Tools for Climate Change Adaptation and Flood Risk Resiliency

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Presentation Outline

• **Background**
  – Climate Change, Extreme Events, Storm Surge

• **How to Decrease Risk and Increase Resiliency?**

• **Tools:**
  - **Identify the Problem**
    - Visualization
  - **Assess the Problem**
    - Audits
  - **Prepare for Impact**
    - Dashboards
  - **Implement Solutions**
    - Active Control
What Climate Changes Means for MA

- 10% increase in avg. annual precip. in Northeast (1895 – 2011)
- Precip. from heavy storms has increased 70% since 1958
- Increased intensity of both floods and droughts
- Erosion of wetlands and beaches from coastal storms from sea level rise and storm surge
- Loss of coastal wetlands removes defense against coastal flooding
• **Storm Surge** is an abnormal rise of water generated by a storm, over and above the predicted astronomical tides.

This rise in water level can cause extreme flooding in coastal areas particularly when storm surge coincides with normal high tide.

Source: http://www.nhc.noaa.gov/surge/
Storm Surges and Climate Change

• Storm surges expected to become more frequent and/or intense with changing climate
  – More intense precipitation
  – Higher sea level/ tides

• Storm Surge Resiliency Planning for Climate Change:
  – Provides present day benefit (i.e. resiliency for 5-yr)
  – Provides a “preview” of surges/ sea level rise anticipated later in the century
  – Starts the needed process of implementation of resilient coastal infrastructure
Identify the Problem:
Modeling and Data Visualizations
• Geospatial Analysis Tool
  – Climate change resiliency planning
    • Sea level rise scenarios
    • Storm surge Scenarios
  – Ecological restoration planning
    • Where is restoration feasible... Without increased flood risk?
Select flood condition and optional sea level rise to visualize impacts.

Coastal Storm Surge:
- MHHW
- 2-yr flood
- 10-yr flood
- 25-yr flood
- 50-yr flood
- 100-yr flood

Sea Level Rise (ft):
Select a sea level rise condition in feet above Mean Higher High Water (MHHW)
- MHHW
- +1
- +2
- +3
- +4
- +5
- +6
Select flood condition and optional sea level rise to visualize impacts.

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ACarnes & ACAiazzo | Esri, HERE, DeLorme, NGA, USGS
EASTHAM-02 IMPACT ANALYSIS
Surge 10yr; SLR 0
Total Flood: 20.92 ac
Flooded Wetland: 16.31 ac
Structures: 2
EASTHAM-02 IMPACT ANALYSIS
Surge 10yr; SLR 1
Total Flood: 23.71 ac
Flooded Wetland: 16.56 ac
Structures: 3
EASTHAM-02 IMPACT ANALYSIS
Surge 10yr; SLR 3
Total Flood: 25.84 ac
Flooded Wetland: 16.63 ac
Structures: 6
EASTHAM-02 IMPACT ANALYSIS
Surge 10yr; SLR 3
Total Flood: 25.84 ac
Flooded Wetland: 16.63 ac
Structures: 6
• Standardized Field Assessment Protocols / Forms
• 50 Tide Gate Assessments / Staff Training
Identify the Problem: Takeaways

1. Scenario Driven Modeling Results

2. Findings Shareable Via Web (Secure or Public)

3. Interact and Visualize Scenarios
Assess the Problem:
Hyper-Localized Resiliency Audits
RISE:NYC Overview

- Superstorm Sandy business recovery program managed by New York City Economic Development Corporation
- Launched in 2014 as a global competition to identify innovative technologies to improve a business’ ability to adapt to and mitigate the impacts of climate change

Source: http://rise-nyc.com/
Tool #2: Resiliency Audits

• **Purpose:**
  – Identify potential flood risk and flood vulnerabilities

• **Step 1 – Modeling:**
  – Estimate localized flooding elevations under different rainfall, tidal and surge conditions

• **Step 2 – Resiliency Audit:**
  – Field assessment to identify vulnerable building features and measures to help mitigate flood risk
Resiliency Audit Tools

- Allows flexible approach, _with or without_ survey equipment.

