Inaugural Research Webinar

Research Plan to Advance the Understanding of Potential Coastal Green Infrastructure Strategies in New York City

March 24, 2015

NEIWPCC

Established in 1947 by an Act of the U.S. Congress
One of six congressionally authorized, nationally recognized interstate agencies
501(c)(3) Not-for-Profit Organization
Compact member states and jurisdictional area include: New York, Rhode Island, Connecticut, Massachusetts, Maine, Vermont and New Hampshire

NEIWPCC Mission

The New England Interstate Water Pollution Control Commission, a not-for-profit interstate agency established by an act of Congress, serves and assists its member states individually and collectively by providing coordination, public education, research, training, and leadership in water management and protection in the New England region and New York State.

Hudson River Programs

NEIWPCC has administered program staffing and finances for 15 years!
Two multi-year contracts with NY for two distinct programs
Current combined-total: $14,000,000+ for efforts through 2020
- Hudson River Estuary Program
- Hudson River National Estuarine Research Reserve
Hudson River Programs

Estuary
- 8 full-time staff
- 3 office locations
- ~$2M annual budget
- Resource management, climate change, green infrastructure, education, improving access

Research Reserve
- 3 full-time staff
- Norrie Point Env. Center. (Staatsburg)
- ~$300k annual budget
- Research, sustainable shoreline, stewardship and conservation, education, sea-level rise

Select Project Partners

Kristin Marcel
- Climate Resiliency Project Coordinator, Hudson River Estuary Program
- NYS Department of Environmental Conservation
- Kristin.Marcell@dec.ny.gov
- (845) 256-3017

Jessica Fain
- Planner, Waterfront and Open Space Division
- NYC Department of City Planning
- jfain@planning.nyc.gov
- (212) 720-3525

Today’s Presenter

Hugh Roberts, PE
- Associate Vice President, ARCADIS
- National Integrated Planning and Numerical Model Lead
- Hugh.Roberts@arcadis-us.com
- (303) 885-4433

Contributing Authors

ARCADIS
- Haihong Zhao
- Hugh Roberts
- Jessica Ludy

Stevens Institute of Technology
- Andrew Rella
- Jon Miller
- Philip Orton

NYC Parks
- Jamie Ong, Marit Larson

Scape Landscape
- Kate Orff, Gena Wirth, Lauren Elachi

The Nature Conservancy
- George Schuler, Lauren Alleman, Andrew Peck, Rebecca Shirer

Matthews Nielsen
- Kim Mathews
Online Access
http://www.dec.ny.gov/lands/100057.html

Project Goal
Develop a research plan that will advance the understanding of the benefits and costs of CGI strategies, ultimately facilitating the selection and implementation of projects which can most successfully improve resiliency in the New York City coastal environment.

CGI Strategies
- Constructed wetlands and maritime forests
- Constructed reefs
- Constructed breakwater islands
- Channel shallowing
- Ecologically enhanced bulkheads and revetments
- Living shorelines (sill-type)

Methodology
- Literature review
- Team discussions
- Expert interviews
- Workshops
  - Project initiation
  - Existing Regulatory Framework
  - Review of Preliminary Research Agenda
  - Over 40 participants and 19 agencies
- Report reviews
Focus Areas
- Hazard mitigation potential
- Potential ecological benefits
- Possible failure causes
- Data required to design, plan, and implement

Report Structure
- Regulatory considerations
- Six CGI strategies
  - Constructed wetlands and maritime forests
  - Constructed reefs
  - Constructed breakwater islands
  - Channel shallowing
  - Ecologically enhanced bulkheads and revetments
  - Living shorelines (sill-type)
- Data, monitoring and integration
- Research Agendas

Regulatory
- Success stories in other states
- No easy assessment of hazards mitigation and ecological benefits
- A thorough habitat evaluation tradeoff is necessary
- Pilot studies relieve some of the regulatory burden by simplifying the approval of CGI

