

Resilience: Going Beyond Recovery



Gulf Coast Water Efficiency Network
January 25, 2018

Lisa Gonzalez
President



Current Status: GalvBayGrade.org



HARC



GALVESTON BAY
FOUNDATION

HUMAN HEALTH RISKS

C



INDICATORS	Galveston Bay	Rivers & Bayous
Seafood Consumption Safety	C	D
Recreation Safety	A	B

What Can You Do?

Protect Family, Friends, and Yourself

- Check for seafood consumption advisories in effect for the areas where you fish or crab.
- Pump out boat sewage at designated facilities — not in the Bay. Properly dispose of pet waste.
- Contact your local officials about improving sewage infrastructure. Regularly maintain onsite septic systems so that they do not pollute the environment or pose health hazards to people.

WATER QUALITY

A



INDICATORS	Galveston Bay	Rivers & Bayous
Nitrogen	A	A
Phosphorous	A	B
Dissolved Oxygen	A	A

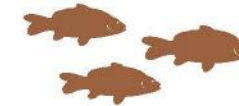
What Can You Do?

A Little Goes a Long Way

- Slow runoff by maintaining natural habitat, reducing paved areas and installing rain barrels.
- Apply lawn fertilizers sparingly, if at all, and avoid overuse near bodies of water. Properly dispose of pet waste.
- Help preserve and restore habitats that promote high oxygen levels like wetlands and forests near streams and rivers.

WILDLIFE

C



INDICATORS	Galveston Bay	Rivers & Bayous
Shellfish	C	
Finfish	C	
Birds	C	
Invasive Species	B	D

What Can You Do?

Take Care of Animals, Land and Sea

- Keep your distance from bird nesting areas. Don't walk or allow pets near these sensitive habitats.
- If you fish, it's important to know the rules and regulations regarding fishing seasons, size and daily limits. Catch and release when possible.
- If you don't know it, don't grow it. Never release unwanted pets into local habitats and waterways.

HABITAT

D



INDICATORS	
Saltwater Wetlands	I
Freshwater Wetlands	I
Underwater Grasses	C
Oyster Reefs	I

What Can You Do?

Save the Land We Love

- Volunteer to restore habitat around the Bay by participating in conservation projects.
- Conserve land by donating it to a land trust or by establishing a conservation easement.
- Use the Watershed Information Tool to learn about wetlands near your home, work and school. (harcresearch.org/wetlandplanningtool).

COASTAL CHANGE

C



INDICATORS	
Freshwater Inflow	C
Sea Level Rise	F
Winter Water Temperature	A
Water PH	A

What Can You Do?

Our Actions Impact Coastal Resilience

- Learn about floodplains and determine the proximity of your home or business to 100-year and 500-year floodplains. (harcresearch.org/wetlandplanningtool).
- Reduce greenhouse gas emissions by conserving electricity, purchasing green power (solar or wind), driving less and considering fuel efficiency when purchasing a vehicle.
- Recycle and use less stuff by reusing, repurposing; this conserves energy and reduces pollution and greenhouse gas emissions.

POLLUTION EVENTS & SOURCES

C



INDICATORS	Galveston Bay	Houston Ship Channel	Total No. of Spills	Total Volume of Spills
Toxic Metals in Sediment	A	B		
Organic Toxins in Sediment	I	B		
Dioxin in Sediment	I	D		
Oil Spills			C	F
Litter & Trash	I			

What Can You Do?

Prevent Pollution in Your Area

- Urge local officials to prioritize Bay cleanup and preservation.
- Report environmental emergencies, discharges, spills, or air releases at www.galvbay.org/GBAN.
- Protect bay habitats, and keep trash and debris out of the water.

6 categories ♦ 22 Indicators



EXCELLENT



GOOD



ADEQUATE
FOR NOW



REQUIRES
ACTION

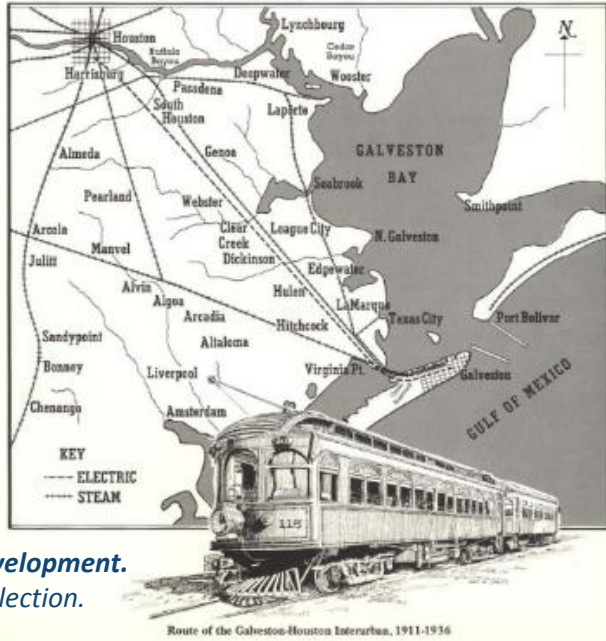


CRITICAL

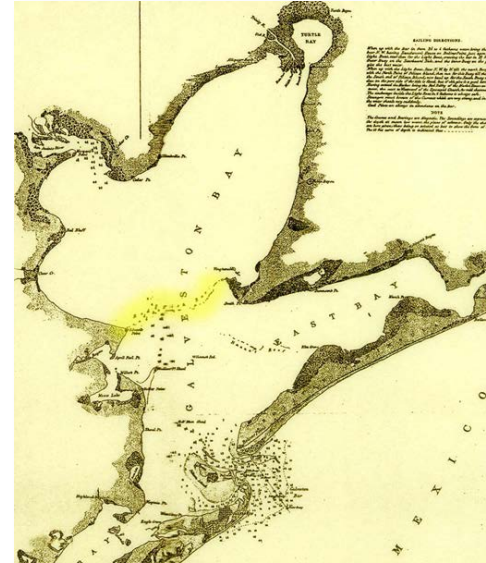


INSUFFICIENT
DATA

A Region Shaped by Infrastructure



Rail drove post Civil War development.
Image courtesy Gallaway Collection.



Galveston Bay and Redfish Bar in 1851
Image courtesy National Archives.



Sawmill and log trap at Wallisville circa 1900.
Image courtesy Wallisville Heritage Park.



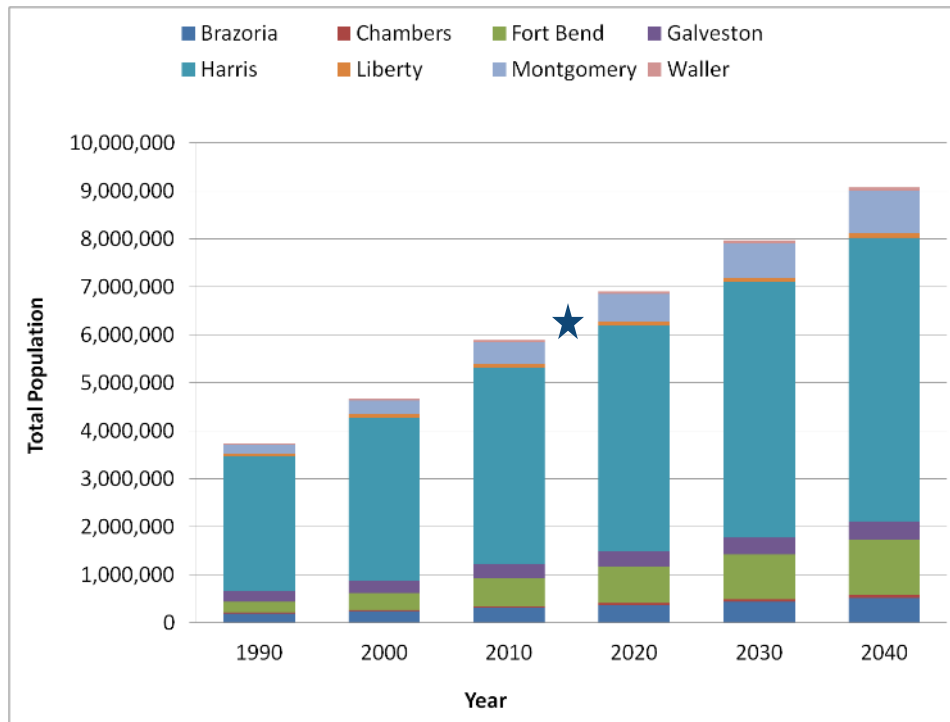
The Goose Creek oil field in Tabbs Bay near Baytown circa 1908. Image courtesy National Archives.



Channelization White Oak Bayou 1955.
Image courtesy <http://whiteoakbayou.org>; HCFCD

