
Introduction – Changing Conditions in the Mississippi Delta from 1700 to 2100 and Beyond: Avoiding Folly

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Abstract

The Mississippi River delta developed over the past several 1000 years after sea level stabilized at the end of the last glaciation. Native Americans lived in the delta during this time but had almost no impact on its functioning. This all changed with the arrival of European colonialists at the beginning of the eighteenth century. Over the ensuing two centuries, human impact multiplied. This included levee construction, closing of distributaries, and reclamation. But it was not until the twentieth century that human intervention had a major impact, culminating in the loss of about a quarter of the wetlands of the Mississippi delta by the end of the twentieth century. Recent studies have documented how profoundly the delta has changed and what the future portends if nothing is done. Currently there is an ambitious plan to restore the sustainability of the Mississippi delta. This book contributes to this effort to define sustainable pathways for the restoration of the delta. The book grew out of two efforts. One is an earlier volume in the Estuaries of the World Series entitled Perspectives on the Restoration of the Mississippi delta. This effort was supported by environmental organizations to provide independent advice to the philanthropic community and non-governmental organizations on how best to support the restoration of one of North America's premier ecological assets, the Mississippi delta. The second effort, called Changing Course, was a design competition that sought to bring teams of some of the world's best delta engineers, scientists, and planners to address the question of the future of the Lower Mississippi River Delta and its dependent resources and communities. This Initiative specifically sought to understand how the Mississippi River's water and sediment can be used to maximize rebuilding the delta wetlands while meeting or even enhancing the needs of navigation, flood protection, industries and coastal communities. In the current book, we investigate possible future pathways for sustainable management of the Mississippi delta. We consider current conditions as well as future trajectories of climate and energy and resource scarcity. We conclude that without profound changes of how humans live in and manage the delta, sustainability of the delta will be profoundly compromised.

Keywords

Mississippi River history • New Orleans • Changing course • Coastal land loss • Wetland restoration

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In 1699, in response to English territorial ambitions, the French government sent an expedition to the northern Gulf of Mexico coast. The expedition was under the command of Pierre Le Moyne, Sieur d'Iberville, who was accompanied by his younger brother Jean-Baptiste Le Moyne, Sieur de Bienville. Their orders were to locate "the mouth of the Mississippi River," . . . and to "select a good site that can be defended with a few men, and block entry to the river by other nations." The expedition entered the river on March 2, 1699. On March 3, the day before Ash Wednesday and the beginning of Lent, they camped on the bank of the river a few leagues upriver from the mouth and named the location Point de Mardi Gras. This led to the first permanent settlement in 1718 on the Mississippi further upriver at what is now New Orleans. Many consider the encampment at Point de Mardi Gras to be the date that the French established a permanent presence along the lower Mississippi. This story is recounted by Lawrence Powell (2012) in his fascinating history of the first century of New Orleans, *The Accidental City*.

Let's conduct a thought experiment about south Louisiana beginning in 1700. Imagine that Bienville, standing on the bank of the Mississippi at Point de Mardi Gras in 1699, could have looked into the future until 1900. What would have happened over those two centuries? Sea level varied only a few cm and the mean annual temperature did not significantly increase, and carbon dioxide levels remained fairly constant around the preindustrial level of about 280 parts per million. The mean flow of the great river would remain more or less the same, albeit with considerable variability from year to year, and deliver large volumes of freshwater and sediments that flowed over and nourished almost all of the deltaic plain (Condrey et al. 2014), while the economy of south Louisiana grew and prospered. The City of New Orleans ended the nineteenth century with a population of about 290,000, nearly 25% of Louisiana's total population of 1.2 million, and practically all of the city was above sea level (Fig. 1). The world population did not reach 2 billion until 1927, the year of the great flood. So the human population, both in south Louisiana and globally, likely could have been supported by the ecosystem services by the biosphere. Fossil fuel use was less than 1% of what it is currently. The broad Mississippi delta ended the nineteenth century with a large area of marshes and freshwater forested wetlands that were much more extensive and extended much further south than at present. It is likely that had Bienville searched, he would have found the tropical black mangrove, *Avicennia germinans*, to be very rare. Hurricanes would pound the coast in the ensuing two centuries but their average strength and frequency did not grow and the extensive wetlands south of the city provided an effective buffer against the storms. Regardless of our thought experiment, it is clear that even if Bienville had been able to look into the future, he would not have understood what he saw because much of the scientific understanding we have now did not

exist in 1700. But in the first quarter of the twenty-first century, we have extensive information about the past and can reconstruct much of what happened from 1700 to 1900. And there is now abundant information that allows us to have a fairly good general idea of what will have happen in the next two centuries.

