Nonstructural vs. Structural: Strategizing Long-Duration Coastal Protection in Southern Louisiana

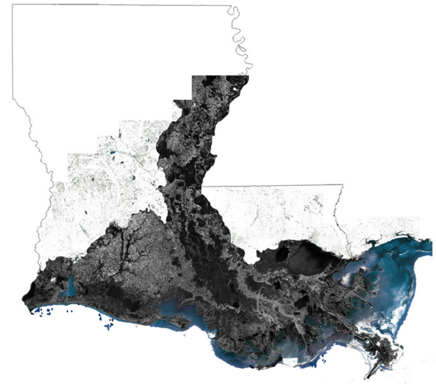
Meredith Sattler
Louisiana State University

Since 1932, the state of Louisiana has lost land at the rate of a football field every hour[1] totaling 16.57 square miles per year.[2] This is largely the by-product of flood control structures intended to keep water out of a naturally soaked landscape.

Despite the fact that as early as 1897 E. J. Corthell predicted the negative impacts of massive leveeing of the Mississippi River that are experienced today,[3] private landowners and public policy have consistently biased shorter term flood protection over longer term coastal biogeochemical system health. After the devastating floods caused by Hurricane Katrina in 2005, exacerbated by both structural levee failure and non-structural wetland storm surge buffer loss, the State of Louisiana initiated a coastal planning process which resulted first in the 2007 Coastal Master Plan, and five years later the 2012 Coastal Master Plan.

The 2012 Plan determined specific risk reduction and restoration projects the state would appropriate funds to implement over the next fifty years. The plan is a timely example of a rigorous analytical and research driven planning process that grapples with the uncertainties of climate change, sea level rise, and catastrophic storm behaviors increasingly affecting sub-tropical coastal communities, particularly those located within deltaic systems. The plan acknowledges the need for both *structural* ("levees, floodwalls, and pumps that protect large areas"[4]) and *nonstructural* ("risk reduction actions that homeowners and businesses can individually take, such as elevating or flood proofing"[5]) in an attempt to both reduce future risks and restore the coast. However, the plan concentrates primarily on the determination of structural and restoration projects, which occur predominantly at landscape scale, not nonstructural, which occur at building and urban scale. Structural projects provide significant protection up to the point at which they fail. Once their threshold is breached, these flood control strategies often exacerbate dangerous flooding conditions, instead of continuing to reduce risk. Additionally, despite their massive infrastructural scale, only a small percentage of the entire coast can be protected structurally, leaving most populated areas under the current plan to fend for themselves utilizing nonstructural strategies.

Because nonstructural strategies mediate between landscape, urban, and building scales they have the greatest potential to mitigate and adapt to the dynamic conditions of the Southern Louisiana Delta. However, they are grossly undeveloped in the plan: less than one percent of its content is devoted to detailed discussion of their role and implementation, despite the fact that the Plan allocates approximately one-fifth of its budget to nonstructural protection.[6] This essay examines the planning process that resulted in this bias, questions the lack of emphasis on nonstructural measures, and proposes a more appropriate framework for designing and implementing nonstructural measures in populated dynamic deltaic conditions.



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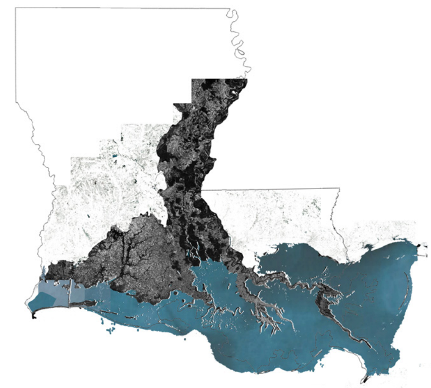

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A HISTORY OF DISTURBANCE REGIMES

A brief primer on the conditions of the Louisiana Delta is necessary in order to contextualize the Master Plan's values and assumptions. The Delta has long been a dynamic working coastal region visibly expressing its "...struggles, compromises, and temporarily-settled relations of competing and co-operating social [and ecological] actors"[7] within the landscape. Since Europeans permanently settled in the 1700's, bringing with them strategies for flood control, the landscape has been altered at expanding scales in an attempt to render permanently *dry* land from a spatially and temporally *wet* landscape. As sea-levels rise, subsidence quickens, and hurricanes pound the coast with water, it is proving increasingly challenging to keep these designated *dry* areas, and the two million people who live within them, above the water line.

