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Air pollution dispersion in urban street

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ABSTRACT

The purpose of this study is to determine the level of air pollution due to traffic and the amount of CO, CO_2, and water quality monitors issued by vehicles in the city of Bandung. To measure the dispersion of air pollution, we measure at different altitude points in the same location. One is measured on the ground, and another is measured at an altitude of approximately 35 meters. For comparison, we tested measurements before and after rain. The results show that the basic and above concentrations are different. Even though the conditions are rainy, it still shows similar results, if at the bottom of the soil the concentration is higher than the concentration of a height of 35m. That happened because the most polluted sources of air pollution are at point 0 M, because the biggest source of air pollution in big cities like Bandung is motorcycle fumes. Y concentration is lower than that at bottom. Therefore, this study can provide information about the existence of pollution dispersion processes that can be a reference when calculating the actual situation.

Keywords: Air quality monitor; CO; CO_2; education; pollution.

INTRODUCTION

Air pollution occurs when harmful or excessive quantities of substances including gases, particles, and biological molecules are introduced into Earth's atmosphere. It may cause diseases, allergies, and even death to humans; it may also cause harm to other living organisms such as animals and food crops and may damage the natural or built environment. Both human activity and natural processes can generate air pollution. Sources of air pollution can come from natural sources, such as volcanoes and sources made by human actions, such as industrial exhaust gases and motorized vehicles. In urban areas, more air pollution problems originate from artificial sources. The problem of artificial pollution in urban areas will increasingly increase along with the rapid urbanization process. This increase in population is relatively high in urban areas, causing problems for the environment, one of which is air pollution. Therefore, the rapid increase in population in urban areas with mobility activities will affect the environment. Increasing the number of residents in the city increases the number of trips per day, at least equal to the increase in population. Furthermore, an increase in the number of trips will increase the vehicle use, one of which is motorized vehicles, where the largest source of air pollution in large cities is motor vehicle fumes (Kwanda, 2003). The imbalance in the increase in the number of vehicles with available road facilities has resulted in several road segments becoming the main public transportation routes in the city, which can cause problems such as congestion. Congestion is a condition when there is an increasing number of vehicles on the road so that the road cannot accommodate the number of vehicles until there is no movement in the road. Besides that, a road can be indicated to happen in a congestion when the number of vehicles is out of capacity. Therefore, it can result in no vehicle movement and has a tendency to slow down.

According to Ali *et al.* (2015), motorized traffic jams can cause negative impacts in various aspects such as aspects of time, cost aspects, and environmental aspects of traffic congestion that will cause air pollution. Pollutants released by motorized vehicles include carbon monoxide (CO), nitrogen oxides (NOx), hydrocarbons (HC), sulfur dioxide (SO_2), lead (Pb), and carbon dioxide (CO_2). Based on its physical properties, pollutants can be divided into gas pollutants and particle pollutants. Gas pollutants are air pollutants in the form of gas or steam. Gas pollutant molecules can directly enter the respiratory tract. Particle pollutants are often referred to as particulate matter (PM). Particulate matter is the main pollutant that has an impact on health. This pollutant consists of elements of sulfate, nitrate, ammonia, sodium chloride, carbon mineral dust, and water suspended in the liquid phase and solid in the air. The type of PM as an indicator of air pollutants can be divided into PM10 and PM2.5. The size of PM10 diameter was 2.5–10 μm while PM2.5 was < 2.5 μm (Faisal *et al.,* 2019). At present, there is a lot of research on the occurrence of air dispersion. Dispersion is a process that occurs through the air and the chimney (plume) causing the movement of contaminants and is able to spread it to a large area so that the concentration in the area becomes reduced. Sengkey *et al.* (2011) explained on weekdays that the highest concentration of pollutants in big cities occurs during the day. The highest concentration of pollutants occurs in the afternoon, while the research of Pande Made Udiyani *et al.* explains the consequences of dispersion of urban and rural areas, which results in higher air dispersion and surface deposition activities in rural areas compared to urban areas (Udiyani *et al.,* 2015). Accepted doses for rural areas is higher compared to the received doses of urban areas. The maximum effective individual dose for rural areas is 9.24×10^{-2} Sv and the urban area (urban), 5.14×10^{-2} Sv (Udiyani *et al.,* 2015). While Soleiman and Ismiyati *et al.* (2008; 2014) explained motorized vehicle emissions, namely, the Efforts to Reduce the Impact of Pollution / Air Pollution in urban areas, they both argued that reducing private vehicles and increasing the desire for public transportation were a powerful method, besides also being helping with the role of local government. Conforming to literature (Gorahe *et al.,* 2015), besides speed influencing the amount of emissions by vehicles, the amount of traffic volume on the highway affects the amount of emissions generated by them. As for the highway street, the amount of emissions produced is the effect of the number of vehicles and traffic volume. Therefore, in the case of air pollution around the highway, a certain length of the main control over traffic emissions is done to control traffic volume. In addition, in managing air quality, the monitoring aspect is not sufficient enough to become the basic information on pollution control efforts. This happens because the identification of sources and the estimated number of air pollutants in each source, region, and a certain period of time are not carried out. Therefore, an emission inventory is needed as a basis for making policies related to strategy and regulation, evaluating air quality status (Handika *et al.,* 2019). Meanwhile, public health issues, namely, regarding the increase in chronic diseases due to air pollution, are increasingly evolving and efforts to reduce these pollution (Kumar *et al.,* 2015).

