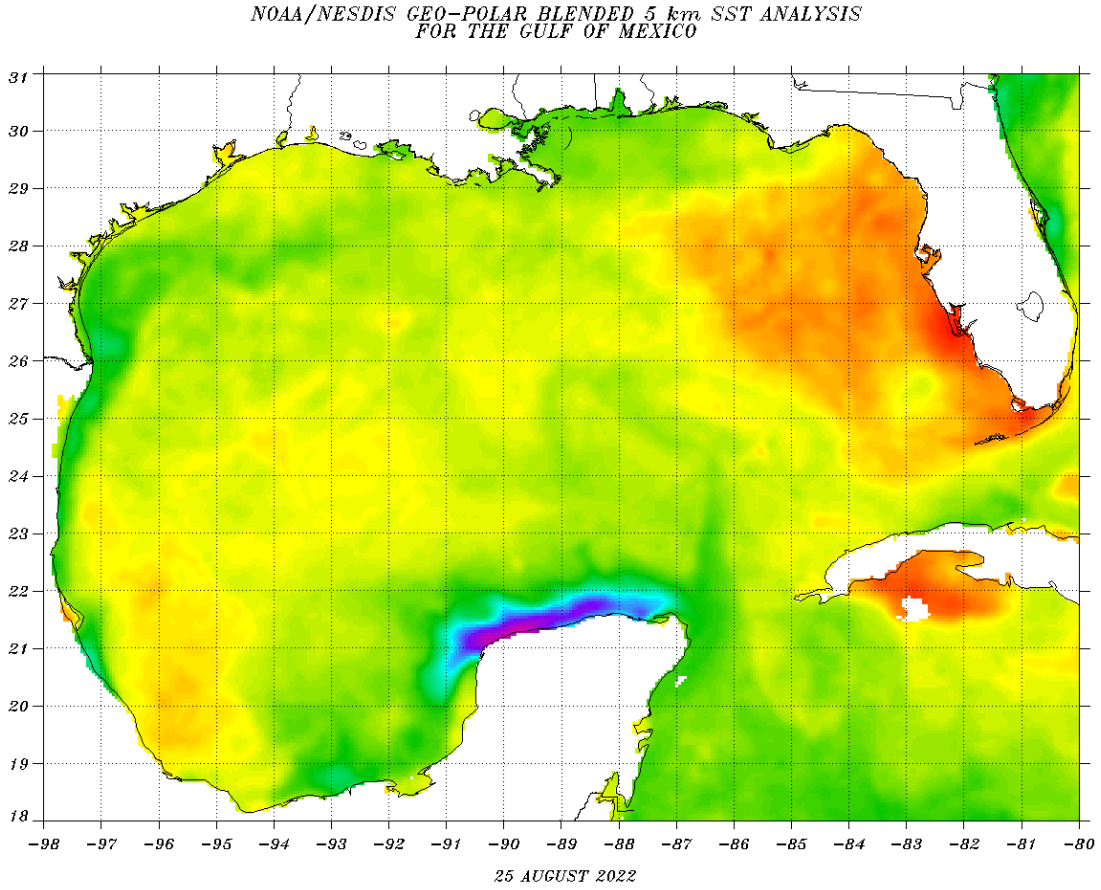
Southeast Texas Flooding

What influences flooding?

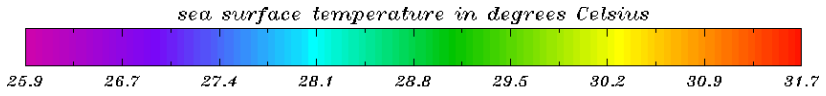
- Function of several different things:
  - **Precipitation intensity/rate and duration**
    - How hard did it rain?
    - How long did it rain?
  - **Infiltration rate**
    - How fast can water soak into soil/ground?
  - **Land use/land cover**
    - Is there a lot of concrete or forest cover?
  - **Size of stream channels**
    - Can the stream hold lots of water like Buffalo Bayou or the San Jacinto River? Or is it a small stream that fills up fast?
  - **Topography/slope**
    - Flatter areas like Houston slow water down and allow it to pool like a big bathtub.
    - Areas like Hill Country have more slope, and the water moves fast, causing dangerous flash flooding.

Why do we get so much rain, and why does it rain so hard?

The Gulf of Mexico is warm and leads to lots of evaporation and moisture being in the atmosphere along the Gulf Coast. It rains with more intensity and for longer durations in this part of the U.S. versus others, because there is a lot more total water vapor in the air that can fall as precipitation.



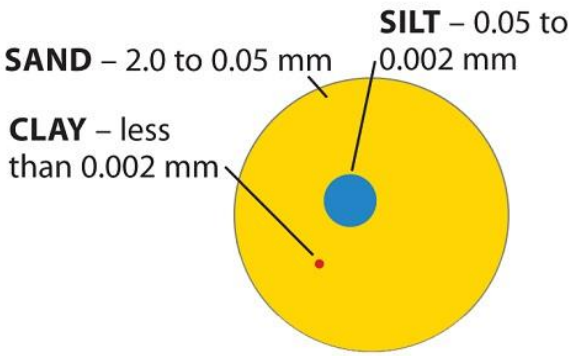
(Temp in°C × 1.8) + 32 = Fahrenheit Temperature

