

# Using Remote Sensing to Track Inundation and Land Change in the Atchafalaya Basin and Coastal Louisiana

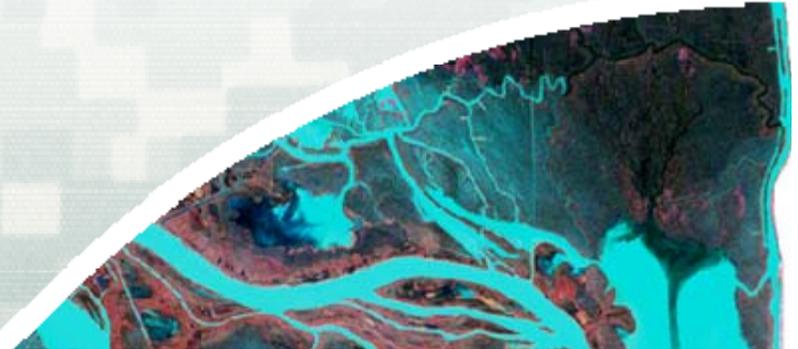
**Yvonne Allen**

Research Ecologist

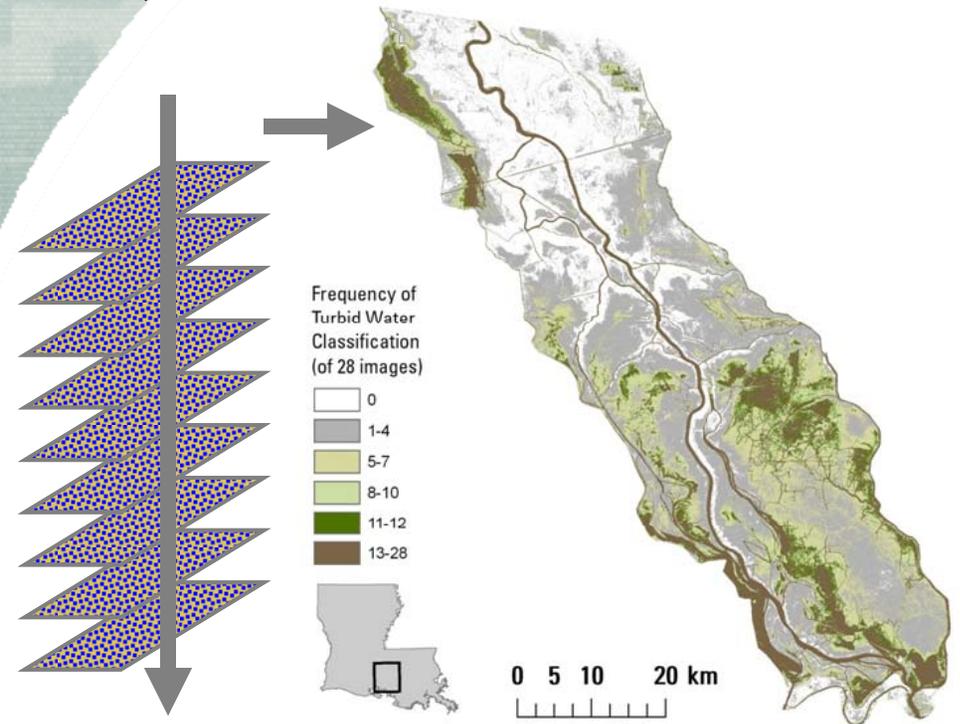
ERDC-EL Environmental Systems Branch

Wetlands Environmental Technologies Research Facility

Baton Rouge, LA



US Army Corps of Engineers  
**BUILDING STRONG**

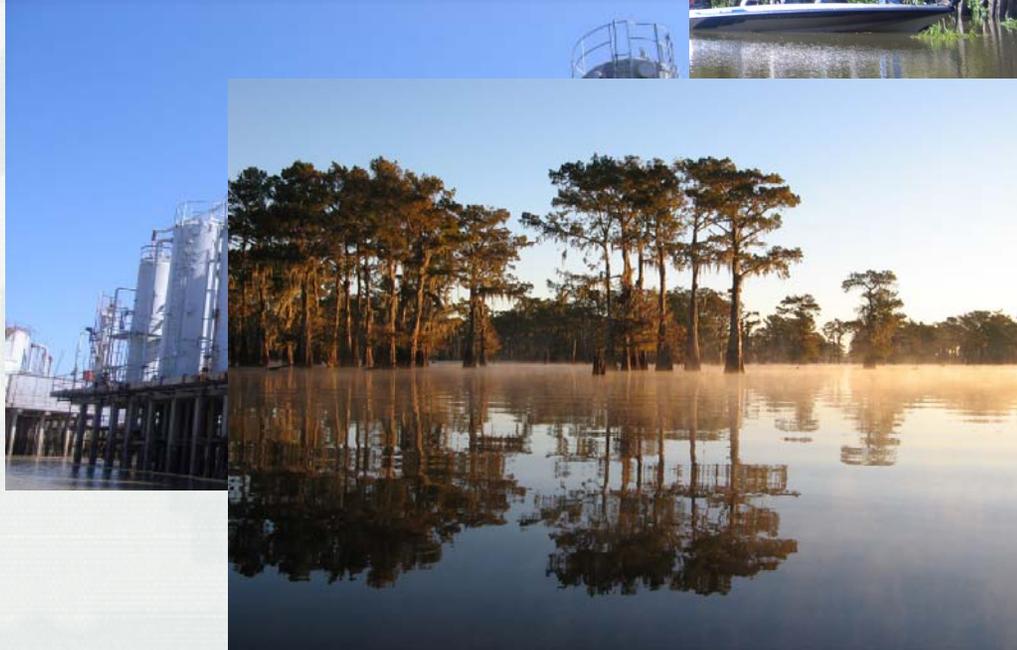


# Outline

- Introduction to the Atchafalaya Basin Floodway System (ABFS)
- Management and “Restoration” in the Basin?
- Natural Resources Inventory and Assessment System (NRIAS)
- Using Inundation Mapping for Other Applications in the Basin
- Measuring Land Change in Coastal Louisiana



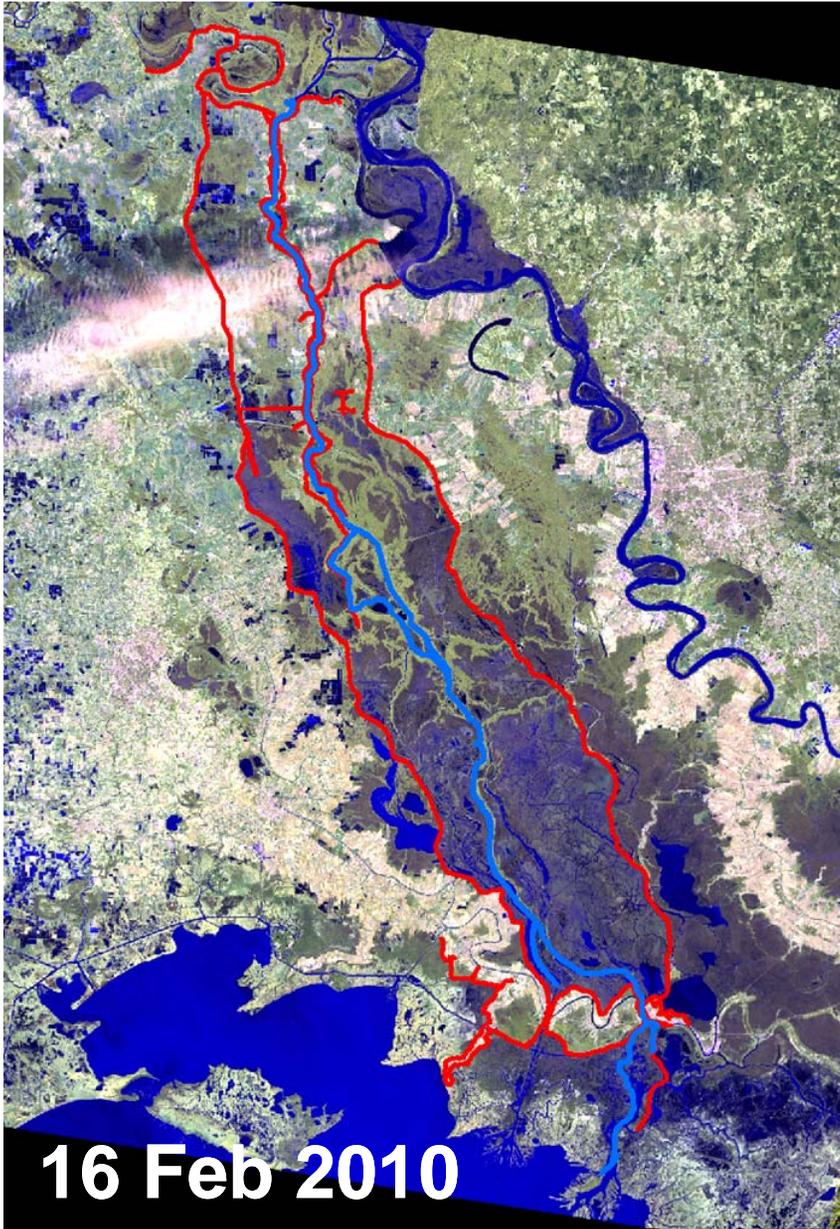
# Atchafalaya Basin Floodway System (ABFS)



- Flood Control
- Navigation
- Commercial Fishing
  - Finfish and Shellfish
- Recreation
  - Fishing, Hunting, General
- Oil and Gas
- Timber
- Invaluable Habitat
- Regional Impact
  - Nutrients, sediments, contaminants, carbon sequestration, nitrogen fixation

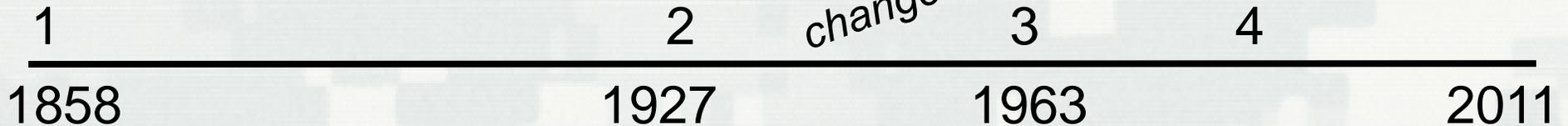
# Putting restoration into perspective...

- 1) Atchafalaya River – a major distributary of the Mississippi River
- 2) Leveed to the coast
- 3) Flow regulated to 30% of MR flood waters
- 4) Channel training – increasingly straight line conveyance of river water directly to the coast



16 Feb 2010

Greatest land  
change



## **LDNR Atchafalaya Basin Program**

- ABP charged with soliciting, evaluating, designing and executing water quality and access improvement projects in the Basin.

### **Natural Resources Inventory and Assessment System**

- Develop system-wide comprehensive data layers that will be the primary sources of geospatial information for making science-based management decisions in the Basin.
- Make these data layers available to scientists and managers in a useful context and format.



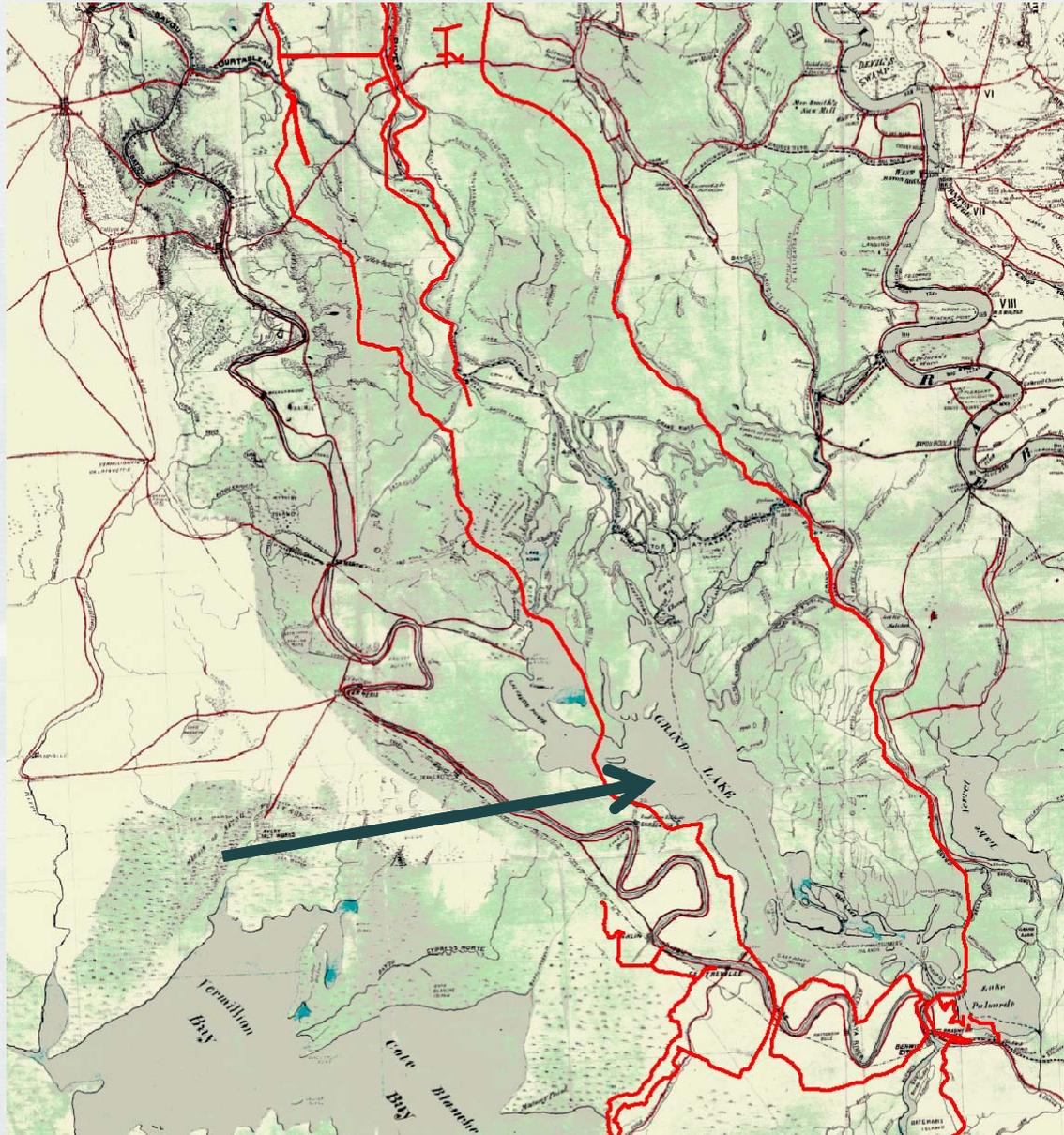
# NRIAS

## Geospatial Analysis Resource Set:

1. Historical record and progression of land change
2. Base imagery – satellite and aerial at many river levels
3. Interpreted imagery – water and water quality categories at many river levels
3. Frequency maps – water and water quality
4. Inundation prediction maps
5. Elevation and Elevation uncertainty maps
6. Historical record of gage data
7. Geotagged photos
8. *Developing: Resource Assessment Units*



