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Environmental Quality Analysis on Jatiluhur Reservoir

Lia Warlina[(a)]*, Senny Luckyardi[(b)], Agis Abhi Rafdhi[(c)], Herry Saputra[(c)], Natasha Puspa Dewi[(d)]

[(a)] *Departemen Perencanaan Wilayah dan Kota, Universitas Komputer Indonesia, Indonesia*
[(b)] *Departemen Manajemen, Universitas Komputer Indonesia, Indonesia*
[(c)] *Departemen Sistem Informasi, Universitas Komputer Indonesia, Indonesia*
[(d)] *Departemen Sastra Inggris, Universitas Komputer Indonesia, Indonesia*

** Corresponding author:*
nandiyanto@upi.edu
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Abstract

This study aims to examine the air quality in the Jatiluhur reservoir and observe the surrounding area by analyzing the water and air quality. The study of air quality is used as a reference for policy analysis to measure the air quality that is a source for the surrounding community. The research method used a descriptive analysis using a qualitative approach based on the parameters studied. Some of the parameters studied included the degree of acidity (pH), temperature (oC), Total Dissolved Solid (TDS), and Electrical Conductivity (EC). A total of three water and soil samples from three different locations were taken along the flow of the Jatiluhur reservoir dam. Meanwhile, checks were carried out for air quality measurements at one point by taking data twice. The results show that the air quality is in a safe status starting from TDS, EC, pH, and temperature parameters. While for soil quality, the relative humidity parameter does not enter the normal range because the water content is higher (wetter) even though the content is generally still safe. In conclusion, air quality is still very safe, starting from PM 10, PM 2.5, TVOC, and HCHO levels, all of which are in "Good" status. Based on the measurement of several air, soil, and air quality parameters, it can guarantee that the air quality content in Jatiluhur reservoir is in a safe status for use in daily community activities.

***Keywords**: Air Quality, Water and Soil Quality, Jatiluhur Dam*

1. Introduction

Jatiluhur Reservoir is a water catchment source that can meet the water needs of most people in West Java and DKI Jakarta, such as Bekasi, Karawang, Purwakarta, Cianjur, and so on. The reservoir covers an area of 8,300 ha and can hold up to 12.9 billion m3/year of water [1]. In addition, the Jatiluhur reservoir has a function as a provider of irrigation water for 242,000 ha of rice fields, a source of drinking water, aquaculture, and flood control [2]. Over time, the reservoir, located in Purwakarta Regency, has a fairly high risk of pollution. This can be influenced by population density, industrial waste, and spatial planning that is not fully functioning [3]. As a result of the failure of spatial planning that does not work properly, it is the cause of decreased water discharge in the dry season or flooding during the rainy season [4]. Several previous studies examined the measurement of river water quality and pollution control. This study analyzes the quality of water in the watershed (DAS) and its impact on the communities around the riverbanks that use the water for consumption and activities [5-8]. In addition, research on measuring the level of cleanliness in the lake by assessing water safety against microbial content has been conducted. In fact, one billion people worldwide use water that is moderately contaminated with microbes [9-11]. As a result of declining water quality and rapid changes in land use by users, the environment and the surrounding environment will significantly affect the agriculture and plantations that use water sources from the river [12–14]. Research conducted at the Jatiluhur reservoir was carried out by measuring the level of water quality, referring to several parameters such as acidity (pH), Electrical Conductivity (EC), temperature, and Total Dissolved Solids (TDS). Then, to see the cause of the water quality results, measurements of the quality of the soil content around the reservoir were carried out with the parameters of acidity, temperature, humidity, and light intensity. Finally, air quality measurements are carried out to provide comprehensive environmental quality data covering water, soil, and air quality. This study aims to analyze the content of water quality in the Jatiluhur reservoir and pay attention to its impact on the surrounding environment by analyzing water and air quality. The study of water quality is used as a reference for policy analysis to measure the feasibility of water as a source for the surrounding community. The research method used is a descriptive analysis using a qualitative approach based on the parameters studied. Some of the parameters studied include the degree of acidity, temperature, TDS, and EC. A total of three water and soil samples from three different locations were taken along the flow of the Jatiluhur reservoir.

2. Materials and Methods

The research was conducted on the Jatiluhur Reservoir tourist attraction located in Jatiluhur District, Purwakarta Regency on March 8, 2021 (see Figure 1). Sampling of water, air, and soil was carried out at three different locations around the reservoir by considering the representativeness of the influence of population activity density around the sampling location. Measurement of water, soil, and air quality parameters in sampling was carried out in situ. Total Dissolved Solids (TDS), Acidity (pH), Light Intensity, Temperature (oC), Humidity, Formaldehyde (HCHO), Particulate Meter (PM) 2.5, 1.0, and 10, Total Volatile Organic Compound (TVOC), and Electrical Conductivity (EC) were the parameters measured. The measurement results will be analyzed and explained descriptively and visualized in the form of tables and graphs.

