First Report from the NRC Committee on the Review of the Louisiana Coastal Protection and Restoration (LACPR) Program

Committee on the Review of the Louisiana Coastal Protection and Restoration (LACPR) Program, National Research Council

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Water Science and Technology Board

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SUMMARY OF KEY FINDINGS

In March 2008 the U.S. Army Corps of Engineers (USACE) released a draft technical report entitled "Louisiana Coastal Protection and Restoration Technical Report" (USACE, 2008). The Corps' report responded to federal legislation requiring the Corps to produce a comprehensive Category 5 hurricane protection analysis and design for southern Louisiana.

The following report was prepared by a committee of the National Research Council (NRC), which was appointed to review the Corps' Louisiana Coastal Protection and Restoration (LACPR) 2008 draft technical report and to provide recommendations for its improvement.

The Corps' Louisiana Coastal Protection and Restoration team is to be commended for recognizing that new approaches are necessary to achieve the overarching goal of reducing hurricane risks to the population and infrastructure of coastal Louisiana. Some of the methods developed and applied by the Corps in the LACPR study, such as probabilistic assessments of storm surge and the application of multi-criteria decision-making methods, are innovative. Further, the LACPR's three-pronged approach to reducing risks of storm surge—restoration, nonstructural, and structural measures—is appropriate and necessary in this complex ecological and geological region. The LACPR study team is to be further commended for attempting to integrate all of these measures—some of which go beyond traditional agency mandates and expertise—into a single planning study.

The Louisiana Coastal Protection and Restoration draft technical report, however, does not provide clear recommendations with regard to preferred choices of hurricane protection, risk reduction, or restoration alternatives; nor does the main body of the report clearly provide cost estimates of the various planning alternatives presented there. Furthermore, there are key weaknesses in each of the three main sections of the draft report—restoration, nonstructural, and structural alternatives—and weaknesses regarding the summary and presentation of the key assumptions that underpin the study:

Restoration — The LACPR draft technical report states: "all plans rely on sustaining the existing landscape." Yet the report provides no evidence that it will be possible to maintain the current landscape given current and prospective future rates of subsidence, degradation, and sea level rise. At the most basic level, there is no analysis of the amount of available sediment relative to the amount that will be required to construct levees and sustain wetlands. If wetlands cannot be maintained, the LACPR draft technical report misleads the public into believing that the present coastline can be held in the face of relative sea level rise. All plans that would rely upon maintenance of the existing coastal configuration then are suspect. Also, if wetlands cannot be maintained, decision makers and citizens ultimately will have to make hard choices about where restoration can take place and where it cannot.

Nonstructural — The LACPR draft technical report calculates risk reductions from nonstructural measures *assuming 100 percent compliance* by residents of the region. Yet, participation in these programs will be voluntary and actual compliance is likely to be far less than 100 percent. The technical report does not rigorously assess the degree of risk reduction that would be achieved if more realistic participation and compliance rates are applied. The technical draft report also does not suggest policies and programs that could be employed to encourage high rates of adoption of nonstructural measures.

Close collaboration among the Corps, the State of Louisiana, and local governments will be essential for reliable and cost-effective hurricane protection. Although a great deal of public opinion has been solicited to date by the LACPR staff, the draft technical report provides little evidence of a unified planning effort among these different governmental levels and bodies. These levels of government, for example, can use planning, zoning, building codes, or permitting authorities to promote public safety by steering future development away from more vulnerable, lower elevation areas. An integrated planning and implementation effort among them will be essential to effective coastal restoration and hurricane protection.

The technical report gives insufficient attention to the need to counter the phenomenon of induced development behind protective structures that attracts additional people to these areas and exposes them to residual flood risks there. This phenomenon took place in the decades prior to Hurricane Katrina. It is important that a similar process is not repeated in the future.

Structural — The LACPR draft technical report does not consider the *potential for structural failure* of levees and floodwalls. As a consequence, the true risk to homes and businesses and people behind structures has not been determined. The potential for structural failure is exacerbated by the difficulty of sustaining protective structural measures over time scales of many decades in the dynamic geological setting of coastal Louisiana. In an April 2008 meeting with this NRC committee, however, the LACPR team mentioned plans to consider "system failure," which would include structural failure, in the final version of its report.

Assumptions — As part of the background analyses and evaluations, the LACPR study team made several assumptions regarding physical systems, the success of program implementation, and so on. Clear explanation of all such assumptions is fundamental to understanding the viability and rationale of many parts of the LACPR draft technical report. These assumptions, however, are presented in many different parts of the report, including appendices, making it difficult to clearly and easily understand them all. Future versions of the LACPR study should clearly identify all major assumptions early and in a single section of the report, explain the scientific bases for choosing the assumptions, and provide some indication of the consequences if a given assumption turns out not to be valid.

REPORT SCOPE AND CONTENTS

According to its statement of task, this NRC committee is charged to issue reports "that include conclusions, findings, and recommendations for improving the LACPR study." Many topics are relevant to a comprehensive study of protection and restoration of the southern Louisiana coast, and this NRC committee could have considered issues such as: the historical construction of the region's hurricane protection systems; past Gulf hurricanes, impacts, and societal responses; previous hurricane protection studies and modeling efforts by the Corps of Engineers, the State of Louisiana, and others, and; changes in federal, state, and local programs for hurricane protection and response. Not all of these could be covered in this first (and shorter) report, however, and the NRC committee chose to focus on these and other topics only to the extent they were directly included in the LACPR draft technical report. The committee plans to more broadly consider these issues in the course of preparing its second report.

The remainder of this report is organized into the following sections: background; congressional intent and project goals and objectives; study assumptions; coastal dynamics, sediment budget, and restoration plans; hurricane protection and population distribution in southern Louisiana; monitoring, learning, and adaptation; federal-state cooperation, and; plan formulation and evaluation. These sections contain conclusions, findings, and recommendations, which are presented in bold-faced text.

The background section describes the effects of Hurricanes Katrina and Rita and how they led to the appropriating legislation for the LACPR study; the section on congressional intent and project goals and objectives discusses the language in the appropriating legislation and how it has been interpreted by the LACPR study team in preparing its draft technical report; the section on study assumptions discusses the issue of presentation of key physical, socioeconomic, and other assumptions with the LACPR draft technical report; the section on coastal dynamics, sediment budget, and restoration plans examines issues surrounding coastal dynamics and sediment transport, deposition, and availability in coastal Louisiana; the section on hurricane protection and population distribution in southern Louisiana examines issues of induced development behind flood control structures, the LACPR plans for structural and nonstructural components, and Corps of Engineers regulatory authorities; the section on monitoring, learning, and adaptation discusses ways in which scientific uncertainties might be addressed as part of LACPR program implementation; the section on federal-state cooperation examines the importance of cooperation federal, state, and other governmental bodies in effective implementation of restoration and protective measures, and; the section on plan formulation and evaluation examines the LACPR study team's efforts at employing a multi-criteria decision making (MCDM) approach to eliciting stakeholder preferences.

