A Project to Map and Monitor Baldcypress Forests in Coastal Louisiana, using Landsat, MODIS, and ASTER Satellite Data

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Introduction

- Cypress swamp forests of Louisiana offer many important ecological and economic benefits
  - wildlife habitat, forest products, storm buffers, water quality, and recreation
- Such forests are also threatened by multiple factors
  - subsidence, salt water intrusion, sea level rise, persistent flooding, hydrologic modification, hurricanes, insect and nutria damage, timber harvesting, and land use conversion
- Unfortunately, there are many information gaps regarding the type, location, extent, and condition of these forests
- Better more up to date swamp forest mapping products are needed to aid coastal forest conservation and restoration work (e.g., through the Coastal Forest Conservation Initiative or CFCI)
- In response, a collaborative project was initiated to develop, test and demonstrate cypress swamp forest mapping products, using NASA supported Landsat, ASTER, and MODIS satellite data

Research Objectives

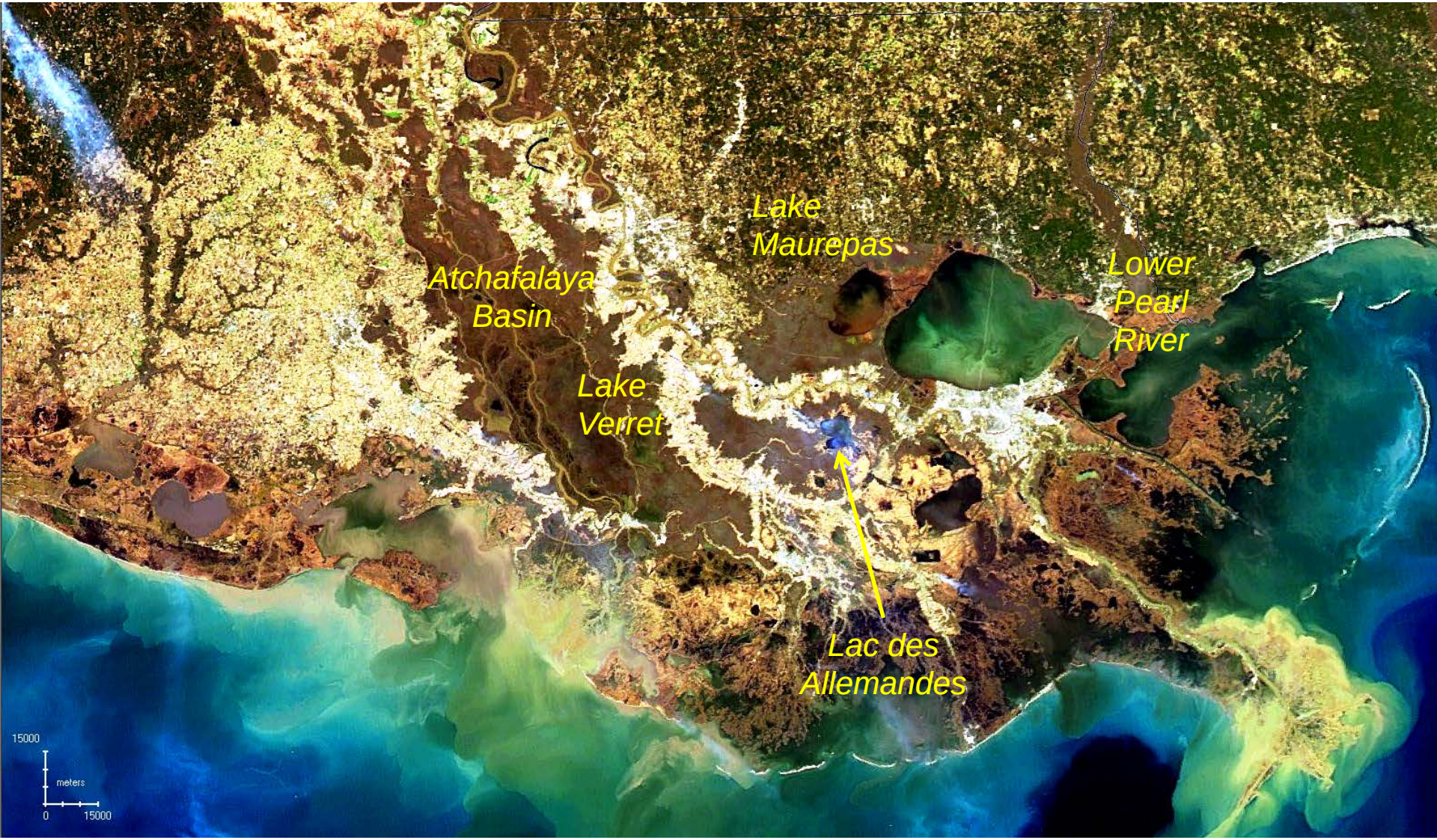
Develop, test, and demonstrate:

- Landsat and ASTER data for computing new cypress forest classification products
- Landsat, ASTER, and MODIS satellite data for detecting and monitoring swamp forest change

Study Area Location

Stennis Space Center

MODIS True Color Image – Acquired December 19, 2003



Data Acquisition

Primary Data

- Landsat data – acquired from early 1970s onwards
- ASTER data – acquired from 1999 onwards
- MODIS NDVI data – 2000 onwards

Ancillary Data

- Historical vertical and oblique aerial photography
- High resolution commercial satellite data
- Field survey data (photos, GPS, notes)

Methods

Cypress classifications

- Cover type classification from ISODATA clustering
- Canopy cover classification with Sub-Pixel classifier software
- Derived from fall 2009 Landsat data

Swamp forest change products

- ISODATA clustering of NDVI data stack for 8 dates from 1972-2010
- Swamp forest change isolated with 1972 swamp forest mask

MODIS forest change

- MODIS data temporally processed using Time Series Product Tool (TSPT) and Phenological Parameter Estimation Tool (PPET) software developed at NASA Stennis Space Center
- Percent change in NDVI products are computed by comparing current and historical “baseline” NDVI

