

Observed Flood Extent

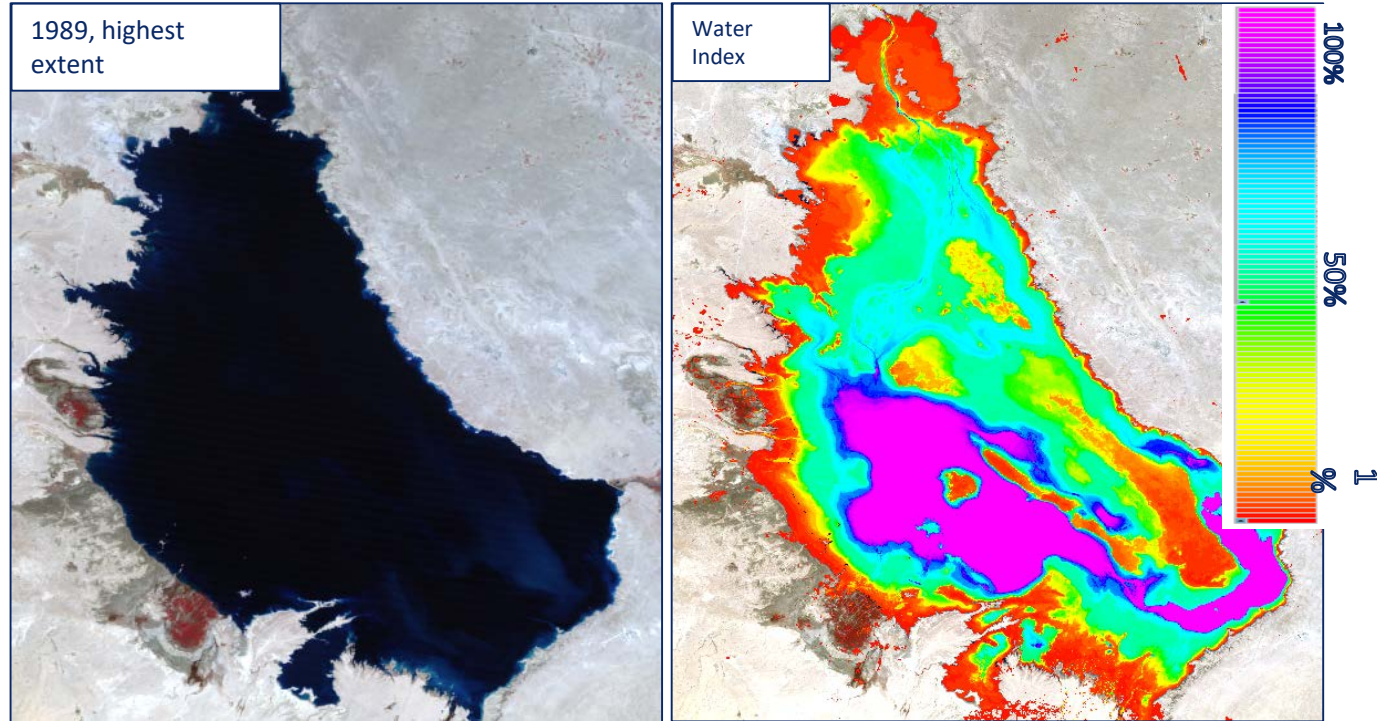
New Urban Flood Risk – DHS Science & Technology Research Study

Catherine Ipsan, Project Manager

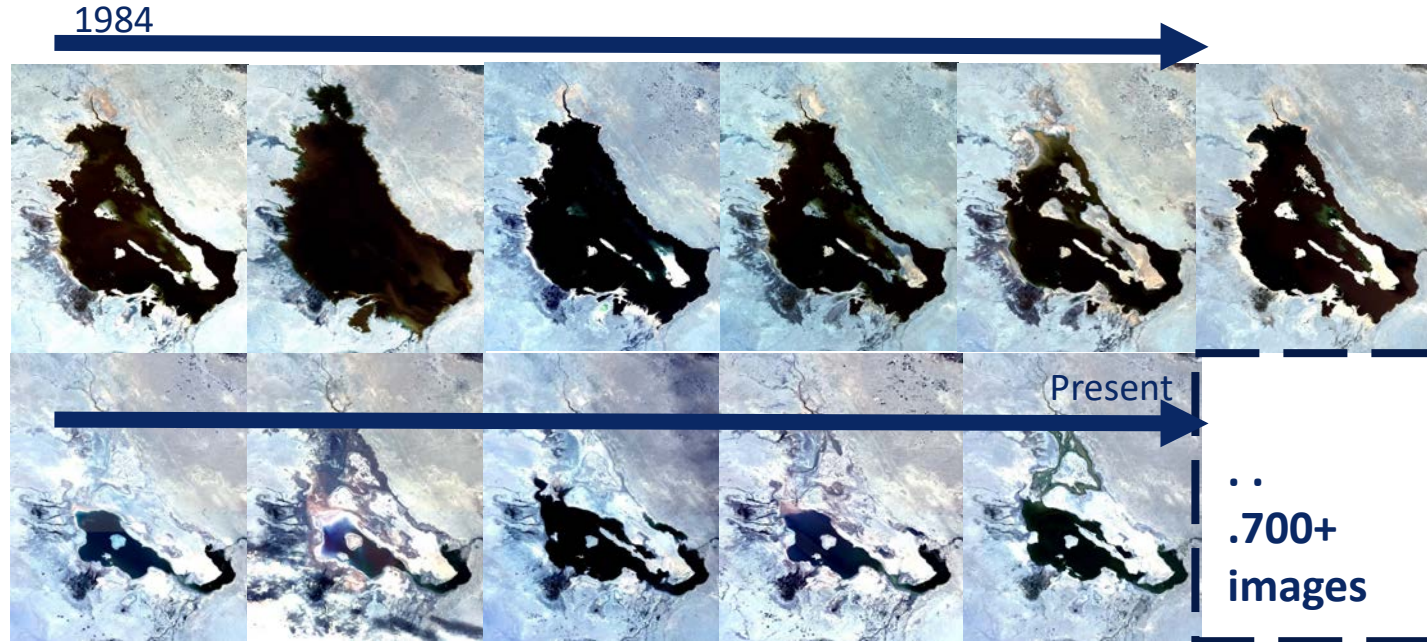
Mihir Datta Chaudhuri, Imagery Scientist

