ANALYSE THE RELATIONSHIP CARBON MONOXIDE STATUS WITH DEVELOPMENT IN KUANTAN, PAHANG

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ANALYSE THE RELATIONSHIP CARBON MONOXIDE STATUS WITH DEVELOPMENT IN KUANTAN, PAHANG

ZAIDATUL SYAHIDA BINTI ADNAN

Thesis submitted in partial fulfilment of the requirements for award of the degree of
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DEDICATION

Every challenging works need self-efforts as well as guidance from the elders.

I dedicate this thesis, to my parents Mr Adnan Zainal Abidin and Mrs SitiKhatijah Ismail. They have taught me that the best kind of knowledge to have is that which is learned for its own sake.
It is their unconditional loves that motivate me to set higher target and never give up.

My humble effort I dedicate to my supervisor who I greatly indebted, Dr Mohamad Idris Bin Ali. Thank you for all your kind advices and constant source of knowledge and inspiration.

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Which without, life is meaningless

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Thank you.

ABSTRACT

In Malaysia, industrialization, urbanization, and rapid traffic growth have contributed significantly to economic growth. Pockets of heavy pollution are being created by emissions of smoke from major industrial zones, a dramatic increase in the number of residences, office buildings, manufacturing industries, increase in number of motor vehicles and trans – boundary pollution based on previous study. This study focused on relationship between carbon monoxide statuses with development in Kuantan, Pahang. The satellite-based carbon monoxide status for the period investigated obtained from public domain.Meanwhile, development status of study area was analysed based on satellite images provided by Google Satellite Pro application.The carbon monoxide status over correspondent development area wasretrieved using geographical information system technique.From statistical analysis, theareas that are developed with industryshows correlation ($r = 0.562$) better than settlements (urban) ($r = 0.460$).As conclusion, the relationship between carbon monoxide emissions and development at study area has positive correlation with each other.Thus, this study can be used as a guideline to local authority in managing and planning for future development.

ABSTRAK

Di Malaysia, perindustrian, perbandaran, dan pertambahan trafik telah menyumbang kepada pertumbuhan ekonomi. Merujuk kepada kajian sebelum ini, kadar pencemaran yang tinggi adalah disebabkan daripada pelepasan asap dari zon industry utama, pertumbuhan pesat bilangan penduduk, bangunan pejabat, kilang pengeluaran, pertambahan bilangan kenderaan bermotor dan pencemaran dari negara jiran. Kajian ini akan memberi tumpuan kepada hubungan antara status karbon monoksida dan pembangunan di Kuantan, Pahang. Status karbon monoksida daripada satelit pada tempoh kajian di perolehi daripada pengkalan data. Sementara itu, status pembangunan di kawasan kajian di analisis berdasarkan gambar satelit daripada aplikasi Google Satelit Pro. Status karbon moksida di kawasan kajian diperolehi dengan menggunakan teknik sistem maklumat geografi (GIS). Daripada analisis statistik, kawasan pembangunan industri menunjukkan korelasi ($r = 0.562$). yang lebih berbanding kawasan bandar yang korelasi sebanyak ($r = 0.460$).Sebagai kesimpulan, kajian ini boleh dijadikan panduan kepada pihak berkuasa tempatan dalam mengurus dan merancang pembangunan untuk masa hadapan.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Effluence generally can be expressed as intentioned environment contamination with human created wastes. The waste is the results of their daily activities occur along energy use such as travelling using any transportation that emits carbon. A pollutant is a material that can cause unfavorable changes in the environment by not only altering a species' growth rate and interfering with food chains, but also bringing disruptions to health, comfort, amenities and human's property values. The consequences from this particular activity will create negative externality. Callan and Thomas (2004) describes negative externality as a 'spill over effect' which sees the production or consumption being extended to a third party outside the market. There are various types of pollution. However for this study, the primary focuses in on air pollution; carbon monoxide with development.

Chemical by-products such as nitrogen oxides, carbon monoxide, suspended aerosol particulates and sulfur dioxides arising from market activities are some of the pollutants that are found to have significant detrimental effects on the natural environment (Roberts, Grimes and Manale, 2003; Friedl and Getzner, 2003). In its *Human Development report*, the United Nations Development Program (UNDP, 2007, p. 3) notes that the stocks of greenhouse gases concentrations have reached 380 parts per million of carbon monoxide equivalent, exceeding the natural range of the last 650,000 years while the threshold for dangerous climate change as a result of greenhouse gases. A pollutant is a material that can cause unfavorable changes in the environment by not only altering a species' growth rate and interfering with food chains, but also bringing disruptions to health, comfort, amenities and human's property values. For this study, the primary focuses in on the relationship of carbon monoxide status with development in Kuantan, Pahang.

Carbon monoxide (CO) is a colorless, odorless, tasteless, non-irritating, a poisonous gas produced when carbon-based fuels burn incompletely, such as gasoline, natural gas, oil, coal, and wood (McMillan et al., 2005). Resulting from fossil fuel combustion has become major issue, especially in air pollution.Carbon monoxide is slightly lighter than air (0.97) and easily moves through small cracks throughout an entire space. Carbon monoxide emitted mainly from industrial processes, motor vehicle exhaust and open burning activities (Buchwitz et al., 2007). The situation will become worsens with the increase use of fuel consumption and increasing in energy demand. Four major sector that used high energy demand; industrial sector, commercial sector, residential sector, transportation sector; reported that industrial energy consumption lead to high energy demand contribute to air pollution (Sieminski et al., 2013). Carbon monoxide is an important constituent affecting climate and a major troposphere air pollutant (Buchwitz et al., 2006). It is also effects the concentration of greenhouse gases such are methane and ozone. Based on research done by Buchwitz in 2006 he stated that carbon monoxide has being secondary pollutant regarding the respiratory problem. Breathing the high concentrations of CO typical of a polluted environment leads to reduced oxygen (O_2) transport by hemoglobin and has health effects that include headaches, increased risk of chest pain for persons with heart disease, and impaired reaction timing.

In Malaysia, industrialization, urbanization, and rapid traffic growth have contributed significantly to air pollution issues (Damish et al., 2009). By referring to statistical analysis from Ministry of Health (MOH) it shown that respiratory disease that related to air pollution has increase over year (Table 1.1). To be specific, the example of respiratory disease that related to air pollution in Malaysia is asthma, bronchitis, chronic lung disease and neurological shortcomings. From year 2011 until year 2013, the percentage cause of hospitalization and death due to respiratory problem has increased.In the studies conducted by Dockery DW, Pope CA 3rd, Xu X, Spengler JD, Ware JH, Fay ME, Ferris BG Jr, Speizer FE. (1993) along with Schwartz and Marcus (1990) on the effects of air pollution on the death rate of adults and the health of their respiratory system, they found that some age groups who are not in their radar of observation appeared to be more vulnerable than the other groups. Saldiva PH, Pope CA 3rd, Schwartz J, Dockery DW, Lichtenfels AJ, Salge JM, Barone I, Bohm GM. (1995) in one example, has shown that the effects on mortality and respiratory system are higher in the adults than in the overall range of the population. Health risks researches among children, which involve cases of hospital admissions for asthma and other respiratory illnesses, suggest that children, being at the other endpoint of the age continuum are becoming increasingly vulnerable to the ill effects air pollution than other age groups in the entire population (Dockery & Pope 1994; Heinrich J, Hoelscher B, Wjst M, Ritz B, Cyrys J, Wichmann H. 1999; Schwartz J, Dockery DW, Neas LM, Wypij D, Ware JH, Spengler JD, Koutrakis P, Speizer FE, Ferris BG Jr. (1994).However, Pahang is one of the state has achieved rapidly growth in some developing area that lead to risk in air pollution.

Table 1.1: Statistical Health due to respiratory problem

Year	MOH GOVERNMENT	
	Hospitalization	Death
2013	11.50% (2)	22.73% (2)
2012	11.02% (2)	18.80% (2)
2011	10.36% (2)	19.48% (2)

Source: Ministry of Health Malaysia Health Informatics Centre Planning Division

Figure 1.1 shows the trend of carbon emission index from the year 1970 to the year 2011. The trend is increasing sharply until the year 1980 and it slowing down and tremendously increases again until year 1995. The next situation is the trend is fluctuating over the year. At year 2015 has been recorded as the highest emission of carbon monoxide.

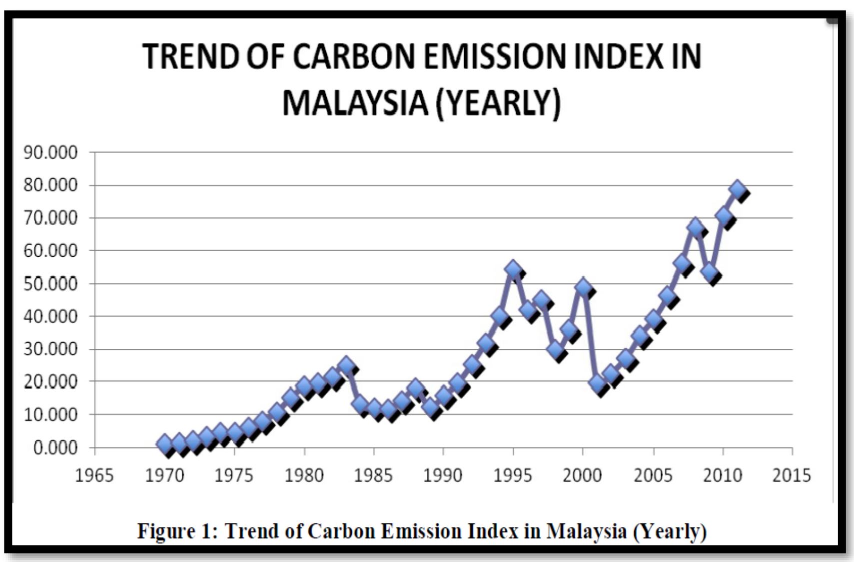

Figure 1.1: Trend of Carbon Emission Index in Malaysia

Source: Economics of Air Pollution in Malaysia

1.2 PROBLEM STATEMENT

Due to rapidly growth developing area in Pahang has worried in increasing of carbon monoxide. Industrial sector will use high electricity, gas, petroleum product, coal and crude oil. All of these things has been proven will give effect to the quality of air that will contributes to the air pollution in the form of chemicals, dust, organic, and inorganic pollutants being released. Carbon monoxide poisoning has haunted mankind and remains the most common cause of death due to poisoning; in health perspective carbon monoxide reduces the flow of oxygen in the bloodstream and is particularly dangerous to persons with heart disease. By referring to the statistical health analysis from ministry of health have shown the respiratory disease especially that related to air pollution has increase. Ministry of health has released a ten disease cause of hospitalization and death and unfortunately disease of respiratory system in a second place of disease among ten other diseases.

