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Land Used Mapping using Unmanned Aerial Vehicle (UAV) along Parit Rasipan Drainage System

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Abstract: Excess nutrients accelerate the growth of plants and algae in water sources, leading to environmental issues like flow retardation (flood), a decrease in the amount of oxygen in the water, and a decline in the quality of the water. Therefore, the goal of this study is to identify the quality Parit Rasipan drainage system's eutrophic level in terms of temperature, dissolved oxygen, pH, and turbidity; and to analyse an NDVI (Normalized Difference Vegetation Index) image taken by unmanned aerial vehicle (UAV) and using Agisoft photoscan software. As a result, four sampling locations—residential (S1), industrial (S2), agricultural (S3), and farming (S4)—have been chosen for water quality sampling and analysis along the Parit Rasipan drainage system. The HACH method was used to analyse water samples that have been obtained according to the Standard Methods for Water and Wastewater Examinations. It was found that agricultural zone was poor water quality compared residential, industrial and farming zones with measurements of 3.82 mg/L, 3.09, 25.57 °C, and 14.6 NTU, respectively, the agricultural zone has the highest values for the four metrics of dissolved oxygen, pH, temperature, and turbidity. This scenario could be due to the usage of the fertilizer to cultivate the oil palm contributed to Parit rasipan drainage system (S3) which resulted in a substantial amount of eutrophication. Hence, the use of UAVs and the agisoft photoscan programme has considerably improved the mapping of the water quality metrics and eutrophic level.

Keywords: Drainage, water quality, unmanned aerial vehicle, mapping, agisoft photoscan

1. Introduction

1.1 Background of Study

The term "land use" refers to how people make use of their surroundings. It represents the economic and cultural activities that take place in a certain location, including agricultural, residential, industrial, mining, and recreational purposes. The goals of public and private property are frequently at odds. Public lands such as parks and wilderness areas, for example, are rarely exploited for urban development, and privately owned lands are rarely protected for wilderness purposes. In contrast to land cover, land use is distinguished by the fact that some uses are not always visible. Land utilized for timber production but not harvested in many years and forested region designated as wilderness, for example, will appear to be forest-covered, but their objectives are very different (Fraser, 2019).

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When farms and forests are converted to urban expansion, the amount of land available for food and timber production declines. Soil erosion, salinization, desertification, and other soil degradations associated to intensive agriculture and deforestation reduce land quality and agricultural production in the future. Changes in land cover and land use (LCLUC) accompany the increase of soil erosion as a result of population growth, infrastructural development, and natural resource extraction (Morozova, 2022).

Rapid urbanization and development will have an impact on the balance of land use in a region, but Malaysia has adopted a number of laws and regulations to guarantee that development in a given area is efficiently regulated. To avoid any malfunctions, agencies, developers, and the general public should utilize the guidelines as a reference while selecting, developing, and building sites, as well as the surrounding environment (Alegre et al., 2016).

Negative zoning humans, on the other hand, do not acquire regions, which consist of marshes and woods. All that exists in its natural state, including non-productive and economic qualities, is designated as the area. Environmental changes have come from people's direct and indirect behaviors and attitudes in the development process, particularly in terms of the physical landscape of the area. Some changes in land use are obviously in line with the trend of modernization, or rather, rapid urbanization, as demonstrated by industrialization, agricultural operations, building and construction, transportation, forestry, and other agricultural sectors like as rubber and oil palm. (Wu et al., 2021).

Malaysia has enacted a number of laws and regulations to ensure that drainage system development is rigorously managed. To avoid any malfunctions, authorities, developers, and the general public should utilize the regulations as a reference while choosing, developing, and building sites along the drainage system and in the surrounding region. The topographical characteristics of the area should be preserved and merged with other characteristics without jeopardizing the parts of the city stability, balance, harmony, and natural individuality.

Exogenous large-scale transformations such as global climate change or annual economic growth in different regions of the world, as well as regional data such as climatic zones and population development aspects, can be visualized using a Geographic Information System (GIS). GIS can be used to visually describe the characteristics of a location. Various layers could be utilized to depict various features of the terrain. GIS can be used to visualize conflicts between local interests such as agriculture, industry, business, recreation, and environmental conservation. (Breiling, 2018).

Thakur et al., 2017 stated that geophysical surveys of gravity, magnetics, and electromagnetics are all part of remote sensing. Only a geophysical survey can reveal what is beneath the surface of data. Remote sensing approaches exceed traditional/conventional techniques in terms of geographical, spectral, radiometric, and temporal data availability. It enables the collecting of real-time or near-real-time data from inaccessible or remote areas in a timely manner. As a result, it's a low-cost, high-impact method for measuring, investigating, evaluating, analyzing, monitoring, and managing groundwater for long-term societal advantages.

Groundwater occurrence and movement are controlled by a variety of parameters and variables, including macro and micro topography, geology, lithology, stratigraphy, structural controls (paleo and neotectonics), geomorphology, soil types, land use/cover, and geological lineaments. Satellite data provide quick and efficient baseline data on these parameters and variables. With the emergence of new fine spatial (hyper spatial) and hyper spectral resolution satellite and aircraft photography, new uses for large-scale mapping and monitoring have become possible (Thakur et al., 2017).

Unmanned Aerial Vehicle (UAV) is a small unmanned aircraft that uses the navigation processor on board to fly low-cost airlines. This small plane can communicate with the ground control system and the Global Positioning System through radio (GPS). The Unmanned Aerial Vehicle (UAV) has become a low-cost choice in sensing technology and data analysis techniques in recent years. Remote sensing is a technique for determining the characteristics of a target object from a distance using electromagnetic waves. It offers the benefits of being thorough, non-invasive, quick, and adaptable. Remote sensing assessments soil properties in the farm is far from actual data due to the intricate natures of remote sensing, agricultural output, and soils (Norasma, et al.,2019).

Many developments have been carried out around the area of Parit Rasipan, which has already become a residential neighborhood, due to the high demand for infrastructural and agricultural advancements. To name a few infrastructure and agricultural improvements, there are residences, stalls, and an oil palm production area. Several apartments and buildings are now under construction due to the geographical area's proclivity for development. While many physical changes represent development and aid the economy, they can often have negative implications, such as environmental hazards and disasters.

