Science Societies

What is soil science?

November 23, 2026

What is Soil Science?

Soil scientists develop management strategies for agriculture, engineering, conservation, and other land uses.



Soil fertility



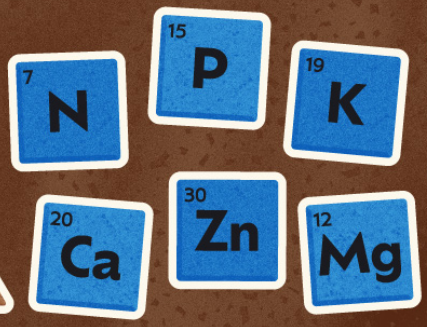


Compaction reduction

Soil scientists study a complex natural resource measuring its physical, chemical, and biological properties.



Physical properties



Chemical properties

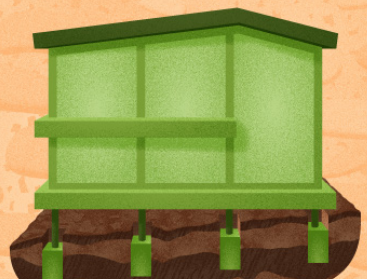


Biological properties

Soil scientists keep our soils healthy so they can continue to sustain life on Earth.







Infographic by Jason Clausen, graphic designer.

> What does it mean to be an agronomist, soil scientist, or crop scientist? We're diving into what it means to be a part of our sciences, continuing the series with soil science. Check out this infographic and article, and make sure to share with your network!
>
> This is part of our Down to Earth series, which breaks down and explains food, farming, and environmental sciences for readers of all backgrounds, including those without formal scientific training.

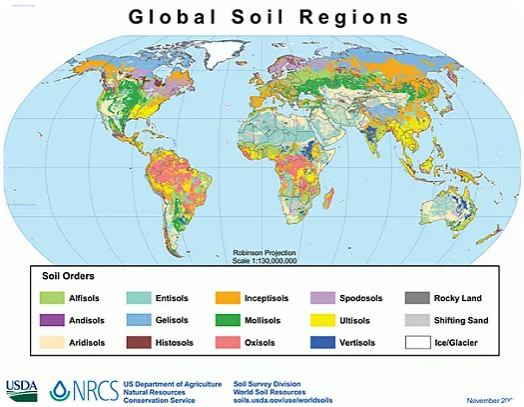
Soil scientists study what's down below

Soil is a mixture of minerals, dead and living organisms (organic materials), air, and water. These four ingredients react with one another in amazing ways, making soil one of our planet's most dynamic and important natural resources.

Soil is used by people in many ways. Because of this, it has many definitions. An engineer may view soils as a material upon which infrastructure is built, while a diplomat may refer to "soil" as a nation's territory. From a soil scientist's perspective, soil is:

"The surface mineral and/or organic layer of the earth that has experienced some degree of physical, biological, and chemical weathering."

Is all soil the same?



Global USDA Soil Taxonomy. Photo courtesy of Wikimedia Commons.

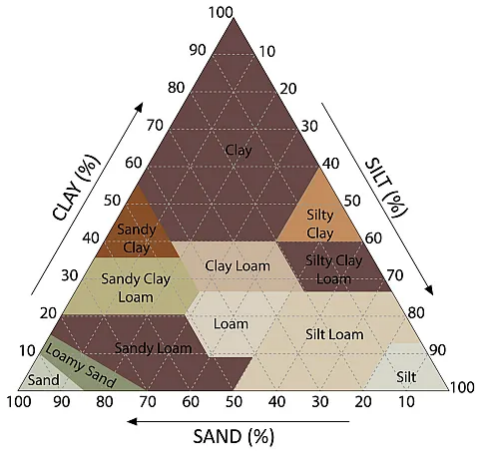
Believe it or not, there are multiple different kinds of soil! Soil scientists have their own kind of classification system, just like plant and animal scientists. The most general level of classification in the United States soil taxonomic system is the soil order. Each order is based on one or two dominant physical, chemical, or biological properties that makes the order distinct from the others. The 12 orders of soil in the United States are:

- Alfisols
- Andisols
- Aridisols
- Entisols
- Gelisols
- Histosols
- Inceptisols
- Mollisols
- Oxisols
- Spodosols
- Ultisols
- Vertisols

Each order ends in “sol,” derived from the Latin “solum,” which means soil or ground. Read more about what makes each order distinct here.

