



ANALYSIS OF PHYSICO-CHEMICAL PROPERTIES OF WETLAND SOIL IN BHANDARA DISTRICT (M.S.)

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Communicated: 25.10.2025

Revision: 28.10.2025 & 16.11.2025
Accepted: 27.11.2025

Published: 30.01.2026

ABSTRACT:

Soil is the uppermost layer of the earth. Soil is a blend of minerals, nutrients, organic matter, air, water, and microbes. Nevertheless, human activities have caused a great deal of damage to the natural resources of the soils. All man-made activities like domestic and industrial waste, agriculture, transportation, etc., are harmful to the quality of soil. Soil pollution has multiple causes, and one of them is the various human activities. Therefore, as part of this study, soil samples were taken from the specified washes to study their physical and chemical characteristics. Six soil samples were collected from a different location in the Bhandara district. The quality of soil is the most important factor that determines the productivity of wetlands and the sustainability of the environment; therefore, it is necessary to evaluate its properties for proper land use and management. The research brings together and synthesizes studies on textures, structure, humidity content, bulk density, and porosity of the soil and also on important chemical parameters such as pH, electric conductivity (EC), Organic Carbon (OC), Nitrogen (N), Phosphorus (P), Potassium (K), and micronutrients (Cu, Fe, Zn, Mn). Propagation of this methodological framework intends to reflect on the research through a detailed study of the soils of Bhandara District regarding their physical and chemical properties, possibly giving hints for better soil health and further sustainable development. The paper emphasizes the distinction in soil properties as per the type of land use and the studied geographical area.

Keywords:- Ecology, Soil, Agricultural, Fertility, humidity, declination

INTRODUCTION:

India's geographical diversity leads to the country experiencing a wide range of climates, vegetation, landforms, and relief features. Such variation has resulted in the evolution of different types of soils in various parts of the country. Soil is the topmost layer of earth. Soil contains minerals, nutrients, organic matters, air, water and microbes. As an agriculture-dominant nation, the success of Indian farming is closely linked to soil health. The physical makeup of soil generally includes 45% minerals, 25% air, 25% water, and about 5% organic matter, although this composition can vary depending on regional and environmental factors. Soil contains particles of different sizes and being the largest, followed by silt and clay which collectively influence its texture, porosity, and water-holding capacity. Other important characteristics include

soil temperature, structure, and color, pH all of which affect its Wetland potential. Wetland soils, also called hydric soils, are different from upland soils because of prolonged saturation or flooding that creates anaerobic conditions. These conditions impact soil chemistry and microbial activities differently than a typical upland soil and create unique activities such as iron, manganese and sulphur compound reduction (Trettin et al., 2020). Hydric soils serve as a nutrient reservoir and are also the most important medium for storing and transforming carbon, nitrogen, and phosphorus. Organic carbon accumulates in marsh soils because decomposition is very slow under anaerobic conditions; wetlands are thus among the most efficient natural carbon sinks in the world (Verry, 2018). Nutrient-dense wetland soil is a major contributor to the rich diversity of



life; it especially aids the proper application of dung and it cuts down the negative effects of petroleum chemical usage to a minimum (ICAR, 2011). The wetland soil is rich in N, P, and K, which are the main nutrients of the soil and their presence or absence determines quite a bit about the soil fertility, which in turn controls the development and production of the plants. Soil quality is a factor that directly affects productivity, sustainability, and health of the ecosystems in wetlands.

Soil testing that includes pH, electrical conductivity, organic carbon, and NPK reveals the status of nutrient cycling and ecosystem productivity, Soil testing is thus a very important avenue that links agricultural science to its practical application in the field. The nutrient management plans that are prepared considering soil tests are effective in obtaining the expected crop growth along with soil fertility conservation in the long run. The district is characterized by an assortment of topography and soils that are formed by the interplay of local geology, rainfall pattern, vegetation, and land use history. Among the soils of Bhandara, a wide spectrum of soil types is represented, ranging from black soils with high clay content to red and lateritic soils of varying drainage capacities. Such variations have an influence on the soil's capacity to support the growth of different plant types and they also affect other critical factors such as nutrient retention, water availability, and root penetration. The global interest and discussions around the concepts of soil health and quality have progressively expanded (Karlen et al. 2001). The primary goal of this research is to assess the nutrient composition of soil samples from various regions in Bhandara District.

