Stormwater:
Too Simple?

CWEA Stormwater Committee
2017 Fall Seminar

Urban Flooding;
The Hidden National Threat

Linthicum, Maryland
December 13, 2017

Center for Disaster Resilience

Gerald E. Galloway, Jr., PE, PhD
Glenn L. Martin Institute Professor of Engineering, University of Maryland
Eminent Scholar in Residence and Visiting Professor, Texas A&M – Galveston
gegallo@umd.edu

Hagler Institute for Advanced Studies

Caution

FEAR THE TURTLE

Two Sentences

Climate scientist makes the most of his parking-lot meeting with Pope Francis

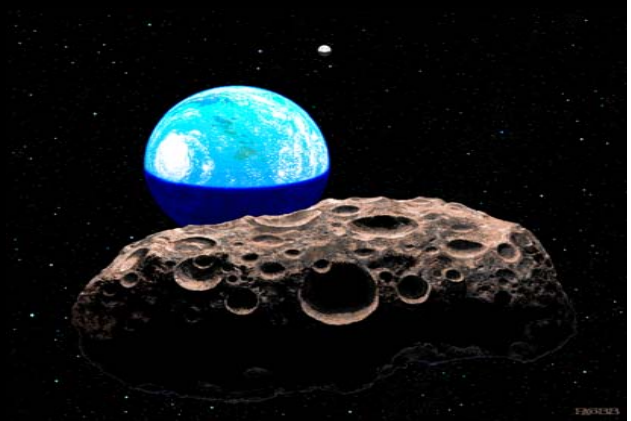
"We have a collection of experts from around the world who are concerned about climate change. The changes are already happening and getting worse, and the worst consequences will be felt by the world's 3 billion poor people."

BLUF (T)

- Urban Flooding Is a Growing National Problem and We Do Not Have a Handle on Its Extent, Consequences and Solutions
- Urban Flooding Has a Disproportionately Large Effect on Those Who Are Least Able to Deal with It

The 21st Century

- Population Explosion
- Pressures for Development
- Crumbling Infrastructure
- Inequalities
- Volatile, Uncertain, Complex, Ambiguous National and World Situations
- Climate Change and Disasters!



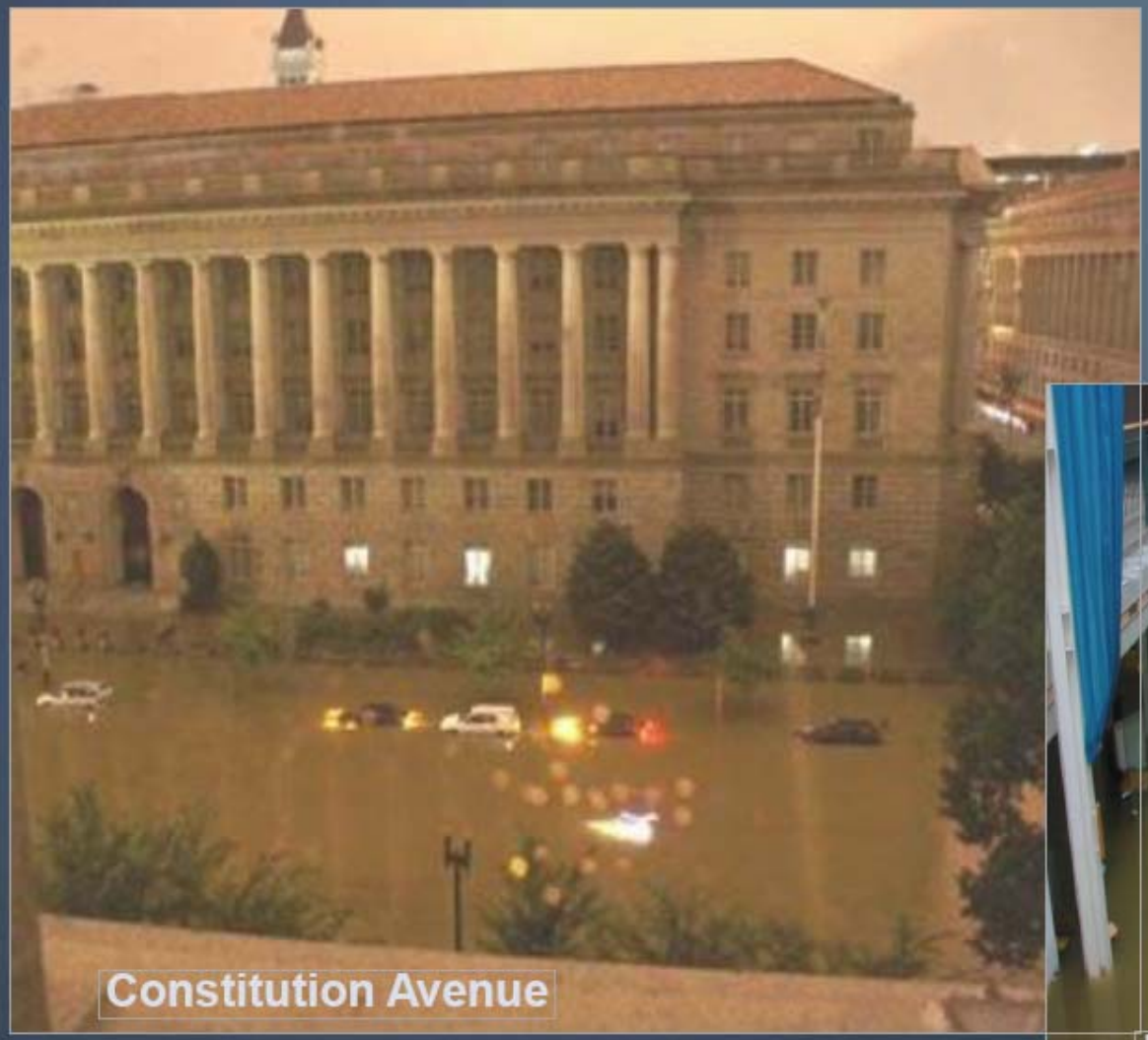

NO
PARKING
8AM-6PM
NO
PARKING
8AM-6PM
OPA!

1993 Mississippi River Flood

Nearly 50 percent of the approximately 100,000 homes damaged, suffered losses due to groundwater or sewer backup [and sheet flows] as opposed to riverine flooding.

National Capital Planning Commission

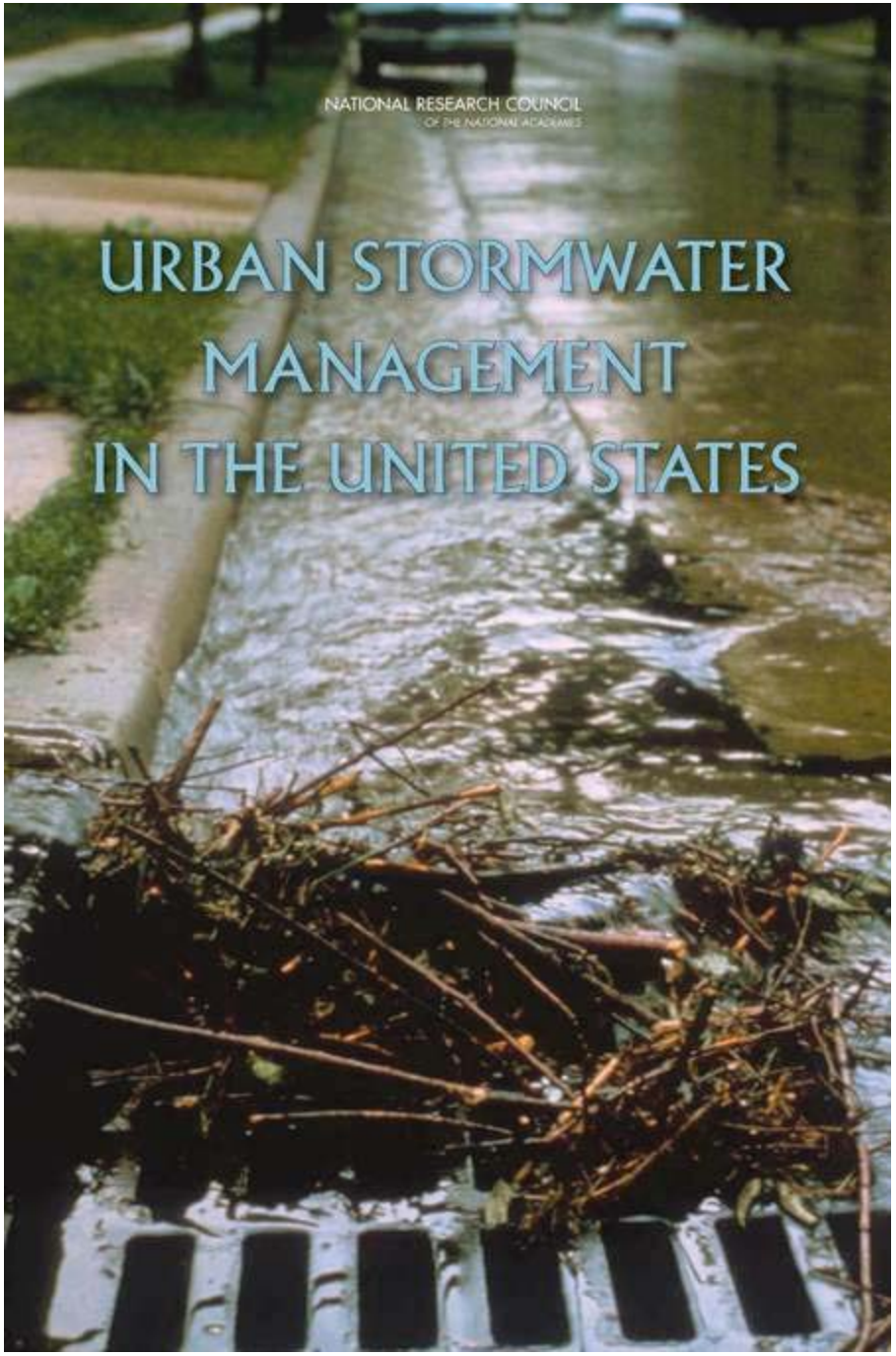
Overview



Constitution Avenue

June 2006
Flooding in the monumental core

Department of Justice

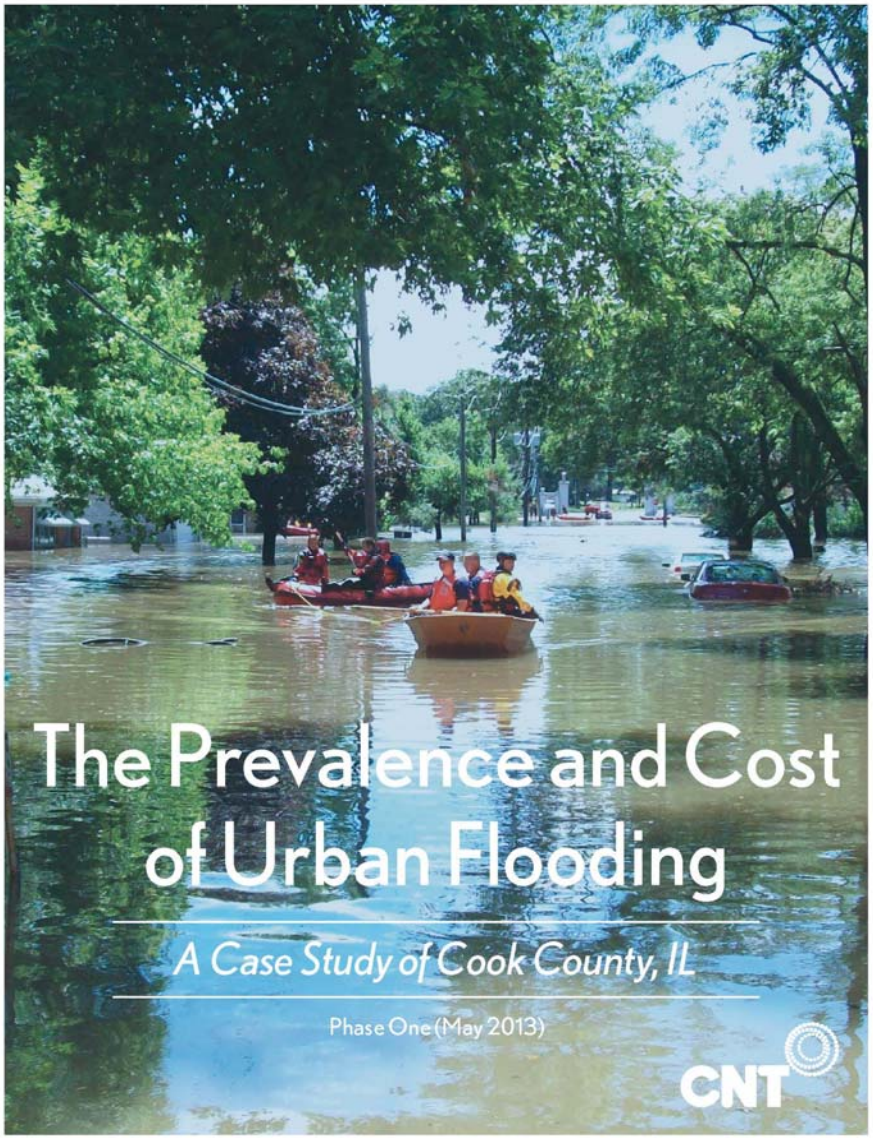


US National Academies

Increased flooding is common throughout urban and suburban areas, sometimes as a consequence of improperly sited development but more commonly as a result of increasing discharges over time resulting from progressive urbanization farther upstream

