POLAR TREC Learning Resources

Details

- Arctic
- About 1 Period
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Paleoclimatology and Poetry

(a lesson across disciplines in three parts)

Overview

The students will analyze T.S. Elliot' s "*The Waste Land*" and make connections between Elliot's premonition of global drought.

Objectives

- Students should be able to define vocabulary at the end of lesson. Analyze section V: "*What Thunder Said*" of Elliot's "*The Waste Land*".
- Students will use graph to tease data.
- Students will write literary response, incorporating data and cite references.
- Student will make connections between global climate change and water availability.

Lesson Preparation

Collect materials to be shown via smart board, projector. Have websites and graphs readily available. Enough poems for groups of two (ideally, every student should have a poem to highlight).

Procedure

1. Students will be given highlighters and copy of poems. The students (in groups of two) will then read section V (What Thunder Said) and discuss and highlight Elliot's predictions of global climate change.
2. Students will take notes in their groups of data slides from the NOAA (climate and weather toolkit) and attached graphs from the book Global Climate Change Impacts in the U.S..
3. Student will look at the repeat photography and discuss evidence of environmental impact in the Toklat River area as well as Alaskan ponds (separate

Materials

- A copy of TS Elliot's poem, "The Waste Land"
- highlighters
- Vocabulary sheet
- Data slides from the NOAA (climate and weather toolkit) and attached graphs from the book Global Climate Change Impacts in the U.S.
- Toklat River repeat photography
- Alaska Ponds repeat photography

graph).

4. Students will then discuss paleoclimateolgoy data on weather and climate and the anthropogenic impact upon weather and climate. Does global climate change have an impact upon the availability of water, specifically freshwater?
5. Students will write an exit ticket in the form of a paragraph, citing specific examples from the poem and using data gleaned from the graphs.

Extensions

If there is enough time, prefixes and root words of vocabulary can be defined.

Resources

"*The Waste Land*" by T.S. Elliot
Toklat River repeat photography (Denali Park- US National Park Services)
www.ncdc.noaa.gov/wct (data weather and climate toolkit)
Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo and Thomas. C. Peterson, (eds.). Cambridge University Press, 2009. (graphs)

Assessment

Students will write a paragraphs exit slip and cite textual evidence of Elliot's predictions of global climate change in section V of "The Waste Land". Students will also use notes of science data to support their assertions.

Author / Credits

Julia Vaughan of Koontz Intermediate in Asheville, NC created this lesson plan as a capstone project for the 2015 teacher training course entitled: Climate Change: Seeing, Understanding, and Teaching, held in Denali National Park. The course is facilitated by the Arctic Research Consortium of the U.S. (ARCUS) in partnership with Alaska Geographic and the National Park Service.

File Attachments

Please list the attached worksheets, data sets, and other associated materials that go with the lesson.

