Tearing Down Homes to Build Community Resilience – An Evaluation of the Benefits of the Nashville Home Buyout Program

Association of State Floodplain Managers
Phoenix, AZ
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The May 2010 flood in Nashville, Tennessee

- Large metropolitan city
  - Population of ~684,410 (U.S. Census Bureau)
  - Low-lying river valley with hilly terrain

- May 1-2, 2010
  - 13 inches of rain =~1,000 year flood event (NOAA)
  - 11 fatalities
  - 11,000 damaged structures (over 6,000 residential properties)
  - Estimated $2 billion in damages
Metro Water Service’s Home Buyout Program

• Program in place for >20 years
  • Prior to 2010 – 102 parcels purchased
  • Since 2010 – 263 parcels purchased
  • Total 200+ acres of greenspace created

• Target repetitive loss homes

• ~85% acceptance rate

• Cost of more than $43 million

• About 100 more homes on “wish list”
Project Objectives

• Evaluate “benefits” of the home buyout program
  • Direct damage reduction
  • Indirect impacts – increased greenspace, etc.

• Consider four scenarios
  • Scenario 1: Included all buyouts that took place between 2005 and 2010.
  • Scenario 2: No buyouts had taken place between 2005 and 2010.
  • Scenario 3: All buyouts completed by 2017 were completed prior to 2010.
  • Scenario 4: “Wish List” homes were already purchased by 2010.

• Synthesize findings for public and council members
Direct Flood Impacts

Health and Safety
• Injuries and casualties

Economic Impacts
• Number of inundated buildings
• Damaged property costs
• Emergency and hazard spending
Indirect Impacts of Flooding

Economic Prosperity
• Hours worked
• Individual debt
• Property taxes collected
• Infrastructure operation and maintenance costs
• Growth in commercial sector

Livability and Opportunity
• Unemployment rates
• Ratio of cost of living to income
• Change in minority population
• Change in senior population
• Change in low income population
• Proximity to greenspace
• Proximity to place of work
Factors Affecting Both Direct and Indirect Impacts

Health and Safety
- Population in inundated homes
- Ability to relocate/rebuild
- Distance to emergency shelters
- Located in floodplain
- Depth of inundation

Economic Prosperity
- Type and size of building
- Located in floodplain
- Depth of inundation
- Extent of flooding

Impacted by ecosystem services (i.e., available greenspace to absorb/offset flood impacts)
Methodology

• **Utilize available data**
  - Parcel data
  - Homes purchased and associated costs
  - Model simulations of the flood inundation from 2010
  - Other data characterizing the Nashville community and landscape

• **Perform analysis and modeling with GIS, Hazus, and R software**
  - Estimate depths of inundation and damage for properties
  - Calculate impervious area removed and runoff reduced

• **Compare results from the four scenarios**

Note: Analysis focused on 2005 to present due to limited data on properties prior to 2005.
Methodology – Underlying Assumptions

• High water on parcel used as indicator of % damage
• Damages > 50% were assumed to be total loss
• FIA depth damage curves used to estimate structural damage for one story and multiple story buildings and mobile homes
Results: Direct Damages

Buyouts 2005-2010

- Number of properties: 54
- Each $1 spent on buyouts from 2005-2010, ~$0.80 in direct flood damages were avoided

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Estimated Direct Damages of the May 2010 Flood</td>
<td>$3.5 B</td>
</tr>
<tr>
<td>Direct Flood Damages Avoided</td>
<td>$5.87 M</td>
</tr>
<tr>
<td>Expansion of Naturally Vegetated Greenspace</td>
<td>4 acres</td>
</tr>
<tr>
<td>Reduction in Stormwater Runoff (for a 100 year storm event)</td>
<td>197,000 gal.</td>
</tr>
<tr>
<td>Value of Runoff Reductions</td>
<td>$1.39 M</td>
</tr>
<tr>
<td>Benefit-Cost Ratio</td>
<td>3:1</td>
</tr>
</tbody>
</table>