1.3 OBJECTIVES OF STUDY

The main objective of the study was to analyse the relationship carbon monoxide status with development in Kuantan, Pahang.To achieve the main objective of this study, there were specific objectives to accomplish as follows;

1. To retrieve distribution carbon monoxide status over development area, and
2. To analyse spatial carbon monoxide status over study area.

1.4 SCOPE OF STUDY

This study was limit to the following:

a. The study area was limited at GebengIndustrial Area and Kuantan town area, Pahang.
b. The period of study was limited from January 2001 until December 2015.
c. Satellite-based carbon monoxide status data obtained from public domain.
d. The development status of study area was analysed based on satellite images provided by Google Satellite Pro application.
e. The carbon monoxide status over correspondent development area were retrieved using geographical information system technique.
f. The statistical analysis technique was used to retrieve the correlation between carbon monoxide status development areas.

1.5 SIGNIFICANCE OF RESEARCH

In the 90s, Kuantan began to grow into a big city with a growing population and an increase in building construction. Kuantan town that was once a peaceful and described as "suitable for those who have retired", got busy. The Gebeng Industrial Area was established with petrochemical giant factory operated in, indicating continued growth in the industrial sector. With the increasing number of transportation and industrial will lead to the increasing amount of carbon emissions from day to day.The significance of this study will help to improved knowledge about this problem to the relevant parties and society. All relevant parties can take action and work together to reduce the air pollutions issues and can give awareness to the society about this problem.

1.6 THESIS STRUCTURE

This research consists of five chapters. Chapter one comprises the introduction section. It states the study background, problem statement, objectives of study, scope of study and lastly significance of study. For chapter two, describe the key term in- purpose of these research and comprises the literature review that related and suitable for these research. Chapter three explains the research methodology that used for planning research type of data collected and the method of data analysis to be employed. For chapter four present the result that obtained from the study area and year of study and discussed the result from analysis. Finally, chapter five comprises the conclusion from the overall chapter and relates some recommendation for future work on research field.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Air pollution occurs when air is contaminated with natural and anthropogenic pollutants. Anthropogenic pollutants are contaminants associated with human activities which include polluting residuals from consumption and production activity (Callan & Thomas et al., 2004). Air pollution happens due to the presence of anthropogenic pollutants and non-point source pollutants in the air.Non-point source pollutants come from sources that cannot be accurately identified. These pollutants have diffusively and indirectly contributed towards the degradation of environment. According to Callan and Thomas(2004), several researches have validated the identified determinants of the world's air pollution. For example, in the investigation done by Zhu (2012), it is found that the vehicle emissions and industrial waste from the nearby Pearl River Delta degrade the quality of the air in Hong Kong. As such, Hong Kong's financial communities areforced to move to Singapore. Marco (2011) posits that air pollution is majorly caused by combustion engine vehicles such as cars, trucks, and planes. Dangerous nitrous oxide, gaseous oxide and carbon monoxide are housed in the exhausts of vehicles. Smog, which can be seen in Los Angeles, is the result of this type of pollution.This type of pollution has also contributed to the thinning of ozone layers. Thus, it increases the earth’s exposure to the harmful rays of the sun. Not only that, it also brings about a host of health problems.

Moreover, Jacob (2010) found that, full life cycle of a vehicle contributes to air pollution, which includes the process of manufacturing, refuelling, emission and disposal of the car. Fuel refining and distribution cause additional pollutants. These pollutants can be further categorized into primary and secondary pollutants. Those considered primary pollutants are released straight to the air. Secondary pollutants on the other hand, are the byproducts of chemical reactions that transpire between the pollutants and other minute particles in the atmosphere.From the previous studies, it can be assumed that most of the major pollutants come from manufacturing activities. It is important to note that the increase in the demand of vehicles and the many economic activities occur along population growth. However, the major concern of scientists as well as economists is the tremendous impacts of the exposure to the air pollution. Heat waves are expected to occur more frequently in the future due to anthropogenic climate change. Urban population in particular may suffer adverse health effects with the combination of poor air quality and high temperatures.

Many studies have found positive and significant relationship between development and carbon emissions (Soytas et al., 2007; Halicioglu, 2009; Dhakal, 2009; Cho et al., 2009). The IPCC Fourth Assessment Report (2007) states that carbon emission from the fossil fuel consumption is the major reason of Greenhouse Gas intensity. It is also indicated that industrial energy consumption constitutes 51% of the global energy usage. Chang and Lin (1999) investigated the factors that alter carbon emissions and discovered that industrial production has the closest relationship with carbon emissions which is followed by electricity consumption. Thus, this study will see the relationship between carbon monoxide status and development in Kuantan, Pahang.

2.2 AIR POLLUTION IN MALAYSIA

Carbon monoxide (CO) is an important pervasive atmospheric trace gas affecting climate and more than 50% of air pollution nationwide and worldwide, which also pays as a significant indirect greenhouse gases due to its influences on the budgets of hydroxyl radicals (OH) and ozone (O_3). The scenario of air pollution in Malaysia is tremendously increased due to various determinants. The increased amount of Carbon Monoxide (CO) in the air is attributed to the rise in income level and the number of vehicles. According to World Resource Institute (2007), the year 2000 itself saw Malaysia producing 5.4 metric ton of CO, which exceeded the global average production of 3.9 metric ton per capita, and Asian average production of 2.2 metric ton per capita. The information from the international body also revealed the increase of CO emission can still be controlled by limiting the numbers of motor vehicles and cutting down travel distance. Emissions from motor vehicles are the single most significant source of air pollution in many Malaysia urban areas including Kuantan, Pahang. The oxidation of the carbon monoxide (CO) contained in the fuel does not proceed to the final product (CO_2) due to a lack of combustion air. Meanwhile, fuel-rich conditions will cause a steep rise in CO formation and emission due to insufficient oxygen being available in the air/fuel mixture. Consequently, a relatively low amount of CO in the exhaust gases indicates that a relatively high amount of complete combustion has taken place in the engine.

The impact of industrial and development area in Malaysia is not a novel issue and has drawn the attention of many NGO_s and political parties, which have been showing growing interest on this matter for the last twenty years. Therefore, Malaysia aspires to reduce the amount carbon monoxide by up to 40 percent by year 2020. Even though Malaysia has the least environmental problems in Asia, given the massive infrastructural changes of recent times through rapid industrialization and other activities (agricultural activities, tourism, and export activities) it indicates that Malaysia has undergone the positive economic growth over the years. Due to this growth, air pollution which can be attributed to industrial activities is inevitable. The worsening cases of pollutions also have many other managing effects other than cause's death. One of the damaging effects that have occurred was global warming due to rising presence of carbon monoxide in the air. The impact of too much carbon monoxide in the environment is that it might negatively affect the flora and fauna that inhabit both land and sea due by contributing to the rise of global temperature. This greenhouse effects also could change the world geographical structure which might causing floods, drought and increase in damaging storms. As for social benefit and health, diseases such malaria and dengue could spread. The disasters such as floods, landslides, erosion and extreme heat happened might destroy many things like houses, cars, home appliances and infrastructure.

The air quality status for Malaysia is determined and disseminated according to the Air Pollution Index (API).

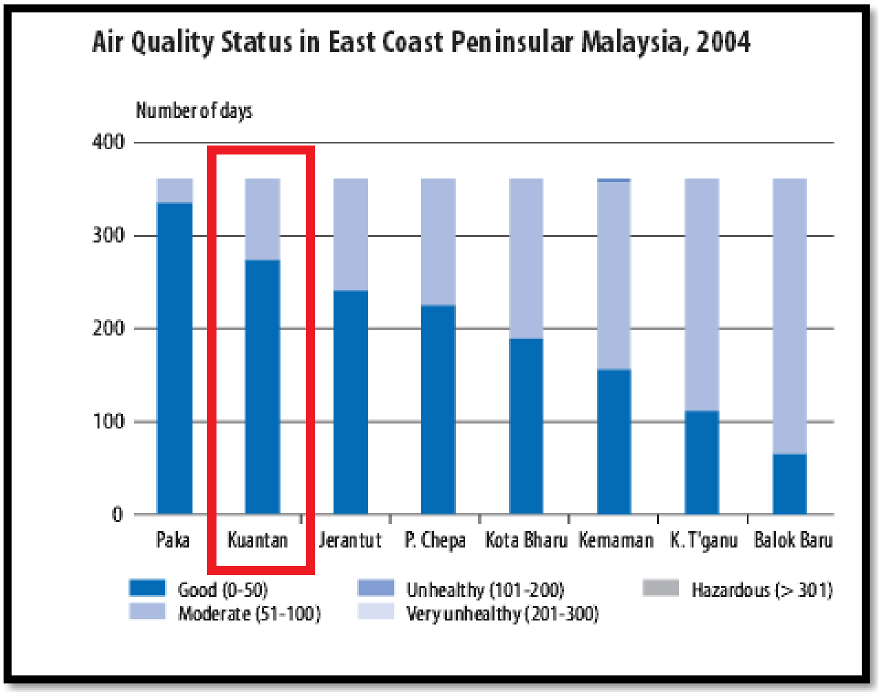

Figure 2.1: Air Quality Status in East Coast Peninsular Malaysia

Source: Malaysia Country Synthesis Report on Urban Air Quality Management

API	Status	Level of Pollution	Health Measure
0–50	Good	Low, no ill effects on health	No restriction of activities for all groups
51–100	Moderate	Moderate pollution, no ill effects on health	No restriction of activities for all groups
101–200	Unhealthy	Mild aggravation of symptoms among high risk groups, e.g. those with heart or lung disease	Restriction of outdoor activities for high-risk persons General population should reduce vigorous outdoor activity
201–300	Very unhealthy	Significant aggravation of symptoms and decreased exercise tolerance in persons with heart or lung disease	Elderly and persons with known heart or lung disease should stay indoors and reduce physical activity General population should avoid vigorous outdoor activity Those with any health problems to consult doctor
301–500	Hazardous	Severe aggravation of symptoms and a danger to health	Elderly and persons with existing heart or lung disease should stay indoors and reduce physical activity General population should avoid vigorous outdoor activity
Above 500	Emergency	Severe aggravation of symptoms and a danger to health	General population advised to follow the orders of the National Security Council and always follow announcements through the mass media

Source: Yahaya et al. (2006).