Louisiana's coast is not a typical coastline, but a deltaic gradient of saline to freshwater vegetation and Mississippi River silt that extends miles inland. Its edges, defined by a series of elevated fingers where land, fresh, and salt water meet, are constantly shifting, driving both natural and anthropocentric processes and patterns in continually pressing ways: salt water intrusion, nutrient loading, and sea level rise. These are exacerbated by pulsing events such as hurricanes, fertilization, and toxic releases, which often quickly leave dramatic marks across this soft landscape.[8] While its geologic history, climactic, and ecology have rendered it abundant in natural resources, namely oil, gas, and seafood, the dynamic landscape that facilitates the continuing supply of these resources, often impedes their identification and extraction.

These disturbance regimes render permanent occupation of the coast problematic and have inspired a host of large scale structural interventions in the landscape, most dramatically, the 1927 hardening of the Mississippi River edges from Cairo, Illinois to the Gulf of Mexico. By stopping the natural sediment rich flooding processes which built the delta, and instead jettisoning the plentiful sediment from the bread basket of America out to sea, we have dramatically altered hydrologic flow and sped up the land loss process. Deltaic soils naturally subside and dissolve. It is only with fresh inputs from the river that they are able to maintain themselves.

Further contributing to Louisiana's land loss is the configuration of the working coast, a silty, gritty, shallow, wet environment speckled with large scale infrastructure and extraction machinery. It is difficult to install and utilize large scale, heavy, semi-permanent equipment within this mucky, lush

Figure 1: 2012 Louisiana Coast, Source: Google Maps, Image: John Mouton

Figure 2: 2100 Projected Louisiana Coast, Sources: Google Maps, 2012 State of Louisiana Coastal Master Plan, NASA, from Blum + Robert (2009), Image: John Mouton

environment. Since the 1950's, over 8,200 miles of canals have been dug through the wetlands in order to facilitate navigation and access to oil and gas extraction and storage wells and pipelines.[9] These canals increase the surface area of wetland exposed to salt water, which kills vegetation holding the sediment together, resulting in catalyzed dissolution.

Communities strategically placed to serve extraction industries must also weather these dynamic conditions. They rest atop layers of organic material suspended in water, thousands of feet deep, causing the land to behave more like thick pudding than solid ground. In this soaked environment, land is leveed off and pumped dry. Soils now exposed to oxygen begin to decompose, forcing the land to sink further, often below sea level. Many ring-leveed towns, with increasingly negative elevations, are built primarily slab on grade. Their building foundations and roadbeds are highly problematic, because of their ridged performance which renders them susceptible to flooding and storm surge.

Over eighty years ago, "…the units of natural resource management and units of social life tended to coincide"[10] producing tight feedback loops between disturbances and their causes. Natural and socio-cultural systems operated on a shorter, more responsive timeframe, more facile in its ability to adapt to changing conditions. As fixed structures and buildings are increasingly introduced, and finer grained mosaics of urban and ecological landscape units propagate, the result is a particularly problematic mash-up of built and natural systems. These new hybrids create ever more complicated environmental feedbacks, which are increasingly difficult to manage on simultaneously long-slow (press) and short-fast (pulse) time scales. The result: intensifying climate-related disruptions which are increasingly experienced as negative disruptions to the flow of people and resources in the delta.

In the long term, the region is predicted to transition more completely into an archipelago of isolated managed hydrologic units, where the tensions between land based settlement patterns and water based conditions intensify. As land is lost and populations decline it becomes increasingly difficult to justify significant federal and state financial support for costly structural and restoration projects. The socio-ecological delta of eighty years ago is forever gone. Today, the circumstances of the delta can be classified as a Wicked Problem: characterized by "…an indeterminate scope and scale…which can't be 'fixed.'[11] The Plan acknowledges this reality, and calls for "…bold coastal protection and restoration measures…"[12] that will not return the coast to its pre-developed state, but that will result in stabilizing measures to mitigate land loss, and ultimately a very differently shaped coast.

For generations, private property rights have been highly valued in Louisiana and coordinated planning has not been favored; in some cases it is mistrusted. Because of this, prior to 2005 the State had never prioritized planning initiatives. Post-Katrina, the necessity for addressing land loss and reducing storm surge flooding risks[13] through a coast-wide coordinated planning process became clear.

