Monitoring the Dengue Population/Breeding ground using Geographic Information System (GIS) for the Dengue Mitigation Process.

By

AMIR FADHLI BIN RAZALI

FINAL PROJECT REPORT

Submitted to the Civil Engineering Programme
in Partial Fulfillment of the Requirements
for the Degree
Bachelor of Engineering (Hons)
(Civil Engineering)

Universiti Teknologi Petronas
Bandar Seri Iskandar
31750 Tronoh
Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Civil Engineering Programme
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Approved:

AP Dr Abdul Nasir Bin Matori
Project Supervisor

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK

June 2008

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

Amir Fadhli Bin Razali

ABSTRACT

This report basically discusses the preliminary research done and basic understanding of the chosen topic, which is **monitoring the dengue population/breeding ground using Geographic Information System (GIS) for dengue mitigation process**. The objective of the project is to find the scientific reasons and proof of the dengue population and search for the factors that make them grow in the community via comparing the pattern of the victims and suspected that are effected by the virus with the transportation way, structures, and residential areas. The challenge in this project is to gather the data required and also a lot of assumption will be done because until now there are no proved scientific data to help the studies. Field work will be done together with the help from the Ministry of Health of Batu Gajah, Perak to gather all data that are required for this project. All the data will be collected and the comparison via GIS will be done to satisfy all assumption that has been done before.

ACKNOWLEDGEMENTS

In the name of Allah. The Most Gracious, the Most Merciful. Praise to Him the Almighty, that is His will and given strength, I management to complete this final year project.

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CHAPTER 1
INTRODUCTION

1.1 Background of Study

Dengue fever is due to an arbovirus mainly transmitted by Aedes aegypti and yearly causing in the tropical area tenths of millions of cases. Since its apparition during the 50's the Dengue Haemorrhagic Fever (DHF) a sever form of dengue infection, has followed a global upward trend in incidence and has been a main public health problem in South East Asia (SEA) and countries in the tropical zone. Dengue is mainly found in the tropics because the mosquitoes require a warm climate. Theoretically, a person living in a dengue endemic area could have as many as four dengue infections during his or her lifetime. The virus is transmitted when a mosquito of the *Aedes genus* bites an individual infected with dengue virus and the virus in the blood of the infected individual then infects the mosquito. The virus will travels from the mosquito's stomach to its salivary glands were the virus multiplies. Then, the spreading process will start when the mosquito injected the virus into another person when it is feeding. The mosquito remains able to transmit dengue for its entire life. Person that is infected by the virus would suffer fever (2-5 days) and present a discrete macular or maculopapular rash, headache, muscle and joint pain, lost of appetite and also lastly it could also cause death. However until now, there are no specific treatment against the virus neither vaccination is available.

The mosquito generally goes through four separate and distinct stages of its life cycle and they are as follows: Egg, Larva, pupa, and adult. Each of these stages can be easily recognized by their special appearance. There are four common groups of mosquitoes living in the Bay Area. They are *Aedes, Anopheles, Culex,* and *Culiseta.*

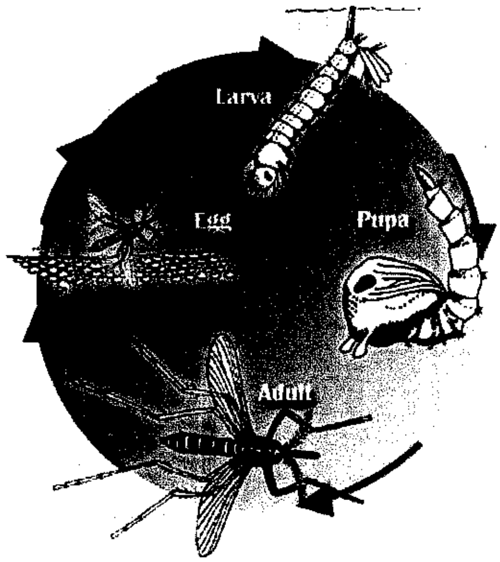

Figure 1: Mosquitoes Life-cycle

Geographic Information System (GIS) is a collection of computer hardware, software, and geographic data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. With this system, information or attributes can be linked to any location data, such as people to addresses, buildings to parcels, or streets within a network. It gives a better understanding of information before any analysis is done. GIS also allow us to see relationship, patterns, or trends intuitively that are not possible to see with traditional charts, graphs, and spreadsheets.

In public health research, GIS has been widely used in disease surveillance and monitoring, research hypothesis, identification of high risk area population at risk. Recent studies have shown that GIS play an important role in public health and epidemiology. (Gupta et al., 2003; Gatrell and Loytonen, 1998; Pearce 1996).

Specific disease and public health resources can be mapped in relation to their surrounding environment and existing health and social infrastructures. Such information when mapped together creates a powerful tool for the monitoring and management of disease. GIS provides a graphical analysis of epidemiological indicators over time, captures the spatial distribution and severity of the disease, identifies trends and patterns and indicates where there is a need to target extra resources (WHO Division of Control of Tropical Disease – Health Map –Using GIS in public health)

1.2 Problem Statement

Dengue occurred almost simultaneously, in Asia, Africa and North America in the 1780s. The disease was identified and named in 1779. A global pandemic began in Southeast Asia in the 1950s and by 1975 DHF had become a leading cause of death among children in many countries in that region. Epidemic dengue has become more common since the 1980s and by the late 1990s, dengue was the most important mosquito-borne disease affecting humans after malaria and there were around 40 million cases of dengue fever and several hundred thousand cases of dengue hemorrhagic fever each year. In February 2002 there was a serious outbreak in Rio de Janeiro, affecting around one million people but only killing sixteen.

Figure 2 : Aedes Aegypti

In Malaysia, dengue has reached epidemics threshold and the full extend still remains to be seen. The dreaded 1000 cases a week mark has been breached (Health Minister, NST Wednesday Oct. 5, 2005). If the pattern continues, the country will be in the midst of a dengue epidemic.

The increases of cases in this country can be linked with poor diseases surveillance especially in aedes breeding areas. In the early years of dengue fever management plans, most of the data regarding patient's location or dengue treatment centers are marked on paper map and computers. Unfortunately this kind of information is hard to be interpreted as patient's database and it is not linked to the available spatial data (e.g. residential area, septic tank distribution etc.)

Other than that, according to some reports, the information on how the mosquito travel, its feeding time, and distances of infection areas are still assumptions, without any scientific proof.

This research will attempt to find correlation between these various contributing factors of dengue cases using GIS technique. GIS will improve the dengue management in term of data mining, saving, processing as well as analyzing. The most important thing is to relate and link all possible data collected in the effected areas as possible hypothesis on how the virus is spread, feeding time, and potential areas as breeding ground. By having all analysis, we can control and prevent this deadly disease from continuingly killing the communities.

1.3 Objective and Scope of Study

1.3.1 Objectives

The objectives to be achieved by the end of this project are:

- To develop appropriate database of spatial and attribute data that contribute to dengue cases and population.
- To perform spatial analysis in order to establish contributing factors to dengue epidemic

1.3.2 Scope of Study

The scope of work for the study on dengue management is to be completed within the time frame given which is approximately 14 weeks. In order to achieve that goal, there are some research, work planning, interview and field work that have to be done. The resources regarding dengue cases and epidemic flow are available in Ministry of Health of Batu Gajah, Perak.

GIS software such as ArcInfo Professional 9.0 was used to configure the transmission of dengue in the Perak state. The program will provide epidemiologist with an efficient tool to identify environmental factors and mosquito breeding sites at risk related to dengue outbreak. Analysis would be made after all the data transmit into layers of structure, transportation connection of the studied area.

CHAPTER 2
LITERATURE REVIEW

2.1 What is Dengue

Dengue Fever (DF) and the more severe Dengue Hemorrhagic Fever (DHF) are caused by one of the four closely related virus DEN-1, DEN-2, DEN-3, and DEN-4 of the genus Flavivirus. This primarily tropical and subtropical disease spread by Aedes aegypti mosquitoes has produced a spectrum of clinical illnesses ranging from nonspecific to severe and fatal in all ages, races, and genders. Although DF is generally considered nonfatal, late treatment may cause serious complications. Recently, the new strain of stereotypes has been reported in a susceptible population probably due to the ability of the vector to travel long distances between population centers via sailing vessels, land transportation, and crossing of international borders by commercial aircraft.

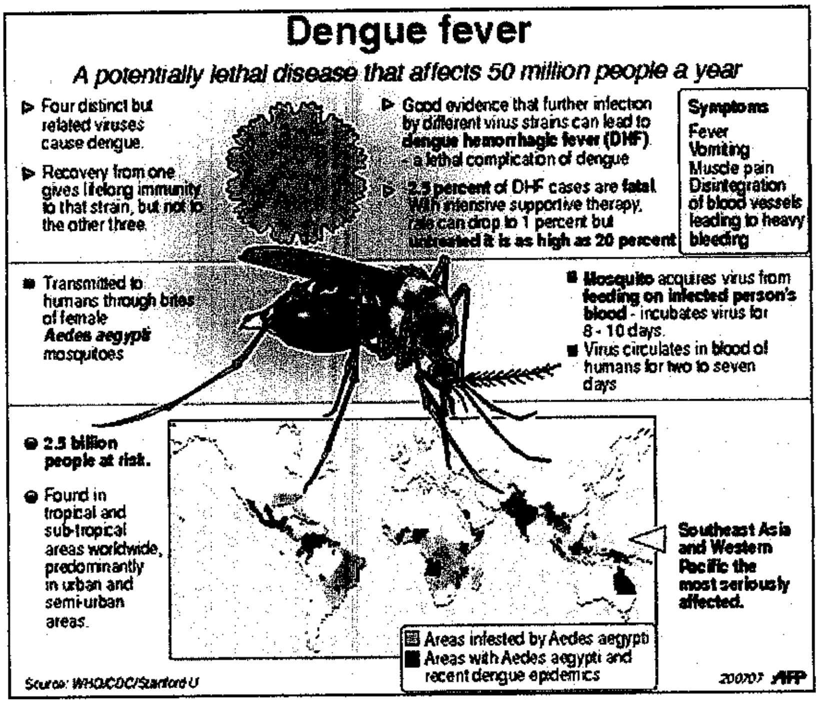

Figure 3: Dengue Fever in Asia

2.2 Dengue in Malaysia

The earliest report of a dengue epidemic in Malaysian Peninsular is in year 1902. In March 1954, an outbreak of febrile illness was reported at Kuala Lumpur. However the first report of the dengue fever with hemorrhagic manifestation was made in 1956 from Penang. Notification of DF and DHF was instituted in 1971 and any case of confirmed or suspected dengue or dengue hemorrhagic fever must be reported to the nearest medical center. Since 1994, The National Dengue Control Programme has led disease surveillance, vector control, health education, community participation programmes and research. Fogging is systematically applied in areas where cases are increasing above usual levels and in 'hotspots' at the beginning of the season.

In 2008, a total of 35 dengue deaths were reported nationwide from early this year to May 2008. There were 38 deaths from 16,260 cases during the same period in 2007. There was also a decrease of about 38 percent for the first three month of the year 2008 compare to the previous year. Between January 1 and March 30 in this year, 9,872 dengue cases were recorded nationwide compare with 13,904 cases cases for the same period in 2007. The number of dengue-related deaths was at 25, compare to 36 last year. (Health Minister, NST Sunday, April 27, 2008).

2.3 Breeding Area of Aegypti

Dengue was found actively breed in many tropical and subtropical regions of the world from Africa, largely through human commerce. As it became established in new areas, it retained its close association with humans. There are substantial differences among regions it inhabits, however, with regard to climate, the type and availability of oviposition sites, contiguous areas of suitable habitat, the nature of vector control efforts, and the role of human-aided dispersal. Variation in these kinds of ecological parameters can profoundly affect the population genetic structure at the regional level of *aegypti* or any other mosquito species. Understanding patterns of gene flow among *aegypti* populations is useful for tracking and even predicting the movement of important genetic traits such as vector competence and insecticide resistance.