3. Results and Discussion

3.1. Jatiluhur Reservoir Water Quality Parameters

3.1.1. Total Dissolved Solid (TDS)

Physically, the indicators of water cleanliness are clear, colorless, and odorless. Chemically, drinking water must not contain toxins or certain substances in excessive amounts. Meanwhile, drinking water must not contain disease-causing bacteria and E-coli group bacteria exceeding the specified limits [15, 16]. The level of turbidity of water is influenced

by the total particles dissolved in it. It means that TDS can be a parameter of water quality. TDS is a term used to indicate the content of inorganic and organic salts contained in aqueous solutions [17]. The main constituents are calcium, magnesium, sulfate, hydrogen carbonate, potassium, carbonate cations, chloride, and nitrate. Based on the results of TDS measurements at three different locations, the lowest value was 126 ppm (location 3), and the highest was 141 ppm (location 1). Some of the compounds dissolved in water are organic chemicals and dissolved gases. Water that contains a number of dirty compounds that exceed the limit indicates poor water quality, which can cause a bad taste, cause nausea, and other diseases [18].

Figure 1. Water, soil and air sampling locations

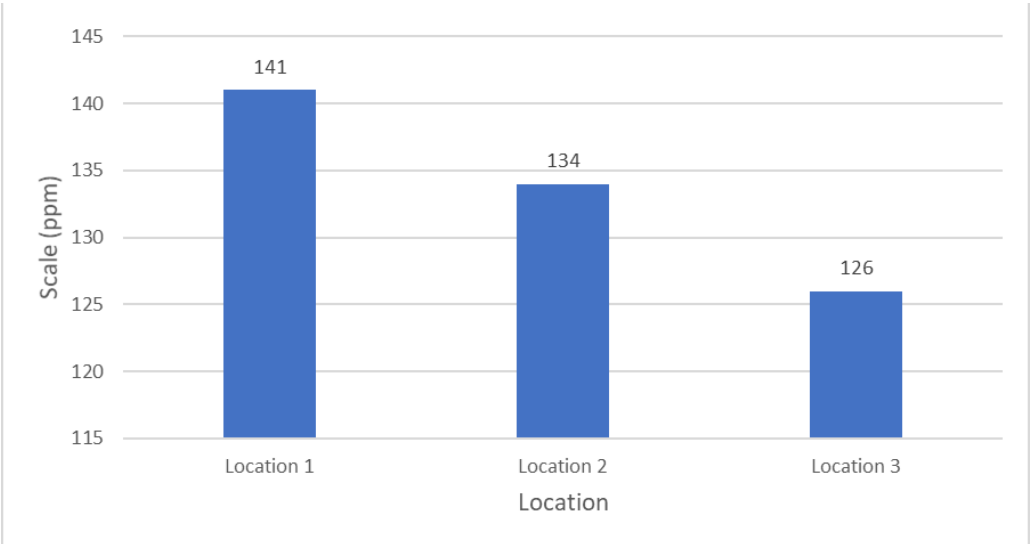

Figure 2. Measurement of Total Dissolved Solid (TDS) at three locations

3.1.2. Acidity (pH)

Measuring the acid or alkaline water level can be done using the pH parameter. pH itself is an abbreviation of the term “power of Hydrogen”. The pH range starts from 0 to 14. A pH value below 7 indicates acidity, while above 7 indicates alkaline [19]. pH measures the number of free hydrogen and hydroxyl ions in an aqueous solution. Water that contains a lot of free hydroxyl ions is acidic, while water that contains more hydroxyl ions is basic [17]. pH can be affected by chemicals in the water. Therefore, pH is an important indicator of chemical changes in water [20].

The pH measurements at 3 points in the Jatiluhur reservoir obtained the highest pH value of 6.66 (Figure 3). Based on the specified clean water quality standard, namely 6.5–9, it shows that the pH of the Jatiluhur reservoir water is following the quality standard.