2. Methodology

2.1 Study Area

The research was placed in the 5-kilometer-long Parit Rasipan drainage system. A ditch was excavated for the purpose of draining or irrigating the land with a tiny artificial river in the Parit Rasipan drainage system. As indicated in Figure 1, point sources such as farms, highways, and workshops contribute to pollution in the Parit Rasipan drainage system.

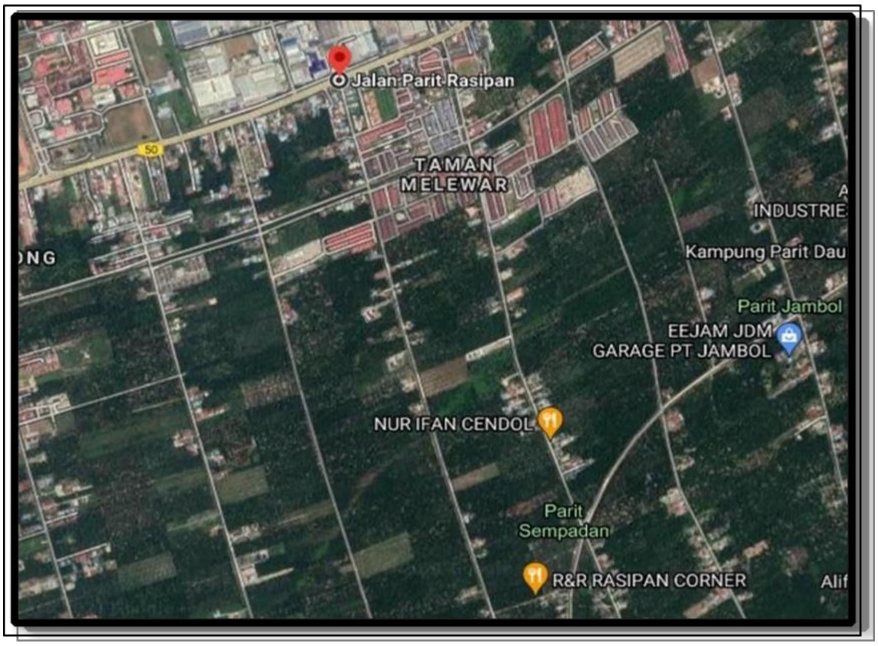


Fig.1 - The study area (source: Google maps)

2.2 Sampling Collection and Processing

Water samples were collected from four places along the Parit Rasipan drainage, which are divided into four stations, as shown in Figure 2 (S1, S2, S3 and S4). The first location was at the Parit Rasipan drainage entrance on Jalan Kluang's curb side. According to Figure 3, the first station (S1) featured human activities in a residential neighborhood, whereas the second station (S2) had industrial activity with a pollution-causing outflow from a neighboring workshop, as indicated in Figure 4. Agricultural activities were carried out at the third station (S3), which featured an oil plantation and a banana farm along the drainage system, as depicted in Figure 5. The goat field was positioned at the fourth station (S4) for farming activities, as indicated in Figure 6. Human and animal activity would alter pollutant concentrations along the Parit Rasipan drainage system.

Fig. 2 - A map presenting locations of sampling on Parit Rasipan drainage (source: Google maps)

Fig. 3 - Residential area (S1)

Fig. 3 - Industrial area (S2)

Fig. 5 - Agricultural area (S3)

Fig. 6 - Farming area (S4)

The sampling points were described in detail in Table 1. In the field, temperature, pH, and dissolved oxygen were measured, whereas turbidity was assessed in the lab. Prior to analysis, water samples were collected in sampling vials and stored at room temperature.

Table 1 - Description of four sampling locations

Stations	Latitude	Longitude
S1 (Residential points)	1.855238°	103.096249°
S2 (Industrial points)	1.834754°	103.101861°
S3 (Agricultural point)	1.815505°	103.108117°
S4 (Farming point)	1.812909°	103.109613°

The DJI Phanton 4 drone (UAV) was flying alongside the sample procedure in order to capture overhead images. A Light Detection and Ranging (LIDAR) camera was used to capture a three-dimensional image of the site study on the ground. The Agisoft Photoscan software was used to process the aerial photographs collected at the site. As illustrated in Figure 7, this flowchart depicts the process of obtaining data using the DJI Phanton 4 drone (UAV).

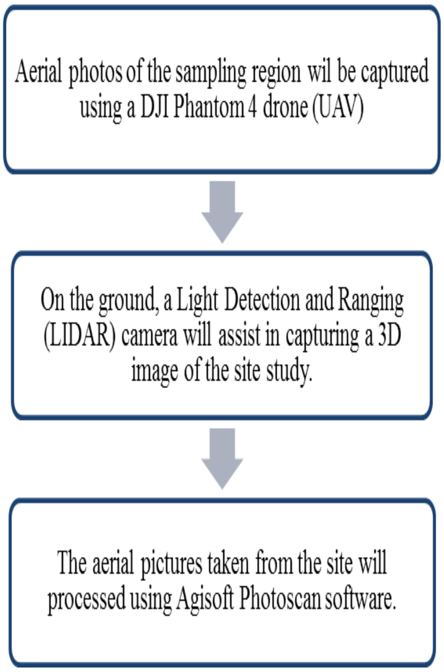


Fig. 4 - Flowchart of data processing using the DJI Phanton 4 drone (UAV)

The grab approach was employed for six sampling collections under different conditions, such as dry or wet seasons, with dry seasons taking three days and rainy seasons taking three days. From April through May 2022, this strategy was used to achieve the objectives. The turbidity of the sample was determined as soon as feasible after it was obtained. To avoid microbial breakdown of solids, the samples had to be refrigerated or cooled to 4°C if storage was required. Figure 8 shows dissolved oxygen samples obtained in a sampling vial. For a maximum of 28 days, the preserved samples were preserved at or below 6°C. This measurement was taken to see if there were any differences in water quality results along the Parit Rasipan drainage system.

Fig. 5 - The sampling bottles

2.3 Analytical Methods

Standard procedures were used to conduct the methods for each parameter. Multi-parameter was used to calculate the pH, temperature, and dissolved oxygen (DO) parameters, as shown in Figure 9. Turbidity meter TB400 was used to determine the turbidity parameter, which performed according to the usual procedure (Method 2130) as stated in Figure 10.