From the results above, the authors analyzed the level of distribution of air pollution due to traffic and the large concentration of CO, CO_2, and air quality monitors. Air Quality Monitor is a tool that is able to continuously monitor the development of air quality both indoors and outdoors. Besides, CO_2 is a liquid gas that is colorless, odorless, non-flammable, and containing little acid, whereas CO is a gas that is colorless, odorless, and tasteless like CO_2 but it consists of one carbon atom, which is covalently bonded with one oxygen atom. There is still a bit of literature that discusses the extent of the spread of air pollution due to traffic and the amount of CO concentration released by vehicle traffic in a city in Bandung. Bandung was chosen because it is a tourist city and a metropolitan city. To measure the dispersion of air pollution, we measure at different altitude points in the same location. One is measured on the base, and one is measured at an altitude of approximately 35 meters. For comparison, we tested measurements before and after rain. The results show that the basic and above concentrations are different; even though the conditions are rainy, it shows similar results. If at the base of the concentration x, and at the height of 35 m the concentration is y. Y concentration is lower than that at bottom. This is due to the possibility that the pollution will spread. Therefore, this study can provide information regarding the existence of pollution distortion processes that can be a reference when considering the actual situation.

METHOD

The research method used is the Observation method in which we conducted a research observation directly on March 30, 2019, starting at 06.30 - 13.40 WIB. This research was conducted using HT-200 (CO_2 meter) tools with professional brands of HH instruments made in US, specifically made in China, and Benetech GM8805 (carbon monoxide monitors) and traffic counters. In addition, we conducted research on 0 M research objects, namely, Dipatiukur road and 35m height to measure parameters such as CO, CO_2, PM1, PM2.5, and PM10 and vehicle volume before and after rain. The location of our research is on Jalan Dipatiukur and at the Indonesian Computer University, Bandung, and West Java. Bandung was chosen as it is one of the metropolitan cities where it has high population and density. Therefore, it is related to the use of private vehicles causing pollution from these vehicles (See Figures 1-4).