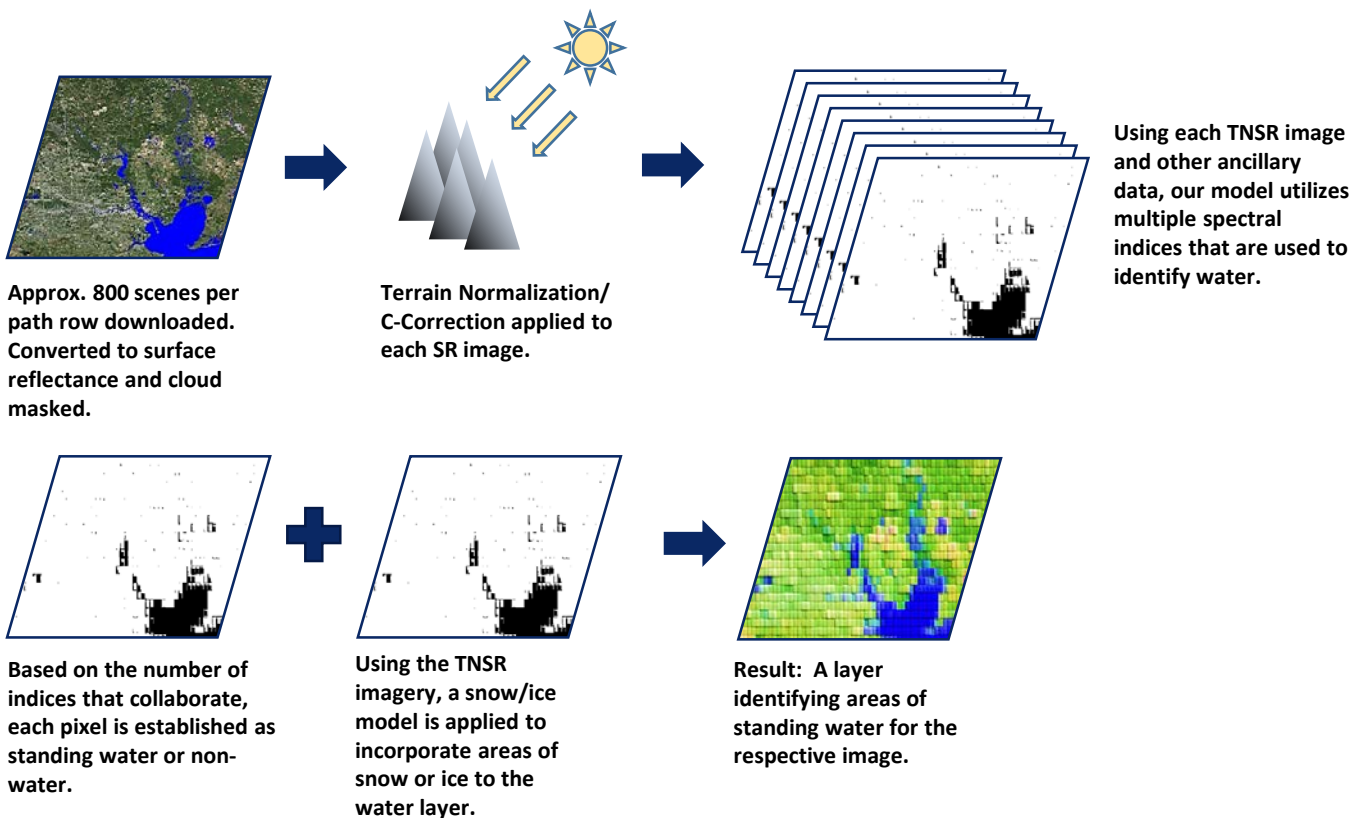
- The New Urban Flood Risk study was in response to a need from DHS to update flood zones and document flooding prior to construction.
- This study focused on using the frequencies of the detected water in OFE to identify flood prone areas.
- **OBJECTIVE:**
 - To use OFE to identify urban outside the SFHA that was built on land that flooded pre development and to calculate the economic impact on these areas using NFIP flood insurance claims.
 1. Mapping historical flood extents, Observed Flood Extent (OFE)
 2. Identifying New Construction at Risk of Flooding (NCRF)
 3. Identifying Flood Post New Construction (FPNC)
 4. Detecting dates of flood events

Capturing Water Extents

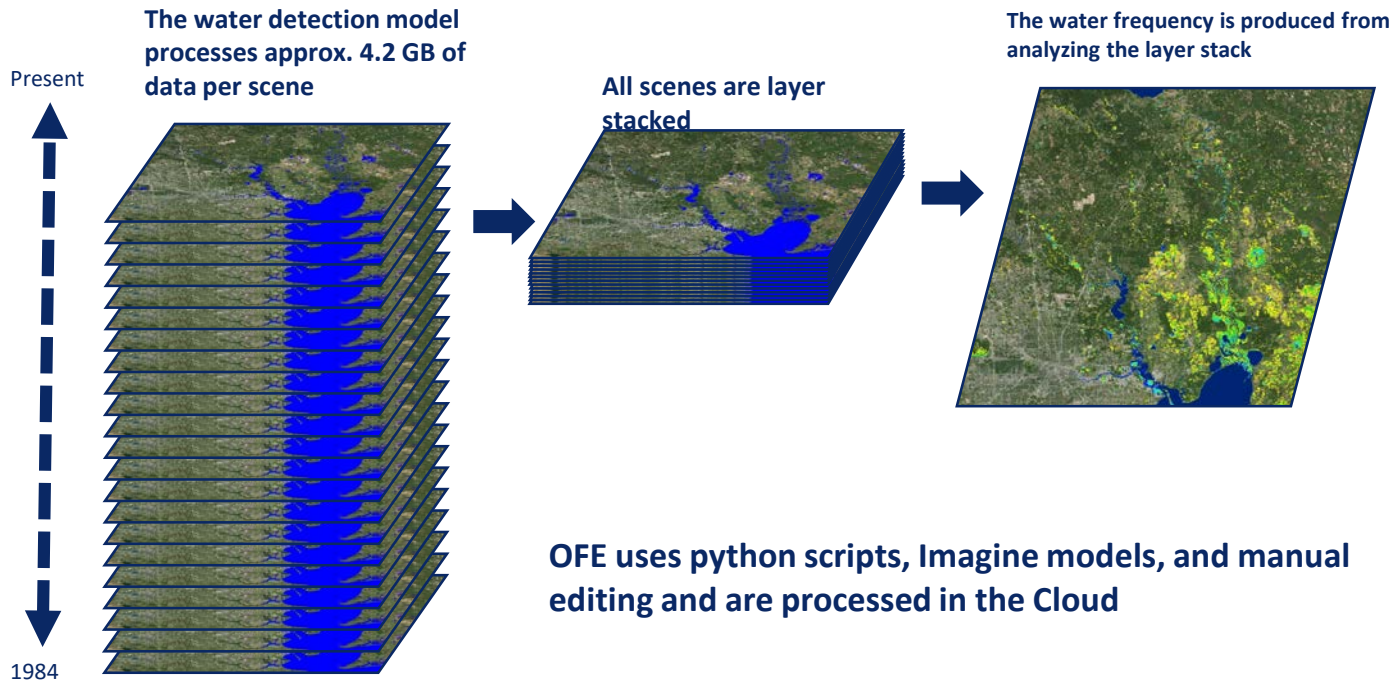


Lake Razzaza has changed significantly over the past 33 years:

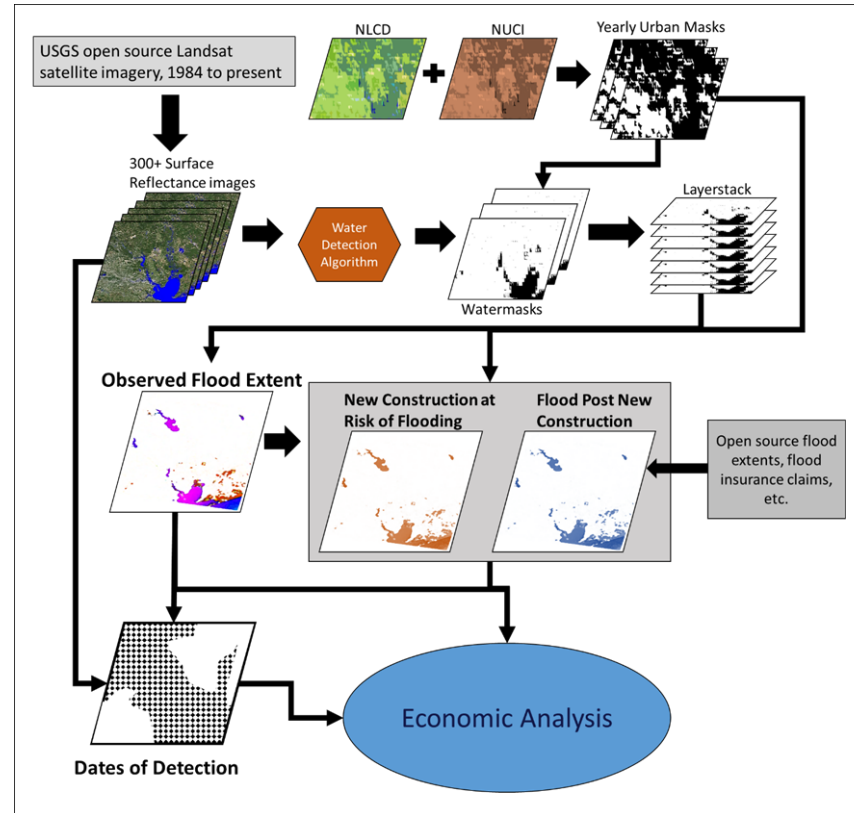




Radiant's water detection algorithm analyzes 30m Landsat imagery and processes up to 800 scenes per path row:

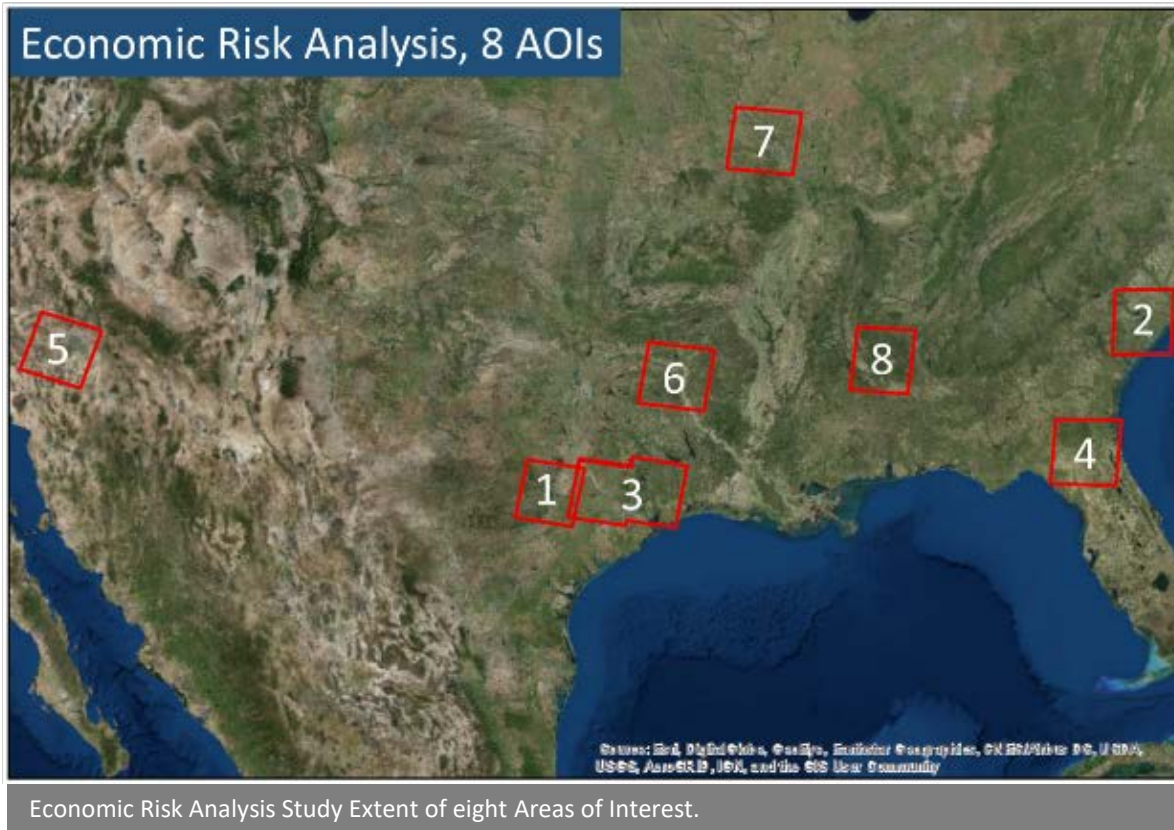


Methodology Workflow – New Urban Flood Risk



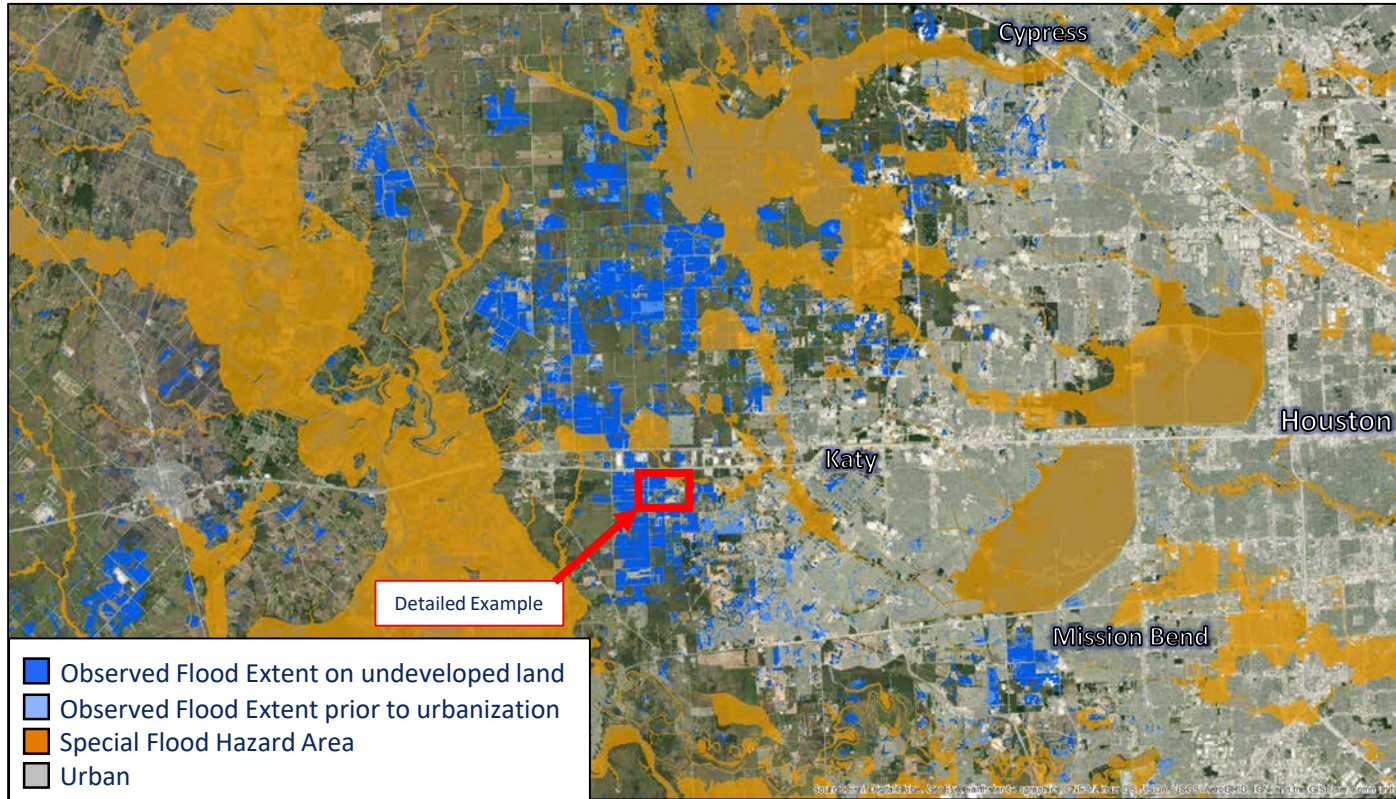
Spatial and Economic Priority

1. Austin, TX
2. Charleston, SC
3. Houston, TX
4. Jacksonville, FL
5. Phoenix, AZ
6. Shreveport, LA
7. St. Louis, MO
8. Tuscaloosa, AL



- <https://www.youtube.com/watch?v=2aOH0C7YDXM&feature=youtu.be>

Flood Risk on Undeveloped Land in Houston, TX



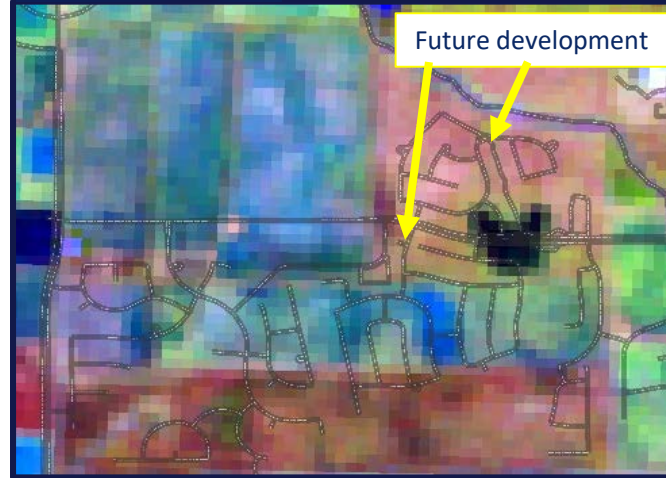
Observed Flooding on Land Prior to Development

In Katy, Texas flooding occurs on undeveloped land in January 1992. Flood waters collect in areas of slight depression and can be seen on Landsat satellite imagery in blues and dark purples. The land is normally dry, as seen in May 2006.

