THE WATER INSTITUTE
OF THE GULF™

LOUISIANA COASTAL ADAPTATION TOOLKIT

Garrett C. Wolf and Craig E. Colten

March 2015

Read this report and more online at **thewaterinstitute.org/products**

INTEGRATING APPLIED RESEARCH | LINKING KNOWLEDGE TO ACTION | BUILDING PARTNERSHIPS

ADAPTATION TOOLKIT

For a consolidated list of links to all of the web resources included in this document, visit:

thewaterinstitute.org/adaptation-toolkit-information

ACKNOWLEDGMENTS

This project has been funded in part by the Louisiana Coastal Protection and Restoration Authority (CPRA) and is part of The Water Institute of Gulf's (the Institute) Human Dimensions effort defined by its Science and Engineering Plan.

Several staff at the Institute played key roles in creating the toolkit. Taylor Marshall and Bethany Garfield lent valuable research assistance. Kathleen Hastings helped refine the text with her editorial skills; Phillip LaFargue provided design and layout out expertise to fashion the final product. Denise Reed and Tim Carruthers offered insightful editorial reviews.

INTRODUCTION

Residents and businesses in coastal Louisiana face a highly dynamic environment. Tropical weather events can deliver storms with powerful winds and copious precipitation. Coastal land loss has been progressing for decades and threatens the existence of current livelihoods, infrastructure, and residences. The arrival of diseases such as West Nile virus and the annual appearance of the hypoxic zone present additional issues in this risky setting. Add to these concerns the threat of sea-level rise, which, according to the National Oceanic and Atmospheric Administration (NOAA), is quite pronounced in southeast Louisiana, and the region faces an exceptionally challenging environmental future. The State of Louisiana has launched an ambitious plan to counter the effects of coastal land loss (CPRA, 2012), and this will insert yet another set of environmental changes into the complex equation. Structural protection, sediment diversions, wetland creation, and barrier island restoration are among a host of techniques planned (CPRA, 2012). They will help stabilize coastal areas but may displace certain economic activities as they restore the littoral landscapes.

Some of these issues are either relatively recent occurrences or recently discovered, yet Louisiana's coastal communities have faced precarious conditions for centuries. In spite of storms, floods, epidemic diseases, and human induced changes, these communities have managed to persist and many would argue, thrive. The ability for a society to persevere in a perilous location is not accidental. It has been achieved in Louisiana through many years of adaptation, identifying risks, and developing techniques to cope with change and to pass those lessons along to successive generations.

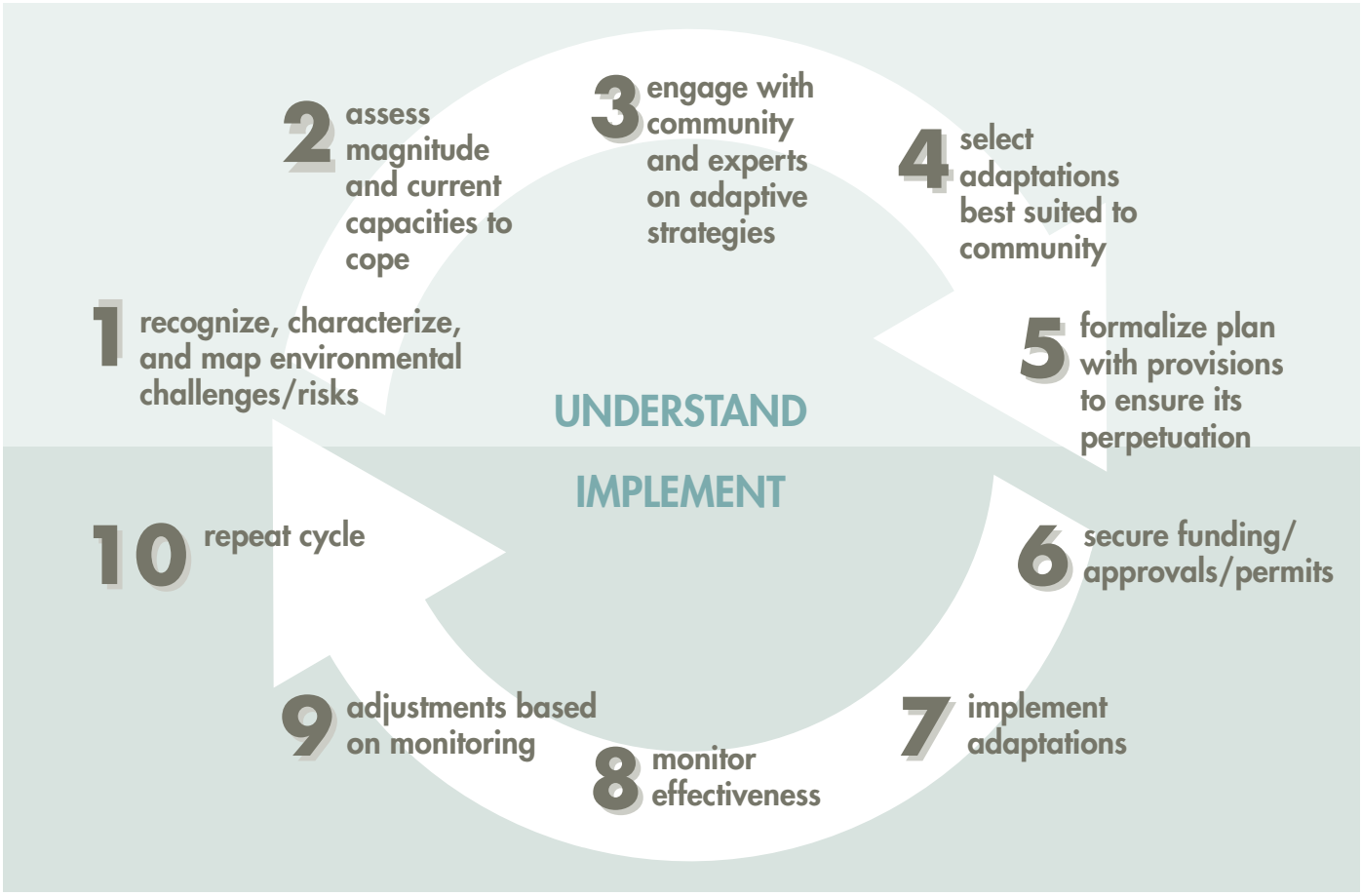
Our current coastal society might not be as malleable as previous generations, given current investments in economic pursuits, government, community, and personal infrastructures. Throughout the first half of the 20th century, many natural resource-based economic activities required relatively small investments; the housing stock of coastal residents reflected rich cultural traditions, but was rudimentary and inexpensive by today's standards. State and federal investment in infrastructure — other than levees, navigation improvements, and highways — was modest. The scale of investment has changed substantially. More so than in the past, high-value factories and other economic facilities are not easily altered or moved. Transportation networks and public works represent sizable, path-dependent investments that are not easily relocated. Large-scale community-level adjustments are expensive and laden with issues of consensus and equity. And, unlike previous generations, more families have corporate or government jobs and mortgages on houses or notes on fishing equipment likewise are less flexible in the face of changing conditions.

The Water Institute of the Gulf (the Institute) has been exploring the "human dimensions" of the Louisiana coast. A critical issue that we identified is how to provide information that can assist communities facing environmental changes. Already other organizations around the world have been formulating guidance for adapting to climate change. This adaptation toolkit is our attempt to provide information to Louisiana residents and decision makers. Its purpose is to guide communities and their leaders, planners, and residents to resources to help them adapt to myriad challenges present in coastal Louisiana. This toolkit highlights options for adjusting various aspects

of community life, as well as guidance on how to use particular policy strategies or work with the natural environment of Louisiana's coast to foster adaptation. In addition to a set of approaches, this toolkit also contains links to further information resources on each of the coastal challenges covered in this document, and funding options to help communities implement their chosen adaptation strategies.

We intend for this work to serve as a general guide to complement the many other documents dealing with adaptations (see Key References). This toolkit is specifically prepared for Louisiana coastal residents, but draws on the experiences of other similar endeavors around the globe. We see this document as a starting point in a long — and hopefully effective — community level response to environmental challenges. To cope with challenges, communities must first identify the particular environmental risk/change that they face (Figure 1). Then they must assess the magnitude of the particular risk to their residents, businesses, and infrastructure. Based on this second step, communities, in consultation with the full range of local stakeholders, can survey the various options discussed in this toolkit, selecting those that meet their needs, their local conditions, budgets, and that are compatible with the community culture. Once adaptations to the particular challenges are selected, community leaders can guide the administrative process to fund and implement the adaptations. It is important to note that the process does not end with the installation of an adaptive process or structure. Communities will want to establish procedures to monitor the effectiveness of the adaptations over time, to incorporate means to adjust and improve the system as both the environment and local demographic and economic conditions change, and also include deliberate steps to perpetuate the adaptations over time.

Figure 1: Steps for Coping with Challenges[1]



We have arranged this toolkit around the many challenges Louisiana's coastal communities face (Table 1), although not all locations are subject to the full array of changing environmental conditions. Some changes, such as sea-level rise and subsidence, may act in concert, but at a very slow pace. Others, such as hurricanes and river floods, are more discrete events in time and location, but are less frequent and can produce devastating impacts. Thus, identifying and coping with challenges demands local attention and finely tuned adaptations[1].

Table 1: Challenges facing coastal Louisiana

Flooding
Hurricanes
Coastal Erosion
Sea-Level Rise
Subsidence
Extreme Temperatures
Thunderstorms, Lightning, Hail
Drought

[1] Louisiana's Hazard Mitigation Plan is an excellent resource for guidance on characterizing risks and developing adaptive strategies. Governor's Office of Homeland Security and Emergency Preparedness, *Final 2011 State Hazard Mitigation Plan Update* [http://gohsep.la.gov/hazmitigatpln_08.aspx].

For each challenge, we provide adaptive options arranged in broad categories: regulatory and planning, design and engineering, ecosystem, and social (Table 2). In most instances, a combination of two or more of these adaptive categories may be most effective. Certainly in most instances, adjusting local regulations and planning will need to be coupled with specific design and engineering efforts. The use of natural ecosystems to aid in protecting and sustaining local communities, with careful planning and design, has proven effective in other locations. And at the core of every effort is the social component. This involves community engagement to allow for the expertise of local residents to guide the overall adaptation process: to enable the participation in educational and outreach efforts that will provide residents with sound and reliable information about any program and also to shape adaptations that are attuned to local cultures and values.

