Estimating the Return on Investment of Buyouts: Loss Avoidance Study for the City of Ottawa, Illinois

Brad McVay, GISP, CFM
Chris Hanstad, P.E., CFM
Sally McConkey, P.E., CFM, D. WRE.
Overview

- City of Ottawa, IL
  - Confluence of Illinois River and Fox River
- Major Flood in 1996
- Over the past 20 years Ottawa has been working to remove at-risk structures from the floodplain
- Case study
  - Estimate the Return on Investment (ROI) for these buyouts
  - State of Illinois Hazard Mitigation Plan
BCA versus Loss Avoidance

- Benefit-Cost Analysis (BCA) vs. Loss Avoidance
  - BCA
    - Estimate of future benefits of a mitigation project
    - Benefit Cost Ratio (BCR)
      - Total Benefits / Total Cost
  - Loss Avoidance Analysis
    - Estimate of the return on investment from real flood events that have occurred in the past
    - Return on Investment
      - Losses Avoided / Project Investment * 100
- Looking at what could happen vs. what has happened
Project Partners

• Illinois State Water Survey (ISWS)
• Critical Infrastructure Resilience Institute (CIRI)
• Illinois Department of Natural Resources, Office of Water Resources (IDNR/OWR)
• Illinois Emergency Management Agency (IEMA)
• City of Ottawa
• LaSalle County
Summary

- Description of Project Area (City of Ottawa)
- History
  - Flooding
  - Funding
- Gathering and Developing Data for Analysis
- Hazus Analysis
- Timeline of Buyouts and Results
- Central Elementary School and Heritage Harbor
- Obstacles
- Drone Flight
City of Ottawa
LaSalle County, Illinois
Recent History of Flooding

• Fox River at Dayton
  • Flood Stage: 12’
  • Moderate: 14’
  • Major: 24’

  • Peaks
    • Peak of Record: 24.63’ (Oct. 1954)
    • 7/19/1996: 24.47’
    • 2/22/1997: 21.46’
    • 1/17/2005: 17.53’
    • 8/24/2007: 16.86’
    • 9/14/2008: 21.48’
    • 4/19/2013: 20.74’
    • 2/21/2018: 15.94’

• Illinois River at Ottawa
  • Flood Stage: 463’
  • Moderate: 466’
  • Major: 469’

  • Peaks
    • Started Recording 2008
    • 9/16/2008: 472.21’
    • 3/11/2009: 470.23’
    • 4/19/2013: 473.72’
    • 2/22/2018: 471.49’

Source: LaSalle Co. FIS, NWS Advanced Hydrologic Prediction Service
Source: NWS Advanced Hydrologic Prediction Service
Summary

- Description of City of Ottawa
- History
  - Flooding
  - Buyouts
- **Gathering and Developing Data for Analysis**
- Hazus Analysis
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Data for Analysis

• Building Inventory
  • Points representing each buyout structure used in analysis

• Flood Depth Grids
  • Generated from 15 modeled historical flood events between 1996 and 2017
  • Will include Feb. 2018 flood event
Data Sources

• Parcel GIS Shapefile
  • Provided by LaSalle County

• Multiple spreadsheets of buyouts provided by Ron Davis (SHMO)
  • Addresses and valuation data

• Buyout files from IDNR/OWR

• City of Ottawa
  • Mike Sutfin
  • Nancy Stisser
Building Inventory

- Converted parcel polygons into points
- Used historical orthophotos to place points where structures used to exist
- Worked with the City of Ottawa to confirm information about the structures
  - Appraisals for each structure
  - Characteristics
- Year of buyouts
  - Assessor’s Website
  - Match Last Sale Price to Acquisition Cost
Building Inventory

- 64 structures identified in this analysis
  - Some are multiple structures on same parcel
- Occupancy
  - 57 Residential
    - 43 Single Family Dwelling
    - 7 Duplexes
    - 1 6-Unit Apartment Building
  - 5 Commercial
  - 1 Industrial
  - Central Elementary School
Ottawa Depth Grids

- Depth grids were created for annual maximum flood events using HEC-RAS models for the Illinois River and Fox River.
- USGS gages at Dayton and Marseilles provided peak flows.
- USACE gages at Starved Rock and Ottawa provided stage.
Ottawa Depth Grids

- The Illinois River HEC-RAS model used the combined flows from the Dayton gage and Marseilles gage along with the Starved Rock stage as a starting elevation.
- The Fox River HEC-RAS model used the Dayton gage flows along with the Ottawa stage as a starting elevation.
- The USACE Ottawa gage has only been recording stage since 2008.
- For flood events prior to 2008 the Illinois River HEC-RAS model served as an estimate of the Fox River starting elevation at Ottawa.
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Hazus Loss Estimation Tool

- Loss estimation software designed by FEMA
- Works with ESRI’s ArcGIS software
- Purpose is to provide the means to identify and reduce risk from natural hazards
- Four Models:
  - Flood
  - Earthquake
  - Hurricane
  - Tsunami
- Hazus 4.0
Levels of analysis

