Reducing Coastal Risk – Structural Protection around Greater New Orleans

Rick Luettich
University of North Carolina
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University of North Carolina at Chapel Hill

Hampton Roads Sea Level Rise/Flooding Adaptation Forum
Megaprojects – Protective Structures for Hampton Roads

5/22/2015
Reducing Coastal Risk

Committee on U.S. Army Corps of Engineers Water Resources Science, Engineering, and Planning: Coastal Risk Reduction

National Research Council
Rick Luettich, Committee Chair

Probabilistic Coastal Flood Hazards Mapping Workshop
5/15/2015
Committee Membership

• RICHARD LUETTICH, JR., Chair, University of North Carolina
• GREGORY BAECHER, University of Maryland
• SUSAN BELL, University of South Florida
• PHILLIP BERKE, Texas A&M University
• ROSS COROTIS, University of Colorado
• DANIEL COX, Oregon State University
• ROBERT DALRYMPLE, The Johns Hopkins University
• TONY MACDONALD, Monmouth University
• KARL NORDSTROM, Rutgers University
• STEPHEN POLASKY, University of Minnesota
• SEAN POWERS, University of South Alabama
• DON RESIO, University of North Florida
• AP VAN DONGEREN, Deltares, The Netherlands

NRC Staff:
Stephanie Johnson, Deborah Glickson, Anita Hall, Sarah Brennan
Statement of Task

Focus on reducing flood risk from storms along the East and Gulf Coasts:

• To what extent have coastal risk-reduction strategies proven effective (life safety, economic return)?

• What are the regional and national implications of expanded coastal risk reduction?

• How might risk-related principles contribute to project design standards and increase community preparedness?

• What general principles might be used to guide future U.S. investments in coastal risk reduction?

Sponsored by USACE, as the 3rd phase of a 5-year study to provide advice on a range of scientific, engineering, and water resources planning issues
Concern – Coastal Risk is Increasing

- Population in southeastern and southern US coastal areas increasing 2x national average
- Warming climate / sea level rise are increasing hazards
- Tropical storms and floods ~ 50% of all natural disaster losses
- Federal Gov’t payout for recovery increased from ~6% in 1950s to ~75% for Sandy
Landscape for Coastal Risk Management

• **No central leadership or unified vision:** Responsibilities spread over multiple levels of government
  – FEMA, USACE, HUD, NOAA, USGS; state, local governments
  – Each driven by different objectives, authorities
  – No coordinating body with singular focus on coastal risk
  – No national priorities (even though the federal government is now paying ~75% of recovery costs)

• **Vast majority of funding for coastal risk-related issues is provided only after a disaster occurs**
  – Mostly for response & recovery
  – Small fraction for mitigation

*Image source: NOAA*
Landscape for Coastal Risk Management

- Few comprehensive regional evaluations of coastal risk have been performed
  - Risk reduction efforts tend to be local, not regional (even though storm response and critical resources, e.g. sand, are often regional)
  - USACE is not authorized to address coastal risk at a national scale.

- Lack of alignment of risk, reward, resources, and responsibility
  - Resulted in significant inefficiencies and inappropriate incentives that increase the nation’s exposure to risk
Risk Reduction Strategies

RISK = HAZARD X CONSEQUENCE

• Reduce the hazard (flooding, wave attack)
  – Hard structures (seawalls, surge barriers)
  – Nature-based strategies
    – Beach nourishment and dune building
    – Saltmarsh, seagrass, reefs

• Reduce the consequences
  – Building elevation and flood proofing
  – Non-structural (e.g., Land-use planning, preparedness, buyouts)

Optimal approaches will be site-specific, may involve multiple strategies

Image sources: N. Aquino, FEMA, committee
Strategies to Reduce the Hazard: Beach Nourishment and Dune Building

- Short term environmental impacts significant; long-term impacts unknown

- Can be designed to reduce short-term impacts and increase ecological value

*Data source: USACE*

*Image source: NOAA*
Strategies to Reduce the Hazard: Other Nature-Based “Green” Approaches

Saltmarsh, seagrass, mangroves, coral or oyster reefs, etc.

