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TECHNICAL REPORT

# Planning Tool to Support Louisiana's Decisionmaking on Coastal Protection and Restoration

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## Technical Description

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Sponsored by the Coastal Protection and Restoration Authority of Louisiana



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## Summary

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### Louisiana's Coastal Crisis

Coastal Louisiana is on an unsustainable trajectory of ongoing conversion of coastal land to open water and increasing hurricane flood risk. Since the 1930s, 1,800 square miles of land have been lost to open water (Couvillion et al., 2011). This loss of land is changing the nature of the coastal environment profoundly and diminishing many of its benefits, including habitats for commercially and recreationally important species. Land loss is also decreasing the region's natural buffer against hurricane storm surges.

The causes of the ongoing land loss are varied and include natural and human-caused land subsidence, rising sea level, and the loss of nourishing sediment from Mississippi river flows that is now deposited deep in the Gulf of Mexico. Without major investments in coastal restoration, the Coastal Protection and Restoration Authority (CPRA) estimates that an additional 800 square miles could be lost over the next 50 years under moderate assumptions about future conditions, and 1,800 square miles under less optimistic assumptions (CPRA, 2012a). As communities and economic assets grow during the coming decades, the land that provides a protected buffer against storm surges is anticipated to continue to degrade. Sea-level rise and subsidence rates may accelerate (Vermeer and Rahmstorf, 2009; Kolker, Allison, and Hameed, 2011), and hurricanes may increase in frequency and magnitude in response to changing climate patterns (Knutson et al., 2010). As a consequence, flood risk is expected to rise significantly if further investments in risk-reduction and restoration projects are not made.

### The Louisiana Comprehensive Master Plan and Planning Tool

To address this challenge, CPRA developed *Louisiana's Comprehensive Master Plan for a Sustainable Coast* (CPRA, 2012c), a 50-year plan for reducing hurricane flood risk and achieving a sustainable landscape. As part of this effort, CPRA supported the development of a computer-based decision-support tool called the *Planning Tool*. The Planning Tool was designed to support a *deliberation-with-analysis process* by which quantitative analysis is used not to provide a single answer but rather to frame and illuminate key policy trade-offs (National Research Council, 2009). Specifically, the Planning Tool helped CPRA to (1) make analytical and objective comparisons of hundreds of different risk-reduction and restoration projects, (2) identify and assess groups of projects (called *alternatives*) that could make up a comprehensive solution, and (3) display the trade-offs interactively to support iterative deliberation over alternatives.

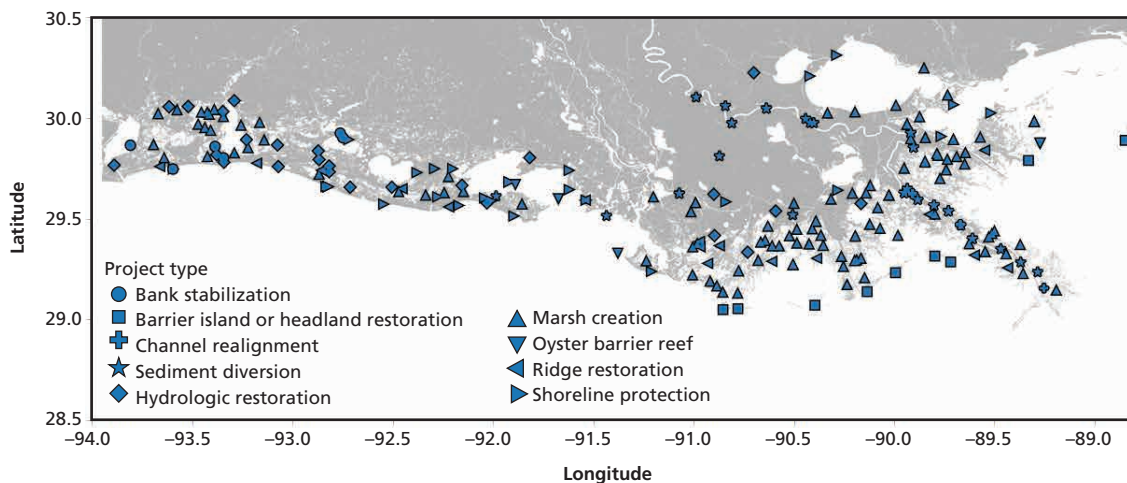
### Comparing Individual Risk-Reduction and Restoration Projects

The Planning Tool compares the ways in which individual projects affect the main objectives of the Master Plan—reducing hurricane flood risk and building and maintaining the coastal landscape. The Master Plan analyzed more than 40 structural risk-reduction projects, including levees and floodwalls, and nonstructural programs across the coast that reduce flood damage to residential and commercial structures through elevating, flood-proofing, or removing the structures. The Master Plan also analyzed approximately 250 restoration projects, including bank stabilization, barrier island restoration, channel realignment, sediment diversion, hydrologic restoration, marsh creation, oyster barrier reef, ridge restoration, and shoreline protection (Figure S.1).