# Establishing a Spatial Context for Land Change: ABFS in 1863



# Former Extent of Grand Lake

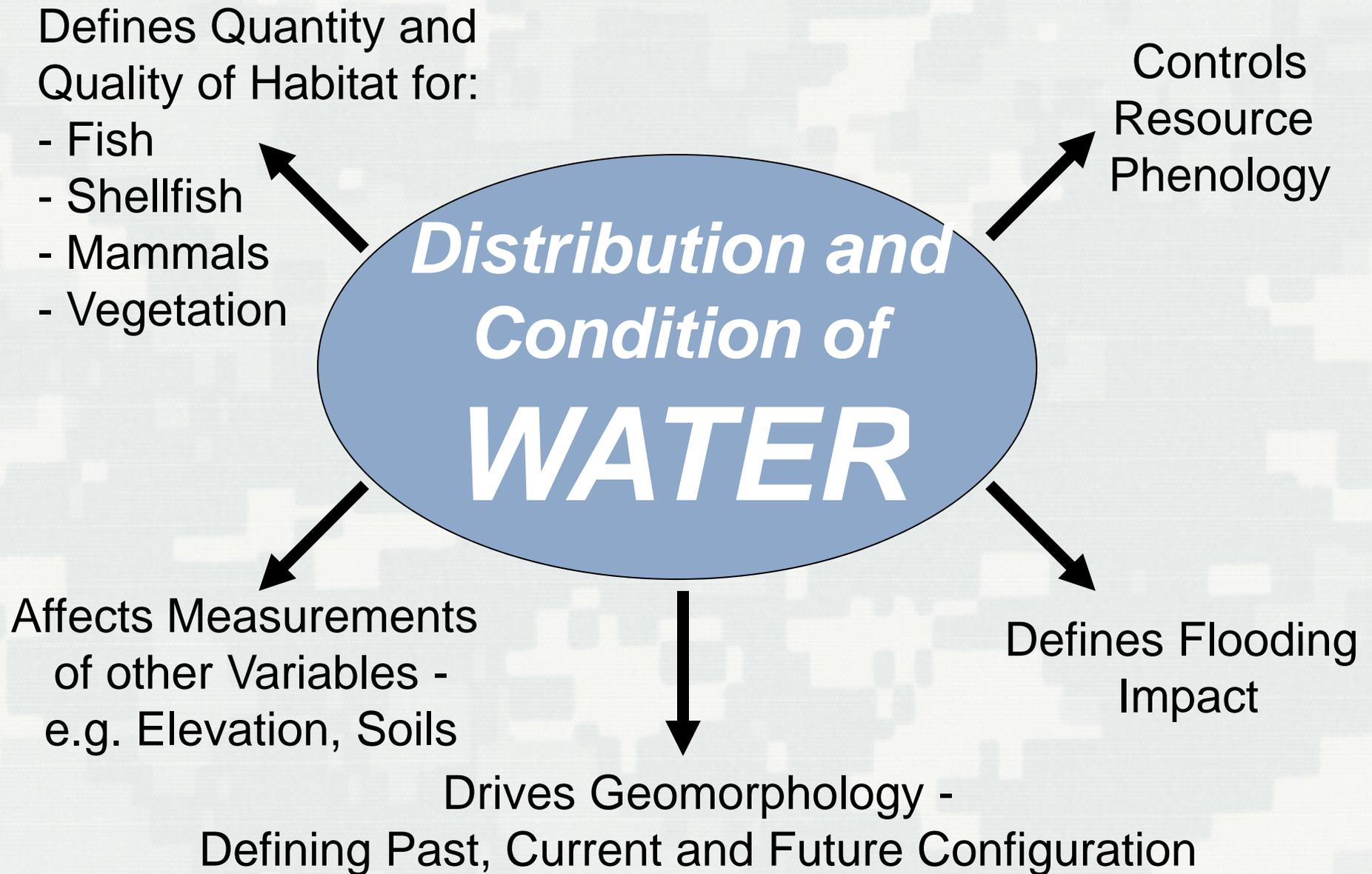




# River Water as a Land Change Driver

- River delivers fresh oxygenated water to the swamp, but also delivers sediment
- Any WQ management project must think about potential land change consequences





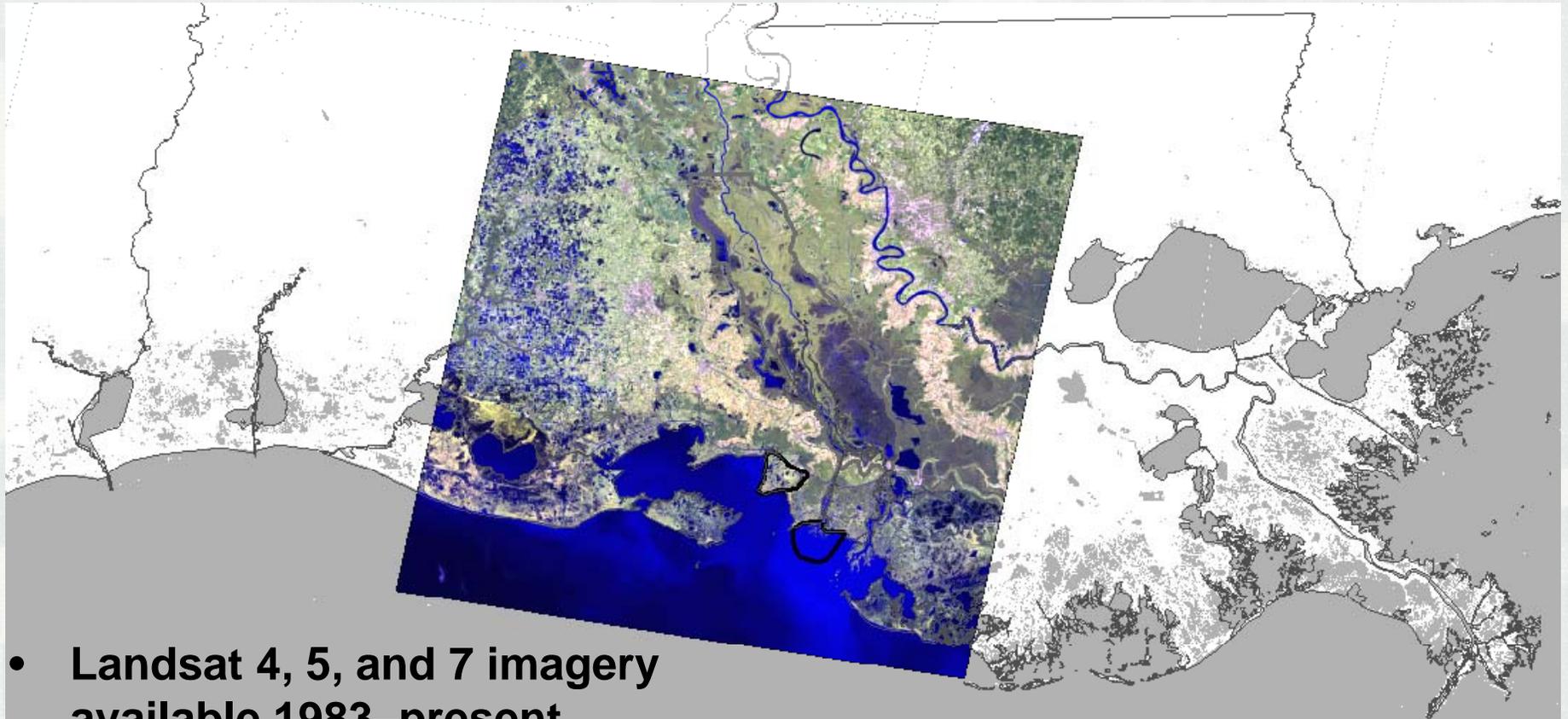
# Challenge: Quantifying extent of water in the Atchafalaya Basin



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# Using Landsat to capture *system wide* conditions:



- Landsat 4, 5, and 7 imagery available 1983–present
- 16 day repeat cycle
- 30 m pixel resolution
- 6 spectral bands in visible and infrared
- Large scene capture area (184x185 km)
- Entire system may be available in one scene

# Finding Water using Landsat

- 1983-2008
- Cloud-Free
- Leaf-Off (Dec-Mar)
- 28 Images
- Classify each Image for:
  - Land
  - Open Turbid
  - Flooded Turbid
  - Open Non-turbid
  - Flood Non-turbid
  - Aquatic Vegetation
- Multi-temporal Analysis

