LESSON 18: CONCEPTUALIZING MODULE III

PURPOSE/QUESTION
Students will consider the many climate change impacts on our lives and our planet, and some adaptation options.

GRADE LEVEL
9-12

TIME TO COMPLETE
1 – 50 minute time periods

STANDARDS
See appendix below-page 5

LEARNING OUTCOMES
- Students will expand their knowledge base by working with their peers.
- Students will make connections between each of the lessons in Unit 3.
- Students will consider policy and individual actions that could help communities and ecosystems adapt to climate change.

STUDENT OBJECTIVES
- Use prior lessons and Figure C1 to identify climate change impacts already underway and expected under different warming scenarios.
- Identify possible responses to the climate.
- Design a foldable demonstrating what you have learned from Unit III.

TEACHER BACKGROUND

Lessons 10-17 allowed students to explore some of the impacts of climate change on communities and ecosystems. Yet, these are just a handful of the many ways that climate change will affect our lives and our planet in the coming decades. This mini-lesson challenges students to think about the wide range of potential impacts, the extent to which we can or cannot avoid impacts, and some of the options available for addressing them.
The fourth assessment of the Intergovernmental Panel on Climate change (IPCC, 2007c) defines ***climate adaptation*** as "initiatives and measures designed to reduce the vulnerability of natural and human systems against actual or expected climate change effects." Such actions may be intended to avoid, minimize, or even take advantage of current and projected climate changes and impacts. These actions may be anticipatory or reactive.

PREREQUISITES
- Any combination of lessons where students now have an understanding of how climate change affects both natural and human systems

MATERIALS & TOOLS
- Computer with Internet access

VOCABULARY
- Climate impacts
- Anthropogenic
- Climate adaptation
- Maladaptation

LESSON LINKS
- EPA Climate Change Adaptation Summary
- UN Framework Convention on Climate Change
- Copenhagen Accord
- IPCC Fourth Assessment

QUESTIONS FOR MAKING CONNECTIONS - 1

Refer to Figure B2 from Mini Lesson B to see how much temperatures have risen since preindustrial times and how much warming is projected under different emissions scenarios. Then look at Figure C1 to answer the following questions. Note that the two charts use different units for temperature, so you will need to make the appropriate unit conversion. Also note that the two charts use different baselines (in other words, zero corresponds to a different time period).

1. What climate impacts listed in Figure C1 are already taking place due to warming over the past 100 years?
2. What are some climate impacts that you think might be happening where you live? They can be something listed in Figure C1 or other changes that you have noticed.
3. About the same warming is expected between now and 2030 for all emissions scenarios. Why do you think this might be the case?
4. What sorts of impacts are projected by 2030 based on the expected temperature increase?
5. What are some characteristics of the systems that are most vulnerable to climate change?
6. Policy makers have attempted to set a threshold for how much temperature can increase before we begin experiencing impacts that cause "dangerous anthropogenic interference." Based on Figure C1, what do you think would be an appropriate threshold?

