A REVIEW ONSOIL QUALITY AND ITS POTENTIAL INDICATORS UNDER DIFFERENT LAND USE SYSTEM

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Abstract

A complex mixture of minerals, nutrients, organic matter, water, air, and living things. Soil is influenced by a variety of environmental factors including the climate, parent materials, relief, organisms, and time factors. The ability of a soil to work within an ecosystem's bounds in order to preserve biological productivity, uphold the quality of the air and water, and support human habitation and health is known as soil quality. At *all scales, from the individual plot to the national level, soil is sampled, analyzed, or visually inspected to determine its condition and potential for use. Due to the complexity and site-specificity of soils, the effects of historical land use, and trade-offs between ecosystem services, the selection of pertinent soil properties and the interpretation of measurements are not simple tasks. Here, we go over the definition, methods of evaluation, and choice and interpretation of indicators for soil quality and other related issues.*

Keywords: *Soil, pH,* Electrical conductivity, Plant available P, Bulk density,*Microbial biomass carbon*.

INTRODUCTION

A complex mixture of minerals, nutrients, organic matter, water, air, and living things. soil is influenced by a variety of environmental factors including the climate, parent materials, relief, organisms, and time factors.[1] Due to changes in terrain, climate, weathering processes, vegetation cover, microbiological activity, and other biotic and abiotic factors, soils' physio-chemical characteristics fluctuate across time and space.[2] Fertility loss is a significant factor in land degradation and a key barrier to increasing food security in underdeveloped nations.[3] The ability of a soil to work within an ecosystem's bounds in order to preserve biological productivity, uphold the quality of the air and water, and support human habitation and health is known as soil quality.[4] There are two components to soil quality: the intrinsic component, which refers to the soil's natural ability for crop growth, and the dynamic component, which is modified by the soil user or manager.[5]The impact of human usage and management on soil function results in dynamic soil quality.[6] A soil's physical, chemical, and biological characteristics are determined by its nutrient stocks and pools, which are influenced by land use and a number of other management considerations.[7] The global ecology, economic growth, and agricultural output have all been threatened by the degradation of soil quality.[8] Resulting from poor land use and soil management, unpredictable and erosive rains, steep topography, deforestation, and overgrazing. Soil deterioration has been mostly caused by the overuse of chemical fertilizers and pesticides in emerging nations like Nepal.[9] The multiple connections between soil functions and soil-based ecosystem services, together with the complexity and site-specificity of the underground component of terrestrial ecosystems, are all reflected in this description. In fact, soil compared to the complexity of air and water quality, quality is not simply due to the fact that soil contains solid, liquid, and gaseous phases as well as the fact that soils can be employed for a wider range of uses. When soil quality is assessed, this multi-functionality of soils is also defined as "the capacity of the soil" from an environmental perspective to encourage plant growth, safeguard watersheds by controlling the water and air penetration, precipitation partitioning and by absorbing potential pollutants such industrial chemicals, organic waste, and agricultural chemicals.[10-11] Improve the quality of the water and air, support human health, and dwelling. Typically, it is said to have three major physical, chemical, and biological elements of soil preparation and is crucial for determining the extend of land degradation also to identify sustainable land use techniques.[12] Soil quality means a certain type of soil’s ability to work within the natural or managed boundaries of an ecosystem, support plant and animal productivity, maintain or improve the quality of the water and air, and support human health and habitation.[13] The quality of the soil directly affects agricultural production, and crop yield decreases as soil quality declines. It’s critical to maintain soil quality not just for agriculture sustainability, but also for the preservation of the environment. Mechanisms to track soil quality changes are crucial if the management of the soil/crop system must be improved through the work of soil scientists.[14] Integration of numerous parameters, including physical, chemical, biological, and enzymatic activity, can result in a more accurate and superior soil assessment. These elements ought to be combined in order to serve as indicators of soil quality analysis.[15] Evaluation of soil quality is crucial because soil contributes to the production of food, fibres, and the preservatives of environment quality.[16] Understanding the relationship between a soil indicator and a soil function is crucial for the accurate assessment of soil quality. These relationships are important to assess whether changes in a soil indicator imply an improvement or declines in a soil function, as well as to determine whether it is important to take note of changes in an indicator's value over time or between treatments. Numerous strategies exist for evaluating the markers of soil health and soil functioning. The soil function index is one useful tool for linking soil indicator measures to soil performance. [17] The physical, chemical, and biological characteristics of the soil defines its quality, but soil enzymes are determinants of soil fertility. There are several enzymes' sources in the soil, including plants and animals as well as microbes. Enzyme is typically linked to living cells, however they can discharge by dead cells into the soil's liquid solution. The solution's included enzyme either take up humic acid to form a compound with it or things made of clay. It is known that soil-based enzymes play a role in biochemical activity and nutrient recycling.[18-19] Practically speaking, soil quality can be used to assess the effects on crop output, erosion, ground and surface water status and quality, as well as food and air quality.[20] Under various farming settings, soil quality assessments have been made, including: tillage and residue management, crop rotation, application of biochemical properties, manure application and impact of village machinery traffic on the condition of the soil near mining locations. Several minimum data sets have been suggested at various scales in several literary works.[21-22]