2009

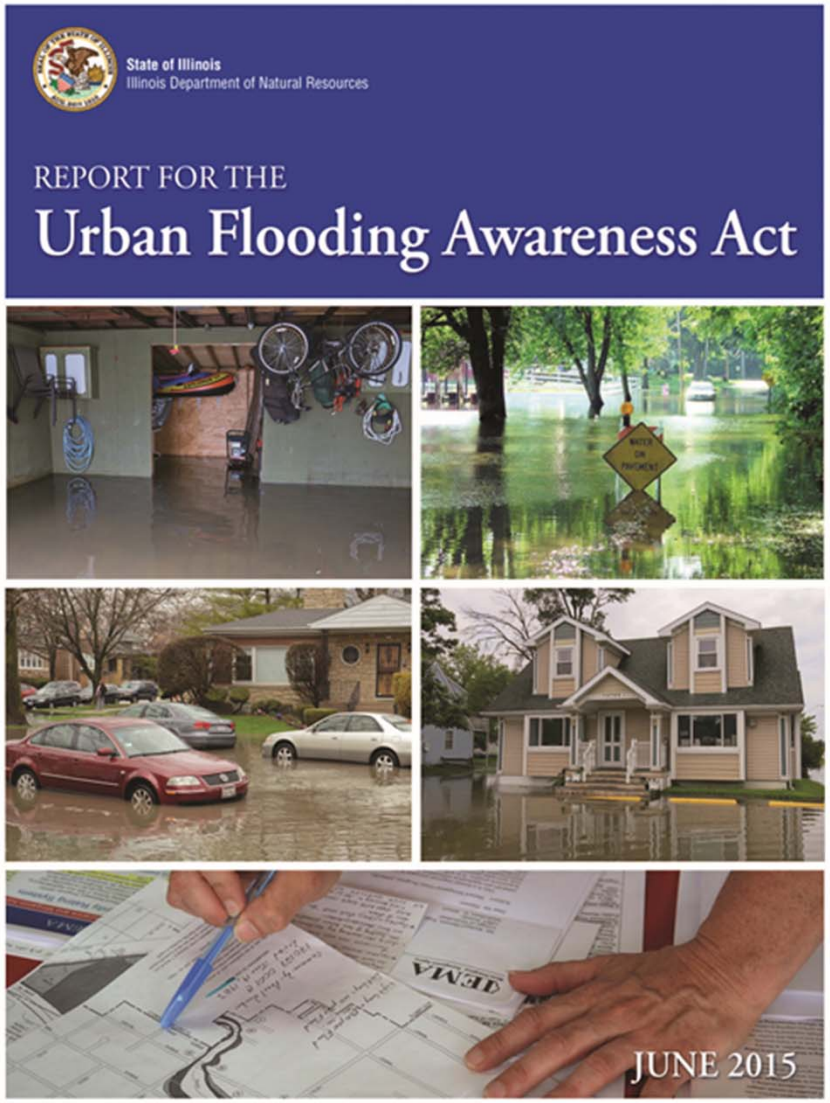
Nashville 2010



THE CENTER FOR NEIGHBORHOOD TECHNOLOGY

Harriet Festing, Project Manager
Cindy Copp, Data and GIS Analyst
Hal Sprague, Policy
Dan Wolf, Research
Ben Shorofsky, Research
Kathrine Nichols, Report Layout

2013



An Illinois Team

Brad A. Winters
Jim Angel
Clayton Ballerine
Jennifer Byard
Amanda Flegel
Daniel Gambill
Emily Jenkins
Sally McConkey
Momcilo Markus
Bruce A. Bender
Molly J. O'Toole
Jeanne Handy

Office of Water Resources, DNR
Illinois State Water Survey
Prairie Research Institute
University of Illinois
Bender Consulting Services, Inc.
Molly O'Toole & Associates, Ltd.

2015

Congressional Actions

- Rep Quigley - Call for study

  2D SESSION H. R. 5521
  To direct the Administrator of the Federal Emergency Management Agency to enter into an agreement with the National Research Council to conduct a study on urban flooding, and for other purposes.
  IN THE HOUSE OF REPRESENTATIVES, SEPTEMBER 17, 2014

- Sen Durbin, Rep Quiqley Approps for Study.

  address cost-effective strategies to reduce the impacts of urban flooding and the most sustainable and effective methods for funding flood risk assessments and flood damage reduction efforts at all levels of government

What is Urban Flooding

US Congress: Urban Flooding Awareness Act of 2014 (not passed)

the inundation of property in a built environment, particularly in more densely populated areas, caused by rain falling on increased amounts of impervious surface and overwhelming the capacity of drainage systems.

FEMA

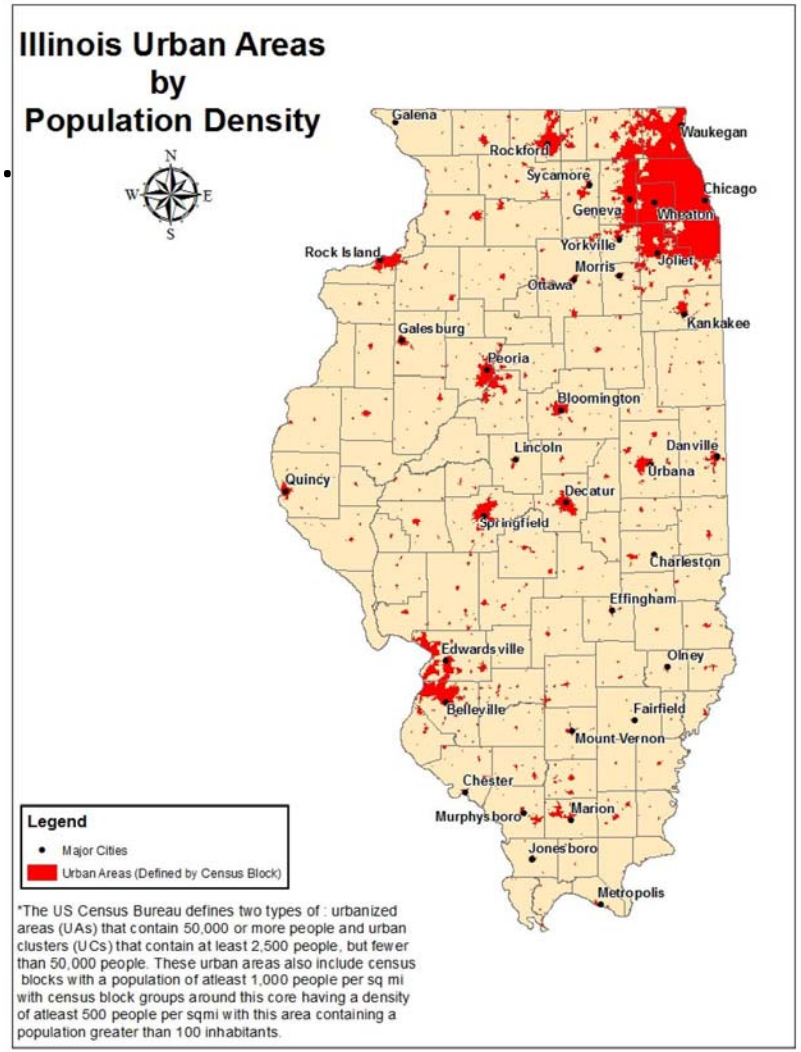
Urban flooding can be defined as the inundation of property in a built environment, particularly in more densely populated areas, caused by rain falling on increased amounts of impervious surface and overwhelming the capacity of drainage systems. It excludes flooding in undeveloped or agricultural areas. It includes situations in which stormwater enters buildings through: a. windows, doors, or other openings; b. water backup through pipes and drains; c. seepage through walls and floors;

Illinois Urban Flooding Act

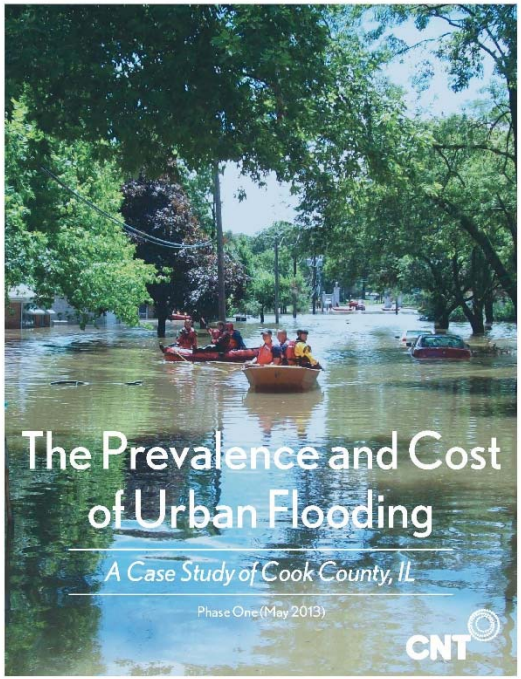
The inundation of property in a built environment, particularly in more densely populated areas, caused by rainfall overwhelming the capacity of drainage systems, such as storm sewers. ‘Urban flooding’ does not include flooding in undeveloped or agricultural areas.”

Urban Areas

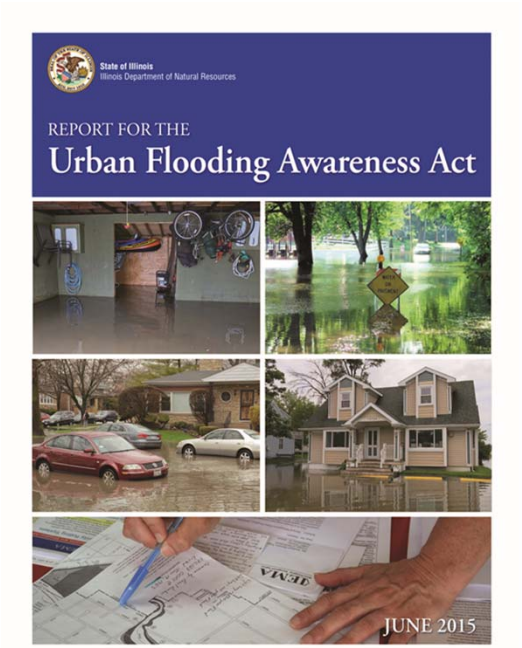
Urban areas are defined by the U.S. Department of Commerce, Census Bureau (USCB) as densely developed residential, commercial and other nonresidential areas. The USCB identified two types of urban areas: urbanized areas for 50,000 or more people and urban clusters of at least 2,500 and less than 50,000 people (2012).



WHAT HAVE WE LEARNED?

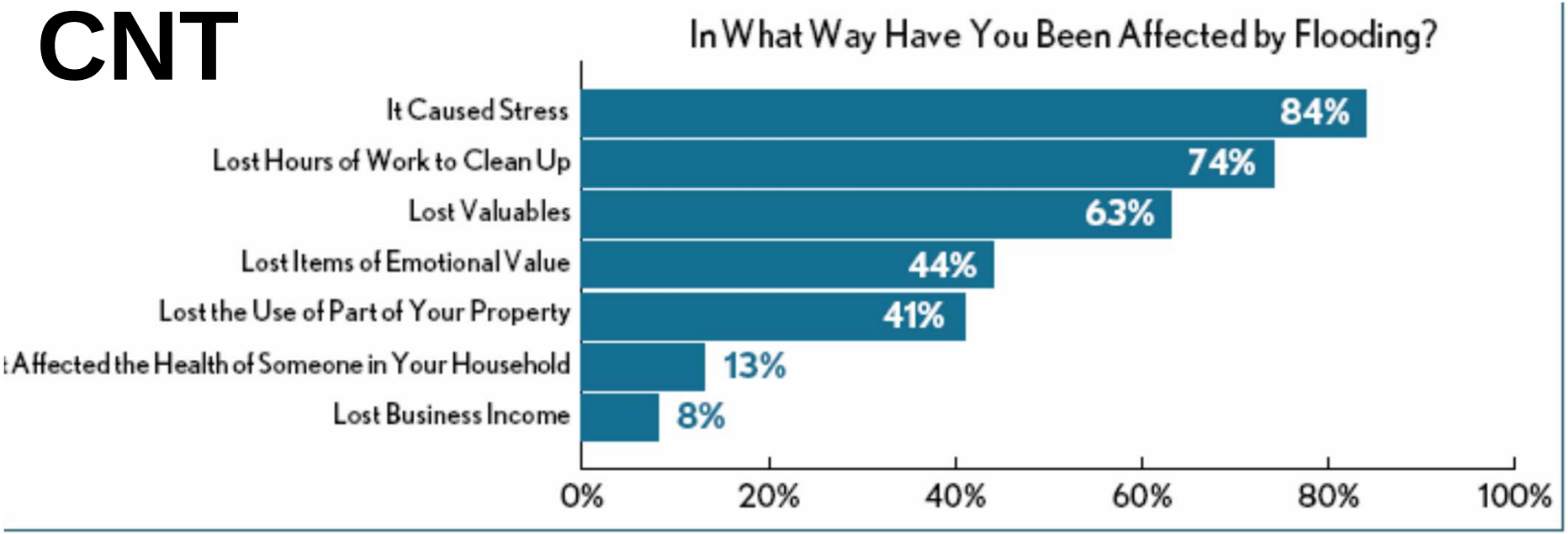


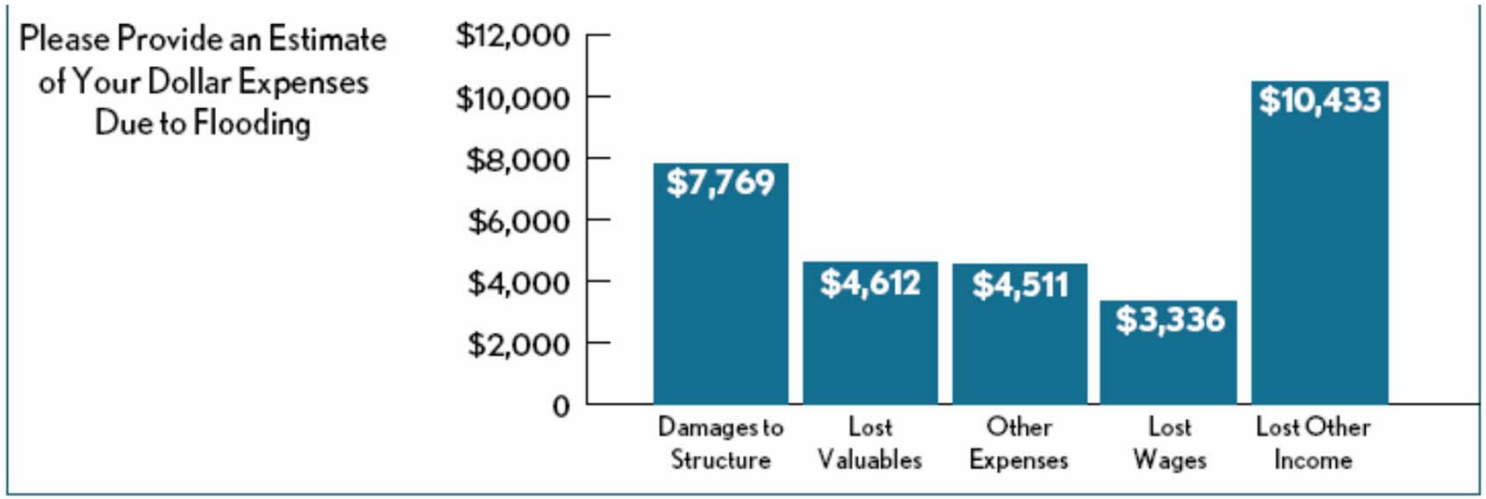
- **Urban flooding in Cook County, IL is chronic and systemic, resulting in damage that is widespread, repetitive and costly**
- **There are multiple social and economic impacts on property owners**
- **There is no correlation between damage payouts and the floodplains**
- **Claims were made across income groups.**
- **NFIP Flood insurance is not carrying the burden of damage payouts:**
- **No clear solutions for property owners**



- **Flooding in urban areas has received increasing attention in the last decade, with at least $2.319 billion in documented damages between 2007 and 2014, of which $1,240 billion were private claims that typically represent basement flooding and sewer backup.**
- **Although the largest percentage of insurance claims is from northeastern Illinois, urban flood damages and problems occur statewide in urban areas.**
- **There are numerous contributing factors to urban flooding, and in any location the causes may be unique.**