Series 1 - Cypress Forest Classification Products

Landsat Classification of Cypress Forest Types

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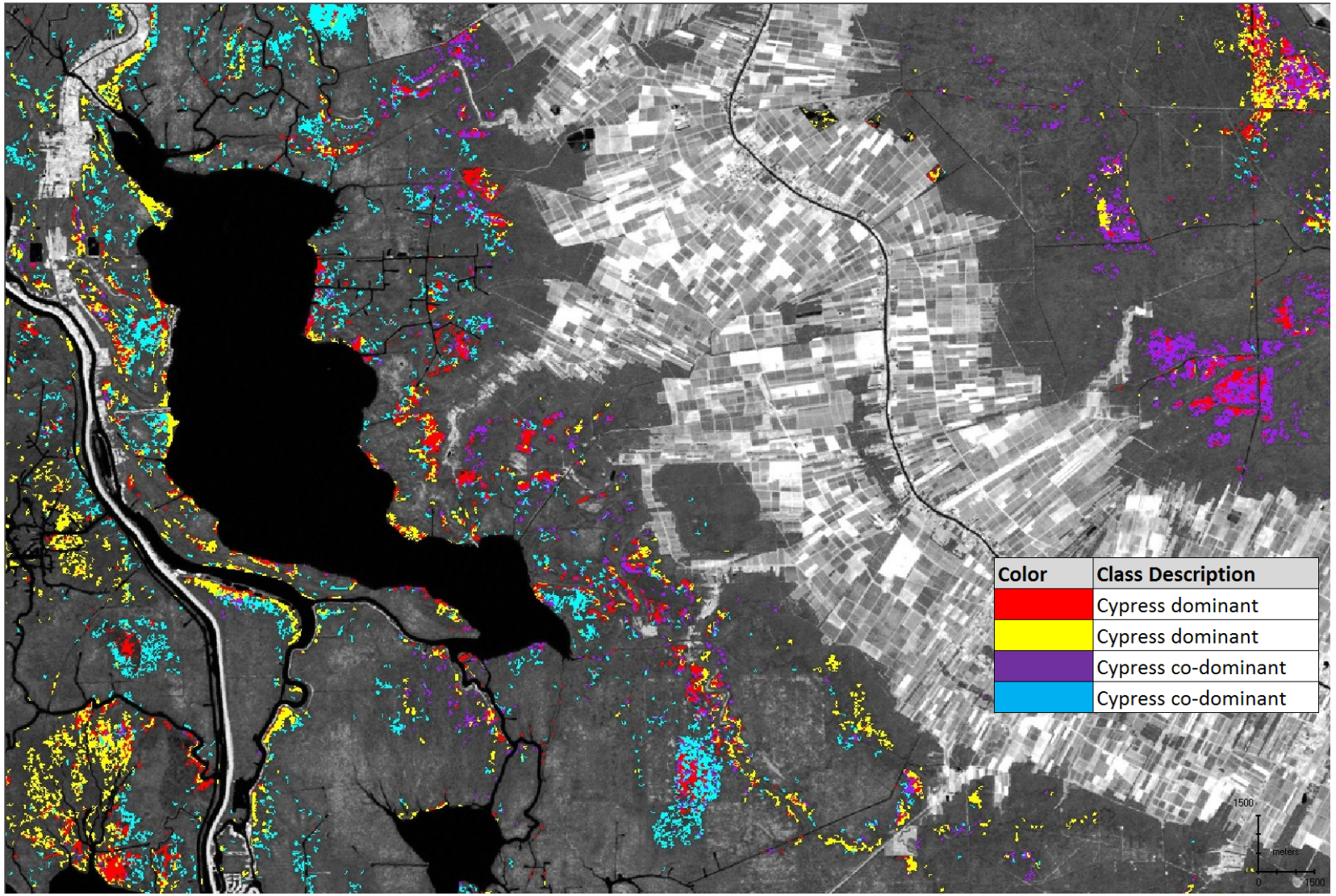
Results for Lake Verret, Louisiana From Landsat Data Acquired 10-20-2009



Landsat False Color RGB Acquired 10-20-2009

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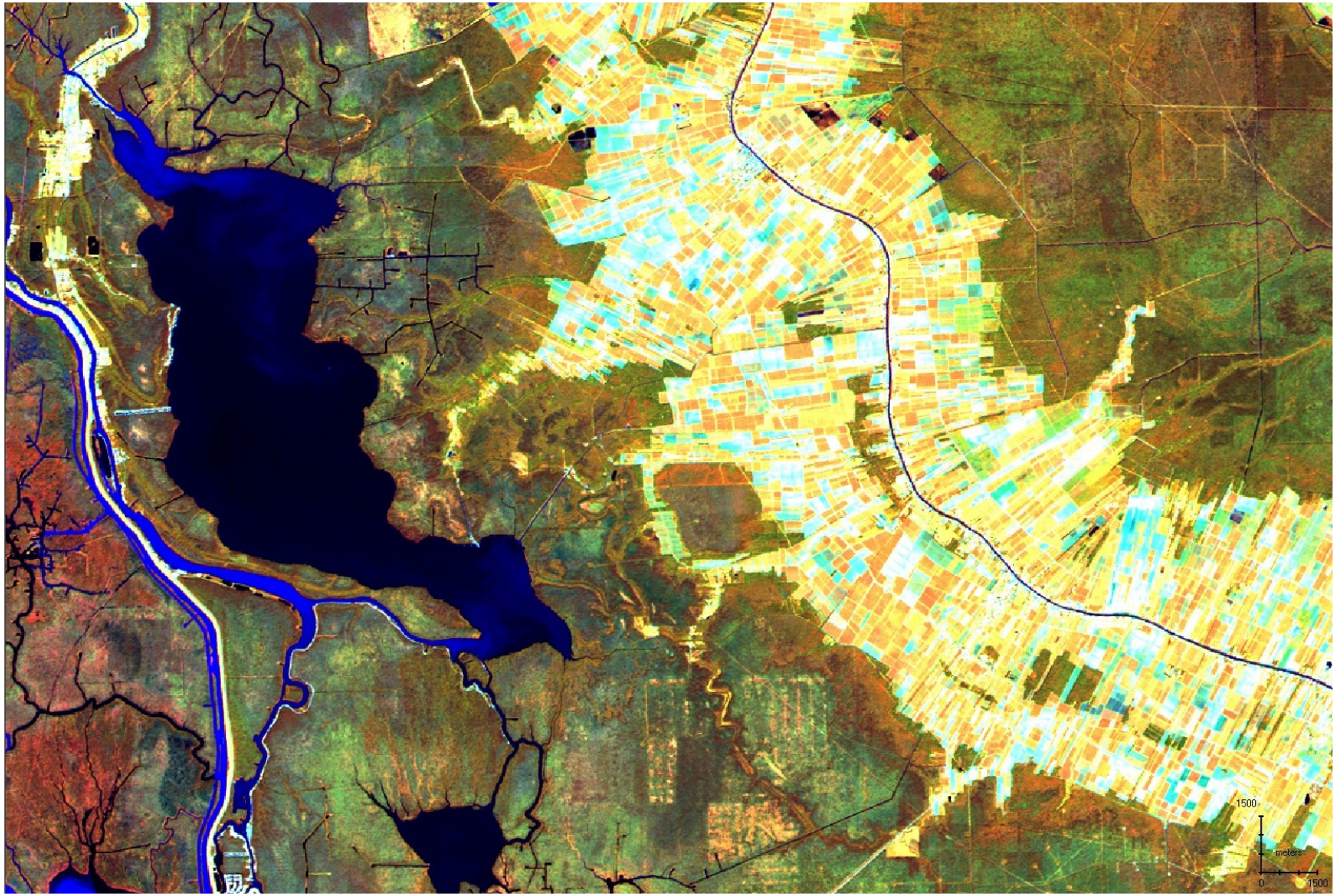
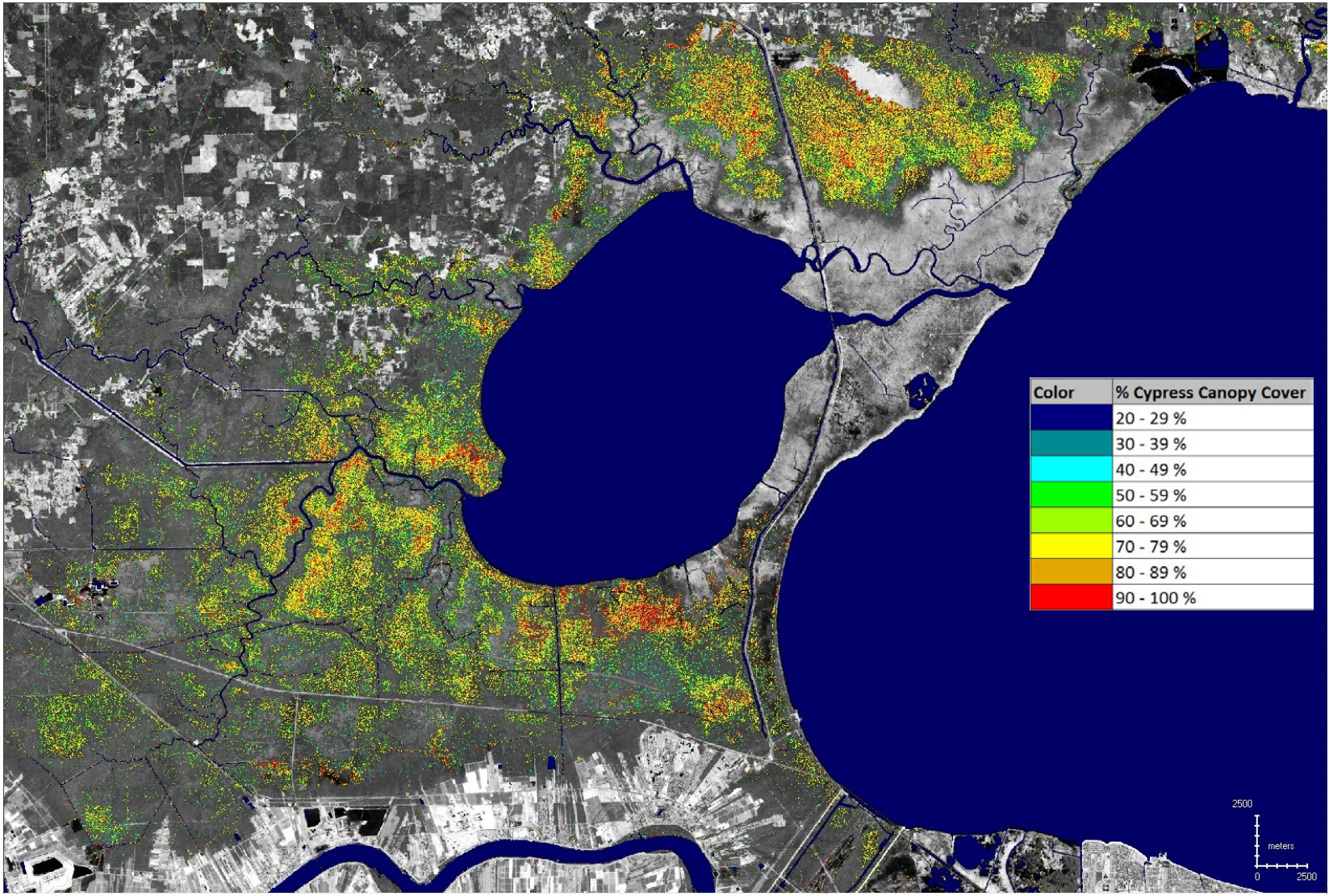
Cypress Forest Foliage in Chocolate Tones – Water Tupelo in Leaf Off State



