



## Climate Change and the Urban Heat Island Effect

**Name:** Climate Change and the Urban Heat Island Effect

**Grade:** 6<sup>th</sup>-8<sup>th</sup>

**Topic:** Learn how climate change and the urban heat islands affect one another

**Time:** 60-90 mins

### Introduction:

Climate change is a long-term shift in temperatures and weather patterns. While some shifts may be naturally occurring, human activities have been the main driver of climate change since the 1800s. Human activities that primarily contribute to climate change include burning fossil fuels, which causes greenhouse gas emissions. Greenhouse Gases (GHGs) are a collective term for a group of different chemical compounds as listed in **Table 1** below. The increase in infrared energy-absorbing gases in the lower atmosphere causes a rise in the earth’s average global temperature, also known as the *greenhouse effect*.

*Table 1: Sources of Greenhouse Gases (GHG)*

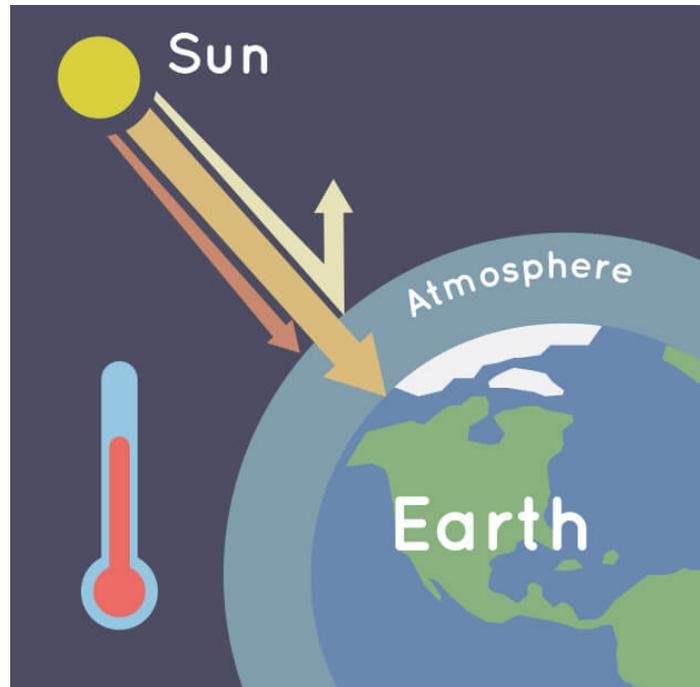
GHG	Human Sources
<b>Carbon dioxide</b>	Burning Fossil Fuels, deforestation
<b>Methane</b>	Feedlots, rice fields
<b>Nitrous oxide</b>	Vehicles, machinery, agricultural fields
<b>Chlorofluorocarbons</b>	Coolants, spray cans
<b>Water vapor</b>	Evapotranspiration (natural)

Urban Areas, such as Dallas Fort Worth (DFW), have many structures such as buildings, roads, and other infrastructure which absorb and re-emit the sun’s heat more than natural landscapes

such as forests and water bodies. Metropolitan Areas, including DFW, where these structures are highly concentrated have higher temperatures and become “islands”, also known as the *heat island effect*. The heat island effect can result in daytime temperatures in urban areas being 1-7° F higher than temperatures in outlying areas.

Climate Change and heat islands interact in important ways. In many areas of the U.S., steadily warming trends from climate change are intensifying already higher temperatures in heat island areas. This trend is expected to worsen as urban populations densities increase and natural land areas decrease. However, communities can take actions to reduce their local heat island by installing cool roofs and increasing tree canopy to lower heat island temperatures, lessen exposure to climate change impacts, and lower GHGs emissions.

Figure 1: Earth's atmosphere traps some of the Sun's heat, preventing it from escaping back into space at night



<https://climatekids.nasa.gov/greenhouse-effect/>

### Key Terms:

**Climate Change**- long-term shifts in temperatures and weather patterns.

**Greenhouse Gases**- Gases that trap heat in the atmosphere.

**Greenhouse Gas Effect**- Process that occurs when gases in Earth's atmosphere trap the Sun's heat.

**Urban Heat Island Effect**- occurs when a city experiences much warmer temperatures than nearby rural areas.

**Emissions**- Gases and particles which are put into the air or emitted by various sources.

**Anthropogenic heat** – The release of heat from burning of fossil fuels can also raise urban temperatures when a city experiences much warmer temperatures than nearby rural areas.

**Albedo** – the proportion of light reflected from a surface.

## Investigation 1, Part 1: Surface Temperature

### Materials:

Kit will include:

- Infrared Thermometer
- Surface Temperature Lab Report



*Videos and additional  
Information can be found on  
the DFW Earth Day website*

### Procedure:

#### Investigation 1, Part 1: Surface Temperature

If it were a hot summer day, where would you go outside to cool off? Have you ever noticed how hot it is on a basketball court, versus under a tree at the park? Why do you think that is? Today you will be exploring these questions through our experiment today.

Today we will be observing how temperatures of exterior surfaces differ on a warm day by following the below steps.

