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Assessing the Seasonal Variation of Particulate Matters Concentration in Perak, Malaysia

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Abstract. The aim of this study is to identify the relationship between the seasonal variations and concentration of particulate matter (PM_{10}) in Perak using 2015 data sets from ASMA. The concentrtaion PM_{10} becomes complicated when in contact with meterological parameters, thus, requires thorough investigation. The need to study the point of origins and factors that may contribute to the distribution of PM_{10} in the atmosphere annually can provide new information to mitigate against future impact of PM_{10} on the health of the society. Correlation and factor analysis were used for data analyse. The result shows that PM_{10} concentration during the year 2015 was mostly caused by a transboundary source from a fire in Indonesia which resulted in a massive haze that affected most of South East Asia, including Malaysia. However, there is a negative correlation between weather parameters and PM_{10} concentrations in the month of September and October.

Keywords: PM_{10}, seasonal variation, concentration, Perak, emission.

1 Introduction

In this era of globalisation, Malaysia has undergone some rapid developments to earn its status as a developing nation. But following the growth of the nation is a number of problems faced not only in Malaysia but even in the most developed countries of the world. One of the problems that is usually experienced in a developing country is the pollution that comes with the improvement of the

industry, particularly on pollution that affects the country's air or atmosphere [1].

Air pollution has long been a serious problem that requires prompt notice from all involved parties of the world. According to a case study done by Azid et al. [2], air pollution has become one of the most significant elements that contributes to the deterioration of life and living quality in Malaysia. The main sources of this major environmental issue usually originates from the increased number of vehicles, trans-boundary pollution from neighbouring countries as well as the rise in industrial activities. As a result, health problems can occur to humans who are exposed to these lower quality environment caused by air pollutions.

In addition, one of the main pollutant found in capitol urban areas is known as particulate matter (PM10) and it is characterised to have an aerodynamic diameter of less than 10 μm. The pollutant mentioned is one of the crucial air pollutants and drastically impacts the Malaysian Air Pollution Index (MAPI) [2]. Therefore, extensive study and analysis of the sources, distributions and dispersive attributes of PM10 over a specified area is important in order to apply effective management and mitigation policies.

2 Review of Relavant Literature

2.1 Identification of PM_{10} Emission Sources

Biomas burning constitute a leading regionl source of particulate matter emission in Southeast Asia, especially from June to September where the skies are relatively dry. [3-6]. This allows for easy movement and accumulation of pollutants in high concnetration in Malaysia. This is noteable during the Sumatra and Indochina bush burning that releases smoke, consisting of a high quantity of particulate matter, into the atmosphere [4], [7]. This transboundary source of particulate emission has for long contributed to the deterioration of air quality in Malaysia.

Previous study have shown that the Valley is the most affected part in Malaysia with concentration of PM_{10} exceeding the maximum permissible limits especially during the summer monsoon dry season [6]. This is due to the smoke from trans-boundary biomass burning in Sumatra, Indonesia. [8]. Although, local environmental factors and industrial development may also trigger a variation in the pattern of PM_{10} in Klang Valley. More so, traffic congestion contribute to the concentration of PM_{10} in urban Klang Valley compared with those of quieter and more rural areas [3].

2.2 Factors that Influence the Pattern of Air Pollution

Apart from emission sources, other factors such as complex interactions in meteorological conditions, chemical reactions, transportation as well as wet and dry depositions, etc play a key role in influencing the concentration of PM_{10} [9]. Thus, the pattern of air pollution in any given area is not only determined by a single source, but also by multifaceted weather elements over various spatio-temporal scale. These weather elements that cut-across temperature, wind speed, relative humidity, solar radiation flux and cloudiness can affect local biogenic, dust emissions and chemical reaction processes. On the other hand, the boundary layer turbulence and synoptic atmospheric circulation may affect air quality. According to a study done by Zizi et al [10], which focused on heavily crowded industrial areas, namely Nilai, Petaling Jaya and Seberang Perai, over a period of five years from 2008 to 2012, they observed that the concentration of PM_{10} hits a peak during the dry season as well, which simultaneously occurred with the southwest monsoon and could also be influenced by direct-influence of the southwest winds which had caused a slightly moderate haze in Southeast Asia. Through their analysis, they found that ambient temperature shows the strongest correlation to PM_{10} concentration, which means that ambient temperature usually contributes to the increased concentration of PM_{10} [10].

Methodology

Sampling Site

For this project, the sampling area to be analyse is Perak which is located in the north western part of Peninsular Malaysia. With a landmass covering and area of 21,006 km, Perak is the second largest state in Peninsular Malaysia and it has a tropical monsoon climate, getting rainfall all year round with a constant temperature and relatively high humidity.

