# Community-Based Climate Resilience Planning

As climate patterns become more variable, communities are challenged to **consider risks that threaten investments in infrastructure, public health, and quality of life**. Because communities bring firsthand knowledge of their environment, **they can play a key role in determining which climate hazards present the greatest potential risk to their community assets**. Adaptation actions are strengthened when members of the community from multiple backgrounds and experiences participate in resilience thinking. By preparing for future hazards and risks that are connected to our changing climate, communities can better withstand extreme events and lessen detrimental effects.

## How can communities adapt?

- **Engage your community**
- **Identify key vulnerabilities**
- **Make changes to reduce or eliminate risks**
- **Examine co-benefit solutions**
- **Evaluate progress and make changes**
- **Share what you learn with other communities**

## What resources are available?

U.S. Climate Resilience Toolkit
Provides steps for resilience, projected conditions, and case study examples

U.S. EPA Planning for Climate Change Adaptation
Provides guides for local and community-based adaptation and infrastructure

HARC's Resilience Science Information Network
Identifies key vulnerabilities for communities in the Houston-Galveston region

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# Using *Resilience Science Information Network* to Plan for Climate Adaptation

To plan for climate adaptation, communities should first identify key vulnerabilities. Climate indicators included in RESIN describe potential future scenarios related to **temperature**, **heat**, **energy**, and **precipitation** in a nine county area of the Upper Texas Coast. The RESIN Mapping Narrative introduces the climate indicators. Download climate indicator data here or at harcresearch.org.

- Days per Year Above 100°F
- Nights per Year Above 80°F
- Heating Degree Days
- Length of Summer
- Longest Heatwave
- Cooling Degree Days
- Sea Level Rise
- Annual Total Precipitation
- Drought

## Evaluate Infrastructure, Hazards, and Population Risks

It is important for communities to understand vulnerabilities to climate change for critical **infrastructure**, **environmental hazards,** and **natural habitats** and to recognize which **residents** could be most vulnerable. The RESIN Mapping Narrative introduces key vulnerabilities. Explore how climate indicators might affect regional concerns in the RESIN Mapping Applications.

- Vulnerable Populations
- Infrastructure
- Natural Habitat
- Environmental Hazards
- Urban Heat

Climate indicators were produced by Drs. Katharine Hayhoe and Anne Stoner of ATMOS Research & Consulting. For further information refer to the Climate Impact Assessment for the City of Houston report.

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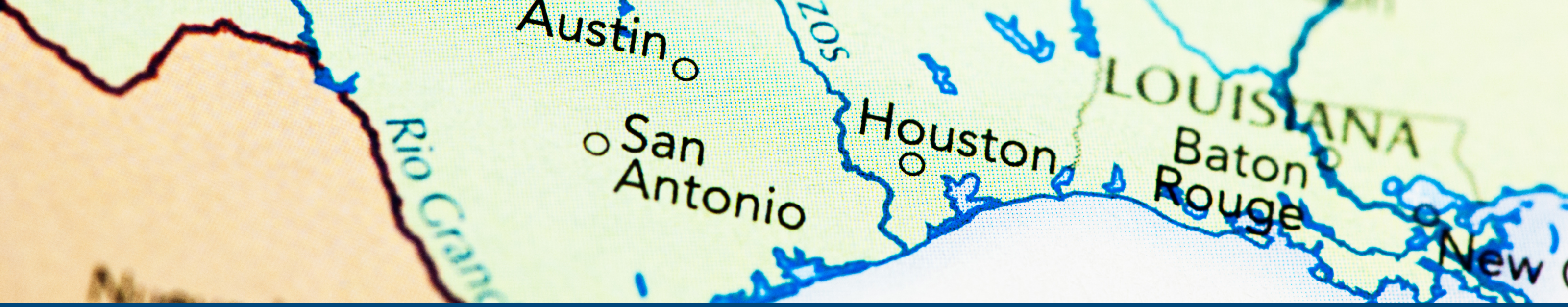



# How To: RESIN Mapping Applications

The RESIN Mapping Applications are made up of three web-based applications. Each application contains data layers that are added to the map when checked. All of the applications include climate indicators and content layers listed here (titles are links to each application).