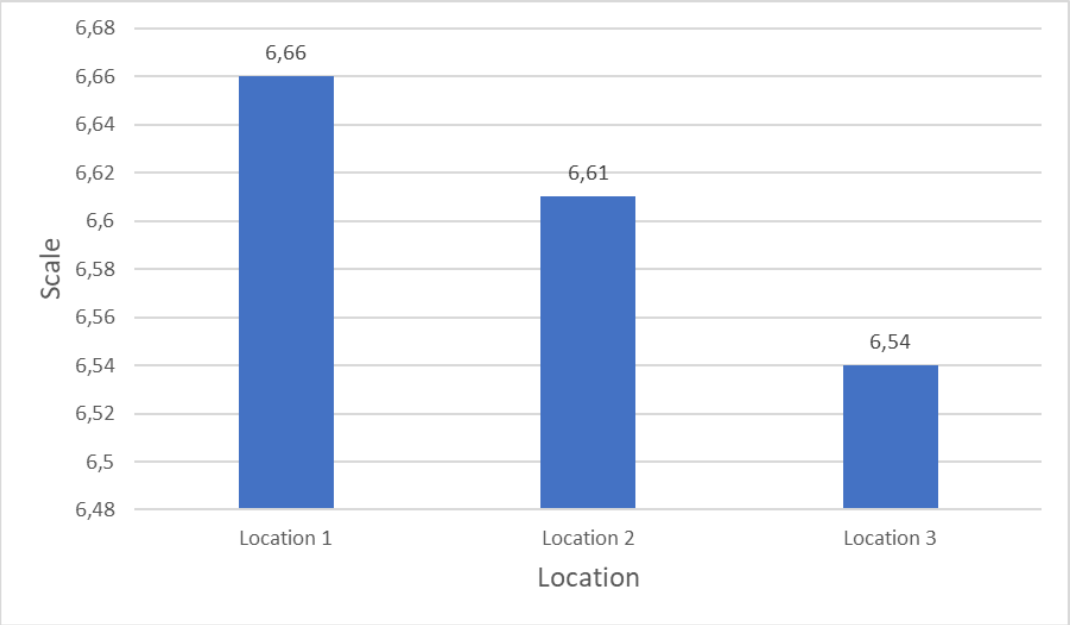

Figure 3. Measurement of water pH at three locations

3.1.3. Temperature

Based on the measurement of water temperature parameters at 3 location points in the Jatiluhur reservoir (Figure 4), it shows that locations 1 and 2 have relatively the same temperature, namely 28 and 28.5 Co. Location 3 has a much higher temperature of 31.5 °C. Based on these results, it can be concluded that the water temperature of the Jatiluhur Reservoir is still within the safe limits of the quality standard and meets the needs of the biota and the ecosystem within it. Water temperature is caused by heat on the surface of the water due to the absorption of solar radiation by the water surface [21]. Differences in water temperature can be caused by pathogenic factors such as sewage disposal and various human activities around water sources. The existence of human activities can cause changes in water temperature [21, 22].

