EARTH: THE APPLE OF OUR EYE

EARTH matters
Studies For Our Global Future

introduction

We currently use about 8 percent of the Earth's surface, or half of all **habitable land**, to produce food for humans.[1] Over the past century, farming technology has made it possible to produce more food from the world's **agricultural land** in order to feed the growing human population. However, human activities have increasingly threatened agricultural land and soil health, resulting in the need for new agricultural land to feed the ever-increasing number of people on the planet. This expansion has led to the diminishing of the Earth's forests, wild shrub and grasslands, and other wildlife ecosystems. Finding ways to sustainably manage agricultural land and protect soil health, while feeding a growing human population, is now more important than ever.

Vocabulary: agricultural land, contour plowing, cover crops, habitable land, inhospitable, no-till farming, over-cultivation, overgrazing, perennial crops, riparian buffers, salinization, soil erosion, strip cropping, terracing, topsoil, windbreaks

materials

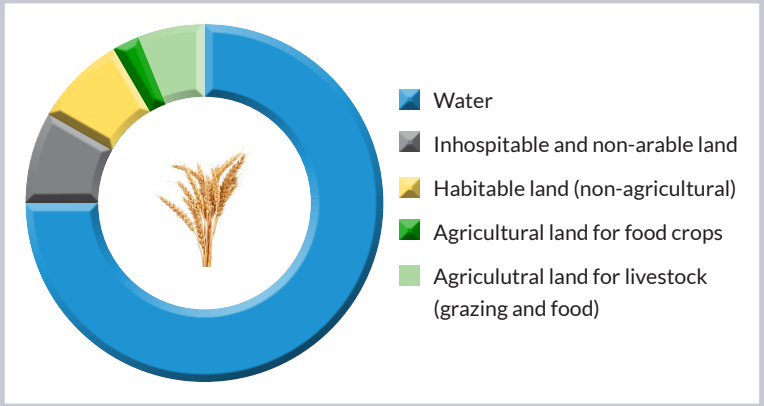
Part 1:

- Apple*
- Knife
- Cutting board

*Non-food alternative to apple and knife: Ball of Play-Doh and dental floss

Part 2:

- Article: "Do We Treat Our Soil Like Dirt? The Effects of Soil Erosion"
- Soil Conservation Assignment Cards (provided)



concept

Agricultural land and nutrient-rich soil are critical resources that we depend on for our food. As the population grows, food needs increase, but so do threats to agricultural land and soil health due to human activities.

objectives

Students will be able to:

- State what percentage of the Earth is made up of water, habitable land, inhospitable land, developed land, and agricultural land.
- Discuss threats to agricultural land, soil health, and ways to protect these resources.
- Read an article, conduct research, and create a presentation on a topic related to soil health (including threats to soil health and conservation practices).

subjects

Environmental Science (General and AP), AP Human Geography, World Geography

skills

Observing, understanding cause and effect, identifying trends and patterns, conducting research to build and present knowledge, communicating research results

method

An apple is sliced into pieces to model the current amount of agricultural land on Earth. Then students read an article about soil erosion and conduct outside research to create presentations on threats to soil health for an "ask the experts" soil fair.

Part 1: The Size of Agricultural Land

procedure

Slice the apple according to the instructions, narrating as you go, and then go through the Discussion Questions as a class. For a non-food option, use a baseball-size ball of Play-Doh. The Play-Doh will need to be somewhat firm so it keeps shape while you cut it with the dental floss.

