CERTIFICATION OF APPROVAL

Geographical Information System (GIS) for Dengue Management System

by

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ABSTRACT

Geographic Information System (GIS) is one of the powerful tools in public health research. It has been used widely used in disease surveillance and monitoring, identification of high risk area and population at risk. This research will utilize the spatial analytical tools in GIS to establish the relationship between dengue fever cases and factors that contribute to transmission of dengue. It will provide aid to the dengue management system from the aspect of surveillance and investigation where the conventional method of health mapping and analysis can be improved. 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. GIS is being introduced into the dengue management system mainly to increase awareness of GIS technology in the public health sector.

ACKNOWLEDGEMENT

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

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CHAPTER 1
INTRODUCTION

1.1 Background of Study

Dengue fever is an infection caused by a virus in the family Flaviviridae. In terms of morbidity, mortality and economic costs, dengue fever is the most important mosquito-borne viral disease of humans. Aedes aegypti is the principal mosquito vector of dengue. A person living in a dengue endemic area could theoretically have as many as four dengue infections during his or her lifetime. Infection with the dengue virus may be subclinical (asymptomatic) or may cause illness ranging from a mild fever to a severe, even fatal condition, ie. dengue haemorrhagic fever (DHF) or dengue shock syndrome (DSS). Typical dengue fever symptoms include: sudden onset of fever (lasting three to seven days), intense headache (especially behind the eyes), muscle and joint pain (ankles, knees and elbows), pain, loss of appetite, vomiting and diarrhoea, skin rash, minor bleeding (nose or gums) and extreme fatigue. DHF manifests as severe bleeding and can be fatal, particularly among young children. There is no medical cure for dengue and no vaccine to provide immunity.

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 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 relationships, 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 and 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)

1.2 Problem Statement

Dengue occurs in over 75 countries worldwide and if found primarily in urban settings in the tropics. Each year, between 50 to 100 million dengue cases reported around the world. Over 2.5 billion people are at risk of dengue infection. Some of the cases results in dengue hemorrhagic fever (DHF) with average fatality rate of 5% (Gubler 1997).

In Malaysia, dengue has reached epidemic threshold and the full extent still remains to be seen. The dreaded 1,000 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 increase of dengue cases in this country have been linked with poor disease 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 databases are not linked to the available spatial data (e.g. housing area, septic tank distribution, and distance to the nearest health center).

This research will attempt to find correlation between these various contributing factors of dengue cases using GIS technique. GIS will improve the dengue management system in terms of data mining, saving, processing as well as analyzing. Theoretically the spatial data and attribute data can be combined by using data visualization method provided in GIS therefore helps in reducing the dengue epidemic in this country.

1.3 Objective and Scope of Study

1.3.1 Objective

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

1.3.2 Scope of Study

The study on dengue management system is to be completed within the time frame given which is approximately 13 weeks. In order to achieve that goal, the author has to do some research, work planning, and interview. Resources regarding dengue cases and the epidemic flow are available in Batu Gajah and Ipoh Hospital.

Author has to use the GIS software such as MapInfo Professional 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.

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 serotypes 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 serotypes 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.

2.2 Dengue in Malaysia

The earliest report of a dengue epidemic in Malaysian Peninsular is the 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 1965 from Penang. Notification of DF and DHF was instituted in 1971, any case of confirmed or suspected dengue or dengue hemorrhagic fever must be reported to the nearest medical centre. Since 1994, The National Dengue Control Programme has led disease surveillance, vector control, health education, community participation programmes and research. Space spraying (fogging) is systematically applied in areas where cases are increasing above usual levels and in 'hotspots' at the beginning of the season.

2.3 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 the disease. Roles played by these agencies 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

2.4 Disease Surveillance

Disease surveillance is the first defence 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 disease to other places.

2.5 Mosquito surveillance and control

Mosquito surveillance and control plays an important preventive role during non-outbreak periods. It is used to monitor mosquito 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.

Elimination of mosquito involves yard-to-yard inspections. This is a collaborative effort between local government and community councils. The methods used in mosquito elimination involve removal or treatment of containers that can potentially breed larvae and pupae; and discreet interior spraying to kill adult mosquitoes.

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

2.6 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 role in eliminating mosquito breeding at home and protecting themselves from dengue.

Education programs utilise public relations, advertising, promotional materials (brochures, posters), training sessions and information sheets. Programs are either targeted at the general community or specific community settings such as schools, work sites and traveller hostels.

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

2.7 Application of GIS in Dengue Management System

GIS has become one of the 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 linking spatial data with the ordinary mapping tools etc. In dengue management system, it enables researchers to:

- Strengthen dengue outbreak control measures

- Identify population at risk
  - ✓ People lives near the dengue outbreak has high potential of being bitten by an aedes aegypti

- Identify the pattern of dengue outbreak

- Maps depicting area of responsibility
  - ✓ Fogging and larvae control should be conducted within 200-400m radius of the dengue case. A female aedes can fly up to 400m (Muir and Kay, 1998)

Correlation between dengue cases and its causes can be linked and investigated by the use of GIS. Data obtained can be recalled faster and multiple scenarios in planning can be performed easily. The trend of dengue epidemic therefore can be recognized and prevented if possible.

CHAPTER 3
METHODOLOGY

3.1 DATA

3.1.1 Data Collection

- Dengue epidemic data from medical centres, hospitals and the internet are collected and manipulated before integrated into the GIS. Those data include dengue statistics, laboratory results, rate of recurrence, and the disease's mode of transmission. Most of the data are provided by Ministry of Health in their website and pamphlets for reference. By gathering all information about dengue epidemiology, summary can be made on how to start the management plan.

- Spatial data consists of housing area and topographic maps, stagnant water areas as well as area of the dengue breakout 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 very essential to the project. It shows the distance from dengue outbreak area to the nearest medical centre where infected patient can be treated immediately.

- Information from interviews will be used if found useful to the research. Health officers or personnel from Disease Control Division, Ministry of Health Malaysia can be contacted via email or telephone. Any news or findings from them are crucial to the research.

3.2 TOOLS

3.2.1 Hardware

- Minimum specifications of computer facilities need to be prepared by author in order to run the software, preparing reports and accessing data

3.2.2 Relevant Software

- MapInfo Professional 7.0
- ArcView GIS Version 3.1

MapInfo Professional 7.0

- **MapInfo** has the capability to turn data from word processors and spreadsheets into 'mini-MapInfo' program. A map can be created and edited for presentation or reporting purposes.

- **Object Linking and Embedding (OLE)** is a process of server application (such as MapInfo) provides information that is stored in a client application that can accept OLE information (such as a word processor). Any kind of map can be embedded in any application that accepts OLE objects.

- **MapInfo Map** 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

3.3 METHODS

3.3.1 Storage and Analysis of data and information

- GIS has been built to store the data related to the study, including their geographical coordinates (latitude, longitude and sub-district code).
- Statistics and other type of queries including spatial comparison are performed through the GIS.
- Data refer to different domains: epidemiology, demography, land use, climate, socio-economic information (water network, types of roads)

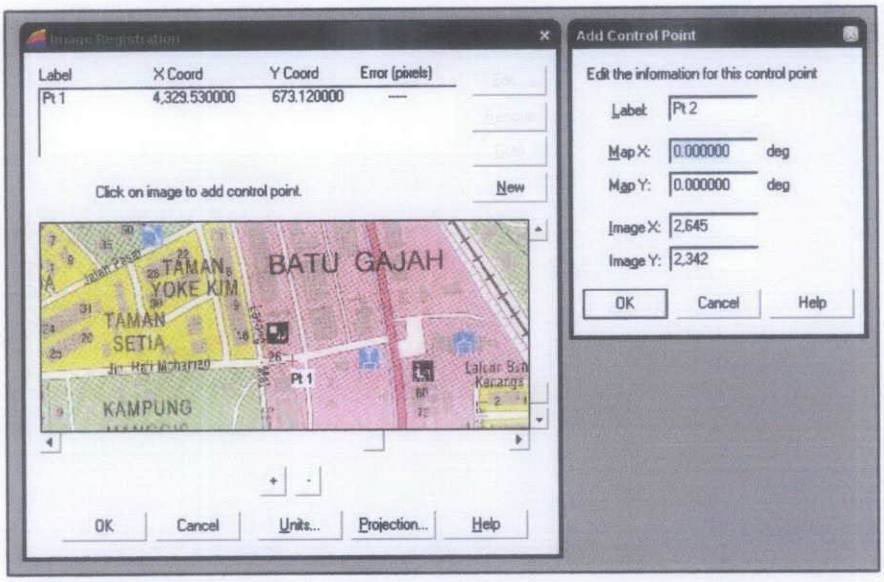

Figure 1: Digitalize the map. Adding layer for road and branch road

- Registration of raster image requires the author to enter the coordinate of certain landmarks on the map.

