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Study of Ammonia-Nitrogen and Phosphorus in Parit Rasipan Canal During the Wet Season

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Abstract: The Parit Rasipan Canal's deteriorating water quality and eutrophication are both blamed on ammonia-nitrogen and phosphorus. In order to conserve freshwater resources, it is crucial to understand the relationship between land use and water quality. It is also crucial to evaluate how land use affects the pollutants load. In this study, eutrophication along the Parit Rasipan drainage system will be identified, water quality will be investigated in terms of phosphorus and ammonia nitrogen concentration and classified according to land use type during the wet season, and ammonia-nitrogen and phosphorus concentrations will be compared with Normalized Difference Vegetation Index (NDVI) using unmanned aerial vehicles (UAV). At a specific location along the Parit Rasipan drainage system, samples were taken. The USEPA PhosVer 3 (Method 8190) and Nessler's Method (Method 8038) were used, respectively, to measure phosphorus and ammonia nitrogen. Ammonia nitrogen and phosphorus final effluent concentrations ranged from 3.21 mg/L to 5.96 mg/L and 0.36 mg/L to 1.55 mg/L, respectively. The residential area's water, on the other hand, had significant concentrations of ammonia, nitrogen, and phosphorus, which contributed to eutrophication in the wake of industrial, agricultural, and farming activities.

Keywords: Eutrophication, ammonia nitrogen, total phosphorus

1. Introduction

Anthropogenic activities have significantly increased the input of nutrients to aquatic ecosystems globally, with the pace of increase quickening in recent years [1]. When it relates to water resources, affected by human intervention across the world, through point and diffuse pollution sources and other impacts (e.g., dam building, mining), may create irreparable harm to the waterways, preventing the auto depuration process in the field of applied ecosystem and imposing qualitative and quantitative constraints on water supply. Diverse pollution sources, on the other hand, are determined by land use in the watershed. Many studies have attempted to explore the effects of land use on stream water nutrients, which are mostly processed by runoff, and their ecological consequences, with a focus on rural areas [2]. Population expansion and food production cause significant changes in the terrain, which increase sewage discharges and runoff from agricultural and inhabited areas. Eutrophication is increasingly acknowledged as a significant contributor to habitat alteration and the geographical and temporal spread of some hazardous algal bloom (HAB) species [3].

The purpose of this study is to discover eutrophication along the Parit Rasipan drainage system, where two parameters, ammonia nitrogen and phosphorus concentration, were measured during the wet seasons. The water

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sample collected from the Parit Rasipan drainage system was bottled in 1000ml HDPE bottles before being sent to the laboratory for wet season testing. Using unmanned aerial vehicles, the study will be compared to the Normalized Difference Vegetation Index (NDVI). The Standard Method for Water and Wastewater Examination was followed in all laboratory investigations.

2. Materials and Method

2.1 Study Area in Parit Rasipan Canal

Both laboratory and field activities were done throughout the inquiry, which was conducted in Parit Rasipan, Batu Pahat, Johor. A field study was done to count the sampling locations and measure the various factors. To identify the non-point and point sources of pollution, land use and activity patterns in the research region were monitored and investigated. Based on land use, four sample places were chosen, and their coordinates were found using a DJI Phantom 4 Pro drone and a Garmin GPS 73. The sampling points are depicted in Fig. 1 and their coordinates are listed in Table 1.

