**UNIVERSITI PUTRA MALAYSIA**

# *APPLICATIONS OF REMOTE SENSING AND GIS FOR DENGUE EPIDEMIC SURVEILLANCE IN PETALING JAYA, MALAYSIA*

***MIOR MOHD HADAFI BIN AHMAD ZAHAWIR***

**FK 2008 76**

# APPLICATIONS OF REMOTE SENSING AND GIS FOR DENGUE EPIDEMIC SURVEILLANCE IN PETALING JAYA, MALAYSIA

MIOR MOHD HADAFI BIN AHMAD ZAHAWIR

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MASTER OF SCIENCE
UNIVERSITI PUTRA MALAYSIA

2008

# APPLICATIONS OF REMOTE SENSING AND GIS FOR DENGUE EPIDEMIC SURVEILLANCE IN PETALING JAYA, MALAYSIA

**BY**

**MIOR MOHD HADAFI BIN AHMAD ZAHAWIR**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Master of Science**

**AUGUST 2008**

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***DEDICATION***

*To Allah S.W.T. and His Messenger Muhammad S.A.W.*

*To my father, my mother and all my family members, to my beloved wife Najwa Jamri and my daughters Marsya Huda, Maryam 'Audah and Munirah Afiqah for support and understanding of my work.*

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Master of Science.

**APPLICATIONS OF REMOTE SENSING AND GIS FOR DENGUE EPIDEMIC SURVEILLANCE IN PETALING JAYA, MALAYSIA**

By

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**FEBRUARY 2009**

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Remote sensing and GIS data was used in dengue epidemic mapping. The work focused on three main applications. First, mapping the dengue epidemic incident location by analysing the cases which have relationship between one another, like cases occurring in 200 meter range from the first case and time period in one to two weeks. Secondly, application for landuse, where landuse information was extracted from high resolution satellite image, Ikonos. Dengue cases occurred in any landuse will be observed where the epidemic was influenced by landuse factors. Thirdly, the dengue cases occurred will be observed whether it was influenced by climate factors such as rainfall and temperature, including temperature and vegetation indices, obtained from medium resolution satellite images. These data was then analysed using statistical method. Although the results can show the spot area of dengue cases occurrence, the dengue cases risk index in area based on landuse and other factor in that area will also be shown. Results from statistical analysis will show the model development and verification, whether

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it can be accepted or not. The main conclusion of this work will show the levels of remote sensing and GIS technology used, which can help in dengue epidemic monitoring in Malaysia.



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Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains.

**APLIKASI PENDERIAAN JAUH DAN SISTEM MAKLUMAT GEOGRAFI BAGI PENGAWALAN WABAK DENGGI DI PETALING JAYA, MALAYSIA**

Oleh

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Data remote sensing dan GIS digunakan dalam pemetaan wabak denggi. Kerja-kerja ini difokuskan kepada tiga aplikasi utama. Pertama, memetakan lokasi kejadian wabak denggi dengan menganalisa kes-kes yang mempunyai pertalian antara satu sama lain, iaitu kes yang berlaku dalam jarak 200 meter dari kes sebelumnya dan dalam jarak masa antara seminggu hingga dua minggu. Kedua, aplikasi bagi faktor guna tanah di mana pemetaan guna tanah dilakukan dengan menggunakan image satelit beresolusi tinggi iaitu Ikonos. Kes denggi yang berlaku dalam mana-mana kawasan gunatanah akan dilihat samada wabak tersebut dipengaruhi oleh faktor guna tanah tersebut. Ketiga, Kes denggi yang berlaku akan dilihat samada dipengaruhi oleh faktor cuaca seperti hujan dan suhu termasuk suhu dan indek tumbuh-tumbuhan yang diperolehi dari satelit beresolusi sederhana. Data-data ini kemudiannya dianalisa menggunakan kaedah statistik. Keputusan kajian disamping menunjukkan kawasan-kawasan spot berlakunya kes denggi, akan juga menunjukkan index risiko kes denggi dalam kawasan tersebut

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berdasarkan faktor guna tanah dan faktor kawasan itu sendiri. Keputusan dari analisa statistik pula akan menunjukkan pembangunan model berlakunya kes denggi dalam tahun-tahun kajian, seterusnya model tersebut akan dibuat pengesahan samada ianya boleh diterima atau sebaliknya. Kesimpulan utama yang dapat dibuat akan menunjukkan setakat mana teknologi remote sensing dan GIS yang digunakan dapat membantu usaha-usaha pemantauan wabak denggi di Malaysia.



