CMAP

Targeting the need:

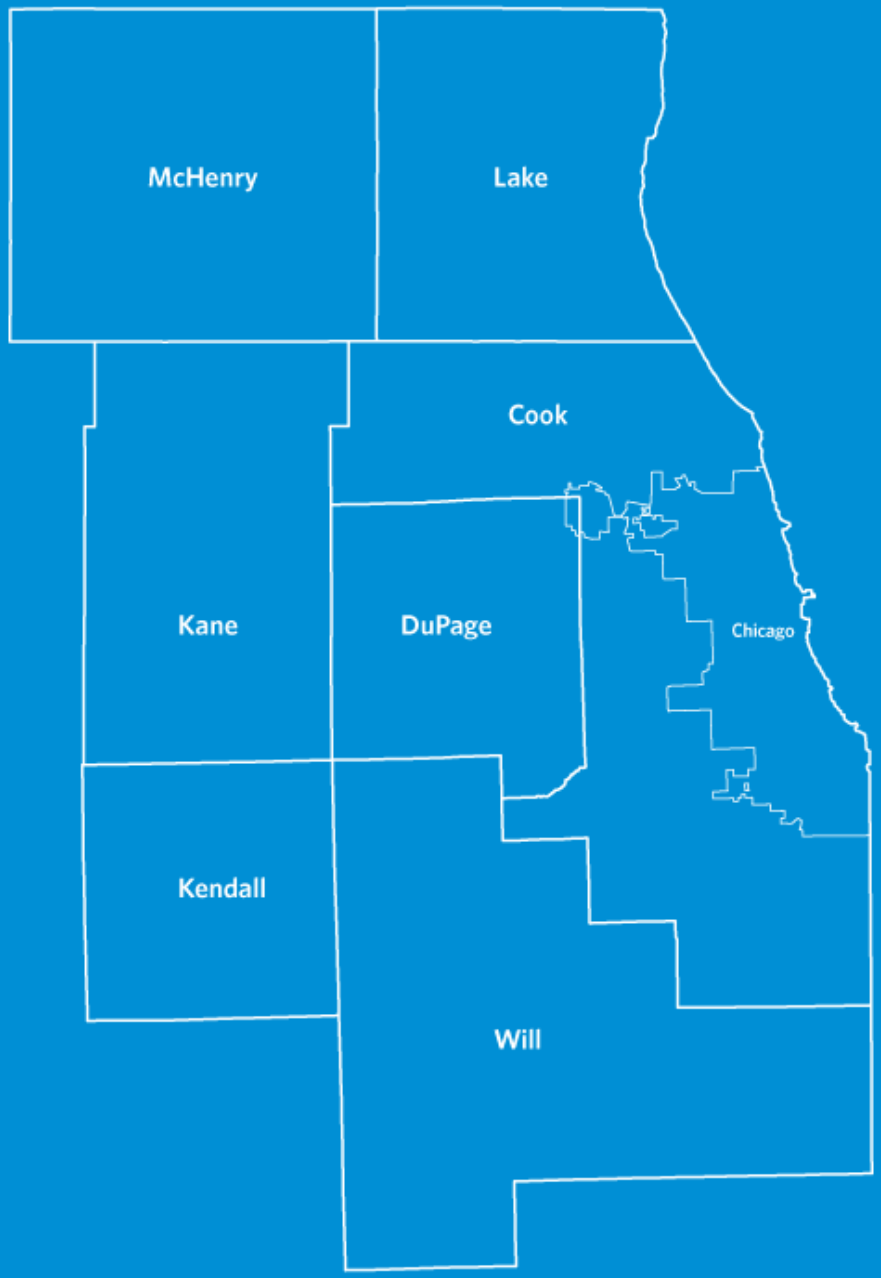
Identifying urban flood risk for prioritized investments

284 municipalities

Median utility serves 4,200 households

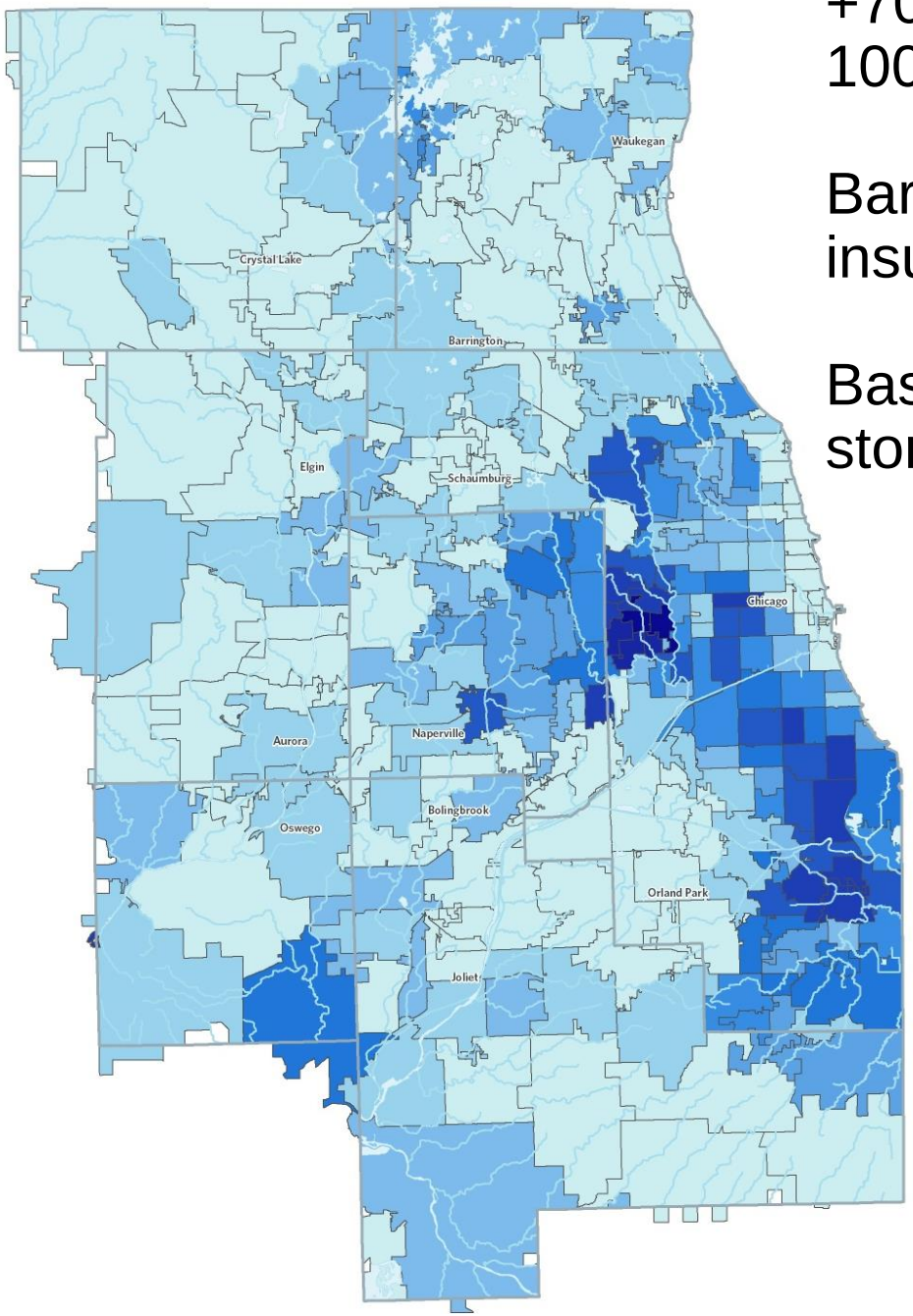
Few models for urban flooding

40% of developed land area built prior to 1974



Total damage costs of NFIP, IA, and SBA payouts per 2010 household by zip code from 2003-2015

- $0 - $40
- $40.01 - $100
- $100.01 - $200
- $200.01 - $350
- $350.01 - $600
- $600.01 - $850
- $850.01 - $1,200
- $1,200.01 - $1,800
- $1,800.01 - $3,000
- $3,000.01 - $5,881



