

HARC

Summarizing Hurricane Harvey's Environmental Impacts

**Dr. Stephanie
Glenn**

HARCresearch.org



Intro

Water

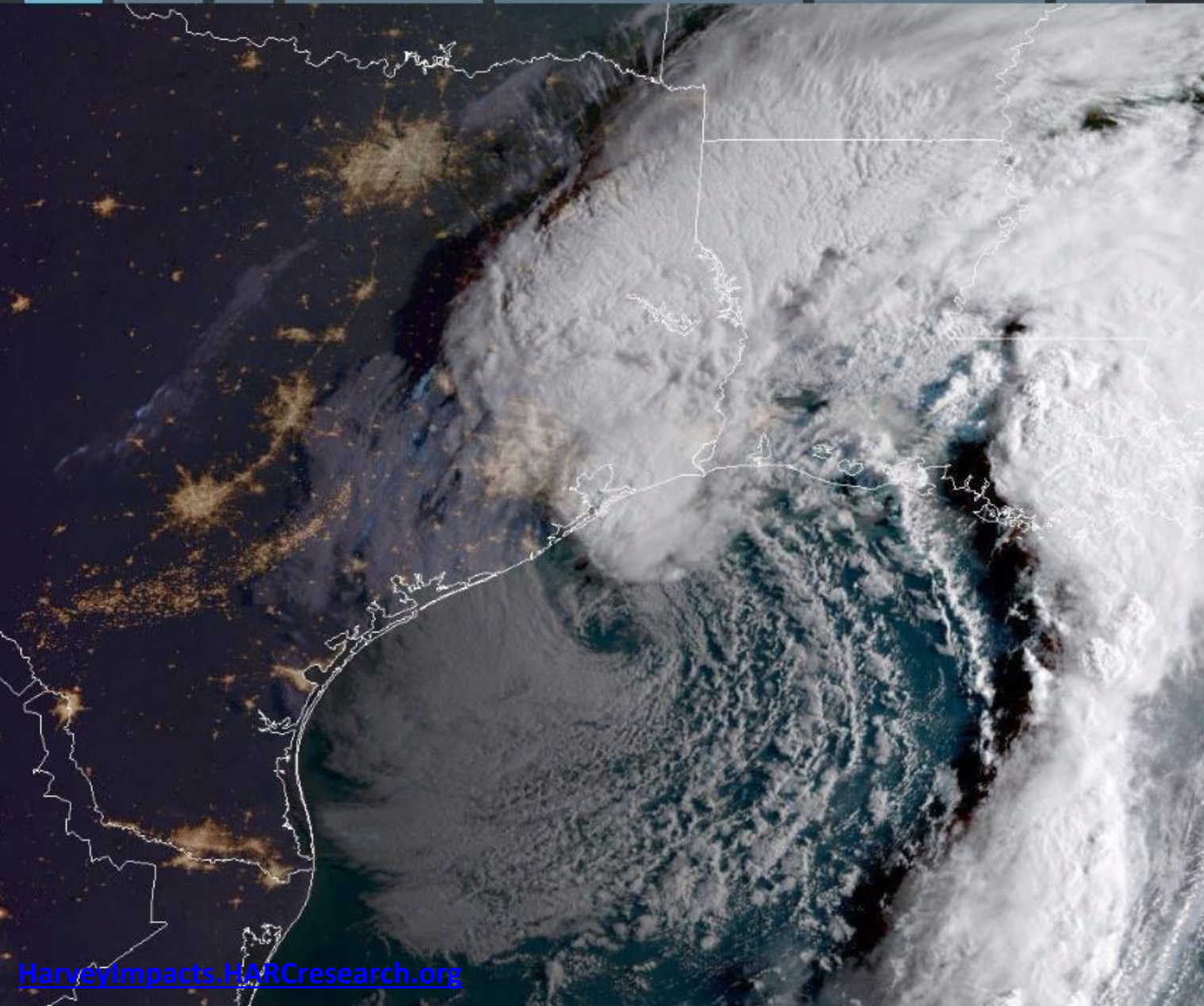
Air

Health and Safety

Built Environment and People

Electricity and Energy

About



The Houston-Galveston Region receives on average 45 inches of rainfall each year. During Harvey, some areas received more than **50 inches of rain in less than one week.**

Disclaimer: This application is for informational purposes only and may not be suitable for legal, engineering, or surveying purposes. Mapping may not necessarily reflect on-the-ground conditions. HARC makes no claims as to the accuracy or reliability of the data, and neither assumes nor accepts liability for use. Use or reproduction of these data without acknowledging HARC as the source is prohibited.

Image Courtesy of NOAA





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What the Water Carried

Salinity and Temperature

Bacteria

Flow



What the water carried

Harvey's flood waters carried enormous amounts of debris, sediments, and hazardous pollutants. Satellite imagery (left image) clearly shows the murky waters from Harvey flowing into the Gulf of Mexico. Toxins and pathogens such as viruses and bacteria were intermixed and transported along with contaminated sediments and floating debris. Hurricane Harvey has created a legacy of health concerns for residents, rescue workers, and the environment that will linger for years to come and have to be addressed.



Photo by Revolution Messaging

Sediment

Hurricane Harvey stripped sediments from

Water

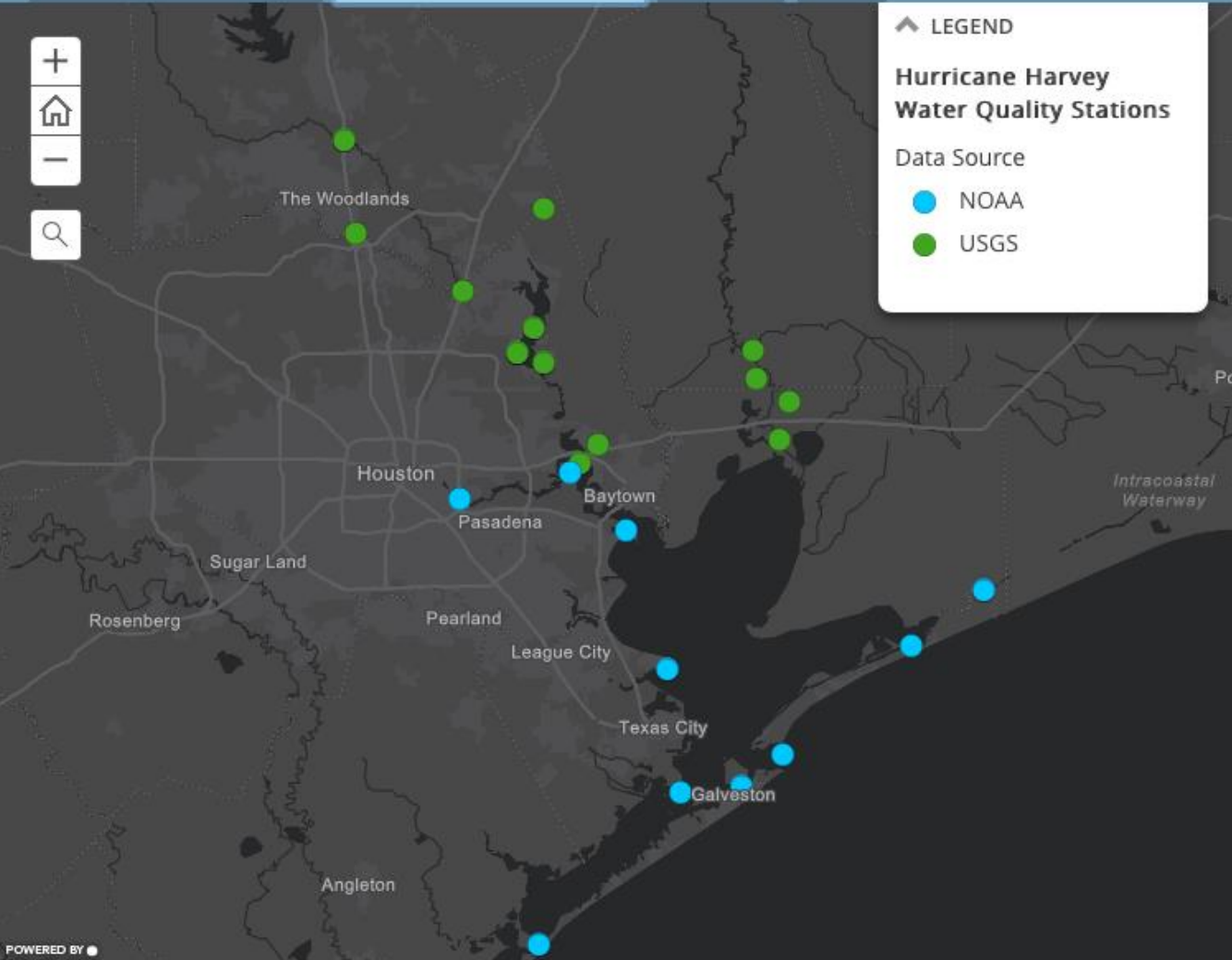


LEGEND

Hurricane Harvey Water Quality Stations

Data Source

- NOAA
- USGS



The region received trillions of gallons of rain, which resulted in vast amounts of freshwater inflows to Galveston Bay. The preliminary estimate of inflows, according to the Texas Water Development Board, is 12.2 million acre-feet to Galveston Bay - **more water than Galveston Bay typically receives in a year.** TWBD preliminary estimates show that inflow during August of 2017 is the highest August inflow on record (1977-present). Decreasing salinity and temperatures followed, with disastrous impacts on oysters. TPWD estimates that it could take more than two years for oysters to repopulate Galveston Bay. Some industry experts believe that as much as 90% of all Galveston Bay oysters may have been lost.

