Introduction to Soils

Functions of Soils

Medium for plant growth
Regulate water quality and supply
Nutrient cycling
Habitat for soil organisms
Engineering medium

For plant growth soils provide mechanical support, water, nutrients and root aeration. Soils also buffer temperature in the root zone.

As regulator of water quantity and quality, soils limit surface runoff, recharge ground and surface water supplies, and filter and purify water.

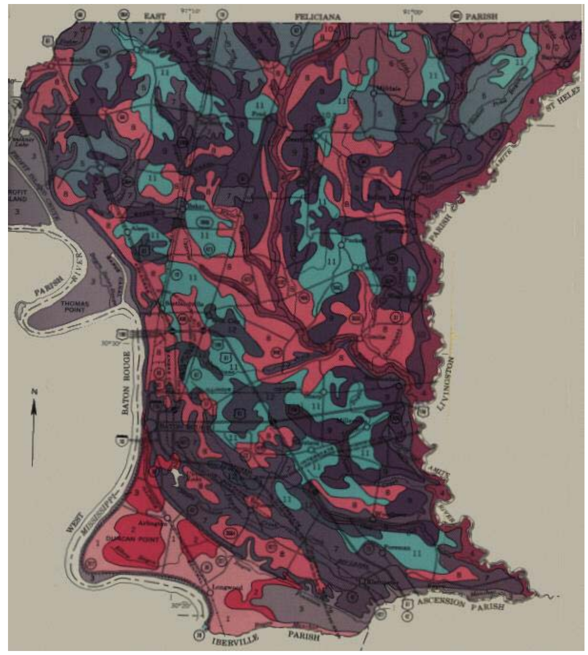
Via recycling of nutrients, soils prevent sequestering of C, N, P and other nutrients, thereby ensuring a continued supply of these nutrients to plants.

As a habitat for diverse organisms, soil is an integral part of the terrestrial ecosystem, indispensable to plants and water quality.

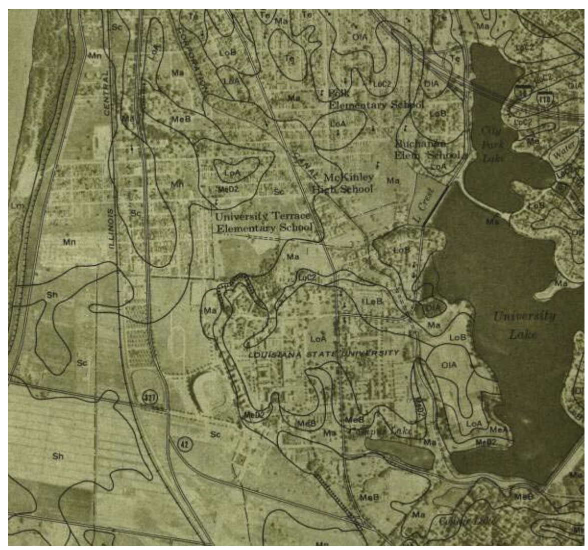
Soils also affect engineering design due to variable bearing strength, compressibility, shear strength and stability.

Soils as Natural Bodies

Distinct from geologic deposits of unconsolidated material, soils exist due to actions of *pedogenic* processes over time. Soils exhibit lateral variability across the landscape and internal (vertical) variability. Soils overlie consolidated rock and may have formed from rock weathered in place or formed in unconsolidated material transported from elsewhere.



General soils map of East Baton Rouge Parish showing variability in *soil associations* (groups of soils that typically occur together).



Detailed soils map of LSU campus showing small scale variability in soil *mapping units*. Published 1964.

The unconsolidated material above rock is called the *regolith*. Soils form at the surface of the regolith. As soil development proceeds, *horizons* evolve. The *solum* is typically limited to upper 1 to 2 m.

Profile of a Ruston *series* soil showing A, E and multiple B horizons. See brief descriptions below.

Soil Profile

The sequence of horizons that make up a soil profile is clearly revealed in a soil pit or road cut. This sequence may include some or all of the *master soil horizons* listed below.

O Organic matter above the surface of a mineral soil.

A Zone of accumulation of organic matter at and below the mineral soil surface. It is darker than horizon(s) below it.

E Zone of maximum leaching. It contains little organic matter and is lighter than horizons below it.

B Zone of maximum accumulation of clay or salts translocated from above. It is typically brighter color than the other horizons.

C Shows little or no development.

General Composition of Soil

Soil is composed of mineral and organic particles and pore space. The latter is filled with air and water.

Mineral Particles

These vary in size and mineralogy. The, individual particles are typically aggregated together.

Size classes divided among coarse fragments (> 2 mm) and fine earth (< 2 mm). The latter are divided among sand, silt and clay separates.

Sand	2.00 to 0.050 mm
Silt	0.05 to 0.002
Clay	< 0.002

The relative proportion of these various sized particles is called soil *texture*. The smaller clay (and soil organic matter) is colloidal. Colloids remain in suspension and exhibit a high surface area per unit mass. Soil colloids carry electrostatic charges and adsorb ions and water.

Primary and *secondary minerals* occur in soil. Sand and silt are dominated by primary minerals (precipitated as molten magma cooled) such as quartz, micas and feldspars. The clay size fraction is dominated by secondary minerals formed by weathering of less resistant primary minerals. Secondary clay minerals include silicate clays and oxides.

Individual particles may be aggregated to produce larger units of soil *structure*. The relatively large pores between units of structure increase air and water movement in soil.

Organic Matter

Mineral soil typically contains 1 to 6 % organic matter. It consists of living biomass, partially decomposed plant and animal residue and products of microbial biosynthesis.

The dark colored colloidal fraction of soil organic matter is called *humus*. Soil organic matter is important because it increases the water holding capacity of soil and provides nutrients to plants and other soil organisms.

Soil Water

Soil water contains various inorganic and organic solutes. Accordingly, it is referred to as the *soil solution*.

Soil Air

Air-filled pore space and water-filled pore space vary inversely. The gaseous composition of soil air depends on the metabolic activity of soil organisms. Compared to the above ground atmosphere, soil air typically is higher in water vapor (relative humidity near 100%), higher in carbon dioxide and lower in oxygen. Aeration is affected not only by water content but also by soil pore size distribution. If most pores are small (*micropores*), aeration is poor.

Nutrient Content in Soil and Uptake by Plant Roots

Sources of Nutrients

Structural component of minerals and soil organic matter
Adsorbed on mineral and organic colloids
Dissolved in the soil solution

The release of nutrients from mineral and organic combination depends on chemical weathering and microbial decomposition.

Release from colloidal surfaces occurs by a physicochemical process that is called *ion exchange*. Weathering is very slow, decomposition slow but ion exchange fast. Nutrients in the soil solution are directly available for plant uptake.

Processes that Bring Roots in Contact with Nutrients

Root interception	Growth into an unexploited zone
Mass flow	Nutrients move with soil water toward a root that is absorbing water
Diffusion	From a zone of high to low concentration

Soil environmental conditions such as low water content or soil compaction adversely affect these mechanisms Poor aeration or temperature extremes may also affect the active uptake of nutrients.