In Malaysia, eighty percent of construction sites and abandoned projects inspected in Selangor were found to be breeding grounds for Aedes mosquitoes. This have been referred as the main factors contributing to the high number of dengue cases in the state by the State Health Director, Dr Rosnah Hadis, Aedes larvae were found in polystyrene containers left by workers, wheelbarrows and even in puddles of water on the floors of unfinished buildings.

In 2008, Selangor topped the list with 3,742 dengue cases for the first three month, followed by Kuala Lumpur (1,119) and Perak (1,048). The top five hotspots in the country are Shah Alam with 719 cases, Klang (582), Johor Baru (536), Kajang (514) and Subang Jaya (457).(24th Asian Parliamentarians and Development: Climate Change, Infectious Disease and Population Issues, NST, April 27,2008)

2.4 Ways of Controlling Aegypti

In finding ways of controlling the disease, many researches have been done. In 2008, cases recorded are kept on increasing. According to *The Telegraph,* Calcutta's newspaper, it has been reported that the sterile insect technique (SIT), which involves releasing millions of sterile male insects over a wide area to mate with the female ones, had been around for decades. The conventional sterilization programmes using radiation or chemical to foster sterility, which was tried on mosquitoes as well, did not work. Irradiation rendered these mosquitoes so sickly and unattractive that their female counterparts shunned them for the wild ones.

New ways of introducing genetically modified (GM) warrior Aedes mosquitoes have been done recently in Malaysia. The GM male Aedes aegypti mosquitoes, which carry killer genes, will be released into wild to eliminate the Aegypti mosquito population which spreads dengue fever. The research and field trial will be place in

Pulau Ketam, a fishing village off Selangor and were conducted by the Health Ministry's Institute of Medical Reseacrh (IMR) in collaboration with British-based Oxitec Ltd, an insect bio-tech company part-owned by the University of Oxford. This technique involves releasing GM male aedes mosquitoes to mate with the female and the lethal genes cause the larvae to die.

2.5 Usage of GIS in Ovitrap Monitoring in Singapore

Ovitraps are used extremely extensive in Singapore as a tool to monitor, detect and control aedes populations. They give an approximate gauge of the adult population in an area and act as an early warning signal to pre-empt and impending dengue outbreaks. A Geographical Information System (GIS) was established in 1998 to develop a real-time aedes mosquito control and monitoring system for spatial epidemiological study. The GIS monitors the network of 2000 ovitraps placed island-wide to better understand vector trends and diseases patterns. Analysis is done on the ovitrap breeding data collected weekly to identify hotspots and risk areas where there is a danger of high aedes aegypti infestation. The analysis results are used to plan vector surveillance and control operations.

2.6 Dengue Management System

Dengue Management System has been developed by National Dengue Control Programme to guide and coordinate efforts to manage dengue fever in Malaysia. The plan calls for continuous collaboration between government and non-government agencies in dealing with this disease. Roles played by this agency could be different and procedures of each component of the plan differ according to the status of dengue activity in Malaysia.

The plan aims to reduce the risks of dengue outbreaks in this country as well as strengthen the control measures for any future outbreaks. Existing procedure in the plan focuses on:

- Disease surveillance
- Mosquito surveillance and control
- Education

2.7 Diseases Surveillance

Disease surveillance is the first defense against dengue. This plan relies on general practitioners, doctors and laboratories results to notify about the possible cases of dengue. The professionals are the one that have first contact with potential dengue patients. Dengue can be transmitted through infectious traveler. The patient probably became infected by mosquito in his/her local area and spread the diseases to other places.

2.8 Mosquito Surveillance and control

Mosquito surveillance and control plays an important role in preventing the mosquito's numbers and conduct routine elimination of aedes aegypti breeding sites. Surveillance and control becomes critical when an imported case or locally-acquired case of dengue is reported.

Interior spraying is conducted preferentially over external fogging because interior spraying targets the resting sites of adult aedes egypti. Spraying these areas thoroughly with residual insecticides is crucial to the eventual elimination of the tenacious Dengue-3 virus (Cairns, Mossman and Port Doughlas, 1998/99).

The reasons for this dramatic global emergence of dengue/DHF as a major public health problem are complex and not well understood. However, several important factors can be identified.

1. Effective mosquito control is virtually nonexistent in most dengue-endemic countries. Considerable emphasis for the past 20 years has been placed on ultra-low-volume insecticide space sprays for adult mosquito control, a relatively ineffective approach for controlling *Ae. aegypti.*

2. Major global demographic changes have occurred, the most important of which have been uncontrolled urbanization and concurrent population growth. These demographic changes have resulted in substandard housing and inadequate water, sewer, and waste management systems, all of which increase *Ae. aegypti* population densities and facilitate transmission of *Ae. Aegypti-borne* disease.

3. Increased travel by airplane provides the ideal mechanism for transporting dengue viruses between population centers of the tropics, resulting in a constant exchange of dengue viruses and other pathogens.

4. In most countries the public health infrastructure has deteriorated. Limited financial and human resources and competing priorities have resulted in a "crisis mentality" with emphasis on implementing so-called emergency control methods in response to epidemics rather than on developing programs to prevent epidemic transmission. This approach has been particularly detrimental to dengue control because, in most countries, surveillance is very inadequate; the system to detect increased transmission normally relies on reports by local physicians who often do not consider dengue in their differential diagnoses. As a result, an epidemic has often reached or passed transmission before it is detected.

2.9 Education

Aedes aegypti is a mosquito that primarily breeds in containers, which hold water, in and around the house and yard. Mosquito control personnel cannot eliminate mosquito breeding in all homes. Therefore members of public should play their rol in eliminating mosquito breeding at home and protecting themselves from dengue.

Education programs utilize public relations, advertising, promotional materials (brochures, posters), training sessions or specific community setting such as schools, work sites and traveler hostels.

Public health education during non-outbreak periods highlights the simple preventive measures that householders can take for dengue mosquito control. Campaign commenced throughout the years will help to remind members of the public of their responsibility to keep their homes free of dengue mosquitoes.

2.10 Application of GIS in Dengue Management System

GIS has been on of the most important tools to control and manage problems associated with public health and epidemiology. The system can provide a great deal of problem-solving capabilities such as a linking spatial data with the ordinary mapping tools etc.

In Dengue Management System, it enables researches to:

- Strengthen dengue outbreak control measures
- Identify population at risk
- Identify the pattern of dengue outbreak
- Maps depicting area of responsibility

Correlation between dengue cases can be linked and investigated by the used of GIS. By inter relating all the pattern, main road of the infected area, residential area and potential breeding area such as septic tank can be put under hypothesis in showing that they are all the element of spreading the virus.

Looking at other country that is having this disease problem such as Singapore and Thailand, they used the GIS system to control the virus from getting spread. For example, in Singapore, they are using the ovitrap in observing the numbers of mosquitoes in an area. Ovitraps that have been placed will be plotted into the GIS and data were collected weekly and the numbers of mosquitoes were taken. Data in week 1, 2 and 3 will be analysis to determine whether there will be any potential case in the area. This method can also be implemented in this project.

CHAPTER 3
METHODOLOGY

This study was based on the research and development approach which involve data gathering, database development and analysis. A number of steps are taken to carry out to accomplish the objectives of the project. The Health, Safety and Environment (HSE) element were also taken into consideration while doing the research. The project flow can be viewed in figure below.

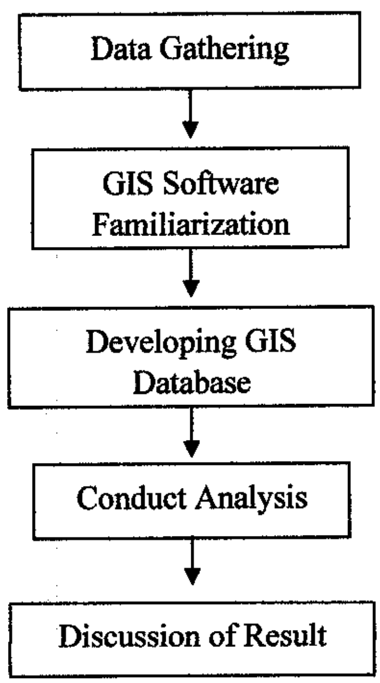

Figure 4 : Project's Flow

3.1 Data

3.1.1 Data Collection

Dengue epidemic data from medical centers, hospitals and the internet are collected and manipulated before integrated into the GIS. Those data include the dengue statistics, cases, area that are affected and the disease's mode of transmission.

Table 1: Example of Data Received from the Ministry of Health

MONTH	WEEK	NAME	CASE	AGE	RACE	NATIONALITY	OCCUPATION	HOUSE
JAN	1	MEOR AHMAD B MEOR	DD	51	M	Malaysia	Sendiri	2,828
JAN	2	SADASIVAM A/L APPAHOC	DD	61	I	Malaysia	Pengawal	0
JAN	2	RAJA A/L SURIA	DD	33	I	Malaysia	Sendiri	0
JAN	2	SAIFUL FADZLY	DD	2	M	Malaysia	Kilang	0
JAN	2	THURAIRAJA	DD	18	I	Malaysia	Pelajar SMT (18-19)	155,63
JAN	2	SUNDARI	DD	36	I	Malaysia	Penoreh getah	20
JAN	2	ZANARIA BT MOHAMED	DD	41	M	Malaysia	Surirumah	22
JAN	2	SAIFUL ANUAR	DD	15	M	Malaysia	Pelajar SMR (13-15)	229

Spatial data consist of housing area and topographic maps, stagnant water area as well as area of the dengue break out of Batu Gajah are fully utilized. Any relevant source that related to the disease area should be taken into account too. Transportation route of the study area are also essential to the project. It can be relate to the distance from an effected area to one another and the travel route of the mosquito via the transportation such as cars and bus. The data of the map are collected in AutoCAD type of file.

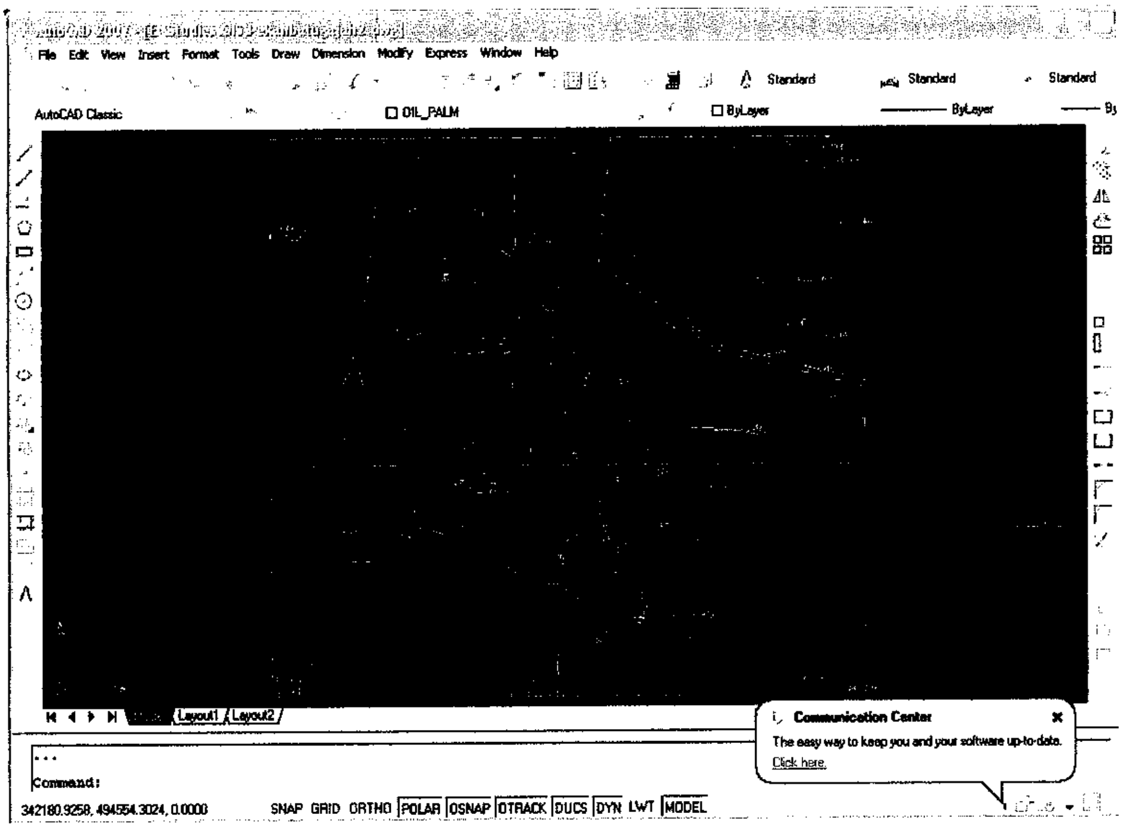

Figure 5: Batu Gajah in AutoCAD

3.2 Tools

In this research, some software is used to build up the data into spatial layers. Software used are:

1. **ArcGIS Professional 9.0**
2. **AutoCAD 2007**

ArcGIS Professional 9.0

ArcGIS presents a comprehensive set of geoprocessing tools that work with all the supported data formats, including geodatabase features. It also offers a completely new framework for working with these tools that enables to open them individually, combine them in a visual modeling environment, write scripts in standard scripting languages, and run the tools as commands in a command line window.