Figure 2.2: API Status Indicator

Source: Malaysia Country Synthesis Report on Urban Air Quality Management

The annual 8-hourly average concentrations of CO from 1996 to 2004 were consistently higher in urban areas where the main sources of emissions were industrial areas, motor vehicles, than other land use.

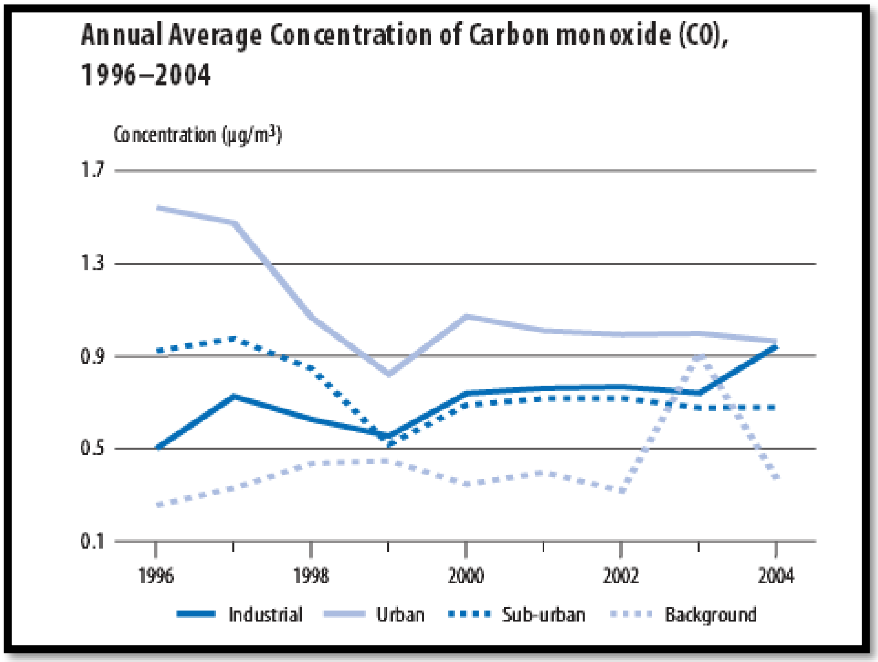

Figure 2.3: Annual Average Concentration of Carbon Monoxide (1996-2004)

Source: Malaysia Country Synthesis Report on Urban Air Quality Management

The major industries in the country affecting air quality are the iron and steel industry, nonferrous metal industry, non-metallic (mineral) industry, oil and gas industry, petrochemical industry, pulp and paper, power plants, and waste incineration sector. GebengIndustry Area is one of the petrochemical giant industry in Kuantan. The industrial production growth rate was 10.2% (2004 estimate). Figure 2.4 shows the number of industries that contribute to air pollution in Malaysia.

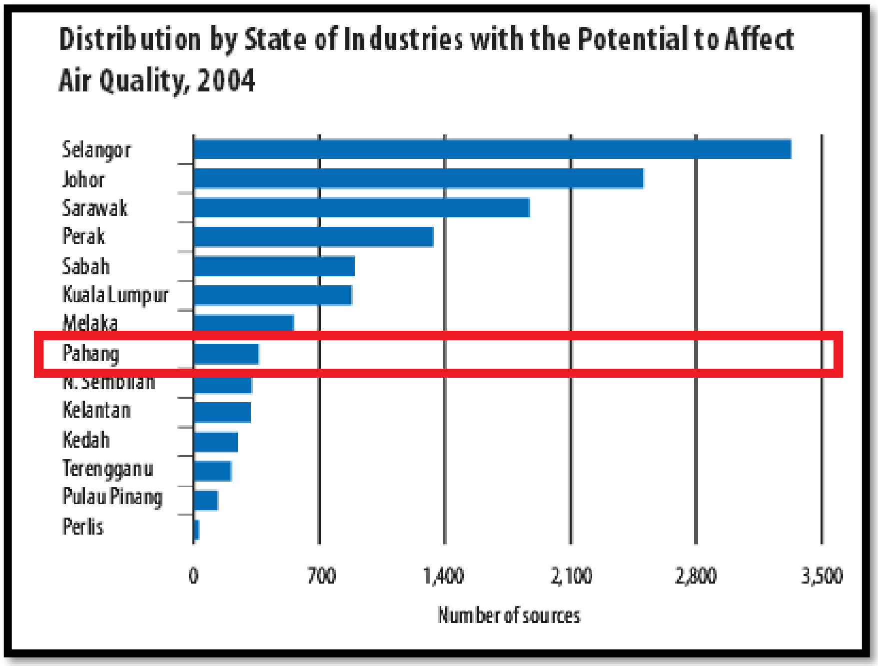

Figure 2.4: Distribution by State of Industries with Potential Affect Air Quality (2004)

Source: Malaysia Country Synthesis Report on Urban Air Quality Management

The primary energy source for Malaysia is crude oil followed by natural gas. The country's crude oil and condensate reserves amounted to 5.3 billion barrels in 2005. The average production of domestic crude oil and condensate increased from 681,000 barrels per day (bpd) in 2000 to 727,000 bpd in 2005. The energy demand by sector and the primary demand by source in Malaysia fro 2000, 2005, and 2010 are shown in the figure 2.5 and 2.6. The transport sector has accounted for the largest energy demand in 2005. Crude oil and petroleum products will remain as the major sources of energy in the country.

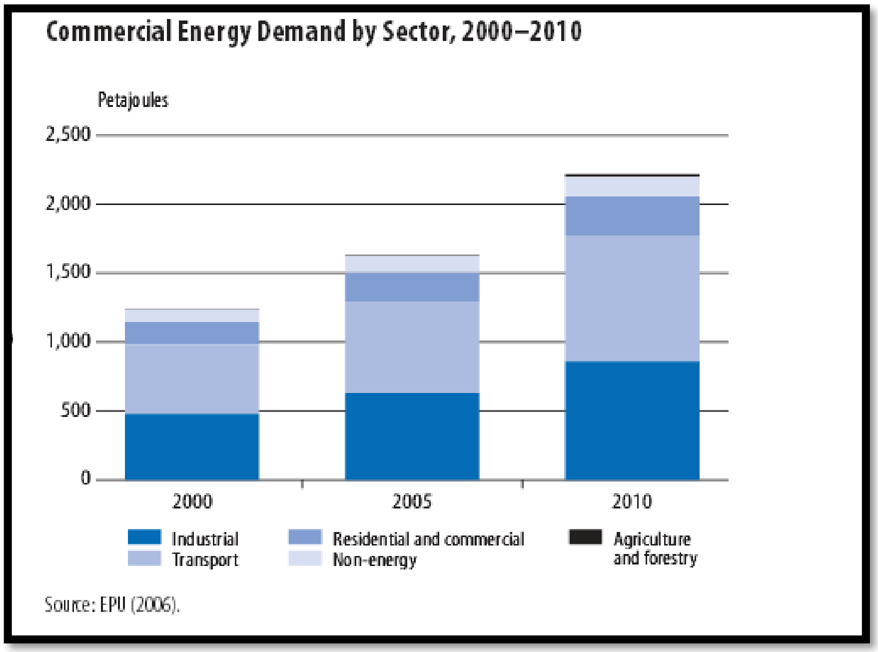

Figure 2.5: Commercial Energy Demand by Sector (2000 – 2010)

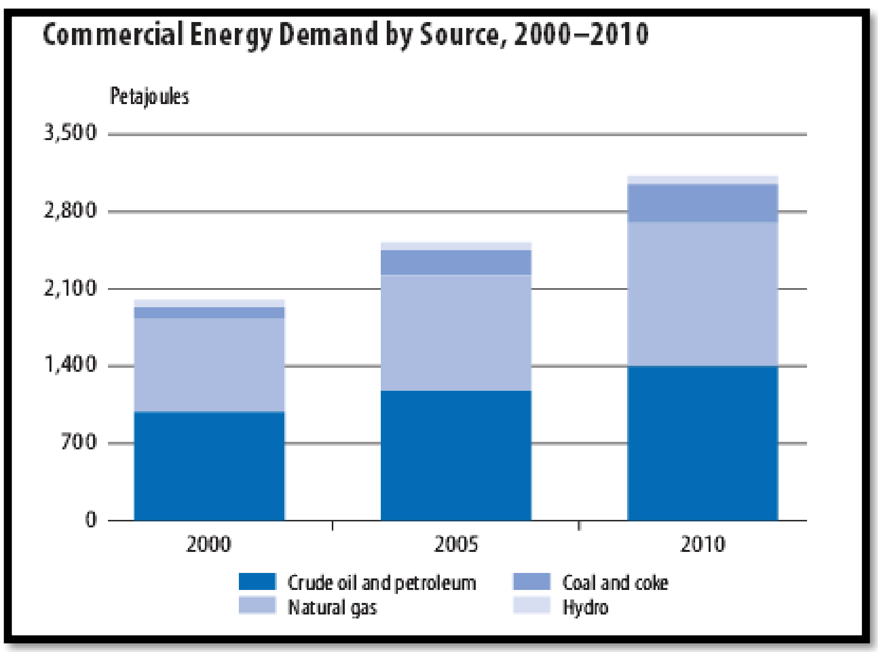

Figure 2.6: Commercial Energy Demand by Source (2000 – 2010)

Source: Malaysia Country Synthesis Report on Urban Air Quality Management

2.3 GEOGRAPHICAL INFORMATION SYSTEM

Geographical Information System (GIS) software is designed to store, retrieve, manage, display, and analyze all types of geographic and spatial data. GIS software lets to produce maps and other graphics displays of geographic information for analysis and presentation. GIS is an organized collection of computer hardware, software, geographic data, and personnel to efficiency capture, store, update, manipulate, analyze, and display all forms of geographically referenced information. GIS also let to visualize, question, analyze, and interpret data to understand relationship, patterns, and trends.