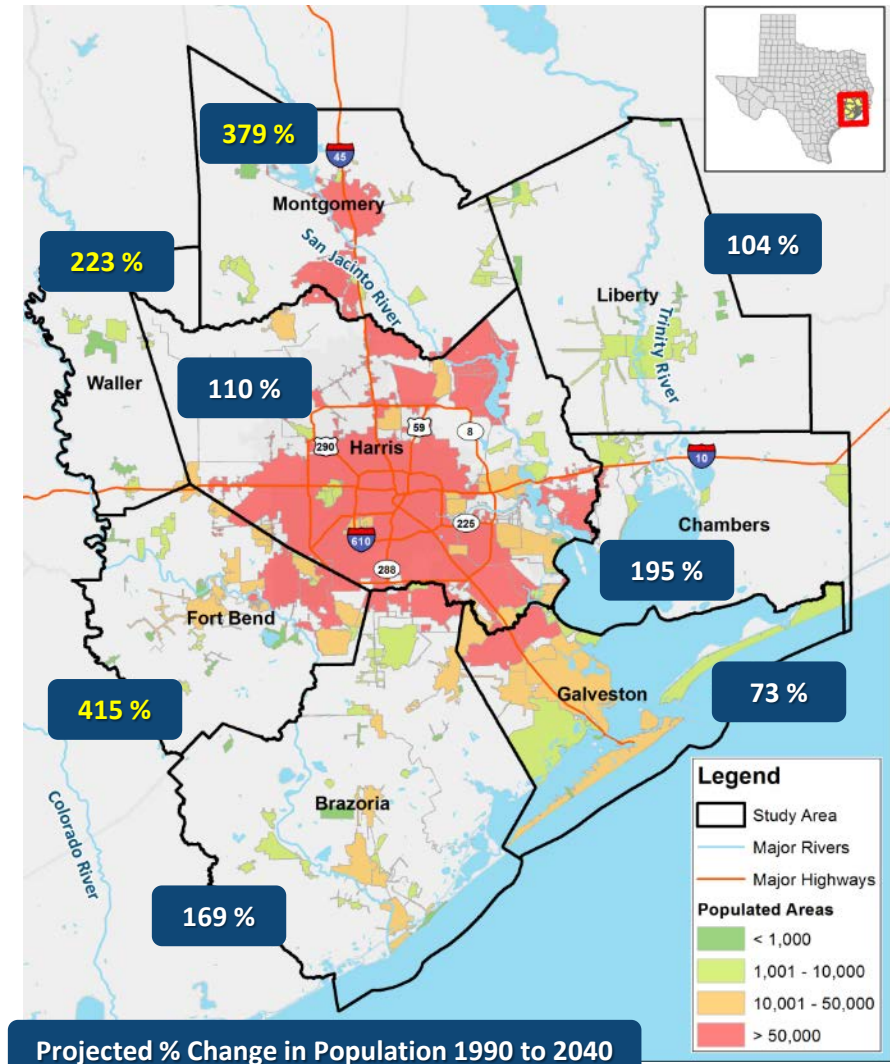
Growing Coastal Region & Urban Estuary

Population Growth



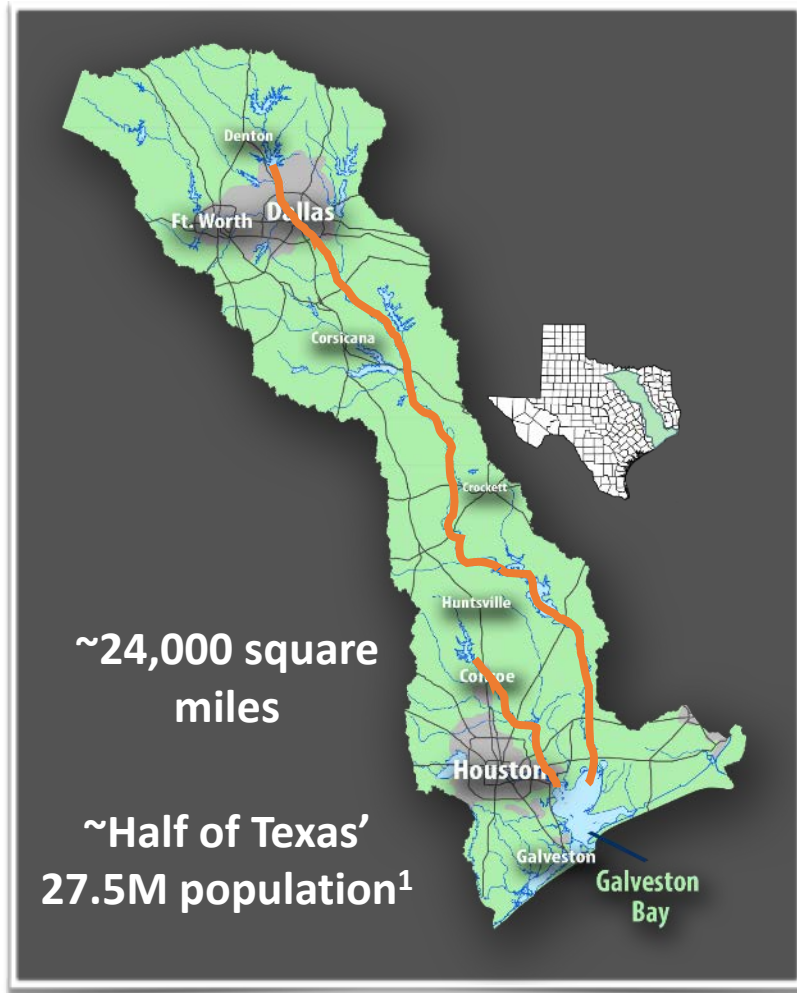
Population Change 1990 - 2040

Data Source: U.S. Census, 2016



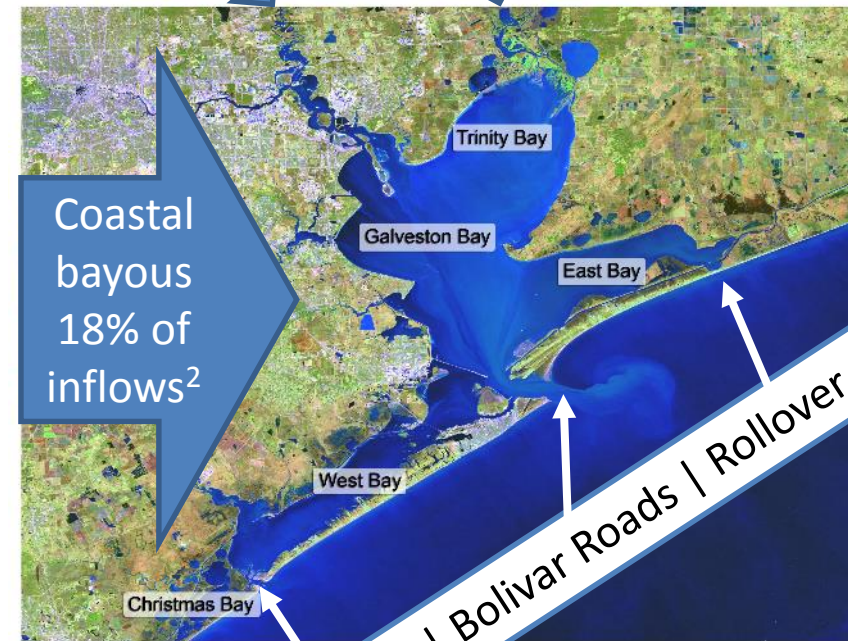
Projected % Change in Population 1990 to 2040

Water: It's all Connected



San Jacinto River
28% of inflows²

Trinity River
54% of inflows²



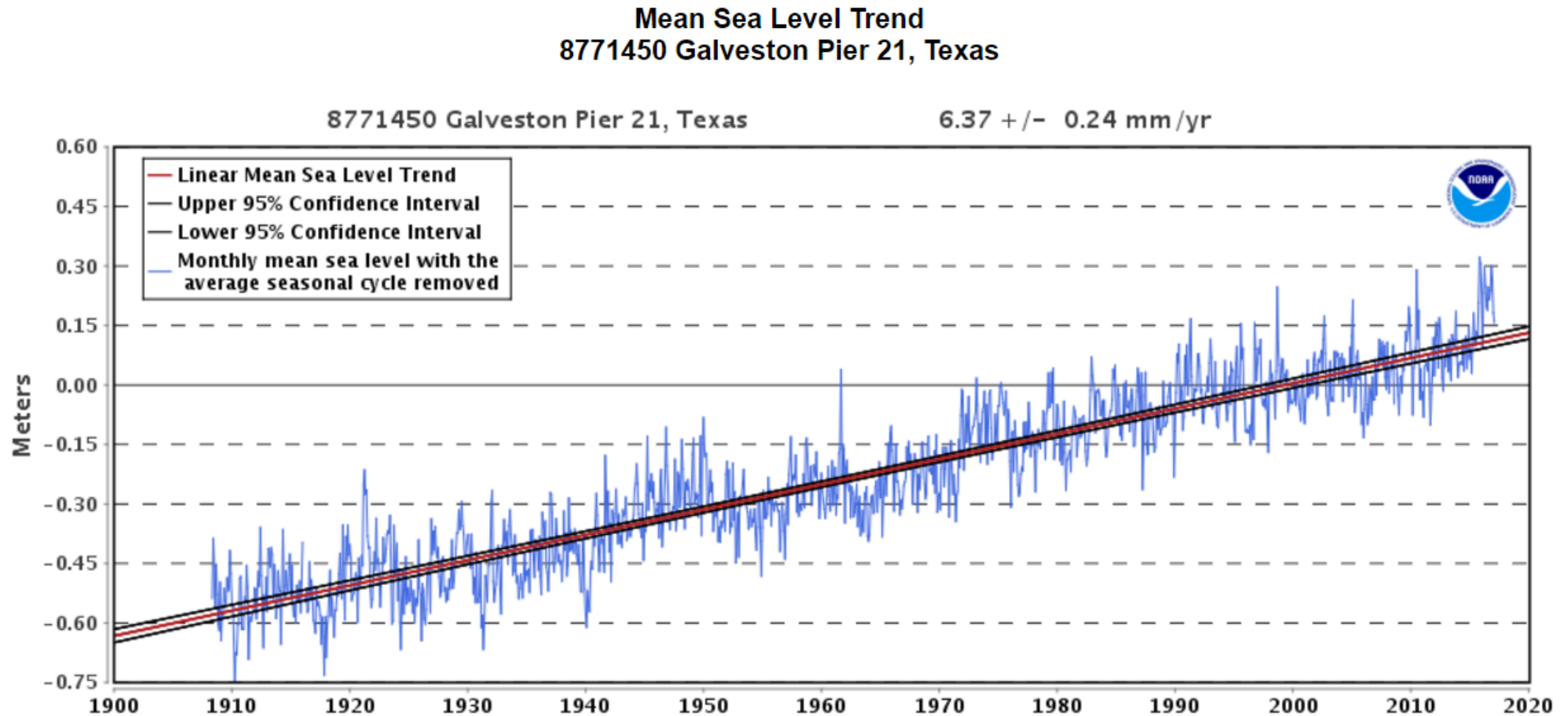
San Luis Pass | Bolivar Roads | Rollover Pass

¹U.S. Census, July 2015

²Texas Water Development Board



Sea Level Rise

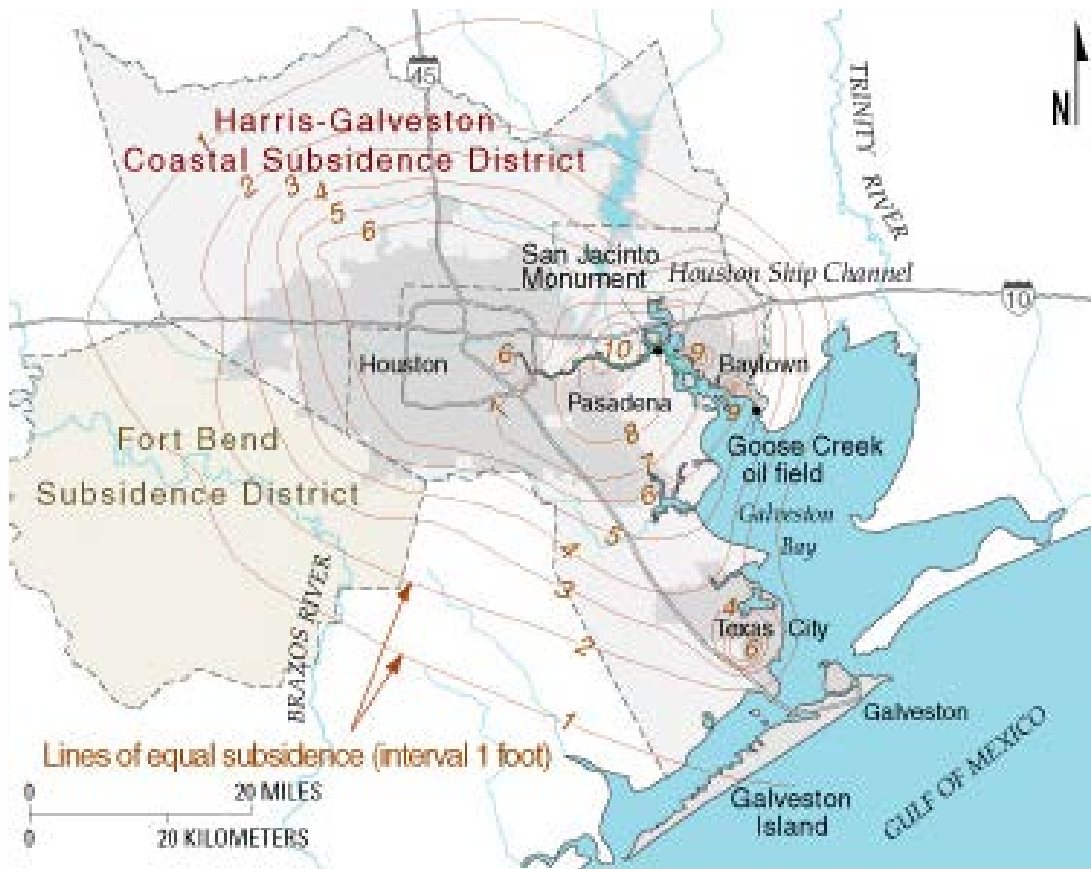


*The mean sea level trend is 6.37 millimeters/year with a 95% confidence interval of ± 0.24 mm/yr based on monthly mean sea level data from 1908 to 2015 which is equivalent to a change of **2.09 feet in 100 years**.*