+70% outside of 100-year floodplain

Barriers to insurance

Based on larger storm events

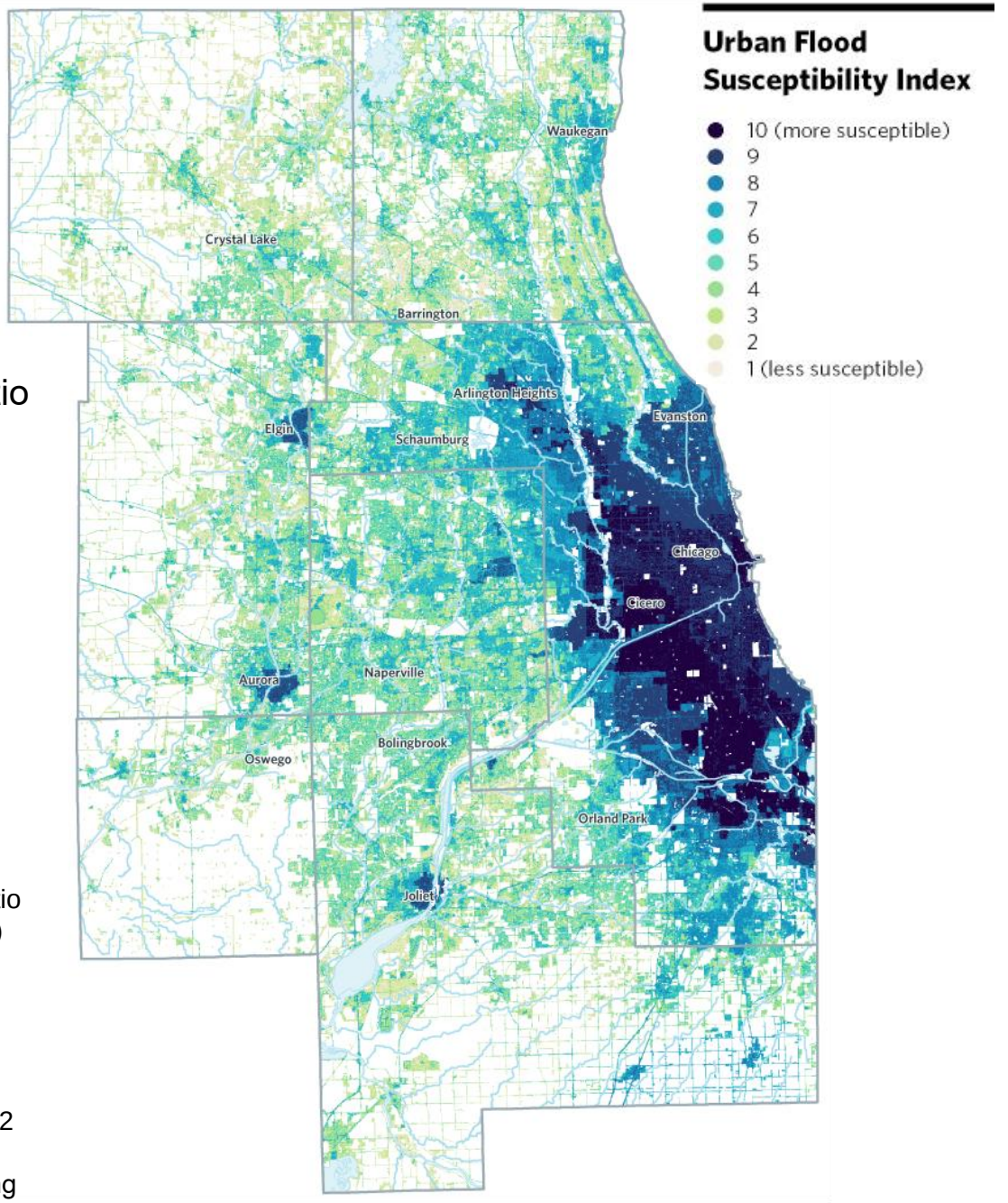
Urban Flood Susceptibility Index

Identify priority areas across the region for flood mitigation activities

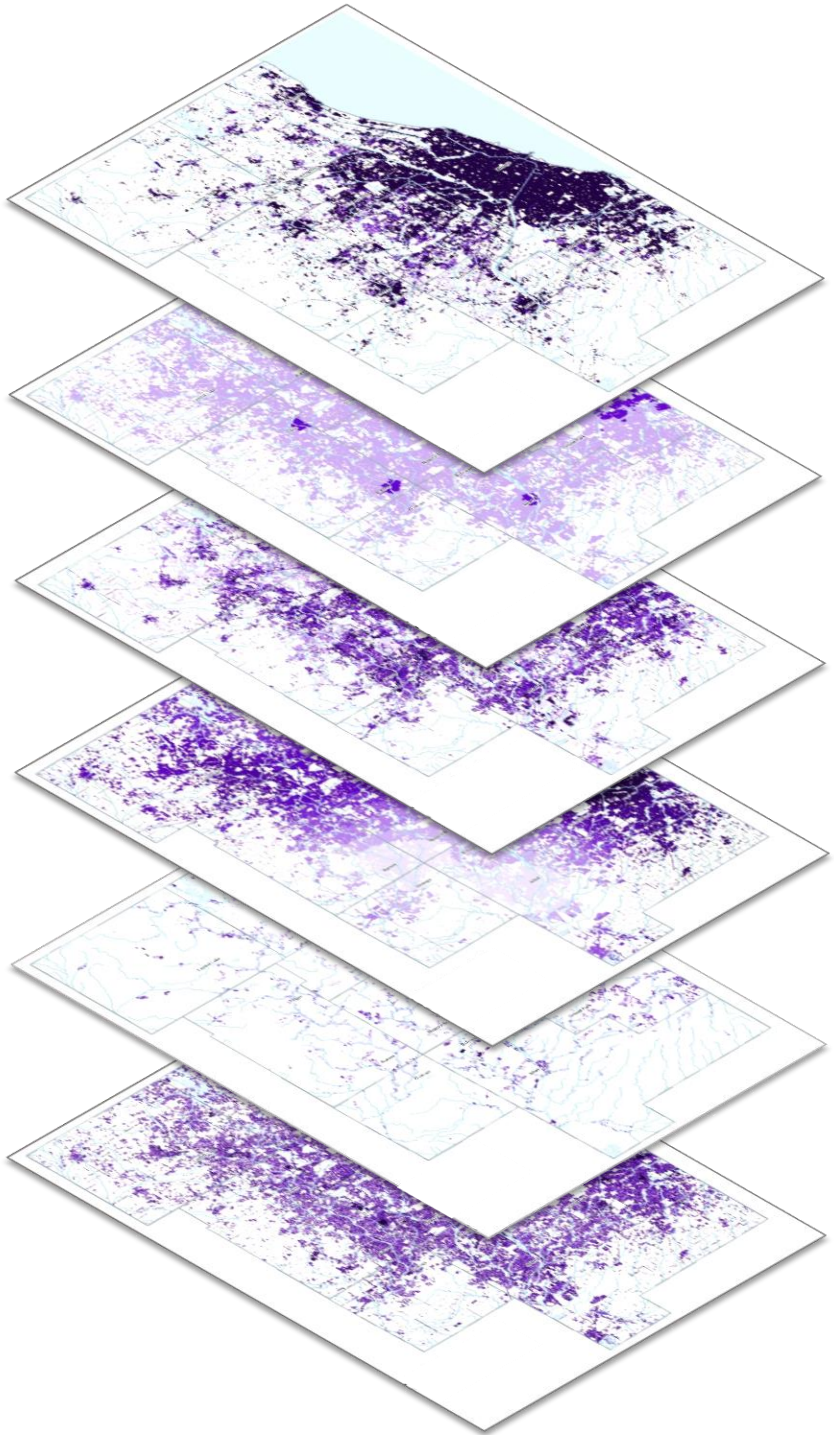
Focused on developed areas outside of 100-year floodplain

Frequency Ratio

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



- Saro Lee, Biswajeet Pradhan, “Landslide hazard mapping at Selangor, Malaysia using Frequency Ratio and Logistic Regression Models,” Landslides, (2007) 4:33-41
- Moung-Jin Lee, Jung-eun Kang, Seongwoo Jeon, “Application of frequency ratio model and validation for predictive flooded area susceptibility mapping using GIS,” Geoscience and Remote Sensing Symposium, 2012 IEEE International 22-27 July 2012
- Arzu Erener, Suzanne LaCasse, Amir M. Kaynia, “Hazard Mapping by Frequency Ratio Approach using GIS,” International Centre for Geohazards, 2015.



Six factors

Age of first development

Sewer type

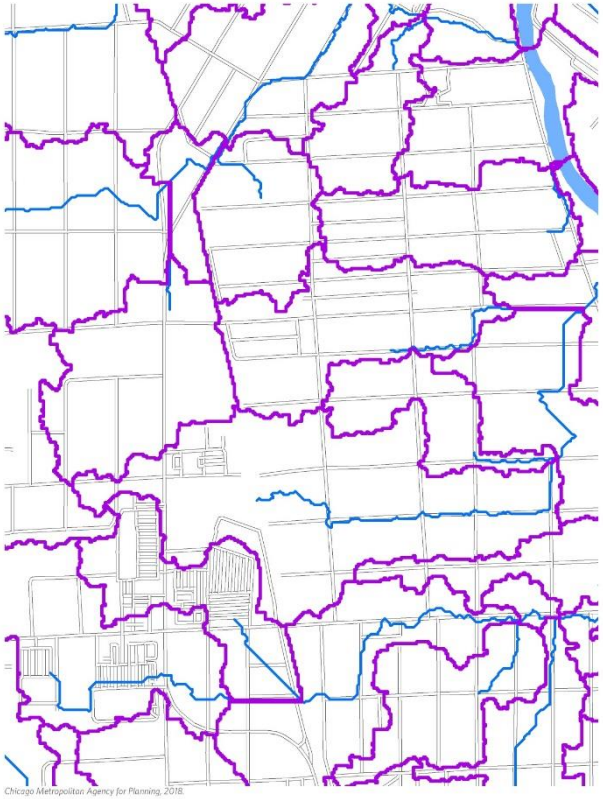
Impervious cover

Precipitation variation,
10-year, 2-hour storm event

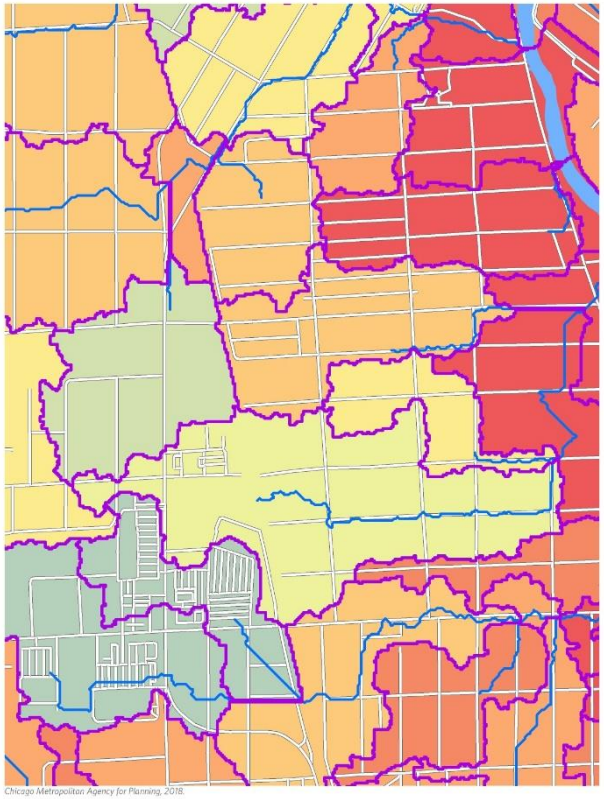
Elevation differential
with base flood elevation