Fig. 6 - The multi-parameter to measure the pH, temperature and dissolved oxygen

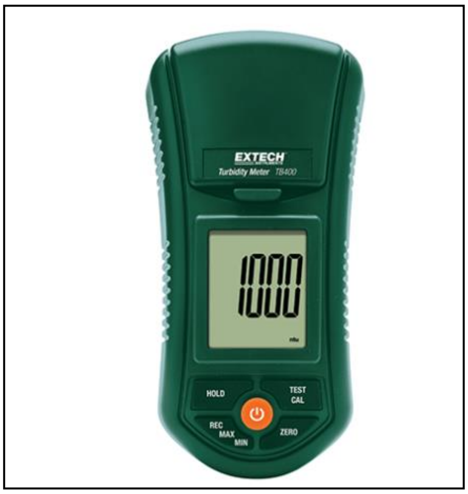


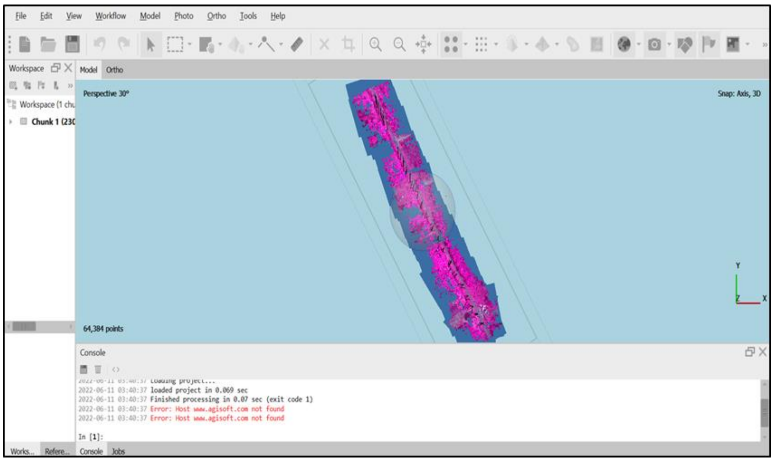
Fig. 10 - The turbidity meter

2.4 Statistical Analysis

Agisoft photoscan software was applied to process the aerial images from UAV from the Parit Rasipan drainage system. From the geo-referenced ortho-photo, a normalized difference vegetation index (NDVI) image for the 4 sample point zone (residential, industrial, agricultural and farming) from adaptation of the index was used as shown in equation (1).

$$NDVI = \text{Band 4-Band 1/Band 4+Band 1} \tag{1}$$

This study technologically advanced visible bands (blue, green and red) and near-infrared (NIR) band to define the correlation between spectral reflectance values and NDVI values. All image data were in GeoTIFF format. Data was presented in tables and maps after analysing using the Agisoft Photoscan software as dedicated in Figure 11.



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2022-06-11 03:40:37 Loading project...
2022-06-11 03:40:37 loaded project in 0.069 sec
2022-06-11 03:40:37 Finished processing in 0.07 sec (exit code 1)
2022-06-11 03:40:37 Error: Host www.agisoft.com not found
2022-06-11 03:40:37 Error: Host www.agisoft.com not found

In [1]:
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Fig. 11 - Agisoft Photscan software (agisoftsoftware.com)

3. Result, Analysis and Discussion

Standard procedures were used to conduct the methods for each parameter. Multi-parameter would be used to calculate the pH, temperature

3.1 Water Quality of Parit Rasipan Drainage

In this investigation, the collected sampling along the Parit Rasipan drainage was transferred to the laboratory and examined according to the laboratory standard technique (Water and Wastewater Standard Method 22nd Edittion, 2012). These samples were taken on 18th April 2022, 28th April 2022, and 18th Mei 2022 during the dry season, and on 18th April 2022, 24th April 2022, and 27th April 2022 during the wet season.

3.2 Water Quality Data for Dry Season

For the dry season, the allowed limit of water quality in drainage for each parameter was shown in Tables 2 to 4. Figures 12 to 15 depicted a graph of concentration for each parameter.

Table 2 - Data water quality of Parit Rasipan drainage on first day for dry season

1ST Day (18th April 2022)					
Parameters	**Residential**	**Industrial**	**Agricultural**	**Farming**	**Permissible limit (Malaysia Standard)**
pH	5.20	5.20	3.97	4.12	6.5 -8.0
Temperature (℃)	25.2	26.2	26.27	25.07	30.0, Normal ±
Turbidity (NTU)	87.67	244	19.30	6.20	≤ 50

DO (mg/L)	5.96	5.90	6.92	7.15	6.5 -8.0

Table 3 - Data water quality of Parit Rasipan drainage on second day for dry season

2ND Day (18th April 2022)					
Parameters	**Residential**	**Industrial**	**Agricultural**	**Farming**	**Permissible limit (Malaysia Standard)**
pH	6.27	2.71	2.73	2.80	6.5 -8.0
Temperature (℃)	27.81	27.94	27.71	27.08	30.0, Normal ±
Turbidity (NTU)	123.67	31.01	14.76	3.14	≤ 50
DO (mg/L)	0.57	0.72	0.41	1.21	6.5 -8.0

Table 4 - Data water quality of Parit Rasipan drainage on third day for dry season

3RD Day (18th Mei 2022)					
Parameters	**Residential**	**Industrial**	**Agricultural**	**Farming**	**Permissible limit (Malaysia Standard)**
pH	6.02	2.54	2.73	2.80	6.5 -8.0
Temperature (℃)	27.26	27.47	27.06	27.07	30.0, Normal ±
Turbidity (NTU)	61.33	24.18	31.52	3.69	≤ 50
DO (mg/L)	0.59(2.37)	0.83(2.48)	1.94 (3.09)	2.86(3.74)	6.5 -8.0