Data Collection

Air quality trend analysis in Perak, Malaysia from 2015 is covered in this study. The data used for this study comprising of air quality and meteorological parameters were obtained from ASMA. Hourly data was based on the average concentration of PM_{10}, O_3, CO, SO_2 and NO_2 as well as other weather parameters such as wind speed, wind direction, temperature and humidity. Data collected were from 2 monitoring stations namely Sek. Men. Jalan Tasek, Ipoh and Sek. Men. Pegoh, Ipoh, Perak as shown in Table 1.

Table 1: Air Monitoring Stations Sampling Point

No.	Location	Latitude (N)	Longitude (E)
1	Sek. Men. Jalan Tasek, Ipoh	04°37.781'	101°06.964'
2	Sek. Men. Pegoh, Ipoh	04°33.155'	101°04.856'

Data Analysis

Correlation Analysis

For this study, PM_{10} concentration will be compared to other pollutants from the data gathered and the correlation analysis will help with identifying which pollutants highly correlated with the concentration of PM_{10}. This can help with identifying the origins of PM_{10} and which activity is most likely to cause the increased concentration of PM_{10}.

Factor Analysis

In this study, factor analysis will be used to identify which atmospheric variations contributes to the increased of PM_{10} concentration by grouping them separately and finding which variable will most likely be the biggest factor of causing PM_s concentration to rise.

Results and Discussions

Correlation between PM_{10} Concentrations with Other Pollutants

The primary sources of PM_{10} can be easily identified by correlating its

concentration with other pollutants. Below shows the concentration of the pollutants mentioned on a monthly basis from the year 2015.

Fig 1: Monthly Average of PM_{10} concentration

From the graph, it can be seen that the average PM_{10} concentration reached a peak value of 102.5 in October, which is considered to be unhealthy based on the API threshold. Therefore, it is important to understand where the increased of PM_{10} concentration came from, which can be done by doing the correlation analysis between the concentration of PM_{10} and other pollutants. A correlation table can be generated using the Excel data analysis tool pack. A variable is said to be correlated when the correlation number generated in the table is closest to 1 and uncorrelated when closest to 0 (Gogtay & Thatte, 2017).

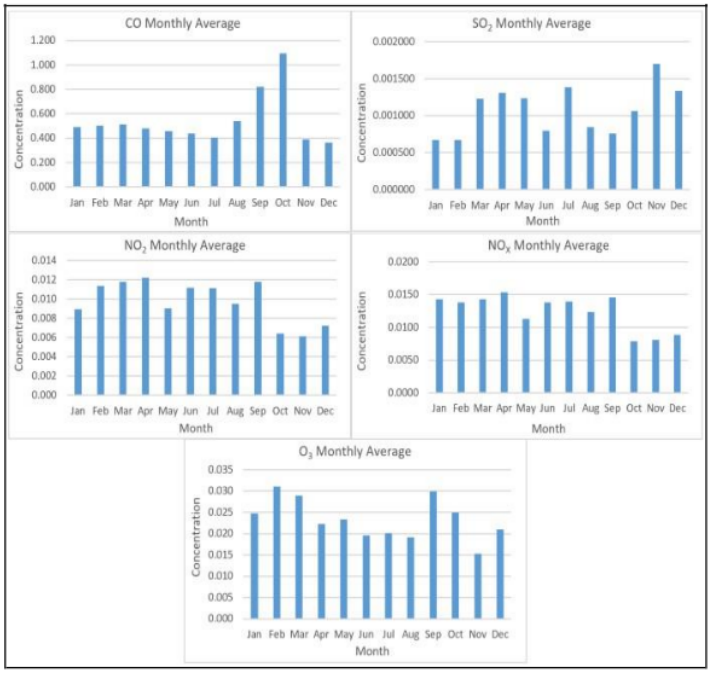

Fig 2: Collected Data of Other Pollutants.

Figure 2 shows the collection of data for other pollutants namely carbon monoxide (CO), Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2), Nitrogen Oxide (NOX) and Ozone (O_3). Each pollutant have very distinct characteristics and very different points of origin which can help deduce the point of emission of PM_{10} with the use of the correlation table analysis. Just from the table itself, it can be seen that the pollutant with the most similar trend to the PM_{10} concentration is CO, where it reached a peak during October, which is the same month as PM_{10} monthly averaged concentration in the year 2015. According to Table 2, the correlation value between PM_{10} and CO are mostly correlated with each other as it is closer to the number 1 while the other pollutants are not correlated at all with their correlation values reaching closer to the value 0. This shows that the emission of PM10 most likely came from the same source as CO emissions. According to National Research Council (2002), CO gas is created mainly when carbon fuels are not completely burnt, where mobile sources count for the majority of CO emissions. These sources comprises of automobiles (e.g., cars, trucks, motorcycles) and heavy machineries (e.g., farm equipment, construction equipment, aircraft and marine vessels).

