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ESTIMATION OF THE IMPACT OF TRAFFIC DENSITY ON AMBIENT AIR DUST LEVELS IN URBAN AREAS THROUGH SPATIAL ANALYSIS

NARIS DYAH PRASETYAWATI [1], SURANTO TJIPTOWIBISONO [2]*, PRANOTO PRANOTO [3] and SUNARTO SUNARTO [4]

[1, 2, 3, 4] Environmental Science Study Program, Sekolah Pascasarjana Universitas Sebelas Maret Surakarta, Central Java, Indonesia. *Corresponding Author Email: suranto57@staff.uns.ac.id
Email: [1]naris.dyahp@student.uns.ac.id, [3]pakpranoto@gmail.com, [4]rm.sunarto@staff.uns.ac.id

Abstract

Global carbon emissions reached 32 billion tons of CO2 in the atmosphere in 2020, and this condition is not yet seen to decrease in the future. CO2 emissions continue accumulating and cause a temperature rise that causes global warming by about 1o C. Sources of outdoor air pollution come from traffic activities, industrial chimneys, forest fires, and household waste incineration activities. This study aims to determine the estimated impact of traffic density on ambient air dust levels in urban areas through spatial analysis. This research uses a descriptive qualitative method. Data collection is carried out by direct measurement at the location and then continued examination in the laboratory. The ampelous sampling point was taken on the highway using roadside air sampling. Furthermore, this study's results state a significant relationship between traffic density and the volume of dust particle levels in the surrounding environment. Identification of hazards and risks from traffic conditions to impacts must be detailed. Furthermore, it can also determine the value of risks and control efforts that can be carried out to minimize the impact that occurs. If these mitigation efforts can be carried out, then the parties' involvement is also significant to be optimized.

Keywords: Traffic Density; Dust Content; Ambient Air; Spatial Analysis

INTRODUCTION

Global carbon emissions reached 32 billion tons of$_{CO2}$ in the atmosphere in 2020, this condition is not yet seen to decrease in the future. CO_2 emissions globally continue to accumulate and cause temperature rise to cause global warming around 1^o C (Garret, 2022). Sources of outdoor air pollution come from traffic activities, industrial chimneys, forest fires and household waste incineration activities. The main types of pollutants that cause health problems are particulates, Carbon monoxide, ozone, nitrogen dioxide and sulfur dioxide (WHO, 2022). This has caused urban air quality to decline (Padoan, et al., 2018). Meanwhile, primary emissions of urban air from traffic (28%) and industry (27%) are also caused by the contribution of PM_{10} and $PM_{2,5}$ (Han, et al., 2022), these two parameters during the lockdown period due to the Covid 19 pandemic experienced a significant decrease in several locations compared to the same time period in the previous year (Said, et al., 2022). Traffic activity contributes greatly to the presence of $PM_{2.5}$ particles in the atmosphere through engine exhaust emissions and dust formation on highways (Wang, et al., 2022). Although the information available is very limited, it is strongly suspected that there are harmful elements of bus dust that settle on the road, posing a risk to individual health. (Botsou, et al., 2020). Road dust resuspension has the highest impact on PM_{10} concentrations Ambient air pollution by $PM_{2.5}$ and ozone was found to be linked to all causes of death of up to 9 million deaths in 2015 and was largely cerebro and cardiovascular

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(stroke and heart disease) (Daiber, et al., 2020). Road dust resuspension has the highest impact on PM_{10} concentrations Ambient air pollution by $PM_{2.5}$ and ozone was found to be linked to all causes of death of up to 9 million deaths in 2015 and was largely cerebro and cardiovascular (stroke and heart disease) (Padoan, et al., 2018). Areas with foggy daily conditions will weaken the vertical mixing process and are directly related to an increase in aerosol concentration on the surface (Ngoc, et al., 2021)

