National Aeronautics and
Space Administration

2018 Summer | Virginia – Wise

LOUISIANA ECOLOGICAL FORECASTING

Using Landsat to Monitor and Predict Roseau Cane Die-offs Caused by The Invasive Roseau Cane Scale and Other Environmental Factors

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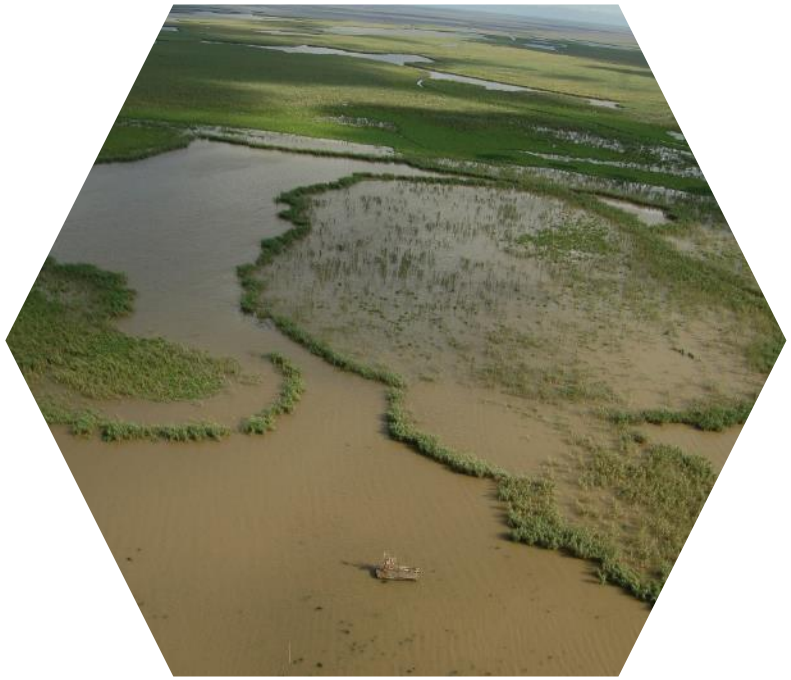
Partner

- National Wildlife Federation

Dr. Alisha Renfro

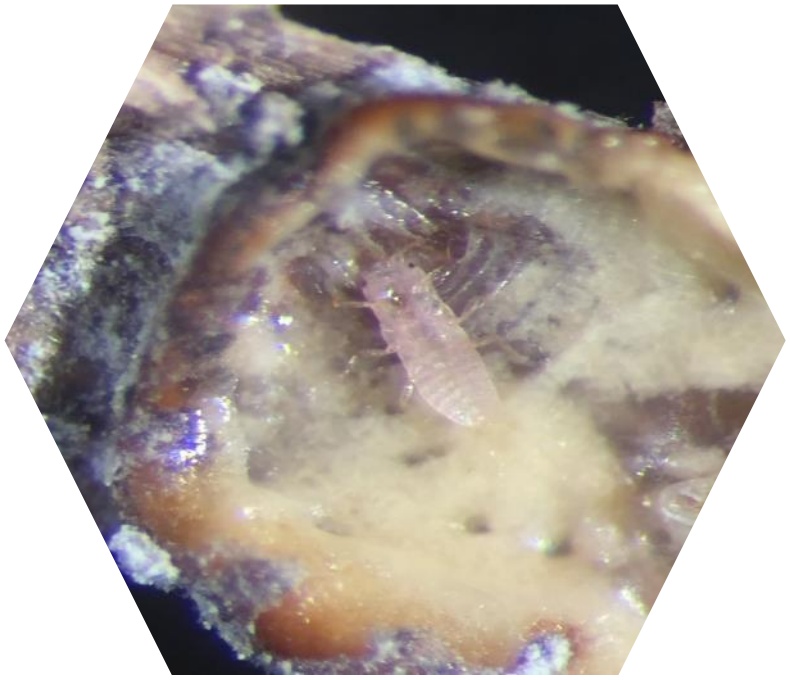
Credit: Coast 360

Community Concerns



- Invasive species threaten natural ecosystems, often disrupting ecosystem dynamics and decrease ecosystem goods and services.

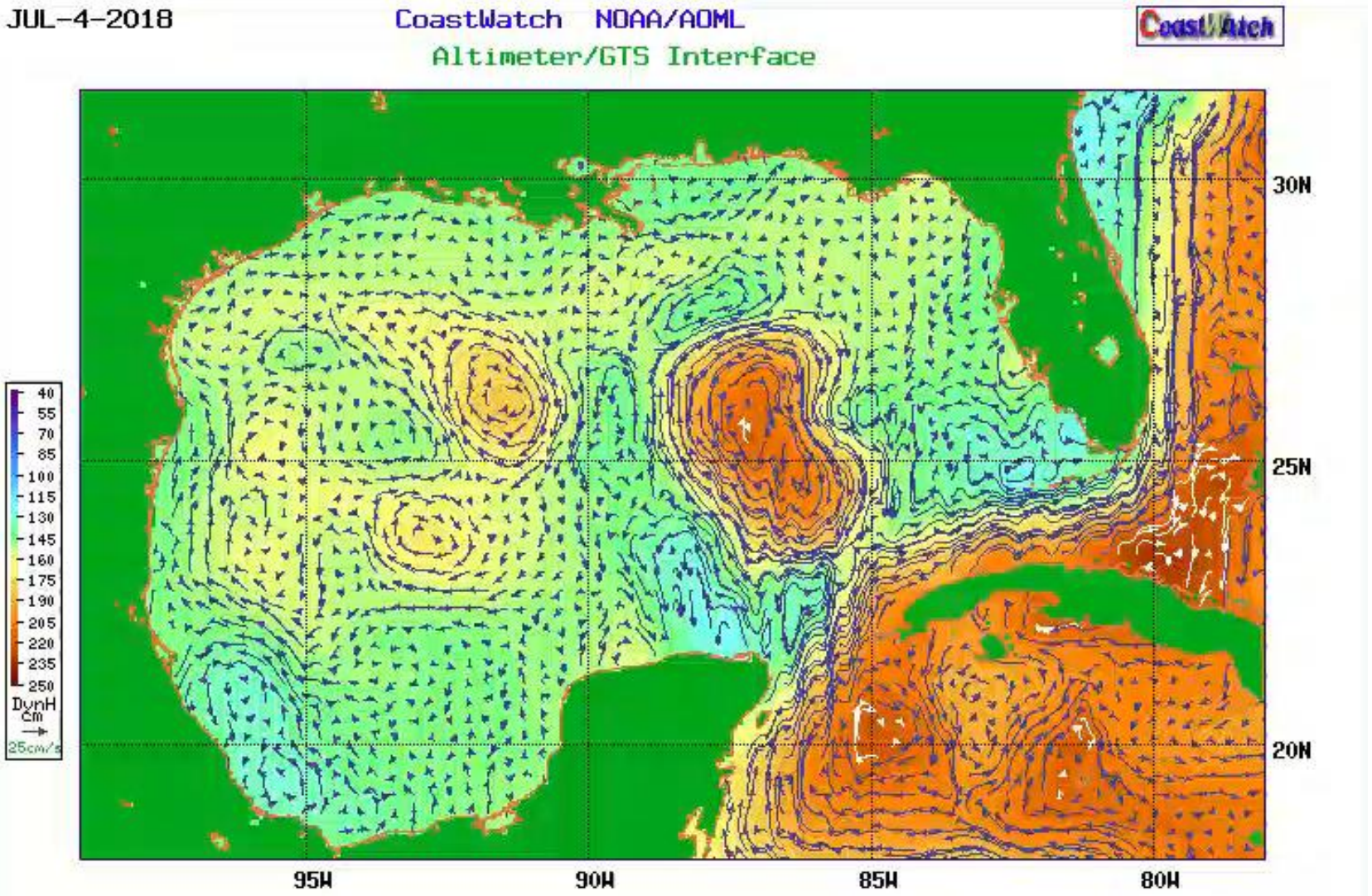
- The National Wildlife Federation intends to use science-based tools to inform decision-making in mitigation, management & restoration in the Mississippi River Delta.



- Roseau cane scale depletes Roseau cane of nutrients & degrades rhizomes, so grow-back is decreased and/or halted, creating areas of open water.