Topographic wetness index

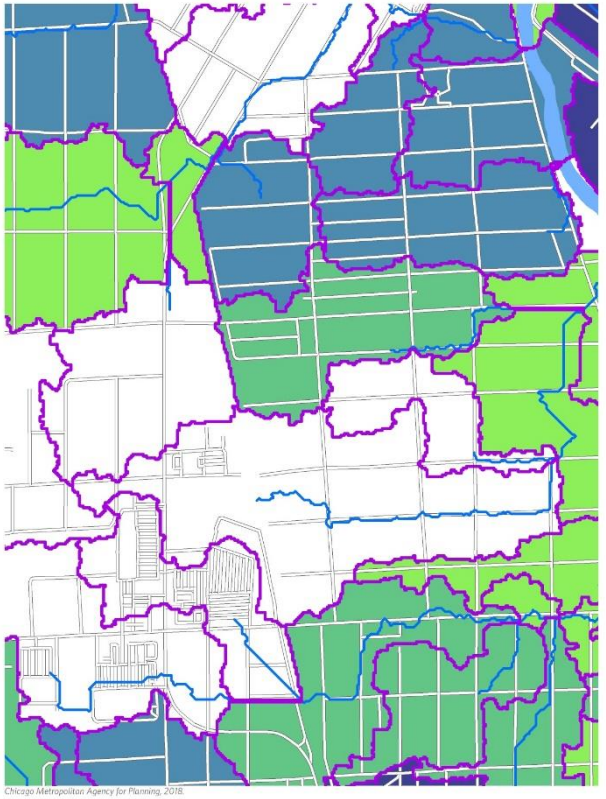
Local planning



ArcHydro derived catchments and flowpaths



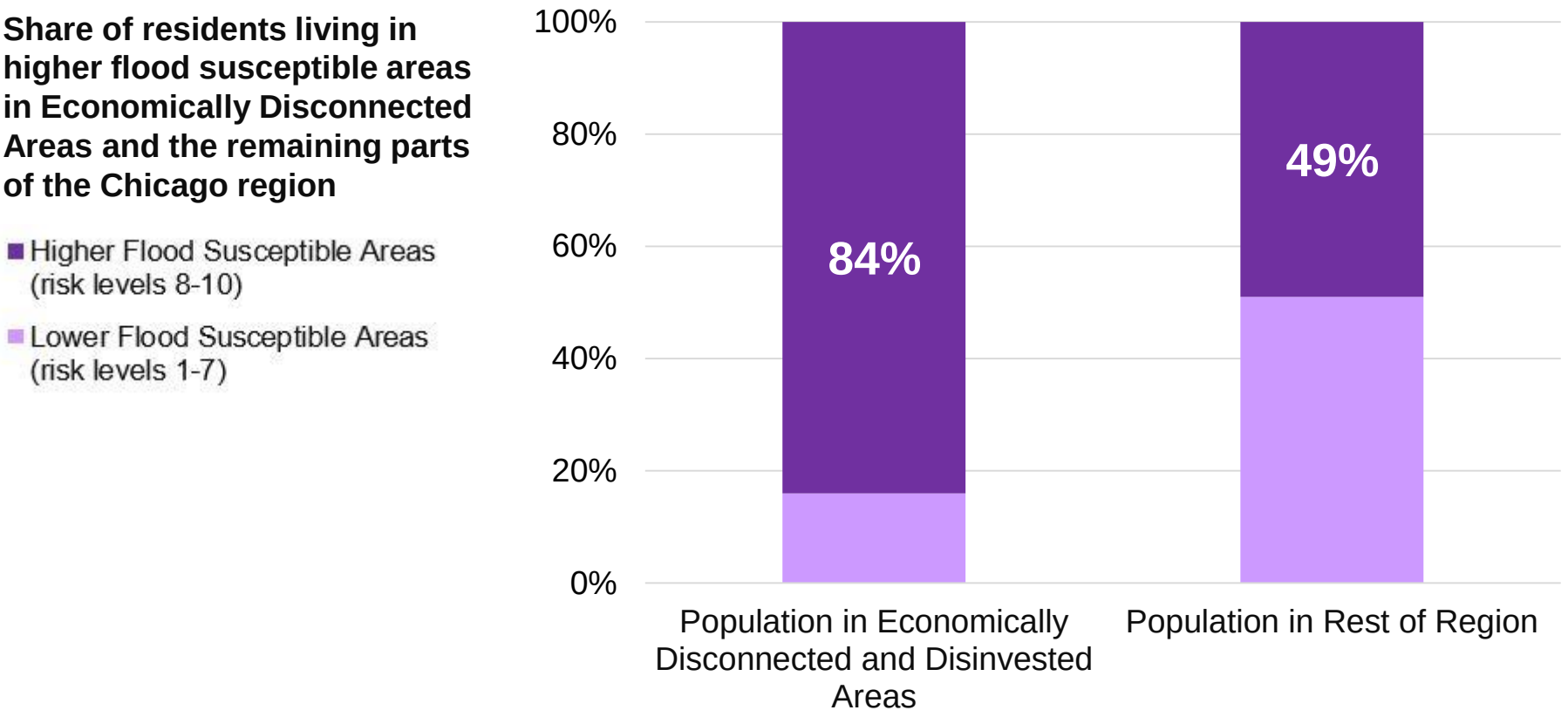
Summarized FSI by catchment



Identified land use opportunities

Regional policy

Share of residents living in higher flood susceptible areas in Economically Disconnected Areas and the remaining parts of the Chicago region



Next Steps

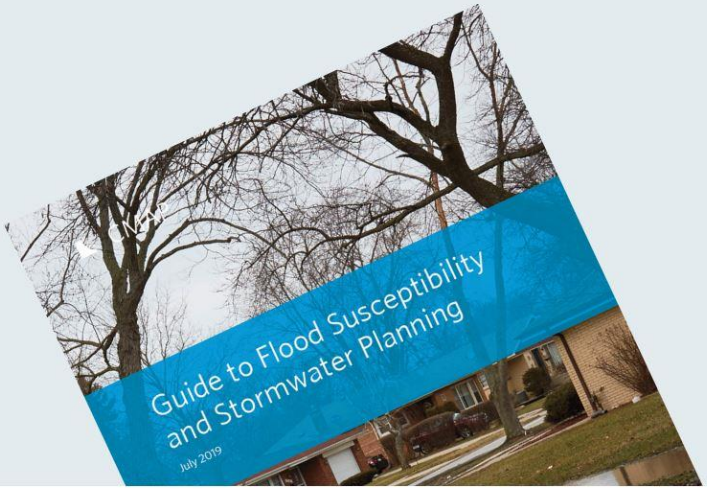
Evaluate relative importance of existing factors

Explore additional factors, more recent damages

Develop transportation-focused FSI

Explore climate projections

Methodology, guide and data are at www.cmap.illinois.gov



Guide to Flood Susceptibility and Stormwater Planning

Download PDF [7.4MB]

