A Review: Air Pollution Index in Selangor for Year 2014

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***Abstract*— The worsening of air quality is parallel with fast urbanization and industrialization in the country. The study targets to determine the trend of concentration of five main of air pollution (i.e. PM_{10}, SO_2, NO_2, CO, O_3) with five different location of Malaysian air monitoring station in Selangor for year 2014. To determine the association between meteorological factors and pollutants, the recommended Malaysian Ambient Air Quality Guidelines (MAAQG) standard will be compared from the integrated analysis. Index system for determination ambient air quality and classification was introduced by Air Pollution Index in Malaysia (APIMS). Klang Valley were below the MAAGQ standard from the statistical analysis for 24 average hour result of PM_{10}, SO_2, NO_2, CO and O_3. Petaling Jaya recorded the highest of concentrations of NO_2 and CO while Klang recorded the highest of concentration of PM_{10} for year 2014. From the trend analysis, during north-east monsoon (wet season), level of concentration of CO remained high while PM10 levels remain highly concentrated during south-west monsoon (hot dry season). During February and March, the PM_{10} exceed the MAAQG standard result by open burning in Sumatera, Indonesia.**

Keywords*— *Ambient air concentration, Klang Valley, Monsoon

I. INTRODUCTION

The presence of air contaminant such as odor, smoke, vapor gas, mists dust and gas to the atmosphere is the definition of air pollution. Air pollution can cause injuries to human, animal and plant. The growth of industrial production, distance travelled, mega construction and number of vehicles will reached the critical level of air pollution especially in metropolitan areas.

In China, the one of top natural worries of air pollution has turned out. The most economically vibrant regions in China currently such as Shanghai, Beijing and Pearl River Delta area including Hong Kong, Shenzhen and Guangzhou and their immediate vicinity. Engine of world's economic growth currently thought in China. Related health impacts, air pollution and energy consumption expansion has brought in China's economic growth. Acid rain problems were created in 38% of the urban communities that exceeded the Chinese Grade-II standards in 22% of the country's urban areas from SO_2 concentrations [1]. A considerable lot of the most elevated particulate matter concentration additionally happen especially in the Beijing to Shanghai corridor as well as pollution emission is regularly limited. Not all major urban areas have high pollution fluxes such as Wuhan, Chengdu and Chongqing and Hangshou, Linyi, Tangshan, Zibo, Shijazhuang and Handan were the greater part of the largest emissions show up in or close urban zones [2].

In United State (USA), concentrating on two regular air pollutants such as ozone (O_3) and fine particulate matter ($PM_{2.5}$) caused the toll that air pollution goes up against the health of New Yorkers evaluated by The Health Department. Unfavorably influence health and concentrations above clean air guidelines are found in New York City's that both pollutants are among the most investigation of natural hazard. From the **Figure 1**, trend show that mean of concentration NO at very high at Times Square in New York during winter 08 and exceed dangerous line during spring 09 [3].

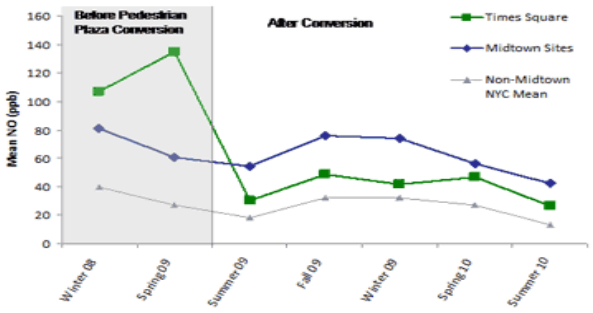

Figure 1: Mean of concentration NO at very high at Times Square in New York

The air monitoring station functioning to detecting and scanning the air pollutants such as particulate matter, nitrogen oxides, ozone, carbon monoxide and sulphur dioxide. The information that obtained by air monitoring station will evaluated by APIMS that assist in evaluating the air concentration trend profile in Selangor.

The development of extensive physical in Klang Valley such as urbanization, industrialization and mega infrastructure will considerably deteriorated the air quality [4]. Major mobile source of air pollution is from motor vehicles in developing countries such as Petaling Jaya, Klang and Shah Alam. Lead, suspended particulate matter and dust fall-out from motor vehicles are the among the elements detected in the ambient air along the congested road [5]. The emission of dust from urban construction works and quarries, industrial waste incinerators, power plants and open burning are the other sources of air pollution. The widespread forest fires in Sumatera and Kalimantan efeect the quality of air in Klang Valley and also hit the areas in Malaysia [6].

