Spatial Deterministic Interpolation of PM10 Concentration in Klang Valley from 2015 to 2016.

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Abstract

Nestled in the heart of urbanization, the Klang Valley faces a vital concern, grappling with the pressing issue of air quality degradation. PM_{10}, the ubiquitous pollutant, looms large as the primary pollutant behind the city's smog-filled skies, calling for urgent attention and effective solutions to ensure a sustainable and breathable future for all its inhabitants. This study aimed to assess the seasonal distribution of PM_{10} concentration in a specific area within Klang Valley, Malaysia, using the spatial deterministic interpolation method known as Inverse Distance Weight (IDW). 768 data from eight air quality monitoring stations of in Klang Valley were used which considered PM_{10} concentrations and meteorological parameters (humidity, temperature and wind speed) in 2015 and 2016. The data was run for descriptive analysis, normality distribution test, Spearman Correlation and spatial interpolation analysis. This study found that, Kuala Selangor, a suburban area, had the best air quality (42.8 µg/m^3 in 2015; 42.42 µg/m^3 in 2016) in both years as it had the lowest population. Meanwhile, Shah Alam (an urban area) was recorded as the area with the highest PM_{10} concentration (426.6 µg/m3) at the hazardous level, particularly during the haze episodes which occurred more than two months in 2015. The seasonal spatial interpolation analysis indicated that the period with the least air pollution occurs during the northeast monsoon (42.42-127.1 µg/m^3). The only significant correlation was analysed between humidity and PM_{10} concentration during northeast monsoon (R-value = -0.324) and spring inter-monsoon (R-value = 0.528) respectively. Overall, the pollutant distribution vary depending on the seasons, influenced by factors such as population density, land use and land cover (LULC), transboundary haze, the natural environment, and local meteorological conditions. While these data provide valuable insights into the spatial and seasonal patterns during that specific period, they may not fully capture the current air quality dynamics in the region and few of the data were also missing. Additionally, the focus on the IDW interpolation technique might overlook other potentially effective interpolation methods, which could warrant further exploration for more accurate and comprehensive results. Holistically, the comprehensive analysis of PM_{10} concentration's spatial interpolation in this study may be able to help the decision makers in informing effective air quality management strategies and promoting sustainability in rapidly urbanizing regions.

Keywords: Air quality, inverse distance weight, Klang Valley, particulate matter, spatial interpolation.

1. INTRODUCTION

In the new global economy, air pollution has become a central issue for the urban area. Urbanization areas that are familiar with industrialization and development are battling against air pollution every day. The density of population, industrialization and motor vehicle possession worsen the quality of air in the urbanization area (Lin & Zhu, 2018). Forest clearance for agricultural and urban purposes has consistently been a primary driver of environmental transformations, leading to various socio-economic and environmental repercussions (Kanianska, 2016). The land use and land cover (LULC), which modifies the physical and thermal characteristics of the land surface, has also impacted the air quality in urban areas resulting in varying levels of pollutant emissions (Asnawi & Choy, 2016; Kean et al., 2018; Shahrin et al., 2019). In Malaysia, Klang Valley is the mainstream economic area with substantial physical infrastructure growth, industrialization and urbanization that has dramatically deteriorated air quality (Department of Statistics Malaysia, 2012). The significant effect of urbanization and industrialization on the air quality of Klang Valley is vividly seen during the Movement Control Order (MCO) in 2020 due to the outbreak of CoronaVirus Disease when the air quality was getting better than before due to the reduction of pollutants emission (CoVID-19) (Abdullah et al., 2020; Khor et al., 2020; Tang, 2020).

Furthermore, one of the most unforgettable episodes of air pollution in Malaysia is the haze which happens almost every year. The issue of transboundary haze has been a controversial subject in Southeast Asia countries due to illegal slash-and-burn forests in Indonesia to expand their viable palm oil plantations (Arandas & Ling, 2020). Besides, the most intense biomass burning happened in Equatorial Asia between September to October 2015, and the worst scenario is when the region was facing extremely dry weather due to the strong El Nino Southern Oscillation (ENSO) occurrence (Mead et al., 2018). The warmer conditions will decrease the season of dry rainfall, then decrease the peatlands' water table, elevate their flammability, and enhance the longer-range transport of the smoke (Reid et al., 2013). Few studies (Samsuddin et al., 2018; Urbančok et al., 2017) revealed that, Sumatra and Kalimantan, Indonesia primarily proved as the origin of the smoke-haze episodes due to the forest and peat fires that affected Malaysia and Singapore in September and October 2015. Particulate matter with a diameter less than 10 µm (PM10) is known as a significant component of these air pollution phenomenon (Xiang et al., 2020)

PM10 comes from both human and natural sources (such as desert dust, industrial emissions, and commuting emissions). This pollutant impairs visibility and poses a health risk, especially in large cities (Khomsi et al., 2020). Abdullah et al. (2019) reported that, it is the highest sub-index from air pollution index (API) instead of other pollutants by years. Sentian et al. (2019), reported that the concentration of PM10 average was in large coefficient variations by years while carbon monoxide (CO) and nitrogen oxide (NOx) have lower coefficient variation excluding certain sites of monitoring. The PM10 and O3 highest relative risk (RR) were observed in the model of single-pollutant and the result shows that, by increased exposure of PM10, there will be a rise of 0.99% in natural mortality as well as 3.63% elevation in mortality of respiratory (Mahiyuddin et al., 2013).

