TEAM EFFORT

The Water Institute of the Gulf

- Natural Systems Modeling and Monitoring
  - Model setup, calibration, validation and production runs
- Physical Processes and Sediment Systems
  - Data collection for model calibration and validation
  - QA/QC model output
- Coastal Ecology
  - Data collection for model calibration and validation
  - QA/QC model output
- People, Resources & Technology
  - Calculation and preparation of land change maps

CPRA

- Elizabeth Jarrell
- Carol Parsons Richardson
- Joseph Wes Leblanc
- Brian Lezina
- Bren Haase
- Austin Feldbaum
- Kent Bolfrass
- James Pahl
- Brian Vosburg
- Angelina Freeman
- David Lindquist
- Ed Haywood
- Elizabeth Davoli
- James Wray
- Jammie Favorite
- Jennifer Mouton
- Syed Khalil
- Ann Howard
- Richard Raynie
TEAM EFFORT

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Collaborators

• University of Louisiana-Lafayette
  – Development and integration of vegetation model
• Louisiana State University
  – Geotechnical data collection and laboratory analysis
• Deltares
  – Support of model setup, calibration and validation activities
PRESENTATION OUTLINE

• Project Overview
• Modeling Approach
• Model Calibration and Validation
• Results
  – Hydrodynamics
  – Nutrient Dynamics
  – Vegetation Dynamics
  – Morphodynamics
PROPOSED SEDIMENT DIVERSIONS

- Mid-Breton (35,000 CFS)
- Mid-Barataria (75,000 CFS)
- Lower Breton (50,000 CFS)
- Lower Barataria (50,000 CFS)
PROJECT GOAL

• Produce a calibrated and validated model capable of simulating:
  – Land change processes that occur during the creation of a new delta and wetland areas
  – Nutrient effects to the wetland vegetation, soil, and the phytoplankton of Breton Sound and Barataria Basin
PRESENTATION OUTLINE

• Project Overview
• Modeling Approach
• Model Calibration and Validation
• Results
  – Hydrodynamics
  – Nutrient Dynamics
  – Vegetation Dynamics
  – Morphodynamics
MODEL OVERVIEW

- MODEL OVERVIEW
- D-FLOW
- HYDRODYNAMICS
- D-WAQ
- NUTRIENT DYNAMICS
- VEGETATION DYNAMICS
- VEGMOD\LA VEGMOD.DM\LA VEGMOD.ROOTSHOOT
- MORPHODYNAMICS
- D-FLOW-SED-ONLINE
- FOOD WEBS
- EWE & CASM
DELFT-3D MODEL: DOMAIN AND GRID DESIGN
# SEDIMENT DIVERSION PRODUCTION RUNS

<table>
<thead>
<tr>
<th>Description</th>
<th>Design Discharge (CFS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Future Without Project</td>
<td>N/A (No Diversions)</td>
</tr>
<tr>
<td>All Four Diversions</td>
<td>35K, 50K, 50K, 75K</td>
</tr>
<tr>
<td>All Four Diversions - Aggressive</td>
<td>35K, 50K, 50K, 75K</td>
</tr>
<tr>
<td>Dredge Only</td>
<td>N/A (No Diversions)</td>
</tr>
</tbody>
</table>
OPERATION PLAN

Less-Aggressive Operations

- MISSISSIPPI RIVER
- DAVIS POND
- CAERNARVON
- MID-BRETON
- MID-BARATARIA
- LOWER-BARATARIA
- LOWER BRETON

Mississippi River Discharge (CFS)

Sediment Diversion Discharge (CFs)

Feb 20th

July 5th

OPERATION PLAN

MRDM - Delft3D - Alternatives
PRESENTATION OUTLINE

• Project Overview
• Modeling Approach
• Model Calibration and Validation
• Results
  — Hydrodynamics
  — Nutrient Dynamics
  — Vegetation Dynamics
  — Morphodynamics
USING EXISTING DATA AND TARGETED DATA COLLECTION

• Model Setup
  – Update bathymetry to build grids
  – Utilize locally observed values within model (e.g., soil properties, water quality, meteorology, ocean forcing, etc.)

• Calibration and Validation
  – Key parameters to tune model performance

• Improved Understanding of Processes
  – Compare model outputs to observed basin behavior, ensuring dynamics are captured by the model design
CALIBRATION AND VALIDATION
(MISSISSIPPI RIVER AT BELLE CHASSE)

Flow

Water Level

Suspended Sand

Suspended Fine
HYDRODYNAMICS: CALIBRATION AND VALIDATION

Water Level

Salinity
NUTRIENT DYNAMICS: CALIBRATION AND VALIDATION

Grand Isle

Nitrate

Chlorophyll a

Total Suspended Sediment
VEGETATION DYNAMICS: CALIBRATION AND VALIDATION

Vegetation Biomass

CRMS 0135

Live AG Biomass (g C m⁻²)