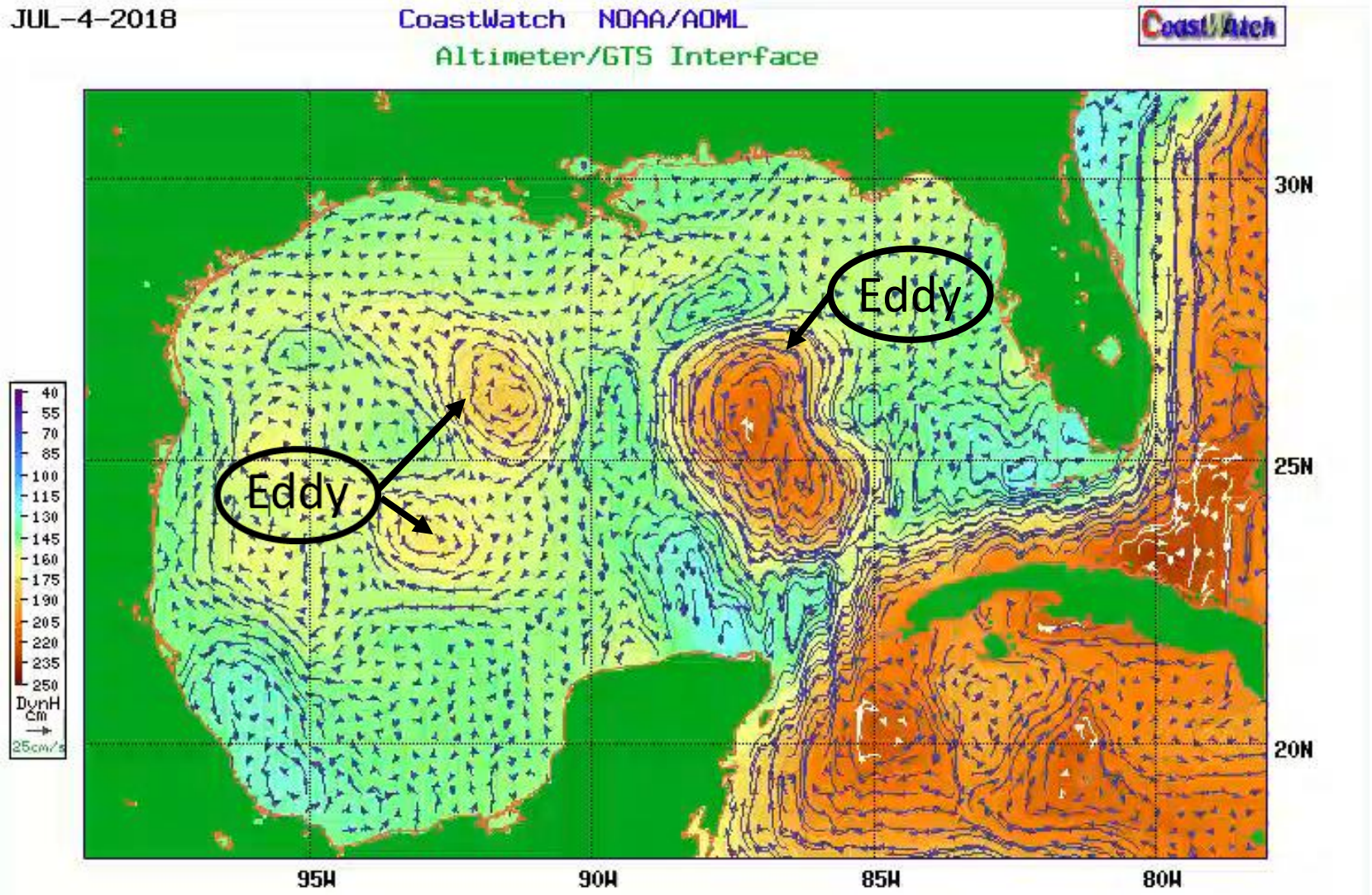
Credits: LSU Ag Center, Louisiana Wildlife & Fisheries

Credit: Tristan Baurick



Gulf Loop Current time-lapse NOAA Animation

Louisiana Land-loss and Roseau Cane Die-offs

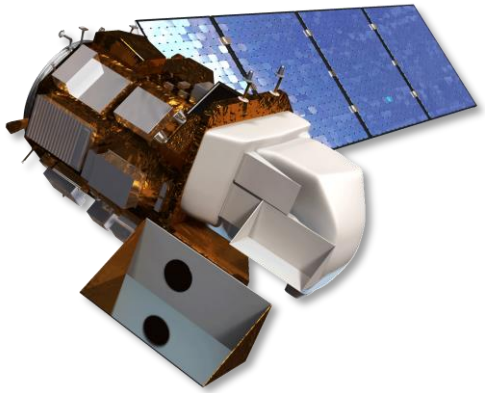


Gulf Loop Current time-lapse NOAA Animation

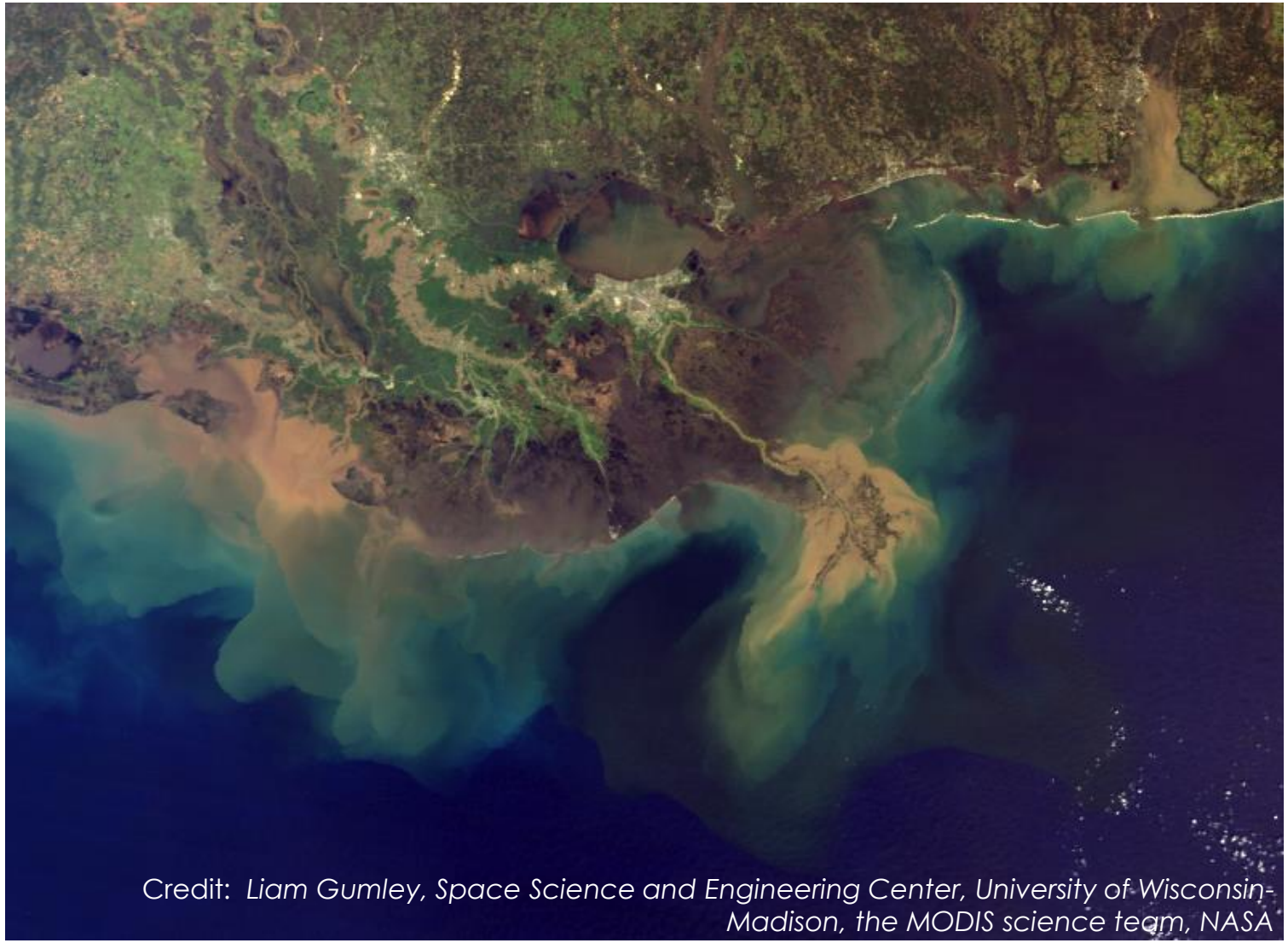
Louisiana Land-loss and Roseau Cane Die-offs

