Nicole McCarthy

Houston Climate Change Report

1931-2024

Contents

[Abbreviations 3](#_Toc198818672)

[Executive Summary 3](#_Toc198818673)

[Introduction 3](#_Toc198818674)

[Howdy, Y’all: The Demographics of ‘Y’all’ 3](#_Toc198818675)

[Bayou City: The Local Environment 4](#_Toc198818676)

[Space City: Major Industries 4](#_Toc198818677)

[Results 6](#_Toc198818678)

[Climate Data 6](#_Toc198818679)

[Average Temperatures 6](#_Toc198818680)

[Average Precipitation 8](#_Toc198818681)

[Energy Industry Growth 11](#_Toc198818682)

[Waste Management 11](#_Toc198818683)

[Discussion 11](#_Toc198818684)

[Effects of Climate Change on Houston 11](#_Toc198818685)

[Environmental Impact 11](#_Toc198818686)

[Public Health Impact 12](#_Toc198818687)

[Economic Impact 12](#_Toc198818688)

[Houston’s Role in Climate Policy 12](#_Toc198818689)

[Global Policies 12](#_Toc198818690)

[Local Policies 12](#_Toc198818691)

[Clutch City? A Plan of Action 13](#_Toc198818692)

[Conclusion 13](#_Toc198818693)

# Abbreviations

# Executive Summary

# Introduction

The purpose of this report is to analyze the changes in Houston’s climate over the past eighty years and discuss the city’s impact on these changes through industry and policy. Houston is located on the Northern portion of Texas’s coastline and is one of the state’s major urban centers. It is the fourth most populous city in the United States and the largest in the American south. Additionally, the landmass of the Greater Houston area is approximately the same size as the state of Massachusetts (City of Houston, 2025a). Therefore, understanding the nature of Houston’s environment, politics, and economy is crucial to becoming familiar with the current structure and future prospects for southerners and Americans at large.

## Howdy, Y’all: The Demographics of ‘Y’all’

As of 2024, the city of Houston alone (not including the surrounding municipalities) is home to over 2.3 million people. Its population is young, with only 12% over the age of 65. Unfortunately, almost 20% of residents are living in poverty. A break down of the diversity of Houston can be seen below (United States Census Bureau, 2024).

|  |  |
| --- | --- |
| **Race** | **Percentage of Population** |
| White only | 23% |
| Black only | 23% |
| Hispanic or Latino | 44% |
| Two or more races | 19% |
| Native American or Asian only | 8% |

These quick figures paint a picture of a city that is extremely diverse in race and economic background, with a clear lean towards the younger end of the spectrum for adults. This population is projected to continue to grow well into the next decade, indicating all the more reason to study its environmental impact (City of Houston, 2025a).

## Bayou City: The Local Environment

Houston has been lovingly nicknamed ‘Bayou City’ for the multiple bayous that run through its neighborhoods. However, like its population, the Greater Houston area is the most ecologically diverse major urban area in the nation. This includes forested areas typical of East Texas, bottomlands near all the rivers, savannah to the northwest, prairies through the center of Houston proper, which is of course crisscrossed with bayous, coastal marshes, and estuaries and bays next to the Gulf of Mexico (Houston Wilderness).

Being on a southern coastline of the United States, Houston naturally has a subtropical climate with high humidity, mild winters, and sweltering summers. Its most common natural disasters include flooding and hurricanes, though a derecho also hit Houston last summer, causing serious damage to the northwest and downtown regions with its high wind speeds. Because it is further inland than Galveston and bordering coastal towns, it is often less affected by the hurricanes that make landfall nearby. However, the residents of Houston are well versed in hurricane preparedness and whether their neighborhood typically takes on significant flooding during these types of events.

## Space City: Major Industries

Houston has also been nicknamed ‘Space City’ because it is home to NASA, the National Aeronautics and Space Administration. Murals of cowboy astronauts are not uncommon to find on buildings and the catch phrase “Houston, we have a problem,” which refers to an Apollo 13 astronaut’s communications to ground control, is still popular in American culture.

Nevertheless, Houston is at the forefront of several other industries. In fact, it is home to 23 Fortune 500 companies. Houston’s port brings in the most international tonnage to the United States and is ranked second for total tonnage. This is assisted by the significant trucking firms and rail systems. However, after the space industry, Houston is probably most well-known for its energy sector. In 1981, this sector employed around 85% of the city’s workforce. Today, that has shrunk to closer to 50% as the technology, medical, and manufacturing sectors have significantly increased (City of Houston, 2025b).