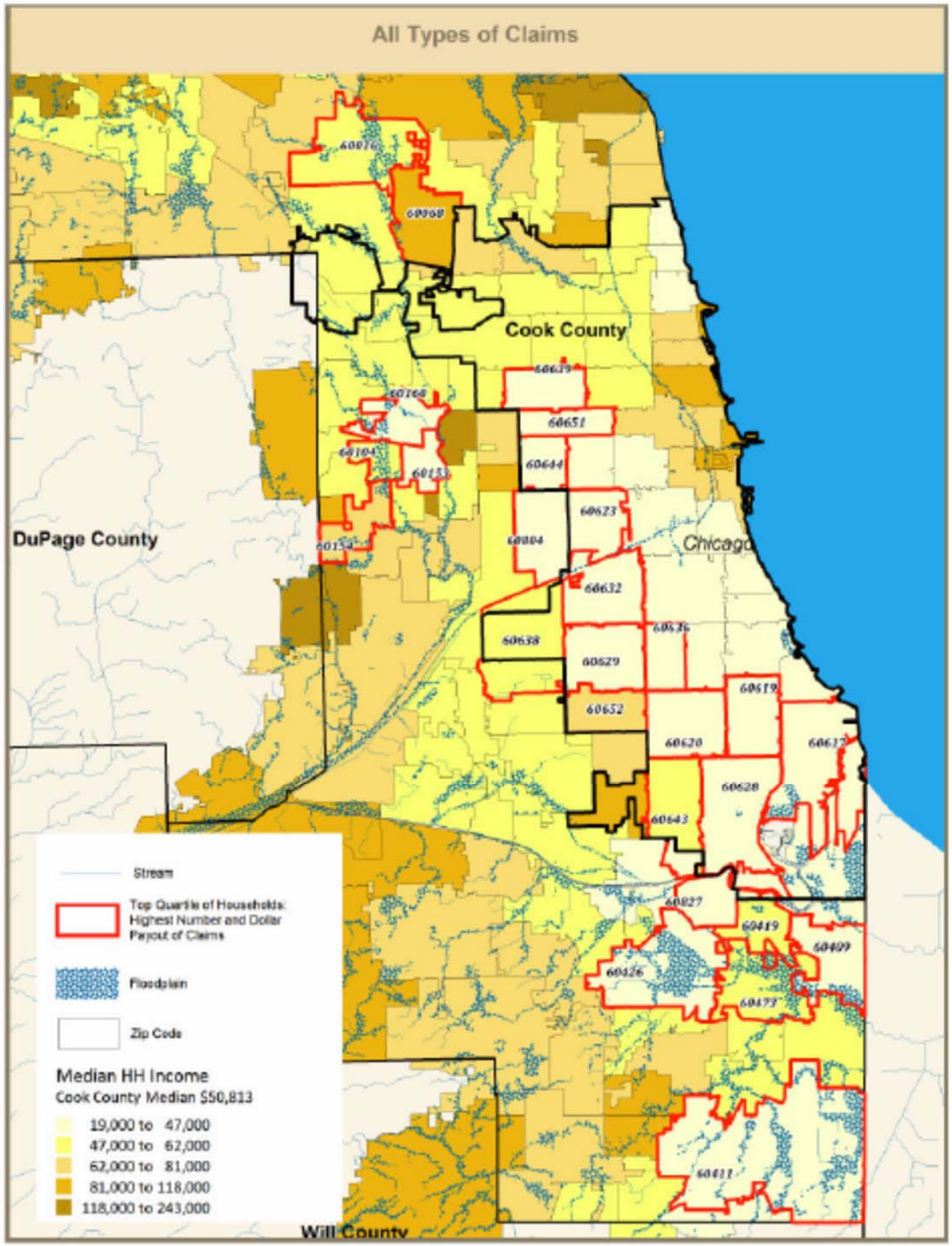
CNT


In What Way Have You Been Affected by Flooding?
It Caused Stress
84%
Lost Hours of Work to Clean Up
74%
Lost Valuables
63%
Lost Items of Emotional Value
44%
Lost the Use of Part of Your Property
41%
Affected the Health of Someone in Your Household
13%
Lost Business Income
8%
0%
20%
40%
60%
80%
100%


Please Provide an Estimate of Your Dollar Expenses Due to Flooding
$12,000
$10,000
$8,000
$6,000
$4,000
$2,000
0
$7,769
$4,612
$4,511
$3,336
$10,433
Damages to Structure
Lost Valuables
Other Expenses
Lost Wages
Lost Other Income

CNT

Median Household Income in ZIP Codes with Largest Total Claims (Number and Dollar Payout), 2007–11



On Whom Is the Greatest Impact?

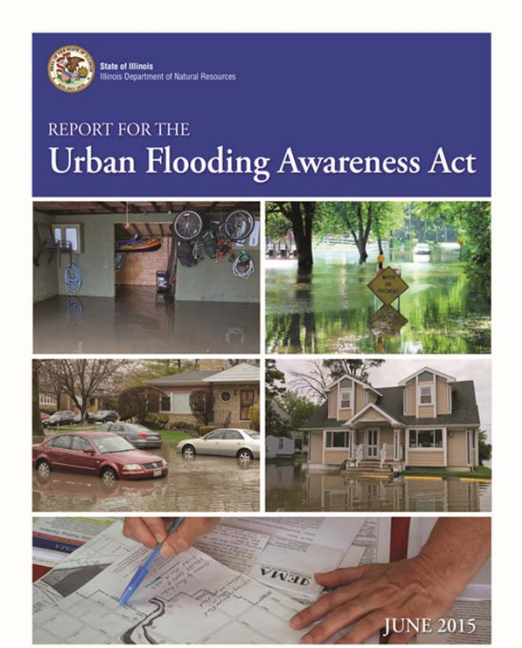
Tercha, M. (2008) Chicago Tribune

Kaleta, A. (2008) Pioneer Press

Kaleta, A. (2008) Pioneer Press

From Brad Winters, IL DNR

What is a “Nuisance” flood to you
is a “Disaster” for me



- **Over 90% of urban flooding damage claims from 2007 to 2014 were outside the mapped floodplain**
- **Communities may have the authority to impose design standards and ordinances but often do not have the legal authority to establish a dedicated funding stream,**
- **Urban flooding is expected to increase unless action is taken.**
- **Storm sewer infrastructure is the underpinning of urban drainage, and action is needed to update aging, undersized systems.**
- **Changes to infrastructure and the urban landscape will take years; however, communities and individuals can take action now to reduce risk and damages**
- **The responsibility for urban flooding lies at all levels, from state government to individual property owners, and a tiered approach is required for all aspects of stormwater management.**

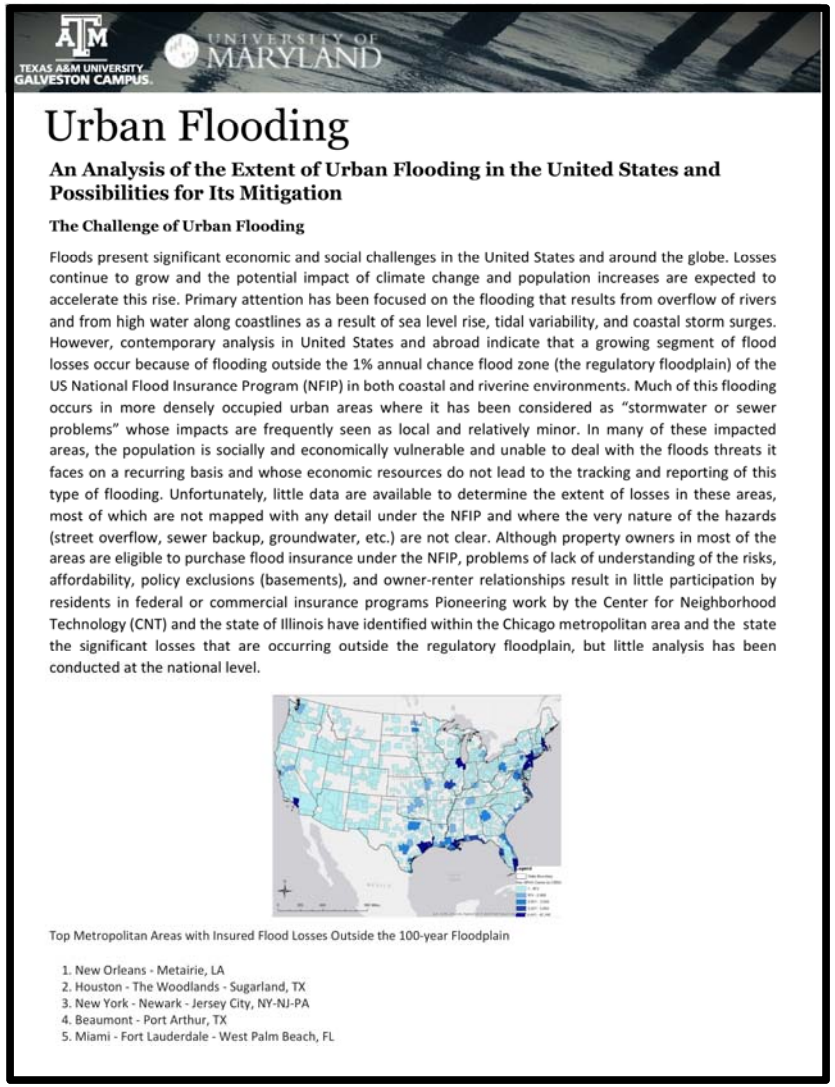
On Going efforts

- CNT
- National Academies
- Texas A&M – Maryland - Others

The National Academies of SCIENCES ENGINEERING MEDICINE

Organize a series of regional workshops or case studies to explore the issue of urban flooding in 3 to 8 metropolitan areas in order to gain an initial understanding of its extent and causes in the chosen locations.

- How big is the problem of flooding in each metropolitan area?
- What causes the worst impacts of flooding–
- How could the worst impacts be avoided or mitigated?
- Who is affected most by floods in the metropolitan area?
- Which regions of the metropolitan areas see the longest lasting or most costly effects of flooding?



TEXAS A&M UNIVERSITY GALVESTON CAMPUS

UNIVERSITY OF MARYLAND

Urban Flooding

An Analysis of the Extent of Urban Flooding in the United States and Possibilities for Its Mitigation

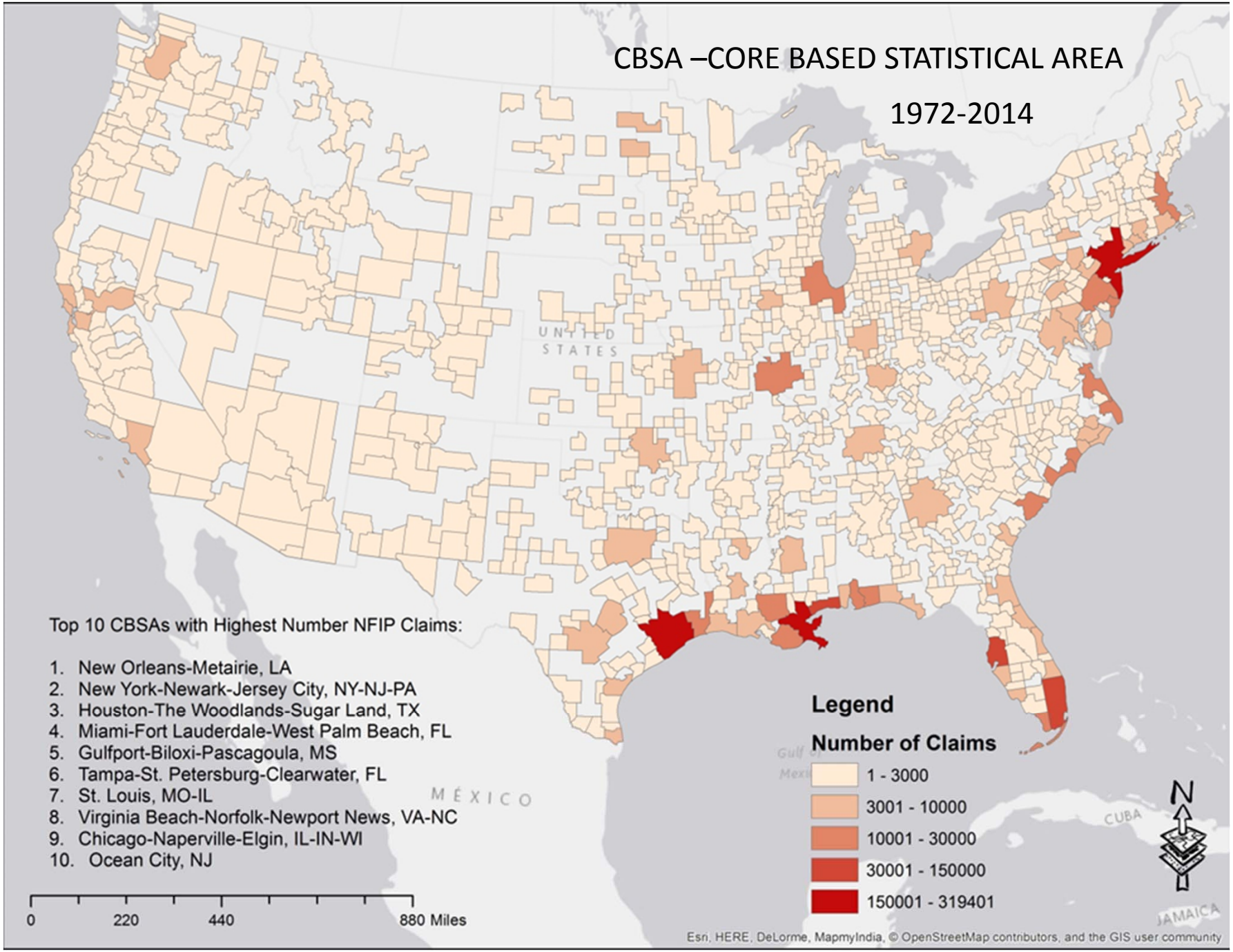
The Challenge of Urban Flooding

Floods present significant economic and social challenges in the United States and around the globe. Losses continue to grow and the potential impact of climate change and population increases are expected to accelerate this rise. Primary attention has been focused on the flooding that results from overflow of rivers and from high water along coastlines as a result of sea level rise, tidal variability, and coastal storm surges. However, contemporary analysis in United States and abroad indicate that a growing segment of flood losses occur because of flooding outside the 1% annual chance flood zone (the regulatory floodplain) of the US National Flood Insurance Program (NFIP) in both coastal and riverine environments. Much of this flooding occurs in more densely occupied urban areas where it has been considered as "stormwater or sewer problems" whose impacts are frequently seen as local and relatively minor. In many of these impacted areas, the population is socially and economically vulnerable and unable to deal with the floods threats it faces on a recurring basis and whose economic resources do not lead to the tracking and reporting of this type of flooding. Unfortunately, little data are available to determine the extent of losses in these areas, most of which are not mapped with any detail under the NFIP and where the very nature of the hazards (street overflow, sewer backup, groundwater, etc.) are not clear. Although property owners in most of the areas are eligible to purchase flood insurance under the NFIP, problems of lack of understanding of the risks, affordability, policy exclusions (basements), and owner-renter relationships result in little participation by residents in federal or commercial insurance programs Pioneering work by the Center for Neighborhood Technology (CNT) and the state of Illinois have identified within the Chicago metropolitan area and the state the significant losses that are occurring outside the regulatory floodplain, but little analysis has been conducted at the national level.

