

URBAN FLOODING

A GROWING NATIONAL CHALLENGE

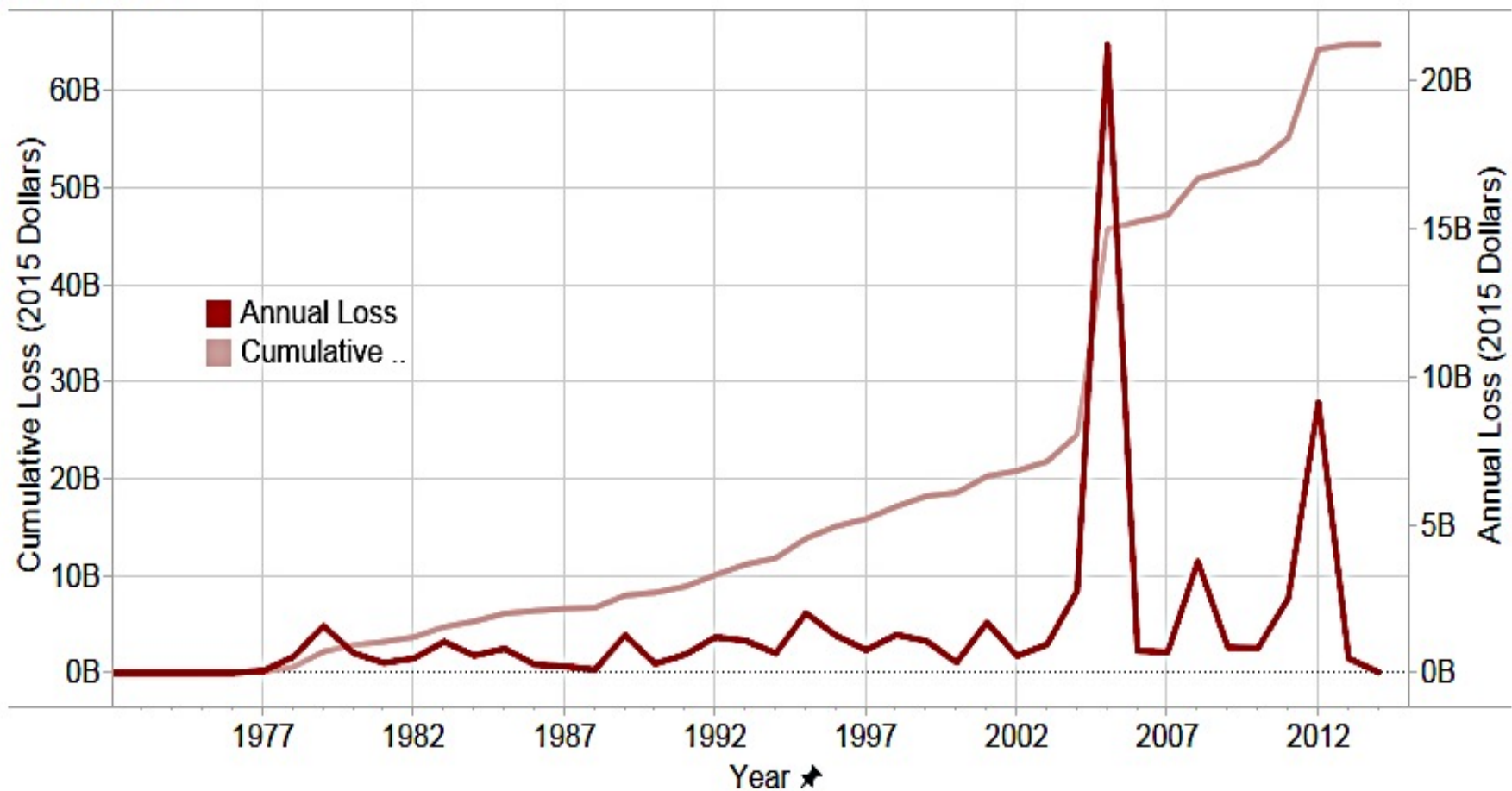
Samuel D. Brody, Josh Gunn, Jayton Rainey, Wesley Highfield
Texas A&M University

Gerry Galloway
University of Maryland

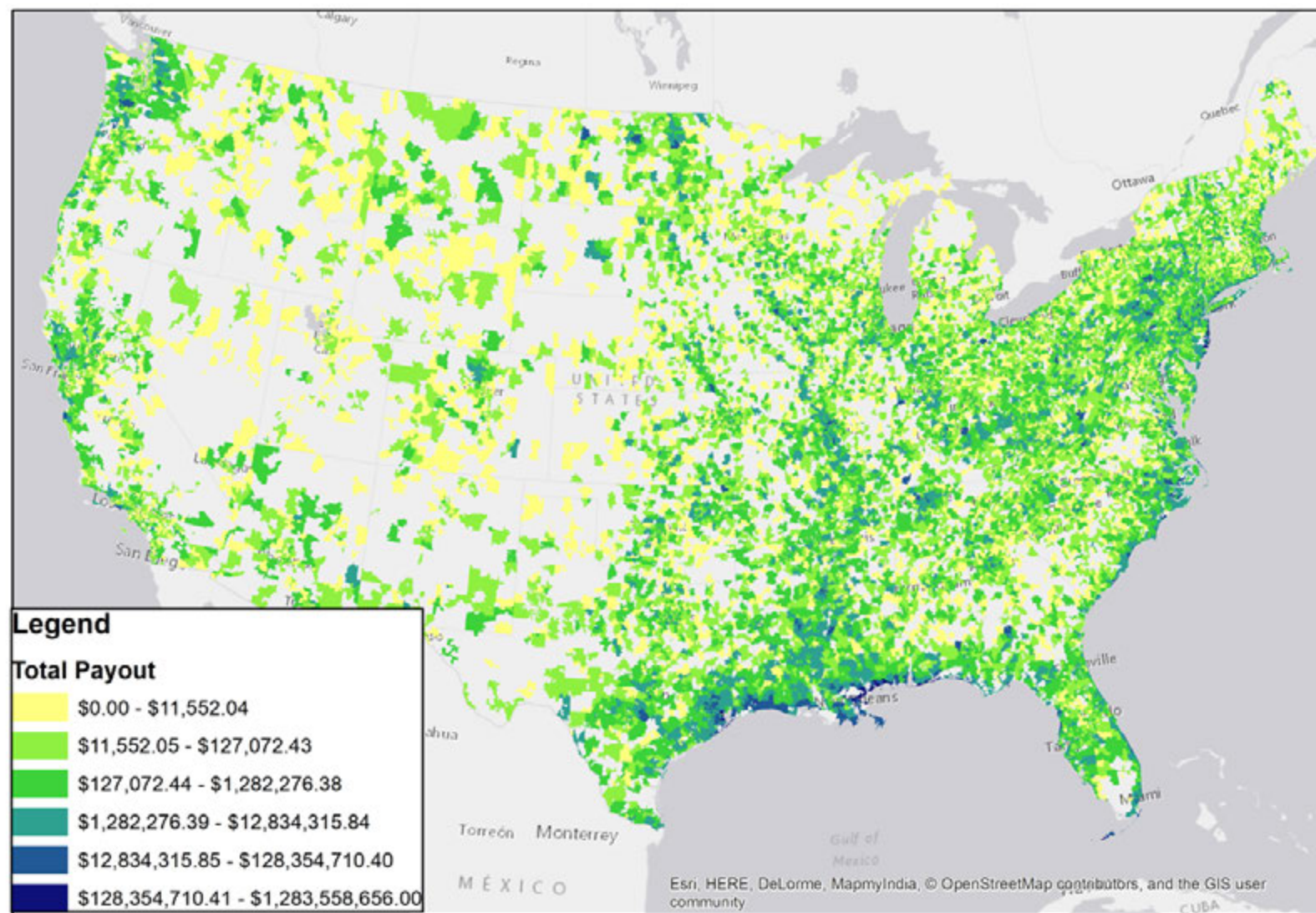


CUMULATIVE FLOOD LOSS: 1972-2015

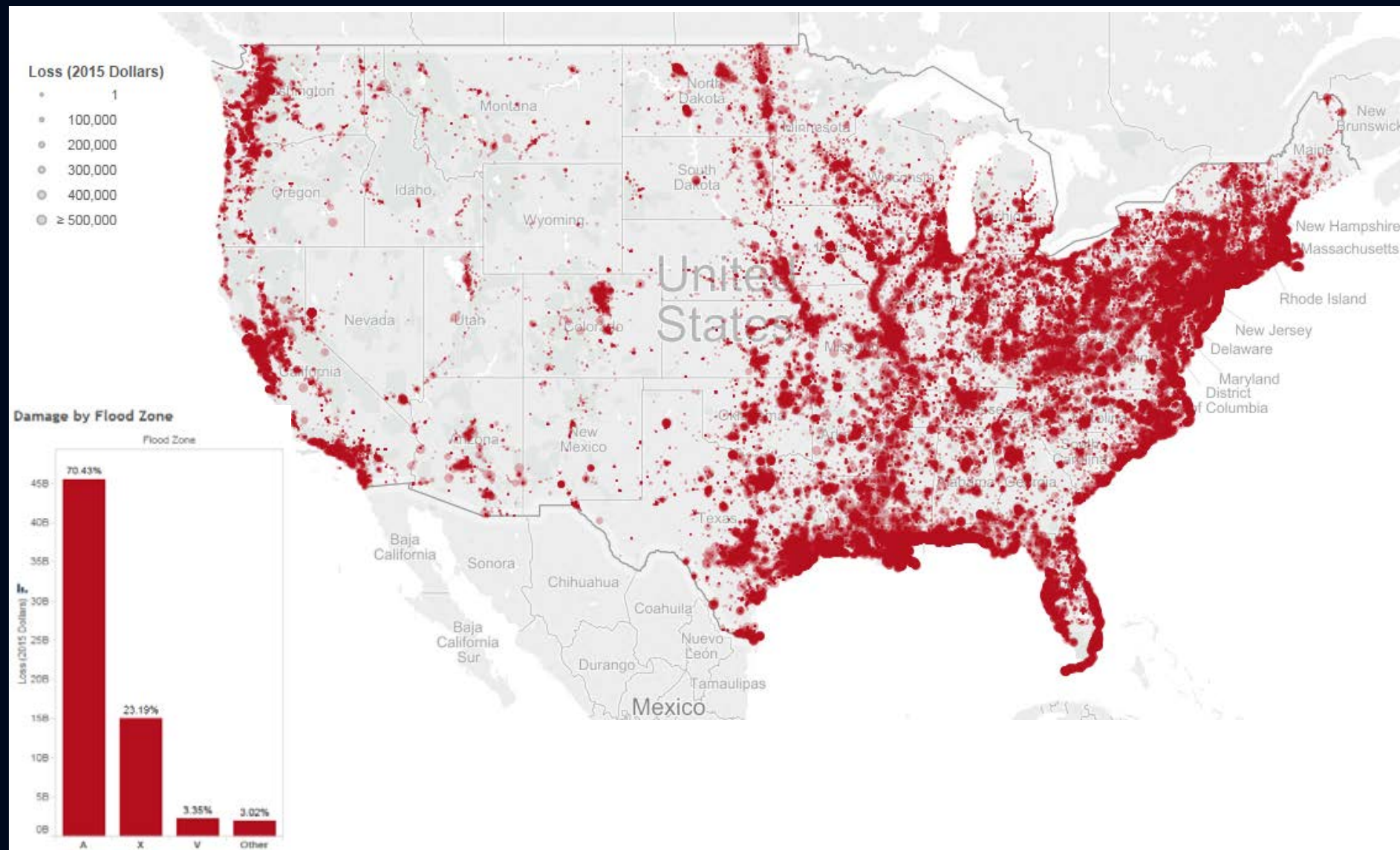
Loss per Year



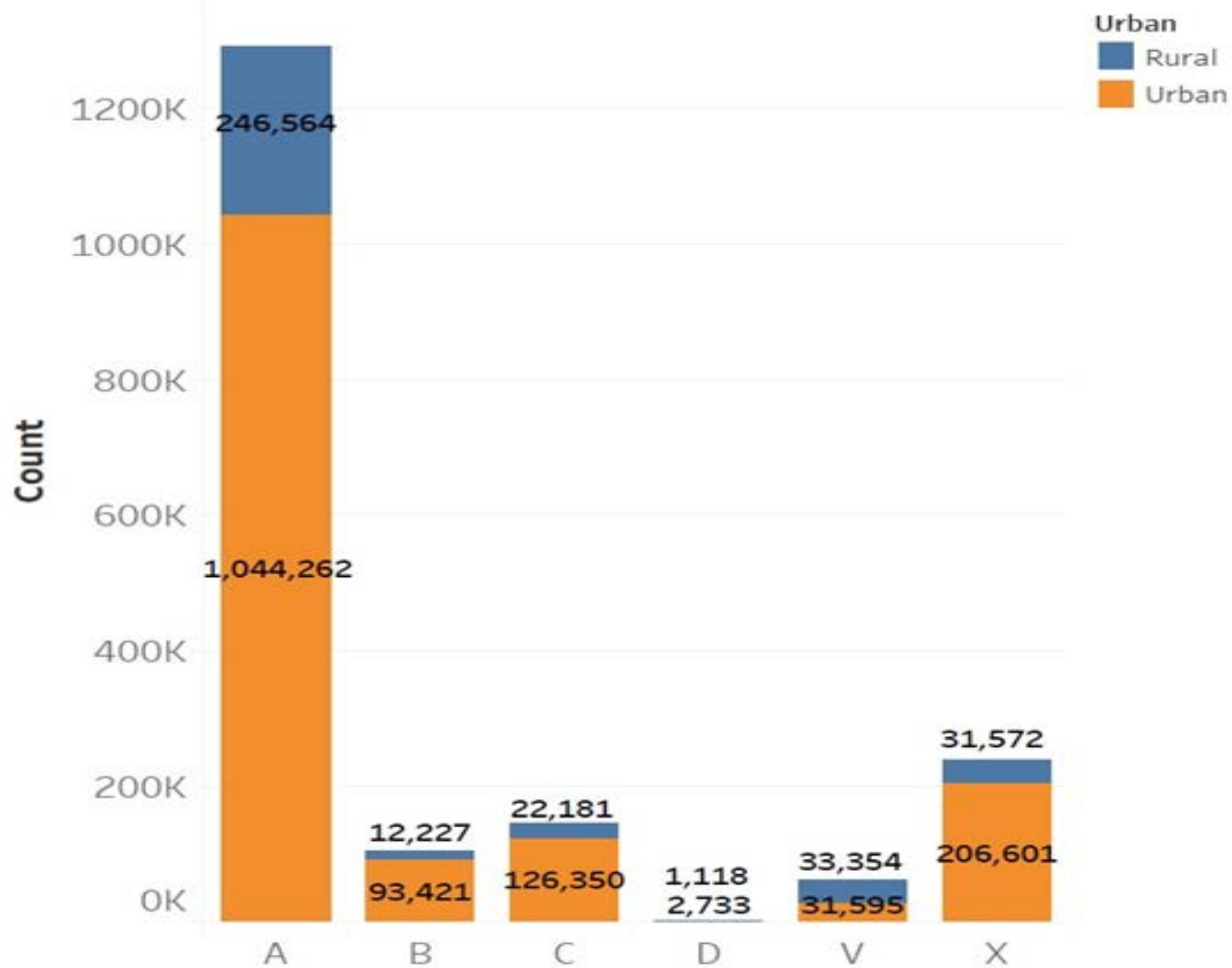
Total Payout of NFIP claims (in dollars) by Zipcode, 1972-2014

