Not Your Average Risk Assessment: Multi-Stage Risk Assessments for Sites in the Passaic River Basin

Stuart Geiger, CFM
Joseph Ruggeri, PE, CFM
Agenda

• Project Background

• Risk Assessment Development
  • Refined structure and parcel information
  • Pitfalls and Workarounds

• How one FIM library assesses a location’s flood risk

• How the results of a flood risk assessment can be used to identify targets for future mitigation
About the Project

• Gov. Christie signs Exec. Order 23 establishing Passaic River Advisory Commission in 2010

• 15 Recommendations

• Inundation Mapping underway at 21 locations

• All locations to receive risk assessment

• Partners

- National Weather Service
- USGS: science for a changing world
- US Army Corps of Engineers
<table>
<thead>
<tr>
<th>Work Underway</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summary of Gage Locations</strong></td>
</tr>
<tr>
<td>Hackensack River</td>
</tr>
<tr>
<td>at Rivervale</td>
</tr>
<tr>
<td>at New Milford</td>
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<tr>
<td>Passaic River</td>
</tr>
<tr>
<td>at Two Bridges</td>
</tr>
<tr>
<td>at Pine Brook</td>
</tr>
<tr>
<td>near Chatham</td>
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<tr>
<td>near Millington</td>
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<tr>
<td>at Little Falls</td>
</tr>
<tr>
<td>Dundee Dam at Clifton</td>
</tr>
<tr>
<td>Pequannock River</td>
</tr>
<tr>
<td>at Macopin Intake Dam</td>
</tr>
<tr>
<td>Ramapo River</td>
</tr>
<tr>
<td>at Pompton Lakes</td>
</tr>
<tr>
<td>at Oakland</td>
</tr>
<tr>
<td>near Mahwah</td>
</tr>
</tbody>
</table>
Project Process

Data Collection

- H&H Models from ongoing FEMA re-studies
- LiDAR
- NWS Flood Impacts (E-19)

Inundation Mapping

- Calibrate FEMA model to USGS rating curve
- Establish WSEL values for target stages
- Develop inundation maps and depth grids

Risk Assessment

- Develop user-defined facilities from NJ ModIV tax rolls
- Evaluate parcels/structures against FIM depth grids
- Run HAZUS
Developing UDFs
From Tax Roll to HAZUS

• Develop Hazus User-Defined Facilities (UDF)
  • Individual buildings in Hazus
  • Represented as point feature
  • Required model attributes:
    • Occupancy (33 Default Types)
    • Building Type (5 Default Types)
    • Replacement Cost
    • Year Built
    • Number of Stories
    • Foundation Type (7 Default Types)
    • 1st-Floor Height
Challenges in Developing UDFs

• Building Footprint
  • Sporadic throughout project area
    • Digitize or Use Parcel Centroid?
  • Differentiate use types or accessory buildings
    • Consider a strip mall typically COM1 – Retail
    • What if strip mall has the following?
      • Restaurant (COM8)
      • Beauty Salon (COM3)
      • Clothing store (COM1)
  • CHALLENGE: replacement values will suffer if not differentiated?
Sporadic Building Coverage

**Project Stream Gages and Project Areas**

**Building Footprint Coverage in Red**

**SOLUTION**: use centroid of parcel; not perfect but is considered industry-standard
One footprint, many uses

SOLUTION: split building polygons

<table>
<thead>
<tr>
<th>Occupancy</th>
<th>Cost_SF</th>
</tr>
</thead>
<tbody>
<tr>
<td>COM1</td>
<td>$82.63</td>
</tr>
<tr>
<td>COM2</td>
<td>$75.95</td>
</tr>
<tr>
<td>COM3</td>
<td>$102.34</td>
</tr>
<tr>
<td>COM4</td>
<td>$133.43</td>
</tr>
<tr>
<td>COM5</td>
<td>$191.53</td>
</tr>
<tr>
<td>COM6</td>
<td>$224.29</td>
</tr>
<tr>
<td>COM7</td>
<td>$164.18</td>
</tr>
<tr>
<td>COM8</td>
<td>$170.51</td>
</tr>
<tr>
<td>COM9</td>
<td>$122.05</td>
</tr>
</tbody>
</table>

Salon (COM3) $102.34/ft²
Restaurant (COM8) $170.51/ft²
Retail (COM1) $82.63/ft²
Outbuildings

- Distinction between "MAIN" and "ACCESSORY" necessary for conflation of parcel attributes to building footprints.
More challenges...

