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Louisiana's Barrier Islands: An Evaluation of their Geological Evolution, Morphodynamics and Rapid Deterioration

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ABSTRACT

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Louisiana leads the United States of America, and likely the world, in coastal erosion and wetland loss. Landward translation of the barrier islands fronting the bays and estuaries of Louisiana exceeds 20 m/yr. Over the last century or so, the subaerial mass of many of these islands has been reduced by between 40 and 75 percent. Recent findings indicate that entire barriers will likely be transformed into shoals over the next decade or so. Ongoing numerical model studies indicate that this will result in significant increases in wave energy in the bays and estuaries, likely increasing rates of fringing marsh deterioration. Considering that Louisiana contains 40 percent of the Nation's coastal and estuarine wetlands in the 48 conterminous states, and that 80 percent of the Nation's total loss of wetlands has occurred in Louisiana, the problem transcends the State boundaries and has become one of National concern.

In April 1995 a workshop was held in New Orleans to address the Louisiana barrier island erosion and wetland loss issue. Some 15 presentations were made and 5 panel sessions held which combined, included over 30 scientists, engineers and coastal managers from Louisiana and elsewhere in the United States. The primary topics presented and discussed centered on identifying the magnitude of the erosion and wetland loss problem in Louisiana; causal linkages to bio-physical processes; future predictions of coastal conditions using historical time series and predictive models; evaluation of options and strategies including no action, strategic landward retreat, "soft" and "hard" engineering approaches, cost/benefit analyses and funding; restoration plan development, implementation and monitoring. Professionals attending the workshop agreed that the coastal community at large would benefit and be interested in the information presented at the workshop and that the *Journal of Coastal Research* would be an excellent vehicle for dissemination. Papers were submitted to the guest editors and subsequently vetted for external, peer review. Ten papers were selected for publication in this thematic issue.

In the opening paper, "A Perspective on the Louisiana Wetland Loss and Coastal Erosion Problem," S. J. Williams *et al.* set the stage for the thematic issue by presenting a perspective on the Louisiana wetland loss and coastal erosion problem. Their paper succinctly presents the magnitude of the problem and the involvement of federal state and local agencies as well as academic research efforts directed at understanding and mitigating Louisiana's coastal issues. The significance of a federal law entitled the Coastal Wetlands Planning, Protection and Restoration Act, passed by Congress in 1990, is also discussed. The second paper, "Regional Coastal Morphodynamics Along the United States Gulf of Mexico" was written by R. A. Davis to demonstrate the magnitude of the Louisiana coastal erosion problem when compared to the remaining beaches in the U.S. Gulf of Mexico. The third paper, "Dynamic Changes of the Holocene Mississippi River Delta Plain: The Delta Cycle", by H. H. Roberts, presents and elucidates the cyclic-delta building events that are responsible for the modern delta plain and associated barrier island and shoal complexes. The depositional architecture of the delta plain is presented and linked to the mechanism of delta switching, subsidence, submergence and the transgressive evolution of headland beaches and spits, to barrier islands, shoals and submarine sand bodies. The fourth paper, "Regional Variations in Shore Response along Barrier Island Systems of the Mississippi River Delta Plain: Historical Change and Future Prediction", by R. A. McBride and M. R. Byrnes is a detailed summary of historic (1855–1989) shoreline changes around the Louisiana barrier island coast. This paper demonstrates the magnitude of the erosion problem in Louisiana and reports Gulf side erosion at rates of over 23 m/yr., in addition to bayside erosion of up to 5 m/yr. The authors conclude that the structural continuity of the islands continues to weaken as they narrow, fragment and ultimately

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disappear. Areas including the Isles Dernieres, Grand Terre Islands and the eastern Plaquemines are expected to become subaqueous within approximately 25 years. In the fifth paper, "Overview and Significance of Hurricanes on the Louisiana Coast, U.S.A.," G. W. Stone *et al.* present an historical overview of hurricanes making landfall along the Louisiana coast. Their review indicates that of the 50 strongest storms on record to have made landfall around the U.S., 11 have made landfall in Louisiana. While the response of the barrier islands to hurricanes has been one of destruction, the authors point to data indicating that many of the marshes undergo vertical accretion during and after landfall. Physically-stressed marshes, however, undergo rapid deterioration due to high winds accompanying the hurricanes. Predictions of future impacts of severe hurricanes along the Louisiana coast indicate a gradual landward shift of larger waves due to the predicted disappearance of the barrier islands, and that densely populated areas such as New Orleans, will be subject to the devastating effects of storm surge and storm waves during severe hurricanes. The sixth paper, "Bathymetric Comparisons Adjacent to the Louisiana Barrier Islands: Processes of Large-Scale Change", by J. H. List *et al.* summarizes the results of a comparative bathymetric study along 150 km of the southcentral coast. The data presented in this paper show large-scale, coherent patterns of sea-floor erosion and accretion related to the rapid deterioration of the barrier islands. The authors present two primary processes driving this change: massive longshore transport and increased sediment storage in ebb-tidal deltas, and conclude that the rapid rise in relative sea level is an indirect cause of shoreline erosion along this coast.