By providing this toolkit, a goal of the Institute is to help communities be aware of the resources available to them to become more resilient; meaning they successfully complete and sustain these adaptations in ways that enable them to continue functioning as viable places for people to live, work, and play. Previous generations adapted and have been able to persist in place, but current social and economic conditions demand more deliberate and assertive adaptive strategies in the face of greater environmental challenges and our substantial fixed investments on the coast. This document, in conjunction with other efforts of the Institute and the many other organizations dedicated to sustaining coastal Louisiana, aims to assist with that process.

Table 2: Adaptation Applications

	Adaptive Challenge							
Adaptation	Flooding/ Storm Surge	Hurricanes/ High Winds	Coastal Erosion	Drought	Sea-Level Rise	Subsidence	Extreme Temps	Thunderstorm, Lightning, Hail
Regulatory and Planning								
Comprehensive Plan	●	●	●	●	●	●	●	●
Zoning	●	●	●		●	●		
Floodplain Regulations	●							
Water Conservation Code				●				
Building Codes	●	●	●		●	●	●	●
Retrofitting	●	●	●	●	●	●	●	●
Redevelopment Restrictions	●	●	●		●	●		
Easements	●	●	●		●	●		
Acquisitions/Demolition/Resettlement	●	●	●		●	●		
Setbacks	●	●	●		●	●		
Open Space Preservation	●	●	●		●	●		
Design and Engineering								
Transportation Networks	●	●	●		●	●	●	
Elevate/Placement of Critical Infrastructure	●	●	●		●	●	●	●
Electrical Networks	●	●	●		●	●		
Public Utilities							●	
Water and Sewerage Systems	●	●	●		●	●		
Shore Structures	●	●	●		●			
Reduce Impermeable Surfaces			●	●				
Increase Storage Capacity				●				
Ecosystem								
Ecological Buffers	●	●	●		●	●		
Protection and Maintenance	●	●	●	●	●	●	●	
Restoration, Creation, and Enhancement	●	●	●	●	●	●		
Social								
Conservation				●				
Public Participation	●	●	●	●	●	●	●	●
Education & Outreach	●	●	●	●	●	●	●	●
Mobility	●	●	●	●	●	●		
Perpetuation of Adaptations	●	●	●	●	●	●	●	●

USING THE TOOLKIT

We developed this toolkit to function in some respects like a cookbook. Communities can decide what dish they want to prepare and turn to the toolkit for the recipe. There are options for the many courses and side dishes that might complete the adaptive feast.

Yet unlike a true cookbook, we do not prescribe specific amounts of each ingredient. We outline the key coastal challenges and adaptive ingredients to attend to them. The particulars depend on local circumstances and the various resources included in the toolkit will help communities decide on whether they need a cup or a dash of a particular adaptive ingredient. Improvisation — fine tuning an approach at the local level within prevailing best practices — is at the core of effective adaptations and is a practice familiar to Louisiana cooks.

Also, several of the environmental challenges have obviously overlapping impacts. Adaptations that address the consequences of multiple causes can often serve multiple purposes. Planning and implementation need to be scaled to encompass the overlapping challenges and integrate the solutions.

In each section we include references to useful documents that can provide more detailed information. Federal agencies such as the Federal Emergency Management Agency (FEMA) and NOAA have developed useful tools that are designed for audiences nationwide and consequently, are quite generic. Local organizations such as the Center for Planning Excellence (CPEX) and Louisiana Sea Grant have produced tools that are much more locally oriented. Valuable information can be obtained from these documents.

We have reviewed these documents, along with others, and have assembled the following steps as general framework for using this toolkit (Table 3). Communities with hazard mitigation plans or those that are engaged in FEMA's Community Rating System will be well prepared to begin using this document. For those who have completed risk assessments, there is no need to replicate that step, so as in the selection of tools, local circumstances and existing preparation should guide community use of the toolkit.

The references in the text offer guidance to potential funding sources to carry out both the assessment of environmental challenges and the implementation of adaptations. For small communities or parishes without staff dedicated to these activities, we encourage the pooling of talent and resources. Various state and federal agencies, include Louisiana Sea Grant and LSU Agcenter, have professionals who can assist communities in these endeavors. If several communities or parishes, with similar environmental circumstances, band together to seek assistance the assistance can be delivered more efficiently to a wider area and the funds allocated with broader geographic impact.

Table 3: Steps for Using the Toolkit

1	**Recognize environmental challenges.** Most communities have taken an assessment of their high hazard risks, such as hurricanes and floods. There are numerous tools, identified in the discussions of particular challenges, that can help map areas at risk. By thoroughly inventorying, characterizing, and mapping risks, communities can prioritize the challenges they face.
2	**Assess magnitude and capacities.** Working with emergency response organizations, a community can assess the risk of particular events and also survey local capacities to cope with them. This step can refine the initial prioritization. High-risk events and low community capacity deserve immediate attention. Lower risk events that a community is well-equipped to address can follow actions taken to address the top-priority challenges.
3	**Engage with community and experts.** Before any direct actions are taken, community leaders should engage with the full range of community stakeholders in order to relay the findings of the initial assessment of challenges and solicit their involvement in selecting adaptive strategies. Outside the community, independent experts from Sea Grant, LSU Agcenter, and universities can also provide valuable input.
4	**Select adaption strategy suited to community.** Based on stakeholder input, the specific challenges faced, and the current capacities to cope with disruption, the community should select an adaptation strategy that is best suited to the situation and the local culture. Communities should consider the time frame of the environmental challenge and the adaptation. Many adaptations take years to put into action and sufficient lead time needs to be incorporated in the initial planning.
5	**Formalize adaptive plan with provisions to ensure its perpetuation.** Community leadership, perhaps working with appropriate consultants, can guide the creation of a plan that includes explicit provisions to ensure that the adaptation is not allowed to diminish over time, that it is sustained over multiple administrations and generations. This stage will include developing a budget for the adaptive procedure.
6	**Secure funding/approvals/permits.** Community leaders can then proceed to secure funding to carry out the project. Funding options are included in this toolkit, although there are others. All permits and approvals should be secured before projects begin. Effective community engagement and support prior to this stage minimizes the potential for interruptions in the permitting/approval stage.
7	**Implement adaptation.** With funding in hand, the adaptive strategy can be put in place.
8	**Monitor effectiveness.** To gauge the effectiveness of a project, it is important to follow the benefits derived from it. Keeping an effective tabulation of social, economic, and environmental conditions during the project's implementation and after its completion provides a means to determine its effectiveness and weaknesses.
9	**Adjustments based on monitoring.** Monitoring can reveal weaknesses and allow a community to fine-tune or modify a project to enhance its effectiveness.
10	**Repeat cycle.** Communities should regularly conduct a review of challenges/risks and assess the magnitude of potential environmental change on their businesses and residents. From this regular review, new adaptive strategies can be launched.

ADAPTIVE CHALLENGE

FLOODING

REGULATORY AND PLANNING ADAPTATIONS

- Comprehensive Plan
- Zoning
- Floodplain Regulations
- Building Codes/Resilient Design
- Retrofitting
- Redevelopment Restrictions
- Conservation Easements
- Acquisitions, Demolition, and Resettlement
- Setbacks
- Open Space Preservation and Conservations

DESIGN/ENGINEERING ADAPTATIONS

- Protect Transportation Networks
- Protect Electrical Networks
- Elevate Critical Infrastructure
- Protect Water and Sewer Infrastructure
- Shore Protection Structures

ECOSYSTEM-BASED ADAPTATIONS

- Ecological Buffer Zones
- Ecosystem Protection and Maintenance
- Ecosystem Restoration, Creation, and Enhancement

SOCIAL ADAPTATIONS

- Public Participatory Practices
- Public Education and Outreach
- Mobility
- Perpetuation of Adaptations

Adaptation: Elevate Critical Infrastructure

REGULATORY AND PLANNING ADAPTATIONS

Comprehensive Plan

Developing a long-term plan to help guide future development is an integral part of anticipatory adaptations. Specific measures to minimize the impacts of future flooding are to encourage development on ground above the designated 100- and even the 500-year floodplain. Flexibility is also necessary since floodplain designations can change over time.

Zoning

Regulating land uses through zoning ordinances can play an important role in steering valuable commercial and residential activities to safe locations outside high risk territory. New zoning can amend local ordinances to specify setbacks, control densities, and limit future damage.

Floodplain Regulations

Municipal or parish rules or regulations can limit unsafe development and inappropriate landuse within the 100-year floodplain. Communities can enhance floodplain safety by expanding the reach of regulations to include the 500-year floodplain. In addition, communities can limit land use within the 100- and 500-year floodplain to agriculture or recreation.

Building Codes/Resilient Design

Construction practices can minimize damage and maximize protection from flooding. A community or building owner can adapt to future flood risk by building elevated structures, constructing

floating structures, or anchoring structures and strengthening walls to resist flood pressure and debris. Building codes offer the mechanism to encourage this set of adaptations.

Retrofitting
For existing structures, the use of resilient or flood-proof retrofitting is an option. Existing structures can be elevated, or communities and property owners can use dry and wet flood proofing, which either seal the structure or modify a structure to allow flood waters to enter and then escape.

Redevelopment Restrictions
Restrictions on rebuilding structures lost to a storm, structures that have endured repetitive loss, as well as structures lost within the 100- or 500-year floodplain provide an option for reducing future losses. Redevelopment restrictions are often coupled with acquisition/demolition/resettlement (A/D/R) programs to provide safer redevelopment opportunities.

Conservation Easements
Preserving open space for floodwater retention through easements is an additional strategy to manage development while allowing land owners to retain title. Offering incentives, ranging from direct payments to tax breaks, to land owners can encourage the creation of easements.

Acquisitions, Demolition, and Resettlement
A/D/R programs can help prevent damage to buildings and infrastructure by removing buildings from high-risk sites. While sometimes a costly option, in the long run these practices offer lasting risk reduction.

Setbacks
Establishing a geographic buffer — or setback — in high-risk areas that are prone to flooding can clearly delimit inappropriate land uses, alert the public to flood risks, and limit inappropriate development.

Open Space Preservation and Conservation
By setting aside high-risk areas as open space and preventing development in these areas, communities can both protect themselves from floodwaters and limit damages from flooding.

DESIGN/ENGINEERING ADAPTATIONS

Protect Transportation Networks
Protecting transportation networks from river or storm surge flooding can minimize major disruptions before, during, and after high-water events. There are two major strategies to protect these networks: raise roadways or improve drainage systems. Roads can be raised either on fill or piers. Piers are generally a preferred choice, since fill can compound flooding problems by impounding water. Drainage can be improved by regular monitoring to ensure drainage systems remain free of obstructions; road networks can be designed with multiple levels of stormwater drainage to remove water from roadways and prevent treatment systems from becoming overwhelmed. Pump systems need to be placed in safe locations and they need regular maintenance and monitoring as well.