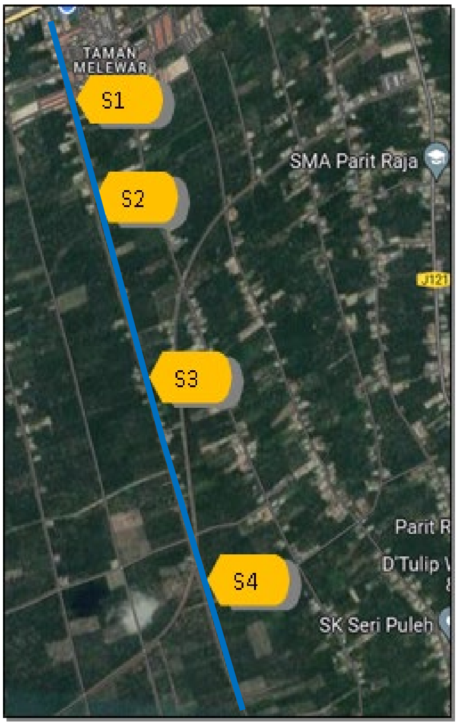


Fig. 1 - Sampling point along Parit Rasipan canal

Table 1 - Types of land used and sampling point coordinates

Sample Point	Land Used Zone	Coordinates of sampling point	
		N	E
S1	Residential	1°51'10.9"	103°05'48.5"
S2	Industrial	1°50'57.5"	103°05'51.6"
S3	Agriculture	1°48'56.9"	103°06'28.4"
S4	Farming	1°48'46.9"	103°06'34.4"

2.2 Data Collection and Aerial Image Processing

In this investigation, aerial pictures of the sample area were taken using a DJI Phantom 4 Pro unmanned aerial vehicle. On the ground, an NDVI camera will help to create a 3D view of the region. In order to record moving objects or those moving quickly while also preventing rolling shutter distortion and producing crisper, more vibrant photographs and films, a camera was mounted on the drone. The aerial pictures from the research region that were processed using Agisoft PhotoScan software and the results of the analysis are displayed in Geotiff format. The aerial photos were shown in the colours red, orange, yellow, and green to illustrate the concentration of each water quality metric.

2.3 Water Sampling and Data Analysis

Samples of water were collected from several sampling zones in the drainage system at Parit Rasipan over the course of three consecutive days with wet weather. The water samples have been analysed at MPRC, UTHM tested following the Standard Methods for wastewater analysis. The biological and environmental conditions in the vicinity of the sample zone were also observed at the same time. The samples concentrations of ammonia nitrogen and total phosphorus were assessed using the Nessler Method (Method 8038) and the acid persulfate digestion Method (Method 8190), respectively, using the HACH DR6000 Spectrophotometer. Water's chemical, physical, and biological characteristics might create challenges for the storage and preservation of water samples. In addition, various nutritional samples refer to various methods of preservation and storage. As a result, Table 2 details how the water sample was preserved and stored to determine its nitrogen and phosphorus content.

Table 2 - Storage and preservation of parameters [4]

Parameter	Sample Preserved	Storage recommended
Ammonia-N,	Analyze as soon as possible or add H_2SO_4 to pH<2 and cool, ≤6°C	7 days
Total-P	Add H_2SO_4 to pH<2 and cool, ≤6°C	28 days

3. Results and Discussion

3.1 Ammonia-N and Total-P

Tables 1 and Table 2 shows ammonia-nitrogen and total-phosphorus results. The water quality parameter value has been tabulated for the wet season. The difference in value in each selected point of land use was the reason for selecting the wet season.

Table 3 - Data result for Ammonia-N at selected point

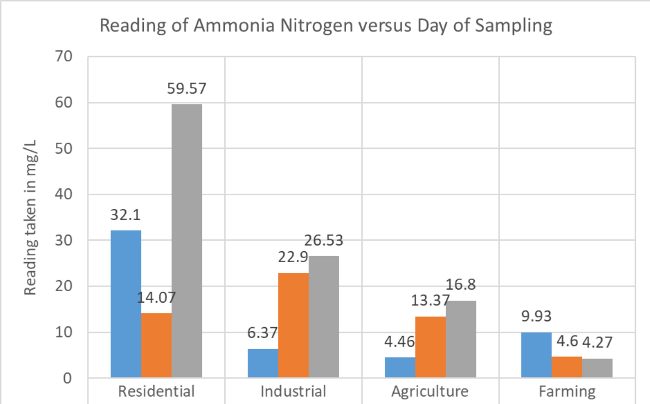
Sample	Reading of Nitrogen Ammonia $NH_3^{-}N$ in mg/L											
	Sampling 1				Sampling 2				Sampling 3			
	1	2	3	Avg.	1	2	3	Avg.	1	2	3	Avg.
Residential sone	3.21	3.21	3.21	3.21	1.48	1.50	1.51	1.50	5.90	5.96	6.01	5.96
Industrial zone	0.66	0.67	0.69	0.67	2.29	2.29	2.29	2.29	2.65	2.65	2.66	2.65
Agriculture zone	0.44	0.45	0.45	0.44	1.33	1.33	1.35	1.34	1.66	1.68	1.70	1.68
Farming zone	0.98	1.00	1.00	0.99	0.45	0.46	0.47	0.46	0.42	0.43	0.43	0.43