- **Coordinate** of the study area plays an important role in the research. It can help the author to identify the distance of certain area of study and provide the exact location of suspected/confirmed cases of dengue.

Figure 2: Digitalize the map. Adding layer for road and branch road

- All roads (main and branch) on the map were traced and labeled using MapInfo software.

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

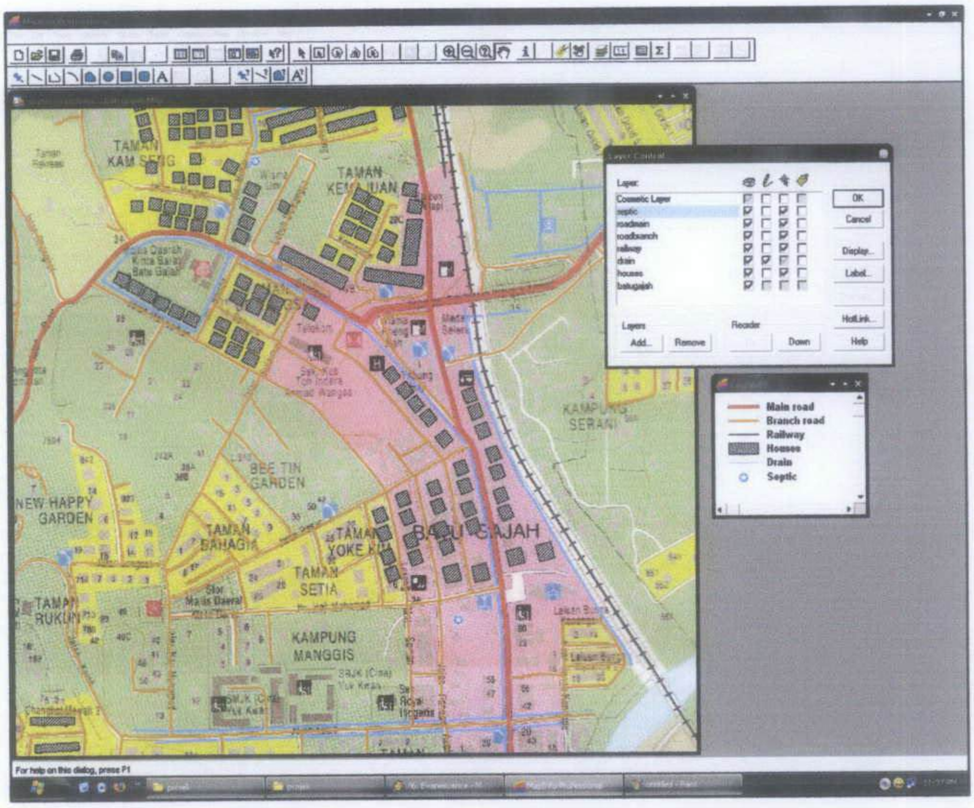

Figure 3: Layer for drainage, houses and septic tanks

- Drainage systems, housing areas and septic tanks layers were created independently.
- **Drainage systems** layers are crucial to the research. Stuck drain (stagnant water) always been linked to increase of aedes breeding sites.
- **Housing area** layers will help the author to identify the patients house directly and make investigation at patients home surrounding
- **Septic tank** layers serves as hypothesis tool in the research. The author tries to determine whether septic tank is one of the aedes breeding sites.

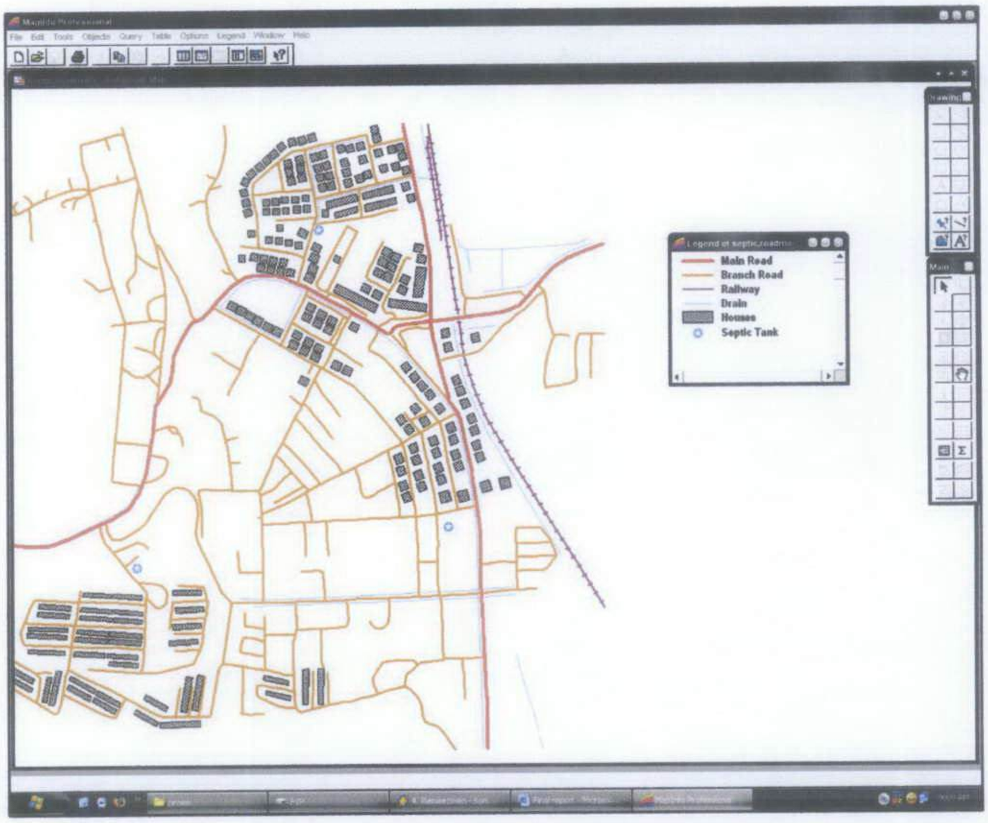

Figure 4: All layers loaded with legend

- Legends for the map were created after all layers has been completed

- By combining all the layers, transmission of the disease can be observed and analysis of dengue incidence fluctuation at the study area can be conducted.

3.3.2 Database Development

A Geographic Information System (GIS) was established to develop a real-time *Aedes* mosquito control and monitoring system for spatial epidemiological study. The GIS monitors the network of ovitraps and other cases of dengue outbreaks to better understand vector trends and disease 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. A better identification of area at risk will substantially help in finding the best method to control any future dengue outbreak.