Moreover, the air quality is also strongly influenced by multiple meteorological conditions such as wind speed, temperature and humidity (Jumaah et al., 2019; Qi et al., 2021; Qiao et al., 2019). This is because the location of Malaysia is situated near the equator, so it is known for the hot and damp climate throughout the year which leads to the north-east monsoon and the south-west monsoon (Jabatan Meteorologi Malaysia, 2019). The southwest monsoon between May to September causes the weather to be drier than usual. Meanwhile, during the northeast monsoon between November to March, the country tends to have higher levels of precipitation, especially in the early months of the seasons (Shaadan et al., 2015). Therefore, the atmospheric pollution level will be reduced on north-east monsoon since the pollutants will be washed out by the precipitation (Hoque, 2020), but then will be elevated during the south-west monsoon, when the pollutants become unstable due to the shifting of warm air to the higher region from the earth (Barmpadimos et al., 2011; Mohd. Odli, 2009). Due to the seasons of monsoon, Tarmizi et al. (2014) exposed that the distribution of PM10 is different depending on the seasons. Based on their study, the PM10 was found to be lower during northeast inter-monsoon. However, it was observed to be higher in southwest monsoon, followed by the two inter-monsoon (spring inter-monsoon and autumn inter-monsoon).

The main effect of air pollutants on humans is usually related to the respiratory health effect, cardiovascular system, cerebrovascular and cancer death as well as hospitalization (Al Ahad et al., 2020). As an instance, Maleki et al. (2016) exposed that 3777 of people's death has been recorded in Ahvaz, Iran due to the exposure of PM10 in 2009 to 2014 which means, 630 of total mortality recorded annually between that years. Furthermore, visibility also will be affected due to air pollution since it could be impaired by air pollutants through the diffusion of light and the absorption of fine particles into the atmosphere (Chen et al., 2018). If the trend of PM10 can be analyzed, the forecasting and clarification will assist the authorities in obtaining early information for maintaining the air quality particularly during transboundary haze (Abdullah et al., 2020).

Additionally, there have been studies that have investigated the spatial distribution of pollutants distribution levels in urban areas which concerning the meteorological parameters (Ku, 2020; Yan et al., 2021; Yang et al., 2021). Yan et al. (2021) analysed the seasonal spatial distribution of air quality index (AQI) in the city of Lanzhou, China by using inverse distance weight (IDW) and Getis-Ord Gi. This paper indicated a significant correlation between air pollution levels in the city and the meteorological conditions. Therefore, the main objective of this study was to determine the seasonal spatial pattern of PM10 concentration in a selected region of the Klang Valley, Malaysia, by employing the interpolation Inverse Distance Weight (IDW) technique.

2. METHODOLOGY

2.1 Study Sites

This study is located in the Klang Valley area that is well-known as a highly developed and economic area which is located at N 3.139003 and E 101.686855 or generally, it is at the centre of the west coast of Peninsular Malaysia (Hayati et al., 2014). Rostam (2006) as cited in Latif et al. (2015) mentioned that the area is around 29,11.5 km^2 which covers the regions of Kuala Lumpur, Selangor and Putrajaya. Eight Continuous Air Quality Monitoring (CAQM) stations were selected which are Kuala Selangor, Klang, Batu Muda, Cheras, Petaling Jaya, Shah Alam, Putrajaya and Banting (Ministry of Environment and Water Malaysia, 2021). The location of CAQM station in Klang Valley can be seen in **Figure 1**. These areas are facing two types of major monsoon seasons which are southwest monsoon (June - September), autumn inter-monsoon (October to November), northeast monsoon (November to March) and spring inter-monsoon (March to May) (Dahari et al., 2020). A severe haze incident happened in 2015 due to El-Nino and several countries in Southeast Asia were adversely affected by it (Mead et al., 2018). These meteorological factors of Klang Valley can influence the PM_{10} distribution.

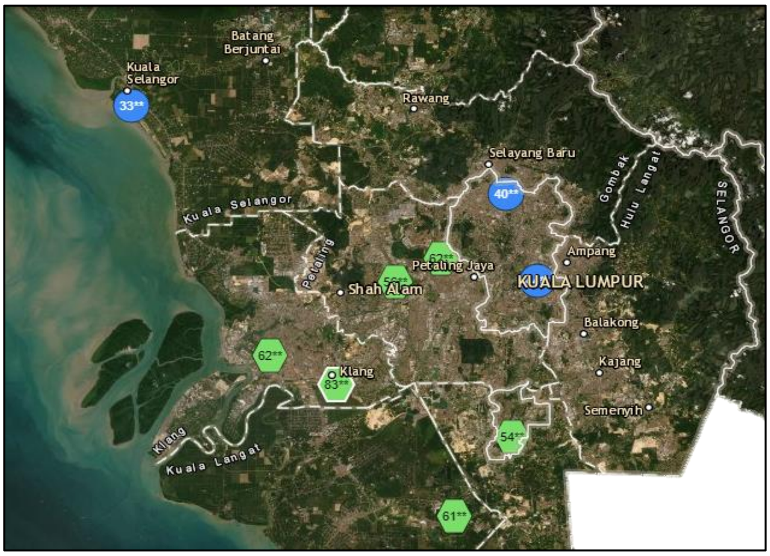

Figure 1: The Eight Monitoring Stations of Air Quality in Klang Valley Area.