Cypress Forest Canopy Cover Classification from Landsat Data

Stennis Space Center

Results for Lake Maurepas, Louisiana From 10-20-2009 Landsat Scene



Cypress Forest Canopy Cover Classification from Landsat Data

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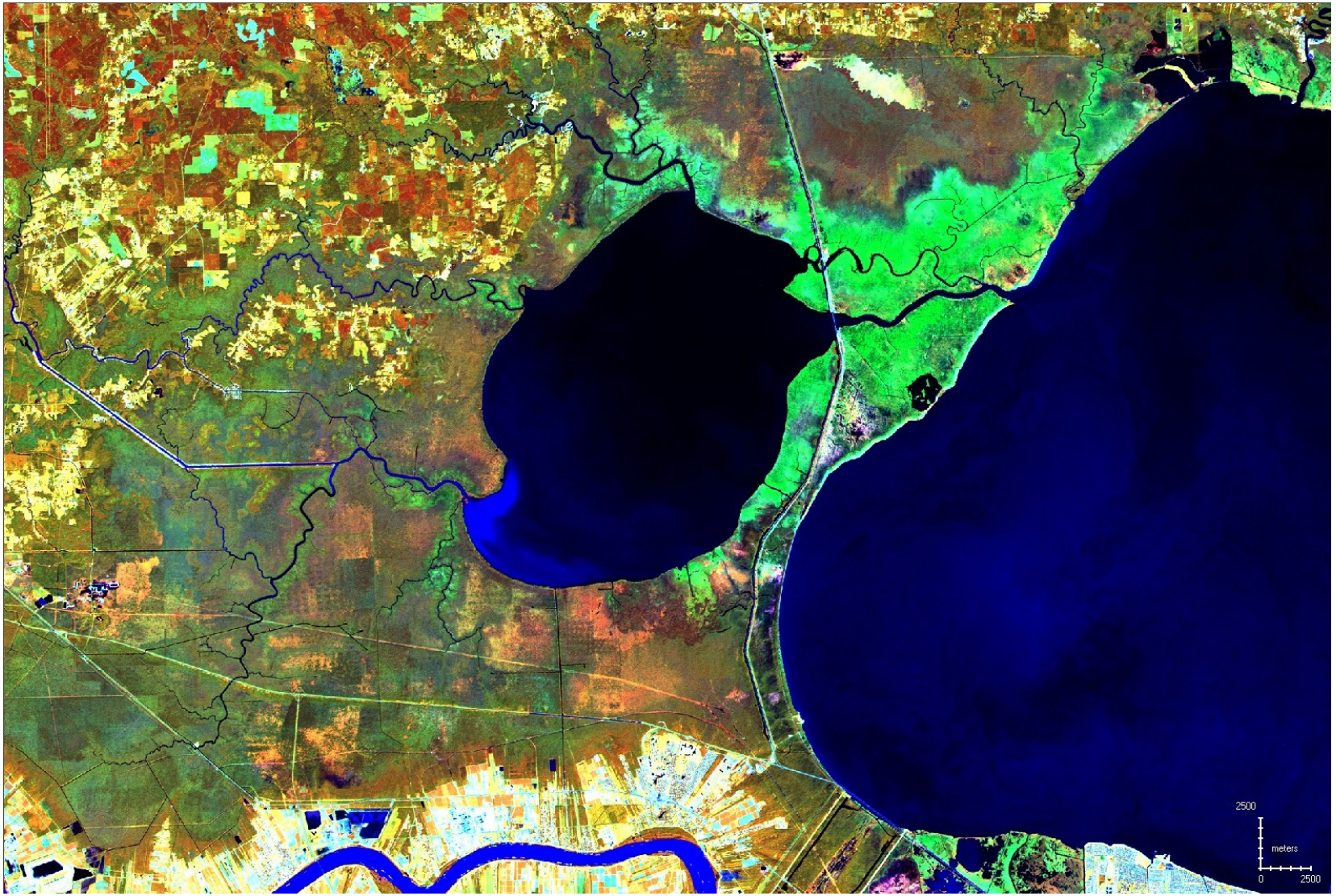
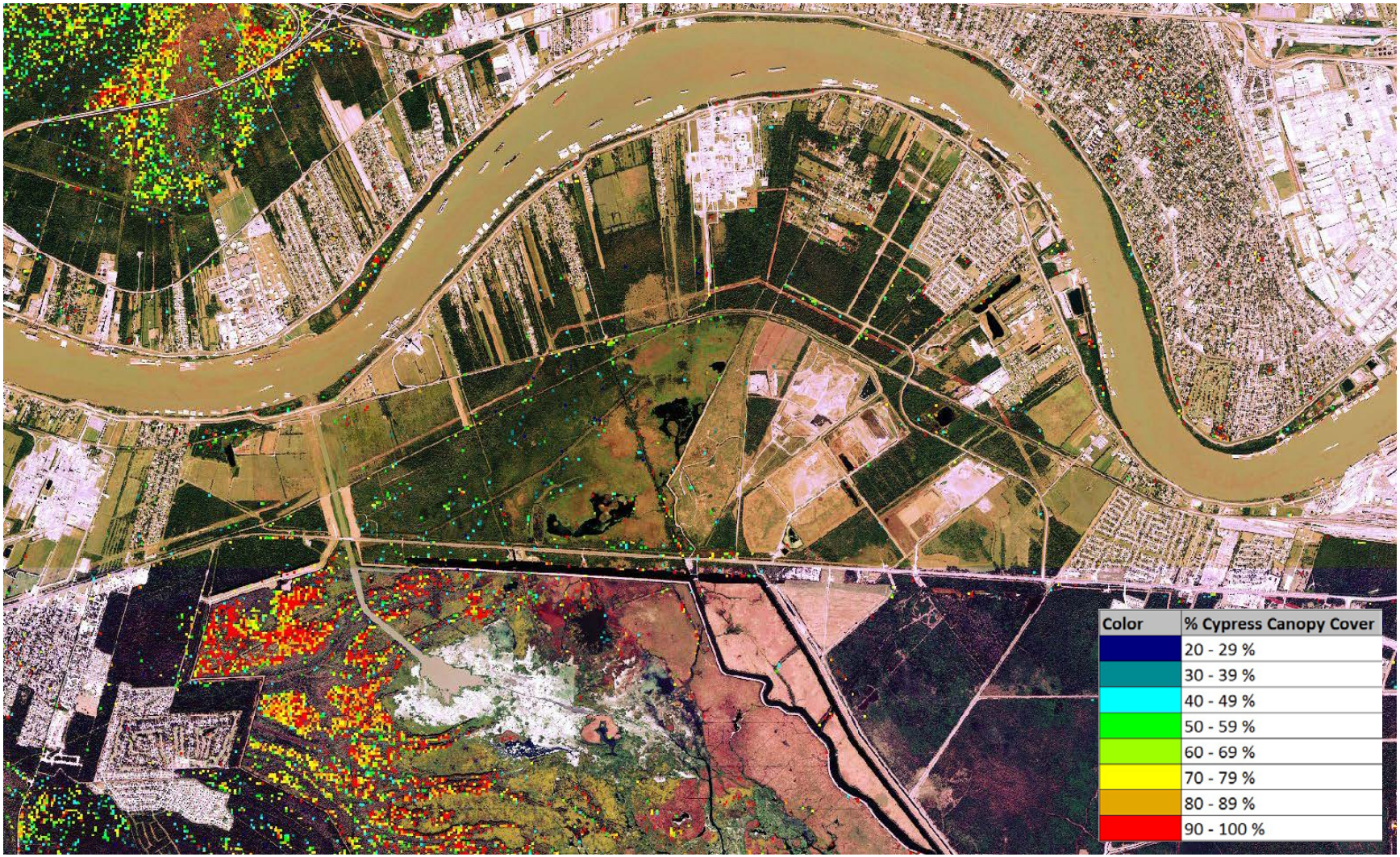
Cypress Forest Foliage in Chocolate Tones – Water Tupelo in Leaf Off State



