

Gaining Ground: Wetlands, Hurricanes, and the Economy: The Value of Restoring the Mississippi River Delta

by David Batker, Isabel de la Torre, Robert Costanza, Paula Swedeen, John Day, Roelof Boumans, and Kenneth Bagstad

David Batker is co-founder and executive director of Earth Economics. Isabel de la Torre is co-founder of Earth Economics. Robert Costanza directs the Institute for Sustainable Solutions at Portland State University. Paula Swedeen is the director of ecosystem service programs at the Pacific Forest Trust. John Day is a distinguished professor at Louisiana State University's School of the Coast and Environment. Roelof Boumans is the director of AFORDableFutures LLC. Kenneth Bagstad is a post-doctoral associate at the University of Vermont.

Economies need nature. Natural systems provide foundational economic goods and services, including oxygen, water, land, food, climate stability, storm and flood protection, recreation, aesthetic value, raw materials, minerals, and energy. All built capital is made of natural capital, including cars, buildings, and food. The coastal economy of the Mississippi River Delta also requires hurricane protection, a stable climate, waste assimilation, and other natural services. No economy can function without nature's provision of economic goods and services. This is most apparent in North America's largest river delta.

This Article is a brief synthesis of a more extensive report we carried out to evaluate the value of ecosystem services of the Mississippi Delta.¹ That report—the most comprehensive measure of the economic value of Mississippi River Delta natural systems to date—is available at www.earthconomics.org.

I. The Economic Value of the Mississippi River Delta

The Mississippi River Delta ecosystems provide at least \$12-47 billion in benefits to people every year. If this natural capital were treated as an economic asset, the delta's minimum asset value would be \$330 billion to \$1.3 trillion (3.5% discount rate). Marine waters, wetlands, swamps, agricultural lands, and forests provide natural goods and services. The

goods and ecosystem services valued in our study include hurricane and flood protection, water supply, water quality, recreation, and fisheries. The Mississippi River Delta is a vast natural asset, a basis for national employment and economic productivity. It was built by literally gaining ground: building land with sediment, freshwater, and the energy of the Mississippi River.

Yet, this vast national economic asset is being squandered at a tremendous cost. While the oil spill in the Gulf of Mexico has focused the country's attention on the value and vulnerability of coastal wetlands, decades of wetland loss remains the greater threat to the long-term ecological and economic health of the Gulf. The Mississippi Delta lost over 1.2 million acres of land in the last 80 years. In some areas, the coastline has retreated by as much as 30 miles. The lower Mississippi River has been constricted by levees since the 1930s, resulting in billions of tons of valuable sediment and trillions of gallons of valuable freshwater being channeled into deep water off the edge of the continental shelf. The Mississippi's energy to move vast amounts of sediment and water could have built additional land and provided hurricane protection and other economic benefits at no significant cost.

Without the input of sediment and water, wetland systems collapse. Land is lost to the waters of the Gulf of Mexico causing tremendous economic and human cost. Wetlands provide vital protection against hurricanes. When land disappears, so do the economies, homes, and communities that depend on it. Solving this problem requires an accounting of and investment in the economic assets of nature—natural capital—as an integral component of hurricane damage prevention and as a critical foundation for healthy communities and economies.

1. DAVID BATKER ET AL., GAINING GROUND: WETLANDS, HURRICANES, AND THE ECONOMY: THE VALUE OF RESTORING THE MISSISSIPPI RIVER DELTA (Earth Economics 2010), available at http://www.earthconomics.org/FileLibrary/file/Reports/Louisiana/Earth_Economics_Report_on_the_Mississippi_River_Delta_compressed.pdf.

Is this national investment worthwhile during a period of financial crisis? The results of our report point to an unequivocal “yes.” Seventy years ago, investments in roads yielded high economic returns because the United States was transitioning from a horse-and-wagon road system to a motorized system. Today, roads are neither scarce nor a barrier for economic recovery. Hurricane protection is scarce, and hurricanes hamper national economic productivity; the disruption of oil and gas supplies alone costs U.S. citizens dearly. Today, a major investment in natural capital is required for economic development. An investment in restoring the Mississippi River Delta is both a local and national investment that realizes local and national economic benefits.