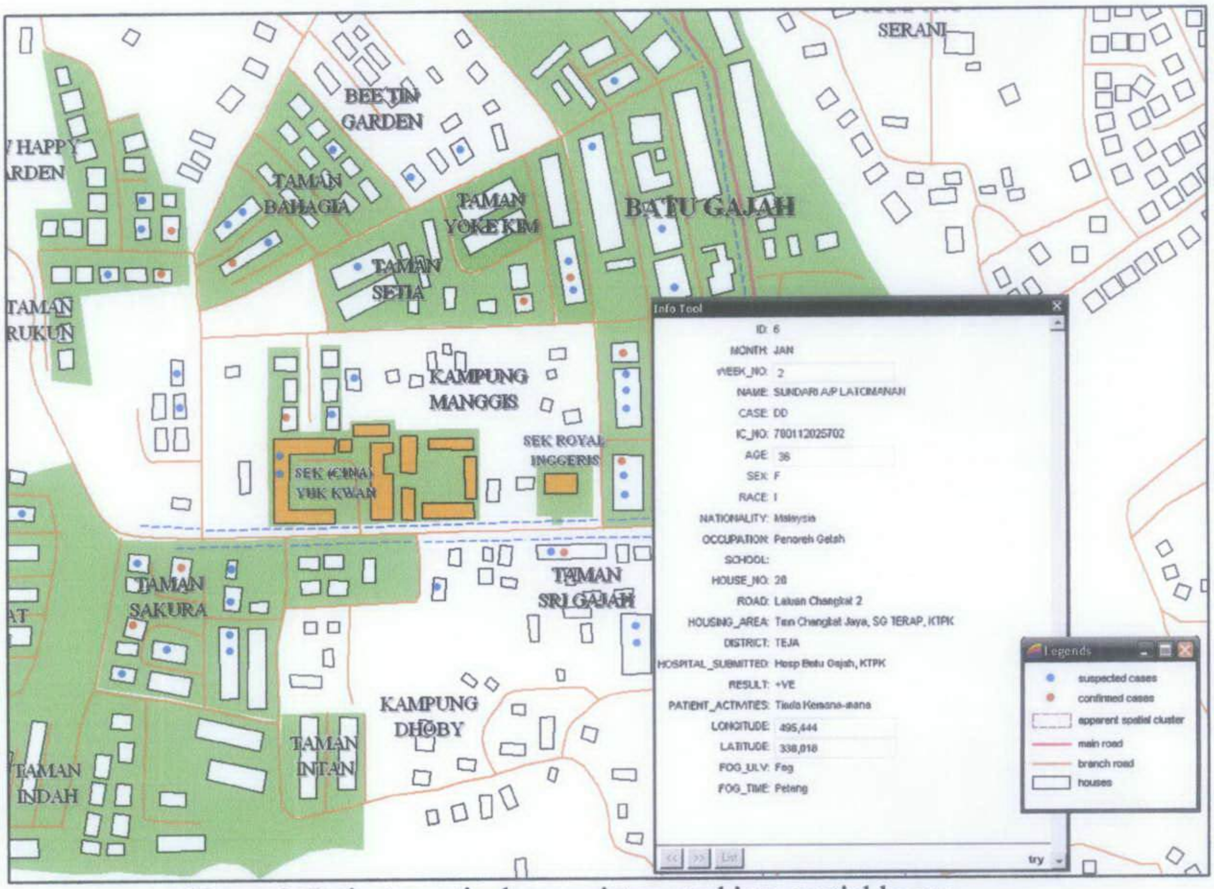

Figure 5: Patients particulars are integrated into spatial layers

CHAPTER 4

RESULT AND DISCUSSION

4.1 FINDINGS

4.1.1 Dengue in Perak

Table 1: Comparison of Dengue Cases for 28th week with the same period last year (9/7/2006 – 15/7/2006) (Ministry of Health Malaysia, 2006)

No	State	2005		2006	
1	Selangor	238	34.8%	329	37.9%
2	WP Kuala Lumpur	80	11.7%	192	22.1%
3	Pulau Pinang	39	5.7%	51	5.9%
4	Kedah	32	4.7%	49	5.7%
5	Johor	61	8.9%	40	4.6%
6	Kelantan	31	4.5%	39	4.5%
7	Perak	63	9.2%	29	3.3%
8	Negeri Sembilan	15	2.2%	28	3.2%
9	Pahang	25	3.7%	28	3.2%
10	WP Putrajaya	6	0.9%	24	2.8%
11	Melaka	10	1.5%	22	2.5%
12	Sarawak	32	4.7%	18	2.1%
13	Terengganu	25	3.7%	11	1.3%
14	Sabah	16	2.3%	5	0.6%
15	Perlis	11	1.6%	1	0.1%
16	WP Labuan	0	0.0%	1	0.1%
Total		**684**	**100%**	**867**	**100%**

A study by Ministry of Health Malaysia shows that the weekly rise of dengue cases around the country. Amount of cases increase about 26.8% on the 28^{th} week of this year (9 – 15 July 2006) if compared to the same period last year. This country experiences a total of 867 notified cases where 819 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 if compared to the same period last year which is 21,011 cases. From that amount, only 5460 cases were tested positive for dengue fever (29.5%).

Cumulative fatality rate recorded is 35 cases if compared to the same period last year which is 54 cases. Selangor leads the highest dengue related cases with;

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

From figure above, Perak is the fourth highest state that facing problems with dengue fever cases. It shows that Perak capable to be a dengue endemic area if not carefully prevented or managed. As one of the largest state in Peninsular Malaysia, Perak need routine prevention procedures such as disease surveillance. However, in this research the author has taken Batu Gajah to be the control project.

4.1.2 Batu Gajah

Batu Gajah is a small town located 24km from Perak state capital, Ipoh. 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.

The town also had a high number of dengue occurrences each month (Ministry of Health Malaysia, 2006). With an average of 7 cases per month, the disease reached the peak during hot and rainy season. Numbers of cases continue to rise because there was no developed system to monitor dengue. Action will only be taken after notification of dengue case from private/general hospital was received. It means that the authority focused on treating the disease rather than preventing it.

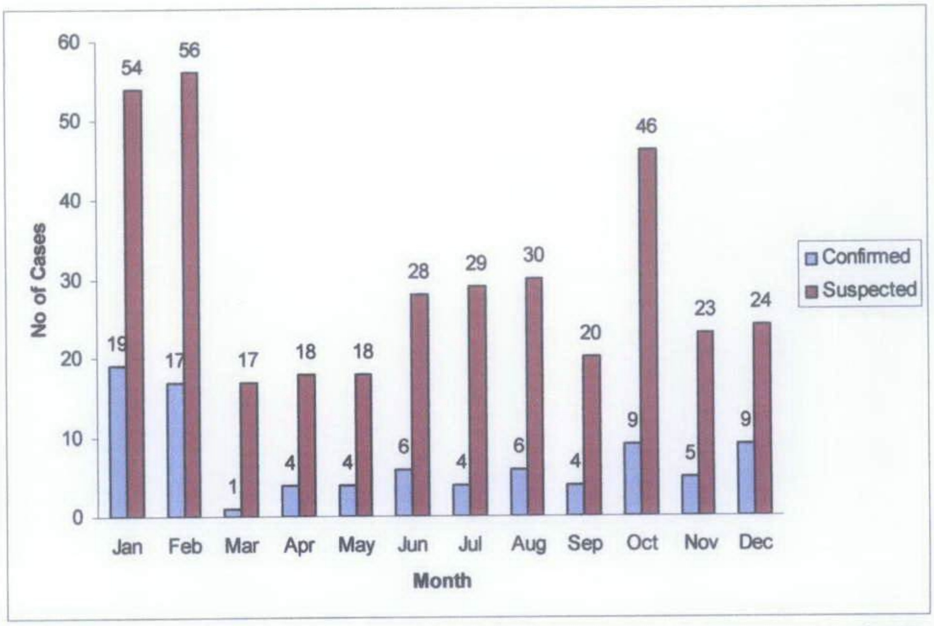

Figure 6: Graph shows numbers of confirmed and suspected dengue cases for Batu Gajah in 2006

Although Batu Gajah is a small town, many dengue cases were reported each year. Among details needed in the report is patients' personal information, addresses and patients' latest activities before getting the fever. Reported dengue cases can be divided to two types:

1) An imported case of dengue (suspected and confirmed)
2) A possible locally-acquired case (suspected)

When there were no current dengue cases in a particular zone, the possible locally-acquired case could be a false alarm (e.g. the person only had normal fever). The case must still be reported to the authority before preliminary investigation was conducted. If it was a false alarm, no further action was taken.

However if the case was confirmed, immediate follow up and mosquito control action is required.

