The dispersion pattern of PM10 dan SO2 on Highway Kuin Utara and Kuin Selatan banjarmasin City based on GIS spatial model

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Abstract. The transportation sector primarily causes urban air pollution in Indonesia and has a significant role in environmental emissions. Emissions resulting from vehicles are particulate matter, SO_2, CO_2, CO, HC, and NO_x. The concentration and dispersion of PM_{10} and SO_2 from the activity of the traffic on the roads Kuin Utara and Kuin Selatan, Banjarmasin City, observed in this study. The dispersion model of the concentration of PM_{10} and SO_2 from traffic activity using GIS Spatial Models has been conducted. Research has been carried out for two days as representing weekend and weekdays at the three stations. After modeling and mapping the highest value for the concentration of PM_{10} on the weekend, it was obtained at station three, which was 167.3 $\mu g.m^{-3}$. The highest level of PM_{10} on weekdays was achieved at station 3 with an amount of 236.3 $\mu g.m^{-3}$. Based on modeling, the highest level SO_2 on weekdays reached in station 3, which was 423 $\mu g.m^{-3}$.

1. Introduction

At this time, the high level of air pollution in the urban environment is a concern of society, especially its negative influence on public health [1-6]. Developing countries have problems that are more complex if compared with developed countries, and this is due to factors of urbanization and the quantity of the dense population [7-9]. Urbanization leads to rapid development in the industrial sector, commercial business activities, transportation, which leads to significant energy consumption [10]. Level PM_{10} and $PM_{2.5}$ have been reported frequently above the established quality threshold [11-12]. Furthermore, the health burden associated with air pollution is the highest predicted in LMICs (low- and middle-income countries) in the Western Pacific Region and Southeast Asia.

Rapid technological development in urban areas is closely related to environmental problems caused, one of which is air pollution [13]. The occurrence of air pollution comes from the industrial sector, transportation, and household activities. The transportation sector is the dominant source of pollution in big cities. The transportation sector is proven to contribute to the highest air pollution in Indonesia, around 85% [14]. The transportation sector is a source of moving pollution, including cars, trucks, buses, motorcycles, planes, and ships. The use of fuel oil by the transportation sector is known to have a significant impact on the environment. According to the Ministry of Environment in 2012, air pollution

from motor vehicles contributed 70.5% Carbon Monoxide, 18.34% Hydrocarbons, 8.89% Nitrogen Oxides, 1.33% Particulates, and 0.88% Sulfide Oxides.

The WHO reported that 92% of the world's population had been exposed to air pollution are concentrated, where 90% of the cause of death in LMICs [2] as many as seven out of ten countries in Asia have been reported to have a concentration of PM_{10} that exceeds the WHO average annual standard [15]. Air pollution outside of the room can result in public health is disturbed, and contributes to the risk of premature death in Asia and that about 2.1 million deaths annually [16]. Air pollution outside of space has been known as the ten most significant health risks in the world and among the top five risks in developing countries in Asia [11]. The impact of PM_{10} can reduce lung and heart function, nervous system, and blood vessel disorders that come in contact for several days, weeks, months, even years [17]. Emissions SO_2 can cause an irritating effect on the airways causing symptoms of coughing, shortness of breath, and increasing asthma [18]. Based on data from the S. Parman Community Health Center, Upper Respiratory Tract Infection is the number 2 disease most complained by the community and obtained 2410 people in 2017.

South Kalimantan is a province that has many rivers. River Kuin that crosses The Kuin Utara, Kuin Selatan, and Kuin Cerucuk villages are still living on the banks of the river or above the river. Besides, increasing population growth has led to increased housing and road construction [19]. Based on observations, The Kuin Utara and Kuin Selatan roads are roads leading to tourism, industrial, and residential areas. This road section is crossed by motorized vehicles, cars, and trucks. Increased transportation through highway affects air quality. Also, The Kuin River is the primary access crossed by tourist or commercial motorized boats. Transport of water that separates The road Kuin Utara and Kuin Selatan is also expected to contribute from ship emissions motor. Based on this background and the data centers that show the number of respiratory diseases hence the importance of this study due to PM_{10} and SO_2 in the air can cause disturbances in health, especially breathing. The concentration and dispersion of PM_{10} and SO_2 from the activity of the traffic on the roads Kuin Utara and Kuin Selatan, Banjarmasin City, observed in this study.