The principle of Geographical Information System (GIS) software is as follow:

- Data Capture: Data sources are mainly obtained from manual digitization and scanning of aerial photographs, paper maps, and existing digital data sets.
- Database Management and Update: Data security, data integrity, and data storage and retrieval, and data maintenance abilities.
- Geographic Analysis: The collected information is analyzed and interpreted qualitatively and quantitatively.
- Preparing Result: One of the most exciting aspects of GIS technology is the variety of different ways in which the information can be presented.

The functions of Geographical Information System (GIS) software is as follow:

- Functions Data Capture; The input of data into GIS can be achieved through many different methods of gathering. For example, aerial photography, scanning, digitizing, GPS or global positioning system is just a few of the ways a GIS user could obtain data.
- Data Storage: Some data is stored such as a map in a drawer, while others, such as digital data, can be as a hardcopy, stored on CD or on your hard drive
- Data Manipulation: The digital geographical data can be edited, this allows for many attribute to be added, edited, or deleted to the specification of the project.
- Query and Analysis; GIS was used widely in decision making process for the new commissions districts. We use population data to help establish an equal representation of population to area for each district.
- Visualization: This represents the ability to display your data, your maps, and information.

2.4 ARC MAP APPLICATION

Arc Map is the main component of Esri's Arc GIS suite of geospatial processing programs, and is used primarily to view, edit, create, and analyze geospatial data. Arc Map allows the user to explore data within a data set, symbolize features accordingly, and create maps. This is done through two distinct sections of the program. Arc Map represents geographic information as a collection of layers and other elements in a map. Common map elements include the data frame containing map layers for a given extent plus a scale bar, north arrow, title, descriptive text, and a symbol legend.

Arc Map users can create and manipulate datasets to include a variety of information. The software package includes a style-set of these features. As well as the ability to upload numerous other reference styles to apply to any mapping function.

2.4.1 Typical Tasks Performed in Arc Map.

Arc Map is the primary application used in Arc GIS and s used to perform a wide range of common GIS tasks as well as specialized, user-specific tasks. The following is a list of some common workflows that can be performed.

- Work with maps: open and use Arc Map documents to explore information, navigate around the map documents, turn layers on and off, query features to access the rich attribute data that is behind the map, and to visualize geographic information.
- Print maps: User can print maps, from the simplest to very sophisticated cartography, using Arc Map.

- Compile and edit GIS datasets: Arc Map provides one of the primary ways that users automate geodatabase datasets. Arc Map supports scalable full function editing. User select layers in the map document to edit and the new and updated features are saved in the layer's dataset.
- Use geoprocessing to automate work and perform analysis: GIS is both visual and analytical. Arc Map has the ability to execute any geoprocessing model or script as well as to view and work with the results through map visualization. Geoprocessing can be used for analysis as well as to automate many mundane tasks such as map book generation, repairing broken data links in a collection of map documents, and to perform GIS data processing.
- Organize and manage the geodatabases and Arc GIS documents: Arc Map includes the Catalog window that enables user to organize all of GIS datasets and geodatabases, map documents and other Arc GIS files, geoprocessing tools, and many other GIS information sets. User can also set up and manage geodatabase schemas in the Catalog window.
- Publish map documents as map services using Arc GIS for server: Arc GIS content is brought to life on the web by publishing geographic information as a series of map services. Arc Map provides a simple user experience for publishing map documents as map services.
- Share maps, layers, geoprocessing models, and geodatabases with other users: Arc Map includes tools that make it easy to package and share GIS datasets with other users. This includes the ability to share GIS maps and data using Arc GIS Online.
- Document Geographic information: A key goal in GIS communities is to describe geographic information sets to help user to document the projects and for more effective search and data sharing. Using the Catalog window, user can document all of GIS contents. For organizations who use standards based metadata, user can also document datasets using the Arc GIS metadata editor.

- Customize the user experience: Arc Map includes tools for customization, including the ability to write software add-ins to add new functionality, to simplify and streamline the user interface, and to use geoprocessing for task automation.

2.5 SATELLITE- BASED CARBON MONOXIDE DATA

Carbon monoxide is one of the six major air pollutants regulated in the United States and in many other nations around the world. When carbon-based fuels, such as coal, wood, and oil, burn incompletely or inefficiently, they produce carbon monoxide. The gas is spread by winds and circulation patterns throughout the lower atmosphere (called the troposphere).

These maps show monthly averages of global concentrations of troposphere carbon monoxide at an altitude of about 12,000 feet. The data were collected by the MOPITT (Measurements of Pollution in the Troposphere) sensor on NASA's Terra satellite. Concentrations of carbon monoxide are expressed in parts per billion by volume (ppbv). A concentration of 1 ppbv means that for every billion molecules of gas in the measured volume, one of them is a carbon monoxide molecule. Yellow areas have little or no carbon monoxide, while progressively higher concentrations are shown in orange and red. Places where the sensor didn't collect data, perhaps due to clouds, are gray.

In different parts of the world and in different seasons, the amounts and sources of atmospheric carbon monoxide change. In Africa, for example, the seasonal shifts in carbon monoxide are tied to the widespread agricultural burning that shifts north and south of the equator with the seasons. Fires are an important source of carbon monoxide pollution in other regions of the Southern Hemisphere, such as the Amazon and Southeast Asia.

In the United States, Europe, and eastern China, on the other hand, the highest carbon monoxide concentrations occur around urban areas as a result of vehicle and industrial emissions. Fires burning over large areas in North America and Russia in some years can be an important source. The MOPITT observations often show that pollution emitted on one continent can travel across oceans to have a big impact on air quality on other continents.

The concentration of carbon monoxide in Earth's atmosphere had been increasing mainly because of increased human activities. However, some recent surface measurements show a leveling off of the carbon monoxide concentration. The full range of the effects of the increased concentration of carbon monoxide is not fully understood at the present time, but it is believed that carbon monoxide is photochemically active and plays a major part in the concentration of OH radicals in the troposphere. Increased carbon monoxide may deplete tropospheric OH radicals, thereby reducing the yearly removal of many natural and anthropogenic trace species. In particular, this effect may add to the increase of methane, which in turn could further reduce OH concentration.

Increased carbon monoxide may also indirectly intensify global warming and perturb the stratospheric ozone layer by increasing the lifetime of trace gases such as methane and chlorofluorocarbons (CFCs). Global measurements of carbon monoxide and methane (also measured by MOPITT) will undoubtedly shed light on the concentration of OH, which is one of the most important and difficult species to measure from space due to its very low concentration. Those measurements will enhance our knowledge of the chemistry of the troposphere, and particularly how it interacts with the surface/ocean/biomass systems, atmospheric transports, and the carbon cycle.

Global carbon monoxide and CH4 measurements from MOPITT will also be used in parallel modeling efforts to advance our understanding of global tropospheric chemistry and its relationship to sources, sinks, and atmospheric transports, which can be determined from other data. Understanding their biogeochemical cycles and their intimate interrelation with each other and with climate will lead to better predictions of possible effects of anthropogenic activities.

The MOPITT Level-2 carbon monoxide data product consists of the geolocated, retrieved carbon monoxide profiles and total column amounts for carbon monoxide and methane. The horizontal footprint of each MOPITT retrieval is 22 kilometers by 22 kilometers. Ancillary data concerning surface properties and cloud conditions at the locations of the retrieved parameters are also included. MOPITT geophysical parameters are derived from the Level-1B radiances in combination with ancillary data describing the global distribution of surface and atmospheric temperature and humidity.

Radiance measurements in the 4.7-micrometer carbon monoxide band provide the primary information on the vertical carbon monoxide mixing ratio profile in the troposphere. Total column abundances of carbon monoxide and methane are derived primarily using measurements of reflected solar radiation in 2 bands near 2.3 micrometers, and best retrievals thus occur in sunlit portions of the orbits. Clouds have a large influence on the observed radiances and their effects must be modeled appropriately in the retrieval algorithms.

2.6 SUMMARY

Carbon monoxide is a trace gas in the atmosphere, and it does not have a direct effect on the global temperature, like methane and carbon dioxide do. However, carbon monoxide plays a major role in atmospheric chemistry, and it affects the ability of the atmosphere to cleanse itself of many other polluting gases. In combination with other pollutants and sunshine, it also takes part in the formation of lower-atmospheric ("bad") ozone and urban smog. Places where the sensor didn't collect data, perhaps due to clouds, are gray.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter describes the phases involved in achieving the study objectives. There were FOUR (4) phases, namely; i) data collecting, ii) pre-processing, iii) processing, and iv) results and analysis (Fig. 3.1). Data collecting, pre-processing and the processing will be explained in the following sections in this chapter. While the results and analyses are described in Chapter 4.

The research will be starting with obtained the location of study area from Goggle Earth Satellite (https://www.google.com/earth/). Meanwhile, carbon monoxide status data are obtained from satellite of public domain database (NASA Earth Observations, http://neo.sci.gsfc.nasa.gov/view.php?datasetld=MOP_CO_M). Data of carbon monoxide status data will be collected from January 2001 until December 2015.

