

What can we learn from 300 years of urbanizing the Mississippi Delta?

**Delta cities are great places.** The strategic natural advantages that encourage delta urbanization render culturally rich and diverse places, manifested in everything from architecture to linguistics, food, music, traditions, atmosphere, and civic spirit. Deltaic cities also usually claim tumultuous political and military histories, making them among the most fascinating places on Earth. Deltaic cities are treasure troves of the human experience, worth sustaining for their past but even more so for their current and future functions.

**Deltas need freshwater and sediment.** Deltas are floodplains. They are existentially tied to occasional inundations. Riverine injections of freshwater and sediment counteract the soil compaction and wave action that naturally reduce alluvial deposits. Building deltaic cities in a manner that accommodates seasonal flooding—by primarily urbanizing higher natural levees, leaving low-lying swamps and marshes undeveloped to store water, and strategically perforating riverfront levees—balances urban requirements with deltaic processes. Perforating riverfront levees means diverting the river's water and sediment (suspended load as well as bedload) out of the channel and onto adjacent wetlands, via controlled diversions, sediment siphons, and uncontrolled crevasses. Sediment dredged from navigation-impeding shoals, which develop wherever the river is diverted, should be siphoned into wetlands, not merely mobilized in the water column and dumped uselessly into the sea. Sediment may also be excavated from the bottom of nearby bays and pumped onto wetlands—dedicated dredging—to speed the land-creation process.

**Strengthen existing levees, but avoid building new ones.** Deltas are products of fluidity and dynamism. Humans resist such geological volatility and seek to tame it by imposing rigidity, constraint, and order upon it. Levees are the premier tool of anthropogenic control of unruly alluvial environments, and when built sturdily they succeed in reducing the nuisance of springtime floods. But they inevitably trigger sinkage of the soils behind them, particularly when accompanied by municipal drainage. They also eliminate freshwater and sediment inputs to the backswamp and marshes, compromising their ecological and geological health. *Existing* levees that protect populated areas must of course be maintained, strengthened, heightened, and regularly inspected, but *new* levees across open marsh are usually ill-advised, as they will further strangle coastal processes and continue to lure people into harm's way.

**Soft edges can protect better than hard edges.** New Orleans's 19th-century floods inundated only about one-tenth the population, damaged a small percentage of homes, destroyed even fewer, and hardly killed anyone. What made New Orleans resilient to those historical floods was the fact that the city's rear flank petered out softly into the backswamp; most floodwaters accumulated harmlessly in vacant lowlands while higher urbanized areas generally remained dry. It was not until humans built levees and drained and populated those lowlands that flooding became problematic there. Deltaic urbanism is safer when the "soft" protections of natural topography and marshy buffers are exploited to the maximum and the "hard" protection of levees, floodwalls, gates, and barriers are deployed only when necessary.

**Where hard edges are necessary...** Breaches during Hurricane Katrina revealed certain truisms about levee construction. The best levees are built of pure, cohesive clays with a minimum of organic matter and a minimum of coarse soil particles such as sand. Levee elevations must be periodically raised to account for local subsidence and sea-level rise. If floodwalls are built atop or in lieu of earthen levees, their steel sheet piling should penetrate the earth in the form of a stable T-wall, rather than the unstable I-walls lacking lateral support that Katrina's surges pushed over. Sheet piling should penetrate deeply, beyond the porous layers of peat and sand that allow seepage to pass. Floodwalls should also have con-



crete aprons on their dry sides, to prevent undermining if and when overtopping occurs. Short sheet pilings, excessive organic matter, inconsistent soil texture, insufficient height, inadequate lateral support, and unprotected shoulders were the immediate causes of most Katrina levee failures. Centuries of environmental manipulation and deltaic deterioration were the ultimate cause.

**Healthy deltas need healthy valleys.** Water quality, volume, sediment load, biota, and other inputs arrive at a delta from across hundreds of thousands of square miles, regardless of jurisdictional lines. Integrated management among the various basins, agencies, states, and nations that a watershed comprises is necessary to maintain the health of a delta. The New Orleans region bears a disproportionate share of the burden of basin wide environmental impacts, including dam and lock construction on sediment-bearing tributaries, diminishing sediment supply in the river; fertilizer and urban runoff, causing the hypoxic dead zone in the Gulf of Mexico; pollutants in the river, affecting drinking water supplies; and invasive species such as the zebra mussel and Asian carp.

**Raised houses individualize flood protection.** All structures, particularly residences, should be raised

Hard lines in soft environments: Much of the Mississippi Delta's land loss can be attributed to the excavation of oil, gas, navigation, and other man-made canals, which cause saltwater intrusion, swamp die-off, erosion, and surge funneling.

*Photograph by Peter Hermans / David Waggoner, Dutch Dialogues, 2009.*

on pilings or piers. This tradition prevailed in New Orleans for over 200 years, only to be abandoned after World War II in favor of cheap concrete slabs poured at grade level. Living at grade level places too much faith in flood-control and drainage infrastructure. Building above the grade empowers the individual to play a role in minimizing personal flood damage should other systems fail.

**Municipal drainage comes at a cost.** Draining the swamps around New Orleans helped solve the problem of insufficient living space. It also created a new problem. Water being a major component of deltaic soils, drainage caused the soil body to shrink and collapse, sending half the metropolis below sea level. Finding an aesthetic way to integrate runoff into the cityscape—through canals, as the Dutch do—or to store it in specially designed areas that double as parks when dry, restores the hydric component to the soil body and reduces subsidence rates. Storing water on the cityscape also reduces pump capacity requirements and minimizes the need to activate the pumps after every rainfall.