Table 4 - Data result for Total - P at selected point

Sample	Reading of Total Phosphorus PO_4^{3-} in mg/L											
	Sampling 1				Sampling 2				Sampling 3			
	1	2	3	Avg.	1	2	3	Avg.	1	2	3	Avg.
Residential zone	0.37	0.36	0.36	0.36	0.67	0.67	0.64	0.66	1.56	1.55	1.55	1.55
Industrial zone	0.84	0.82	0.81	0.82	0.96	0.93	0.93	0.94	0.87	0.84	0.82	0.84
Agriculture zone	0.31	0.30	0.30	0.30	0.87	0.86	0.85	0.86	0.66	0.66	0.66	0.66
Farming zone	0.27	0.27	0.26	0.27	0.41	0.40	0.41	0.41	0.61	0.60	0.60	0.60

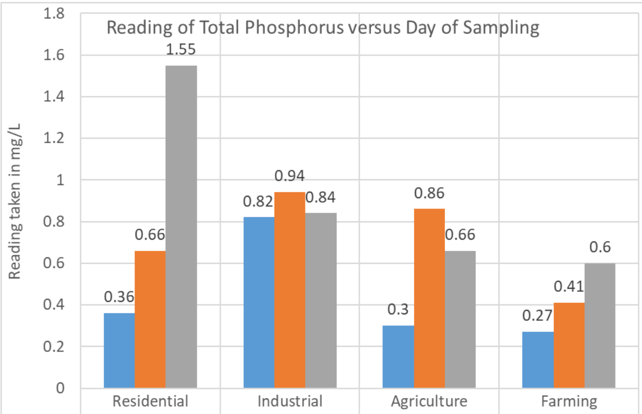
As shown in Fig. 2, the highest ammonia nitrogen concentrations were recorded on sampling 3, for the wet season were continuously recorded from Point 1 (residential area), ranging from 3.21 mg/L to 5.96 mg/L. The lowest ammonia-nitrogen concentrations were found at Point 4 (agricultural area), where they varied from 4.60 mg/L to 9.93 mg/L. For Malaysian surface water to support aquatic life, the NWQS maximum threshold level for ammoniacal nitrogen is 0.90 mg/L [5].

Meanwhile, as shown in Fig. 3 below, the phosphorus concentrations in Point 1 (residential areas) on sampling 3, for the wet season varied from 0.36 mg/L to 1.55 mg/L, as predicted. The primary sources are waste products from the local community's regular activities, such as human faeces and detergents. By hydrolysis in natural water, detergent polyphosphates generate orthophosphates, and these are the only forms of soluble inorganic phosphorus that may be used directly [6]. The lowest value of 0.27 mg/L was recorded on April 18th, 2022, at Point 4 (farming area).