The impact of air pollution resulting from traffic activities in urban environments is a social and scientific topic that is widely studied, this is related to the health and economic impacts on individual communities and communities (Morillas, et al., 2022). Air pollution can have a severe impact on public health. An increase in one standard deviation (P.Bachler, et al., 2021) in PM 10 led to an additional 0.79 hospitalizations per 100,000 inhabitants. While older people become a sensitive group to exposure to air pollutants (Giaccherini, et al., 2021). In particular, $PM_{2.5}$ is able to pass through the deepest respiratory tract causing the onset of diseases of the respiratory tract, causing cardiovascular (Cristaldi, et al., 2022) disorders because it causes dysregulation of neurohormonal stress pathways and can trigger inflammation and oxidative stress that causes secondary damage to cardiovascular structures. Another impact is (Daiber, et al., 2020)neurodegenerative disorders (progressive nerve dysfunctions that can cause Alzheimer's disease, Parkinson's, vascular dementia, multiple sclerosis). (Cristaldi, et al., 2022)Traffic noise has a positive relationship to mental disorders and bipolar while in the event of major depression it has a negative relationship (Hao, et al., 2022)

Using the Geographic Information System, people can easily understand and see the air conditions in their environment. The distribution of pollutants and the range can also be estimated before they occur. Through this medium can be made certain spatial characteristics representing the conditions of PM emissions from the surrounding environment. Efforts to estimate the impact of air pollution using the GIS spatial analysis method have been carried out in Iran in the form of sandstorm and dust vulnerability (Yang, et al., 2020)(Boloorani, et al., 2021) The impact of air pollution is very large and widespread, but there is not much information and data about these conditions. Society is also less socialized about this condition. This study aims to show the influence of traffic density with the occurrence of particle pollution in ambient air through spatial analysis.

METHOD

Data collection is carried out by direct measurement at the location then continued examination in the laboratory. The ampelous sampling pointwas taken on the highway using the roadside air sampling method. Measurements are carried out on site on the traffic density parameter carried out calculations directly in the field while for dust particles, samples that have been taken are then taken to the laboratory for the drying and weighing process of filter paper. The sampling location is carried out at the point shown in table 1.

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Table 1

Location Code	Pickup Location	Coordinates	
		X	Y
1	Jl. Kyai Mojo 115 Yogyakarta	0428458	9139817
2	Jl. Magelang 127 Karangwaru Yogyakarta	0429570	9140817
3	Jl. Bantul 302 Yogyakarta	0428852	9134978
4	Jl. Kusumanegara 182 Yogyakarta	0433200	9137532
5	Jl. Laksda Adisucipto 77, Demangan, Gondokusuman, Yogyakarta	0432920	9139612
6A	Jl. Jend. Sudirman 70, Gondokusuman, Yogyakarta	0431503	9139635
6B	Jl. Jend. Sudirman 38, Gondokusuman, Yogyakarta	0430779	9139641
6C	Jl. Jend. Sudirman 10, Jetis, Yogyakarta	0430262	9139637
7A	Jl. P. Mangkubumi No 58a, Jetis, Yogyakarta	0430205	9139577
7B	Jl. P. Mangkubumi 95, Jetis, Yogyakarta	0430166	9139284
7C	Jl. P. Mangkubumi 05, Gedong Tengen, Yogyakarta	0430134	9138967
8A	Jl. Malioboro 61, Yogyakarta	0430139	9138849
8B	Jl. Malioboro 51, Yogyakarta	0430059	9138340
8C	Jl. Malioboro 39, Yogyakarta	0429995	9137924
9	Jl. RE Martadinata 61, Yogyakarta	0428347	9137644