**Pumping stations should be optimally sited.** Pumping stations, which remove runoff via outfall canals into adjacent water bodies, should be located at the mouths of those canals, not at their headwaters. In this manner, runoff is pulled from throughout the city via low, below-grade outfall canals and raised at the very last moment. Such pumps can also double as canal gates, preventing outside water from intruding inland. This design eliminates the need for levees and floodwalls intruding into neighborhoods. New Orleans in the 1890s located its pumps in the middle of the area being drained, at the headwaters of the outfall canals, where they pushed runoff into Lake Pontchartrain. Decades of subsidence forced the pumps to push that runoff uphill by increasingly steeper inclines. This meant that the outfall canals had to flow above houses, requiring levees and floodwalls to contain them. It also meant that incoming storm surges penetrated the (ungated) outfall canals and dangerously raised water levels—until, finally, the point of floodwall collapse during Katrina. Most planners now agree that pumping stations should be relocated to the lakefront, as they are in Jefferson Parish and New Orleans East, which learned from New Orleans's mistake. Such a relocation would allow canals to be redesigned to flow below grade and

beautified into urban amenities, as they are in Amsterdam. Financial constraints, however, currently prevent this costly correction from being enacted. There is also a concern that below-grade canals would increase subsidence rates.

**Canals usually bear more costs than benefits.**

Deltaic cities often begin as transshipping nodes and develop into ports of national or international importance. Competition forces ports to make docking at their wharves as fast, cheap, and efficient as possible, a pressure that often justifies the excavation of navigation canals. Throughout coastal Louisiana, oil and gas companies joined the shipping industry in scoring and scouring the deltaic plain with innumerable man-made waterways. Most seemed to make sense at the time, but their long-term costs may ultimately kill this place. Canals that have proven to be more detrimental than beneficial should be barricaded with rock barriers, pilings, gates, or other devices to prevent further saltwater intrusion—and, if feasible, filled in with sediment.

**Diversions alone may not be sufficient to rebuild coastal marshes.**

Diverting the Mississippi River out of its man-made straitjacket and allowing it to deposit its sediment-laden waters into adjacent coastal wetlands is widely viewed as fundamental to saving the Mississippi Delta. Crevasses—that is, uncontrolled diversions—are even better. But locks and dams on the western distributaries of the Mississippi River system have so radically reduced the quantity and quality of sediment reaching the delta that diversions and crevasses are no longer sufficient to restore coasts. Sediment must be actively mined from the bottom of the river and bays and siphoned into the marshes. Gravity alone will not solve this problem.

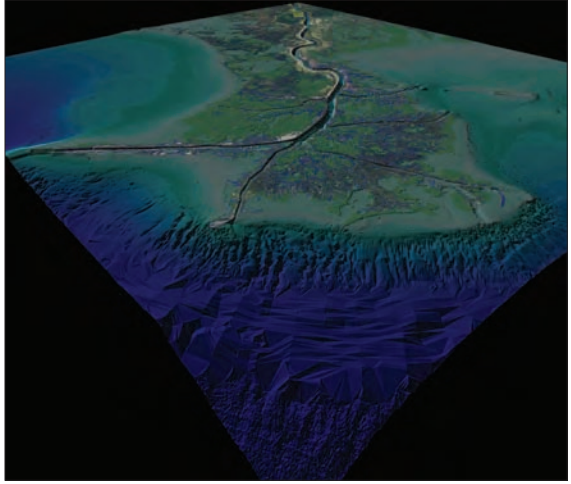
**Legal issues complicate restoration efforts.**

Over three-quarters of the Louisiana coastal region is in private hands. Leases of adjacent water bodies for fisheries and other resources further complicate the cadastral landscape. A single coastal restoration proposal thus affects numerous parties, livelihoods, and ways of life. Coping with this complexity requires legal mechanisms, compensation funds, mitigation plans, and other creative solutions.

**Expect the paradoxical in the wake of urban disasters.** Planners might reasonably view the aftermath of an urban disaster as an opportunity to correct entrenched problems with ambitious and revolutionary rebuilding

This computer-generated perspective of the active “birdfoot” delta of the Mississippi River, vertically exaggerated fortyfold for visibility purposes, derives from multibeam SONAR-based water depth measurements combined with LIDAR-based terrestrial elevation data. Riverborne sediment that once dispersed laterally throughout the deltaic plain, building up its soils and nourishing its biota, now spills out uselessly on the continental shelf (foreground).

*GIS processing by Richard Campanella based on data from C&C, Louisiana Department of Natural Resources, and University of Louisiana at Lafayette.*



plans. Post-Katrina New Orleans certainly saw its share of bold urban planning visions, offered by some of the best minds in the profession. All failed, in large part because flood victims primarily sought to return to normalcy, not further tumult. Planners should expect particularly fierce resistance if their plan entails moving people out of harm's way by closing down unsustainable neighborhoods—*footprint shrinkage*, in post-Katrina parlance. In the absence of immediate and generous compensation, home owners affected by disaster will defend the one major life investment they still possess—their property—and advocate for the default plan of simply rebuilding in place, regardless of future risk.

**Deltaic sustainability entails grappling with dilemmas.** Whereas a problem typically ends with a solution, a dilemma usually ends with a choice—a difficult value judgment, which yields unpleasant consequences and unhappy stakeholders. Saving deteriorating deltas will mean that some human communities, despite their historical, cultural, and economic significance, will have to relocate to minimize future loss and allow aggressive coastal restoration to commence. Resistance will be passionate and often imbued with social tensions and historical distrusting. But the geophysical realities of sea-level rise demand that we make mature decisions about where and how humans inhabit deltas—or else they will be made for us.