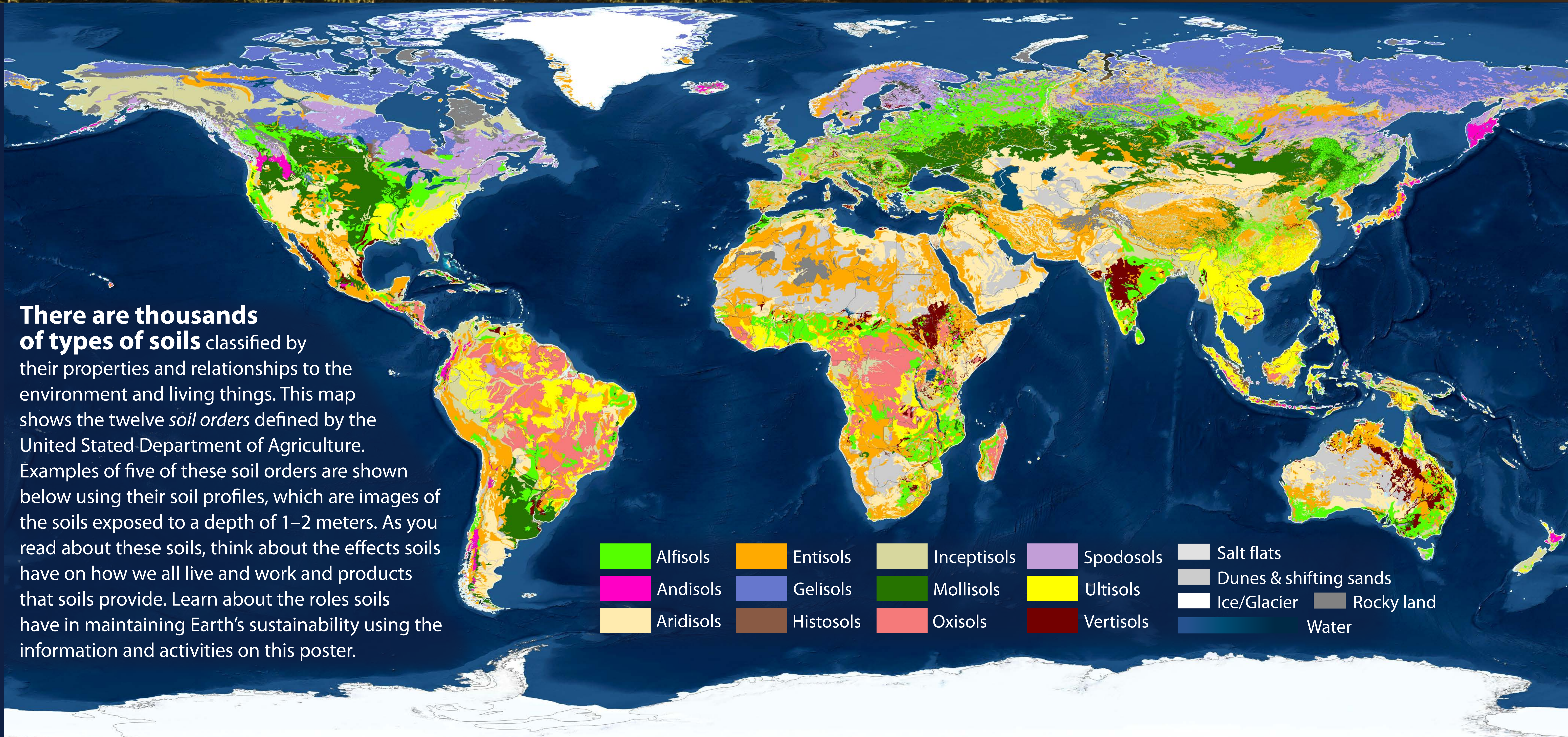
SOILS SUSTAIN THE WORLD

GEOLOGIC MAP DAY: FRIDAY, OCTOBER 14, 2022

U.S. Geological Survey • Association of American State Geologists • National Park Service • Natural Resources Conservation Service • Geological Society of America • Soil Science Society of America • NASA • American Geosciences Institute