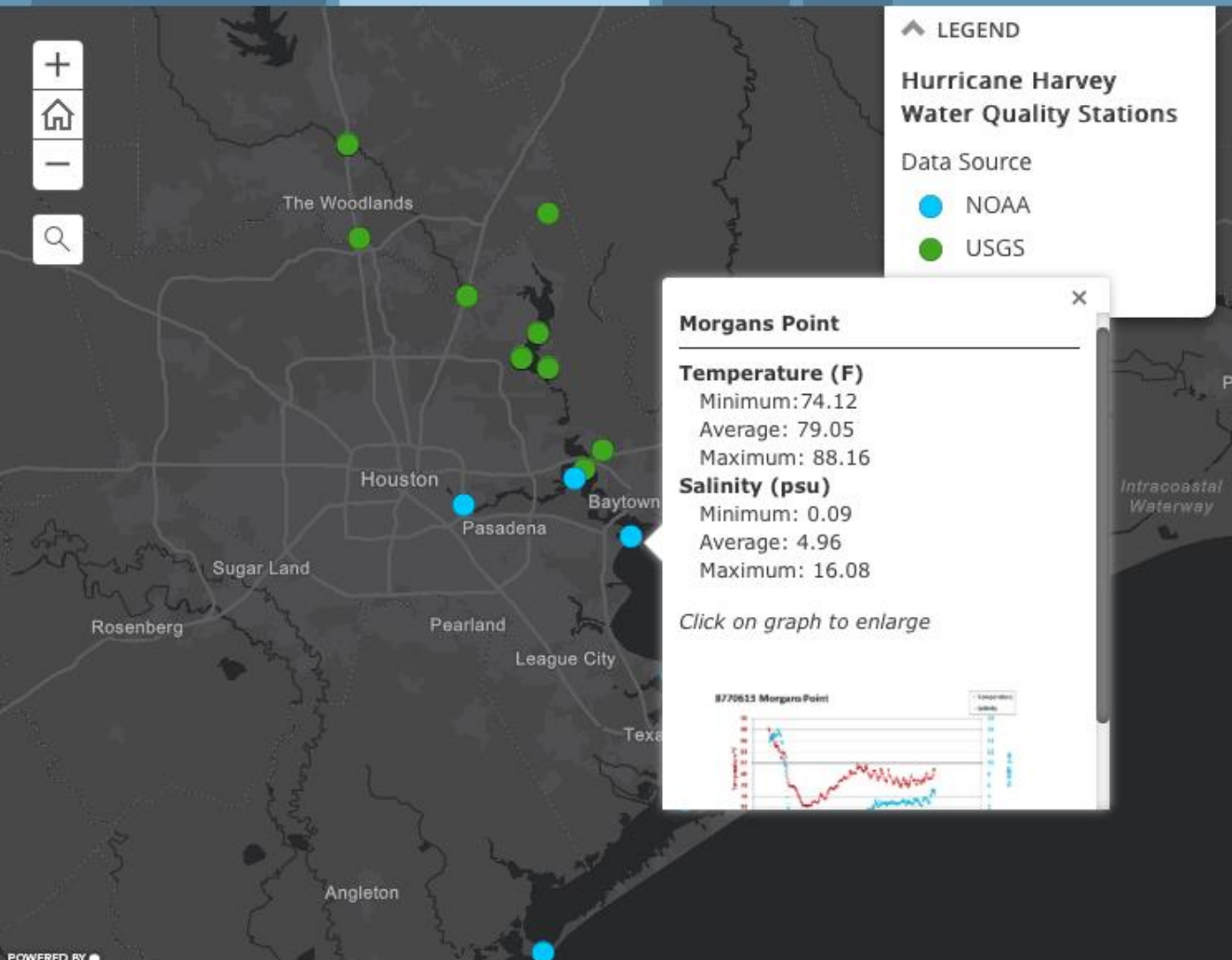




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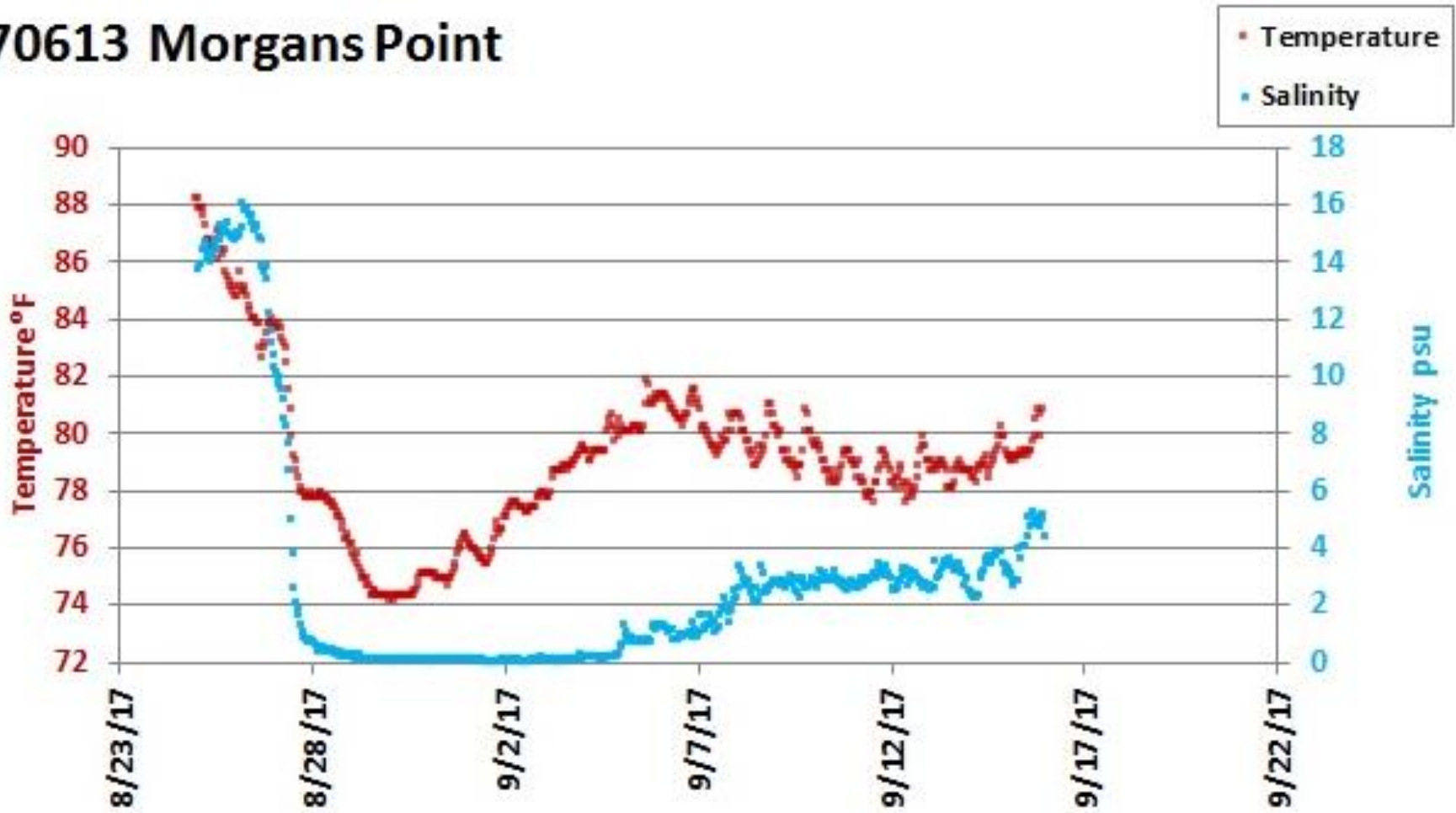


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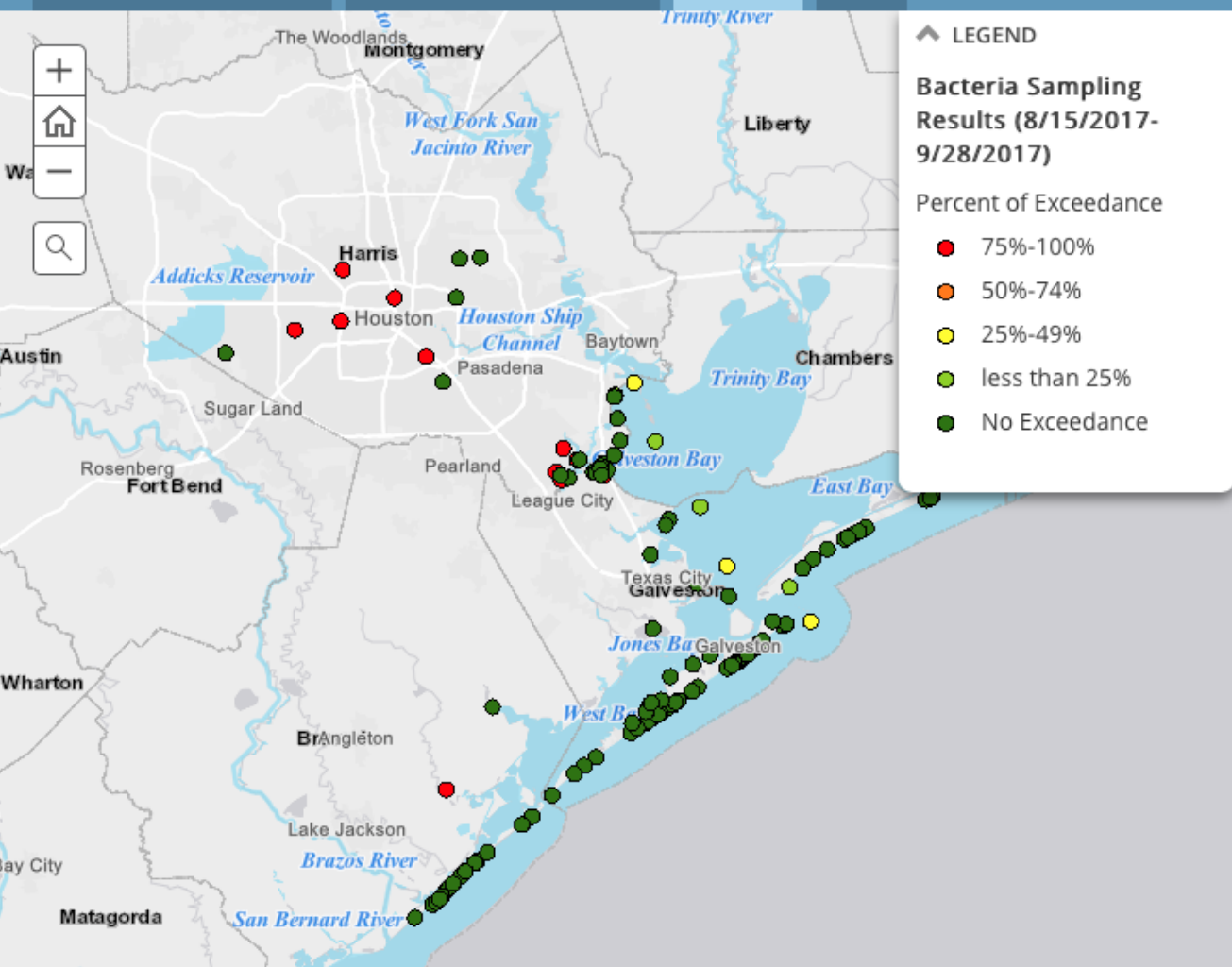
Temperature & Salinity

8770613 Morgans Point





Water



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Bacteria Sampling Results (8/15/2017-9/28/2017)

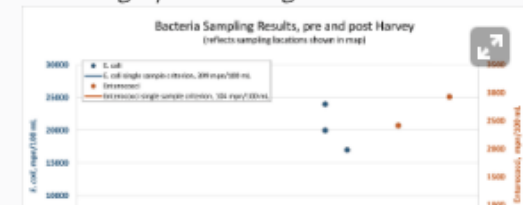
Percent of Exceedance

- 75%-100%
- 50%-74%
- 25%-49%
- less than 25%
- No Exceedance

Elevated levels of bacteria are used to indicate risk from fecal contamination and associated pathogens in waterbodies. Bacteria are found in fecal wastes of all warm-blooded animals, including humans, livestock, and wildlife. Waterways are considered impaired for contact recreation if bacteria levels exceed health standards set by federal and state agencies. When bacteria levels are too high, infections and gastrointestinal distress can occur. Extreme events such as Harvey can cause sewer systems to fail, which means untreated wastewater is mixed with flood waters. As a result, bacteria in flood waters are often well above safe levels for human contact.

Bacteria data courtesy of Galveston Bay Foundation, Texas GLO Beach Watch Program, Texas A&M Galveston, Texas A&M and University of Houston Clear Lake, and Houston Health Department.

