

# FROM FLOOD RISK TO FLOOD RESILIENCE



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OCTOBER 1, 2018

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# A TALK IN 3 ACTS

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Part I: Introduction

Part II: Framing Resilience and Flood Resilience

Part III: Next Steps and Taking Action

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# LET'S GET STARTED

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# PART I: INTRODUCING: FLOODING

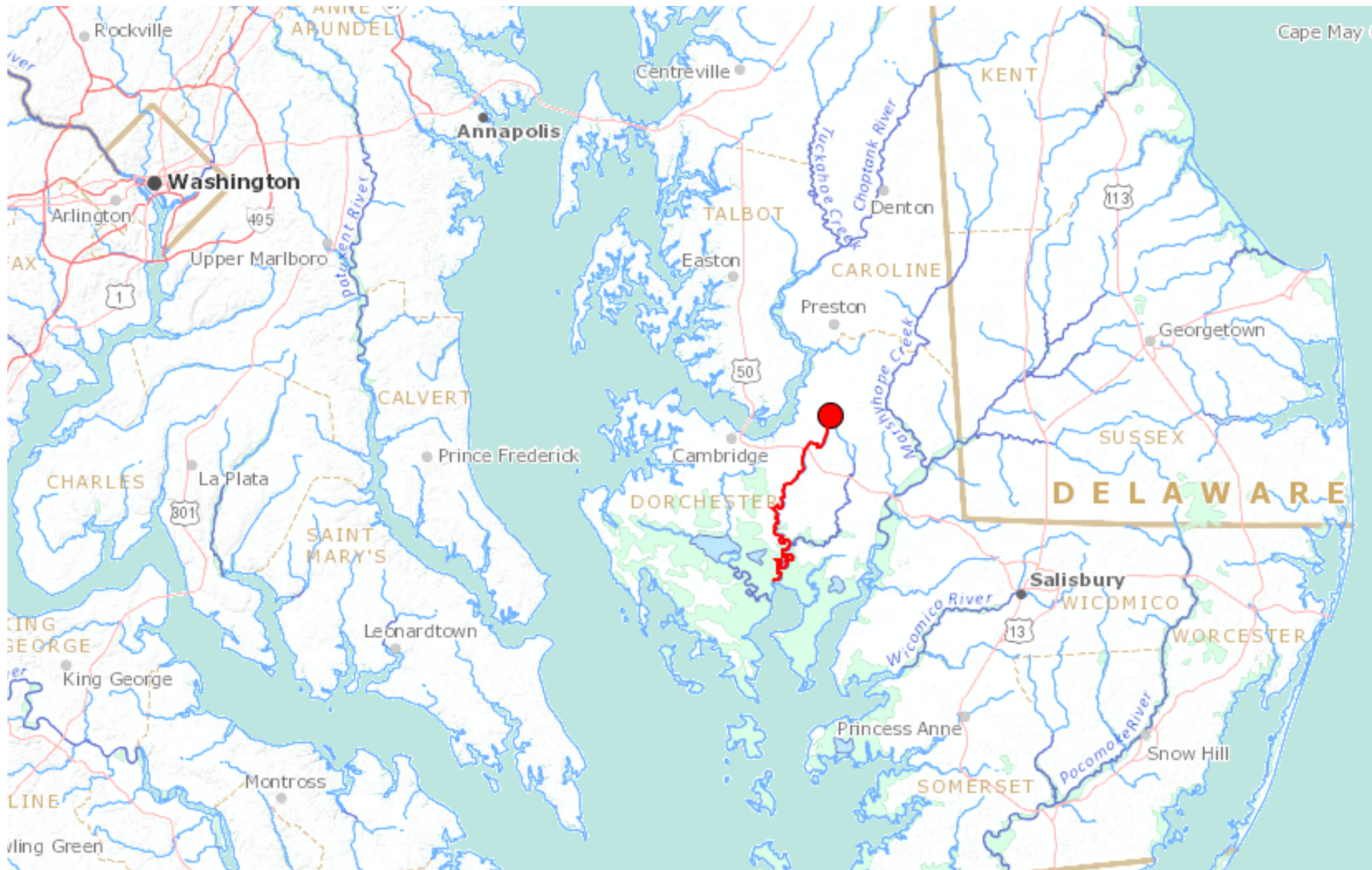
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# MY EVOLVING UNDERSTANDING OF FLOODS

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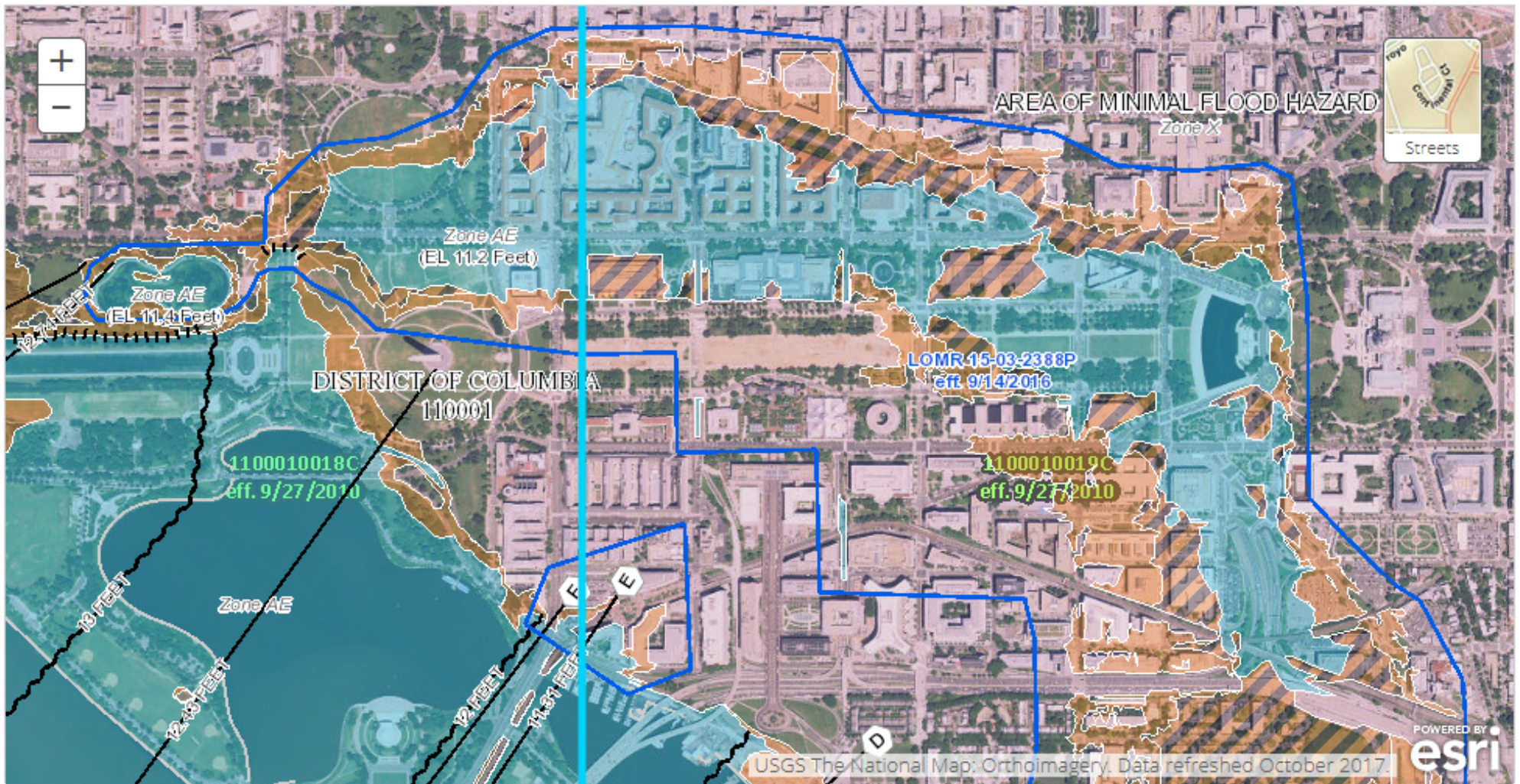




Mississippi River August 1991



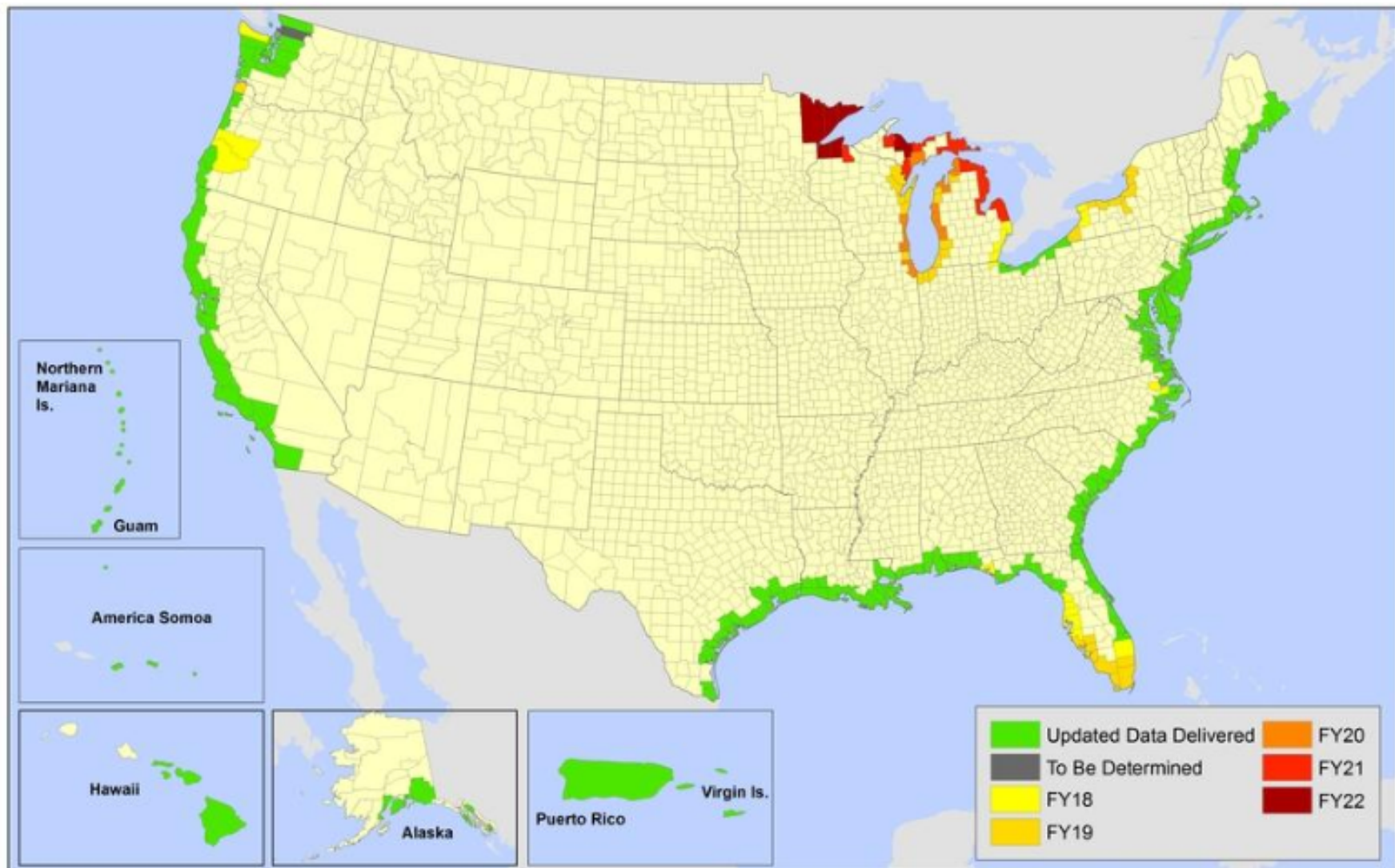
Mississippi River August 1993



<p><b>PIN</b></p> <ul style="list-style-type: none"> <li> Approximate location based on user input and does not represent an authoritative property location</li> </ul> <p><b>MAP PANELS</b></p> <ul style="list-style-type: none"> <li> Selected FloodMap Boundary</li> <li> Digital Data Available</li> <li> No Digital Data Available</li> <li> Unmapped</li> </ul> <p><b>OTHER AREAS</b></p> <ul style="list-style-type: none"> <li> Area of Minimal Flood Hazard Zone X</li> <li> Effective LOMRs</li> <li> Area of Undetermined Flood Hazard Zone D</li> </ul>	<p><b>SPECIAL FLOOD HAZARD AREAS</b></p> <ul style="list-style-type: none"> <li> Without Base Flood Elevation (BFE) Zone A, V, A99</li> <li> With BFE or Depth</li> <li> Regulatory Floodway Zone AE, AO, AH, VE, AR</li> </ul> <p><b>OTHER AREAS OF FLOOD HAZARD</b></p> <ul style="list-style-type: none"> <li> 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X</li> <li> Future Conditions 1% Annual Chance Flood Hazard Zone X</li> <li> Area with Reduced Flood Risk due to Levee. See Notes, Zone X</li> <li> Area with Flood Risk due to Levee Zone D</li> </ul>	<p><b>OTHER FEATURES</b></p> <ul style="list-style-type: none"> <li> 20.2 Cross Sections with 1% Annual Chance Water Surface Elevation</li> <li> 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation</li> <li> Coastal Transect</li> <li> 25 Base Flood Elevation Line (BFE)</li> <li> Limit of Study</li> <li> Jurisdiction Boundary</li> <li> Coastal Transect Baseline</li> <li> Profile Baseline</li> <li> Hydrographic Feature</li> </ul> <p><b>GENERAL STRUCTURES</b></p> <ul style="list-style-type: none"> <li> Channel, Culvert, or Storm Sewer</li> <li> Levee, Dike, or Floodwall</li> </ul>
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## Schedule of Coastal Counties Receiving Updated Mapping Data as of January 2018



