II
VECTOR-BORNE DISEASES

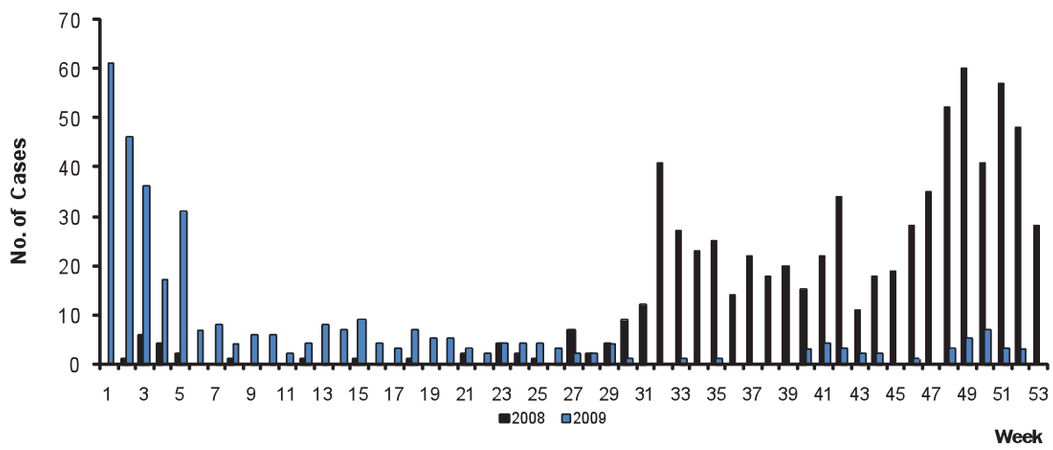
Vector-borne and zoonotic diseases are diseases that are transmitted to humans by insects or animals. Vectors may transmit infectious diseases to humans through blood-feeding arthropods such as mosquitoes and ticks or through contaminated urine, tissues or bites of infected animals such as rats or dogs. The causative organism may be viral, bacterial, fungal or protozoan and transmission can be via direct contact, food and water.

CHIKUNGUNYA FEVER

Chikungunya fever is an acute febrile disease caused by the chikungunya virus. The disease is characterised by fever, chills, headache, nausea, vomiting, joint pain with or without swelling and lower back pain. Some patients may develop a rash affecting the trunk and limbs. The disease is usually self-limiting. Most symptoms last for 3 -10 days and the joint pain may last for weeks to months. The main vector is the *Aedes* mosquito.

A total of 341 laboratory-confirmed cases of chikungunya fever were reported in 2009. Out of the 341 cases, 136 were Singaporean or permanent residents with 35 imported and 101 indigenous cases. The remaining 205 cases were foreigners including work permits holders consisting of 31 imported and 174 indigenous cases. The year began with a high incidence of cases that decreased sharply in the first quarter of the year; followed by a steady decrease towards end of third quarter before a slight rise of cases until the end of 2009 (Figure 2.1).

Figure 2.1
E-weekly distribution of Chikungunya fever cases, 2008 – 2009



The incidence rate among indigenous cases was highest in the 25 – 34 years age group with a male to female ratio of 5.2:1 (Table 2.1). Amongst the three major ethnic groups, Chinese had the highest incidence rate, followed by Indians and Malays. Foreigners comprised of 63.3 % of indigenous cases (Table 2.2).

Table 2.1
Age-gender distribution and age-specific incidence rates of indigenous# chikungunya fever cases, 2009

Age (Yrs)	Male	Female	Total (%)	Incidence rate per 100,000 population*
0 – 4	1	0	1 (0.4)	0.5
5 – 14	1	7	8 (2.9)	1.6
15 – 24	42	6	48 (17.5)	6.0
25 – 34	68	13	81 (29.4)	7.5
35 – 44	43	13	56 (20.3)	6.4
45 – 54	31	11	42 (15.3)	6.1
55+	24	15	39 (14.2)	4.8
Total	**210**	**65**	**275 (100.0)**	**5.5**