Top Metropolitan Areas with Insured Flood Losses Outside the 100-year Floodplain

1. New Orleans - Metairie, LA
2. Houston - The Woodlands - Sugarland, TX
3. New York - Newark - Jersey City, NY-NJ-PA
4. Beaumont - Port Arthur, TX
5. Miami - Fort Lauderdale - West Palm Beach, FL

- What is the extent of urban flooding nationally?
- What are its characteristics and consequences?
- How might it be mitigated?


CBSA –CORE BASED STATISTICAL AREA
1972-2014
Top 10 CBSAs with Highest Number NFIP Claims:
1. New Orleans-Metairie, LA
2. New York-Newark-Jersey City, NY-NJ-PA
3. Houston-The Woodlands-Sugar Land, TX
4. Miami-Fort Lauderdale-West Palm Beach, FL
5. Gulfport-Biloxi-Pascagoula, MS
6. Tampa-St. Petersburg-Clearwater, FL
7. St. Louis, MO-IL
8. Virginia Beach-Norfolk-Newport News, VA-NC
9. Chicago-Naperville-Elgin, IL-IN-WI
10. Ocean City, NJ
0
220
440
880 Miles
Legend
Number of Claims
1 - 3000
3001 - 10000
10001 - 30000
30001 - 150000
150001 - 319401
N
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Urban Flooding in the United States: A Growing National Challenge

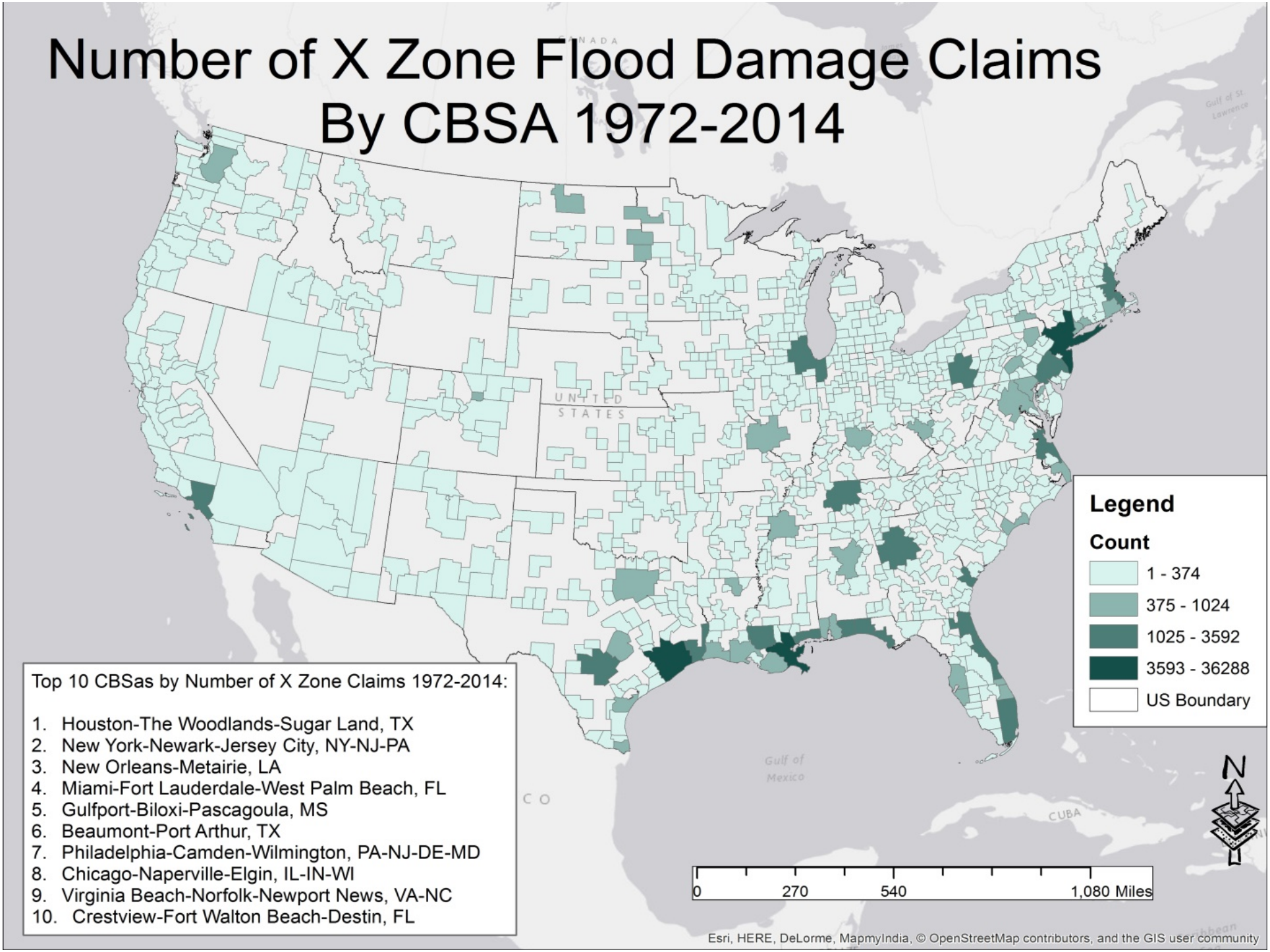
1. Background of the Study

Floods of all types present significant economic and social challenges in the United States and around the globe. Losses continue to grow and the potential impact of climate change and population increases are expected to accelerate this rise. Hurricanes Maria, Harvey, and Irma have reemphasized the magnitude of the impacts that floods pose to the nation. Primary attention has been focused on the flooding that results from the overflow of rivers and from high water along coastlines as a result of sea level rise, tidal variability, and coastal storm surges. However, contemporary analysis in the United States and abroad indicate that a growing segment of flood losses occur because of flooding outside the 1% annual chance flood zone (the regulatory floodplain) of the US National Flood Insurance Program (NFIP) in both coastal and riverine environments. Much of this flooding occurs in more densely occupied urban areas where it has been considered as "stormwater or sewer problems" whose impacts are frequently seen as local and relatively minor. In many of these impacted areas, the population is socially and economically vulnerable and unable to deal with the flood threats it faces on a recurring basis and whose economic resources do not lead to the tracking and reporting of this type of flooding.

Unfortunately, little data are available to determine the extent of losses in these areas, most of which are not mapped with any detail under the NFIP and where the very nature of the hazards (street overflow, sewer backup, groundwater, etc.) are not clear. Although property owners in most of the areas are eligible to purchase flood insurance under the NFIP, problems of lack of understanding of the risks, affordability, policy exclusions (basements), and owner-renter relationships result in limited participation by residents in federal or commercial insurance programs. Pioneering work by the Center for Neighborhood Technology (CNT) and the State of Illinois have identified significant losses within the Chicago metropolitan area and the state that are occurring outside the regulatory floodplain.The State reported that flooding in urban areas in Illinois caused, between 2007 and 2014, at least $2.319 billion in documented damages, of which $1,240 billion were private claims that typically represent basement flooding and sewer backup and that over 90% of urban flooding damage claims from 2007 to 2014 were outside the FEMA Special Flood Hazard Area. Unfortunately, little analysis has been conducted at the national level.

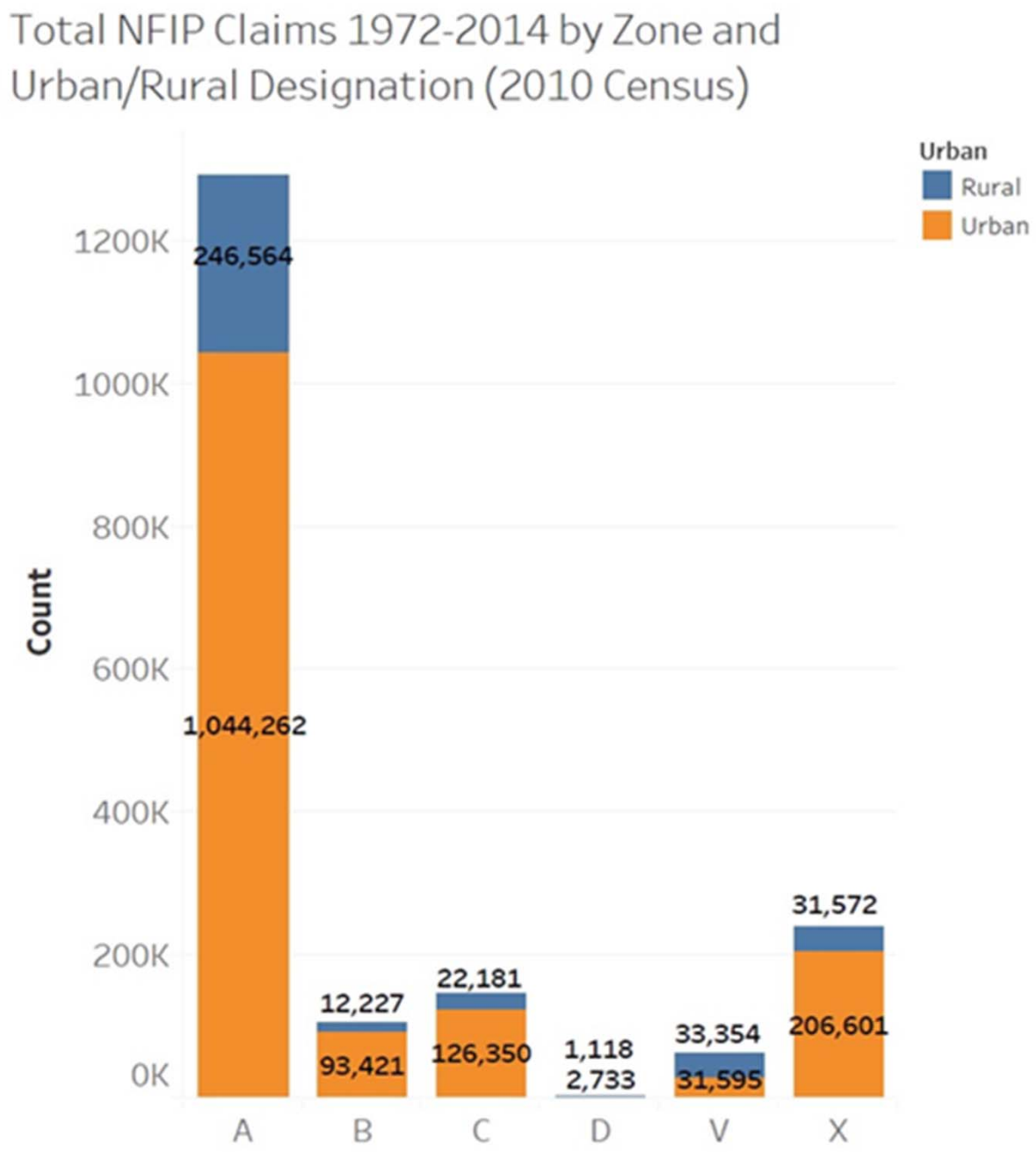
The University of Maryland Center for Disaster Resilience and the Texas A&M Center for Texas Beaches and Shores, with the support of the Hagler Institute for Advanced Study at Texas A&M University, are conducting a scoping analysis of the extent and consequences of urban flooding and identifying potential solutions for mitigation of such flooding. With the cooperation of the Federal Emergency Management Agency, the National Oceanic and Atmospheric Administration, the Small Business Administration and the Census Bureau, the study team has analyzed data concerning reported flood losses across the country. However, since the majority of these data apply to riverine and coastal flooding and since federal assistance is not normally provided for smaller non-riverine/coastal events, it has been difficult to more precisely identify where urban flooding is a problem for communities. It is clear from the data that has been obtained and spatial analysis of claim locations that substantial flood losses occur outside the 1% floodplain of the NFIP and, in many cases, in areas not connected directly to riverine or coastal sources.

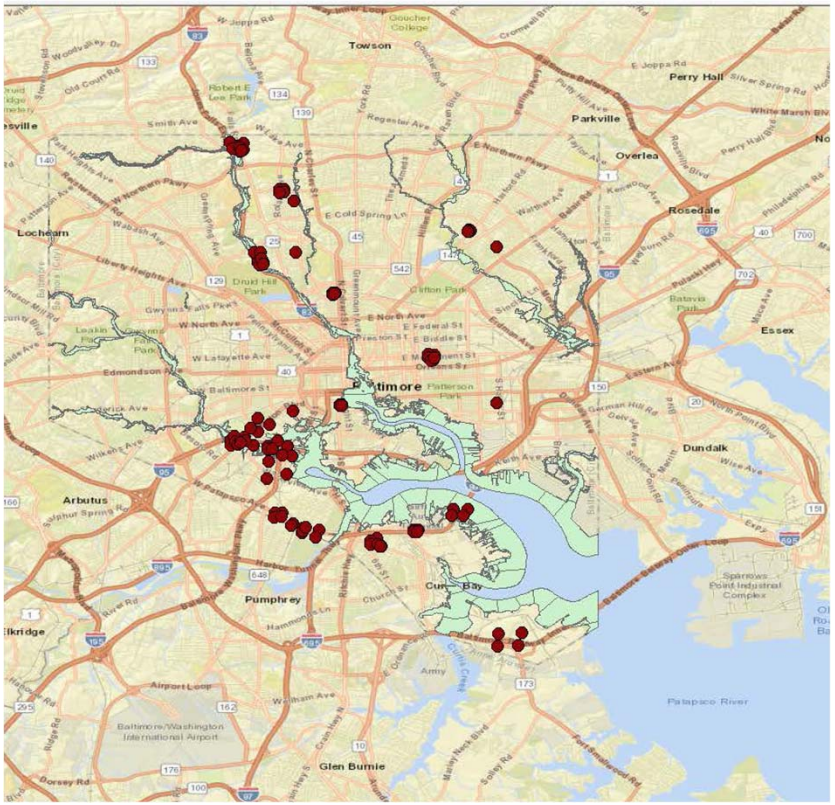
Number of X Zone Flood Damage Claims By CBSA 1972-2014