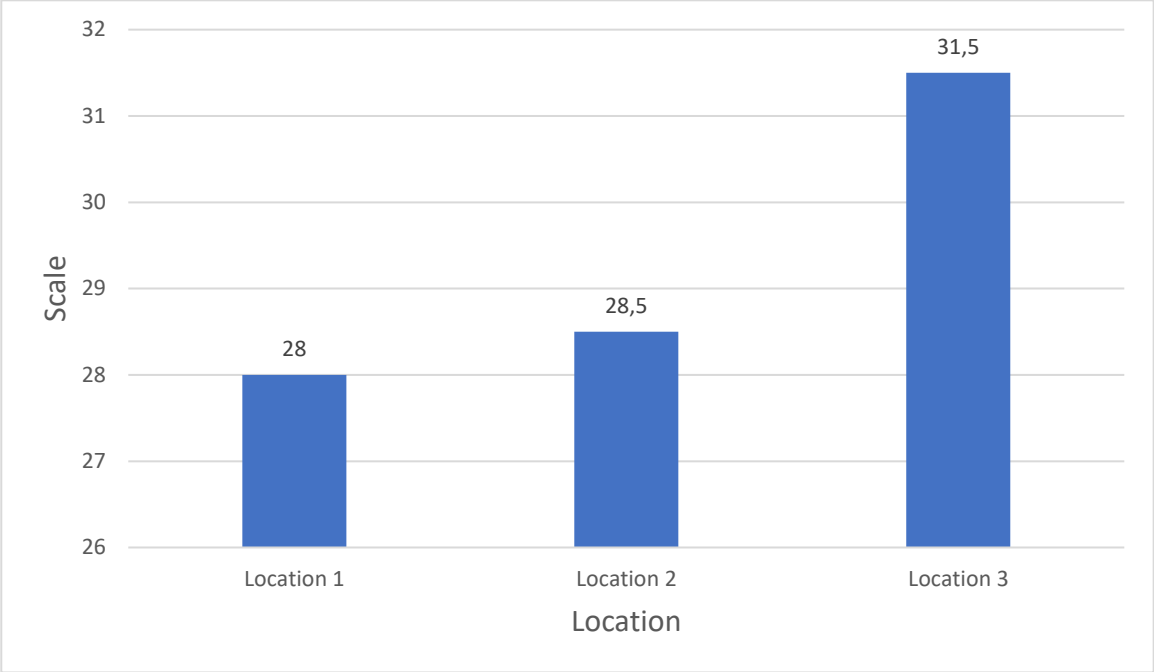

Figure 4. Measurement of water Temperature at three locations

3.1.4. Electrical Conductivity (EC)

The conductivity is significantly related to parameters such as pH value, temperature, total hardness, alkalinity, calcium, iron concentration, total solids, TDS, and chloride chemical oxygen demand. Water conductivity is generally influenced by the geology of the area in which the water flows. Streams flowing through areas with granitic bedrock tend to have lower conductivity because granite consists of weaker materials that do not ionize (dissolve into ionic components) when washed into water [23, 24]. A failed sewage system will increase the conductivity due to phosphates, chlorides, and nitrates; oil spills will reduce the conductivity [24].

EC is a parameter used to measure the ability of water to carry electricity, which is influenced by the mineral content and the amount of salt dissolved in water [21]. The conductivity of water in the Jatiluhur reservoir from the three points that have been sampled has a value of between 246 and 279 uS/cm. Based on the conductivity value, drinking water has a conductivity value ranging from 42-500 mhos/cm. This shows that the water in the Jatiluhur Reservoir is still within the water consumption limit based on its electrical conductivity [25, 26].

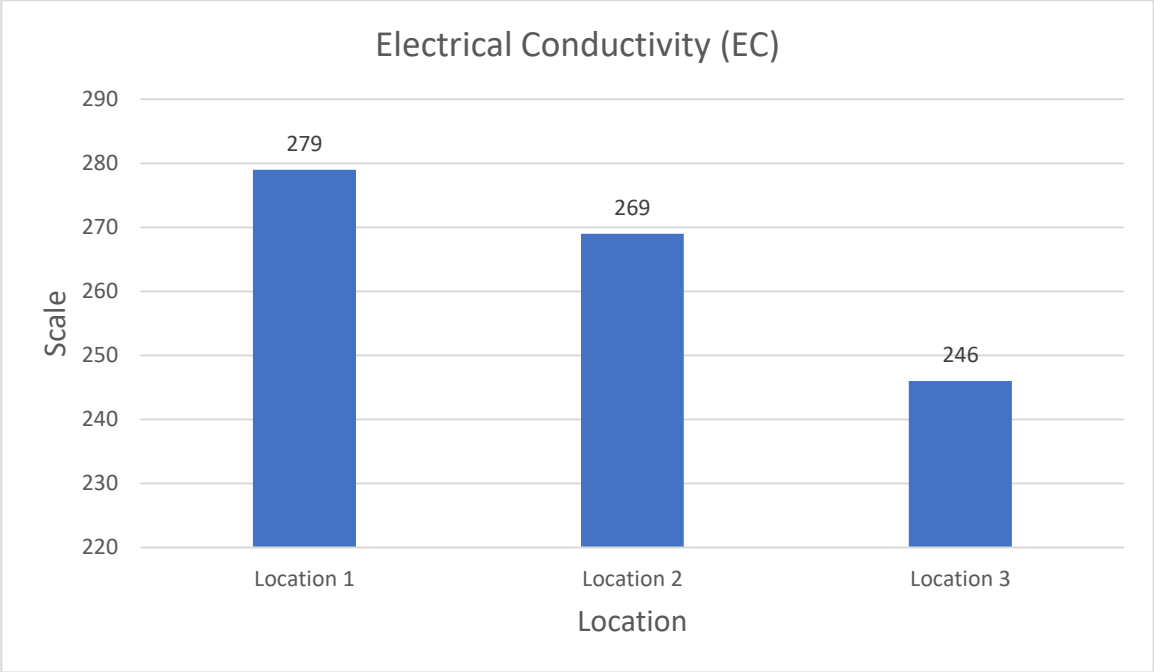

Figure 5. Measurement of Water Electrical Conductivity (EC) at three locations

3.2. Quality Parameter of Jatiluhur Reservoir

3.2.1. Soil Acidity (pH)

Fertile soil contains sufficient nutrients, oxygen and water for plants to grow. Therefore, physical, chemical, and biological properties of soil have a large influence on plants. Soil fertility means the ability of the soil to provide sufficient nutrients for plants [27]. Chemical substances in soil also determine their acidity, expressed in a unit called Power of Hydrogen (pH) and measured in a scale of 0 to 14. Acidic soil has a pH scale below 7 and Alkaline soil has pH scale above 7. Optimal soil acidity for most plants ranges from 6.5 to 8.5. Figure 6 is a graph of soil pH measurements taken from 3 samples with different locations in the Jatiluhur Reservoir.

