# DIGITAL VISIBILITY MAP DURING HAZE OCCURRENCE IN MALAYSIA

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BORANG PENGESAHAN STATUS TESIS*

JUDUL: DIGITAL VISIBILITY MAP DURING HAZE OCCURRENCE IN MALAYSIA
SESI PENGAJIAN: 2013/2014
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SUPERVISOR: DR. ASMALA BIN AHMAD Date: _____

# DEDICATION

I dedicate my final year project report to my beloved parent, Mr Abd Lateh Bin Man and Mrs Rohana Binti Hj Zakaria. As well as my siblings Mohd Nasir, Mohd Fairos, Mohd Fariz, Farawahidah and Siti Rohaida. I am really appreciate and thankful for your support towards completion of this project.

To my supervisor, Dr. Asmala Ahmad for the guidance and advice during the completion of my final year project.

To my beloved friends, Sarah Izzati binti Ghazali, Lee Bee Teng and Ahmad Marzuki for sharing and helping along the way.

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I would like to express my sincere gratitude to my parents, my brother and sisters, and my dear friends.

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## ABSTRACT

MODIS satellite data in 2005 were used to determine atmospheric visibility during haze episode in Malaysia. Initially, haze measurements (in term of atmospheric visibility) were taken from fourteen air pollution stations in Peninsular Malaysia. Band 3 of MODIS were converted from digital numbers (DNs) to reflectance before undergoing geometric correction. The relationship between the reflectance and the corresponding visibilities for all fourteen air pollution were carried out using regression analysis. The power regression model was chosen as the best model for this project and was used to map the visibility within the MODIS data using density slicing technique. Multi-temporal analysis was also performed to map the visibility within the data from different dates. The results of this project indicate that remote sensing technique using MODIS bands 3 was able to map visibility spatially during the haze occurence throughout the study areas.

# ABSTRAK

Data MODIS satellite pada tahun 2005 digunakan untuk menentukan jarak penglihatan semasa Jerebu di Malaysia. Pada mulanya, pengukuran jerebu (dari segi jarak penglihatan) diambil daripada empat belas stesen pencemaran udara di Semenanjung Malaysia. Jalur 3 MODIS ditukar daripada nombor digital (DNs) kepada *reflectance* sebelum melalui pembetulan geometri. Hubungan antara *reflectance* dan jarak penglihatan yang sepadan untuk empat belas stesen pencemaran udara dijalankan menggunakan analisis regresi. Model regresi kuasa dipilih sebagai model yang terbaik untuk projek ini dan digunakan untuk memetakan jarak penglihatan pada data MODIS meggunakan teknik *Density Slicing*. Analisis *Multitemporal* juga dijalankan untuk memetakan jarak penglihatan pada data yang berlainan tarikh. Hasil keputusan daripada projek ini telah menunjukkan teknik *remote sensing* menggunakan jalur 3 MODIS berupaya untuk memetakan jarak penglihatan secara *spatial* semasa kejadian jerebu di kawasan kajian.

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# LIST OF ABBREVIATIONS

| | |
|---|---|
| ENVI | Environment for Visualizing Images |
| DN | Digital Number |
| MODIS | Moderate Resolution Imaging Spectroradiometer |
| DOE | Department of Environment |
| MMD | Malaysia Meteorological Departments |
| API | Air Pollution Index |
| NOAA | National oceanic and atmospheric administration |
| AVHRR | Advanced Very High Resolution Radiometer |
| CESAR | Central European study of air pollution and respiratory health |
| RMSE | Root mean square error |
| GIS | Geographical information system |
| IPU | Indeks pencemaran udara |
| $O_3$ | Ozone |
| $NO_2$ | Nitrogen Dioxide |
| PM10 | Particulate Matter |
| $SO_2$ | Suiphur Dioxide |
| CO | Carbon Monoxide |
| IR | Infrared |
| NIR | Near infrared |

# CHAPTER I

# INTRODUCTION

## 1.1 Project Background

Environmental issues may cause a serious problem not only to environment but also to humans. As Malaysia grows to become a country that is comparable to other developed countries, it is undeniable that some negative effects also come along. One of the most serious effects is the increasing air pollution caused by particularly growing number of vehicles, expansion of industrialization areas and forest fire.