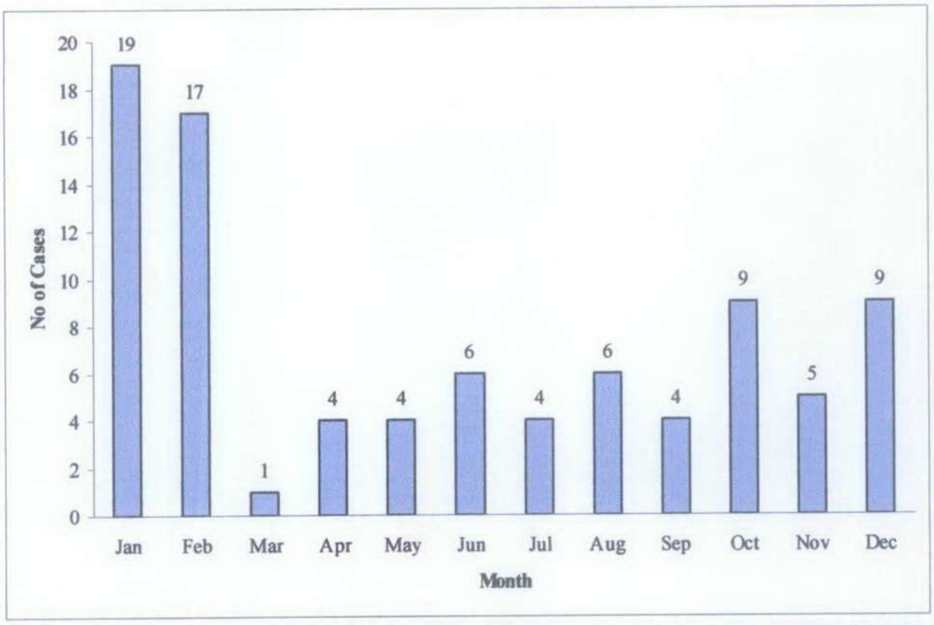

Figure 7: Graph shows numbers of confirmed dengue cases for Batu Gajah in 2006

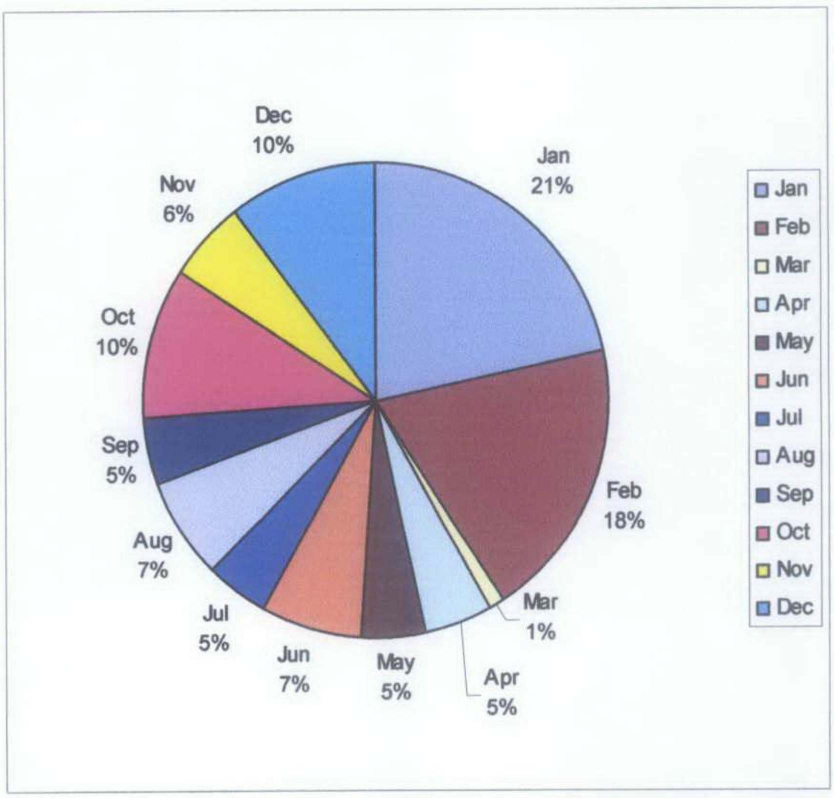

Figure 8: Percentage of confirmed dengue cases for Batu Gajah in 2006

The highest numbers of dengue cases took place at the beginning of year 2006 (figure 6). Although 54 suspected cases were reported at that time, the confirmed cases were only 19 which are 21% percent of the whole year. It was considered very serious because the average dengue incidences of Batu Gajah area were only 7 cases per month.

Two main patterns may describe the fluctuation of dengue incidence. The first pattern corresponded to the seasonal variations of transmission. From Figure 6, the results showed that the dengue incidence occurred at the beginning and at end of the 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 very active during the season. The end of the rainy season led to a lower level of transmission.

The second pattern corresponded to important rises in dengue epidemic. 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).

4.1.3 Dengue Outbreak Pattern

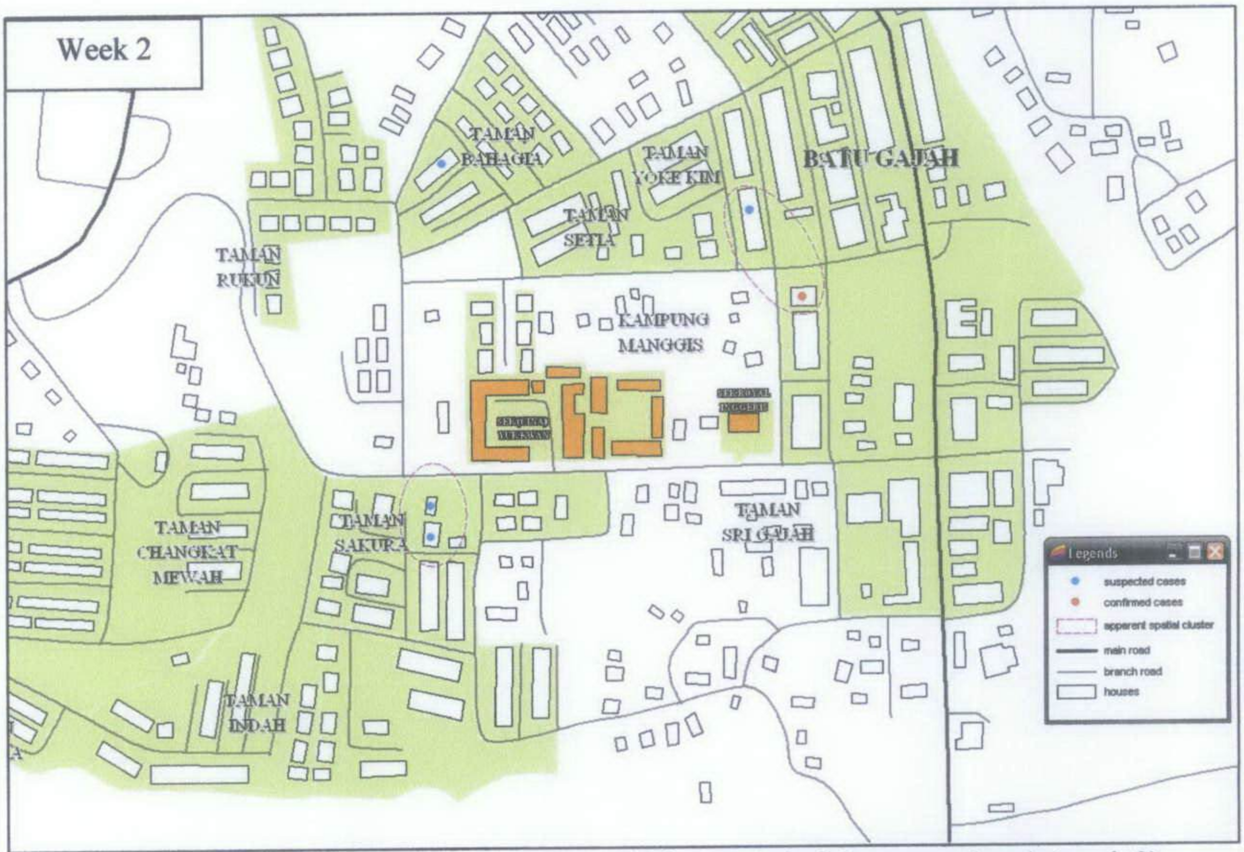

Figure 9 (a): Locations of dengue patients during period of dengue outbreak (week 2)

- There were several suspected cases and at least one confirmed case reported during the first two week of the dengue outbreak.
- The cases were distributed far from each other
- Spatial clusters were not visible