The Planning Tool draws on results from computer models (called *predictive models*) that estimate the hydrodynamic and ecological effects that risk-reduction projects can have on asset damage and the effects of restoration projects on land building. Effects were considered for a range of risk-reduction, landscape, and ecosystem-service metrics and were made for two different environmental scenarios: moderate and less optimistic. The less optimistic scenario assumed higher sea-level rise and subsidence rates along with more-frequent and more-intense hurricanes than for the moderate scenario.

Specifically, the predictive models estimated the effects of risk-reduction projects on residual damage at three recurrence intervals (50, 100, and 500 years) across 56 communities in coastal Louisiana. Similarly, the models estimated the effects of restoration projects on 14 ecosystem-service metrics across 12 regions in coastal Louisiana. The Planning Tool also evaluated the effects of projects and alternatives on 11 additional decision criteria, such as *support of navigation* and *use of natural processes*, using project-specific information along with the risk-reduction and ecosystem-service effects of the projects.

**Figure S.1**  
Locations of Restoration Projects Evaluated by the Planning Tool



NOTE: Each symbol represents an individual project that may cover a much larger area than the symbol itself does, such as an entire parish.

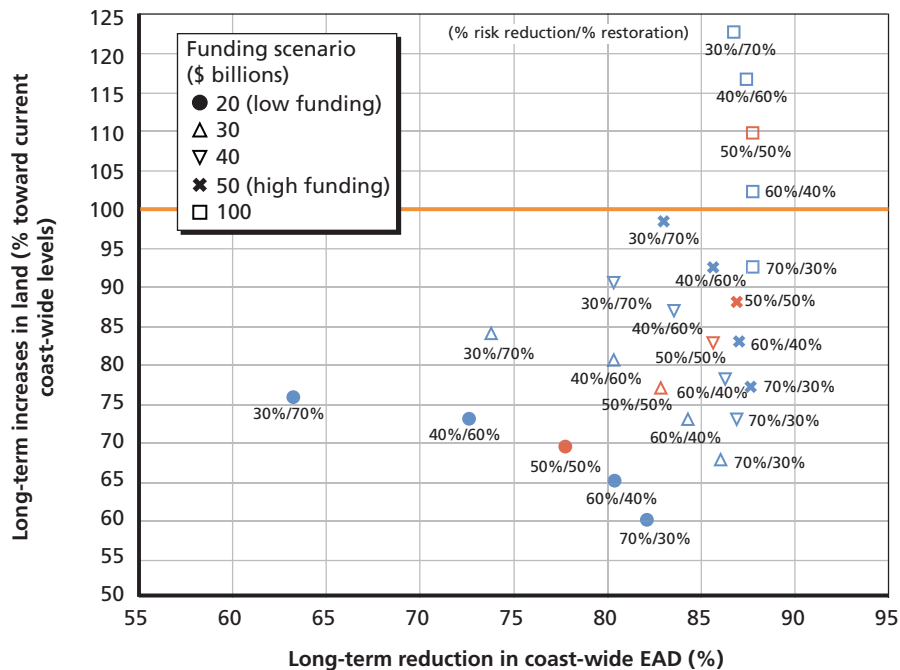
### Formulating Alternative Comprehensive Solutions

The Planning Tool identifies *alternatives* (groups of projects) over a 50-year planning horizon using an optimization model. The Planning Tool uses a *mixed-integer program* (MIP) to identify alternatives that minimize coast-wide risk to economic assets through risk-reduction projects and maximize coast-wide land building through restoration projects while satisfying a set of constraints. Specifically, an alternative’s estimated costs cannot exceed available funding, sediment requirements cannot exceed available sediment resources, and river flow from diversions cannot reduce downstream flows below an acceptable level.

CPRA used the Planning Tool to iteratively develop and evaluate a large set of alternatives. For each iteration, the RAND team used the Planning Tool to formulate different alternatives. These results were provided to CPRA through an interactive, computer-based interface. CPRA then reviewed the analysis, shared selected results with its stakeholders, and provided the RAND team with revised specifications for additional alternatives.