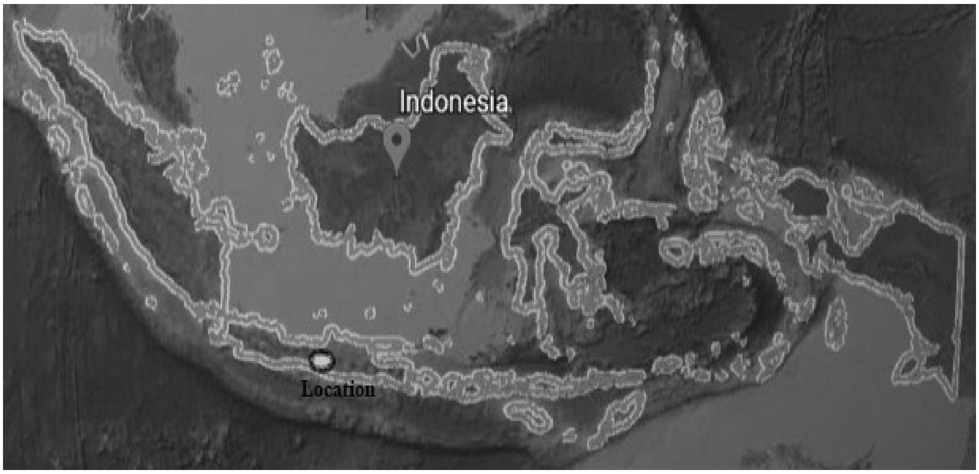


Fig. 1. Map of Indonesia. The figure was adopted from https://earth.google.com/web/ and was taken on May 25th 2019.

Fig. 2. West Java map. The figure was adopted from https://earth.google.com/web/ and was taken on May 25th 2019.

Fig. 3. Dipatiukur street map. The figure was adopted from https://earth.google.com/web/ and was taken on May 25th 2019.

Fig. 4. Bandung City map. The figure was adopted from https://www.google.co.id/maps and was taken on May 26th 2019.

Fig. 5. Adjacent side of Unikom. The figure was adopted from https://www.google.co.id/maps and was taken on May 26th 2019.

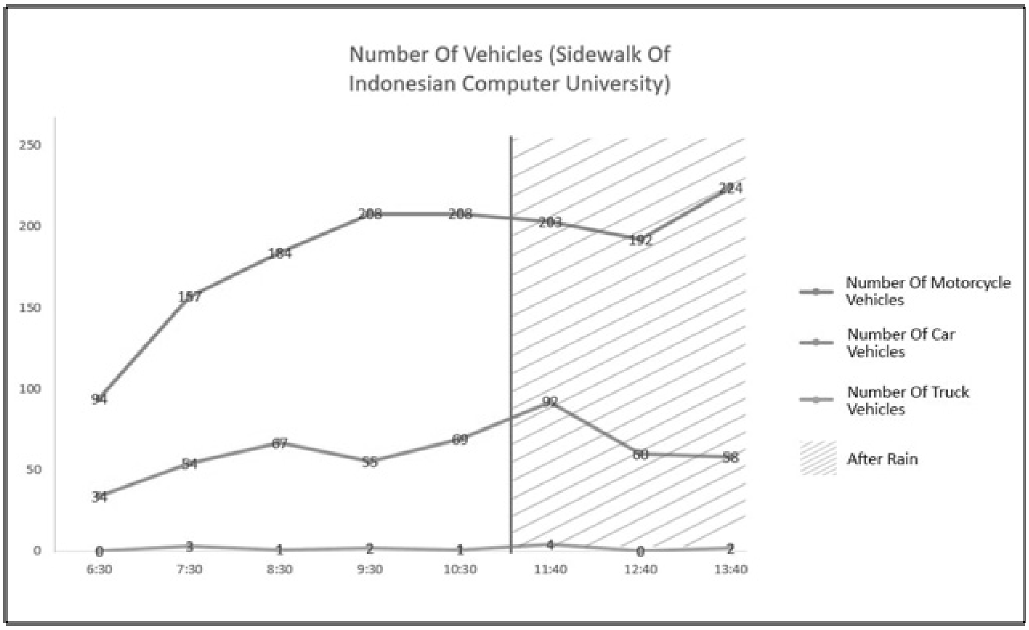
Fig. 6. Front side of Unikom. The figure was adopted from https://www.google.co.id/maps and was taken on May 26th 2019.