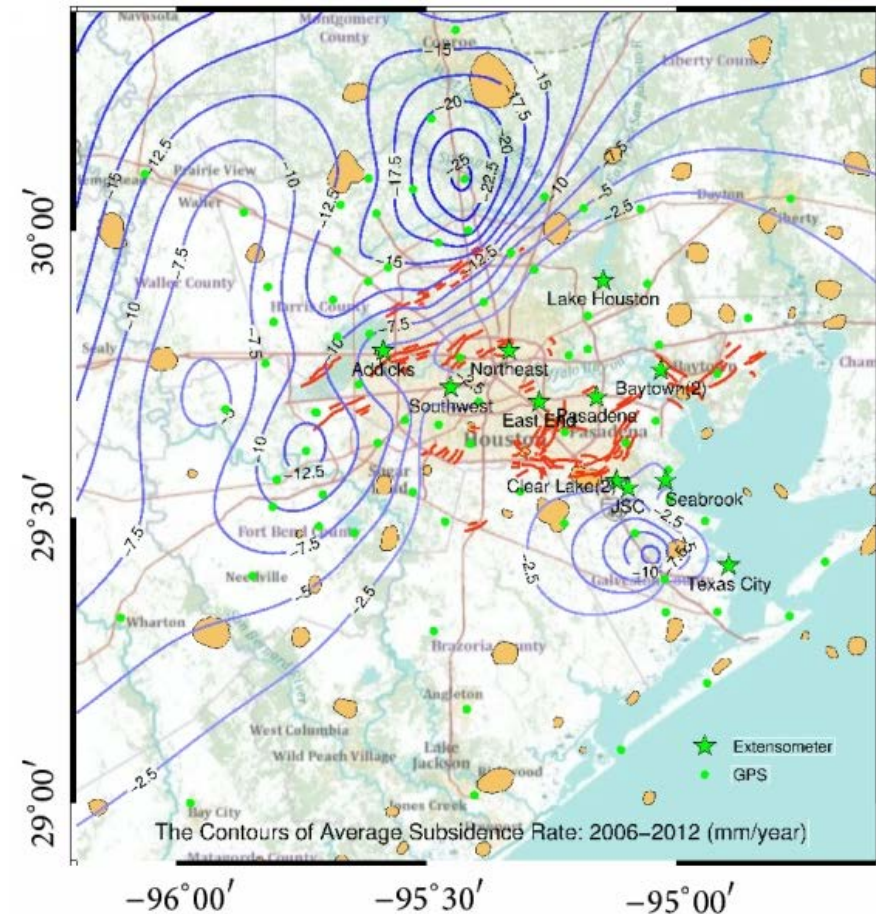
Regional Subsidence

Extent of subsidence in the Houston-Galveston Bay area; 1906–95.



USGS Report # FS-051-00

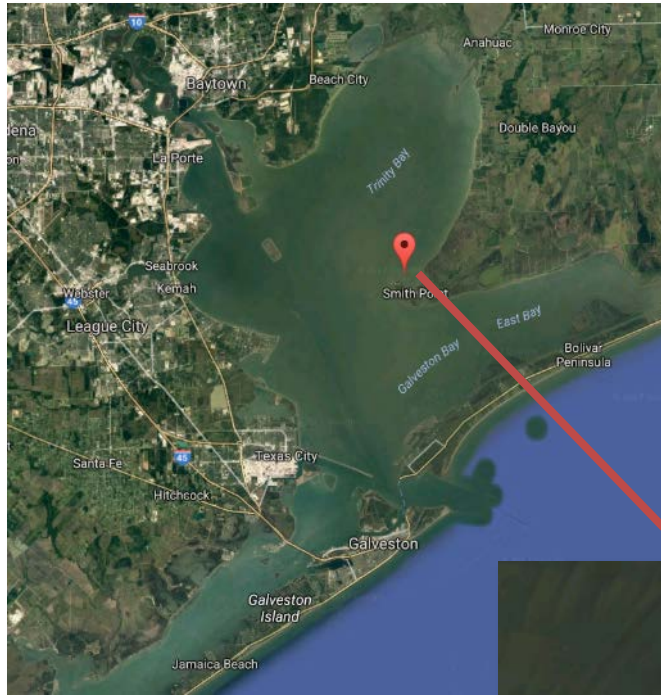
Average subsidence rate (mm/year); 2006-12



Yu J., G. Wang, T.J. Kearns, and L. Yang. 2014.
International Journal of Geophysics.



Impacts of Relative Sea Level Rise



Vingt-et-un “21” Islands
waterbird rookery



Brownwood Subdivision in Baytown, TX abandoned in 1990s.

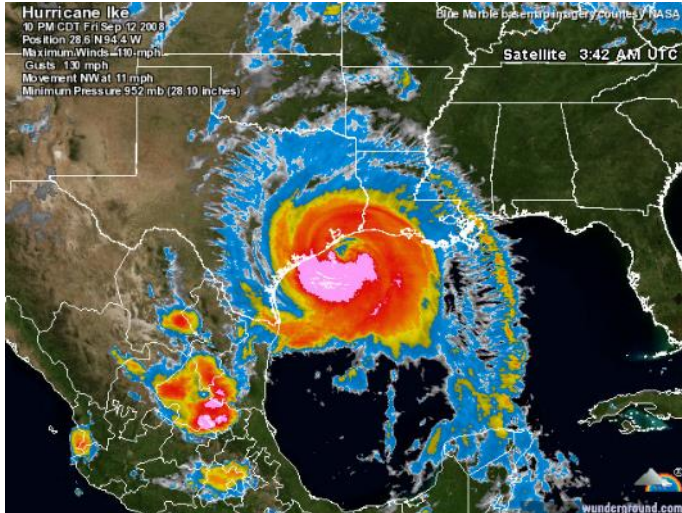


*Broadway Boulevard in Galveston after 9/1/2015 rain storm.
Galveston County daily News*



Coastal Storms & Storm Surge

2011 Hurricane Ike

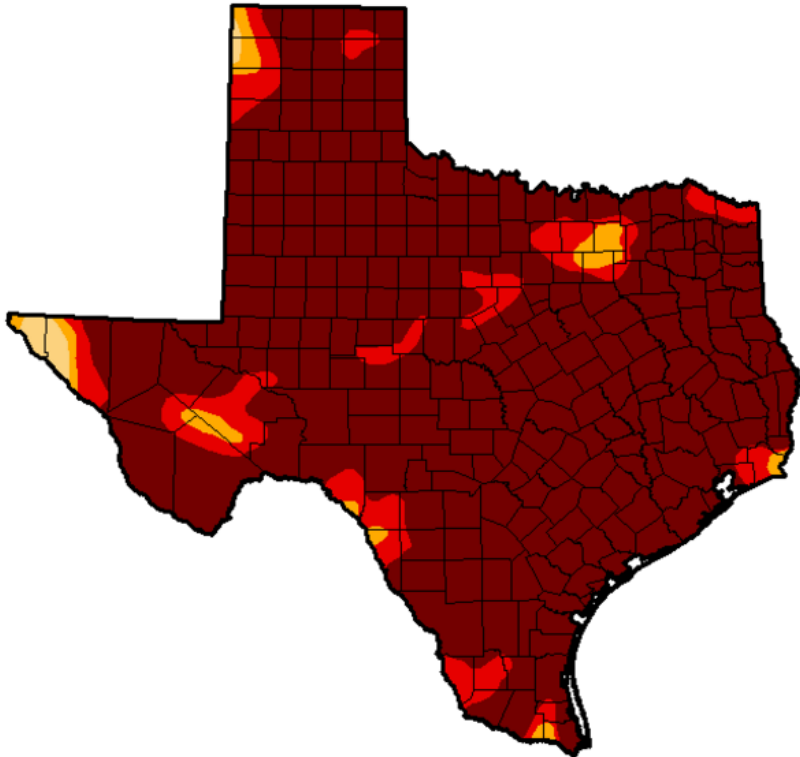


How can storm surge solutions balance economic, social and environmental needs?

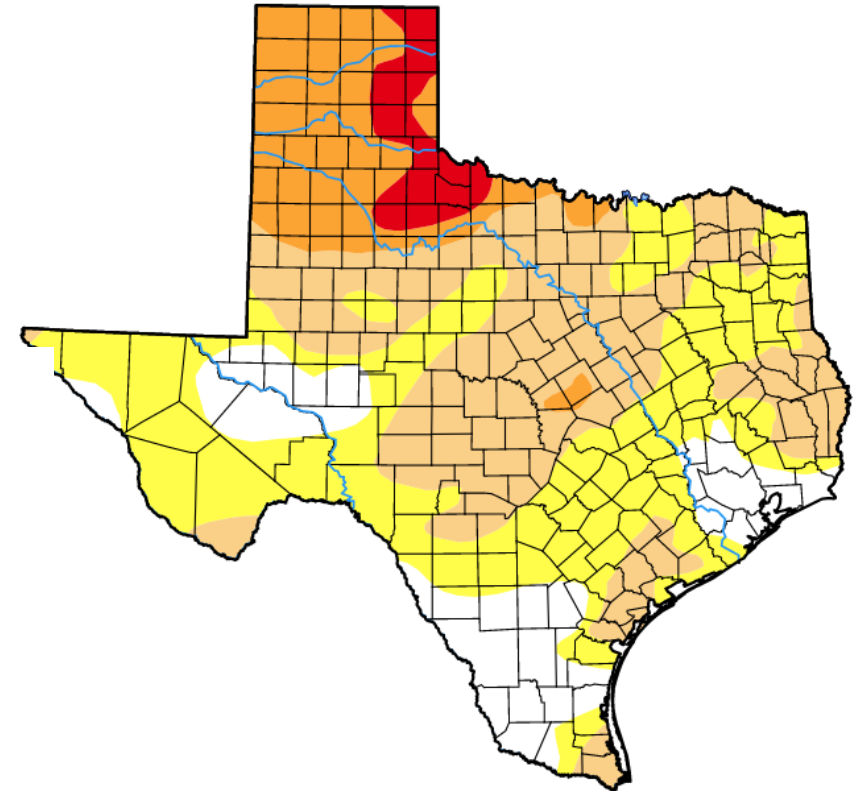


Drought Conditions

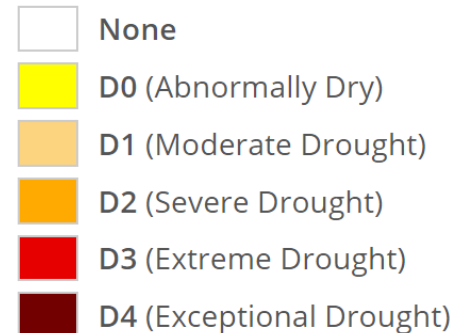
*Area with drought conditions:
10/4/2011: 100% area (25 M people)*