II. METHODOLOGY

A. Description of Study area

Klang Valley is urbanized region in Peninsular Malaysia consists of Rawang, Gombak, Petaling Jaya, Subang Jaya, Shah Alam, Selayang, Ampang Kuala Lumpur, Cheras, Serdang, Puchong Klang, Subang and Cyberjaya that located at N 3.139003 and E 101.686855 with 29,11.5 km^2 of total area (**Figure 2**) [7]. In this area, it contributed 23.5% of the growth Domestic Product of Malaysia in 2012. In this research, it only target five locations of in

Selangor which are Shah Alam, Petaling Jaya, Banting, Kuala Selangor and Klang.

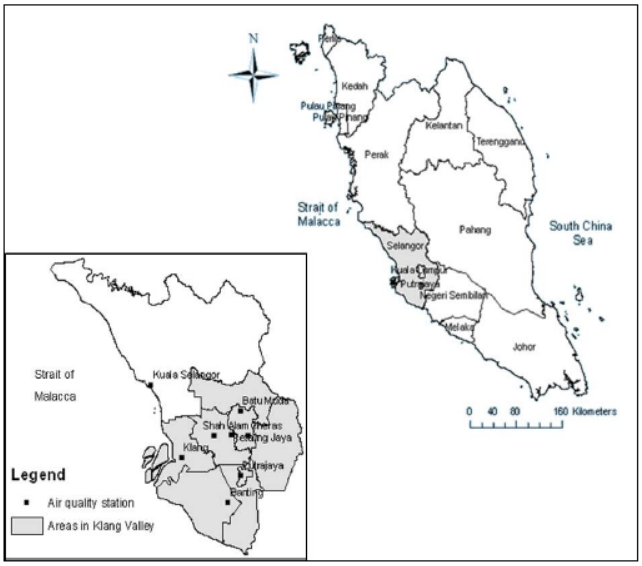

Figure 2: The areas and air quality stations in the Klang Valley

B. *Air Quality Sampling Stations*

Table 1: The air quality monitoring stations in Selangor

Air quality station location	Area	Coordinates	Area category
Sekolah Kebangsaan TTDI Jaya	Shah Alam	N 3.104710 E 101.556179	Urban
Sekolah Menengah Perempuan Raja Zarina	Klang	N 3.009994 E 101.408374	Urban
Sekolah Kebansaan Bandar Utama	Petaling Jaya	N 3.1541 E 101.6117	Urban
Kolej MARA Banting	Banting	N 2.816971 E 101.623052	Suburban
Sekolah Menengah Sains Kuala Selangor	Kuala Selangor	N 3.326548 E 101.258880	Suburban

Source: Department of Environment (DOE)

Table 1 is the list detailed of five air monitoring stations in Selangor. The characterizations of this location are urban and suburban. Main road and highways, residential areas and industrial are location that near the air monitoring station of Shah Alam, Klang and Petaling Jaya that experienced traffic-related pollution. **Figure 3** is the example of air monitoring station in Shah Alam.

Figure 3: Air Monitoring Station in Sekolah Kebangsaan TTDI Jaya, Shah Alam, Selangor

C. *The Air Quality and Meteorological Data*

The air monitoring station functioning to capture and analyses the data of selected pollutants such as ozone (O_3), carbon monoxide (CO), nitrogen oxide (NO_2), sulphur dioxide (SO_2) and particulate matter that less than 10 microns (PM10). Air Pollution Index of Malaysia (APIMS) in **Table 2** will translate the air quality concentration with the number and then calculated based on average daily. The concentration of PM_{10} is the highest compared to the other type of concentration. 300 of API reading is considered as hazardous, very unhealthy for 200 to 300, unhealthy for 100-200, moderate for 51 to 100 and 0 to 50 as good.

Table 2: Malaysian Air Quality Guidelines

API	Status	Level
0-50	Good	The level of air pollution is low
51-100	Moderate	The level of air pollution is moderate
101-200	Unhealthy	Can be worse for someone who have heart disease
201-300	Very Unhealthy	Worse air pollution and can endangered toward who have disease
301-500	Hazardous	Very worse the air pollution
Above 500	Emergency	Very worse air pollution

Source: Air Pollution Index Malaysia (APIMS)

For this review, 24 hour of PM_{10}, CO, SO_2, O_3 and NO_2 were sourced from the air monitoring station at five different location by Department of Environment (DOE). PM_{10} calculated in unit ($\mu g/m^3$) while other component unit in part per million (PPM).