All of this average stability and predictability changed in the twentieth century. CO₂ levels soared to over 400 ppm by 2015, a level not seen for over 3 million years. Global mean temperature rose by about one degree Centigrade in the twentieth century. At the end of the last ice age, it took about 1000 years for temperature to increase by a similar amount. Temperature is projected to increase by 3–5 °C by 2100. The rate of sea-level rise increased from about one mm per year in the late 1800s to between 3 and 4 mm per year in the early twenty-first century (Fitzgerald et al. 2008). By the end of the twentieth century, continuous levees separated the river from almost all of the deltaic plain and the great delta was collapsing (Day et al. 2007, 2014a, b).

With this in mind, we can imagine one of Bienville's descendants in 2016 looking out over the river and coast and thinking about what the ensuing two centuries would be like. Perhaps a dowager of the French Quarter looking out an upper story window, or a street person lounging on the levee in front of Jackson Square, or one of the culturally and racially diverse inhabitants of south Louisiana cutting through the coastal wetlands in a fishing boat. What might the vision of Bienville's descendant be if current environmental trajectories continue until 2217? Unlike Bienville, these people if they so choose can have a fairly in depth understanding of what the next two centuries will be like based on an extensive array of scientific information.

Temperature rise will be dramatic, probably several degrees Centigrade globally, and the entire Gulf coast will be tropical. Wetland loss in the delta is dramatic (Fig. 2). Where saline wetlands exist, if indeed they survive at all, they are dominated by mangroves. These include not just the most cold-tolerant black mangrove (*Avicennia germinans*) but all three species common to the southern Gulf of Mexico – red mangroves (*Rhizophora mangle*) with their graceful arching prop roots as well as white mangrove (*Lagunculara racemosa*) with finger like pneumatophores sticking up from the muddy sediment. Sea level is much higher, perhaps by as much as three to five meters. Katrina-strength hurricanes with wind speeds of 150 miles per hour or more are much more frequent and regularly ravage the coast. The number of large floods on the Mississippi River has increased significantly due to both climate change and land-use changes. Fossil fuels are largely non-existent and what is left is extremely expensive. The flood control system on the Mississippi River, the vaunted Mississippi River and Tributaries project that was developed after the 1927 flood, has largely failed. Humans have lost control of the river and it has broken through the levees and is restoring the coast in

