# Tracking sediment-laden Mississippi River water through Louisiana's river diversions with MODIS data

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### **Direct Broadcast Satellite Data Ground Station**

- Founded, 1988 by Prof. Oscar Huh
- Prof. Nan Walker, Director since 2003
- Over 25 years experience in image processing, analysis and dissemination
- Extensive environmental data archive

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Missions: Emergency Response Research 

### **Real-time and Archived Data/Products** $\square$

**NOAA AVHRR Orbview-2 SeaWiFS Terra/Aqua MODIS** 

1988-present 1997-2010 2001-present\*

**GOES East GVAR** Oceansat-1 OCM Suomi NPP VIIRS

1996-present 2002-2010 2012-present\*



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### Education

## The Water Institute of the Gulf (of Mexico) thewaterinstitute.org

THE WATER INSTITUTE OF THE GULF	Coasts & Deltas Communities	Water Resources	<ul> <li>Founde</li> <li>Adminis</li> <li>Excelle</li> </ul>
ABOUT	SEDIMENT AVAILABILITY AND MANAGEMENT	OUR CLIENTS	
	posted on 01.25.2013	OUR PROJECTS	
WHO WE ARE	Duration: 2 years Project Team	APPLIED RESEARCH	Sust
WHAT WE DO	<ul> <li>Mead Allison, Principal Investigator</li> <li>Ehab Meselbe</li> </ul>	TECHNICAL SUPPORT	and
PRODUCTS	<ul> <li>Brendan Yuill</li> </ul>		Coa
Connect with us on these channels.	Restoration of coastal Louisiana's wetlands depends on sediment availability and the effective management of all sediment resources, including riverine sediment, in-system sediment from coastal bays and channels, and offshore sand that can be used for restoring barrier islands and wetlands. This project identifies sediment resources that can be used for restoration and protection without causing adverse ecological or economic consequences. The research involves improving the estimation of sediment budgets and predicting how sediment naturally moves from one location to another in rivers, along the barrier shoreline, and in bays and wetlands.		<ul> <li>Condui private</li> <li>Approa compor</li> <li>Results Ramato</li> </ul>

Project leading to our collaboration

### ed in 2011

- sters the RESTORE Act Center of nce
- ources and Ecosystems
- tainability, Tourism Opportunities,
- **Revived Economies (of the Gulf** st States)
- between academic, public and research communities
- ched ESL to add remote sensing nent to ongoing sediment research shown here presented by Cyndhia chandirane (TWIG) at 2016 State of ast, paper currently in preparation



# **Spillways & Diversions**

### Bonnet Carré Spillway

- **5.7 mi spillway by 7-12k feet wide**
- **Flows into Lake Pontchartrain**
- 2008 (46% of 350 bays), 2011 (94%), 2016 (60%)









# Spillways & Diversions

- **Davis Pond Freshwater Diversion** 
  - **Completed in 2002**
  - Largest of the FDs in Louisiana
  - **Combat salt water intrusion**
  - Promote healthy environment for seafood industry
  - □ **10,000** acres
  - □ Max flow > 16000 cfs
  - Combat land loss







# Study Area

## Lake Cataouache

- Lake Salvador
- Bayou Rigolettes
- Little Lake
- Bay Dosgris
- Barataria Bay



# **Study Summary**

- Locate clear-sky MODIS imagery for dates of field data
- **Perform atmospheric correction**
- **Develop regression model correlating reflectance to sediment concentration**
- **Challenges : Solutions** 
  - Unfortunately, field work not planned around use of satellite imagery!
  - Difficulty utilizing NASA algorithms on small inland waters : Employ clear-water pixel algorithm on Rayliegh-corrected reflectance
  - Spatial Resolution : Utilized 645nm (red) channel for 250m resolution
  - Fixed stations proximal to shoreline where stray light contaminates imagery : Ultimately rejected altogether
- Apply model to scenarios combining diversion discharge and wind conditions
- Extract data over water pixels in provided polygons for simple statistics



# Methodology & Tools

### Utilize SeaDAS for image processing/analysis

- Derive Rayleigh-corrected reflectance ( $rho_s$ )
- Leverage powerful masking capabilities of SeaDAŠ
- Easy band math for clear-water pixel subtraction
- **Miscellaneous post-processing in Python**



## $SSC = 20,180(R_{645})^2 + 100.59(R_{645}) + 0.26$



R-Sq = 0.84n = 108 RMSE = 20.95 mg/L

# Results





## May 10, 2010

High discharge from DPFD

Light wind regime

High sediment also seen from Caernarvon Diversion on east side of Miss. River

# Results



![](_page_12_Figure_2.jpeg)

## March 27, 2015

## **Pulse from DPFD**

# Immediately following southerly wind regime

# Results

![](_page_13_Picture_1.jpeg)

the east

## Jan 27, 2010 **Easterly wind regime Note sediment from Miss. River approaching from**

![](_page_13_Picture_4.jpeg)

# **Extending to Lake Pontchartrain**

![](_page_14_Figure_1.jpeg)

## Rare opportunity: Bonnet Carré Spillway opening

## **MS thesis work of Robert**

![](_page_14_Figure_4.jpeg)

# **Extending to Lake Pontchartrain**

![](_page_15_Picture_1.jpeg)

# $ISC = 1.5559e^{46.641x}$

# 29 January $50 \text{ mg/L plume area: } 1,053.7 \text{ km}^2$ BCS (open) + 19 $100 \text{ mg/L plume area: } 905.9 \text{ km}^2$

Inorg	(mg/L)			
0	75	150	225	300

## 27 February BCS (closed) + 26

![](_page_17_Picture_1.jpeg)

# Conclusions

- Use of MODIS satellite imagery to hindcast sediment distribution and behavior proved useful, if challenging
- **Regression models successfully developed**
- Winds seem to play a large role in of sediment behavior
- □ Field data collection:
  - **Fun (?) but burdensome**
  - Obvious need to coordinate with satellite schedules
  - Need more *in situ* sensors, away from shorelines for better atmospheric correction
- Provide information for the planning of future diversions
- Can inform sediment behavior during future spillway openings
- Strengthen models through further study

# Acknowledgements

- Thank you!
- Thanks also to:
  - The Water Institute of the Gulf  $\square$ 
    - **Pls: Cyndhia Ramatchandirane, Mead Allison**
  - LSU Coastal Studies Institute
    - Ishan Joshi (SeaDAS bootstrap!)

![](_page_19_Picture_7.jpeg)

Questions?

![](_page_20_Picture_1.jpeg)