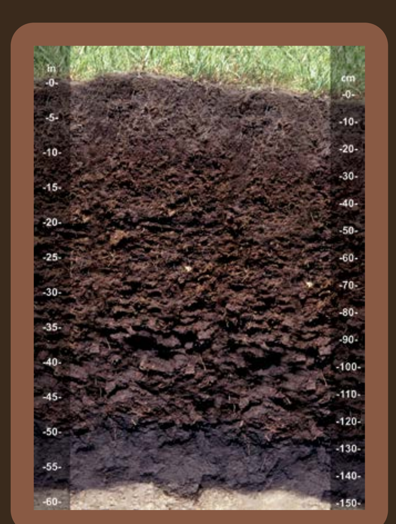


There are thousands of types of soils classified by their properties and relationships to the environment and living things. This map shows the twelve *soil orders* defined by the United Stated Department of Agriculture. Examples of five of these soil orders are shown below using their soil profiles, which are images of the soils exposed to a depth of 1–2 meters. As you read about these soils, think about the effects soils have on how we all live and work and products that soils provide. Learn about the roles soils have in maintaining Earth's sustainability using the information and activities on this poster.

Gelisols are soils frozen to a depth of 2 meters and are typically found in arctic regions. In certain areas these soils store large amounts of carbon. As these soils thaw, previously-frozen organic carbon compounds in the soil are decomposed, releasing carbon dioxide into the atmosphere.

Mollisols are known for being deep, dark soils associated with native grasslands. The dark colors of these soils are derived from the large amount of plant matter that is deposited into the soil each year. These soils are well-suited for crop production.

Vertisols are heavy clay soils that shrink when dry and expand when wet. They are typically found in grasslands or savannahs and can support crop production. However, the shrinking and swelling of these soils can crush plant roots and contribute to damage caused to structures built on them.



Histosols are soils that have at least 40 cm of organic material in the upper 80 cm. These soils are primarily located in wetlands and bogs. They are commonly found in coastal areas and are critical for flood moderation, water filtration, and wildlife preservation.

Ultisols are well-developed, red, clay-rich, acidic soils that naturally support a mixed-forest vegetation. If native forest vegetation grown in Ultisols is cleared, the soils may be used for plantation forestry and are also well-suited for construction purposes.

Global Soil Orders map by USDA-NRCS Soil and Plant Science Division. Ocean background from Esri, Redlands, CA. Soil photos provided by John A. Kelley, USDA-NRCS. Top background photo: USDA/Lance Cheung

Celebrate Geologic Map Day!

Friday, October 14, 2022

www.earthsciweek.org/geologicmap/

CLORPT is an acronym for the five factors that affect soil formation. See Soil Basics for more information.
Credit: Pat Scullion/SSSA. Image Credits: Organisms, Climate, Relief: Morgue File. Parent, Time: Adobestock

SOIL CLASSIFICATIONS

Soils can be classified in many ways. Soils are usually defined by a dominant characteristic such as the type of parent material they are derived from, the presence of a certain diagnostic horizon, the climate in which they formed, common vegetation they are associated with, or the amount of weathering they have experienced, among other factors. The United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS) classifies soils according to a *soil taxonomy* that consists of twelve major *soil orders,* which are displayed on the front of the poster. The World Reference Base for Soil Resources (WRB) suggests classifying soils into 32 reference *soil groups* (**https://soilgrids.org/**, click 'soil classes;' then click 'World Reference Base [2006] Soil Groups'). There are other classification systems as well. No matter the system, all classification systems help differentiate soils and demonstrate the variety of soil types.

Learning Activities

1 Examine the front of the poster. Identify your location on the map and the *soil order* shown there. Is that *soil order* common, or one of the more unique *soil orders* on the map?

2 Explore the Web Soil Survey to learn about your local soils, including uses and limitations (**www.agronomy.org/files/s4t/mapping-your-soil-activity.pdf**). Did you know each US state has a state soil? USDA-NRCS and Soil Science Society of America (SSSA) resources have information on each state soil (**https://bit.ly/NRCSstatesoils, www.soils4teachers.org/state-soils**).