RESULTS

A passenger car unit (smp) is a unit of vehicle in traffic flow, equivalent to using the equivalent equivalence of a passenger car vehicle. The unit of passenger car is influenced by the type or type of vehicle, the dimensions of the vehicle and the ability to move the vehicle. Traffic volume is the number of vehicles passing through a certain point or line at a cross section of the road. *Traffic counting* is a method to get the results of calculating traffic volume by enumerating traffic flow. This method is carried out by calculating all types of vehicles passing in each direction of the vehicle and then recorded in a recording result. The required enumeration time interval is between 15-20 minutes. Light vehicles (LVs) include passenger cars, microbes, pickups and sedans. Heavy vehicles (HVs) include buses, 2 US trucks, 3 US trucks and motor vehicles over 4 wheels while motorcycles (MC) include 2- and 3-wheeled motor vehicles. The total traffic flow in passenger car units (smp) per hour is: (Sweroad, PT Bina Karya (Persero), 1997)

$$\mathbf{Q\ smp = (Emp_{LV} \times LV + Emp_{HV} \times HV + Emp_{MC} \times MC)}$$

Q : motor vehicle volume

Emp LV : the equivalent value of a passenger car for a light vehicle

Emp HV : passenger car equivalent value for heavy vehicles

Emp MC : equivalent value of a passenger car for a motorcycle

LV : notation for light vehicles (1, 0)

HV : notation for heavy vehicles (1, 3)

MC : notation for motorcycles (0.40)

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This study was conducted by taking data twice in one day, namely in the morning between 07.00-09.00 WIB and in the afternoon between 16.00-18.00 WIB. Data collection is carried out at 15 points which are locations with indications of heavy traffic density. The location is also a crossing route between Yogyakarta City and the surrounding buffer area, so that every morning and evening it is the main route for students and workers to do activities in Yogyakarta City. The results of the enumeration of motor vehicle volumes are shown in table 2.

Table 2: The results of the enumeration of vehicle volume on the road section of Yogyakarta City, Indonesia

No	Point Code	Passenger car equivalent (Emp) morning			Passenger car equivalent (Emp) afternoon		
		MC	LV	HV	MC	LV	HV
1	**1**	684.8	286	11	619.6	421.2	4
2	**2**	750	1205.1	14	577.2	578.5	9
3	**3**	442	334.1	10	440.4	208	3
4	**4**	447.2	185.9	14	263.2	226.2	24
5	**5**	1196.4	566.8	15	672.8	642.2	4
6	**6A**	471.2	495.3	6	93.6	1397.5	5
7	**6B**	478.8	400.4	10	538	462.8	2
8	**6C**	456.4	507	25	546.4	573.3	10
9	**7A**	248	247	2	232.4	256.1	6
10	**7B**	174.4	161.2	7	236.4	269.1	7
11	**7C**	111.2	152.1	4	162.4	180.7	6
12	**8A**	164.4	267.8	5	193.2	266.5	1
13	**8B**	139.6	188.5	4	70.8	496.6	3
14	**8C**	152.4	200.2	6	150.8	195	4
15	**9**	813.6	266.5	13	802.8	328.9	10

