

Hot Time in the City Lesson Plan

Students investigate climate, land use and the urban heat island effect.

Lesson Summary: Students consider how Florida's climate has affected its economy and society throughout its history, observe current land use patterns, and investigate the urban heat island effect.

Grade Level: High School

Time Allotted: Three 50-minute class periods (does not include field trip extension)

Performance Objectives

References are to the Next Generation Sunshine State Standards (2007).

Social Studies

- SS.912.A.1.2 Utilize a variety of primary and secondary sources to identify author, historical significance, audience, and authenticity to understand a historical period.
- SS.912.A.1.5 Evaluate the validity, reliability, bias, and authenticity of current events and Internet resources.
- SS.912.G.1.2 Use spatial perspective and appropriate geographic terms and tools, including the Six Essential Elements, as organizational schema to describe any given place.
- SS.912.G.3.2 Use geographic terms and tools to explain how weather and climate influence the natural character of a place.
- SS.912.G.3.3 Use geographic terms and tools to explain differing perspectives on the use of renewable and non-renewable resources in Florida, the United States, and the world.
- SS.912.G.4.5 Use geographic terms and tools to analyze case studies of the development, growth, and changing nature of cities and urban centers.
- SS.912.G.4.6 Use geographic terms and tools to predict the effect of a change in a specific characteristic of a place on the human population of that place.
- SS.912.G.5.3 Analyze case studies of how changes in the physical environment of a place can increase or diminish its capacity to support human activity.
- SS.912.G.5.23. Analyze case studies of the effects of human use of technology on the environment of places.

Science

- SC.912.E.7.8 Explain how various atmospheric, oceanic, and hydrologic conditions in Florida have influenced and can influence human behavior, both individually and collectively.
- SC.912.N.1.1 Define a problem based on a specific body of knowledge, for example: biology, chemistry, physics, and earth/space science, and do the following: pose questions about the natural world, conduct systematic observations, examine books and other

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sources of information to see what is already known, review what is known in light of empirical evidence, plan investigations, use tools to gather, analyze, and interpret data (this includes the use of measurement in metric and other systems, and also the generation and interpretation of graphical representations of data, including data tables and graphs), pose answers, explanations, or descriptions of events, generate explanations that explicate or describe natural phenomena (inferences), use appropriate evidence and reasoning to justify these explanations to others, communicate results of scientific investigations, and evaluate the merits of the explanations produced by others.

- SC.912.N.1.3 Recognize that the strength or usefulness of a scientific claim is evaluated through scientific argumentation, which depends on critical and logical thinking, and the active consideration of alternative scientific explanations to explain the data presented.
- SC.912.N.1.6 Describe how scientific inferences are drawn from scientific observations and provide examples from the content being studied.
- SC.912.N.1.7 Recognize the role of creativity in constructing scientific questions, methods and explanations.

Language Arts – Writing

- LA.910.3.1 The student will use prewriting strategies to generate ideas and formulate a plan.
- LA.910.3.2 The student will write a draft appropriate to the topic, audience, and purpose.
- LA.910.3.3 The student will revise and refine the draft for clarity and effectiveness.
- LA.910.3.4 The student will edit and correct the draft for standard language conventions.
- LA.910.3.5 The student will write a final product for the intended audience.
- LA.910.4.1 The student develops and demonstrates creative writing.

Prior Knowledge: None.

Overview

Florida's landscape has undergone extensive revisions during the past 100 years as the state's population has grown. Studies have shown that widespread landscape changes have had a demonstrable impact on Florida's climate. It is expected that climate changes will affect future land use in the state, as rainfall and temperature fluctuations, storm frequency and intensity changes, and coastal inundation change agricultural and urban development patterns.

Land use and climate change are inextricably linked. The ways that humans use land directly impact the production of greenhouse gases that produce global warming. Conversely, the effects of climate change will inevitably cause humans to use land differently as we act to improve energy efficiency to

reduce our “carbon footprint” and try to adapt to the negative effects of climate change on our economy and ecosystems.

Key Vocabulary

Adaptation

Initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects.

Anthropogenic

Caused by humans; relating to or resulting from the influence that humans have on the natural world.

Climate

The long-term average of conditions in the atmosphere, ocean, and ice sheets and sea ice described by statistics, such as means and extremes.

Climate change

A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces, or to persistent anthropogenic (human-caused) changes in the composition of the atmosphere or in land use.

Climate Variability

Natural changes in climate that fall within the normal range of extremes for a particular region, as measured by temperature, precipitation, and frequency of events. Drivers of climate variability include the El Niño Southern Oscillation and other phenomena.

Feedback

The process through which a system is controlled, changed, or modulated in response to its own output. Positive feedback results in amplification of the system output; negative feedback reduces the output of a system.