	Residential	Industrial	Agriculture	Farming
Day 1	32.1	6.37	4.46	9.93
Day 2	14.07	22.9	13.37	4.6
Day 3	59.57	26.53	16.8	4.27

Fig. 2 - Reading of Ammonia-Nitrogen for residential, industrial, agriculture and farming zone



	Residential	Industrial	Agriculture	Farming
Day 1	0.36	0.82	0.3	0.27
Day 2	0.66	0.94	0.86	0.41
Day 3	1.55	0.84	0.66	0.6

Fig. 3 - Reading of Phosphorus for residential, industrial, agriculture and farming zone

3.2 NDVI Image of Ammonia-Nitrogen and Total-P

Overall findings, as shown in the figure, show the Parit Rasipan drainage's NDVI map. Within the vegetation cover, an area of red represents the highest NDVI; orange suggests slightly higher NDVI; yellow indicates moderate NDVI; and green indicates lower NDVI. The NDVI value is determined using ammonia nitrogen (AN) and phosphorus concentrations in mg/L. Hence, 3 days of NDVI images were plotted and produced by using Agisoft Photoscan software as shown in Fig. 4 to Fig. 9.

Based on the 3 days of NDVI images of AN, it can be indicated that residential area on day-1 (32.10 mg/L) and day-3 (59.57 mg/L) and industrial area on day-3 (26.53 mg/L) were the highest area with the most concentrated AN which labelled with red indicator. The high amount of ammonia nitrogen presence believed to be due to domestic waste and chemicals of industrial waste such as oil and grease. As stated by Chong et al. [7], the main sources of ammonia nitrogen come from domestic waste, livestock, farming and other liquid organic waste, especially heavy metals. Meanwhile for farming and agricultural areas were in range orange and green color indicator. It states that these two areas were slightly polluted with the low concentration of AN as shown in Fig. 4 to Fig. 6. According to Buss & Achten [8], the application of manure on farmland originating the high amount of nitrate in the surface water and agriculture is the sources of organic pollutant such as pesticides, biocides and pharmaceutical. It also states that nitrate is the main key parameter in catchment area which is dominated by agriculture.

The plotting of NDVI image of phosphorus is based on the result of water sample analysis as shown in Fig. 7 to Fig. 9. Based on 3 days of NDVI images, it can be indicated that industrial area in day-1 and day-2 and residential area day-3 were the highest area with the most concentrated phosphorus with labelled red indicator which are 0.82 mg/L, 0.94 mg/L and 1.55 mg/L, respectively. According to Ukaogo et al. [9], the presence of physiochemical content such as phosphate in water sources is caused by automobile repair activities. Thus, the discharge of industrial waste into the Parit Rasipan drainage system had increased the amount of concentration phosphorus. In the meantime, the high amount of phosphorus in residential areas was believed to be due to waste discharge from housing without any treatment and proper management [10]. Moreover, farming areas are the least contributor of phosphorus intro the Parit Rasipan drainage system. As shown in Fig. 7 to Fig. 9, it lays down on green indicator for day-1, day-2 and day-3 which are 0.27 mg/L, 0.41 mg/L and 0.6 mg/L, respectively. At the same time, agricultural area in day-2 slightly polluted by phosphorus and indicate by orange color. This is believed due to widely used of fertilizer in agricultural activities. According to Ferronato & Torretta [11], extensive use of organic fertilizer increases the collection of phosphorus in soil which may be lost into water sources through surface runoff and groundwater especially during wet season. Overall, the high contributor of phosphorus into Parit Rasipan drainage system is industrial area.

