ALABAMA A&M AND AUBURN UNIVERSITIES

ALABAMA COOPERATIVE Extension SYSTEM

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Soil Management To Protect Water Quality

Understanding Soils And How They Affect Water Quality

When a soil is well managed, it is an efficient receiver of rainwater. If the soil is improperly managed, however, rainwater may run off, carrying soil particles, nutrients, and organic material with it.

A good understanding of the soil and its properties is essential to good soil management that, in turn, will lead to maintaining good water quality.

What Is Soil?

Soil is the upper portion of the earth's crust. Soil is to the earth as a rind is to an orange, although soil is much less uniform in thickness and composition. Soil ranges in thickness from a few inches to more than 10 feet.

Each individual soil has a unique combination of properties; however, some properties are common to all soils. All soils consist of solid particles arranged in aggregates and pores. Particles can be mineral or organic matter. The pores are filled with air, or water, or both. The relationship of solids to pores changes with soil depth.

From a water quality standpoint, soil serves as a filter. As surface water seeps through the soil layers, impurities are removed, and eventually the purified water reaches groundwater supplies. But several factors affect a soil's ability to remove impurities: texture, structure, organic matter, permeability, and soil microbiology.

Texture and organic matter content are determined by routine soil analysis, while permeability and soil structure can be inferred from soil taxonomy or field observations.

Soil Texture

Texture describes how coarse or fine a soil is and includes stones and gravel. The coarsest of the chemically active particles is sand. Clay particles are the finest, and silt is intermediate. Soils that contain a large amount of sand feel gritty, while silty soils feel smooth. Clay soils feel hard when dry, and sticky and plastic (moldable) when moist.

Silt and sand particles are not very active chemically; they contribute little to the ability of the soil to adsorb (bind) contaminants but have a significant impact on overall soil structure and how it affects drainage. Most clay particles are structurally and chemically quite different from sand and silt and are smaller. Clay is responsible for much of the chemical activity and accounts for a good portion of the water-holding capacity in soils. The soil water that is available to plants depends mostly on porosity.

A loamy soil contains a roughly balanced mixture of sand, silt, and clay. Loamy soils have more chemical activity than sandy soils and hold more water. They offer more protection to groundwater because water tends to infiltrate through them at a slow enough rate to allow for purification and rapid enough to prevent excessive runoff. Sandy soils drain excessively while clay or fine-textured soils promote runoff.

Structure

Individual particles of sand, silt, and clay tend to become clustered together in soil. This clustering of particles into aggregates gives structure to the soil. The granules of soil that we see hanging to grass roots when we dig into sod is a type of soil structure.

Structure is important because it determines the ratio between large and small pores in a soil. In fine-textured soils, structure is essential to movement of water (infiltration) and air into the soil.

Organic Matter

Organic matter is formed from the decomposed remains of plants, animals, and microorganisms. Well-decomposed organic matter is called humus. Humus gives topsoil its dark color.

Organic matter plays an important role in forming structure in soils by helping to bind soil particles into aggregates. Organic matter also resembles clay in that it is chemically active. Organic matter is especially effective at binding many pesticides and plays a key role in keeping pesticides out of groundwater. Increasing the organic matter in a soil can reduce the risk of pesticide leaching.

Soil Permeability

Soil permeability is the property that describes the tranfer of water and air through the soil. It is measured as the rate of flow, principally downward, at which soil transmits water while saturated.

Differences in soil permeability are caused by the varying pore sizes, which are related to the soil's texture (particle size distribution) and structure (aggregation of soil particles). Gravels and sands are highly permeable because their large soil particles create large pore spaces through which water can readily move. Clay soils are fine textured with small pores and low permeability.

Texture, structure, and organic matter affect drainage. Poorly and excessively drained soils are poor filters. Poorly drained soils also increase water runoff and the susceptibility of the soil to erode or wash away and pollute rivers and lakes. Excessively drained soils do not allow drainage water to be purified.

Tools To Evaluate Soil Properties

Direct Observation. The best way to gather site-specific soils information is by directly observing soils in the field. Observe texture, structure, organic matter, and permeability.

Excavated Pits Or Borings. Because detailed site-specific information is needed for septic tank system design, soils are evaluated in pits or borings before any septic system is installed. Soils with high water tables often have gray or mottled colors in the subsurface while well-drained soils are a more uniform brown or red color. In well-drained soils, enough air generally occurs in the soil pores to keep soil microbes supplied with oxygen. Under these conditions, microbes from septic systems, some of which may cause diseases, are rapidly degraded and do not leach to groundwater. When a high water table exists, soil microbes cannot get much air. They are then much less effective at removing pathogens from sewage.