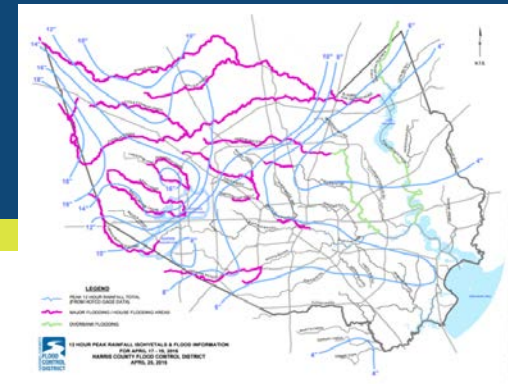
*Area with drought conditions:
1/23/2018: 85% area (7.2 M people)*



Intensity:



Extreme Rain & Flood Events



Tropical Storm Claudette 1979

- 43" of rain near Alvin in Brazoria County



Tropical Storm Allison 2001

- Max rainfall 28.5" in 12 hours on Greens Bayou.
- >35" of rainfall over the five-day period



Memorial Day Floods 2015

- Rain event total 162 billion gallons of water

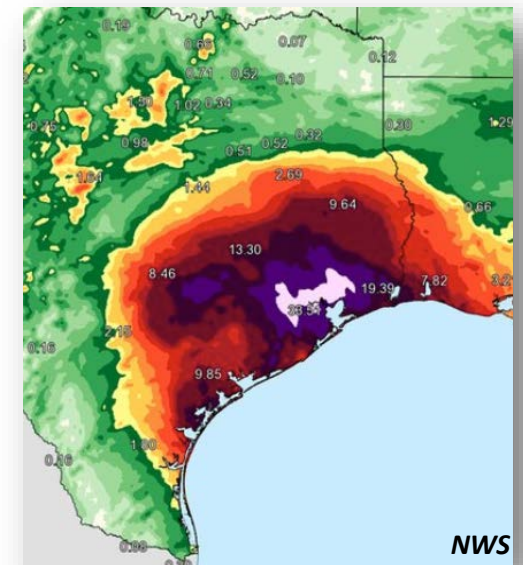


Tax Day Floods 2016

- Rainfall rates of 1" in 5 minutes
- Maximum hourly rate of 4.7"
- Highest rainfall total in the region was 23.5" recorded in 14.5 hours in Waller County



Harvey

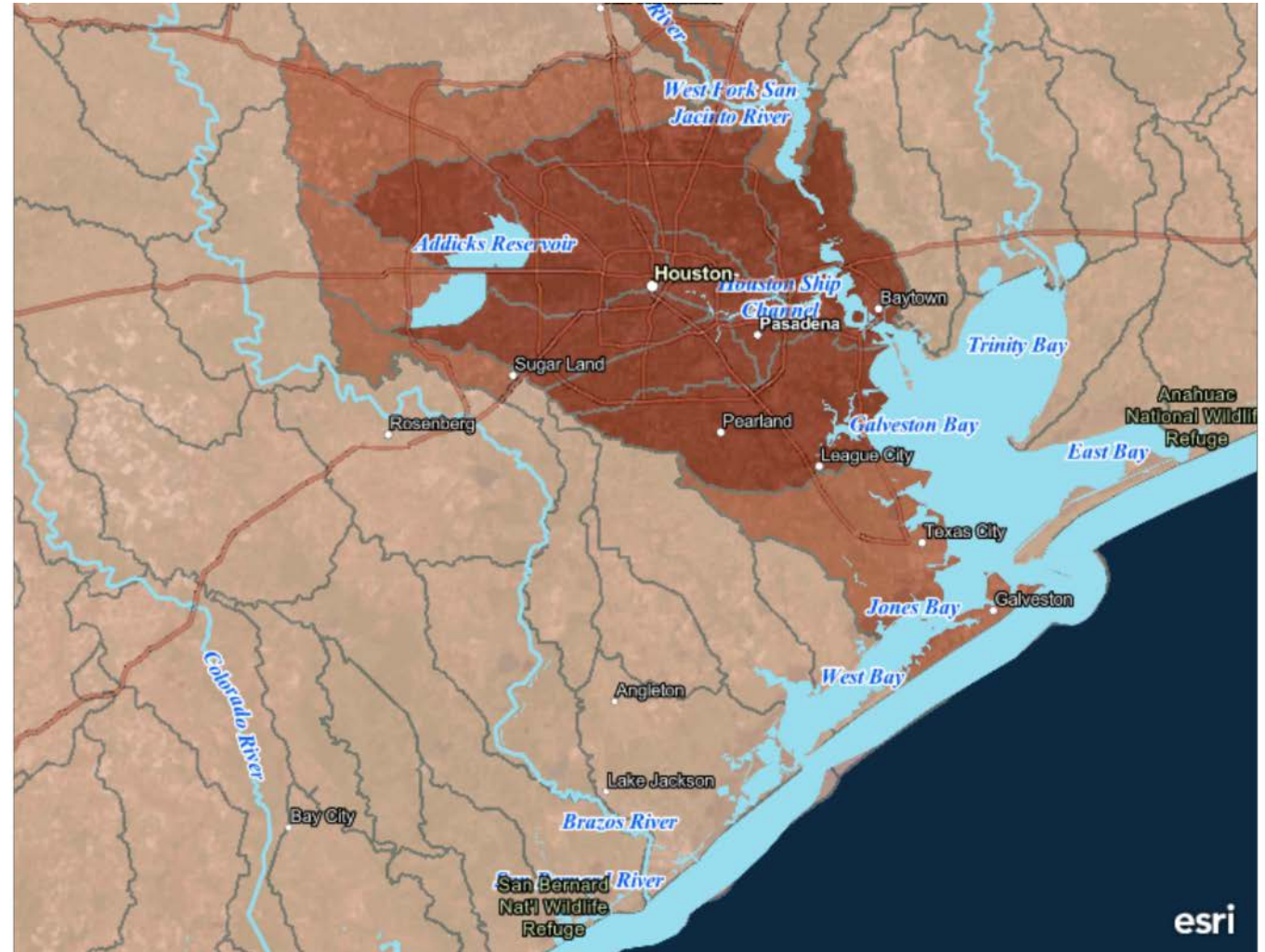
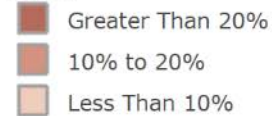


Regional Imperviousness

- Sensitive streams impacted by 5-10 % impervious surface area
- Greater impairments when rates exceed 20-25 percent

USGS Watersheds HUC10 Imperviousness (2011)

Watershed Imperviousness
(2011)