The report shows the value of investing in the restoration of the Mississippi River Delta. The value of natural capital is a critical and large part of the economy. Ecosystem services and goods directly benefit people but have been overlooked historically. Table 1 shows low and high estimates of the sum of 11 ecosystem services calculated for each land-cover type. This provides a low and high total estimate for the annual benefits that natural systems of the Mississippi River Delta provide.

Table 1. Total Value Based on Acreage for Each Ecosystem Type (2007 Dollars)

Land Cover Type	Acres	Low Value Estimate	High Estimate
Fresh Water Marsh	877,099	\$2,833,616,569	\$11,077,411,806.55
Intermediate Marsh	660,933	\$1,823,993,642	\$4,429,535,089.73
Brackish Marsh	547,445	\$1,510,797,014	\$3,668,942,825.58
Saline Marsh	421,561	\$1,098,191,310	\$2,760,038,549.65
Shrub-Scrub Wetland	172,106	\$393,890,419	\$1,531,460,185.19
Forested/Swamp Wetland	1,031,561	\$3,335,203,387	\$13,258,333,954.99
Open Freshwater	992,127	\$428,346,204	\$2,959,631,369.64
Open Estuarine Water	3,549,990	\$68,661,717	\$6,822,566,401.65
Upland Shrub-Scrub	84,799	\$9,090,572	\$135,305,795.41
Upland Forest	172,106	\$78,575,469	\$699,135,025.33
Pasture-Agriculture	481,575	\$37,997,389	\$42,802,567.96
Total	8,940,461	\$11,953,060,333	\$47,385,163,571.67

We also carried out a valuation of ecosystem services in the Mississippi Delta, calculated their present value, for which we estimated the flow of value over time, providing low and high estimates analogous to a capital asset value (\$330 billion-1.3 trillion at a 3.5% discount rate). The dramatic dynamic physical changes affecting the Mississippi River Delta have profound economic implications for the region and our nation. Below, we examine three investment/restoration scenarios for the Mississippi Delta.

The first scenario involves doing nothing new: invest nothing in natural capital and keep building costly levees repeatedly damaged by storms while land continues to wash

away. Practiced for 80 years, this option has had the goal of increased hurricane buffering but has proven to be both costly and ineffective. It has resulted in a retreating coastline in the Mississippi Delta, causing a retreat of people, communities, industry, built capital, and the economy. It has left people and economic assets increasingly vulnerable to hurricane damage. Examining 11 ecosystem services and their value-changes with expected coastal deterioration, we estimate the losses associated with this option at \$41 billion. This does not include estimates of damage from another major hurricane, certain to happen. Hurricane Katrina caused \$200 billion in damages, and with further land loss in the future, damages may be much higher under this “do-nothing” approach. We therefore consider losses of \$41 billion to be a significant underestimate of the potential costs.

The nation breathed a sigh of relief when Hurricane Gustav’s path in 2008 was such that New Orleans escaped serious damage. Had the hurricane struck slightly to the east, the impact could have been far more damaging. Hurricane Gustav caused significant damage in Baton Rouge, with thousands of trees blown down. Hurricane Ike was perhaps more powerful than Hurricane Katrina. The resulting devastation along the Texas coast demonstrated that the entire U.S. Gulf Coast and eastern seaboard are now vulnerable to hurricanes and storm surges of increasing power. The contribution of natural capital in protecting people and economic assets needs to be considered throughout the Gulf of Mexico and southern Atlantic seaboard. Hurricanes Gustav and Ike caused tens of billions of dollars in damage, much of which would have been reduced had larger barrier islands and a greater wetland buffer been in place. This first scenario continues the historic path of diminishing natural hurricane buffering, while vast resources of sand, sediment, and water continue to be wasted. The less work that nature does, the more work the Federal Emergency Management Agency (FEMA) will have

to accomplish.