Protect Electrical Networks
A primary adaptation to minimize flood impacts to electrical networks is the use of materials that can resist the effects of inundation.

Elevate Critical Infrastructure
Installing or raising critical infrastructure above potential flood levels can help prevent major failures during hurricane-induced inundation. This can be done by raising facilities on piers or placing them on upper levels of multistory structures. Current recommendations call for raising critical facilities 3 feet above the 100-year flood elevation. Another option is to relocate movable facilities to areas with a lower flood risk.

Protect Water and Sewer Infrastructure
Constructing wastewater treatment plants in low risk areas or armoring those in the floodplain can be an effective adaptation. Also, provision of backup generators can enable service to continue even if a flood impacts the local power source. Areas with private septic tanks are better prepared for flooding, but responsibility rests primarily with homeowners to ensure they are properly maintained. Local governments and the State Department of Health and Hospitals are responsible for enforcement of local sanitation regulations to prevent wastewater contamination.

Shore Protection Structures
Shore protection structures have two main types: soft and hard. They can mitigate flooding from storm surge. Hard shore protection structures should be used when they are the only option. Their construction and presence can result in negative impacts on water movement, sediment transport, and ecological systems. Soft style protection structures can provide flexible protection that also help to restore and protect the natural shoreline.

Ecological Buffer Zones
Preserving natural landscapes as buffers between people and developed property and flood hazards serves multiple purposes. It reduces damage to natural areas that absorb the initial impacts of floods and also deters inappropriate development in high-risk zones. By preserving these areas in their natural state, they provide flood storage, reduce flood velocity, and improve water quality. Additionally, they can provide wildlife habitat, minimize erosion, and stabilize soil and vegetation. Buffers can be achieved through land-banking.

Ecosystem Protection and Maintenance
Managing human activities, such as water pollution, that might damage environments that naturally mitigate flooding is one form of protection. Active efforts to restore or maintain natural ecological processes that sustain flood dampening environments can complement managing human activities.

Ecosystem Restoration, Creation, and Enhancement
Creating living shorelines and restoring wetlands offer additional ecosystem-based protection. Living shorelines are a type of soft protection structure that may restore, protect, and enhance the natural shoreline by using vegetation and fill, sometimes combined with additional structural shore protection elements to contain sediment and reduce wave energy. Wetlands can be restored, created, or enhanced by planting and seeding, water flow modification, sediment diversion, dredging, removing impediments to natural processes, and invasive species control.

Public Participatory Practices
Adaptations demand public support and there are many techniques to ensure the public is involved from the initial stages of deliberations. Interactive community forums, public surveys, targeted interviews, community mapping exercises, and scenario-building workshops offer means to overcome the "democratic deficit" of top-down planning. These processes also result in a better informed population that has bought into the plan though their contributions to the decision-making process.

Public Education and Outreach
Underlying effective adaptations is public comprehension of the challenges and the solutions offered by these adaptations. Communication of complex science and engineering ideas to the general public is essential and requires carefully crafted

programs that utilize formal educational programs as well as traditional public media such as newspapers and radio and digital social media.

Mobility

One potential social adaptation is facilitating the movement of people and communities. Evacuation before hurricanes is a long-standing adaptation and enables the reduction of risk. Transplanting families, neighborhoods, or entire communities may occur within the boundaries of the current municipality or it may involve movement to an entirely different area, depending on the severity of the risk. Residents will be extremely sensitive to any discussion of resettlement. In order for community members to make a decision about an adaptive move, they must receive information and support from local, state, and possibly federal authorities. Equal attention must be directed to preparations at the departure and destination locations. This process can be financially burdensome. Provisions need to be made to compensate landowners who might decide to relocate, and sometimes monetary incentives can facilitate the process.

Perpetuation of Adaptations

To overcome the tendency for communities to "lose the sense of urgency" after adaptations are completed, any program that garners support for implementation must include plans and funding to ensure it is sustained over generations.

INFORMATION

ASCE
Flood Resistant Design and Construction
http://ascelibrary.org/doi/book/10.1061/9780784408186

FEMA
Community Rating System
http://www.fema.gov/national-flood-insurance-program-2/community-rating-system

Home Builder's Guide to Coastal Construction
https://www.fema.gov/media-library/assets/documents/6131

Coastal Construction Manual: Principles and Practices of Planning, Siting, Designing, Constructing, and Maintaining Residential Buildings in Coastal Areas
https://www.fema.gov/media-library/assets/documents/3293

Hazard Mitigation Assistance Grant Programs
This program provides grants for state and local governments for the implementation of long-term hazard mitigation measures following major disasters.
http://www.fema.gov/hazard-mitigation-grant-program

Repetitive Flood Claims Program
http://www.fema.gov/repetitive-flood-claims-program

Flood Mitigation Assistance
http://www.fema.gov/flood-mitigation-assistance-program

NOAA
Adapting to Climate Change: A Planning Guide for State Coastal Managers
http://coastalmanagement.noaa.gov/climate/adaptation.html

CPRA
Flood Risk and Resilience Viewer
http://cims.coastal.louisiana.gov/floodrisk/

Pocket Guide to Funding Resources
http://coastal.la.gov/wp-content/uploads/2014/03/CPRA-Pocket-Guide-to-Funding-Resources.pdf/

2012 Louisiana Coastal Master Plan
http://coastal.la.gov/a-common-vision/2012-coastal-master-plan/

LSU AgCenter
Preventing Flood Damage
http://www.lsuagcenter.com/en/family_home/home/design_construction/Design/Remodeling+Renovation/Preventing+Flood+Damage/

Louisiana Sea Grant
Louisiana Homeowners Handbook
http://www.laseagrant.org/sglegal/publications/other/homeowners-handbook/

Resilience: A Community Self-Assessment
This resource is of particular importance, because it helps communities evaluate particular challenges that exist within their communities.
http://www.southernclimate.org/documents/Coastal_Resilience_Index_Sea_Grant.pdf

CPEX
Louisiana Land Use Toolkit-Implementation Handbook
http://landusetoolkit.com/download.html

Louisiana Land Use Toolkit-Zoning Code
http://landusetoolkit.com/zoning.html

University of New Orleans Center for Hazards Assessment, Response & Technology
Flood Preparedness
http://uno.edu/chart/documents/FloodPreparedness.pdf

Flood Safety Checklist
http://uno.edu/chart/documents/FloodInCaseOf.pdf

HUD
Sustainable Communities Initiative
This grant program provides funding to improve planning efforts that integrate housing, transportation, landuse, and economic development to improve social equity, economic competitiveness, and environmental protection.
http://www.sustainablecommunities.gov/

Choice Neighborhoods
This grant program provides funding for comprehensive neighborhood revitalization plans to achieve housing, resident, and neighborhood related goals.
http://portal.hud.gov/hudportal/HUD?src=/program_offices/administration/grants/fundsavail/nofa14/cnpg

ADAPTIVE CHALLENGE

HURRICANES

REGULATORY AND PLANNING ADAPTATIONS

- Comprehensive Plan
- Zoning
- Building Codes/Resilient Design
- Retrofitting
- Redevelopment Restrictions
- Conservation Easements
- Acquisitions, Demolition, and Resettlement
- Setbacks
- Open Space Preservation and Conservations

DESIGN/ENGINEERING ADAPTATIONS

- Protect Transportation Networks
- Protect Electrical Networks
- Protect Critical Emergency Response Infrastructure
- Protect Water and Sewer Infrastructure
- Shore Protection Structures

ECOSYSTEM-BASED ADAPTATIONS

- Ecological Buffer Zones
- Ecosystem Protection and Maintenance
- Ecosystem Restoration, Creation, and Enhancement

SOCIAL ADAPTATIONS

- Public Participatory Practices
- Public Education and Outreach
- Mobility
- Perpetuation of Adaptations

Adaptation: Protect Transportation

REGULATORY AND PLANNING ADAPTATIONS

Comprehensive Plan

Developing a long-term plan to help guide future development is an integral part of anticipatory adaptations. Specific measures to minimize the impacts of powerful winds or wind and surge are to encourage constructions of dual-purpose facilities that can be used as community shelters, storm resistant transportation networks, redundancy in communication systems, adequate facilities for emergency supplies, and limiting development to areas above the designated 100- and even the 500-year floodplain.

Zoning

Regulating land uses through zoning ordinances can play an important role in steering valuable commercial and residential activities to safe locations outside high-risk territories. New zoning can amend local ordinances to specify setbacks, control densities, and limit future damage.

Building Codes/Resilient Design

Construction practices can minimize damage and maximize protection from hurricanes. A community or building owner can adapt to the potential of high water by building an elevated structure, constructing floating structures, or anchoring structures and strengthening walls to resist flood and wind pressures and debris. Building codes offer the mechanism to encourage this set of adaptations. Further siting and structural upgrades can be found in publications from

FEMA Coastal Construction Manual, (2014) and FEMA's Home Builder's Guide to Coastal Construction (2010).

Retrofitting
For existing structures, use of resilient or flood and wind-proof modifications is an option. Adaptations include elevating structures, reinforcing roofs and doors, anchoring homes to foundations, installing shutters on windows, replacing exterior building components with hazard-resistant alternatives, modifying structures to allow flood waters to enter and escape, and sealing a structure to prevent water from entering. Additional retrofitting options and suggestions can be found in NOAA's *Adapting to Climate Change* (2012), and FEMA's construction manuals listed above.

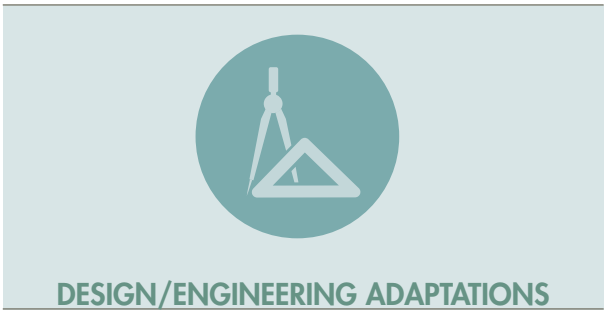
Redevelopment Restrictions
Restrictions on rebuilding structures lost to a storm, structures that have endured repetitive loss, as well as structures lost within the 100- or 500-year floodplain provide options for reducing future losses. Redevelopment restrictions are often coupled with acquisition/demolition/resettlement (A/D/R) programs to provide safer redevelopment opportunities.