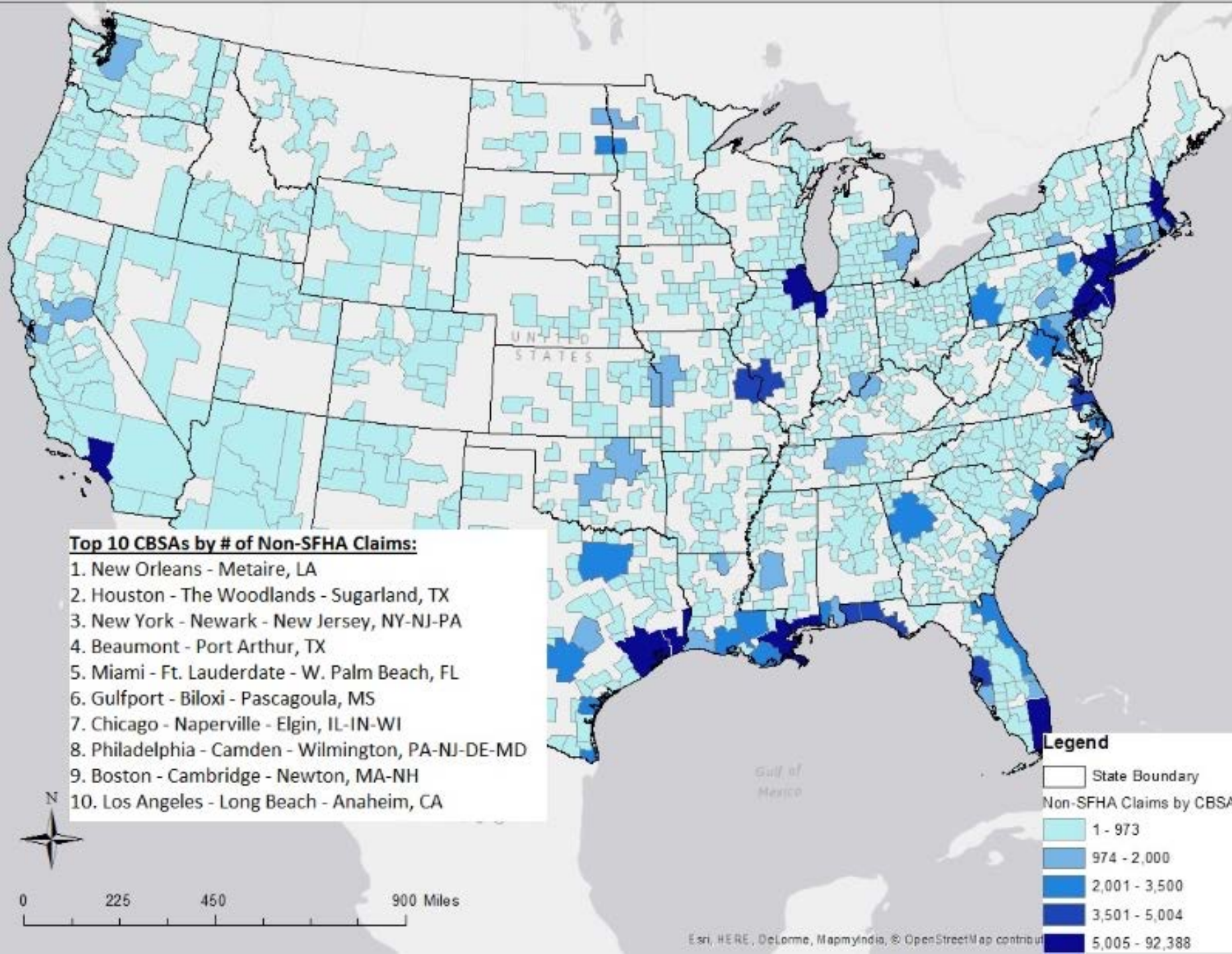


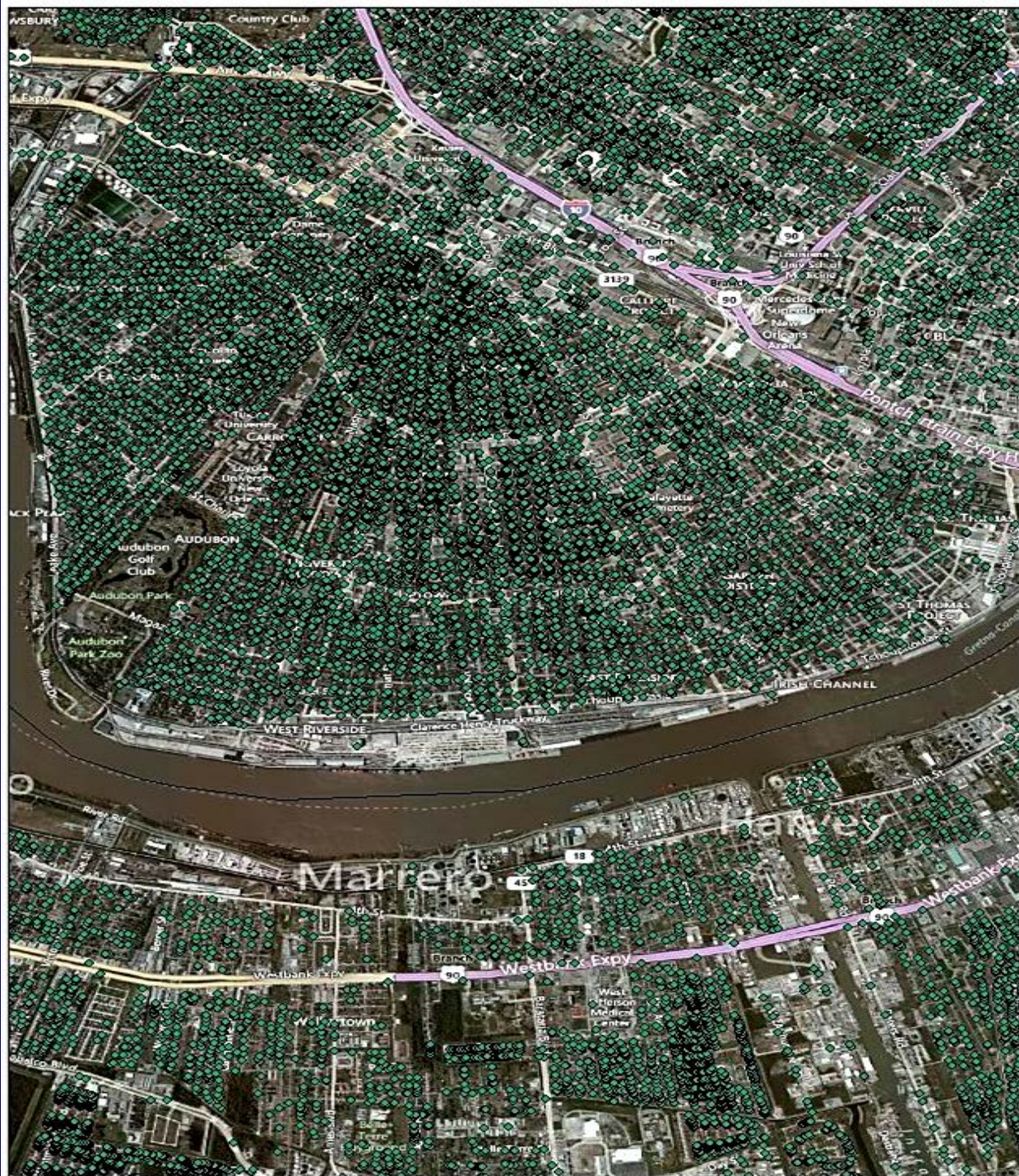
INSURED FLOOD LOSS: 1972-2015



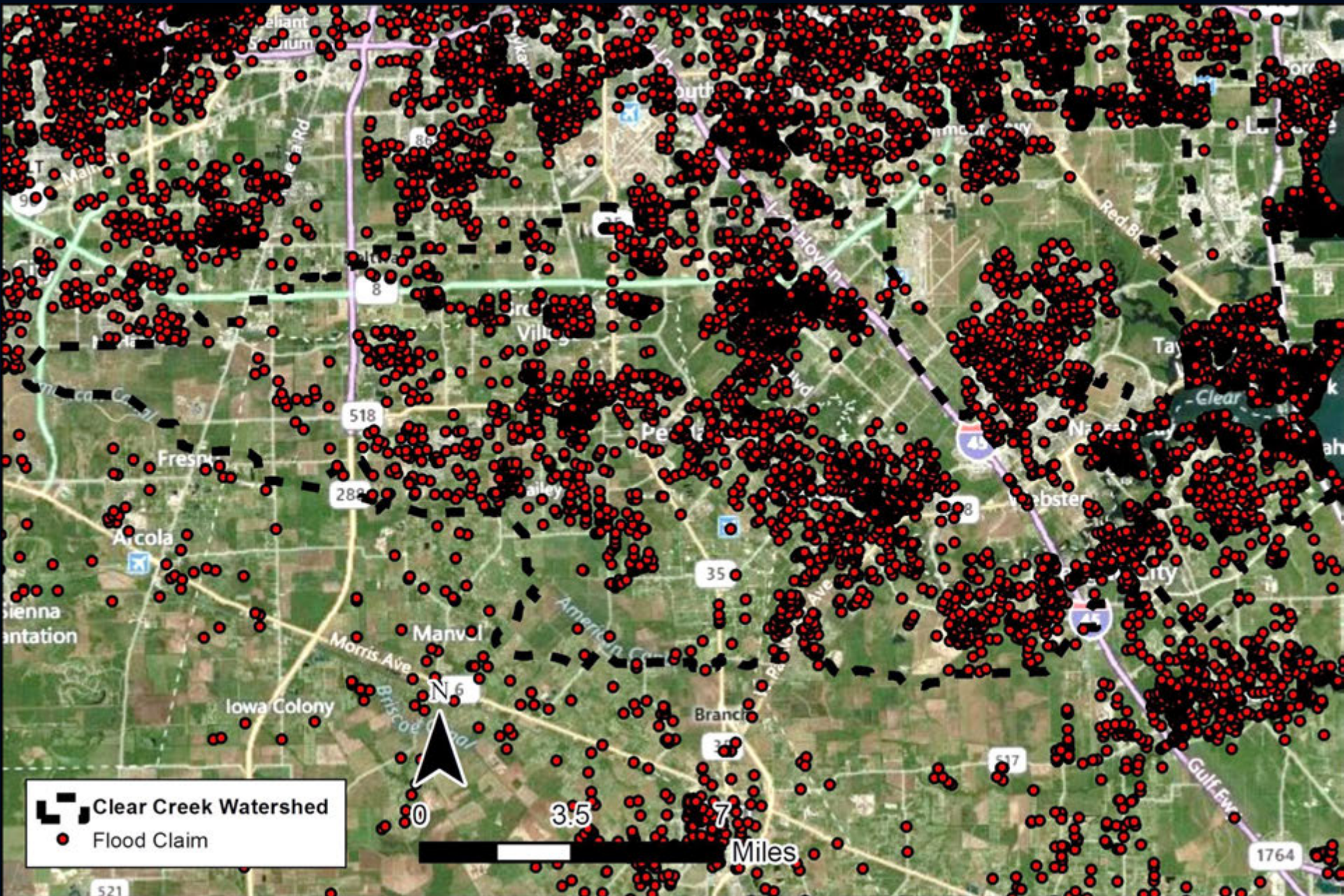
Total NFIP Claims 1972-2014 by Zone and Urban/Rural Designation (2010 Census)