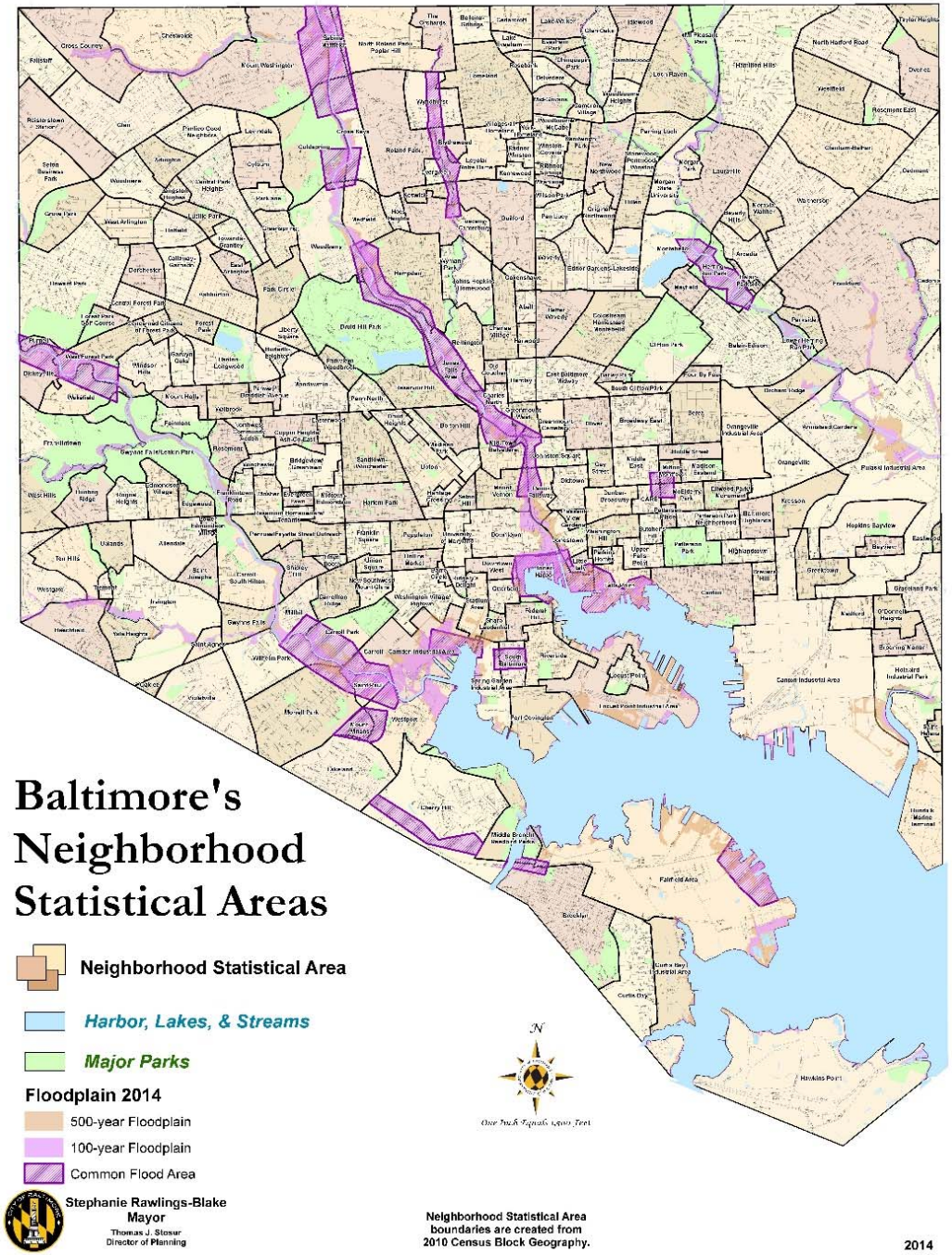
Top 10 CBSAs by Number of X Zone Claims 1972-2014:

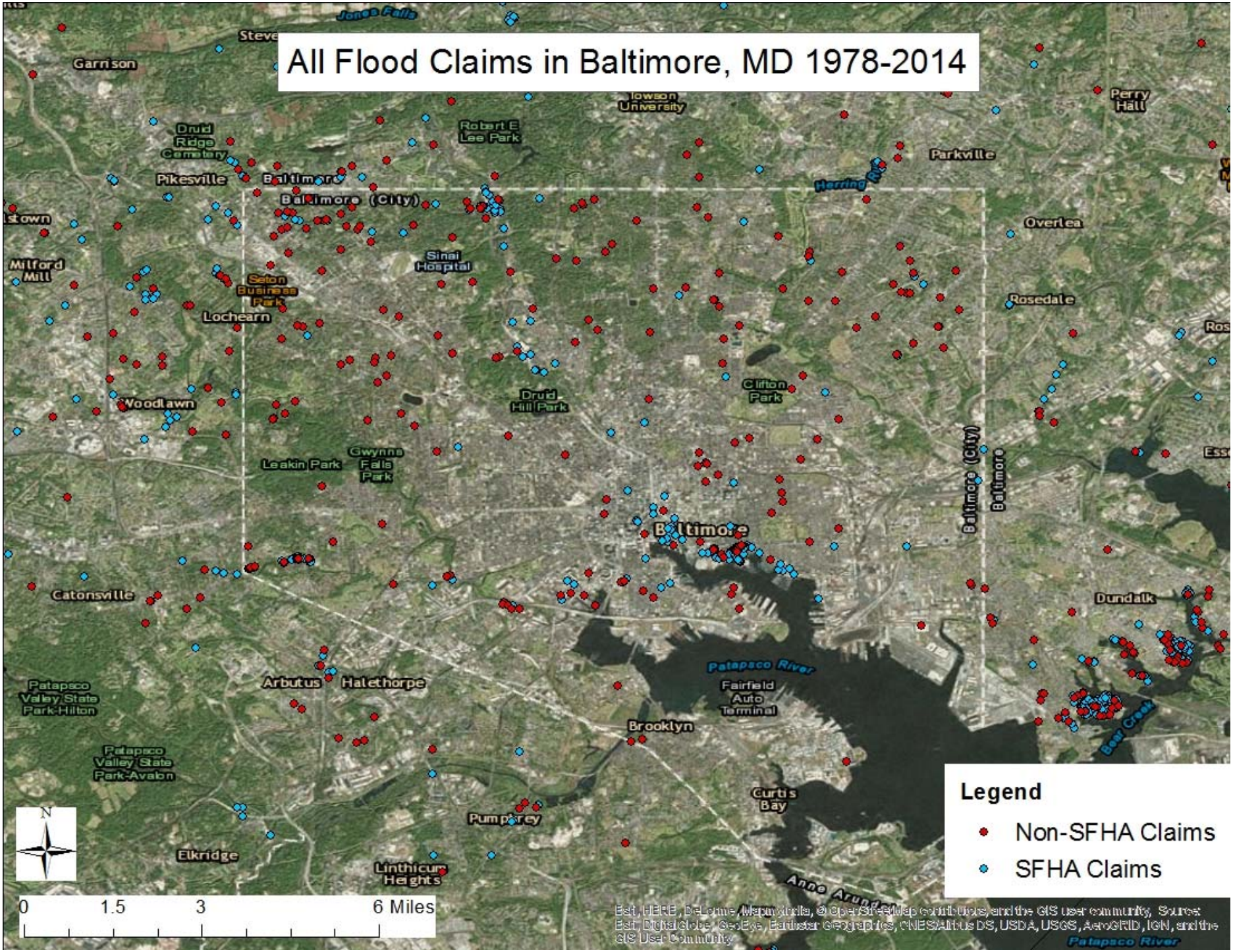
1. Houston-The Woodlands-Sugar Land, TX
2. New York-Newark-Jersey City, NY-NJ-PA
3. New Orleans-Metairie, LA
4. Miami-Fort Lauderdale-West Palm Beach, FL
5. Gulfport-Biloxi-Pascagoula, MS
6. Beaumont-Port Arthur, TX
7. Philadelphia-Camden-Wilmington, PA-NJ-DE-MD
8. Chicago-Naperville-Elgin, IL-IN-WI
9. Virginia Beach-Norfolk-Newport News, VA-NC
10. Crestview-Fort Walton Beach-Destin, FL

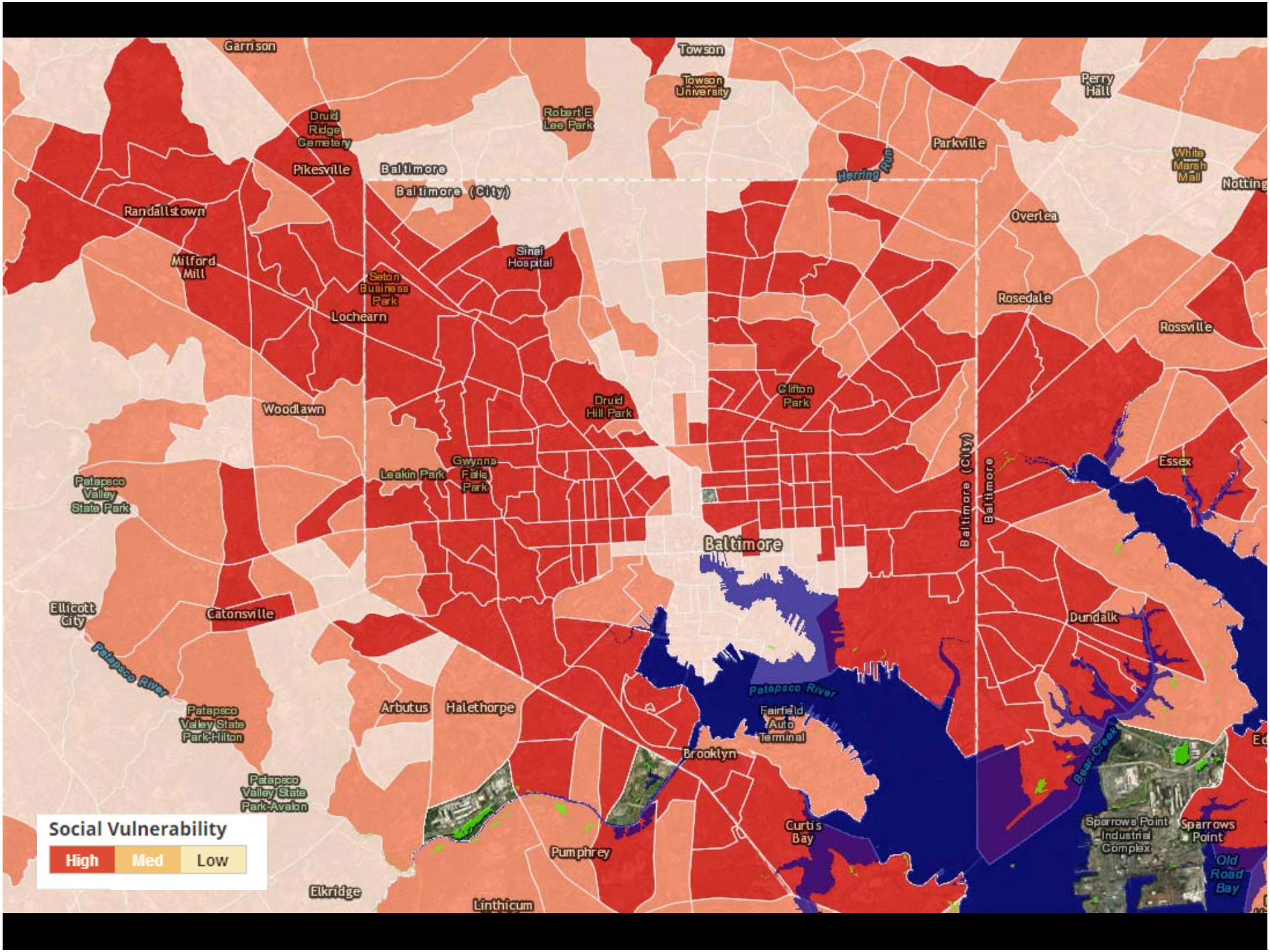

Total NFIP Claims 1972-2014 by Zone and Urban/Rural Designation (2010 Census)
Urban
Rural
Urban
Count
1200K
1000K
800K
600K
400K
200K
0K
246,564
1,044,262
12,227
93,421
22,181
126,350
1,118
2,733
33,354
31,595
31,572
206,601
A
B
C
D
V
X

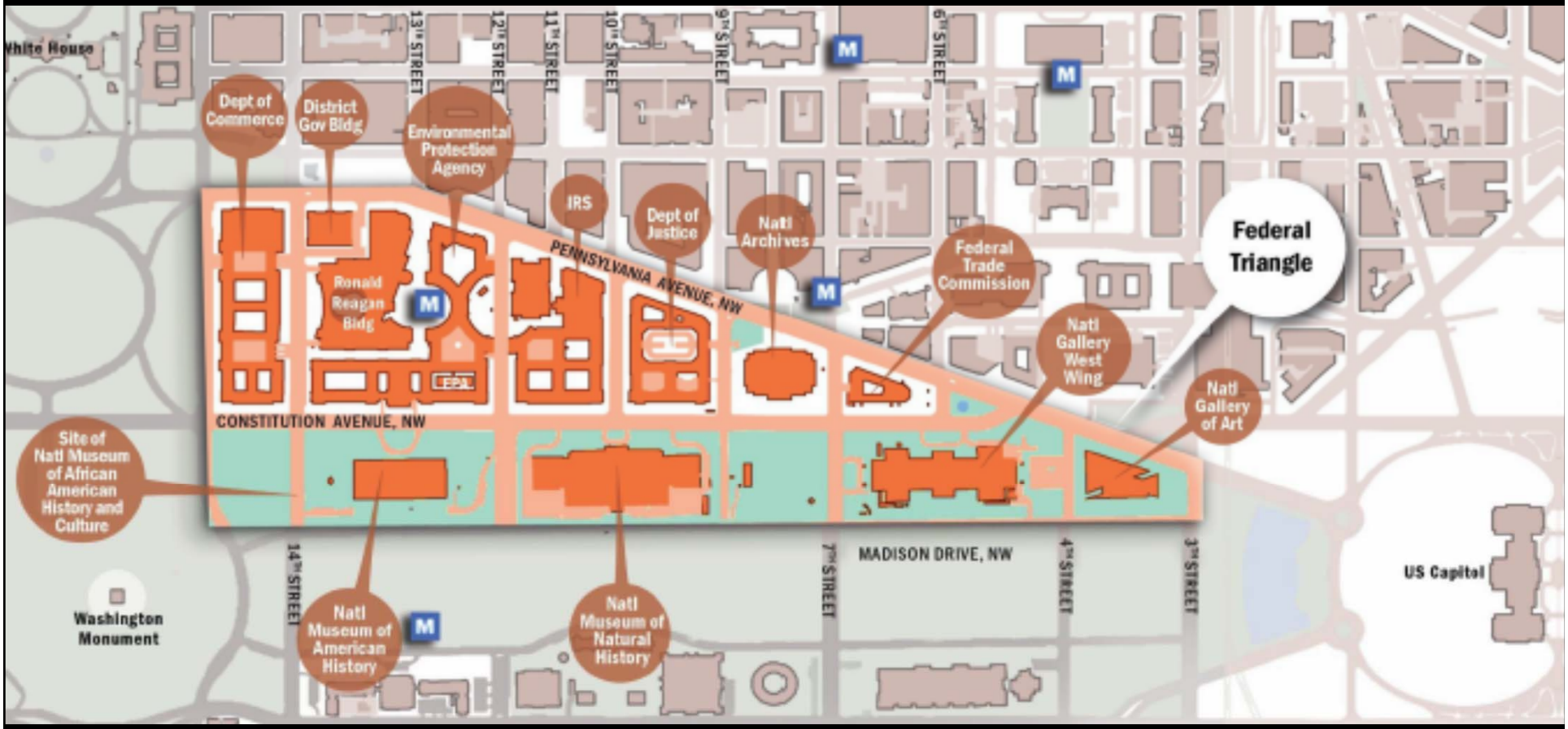


National Weather Service




All Flood Claims in Baltimore, MD 1978-2014
Garrison
Druid Ridge Cemetery
Pikesville
Baltimore
Baltimore (City)
Robert E Lee Park
Towson University
Perry Hall
Parkville
Herring Run
Overlea
Rosedale
Milford Mill
Sinai Hospital
Seton Business Park
Lochearn
Woodlawn
Druid Hill Park
Clifton Park
Leakin Park
Gwynns Falls Park
Baltimore (City)
Baltimore
Catonsville
Dundalk
Patapsco River
Arbutus
Halethorpe
Fairfield Auto Terminal
Brooklyn
Bear Creek
Patapsco Valley State Park-Hilton
Patapsco Valley State Park-Avalon
Curtis Bay
Pumphrey
Elkridge
Linthicum Heights
Anne Arundel
N
0
1.5
3
6 Miles
Legend
Non-SFHA Claims
SFHA Claims
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