**FEMA**

Updated mapping data consist of both preliminary Flood Insurance Rate Maps (FIRMs) and other non-regulatory products delivered to the county by FEMA. Data are tracked by fiscal year (FY), October through September. Data are updated quarterly and therefore subject to change. For more information, please call 1-877-FEMA MAP (1-877-336-2627), email [FEMAMapSpecialist@riskmapcfs.com](mailto:FEMAMapSpecialist@riskmapcfs.com), or visit <https://www.fema.gov/coastal-flood-risks>

**RiskMAP**  
Increasing Resilience Together

# NEW ORLEANS, LOUISIANA 2005



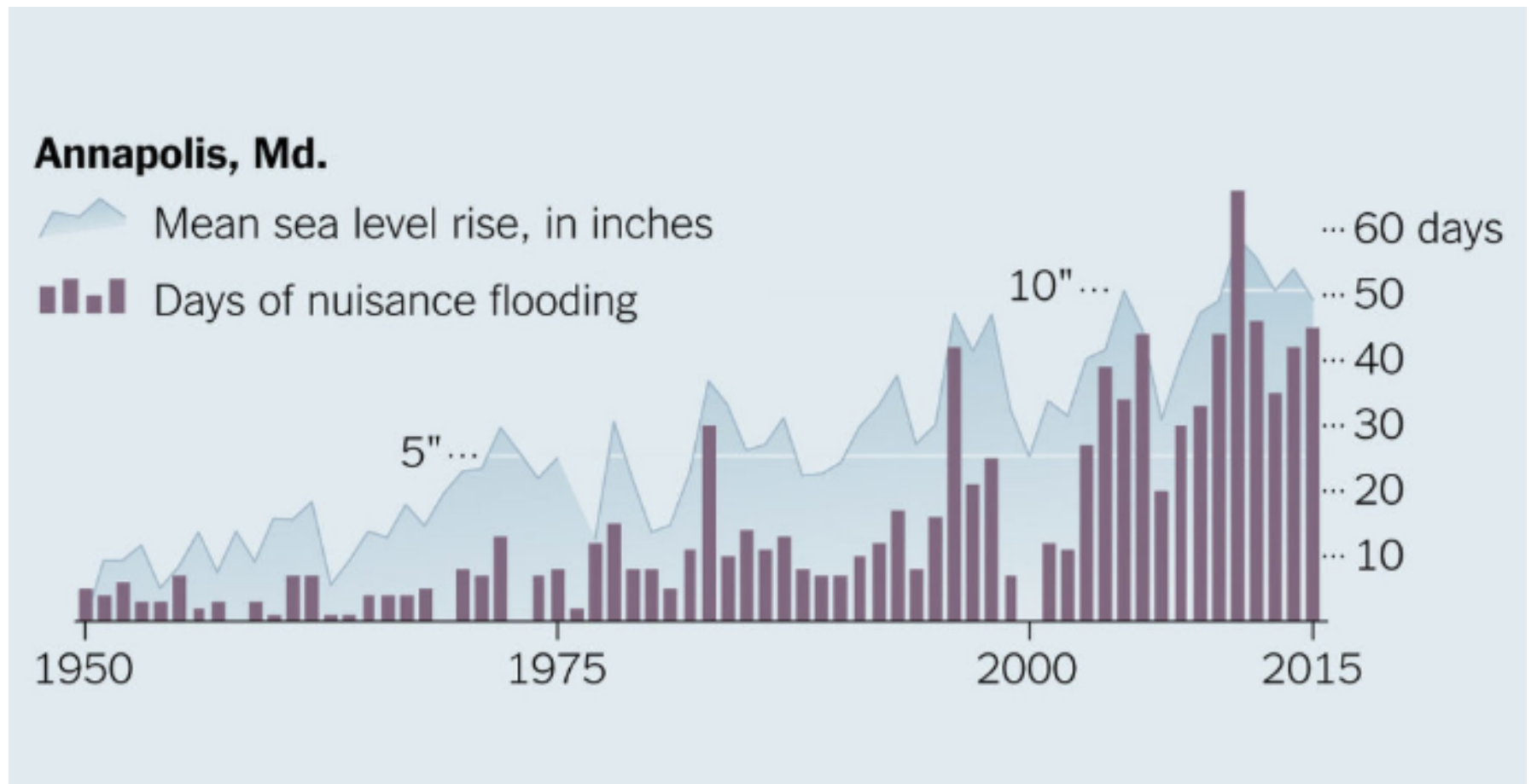
# NEW JERSEY, 2012



# NEW BERN, NORTH CAROLINA 2018



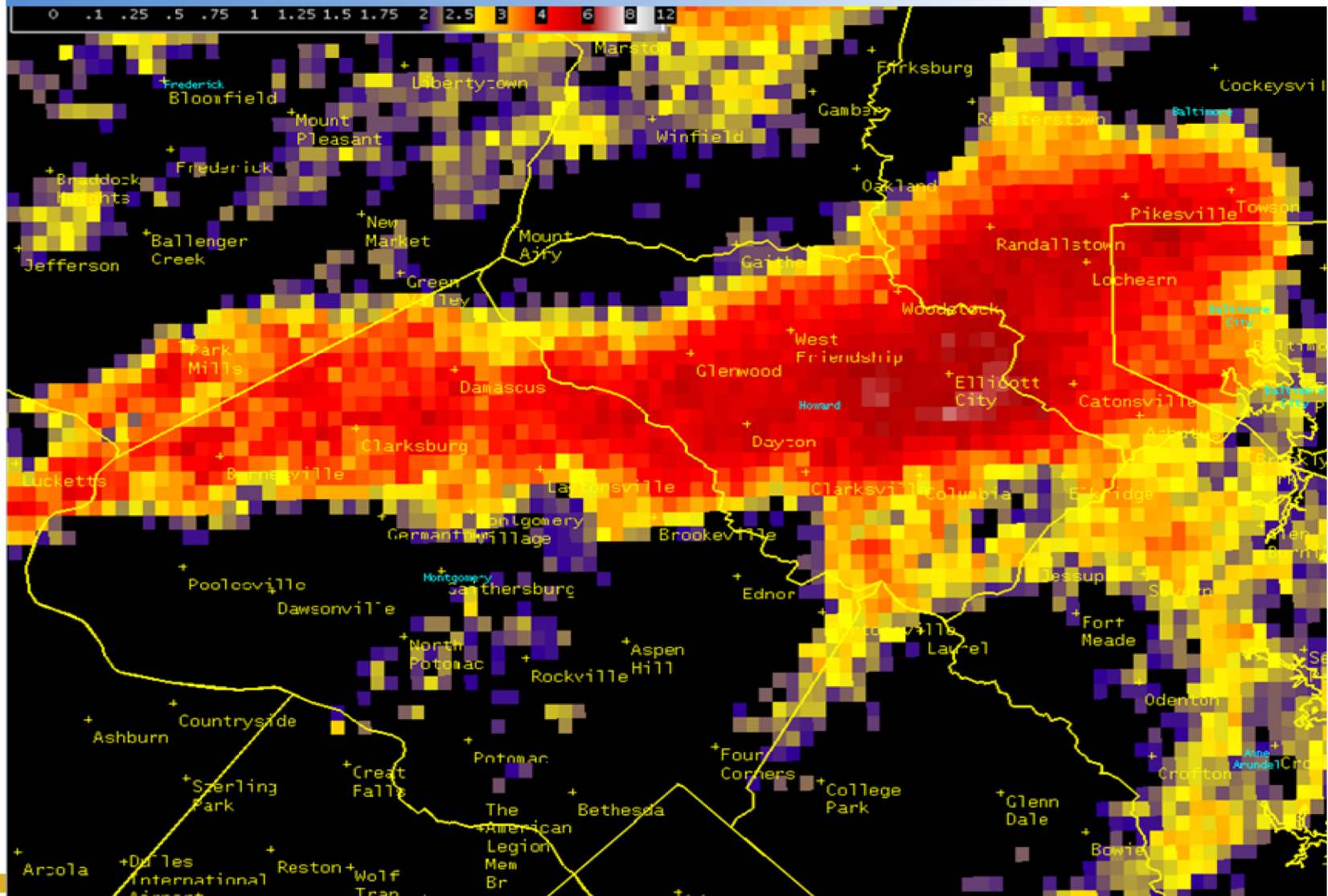
# OTHER TYPES OF FLOODS



Blue-Sky Flooding (Annapolis)

# EXTREME PRECIP: ELICOTT CITY, MARYLAND 2016

Precipitation Estimates – July 30, 2016

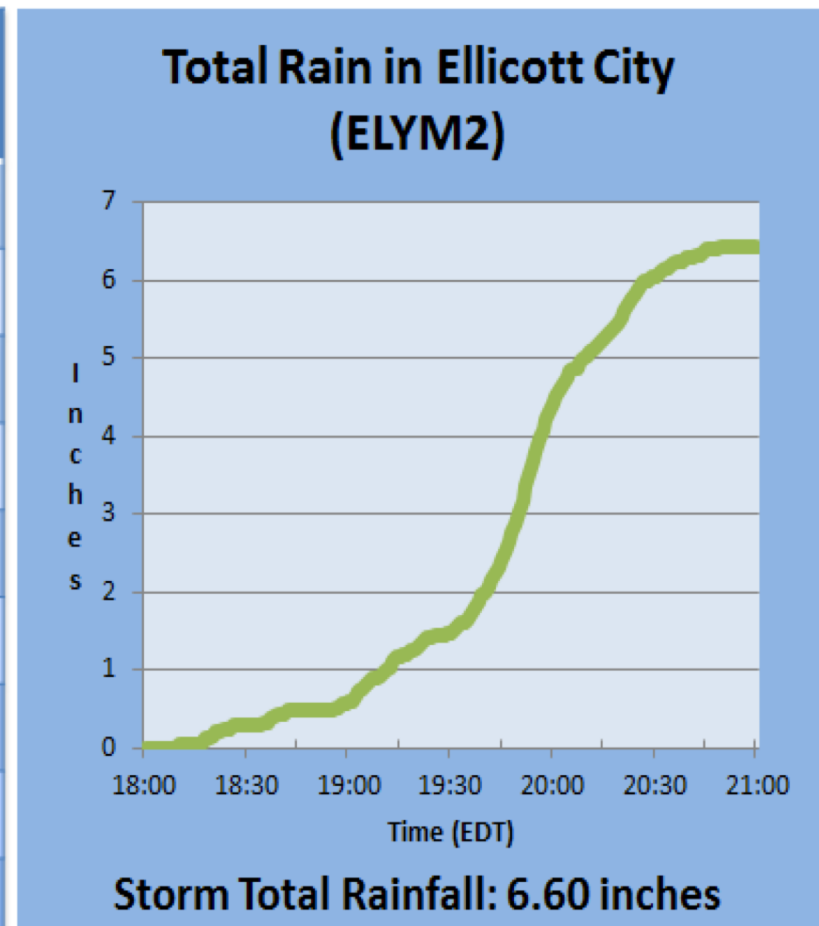


# ELLICOTT CITY, MARYLAND BY THE NUMBERS

## Historic Rainfall in Ellicott City, Maryland – July 30, 2016



Duration	Max Rainfall in Duration	Time of Occurrence
1 minute	0.20"	7:52pm-7:53pm
5 minutes	0.80"	7:50pm-7:55pm
10 minutes	1.44"	7:50pm-8:00pm
15 minutes	2.04"	7:46pm-8:01pm
20 minutes	2.44"	7:44pm-8:04pm
30 minutes	3.20"	7:36pm-8:06pm
60 minutes	4.56"	7:30pm-8:30pm
90 minutes	5.48"	7:00pm-8:30pm
2 hours	5.96"	6:50pm-8:50pm



*Information obtained from the Ellicott City (ELYM2) rain gauge. This gauge reports in 0.04" increments.*

# AND STILL OTHER TYPES





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# HOW BIG IS THE FLOODING PROBLEM?