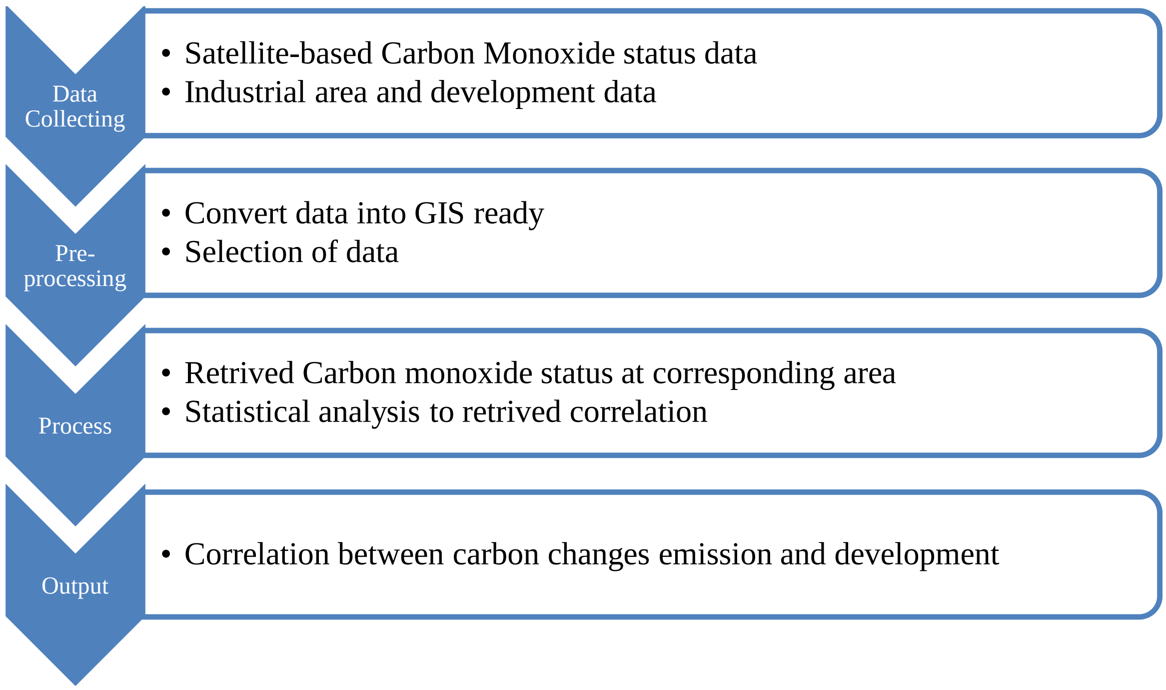

Figure 3.1: Methodology of Flow Chart

3.2 DATA COLLECTING

The locations of study area were identifiedusing satellite image provided by Google Earth Pro application. GoggleEarthPro application provided historical imagery to allow users to traverse back in time and study earlier stages of any place. This feature allows research that requires analysis of past records of various places. So the development status of the locations at study area from January 2001 until December 2015 obtained from historical imagery Google Earth Pro application. Thus, the location of study area involves two differences location in Kuantan:

1. The Gebeng Industrial Area.
2. The Kuantan Town Area.

Figure 3.2: Gebeng Industrial Area location.

Source: Kuantan Port Consortium SDN BHD Malaysia

Gebeng industrial area a world – class chemical and petrochemical industrial zone. With four development phases totaling 8,600 hectares of land, it is strategically located 20km from Kuantan Town, 5 km from Kauantan Port, 36km from Kuantan Airport and 271km from Kuala Lumpur City. Currently there are two main phases of industrial area developed since the 1970s. Phase one is near the main trunk road Kuantan-Gebeng by-pass and consisting of small and medium scale industries such as wood processing industries, metal works factories and concrete ducting company. Phase two was developed in the early 1990s and the majority of industries here are petrochemical companies such as Petronas MTBE-Polypropylene, BP Chemicals, WR Grace, EASTMAN, Kaneka and Cryovac. The third phase currently occupied by Polyplastics Asia Pacific, BASF-Petronas, Petronas CUF, Petronas Centralized Emergency Facilities and PDH Plant.

Figure 3.3: Location of Study Area.

The location of study area are obtained from Goggle Earth Satellite
https://www.google.com/earth/

In Figure 3.3, there are two differences boxes. Box A represents as the location of Gebeng Industrial area, and box B represent as the location of Kuantan Town area. The Carbon Monoxide Status Data are obtained from satellite of public domain database.

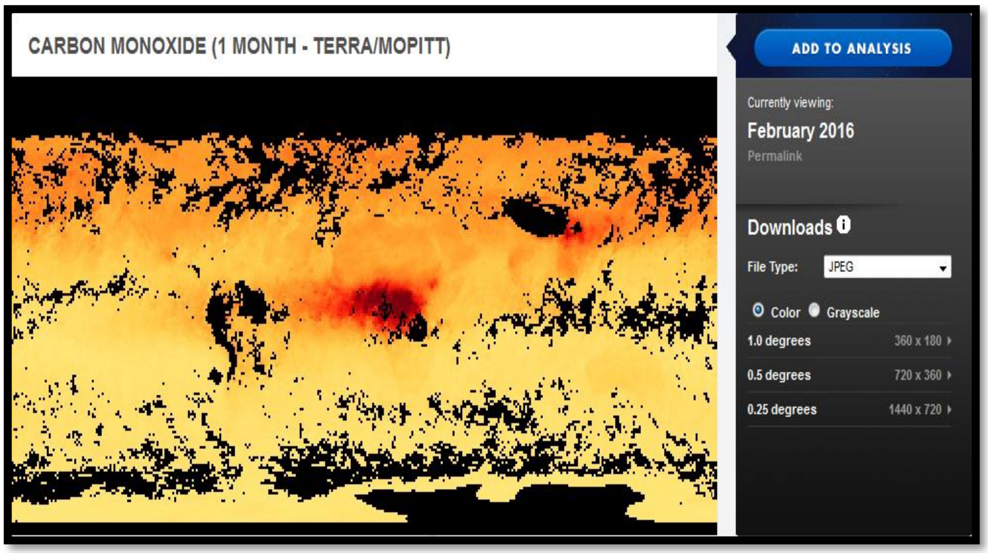

Figure 3.4: Carbon Monoxide Status Data

Carbon Monoxide Status Data are obtained from satellite of public domain database.

http://neo.sci.gsfc.nasa.gov/view.php?datasetId=MOP_CO_M

3.3 DATA PRE PROCESSING

To retrieved satellite-based carbon monoxide status over development at study area, Geographical Information System (GIS) technique will be using. The image of carbon monoxide status data will be added into GIS software. All the carbon monoxide status data from public domain data base will be exported into raster data to enable the processing in GIS software. Meanwhile, all selected area in the image from Goggle Earth are been exported into shapefile data. The carbon monoxide status data will be merging with the location of study area after the export process complete in order to see the amount of carbon emission, relationship and the linear correlation of coefficient between carbon monoxide status data with development as shown in figure 3.5 until figure 4.1.

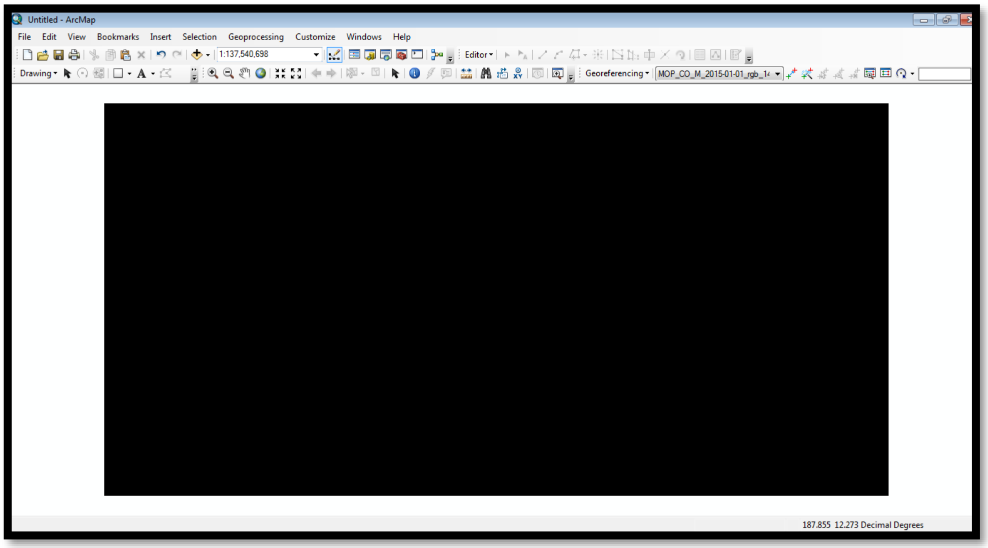

Figure 3.5: Carbon Monoxide Status Data added in GIS software.

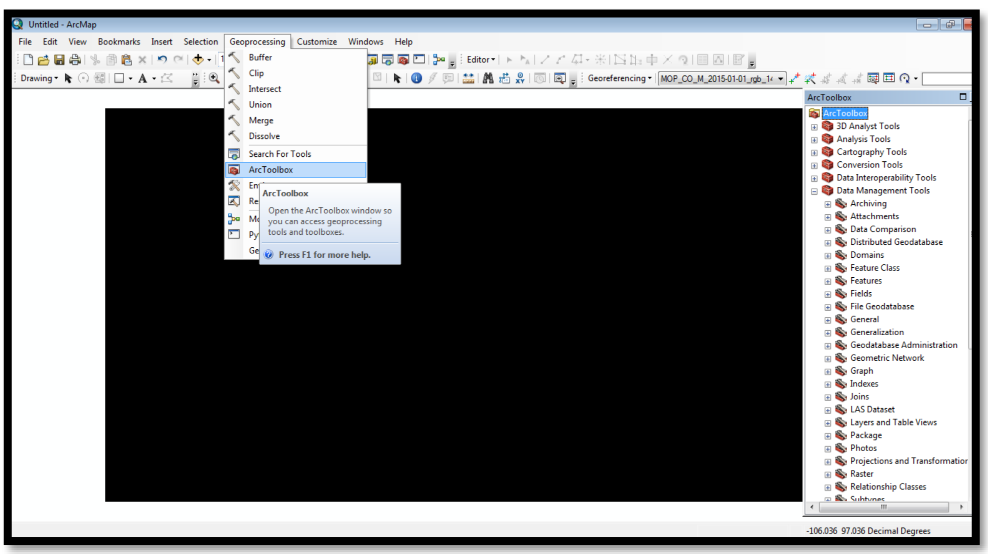

Figure 3.6: Carbon Monoxide Status Data added in GIS software.