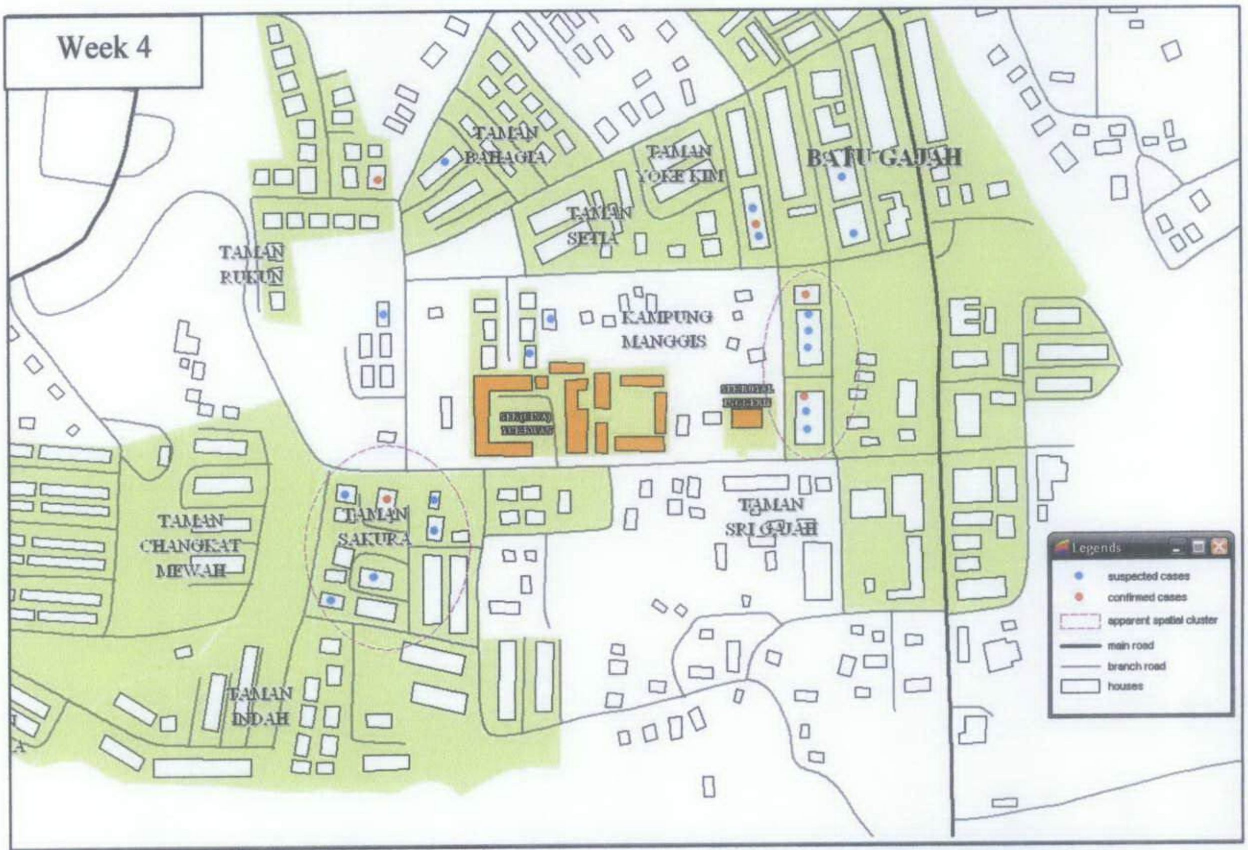

Figure 9 (b): Locations of dengue patients during dengue outbreak period (week 4)

- More suspected and confirmed cases were reported at the end of fourth week. The newly reported cases occurred surrounding the previous cases.
- The cases were distributed close to each other
- One or two spatial clusters were visible

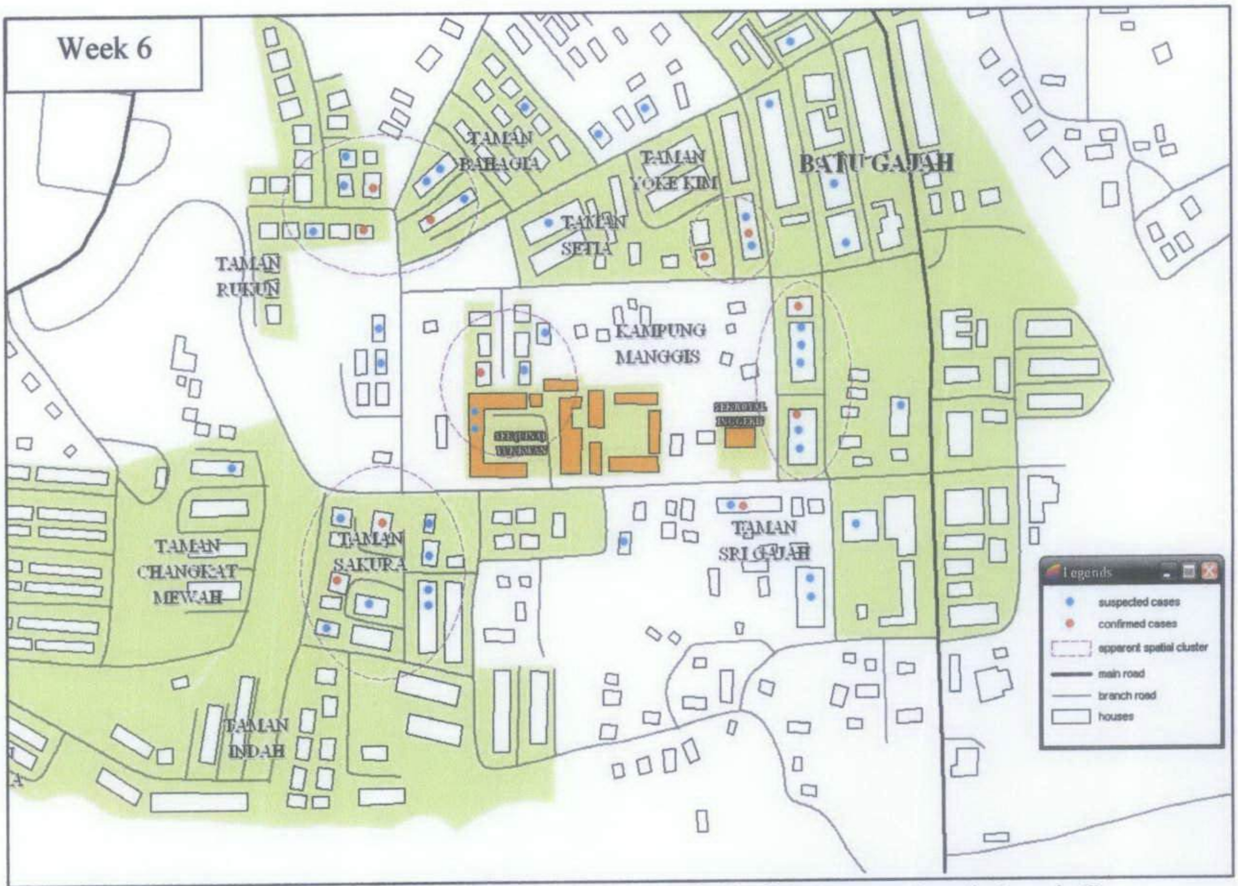

Figure 9 (c): Locations of dengue patients during period of dengue outbreak (week 6)

- Suspected and confirmed cases reported keep on increasing at the end of fourth week.
- The cases were spread evenly to the nearby housing areas
- Many spatial clusters were visible. A pattern of spatial distances were observed between occurred cases.

The first suspected dengue case was reported on 24 December 2005 but samples were not analyzed. The first confirmed dengue case occurred on 8 January 2006. Then, the epidemic spread rapidly through the community (Figure 9(b)), with a temporal lag between the cases. The first glimpse of the spatial distribution of confirmed and suspected cases shows the existence of apparent spatial clusters (more than 2 confirmed cases or 3 suspected cases in the same neighborhood)

To study the dynamics of a dengue outbreak in the small municipality like Batu Gajah, patients' home address must be determined in time by obtaining the latest date of onset of symptoms. A hypothesis can be made that patients have contracted the disease at home and spread through the community temporally. This hypothesis is based on practical constraints and on the results of several studies confirming that dengue risk exposure is more important at home because *Aedes aegypti* mosquitoes are endophilic and take their blood meal during the day with often a peak in the early morning and in the evening, and even sometimes during the night.

The difficulty arises when it comes to locate each patient's home. Many houses at the countryside were built on private lands and their addresses were not updated to the Ministry of Housing and Local Government of Malaysia. A substantial time investment is required to identify and verify patients' home on the current not-updated map of Batu Gajah. If the problem is solved, surveillance of group of patients can easily and quickly be done.