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Hint: we don't know

# Risks and impacts are evolving



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# INTRODUCING: THE ACADEMIES

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# THE NATIONAL ACADEMIES 101

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The National Academies of Sciences, Engineering, and Medicine are a private, non-profit organization. The National Academies are the nation's pre-eminent source of **independent, high-quality, objective advice** on science, engineering, and health matters.

We are a powerful convener, able to bring together diverse stakeholders to foster exchange between and among sectors, and promote creative thinking in finding resilience solutions.

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# CORE BELIEF

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Use science to bring benefit to society

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# SECTION II: FRAMING RESILIENCE

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# WHO WANTS TO BE RESILIENT?

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# WHO KNOWS HOW TO BECOME RESILIENT?

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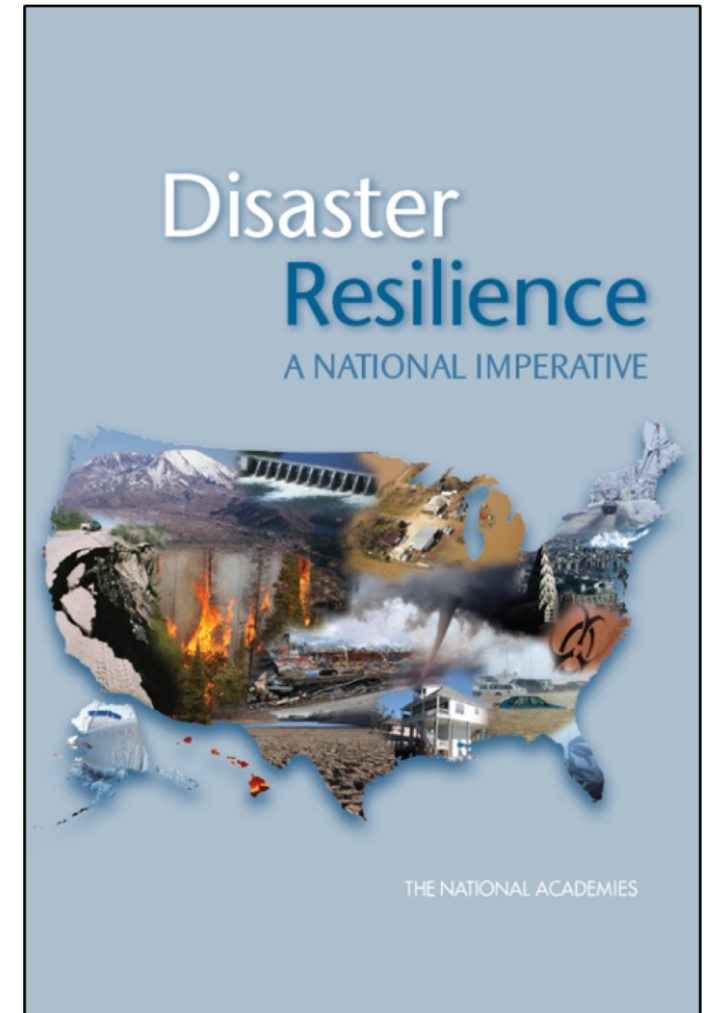




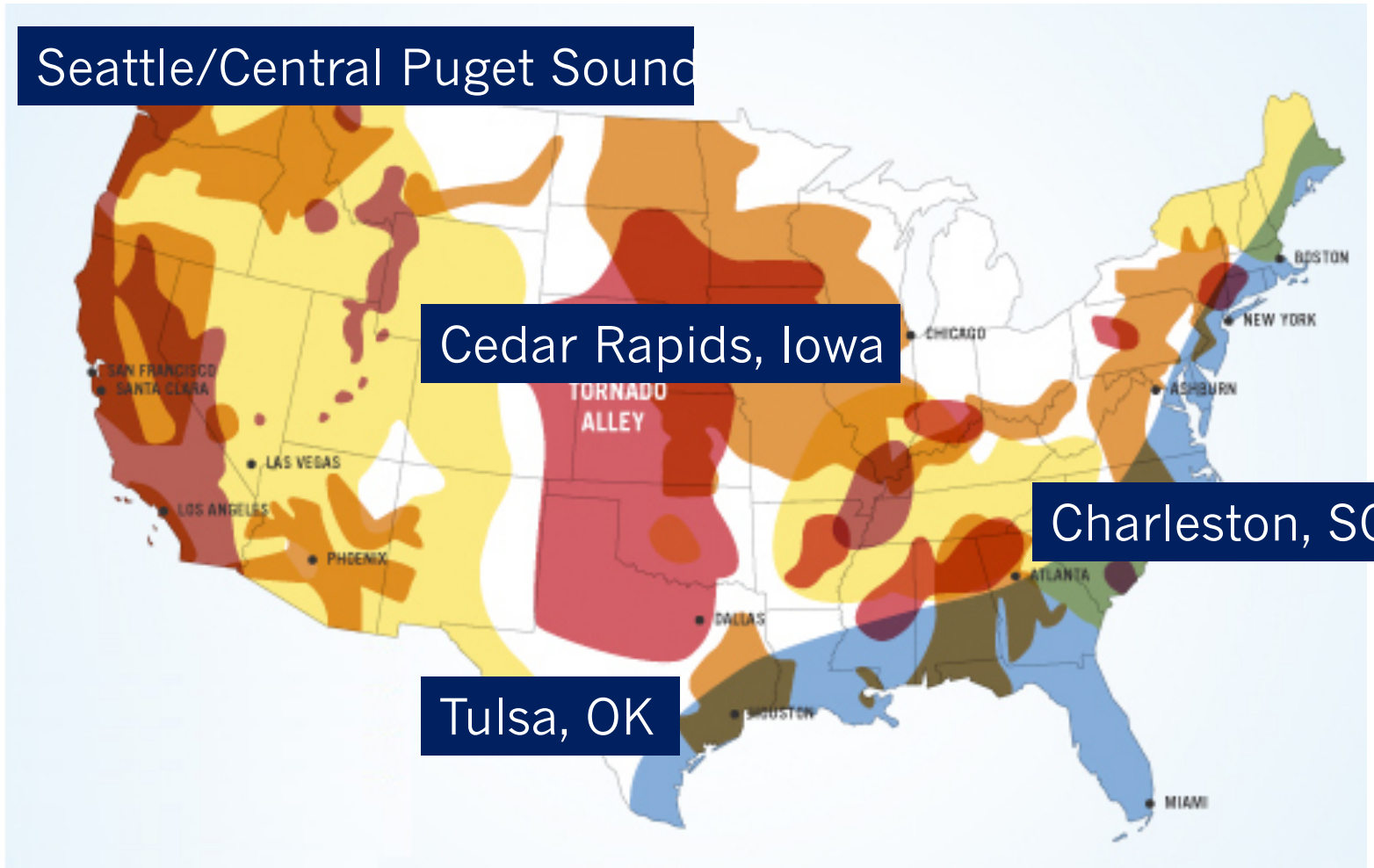
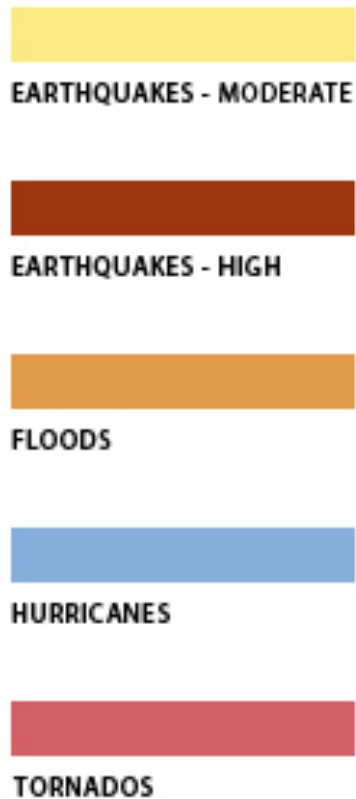
# FOUR PILLARS OF RESILIENCE

Resilient America program is based on four key actions communities could take to build resilience:

- Understand and **communicate disaster risk**;
- **Build or strengthen partnerships** with community stakeholders;
- Identify or develop ways to **measure disaster resilience**;
- **Share and get access to information**, tools, data, and experts needed to build disaster resilience.



# RESILIENT AMERICA PILOT COMMUNITIES



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# SOURCES OF FLOODING IN CHARLESTON

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- Riverine flooding
- Coastal flooding
- Tidal flooding
- Surge
- Pluvial flooding
- Overland flooding
- Extreme precipitation

Lots of ways to get wet in Charleston

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# CHARLESTON, SOUTH CAROLINA

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“We just don’t  
want to be wet.”

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# FRAMING FLOOD RESILIENCE

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# USING FOUR DIMENSIONS FOR FLOOD RESILIENCE

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1. Physical dimension
2. Information dimension
3. Social dimension
4. Decision-making dimension

**How can science inform each of these dimensions?**

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# PHYSICAL DIMENSIONS

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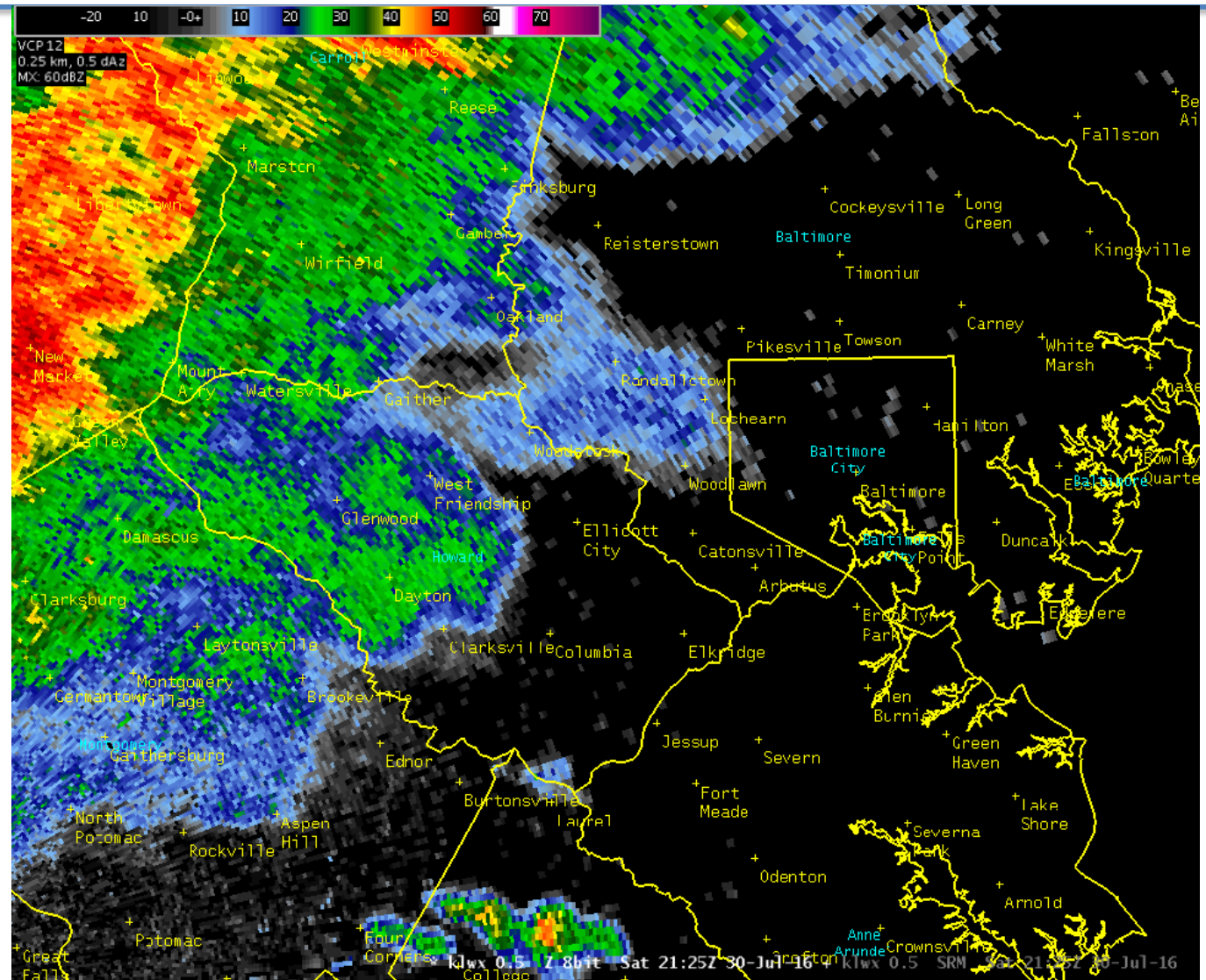
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# PHYSICAL: METEOROLOGY