Flood Susceptibility and Stormwater Planning

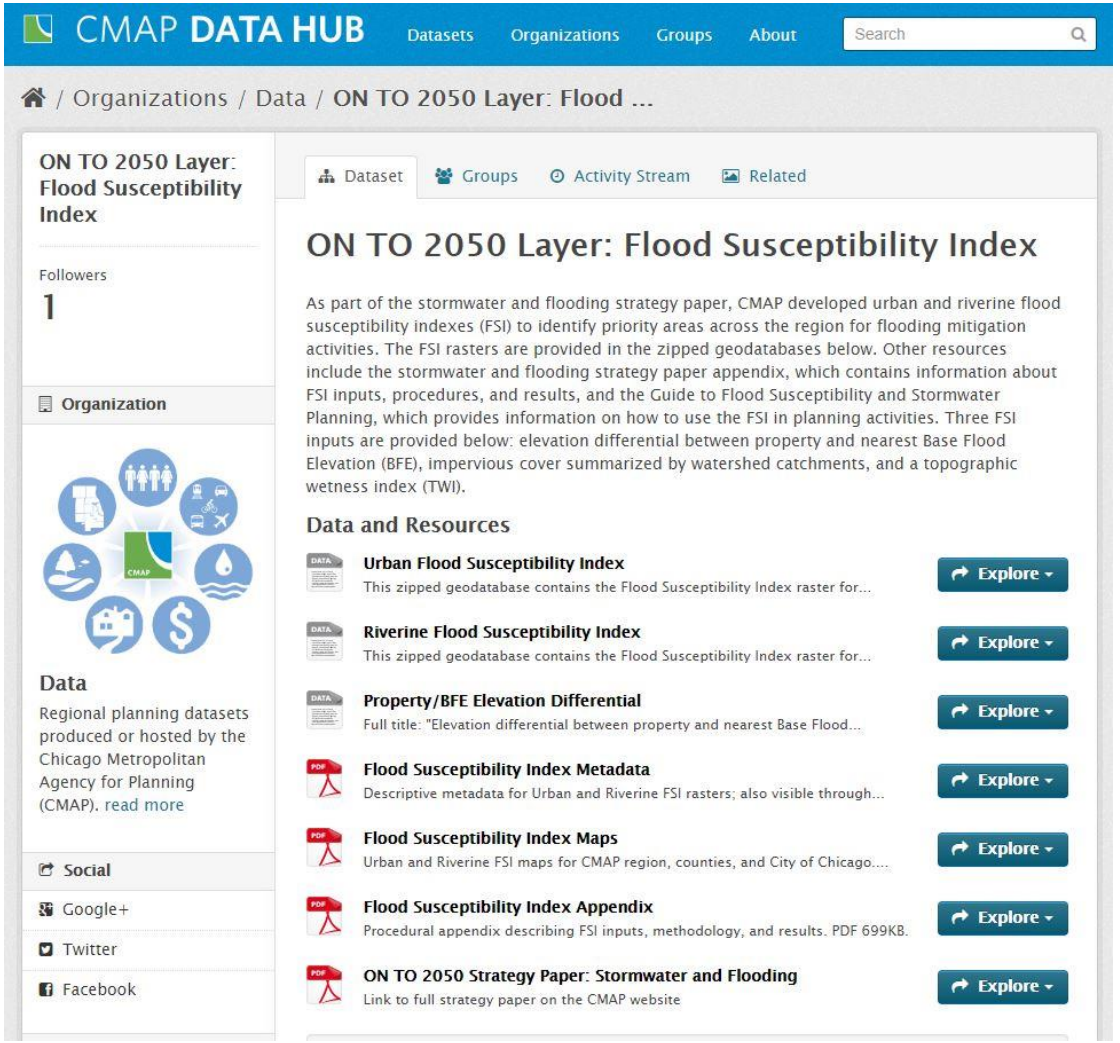
Urban flooding is a common concern among the region's municipalities, yet many lack the resources to identify opportunities and strategies to address flooding issues. For example, a village may be aware of an area that floods regularly, but they may not know the cause or the drainage area that flows to the flooded area. One strategy for addressing this is to better integrate stormwater management into decisions about land use and development. The location and form of our development patterns play a large role in the amount of stormwater runoff generated and can be a key part of the solution.

To better position communities to improve stormwater management, CMAP has developed an approach to help identify problem areas and causes and begin to articulate discrete, on-the-ground opportunities for improvements that can reduce flooding. The purpose of this approach is to present a cost-efficient planning

CMAP DATA HUB

Visit datahub.cmap.illinois.gov

Search for “urban flooding”



CMAP

https://cmap.is/flood-index

Nora Beck
nbeck@cmap.illinois.gov
312-386-8677

Metropolitan Water Reclamation District of Greater Chicago

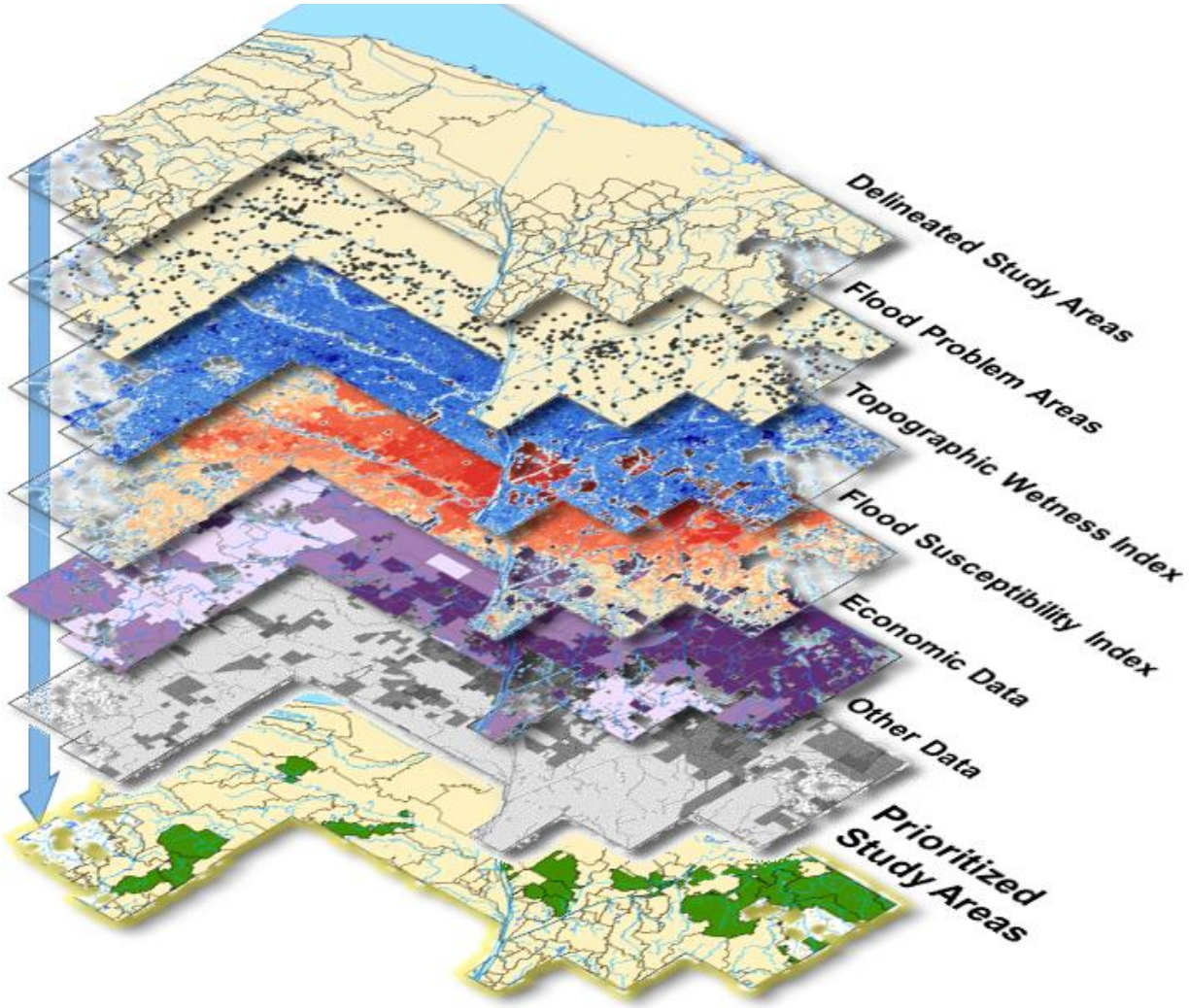
Using the FSI to prioritize Combined Sewer Study Areas

Why Use FSI?

- Excellent “starting point” in reviewing stormwater management needs for the combined sewer area
- Lack of existing stormwater modeling data for combined sewer areas
- Outdated or incomplete sewer atlas information
- Reduced municipal capacity
- Source of consistent, transparent data
- Utilize research already performed*

Process Overview

- Collected Available Data
- Identified Geographic Study Areas
- Used GIS to combine and analyze data layers
- Weighted system to prioritize areas for study