Level 3: Input detailed engineering data

Level 2: Combination of local and default hazard, building, and damage data

Level 1: Default hazard, inventory, and damage information

Required user effort and sophistication
Input for Level 2 Analysis

• **Building Inventory**
  • Point feature class in a personal gdb
  • Contains the attributes for each buyout structure
  • Lat Long values to represent location

• **Flood Depth Grids**
  • ESRI Grid format
Attributes for Hazus

- Occupancy Class

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

- Residential
- Commercial
- Industrial
- Agricultural
- Government
- Religious

**Residential**
- 8051, 80

**Commercial**
- 52, 53, 5
- 42, 50, 5
- 72, 75, 7
- 40, 41, 4
- 78 (excl)
- 60
- 8062, 80
- 80 (excl)
- 48, 58, 7
- 7832, 79
- Parking

**Industrial**
- 22, 24, 2
- 23, 25, 2
- 39
- 20, 21, 2
- 10, 12, 1
- 3571, 35
- 15, 16, 1

**Agriculture**
- 01, 02, 0
Attributes for Hazus

• Building Cost
  • Appraised Value

• Content Cost
  • Contents of the Structure
  • Couch, Refrigerator, etc…
  • Multiplier based of Occupancy Class of the Structure

• Converted to 2017 U.S. Dollars
  • Bureau of Labor Statistics-Consumer Price Index
Attributes for Hazus

- Provided by City of Ottawa
  - Square Footage
  - Number of Stories
  - Year Built
  - Design Level
    - Based off of Year built
- Foundation Type

Table 6.2  DesignLevel Field Description

<table>
<thead>
<tr>
<th>YearBuilt</th>
<th>Design Level</th>
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<tr>
<td>Prior – 1950</td>
<td>1</td>
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<tr>
<td>1950 – 1970</td>
<td>2</td>
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<tr>
<td>Post 1970</td>
<td>3</td>
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<tr>
<td>0 (set to Null)</td>
<td>0</td>
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</table>

Table 6.3  FoundationType Field Description

<table>
<thead>
<tr>
<th>Real Foundation Type</th>
<th>FoundationType</th>
<th>Basement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pile</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Pier</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Solid Wall</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Basement / Yard</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Crawl Space</td>
<td>5</td>
<td>0</td>
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<tr>
<td>Fill</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Slab on Grade</td>
<td>7</td>
<td>0</td>
</tr>
</tbody>
</table>
Attributes for Hazus

- First Floor Height
  - The height of the first floor, in feet, above ground elevation.

<table>
<thead>
<tr>
<th>ID</th>
<th>Foundation Type</th>
<th>Pre-FIRM</th>
<th>Post-FIRM</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Pile</td>
<td>7 ft</td>
<td>8 ft</td>
</tr>
<tr>
<td>2</td>
<td>Pier (or post and beam)</td>
<td>5 ft</td>
<td>6 ft</td>
</tr>
<tr>
<td>3</td>
<td>Solid Wall</td>
<td>7 ft</td>
<td>8 ft</td>
</tr>
<tr>
<td>4</td>
<td>Basement (or Garden Level)</td>
<td>4 ft</td>
<td>4 ft ¹</td>
</tr>
<tr>
<td>5</td>
<td>Crawlspace</td>
<td>3 ft</td>
<td>4 ft</td>
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<tr>
<td>6</td>
<td>Fill</td>
<td>2 ft</td>
<td>2 ft</td>
</tr>
<tr>
<td>7</td>
<td>Slab</td>
<td>1 ft</td>
<td>1 ft ¹</td>
</tr>
</tbody>
</table>
Hazus Analysis

• Import user data into Hazus
  • Building Inventory
  • Import into CDMS
  • Depth Grids
Depth-Damage Curves

- Percentage of damage is calculated for each structure based on the depth of flooding.
  - Based on Attributes of the structures
  - For buildings, first floor height
  - For equipment, height above first floor

- Damage percentage is used to determine loss in USD
Analysis Output

- Building Loss
- Content Loss
- Business Inventory Loss
- Percent Damaged for Structures
Summary

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<tr>
<td>1996</td>
<td>N/A</td>
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</tr>
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**Buyout Structures 1996**

City of Ottawa
LaSalle County, Illinois

**Depth Grid**
- Green: Removed Structure
- Yellow: Buyout Structure
- Red: Existing Structure
- Gray: Parcel

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<tr>
<td>1997</td>
<td>N/A</td>
<td>N/A</td>
<td>7</td>
<td>$437,551</td>
<td>N/A</td>
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**Buyout Structures 1997**

City of Ottawa
LaSalle County, Illinois

![Map of Fox River and Ottawa with Buyout Structures]
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<tr>
<td>1998</td>
<td>6</td>
<td>$179,301</td>
<td>19</td>
<td>$1,823,700</td>
<td>10%</td>
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**Buyout Structures 1998**

