USACE Perspective on Mississippi River Sediment Diversions

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Presentation Outline

- The Value of the Mississippi River to the United States
- The Causes of Wetland Loss in Louisiana
- How Well Will Sediment Diversions Work?
- Can We Quantify and Mitigate for the Unintended Consequences of Diversions?
- How Should a Full Array of Alternatives Best Be Applied?
- What permits and permissions are required?
U.S. Ports: Vital to Trade
…and to Our National Economy
1927 vs. 2011 Mississippi River Record Flood: From “Levees Only” to “Room for the River”

- 1927 Flood = 16.8 million acres
- 2011 Flood = 6.4 million acres
- $14 billion Investment since 1928
- $234 billion damages prevented (2011) 84% of the damages prevented were in Louisiana

- ✓ $612 billion since 1928
- ✓ 44 to 1 return on investment
- Over 4 million people protected
- $3 billion annual transportation rate savings
- Untold economic productivity enabled: Farms, towns, factories

[Map showing the comparison between 1927 and 2011 floods]
Value to the Nation
Coastal Louisiana Fisheries and Wetland Values

- USFWS: “Louisiana is the most productive fishery in North America”
  - 25% of continental US commercial fisheries
  - More than 1 billion pounds caught annually with a dockside value $291 million
  - Recreation value $900 million to $1.2 billion
- Louisiana has 40% of the coastal marshlands in the continental United States which support:
  - Five million waterfowl
  - 25 million songbirds
  - 70 rare, threatened or endangered species
Causes of Land Loss in Coastal Louisiana
Major Causes of Wetland Loss

Barrier Island Degradation
Storms
Oil & Gas Development
Canals
Levee System
Subsidence
Sea Level Rise
Herbivory
Saltwater Intrusion
Sediment Reduction
Cypress Harvesting

"Land Area Change in Coastal Louisiana from 1932 to 2010" USGS, 2011.
### Land Loss in Coastal Louisiana by Basin, 1932 – 2010

<table>
<thead>
<tr>
<th>MISSISSIPPI RIVER INFLUENCE</th>
<th>OUTSIDE OF MISS RIVER INFLUENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Atchafalaya: 16 mi²</td>
<td>• Calcasieu-Sabine: - 214 mi²</td>
</tr>
<tr>
<td>• Barataria: - 456 mi²</td>
<td>• Mermentau: - 154 mi²</td>
</tr>
<tr>
<td>• Breton Sound: - 174 mi²</td>
<td>• Teche-Vermillion: - 77 mi²</td>
</tr>
<tr>
<td>• Miss. Delta: - 124 mi²</td>
<td>• Terrebone: - 506 mi²</td>
</tr>
<tr>
<td>• Pontchartrain: - 194 mi²</td>
<td>TOTAL: - 951 mi²</td>
</tr>
<tr>
<td><strong>TOTAL:</strong> - 932 mi²</td>
<td><strong>TOTAL:</strong> - 951 mi²</td>
</tr>
</tbody>
</table>

Oil and Gas Extraction

**Impacts:**
- 8,000 – 10,000 miles of canals
- Salt water intrusion
- Hydrologic alteration
- Subsidence due to fluid withdrawal
- Recent article puts value of oil and gas mediated losses are as high as 36%

Oil and Gas Exploration:
- First Coastal Oil Well → 1901
- First Offshore Well → 1934
- By 1950’s, 92 Offshore Platforms to Depths of 100 Feet
- End of 1960’s, 500 Platforms to Depths up to 350 feet
- End of 1970’s, over 12,500 Offshore Rigs Producing Hydrocarbons


Wetland Loss Due to Hurricane Damage

• Direct impacts of selected storms:
  • Audrey (Max. Wind 100 mph)
    • Beach Erosion: 200-300 ft
    • Increased Water Area: Not Measured
  • Hilda (Max. Wind 134)
    • Beach Erosion: Not Measured
    • Increased Water Area: Not Measured
  • Andrew (Max. Wind 121)
    • Beach Erosion: 200-330 ft
    • Increased Water Area: Not Measured
  • Katrina (Max. Wind 125)
    • Beach Erosion: 180 ft
    • Increased Water Area: 89 mi²
  • Rita (Max. Wind 125)
    • Beach Erosion: 130-260 ft
    • Increased Water Area: 114 mi²
  • Gustav (Max. Wind 106)
    • Beach Erosion: 150-525 ft
    • Increased Water Area: 48 mi²
  • Ike (Max. Wind 87)
    • Beach Erosion: 30-150 ft
    • Increased Water Area: 77 mi²

• Indirect impacts:
  • Salt water intrusion
    • Impact unknown

• Summary:
  • Open water area has increased by 328 mi² just from the four measured storms that have occurred since 2005
  • USGS estimates that 25% to 35% of wetland loss since the 1940’s is due to direct and indirect storm-induced losses.