An initial interpretation of the spatial dengue distribution shows that all areas of Batu Gajah were rapidly affected by the disease. Moreover, the distribution highlights spatial case-clusters inside individual houses and in the nearby neighborhoods of case-patients. One of the aims of the spatial and temporal patterns analysis was to clarify the qualitative interpretation.

4.2 RESULTS AND DISCUSSIONS

Buffers of 400m diameter were created using MapInfo 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)

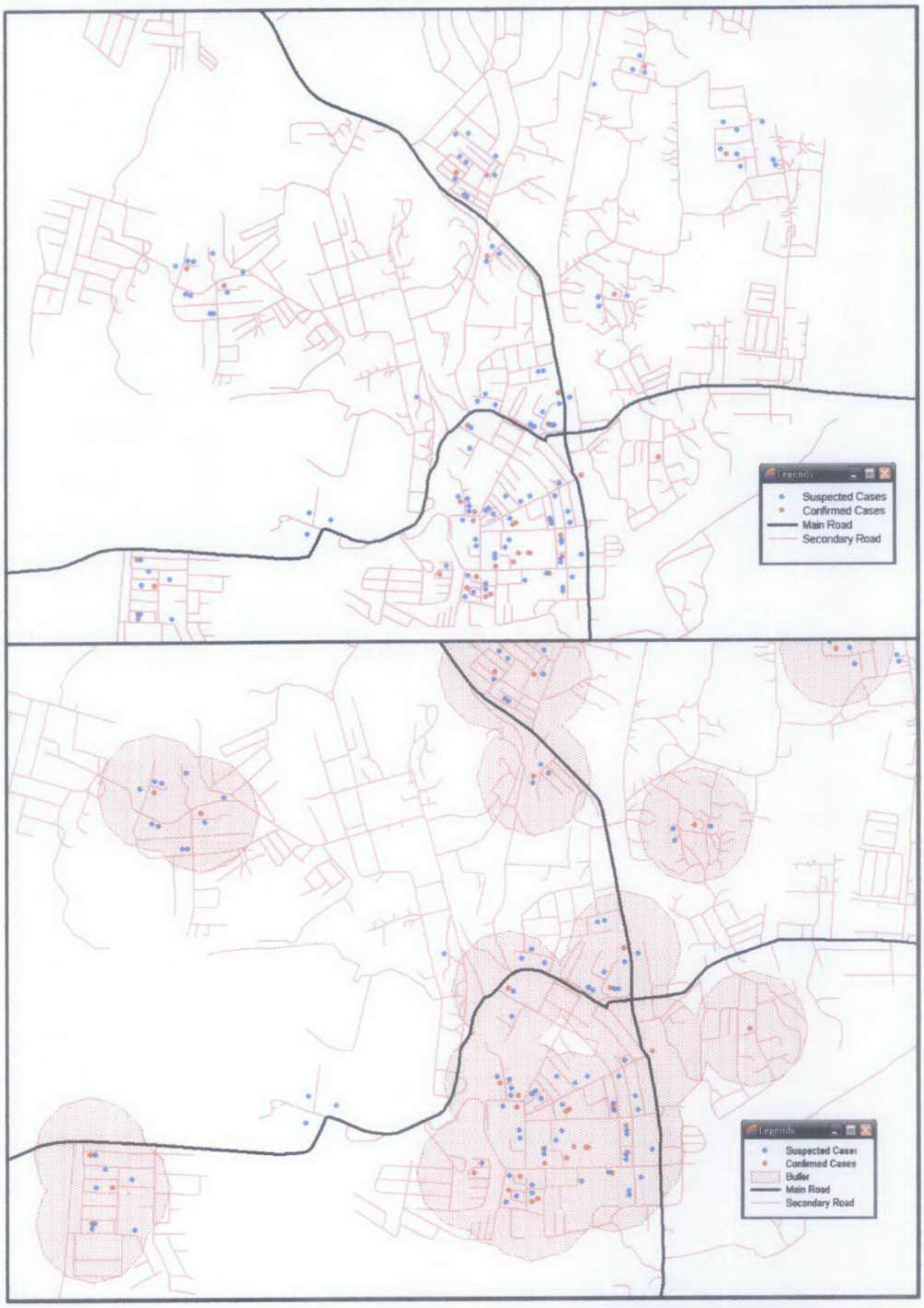

Figure 10: Correlation between roads and dengue cases

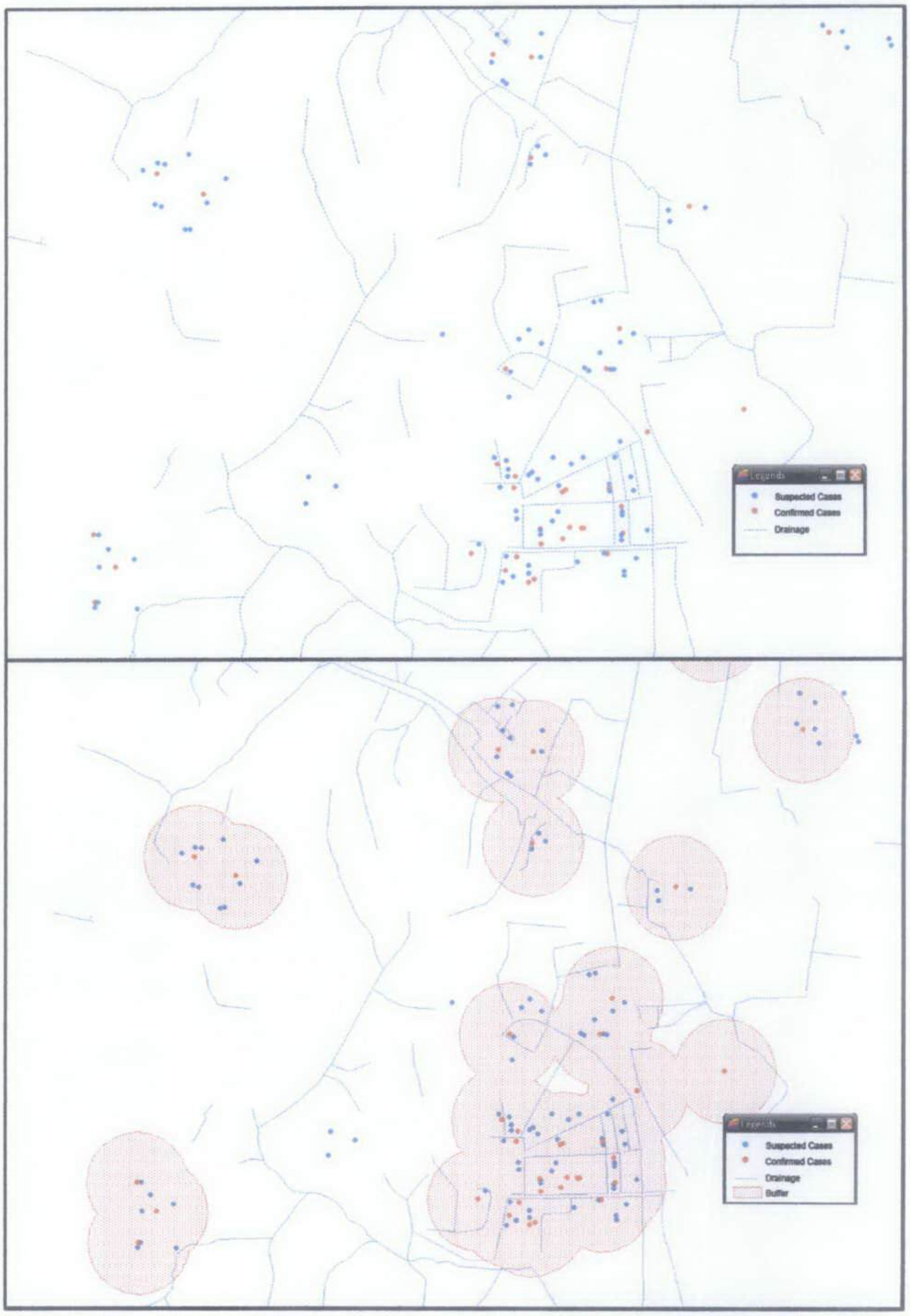

Figure 11: Correlation between drainage system and dengue cases

Table 2: Correlation between no. of dengue cases with places in Batu Gajah

No.	Location	No. of Confirmed Dengue Cases	Location close to		
			Main Road	Drainage	Septic Tank
1	Taman Damai	4	No	Yes	No
2	Pekan Batu Gajah	3	Yes	Yes	No
3	Desa Changkat	2	Yes	No	Yes
4	Kg. Kamariah	1	No	No	Yes
5	Bemban	3	Yes	Yes	No
6	Taman Happy	3	Yes	Yes	No
7	Taman Sakura	4	No	Yes	No
8	Taman Changkat Mewah	2	No	Yes	No
9	Kg. Sri Indah	1	No	No	Yes
10	SJK (C) Yuk Kwan	6	No	Yes	No
Total		**29**	**4**	**7**	**3**