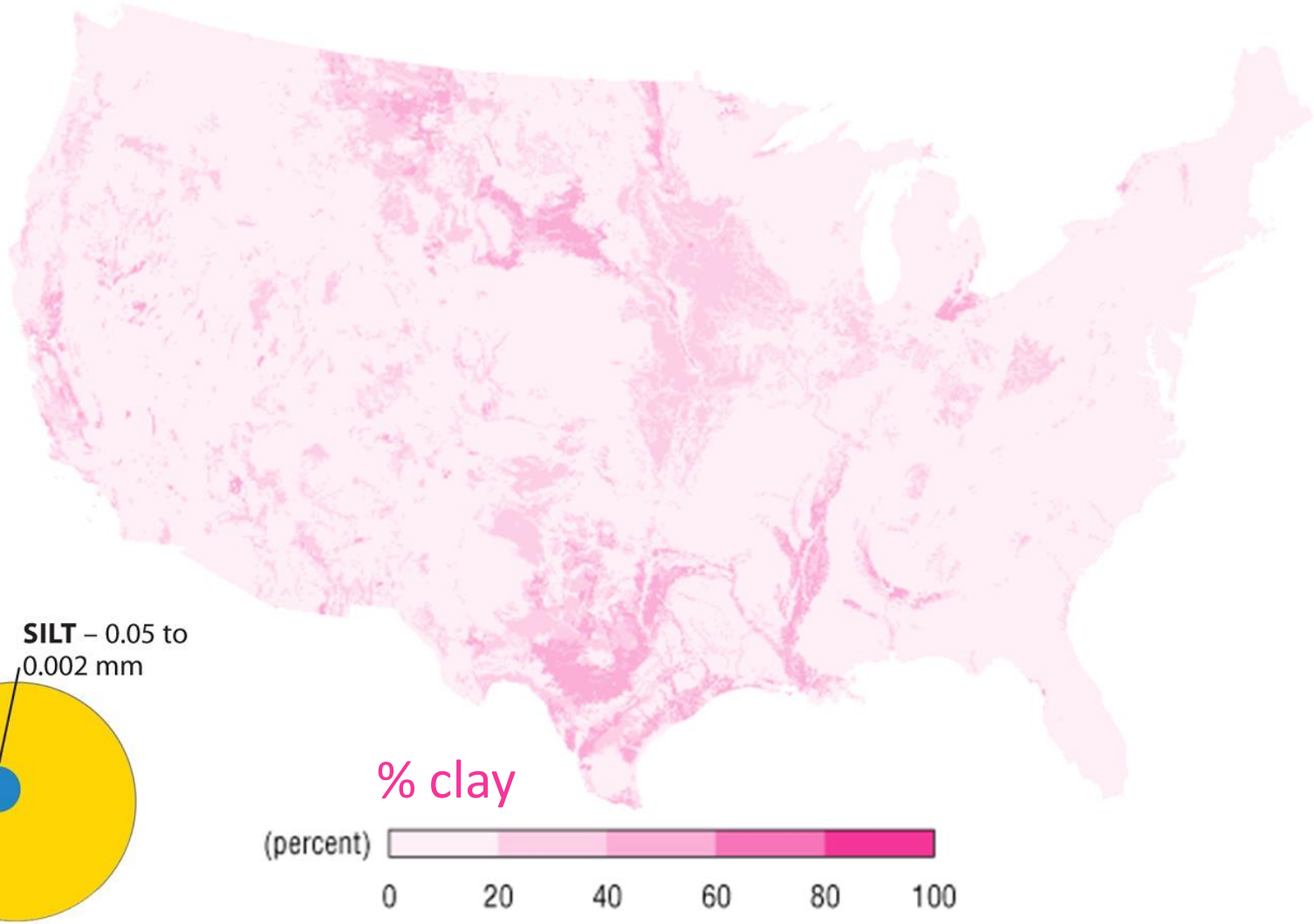


https://www.ospo.noaa.gov/Products/ocean/sst/contour/

Where does the rain go when it falls?

Some rain infiltrates/soaks into the ground, but the rain that can't pools at the surface or runs downhill toward sewers, rivers, streams, and roads. Water infiltrates more quickly into sandy soil and much more slowly into clay-rich soil. That's partially because the spaces between clay particles are smaller and harder for water to move through. And Texas has a lot of clay!





Infiltration rates vs. rainfall rates

Notice how much faster water can move into sand acompared to clay. Sometimes, during major storms and hurricanes in Texas, rain can fall at rates of 6 inches per hour! The only soil below that can allow water into the soil at that rate is sand. But, much of Southeast Texas isn't a pure sand soil, so the extra water that can't infiltrate winds up flowing downhill. Notice too how slowly water can soak into really clayey soil during storms!