2. Materials and methods

2.1. Study area

This research was conducted at Road Kuin Utara, and Kuin Selatan, Banjarmasin City. Sampling was carried out at three stations representing each region. The coordinates of the research location can be seen from Table 1, and visually it can be seen in **Figure 1**.

Figure 1. Research location map

Table 1. Research location coordinates

	Location	Coordinates	
		South Latitude	East Longitude
Station I	Road Kuin Selatan Neighbourhood 16	03^{O} 17.879'	114^{O} 34.763'
Station II	Yard of Sultan Suriansah Mosque	03^{O} 17.406'	114^{O} 34.342'
Station III	Industrial Area Pertamina	03^{O} 17.649’	114^{O} 34.216’

2.2. Research design

This research was conducted for two days. This measurement has been carried out for two days, where one day on weekdays representing Monday to Friday, and weekend s serving Saturday and Sunday. PM_{10} concentration measurements were carried out for 24 hours based on SNI 7119.15: 2016 and South Kalimantan Governor Regulation Number 53 (2007). While SO_2 measurements were carried out for 1 hour based on SNI 7119.7: 2005 and South Kalimantan Governor Regulation number 53 the Year 2007. Analysis of SO_2 will be carried out on peak hours morning, afternoon, and evening. This research was conducted at three observation stations.

The calculation of the amount of land transportation that passes is calculated for 24 hours with a span of 1 hour ago converted to get the value of the volume of traffic in passenger car units (PCU). Then the emission rate of PM_{10} concentration is calculated. The amount of water transportation that passes for 24 hours is then calculated the emission rate of the PM_{10} level. As for SO_2, land and water transport will be calculated for 1 hour during the measurement. Determination of peak hours is done in the morning, afternoon, and evening based on the results of counting obtained. Then the results are converted into units of passenger cars that will get traffic volume [20].

2.3. Data analysis

The wind direction obtained from the laboratory results is then plotted into the WRPlot program. The result of WRPlot used is the dominant wind direction that will be inputted on the Caline4 program. Then the results from Caline4 produce a prediction of the concentration at the receptor station to be patterned on the Quantum GIS program. But there are differences for SO_2, after getting the WRPlot results and then entering it into the AERMOD View program. The dispersion pattern directly obtains the results of the AERMOD View program. So the dispersion patterns can be mapped in QGIS [21]. Using QGIS has an advantage that makes it easier to get information that has been processed and stored as attributes of a location or object. The main feature of data that can be utilized in geographic information systems is data that has been tied to the area and is primary data that has not been specified. The geographic Information system is a reliable tool for handling spatial data [22-24].

3. Results and Discussion

3.1. Measurement results concentration of PM_{10} and SO_2

Particulate matter (PM_{10}) is particles of air in the form of solid with a diameter of fewer than 10 micrometers. The existence of those particles in a relatively long time will hover and enter into the human body through the respiratory tract, causing health disorders [14]. PM_{10} can be either non-carcinogenic or carcinogenic. The nature of the carcinogenic PM_{10} generated from the content contained in the $PM_{10,}$ such as PAHS and lead. Carcinogenic properties can be seen from the acute effects and the effects of chronic caused by exposure to PM_{10}. The source of the main pollutant PM_{10} derived from transportation activities [17]. Particulate matter is mostly generated from the presence of residue in the fuel. Such residues are not burnt and wasted through the exhaust pipes because of the processing of the fuel not better [25].

The measurement of the concentration of PM_{10} in this study using the method of gravimetric. The results of the analysis of PM_{10} on the weekend obtained at all points do not exceed the quality standard.

However, on weekdays only in station three, that exceeds the quality standard that is 205.0 $\mu g.m^{-3}$. Based on The Governor Decree of South Kalimantan No. 53 (2007) for Maximum Limit Air Quality and Noise, the value PM_{10} of 150 $\mu g.m^{-3}$. The results of the measurement of PM_{10} can be seen in Table 2.