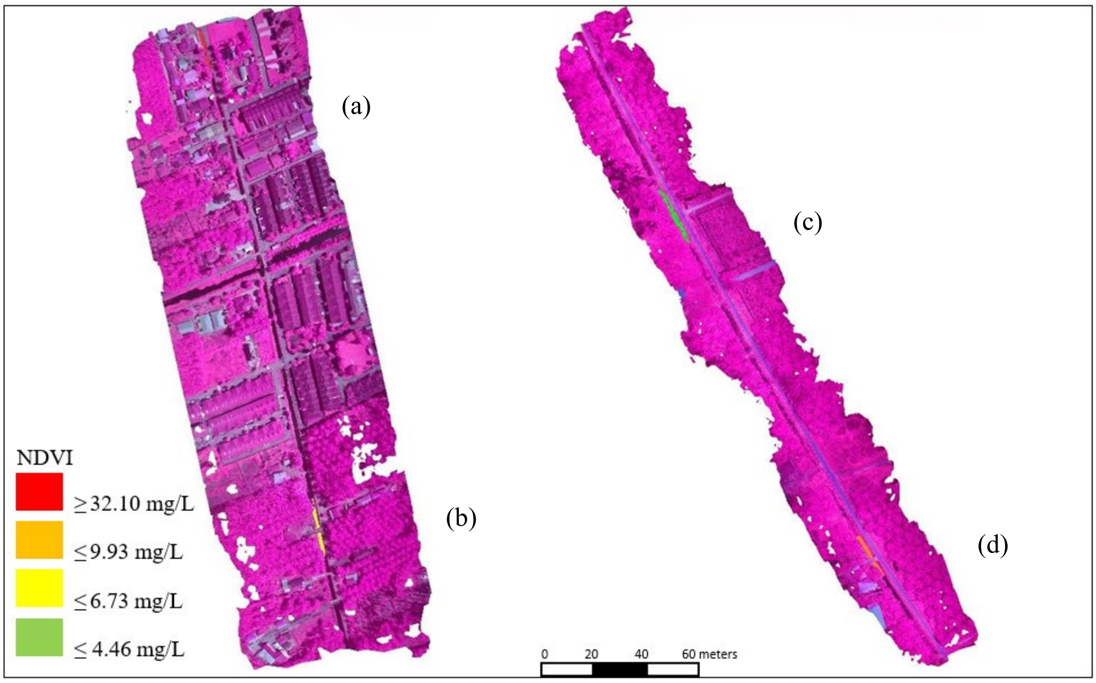


Fig. 4 - Day-1 NVDI image of AN concentration at (a) residential; (b) industrial; (c) agricultural, and; (d) farming

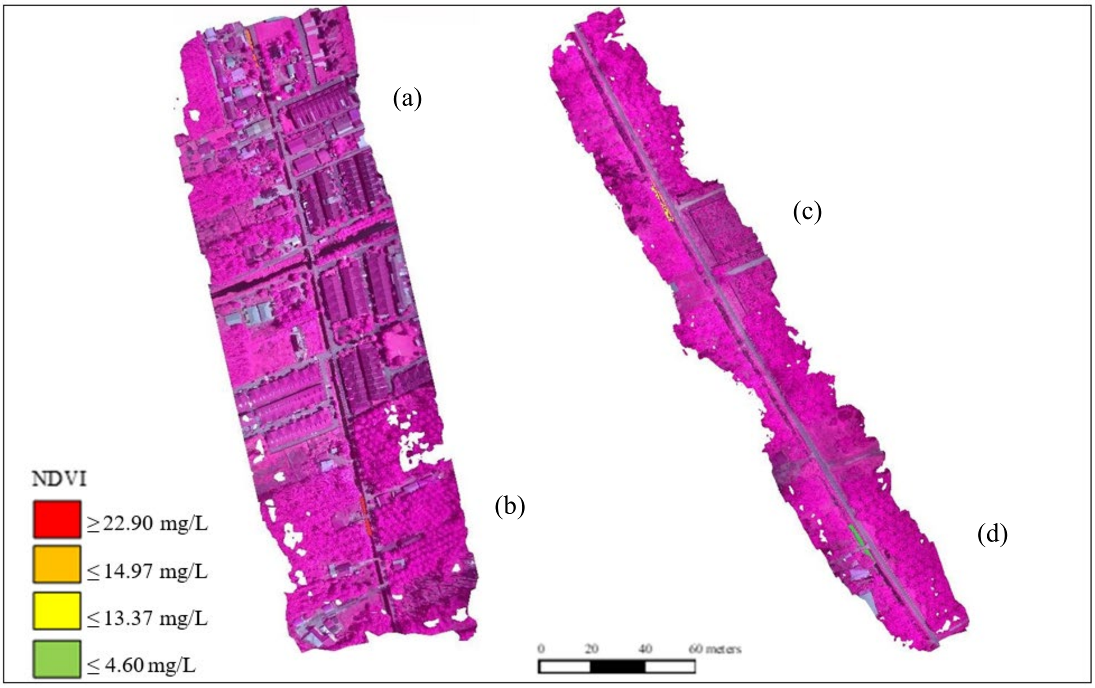


Fig. 5 - Day-2 NVDI image of AN concentration at (a) residential; (b) industrial; (c) agricultural, and; (d) farming