Basically, air pollution can be divided into two main categories that are natural air pollution, and anthropogenic air pollution (caused by human activities). Normally, anthropogenic air pollution occurs at small scale (affects small area) but natural air pollution occurs at large scale (affects large area).

Between June and October for the past few years, the Southeast Asia region was covered with smoke due to land and forest fires. While, between December and March, the northern part of the region was blanketed with smoke resulting from agricultural burning activities. These phenomena, known as 'haze' have spread to most countries within the region, including Malaysia. The haze is a condition that occurs when sunlight reacts with tiny particles and gaseous suspended in the air before reaching our eyes. The main pollutants related to haze are, Sulphur Dioxide ($SO_2$), Nitrogen Dioxide ($NO_2$), Ozone ($O_3$), Carbon Monoxide (CO), and fine particulate matter ($PM_{10}$).

$PM_{10}$ (particulate of size 10 micron and below) is the main concern as it may lead to deteriorating human welfares and unhealthy conditions.

Haze can cause the field of view to blur. Asthma is a respiratory problem that is due to fine particles in the air and is commonly associated with haze. Studies have shown that the haze occurrence has caused the number of hospitalizations for asthma increases. Bronchial Asthma or chronic bronchitis is a disease which is caused by the inflammation bronchus where the airways get easily irritated and narrowed and can be triggered when inhaling air that is polluted with fine particles.

Such conditions are also visible from the images recorded by electronic devices including those recorded by remote sensing satellites. Remote sensing is a technology that can provide a unique perspective in which to observe large regions and global monitoring is possible from nearly any site on earth. In this project, remote sensing methods will be used to monitor and map haze. In order to do so, this project incorporates a number of digital image processing techniques. In general, image processing involves changing the nature of an image in order to either improve its pictorial information for human interpretation or to render it more suitable for autonomous machine perception. Digital image processing involves using a computer to change the nature of a digital image.

## 1.2 Problem Statement

This type of digital visibility map is not available in Malaysia as compared to other countries because Malaysia used conventional method to measured visibility However, there is the disadvantage of an air pollution station in which it is designed to measure at only the particular location where it is located, i.e. at big cities and high populated areas. Such approach gets more expensive if to be made available at more locations.

The records of daily mean Horizontal Visibility for Petaling Jaya station in 1999-2008 by Malaysian Meteorological Department show the worst haze episod is in year 2005 which show the lowest visibility compare to years before and after year 2005.