Sea-Level Rise

global rise = 0.07 inches/year

Pensacola, FL (0.08 inches/year)

Mean sea level trend is 0.08 ± 0.01 inches/year or 0.69 feet in 100 years.

High subsidence rate + sea-level rise makes wetlands more vulnerable to submergence and erosion.

Relative Sea-Level Rise

global rise + local sinking

Grand Isle, LA (0.4 inches/year)

The mean sea level trend is 0.4 inches/year or 3.0 feet in 100 years.

NOTE: Grand Isle is an official NOAA gage with records back to the 1950’s. Other gages in the Mississippi River Delta show much higher rates of RSLR, up to 1.0 inches per year.
Additional Estimates of Subsidence Rates

Rates over 24mm (1 inch) per year.

LA State Master Plan, 2012.
Maximum rates in the Bird’s Foot between 15-35 mm per year.

Variation in Subsidence Rates

Subsidence Advisory Panel Members: Louis Britsch, PhD, PG, USACE-MVN; Roy Dokka, PhD, LSU; Joseph Dunbar, PG, USACE-ERDC; Mark Kulp, PhD, UNO; Michael Stephen, PhD, PG, CEC; Kyle Straub, PhD, Tulane; Torbjorn Tornqvist, PhD, Tulane
How Well Will Sediment Diversions Work?
(What Have We Learned in the Last Few Years?)
About 50% of the water and suspended sediment of the Mississippi River is diverted from the river between Baton Rouge and Head of Passes – it is not all being “lost off of the continental shelf.”

Reach Assessment 1970s to 2000s

Sustainability of Diversions

Figure 2. Life cycle of subdeltas of the Mississippi River Delta (from Wells and Coleman, 1987).

Wax Lake Outlet has built about 1 km² per (250 acres) year between 1983-2010, utilizing about 10% of the flow of the MS River. The overall land loss in Coastal Louisiana is about 10,600 acres per year over the same time period.

Table 3. Summary of Fort St. Philip study area acreages, and percentages of area change, for select time periods - from high resolution analyses. The color-ramp illustrates the type and magnitude of land change – the darkest red represents loss maxima and darkest green represent gain maxima.

<table>
<thead>
<tr>
<th>Period of Analysis</th>
<th>Years</th>
<th>Land Area (initial)</th>
<th>Land Area (ending)</th>
<th>Area Change</th>
<th>Area Change†</th>
<th>Area Change‡</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>acres</td>
<td>acres</td>
<td></td>
<td>percentage</td>
<td>percentage</td>
</tr>
<tr>
<td>1956 to 1971</td>
<td>15</td>
<td>5,012</td>
<td>4,377</td>
<td>-635</td>
<td>-13%</td>
<td>-13%</td>
</tr>
<tr>
<td>1971 to 1978</td>
<td>7</td>
<td>4,377</td>
<td>2,760</td>
<td>-1,617</td>
<td>-37%</td>
<td>-32%</td>
</tr>
<tr>
<td>1978 to 1988</td>
<td>10</td>
<td>2,760</td>
<td>2,444</td>
<td>-316</td>
<td>-11%</td>
<td>-6%</td>
</tr>
<tr>
<td>1988 to 1998</td>
<td>10</td>
<td>2,444</td>
<td>1,780</td>
<td>-664</td>
<td>-27%</td>
<td>-13%</td>
</tr>
<tr>
<td>1998 to 2008</td>
<td>10</td>
<td>1,780</td>
<td>2,102</td>
<td>322</td>
<td>18%</td>
<td>6%</td>
</tr>
<tr>
<td>1956 to 2008</td>
<td>52</td>
<td>5,012</td>
<td>2,102</td>
<td>-2,910</td>
<td>-58%</td>
<td>-58%</td>
</tr>
</tbody>
</table>

† Land change percentage is based on initial land area of the period analysis. ‡ Land change percentage is based on the 1956 land area.