Open  
Non-turbid

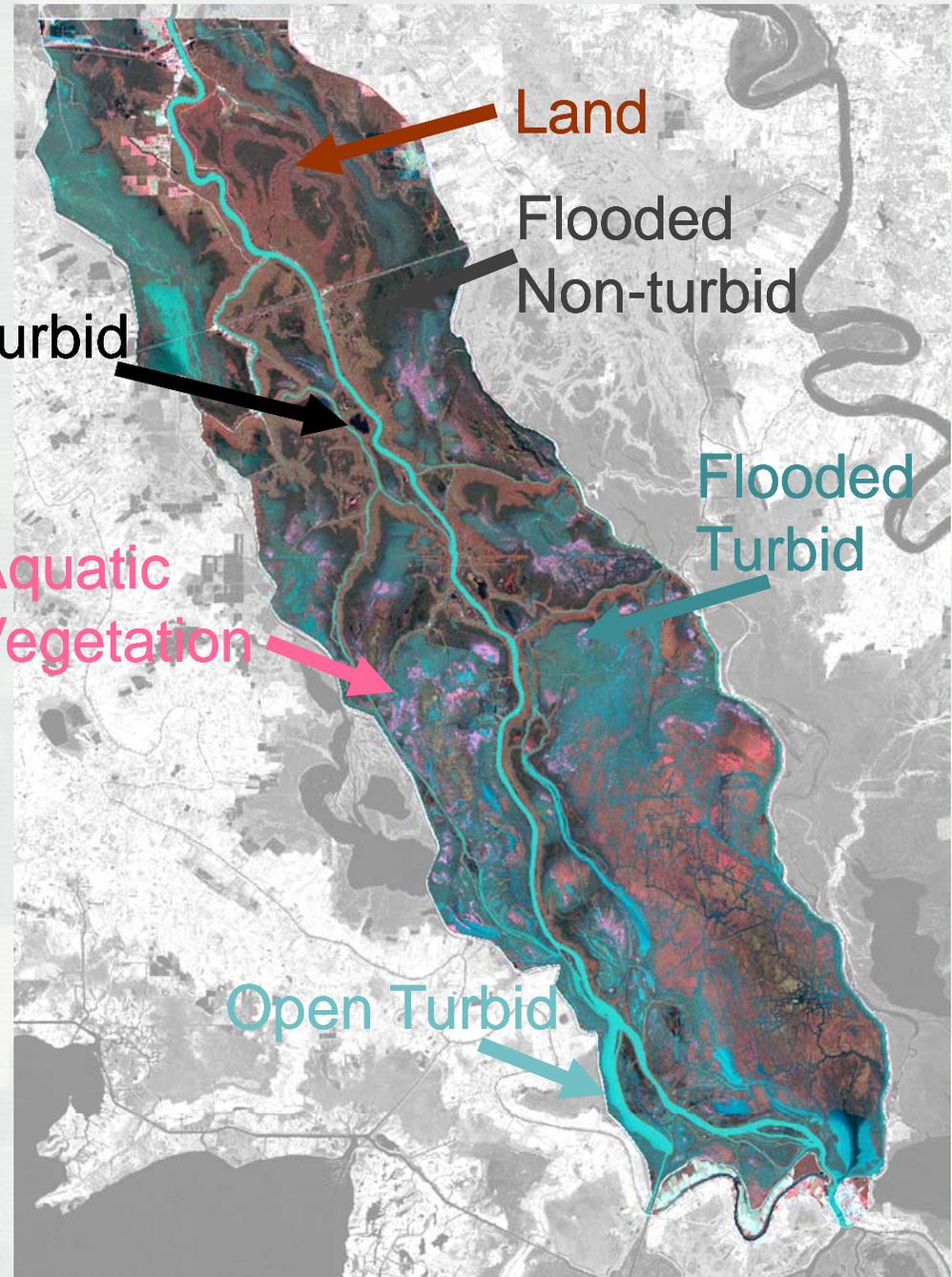
Aquatic  
Vegetation

Land

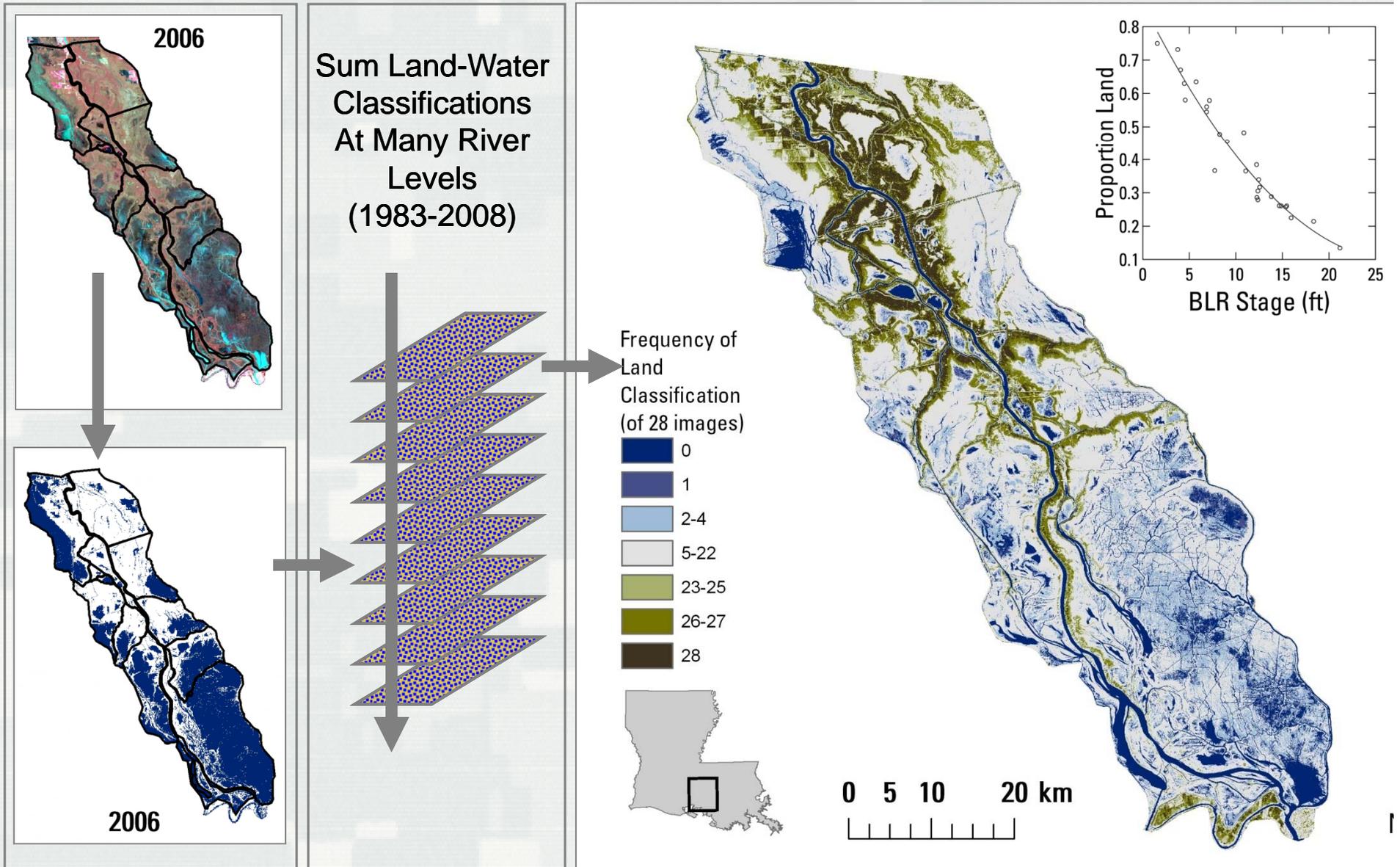
Flooded  
Non-turbid

Flooded  
Turbid

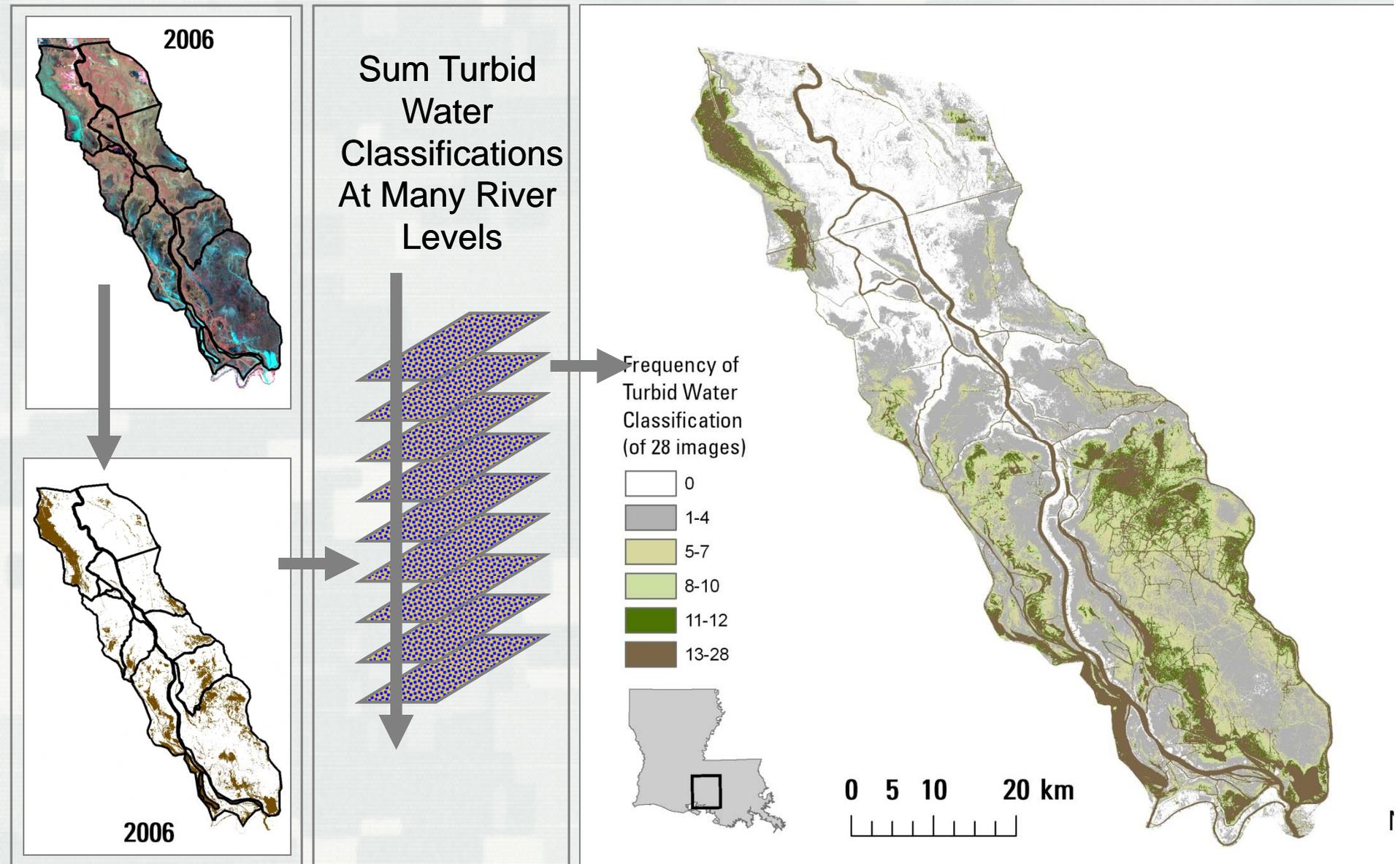
Open Turbid



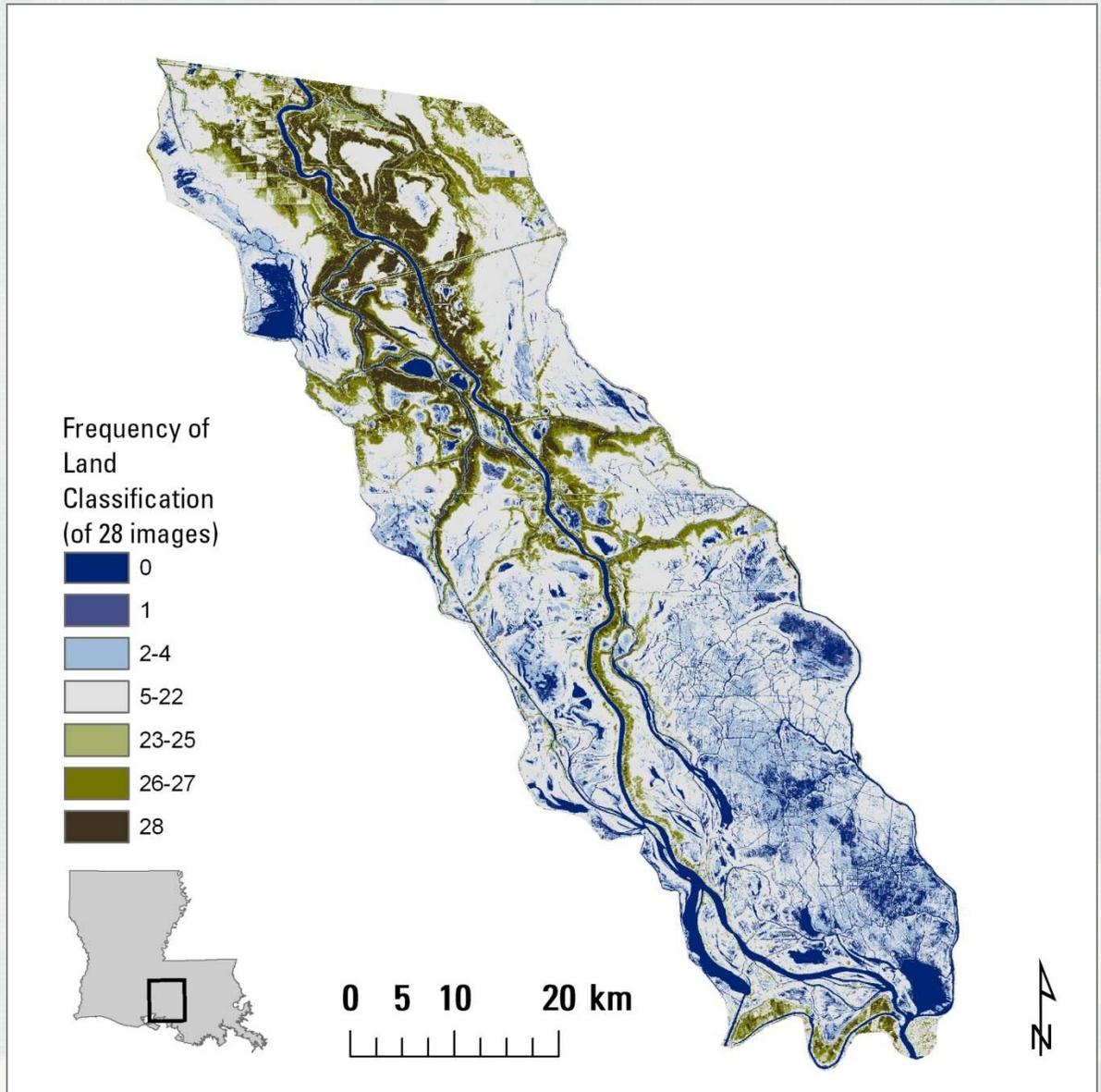
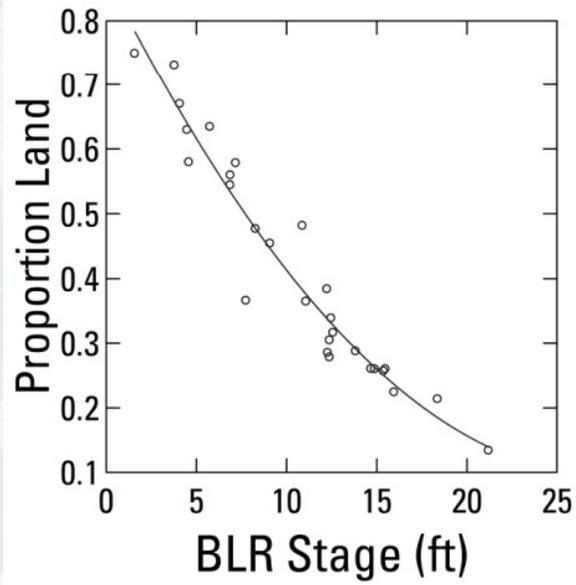
# Spatial Distribution and Frequency of Water in the AFBS



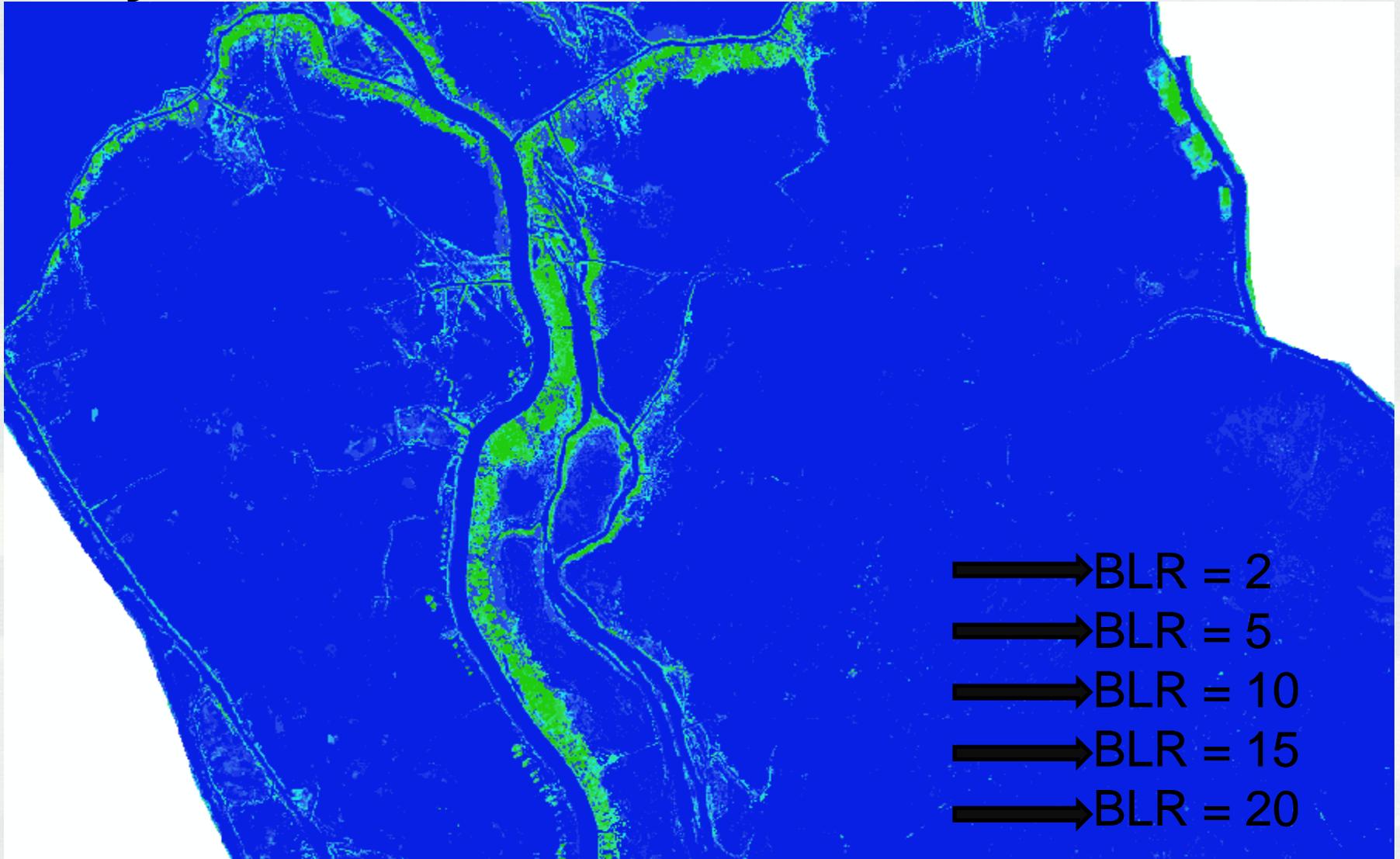
# Spatial Distribution and Frequency of Turbid Water in the AFBS