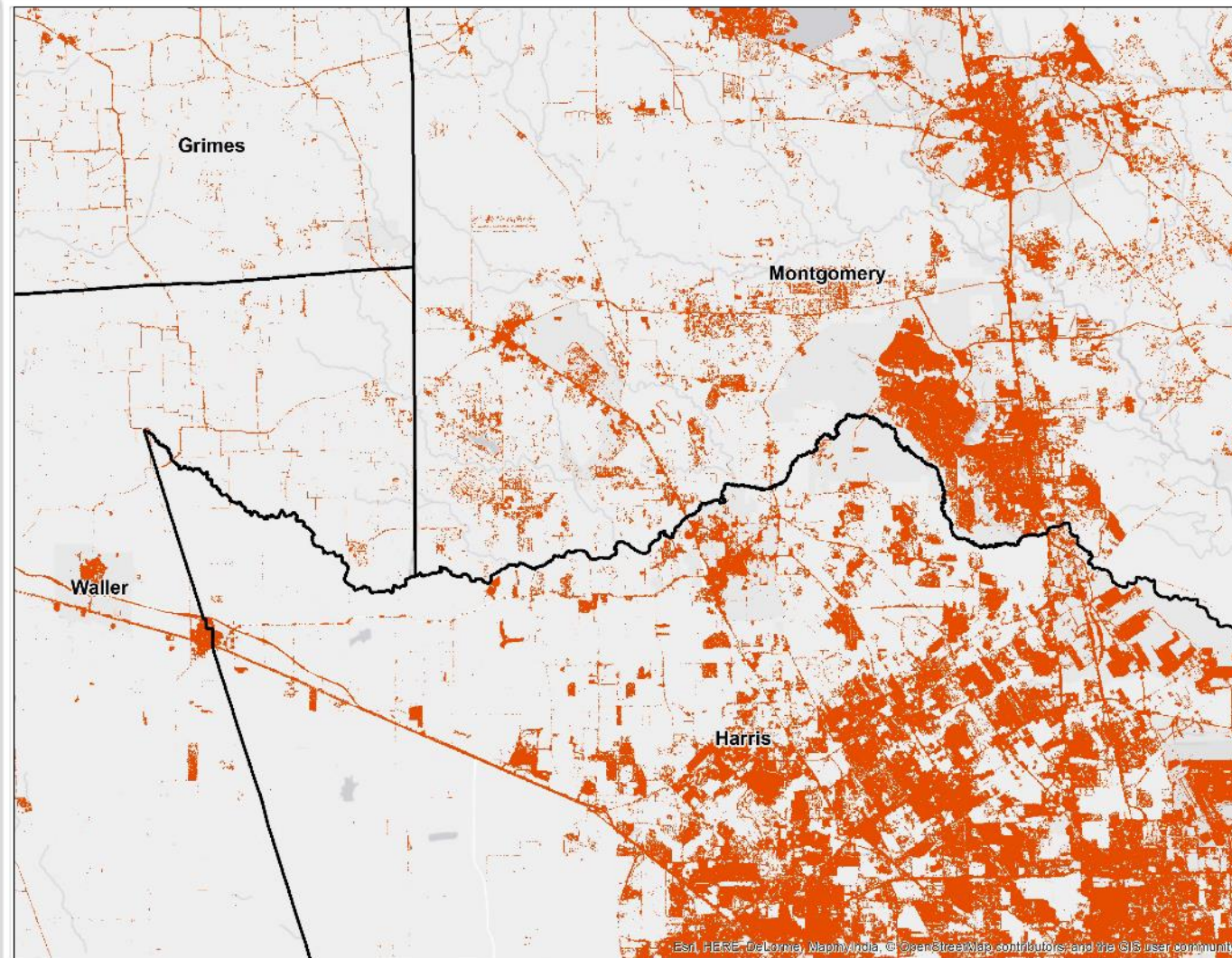


Land Cover Change

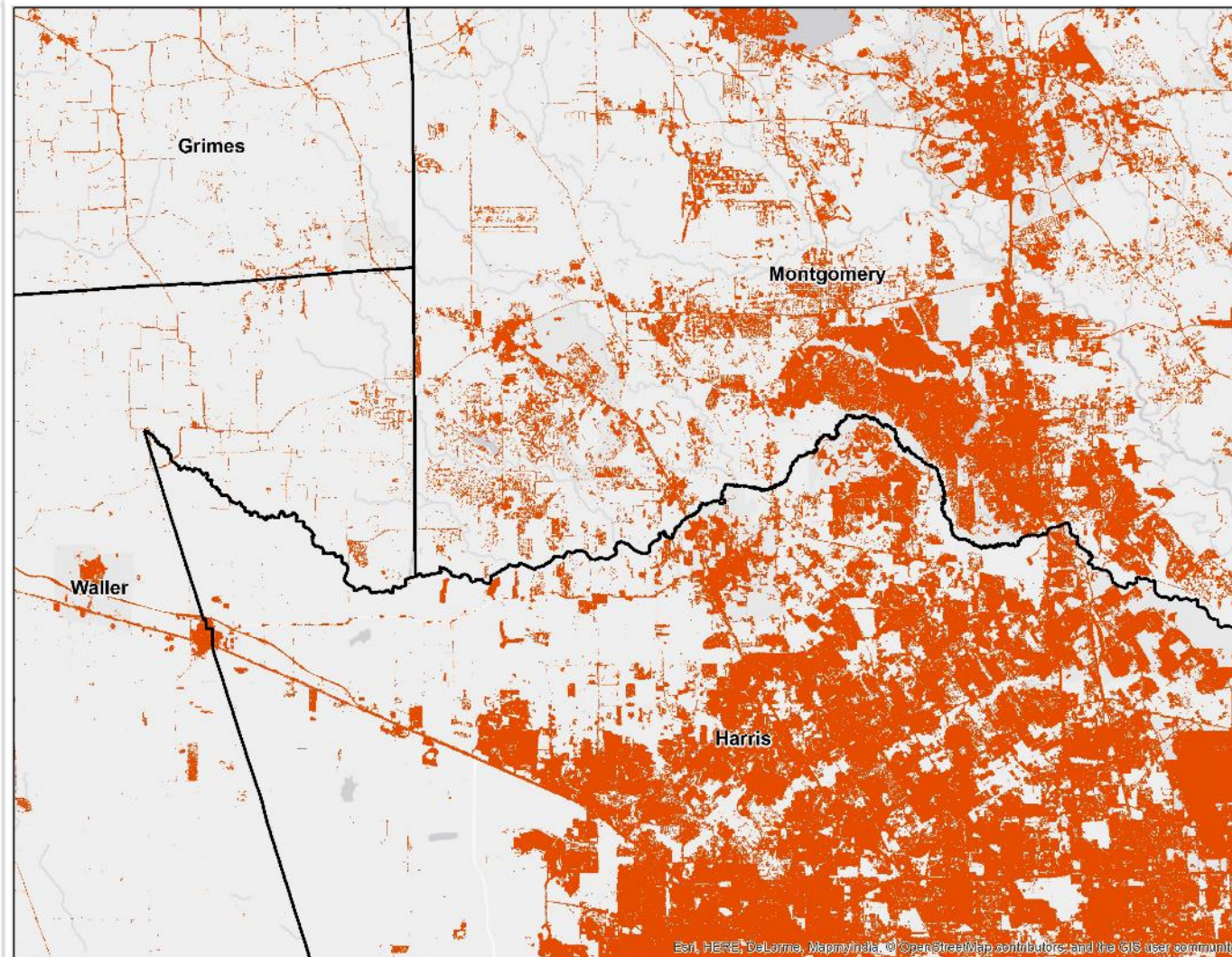
- Growth in impervious & developed areas
- Wetland areas decreased by 54,000 acres; 1996-2010

	Imperviousness				Developed				Wetlands			
	2001	2011	Change 2001-2011		1996	2010	Change 1996-2010		1996	2010	Change 1996-2010	
County	Acres	Acres	Acres	Pct	Acres	Acres	Acres	Pct	Acres	Acres	Acres	Pct
Brazoria	26,389	33,434	7,044	26.69%	71,016	85,530	14,513	20.44%	307,870	304,674	-3,197	-1.04%
Chambers	8,838	10,619	1,781	20.15%	22,888	27,097	4,209	18.39%	137,993	135,344	-2,649	-1.92%
Fort Bend	30,856	47,268	16,411	53.19%	64,106	106,797	42,690	66.59%	63,901	59,983	-3,918	-6.13%
Galveston	27,449	33,668	6,218	22.65%	73,562	85,411	11,849	16.11%	78,696	75,358	-3,339	-4.24%
Grimes	6,848	7,061	213	3.11%	15,833	16,953	1,121	7.08%	38,294	38,247	-47	-0.12%
Hardin	7,259	7,903	644	8.88%	16,713	19,878	3,165	18.94%	202,515	197,379	-5,136	-2.54%
Harris	279,648	337,791	58,143	20.79%	522,137	639,135	116,998	22.41%	100,181	87,409	-12,772	-12.75%
Jefferson	37,861	40,974	3,112	8.22%	88,113	94,828	6,715	7.62%	232,672	223,397	-9,275	-3.99%
Liberty	9,333	9,898	564	6.04%	22,794	26,126	3,331	14.62%	272,260	266,033	-6,228	-2.29%
Montgomery	35,137	46,966	11,829	33.66%	75,362	117,477	42,115	55.88%	90,108	83,464	-6,644	-7.37%
Polk	7,639	7,955	316	4.14%	14,750	17,436	2,686	18.21%	105,625	106,859	1,234	1.17%
San Jacinto	3,510	3,694	184	5.24%	6,517	8,002	1,485	22.79%	55,041	54,856	-185	-0.34%
Walker	7,442	7,877	435	5.85%	16,942	18,317	1,375	8.12%	50,962	49,123	-1,840	-3.61%
Waller	3,363	3,957	594	17.65%	9,403	11,575	2,172	23.10%	23,607	23,506	-101	-0.43%
Totals	491,574	599,063	107,490	21.87%	1,020,135	1,274,562	254,427	24.94%	1,759,726	1,705,631	-54,095	-3.07%