2012 STATE OF LOUISIANA MASTER PLANNING PROCESS

Because of the skepticism surrounding planning in the state, the Master Plan carefully considered a three stage process: both objective quantitative and qualitative methodologies were engaged to determine which structural and restoration projects would be included. The first stage utilized cutting edge

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ecological systems modeling to generate predictive data about the future morphological and ecological conditions of the coast, then tested how possible projects would perform in these scenarios. Seven systems models including ecohydrology, wetland morphology, barrier shoreline morphology, storm surge/waves, vegetation, ecosystem services and risk assessment,[14] were linked to predict possible project performance. "Advanced technical analysis was used to evaluate hundreds of projects in order to select a plan that provides the greatest return on investment while considering the constraints of the natural system."[15] The modeled results were only as robust as the data sets, and quantifiable unknowns made a significant difference in the predictive process.

Figure 3: 2013 Cancer Alley: Baton Rouge to New Orleans, LA, Source: Google Maps + SONRIS, Image: John Mouton

Figure 4: 2100 Projected Cancer Alley: Baton Rouge to New Orleans, LA, Sources: Google Maps + SONRIS, 2012 State of Louisiana Coastal Master Plan, NASA, from Blum + Robert (2009), Image: John Mouton

Once model output was reviewed and deemed appropriate, it was run through the second phase: a hybrid quantitative and qualitative Planning Tool. Designed with the assistance of the Rand Corporation, it contained detailed sets of assumptions, constraints, and decision criteria that facilitated an "…understand[ing of] the practical implications of different project options and how gains in one area might create losses in another…"[16] It determined which constellations of projects would produce the most ecologically, culturally, and financially effective outcomes. It did not evaluate nonstructural programmatic measures, however.[17]

> "The Planning Tool, which was designed to translate the models' scientific output, was used to show the practical implications of different options and preferences…it effectively and systematically evaluated project data over the 50-year planning horizon and selected projects that would best achieve the master plan objectives while satisfying constraints relative to limits of funding, limits on other resources, the preferences of CPRA, and plausible estimates of stakeholder values."[18]

By utilizing this three stage approach, the state captured and analyzed both the strengths and weaknesses of the "…qualitative nature of soft system approaches and the quantitative nature of hard system methodologies."[19]

The final stage of the process was expert evaluation, which included adjustments, as to how effectively the selected projects were expected to deliver the two overriding decision drivers within a fifty year timeframe:

- **Protection (Risk reduction)**: Combinations of restoration, nonstructural, and targeted structural measures were analyzed for their ability to provide increased flood protection for all communities. The driving question being "**How well did the projects reduce flood risk?**"[20]

- **Restoration (Land area built or maintained)**: An integrated and synergistic approach designed to ensure a sustainable and resilient coastal landscape was developed to analyze "**How well did the projects build new land or maintain the land already in the system?**"[21]

Plan authors developed and utilized an objective Decision Framework to determine a list of thirty-three structural and one hundred and sixteen nonstructural projects that are eligible for state approved funding between 2012 and 2062. The Decision Framework "…reflects the needs and priorities of the state as well as planning conditions not necessarily under the control of the state,"[22] and incorporated a series of principles to guide the accomplishment of sustainability, management of expectations, facilitation of implementation, and definition of roles[23] in addition to the five objectives that drove the planning process:[24]

- **Flood Protection:** Providing for varying levels of protection from storm surge based flooding and aiming to reduce residual risk, while acknowledging that some residual risk is unavoidable.

- **Natural Processes:** Promote a sustainable coastal ecosystem by harnessing the processes of the natural system.

- **Coastal Habitats:** Provide habitats suitable to support an array of commercial, recreational, and ecosystem service delivery activities coastwide, including carbon sequestration.

- **Cultural Heritage:** Sustain unique cultural heritage by protecting historic properties and traditional living cultures and their ties and relationships to the natural environment. "The plan seeks to show sensitivity and fairness to those in coastal communities, whose homes, lands, livelihoods, and ways of life may be adversely affected wither by projects recommended in the plan or by continued rates of land loss and flooding."[25]

- **Working Coast:** Promote a viable working coast to support regionally and nationally important businesses and industries.

