Writing Earth history with continental-margin sedimentary processes

STUPID HUMAN TRICKS

Po and Mississippi Rivers
Po River

Drainage basin includes:
  south flank of Alps,
  north flank of Apennines

Area = 75,000 km²
(Columbia River = 670,000 km²)

Sediment discharge = ~15 million t/y
(Columbia River = 10 million t/y)

Po sediment yield (production from square meter of land surface) is much greater than Columbia River basin
Po River

Drains northern Italy

Enters the northeast Adriatic Sea, forming delta in late Holocene

Evidence of lobe switching dated in sediments back to Bronze Age

Sedimentation causes northward migration of delta

Sediment began to enter Venice lagoon to north

Filling of lagoon would have eliminated the “natural moat” protecting the Republic of Venice

Therefore, path of Po River altered to a southward location (1599-1604)
Ancient Po mouth had many distributaries covering a large area.

Flow was not concentrated at a narrow location on coast.
Before human control

- Natural rate of coastal progradation 4 m/y from 1000 B.C. to 1200 A.D.
- Seven points of discharge described by Plinio il Vecchio
The artificial form of the modern delta

- abandonment of Po di Primaro
- 1152 AD a major natural avulsion
- northward shifting of distributary channels
- Venice Republic is threatened by the potential infilling of the lagoon
- 1604 AD digging of a diversionary canal (Taglio di porto Viro)
Modern Po Delta

Five distributaries, but only one operates during non-flood conditions.

Predominant southward transport and accumulation of sediment, which causes northward migration of delta.
Po River today

Sediment supply reduced by dams and mined for construction aggregate

Sediment reaching river is constrained by artificial levees (i.e., does not reach floodplains), and carried to Adriatic Sea

Cuspate delta builds into Adriatic Sea
    ~50% of sediment discharge

Located far enough south of Venice, sediment carried away
    ~50% of sediment discharge
River manipulation caused fast progradation and delta lobe switching.

Rapid accumulation of a large amount of sediment caused by confining the Po discharge to a small area.

The present delta is artificially held in position within context of the northern Adriatic oceanographic processes.

Natural and artificial subsidence are enhanced by levee construction, which prevents overbank sedimentation.

River-bed excavation and river damming in the drainage basin during the last 50 years led to a marked decrease in sediment supply.
Despite the best intentions of humans...

October 2000 flood
A Less Mighty Mississippi

During the past 7,000 years, much of the Louisiana coast was created as the mouth of the Mississippi River meandered across the region, filling the coastline with sediment. Now, levees and dams are preventing much of that sediment from replenishing the coast.

DRAINAGE BASIN

The Mississippi drains more than 40 percent of the continental United States.

A LOSS OF SEDIMENT

The Mississippi River transports 200 million tons of sediment per year to the Gulf of Mexico. But that is half of what the river carried three centuries ago, before European colonists first moved to the area and built levees and dams to protect themselves from floods.

1700

Large reservoirs on the Missouri and Arkansas Rivers account for the biggest loss of sediment.

1980-90

Deforestation and farming have resulted in a tenfold increase in sediment from the Ohio River.

In a controlled diversion, part of the Mississippi River and its sediment is now sent down the Atchafalaya River.

Sources: United States Geological Survey, "Contaminants in the Mississippi River"
Coastal Defenses Are Disappearing

Ever since the early 1700's, when New Orleans was founded and settlers began building levees and canals to control the Mississippi River, Louisiana's coastline has been sinking. Marshes and barrier islands, which protect New Orleans from hurricanes, are eroding fast.

1700 During floods, the muddy water washed over surrounding land, leaving sediments and nutrients behind.

- Sediments built up land.

TODAY Levees and canals channel the river and its sediments past the wetlands to the Gulf of Mexico.

- Saltwater moves in, killing marsh plants. Nothing remains to hold the marsh together.
- As sediment compacts, sinks and erodes, nothing comes in to replace it.

Source: Louisiana Water Resources Research Institute, Louisiana State University
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List of some things we did

Dammed river - reduced sediment supply, 400 million t/y to 200 t/y

Built artificial levees - reduced nourishment of flood plain

Constrained flow to modern Balize delta - caused delta to build to shelf break, and lose sediment to continental slope

Prevented lobe switching - eliminated sediment supply to other parts of delta plain

Removed water and natural gas - accelerated consolidation of deltaic sediment and subsidence of land surface

Dredged channel - created depressions that act as sediment traps