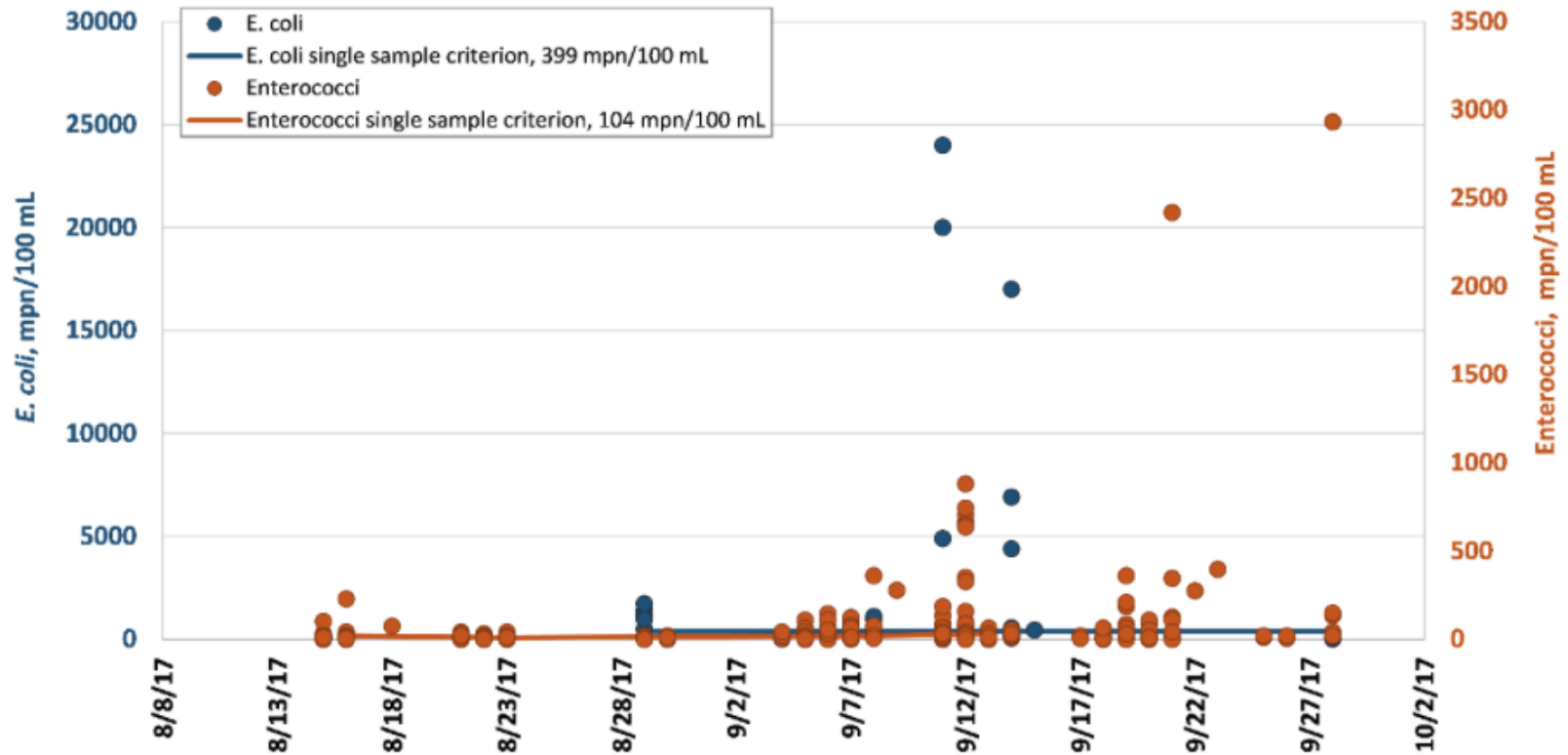
Click on graph to enlarge





Water

Bacteria Sampling Results, pre and post Harvey (reflects sampling locations shown in map)

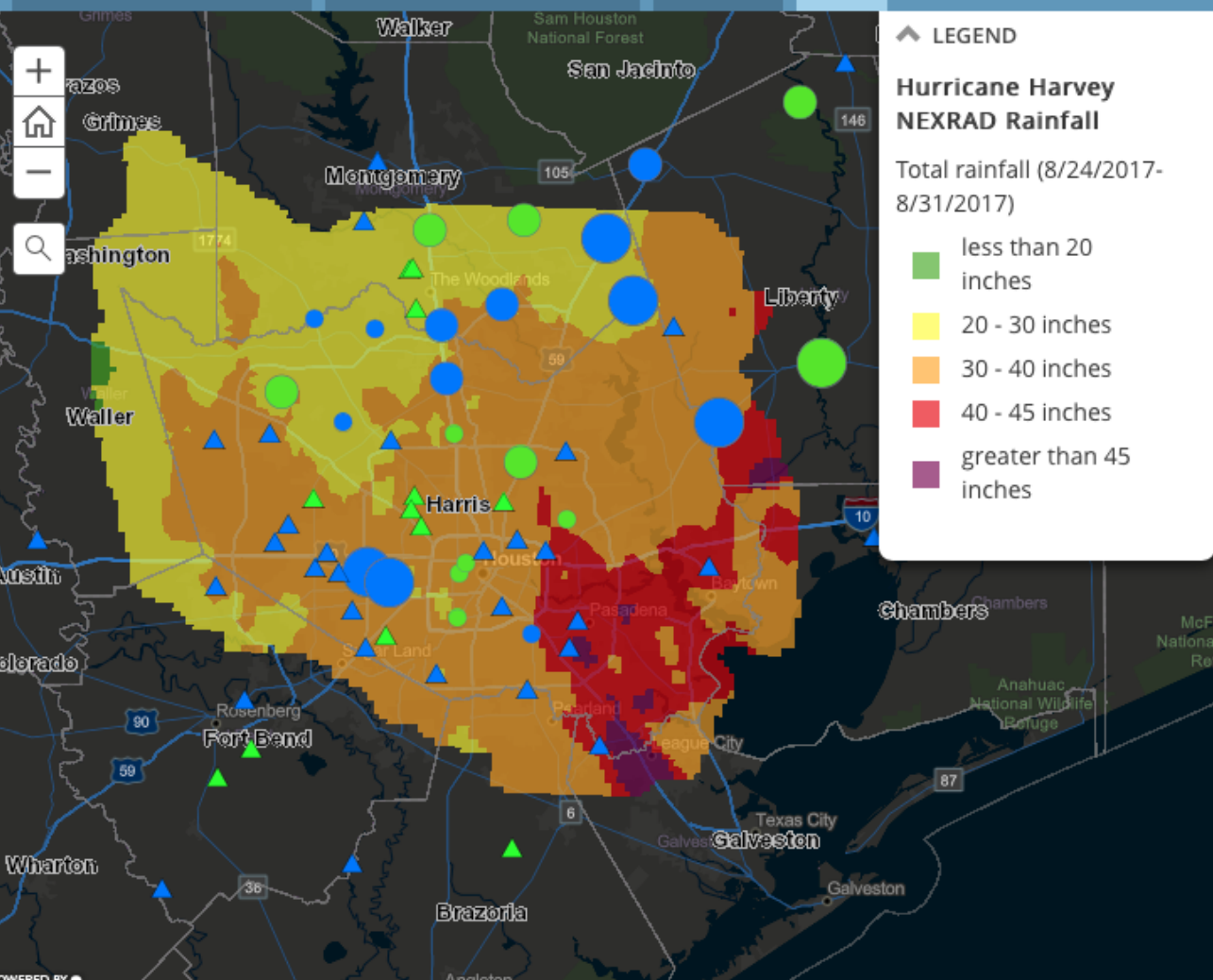




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Hurricane Harvey NEXRAD Rainfall

Total rainfall (8/24/2017-8/31/2017)

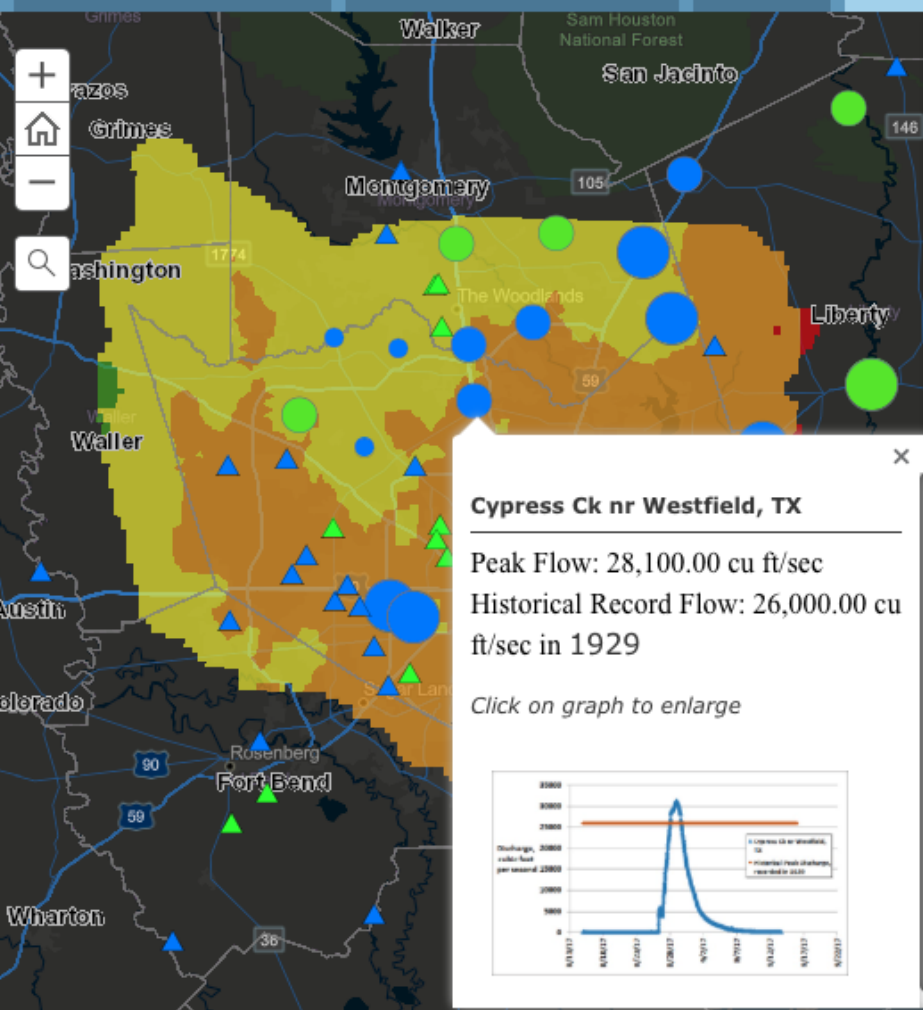
- less than 20 inches
- 20 - 30 inches
- 30 - 40 inches
- 40 - 45 inches
- greater than 45 inches

The map to the left shows USGS stream gauges; the size of the circle corresponds to days the gauge reported waters over flood stage (triangles did not have records available to indicate number of days above flood stage). **Blue** indicates flow at that gauge exceeded Historical Flood peaks (ft³/s) during Harvey. **Green** indicates flow at that gauge did not exceed peaks. Click on the circles to view a hydrograph for flow at that gauge during Harvey.

Harvey resulted in catastrophic flooding. Stream flow gauges at various locations around the region measured flooding that exceeded historically recorded flood values. The amount of flood waters associated with Hurricane Harvey can be better understood by examining these stream flow gauges. This map shows USGS and some shared NWS stream gauges only. There may be other complete flow data sets for this time period.