The second scenario covers a suite of projects that aim to maintain the current amount of land across the delta, so as to “hold the line,” and prevent net land loss. The U.S. Army Corps of Engineers (the Corps) adopted this scenario in the 2008 Louisiana Coastal Protection Technical Report.² Holding the line provides greater benefits than the first do-nothing-new, let-it-deteriorate scenario. However, it does not significantly secure greater natural hurricane buffering than

2. U.S. ARMY CORPS OF ENGINEERS, LOUISIANA COASTAL PROTECTION AND RESTORATION DRAFT TECHNICAL REPORT (2008).

available the day Hurricane Katrina hit. It will leave New Orleans and other populated areas no better protected, with yet significantly degraded natural systems. This scenario depends on larger and more expensive levees that actually require wetlands as buffers for success. Hurricanes Gustav, Ike, Katrina, and Rita provided an important lesson, recognized by the Corps, that levees protected by wetlands perform better and fail less than levees directly exposed to hurricane storm surges. Although this scenario takes into account some lessons from recent hurricanes, it is not a solution rooted in the geology and biology of water, sediment, and flow that shape deltas. The Mississippi River Delta is tremendously dynamic, either expanding or shrinking, depending on the allocation of vast quantities of water and sediment far greater than any other delta in North America. Attempting to “hold the line” is not realistic in a deltaic system of this scale. It is more difficult and more costly than actually reestablishing deltaic processes and using the energy and water of the Mississippi River on a larger scale to reap far greater benefits. The “hold-the-line” scenario is a better strategy than doing nothing, but it is not systemic, and it underinvests in an asset the scale and value of the Mississippi Delta. It is simply not a deltawide solution.

The final scenario, sustainable restoration, implements large-scale, controlled diversions of water and sediment from the Mississippi River to reconnect it to the delta. This will gain ground, restoring deltaic processes at the scale that the delta requires to stop land loss and maintain a net expansion of land. It will build a larger natural asset base and yearly provide greater ecosystem services, such as fisheries production and direct expansion of hurricane buffering before hurricanes hit the levees and inhabited areas. Studies show that diversions and plant growth outpace expected sea-level rise that the Intergovernmental Panel on Climate Change has predicted. This scenario offers the best economic investment in terms of producing the greatest benefits in safety, economic viability, and habitability of the Mississippi River Delta. It is also the most resilient option to uncertainty in the face of climate change, as well as oil prices and other economic uncertainties. Initial investments in diversion structures utilize the energy of the Mississippi River and are inexpensive to operate over the long run.

The lands gained from this scenario will avoid the \$41 billion in damage under scenario 1 and will produce benefits with an additional estimated present value of at least \$21 billion, bringing in an annual net benefit of \$62 billion. This includes partial values of 11 ecosystem services. It does not include the value of increased protection for levees or avoided catastrophic impacts, such as levee-breaching under another Hurricane Katrina scenario, in which the benefits could easily be doubled. Nor does it include the benefit of reduced displacement of residents, avoided economic losses, reduced FEMA relief and recovery costs, lower insurance rates, lower national oil and gas prices, less litigation, or the benefits of an expanding coastal economy, greater employment, and stability gained for existing communities and residents. Future studies of ecosystem services should include these benefits.

Because natural systems tend to appreciate in value rather than depreciate and fall apart as does built capital, there is good reason to be informed of the total value provided to people, if benefits in the future are not discounted so steeply. Table 2 shows the value of scenario 3 under different discount rates for a 100-year period. In 1899, for example, the city of Seattle acquired the Cedar River Watershed to provide and filter the city’s water. Had the goal of the city been to maximize present value, and had they used modern economic analysis, heavily discounting future benefits, the project would likely have not been approved. The goal, however, was to provide the citizens with a sufficient and clean drinking water supply *in perpetuity*. It turned out to provide a spectacular return. To build a filtration plant today would cost Seattle \$250 million. And between 1899 and today, the city would have had to build at least four filtration plants. The city has likely saved over a billion dollars over the last 100 years because the wise investors on the city council in 1899 understood the value that healthy natural systems could provide across generations. Restoring the Mississippi Delta is a similar, long-lived investment.

A comparison of the three scenarios—with 27 other criteria, including contribution to coastal stability, capacity to expand economic development, and protection of water quality and energy infrastructure—shows scenario 3 to have the highest ranking, by far.

Table 2. Total Present Value (PV) for Scenario 3, Avoided Losses and Gains Realized in \$ Billions

Major Restoration Scenario	PV 0% Discount Rate	PV 2% Discount Rate	PV 3.5% Discount Rate	PV 5% Discount Rate
Total PV Avoided Costs and Direct Gains	322	113	62	38

With an expanded Mississippi Delta, the prevention of damage from levee failure or the protection of an existing levee infrastructure can provide benefits on the level of tens of billions of dollars in a single hurricane event. These values are difficult to estimate. However, it is clear that a strategy of gaining ground will provide critical natural goods and services, such as public safety, storm protection, and oil and gas, thereby expanding the economic base of the Mississippi Delta and the nation. This is not a cut-the-river-loose scenario, but a managed system of diversions to use sediment and water to increase the area of protective deltaic wetlands, providing for public safety and increased economic benefits.

