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Urban Air Quality and Human Health Effects in Selangor, Malaysia

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Abstract

Selangor has five stations set in residential, traffic and industrial areas designed to research the data obtained from the Air Pollution Index (API) and detect any significant change in the air quality to avoid any harm upon the human health and environment (DOE, 2012). The research would adhere the API scale provided by the DOE in order to promote a better understanding on the data as it would reflect the effects of air pollution on human health (DOE, 2012). Research methods in this research include the theoretical analysis of Urban Air Quality and acquiring important information from key informants and public to scope the issues and problems using the structured questionnaire.

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Keywords: Air quality; respiratory; API; health

1. Introduction

“More than 2 million premature deaths each year can be attributed to the effects of urban outdoor air pollution and indoor air pollution (caused by the burning of solid fuels). More than half of this disease burden is borne by the populations of developing countries” (WHO, 2006). Heart attacks, respiratory diseases, and lung cancer are all significantly higher in people who breathe dirty air compared to matching groups in cleaner environments (Cunningham, et al 2005).

As mentioned above, Enger & Smith (2000) also stated that air pollution is not just an aesthetic problem. It also causes health problems. Hundreds of deaths have been directly related to poor air quality

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in cities. According to the same author there was case of air pollution that was harmful to human health occurred in Donora, Pennsylvania in October 1948. Air pollution in that area came from pollutants from a zinc plant and steel mills became trapped in the valley, and dense smog formed. Within five days, seventeen people died and 5910 persons became ill. The polluted atmosphere affected nearly 50 percent of the city's 12300 inhabitants.

Regardless of the incident mentioned above many other megacities of developing world have extremely poor air quality. Beijing, Seoul, Mexico City, and Cairo exceed World Health Organization guidelines for air quality for at least two pollutants. The causes of this air pollution are open fires, large numbers of poorly maintained motor vehicles, and poorly regulated industrial plants. The WHO estimates that particulates in Mexico City contribute to 6400 deaths each year. Not only does poor air quality in such cities increase the death rate, but the general health of the populace is lower (Enger & Smith, 2000).

The distribution of air pollutants is influenced by wind and geographical factors (Sham, 1998). This is proven by scholars as some air pollutants are able to spread so far away due to their long atmospheric lifetime (Harrison, 2006). Therefore, study on air quality and the health effect also important to cover a wider geographical area, i.e. an urban regional area.

The five major pollutants listed by the Malaysian Department of Environment (DOE) are sulphur dioxide, nitrogen dioxide, carbon monoxide, particulate matter with 10-micron (PM10) size in diameter and ground-level ozone. These pollutants are likely to cause significant damages to health, environment and property.

2. Literature Review

In referring to Wagner (1994), though we have exploited our incredible ability to manipulate the environment, we are beginning to realize that every impact we bring upon the environment also has an impact on us. The analogy of environment and pollution given by Wagner in 1994 was Earth can be compared to a fish bowl. That is, the Earth, like a fish bowl, is a contained environment; what goes in stays in. Pollutants that are emitted or discharged do not disappear, but will remain to impact us.

Due to the unstoppable urbanisation in this world and Malaysia especially, risk of getting affected by pollution is high. According to Wiwanitkit (2011), pollution, an unwanted destruction of the natural environment by human and naturally induced insults, is a problem facing the present world. Due to the expansion of the world population, the number of people is rapidly growing. It is accepted that pollution is a problem, not for a specific group but for everyone.

2.1. Air pollution

Air pollution is physical or chemical changes brought about by natural processes or human activities that result in air quality degradation (Cunnigham et al, 2005). Significance relation of air pollution by Enger & Smith (2000) are pollution began when human populations became so concentrated that their waste materials could not be broken down as fast as they were produced. As the population increased, people began to congregate and establish cities. The release of large amounts of smoke and other forms of waste into the air caused an unhealthy condition because the pollutants were released faster than they could be absorbed and dispersed by the atmosphere (Enger & Smith, 2000).

