Environmental Manipulations and their Consequences for the Mississippi River Delta

Manipulations de l'environnement et conséquences pour le delta du Mississippi

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RÉSUMÉ

Le Mississippi est une artère commerciale majeure en dépit de conditions naturelles sauvages et dangereuses. Les interventions humaines visent simultanément à favoriser la navigation et à prévenir les inondations. Depuis 1849, les autorités fédérales se sont vues impliquées dans des aménagements de plus en plus importants. Jusqu'à présent, ces aménagements sont un succès. Notre présentation se concentre sur le confluent du Mississippi et de la Rivière Rouge. Les aménagements successifs dans ce secteur illustrent la puissance des effets de la manipulation du cours d'eau sur son delta. De la création du « raccourci de Shreve » en 1831 à l'expansion des Structures de Contrôle de l'Ancienne Rivière en 1987, les ingénieurs s'efforcent d'empêcher le Mississippi de dévier son cours vers celui de l'Atchafalaya. Les experts soulignent deux risques majeurs : une défaillance possible des structures de contrôle et la lente submersion d'un delta privé d'apport sédimentaire.

ABSTRACT

The Mississippi River is a highway of commerce, despite its wild and dangerous natural conditions. Human intervention aims simultaneously at fostering navigation and preventing floods. Since 1849, the federal government has been involved in the development of ever expanding public works. So far, these public works have proved successful. Our presentation focuses on the confluence of the Mississippi and the Red River. The successive developments of this sector illustrates the full extent of the impact of River manipulation on its delta. Tracking back from the creation of "Shreve's Cutoff" in 1831 to the expansion of the Old River Control Structures in 1987, engineers try to avoid the Mississippi River to shift its main course to the Atchafalaya River. Experts point two impending risks: a possible failure of the Old River control structures, and the slow shrinkage of the sediment-starving delta.

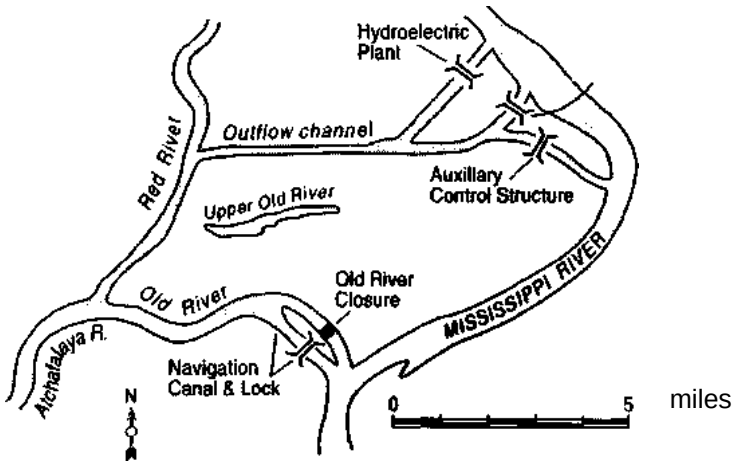
KEYWORDS

Environmental manipulation, upstream – downstream connection, flood mitigation, river navigation, Mississippi.

1 A WILD AND DANGEROUS RIVER

The Mississippi River is the classic example of a meandering alluvial river. From the Ohio River junction to the Gulf of Mexico, the Lower Mississippi River runs 1,535 km to the sea, and drops only 91 m in elevation (avg. gradient 0.006%). The River meanders through the huge floodplain it has constructed with its high sediment load since the glaciations. The lower Mississippi River is characterized both by its huge water discharge, an average of 16,792 m^3/s, and a heavy sediment load, estimated approximately 400 millions metric tons a year prior any man-made river manipulation (Kesel, Yodis, McCraw 1992). The River used to shift often its main course at irregular intervals during major Spring flood events by breaching through its banks. The Mississippi delta begins downstream of the Red River junction, located 489 km of the River mouth at an elevation of 12 m only (gradient 0.002%). The Mississippi River has built several successive delta lobes in the last 6,000 years, the present delta being only about 500 years old.

In its natural conditions, the River course was crowded with shifting sandbars and driftwood, making its navigation excessively dangerous in the early years of the Steamboat Era. Nonetheless, the Mississippi River has become a highway of commerce after the Louisiana Purchase included the entire valley within the United States of America. This led to repeated interventions to artificially regulate the River. Human intervention aims simultaneously at fostering navigation and preventing floods. Our presentation focuses on the confluence of the Mississippi and the Red River (map). The successive developments of this sector illustrates the full extent of the impact of River manipulation on its delta. Since 1831, engineers have attempted to accommodate human needs and prevent the Mississippi River to shift its main course to the Atchafalaya River.