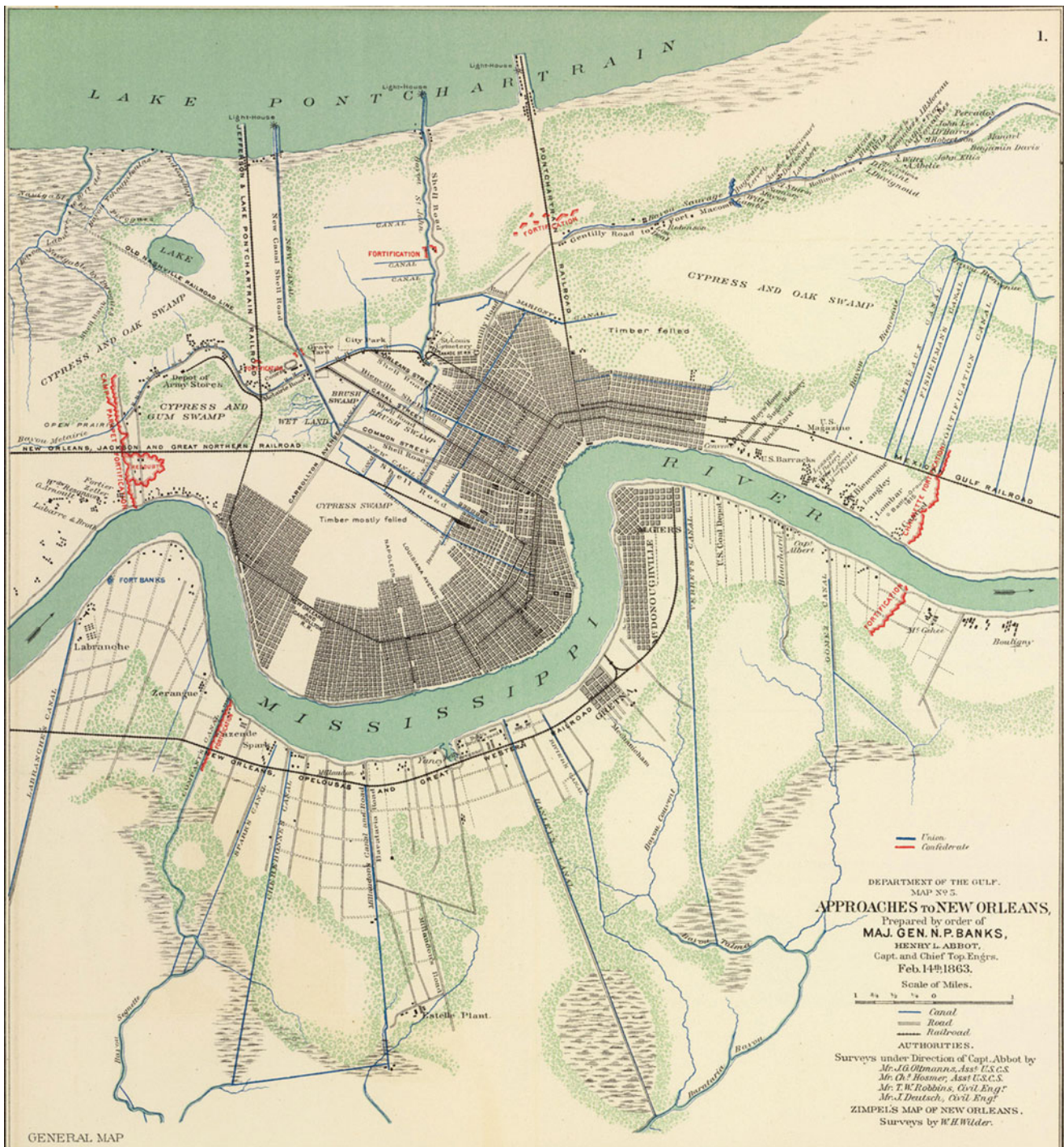


Fig. 1 Civil War era map of New Orleans dated 1863. The developed area is located on the natural levee of the river and to a lesser extent on the Metairie Ridge, an abandoned distributary of the St. Bernard delta. At this time, New Orleans was still almost completely above sea level, a situation that would soon change. There was also a broad band of cypress swamp between the city and Lake Pontchartrain that protected

it against hurricane surge (Source: Department of the Gulf, Map No. 5. Approaches to New Orleans, Prepared by order of Maj. Gen. N.P. Banks, Henry L. Abbot, Capt. and Chief Top. Engrs. Feb. 14th, 1863. From the “War of the Rebellion Atlas”, reproduced with permission: Courtesy of the Texas Collection, Baylor University <http://digitalcollections.baylor.edu/>)

places in a much more effective manner than the coastal master plan whose implementation sputtered by the middle of the twenty-first century. The river may well have changed channels. Below sea level areas like metropolitan New

Orleans do not exist. Coastal communities have either retreated to high ground far from the coast or elevated structures to dizzying heights. These visions are also reflected in *The Not Yet* by Moira Crone (2012), an