Conservation Easements
Preserving open space for floodwater retention or in areas subject to winds and surge is an additional strategy to manage development while allowing land owners to retain title. Offering incentives to land owners can encourage the creation of easements.

Acquisitions, Demolition, and Resettlement
A/D/R programs can help prevent damage to buildings and infrastructure by removing buildings from high-risk sites. While sometimes a costly option, in the long run these practices offer lasting risk reduction.

Setbacks
Establishing a geographic buffer — or setback — in high-risk areas that account for hurricane driven waves surge can clearly delimit inappropriate land uses, alert the public to flood risks, and limit inappropriate development.

Open Space Preservation and Conservation
By setting aside high-risk areas as open space and preventing development in these areas, communities can both protect themselves from wind and storm-driven wave action. and wind damages.



DESIGN/ENGINEERING ADAPTATIONS

Protect Transportation Networks
Protecting transportation networks from hurricanes can minimize major disruptions before, during, and after high-water events. Careful selection of urban trees that are less prone to fall during high wind can an minimize obstructions to roadways. Acquisition and maintenance of road-clearing equipment enhances preparedness.

Protect Electrical Networks
The primary adaptations to protect electrical networks from hurricane winds and flooding is to upgrade to materials that can better resist high winds, water, and pressure and to position them above flood hazards. Safe and secure placement of transformers and other essential infrastructure offers protection from tropical weather events.

Protect Critical Emergency Response Infrastructure
Placing critical infrastructure in locations where they will be protected from high winds or damage from wind-blown debris can help prevent major failures during hurricane-induced winds. Protection can be accomplished by anchoring them to their base to prevent wind damage.

Protect Water and Sewer Infrastructure
Constructing wastewater treatment plants in low-risk areas or armoring those in the floodplain can be an effective adaptation. Also, provision of backup generators can enable service to continue even if a flood or wind impacts the local power source.

Shore Protection Structures
Shore protection structures have two main types: soft and hard. They can mitigate flooding from storm driven waves. Hard shore protection structures should be used when they are the only option. Their construction and presence can result in negative impacts on water movement, sediment transport, and ecological systems. Soft style protection structures can provide flexible protection that also help to restore and protect the natural shoreline.

ECOSYSTEM-BASED ADAPTATIONS

Ecological Buffer Zones
Preserving natural landscapes as buffers between people and developed property and hurricane hazards serves multiple purposes. It reduces damage to natural areas that absorb the initial impacts of hurricane-induced waves and also deters inappropriate development in high-risk zones. By preserving these areas in their natural state, they can provide flood storage, reduce flood velocity, and improve water quality. Additionally, they can provide wildlife habitat, minimize erosion, and stabilize soil and vegetation. Buffers can be achieved through land-banking.

Ecosystem Protection and Maintenance
Managing human activities, such as water pollution, that might damage environments that naturally mitigate wind damage is one form of protection. Active efforts to restore or maintain natural ecological processes that include ecosystems adapted to high-wind events will lessen post-storm disruptions.

Ecosystem Restoration, Creation, and Enhancement
Creation of living shorelines and wetland restoration offer additional ecosystem-based protection. Living shorelines are a type of soft protection structure that may restore, protect, and enhance the natural shoreline. Living shorelines utilize vegetation and fill that is sometimes combined with additional shore protection elements to contain sediment and reduce wave energy. Wetlands can be restored, created, or enhanced to minimize the disruptions caused by hurricanes. . This process is accomplished by planting and seeding, water flow modification, sediment diversion, dredging, removing impediments to natural processes, and invasive species control.

SOCIAL ADAPTATIONS

Public Participatory Practices
Adaptations demand public support, and there are many techniques to ensure the public is involved from the initial stages of deliberations. Interactive community forums, public surveys, targeted interviews, community mapping exercises, and scenario-building workshops offer the means to overcome the "democratic deficit" of top-down planning. These processes also result in a better informed population that has bought into the plan though their contributions to the decision-making process.

Public Education and Outreach

Underlying effective adaptation is public comprehension of the challenges and the solutions offered by adaptations. Communication of complex science and engineering ideas to the general public is essential and requires carefully crafted public programs that utilize formal educational programs as well as traditional media such as newspapers and radio media and digital social media.

Mobility

One potential social adaptation is facilitating the movement of people and communities. Evacuation before hurricanes is a long-standing adaptation and enables the reduction of risk. Transplanting families, neighborhoods, or entire communities may occur within the boundaries of the current municipality or it may involve movement to an entirely different area, depending on the severity of the risk. Residents will be extremely sensitive to any discussion of resettlement. In order for community members to make a decision about an adaptive move, they must receive information and support from local, state, and possibly federal authorities. Equal attention must be directed to preparations at the departure and destination locations. This process can be financially burdensome. Provisions need to be made to compensate landowners who might decide to relocate, and sometimes monetary incentives can facilitate the process.

Perpetuation of Adaptations

To overcome the tendency for communities to "lose the sense of urgency" after adaptations are completed, any program that garners support for implementation must include plans and funding to ensure it is sustained over generations.

INFORMATION

CPRA

Flood Risk and Resilience Viewer
http://cims.coastal.louisiana.gov/floodrisk/

Pocket Guide to Funding Resources
http://coastal.la.gov/wp-content/uploads/2014/03/CPRA-Pocket-Guide-to-Funding-Resources.pdf/

2012 Louisiana Coastal Master Plan
http://coastal.la.gov/a-common-vision/2012-coastal-master-plan/

2012 Louisiana Coastal Master Plan Appendix C: Environmental Scenarios
http://coastal.la.gov/a-common-vision/2012-coastal-master-plan/cmp-appendices/

FEMA

Community Rating System
http://www.fema.gov/national-flood-insurance-program-2/community-rating-system

Home Builder's Guide to Coastal Construction
https://www.fema.gov/media-library/assets/documents/6131

Coastal Construction Manual: Principles and Practices of Planning, Siting, Designing, Constructing, and Maintaining Residential Buildings in Coastal Areas
https://www.fema.gov/media-library/assets/documents/3293

Hazard Mitigation Assistance Grant Programs
This program provides grants for state and local governments for the implementation of long-term hazard mitigation measures following major disasters.
http://www.fema.gov/hazard-mitigation-grant-program

NOAA

Adapting to Climate Change: A Planning Guide for State Coastal Managers
http://coastalmanagement.noaa.gov/climate/adaptation.html

HUD

Sustainable Communities Initiative
This grant program provides funding to improve planning efforts that integrate housing, transportation, landuse, and economic development to improve social equity, economic competitiveness, and environmental protection.
http://www.sustainablecommunities.gov/

Choice Neighborhoods
This grant program provides funding for comprehensive neighborhood revitalization plans to achieve housing, resident, and neighborhood related goals.
http://portal.hud.gov/hudportal/HUD?src=/program_offices/administration/grants/fundsavail/nofa14/cnpg

ADAPTIVE CHALLENGE

COASTAL EROSION

REGULATORY AND PLANNING ADAPTATIONS

- Comprehensive Plan
- Zoning
- Building Codes/Resilient Design
- Retrofitting
- Redevelopment Restrictions
- Conservation Easements
- Acquisitions, Demolition, and Resettlement
- Setbacks
- Open Space Preservation and Conservations

DESIGN/ENGINEERING ADAPTATIONS

- Protect Transportation Networks
- Protect Electrical Networks
- Adjust Placement of Critical Infrastructure
- Protect Water and Sewer Infrastructure
- Shore Protection Structures

ECOSYSTEM-BASED ADAPTATIONS

- Ecological Buffer Zones
- Ecosystem Protection and Maintenance
- Ecosystem Restoration, Creation, and Enhancement

SOCIAL ADAPTATIONS

- Public Participatory Practices
- Public Education and Outreach
- Mobility
- Perpetuation of Adaptations

Adaptation: Ecological Buffer

REGULATORY AND PLANNING ADAPTATIONS

Comprehensive Plan

Developing a long-term plan to help guide future development is an integral part of anticipatory adaptations. Specific measures to minimize the impacts of land loss are to encourage development on ground beyond the zone of anticipated erosion. Developing sediment and erosion controls and an erosion management plan are other important adaptations.

Zoning

Regulating land uses through zoning ordinances can play an important role in steering valuable commercial and residential activities to safe locations outside high-risk territory. New zoning can amend local ordinances to specify setbacks, control densities, and limit future damage.

Building Codes/Resilient Design

Construction practices can minimize damage and maximize protection from coastal erosion. A community or building owner can adapt to future risks by raising the structure, constructing floating structures, or anchoring structures and strengthening walls to resist the impacts of land loss and intrusion of coastal waters. Building codes offer the mechanism to encourage this set of adaptations.

Retrofitting

For existing structures, the use of resilient retrofitting is an option to reduce current and future risks associated with coastal

erosion. Existing structures can be elevated, or communities and property owners can use dry and wet flood proofing, that either seal the structure or modify a structure to allow high water to enter and then escape. Additional options and can be found in NOAA's Adapting to Climate Change (2012), and FEMA's construction manuals.

Redevlopment Restrictions
Restrictions on rebuilding structures lost to coastal erosion, structures that have endured repetitive loss provide options for reducing future losses. In areas with higher risk and higher rates of coastal erosion, the potential for repetitive loss is dramatically increased. By restricting redevelopment in these areas, communities can limit damage and protect resources. Redevelopment restrictions are often coupled with A/D/R programs to provide safer redevelopment opportunities.

Conservation Easements
Preserving open space uses through easements is an additional strategy to manage development while allowing land owners to retain title. The preservation or creation of easements in areas with high levels of coastal erosion is important to prevent development and future damage in high-risk zones, by creating a buffer. Offering incentives to land owners can encourage the creation of easements. Understanding both historic and future coastal erosion rates is important in determining the size of easements.

Acquisitions, Demolition, and Resettlement
A/D/R programs can help prevent damage to buildings and infrastructure by removing buildings from sites at high risk of coastal erosion. While sometimes a costly option, in the long run these practices offer lasting risk reduction.

Setbacks
Establishing a geographic buffer — or setback — in high-risk areas that account for potential coastal erosion can clearly delimit inappropriate land uses, alert the public to risks, and limit inappropriate development.

Open Space Preservation and Conservation
By setting aside high-risk areas as open space and preventing development in these areas, communities can protect properties and limit damages from flooding, storm surge waves, and other hazards associated with — and exacerbated by — coastal erosion. Understanding both historical and future coastal erosion rates is important in determining the optimal size of open space areas.