Garrison
Towson
Towson University
Perry Hall
Druid Ridge Cemetery
Robert E Lee Park
Parkville
Pikesville
Baltimore
Herring Run
White Marsh Mall
Baltimore (City)
Randallstown
Overlea
Milford Mill
Sinai Hospital
Seton Business Park
Rosedale
Lochearn
Rossville
Clifton Park
Druid Hill Park
Woodlawn
Gwynns Falls Park
Leakin Park
Essex
Patapsco Valley State Park
Baltimore (City)
Baltimore
Ellicott City
Catonsville
Dundalk
Patapsco River
Arbutus
Halethorpe
Fairfield Auto Terminal
Patapsco Valley State Park-Hilton
Brooklyn
Bear Creek
Patapsco Valley State Park-Avalon
Curtis Bay
Sparrows Point Industrial Complex
Sparrows Point
Pumphrey
Old Road Bay
Elkridge
Linthicum
Social Vulnerability
High
Med
Low



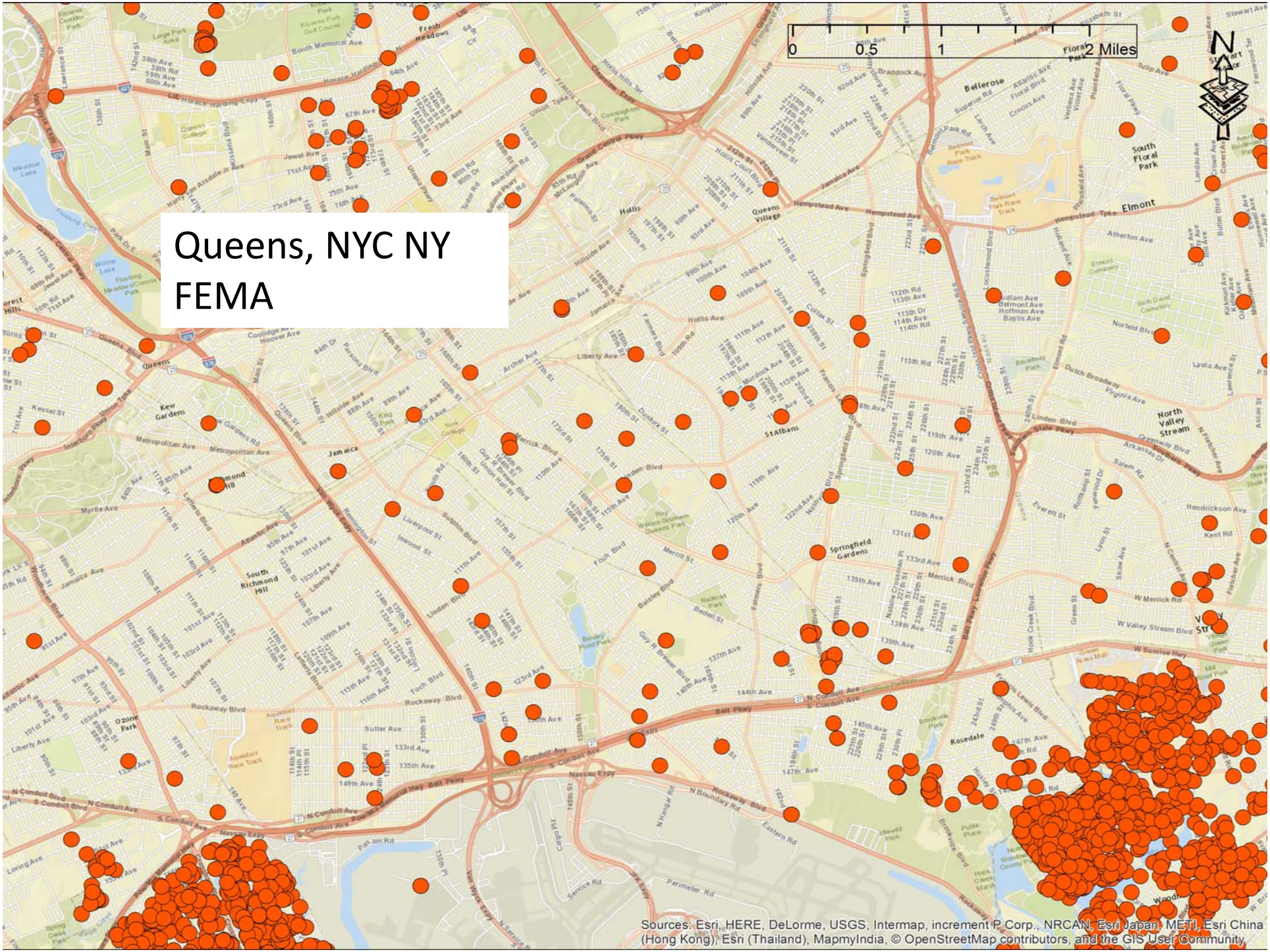
The Federal Triangle,
Washington DC

National Capital Planning Commission

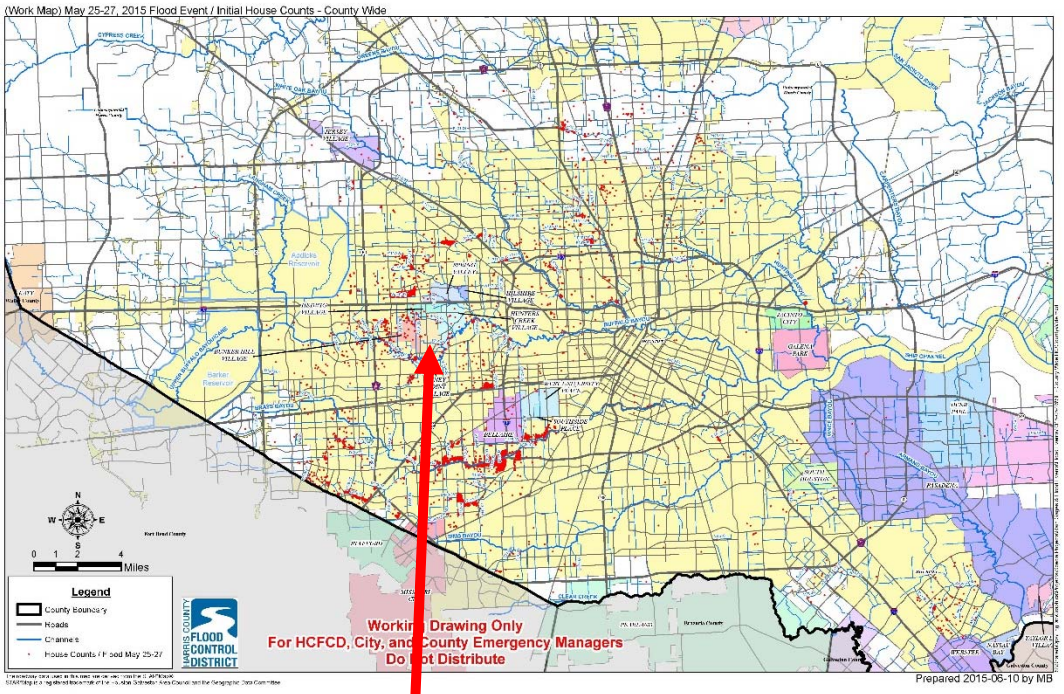
How the Working Group will use the Study

Preparations for Hurricane Irene at IRS Headquarters

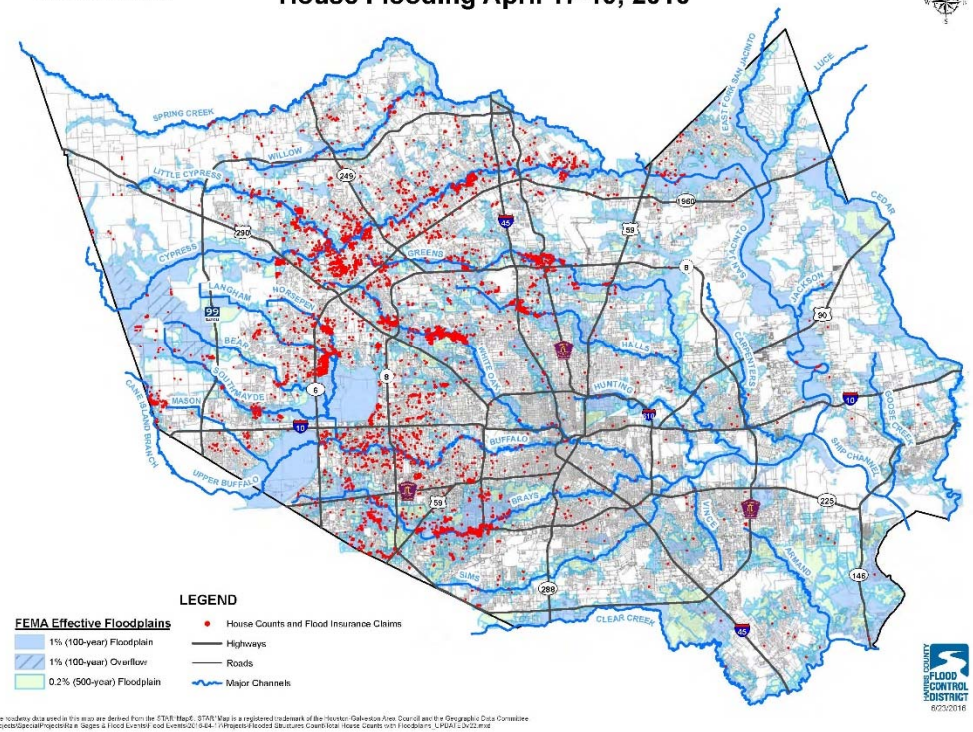
WMATA vents with one layer of sandbags prior to Federal Triangle Stormwater Study (above) and increased protection using the Study's predicted ponding levels (below)

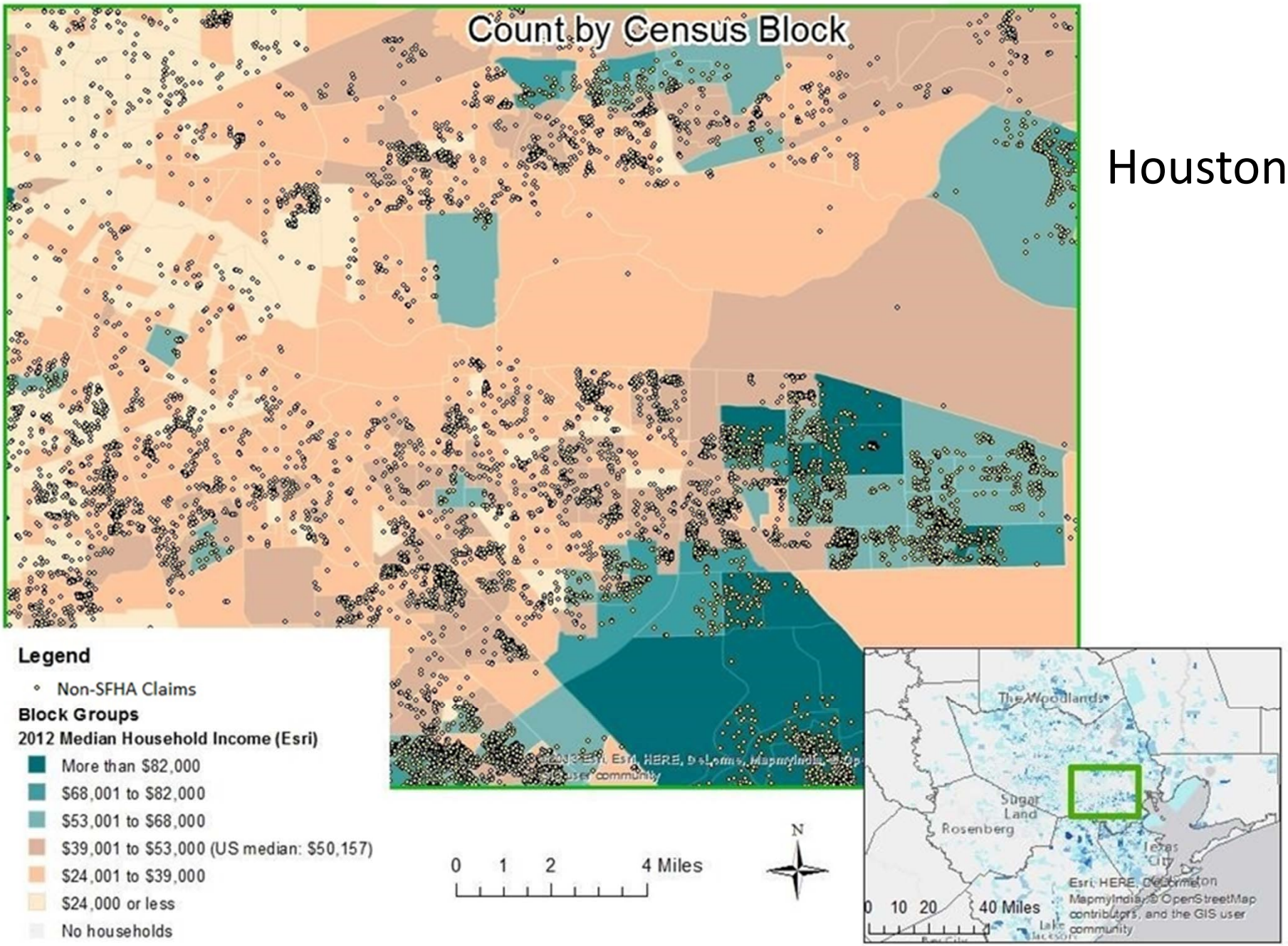

Queens, NYC NY
FEMA
0
0.5
1
2 Miles
N
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Houston
311 Call-In