Dry, May 2006

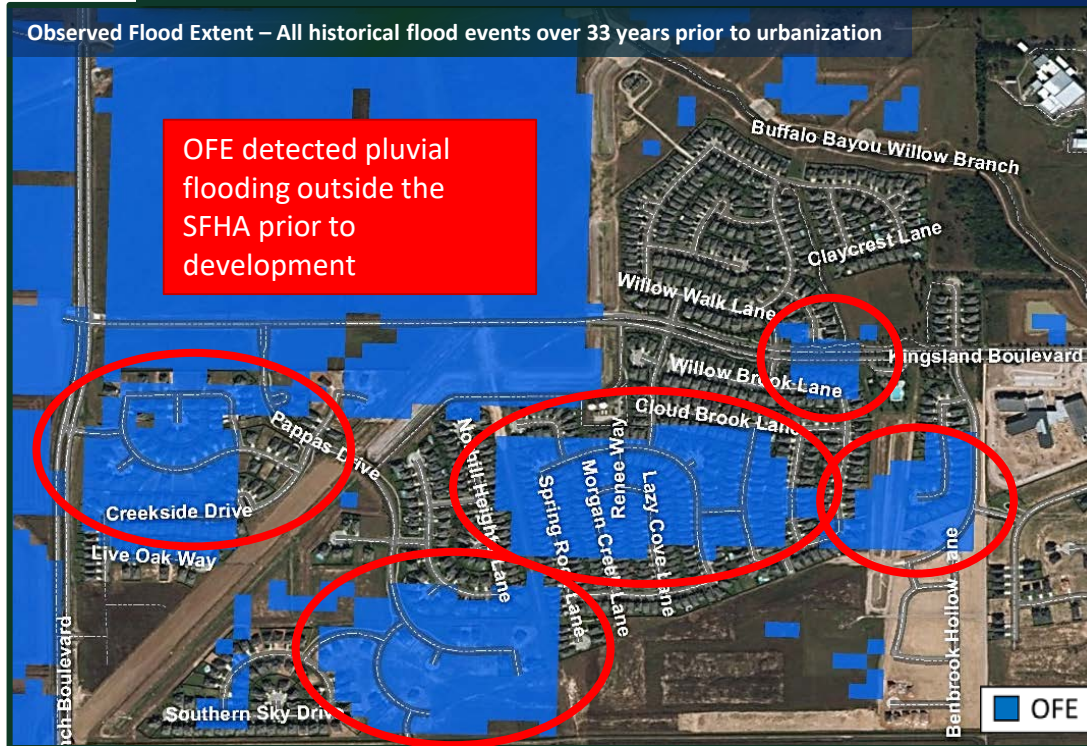


Flooded, January 1992



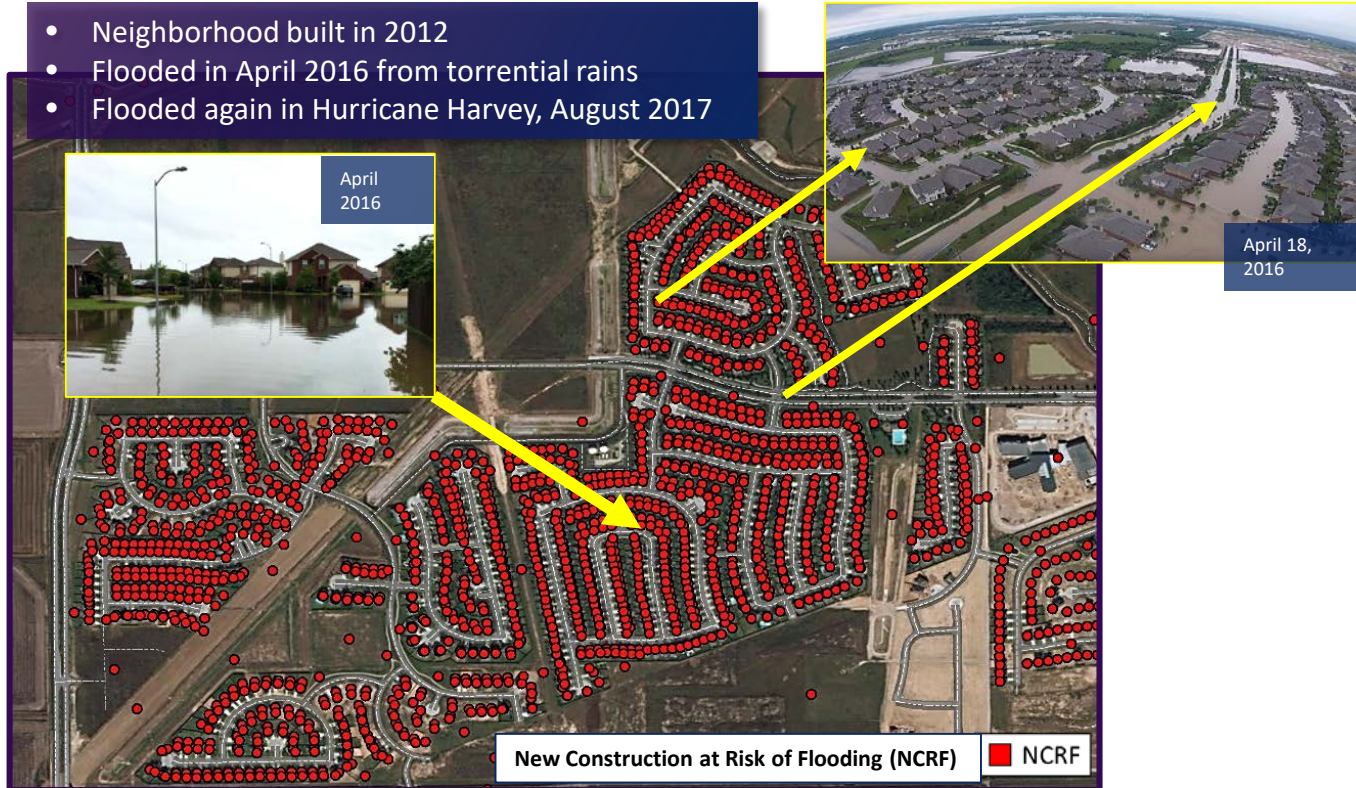
New Construction on Flood Prone Land

Observed Flood Extent (blue) detected flooding in the area prior to development.

