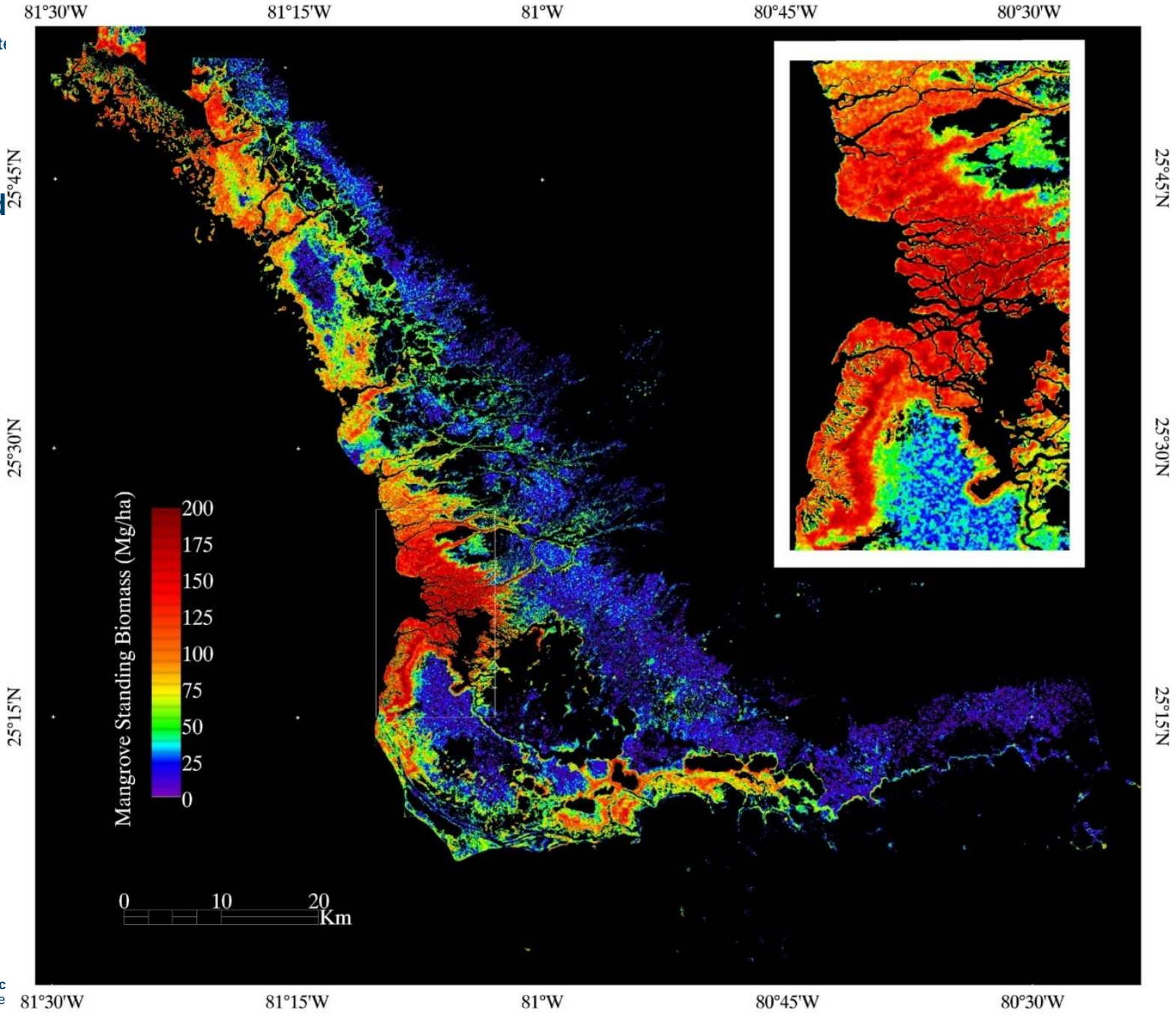
Darmawan, S., et al. "Characterization and spatial distribution of mangrove forest types based on ALOS-PALSAR mosaic 25m-resolution in Southeast Asia." *IOP Conference Series: Earth and Environmental Science*. Vol. 37. No. 1. IOP Publishing, 2016.