Despite the decrease of energy in the makeup of the economic activity of Houston, the city is still called “the energy capital of the world,” (Roberts, 2021). This is in part due to the increase in fracking, and therefore oil exports, over the last decade or two. Most of Houston’s fracking activity occurs on offshore oil platforms.

Fracking is a method of drilling for hydrocarbons that pushes what is called “drilling mud,” or simply “mud” at high pressure down the drill string, or pipeline, to remove rock cuttings and clean the drilling tool as the fluid is pushed back up to the surface. Fracking raises a few environmental concerns. The first is that it releases methane, one of the most impactful greenhouse gases, into the atmosphere. Second, because the drilling mud is actually a mixture of water, clay, and other chemical additives, it can contaminate ground water if the drilling comes in contact with an aquifer. Lastly, fracking can contaminate soil and agricultural land for similar reasons. With Houston’s fracking occurring mostly offshore, contamination of ground water and soil is not a concern. However, oil spills due to oil platform accidents have been known to happen, including the Deepwater Horizon accident in 2010, the largest oil spill in the history of marine oil drilling.

# Results

## Climate Data

The data for this analysis was recorded at Hobby Airport, located just east of downtown. The data includes daily temperature minimum, maximum, and average, as well as the amount of precipitation in inches.

### Average Temperatures

A loess regression line was fitted to the annual average temperature, showing an overall increase in average temperature since 1931 (Figure 1). A few years with significantly lower average temperatures can be seen. These are 1942-1946. This is a global phenomenon that is linked, but not explained by, the significant bombings of World War II (Robock and Zambri, 2018).

A graph showing the temperature of an airplane

AI-generated content may be incorrect.

Figure Average Annual Temperature in Houston (1931-2024)

To make sure that the positive trend in average temperature was accurate and not a result of the anomalies of the 1940s, those datapoints were removed and the set was plotted again with a new regression line (Figure 2). This resulted in another clearly positive trend in the average annual temperature. This increase in temperature is likely a result of global climate change as there are no other obvious reasons for this longstanding trend.

A graph showing the temperature of an airplane

AI-generated content may be incorrect.

Figure Average Annual Temperature without 1942-1946 as outliers

For further analysis, the data was aggregated into decades and plotted on a bar chart (Figure 3). The anomaly of the 1940s is obvious. However, the trend of increasing temperature over the period of ten years is also shown here from the 1990s. The slight increase in temperature in the 1950s followed by a small decrease until the 1980s is hypothesized to be the result of atomic and hydrogen bomb testing following World War II and the decrease in testing until the fall of the Soviet Union due to international agreements to do so.

A graph of a number of blue bars

AI-generated content may be incorrect.

Figure . Average Temperature for each Decade in Houston

### Annual Precipitation

Because information on drought in Houston specifically was not easily accessible, this section will discuss the history of drought in Texas in general, followed by an analysis of precipitation in Houston.

Texas has experienced many droughts of varying severity. The Great Depression of the 1930s was famously caused by drought and dust storms in the panhandle region. However, the worst droughts in Texas history occurred from 1950-1957. The increase in average temperature seen in Figure 3 contributed to water scarcity across the state. The most recent severe drought in the state occurred from 2010-2014. This was more severe than the drought of the 1950s, which was often considered to be a worst-case scenario, though it was shorter. 2022 was ranked the eleventh driest year in the last 128 years, but this drought was eased by rainfall quickly (Donald and Grubbs, 2022). This may indicate an increase in both frequency and severity of droughts, though perhaps also a shortening of the drought cycle, providing relief sooner to Texans.

Houston’s precipitation seems to follow the general trends of Texas, with the exception of the 1950s drought. Rainfall increased until around 1970, stabilized until around 2000, then began to gradually drop again (Figure 4). This indicates Houston is also experiencing less rainfall in the last decade or two that has been reported across the entire state. This may be partially a result of increasing temperatures, discussed earlier.

A graph of precipitation in houston

AI-generated content may be incorrect.

Figure Total Precipitation per Year in Houston

To get a better idea of the long-term trends, the annual precipitation was averaged across decades and found that, with the exception of the 1970s, which was abnormally high on average, the average annual precipitation steadily increased throughout the twentieth century and began to decrease at the onset of the twenty-first century (Figure 5). The rate of decreasing in recent decades is far quicker than that of the increase before. With the data available for the first half of the 2020s, precipitation is already lowered to levels seen in the 1960s. Of course, the second half of this decade remains to be seen and may turn those numbers around.