With this new geoprocessing environment, ArcGIS completes the transition of ESRI's geographic information system (GIS) tools to the desktop that began with the introduction of ArcGIS 8. ArcGIS 8.x provided a new framework for managing, sharing, mapping, and editing data, along with a comprehensive new data model—the geodatabase.

ArcGIS provides a variety of map display, viewing and editing capabilities. Dengue outbreak area can be viewed easily using this function. More of its capabilities including;

a) opening multiple tables at once
b) controlling individual layer properties like display and labeling
c) creating and modifying thematic maps
d) manipulating the Map window view
e) finding information associated with a map layer

AutoCAD 2007

AutoCAD is a CAD software application for 2D and 3D design and drafting, developed and sold by Autodesk, Inc. Initially released in late 1982, AutoCAD was one of the first CAD programs to run on personal computers, and notably the IBM PC. Most CAD software at the time ran on graphics terminals connected to mainframe computers or mini-computers. Original map was digitizing using the software and it has to be layered before transfer to the ArcGIS.

3.3 Methods

3.3.1 Storage and Analysis of Data and Information

- The development of GIS start with using a topography map

- Topography map was first digitized using AutoCAD software. Data regarding the road, communication ways, houses, district, and area name were transferred into AutoCAD.

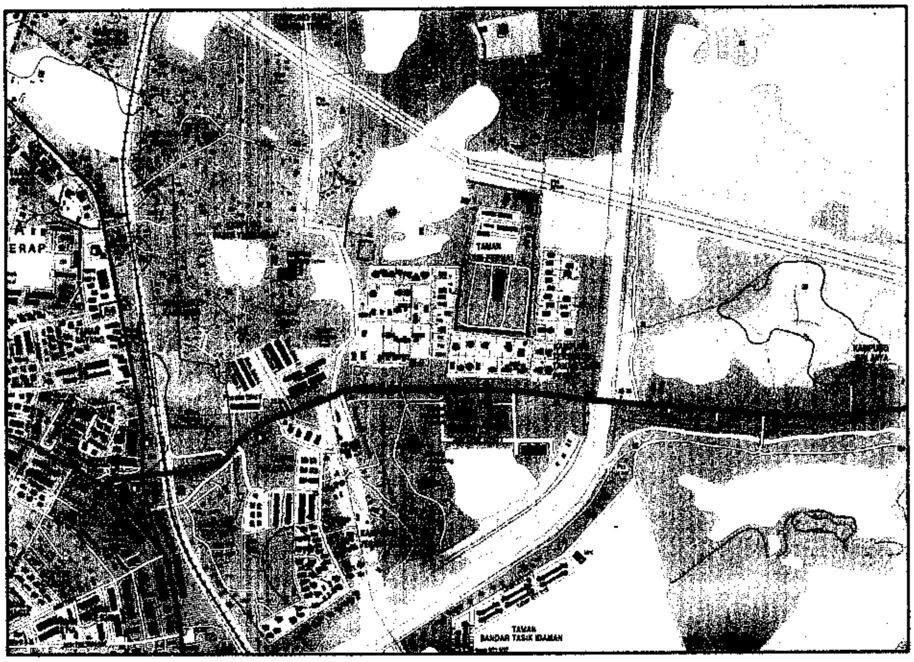

Figure 6: Topography Map

- Digital map in AutoCAD then was import into GIS using ArcGIS Professional 9.0.

- GIS has been built to store the data related to the study, including their geographical coordinates (latitude, longitude and sub-district code).

- Statistic and other type queries including spatial comparison are performed through GIS.

- Data referred to different domains: epidemiology, demography, land use, climate, sosio-economics information.

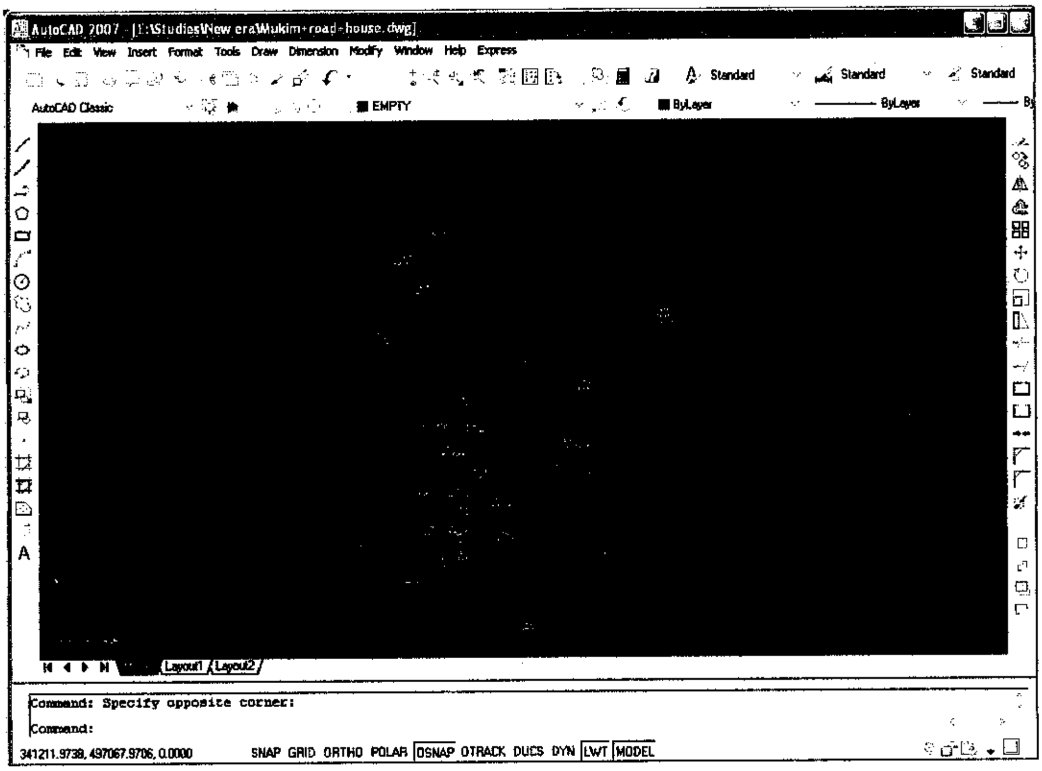

Figure 7: Digitizing the topography map using AutoCAD

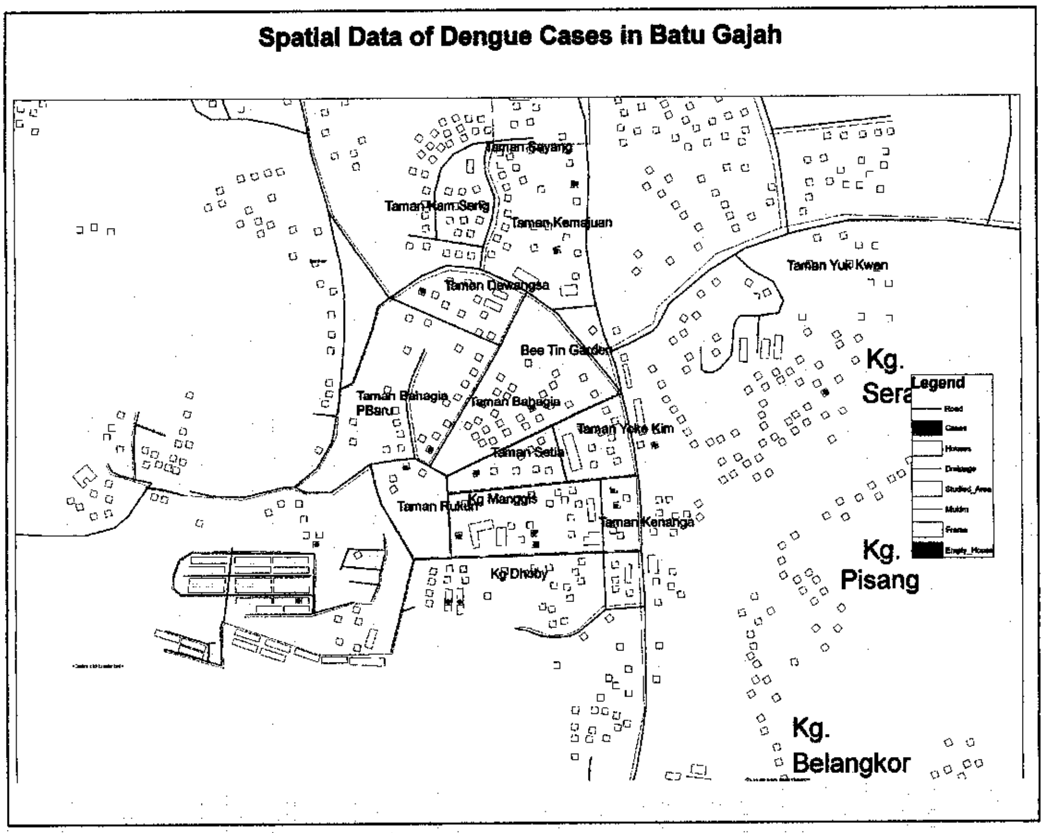

Figure 8: Transferring the AutoCAD map into GIS

- Road layers provide the author the information regarding distance between certain places on the map. It is useful in locating the patients in the area of study.