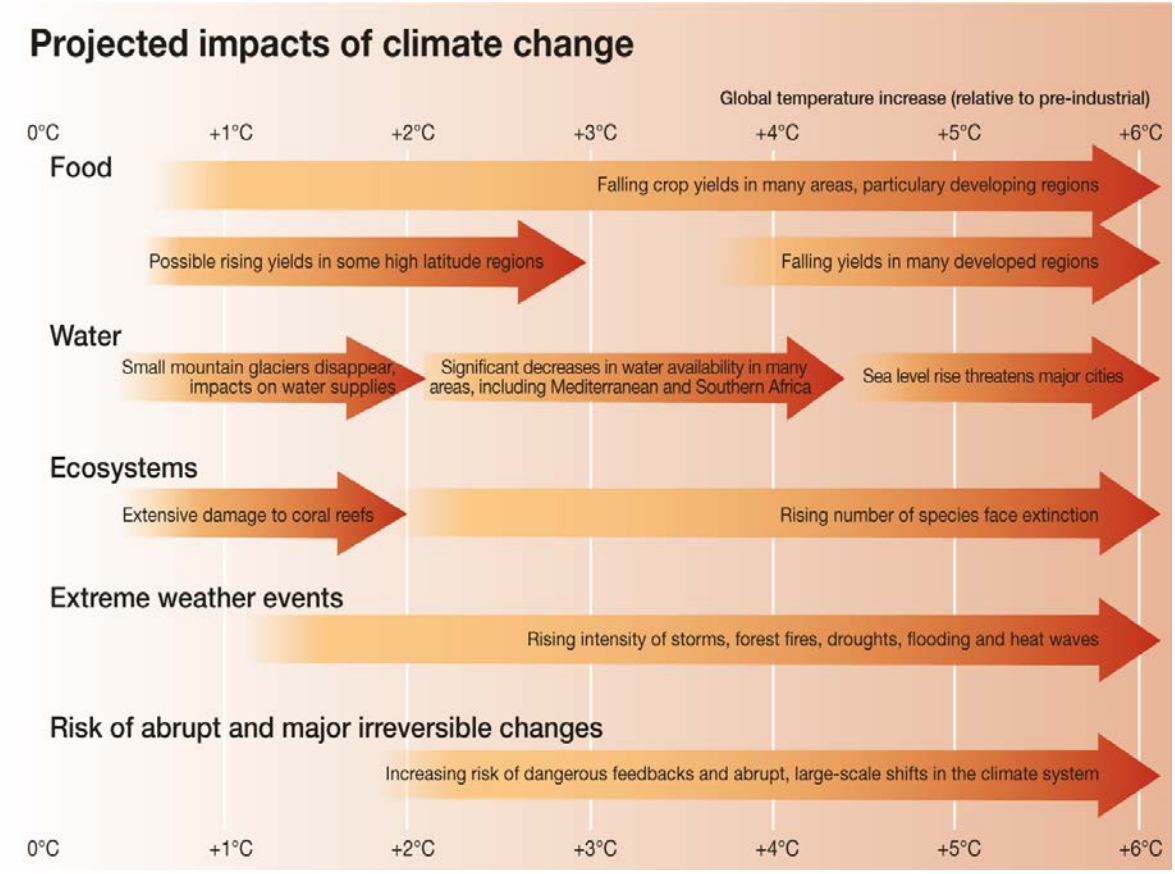


FIGURE C1

Climate impacts associated with different amounts of global temperature increase
Image source: http://maps.grida.no/go/graphic/projected-impacts-of-climate-change
Image designer: Hugo Ahlenius, Nordpil *Data source:* Stern Review, 2008.

QUESTIONS FOR MAKING CONNECTIONS – 2

As you learned in Question 1, climate change impacts are already happening and additional impacts are unavoidable. Thus, we need to start taking some actions to help our communities and ecosystems adapt to these changes. Read the Environmental Protection Agency's summary of Adaptation (http://www.epa.gov/climatechange/effects/adaptation.html) to learn more and then answer the following questions.

1. Divide the class into groups. Each group will focus on one of the impacts studied in lessons 10-17 and discuss the following question: what are some actions that could be taken to help adapt to these climate impacts? Then, the groups will present their conclusions to the full class for further discussion.
2. What are some sorts of activities that might make ecosystems or communities more vulnerable to climate impacts, and thus should be avoided in the future?
3. How can changes in the way we manage forests and other landscapes affect future CO_2 emissions?

Concept Quiz
found on pg. 9

Essay
found on pg. 12

Foldable® Assessment
Students will design a comprehensive Foldable demonstrating their understanding of Unit III, *How Climate Change Affects Natural and Human Systems*. This is a creative and research tested method for students of all ages to express their understanding of content and concepts. Go to the assessment folder to the rubric for assessing Foldables and other graphic organizers.