## Critical Infrastructure and Climate

- National Bridge Inventory
- Wastewater Outfalls
- Surface Drinking Water Intakes

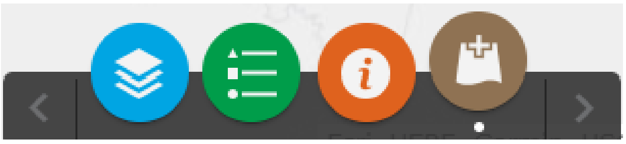
## Social Vulnerabilities and Climate

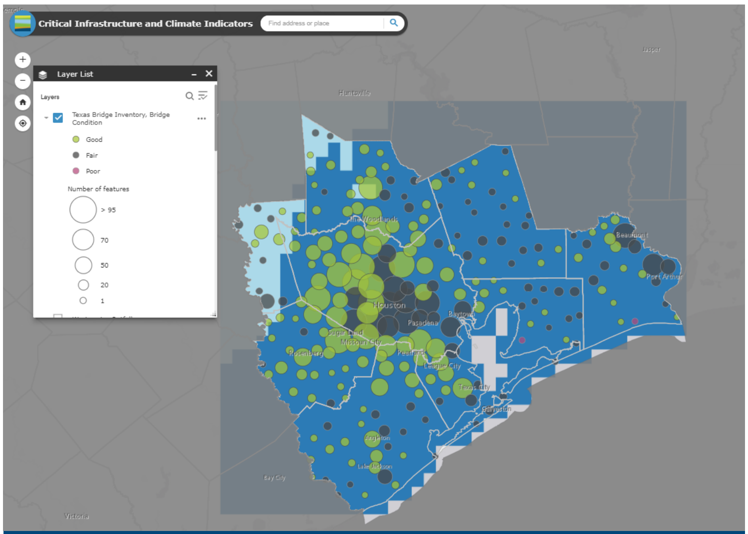
- Social Vulnerability Index
- Severe Repetitive
- Loss Properties
- Leaking Petroleum Storage Tanks, Brownfields, and Superfunds

## Natural Habitats and Climate

- Bare Land
- Agriculture
- Natural Habitat
- Open Water Habitat
- Developed

- When a climate indicator is selected, the application will animate the change for that indicator over the years 2000 to 2100. *It is recommended that you only check one climate indicator layer at a time.*
- Add layers to the mapping application using the brown "Add Data" button at the bottom of the screen.






RESIN Mapping Application showing the National Bridge Inventory and **Days per Year Above 100˚F**

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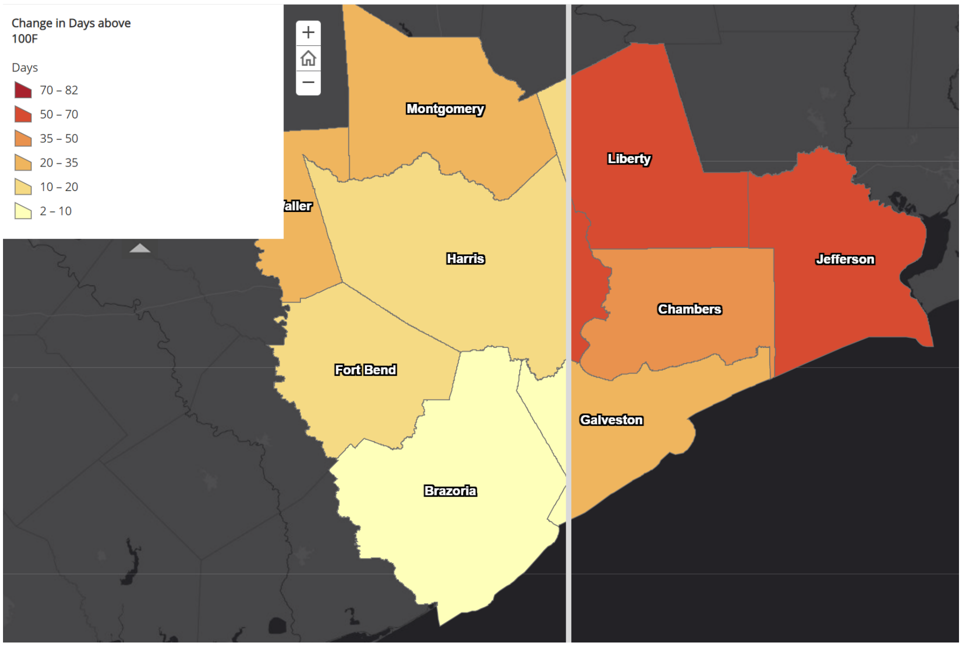
# Climate Indicator: Days Above 100 °F

**Days per Year Above 100 °F** describes the change in days per year for which the maximum temperature exceeds 100ºF.

## How Does 'Days per Year Above 100 °F' Look?

**Days per Year Above 100 °F** are displayed using two different future scenarios, ***RCP4.5 (Moderate)*** and ***RCP8.5 (High)*** between the years 2000 and 2100.

