SC ADOPT-A-STREAM IN THE CLASSROOM
High School Curriculum

Climate Change
A warming world

Clemson University Center for Watershed Excellence

LEARNING OBJECTIVES: Find and summarize scientific information. Utilize scientific conventions to communicate results, data, and interpretations. Construct scientific arguments about ecosystem resilience and impacts of a changing climate.

INTRODUCTION

Climate change is real. Climate change is happening. We've known the basics of climate change for decades. Greenhouse gases, which occur naturally in relatively small amounts, help keep the Earth at just the right temperature to continue life on this planet as we know it. The problem with greenhouse gasses like water vapor, nitrous oxide, carbon dioxide, and methane is their ability to retain solar radiation, preventing it from being reflected back into space. When there is too much of these gases in Earth's

atmosphere, they hold more heat and the global average temperature rises. Rising temperatures, if left unchecked. will lead to devastating consequences for most living organisms on this planet.

Some of these consequences are currently being felt by human populations, especially by people who live in poverty and do not have the financial resources to leave areas most vulnerable to the effects of climate change. Severe and more frequent weather events (e.g., hurricanes, drought, flooding), wildfires, agricultural impacts, decreases in freshwater supplies, and increasing levels of plant, insect, and wildlife mortality are all attributed to climate change. There is a strong scientific consensus that environmental limits have already been surpassed and we, and many other species, must adapt to new climatic conditions if we want to survive.

Zoom in on some of the impacts of climate change:
https://earth.app.goo.gl/eKJp6w

CLIMATE CHANGE AND WATER RESOURCES

Climate change is having, and will continue to have, an astounding effect on how the world works. In this program, we will focus on just three of the ways climate change will impact our world.

THE WATER IS ARISING

Communities around the world are already seeing the impacts of sea level rise. In fact, rising sea levels could threaten the homes of up to 340 million people in the US by 2050. Miami, a major tourist destination, experiences regular flooding in downtown city streets at high tide. Venice suffered from extreme flooding in late 2019, due to the double punch of a sinking city and rising tides. Villages from the island nation of Kiribati, which only sits 2 meters above sea level, have been forced to relocate to escape the rising water. Stories like these are playing out in coastal nations across the globe.

Interactive map of sea level rise:
https://coast.noaa.gov/slr/

Climate change is the main driver of sea level rise. Higher air temperatures are melting glaciers and the polar ice caps, increasing the volume of water in the oceans. At the same time, the ocean water itself is getting warmer, causing the water to expand in volume even more. Global sea level has risen 20 centimeters since 1880 and is expected to rise another 30 to 122 centimeters. Not only do rising sea levels endanger property and swallow up valuable coastal land, but salt water can pollute coastal freshwater resources such as rivers, lakes, aquifers, or natural underground water storage. This can taint critical water supplies as well as damage freshwater ecosystems.

THE WATER CYCLE

Alterations to the water cycle as a result of climate change will not be consistent across the world. Some areas may experience severe difference as the effects of climate change unfold, while others may not notice any change at all. However, it is unlikely that any individual on this planet will not feel the consequences of climate change, either directly or indirectly. Global precipitation is expected to increase as the global mean surface temperature increases. But these changes will vary across the world, with some regions receiving more precipitation, other regions receiving less, and some not seeing any significant change at all. Experts predict that the contrast between dry and wet areas will increase (dry areas will get drier, and wet areas will get wetter). Similarly, evaporation of water from the Earth's surface is expected to increase, even though surface runoff will increase in some areas, while decreasing in others. Further, experts expect that the difference between wet and dry seasons in an area will increase (monsoon seasons will dump more rain, dry seasons will be drier) as the Earth heats up.

FOOD SECURITY

Climate change will be particularly hard on the world's farmers. Because there will be changes to the water cycle, in addition to rising temperatures, farmers around the world will need to adapt to a new climate reality in order to supply the world with food. These warmer temperatures and associated changes in precipitation patterns have altered crop growing seasons and reduced crop yields. Heat stress can limit fruit production resulting in yield losses, lower quality fruits, and increasing food waste. Shifting climate patterns may make current croplands unsuitable, or force farmers to change their crop, especially since some fruits and vegetables require a period of cold in

order to fully mature, which warmer winters may not provide. In addition, unpredictable and extreme weather events are increasingly posing more danger to our global food supply. In 2019, droughts, flooding, hurricanes, wildfire devastated farmers and their crops.