Air is invariably impure and is always contaminated with gases like CO, NO₂, SO₂, and others (which are poisonous in nature) and finely divided solid and liquid particles and smog. Air becomes polluted due to the presence of the above contaminants. The presence of these contaminants in the air is called air pollution and the materials which pollute the air are called air pollutants (Sunita & Ahluwalia, 2008).

2.1.1. *Urban air pollution*

Problems of waste disposal arise whenever people congregate in large numbers as they do in cities, as for airborne wastes emitted into the atmosphere in and above cities (Kemp, 2004), in reality many urban cities in the developed world have an urban structure which encourages unsustainable practices with regard to water management, biodiversity and air quality or green house emissions (Marquez & Smith, 1999). Furthermore, Kemp, 2004 also stated that air pollution was most common in large cities that had high seasonal heating requirements, were heavily industrialized, had large volumes of vehicular traffic or experienced a combination of all three. In cities, the rigid separation of housing, employment, commercial and recreational activities creates a dependency on road-based transport, which in turn contributes to high levels of urban air pollution and greenhouse emissions (Marquez & Smith, 1999). Urban air pollution caused by the inability of the local environment to accommodate the level of waste produced by large numbers of people concentrated in relatively small areas (Kemp, 2004).

2.2. *Health effects of air pollution*

The adverse health effects associated with urban air pollution, which include respiratory morbidity, cardiovascular diseases and mortality, have contributed in creating public awareness in this kind of pollution. Health risk evaluation and assessment have now become important since these serve as the basis for any re-formulation or review of current air quality standards (Colls & Micallef, 1997).

The health effects mentioned regarding the bad air pollution in these cities are chronic coughing and susceptibility to infections, while deaths from air pollution occur primarily among the elderly, the infirm, and the very young. Bronchial inflammations, allergic reactions, and irritation of the mucous membranes of the eyes and nose all indicate that air pollution must be reduced (Enger & Smith, 2000). In addition, WHO estimates that 2 million children under age 5 die each year from acute respiratory diseases exacerbated by air pollution (Cunningham et al, 2005).

Air pollution cause health effects by inhalation, or direct absorption through the skin or contamination of food and water. These air pollutants elements are very strong oxidizing agents, sulfates, SO₂, NO₂, and O₃ act as irritants that damage delicate tissues in the eyes and respiratory passages (Cunningham et al, 2005).

Proven by Marquez & Smith (1999), particulates (PM₁₀) and ozone, primarily resulting from emissions of oxides of nitrogen (NO_x) and hydrocarbons/air toxins (HC or VOCs), destroy sensitive tissues (in people, animals and plants) and impair respiratory functions. Research by Marquez & Smith (1999) stated the significant impact of urban form (transportation and air quality). Bangkok has three times the rate of lung cancer as the rest of Thailand. This has been mostly attributed to transport-related miasmas (Manins, 1997). The haze and filth from the diesel exhausts in Manila and Calcutta are so thick that it is frequently difficult to breathe. Mexico City experiences ozone levels up to three times the detrimental level set for Melbourne (Manins, 1997). The American Lung Association estimates that over 60,000 people die prematurely in the USA (by up to two years) due to exposure to PM10 particles (ALA, 1996).

3. Objective

The aim of this study is to formulate the relationship between human health and urban air quality in an urban region, state of Selangor. In order to achieve the aim of the research, three objectives have been formulated, these are:

- To identify urban air quality and human health level.
- To investigate the relationship between air quality and human health.
- To identify recommendation based on the findings.

4. Methodology and Case Study

Study will be focusing on the regional context of Selangor. This is because air quality is not localized and affected by several factors such as geography and wind, therefore study should better not to be focuses on one city only. As what have been proved by Harrison (2006), some air pollutants are able to travel far away from the sources even at regional scale due to the long atmospheric lifetimes. However, there were a number of previous study made by other scholar focusing on localized city.