- Typha spp.
- Phragmites spp.
- Spartina alterniflora
- Spartina patens
- Sagittaria lancifolia
- Sagittaria latifolia
- Zizaniopsis miliacea
- Other
- Grand Total

Modeled Above
Observed Above
MORPHODYNAMICS CALIBRATION AND VALIDATION: CAERNARVON

Model Results in 2011

Observed: 0.75 - 1.57 cm/yr.
Model: 1.71 cm/yr. (2011)

Model Results in 2014

Observed: 0.75 - 1.57 cm/yr.
Model: 0.85 cm/yr. (2014)
PRESENTATION OUTLINE

• Project Overview
• Modeling Approach
• Model Calibration and Validation

• Results
  – Hydrodynamics
  – Nutrient Dynamics
  – Vegetation Dynamics
  – Morphodynamics
RESULTS: WATER LEVEL

Diagram showing the relationships between different modules and dynamics, including:
- Food Webs
- EWE & CASM
- Nutrient Dynamics
- Hydrodynamics
- Vegetation Dynamics
- Morphodynamics
- D-FLOW
- D-FLOW-SED-ONLINE
- D-WAQ

Modules are interconnected, indicating flow and dependencies between water level and related environmental factors.
WATER LEVEL
NEAR MID-BARATARIA DIVERSION, YEAR 2070

Note: Red Vertical Line represents end of less aggressive operational schedule
WATER LEVEL
NEAR LAFITTE, YEAR 2070

Note: Red Vertical Line represents end of less aggressive operational schedule
WATER LEVEL DIFFERENCE

Difference Between Future Without Project and 4 Diversions (Year 2070)

Difference Between Future Without Project and 2 Diversions (Year 2070)
SALINITY
NEAR MID-BARATARIA DIVERSION, YEAR 2070

Note: Red Vertical Line represents end of less aggressive operational schedule
SALINITY
NEAR LAFITTE, YEAR 2070

Note: Red Vertical Line represents end of less aggressive operational schedule
SALINITY
NEAR MID-BRETON DIVERSION, YEAR 2070

Note: Red Vertical Line represents end of less aggressive operational schedule
SALINITY: ANIMATION

FWOP: Salinity 01-Jan-2070 00:00:00

All Diversions: Salinity 01-Jan-2070 00:00:00
SALINITY - YEAR 2070

All Diversions – Future Without Project

April

October
RESULTS: NUTRIENT DYNAMICS
NITRATE: YEAR 2070

All Diversions – FWOP

Mid Diversions – FWOP

April

October
CHLOROPHYLL A : YEAR 2070

All Diversions – FWOP

Mid Diversions – FWOP

April

October

MRDM - D
RESULTS: VEGETATION DYNAMICS
VEGETATION: YEAR 2070

FWOP  

All Diversions

MRDM - Delft3D - Alternatives
RESULTS: MORPHODYNAMICS
LAND CHANGE BY YEAR 2070
FUTURE WITHOUT PROJECT

Year 1 - Year 50 (FWOP)
Land = 10cm
- Land Lost
- Land Gained

Orientation:
- N (North)
- W (West)
- E (East)
- S (South)
LAND CHANGE BY YEAR 2070
ALL DIVERSIONS

All Diversions Year 50
Landscape Change Referenced to FWOP

Net Land Gain
40,500 acres
BED LEVEL CHANGE: MID-BARATARIA

Land Change 02-24-2020
## MR Delta Management Land Change Summary - 2070

### Acreage: Net Land Gain/Loss

<table>
<thead>
<tr>
<th>Name</th>
<th>Barataria</th>
<th>Breton Sound</th>
<th>MR Delta and NWR</th>
<th>Net</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Diversions - Less Aggressive</td>
<td>31,987</td>
<td>16,421</td>
<td>-7,888</td>
<td>40,520</td>
</tr>
<tr>
<td>Mid Diversions-Less Aggressive</td>
<td>23,704</td>
<td>14,855</td>
<td>-4,321</td>
<td>34,237</td>
</tr>
</tbody>
</table>

### MR Delta Management Land Loss in FWOP: 2020 - 2070

<table>
<thead>
<tr>
<th>Name</th>
<th>Acreage: Land Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barataria</td>
<td>-152,810</td>
</tr>
<tr>
<td>Breton Sound</td>
<td>-96,687</td>
</tr>
<tr>
<td>MR Delta and NWR</td>
<td>-59,287</td>
</tr>
</tbody>
</table>
DREDGE ONLY: MARSH AREA

TOTAL MARSH CREATION (OVER FOUR DECADES): 13,890 ACRES

MARSH REMAINING BY YEAR 2070: 7,240 ACRES
CONCLUSIONS

• Biophysical model significant advancement in evaluating ecosystem restoration projects
• Model efficiently informs the decision making process
• Mid Diversions performed better than lower diversions (due to better sediment capture/retention)
• Marsh/ridge creation could enhance the outcome of diversions by improving sediment retention