Livestock are also threatened by climate change, where pasture productivity will decrease in some areas, therefore affecting the health of the animals that depend on those rangelands for grazing. As pastoralism is practiced in more than 75% of countries by 200 - 500 million people around the globe, with many more depending on the animal products they provide, potential damage to livestock herds is a significant threat to the world's food security.

THERE IS HOPE

All is not lost- there is still time for humans to limit the damage to our planet. While we can't fully stop climate change, most scientists think it is possible to avoid the worst of its effects. But we only have a short time in which to act. The Intergovernmental Panel on Climate Change (IPCC) is made up of experts from the United Nations and is tasked with assessing the science related to climate change. In 2019, IPCC released a report (https://www.ipcc.ch/) which included ways to mitigate and reduce the impact climate change will have on our lives and on future generations. Some of their suggestions include:

1. Make land management changes to reduce the amount of greenhouse gas emissions and increase carbon uptake (e.g., enhance crop productivity, improve soil nutrient status or microclimate).

2. Change consumer behaviors to reduce the over-consumption of food and energy.

3. Consider women's and indigenous people's rights to access and use land to increase the equitable sharing of land resources, improve food security and build knowledge about land use, which can increase opportunities for adaptation and mitigation.

But what can you do? Explore opportunities and ideas you can use to fight climate change here: https://unfccc.int/topics/education-and-outreach/workstreams/youth-engagement

LOOKING TO THE FUTURE

This chapter discusses findings and actions that are considered controversial in some conversations. Wherever one may stand on the issue, everyone can and should start at home, decreasing their footprint on the Earth and our limited resources. Unfortunately, not every household has the information they need to make this happen. Thus, we need individuals willing to work in land and water conservation departments across the country to help. These individuals engage with landowners to promote land conservation alternatives and implement best management practices for water conservation, wetland restoration, and climate change adaptation on the current and future wintering grounds. If working in this field, you would be able to interact with many people, businesses, and organizations, while speaking publicly about issues that you're passionate about.

ACTIVITY: CLIMATE CHANGE AND WATER CHALLENGES IN THE REAL WORLD

In 2015, the members of the United Nations (UN) committed to 17 goals designed to improve the lives and futures of all people around the world by 2030. In this activity, you will work in teams of 2-6 to explore these goals, discuss ways that climate change and issues with local water resources may affect successfully achieving them, and brainstorm ways to mitigate challenges from climate change and water resource issues.

1. Visit https://sustainabledevelopment.un.org/sdgs and spend a few minutes reviewing the 17 UN Sustainable Development Goals (SDGs).

2. Once you have familiarized yourself with the goals, each team should divide into two groups.
    a. Group 1- examine each UN SDG and give a brief explanation of how the poor water quality or insufficient water resources may make it challenging to reach each goal.
    b. Group 2 – examine each UN SDG and give a brief explanation of how a warming world and the effects of climate change may make it challenging to reach each goal.

3. After both groups have finished, share your answers with the other half of the team. Do the challenges presented by both threats overlap at all?

4. As a team, brainstorm possible ways to mitigate the effect of water resource issues and climate change on achieving each goal.

CHAPTER ASSESSMENT

1. Explain how greenhouse gases affect the atmosphere and climate. Name some common sources of greenhouse gases.
2. Look up ozone depletion and Chlorofluorocarbons (CFCs). What are the differences between ozone depletion and the greenhouse effect? What are the similarities? Greenhouse gases vs CFCs?
3. Based on the information read, make an argument claiming why either large agricultural areas (with industrial equipment and lots of animals) or industrialized cities (with a lot of cars and factories) make a larger impact on the Greenhouse Effect.
4. Using your previous claim, what do you think would help to improve the area that was creating more emissions of greenhouse gases?