Satellites

Landsat 5 TM



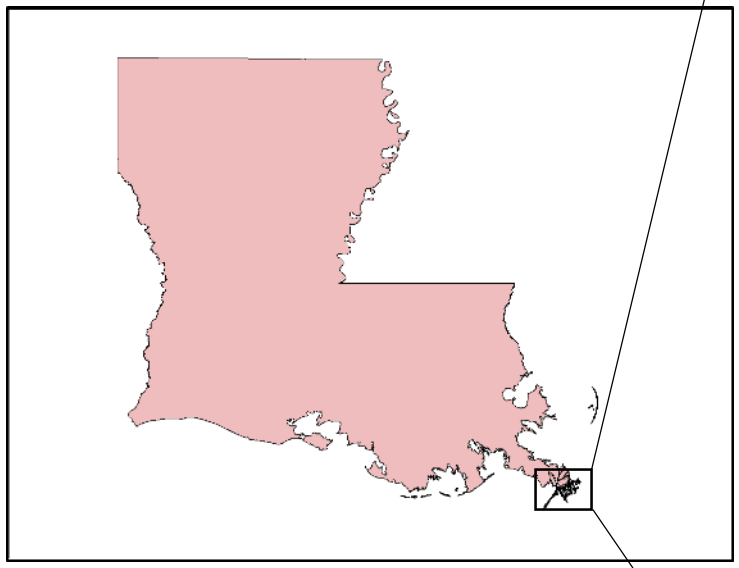
Landsat 8 OLI



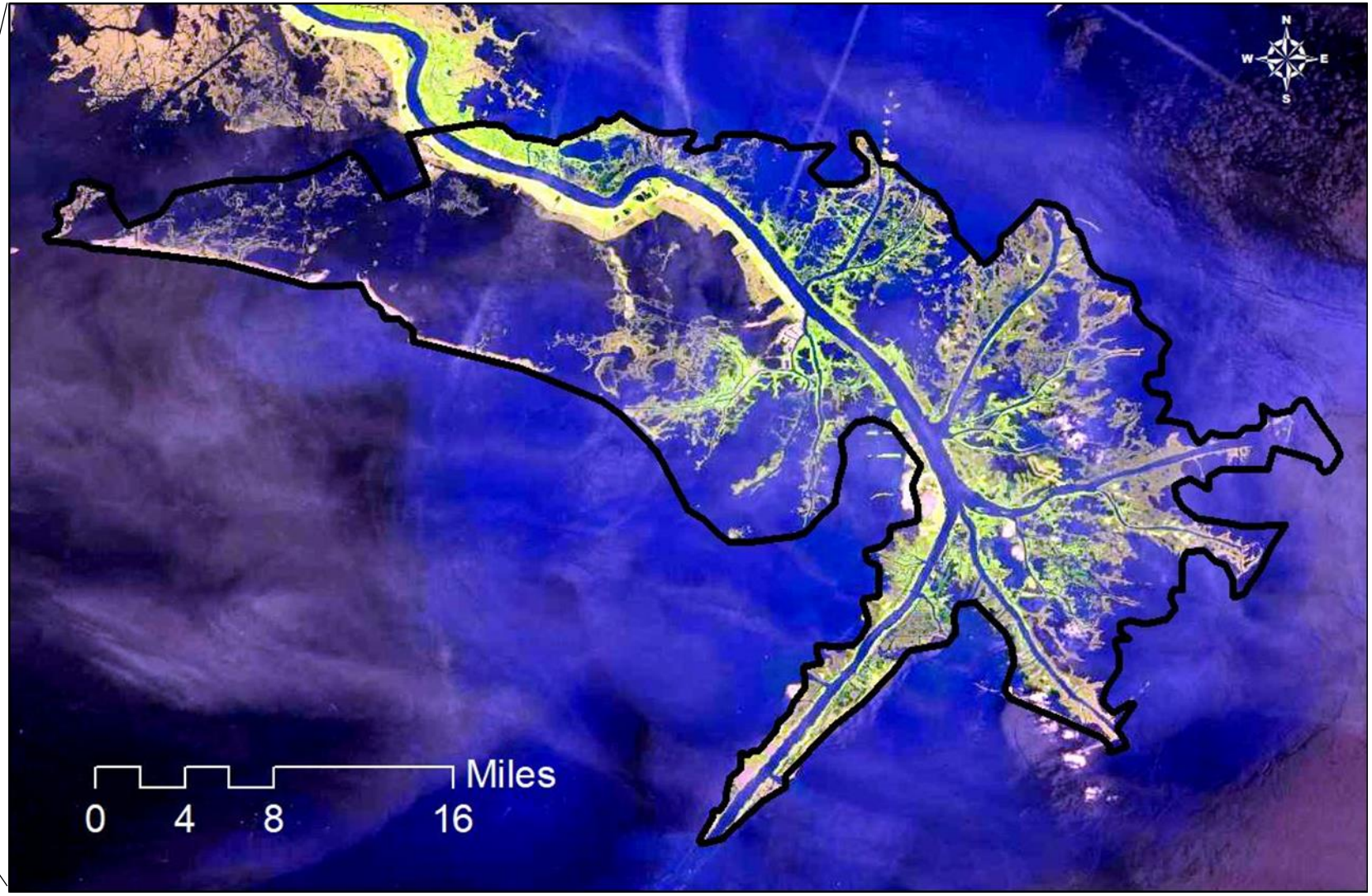
Mississippi River Sediment Plume (March 16, 2001)

Study Area

Southern Plaquemines Parish, LA, USA and the state of Louisiana inset



Study Period: 2005-2017
Forecasting to 2030
(Gap year: 2012
no cloud-free data)



Objectives

- **Generate** NDVI maps to monitor marsh health (i.e. greenness) between 2005-2017
- **Assess** landcover change in the study area over the study period
- **Compute** annual NDVI change maps and study period change maps for 2005-2017
- **Forecast** out to 2030 locations of Roseau cane dominated marsh using SAHM
- **Determine** areas of high vulnerability and resilience to major disturbances

Methodology

Google Earth Engine's (GEE) Integrated Development Environment (IDE)

↓

QGIS NDVI Change

↓

Coastwide Reference Monitoring Systems (CRMS) stations & aerial photos

↓

ArcGis & Dr. Madden randomly distributed Roseau cane points

↓

Software for Assisted Habitat Modelling (SAHM) model

Acquire Landsat imagery

Preprocess imagery, composite bands, least cloudy single scene chosen

Compile a code in GEE for NDVI classification using "greenest pixel"

Analyze NDVI yr. to yr. change in QGIS, stacking yrs. 2005, 2011, 2017

Create classified Roseau cane distribution maps from CRMS points & aerial photos

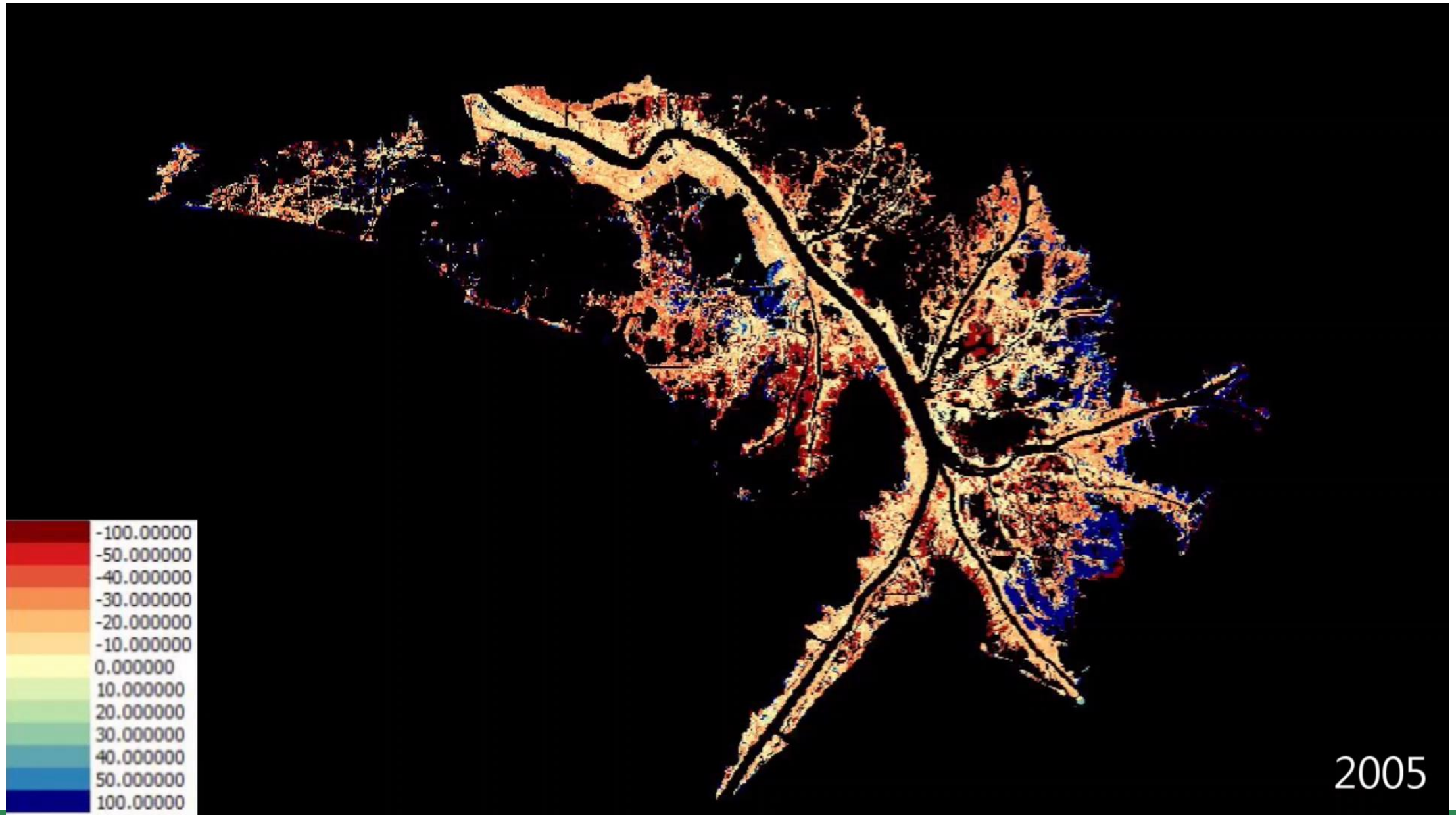
Input *in-situ* data & extrapolated presence/absence pts. of cane into the SAHM model

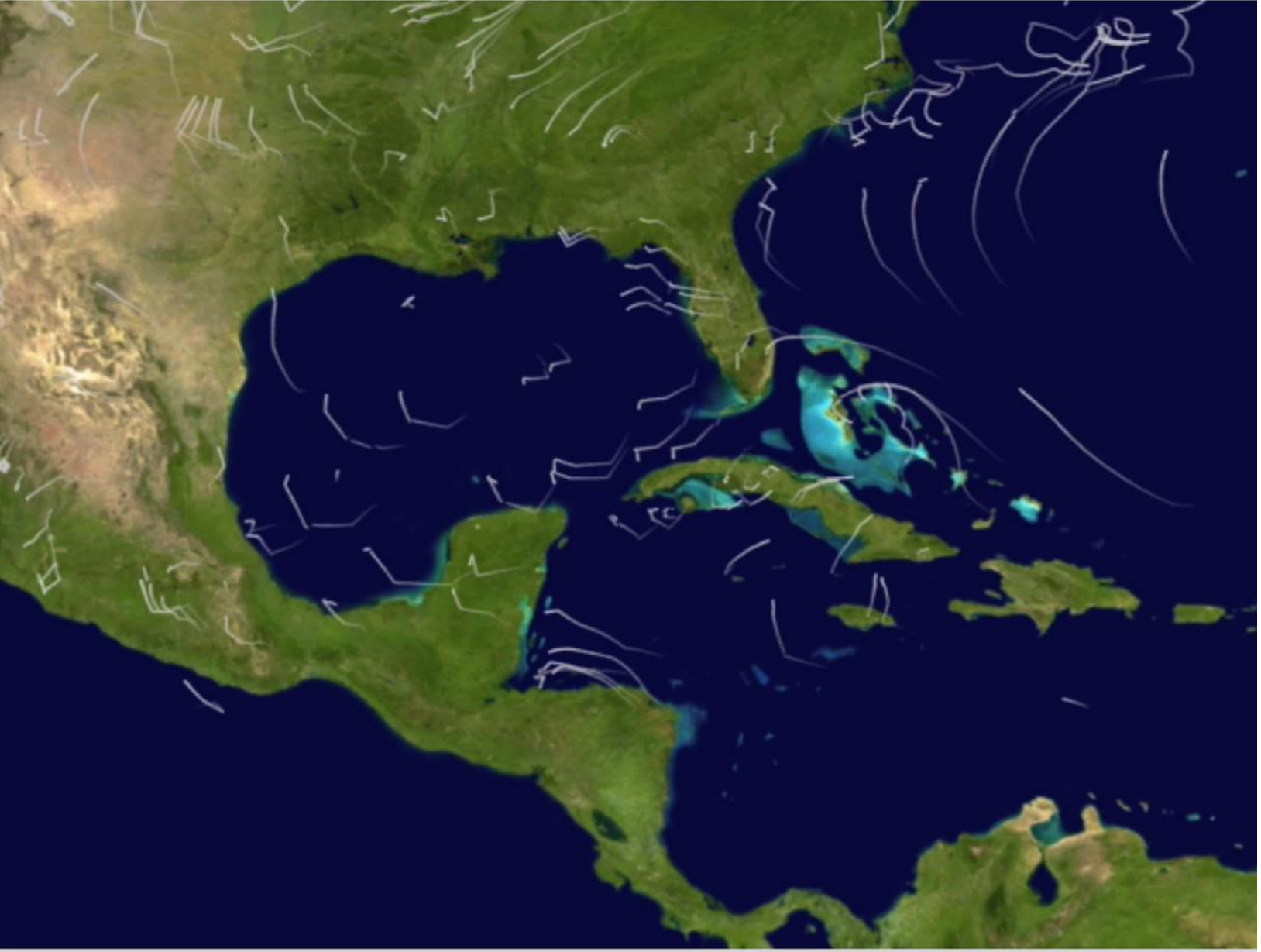
Input NDVI, CoNED DEM & climate data into SAHM

