Analyzing data to minimize land use impacts

Focus question	How can we utilize soil, water, and land use data to make land use decisions?
Learning target	Students evaluate living and nonliving factors of ecosystems in order to rate the health of soil, water, and land resources.
Vocabulary	Best management practices, conservation tillage, crop nutrient management, pest management, conservation buffers

MS-ESS3: Earth and Human Activity

Performance expectation MS-ESS-3	**Classroom connection:** This lesson provides students with the living and nonliving data needed to construct an explanation for the current health of an ecosystem.

Science and engineering practices

Analyzing and Interpreting Data	**Classroom connection:** Students analyze and interpret data to assess soil, water, and land use systems.
Constructing Explanation and Designing a Solution	**Classroom connection:** Students construct an explanation for the data and design a solution to minimize the human impact that has led to the data they receive.

Disciplinary core ideas

ESS3.A: Natural Resources	**Classroom connection:** Humans have used water and soil/land resources to increase the production of food. Technological advances allow nutrient levels to be manipulated in soil/land resources to meet the demand for higher yields, but may have a detrimental effect on water resources.
ESS3.C: Human Impacts on Earth Systems	**Classroom connection:** Students will analyze the soil, water, and land use data to determine human impact on water and soil systems.

Cross-cutting concepts

Cause and Effect	**Classroom connection:** Humans have had significant impacts on water and soil/land resources. Students will interpret data on ecosystem resources and design possible solutions to minimize human impact.

Background

Humans have made use of land and water ecosystems in order to efficiently plant and raise food for consumption. In the thousands of years that humans have practiced agriculture, many advances in technology have improved yield, nutrition, and flavor in the foods produced. Farming is becoming a high tech and high talent industry, requiring fewer individuals on the farm and a growing number of individuals off the farm to support food production. As of 2021, 27% of the world labor force was employed in agriculture, with only 1–2% of the United States labor force actively engaged on the farm. Several ag-related careers gather data to help farmers better understand the health of the soil and water ecosystems on their land.

This lesson allows students to compare the data from tests they've completed in their local area using nourishthefuture.org lessons and activities to these sample situations using the kinds of data available in modern agriculture.

- **Water quality unit: (ntf.plus/curriculum/water-quality)**
  - Biotic sampling
  - Physical and chemical water testing
- **Soil and sustainability unit: (ntf.plus/curriculum/soil-sustainability)**
  - Soil texture
  - Soil nutrient testing

Farmers prioritize agricultural best management practices to lessen agricultural impact on the environment, such as conservation tillage, crop nutrient management, pest management, and conservation buffers.

Prior knowledge

Students should have a complete understanding of ecosystems and the complex interactions that occur within those ecosystems. Students should know how macroinvertebrates can be used to assess water quality and be able to use a key to identify macroinvertebrates. Students should have a good understanding of nutrients and how they may impact soil and water ecosystems. Students should know the three different sediments in soil: sand, silt and clay, and be able to calculate percentages to identify soil types. Students also need to know the three major nutrients found in soil are nitrogen (N), phosphorus (P) and potassium (K) and how those nutrients impact water quality. Finally, students should be able to analyze how human land use has impacted the functionality and stability of each ecosystem.

Materials

- Macroinvertebrate cards
- Water test cards
- Water test reference cards
- Soil texture cards
- Soil nutrient test cards
- Soil nutrient test reference cards
- Land use cards

Teacher preparation

1. Print off the accompanying student handout.
2. Divide students into groups that will analyze each data card set: A–F. Within each group, a student or pair of students are responsible for analyzing each type of data card: macroinvertebrates, water nutrient tests, soil texture, soil nutrient tests, and land use.
3. This lesson should require four classroom periods of time: one day to research, one day to conduct tests and analyze data, one day to design solutions, and one day to report out.

Student handout

Reflection

Create an explanation for the current state of each data card that you are asked to interpret. Did the water/soil data cards correspond to the type of land use represented? Look at your group's recorded information above. Reflect on the following questions while creating your explanation.

1. How did your data cards compare? Did they demonstrate similar results or different results?

Student answers will vary.

2. Did any particular group of data stand out? If so, why do you think this set of data was different from the rest?

Student answers will vary.

3. How do these different ecosystems interact with each other or potentially change throughout the year? For example, water temperature has a direct impact on the percent saturation of dissolved oxygen. How could the climate impact the biodiversity of the local flora and fauna if the percent saturation of DO changes?

Student answers will vary.

4. How can human impact alter established ecosystems?

Student answers will vary.

5. Design a possible solution to improve the quality of the ecosystem and/or land use card in each data card set your group analyzed.

Student answers will vary.

Differentiation

Other ways to connect with students with various needs:

- **Local community:** Students may investigate water, soil, and land use systems from their local community by referring to the other curriculum resources indicated above in this lesson. Students may also invite local county park naturalists or Soil and Water District employees to the classroom for a panel discussion.
- **Students with special needs (language/reading/auditory/visual):** Students in cooperative groups can rotate tasks and utilize all students' strengths. Students can design an alternative solution by creating a model of their design solution. Watch this video: youtu.be/SXp8Lg0SFPQ for a soil texture triangle tutorial.
- **Extra support:** Watch these videos:
  - Volunteer Stream Monitoring, A Methods Manual epa.gov/sites/default/files/2015-06/documents/stream.pdf
  - Nutrient testing experiment, Iowa State University crops.extension.iastate.edu/video/soil-nutrient-testing-experiment
- **Extensions:** Students can help to solve real water problems within their community. Take part in organizations such as Give Water a Hand: erc.cals.wisc.edu/gwah/. Ask students to research local land use impacts on natural ecosystems and determine their resilience.

Assessments

Rubric for assessment

Skill	Developing	Satisfactory	Exemplary
Analyzing and interpreting data sets.	Student can analyze the data from most of the data sets.	Student can analyze the data from the data sets and assess most of each data card accurately.	Student can analyze and interpret the data from the data sets and explain how to assess each ecosystem to another student.
Construct an explanation for the current state of the data sets.	Student can interpret some of the data sets accurately and begin to explain potential actions that can cause this data set.	Student can interpret the data sets accurately and explain the impact each card has on a natural ecosystem.	Student can interpret the data sets, explain each impact on a natural system, and explain how humans may have altered the natural system.

Rubric for self-assessment

Skill	Yes	No	Unsure
I can identify macroinvertebrates and utilize the biotic index to determine water quality.			
I can interpret chemical and physical water data to assess water quality.			
I can interpret soil texture volume data on the soil triangle to determine soil texture.			
I can interpret soil nutrient data and make recommendations for amending soil nutrients.			
I can design solutions to improve current land use impacts on water and soil quality.			