Apple	Earth	Narrative
Whole Apple	Planet Earth	Hold the apple out so the class can see it. "*This apple represents our planet.*"
3/4	Water	Cut the apple into quarters. Hold out 3/4 in one hand. Ask the class, "*What do these 3/4 represent?*" (Water.) Set the three "water" sections aside.
1/4	Land	Hold out the remaining quarter. Ask the class, *"What fraction of the apple remains?"* (1/4) *"This 1/4 represents all of Earth's land."*
1/12	Inhospitable & non-arable land	Slice the land (the remaining 1/4) into thirds, lengthwise. Hold out one of the pieces and ask the class, *"What fraction of the apple is this?"* (1/12) *"This 1/12 represents the Earth's land that is **inhospitable** to people and to crops: the polar regions, deserts, salt flats, and high or rocky mountains."* Set the "inhospitable land" slice aside.
2/12 (or 1/6)	Habitable land	Hold up the remaining 2/12. Ask students, *"What fraction of the Earth is this?"* (2/12 or 1/6) *"This is land that is **habitable** – land where people can live and we could grow food. But we do not use all of this land for agriculture."*
1/12	Habitable land that is not used for agriculture	Hold up one of the two remaining 1/12 pieces. Explain, *"This is habitable land we do not use to grow crops for food."* Ask, *"What types of things might we find on this land?"* (Forests, wild shrub and grasslands, public lands, nature reserves, and developed areas like roads, schools, houses, etc.) You may want to share that most of this land (72 percent) is forests that are home to rich and diverse wildlife, and provide a host of ecosystem services, such as regulating the Earth's temperature and weather, and converting carbon dioxide to oxygen. Some of it, but only a small fraction (1 percent), is developed by humans. Set this "habitable land" slice aside.

1/12	Agricultural land	Hold out the final 1/12 piece of the apple. *"1/12 of the Earth's surface is agricultural land, used to produce the food that feeds the human population."* Note that a small portion of this section is used to grow nonfood crops, for example crops used to make biofuels and fibers for textiles.[2] You may want to remind students that this is half of all habitable land on Earth.
1/12 peel	Topsoil of agricultural land	Carefully peel the 1/12 slice of Earth. Hold out the peel. *"This peel represents **topsoil**, the very thin layer of the Earth's crust in which plants grow and livestock graze. It is, on average, less than five feet deep and it takes 100 years for one inch of topsoil to form. It is very important that this soil be taken care of so that we can grow food for all the Earth's people."*
1/48 peel	Land used to grow crops directly for human consumption (does not include livestock)	Say, *"But not all of the crops grown in this soil are being used in the same way."* Slice the 1/12 peel into four equal pieces cross-wise. Hold up one piece and ask students, *"What fraction of the Earth's surface is this?"* (1/48) Explain, *"This 1/48 slice of peel is the amount of our agricultural land that is being used to grow crops like beans, fruits, vegetables and grains that get harvested for humans to eat. What fraction of our agricultural land is this?"* (1/4)
3/48 peel	Land for livestock production	Ask, *"What do you think the remaining agricultural land is used for?"* *"The remaining 3/4 of agricultural land is used for livestock like cows, pigs, chicken and sheep. Some of this land is used to grow livestock feed like corn, soybeans, oats, and barley. A large portion of this land is used for grazing, pastures where livestock eat grasses and other plants. It's worth noting that it's not possible to convert all of the land used to raise livestock into land that can grow crops for human consumption."*[3]

Some Facts About Farmland

- **Soil erosion** by wind and water is the most serious cause of soil loss and degradation. Although it is a natural process, soil erosion is accelerated greatly by things like construction, deforestation, unsustainable farming practices, and **overgrazing**.
- Around the world, soil is being swept away 10-40 times faster than it is being replenished, destroying roughly 23 million acres of cropland every year. As a result of soil erosion over the past 40 years, 30 percent of the world's arable land has become unproductive.[4]
- As the global population grows to a projected 9.8 billion in 2050, and incomes grow across the developing world, overall food demand is on course to increase by more than 50 percent, and demand for animal-based foods by nearly 70 percent.[5]
- Land degradation is intensifying in many parts of the world, with more than 24 percent of cultivated areas undergoing degradation, affecting one-fourth of the world's population.[6]

discussion questions

1. Why do you think there is so much more agricultural land dedicated to producing livestock than agricultural land dedicated to producing crops directly consumed by humans?