The RESIN Mapping Narrative depicts the difference between these scenarios using a slider map to show how both scenarios would affect the nine-county area.




RESIN Mapping Narrative: The line depicts a slider between the ***Moderate*** (left) and the ***High*** (right) scenarios.

## Expect Hotter Days

In both the ***Moderate*** and ***High*** scenarios, the inland counties of Waller and Montgomery are projected to have the largest increase of **Days per Year Above 100 °F** by end of century while coastal counties including Brazoria, Galveston, Chambers, and Jefferson are expected to have the lowest increase.

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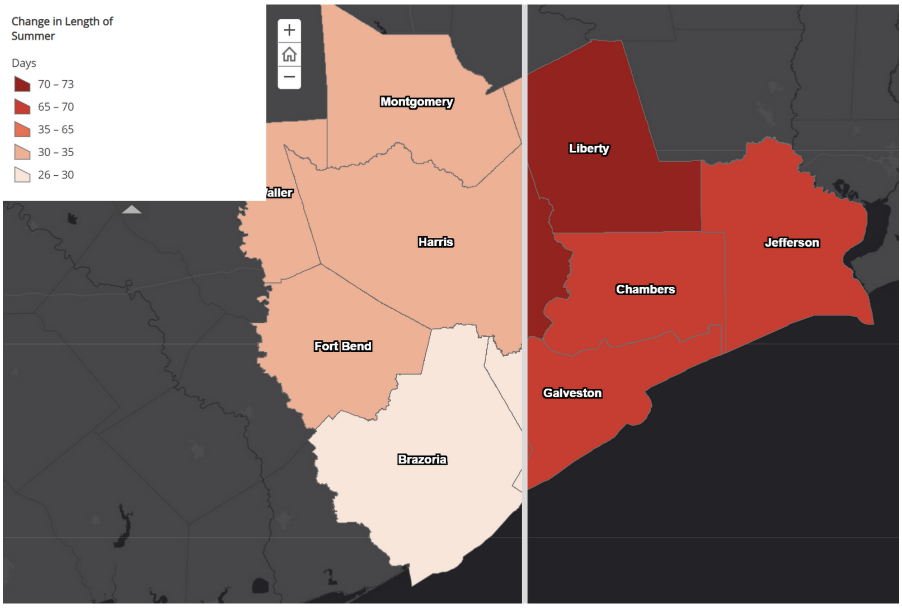
# Climate Indicator: Length of Summer

**Length of Summer** describes the change in duration of the summer season in number of days.

## How Does 'Length of Summer' Look?

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The RESIN Mapping Narrative depicts the difference between two scenarios using a slider map to show how both scenarios would affect the nine-county area.

## Expect Longer Summers

In both the ***Moderate*** and ***High*** scenarios, **Length of Summer** increases because summers are likely to start earlier and end later, compared to historical dates. Inland counties of Waller, Montgomery, Liberty, Harris, and Fort Bend will experience longer summers than the coastal counties of Brazoria, Galveston, Chambers, and Jefferson.

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# Climate Vulnerabilities for Water & Wastewater Infrastructure

The proximity of many water and wastewater facilities to waterways and low-lying areas makes the infrastructure more susceptible to damaging effects of flooding, caused by extreme **Precipitation** and **Sea Level Rise**. In the RESIN area, annual precipitation is projected to decrease but storms may be more frequent and intense.

Increased **Days per Year Above 100˚F** and **Nights per Year Above 80˚F** can affect surface water quality, supply, use, and treatment at water facilities. Temperature is expected to increase in the RESIN area with the largest increases occurring in inland counties.

Lower surface water levels due to **Drought** and **Longer Heatwaves** mean more water in waterways can be made up of treated effluent from upstream wastewater plants instead of rainfall. The RESIN area is expected to have longer heatwaves and more frequent and intense drought.

Longer summers lead to higher demand for lawn watering and an increasing strain on water treatment facilities. All nine RESIN counties are expected to have longer summers.

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# Climate Vulnerabilities for Transportation Infrastructure

Roads, railroad tracks, and waterways move people and products throughout a region. Transportation disturbances pose risks for the people using them and communities or wildlife living nearby and inhibit supply chains for industries that depend on infrastructure for distribution of goods, such as grocery stores and gas stations.

**High precipitation** events can inhibit road use, particularly at low-water crossings, flood train tracks or block them by depositing debris, and limit air travel. Debris left after storms can reduce passage for larger ships. In the RESIN area, annual precipitation is projected to decrease but storms may be more frequent and intense.