#Cases acquired locally among Singaporeans, permanent and temporary residents.
*Rates are based on 2009 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 2.2
Ethnic-gender distribution and ethnic-specific incidence rates of indigenous# chikungunya fever cases, 2009

	Male	Female	Total (%)	Incidence rate per 100,000 population*
Singapore Resident				
Chinese	53	32	85 (30.9)	3.1
Malay	2	1	3 (1.1)	0.6
Indian	7	1	8 (2.9)	2.3
Others	4	1	5 (1.8)	4.2
Foreigner	144	30	174 (63.3)	13.9
Total	**210**	**65**	**275 (100.0)**	**5.5**

#Cases acquired locally among Singaporeans, permanent and temporary residents.
*Rates are based on 2009 estimated mid-year population.
(Source: Singapore Department of Statistics)

There were 66 (19.4%) imported cases, defined as residents and non-residents with a history of travel to chikungunya endemic countries twelve days prior to the onset of illness. 30 (45.5%) and 26 (39.4%) cases were from India and Malaysia respectively(Table 2.3).

Table 2.3
Imported chikungunya fever cases, 2006 – 2009

	Year			
	2006	2007	2008	2009
Southeast Asia				
Cambodia	0	0	1	0
Thailand	0	0	0	2
Myanmar	0	0	0	2
Malaysia	0	1	166	26
Indonesia	0	1	6	4
South Asia				
India	2	6	4	30
Sri Lanka	1	0	2	0
Maldives	0	0	0	2
Other Regions	0	2	2	0
Total	**3**	**10**	**181**	**66**

Residents in the Housing and Development Board (HDB) flats, condominiums and compound houses constituted 24.0% 6.2% and 30.2% of the cases, respectively. 109 cases (39.6%) were residing in temporary residences and dormitories that cannot be classified under the three main residence types (Table 2.4).

Table 2.4
Incidence rates of reported indigenous# chikungunya fever cases by housing type, 2009

Housing Type	No.	%	Incidence rate per 100,000 population*
Compound houses (including shophouses)	83	30.2	22.1
HDB Flats	66	24.0	1.8
Condominiums	17	6.2	5.0
Others	109	39.6	17.3
Total	**275**	**100.0**	**5.5**

#Cases acquired locally among Singaporeans, permanent and temporary residents.
***Rates are based on census of population 2000.**
(Source: Singapore Department of Statistics)

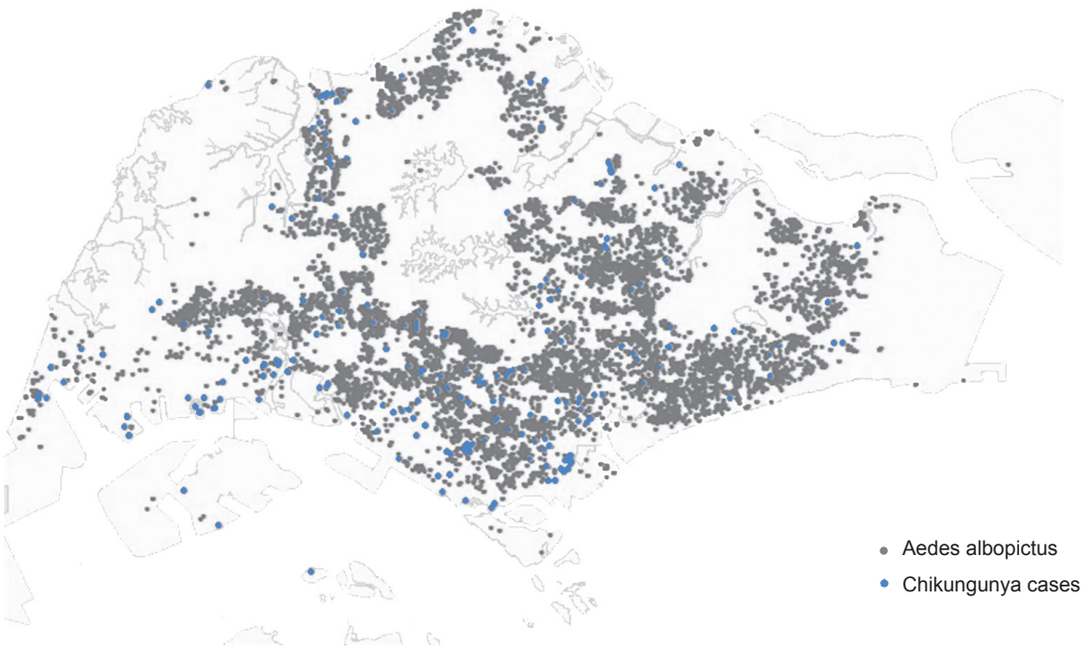
A total of 123 cases were identified in 37 clusters. A cluster is defined as two or more cases occurring within 300 meters of each other with onset dates at most 24 days apart. A total of 7 (18.9%) clusters with 5 or more cases were identified (Table 2.5). The median number of cases in these 7 large clusters was 5 (range 5 – 11) and the median duration of transmission for clusters with 5 or more cases was 21 days (range 19 – 60).