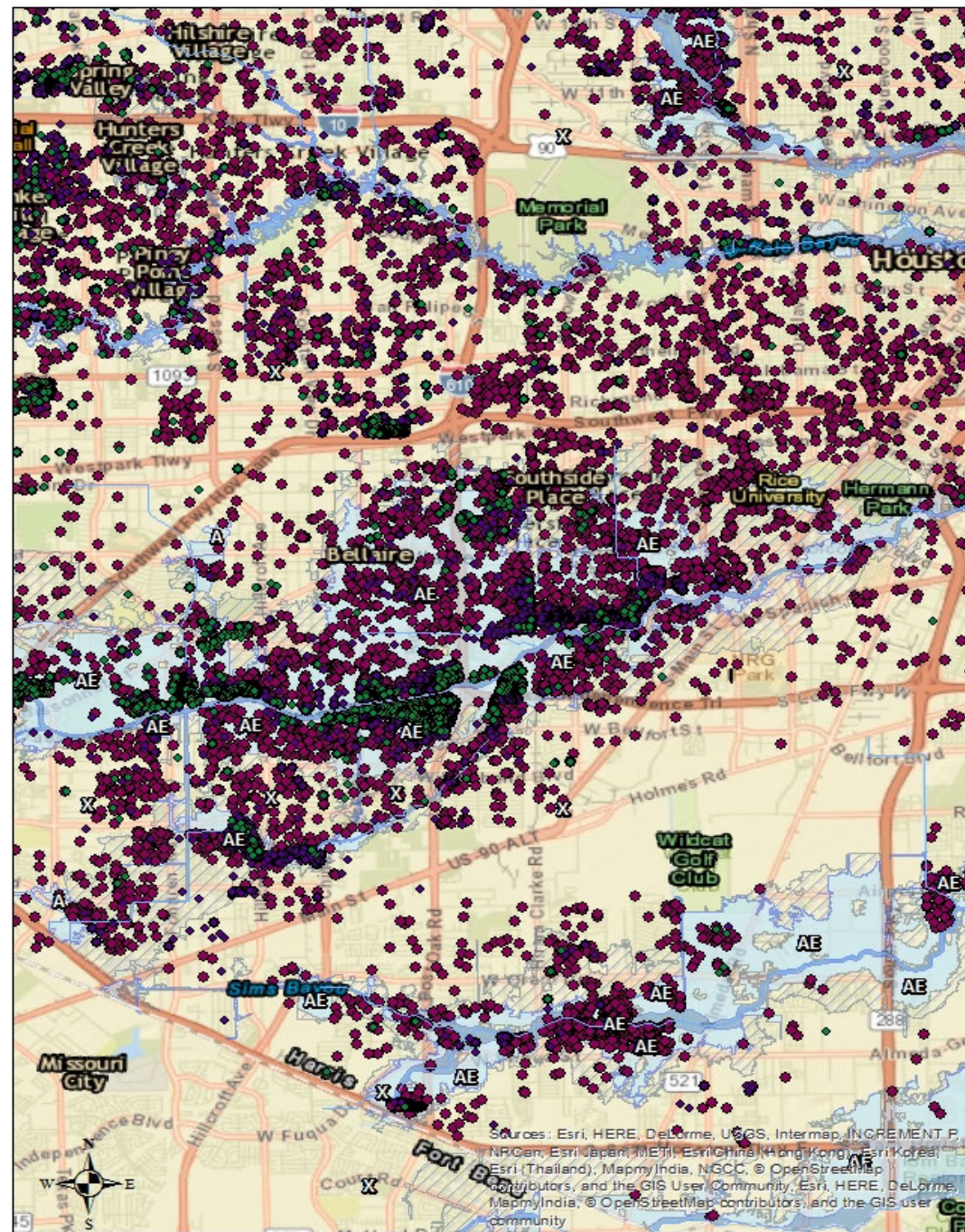


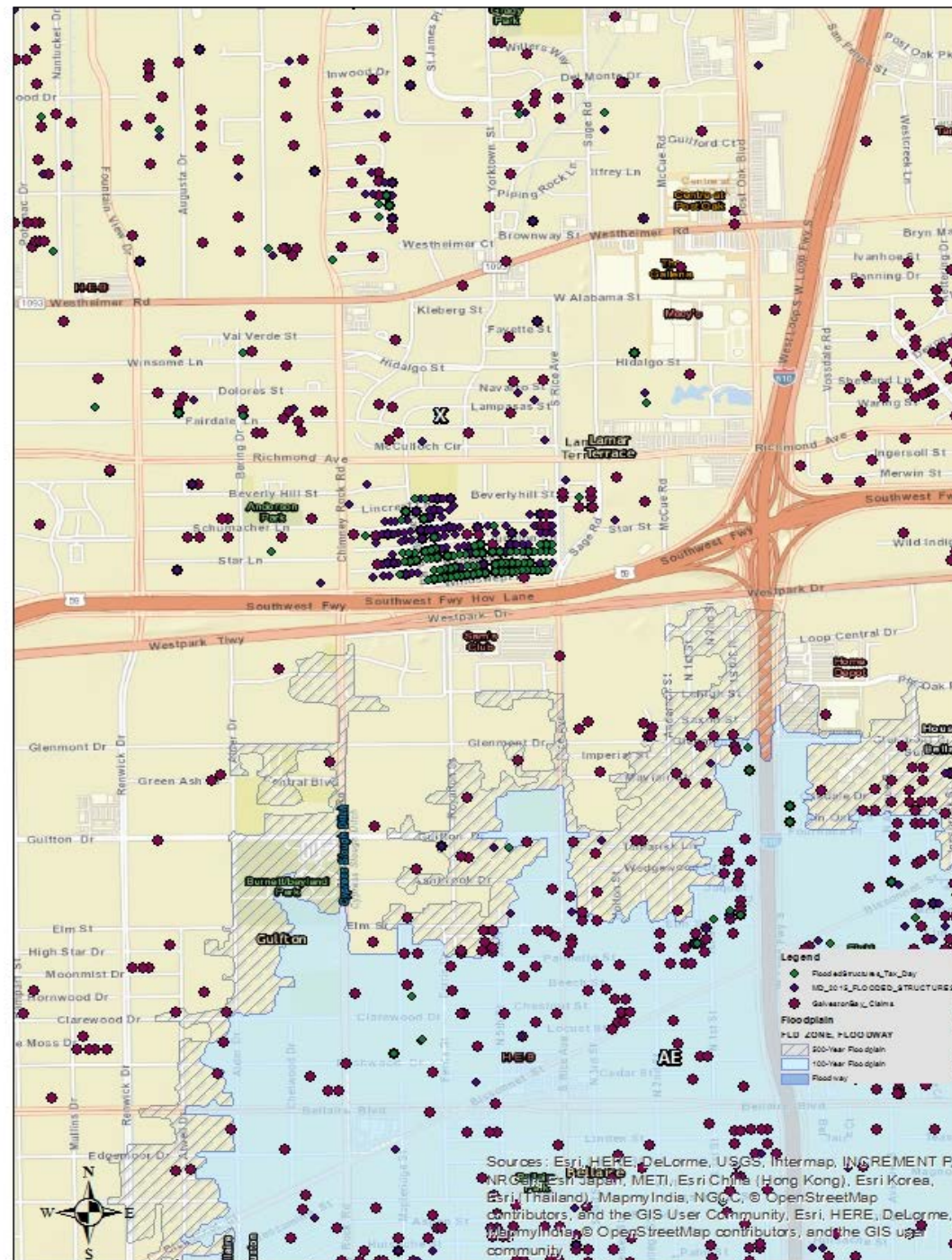




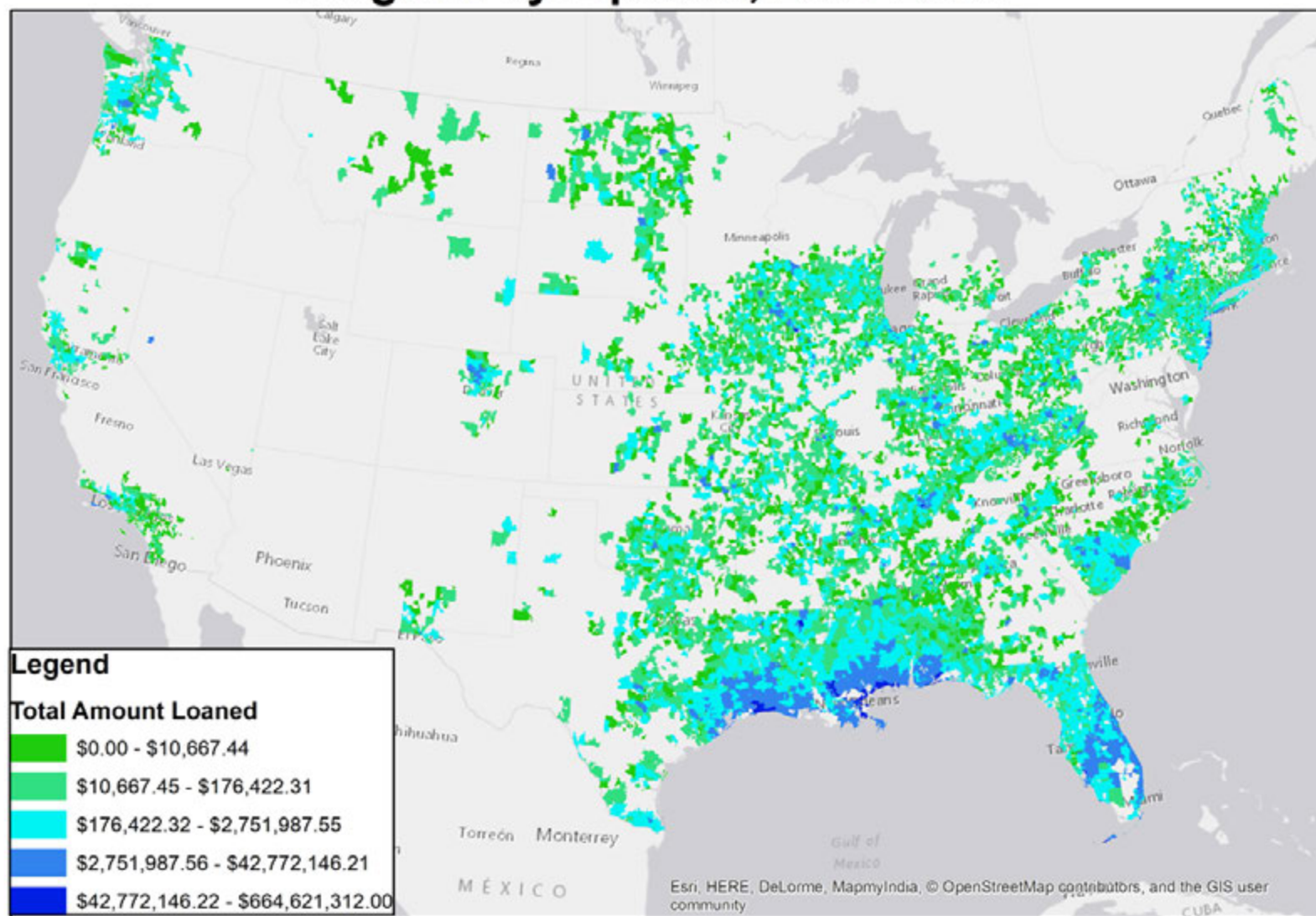








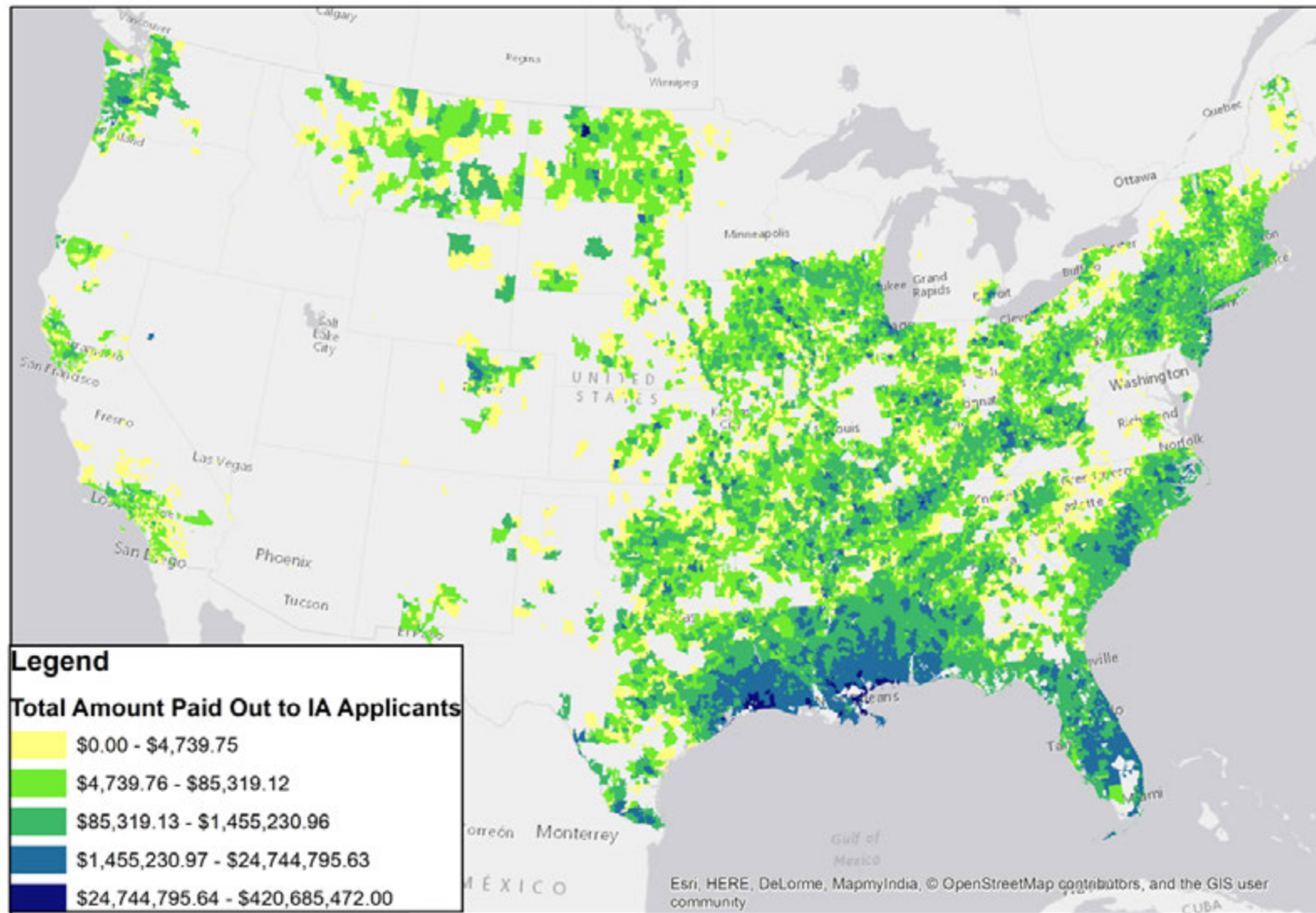
Total Loaned Amount in SBA Disaster Loan Program by Zipcode, 2004-2016