This process resulted in three unanticipated key findings: 1. the Plan calls for a fifty-fifty funding split "...between projects designed primarily for risk reduction and projects designed for coastal restoration,"[26] 2. near term and long term project implementation produced phasing/funding units of years one through twenty, and years one through fifty,[27] 3. a pattern of selected project locations emerged which "...tended to be in the upper end of the estuaries, closer to existing land, rather than projects close to the Gulf of Mexico."[28] Each of these has significant impacts on future sustainable coastal development, particularly the creation of buildings and urban environments.

2012 STATE OF LOUISIANA MASTER PLAN IMPLICATIONS

The Plan results in several implications, some of which are more readily addressed by architecture than others. The following three implications are not easily solved by Architecture: **Risk mitigation** is inherently limited by disturbance regime severity. The plan states that "...no feasible combination of projects is able to eliminate all risk."[29] The Plan assumes that **funding** scenarios are known; funding is available for the entire implementation period; and funding cannot be saved for use in later implementation periods.[30] It also assumes that approximately fifty-billion dollars of primarily public funding will be available over the next few years to initiate all of the selected projects. While this is not a totally unreasonable estimation, it is optimistic given recent federal funding patterns and population decline in certain regions. It also assumes an amount of **coordinated effort between individual land owners, regional, state, and federal agencies** which will likely prove challenging.

Architects; however, have significantly more agency in relationship to the following implications:

- **Public Participation:** Significant Plan success was achieved with the series of town meetings conducted during the plan formation to solicit public input and conversation. This could be enhanced utilizing architects' as facilitators of meetings and charrettes.

- **Coordination of Socio-Economic Factors:** The Plan has called out but not detailed tactics for addressing socio-cultural barriers to plan implementation, aside from sweeping statements concerning communication and coordination such as: "...nonstructural projects be implemented in coordination with other community resilience, development, and economic plans along with emergency response and evacuation plans to ensure that projects are considered and evaluated as a whole to maximize limited resources and the synergies of each plan."[31] In future iterations, the plan could utilize the assistance of Architects to identify and design for linked eco-socio-cultural feedbacks through implementation strategies that ensure actual risk reduction performance aligns more closely with the predictive modeling results on which the Plan is based.

▪ **50 Year Prediction Horizon:** Plan authors selected a fifty year time-frame assuming that predictions beyond that horizon are subject to too much uncertainty to be meaningful. Within that fifty years, oil production will likely be less active than today, and certainly more extraction will occur in deepwater, away from the coast.[32] A significant portion of current housing stock will be underwater, or will have undergone significant renovation including elevation. And land loss will have advanced requiring significant adaptation of structures and urban infrastructure. The Plan does not include fifty year scenarios that address socio-cultural or resource extraction issues which are critical for stronger visioning. And while it identifies varying levels of needs and availability of resources among different socio-cultural jurisdictions, confusion regarding different funding sources, lack of adequate enforcement, the need for regulatory changes, induced development, and the need for greater communication and coordination, it does not employ scalar domains to address these problems in a more sophisticated manner.[33] Architects visioning and project coordination skills would be beneficial in visioning and actualizing needed scenarios.

▪ **Strategic Project Placement:** Selected Plan projects bias risk reduction and restoration for the larger cities of the region: New Orleans, Houma, Morgan City, and Lake Charles, at the expense of smaller communities and critical infrastructures such as Port Fourchon and Henry Hub. The resulting spatial implications have yet to be fully understood.

▪ **Combinations of Projects, Adjacencies, and Conflicting Outcomes:** Though the Plan decouples risk reduction and restoration projects, in actuality, they often operate in tandem in the field. In many cases it is likely that they will support each other in further enhancing their desired effects, but in some cases the reverse may result. Particularly in areas where structural projects are directly adjacent to restoration projects, Planning Tool "...results [have]indicate[d] that some structural projects intended to decrease risk actually increase risk by inducing flooding in adjacent areas and/or trapping overtopped surge or wave water from some storm events,"[34] contributing to the demise of the adjacent restoration project. Additional socio-cultural influences, not accounted for in the Planning Tool, such as induced development into otherwise hazardous areas, may also affect outcomes.[35] These are particularly problematic when considering their second assumption: that the physical and biological effects of individual projects are additive, and become increasingly additive as more projects are included in the cluster.[36] In reality, because of the complexity of the new intervention into the existing biogeochemical circumstances, it is difficult to predict if these additions will perform additively, or subtractively.