Clusters were distributed in the northwest, northeast, central and southwest parts of Singapore and coincided with areas where Aedes albopictus mosquitoes were present (Figure 2.2).

Table 2.5
Chikungunya clusters identified, 2009 (5 or more cases)

S/No	Location	No. of cases	Month
1	Sussex Garden	11	Mar – Apr
2	Tuas South Avenue 4	8	Feb – Apr
3	Kranji Loop	6	Apr – May
4	Queen Astrid Park	5	Jan – Feb
5	Dalvey Road	5	Apr – Jun
6	Cluny Road	5	May – Jun
7	Lorong Buangkok	5	Nov – Dec

Figure 2.2
Geographical distribution of *Aedes albopictus* and chikungunya fever cases, 2009



(Source: National Environment Agency)

Chikungunya Deaths

There were no deaths for the year 2009. No chikungunya-related deaths have been reported in Singapore before.

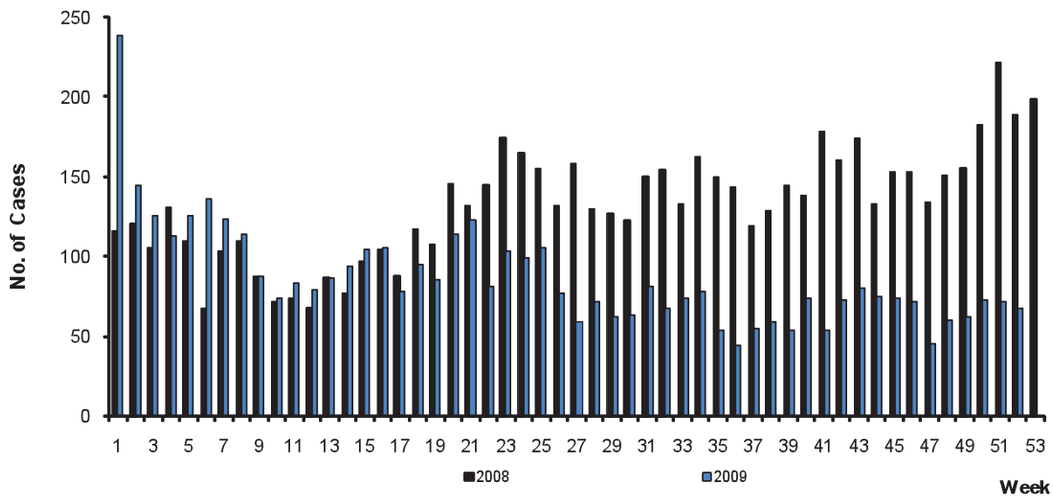
DENGUE FEVER/DENGUE HAEMORRHAGIC FEVER (DF/DHF)

Dengue fever is an acute febrile viral disease characterised by sudden onset of fever for 3 – 5 days, intense headache, myalgia, arthralgia, retro-orbital pain, anorexia, gastrointestinal disturbances and rash. Early generalised erythema may occur in some cases. The infectious agents are flaviviruses comprising four serotypes (dengue-1, 2, 3 and 4) and are transmitted by the *Aedes* mosquito. In some cases, dengue haemorrhagic fever - a potentially fatal complication characterised by high fever, thrombocytopaenia, haemorrhagic manifestations, and evidence of plasma leakage may develop.