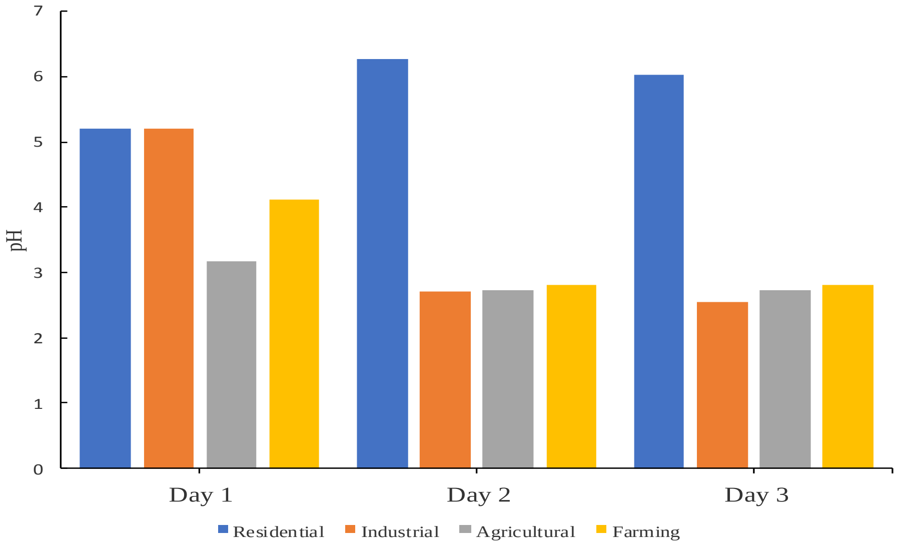

Fig. 7 - Difference of pH value over four sampling locations (dry season)

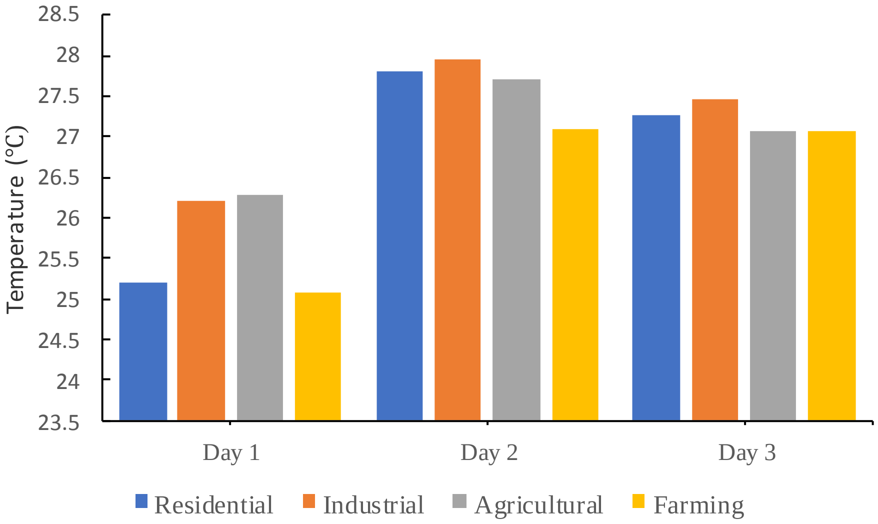

Fig. 8 - Difference of temperature over four sampling locations (dry season)

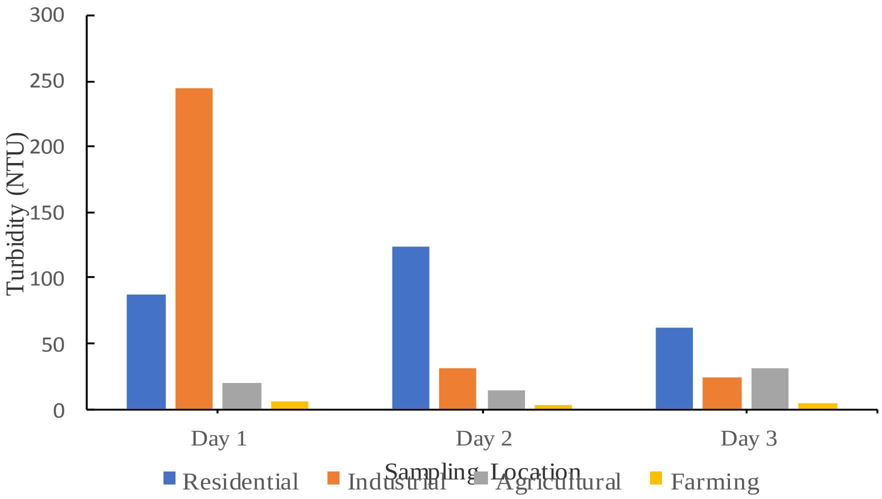

Fig. 9 - Difference of turbidity value over four sampling locations (dry season)

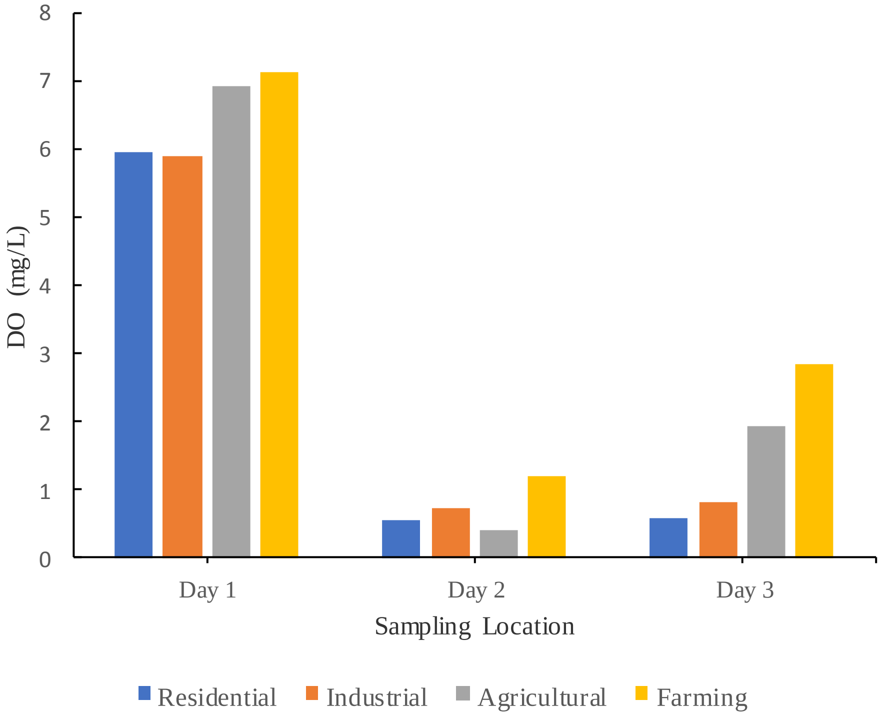

Fig. 10 - Difference of DO value over four sampling locations (dry season)

3.3 The Image of Normalize Difference Vegetation (NDVI) using the Unmanned Aerial Vehicle (UAV) for Dry Season

The image of normalized difference vegetation (NDVI) utilizing an unmanned aerial vehicle (UAV) for the dissolved oxygen (DO) parameter may be seen from Figure 16 to Figure 19. Meanwhile, the pH parameter is shown in Figures 20 to 23, and the temperature parameter is shown in Figures 24 to 27. The turbidity parameter was shown from Figure 28 to Figure 31.