   Agricultural land used for livestock production includes land for grazing, where livestock eat grasses and other plants. It also includes land to grow crops like corn, soybeans, oats, and barley that go into livestock feed. Livestock eat a lot over the course of their lifetime, so a lot of space is needed to grow grasses and grains to feed animals.

2. How do you think population growth contributes to either the expansion or loss of agricultural land?

   *Answers will vary. With more people to feed on the planet, more land is necessary to grow crops. As more people become affluent and start to consume more animal-based diets, more land is required to meet this demand. At the same time, **over-cultivation** of the land can reduce the fertility of the soil and result in a decreased amount of productive agricultural land.*

3. Given that the human population is still growing and food needs are increasing, what do you think are some options for increasing food production? Do some of these options have drawbacks? If so, what?

   Answers will vary. We could put some of the habitable land into production that is not currently used for agriculture, but this might impact wildlife habitat, compromise ecosystems, and decrease biodiversity. We could try to produce more food on current agricultural land, but this might entail the use of more chemicals such as pesticides, herbicides, and fertilizers, which can have a negative impact on both human and environmental health. Bioengineered crops might be able to produce more food in the same space, but may also lead to the migration of genes into wild plants, the development of super pests, and changes to local agricultural economies.

4. Are there any changes in practices and behaviors that could reduce the growing demand for more food production?

   Eating more plant-based foods and fewer animal-based foods could reduce the amount of agricultural land used for livestock rangeland and for animal-feed crops. Reducing food waste could also have a positive impact. The UN estimates that 30-40 percent of food grown is lost to waste either in transportation, storage, or by consumers.

5. Various human activities, including unsustainable farming practices, contribute to an increase in human-caused soil erosion. As a result, new agricultural land is required to make up for the nutrient-rich topsoil lost. This expansion in agricultural land takes away portions of other forms of habitable land that are home to wildlife, such as shrub and wild grasslands, and forests. Why is protecting other forms of habitable land important? What are some ways we can protect our current agricultural land to make sure we do not need to expand agricultural land into wild areas, while still feeding a growing population?

   Answers will vary. Protecting habitable land for non-agricultural use is important to the health of people and a vast array of ecosystems, which may be home to diverse wildlife, store carbon (as with forests), and provide other ecosystem services such as water purification and flood control.

   Some ideas for protecting our current agricultural land include: Advocate for laws and policies to prevent human-caused threats to current agricultural land, like climate change, deforestation, and unsustainable farming practices. Support local farmers that use more sustainable farming practices. Avoid purchasing beef from companies that practice unsustainable livestock production. Limit the impact of new construction on soil health and agricultural land.

Part 2: Soil Conservation Experts

procedure

1. Before class, access the National Geographic article, "Do we treat our soil like dirt?" Print and distribute the article or have students read it online. The article identifies some of the threats to soil and mentions some of the soil conservation measures that could save our land from further degradation.

2. Distribute the Soil Conservation Assignment Cards to student pairs or small groups.

3. Students investigate the soil topic on their Assignment Card and answer the guiding questions. They will prepare a visual presentation to share while serving as an "expert." Their presentation should answer all of the questions included on the Card as well as any additional information they find interesting.

4. Allow a few days for students to do their research. In addition to web resources, they might also find it useful to interview someone with knowledge of the topic such as a local farmer or staff at a 4-H Cooperative Extension (usually affiliated with a state university). Each group can choose the format for presenting their information – poster board, slide deck, etc.

5. Set up an "ask the experts" soil fair. Each group sets up a station around the classroom and group members take turns serving as experts (being on hand to answer questions from classmates). Students visit other groups' stations to learn about the different topics related to soil health.

assessment

Students write a one-paragraph summary of their group's key findings, followed by one paragraph connecting what they learned in the "ask the experts" fair to what they learned from the apple demonstration.

follow-up activities

1. Have students explore several of the interactive maps at the World Atlas of Desertification site developed by the European Commission's Joint Centre on Research. Specifically, ask them to examine the maps showing types of cropland, extent of global agriculture, and soil erosion. Discuss as a class which regions are growing the largest percentage of food crops and which areas are experiencing the greatest amount of soil erosion.