Table 2. Research measurement results from concentration of PM_{10}

	Time	Unit	Concentration of PM_{10}	
			Measurement results	Maximum Limit
Station I	Weekend	$\mu g.m^{-3}$	65.8	150
	Weekdays	$\mu g.m^{-3}$	56.4	150
Station II	Weekend	$\mu g.m^{-3}$	131.4	150
	Weekdays	$\mu g.m^{-3}$	116.2	150
Station III	Weekend	$\mu g.m^{-3}$	147.9	150
	Weekdays	$\mu g.m^{-3}$	205.0	150
	Average		120.45	150

PM_{10} concentration values in Banjarmasin are lower than in several cities in other countries. Pakistan has the most pollution levels. The PM_{10} concentration value for each country is that Pakistan (2010) has average PM_{10} pollution of 282 $\mu g.m^{-3}$, Qatar (2012) has average PM_{10} pollution of 165 $\mu g.m^{-3}$, and Bangladesh (2013) has average PM_{10} pollution of 163 $\mu g.m^{-3}$[26].

SO_2 is a component of pollutants in the atmosphere obtained from the burning of fossil fuels and other processes that have sulfate content. SO_2 can cause acid rain, which is the accumulation of acidic substances in the air so that it is dangerous for the health of living things. SO_2 has a characteristic odor that is sharp and does not burn. SO_2 can cause an irritating effect on the airways causing symptoms of coughing, shortness of breath, and increasing asthma. SO_2 is a gas that is very soluble in water. SO_2 in the air can dissolve in water vapor, then form acid and fall as acid rain. The impact of acid rain can occur in areas far from SO_2 polluting sources due to the influence of wind [18].

The measurement of the concentration of SO_2 in this study using the method of pararosaniline. The results of the analysis of SO_2 on weekends and weekdays are obtained at all points and do not exceed the quality standard. Based on the Governor decree of South Kalimantan No 53 (2007) for Maximum Limit Air Quality and Noise, the value SO_2 of 900 $\mu g.m^{-3}$. The results of the measurement of SO_2 can be seen in Table 3.

Table 3. Research measurement results from concentration of SO_2

	Time	Unit	Concentration of SO_2	
			Measurement results	Maximum Limit
Station I	Weekend	$\mu g.m^{-3}$	5.4	900
	Weekdays	$\mu g.m^{-3}$	5.4	900
Station II	Weekend	$\mu g.m^{-3}$	5.4	900
	Weekdays	$\mu g.m^{-3}$	5.4	900
Station III	Weekend	$\mu g.m^{-3}$	154.1	900
	Weekdays	$\mu g.m^{-3}$	5.4	900

Based on the highest SO_2 concentration values from the measurement results, it is known that SO_2 pollution in Banjarmasin City is lower than in several cities in other countries. China has the highest pollution level. The SO_2 concentration value of each country is that China has average SO_2 pollution of 17300 $\mu g.m^{-3}$, Malaysia has a common SO_2 infection of 8300 $\mu g.m^{-3}$, and South Korea has average SO_2 pollution of 8600 $\mu g.m^{-3}$[27].

3.2. The dispersion pattern of the concentration of PM_{10}

Map the dispersion pattern of PM_{10} is obtained from the program Caline4. The visualization of the dispersion pattern of concentrations of PM_{10} using the QGIS program. The QGIS Program used for making contour maps by doing plotting of the data of XYZ to be the grid. The concentration of PM_{10} produced from the pollutants generated by the activity of traffic on a toll road. Figure 2 showed the dispersion pattern of the level PM_{10} on the weekend at station 1 to a maximum was 90.6 $\mu g.m^{-3}$, and the level of the minimum amount of 63.3 $\mu g.m^{-3}$. At station 1, the direction of the wind towards the south at an average speed of 0,8025 $m.s^{-1}$. Figure 3 shows the dispersion pattern of PM_{10} concentration on weekend s at the maximum station 2 of 146.8 $\mu g.m^{-3}$ and the minimum level of 132.7 $\mu g.m^{-3}$.

At station 2, the wind direction goes east with an average speed of 2.387 $m.s^{-1}$. Figure 4 shows the dispersion pattern of PM_{10} concentration on weekend s at the maximum station 3 of 167.3 $\mu g.m^{-3}$ and the minimum level of 146.7 $\mu g.m^{-3}$. At station 3, the wind direction goes east with an average speed of 0.756 $m.s^{-1}$. The high degree of pollutants is influenced by the direction and speed of the wind, and the volume of traffic. According to Huda, the direction and speed of the wind that blows will affect the spread of concentration. The farther away from the source of pollutants from the receptor station, the level of contaminants will decrease [28].