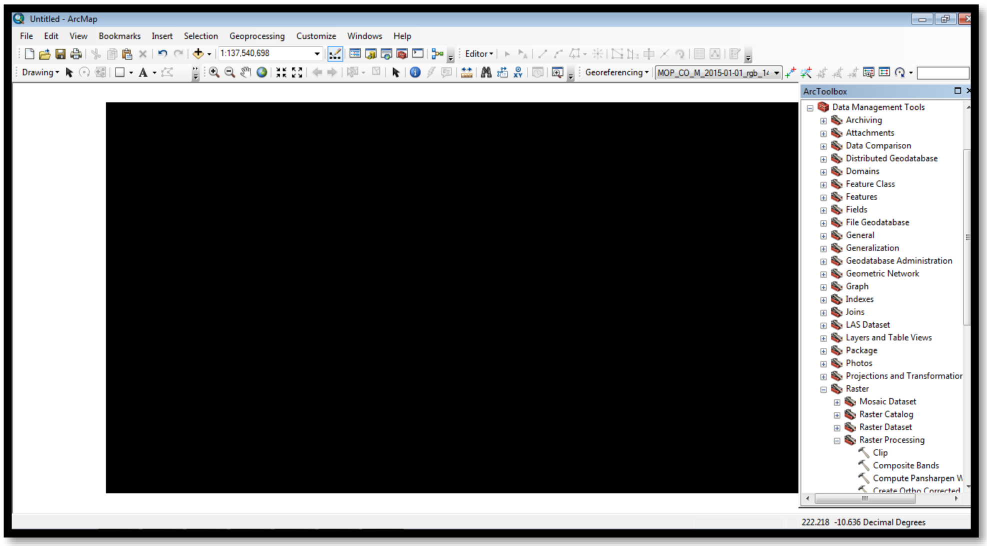

Figure 3.7: Carbon Monoxide Status Data been processing in GIS software

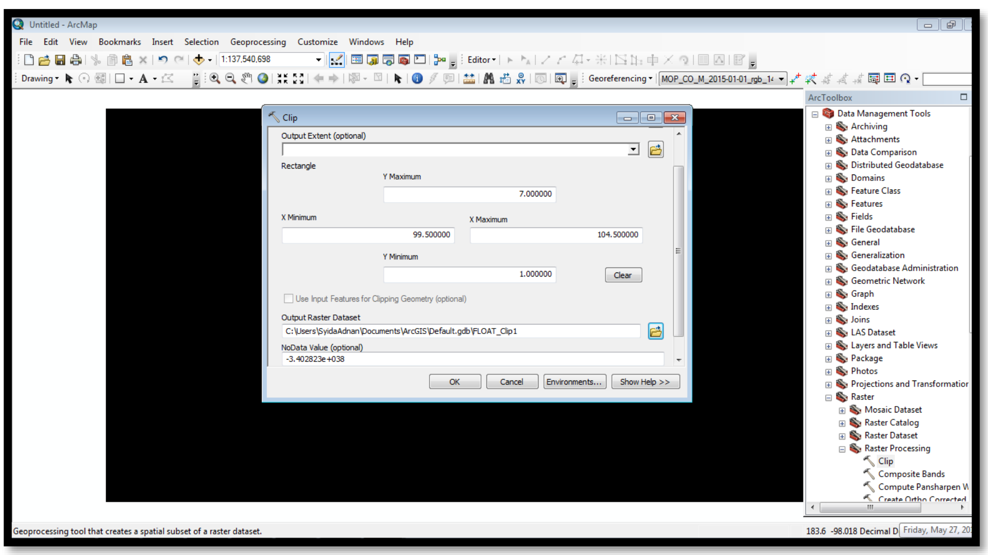

Figure 3.8: Carbon Monoxide Status Data been processing in GIS software

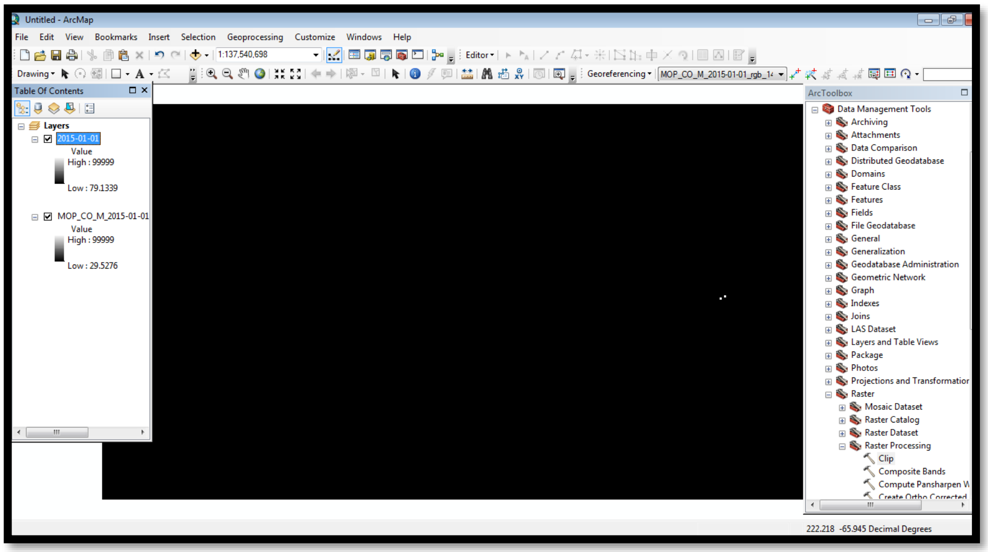

Figure 3.9: Location of study area from Goggle Earth been exported into shapefile data in GIS software.

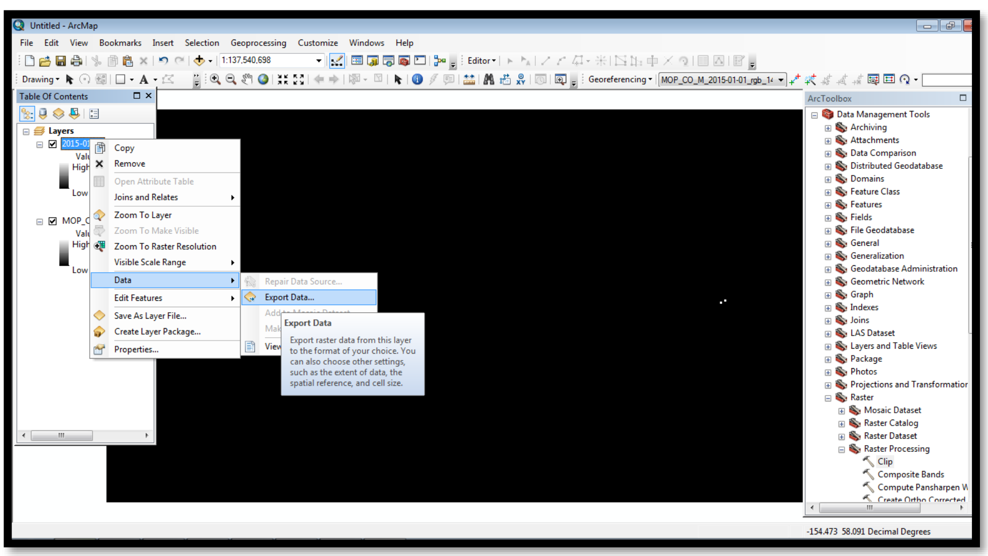

Figure 3.10: Carbon Monoxide Status Data exported into raster data in GIS software

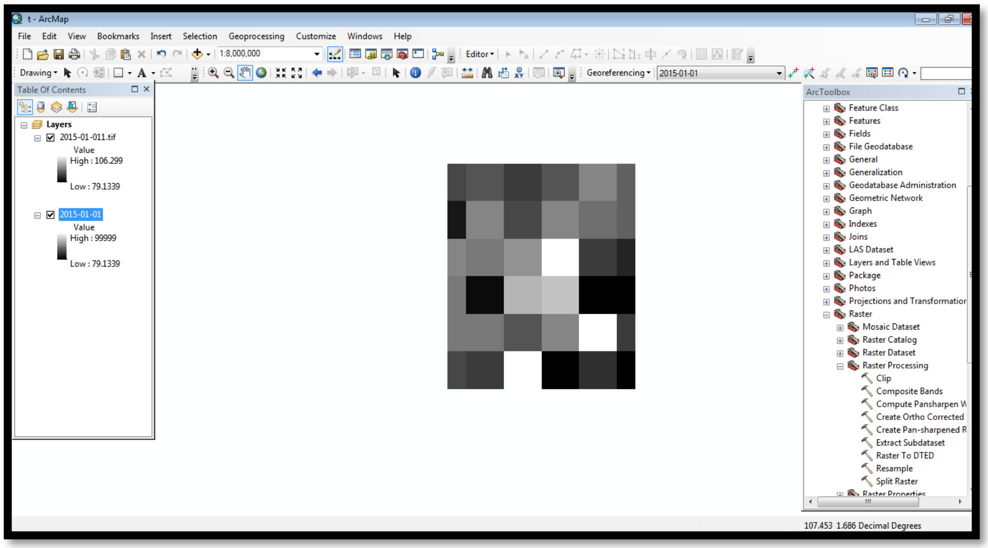

Figure 3.11: Carbon Monoxide Status Data been merge with the location of study area in GIS software

3.4 DATA PROCESSING

A table of Carbon Monoxide and Development data been presented after the amount of carbon emission and the percentage of development at the location of study area are recorded. The data will be from January 2001 until December 2015. The actual data is obtained, however at some month, data of carbon monoxide status data thus not available or provided from public domain data base satellite due to cloud and wind. So the regression technique been using because regression is the process of fitting an (approximated) continuous function to a set of independent data points. This technique is useful for approximating dependent values (y) for independent values (x) that are not present in the data set. Thus, final data of carbon monoxide status and development at Gebeng industrial area and Kuantan town area represented in figure 4.2

.

Table 3.12: Table of Carbon Monoxide and Development Data

from year 2011 until year 2015.