- Lidar data



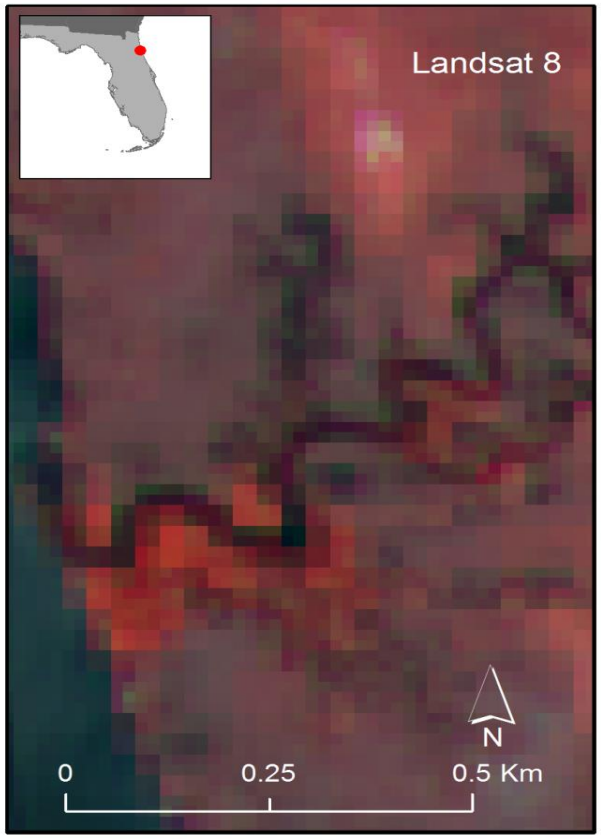
United States Environmental Protection Agency

SRTM d



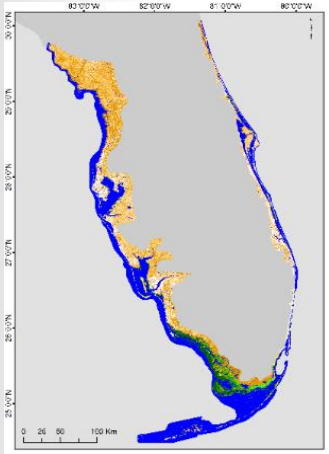
Small patches?