Urban Area Name	Total Number SBA Loans 2004-2016
New York--Newark, NY--NJ--CT Urbanized Area	3666
Miami, FL Urbanized Area	1805
Houston, TX Urbanized Area	1295
Chicago, IL--IN Urbanized Area	1175
New Orleans, LA Urbanized Area	997
Tampa--St. Petersburg, FL Urbanized Area	682
Boston, MA--NH--RI Urbanized Area	574
Philadelphia, PA--NJ--DE--MD Urbanized Area	535
Baton Rouge, LA Urbanized Area	505
Orlando, FL Urbanized Area	495
Detroit, MI Urbanized Area	459
Atlanta, GA Urbanized Area	391
Los Angeles--Long Beach--Anaheim, CA Urbanized Area	372
Palm Bay--Melbourne, FL Urbanized Area	333
Port St. Lucie, FL Urbanized Area	328
Mobile, AL Urbanized Area	298
Palm Coast--Daytona Beach--Port Orange, FL Urbanized Area	286
Jacksonville, FL Urbanized Area	274
Pittsburgh, PA Urbanized Area	265
Seattle, WA Urbanized Area	258

Urban Area Name	SBA Total Amount Loaned 2004-2016
New Orleans, LA Urbanized Area	\$5,420,000,000.00
New York--Newark, NY--NJ--CT Urbanized Area	\$2,390,000,000.00
Gulfport, MS Urbanized Area	\$1,810,000,000.00
Baton Rouge, LA Urbanized Area	\$1,220,000,000.00
Miami, FL Urbanized Area	\$869,000,000.00
Slidell, LA Urbanized Area	\$545,000,000.00
Pensacola, FL--AL Urbanized Area	\$496,000,000.00
Houston, TX Urbanized Area	\$399,000,000.00
Pascagoula, MS Urbanized Area	\$312,000,000.00
Port Arthur, TX Urbanized Area	\$249,000,000.00
Lake Charles, LA Urbanized Area	\$211,000,000.00
Chicago, IL--IN Urbanized Area	\$199,000,000.00
Buras, LA Urban Cluster	\$189,000,000.00
North Port--Port Charlotte, FL Urbanized Area	\$178,000,000.00
Fort Walton Beach--Navarre--Wright, FL Urbanized Area	\$169,000,000.00
Mandeville--Covington, LA Urbanized Area	\$159,000,000.00
Port St. Lucie, FL Urbanized Area	\$151,000,000.00
Mobile, AL Urbanized Area	\$149,000,000.00
Nashville-Davidson, TN Urbanized Area	\$147,000,000.00
Beaumont, TX Urbanized Area	\$146,000,000.00

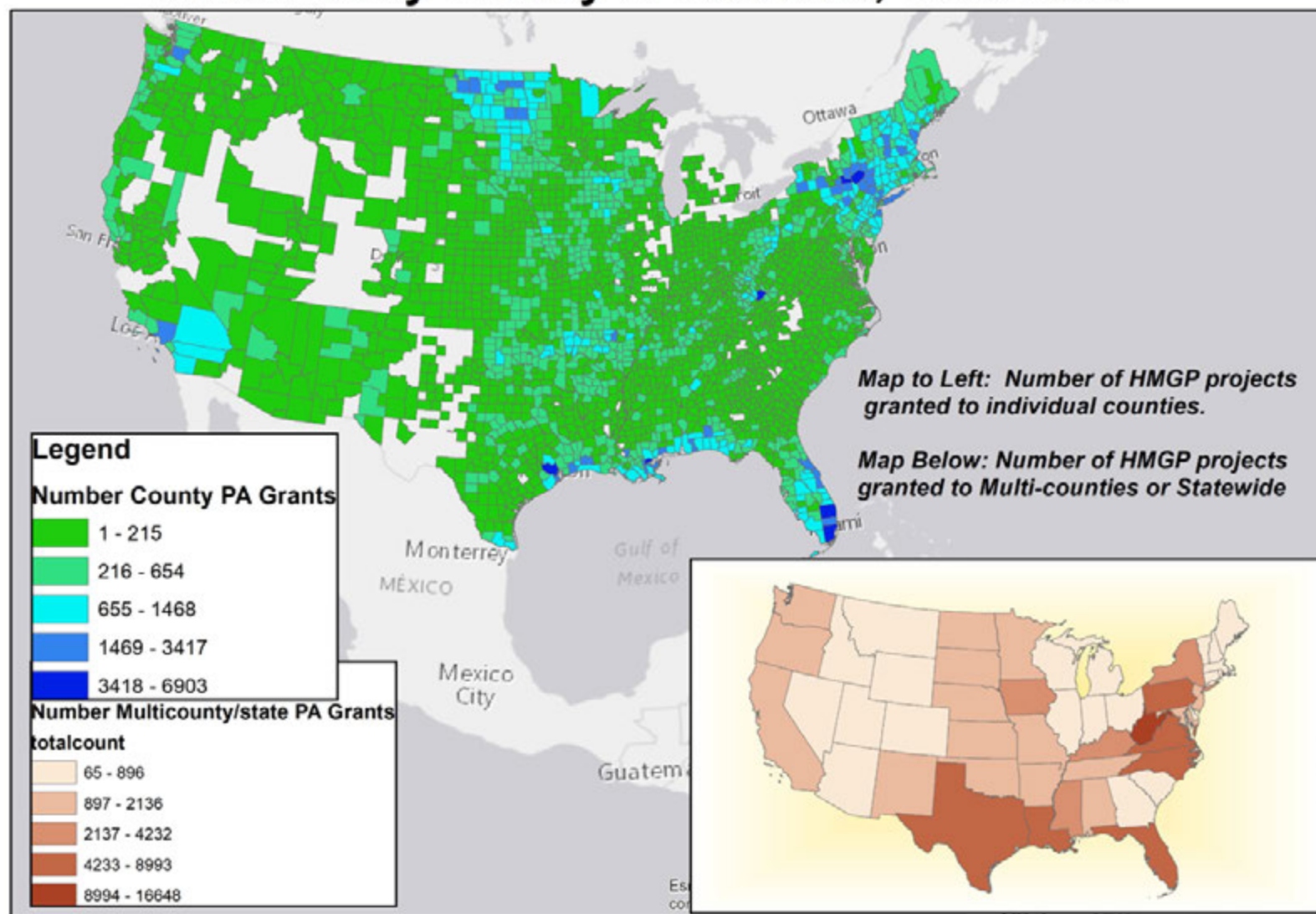
Total Amount Paid Out to FEMA Individual Assistance Applications by Zipcode, 2004-2016



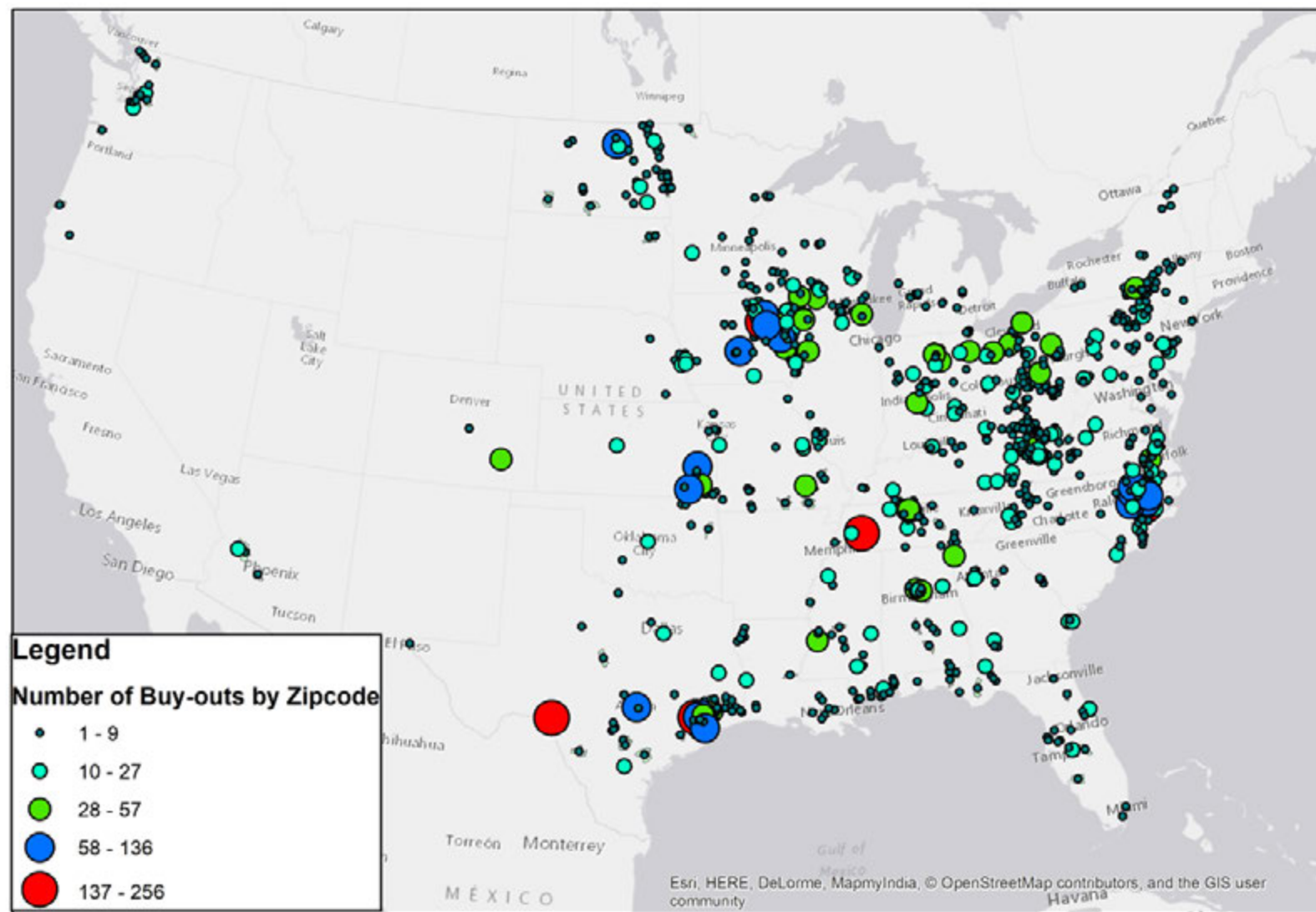
Urban Area Name	Number Approved IHP Applications 2004-2017
New York--Newark, NY--NJ--CT Urbanized Area	3666
Miami, FL Urbanized Area	1805
Houston, TX Urbanized Area	1295
Chicago, IL--IN Urbanized Area	1175
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Mobile, AL Urbanized Area	\$149,000,000.00
Nashville-Davidson, TN Urbanized Area	\$147,000,000.00
Beaumont, TX Urbanized Area	\$146,000,000.00

Total Number of FEMA Public Assistance Grants Awarded by County or Statwide, 1998-2016