In Figures 1-6, the study was conducted on the object of 0M research, namely, on the Dipatiukur road and 35 m height, namely, Indonesian Computer University. We conduct this research by using a traffic counter tool, a tool to calculate the number of vehicles passing on the road measured by the time we have set, namely, 6:30 a.m. to 13:40 a.m. and counting also when it rains or after rain. In addition, a tool was used to measure several parameters (CO, CO_2, PM1, PM2.5, and PM10) before and after rain. This research was conducted right before and after the rain to discover whether air pollution decreased or not in terms of its concentration

RESULTS AND DISCUSSION

Vehicle volume analysis

The Transportation Sector plays an important role in air pollution. Various studies show that transportation is the main source of air pollution where the transportation sector accounts for 70% of total air pollution. One of the most common forms of air pollutants is particles. Particles can be interpreted purely or narrowly as solid pollutants (Anjarsari, 2019). Therefore the more the increasing volume of vehicles, the more the pollutants produced from these vehicles. From the results of this study it can be seen that the volume of vehicles before and after rain is very different (see Figure 7).



Source: Field Study 2019

Fig. 7. Number of vehicles before it rains on the sidewalk of Universitas Komputer Indonesia.

The results of the study were the number of vehicles that crossed the sidewalk in Unikom before the rain at 06.30 - 10.30. the vehicles that passed the most were motorbikes, which were as many as 851 vehicles and the least passing trucks, which were as many as 7 vehicles and 279 passing cars, whereas after rain at 11:30 - 13:30, the vehicle volume is declining where motorcycle vehicles reach 619 vehicles, as many as 7 trucks and 210 private cars.

It can be concluded that, from the front road section of the Unikom sidewalk, the number of vehicles tends to decrease after rain. This can be caused by various causes, one of which is the weather conditions that have eventually made many people choose to stay in their closest place when rain was about to happen or even choose to return back home. In addition, when rain happened, there were many drivers choosing to stay to avoid the accident caused by bad weather. That may happen as the rain can trigger accidents as well. Meanwhile, the post-rain could make the drivers who take refuge from the rain will immediately continue their activities.

Concentration analysis

Air pollutants are various types of gas and particle compounds whose presence in certain concentrations can endanger humans; there are several types of pollutants, but we are here more focused on discussing CO, CO_2, and Air Quality Pollutants. The transportation sector has become a major contributor to air pollution, especially in Indonesia. The use of environmentally friendly fuels from motorized vehicles produces dust and exhaust gases, which are a mixture of gases and particles that are harmful to human health and even to the surrounding environment. The particles of air pollution that spread include lead in dust, 2.5 μm of solid particles, 10 μm of solid particles, and aerosols in motorized exhaust gases consisting of carbon monoxide (CO), nitrogen oxide (NOx), hydrocarbons (HC), sulfur oxide (SOx), and lead (Plumbum / Pb) (Ruslinda *et al.,* 2016). The exhaust gas from the combustion of motorized vehicles generally produces several gas and particulate compounds, which can endanger human health. Gas-shaped compounds that emerge from motor vehicle exhaust can be carbon monoxide (CO), nitrogen oxide (NOx), hydro-carbon (HC), particulates, and lead (Pb) (Istirokhatun *et al.,* 2014). The following are the results of the Concentration Analysis on carbon dioxide (⟦CO_2) per unit ppm, centigrade, and RH at points 0 and 35 m at 06.30 - 13.40 (see Figure 8).

Indonesia Computer University Sidewalk (0 Meters)										
CO2	Time	6:30	7:30	8:30	9:30	10:30	After Rain	11:40	12:40	13:40
	PPM	675	648	668	648	658		662	672	636
	CELCIUS	23.7	25.5	27.8	30	28.9		29.3	29.8	31.1
	%RH	80.6	75.9	69.8	59.4	59.1		67.5	62.7	60.4

Indonesia Computer University 16th Floor (35 Meters)										
CO2	Time	6:40	7:40	8:40	9:40	10:40	After Rain	11:50	12:50	13:50
	PPM	619	624	610	602	599		574	585	594
	CELCIUS	28.9	28.9	28.5	28.9	28.8		30.5	29.4	29.8
	%RH	68.5	75.4	87.3	62.4	62.4		59.8	62.6	59.4

Fig. 8. The amount of CO_2 concentration at 0 M and 35 M before and after rain.