- 

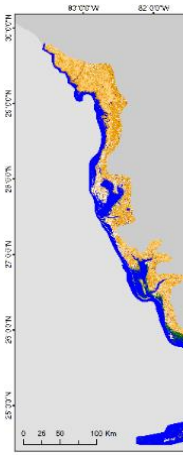


Mangrove Change, Florida, USA

1980

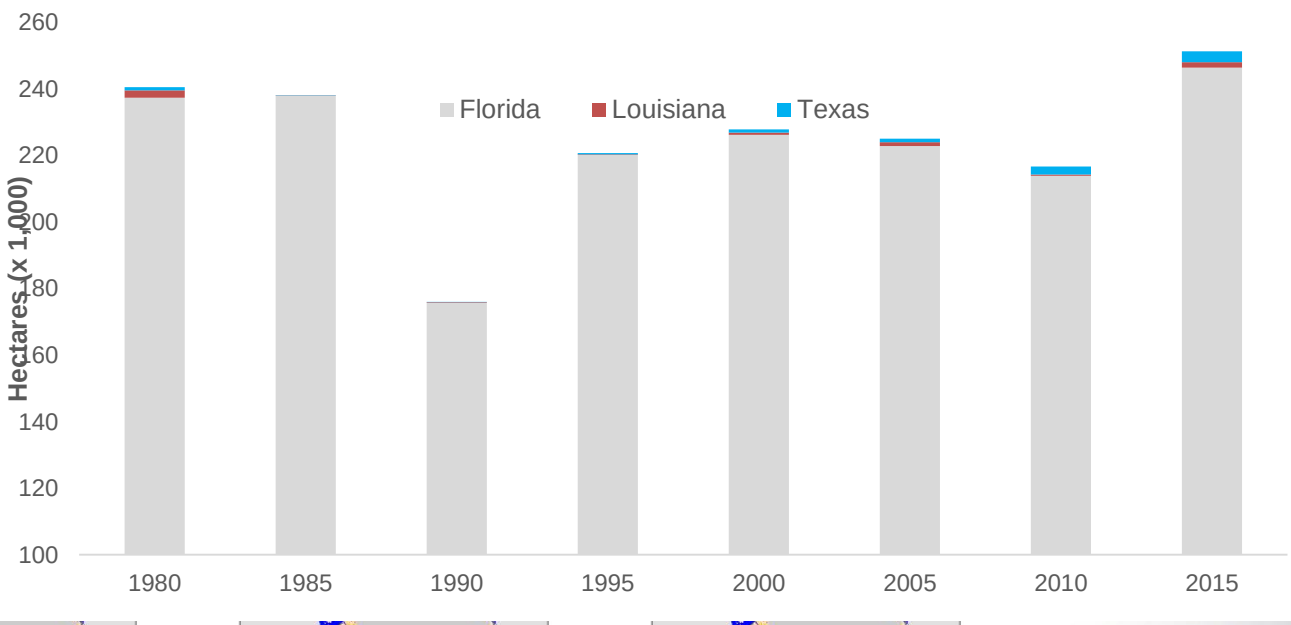


1985

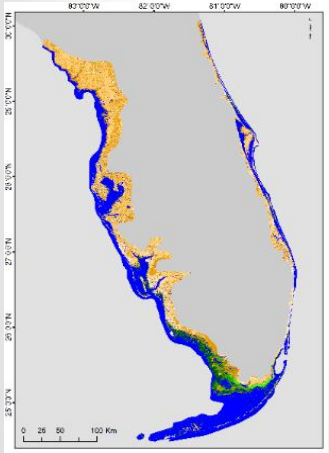


1990