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Hurricane Harvey NEXRAD Rainfall

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Toxics

Daily Maximum 8-hour Ozone Concentrations

8/15/2017 - 9/15/2017

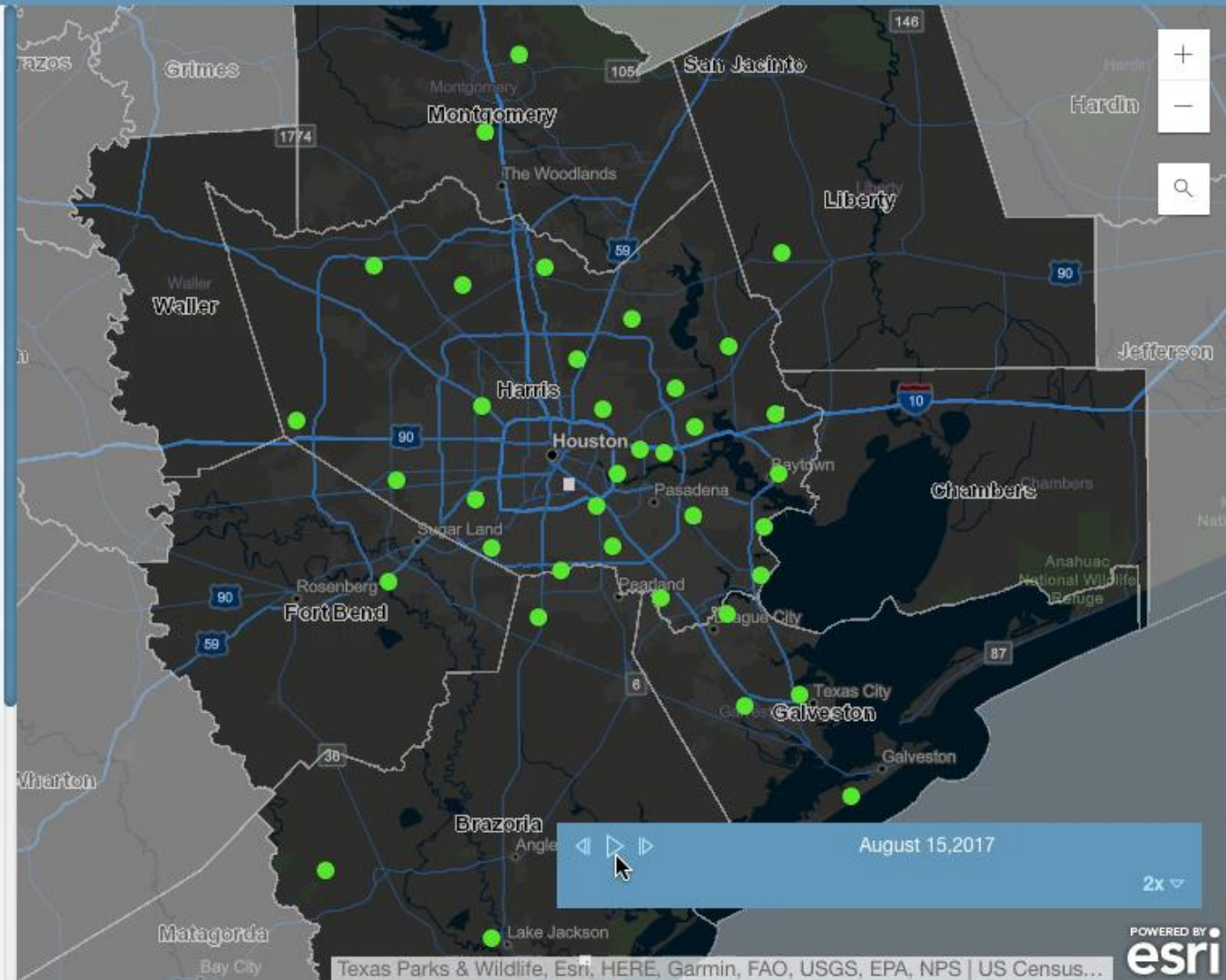
- Good
- Moderate
- Unhealthy for Sensitive Groups
- Unhealthy

Sites without data



The slider at the bottom right will advance the time series by day. Click the arrows right or left to see differences between days.

Ground level (tropospheric) ozone is a secondary air pollutant formed by the chemical reaction between volatile organic compounds (VOCs) and nitrogen oxides (NO_x) in the presence of sunlight. Ozone is a respiratory irritant that can lead to coughing, difficulty breathing and shortness of breath, exacerbate the frequency and intensity of asthma attacks, throat irritation, and even lung infections and damage. Children and the elderly are especially sensitive to these health effects. Ozone can also affect the growth of vegetation and trees and reduce crop yields. High levels of ozone can be caused by elevated emissions of VOCs and NO_x.



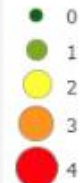
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Ozone

Toxics

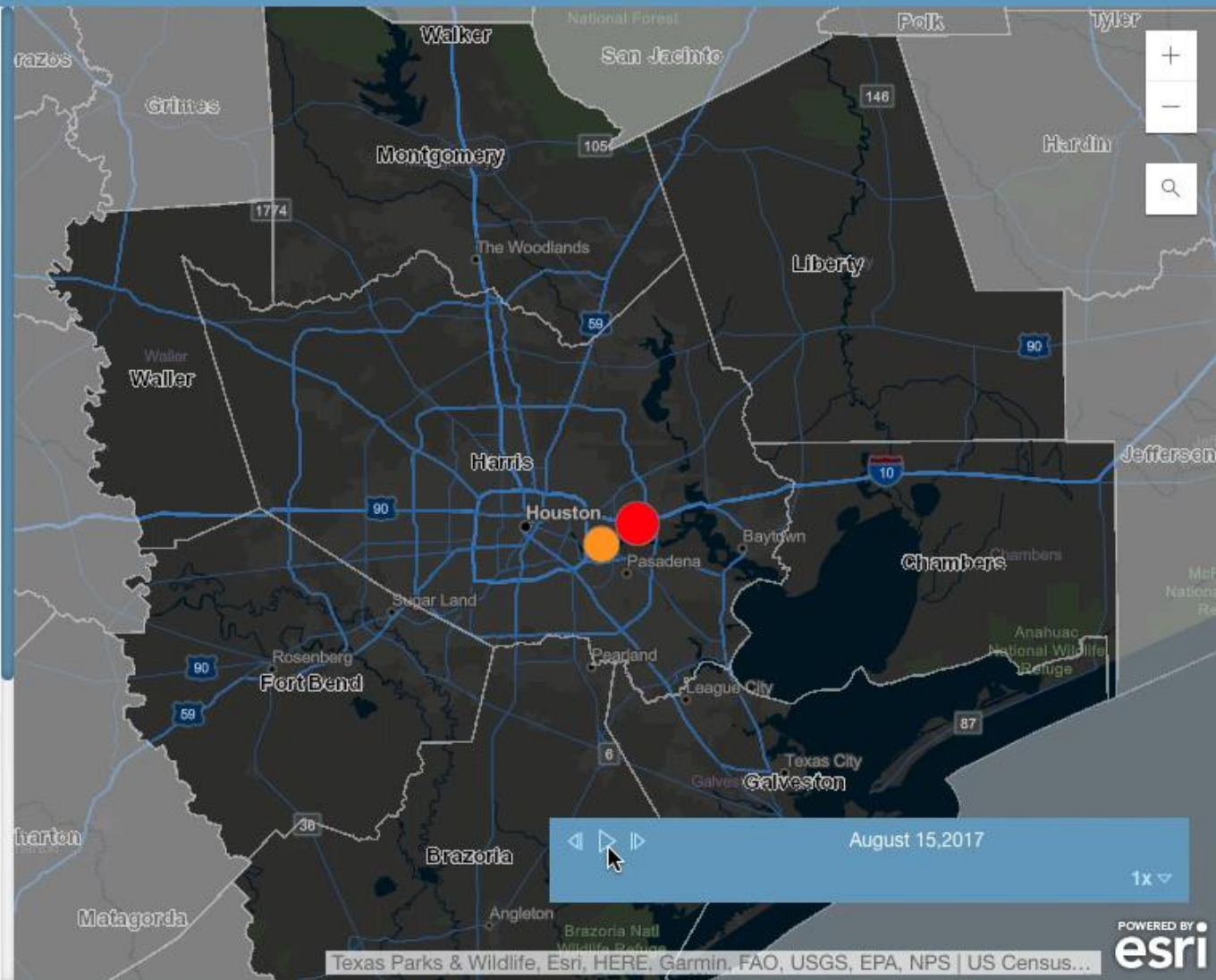
Hurricane Harvey BTEX

Number of BTEX compounds above Pre-Harvey Mean



The slider at the bottom right will advance the time series by day. Click the arrows right or left to see differences between days.

"BTEX" refers to a group of volatile organic compounds (VOCs) made up of benzene, toluene, ethylbenzene, and xylenes. The primary sources of BTEX emissions are refineries, petrochemical plants, vehicle emissions, and evaporative losses from fuel storage tanks. Exposure to toxic air pollutants (air toxins) that comprise BTEX gases can lead to headaches, eye and nose irritation, and nervous system, liver, and kidney damage. Benzene is a known carcinogen (cancer causing). Elevated levels of these hazardous air pollutants (HAPs) seen after Hurricane Harvey are likely due to storm-related spills and releases at industrial facilities, shutdowns and startups at refineries and petrochemical facilities, as



