Pollution and Life Cycle Analysis

7th Grade Science

Unit Summary:

This unit will develop an understanding of air, soil, and water pollution. The unit will develop an understanding of life cycle analysis. The students will understand how the production of goods contributes to pollution and how the legacy effect of a product is forever. The students will be introduced to creating graphs from data tables and interpreting graphs. The students will understand connectivity and how pollution of the air, soil, and water is one in the same due to environmental connectivity. The students will critically think about alternatives to mitigate pollution.

This unit would best be taught following units that discuss the water cycle, nutrient cycling, and the idea of greenhouse gases and global climate change. The students should be comfortable with the topics of connectivity and how water and nutrients move through soils, influence plants and animals, and cycle in and out of the atmosphere. Units that would follow these lessons would deal with global climate change in greater detail.

Next Generation Science Standards:

MS-ESS3-3.	Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
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.
MS-ESS3-5.	Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Learning Objectives:

1. Students will be able to define carbon dioxide.
2. Students will be able to write the chemical nomenclature of carbon dioxide.
3. Students will be able to create a graph from a data table.
4. Students will be able to describe how carbon dioxide and methane are greenhouse gases.
5. The students will be able to calculate how burning fossil fuels contributes to atmospheric carbon dioxide levels.
6. Students will be able to identify soil pollution.
7. Students will be able to list how soil pollution influences plant life.
8. Students will be able to diagram how soil pollution negatively influences nutrient cycling and is mobile through groundwater movement.
9. Students will be able to identify the mechanisms of soil pollution removal or mediation.
10. Students will be able to map the trophic levels and explain how water pollution has a negative impact on the environment from primary producers to top-level consumers.

11. Students will be able to apply a linear relationship of water temperature and fish population impacts.
12. Students will be able to describe the relationship of heat and water temperature and how it is a pollutant to aquatic life.
13. Students will be able to read an XY graph and obtain the important information from the graph.
14. Students will be able to develop an action plan.
15. Students will be able to construct what a Life Cycle Analysis (LCA) is and how it can be used to understand how humans impact the environment
16. Students will be able to diagram the process of making a product that they use every day, starting at raw materials and what happens to that product after they are done using it (steps: Raw materials, manufacturing, packaging, transportation, use and maintenance, recycling and disposal)
17. Students will be able to list the environmental impacts of every part of the example products' life.
18. Students will define new terms: Life Cycle Analysis, "Cradle-to-Grave". Life cycle analysis is the process of calculating carbon emissions for each step in developing, making, marketing, and selling of a product.

Table of Lessons:

Lesson Title- Brief Description	Learning Objectives	NGSS Addressed (codes)	Materials
Air Pollution: This lesson builds on the students understanding of global climate change by introducing them to carbon dioxide emissions from a vehicle. The students will build a graph from a data table and draw conclusions.	1. Students will be able to define carbon dioxide. 2. Students will be able to write the chemical nomenclature of carbon dioxide. 3. Students will be able to create a graph from a data table. 4. Students will be able to describe how carbon dioxide and methane are greenhouse gases. 5. The students will be able to calculate how burning fossil fuels contributes to atmospheric carbon dioxide levels.	MS-ESS3-3 MS-ESS3-5	• Paper and Pencil • Worksheet: **Carbon dioxide emissions from a gasoline combustion engine**
Soil Pollution: This lesson provides a story problem for the students to work through. The students will deal with a hazardous waste spill and get their hands dirty! They will develop mitigation tactics to clean up contaminated soil.	1. Students will be able to identify soil pollution. 2. Students will be able to list how soil pollution influences plant life. 3. Students will be able to diagram how soil pollution negatively influences nutrient cycling and is mobile through groundwater movement. 4. Students will be able to identify the mechanisms of soil pollution removal or mediation.	MS-ESS3-3	• Shallow plastic tubs • Soil (sand) • Vegetable oil • Spoons • Sponges • Syringes • Index cards • Paper and Pencil • Worksheet: **Containing an oil spill**
Water Pollution: This lesson talks about heat as a pollutant for fish populations. The students will link plant, animal, and insect life	1. Students will be able to map the trophic levels and explain how water pollution has a negative	MS-ESS3-3 MS-ESS3-5	• Paper and Pencil • Worksheet: **Hot Water and**