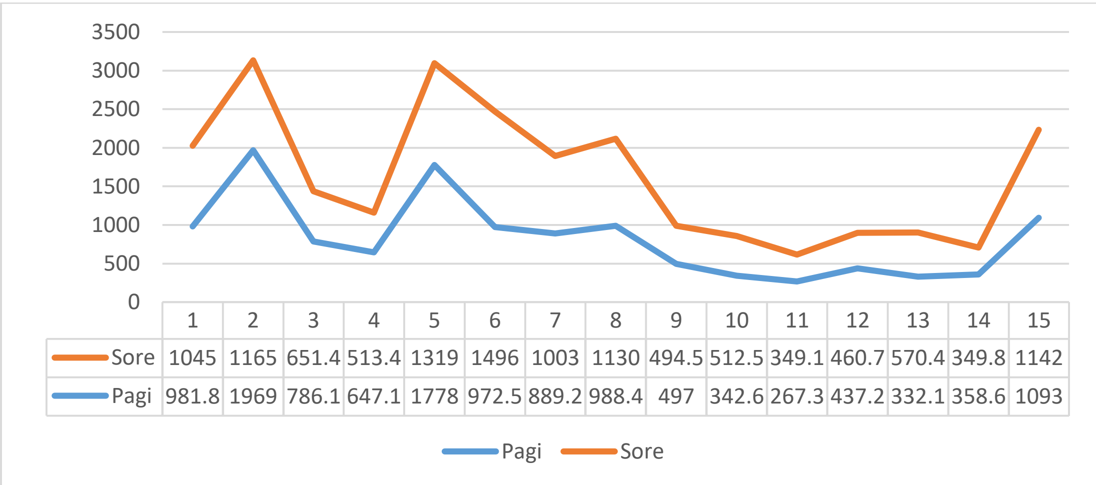

Figure 1: Comparison of the volume of motorized vehicles on the roads of Yogyakarta City, Indonesia

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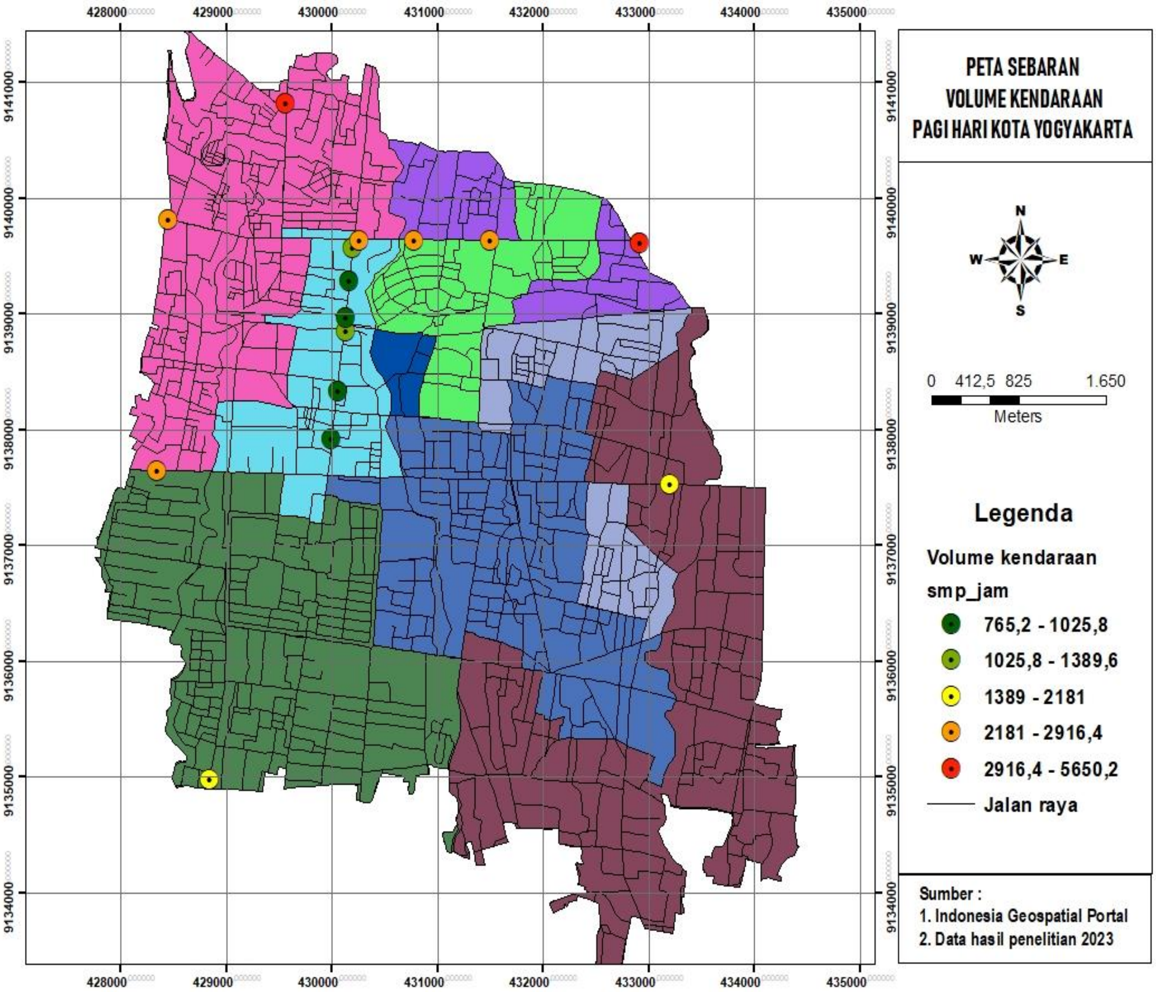