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## ACKNOWLEDGEMENTS

All praise to Allah S.W.T. the Most Gracious and Most Merciful for giving me the strength, health and self-confidence to complete my study. My greatest pleasure and salaam to the great Prophet Muhammad S.A.W.

First of all, I would like to express my gratitude to my supervisor, Assoc. Prof. Dr. Abdul Rahman Ramli, Prof. Dr. Shattri Mansor, and Assoc. Prof. Dr. Abdul Rashid Mohamed Shariff for their sincere, frank advice, constructive criticism, patience and guidance throughout this research. My appreciation is also extended to Dr. Ahmad Rodzi Mahmud, Dr. Shamsul Azhar Shah, Mr. Ibrahim Selamat and Dr. Laili Nordin for their guidance and support throughout the stages of my study.

My special appreciation to Malaysian Centre for Remote Sensing (MACRES) for providing the satellite images (Landsat 7 ETM+ and Ikonos) and dengue cases data for my study area.

Special thanks also to University Putra Malaysia (UPM) for the financial support at the beginning of my study. Finally, I wish to convey my special thanks to my parent, Hj. Ahmad Zahawir Saaia and Allahyarhamah Pn. Asmah Abdul Wahab, all my brothers and sisters, my beloved wife Najwa Jamri, my daughters Marsya Huda, Maryam 'Audah and Munirah Afiqah for their contribution and support toward the success of this study. Last but not least, all my friends, who contributed to my study, May Allah bless all of you.

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I certify that a Thesis Examination Committee has met on 13 August 2008 to conduct the final examination of Mior Mohd Hadafi Bin Ahmad Zahawir on his thesis entitled "Application of Remote Sensing and GIS for Dengue Epidemic Surveillance in Petaling Jaya, Malaysia" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 march 1998. The Committee recommends that the student be awarded the Master of Science.

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I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

---

**MIOR MOHD HADAFI BIN AHMAD ZAHAWIR**

Date: 31 October 2008

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# LIST OF ABBREVIATION

| | |
|---|---|
| ADB | Asian Development Bank |
| CDC | Centre for Disease Control |
| CHAART | Centre for Health of Aerospace Related Technologies |
| DBMS | Database Management System |
| DID | Department of Irrigation and Drainage |
| DOE | Department of Environment |
| ESRI | Environmental System Research Institute |
| ETM | Enhance Thematic Mapper |
| GIS | Geographical Information System |
| GPS | Global Positioning System |
| IMR | Institute for Medical Research |
| JRI | Joint Research Interchange |
| JUPEM | Jabatan Ukur dan Pemetaan Malayisa |
| KLIA | Kuala Lumpur International Airport |
| LST | Land Surface Temperature |
| MACRES | Malaysian Centre for Remote Sensing |
| MARDI | Malaysian Agriculture Research and Development Institute |
| MOH | Ministry of Health |
| MBPJ | Majlis Bandaraya Petaling Jaya |
| MPOB | Malaysian Palm Oil Board |
| RFLP | Restriction-Fragment Length Polymorphism |
| SQL | Sequel Query language |
| WHO | World Health Organization |

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Locality Name:

| | |
|---|---|
| PJS | Petaling Jaya Selatan |
| SS | Subang Selatan |
| SKA | Sungai Kayu Ara |
| PJU | Petaling Jaya Utara |
| SEK | Seksyen |
| KL | Kampung Lindungan |
| KD | Kota Damansara |

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# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

Remote sensing when intelligently incorporated with Geographic Information System (GIS) has been identified as being a potential enabling technology to be use in the public health sector. This technology is transforming the way we describe and study the earth. However, being somewhat new to Malaysia, and the lack of knowledge in this technology among the Malaysian society, much effort is required to train the relevant personnel to efficiently utilised and apply remote sensing and the related technologies for the well being of the nation, especially in this case, the public health sector. Albeit the many effort and research that has been done to familiarize with the technology, little action has been taken to implement the application of this technology in the public health sector. Application of remote sensing technology in the public health sector to many people appears to be rather impractical. The common question being, how much can this technology assist the public health sector to monitor, analyze, or predict the many possible health hazards? Thus far, the development of Remote Sensing and the related technologies in the country has been made to many advantages in the

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various sectors such as the military, agriculture, geology, and etc. Now numerous introductory efforts have been carried out to use remote sensing and its related technologies in the public health sector.

