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Soil Quality Indicator: A Functional Measure of Soil

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INTRODUCTION

The idea of soil quality evolved in response to the growing emphasis on sustainable land use around the world, with a comprehensive approach that highlights the need for more than only controlling soil erosion for sustainable soil management. Basically, soil quality is the ability of a particular type of soil to sustain biological productivity, preserve environmental quality, and support plant, animal, and human health within an ecosystem and land-use boundaries. It is regarded as soil usefulness for a particular purpose over an extended period, which is comparable to intrinsic or static soil quality.

However, soil quality cannot be directly measured. Therefore, soil markers are used by scientists to evaluate the soil's performance. The process of evaluating soil quality entails determining which soil properties are susceptible to treatment, influence or correlate with current environmental outcomes, and can be correctly tested within particular technological and economical constraints.

IDEAL INDICATORS

Idea indicators should have the following characteristics:

- relate well to ecosystem processes
- integrate soil physical, chemical, and biological properties and processes
- be easily accessible to large number of users
- be components of existing databases
- be interpretable
- have expected or threshold values
- have low measurement errors
- be economical
- have community acceptance and involvement

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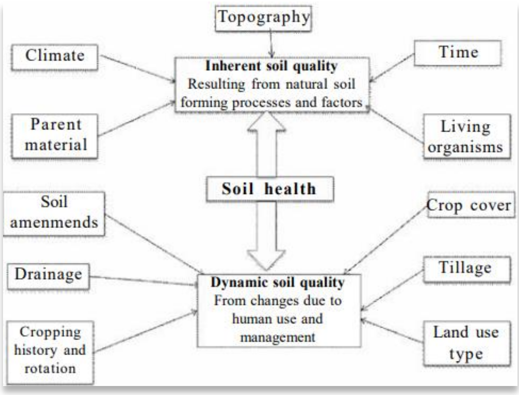
The indicators used or selected for different researchers in different regions may be different because soil quality assessment is purpose and site specific. However, while selecting the indicators, it is important to ensure that indicators should fulfil all relevant characteristics of an ideal indicator Inherent and dynamic soil qualities are the two separate but related components that make up a soil's quality. The majority of soil quality research focuses on how dynamic soil attributes function and alter in response to the soil's natural characteristics. Dynamic soil quality is influenced by management techniques, whereas inherent quality is related to genetic traits. There is interaction between the intrinsic and dynamic components of soil quality.



(Source: Padekar *et al*., 2018)

TYPES OF INDICATORS

There are four main categories of soil indicators: visual, chemical, physical, and biological indicators. Typical soil tests only consider chemical indicators. Soil quality attempts to integrate all four types of indicators. The categories do not individually aligns with the different soil functions, so integration is necessary.

Visual indicators: Plant response, weed species, decomposition, gullies, pounding, runoff, subsurface exposure, and changes in soil colour are examples of visual markers. These can be acquired through photographic interpretation or observation. The quality of the soil may be clearly threatened or changing based on visual evidence.

Chemical indicators: Plant health, the nutritional needs of plant and soil animal communities, the levels of soil contaminants and their availability for animal and plant uptake, and the balance between soil solution (soil water and nutrients) and exchange sites (clay particles, organic matter) can all be determined using chemical indicators. Soil response (pH), electrical conductivity, and soil nitrate are a few examples of common chemical indicators.

Physical indicators: Information regarding the hydrologic properties of the soil, such as water entry and retention, that affect plant availability is provided by physical indicators. Certain factors have an impact on rooting volume and aeration status, which relates to nutrient availability. Other metrics provide information on the state of erosion. Measures of bulk density, infiltration, slaking, aggregate stability, accessible water capacity, soil crusting, soil structure, porosity, etc. are examples of indicators.

Biological indicators: These indicators can provide information on the organisms that make up the soil food web and are involved in the nutrient cycle and organic matter breakdown. These indications include soil enzymes, total organic carbon, possibly mineralizable nitrogen, microbial counts, and particle organic matter.

METHOD OF SOIL QUALITY ASSESSMENT

The assessment of soil quality involves three main steps:

1. Selection of appropriate indicators for Minimum Data Set
2. Transformation of indicator values to scores
3. Integration of scores into index

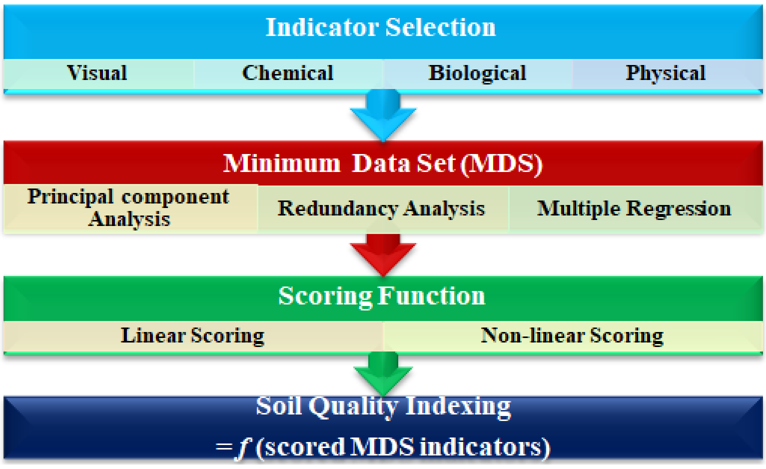


Fig1: Flowchart of Methodology for Soil Quality Assessment

CONCLUSION

Soil quality assessment is a crucial process for understanding the health, productivity, and sustainability of soil systems. It provides valuable insights into the soil's ability to function effectively in supporting plant growth, regulating water, cycling nutrients, and filtering pollutants. Key indicators of soil quality include physical (e.g., texture, structure, bulk density), chemical (e.g., pH, nutrient levels, cation exchange capacity), and biological properties (e.g., microbial biomass, soil respiration, enzyme activity). These indicators are selected based on the specific land use, climate, and soil type, and they reflect the dynamic nature of soil functions and processes. Various methods are used in soil quality assessment, ranging from field observations and laboratory analyses to advanced techniques such as remote sensing and soil quality indexing. Integrated approaches that combine multiple indicators and methods are increasingly favoured for providing a comprehensive evaluation of soil health. In summary, regular and systematic soil quality assessment is vital for ensuring long-term soil productivity, environmental protection, and food security.

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