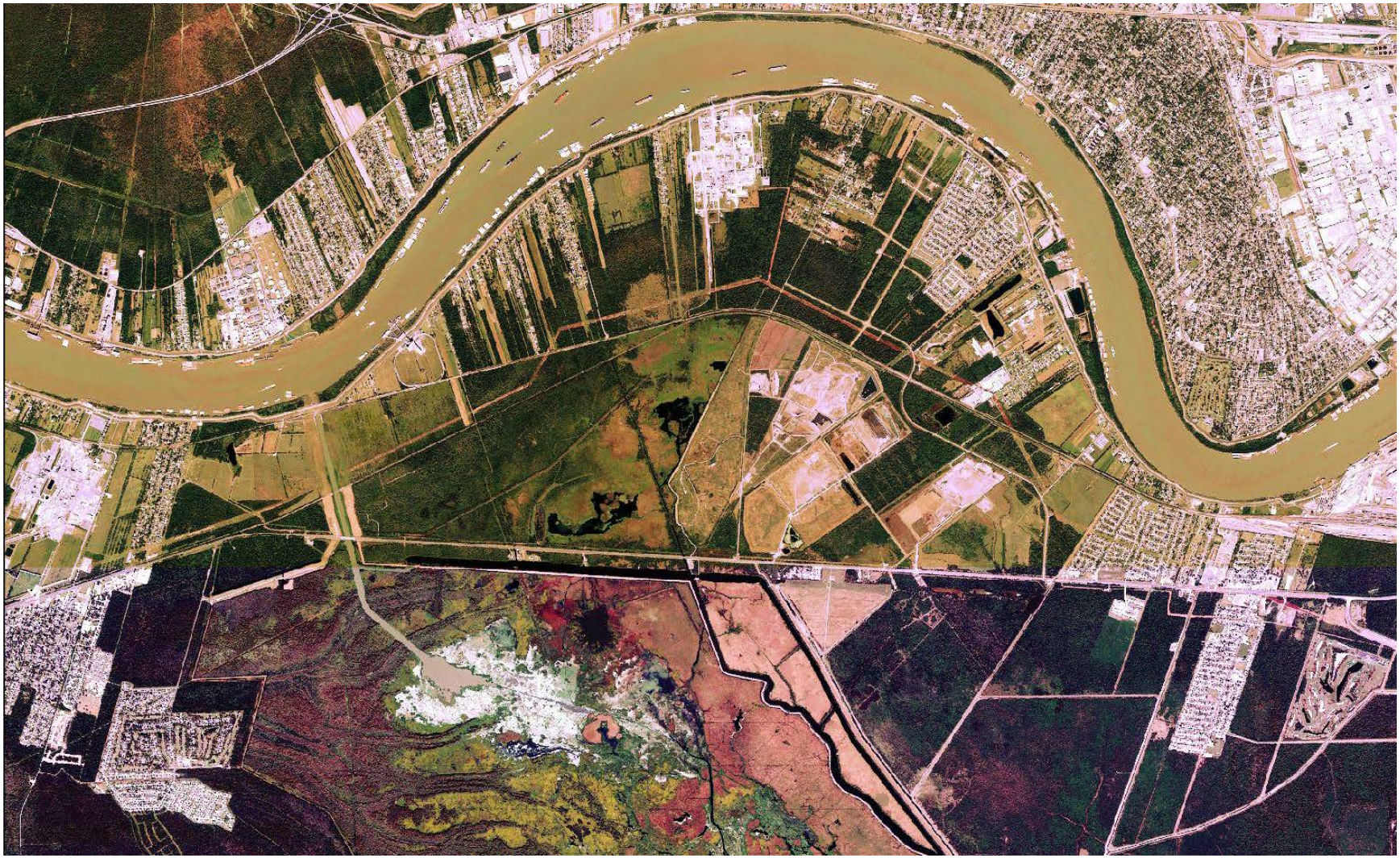
Landsat Classification of Cypress Forest Canopy Cover in 2009

Results for Boutte, Louisiana Draped over 2006 QuickBird True Color RGB



QuickBird True Color Image from October 6, 2006

Cypress Forest in Peak Fall Red Brown Tones



Series 2 – Swamp Forest Change Products from Landsat NDVI Data

Classification of Swamp Forests From 1972 Landsat MSS Data

Results for New Orleans, Louisiana Using Landsat Data from 10-1-1972

False Color RGB from Landsat MSS Data Acquired 10-1-72

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Swamp Forests Appear to Be Largely Leaf Off and Flooded