Global Warming

The observed increase in average temperature near the Earth’s surface and in the lowest layer of the atmosphere. In common usage, “global warming” often refers to the warming that has occurred as a result of increased emissions of greenhouse gases from human activities. Global warming is a type of climate change; it can also lead to other changes in climate conditions, such as changes in precipitation patterns.

Infrastructure

The basic physical and organizational structures and facilities (e.g., buildings, roads, and power supplies) needed for the operation of a society or enterprise.

Land cover

The observed (bio)physical cover on the earth's surface.

Land use

The way in which land is used, or categorized for use, by humans.

Mitigation

Human interventions to reduce the sources of greenhouse gases or enhance the sinks that remove them from the atmosphere.

Permeability

The extent of a material to allow water to pass through it.

Solar radiation

Heat energy from the sun, including the infrared, visible, and ultraviolet wavelengths.

Solar reflectance

The percentage of solar energy reflected by a surface. "Albedo" is another term that means the same thing.

Thermal emissivity

The relative ability of its surface to emit energy by radiation. It is the ratio of energy radiated by a particular material to energy radiated by a black body at the same temperature.

Urban heat island

A phenomenon whereby urban regions experience warmer temperatures than their rural surroundings.

Weather

The specific conditions of the atmosphere at a particular place and time, measured in terms of variables that include temperature, precipitation, cloudiness, humidity, air pressure, and wind.

Materials

- Computer with internet access.
- Historic photos of Orange County people and places. (Possible sources under References, below)

References

The following references are available in the [Digital Library](#) of the Orange County Water Atlas.

[2010 - 2030 Comprehensive Plan Land Use Map—Orange County](#). 2010. Orange County Growth Management Department.

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[Climate Change and Land Use in Florida: Interdependencies and Opportunities](#). Century Commission for a Sustainable Florida. Retrieved from the website of the University of Florida School of Natural Resources and Environment, 2011.)

[Climate Literacy: The Essential Principles of Climate Sciences](#). 2009. U.S. Global Change Research Program.

[Cooling Summertime Temperatures: Strategies to Reduce Urban Heat Islands](#). 2003. U.S. Environmental Protection Agency.

[Reducing Urban Heat Islands: Compendium of Strategies](#). 2009. U.S. Environmental Protection Agency.

Other references:

[Central Florida Memory](#). The University of Central Florida Library, The Orange County Regional History Center, and The Orange County Library System.

[Intergovernmental Panel on Climate Change](#). Website. Accessed June 2011.

[Orange County Regional History Center](#).

[Power Up Florida](#) (Orlando/Orange County web portal to sites for electrical efficiency, solar usage, electric vehicles, clean technology, Climate Change Education Center, etc.). Accessed July 2011.

Sonne, Jeffrey K., and Robin K. Viera. [Cool Neighborhoods: The Measurement of Small Scale Heat Islands](#). 2000. Proceedings of 2000 Summer Study on Energy Efficiency in Buildings, American Council for an Energy-Efficient Economy, 1001 Connecticut Avenue, Washington, DC. (Retrieved from the website of the [Florida Solar Energy Center](#), 2011).

[State Library and Archives online photographic collection](#). State of Florida.

Cook, John. [Skeptical Science: Getting Skeptical About Global Warming Skepticism](#). Website. Accessed June 2011.

Stanton, Elizabeth K., and Frank Ackerman. [Florida and Climate Change: The Cost of Inaction](#). 2007. Tufts University Global Development and Environment Institute and Stockholm Environment Institute—US Center.

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Photo source: cfmemory.org, ca. 1935

Procedure – Day 1

Engage/Elicit

Lead a class discussion about what it would have been like to live in Orange County in earlier times, when there were fewer people, fewer buildings, fewer roads and more open space. Ask students if they have family members with a long history in the county who have told them how it has changed during their lifetimes. If so, what have they been told?

Explore

Provide each student (or small group of students, if you like) with a photo or illustration of a particular time in Orange County's history. (Use photos from various time periods.) Ask each student/group to research the impact of climate on people in that place/time/occupation, as well as what the major uses of land were in Orange County at that time. They should write a description of the place/time incorporating as many of the Six Essential Elements of Geography as possible. Some of the questions they might address are:

- How many people lived in the state at that time?
- What were the main occupations of people?
- What were people's sources of energy, food, water, building materials?
- What were the most common forms of transportation?
- How did the climate benefit people in making their living?

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- What challenges did climate present to people?
- What measures did people take to overcome those climate challenges?
- What major events of the time impacted people's lives? How was climate a factor? (Seminole Indian attacks, World War I and II, rise of agriculture, hurricanes, yellow fever, construction of theme parks, advent of the space program, etc.)?

Explain

Have each student write a story written in the form of a letter to people of our time; it should be in first person, from the perspective of a fictional person who lived at the time depicted in the photo, using the photo as inspiration and drawing on the historical research performed by students.