- Can use web-accessible device _or_ paper field forms
Resiliency Audits Protocol

• **Site Review:**
  – Locate site features (parking lots, alleys, private storm sewers)
  – Examine elevations of features and compare with estimated flood elevations (from modeling)

• **Building Exterior Check:**
  – Identify exterior features - window, doors, utilities
  – Examine elevation, seals, current floodproofing

• **Building Interior Check:**
  – Examine interior seals and current floodproofing (if present)
  – Identify valuable equipment or materials located below estimated flood elevations
Assessing Exterior Vulnerabilities

Superstorm Sandy High Water Mark
Assessing Interior Vulnerabilities

Seepage
Flood Resiliency Audit Form

Sample Company Audited: XX/XX/20XX

[Photo(s) of identified Building Zone vulnerabilities]

1. (01)-161206-018.JPEG

Steel door at southern building exterior

2. Vulnerability indicates the number of potential risk areas identified in the flood modeling process. Flood risk predictions are provided for information purposes only.

Number of Identified Vulnerabilities

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<th>Stairs</th>
<th>Basement</th>
<th>Build</th>
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<tbody>
<tr>
<td>Max</td>
<td>Min</td>
<td>Min</td>
<td>Max</td>
</tr>
</tbody>
</table>

3. Potential Solutions: Floodproofing and/or flood control measures are listed below. Potential floodproofing strategies could be used to mitigate any potential flood risk.

The most effective potential measures include:
- Stackable flood gate for storefront windows.
- Waterproofing of stairwells.
- Floodproofing of basements.
- Floodproofing of buildings.

Background and Purpose:

This business was selected for inclusion in a flood resiliency audit program managed by the Development Block Office, Urban Development, receiving flood resilient zone funds. This report was developed to provide an explanation of specific vulnerabilities considered to help mitigate flood risk.

Disclaimer and Limitations:

Information collected for this audit is based on the flood modeling assumptions and flood risk predictions provided. The results are intended for informational purposes only.

Summary of Findings:

Three flood risk zones potentially occur: 1) Inundation risk for each flood zone, 2) basement floor of the building above the flood level, and 3) flooding in the building.

1. Inundation Risk:
   - Risk for each flood zone is determined by the combined precipitation expected to occur once every mean high-water level.
   - Annualized risk is based on the inundation depth.

Refer to the accompanying audit report for additional information.
Accompanying Fact Sheets

**Floodproofing Fact Sheets**

**SUMP System Detectors**
- Pros: Keeps flooding under control
- Cons: Can be a subject to mechanical failure

**ELEVATING Method entails elevating them a foot on top of it**
- Pros: Lower cost, more likely to be maintained
- Cons: Can be a subject to mechanical failure

**SEWER**
- Pros: Prevents or reduces flooding
- Cons: Requires substantial excavation

**RETRACTABLE Gates**
- Pros: Provides permanent flood protection
- Cons: Requires extensive excavation

**SAND BAGS**
- Pros: Provides temporary flood protection
- Cons: Requires additional labor

**INFLATABLE BARRIERS**
- Pros: Inflatable and deflatable
- Cons: Requires additional labor

**Local New York Suppliers:**
- www.sumpwarehouse.com
- www.elevatingproducts.com
- www.retractablegates.com
- www.sandbagging.com
- www.inflatablebarriers.com

**Cost for Average Building Installation**

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**Sources and Additional Information:**
- www.fema.gov/500edition
- www.fema.gov/500edition
- www.fema.gov/500edition
- www.fema.gov/500edition
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Assess the Problem: Takeaways

1. Location Specific Resiliency Assessments

2. Data Collection via. Web-Based Form

3. Auto Generated Reports
   - Modeling Results & Expected Risk
   - Identified Vulnerabilities
   - Recommendations & Fact Sheets
Prepare for Impact: Resiliency Dashboards
Resiliency Network – Map Dashboard

Color-coded locations by real-time estimated flood inundation level

Forecasted flood risk/inundation level for each business
Site-Specific Resiliency Dashboard

- Estimated Flood Risk Indicator
- Precipitation Forecast
- Storm Surge Forecast
- List of Major Flood Risks
- Links to Reports
- National Precipitation Forecast

Resiliency Dashboard

Site Information
ABC Business
123 Sesame St.
New York, NY
11614
(917) 776-1234

Current Status
- System Status
- Notification Sent

Major Flood Risks:
- Basement flooding of inventory
- Flooding of loading dock

Additional Information:
- Resiliency Audit
- Flood Proofing Fact Sheets
- City Wide Emergency Notification Sites