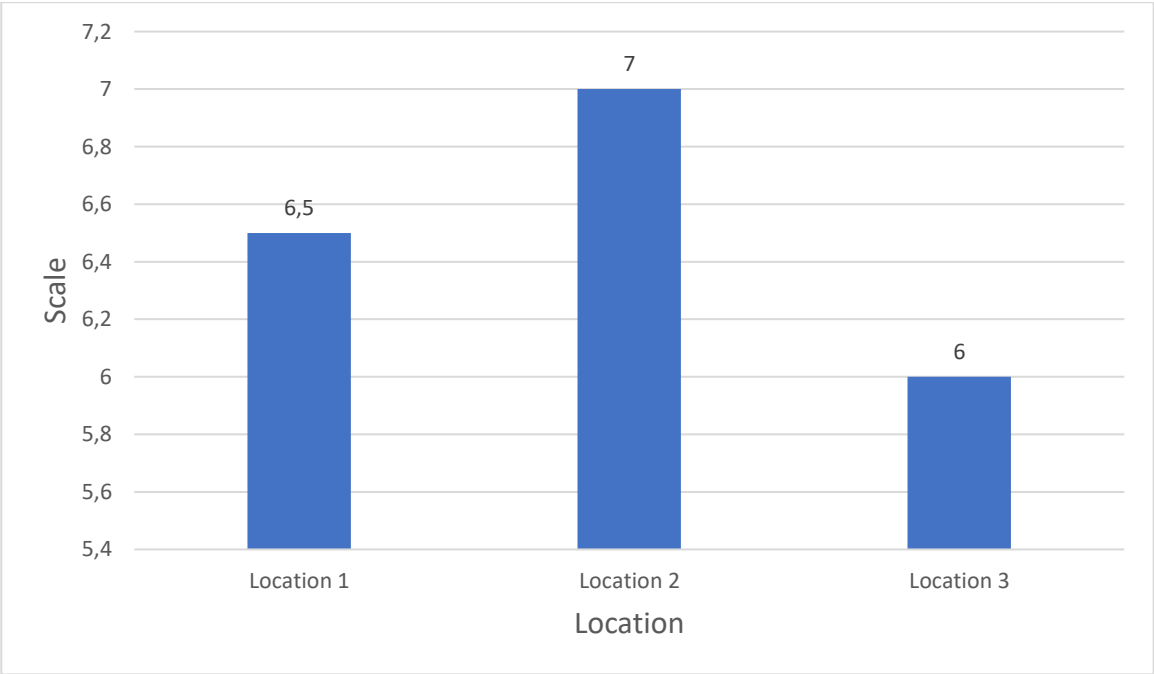

Figure 6. Measurement of Soil pH at three locations

Of the three samples taken, two of them have optimal pH levels, namely at Location 1 and 2 with pH levels of 6.5 and 7.0. On the other hand, the soil acidity of Location 3 is a bit acidic with pH level of 6, not far from the normal level. This proves that the soil around Jatiluhur Reservoir is optimal for plant growth.

3.2.1. Temperature

The depth of measurement affects the soil temperature obtained. This happens because of the different soil topography as well as fluctuations in air temperature directly affect the soil temperature. In short, air temperature affects the temperature of soil surface as it is exposed directly to open air, while the layers beneath the surface gradually change according to the temperature of the surface and the bottom layer [28].

The standard soil temperature with a low depth (5-15 cm) ranges from 28-31.5oC [29]. In this research, the soil was measured in three different locations with a depth of 10 cm. From the results, all locations were under normal temperature conditions, Location 1 with 28oC, Location 2 with 30oC, and location 3 with 30oC (see Figure 7).