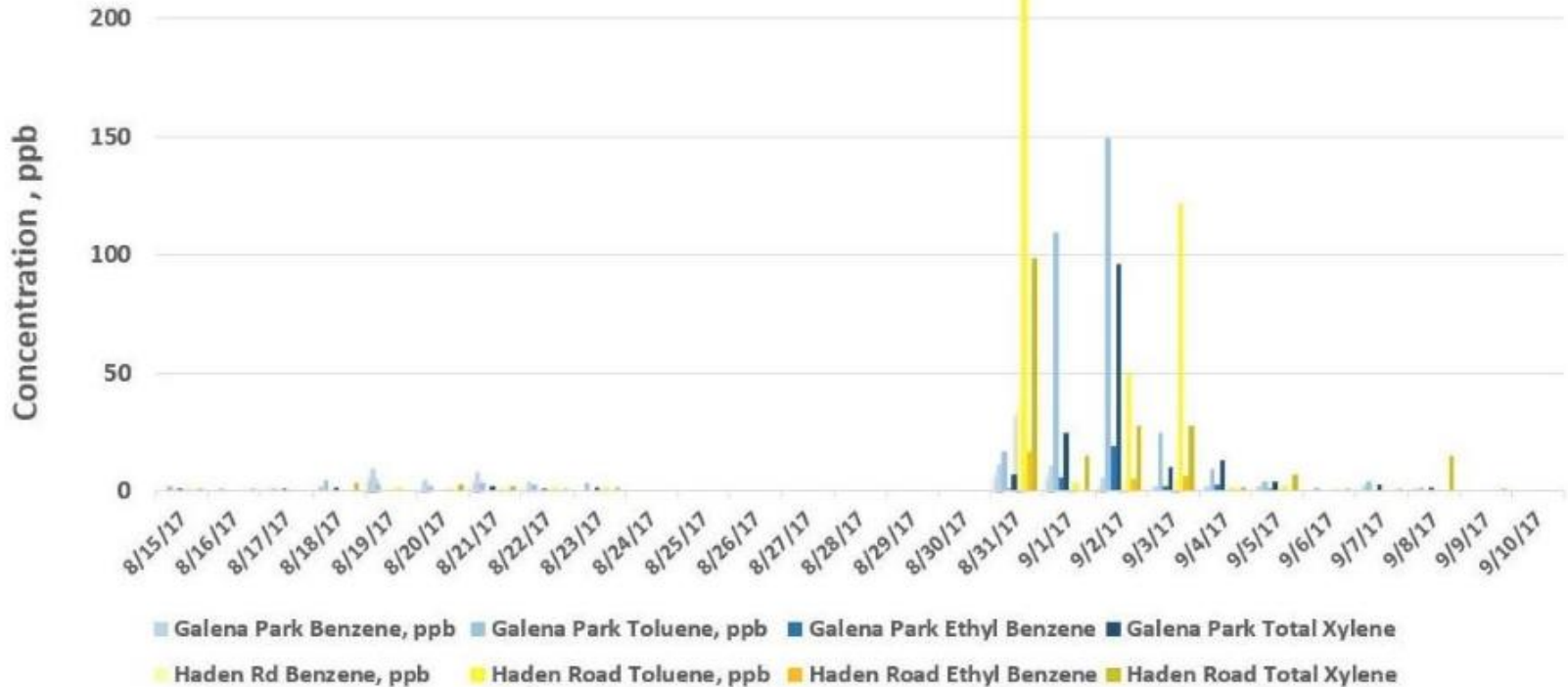


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BTEX Compounds





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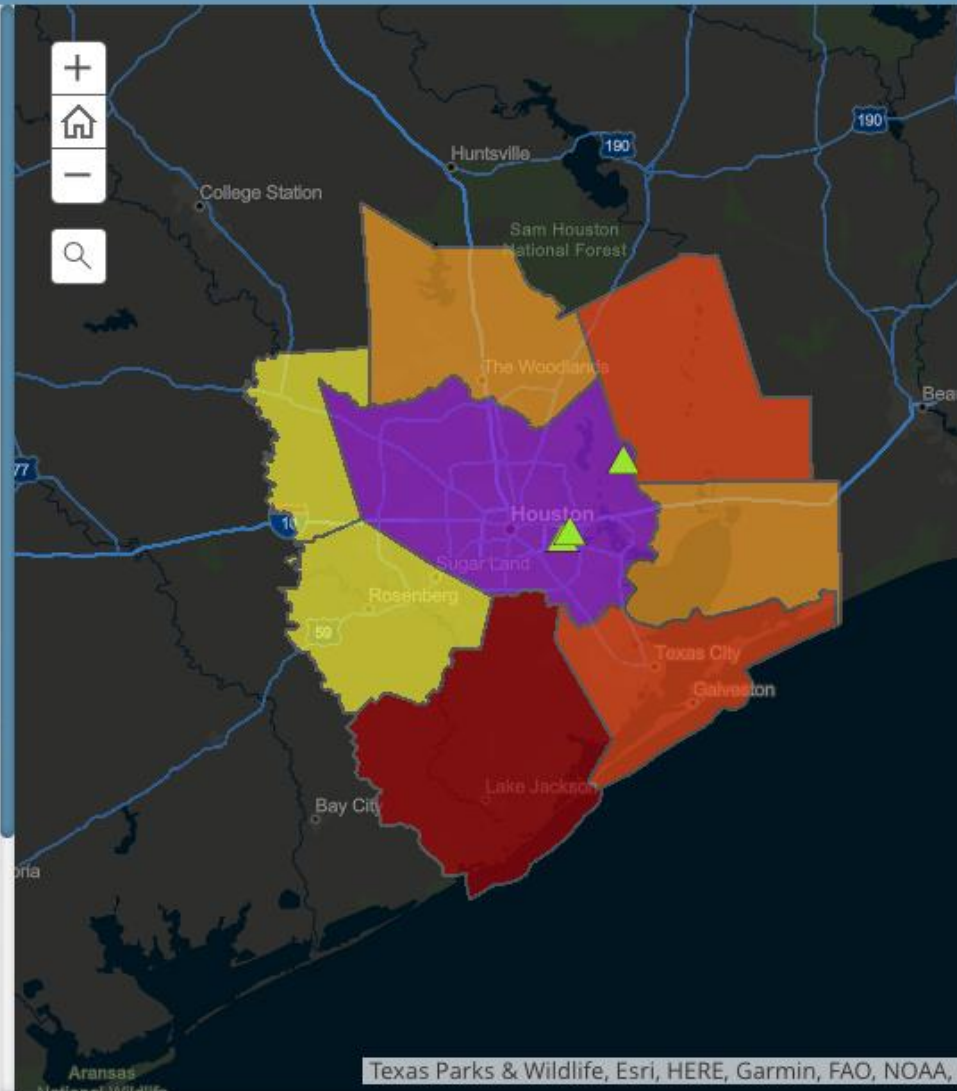
Health and Safety

Hazardous Releases

Superfund

The USCG National Response Center maintains a database of reported incidents involving hazardous materials across the United States. These data facilitate public awareness about the nature, timing and location of chemical, oil, and other hazardous spills. Please note these data include only reported releases and likely represent a mere fraction of Harvey-related pollutant impacts in the regional environment.

During Hurricane Harvey, 90 incidents were reported in the greater Houston-Galveston region involving more than 700,000 gallons of pollutants released into water and on land, and more than 38,000 pounds of air pollutants. Pollutants included oil and gasoline compounds, organic toxics such as benzene, PCBs, and butadiene, nitrogen oxides, ammonia and sulfur dioxide among others. Volumes of liquids spilled ranged from less than five to more than 460,000 gallons. Air pollutant releases ranged from less than five to more than 10,000 pounds.



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Hurricane Harvey NRC Hazardous Incidence Reports

Major Incidents



Total Incidents by County

1

2 to 5

6 to 10

11 to 20

More Than 20





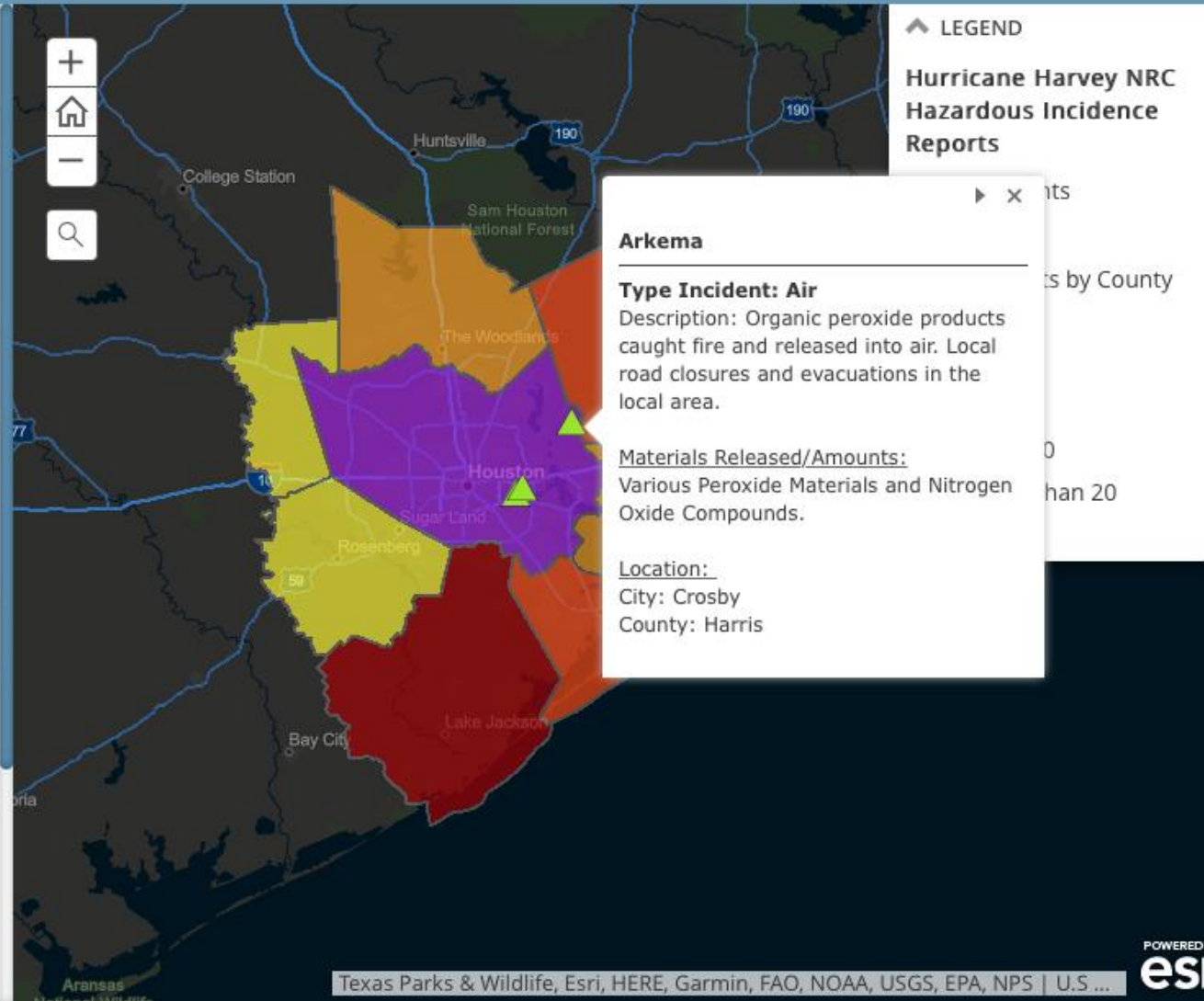
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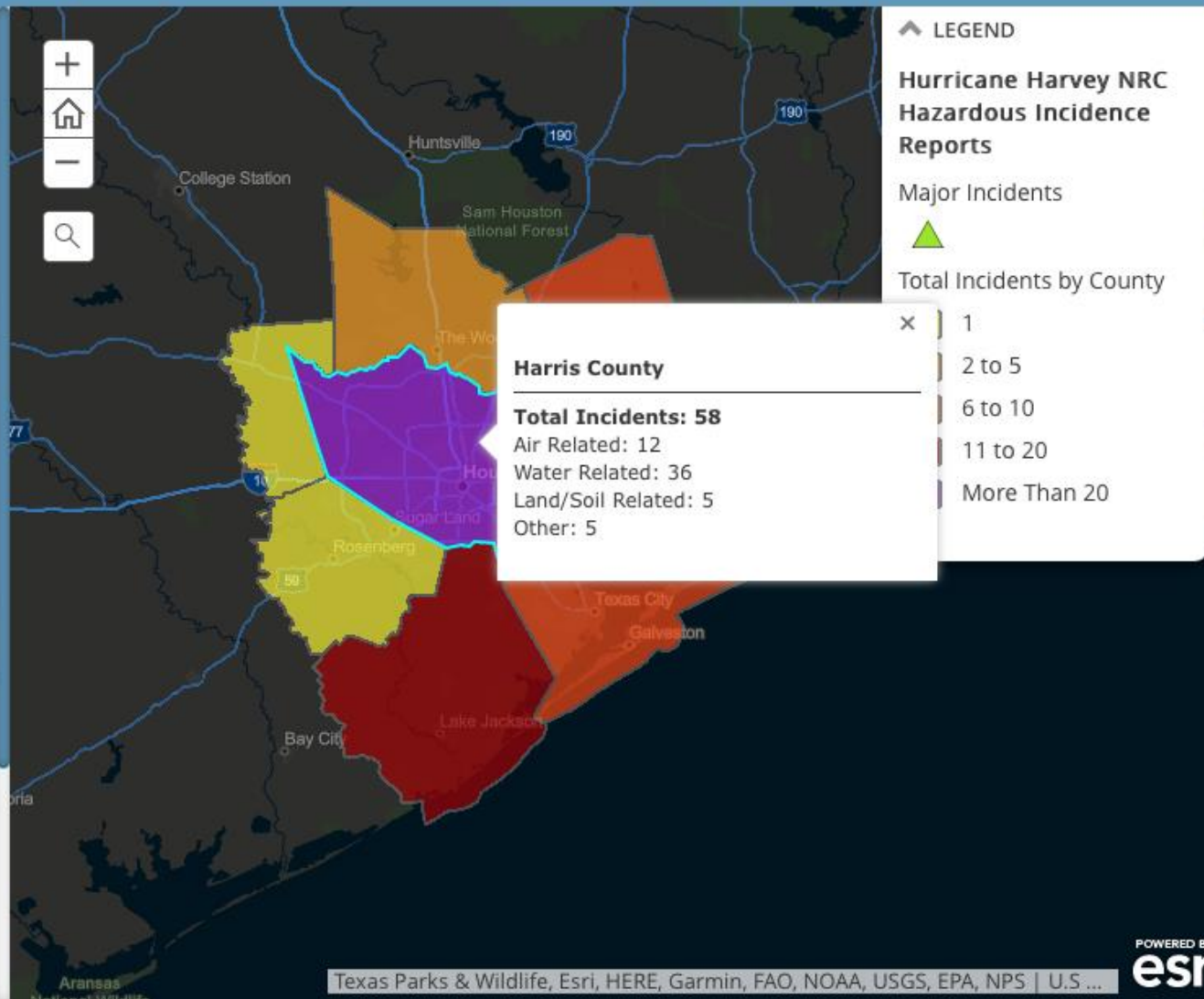
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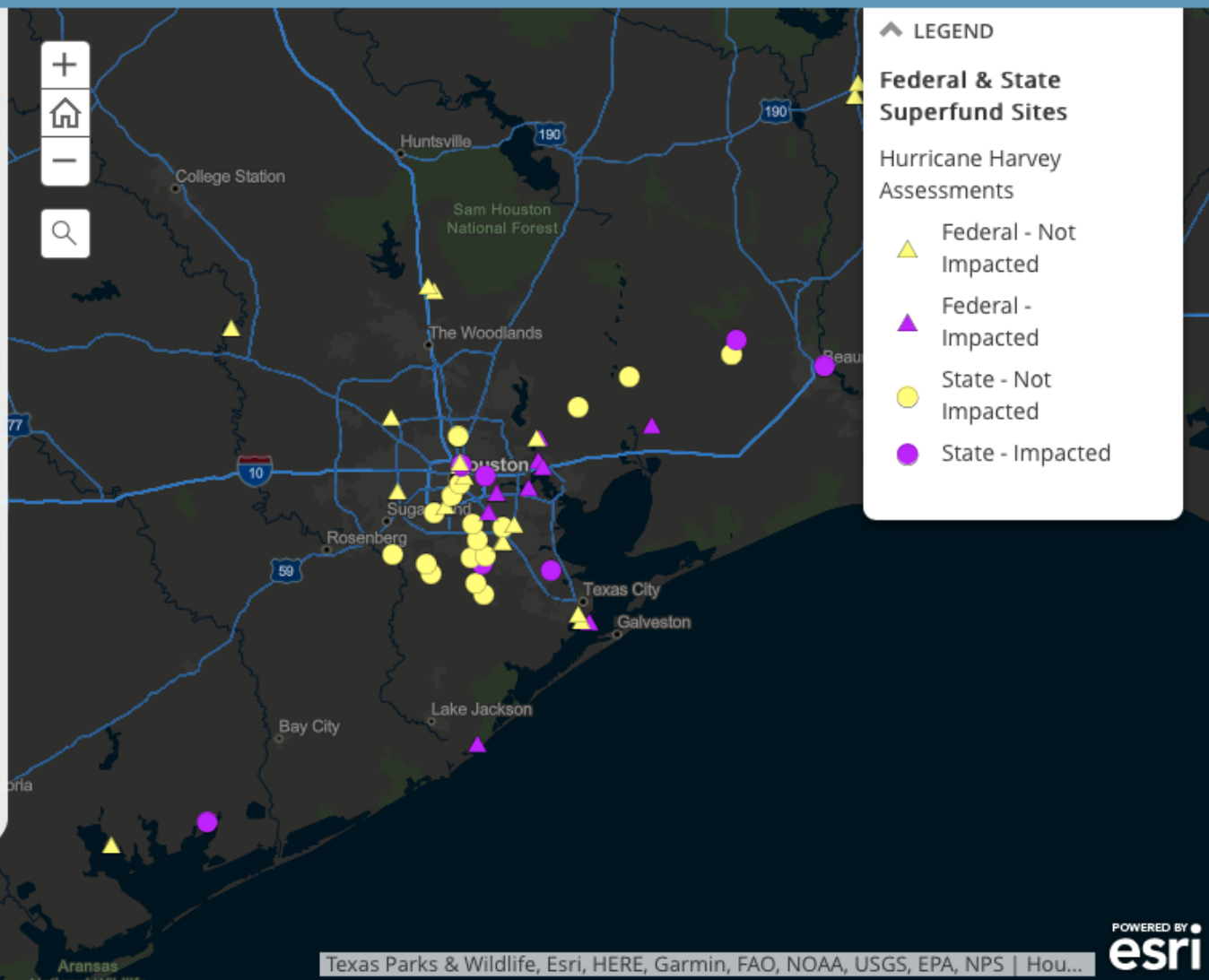
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Hazardous Releases