A total of 4,497 laboratory confirmed cases of DF/DHF [comprising 4,451 cases of dengue fever (DF) and 46 cases of dengue haemorrhagic fever (DHF)] were reported in 2009, a decrease of more than 30 percent from the 7,031 dengue fever cases reported in 2008. Of these, 2,907 were local residents with 85 imported and 2822 indigenous cases. The remaining 1,590 cases were foreigners, of which 1365 cases were infected locally and 225 cases acquired the infection overseas.

Majority of those who acquired the infection overseas were foreigners who came to Singapore for medical treatment. The incidence remains low throughout the year except for a slight increase during the second half of the year (Figure 2.3).

Figure 2.3
E-weekly distribution of DF/DHF cases, 2008 – 2009



The incidence rate among indigenous cases was highest in the age group of 55+ with a male to female ratio of 1:1 (Table 2.6). Among the three major ethnic groups, Chinese had the highest incidence rate, followed by Malays and Indians. Foreigners comprised 32.4% of the indigenous cases (Table 2.7).

Table 2.6
Age-gender distribution and age-specific incidence rates of indigenous# DF/DHF cases, 2009

Age (Yrs)	Male	Female	Total (%)	Incidence rate per 100,000 population*
0 – 4	24	25	49 (1.2)	22.6
5 – 14	143	75	218 (5.2)	43.1
15 – 24	499	279	778 (18.6)	97.9
25 – 34	643	336	979 (23.4)	90.6
35 – 44	526	281	807 (19.3)	91.8
45 – 54	312	222	534 (12.7)	77.1
55+	405	417	822 (19.6)	100.5
Total	**2,552**	**1,635**	**4,187 (100.0)**	**83.9**

#Cases acquired locally among Singaporeans, permanent and temporary residents.
*Rates are based on 2009 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 2.7
Ethnic-gender distribution and ethnic-specific incidence rates of indigenous# DF/DHF cases, 2009

	Male	Female	Total (%)	Incidence rate per 100,000 population*
Singapore Resident				
Chinese	1,227	970	2,198 (52.5)	79.3
Malay	158	125	283 (6.8)	56.6
Indian	106	86	191 (4.6)	55.9
Others	93	64	157 (3.7)	130.8
Foreigner	968	390	1,358 (32.4)	108.3
Total	**2,552**	**1,635**	**4,187 (100.0)**	**83.9**

#Cases acquired locally among Singaporeans, permanent and temporary residents.
*Rates are based on 2009 estimated mid-year population.
(Source: Singapore Department of Statistics)

There were 83 (1.8%) imported cases, defined as local residents with a history of travel to endemic areas seven days prior to the onset of illness. The majority of these cases (87.4%) were from Southeast Asian countries: 32 from Malaysia, 19 from Indonesia, four from Vietnam, three from Cambodia, three from Philippines, two from Thailand, one from Myanmar, one from Brunei, one from Laos and one from East Timor (Table 2.8).

Table 2.8
Imported DF/DHF cases, 2005 – 2009

	Year				
	2005	2006	2007	2008	2009
Southeast Asia					
Brunei	0	0	1	0	1
Cambodia	0	4	4	4	3
East Timor	0	0	1	1	1
Indonesia	11	34	34	40	19
Laos	0	1	0	0	1
Malaysia	2	25	31	42	32
Myanmar	0	0	4	1	1
Philippines	0	5	6	4	3
Thailand	1	8	14	15	2
Viet Nam	0	2	8	8	4
South Asia					
Bangladesh	0	5	2	2	0
India	0	12	20	13	9
Maldives	0	2	0	1	0
Nepal	0	0	0	0	1
Pakistan	0	0	0	0	0
Sri Lanka	0	1	2	1	0
Other Regions	0	4	12	11	6
Total	**14**	**103**	**139**	**143**	**83**

Residents in Housing & Development Board (HDB) flats, compound houses and condominiums constituted 67.6%, 20.4% and 9.8% of the cases, respectively. Similar to previous year, the incidence rate of residents of compound houses (227.9 per 100,000) was over triple that of residents in HDB flats (120.6 per 100,000) (Table 2.9).