**Heat** can affect transportation infrastructure, causing deformation in materials. **Extreme temperatures** and **extended heat waves** may result in train derailment if proper maintenance and speed reductions are not implemented. Temperature fluctuations are of particular concern for bridges because they increase stress on bridge joints. **Heat** may affect airplane performance. All nine RESIN counties are expected to have longer heatwaves and higher temperatures.

**Rising sea levels** limit the overhead height for boats traveling under bridges and can flood transportation routes in coastal areas. The Houston Ship Channel and the low-lying coastline of Jefferson, Chambers, Galveston, and Brazoria are vulnerable to sea level rise.

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# Climate Vulnerabilities for Energy Infrastructure

Facilities that generate power are exceedingly vulnerable to disastrous events. The leading cause of power outages are natural hazards and disasters. Additionally, changes in temperature will affect energy demands in the future.

Flooding caused by **extreme precipitation** and **rising sea levels** can prevent a power plant from generating electricity or limit transport of fuel. Storms can damage power lines and substations. In the RESIN area, annual precipitation is projected to decrease but storms may be more frequent and intense. The Houston Ship Channel and the low-lying coastline of Jefferson, Chambers, Galveston, and Brazoria are vulnerable to sea level rise.

The **Heating Degree Days (HDD)** climate indicator measures the cumulative number of degrees each day's average temperature is below 65°F. Higher HDD means more energy could be needed for heating in buildings. In the RESIN area, HDD is expected to decrease over time, meaning there will be less energy demand for heating in the future.

The **Cooling Degree Days (CDD)** indicator measures the cumulative number of degrees each day's average temperature is above 65°F. Higher CDD means more energy could be needed for cooling in buildings. In the RESIN area, CDD is expected to increase over time, meaning there will be more energy demand for cooling in the future.

**Drought** limits water availability for coal, natural gas, and nuclear power plants reliant on water for cooling or hydroelectric power plants reliant on water for power generation. The RESIN area is expected to experience more frequent and intense drought.

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# Examples of Climate Adaptation in Action: Water & Wastewater Infrastructure

## Drinking Water in Berwick, ME

**Concern:** loss of drinking water treatment for 1,000 residents

**Vulnerability:** located near rivers and flood-prone areas

**Resources used:**

- Federal Emergency Management Agency flood maps
- EPA's Flood Resilience: A Basic Guide for Water and Wastewater Utilities

**Actions taken:**

- Identified vulnerable equipment
- Evaluated mitigation measures
- Implemented multiple low-cost actions
- Planned for long-term actions through capital improvement plan

**Adaptation Actions:**

- Placed sandbags at utility entrances
- Installed backflow preventers on overflow pipes in low-lying areas
- Elevated or secured chemical tanks
- Filled up water towers before storm events

## Wastewater Infrastructure in Manchester-by-the-Sea, MA

**Concern:** loss of wastewater treatment for 6,000 residents

**Vulnerability:** located near Atlantic Ocean & w/in 100-year floodplain

**Resources used:** EPA's Creating Resilient Water Utilities program, Climate Resilience Evaluation and Awareness Tool, and Coastal Inundation Toolkit

**Actions taken:**

- Applied for and received a Coastal Zone Management Grant
- Assessed vulnerabilities
- Prioritized assets most at risk to implement most needed actions

Sources: https://toolkit.climate.gov/case-studies/exploring-adaptation-options-water-infrastructure-sea-level;
https://www.epa.gov/arc-x/manchester-sea-massachusetts-assesses-climate-vulnerability;
https://toolkit.climate.gov/case-studies/small-water-utility-builds-flood-resilience

# Examples of Climate Adaptation in Action: Transportation Infrastructure

## Transportation Infrastructure in Mobile, AL

**Concern:** failure of roads, bridges, rails, and ports
**Vulnerability:** coastal location, storm surge, and extreme events
**Resources used:** Federal Highway Authority (FHWA)'s Impacts of Climate Change and Variability on Transportation Systems and Infrastructure (Phase 1 & 2)
**Steps taken:**

- Partnered with FHWA for 2nd phase of study
- Developed methods to assess vulnerability
- Tested and refined methods
- Identified best practices for other regions
- Considered adaptations (redesigning bridge abutments to withstand surge and increasing bridge height)

## Transportation Infrastructure in Colorado

**Concern:** failure of state highway and local roadway
**Vulnerability:** close proximity to river, flooding
**Resources used:** National Oceanic and Atmospheric Administration (NOAA) climate data and U.S. Geological Survey (USGS) stream gauge data
**Steps taken:**