Superfund

Select a station to learn its floodplain, activity and phase status, as well as pollutants associated with the site.

Superfund is a US government program designed to fund the cleanup of sites contaminated with hazardous substances and pollutants. Superfund sites are typically designated because the substances pose a risk to human health and/or the environment. The EPA has **determined** that 13 federal Superfund sites in the Houston region experienced flooding by Harvey. As of September 14, two sites have been **identified for additional assessment**: U.S. Oil Recovery and The San Jacinto Waste Pits. The potentially responsible parties of the San Jacinto Waste Pits Superfund site have been **directed to take immediate action** to address damages. TCEQ identified 13 State Superfund sites for impact assessment post-Harvey. **No major issues were noted.**





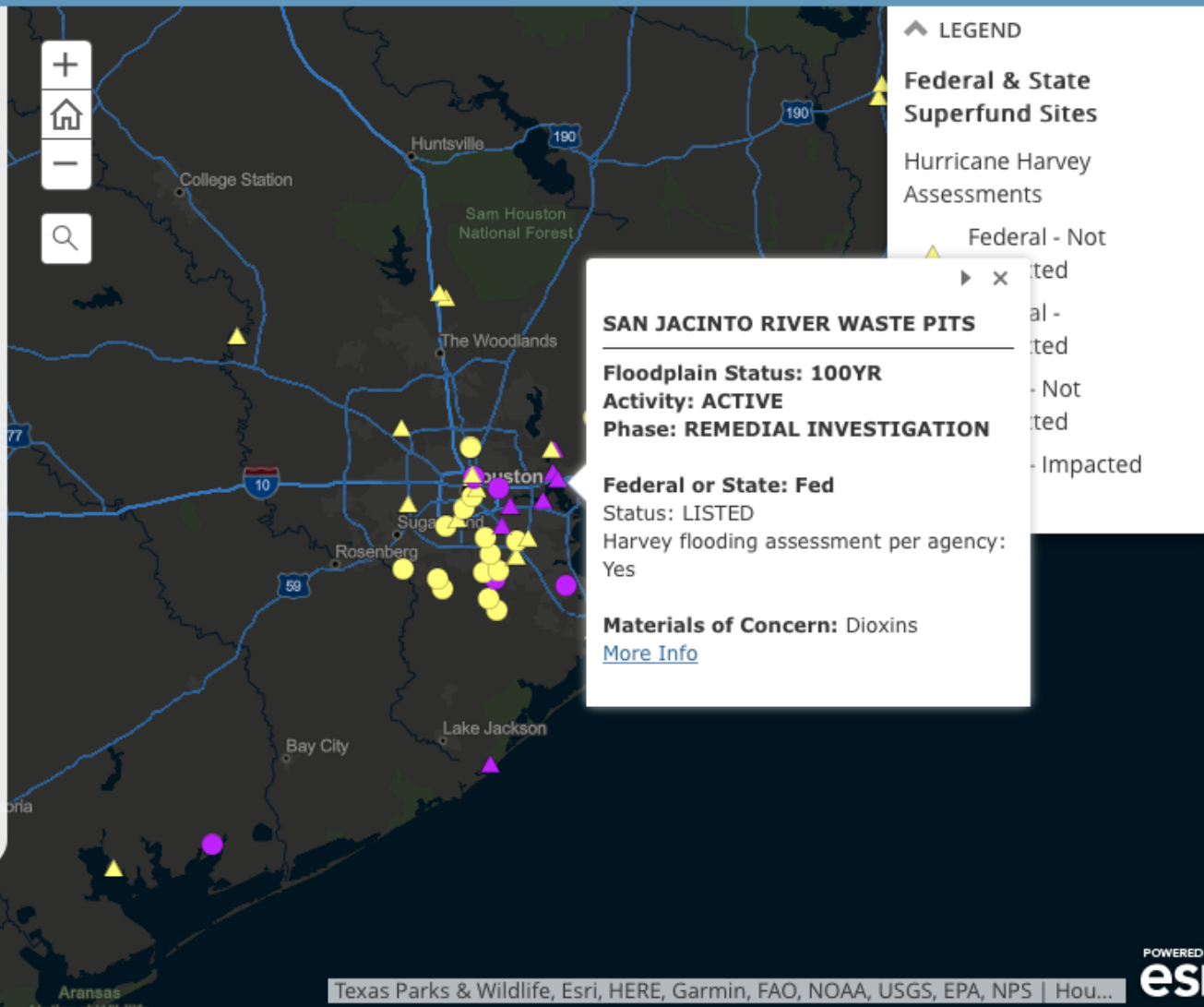
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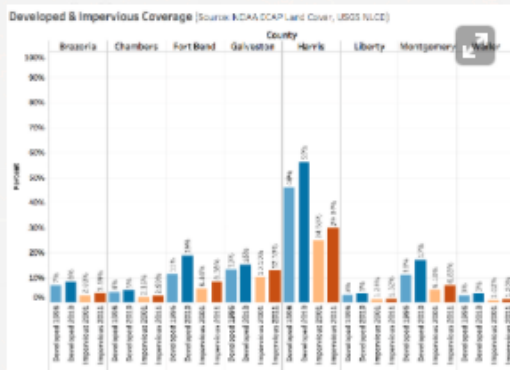
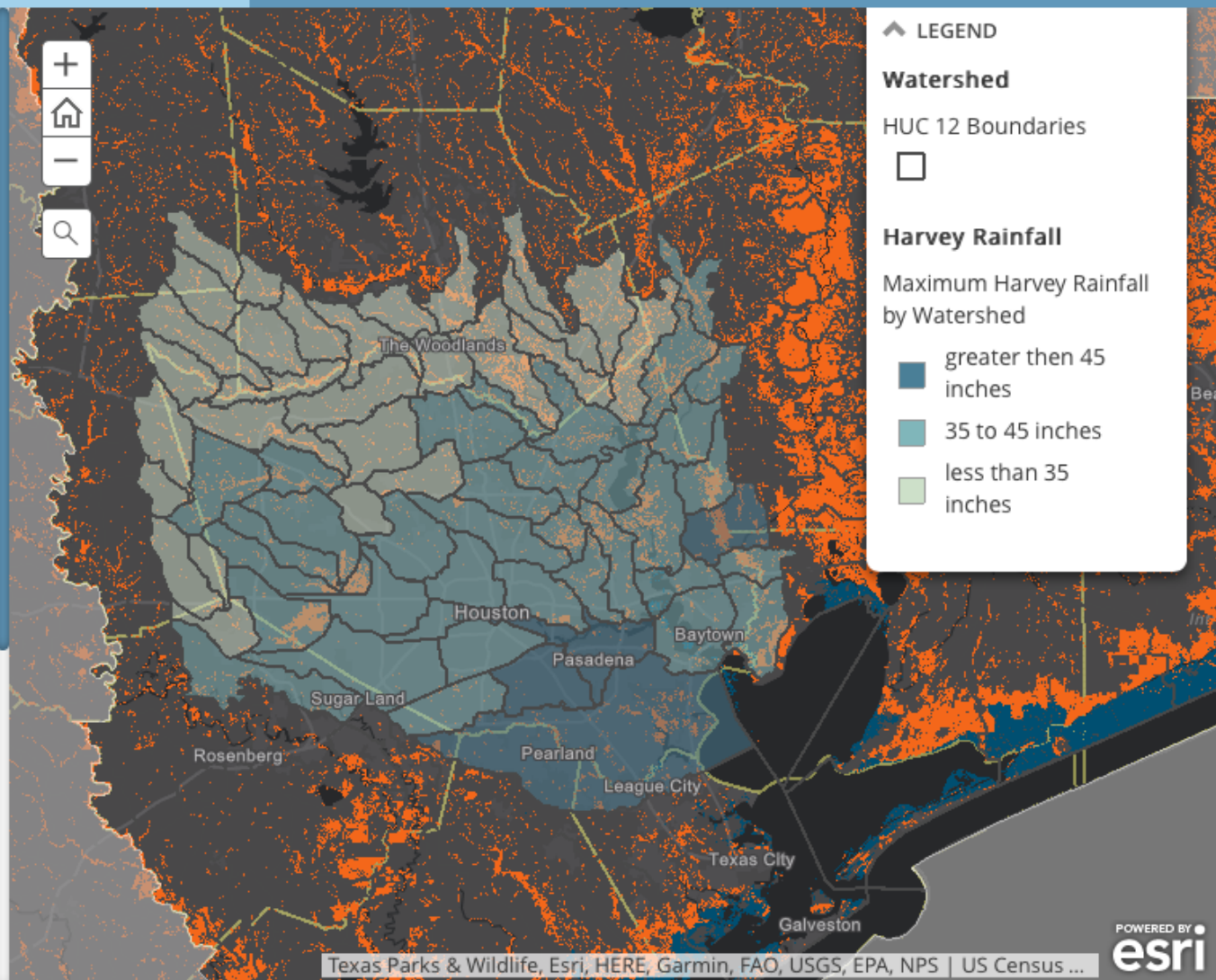


