

SEDIMENT, NUTRIENT, AND CARBON SEQUESTRATION WITHIN LOWLAND BOTTOMLAND ECOSYSTEMS: PAST, PRESENT, FUTURE STUDY IN THE ATCHAFALAYA BASIN AND OTHER LOWER MISSISSIPPI AREAS

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Riparian ecology, floodplain sedimentation, wetland ecosystem services



The flux and storage of material from the channel onto and off the floodplain and various biogeochemical processes during storage of ----

- sediment
- nutrients (C, P, N)
- contaminants

are important, if not critical, *ecosystem services* where maintaining the flow to floodplain *connectivity* is paramount.



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RECENT SEDIMENTATION PATTERNS WITHIN THE CENTRAL ATCHAFALAYA BASIN, LOUISIANA

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Abstract: Sediment deposition and storage are important functions of forested bottomlands, yet documentation and interpretation of sedimentation processes in these systems remain incomplete. Our study was located in the central Atchafalaya Basin, Louisiana, a distributary of the Mississippi River and contains the largest contiguously forested riparian wetland in North America, which suffers from high sedimentation in some areas and hypoxia in others. We established 20 floodplain transects reflecting the distribution of depositional environments within the central Basin and monitored general and local sediment deposition patterns over a three-year period (2000-2003). Deposition rate, sediment texture, bulk density, and loss on ignition (LOI, percent organic material) were determined near or just above artificial markers (clay pads) located at each station per transect. Transect mean sedimentation rates ranged from about 2 to 42 mm/yr, mean percent organic material ranged from about 7% to 28%, mean percent sand (> 63 μ) ranged from about 5% to 44%, and bulk density varied from about 0.4 to 1.3. The sites were categorized into five statistically different clusters based on sedimentation rate; most of these could be characterized by a suite of parameters that included hydroperiod, source(s) of sediment-laden water, hydraulic connectivity, flow stagnation, and local geomorphic setting along transect (levee versus backswamp), which lead to distinct spatial sedimentation patterns. Sites with low elevation (long hydroperiod), high hydraulic connectivity to multiple sources of sediment-laden water, and hydraulic damming (flow stagnation) featured the highest amounts of sediment trapping; the converse in any of these factors typically diminished sediment trapping. Based on aerial extent of clusters, the study area potentially traps 6,720,000 Mg of sediment annually, of which, 820,000 Mg represent organic materials. Thus, the Atchafalaya Basin plays a substantial role in lowland sediment (and associated contaminant) storage, including the sequestration of carbon. Findings on local sedimentation patterns may aid in management of flow to control sediment deposition and reduce hypoxia.

Key Words: floodplain connectivity, forested wetlands, hydroperiod, sediment trapping

Atchafalaya River, mainstem

Average annual discharge of 6410 m³/s (5th largest in U.S.).
 Receives about 25% of the Mississippi River flow annually and all of the Red River flow.

Conducts as much as 35% of the suspended- and 60% of the bed-sediment load of the Mississippi River.

The Basin wetland (5670 km2) is about 70% forested (largest contiguously forested wetland in North America); the remainder is open water and marshland.

Forests are of three main communities; 1. typical bottomland hardwoods on levees and transitional areas, 2. cypress/tupelo stands in backswamps, 3. successional, predominantly willow stands on recently aggraded bars (common).



Multiple Impacts within the central Atchafalaya Basin





The Basin experiences complex hydrologic/hydraulic conditions during inundation periods

And

During draining periods hypoxic swamp water may mix with sediment laden river water

The degree of connectivity any floodplain site has to sediment-laden water strongly influences sedimentation patterns









Placement of powdered feldspar; "clay pad"

Sediment sampling for C/N/P concentration





average site deposition



transects have been established in the central part of the Atchafalaya Basin.



All groups significant at P < 0.002, Tukey HSD

≈USGS

Spatial Patterns of Deposition (cumulative depth)





Mostly on levee (typical)



Mostly in backswamp (variable sources of flow and sediment)











Greatest amounts of sediment and nutrient trapping occur in floodplain areas that have:

High connectivity to sediment laden water,
 Long hydroperiods (low elevation),
 Multiple sources of flow,
 Hydraulic damming,



Fine sediment trapped in lowland forested wetlands may be substantially organic, with LOI values from 10 to 75 %.

Thus, along with mineral sediment, these systems may be an important site for carbon sequestration and nutrient storage.