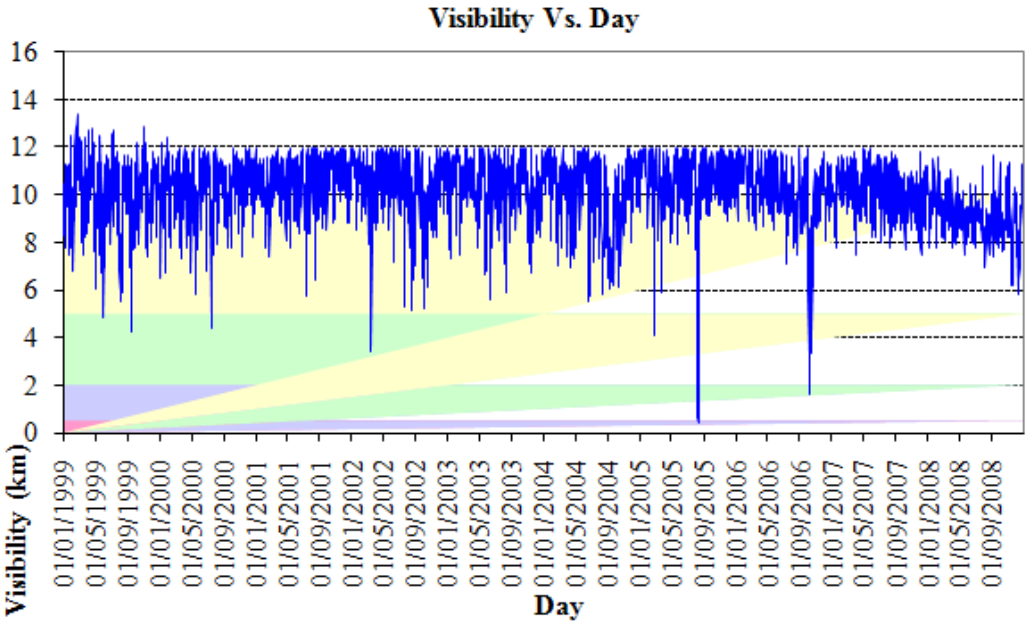


**Figure 1.1: The graph of Visibility against day for 1999-2008**

## 1.3 Objectives

The aim of the study is to develop a technique of determining haze concentration and to detect haze on the desired region using remote sensing data based on artificial intelligent methods.

In order to achieve this aim, the objectives below are concerned:

1. To determine the relationship between visibility and spectral measurement from remote sensing satellite.
2. To develop a remote sensing technique to monitor and map haze in order to produce a digital visibility map.
3. To evaluate and test the accuracy of the visibility map.

## 1.4 Scopes

Scopes of the study are divided into three parts: software scope, area of study scope and user scope.

### 1.4.1 Software Scope

All of the software in Table 1.0below is required in digital haze mapping from the beginning of the mapping until the end of the mapping process.

**Table 1.1: List of software required**

| SOFTWARE | REQUIREMENT |
|---|---|
| Operating System(OS) | Microsoft Windows 7 Ultimate |
| Image Processing Software | ENVI 4.5 |
| Software Support | Adobe Illustrator CS5<br>Matlab 2010a |
| Database Support | Microsoft Excel 2007 |

### 1.4.2 Area of Study Scope

The study area is Peninsular Malaysia, located within latitude 6°47’ N, longitude 88°25’ E (upper left), and latitude 1°21’ N, longitude 106°20’ E (lower right) as shown in figure 3.1.

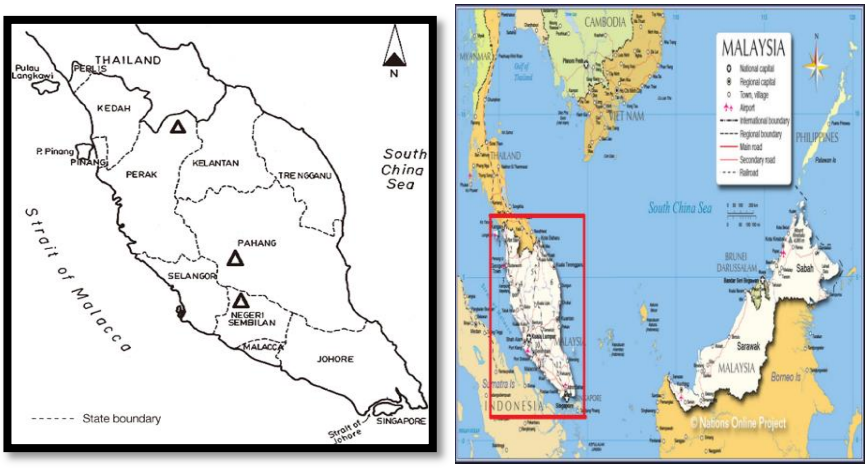


**Figure 1.2: Map of Peninsular Malaysia**

### 1.4.3 User Scope

- **Researchers**

The final output will be used as a part of research materials for future studies or as a research for next studies.

- **Student/Lecturer**

The final output will be the next use for the purpose of teaching and learning.

- **Haze planners**

The final output helps for planning purpose of determining the concentration of the haze that frequently occur.

## 1.5 Project Significant

The digital visibility map developed in this project will be very useful to people with asthmatic problem to help them to guide their way while travelling.

## 1.6 Expected output

The expected outcome from this project is a digital visibility map to assist people with asthma while travelling to different places.

## 1.7 Conclusion

As conclusion, this project will determine the concentration of haze components in Malaysia. Later, a digital visibility map for asthmatic people is to be developed to assist them while travelling.

# CHAPTER II

# LITERATURE REVIEW AND ANALYSIS

## 2.0 Introduction

This chapter reviews previous research and studies to gain ideas and information related to the project. This will assists the tasks in designing the methodology to solve the problem that should be done in a limited period of time allocated.