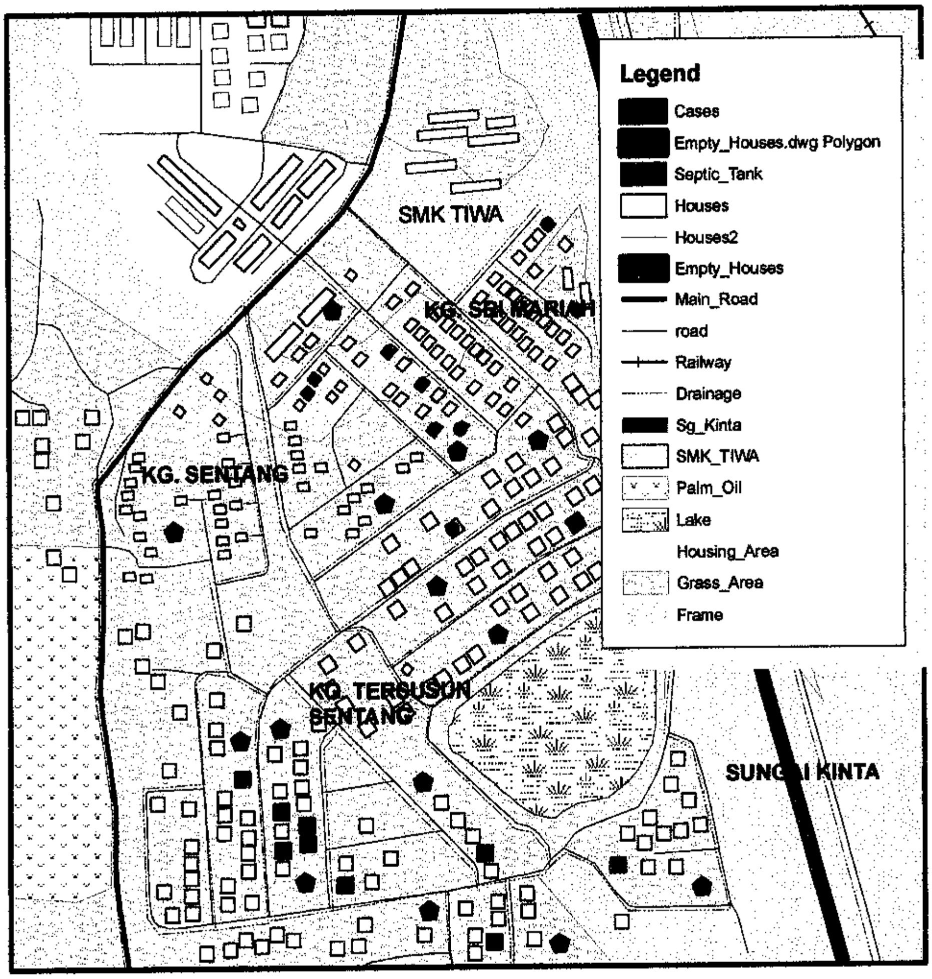

Figure 9 : GIS with layers as according to the legend

- Housing area layer are done via referring to the map. Drainage systems, septic tank and left-empty houses layers were created independently via site visit to the study area.

- Housing area will help in identify the patient's house and in the same time would show the pattern of the cases near the affected individual house.

- Drainage area layers are crucial to the research. Clog/ unmanaged drainage are always link to the increases of dengue cases

- Septic tank layers serve as one of hypothesis in the research. It was determine as one of the potential breeding area of the mosquitoes.

- Empty-left houses layer are also play role as one of the hypothesis. It is also determine as one the potential breeding area of the mosquitoes.

3.4 Database Development

In the early stage of Dengue Management System, all the data are not well managed into computers. Hardcopy are more popular. It is hard to determine the pattern of the disease and this result in less efficiency of dengue control.

A Geographical Information System (GIS) was established to develop a real-time Aedes mosquito control and monitoring system for spatial epidemiological study. With the use of GIS spatial data can be presented by detailed mapping and modeling. It gives a better understanding of the epidemic flow therefore control and prevention plan be implemented for instance The GIS monitors the network of ovitraps and other cases of dengue outbreaks to better understanding of the vector trends and disease patterns. Analysis is done on the ovitrap breeding data collected weekly to identify the hotspots and potential risk areas where there is a danger of high Aedes aegypti infestation.

The analysis results are used to plan vector surveillance and control operations. A better identification of area at risk will substantially help in finding the best method to control any future dengue outbreak. GIS is being introduced into the dengue management system mainly to increase awareness of GIS technology in the public health sector.

With the assistant of GIS, all data are well-managed and it is easier to do some analysis on the pattern and possibility of next affected area.

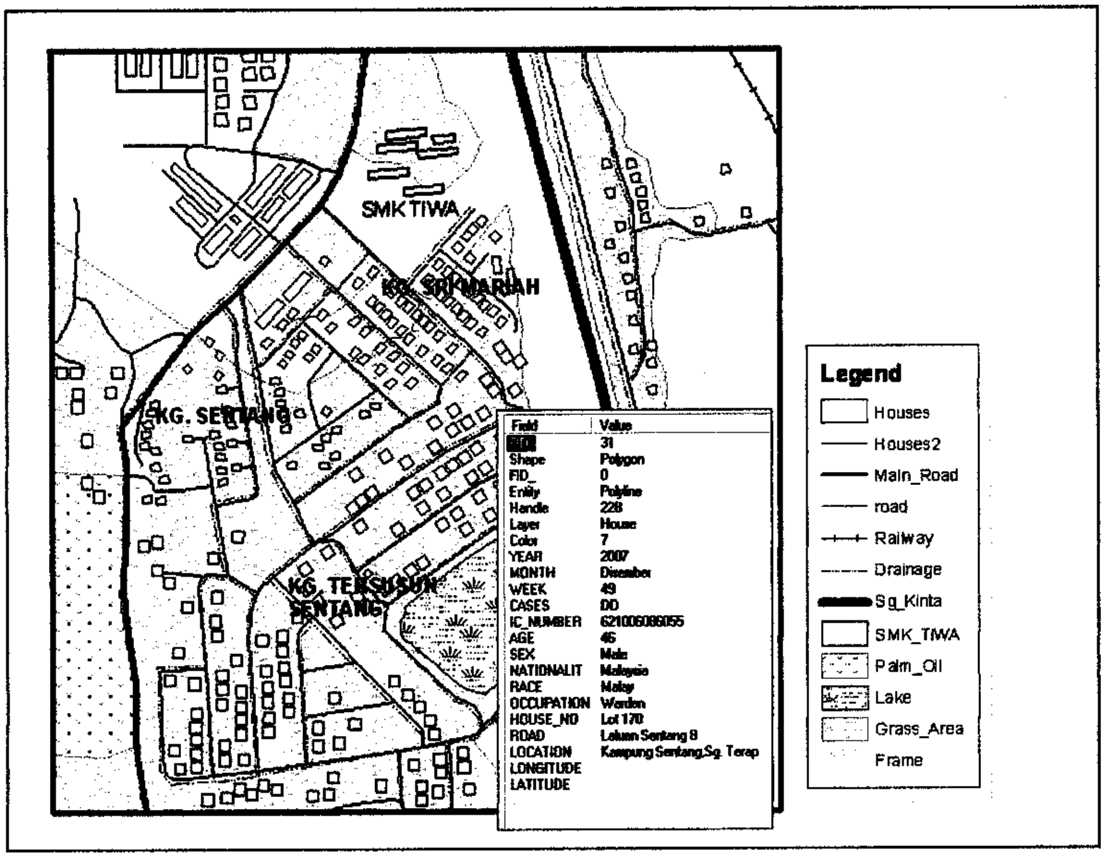

Figure 10: Patients particulars are integrated into spatial layers

3.5 Health, Safety and Environment (HSE)

This project involves a long duration of time facing the workstation/computer. As far as the hazards are concern, there are some ergonomics precautions that are taken while doing the projects.

3.5.1 Computer/Workstation Ergonomics

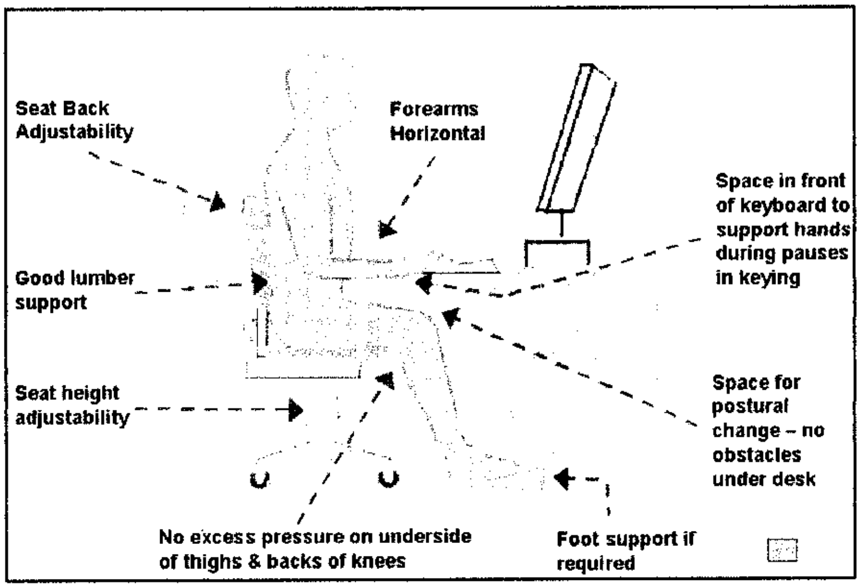

Figure 11: Workstation ergonomics

The work area should be large enough to accommodate user, allow the full range of motions involved in performing required tasks, and provide room for the equipment and materials that make up the workstation.

1. Use a headset for lengthy or frequent telephone work.
2. Place the items that are used most frequently directly in front of.
3. Avoid overcrowding computer work areas.

3.5.2 Desk/Workstation

Standard furniture cannot accommodate everyone's needs. A taller person may need a one-time adjustment to have his or her work surface raised somewhat; a shorter person may need a footrest or other accessories. Adjustable furniture may be needed in situations where people share or use the same workstation.

1. The desktop should be organized so that frequently used objects are close to the user to avoid excessive extended reaching.
2. The work surface should have a matte finish to minimize glare or reflections.
3. The area underneath the desk should always be clean/ uncluttered to accommodate the user's legs and allow for stretching.
4. If a fixed-height desk is used, keyboard tray that adjusts vertically is added to provide added adjustability.
5. A footrest should be used if, after adjusting the height of the chair, feet do not rest flat on the floor.
6. Headset or speaker phone is used to avoid neck and shoulder discomfort if the user uses a phone frequently throughout the day.
7. Phone are placed on the side of user's non-dominant hand (i.e., left side if right-handed, right side if left-handed)
8. Desk lamp is position so that it illuminates source documents without causing either glare on the computer screen or direct illumination to user's eyes.

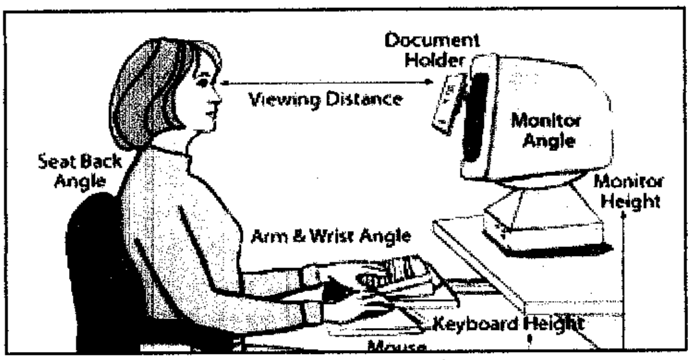

Figure 12: Best distant and position when using computer

9. A document holder should be used if documents are referred to during keying. The document holder should:

- Be stable and adjustable (height, position, distance, and angle of view).
- Support user's document on either side of the monitor.
- Be at the same distance from eyes as the display screen to avoid frequent changes of focus and user should be able to look from one to the other without moving your neck or back

CHAPTER 4
RESULT AND DISCUSSION

4.1 Findings

4.1.1 Dengue in Perak

A study by Ministry of Health Malaysia shows that the weekly rises of dengue cases are around the country. Amount of cases increased about 26.8% on the 28th week of year 2006 (9-15 July 2006) if it is compared to the same period last year. This country experiences a total of 867 cases where 816 of them are dengue fever (94.5%) and the remaining 48 cases are dengue hemorrhagic fever (5.5%). Until 15 July 2006, cumulative amount of dengue suspected cases is 18,484. It is less, compared to last year which s 21,011 cases. From that number, only 5460 cases were tested positive for dengue fever (29.5%).