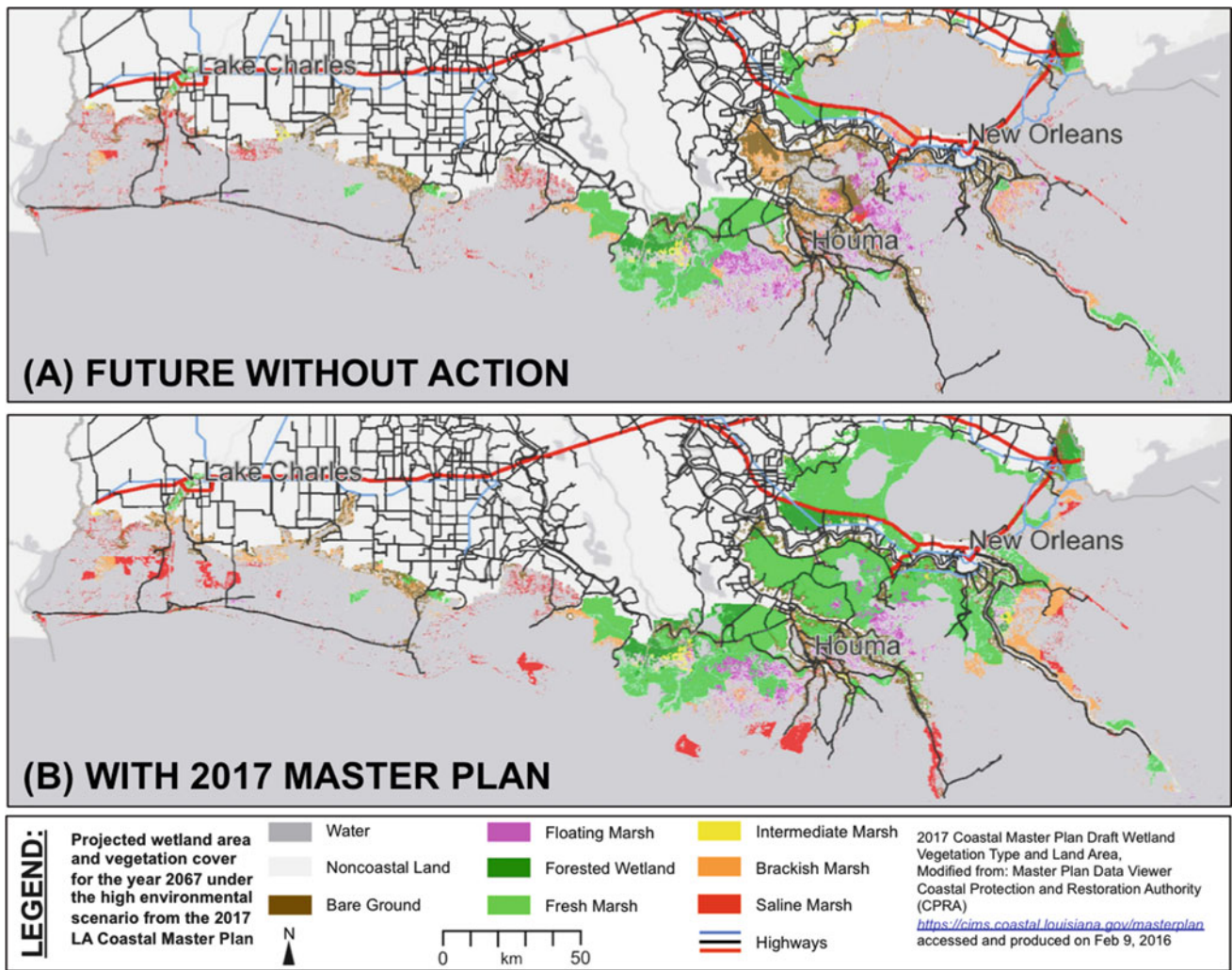


Fig. 2 A projection of the Louisiana coastline and vegetation types 50 years in the future under without action and with the 2017 Coastal Master Plan. The high scenario, shown here, considers the most severe possible sea-level rise, subsidence, storm intensity, and storm frequency. In this scenario, it is unlikely that the New Orleans

metropolitan area or the natural levee south of Raceland would survive without protective wetlands (Modified from: Coastal Restoration and Protection Authority <http://cims.coastal.louisiana.gov/masterplan/> Accessed 3/11/2017)

apocalyptic vision of New Orleans in the twenty-second century. She refers to Lake Pontchartrain as the open sea and has merged with Lake Maurepas to form a single water body and barrier beaches have disappeared. This is strikingly similar to current projections for the coast. The loss of control of the river are also reflected in the words of the poet and former LSU professor, William Hathaway:

Our river will soon vault
these flimsy levees and with one world's spin
twist free in its wild thirst for salt.

Elizabeth Kolbert, the well known writer for the *New Yorker* and author of *The Sixth Extinction*, put these issues of sustainability and survivability into a broader context when she wrote:

It may seem impossible to imagine that a technologically advanced society could choose, in essence to destroy itself. But that is what we are now in the process of doing.

In this book, we examine the science and societal actions that underlie the assumptions of the preceding paragraphs and offer some possible alternatives.

No Living Memory – Paradise Lost

When we speak of the current Mississippi delta and the services and benefits that it now provides to the human economy, we don't mean a pristine natural system. There are few ecosystems globally that have not experienced significant levels of human impact. And these impacted

systems often don't provide the level of goods and services to humans as fully intact ones. For people living in the Mississippi delta and a broader audience concerned with the delta, there is no living memory of what a fully functioning natural deltaic ecosystem in its natural state was like.

The following passage from *Father and Son* by Edmund Gosse is a beautiful statement of such lost visions. Gosse was a writer popular in England around the turn of the twentieth century. His father, Philip, was a well-known naturalist, in the manner of nineteenth century gentlemen naturalists, who studied and published a number of books on sea life in tide pools along the Cornwall and Devon coasts of southern England. The elder Gosse was a Fellow of the Royal Society and an acquaintance of Charles Darwin. He was also an evangelical Christian and when Darwin published *Origin of Species*, Philip published a biblical interpretation of the diversity he saw in nature, for which he was much ridiculed. *Father and Son* is Edmund Gosse's (2004) personal account of growing up and coming of age while living with his father. Some of his fondest memories were of trips with his father to the Cornwall coast on collecting trips. The following is his remembrance of how the area had changed since he first visited it.

It was down on the shore, tramping along the pebbled terraces of the beach, clambering over the great blocks of fallen conglomerate which broke the white curve with rufous promontories that jutted in the sea, or, finally, bending over those shallow tidal pools in the limestone rocks which were our proper hunting ground—it was in such circumstances as these that my father became most easy, most happy, most human. That hard look across his brows, which it wearied me to see, the look that came from sleepless anxiety of conscience, fades away and left the dark countenance still always stern indeed, but serene and unupbraiding. Those pools were our mirrors in which, reflected in the dark hyaline and framed by the sleek and shining fronds of oarweed, there used to appear the shapes of a middle-aged man and funny little boy, equally eager and, I almost find the presumption to say, equally well prepared for business.