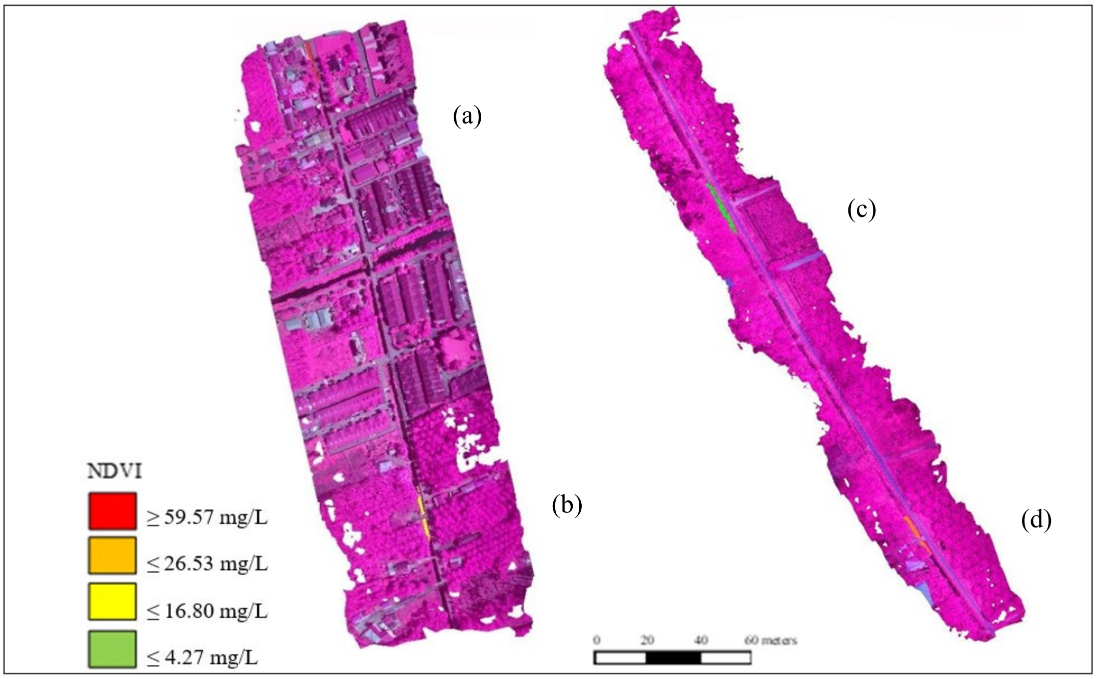


Fig. 6 - Day-3 NVDI image of AN concentration at (a) residential; (b) industrial; (c) agricultural, and; (d) farming