The fresh and brackish portions of the estuary experienced more than 25.7% failure versus 2-4% in the more saline regions. (Kulp, et.al., 2009.)
“A general conclusion on the expected short-term and long-term responses of marsh belowground production to Freshwater Diversions in Louisiana could not be drawn from the available evidence.”

“With regard to Freshwater Diversions, data are particularly needed on how changes in water chemistry or plant community composition may influence plant production-decomposition processes and resultant effects on soil volume and elevation change.”
**Energy Budget of a Sediment Diversion**

![Diagram of energy budget components](image)

**The Energy Budget:**

\[ H_{\text{TOTAL}} = H_{\text{DD}} + H_{\text{ST}} + H_{\text{DC}} + H_{\text{RB}} \]

- \( H_{\text{TOTAL}} \): The total potential energy available to transport water and sediment.
- \( H_{\text{DD}} \): The loss of potential energy in the river due to the drawdown caused by the reduction in river flow.
- \( H_{\text{ST}} \): The kinetic energy loss across the diversion structure.
- \( H_{\text{DC}} \): The kinetic energy loss due to friction in the diversion channel.
- \( H_{\text{RB}} \): The kinetic energy loss due to friction (backwater effects) in the receiving basin.

Summary of Energy Budget Constraints on Diversion Design

- The application of basic hydraulic and geomorphic principles to a sediment diversion has shown that, for a given total available head, the greater the sand load one diverts, the shorter the distance one can transport it.
- As time progresses, deposition in the diversion outfall will become emergent land and begin to obstruct flow. This will induce an increase in the water surface elevation at the downstream end, and an upstream extension of the zone of deposition.
- When the water surface elevation increases to the point where the diversion can no longer pass the design flow, the diversion can no longer be operated at full capacity.
- If the diversion channel is too short to be truncated or redirected, and if there is no mechanical redistribution of the deposited sediment, then the life-cycle of the diversion is effectively complete.
- Hence, this results in the following general statement of the consequences of the energy constraint on sediment diversion design:
  - In the absence of any mechanical redistribution of the deposited sediment, the greater the sand load diverted, the shorter the life-span of the diversion.
- Note that this conclusion is essentially qualitative and simplified. To determine whether or not this principle has a measurable and quantifiable impact on any specific diversion, it is necessary to do a more sophisticated analysis, including modeling.
- Preliminary attempts at this type of analysis have indicated that the energy budget is likely to be a significant and measurable constraint on diversion design.

SIDE VIEW

- Increasing stage over time due to sediment deposition
- Shading = zone of deposition
Preliminary Outfall Channel Analysis

WATER DEPTH, FEET
5.5
4.8
4.2
3.6
3.0
2.4
1.8
1.2
0.6
0.0
DIVERSION INFLOW

SIMULATION OF APPROXIMATELY 10 YEARS OF DIVERSION OPERATION

EMERGENT LAND

U.S. Survey Feet
0 5000
Can We Quantify and Mitigate for the Unintended Consequences of Diversions?
ACCCUMULATED DEPOSITION  2020 - 2079

Alternative 18 allows for the “free flow” of Davis Pond, subject to river head, and assumes a 15,000 cfs diversion at Myrtle Grove.
How Should a Full Array of Alternatives be Applied?
Need to be addressed by existing federal projects, environmental documentation for permits or certifications, or other means. Includes, but not limited to:

- Land building estimation and sustainability
- Inadequacy of field data collection for salinity and temperature
- Ecological Effects to Oysters, Brown Shrimp, Sea Trout, etc.
- Ecological Effects of nutrient-rich freshwater on salt and brackish marshes
- Extent of increase of water elevation on communities and back levees
- Geotechnical considerations
- The ability of the sediment to "disperse" into the Delta, or the cost of O&M to redistribute the material
- The sustainability of the diversion – when will head differences render the diversion unusable

Total Cumulative Acres Created: 28,969 Acres

~22,026 acres wetlands
~3,943 acres other habitats
~3,000 acres uplands (Southwest/SouthPass)

1976-2011 ~28,969 acres of created land (~45 square miles of land)
Myrtle Grove Vicinity