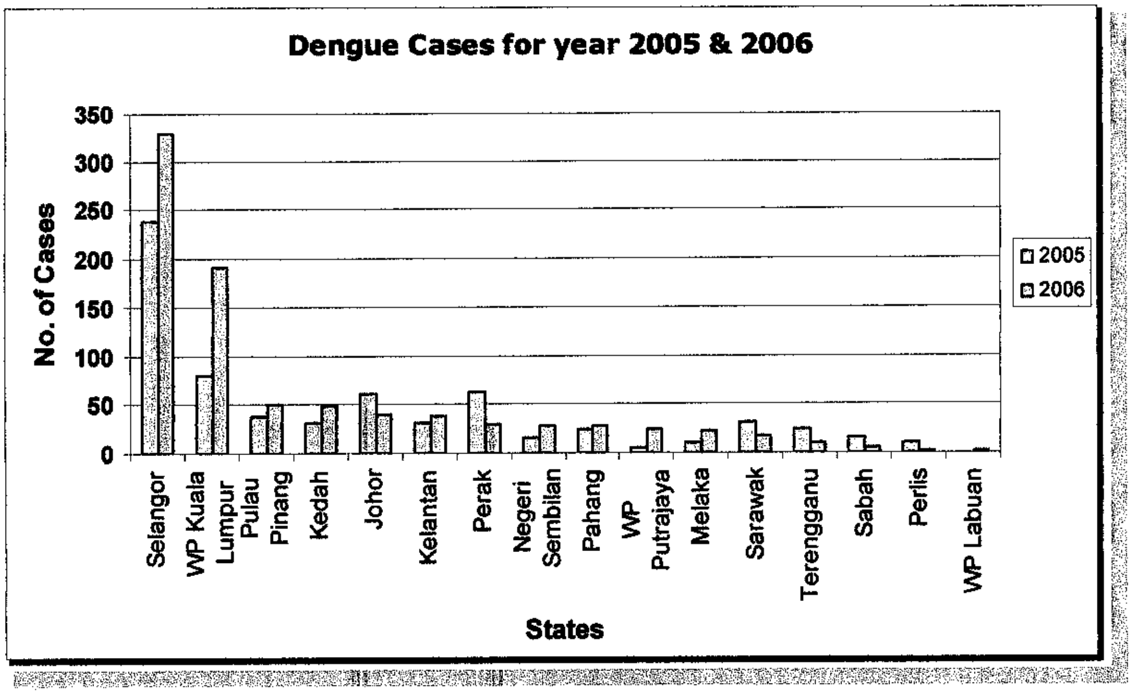

Figure 13 : Graph shows number of dengue cases in Malaysia in year 2005 and 2006

Selangor leads the highest dengue for the period of 9 – 15 July as per below:

i.	Selangor	5964 cases, 9 fatalities
ii.	Wilayah Persekutuan	3440 cases, 3 fatalities
iii.	Johor	1636 cases, 4 fatalities
iv.	Perak	1026 cases, 2 fatalities

As the numbers are keep on increasing in some countries, routine prevention procedure such as disease surveillance are needed. Perak are capable to be dengue a dengue endemic area if it is not carefully prevented. For this research, the author has chosen Batu Gajah as the study area as it is located in Perak.

4.1.2 The study area, Batu Gajah

Batu Gajah situated in Perak, Malaysia and coordinated at 4° 28' 0" North, 101° 3' 0" East, 24km from Perak state capital, Ipoh and its original name (with diacritics) is Batu Gajah..Batu Gajah was placed under district of Kinta with the highest numbers of people, 970,000 compare to the other place in Perak. It is popular with the industry of tin and has a lot of mining pool around the district. The climate of Batu Gajah is tropical with average temperature at 81f. The highest temperature recorded is 82F in May/Jun every year. Heavy rains come in November/December and the hot season come in Jun/July. Each year Batu Gajah receives average 2000 inches of rain.

With current population around 34,000 people, the town has the capability and potential to grow bigger. It has seen a lot of improvements recently in terms of housing areas, schools, roads and public facilities. Located near to two universities (UTP and UITM Seri Iskandar), Batu Gajah is an ideal place for population growth. Instead of recent improvements, Batu Gajah lack of proper drainage system. Drainage at the rural areas were very poor and not working properly especially during the rainy season. The problem got worse with the lack municipal maintenance. Stuck drain water (stagnant water) created an ideal place for aedes breeding site.

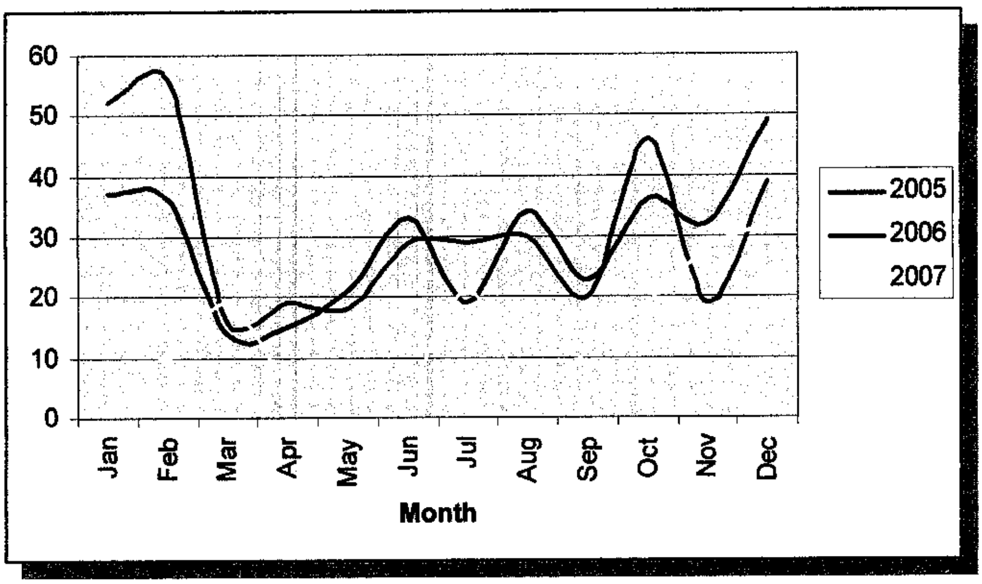

Figure 14: Graph of dengue Cases for Batu Gajah in 2005-2007

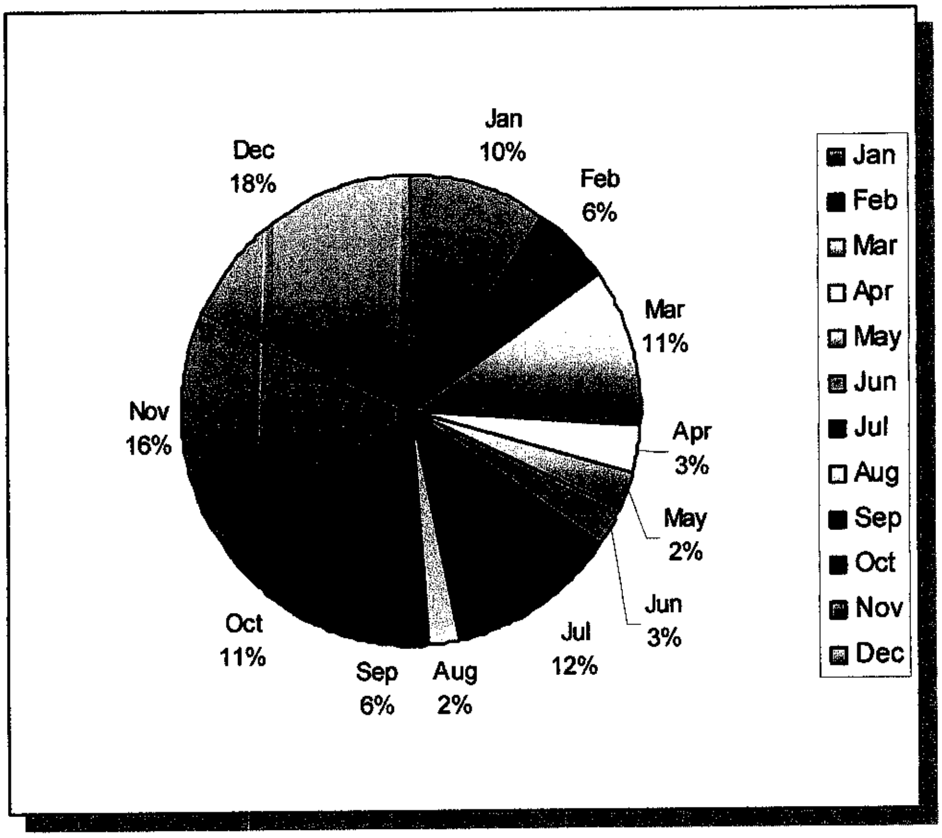

Figure 15: Graph of Dengue Cases for Batu Gajah in 2007

In year 2007, the highest cases reported took place in December. 32 cases involved with 18% of the dengue cases of the year. Record shows that the highest affected area located in Kampung Sentang and Kampung Sri Mariah, a residential area which contain both modern and traditional types of houses.

Two main patterns may describe the fluctuation of dengue incidence. The first pattern corresponded to the seasonal variations of transmission. From figure 9, the results showed that the disease start spreading and increasing in the end of the year to the earlier month of the coming year. The dengue transmission was observed to reach the peak during the hot and rainy season (November to March). It was the time when the dengue vectors are very active.

The second pattern corresponded to important rises in dengue epidemics. They were non-seasonal increases variable duration and separated by periods of lower incidence lasting 2 – 5 years. The pattern also matched the very basis of epidemic characterization (Philippe Barbazan, 1998).

4.2 Results and Discussion

Buffers of 400m diameter were created using ArcGIS software to relate between confirmed dengue cases and the contributing factors. The buffer refers to the distance traveled by mosquito from the breeding sites. Female Aedes aegypti can fly up to 400m during one feeding session. (Reiter, 1995)

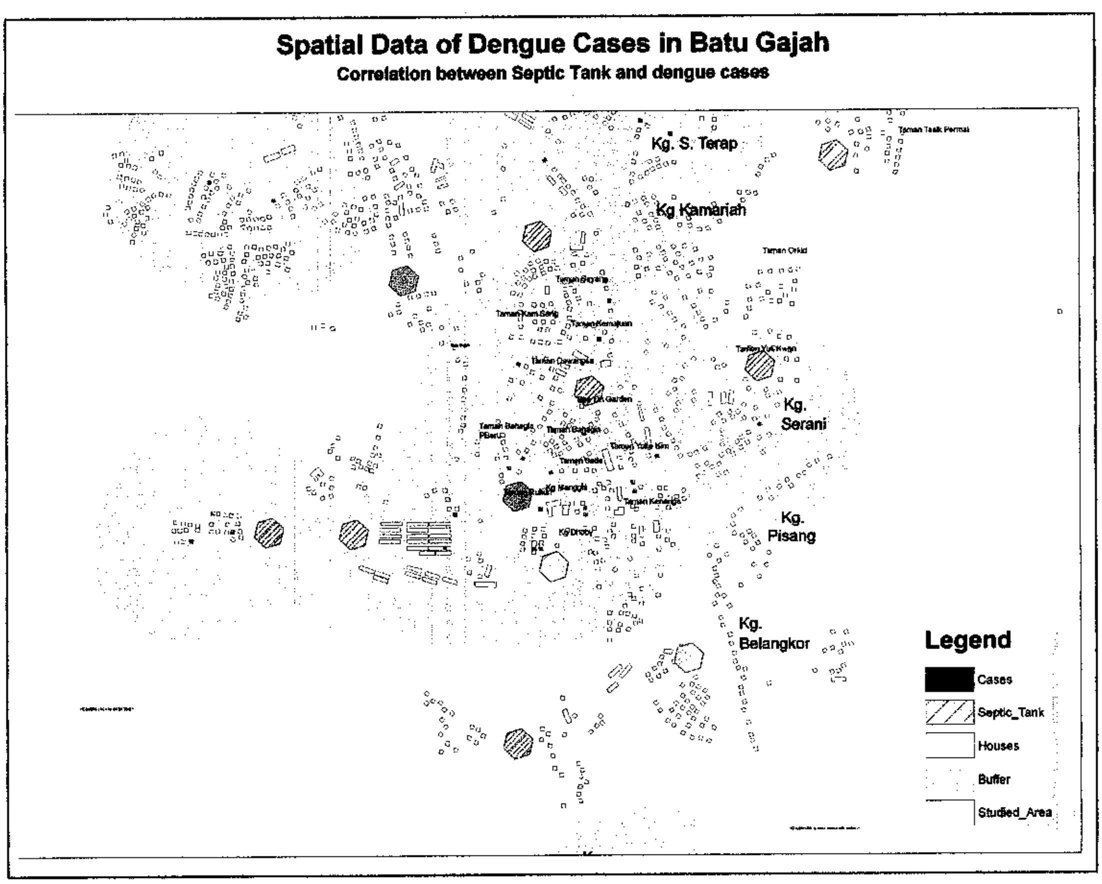

Figure 16 : Correlation between cases, septic tank and drainage with buffer within 400m from each case