Run SAHM model & perform statistical analysis

Forecast the spread of Roseau cane die-offs and predict future health of the marsh out to 2030

NDVI Classification & Comparisons

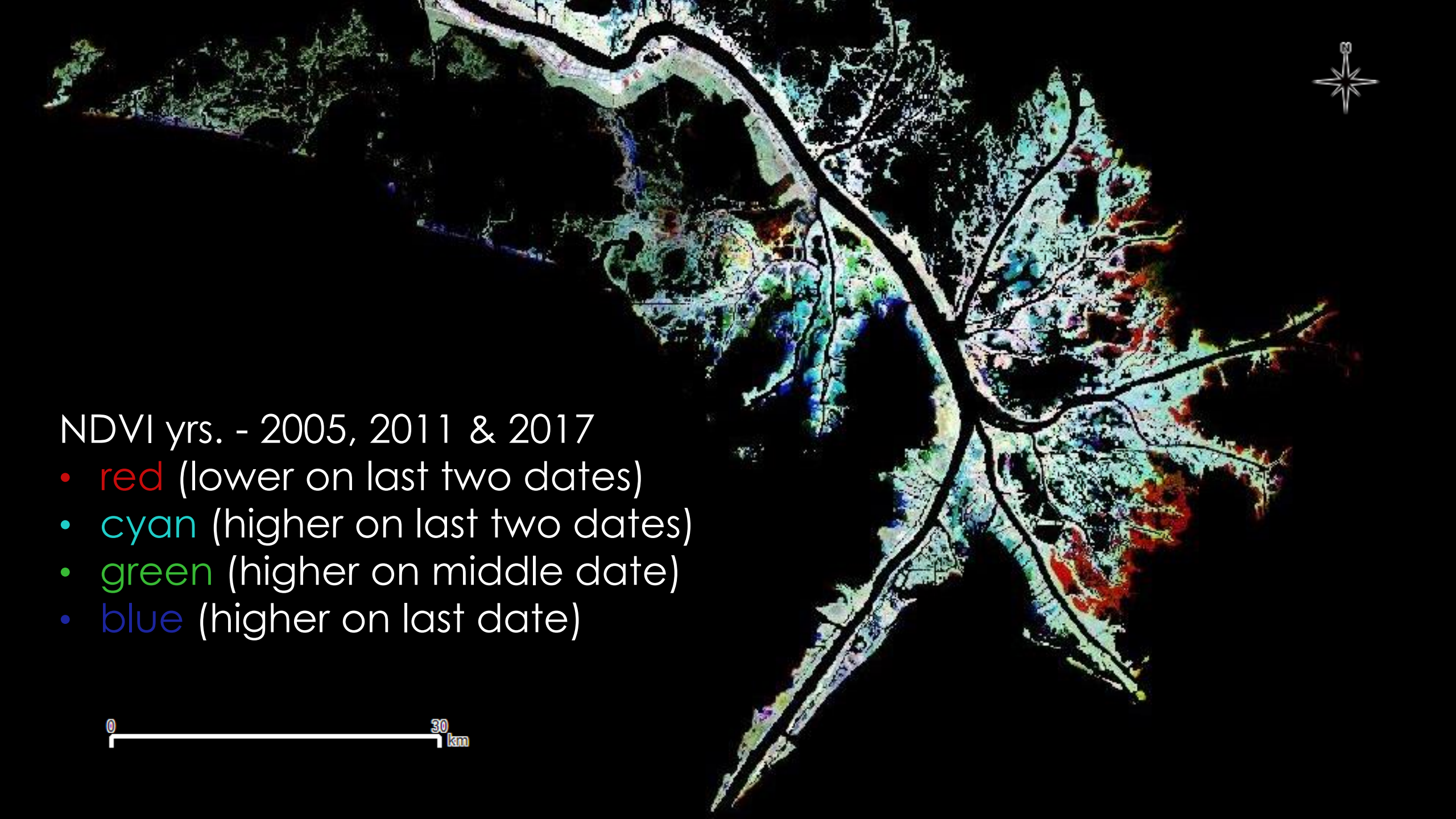




The animation shows the wind analysis data from August 23 through 31, 2005 from NASA's Modeling, Analysis and Prediciton Program 2005. This preview image shows Hurricane Katrina's winds just before landfall on August 29, 2005. At this point, the storm has sustained winds near 145 mph.

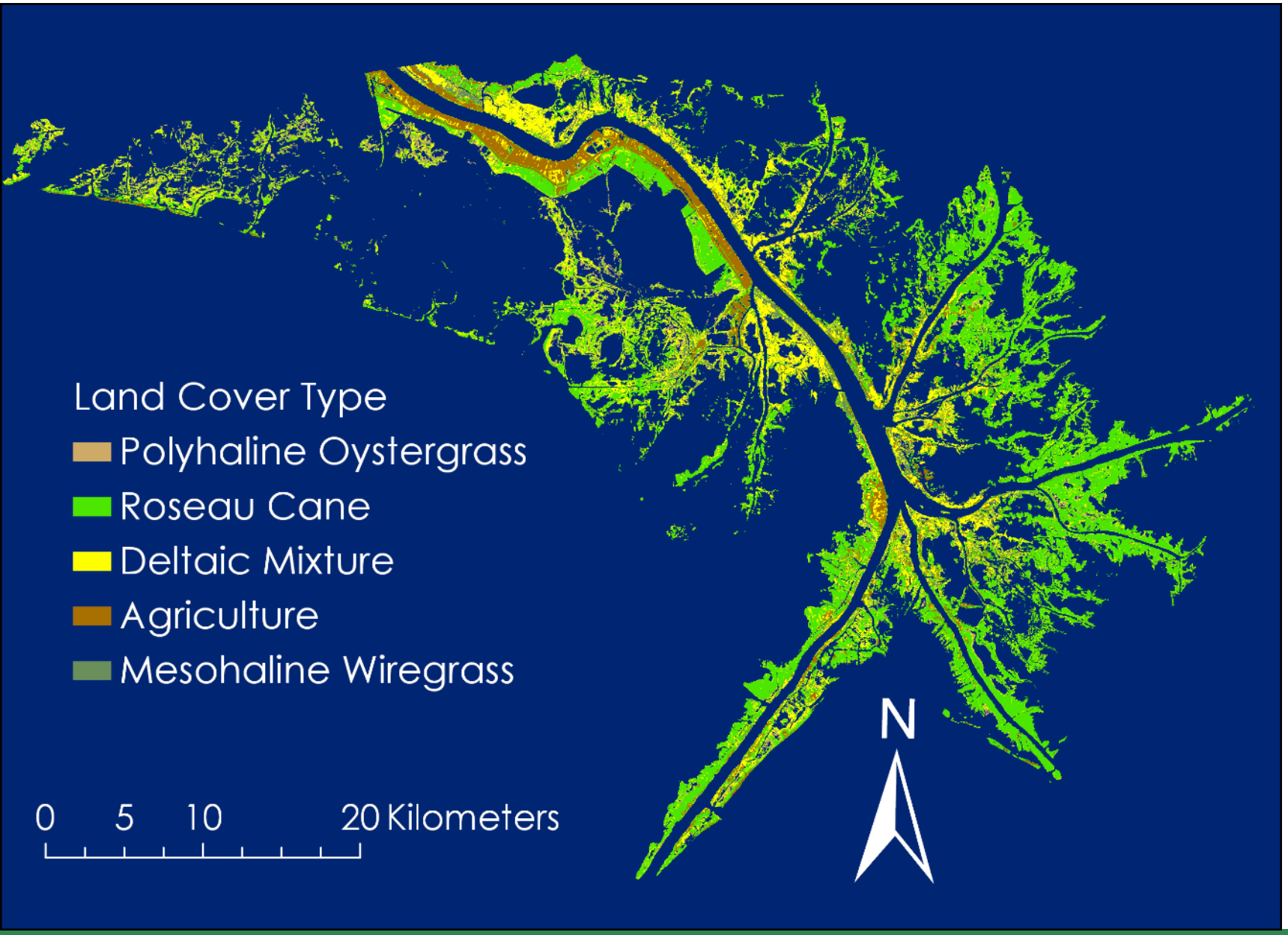
Download

- Hurricane Katrina's winds just before landfall on August 29th, 2005
- Storm winds near 145 mph


NDVI yrs. - 2005, 2011 & 2017
red (lower on last two dates)
cyan (higher on last two dates)
green (higher on middle date)
blue (higher on last date)
0
30
km