BACKGROUND

In 2005 the Gulf of Mexico experienced two Saffir-Simpson scale Category 5 hurricanes. Hurricane Katrina made landfall on the U.S. Gulf Coast on August 29, 2005. The resulting deaths and economic destruction made the storm one of the most devastating natural disasters in U.S history. Less than one month later, Hurricane Rita struck the Texas coast and brought additional destruction to coastal Louisiana. The associated losses of lives and property from these storms, due to wind, rain, waves, and flooding, intensified interest in the linkages among hurricanes and storm surges, viable hurricane protection measures, and the condition of coastal wetlands in the region and their role in attenuating hurricane storm surges.

Over a period of many decades, citizens of the region, the State of Louisiana, and the federal government have designed a large variety of physical structures, programs, studies, and other measures to provide protection against hurricanes. Hurricane protection for coastal Louisiana is a complicated and multidisciplinary venture requiring expertise in a variety of engineering, scientific, economic, and public administration fields.

Concerns regarding regional hurricane protection are closely linked to ongoing losses of Louisiana coastal wetlands, and how those losses may be increasing regional vulnerability to hurricane damages. Key legislative actions designed to curtail wetland losses include passage of the federal "Breaux Act" in 1990, and later establishment of the Louisiana Coastal Authority (LCA). The rate of wetlands loss in coastal Louisiana is of particular concern—these wetland ecosystems have been eroding at a rate of approximately 24 square miles per year for the last 50 years (Barras et al., 2003). A combination of natural and human-induced factors contribute to these losses, such as: the reduction of sediment supply from the Mississippi River; soil consolidation and subsidence of the lower Mississippi River deltaic plain; geological faulting; rising sea level; levee construction; and the cutting of navigational and drainage canals through the wetlands.

In November 2006, a year after Hurricane Katrina, the U.S. Congress directed the Secretary of the Army, through the Chief of the U.S. Army Corps of Engineers, to conduct an assessment of hurricane protection for coastal Louisiana. The Energy and Water Development Appropriations Act, 2006 (P.L. 109-103) states:

> *Provided further,* That using $8,000,000 of the funds provided herein, the Secretary of the Army, acting through the Chief of Engineers, is directed to conduct a comprehensive hurricane protection analysis and design at full federal expense to develop and present a full range of flood control, coastal restoration, and hurricane protection measures exclusive of normal policy considerations for South Louisiana and the Secretary shall submit a preliminary technical report for comprehensive Category 5 protection within 6 months of enactment of this Act and a final technical report for Category 5 protection within 24 months of enactment of this Act: *Provided further,* That the Secretary shall consider providing protection for a storm surge equivalent to a Category 5 hurricane within the project area and may submit reports on component areas of the larger protection program for authorization as soon as practicable: *Provided further,* That the analysis shall be conducted in close coordination with the State of Louisiana and its appropriate agencies.

Additional legislation was provided through the Department of Defense Appropriations Act, 2006 (P.L. 109-148), signed on December 30, 2005 and amended as follows:

> that none of the $12,000,000 provided herein for the Louisiana Hurricane Protection Study shall be available for expenditure until the State of Louisiana establishes a single state or quasistate entity to act as local sponsor for

construction, operation and maintenance of all of the hurricane, storm damage reduction and flood control projects in the greater New Orleans and southeastern Louisiana area.

In response to this legislation, the Corps of Engineers assembled a group of its engineers, scientists, and other experts to conduct these evaluations. The Corps' LACPR team has been conducting an extensive set of analyses aimed at producing both structural and nonstructural plans for reducing hurricane risks to coastal Louisiana.

The LACPR team has produced several reports, all of which are available on the LACPR web site: http://lacpr.usace.army.mil. Six months into the study, the LACPR released the Preliminary Technical Report to United States Congress (USACE, 2006), which provided background for the study and some of the approaches to be taken in coastal Louisiana. In 2007, the LACPR published the Plan Formulation Atlas (USACE, 2007a), which catalogued the large number of alternatives protection schemes available, gleaned from the State of Louisiana's Comprehensive Master Plan (La CPRA, 2007), the Corps' previous alternatives (e.g., USACE, 2007a), and from stakeholders (e.g., Multiple Lines of Defense Assessment Team, 2007).

To provide independent advice on the LACPR studies, the Corps of Engineers requested the National Academies to convene a committee of experts to review a draft report and the final report from the LACPR. In response to this request, the Academies' National Research Council Committee on the Review of the Louisiana Coastal Protection and Restoration Program was established in June 2007 (Appendix A lists the committee's statement of task; Appendix B lists the committee membership). To promote dialogue between the LACPR and the NRC committee, meetings were held in July and August 2007, and in April 2008. All meetings included open, public sessions, and the 2007 meetings featured several invited guest speakers from academia and NGOs in the region. This following report is based on the NRC committee's review of the Corps' LACPR 2008 draft technical report (USACE, 2008). This committee also is scheduled to issue a second report, which will review the LACPR final report.

CONGRESSIONAL INTENT AND PROJECT GOALS AND OBJECTIVES

Congressional Legislation and Hurricane Protection

Ideally, the LACPR study would be conducted with a set of clearly understood goals, which would be reached through the accomplishment of specific, measurable objectives. The choice of goals, in this case, is properly a matter of public policy and social decision-making. The appropriating legislation for the LACPR program, however, does not present a clear and unambiguous set of goals for this study.

This legislation directs the Corps of Engineers to report on an analysis and design of "comprehensive Category 5 protection" and to "consider providing protection for a storm surge equivalent to a Category 5 hurricane." This legislation poses ambiguities for the LACPR because of complexities in the relationships between hurricane wind speed and storm surge. The "comprehensive Category 5 protection" criterion mentioned in the appropriating legislation refers to a storm that is categorized according to the wind speed-based Saffir-Simpson Hurricane

Scale. However, Saffir-Simpson is a poor predictor of hurricane hazard—especially storm surge—in this region. In response to the legislation, the LACPR study team has chosen to focus to characterize storm surge in probabilistic terms to parameterize plan elements. That is, projects may be designed for 100-year, 400-year, or 1,000-year return interval storm surges. As a way of approximating the Category 5 criterion, which covers a range of wind speeds, the LACPR technical report separately ranks those plan alternatives designed for 400-year or 1,000-year events. The use of a probabilistic framework to evaluate storm surge within the LACPR draft technical report is a more comprehensive and sophisticated approach to evaluating plan elements than characterizing and evaluating storms based principally on the Saffir-Simpson Hurricane Scale.

Related to these analyses of hurricanes and associated storm surges is the possibility of changing hurricane patterns, strengths, and intensities as a result of changes in the global climate system. Concerns regarding such changes are driven by factors such as the occurrence of Hurricanes Katrina and Rita (both rare Category 5 storms) in the same hurricane season, and an increase in north Atlantic hurricane activity beginning in or about 1995. It is not clear how changes in global climate will affect future hurricane patterns in the north Atlantic and Gulf of Mexico, nor is it clear how the LACPR should accommodate these possible future changes within its study. Given that changes in the patterns of Gulf hurricanes have considerable implications for coastal Louisiana, future versions of the LACPR study should include more explicit explanation of the evolving science of possible changes in future hurricane patterns, and how this might affect planning.