# Beyond Frequency..



# Filling in the Gaps: Probability of Inundation - Spatial Probit Analysis



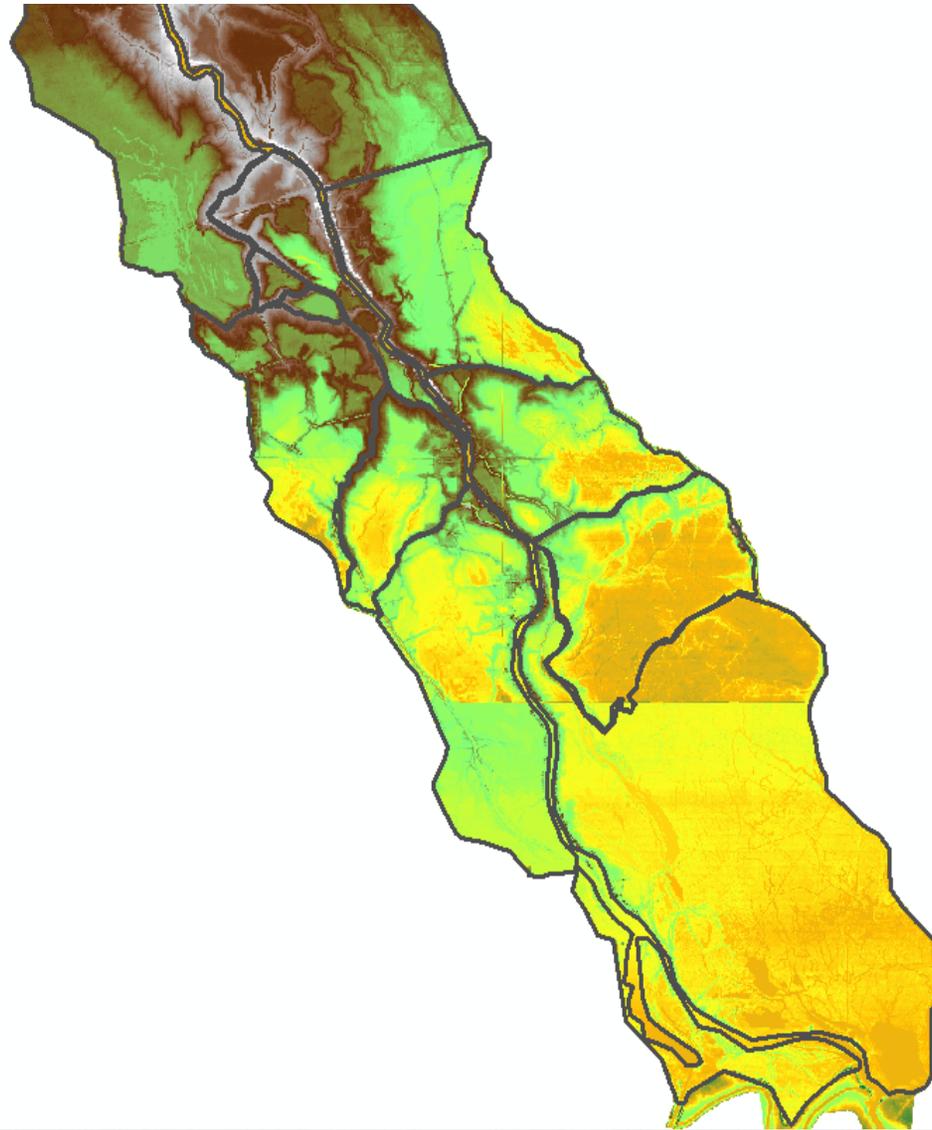
# NRIAS

## Geospatial Analysis Resource Set:

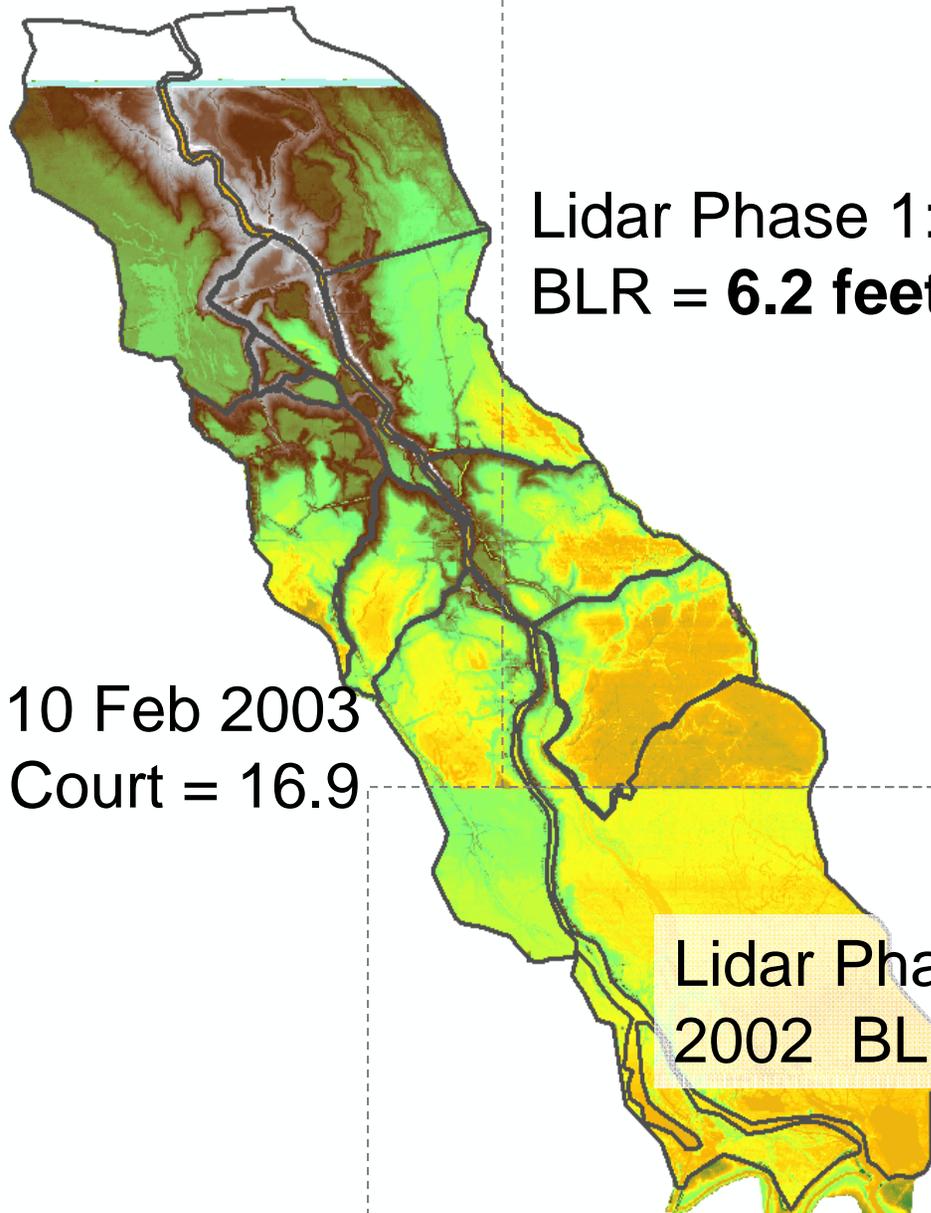
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- 9) *Developing: Resource Assessment Units*



## Using water distribution to assess LiDAR accuracy



# Interpreting LiDAR Data

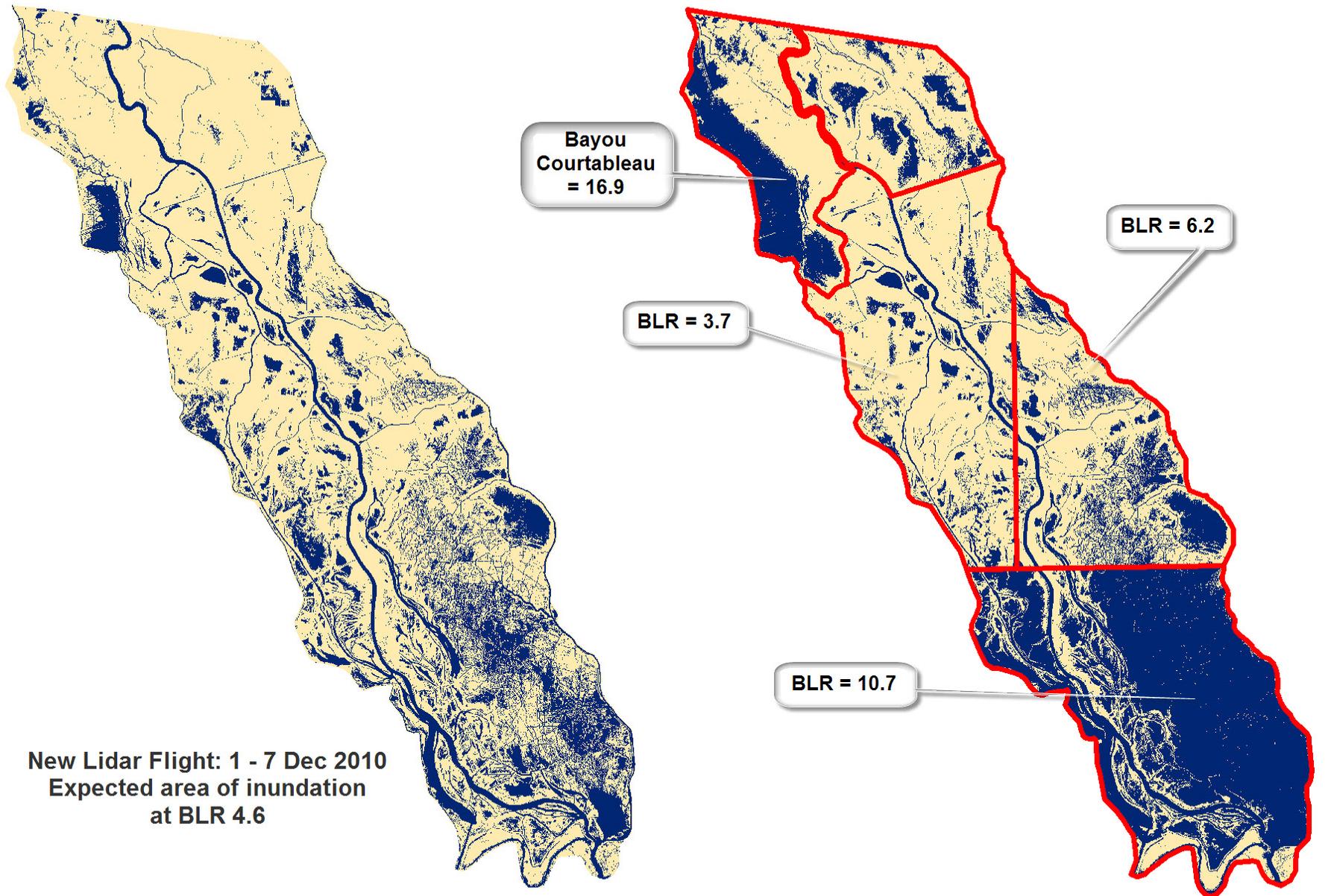


Lidar Phase 1: 27 Feb 2000  
BLR = **6.2 feet**

Lidar Phase 3: 10 Feb 2003  
BLR = **3.7 feet** Court = 16.9

Lidar Phase 2: 24 Feb  
2002 BLR = **10.7 feet**

# Greatly improved LiDAR acquisition: Dec 2010



New Lidar Flight: 1 - 7 Dec 2010  
Expected area of inundation  
at BLR 4.6

# Using the NRIAS to plan improvement projects:

1) Solicit public input

Evaluate:

1) Water quality

2) Accretion patterns

3) Elevation accuracy

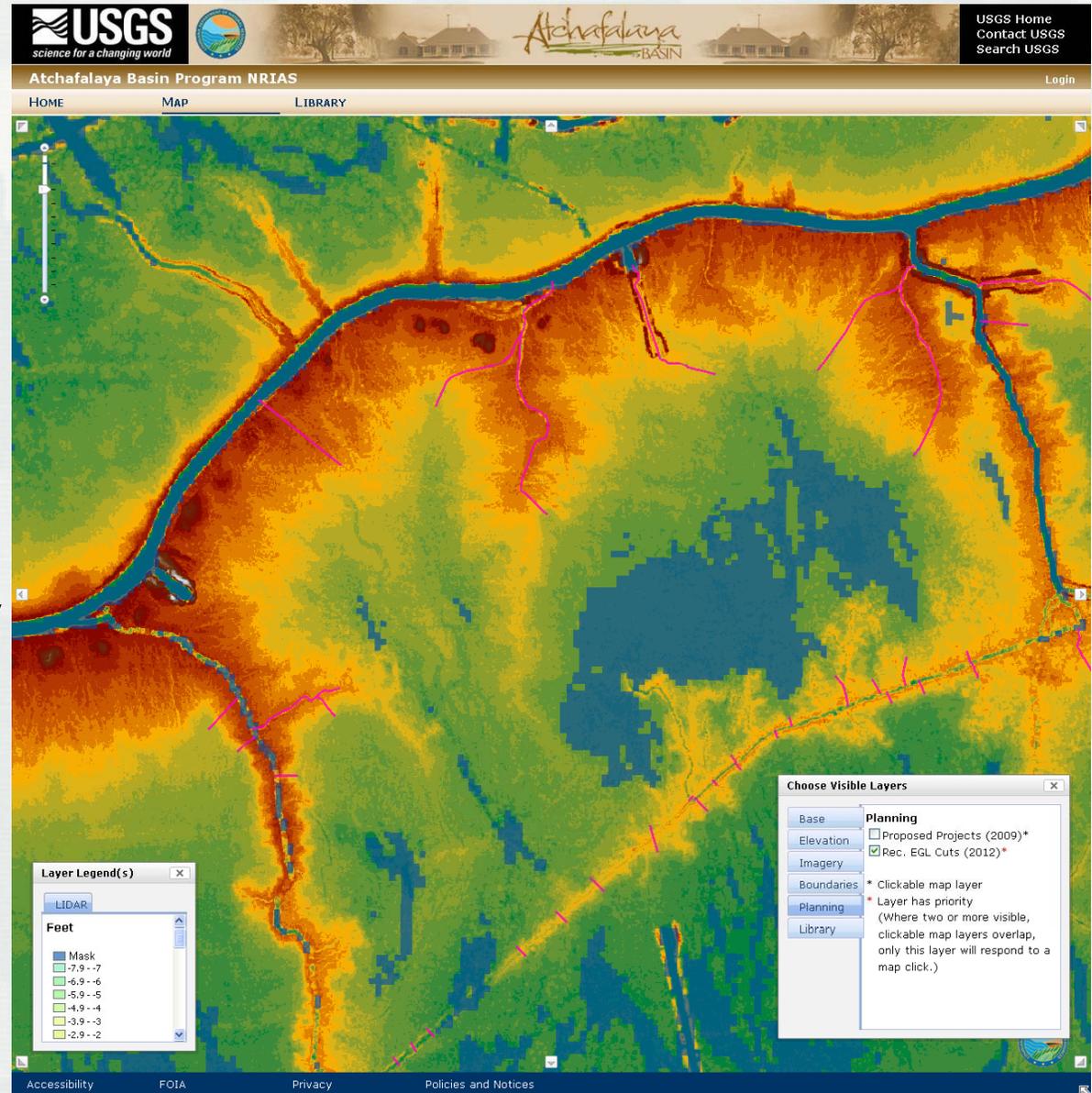
4) Historical Setting

5) Identify possible solutions

6) Recon

7) Vet solution set to public sponsor, CPRA, legislature

8) Web presentation

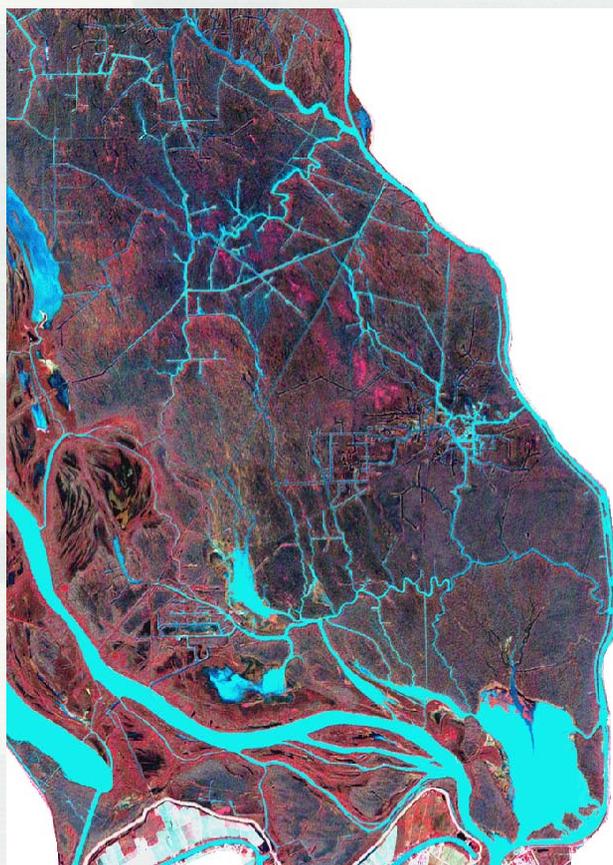


# Other Applications for Inundation Mapping using Landsat

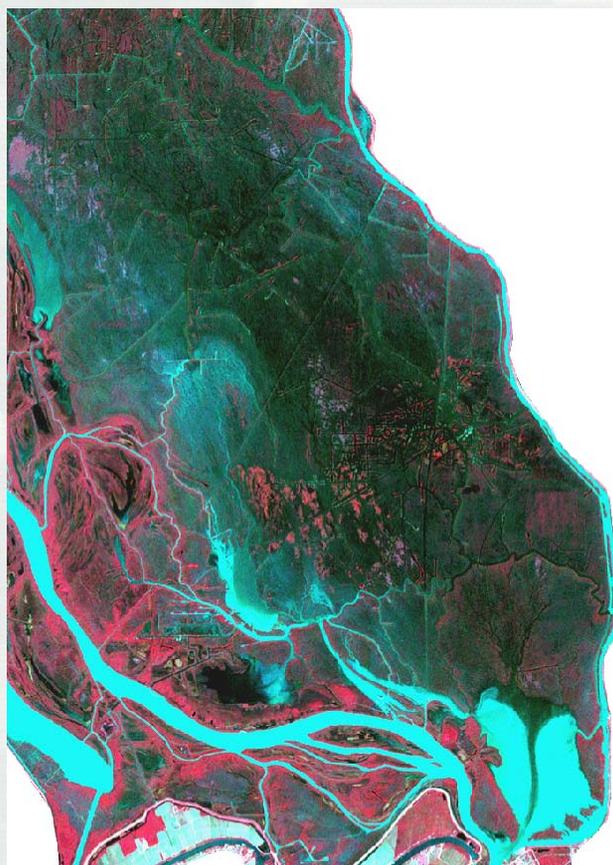
- Understand hydrology: the timing of overbank vs. channelized flow.
- Define the seasonal extent and quality of aquatic and terrestrial habitats.
- Identify effectiveness of management projects.
- Identify areas of potentially increased mercury methylation.
- Identify areas that will be seasonally suitable for Black Bears
- Track hydrology under certain conditions (post-hurricane).