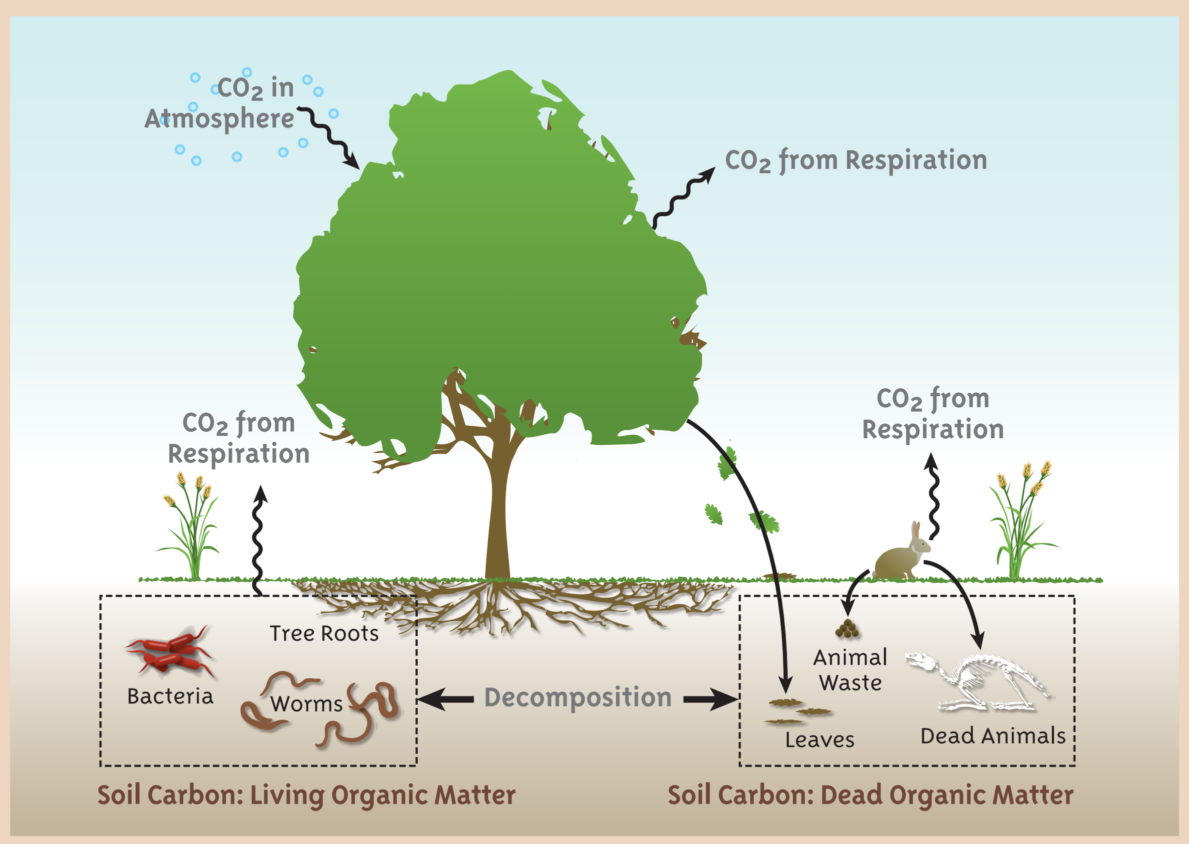
GEOLOGIC MAPS

Geologic mapping is a scientific and technical process that produces maps for many applications, including investigations of geologic hazards; groundwater, energy, and mineral resources; land management and land-use planning; general education; and others. These maps depict observations and interpretations about the composition, structure, and genesis of geologic materials at the Earth's surface and at depth.

Soil is defined as unconsolidated mineral or organic material at the surface of Earth's geosphere. The Earth's surface soil layer varies in thickness from zero (e.g., bare rock, deep water areas) to several meters thick. At its lower extent, soil typically contacts the rocks that serve as the soil's parent material, which have been altered over time by the interactions of climate, relief, and organisms (though some parent material comes from other sources, such as windblown sand).

Soil mapping, a subset of geologic mapping, classifies soils into map units and captures soil property information used to interpret and depict soil types. This Geologic Map Day poster highlights the importance of soils in sustainability as a part of the 2022 Earth Science Week theme, "Earth Science for a Sustainable World."

This information was modified from United States Geological Survey (USGS) and USDA-NRCS resources.