House Flooding April 17-19, 2016




Count by Census Block
Houston
Legend
Non-SFHA Claims
Block Groups
2012 Median Household Income (Esri)
More than $82,000
$68,001 to $82,000
$53,001 to $68,000
$39,001 to $53,000 (US median: $50,157)
$24,001 to $39,000
$24,000 or less
No households
0 1 2 4 Miles
N
The Woodlands
Sugar Land
Rosenberg
Texas City
0 10 20 40 Miles
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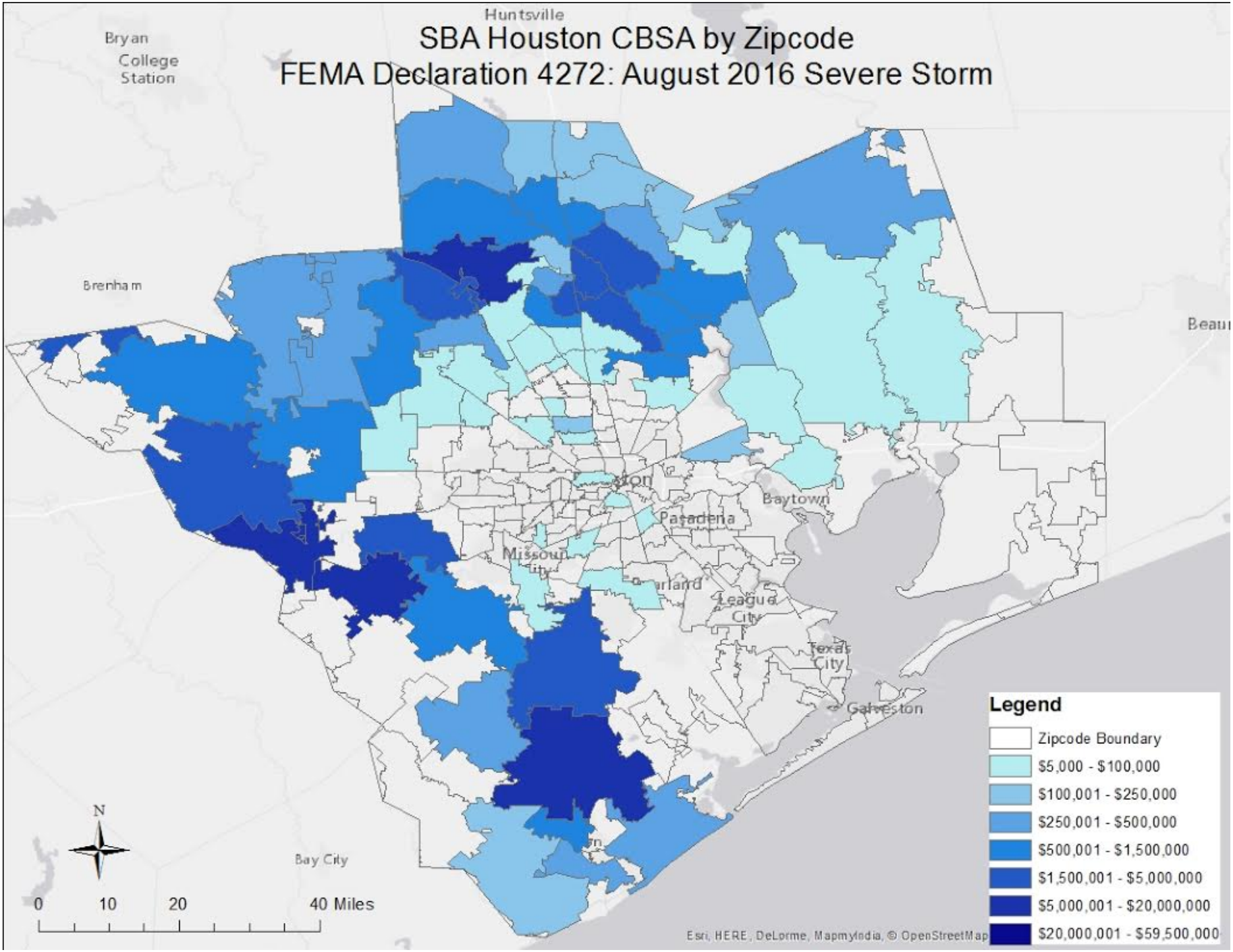

SBA Houston CBSA by Zipcode
FEMA Declaration 4272: August 2016 Severe Storm
Huntsville
Bryan
College Station
Brenham
Baytown
Pasadena
Missouri City
League City
Texas City
Galveston
Bay City
N
0
10
20
40 Miles
Legend
Zipcode Boundary
$5,000 - $100,000
$100,001 - $250,000
$250,001 - $500,000
$500,001 - $1,500,000
$1,500,001 - $5,000,000
$5,000,001 - $20,000,000
$20,000,001 - $59,500,000
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap

Harvey 2017

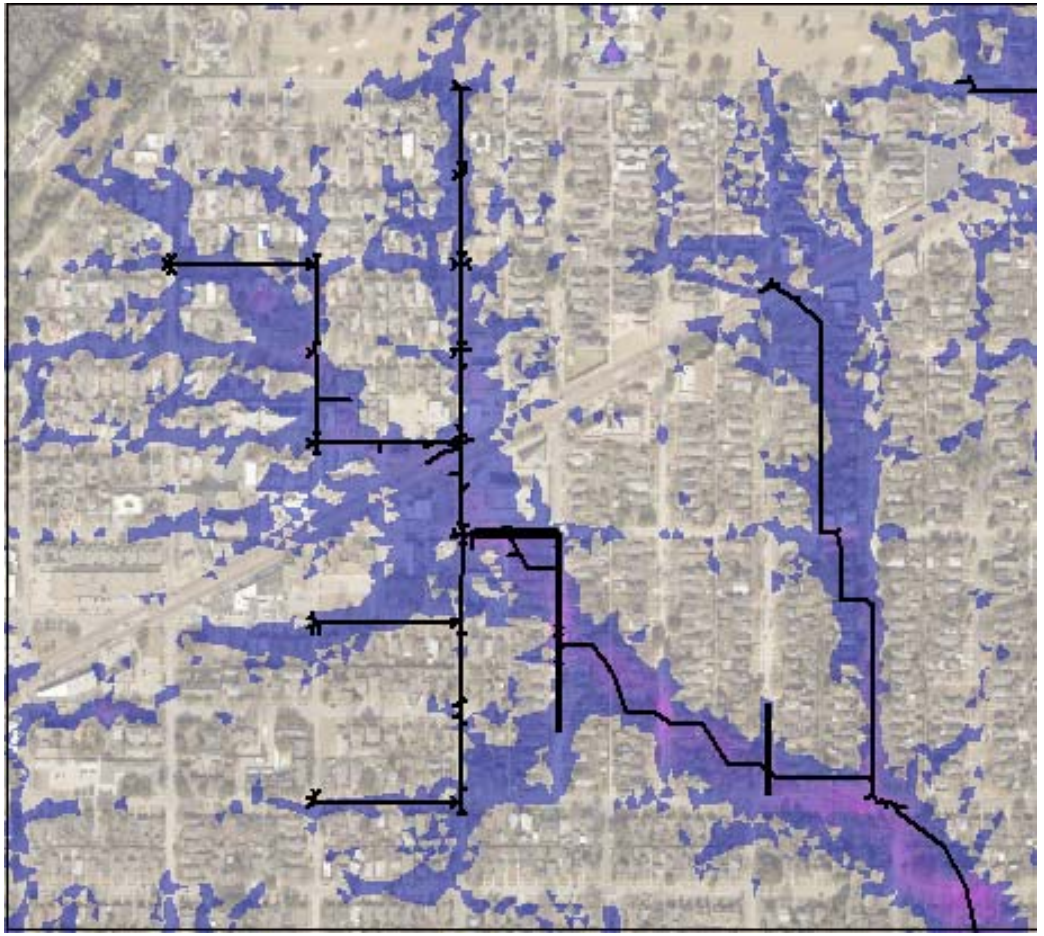
Issues in Getting the Picture

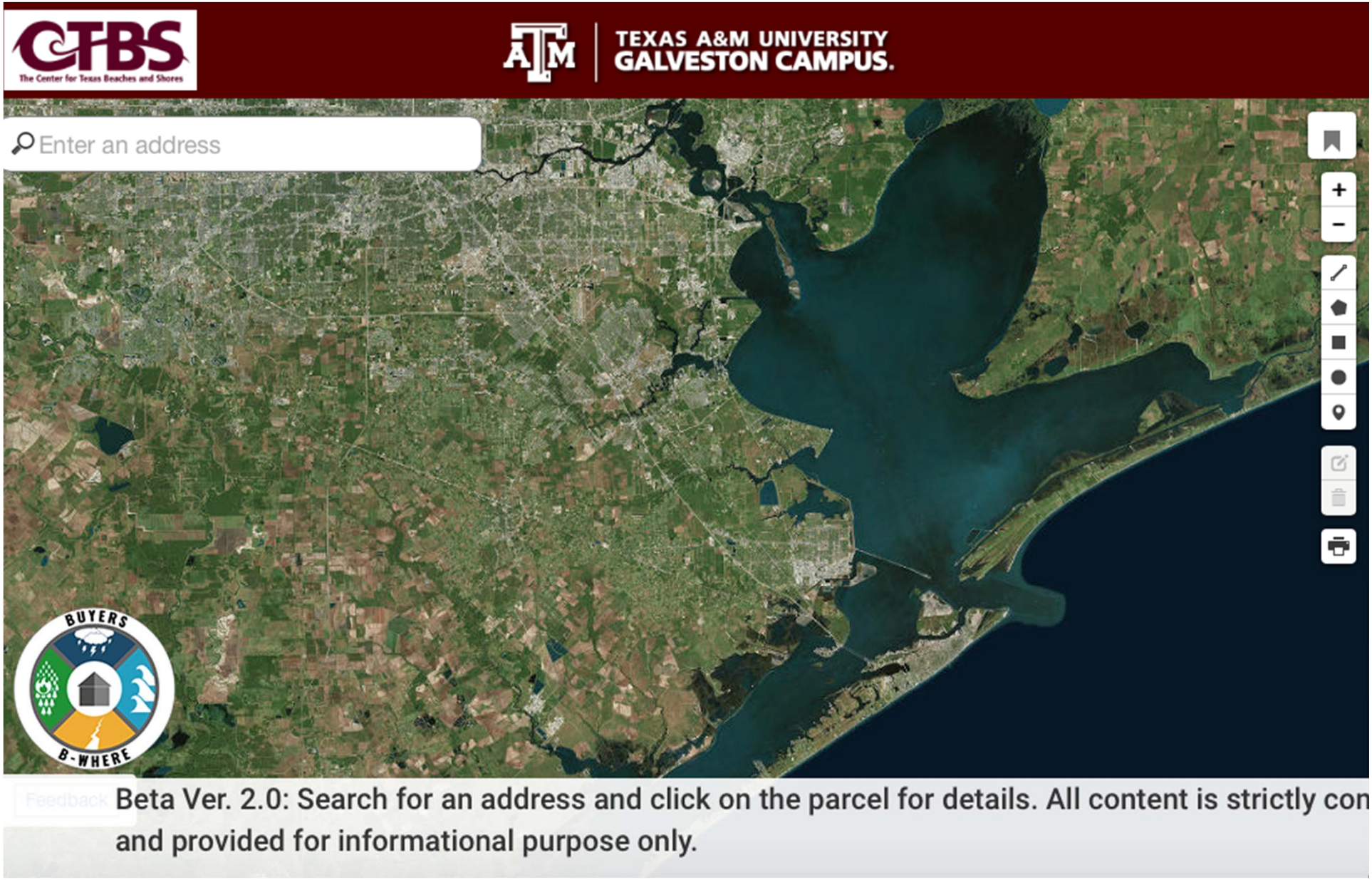
- Sources – Who has what?
  - FEMA, HUD, Commerce, USGS, SBA, CDC, EPA
- Format
- Complexity
- Time scales
- Resolution
- Privacy

Initial Insights
Issues in Urban Flooding

- Governance Authorities and Rules
- Who Pays?
- Mapping
- NFIP
- Social/Environmental Justice - Affordability
- Renters – Public Housing
- Crumbling, Ill-Maintained Infrastructure
- Continuing Development
- Not Big Disaster Events