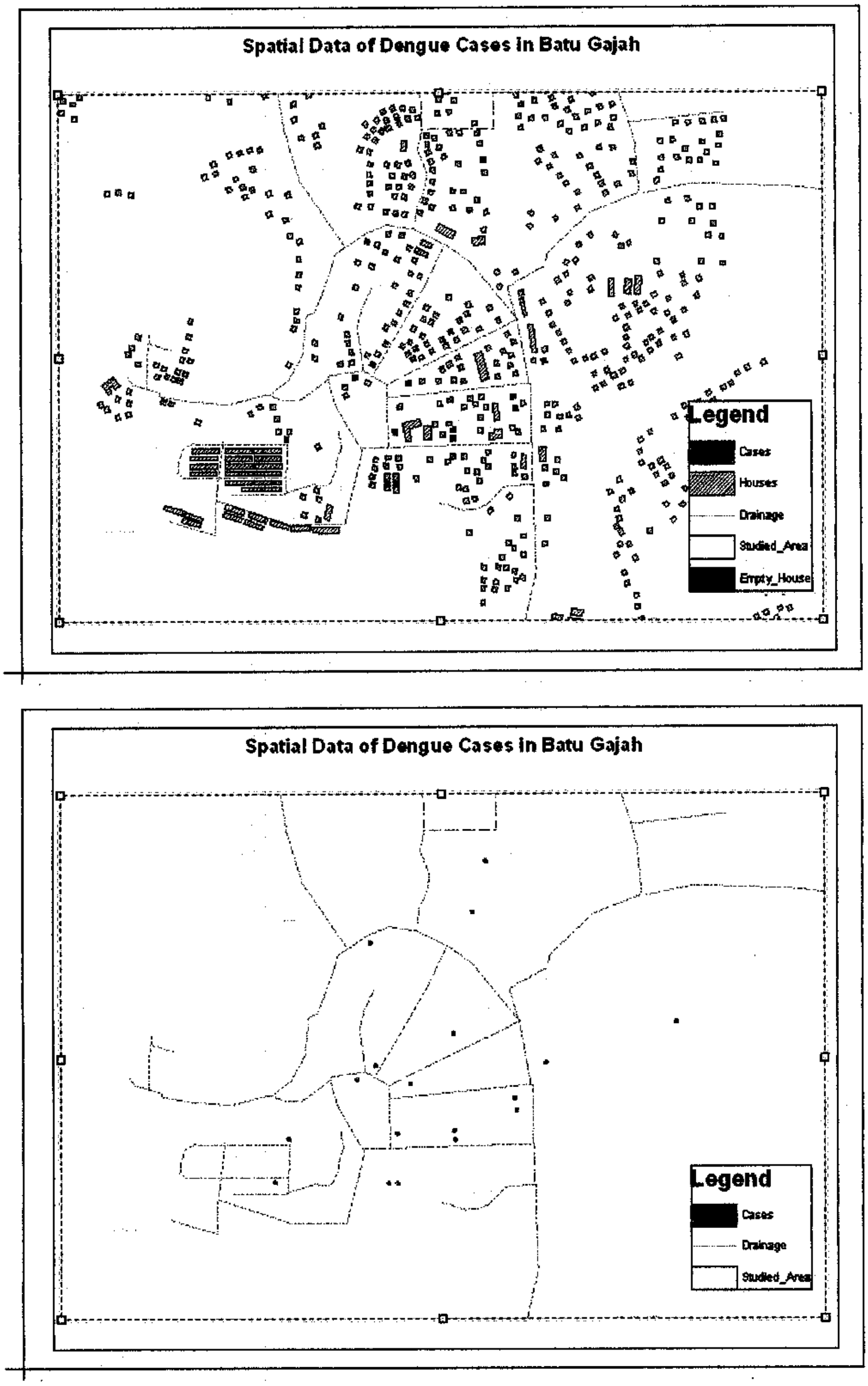

Figure 17: Correlation between drainage and cases

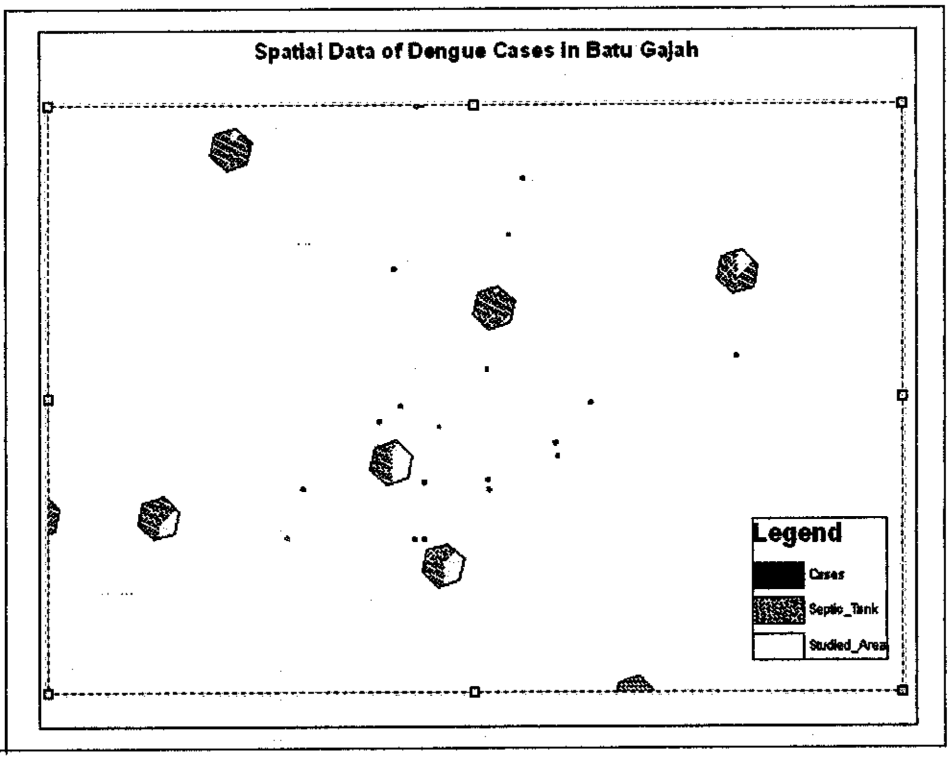

Figure 18: Correlation between septic tank and cases

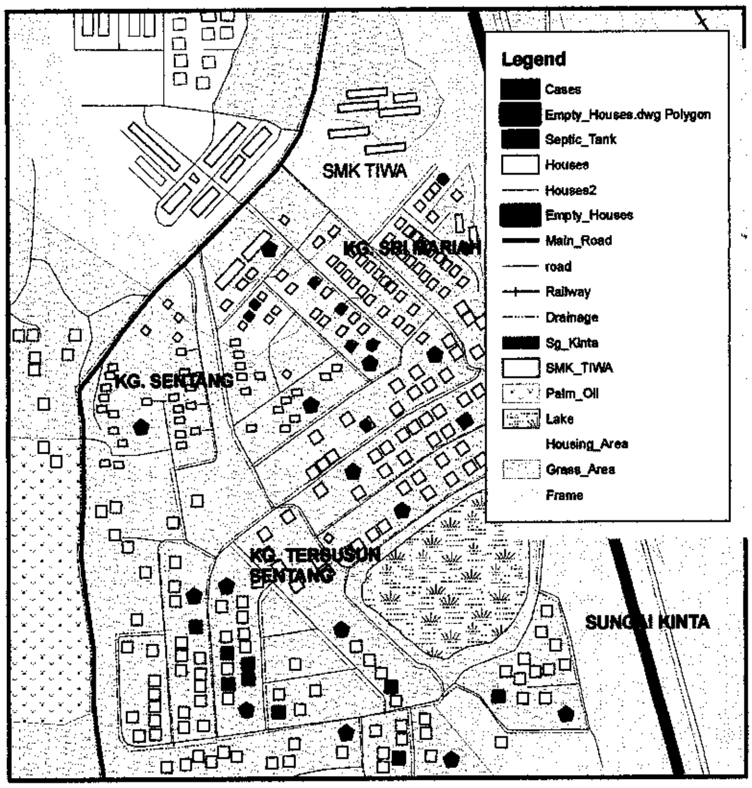

Figure 19 : Kampung Sentang; highest recorded cases in 2007

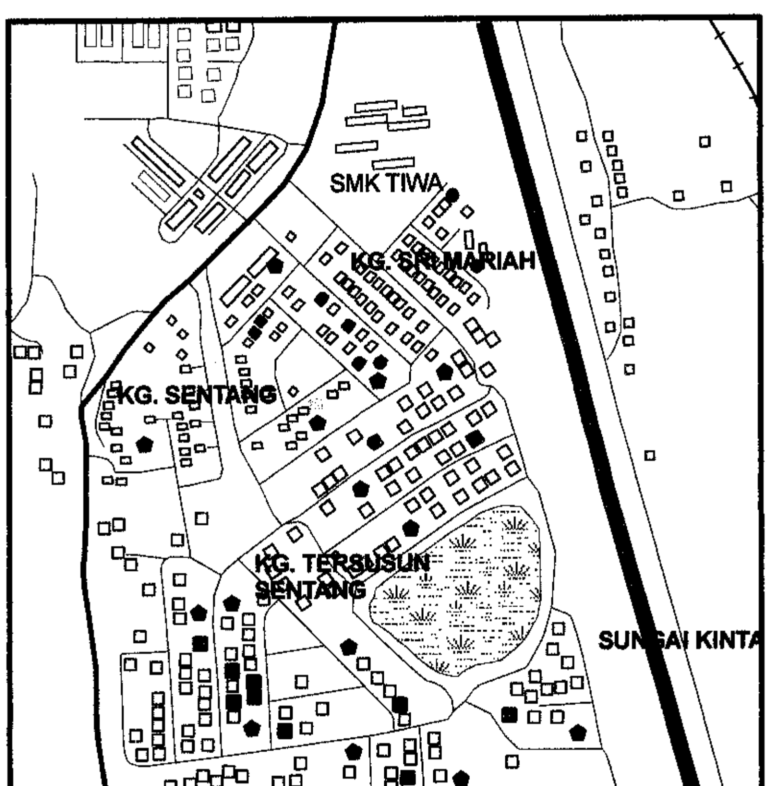

Figure 20 : Kampung sentang; Correlation between septic tank and cases.