Source: Ministry of Environment and Water Malaysia (2021).

Table 1 The Details of The Air Quality Station Based on Districts, Coordinates and the Category of Area.

Name of Air Quality Station	Districts	Coordinates	Category of Area
Sekolah Kebangsaan Batu Muda	Kuala Lumpur	N 3.212417 E 101.682209	Urban
Sekolah Menengah Perempuan Raja Zarina	Klang	N 3.009994 E 101.408374	Urban
Sekolah Kebangsaan Bandar Utama Damansara	Petaling Jaya	N 3.14103 E 101.614246	Industrial
Sekolah Kebangsaan Presint 8(2)	Putrajaya	N 2.931862 E 101.681775	Urban
Sekolah Kebangsaan TTDI Jaya	Shah Alam	N 3.104710 E 101.556179	Urban
Sekolah Menengah Sains Kuala Selangor	Kuala Selangor	N 3.326548 E 101.258880	Sub-urban
Sekolah Menengah Kebangsaan Seri Permaisuri	Cheras	N 3.106222 E 101.717909	Urban
Kolej MARA Banting	Banting	N 2.816971 E 101.623052	Sub-urban

Source: Latif et al. (2015).

2.2 Data Acquisition

This study used the air quality data that included the PM_{10} sub-index and the meteorological factors (humidity, wind speed and temperature) hourly between 2015 to 2016 by days from Department of Environmeny (DOE), Malaysia. The hourly data then will be averaged in order to obtain the daily data which followed by monthly data. The air quality data were obtained from the Air Quality Division of DOE at study sites stations that are located in Klang Valley (as shown in **Figure 1**) which are urban, sub-urban or industrialization area.

2.3 Descriptive Analysis

In this study, there are 768 data from eight CAQM stations in Klang Valley which consist of PM_{10} concentrations, wind speed, humidity and temperature readings. There is a total of 731 days (2 years) of data used in this study. There is a very small percentage of missing data (<2%) in the data set of PM_{10}, wind speed, humidity and temperature from 2015 to 2016. The percentage was calculated from the total missing daily observation divide with total observations during the study period and multiply by 100 as stated in Equation 1 (Tarmizi, 2016).

$$\text{Total missing data} = \frac{\text{Missing Observation}}{\text{Total Observation}} \times 100 \quad \text{………………...….Eq. (1)}$$

The replacement of missing data was applied through SPSS Statistic Software by using linear interpolation. By using the linear interpolation, this estimation method able to replace the missing values (Abdullah et al., 2019). The interpolation uses the last valid value prior to the missing value and the first valid value following the missing value. Then, the descriptive analysis was conducted. The normality of the data also was tested.

2.4 Spatial Interpolation by Inverse Distance Weighted (IDW)

In order to analyse the distribution of PM_{10} in 2015 and 2016, IDW method was applied in this study. This will help the researcher to visualize the air pollutant distribution from the geographical database and then will be able to assess the correlation between the high level of concentration and possible sources of pollution (Rahman et al., 2015). Several studies applied and proved the reliability of this method to determine the correlation of pollutant concentration and meteorological factors (Jha et al., 2011; Tarmizi et al., 2014). The basic concept of GIS interpolation is to measure the relationship between the percentage of dependency among nearby and the element of distance (Ajaj et al., 2017). The GIS adoption for interpolation in this analysis will be a very realistic approach to visualize the air quality distribution in the region of future studies (Mohamad et al., 2015). Additionally, to generate the outputs of the final maps which include the legend and scale bar (Jumaah et al., 2019), the ArcGIS was used for interpolation research.

As mentioned by Rahman et al. (2015), this interpolation technique will rise the weight in the process of average when the distance between the point with the location centre is shorter instead of the location that is further from the location centre. Lloyd (2010) stated that, as a particular interpolator, in order to establish a point value probability of the experimented property in the location s_0, IDW will use the measurement of $z(s_i)$, i = 1, 2,…, n, set in points location if the observations are absent. The element distance from the estimated location is known as the function of element weight from inverse squared distance that is denoted by exponent-2. The interpolation function can be defined in Equation(2):

$$\hat{z}(s_0)\frac{\sum_{i=1}^{n} z(s_i)d_{i0}^{-2}}{\sum_{i=1}^{n} d_{i0}^{-2}} \quad \text{……………………………Eq (2).}$$

by a detachment of s_0 and s_i while the d_{i0} represents the distance. IDW was reported as a method that can give a smaller value of root mean square error (RMSE) rather than other techniques like Kriging and Spline (Lu & Wong, 2008). However, Saniei et al. (2016) in their previous study argued that Ordinary Kriging has higher accuracy for AQI modelling also due to the lower RMSE value.