On the evening of July 30, 2016, heavy rain formed into a persistent band affecting a small multi-county area in central Maryland.

*KLWX Radar loop from 2125 UTC 30 July to 0102 UTC 31 July*

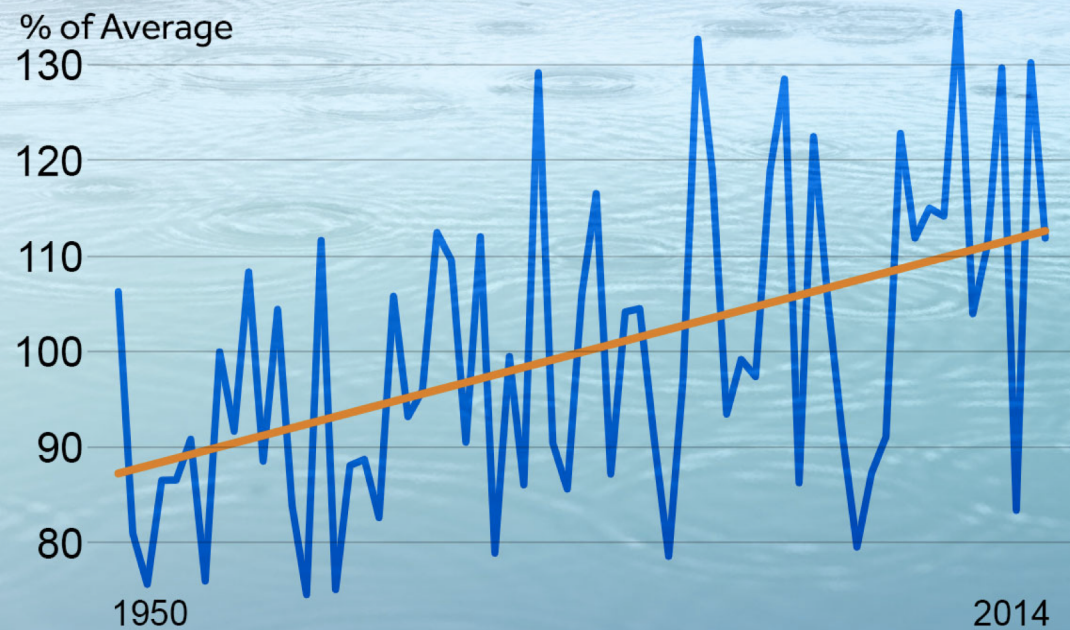
*Credit: Steve Zubrick, NOAA*





# EXTREME PRECIPITATION IS EXTREME

## MORE U.S. DOWNPOURS Days with 2" or More



Based on methodology by Brian Brettschneider.  
Source: Applied Climate Information System (rcc-acis.org)

CLIMATE  CENTRAL

# PHYSICAL: INFRASTRUCTURE

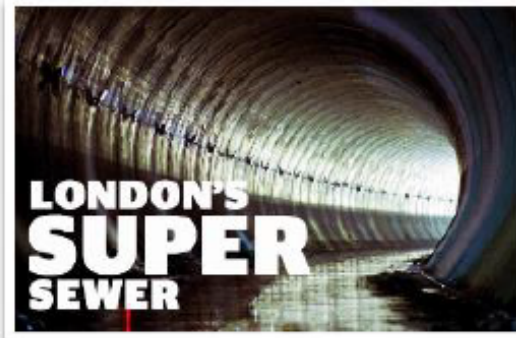
Melbourne, Australia



Seattle, Washington



London, England



Vienna, Austria



Milwaukee, Wisconsin

*MMSD Deep Tunnel*



Portland, Oregon



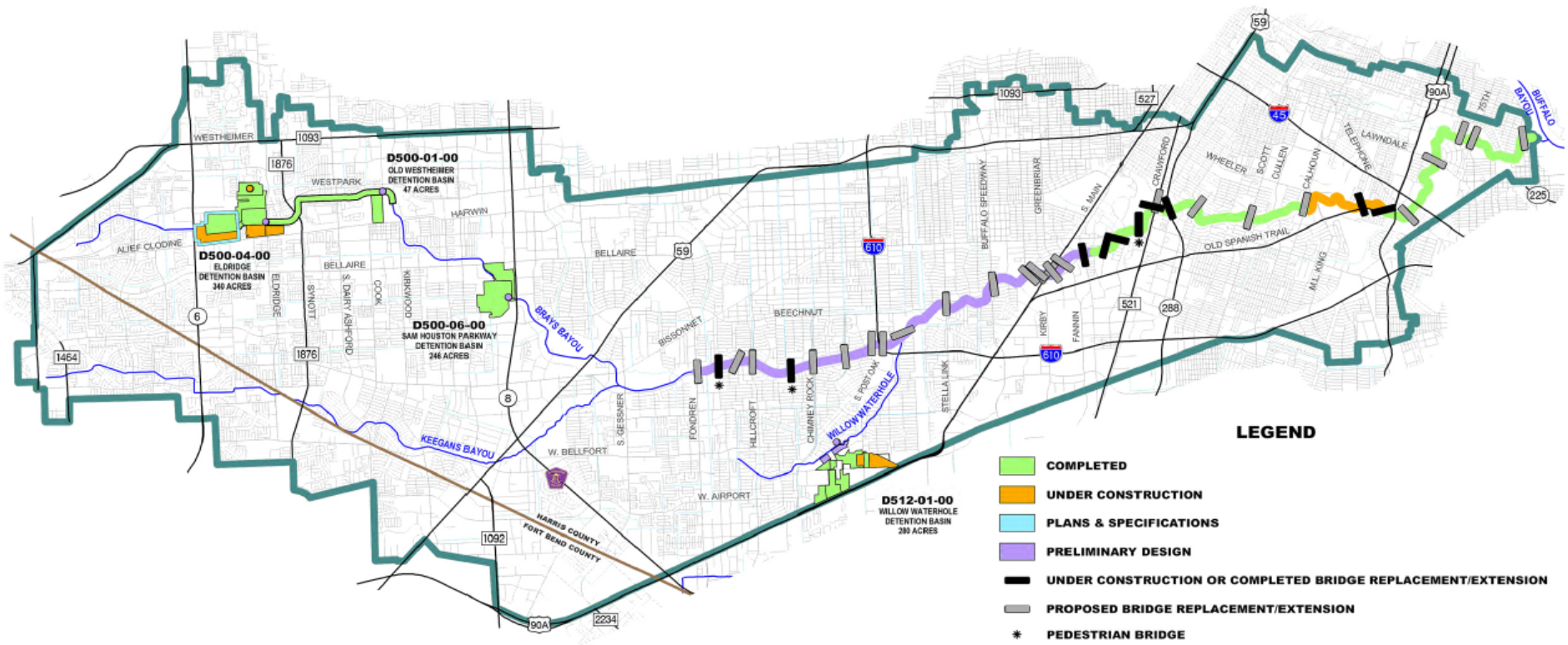
Singapore



# AGEING INFRASTRUCTURE AND BUILDING CHOICES



# INFRASTRUCTURE: PROJECT BRAYS



- \$550 million federal funded flood control project (began in early 2000s, original completion date 2014, now expected completion in 2021) to mitigate flooding in Brays Bayou Watershed
- Project consists of large detention basins along upper reach, bridge and channel modifications along middle and lower reaches

# ROLE OF SCIENCE

## Elevation of Baltimore,US Elevation Map, Topo, Contour

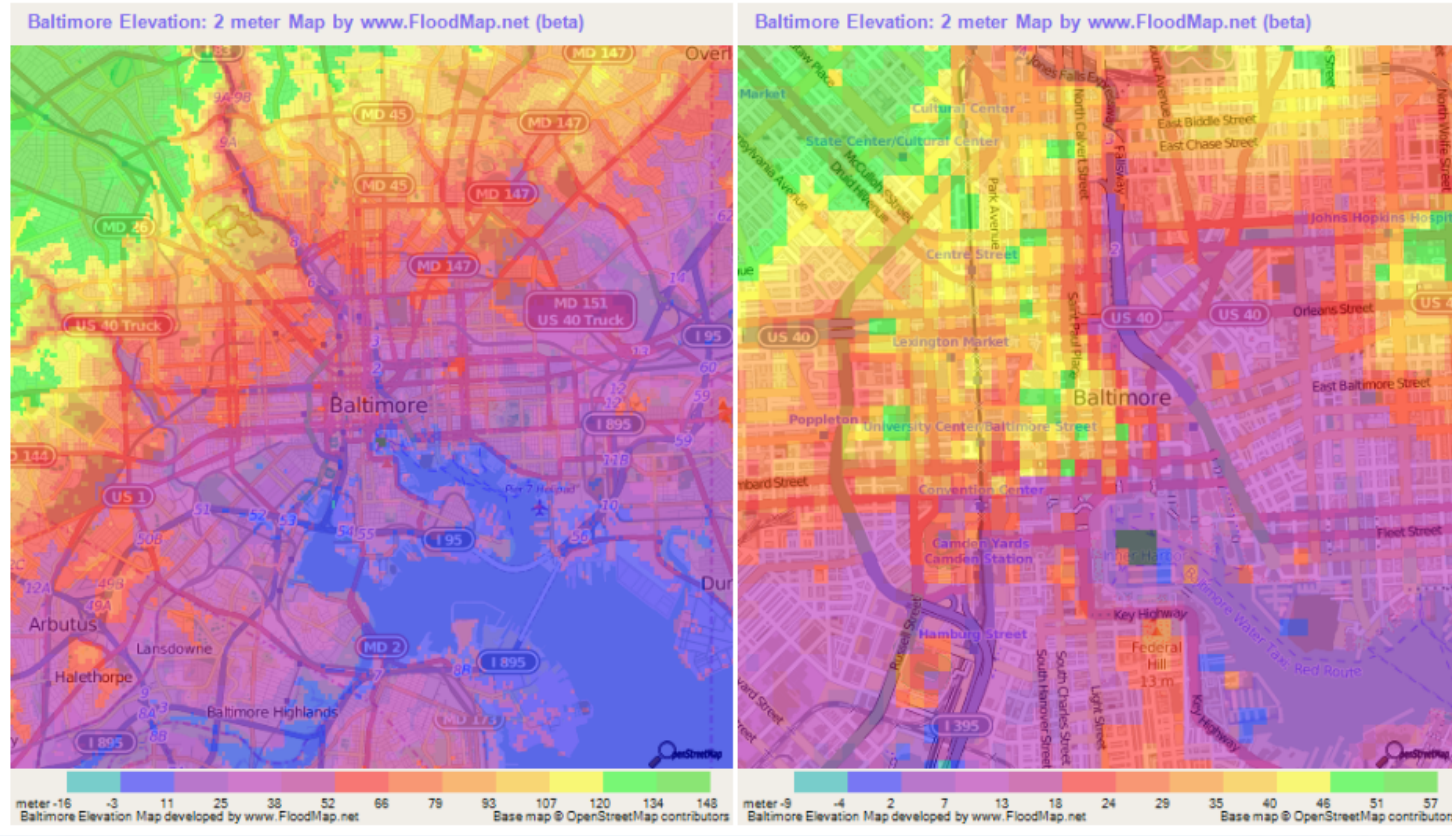
2 meter

Below is the Elevation map of Baltimore,US, which displays range of elevation with different colours.