Extend

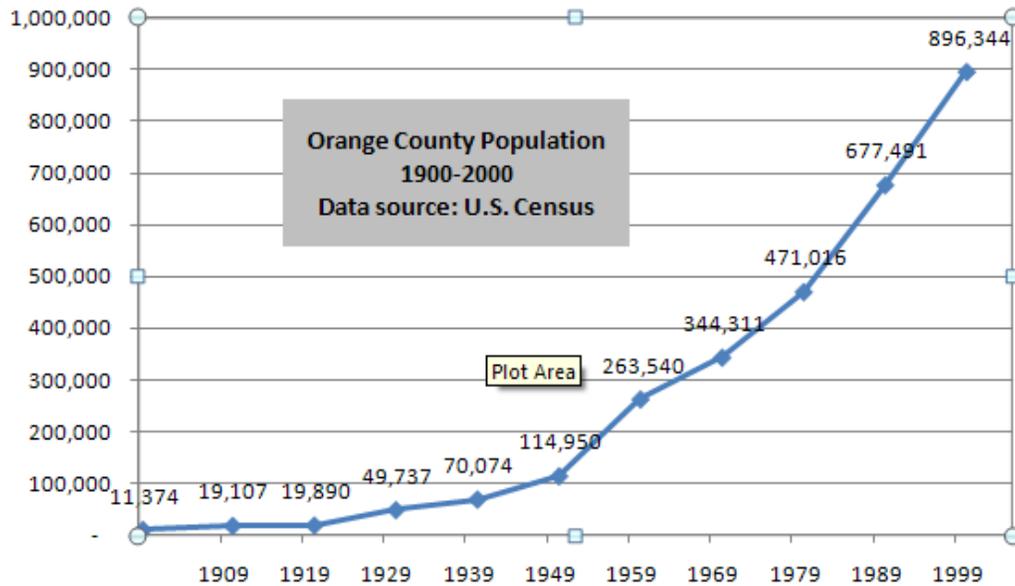
Plan a class visit to the Orange County Regional History Center in Orlando.

Exchange/Evaluate

Post the students' photos and short stories on the Orange County Water Atlas Watershed Excursion.

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Procedure - Day 2

Engage/Elicit

1. Ask students about their lives today, and how they differ from those of the people they wrote about on Day 1. What are the most prominent features of the landscape in their community today? What did their community look like 25 years ago? 50? 100?
2. Ask the class if they have heard of urban heat islands, and if so, what they know about them. Give them the definition as shown in the Key Vocabulary, above. Ask students to suggest factors that might account for the tendency of urban areas to be warmer than rural ones. Make a list on the board. Why might climate change make this an even more important issue?

Explore

1. Guide students to the **Advanced Mapping** application on the [Orange County Water Atlas](#). (From the **Data & Mapping** menu, have them choose **Advanced Mapping Tools**.) Have them click the **Map Themes** button on the upper right, and then choose the link for **Land Use**.
2. Have students observe the land use types shown on the map. Allow them a few minutes to explore the map. They may wish to compare previous land use maps with the most current one, find their own homes or their school on the map and observe surrounding land use, observe which land use types dominate in which parts of the county, or print a copy of the map for reference. Point out to them, in particular, the extent of the "Urban/Built Up" land use type.
3. Refer students to the resources listed in the Reference section that are related to the urban heat island effect. What other factors, besides the ones the class listed, contribute to the phenomenon? What is the difference between surface and atmospheric urban heat islands?

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Explain

Direct students to design an investigation the "urban heat island" effect by proposing a hypothesis about heat retention in urban settings, and an experiment to test it. Students may wish to use thermometers to measure the temperature at areas around their school with various surfaces— parking lot, dark-colored roof, light-colored roof, sunny/grassy field, wooded area, etc.—at different times during the day/night. They may wish to apply different coatings to a surface and compare their emissivity. They may wish to compare the tendency of a parking lot without trees to hold heat throughout the night with one that is shaded by vegetation. In addition to a statement of their problem and investigation method, one product of their investigations might be a time/temperature graph showing the differences in temperature in different locations, as well as the rate at which the temperature changes throughout the day/night. Which locations have the highest/lowest temperature? Which locations hold heat longest?

Extend

What measures have been taken in your community to reduce the urban heat island effect? You may be able to find out by contacting the zoning/development department of your county or municipality. What measures can students suggest to make their school "cooler"?

Evaluate/Exchange

1. Students' hypotheses should be testable, and each experiment should be designed to prove or disprove it.
2. Students may be graded on their scientific procedure and on the completeness, organization, and presentation of their results.
3. You may wish to assign students to work in groups to design and execute their investigations; when complete, have each group share their investigation with the rest of the class.

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