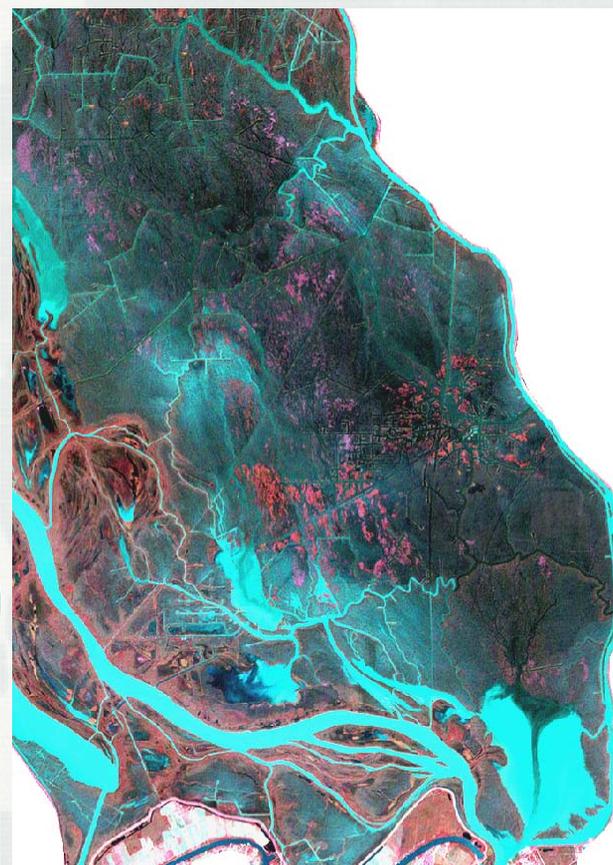
Other Applications:  
Predict the timing of channelized vs.  
overbank flow



BLR = 7.2

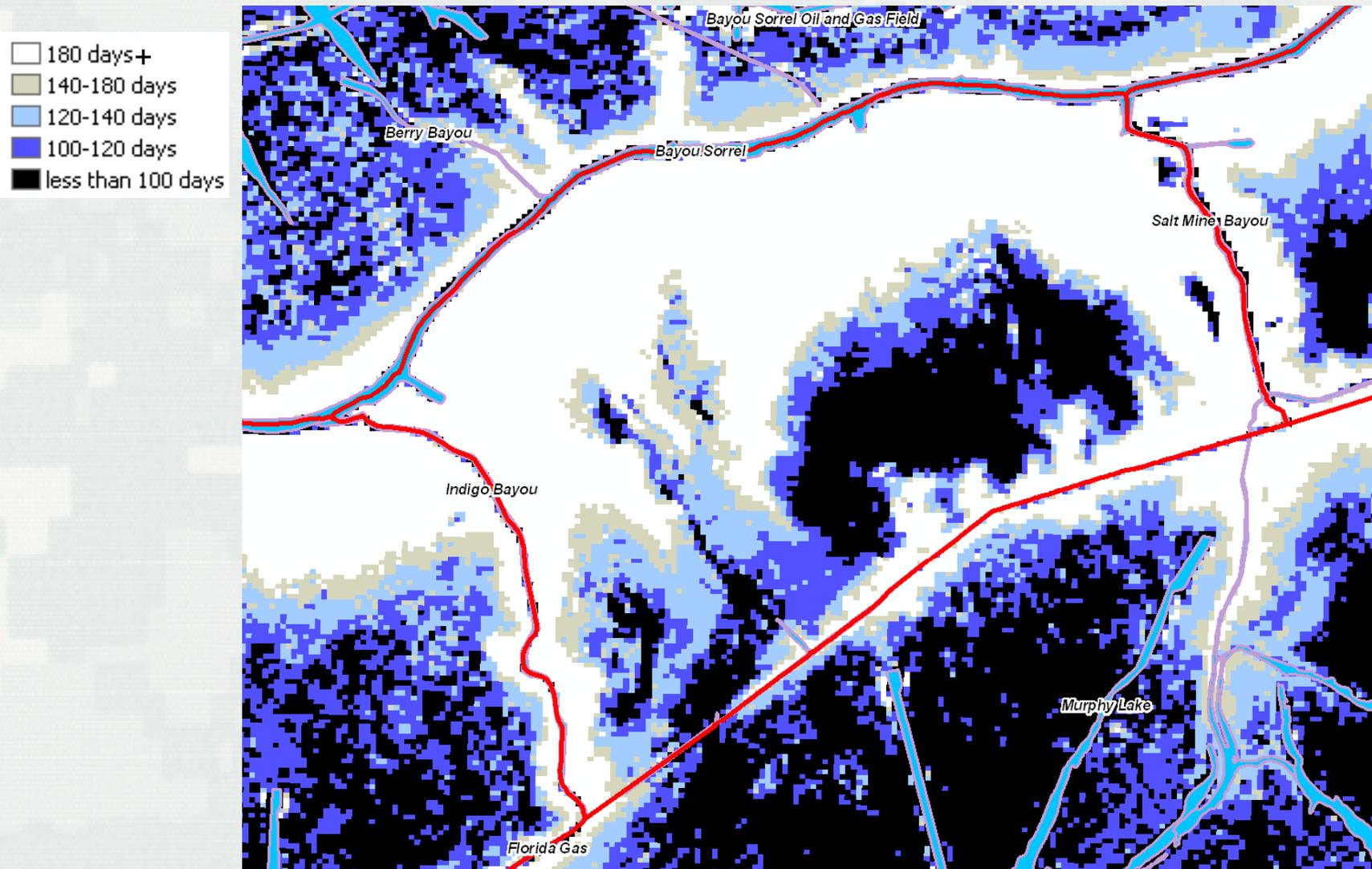


BLR = 9.1



BLR = 11.1

**Other Applications: Define the seasonal extent and quality of terrestrial habitats: number of consecutive dry days in a typical growing season**

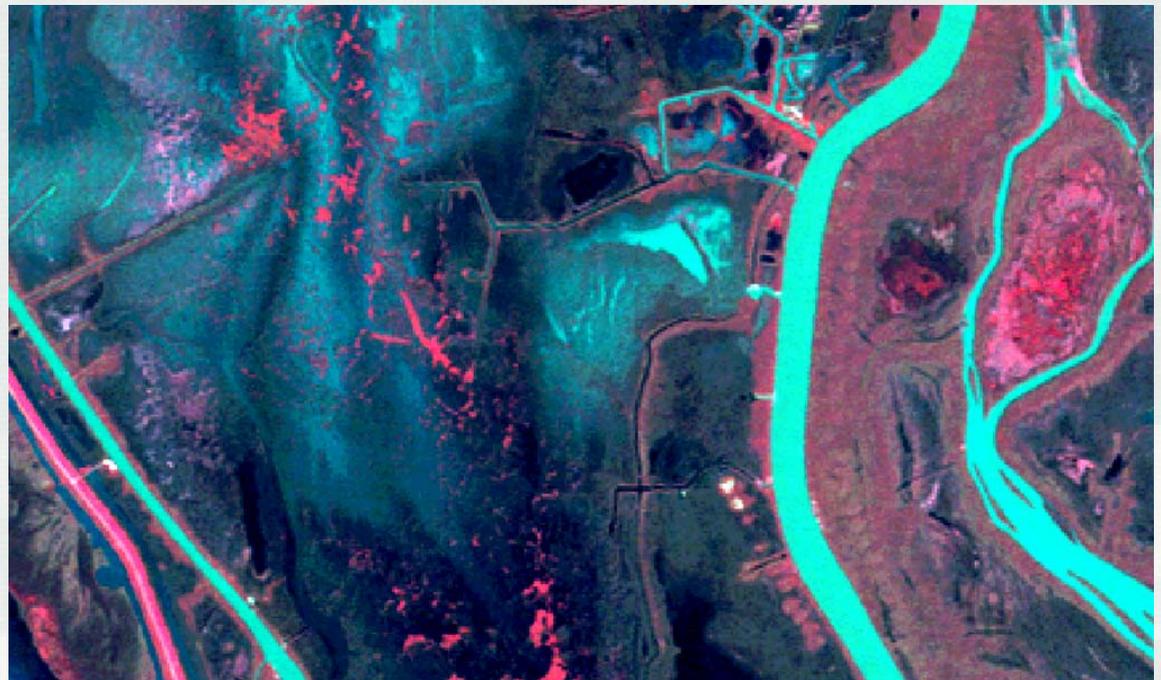


**Other  
Applications:  
Identify  
effectiveness of  
management  
projects**

**5 Feb 2006**

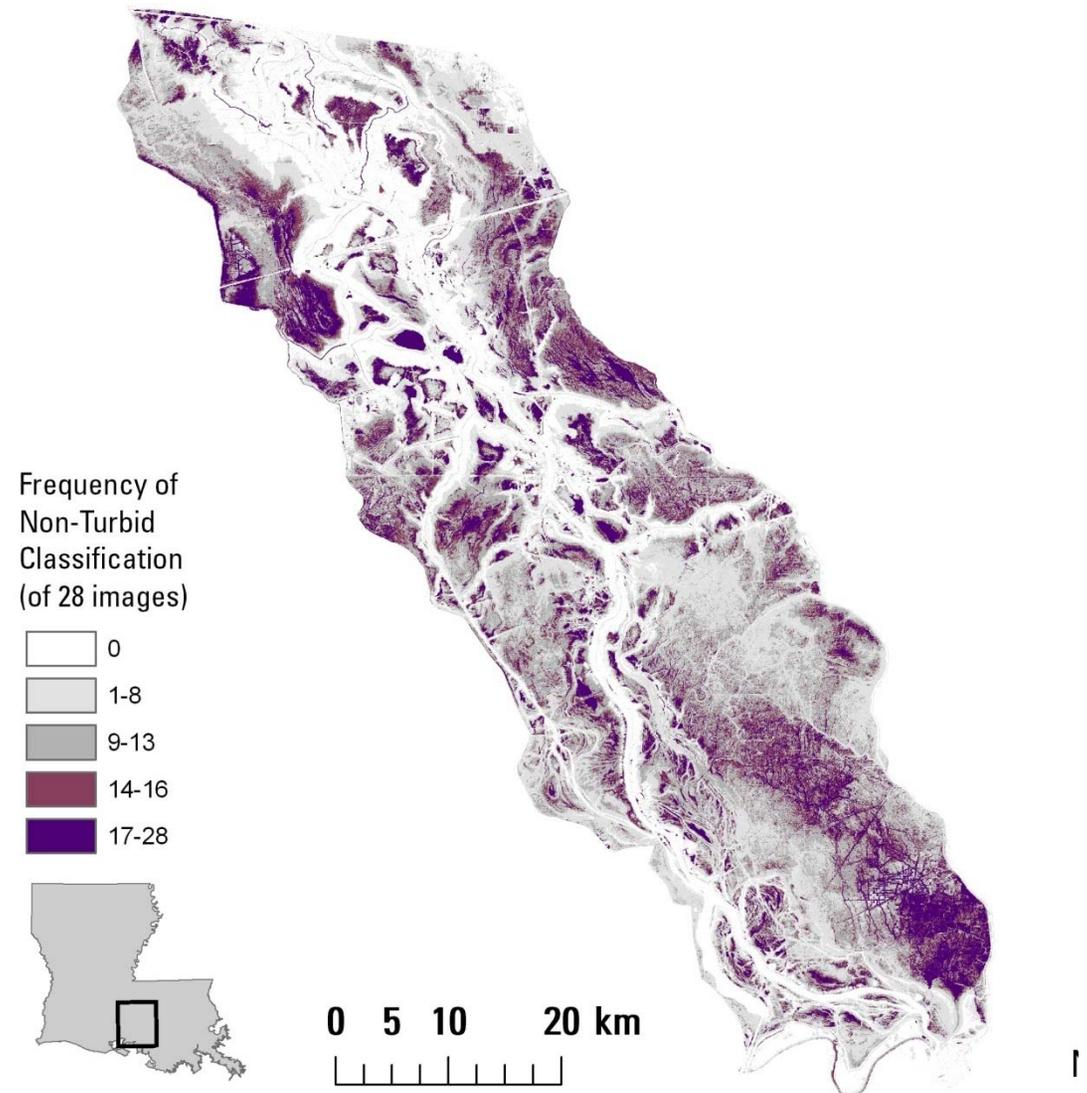


**27 Feb 2008**



## Other Applications: Using non-turbid water maps to predict potential areas associated with:

- Low [DO]
- Increased temperature
- Increased [DOM]
- Decreased pH
- 
- Increased mercury methylation?
- Increased denitrification?