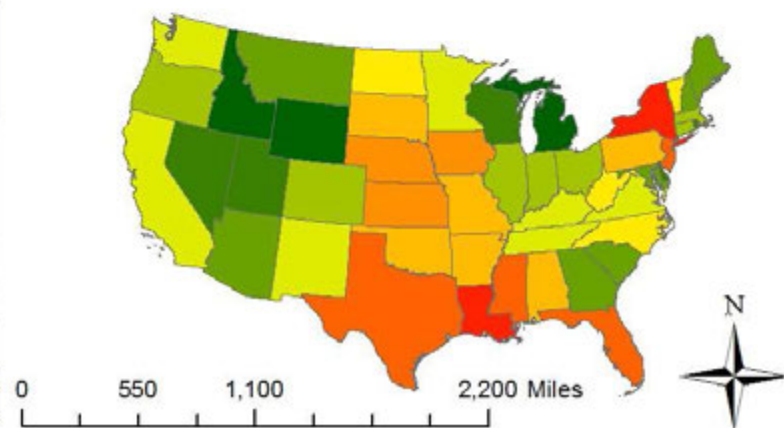
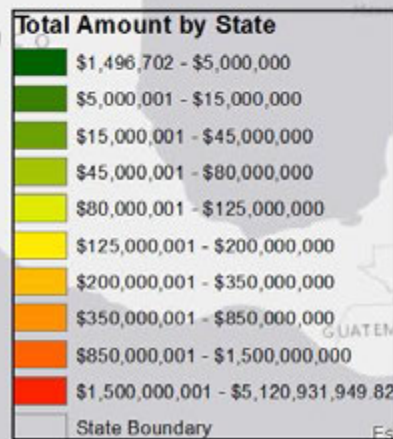
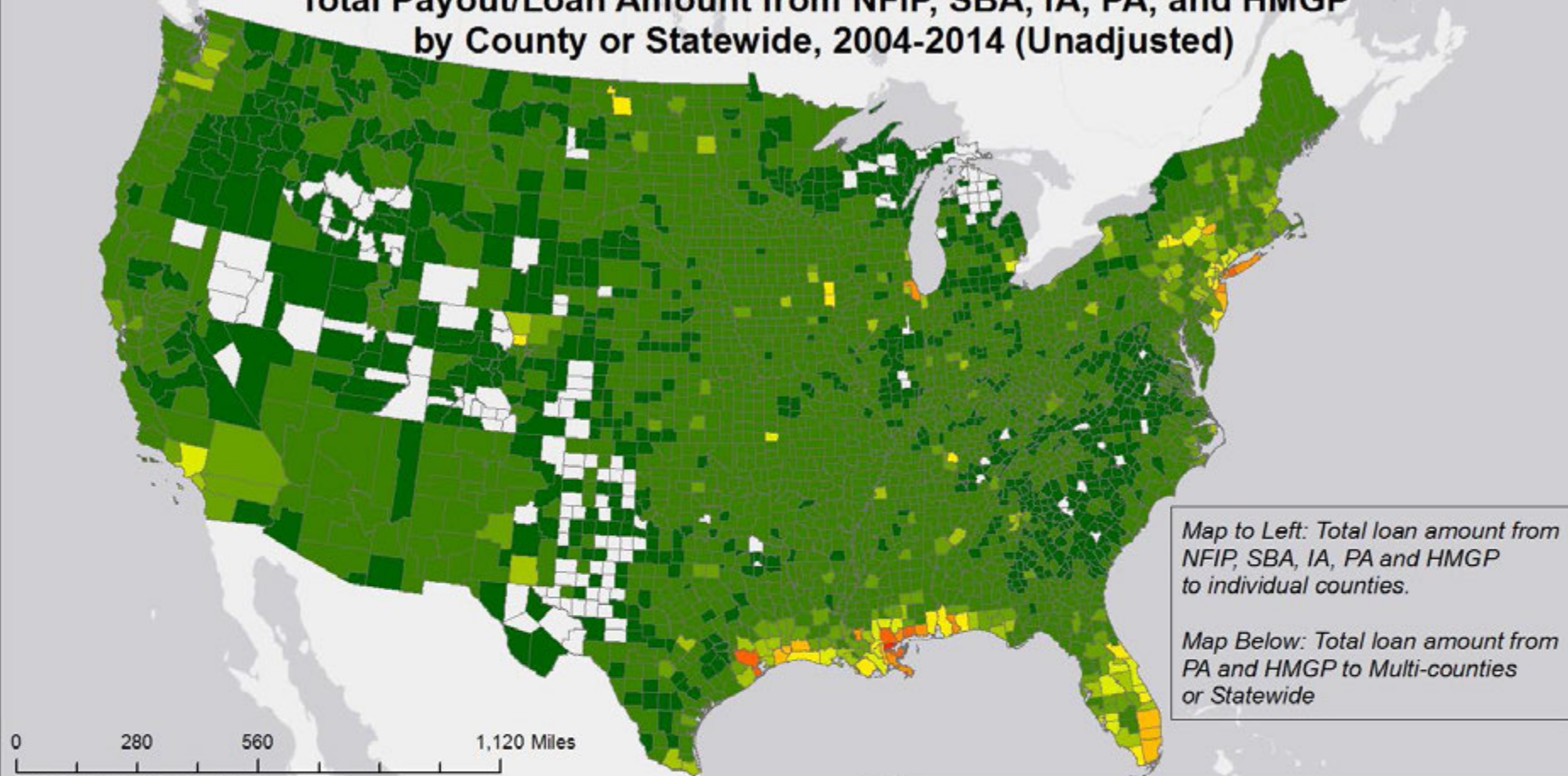
Number of Buy-outs in FEMA HMGP by Zipcode, 1998-2013



Urban Area Name	Total Number Buyouts 1998-2013
Houston, TX Urbanized Area	1189
Kinston, NC Urban Cluster	318
Waterloo, IA Urbanized Area	298
Greenville, NC Urbanized Area	254
Nashville-Davidson, TN Urbanized Area	167
Jackson, TN Urbanized Area	166
Rocky Mount, NC Urbanized Area	166
Del Rio, TX Urban Cluster	163
Goldsboro, NC Urbanized Area	149
Birmingham, AL Urbanized Area	132
Austin, TX Urbanized Area	124
Des Moines, IA Urbanized Area	99
Cedar Rapids, IA Urbanized Area	99
Grifton, NC Urban Cluster	96
Binghamton, NY--PA Urbanized Area	92
Independence, KS Urban Cluster	89
Pittsburgh, PA Urbanized Area	87
Waverly, IA Urban Cluster	78
Philadelphia, PA--NJ--DE--MD Urbanized Area	77
Wilson, NC Urban Cluster	77

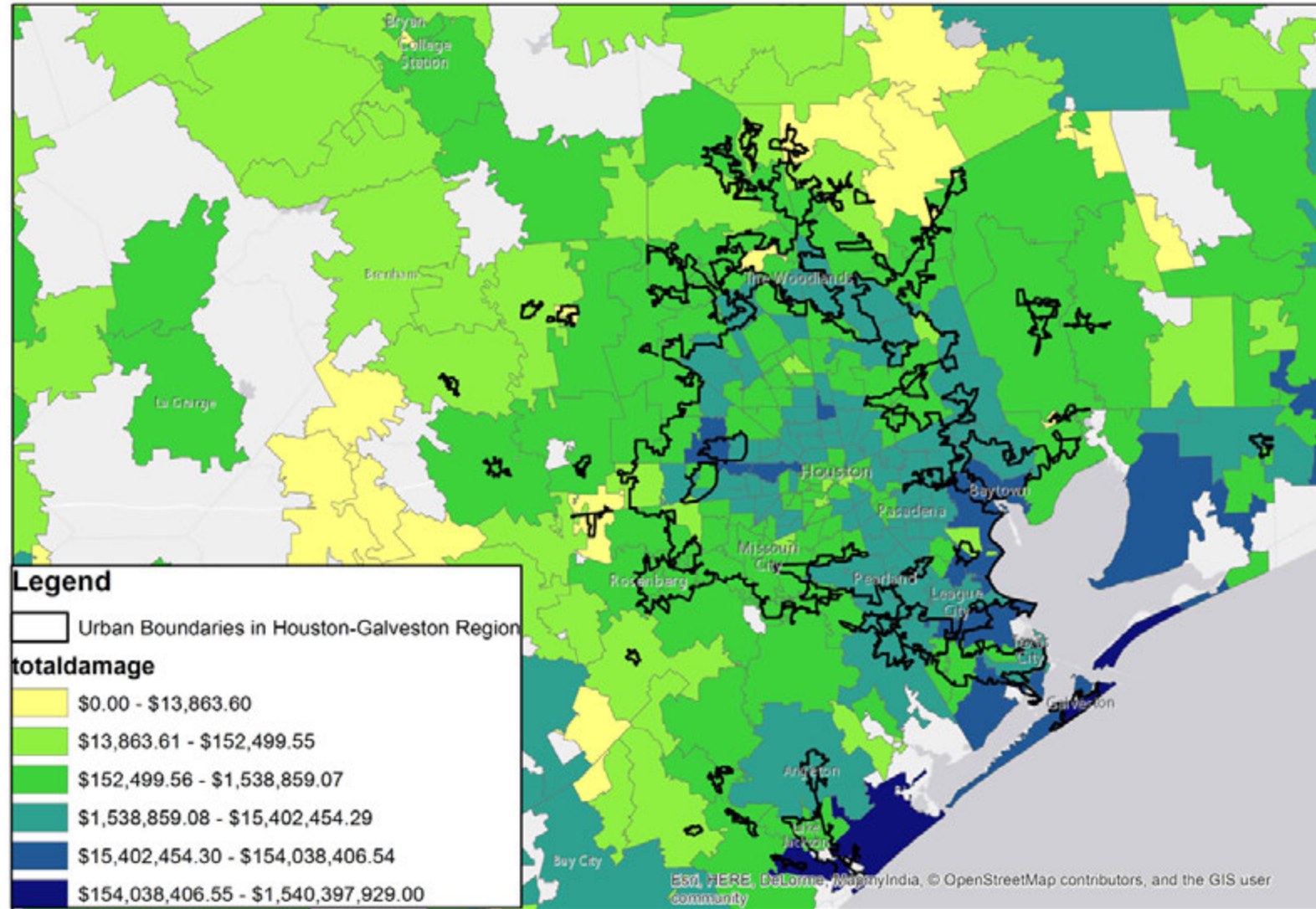
Urban Area Name	Total Cost of Buyouts 1998-2013
Houston, TX Urbanized Area	\$88,900,000.00
Nashville-Davidson, TN Urbanized Area	\$20,800,000.00
Waterloo, IA Urbanized Area	\$16,100,000.00
Greenville, NC Urbanized Area	\$15,600,000.00
Iowa City, IA Urbanized Area	\$12,300,000.00
Rocky Mount, NC Urbanized Area	\$10,200,000.00
Philadelphia, PA--NJ--DE--MD Urbanized Area	\$9,250,657.00
Kinston, NC Urban Cluster	\$9,138,473.00
Austin, TX Urbanized Area	\$7,819,530.00
Birmingham, AL Urbanized Area	\$7,703,719.00
Goldsboro, NC Urbanized Area	\$7,196,336.00
Binghamton, NY--PA Urbanized Area	\$5,979,939.00
Des Moines, IA Urbanized Area	\$5,974,909.00
Pittsburgh, PA Urbanized Area	\$5,760,471.00
Del Rio, TX Urban Cluster	\$5,145,655.00
Seattle, WA Urbanized Area	\$4,987,729.00
Waverly, IA Urban Cluster	\$4,960,425.00
Wilson, NC Urban Cluster	\$4,883,629.00
Round Lake Beach--McHenry--Grayslake, IL--WI Urbanized Area	\$4,765,048.00
Omaha, NE--IA Urbanized Area	\$4,714,909.00

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

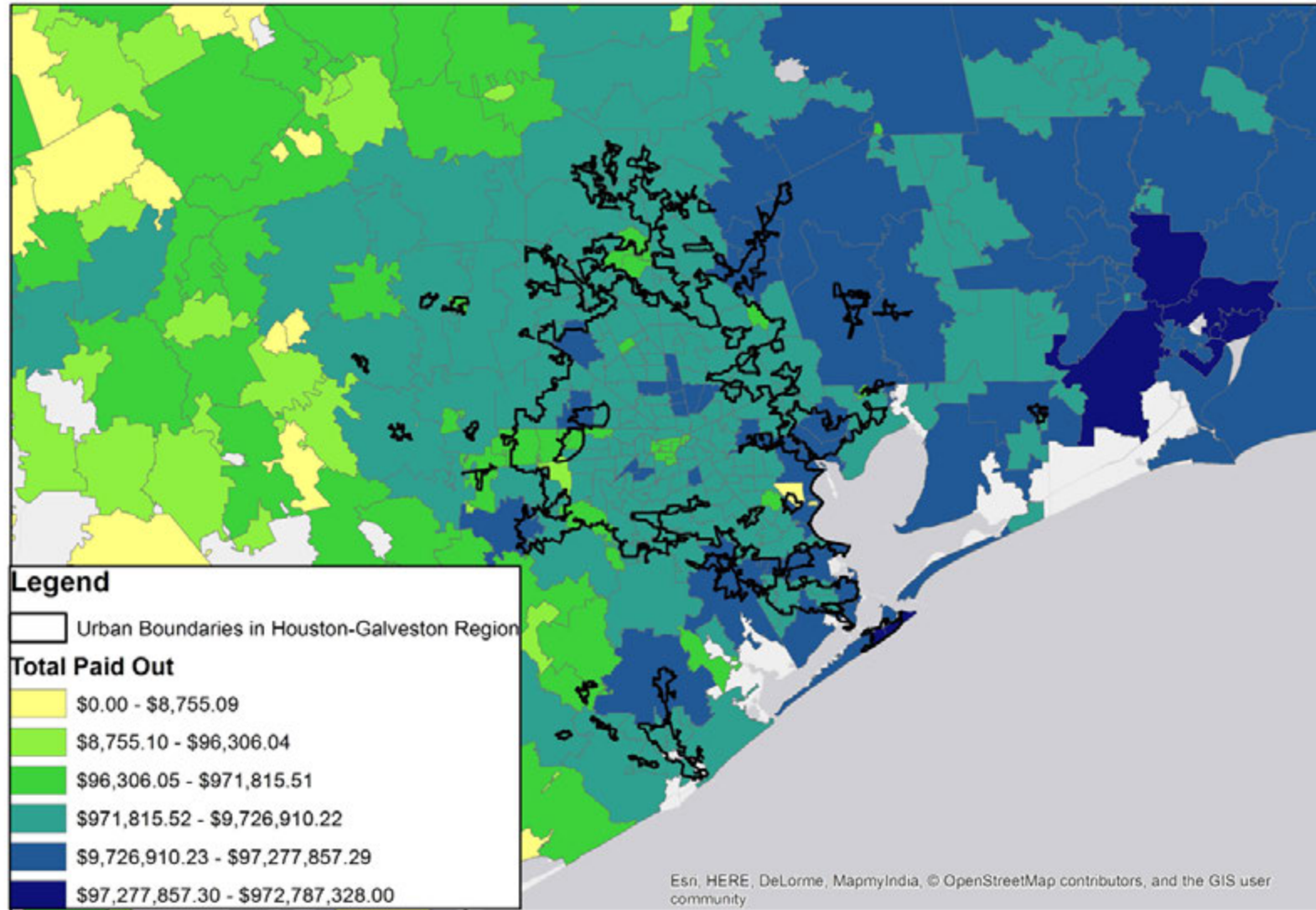


County	State	Total Payout/Loan Amount
New York	New York	\$9,505,975,452.30
Orleans	Louisiana	\$8,820,351,309.00
Nassau	New York	\$4,858,218,720.59
Harrison	Mississippi	\$3,703,811,733.30
Harris	Texas	\$3,401,099,037.48
St. Tammany	Louisiana	\$3,371,262,263.13
St. Bernard	Louisiana	\$3,288,060,580.69
Galveston	Texas	\$3,052,597,549.50
Queens	New York	\$2,437,167,329.50
Plaquemines	Louisiana	\$2,022,090,084.80
Hancock	Mississippi	\$1,939,542,713.48
East Baton Rouge	Louisiana	\$1,914,549,217.06
Jackson	Mississippi	\$1,767,477,620.18
Cook	Illinois	\$1,707,853,674.60
Escambia	Florida	\$1,690,126,868.46
Monmouth	New Jersey	\$1,503,382,722.00
Suffolk	New York	\$1,502,861,880.60
Jefferson	Texas	\$1,441,447,485.00
Miami-Dade	Florida	\$1,381,758,734.50
Greene	New York	\$1,159,066,461.42