This iterative process helped inform CPRA decisions about allocating funding between risk-reduction and restoration projects and the relative emphasis to place on near-term versus long-term benefits. Figure S.2, for example, shows estimates of long-term coast-wide land

**Figure S.2**  
**Long-Term Risk Reduction and Long-Term Land Building for Different Funding Splits and Funding Scenarios**



NOTE: Percentage of risk reduction is presented as a percentage of future without action (FWOA) expected annual damage (EAD) from flooding. EAD represents the monetary damage that would occur, on average, as a result of flooding from category 3 or greater storms in any given year, if a particular region were subjected to the same specific conditions and probability distribution of flood depths over many years. Land building is presented as a percentage of land lost under FWOA conditions. Long-term results are those for year 50. Symbols indicate different funding scenarios. Labels indicate different funding splits (risk reduction/restoration). Results are for the moderate scenario. Results for a 50/50 split are colored red.

area (vertical axis) and long-term coast-wide risk reduction (horizontal axis) for alternatives that differ in terms of total available funding (symbol) and different allocations between risk-reduction and restoration projects (labels and coloring). This figure helped CPRA decide to develop the Master Plan around a \$50 billion budget and to allocate funding equally to risk-reduction and restoration projects.

### **Deliberating over Alternatives to Develop the Master Plan**

RAND developed several versions of a visualizer of Planning Tool results to support the Master Plan deliberations. Each version contained specific visualizations based on a set of Planning Tool evaluations stored in an internal database. These visualizations were used to support numerous workshops with stakeholders and meetings with CPRA management and other key decisionmakers.

CPRA used the Planning Tool to support its selection of the specific alternative that serves as the foundation of the 50-year, \$50 billion 2012 *Louisiana's Comprehensive Master Plan for a Sustainable Coast*. The draft Master Plan (CPRA, 2012a) was released in January 2012 for public review and comment. CPRA subsequently held three all-day public meetings and more than 50 meetings with community groups, parish officials, legislators, and stakeholder groups. CPRA then used the Planning Tool to reformulate alternatives based on revised project information and input from public comments. This information helped develop the final Master Plan (CPRA, 2012c), which was presented to the Louisiana legislature in April 2012 and passed into law in May 2012.

### **The 2012 Master Plan**

The 2012 Master Plan is the first comprehensive solution for Louisiana's coast to receive broad support from the Louisiana public and the many agencies, federal, state, and local, engaged in protecting the Gulf Coast. It is based on \$50 billion of funding (in 2010 dollars) over the next 50 years allocated broadly across the coast and among different project types (Figure S.3).

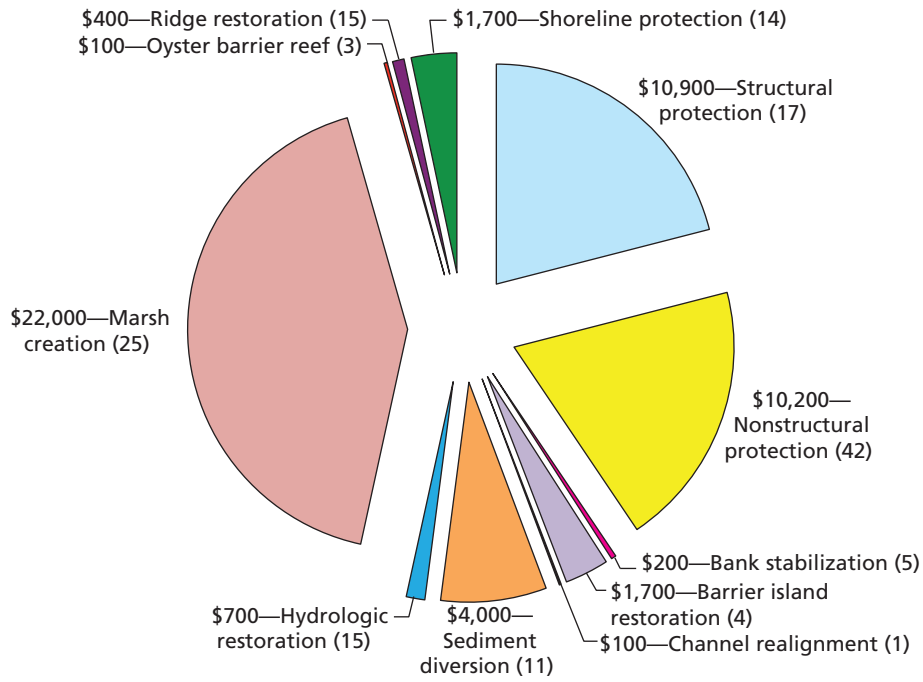
The Planning Tool estimates that implementation of the Master Plan would dramatically decrease coast-wide flood risk from a currently estimated level of \$2.4 billion on average today to between \$2.4 billion and \$5.5 billion in year 50 with the full implementation of the Master Plan (Figure S.4). Without the Master Plan in place, EAD could exceed \$23 billion under the less optimistic scenario.