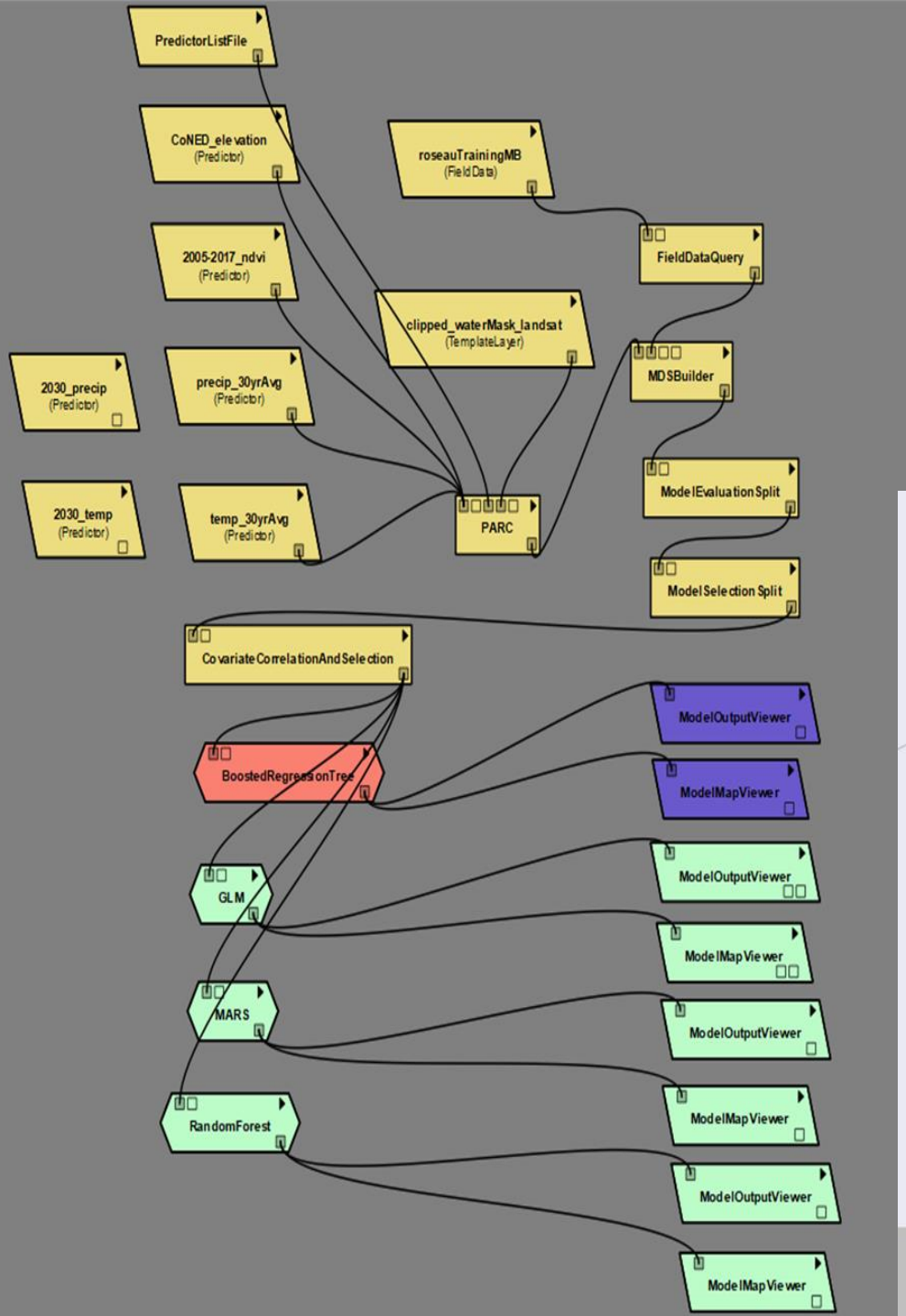

CRMS Aerial Photo
Unsupervised Classification
CRMS Station
Water Mask
Training Points

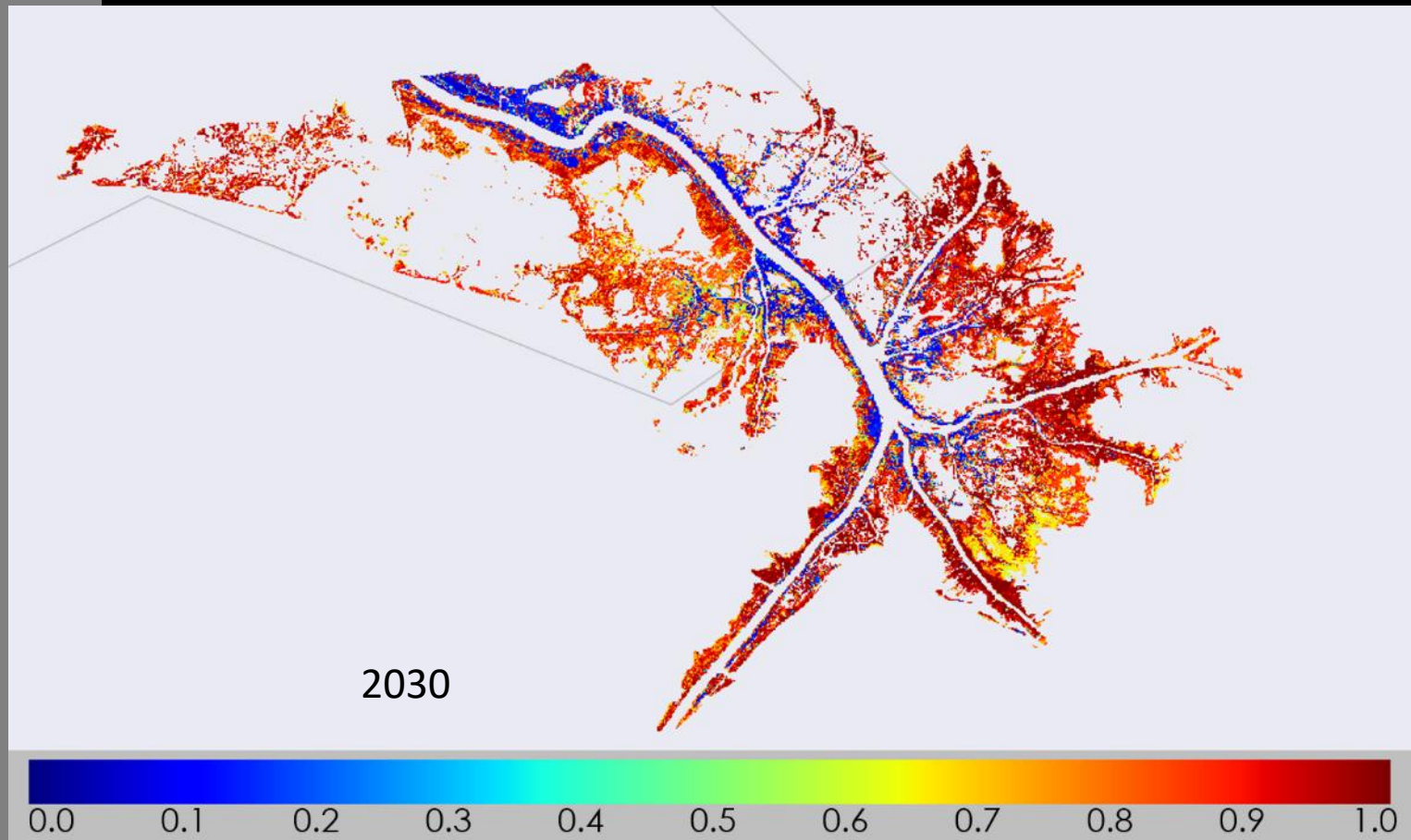
Classified Distribution Map



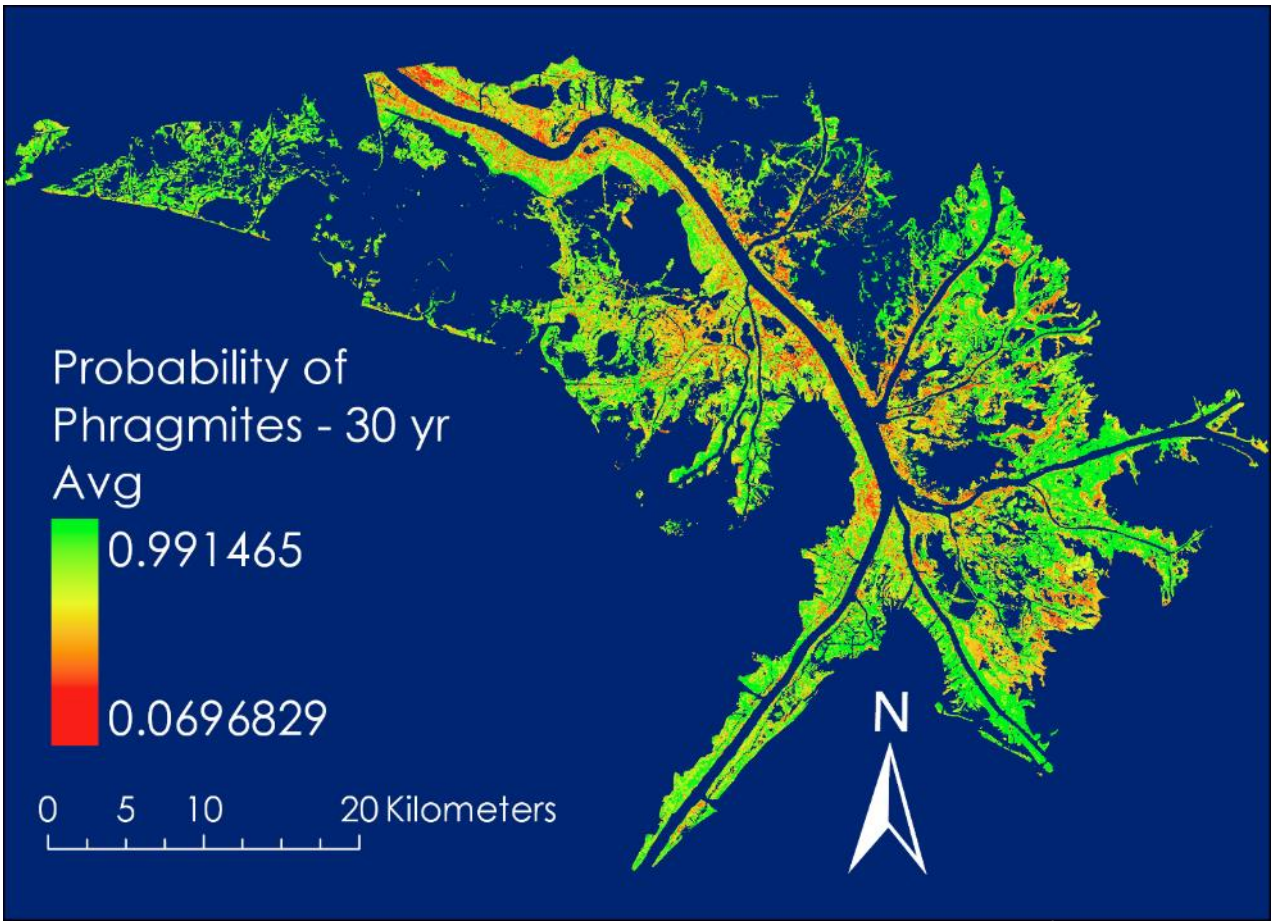
- Based on 2011 Landsat 5 TM Imagery
- Classified using combination of NAIP & CRMS