The evidence is clear: invest in the Mississippi River rebuilding the delta to gain ground, physically and economically. On the other hand, ground loss results in loss of nature’s services, causing a hurricane-driven disorderly retreat inland and damaging people and businesses. This analysis strengthens ongoing planning by providing the economic justification for large-scale restoration. It complements efforts like

the state of Louisiana's *Comprehensive Master Plan for a Sustainable Coast*³ and the *Multiple Lines of Defense* strategy developed by the Lake Pontchartrain Basin Foundation and Coalition to Restore Coastal Louisiana.⁴

Academics, nonprofit organizations, state officials, residents, and just about every person who studied this issue carefully support the restoration of the Mississippi Delta. Gaining ground provides economic benefits by:

1. Rebuilding land with more than one-half of the Mississippi River's peak flow water and sediment;
2. Adding economic value, including hurricane protection and protection of existing levees;
3. Spurring wetland plant growth that soaks up carbon, increases fisheries production, and offers other benefits;
4. Building land with plant growth that beats sea-level rise and land subsidence;
5. Helping stabilize barrier islands, which increases hurricane protection and coastal stability;
6. Reducing the dead zone in the Gulf of Mexico, which will increase fisheries and other benefits;
7. Yielding greater ecosystem services for better water quality, wildlife habitat, and hurricane protection;
8. Securing the nation's energy infrastructure and inhabitable area of the Mississippi River Delta;
9. Providing a more sustainable, vibrant economy with a higher quality of life; and
10. Setting an example for the nation, Gulf Coast, and eastern seaboard in natural hurricane buffering.

The use of diversions for restoration is a proven strategy, not an experimental approach. Over 30 years of experience of water and sediment diversion shows diversions to be outstanding in building land area and restoring wetlands. The Old River Control Structure diverts water and sediment down the Atchafalaya River. The sediment and freshwater from this diversion has created new deltas in Wax Lake. These examples can be replicated on a much broader scale.

With such a wide range of economic benefits, the report provides a starting point to inform investments in levees, restoration, land use, and economic development in the Mississippi River Delta. The study provides the most comprehensive valuation of natural capital assets in the Mississippi River Delta to date; however, it is still a partial valuation and an underestimate of the delta's total potential economic value. This valuation does not include economically valuable benefits, such as navigation, protection of oil and gas infrastructure, and aesthetic value. Even with a wide range

of estimates, it points to critical tools that can better inform investments in levees, restoration, land use, and economic development in the Mississippi River Delta.

We show conclusively that physical sustainability and delta expansion secures vast economic benefits locally and nationally. Within the context of the current financial crisis, investment in restoration secures short-term benefits of employment, income generation, greater ecosystem services, and other economic benefits, and the long-term goals of increased storm protection, greater oil and gas supply reliability, and other economic benefits. A sustainable restoration of the Mississippi River Delta is a good investment with a high rate of return. Gaining ground is the most successful economic strategy for securing hurricane defenses and economic development.

II. Conclusion

Mississippi River Delta ecosystems provide economically valuable services, including hurricane storm protection, water supply, climate stability, food, furs, waste treatment, wildlife habitat, recreation, and other benefits. This flow of annual benefits provides a vast amount of value to people across time. A natural capital asset value can be established from these annual benefits. The present value of the benefits from these ecosystem goods and services provided by the Mississippi Delta, analogous to an asset value, is worth at least \$330 billion to \$1.3 trillion.

These benefits are derived from natural capital, which is self-maintaining and lasts for a long time; it is fundamentally different from built capital, which depreciates quickly and requires capital and maintenance costs. In the past, our natural capital was taken for granted. Although natural systems provide economic goods and services, such as fish and hurricane protection, they have not been valued as economic assets and were excluded from economic analysis and investment decisions.