1972 – 2010 Swamp Forest Change Based on Landsat Data

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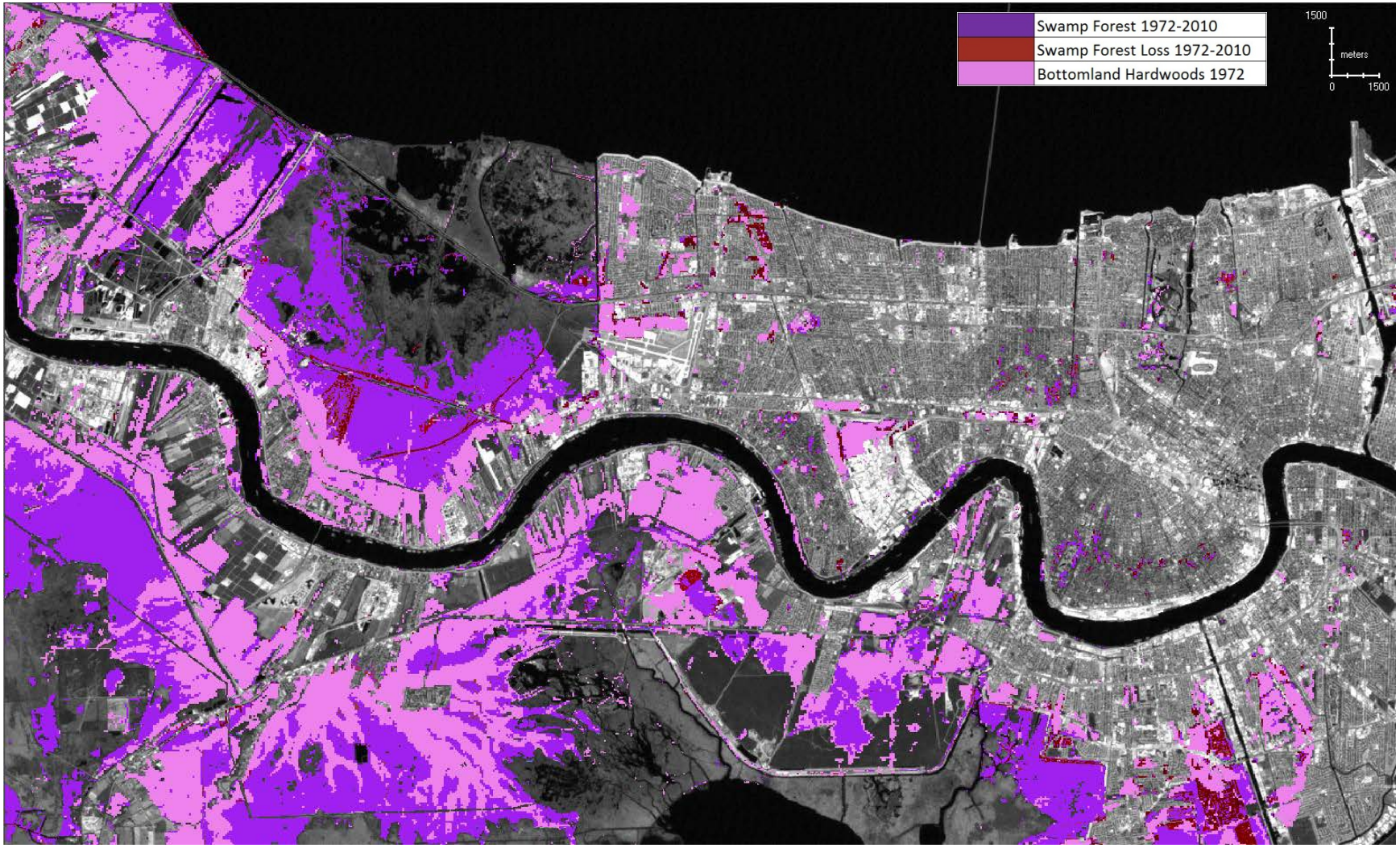
Forest Change Shown in Red Tones – Only Swamp Forest Change Shown



False Color RGB Image from Landsat TM Data Acquired 10-7-2010

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Most Swamp Forest Change in This Area is From Urbanization

Series 3 – Swamp Forest Monitoring Products from MODIS NDVI Data

Landsat Forest Change Product Showing 2010 Insect Defoliation

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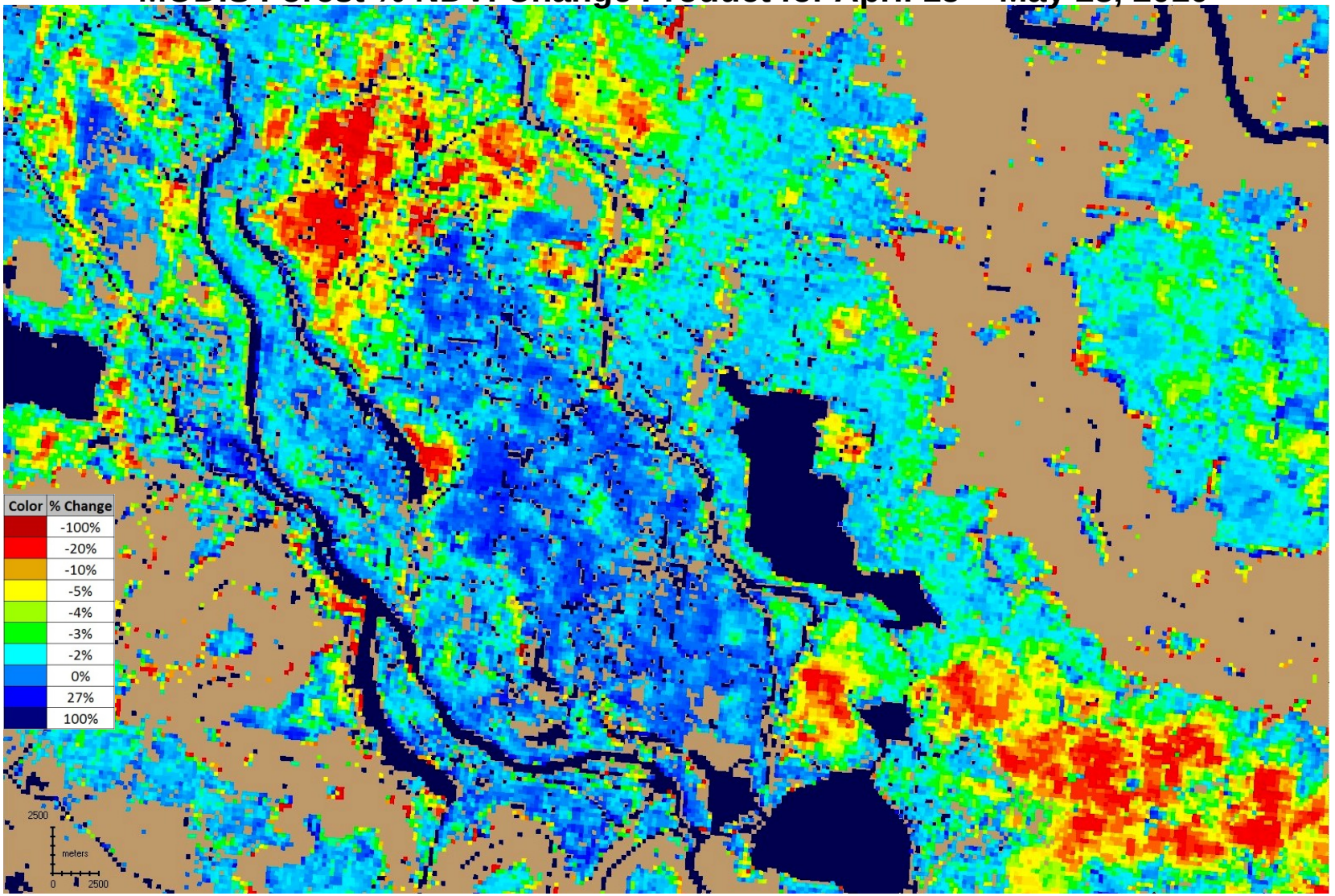
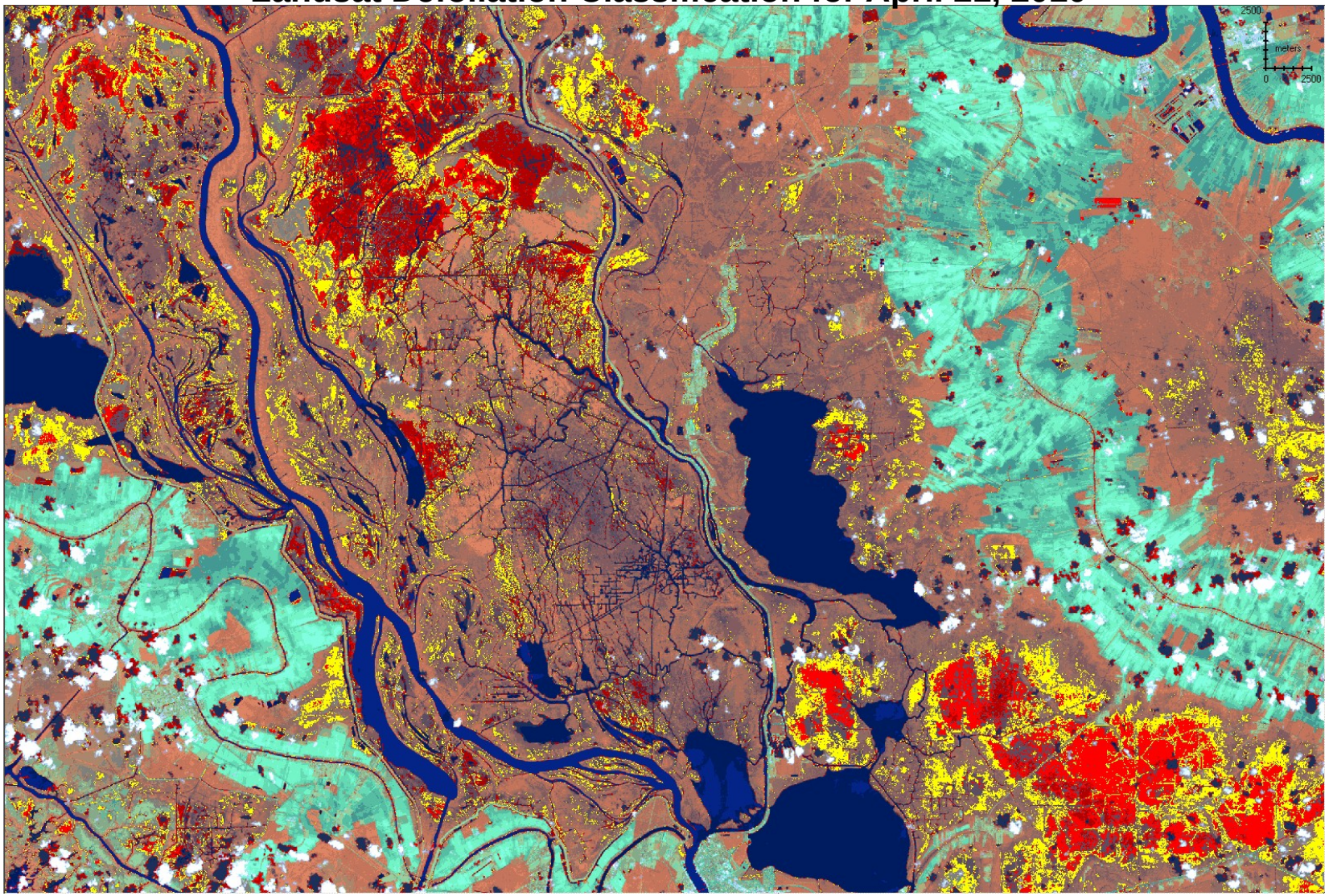
MODIS Forest % NDVI Change Product for April 15 – May 28, 2010