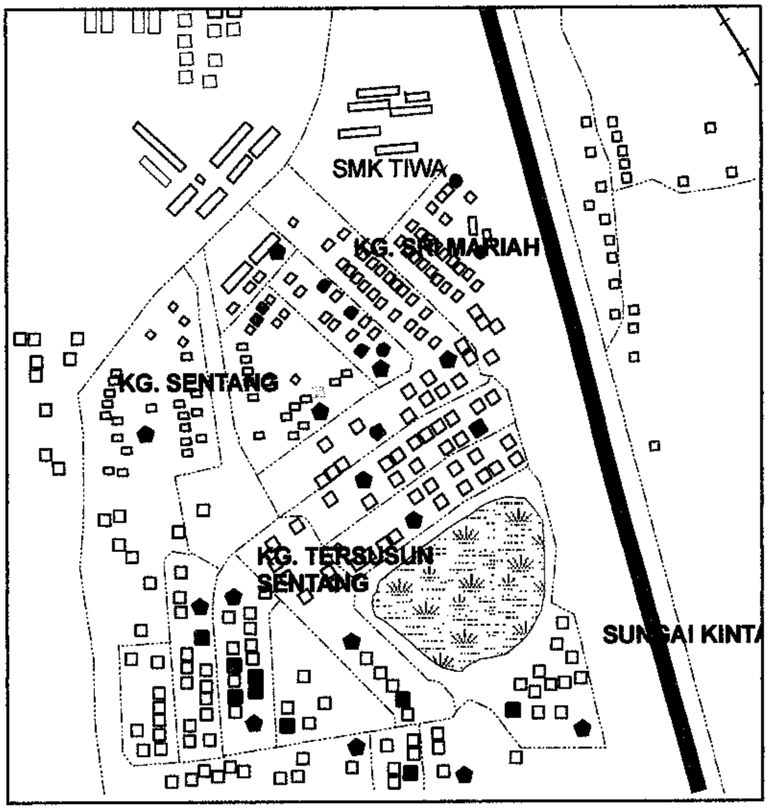

Figure 21 : Kampung Sentang; Correlation between septic tank, drainage and cases (Note: blue line is the drainage system; purple dot is the septic tank)

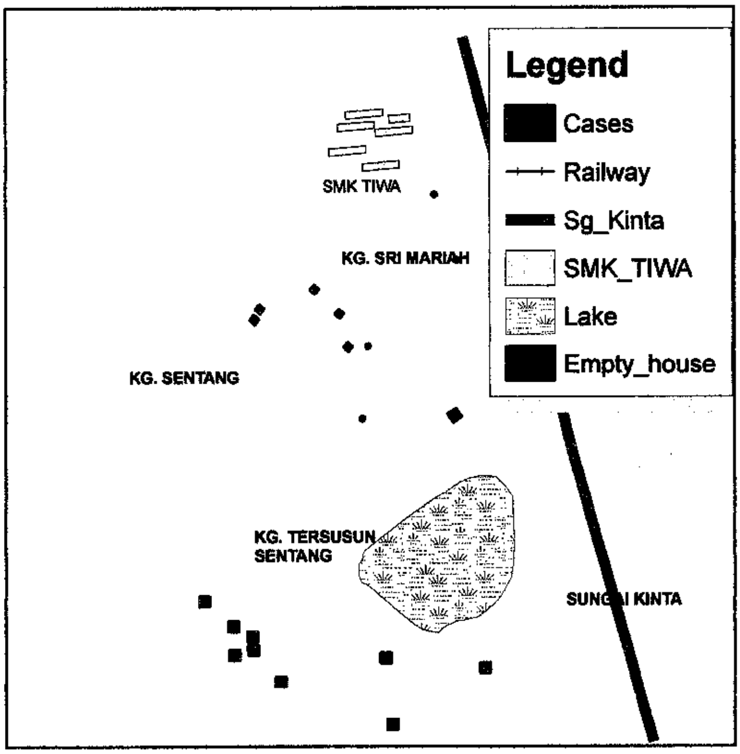

Figure 22 : Kampung Sentang; Correlation between empty-left houses with cases

As the objective to monitor the breeding area of the mosquito, three possible factors have been found as the breeding area. As shown in figure 15, they are the septic tank, clog/unmanaged drainage and empty-left house. Hypothetically a person that lives near unmanaged drainage system are facing a risk of being infected by dengue when epidemic struck. The person is possibly get bitten by the aedes aegypti during the hot and rainy season where most of the stuck drains are filled with water (Ideal place for aedes breeding sites). This could be related to the life-style of the communities in the area. Lack of awareness to cleanliness, and knowledge in the diseases, it lead to problems such as the clog drainage.

Figure 23: Clog/ Unmanaged drainage. Photos were taken from Taman Batu Gajah

Correlations between septic tanks and the increase of dengue cases in Batu Gajah were also found significant. The resident areas in Batu Gajah are found to use septic tank for their sludge holder. There is no sludge treatment plant (STP) in Batu Gajah.

Figure 24: Septic Tank

Referring to Figure 21, one more possible breeding area is found. Empty-left houses in Kampung Sentang and Kampung Sri Mariah were very suitable for the mosquito to breed as there are many objects that can contain the water as the mosquito's habitat. The bushes that are unmanaged, covering the houses were also helping in providing the mosquito a good area to breed.

Figure 25 : Empty-left house, one of the potential breeding areas for mosquitoes. Photo is taken from Kampung Sri Mariah

Batu Gajah residents were assumable to get infected by dengue if they live close to the main road. It is a route where people travel to work, schools and other places. High density of people, especially near the main road is a fine feeding place for mosquito. An Aedes aegypti capable of biting and infecting several people during one feeding session (Dengue Fever Management Plan for North Queensland, 2005).

These hypotheses are not an absolute solution to the contributing factor of dengue cases in Batu Gajah. The result maybe right depending on the data collected throughout the research. Further more, the research might have wrong result if there were dengue cases which was not reported to the hospitals or medical centers in that particular area. However it can be used to show how the pattern of dengue cases occurs during a study period

4.3 Dengue Outbreak Pattern

As the usage of GIS to determine the pattern of dengue cases in a specific period of dengue outbreak, this research implement the system in the study area to look onto the pattern of the disease. In the figure below (Figure 26, 27, 28), suspected cases and confirmed cases are located in the GIS layers. Confirmed cases are the cases that are list as dengue affected patient while suspected cases are patient that are having the symptom such as fever but still in the blood are test in the lab to confirm that they are affected.

In figure 26, there are several suspected cases and at least one confirmed cases reported during the first two week of the dengue outbreak. The cases were distributed far from each other and spatial cluster were not visible.

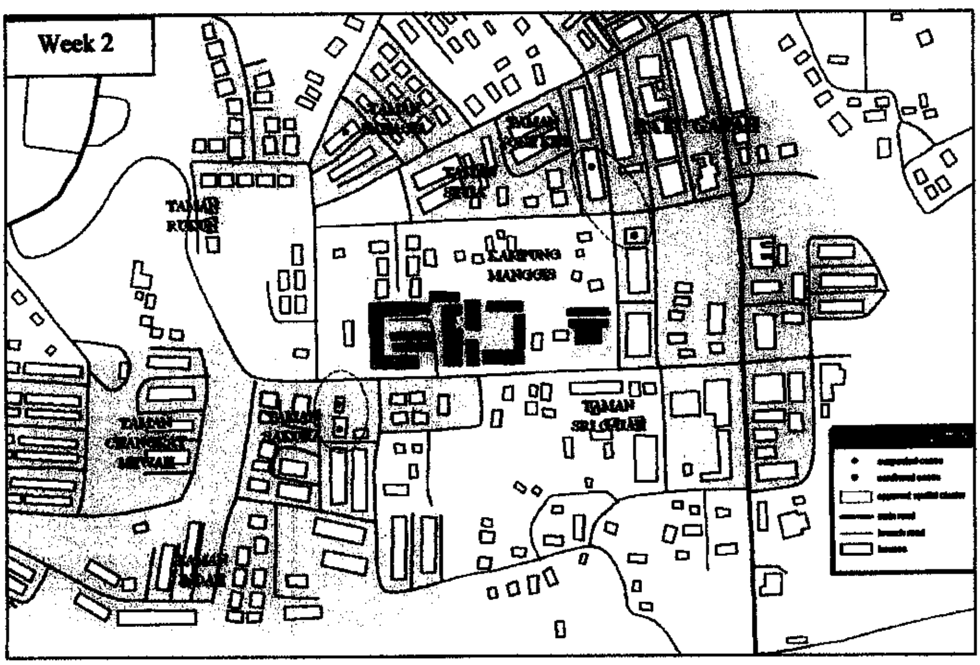

Figure 26 : Locations of dengue patient during period of dengue outbreak (Week 2)

In figure 27, more suspected and confirmed cases were reported at the end of fourth week. The newly reported cases occurred surrounding the previous cases in week 2. The cases were distributed close to each other and one or two spatial cluster were visible.

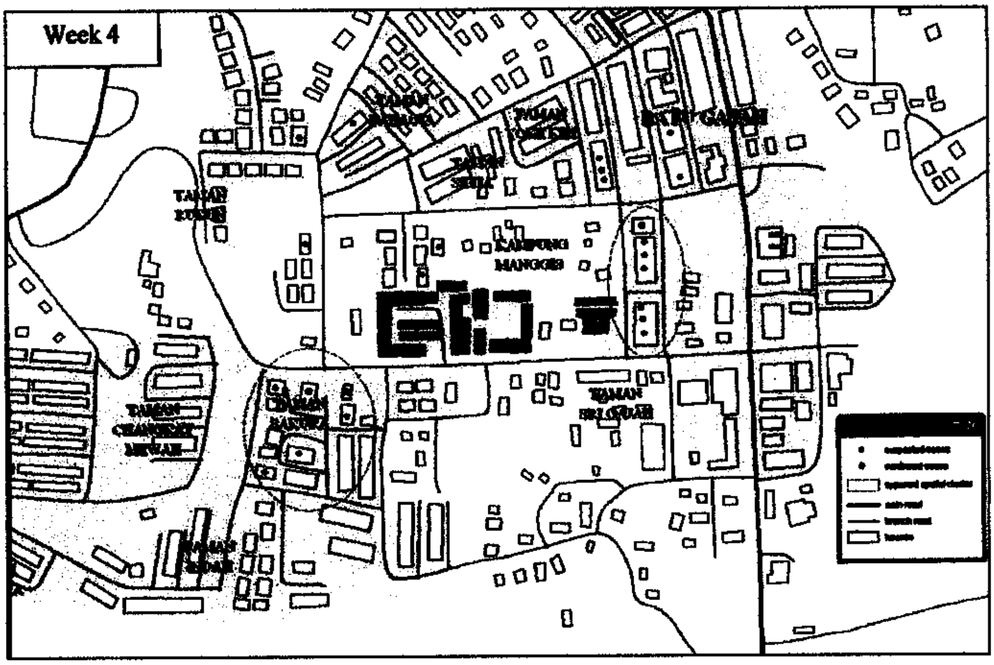

Figure 27 : Location of dengue patients during dengue outbreak period (Week 4)

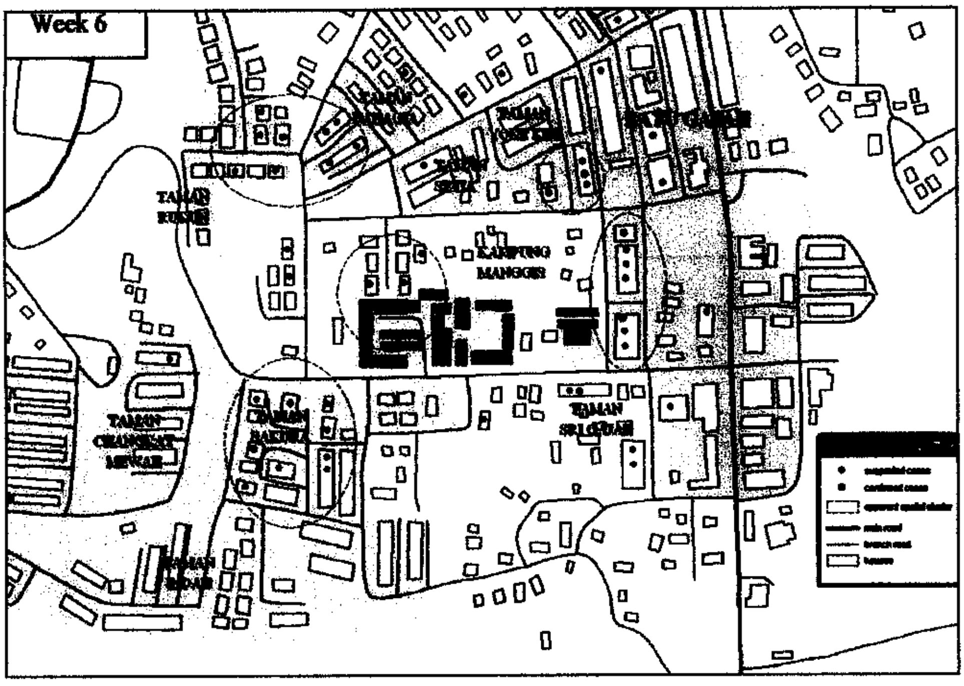

Figure 28 : Locations of dengue patients during dengue outbreak period (Week 6)

In Figure 28, suspected and confirmed cases reported are keep on increasing at the end of the forth week. The cases were spread evenly to the nearby housing areas. Many spatial clusters were visible.