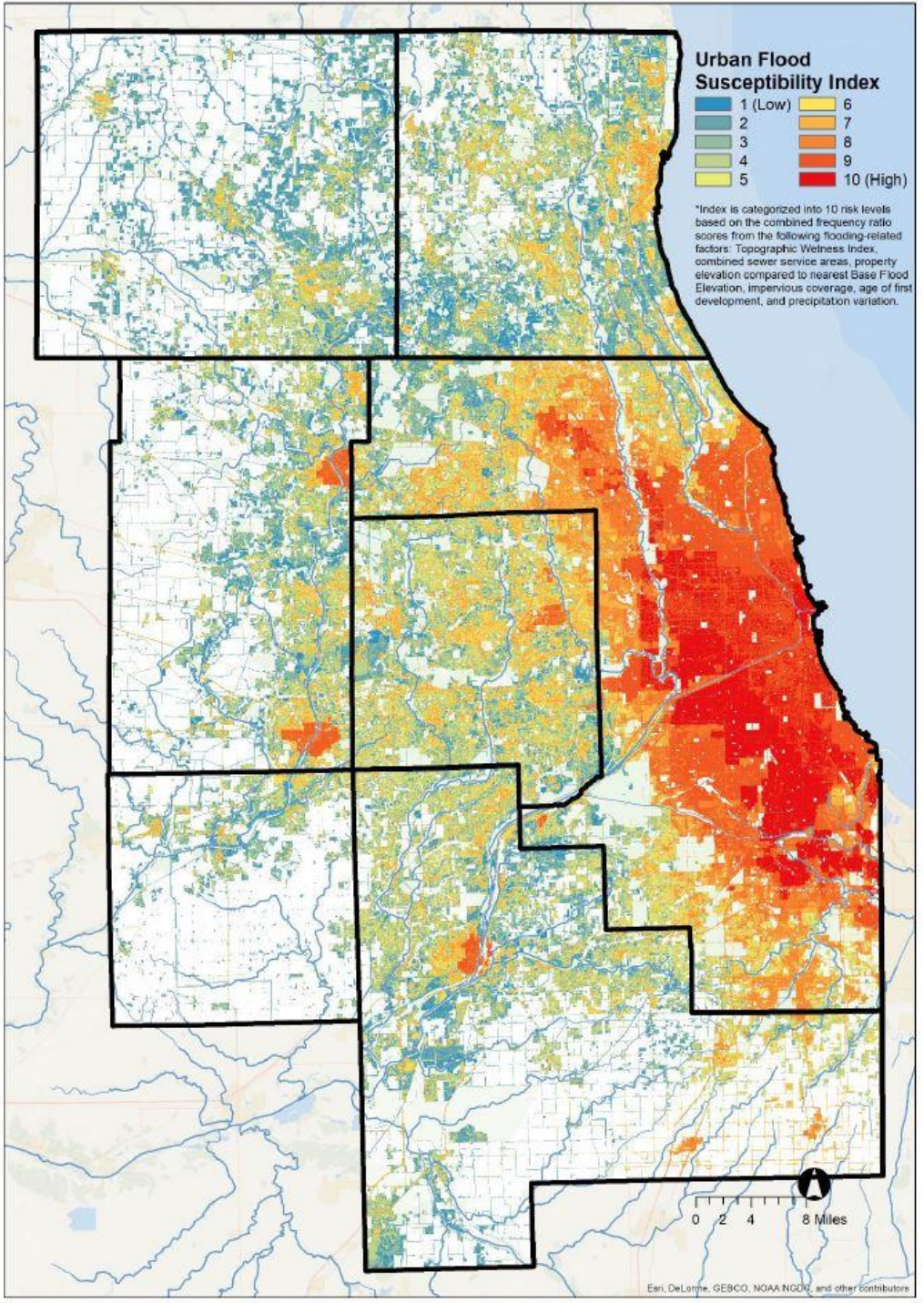


Process Overview

- This process was used for data assessment for the Combined Sewer Area (CSA) outside of the City of Chicago (68 municipalities/townships)
- Prioritization steps:
  - Evaluate and rank municipalities based on risk of urban flooding (FSI)
  - Evaluate municipalities based on socio-economic need
  - Qualitative final assessment
- Develop an adaptive, transparent approach

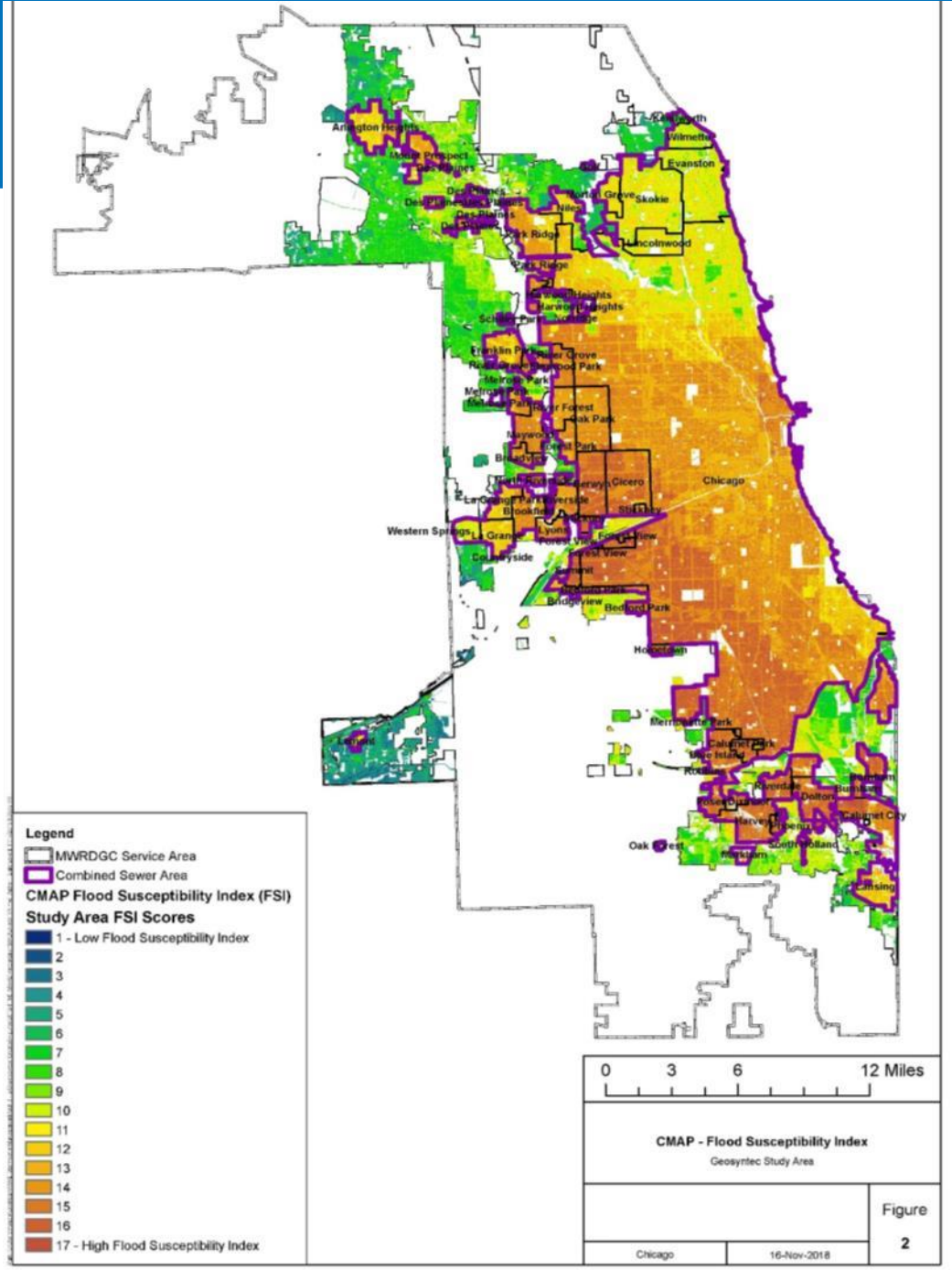
Flood Risk Prioritization

- CMAP developed “heat map” for Urban FSI scores (gradient through municipalities)
- District developed an average raw FSI score for each municipality
- Compare and rank municipalities as a whole
- Consider any municipalities with combined sewers (even if not 100% combined area)



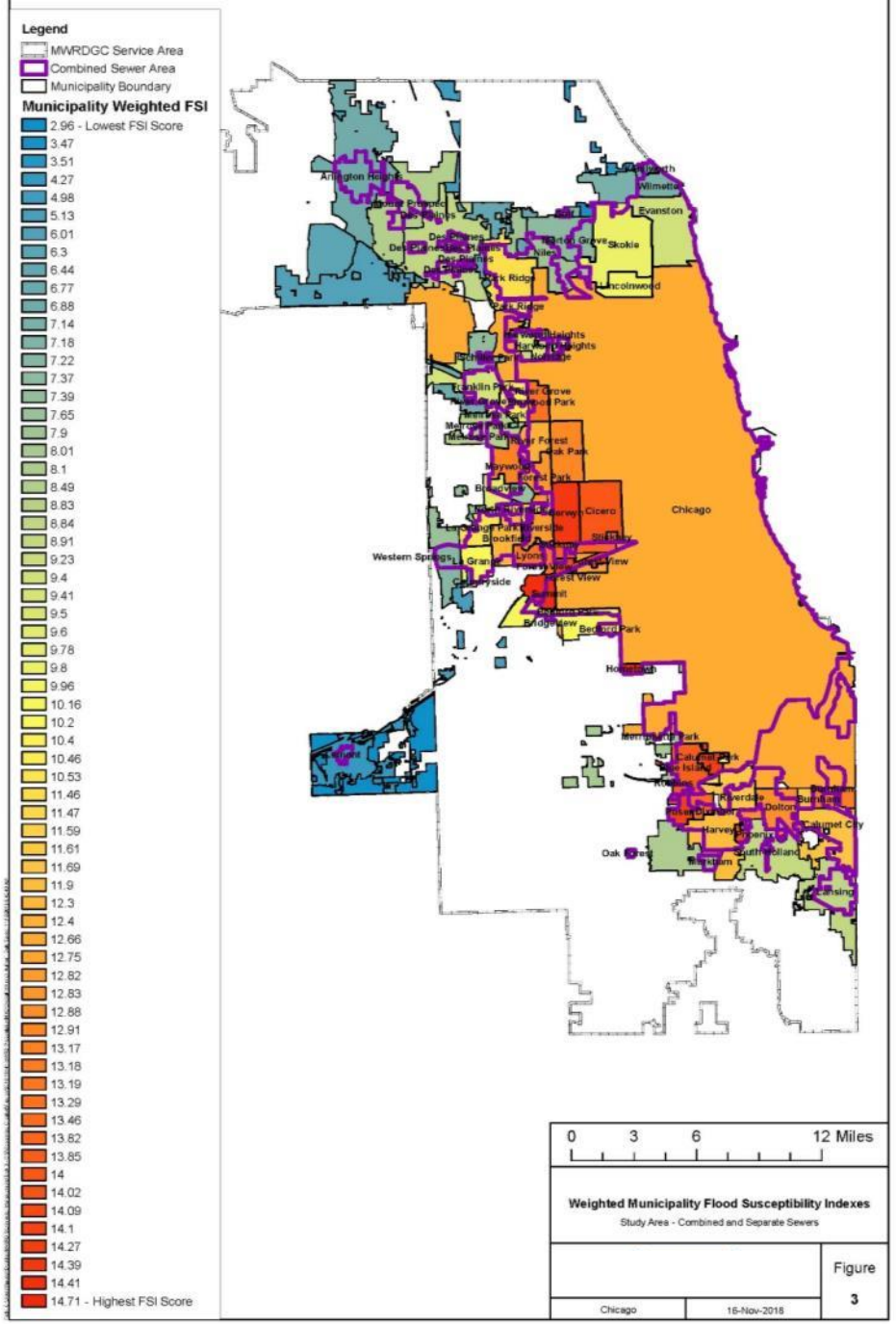
Flood Risk Prioritization

- District compiled raw data for each discrete point within each municipality using GIS
- Use raw scores for the FSI (not adjusted 0-10 scale)
- All FSI contributing factors:
  - Total Wetness Index
  - BFE Differential
  - Impervious Cover
  - Age of 1st Development
  - Precipitation Variation
  - Combined Sewer (factor not removed)