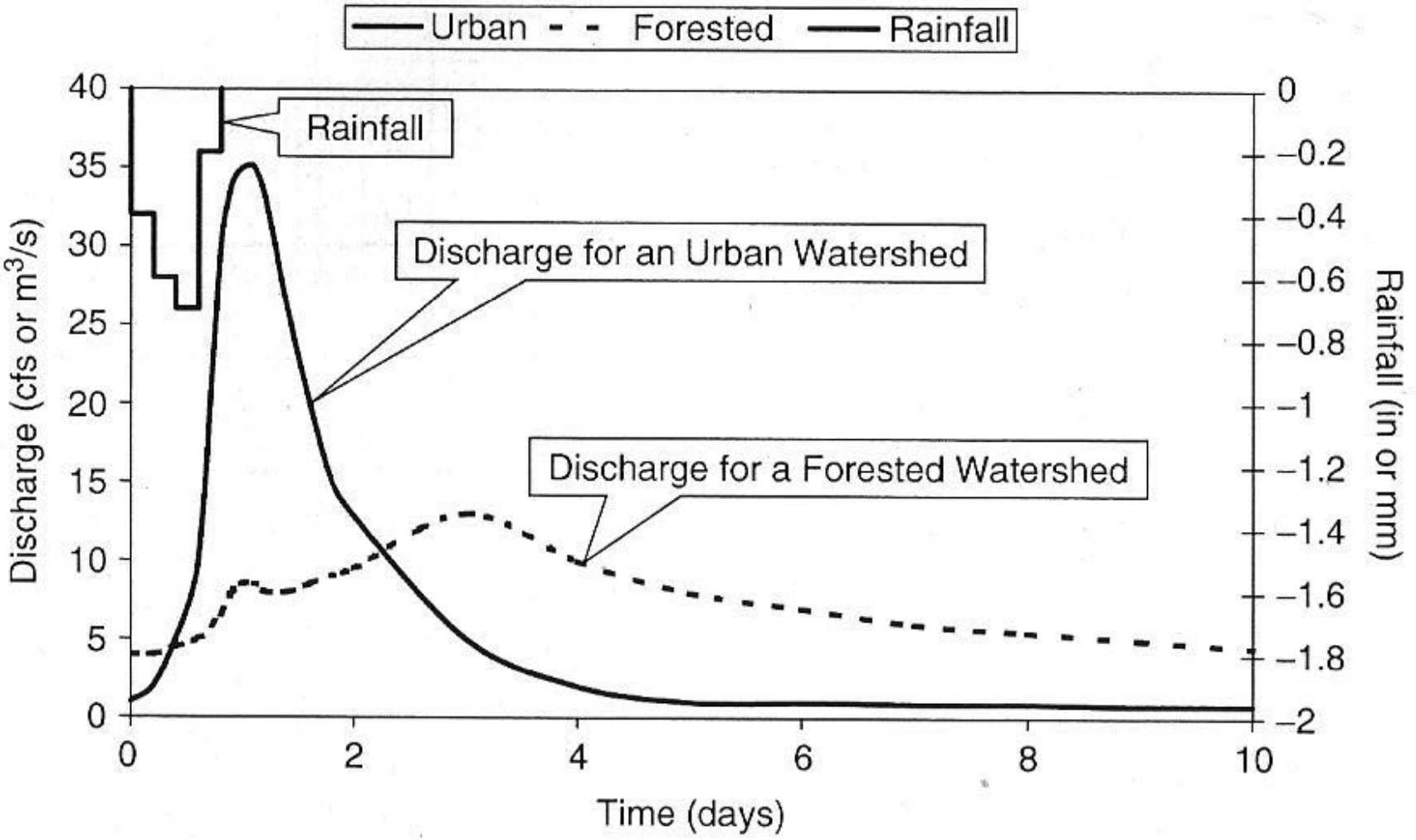
		Saturated infiltration rate	
Soil group	**Soil texture**	**Mm/hr**	**In/hr**
A	Sand	200	8.0
A	Loamy sand	50	2.0
B	Sandy loam	25	1.0
B	Loam	12.7	0.5
C	Silt loam	6.3	0.25
C	Sandy clay loam	3.8	0.15
D	Clay loam and silty clay loam	2.3	0.09
D	Clay	1.3	0.05

Source: Texas Council of Governments, 2003.

Rain that falls and runs off at the surface works its way downhill within a **watershed or drainage basin**. For example, all excess rainfall that runs off within the Trinity or the San Jacinto River Basins will ultimately wind up in those rivers (and then Galveston Bay) if it keeps flowing downstream.

Development and land use/land cover

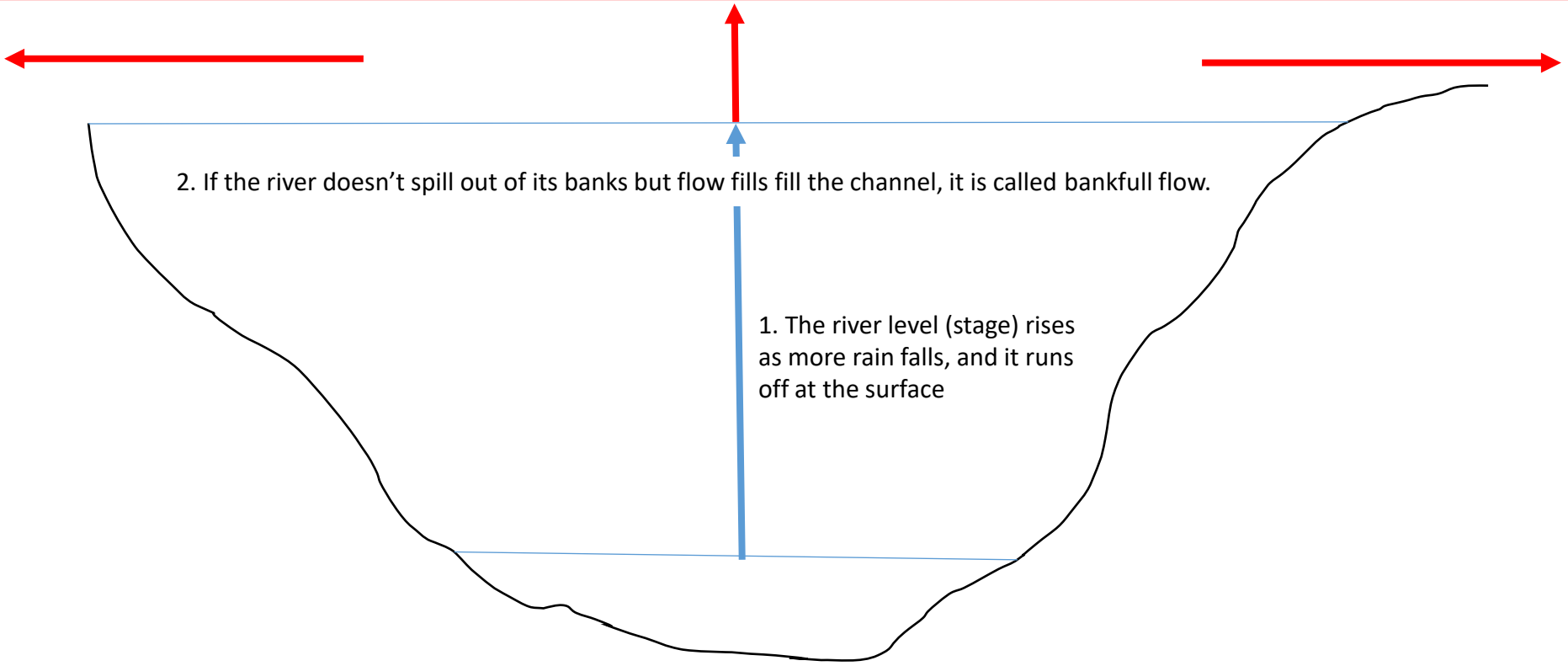
In urban and suburban areas, like metro Houston, there are a lot of impervious surfaces (like concrete roads, parking lots, sidewalks, rooftops) that don't allow water to infiltrate. When the water can't soak into the ground, it runs off. This means urban areas have high runoff, and the water flows quickly. We can see in the example below that after rainfall, the urban river's flow (discharge) increases faster and peaks higher than the same storm that impacts a natural, forested watershed/drainage basin.