2. Sustainable agriculture features prominently in the UN Sustainable Development Goals (SDGs). Have students visit the SDG website and click on different goals to identify at least five targets related to sustainable food production and consumption, land conservation, and nutritional health.

3. Students in the U.S. can explore their state's soil profile by viewing the factsheet for their corresponding state at the U.S. Department of Agriculture. After learning about and viewing the image of their local soil, students can each bring in soil from their backyard, local park, etc. and compare what they found to the image of the state's typical soil. If students live in urban area without much access to soil, you may need to provide a sample. Store bought potting soil can be used if needed.

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[1] Ritchie, H. (2019, November 11). *Half of the world's habitable land is used for agriculture*. Our World in Data. Retrieved from https://ourworldindata.org/global-land-for-agriculture

[2] University of Virginia. (2016, March 3). Fuel or food? Study sees increasing competition for land, water resources. ScienceDaily. Retrieved February 25, 2022 from https://www.sciencedaily.com/releases/2016/03/160303133614.htm

[3] Food and Agriculture Organization of the United Nations. (2017). More Fuel for the Food/Feed Debate. Retrieved from https://www.fao.org/ag/againfo/home/en/news_archive/2017_More_Fuel_for_the_Food_Feed.html

[4] Pimentel, D. (2006). Soil Erosion: A Food and Environmental Threat. Environment, Development and Sustainability (8). 119-137.

[5] Searchinger, T., et. al. (2019, July). *World Resources Report: Creating a Sustainable Food Future*. World Resources Institute. Retrieved from https://research.wri.org/wrr-food

[6] Food and Agriculture Organization of the United Nations. (2015). *Status of the World's Soil Resources*. Retrieved from http://www.fao.org/documents/card/en/c/c6814873-efc3-41db-b7d3-2081a10ede50/

EARTH: THE APPLE OF OUR EYE | soil conservation assignment cards

The Dust Bowl

What was it? Where and when did it occur? What caused it? What were the impacts on affected land and resident communities? What were three lessons learned for future farming as a result?

The Green Revolution

What was it? Where and when did it occur? What were the impacts for feeding a growing population? What were the impacts on land use and soil health? What were three lessons learned as a result?

Soil Salinization

What is it? Why does it occur? Where is it most widespread? What are three measures that can be taken to prevent it?

Slash and Burn Farming

What is it? Where is it being practiced and why? What are three impacts on soil health?

Improving Soil Fertility – Crop Rotation

How does crop rotation work and what are the benefits to soil? What is the history of crop rotation? Where is crop rotation being practiced today? What are two obstacles to broadening the practice of crop rotation and two incentives?

Improving Soil Fertility – Organic Additives

How does adding green manure and/or limestone benefit the soil? How have these additives been used historically? What are two obstacles to broadening the practice of these additives and two incentives?

Preventing Soil Erosion – Group 1

Pick three of the following: contour plowing, windbreaks, terracing, no-till farming, strip cropping, riparian buffers, strip cropping, cover crops, perennial crops. How does the practice work to prevent soil erosion? Where is it being used? What are two potential impacts for soil conservation?

Preventing Soil Erosion – Group 2

Pick three of the following: contour plowing, windbreaks, terracing, no-till farming, strip cropping, riparian buffers, strip cropping, cover crops, perennial crops. How does the practice work to prevent soil erosion? Where is it being used? What are two potential impacts for soil conservation?

Climate Change and Soil Health

How does climate change negatively impact soil health? Conversely, how can improving soil health help to combat climate change (e.g. storing carbon) and make cropland more resilient to climate change impacts?