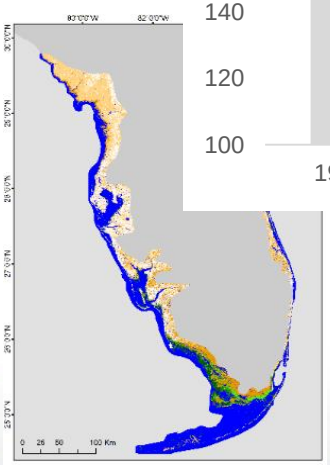
1995

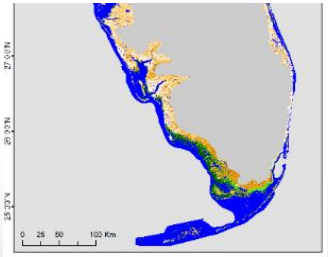


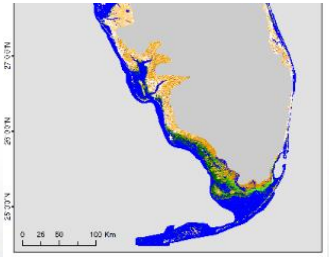
2015

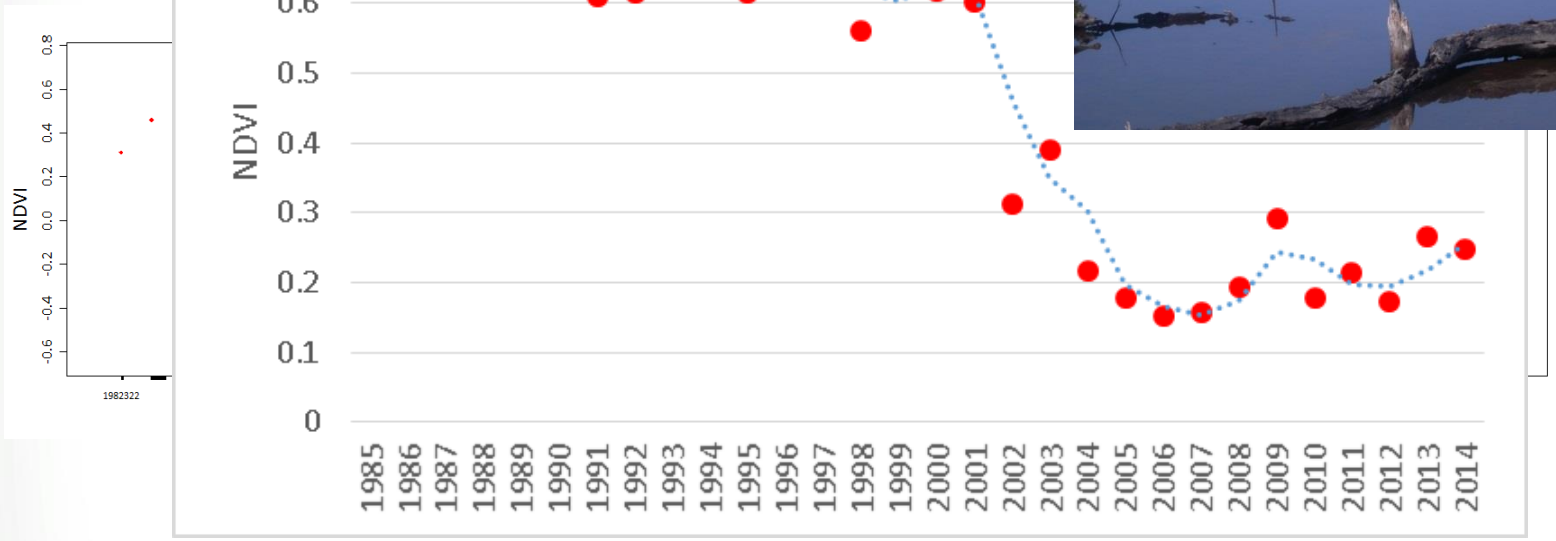


2010








-80.5038, 25.0362
NDVI