City of Ottawa
LaSalle County, Illinois

- Green: Removed Structure
- Yellow: Buyout Structure
- Red: Existing Structure
- Orange: Parcel

**Depth Grid**

- Greater Depth
- Lesser Depth

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**Buyout Structures**

2001

City of Ottawa
LaSalle County, Illinois

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**Depth Grid**

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**Buyout Structures 2005**

City of Ottawa
Lasalle County, Illinois

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<td>22%</td>
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<tr>
<td>2007</td>
<td>44</td>
<td>$1,785,922</td>
<td>N/A</td>
<td>$3,754,925</td>
<td>48%</td>
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</tr>
<tr>
<td>2008</td>
<td>54</td>
<td>$4,164,146</td>
<td>N/A</td>
<td>$3,754,925</td>
<td>111%</td>
</tr>
</tbody>
</table>

**Buyout Structures 2008**

City of Ottawa
LaSalle County, Illinois

**Depth Grid**

- Greater Depth
- Lesser Depth

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<td>48</td>
<td>$5,328,594</td>
<td>N/A</td>
<td>$3,754,925</td>
<td>142%</td>
</tr>
</tbody>
</table>
| Year | Impacted Structures | Cumulative Losses Avoided | Number of Buyouts | Cumulative Project Investment | ROI  
|------|---------------------|--------------------------|-------------------|------------------------------|-----
<p>| 2009 | 48                  | $5,328,594               | N/A               | $3,754,925                   | 142% |
| 2012 | N/A                 | $5,328,594               | 4                 | $4,132,768                   | 129% |
| 2013 | 59                  | $8,017,478               | 5                 | $4,519,324                   | 177% |</p>
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**Buyout Structures**

City of Ottawa
LaSalle County, Illinois

**Depth Grid**
- Greater Depth
- Lesser Depth

Service Layer Credits: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, ©OpenStreetMap contributors, and the GIS User Community

Illinois State Water Survey | ILLINOIS
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$8,448,000

Buyout Structures 2017
City of Ottawa
LaSalle County, Illinois

Depth Grid
- Greater Depth
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$8,448,000

187%
Current Conditions

- Fox River Park
- Playground
- Green Space
March 25th, 1998
September 20\textsuperscript{th}, 2015
Summary

- Description of City of Ottawa
- History
  - Flooding
  - Funding
- Gathering and Developing Data for Analysis
- Hazus Analysis
- Timeline of Buyouts and Results
- Central Elementary School and Heritage Harbor
- Obstacles
- Drone Flight
Central Elementary School

- Flooded Sept. 2008
- Demolished in August, 2013
- New School Built
- What if the new school was built in the location of the original?
- Modeled flood event is April, 2013
- Replacement cost of $22 million adjusted to 2017 dollars
- Funds awarded
  - FEMA $12 million
  - Illinois $10 million

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<tr>
<th>Year of Flood Event</th>
<th>Structure</th>
<th>Losses Avoided</th>
<th>Project Investment</th>
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<tr>
<td>2013</td>
<td>Central Elementary School</td>
<td>$7,914,420</td>
<td>$23,132,010</td>
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</tbody>
</table>
Heritage Harbor

• High value Condos

• New construction required to be 2 feet above the 1% annual chance base flood elevation.

• Building Value
  • Estimated Fair Market Value using 2017 assessor’s data.
  • Assessed Building Value multiplied by 3
Heritage Harbor

- Hazus Analysis
  - Depth Grids
    - 1% Annual Chance Flood event
  - Ran analysis with two versions of each structure
    - With current elevation
    - With simulated elevation 2’ below current conditions

<table>
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<tr>
<th>Event Type</th>
<th>Projected Structures impacted without 2’ Higher Elevation Requirement</th>
<th>Total Loss without 2’ Higher Elevation Requirement</th>
<th>Total Loss with Current Construction</th>
<th>Total Losses Avoided</th>
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<td>1% Annual Chance Flood (100 year)</td>
<td>23</td>
<td>$2,124,200</td>
<td>$0</td>
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Summary

• Description of City of Ottawa
• History
  • Flooding
  • Buyouts
• Gathering and Developing Data for Analysis
• Hazus Analysis
• Timeline of Buyouts and Results
• Central Elementary School and Heritage Harbor
• Obstacles
• Drone Flight
Obstacles and Limitations

- Structures no longer exist
- Combining data from a variety of different sources in one building inventory
- The USACE Ottawa gage has only been recording stage since 2008
- Representing structures as points instead of polygons
- Accounting for all of the associated costs
  - Buyouts
    - Taxes, asbestos removal, etc.
  - Flood Losses
    - Displaced population, loss of service, etc.
- Results are Estimates
Drone Flight – Feb. 2018 Flood
Thanks!

Questions?

Brad McVay
 bmcvay@illinois.edu