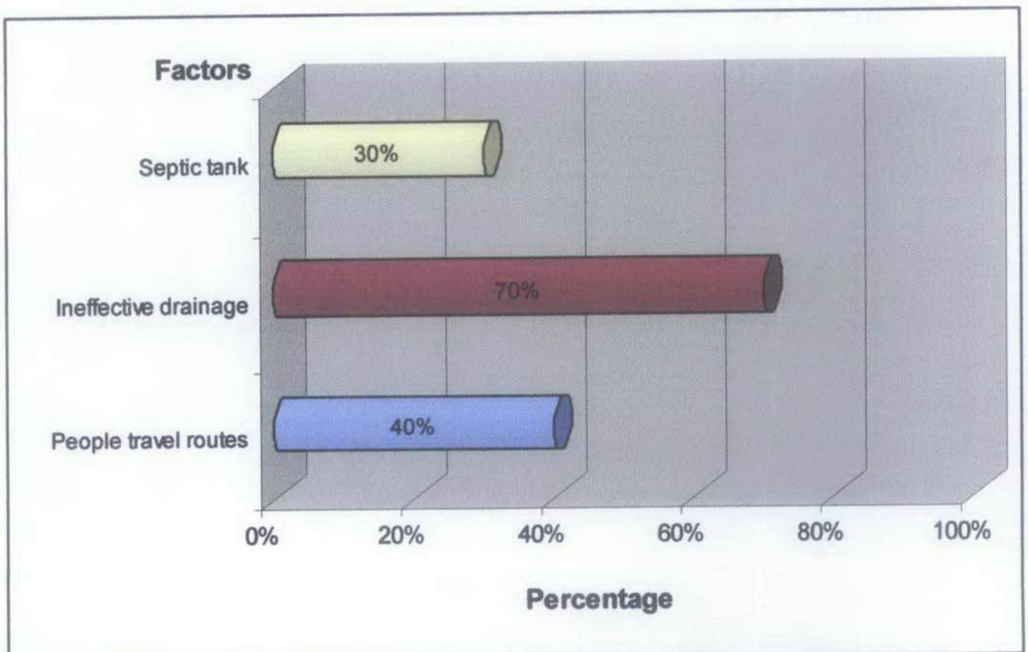

Figure 13: Percentage of dengue contributing factors for Batu Gajah

From Figure 10, the ineffective drainage showed the highest result for the contributing factor to dengue cases. 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).

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).

Correlations between septic tanks and the increase of dengue cases in Batu Gajah were not significant. Only 30% of the dengue cases were close enough to the septic tanks. Although septic tanks capable to be one of the aedes breeding sites, it did not produced the best result in this spatial analysis.

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.

CHAPTER 5
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.

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5) Okanurak, K. et al. (1997) The cost dengue hemorrhagic fever in Thailand. Southeast Asian J. Trop. Med. Public Health 28, 711-717

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APPENDIX – A

GEOGRAPHICAL INFORMATION SYSTEM

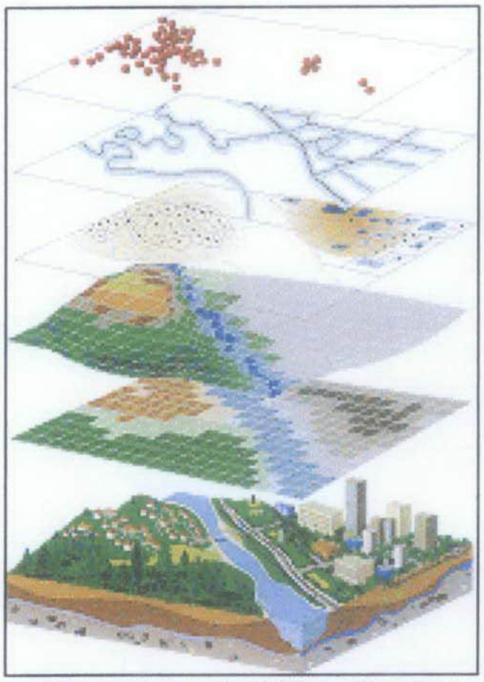


Figure: Layers in GIS application

MONT	WEEK_NO	NAME	CASI	AGE	SEX	RACE	NATIONALITY	OCCUPATION	SCHOOL	HOUSE_I
JAN	1	MEOR AHMAD B MEO HAMZ	DD	51	M	M	Malaysia	Kerja Sendiri		2,828
JAN	2	SADASIVAM A/L APPAHOC	DD	61	M	I	Malaysia	Pengawal	Bukit Merah, GSM	0
JAN	2	RAJA A/L SURIA NARAYAN	DD	33	M	I	Malaysia	Kerja Sendiri		0
JAN	2	SAIFUL FADZLY B AZMAN	DD	2	M	M	Malaysia	Kerja Kilang	UNISEM	0
JAN	2	THURAIRAJA A/L SUBRAM/	DD	18	M	I	Malaysia	Pelajar SMT (18-19)		155,638
JAN	2	SUNDARI A/P LATCIMANAN	DD	36	F	I	Malaysia	Penoreh Getah		20
JAN	2	ZANARIA BT MOHAMED	DD	41	F	M	Malaysia	Suri Rumah		22
JAN	2	SAIFUL ANUAR B MOHD SA	DD	15	M	M	Malaysia	Pelajar SMR (13-15)	SM Dato Ahmad Said, KTPK	229
JAN	2	SUNDAR A/L SUBRAMANIA	DD	44	M	I	Malaysia	Kerja Sendiri		77
JAN	2	NAGEMDRAN A/L KRISHNAI	DB	46	M	I	Malaysia	Kerja Sendiri		0
JAN	2	ROSNANI BT MOHAMAD	DD	35	F	M	Malaysia	Suri Rumah		120
JAN	2	YAHYA B ABD. RAHMAN	DD	67	M	M	Malaysia	Kerja Sendiri		58
JAN	2	LEONG WAI HANG	DD	9	M	C	Malaysia	Pelajar SK (7-12)	SJK (C) Yuk Kwan, KTPK	135
JAN	2	LOGENIS A/L RAGHU	DD	11	M	I	Malaysia	Pelajar SK (7-12)	SK Sentosa, KTPK	773
JAN	2	NURUL AINA FATIHA BT JAI	DD	7	F	M	Malaysia	Pelajar SK (7-12)	SK Seri Jaya, KTPK	72
JAN	2	YAN CHEOU HONG	DD	22	F	C	Malaysia	Juru Jual	Kedai Pakaian Samudera	184
JAN	2	SELLAMURUGAN	DD	23	M	I	Malaysia	Kerja Swasta	Kedai Runcit Abu Bakar	47
JAN	2	MARZIAH BT HARUN	DD	17	F	M	Malaysia	Lepasan SPM		43
JAN	2	SHALENA BT ABD MANAF	DD	39	F	M	Malaysia	Suri Rumah		43
JAN	2	LEONG YOKE TONG	DD	38	M	C	Malaysia	Berniaga Sendiri	Kedai Kek	135
JAN	2	ASRUL SANI B MUSTAFAK/	DD	18	M	M	Malaysia	Lepasan SPM		0