So, when does flooding occur in the stream?

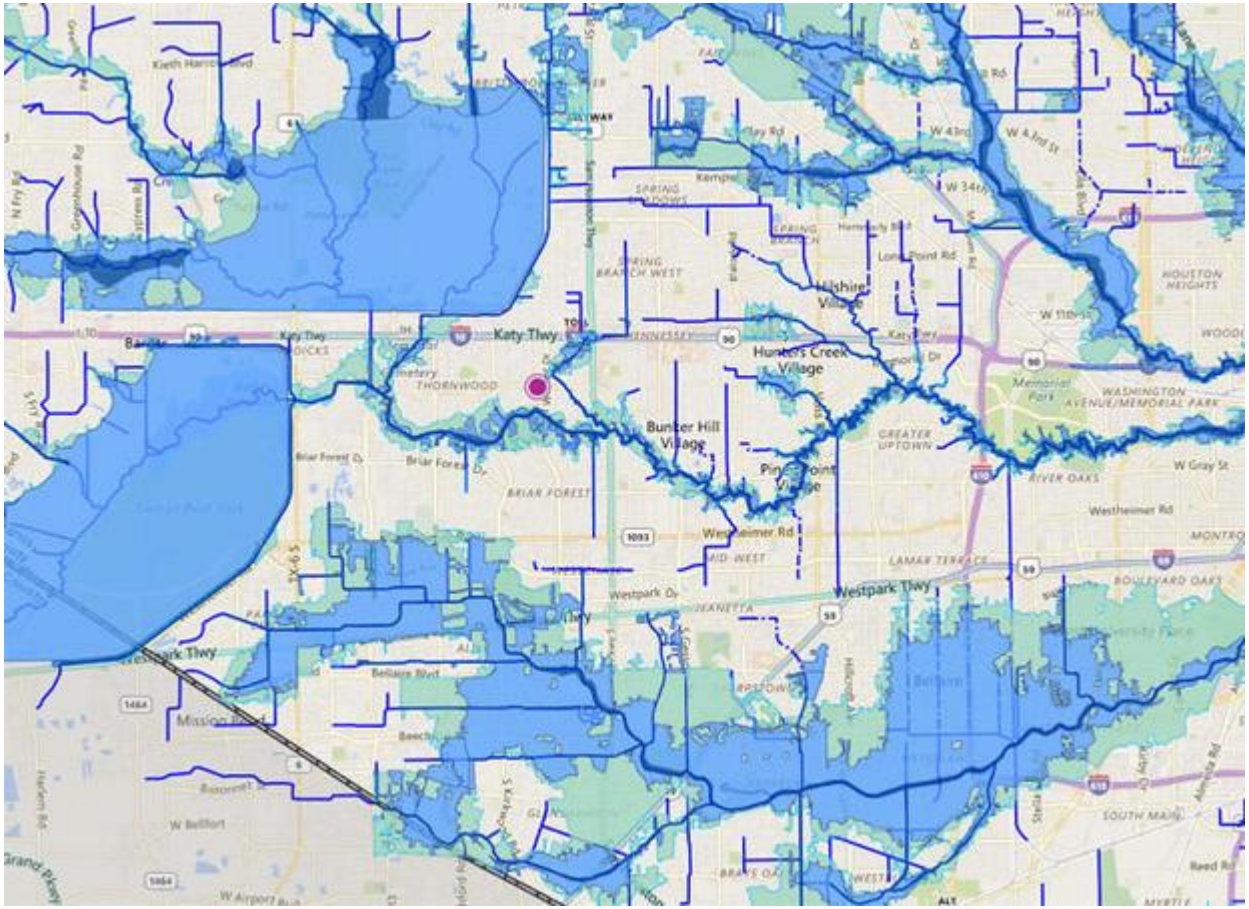
River-based flooding occurs when there is too much excess runoff and water for the stream's channel to accommodate. This happens especially as more and more surface runoff reaches the stream. In urban/suburban areas, there is more excess runoff, and this becomes a problem for homes, cars, and people.

3. If the river continues to rise past bankfull stage, it spills out of the channel, and water spreads across the floodplain. The river is now flooding the landscape. If more rain continues to fall, the water level will continue to rise and flood more areas.



Once geoscientists and engineers know flood levels, they can map them.

Models can be built that replicate how water will flow across the landscape during a flood. Creating flood maps results in the ability to communicate risk and areas where the hazard is more or less likely to occur. But, flood maps are a snapshot in time and may not include new, record-breaking events. To be more accurate, new maps should be drawn after events like Hurricane Harvey.



HARRIS COUNTY FLOOD CONTROL DISTRICT

Additional Data Resources

Floodplain viewers:

Harris County
Montgomery County
Walker County
Fort Bend County

FEMA Flood Map Service Center for Other Counties Around the U.S.