The elevation map of Baltimore,US is generated using elevation data from NASA's 90m resolution SRTM data.

The maps also provides idea of topography and contour of Baltimore,US.

Baltimore,US Elevation Map is displayed at different zoom levels.



<http://www.floodmap.net/Elevation/ElevationMap/?gi=4347778>

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# SOCIAL DIMENSIONS

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# WHO IS FLOODED?



Photo credit: Dr. Sam Brody, TAMUG

# WHO?

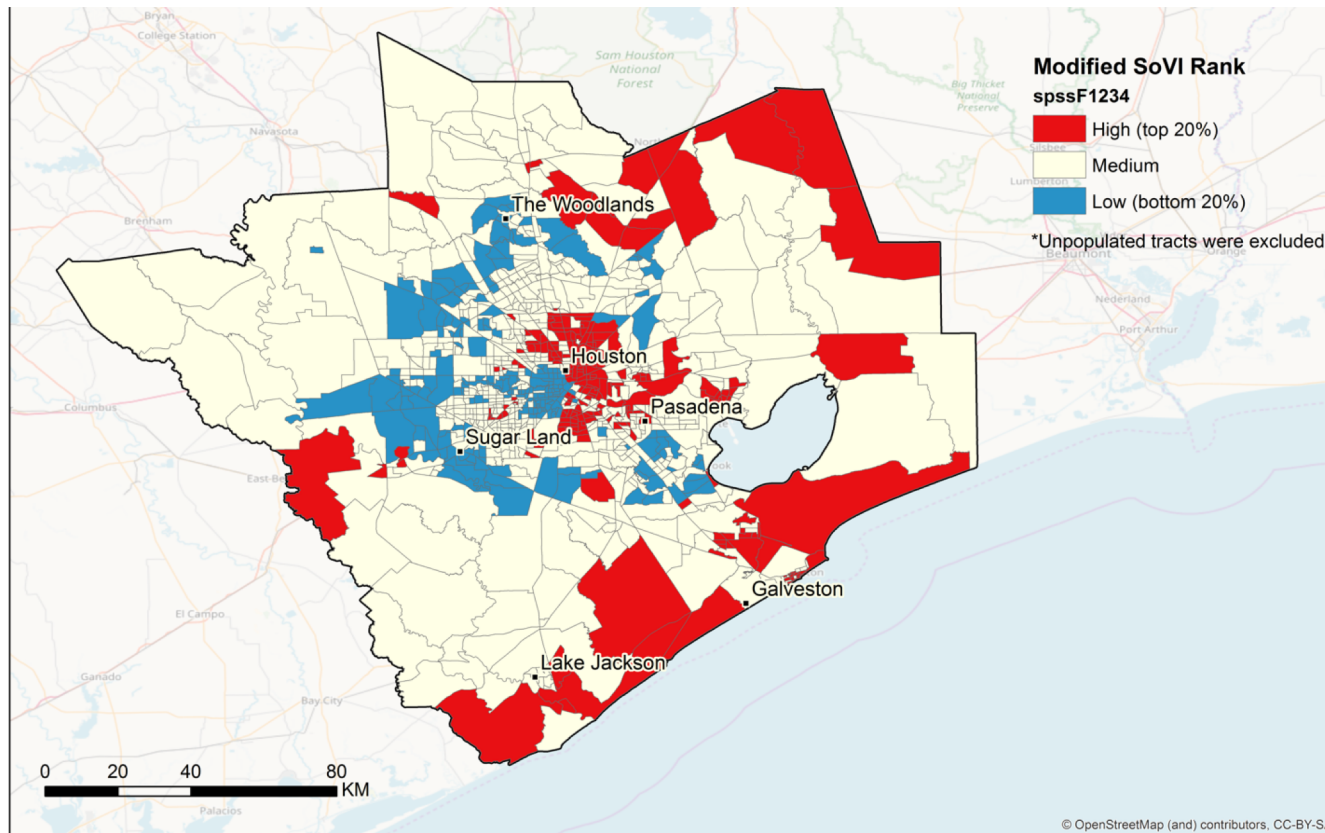




# AND WHO DOES NOT FLOOD?



# THE ROLE OF SCIENCE



A modified SoVi map for Houston, courtesy of Dr. Eric Tate, University of Iowa

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And how do we know?

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# INFORMATION DIMENSION OF FLOODING

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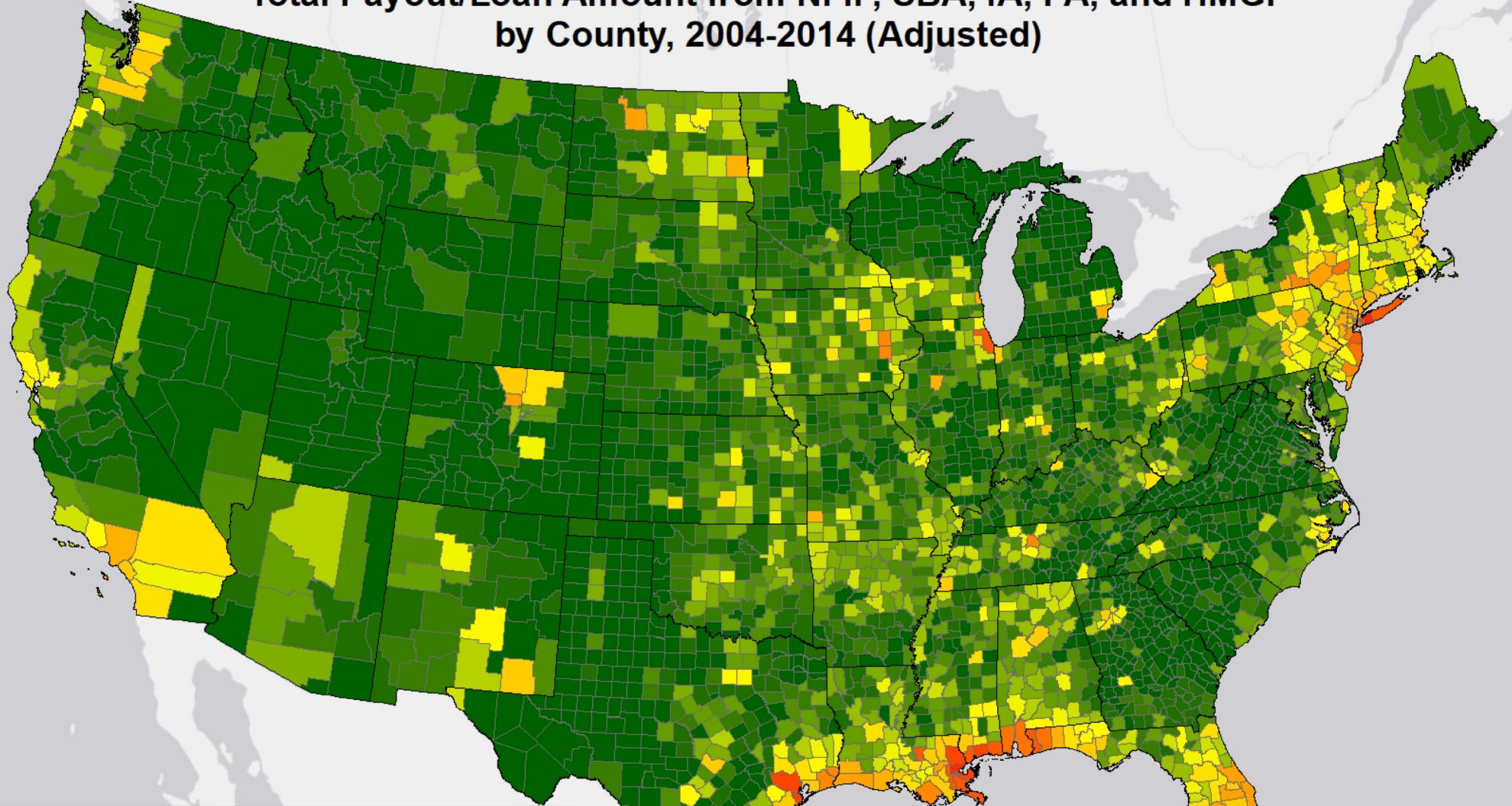
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OY YOI YOI.

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# Total Payout/Loan Amount from NFIP, SBA, IA, PA, and HMGP by County, 2004-2014 (Adjusted)



## Legend

State Boundary

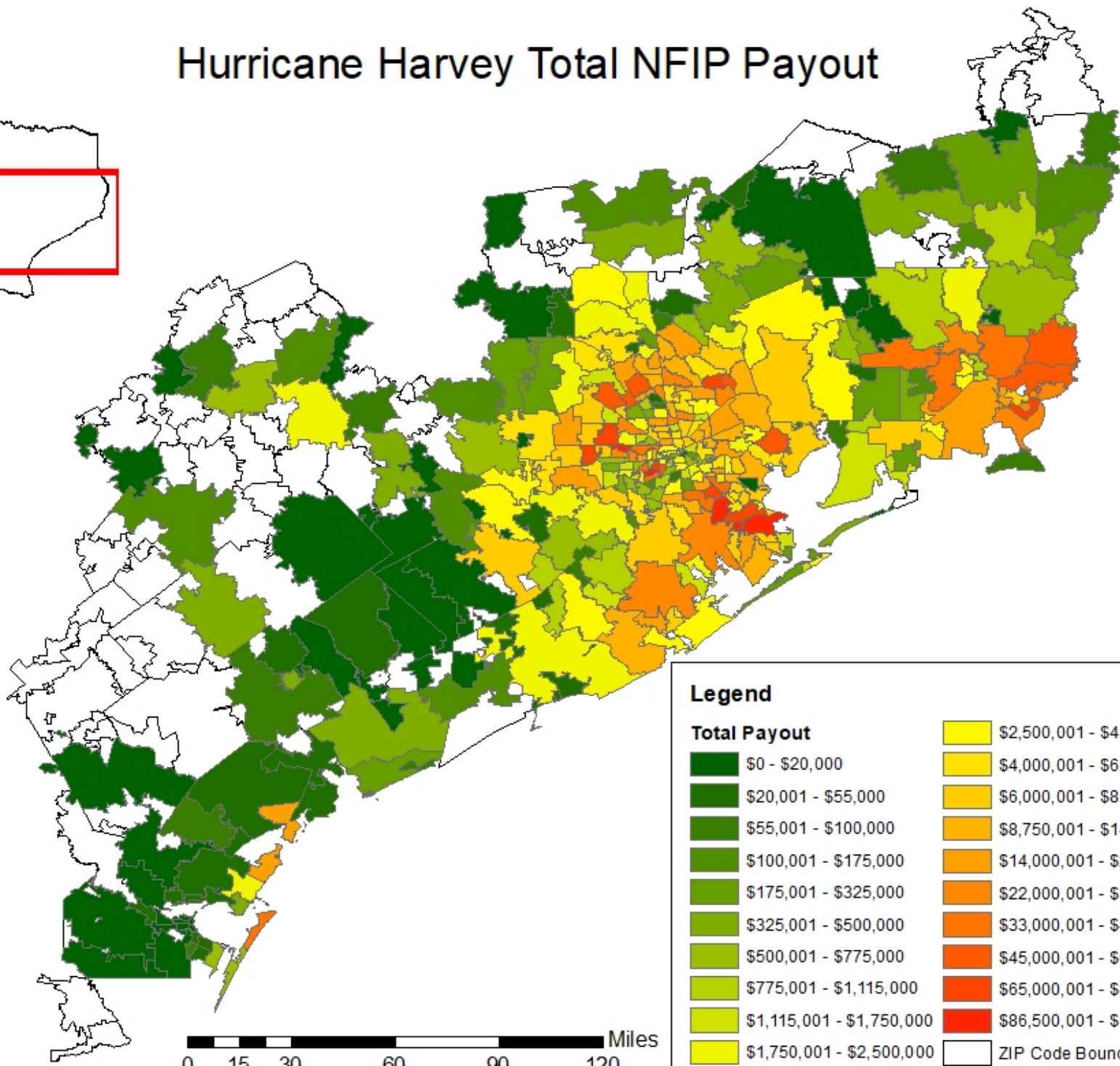
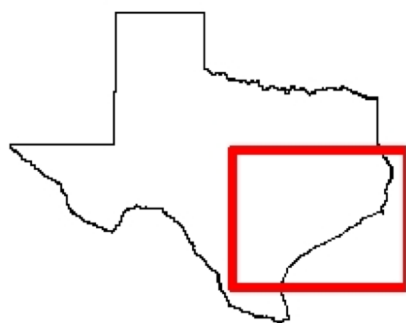
### Total Payout/Loan Amount