Beyond the complexities of categorizing hurricane hazards, the appropriating legislation directs the Corps to prepare its report "exclusive of normal policy considerations." The LACPR draft technical report further explains this clause: "Congress also directed a technical report rather than a reconnaissance or feasibility report as described by normal USACE policy" (USACE, 2008, p. 3). The traditional Corps of Engineers planning process entails the preparation of reconnaissance and feasibility reports, and the identification of a plan for implementation.

It is not clear to the NRC committee that the intent of Congress was that, owing to the urgency of providing hurricane protection to the State of Louisiana, the LACPR team was to provide a design for immediate implementation, independent of the usual Corps policy considerations. However, the Corps has interpreted the congressional language as a call for the presentation of a comprehensive set of alternatives and methods for making selections between various plans, but not identifying a single best course of action, and the LACPR draft technical report does not provide clear recommendations for preferred projects.

In order to provide a suitable goal statement for the technical study, the LACPR study team developed the following planning goals (USACE, 2008, p. 23):

- Reduce risk to public health and safety from catastrophic storm inundation
- Reduce damages from catastrophic storm inundation
- Promote a sustainable coastal ecosystem
- Restore and sustain diverse fish and wildlife habitats
- Sustain the unique heritage of coastal Louisiana by protecting historic sites and supporting traditional cultures

These five planning goals then were translated into fourteen specific, measurable objectives (termed "metrics" in the report). The metrics, in turn, are grouped into the four accounts of the federal Principles and Guidelines planning document (national economic development; environmental quality; regional economic development, and; other social effects; WRC, 1983).

The planning objectives all represent valuable outcomes that are desirable to stakeholders. However, there inevitably will be instances in which planning objectives are not fully compatible with one another, and some in which they may be in direct conflict. For example, the objective to protect a key historic site may preclude another objective of restoration and the sustenance of fish and wildlife habitat. In theory, the preferred plan will be the one that achieves the best combination of outcomes with respect to the planning objectives, taking account of the conflicts, synergies, and trade-offs that exist among them. The identification of such a plan is the purpose of the multi-criteria decision analysis employed by the LACPR.

The congressional language authorizing the LACPR study and report presents some ambiguities for the LACPR team. In responding to this legislation, the LACPR study team adopted a goal statement and related set of measurable objectives that may reflect the intent of Congress. The LACPR approach also considers a broad range of social goals and does so in a way that lends itself to effective planning and plan evaluation. Moreover, the use of a probabilistic framework to evaluate storm surge within the LACPR draft technical report is a more comprehensive and sophisticated approach to evaluating plan elements than by use of the Saffir-Simpson Hurricane Scale. Future versions of the LACPR study should include more explicit explanation of the evolving science of possible changes in future hurricane patterns, and how this might affect planning.

LACPR Priorities and Alternatives

There is no blueprint for a coastal restoration program of this scale. It thus may be unrealistic to expect an ideal restoration and protection program or plan to emerge from the current LACPR effort, as any course of action will necessarily entail many changes and adjustments over time. At the same time, some projects and initiatives have higher priority than others in the sense that some alternatives will be easier than others to implement in the short term, some alternatives promise to yield greater and more immediate reductions in risk, and some alternatives promise greater increases in environmental and economic benefits than others. There may be reasons for not identifying a single plan, if the LACPR technical report, as is stated, "is not suitable for making project authorizations, appropriations, or non-governmental decisions." Congress and the citizens of Louisiana look to the Corps of Engineers and the LACPR, with their considerable engineering and coastal restoration knowledge, for leadership and direction on this complex planning program. Unless some advice regarding promising initial projects for ecosystem restoration, hurricane protection, and buyouts and relocations is provided, the LACPR planning effort will fall short of its potential to offer science-based, analytical advice on hurricane protection and coastal ecosystem restoration.

The congressional language, despite ambiguities, does request "…analysis *and design.*" The LACPR draft technical report provides no clear recommendations to Congress or to the State of Louisiana with regard to preferred initial choices of hurricane protection, risk reduction, or restoration alternatives. Nor does the draft report provide clear estimates of costs in the main body of the report for the various planning alternatives considered (although some information on costs is presented in appendices). The draft technical report also does not suggest clear priorities for future restoration, structural, and nonstructural projects and activities. This is despite the fact that some of the planning alternatives considered within the LACPR study will be more physically, ecologically, and economically viable than others.

The lack of some prioritization of alternatives—based upon their relative merits in terms of cost and restoration and risk reduction potential—constitutes a weakness within the draft technical report. Future versions of the LACPR report should include additional, more explicit, information on cost estimates for alternative projects. Future versions of the LACPR report will be of greater value to the extent that they identify projects of higher priority that promise to yield greater and more immediate benefits in terms of flood risk reduction and ecosystem restoration.

STUDY ASSUMPTIONS

In preparing the LACPR draft report, the project team had to make many assumptions. Some of these concern physical constraints such as the stability of the present coastal configuration, the role of wetlands in attenuating storm surge, projected sea level rise over the course of the project, and the validity of using current Atlantic and Gulf hurricane statistics in projections of future conditions. Others have to do with the political environment such as decisions about the success of buy-out and relocation efforts. Many of these assumptions are spelled out in the detailed sections and appendices of the report, but they are not explicitly stated in a single section near the beginning of the report. Other points that underpin the analyses within the draft report, such as priorities, limitations, topics not discussed, and so on, should also be explained early in the main body of the report. For many of these assumptions, the choice of a given assumption plays a crucial role in many subsequent computations and decisions. If such assumptions are not clearly stated early in the report, along with some rationale for their selection, key analyses within the report may be flawed and readers of the report may be confused. Furthermore, if key assumptions turn out to be partly or wholly incorrect, this can invalidate subsequent analyses.

Future versions of the LACPR report should identify and present clearly, in a single section early in the report, the major assumptions that were made, the scientific basis for the choices that were made, and give some indication of the consequences if the assumptions turn out not to be valid.

COASTAL DYNAMICS, SEDIMENT BUDGET, AND RESTORATION PLANS

Changes and Losses of Louisiana's Wetlands

For millions of years, the Mississippi River has carried sediment to the lowlands of

Louisiana and into the Gulf of Mexico. Over the last six thousand years, these sediments have supported the growth of numerous lobes across the Mississippi River delta. Each lobe in its turn has gone through a millennial cycle during which it grew upward and seaward by the accumulation of river-deposited sediment and, when the river shifted laterally to form a new lobe, became subject to erosion and degradation. Even though delta deposits were eroding in some places while new deposits were accumulating in other places, the river sediments, on balance, kept large areas of the wetlands of Louisiana from being inundated by the sea, which has been rising steadily since the end of the last Ice Age roughly twenty thousand years ago.

For the past 200 years, human activities have adversely affected these sedimentary processes and the condition of Louisiana's coastal wetlands, with the result that the wetlands are now degrading severely—roughly 24 square miles per year have been lost over the past 50 years. The result of these activities, as stated by one of the region's coastal science experts, is that "The state is rapidly disappearing into the Gulf of Mexico" (Penland, 2005). Figure 1-1 illustrates how these rates of land loss have been affecting Louisiana's coastal areas, and how much additional land area is forecast to be submerged by the year 2050.

Coastal Restoration within the LACPR Draft Report

Sediment Mass Balance

Many coastal restoration measures are proposed within the LACPR draft report as a means to counter the effects of relative sea level rise and to help reduce risks from hurricanes. Coastal restoration is put forth as one of the three major components of hurricane risk reduction (the other two being structural measures such as levees, and nonstructural measures such as buyouts and relocations).