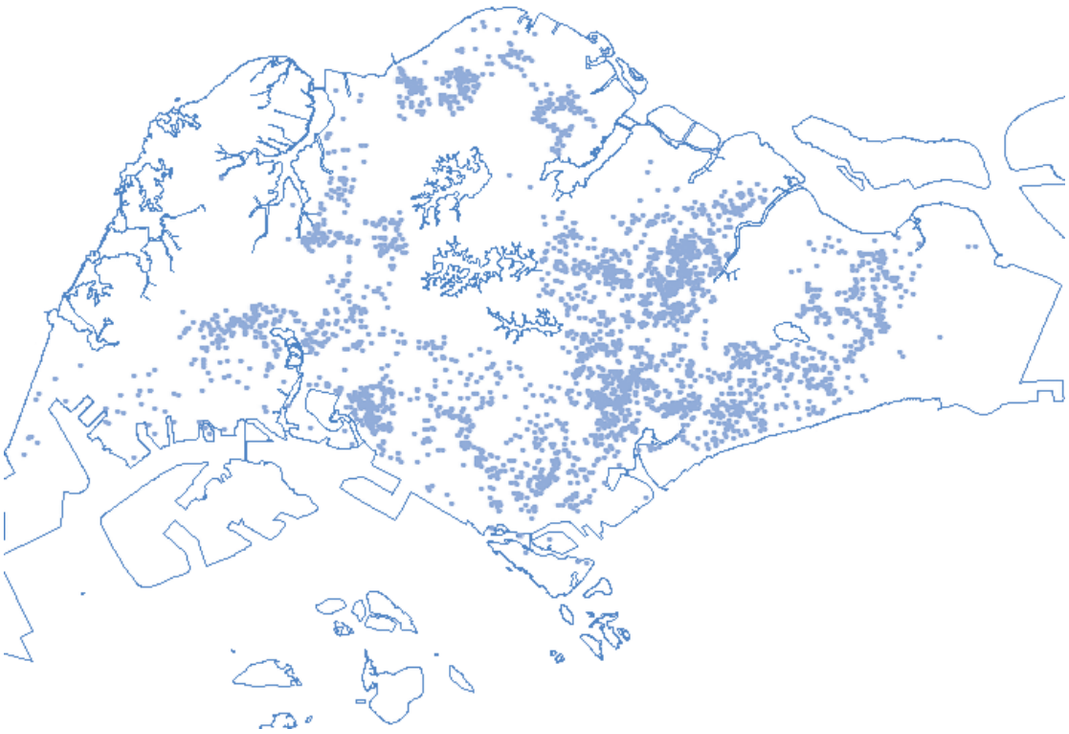
Table 2.9
Incidence rates of reported indigenous DF/DHF cases by housing type, 2009

Housing Type	No.	%	Incidence rate per 100,000 population*
Compound houses (including shophouses)	856	20.4	227.9
HDB Flats	2,830	67.6	77.8
Condominiums	410	9.8	120.6
Others	91	2.2	14.4
Total	**4,187**	**100.0**	**83.9**

*Rates are based on census of population 2000.
(Source: Singapore Department of Statistics)

Though cases were concentrated in the central and south-eastern parts of Singapore, cases were reported from around the island [according to the boundary demarcated by the Community Development Council / National Environment Agency (NEA) Regional Office] (Figure 2.4).

Figure 2.4
Geographical distribution of dengue cases, 2009



A total of 392 clusters involving 1,456 epidemiologically linked cases were identified. The median number of cases in each cluster was three (range 2 to 42) and the median duration of transmission was 7 days (range 1 to 48) (Table 2.10). The number of clusters decreased by 31.9% compared to the previous year.