Value provided by buyout activity between 2005 and 2010
Results: Direct Damages

Benefit of “Wish List” Properties

- Total of 398 properties evaluated
  - All properties bought by 2017 plus wish list
- Each $1 spent on buyouts = ~$1 in direct flood damages avoided

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Flood Damages Avoided</td>
<td>$50 M</td>
</tr>
<tr>
<td>Persons Removed from Harm’s Way</td>
<td>980</td>
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<tr>
<td>Expansion of Naturally Vegetated Greenspace</td>
<td>51 acres</td>
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<tr>
<td>Reduction in Stormwater Runoff (for a 100 year storm event)</td>
<td>2.1 M gal.</td>
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<tr>
<td>Value of Runoff Reductions</td>
<td>$14.7 M</td>
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<td>Benefit-Cost Ratio</td>
<td>4:1</td>
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</table>

Value provided by buyout activity including “wish list” properties
Damage and Exposure Counts
Results: Indirect Impacts

Impervious Area Reduced

• Removal of all buyout homes reduces the impervious surface area of the county by ~500,000 square feet (11.5 acres)

• Average reduction of 1,225 square feet (0.03 acres) in each micro-watershed

• Total increase in impervious building cover from 2010 to 2015 of ~15,000,000 square feet (361 acres)

• Average increase of ~39,000 square feet (0.9 acres) in each micro-watershed
Results: Indirect Impacts

Greenspace Created
- Prior to 2010: ~1 acre
- With “wish list” properties: ~17 acres

Runoff
- **Reduction in runoff offered by buyout scenarios**
  - Reduction of 71,600 ft\(^3\) of runoff from removal of buyout buildings
  - Average reduction of 2,600 ft\(^3\) per watershed where buyouts took place
- **Change in runoff from 2010 to 2015**
  - Increase of 2,254,000 ft\(^3\) of runoff from buildings
  - Average increase of 5,500 ft\(^3\) per watershed

Change in runoff volume between 2010 and 2015 in watersheds where buyouts took place (in thousands of cubic feet)
Bonus: 4’ Freeboard Regulation

- Established in 1979 for all new construction in flood plain
- Estimated damages with no freeboard
  - $2.2B across county
  - $6M for buyout properties

Source: FEMA 2014.
Challenges and Lessons Learned

Data Issues

• 2010 had incomplete data for building footprints

• No access to elevation certificates or repetitive loss information

• Without elevation certificates and detailed information for each property, estimates are required

Process for building an estimated 2010 building footprint shapefile.
Key Takeaways

• The buyout program....
  • Reduces flood damages
  • Reduces population exposure
  • Creates greenspaces that provide flood attenuation services
  • Is expected to reduce flood fatality and water rescue likelihood
  • Is cost effective with ROIs near 3:1
• Freeboard regulations can be a low/no-cost mitigation approach with huge damage reduction potential
• Continuing a proactive buyout and freeboard program is a worthy investment
Thank you!

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Background

• As climate changes we expect hazardous events to increase in frequency and severity
• Short term events can create long-term impacts
• Understanding the impacts to a community and the effectiveness of adaptation strategies is needed to gain community buy-in and acceptance to create true resilience
• Home buyout programs are one approach to adapt to increasing flood risks and mitigating flood-related damages
What do we mean by **Vulnerable Landscapes** and **Resilient Community Assets**?

- **Vulnerable Landscapes** → physical areas that present an increased risk of exposure to hazards resulting in bodily harm or damage to property or ecosystems.

- **Resilient Community Assets** → physical features of the community that positively impact a community's desired performance in terms of improving well-being, reducing hazard risks, and fostering the growth of social capital.
Health and Safety

• High local depth of inundation and high volume of runoff in a watershed significantly increase likelihood of a flood fatality occurring.

• Higher flood risk and more severe flooding areas more likely to have a water rescue occur.

• Areas with low population density, but elevated renter and foreign born populations have an increased likelihood of a water rescue occurring.
Ecosystem Services

• Impervious area
  • Impacts stormwater runoff volumes

• Riparian buffer
  • The area in which flood waters can spread beyond streambanks without encountering buildings
Impervious Area