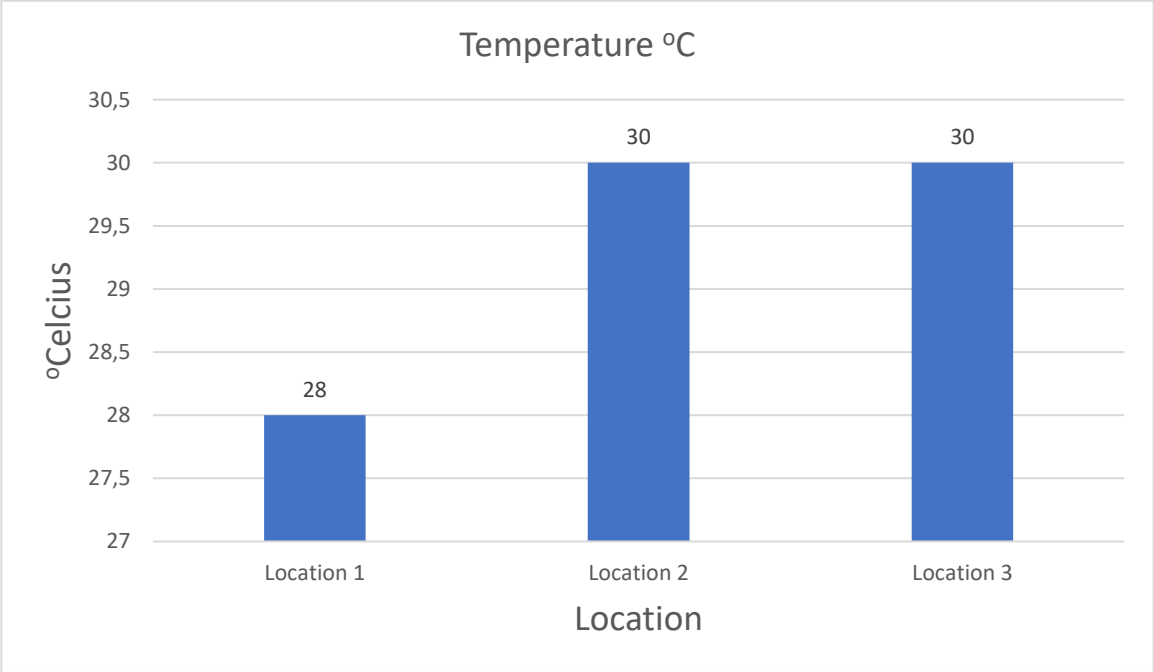

Figure 7. Measurement of Soil Temperature at three locations

3.2.2. Humidity

Soil humidity is a condition where water fills part or all of the soil parts that exist in a place. It is dynamic and could change quickly, influenced by air conditions, weather, and temperatures around the soil. Rainfall, soil type, and rate of evapotranspiration are some of the factors that affect soil humidity that determine the availability of water for plant growth [30]. Table 1 shows the results of soil moisture measurements from 3 different locations. From the results, two of them have high humidity. This could have happened due to the influence of measurements around the Jatiluhur reservoir location so that the surrounding soil contains excess water.

Table 1. Soil Humidity around Jatiluhur Reservoir

Location	Humidity
1	Normal
2	Wet+
3	Wet+

3.2.3. Light Intensity

Soil light intensity means the ability of light to penetrate the soil layer based on a certain depth. The intensity increases if the soil part is exposed to light. If the soil are dense, light cannot penetrate deeply, it would only penetrate slightly or even unable to penetrate at all, resulting in lower light intensity [31]. This research shows that the soil around Jatiluhur Reservoir has the characteristics of being quite dense so that the light intensity is low. Measurements were carried out at a depth of 10 cm and obtained results from the three locations in the category of Low and Low+ light intensity. This means that light cannot penetrate the soil pores which tend to be dense even at a depth of 10 cm, it is already in the Low category, even at location 1 it is in the Low+ category, meaning no light is detected (see Table 2).

Table 2. Soil Light Intensity around Jatiluhur Reservoir

Location	Light Intensity
1	Low+
2	Low
3	Low

3.3. Jatiluhur Reservoir Air Quality Parameters

The air quality of a tourist site must be carefully considered. This is due to the fact that a tourist attraction would be visited by a large number of people from various locations. As a result, in this study, we used a variety of tools to measure air quality at the Jatiluhur Reservoir tourist destination. To assess air quality, we used parameters such as Particulate Matter content (PM2.5 and PM10), HCHO, TVOC, temperature, and humidity at specified places. Particulate matters (PM2.5 and PM10) are used as parameters since excessive levels of these particles might affect human lung health [32]. The difference between PM2.5 and PM10 is in the particle size, where PM2.5 particle size is 2.5 micrometers and PM10 particle size is 10 micrometers [33]. Furthermore, these parameters may be used to measure the air pollutants in a place. Designs classifies the levels of PM2.5 and PM10 particles in the air as Good, Moderate, Unhealthy for sensitive groups, Unhealthy, Very Unhealthy, Hazardous, and Very Hazardous (See Table 3) [34]. Air quality ‘Good’ is defined as PM2.5 and PM10 levels ranging from 0.0 to 12.0 g/m3 and 0 to 54 g/m3, respectively. Meanwhile, an area's air quality is classified as Very Hazardous if the PM2.5 and PM10 levels are 350.5 to 500.4 g/m3 and 505 to 604 g/m3, respectively.