Harris County Flood Warning System Precipitation and River Data

Climate Data:

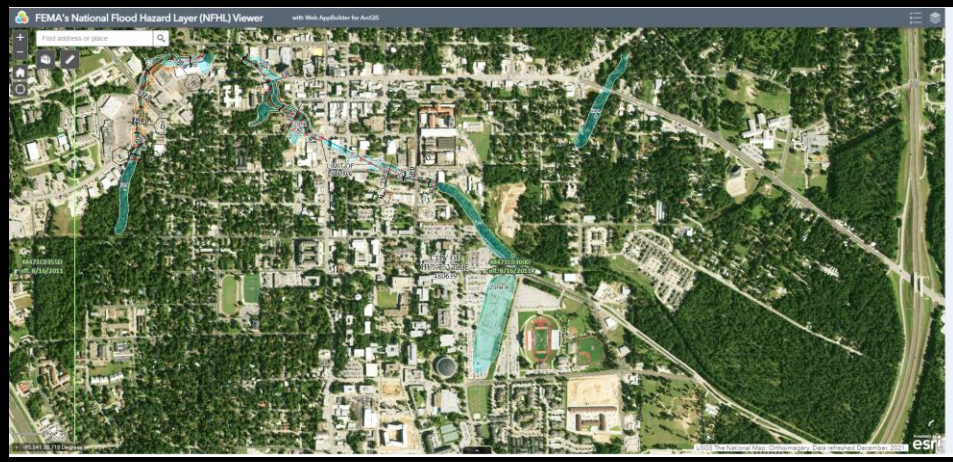
NOAA Atlas 14 Precipitation Data for the US
Southern Regional Climate Center

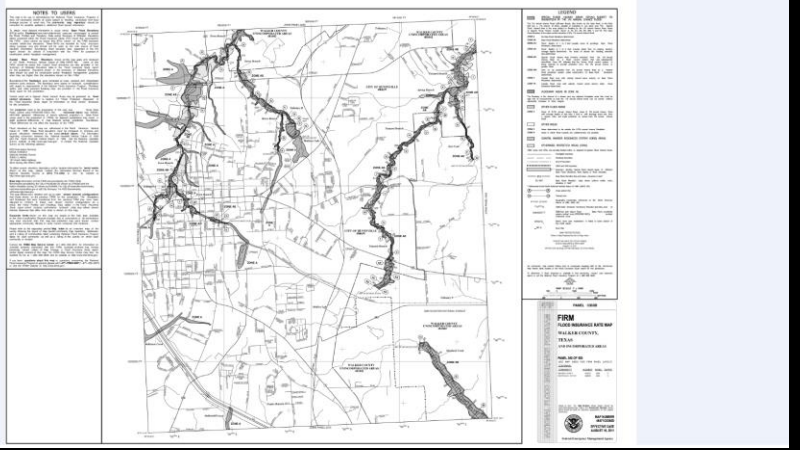
Harvey Resources:

Harvey's Environmental Impact Story Map

Houston Env. Research

HARC

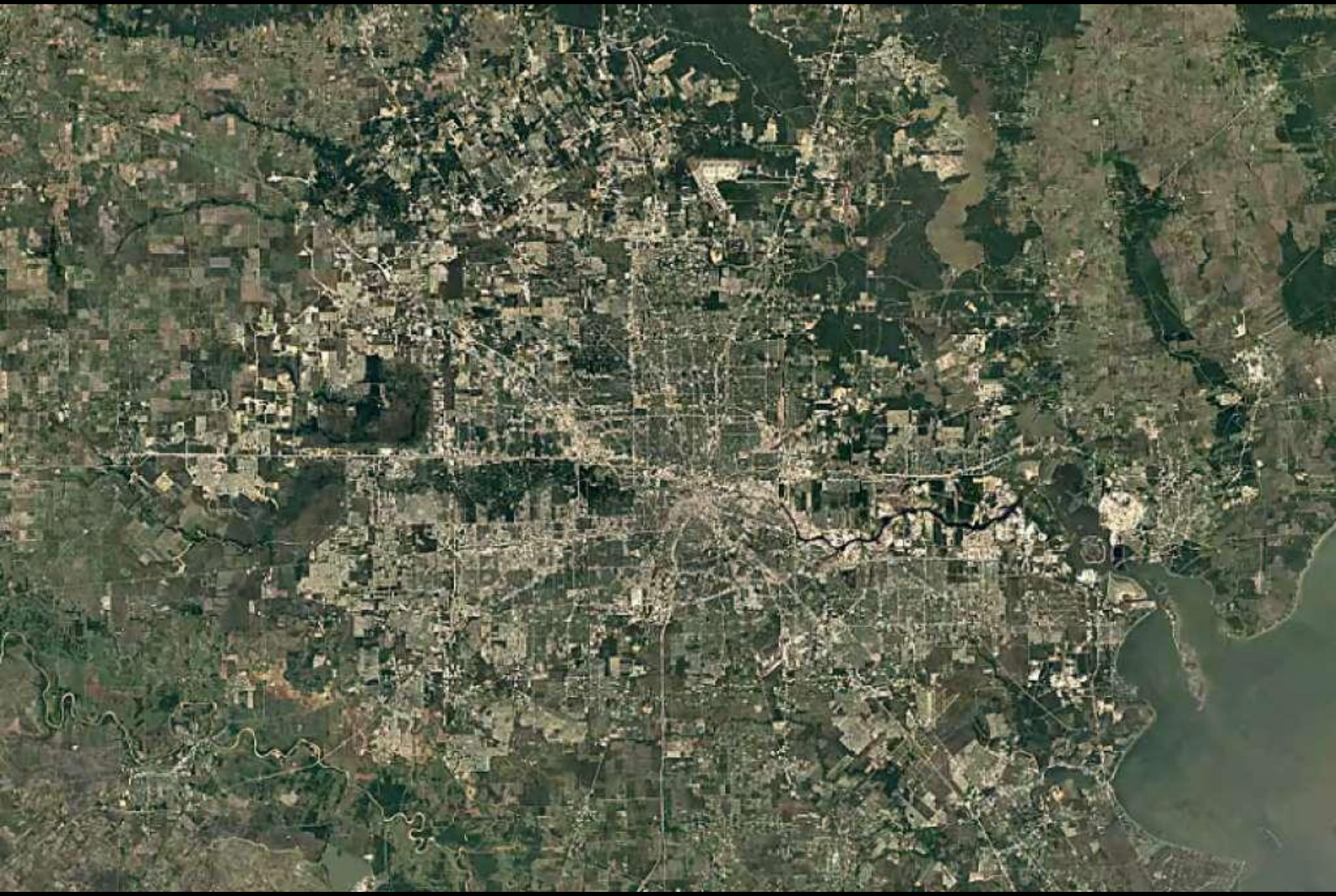




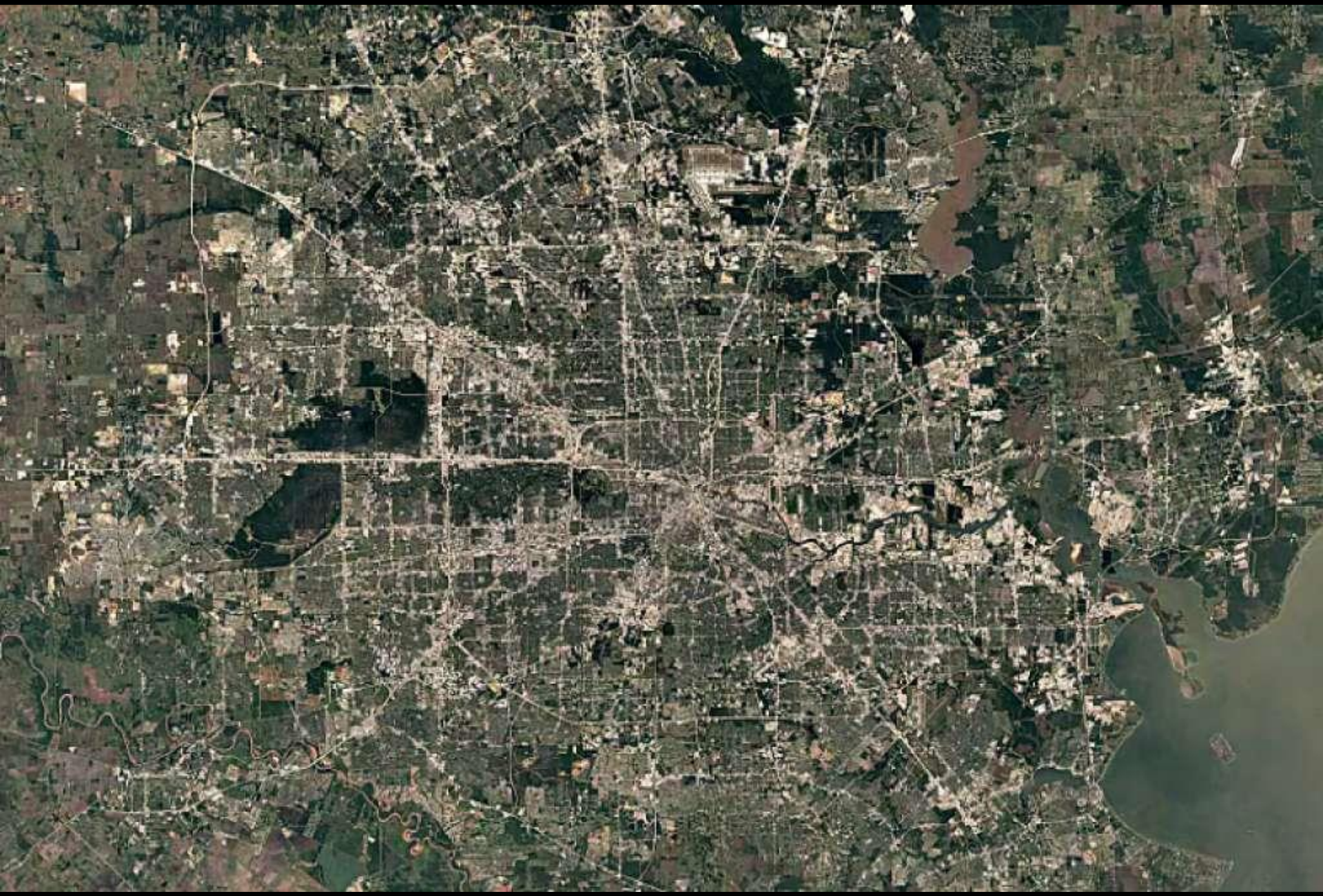
Optional Exercise:
Teachers and students can use the Google Earth tools here to look at changes in their own areas to discuss how flood risk may have changed over time:

SHSU NGS Google Earth Tools

Select Google Earth Examples follow of Changing Land Use and Development from the 1980's and 2016 (right before Harvey)