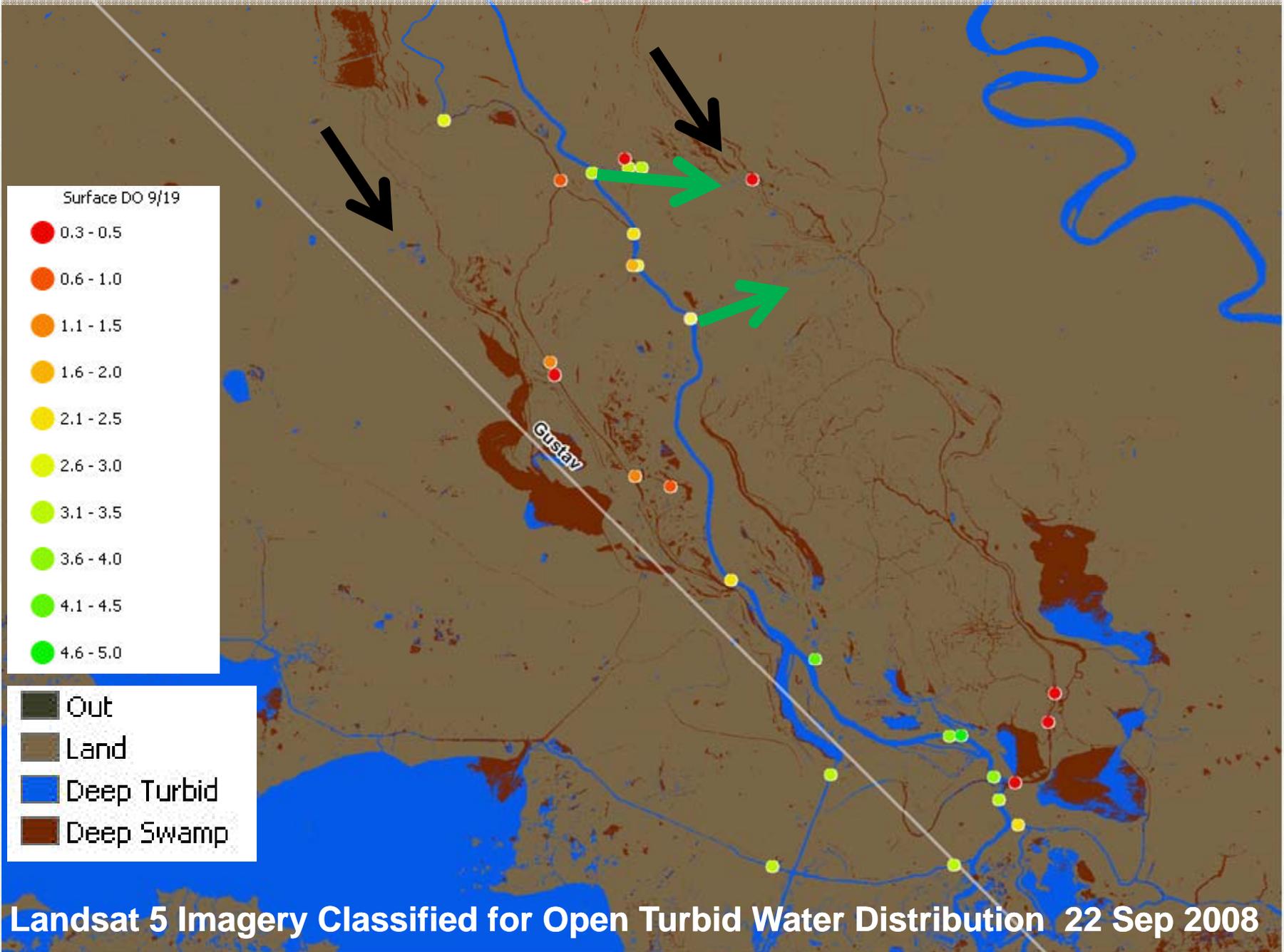
# Other Applications: Track water quality post-hurricane



8 Oct 2008



# Other Applications: Track water quality post-hurricane



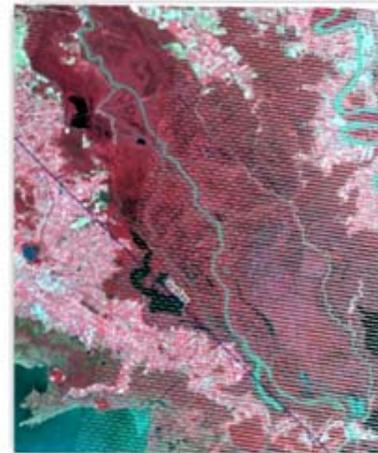
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29 Aug 2008