Figure 2: Map of the distribution of vehicles in the morning in Yogyakarta City

Through the map in figure 2, it can be seen that there are seven points with vehicle density levels between 2181-5850 smp / hour. This condition describes the relationship between volume and traffic density. Traffic density will increase if the traffic volume also increases, When the maximum volume is reached, the road lane capacity has been reached. The volume of vehicles will decrease even if the density increases, resulting in congestion (Abdi, et al., 2019).

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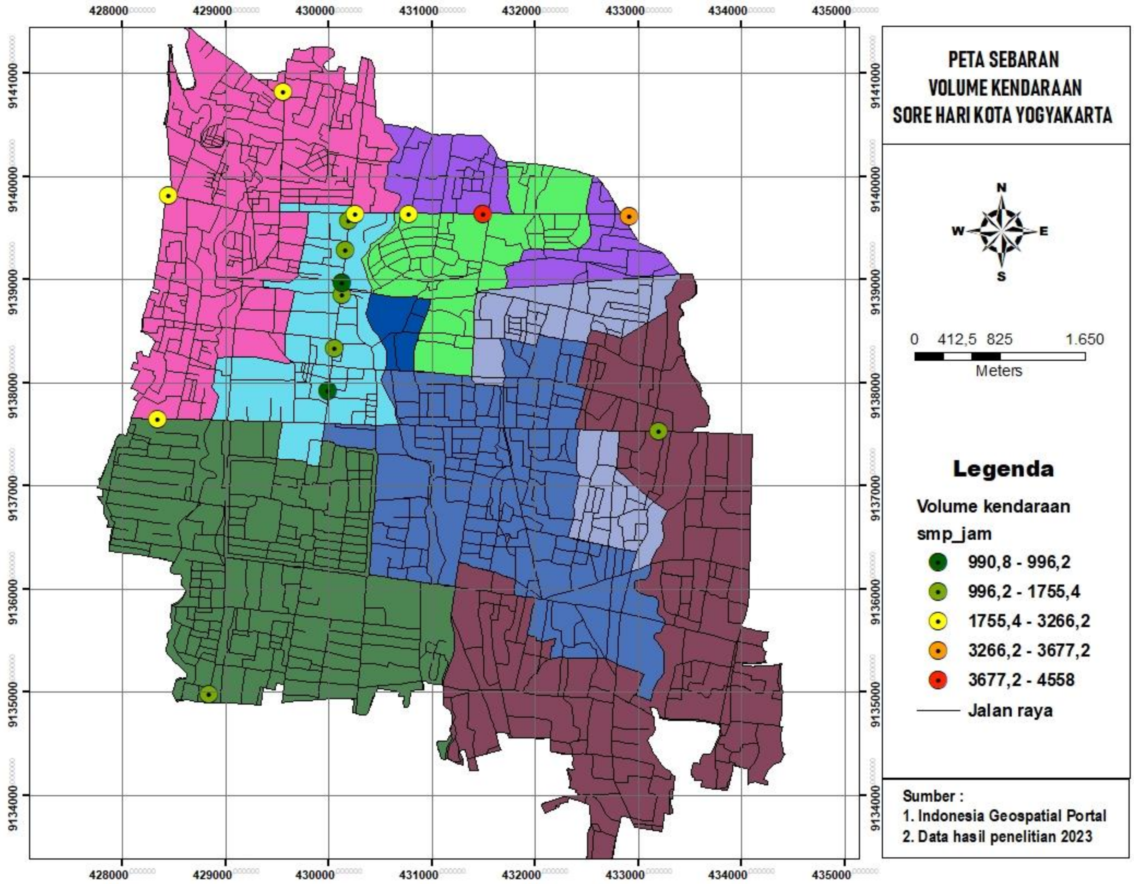