Table 3. Particulate Matter (PM) Category [34]

PM2.5 (µg/m^3)	PM10 (µg/m^3)	AQI	Category
0.0 to 12.0	0 to 54	0 to 50	Good
12.1 to 35.4	55 to 154	51 to 100	Moderate
35.5 to 55.4	155 to 254	101 to 150	Unhealthy for sensitive group
55.5 to 150.4	255 to 354	151 to 200	Unhealthy
150.5 to 250.4	355 to 424	201 to 300	Very Unhealthy
250.5 to 350.4	425 to 504	301 to 400	Hazardous
350.5 to 500.4	505 to 604	401 to 500	Very Hazardous

We collected two samples in this study to evaluate the air quality in the Jatiluhur Reservoir. This is done so that we can compare the air quality at the research location using indicators such as PM2.5, PM10, HCHO, TVOC, temperature, and humidity. Sample 1 was collected at 10.10 a.m., whereas Sample 2 was collected at 10.15 a.m. Figure 8 depicts the PM2.5 and PM10 levels at Jatiluhur Reservoir.

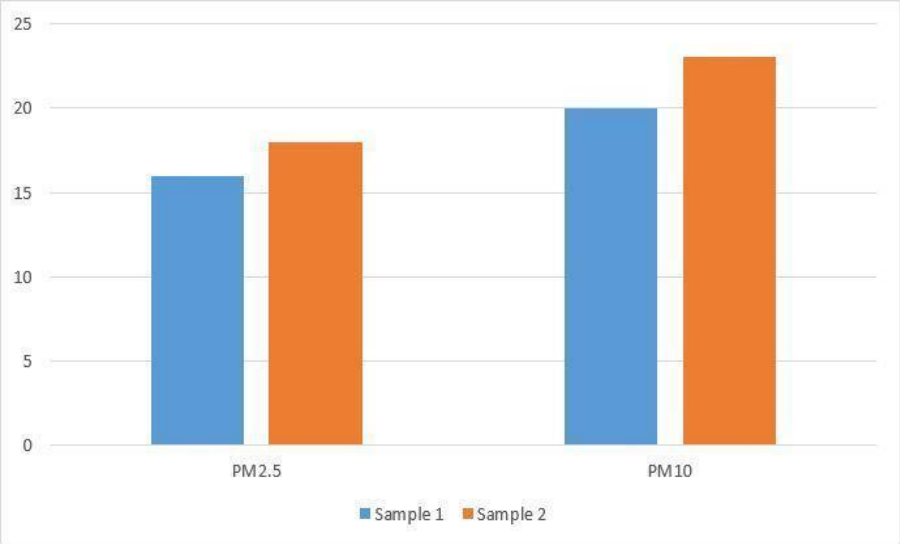

Figure 8. Particulate Matter (PM) in Jatiluhur Reservoir Air

The figure depicts the PM2.5 and PM10 levels in the Jatiluhur Reservoir. PM2.5 and PM10 levels in Sample 1 were 16 and 20 g/m3, respectively. According to the PM quality standard category in Table 3, the air quality in Sample 1 is Moderate for PM2.5 and Good for PM10. This is because in Sample 1, the PM2.5 level contained is 16, so it is in the range of 12.1 to 35.4 (Moderate). Meanwhile, the PM10 level contained is 20, so it is in the range 0 to 54 (Good).

Like Sample 1, the air quality in Sample 2 is Moderate for PM2.5 and Good for PM10. This is because in Sample 2, the PM2.5 level contained is 18, so it is in the range of 12.1 to 35.4 (Moderate). Then, the PM10 level contained is 23, so it is in the Good range, which is 0 to 54. As a result, the air quality of Jatiluhur Reservoir is in the 'Good' category.

In addition to PM2.5 and PM10, we used HCHO and TVOC as air quality indicators in the Jatiluhur Reservoir. According to Zhai et al., if the HCHO level in a region is less than 0.080 mg/m3, the air quality in that area is considered to be safe. Then, if the HCHO level in a certain location is in the range of 0.080 to 0.300 mg/m3, the air quality in that area can be classified as borderline since it is neither safe nor dangerous. Then, if the HCHO level in a region exceeds 0.300 mg/m3, the air quality in that area is classified as dangerous [35].