At numerous locations within the technical report's Coastal Restoration Plan Component Appendix, it is stated that, "Sufficient marsh creation measures have been proposed to achieve basin-level wetland sustainability," and the main body of the technical report contains the crucial premise that ". . . maintaining approximately the present landscape configuration would be a key component of a comprehensive storm risk reduction strategy for the region." Apparently, the current coastal and wetlands configuration was used for the hydrodynamic surge model and the various protection alternatives, without analysis of whether the current Louisiana coast could be sustained in the future. Unfortunately, the report does not answer the fundamental question: Is coastal restoration, at the scale envisioned, at all possible?

Questions regarding the prospects for stabilizing the current wetlands have been posed and considered previously by other groups. For example, a 2006 NRC report questioned the viability of maintaining the current extent of coastal land areas:

> Achieving no net loss is not a feasible objective because the social, political, and economic impediments are extensive; the sediment supply is limited; and the affected area is large. . . These facts have to be broadly appreciated to avoid widespread disappointment with the LCA projects (NRC, 2006; p. 162-163).

An important step toward answering the question of the long-term feasibility of coastal restoration would be the preparation of a sediment budget for coastal Louisiana. There is only a given amount of sediment arriving into Louisiana via the Mississippi River. As that sediment is transported southward, most of it remains between the Mississippi River levees; then it is carried off the continental shelf and effectively lost to deep water beyond the so-called bird's foot delta of the Mississippi River. Any restoration plan for coastal Louisiana optimally would account for all sediment entering and leaving coastal Louisiana, including from neighboring coastal states, and would assess existing sediment resources within the state. Further, for each planning unit along coastal Louisiana, the amounts and rates of sediment input and output would be identified (one of the losses of sediment, which can be stopped or reduced, is the offshore disposal of dredged materials from the navigable waters of the state). However, the LACPR draft technical report contains no discussion of plans for compiling "sediment budgets" for the state.

The importance of a sediment budget is that the volume of sediment necessary to counter the effects of relative sea level is very large. This volume can conservatively be estimated as the area of the wetlands of Louisiana (24,000 km^2; Day et al., 2007), times the rate of relative sea level rise. This would ensure that the current Louisiana coast is maintained against the ongoing change in sea level.

A key parameter in determining the amount of sediment necessary to enable wetlands to grow upwards and to counter the effect of relative sea level rise is the amount of inorganic sediment to be supplied, versus the wetland's own organic contribution to marsh building.

If a sediment budget for the entire state shows that the underlying premise of "sustaining the existing landscape" is not achievable, proposed structural and nonstructural projects may be only partly feasible, or infeasible. Further, if a stable coastline is not achievable, it will be important to openly and directly acknowledge this, as doing so helps planners, citizens, and elected officials begin to consider higher priority targets for restoration and protection, while planning for retreat from areas that cannot be saved. As stated in the previous report from the NRC that studied Louisiana coastal restoration prospects:

> Louisiana's coastal restoration plans must acknowledge . . . limitations prominently and adjust goals and public expectations accordingly (NRC, 2006, p. 163).

The LACPR study team should develop sediment budgets for the wetlands of coastal Louisiana to determine the feasibility of maintaining coastal Louisiana in roughly its present condition. A sediment budget should be developed for each LACPR study planning unit. Options for reducing losses of sediment also should be explored. If the results show that it is infeasible to maintain the current coastal landscape, then the LACPR

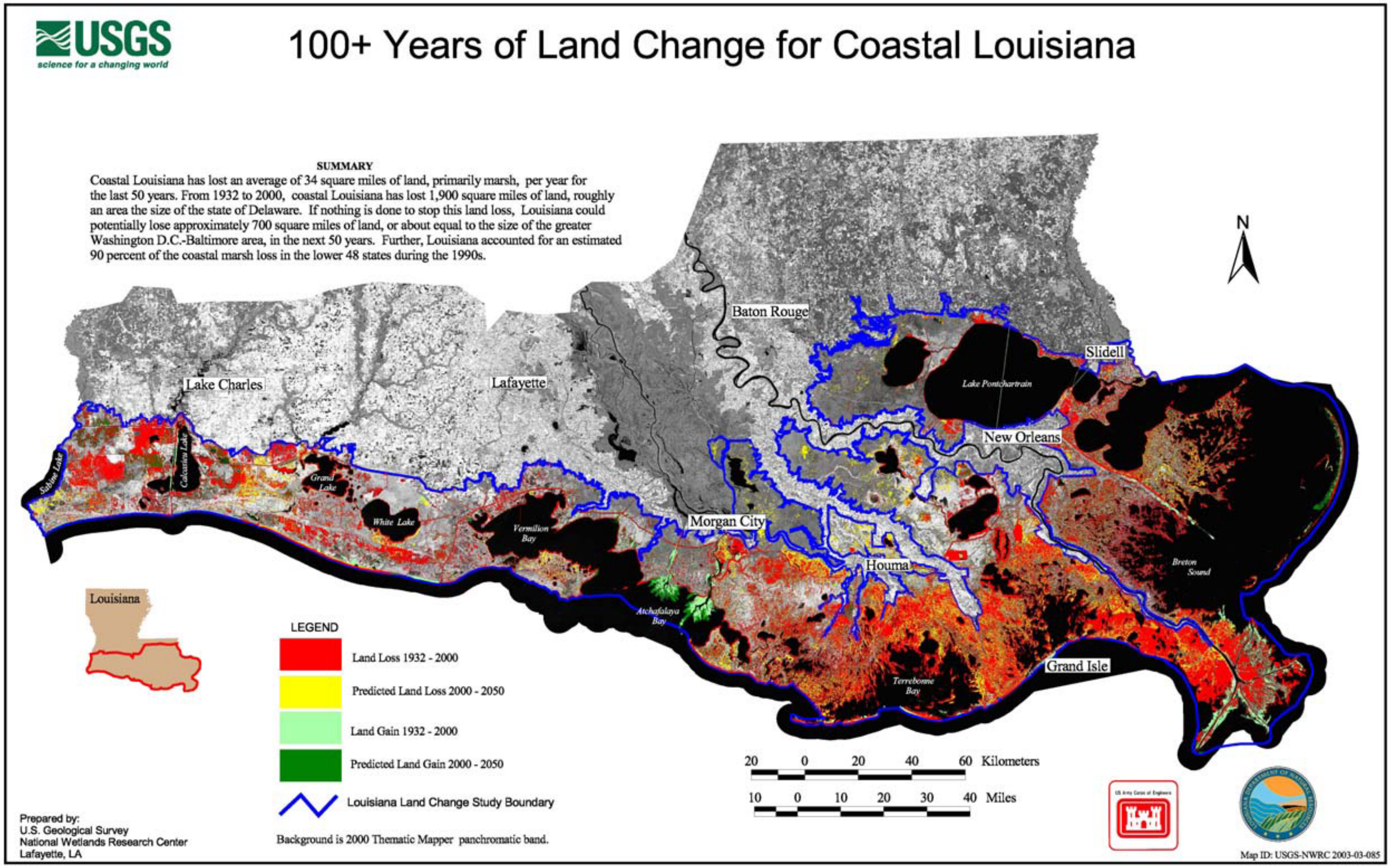

FIGURE 1-1 100+ Years of Land Change for Coastal Louisiana. SOURCE: U.S. Geological Survey

will need to reassess the role of the proposed structural and nonstructural designs that are based on the assumption that the current coastal configuration will be maintained.