Ft Worth Experimental

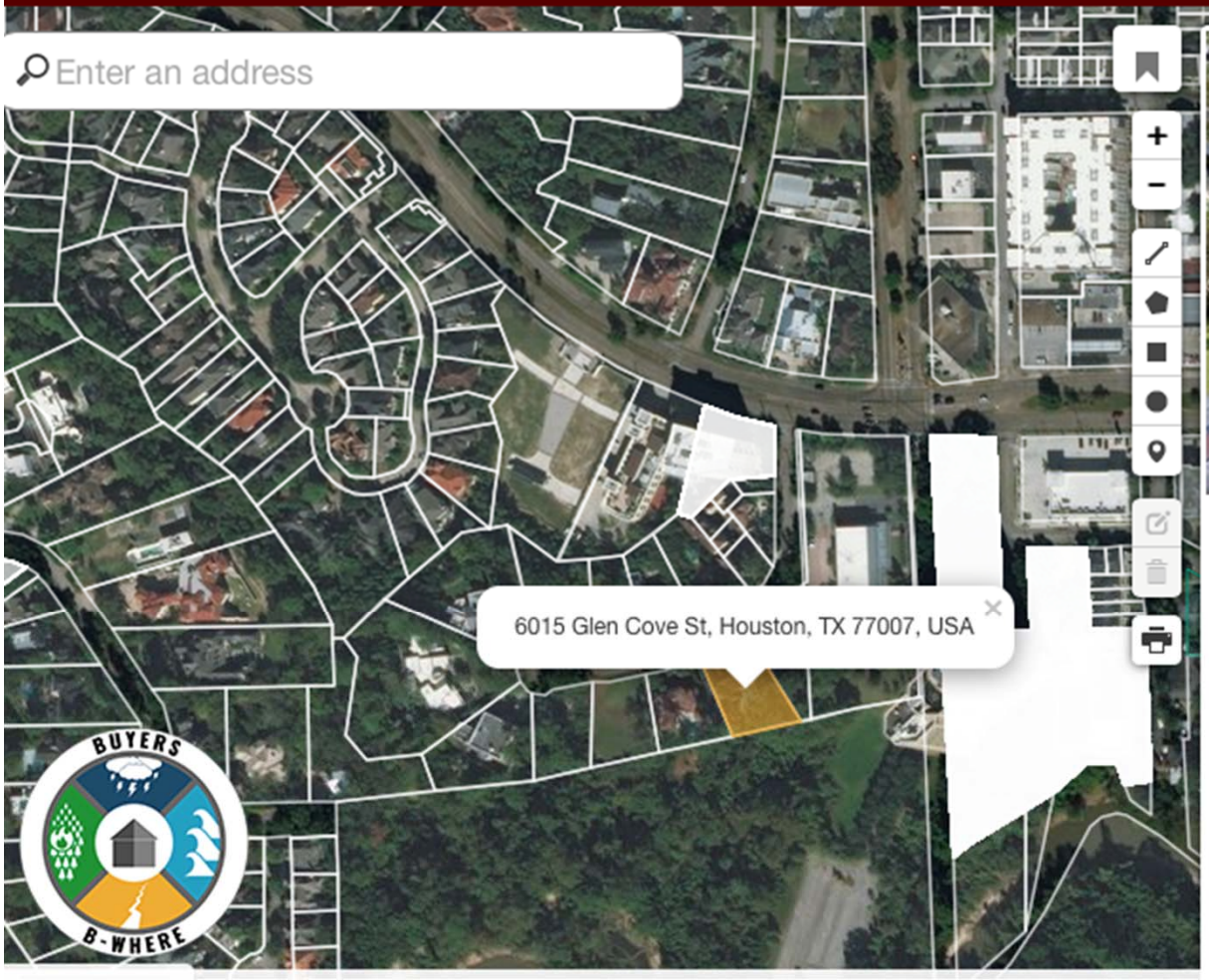


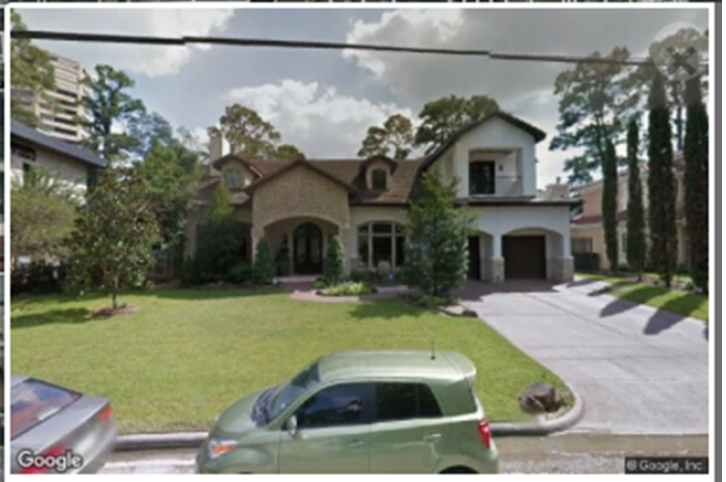


http://www.texascoastalatlas.com/buyersbewhere

CTBS
The Center for Texas Beaches and Shores

TEXAS A&M UNIVERSITY
GALVESTON CAMPUS.





6015 Glencove Street

Houston, Texas, 77007

OVERALL HAZARD RISK SCORE

Click for Details

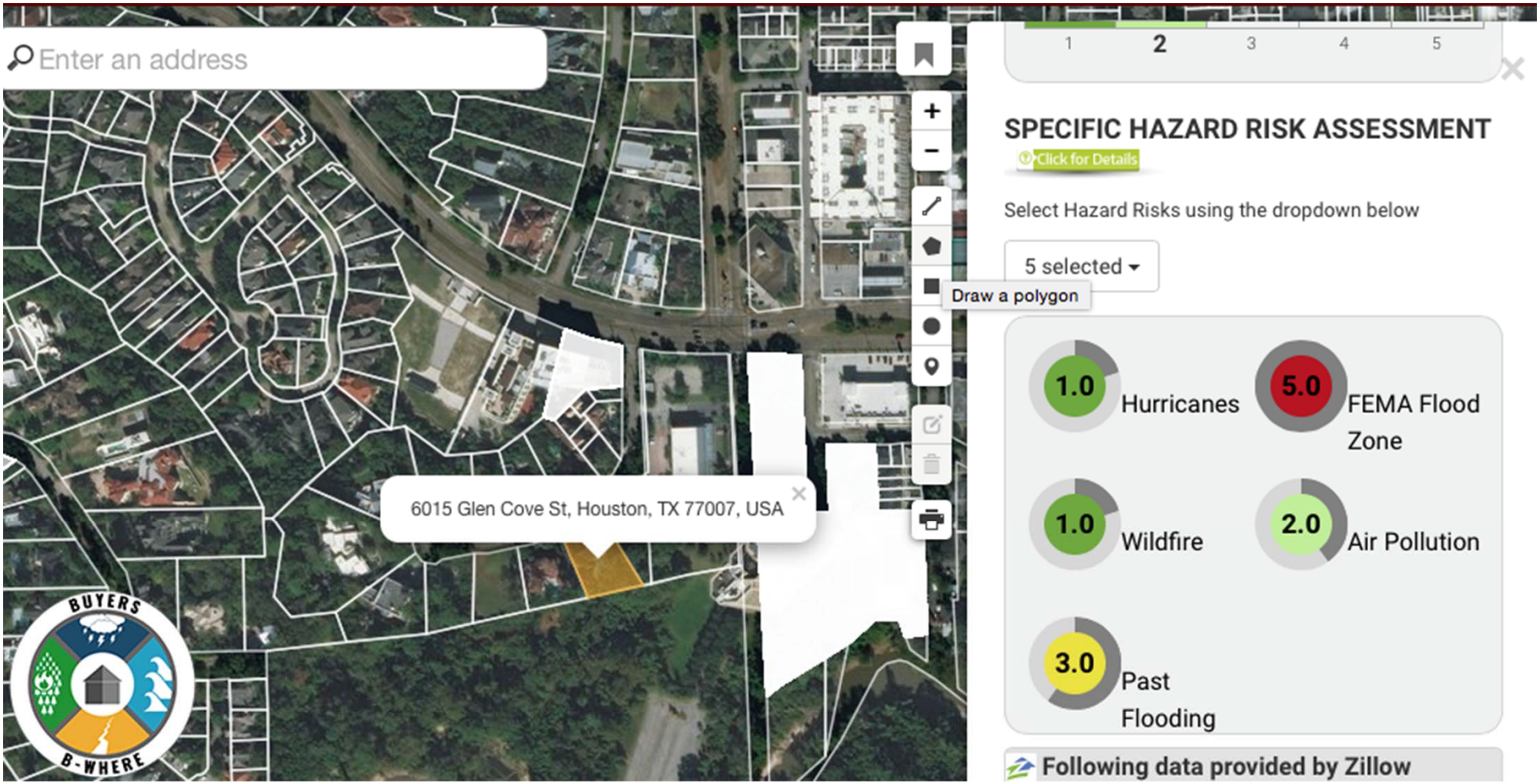
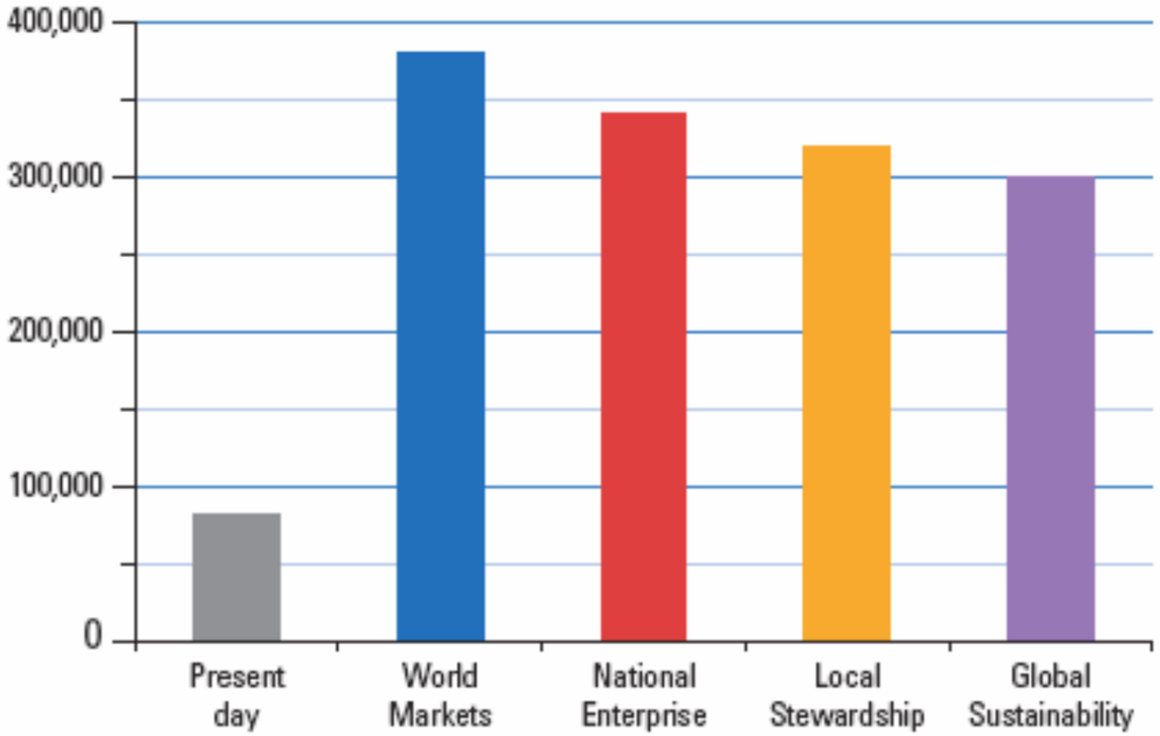
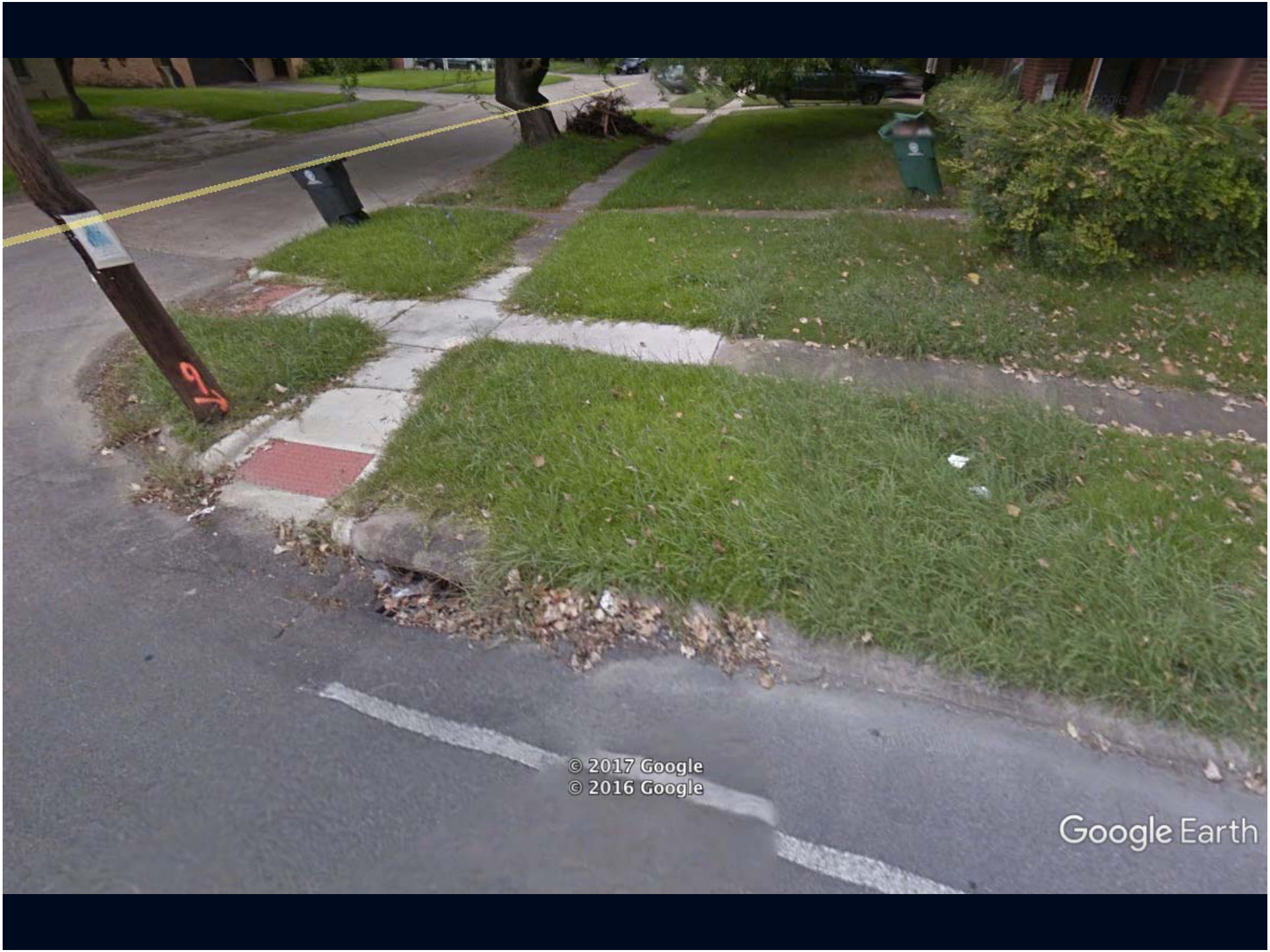

Enter an address
6015 Glen Cove St, Houston, TX 77007, USA
Draw a polygon
1
2
3
4
5
SPECIFIC HAZARD RISK ASSESSMENT
Click for Details
Select Hazard Risks using the dropdown below
5 selected
1.0
Hurricanes
5.0
FEMA Flood Zone
1.0
Wildfire
2.0
Air Pollution
3.0
Past Flooding
Following data provided by Zillow
BUYERS
B-WHERE

Chart 2.3 Number of properties in the UK at high risk from intra-urban flooding – today and in the four future scenarios in the 2080s



CECW-PR Regulation No. 1165-2-21	Department of the Army U.S. Army Corps of Engineers Washington, DC 20314-1000	ER 1165-2-21 30 Oct 80
	Water Resources Policies and Authorities FLOOD DAMAGE REDUCTION MEASURES IN URBAN AREAS	
	Distribution Restriction Statement Approved for public release; distribution is unlimited.	

Urban water damage problems associated with a natural stream or modified natural waterway may be addressed under the flood control authorities downstream from the point where the flood discharge of such a stream or waterway within an urban area is greater than 800 cubic feet per second for the 10-percent flood (one chance in ten of being equaled or exceeded in any given year) under conditions expected to prevail during the period of analysis.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Google Earth

BLUF (T)

- Urban Flooding Is a Growing National Problem and We Do Not Have a Handle on Its Extent, Consequences and Solutions
- Urban Flooding Has a Disproportionately Large Effect on Those Who Are Least Able to Deal with It


WAnTed:
Large,LArGE
SPONGE

Remember:
Nature Bats Last

Thank You!