A Systems Approach Encompassing Natural Defenses and Resilient Structures: Innovative Funding Strategies

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Sandy triggered increased urgency to better prepare coastal areas to meet future risks
- Increasing sea level
- Continued development in vulnerable areas
- Potential changes in storm conditions
- Constrained economic conditions

Systems approaches encompass novel combinations of natural defenses and resilient structures

Innovative funding strategies may be needed
What does the future hold for us?

Increased frequency and intensity of heat waves, along with health and worker safety impacts, drought, species disruptions, increased energy demand for cooling, altered material properties

Changing precipitation, including increases in very heavy precipitation and more intense droughts

Rising sea levels and associated waves, tides, and surges

Continued development in increasingly more vulnerable areas
The Good News: Constraints Can Breed Creativity

- Opportunities for creative problem-solving exist where impacts and constraints are significant
  - Status quo for familiar challenges and constraints
  - We are forced to innovate when the problems are different and funds are tight
  - Solutions will likely involve novel application of existing technologies and materials, or combinations of existing and new technologies and materials
  - Innovative funding is needed as well as innovative engineering
**EO 13653:** Climate is Changing

- Changes are already affecting communities, natural resources, ecosystems, economies, public health
- Impacts are most significant for communities already facing economic or health-related challenges, and for species and habitats already facing other pressures

EO 13653 Definitions

- **Preparedness:**
  - Actions taken to plan, organize, equip, train, and exercise to build, apply, and sustain the capabilities necessary to prevent, protect against, ameliorate the effects of, respond to, and recover from climate change related damages to life, health, property, livelihoods, ecosystems, and national security

- **Resilience:**
  - Ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions
Investing $315 Million in strategic fortification can safeguard $1.1 Billion of vital infrastructure and save the city $2.5 Billion in emergency response costs over the next 50 years.
"Sea level along much of the eastern U.S. was higher than normal for much of June and July 2009, enough to cause significant attention from coastal communities because of the lack of coastal storms that normally cause such anomalies...."

"... unique in that the NE winds were not at a multi-year high or the Florida Current transport at its low. But the coupled effect of the two forces created SL residuals that were at highest levels all along the East Coast."
Multiple Scenarios for Sea Level Change

Comparison of Sea Level Rise Scenarios

Mean Sea Level Trend
9419330 La Jolla, California

USACE Planning Horizon: 2010-2050
Tipping Points: Thresholds, Lead Times, Decision Points

Indicator value
(e.g. sea level rise)

Threshold value of indicator when intervention is needed

Decision point based on best estimate

Predicted values of indicator based on rate of change

Recorded values of indicator

Date of review

Lead time for planning and construction

Time

UK ETL Team Members: Jonathan Simm, Robert Nicholls
Purpose-Driven – Illustration Only

- Coastal Storm Damage Reduction
  - Proximity to water required
  - Navigation
  - Existing infrastructure / sunk costs

- Flood Risk Reduction
  - Density of population impacted
  - Likelihood of repetitive damages

- Ecosystem
  - Rare habitat / endangered species
  - Available retreat/migration space

- Natural to Developed

- Protect
- Accommodate
- Retreat
Performance Ranges: Example for Coastal Storm Damage Reduction

Urbanization

High

Surge Barriers
Seawalls/Revetments
Nonstructural-Floodproofing
Breakwaters
Coral Reefs
Barrier islands
Dunes
Beaches
Salt marshes
Maritime forests

Low

Current

SLR

Strom Impact

Future

Low

High
Example of Alternative Pathways

- Managed retreat (NR)
- Flood plain management (NS)
- Beach nourishment (NS)
- Groins with nourishment (S)
- Dune and foredune vegetation (S)
- Breakwaters (S)
- No action

Legend:
- 50-year planning horizon
- Lead time
- NS: Non-Structural
- S: Structural
- Alternative Pathways

Graph showing Relative Sea Level Rise at 50 years under High SLR scenario.
Integrated Approaches Aren’t New