DESIGN/ENGINEERING ADAPTATIONS

Protect Transportation Networks
Protecting road and street networks from the effects of coastal erosion can minimize major disruptions before, during, and after high-water events. Building roads on secure piers, designed to be in open water, is one option. Relocating key arteries to more inland locations is another.

Protect Electrical Networks
The primary adaptation to protect electrical networks from hazards caused by coastal erosion is to upgrade to materials that can better resist damage from flooding, storm surge waves, and other hazards associated with — and exacerbated by — coastal erosion. Relocating or building new key facilities in more inland locations also offers longer-term security.

Adjust Placement of Critical Infrastructure
Installing or relocating critical infrastructure above potential flood levels that may accompany coastal erosion can help prevent major failures that can result from extreme events after the coast has retreated. This can be done by relocating facilities further inland or to higher ground, raising facilities on pilings, placing them on upper levels of

multistory structures, or anchoring them to their base to avoid damage. The importance of raising this critical infrastructure in areas at high risk of coastal erosion is extremely high because increased coastal erosion results in higher risk of storm-induced flooding. Areas that were previously far enough inland to receive natural protection are increasingly encroached upon, and require additional adaption to coastal challenges. Current recommendations call for raising critical facilities 3 feet above the 100-year flood elevation. Another option is to relocate movable facilities to areas with lower flood risk.

Protect Water and Sewer Infrastructure
Constructing wastewater treatment plants in low risk areas or armoring those in areas impacted by coastal erosion can be an effective adaptation. Loss of shoreline can expose infrastructure to wave action, high tides, and storm surge and should therefore be built a safe distance inland. Higher groundwater levels may impact private septic systems. Backup generators can enable service to continue even if high water impacts the local power source.

Shore Protection Structures
Soft and hard structural fixtures armor shorelines. Shore erosion can expose previously safe areas to wave action. Hard shore protection structures should be a last resort. Their construction and presence can result in negative impacts on water movement, sediment transport, and ecological systems. Soft style protection structures can provide flexible protection that also help to restore and protect the natural and can be more easily modified as erosion progresses Other adaptations to help lessen the impact of erosion include constructing groins to capture and retain sand, installing geotextile sand tubes to trap sand and protect coastal properties, building coastal berms to absorb waves and protect the shoreline form erosion, and building storm berms to keep rock protection in place and provide a supply of sediment to the coastal system. In addition, bank stabilization through hard and soft methods is another potential adaptation to coastal erosion.

Ecological Buffer Zones
Preserving natural landscapes as buffers between people and developed property and areas of coastal erosion serves multiple purposes. It reduces damage to natural areas that absorb the initial wave action and also deters ina ppropriate development in high-risk zones. By preserving these areas in their natural state, they can minimize erosion, provide wildlife habitat, and stabilize soil and vegetation. Buffers can be achieved through a land banking program.

Ecosystem Protection and Maintenance
Managing human activities, such as water pollution, that might damage environments that naturally mitigate coastal erosion is one form of protection. Active efforts to restore or maintain natural ecological processes that sustain vegetation that protects coasts can complement managing human activities.

Ecosystem Restoration, Creation, and Enhancement
Creation of living shorelines and wetland restoration offer additional ecosystem-based protection. Living shorelines are a type of soft protection that may restore, protect, and enhance the natural shoreline. Living shorelines utilize vegetation and fill and are sometimes combined with additional shore protection elements, to contain sediment and reduce wave energy. Wetlands can be restored, created, or enhanced to provide significant protection from flooding. This process is accomplished by planting and seeding,

water flow modification, sediment diversion, dredging, removing impediments to natural processes, and invasive species control. These actions serve to limit coastal erosion by stabilizing existing coastal areas and potentially allowing the coast to capture more sediment and build additional coast.

SOCIAL ADAPTATIONS

Public Participatory Practices

Adaptations demand public support and there are many techniques to ensure the public is involved from the initial stages of deliberations. Interactive community forums, public surveys, targeted interviews, community mapping exercises, and scenario-building workshops offer means to overcome the "democratic deficit" of top-down planning. These processes also a better informed population that has bought into the plan though their contributions to the decision-making process.

Public Education and Outreach

Underlying effective adaptation is public comprehension of the challenges and the solutions offered by adaptation. Communication of complex science and engineering ideas to the general public is essential and requires carefully crafted programs that utilize formal educational programs as well as traditional public media such as newspapers and radio and digital social media.

Mobility

One potential social adaptation is facilitating the movement of people and communities. Transplanting families, neighborhoods, or entire communities may occur within the boundaries of the current municipality or it may involve movement to an entirely different area, depending on the severity of the risk. Residents will be extremely sensitive to any discussion of resettlement. In order for community members to make a decision about an adaptive move, they must receive information and support from local, state, and possible federal authorities. Equal attention must be directed to preparations at the departure and destination locations. This process can be financially burdensome. Provisions need to be made to compensate landowners who might decide to relocate and sometimes monetary incentives can facilitate the process.

Perpetuation of Adaptations

To overcome the tendency for communities to "lose the sense of urgency" after adaptations are completed, any program that garners support for implementation must include plans and funding to ensure it is sustained over generations.

INFORMATION

CPRA

2012 Louisiana Coastal Master Plan Appendix C: Environmental Scenarios
http://coastal.la.gov/a-common-vision/2012-coastal-master-plan/cmp-appendices/

FEMA

Home Builder's Guide to Coastal Construction
https://www.fema.gov/media-library/assets/documents/6131

Coastal Construction Manual: Principles and Practices of Planning, Siting, Designing, Constructing, and Maintaining Residential Buildings in Coastal Areas
https://www.fema.gov/media-library/assets/documents/3293

Hazard Mitigation Assistance Grant Programs
This program provides grants for state and local governments for the implementation of long-term hazard mitigation measures following major disasters.
http://www.fema.gov/hazard-mitigation-grant-program

NOAA

Adapting to Climate Change: A Planning Guide for State Coastal Managers
http://coastalmanagement.noaa.gov/climate/adaptation.html

HUD

Sustainable Communities Initiative
This grant program provides funding to improve planning efforts that integrate housing, transportation, landuse, and economic development to improve social equity, economic competitiveness, and environmental protection.
http://www.sustainablecommunities.gov/

Choice Neighborhoods
This grant program provides funding for comprehensive neighborhood revitalization plans to achieve housing, resident, and neighborhood related goals.
http://portal.hud.gov/hudportal/HUD?src=/program_offices/administration/grants/fundsavail/nofa14/cnpg

ADAPTIVE CHALLENGE

SEA-LEVEL RISE

REGULATORY AND PLANNING ADAPTATIONS

- Comprehensive Plan
- Zoning
- Building Codes/Resilient Design
- Retrofitting
- Redevelopment Restrictions
- Conservation Easements
- Acquisitions, Demolition, and Resettlement
- Setbacks
- Open Space Preservation and Conservations

DESIGN/ENGINEERING ADAPTATIONS

- Protect Transportation Networks
- Protect Electrical Networks
- Adjust Placement of Critical Infrastructure
- Protect Water and Sewer Infrastructure
- Shore Protection Structures

ECOSYSTEM-BASED ADAPTATIONS

- Ecological Buffer Zones
- Ecosystem Protection and Maintenance
- Ecosystem Restoration, Creation, and Enhancement

SOCIAL ADAPTATIONS

- Public Participatory Practices
- Public Education and Outreach
- Mobility
- Perpetuation of Adaptations

Adaptation: Ecosystem Restoration, Creation, and Enhancement

REGULATORY AND PLANNING ADAPTATIONS

Comprehensive Plan

Developing a long-term plan to help guide future development is an integral part of anticipatory adaptations. Specific measures to minimize the impacts of future flooding are to encourage development on ground above the projected 100- and even the 500-year floodplain. It is important that coastal communities begin to use predictive modeling in addition to historical sea-level rise data in determining how to develop in an adaptive and resilient way to adapt to sea-level rise.

Zoning

Regulating land uses through zoning ordinances can play an important role in steering valuable commercial and residential activities to safe locations that are outside areas threatened by sea-level rise. Determining areas that are most vulnerable to sea-level rise and limiting the density and type of development that can occur in these areas can help communities limit risk. New zoning can amend local ordinances to specify setbacks, control densities, and limit future damage.

Building Codes/Resilient Design

Construction practices can minimize damage and maximize protection from flooding, storm surge, rising average tides, and other sea-level rise risks. A community or building owner can adapt to future sea- level rise risk by requiring new structures to be elevated, , utilize a floating construction method, anchoring structures, or strengthening walls to

resist pressure and debris caused by challenges that are exacerbated by sea-level rise. Building codes offer the mechanism to encourage this set of adaptations.

Retrofitting
Since sea-level rise raises the risk of flooding from storms, but also more regularly from tides, and ultimately, a permanently elevated sea level, it is important to plan for these challenges. For existing structures, the use of resilient or floodproof retrofitting is an option. Existing structures can be elevated, or communities and property owners can use dry and wet flood proofing, which either seal the structure or modify a structure to allow water to enter and then escape. In addition, raising and adapting structures in this way can allow the structure to remain in the event that it is no longer over dry land. Reinforcing roofs and doors, installing shutters on windows, and replacing building components with more hazard resistant materials are other options. Additional options and can be found in NOAA's Adapting to Climate Change (2012) , and FEMA's construction manuals.

Redevelopment Restrictions
Restrictions on rebuilding structures lost to temporary high water, structures that have endured repetitive loss, as well as structures lost within the 100- or 500-year floodplain provide an option for reducing future losses in areas impacted by sea-level rise. Redevelopment restrictions are often coupled with A/D/R programs to provide safer redevelopment opportunities. In addition, by using predictive modeling, communities can determine if areas that have experienced repetitive loss may not remain above sea level, and thus require limits on redevelopment.

Conservation Easements
Preserving open space that may be lost to sea-level rise through easements is an additional strategy to manage development while allowing land owners to retain title. Offering incentives to land owners can encourage the creation of easements. These easements can prevent development in areas at high risk of inundation and sea-level rise.

Acquisitions, Demolition, and Resettlement
A/D/R programs can help prevent damage to buildings and infrastructure by removing buildings from sites likely to fall victim to sea-level rise. While sometimes a costly option, in the long run these practices offer lasting risk reduction. Sea-level rise in coastal Louisiana is a documented reality. An unfortunate side effect is that relocation may be required if areas that were once above sea level do not remain so.

Setbacks
Establishing a geographic buffer, or setback, in high-risk areas that account for potential sea-level rise can clearly delimit inappropriate land uses, alert the public to flood risks, and limit inappropriate development.

