Classroom Interaction Lesson Plan Template

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Name of Course, Grade, and Level: AP Environmental Science, Environmental Science, 6-12

Math/Science Topic	Climate Change

Title of Lesson: How Does Climate Change Affect Agriculture?

Source of Lesson:

Note: This lesson is intended to demonstrate the connections between climate change and agricultural productivity (e.g. how many crops and how much of each are being produced, types of livestock raised, etc). Students should already have a background knowledge of climate change including a definition of the phenomenon, the greenhouse effect and the causes of climate change (i.e. being affected by humans). Most of this lesson is exploratory and should be used to support a larger/longer unit on climate change (this could also be used in conjunction with a PBL). This lesson plan was written in alignment with NGSS using the 5E (Learning cycle) model.

List of appropriate national standards: (Math – NCTM; Science – NGSS)

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. [Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]

HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.* [Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen.]

HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. [Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.] [Assessment Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.]

HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* [Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).]

HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to

Earth systems. [Clarification Statement: Examples of evidence, for both data and climate model outputs, are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).] [Assessment Boundary: Assessment is limited to one example of a climate change and its associated impacts.]

HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. [Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.] [Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.]

MS-ESS3-1. Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes. [Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).]

MS-ESS3-2. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. [Clarification Statement: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]

MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.* [Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]

MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. [Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]

MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.[Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]

	Previous Objectives Write objectives in SWBAT form.
1	SWBAT describe what climate change is
2	SWBAT explain the causes of climate change, specifically what types of gasses cause climate change
3	SWBAT discuss how human activity has affected/caused climate change

	Objectives Write objectives in SWBAT form.	Evaluation Questions
1	SWBAT determine if there is a connection between climate change and agriculture	What evidence have you seen that supports your point of view? How does it do so? How can you use data to back up these claims?
2	SWBAT explain the connection between climate change and agriculture	What does this connection mean for the future of the human species? What does this connection mean for the future of the earth? What did you see on the computer program that supports this and how?

Resources, Materials, Handouts, and Equipment List in the form of a table: Change font color to black

Materials, Handouts, & Equipment	**Quantity**	**Source or Responsibility** (teacher, student, group)
Computer	1 for every student/group	Teacher/Computer lab
Link to AgroSphere App: AgroSphere App About AgroSphere: AgroSphere - About Page *Note: As of August 2, 2017, the AgroSphere app only contains historical weather data for a limited number of weather stations for a limited time period (1989-2014). The agriculture data is a bit more extensive, going back to 1961 and ending in 2014 again. If you would like the students to look at more data, the United Nations (UN) has more data that the developers of the app did not have time to implement. Here is the link: UN Atmo Data		

Safety Issues:

Accommodations for learners with special needs (Special Ed, 504, GT, etc…)

Learning Cycle

EXPLORATION (engage/explore)	**Time: # Minutes _60 Mins._**	
What the Teacher Will Do and Student Misconceptions	**Probing/Eliciting Questions and Predicted Student Responses**	**What the Students Will Do**
Engage (10-15 mins.): Begin class discussing what the students have learned about climate change in previous lessons. Continue discussion by asking students if they think climate change is affecting us already and how so. Direct this part of the conversation to farming/agriculture. 1. The teacher will facilitate the discussion. 2. Students may have misconceptions about the role of agriculture in the production of meat 3. Students may not know if climate change is affecting humans yet in terms of weather and/or agriculture.	**Engage (10-15 mins.):** 1. What is climate change? Is it different from weather? Student responses: climate change is when the world heats up. It is not the same as weather; weather is what happens on the day to day basis and climate is an average of weather. 2. What causes climate change? Student responses: people, too much gas, too many cars, the meat industry 3. What aspects of human activity has climate change affected already? Student responses: we all drive cars, we eat meat, we had the industrial age.	**Engage (10-15 mins.):** 1. Students will discuss respectfully and guide the conversation (not debate)
Explore (45-50 mins.): Monitor students as they use the computers. 1. Students can work individually or in groups 2. Students should also consider more efficient practices and technology before making conclusions.	**Explore (45-50 mins.):** 1. What kind of atmospheric conditions affect agriculture the most? 2. How do these conditions affect agriculture? 3. Does every country region produce the same crops/livestock? 4. Can we lump large countries (e.g. the U.S) into one region?	**Explore (45-50 mins.):** Students will use computers to access a web app that displays atmospheric and agricultural data. They will use this app/data to determine the connection, if any, between climate change and agricultural productivity.
Decision Point/Formative Assessment		**Student Outcomes**
Once the students start making conclusions about the connection between climate change and agriculture, the teacher should move on to the next stage. Teacher will determine this by asking questions to the students. Guiding questions: -What kind of data are you seeing? -What kind of conclusions are you drawing from this? -How have your ideas changed? Have they been reinforced? -Has the data brought any new ideas out?		Students should decide based on the app if there is a connection between climate change and agriculture. They should be able to back up their conclusions with evidence.
Transition Statement: Let's discuss what you discovered.		