▪ **Scalar Links:** At the meta-level, the Master Plan emphasizes predominantly local, regional, and coastwide (landscape scales), whereas smaller scales such as those of the building or urban (human scale) are downplayed. This is a catastrophic error when master planning for the sustainability and resiliency of coupled natural-human systems because human needs are dominant drivers of system processes and delivered services at particular scales in space and time.[37] "Many environmental problems originate from the mismatch between the scale at which ecological processes occur and the scale at which decisions on them are made.

Outcomes at a given scale are often critically influenced by interactions of ecological, socioeconomic, and political factors from other scales."[38] This lack of emphasis on human scale may be driving, or the result of, the lack of attention paid to sub-landscape scale nonstructural measures which address the building and urban conditions. If linked scalar processes had informed the analysis of connections between urban infrastructure and building life cycles, natural processes life cycles, and resource extraction life cycles, a very different picture of the coast may have emerged.

▪ **Structural vs. Nonstructural:** The Plan defines nonstructural projects as those that "...reduce hurricane-related flood risk through the implementation of various actions to individual residential and nonresidential structures...[and] These measures can be utilized as primary or secondary lines of defense and include floodproofing for structures located in floodplanes where the projected 100-year flood depth is one to eighteen feet, acquiring or relocating residential structures that would need to be elevated greater that eighteen feet to reach FEMA's Base Flood Elevation plus one foot, implementing ordinances and building codes with higher risk reduction standards, floodplane management land use planning, building code revisions, and public education. Though the Plan identifies numerous measures, and specifies that "...the final design of nonstructural physical measures will be based on detailed information regarding flood depths at individual structures, the structural stability of that particular structure, the type of funding available, individual parish and municipal requirements and the willingness and ability of the owner to participate"[40] it provides little detailed support or guidance for individual homeowners, community engagement, local policy generation, or urban infrastructure retrofitting. "While the master plan offers guidance and recommendations for nonstructural program implementation, it does not address specific structures or constitute a comprehensive implementation plan."[41] By relegating the bulk of nonstructural physical and programmatic measures to the private sector, including funding, design, and implementation it places too much responsibility for implementation on the private sector to ensure significant implementation. It is here where perhaps the greatest opportunities for Architecture exist in the plan.

OPPORTUNITIES FOR DESIGN INTERVENTIONS FOR CHANGING CLIMATES

The Master Plan's three phase process, has generated some of the most rigorous morphological, biogeochemical, and ecological science on the Mississippi Delta to date. However, it has been at the expense of the socio-cultural aspects which are driving much of the delta's performance today. It is in the cross-pollination of the morphological, ecological, and the socio-cultural that the future of habitation on the coast will be determined. It is here that architects have significant agency, but architectural expertise must couple with deep understandings of socio-ecological drivers in order to generate effective responses.

Stewart Picket, et. al. have proposed a framework for coupled human-natural systems which may be adapted by designers for use in future Master Plan interdisciplinary iteration. The framework utilizes general relationships between dimensions of spatial (structure), organization (connectivity), and temporal (contingency) complexity, in transdisciplinary language, to bridge across multiple disciplines.[42] By plugging in specific drivers of land loss and

ENDNOTES

1. "Coastal Crisis - Land Loss," State of Louisiana Coastal Protection & Restoration, accessed April 3, 2013, http://coastal.louisiana.gov/index.cfm?md=pagebuilder&tmp=home&pid=112
2. Brady R. Couvillion, John A. Barras, Gregory D. Steyer, William Sleavin, Michelle Fischer, Holly Beck, Nadine Trahan, Brad Griffin, and David Heckman, "Land Area Change in Coastal Louisiana from 1932-2010," United States Geological Survey National Wetlands Research Center, (2011): 1-12.
3. E. J. Corthell, "The Delta of the Mississippi River," *The National Geographic Magazine*, VIII(12) (1897): 351-354.
4. Coastal Protection and Restoration Authority of Louisiana, *Louisiana's Comprehensive Master Plan for a Sustainable Coast*, (2012): 30.
5. Ibid: 30.