The Planning Tool also estimates that the Master Plan, under moderate assumptions, would stabilize the coastal land area by around 2040 and increase land thereafter (Figure S.5). Under less optimistic assumptions, however, coast-wide land area never stabilizes, and land loss would be severe (Figure S.6). This result suggests that it will be critical to adapt the Master Plan if sea level rises and other key conditions are less favorable than those in the moderate scenario.

The Planning Tool played a critical role in the development of CPRA's Master Plan by providing information to support the deliberation needed to formulate a single 50-year plan. It provided a structured, analytic framework for comparing different risk-reduction and restoration projects, formulating many different alternatives, each representing one possible comprehensive approach to solving the coast's flood risk and land-loss problems. The resulting 50-year Master Plan received strong public support and passed the Louisiana legislature unanimously in May 2012.

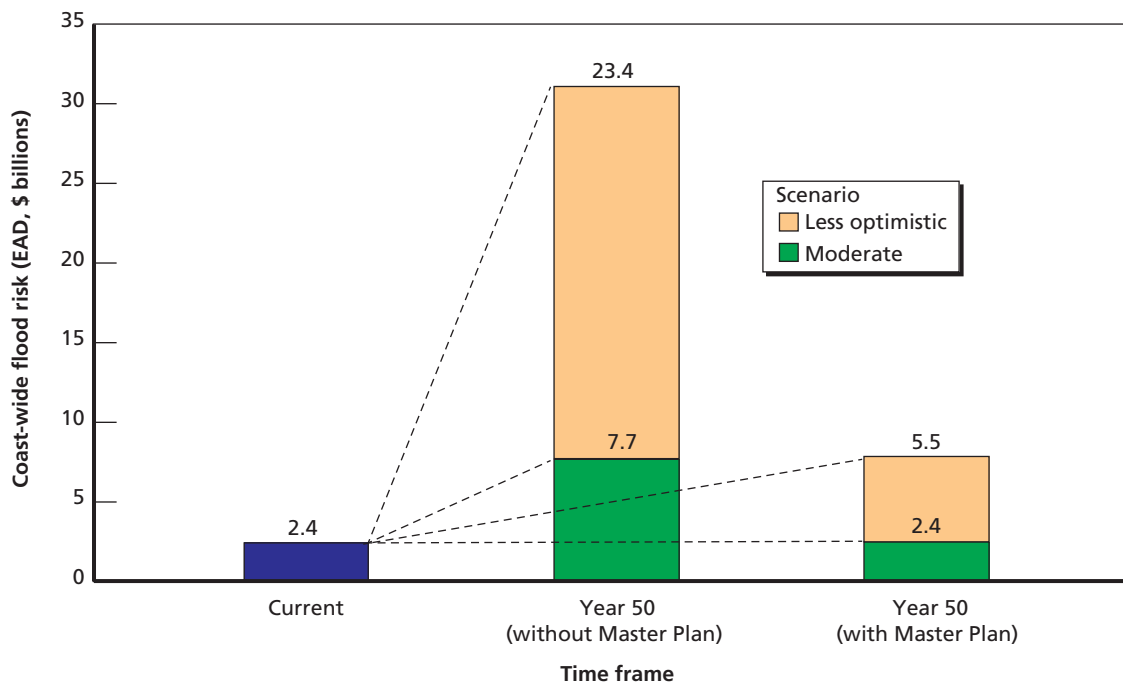


**Figure S.3**  
**Master Plan Funding, by Project Type (millions of 2010 dollars)**



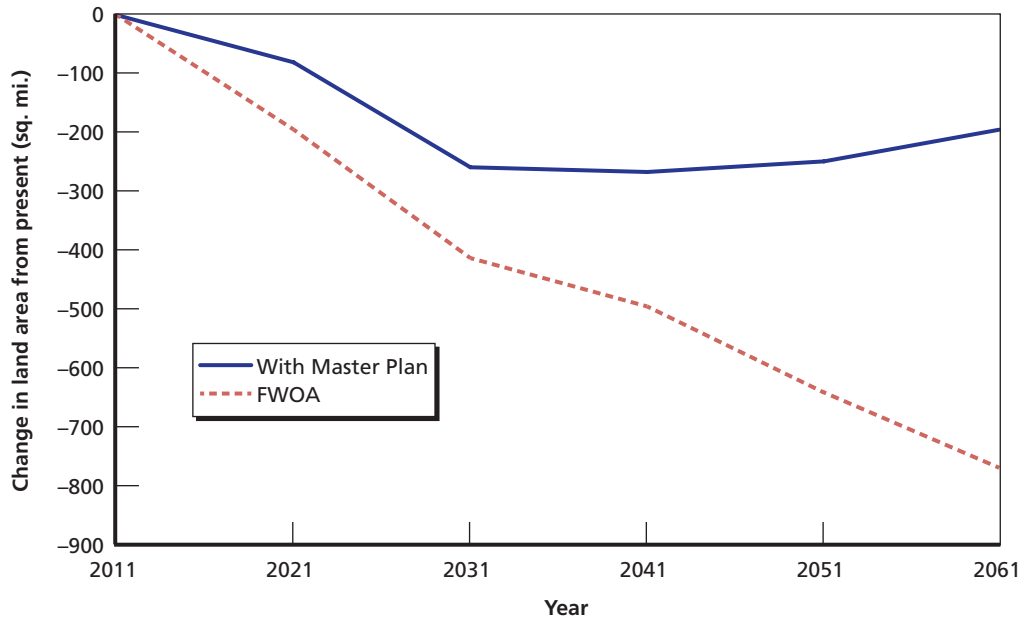
NOTE: The numbers in parentheses indicate the number of projects of each type included in the Master Plan. Funding is rounded to the nearest \$100 million  
 RAND TR1266-S.3

**Figure S.4**  
**Coast-Wide Flood Risk for Current Conditions, Year 50 Without the Master Plan, and Year 50 with the Master Plan for the Moderate and Less Optimistic Scenarios**



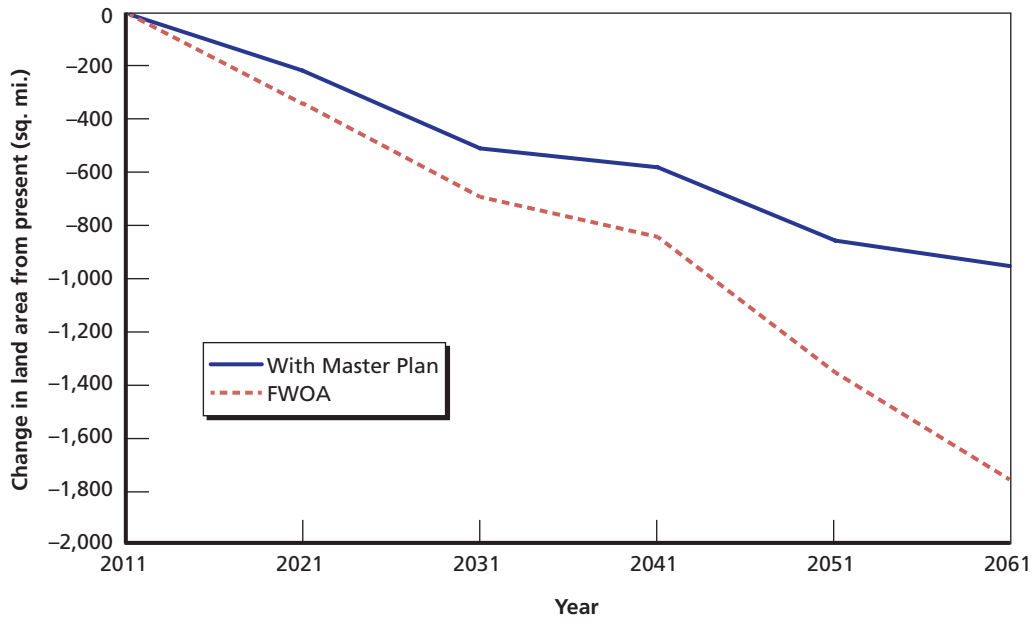
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**Figure S.5**  
Change in Land Area With and Without the Master Plan for the Moderate Scenario



RAND TR1266-S.5

**Figure S.6**  
Change in Land Area With and Without the Master Plan for the Less Optimistic Scenario



RAND TR1266-S.6