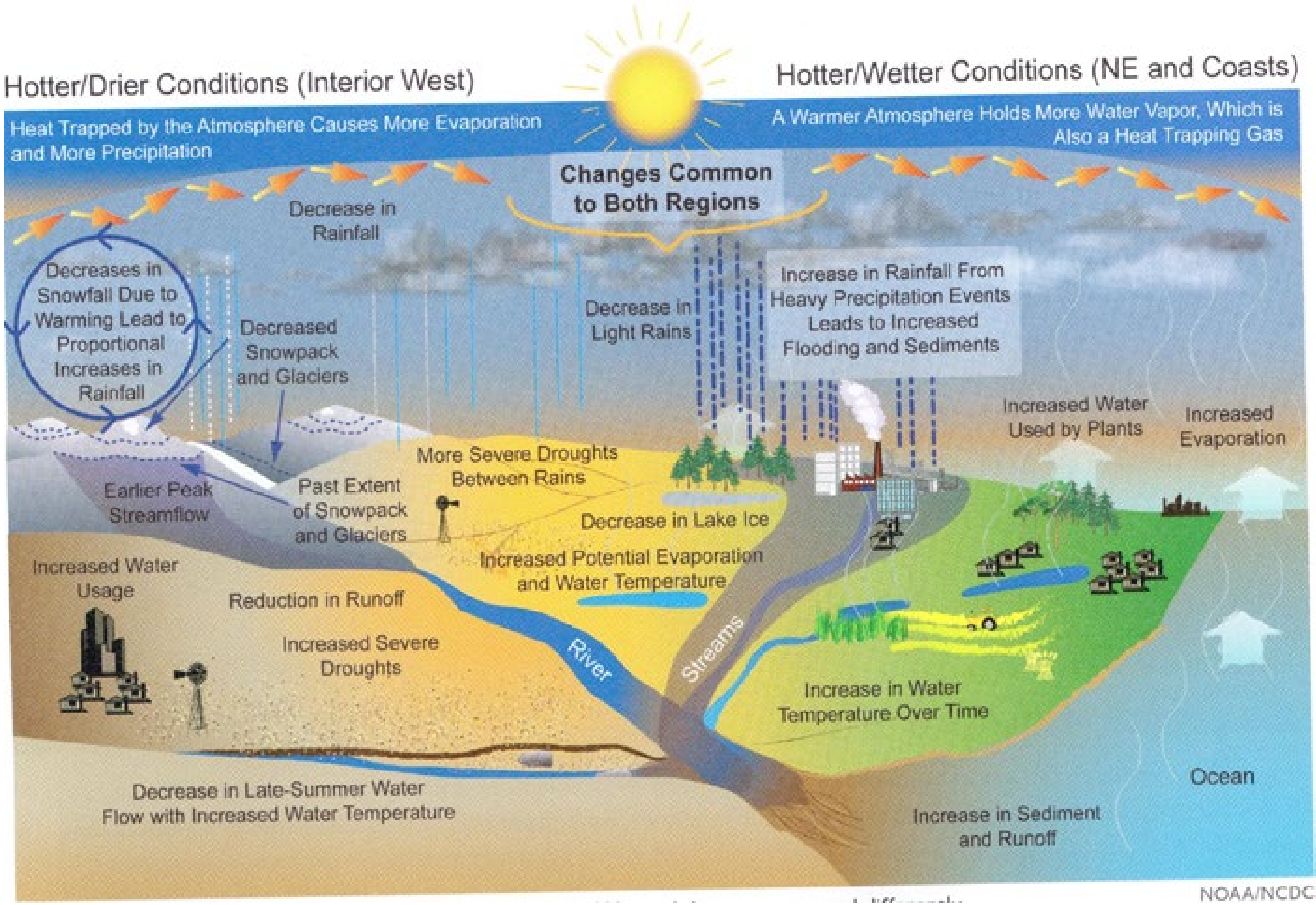
Standards

CCSA ELA 9-10.1 Literacy and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

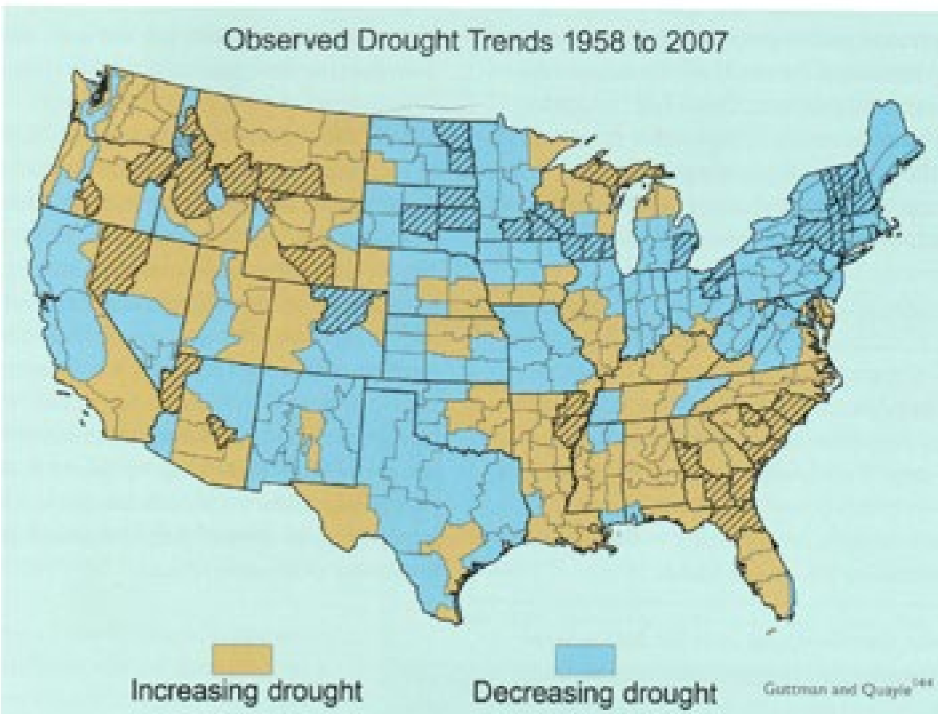
EEn2.4 Evaluate how humans use water.

