Soil

Soils are the loose materials that cover the Earth's surfaces, an accumulation of particles of rock, minerals, microorganisms, and other organic matter formed by weathering and other natural processes. Soils form continuously, but very slowly ? only about one inch forms every 500 to 1,000 years. Bedrock exposed to weathering starts the process of creating nearly all soils. Weathering, and the speed at which it occurs, is driven by water, wind, and temperature. It is the continual breakdown of debris that results in soil formation.

Soil

Drought
Soil Ecosystems
Soil Microbiology
Threats to the Soil

Soils are a mix of inorganic mineral particles, organic matter, air and water. The mineral particles ? sand, silt, or clay ? contain a variety of chemicals, many of which are utilized for plant growth. Organic matter, typically from plants and/or small organisms that have died and decayed, provides nutrients to the soil which are essential for fertility. The ability of soil to retain and transport water is an important factor in bringing nutrients to plants. However, plant and animal life also needs oxygen for their survival; therefore, a balance between air and water in the soil is extremely important.

The composition of a soil, along with a variety of characteristics, is what makes up a soil's properties. It is these properties, and the degree to which they appear, that provide for the level of soil quality. Mineral and organic particles make up about half of a soils volume; pores containing air and water make up the remaining volume. Soils vary in composition, but generally consist of four main mineral types: sand, silt, clay, and loam. Sandy soils have a coarse texture, clay soils have a sticky texture, and silt particles, which are smaller than sand particles but larger than clay particles, give soil a silky, powdery texture. Soils in which all three minerals contribute equally to their texture are called loam soils and thought to be best for agriculture.

Soil quality can also be distinguished by a variety of soil characteristics. **Color** can indicate specific soil properties, especially as it relates to water and oxygen content. For example, dark soils typically indicate significant organic matter content; red and yellow soils indicate the presence of iron which is left behind as water leaches the more soluble minerals; and, saturated soils which are poorly aerated are often found to have a hue of grey, blue or green.

Texture , often based on the mineral component of the soil, helps to measure soil productivity as it relates to drainage and fertility. At the

extremes, the larger particle and very fine particle soils are less productive. The structure of the soil ? its **aggregation** ? is a measure of soil strength (from sandy to clay to rocky soils). Again, it is the mid-level soils that provide the greatest stability necessary for functional use. Related to both texture and aggregation, **porosity** of the soil is extremely important for the transport of both water and oxygen.

Chemical characteristics are also important for determining the quality of the soil. Soils that are particularly able to hold and exchange ions (groups of atoms) are more fertile. The **ion content** of the soil makes it possible for important nutrients ? calcium, potassium, and magnesium ? to be changed into a form that is beneficial for plant growth. The measure of a soil's **pH level** (1-14) is also an important chemical factor to determine what can be grown successfully. For example, while most plants prefer a pH closer to neutral (7), others have a preference for either acidic (1-6) or alkaline (8-14) soils. In addition, if a soil is toward one extreme or the other, fertilizer (to lower pH) or lime (to raise pH) can be used.

In addition to the minerals from the weathering of rocks, healthy soils contain millions of different bacteria, plants, and other organisms which are added to the soil as organic matter, called humus, when they die and decompose. As soils form, layers ? called horizons ? build up, each with its own distinct characteristics and composition reflecting different timelines and weathering processes. This layering makes up a soil's profile.

Soils are dynamic ecosystems composed of a combination of minerals, organic matter, and living organisms thought to be one of our most fundamental natural resources. Vital, healthy soils are critical in cycling nutrients and necessary in sustaining plant growth. Without the oxygen and food supplied by plants and crops, life on Earth would not be possible, so the quality of soil ecosystems is a matter of considerable importance.

Soil ecosystems can be damaged through the force of nature or by poor management practices. Significant amounts of topsoil are lost through erosion, a natural process caused by water and wind. It can also be exacerbated by human activities, such as land clearing, poor farming methods, and the addition of pollutants. Modern agricultural practices often include the use of fertilizers to increase soil productivity; however, their use can cause nutrients to leach out of the soil, add heavy metals, or cause other environmental damage.

There is now considerable research being done to improve both soil management and agricultural practices. As population increases, there will be a greater demand for food resources and maintaining healthy soils will be critical to minimize erosion and maintain soil fertility and productivity.

Recommended Resources

Soil Science Education Home Page

Developed by NASA, this easy-to-use educational site provides an enormous amount of information on soil, from soil science basics to soil and our society to the interactions between soil and the environment.

Soil-Net.com

This free internet resource, developed by Cranfield University's

National Soil Resources Institute in the UK, provides teachers and students with extensive information and activities about soil, from what soil is to life in soil to the threats that soil faces.

Soil Collections
The Oak Ridge National Laboratory offers a wealth of data on soil types and characteristics, annual soil respiration and soil water capacity, organic soil carbon and nitrogen, and a database of northern and mid-latitude soils.

Soil Forming Factors
NASA's soil education site offers an excellent introduction to rocks and the factors necessary for soil formation.

From The Surface Down: An Introduction to Soil Surveys for Agronomic Use
This document, prepared by the U.S. Department of Agriculture, explains soil formation and properties, soil horizons, information on soil management, and much more.

Soil Quality Concepts
The Natural Resources Conservation Service provides an overview of soil quality, in addition to providing links for more information.

Nutrients in the Soil
The North Carolina Department of Agriculture provides a useful explanation of macronutrients and micronutrients in the soil and the role they play in plant growth.

Soil Characterization Field Guide
NASA provides a handy guide of the protocols that the GLOBE (Global Learning and Observations to Benefit the Environment) program uses for soil characterization.

LAWS & TREATIES

2007 Farm Bill
The U.S. Department of Agriculture provides the most comprehensive information available on the most recent Farm Bill.

History of the Farm Bill
This site provides a synopsis of important soil legislation. Highlights include the Soil Conservation Act of 1935, the Agricultural Act of 1956 and the 1985 Farm Bill, along with its reauthorized bills through 2002.

FOR THE CLASSROOM

Soil Education
The U.S. Department of Agriculture's Natural Resources Conservation Service website contains a section on soil education that includes resources for teachers and students.

Soil Activity Sheets
The Soil-net.com website contains a section with a variety of activity sheets for download. Activities range from soil properties and chemistry to soil mapping.

NASA: Soil Science Education
The teaching resources and activities presented by NASA include

student friendly essays on soil science basics, soil microbes, and sections featuring soil in the news and soil and society.

GLOBE: Soil Investigation

The GLOBE program, sponsored by NOAA, NASA, NSF, and the EPA, has an extensive teacher's guide with soil investigation activities.

Lessons and Activities

The Soil Science Society of America provides lessons on both soil texture and color.

Soil Texture

In this lesson, students compare soil texture based on physical characteristics of soil particles.

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Please send questions and comments to info@enviroliteracy.org.