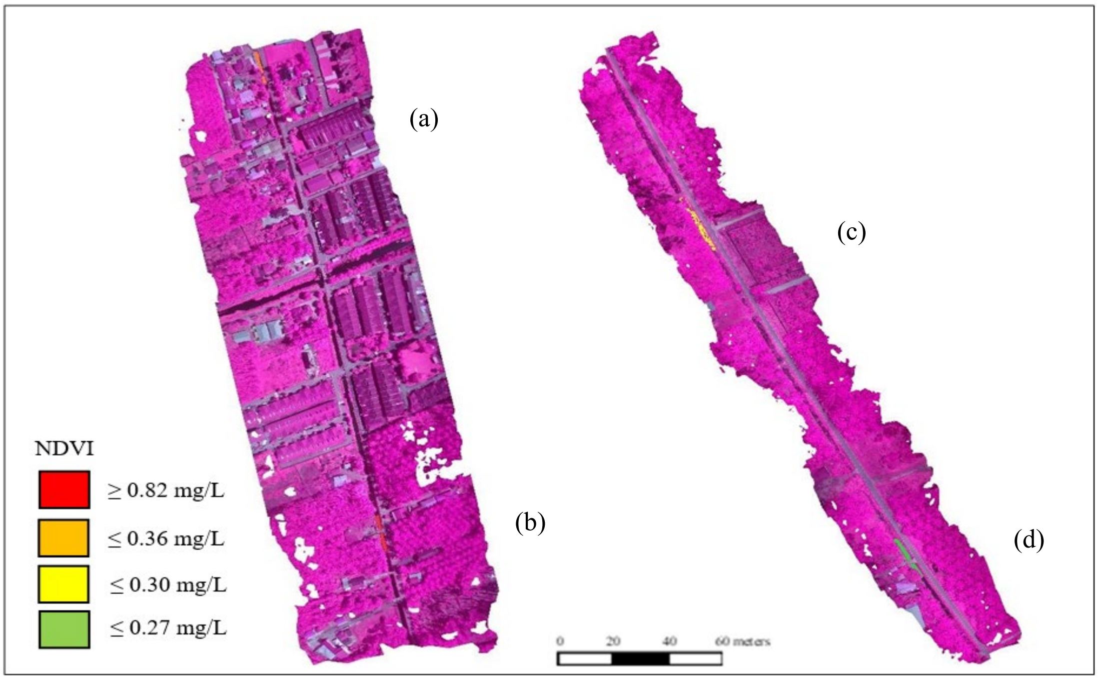


Fig. 7 - Day-1 NVDI image of phosphorus concentration at (a) residential; (b) industrial; (c) agricultural, and; (d) farming

(d)

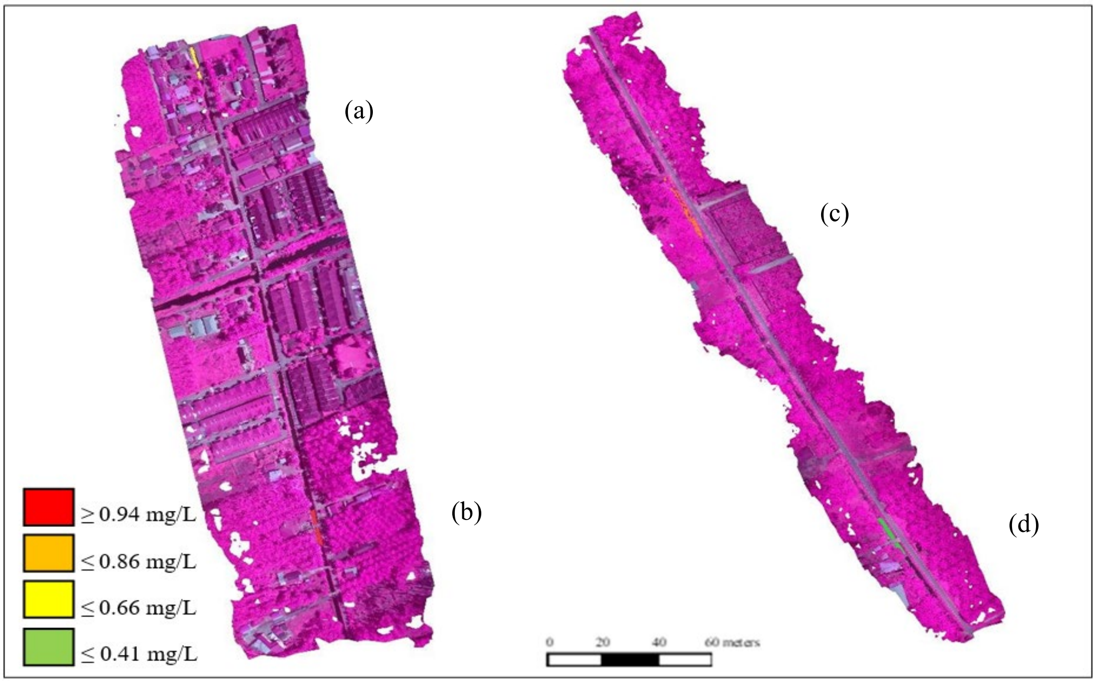


Fig. 8 - Day-2 NVDI image of phosphorus concentration at (a) residential; (b) industrial; (c) agricultural, and; (d) farming