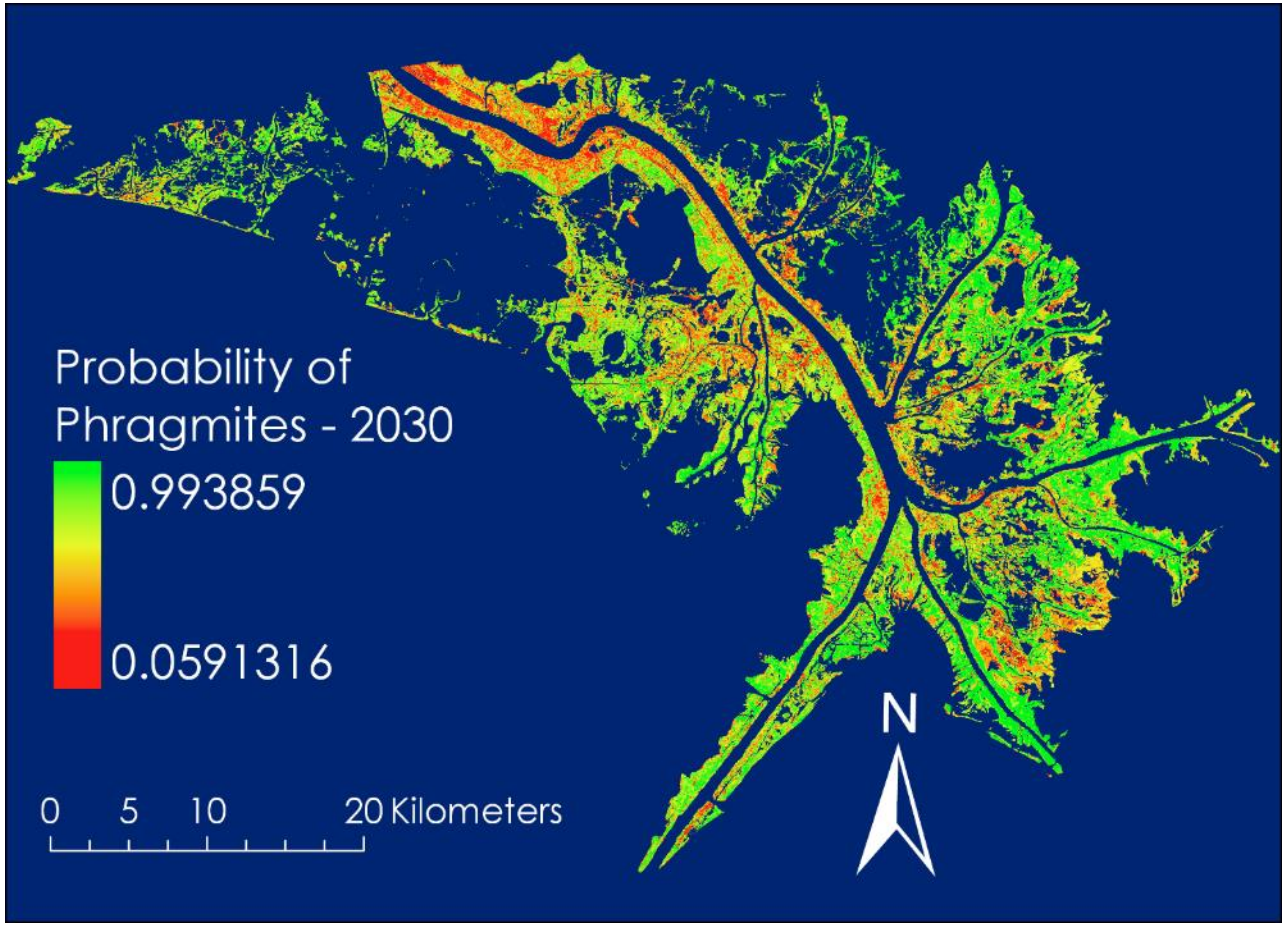
oftware for Assisted Habitat Modelling - SAHM Model Forecasting Marsh Health to 2030