LESSON 18-APPENDIX

WEB ADDRESSES FOR HYPER LINKS

Vocabulary

- **Climate impacts**
  https://www.google.com/search?hl=en&rls=com.microsoft:*&q=define:environmental+impact&defl=en&sa=X&ei=dEHHTPWEAsH58Aaz_sHcDw&ved=0CAQQowMoAA
- **Anthropogenic**
  http://mw2.merriam-webster.com/dictionary/anthropogenic
- **Climate adaptation**
  https://www.google.com/search?hl=en&rls=com.microsoft:*&defl=en&q=define:climate+adaptation&sa=X&ei=YkDHTPexE8L78AaMy-HYDw&ved=0CBYQkAE
- **Maladaptation**
  http://mw2.merriam-webster.com/dictionary/maladaptation

Lesson Links

- **EPA Climate Change Adaptations Summary**
  http://www.epa.gov/climatechange/impacts-adaptation/
- **UN Framework Convention on Climate Change**
  http://unfccc.int/essential_background/items/6031.php
- **Copenhagen Accord**
  http://unfccc.int/meetings/copenhagen_dec_2009/items/5262.php
- **IPCC Fourth Assessment**
  http://www.ipcc.ch/publications_and_data/ar4/syr/en/contents.html

LESSON 18-STANDARDS

National Science Education Standards

Unifying Concepts and Processes

- Systems, Order, and Organization
- Evidence, Models, and Explanations
- Change, Constancy, and Measurement
- Equilibrium

Standard A – Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Standard C – Life Science

- Interdependence of organisms
- Matter, energy, and organization in living systems

Standard D – Earth and Space Science

- Energy in the earth system
- Geochemical cycles

Standard E – Science and Technology

- Abilities of technological design
- Understandings about science and technology

Standard F – Science in Personal and Social Perspectives

- Personal and community health
- Natural resources
- Environmental quality
- Natural and human induced hazards
- Science and technology in local, national, and global challenges

Standard G – History and Nature of Science

- Science as a human endeavor
- Nature of scientific knowledge
- Historical perspectives

National Education Technology Standards

Standard 1: Creativity and Innovation

- Use models and simulations to explore complex systems and issues
- Identify trends and forecast possibilities

Standard 4: Critical Thinking, Problem Solving, and Decision Making

- Collect and analyze data to identify solutions and/or make informed decisions.

National Council of Teachers of Mathematics Education Standards

Measurement

- Understand measurable attributes

Process

- Connections
  - Recognize and apply mathematics in contexts outside of mathematics
- Representation
  - Use representations to model and interpret physical, social, and mathematical phenomena

Climate Literacy Principles

Principle 1: The sun is the primary source of energy for Earth's climate system.
Principle 2: Climate is regulated by interactions among components of the Earth system.
Principle 3: Life on Earth depends on, is shaped by, and affects climate.
Principle 4: Climate varies over space and time through both natural and man-made processes.
Principle 5: Our understanding of the climate system is improved through observations, theoretical studies, and modeling.
Principle 6: Human activities are impacting the climate system.
Principle 7: Climate change will have consequences for the Earth system and human lives.

Energy Literacy Principles

Principle 1: Energy is a measurable quantity that follows physical laws.
Principle 2: Physical Earth processes are the result of energy flow through the earth system.
Principle 3: Biological Earth processes depend on energy flow through the earth system.
Principle 6: The amount of energy human society uses depends on many factors and can be reduced in many ways.
Principle 7: The energy choices made by individuals and societies affect quality of life.

LESSON 18-ESSENTIAL QUESTIONS ANSWER KEY

Making Connections - 1

1. What climate impacts listed in Figure C1 are already taking place due to warming over the past 100 years?
   [Small mountain glaciers are disappearing and coral reef ecosystems are being damaged.]

2. What are some climate impacts that you think might be happening where you live? They can be something listed in Figure C1 or other changes that you have noticed.
   [Will depend on location.]

3. About the same warming is expected between now and 2030 for all emissions scenarios. Why do you think this might be the case?
   [Some of the projected warming is due to the greenhouse gases that we have already emitted to the atmosphere. Some of the projected warming is expected because it will take some time to transition away from our dependence on fossil fuel sources for energy.]

4. What sorts of impacts are projected by 2030 based on the expected temperature increase?
   [According to Figure B2, temperatures are expected to have increased by about 2.5°F since 1900. This is equivalent to about 1.4°C. Looking at Figure C1, we should expect to see more declining crop yields on average, although some high latitude regions will see improved crop yields. Mountain glaciers and coral reefs will see severe impacts. And, the intensity of extreme weather events will be increasing further.]