Open Space Preservation and Conservation
By setting aside high-risk areas as open space and preventing development in these areas communities can protect themselves and limit damages from flooding driven by sea-level rise, as well as permanent sea-level rise. In addition, communities can limit these areas to particular land use such as agriculture or recreation, which are better able to handle occasional flood waters and cost of damage is lower.

DESIGN/ENGINEERING ADAPTATIONS

Protect Transportation Networks
Protecting road and street networks from temporary flooding events, or permanent sea-level rise can minimize major disruptions before, during, and after periodic high-water events. There are two major strategies to protect these

networks: raise roadways or drastically improve drainage systems. Roads can be raised either on fill or piers. Piers are generally a preferred choice, since fill can compound flooding problems by impounding water. Drainage can be improved by regular monitoring to make sure drainage systems remain free of obstructions, and road networks can be designed with multiple levels of stormwater drainage to remove water from roadways and prevent treatment systems from becoming overwhelmed.

Protect Electrical Networks
The primary adaptations to protect electrical networks from flooding and other sea-level rise risks are to upgrade to materials that can better resist high winds, water, and pressure, and position them above anticipated water levels.

Elevate Critical Infrastructure
Installing or raising critical infrastructure above potential higher sea levels can help prevent major failures during temporary storm-induced inundation or permanent sea-level rise. This can be done by raising facilities on piers or placing them on upper levels of multi-story structures. Current recommendations call for raising critical facilities 3 feet above the 100-year flood elevation. Another option is to relocate movable facilities to areas with lower flood risk.

Protect Water and Sewer Infrastructure
Constructing wastewater treatment plants in low risk areas or armoring those in areas potentially impacted by sea-level rise can be an effective adaptation. Also, provision of backup generators can enable service to continue even if a flood impacts the local power source. Areas with private septic tanks face serious challenges with sea-level rise. Local governments and the State Department of Health and Hospitals are responsible for enforcement of local regulations to prevent wastewater contamination.

Shore Protection Structures
Shore protection structures have two main types: soft and hard. Hard shore protection structures should be a last resort. Their construction and presence can result in negative impacts on water movement, sediment transport, and ecological systems. Also, with sea-level rise fixed infrastructure may become obsolete. Soft style protection structures can provide flexible protection that also help to restore and protect the natural shoreline.

ECOSYSTEM-BASED ADAPTATIONS

Ecological Buffer Zones
Preserving natural landscapes as buffers between people and developed property and permanent sea-level rise serves multiple purposes. It reduces damages to natural areas that absorb the initial impacts of higher water and provides a temporary line of defense against sea-level rise. These buffers also deter inappropriate development in areas most likely to succumb to sea-level rise. By preserving these areas in their natural state, they provide flood storage, reduce wave impact, improve water quality, and prevent development in areas that eventually will not be above sea level. Additionally, they can provide wildlife habitat, minimize erosion, and stabilize soil and vegetation. Buffers can be achieved through a land banking program.

Ecosystem Protection and Maintenance
There are more active forms of ecosystem adaptation that function by restricting activities, restoring natural processes, reducing pollution, monitoring invasive species, acquiring additional protective buffers, and creating and connecting protected areas. Communities that engage in these more active forms of adaptation can delay the impacts of sea-level rise by maintaining the existing coastline. If the coastline were to erode, then sea-level rise would have a more immediate impact.

Ecosystem Restoration, Creation, and Enhancement

Creation of living shorelines and wetland restoration offer additional ecosystem-based protection. Living shorelines are a type of soft protection structure that may restore, protect, and enhance the natural shoreline. Living shorelines utilize vegetation and fill, sometimes combined with additional shore protection elements to contain sediment and reduce wave energy. Wetlands can be restored, created, or enhanced to provide significant protection from flooding. This process is accomplished by planting and seeding, water flow modification, sediment diversion, dredging, removing impediments to natural processes, and invasive species control. These active ecological strategies can help maintain and potentially expand the existing coastal area, thus delaying the impacts of sea-level rise.

SOCIAL ADAPTATIONS

Public Participatory Practices

Adaptations demand public support and there are many techniques to ensure the public is involved from the initial stages of deliberations. Interactive community forums, public surveys, targeted interviews, community mapping exercises, and scenario building workshops offer means to overcome the "democratic deficit" of top-down planning. These processes also a better informed population that has bought into the plan though their contributions to the decision making process.

Public Education and Outreach

Underlying effective adaptation is public comprehension of the challenges and the solutions offered by adaptation. Communication of complex science and engineering ideas to the general public is essential and requires carefully crafted programs that utilize formal educational programs as well as traditional public media such as radio and newspapers and digital social media.

Mobility

One potential social adaptation is facilitating the movement of people and communities. Evacuation before floods is a long-standing adaptation and enables the reduction of risk. Transplanting families, neighborhoods, or entire communities may occur within the boundaries of the current municipality or it may involve movement to an entirely different area, depending on the severity of the risk. Residents will be extremely sensitive to any discussion of resettlement. In order for community members to make a decision about an adaptive move, they must receive information and support from local, state, and possibly federal authorities. Equal attention must be directed to preparations at the departure and destination locations. This process can be financially burdensome. Provisions need to be made to compensate landowners who might decide to relocate and sometimes monetary incentives can facilitate the process.

Perpetuation of Adaptations

To overcome the tendency for communities to "lose the sense of urgency" after adaptations are completed, any program that garners support for implementation must include plans and funding to ensure it is sustained over generations.

INFORMATION

CPRA
2012 Louisiana Coastal Master Plan Appendix C: Environmental Scenarios
http://coastal.la.gov/a-common-vision/2012-coastal-master-plan/cmp-appendices/

ASCE
Flood Resistant Design and Construction
http://ascelibrary.org/doi/book/10.1061/9780784408186

NOAA
Adapting to Climate Change: A Planning Guide for State Coastal Managers
http://coastalmanagement.noaa.gov/climate/adaptation.html

Understanding Coastal Inundation
http://csc.noaa.gov/digitalcoast/inundation/understand/

FEMA
Community Rating System
http://www.fema.gov/national-flood-insurance-program-2/community-rating-system

Home Builder's Guide to Coastal Construction
https://www.fema.gov/media-library/assets/documents/6131

Coastal Construction Manual: Principles and Practices of Planning, Siting, Designing, Constructing, and Maintaining Residential Buildings in Coastal Areas
https://www.fema.gov/media-library/assets/documents/3293

Pre-Disaster Mitigation Grant Program
http://www.fema.gov/pre-disaster-mitigation-grant-program

Hazard Mitigation Grant Program
http://www.fema.gov/hazard-mitigation-grant-program

CLIMATE ADAPTATION KNOWLEDGE EXCHANGE
Sea-Level Rise in the Gulf of Mexico
http://www.cakex.org/case-studies/2811

HUD
Choice Neighborhoods Planning Grants
http://portal.hud.gov/hudportal/HUD?src=/program_offices/administration/grants/fundsavail/nofa14/cnpg

EPA
Wetlands Program Development
http://water.epa.gov/grants_funding/wetlands/grantguidelines/index.cfm

ADAPTIVE CHALLENGE

SUBSIDENCE

REGULATORY AND PLANNING ADAPTATIONS

- Comprehensive Plan
- Zoning
- Floodplain Regulations
- Building Codes/Resilient Design
- Retrofitting
- Redevelopment Restrictions
- Conservation Easements
- Acquisitions, Demolition, and Resettlement
- Setbacks
- Open Space Preservation and Conservations

DESIGN/ENGINEERING ADAPTATIONS

- Protect Road and Street Networks
- Protect Electrical Networks
- Elevate Critical Infrastructure
- Protect Water and Sewer Infrastructure
- Shore Protection Structures

ECOSYSTEM-BASED ADAPTATIONS

- Ecological Buffer Zones
- Ecosystem Protection and Maintenance
- Ecosystem Restoration, Creation, and Enhancement

SOCIAL ADAPTATIONS

- Public Participatory Practices
- Public Education and Outreach
- Mobility
- Perpetuation of Adaptations

Adaptation: *Building Codes/Resilient Design*

REGULATORY AND PLANNING ADAPTATIONS

Comprehensive Plan

A particularly important aspect of planning in terms of subsidence is controlling land use to avoid large scale changes to the regional water table. In Louisiana, building levees and draining wetlands has accelerated subsidence. Extraction of oil and natural gas is also a contributor to subsidence. Plans that provide mechanisms to replenish the water table can offset some subsidence. It is possible to inject water into the reservoirs left by oil and gas removal to slow subsidence. Planning should also include monitoring and managing groundwater levels and areas where natural resources are removed from underground. If advisable, communities can fill or buttress spaces vacated by water and natural resources to prevent collapse. Additional adaptations include planning to locate future critical facilities outside of areas susceptible to subsidence, and the increased risk of other challenges such as flooding and storms, which are exacerbated by subsidence. In addition, locating all critical infrastructure 1 foot above the projected 500-year flood elevation due to subsidence.

Zoning

Regulating land uses through zoning ordinances can play an important role in steering valuable commercial and residential activities to safe locations outside high-risk territory. New zoning can amend local ordinances to specify setbacks, control densities, and limit future damage.

Building Codes/Resilient Design
To adapt to subsidence, communities may introduce strict building codes and permitting to evaluate sites for ground stability. If the ground is unstable, builders can be required to utilize the best science to stabilize it prior to development and construction. Pilings and other support devices can stabilize structures. Also, codes can include the promotion of subsidence sensitive construction practices.

Retrofitting
Many builders suggest there are no real options for retrofitting structures for subsidence. However, there are ground stabilization techniques that can be used to increase resistance to subsidence damage and stabilize subsidence prone soils. These techniques include: shear walls, geofabrics, and dynamic compaction.

Redovelopment Restrictions
Parish or municipal ordinances can prohibit development or redevelopment in areas with a high risk of subsidence, and with soil that is unstable and unsuitable for development.

Conservation Easements
Preserving open space through easements is an additional strategy to manage development while allowing land owners to retain title. Offering incentives to land owners can encourage the creation of easements. Using easements to limit damage from subsidence is more complicated than other coastal easements because of the geological data required to determine the optimal areas for open space.

Acquisitions, Demolition, and Resettlement
A/D/R programs can help prevent damage to buildings and infrastructure by removing buildings from sites located in areas with a high risk of subsidence. While sometimes a costly option, in the long run these practices offer lasting risk reduction.

Setbacks
Establishing a geographic buffer — or setback — between areas at high risk of subsidence and areas of development can help prevent inappropriate land uses and property damage. In addition, these setbacks can help prevent post-subsidence damage from the increased impacts of flooding and storms.