D. *Data Analysis*

The data analyses in 2014 will be compared to the Malaysian Ambient Air Quality Guidelines (MAAQG) by DOE. To protect human health and environment, the MAAQG value are the minimum requirement for outdoor air quality. Lead (Pb) and total suspended particulates (TSP) were not analyses as these variables are not constantly over the year.

Table 3: Recommended Malaysian Ambient Air Quality Guidelines

Pollutant	Averaging time	Malaysian Guidelines	
		ppm	$\mu g/m^3$
Ozone (O_3)	1 Hour	0.10	200
	8 Hours	0.06	120
Carbon Monoxide (CO)	1 Hour	30.0	35 mg/m^3
	8 Hours	9.0	10 mg/m^3
Nitrogen dioxide (NO_2)	1 Hour	0.17	320
	24 Hours	0.04	75
Sulphur dioxide (SO_2)	1 Hour	0.13	350
	24 hours	0.04	105
Particulate matter (PM_{10})	24 hours	-	150
	12 months	-	50
Total suspended particles (TSP)	12 hours	-	260
	12 months	-	90
Lead (pb)	3 months	-	1.5

Source: DOE

III. RESULTS AND DISCUSSION

A. The Comparison of Ambient Air Pollutants with the Malaysian Ambient Air Quality Guidelines (MAAQG)

Figure 5, Figure 6, Figure 7, Figure 8 and **Figure 9** was illustrates the trend of air pollution in 2014 of PM10, CO, NO_2, O_3 and SO_2 in the five different location of Selangor that detected by air monitoring station. From the trend, the pollutant level did not exceed MAAQG level standard except PM10 due to open burning in Sumatera, Indonesia during early month. The other factors such as industrial activity and construction also influenced the reading of concentration of pollutant. In Klang, the biggest port in Malaysia named Port Klang possibly highly traffic congestion almost every day that link with Jalan Persiaran Raja Muda Musa. Now, Klinik Kesihatan Pendamaran is the new air monitoring station in Klang that situated in Jalan Persiaran Raja Muda Musa since 2015.

Figure 4: Port Klang (Link with Jalan Persiaran Raja Muda Musa)

The trend of air pollution in Selangor for year 2014 was illustrated in form of graph with concentration of the type of pollution vs weeks. The trend shows in **Figure 5, Figure 6, Figure 7 Figure 8** and **Figure 9**.

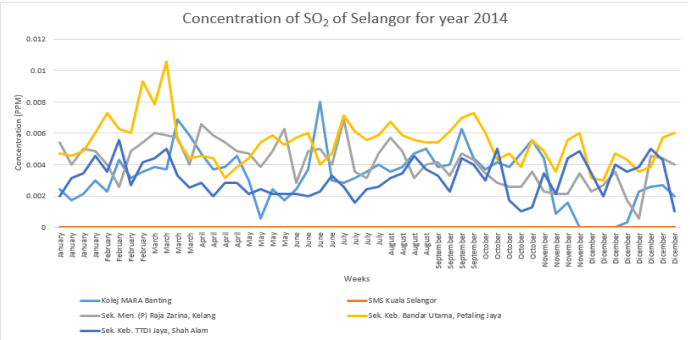

Figure 5: Graph of Concentration of Sulphur dioxide (SO_2) versus Week of Selangor in year 2014.

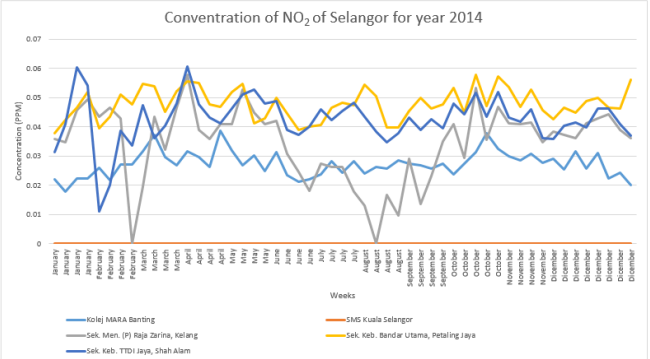

Figure 6: Graph of Concentration of Nitrogen dioxide (NO_2) versus Week of Selangor in year 2014.

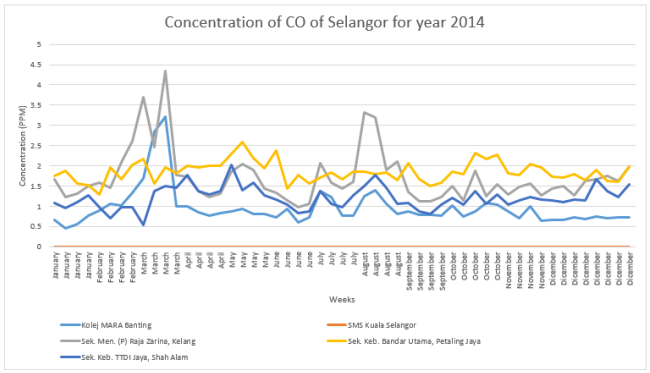

Figure 7: Graph of Concentration of Carbon Monoxide (CO) versus Week of Selangor in year 2014.