Possible Realignment of Lower Mississippi River

One proposal that has long been considered as a possibility for delivering large amounts of sediments to the wetlands near the Mississippi River mouth is a "major realignment of the lower Mississippi River" (USACE, 2008, p. 26). Significant realignment of the lower river and its delta would help retain large amounts of sediment, now lost to the deep water of the Gulf of Mexico, for wetlands restoration. Such realignment also would likely entail disruptions to commercial navigation and could entail substantial costs. Nevertheless, given the scale of coastal restoration envisioned within the LACPR draft report, and the large amounts of sediment necessary to achieve this restoration, changes to the alignment and levee system of the lower Mississippi River may be required for restoration actions.

The LACPR draft technical report does not consider seriously the option of major lower Mississippi River realignment, stating: "the alternative was considered to be beyond the scope of the current effort and could not be adequately evaluated within the scope of this effort." It is not clear, however, that this alternative is beyond the scope of the LACPR study. Major realignment of the lower Mississippi River naturally is a controversial measure and there has been reluctance to consider the measure carefully. The 2006 NRC report, for example, noted: "Although this alternative [of abandonment] has been widely acknowledged as possible, its feasibility has, for various reasons, not been seriously considered by USACE" (NRC, 2006, p. 138).

An evaluation of how a major realignment of the lower Mississippi River mouth may affect sediment capture and diversion should be conducted.

Calculating Restoration Benefits

Annual wetland acreage gains through marsh creation, diversions, and other measures, were assessed using a desktop model that accounts for nutrient and sediment benefits from diversions, and an assessment of the annual production rates for prioritized marsh creation sites. The net benefit of flow diversion was identified as: Net Benefit = Nutrient Benefit + Sediment Benefit – Land Change Rate. The LACPR draft technical report presents too little information about this equation and its assumptions to evaluate or calibrate it, nor does it compare this model to others that currently exist.

The evaluation of the coastal restoration measures should be more fully explained, including source of material, and the local sediment budget needs to be determined. Coastal restoration models should be clearly discussed and their validity demonstrated.

HURRICANE PROTECTION AND POPULATION DISTRIBUTION IN SOUTHERN LOUSIANA

Creative and sustainable hurricane protection solutions for southern Louisiana will have to consider both structural and nonstructural options. Nonstructural features include evacuation plans, building and zoning regulations, buy-outs, elevation of existing buildings, and insurance. Unfortunately, the construction of hurricane protection structures for southern Lousiana, and the development of complementary, nonstructural programs, have not always proceeded along parallel tracks and with similar emphases. Furthermore, the construction of the Lake Pontchartrain and Vicinity, Louisiana Hurricane Protection Project (LP&VHPP) has not consistently considered the limitations and unintended consequences associated with levee construction.

This section examines the phenomenon of land development and population growth behind protective structures; the LACPR draft report plans for implementing structural and nonstructural measures; and the relevance of regulatory authorities to future development.

Future Settlement and Induced Development in Hazardous Areas

The LACPR draft report proposes the construction of levees to protect existing communities and infrastructure. However, the addition of new coastal protective structures may lead to new settlement in low-lying, hazardous areas. Plans that encourage people to move into hazardous areas puts them at risk in future hurricanes. Moreover, as the LACPR plans are being developed in a setting of relative sea level rise and disappearing coastal wetlands, “in order to reduce risk to public health and safety from catastrophic storm inundation” (USACE, 2008, p. 23), some priority will have to be devoted to discouraging settlement in high risk areas. Measures that direct growth away from lower lying, more hazardous areas, toward higher ground—which may be many miles inland—will reduce the amount of infrastructure subject to hurricane damages.

The LACPR technical report assumes that future land use in high hazard areas located outside of present and future levees will continue to develop under one of two scenarios. The first assumes current employment trends and relatively compact development patterns, while the second assumes higher employment levels and dispersed development patterns. The draft technical report then looks at courses of action for limiting the vulnerability of existing and projected future development in these areas. These include buy outs of structures located in areas with potential inundation levels of 14 feet or more and raising of structures located in areas with lower potential flood heights. These methods are appropriate for reducing property losses to development existing in 2010, but they are too limited as a method for dealing with the increase in vulnerability due to *new* development occurring after 2010 in hazardous areas.

The LACPR draft technical report would be stronger if it proposed an integrated set of measures for limiting future increases in vulnerability. These would include comprehensive plans prepared by parishes and municipalities that assess the suitability of land for development and propose policies for limiting development in areas deemed unsuitable due to the risk of flooding. Potential policies that are regularly used for this purpose throughout the United States include: (1) zoning regulations that limit the intensity of development to a level appropriate for the degree of flood risk; (2) subdivision regulations with flood-hazard mitigation provisions; (3) building regulations that require additional freeboard beyond that mandated by the National Flood Insurance Program; (4) public acquisition of land for open space, habitat protection, and outdoor recreation; (5) public acquisition of easements that limit the amount of development possible in the future; and (6) location of new public infrastructure (e.g., roads and water and sewer lines) such that it does not induce or support unsafe new development in flood-hazard areas.

Some sections of the LACPR draft technical report—especially those that consider future redevelopment scenarios and increases in population growth—are written with a limited appreciation of the fact that the region's coastal areas are experiencing rapid rates of degradation and subsidence and are in fact disappearing. These scenarios of redevelopment thus may be inconsistent with the report's stated objectives of reducing risks to public health and safety, and reducing damages from catastrophic storm inundation.

The LACPR draft report gives insufficient attention to the need to counter the phenomenon of induced development behind levees and to preventing the future development of high-hazard areas not protected by levees. For example, the LACPR technical report's assumptions, guidelines, and constraints (USACE, 2008, p. 23-24) note that the "LACPR analysis does not take into account local actions (e.g., land use restrictions, change in building codes, etc.)." Since such local actions would be a critical element in the conception, adoption, and implementation of nonstructural measures, this assumption is a key omission if a goal is development of a systematic, comprehensive, integrated suite of nonstructural alternatives. For example, local land-use regulations play an important role in preventing the future intensification of development in high risk areas. Local enforcement of building regulations is important to improve the capacity of buildings to withstand high winds and to ensure adequate elevation of new structures. **In its future reports, the LACPR team is encouraged to present an integrated set of measures that can limit future development in low-lying, flood prone areas.**

Structural Measures

A major portion of the storm protection plans within the LACPR draft report call for the construction of levees protecting different cities and municipalities. New Orleans is one of the nation's largest metropolitan areas protected by levees and many of the structures within its hurricane protection system are being raised and strengthened in the wake of Hurricane Katrina. In addition to levees (or ring levees) being proposed for Houma and Morgan City, levees are proposed for even smaller communities, such as Erath and Delcambre (in planning unit 3-B). Properly designed and constructed coastal protection structures can increase levels of protection; these structures, however, require inspection, maintenance, and upgrades, and there is always a possibility of overtopping or structural failure. This requires a sustained and long-term commitment if these structures are going to offer reliable protection in the face of rising sea level.