degradation from increased heat pollution. The students will address a power plants discharge of hot water into a river system.	impact on the environment from primary producers to top-level consumers. 2. Students will be able to apply a linear relationship of water temperature and fish population impacts. 3. Students will be able to describe the relationship of heat and water temperature and how it is a pollutant to aquatic life. 4. Students will be able to read an XY graph and obtain the important information from the graph. 5. Students will be able to develop an action plan.		**Trout Don't Mix**
Life Cycle Analysis: This unit brings together the previous three units and develops the students' understanding of life cycle analysis. The students will work through a product of their choosing and create a map of when pollution occurs during that products life.	1. Students will be able to construct what a Life Cycle Analysis (LCA) is and how it can be used to understand how humans impact the environment 2. Students will be able to diagram the process of making a product that they use every day, starting at raw materials and what happens to that product after they are done using it (steps: Raw materials, manufacturing, packaging, transportation, use and maintenance, recycling and	**MS-ESS3-3** **MS-ESS3-4**	• Paper and Pencil • Worksheet: **Life Cycle Analysis For a Product**

	disposal) 3. Students will be able to list the environmental impacts of every part of the example products' life. 4. Students will define new terms: Life Cycle Analysis, "Cradle-to-Grave". Life cycle analysis is the process of calculating carbon emissions for each step in developing, making, marketing, and selling of a product.		

Safety Considerations:
There are no safety considerations for this unit.

Evaluation Plan:

Lessons 1-3 will give the teacher the opportunity to check-in with the students and understand their ability to follow the material being presented to them. During this time, it is appropriate to exercise the formative assessment while the students are completing their worksheets and group work. The teacher should be looking for student responses that stress the connection of the water cycle and the movement of pollutants from the soil to the air. When assessing student comprehension, the teacher should be looking for the students to respond with the "big ideas" within these lessons. The big ideas are that humans have severely altered nutrient cycling, water resources, and contributed greatly to global climate change. By using the examples provided in the lessons the students should be linking these human activities to the changes we see in our environment. This should be done by asking the students questions and allowing them to fix their own misconceptions rather than telling the student he/she is wrong. The summative assessment tool is the final lesson of the unit (lesson 4). This lesson is created to assess the student's overall understanding of the topic by asking them to draw conclusions from the steps the teacher has walked them through during lessons 1-3. The final letter of recommendation that the student submits from lesson four, is the summative assessment. How they support their recommendation, how they explain their graphs and figures, and how they link their findings to the water cycle will inform the teacher whether or not the student understands the material.

Resources (websites):

Carbon emissions - https://www3.epa.gov/otaq/climate/documents/420f14040a.pdf

Lifecycle Analysis - www.gdrc.org/uem/lca/lca-define.html

Lifecycle Analysis - www.istc.illinois.edu/info/library_docs/tr/tr40.pdf

Brief description of how this unit relates to your graduate research. (1 page):

Pollution of the air, soil, or water is a threat to our environment. Pollution increases the susceptibility of an ecosystem to global climate change. Global climate change is the number one threat to the health of our environment. My graduate work focuses on the resistance and resilience of forested ecosystems and their ability to adapt to an ever changing climate. This unit draws on the principles of hydrologic connectivity which is at the core of my work assessing the implications of an invasive insect outbreak within North American forested wetlands.

My graduate work also focuses on carbon cycling within forested wetlands. By focusing on carbon dioxide and methane I'm addressing the issue of natural systems input to the greenhouse effect we're experiencing. Although human influences have dramatically changed the projection of global temperatures which adjust our local climates, natural sources of greenhouse gases mitigate the greenhouse effect greatly. The foundation of this unit (carbon cycling, hydrological processes, and connectivity) are imperative to my graduate work.

Through studying the losses of the tree canopy along riparian corridors I am studying the increased solar radiation reaching the river. This increase in solar radiation increases the temperature of river water which hinders fish populations. It's difficult to understand how heat can be a pollutant and this unit talks about that process in detail. Increased heat in our water or air can dramatically change the life cycles of animal life. My PhD work focuses on vegetation management, but the connectivity of vegetation to climate characteristics and animal life is strong. This unit develops student understanding of that connectivity and helps them understand that their actions have a ripple effect locally and globally.