Large-scale physical changes are affecting the Mississippi River Delta. In the last 30 years, oil and energy costs have been increasing, hurricanes have become larger and more frequent, sea level has risen, atmospheric temperatures have risen, the delta has been subsiding, and, since 1930, has lost 1.2 million acres of land. This loss has had tremendous economic implications, including exposing cities like New Orleans to greater threats from hurricanes.

Hurricanes Katrina and Rita triggered a warning that has been sounded several times before. The current management of the Mississippi River, moving the sediment and freshwater of the river off the continental shelf, has damaging economic costs in terms of land loss. The river has been walled off from the Mississippi River Delta since the 1930s. The public, academics, and the state of Louisiana have sought to reconnect the river to the delta and utilize its sediment, water, and energy to renew the processes that added land to the delta for thousands of years.

It is clear that restoration of the deltaic processes and levees are needed to secure public safety, economic assets, and valu-

3. LOUISIANA COASTAL PROTECTION & RESTORATION AUTHORITY, INTEGRATED ECOSYSTEM RESTORATION AND HURRICANE PROTECTION, COMPREHENSIVE MASTER PLAN FOR A SUSTAINABLE COAST (2007), available at <http://coastal.louisiana.gov/index.cfm?md=pagebuilder&tmp=home&pid=28>.

4. LAKE PONTCHARTRAIN BASIN FOUNDATION & COALITION TO RESTORE COASTAL LOUISIANA, THE MULTIPLE LINES OF DEFENSE STRATEGY TO SUSTAIN COASTAL LOUISIANA (2006), available at <http://www.mlods.org/home.html>.

able ecosystem services. The best solution is a sustainable restoration option, which would avoid \$41 billion in losses and secure an additional \$21 billion in benefits, providing \$62 billion in net present value benefits. This major investment to restore the deltaic processes of the Mississippi River Delta is required to maintain or expand the vast value of this natural asset. The movement of water and sediment and the maintenance and expansion of land underlies the production of many economic benefits, including protection against hurricanes. Without this investment, people and economic assets will be forced to retreat from the coastline.

Our analysis does not include many ecosystem services with clear economic value. It is part of a series of efforts to understand the value of the natural capital in the Mississippi Delta. More work is critically needed to understand how and what investments in diversions, levees, or other structures can produce the best and most long-lasting benefits.

Ecological engineering must form the basis of delta restoration. High and rising energy costs will erode the economics of energy-intensive options, such as levees and sediment pumping, while water and sediment diversions utilize the Mississippi River's energy and can be easily maintained over many decades.

The overarching solution is well understood: large diversions of water and sediment from the Mississippi River are required to rebuild the Mississippi Delta and to secure the many benefits, including the economic productivity, that the river provides. The management of more coarse sediments in the Mississippi Basin, currently trapped behind dams, should also be considered, as these sediments will eventually be released in the next 100 years and can contribute substantially to the delta's restoration.

Overall, the study shows that a major investment of \$15-20 billion for restoring the Mississippi River Delta to significantly increase land building would return at least four to five times that amount in the order of \$62 billion in net present value at a 3.5% discount rate.

Once restored in a manner that allows the maintenance of natural processes, these wetlands will continue to support the economic health of the Mississippi River Delta. With the river reconnected to the delta, the system will be closer to self-maintaining at the operating cost for diversion structures.

Without a large investment in restoration, hurricane damage will clearly increase and other ecosystem services will be lost. The economic viability and habitability of the Mississippi River Delta will be threatened. This could result in vast losses to the country in terms of irreplaceable cultural and natural resources.

Within the context of the current financial crisis, investment in the restoration of the Mississippi River Delta provides high-, short-, and long-term returns. Federal, state, and local governments should dramatically increase expenditures for the restoration of the Mississippi Delta.

The Mississippi River Delta, the largest delta in North America, houses oil and natural gas resources, refineries, fertilizer and chemical facilities, and other industries that are vital to the country's economic health. It also comprises 40% of U.S. coastal wetlands, a crucial flyway for migratory birds. It is by far the most productive delta in the United States.

Economies need nature. This is very evident in the Mississippi River Delta. If the Mississippi River is not reconnected to the delta on a large-scale basis, the land, culture, and economy of this vast and productive area will be lost. Effective hurricane defenses require wetland expansion. Reconnecting the river to the delta at the appropriate scale will accomplish restoration that is needed and create far more economic value than the cost of restoration. This is an investment clearly in the best interest of the people of the United States.