Figure: Example of database in MapInfo

APPENDIX – B

DENGUE MANAGEMENT SYSTEM

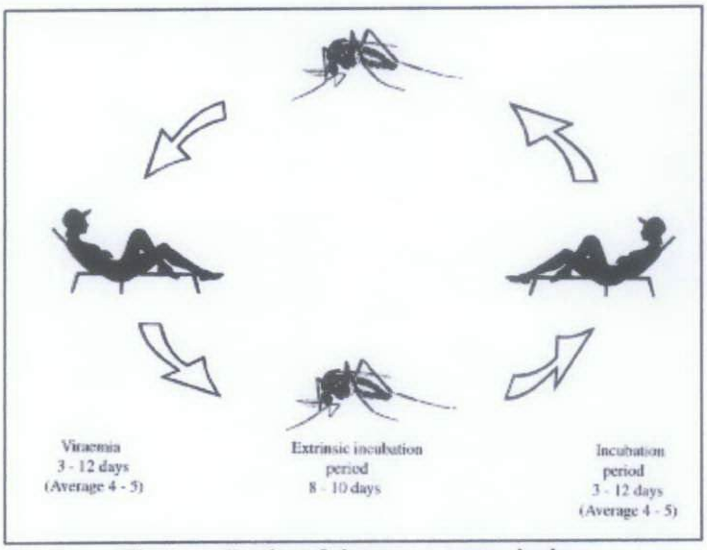
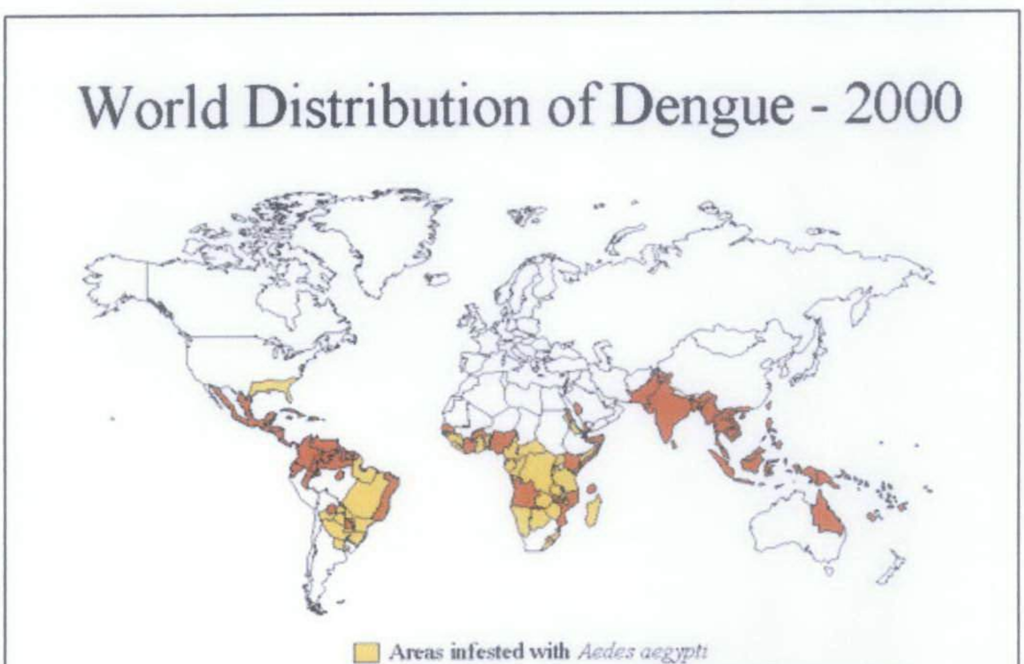
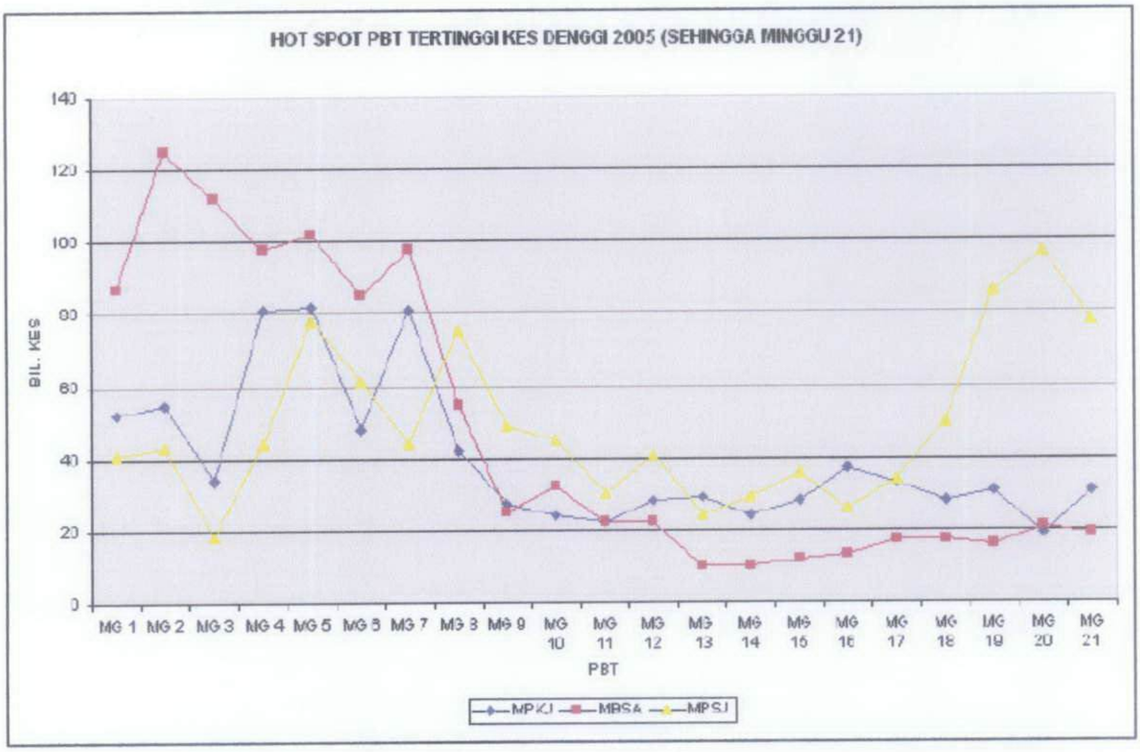
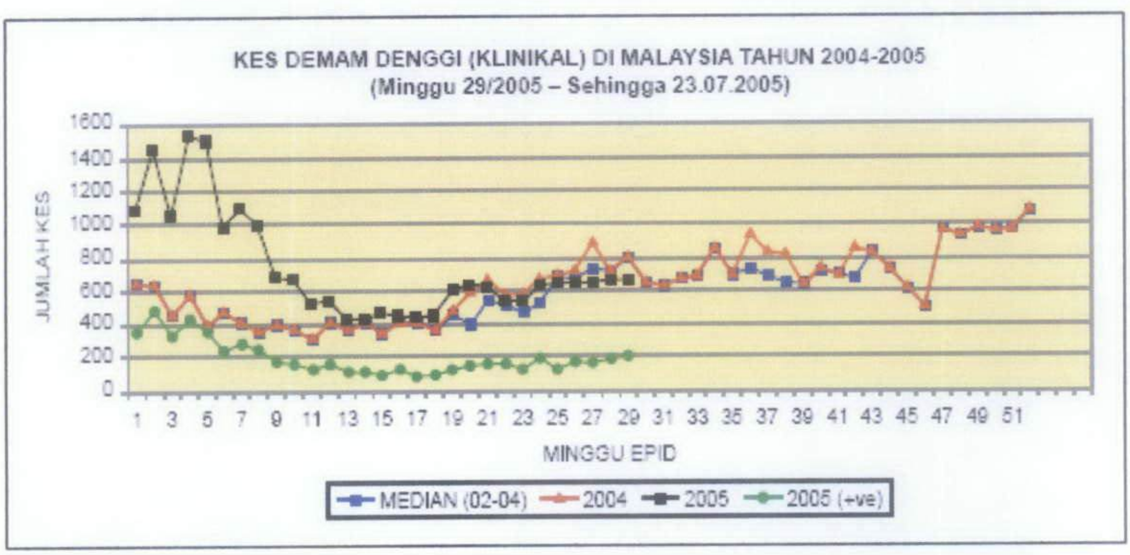


Figure: Cycle of dengue transmission



Source from World Health Organization (WHO)


HOT SPOT PBT TERTINGGI KES DENGGI 2005 (SEHINGGA MINGGU 21)
BIL. KES
PBT
MPKJ
MBSA
MPSJ


KES DEMAM DENGGI (KLINIKAL) DI MALAYSIA TAHUN 2004-2005
(Minggu 29/2005 – Sehingga 23.07.2005)
JUMLAH KES
MINGGU EPID
MEDIAN (02-04)
2004
2005
2005 (+ve)