Built Environment and People

FEMA Modeled Damages

Development, Rainfall and Wetlands

Click on a watershed to display a popup with Harvey rainfall information. Hint: Use arrows (in the top right corner of the popup header) to cycle through additional information on Harvey rainfall amounts, impervious coverage (types of land cover that do not allow water to pass through, such as pavement), watershed wetlands, and land use. In the map estuarine wetlands are shown in blue, and palustrine wetlands are shown in orange, per the NOAA 2010 Coastal Change Analysis Program data. Click on the graph below to see statistics by County.

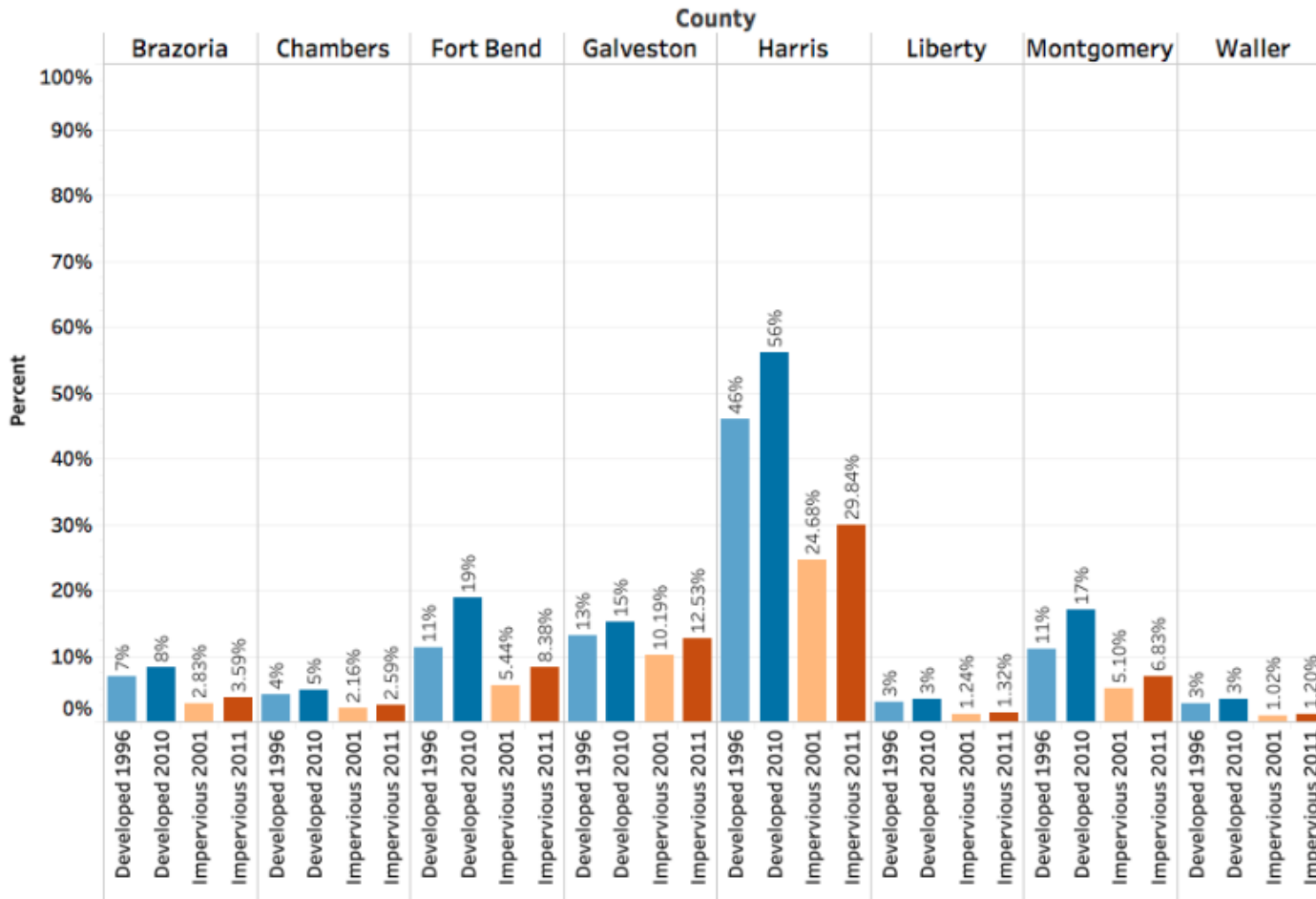


Wetlands, forests, and prairies are natural habitats vital to mitigating impacts and damages caused by high precipitation storm events such as Harvey. These



Built Environment and People

Developed & Impervious Coverage (Source: NOAA CCAP Land Cover, USGS NLCD)



Click on a watershed with Harvey rainfall arrows (in the top header) to cycle through information on Harvey impervious coverage that do not allow such as pavement and land use. In the wetlands are shown NOAA 2010 Coastal Program data. Click see statistics by County



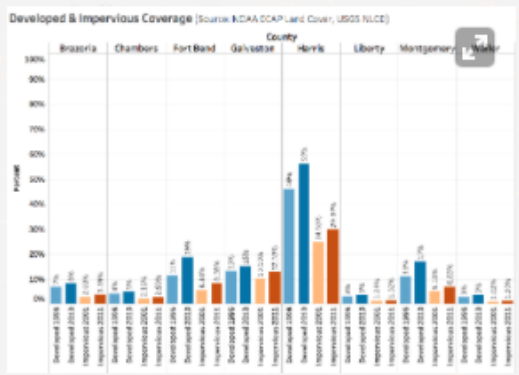
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LEGEND

Watershed

HUC 12 Boundaries

Harvey Rainfall

Maximum Harvey Rainfall by Watershed

- greater than 45 inches
- 35 to 45 inches
- less than 35 inches

Rainfall for Clear Creek-Frontal Galveston Bay Watershed

Minimum: 29.55
 Maximum: 49.23
 Average: 38.89
 Median: 39.90

*Amounts calculated from 1 Km by 1 Km Nexrad radar grid.



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Power Generation and Outages

Power Demand

DOE US Power Plants

Type of Power Plant

- Combined Heat and Power
- Electric, Commercial, and Industrial

Hurricane Harvey Power Outages by Zip Code

Percentage of Customer Outages

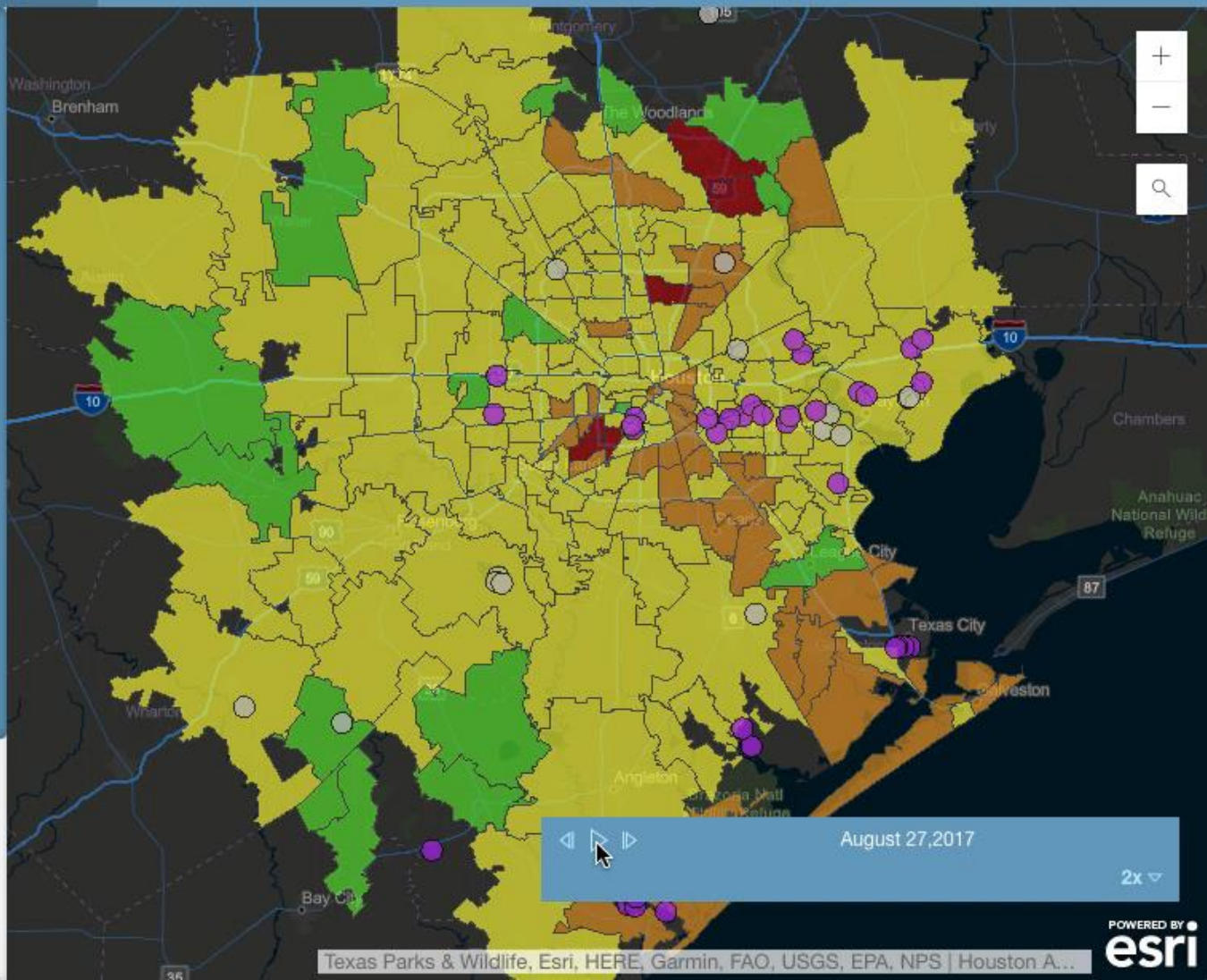
- No Outage
- Up to 5% of Customers
- 5% to 20% of Customers
- 20% or More of Customers

The slider at the bottom right will advance the time series by day. Click the arrows right or left to see differences between days.



