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Analysis of Soil Salinity Distribution in the Wonorejo Mangrove Botanical Gardens, Surabaya

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Abstract

Environmental factors, particularly salinity conditions, influence the function of mangrove forests. Salinity plays a crucial role in the growth, resilience, and zonation of mangrove species. Therefore, it is essential to analyze salinity levels. This study aims to assess salinity levels to determine their effect on soil fertility and to evaluate the influence of the distance from salinity sources in the Wonorejo Mangrove area. Soil sampling was conducted at distances ranging from 5 meters to 60 meters from the riverbank, along three designated paths: J1 (first path), J2 (second path), and J3 (third path). Both composite and intact soil samples were collected. Composite and intact soil samples were taken at intervals from 5 to 60 meters from the riverbank, with each path containing two sampling points, resulting in a total of six sample points (T1, T2, T3, T4, T5, T6), each repeated three times. The observed parameters included soil pH, electrical conductivity (EC), soil permeability, soil texture, cation exchange capacity, and organic carbon content. The results of the chemical and physical analyses of the mangrove forest soil samples indicate that salinity levels range from high to very high. This finding is evidenced by the lowest EC value recorded in soil sample T3U3, which was 15.9 dS/m, indicating high salinity.

Keywords: Chemical Property Analysis, Mangrove Forest, Physical Property Analysis, Salinity, Soil Science

1. Introduction

Mangrove forests are coastal ecosystems that play a vital role in the environment, providing important ecological, biological, tourism, economic, educational, and research functions (Khambali et al., 2020). Salinity variations in waters far from river mouths are relatively small compared to those near the coast, especially when river water inflow occurs. Changes in salinity do not directly affect the chemical properties of seawater. However, salinity can increase due to seawater intrusion, leading to excess soil salt, irrigation with water high in dissolved salts, and high evaporation rates despite low rainfall (Atamimi & Sugiyarto, 2022). This study aims to determine the level of soil salinity in the vicinity of the Wonorejo Mangrove Botanical Garden in Surabaya. Other functions include trapping sediment, protecting nearshore water quality, protecting the shoreline, providing fish and wildlife habitat, and stabilizing mudflats.(Setiawati, 2019)

This research was conducted to analyze salinity in the Wonorejo Surabaya Mangrove Botanical Garden by measuring soil salinity levels in the surrounding area. The study involved selecting sample points, conducting observations, and applying chemical treatments to improve soil salinity and fertility within the forest. The primary objectives of this research, titled "Soil Salinity Levels in the Wonorejo Surabaya Mangrove Botanical Garden," are to assess the presence of salinity in the garden, quantify soil salinity levels in the surrounding area, and identify strategies to improve soil salinity conditions around the Wonorejo Surabaya Mangrove Botanical Garden.

2. Material and Methods

Soil sampling and ongoing research were conducted in the mangrove conservation area along the east coast, specifically in the mangrove forest area of Wonorejo sub-district, Surabaya City. The Mangrove Ecotourism is located on Jl. Wonorejo Timur No. 1, Mangrove, Rungkut, Surabaya City, East Java, with an area of 700 ha. Wonorejo Mangrove

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Ecotourism is included in the East Coast Area of Surabaya, which is located at coordinates 7°15'19.60" South Latitude - 7°17'13.25" South Latitude 112°48'35.69" East Longitude - 112°48'40.72" East Longitude with a land area of ± 2,503.9 Ha.

The source of these maps is aerial photographs of the research location at three points, obtained from Google Earth, and the RBI map of Wonorejo sub-district at a scale of 1:25,000. The equipment needed for the field survey is an aerial photograph of the research location at three points: from the river bank, away from the river bank, and towards the land. Meanwhile, soil sampling starts at a distance of 5m from the riverbank to 20m. At each sampling point, intact soil samples were collected using a cylindrical ring at a depth of 00-30 cm.