ArcMap 10.8 from the ArcGIS software was selected to map the PM_{10} distributions for the spatial interpolation analysis. The result of pollutant concentration then will be categorized based on the value and its description as shown in **Table 2**.

Table 2 The Description of PM_{10} Concentrations Based on The Values.

Category	PM_{10} Concentration ($\mu g/m^3$)
Good	0-54
Moderate	55-154
Unhealthy for Sensitive Groups	155-254
Unhealthy	255-354
Very Unhealthy	355-424
Hazardous	425-504
Hazardous	505-604

Source: Latif & Hamzah (2016)

3. RESULTS AND DISCUSSION

3.1 Descriptive Analysis

Table 3: The Descriptive Analysis of the PM_{10} concentration and meteorological factors.

	N	Min	Max	Mean, μ	Median	SD, σ
PM_{10} Concentration (μg/m^3)	192	42.42	426.57	109.40	79.45	83.40
Wind Speed (km/h)	192	0.10	43.10	14.14	14.14	4.78
Temperature (°C)	192	31.50	40.60	35.75	35.75	1.69
Humidity (%)	192	79.20	99.80	94.44	94.44	4.08

Table 3 shows the descriptive analysis of the data used during the study. Based on the result, the total of data used was 192 based on each parameter. The average of PM_{10} concentration, wind speed, temperature and humidity are 109.40 μg/m^3, 14.14 km/h, 35.75(°C and 94.44% respectively. Meanwhile, the standard deviation of PM_{10} concentration is 83.40. This indicates that the data values are far from the average value as the σ value is high (Rumpf, 2004).

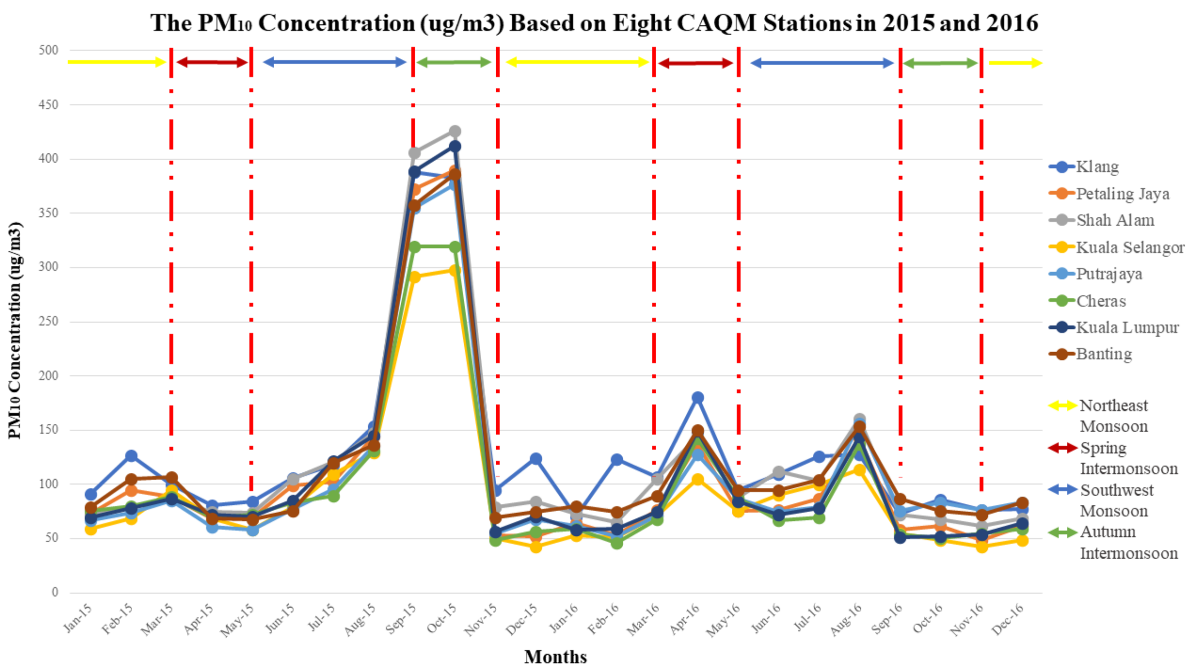

Figure 2: The peak of PM_{10} concentration value can be seen during September and October 2015 particularly within the area of Shah Alam.

Between these two years, the lowest PM_{10} concentrations can be observed in Kuala Selangor (2016) with the lowest value 42.4 μg/m^3. Meanwhile, the highest concentration was noticed in the area of Shah Alam (426.6 μg/m^3) in 2015 (*as shown in **Figure 2***). The lowest windspeed can be identified in Shah Alam (0.1km/h) while the highest was within the area of Cheras (43.1 km/h). Additionally, the lowest humidity between the period of study was 79.2% around Shah Alam. On the other hand, the highest humidity was 99.8% in Batu Muda. Meanwhile, the lowest and the highest temperature was noticed in the area of Putrajaya (31.5°C) and Cheras (40.6°C) respectively.