Table 2.10
Dengue clusters identified, 1990 – 2009

Year	No. of indigenous cases	No. of clusters*	No. of cases in cluster area (% total cases)	No. of clusters with ≥ 10 cases (% total clusters)	Median no. of cases per cluster	Median duration of transmission (days)
1990	1,640	40	270 (16.5)	11 (27.5)	4.5	10
1991	2,062	74	414 (20.1)	9 (12.2)	3.5	6
1992	2,741	134	733 (26.7)	13 (9.7)	3	5
1993	794	33	183 (23.0)	4 (12.1)	3	8
1994	1,084	75	424 (39.1)	8 (10.7)	3	7
1995	1,756	118	679 (38.7)	16 (13.6)	3	7
1996	2,877	143	1,088 (37.8)	27 (18.9)	3	6
1997	4,039	198	1,124 (27.8)	24 (12.1)	3	5
1998	5,105	239	1,197 (23.4)	23 (9.6)	2	7
1999	1,138	54	230 (20.2)	6 (11.1)	3	11
2000	402	9	40 (10.0)	1 (11.1)	4	15
2001	2,064	93	531 (25.7)	15 (16.1)	3	8
2002	3,560	73	725 (20.4)	30 (41.1)	7	20
2003	4,542	180	1,405 (30.9)	38 (21.1)	4.5	12
2004	9,297	559	2,434 (26.2)	34 (6.1)	3	4
2005	14,032	1,190	5,362 (37.7)	93 (7.8)	3	5
2006	2,844	172	871 (30.6)	19 (11.0)	3	5
2007	8,287	949	3,877 (46.8)	58 (6.1)	3	10
2008	6,631	576	2,267 (34.2)	34 (5.9)	2	7
2009	4187	392	1456 (34.8)	17 (4.3)	3	7

*A cluster is defined as two or more cases epidemiologically linked by place [within 150m (200m till 2002)] and time (within 14 days)

Of the 392 clusters identified, there were 17 clusters (4.3%) having 10 cases or more. They were in the areas listed in Table 2.11. The median number of cases in these 17 clusters was 15 (range 10 to 42) and the median duration of transmission was 26 days (range 13 to 48).

Table 2.11
Dengue clusters identified, 2009 (10 or more cases)

S/No	Location	No. of cases	Month
1	West Coast Dr (Blk 95, 113A) / West Coast Lane / West Coast Pl / West Coast Ter	42	Mar - May
2	Chay Yan Street/Yong Siak St/Guan Chuan St/Moh Guan Ter/Kim Tian Rd	36	July - Sep
3	Hougang St 61 (Blk 686, 688, 690)	27	Jun- Jul
4	Mergui Rd/Rangoon Rd/Kent Rd	27	Oct - Nov
5	Clementi Ave 5 (Blk 339, 341)	21	Mar – Apr
6	Ang Mo Kio Ave 10 (blk416,418,440,441,443)	19	Feb - Mar
7	West Coast Dr (Blk 506, 507)	18	Apr – Apr
8	Moonstone Lane/Opal Cres/Ruby Lane	16	Mar - Apr
9	Hougang St 61 (Blk 686, 688, 689, 690)	15	Feb – Mar
10	Taman Mas Merah / Jln Mas Kuning / Jln Mas Puteh	15	Jun – Jul
11	Hougang St 11 (Blk 152, 153)	13	Sep – Sep
12	Woodlands Circle (Blk 728, 734, 737, 739, 741) / Woodlands Dr 70 (Blk 713, 715)	13	Jan - Jan
13	Fowlie Rd / Marshall Rd / Ean Kiam Pl / Ceylon Rd / Mugliston Rd	12	Jan - Feb
14	Pasir Ris St 21 (Blk 222, 223, 224, 225, 226)	11	Jul - Aug
15	Yishun Ring Rd (Blk 238, 240, 243)	11	Feb - Feb
16	Owen Rd/Oxford Rd/Rangoon Rd/Gloucester Rd	11	Oct - Oct
17	Jln Mas Puteh / West Coast Walk / Jln Mas Kuning / West Coast Rd	10	May - May

Dengue Deaths

A total of eight fatal cases of DF/DHF, comprising of five DF cases and three DHF cases were reported in 2009. Of these, all cases were indigenous infections among six local residents and two non-resident foreigners.