Open Space Preservation and Conservation
By setting aside areas at a high risk of subsidence as open space and preventing development in these areas, communities can both protect themselves from property damage and loss associated with subsidence and from the damage and loss caused by flooding and storms which are exacerbated by subsidence.

DESIGN/ENGINEERING ADAPTATIONS

Protect Road and Street Networks
The primary adaptation to protect road and street networks from the effects of subsidence are to underpin the surface of the road or street by building a solid foundation underneath to increase stability. This can be accomplished in a variety of ways including continuous mass underpinning; beam and base underpinning; mini-piled underpinning; displacement piles; expanding resin injection; micropiles; ground bearing raft; structural strengthening; jet grouting; and geopolymer injection.

Protect Electrical Networks
Again, underpinning is the primary adaptation to protect electrical networks from subsidence. In this case, since the locations to be underpinned may be point-based and spread out, understanding geological data throughout a community is extremely important.

Elevate Critical Infrastructure
Elevating critical infrastructure may not necessarily protect this infrastructure from subsidence;

however, if there is nowhere else in a community in which critical infrastructure can be located, then elevating infrastructure combined with underpinning to create the safest possible situation for critical infrastructure in a community is the best option. When elevating critical infrastructure, installing or raising critical infrastructure above potential flood levels can help prevent major failures during storm-induced inundation. This can be done by raising facilities on piers or placing them on upper levels of multistory structures. Current recommendations call for raising critical facilities 3 feet above the 100-year flood elevation. Another option is to relocate movable facilities to areas with lower flood risk.

Protect Water and Sewer Infrastructure
Constructing wastewater treatment plants in areas at low risk of subsidence or underpinning essential water and sewer infrastructure that cannot be relocated can be an effective adaptation. Areas with private septic tanks should also utilize geological data to determine if the location of septic tanks are in areas at a low risk of subsidence, but responsibility rests primarily with homeowners to ensure they are in a safe location and maintained properly. Local governments and the State Department of Health and Hospitals are responsible for enforcement of to prevent wastewater contamination.

ECOSYSTEM-BASED ADAPTATIONS

Ecological Buffer Zones
Preserving natural landscapes as buffers between people and developed property allows for the impact of subsidence on a community to be limited. By creating a buffer, communities allow for subsidence to occur with minimal impact on property. As previously mentioned, understanding where subsidence is likely to occur is important to understanding where zones and easements should be located. By preserving these areas in their natural state, they also provide flood storage, reduce flood velocity, and improve water quality. Additionally, they can provide wildlife habitat, minimize erosion, and stabilize soil and vegetation. Buffers can be achieved through a land banking program.

Ecosystem Protection and Maintenance
Managing human activities, such as groundwater and mineral extraction, that may contribute to subsidence is an adaptive practice to maintain natural systems.

Ecosystem Restoration, Creation, and Enhancement
The creation of living shorelines and wetland restoration offer additional ecosystem-based protection. Living shorelines are a type of soft protection structure that may restore, protect, and enhance the natural shoreline. Living shorelines utilize vegetation and fill and are sometimes combined with additional shore protection elements to contain sediment and reduce wave energy. Wetlands can be restored, created, or enhanced to delay the impacts of coastal challenges, including subsidence. This process is accomplished by planting and seeding, water flow modification, sediment diversion, dredging, removing impediments to natural processes, fill, underpinning, and invasive species control. These restoration, creation, and enhancement processes help to stabilize both the soil and the subsurface, thus offsetting the immediate impacts of subsidence.

SOCIAL ADAPTATIONS

Public Participatory Practices

Adaptations demand public support and there are many techniques to ensure the public is involved from the initial stages of deliberations. Interactive community forums, public surveys, targeted interviews, community mapping exercises, and scenario building workshops offer means to overcome the "democratic deficit" of top-down planning. These processes also create a better informed population that has bought into the plan though their contributions to the decision-making process.

Public Education and Outreach

Underlying effective adaptation is public comprehension of the challenges and the solutions offered by adaptation. Communication of complex science and engineering ideas to the general public is essential and requires carefully crafted programs that utilize formal educational programs as well as traditional public media such as radio and newspapers and digital social media.

Mobility

One potential social adaptation is facilitating the movement of people and communities. Transplanting families, neighborhoods, or entire communities may occur within the boundaries of the current municipality or it may involve movement to an entirely different area, depending on the severity of the risk. Residents will be extremely sensitive to any discussion of resettlement. In order for community members to make a decision about an adaptive move, they must receive information and support from local, state, and possibly federal authorities. Equal attention must be directed to preparations at the departure and destination locations. This process can be financially burdensome. Provisions need to be made to compensate landowners who might decide to relocate and sometimes monetary incentives can facilitate the process.

Perpetuation of Adaptations

To overcome the tendency for communities to "lose the sense of urgency" after adaptations are completed, any program that garners support for implementation must include plans and funding to ensure it is sustained over generations.

INFORMATION

CPRA

2012 Louisiana Coastal Master Plan Appendix C: Environmental Scenarios
http://coastal.la.gov/a-common-vision/2012-coastal-master-plan/cmp-appendices/

ASCE

Flood Resistant Design and Construction
http://ascelibrary.org/doi/book/10.1061/9780784408186

NOAA

Adapting to Climate Change: A Planning Guide for State Coastal Managers
http://coastalmanagement.noaa.gov/climate/adaptation.html

Understanding Coastal Inundation
http://csc.noaa.gov/digitalcoast/inundation/understand/

FEMA

Home Builder's Guide to Coastal Construction
https://www.fema.gov/media-library/assets/documents/6131

Coastal Construction Manual: Principles and Practices of Planning, Siting, Designing, Constructing, and Maintaining Residential Buildings in Coastal Areas
https://www.fema.gov/media-library/assets/documents/3293

Pre-Disaster Mitigation Grant Program
http://www.fema.gov/pre-disaster-mitigation-grant-program

Hazard Mitigation Grant Program
http://www.fema.gov/hazard-mitigation-grant-program

Public Assistance Grant Program
http://www.fema.gov/public-assistance-local-state-tribal-and-non-profit

Flood Mitigation Assistance Program
http://www.fema.gov/flood-mitigation-assistance-program

OTHER

Understanding Subsidence in Coastal Louisiana
http://155.76.244.234/lcast/pdfs/UNO_SubsidenceinLA_09.pdf

Sea-Level Rise and Subsidence: Implications for Flooding in New Orleans, Louisiana
http://ossfoundation.us/projects/environment/global-warming/summary-docs/oss-reports/slr-research-summary-2008/Sea-Level-Rise.pdf

HUD

Choice Neighborhoods Planning Grants
http://portal.hud.gov/hudportal/HUD?src=/program_offices/administration/grants/fundsavail/nofa14/cnpg

USDA

Conservation Innovation Grants
https://www.cfda.gov/ index?s=program&mode=form&tab=core&id=78d2ce2eca781b10d567c136a630f384

ADAPTIVE CHALLENGE

EXTREME TEMPERATURES

REGULATORY AND PLANNING ADAPTATIONS

Comprehensive Plan
Building Codes/Resilient Design
Retrofitting

DESIGN/ENGINEERING ADAPTATIONS

Protect Transportation, Critical Infrastructure, and Public Utilities

ECOSYSTEM-BASED ADAPTATIONS

Ecosystem Restoration, Creation, and Enhancement

SOCIAL ADAPTATIONS

Public Participatory Practices
Public Education and Outreach
Mobility
Perpetuation of Adaptations

Adaptation: Plant Shade Trees

REGULATORY AND PLANNING ADAPTATIONS

Comprehensive Plan

Extreme heat is a challenge to consider during planning for a community or any project in south Louisiana. Increasing areas of shade through select species of tree plantings is a way both to reduce the effects of heat as well as cost of cooling structures.

Building Codes/Resilient Design

The use of green roofs, or roofs that reflect sunlight away from the building, are other adaptations to reduce risk from heat.

Retrofitting

Similar to resilient design solutions communities and property owners can lower the risk of high temperatures by reroofing structures to reflect sunlight or adding porches with roofs.

DESIGN/ENGINEERING ADAPTATIONS

Protect Transportation, Critical Infrastructure, and Public Utilities

Increasing shade trees and structures along roadways and other impervious surfaces that retain heat can reduce increases in extreme temperatures.

Tree planting must be balanced with the risks associated with tree-fall during high wind events and also damage that their roots can cause to infrastructure. Providing adequate shade/shelter and climate control for vital infrastructure and public utilities also needs attention.

ECOSYSTEM-BASED ADAPTATIONS

Ecosystem Restoration, Creation, and Enhancement

Finding appropriate native species of shade trees that also help to adapt to other challenges is key to maximizing overall adaptation and efficiency of a community's adaptation.

SOCIAL ADAPTATIONS

Public Participatory Practices

Adaptations demand public support and there are many techniques to ensure the public is involved from the initial stages of deliberations. Interactive community forums, public surveys, targeted interviews, community mapping exercises, and scenario-building workshops offer means to overcome the "democratic deficit" of top-down planning. These processes create a better informed population that has bought into the plan though their contributions to the decision making process.

Public Education and Outreach

The primary social adaptation for dealing with extreme heat is communication and care. Provisions for communicating with the elderly and infirm, creating a system of cooling shelters, and establishing systems to distribute fans and other cooling devices can aid the vulnerable members of a community. Underlying effective adaptation is public comprehension of the challenges and the solutions offered by adaptation. Communication of complex science and engineering ideas to the general public is essential and requires carefully crafted programs that utilize formal educational programs as well as traditional public media such as newspapers and radio and digital social media.

Perpetuation of Adaptations

To overcome the tendency for communities to "lose the sense of urgency" after adaptations are completed, any program that garners support for implementation must include plans and funding to ensure it is sustained over generations.