• Provides substantial ecological benefits and varying levels of coastal risk reduction
  – Low to moderate energy events – can be effective for waves & erosion
  – Moderate to high energy events – more effective for damping waves than surge
  – May require large expanses of habitat
  – Continued research needed to develop design guidance, alone & combined with hard structures

• May motivate conservation and restoration activities

Image sources: NOAA
Strategies to Reduce the Hazard: Hard Structure “Grey” Approaches

• Hard structures are likely to become increasingly important in densely populated urban areas - space is limited for nature-based strategies

• Adverse environmental impacts exist, designs can lessen these impacts

Look for ways to couple grey and green approaches
Strategies to Reduce the Consequences

- Includes hazard zoning, building elevation, land purchase, and setbacks
- High documented benefit-cost ratios (5:1 to 8:1)
- Given less attention by the federal government
- Other than building elevation, these are viewed as difficult to implement by states

Image source: FEMA
Guiding Investments in Risk Reduction

Two basic approaches for evaluating investments:

1) Risk-standard
2) Benefit-cost

- There is **no basis to justify a default** 1-percent annual chance (**100-year** design level) for coastal risk.

- **Benefit-cost analysis constrained by acceptable risk and social and environmental dimensions** provides a reasonable framework
  - Constraints could include mass casualties or individual risk
  - Costs/benefits that are difficult to measure can also be constraints
Guiding Investments in Risk Reduction

• Capacity to consider different costs and benefits has been limited in USACE decision frameworks
  – National Economic Development (NED) given priority
  – Social / environmental benefits rarely influence decisions
  – Life-safety only recently a consideration for dams & levees.

• *Principles and Requirements for Federal Investments in Water Resources* (CEQ, 2013)
  – Provides framework for consideration of broad-based costs and benefits
Guiding Investments in Risk Reduction

• CEQ should expedite efforts to complete accompanying Guidelines required to implement the P&R.

• CEQ released Guidelines in 12/2014, enabling implementation of P&R which contain explicit instructions to consider
  – Healthy and resilient ecosystems
  – Sustainable economic development
  – Public Safety
  – Environmental Justice
  – Flood Plains
  – Watershed Approach
Vision Toward Coastal Risk Reduction

• A National Vision for coastal risk management is needed.
  – Use federal resources to reduce coastal risk vs enabling it to increase
  – Clarify roles and responsibilities of federal, state and local governments for reducing coastal risk

• The federal government should work with states to develop a national coastal risk assessment
  – Use this to assess economic, life-safety, social, and environmental costs and benefits under various risk management scenarios

Image source: NOAA
Vision Toward Coastal Risk Reduction

- Stronger incentives are needed to improve pre-disaster risk mitigation efforts at the local level
  - Better align risk, rewards, responsibilities

- The USACE should seize opportunities within existing and new authorities to strengthen coastal risk reduction
  - Evaluate incentives (e.g., cost-share) for sound planning
  - Develop modeling tools, expanded methodologies
  - Re-evaluate 50-yr planning horizon
Summary

• **Coastal risk is increasing**

• Current framework for addressing coastal risk is *reactive rather than proactive* and *encourages risky development*

• **Full array of risk reduction strategies** should be considered

• *Benefit-cost analysis* (constrained by *acceptable risk*, social/environmental considerations) is an appropriate decision framework for investments. *PR&G* provide a framework for this

• A *national vision* for coastal risk management is needed

• Federal government, states should develop a *national coastal risk assessment*

• *Stronger incentives* needed to better align risks, rewards, and responsibilities
Epilogue - New Standards for Flood Protection in the Netherlands

• Announced September 2014
• Revision to flood protection standards dating to 1950s, under development since 2006.

• Risk-based, flood protection standards to control the probability of flooding from a national perspective
  – Benefit-Cost analysis - controls 2/3 of country
  – Local Individual Risk – individual probability of death by flooding < $10^{-5}$
  – Catastrophic loss of life or economic loss - resilience
  – Protect vital and vulnerable infrastructure – resilience

• Prioritizes protection system upgrades (completed by 2050)
• Results in varying level of protection nationally
Epilogue - New Standards for Flood Protection in the Netherlands
Epilogue - New US Policy

• “Guidelines” to accompany *Principles and Requirements for Federal Investments in Water Resources* released 12/2014

• EO 13690 – *Establishing a Federal Flood Risk Management Standard (FFRMS)* …..1/30/2015
  – Updates Executive Order 11988 – Floodplain Management
    i. the *elevation and flood hazard area* that result from using a *climate informed science approach* that uses the best-available, actionable hydrologic and hydraulic data and methods that *integrate current and future changes in flooding based on climate science*;
    ii. BFE + 2’ non-critical, BFE + 3’ critical
    iii. area subject to flooding by the 0.2 percent annual chance flood

• North Atlantic Comprehensive Study – step toward National Risk Assessment
The New Orleans Situation

N.O. largely below sea level
Some areas are sinking >1 inch/yr
BARRIERS OF EARTH AND CONCRETE

Levees and floodwalls that protect against flooding from both the Mississippi River and hurricanes are built by the Army Corps of Engineers and are maintained by local levee districts. The corps and the local districts share the construction cost of hurricane levees, while the Mississippi River levees are a federal project. Local levee districts also build and maintain nonfederal, lower-elevation levees with construction money from each district’s share of property taxes and state financing.