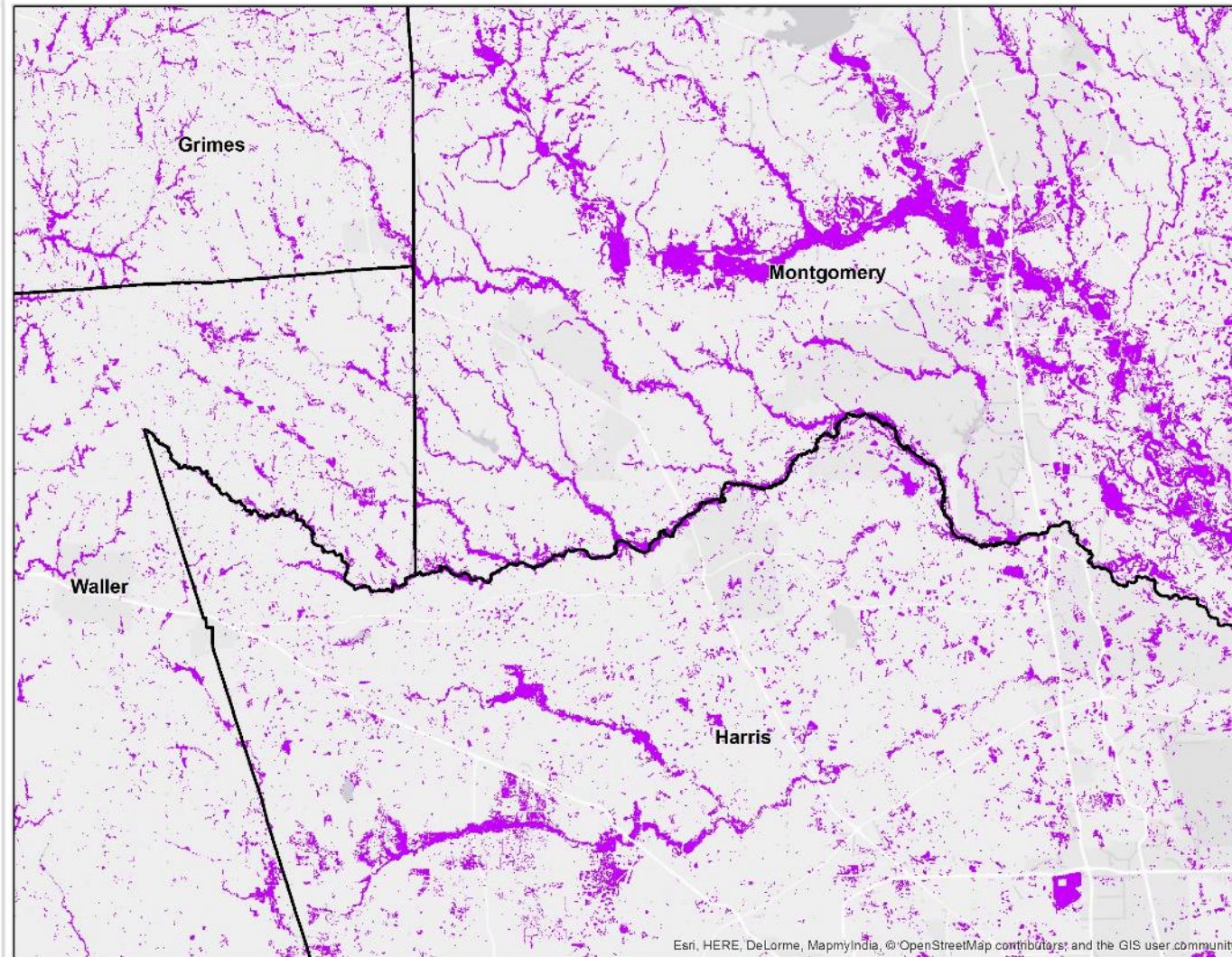
Developed Areas 1996



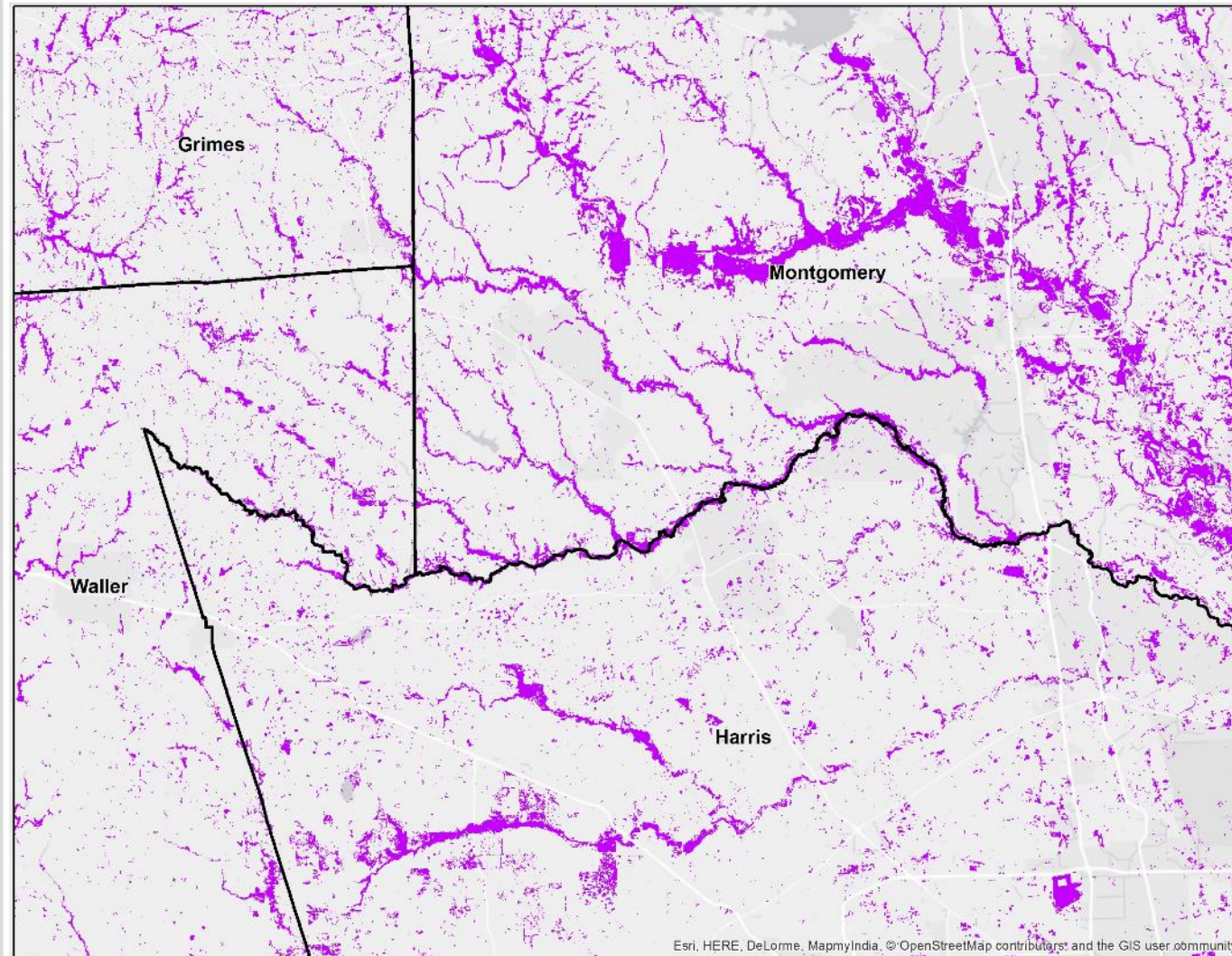
Developed Areas 2010



Wetland Areas 1996



Wetland Areas 2010



Greater Houston Region's Water Systems

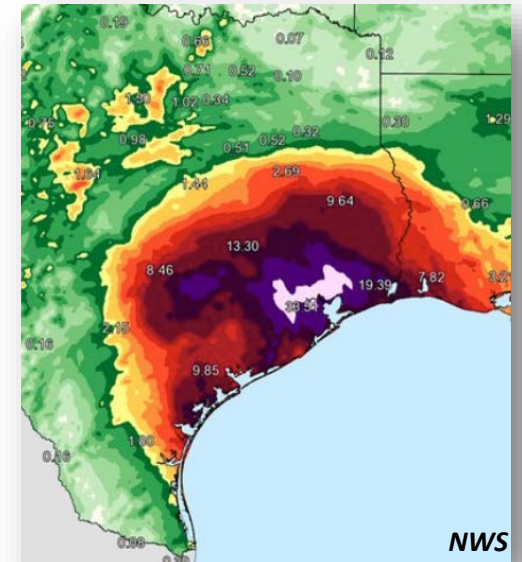
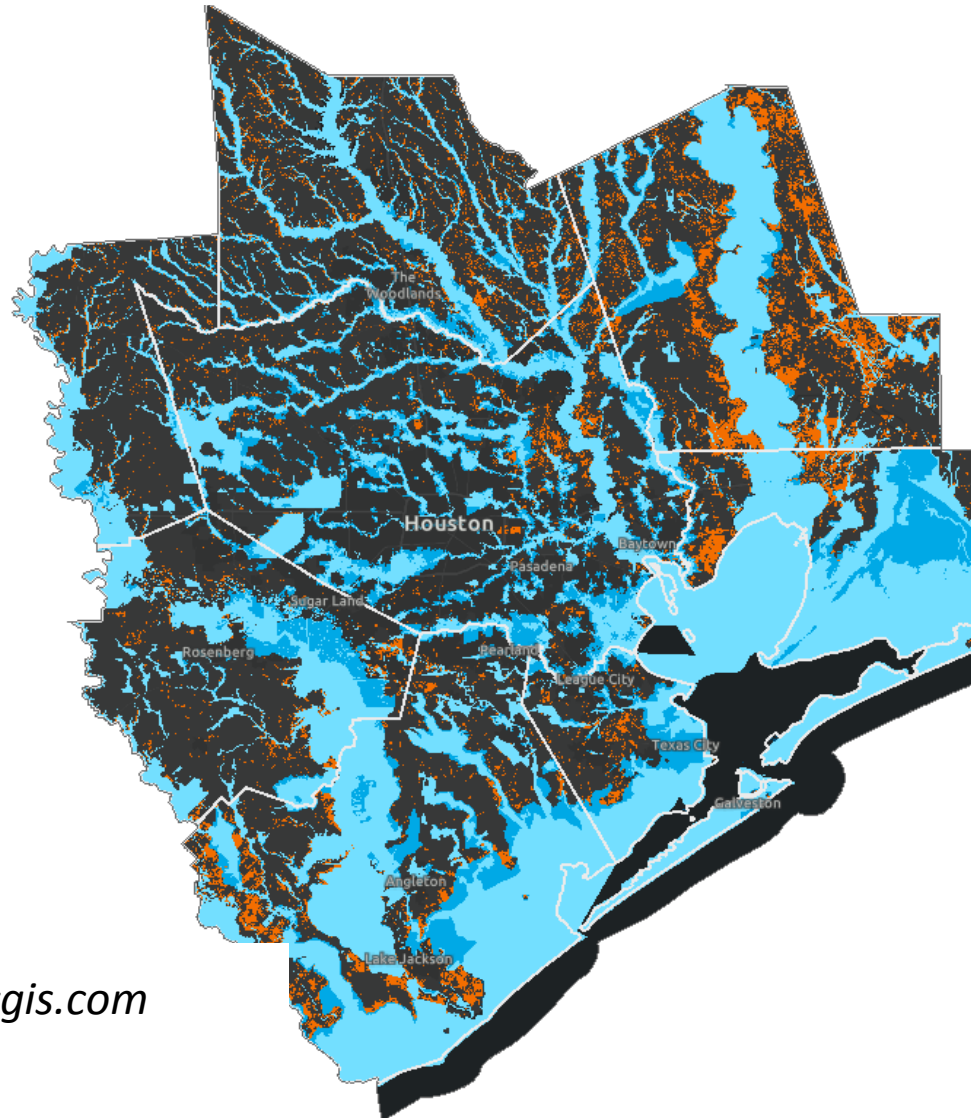
The Floodplain & Wetlands

FEMA Floodplains

- 100 Year (1% probability)
- 500 Year (0.2% probability)

NOAA Wetlands

- Estuarine Wetlands
- Palustrine Wetlands

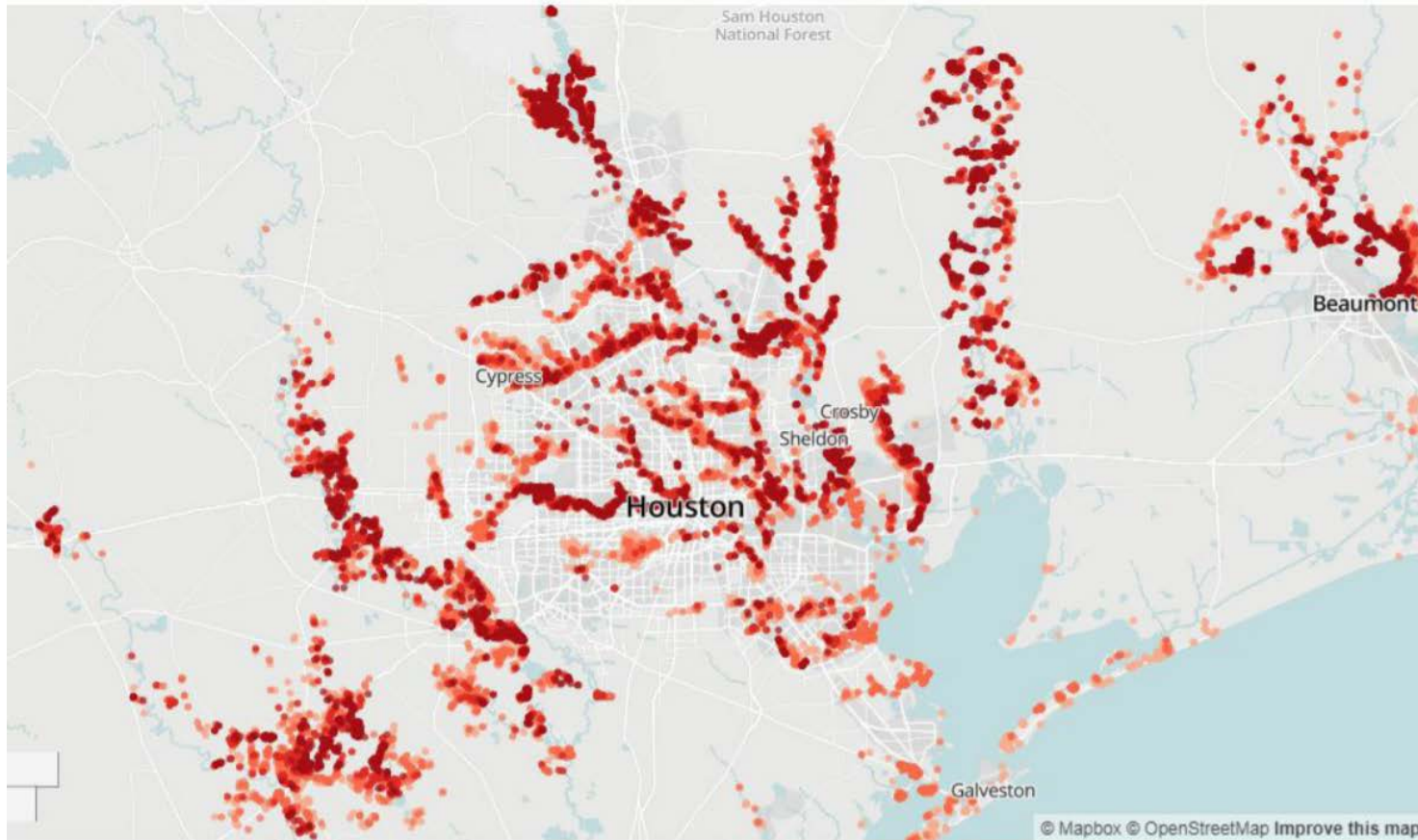


harcresearch.maps.arcgis.com

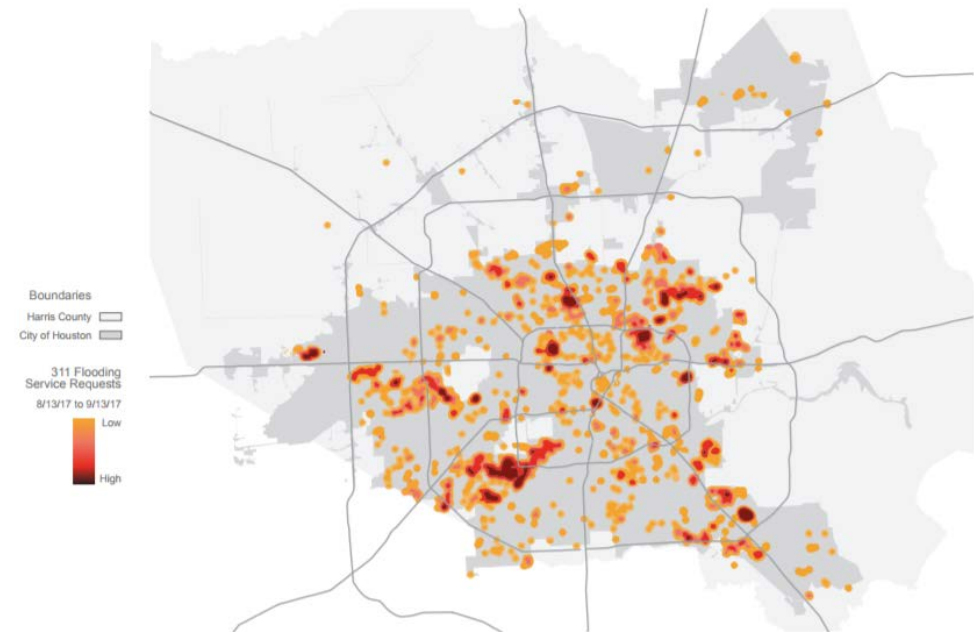


The Impacts

Initial FEMA Assessment
● Destroyed ● Major damage ● Minor damage ● Affected by floods