In this study only 5 major pollutants listed by Department of Environment Malaysia (DOE) will be count in, which are Sulphur Dioxide (SO₂), Nitrogen Dioxide (NO₂), Carbon Monoxide (CO), and Particulate Matter with diameter 10 micron (PM₁₀) and Ground Level Ozone (O₃). In addition this study will focus on 5 areas only, where the air quality monitoring stations are located. The areas are Banting, Kuala Selangor, Kelang, Petaling Jaya and Shah Alam. The stratified random sampling is divided by Low Cost Houses, Medium Cost Houses and High Cost Houses.

The regional context of defining the ambient air quality of the whole chosen area will be based on the reason that distribution of air pollutants are influenced by the effects of wind and geographical factors (Sham, 1998). This study will focus on the outdoor air quality of Selangor. However, the data of ambient air quality in this research will only be obtained by secondary data provided by Department of Environment Malaysia (DOE) which is the API data, refer Table 1. While for human health, study focussing only for the aspect of health effects that related to air quality (respiratory diseases). From this study relationship analysis between air quality and health effects will be carried out.

Area chosen for the study of urban air quality and health effects is Selangor. State Structure Plan of Selangor 2020 stated that Selangor will be populated with 7.3 million people in the year of 2010. Approximately, 36,592.52 hectare of land has been classified for development; whereas 80% of the land majority will be mix development (committed mix development).

Being major concern for this research, rapid urbanisation in Selangor has led to extreme changes in the state land use pattern. In the year of 1991-2002 saturated land use of this state increase from 33,680 hectare to 127,591 hectare (State Structure Plan of Selangor, 2020). Even though development is good for the nation, the impact towards the environment especially urban air quality is worrying. Selangor is connected in within districts, province and its surrounding area by highways (Federal Highway, MRR2, etc) and railways (KTM, ERL). In that case, data will be obtained according to the Air Pollution Index (API) data from the established air quality monitoring stations at study area, from Department of Environment (DOE). As for Selangor, there are 5 stations strategically located in residential, traffic and industrial areas to detect any significant change in the air quality which may be harmful to human health and the environment (DOE, 2012). The 5 air monitoring stations located at Banting, Kuala Selangor, Pelabuhan Klang, Petaling Jaya and Shah Alam. Automatic Air Quality Monitoring Station involves in this study are located at the following schools:

- Kolej MARA Banting, Selangor
- SMS Kuala Selangor, Selangor
- SMK Raja Zarina, Kelang, Selangor
- SK Seri Petaling, Petaling Jaya, Selangor
- SK TTDI Jaya, Shah Alam, Selangor

The purpose of the research is to formulate the relationship between urban air quality and human health effects. Thus, the intention is to interview a variety of people with range of environmental health experiences. This study initially employs a sampling technique known as purposive strategy. This offered the practical advantage of expanding the range of research participants that readily known their contribution. It facilitated exploration in qualitative research, in particular through interviews (Atkinson & Flint, 2001).

4.1. Using multiple methods

The key aim of this study is to explore how urban development affecting the environmental health and specific agencies play within the process of decision making. Therefore, triangulation method is adopted to achieve an understanding of respondents health level and air quality indicator. The triangulation method is an approach to research that uses a combination of more than one research strategy in a single investigation (Faisal, 2012). This is adopted in this research to combine information about human health and urban air quality drawn from in-depth interviews with data gathered from a wider range of participants by a questionnaire survey.

With regard the questionnaire survey, the respondents are selected from each of the API station proximity area, using a stratified random sampling procedure. The stratified sampling method ensured that types of respondents' houses (by flat house, apartment, condominium, terrace, semi-detach, detaches and shop houses) are selected. Based on the total number of residents live in the five study area that is 108075 with 95% confidence level and sampling error 5%, the total number of respondents in this study is 383. The next stage is to determine the number of respondents from each type of houses. Health data will be collected in this stage through questionnaire survey from house to house. This study will use stratified random sampling, where the population will be split into strata/sections/segments/categories that relevant to this research. A stratified random sampling will be selected by randomly choosing residents as sample in within the study area.