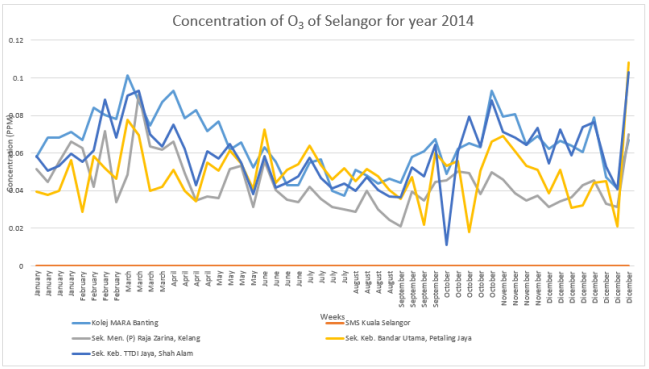

Figure 8: Graph of Concentration of Ozone (O_3) versus Week of Selangor in year 2014.

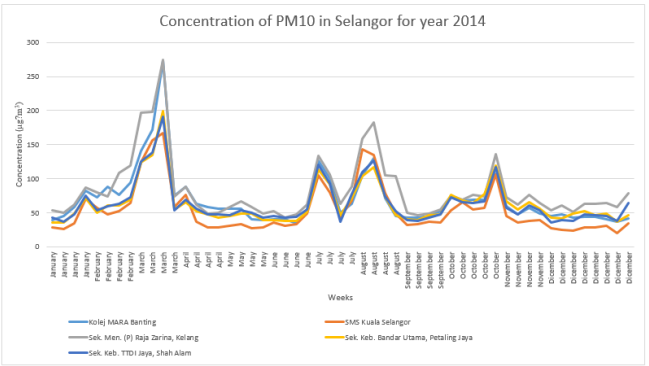

Figure 9: Graph of Concentration of Particulate Matter 10 (PM_{10}) versus Week of Selangor in year 2014.

Regarding on Figure 6 and 7, Petaling Jaya was experienced the highest concentration of CO and NO_2. The factor that related to this location is this areas surrounded by many commercial areas, industries, residential and mega infrastructure. The air concentration mostly conquered by all types of concentration. The total of population in this area is 638516 people with total area 97.2 km^2. Petaling Jaya experienced the highest concentration of PM_{10} which is 199.49 $\mu g/m^3$ that exceed Recommended Malaysian ambient Air Quality Guidelines (MAAQG) [8]. Fuel combustion with high pressure and also temperature will oxidizes the nitrogen to form NO_2 with sufficient oxygen. From the case study, the concentration of NO_2 were at peak form 7 a.m to 9 a.m. the increasing of NO_2 because of people start to going to work and possibly sending their children to any institutions or school. Petaling Jaya was dominated the highest concentration of NO_2 starting from week 7 until the end of the year.

Figure 10: Federal Highway in Petaling Jaya

Comparing to other locations, Shah Alam was the highest record of concentration for NO_2 at the week 3 and week 13 which more than 0.06 ppm. . The recommendation of Malaysian limit 0.17 ppm so that Shah Alam still below the range that recommended by Malaysian Ambient Air Quality Guidelines that had been decide by DOE Malaysia.

Figure 11: Jalan Persiaran Kayangan, section 7, Shah Alam (Near Hospital Shah Alam)

Petaling Jaya was dominated the highest trend of concentration of SO_2 in 2014. Regarding the Recommended Malaysian Ambient Air Quality Guidelines (RMAAQG), the average time of SO_2 in 24 hours is 0.04 ppm. Based on the guidelines, Selangor still in range that experienced of pollutant and less polluted means that air pollution in this place is safe. The increased of population also had tendency to developed the new industrial project, road project and monitoring landfill. **Figure 5** shows the peak of the SO_2 in Petaling Jaya was 0.011 ppm that dominates the highest of concentration in 2014. Another areas quite up and down synchronized well within range 0.002 to 0.006 ppm of concentration of SO_2.