\$0 - \$1,500,000	\$45,000,001 - \$60,000,000
\$1,500,001 - \$4,000,000	\$60,000,001 - \$90,000,000
\$4,000,001 - \$7,000,000	\$90,000,001 - \$150,000,000
\$7,000,001 - \$10,000,000	\$150,000,001 - \$250,000,000
\$10,000,001 - \$15,000,000	\$250,000,001 - \$400,000,000
\$15,000,001 - \$20,000,000	\$400,000,001 - \$600,000,000
\$20,000,001 - \$25,000,000	\$600,000,001 - \$850,000,000
\$25,000,001 - \$32,500,000	\$850,000,001 - \$1,250,000,000
\$32,500,001 - \$45,000,000	\$1,250,000,001 - \$2,500,000,000
	\$2,500,000,001 - \$5,000,000,000
	\$5,000,000,001 - \$10,676,100,096

0 250 500 1,000 Miles



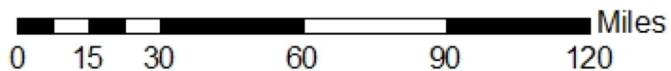
# Hurricane Harvey Total NFIP Payout



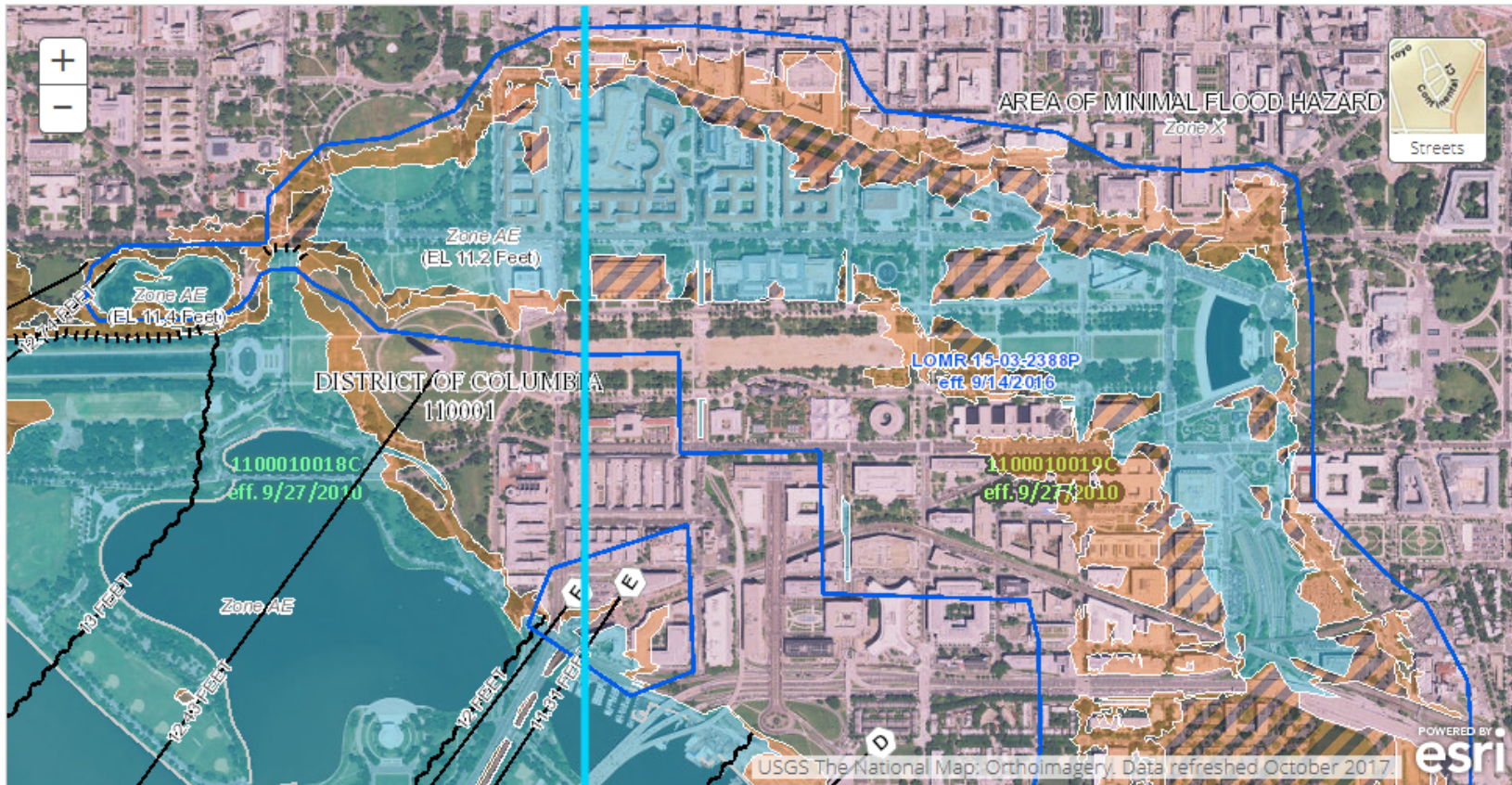
## Legend

### Total Payout

Dark Green	\$0 - \$20,000	Light Yellow	\$2,500,001 - \$4,000,000
Medium Green	\$20,001 - \$55,000	Yellow	\$4,000,001 - \$6,000,000
Light Green	\$55,001 - \$100,000	Orange	\$6,000,001 - \$8,750,000
Lighter Green	\$100,001 - \$175,000	Dark Orange	\$8,750,001 - \$14,000,000
Yellow-Green	\$175,001 - \$325,000	Red-Orange	\$14,000,001 - \$22,000,000
Yellow	\$325,001 - \$500,000	Red	\$22,000,001 - \$33,000,000
Light Yellow	\$500,001 - \$775,000	Dark Red	\$33,000,001 - \$45,000,000
Yellow-Green	\$775,001 - \$1,115,000	Red-Orange	\$45,000,001 - \$65,000,000
Yellow	\$1,115,001 - \$1,750,000	Dark Red	\$65,000,001 - \$86,500,000
Light Yellow	\$1,750,001 - \$2,500,000	Red	\$86,500,001 - \$134,374,390
		White outline	ZIP Code Boundary



# RIVERINE FLOOD MAPS: IN OR OUT



- PIN**
  - Approximate location based on user input and does not represent an authoritative property location
- MAP PANELS**
  - Selected FloodMap Boundary
  - Digital Data Available
  - No Digital Data Available
  - Unmapped
- OTHER AREAS**
  - Area of Minimal Flood Hazard Zone X
  - Effective LOMRs
  - Area of Undetermined Flood Hazard Zone D

- SPECIAL FLOOD HAZARD AREAS**
  - Without Base Flood Elevation (BFE) Zone A, V, A99
  - With BFE or Depth
  - Regulatory Floodway Zone AE, AO, AH, VE, AR
- OTHER AREAS OF FLOOD HAZARD**
  - 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
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  - Area with Reduced Flood Risk due to Levee. See Notes. Zone X
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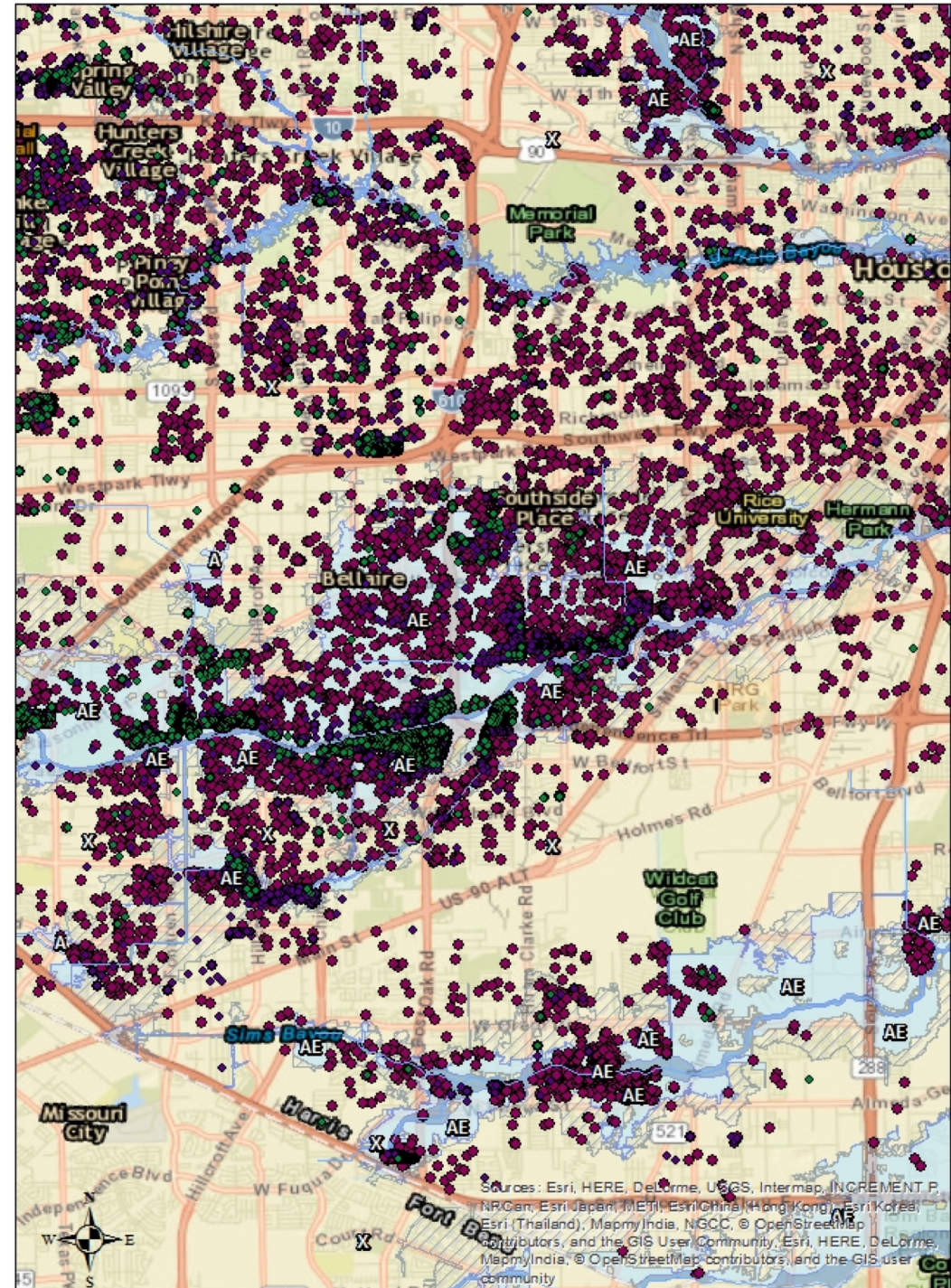
- OTHER FEATURES**
  - 20.2** Cross Sections with 1% Annual Chance Water Surface Elevation
  - 17.5** Coastal Transect Base Flood Elevation Line (BFE)
  - Limit of Study
  - Jurisdiction Boundary
  - Coastal Transect Baseline
  - Profile Baseline
  - Hydrographic Feature
- GENERAL STRUCTURES**
  - Channel, Culvert, or Storm Sewer
  - Levee, Dike, or Floodwall