Selangor has five stations set in residential, traffic and industrial areas designed to research the data obtained from the Air Pollution Index (API) and detect any significant change in the air quality to avoid any harm upon the human health and environment (DOE, 2012). The research would adhere the API scale provided by the DOE in order to promote a better understanding on the data as it would reflect the effects of air pollution on human health (DOE, 2012). Research methods in this research include the theoretical analysis of Urban Air Quality and acquiring important information from key informants and public to scope the issues and problems using the structured questionnaire.

In addition to the air quality status data, the research requires a survey on health effects by the selected study area. It would focus to gather data on the symptoms or diseases related to air pollution in order to find the connections between the human health and urban air pollution and at the same time study the actual relationship shared by the human being and air quality.

4.2. Framework

Conceptual framework for this study was constructed based on the relationship between urban air quality and the impact to human health. Urban planning and previous research were also taken into consideration in constructing this conceptual framework.

In referring to previous study by Ling (2011) conceptual framework for this study were constructed based on the understanding of the chain of causality in urban environmental health. Chain of causality in urban environmental health begin with human factors (driving force and pressure), followed by the impact of human factors (urbanisation) on the environment and human health (Ling, 2011).

The concept of environmental health consists of 'cause and effect' relationship or 'chain of causality'. The conceptual framework is 'human factors/activities – (human exposure to) – human health (health effects) – mitigation actions (human responses)' (Ling, 2011). Refer to figure 1.

The conceptual can be restructured as 'Driving force – Pressure – State – Exposure – Effect – Action' (DPSEEA) framework. Other than that, it can also be structured as 'Driving force – Pressure – State – Impact – Response' (DPSIR), (Ling, 2009). Four major aspects that become the variables in this study with clear cause and effect relationships as listed below:

- Human factors (Driving force – Pressure)
- Environment (State – Exposure)
- Human health (Effects)
- Human actions (Actions – Response)

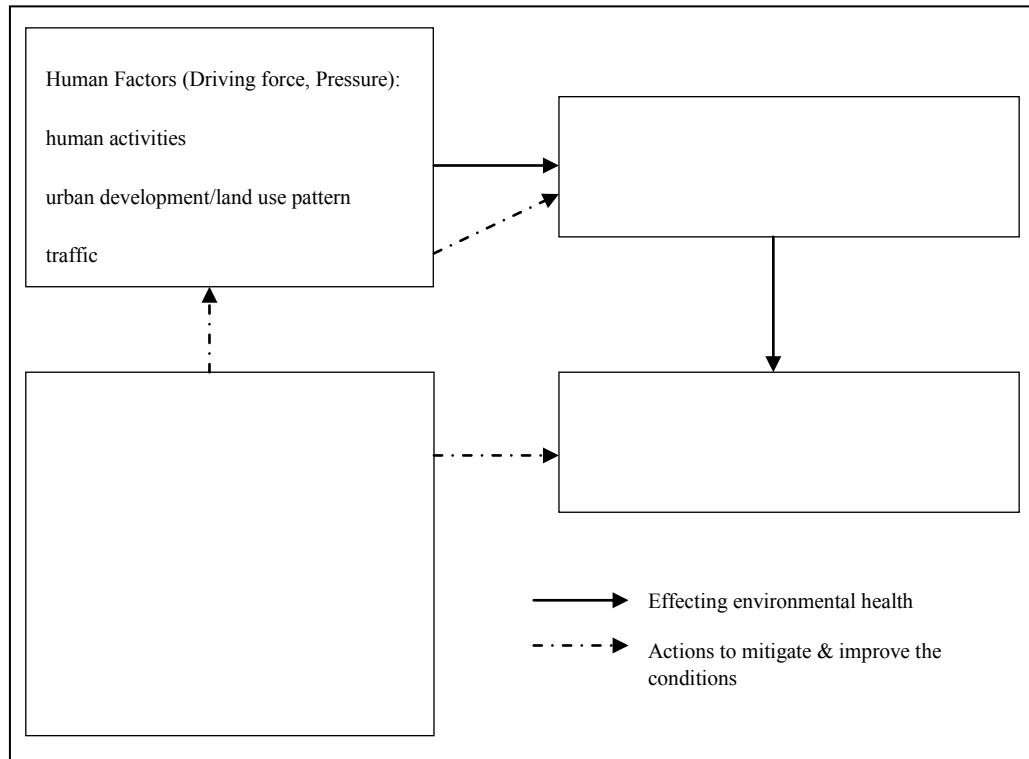


Fig. 1. Environmental health conceptual framework
Source: Adapted from Ling (2011)