A graph of blue bars

AI-generated content may be incorrect.

Figure Average Annual Precipitation per Decade in Houston

Because the drought of the 1950s has been recognized as a major urbanizing event of Texas, pushing farmers off their land into cities to find work, the effect of drought on Houston is different than it is for the rest of the state. The city’s increasing population for the last several decades is partially due to this, which increases demand for water in the city. However, as seen in the introduction, many rivers and bayous run through the Greater Houston area, allowing Houston to have lessened effects of drought and leaving it to feel the constraints of it last.

## Energy Industry Growth

1. Investigate the growth of renewable energy in Texas. What are the main sources of renewable energy in the state, and how have they evolved over the past 20 years?
2. Discuss the role of nuclear energy in Texas's energy mix. What are the benefits and challenges associated with nuclear energy in the state?

## Waste Management

1. Analyze the waste management practices in Texas. How does the state handle waste from various industries, including energy and agriculture?

# Discussion

## Effects of Climate Change on Houston

### Environmental Impact

1. Discuss how climate change has affected Texas in the past 80 years. What evidence is there of climate change impacting temperature, rainfall, and extreme weather events?
2. Explain the impact of El Niño and La Niña events on Texas's climate. Provide examples of specific years when these phenomena significantly influenced weather patterns in Texas. (Cite Sources)
3. Explain what Representative Concentration Pathways are and how they are used in climate modeling. Discuss the potential impact of different RCP scenarios on Texas's climate by 2100.

### Public Health Impact

1. Examine the potential impacts of climate change on public health in Texas. What measures can be taken to mitigate these impacts?

### Economic Impact

1. Discuss the economic impact of climate change on Texas. How might changes in climate affect key industries like agriculture, energy, and tourism?

## Houston’s Role in Climate Policy

### Global Policies

1. Summarize the key goals of the Paris Agreement. How is Texas contributing to the United States' commitments under the Paris Agreement? Is the US even in accord with the Paris Agreement?
2. Provide an overview of the Kyoto Protocol. Was Texas affected by policies implemented under the Kyoto Protocol? If so, how? Was it even impelented in America? Were other states/ government agencies affected by this protocol? Elaborate.
3. What was the purpose of the Nuclear Energy Advisory Committee (NEAC) established in 2008? How has it influenced nuclear energy policies in Texas?

### Local Policies

1. Investigate the key environmental policies implemented in Texas over the past 20 years. How have these policies addressed climate change and environmental protection?

## Clutch City? A Plan of Action

1. Create a personal action plan that outlines steps individuals in Texas can take to reduce their carbon footprint and contribute to climate mitigation efforts. (a paragraph in length suffices).
2. What is carbon capture and storage (CCS), and how can it help mitigate climate change? Discuss any CCS projects or initiatives in the state of Texas.

# Conclusion

1. What did you learn most from this project. Have you had any change of views pertaining to any topics discussed in this course/final exam. Please elaborate.

# References

City of Houston. (2025a). “About Houston: Fast Facts and Figures.” *City of Houston, Texas.* <https://www.houstontx.gov/abouthouston/houstonfacts.html>.

City of Houston. (2025b). “About Houston: Business Overview.” *City of Houston, Texas*. <https://www.houstontx.gov/abouthouston/business.html/>.

Donald, J. and Grubbs, S. (2022). “Drought in Texas: How Rain Scarcity Affects Texans and the Economy.” *Comptroller.Texas.Gov*. <https://comptroller.texas.gov/economy/fiscal-notes/archive/2022/dec/drought.php>.

Houston Wilderness. “Ecoregions.” *Houston Wilderness*. <https://houstonwilderness.org/about-ecoregions>.

Roberts, K. (2021). “Fracking Has Transformed Port of Houston from Import to Export Powerhouse.” *Forbes*. <https://www.forbes.com/sites/kenroberts/2021/08/13/fracking-has-transformed-port-of-houston-from-import-to-export-powerhouse/>.

Robock, A. and Zambri, B. (2018). “Did Smoke from City Fires in World War II Cause Global Cooling?” *Journal of Geophysical Research: Atmospheres 123*, 10,314–10,325. <https://doi.org/10.1029/2018JD028922>.

United States Census Bureau. (2024.) “Quick Facts: Houston city, Texas.” *United States Census Bureau*. <https://www.census.gov/quickfacts/fact/table/houstoncitytexas/PST045224>.