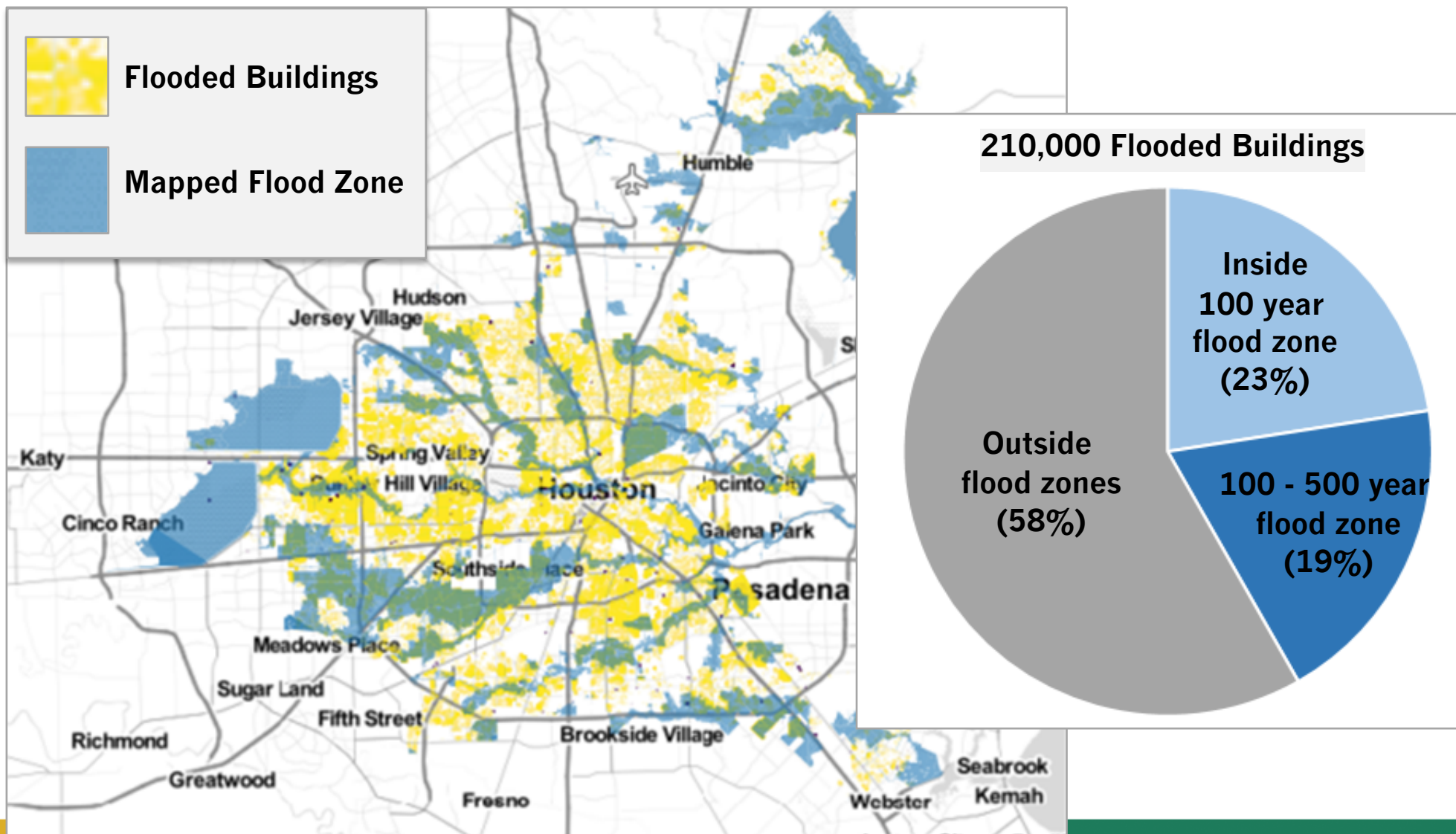
# RIVERINE FLOODING

Dark red dots: payouts outside of the SFHA

Green dots: payouts inside the SFHA



# HOUSTON: IN AND OUT



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## BUT WHAT'S NOT INCLUDED?

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- Uninsured losses
- Pluvial flooding
- Overland flow
- Seepage—and almost all basement flooding
- Combined sewer-stormwater systems
- People in the way of water, especially poor, brown, tan, non-English speaking, and old people

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# FLOODING RISK, EXPOSURE, AND IMPACT PICTURE

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# ROLE OF SCIENCE

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Help create a more complete picture of who floods, when, how badly, how much it costs, what they should expect, what's driving increased flooding, and what we can do about it.

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# DECISION MAKING

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# THERE IS A ROLE FOR EVERYONE

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- Federal agencies
- State agencies
- Local governments
- Private sector
- NGOs
- Individuals
- Academicians

WHICH IS ...

## Just Like Herding Cats





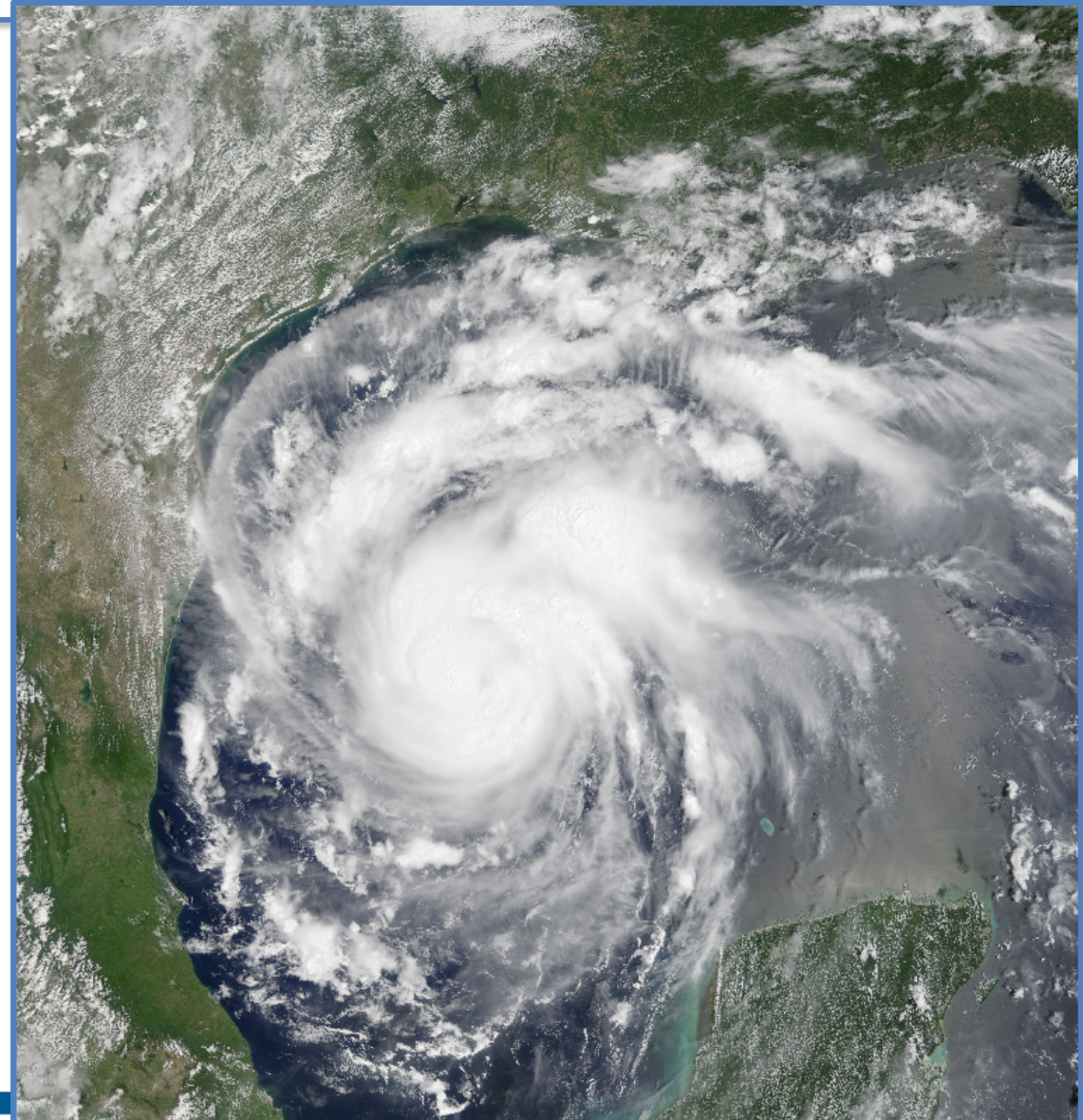
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# PART III: NEXT STEPS & TAKING ACTION

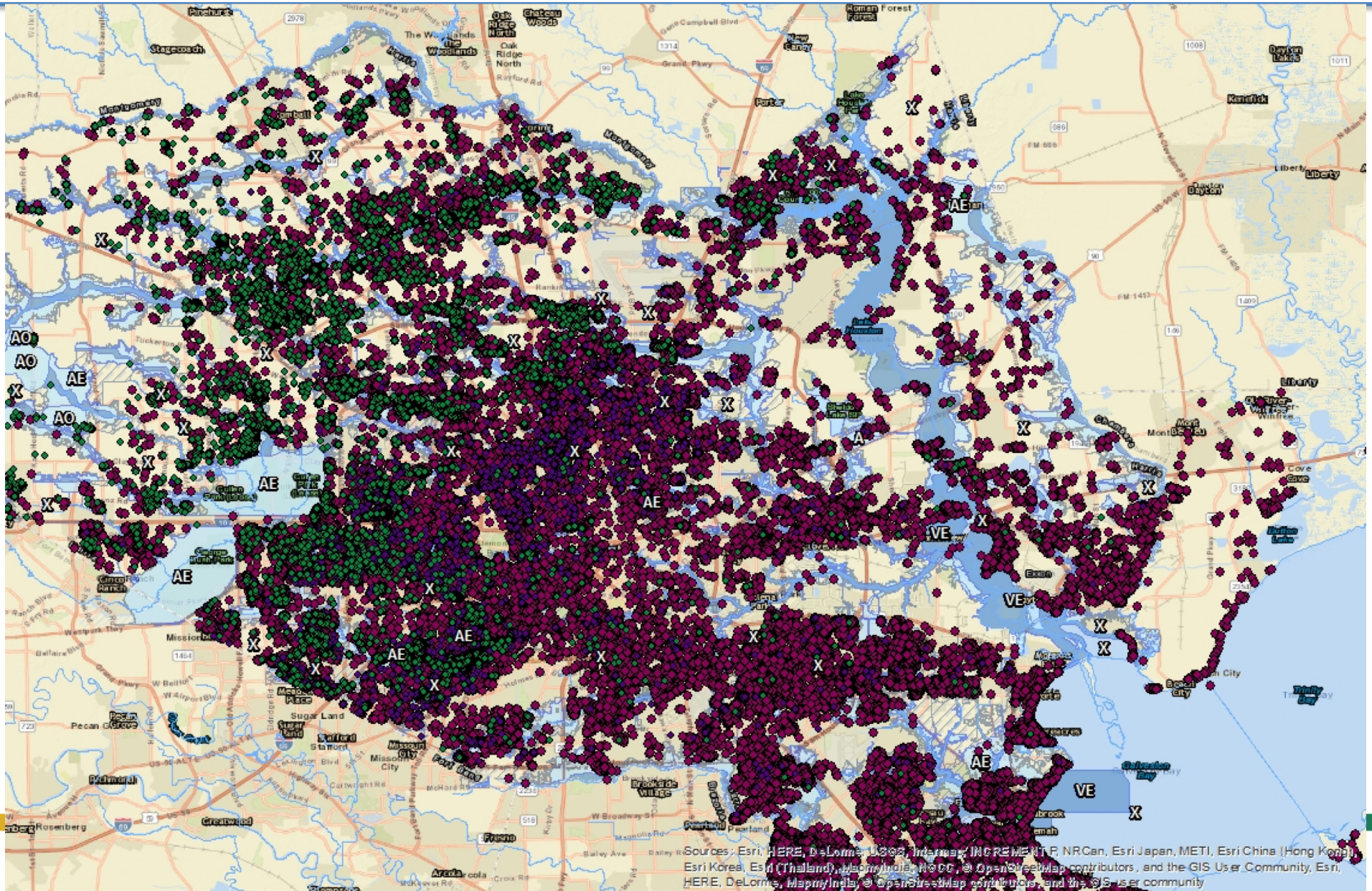
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# SO...HARVEY CAME TO TEXAS...