The carbon cycle and its interaction with soils. Organic matter in soil can be found in living organisms and decomposed material, which comes from the breakdown of dead organisms and wastes. Carbon is also exchanged with the atmosphere through plant and animal respiration.
Credit: Soil Science Society of America

SOIL BASICS

Soil is made up of minerals, air, water, and organic matter; it is a living, dynamic resource which is different than dirt (a lifeless, out of place mixture). There are different types of soils depending on the **Cl**imate of the location, **O**rganisms in the soil, the **R**elief (slope) of the land, **P**arent material, and the length of **T**ime they have had to develop — CLORPT for short. Soil is different around the world, and even within a backyard. Soil also changes over time. Water, wind, ice, the sun, and organisms transform the soil from its parent material into something that is often quite different.

Soil is made of layers, or horizons. When viewed from the side, these horizons are found one on top of the other and together they form a soil profile. This profile tells a story about the life of a soil, much like a biography. On the front of the poster there are examples of five soil profiles.

In addition to different horizons, soils have other characteristics that distinguish them from one another – texture, structure, and color. The texture is a measure of how much sand, silt, and clay is contained in a given soil. The structure of a soil relates to how the particles fit together to form larger clumps of soil called aggregates. The color of a soil is related to the mineral content of the soil and can also give information about how it behaves (for example, a soil that drains well is likely to be brightly colored).

Soil Basics adapted with permission from SSSA materials, which can be found at: **www.soils4teachers.org/**.

Learning Activities

1 Five soil profiles are pictured on the poster front. What observations can you make about each profile? How many horizons can you spot in each profile? What are some similarities and differences between the different soil profiles? How might these differences relate to the different uses of the soils?
- SSSA has more information and images of the 12 *soil orders*, as well as activities related to soil characteristics (**www.soils4teachers.org/esw/**).

2 What are the characteristics of the soil near you? Collect a soil sample and investigate its texture, which is a measure of the sand, silt, and clay content. SSSA has a qualitative method to determine a soil's texture by feel (**https://bit.ly/texturebyfeel**). SSSA also has a quantitative way to determine the sand, silt, and clay contents of your soil (**https://bit.ly/texturebyjar**).
- USDA-NRCS has more activities related to soil characteristics (**https://bit.ly/NRCSlessonplans**).

3 Consider what soil is made of and how it develops. How do the Earth systems (the atmosphere, geosphere, biosphere, and hydrosphere) play a role in soil formation and development? AGI's Earth systems diagram can be used to organize your thoughts (**www.americangeosciences.org/sites/default/files/education-Systems-Diagram.pdf**).

Geologic Map Day is sponsored by:

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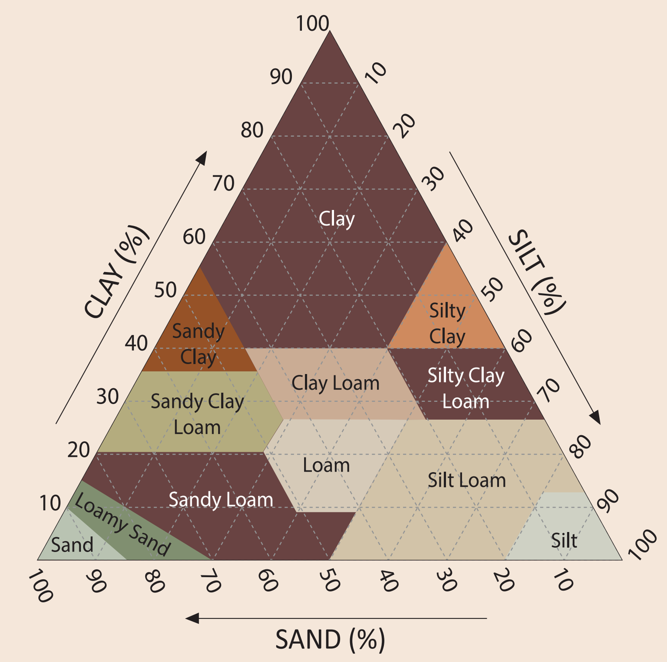
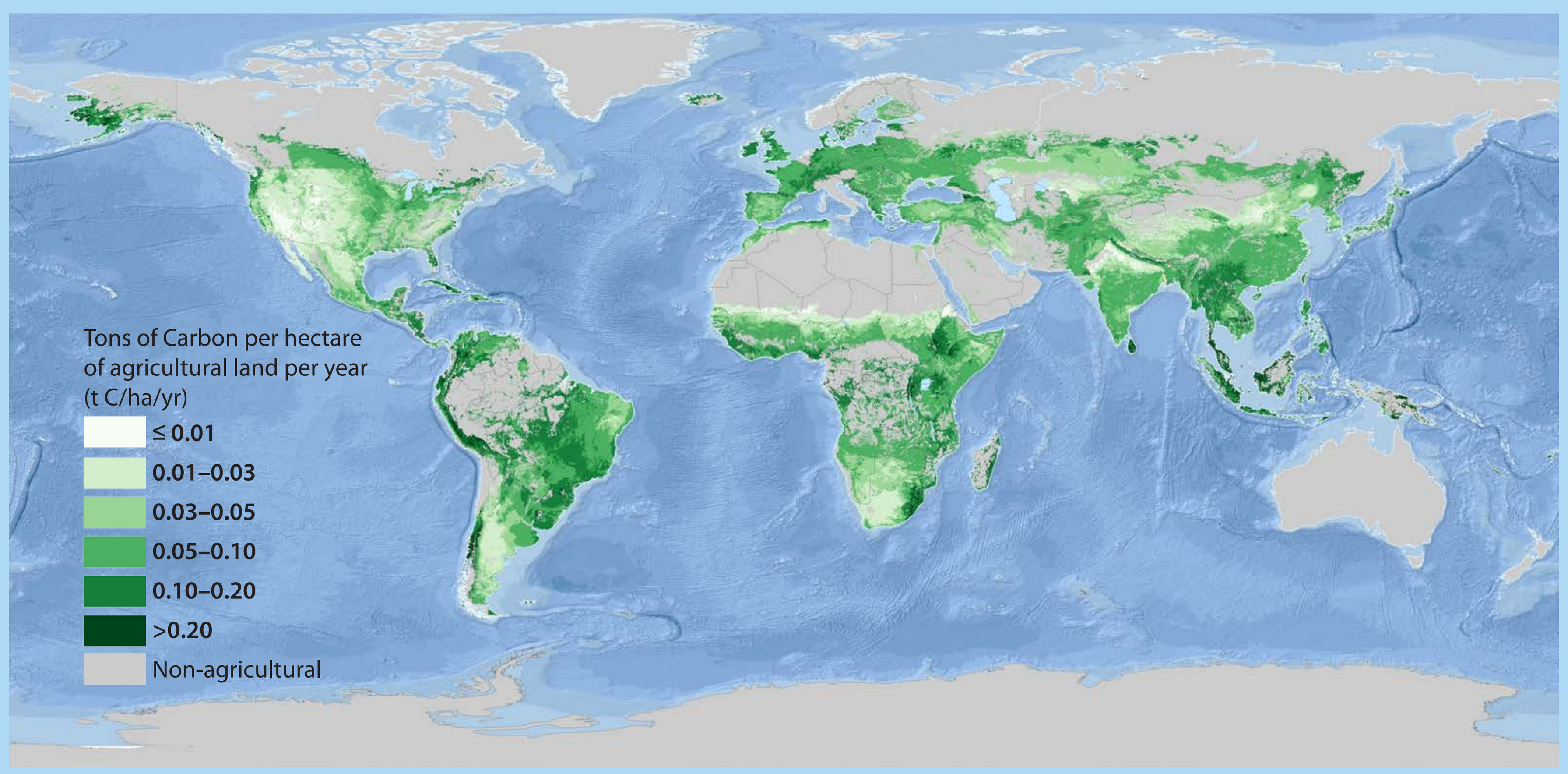
Equilateral Soil Textural Triangle



This diagram is used to identify soils by the relative amounts of silt, clay, and sand they contain.
Credit: USDA, Davis and Bennett, 1927. Adapted by SSSA.

SOIL'S ROLE IN CARBON SEQUESTRATION IN AGRICULTURAL LANDS



Credit: Paul Reich using data from FAO. 2022.

Learning Activities:

1 Examine the map, "Soil's Role in Carbon Sequestration" and determine what the carbon sequestration potential of the soil is in your area. How does it compare to other areas? What trends do you see on the map?

2 Compare the green areas on the soil sequestration map to the soil types on the map on the front of the poster. Do you see any trends? Analyze the information from the map, and compare it to other data sources (**https://bit.ly/C-Sequestration**).