• Parcel Polygons
  • Parcels may come from different base map than footprints
    • Spatial inaccuracy such that footprint may not be 100% contained in proper parcel
    • CHALLENGE: buildings assigned to wrong parcel will have wrong attributes

• State-Level Assessor Attributes
  • Prepared to join with Parcel Polygons but NOT:
    • 100% of a 1 To 1 Relationship (e.g. condominiums)
    • CHALLENGE: assigning proper model attributes, calculating proper replacement cost
Spatial Inconsistencies

• Structures straddle parcels; Tax Assessor records only associated with one of the parcels

• Structures straddle Census Blocks; assignment affects Risk MAP census block totals

SOLUTION: analyze building polygons and assign appropriate parcel and census block
Conflation

• Translate existing tax data to parcels/structures

• Tax Records
  • NJ Assessor Database
    • Some attributes cannot fully translate to the 33 Hazus Occupancy Types
  • Building Description Issues
    • Many records do NOT follow the data dictionary
    • CHALLENGE: inability to assign Occupancy and other Hazus UDF attributes
Property Class - 2 in NJ can be one of four types in Hazus

Table 3.1 Hazus Building Occupancy Classes

<table>
<thead>
<tr>
<th>Hazus Label</th>
<th>Occupancy Class</th>
<th>Standard Industrial Codes (SIC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RES1</td>
<td>Single Family Dwelling</td>
<td></td>
</tr>
<tr>
<td>RES2</td>
<td>Mobile Home</td>
<td></td>
</tr>
<tr>
<td>RES3A</td>
<td>Multi Family Dwelling - Duplex</td>
<td></td>
</tr>
<tr>
<td>RES3B</td>
<td>Multi Family Dwelling – 3-4 Units</td>
<td></td>
</tr>
<tr>
<td>RES3C</td>
<td>Multi Family Dwelling – 5-9 Units</td>
<td></td>
</tr>
<tr>
<td>RES3D</td>
<td>Multi Family Dwelling – 10-19 Units</td>
<td></td>
</tr>
<tr>
<td>RES3E</td>
<td>Multi Family Dwelling – 20-49 Units</td>
<td></td>
</tr>
<tr>
<td>RES3F</td>
<td>Multi Family Dwelling – 50+ Units</td>
<td></td>
</tr>
<tr>
<td>RES4</td>
<td>Temporary Lodging</td>
<td>70</td>
</tr>
<tr>
<td>RES5</td>
<td>Institutional Dormitory</td>
<td></td>
</tr>
<tr>
<td>RES6</td>
<td>Nursing Home</td>
<td>8051, 8052, 8059</td>
</tr>
</tbody>
</table>

SOLUTION: additional attributes MUST be considered
Deciphering MOD IV

Revised as of January 2010

MOD IV USER MANUAL
TABLE OF CONTENT

Building Description Field
This is a fifteen space, alpha-numeric field.

Example: 1.5SSTL2AG means: 1 1/2 story stone colonial with a 2 car attached garage

   BLDG_DESC | FREQUENCY | INTERPRETATION
-------------|-----------|---------------------
   2SF        | 1573      | 2story framed       
   1SF        | 1488      | 1story framed       
   1F         | 1458      | 1story framed       
   1SF1G      | 1077      | 1story framed 1garage
   2SF2G      | 787       | 2story framed 2garages
   1SF2G      | 695       | 1story framed 2garages
   1SFG1      | 654       | 1story framed 1garage
   1S F       | 572       | 1story framed       
   1F         | 496       | 1story framed       
   1S F G1    | 465       | 1story framed 1garage
   2SF1G      | 432       | 2story framed 1garage
   2S-F       | 386       | 2story framed       