Organic Rich Floodplain Sediment ---up to 15cm/yr in the Atchafalaya

> Lowland riparian (Coastal Plain) areas may be the last great places for sediment/C, N, P storage and natural biogeochemical remediation before reaching critical estuarine habitats



The Atchafalaya Basin is the only semi-natural remaining riparian area Along the Mississippi River mainstem Below the confluence of the Ohio River

Annual Sequestration:

Sediment 4.3 billion kg Organic Material 435 million kg Total Carbon 175 million kg

The loss of this trapping function through hydro-geomorphic alteration here and along other Coastal Plain streams has severely reduced the ecosystem service these streams could potentially provide









Carbon Sequestration in Lowland Fluvial Landforms??

Riverine export of aged terrestrial organic matter to the North Atlantic Ocean. P.A. Raymond and J.E. Bauer, *Nature*, 25 January 2001)

(we) "...find that these rivers are sources of old 14C-depleted)... terrestrial (doc)... much of the young (doc) can be selectively degraded over the residence times of river and coastal waters, leaving an even older and more refractory component for oceanic export. Thus, pre-aging and degradation may alter significantly the structure, distributions and quantities of terrestrial organic matter before its delivery to the oceans".

"...at least the results of Raymond and Bauer (2001) remind us that the organic matter that runs from rivers into the sea is not necessarily identical to the organic matter of the plants and soils upstream in river catchments. Certainly, other processes taking place on floodplains or in river channels, such as slowed transport caused by cycles of deposition and movement downstream, may also have to be considered to better understand the composition and fluxes of river carbon". *Wolfgang Ludwig, Nature, 25 January 2001*



We estimate (Noe and Hupp, in press) that Coastal Plain wetlands along the Atchafalaya River, Roanoke River (NC), and tributaries to the Chesapeake Bay cumulatively trap;

9.7 x 10¹² g/yr of sediment
7.7 x 10¹¹ g/yr of carbon
4.0 x 10¹⁰ g/yr of nitrogen
1.1 x 10¹⁰ g/yr of phosphorus

Carbon fluxes represent 1.3% of total C sequestration in North America and 14.6% of the C sequestration in alluvial wetlands in the conterminous United States.

041 69 Barton: Palo Alto 3089 Carrolwood New Sites with very high 51 Grand Point Helvetia Bruly St Belle Rose Welcome Garyville Reserve LaPlace Martin sedimentation rates and Lutcher Kessler Brulie Gramercy. e Edgard LUC 61 Convent Rem Grand Bayou sse Klotzville Maurin organic content Paulina Columbia Killona 1e Oneida Johnson Bayou Come Paincourtville Bon Secours Vacherie ourgeois Westfield St James Waterford New Si Plantation * Plattenville nding Webre Steib Fish Island Pierre Part Lagan Plantation 3127 **Brusle St Vincent** Golden Star Destre Napoleonville Plantation Elm Hall Lower Vacherie Foley 2 rette Lac des Mim Bellewood Woodlawn Allemands Sorrel Attakapas Canal 20 Charenton Chackbay Cancienne Little Texas Paradis Adeline **Bayou Boeuf** Kraemer Lake Supreme Choupique ulien Linwood Oxford Verret Bayou Crab Himalaya Baldwin nd Lower Texas Katy Rienzi Des / Labadieville Rodriguez **Bayou Geneve** Plantation Homeygo Caffery Brule Abby Plantation Lake Lowlands Thibodaux Franklin: Boeut Stephenville 1 wn Rousseau Verdunville 90 Johnson Ridge Flat Schriever Landing Lewistown Lake Raceland Minerva Avalon Lake 70 Todd Plantation Palourde 3052 Gray Patterson Mathews Gibson Greenwood 182 Idlewild Morgan C North Bend Gheen Bus Rebecca Plantation Clotilda Lagonda Ramos Ursa McBride Midway 90 Lockport 24 Ame Savoie Oak Forest Central _ockpor South Bend **Bayou** Cane Heights Norah Humphreys, Houma Valentin Sweet East Cote Hollywood Bay Southdown Lake Blanche Waterproof Fivemile Oaks Bourg Grandbois Presquille Bay Crozier Ashland Sarah Plantation Montegut Chauvin Point Barre Boudreaux Lake de Theriot Atchafalaya Bay Cade Lapeyrouse d Dulaco. ©2009 Microsoft Corporation



New focus on Carbon Sequestration





Autochthonous versus allochthonous?



Kissimmee River Floodplain Monitoring

Channelized → Returned to old channel











* BC4, 5, and 7 all represent channel fill material (fine to medium sand)



Organic Soil Loss, Pocomoke River Maryland

(Kroes and Hupp, hopefully soon)





Study sites for Hurricanes Katrina and Rita impacts on coastal forests



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Thank You