Flood Risk Status
- ABC Business Current Flood Risk Status

24hr Forecasted Precipitation
3 in

Storm Tide
5.5 feet

National Forecast (6 Hours)
The Resiliency Dashboards will monitor forecasted storm event conditions and alert business owners of current estimated flood risk (in real-time!) so actions can be taken, if necessary, to prepare for the storm.
Prepare for Impact: Takeaways

1. Real-Time estimates of flooding inundation risk (including timing)

2. Actions can be taken to prepare for storm and increase resiliency

3. Heightens overall community awareness
Implementing Solutions:
Active Management & Control
Tool #4: Active Alerting Dashboard

Human Active Control
- Site Information
  ABC Business
  123 Sesame Street
  New York, NY
  11694
  (917) 776-1234

  - Current Status
    - System Status
    - Notification Sent

  - Major Flood Risks:
    - Basement flooding of inventory
    - Flooding of loading dock

  - Additional Information:
    - Resilience Audit
    - Flood Proofing Fact Sheets
    - City Wide Emergency Notification Sites

Data is subject to datasource availability.

Recommended Actions Listed
- Flood Risk is Low
  - No Action Needed

National Forecast (6 Hours)
Floodproofing Fact Sheets

Wet/Dry Sensor

Wet sensors, which detect the presence of water, are often used in flood monitoring systems to alert businesses or homeowners to potential water damage. These sensors are typically installed in areas prone to flooding, such as basements or attics. When activated, they trigger an alarm or send a signal to a central monitoring station.

**Pros**
- Reliable detection of water levels
- Early warning system

**Cons**
- Requires maintenance and occasional calibration

**Active Floodproofing System**

Active floodproofing systems alert businesses and homeowners to immediate flooding threats. These systems can be installed as permanent fixtures or as temporary solutions. They are designed to prevent water from entering critical areas and to minimize damage.

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**OptiFlood**

OptiFlood is a web-based platform that incorporates weather forecast and other real-time, forecasted, sensor and site-specific data to provide a current flood risk assessment and floodproofing recommendations. This system also provides remote manual and/or automated control options for Temporary Barrier Systems.

**Pros**
- Provides real-time flood risk assessment
- Customizable control options

**Cons**
- Requires internet connection
- May require specialized training to use
The Active Floodproofing Dashboards will alert business owners of any specific actions taken by the system to increase their storm surge resiliency.
Tool #4: Active Controls

• Case Study: Curtiss Pond, Minnesota

• Goal
  – Increase Efficiency of Pond through retrofit with Continuous Monitoring and Control

• Benefits

  - Minimize Flooding & Reduce Site Risk
  - Intelligent Infiltration
  - Minimal Maintenance
  - Remote Monitoring & Programming
Site Overview

- Control Panel
- Pond
- Existing Manhole
- Access to Infiltration Gallery
Site Overview
Manhole with Equipment

- Actuator
- Overflow Weir
- Level Sensor
How Does it Work?

Opti

Cloud-native platform that uses sensor data, forecast information, & modeling to actively control and/or maintain/monitor water infrastructure.
Traditional Infrastructure

- Stormwater runoff is managed with passive infrastructure designed for a single purpose and design storm
- Performance and maintenance needs of stormwater infrastructure are manually calculated or unknown

*Image Courtesy of OptiRTC*
Continuous Monitoring & Adaptive Control

*Image Courtesy of OptiRTC*
Control Dashboard Visualization
Control Dashboard Visualization

- **Forecasted Incoming Runoff**
  - Volume (ft³)
    - 2015-11-11 17:35:49
    - 62991.4

- **System Control**
  - Operation Mode
    - Automatic Control
    - Manual Control
  - Valve Control
    - Open
    - Close

- **System Status**
  - Manual Control State
    - 100.0% Auto | 0.0% Manual
  - Valve Position
    - 96.8% Closed | 3.2% Open
  - Connectivity
    - 99.2% Online | 0.8% Offline

Requested changes may take several minutes to be verified.
Control Dashboard Visualization

Pond Level

Pond drained before Storm (~10,000-CF Drained)

Precipitation Forecast

Forecast Rain of Over 1 Inch

Infiltration Gallery

GEOSYNTec CONSULTANTS
Overflow Capacity Reached

8’ depth reached! (Max = ~10’)

Capacity regained

Post-Storm
1. Optimize performance of traditional infrastructure

2. Remote monitoring and programming

3. Minimize potentialflooding risk