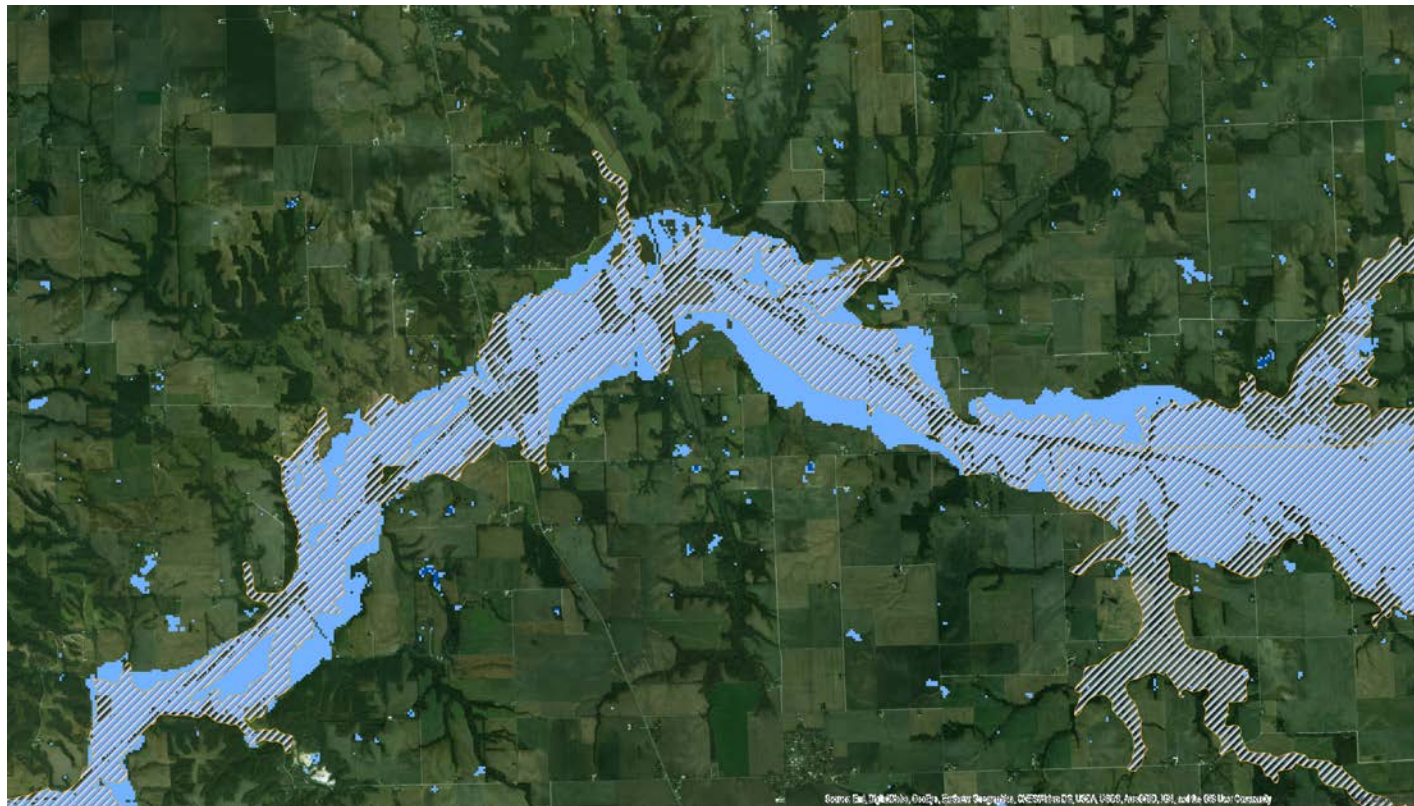


Flooding on Recent Construction

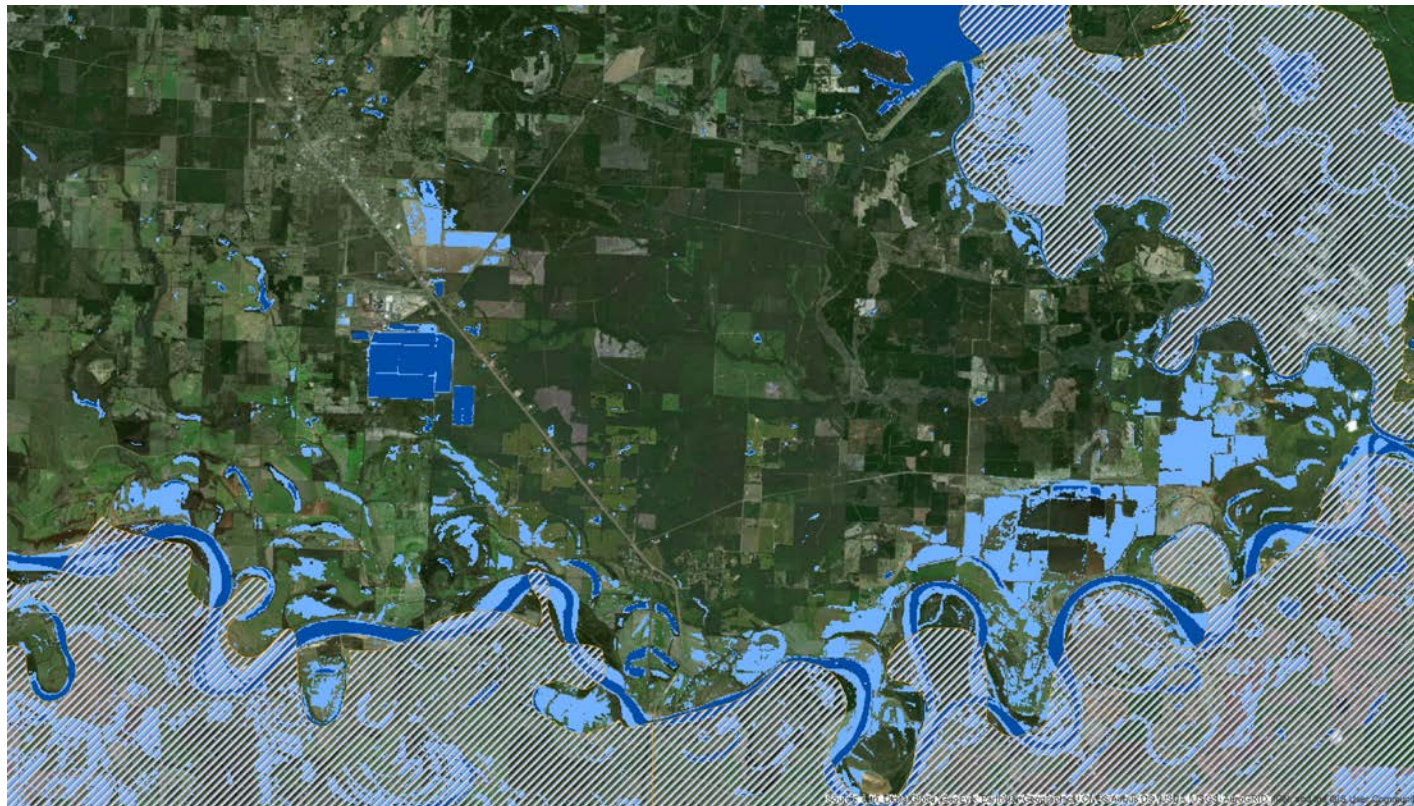
- Neighborhood built in 2012
- Flooded in April 2016 from torrential rains
- Flooded again in Hurricane Harvey, August 2017