Figure 3: Map of the distribution of vehicles in the afternoon in Yogyakarta City

There was an increase in the number of vehicles leaving Yogyakarta City in the afternoon. This condition is seen in figure 3, the value of smp/hour has increased. This condition can occur because in the afternoon the time of completion of work in several agencies in Yogyakarta City is completed between 15.00-16.00 WIB.

Table 4: Ambient air dust content in Yogyakarta City, Indonesia

Location Code	Gram/m dust content^3 (30 minutes) morning	Gram/m dust content^3 (24 hours) morning	Gram/m dust content^3 (30 minutes) afternoon	Gram/m dust content^3 (24 hours) afternoon
1	0.002666667	0.128	0.001333333	0.064
2	0.002666667	0.128	0.000666667	0.032
3	0.002	0.096	0.005333333	0.256
4	0.002	0.096	0.002666667	0.128
5	0.002666667	0.128	0.002666667	0.128
6A	0.001333333	0.064	0.002	0.096
6B	0.002666667	0.128	0.001333333	0.064
6C	0.002666667	0.128	0.002	0.096
7A	0.001333333	0.064	0.002	0.096

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7B	0.002	0.096	0.002	0.096
7C	0.001333333	0.064	0.001333333	0.064
8A	0.002	0.096	0.000666667	0.032
8B	0.002666667	0.128	0.001333333	0.064
8C	0.001333333	0.064	0.003333333	0.16
9	0.004	0.192	0.003333333	0.16