5. What are some characteristics of the systems that are most vulnerable to climate change?
   [Systems with direct and sensitive temperature dependencies, like corals and glaciers, are very vulnerable. Also, places with low capacity to adapt to changes, for example developing countries with limited resources, are also especially vulnerable.]

6. Policy makers have attempted to set a threshold for how much temperature can increase before we begin experiencing impacts that cause “dangerous anthropogenic interference.” Based on Figure C1, what do you think would be an appropriate threshold?
   [Students can form their own opinions. The Copenhagen Accord, agreed to by many nations as part of the United Nations Framework Convention on Climate Change, has selected a threshold of 2°C above preindustrial temperatures (see Decision 2, point 2). This threshold is informed by scientific information, such as that presented in Figure C1, but ultimately is a value judgment of how much risk and climate disruption we are willing to tolerate.]

Making Connections - 2

1. Divide the class into groups. Each group will focus on one of the impacts studied in lessons 6-12 and discuss the following question: what are some actions that could be taken to help adapt to these climate impacts? Then, the groups will present their conclusions to the full class for further discussion.
   [There are many possible answers on these. Here are a few examples for each topic.
   Arctic Sea Ice and Polar Bears: Sadly, there’s not much that can be done to help polar bears adapt. One idea that has been suggested is to build artificial ice floes to replace the lost sea ice. It’s not clear whether such an approach is even practical.

Heat Waves: Projects that reduce urban temperatures, such as tree planting, green roofs, and highly reflective roofs. Public health measures, including public advisories, cooling centers, and efforts targeted at the most vulnerable populations.

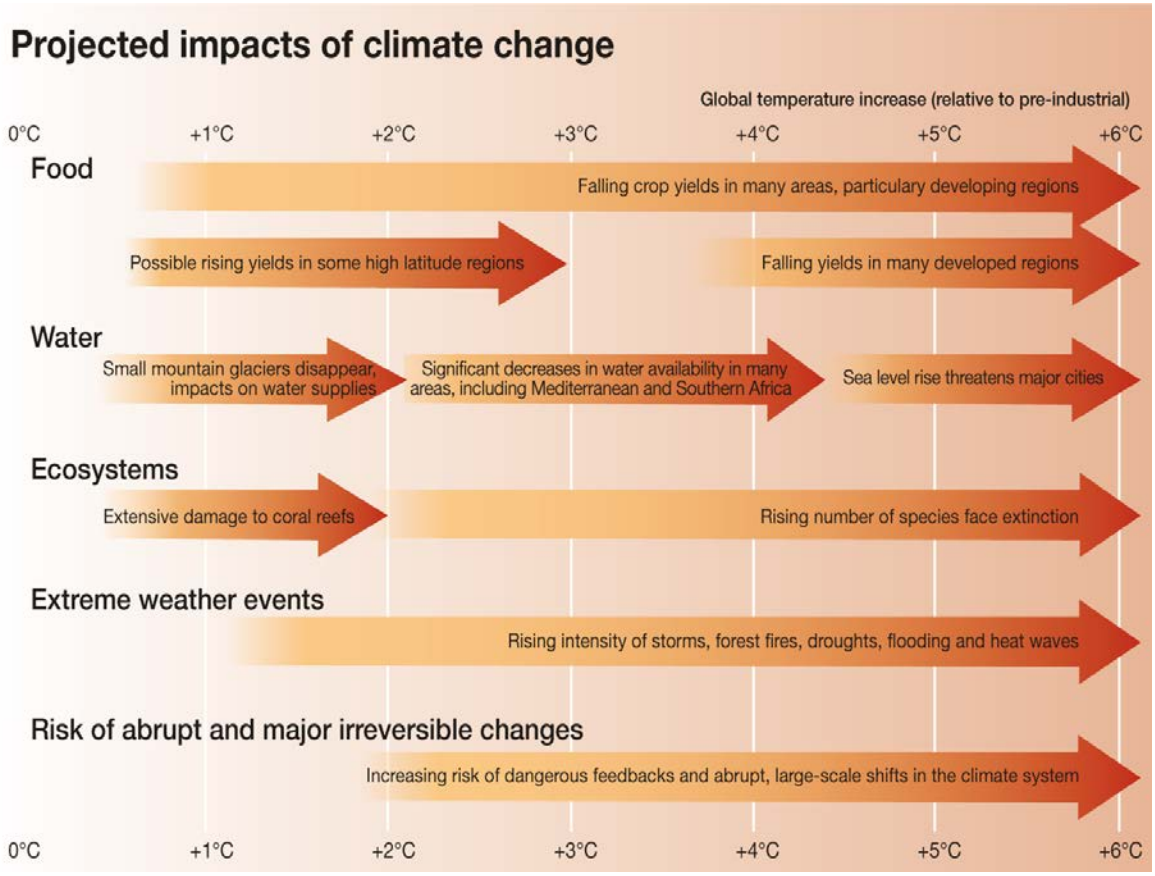
More Heavy Rainfall Events/More Drought: Farmers could modify the sorts of crops they plant, when they plant, and their irrigation practices. Urban water managers can redesign storm sewers to accommodate larger rainfall events.

