Urban Flooding: How can planners help?

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- CMAP background
- Impacts of urban flooding
- Urban flooding susceptibility index for the Chicago region



## **Chicago Metropolitan Agency for Planning**

- Official regional planning organization and MPO for northeastern Illinois
- Adopted GO TO 2040 regional plan in 2010
- Local Technical Assistance Program

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# **Chicago Metropolitan Agency for Planning**







# Impacts of urban flooding in the CMAP region



# **Urban flooding impacts**

#### 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.

Source: Brad Winters, et al, "Report for the Urban Flooding Awareness Act," State of Illinois Department of Natural Resources, Office of Water Resources, June 2015, www.isws.illinois.edu/hilites/more.asp?id=ufaa&fr=hi.



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## 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.



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10





Chicago Metropolitan Agency for Planning, 2017.

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### **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.

Total Damage Costs of NFIP, IA, and SBA Payouts (per household, 2010)



### Impacts to transportation and open space

- 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

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# **Urban Flooding Susceptibility Index**

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#### 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

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

 $\frac{Percent \ of \ flood \ events \ in \ factor \ category}{Percent \ of \ study \ area \ in \ factor \ category} = Frequency \ ratio$ 

![](_page_12_Picture_3.jpeg)

#### **Calculation example:**

#### **Combined Sewer Service Areas for the Urban Index**

Factor	Categories	Percent (%) of Study Area	Percent (%) of Flood Locations	Frequency Ratio
Combined Sewer	Present	15.8%	27.4%	2.35
Service Area	Absent	84.2%	72.6%	0.75

27.4% of flood locations in "Present" category 15.8% of study area is "Present" category  $= FR \ of \ 2.35$ 

![](_page_13_Picture_5.jpeg)

- 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

![](_page_14_Picture_7.jpeg)

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### **Example: Age of First Development**

![](_page_17_Figure_1.jpeg)

#### 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.

	Categories	Percent (%) Study Area		
	Prior to 1974	41.2%		
2	1974-1982	5.4%		
3	1982-1992	3.3%		
4	1992-2002	5.0%		
5	2002-2012	4.6%		
6	Undeveloped/ post-2012	40.6%		

## **Example: Age of First Development**

	Categories	Percent (%) of Study Area	Percent (%) of Flood Locations	Frequency Ratio
	Prior to 1974	41.2%	74.0%	1.8
2	1974-1982	5.4%	4.4%	0.81
3	1982-1992	3.3%	1.9%	0.56
4	1992-2002	5.0%	1.9%	0.38
5	2002-2012	4.6%	1.1%	0.24
6	Undeveloped/ post-2012	40.6%	16.8%	0.41

![](_page_18_Picture_2.jpeg)

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![](_page_19_Picture_7.jpeg)

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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

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# **Urban Flooding Susceptibility Index**

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#### Accuracy assessment using validation data

Index Level	Count of Flooding Locations	Flood Occurrence (%)		
1 (lowest)	406	0.9%		
2	625	1.3%		
3	896	1.9%		
4	1113	2.4%		
5	1360	2.9%		
6	1602	3.4%		
7	2504	5.4%		
8	4945	10.6%		
9	8719	18.7%		
10 (highest)	24460	52.5%		

![](_page_22_Picture_4.jpeg)

- 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?

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- Incorporate additional reported flooding locations
- Explore additional flooding-related factors
- Assess how climate projections could be incorporated

![](_page_24_Picture_4.jpeg)

 Integrate stormwater management decisions into local planning

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![](_page_25_Picture_3.jpeg)

1. Identify and prioritize potential flooding problem areas

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Is urban flooding a potential problem and where?

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1. Identify and prioritize potential flooding problem areas

![](_page_27_Figure_2.jpeg)

1. Identify and prioritize potential flooding problem areas

![](_page_28_Figure_2.jpeg)

Where have capital improvements occurred to mitigate flooding or improve stormwater management?

![](_page_28_Figure_4.jpeg)

### Local applications

- 1. Identify and prioritize potential flooding problem areas
- 2. Groundtruth

![](_page_29_Picture_3.jpeg)

![](_page_29_Picture_4.jpeg)

- 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

![](_page_30_Figure_4.jpeg)

![](_page_30_Picture_5.jpeg)

### Local applications

#### Limitations

 Distinguishing urban flooding from riverine flooding

![](_page_31_Figure_3.jpeg)

![](_page_31_Figure_4.jpeg)

# Local applications

#### Limitations

 Dense urban areas require additional information to prioritize areas

![](_page_32_Figure_3.jpeg)

![](_page_32_Picture_4.jpeg)

### Where to find the FSI?

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

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## 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

![](_page_34_Picture_10.jpeg)

![](_page_35_Picture_0.jpeg)

# Thank you!

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![](_page_35_Picture_4.jpeg)