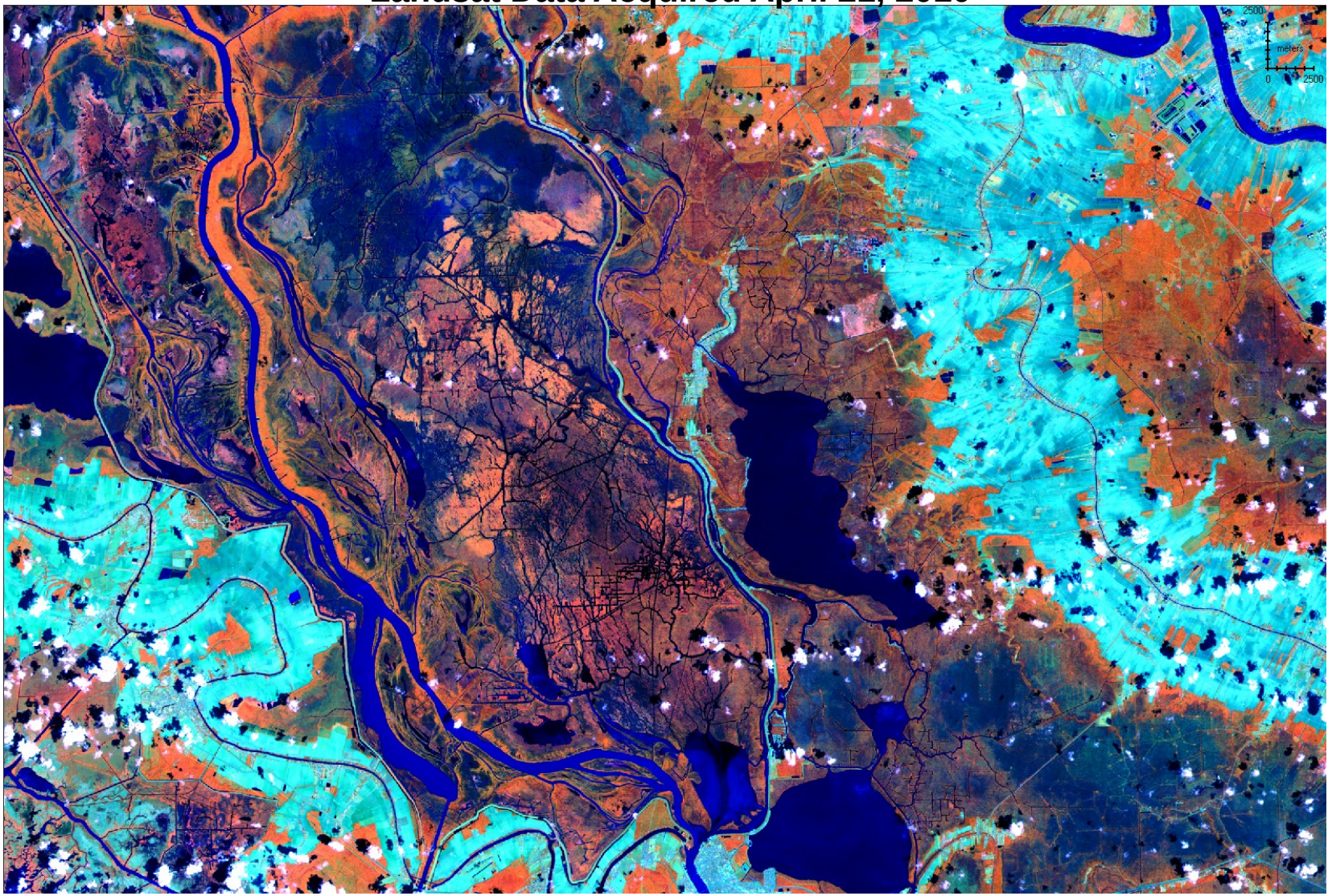
Landsat Classification of 2010 Insect Defoliation

