Sediment in the Mississippi River: The “Supply-Side” of Coastal Restoration

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LOWER (LA) MISSISSIPPI RIVER WATER SURFACE ELEVATION

Maximum

Minimum

ESTUARINE

TIDAL (low discharge)

high

low
Engineering for Coastal Restoration in Louisiana:

1. Large freshwater-sediment diversions (10,000-250,000 cfs) – suspended load
2. Long-distance pipeline conveyance -- bedload/stored suspended/relict source

Supporting Science Questions:

1. What non-renewable and renewable sediment resources are available for use in coastal restoration within the levees?
2. What do we still need to know to adequately manage the resource?
3. How does the sedimentological/hydrological/rheological character of the system control potential extraction methods?
(1) Post-Levee Batture

- relatively high quality sand
- limited sediment volume
- already mined for local projects including levee reinforcement
- removal by land mining
(2) Pre-Levee Point Bars

- high quality sand
- few in number in lower river
- removal will affect downriver hydrodynamics
- difficult to transport to site (removal method, consolidation)?
NON-RENEWABLE SEDIMENT RESOURCES FOR RESTORATION

Deep Meander Reach

(3) Relict Incised Strata

- variable, layer-specific composition (sand, mud, peat)
- fluvio-deltaic origin
- range in age from Plaquemine-Balize lobe to Pleistocene
- increase in age with depth in channel and upriver
  (strata dip seaward)

- highly consolidated
- difficult to remove and transport
- suitable for marsh restoration substrate?
1. What non-renewable and renewable sediment resources are available for use in coastal restoration within the levees?

**Suspended Sediment Loads of the Lower Mississippi-Atchafalaya**

- **400 mt** (Pre-1850; Kesel et al., 1988)
- **394 mt** (Pre-1963; Keown et al., 1986)
- **230 mt** (Pre-1993 + Red; Horowitz et al., 2001)
- **190 mt** (Post-1993 + Red; Horowitz et al., 2001)

*Dams, Soil Conservation, Elimination of Bank Caving, etc.*

---**124 mt** in Miss
LOWER MISSISSIPPI RIVER SEDIMENT CYCLE

LOW DISCHARGE

- SUSPENDED LOAD (mud)
- BEDLOAD (sand)
- RELICT (mixed)

HIGH DISCHARGE

- SUSPENDED LOAD (mud+sand)
- BEDLOAD (sand)
- RELICT (mixed)

LOCAL VS UPSTREAM SEDIMENT SOURCES?
RENEWABLE (BED) SEDIMENT RESOURCES FOR RESTORATION

High River Stage

Low River Stage

LEVEE

HIGH DISCHARGE MUD DEPOSITION

Low Discharge

High Discharge

TIDAL SHALLOW REACH

TIDAL DEEP MEANDER REACH

Estuarine

SALT STRATIFICATION

Tidal

High Discharge

Low Discharge

ESTUARINE REACH
RENEWABLE (BED) SEDIMENT RESOURCES FOR RESTORATION

Low Discharge Mud Storage (1999-2002)

Tidal

14 MT (RM181-13)

Estuarine

10 MT (RM13-Passes)

Venice

Mud Thickness (meters)
- 0 - 0.15
- 0.15 - 0.5
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00
Mississippi River Discharge at Tarbert Landing, MS 2003-2005

Additional Audubon surveys in August 2005, February 2006

Audubon only
All sites

1961-2004 mean
Evaluation of Bedload (bedform) Sand Flux Using Multibeam Resurvey Method (2 or more surveys over 8-24 hrs)

Audubon Bathymetric Change (8 hrs.), January 2005, Discharge: 34,292 m³/sec

Accretion (+) and Erosion (-) (m)
- 2.0-3.0
- 1.5-2.0
- 1.0-1.5
- 0.25-1.0
- -0.25 to 0
- 0.25 to 1
- -1.0 to -1.5
- -1.5 to -2.0
- -2.0 to -3.0
Audubon Park
(2 of 8 dates)

FINAL BEDLOAD TRANSPORT RATES

January 2005 (34,290 m$^3$/s)

February 2004 (14,200 m$^3$/s)
BEDLOAD TRANSPORT VS RIVER DISCHARGE

- Audubon: $R^2 = 0.84$
- All: $R^2 = 0.82$

Y-axis: Bedform Transport (kg/day)
X-axis: River Discharge (m³/sec)
How Much Sand is Transported in Suspension?

% Sand in Suspension

FROM 1978-2001 AT St. FRANCISVILLE

FROM 1977-1997 AT BELLE CHASSE

% Sand (<62 microns) in Suspension
(from USGS Water Quality Data)
St. Francisville

Total Suspended load

124 mt (post-1993)*
153 mt (pre-1993)

Suspended Sand Load

22.3 (18% of above)

Bedload (sand)

? (Suspended)

Belle Chasse

same?

Suspended

9.9 (8% of above)

Bedload (sand)

0.1 0.1 0.1

SW Pass

Annual Nav Dredging

10-15 myd$^3$

= 4.1-6.2 mt of Sand

*From Horowitz et al. (2001; pers. Comm)
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Annual Nav Dredging:

10-15 myd$^3$ = 4.1-6.2 mt of Sand

**Why the Difference?**

1. Bed aggradation between RM266 and RM76 (see Galler et al., 2003)
2. Limited # of measurements and no near-bed sampling
3. Reach-scale variability in bedload-suspended load cycling
Audubon Sand Loss

Elevation Differencing (Nov-Jan)

Loss to suspension of

327,600 tons

Equivalent to a layer 0.32 m thick
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Loss to suspension of

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LOWER MISSISSIPPI RIVER SEDIMENT CYCLE

LOW DISCHARGE

- SUSPENDED LOAD (mud)
- ACTIVE BEDLOAD
- LONG-TERM STORAGE
- RELICT (mixed)

HIGH DISCHARGE

- SUSPENDED LOAD (mud+sand)
- ACTIVE BEDLOAD
- LONG-TERM STORAGE
- RELICT (mixed)

Difference from:
1) Increased size of dunes
2) Loss to suspension
RENEWABLE (BED) SEDIMENT RESOURCES FOR RESTORATION

Low Discharge Sand Storage (Nov 2003 Bed Survey)

So: Hydraulic Energy Decreases Downstream Even in the Lower River
2. What do we still need to know to adequately manage the resource?

A. River observatories to provide comprehensive sediment monitoring (bed and susp)

B. Establish a 10-20 river mile long experimental transect to facilitate 3-D numerical model development (CWPPRA Scofield Island?)

**Tulane/LUMCON AUDUBON RIVER OBSERVATORY**

http:\\weather.lumcon.edu

**SINCE 2003**
- water quality (nitrate, temperature, chlorophyll, turbidity)
- bedload transport (multibeam)
- particle-reactive radiotracers (pumped)

**BEGINNING 2006**
- suspended concentration
- suspended grain size
- bed grain size
- x-sectional discharge (ADCP)
- floc size (LISST)

**FUTURE**
- discharge (H-ADCP)
- sand sheet thickness (CHIRP)
- CDOM (backscatter)