1. Divide the students into teams.
2. Provide students with the lab report for this experiment (see below attachment).
3. Each lab teams will identify exterior surface(s) to measure the temperature and compare it to the temperature in a grassy area.
4. Students to define what the independent and dependent variables will be for the experiment.
5. Have students work with the lab partner(s) to formulate the Question, Hypothesis, and Procedure, and complete these sections on their lab report.

Once students have finished, take a moment to review these sections as a class, identify each surface that will be measured, and discuss the procedure they will all be using.

## Surface Temperature Lab Report

Student Names:

Date:

Class:

What is the independent variable for the experiment today?

What is the dependent variable for the experiment today?

Question: What is the effect of the independent variable on the dependent variable?

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Establish our hypotheses: If \_\_\_\_\_ then \_\_\_\_\_ because \_\_\_\_\_

Materials: Infrared thermometer, and Lab Report

Establish our procedure. What are the single actions taken to conduct the experiment that are numbered in sequential order.

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Data:

Ground Type	Temperature Reading 1	Temperature Reading 2	Temperature Reading 3	Average Temperature
Grass				
Asphalt				

Data Analysis: Describe what your data shows. Use the calculations to compare results.

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Conclusion: Discuss whether your hypothesis was accepted or rejected.

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## Investigation 1, Part 2: Real World Connection

### Procedure:

#### Investigation 1, Part 2: Real World Connection

Questions from the Surface Temperature Investigation:

- What were your findings from the surface temperature experiment that we did?
- What do you think this might tell you about summers in different types of places?
- What would the temperature be like in a rural area with lots of fields?
- What about an urban area with lots of pavement?
- Are these surfaces/environments naturally occurring? Where do they come from?

We will be exploring what different surfaces do to the temperatures in different environments. Students will watch the following video as an introduction to Urban Heat Islands:

[WHY ARE CITIES HOTTER THAN THE COUNTRYSIDE? - The urban heat island effect](#)



**As a class, discuss Urban Heat Islands and humans' impacts on the environment:**

- What is the Urban Heat Island effect?
- What causes cities to be hotter than rural areas? (humans, urbanization, pavement)
- What effects does this have on cities?
- How have human activities impacted the surface temperature of certain areas?

Complete the "Urban Heat Island Graph Analysis" Worksheet (shown below).

**Optional:**

1. Students will work with their partner to read through "Urban Heat Islands" at <https://scied.ucar.edu/learning-zone/climate-change-impacts/urban-heat-islands>.
2. After reading the article, students will complete the "Claim, Evidence, Reasoning" organizer where you will use the data from the previous experiment to state a claim while providing evidence, and using information from the article for your scientific reasoning.
3. Provide each pair of students with a piece of chart paper and a marker.

## Conclusion/Key Take away:

**As vegetation is replaced by asphalt and concrete for roads, buildings, and other structures necessary to accommodate growing populations, heat islands form.**

Surfaces such as asphalt and concrete, absorb, rather than reflect, the sun's heat, causing surface temperatures and overall ambient temperatures to rise. Displacing trees and vegetation minimize the natural cooling effects of shading and evaporation of water from soil and leaves. Waste heat from vehicles, factories, and air conditioners may also add warmth to their surroundings, and further impact the heat island effect.

### Urban Heat Island Graph Analysis

Directions: Use the Urban Heat Island graph (Figure 1) below to complete the table showing the relation between different environments and temperatures. Based on the information in the table and the information you have learned about urban heat islands answer the questions

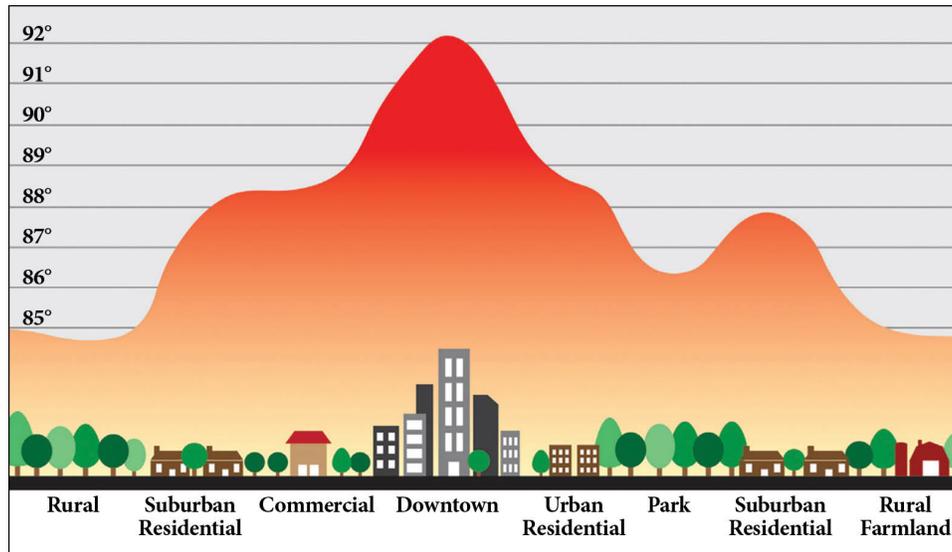


Figure 1. Urban Heat Island Profile Graph in Fahrenheit.