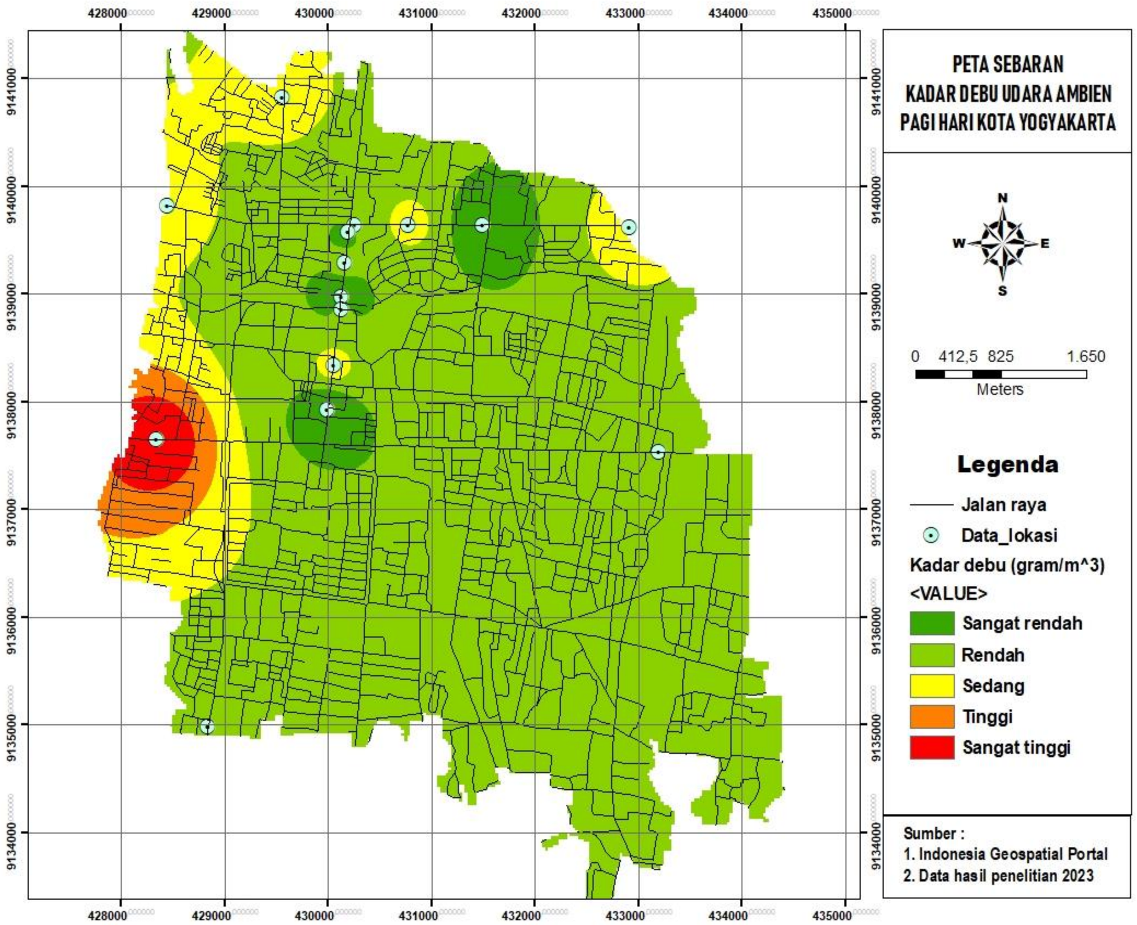

Figure 5: Ambient air dust level conditions in the morning in Yogyakarta City

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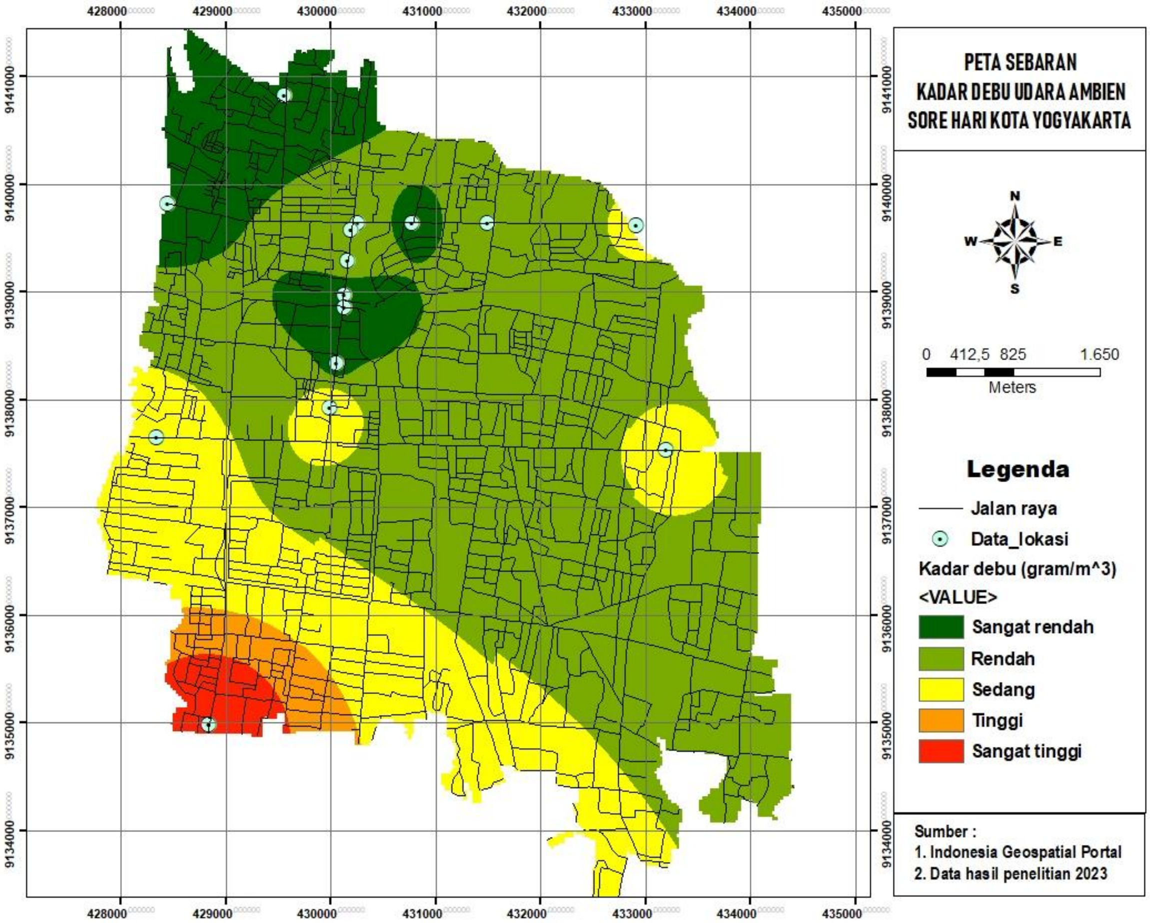