Besides, in order to analyse the normality of the data, a bell-shaped histogram was used. The result proved that the PM_{10} concentration in these eight CAQM stations was not normally distributed. This is because the tail lied on the right side which means it is positively skewed. According to Mood et al. (2015), this happens because most of the dataset is relatively low while some are extremely high. Additionally, the distribution shape of the data is platykurtic. This means the data set has more scattered values. This might be because the PM concentration data reported in terms of temporal change do not exhibit linear features and are thus difficult to analyse and anticipate effectively (Abdullah et al., 2019). Furthermore, the huge amount of land and forest fires in September 2015 in Sumatra and Kalimantan exacerbated the PM_{10} concentration for more than 2 months. Besides, this is the second-worst episode of haze after 1997 (Latif & Hamzah, 2016).

3.2 Statistical Analysis Between PM_{10} Concentration and Meteorological Factors

There are three meteorological factors that have been focused on in this study which were temperature, windspeed and humidity. The meteorological parameters were affected by few types of monsoons such as the southwest monsoon, first inter-monsoon, northeast monsoon and second inter-monsoon. Malaysia usually faces the southwest monsoon between May to September which causes the weather to be drier than usual. Meanwhile, during the northeast monsoon between November to March, the country tends to have higher levels of precipitation, especially in the early months of the seasons (Shaadan et al., 2015).

The PM distribution data is considered not normally distributed. This is because the PM concentration data reported in terms of temporal change do not exhibit linear features and are thus difficult to analyse and anticipate effectively (Abdullah et al., 2019). Therefore, Spearman Correlation (R-value) test has been selected as this method able to analyze the correlation between two sets of data which been collected from the same subject. According to Chua (2006), Spearman correlation test can only be used when the two set of data are categorized as ordinal type. It is known as non-parametric test when the data is not normally distributed.

Table 3 shows the correlation analysis between PM_{10} concentration and meteorological parameters. Based on the results, most of the variables result show that the p-value > 0.05 which means, the null hypotheses between variables are failed to be rejected except the humidity and PM_{10} concentration during northeast monsoon and spring inter-monsoon. By all way means, there is no significant correlation between the temperature, wind speed and PM_{10} concentration. The analysis indicated that the null hypothesis between humidity and PM_{10} concentration during northeast monsoon and spring inter-monsoon was rejected as the p-value < 0.050. Therefore, there is a significant correlation between humidity and PM_{10} concentration as the R-value = -0.324 and 0.528 respectively. Therefore, there is fairly low negative and moderate positive correlation between humidity and PM_{10} concentration during northeast monsoon and spring inter-monsoon respectively (Mood et al., 2015). Hence, humidity is considered as a significant variable that may affect the PM_{10} concentration.

Table 3: The Summary Result of Statistical Inference Between Variables.

Correlation Between Variables	p-value	R-value
Northeast Monsoon		
Temperature - PM_{10} Concentration	0.059	-
Humidity - PM_{10} Concentration	0.003*	-0.324

Wind Speed - PM_{10} Concentration	0.055	-
Southwest Monsoon		
Temperature - PM_{10} Concentration	0.077	-
Humidity - PM_{10} Concentration	0.210	-
Wind Speed - PM_{10} Concentration	0.161	-
Spring Inter-monsoon		
Temperature - PM_{10} Concentration	0.002	-
Humidity - PM_{10} Concentration	0.462*	0.528
Wind Speed - PM_{10} Concentration	0.264	-
Autumn Inter-monsoon		
Temperature - PM_{10} Concentration	0.110	-
Humidity - PM_{10} Concentration	0.304	-
Wind Speed - PM_{10} Concentration	0.163	-

*p is significant when <0.05

3.3 The Deterministic Interpolation by Inverse Distance Weighted (IDW)

The spatial interpolation of PM_{10} distribution in Klang Valley was analysed monthly from 2015 to 2016 by IDW. ***Figure 3 to Figure*** 5 illustrate the seasonal spatial interpolation of PM_{10} distribution in Klang Valley in 2015 and 2016 respectively.

Based on the spatial analysis, it was noticed that the lowest PM_{10} concentration in 2015 was between 42.8 µg/m^3 in Kuala Selangor in December 2015. Kuala Selangor, which is a suburban area was noticed as the region with the lowest PM_{10} concentration frequently compared to other regions. This result also similar to a finding by Tarmizi et al. (2020) which observed Kuala Selangor as the station with the lowest PM_{10} concentrations regularly compared to other stations. The area was found as an area with the lowest population compared to another region of Klang Valley (Mabahwi et al., 2018). As cited by Abdul Shakor et al. (2020), there are multiple studies proved that the PM_{10} concentrations were observed increasing as the population density is higher (An et al., 2013; Hou et al., 2016; Prasannavenkatesh et al., 2015; Wang et al., 2015).