The seventh paper, "Implementing a Barrier Island and Barrier Shoreline Protection Program—the State of Louisiana's Perspective," written by I. Ll. van Heerden and K. DeRouen, presents the "Big Picture" implementation strategy of large-scale offensive and multi year projects designed for coastal wetland and barrier island restoration. The paper presents insights on the value of the barrier islands in Louisiana, the priorities associated with using financial appropriations, negotiations held with federal agencies and national environmental groups in addition to reviewing the feasibility and environmental impact statement studies. In the eighth paper, "Modeling Impacts of Louisiana Barrier Islands on Wetland Hydrology," J. N. Suhayda presents a description of the methodology being used in Louisiana to evaluate the role of barrier islands in influencing wetland hydrology and some preliminary findings. More specifically, the paper presents the effects of barrier island geometry on the duration and depth of inundation of coastal wetlands under average and extreme conditions. The data indicate that predicted surge levels inland would have been 1.5 m lower than was actually observed during Hurricane Andrew if the barrier islands were raised and inlets narrowed. The ninth paper, "Models for Barrier Island Restoration", by R. G. Dean, presents first level response models for preliminary design of the approximate effectiveness of candidate barrier island stabilization measures, optimum engineering approaches and the associated quantities and costs to accomplish barrier island restoration. Dean suggests that the vast quantities of sediment likely required for barrier island restoration may be somewhat reduced by the careful use of structures, principally sand retention structures at inlets. In the final paper "Responding to Coastal Erosion and Flooding Damages," J. Pope presents a general overview of coastal management strategy, including the decision to incorporate shore protection works, based upon a clear understanding of the problem, site conditions and socio-economic expectations. The author emphasizes that the full integration of geological insights, engineering technology and human anticipation is particularly critical in addressing Louisiana's problems.

Since the pioneering work of Fisk, McFarlan, Russelll, Morgan and Coleman, carried out on the lower Mississippi River delta since the early part of this century, scientists have continued to unveil and elucidate the complexities of the delta plain and adjacent coast. Numerous papers published primarily in the geologic literature, have permitted an in-depth understanding of this system in its entirety. In the current issue, Dr. Robert G. Dean, Professor of Coastal Engineering at the University of Florida makes a particularly provocative statement in his introductory remarks. Dr. Dean suggests that channelization of the Mississippi River and subsidence due to hydrocarbon and other fluid extraction have substantially destabilized the barrier islands west of the river. The direct relationship between sediment diverted offshore to the shelf and erosion along the barrier islands west of the Mississippi River has not, to our knowledge, been demonstrated in the published literature. Dr. Dean does not provide data to support his argument but given the significance of his statement, he is willing to enter into a professional dialogue. The *Journal of Coastal Research* is an excellent venue for this discussion.

A considerable amount of time and effort has been spent by the editors of this thematic issue ensuring a high quality, state-of-the-art review of Louisiana's coastal problems. This could not have been accomplished without the assistance of the following external reviewers: K. Bodge, T. Campbell, R. Dean, J. Donoghue, S. Douglas, W. Dupre, D. Fitzgerald, F. Gerritsen, G. Griggs, R. Hallermeier, J. Kelley, B. Kjerfve, R. Morton, T. Moslow, R. McBride, O. Pilkey, N. Scheffner, R. Seymour, D. Stanley, F. Stapor, D. Warne. In addition, we gratefully acknowledge funding made available for publishing costs by the following agencies: C.F. Bean, Inc.; Center for Coastal, Energy and Environmental Resources; Coalition to Restore Coastal Louisiana; Coastal Environments, Inc.; Edward Wisner Foundation; Governor's Office Coastal Activities; Gulf Intracoastal Canal Association; Jefferson Parish Government; Louisiana Department of Natural Resources; Louisiana Oil Spill Coordinators Office; National Marine Fisheries Service; Plaquemines Parish Government; T-Baker Smith and Son, Inc.; Terrebonne Parish Government; T.L. James Marine Group; United States Environmental Protection Agency; United States Fish and Wildlife Service; United States Geological Survey; and United States Minerals Management Service.