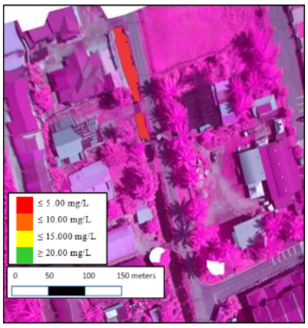

Fig. 11 - Residential area (S1) for dissolved oxygen (DO)

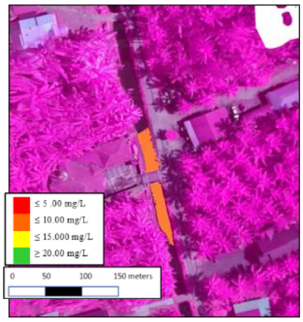

Fig. 12 - Industrial area (S2) for dissolved oxygen (DO)

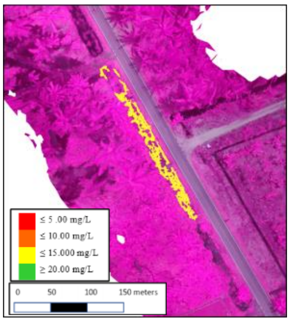

Fig. 18 - Agricultural area (S3) for dissolved oxygen (DO)

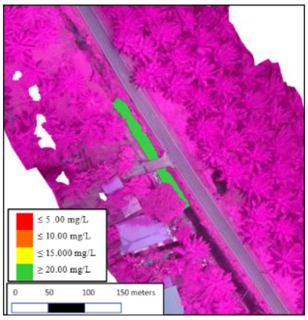

Fig. 19 - Farming area (S4) for dissolved oxygen (DO)

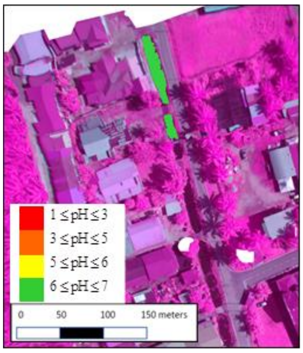

Fig. 20 - Residential area (S1) for pH

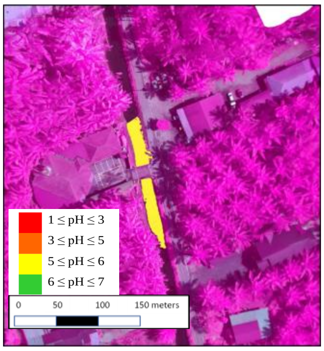

Fig. 21 - Industrial area (S2) for pH

Fig. 22 - agricultural area (S3) for pH

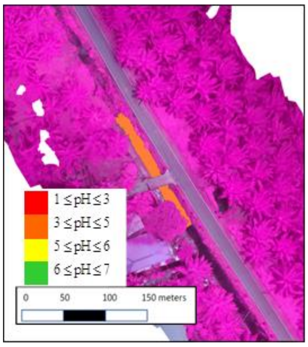

Fig. 23 - Farming area (S4) for pH

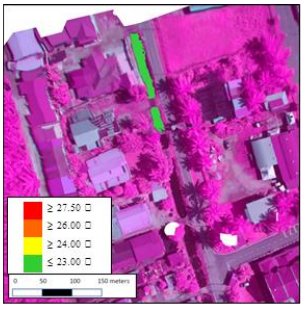

Fig. 24 - Residential area (S1) for temperature

Fig. 25 - Industrial area (S2) for temperature

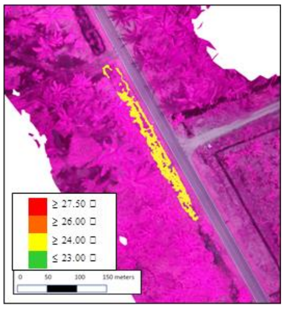

Fig. 26 - Agricultural area (S3) for temperature

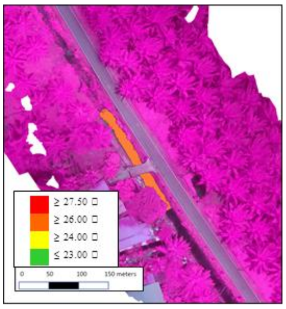

Fig. 27 - Farming area (S4) for temperature

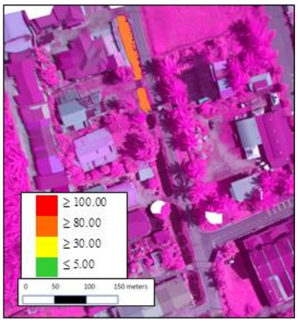

Fig. 28 - Residential area (S1) for turbidity

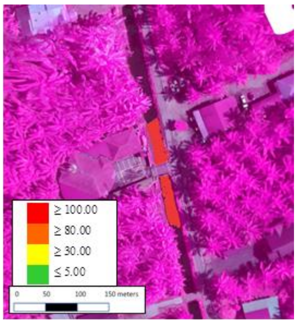

Fig. 29 - Industrial area (S2) for turbidity

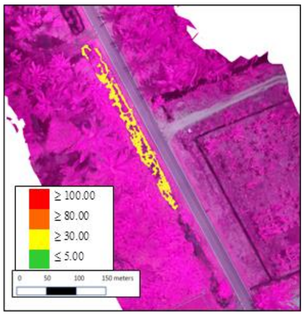

Fig. 30 - Agricultural area (S3) for turbidity

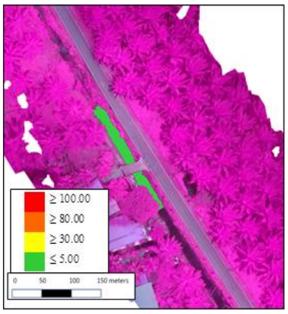

Fig. 31 - Farming area (S4) for turbidity

3.4 Water Quality Data for Wet Season

For the wet season, the allowed limit of water quality in drainage for each parameter was shown in Tables 5 to Table 7 Figures 32 to 35 depicted a graph of concentration for each parameter.