Hurricane Katrina drove home the point that "protection" from hurricanes and storm surge in southern Louisiana and much of the U.S. Gulf Coast is a relative concept. Decades of experience with floods and protective measures shows clearly that absolute protection from all hurricanes in this region is not possible. There can be only degrees of protection. Regardless of the size and strength of any protective structure, there is always a risk of residual damage from overtopping of such structures by a storm larger than the design storm.[1] Perhaps more important is the risk of structural failure without overtopping, with the additional risks that nonstructural alternatives have not been adequately implemented and that evacuation routes and planning are inadequate. Structural measures can only reduce, not eliminate, the probability of flooding. Despite the possibility of structural failure of flood protection structures, the LACPR draft technical report does not incorporate the probability of such failure in the analytical models used in the study. History has amply demonstrated that structural systems can fail, and future versions of the LACPR report will be improved to the extent they can incorporate the probabilities of structural failures in their analyses. This has been recognized in the work of the Interagency Performance Evaluation Task Force (IPET), which has been conducting an evaluation of the performance of the New Orleans hurricane protection system during Hurricane Katrina (USACE, 2007b). The IPET risk analysis study has incorporated the possibility of structural failure using fragility curves (see USACE, 2007c).

The LACPR report should consistently refer to relative levels of protection from hurricanes and storm surge, and make it clear that absolute protection is not possible. Future analyses should explicitly include probabilities of failure or inadequate performance, and should also consider possible effects of human actions such as improper operations during an emergency.

Hurricane Protection for the City of New Orleans

The LACPR draft technical report defines Category 5 protection as falling in the range of a 400-year storm to a 1,000-year storm. Plans based on these types of storms, as well as the 100-year storm, are presented. For New Orleans, the drawbacks of designing for a 100-year storm were demonstrated during Hurricane Katrina. As the LACPR draft technical report notes, a 100-year storm has a 63 percent likelihood of occurring during a 100-year time frame.

Given the considerable economic, cultural, and other values of the City of New Orleans, and a congressional mandate to produce a design for Category 5 protection, the LACPR report should focus on producing designs and plans based on storms with return intervals associated with Category 5 storms.

Nonstructural Measures

The LACPR draft report identifies a number of nonstructural measures—such as the

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[1] Residual damage refers to flood-related damage expected to occur in areas behind levees as a result of storm surge that overtops levees.

raising of buildings, floodproofing modifications to structures, evacuation plans, and the buyout and relocation of citizens and properties from flood zones—that could be implemented to help reduce risks from hurricanes and storm surge. The emphasis on nonstructural measures is appropriate, as history has shown there is a strong tendency to build a hurricane protection project and its related engineered structures, but then neglect to adequately implement complementary measures that are equally important to public safety and preparedness, such as flood insurance, zoning, public education, and evacuation plans. Nonstructural measures are an essential complement to structural measures and a crucial part of a comprehensive flood risk reduction program.

The LACPR draft technical report properly includes discussion of many of these nonstructural strategies, and the LACPR team should be credited for evaluating such measures. The report lacks a systematic analysis of the obstacles that limit local government, households, and businesses from adopting these nonstructural measures, and it fails to identify an adequate suite of remedies that could help address these obstacles. The LACPR team is encouraged to more carefully identify and discuss these challenges and obstacles in its final report.

Buyouts and Relocations

The possibility of relocation or removal of assets from flood affected zones is mentioned within the LACPR draft report. Such permanent evacuation plans include "buyouts," which entail the purchase of residential property, having the owners move from it, and then rezoning the property as a floodway or for open space. This process can be complex, socially sensitive, and politically controversial. Despite potential controversies, buyouts may represent a cost-effective option for removing vulnerable properties and residents from hurricane risks, as they eliminate the need for future payouts or expensive structural measures and will move residents to higher and safer ground. Buyouts need not be mandatory, but residents in highly vulnerable areas who do not accept buy out offers should have well designed hurricane preparedness plans (e.g. evacuation routes and plans). Furthermore, strict zoning regulations are necessary to ensure that bought-out areas are not developed in the future.

The LACPR technical report's "Findings to Date" section importantly concludes that "…relocation or removal of assets from a flood affected zone...can significantly and reliably reduce risks." The relocation option often provides an excellent means for improving safety and reducing potential damages. It is a promising alternative and, as the report also points out, should be considered via "collaboration between Federal, State and local agencies."

Within the LACPR technical report nonstructural appendix (USACE, 2008; appendix D, p. 27-28), demonstration buyout/relocation projects are proposed in a few different sections of metropolitan New Orleans. The specific projects proposed seem reasonable and they promise to provide both a reduction in risks and an opportunity to gain valuable experience with the buyout/relocation process. Compared to the scale required to substantially reduce risks across the city, however, these projects are modest. Regardless of the scope of these demonstration projects, the value of such projects will be greater if they can be conducted as early as possible in the process of redeveloping flood-damaged areas.

In addition to prompt implementation of the proposed nonstructural demonstration projects, the LACPR report would be strengthened if more information were provided about the steps that need to be taken by the Corps and State of Louisiana to move from demonstration projects to a full-scale program to buyout or floodproof the vast number of at-risk structures in the region—194,000 vulnerable from a 100-year flood event; 514,000 vulnerable from a 400-year event; and 597,000 vulnerable from a 1000-year event. In doing so, the LACPR team is encouraged to consider lessons learned by the Corps' Huntington District in the large-scale nonstructural effort it undertook to reduce flood risks in some Virginia communities.

The LACPR study team is encouraged to extend the scope of these types of demonstration projects in its final report. The LACPR study team, along with relevant state and local administrative entities, is encouraged to move ahead quickly with these demonstration projects. The LACPR report will be strengthened to the extent it provides additional information about the necessary steps to move to a more active nonstructural flood damage reduction program that includes buyouts and floodproofing measures.

Corps of Engineers Regulatory Authorities and Future Development

The Corps of Engineers has regulatory authorities to limit the conversion of water and wetlands to urban and other uses, under the 1899 Rivers and Harbors Act (Section 10 permits) and the 1972 Clean Water Act (Section 404 permits). The LACPR draft report does not suggest the use of either of these permitting programs to help achieve hurricane protection goals by minimizing new development in flood-hazard areas by limiting the conversion to urban uses of wetlands within newly constructed levees (i.e., limit induced development). Instead, the LACPR draft report limits its attention to permanent evacuation of development subject to extreme flood risks (flood elevations of 14 feet or more) and elevation/floodproofing of existing development subject to lower flood depths. The State of Louisiana plan identifies the need to avoid further development in areas at risk and it notes the need to protect wetlands behind areas newly protected by levees, to retrofit existing development at risk, and to increase flood insurance coverage for property protected by levees (La CPRA, 2007), but it does not discuss or propose how these objectives can be realized.