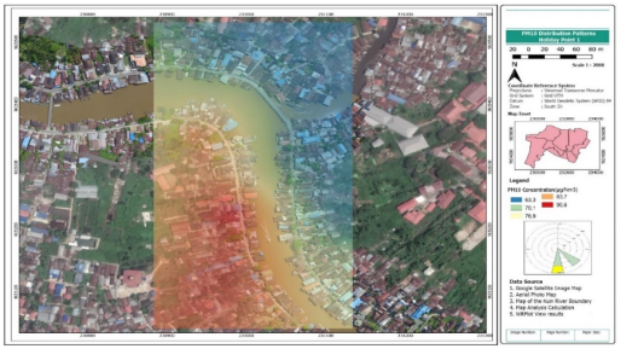

Figure 2. PM_{10} dispersion patterns station I (weekend)

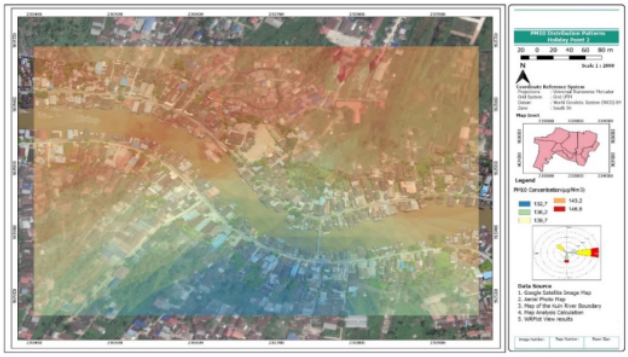

Figure 3. PM_{10} dispersion patterns station II (weekend)

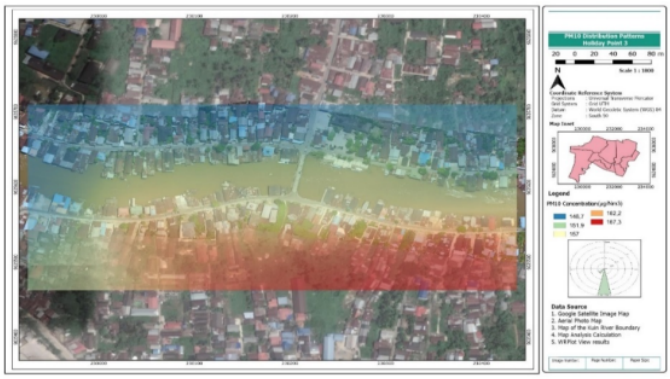

Figure 4. PM_{10} dispersion patterns station III (weekend)

Figure 5 showed the dispersion pattern of PM_{10} concentration on weekdays at station one maximum of 132.5 $\mu g.m^{-3}$ and a minimum level of 32.5 $\mu g.m^{-3}$. At station 1, the direction of the wind is going west with an average speed of 0.37 $m.s^{-1}$. Figure 6 shows the dispersion pattern of PM_{10} concentration on weekdays at the maximum station 2 of 164.8 $\mu g.m^{-3}$ and the minimum level of 119.5 $\mu g.m^{-3}$. At Station 2, the direction of the wind is heading east with an average speed of 0.707 $m.s^{-1}$. Figure 7 shows the dispersion pattern of PM_{10} concentration on weekdays at the maximum station 3 of 236.3 $\mu g.m^{-3}$ and the minimum level of 203.1 $\mu g.m^{-3}$. At Station 3, the wind direction is heading south with an average speed of 0.292 $m.s^{-1}$. The high concentration of PM_{10} is influenced by the direction and speed of the wind, and the volume of traffic. According to Huda, the direction and speed of the wind that blows will affect the spread of concentration. The farther away from the source of pollutants from the receptor station, the level of PM_{10} will decrease [28]. Based on Appendix E, the partial t-test shows that the wind speed variable has a probability value <0.05. So, it can be concluded that the wind speed variable has a significant effect on PM_{10} concentration. PM_{10} is very dangerous for human health. The existence of PM_{10} in the air is relatively long will enter the human body through breathing, and into the lungs. PB is one of the ingredients of PM_{10}. The presence of Pb in ambient air can cause anemia, increased blood pressure, kidney damage, nervous system disorders, damage the brain, and decrease IQ [14].