According to the results of the analysis, the concentration of carbon dioxide (CO_2) is at the point of 0 meters and a height of 35 meters. At 0 meters, the highest concentration of carbon dioxide (CO_2) is at 06: 30-10: 30, which is 675 ppm (before rain) and the lowest concentration of carbon dioxide is at 11:40 - 13:40, which is 636 (after rain). In addition, it can be seen that the highest temperature at 06:40 - 10:30 is 31.1°C (before rain), and the lowest temperature is at 11:40 - 13:40, which is 23.7°C (before rain). Moreover, the highest humidity is at 6:30 - 10:30, which is 80% (after rain) and at 11:40 - 13:40 the lowest is 60%. Meanwhile, at an altitude of 35 meters, an analysis test was carried out differently since, at 35 m, it was found that the duration is 10 minutes slower than 0 meters due to the pollution produced at the 0-meter point. It took a few moments to reach 35 meters. Therefore, to get maximum results we chose to wait for a while. Conforming to the results of the analysis, it was discovered that there were increase and decrease in ppm, temperature, and humidity. The highest concentration of carbon dioxide (CO_2) at 06:40 - 10:40 is 624 ppm (before rain) and the lowest concentration of carbon dioxide at 11:50 - 13:50 is 574 ppm. In addition, the highest temperature is 30.5°C at 11:50 - 13:50 and the lowest temperature is 28.5°C at 6:50 - 10:50. The highest humidity at 06: 50-10:50 is 87% and the lowest humidity at 12:50 - 13:50 is 59%.

From the two results of the analysis of carbon dioxide concentration (⟦CO_2 _2), points 0 and 35 m have a tendency for different values at each ppm, temperature, and RH. If seen from ppm 0 m tends to be higher than at 35 m height.

This is influenced because at point 0 m the biggest source of air pollution is motor vehicle fumes compared to 35 M altitude. In addition, the concentration of carbon dioxide (CO_2) is also affected by the number of drivers passing on the road measured. Temperature can also affect carbon dioxide, where the higher the number of vehicles passing, especially motors, the CO_2 concentration will also increase. The increased CO_2 concentration will increase the air temperature, because the nature of CO_2 is absorbing heat and this is also related to RH (air humidity). The relationship between temperature and RH or humidity is closely related. The higher the air temperature, the lower the humidity. This can occur since high temperatures can cause precipitation that is commonly called as condensation of water molecules. It is contained by air so that the water contained in the air decreases. According to the health standards, CO_2 concentration is between 350 and 450 ppm. And when compared with the results of the analysis, it was found that the concentration of carbon dioxide exceeds health standards and can be said to be unhealthy. Besides analysis of CO_2 concentration, the authors analysed CO concentrations at 0 meters and 35 meters (see Figure 9).

Indonesia Computer University Sidewalk (0 Meters)										
CO	*Time*	**6:30**	**7:30**	**8:30**	**9:30**	**10:30**	After Rain	**11:40**	**12:40**	**13:40**
	PPM	0	0	0	0	0		0	0	0
	CELCIUS	25.4	27	28.7	32	29.7		30.7	32.5	33.3

Indonesia Computer University 16th Floor (35 Meters)										
CO	*Time*	**6:40**	**7:40**	**8:40**	**9:40**	**10:40**	After Rain	**11:50**	**12:50**	**13:50**
	PPM	0	0	0	0	0		0	0	0
	CELCIUS	27	27.5	28.7	30.5	27.7		33.4	32	30.6

Fig. 9. CO concentration of 0 and 35 meters before and after rain.