MONITORING, LEARNING, AND ADAPTING

The LACPR program represents one of the world's largest ecosystem restoration programs. Given the size, complexity, and interactions of these systems, there are many scientific unknowns and uncertainties that will affect and pose challenges to implementing the LACPR restoration and risk reduction plans. Periodic and formal monitoring efforts will be essential to improve scientific knowledge and better understand the effectiveness of various elements of the LACPR implementation strategy. This type of monitoring and learning is conducted not simply to satisfy scientific curiosities; rather, it is essential to increasing the benefits of all aspects of project design and implementation (NRC, 2004).

This process of monitoring-learning-adaptation is central to the concept of adaptive management, and while adaptive management typically is geared to ecosystem monitoring and learning, in the LACPR setting it also can be applied to structural and nonstructural approaches to hurricane preparedness. The LACPR draft technical report does include a section on Adaptive Management (P. 149-152); the specifics of such efforts, however, are not spelled out clearly and it is not yet clear how prominent this concept will be in moving forward with LACPR project implementation.

Future versions of the LACPR report should more explicitly explain plans for using monitoring and related strategies to strengthen scientific knowledge and to learn from the processes of restoration, structural, and nonstructural project implementation.

FEDERAL-STATE COOPERATION

The many coastal protection and restoration alternatives presented in the LACPR entail a large array of both structural and nonstructural plans. For instance, the “Multiple Lines of Defense” strategy presented in the LACPR draft technical report (and in the State of Louisiana Master Plan) considers some combination of evacuation routes, elevated buildings, levees, marshes, and barrier islands to be used to reduce risks from hurricanes (see Multiple Lines of Defense Assessment Team, 2007). The Corps of Engineers, and its partners and consultants, has the capacity and experience to undertake most structural and coastal restoration aspects of coastal protection and restoration. The Corps, however, lacks extensive experience and capacity in the development and implementation of nonstructural measures for reducing flood and storm surge damages; many of these measures also go beyond Corps of Engineers’ traditional mandate and mission.

Widespread, successful implementation of nonstructural measures therefore will require the cooperation of the State of Louisiana, parishes, municipalities, and other local entities. The LACPR draft technical report acknowledges this, noting that “a new approach is required” to implement nonstructural measures. In its work to improve hurricane protection for greater metropolitan New Orleans, the Corps of Engineers and the Interagency Performance Evaluation Task Force (IPET) acknowledge that a systems approach is necessary, not one focused on individual levee reaches or projects. Similar, systems-level thinking needs to be applied to institutional and other arrangements that will be necessary to implement nonstructural aspects of comprehensive hurricane protection.

Furthermore, systems-level thinking and action will be useful in integrating and implementing the restoration, structural, and nonstructural aspects of hurricane protection for southern Louisiana. The Multiple Lines of Defense strategy presented in the LACPR draft technical report appropriately proposes a variety of structural and nonstructural measures. As the Corps, the State of Louisiana, parishes, and other entities proceed with implementing this comprehensive protection strategy, their efforts will be enhanced to the extent that restoration, structural, and nonstructural components are not viewed separately, but as part of a systematic, integrated program of hurricane protection. This type of integration also will help plan for the inevitable tradeoffs that will be part of LACPR and to incorporate methods perhaps little considered in the past. Implementation also will be enhanced to the extent that federal, state, parish, and other entities can cooperate and efficiently define responsibilities among restoration, structural, and nonstructural efforts.

Some sections of the LACPR draft technical report exhibit systems-level thinking. The main body of the report, for instance, notes that:

> The LACPR and MsCIP (Mississippi Coastal Improvements Program; definition added) efforts were coordinated during all phases, including planning, technical analyses, and stakeholder engagement. The teams are also using common planning, technical members and tools to further coordinate development of the plans (USACE, 2007a, p. 6).

The LACPR team is encouraged to promote this type of geographic and organizational coordination through the LACPR planning and implementation process.

The LACPR draft report provides little discussion of the details of the federal-state-local cooperation that will be necessary to fully implement nonstructural measures of the integrated Multiple Lines of Defense Strategy proposed in the technical report. The LACPR study team, working with the State of Louisiana and parish- and other local-level entities, is encouraged to explore further the institutional and administrative needs regarding effective implementation of nonstructural (and other) measures for hurricane protection, and how state, local, and other bodies can complement the roles of the LACPR and Corps of Engineers. All parties involved are encouraged to consider implementation of restoration, structural, and nonstructural measures as part of a systematic and integrated program of hurricane protection.

PLAN FORMULATION AND EVALUATION

Formulation

The LACPR draft report and the Plan Formulation Atlas describe the plan formulation process in general and present results for five geographical divisions of the study area (planning units). Each alternative plan is created by combining one or more measures or projects. Three categories of measures are considered in this process: coastal restoration measures, nonstructural measures, and structural measures. Individual measures are screened prior to plan formulation, in order to remove infeasible, ineffective, or dominated measures. Alternative plans then are assembled from the remaining measures, as follows:

- No-action plan
- Coastal restoration only
- Coastal restoration and nonstructural measures
- Coastal restoration and structural measures
- Comprehensive (all measures used)

Based on the Plan Formulation Atlas, 266 alternative plans were defined, including no-action plans for each planning unit. Further screening reduced this list to 27 alternative plans for

Planning Unit 1, 33 alternatives for Planning Unit 2, 13 alternatives for Planning Unit 3a, 17 alternatives for Planning Unit 3b, and 19 alternatives for Planning Unit 4: a total of 109 alternative plans.

The details of the plan formulation process are difficult to follow in the draft final report, and it is not clear what each plan involves. Project locations can be obtained from figures in the LACPR draft technical report and in the 2007 Plan Formulation Atlas, but detailed descriptions of each plan are not provided. An important observation is that only those combinations that include coastal restoration projects are included. The coastal restoration projects proposed for the various planning units all are described as maintaining 100 percent of the existing coastal landscape (or its equivalent). Even if this were physically and economically feasible, the decision to include the same coastal restoration project in each alternative plan (except the no-action alternative) prevents the project evaluation process from providing data on the efficacy of coastal restoration.

The plan formulation process organizes a large number of potential measures, screens out inferior or infeasible choices, and assembles the remainder into 109 alternative plans distributed over five planning units. However, as reported, the process contains a critical embedded assumption: all plans include the coastal restoration alternative, which is said to preserve 100 percent of the coastal landscape. If this assumption were feasible, including it in all alternative plans precludes any evaluation of its efficacy. If the assumption is not feasible, efforts to elicit stakeholder preferences will not provide information suitable for use in the plan evaluation process.

Evaluation

The plan evaluation process utilizes a multi-attribute utility (MAU) function approach. A weighted linear function is employed, where the value of the function is found by multiplying a fixed weight times the value score derived for each metric, then summing over all metrics. Both weights and value scores are expressed on 0-1 scales. The result is taken to be an estimate of the contribution to community utility, assumed equivalent to the social welfare change.

The evaluation process within the LACPR draft technical report consists of four steps: measurement, value scoring, weighting, and plan evaluation. One of these four steps—the provision of weights—is performed by stakeholders. All other steps and computations, including definition and choice of metrics, measurement of plan performance against each metric, conversion of measurements to value scores, and the final computation of MAU scores, are performed by the LACPR study team.