EEn2.4.1 Evaluate human influences on freshwater availability.

EE.n.2.4.2. Evaluate human influences on water quality in North Carolina River basins, wetlands and tidal environments.

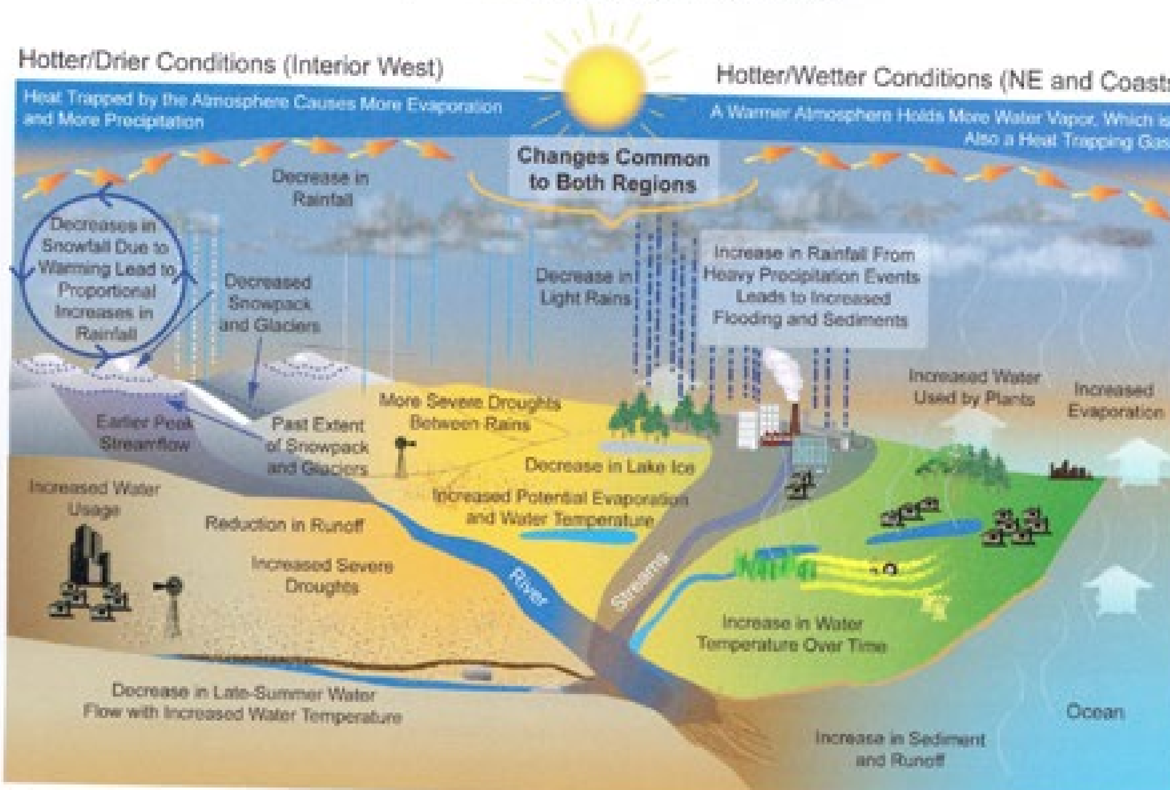

Hotter/Drier Conditions (Interior West)
Hotter/Wetter Conditions (NE and Coasts)
Heat Trapped by the Atmosphere Causes More Evaporation and More Precipitation
A Warmer Atmosphere Holds More Water Vapor, Which is Also a Heat Trapping Gas
Changes Common to Both Regions
Decrease in Rainfall
Decreases in Snowfall Due to Warming Lead to Proportional Increases in Rainfall
Decreased Snowpack and Glaciers
Decrease in Light Rains
Increase in Rainfall From Heavy Precipitation Events Leads to Increased Flooding and Sediments
Increased Water Used by Plants
Increased Evaporation
More Severe Droughts Between Rains
Past Extent of Snowpack and Glaciers
Earlier Peak Streamflow
Decrease in Lake Ice
Increased Potential Evaporation and Water Temperature
Increased Water Usage
Reduction in Runoff
Increased Severe Droughts
River
Streams
Increase in Water Temperature Over Time
Ocean
Decrease in Late-Summer Water Flow with Increased Water Temperature
Increase in Sediment and Runoff
NOAA/NCDC

Observed Water-Related Changes During the Last Century[142]		
Observed Change	**Direction of Change**	**Region Affected**
One to four week earlier peak streamflow due to earlier warming-driven snowmelt	Earlier	West and Northeast
Proportion of precipitation falling as snow	Decreasing	West and Northeast
Duration and extent of snow cover	Decreasing	Most of the United States
Mountain snow water equivalent	Decreasing	West
Annual precipitation	Increasing	Most of the United States
Annual precipitation	Decreasing	Southwest
Frequency of heavy precipitation events	Increasing	Most of the United States
Runoff and streamflow	Decreasing	Colorado and Columbia River Basins
Streamflow	Increasing	Most of East
Amount of ice in mountain glaciers	Decreasing	U.S. western mountains, Alaska