Based on the results of the analysis on CO concentration influenced by temperatures at points 0 M and 35 m, seen in the CO concentration at point 0 m or CO concentration at an altitude of 35 m, there is no increase in the value of CO concentration. This is because the relationship of temperature to CO concentration shows an inverse relationship; namely, the higher the temperature, the lower the CO concentration. During the day with sunny weather conditions the air temperature will be high due to the sunlight received so that it will cause expansion of the air. This causes the dispersion of pollutants so that CO concentrations will be low (Lu *et al.,* 2015). And the results of the analysis, seen at the 0 Meter point at 6:30 - 13:40 the temperature obtained is high and the CO concentration value obtained is 0 ppm. This means that the environmental conditions of the study can still decompose CO gas well; therefore, the results show that the concentration of ppm is always 0 at an altitude of 0 meters, as well as the results of analysis at an altitude of 35 meters at 06:50 - 13:50; the temperature obtained is high and the CO concentration value obtained is 0 ppm.

Based on the standard, CO concentration that is good for health is 0-1 ppm. So it can be concluded that CO concentrations at points 0 and 35 meters are good for health because the value is 0 ppm or below the standard of good health.

One of the substances that can act as a cause of air pollution is particulates. Particulates are all substances, except pure water, which is in the liquid or solid phase and is contained in the atmosphere under normal conditions with microscopic or semimicroscopic size but larger than molecular (2 Å) dimensions. Particles with 2.5 to 10 μm are called coarse particles. Particles less than 2.5 in diameter are called fine particles and include ultra-fine particles of less than 0.1 μm (PM 0.1). In addition, one component of pollutants in the air that has a major impact on health, which is Particulate Matter (PM). PM is a general physical classification of particles found in the air, such as dust, dirt, soot, and smoke. PM is not referring to certain chemical entities but is a mixture of particles from different sources of various sizes, compositions, and properties (Virgiyanto *et al.,* 2019). PM2.5 is another name for particulates smaller than 2.5 μm in size or also called fine particles. Carbon is a major component in particulates in urban areas. The main source of these pollutants is from burning fossil fuels and biomass. PM2.5 is home to the carbon produced from the combustion process and PM2.5 is a particulate that has a residence time in the atmosphere for a long period of time and has the potential to penetrate into the interior of the human respiratory system (Briggs *et al.,* 1997). Based on the results of data analysis, the concentration on Air Quality Pollution at 0 and 35 meters was seen to be a stable increase and decrease in the value of PM2.5 at the time before rain and after rain (see Figure 10).

Air Quality Monitor

Time	PM2.5	PM1.0	PM10	HCHO	TVOC	Temperature	HUM
6:30	45	27	58	0.023	0.361	17.4	99%
7:30	49	29	63	0.015	0.14	19.2	91%
8:30	77	47	100	0.017	0.107	21.4	87%
9:30	45	28	59	0.022	0.214	24.2	70%
10:30	35	23	47	0.013	0.015	22.2	73%
				After Rain			
11:40	45	58	27	0.025	0.524	22.7	82%
12:40	28	17	36	0.017	0.065	25.6	72%
13:40	25	14	31	0.022	0.038	22.8	68%

Air Quality Monitor

Time	PM2.5	PM1.0	PM10	HCHO	TVOC	Temperature	HUM
6:40	34	21	45	0.025	0.078	21.2	77%
7:40	51	30	65	0.023	0.092	21	78%
8:40	60	35	76	0.022	0.059	22	77%
9:40	48	26	54	0.019	0.024	22	70%
10:40	38	24	50	0.017	0.024	21.2	78%
				After Rain			
11:50	26	34	16	0.016	0.324	23.9	68%
12:50	18	11	23	0.014	0.188	23.7	69%
13:50	22	12	27	0.014	0.209	23.4	71%

Fig. 10. Air Quality Pollution at 0 and 35 meters before and after rain.