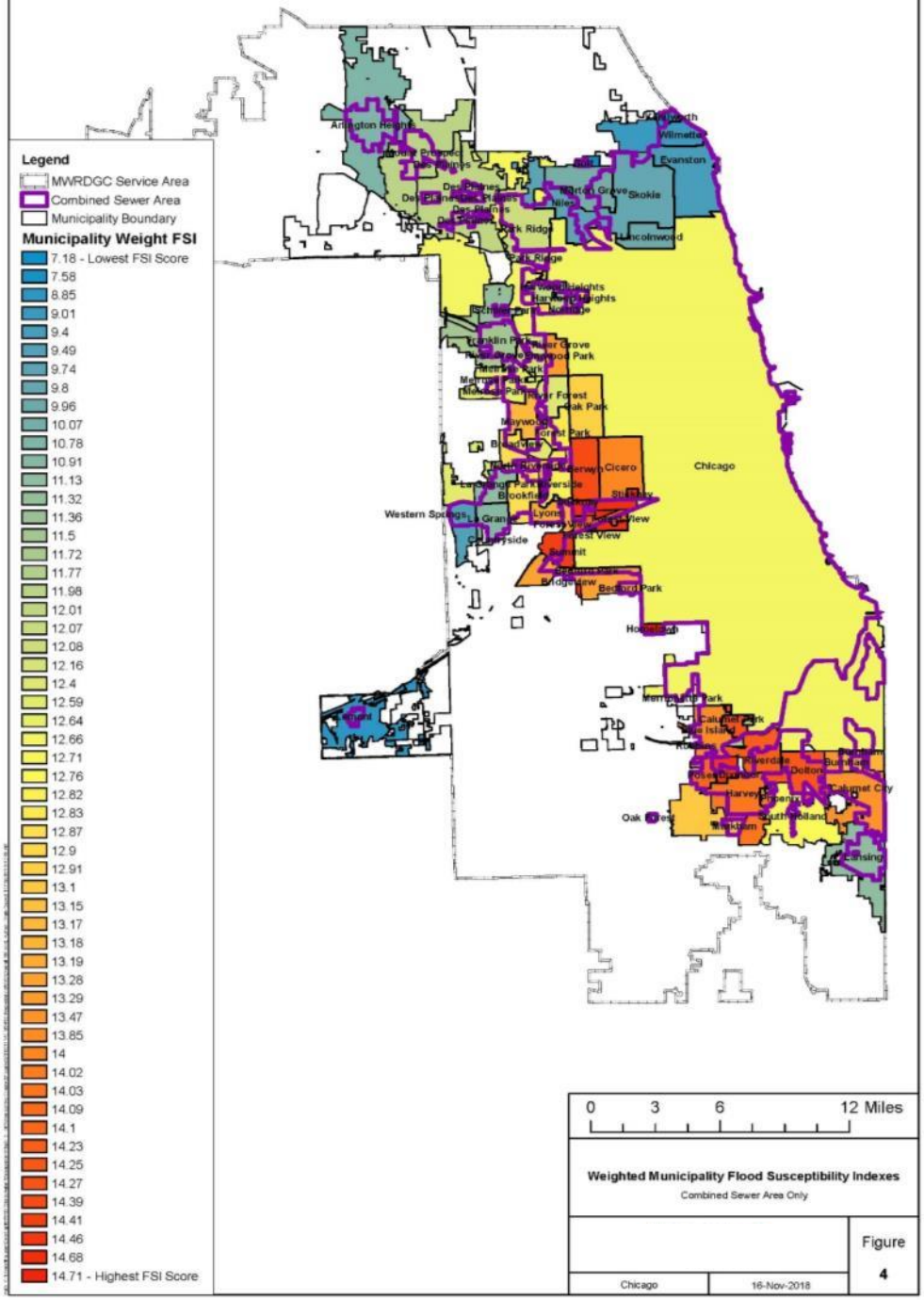
Flood Risk Prioritization

- Municipal Weighted FSI
  - Averaged the raw FSI values associated with discrete points for each (6) contributing factor for each municipality
  - Summed the contributing factors for each municipality to develop an average FSI value over entire municipality
- Summing the factors allows District flexibility in the future