YEAR	MONTH	%	A	%	B
2015	JANUARY	55	84.4488	60	81.4961
	FEBRUARY	55	89.7638	60	88.5827
	MARCH	55	92.126	60	92.126
	APRIL	55	62.0079	60	62.5984
	JUN	55	57.874	60	56.6929
	JULY	55	62.0079	60	62.5984
	SEPTEMBER	55	118.11	60	128.74
	OCTOBER	55	162.402	60	181.89
	NOVEMBER	55	98.0315	60	90.9449
2014	JANUARY	50	85.0394	51	81.4961
	FEBRUARY	50	93.3071	51	100.394
	MARCH	50	102.756	51	102.756
	APRIL	50	76.1811	51	76.7717
	MEI	50	65.5512	51	67.3228
	JUN	50	73.2283	51	76.7717
	SEPTEMBER	50	66.1417	51	64.9606
	OCTOBER	50	95.0787	51	103.937
	NOVEMBER	50	86.2205	51	
2013	JANUARY	35	89.7638	51	
	FEBRUARY	35	95.0787	51	93.3071
	MARCH	35	85.0394	51	86.2205
	APRIL	35	75	51	77.9528
	JUN	35	72.6378	51	77.9528
	JULY	35	64.9606	51	69.685
	AUGUST	35	63.189	51	62.5984
	SEPTEMBER	35	60.8268	51	59.0551
	OCTOBER	35	59.6457	51	56.6929
2012	JANUARY	35	73.2283	51	62.5984
	FEBRUARY	35	83.2677	51	77.9528
	MARCH	35	108.071	51	95.6693

	APRIL	35	68.5039	51	63.7795
	MEI	35	65.5512	51	67.3228
	JUN	35	76.1811	51	73.2283
	JULY	35	60.2362	51	60.2362
	AUGUST	35	66.7323	51	67.3228
	SEPTEMBER	35	75	51	73.2283
	OCTOBER	35	74.4095	51	80.315
	NOVEMBER	35	70.2756	51	62.5984
	DECEMBER	35	85.0394	51	
2011	JANUARY	35	109.252	45	112.205
	FEBRUARY	35	85.0394	45	88.5827
	MARCH	35	109.843	45	
	APRIL	35	75	45	79.1339
	MEI	35	57.2835	45	60.2362
	JUN	35	57.2835	45	60.2362
	JULY	35	66.1417	45	69.685
	AUGUST	35	62.5984	45	64.9606
	SEPTEMBER	35	69.685	45	74.4094
	OCTOBER	35	75.5906	45	
2010	JANUARY	30	78.5433	42	81.4961
	FEBRUARY	30	79.7244	42	79.1339
	MARCH	30	77.3622	42	76.7717
	APRIL	30	71.4567	42	73.2283
	MEI	30	70.8661	42	66.1417
	JUN	30	62.0078	42	57.874
	JULY	30	50.7874	42	50.7874
	AUGUST	30	51.9685	42	53.1496
	SEPTEMBER	30	63.7795	42	68.5039
	OCTOBER	30	81.4961	42	81.4961
	NOVEMBER	30	67.9134	42	73.2283

	DECEMBER	30	67.3228	42	67.3228
2009	JANUARY	30	80.315	42	80.315
	FEBRUARY	30	87.4016	42	90.9449
	MARCH	30	72.6378	42	70.8661
	APRIL	30	62.0079	42	62.5984
	MEI	30	59.0551	42	
	JUN	30	63.7795	42	60.2362
	JULY	30	54.3307	42	55.5118
	OCTOBER	30	77.3622	42	77.9528
	DECEMBER	30	82.6772	42	77.9528
2008	JANUARY	30	79.1339	40	77.9528
	MARCH	30	65.5512	40	68.5039
	APRIL	30	72.6378	40	69.685
	MEI	30	73.2283	40	74.4094
	JUN	30	55.5118	40	59.0551
	JULY	30	57.2835	40	56.6929
	AUGUST	30	60.2362	40	61.4173
	SEPTEMBER	30	58.4646	40	61.4173
	OCTOBER	30	55.5118	40	63.7795
	DECEMBER	30	76.7717	40	76.7717
2007	JANUARY	33	82.0866	38	85.0394
	FEBRUARY	33	85.6299	38	86.2205
	APRIL	33	93.8976	38	99.2126
	MEI	33	66.1417	38	70.8661
	JUN	33	50.7874	38	51.9685
	JULY	33	67.3228	38	67.3228
	AUGUST	33	60.8268	38	64.9606
	SEPTEMBER	33	53.7402	38	60.2362
	OCTOBER	33	65.5512	38	67.3228
	DECEMBER	33	94.4882	38	96.8504

2006	JANUARY	33	94.4881	38	83.8583
	FEBRUARY	33	86.811	38	85.0394
	MARCH	33	78.5433	38	80.315
	APRIL	33	69.685	38	69.685
	MEI	33	64.3701	38	66.1417
	JUN	33	56.6929	38	56.6929
	JULY	33	64.3701	38	64.9606
	AUGUST	33	62.5984	38	63.7795
	SEPTEMBER	33	82.6772	38	87.4016
	OCTOBER	33	109.843	38	102.756
	NOVEMBER	33	90.3543	38	95.6693
2005	JANUARY	33	105.118	38	105.118
	FEBRUARY	33	108.071	38	103.937
	MARCH	33	111.614	38	111.024
	APRIL	33	88.5827	38	92.126
	MEI	33	60.2362	38	61.4173
	JUN	33	67.3228	38	76.7717
	JULY	33	54.9213	38	55.5118
	AUGUST	33	63.189	38	64.9606
	SEPTEMBER	33	72.6378	38	76.7717
	OCTOBER	33	62.5984	38	63.7795
	DECEMBER	33	80.315	38	80.315
2004	JANUARY	33	80.9055	38	79.1339
	FEBRUARY	33	111.614	38	111.024
	MARCH	33	100.984	38	111.024
	APRIL	33	92.126	38	88.5827
	MEI	33	59.6457	38	60.2362
	JUN	33	77.9528	38	76.7717
	JULY	33	51.9685	38	50.7874
	AUGUST	33	63.7795	38	63.7795

	SEPTEMBER	33	77.9528	38	81.4961
	OCTOBER	33	113.386	38	119.291
	NOVEMBER	33	67.3228	38	67.3228
2003	FEBRUARY	33	87.9921	36	87.4016
	MARCH	33	87.4016	36	87.4016
	APRIL	33	70.8661	36	68.5039
	MEI	33	72.6378	36	73.2283
	JUN	33	79.1339	36	70.8661
	JULY	33	72.0472	36	72.0472
	AUGUST	33	66.1417	36	67.3228
	SEPTEMBER	33	64.3701	36	64.9606
	OCTOBER	33	90.9449	36	86.2205
	NOVEMBER	33	70.2756	36	69.685
2002	JANUARY	33	105.669	36	115.748
	FEBRUARY	33	99.2126	36	101.575
	MARCH	33	112.795	36	118.11
	APRIL	33	85.6299	36	85.0394
	MEI	33	77.3622	36	79.1339
	JUN	33	66.7323	36	69.685
	JULY	33	64.9606	36	64.9606
	AUGUST	33	68.5039	36	72.0472
	SEPTEMBER	33	112.205	36	122.835
	OCTOBER	33	121.654	36	124.016
	NOVEMBER	33	77.9528	36	
2001	FEBRUARY	33	113.976	32	114.567
	MARCH	33	81.4961	32	81.4961
	APRIL	33	69.0945	32	67.3228
	SEPTEMBER	33	65.5512	32	62.5984
	OCTOBER	33	57.2835	32	55.6929

3.5 OUTPUT

From the table of carbon monoxide and development data, graph between carbon monoxide status data and development can be plotted and statistical analysis was used to analysed relationship between carbon monoxide status data and development. Linear correlation coefficient ® can be obtained from the graph in order to see the correlation carbon monoxide status and development.

3.6 SUMMARY

From the table, it is shown that the percentage of development at Kuantan town area is higher compared to the percentage of development at Gebeng Industrial area. The linear correlation coefficient can be obtained only after graph between carbon monoxide and development been plotted.

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

In this chapter, the findings of which were obtained from Chapter 3, was shown in the graph from statistical analysis. Further analysis was conducted in this Chapter.

4.2 RESULT AND DISCUSSION

Linear correlation coefficient, *r*, measures the strength and the direction of a linear relationship between two variables. The value of r is such that $-1 \leq r \leq +1$. The + and – signs are used for positive linear correlations and negative linear correlations respectively

- Positive correlation; If x and y have strong positive linear correlation, r is close to +0.5- +1. An r value of exactly +1 indicated a perfect positive fit. Positive values indicate a relationship between x and a y variable such that as values for x increases, values for y also increase.

- Negative correlation; If x and y have a strong negative linear correlation. R is close to -1. An r value of exactly -1 indicates a perfect negative fit. Negative values indicate a relationship between x and y such that as values for x increase, values for y decrease.
- No correlation; If there is no linear correlation or a weak linear correlation, r is close to 0. A value near zero means that there is a random, nonlinear relationship between the two variables.

For this study, the x and y variables are percentage development at the location of study area and carbon monoxide status, respectively. The graph below been plotted from the table of data.

From figure 4.1, shown graph of carbon monoxide against development at A; Gebeng industrial area. From the graph the linear correlation coefficient, *r* is 0.562. This is mean that at GebengIndustrialArea there is positive relationship and strong linear correlation between carbon monoxide and development. The amount of carbon emission at industrial area depends on the industrial sector at there.

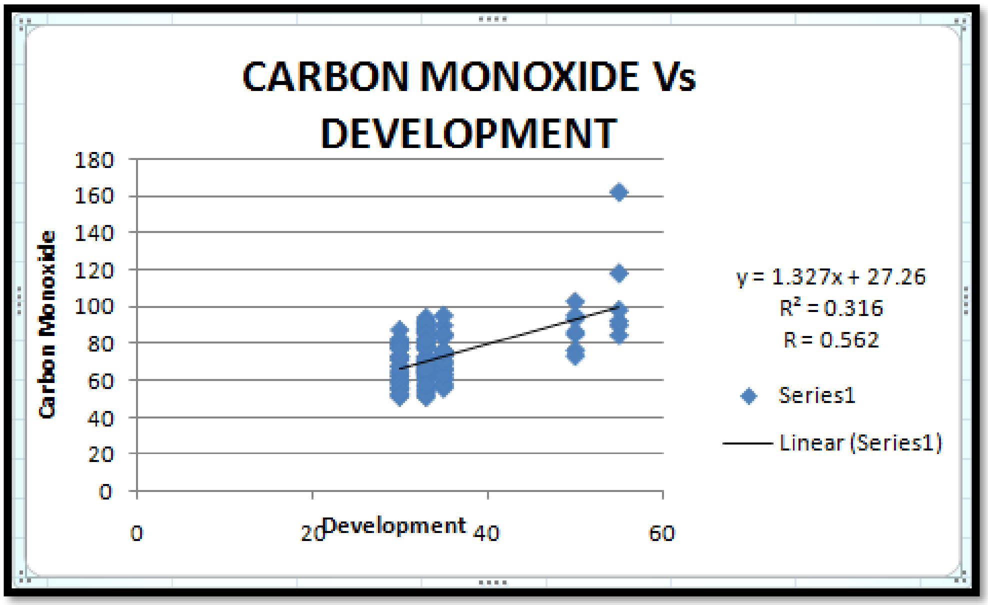

Figure 4.1: Correlation between Carbon Monoxide and Development at A

From figure 4.2, shown graph of carbon monoxide against development at B; Kuantan town area. From the graph the linear correlation coefficient, *r* is 0.460. The r value at Kuantan town area is lower compared to the r value at GebengIndustrial Area. Even though the r value is lowered at Kuantan town area, there is still positive relationship between carbon monoxide and development however the linear correlation coefficient at town area is not strong compared to the linear correlation coefficient at industrial area. The amount of carbon emission at Kuantan town area depends on the number of transportation at there.