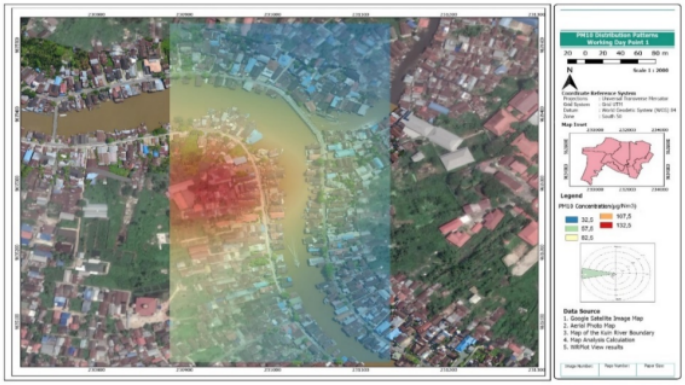

Figure 5. PM_{10} dispersion patterns station I (weekdays)

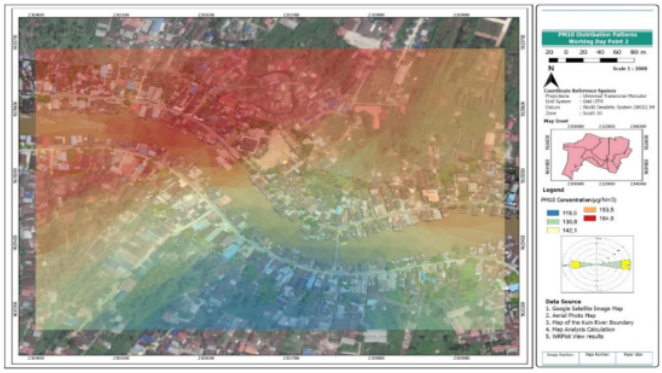

Figure 6. PM_{10} dispersion patterns station II (weekdays)

Figure 7. PM_{10} dispersion patterns station III (weekdays)

3.3. The dispersion pattern of the concentration of SO_2

This SO_2 dispersion pattern map was obtained from the AERMOD View program. Visualization of SO_2 concentration dispersion patterns using the AERMOD View program. The AERMOD View program is used for air quality simulations and can directly create contour maps based on a grid. SO_2 concentrations generated from pollutants generated by traffic activities on a road section. Figure 8 shows the dispersion pattern of the SO_2 level of weekend s at peak daylight hours at the maximum station of 67.5 $\mu g.m^{-3}$ and the minimum concentration of 0.7 $\mu g.m^{-3}$. At station 1, the wind direction goes east with an average speed of 1.98 $m.s^{-1}$. Figure 9 shows the dispersion pattern of the SO_2 concentration of weekend s at peak daylight hours at a maximum station of 38.7 $\mu g.m^{-3}$ and a minimum level of 0.4 $\mu g.m^{-3}$. At station 2, the wind direction goes east with an average speed of 3.49 $m.s^{-1}$. Figure 10 shows the dispersion pattern of the SO_2 concentration of weekend s at peak afternoon hours at the maximum station of 423 $\mu g.m^{-3}$ and the minimum level of 4 $\mu g.m^{-3}$. At station 3, the direction of the wind is heading south with an average speed of 0.81 $m.s^{-1}$.

Figure 8. SO_2 dispersion patterns station I (weekend)

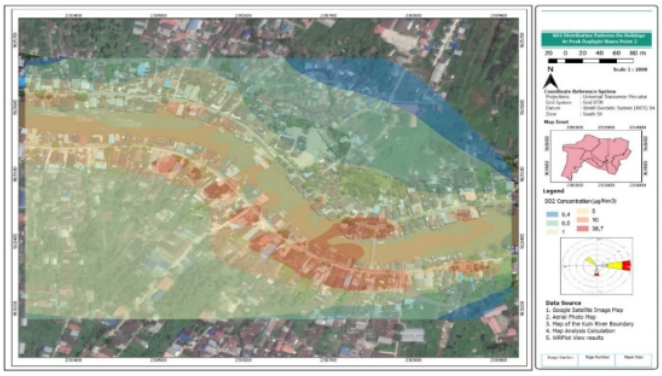

Figure 9. SO_2 dispersion patterns station II (Weekend)