- Jadwin Report after Flood of 1927
  - Require floodplains to carry flow, robust to floods of 2011
- Mississippi Coastal Improvement Project after Katrina
  - Increased coastal community resiliency
  - Restoration of barrier and near-shore islands enhances protection of mainland areas.
    - Moving private lands into the public sector reduces impacts of future storms and hurricanes and increases resiliency and sustainability
- Natural and nature-based measures can improve the quality and resilience of economic, ecologic, and social systems
- Multiple lines of defense with components addressing different threats support creative and comprehensive approaches
Multiple Lines of Defense

- Quantification of performance of natural and nature-based coastal risk reduction measures is a critical knowledge gap

Sandy’s Rebuild By Design Effort: Hoboken
SAGE – Systems Approach to Geomorphic Engineering

- **Collaborative:**
  - USACE, NOAA, FEMA, The Nature Conservancy, The Conservation Fund, Virginia Institute for Marine Sciences, University of New Orleans, University of Rhode Island
  - Additional experts from states, academia, NGOs, private sector

- **Focuses on innovative approaches to coastal landscape transformation**
  - Comprehensive view of shoreline change
  - Integrate hybrid approaches in coastal communities and shorelines to slow, prevent, mitigate, and adapt to the impacts and consequences of changing weather and climate patterns
Natural and Nature-Based Infrastructure at a Glance

**General Coastal Risk Reduction Performance Factors:**
Storm Intensity, Track, and Forward Speed; Surrounding Local Bathymetry and Topography

- **Dunes and Beaches**
  - Benefits/Processes
    - Breaking of offshore waves
    - Attenuation of wave energy
    - Slow inland water transfer
  - Performance Factors
    - Berm height and width
    - Beach slope
    - Sediment grain size and supply
    - Dune height, crest, and width
    - Presence of vegetation

- **Vegetated Features**
  - Benefits/Processes
    - Breaking of offshore waves
    - Attenuation of wave energy
    - Slow inland water transfer
  - Performance Factors
    - Marsh, wetland, or SAV elevation and continuity
    - Vegetation type and density

- **Oyster and Coral Reefs**
  - Benefits/Processes
    - Breaking of offshore waves
    - Attenuation of wave energy
    - Slow inland water transfer
  - Performance Factors
    - Reef width, elevation, and roughness

- **Barrier Islands**
  - Benefits/Processes
    - Wave attenuation and/or dissipation
    - Sediment stabilization
  - Performance Factors
    - Island elevation, length, and width
    - Land cover
    - Breach susceptibility
    - Proximity to mainland shore

- **Maritime Forests/Shrub Communities**
  - Benefits/Processes
    - Wave attenuation and/or dissipation
    - Shoreline erosion stabilization
    - Soil retention
  - Performance Factors
    - Vegetation height and density
    - Forest dimension
    - Sediment composition
    - Platform elevation
Nonstructural and Floodproofing Measures at a Glance

**General Coastal Risk Reduction Performance Factors:**
Collaboration and Shared Responsibility Framework, Wave Height, Water Level, Storm Duration

- **Floodplain Policy & Management**
  - Benefits/Processes: Improved and controlled floodplain development, Reduced opportunity for damages, Improved natural coast environment
  - Performance Factors: Wave height, Water level, Storm Duration, Agency Collaboration

- **Floodproofing and Impact Reduction**
  - Benefits/Processes: Reduced opportunity for damages, Increased community resiliency, Does not increase flood potential elsewhere
  - Performance Factors: Wave height, Water level, Storm Duration

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  - Benefits/Processes: Reduced opportunity for damages, Increased community resiliency, Does not increase flood potential elsewhere
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- **Relocation**
  - Benefits/Processes: Reduced opportunity for damages, Does not increase flood potential elsewhere, Improved natural coast environment
  - Performance Factors: Wave height, Water level, Storm Duration
Nonstructural and floodproofing measures, including coastal zone management, can have a high return on investment and are a valuable part of a systems approach.
Gilbert F. White, PhD, pioneer in the field of flood risk management:

- “Floods are 'acts of God,' but flood losses are largely acts of man.”