Landsat Defoliation Classification for April 21, 2010



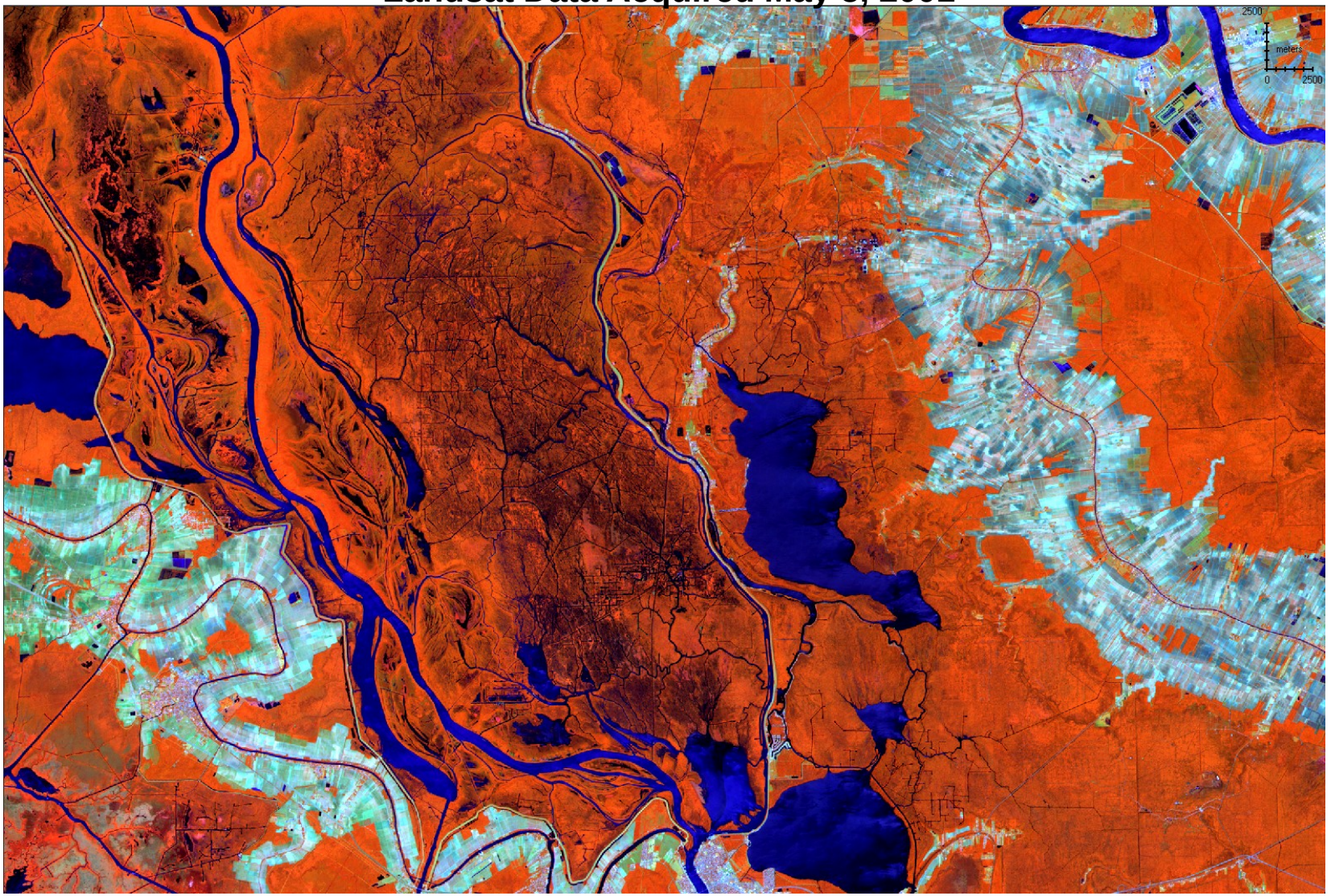
Landsat False Color Image of 2010 Insect Defoliation

Landsat Data Acquired April 21, 2010



Landsat False Color Image of Same Area in Non-Defoliated State

Landsat Data Acquired May 5, 2001



MODIS Map of 2011 Flooding During Morganza Spillway Release

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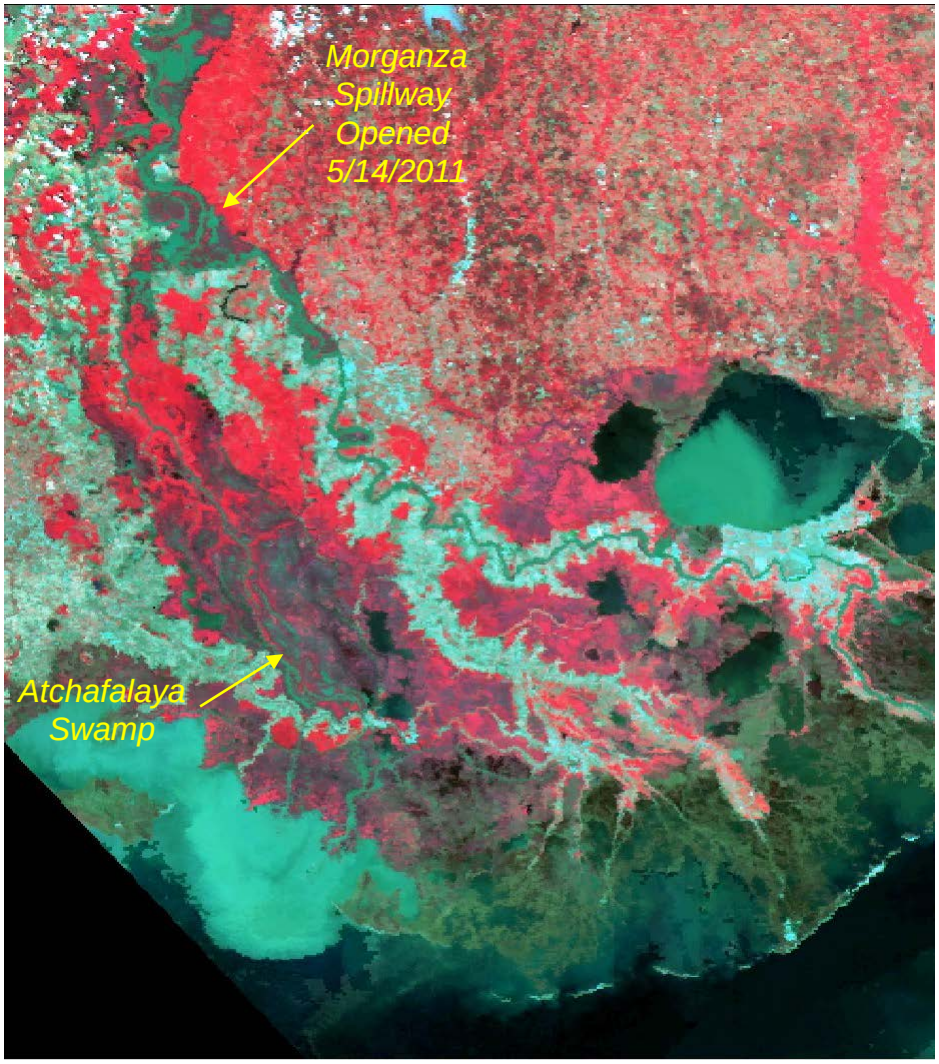
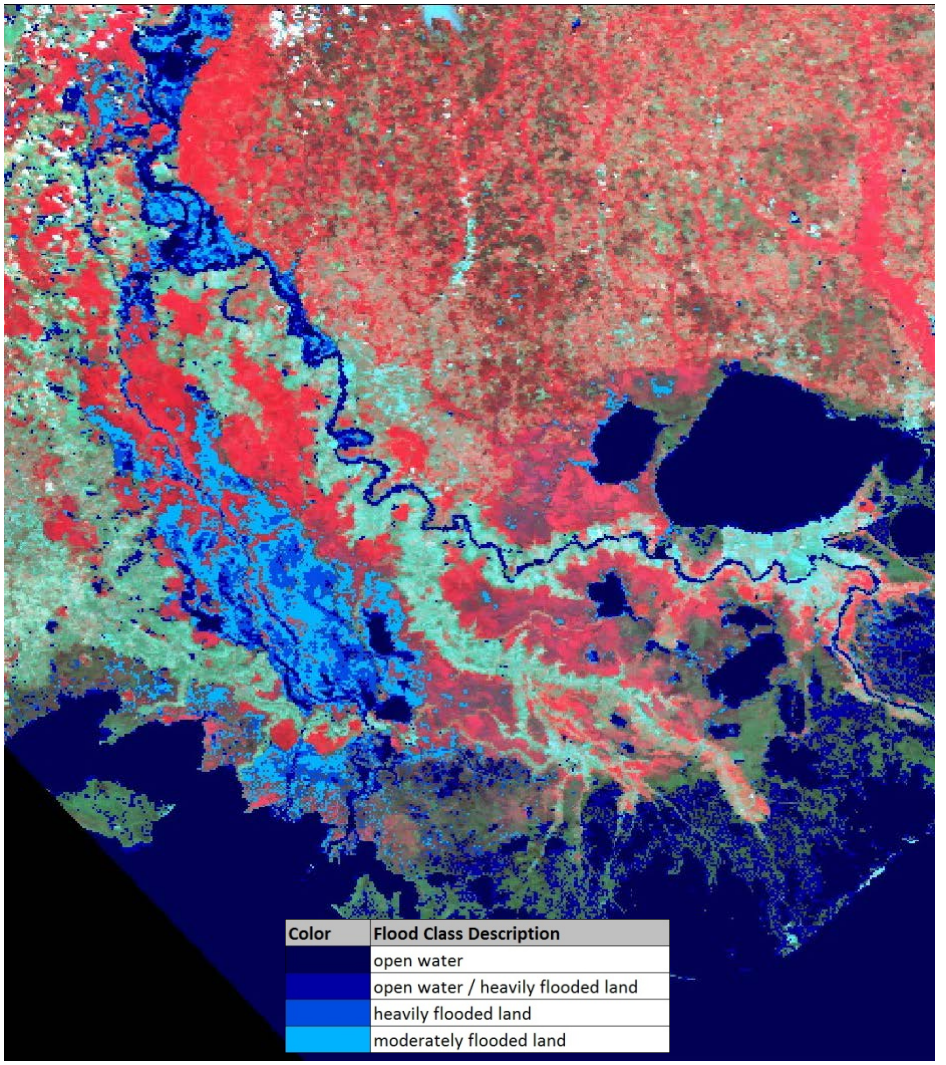
MODIS False Color Image from May 17, 2011