311 call data by City of Houston, mapped by UH CDRC



Source: Greater Houston Flood Mitigation Research Consortium



Traditional Response & Recovery



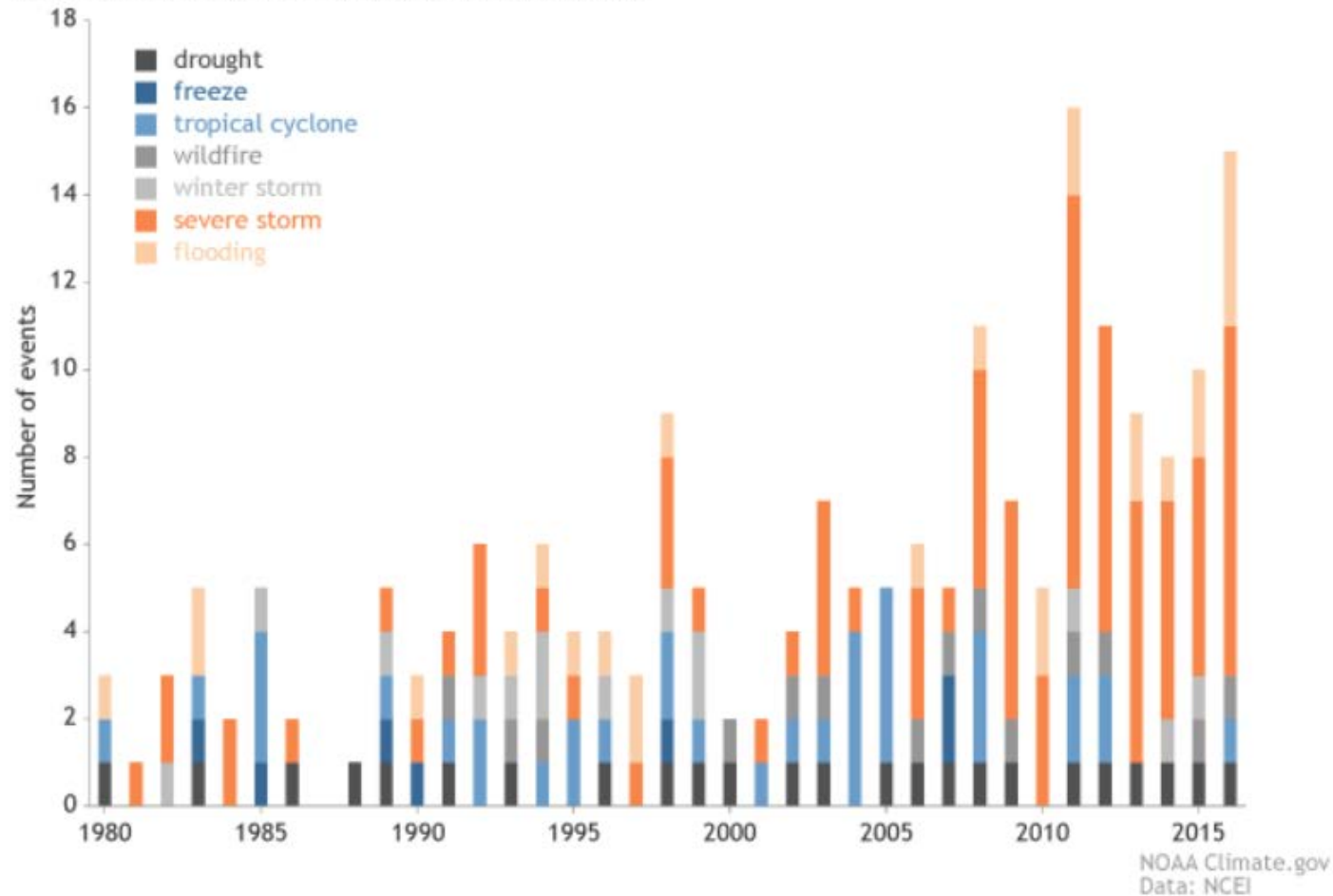
Warn

Rescue

Rebuild

Future Likelihood of Extreme Events

Billion-dollar disasters by type, from 1980-2016



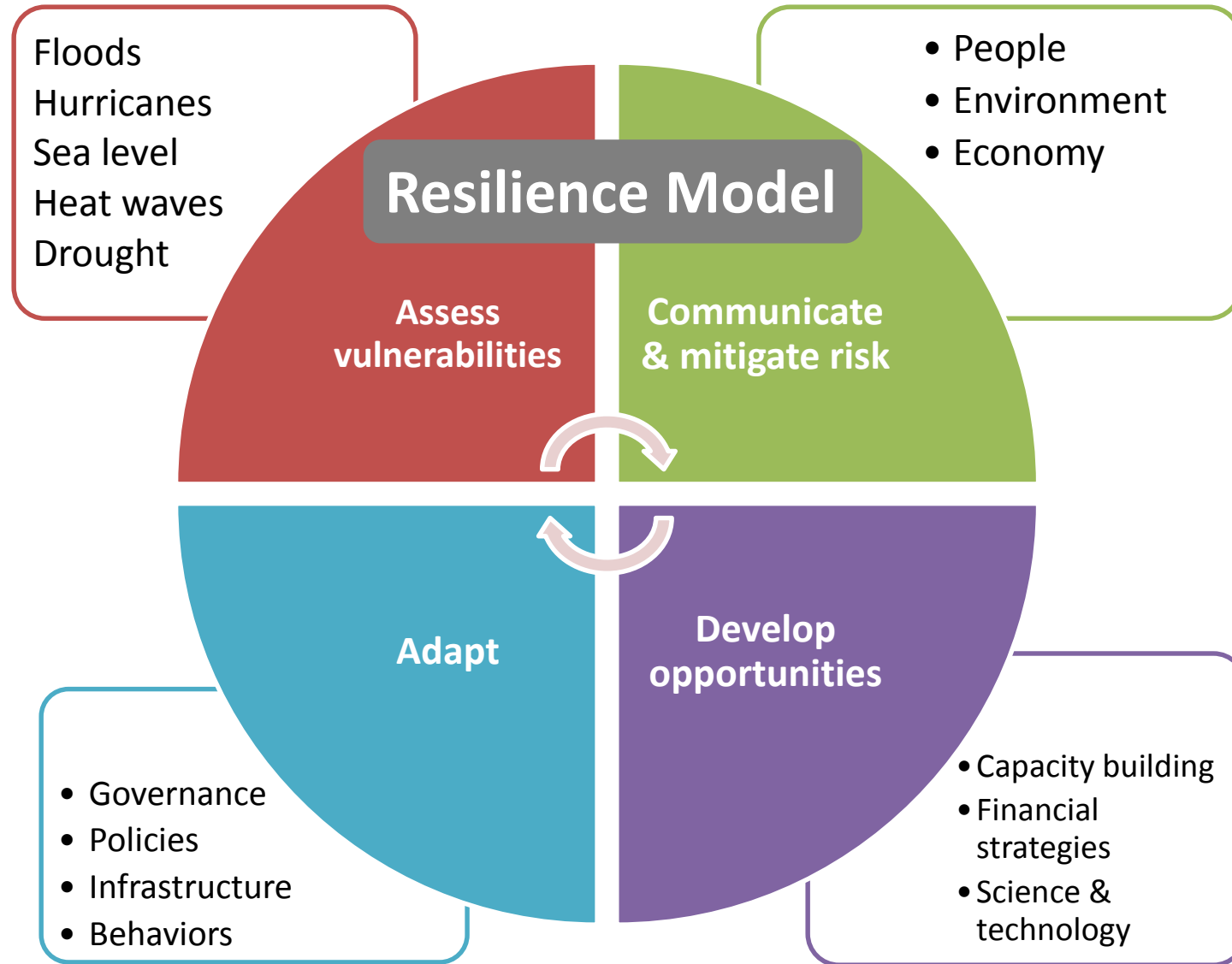
Increasing annual likelihood of Texas rainfall events > 20 inches:

- Yr 2000 ~ every 100 years
- Yr 2017 ~ every 16 years
- Yr 2100 ~ every 5.5 years

K. Emanuel. 2017. Assessing the present and future probability of Hurricane Harvey's rainfall. Proc Nat. Acad. Sci.



Resilience: Going Beyond Recovery

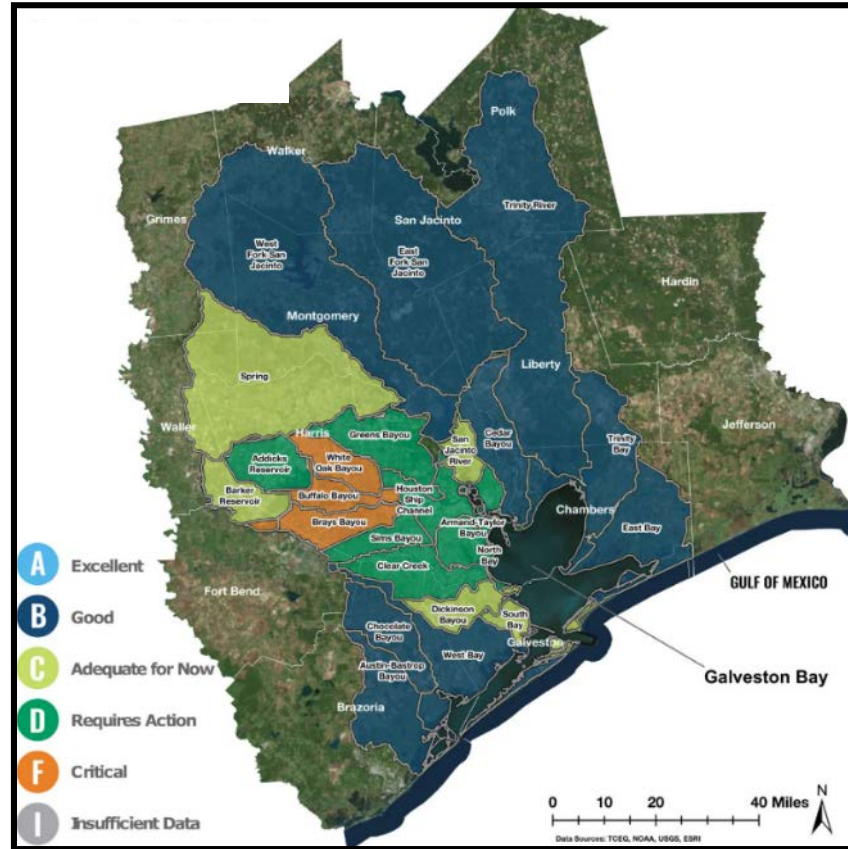


Connecting Land & Water: A Watershed Approach

Houston-Galveston Watershed	HARC Wetland & Development Index
Brays Bayou	73%
White Oak Bayou	67%
Buffalo Bayou	56%
Sims Bayou	50%
Houston Ship Channel	41%
Greens Bayou	44%
Armand-Taylor Bayou	38%
Clear Creek	42%
North Bay	30%
Addicks Reservoir	26%
Dickinson Bayou	23%
Barker Reservoir	22%
South Bay	20%
Spring Creek	18%
San Jacinto River	15%
West Bay	9%
Cedar Bayou	8%
West Fork San Jacinto	9%
Chocolate Bayou	7%
Trinity Bay	3%
East Fork San Jacinto	3%
Austin-Bastrop Bayou	3%
East Bay	2%
Trinity River	2%

Flooding & Water Quality Issues

Wetlands & Development



2017 Galveston Bay Report Card

Rethink development design practices, ordinances & building codes

Low Impact Development (LID)

Retrofit existing homes

Bayou greenways & buffers

Stormwater detention with created wetlands

Rain cisterns, gardens, barrels

Wetland protection & conservation easements

EMPLOY A WATERSHED APPROACH THAT ACCOUNTS FOR CONNECTIVITY & CUMULATIVE IMPACTS

Is Designing with Nature Possible in Houston?



