



Investment Decisions for Coastal Restoration: Timely Actions, Sustainable Benefits

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INTRODUCTION

A healthy coast is an unparalleled resource for Louisiana, providing raw materials for a wide range of economic activities, embedding unique cultural and educational values, and enhancing environmental security. Widely recognized as a natural capital asset for Louisiana, the coast and its value could be impacted by both the natural environment and human interventions.¹ In the context of global climate change, the sustainability of Louisiana's coast is increasingly under pressure from risks associated with sea level rise and local landscape changes, such as coastal land loss. To preserve the environmental performance and socioeconomic value of the coast, timely investment in restoration is critical. The returns from expenditures in coastal restoration sometimes appear to occur over the long term, creating uncertainties and debates about the urgency of making such endeavors. However, scientific research shows that investment in coastal restoration in the context of a changing environment is time-sensitive, highlighting the significance of maximizing the benefits from restoring coastal ecosystems by taking actions as soon as possible.

HIGHLIGHTS

- Coastal Louisiana is ecologically diverse, providing all types of ecosystem services which offer both monetary and non-monetary values within the state and beyond.
 - Coastal ecosystems in Louisiana are subject to sea level rise and subsidence, both of which may impact the effectiveness of manufactured efforts in coastal restoration.
 - Ecological evidence indicates the timing of projects could influence the sustainability of services provided by restored ecosystems to a large extent, especially in the context of sea level rise.
 - Economic perspective shows that earlier actions on beneficial projects are likely to yield larger benefits than later ones when discounted to their present values.
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ECONOMIC VALUES OF COASTAL ECOSYSTEMS

The coast provides essential inputs for local, regional, and state economies, culture, and social wellbeing in Louisiana. Such provisions are usually conceptualized as ecosystem services, which are defined as “benefits people obtained from ecosystems.”² There are four types of ecosystem services, including provisioning services (e.g., food and fresh water), regulating services (e.g.,

climate regulation and flood regulation), cultural services (e.g., aesthetic and recreational values), and supporting services (e.g., soil formation and primary production).

As one of the most ecologically diverse environments, coastal ecosystems provide a wide range of ecosystem services. Table 1 displays examples of unique benefits that coastal Louisiana offers.^{3,4}

Table 1. Types and Examples of Ecosystem Services from Coastal Wetlands in Louisiana.

Types of Ecosystem Services	Definition	Example of Services from Coastal Wetland in Louisiana
Provisioning Services	Providing material benefits, including edible plants and animals for human consumption.	Production of shrimp, oyster, fish, etc.; Retention and storage of freshwater.
Regulating Services	Maintaining essential ecological processes and life support systems for human well-being.	Protection for coastal communities from storm surge; Erosion control and sediment retention.
Cultural Services	Enhancing emotional, psychological, and cognitive well-being.	Destination for recreational fishing, birding, etc.; Use of natural areas for scientific and educational enhancement.
Supporting Services	Supporting the production of all other ecosystem services.	Support for deltaic formation processes; Support for nutrient cycling and water cycling.

Ecosystem services provided by Louisiana's coast have both monetary (such as production of seafood) and non-monetary (such as appreciation of aesthetic sea views) values. Although the former is easier to assess, few studies have investigated and measured the monetary values of ecosystem services in coastal Louisiana to date. One such example is an economic evaluation of coastal land loss in Louisiana which reveals that storm protection, public land use, and inputs for fisheries are the top three ecosystem services generating substantial economic values in coastal Louisiana.⁵

Table 2. Estimates for Economic Values of Hazard Protection by Coastal Lands.

Protection by Coastal Lands and Consequently Avoided Losses	Economic Values Estimated
Avoided capital stock loss from land loss	\$2.8 billion to \$4.6 billion
Economic activity disruption from land loss	\$7.7 billion to \$9.8 billion
Capital stock loss from increased storm damage	\$13.3 billion to \$176.4 billion
Economic activity disruption from land loss	\$6.6 billion to \$67.7 billion

* Dollars adjusted to 2023 values based on Consumer Price Index data from the Bureau of Labor Statistics and the Federal Reserve Bank of Philadelphia.^{6,7}

For instance, coastal lands could serve as buffer zones for capital stocks and economic activities against coastal hazards (Table 2).⁵ These estimates are intended to capture regulating services of coastal ecosystems for resident and non-resident structures and network infrastructure, as well as in-state and out-of-state economic activities.

Fisheries and outdoor recreation are two examples of industries that are heavily reliant on robust coastal ecosystems while playing an indispensable role in the state economy. Recreational and commercial fishing industries directly employ 927 and 11,054 people in Louisiana, respectively in 2021.^{8,9} If coastlines retreat persistently in the long run, catch rates may decrease together with the declines of marsh edge,⁵ potentially impacting employment in and revenues from fishing industries as well as impacts to down- and up-stream industries. At the same time, outdoor recreational activities generate approximately \$4 billion annually in Louisiana, and much of that industry is concentrated in coastal areas, where potentially 13% of wildlife management areas, reserves, and parks are subject to coastal land loss.