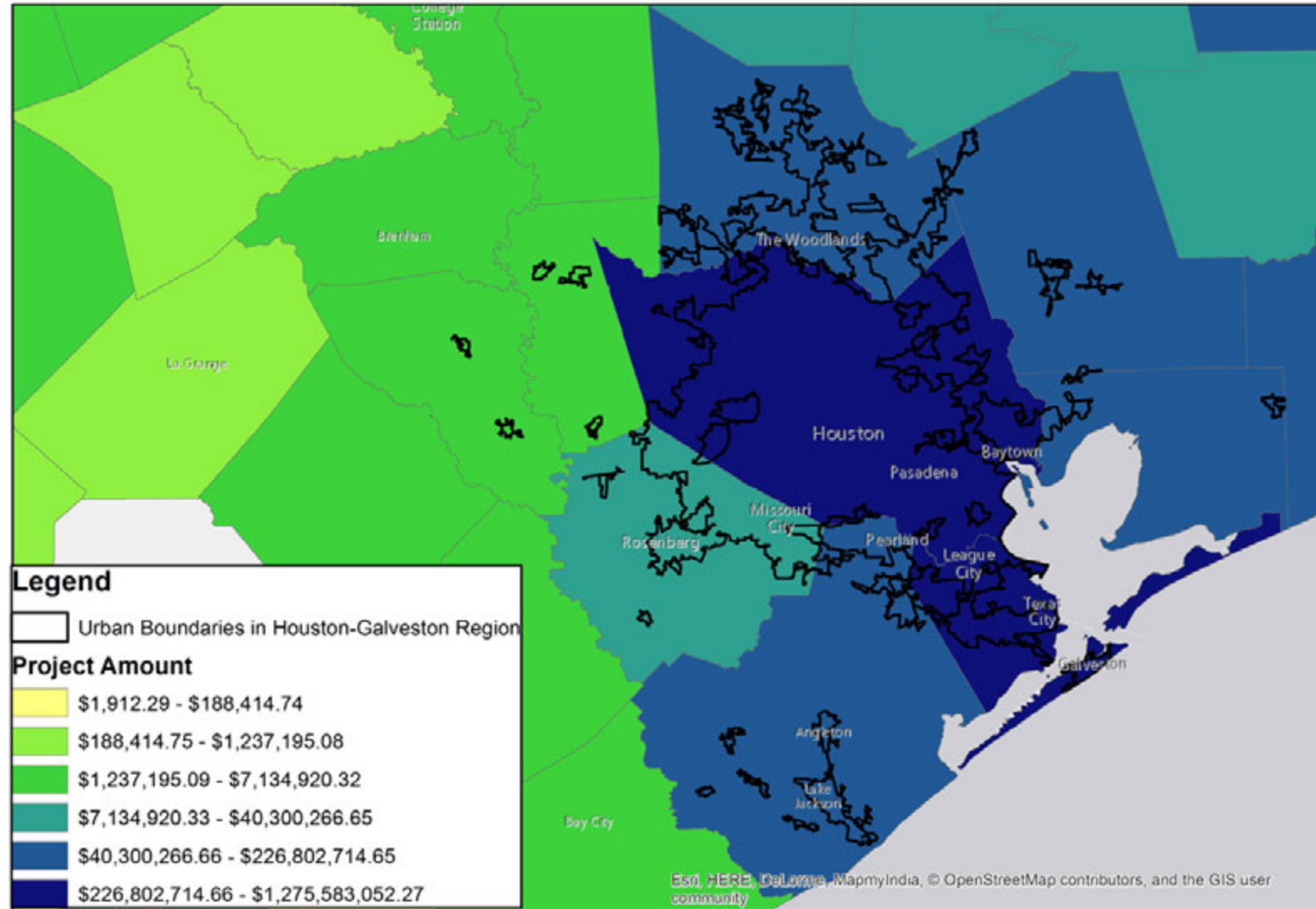
FEMA National Flood Insurance Program Damage Estimates in Houston/Galveston Region by Zipcode, 2004-2014



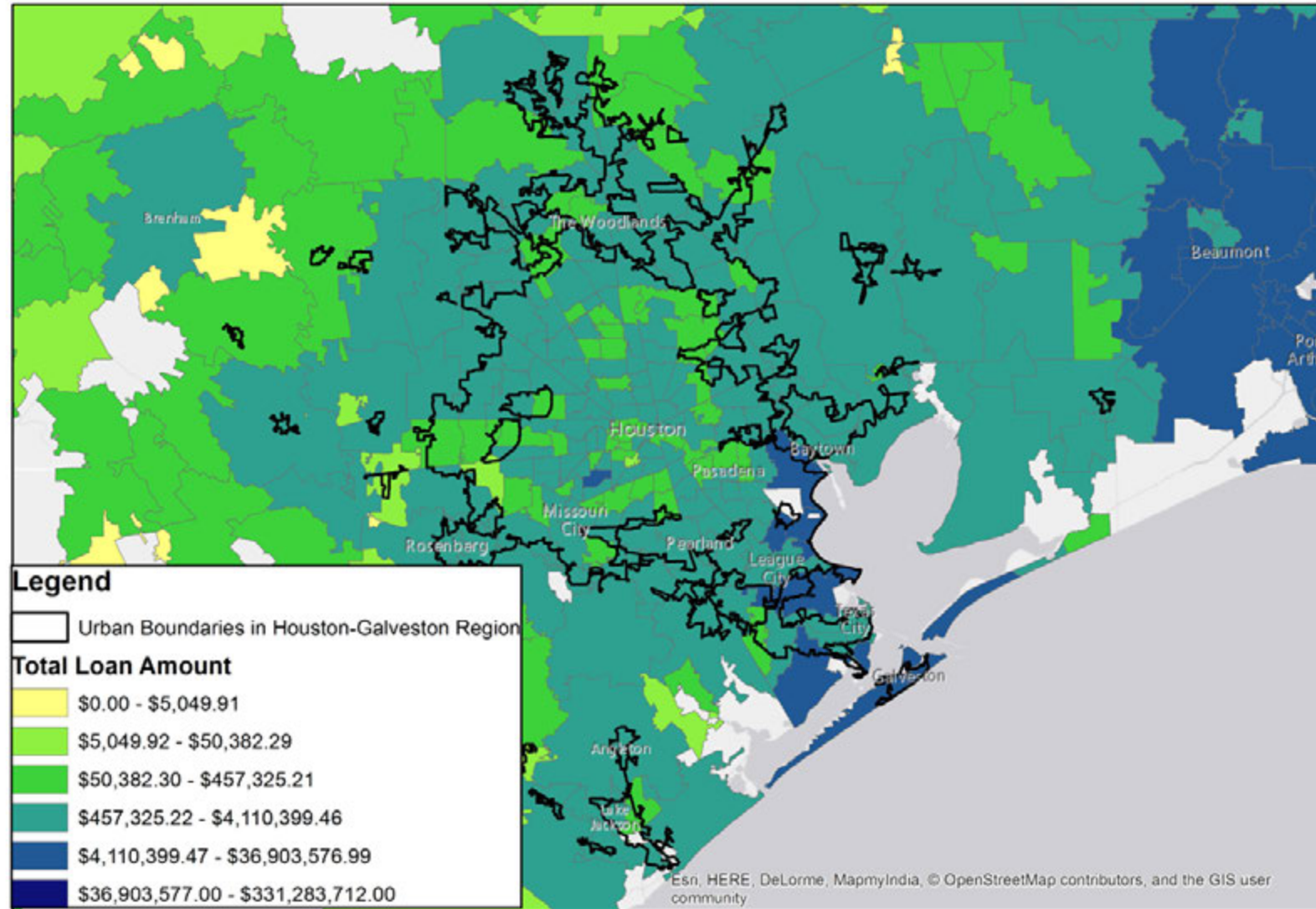
FEMA Individual Assistance (Owner and Renter) Dollars Paid Out in Houston-Galveston Region by Zipcode, 2004-2017



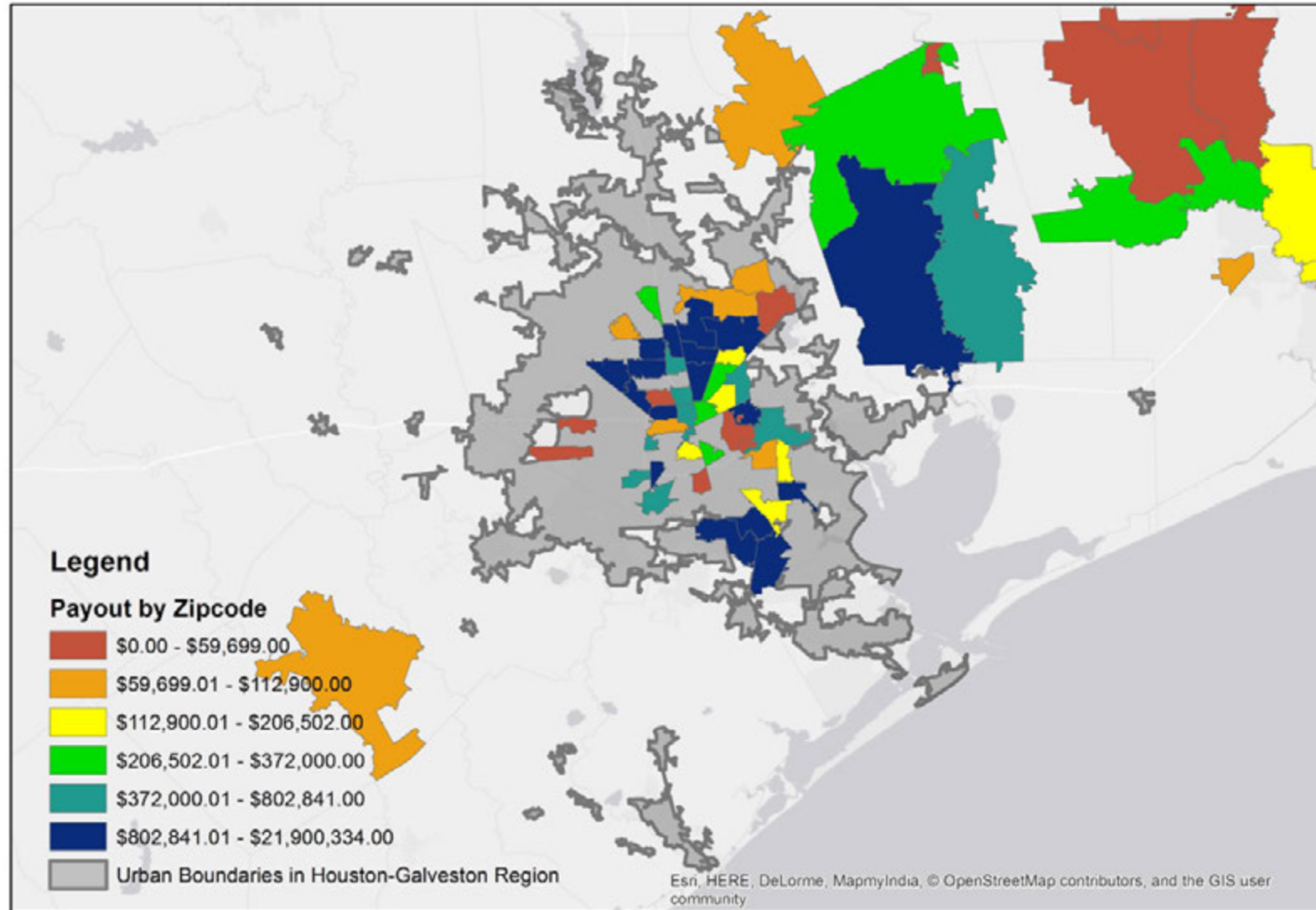
FEMA Public Assistance Program Payout in Houston/Galveston Region by County, 2004-2017



Small Business Administration (Individual and Business) Loan Amount in Houston/Galveston Region by Zipcode, 2004-2017