August 23, 2012
ADCP
175,000 cfs

- CTD/turbidity/LISST casts

Figure from Mead Allison, 2013
Wetlands Restored With Material Placement

Wetlands Restored With Diverted Sediments
Summary: LMR Diversion Principles

- Consider All Coastal Loss Mechanisms
- Balance Competing Uses of the River and River Resources
- Apply Sound Science
- Reasonable Use of River Resources
- Evaluate State’s Diversion Portfolio as a System
- Utilize Controlled Diversions
- Employ Diversion Adaptive Management
- Consider Mississippi River Commission Recommendations
Mark Wingate
Chief, Projects and Restoration Branch
US Army Corps of Engineers
New Orleans District

New Orleans District Section 408 Liaison for Mississippi River Diversions

February 6, 2014

Barataria-Terrebonne National Estuary Program Management Conference
Dept. of Army Permit Authority

- A Department of the Army permit will be required pursuant to:
  - Section 10 of the Rivers and Harbors act of 1899; and
  - Section 404 of the Clean Water Act
Section 408 Authority

- 33 USC 408 provides authority that the Secretary of the Army may permit alteration to existing Corps projects if the alteration:
  1) Does not impair the usefulness of the project; and
  2) Is not injurious to the public interest

- Approval authority delegated to Chief of Engineers for Major Alterations

- The District cannot issue a Section 404/10 Permit Decision until Section 408 approval is obtained
Section 408 Decision Making

- USACE Implementation Guidance dated 17 Nov 08

- Principles in USACE Decision Making: Lower Mississippi River Diversions (2 Aug 13)

- Overview of Applicant Requirements for Section 408 Request to Alter an Existing Federal Project Related to Proposed Lower Mississippi River Diversions (User’s Guide)

- Section 408 Process Flow Chart for Major River Diversions
Mid-Barataria Sediment Diversion

- Large Mississippi River Diversion (discharge to be determined)
  - Purpose is to restore the connection between the Mississippi River and the mid-Barataria Basin to divert sediment-laden water into the basin to build land
- DA Permit application submitted by CPRA on 30 Jul 13
- Section 408 permit request submitted by CPRA on 8 Aug 13
- Engineering Design
  - CPRA provided 15% engineering design package on 19 Sep 13
  - MVN-ED currently reviewing 15% package
- NEPA Compliance
  - Notice of Intent published in Federal Register on 4 Oct 13
  - Working with CPRA to select a Third Party Contractor to prepare the EIS
Maurepas Diversion

- Small Mississippi River Diversion (≈5,000 cfs)
  - Purpose is to convey freshwater, nutrients, and sediments from the Mississippi River to restore the health and essential functions of Maurepas Swamp
- DA Permit application submitted by CPRA on 26 Jun 13
- Section 408 permit request submitted by CPRA on 8 Aug 13
- NEPA Compliance
  - Public Notice for DA Permit issued on 22 Aug 13
  - Public comment period ended 21 Oct 13
  - Path forward being evaluated
Mississippi River

Cultural Resources

Proposed Diversion Location Study Area

Proposed Channel Location (75,000 cfs)

Proposed RAM Terminals Site

Proposed RAM Barge Fleeting Area

Direct 408 Impact

Mississippi River Levee System

NOGC Railroad Bridge Approach (3,000’/Approach)

Proposed Diversion

Location Study Area

Direct 408 Impact

Future NOV NFL

Myrtle Grove

Ironton

LA Hwy 23

508 Impact

Proposed Mid-Barataria Sediment Diversion Project

Proposed RAM Terminals Site

NOGC Railroad

Direct 408 Impact

Future NOV NFL
Mid-Barataria Diversion Conceptual Schematic

“Cartoon Rendering”

- Outfall Area
- Guide Levees (to be constructed to MRL/HSDRRS design standards)
- NOV Levee +11.5’
- NOGC Railroad (Raise/Bridge)
- LA-23 (Raise/Bridge)
- MRT Levee +16’
- Cofferdam (MRL design standards)
- Batture Trees (to be removed in diversion path)
- Inflow Flume
- Flow 75,000 cfs
- Diversion Structure

Not to Scale
Federal Projects Potentially Affected by Planned State of Louisiana Diversions

Key
- LA State Planned Diversions
- CWPPRA Project Locations