Sea-level Rise: Promoting coastal land-use plans that allow for habitats to migrate as sea level rises. Avoiding building in places where sea level rise is expected. Improve early warning systems and flood mapping for severe storms.]

2. What are some sorts of activities that might make ecosystems or communities more vulnerable to climate impacts, and thus should be avoided in the future?
   [These sorts of actions are called maladaptation. Many answers could be valid. For communities, examples include building in areas vulnerable to sea level rise or to river flooding associated with more extreme rainfall events; constructing new buildings that contribute to the urban heat island effect; or relying on rainfall to supply drinking water in places where drought is expected to become more common. For ecosystems, example, include fragmenting habitats thereby preventing animals and plants from shifting their ranges in response to changing climate; building right up to the edge of rivers and coasts, which eliminates that natural response of wetlands to flooding events (and increases the vulnerability of the built environment); planting non-native trees that are vulnerable to strong winds during severe storms.]

Name: _____ Date: _____

Science Concept Quiz
Lesson 18: Conceptualizing Module III



Climate impacts associated with different amounts of global temperature increase
Image source: http://maps.grida.no/go/graphic/projected-impacts-of-climate-change
Image designer: Hugo Ahlenius, Nordpil Data source: Stern Review, 2008.

Using the chart above chose the best answer based on the evidence.

A. No climate impacts will occur until the temperatures rise 4°C.
B. Extreme weather events will intensify starting with an increase in temperatures of 3°C.
C. Because changes to our food and water supply will be effected with a rise in temperatures of less than 1°C we can expect to see prices for food increase and clean water availability decrease.
D. Species extinction will increase as global temperatures fall.

_____ points out of 20

I. Answer

A.○ B.○ C.○ D.○

_____ points out of 15

II. What is the main concept behind the question?

1. Climate impacts on food and water supply
2. Making Predictions
3. Extreme weather events
4. Reading charts and graphs

_____ points out of 25

III. Provide the reasoning for choosing your answer in part II.

_____points out of 40

IV. Why are the other responses in part I not the best answer choice?

1.

2.

3.

4.

Teacher Answer Key

1. C

2. 4

3. Answers will vary. To be able to correctly answer the question you must be able to understand what the chart is trying to tell you.

4. Answers will vary.

   A) The chart is full of impacts. Nowhere does the chart say there are no impacts related to an increase in temperatures.

   B) Extreme weather events will intensify but not starting at 3°C, but at just over a 1°C change in temperature.

   C) This is the correct answer. According to the chart there will be significant effects to overall food production and water availability.

   D) The chart does not indicate a decrease in temperatures; therefore this is a false statement.

Student Name
Teacher/Class
Date

Lesson 18: Conceptualizing Module III

Module three addresses climate change impacts on human and natural systems. Explain the impacts that a global temperature increase of one degree centigrade will have on various earth systems.

What Is the Expectation?

Use new lesson knowledge or student readings to support your position

Visual representations if applicable

Key vocabulary

Evidence of on grade level spelling and grammar usage