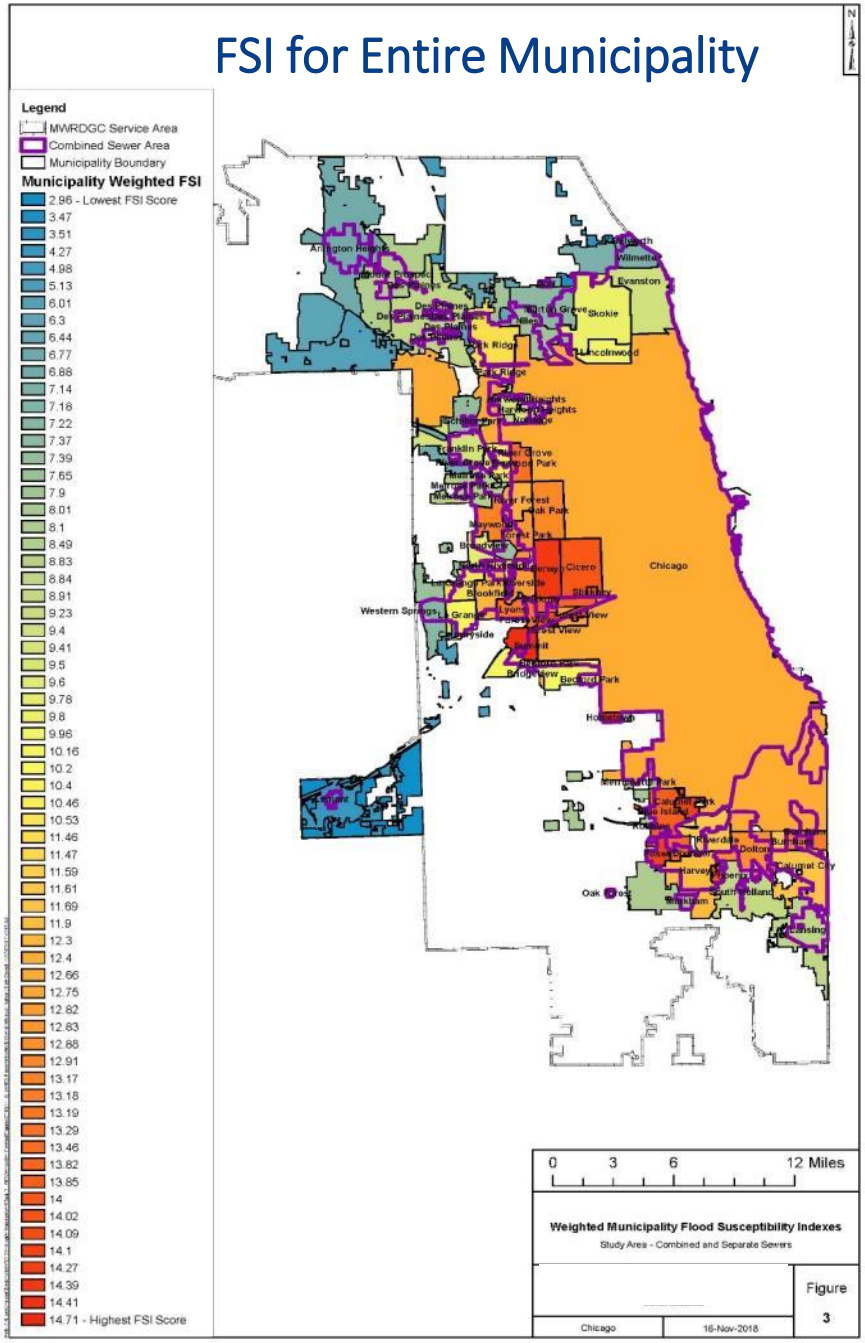


Flood Risk Prioritization

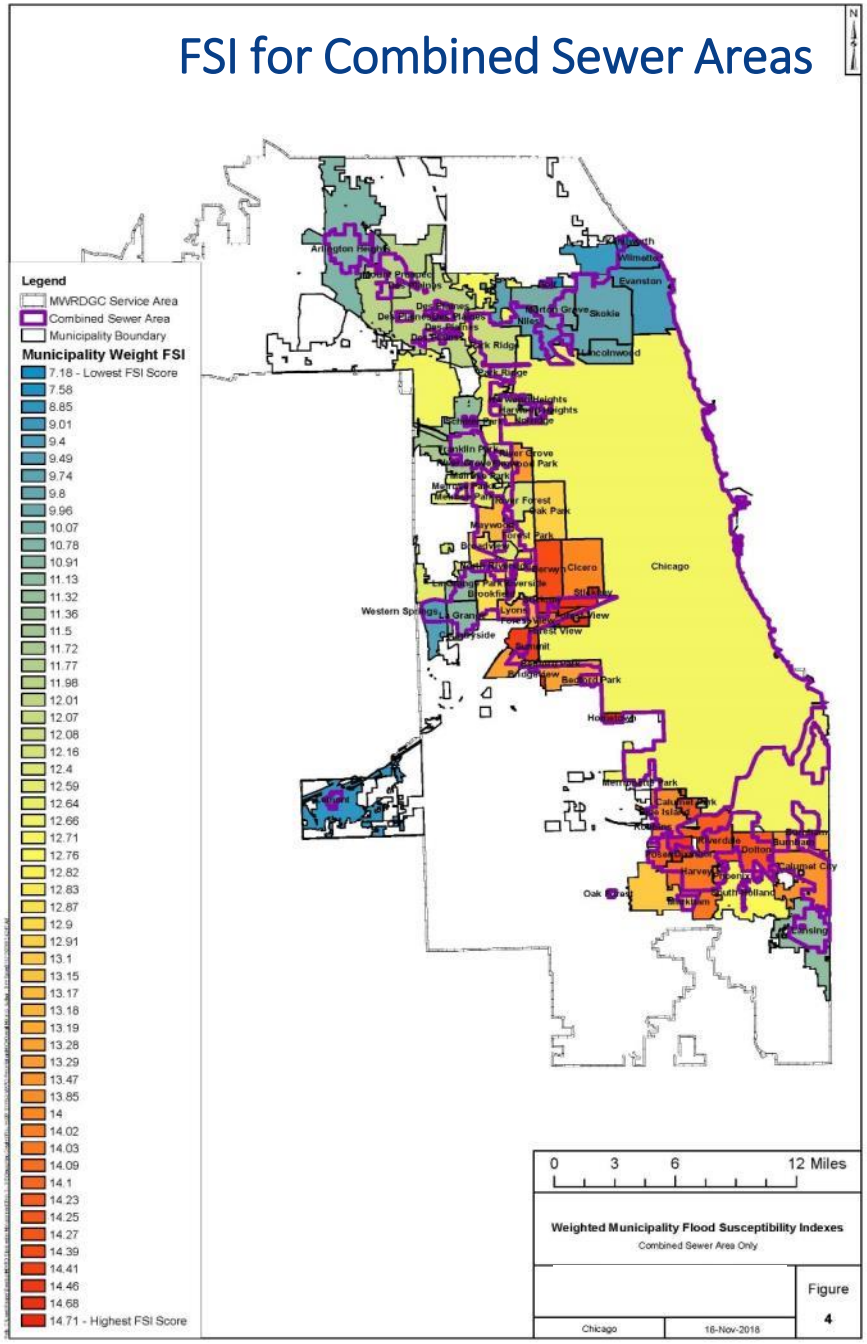
- Two approaches to consider for final FSI score
  - Use average FSI score across entire municipality
  - Use average FSI score only from the combined sewer area and apply to entire municipality
- Use latter approach to better represent municipalities with most need



FSI for Entire Municipality



FSI for Combined Sewer Areas



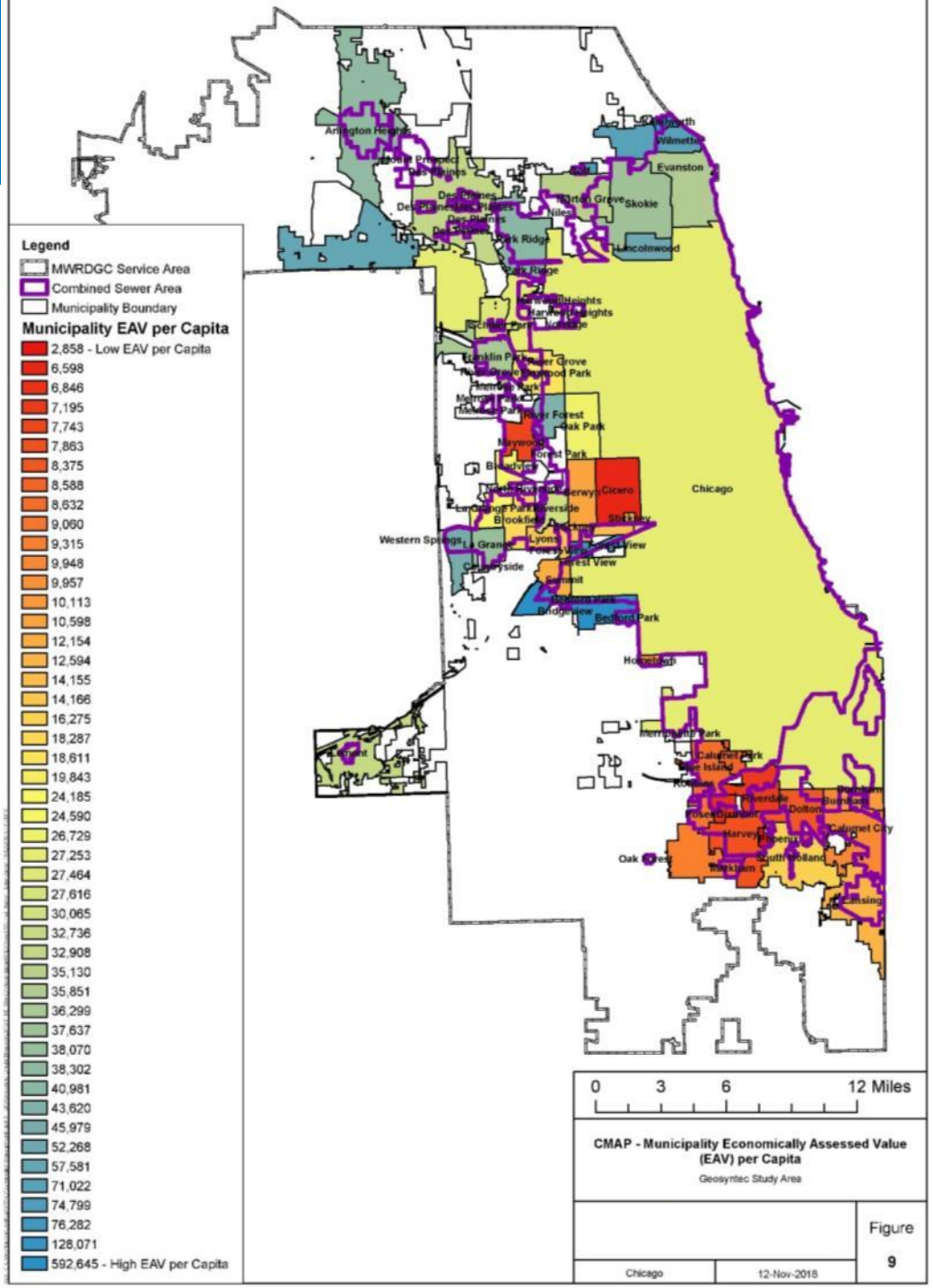
Economic Prioritization

- Goals:
  - Provide assistance to municipalities that need it most
  - To have successful implementation of flood reduction projects
- Examined three sets of factors:
  - Economic Assessed Value (EAV)
  - Economic Disconnected Areas
  - Economic Disinvested Areas

EAV Parameters

Economic Assessed Value per Capita

- Residential, commercial, industrial, agricultural, and railroad
- EAV is the value of a property for taxing purposes
- Each municipal EAV is summed over its area and divided by the population



Economic Prioritization

- Disinvested: those areas "experience[ing] a persistent lack of private and civic investment after the long-term flight of businesses and/or residents."[1]
  - Non-residential market values
  - Employment
  - Levels of lending to businesses

- Disconnected: census tract with a concentration of either
  - Low-income households AND minority population OR
  - Low-income households AND limited English proficiency population