COMPONENTS OF SOIL

pH – Because of its effect on nutrient availability (e.g. P amd Zn) and both toxicities (e.g. Al or Mn) and deficiencies (e.g. Mn, Fe, and Zn), ammonification and nitrification processes, microbial habitat, and plant root growth and development. Soil pH is also a good indicator of the attention being given to effects of management practices such as the use of ammonium fertilizers, liming, and animal manure application.Electrical conductivity (EC) – has generally been associated with determining soil salinity, but it can also serve as a measure of soluble nutrients – both cations and anions (Smith and Doran, 1996). Within a specific range, EC can be used to indicate the status of nutrient availability for plants, with the low end indicating nutrient poor soil that is structurally unstable and disperses readily. High EC values often reflect poor plant growth conditions and the potential for salinity problems.[23]

Plant available P It is important because of it role in supporting plant growth, but must also be monitored to ensure that it does not become an environmental hazard if surface runoff occurs. Management practices can influence available P through fertilizer and animal manure applications as well as by maintaining a near neutral pH.[24]

Nitrate-N (NO3-N) – reflects the residual effects of a many practices including crop rotation, fertilization strategies, and use of animal manure. It provides insight regarding the potential for leaching and contamination of groundwater or surface water and for release of nitrous oxides (NOx) emissions.[25]

Microbial biomass carbon – provides a measure of the biological activity within a soil. It reflects nutrient cycling processes that are essential for meeting crop growth. It is also influenced by management practices such as tillage intensity, crop type (annuals versus perennials) and crop residue management strategies.

Bulk density (BD) – defined as the mass of dry soil per unit volume is an important soil quality indicator because of its potential effects on plant root development, exploration, and thus the volume of soil that each plant can draw upon to meet their water and nutrient needs.[26] Soil quality means a certain type of soil's ability to work within the natural or managed boundaries of an ecosystem, support plant and animal productivity, maintain or improve the quality of the water and air, and support human health and habitation.[27]
The quality of the soil directly affects agricultural production, and crop yield decreases as soil quality declines. It's critical to maintain soil quality not just for agriculture sustainability, but also for the preservation of the environment. Mechanisms to track soil quality changes are crucial if the management of the soil/crop system must be improved through the work of soil scientists.[28]

Integration of numerous parameters, including physical, chemical, biological, and enzymatic activity, can result in a more accurate and superior soil assessment. These elements ought to be combined in order to serve as indicators of soil quality analysis.[29]
Evaluation of soil quality is crucial because soil contributes to the production of food, fibres, and the preservatives of environment quality.[30]

Understanding the relationship between a soil indicator and a soil function is crucial for the accurate assessment of soil quality. These relationships are important to assess whether changes in a soil indicator imply an improvementor declines in a soil function, as well as to determine whether it is important to take note of changes in an indicator's value over time or between treatments. Numerous strategies exist for evaluating the markers of soil health and soil functioning. The soil function index is one useful tool for linking soil indicator measures to soil performance.[31]

The physical, chemical, and biological characteristic of the soil defines its quality, but soil enzymes are determinants of soil fertility. There are several enzymes' sources in the soil, including plants and animals as well as microbes. Enzyme is typically linked to living cells, however they can discharge by dead cells into the soil's liquid solution. The solution's included enzyme either take up humic acid to form a compound with it or things made of clay. It is known that soil-based enzymes play a role in biochemical activity and nutrient recycling.[32-33]
Practically speaking, soil quality can be used to assess the effects on crop output, erosion, ground and surface water status and quality, as well as food and air quality.[34]
Under various farming settings, soil quality assessments have been made, including: tillage and residue management, crop rotation, application of biochemical properties, manure application and impact of village machinery traffic on the condition of the soil near mining locations. Several minimum data sets have been suggested at various scales in several literary works.[35-36]