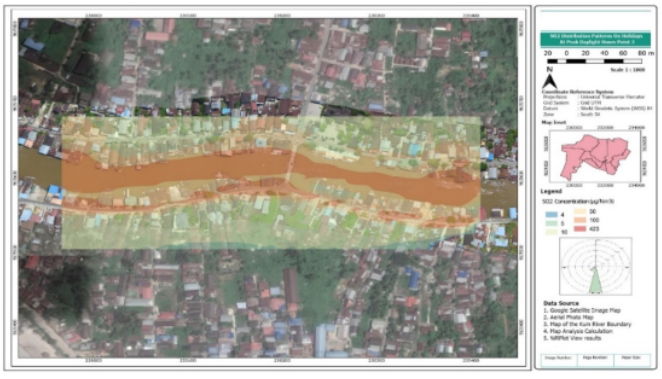

Figure 10. SO_2 dispersion patterns station III (weekend)

The high concentration of pollutants is influenced by the direction, speed wind, and the volume of traffic. According to Huda, the direction and speed of the wind that blows will affect the spread of

concentration. The farther away from the source of pollutants from the receptor station, the concentration of pollutants will decrease [28]. Based on Appendix E, the partial t-test shows that the wind speed variable has a probability value <0.05. So, it can be concluded that the wind speed variable has a significant influence on SO_2 concentration. The impact of SO_2 in the air can cause respiratory tract irritation and an increase in mucosal secretions. SO_2 emissions are known as substances that are harmful to health, especially in patients with chronic respiratory diseases and the elderly. At very high concentrations can cause death [29-30].

4. Conclusion

The results of direct measurements on the Kuin Utara and Kuin Selatan highway sections obtained only PM_{10} concentrations that exceeded the quality standard station three, which was 167.3 $\mu g.m^{-3}$. The highest level of PM_{10} on weekdays was achieved at station 3 with an amount of 236.3 $\mu g.m^{-3}$. The results of the mapping dispersion pattern of concentration of SO_2 obtained in a station three at the peak hours of the day to a maximum was 423 $\mu g.m^{-3}$. Whereas on immediate measures of SO_2 level, nothing exceeded the quality standards based on South Kalimantan Governor Regulation No. 53 (2007). Although the SO_2 level is small, however, if exposed for long periods will cause changes in lung function.

References

[1] Biswas P *et al*. 2006 Health effects of fine particulate air pollution: Lines that connect *J. Air Waste Manag. Assoc*. **56**(6) pp. 707–8
[2] World Health Organization 2014 Methods for the burden of disease attributable to 795 ambient air pollution for the year 2012 Acessed online from: http://www.who.int/phe/health_topics /outdoorair/databases/AAP_BoD_methods_March2014.pdf?ua=1
[3] Hankey S and Marshall J 2017 Urban Form, Air Pollution, and Health *Curr. Environ. Heal. Reports* **4** (4) 491–503
[4] Wang Q 2018 Urbanization and global health: The role of air pollution *Iran. J. Public Health*, **47**(11) 1644–52
[5] Schiavon M *et al*. 2015 Assessing the air quality impact of nitrogen oxides and benzene from road traffic and domestic heating and the associated cancer risk in an urban area of Verona (Italy)," *Atmos. Environ*. **120** 234–43
[6] Lancet Planet Health 2019 The impact of air pollution on deaths, disease burden, and life expectancy across the states of India: the Global Burden of Disease Study 2017 *Lancet* **18** 30261–4
[7] Baldasano J M, Valera E and Jimenez P 2003 Air quality data from large cities *Sci. Total Environ*. **307** 141–65
[8] UN 2007 World Urbanization Prospects: The 2007 Revision Population Database New York
[9] Mannucci P M and Franchini M 2017 Health effects of ambient air pollution in developing countries *Int. J. Environ. Res. Public Health* **14**(9) 1–8
[10] Gulia S., Nagendra S M S , Khare M and Khanna I 2015 Urban air quality management–A review *Atmos. Pollut. Res*. **6** 286–304
[11] ADB 2014 Improving Air Quality Monitoring in Asia: A Good Practice Guidance, Final report, Asian Development Bank, Mandaluyong City, Philippines: Asian Development Bank, 2013 Accesed online from: http://cleanairasia.org/wp-content/uploads/portal/files/improving_ aqmt_in_asia.pdf.
[12] Worobiec A., Vermaak S S P, Berghmans P, Winkler H, Burger R and Van Grieken R 2011 Air Particulate Emissions in Developing Countries: A Case Study in South Africa *Anal. Lett*. **44**(11) 1907–24
[13] Bachtiar V S 2013 Studi Paparan Konsentrasi Gas Karbonmonoksida (CO) di Lingkungan Kerja Petugas Parkir Dan Polisi Lalu Lintas Di Kota Padang *J. Dampak* **10**(1) 60–72
[14] Roza V, Ilza M dan Anita S 2015 Korelasi Konsentrasi Particulate Matter (PM10) di Udara dan