## 2.1 Air Quality system in Malaysia

The existence of the air quality system in Malaysia for measuring the air quality influences haze studies related. Such existing system in Malaysia is monitored by Malaysian Meteorological Department (MMD) and Department of environment (DOE) that responsible in the formation, transport and dispersion of air pollutants including haze occurrence.

### 2.1.1 Malaysian Meteorological Department (MMD)

The Malaysian Meteorological Department has established the Environmental Studies Division in 1976 to contribute to the conservation and enhancement of environmental quality and the advancement of knowledge and understanding of atmospheric processes. Services that provided by Malaysian Meteorological Department are meteorological and air quality data from a network of monitoring stations for public, private and commercial. There exist 52 automatic air quality stations and 14 manual air quality stations in Malaysia that is located at strategic places such as industrial area, urban, sub-urban and rural area.

At the same time, meteorological department also alert by giving early warning of environmental disasters by monitoring changes in atmospheric composition and environmental conditions. Other than providing meteorological data, meteorological department also provides air quality forecasts and coordinate the department's response to nuclear, chemical spills, emergency-haze events and other environmental emergencies. The most important thing regarding this department is it conducts research to advance knowledge and understanding of the atmosphere.

### 2.1.2 Department of Environment

The Malaysian Department of Environment complements the Malaysian Meteorological Department in conducting air quality monitoring program in the country. The pollutants monitored include SO2, NO2, O3, CO, and PM10. The telemetry monitoring tools provide an immediate reading of the level of air pollution. This tool is installed in industrial, urban, sub-urban and rural. In addition, a joint program between this department through the air monitoring of the environment and the royal Malaysian police air unit also conducted to monitor and detect excessive smoke emissions from factories and open burning.

### 2.1.3 Malaysian Air Quality Monitory and Measurement System in Malaysia

In Malaysia, air quality monitoring network is carried out by Malaysian Meteorological Department and Department of Environment Malaysia through a network of 52 automatic stations and 14 manual stations whereby it is located at strategic places that are industrial, urban, sub-urban and rural. This system provides immediate reading of the level of air pollution. The figure 2 shows the stations in Peninsular Malaysia. Different colour dots represent different place for entire figure.

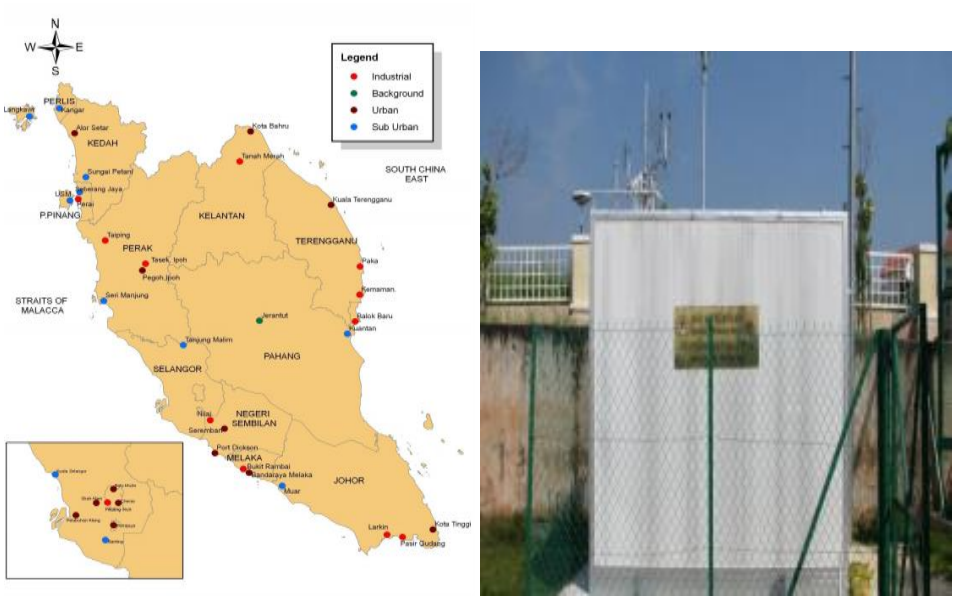


**Figure 2.1: The air quality stations in Malaysia.**