Laboratory Surveillance

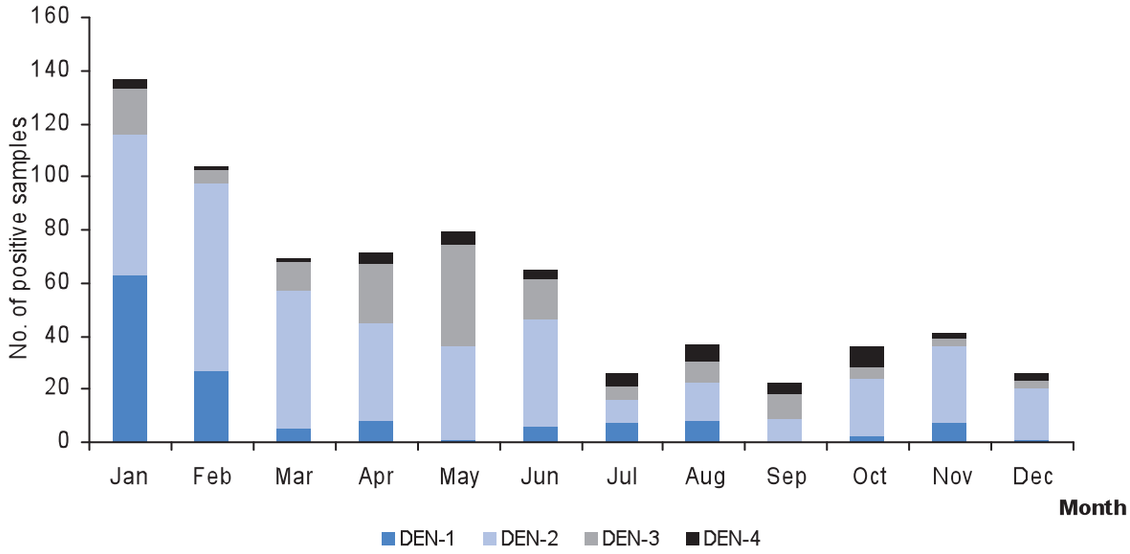
All reported cases of DF/DHF were confirmed by one or more laboratory tests; viz. anti-dengue IgM antibody, enzyme linked immunosorbent assay (ELISA), and polymerase chain reactions (PCR).

A total of 747 blood samples obtained from both inpatients and outpatients tested positive for dengue virus by Polymerase Chain Reactions (PCR) at the Department of Pathology and Laboratory Medicine, Tan Tock Seng Hospital, National University Hospital's Laboratory and the Environmental Health Institute, National Environmental Agency.

All four dengue serotypes were detected, comprising DEN-1 (18.1%), DEN-2 (52.1%), DEN-3 (18.7%) and DEN-4 (6.6%). 4.6% was indeterminate (Figures 2.5 & 2.6).