Wetlands and Maritime Forests
- Hazard Mitigation
  - Laboratory and numerical modeling experiments are most common
  - Field measurements during storm events are relatively rare
  - Vegetation resistance is dependent on internal factors (stem density) and external (water depth) factors
### Internal/External Factors

<table>
<thead>
<tr>
<th>Factors</th>
<th>Parameters</th>
<th>Impacts on Vegetative Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetation morphology</td>
<td>Height, stem/trunk diameter, branch, and foliage</td>
<td>Positively correlated</td>
</tr>
<tr>
<td>Vegetation biomechanical</td>
<td>Stiffness of plant shoot (might vary seasonally)</td>
<td>Positively correlated</td>
</tr>
<tr>
<td>properties</td>
<td>Stem density and communities arrangement</td>
<td>Positive correlated</td>
</tr>
<tr>
<td>Wetland continuity</td>
<td>Distance to main coast, edge fringe, dimension,</td>
<td>Intact wetland has the</td>
</tr>
<tr>
<td></td>
<td>ratio of vegetated land area to non-vegetated</td>
<td>highest bulk resistance</td>
</tr>
<tr>
<td></td>
<td>area (water area, road area, swales, mudflats,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>etc.)</td>
<td></td>
</tr>
<tr>
<td>Horizontal extent</td>
<td>Distance in wave propagation or flooding direction</td>
<td>Positively correlated</td>
</tr>
<tr>
<td>Vertical extent</td>
<td>Platform elevation</td>
<td>Positively correlated</td>
</tr>
<tr>
<td>Topographic complexity</td>
<td>Arrangement of topographic features (hummocks,</td>
<td>Unknown</td>
</tr>
<tr>
<td></td>
<td>dunes, swales)</td>
<td></td>
</tr>
<tr>
<td>Water surface elevation</td>
<td>Flow depth</td>
<td>Maximum resistance when flow</td>
</tr>
<tr>
<td>(surge height during a storm</td>
<td></td>
<td>depth is about the height of</td>
</tr>
<tr>
<td>event)</td>
<td></td>
<td>the vegetation (stem), i.e.,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>near-emergent condition</td>
</tr>
<tr>
<td>Wave climates</td>
<td>Wave height and wave period</td>
<td>Not in consensus</td>
</tr>
</tbody>
</table>

### Wetlands and Maritime Forests

- **Ecological Benefits**
  - Quantification/comparison of habitat values to support effective policy-making and management is necessary
  - Review and improve existing habitat values evaluation tools, models and metrics
  - Pilot projects recommended to collect data, test hypotheses, and to support the permitting process

### Reefs
- Wave dissipation is not as standard as traditional breakwaters
- Ecosystem benefits should be better understood
- Some guidance exists for siting, designing and regular monitoring
- Along the north Atlantic coast, reefs are highly susceptible to damage from debris, ice, and/or longshore shifting sediment

### Breakwater Islands
- Benefits vary with project scale, structure, and habitat types
- Challenges associated with this strategy are planning, permitting, and constructing and maintaining a large in-water structure
- A large volume of sediment fill is required
**Channel Shallowing**
- Potential for inundation reduction and ecosystem integrity improvement
- Knowledge on sediment transport and budget is essential
- Urban features and human activities (e.g. water quality and navigation) play important roles affecting the targeted performance

**Ecological Enhancements**
- Lowering pH and texturizing or increasing the complexity of the surface, results in a more diverse recruitment
- The timing of initiation and project implementation is important (e.g. ice and uprooting)
- No standard design guidelines

**Living Shorelines (sill type)**
- The feature is a combination of sill, sediment fill and vegetation planting
- Sills can be easily adjusted to accommodate changes in water level due to rising seas
- Ice and wake damages need be considered
- No standard design guidelines

**Data Management**
- Effective data dissemination requires a cross-agencies platform to unify the data format, to avoid duplicate efforts, and improve data availability
- Baseline Data Needs
  - Currents and wave
  - Ice (floating and build-up)
  - Wakes
  - Vegetation biomechanics
  - Other ecosystem indicators (e.g. species abundance)
Integration

- Conceptual models as non-quantitative planning tools are needed to synchronize science, data and policy across agencies.