In addition, the TVOC levels in an area also affect the air quality. The quality TVOC levels are categorized into Low, Acceptable, Marginal, and High [32]. The TVOC levels standard are presented in Table 4.

Table 4. Standard of TVOC Levels [32]

TVOC Level (mg/m^3)	Level of Concern
Less than 0.3	Low
0.3 to 0.5	Acceptable
0.5 to 1	Marginal
1 to 3	High

Based on Table 4, if the TVOC level in the air is less than 0.3 mg/m3, it can be classified as a Low level. Then, if the TVOC level is between 0.3 and 0.5 mg/m3, it can be categorized as Acceptable. Moreover, if the TVOC levels in the air is between 0.5 and 1 mg/m3, it can be classified as Marginal. Meanwhile, the TVOC level in the air is categorized as High, if it is between 1 and 3 mg/m3. In this research, the HCHO and TVOC levels in Jatiluhur Reservoir air is presented in Table 5.

Table 5. HCHO and TVOC Level in Jatiluhur Reservoir Air

Sample Name	HCHO (mg/m^3)	TVOC (mg/m^3)
Sample 1	0.007	4.566
Sample 2	0.007	1.479

Table 5 showed the HCHO and TVOC levels in Jatiluhur Reservoir. In the table, it can be seen that the HCHO levels in Samples 1 and 2 are in the same level, namely 0.007 mg/m3. Based on the safety standards for HCHO levels in the air, the HCHO levels in Samples 1 and 2 are categorized as safe. It is because the HCHO levels in Samples 1 and 2 are less than 0.030 mg/m3. Meanwhile, the TVOC levels in Samples 1 and 2 are 4.566 and 1.479 mg/m3, respectively. Based on the standard TVOC levels in the air shown in Table 4, the TVOC levels in Samples 1 and 2 are classified in the High category. It is because the TVOC levels are more than 3 mg/m3. Therefore, in general, the air quality in Jatiluhur Reservoir based on the HCHO levels are categorized as safe. Meanwhile, the TVOC levels in Jatiluhur Reservoir are categorized high. In addition to the parameters previously mentioned, we also used temperature and humidity as

indicators to determine the air quality in Jatiluhur Reservoir. The high temperature and humidity in an area have an impact on whether the air is dry or not. The higher the temperature, the lower the humidity in the area. Standard of temperature and humidity in the air can be seen in Table 6 [36].

Table 6. Air Temperature and Humidity Standards

Climate	Temperature (ºC)	Humidity (%)
Hot, humid	22 – 28	55 - 70
Hot, dry	22 – 28	40 - 60
Temperate	18 – 24	45 - 65

In this study, the temperature and humidity levels in Jatiluhur Reservoir are shown in Table 7. The air temperature in Sample 1 was 31.4oC, with a humidity of 65%. Meanwhile, the temperature in Sample 2 was 32.9oC, with a humidity of 53%. Therefore, the air in Jatiluhur Reservoir tend to be dry because it has a fairly high temperature and relatively low humidity. Based on the standard temperature and humidity of the air in Table 6, the air in Sample 1 is included in the Hot, humid category. Meanwhile, the air in Sample 2 is included in the Hot, dry category. Therefore, in general, the air at Jatiluhur Reservoir is included in the hot and relatively dry category.

Table 7. Temperature and Humidity Levels in Jatiluhur Resevoir

Sample Name	Temperature (ºC)	Humidity (%)
Sample 1	31.4	65
Sample 2	32.9	53

Conclusion

Based on the research results conducted on the three components, the quality of water, soil, and air as a whole is at a safe level. The water quality is still safe enough to meet the community's needs for agriculture, fisheries, and daily consumption. Water quality parameters such as Total Dissolved Solid (TDS) obtained the value of 126 - 144 ppm, the temperature is between 28-31,5 ºC, Electrical Conductivity (EC) ranges from 246 – 279 uS/cm, and the acidity (pH) obtained the highest scale at 6.6 which means it is still in the safe category for human needs. Meanwhile, for soil quality starting from pH and temperature, a safe scale is obtained, namely the highest values obtained at 7 and 30oC, respectively. However, the moisture and light intensity parameters were not in the normal category because the soil moisture was too wet and the light intensity on the soil was low. On the air component, the results obtained are quite safe starting from the Particulate Matter (PM) parameters, namely PM2.5 and PM10, which are still in the range of 12.1 to 35.4 (Moderate) and 0 to 54 (Good), respectively. The HCHO levels are also categorized as safe, which is 0.007 mg/m3, and the air climate tends to be hot and relatively dry. However, the TVOC level parameter in the Jatiluhur Reservoir is categorized in the very high category, which is more than 3 mg/m3.

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