Soil scientists study soil behavior

Soil physical, chemical, and biological properties are what makes soil, soil. Different kinds of soil will have different traits—physical properties of soil especially influence a soil's behavior.



The soil texture triangle is used to define terms like "clay," "silt," and "loam." Photo courtesy of Adobe Stock.

Texture

Soil particles are split into three sizes: sand, silt, and clay. Clay particles are the smallest and sand particles are the largest. Usually, soil is made up of some kind of combination of the three.

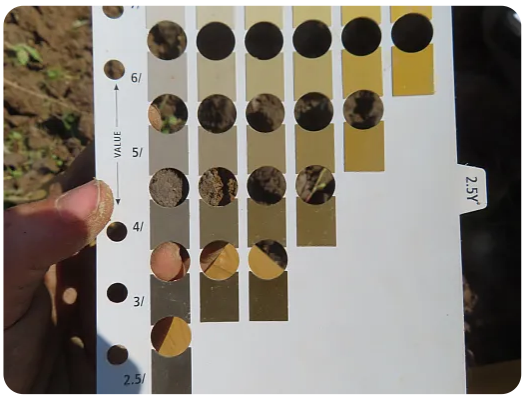
Structure

Soil particles then bind with organic matter and are arranged into small clumps, also known as "peds." For the most part, peds roughly resemble balls, blocks, columns, and plates, and have pores between them, through which air, water, and living things can move. Peds can look and behave different based off of the particles and other "ingredients" that make them up in addition to the conditions that were in place while they were being formed—even people walking on soil can change the shape of the peds!

And how can these traits impact behavior? Texture and structure will influence how well soils hold water and nutrients. For example, not all soils farm the same—a granular soil (think gardening soil) with loamy texture will hold onto water and nutrients much better than a single-grained, sandy soil.

Color

Even a soil's color can give us information about its character. Soils high in iron are deep orange-brown to yellowish-brown, and soils with lots of organic matter are dark brown or black. How well a soil can drain water can also be seen: A brightly colored soil drains well, but one that is often wet and soggy will likely have mottled patterns of grays, reds, and yellows.



Soil color value chart. Photo courtesy of Jaclyn Fiola, Delaware Valley University.

Soil scientists protect a limited natural resource

Soils are known as a renewable natural resource because they are constantly being formed. However, the rate that they're forming at is extremely slow—even just one inch of topsoil can take a few hundred years to develop.

Soils form from weathered parent material, usually rock. Over centuries, rocks are broken into small pieces through physical, biological, and chemical weathering: Freezing and thawing physically breaks the rocks down, plant roots can continue to break down the rock even more, and chemicals in the environment chip the rock pieces into sand, silt, and clay particles.

Soil formation is thus influenced by five factors:

- **Parent material:** The type of rock or unconsolidated material we start with
- **Vegetation:** The action of plant roots and the addition of organic matter
- **Climate:** Controls physical and chemical weathering processes

- **Topography:** Controls the stability of the soil in the landscape
- And of course, **time!**

Over the years, soil will look less and less like its parent material, which is why we call it a dynamic resource—it's always changing.

These dynamic and limited natural resources are so important, which is why soil scientists aim to protect and improve soil health. Life as we know it would not exist without them, as they provide countless services that benefit all humans. These 'goods and services' provided by soils are called ecosystem services: Clean air and water, the clothes on our backs, habitat, and food for plants and animals (and us) are just a few things we can thank soils for.

Soil scientists combat contaminants

Humans have unintentionally poured harmful products into soil over the years. Manufacturing, construction, industrial dumping, land development, waste disposal, excessive pesticide and fertilizer use, and heavy vehicle traffic can contaminate soil. The waste not only hurts the soil—it can hurt plant life, animal life, and possibly human health, too.

Soil contaminants, formally, are any substances that exceed naturally occurring levels and can pose possible harm to human health. An example of this is lead: It's found naturally in low levels in some soils but is also a well-known soil contaminant, thanks to its use in gasoline until 1989. Excessive amounts of lead can still be found in some soils, even today.

Urban spaces and former industrial sites have the biggest risk for soil contaminants, with pesticides, petroleum products, radon, asbestos, lead, and wood preservative

chemicals being common soil contaminants. Even excess winter salt can harm soils.

How can soil contaminants hurt us?