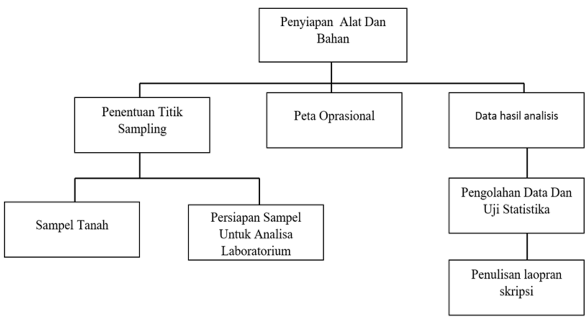

Figure 1. Research flow diagram

The tools used in this research include: (1) Soil sampling starting at a distance of 5m from the river bank to 60m away from the inland river bank with a distribution of soil sampling paths, namely J1 (first path), J2 (second path), and J3 (third path). Soil sampling was carried out in a composite and intact manner. Composite soil sampling was carried out by crossing at a distance of 10m from the intact soil sample.

Soil sampling was carried out 60m from the inland river at 6 points (T1, T2, T3, T4, T5, T6), divided into 3 observation lines, with each observation line consisting of 2 soil sample points, and each soil sample point was collected 3 times. At each sample point, intact soil samples were collected using a cylindrical ring at a depth of 0-30 cm.

Soil samples were then surveyed using GPS to determine the distance between the sample points and the coastline or river, which is the boundary between land and sea during high tide. The coastline was determined based on data available on the Indonesian Topographic Map (RBI) for the region.

3. Results and Discussion

3.1. Soil pH Value

The degree of acidity or soil reaction (pH) indicates the level of acidity and alkalinity expressed in pH values. The results of the soil pH analysis at the research location are shown in the following graph (Figure 2).

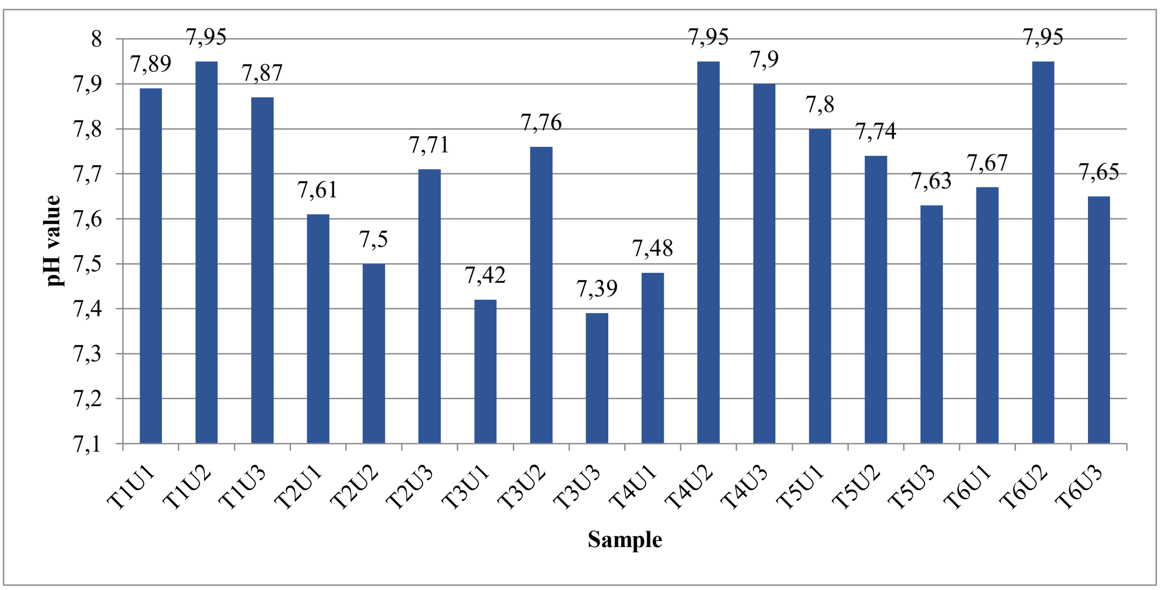

Figure 2. Soil pH Analysis Graph

The soil pH at the research site was neutral to slightly alkaline. The lowest pH was observed in soil sample T3U3 (7.39), which falls within the neutral pH range. This finding is because the T3 sample was taken quite far from the river, which is the source of salinity. According to Arigowo et al. (2021), the distance from the salinity source significantly influences pH. A high pH value indicates saline soil, which can lead to less fertile soil conditions.