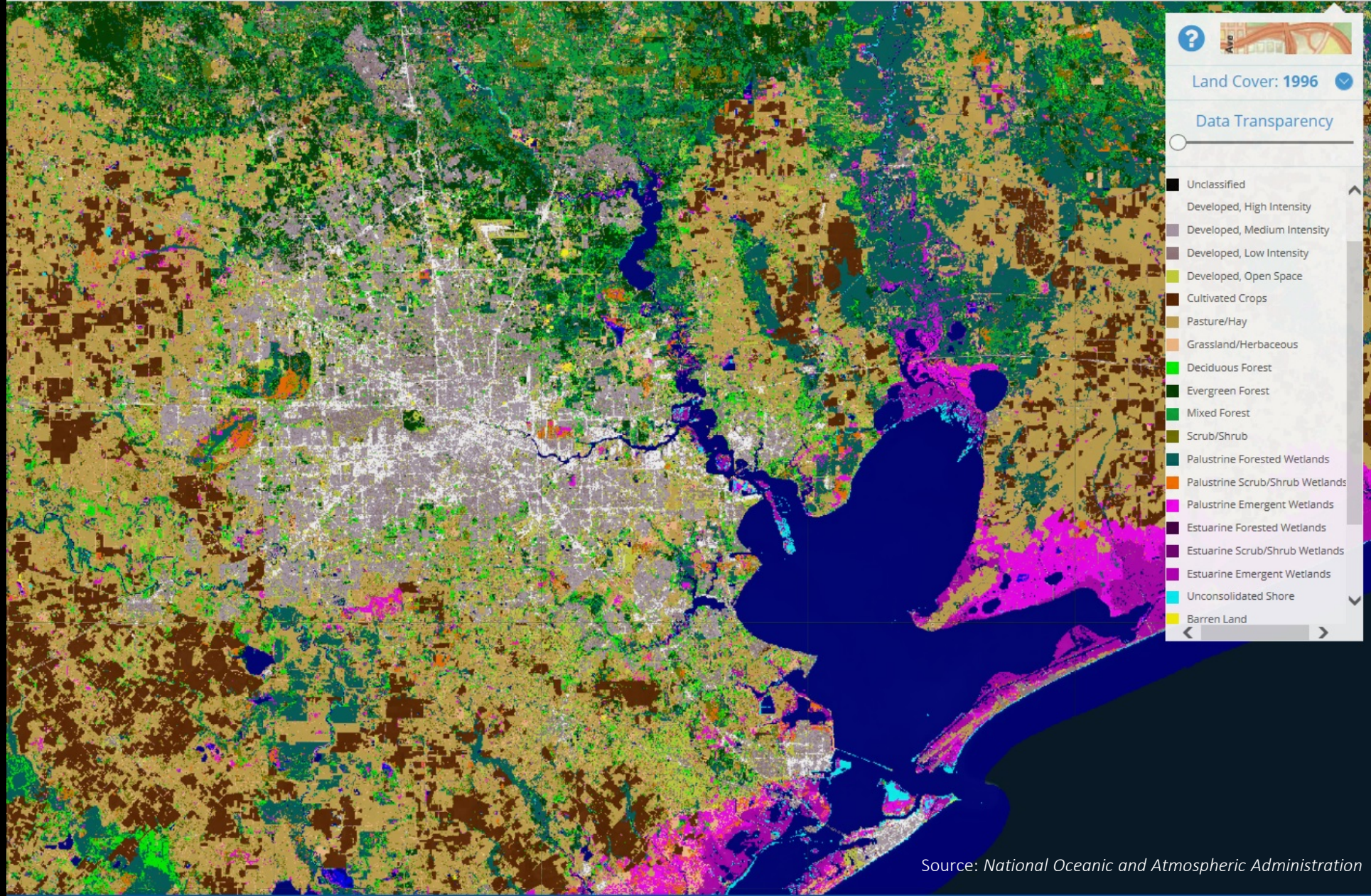
FEMA HMGP Buy-out Program Amount Paid in Houston-Galveston Region by Zipcode, 1999-2017