- **Ingestion of soil:** Eating unwashed produce (or soil itself) can come with risks if the soil is contaminated.
- **Airborne particles:** Uncovered soil particles can become airborne with wind (or other disturbance, like construction, mining, or poor landscaping work). Breathing in contaminated dust may cause damage to human health.
- **Absorption through skin:** An example of this is creosote, a common wood preservative, which can leach out of treated wood and into the soil. Contact with these chemicals over time can cause the skin to blister, peel, or severely redden.
- **Food grown in contaminated soil:** If you grow food in contaminated soil, there's a risk your food is also contaminated, as many herbs and veggies absorb contaminants as they grow.

Of course, most soil is perfectly safe for play, gardening, and recreation, but if you are concerned about the condition of the soil near your home or property, it's best to have a soil test done to be sure about its safety.



When it rains, it pours: Oil from cars can get washed away by rain and end up in the soil. Photo courtesy of Adobe Stock.

Soil scientists study conservation practices to protect our waters

Contaminants can get into our water supply, too, further putting human health and environmental quality at risk. Luckily, soils can act as "earth's kidney" to help mitigate the issue, if our soils and green spaces are well maintained.

When we get an influx of rain, the excess stormwater can pick up water-borne contaminants like plant nutrients (such as N and P), metals, organic chemicals from gasoline products and pesticides, pathogens from feces, and plastics/trash.

How do we typically deal with stormwater? Images of "gray infrastructure" probably come to mind—pipes, drains, and pumps. This gray infrastructure was designed to get as much water off of the streets as possible. The water is then carried via pipes to water treatment facilities before flowing directly into surrounding bodies of water. The city will then either spend excess resources to clean that water, or in cases of extreme/heavy rains, large volumes of excess stormwater will overload the facility. In this case, the facility could be forced to release some of that untreated stormwater, along with untreated sewage, into the surrounding natural waters. Municipalities are allowed a certain number of these events per year, but concerns about water quality are tightening these regulations.

Nature has its own way to deal with excess water. In forests, wetlands, and other, mostly unchanged landscapes, water is managed naturally, and it's the soil that is the foundation of these networks.

Soils are permeable. In forests and in fields, rainwater soaks into the soil. The soil stores some of this water, and the rest slowly moves to streams or into the groundwater.

Even during heavier rains, most rain will stay in (or move slowly through) fine-textured and well-developed soils. In more coarsely texture soils, water will move through the soil more quickly. Either way, water can enter and move through the soil because it is permeable.

But when it rains in a city, the rain can't soak into the soil underneath pavement and asphalt. As water travels over these surfaces, it can cause flooding and erosion, and can carry sediment, nutrients, and other contaminants. And as these impermeable surfaces increase with increased urbanization, so too does the amount of potential runoff. Even when not covered by impermeable surfaces, urban soil is often compacted, which drastically slows the rate water can infiltrate the soil. These soils act more like asphalt than healthy soils.

So, what do we do? Soil scientists can help implement "green infrastructure" into cities. Green stormwater infrastructure refers to the green spaces in our cities that manage stormwater while providing recreation spaces and wildlife habitats. They increase the permeability of cityscapes, which helps reduce runoff to natural waters and the burden on our wastewater treatment facilities. There are several types of green infrastructure, like permeable pavement, green roofs, urban forests, wetlands, and rain gardens.

Green infrastructure can be engineered to fit a business' or town's particular needs or can be completely nature-made—both methods have their pros and cons. But arguably, the most important aspect of any kind of green infrastructure is its soil. Take bioswales for example—these are landscape depressions designed to capture and treat runoff as it moves downstream. Bioswale soils must:



- **Infiltrate water quickly, but not too quickly.** Water needs to travel slowly enough through the soil for filtering and adsorption of contaminants but must also infiltrate fast enough to prevent flooding.

A bioswale in Washington, DC. Photo by Erica Fischer, courtesy of Wikimedia Commons.

- **Resist compaction.** Compaction of soils can greatly reduce infiltration rates, making the bioswale ineffective.
- **Hold enough water and nutrients to maintain healthy plant life.** While the soil alone can significantly reduce water pollution, no one will want a "garden" of bare soil or half dead plants in their front yard.

Soil science plays a key role in sustaining our food and environmental systems, and soil scientists are working across the globe to address some of the world's most pressing challenges. We hope showcase the work done by top soil scientists in our magazines: *CSA News* and *Crops & Soils*. Read more!

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