USDA Natural Resources Conservation Service

Indicator ? | Test ? | Function ?

Soil Quality Indicators

Physical, Chemical, and Biological Indicators for Soil Quality Assessment and Management

A series of information sheets for physical, chemical, and biological indicators is available to help conservationists and soil scientists with soil quality assessment. Use this guide to learn more about selecting appropriate soil quality indicators to assess specific soil functions. Visit http://go.usa.gov/zUAH for more information and to download copies of the information sheets.

What is soil quality?

Concise definitions for soil quality include "fitness for use" and "the capacity of a soil to function." Combining these, soil quality is the ability of a soil to perform the functions necessary for its intended use.

Soil functions include:

- sustaining biological **D**iversity, activity, and productivity
- regulating **W**ater and solute flow
- **F**iltering, buffering, degrading organic and inorganic materials
- storing and cycling **N**utrients and carbon
- providing physical **S**tability and support

TIP: *The* ***Function*** *icon at the top right corner of each information sheet uses* ***D, W, F, N, or S*** *to show the function(s) that is most affected by the subject indicator.*

How is soil quality measured?

The quality of a soil, or its capacity to function, is evaluated using ***inherent*** and ***dynamic*** soil properties. These properties serve as ***indicators*** of soil function because it is difficult to measure function directly and observations may be subjective.

Inherent, or use-invariant, soil properties change very little or not at all with management. Inherent soil properties form over thousands of years and result primarily from the soil forming factors: climate, topography, parent material, biota, and time. Examples of inherent properties are soil texture, type of clay, depth to bedrock, and drainage class.

Dynamic, or management dependent, soil properties are affected by human management and natural disturbances over the human time scale, i.e., decades to centuries. Significant changes in dynamic soil properties can occur in a single year or growing season. There are many dynamic soil properties, several of which are the subjects of this information sheet series.

Soil indicators are often divided into **P**hysical, **C**hemical and **B**iological categories depending on how they affect soil function. However, these categories are not always clearly defined since a soil property or indicator can affect multiple soil functions or categories.

TIP: *The* ***Indicator*** *icon at the top right corner of each information sheet uses* ***P, C, or B*** *to show the category in which the indicator best fits.*

Depending on the indicator and the method used to evaluate it, properties are assessed in the **F**ield, **L**aboratory, or even an **O**ffice when no special equipment is required.

TIP: *The* ***Test*** *icon at the top right corner of each information sheet uses* ***F, L, or O*** *to show where indicator assessment takes place for the method highlighted on the information sheet.*

Selecting soil quality indicators

A soil function – indicator matrix (fig. 1) can be used to select appropriate indicators for assessing a particular soil function. Additionally, if an indicator is already being measured, the matrix reveals the indicator's relationship to other soil functions, thus maximizing the usefulness of the collected data.

Each indicator listed in the matrix below is linked to its accompanying information sheet. The information sheets:

- define and describe the indicator
- relate the indicator to soil function
- discuss inherent and dynamic factors influencing it
- suggest management practices to improve soil function
- provide a reference for an assessment method

Figure 1. Soil function – indicator matrix: when a direct relationship exists between the function and indicator, increasing reliability and ease of use of the associated assessment method is shown with increasing stars.

	Soil Function				
Soil Quality Indicator	**Sustain biological diversity, activity, and productivity "D"**	**Regulate and partition water and solute flow "W"**	**Filter, buffer, degrade, detoxify organic and inorganic materials "F"**	**Store and cycle nutrients and carbon "N"**	**Physical stability and support for plants and structures associated with human habitation "S"**
Aggregate Stability [a,c,f]	★★	★★	—	★★	★★½
Available Water Capacity [a,g]	★★★	★★½	—	★★	—
Bulk Density [a,h]	★★½	★★★	—	★	★★★
Earthworms [b,d]	★★★	—	★★★	★★★	★★★
Infiltration [b,e,i]	—	★★	★	—	—
Particulate Organic Matter [a,c]	★★★	★★★	★★★	★★★	★★★
Potentially Mineralizable Nitrogen [a,c]	★★★	—	—	★★★	—
Reactive Carbon [a]	★★	★	★★★	★★	★★
Slaking [b,e,i,j]	★	★★½	—	—	—
Soil Crusts [b,d]	—	★★½	—	—	—
Soil Electrical Conductivity [b]	—	★★★	—	—	—
Soil Enzymes [a]	★★★	—	—	★★★	—
Soil Nitrate [b]	★	★	—	—	—
Soil pH [b,d]	★★	★★★	★★★	★★★	—
Soil Respiration [a,b,c]	★★★	—	★	★★★	★★
Soil Structure and Macropores [b,d]	★½	★½	★	★	★★
Total Organic Carbon [a]	★★★	★★★	★★★	★★★	★★★

[a] laboratory/office method
[b] field method
[c] time consuming
[d] simple visual observation
[e] variability requires large sample number
[f] perhaps the most informative physical indicator
[g] important for drought prone areas
[h] important for weight to volume conversions, small sampling errors result in significant interpretation problems
[i] effective educational method
[j] qualitative