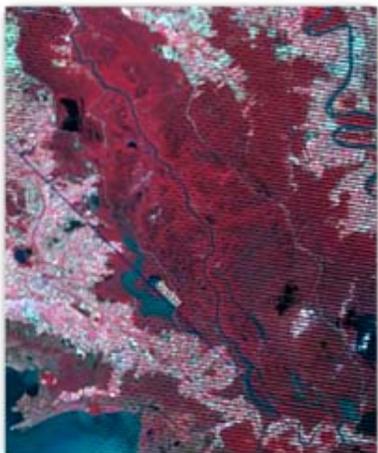
22 Sep 2008



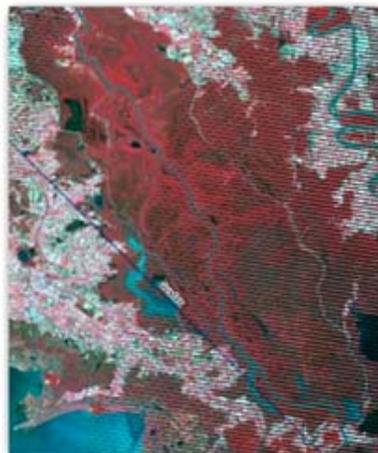
30 Sep 2008



08 Oct 2008



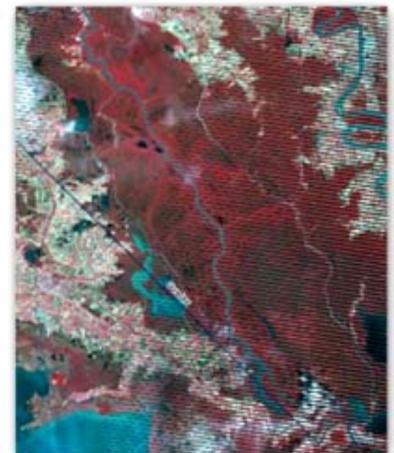
01 Nov 2008



17 Nov 2008

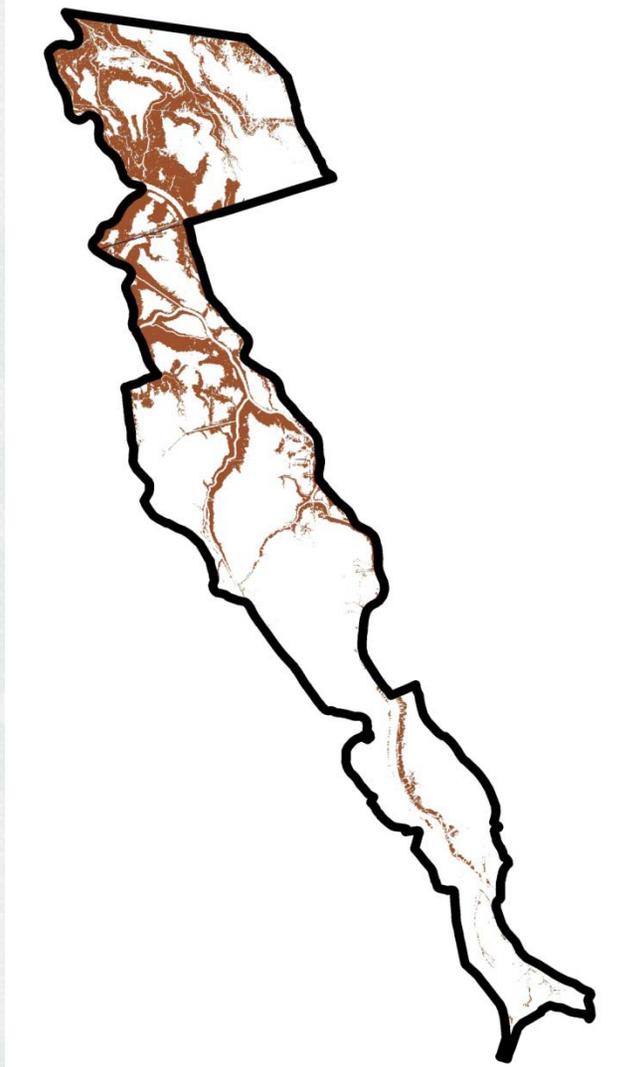


25 Nov 2008

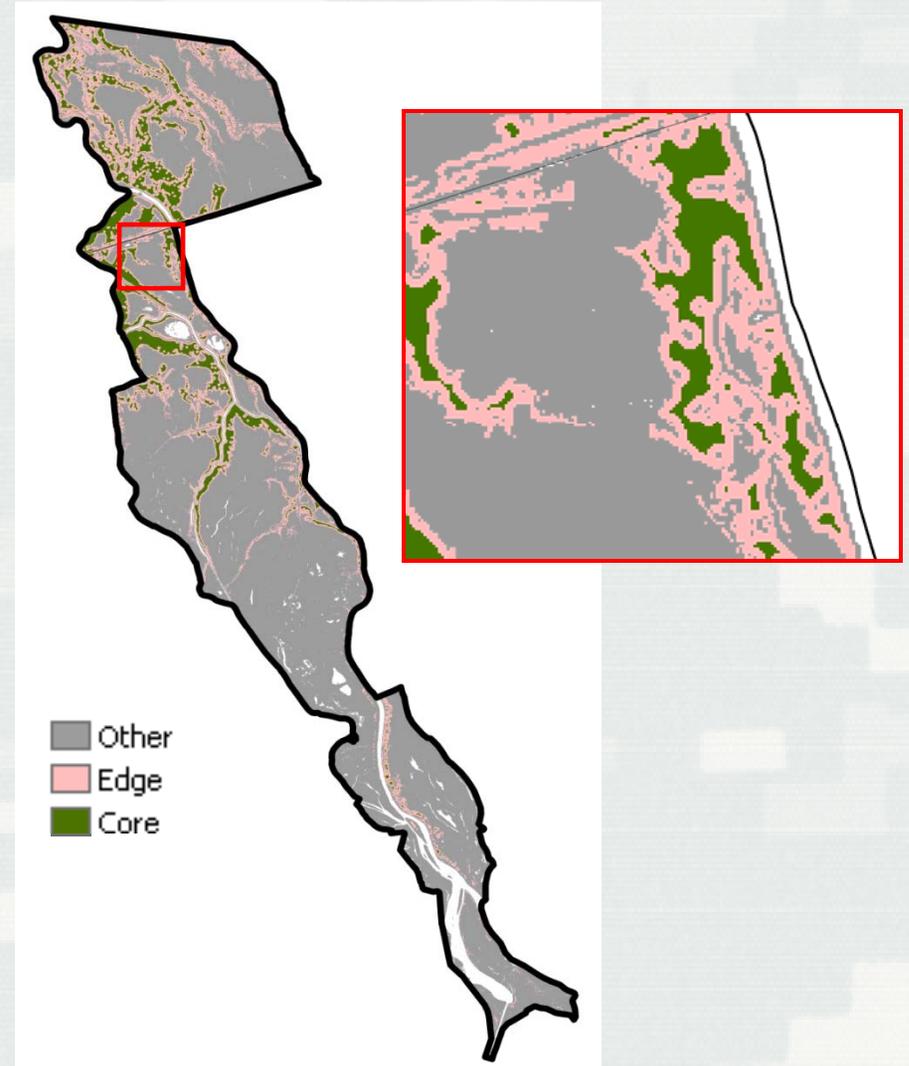


03 Dec 2008

# Other Applications: Identify Optimal Black Bear Denning Habitat



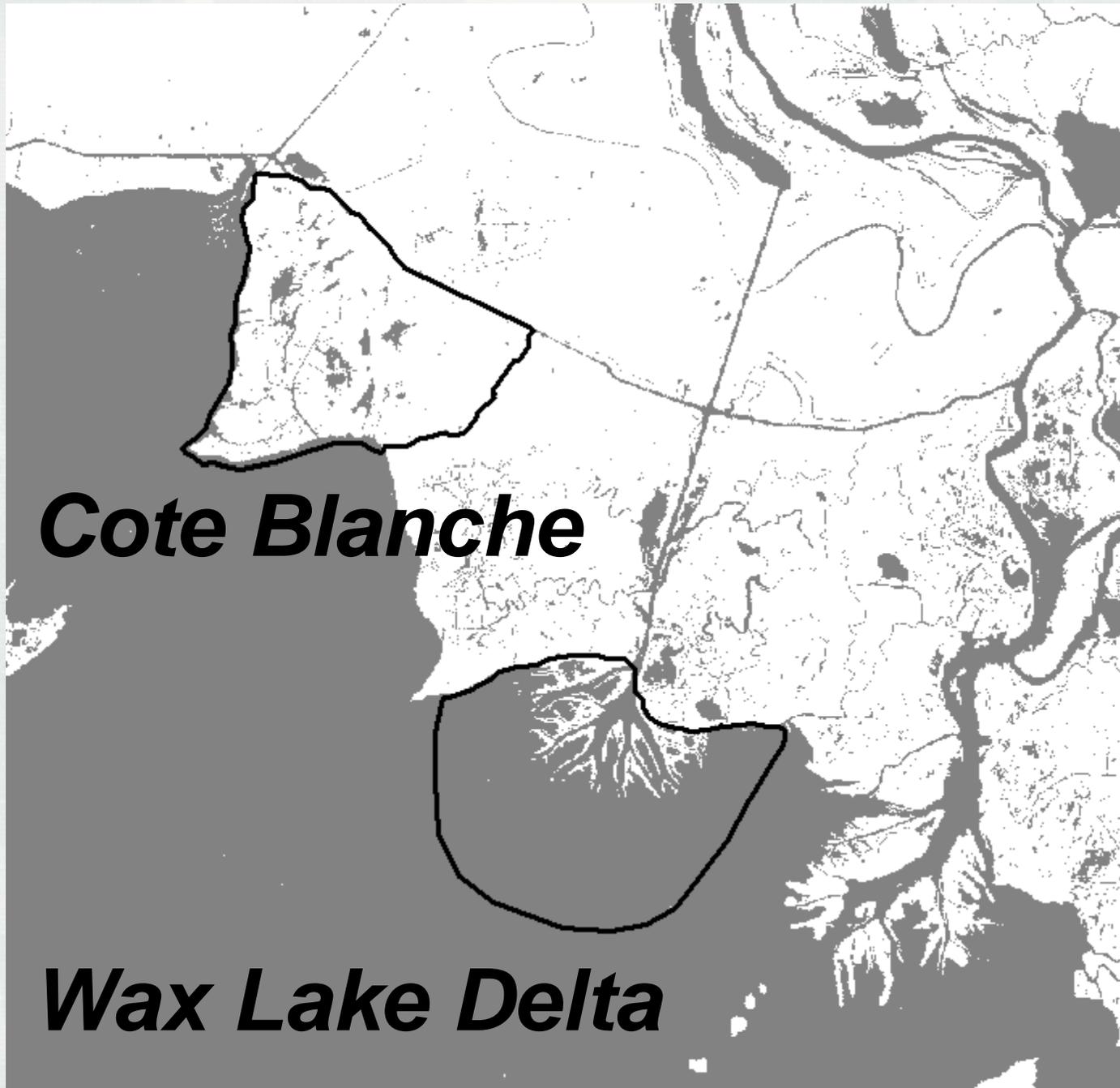
Dry Habitat during  
Denning Season



Dry Habitat during  
Denning Season that is Core

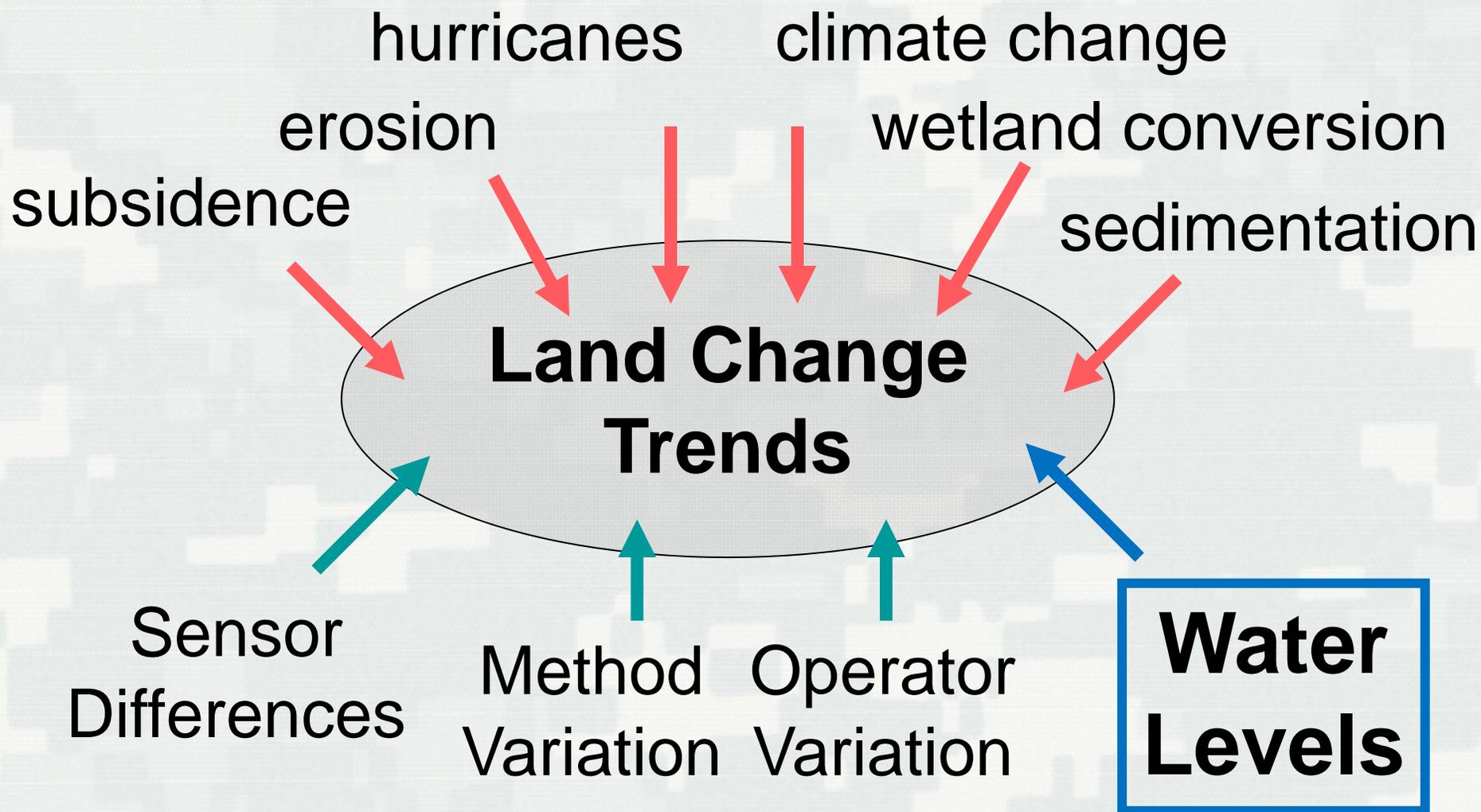
# Using Multitemporal Remote Sensing Imagery and Inundation Measures to Improve Land Change Estimates in Coastal Wetlands