Table 5 - Data water quality of Parit Rasipan drainage on first day for wet season

		1ST Day (18th April 2022)			
Parameters	**Residential**	**Industrial**	**Agricultural**	**Farming**	**Permissible limit (Malaysia Standard)**
pH	6.58	7.27	3.67	2.92	6.5 -8.0
Temperature (℃)	17.20	17.60	17.30	25.90	30.0, Normal ±

Turbidity (NTU)	20.17	23.23	7.95	7.31	≤ 50
DO (mg/L)	6.93	6.88	7.64	8.14	6.5 -8.0

Table 6 - Data water quality of Parit Rasipan drainage on second day for wet season

2ND Day (24th April 2022)					
Parameters	**Residential**	**Industrial**	**Agricultural**	**Farming**	**Permissible limit (Malaysia Standard)**
pH	6.87	3.97	2.91	2.91	6.5 -8.0
Temperature (℃)	27.43	27.40	27.17	27.0	30.0, Normal ±
Turbidity (NTU)	89.67	11.44	5.13	2.78	≤ 50
DO (mg/L)	6.31	4.90	5.41	6.50	6.5 -8.0

Table 7 - Data water quality of Parit Rasipan drainage on third day for wet season

3RD Day (27th April 2022)					
Parameters	**Residential**	**Industrial**	**Agricultural**	**Farming**	**Permissible limit (Malaysia Standard)**
pH	6.18	2.66	2.58	2.72	6.5 -8.0
Temperature (℃)	28.89	30.65	27.92	29.11	30.0, Normal ±
Turbidity (NTU)	192.32	3.60	8.99	3.15	≤ 50
DO (mg/L)	0.73 (4.65)	1.42 (4.4)	0.62 (4.55)	1.58 (5.41)	6.5 -8.0

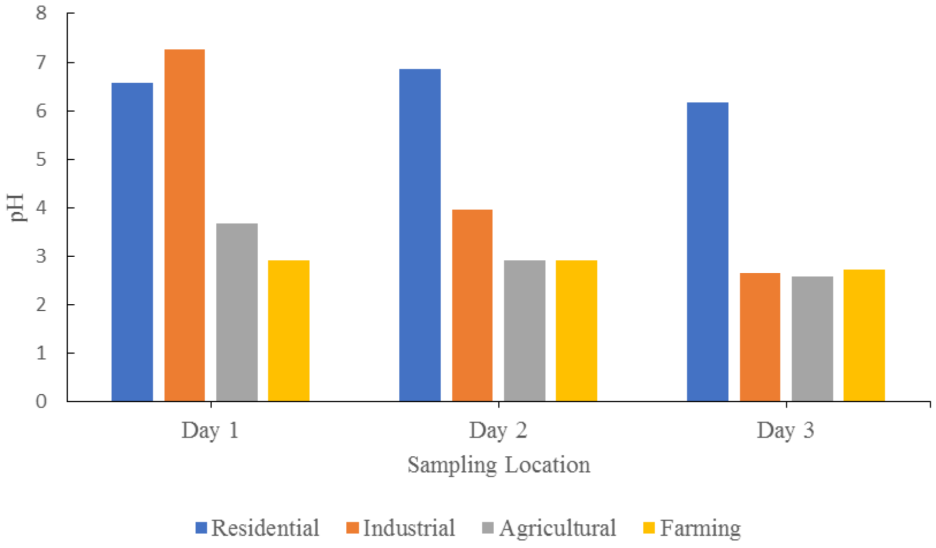

Fig. 32 - Difference of pH value over four sampling locations (wet season)

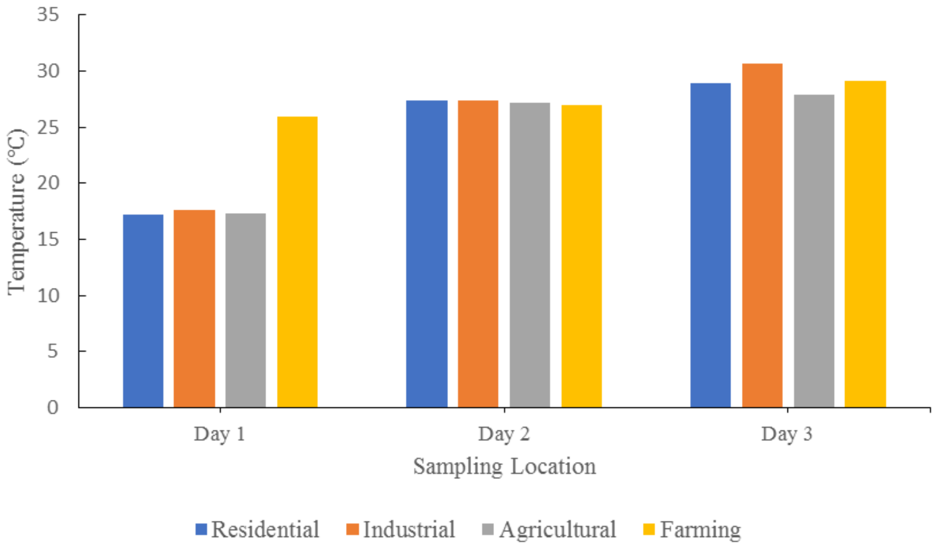

Fig. 33 - Difference of temperature over four sampling locations (wet season)