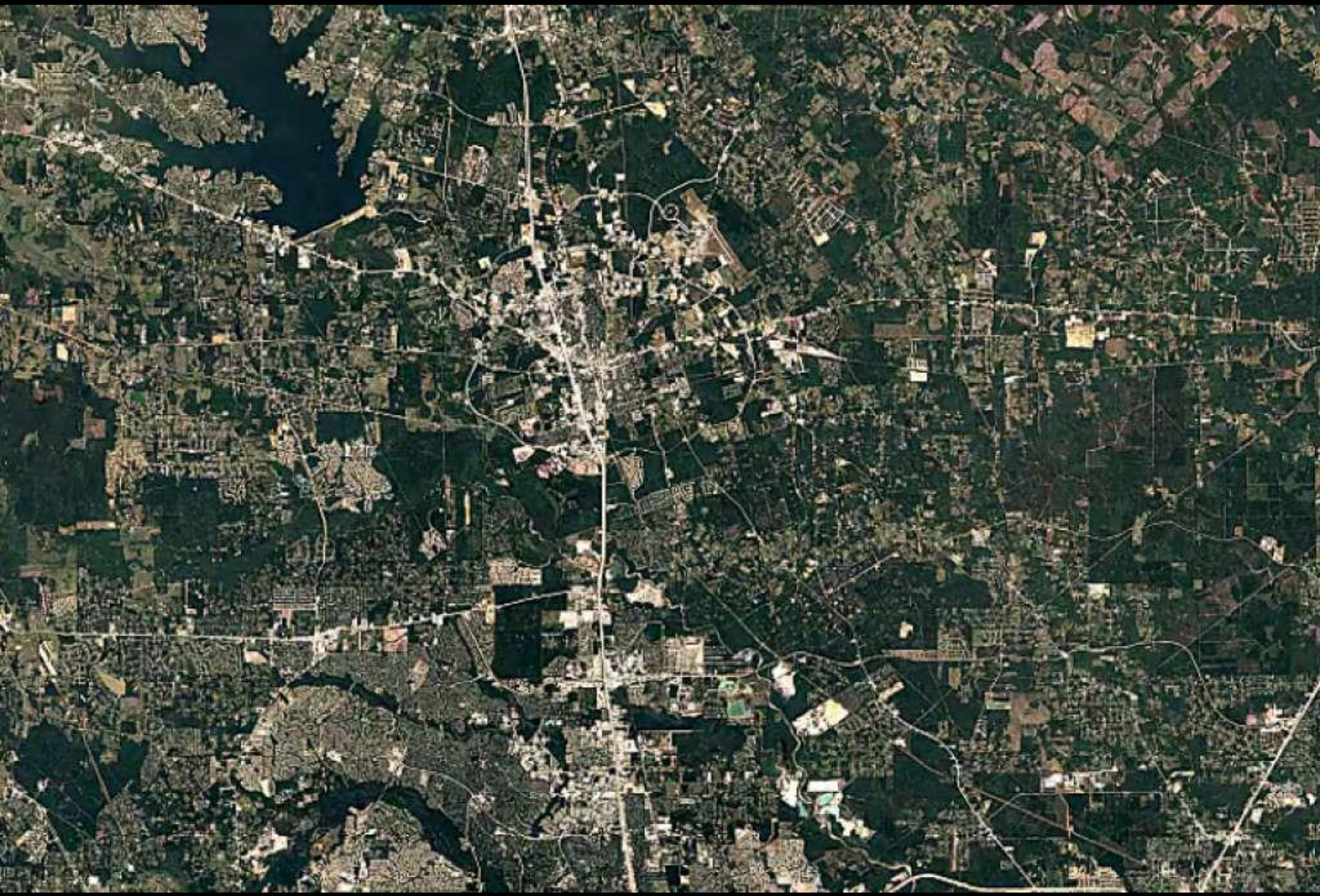


Houston: 1984

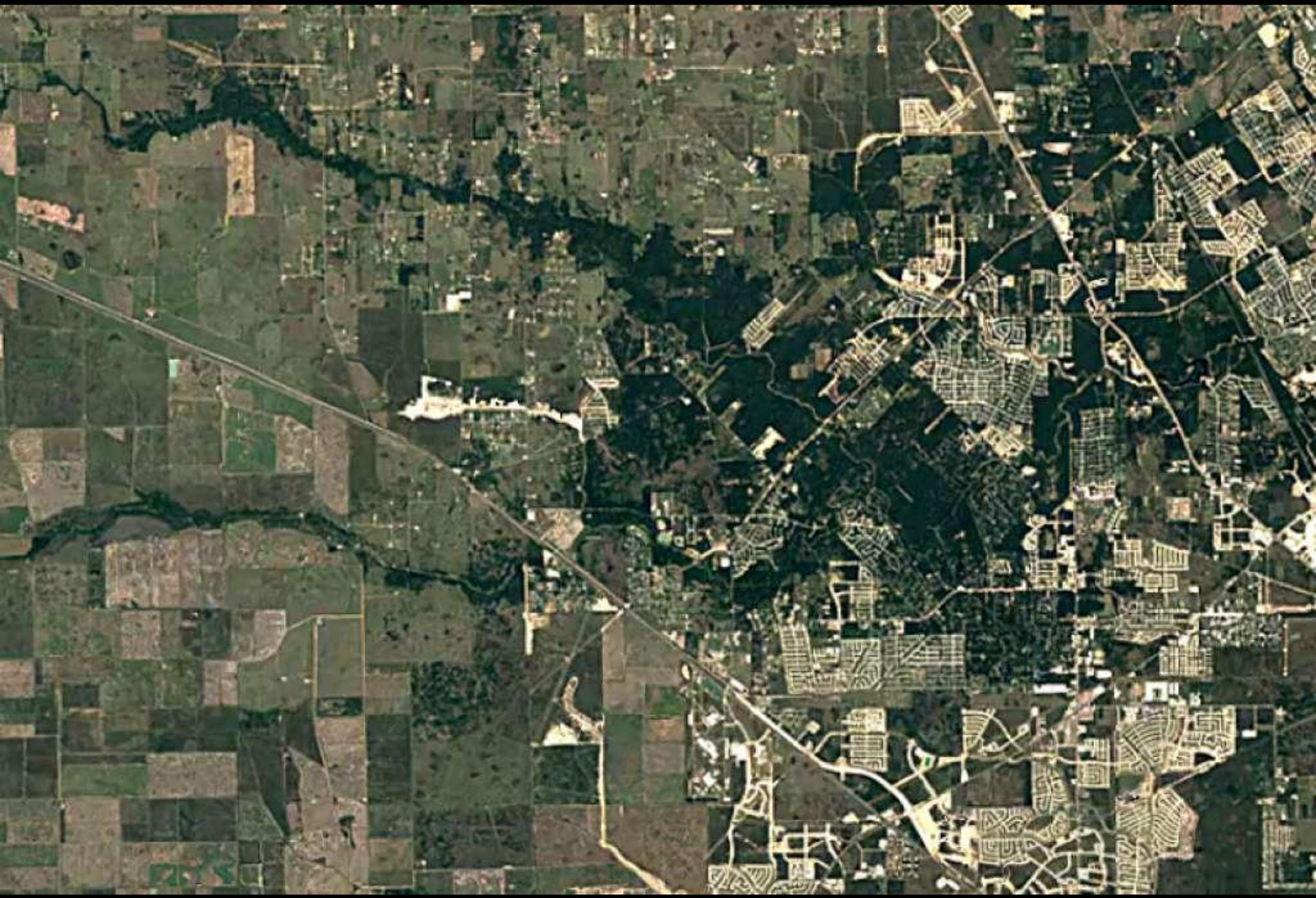


Houston: 2016

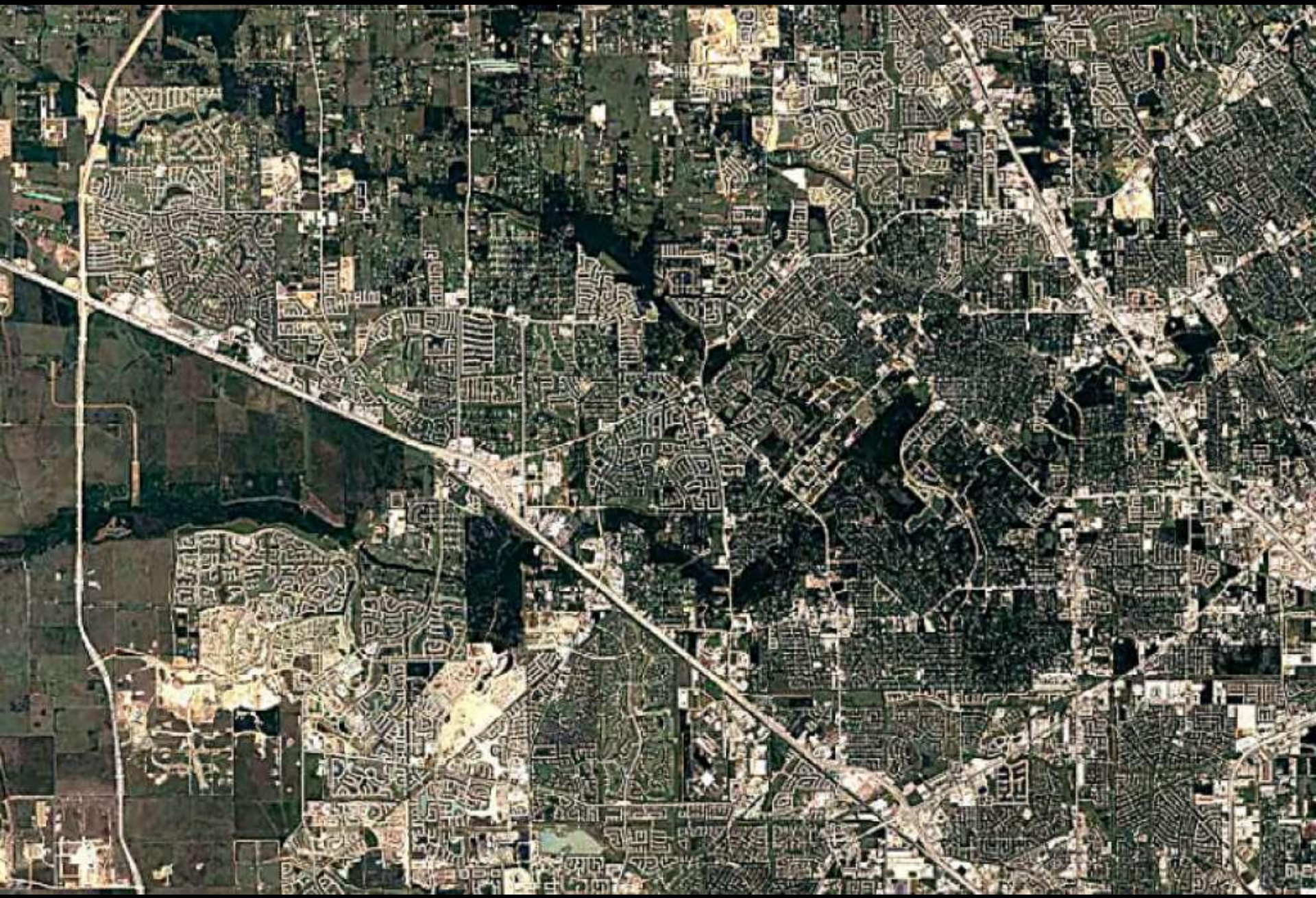
The Woodlands and Conroe: 1984



The Woodlands and Conroe: 2016



Cypress Area: 1984



Cypress Area: 2016

NGS Flood Module

Key Terms:

Watershed/drainage basin: the land area which drains to a common point; water that falls over this area as precipitation ultimately makes it to a single river or lake outlet

Infiltration rate: the depth of water that can enter the soil per unit time (typically measured in inches/hour)

Land use/land cover: What the land is physically used for (urban, forest, agriculture, etc.)

Discharge: The volume of water flowing per unit time

Stage: The height of the water surface elevation in a river relative to sea level

Slope: Change in land elevation over distance

Articles/Readings and Videos for Further Discussion:

Washington Post Video on Houston Flooding (~3.5 minutes)

60 Minutes Video on Dutch Flood Management (~15 minutes)

ProPublica Story – "Boomtown, Flood Town" on Houston and flood risk

NPR Story - "National Weather Service Adds New Colors So It Can Map Harvey's Rains"

Five Thirty Eight Story - "It's Time to Ditch the Concept of '100-year Floods'"

Harvey's Environmental Impact Story Map – Houston Advanced Research Center

Discussion Questions:

Why is flooding so much worse in Houston compared to some other cities around the U.S. and world?

Using the videos above, how does Dutch flood management, where much of the country if below sea level, differ from Houston flood management?

Using the data and resources links for floodplain viewers, what are students risks of flooding given where they live?

Based on the articles, videos, and module slides, what are some things Houston can do to reduce flood risk? What variables that influence flooding can we not change?

Linking to Regional Geography - How have rivers and floodplains shaped development around the world?