Soil Surveys Reports. These reports are used to supplement site-specific information and to provide broad information when it is needed over a large land area. This recorded information is extremely valuable in making sound decisions regarding land use and management on a regional basis. The USDA Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service (SCS), in cooperation with state agricultural experiment stations and others produces and publishes these reports on a county basis. The status of published soil surveys in Alabama is shown in Figure 1.

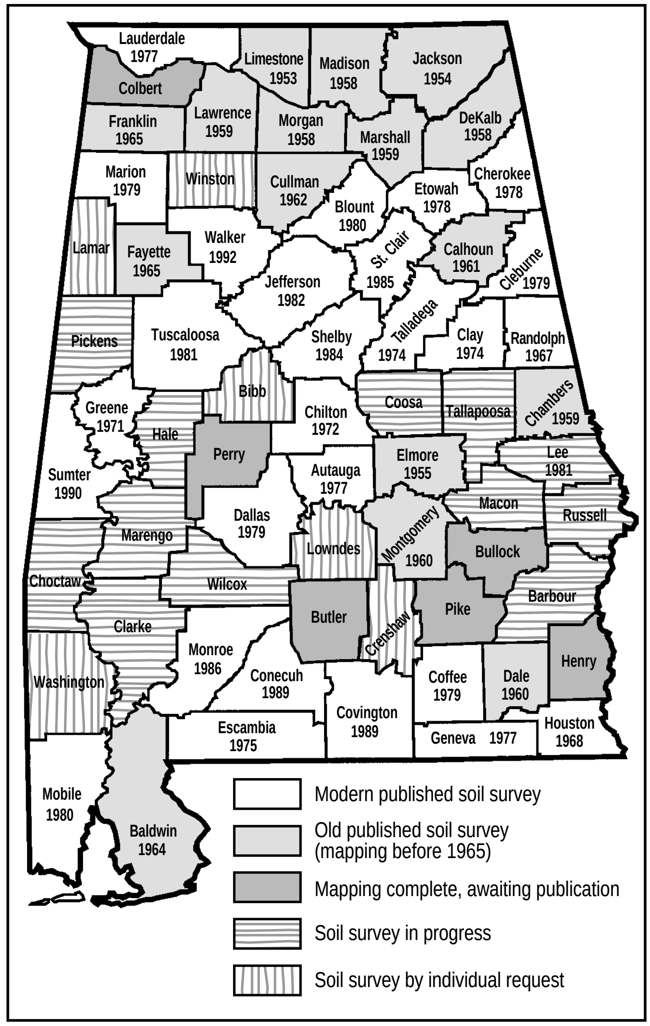

Figure 1. Status of soil surveys in Alabama (after USDA-SCS National Cartographic Center, 1992).

Each soil survey contains maps, tables, and text describing soils in the county. Soil types are called series. Soils with similar properties are grouped and mapped as one map unit. Soil survey maps show the locations of each unit in the county. The most detailed mapping unit is phases of soil series. Each series is divided into phases on the basis of slope, erosion, texture, or some other property significant to the use and management of the soil.

Tables and text describe properties, use, and suggested management for each series. The tables and text also include information on slope, depth, drainage, texture, landscapes, and parent materials for each soil series. In addition, the soil survey report gives information on the variability expected to be found in the field.

Soil surveys are available from NRCS offices located in each county. The county offices can assist you in using the soil survey to identify ways to improve surface water and groundwater protection.

Table 1. Soil Hydrologic Groups.

Group	Type	Infiltration Capacity/Permeability	Leaching Potential	Runoff Potential
A	Deep, well-drained sands and gravels	High	High	Low
B	Moderately, deep to deep, moderately drained, moderately fine to moderately coarse texture	Moderate	Moderate	Moderate
C	Impeding layer, or moderately fine to fine texture	Low	Low	High
D	Clay soils, soils with high water table, shallow soils over impervious layer	Very low	Very low	Very high

Source: van Es, et al., 1991.

Soil Hydrologic Groups. Soils are categorized into hydrologic groups based on how much water will infiltrate when the soils are wet and without plant cover. The four hydrologic groups and their potential for leaching and runoff are described in Table 1.

Conclusion

When properly managed, soil can serve as a filter and prevent pollutants from reaching groundwater. Except in excessively drained soils, leaching of pollutants through the soil is usually a very slow process. This slow movement through the soil allows microorganisms to absorb and further degrade pollutants into simple, harmless substances commonly found in nature. Even if soil is an excellent and efficient filter, excessive amounts of pollutants can overload the filter system and still pollute the water. Proper soil and crop management is certainly the safest and least costly way to prevent pollution of our surface water and groundwater.

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For more information, call your county Extension office. Look in your telephone directory under your county's name to find the number.

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