UTMB Galveston Post Ike 2008

Hurricane Harvey wreaked considerable havoc on the electric power transmission and distribution system. During the span of the storm approximately 1.5 million power customers along the Gulf Coast lost power.





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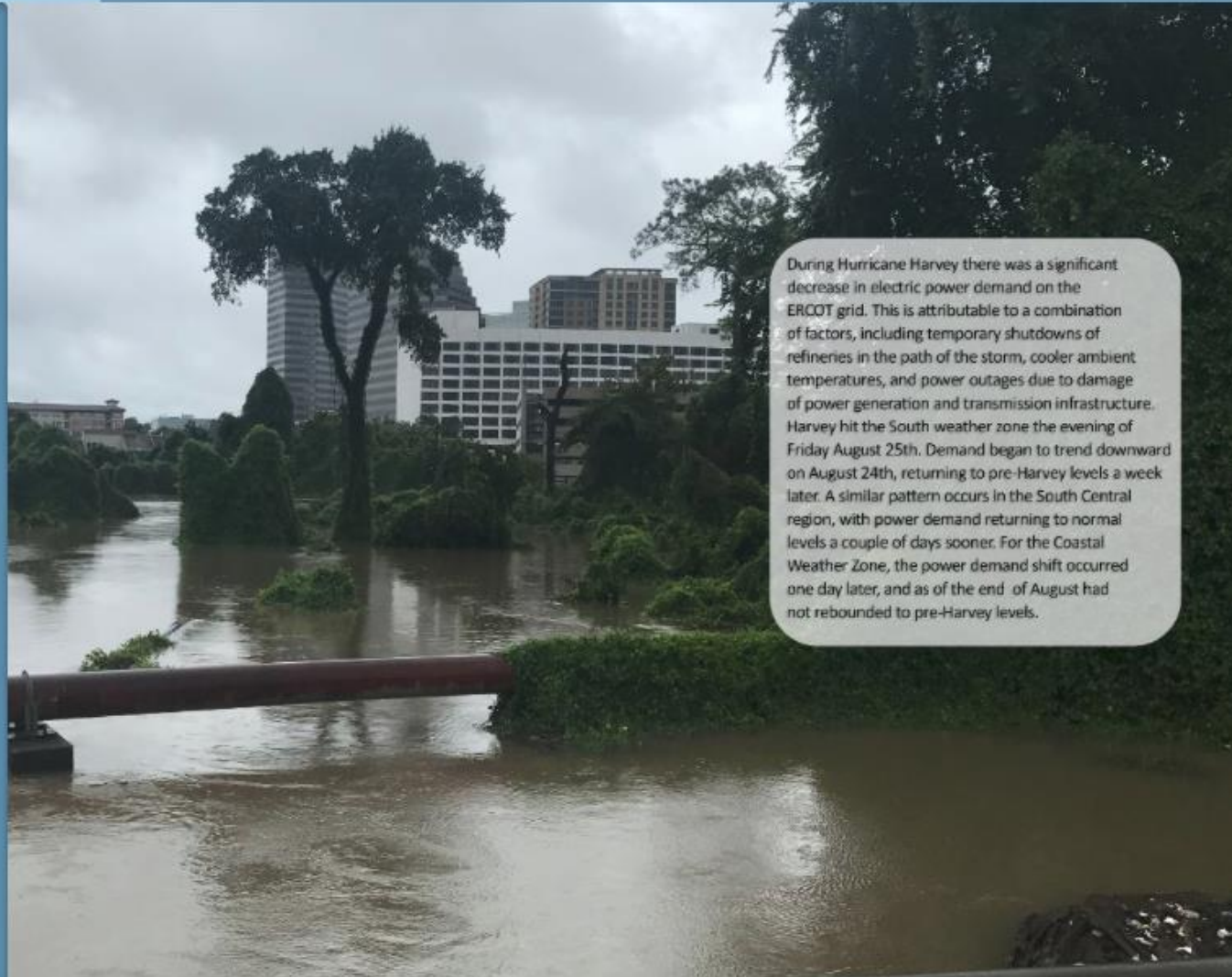
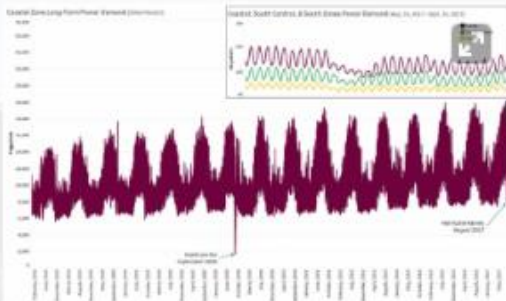
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Power Generation and Outages

Power Demand

Click on the graph below to see regional ERCOT power demand from 2002 to 2015, showing an overall increasing trend, with dips for Hurricanes Ike and Harvey. The inset graph in the top right hand corner shows Harvey power demand by weather zones.

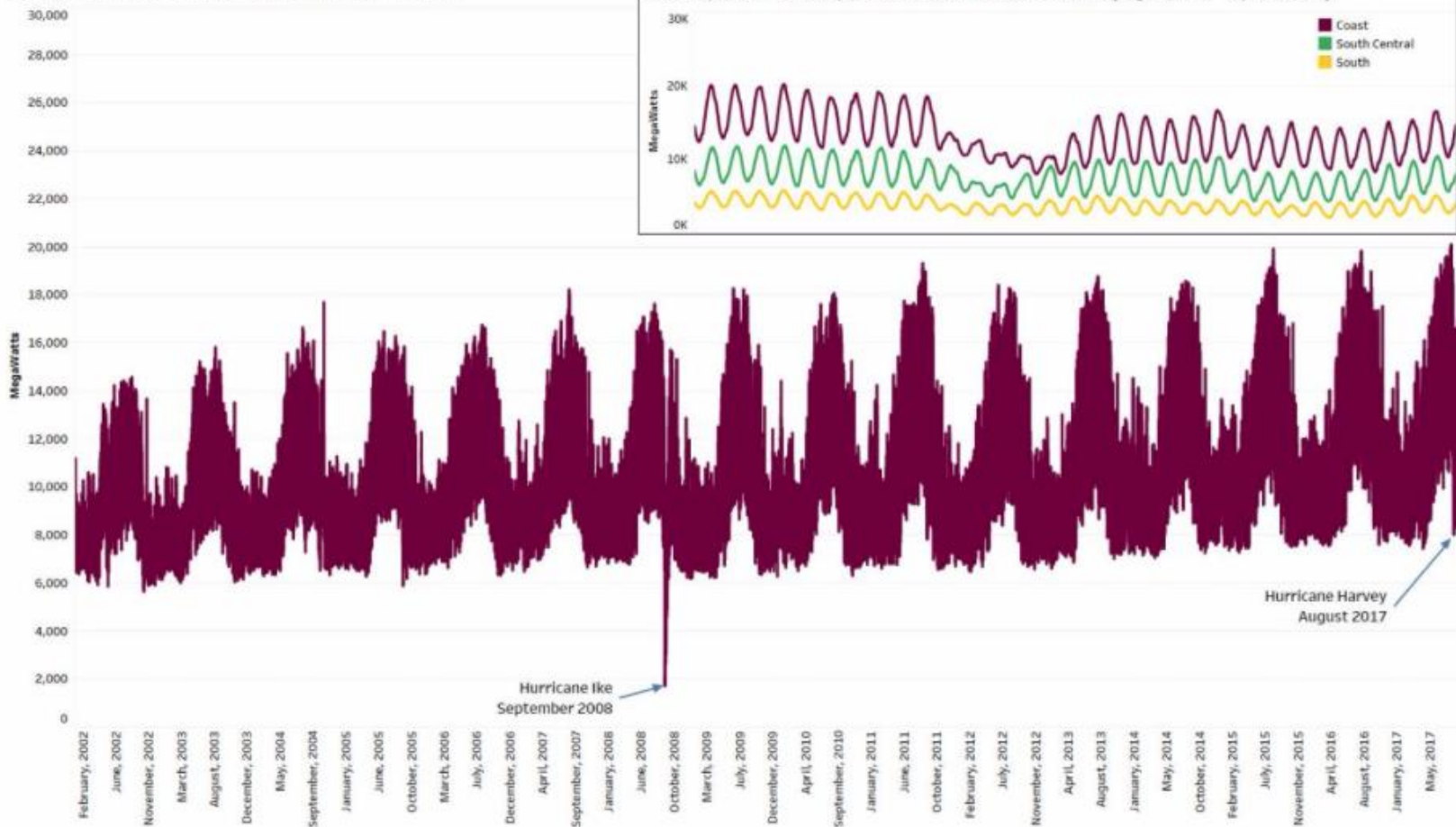


During Hurricane Harvey there was a significant decrease in electric power demand on the ERCOT grid. This is attributable to a combination of factors, including temporary shutdowns of refineries in the path of the storm, cooler ambient temperatures, and power outages due to damage of power generation and transmission infrastructure. Harvey hit the South weather zone the evening of Friday August 25th. Demand began to trend downward on August 24th, returning to pre-Harvey levels a week later. A similar pattern occurs in the South Central region, with power demand returning to normal levels a couple of days sooner. For the Coastal Weather Zone, the power demand shift occurred one day later, and as of the end of August had not rebounded to pre-Harvey levels.



Electricity and Energy

Coastal Zone Long-Term Power Demand (2002-Present)



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We at HARC are grateful to [Houston Endowment](#) for their support in the development of this project.

Hurricane Harvey brought record rainfall to Houston; the resulting flooding led to regional devastation, impacting lives, homes and livelihoods. The storm also had numerous environmental impacts. The Houston Advanced Research Center ([HARC](#)) mobilized swiftly to acquire and process data and information about the flooding and related environmental impacts, such as storm-related spills, pollutants, Superfund site impacts, water quality, air quality, and power generation. The resulting analysis is shown through narrative summaries, maps, and infographics in the story map, "Summarizing Hurricane Harvey's Environmental Impacts". For general feedback on this application, please contact us at harcgis@harcresearch.org.

**HARC**

HOUSTON ENDOWMENT

A PHILANTHROPY ENDOWED BY JESSE H. AND MARY GIBBS JONES

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- Dr. Erin Kinney - Water & Environment ([Profile](#))
- Ryan Bare - Water & Environment ([Profile](#))
- Dr. Mustapha Beydoun - Air Quality ([Profile](#))
- Dr. Gavin Dillingham - Energy/Energy Policy ([Profile](#))
- Bill Bass, GISP - GIS Lead ([Profile](#))
- Qian Song - GIS Analyst ([Profile](#))
- Likun Chen - IT Analyst ([Profile](#))

Partners:

HARC would like to thank the following organizations for making data accessible for use within this story map.

- [National Oceanic and Atmospheric Administration](#)
- [United States Geological Survey](#)
- [National Weather Service](#)
- [Vieux Inc.](#)
- [Texas Parks & Wildlife Department](#)
- [Texas Commission on Environmental Quality](#)
- [Environmental Defense Fund](#)

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an independent research
hub helping people thrive
and nature flourish.