The concentration of ions (salts) contained in plants can create a natural flow of water from the soil to the roots of plants, and when the soil is saline, it can inhibit the movement of water from the roots of plants, resulting in water being drawn back into the soil so that the plants cannot take up enough water. Osmotic pressure can increase if the concentration of dissolved salts in the soil increases. This problem can hamper nutrient and water absorption, reducing the amount entering the roots and depleting nutrient and water supplies in the plant (Muliawan et al., 2016).

3.2. Electrical Conductivity (EC)

Soil salinity levels based on Electric Conductivity (EC) values are divided into 5 categories, namely non-saline (EC = 0 - 2 dS/m), low (EC = 2 - 4 mS/m), moderate (EC = 4 - 8 mS/m), high (EC = 8 - 16 mS/m), and very high (EC = >16 dS/m) (Tolib et al., 2017). The results of the Electric Conductivity (EC) analysis at the research location are shown in the following bar chart (Figure 3).

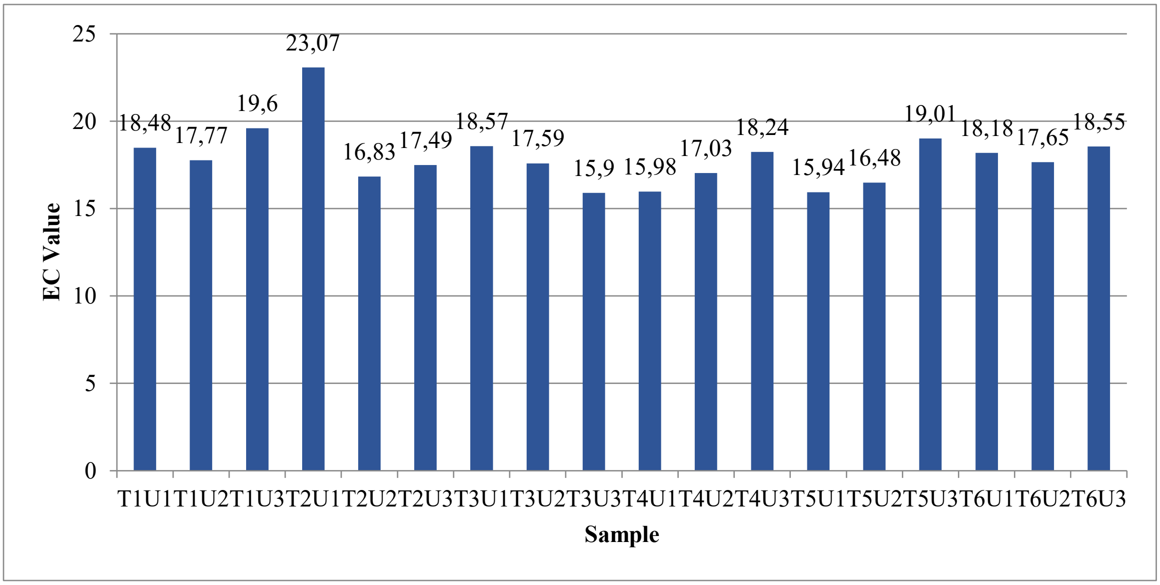

Figure 3. Electric Conductivity (EC)

3.3. Permeability

The lowest permeability was observed in the T1U2 treatment, with a value of 0.03 cm/hour, which falls into the slow class. The low permeability is thought to be due to very small pore spaces or pore sizes in the soil. According to Mulyono et al (2019), soil pore size can determine whether the soil has low or high permeability. Very small soil pores, such as those in clay, can exhibit permeability values close to zero and fall into the slow classification.