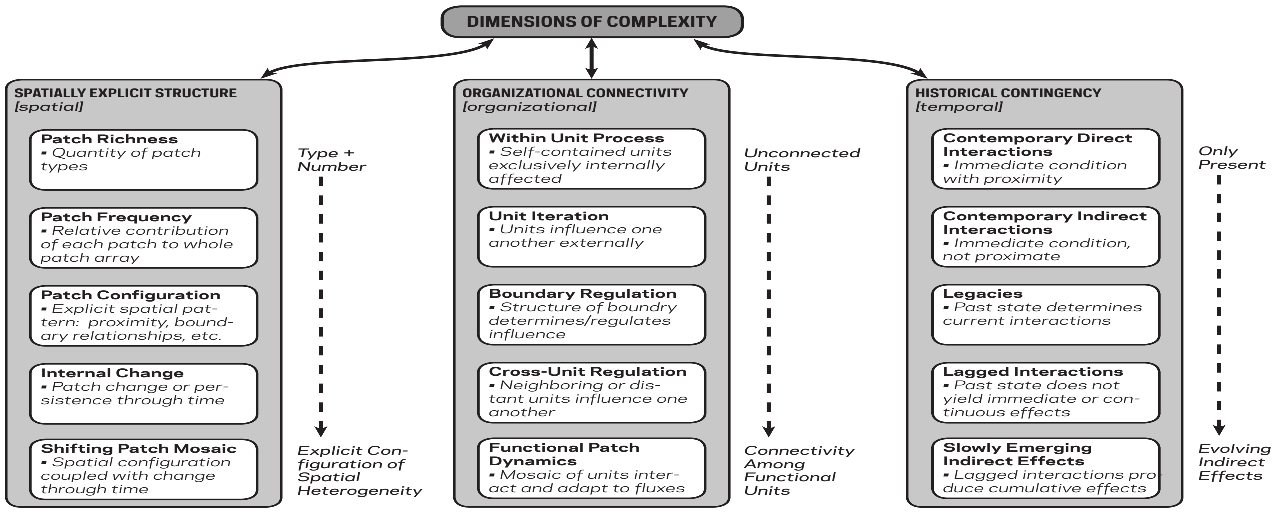

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Figure 5: Dimensions of Complexity Framework, *Adapted by Author from: S.T.A. Pickett, M.A. Cadenasso, and J.M. Grove, "Biocomplexity in Coupled Natural-Human Systems: A Multidimensional Framework," Ecosystems, 8 (2005): 225-232.*

risk in the delta, and connecting them through causal flows, a more clear synergetic picture of the delta emerges, which reveals gaps and opportunities for linkages between scalar domains, and top-down structural vs. bottom-up nonstructural design interventions and innovations.

The citizens of Louisiana have made it clear that it is not an option to eliminate the opportunity for long duration habitation of the coast. But the reality of the scope, scale and density of that habitation still hangs in the balance. As the landscape increasingly shifts from fingers protruding into the Gulf to a networked archipelago matrix, we will see increased densities within distributed coastal cities and communities comprised of ring levee hydrological units that support key nodes of culture, ecology, or resource extraction. Many of these will continue to shrink over time as water encroaches and populations decline. Simultaneously, transportation networks and links to smaller nodes will become critical as densities decrease in elevated habitation outside of the levees. Semi-permanent habitation patterns already present in the Delta will increase as people must evacuate to higher ground more frequently, or choose to utilize multiple temporary homes. Design for centrality cannot effectively work in this condition that is transitioning from a linear to an archipelago system.

The plan's classification of nonstructural measures, informed by the scalar domains of Pickett's framework, provides the most significant opportunities and new territories for architects. Beyond the plan's acknowledgement that "physical projects reduce risk for the existing building inventory, while programmatic measures focus on reducing risk for the future building inventory,"[43] architects' modus operandi is necessary to assist the visioning and construction of a continuum of habitation in the delta wrought with architectural challenges. It is in this intersection of the physical and the programmatic that designers can most effectively leverage the plan's latencies of duration and scale, creating architectural solutions that engage the minimum scope of nonstructural interventions called for in the plan: land use planning, land use ordinances, hazard mitigation planning, higher regulatory standards, building codes, flood insurance requirements, and public education.[44]

Ultimately, "…what needs to change is the socioeconomic system in order to rehabilitate the biophysical system to meet humanly defined socioeconomic