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1985
1986
1987
1988
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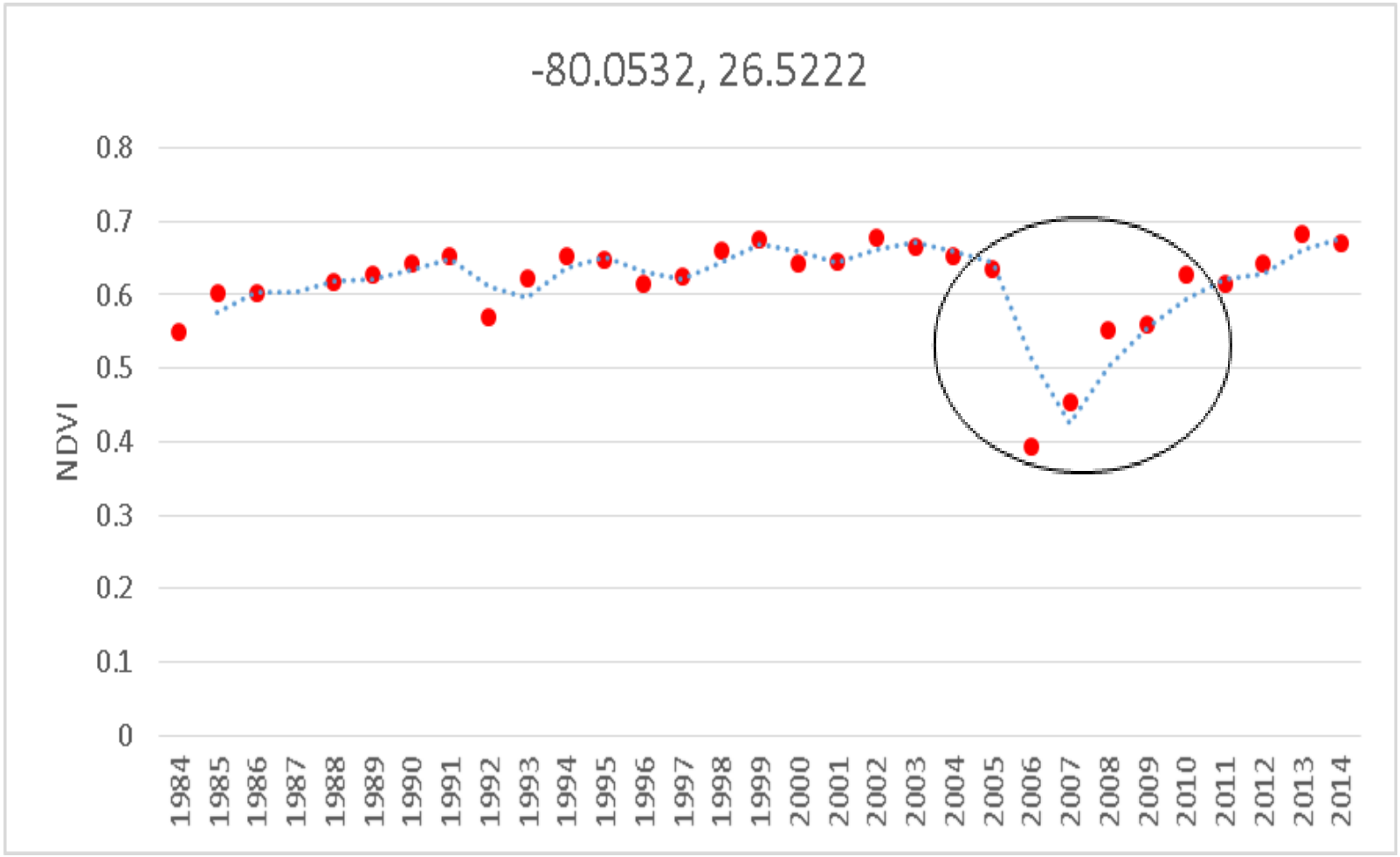
2010
2011
2012
2013
2014
NDVI
1982322