Map: the present Old River Control Structures (after Yodis, Kesel and Colten 2003)

2 OPENING THE RIVERS TO NAVIGATION

The first steamboat travel from Pittsburgh to New Orleans introduced the era of river navigation in 1811. The relationship between the Mississippi, the Red and Atchafalaya Rivers was first altered when the superintendent Henry Shreve was authorized in 1831 to cut the Turnbull Bend meander neck, about 250 m wide, creating a 29 km shortcut for navigation (Hale 1995). Afterwards, the State of Louisiana authorized the removal of the 50 km logjam that obstructed the Atchafalaya River headwaters and to dredge its channel in order to open a new waterway to navigation. This task was undertaken from 1839 to 1855. This human induced reactivation of the Atchafalaya River opened a new potential 220 km road to the sea with a gradient of 0,0055 %.

In the mid-19th Century, the Atchafalaya captured approximately 12% of the Mississippi River water discharge, according to the relative water stages of the Mississippi and the Red Rivers. From 1855 to 1936, the Old River channel acted either as a tributary in normal period or a distributary of the flooding Mississippi. The Flood Control Act of 1936 authorized the dredging of the Atchafalaya River to expand its navigation potential. The deepened and enlarged channel now accommodated an ever expanding

water discharge, offering the Mississippi a shortcut to the gulf with a 3 to 1 advantage in slope over its current channel. As the Atchafalaya captured 43.7% of the combined water discharge of the Mississippi and Red, it became obvious during the 1945 flood that the Mississippi River was on the verge of shifting its main course to the Atchafalaya. The Federal law of 1954 provided funding for development of the Old River sector to prevent the capture of the Mississippi water by the Atchafalaya and prevent the impending economic catastrophe for the Mississippi River ports stretching from Baton Rouge to Venice, which is actually the third largest port complex in the world by tonnage.

3 PREVENTING FLOODS

The Old River Control Structures aim primarily at protecting the navigation industry and its associated industrial complex. Inaugurated in 1956, the Morganza Spillway turned the entire Atchafalaya River Basin into a gigantic floodway for the Mississippi. In the Old River sector, a first complex of control structures was completed in 1963. It was designated to permanently divide the water 70/30 between the Mississippi and Atchafalaya and provide further flood protection. However, it proved to be vulnerable during the major flood of 1973, when the formation of sand boils put the structures on the verge of collapse. Subsequently, the Old River Control Structures have been expanded to their present state by 1987, to provide improved flood control and generate power. The May 2011 flood broke the historical records floods of 1927, 1937 and 1973 from Vicksburg to Red River Landing. Despite a measured peak flow of 46,500 m^3/s, it was far from the estimated maximum capacity of the Old River Structures Complex (59,500 m^3/s). In consequence, the flooded area was much reduced in comparison to the Great Flood of 1927 with its estimated discharge of only 41,000 m^3/s at Red River Landing.

4 CONSEQUENCES AND CHALLENGES

On the long run, river manipulation have changed the Mississippi delta. Ever expanding public works have changed the Mississippi River from its wild and untamed natural state to its present artificialized and regulated course. Powerful levees and spillways have been raised along the River after the disastrous flood of 1927. Meanwhile, major tributaries were dammed upstream from the 1930s to the 1950s, reducing the River's load of sediments approximately from approximately 400 to 150 millions metric tons a year. The Old River Control Structures is a masterpiece of this regulation system. However, these structures are not immune to the risk of failure on the one hand, and the sediment-starving delta is slowly shrinking into the Gulf on the other hand.

So far, the numerous developments along the Mississippi River Channel have proven successful in their assigned role to improve navigation conditions and mitigate floods. Unfortunately, it has deprived the Mississippi River delta from its natural freshwater and sediment supply. Meanwhile, the Oil and Gas industry have accelerated ground subsidence during the 20th Century and Global Warming is causing a 3 mm a year sea-level rise. Louisiana has lost approximately 5,000 sq km of wetlands to the sea since the 1930's. Experts argue whether controlled River diversions are able to bring enough sediment to slow down the drowning of Southern Louisiana. Some new delta building can be observed at the mouth of the Atchafalaya River, but it is no match to the continued wetland losses observed in the Barataria basin and East of New Orleans. Furthermore, the Old River Control Structures are not immune to a possible future major flood of diluvian proportion that will exceed their capacity, and cause the River course change they are designed to prevent.

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