Kandungan Timbal (Pb) dalam Rambut Petugas SPBU di Kota Pekanbaru *Din. Lingkung.* **2**(1) 52–60

[15] CAA (Clean Air Asia) 2016 Guidance Framework for Better Air Quality in Asian Cities. Pasig City, Philippines Accesed online from: http://cleanairasia.org/ibaq/wp-content/themes/ibaq/pdf/Ambient Air Quality Standards and Monitor.pdf.

[16] Lim S S *et al*. 2012 A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: A systematic analysis for the Global Burden of Disease Study 2010 *Lancet* **380**(9859) 2224–60

[17] Wulandari A, Darundiati Y H and Raharjo M 2016 Analisis Risiko Kesehatan Lingkungan Pajanan Particulate Matter (PM10) pada Pedagang Kaki Lima Akibat Aktivitas Transportasi (Studi Kasus: Jalan Kaligawe Kota Semarang) *J. Kesehat. Masy.* **4**(3) 677–91

[18] Muziansyah D, Sulistyorini R and Sebayang S 2015 Model Emisi Gas Buangan Kendaraan Bermotor Akibat Aktivitas Transportasi (Studi Kasus: Terminal Pasar Bawah Ramayana Koita Bandar *J. Rekayasa Sipil Dan Desain* **3**(1) 57–70

[19] Rochgiyanti 2011 Fungsi Sungai Bagi Masyarakat di Tepian Sungai Kuin Kota Banjarmasin *Komunitas* **3**(1) 51–9

[20] Arisnawati R S, Riduan R and Annisa N 2016 Pemetaan Distribusi Konsentrasi Karbon Monoksida (CO) Dihubungkan Dengan Aktivitas Kendaraan Bermotor di Kampus Universitas Lambung Mangkurat Banjarbaru *Univ. Lambung Mangkurat. Banjarbaru*

[21] Prahasta E 2002 *Konsep-konsep Dasar Sistem Informasi Geografis* (Bandung: Informatika)

[22] Dulbahri 1993 *Sistem Informasi Geografis* (Jakarta: Gramedia)

[23] Riduan R, Sasmalini, Prasetia H and Annisa N 2019 Evaluation of Tidal Swampland Suitability Based on GIS Spatial Model on Barambai Reclamation Unit, South Kalimantan *MATEC Web Conf.* **280** 05020

[24] Annisa N, Prasetia H and Riduan R 2019 Green Configuration-Based GIS Spatial Model in Riparian Area of the River Kuin Banjarmasin, Indonesia *MATEC Web Conf.* **280** 04006

[25] Purwanto C, Arthana I W and Suarna I W 2015 Inventarisasi Emisi Sumber Bergerak di Jalan (On Road) Kota Denpasar *ECOTROPHIC J. Ilmu Lingkung. (Journal Environ. Sci.*, **9**(1) 1–9

[26] Rodriguez-Urrego D and Rodriguez-Urrego L 2020 Air quality during the COVID-19: $PM_{2.5}$ analysis in the 50 most polluted capital cities in the world *Environ. Poll.* **266**(1) 115042

[27] Susanto J P 2005 Kualitas udara beberapa kota di asia *J.Tek.Ling* **6**(1) 324–9

[28] Huda S N 2017 *Pengaruh Lalu Lintas Terhadap Sebaran PM10 di SDN 1 Syamsudin Noor Kota Banjarbaru* (Banjarbaru: Universitas Lambung Mangkurat)

[29] Damri, Ilza M and Afandi D 2016 Analisis Paparan CO Dan SO2 Pada Petugas Parkir di Basement Mall Ska di Kota Pekanbaru *Din. Lingkung.* **3**(1) 42–7

[30] Turyanti A 2016 *Pemodelan Dispersi PM10 Dan SO2 Dengan Pendekatan Dinamika Stabilitas Atmosfer Di Lapisan Perbatas Pada Kawasan Industri*. (Bogor: Institut Pertanian Bogor)

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GRADEMARK REPORT

FINAL GRADE

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GENERAL COMMENTS

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