MAJOR TRIGGERS OF URBAN FLOOD LOSS

LAND USE CHANGE

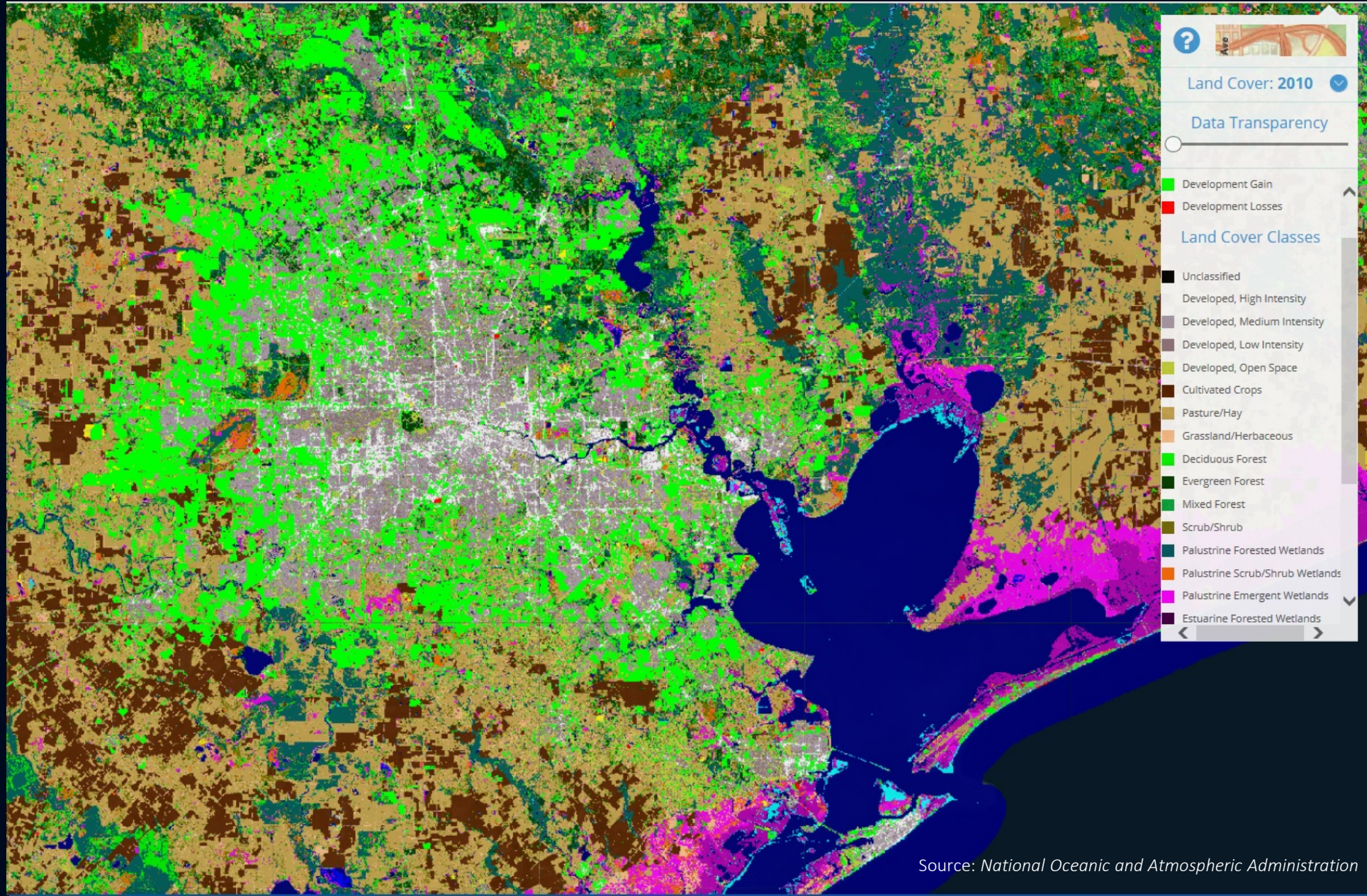
HOUSTON AREA 1996 LAND COVER



Source: National Oceanic and Atmospheric Administration

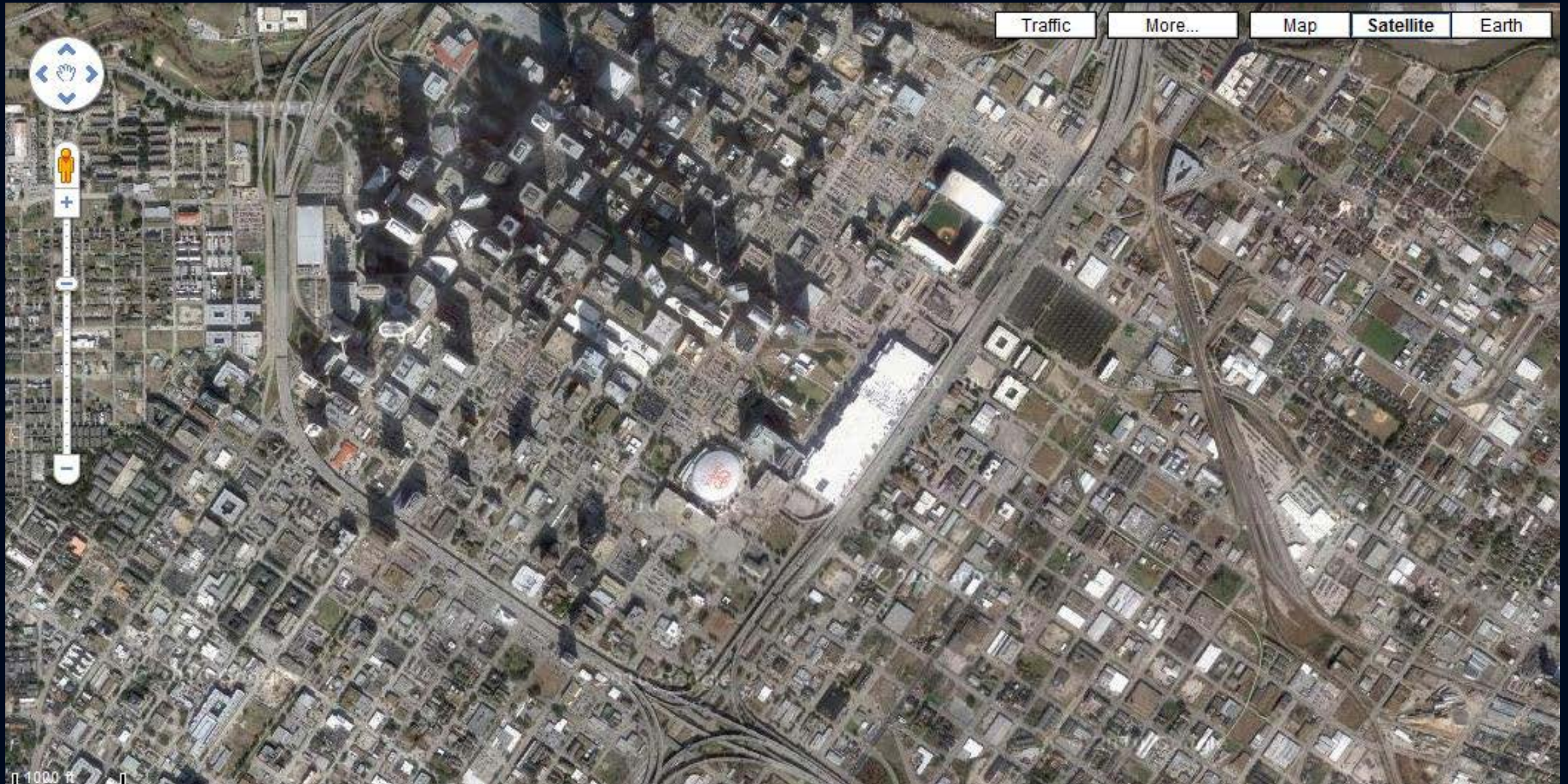
LAND USE CHANGE

HOUSTON AREA DEVELOPMENT CHANGE 2011

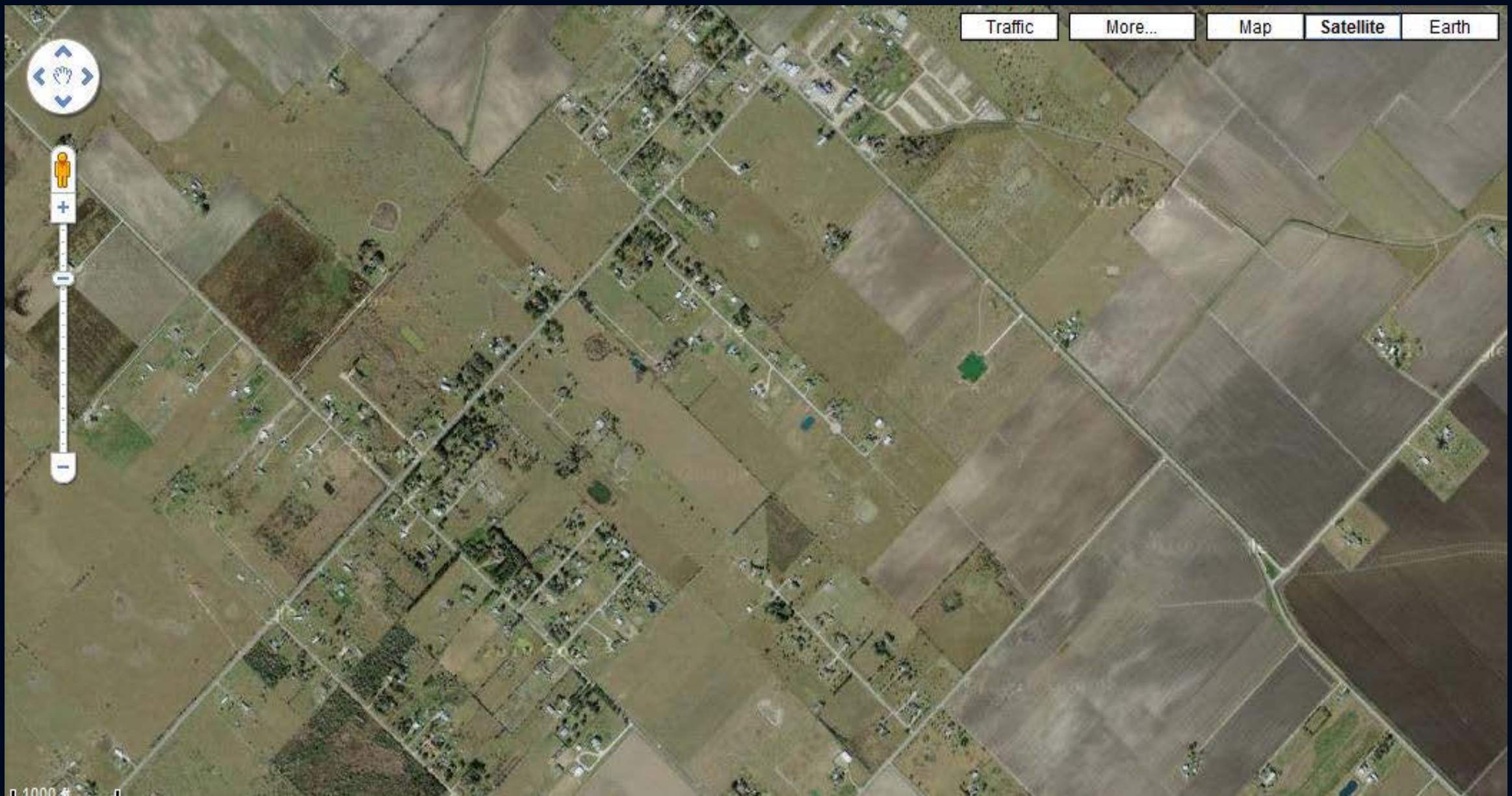


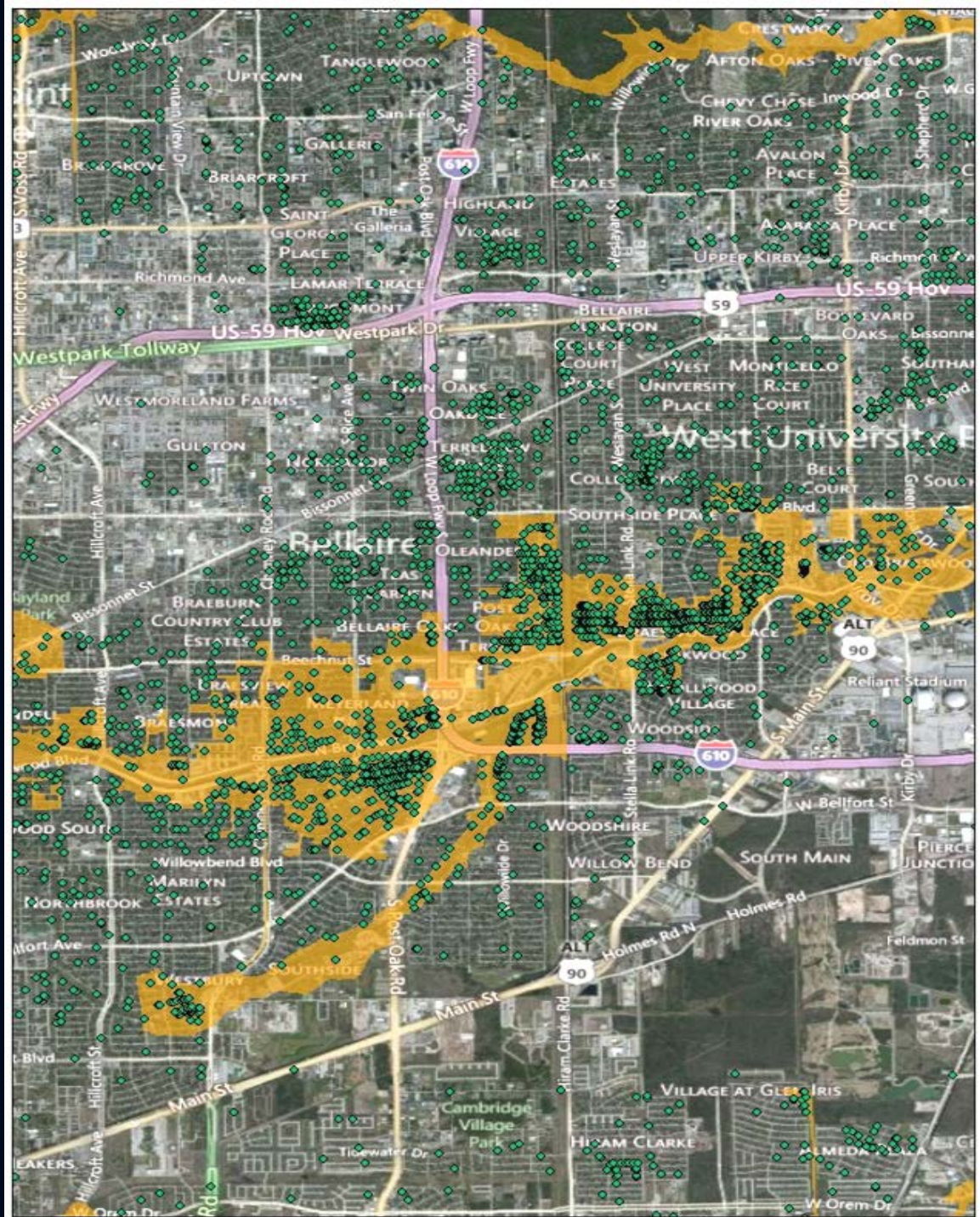
Source: National Oceanic and Atmospheric Administration

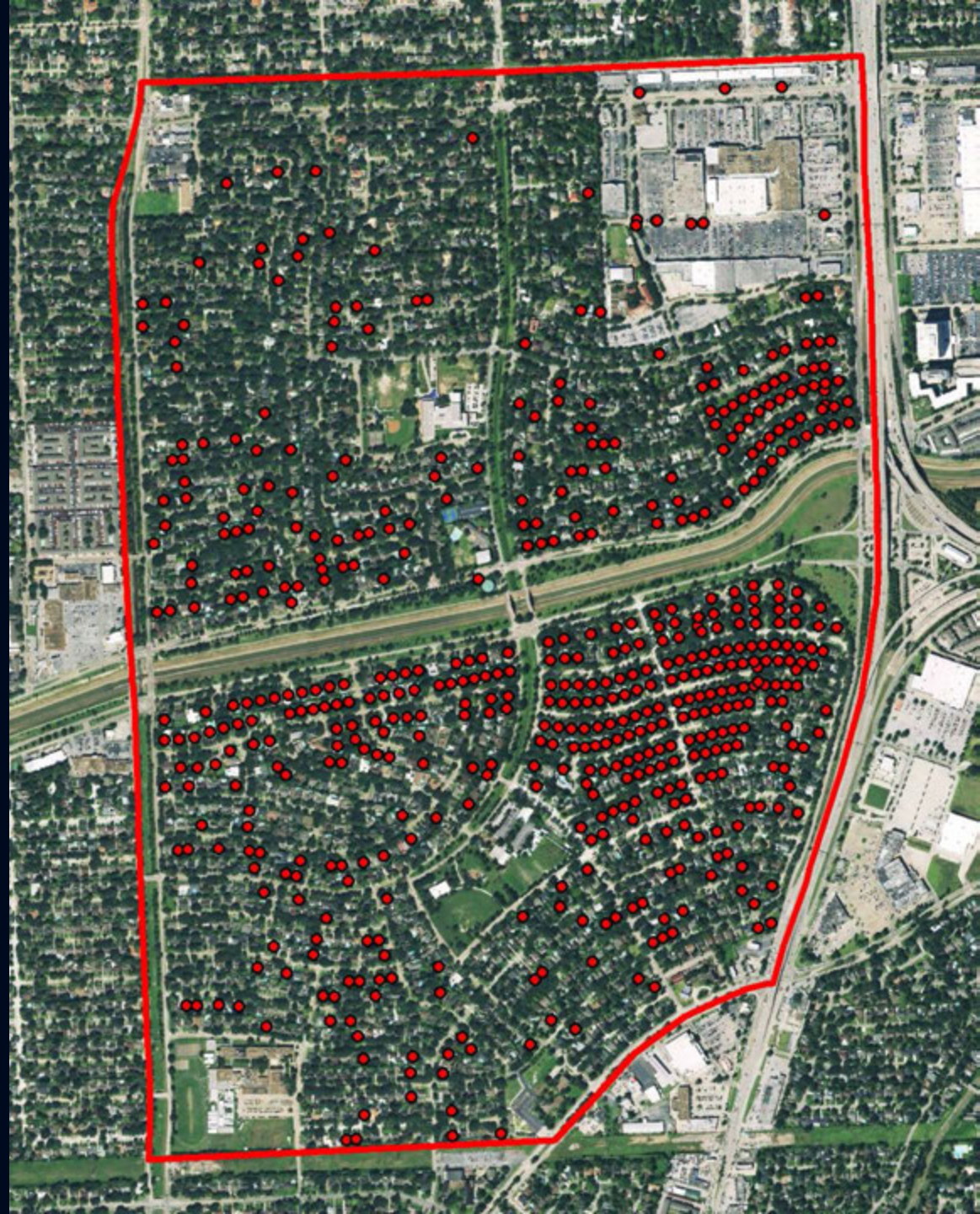
HIGH-INTENSITY DEVELOPMENT PATTERN



LOW-INTENSITY DEVELOPMENT PATTERN







CHANGING FLOODPLAIN BOUNDARIES

1979



1982



1985



1987



2000



2016







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WHAT WORKS:

THE COST SAVINGS OF
FLOOD MITIGATION TECHNIQUES

Mitigation Strategies

- *Avoidance*
 - Freeboard, fill, elevate.
 - Acquisition, relocation, protected areas.
 - Setbacks, clustering, TDR, targeted growth.
- *Resistance*
 - Flood walls, levees, dams, flood gates, urban design.
- *Acceptance*
 - Retention/Detention, drainage, cisterns, constructed wetlands.
- *Awareness*
 - Flood risk information, education/training, hazard disclosure.

AVOIDANCE

VERTICAL AVOIDANCE, ELEVATED STRUCTURES



AVOIDANCE

VERTICAL AVOIDANCE, ELEVATED STRUCTURES





AVOIDANCE

VERTICAL AVOIDANCE, ELEVATED STRUCTURES



AVOIDANCE

VERTICAL AVOIDANCE, ELEVATED STRUCTURES



AVOIDANCE

HORIZONTAL AVOIDANCE, OPEN SPACE PROTECTION



AVOIDANCE

HORIZONTAL AVOIDANCE, OPEN SPACE PROTECTION



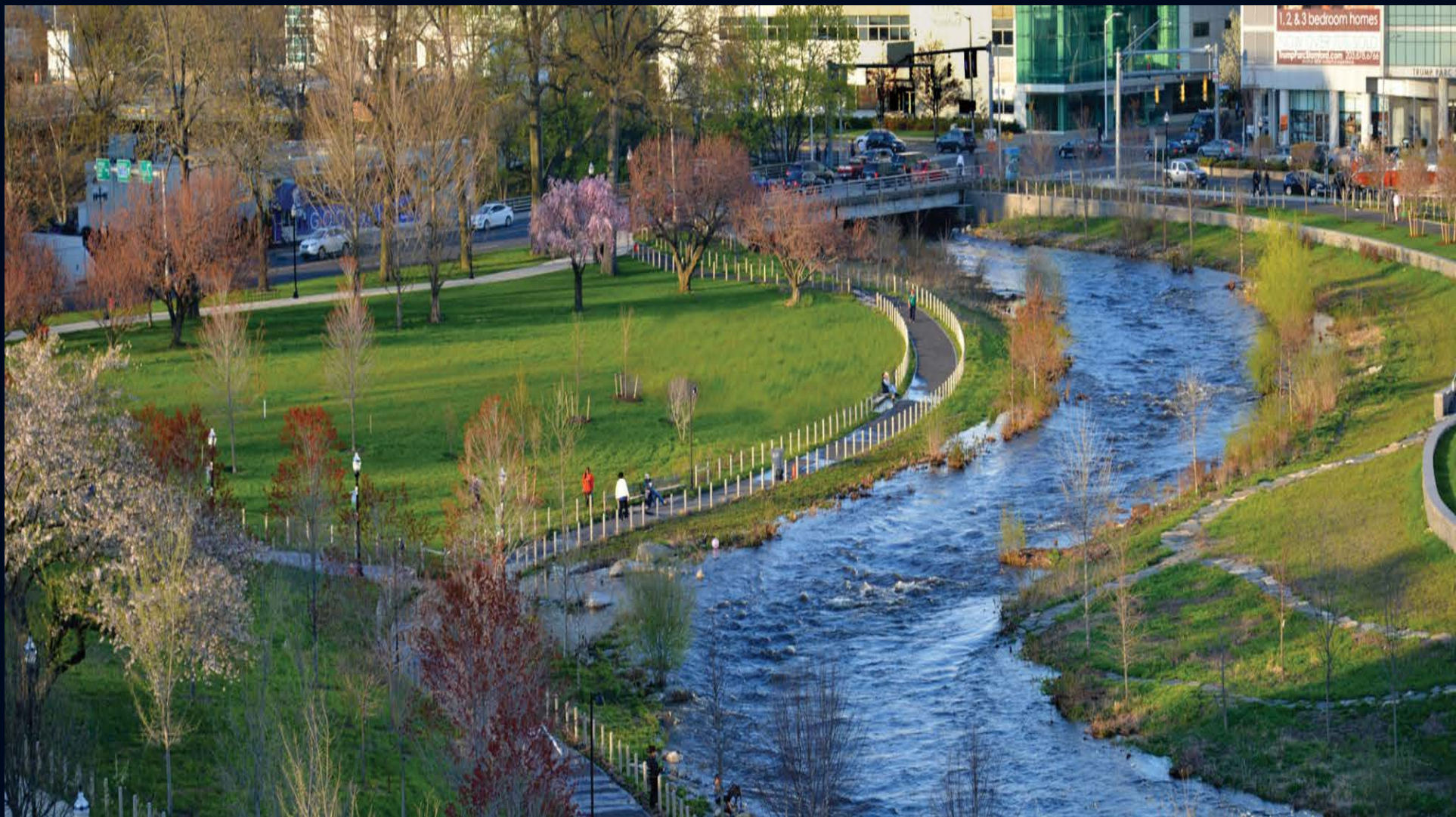
AVOIDANCE

HORIZONTAL AVOIDANCE, OPEN SPACE PROTECTION



AVOIDANCE

HORIZONTAL AVOIDANCE, OPEN SPACE PROTECTION



AVOIDANCE

HORIZONTAL AVOIDANCE, SETBACKS AND BUFFERS













THANK YOU



CTBS

The Center for Texas Beaches and Shores

Dedicated to the protection of the Texas coastal regions and its communities

www.tamug.edu/CTBS