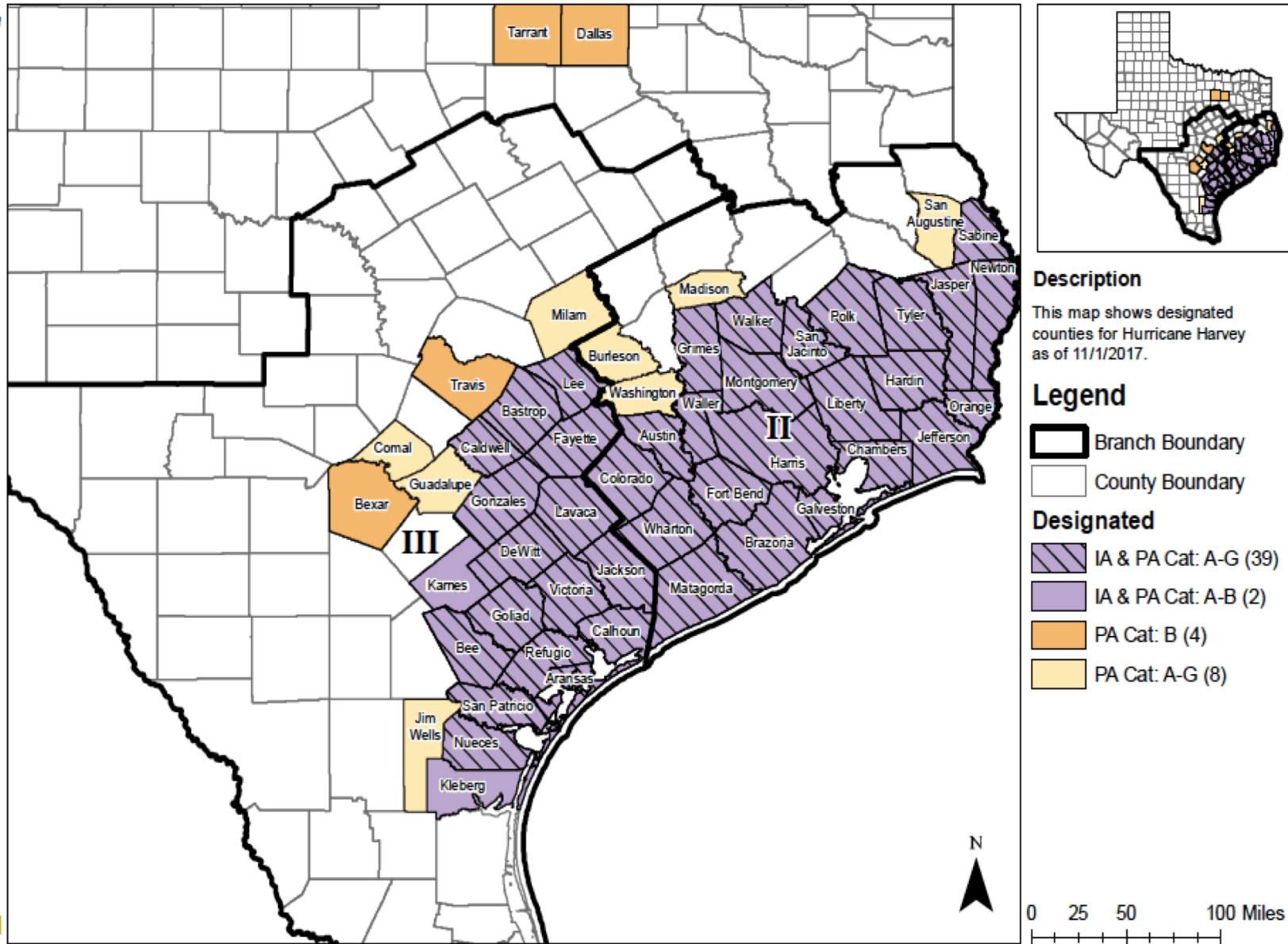
- **Largest rainfall event in US history**
  - Max. precipitation 64.58 inches
  - 19 trillion gallons of water
  - 80,000 homes flooded 18+ inches
  - 23,000 homes flooded 5+ feet
- **Total Damage Est. \$125B**
  - NFIP = \$8.8 billion
  - SBA = \$3.4 billion
  - IA = \$1.6 billion
  - TWIA = \$1 billion
  - NICB Claims = 366,000
- **Damages were driven by**
  - Wind
  - Surge; Rain (pluvial); River (fluvial)
  - Reservoir releases & levee failures
- **Historic response mobilized**
  - 31,000 federal employees
  - 120,000+ rescues



# NFIP PAYOUTS POST HARVEY



# WHO WAS IMPACTED BY HARVEY?



Prepared By: FEMA DR-4332 JFO GIS

Source: FEMA, ESRI, Datum: WGS 1984

Date: 11/1/2017

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# STAKEHOLDERS

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- Homeowners
- FEMA
- HUD
- USACE
- State
- Harris County
- Cities and Municipalities
- Private and NGOs

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# STAKEHOLDER RESPONSIBILITIES

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- Homeowners—repairs to personal property
- FEMA-mitigation, recovery, IA, PA, NFIP, mapping
- HUD—CDBG-DR, long-term recovery
- USACE—infrastructure, modeling
- State—infrastructure, relief, recovery
- Harris County, Cities and Municipalities—local level improvements and investments
- NGOs, Private sector, and academia



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# A PROGRAM TAKES SHAPE

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# PILOT PROGRAM ON FLOOD RESILIENCE IN SOUTHEASTERN TEXAS

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# WHY: THE PROBLEM WE ARE TRYING TO ADDRESS

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- Hurricane Harvey demonstrated the disparity and lack of existing information to convey: **where** floodwaters would pool or move; **when** the water would recede; and **how many people/who** were exposed to floodwaters and related risks.
- First responders, emergency managers, urban planners, and health care facilities used incomplete or inaccurate information to make decisions.

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# WHAT: PILOT PROGRAM ON FLOOD RESILIENCE IN SOUTHEASTERN TEXAS

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Texas A&M University System, Texas GLO, FEMA, DHS, and the National Academy of Sciences, Engineering, and Medicine (NASEM) will conduct a pilot project that **integrates data in new ways to visualize** hazards, risks, and impacts of flooding in the areas of Southeastern Texas, coastal communities subject to repetitive floods.

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## WHAT: DESIRED OUTCOMES

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- New partnerships and enhanced network of flood-experts and stakeholders
- Increased understanding of the physical, social, and informational dimensions (strengths, opportunities, gaps) of flooding in Southeastern Texas
- Stronger communications mechanisms for flood hazard, risk, and impacts
- Stronger foundation for decision-making around land use, insurance, mitigation, and community engagement
- New information from the community about flood impacts

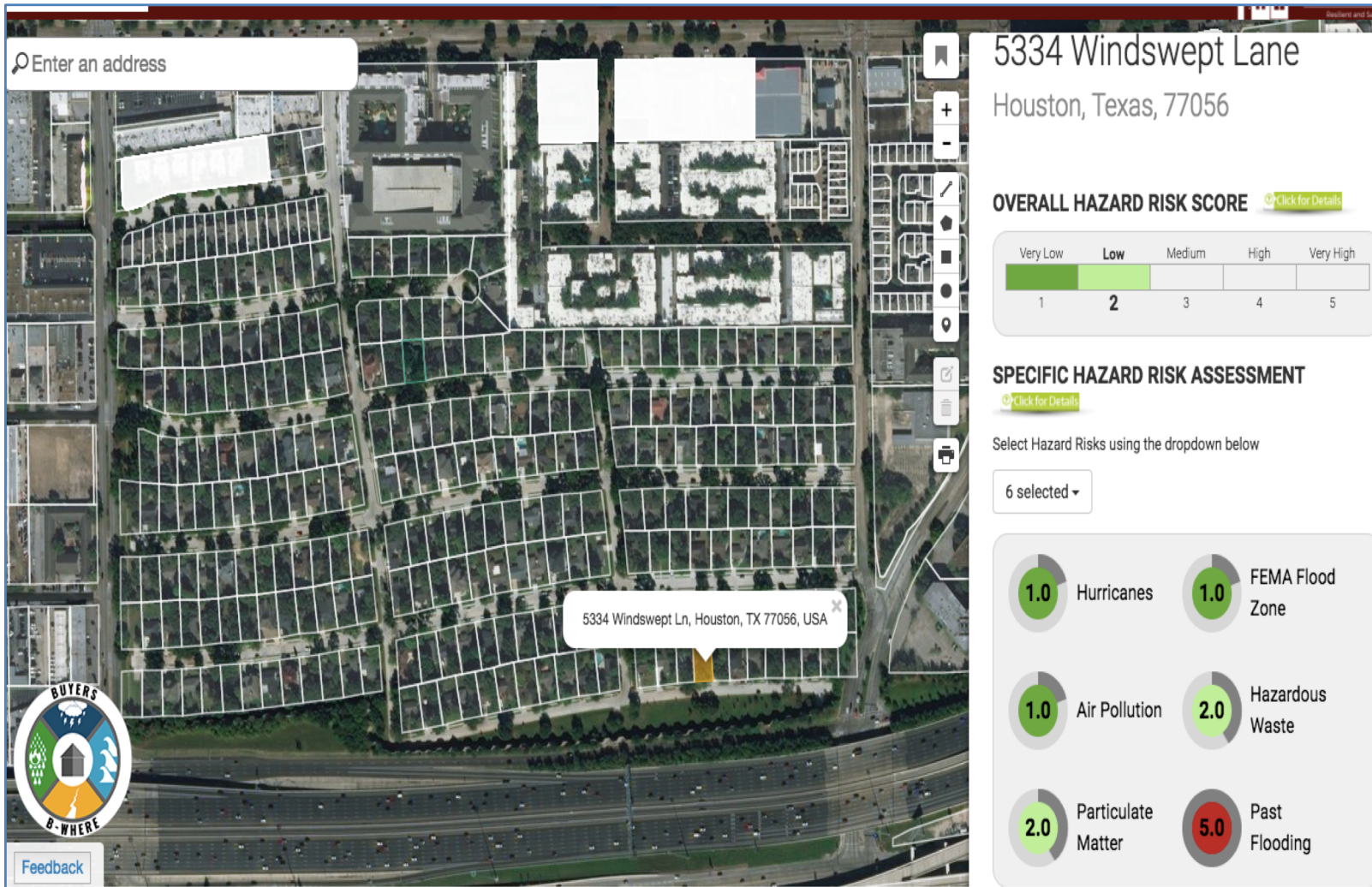
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## WHAT: EXPECTED OUTPUTS

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- Maps and other visuals that link the natural and built environment to the locations of people, resources, vulnerabilities, and capabilities in the path of flood water
- Maps and other visuals that reflect flood hazard from a range of sources of populated areas, including riverine, coastal, pluvial, overland, and sources altered by infrastructure age or capacity
- Maps and other visuals that indicate flood impact, even at the parcel scale
- A few written reports along the 4-year project, including an annual report
- Annual partner meetings and an annual conference

# WOULDN'T IT BE NICE...?



Parcel-scale  
Has the  
property flooded  
before

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# WHO: A NEW PARTNERSHIP TAKES SHAPE

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- State of Texas, using CDBG-DR funds
- National Academies (intellectual and convening power)
- FEMA, mapping, modeling, and financial resources
- Other partners from federal agencies, private sector, and NGOs, not yet ready for reveal

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# WHEN: TIMELINE

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- 4-year project
- To begin January 2019

Stay tuned

THANK YOU!

Visit us: <http://ResilientAmerica.nas.edu>

Contact: [laugustine@nas.edu](mailto:laugustine@nas.edu)