Concept Invention (explain)	**Time: # Minutes _15 Mins._**	
What the Teacher Will Do and Student Misconceptions	**Probing/Eliciting Questions and Predicted Student Responses**	**What the Students Will Do**
The teacher will facilitate another discussion about the students' discoveries. Start with partner/group discussions, then move to class discussions.	1. What did you find out? 2. Is there a connection between climate change and agricultural productivity? 3. What is this connection? 4. Does it make it more or less productive? 5. Are there any other factors that may play a role in agricultural productivity? a. More efficient farming techniques and technology 6. What atmospheric factors affect agricultural production? (e.g. temp, precip.) 7. Are temperature and precipitation the only factors that affect productivity?	Students will first discuss with a partner/group if they think there is any connection between climate change and agricultural productivity. Then they will discuss as a class.
Decision Point/Formative Assessment		**Student Outcomes**
Once the class comes to some sort of consensus (unanimous or not) on the connection, the teacher should move on to the next phase.		Individual students, as well as the class as a whole, should determine if there's a connection between climate change and agricultural production. These conclusions should be backed up by evidence found in the app. The students should be able to make a coherent and concise argument about their conclusion.

APPLICATION (elaborate/evaluate)		Time: _15 Mins_
What the Teacher Will Do and Student Misconceptions	**Probing/Eliciting Questions and Predicted Student Responses**	**What the Students Will Do**
The teacher will connect this lesson's activity to the previous lessons on climate change as well as discuss how this leads into future lessons on climate change.	1. Is climate change affecting agriculture? Or vice versa? Both? Does one have a greater effect on the other? 2. How do your conclusions about the relationship between climate change and agriculture fit into your idea/model of climate change so far? 3. If climate change is affecting agriculture (or vice versa), what can we start doing to abate those effects? a. Can we start using renewable energy in the production of agriculture?	The students will incorporate their new conclusions into their already-existing model of climate change. They should also start developing ideas on how to minimize the effects of climate change on agriculture and vice versa.
Decision Point/Formative Assessment		**Student Outcomes**
Plan for Fast Track Learners or non-traditional learners		
For students who complete an appropriate analysis quickly, the teacher can have them look up more long-term weather/climate and/or agricultural data. They can also look for scholarly articles that may discuss climate's effect on agriculture or agriculture's effect on climate.		

EVALUATION		Time:
What the Teacher Will Do	**Probing/Eliciting Questions**	**What the Students Will Do**
Throughout the lesson, the teacher will ensure the students are looking at the proper data and making appropriate conclusions. As a summative assessment, the students could write/type a short paragraph detailing the conclusions they drew from the app with references to specific data/graphs to support their conclusion. This can be done by individuals or partners/groups.	1. Can you make any significant conclusions based on the data? a. What conclusions can you make based on the data? 2. What evidence do you have to back up your claims? 3. How reliable is the data? a. Would it be better to have more data? b. What kind of data? c. From what sources?	The students will demonstrate an understanding of how climate change affects agriculture, or how agriculture affects climate change, if at all.