Drainage swales surrounded by preserved habitat



Natural bank ponds



Collector streets, check dams, water impoundment on soils with good infiltration capacity

- Less stormwater runoff during 100-year storms
- Lower nutrient loadings
- Lower levels of forest fragmentation
- Average of 2°C lower land surface temperature
- Higher walkability and pedestrian access to open space

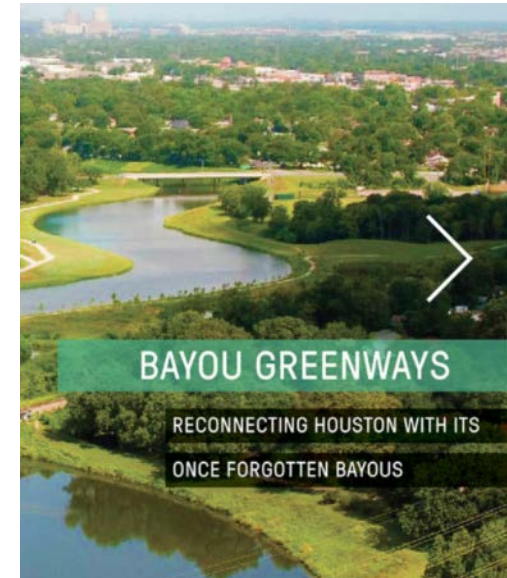
B. Yang & S. Li. 2015. Design with Nature: Ian McHarg's ecological wisdom as actionable and practical knowledge. Landscape & Urban Planning.

Financing Resilience

- Total Harvey costs ~ \$180B
- Harvey, Irma & Maria exceed federal recovery capacity
- Harvey recovery funds → traditional infrastructure & buyout projects

What about everything else?

- Innovative financing needed for future resilience projects
 - **Property Assessed Clean Energy (PACE Financing)**
 - **Green Bonds (standard bonds)**
 - **Resilience Bonds (bond premium rebates)**
 - **Environmental Impact Bonds (with private sector investment)**



Moving Forward...Talking Climate Solutions

- Focus on resilience
- Different communities experience different impacts
- Seek solutions

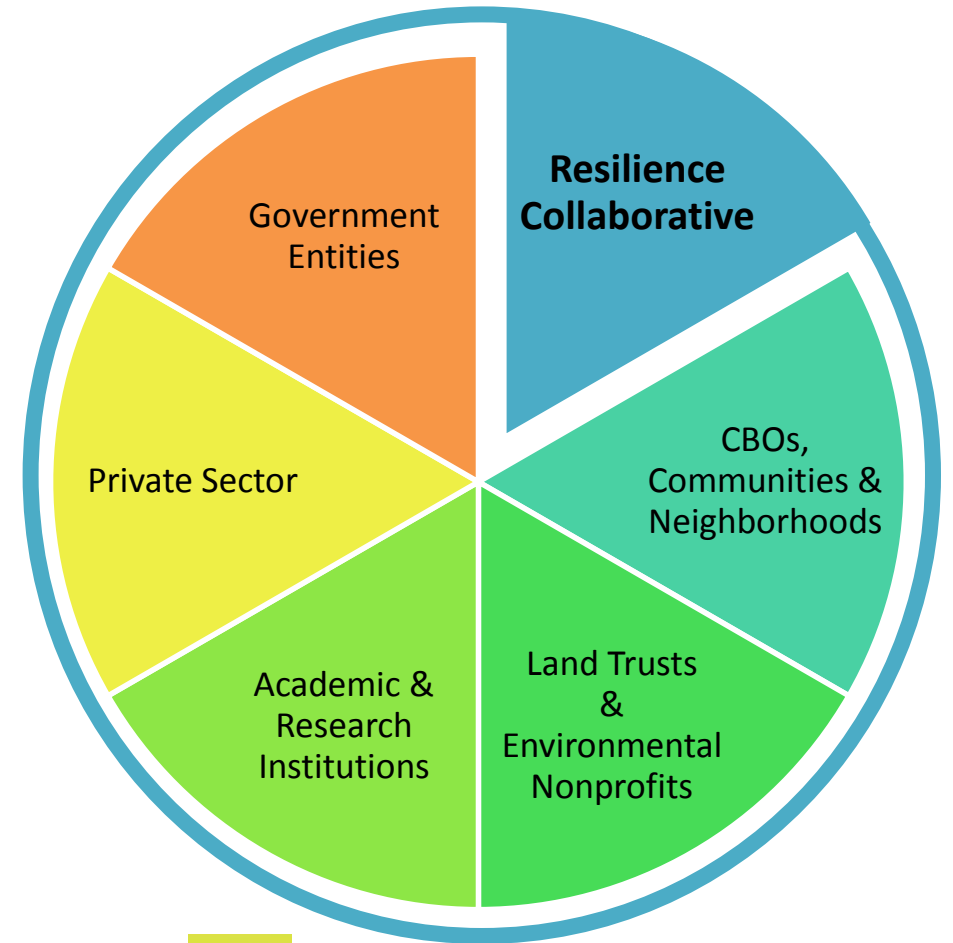


People & Nature Speak Series featuring Dr. Katharine Hayhoe & Gov Bill Ritter



Creating a Regional Adaptation & Resilience Collaborative

- National trend in resilience collaboratives
- **Goal:** Build long-term capacity
- Approach: multi-institutional & regional
 1. ***Assess progress and barriers*** to community resilience along the Texas Gulf Coast
 2. Create a ***science information network***
 3. Develop a regional ***framework of resilience and adaptation strategies*** with broad input
 4. Build a ***community of practice*** to share technical expertise, leverage resources, and advance comprehensive and coordinated strategies



New Local Initiatives

- Greater Houston Flood Mitigation Research Consortium (Huitt-Zollars)
- Built Environment Working Group (ULI-HARC)
- Environmental and Social Justice Coalition (Air Alliance Houston)
- Houston Housing Working Group (LISC)
- Habitat & conservation lands (KPC)
- Others...



www.compactofcoloradocommunities.org



Upcoming Events

- **RICS Summit Series Americas 2018 – Houston**
January 30
<http://www.rics.org/ca/training-events/conferences-seminars/rics-summit-series-2018---houston/houston/>
- **I-LinCP – Exploring Resiliency**
January 24
<https://i-lincp.wildapricot.org/event-2672464>
- **Houston Climate Forum 2018 – Texas’ 7th District Congressional Candidates**
January 27
<https://www.eventbrite.com/e/houston-climate-forum-2018-location-change-tickets-41611344652>
- **Greater Houston Flood Mitigation Consortium – Buyout best practices in the wake of Harvey**
February 6
<https://www.eventbrite.com/e/buyout-best-practices-in-the-wake-of-harvey-tickets-41963818912>
- **CoreNet / IFMA – Building a more resilient Houston**
February 8
<http://network.corenetglobal.org/events/eventdescription?CalendarEventKey=48c34e33-f8a0-4493-8ebf-d98eb4221f67&CommunityKey=f811f7de-cb03-4fab-aa5b-15d9895bb1fa&Home=%2fevents%2frecentcommunityeventsdashboard>
- **Kinder Institute Forum: What is the Future of Houston in a Disaster Prone World**
February 21
<https://www.eventbrite.com/e/kinder-institute-forum-what-is-the-future-of-houston-in-a-disaster-prone-world-tickets-41524866995>
- **SSPEED Urban Flooding and Infrastructure Conference**
February 21-22
http://sspeed.rice.edu/sspeed/downloads/Conference_Harvey.pdf



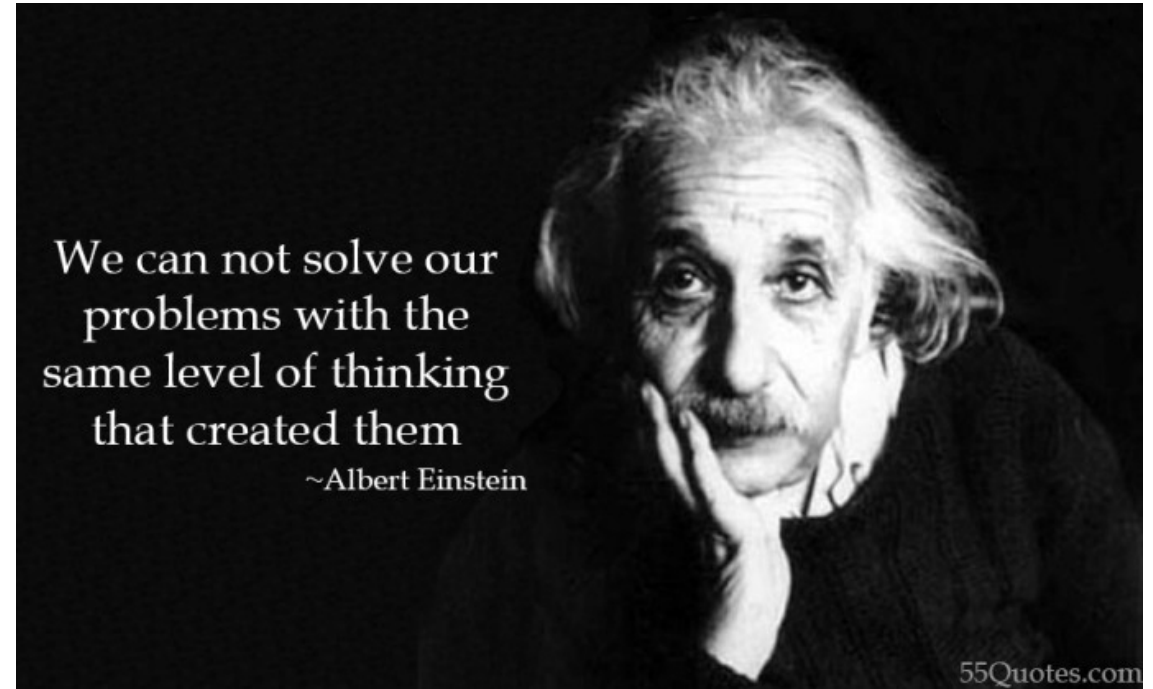
Thank You



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HARCresearch.org



HARC (härk), *n.*
an independent research
hub helping people thrive
and nature flourish.