2. PARAMETERS & PROCEDURE:

1. pH: - pH is master varying in soil as it manage various processes like chemical and biochemical processes running within the soil. In agriculture determination of soil pH is very essential because it manage nutrients accessibility by controlling chemical forms of various nutrients and also affect their chemical reactions. pH of soil is determined by using pH meter.[37]

PROCEDURE

1. Weigh 1g fine soil into 100ml beaker.
2. Add 50mlNaF 1M .
3. Stir suspension for 1 minute with glass rod.
4. Immerse electrode in upper part of suspension.
5. Continue stirring and read pH exactly 2 minutes after adding NaF solution.[38]

2. MOISTURE CONTENT:In soil, water is held inside the pores of soil. Soil water is main constituent of soil for the growth of plant. For plant growth if the soil moisture content is important, plant caneasily absorb soil water. Soil analysis is done on the basis of oven dry soil.[39]

PROCEDURE:

1. Transfer approx. 5g of fine soil to a tared moisture tin, then weigh it precisely at 0.001g (A gram)
2. Dry & 105degree C overnight (lid removed)
3. Tin should be taken out of the oven, covered, cooled in a desiccator, and weighed (B gram).

FORMULA:

MOIST. (weight %) = A-B / B- tare tin * 100[40]

3. **CHLORIDE**: For the soil fertility chlorine is essential and it also provide nutrient for crops. An excessive amount of the chlorine anion (Cl^-) is frequently accumulated in soils as a result of human activity, either directly through the application of animal wastes that are typically high in Cl^- or indirectly through atmospheric depositions from commercial and municipal sources. A surplus of Cl^- in environment can reduce the fertility of the soil and poison crops, reducing the amount of land that can be used for agriculture.[41]

PROCEDURE:

1. Pipette an aliquot of the sample (often 5 ml) into a 100 ml beaker, then diluted it with distilled water to make 50 ml.
2. Set the instrument's Cl^- measuring parameters, then titrate the sample with an AgNO3 solution to the desired result (70 mv)
3. Titrate 50 ml of distilled water as a blank for every set of samples.

CALCULATIONS

Cl^-(meq/L) = (Vs –Vb) * N * 1000/aliquot of sample (ml)

Vs= ml of AgNO3 used to reach endpoint of sample

Vb = ml of AgNO3 used to reach endpoint of blank[42]

N = Normality of AgNO3

4. CARBONATE: Many semi-arid regions have carbonated soils. Where lithogenic and secondary carbonates play a significant role in the mineral matrix of the soil. Due to chemical stabilization mechanism, the presence of CaCO3 in calcareous soils has been identified as an agent for stabilising organic matter. The significance of CaCO3 on soil physical features was underlined in two recent studies in the north of spain because it was found to operate as a stabilising agent for macroaggregates.[43]

PROCEDURE:

1. Pipette an aliquot (often 5ml) of the sample into a 100ml beaker, then add distilled water to make it to 50ml.
2. Test the instruments calibration by submerging an electrode in pH buffer 7.0, then in pH=4, rinse electrode.
3. Place an electrode inside a sample, titrate it, and note the amount of titrant that was applied reach the pH 89.3 and pH 4.5 endpoints that have been specified.
4. Titration is performed on a blank using 50ml of distilled water.

CALCULATIONS:

$$CO_3^{2-} \text{ (meq/L)} = 2P*N*1000/\text{aliquot of sample (ml)}$$ [44]

5. ORGANIC MATTER: Organic component of soil is soil organic matter and it comprises of organic material from plants and animals and material that has been transformed by microorganism at different stages of decomposition in soil. In forestry and agricultural production organic matter of soil has primary benefit. Diseases that are transmitted through the soil can be prevented and treated more effectively in healthy soils with consistent amount of soil organic matter. Organic material in soil has a essential component of improving fertility and quality of soil.[45]

PROCEDURE:

1. Soil sample is passed through through a sieve 0.5mm and 0.50g soil is weigh out into a 500ml Erlenmeyer flask.
2. 10ml of 1N $K_2Cr_2O_7$ solution is added and swirl the flask to gently disperse the soil in the solution.
3. Add 20ml of concentrated H_2SO_4 rapidly swirl for 10 seconds. Let cool uniformly to room temperature, at least 20 min .
4. Dilute to approximately 150 ml with distilled water and add 10 ml of concentrated H_3PO_4. The addition Of H_3PO_4 is optional and the OSUSTL omits this step for routine.
5. Add 6 drops of O-phenanthroline indicator to the solution. Titrate with the ferrous ammonium sulfate solution (FAS) until the color changes from yellow or yellow-green to blue to finally a reddish brown endpoint. Record the volume (mLs) of FAS used to reach the endpoint.
6. Analyze a blank simultaneously following steps 2-5.