LEVEES AND FLOODWALLS

- Mississippi River
- Hurricane protection
- Interior parish

Notes: Levee and floodwall elevations are drawn with an extremely exaggerated vertical height but are in proportion to each other. Numbers on epidemic sections represent average heights in feet above sea level.

HEIGHT ISN’T EVERYTHING

Different factors permit Lake Pontchartrain levees of varying elevations to withstand an 11½-foot storm surge plus several feet of waves:

- Levees on higher ground and separated from the water by 5 miles of marshland need be only 12½ feet tall
- Levees fronted by breakwaters can be about 14 feet high
- Levees without any breakwaters need to be about 17 feet tall or taller

Seawalls on the water must be 22 feet high

Note: The height and shape of a levee is based on the roughness of the area over which waves pass to reach the structure, and the slope of the structure.
Flood Protection Structures within SLFPA-East

187 Total miles of levee

3,500+ Acres of levee maintenance

8 Navigational structures

259 Land based floodgates

100 Valve gates

56 Total miles of canals

5.4 Miles of seawall

8 Pump stations
Navigational Flood Gates

Lake Pontchartrain

Seabrook Complex Structure
GIWW East Closure By-Pass Gate
Bayou Bienvenue Sector Gate
GIWW East Closure Sector Gate
Bayou Bienvenue Vertical Lift Gate
Bayou Dupre Sector Gate
Caernarvon Sector Gate
Bayou Bienvenue Vertical Lift Gate
Swing Gate
Roller Floodgate
Funding
(Planning, Design and Construction)

- US Congress
  - Authorization
  - Appropriation (Fed Share)

- US Army Corps of Engineers
  - Design and Construct

- Local Sponsor
  - Matching Funds
  - LERRDS

Project Partnering Agreement

Thinking and acting regionally
Operations and Maintenance Activities

- Levee Maintenance
  - Vegetation Management
  - Embankment Repairs
  - Floodwall Maintenance
  - Floodgate Operation and Maintenance

- Drainage Pump Station Operation and Maintenance
- Drainage Canal Maintenance
- Fleet Maintenance
- Permitting
- Inspection and Monitoring
- Emergency Response and Recovery
Operations and Maintenance

• Surge Barrier and Seabrook Complex
  – Acquiring Expertise
  – Coordinating with Maritime Interests
  – Funding

Thinking and acting regionally
EMERGENCY RESPONSE AND RECOVERY

• Floodfight Activities (Response)
  – Monitor Conditions
  – Advise Officials
  – Close Gaps in system
    • Floodgates and Valves
    • Control Structures
    • Sandbagging
  – Initiate Pumping Operations
  – Provide safe havens for employees

• Recover
• After Action Review

Thinking and acting regionally
Thinking and acting regionally, then there's a taxation challenge.

Funding Challenges

Water respects no political boundaries – but money does!
## Annual Operations and Maintenance

### 2016 Projected Annual O&M Revenue / Expenditures:

<table>
<thead>
<tr>
<th>Location</th>
<th>Revenue</th>
<th>Expenditure</th>
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<tbody>
<tr>
<td>East Jefferson</td>
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Thinking and acting regionally
### Annual Operations and Maintenance

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<td>$17 M</td>
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<tr>
<td>Orleans – special</td>
<td>$18 M</td>
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Dashed lines are outside SLFPA-E jurisdiction
Lift project's estimated cost = $40 - $50 million.
## Annual Operations and Maintenance

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Thinking and acting regionally
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<tr>
<td>Lake Borgne Basin (2015)</td>
<td>$ 3.7 M</td>
<td>$ 4.4 M</td>
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2014 & 2015 attempted prop tax increase = $2.5 M /yr → $6 M total / yr

Thinking and acting regionally
A Few Lessons Learned

• FEMA Accreditation (100 – yr protection) does not equal flood safety

• Water respects no political boundaries

• Flood Protection is a shared responsibility

• Flood Protection and Coastal Restoration are not mutually exclusive

• A proactive approach is much less expensive than a reactive approach, (but reaction is often needed to get large $ moving).

• O&M funding challenges are quite different from construction funding challenges....