Urban Flooding: How can planners help?

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Chicago Metropolitan Agency for Planning

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Agenda

- CMAP background
- Impacts of urban flooding
- Urban flooding susceptibility index for the Chicago region
Official regional planning organization and MPO for northeastern Illinois

Adopted GO TO 2040 regional plan in 2010

Local Technical Assistance Program
Impacts of urban flooding in the CMAP region
- Urban Flooding and Awareness Act
  - 79% of payouts were in the CMAP region.

Total public and private flood insurance and disaster relief payouts for flooding, by geography, 2007-14

- CMAP region $1.8 billion
- Rest of Illinois $325 million
- Statewide $162 million

Note: “Chicago Metropolitan Agency for Planning region” does not include Kendall County. “Statewide” includes Public Assistance grants, which are not broken down by geography.

Damages documented by federal programs

Total flooding damage payments associated with National Flood Insurance Program, Individual Assistance, and Small Business Administration programs per 2010 household by zip code in the Chicago region from 2003 to 2015.
Flooding damages and communities

Economically disconnected communities and total flooding damage payments associated with NFIP, IA, and SBA programs per 2010 household by zip code in the Chicago region, from 2003 to 2015.
Road and transit closures can lead to declines in economic productivity, safety, and emergency service provision.

Flooding adds to maintenance and replacement costs over time.

Open space areas will face increasing floods or pressures to handle stormwater to the potential detriment of other habitat goals.
Warmer, wetter, and more variable

Range of projected annual total precipitation, in inches, in northeastern Illinois

Urban Flooding Susceptibility Index
**Purpose**
Identify priority areas across the region for flooding mitigation activities.

**What it is:**
- Uses flooding-related factors to identify priority areas based on past flooding locations
- **Study area:**
  - Developed areas in the CMAP region
  - Riverine Index: areas within FEMA 100-yr floodplain/MWRD 100-yr inundation
  - Urban Index: outside of these areas

**What it’s not:**
- Floodplain Inundation mapping
- Sewer System modeling
- Rainfall-runoff modeling
Frequency ratio approach

Statistical method to identify higher risk areas based on the observed relationship between reported flooding locations and flooding-related factors.

\[
\frac{\text{Percent of flood events in factor category}}{\text{Percent of study area in factor category}} = \text{Frequency ratio}
\]
### Frequency ratio approach

#### Calculation example:
Combined Sewer Service Areas for the Urban Index

<table>
<thead>
<tr>
<th>Factor</th>
<th>Categories</th>
<th>Percent (%) of Study Area</th>
<th>Percent (%) of Flood Locations</th>
<th>Frequency Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined Sewer Service Area</td>
<td>Present</td>
<td>15.8%</td>
<td>27.4%</td>
<td>2.35</td>
</tr>
<tr>
<td></td>
<td>Absent</td>
<td>84.2%</td>
<td>72.6%</td>
<td>0.75</td>
</tr>
</tbody>
</table>

\[
\frac{27.4\% \text{ of flood locations in "Present" category}}{15.8\% \text{ of study area is "Present" category}} = FR \text{ of } 2.35
\]
Five steps:

1. Assemble and categorize reported flooding locations
2. Assemble and categorize potential flooding-related factors
3. Calculate the frequency ratio for factor categories
4. Add frequency ratios for selected factors
5. Assess accuracy of index
Frequency ratio approach

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Example: Age of First Development

Logic:

Identifies areas that were developed under different stormwater and floodplain management standards. Areas developed prior to these practices may be more likely to experience flooding.

<table>
<thead>
<tr>
<th>Categories</th>
<th>Percent (%) Study Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Prior to 1974</td>
<td>41.2%</td>
</tr>
<tr>
<td>2 1974-1982</td>
<td>5.4%</td>
</tr>
<tr>
<td>3 1982-1992</td>
<td>3.3%</td>
</tr>
<tr>
<td>4 1992-2002</td>
<td>5.0%</td>
</tr>
<tr>
<td>5 2002-2012</td>
<td>4.6%</td>
</tr>
<tr>
<td>6 Undeveloped/post-2012</td>
<td>40.6%</td>
</tr>
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Urban Flooding Susceptibility Index

Urban Analysis

- All developed areas outside of the 100-yr FEMA floodplain or MWRD 100-yr Inundation area

- Flooding-related factors:
  - Topographic Wetness Index
  - Combined Sewer Service Area
  - Elevation differential between property and nearest FEMA BFE
  - Impervious Cover
  - Age of First Development
  - Precipitation variation with 10-yr, 2-hr storm from NOAA Atlas 14
### Urban Flooding Susceptibility Index

#### Accuracy assessment using validation data

<table>
<thead>
<tr>
<th>Index Level</th>
<th>Count of Flooding Locations</th>
<th>Flood Occurrence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (lowest)</td>
<td>406</td>
<td>0.9%</td>
</tr>
<tr>
<td>2</td>
<td>625</td>
<td>1.3%</td>
</tr>
<tr>
<td>3</td>
<td>896</td>
<td>1.9%</td>
</tr>
<tr>
<td>4</td>
<td>1113</td>
<td>2.4%</td>
</tr>
<tr>
<td>5</td>
<td>1360</td>
<td>2.9%</td>
</tr>
<tr>
<td>6</td>
<td>1602</td>
<td>3.4%</td>
</tr>
<tr>
<td>7</td>
<td>2504</td>
<td>5.4%</td>
</tr>
<tr>
<td>8</td>
<td>4945</td>
<td>10.6%</td>
</tr>
<tr>
<td>9</td>
<td>8719</td>
<td>18.7%</td>
</tr>
<tr>
<td>10 (highest)</td>
<td>24460</td>
<td>52.5%</td>
</tr>
</tbody>
</table>
Regional applications

- Help CMAP focus Local Technical Assistance Projects
- Assess urban flooding impacts to transportation network
- Explore impacts on vulnerable populations
- May help coordinate partners:
  - Inform open space preservation and restoration decisions?
  - Other activities?
Refinements

- Incorporate additional reported flooding locations
- Explore additional flooding-related factors
- Assess how climate projections could be incorporated
Integrate stormwater management decisions into local planning
1. Identify and prioritize potential flooding problem areas
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When summarized, how do certain areas rank over others?

Urban FSI\(^*\) by Catchment

- 1: 7
- 2: 8
- 3: 9
- 4: 10
- 5
- 6

Flowpath

C Catchments
1. Identify and prioritize potential flooding problem areas

Where have capital improvements occurred to mitigate flooding or improve stormwater management?
1. Identify and prioritize potential flooding problem areas

2. Groundtruth

- Conduct surveys, interviews, and mapping exercises
- Confirm with public works, community development, other agencies
1. Identify potential flooding problem areas
2. Groundtruth
3. Identify opportunities for green infrastructure and engineering studies
Local applications

Limitations

- Distinguishing urban flooding from riverine flooding
Local applications

Limitations

- Dense urban areas require additional information to prioritize areas
Where to find the FSI?

- Available on the CMAP Data Hub: https://datahub.cmap.illinois.gov/
- Developing a how-to guide
Funding and technical assistance

**Grants**
- Cook County CDBG-Disaster Recovery
- MacArthur Foundation

**Technical assistance**
- Christopher B. Burke Engineering
- Conservation Design Forum
- Geosyntec Consultants
- Hey and Associates
- Michael Baker International
Thank you!

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