ground water

Guest Editorial/

Hurricanes Create a Crossroads for Hydrological Management of the Mississippi River Delta

by Richard F. Keim[1] and William J. Blanford[2]

The flooding of New Orleans by Hurricanes Katrina and Rita has forced the public to confront the concepts of hydrological risk and hazard, both directly in the form of engineering obstacles and as interwoven into overlapping and evolving sociological, geological, and ecological systems. The problems in the Mississippi River delta were not caused by the storm but arose gradually with the development of economic infrastructure in the region. Neither will the complex of problems be eliminated by any solution designed to prevent repetition of an event of this type. Instead, the continually changing systems are best approached by adaptive management that integrates hydrological engineering and ecological restoration. The ''permanent'' fix to sustainable development of coastal Louisiana actually lies with adopting evolving management plans that incorporate multiple values to recognize engineering, economic, and hydrologic realities.

The task for engineering hydrologists, as it is being defined in the months following the storms, is to generate technological solutions to prevent another major flooding event in the city. Solutions will require rapid and thorough evaluation of the engineering and maintenance flaws in the present storm management system and marshaling political will to pay the daunting costs to address them. Technical reviews of the structural failures that occurred in the city's flood-control infrastructure during Katrina are being conducted by the National Academies of Science and Engineering, the American Society of Civil Engineers, the Louisiana State University Hurricane Center, and other organizations. Early results of these inquiries suggest that hydrological stresses did not exceed the design standards of all levees and canals, but that design and construction flaws were responsible for at least some of the failures. Importantly, desires to reduce construction or maintenance costs associated with constructing a functioning levee system within the context of local geological conditions and pressures to minimize the effect on local commerce appear to have contributed to these flaws.

Understandably, displaced residents and businesses have expressed reluctance to return to a city that presently has minimal flood protection and uncertain long-term protection. The response from political leaders has been to ask the hydrological engineering community to develop fail-safe solutions rapidly. Perhaps, because the flooding from Katrina in retrospect seems to have been partially preventable, there is a sense among the public that new and substantially improved water-control structures can provide the needed security. In fact, structures likely can be developed to protect New Orleans, despite considerable technical difficulties that include rapid regional and local subsidence, unstable soils, and the proximity to sea level. For example, some have suggested hydrological compartmentalization of the city to reduce the consequences of failure for any single flow-control structure.

Unlike the New Orleans metropolitan area, most communities in coastal Louisiana are not surrounded by levees. Although there are disjunct levees built to prevent localized flooding, protection from hurricane surges has mainly been provided by the extensive coastal and deltaic wetlands. But subsidence, storms, and disturbances to those wetlands have eroded the physical extent of their coverage as well as their ability to provide protection from hurricane surges.

Water-control structures on the Mississippi River and its distributaries have tremendously altered the processes responsible for forming and maintaining the delta. Sediment and nutrients formerly delivered to wetlands during floods are now carried to the mouth of the river and off the edge of the continental shelf. Without these additions, deposition rates within wetlands have not kept pace with consolidation rates within the delta and subsidence has resulted. Subsidence appears to have been locally accelerated by extraction of subsurface hydrocarbon deposits. Water impounded by canal spoil banks, highways, and railroads as well as salt water intrusion into fresh water wetlands via canals for navigation and oil and gas exploration have locally disrupted ecosystems and reduced

[1]Corresponding author: Assistant Professor, School of Renewable Natural Resources, Louisiana State University and LSU Agricultural Center, 227 Renewable Natural Resources Building, Baton Rouge, LA 70803; (225) 578-4169; rkeim@lsu.edu

[2]Department of Geology and Geophysics, Louisiana State University, E235 Howe-Russell Building, Baton Rouge, LA 70803

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productivity so that subsidence cannot be counteracted by organic accumulation. The net result of these changes is that land-loss rates are astoundingly high in the coastal wetlands and barrier islands.

The fundamental issue is that the processes that built the delta are dynamic in space and time to a degree that human infrastructure normally cannot accommodate. The routine reaction has been to attempt to reduce and control the variability of natural processes. True to form, political leaders and some residents of coastal Louisiana are now proposing a New Orleans–style, ''category 5'' levee be built to substitute for their deteriorating wetland protection by encompassing the entire deltaic plain. We believe such a levee system would be a shortsighted solution that would jeopardize the long-term ecological and economic productivity of the region. Instead, we hope engineering solutions can be found that preserve and enhance natural processes to sustain wetlands and hope that levees are used only to protect concentrated, high-value infrastructure.

Encircling the delta with a levee will essentially domesticate the natural hydrologic processes that control wetland ecosystems. To maintain the integrity of those wetlands, with all their ecological, economic, and cultural importance, will require active hydrological management. Both surface water and ground water will be affected because of close coupling between surface flow patterns and subsurface chemistry and salinity. The costs of maintenance will be commensurate with the scale of the management structures. Imposing the burden of upkeep on future generations should not be a casual decision. The New Orleans metropolitan area itself is a legacy of past decisions that now require a substantial commitment to maintain. Is society prepared to commit to that style of maintenance for the entire Louisiana coast?

Engineering efforts to work with natural processes and renew the delta by diverting river water into wetlands are ongoing. Success so far has been limited in spatial extent and limited by conflicting economic factors (e.g., freshening of oyster beds). Restoration projects have generally not taken precedence when conflicts with navigation and other human demands arise, which has increased expense and reduced effectiveness. Explicit integration of restoration and flood protection, which will require long-range strategic planning, is needed for both ecological restoration and flood-protection projects to succeed.

Combining restoration and flood-protection efforts synergistically into a single effort can also improve levee effectiveness because wetlands will protect levees from high-energy wind and waves. As an example, initial assessment of the New Orleans levee system suggests that the Mississippi River Gulf Outlet navigation canal may have served as a conduit of surge energy from the Gulf of Mexico directly to the city, with some failures perhaps caused by high-velocity surges. The health and susceptibility of any levee system will be matched by the health of the natural systems and care and attentiveness which we pay to both. Incorporating natural systems as integral to a functional levee system will allow humans to continue to live in precarious coastal communities.

Note: We invited Professors Keim and Blanford to contribute an editorial on this topic; Professor Blanford is an associate editor of the journal. In view of the importance of the issues discussed in this editorial, we have waived the one-page limit requirement for editorials. Opinions expressed in the editorial column are those of the authors and do not necessarily reflect those of the National Ground Water Association or the staff of the journal.