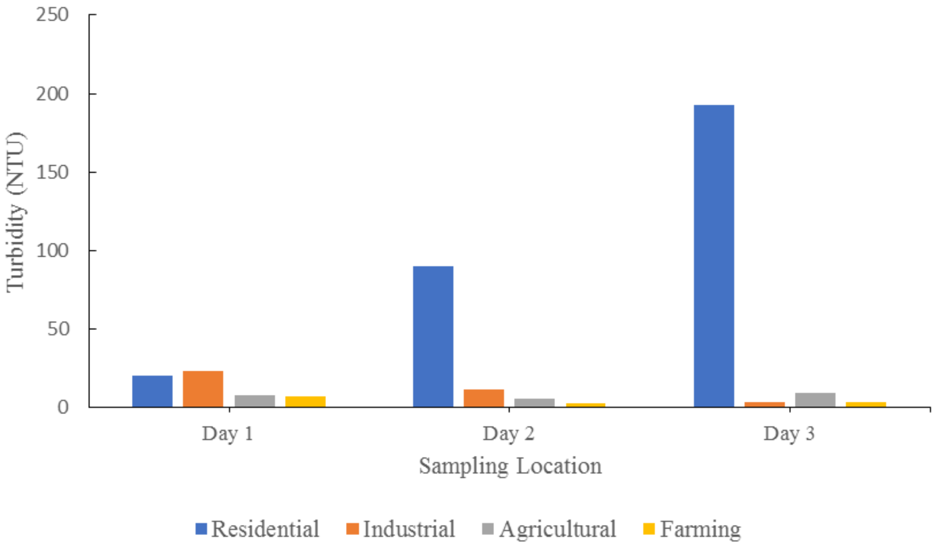

Fig. 34 - Difference of turbidity value over four sampling locations (wet season)

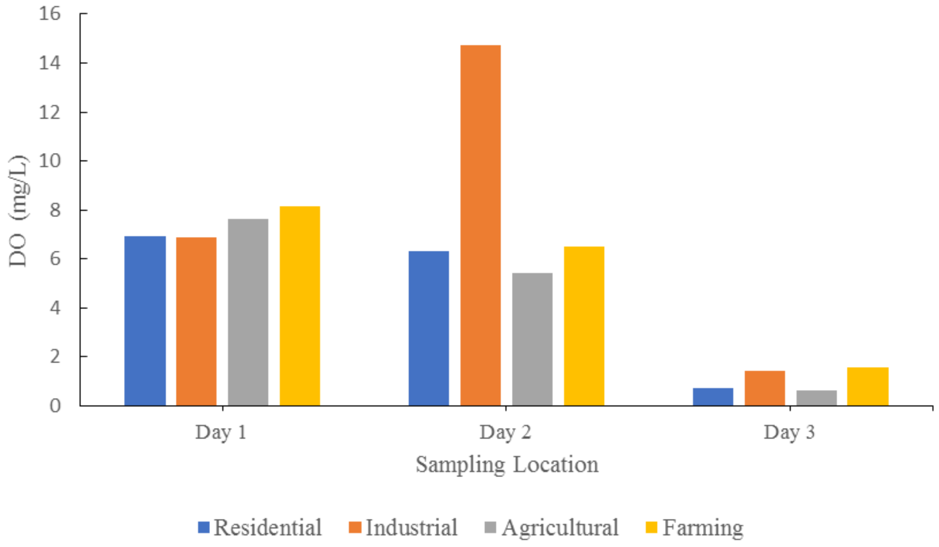

Fig. 35 - Difference of DO value over four sampling locations (wet season)

3.4.1 The Normalize Difference Vegetation (NDVI) using the Unmanned Aerial Vehicle (UAV) for Wet Season

The image of normalized difference vegetation (NDVI) for dissolved oxygen (DO) from Figure 36 to Figure 39 was taken during the wet season using an unmanned aerial vehicle (UAV). Figures 40 to 43 depict pH parameters, while Figures 44 to 47 represents temperature parameters. Also, from Figure 48 to Figure 51, the image for the turbidity parameter.

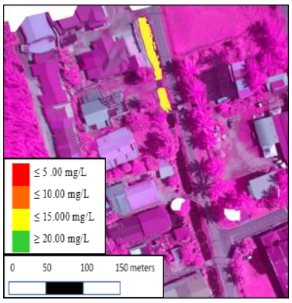

Fig. 36 - Residential area (S1) for dissolved oxygen (DO)