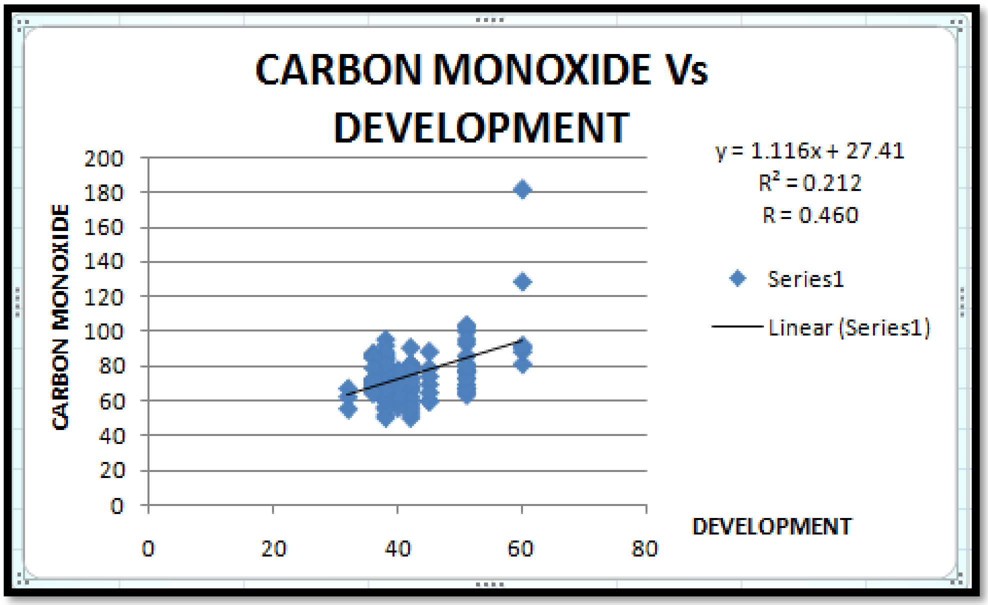

Figure 4.2: Correlation between Carbon Monoxide and Development at B

From figure 4.3, shown graph of carbon monoxide against development at both location Gebeng Industrial Area and Kuantan town area (A+B). From the graph, the average linear correlation coefficient at both locations is 0.460 which mean there is positive relationship between carbon monoxide statuses at development at both location of study area.

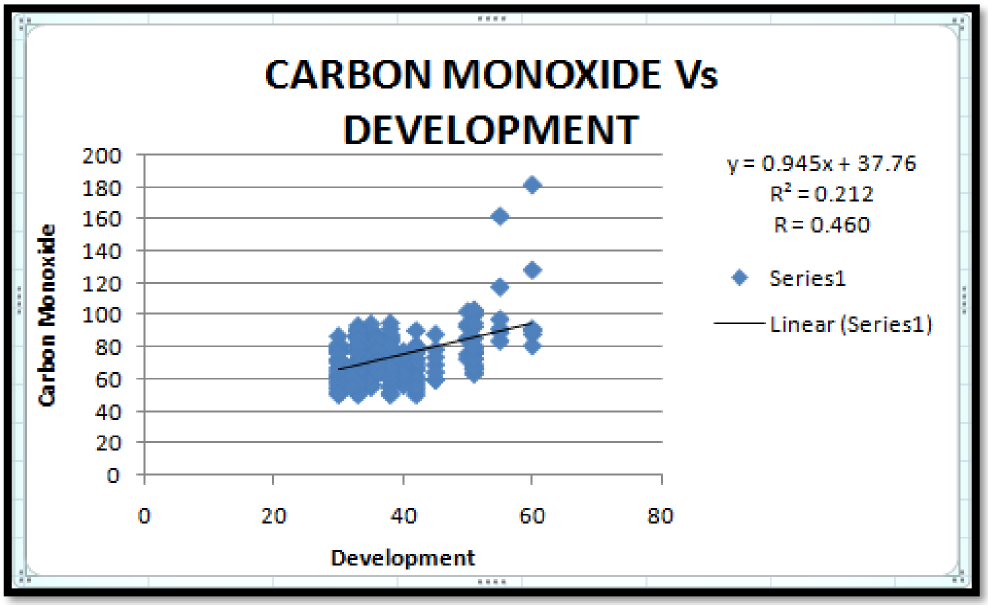

Figure 4.3: Correlation between Carbon Monoxide and Development at A+B

4.3 SUMMARY

Based on the result obtained, it is clear that at GebengIndustrial Area the value of linear correlation coefficient is higher compared the linear correlation coefficient at Kuantan town area. This is because, industrial area tends to release smoke that will contribute more to the emission of carbon monoxide compared at town area because at town area amount of carbon monoxide emission depend on the number of transportation. We know that, industrial sector will use high electricity, gas, petroleum product, crude oil and coal. All of these things have been proven will affect the quality of the air. A research by Seimski at 2013 has been done regarding to this issue, he already stated that carbon monoxide emitted mainly from industrial sector. In his journal, he stated that there are four major sector use high energy demand that will contribute to the emission of carbon monoxide; first sector is industrial sector, second sector commercial sector, residential sector in third place and the last sector is transportation sector. Other research by Zhao at 2009, he analyzed the factors those cause carbon emissions It was found that industrialproduction was the primary force to accelerate carbon emissions level.So from the result both Gebeng Industrial Area and Kuantan town area have positive relationship between carbon monoxide status and development, however industrial sector will give big impact to the emission of carbon monoxide in the air compared the town area that’s way linear correlation coefficient at GebengIndustrial Area is high compared to the linear correlation coefficient at Kuantan town area.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

This chapter describes conclusion of the result and the final output obtained along with the recommendation for this study. After the data obtained and analysed, the assessment result was made.

The study also has quantified the amount of carbon monoxide status based on literature review, news and journals. The resources of data will be getting from satellite of public domain database; Nasa Earth Observations.

There are several limitations facing in executing this study, which lead to produce less accuracy of result. Furthermore, some recommendations also proposed in order to improve the efficiency of studies in future. This chapter is divided into two different parts, which are conclusion and recommendation.

5.2 CONCLUSION

This research was carried out in order to determine the relationship carbon monoxide status with development at Kuantan, Pahang from January 2001 until December 2015. The conclusion of the research need to be evaluated based on the objective of the research. Thus, it is very essential in discover and evaluate back the methodology applied for the research could be achieve the objective.

The study area was selected at Gebeng Industrial Area and Kuantan town area which is the two places tend to release high amount of carbon monoxide from January 2001 until December 2015. The main objective of this research was to analyses the relationship carbon monoxide status with development in Kuantan, Pahang. To achieve the main objective, there were two sub objective which is i) to retrieve distribution carbon monoxide status over development area. ii)to analyse spatial carbon monoxide status over study area. The carbon monoxide status data and the location of study area had been map using Geographical Information System (GIS).

Literature was carried out from the various sources. There were several method used by previous researcher to determine carbon monoxide status data. In this study, Geographical Information System (GIS) software was used in order to determine the carbon monoxide status data and development.

The analysis in this study was carried out using Microsoft Excel. Starting with sorting and determining the carbon monoxide status data.

In this study, time-series graph of carbon monoxide status data and development was used to determine the amount of carbon monoxide status data at the location of study area. The satellite-based data also being validate.

As a conclusion from this study, there is positive and good relationship between carbon monoxide status and development at Gebeng industrial area and Kuantan town area.

5.3 EVALUATION FOR OBJECTIVES

Two sub-objectives had been set-up to accomplish the main objective for this study, the objective have been verified and were discussed in previous chapter. Following shows how the objectives are conclude.

5.3.1 Sub-objective 1: To retrieve distribution carbon monoxide status over development area

This objective was successfully achieved. From the result, carbon monoxide status data over development area were determined by using Geographical Information System (GIS) software and time-series graph produced based on the analysed data from chapter four (4).

5.3.2 Sub-objective 2: To analyse spatial carbon monoxide status over study area.

Based on the result in chapter four (4), this objective was successfully achieved. From the result, there were positive and good correlation linear graphs between carbon monoxide status data and development area. The data was considered valid and can be used for further analysis.

5.4 RECOMMENDATIONS FOR FUTURE RESEARCH

To further this research, there are some action plans that can be taken in order to get better results. Some recommendations that can be implemented to further research area:

1. Further studies should be devoted on the investigation of the long term and casual relationship between different sector and the environment. Any possible nonlinear relationship among variables should be taken into consideration by the prospective studies. To propose efficient and effective solutions for the establishment of environmental friendly should be one of the main focuses of the further studies.
2. Local authorities should play an actions in:
   - Monitor and assess air quality in the area. It will enable them to set priorities for reducing pollution and, if required, to draw up an air quality management plan (AQMP). At the very minimum an AQMP should include air quality standards for each of the main pollutants of concern, dates for meeting WHO, EU or national standards and proposals for reducing pollution levels. Co-operation between local authorities would reduce the cost of such monitoring.
   - Aim to reduce progressively concentrations of air pollutants until they reach WHO, EU or national guidelines and standards.
   - Inform the public about local concentrations of air pollutants, possible effects on health, and the action to take to minimize any health risks.

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