The aim is to examine both the physical (such as texture, bulk density, moisture content, and structure) and chemical properties (including soil pH, electrical conductivity, organic carbon, and essential nutrients like nitrogen, phosphorus, potassium, and trace elements such as zinc, iron,

copper, and manganese). Physical and physico-chemical characteristics are generally useless because they only change when the soil experiences a significant change (Filip 2002). Conversely, biological and biochemical characteristics are susceptible to the minute changes that any degrading agent might bring about in the soil (Nannipieri et al. 1990). Therefore, biological and bio-chemical characteristics must be considered as crucial indicators whenever the overall sustainability of soil natural functions and its many applications need to be assessed (Gil-Sotres et al. 2005).

In addition to proper soil strength or density, sufficient soil air and water storage capacity are necessary for healthy root development and function. Near-surface air-filled soil pore space, or air capacity, should be at least 0.10 to 0.15 m³ m⁻³, according to extensive research conducted over the past 30 years (Cockroft and Olsson 1997). By evaluating these parameters, the research provides insight into the current state of soil quality and highlights areas of nutrient deficiency or excess. Fertilizer overuse will be prevented thus supporting long-term sustainability along with environmental impacts issue reduction. To summarize, the research has provided an insight into soil health in Bhandara district, which serves as a basis for targeted nutrient management and wetland soil quality improvement that coincide with the tenets of sustainable land use and resource conservation.

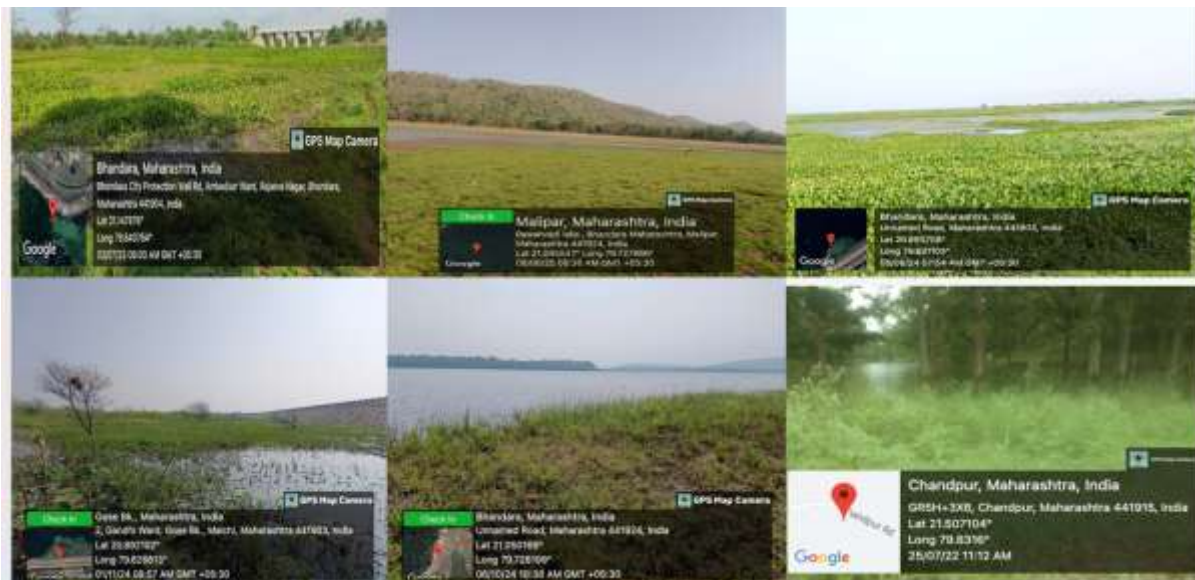
MATERIAL AND METHODS:

Study area: The Bhandara District of eastern Maharashtra is an important area of the Vidarbha region, which is characterized by its unique physiography, diverse wildlife, and extensive wetlands. The district stretches from north to south between the latitudes of 20°39' and 21°37' and from east to west between the longitudes of 79°27' and 80°14'. This district enjoys a very good location in the fertile plains of the Wainganga River basin. Its location at the intersection of riverine ecosystems, agricultural lands, and forested hills

makes it an ecologically sensitive area, hence ideal for the study of water, soil, and plant interactions. (India, 2011).

A comprehensive soil sampling program was carried out from January to April 2024 over six wetland sites situated in the Bhandara district of Maharashtra. The chosen wetlands had been selected so that they would serve as a very good representation of the various ecological conditions prevailing in the region. Soil samples were taken from the upper soil profile, specifically from the 0.5 cm to 15cm depth range, where the most biologically active and nutrient-dynamic layer is

located. The purpose of the sampling was to determine the physicochemical properties and possibly the ecological variations among the wetland soils with time. Standard operating procedures were adhered to, to the letter, in order to secure the proper paraffin and coating of the sample throughout the process, and the tagging was done according to laboratory analysis (Petersen,1994; Choudhari et. al., 2023; APHA 2017). The data collected will aid in understanding the state, nutrient levels and ecological roles of the soils in the wetland area.



1. Fig. Study site: Bhandara(W1), Rawanwadi (W2), Chandpur(W3), Pauni(W4), Vahi(W5), and Gose Dam (W6)

Physical Parameters: The soil samples collected from different study sites were observed and analysed to study the physical characteristics using different parameters such as

- Soil texture (Sandy soil, Clay soil, silt soil)
- Soil structure (Aggregate)
- Bulk viscosity (less pores space and high pores space)

Chemical Parameters: For chemical sample, the exploration focuses on parameters that impact soil quality and factory nutrition, including

- pH (acidity or alkalinity)

- Electrical conductivity (EC) (soil saltiness situations)
- Organic Carbon (indicating soil health and fertility)
- Nitrogen(N), Phosphorus(P), and Potassium(K)
- Micronutrient- Cu, Fe, Zn, Mn.

Research was conducted on the different sites in the Bhandara district based on the nutrient and physicochemical parameters similarities and differences to spatial variations effects.

The fieldwork of the research was carried out during the Pre-monsoon and post-monsoon periods. The samples were analyzed using different

instrumentations. The first chemical sample analysis was done through pH and EC digital measurements. The concentration of the micronutrients was analyzed using an extremely sensitive immersion Spectrophotometer. Moreover, a GPS device was employed to record and keep track of the exact locations in the field. All laboratory methods were in accordance with the Indian standards (BIS) and the guidelines of the American Public Health Association (APHA, 2017).

3. RESULTS AND DISCUSSION:

The soil samples were taken at six various locations: (W1), (W2), (W3), (W4), (W5), and (W6) to conduct this study. Through this research, the condition of the specified soil was determined by scrutinizing several parameters or properties of the soil such as pH, electrical conductivity (EC), Organic carbon (OC), Nitrogen, Phosphorus, Potassium, and Micronutrients-Cu, Fe, Zn, Mn.

Sr. no.	Parameters	Good Quality	W1	W2	W3	W4	W5	W6
1	PH	6.5-7.5 Ph	6.82	5.39	6.35	7	6.88	7.4
2	EC	0-1 1 dS/m	0.3	0.22	0.41	0.4	0.25	0.43
3	OC	0.40-0.60 %	1.3	0.57	0.54	0.66	0.35	0.74
4	Nitrogen	280-420 kg / He	205.72	227.05	235.83	180.41	249.63	189.41
5	Phosphorous	14-21 kg /he	9.69	0.69	6	4	2.54	3
6	Potassium	150-200 kg/He	389.76	255.36	161.28	413.2	416.64	403.2
7	Cu	0.20-99.99 PPM	1.98	1.67	0.88	0.67	0.62	0.77
8	Fe	4.5-99.99 PPM	7.04	7	18.74	2.21	1.97	2.33
9	Zn	0.61-99.99 PPM	0.64	0.57	0.48	0.39	0.46	0.49
10	Mn	2.0-99.99 PPM	17.69	4.7	2.68	8.44	3.16	9.34