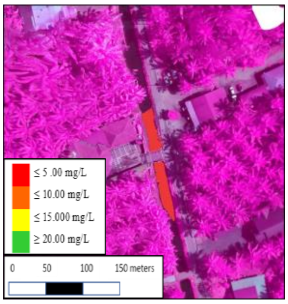

Fig. 37 - Industrial area (S2) for dissolved oxygen

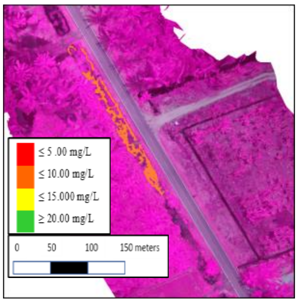

Fig. 38 - Agricultural area (S3) for dissolved oxygen

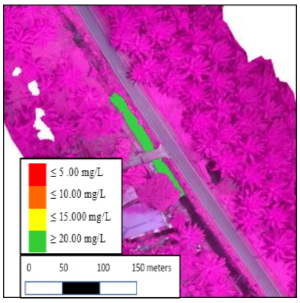

Fig. 39 - Farming area (S4) for dissolved oxygen

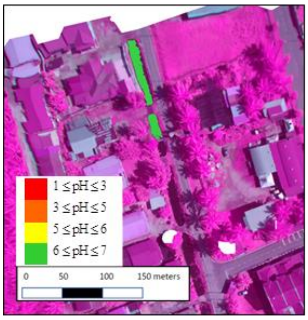

Fig. 40 - Residential area (S1) for pH

Fig. 41 - Industrial area (S2) for pH

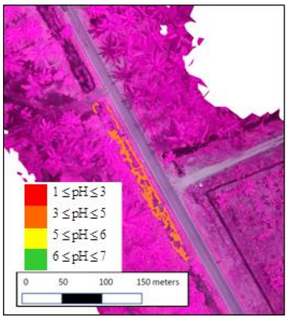

Fig. 42 - Agricultural area (S3) for pH

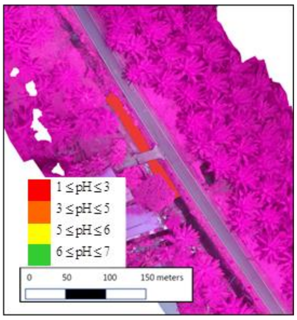

Fig. 43 - Farming area (S4) for pH

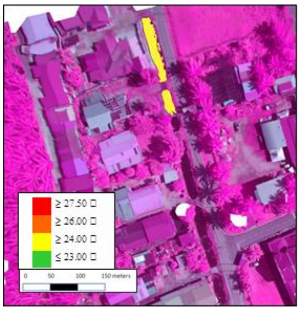

Fig. 44 - Residential area (S1) for temperature

Fig. 45 - Industrial area (S2) for temperature

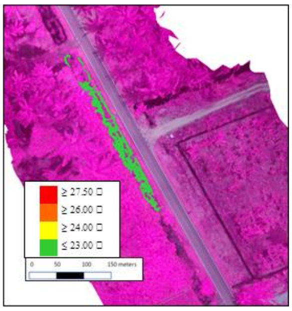

Fig. 46 - Agricultural area (S3) for temperature

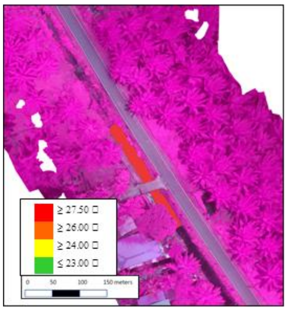

Fig. 47 - Farming area (S4) for temperature

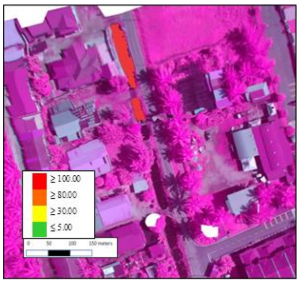

Fig. 48 - Residential area (S1) for turbidity

Fig. 49 - Industrial area (S2) for turbidity

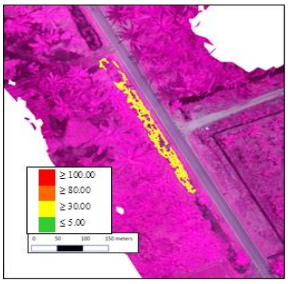

Fig. 50 - Agricultural area (S3) for turbidity

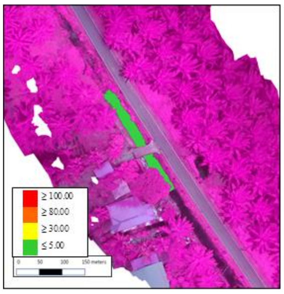

Fig. 51 - Farming area (S4) for turbidity

3.5 Analysis Data of Wet Season and Dry Season for Dissolved Oxygen (DO) pH, Temperature and Turbidity

Every sampling station had varying dissolved oxygen (DO) readings across three days of collection in both the wet and dry seasons. During the dry season, agriculture area (S3) had a lower concentration of dissolved oxygen (DO) (1.94 - 14.93 mg/L) than other areas, but farming area (S4) had a higher concentration of dissolved oxygen (2.38 – 7.15 mg/L) than other areas. According to Wahab et al., 2018 with the increased microbial activity (respiration) during the decomposition of organic matter can lead to decreases in DO concentrations in waste discharges high in organic matter and nutrients. The level of pollution by organic matter in the parameter may be determined by measuring DO, and sampling stations can be used to identify the level of water quality status.

The pH value was critical in assessing whether the water's nature had deteriorated or improved. According to the data acquired, during the dry season, the farming region (S4) had a lower pH (2.72 – 4.12) value, which means that the acidity was higher. This is because there was a well-organized and growing palm oil field near the farming region. As a result, it was discovered that various fertilizers and pesticides were applied in the palm oil field. At those sample points, aquatic species would have a hard time surviving. The pH could modify the aggregation or cohesion behaviors of the particles by changing the surface characteristics of the particles. The pH minimum value in the drainage system, which was less than 6.5, was listed as a non-priority pollutant. The values may have a long-term effect on aquatic life (Kumar Mandal, 2014).

The chemical rate of reactions and aquatic reproduction were influenced by the temperature of the water. The temperature of the sample was determined by the seasons, which consisted of two distinct seasons: dry and wet. The maximum temperature allowed was 30 degrees Celsius. In terms of temperature, the farming region (S4) had the greatest value with 27°C in the dry season, whereas the industrial area (S2) had the highest value with 30°C in the rainy season. When the temperature of the water is too high, it might influence the immunity of aquatics in the drainage because the higher the temperature, the lower the oxygen content (Zajíček et al., 2011).

The greatest value of turbidity for the dry season in the industrial area (S2) was more than 200 NTU. Furthermore, during the wet seasons, residential area (S1) had the highest value of 23.23 NTU. Human activities in the home area can hasten erosion. Tannic acids, which are commonly found in peat and bog environments, color water and produce turbidity. Turbidity can also be caused by algae that feed on nutrients that enter the stream through leaf decomposition or other naturally occurring decomposition processes. Sediment can be released as a result of stream channel movement. High turbidity can significantly reduce the aesthetic quality of lakes and streams, having a harmful impact on recreation and tourism. It can increase the cost of water treatment for drinking and food processing. It can harm fish and other aquatic life by reducing food supplies, degrading spawning beds, and affecting gill function (Fathi et al., 2022).

4. Conclusion

Based on the overall findings, the parameters of this study, such as dissolved oxygen (DO), pH, temperature, and turbidity, may have an impact on water quality. Changes in the concentration of the parameters in the drainage were influenced by land use along the Parit Rasipan drainage. According to the study's objectives, which included determining the water quality along the Parit Rasipan drainage system, the Parit Rasipan drainage system did not meet the NWQS in terms of dissolved oxygen (DO), pH, temperature, and turbidity. Due to the property used along the drainage, which contained the oil palm plantation, banana orchard, and also the sheep shed, the sites that threatened to be contaminated can be determined, which are agricultural area (S3) and farming area (S4). Those circumstances had an outlet that discharged water into the drainage system. Using the Agisoft Photoscan software, we were able to analyses the data and determine which region of the drainage area the highest concentration had based on all parameters. As a result of this condition, the water quality of the Parit Rasipan drainage system was not ideal.

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