- Monitoring programs for the regional baseline data and site-specific data collection are required.

Research Agenda

- Sorted into two groups
  - Meta strategy
  - Strategy Specific

- How were Research Agendas scored?
  - Fundamental Principles
  - Chronology
  - Regional Applicability, and
  - Affordability

Workshop Rankings
**Conceptual Models**
- Develop, refine, and document a common understanding of ecosystems and hazard mitigation.
- Identify important processes, key ecological attributes and indicators, and
- Integrate the current understanding of system dynamics across groups and agencies.

**Priority Habitats Coordination**
- Identify critical species and habitats relevant to overall agency goals
- Standardize and prioritize screening criteria
- Apply NYC-specific research to modify or add to this list of critical species
- Create an overall, agency-coordinated ranking of priority habitats and sites that will allow for more efficient permitting and design along the shoreline

**Monitoring protocol**
- Provide a framework coordinating monitoring efforts and uniting research forces.
### Sediment Study

Understanding both the sediment budget and sediment longshore/cross-shore transport can provide important insight into the nature of the sedimentary system, landscape morphology, and the feasibility of particular CGI strategies.

### Ice Study

**Ice Study**

Improve the guidance for incorporating ice forces into the design of both traditional and CGI coastal protection works, including uprooting of vegetation.

### Vessel Wake Assessment

**Vessel Wake Assessment**

Accurately establish the wave climate including wakes. Wave height drives the design of many CGI projects.
Cross-Agency Data and Metadata Management

Abundant data can improve the understanding of NYC baseline conditions and can provide a better framework in which CGI projects will be designed and implemented. A cross-agency data management tool is recommended both to store and share available observational data and metadata for proposed and implemented projects in NYC to centralize updated project information including goals and objectives, strategy types, innovative design concepts, implementation challenges, performance evaluations, lessons learned, etc.

Pilot Project Identification, Implementation, and Monitoring (Living Laboratory)

Many hypotheses related to the hazard mitigation potential and ecological benefits of CGI strategies require field observation data to further evaluate and refine. Pilot projects are critically important to systematically address hypotheses that require field observations and monitoring. Because pilot projects may be challenging to implement due to regulatory and cost considerations, it is recommended that pilot studies in the area be prioritized prior to implementation.

CGI Strategy and Shoreline Prioritization

- Mapping NYC shorelines with applicable, most beneficial CGI techniques using available data and metrics, including consideration of sea level rise impacts on critical at-risk ecosystems (e.g., evaluate which ecosystems and locations may shift quickly or disappear with sea level rise).
- Helping to prioritize projects throughout the region and to make robust and data-backed decision.
Quantifying Coastal Resiliency Benefits

- CGI strategies generally have little to no impact on stillwater (storm tide) levels during storm events.
- The most significant hazard mitigation benefits are reductions in current velocity and wave energy.
- A systematic means to assess the economic impacts and damage reductions associated with these benefits has not been developed.

Vegetative Flow Resistance and Storm Wave Attenuation Potential of Salt Marsh and Maritime Forest

- Test existing vegetative resistance formula and friction coefficients;
- Examine the potential of intact and fragmented (patchy) wetland and maritime forests for reducing storm surge and waves; and
- Explore surge/wave reduction capability and its relationship with internal and external factors.

Defining and Standardizing Design Guidelines for Living Shorelines and Ecologically Enhanced Bulkheads and Revetments

- Stone size,
- Armoring depth,
- Vegetation maintenance,
- Window spacing, and
- Distance of the sill from the shore edge.
Next Steps

- Partnership: DEC Hudson River Estuary Program, NYC Department of City Planning, the New York-New Jersey Harbor & Estuary Program
- Consensus Building Institute will assist with strategic planning and stakeholder interviews to ID ways to move the plan forward in the years to come.
- Welcome ideas and suggestions!

Questions & Answers

- We will be posting this webinar and future research-related webinars at neiwpcc.org
- Follow @NEIWPCC to keep up-to-date
- THANK YOU!