Example Actual Values

SOLUTION: interpretations and additional attributes, or assign random per Hazus mapping scheme, or contact each municipality
Conflation Issues

Conflation Issues to be aware of:

- Tax Assessors will code Apartments & other rental dwellings as Commercial – HAZUS requires Apartments labeled as Residential (RES3) ; # of units is required to code

- Watch for building footprints that are not split to match ownership; e.g. townhomes
Saddle River at Lodi, NJ
In Action: Saddle River at Lodi, NJ

- Approximately 2.5 mile reach
- Approximately 200 at-risk structures
- Two significant floods in last 6 years:
  - August 2011: 13.5 ft
  - April 2007: 12.9 ft
- Flood of record
  - September 1999: 13.9 ft
Structures by Stage

Impact to Structures by Flood Stage
*Saddle River at Lodi, NJ*

- **5.5 Action Stage**
- **6 Flood Stage**
- **7 Moderate Flood Stage**
- **8 Major Flood Stage**
Financial Losses - Structures

Losses to Structures by Flood Stage
*Saddle River at Lodi, NJ*

- **Losses ($)**
  - $8,000,000.00
  - $6,000,000.00
  - $4,000,000.00
  - $2,000,000.00
  - $-

- **Gage Height (ft)**
  - 0
  - 2
  - 4
  - 6
  - 8
  - 10
  - 12
  - 14
  - 16

- **Structure Losses**

- **Flood Stages**
  - 5.5 Action Stage
  - 6 Flood Stage
  - 7 Moderate Flood Stage
  - 8 Major Flood Stage
Financial Losses - Contents

Losses to Structure Contents by Flood Stage
Saddle River at Lodi, NJ

Gage Height (ft)

- 5.5 Action Stage
- 6 Flood Stage
- 7 Moderate Flood Stage
- 8 Major Flood Stage
Finding Natural Breaks

Average Loss Per Structure by Flood Stage
Saddle River at Lodi, NJ

- Loss/Structure
- 100yr
- 25yr

5.5Action Stage
6Flood Stage
7Moderate Flood Stage
8Major Flood Stage
Breaks Identify Potential for Mitigation

Impact to Structures by Flood Stage
*Saddle River at Lodi, NJ*

- **5.5Action Stage**
- **6Flood Stage**
- **7Moderate Flood Stage**
- **8Major Flood Stage**
Making Use of the Flood Risk Assessment
Mitigation Planning is Key

Hazard Mitigation Planning is part of the overall planning for any community – Comprehensive, economic development, infrastructure, mitigation and emergency planning are all facets of the same process.

- **Initiate Plan**
- **Identify Hazards**
- **Assess Risks**
- **Create Mitigation Strategy**
- **Develop Action Plans**
- **Adopt Plan**
- **Implement Plan**
- **Update Plan**

This Project Covers the Following:

- **Flood Reduction**
Conducting a Flood Risk Assessment

- Risk = Probability x Economic Losses

- Leverage all tools – Map Modernization Program and Risk MAP and now FIM - for flood mapping using today’s and tomorrow’s technologies.

**Tools**

<table>
<thead>
<tr>
<th>Map Mod</th>
<th>Risk MAP</th>
<th>FIM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1% Depth Grid*</td>
<td>0.2%, 1%, 2%, 4%, 10% Depth Grids</td>
<td>Multi-stage depth grids</td>
</tr>
<tr>
<td>Depth-Damage Function</td>
<td>Depth-Damage Function</td>
<td>Depth-Damage Function</td>
</tr>
<tr>
<td>1% Annual Chance Losses</td>
<td>Annualized Losses</td>
<td>Stage-Based Losses</td>
</tr>
</tbody>
</table>

**Flood Data**

**User-Supplied Data**

* Derived from flood hazard data and quality topographical information.
Uses of Inundation Mapping

- Mapped stages cover the areas in between FEMA’s standard 1% and 0.2% annual chance delineations

- Understanding the full spectrum of which structures or parcels that are affected by lower inundation levels is important = greater value for mitigation options.
What goes into a Benefit-Cost Analysis?