If anyone goes down to those shores now, if a man or boy seeks to follow in our traces, let him realize at once, before he takes the trouble to roll up his sleeves, that his zeal will end in labor lost. There is nothing now where in our days there was so much. Then, the rocks between tide and tide were submarine gardens of a beauty that seemed often to be fabulous, and was positively delusive, since, if we delicately lifted the weed curtains of a windless pool, though we might for a moment see its sides and floor paved with living blossoms, ivory-white, rosy-red, orange, and amethyst. . . .

Half a century ago, in many parts of the coast of Devonshire and Cornwall, where the limestone at the water's edge is wrought into crevices and hollows, the tideline was, like John Keats' Grecian vase, 'a still unravished bride of quietness.' These cups and basins were always full whether the tide was high or low, and the only way in which they were affected was that twice in twenty-four hours they were replenished by cold streams from the great sea, then twice were left brimming to be vivified by the temperate movement of the upper air. These were living flower beds, so exquisite in their

perfection that my father used not seldom to pause before he began to rifle them, ejaculating that it was indeed a pity to disturb such congregated beauty. The antiquity of these rock pools and the infinite succession of the soft and radiant forms – sea anemones, seaweeds, shells, fish – which had inhabited them undisturbed since the creation of the world used to occupy my father's fancy. We burst in, he used to say, where no one had thought of intruding before, and if the Garden of Eden had been situated in Devonshire, Adam and Eve, stepping lightly down to bathe in the rainbow-colored spray, would have seen the identical sights that we now saw. . . .

All this is long over. The ring of living beauty drawn about our shores was a very thin and fragile one. It had existed all those centuries solely in consequence of the indifference, the blissful ignorance of man. These rock basins. . . . exist no longer, they are all profaned and emptied and vulgarized. An army of "collectors" has passed over them, and ravaged every corner of them. The fairy paradise has been violated; the exquisite product of centuries of natural selection has been crushed under the rough paw of well-meaning, idle-minded curiosity. . . . No one will see again on the shore of England what I saw in my early childhood, the submarine vision of dark rocks, speckled and starred with an infinite variety of color, and streamed over by silken flags of royal crimson and purple.

Similar stories and recollections could be told about thousands of places on earth from the tropics' disappearing rain forests to receding sea ice in polar regions. The Mississippi delta, compared to many places, has been ravished relatively recently. The delta was still almost completely natural when the European colonists arrived in the sixteenth century; we say almost because Native Americans had lived in the delta for millennia before the Europeans arrived. They prospered in the delta and built hundreds of mounds, called kitchen middens, composed of the shells of the oysters and clams they ate. Mixed in with the shells are pottery shards, some with beautiful markings, and items such as flint that suggests the active trade network with tribes in the southeast and Mississippi alluvial valley. But these early inhabitants had almost no negative impact on the dynamic delta.

Dr. Richard Condrey, an oceanography professor at Louisiana State University – now retired – and two colleagues studied old maps and journals from early French and Spanish mariners who explored the delta. From this information, they developed a description of the delta just before the beginning of the many interventions by the European invaders that led, by the end of the twentieth century, to the collapse of a large part of this enormously valuable ecosystem. They described what they called the last naturally active delta complexes of the Mississippi River (LNDM) as "a vast seaward-advancing arc that occupied, through four distributaries, all of the five most recent delta complexes of the Mississippi River and extended across all of coastal Louisiana. . ." It was characterized by plumes of freshwater that extended for more than 10 miles into the Gulf

of Mexico during the spring flood of the Mississippi River. Overbank flooding of natural levees of the Mississippi and St. Bernard delta complexes occurred as far north as Bayou Baton Rouge (Condrey et al. 2014). This is in stark contrast to the delta today where almost all flow is confined to the leveed Mississippi River, where the offshore reef has completely disappeared, where more than 10,000 miles of canals have been cut through the wetlands, and where a quarter of these wetlands have disappeared over the last 75 years.

The portion of the LNDM west of the Birdsfoot delta received the outflows and overflows of the Mississippi's four distributaries. This coast was also low and subject to overflow; nearly continuous; and characterized by reefs, shoals, drift trees, and shallow inlets. The network of distributaries associated with the western portion of the LNDM nurtured a network of offshore oyster reefs which covered ~2000 km² in the Gulf of Mexico and extended along the coast for more than 150 km (Condrey et al. 2014). From 1500 to 1800, this offshore oyster reef restricted access to the Mississippi's western-most distributary called by the Spanish explorer Chaves the Río del Espíritu Santo. Here, in combination with Louisiana's eastern-most coastal cheniers (Chaves' Cabo de Cruz), the reef produced a natural harbor that was evidently of great importance to Spanish sailors caught in storms along the northern Gulf during the 1500s and 1600s.