Figure 6: Ambient air dust levels in the afternoon in Yogyakarta City

DISCUSSION

The effect of reducing the impact of PM exposure decreases as the distance from the main source of exposure is released. The impact of exposure to air pollution felt indirectly has a significant influence on the effect of individual satisfaction with the journey he travels (P.Bachler, et al., 2021)(Ma, et al., 2021). Efforts to reduce vehicle exhaust emissions are not directly proportional to the presence of dust particles in the air. Road dust that is already in the atmosphere will not decrease at the same speed. The concentration of various harmful substances in dust is significantly higher in transportation areas than in residential and industrial areas. One of these conditions can occur due to tissue density. Non-exhaust particles coming from traffic, especially tires, brakes and road wear are also one of the main sources of microplastics and potential dust in the environment. The wear process that occurs depends on the type of tire, road surface, vehicle being driven, tires and particles using brakes with a size of <10 μm. The presence of microplastics in the air has a significant influence on the presence of dust in the air. In dust samples that settle in the environment found the content of Fe, Carbon

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particles and various particles containing Ba, Cu, Pb and Zn which are usually obtained from motor vehicle emissions. (Wang, et al., 2022)(Chang, et al., 2021)(Monira, et al., 2022)(Botsou, et al., 2020)

Exposure to air pollution has a long-term impact on the occurrence of mental disorders, including nervous symptoms, anxiety, tension, depression and bipolar. Every time the PM 2.5 pollutant level increases by 10g/m^3, the risk of major depression will increase by 2.26 times while bipolar disorder increases by 4.99 times. (Hao, et al., 2022)An individual who inhales Hg vapors and contacts the skin at levels that exceed the threshold can potentially experience health problems in the form of cancer. Passengers of public vehicles have significant potential health risks due to dust exposure from transportation activities. This condition will be increasingly risky in the elderly and elderly groups (Botsou, et al., 2020)(Liu, et al., 2020).

CONCLUSION

Based on the results of the description that has been carried out previously, it can be concluded that there is a significant relationship between traffic density and the volume of dust particle levels in the surrounding environment. Identification of hazards and risks from traffic conditions to impacts must be detailed. Furthermore, it can also determine the value of risks and control efforts that can be carried out to minimize the impact that occurs. If these mitigation efforts can be carried out, then the parties' involvement is also significant to be optimized.

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