In short, coastal ecosystems provide both non-monetary and monetary services, including tremendous economic

values of local capital stock, state and national economic activities, and local livelihoods and industries, such as fisheries and outdoor recreational activities.

SUSTAIN BENEFITS FROM COASTAL ECOSYSTEMS

The benefits the state receives from coastal ecosystem services may decline due to sea level rise and subsidence, and timely efforts to sustain these benefits are needed to support their long-term value. Due to anthropogenic and natural drivers, there are downward trends of ecological health in coastal Louisiana.¹⁰ In attempts to halt and reverse such deterioration, both natural and human impacts should be taken into account. Engineered solutions are likely to be necessary to restore coastal ecosystems given the scale of challenges facing the coastal environment. Environmental factors also influence the effectiveness and efficiency of deliberate restoration efforts. Sea level rise is one the major factors to be considered, because higher relative sea level rise is already leading to losses of coastal areas, including marshes and swamps.^{11,12} Accelerated sea level rise is an even greater threat. The Louisiana Coastal Master Plan is based on sea level rise projections of 0.49-0.76 meters by the year 2050,¹³ and 0.5-2.0 meters by the year 2100, and a 16%-37% loss of current land in coastal Louisiana in 50 years.¹⁴

From an ecological perspective, such influential factors are too important to be excluded in designing restoration projects and underscore the importance of early actions. For example, to measure possible land gains from the Mid-Barataria Sediment Diversion Project, Meselhe et al. examined interactive impacts of sea level rise, land subsidence, riverine freshwater inflow, sediment load, as well as the timing of project implementation.¹⁵ A ten-year delay of implementing this project, from 2025 to 2035, could result in an approximately 40% decrease in land obtained from the diversion by 2100, under the assumption of a one-meter sea level rise. When using an assumption of a two-meter sea level rise, such a ten-year delay would mean the diversion would generate little impact on the local landscape.

Faced with evolving ecological environments, delays in restoring Louisiana's coast do not only result in postponed benefits from repaired coastal ecosystems but could result in diminishing benefits that, depending on the length of the delay, could be reduced to no benefits. Given the long-term outlook for general environmental change in the coastal area, ecosystems benefits from delayed projects are unlikely to be caught

up, may involve irreversible loss, and have a high likelihood of being too costly to complete at a later date.¹⁵ To avoid lost benefits from delays in action and to sustain resilient ecosystem services, consideration of natural dynamics and timely intervention efforts are necessary.

MAXIMIZE RETURNS FROM INVESTMENT IN COASTAL RESTORATION

Returns to timely investment in coastal restoration tend to be achieved over the long run rather than a short one, and therefore their monetary values should be discounted in cost-benefit analysis. For instance, investment in the Mid-Barataria Sediment Project would generate land gains over time, sometimes across generations, instead of immediately. Discounting values of land obtained in the future to current monetary values is necessary because holding everything else about a public investment constant, benefits received today create higher monetary values than those received in the future.¹⁶ This difference arises due to various factors listed as below:¹⁷

- Generally, economic research supports the notion that the public prefers rewards to come sooner rather than later.
- At the same time, overall social wealth is expected to grow over time and receiving an extra dollar today creates a larger marginal benefit than in the future.
- The use of benefits received today can generate additional value over time, which makes earlier benefits more valuable in total than later ones at any future point in time.

The influences of these factors vary across different policy issues,¹⁸ so the appropriate value of the discount rate, a ratio of return used to transfer future cash flows back to their present value, ranges widely, even within the category of coastal policy.¹⁹ A survey of over 200 studies about the discounted value of ecosystem services suggests that timely investment in ecosystem restoration which prevents or mitigates ecological degradation or resource depletion appears to be not only "profitable" but "high-yielding".²⁰

From an economic perspective, once a project has been determined to generate net benefits, earlier investment in Louisiana's coast appears to be preferred because it improves ecosystem services sooner and creates higher monetary values than would a later investment of the same amount. This difference demonstrates the value of time. For instance, assuming a discount rate of 3%, a

\$100 annual permit for the Grand Isle State Park this year, which provides the permit holder access to recreation, has a value that is 16% more than the present discounted value of a permit for access in three years (\$83.74), even if the face value of the future permit is the same. Using a discount rate exemplifies how aesthetic and recreational coastal ecosystem services received earlier are more valuable than those received later.

SUMMARY

Ecosystems provide diverse benefits for communities, including the provision of raw materials/resources, hazard protection, maintenance of ecological processes and systems, and enhancement for cultural value. Coastal ecosystems in Louisiana provide substantial monetary values through protection against coastal hazards, use of coastal land, and support for local industries, such as fisheries and outdoor recreation. Bordered by the Gulf of Mexico, coastal Louisiana is highly subject to subsidence and sea level rise.¹³ Ecological evidence suggests that timely investment could positively impact sustaining coastal resilience and perpetuate services from restored ecosystems, in the context of unpredictable climate change.²¹ In delaying financial support for coastal restoration to sustain coastal land may lead to ineffective investments due to substantial diminishment in benefits from ecosystems. Economic viewpoints further amplify the social value of timely investments, considering that long-term returns starting earlier are more valuable than those occurring later, a concept often captured by discounted potential benefits of projects to their present values.

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