Condrey et al. conclude that the State Coastal Master Plan does not take into consideration the functioning of the last naturally active complexes of the Mississippi River and is based upon an incomplete and incorrect consideration of the historical record. Their study indicates "much of Louisiana's coast was advancing into the sea at the onset of European colonization, that colonial and post-colonial modification of the Mississippi resulted in a cumulating loss of much of this potential, and that Louisiana's total land loss. . . peaked long before" the mid twentieth century. Condrey et al. also state that many of the restoration benchmarks are incompatible with a sustainable coast. These include diversions located too far down on the Mississippi and Atchafalaya Rivers, oyster reefs confined to estuarine environments, brackish-water dominated estuaries in the spring, and retention of most levees and deep shipping channels.

Condrey et al. conclude that the only way to return to a situation similar to the last naturally active delta complexes are "multiple, large-scale diversions of freshwater and sediment which begin at or above the headwaters of the Atchafalaya River, Bayou Plaquemines, and Bayou Lafourche and reconnect the Mississippi River to its Deltaic Plain. . ." Their analysis is consistent with Day et al.'s (2005, p. 1681) recommendation for "reconnecting the river to the deltaic plain via . . . the reopening of old distributaries", as well as the desirability of "a fully revised delta-lobe-scale chronostratigraphy" (Kulp et al. 2005, p. 282). This is also consistent with recent findings by Roberts et al. (2015),

DeLaune et al. (2015), Twilley et al. (2016), and Xu et al. (2016). The vivid picture painted by Condrey et al. is of a wholly natural Mississippi delta where the river is fully connected to and spreads over the deltaic plain. Clearly, we can't go back to this but the clear message is that the resources of the river should be used to the fullest extent possible.

David Muth, an environmentalist and naturalist with the Gulf Restoration Program (and for many years with the National Park Service where he worked in the Jean Lafitte National Historical Park), echoes these sentiments (Muth 2014): "Louisiana's people are hampered by an inherent difficulty to comprehend how much the biophysical baseline has shifted. We lack an historic perspective, unaware of just how much more productive the system was and could be again. Many are engaged in a futile effort to hold onto what is doomed or put back what is already lost, rather than allow what could be: a vibrant new river management system that reignites the process that built the delta and its vast productivity in the first place."

Background for This Book

This book grew out of and was informed by two efforts that took place over the past several years. One is the book *Perspectives on the Restoration of the Mississippi Delta* and the second is the design competition for a new vision for the Mississippi delta called *Changing Course*.

Perspectives on the Restoration of the Mississippi Delta

In 2010, three environmental organizations, the National Audubon Society, Environmental Defense Fund and National Wildlife Federation, established the Science and Engineering Special Team (SEST). These national organizations, along with a number of local groups, were brought together by support from the Walton Family Foundation in 2008 to advocate for an urgent, scientifically credible campaign to restore the Mississippi River Delta (<http://www.mississippiriverdelta.org>). SEST was made up of carefully chosen group of experts on the Mississippi delta and river and chaired by Dr. John Day. SEST was initiated specifically to provide independent advice to the philanthropic community and non-governmental organizations on how best to support the restoration of one of North America's premier ecological assets, the Mississippi delta. The focus was on providing a clear-eyed, objective view of what was known about the delta and the tools available to resuscitate it. Initially, it was envisioned that the main product of the SEST was to provide a report to the NGO

organizations that supported the effort. As the process evolved, it became clear that much new and exciting information was being produced that had a much broader value than just for the Mississippi delta. For this reason, the SEST team decided to publish a book on their findings. The work, *Perspectives on the Restoration of the Mississippi Delta* was published in 2014 (Day et al. 2014a, b) as part of the *Estuaries of the World* series produced by Springer. A portion of this current book, in the same series, is an update of information published in the SEST book.

Changing Course: A Bold and Pragmatic Future

A second important initiative that stimulated the present work was the *Changing Course* initiative also called the Lower Mississippi River Delta Design Initiative (LMRDDI). The design competition sought to bring teams of some of the world's best delta engineers, scientists, designers, and planners to address the question of the future of the Lower Mississippi River Delta and its dependent resources and communities. This Initiative specifically sought to understand how the Mississippi River's water and sediment can be used to maximize rebuilding the delta wetlands while meeting or even enhancing the needs of navigation, flood protection, industries and coastal communities. Solutions had to ensure the balanced interplay of ecosystem, society and economy well into the future. Several authors of the present book participated in the *Changing Course* competition either as members of advisory teams or design teams. The competition was based on the following understanding and thinking about the past, present and future of the delta.