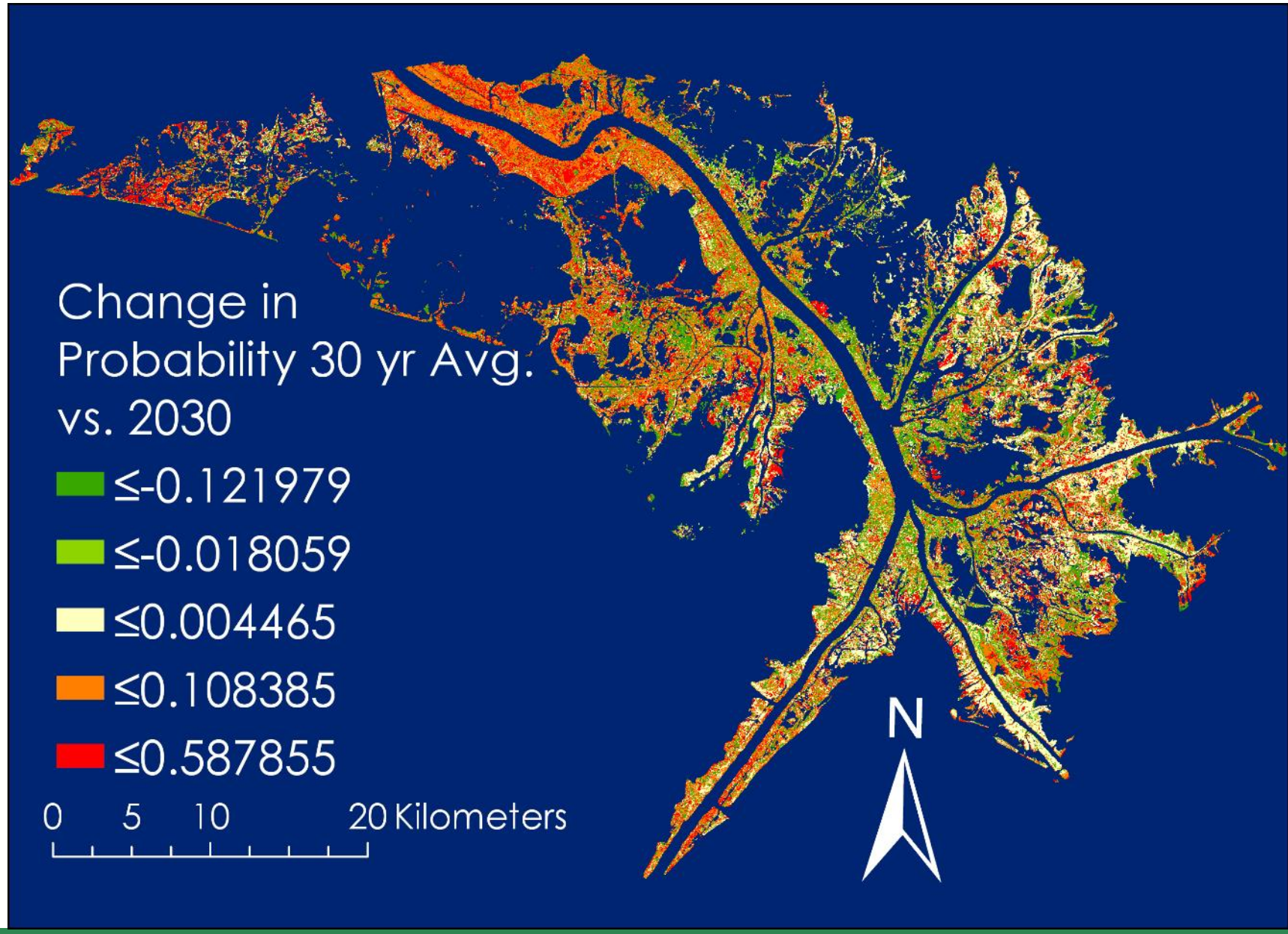
SAHM Results



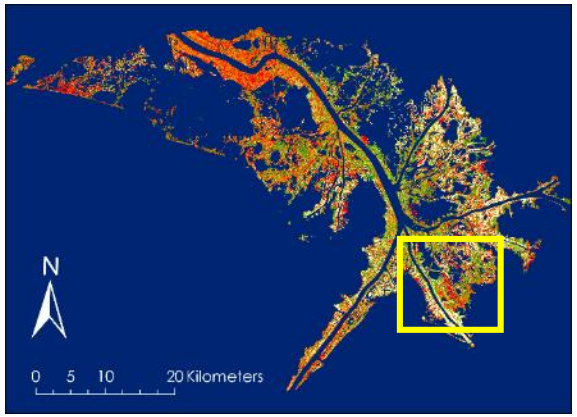


SAHM Results

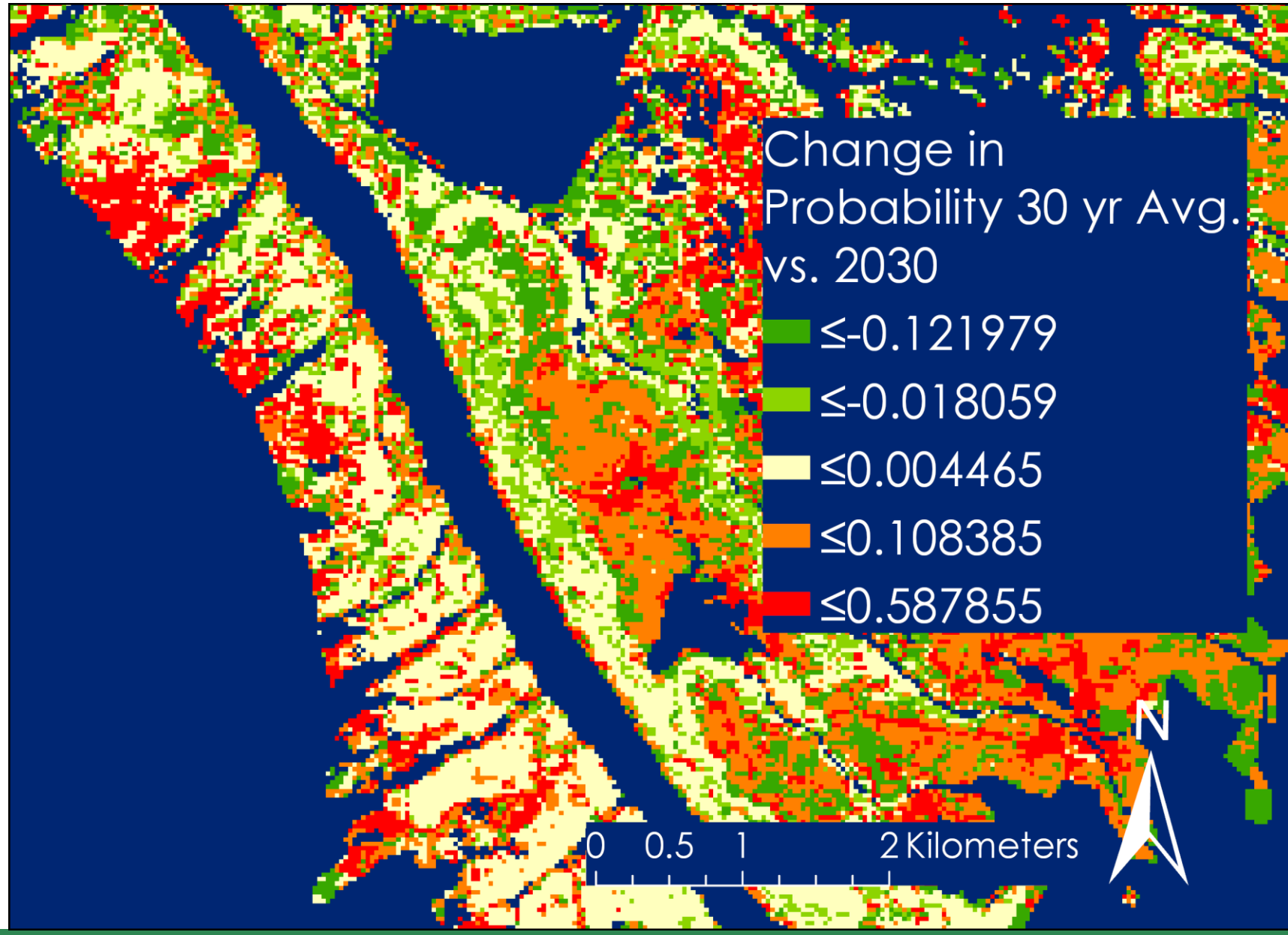
- Overall decrease in probability
- Large decrease in sensitive areas



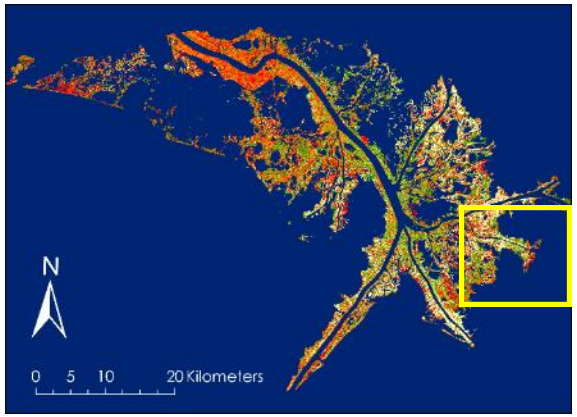
SAHM Results



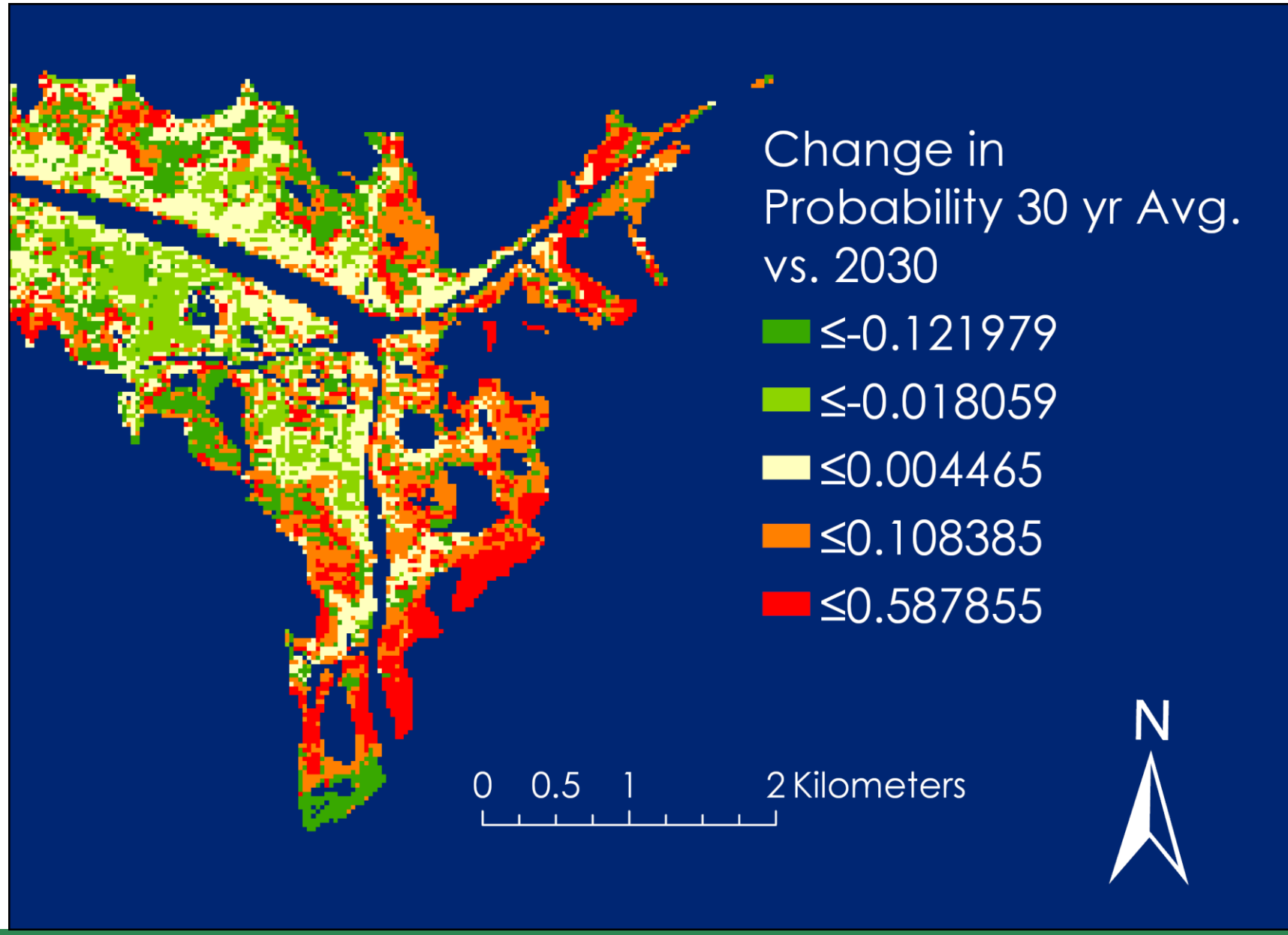
- South Pass Mississippi River
- Current healthiest stands
- Large negative change along coast