In October 2015, Shah Alam was recorded as the highest PM_{10} concentration in 2015 (426.6 µg/m^3) exceeding the concentration limits of PM_{10} based on the Malaysian New Air Quality Standard which is 100 µg/m^3 for a 24-hour average. This area is an extensively urbanized city that encompasses industrial zones, residential neighborhoods, the Subang Airport and is bordered by highways and major roads within 10 kilometers diameter (Zakaria et al., 2018). The category of PM_{10} concentrations in Klang Valley in 2015 was in the category of good to hazardous *as stated in* ***Table 2.*** October 2015 was found to be the month with the highest PM_{10} concentration due to transboundary haze which started at the end of September 2015. Chooi and Yong (2016) as cited in Rani et al., (2018) stated that during the haze, the distribution of PM_{10} is higher compared to the non-haze period. Besides, the severe haze incident happened in 2015 was also due to El-Nino and several countries in Southeast Asia were adversely affected by it (Mead et al., 2018). The PM_{10} distribution between 17 to 19 October 2015 was in the category of moderate. However, it was getting worse on 22 October when the concentration reached the category of unhealthy.

Besides, in November 2016, Kuala Selangor also was recorded as the region with the lowest PM_{10} concentration in 2016 (42.42 µg/m^3). Meanwhile, the highest concentration of PM_{10} can be observed within the area of Klang in April at 180.2 µg/m^3. Klang was discovered as the area with the highest PM_{10} concentration regularly than another region. This result is similar to a finding by Sentian et al. (2019) and Shafie et al. (2022) which indicated that Klang was the hotspot area of PM_{10} distributions. According to Mohamad et al. (2015), the area of CAQM station in Klang was commonly known as an urban area. It is located within a residential area, next to the main route of Port Klang. That area is also near the villages and industrial sectors. Port Klang is one of Malaysia's most important industrial cities, with a large flow of heavy trucks. Mustaffa et al. (2016) mentioned that Port Klang was Malaysia's top busiest port. It was also recorded at the rank of 13th as the liveliest port in the world. Furthermore, this port also trades with over 120 nations and has links with beyond 500 ports across the world (Tarmizi et al., 2020). The oldest gas turbine and coal-fired power are some other PM_{10} sources which also well-known around this port (Mohamad et al., 2015). The activities within the area contributed to higher PM concentrations due to the exhaust of heavy transportation and smoke from chimneys of factories as well as the activities from Port Klang. On a final note, it can be said that the PM_{10} concentration of Klang Valley in 2016 was between good to unhealthy for the sensitive group.