The Mississippi River Delta is the center of a region in peril. For thousands of years a dynamic and tenuous balance existed between land and water. The formidable flow of the river provided a counter balance to the encroaching Gulf of Mexico. However, in recent generations humans tipped this balance, stifling its delta building energy. The stability provided through river control was a boon to a century of industrial expansion providing generations of people with relative comfort and safety. However, as the last decade has made clear, coastal Louisiana is no longer safe behind the veneer of protection provided by the levee system. In fact the protection based on controlling the Mississippi River is making us less safe in the long run. Following the past decade of hurricanes and floods, the region is now reacting to ever increasing risk from encroaching Gulf waters, increased storm intensity, and rising economic instability. Without direct, focused action to transform the relationship between society and environment, Louisiana will be too vulnerable and too unpredictable for sustained economic development. Something bold needs to be done.

Changing Course was an opportunity to think beyond the limits of our everyday decision making process and consider ways to overcome the tremendous risks that sea-level rise and land subsidence and other environmental, economic, and societal forces (e.g., Day et al. 2016) pose for New Orleans and South Louisiana. By convening a large multi-disciplinary teams of scientists, engineers, planners, and designers the competition set out to see anew problems that have vexed the people of South Louisiana for generations. The Competition challenged teams to imagine new frameworks that would lead to better decision making, bolder directions, and effectively shared resources while maintaining the economic value of the Mississippi River.

This competition started from a field of 25 multidisciplinary teams formed by academics, NGOs, and large firms. The field was narrowed to eight and then finally to three teams representing the best in coastal engineering, ecology, planning, design, and other relevant fields. For 5 months the three teams competed to design a framework to transform the lower river, shedding new light on some of our most intractable problems. Teams were encouraged to come up with broad, conceptually new and bold solutions. At the same time, the competition expected designs to be implementable. For this, clear knowledge and understanding of the diverse needs of stakeholders was essential. The process of the competition was augmented with opportunities for engagement with stakeholders.

At the end of the process, the question remains, what is the value of a process like *Changing Course*? What does a design competition achieve that government and the private sector initiatives cannot? How has this particular competition changed the debate in Louisiana, and what is the value of this process to other places outside of the Gulf of Mexico? Will the necessity for change permeating these times provide the radical new ideas and the roadmap to achieve them? How will this thinking help change policy and lead to implementation?

Historically the design competition has been used precisely to shed light on and overcome our most intractable problems. Competitions have often provided public clients the opportunity to develop projects of importance in a context that exceeds the limitations of budget and politics, to provide transcendent, aspirational ideas – and true vision. The different designs suggested such things as realigning parts of the Mississippi delta, large new diversions, new building designs, and ecological engineering on a vast scale.

Context of the Competition

Design competitions have emerged to publicly engage issues that run far deeper than the typical design process can address. Maya Lin's Vietnam Memorial in Washington DC, and Michael Arad's September 11th memorial at the

World Trade Center site in Manhattan were projects that emerged from design competitions. Raw emotion and deep controversy surrounding both of these projects: a memorial to those who served and the nearly 60,000 US soldiers killed in the Vietnam War, and the nearly 3000 people killed by terrorist attacks on September 11th, 2001. The intense spotlight could easily have overly compromised projects designed through more traditional modes. But because these projects were conceived out of a competition, they were in a sense protected throughout the process. The singularity of these visions was not compromised, enabling them to become strong, hopeful symbols in extremely tumultuous times.

After Hurricane Katrina, the design competition emerged from the confines of architecture and public art to include a far broader range and scale of projects. Changing Course emerges out of this context; bridging engineering, ecological design, and urbanism to explore radical solutions to the tremendous challenges facing the River, the coast, and the New Orleans region.

The competition recognized that to overcome challenges rarely seen on such a massive scale, it would be essential to develop processes and solutions on the same scale. All of the three finalists' plans recognize that the Mississippi delta will shrink and it is within this context that planning must go forward (Fig. 3). *Changing Course* provides a vision for how we can bolster the physical environment against the threat of accelerated sea level rise and other factors while creating long-term economic and social opportunities that will enable people to remain and thrive in this environment. Coastal

Louisiana has an opportunity most other coastlines do not: a dynamic ecological system that feeds and builds a rich deltaic zone. While other regional cities are exposed to rising seas on fixed coastal edges, Louisiana can leverage the Mississippi River to sustain a thriving wetland zone that protects and promotes its industrial economy, sustains ecosystem productivity, and nourishes human occupation.