Results of the analysis were obtained as PM 2.5 at the 0 m point; the highest carbon produced is 77 μm before rain, while the lowest carbon produced is 25 μm at the time after rain. Judging from the results of the analysis, it tends to be stable every 1 hour and 30 minutes because the number of vehicles passing and pollutants produced by vehicles are many. In addition, at this time, many people want to move, while the PM2.5 concentration is at an altitude of 35 meters. Here the author also conducted a 10-minute study at a rate of 35 meters from the 0-meter point as in the study of CO and CO_2; the reason is not much different, so that particles of pollution that settle after being released at an altitude of 0 meters can decompose well after a moment ago. The highest PM2.5 produced is 60 μm at the time before rain and PM2.5 at the lowest is 18 μm after rain. This proves that the higher the height measured, the better the quality of the air, because the main pollutant producer is that the motor vehicle is getting smaller, and the pollution only settles a few meters from the source of the pollutant. In addition, good health standards for PM2.5 are 0-12 µm. If seen from the results of the analysis of PM 2.5, which produces the highest pollutant, 77 µm, air pollution is seemingly unhealthy. In addition, there is also PM1.0 concentration. PM1.0 is a particle with a diameter of less than 1 µm. From the measurement results obtained from Figure 10, the concentration of PM1.0 at point 0 Meter, which produces the highest pollutants from the transport at the time (before rain), is 47 µm and the lowest yield pollutants from transportation is 23 µm, while the highest PM1.0 produces pollutants from transportation after rain, which is 58 µm, and the lowest pollutant from transportation is 14 µm. PM1.0 at an altitude of 35 meters produces the highest pollutants from transportation at the time before rain, which is 35 µm, and the lowest produces pollutants from transportation, namely, 14 µm.

Furthermore, Particulate (PM10) is an indicator for the measurement of airborne particulate pollution associated with effects on the respiratory tract, because PM10 is a small group of particulates of 0-10 µm, while these small particulates are the biggest health risks among various particulate sizes due to inhalation. Through the respiratory tract to the part of the respiratory tract carried and deposited in the lungs (Cahyadi *et al.,* 2016). From the measurement results obtained in Figure 10 that PM10 at point 0 of the particle meter is the highest at the time before rain, which is 100 µm, and the lowest is 47 µm and particles that are high (after rain) are 36 µm and the lowest are 27 µm. Meanwhile, at an altitude of 35 meters, the highest particle at the time (before rain) is 76 µm and the lowest is 45 µm and the highest particle (after rain) is 27 µm and the lowest is 16 µm. From the measurement results, it was found that at each post-pollutant rain it was decreased because during the rainy season it caused quite a lot of rainfall so the particulate concentration (PM10) would be very small. This is because pollutants in the air will be lost when exposed to rainwater.

In urban areas, the main source of emissions comes from combustion of Formaldehyde. Formaldehyde is a compound found in many places because it is produced from a photochemical oxidation process, but is often found in low concentrations because it can be removed with sufficiently short time through photolysis and further oxidation. Formaldehyde is produced indirectly by photochemical oxidation of hydrocarbons or from other formaldehyde precursors that result from the combustion process. When in the smoke phase, indirect production of formaldehyde may be greater than direct emissions (Jiwandono *et al.,* 2014). Based on the results of measurements in Figure 10 that HCHO at 0 meters the highest time before rain is 0.023 and the lowest one is 0.013. And the highest HCHO after rain is 0.025 and the lowest is 0.017. While at the height of 35 meters, the highest HCHO at the time before the rain is 0.025 and the lowest is 0.017 and the highest HCHO (when after rain) is 0.016 and the lowest is 0.014. The results of measurements at the point of 0 meters and a height of 35 meters, when viewed based on HCHO health standards, are considered safe, because the safe HCHO standard is < 0.100. If HCHO is obtained above 0.301, the pollution around it is very heavy and can cause disease.