Table 2: Correlation Analysis Table

Pollutants	**PM_{10}**
PM_{10}	1
CO	0.97
O_3	0.44
NO_2	-0.03
SO_2	-0.37
NO_X	-0.11

But based on reports from Field et al. (2016), there was a huge fire breakout in 2015, which started in Sumatra on July and Kalimantan a month later where the fire was mostly confined to a portion of the country in the Southern hemisphere. By September, the majority of both Sumatra and Kalimantan were covered in a thick haze that proceeded through October, with the thick smoke reached to Singapore, Malaysia and Thailand. This incident seems to fit the timeline of when both PM10 and CO reached its peak concentration on September 2015. Therefore, most of the concentration came through transboundary source from Indonesia.

Relationship of PM10 Concentration with other pollutant

To determine the factors in weather parameters that contributes to the increased PM10 concentration, factor analysis can be done by finding the average value of weather parameters for every month and analysing the data when PM10 concentration is at peak and comparing it with the lowest value. Below is the

tabulated data of 3 weather parameters. Based on the PM10 graph shown earlier, it showed an upward and downward trend during the month January up until August, and was still within the moderate API standard. The highest concentration of PM_{10} is found to be around 102.5 especially during October, 2015.

on the month of September and October, the PM10 concentration spiked, reaching a peak of 102.5 on October, 2015. Looking at the tabulated data, it can be seen that the humidity during September and October was fairly high while the temperature was at one of the lowest of the year during October. Figures below shows the trend of both temperature and humidity for the year 2015.

Table 3: Weather Parameters during 2015

Month	Wind Speed Monthly Avg. (m/s)	Temperature Monthly Avg. (^{O}C)	Humidity Monthly Avg. (%)
Jan	7.18	27.66	72.2
Feb	7.71	28.64	63.8
Mar	6.91	28.88	68.1
April	6.72	28.21	80.2
May	6.86	28.79	79.5
Jun	7.00	28.92	75.5
July	6.54	28.55	71.5
Aug	6.49	28.18	79.9
Sept	6.47	28.36	81.1
Oct	6.09	27.76	82.5
Nov	5.83	28.39	81.2
Dec	6.36	28.39	74.5

Looking at the tabulated data, it can be seen that the humidity during September and October was fairly high while the temperature was at one of the lowest of the year during October. Figures below shows the trend of both temperature and humidity for the year 2015.

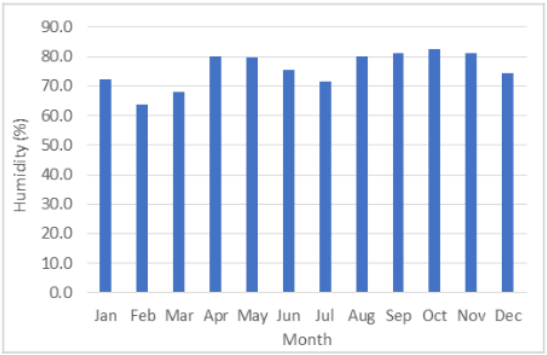

Fig 3: Humidity Monthly Average 2015

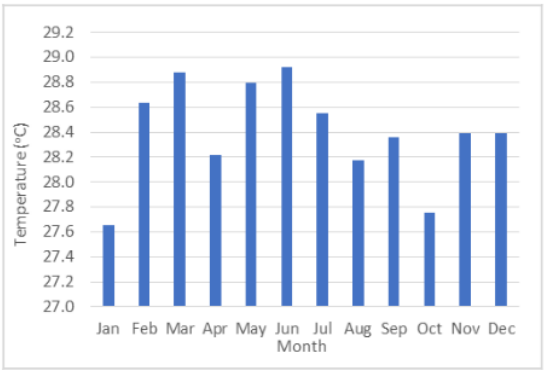

Figure 4: Temperature Monthly Averaged 2015

Both figure shows a fluctuating trend throughout the year, but when comparing the bar graphs with the PM_{10} concentration graph, the months where PM_{10} had the lowest concentration during the month of November and December had high averaged temperatures and humidity, whereas the months where PM_{10} reached high concentration had lower temperatures but still had high humidity as well. Based on these data, it seems that weather parameters played a very small role in the increased in PM_{10} concentration since most previous research states that PM_{10} tends to be higher during the dry monsoon season but in this case, it was during the wet monsoon season.

Conclusion and recommendation

To conclude this study, PM10 emissions was mostly correlated with the emission of Carbon Monoxide (CO), indicating that the main source was from a transboundary haze which came from Kalimantan and Sumatra fires in Indonesia. As for weather parameters, it played a very small role in contributing to the increased PM10 concentration in the year 2015 since comparison between previous studies showed that PM10 is mostly like to increase in the dry monsoon seasons which usually falls between the months of January to Jun. But To provide a more accurate and reliable result, data should also be analyzed in a daily and weekly basis to determine the most critical points of the data. The use of more advanced statistical software could potentially increase the accuracy of the data and can be interpreted in a more comprehensive way. In addition, there should also be data covered from different years so that comparison can be made between the different emission sources that affected different years.

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