## 1.2 Justification

Remote sensing is an important source of information for GIS systems. It is used in various applications like mapping of soil, vegetation, crop monitoring, forestry, environmental issues etc. Maynard (2002) found that many of the environmental factors connected to the public health issues are observable through remote sensing such as air and water quality, thermal, ultraviolet, pollutant and pathogen transport as well as deposition via the atmosphere, ocean, ice and rivers. Combining remote sensing and GIS technologies, may give near real time access to data on temperature, vegetation indices, deforestation and etc. In addition, with the precise geographic location of water bodies, population centres, building, roads, canals, and other infrastructure (WHO, 2002), these technologies are potentially useful for infectious disease surveillance and control for many types of vector borne diseases. The technology will be highly applicable to meet the demands of an outbreak investigation, prompt location of cases, condition of the location, and quick mapping of the epidemic's outbreak area. Thus, the application of remote sensing for health studies can increase the capability and accuracy in its monitoring, surveillance and risk mapping of areas of particular vector-borne disease. In most of these studies remote sensing data were used to

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explore the environmental factors that might be associated with disease-vector habitats and the risks to human transmission.

In Malaysia the Ministry of Health reported that high incidences of dengue in this country are from developed states with a high population density. It is believed that the increase in breeding places at construction sites for houses and townships in urban areas, has contributed to the increase in dengue outbreak cases in the country.

Shekar (1992) in his study on dengue for a period of 14 years (1973-1987) found that 9.2 cases of dengue per 100,000 people were reported yearly. From this rate, 5.4 per 100,000 people were infected with dengue fever while 3.8 per 100,000 people with dengue hemorrhagic fever. The incidence of dengue hemorrhagic fever was reduced from 10.1 cases per 100,000 people in 1973 to 1.9 cases per 100,000 people in 1987. The overall mortality rate for the period of 1973-1987 for dengue hemorrhagic fever was 6.4%. For the year 1990-1995 the mortality rate for dengue fever was between 0.41%-0.59%. This reduction is attributed to the improved surveillance system of dengue and its vector, early diagnosis, early notifications and better management of cases. Figure 1.1 below shows the numbers of cases of dengue fever in Malaysia for the year 1991 – 2002.

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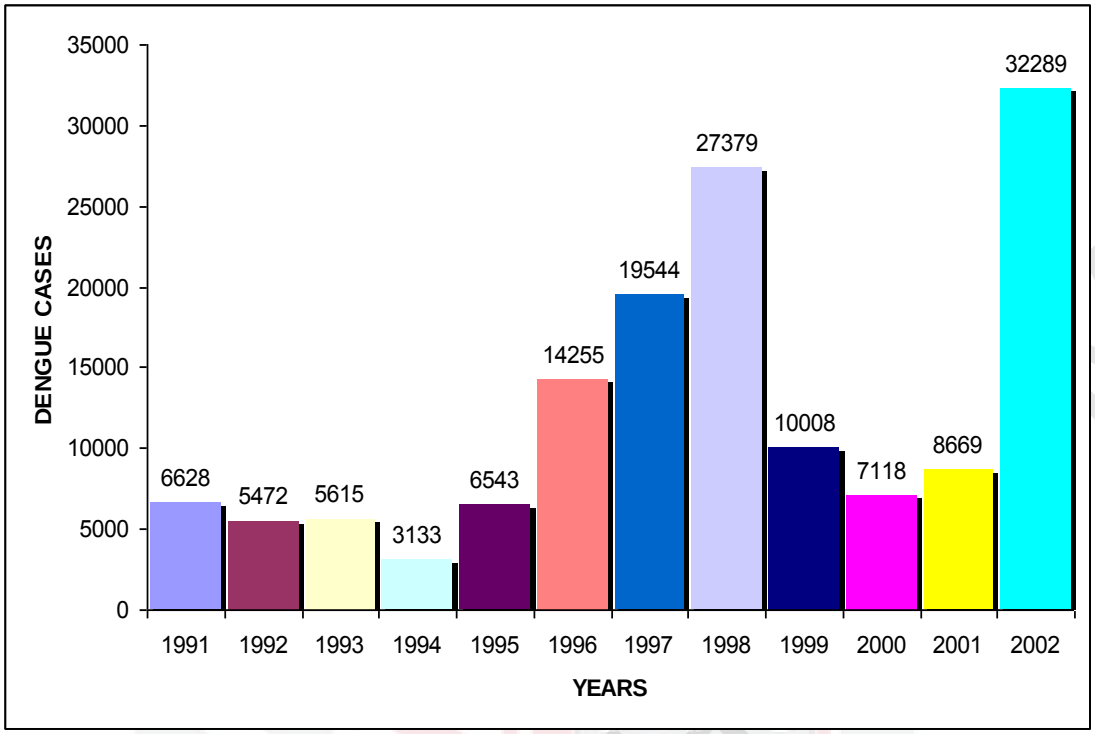