TVOC stands for Total Volatile Organic Compounds. Volatile organic compounds are organic chemicals that have a high vapor pressure at ordinary room temperature. Their high vapor pressure resulted from a low boiling point, which causes large numbers of molecules to evaporate or sublimate from the liquid or solid form of the compound and enter the surrounding air, a trait known as volatility. They refer to all organic gas materials in the area they sample and analyze as VOCs or Volatile Organic Compounds. From the results of the measurement analysis it was found that the highest TVOC at 0-meter point (Figure 10) (before rain) was 0.361 and the lowest was 0.015. And the highest (after Rain) TVOC is 0.524 and the lowest is 0.038. However, for the point of 35 meters, the highest TVOC (before rain) is 0.092 and the lowest is 0.188. Based on the standard safe range, which is <0.600, if TVOC or particles reach above 0.601, then various diseases of the respiratory system will arise. And from the results of the measurement analysis before and after rain at 0 meters and 35 meters including the category of particles scattered in safe air except at 0 meter before the rain reaches 0.361, this is quite high because at the 0-meter point, most of the pollution is from vehicles. Meanwhile, regarding the second Temperature and humidity (RH), it has a relationship with PM particulates, such as PM2.5, PM1.0, and PM10. Based on the measurements (Figure 10), it is found that the temperature at point 0 meters is highest at the time before the rain, 24.2°C, and the lowest is 17.4°C. Other than that, the highest (after rain) temperature is 25.6°C and the lowest is 22.7°C. While the highest temperature at an altitude of 35 meters from the measurement results (Figure 10) (before rain) is 22°C and the lowest temperature is 21°C. And the highest temperature (after rain) is 23.9°C and the lowest is 23.4°C. If you see this, it actually has something to do with the Particulate Meter. When the air temperature rises, the concentration of particulates will also rise. It can be interpreted that when the temperature is high, the environment will be very hot and dry, so that pollutants will easily lift and float in the air, while the humidity of the measurement results at 0 meters (Figure 10) show that the highest humidity at the time (before rain) is 99% and the lowest humidity is 70%. Meanwhile the highest (after rain) humidity is 82% and the lowest is 68%. Compared to the height of 35 meters from the measurement results (Figure 10) the highest humidity (before rain) is 78% and the lowest humidity is 68%. Actually this humidity is related to the Particulate meter because when the relative humidity drops, the particulate concentration will rise. This is because when the air humidity is relatively low, the air condition will dry out so that pollutant/pollutant sources will be easily lifted up and float freely in the air, making it easier to be exposed and will increase the value of particulate concentrations.

CONCLUSION

From this study, it can be concluded that air pollution is related to the number of vehicles and the concentration of CO, CO_2, and Air quality Monitor. The number of vehicles passing most is the type of 2-wheeled vehicle both before and after the rain. The total number of vehicles passing is 851 motorbikes, while the lowest is trucks, and there are only 7 vehicles that cross the Dipatiukur road, so the most pollution is caused by 2-wheeled vehicles. In addition, the concentration of CO_2 tends to be higher than the height of 35 m. This is influenced because at point 0 m the biggest source of air pollution is motor vehicle fumes compared to the height of 35 m. In addition the concentration of CO_2 is also affected by the cause of temperature passing vehicle; the concentration of CO_2 will also increase. And this is also related to RH (air humidity). Air humidity has a relationship with air temperature. Because air humidity is inversely proportional to air temperature, the higher the air temperature, the smaller the pressure.

Based on the results of measurements on the analysis of CO concentrations, it can be concluded that CO concentrations at points 0 and 35 m are good for health because the value is 0 ppm or above the standard of good health, while the results of the measurement of Air quality Monitor can be seen, where the highest PM at the time before rain is PM10 (*i.e.,* 100 ppm) and PM at the time after rain is PM1.0, which is 58 ppm, in addition to TVOC particles that are spread on the road measured according to safe range standards, including secure. As for HCHO particles, from the measurement results at the point of 0 meters and height of 35 m, if seen based on HCHO health standards it is considered as safe. In addition, air humidity has a relationship with air temperature. It turns out that humidity and temperature have a relationship with PM or particulate meters, which when the air temperature rises, the concentration of particulates will also rise and when the relative humidity drops, the concentration of particulates will rise.

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