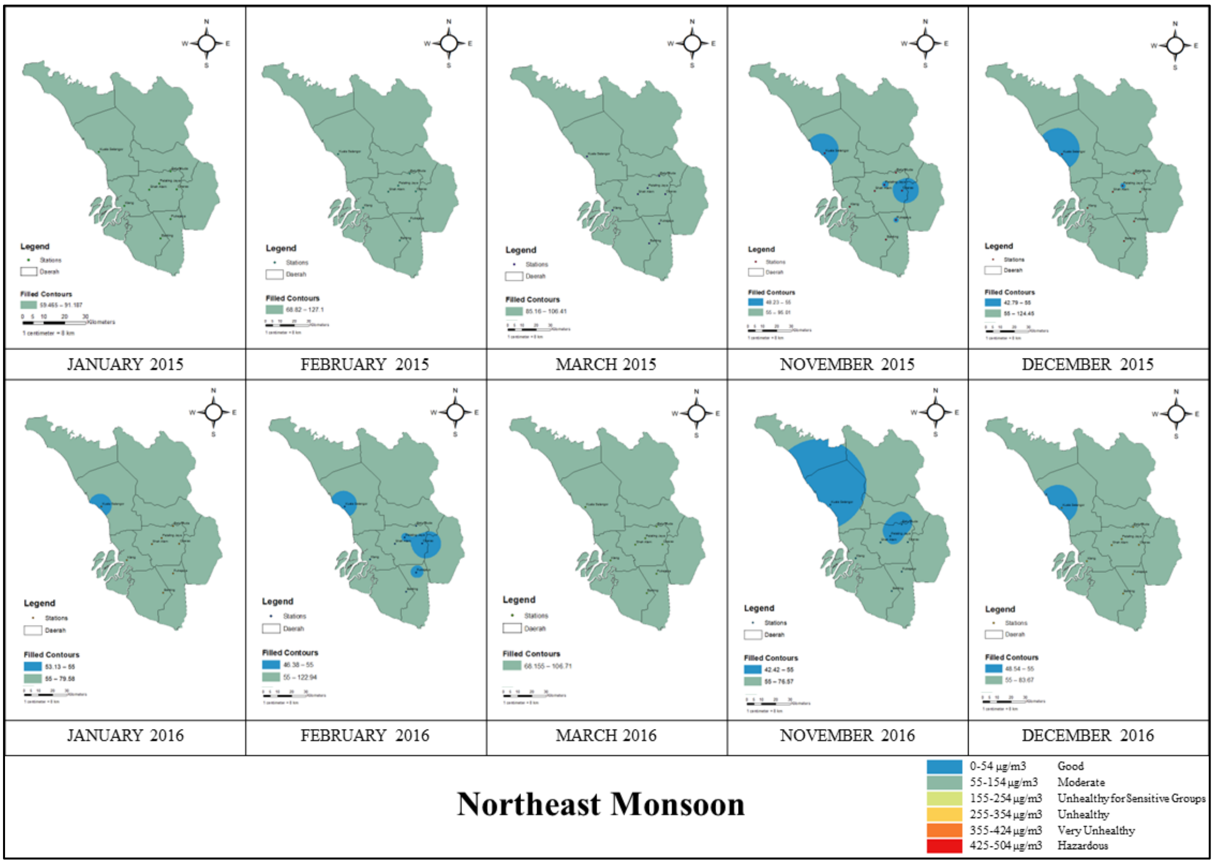

Figure 3: The Spatial Distribution of PM_{10} Within the Area of Klang Valley During Northeast Monsoon That Shows the Best Air Quality.

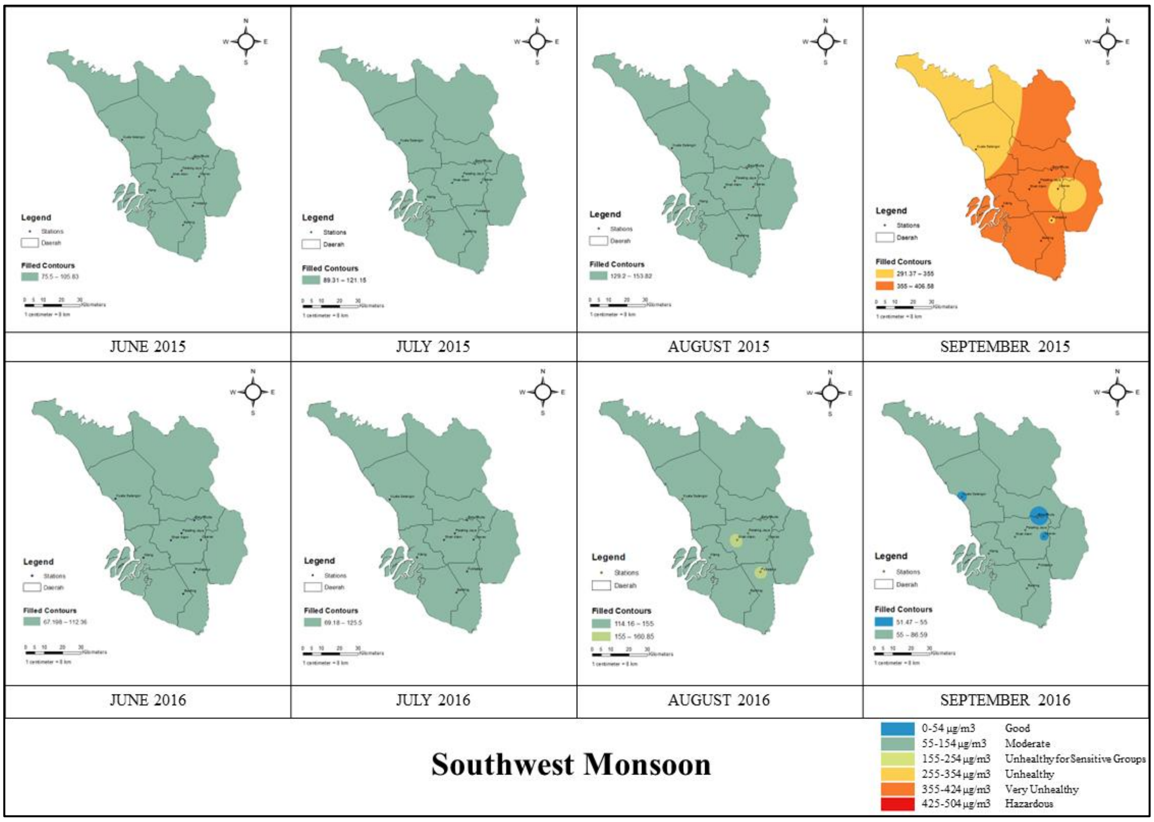

Figure 4: The Spatial Distribution of PM_{10} During Southwest Monsoon That Was Observed at worst in September 2015.