- “Dealing with floods in all their capricious and violent aspects is a problem in part of adjusting human occupancy to the floodplain environment so as to utilize most effectively the natural resources of the plain, and, at the same time, of applying feasible and practicable measures for minimizing the detrimental impacts of floods.”

Structural Measures at a Glance

GENERAL COASTAL RISK REDUCTION PERFORMANCE FACTORS:
STORM SURGE AND WAVE HEIGHT/PERIOD, WATER LEVEL

**Levees**
Benefits/Processes
- Surge and Wave attenuation and/or dissipation
- Reduce Flooding
- Risk Reduction for vulnerable areas

Performance Factors
- Levee height, crest width, and slope
- Wave height and period
- Water level

**Storm Surge Barriers**
Benefits/Processes
- Surge and Wave attenuation
- Reduced Salinity Intrusion

Performance Factors
- Barrier height
- Wave height
- Wave period
- Water level

**Seawalls and Revetments**
Benefits/Processes
- Reduce flooding
- Reduce wave overtopping
- Shoreline stabilization behind structure

Performance Factors
- Wave height
- Wave period
- Water level
- Scour protection

**Groins**
Benefits/Processes
- Shoreline stabilization

Performance Factors
- Groin length, height, orientation, permeability and spacing
- Depth at seaward end
- Wave height
- Water level
- Longshore transportation rates and distribution

**Detached Breakwaters**
Benefits/Processes
- Shoreline stabilization behind structure
- Wave attenuation

Performance Factors
- Breakwater height and width
- Breakwater permeability, proximity to shoreline, orientation and spacing
USACE Infrastructure Strategy

- Manage USACE infrastructure portfolio to be resilient, reliable, and meet the Nation's current and future water resource needs
  - Life Cycle Portfolio Management:
    - Maximize effectiveness of investments to optimize performance over the full lifecycle, including initiation, sustainment, restoration, modernization, and disposition
  - Comprehensive Watershed Planning:
    - Link with federal and non-federal objectives and investments within a watershed or system context
  - Alternative Financing:
    - Leverage alternative financing to sustain CW mission services for existing infrastructure systems and enhance as needed to meet national and regional objectives
  - Strategic Communications:
    - Working relationships with Congress and effective dialogue with traditional and non-traditional stakeholders and partners
Alternative Financing Options

- **Existing Authorities**
  - Contributed funds
  - Hydropower Power Marketing Agreements and Customer Direct Funding
  - Outgrants

- **New Authorities**
  - Federally authorized dedicated taxes and user fees
  - Special experimental program
  - Public-Private Partnerships (P3)

- Deauthorize, dispose/transfer and/or place in caretaker status
Alternative Financing: Initial Existing Authority Pilots

- Pilot-test projects and project actions for which there is non-federal interest and support to use alternative project delivery, funding, or financing under existing authorities
  - Document and evaluate current processes for contributed funds
  - Consider how processes might be streamlined to decrease the time from initial proposal to approval
  - Identify and help implement policy changes to expand opportunities for the use of contributed funds
  - Identify and help secure project actions under current authorities that must be undertaken before proposed alternative processes could move forward

- Pilots cover spectrum of planning, design, construction and O&M
Alternative Financing Pilot Examples

- Planning phase: Los Angeles River Ecosystem restoration feasibility study
- Construction Phase: Folsom Dam accelerated funds agreement
- O&M phase: five-year multi-project maintenance dredging
- More to come
Public-Private Partnership (P3) Requires New Authority

- Examine the potential use of P3 and other alternatives that alter the traditional distribution of project responsibilities
- Evaluate potential to leverage scarce federal resources
  - Identify general project characteristics that are best suited for P3 opportunities
  - Identify current barriers and challenges for employing P3
  - Develop and apply project screening criteria
Summary

- Preparedness is more cost-effective than response/recovery
- Constrained environment can result in creative and innovative engineering approaches
- Employ the full portfolio of measures over a range of potential future conditions
- Consider multiple lines of defense
- Innovative financing can improve speed and effectiveness