A key step in plan evaluation, as described here, is the process of converting measurements of plan performance with respect to each metric into value scores. Yet this critical step is barely mentioned in the documentation. It occupies less than one full page in the "Risk-Informed Decision Framework Appendix" (USACE, 2008, p. 29-30) and does not appear at all in the main body of the LACPR draft technical report. Nowhere is it acknowledged that conversion of measurements to value scores is itself a process of weighting metrics, potentially more influential than the weighting exercise performed with stakeholders.

The LACPR draft technical report does not document the information provided to stakeholders prior to elicitation of weights for the metrics. During the April 2008 meeting with the NRC committee, LACPR staff explained that stakeholders were given a general description of how alternative plans were formulated, including mention of the different kinds of measures that may be included, and that they were acquainted with the definition of each of the metrics that they were asked to weight. The weight elicitation proceeded in several iterations. Between each iteration, respondents were allowed to contrast their own weights to the averages for all other respondents. They were not given any information on the values or range of values for the metrics, or any other data that would indicate the trade-offs that the assigned weights implied. This lack of information leads to a problem described in the literature as "range insensitivity bias," commonly associated with direct weighting methods (von Winterfeldt and Edwards, 1986; Hobbs and Meier, 2000).

The evaluation process presented in the draft final report fails to recognize that a weight applied to a metric measurement defines a tradeoff between that metric and others. Weights attached to archeological sites protected, for example, should reveal the social value of archeological sites. The weight elicitation process should allow participants to make these judgments and reflect them in the weights. Instead, the draft final report presents a double-weighting process: the rescaling of metrics to value scores creates an implicit weighting and the stakeholders' weights are applied to the result. In neither case are actual tradeoffs between metrics known or considered, so the result cannot reflect social preferences.

A further issue concerns the fact that four of the fourteen metrics are measured in monetary terms. A dollar is, by definition, a social welfare weight. Unless certain dollar-denominated metrics are clearly stated in the weighting process to be proxies for other, unmeasured impacts, rescaling or further weighting of these metrics invites spurious and implausible results. For example, for planning unit 1, the results of the reported weightings imply that a one dollar increase in residual damage is four times more valuable than one dollar loss in earned income. Although for reporting purposes it may be useful to separately account for various dollar-denominated metrics, they should be combined for plan evaluation purposes. Furthermore, the kind of direct weighting illustrated in the draft technical report cannot properly deal with monetary metrics.

Given the requirements of LACPR plan evaluation, the direct weighting approach should be replaced with a protocol that allows full visibility of the tradeoffs implied by weighting. One way to accomplish this is to use a "swing weighting" approach. This latter method is significantly more complex than direct weighting, but it is recognized as a reasonable compromise between the need for rigor and the need for a method to be understandable and easily implemented (von Winterfeldt and Edwards, 1986). Swing weighting allows participants to make explicit pair-wise comparisons between metrics, so that tradeoffs are understood at every step. The LACPR study team has stated its intention to repeat the weighting process using the swing weight method. Properly applied, this method holds the promise of producing more credible and representative evaluations of alternative plans.

The process of plan evaluation should be better documented within the LACPR report. One critical step within plan evaluation—the computation of value scores—is barely mentioned. The fact that rescaling metrics to produce value scores, in itself, represents a form of weighting is not acknowledged in the report, and may not have been

explained to the stakeholders. In this case, stakeholders were asked to assign weights to metrics without understanding that the evaluation process has already implicitly weighted these metrics in various ways, which greatly diminishes the value of this exercise.

Multiple criteria decision making, or MCDM, is a useful method when used correctly and applied to non-commensurable metrics. It generally is not appropriate to use MCDM for multiple dollar-denominated metrics, where weighting is implicit in measurement. Combining the several monetary metrics into a single measure—at least for evaluation purposes—is a preferable approach.

The kind of MCDM approach taken in the LACPR draft report generally is a feasible and appropriate way to rank the kinds of alternative plans under consideration. In fact, the LACPR is to be commended for taking this approach, despite the learning curve created by the need to embed this evaluation method in traditional Corps planning. But it will be necessary to repeat the plan evaluation process using a different weighting paradigm, such as swing weighting. It should be noted that the LACPR study team has stated its intention to take this step.

The LACPR team also is encouraged to more clearly present and discuss trade-offs among various planning combinations and alternatives. The LACPR team has correctly integrated restoration, structural, and nonstructural dimensions of hurricane protection in its study. The LACPR team is encouraged to continue to identify and evaluate the connections between these three approaches.

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APPENDIX A

STATEMENT OF TASK
COMMITTEE ON THE REVIEW OF THE LOUISIANA COASTAL PROTECTION AND RESTORATION (LACPR) PROGRAM

This NRC committee will review the evaluations being conducted as part of the Louisiana Coastal Protection and Restoration (LACPR) program. These studies are being conducted by the U.S. Army Corps of Engineers in close coordination with the State of Louisiana. Congress has directed the Corps of Engineers, New Orleans District, in partnership with the State of Louisiana, to compile a 24-month technical comprehensive hurricane risk reduction analysis and design. The Corps and the State of Louisiana thus are evaluating a wide range of flood control, coastal restoration, and hurricane protection measures in this study. The LACPR study began in early 2006 and an interim report was issued in July 2006. The LACPR team plans to issue a draft report in December 2007 and a final report in Spring 2008.

The NRC committee will review all aspects of these latter two reports, including assessment of the hurricane risk reduction framework, alternatives for flood control, storm protection, coastal restoration, and risk analysis. These two LACPR reports will include several technical appendixes (e.g., cost estimates, engineering studies, draft EIS, design appendixes, and public outreach strategy) that will be part of this review. Given the large number of supporting and supplemental documents that are being produced by the Corps and various other parties, the NRC committee will also review supplemental documents as the committee sees fit and within its time and resource constraints.

The NRC committee will issue two reports that include conclusions, findings, and recommendations for improving the LACPR study.

UPDATE 3-17-08: The project duration has been extended. The committee's report is expected to be issued by late April 2008.

APPENDIX B

COMMITTEE ON THE REVIEW OF THE LOUISIANA COASTAL PROTECTION AND RESTORATION (LACPR) PROGRAM

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APPENDIX C

ACKNOWLEDGEMENT OF REVIEWERS

This report was reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise in accordance with the procedures approved by the NRC's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the NRC in making its published report as sound as possible, and to ensure that the report meets NRC institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process.

We thank the following for their review of this report: Mead Allison, University of Texas; Hanif Chaudhry, University of South Carolina; Robert Holman, Oregon State University; David Moreau, University of North Carolina; Rutherford Platt (emeritus), University of Massachusetts; Doug Plasencia, Michael J. Baker, Inc., Phoenix; Tony Pratt, Delaware Department of Natural Resources; Denise Reed, University of New Orleans; Torbjorn Tornqvist, Tulane University; Robert Twilley, Louisiana State University.

Although these reviewers provided constructive comments and suggestions, they were not asked to endorse the report's conclusions and recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by Robert A. Frosch, Harvard University, who was appointed by the NRC's Report Review Committee, and by David A. Dzombak, Carnegie Mellon University, who was appointed by the NRC's Division on Earth and Life Studies. Drs. Frosch and Dzombak were responsible for ensuring that an independent examination of this report was conducted in accordance with NRC institutional procedures and that all review comments received full consideration. Responsibility for this report's final contents rests entirely with the authoring committee and the NRC.