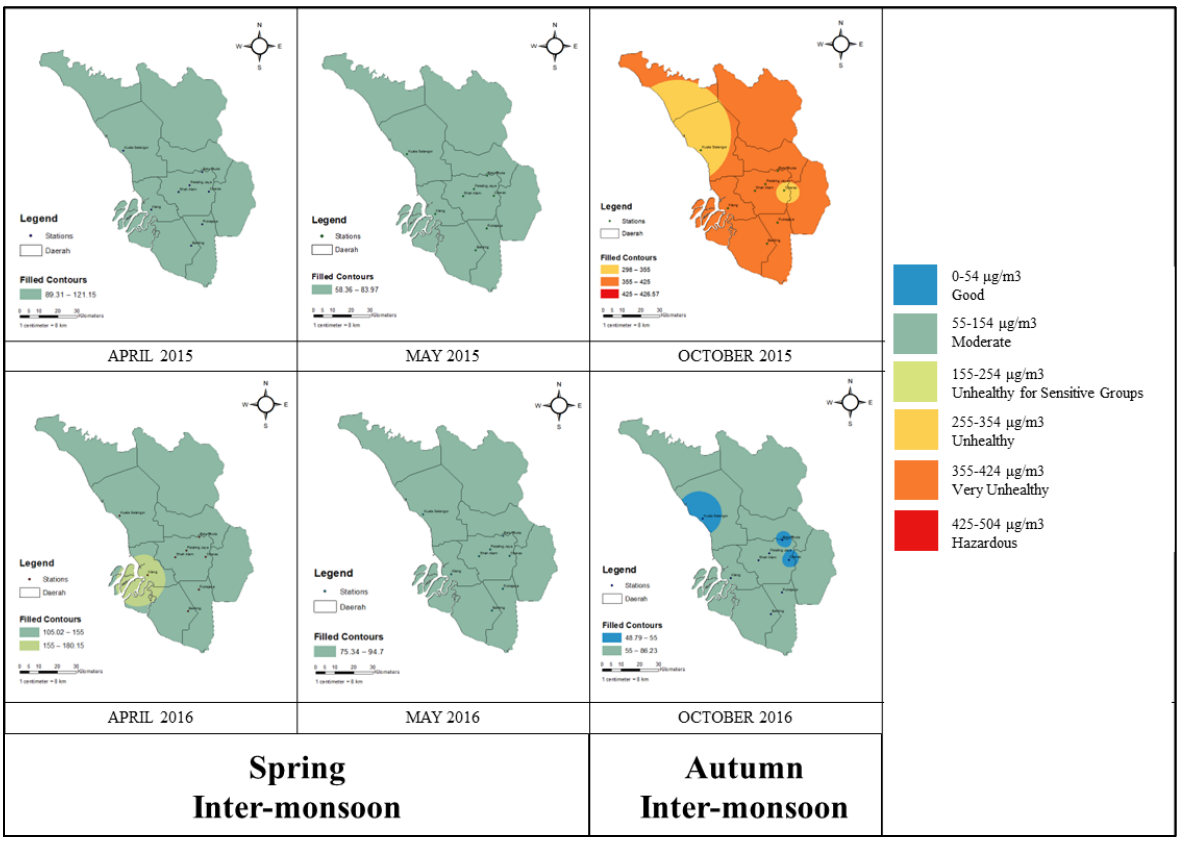

Figure 5: The Spatial Distribution of PM_{10} During Inter-monsoon.

The second month with the highest PM_{10} concentration was September 2015 then followed by August 2015 and August 2016. According to Shaadan et al. (2015), September and August are known as the period of Southwest monsoon which causes the weather to be drier than usual.

Meanwhile, the best air quality can be observed during the northeast monsoon between November to March. The country tends to have higher levels of precipitation, especially in the early months of the seasons. Therefore, the atmospheric pollution level will be reduced on north-east monsoon since the pollutants will be carried to the earth by the precipitation but then will be elevated during the south-west monsoon when the pollutants become unstable due to the shifting of warm air to the higher region from the earth (Barmpadimos et al., 2011; Mohd. Odli, 2009).

4. CONCLUSIONS

As most of the study sites were considered as hustling cities (except Kuala Selangor and Banting), most of the days, the air quality was poor. The transboundary haze and El-Niño phenomenon in October and November 2015 exacerbated the air pollution. Kuala Selangor, a suburban area, was considered to have the best air quality (42.8 $\mu g/m^3$ in 2015; 42.42 $\mu g/m^3$ in 2016) in both years as it had the lowest population. Meanwhile, Shah Alam (an urban area) was recorded as the area with the highest PM_{10} concentration (426.6 $\mu g/m^3$) at the hazardous level particularly during the haze episodes. The lowest air pollution can be observed during the northeast monsoon between 42.42-127.1 $\mu g/m^3$. Besides, there is a significant correlation between humidity and PM_{10} concentration during northeast monsoon (R-value = -0.324) and spring inter-monsoon (R-value = 0.528) respectively. There is fairly low negative and moderate positive correlation between humidity and PM_{10} concentration.

In conclusion, the study findings indicated that the levels of PM_{10} in a specific region within Klang Valley, Malaysia, vary depending on the seasons, influenced by factors such as population density, the local activities, transboundary haze, the natural environment, and local meteorological conditions. The objective of study was answered by determining the seasonal spatial pattern of PM_{10} concentration in a selected region of the Klang Valley, Malaysia, by employing the interpolation Inverse Distance Weight (IDW) technique, to create interpolated surfaces, extending beyond the station radius, to visualize the variability of PM_{10} levels. This information can aid decision-makers in effectively and precisely targeting air pollution mitigation measures.

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