[1] CMAP's ON TO 2050

Data Analysis

Flood Susceptibility Index for All Areas of Communities with Combined Sewers

Rank	Municipality	FSI - All	FSI - Combined Sewer Area Only	EAV per Capita (Dollars)	EDA (% Total Area)	Disinvested Area (% Total Area)	Both EDA and Disinvested Areas (% Total Area)
1	City of Hometown	**14.71**	14.71	$9,957	0.00%	98.81%	0.00%
2	Village of Summit	**14.41**	14.41	$12,154	98.90%	0.28%	0.00%
3	City of Berwyn	**14.39**	14.39	$10,598	6.57%	57.58%	49.40%
4	Village of Calumet Park	**14.27**	14.27	$8,588	23.64%	30.30%	1.74%
5	Village of Posen	**14.10**	14.10	$9,060	100.00%	0.00%	0.00%
6	Village of Forest View	**14.09**	14.09	$76,282	0.00%	0.00%	0.00%
7	Village of Phoenix	**14.02**	14.02	$2,858	99.71%	0.29%	0.29%
8	City of Cicero	**14.00**	14.00	$6,598	31.33%	68.67%	31.33%
9	City of Blue Island	**13.85**	13.85	$8,632	65.11%	34.88%	21.49%
10	Village of Stickney	**13.82**	14.68	$14,155	99.42%	0.54%	0.54%
11	Village of Dixmoor	**13.46**	13.46	$6,846	99.77%	0.23%	0.23%
12	Village of Elmwood Park	**13.29**	13.29	$18,611	0.11%	35.31%	0.01%
13	Village of Lyons	**13.19**	13.19	$14,166	64.88%	0.00%	0.00%
14	Village of Burnham	**13.18**	13.18	$10,113	100.00%	0.00%	0.00%
15	Village of Maywood	**13.17**	13.17	$7,743	0.30%	99.55%	78.28%
16	Village of Oak Park	**12.91**	12.91	$26,729	0.00%	0.02%	0.01%
17	Village of Dolton	**12.88**	14.25	$8,375	44.94%	55.06%	42.31%
18	Village of Forest Park	**12.83**	12.83	$0	0.00%	0.00%	0.00%
19	Village of Riverside	**12.82**	12.82	$30,065	0.53%	0.00%	0.00%
20	Stickney Township	**12.75**	14.68	$0	11.47%	0.06%	0.00%
21	City of Chicago	**12.66**	12.66	$27,253	32.52%	34.85%	27.24%
22	Village of River Forest	**12.40**	12.40	$43,620	0.00%	0.00%	0.00%

Data Analysis

Flood Susceptibility Index for Combined Sewer Area Only

Rank	Municipality	FSI - All	FSI - Combined Sewer Area Only	EAV per Capita (Dollars)	EDA (% Total Area)	Disinvested Area (% Total Area)	Both EDA and Disinvested Areas (% Total Area)
1	City of Hometown	14.71	**14.71**	$9,957	0.00%	98.81%	0.00%
2	Village of Stickney	13.82	**14.68**	$14,155	99.42%	0.54%	0.54%
3	Stickney Township	12.75	**14.68**	$0	11.47%	0.06%	0.00%
4	Village of Summit	14.41	**14.41**	$12,154	98.90%	0.28%	0.00%
5	City of Berwyn	14.39	**14.39**	$10,598	6.57%	57.58%	49.40%
6	Village of Calumet Park	14.27	**14.27**	$8,588	23.64%	30.30%	1.74%
7	Village of Dolton	12.88	**14.25**	$8,375	44.94%	55.06%	42.31%
8	Village of Riverdale	11.61	**14.23**	$7,195	71.51%	28.14%	28.14%
9	Village of Posen	14.10	**14.10**	$9,060	100.00%	0.00%	0.00%
10	Village of Forest View	14.09	**14.09**	$76,282	0.00%	0.00%	0.00%
11	City of Harvey	11.90	**14.03**	$7,863	52.04%	47.48%	47.48%
12	Village of Phoenix	14.02	**14.02**	$2,858	99.71%	0.29%	0.29%
13	City of Cicero	14.00	**14.00**	$6,598	31.33%	68.67%	31.33%
14	City of Blue Island	13.85	**13.85**	$8,632	65.11%	34.88%	21.49%
15	City of Calumet City	11.69	**13.47**	$9,948	48.41%	48.87%	37.68%
16	Village of Dixmoor	13.46	**13.46**	$6,846	99.77%	0.23%	0.23%
17	Village of Elmwood Park	13.29	**13.29**	$18,611	0.11%	35.31%	0.01%
18	Village of Bedford Park	10.16	**13.28**	$592,645	59.74%	0.01%	0.00%
19	Village of Lyons	13.19	**13.19**	$14,166	64.88%	0.00%	0.00%
20	Village of Burnham	13.18	**13.18**	$10,113	100.00%	0.00%	0.00%
21	Village of Maywood	13.17	**13.17**	$7,743	0.30%	99.55%	78.28%
22	Village of North Riverside	11.47	**13.15**	$0	0.00%	4.26%	0.00%

Economic Prioritization

- Ordered municipalities by FSI (use combined sewer FSI values; highest = most risk)
- For socio-economic criteria, communities were divided into quartiles and assigned a ranking of 0, 1, 2, or 3 for each factor (3 = most at risk)
- Communities in which there was no data available were given a value of N/A
- Socio-Economic factors were then summed
- Socio-Economic scores ≥ 6 were considered

Data Analysis

Economic Scores: Top 22 Communities for Combined Sewers Areas Only

Rank	Municipality	FSI - All	FSI - Combined Sewer Area Only	EAV per Capita Score	EDA Score	Disinvested Area Score	Sum of Economic Characteristics
1	City of Hometown	14.71	**14.71**	2	0	3	**5**
2	Village of Stickney	13.82	**14.68**	2	3	1	**6**
3	Stickney Township	12.75	**14.68**	N/A	2	1	**3**
4	Village of Summit	14.41	**14.41**	2	3	1	**6**
5	City of Berwyn	14.39	**14.39**	2	2	3	**7**
6	Village of Calumet Park	14.27	**14.27**	3	2	2	**7**
7	Village of Dolton	12.88	**14.25**	3	2	3	**8**
8	Village of Riverdale	11.61	**14.23**	3	3	2	**8**
9	Village of Posen	14.10	**14.10**	3	3	0	**6**
10	Village of Forest View	14.09	**14.09**	0	0	0	**0**
11	City of Harvey	11.90	**14.03**	3	2	3	**8**
12	Village of Phoenix	14.02	**14.02**	3	3	1	**7**
13	City of Cicero	14.00	**14.00**	3	2	3	**8**
14	City of Blue Island	13.85	**13.85**	3	3	3	**9**
15	City of Calumet City	11.69	**13.47**	3	2	3	**8**
16	Village of Dixmoor	13.46	**13.46**	3	3	1	**7**
17	Village of Elmwood Park	13.29	**13.29**	2	1	3	**6**
18	Village of Bedford Park	10.16	**13.28**	0	3	1	**4**
19	Village of Lyons	13.19	**13.19**	2	3	0	**5**
20	Village of Burnham	13.18	**13.18**	2	3	0	**5**
21	Village of Maywood	13.17	**13.17**	3	1	3	**7**
22	Village of North Riverside	11.47	**13.15**	N/A	0	2	**2**

FSI = Flood Susceptibility Index EDA = Economically Disconnected Area

EAV = Equalized Assessed Value Communities are ranked based on the FSI for combined sewer areas only, from highest to lowest.

Qualitative Review

- Municipalities with updated Stormwater Master Plans would not be included in this initial round of study
- Municipalities with current District stormwater improvements projects not included in initial round
- Prepare SMP for approximately 15 square mile area
- Choose one anchor community based on size and population
- Consider adjacent communities with similar FSI and socio-economic scores

Data Analysis

Economic Scores: Top 22 Communities for Combined Sewers Areas Only

Rank	Municipality	FSI - All	FSI - Combined Sewer Area Only	EAV per Capita Score	EDA Score	Disinvested Area Score	Sum of Economic Characteristics
1	City of Hometown	14.71	**14.71**	2	0	3	**5**
2	Village of Stickney	13.82	**14.68**	2	3	1	**6**
3	Stickney Township	12.75	**14.68**	N/A	2	1	**3**
4	Village of Summit	14.41	**14.41**	2	3	1	**6**
5	City of Berwyn	14.39	**14.39**	2	2	3	**7**
6	Village of Calumet Park	14.27	**14.27**	3	2	2	**7**
7	Village of Dolton	12.88	**14.25**	3	2	3	**8**
8	Village of Riverdale	11.61	**14.23**	3	3	2	**8**
9	Village of Posen	14.10	**14.10**	3	3	0	**6**
10	Village of Forest View	14.09	**14.09**	0	0	0	**0**
11	City of Harvey	11.90	**14.03**	3	2	3	**8**
12	Village of Phoenix	14.02	**14.02**	3	3	1	**7**
13	City of Cicero	14.00	**14.00**	3	2	3	**8**
14	City of Blue Island	13.85	**13.85**	3	3	3	**9**
15	City of Calumet City	11.69	**13.47**	3	2	3	**8**
16	Village of Dixmoor	13.46	**13.46**	3	3	1	**7**
17	Village of Elmwood Park	13.29	**13.29**	2	1	3	**6**
18	Village of Bedford Park	10.16	**13.28**	0	3	1	**4**
19	Village of Lyons	13.19	**13.19**	2	3	0	**5**
20	Village of Burnham	13.18	**13.18**	2	3	0	**5**
21	Village of Maywood	13.17	**13.17**	3	1	3	**7**
22	Village of North Riverside	11.47	**13.15**	N/A	0	2	**2**

FSI = Flood Susceptibility Index EDA = Economically Disconnected Area

EAV = Equalized Assessed Value Communities are ranked based on the FSI for combined sewer areas only, from highest to lowest.

Summary

- FSI is useful resource to highlight areas with substantial flood risk when local data and comprehensive stormwater modeling are unavailable
- CMAP's Urban FSI shows an apparent correlation between municipalities with the most flood risk and the most economic need
- Generally, municipalities with high FSI values and high economic need are clustered geographically, which allows SMP effort to be consolidated
- Qualitative review is critical after rankings are prepared

Contact

Brian Wawczak, P.E., CFM
Senior Civil Engineer
MWRD
WawczakB@mwrd.org
(312) 751-5836