-80.0532, 26.5222
NDVI
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1984
1985
1986
1987
1988
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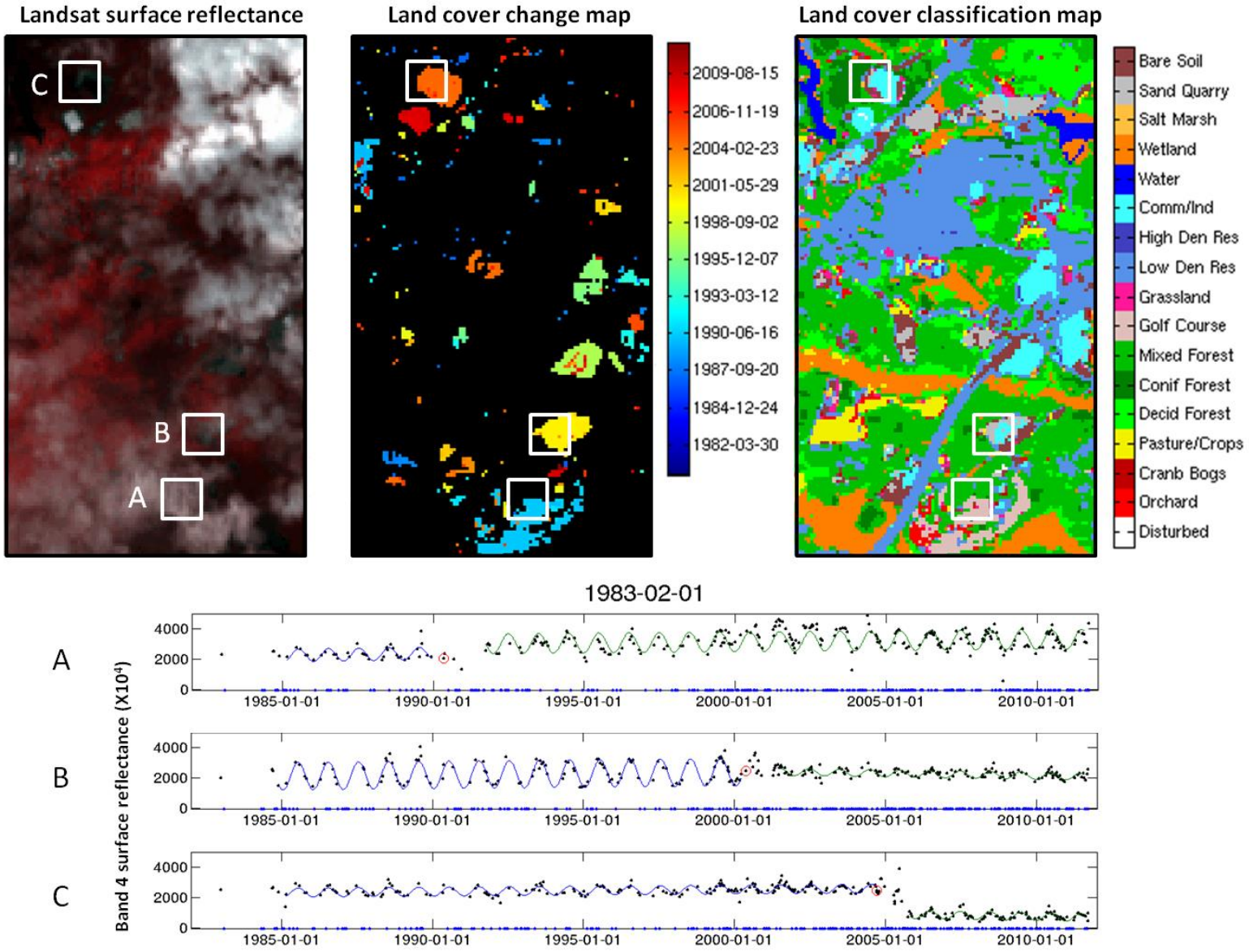
2010
2011
2012
2013
2014


Landsat surface reflectance
Land cover change map
Land cover classification map
C
B
A
2009-08-15
2006-11-19
2004-02-23
2001-05-29
1998-09-02
1995-12-07
1993-03-12
1990-06-16
1987-09-20
1984-12-24
1982-03-30
Bare Soil
Sand Quarry
Salt Marsh
Wetland
Water
Comm/Ind
High Den Res
Low Den Res
Grassland
Golf Course
Mixed Forest
Conif Forest
Decid Forest
Pasture/Crops
Cranb Bogs
Orchard
Disturbed
1983-02-01
A
B
C
Band 4 surface reflectance (X10⁴)
4000
2000
0
1985-01-01
1990-01-01
1995-01-01
2000-01-01
2005-01-01
2010-01-01