<table>
<thead>
<tr>
<th>Window in BCA Software</th>
<th>BCA Attribute</th>
<th>User</th>
<th>Risk MAP</th>
<th>DFIRM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure Identification</td>
<td>Structure Name</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>Structure Type</td>
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<td>✔</td>
</tr>
<tr>
<td></td>
<td>Site Name</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td></td>
<td>Zipcode</td>
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<tr>
<td>Flood Mitigation Type</td>
<td>Mitigation Type</td>
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<tr>
<td>Questionnaire</td>
<td>Is the source of flooding a river?</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td></td>
<td>Coastal A or V Flooding</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>Cost Estimation</td>
<td>Project Useful Life</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>Mitigation Project Cost</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Elevation and Discharge Data</td>
<td>First Floor Elevation (ft)</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>Streambed Elevation (ft)</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>At what Elevation will the barrier be overtopped?</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>Base Flood Elevation or 100-year elevation including wave action (ft.)</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>How many feet is the first floor being raised?</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<td></td>
<td>Return Interval 10</td>
<td>✔</td>
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<td>✔</td>
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<tr>
<td></td>
<td>Elevation Before Mitigation</td>
<td>✔</td>
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<td>✔</td>
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<tr>
<td></td>
<td>Return Interval 10</td>
<td>✔</td>
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<td>✔</td>
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<tr>
<td></td>
<td>Discharge Before Mitigation</td>
<td>✔</td>
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</tr>
<tr>
<td></td>
<td>Return Interval 50</td>
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<td>✔</td>
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</tr>
<tr>
<td></td>
<td>Elevation Before Mitigation</td>
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<td>✔</td>
</tr>
<tr>
<td></td>
<td>Return Interval 50</td>
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<td>✔</td>
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<td>Discharge Before Mitigation</td>
<td>✔</td>
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<tr>
<td></td>
<td>Return Interval 100</td>
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<td></td>
<td>Discharge Before Mitigation</td>
<td>✔</td>
<td>✔</td>
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</tr>
</tbody>
</table>

Information from:
- Structure Identification
- Questionnaire
- Cost Estimation
- Elevation and Discharge Data

<table>
<thead>
<tr>
<th>Window in BCA Software</th>
<th>BCA Attribute</th>
<th>User</th>
<th>Risk MAP</th>
<th>DFIRM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure Information</td>
<td>Total size of building (sf)</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>Value of building (BRV) ($/sf)</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>Is the building residential?</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td></td>
<td>What is the building type?</td>
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<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>What is the foundation type?</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>Is there an obstruction?</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>Does a basement exist?</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

Information from:
- User-Supplied Data

Benefit-Cost Analysis

Flood Hazard Data

User-Supplied Data
Data is great, but...

• ...only if you can use it.

• Individual BCRs may be combined to get an overall project BCR.

Elevation of 3’
BCR: 3.2

Elevation of 1’
BCR: 1.5

Acquisition
BCR: 4.3

Floodwall
BCR: 1.3
What have we created here?

• Quantitative basin-wide assessment of flood risk in populated areas near gages.
  • Actionable data that can support future mitigation planning efforts and provide BCA justifications

• Developed a repository of structure types and estimated losses
  • Stored in a FEMA Flood Risk Database (FRD) schema (with slight modification)
  • Demonstrates how different programs can talk

• Comprehensive identification and assessment of flood risk that can be used to:
  • Communicate risk
  • Develop tools for decision makers
  • Identify markets and/or targets for mitigation
Contact Us

• Joseph Ruggeri  
  New Jersey Dept of Environmental Protection  
  joseph.ruggeri@dep.state.nj.us  
  609.292.2296

• Stuart Geiger  
  Dewberry  
  sgeiger@dewberry.com  
  303.951.0620