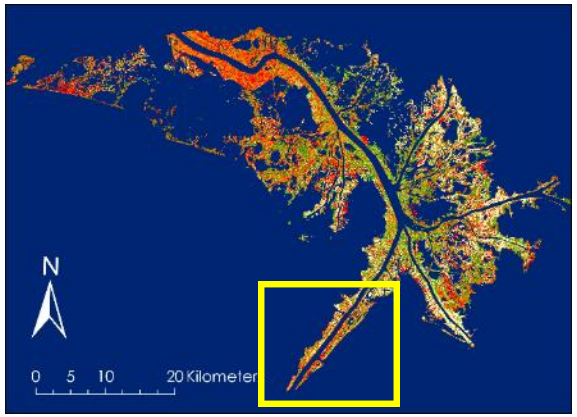
SAHM Results



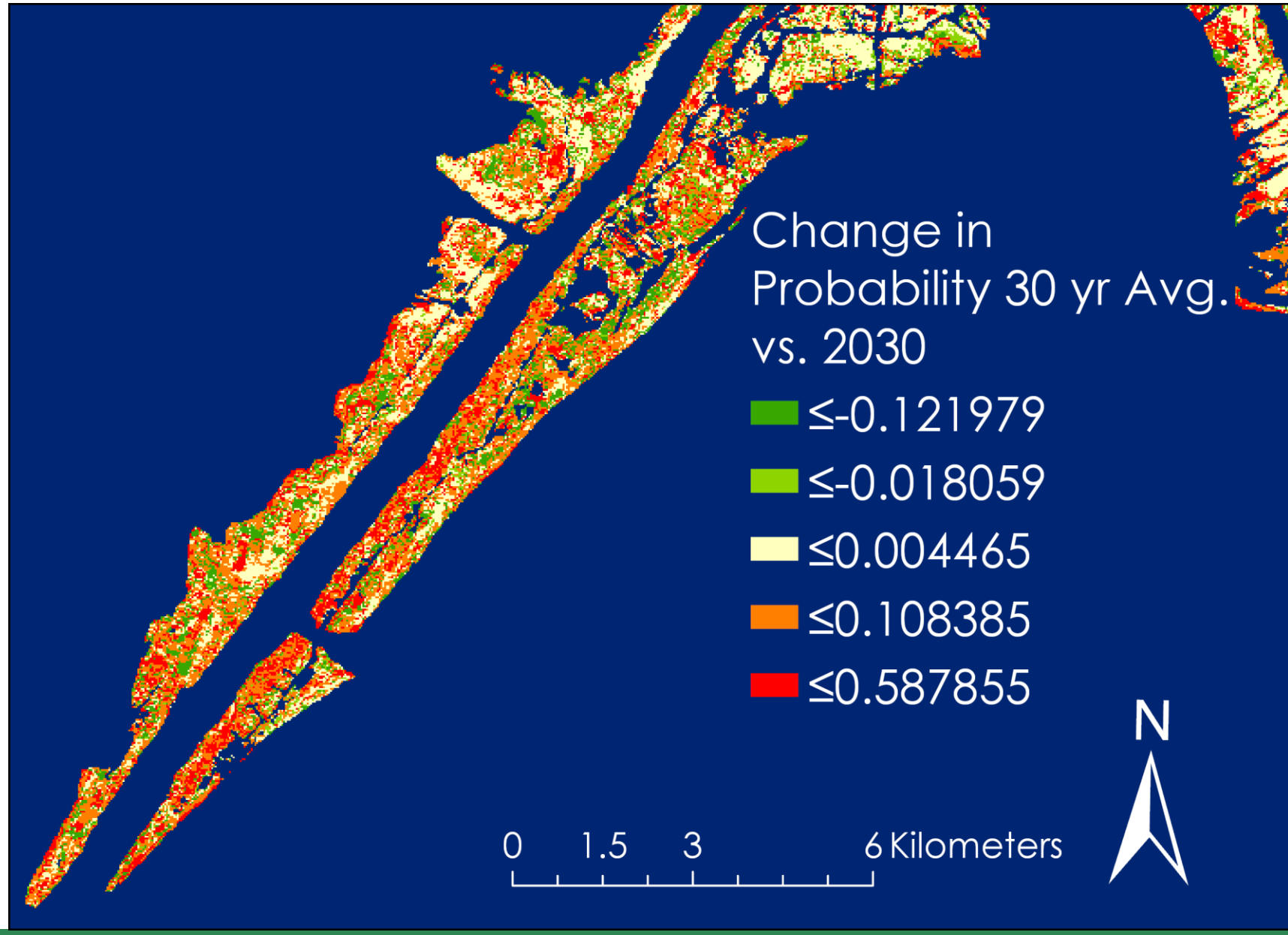
- East pass of Mississippi River
- Overall no change/increase
- Decrease along shore line



SAHM Results



- West pass Mississippi River
- Mix of dredge spoil and natural sediment
- Overall decrease



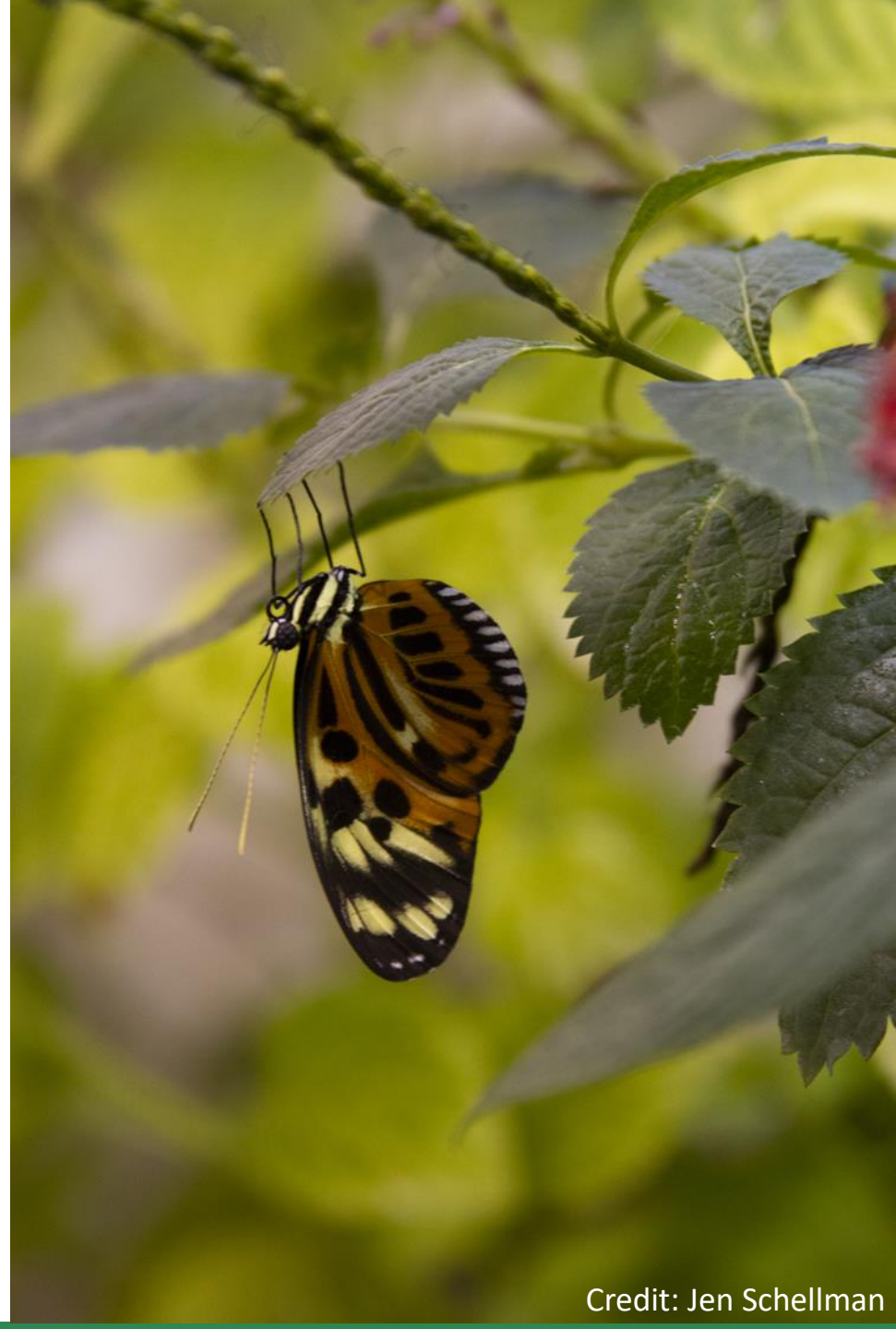

Credit: Jen Schellman

Errors & Uncertainties

- Image resolution
- Limited ground truth
- Greenest pixel bias
- Environmental differences yr. to yr.
- Water and cloud issues (no cloud-free data for 2012-gap yr.)
- Hurricane/big storm-related disturbances skewing data

Errors & Uncertainties

- Roseau cane mealy bug ill-defined (absent) phenology
- Reed die-back syndrome not well understood although well documented internationally (European studies)
- Confounding biotic/abiotic variables contributing to marsh decline (point & non-point source pollution, eutrophication)
- Ecosystem dynamics in constant flux (always changing)-hard to track/measure accurately



Credit: Jen Schellman

Conclusions

- NDVI compared over the study period indicates areas on the eastside of the Delta appear to be more adversely affected by disturbances than the westside.
- Historic trends and patterns emergent from the data show years following major disturbances (e.g., BP oil spill, Hurricane Katrina, El Niño yrs., Roseau cane scale infestation) had lower than avg. NDVI's.
- More recently, peak NDVI's increased slightly, suggesting there's resilience within the marsh

Conclusions

- SAHM model results show locations of Roseau cane out to 2030, which will remain under threat due to increasing land-loss, subsidence and relative sea-level rise
- Overall decrease in probability of phragmites presence in study area
- Large scale decrease in sensitive areas – especially along shoreline
- South and East Pass show signs of resilience – healthiest stands
- West Pass shows an overall decrease, may be more vulnerable


Credit: Jen Schellman

End Products

- Handoff Package
- Annual NDVI change maps of marsh vegetation 2005-2017
- Yr. to yr. changes in annual NDVI compared to the average (between 2005-2017) maps 2005-2017
- Marsh classified distribution maps 2005-2017
- NDVI change map virtually stacked dates 2005, 2011, 2017
- SAHM forecast maps and statistical analysis of vegetative health out to 2030

Future Work


Credit: Jen Schellman

- Further in-depth statistical analysis of SAHM model results
- Multivariate analysis of synergistic effects
- Include data from various contributing pollutants effecting vegetative health (e.g. point & non-point source pollutants)
- Investigate marsh lag-time effects & thresholds

Benefits to Partner

Visualizing areas that are most vulnerable and areas of greater resilience will enhance decision making for our partner.

Credit: Beck Saults

Credit: LDWF

Acknowledgements

- Dr. Alisha Renfro
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