St Louis – Flooding Outside the SFHA



Shreveport– Pluvial Flooding



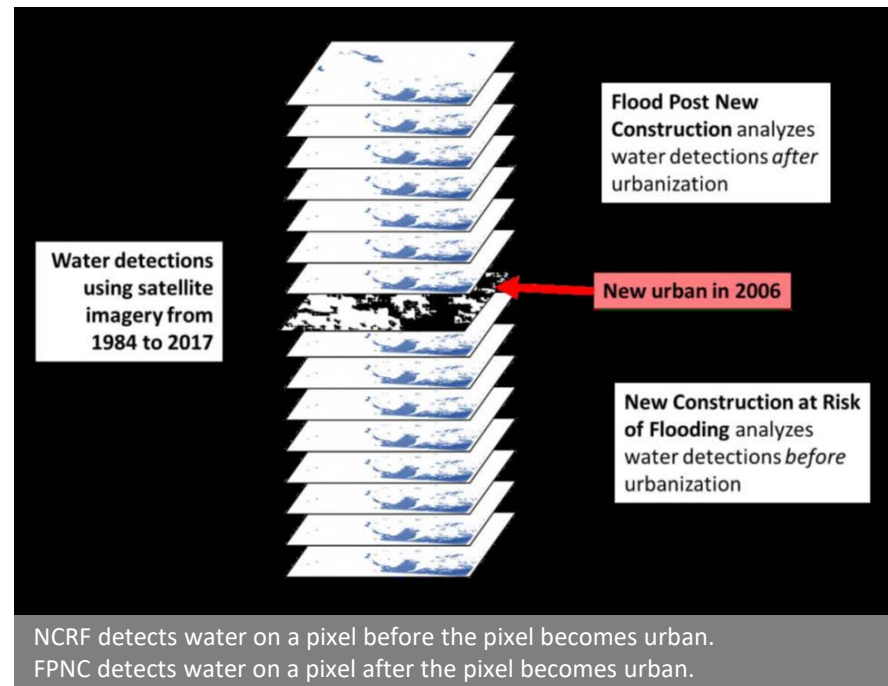
- Random-stratified point sample in low water frequency zones
 - Avoid validating permanent water bodies
 - Better test for overcall

OFE validation results. The results showed that OFE has an average of 99% accuracy

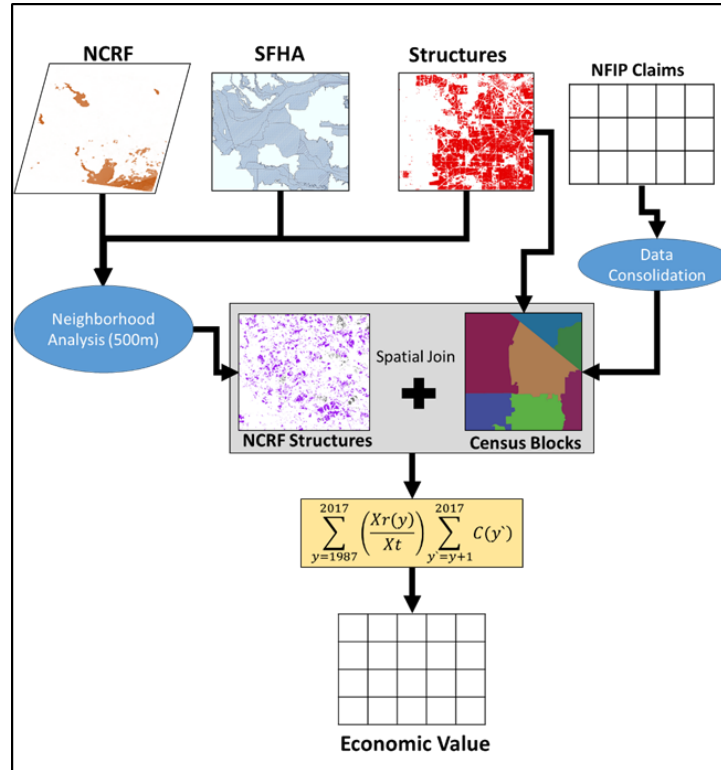
AOI	Accuracy
Austin	93%
Charleston	99%
Houston	100%
Jacksonville	100%
Phoenix	97%
Shreveport	100%
St. Louis	100%
Tuscaloosa	99%
Total	99%

• OUTPUT:

- Identify structures that are considered to be **New Construction at Risk of Flooding** and estimate the potentially preventable economic risk associated with these areas.
 - To support the need for more documentation of the history of flooding outside the SFHA prior to construction.
 - Supporting dataset for the RiskMAP Discovery process.



- **Workflow:**



- **Primary Input Datasets for the Economic Risk Analysis:**

Data	Source	Date/Time-span
NCRF	Radiant Solutions	1987-2017
Block Groups	U.S. Census Bureau	2017
Parcel Points	Core Logic	2017
Statewide NFHL	FEMA Flood Map Service Center	2015/16/17 (varies by state)
Flood Insurance Claims	FEMA	1973 - 2017

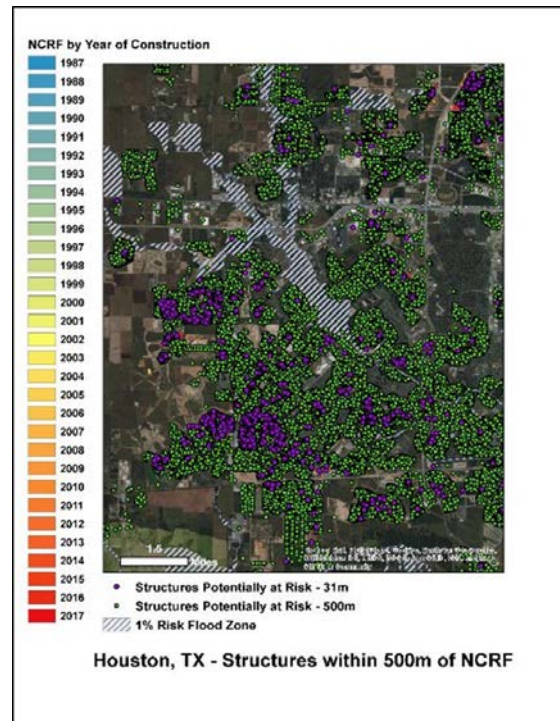
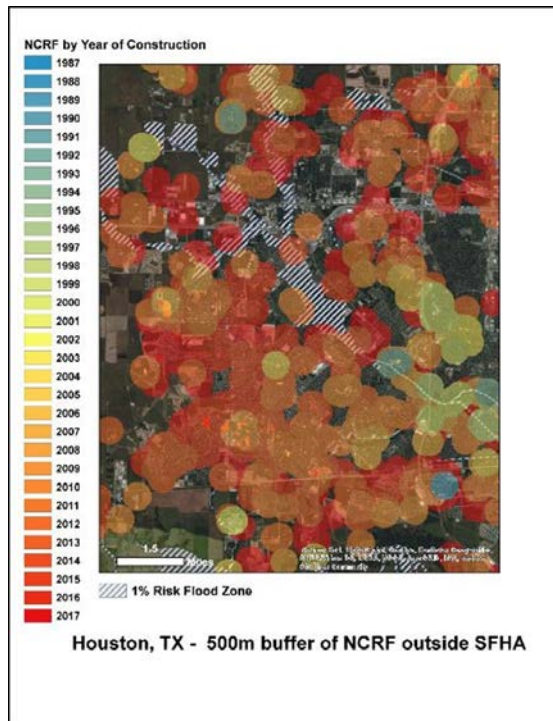
500m from NCRF - Multi-block neighborhood analysis:

- Because the exact location of a flood insurance claim was provided at the Census block group level, it is therefore assumed that flooding generally occurs where it has occurred historically.
 - To maintain a conservative estimate of loss potential for the economic analysis, the estimate takes the fraction of structures (parcel points) in a block group that are identified as “within 500m of NCRF” vs the total # of structures in that block group.
- This fraction is then multiplied by the sum of all claims recorded after that earliest-identified NCRF/structure year (for each structure intersected).
- The calculations are performed on each block group.
 - The economic value in an AOI is based on the total for the block groups in that AOI.
 - The calculations do not account for inflation.

500m from NCRF - Multi-block neighborhood analysis:

$$\sum_{y=1987}^{2017} \left(\frac{X_r(y)}{X_t} \right) \sum_{y'=y+1}^{2017} C(y')$$

$X_r(y)$ is the number of NCRF structures in year (y)
 X_t is the total number of structures in a block group
 C is the total claims in year (y)



• Vulnerable Structures Identified

AOI	Total # structures analyzed	NCRF Structures	% of the total structures that were identified as NCRF	NCRF Structures <i>Outside SFHA</i>	% of the NCRF structures that were outside the SFHA
Austin	725,994	129,097	17.80%	86,505	67.00%
Charleston	414,948	121,306	29.20%	67,646	55.80%
Houston	1,746,060	435,372	24.90%	360,674	82.80%
Jacksonville	481,300	158,284	32.90%	117,360	74.10%
Phoenix	417,265	14,635	3.50%	6,822	46.60%
Shreveport	183,247	35,219	19.20%	17,050	48.40%
St. Louis	778,099	169,374	21.80%	129,359	76.40%
Tuscaloosa	92,299	11,107	12.00%	7,674	69.10%
Total	4,839,212	1,074,394	22%	793,090	74%

- **Potentially Preventable Economic Risk Estimates**

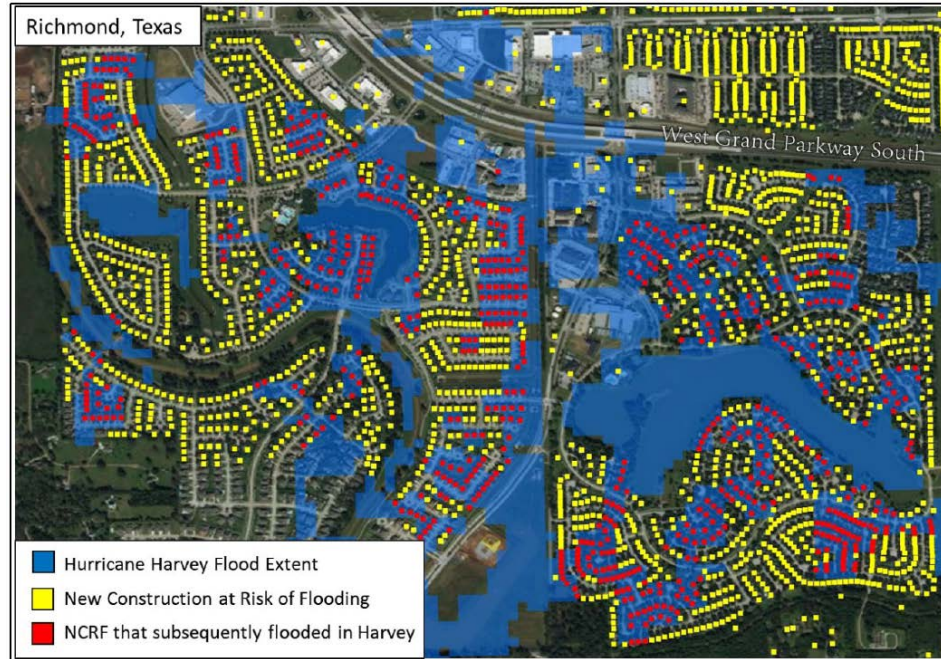
AOI	ALL NCRF	Only NCRF Outside NFHL
Austin	\$29,656,000	\$15,120,000
Charleston	\$49,525,000	\$24,766,000
Houston(pre-Harvey)	\$387,819,000	\$202,472,000
Jacksonville	\$40,866,000	\$21,757,000
Phoenix	\$111,000	\$66,000
Shreveport	\$12,413,000	\$5,675,000
St. Louis	\$70,347,000	\$29,492,000
Tuscaloosa	\$725,000	\$320,000
Total	\$591,462,000	\$299,668,000

• Vulnerable Structures Identified - Hurricane Harvey

*The estimated total loss that the 500m neighborhood buffer of NCRF outside the SFHA could have prevented for Hurricane Harvey – for the 21,338 structures intersecting the Hurricane Harvey Flood Extent - amounts to more than **\$609 million**.*

- *Emphasizes how conservative the base economic analysis method is*
- *Constricting claims to this known event allows for a more direct loss impact analysis with more precise claims location assumption*
- *Applying average dollars instead of fraction of the NFIP claims provides larger economic estimate → ~ \$ 609,989,000.00 of preventable Hurricane Harvey flood damage.*

Vulnerable Structures Identified - Hurricane Harvey



$29^{\circ}39'38.83''N$ $95^{\circ}44'20.63''W$

- Flood Post New Construction
 - Dropped → Very difficult to detect water in urban areas
 - 30 meter pixel of Landsat
 - Cloud cover
 - Still used reports and FEMA issued flood extents
- Incorporate Sentinel 2 and RADARSAT
 - Higher resolution
 - Can capture during flood event → Don't have to worry about cloud cover

Summary:

- Documenting previously unknown flood prone areas prior to new construction will prevent \$ billions in future NFIP claims.
- 10,000's of new homes are being built each year outside the SFHA on undeveloped land with a previously unknown history of pluvial flooding.
- If previously undocumented flood events were known by FEMA/FIMA, communities, developers, banks, insurers, etc., subsequent pre-development hydrologic/mitigation efforts may have prevented most of these NFIP claims.
- The Observed Flood Extent (OFE) product identifies additional flood risk through direct observations of previously unknown flood events using 33 years of satellite imagery for the entire US.

Thank You

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