Environment	Late Afternoon Temperature
Rural	
Suburban Residential	
Commercial	
Downtown	
Urban Residential	
Park	
Suburban Residential	
Rural Farmland	

Steps. Answer the questions. Check with your instructor on how to submit answers.

1. What is the highest temperature in Fahrenheit on the graph?
2. Identify which community (rural, suburban, urban) has the highest surface temperatures and explain why.
3. Identify which community (rural, suburban, urban) has the lowest surface temperatures and explain why.
4. What kind of community do you live in? Describe the surface temperature of your neighborhood by comparing it with other parts of your community.

Claim – Evidence – Reasoning: Surface Temperatures

<p><b><u>State your claim:</u></b></p> <p><b><u>How can human activities / construction impact surface temperatures?</u></b></p>	
<p><b><u>Provide Evidence:</u></b></p> <p><b><u>How did your data from the surface temperature experiment support your claim?</u></b></p>	
<p><b><u>Scientific Reasoning:</u></b></p> <p><b><u>What information does the article and video provide to explain this phenomenon?</u></b></p>	

## Investigation 2: Climate Change and the City

### Materials:

Kit will include:

- Plastic shoe box with lid
- Glue
- Paint
- Paint brushes
- Foil
- Foam board
- Artificial moss
- Digital Hygrometers



*Videos and additional  
Information can be found on  
the DFW Earth Day website*

Additional Optional Materials Needed:

- Plastic Wrap
- Wax Paper
- Pebbles
- Cotton Balls
- Soil
- Live Plants
- Newspaper
- Fabric

### Procedure:

Review the prior two investigations as a class, and ask:

- If we are forecasted to have more heat waves due to climate change, how might this impact residents of cities?
- What might be some possible issues?
- What might be some potential solutions?

Based on the information we have learned from our prior lessons on climate change, and how that relates to the urban heat island effect we will work on findings some possible solutions.

## Directions:

1. Students will form five teams.
2. Each team will be tasked to build and test a roof design to lessen the Urban Heat Island effect.
  - a. Students will work with their partners to review the article “Urban Heat Island” (from Investigation 1, Part 2) about climatologist’s predictions for the impact climate change will have on urban heat islands.
3. As a class discussion:
  - a. What is the problem behind the Urban Heat Island effect?
  - b. Why it’s important to people?
  - c. What are some potential solutions?
4. Next, each team will be given a plastic shoebox that represents a building, the lid acting as the roof, various materials to construct a roof, and a digital thermometer.
  - a. The teacher will define any “constraints,” the teams will need to follow for their roof design (i.e. time, materials, etc.).
5. Students should work with their teams to begin planning their design, using the planning sheet (provided below).
  - a. Students will define the problem they are trying to solve, the constraints involved, their design idea, and how they will measure the effectiveness of their design.
6. Students will construct roof designs.
7. Once all roof designs have been constructed the teams will place their shoe boxes outside on a sunny day for approximately 30-45 minutes and measure the results.
8. Each team will record their result on the planning sheet.
9. As a class compare the results of each team’s roof to see who had the best design.
10. Based on the class results record what your next steps would be to improve your roof design.

Once students have finished, take a moment to review these sections as a class.

## Conclusion/Key Take away:

**By working to reduce our greenhouse gas emissions and modifying how our buildings are constructed, we can help to alleviate the effects the Urban Heat Island Effect.**

Climate change and the Urban Heat Island Effect is a problem anytime people begin to populate urban areas. By understanding what causes the Urban Heat Island Effect we can begin to formulate solutions. We can modify our behaviors, and equipment we can minimize greenhouse gases that are released. We can also use building designs that use clear more reflective surfaces and bring vegetation back into urban areas to better manage solar energy and increase cooling. Through understanding what causes climate change, how it relates to urban heat islands, and how it impacts people we can make changes that will benefit people and the environment.

### Planning Sheet for Reducing the Urban Heat Island – Roof Design Challenge

Name \_\_\_\_\_ Date \_\_\_\_\_ Class \_\_\_\_\_

Group members:

Problem:	Constraints:

Step 1: Design layers: What household/classroom material will you use?

Step 2: What outcome do you hope to achieve with your design? How will you measure the effectiveness of your design?

Step 3: Results and Next Steps

## Sources:

### Climate Change

- <https://climate.nasa.gov/global-warming-vs-climate-change/>
- [What Is Climate Change? | United Nations](#)

### Urban Heat Islands:

- [Urban Heat Islands - Earth Observatory Kids \(nasa.gov\)](#)
- [Climate Change and Heat Islands | US EPA](#)
- [Demographic and economic trends in urban, suburban and rural communities | Pew Research Center](#)

### Overview of Greenhouse Gases:

- <https://www.epa.gov/ghgemissions/overview-greenhouse-gases>

### What is the Greenhouse Effect:

- <https://climatekids.nasa.gov/greenhouse-effect/>