- Armored road base
- Moved road away from river and elevated the roadway
- Constructed a berm to dissipate energy & reduce erosion

https://toolkit.climate.gov/case-studies/increasing-transportation-resilience-gulf-coast;
https://toolkit.climate.gov/case-studies/rebuilding-roads-maximize-resilience

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# Examples of Climate Adaptation in Action: Energy Infrastructure

## Power Infrastructure in New York, NY

**Concern:** failure of electricity generation and substations

**Vulnerability:** coastal location and power generation within 100-year flood plain

**Steps taken:**

- Modeled future risks
- Determined assets most at risk
- Implemented adaption actions

**Adaptation Actions:**

- Bolstered flood barriers,
- Ensured equipment was submersible
- Raised or relocated critical equipment
- Built in flexibility and redundancy
- Moved overhead transmission underground
- Expanded smart grid

## Power Infrastructure in San Diego, CA

**Concern:** failure of electricity generation and substations

**Vulnerability:** high winds, wildfires damaging equipment and infrastructure, power lines causing fires

**Steps taken:**

- Identified risk zones for proactive firefighting in high-risk areas and resident alerts
- Deployed weather sensors to provide real-time information
- Developed fire forecasts six days ahead

https://toolkit.climate.gov/case-studies/working-together-keep-lights-new-york-city;
https://toolkit.climate.gov/case-studies/watching-wind-effort-get-upper-hand-wildfire

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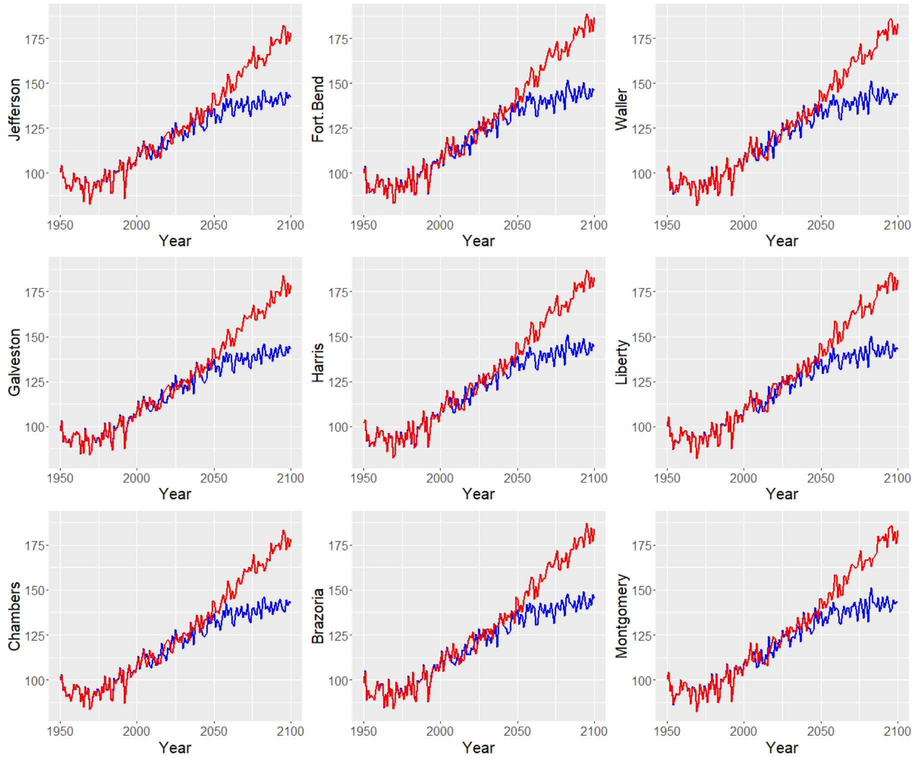
# How to Download RESIN Data




Climate indicator data can be downloaded at this Data Download Link or at harcresearch.org.

Data are available as a bulk download zip file including climate indicators for the nine RESIN counties in csv and shapefile formats.

Left: an example plot of **length of summer** data for all nine RESIN counties and both **Moderate** and **High** scenarios.

## Additional Data Sources

**Centers for Disease Control**

- Social Vulnerability Index

**Homeland Infrastructure Foundation-Level Data**

- National Bridge Inventory

**National Oceanic and Atmospheric Administration, Office for Coastal Management**

- Sea Level Rise
- Land Cover

**Federal Emergency Management Agency**
(via Natural Resources Defense Council)

- Severe Repetitive Loss Properties

**Texas Commission on Environmental Quality**

- Leaking Petroleum Storage Tanks
- Brownfield Site Assessment
- Superfund Sites
- Permitted Wastewater Outfalls
- Public Water System Surface Water Intakes

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