The trend of concentration of ozone was randomly up and down but sometimes corresponding with other different location. Average reading of O_3 concentration are shown in **Figure 8**. For early month, Banting dominates the ranking which released highest amount of O_3 followed by Shah Alam, Klang and Petaling Jaya. This is because open burning activities in Banting affect the quality of air pollution. Shah Alam is the next location that not really synchronized the trend of O_3 concentration. Shah Alam is semi-urban area in Selangor that sometimes recorded the highest released of O_3. From **Figure 8**, in weeks 21, 25 and 31 Shah Alam were dominated the highest concentration of O_3. The reasons why releasing O_3 because of related to the vehicle emission that produced precursor pollutant NOx. Photochemical reaction that involving heat and sunlight will formed O_3 gas that related to the volatile organic compound (VOC) and NOx. In Kuala Selangor, the trend of O_3 cannot be detect because this station only shows particulate matter 10 (PM_{10}) that to trace the presence of haze that come from Sumatera, Indonesia. The increased of rainfall that experienced in Petaling Jaya will cause wet condition in this place. The number of hotspot detected of this area become decreased. . Meanwhile in Shah Alam, the ozone released was decreased slightly starting from February as rainfall at the late of evening which cause the hotspot detected in this area decreased. The Metrological Malaysia Department (MMD) reported the weather of definite zone in Malaysia.

Figure 12: Banting Town

Kuala Selangor was recorded the lowest of PM_{10} concentration compare to the other location based on **Figure 9**. Regarding to the initial monthly resulted, Kuala Selangor, Petaling Jaya, Shah Alam and Banting were ongoing the releasing of PM10 below 50 $\mu g/m^3$ and start to slightly increased for every week. . The monthly values of PM_{10} concentration in Banting and Klang higher compare to the other location. In February, the mean of PM10 concentration in Banting and Klang is 200 to 260 $\mu g/m^3$ respectively while other locations range between 140 to 200 $\mu g/m^3$. . Form the result, PM10 exceeds the MAAQG standard (150 µg/m3) in the certain month of the year which is February, May and August 2014. In addition the PM_{10} concentration value mostly recorded more than 100 µg/m3 was related to the haze episodes from south-west monsoon wind that transport suspended particulate PM_{10} from Sumatra to the west coast of Peninsular Malaysia. The haze episodes will influence the concentration conditions in of surrounding areas especially in all areas in Selangor. It is likely that the distribution of pollutants was influenced by these monsoons. Hot and dry weather also cause the increasing of PM_{10} in Selangor. One of the factors that increasing of PM_{10} concentration are increasing of mobile sources from public and private motor vehicles. This area also is the main sources of releasing of pollution especially in the Klang Valley.

Among all these five stations in Selangor, it clearly shows that Petaling Jaya had the highest pollution index compared to the other station followed by Klang Station and Shah Alam station, Banting station, and last but not least is Kuala Selangor station. The highest concentration of pollution is cause the geographical of location itself. The Kuala Selangor only takes reading for PM_{10} because at this place is rural area that less pollutant among urban and sub-urban area.

Figure 13: Kuala Selangor Town

Compare to other location, Klang station is at the main road especially in Jalan Persiaran Jalan Muda Musa that link with Port Klang and always having traffic congestion in almost every time. The factor that contribute in increasing value of air pollution is from wind direction flow from the north east (NE) in the first three month and then the wind direction change the direction to south west (SW) in the middle of the year 2014. However, the wind blow is make it more worst when there is an open burning at the Sumatra, Indonesia which give a high impact of air quality at

Malaysia. With this graphical data analysis, it shows that higher emission of PM_{10}, CO and O_3. The haze episodes at the early month from Sumatera, Indonesia will cause the higher concentration of PM_{10} in Selangor thus it will effect of human respiratory system. Therefore, a better technology, or a better strategy can be done to overcome this issue.

IV. Conclusion

Overall, air pollution index for Selangor is easily analysed by using graphical data. The station that had a high concentration of air pollution is in Klang, followed by Shah Alam, Petaling Jaya, Kuala Selangor, and lastly Banting. There are five main parameters that can trace the air pollution index, which are PM_{10}, SO_2, NO_2, O_3 and CO. If the concentration of ozone becoming lesser, this condition should be worried and a step should be taken. However, the concentration limits that being compulsory to follow by the Department of Environment Malaysia. The trend of Selangor 2014 in the early month was the highest recorded that cause by open burning from Indonesia and less rainfall at this time. Starting from March to April, the month shows the low pollutant detected because the high humidity and rain fall. Other than that, the open burning from Sumatera, Indonesia was stopped at this time. It can be concluded that during summer season in Malaysia from July to August 2014, the haze season which increase the Air Pollution Index (API).

Acknowledgment

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