Figure 1.1: Dengue Cases in Malaysia 1991-2002.
Source: WHO (2000), and MOH (2003)

## 1.3 Problem Statement

Dengue fever is a fatal disease for human being. When infected, the disease can be fatal in a short period. The disease is caused by the dengue virus, carried and spread by the primarily urban *aedes* mosquito. Currently, when a dengue fever is reported, the local authority and control personnel will immediately investigate the area where the case occurs, and procedures to control the distribution of the dengue vector will be carried out. Unfortunately, the investigations are done ad-hoc with not much of appropriate geographical or real-time information of the locality and the surroundings. With GIS, the control personnel would be able to see the surrounding location and the latest case before new cases are reported. Without GIS the health inspector

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will still be able to know the location from a map but not the detailed information of the cases.

The GIS technology can help the control personnel to get the precise geographical information of the case location together with the complete information of the previous cases. This is more efficient and effective method for their investigation. The remote sensing technology can also help the control personnel to analyze the entire location of high risk area which could have caused the infection.

The monitoring of the dengue vector distribution is important to cope with prevention activity such as fog spray and to locate the nearest health services to alert for possible new cases. In the conventional method the control personnel uses hardcopy map to pin point the location of dengue cases which has occurred without further information of the cases or other analysis work.

## 1.4 Objective

General objective of this study is to monitor dengue risk through remote sensing and GIS technologies. Risk area was identified from the data of dengue cases collected and mapped spatially in GIS. Remote sensing is used to identify the location and surrounding areas, thus identifying the suspected dengue breeding places.

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A few of specific objective in this study were listed below to focus on the research target.

a. To create a spatial database of dengue incident distribution over the study area of Petaling Jaya.
b. To analyze various landuse types over the study area that affects the dengue cases density or risk level.
c. To produce dengue risk assessment index on locality and landuse.
d. To evaluate climate factors like rainfall and temperature that influence dengue cases distribution for the whole study area.

The first objective is to create a spatial database of dengue incident distribution over the study area of Petaling Jaya. The dengue cases are represented by a point over the location of the incident or the victim's house, which plotted using high resolution satellite data. The points contain information of the victim such as name, address, locality, date, serology and etc.

The second objective is to analyze various landuse types, which affects the dengue cases density in the study area. The landuse types were divided into three categories that were analyzed with different methods. The categories such as residential, non-residential and buffer, each category was analyze using different methods.

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The third objective is to produce risk level index of localities in the area study. The dengue risk level will be identified based on the dengue cases density in percent per hectares unit over the area. The risk level is important to determine further action should be taken by control personnel's and local authority to the particular landuse area specifically for monitoring and surveillance purposes.

The fourth objective is to evaluate the environmental factors such as weather, which contains two main elements, rainfall and temperature. Rainfall causes water to fill in pieces of broken glasses, cans, bottles, unused tires etc. The high temperature of the earth's surface can cause a mosquito's life cycle to mature in a shorter period. This situation can cause the population of mosquito to highly increase. There could possibly be a relationship between climate condition and dengue cases occurrence.

## 1.5 Scope of Study

The scope of this study was to focus on the spatial database development as an input data for the analysis. The database includes dengue incident distribution data and landuse type data. Dengue incident distribution data were obtained from the local authorities of Petaling Jaya in tabular data format. The data was then plotted onto a map base with the address stated on the tabular data. The landuse type data was then classified by visual interpretation of high-resolution satellite data.

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For analysis purposes, dengue cases density was analyze to determine risk level of the particular area. Statistical analysis in SPSS was applied to evaluate the correlation of the dengue incident distribution with landuse type area and climate condition such as rainfall and temperature.

## 1.6 Research Contribution

Contribution for this research is to simplify works for dengue cases epidemic surveillance. The officer in-charge of controlling the dengue epidemic can do their work effectively and efficiently, which was helped by GIS and remote sensing map. The surveillance can be done in the right time and the right place without wasting resources, when the surveillance activity was not conducted properly. The officer also can have a mental map of risk level in that area before going to field. Further research can be done such as *aedes* population density, larvae etc.

Local authority can also monitor the expansion of dengue epidemic using GIS interactive map, update with database and remote sensing images. Information on the map can also be shared with public using internet through online map server, to give awareness to the public about the risk in their area.

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## 1.7 Summary

After going through the introduction chapter, we will look at the directions of this study, why it was done and what was focused in this study. In the next chapter, we will see more clearly about the study subject matter such as dengue fever, the researches that have been done, local authority and the technology that were used in this study - remote sensing and GIS.

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