Soils naturally contain carbon as organic matter (residue from decaying plants and animals) and inorganic matter (weathered rocks and minerals). They have the ability to capture and store carbon dioxide (CO_2) from the atmosphere, a process called carbon sequestration, by the uptake of atmospheric CO_2 by plants through photosynthesis. This CO_2 is converted to organic forms of carbon and stored in plants, which are eaten by animals. Eventually, when plants and animals die, the carbon contained in them is stored in the soil as those organisms decompose (measured in t C/ha/yr). Carbon stored in soils increases the soil quality by providing essential nutrients and helps mitigate greenhouse gas emissions, therefore increasing climate resilience.

Certain soil types, such as Histosols, have a higher sequestration potential due to their high clay content. The maximum capacity of soil to store carbon is determined by its clay content, bulk density, depth, and mineralogy. Climate and land management practices also influence how much carbon is actually stored in the soil. If the soil is disturbed, the stored carbon can be released back into the atmosphere. By promoting sustainable practices (such as maintaining groundcover), soil carbon sequestration can be maximized.

SOILS AND THE UNITED NATIONS SUSTAINABLE DEVELOPMENT GOALS (SDGs)

According to the NRCS, a healthy soil is one that has "the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans." Understanding how we can keep soils healthy is vital for sustainability. The SDGs that can be tied directly to the health and use of soils are outlined below along with related activities. The United Nations has more information to learn about all the SDGs (**https://sdgs.un.org/goals**).

2 ZERO HUNGER — Healthy soils are required for growing crops. To test sustainable farming practices, see the Earth Science Week Calendar activities for December and June: **https://bit.ly/ESWCalendar**

6 CLEAN WATER AND SANITATION — Soils can filter pollutants and excess minerals from water. Build and test a soil water filter: **https://bit.ly/SoilWaterFilter**

7 AFFORDABLE AND CLEAN ENERGY — Soils store energy in the form of organic compounds. Emerging technologies are being developed to use soil as a renewable energy source: **https://bit.ly/SoilEnergy**

8 DECENT WORK AND ECONOMIC GROWTH — Soil is vital to many sectors of the economy. There are dozens of careers that study and work with soil: **https://bit.ly/CareersInSoil**

11 SUSTAINABLE CITIES AND COMMUNITIES — Some soils, such as Ultisols, are well-suited for building on. Soils in urban areas are greatly impacted by human activity. Learn more about urban soils: **https://bit.ly/UrbanSoilSurvey**

12 RESPONSIBLE CONSUMPTION AND PRODUCTION — Soil is a non-renewable resource because it takes longer than a human lifetime to produce (1000 years to form an inch of topsoil!). Learn more about protecting soils: **https://bit.ly/CombatingDesertification**

13 CLIMATE ACTION — When organic compounds in soil are used by organisms, carbon dioxide is released to the environment. Watch soil respiration in action: **https://bit.ly/SoilRespirationLab**

15 LIFE ON LAND — Soils are alive and support the growth of plants, animals, bacteria, and fungi. Go outside and see for yourself! Investigate life in soil: **https://bit.ly/LifeInSoil**

ADDITIONAL RESOURCES

- Web soil survey (**https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm**)
- NRCS education materials (**www.nrcs.usda.gov/wps/portal/nrcs/main/soils/edu/**)
- SSSA materials (**www.soils4teachers.org/esw/**)
- GSA Today, "What's Soil Got to Do with Climate Change?" (**https://bit.ly/SoilandClimateArticle**)
- National Geologic Map Database (**https://ngmdb.usgs.gov/ngmdb/ngmdb_home.html**)
- Education GeoSource SSSA curated collection (**https://bit.ly/SSSACollection**)

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Image credits: Poster front: Global Soil Orders map by USDA-NRCS Soil and Plant Science Division. Front soil photos: John A. Kelley, USDA-NRCS. Poster back: Carbon Sequestration Potential Map: Paul Reich using data from FAO. 2022. Global Soil Organic Carbon Sequestration Potential Map – GSOCseq v.1.1. Technical Report. Rome. **https://doi.org/10.4060/cb9002en**. Ocean backgrounds on front and back maps from Esri, Redlands, CA. Poster back: SDG icons: ©United Nations Department of Economic and Social Affairs.

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