MODIS Wetland Flood Map for May 17, 2011



MODIS End of Year Cumulative NDVI for 2010

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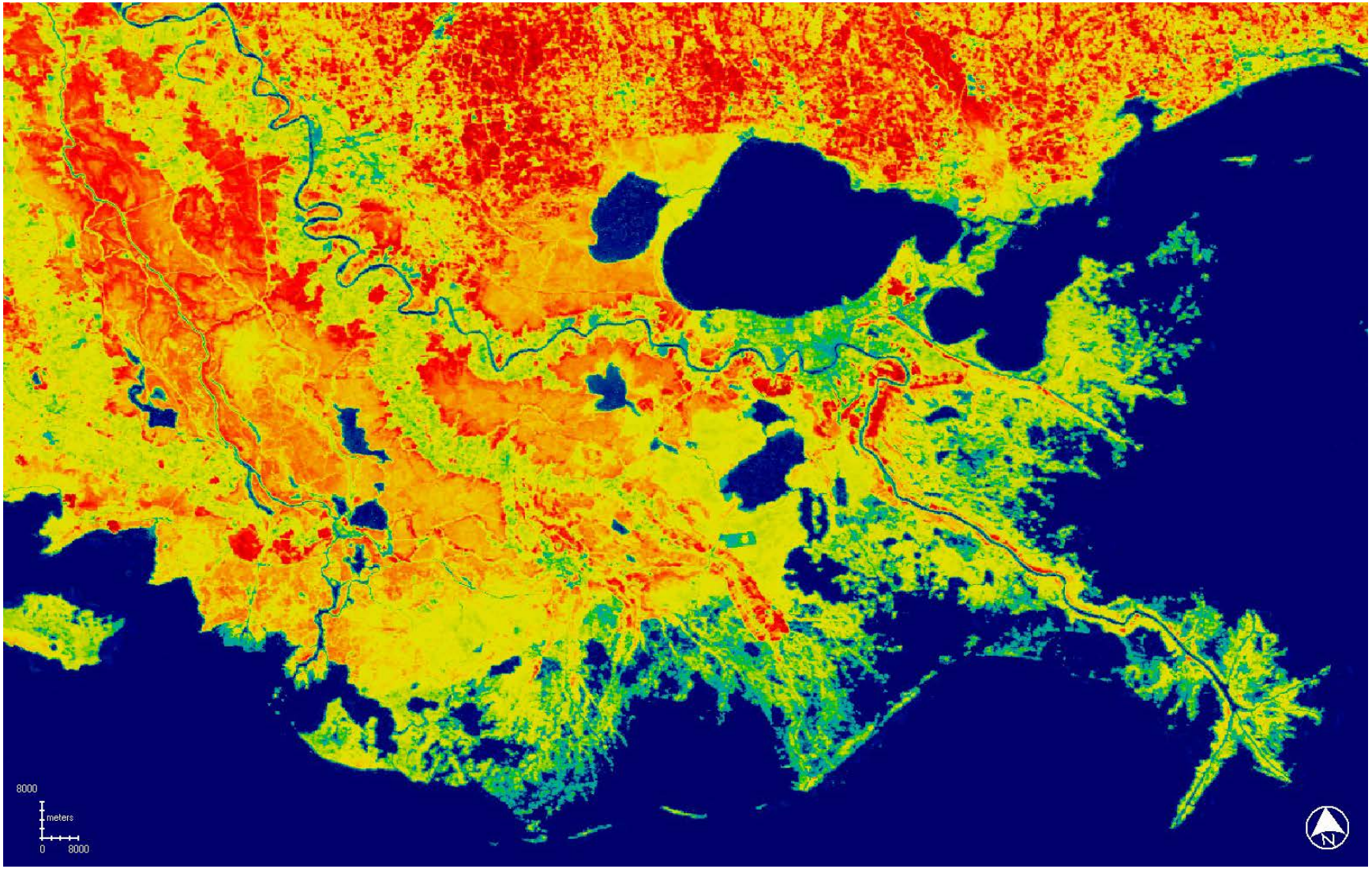
Example Phenology Product with Potential for Monitoring Coastal Forest Health



Findings Thus Far

- Landsat classification of cypress type and canopy cover showed visual agreement to available reference data, though more work is needed to quantify accuracy
  - Areas with cypress concentrations were used to aid the CFCI evaluations for land acquisition and conservation easements
  - Percent cypress canopy cover may be helpful for showing where healthiest cypress stands are located
- ASTER data coverage was limited mostly useful for assessing Landsat and MODIS products
- Landsat swamp forest change products enabled assessment of disturbances occurring since 1972
  - Product detected harvesting and more ephemeral disturbances
- MODIS forest change products showed disturbances from storms, flooding, insect damage and large clearings

Final Remarks

- MODIS end of year cumulative NDVI products appear to have potential for assessing swamp forest health
  - Such products show real forest change, such as forest clearings
  - Such products also show relative variations in yearly canopy greenness "productivity"
- The main problem in doing the project was validation of the percent canopy cover product
  - Reference data acquisition was initially the issue but now resolved
  - Development of a reference product remains a challenge
- For more information on this presentation, email joseph.p.spruce@nasa.gov
- Weekly MODIS forest change products can be viewed on the US Forest Service ForWarn system on-line at: http://forwarn.forestthreats.org/

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