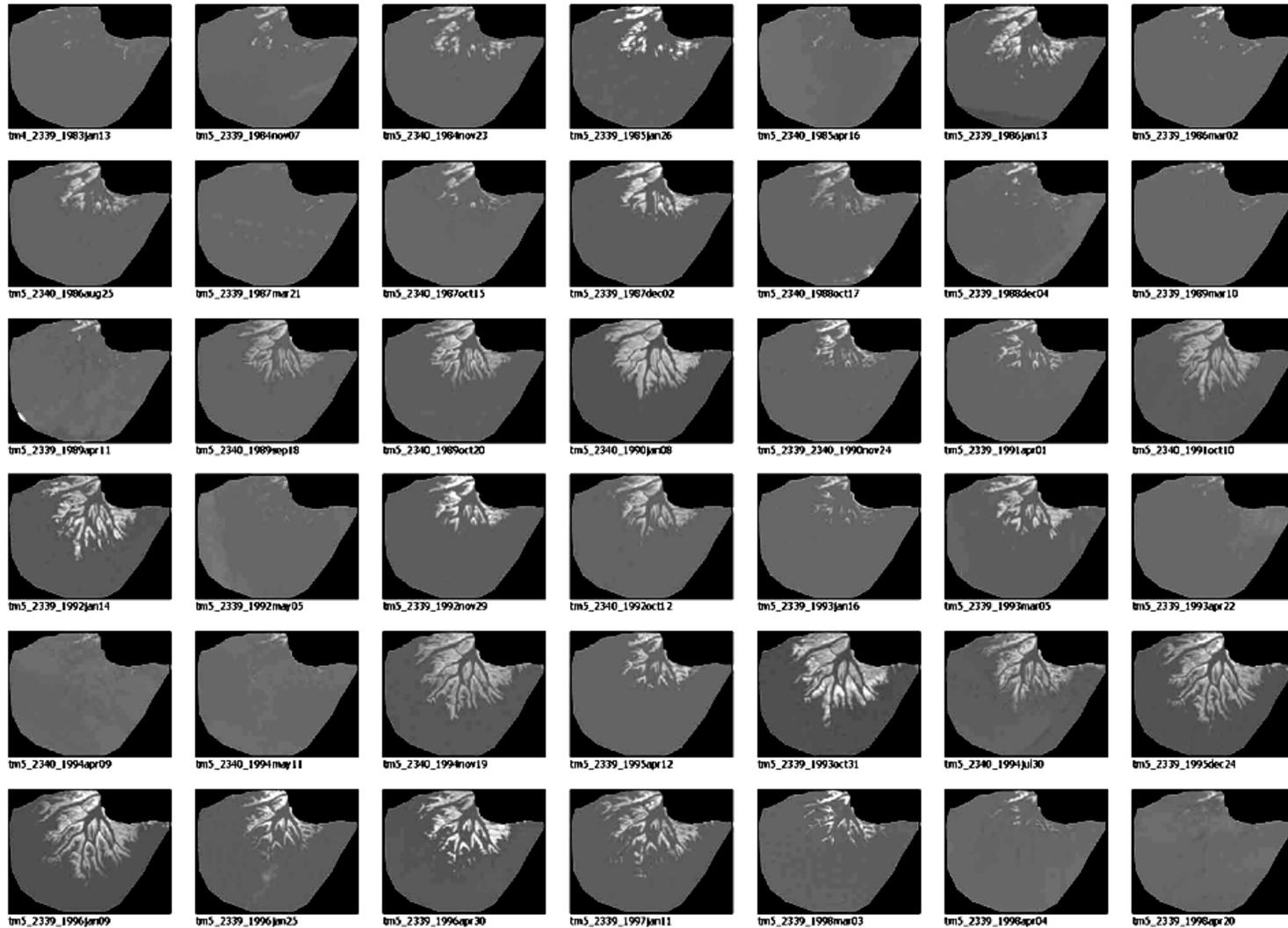


***Cote Blanche***

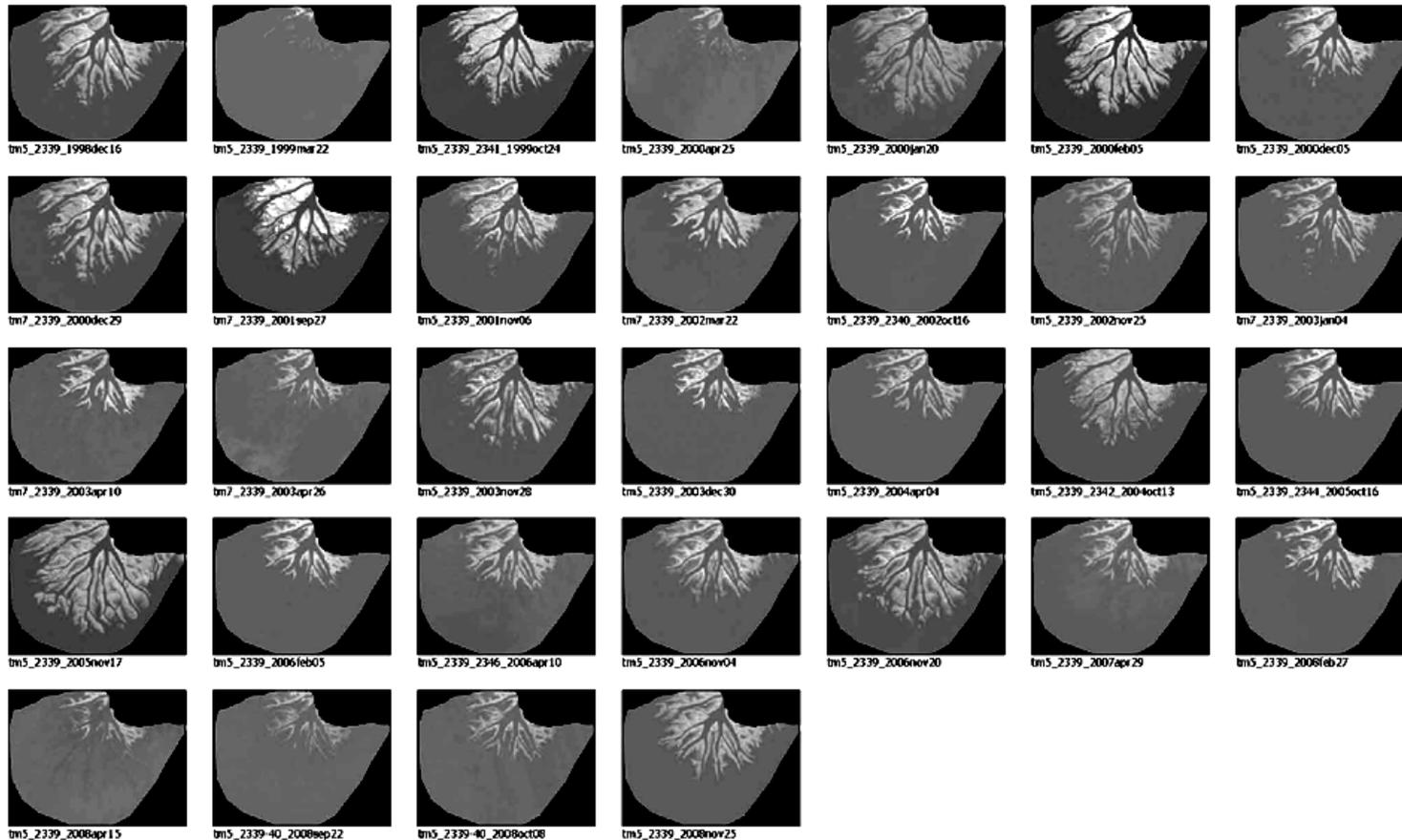
***Wax Lake Delta***



# Classify many images under all available water conditions.

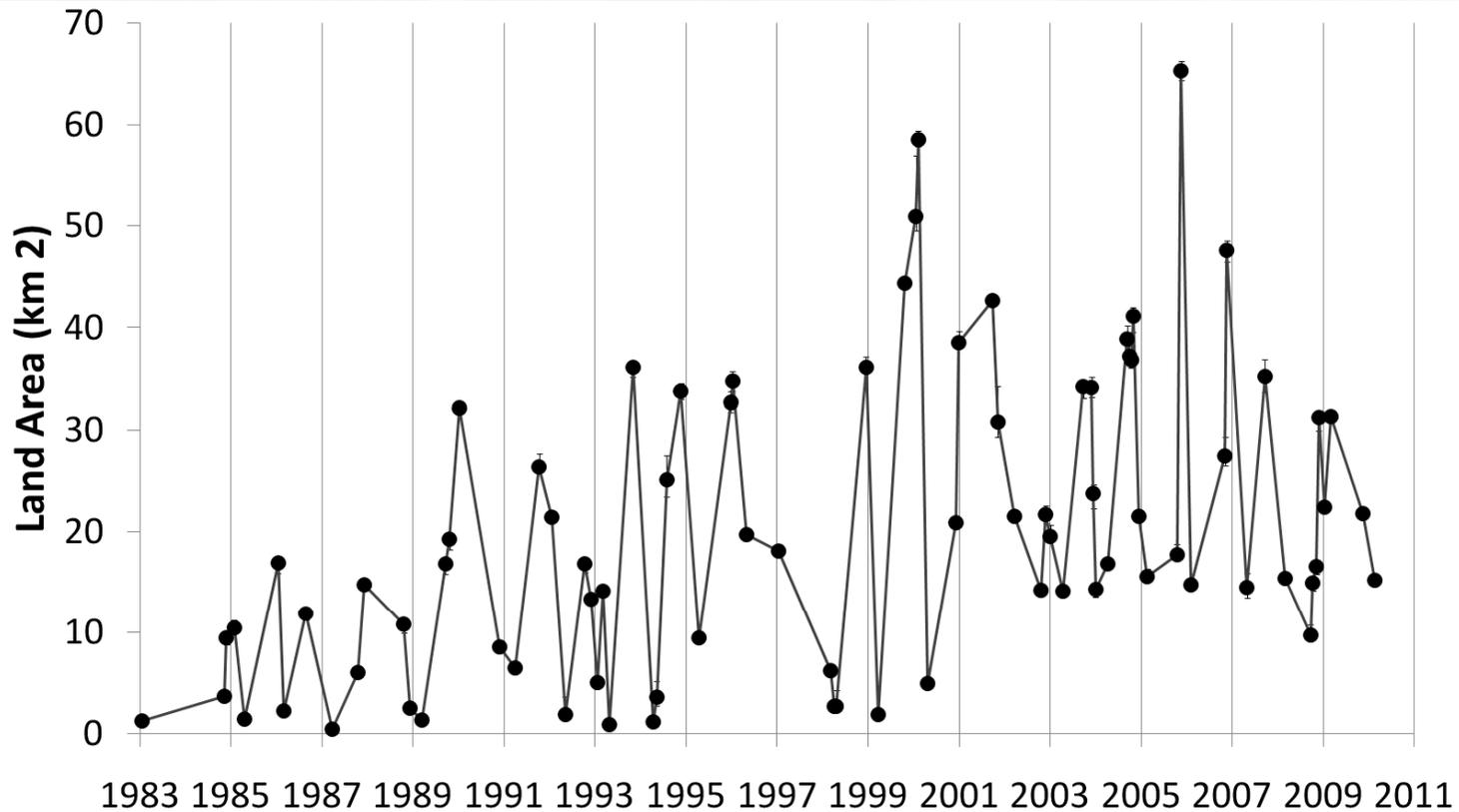


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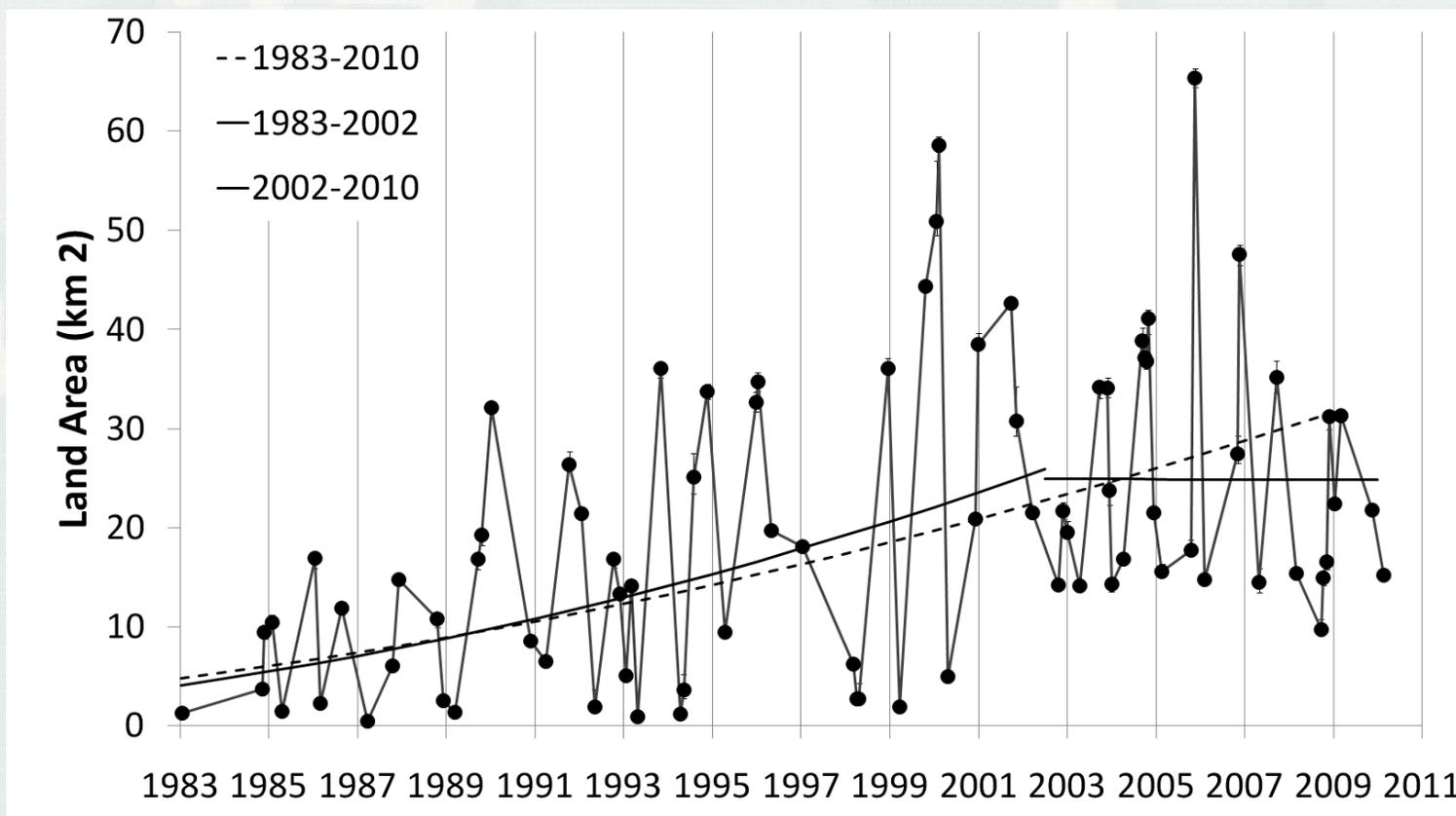
- Dependent Variable: Land Area (km<sup>2</sup>)
- Independent Variables: Date, River Level, Tide Height

# Wax Lake Delta: Date, River and Tide significantly influence land area estimates



Time	N	r <sup>2</sup>	Effect	Coefficient	SE	t	p-value
1983-2010	76	0.75	Const.	-231.3091	31.2439	-7.403	<0.0001
			Date	0.1214	0.0158	7.678	<0.0001
			Tide	-2.9509	0.5681	-5.194	<0.0001
			River	-0.6062	0.0746	-8.125	<0.0001

# Wax Lake Delta: Land Change Trends by Time Period

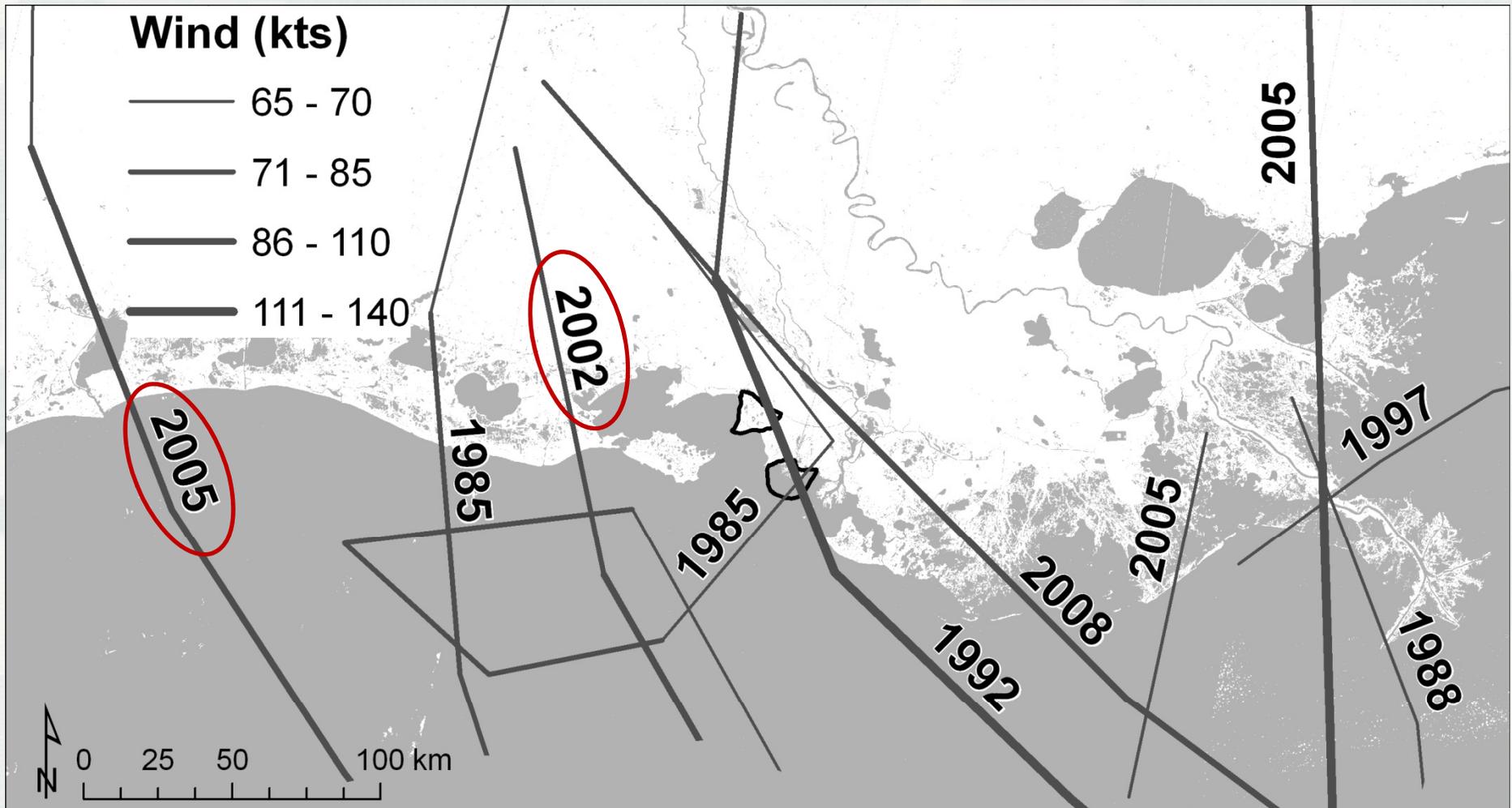


Independent Variables	n	r <sup>2</sup>	km <sup>2</sup> yr <sup>-1</sup>
Date, River, Tide - <b>all years</b>	79	0.74	1.03
Date, River, Tide - <b>pre 2002</b>	49	0.86	1.11
Date, River, Tide - <b>post 2002</b>	28	0.33	-0.01

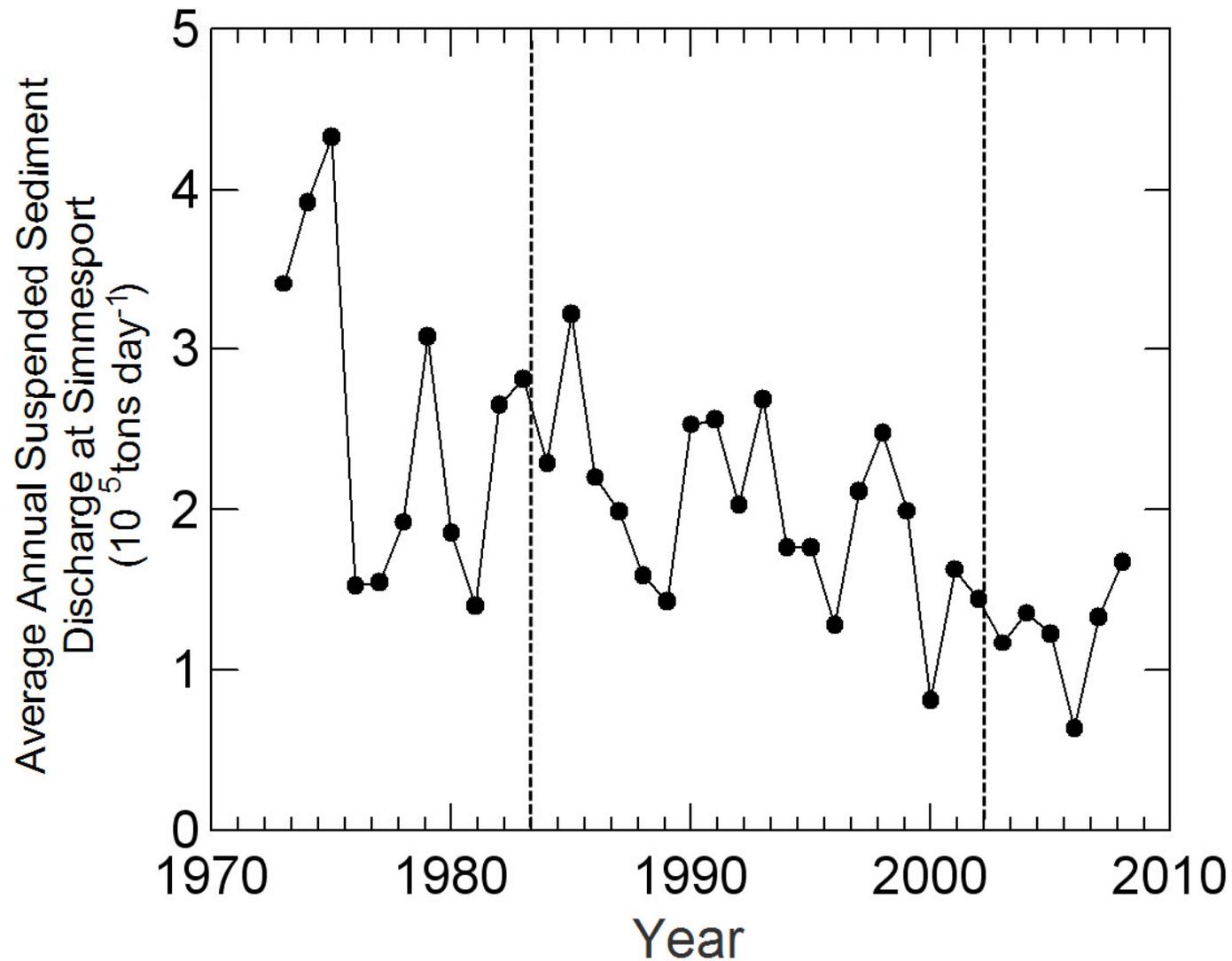
# Potential Processes Contributing to Recent Trends in Land Change

- Hurricanes
- Reduced Sediment Supply
- Relative Sea Level Rise
- Others?

# Potential Contributing Process: Hurricanes

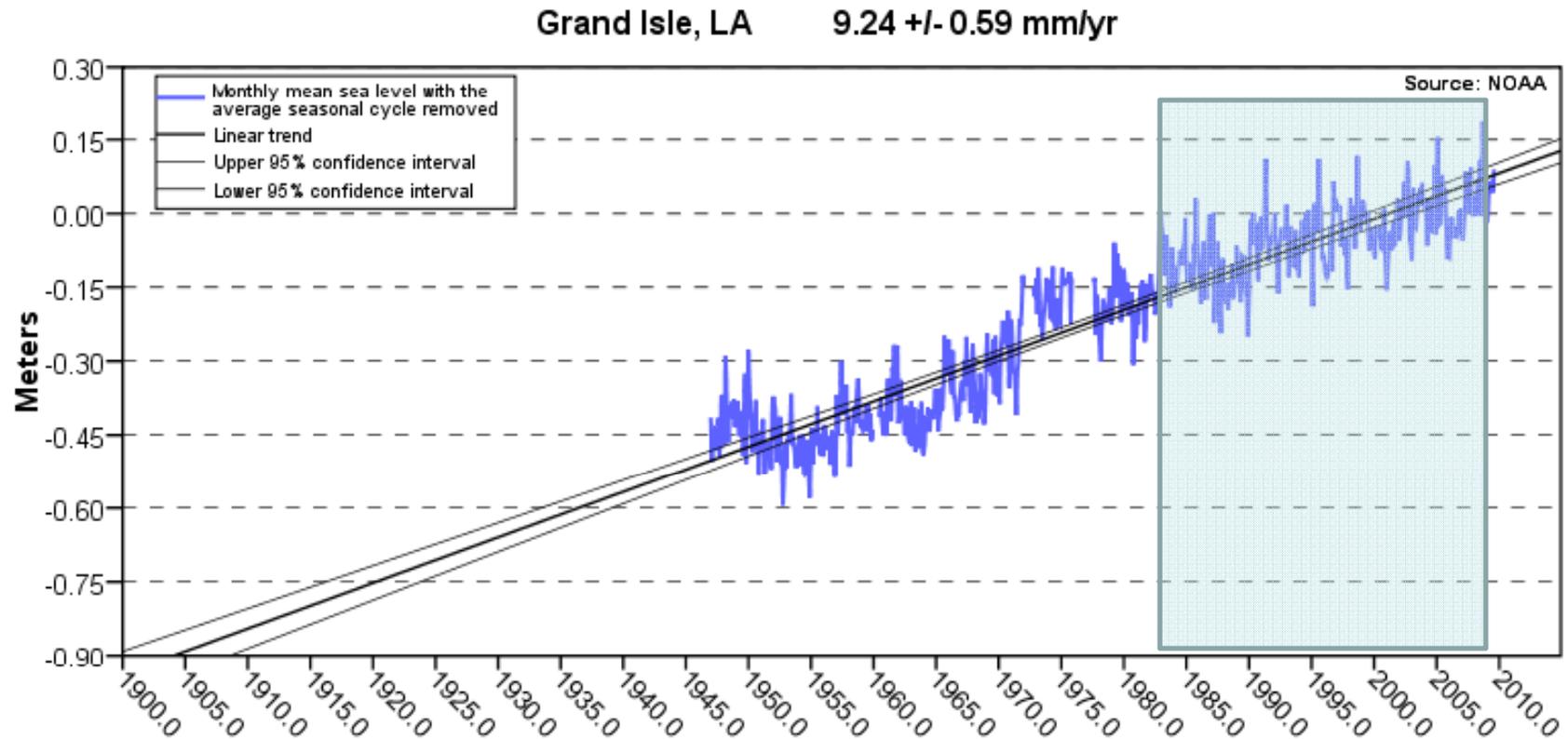


# Potential Contributing Process: Reduced Sediment Supply



# Potential Contributing Process: Relative Sea Level Rise

## Mean Sea Level Trend 8761724 Grand Isle, Louisiana



# Conclusions

- Inundation is an important variable influencing many measurements of ecosystem function, land change and condition in the Atchafalaya Basin and coastal Louisiana.
- Integration of many types of data on a open, available geospatial platform may help to increase consensus and move science based decision-making forward.
- Multi-temporal image analysis with an explicit consideration of water levels can improve the resolution land change measurements – allowing for an examination of actual land change processes.