Water temperature of lakes and streams	Increasing	Most of the United States
Ice cover on lakes and rivers	Decreasing	Great Lakes and Northeast
Periods of drought	Increasing	Parts of West and East
Salinization of surface waters	Increasing	Florida, Louisiana
Widespread thawing of permafrost	Increasing	Alaska



Trends in end-of-summer drought as measured by the Palmer Drought Severity Index from 1958 to 2007 in each of 344 U.S. climate divisions.[144] Hatching indicates significant trends.

Projected Changes in the Water Cycle



The water cycle exhibits many changes as the Earth warms. Wet and dry areas respond differently. NOAA/NCDC

In addition, changes in atmospheric circulation will tend to move storm tracks northward with the result that dry areas will become drier and wet areas wetter. Hence, the arid Southwest is projected to experience longer and more severe droughts from the combination of increased evaporation and reductions in precipitation.[illegible]

Changes in Snowfall Contributions to Wintertime Precipitation
1949 to 2005

Feng and Hu[143]

Trends in winter snow-to-total precipitation ratio from 1949 to 2005. Red circles indicate less snow, while blue squares indicate more snow. Large circles and squares indicate the most significant trends.[143] Areas south of 37°N latitude were excluded from the analysis because most of that area receives little snowfall. White areas above that line have inadequate data for this analysis.

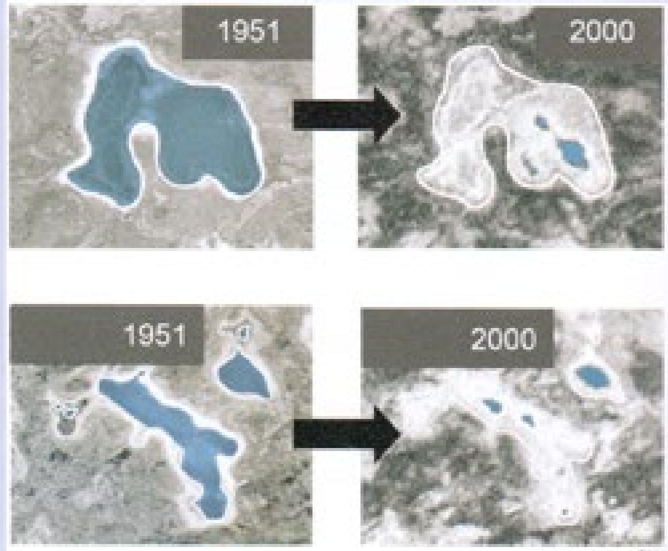
The additional atmospheric moisture contributes to more overall precipitation in some areas, especially in much of the Northeast, Midwest, and Alaska. Over the past 50 years, precipitation and streamflow have increased in much of the Northeast and Midwest, with a reduction in drought duration and severity. Much of the Southeast and West has had reductions in precipitation and increases in drought severity and duration, especially in the Southwest.