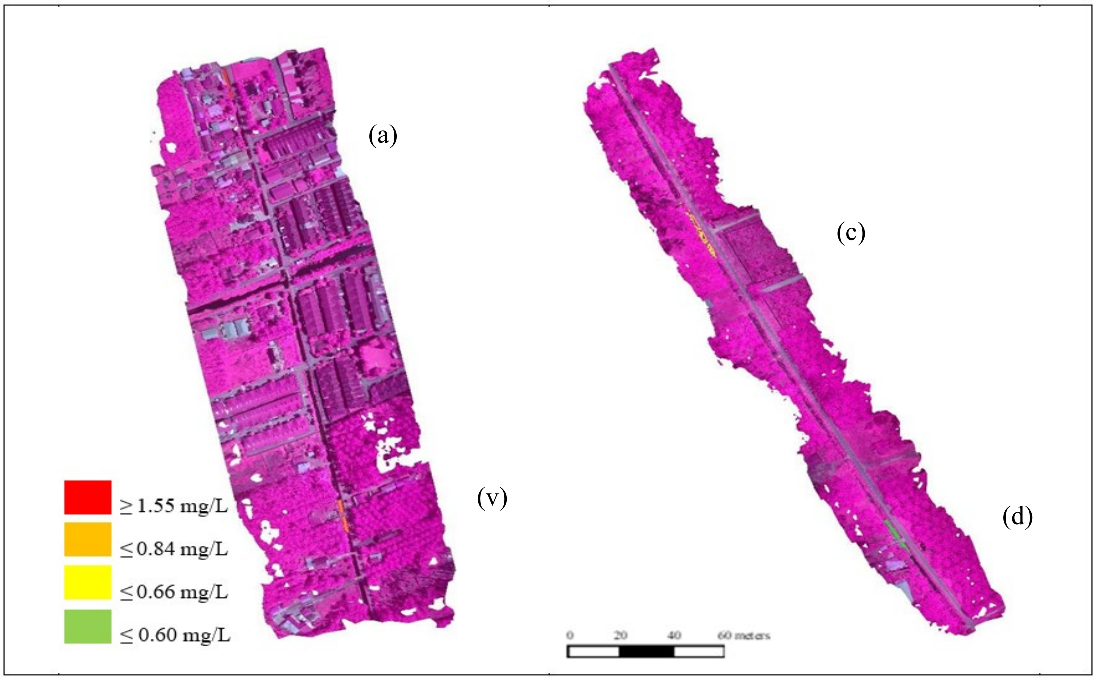


Fig. 9 - Day-3 NVDI image of phosphorus concentration at (a) residential; (b) industrial; (c) agricultural, and; (d) farming

4. Conclusion

The analysis's findings showed that the Parit Rasipan discharge's water qualities fluctuated. In contrast, point 1 is a residential neighbourhood with the greatest ammonia nitrogen concentration range of 3.21 mg/L to 5.96 mg/L, showing that high nitrogen levels in water might cause excessive plant and algae development, lowering oxygen levels to levels that could be fatal when paired with phosphorus. The future study must keep track of all aquatic vegetation and water quality metrics. The two water quality indicators, AN and P, were measured in-situ to provide the inquiry with the most accurate results. The sample should be collected during the wet season for the best results.

The sampling point for the wet season needs to be precise and close to water. The outflow, where sewage is mixed with various chemicals and compounds during the rainy season, must be used to recover water.

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