6. Ibid: 34.
7. Reg Noble, Ricardo Ramirez, and Clive Lightfoot, "Linking Hard and Soft Systems in Local Development," in *The Ecosystem Approach: Complexity, Uncertainty, and Managing for Sustainability*, ed. David Waltner-Toews, James J. Kay, and Nina-Marie Lister, (New York: Columbia University Press, 2008), 141.
8. Scott L Collins, Stephen R Carpenter, Scott M Swinton, Daniel E Orenstein, Daniel L Childers, Ted L Gragson, Nancy B Grimm, J Morgan Grove, Sharon L Harlan, Jason P Kaye, Alan K Knapp, Gary P Kofinas, John J Magnuson, William H McDowell, John M Melack, Laura A Ogden, G Philip Robertson, Melinda D Smith, and Ali C Whitmer, "An Integrated Conceptual Framework for Long-Term Social–Ecological Research," *Frontiers in Ecology and the Environment*, 9 (2011): 351–357.
9. "The Impact of Federal Programs on Wetlands Volume II, Chapter 8: Coastal Louisiana," U.S. Department of the Interior, accessed August 3, 2013, http://www.doi.gov/pmb/oepc/wetlands2/v2ch8.cfm
10. Reg Noble, Ricardo Ramirez, and Clive Lightfoot, "Linking Hard and Soft Systems in Local Development," in *The Ecosystem Approach: Complexity, Uncertainty, and Managing for Sustainability*, ed. David Waltner-Toews, James J. Kay, and Nina-Marie Lister, (New York: Columbia University Press, 2008), 141.
11. Jon Kolko, *Wicked Problems: Problems Worth Solving: A Handbook & A Call to Action*, (Austin: AC4D, 2012), 11.
12. Coastal Protection and Restoration Authority of Louisiana, *Louisiana's Comprehensive Master Plan for a Sustainable Coast*, (2012): 21.
13. Ibid: B-5.
14. Ibid: 79.

expectations."[45] Now that the plan has established its scientific base, in future iterations it must shift focus to addressing the socio-cultural with an emphasis on implementation strategies and the design necessary to achieving effective implementation. The discipline of Architecture may better participate in this process by revisiting methodologies honed in the sixties and seventies at the Berkeley College of Environmental Design, and other environmentally focused curricula.

Ultimately, the delta is of *water* and *atmosphere*, it does not operate as a solid land-based paradigm. The challenge for designers is to interpret and situate strategic moments of the land-based logic of human occupation within the eco-political systems of water-based logic. There is significant potential for architects to innovate both physical and programmatic design practices and products in this territory:

> "For communities to design appropriate strategies for managing their local conditions, innovative changes in civil society will be required. This innovation will only be possible if people are prepared to adopt a learning approach whereby they test out new roles and ways to organize themselves to achieve their environmental goals. Such learning will depend on improved access to appropriate, understandable, and timely knowledge and information concerning both technological (hard system) options and organizational and institutional (soft system) possibilities."[46]

This is perhaps one of the greatest challenges for the discipline of architecture which has spent the last thirty years looking inward.

Nonetheless, there is an emerging cohort of architects, planners and policy maker who are engaging such design practices, in addition to an increasing call for these practices in the wake of Hurricanes Katrina and Sandy. This is evidenced by recent competitions such as *Rebuild by Design: Hurricane Sandy Regional Planning and Design Competition* by HUD and the Hurricane Sandy Rebuilding Task Force.[47] These projects are shifting paradigms and nudging society in the direction of alternative futures. The Dutch have perhaps led the charge with their Deltaworks initiative, in response to the catastrophic floods of 1953,[48] and more recently with their revisioning of the Dutch water quality as it intersects with the urban fabric in their Living with Water initiative.[49] Winy Maas and MVRDV have repeatedly examined density in relationship to flooding conditions in projects such as Floating Freedom, Xinjin Water City, and Kampen Wier.[50] Closer to home, engineer Guy Nordenson has worked extensively on the urban land/water interfaces such as the Mississippi Delta: Constructing with Water[51] project and the On the Water: Palisade Bay project,[52] which was showcased as part of the MOMA: Rising Currents exhibition in 2010.[53] Closer to the delta, the architecture form of Waggonner Ball has hosted a series of design charrettes and workshops in collaboration with Dutch Hydrologists, Engineers and Landscape Architects to reimagine water management within the City of New Orleans.[54] And the Louisiana State University Coastal Sustainability Studio has generated a series of speculative design proposals for more integrated, sustainable, and resilient coastal habitation including "River to Bayou: Bayou Bienvenue and the Lower 9th Ward,"[55] "Flood Depths, Code and Sustainability,"[56] and "Delta Ranch."[57]

As the pace of land loss quickens with climate change and encroaching waters, long-term residents of the Louisiana coast experience geologic time within generations, not millennia, resulting in increasing concern about the