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

GIS for dengue information management system will provide a better picture of spatial data regarding dengue epidemic. It will improve our understanding of the epidemic characteristics, patterns and the disease's mode of transmission. The existing dengue management system can be improved using GIS. Locating the possible breeding places of aedes aegypti is the most crucial aspect in this project because the first action in dengue management system starts from eliminating the source of the disease. Dengue epidemic in the study area can be control with careful planning and preparation. By finding out the history and characteristics of the dengue epidemic will give a better prospect about the research. Using problem modeling, hopefully the dengue management system can be improved and used for future reference.

The increases of cases in this country that are linked with poor diseases surveillance especially in aedes breeding areas is now could be improved. By developing an efficient database using GIS, dengue cases could now be located. The breeding ground that are found in the research; the septic tank, empty-left houses and clog/unmanaged drainage should now be taken care to control and prevent the dengue to spread.

As the conclusion, the objectives of the study were achieved by developing appropriate database of spatial and attribute data that contribute to dengue cases and population. By using GIS also, the duty to perform spatial analysis in order to establish contributing factors to dengue epidemic is succeed.

5.2 Recommendation

Geographic Information System (GIS) give a very wide application in analyzing the breeding area of the dengue whereas some studies and research on the dengue cases are conducted by integrating the possible breeding area; the septic tank, empty-left houses and clog/unmanaged drainage layers in the GIS application.

In the future, further study can be done in details about the relation of the dengue cases with the amount of rain falls in the study area. With this correlation, we could determine specifically the time range that recorded high cases so that every year, we could give a special attention to the specific time.

As recommendations to the department of Civil Engineering, the department can allocate new version of GIS software so that the student can implements many extension of GIS software for details analysis.

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APPENDICES

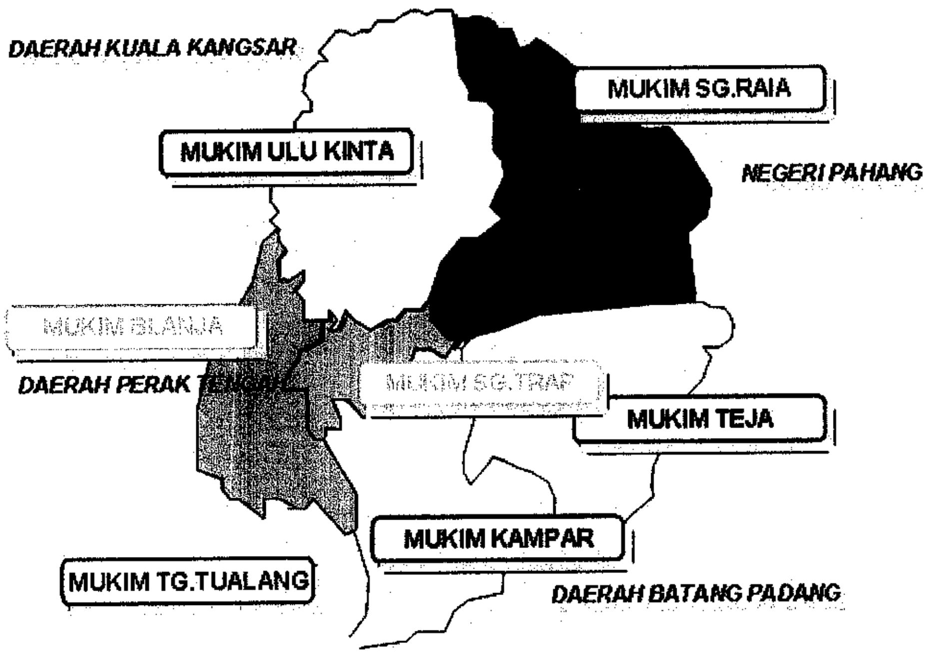

Figure 1: District of Kinta

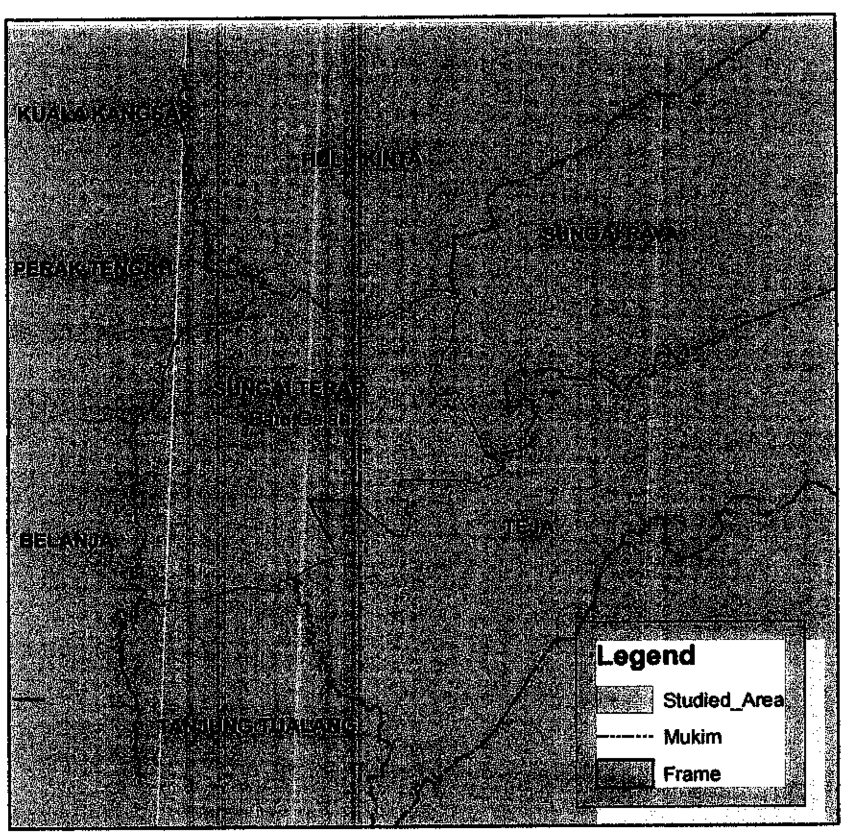

Figure 2: GIS of Kinta

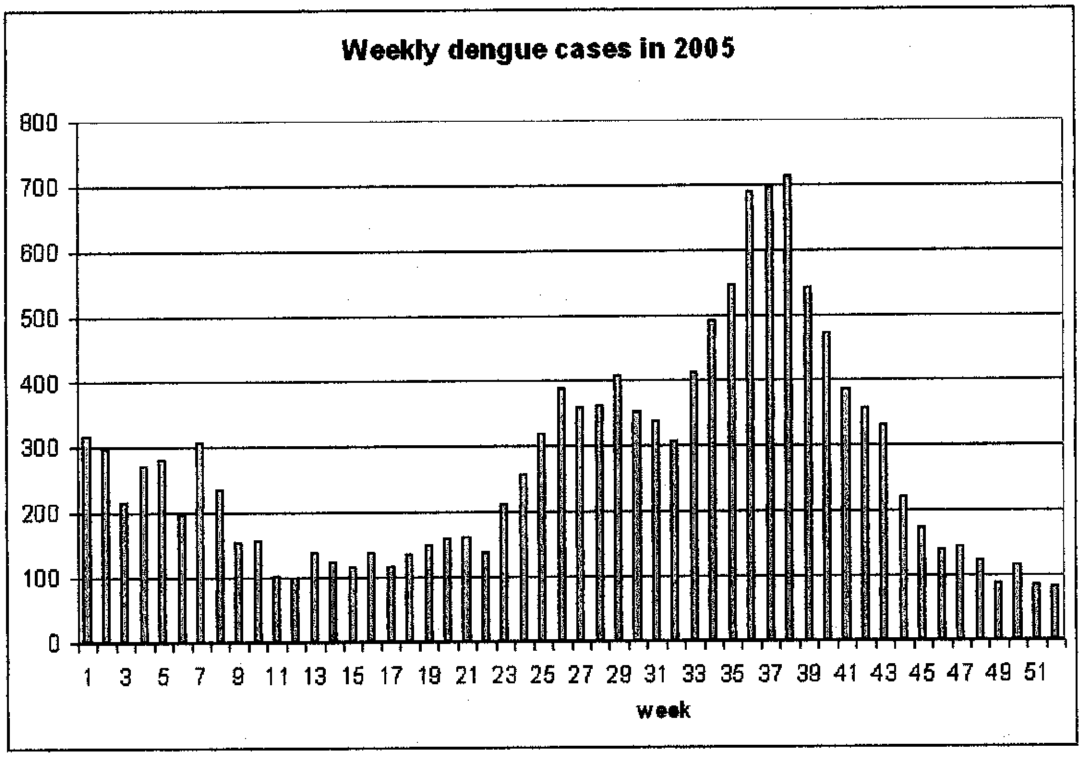

Figure 29 : 2005 Dengue cases in Singapore

BAHAGIAN HIDROLOGI DAN SUMBER AIR	**DOKUMEN KUALITI**	NO. KELUARAN : 1
		NO. PINDAAN : 0
	BORANG PEMBEKALAN DATA HIDROLOGI OLEH JABATAN PENGAIRAN DAN SALIRAN UNTUK PROJEK KERAJAAN / PENYELIDIKAN	TARIKH KUATKUASA : 01/07/06
BHSA-DK-DI.1		MUKA SURAT : 1 drpd. 1

FORM DI.1

1. NAMA PEMOHON (*Name of Applicant*) : ....

2. No. Kad Pengenalan (*I. C No.*) : ....

3. JAWATAN RASMI (*Official Designation*) : ....

4. ALAMAT RASMI (*Official Address*) : ....

   ....

5. NO. TELEFON DAN E-MEL (*Telephone No. and E-mail Address*) : ....

6. NAMA PROJEK (*Name of Project*) : ....

7. LOKASI PROJEK (*Location of Project*) : ....

8. BUTIRAN DATA YG .DI PERLUKAN (*Details of Data Required*) :

Jenis dan Unit Data yg. Diperlukan/*Type and Units of Data Required*	No. Stesen atau Nama Stesen/*Station No. or Name of Station*	Tempoh Data yang diperlukan/*Period of Data Required*	Kegunaan Data/ *Proposed Use Of Data*

In the event of the above hydrological data being supplied by the Department of Irrigation and Drainage, I/we agree to comply with the following conditions:

(a) *that the data shall not be utilized for other project or study unless fresh application has been made to the D.I.D.*

(b) *that acknowledgement for the use of the data obtained from the D.I.D. will be suitably made in any report, paper or publication in which such data have been quoted or utilized and a copy of such report, paper on publication be extended to D.I.D. free of charge, on ....*

(c) *that all application and receipt of any data must be through the Data Information Unit, Hydrology and Water Resources Division.*

(d) *that the data shall be ready for collection within one week from the date of application. In the event that such an arrangement cannot be met, the applicant will be notified through telephone or E-mail for a new date of collection.*

(e) *that the applicant shall collect the data within three months from the date of application. The applicant shall then be requested to make a fresh application there after.*

.... (*Date of Application*)

.... (*Signature of Applicant*)

Figure 3: Form from Jabatan Pengairan dan Saliran