CALCULATIONS:

Calculate the percent organic matter as follow:

%OM = (Blank reading) * 13.6/blank

Calculate the percent organic carbon as follow:
%OC = %OM * 0.58[46]

6. BORON: For physiological functioning ofhigher plants boron is a crucial trace element. Boron deficiency is regarded as a nutritional disease that negatively impacts plant growth and metabolism. Boron is involved in the ion fluxes (H^+, K^+, Rb^+, Ca^{2+}) across the membranes, cell division and carbohydrate metabolism , sugar transport , cytoskeletal proteins, and plasmalemma - bound enzymes, as well as the metabolism and transport of nucleic acid, indoleacetic acid polyamines, ascorbic acid, and phenol the roles of B in plants ,symptoms of a B shortage, and the mechanism of B absorption and transport under low B conditions are all rigorously examined in the review. B insufficiency can be treated with inorganic fertilizers addition, however repeated fertilizer use has negative effects.[47]

PROCEDURE:

1. 15g of soil weigh and scoop into a sealable plastic bag(heat sealed boilable bags or ziplock freezer bags work). 30nl of $CaCl_2$ extracting solution is added.
2 . Place plastic bags into boiling water and leave for 10 min.
3. Remove plastic bags, let cool to room temperature and by using Whatman No.42 and equivalent filter paper the content is filtered.
4. 4.0ml of soil extract is pipette into a 12ml polyethylene sample vial.
5. Add 1ml of buffer masking agent and vortex.
6. 1ml of azomethine -H solution and vortex is added. Allow color to develop for at least 1hr. but no longer than 3hours.
7. Prepare standard curve following steps 4-6, substituting 4.0ml of standard work solution for soil extract. A blank is prepared in the same manner using 4.0ml $CaCl_2$ extracting solution instead of the soil extract.
8. For samples with a yellow extract. Prepare a second sample solution and blank. Add 1.0ml of distilled water. The blank for this determination consist of 5.0ml $CaCl_2$ extracting solution and 1.0 ml buffer masking agent.
9. read all colour intensities on a spectrophotometer set at 420 nm. Read immediately after vortexing.

Calculation

ppm B in soil = (ppm B extract – ppm B in yellow extract) *2[48]

7. PHOSPHORUS: One of the most important soil mineral for plants is phosphorus. It is a component of plant cell and is crucial for cell division and the progress of the plant growing tip. It is essential for young plants and seedlings. It is connected with complex energy transformation in plants. When phosphorus is added to phosphorus deficient soil, it encourages root development and winter hardiness, stimulatetillering and frequently accelerates maturity. Phosphorus- deficient plants develop slowly and frequently have an unusually dark green colour. Thus phosphorus is essential for general health and vigor of all plants.[49]

PROCEDURE:

1. 5g fine earth (accuracy 0.01g) is weigh and add into a 250ml polythene shaking bottle which include two blanks and a control sample.
2. 100ml extracting solution is added.
3. Shake it for 30 minutes.
4. Filter the solution by using Whatman 42 filter paper.
5. Pipette out 3ml of standard series in test tube.
6. Add slowly 3ml of mixed reagent with the help of pipette.
7. Allow the solution to stand for atleast 1 hour to develop blue colour.
8. Measure absorbance on spectrophotometer.

CALCULATION

Plot a calibration graph of absorbance against P concentration.

P(mg/kg soil) = (a-b) *100/1000 * 1000/s * mcf = (a-b) * 100/s * mcf

a = mg/l P in sample extract

b = ditto in blank

s = sample weight in gram

Mcf = moisture correction factor [50]

Conclusion: Soil is a complex mixture of minerals, nutrients, organic matter, water, air, and living things. Soil is influenced by a variety of environmental factors including the climate, parent materials, organisms.The general condition of the soil under various land uses was highest under agricultural land use, followed by forests and non-arable areas, and samples taken from non-arable terrain and afforested forests.This study indicates the various parameters of the soil regarding the soil fertility which includes Ph of soil, moisture content, organic matter, chlorides, nitrogen, phosphorus or boron etc and various standard procedures were followed for the assessment of the following parameters. The management of soil health requires an integrated approach that takes into account the physical, biological, and chemical processes in soils.

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