INFORMATION

FEMA

Extreme Heat Fact Sheet
https://s3-us-gov-west-1.amazonaws.com/dam-production/uploads/20130726-1622-20490-2694/extremeheatfactsheet_final.pdf

Natural Hazards: Extreme Heat
http://www.fema.gov/media-library-data/20130726-1549-20490-2128/natural_hazards_2.pdf

Hazard Mitigation Grant Program
This program provides grants for state and local governments for the implementation of long-term hazard mitigation measures following major disasters.
http://www.fema.gov/hazard-mitigation-grant-program

EPA

Cooling Summertime Temperatures
http://www.epa.gov/heatislands/resources/pdf/HIRIbrochure.pdf

Ontario Ministry of Agriculture, Food, and Rural Affairs
http://www.omafra.gov.on.ca/english/crops/facts/weather-hot.htm

RED CROSS

Heat Wave Safety
http://www.redcross.org/prepare/disaster/heat-wave

NOAA

Heat: A Major Killer
http://www.nws.noaa.gov/os/heat/index.shtml

HUD

Sustainable Communities Initiative
This grant provides funding to improve planning efforts that integrate housing, transportation, land use, and economic development to improve social equity, economic competitiveness, and environmental protection.
http://www.sustainablecommunities.gov/

Choice Neighborhoods Planning Grants
This grant provides funding for comprehensive neighborhood revitalization plans to achieve housing, people, and neighborhood relate goals.
http://portal.hud.gov/hudportal/HUD?src=/program_offices/administration/grants/fundsavail/nofa14/cnpg

ADAPTIVE CHALLENGE

THUNDERSTORMS, LIGHTNING, HAIL

REGULATORY AND PLANNING ADAPTATIONS

Comprehensive Plan
Building Codes/Resilient Design
Retrofitting

DESIGN/ENGINEERING ADAPTATIONS

Protect Transportation, Critical Infrastructure

SOCIAL ADAPTATIONS

Public Participatory Practices
Public Education and Outreach
Perpetuation of Adaptations

Adaptation: Building Codes/Resilient Design

REGULATORY AND PLANNING ADAPTATIONS

Comprehensive Plan

Preparing for lightning strikes by requiring that structures are grounded and encouraging power surge protection devices are important adaptations. Hail often coincides with thunderstorms and can cause a tremendous amount of damage. Spatial planning is not an especially effective adaptation; the primary adaptations are related to structural protection and construction practices.

Building Codes/Resilient Design

Existing and new structures should be required to have lightning rods and grounding to prevent damage and potential fire from lightning strikes. In addition, structures should be outfitted with surge protection devices to prevent damage to sensitive electronic equipment. Adaptations to prevent and limit hail damage include structural bracing, shutters, laminated glass, and hail resistant roof coverings.

Retrofitting

Upgrading siding and roofing, particularly roof sheathing to prevent hail penetration, is the primary adaptation for retrofitting to limit hail damage.

DESIGN/ENGINEERING ADAPTATIONS

Protect Critical Infrastructure

Protecting utility structures by upgrading building materials can prevent damage and outages from hail. In addition, upgrading utility poles and boxes can further limit smaller outages.

SOCIAL ADAPTATIONS

Public Participatory Practices

Adaptations demand public support and there are many techniques to ensure the public is involved from the initial stages of deliberations. Interactive community forums, public surveys, targeted interviews, community mapping exercises, and scenario-building workshops offer means to overcome the "democratic deficit" of top-down planning. These processes create a better informed population that has bought into the plan though their contributions to the decision making process.

Public Education and Outreach

The primary social adaptation for dealing with the somewhat random impacts from lightning and hail is communication. Public education, particularly for the young and those who work outdoors, about the potential effects from thunderstorms and local warnings are vital. Underlying effective adaptation is public comprehension of the challenges and the solutions offered by adaptation. Communication of complex science and engineering ideas to the general public is essential and requires carefully crafted programs that utilize formal educational programs as well as traditional public media such as newspapers and radio and digital social media.

Perpetuation of Adaptations

To overcome the tendency for communities to "lose the sense of urgency" after adaptations are completed, any program that garners support for implementation must include plans and funding to ensure it is sustained over generations.

INFORMATION

NATIONAL LIGHTNING SAFETY INSTITUTE

Fundamental of Lightning Protection
http://www.lightningsafety.com/nlsi_lhm/lpts.html

How to Protect Your Home and its Contents From Lightning
http://www.lightningsafety.com/nlsi_lhm/IEEE_Guide.pdf

LIGHTNING PROTECTION INSTITUTE

Recommended Guide for the Protection of Equipment & Personnel from Lightning
http://lightning-protection-institute.com/lightning-protect.htm

Surge Protection: A General Overview
http://lightning.org/wp-content/uploads/2012/10/M.Guthrie_-_Surge_Protection.pdf

NOAA

Thunderstorms, Tornadoes, Lightning: Natire's Most Violent Storms
http://www.nws.noaa.gov/om/severeweather/resources/ttl6-10.pdf

FEMA

Hazard Mitigation Grant Program
This program provides grants for state and local governments for the implementation of long-term hazard mitigation measures following major disasters.
http://www.fema.gov/hazard-mitigation-grant-program

HUD

Sustainable Communities Initiative
This grant provides funding to improve planning efforts that integrate housing, transportation, land use, and economic development to improve social equity, economic competitiveness, and environmental protection.
http://www.sustainablecommunities.gov/

Choice Neighborhoods Planning Grants
This grant provides funding for comprehensive neighborhood revitalization plans to achieve housing, people, and neighborhood relate goals.
http://portal.hud.gov/hudportal/HUD?src=/program_offices/administration/grants/fundsavail/nofa14/cnpg

Community Development Block Grants
http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/programs

LOUISIANA HOUSING CORPORATION

Weatherization Assistance Corporation
http://resiliency.lsu.edu/funding/louisiana-housing-corporation/

ADAPTIVE CHALLENGE

DROUGHT

REGULATORY AND PLANNING ADAPTATIONS

Comprehensive Plan

Water Conservation Code

Retrofitting

DESIGN/ENGINEERING ADAPTATIONS

Reduce Impermeable Surfaces

Enlarge Storage Capacity/ Identify Alternate Sources

ECOSYSTEM-BASED ADAPTATIONS

Ecosystem Protection and Maintenance

Ecosystem Restoration, Creation, and Enhancement

SOCIAL ADAPTATIONS

Public Participatory Practices

Public Education and Outreach

Mobility

Perpetuation of Adaptations

Adaptation: Water Conservation Code

REGULATORY AND PLANNING ADAPTATIONS

Comprehensive Plan

Developing a plan for how to combat drought is an important adaptation even in areas such as coastal Louisiana. Droughts are hazards that develop over time and communities need to stay attuned to weather information to recognize the early stages of drought. By creating a criteria for the various phases and steps of drought conditions, communities can limit the impact on the water supply. In addition, it is vital to develop agreements for secondary water sources to be used during drought conditions. Finally, establishing irrigation/lawn watering schedules is necessary to prevent simultaneous consumption and allow for adequate groundwater recharge.

Water Conservation Code

Communities can develop codes for water usage to restrict use of public water for nonessential purposes, such as watering grass or washing cars. In addition to limiting water usage, codes can also be developed to prioritize water use; an example would be prioritizing water for emergencies, such as firefighting.

Retrofitting

Communities can construct or retrofit water delivery systems to accommodate drought events. This may include enlarging water storage capacity or increasing the use of additional sensors or monitoring. On a more basic level, systems can be upgraded to eliminate breaks and leaks.

DESIGN/ENGINEERING ADAPTATIONS

Reduce Impermeable Surfaces
By using permeable surfaces in places such as driveways, parking lots, and other surfaces, communities can reduce runoff and promote groundwater recharge. This helps combat drought as well as promoting overall sustainable water usage.

Enlarge Storage Capacity/Identify Alternate Sources
To offset the risk of water shortages, communities may take steps to enlarge reservoir or water storage capacity. Identification of alternate sources of surface or groundwater will offer options in the event of extended drought. Cooperative agreements with neighboring communities to share water can provide relief from temporary shortages.

ECOSYSTEM-BASED ADAPTATIONS

Ecosystem Protection and Maintenance
If drought is a major challenge facing your community, an adaptation such as planting ornamentals and lawn covers that do not require large amounts of water can help relieve pressure in drought conditions. Additional programs such as promoting soil and water conservation can help improve efficient water use.

Ecosystem Restoration, Creation, Enhancement
By restoring permeable surfaces and creating additional open space communities can improve water usage, ecological quality, and groundwater recharge. Tree species that have low water demands can reduce evaporation and help conserve water. Water-consuming trees can have an opposite effect.

SOCIAL ADAPTATIONS

Conservation
When water supplies are depleted during drought, implementing various adjustments in water consumption are essential. Water conservation programs such as restrictions on lawn watering and car washing, plus encouraging homeowners to install water saving devices such as low flow toilets and showerheads are effective as well. Western states such as California have extensive drought coping procedures that can provide a model for adaptations.

Public Participatory Practices
Adaptations demand public support and there are many techniques to ensure the public is involved from the initial stages of deliberations. Interactive community forums, public surveys, targeted interviews, community mapping exercises, and scenario building workshops offer means to overcome the "democratic deficit" of top-down planning. These processes also a better informed population that has bought into the plan though their contributions to the decision-making process.

Public Education and Outreach
Underlying effective adaptation is public comprehension of the challenges and the solutions offered by adaptation. Communication of complex science and engineering ideas to the general public is essential and requires carefully crafted programs that utilize formal educational programs as well as traditional media such as radio and newspapers and digital social media.

Perpetuation of Adaptations

To overcome the tendency for communities to "lose the sense of urgency" after adaptations are completed, any program that garners support for implementation must include plans and funding to ensure it is sustained over generations.

INFORMATION

NOAA

Drought Monitor
http://droughtmonitor.unl.edu/

Southeastern Regional Climate Center
http://www.sercc.com/

Adapting to Climate Change: A Planning Guide for State Coastal Managers
http://coastalmanagement.noaa.gov/climate/adaptation.html

National Integrated Crought Information System
http://drought.gov/media/pgfiles/PAS574.pdf

National Drought Mitigation Center
http://drought.unl.edu/Planning/WhyPlanforDrought.aspx

Guide to Community Preparedness
http://drought.unl.edu/Planning/PlanningProcesses/DroughtReadyCommunities.aspx

FEMA

Pre-Disaster Mitigation Grant Program
http://www.fema.gov/pre-disaster-mitigation-grant-program

Hazard Mitigation Grant Program
http://www.fema.gov/hazard-mitigation-grant-program

HUD

Choice Neighborhoods Planning Grants
http://portal.hud.gov/hudportal/HUD?src=/program_offices/administration/grants/fundsavail/nofa14/cnpg

USDA

Rural Community Development Initiative Grants
http://www.rurdev.usda.gov/had-rcdi_grants.html

INTEGRATING APPLIED RESEARCH | LINKING KNOWLEDGE TO ACTION | BUILDING PARTNERSHIPS

THE WATER INSTITUTE
OF THE GULF™

301 NORTH MAIN STREET, SUITE 2000
BATON ROUGE, LA 70825

(225) 448-2813
WWW.THEWATERINSTITUTE.ORG