The pH values that were measured in all the samples varied from slightly acidic to neutral, which suggests that the nutrient availability was good. The soil at (W2) showed a highly acidic pH (5.39) that could limit the availability of nutrients, especially that of phosphorus, thus making the corrective measures hard to implement. The electrical conductivity (EC) levels were low and below 1 DS/m across all the sampled sites. This shows that the soils are non-saline and hence suitable for growing most plants without stress. Concerning organic carbon, which is essential for increasing soil fertility and biological activity, the values showed significant variability. (W1) displayed a high organic carbon content (1.3), pointing to excellent organic matter presence, while(W5) (0.35) showed slightly lower

content than the asked minimum, indicating the need for organic enrichment.

In studied, found that nitrogen content was lower in all areas. W3 and W5 had more nitrogen amount that is why need to increases nitrogen amount. Phosphorous level extremely low in all sampling sites, particularly at W2 and W5. As Phosphorous is an essential element for growth and development. Potassium content was significantly higher than required amount in all sites with W5 and W6 showing extremely high K+ content that causes imbalance Nutrient content. The concentration of copper was adequate everywhere. The iron content in W4 and W5 was below the required level, which resulted in the plants getting chlorosis and thus slowed down in their growth and development. The zinc present

is barely enough and thus leads to zinc deficiency. The magnesium level is good while W1 and W6 have plenty of mg.

The soil samples obtained from sites W1, W2, W3, W4, W5, and W6 showed significant variations in their physical and chemical properties. The soil pH of the majority of the sites was in the range which is believed to be best for the growth of agricultural crops, which is generally between 6.5 and 7.5. However, soil from W2 was very acidic with a pH of 5.39, which could affect the nutrient availability and thus corrective treatment of the soil may be required. Electrical conductivity of all soil samples was low, well below 1 DS/m, which supports the conclusion that the soils are free from salinity problems and can support healthy plant growth without the risk of salinity. Organic carbon content was notably different between the samples taken from the different sites. Soil from W1 contained high organic carbon (1.3%), which indicates good soil conditions. Nitrogen levels were usually low in all locations. Although W3 and W5 had relatively better nitrogen concentrations, none of the locations met the required nitrogen content for vigorous plant growth. Phosphorus availability was extremely low in all soils, with the most severe deficiency at W2 and W5. Potassium content was relatively high in all samples compared to the recommended levels, but W5 and W6 had particularly high potassium concentrations, which means no immediate need for potassium fertilization. W4 and W5, which may result in chlorosis and reduced photosynthesis in plants. Zinc content was low at all sites, indicating a widespread deficiency of this micronutrient. Manganese content was different among soils; W1 and W6 had more manganese than W3 soil.

CONCLUSION

The physicochemical properties of the soil sample taken from the six-wetland site (W1-W6) were

analyzed, and it was concluded that the majority of the samples were within the significant pH range, and salinity was not an issue. However, the soil was lacking in several essential nutrients. Organic carbon was found in W1 in sufficient quantity, whereas W5 had very little. All wetland sites showed Nitrogen deficiency and low Phosphorous levels which points out the necessity for nutrient improvement. Potassium was found to be in excess at all the sites of the study, which indicates that the addition of K fertilizer is not necessary. The deficiency of Micronutrient Zinc and Iron was quite noticeable while Copper content remained in the suitable range. Soil quality was poor overall because of the nutrient deficiencies, and thus, better management in terms of nutrient addition would be required in terms of organic matter, micronutrition, pH correction, and adjustment in the acidic areas like W2 to support healthy plant growth and improve soil quality.

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