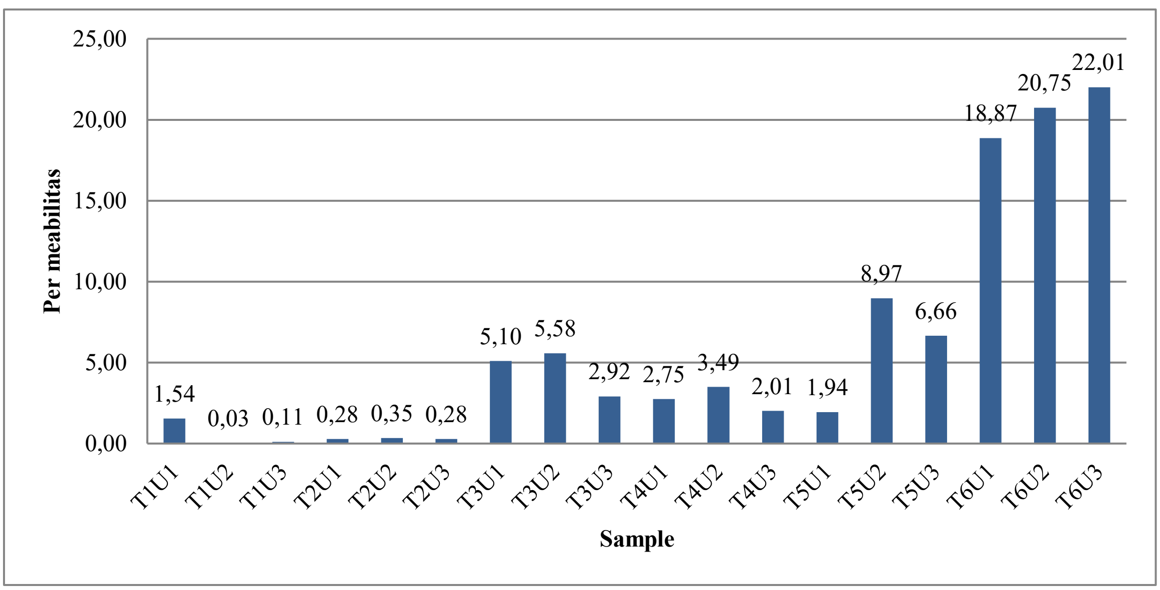

Figure 4. Permeability Results

3.4. 4.4 Soil Texture Analysis

Samples T1 and T2 are predominantly clay fractions, with percentages above 50%, so the texture test indicates they have a clay to dusty clay texture. Sample T3 is predominantly a higher dust fraction, so the T3 texture test shows a dusty clay texture. Soil samples T4 and T5 have a fairly high dust percentage, averaging around 70%, with 30% clay, giving them a dusty clay texture. For sample T6, the dominant clay fraction is up to 65%, indicating a clay texture.

Table 1. Soil Texture Analysis of Mangrove Garden Soil Samples

No	Sample Code	% fraction			Texture
		sand	dust	clay	
1	T1U1	1	30	69	Look
2	T1U2	1	48	51	Dusty Look
3	T1U3	1	2	98	Look
4	T2U1	3	30	67	Look
5	T2U2	1	56	43	Dusty Look
6	T2U3	6	11	83	Look
7	T3U1	1	60	39	Dusty Look
8	T3U2	1	58	41	Dusty Look
9	T3U3	2	56	42	Dusty Look
10	T4U1	4	74	22	Dusty clay
11	T4U2	2	73	25	Dusty clay
12	T4U3	3	73	24	Dusty clay
13	T5U1	5	70	25	Dusty clay
14	T5U2	1	84	15	Dusty clay
15	T5U3	1	66	33	Dusty clay
16	T6U1	5	30	65	Look
17	T6U2	2	28	70	Look
18	T6U3	1	32	67	Look

Note: T: sampling point; U: test

3.5. Organic Materials

Soil samples around the mangroves showed the highest organic carbon value in soil sample T2U2, at 5.24. The lowest value was in sample T1U2, at 1.20. The diagram above shows significant fluctuations in the organic carbon value of the estuary soil near the mangroves. The highest average value in sample T3 was 4.22, indicating a higher graph than the others.

Organic matter content in soil is related to soil porosity, as evidenced by soil texture analysis, which showed that soil samples collected from sampling points near the mangrove estuary had a clayey loam texture. Clay textures have small pores, resulting in a high water-retention capacity.

4. Conclusion

The salinity level of the Wonorejo Mangrove plantation soil is demonstrated by the lowest electrical conductivity (EC) value of 15.9 dS/m found in the T3U3 soil sample, which falls within the high salinity category. Conversely, the highest EC value of 23.07 dS/m was recorded in the T2U1 soil sample, indicating a very high salinity level. Despite this, the organic matter content in the area remains relatively high, as evidenced by cation exchange capacity (CEC) values ranging from 39.89 to 49.43 cmol/kg, which are classified as high. Additionally, the highest organic carbon content was 5.24%, and the maximum permeability measured was 22.01 cm/hour, both of which suggest that organic matter remains abundant in the soil of the Wonorejo Mangrove plantation.

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