In most areas of the country, the fraction of precipitation falling as rain versus snow has increased during the last 50 years. Despite this general shift from snow to rain, snowfalls

Prior to 1990, the spruce budworm was not able to reproduce in interior Alaska.[508] Hotter, drier summers, however, now mean that the forests there are threatened by an outbreak of spruce budworms.[509] This trend is expected to increase in the future if summers in Alaska become hotter and drier.[506] Large areas of dead trees, such as those left behind by pest infestations, are highly flammable and thus much more vulnerable to wildfire than living trees.

The area burned in North America's northern forest that spans Alaska and Canada tripled from the 1960s to the 1990s. Two of the three most extensive wildfire seasons in Alaska's 56-year record occurred in 2004 and 2005, and half of the most severe fire years on record have occurred since 1990.[510] Under changing climate conditions, the average area burned per year in Alaska is projected to double by the middle of this century.[507] By the end of this century, area burned by fire is projected to triple under a moderate greenhouse gas emissions scenario and to quadruple under a higher emissions scenario.[90] Such increases in area burned would result in numerous impacts, including hazardous air quality conditions such as those suffered by residents of Fairbanks during the summers of 2004 and 2005, as well as increased risks to rural Native Alaskan communities because of reduced availability of the fish and game that make up their diet. This would cause them to adopt a more "Western" diet,[511] known to be associated with increased risk of cancers, diabetes, and cardiovascular disease.[512]

Ponds in Alaska are Shrinking (1951 to 2000)
Yukon Flats National Wildlife Refuge



Riordan et al.[514]

Ponds across Alaska, including those shown above in the northeastern interior of the state, have shrunk as a result of increased evaporation and permafrost thawing. The pond in the top pair of images shrunk from 180 to 10 acres; the larger pond in the bottom pair of images shrunk from 90 to 4 acres.

Lakes are declining in area.

Across the southern two-thirds of Alaska, the area of closed-basin lakes (lakes without stream inputs and outputs) has decreased over the past 50 years. This is likely due to the greater evaporation and thawing of permafrost that result from warming.[513,514] A continued decline in the area of surface water would present challenges for the management of natural resources and ecosystems on National Wildlife Refuges in Alaska. These refuges, which cover over 77 million acres (21 percent of Alaska) and comprise 81 percent of the U.S. National Wildlife Refuge System, provide breeding habitat for millions of waterfowl and shorebirds that winter in the lower 48 states. Wetlands are also important to Native peoples who hunt and fish for their food in interior Alaska. Many villages are located adjacent to wetlands that support an abundance of wildlife resources. The sustainability of these traditional lifestyles is thus threatened by a loss of wetlands.

Thawing permafrost damages roads, runways, water and sewer systems, and other infrastructure.

Permafrost temperatures have increased throughout Alaska since the late 1970s.[149] The largest increases have been measured in the northern part of the state.[515] While permafrost in interior Alaska so far has experienced less warming than permafrost in northern Alaska, it is more vulnerable to thawing during this century because it is generally just below the freezing point, while permafrost in northern Alaska is colder.

Land subsidence (sinking) associated with the thawing of permafrost presents substantial challenges to engineers attempting to preserve infrastructure in Alaska.[516] Public infrastructure at risk for damage includes roads, runways, and water and sewer systems. It is estimated that thawing