4.3. Analysis

This is the stage where raw data will be analysed and processed. The analyses involved are descriptive, correlation, trend and quantitative analysis. Descriptive analysis is used to describe and explain more on the attributes analysis on the tables and figures. Quantitative analysis will be carried out by using SPSS as the tools. The trend analysis will be carried out to get the air quality trend while correlation analysis is to get the relationship (correlation) between air quality and health background.

This research will also follow the API scale provided by the DOE to categorize and analysis the data. In addition to the air quality status data, survey will be made to the selected study area on health effects focusing on the symptoms or diseases relating the air pollution. The ambient air quality measurement in Malaysia is described in terms of Air Pollutant Index (API). The API is developed in easily understood ranges of values as a means of reporting the quality of air instead of using the actual concentration of air pollutants. This index also reflects its effect on human health ranging from good to hazardous and also can be categorized according to the action criteria as stipulated in the National Haze Action Plan (DOE,

2012). By gathering all daily data of API during the research, study on human health will be made as well through survey. Only symptoms and diseases in relating to air pollution will be the case study of this research. Data gathered by survey will be used to find the connections between human health and urban air pollution. In addition, data collected from residents regarding their health is to get the health risk and health effects of urban air pollution. This is because, health risk evaluation and assessment have now become important since these serve as the basis for any re-formulation or review of current air quality standards (Colls & Micallef, 1997).

The chart below is the Air Pollution Index Flowchart provided by the DOE and will be used as air quality indicator in this study as well:

Table 1. Air pollution index flowchart

API Scale	Air Quality
0-50	Good
51-100	Moderate
101-200	Unhealthy
201-300	Very unhealthy
301 and above	Hazardous

Source: <http://www.doe.gov.my/portal/air-air-quality/air-pollutant-index-api/>

Enclosed below is the accumulative graph of Air Quality Status 2013 for state of Selangor:

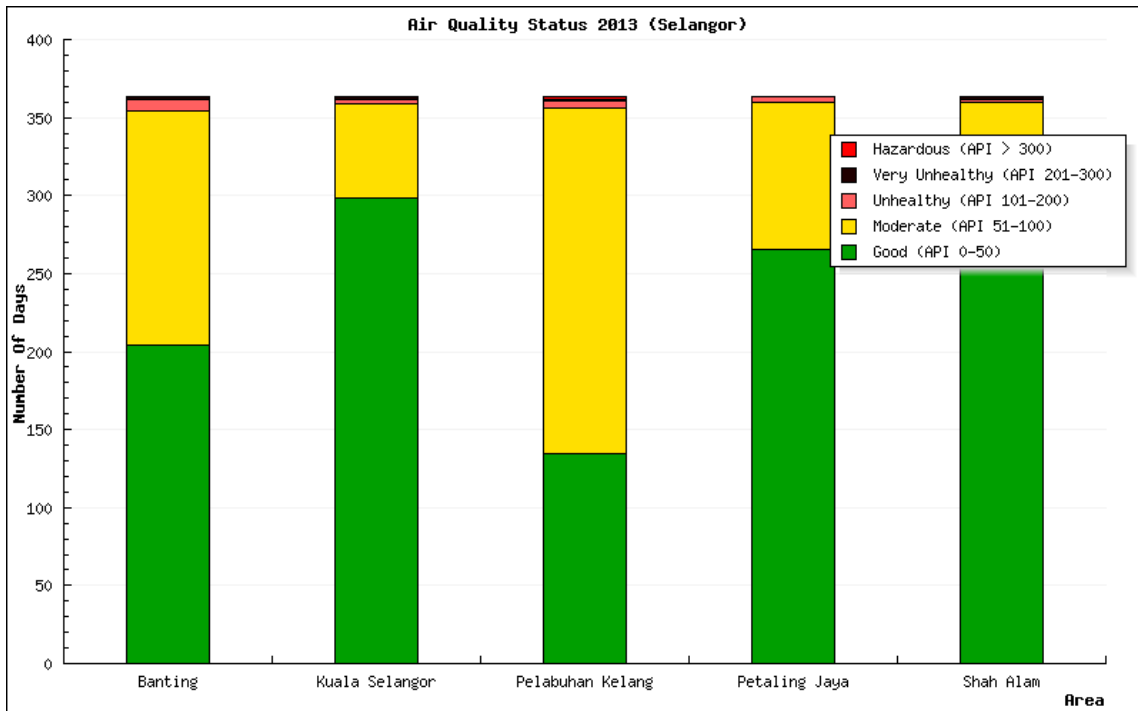


Fig. 2. Accumulative Air Quality Status 2013 in Selangor

4.4. Preliminary findings

Early results of health survey to residents in Selangor prove that majority of the residents only suffer with acute respiratory infections during haze mostly in June 2013.



Fig.3. City of Shah Alam is covered with haze on June 23, 2013. Several parts of Malaysia had been declared emergency status as smoke from neighbouring Indonesia pollutes the air in Malaysia

Source: <http://www.stasiareport.com/the-big-story/asia-report/malaysia/story/malaysias-worst-haze-16-years20130624#sthash.theSYXwA.dpuf>

Approximately 60% of residents experiencing acute respiratory infection during this period, which are cough, difficulty of breathing, sore throat and the rest symptoms of acute respiratory infections. The rest of 40% residents did not faced any symptoms of acute respiratory infections. However, early findings find out that the highest number of residents with acute respiratory infections during haze located at Klang, this is due to the highest API reading at Klang comparing to another area. Thus, Klang has the lowest number of good air quality days comparing to other area.

In June 2013, Malaysia experiencing worst levels of haze in 16 years, which forced the government to declare emergency status and to shut schools in Kuala Lumpur, Selangor and Pahang, as well as the coastal town of Port Dickson. Five areas in Selangor - home to most people who work in Kuala Lumpur - had "unhealthy" levels of haze. Port Klang registered the highest reading of 214.

Health Facts 2012 by Ministry of Health Malaysia (MoH) stated that, in 2011, diseases of respiratory system are one of the principal causes of hospitalization in MoH hospital with the percentage of 10.36% (MoH, 2012). In addition, one of the principal causes of death at MoH hospital in 2011 was also diseases of respiratory system with percentage of 19.48% (MoH, 2012).

In 2013, Statistic Report of PPUKM stated that respiratory disease listed among 10 highest reasons of ward hospital admission and listed among 10 highest reasons of death. Significance needs for this research is because in the year of 2012, respiratory related disease was not listed as 10 highest reasons for hospital admission in Statistic Report of PPUKM.

Based on the early finding data, it is possible to have significant impact of bad urban air quality and human health effects.

5. Conclusion

This paper is not based on the final results yet, since the research is still in progress. Since this is not a first study on urban air quality, however, new research and new outcome will discover new knowledge and newer indicators as well as fresh proposals in overcoming the urban air quality matter and human health. The contributions will be to improve the existing knowledge on air quality and the relationship with human health. Thus is the newest case study with latest health impact and urban air quality issues in the urban region of Selangor. This research focussing on urban regional context of air quality, this is because according to Kemp (2004) air pollution is often most obvious in urban areas, where it has caused deterioration in the health and quality of life of urban dwellers and will guide town planner and decision maker in less air pollution development. In addition, Malaysia experience bad haze every year and Selangor is one of the state usually affected. Therefore, it is necessary to complete this study.

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