15. Ibid: B-5.
16. Ibid: 78.
17. Ibid: F2-6.
18. Ibid: B-10-11.
19. Reg Noble, Ricardo Ramirez, and Clive Lightfoot, "Linking Hard and Soft Systems in Local Development," in *The Ecosystem Approach: Complexity, Uncertainty, and Managing for Sustainability*, ed. David Waltner-Toews, James J. Kay, and Nina-Marie Lister, (New York: Columbia University Press, 2008), 149.
20. Coastal Protection and Restoration Authority of Louisiana, *Louisiana's Comprehensive Master Plan for a Sustainable Coast*, (2012): B-16.
21. Ibid: B-16.
22 Ibid: B-10.
23. Ibid: B-8.
24. Ibid: 43.
25. Ibid: B-7.
26. Ibid: B-28.
27. Ibid: B-28.
28. Ibid: B-37.
29. Ibid: B-29.
30. Ibid: B-11.
31. Ibid: F2-5.
32. "Exploring Gulf of Mexico Deepwater Oil," Lesli Wood, Bureau of Economic Geology, University of Texas at Austin, accessed on August 7, 2013, http://earthsky.org/earth/lesli-wood-exploring-deep-water-oil-in-the-gulf-of-mexico
33. Coastal Protection and Restoration Authority of Louisiana, *Louisiana's Comprehensive Master Plan for a Sustainable Coast*, (2012): F2-9-13.
34. Ibid: B-24.
35. Ibid: F2-14.
36. Ibid: B-11.
37. Millennium Ecosystem Assessment, "Ecosystems and Human Well-Being, a Framework for Assessment: Dealing With Scale," ed. Island Press (Washington D.C.: Island Press, 2005): 107, accessed May 26, 2013, http://www.millenniumassessment.org/documents/document.303.aspx.pdf
38. Ibid, 107.
39. Coastal Protection and Restoration Authority of Louisiana, *Louisiana's Comprehensive Master Plan for a Sustainable Coast*, (2012): F2-2.
40. Ibid: F2-4.
41. Ibid, F2-4.
42. S.T.A. Pickett, M.A. Cadenasso, and J.M. Grove, "Biocomplexity in Coupled Natural-Human Systems: A

long term viability of resource extraction and habitation within the delta. This will prove increasingly the norm in a world that will likely be two to eleven degrees Fahrenheit warmer by 2100, and punctuated by more dramatic disturbance events.[58] The Southern Louisiana Delta is a prototype for coastal areas and deltas globally, not only for its geomorphological and ecological deltaic condition, but also because of its hybrid socio-political organization and operation which manifests somewhere between a *developed* and *developing* world condition. It is especially in hybrid and developing world conditions that nonstructural measures are the primary source of risk reduction. The Master Plan's underdevelopment of these measures greatly affects the plan's ability to address risk reduction across the coast in the next fifty years. It does; however, create significant opportunities for architects and designers to revision the *land-based* paradigms currently latent in the plan with more resilient *water-based* design paradigms for structures and people inhabiting a perpetually soaked landscape. These opportunities are contingent on architects' abilities to engage the sciences and social sciences directly in design. Ultimately, planners and designers need tools and frameworks that facilitate greater interdisciplinary collaboration while remaining true to the disciplinary knowledges and value systems that define Architecture.

Multidimensional Framework," Ecosystems, 8 (2005): 225-232.

43. Coastal Protection and Restoration Authority of Louisiana, *Louisiana's Comprehensive Master Plan for a Sustainable Coast*, (2012): F2-4.
44. Ibid, F2-4.
45. Reg Noble, Ricardo Ramirez, and Clive Lightfoot, "Linking Hard and Soft Systems in Local Development," in *The Ecosystem Approach: Complexity, Uncertainty, and Managing for Sustainability*, ed. David Waltner-Toews, James J. Kay, and Nina-Marie Lister, (New York: Columbia University Press, 2008), 143.
46. Ibid, 142.
47. "REBUILD BY DESIGN: Hurricane Sandy Regional Planning and Design Competition RFQ," HUD, and the Hurricane Sandy Rebuilding Task Force, accessed on July 15, 2013, http://portal.hud.gov/hudportal/HUD?src=/sandyrebuilding/rebuildbydesign
48. "Zeeweringen," Project Zeeweringen, accessed August 6, 2013, http://www.zeeweringen.nl/
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