International Initiatives

GEO GROUP ON EARTH OBSERVATIONS

BLUE CARBON SCIENTIFIC WORKING GROUP
1st MEETING 13-17th FEBRUARY 2011 PARIS FRANCE

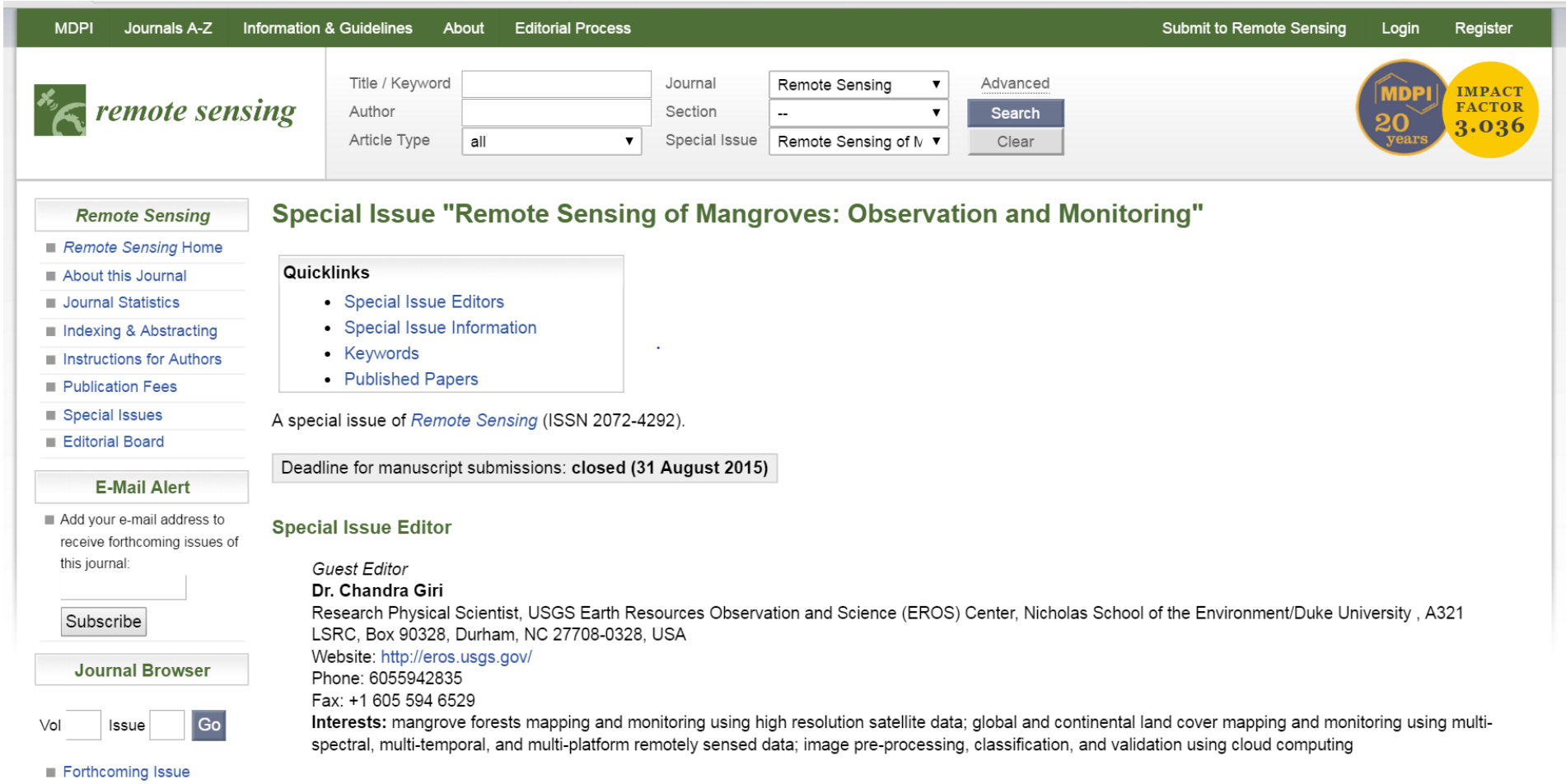
eye on earth
CONVENE | CONVERGE | COLLABORATE

CEC · CCA · CCE

US Federal Government Blue Carbon Working Group

North American Blue Carbon Scientific Working Group

Special Issue: Remote Sensing of Mangrove Forests



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Deadline for manuscript submissions: **closed (31 August 2015)**

Special Issue Editor

Guest Editor
Dr. Chandra Giri
Research Physical Scientist, USGS Earth Resources Observation and Science (EROS) Center, Nicholas School of the Environment/Duke University , A321 LSRC, Box 90328, Durham, NC 27708-0328, USA
Website: http://eros.usgs.gov/
Phone: 6055942835
Fax: +1 605 594 6529
Interests: mangrove forests mapping and monitoring using high resolution satellite data; global and continental land cover mapping and monitoring using multi-spectral, multi-temporal, and multi-platform remotely sensed data; image pre-processing, classification, and validation using cloud computing


Thank you
Voh, New Caledonia
Yann Arthus-Bertrand's book on Earth from Above