The Future Is Now

In this book we will articulate a view that the current trajectory and manner of living in the Mississippi delta is unsustainable, likely profoundly so. Above all, as we move through this century, we must be aware of and avoid folly. But what is folly in the sense that we are speaking of it? The concept of folly comes from *The March of Folly* by Barbara Tuchman in her 1984 book. She defined folly as the pursuit of policies contrary to long-term public interest by a large group – governments or industry, or as far as the Mississippi delta is concerned, the coastal population of a state, a federal bureaucracy dealing with flood control and navigation on the Mississippi River, and a diverse group of industries involved in navigation and water borne trade, petrochemical production, and oil and gas exploration, production, and refining. For an event or series of events to be considered a folly, according to Tuchman, three criteria must be met: The policy must be perceived as counter-productive in its “own time.” That is, a relatively large number of thoughtful people know that the policies are counter-productive and damaging.

Fig. 3 Less land is sustainable today, compared to when the MRD was built, due to reduced sediment loads in the Mississippi River (The Baird Team 2015)



Second, feasible alternative courses of action must be proposed – but are ignored. And the suggested alternatives should come from a group, not an individual leader, and should persist beyond one political lifetime.

The human practices and policies that over a century and a half led to the disasters of the Mississippi delta and New Orleans are classic folly on a grand scale. There is the ongoing disaster of wetland loss as well as that of Hurricane Katrina (and other hurricanes) and the BP spill. If we are to restore the Mississippi to a functioning sustainable system we must avoid folly – don't make costly mistakes. Once used, energy and other resources are not available for a second chance. And time is of the essence. The great megatrends of the twenty-first century have non-linear trajectories so that the rate of change is accelerating. There is a need to understand what is possible and what is not. The current degree of river control as embodied in the Mississippi River and Tributaries project is likely not sustainable. The “Dutch” model will grow increasingly unworkable as the century proceeds and living below sea level will become increasingly untenable (Tessler et al. 2015; Day et al. 2016). The current trajectory is clearly unsustainable. Sustainability depends to a large degree on wise use of the resources of the River but these resources must be used wisely. There is a need to work with the river and delta is what is called ecological engineering.

In this book, we investigate possible future pathways for sustainable management of the Mississippi delta. We consider the history of the development of the Mississippi delta and the causes of its deterioration. In chapter “[A Brief History of Delta Formation and Deterioration](#)”, Lane et al. provide a brief history of the formation of the Mississippi delta and causes for its deterioration and in chapter “[Levees and the Making of a Dysfunctional Floodplain](#)”, Colten discusses the progressive isolation of the delta. In chapter “[The Nutria in Louisiana: A Current and Historical Perspective](#)”, Sasser et al. discuss the role of the introduced rodent, Nutria, in wetland destruction. Shaffer et al. address the wise use of freshwater resources in maintaining fresh marshes and swamps in chapter “[Optimum Use of Fresh Water to Restore Baldcypress – Water Tupelo Swamps and Freshwater Marshes and Protect Against Salt Water Intrusion: A Case Study of the Lake Pontchartrain Basin](#)”. In chapter “[Energy and Climate – Global Trends and Their Implications for Delta Restoration](#)”, Rutherford et al. discuss the great megatrends of the twenty-first century, most importantly climate change and energy and resource scarcity and their implications for river and delta management. Wiegman et al. in chapter “[The Costs and Sustainability of Ongoing Efforts to Restore and Protect Louisiana's Coast](#)” present an overview of the State Master Plan for restoration of the delta. Diversions are a central element of the State Master Plan and in chapter “[Large Infrequently Operated River Diversions for Mississippi Delta Restoration](#)”, Day et al.

discuss the potential use of much larger diversions than are considered in the Master Plan. Large areas of the coast, especially the New Orleans area, are below sea level. Maintaining areas below sea level may become untenable in this century. In chapter “[Raising Urban Land: Historical Perspectives on Adaptation](#)”, Colten provides a historical overview of elevating urban land with lessons for New Orleans. In chapter “[Raising Buildings: The Resilience of Elevated Structures](#)”, Erdman and Williams review how architecture can be designed for a low-lying coastal region like New Orleans. Erdman et al. then present a bold plan (chapter “[Raising New Orleans: The Marais Design Strategy](#)”) for elevating large portions of New Orleans to protect the city against sea-level rise and future hurricanes. In chapter “[Eroding Communities and Diverting Populations: Historical Population Dynamics in Coastal Louisiana](#)”, demographic trends for South Louisiana are discussed by Hammerling and alternatives for sustainable living are considered. A new legal framework to promote safe and sustainable development in coastal Louisiana is considered in chapter “[Raising New Orleans: The Marais Design Strategy](#)” by Wilkins. In chapter “[Eroding Communities and Diverting Populations: Historical Population Dynamics in Coastal Louisiana](#)”, we bring together the elements of the book into a vision for a sustainable pathway forward to coastal Louisiana.

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