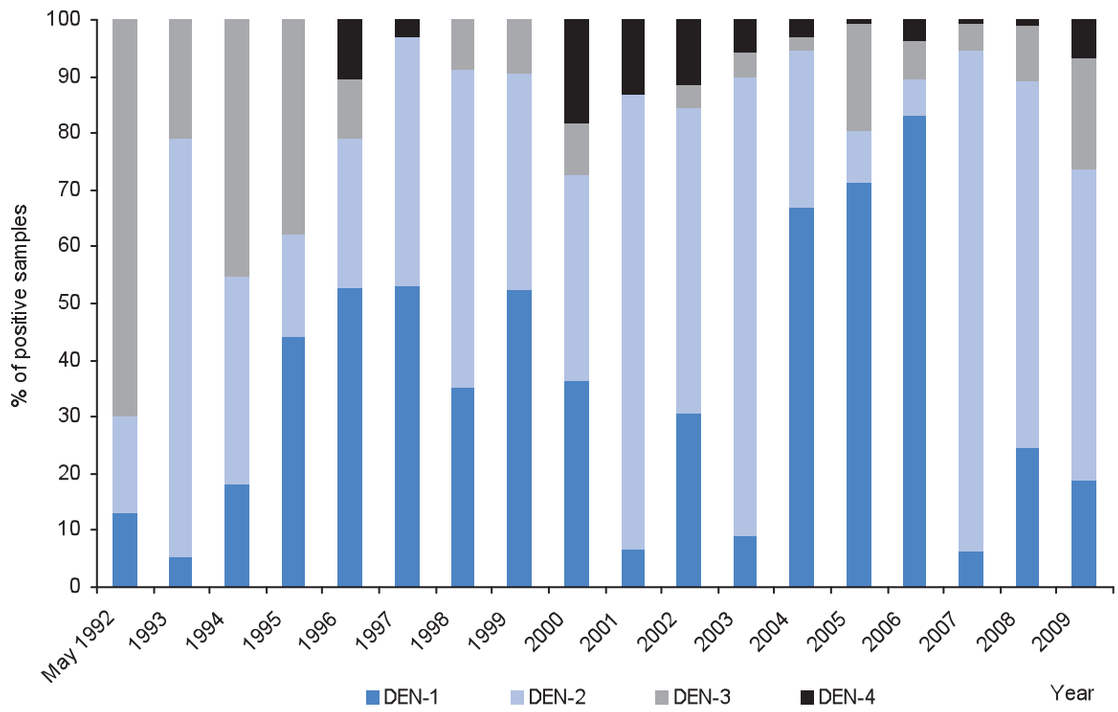
There is no change in the predominant circulating serotype from 2007 and DEN–2 remains the predominant circulating serotype. (Figure 2.6).

Figure 2.5
Surveillance of dengue virus serotypes, 2009



(Source: Environmental Health Institute, Tan Tock Seng Hospital Department of Pathology and Laboratory Medicine, and National University Hospital Laboratory)

Figure 2.6
Surveillance of dengue virus serotypes, 1992 – 2009



(Source: Singapore General Hospital Department of Pathology, Environmental Health Institute, Tan Tock Seng Hospital Department of Pathology and Laboratory Medicine, National University Hospital Laboratory, and KK Hospital Laboratory)

Aedes Surveillance and Control

The NEA adopts an integrated evidence-based approach to dengue control, comprising of pre-emptive source reduction, vector surveillance and control, public education & community outreach, law enforcement, a virus surveillance system, and supported by operationally relevant research. The key thrust of this approach is pre-emptive source reduction, which denies mosquitoes the place to breed, and is recognised by WHO and renowned vector experts as a sustainable way of preventing disease transmission in the absence of a vaccine and an anti-viral drug for dengue.

Since 2006, NEA has implemented a Preventive Surveillance Programme, in which more than 900 officers are deployed island-wide to carry out vector control works, in both premises and outdoor places, to detect and destroy mosquito breeding habitats. Pest control operators, which are engaged by NEA, also supplement the preventive surveillance effort by checking the common public areas in public housing estates. In addition, the works of these 84 teams are further audited by five teams of officers with vast experiences in vector control.

Source reduction is however an extremely labour-intensive activity and a shotgun approach will yield limited results. The success of the dengue control programme is very much dependent on the accurate and effective deployment of a limited pool of skilled vector control officers. Hence, NEA adopted a risk assessment approach to ensure valuable resources are deployed in a strategic and sustainable manner, to achieve the optimal impacts.

A Geographical Information System (GIS) has been employed to monitor and analyse the distribution of *Aedes* mosquitoes and dengue cases. The GIS enables the integration of extensive data such as the location of *Aedes* breeding sites, dengue cases, dengue serotypes, mosquito-related complaints, readings from ovitraps, weather data (e.g. rainfall, ambient temperature and relative humidity) with map layers of roads, buildings, schools, construction sites, electoral divisions vacant premises and etc.One important component of NEA's dengue surveillance and control programme is the development of a set of Focus Areas, using a risk assessment approach and based on the principles of dengue epidemiology. A selection of risk factors which include the level of herd immunity, circulating serotypes, distribution of *Aedes* aegypti and *Aedes albopictus*, age of the estates, demographic information and etc, is analysed using GIS, and the resultant areas considered to have relatively higher epidemic potential are marked out. This exercise is carried out at the beginning of every year, and the Focus Areas are further refined throughout the year, on a regular basis.

Intensive Source Reduction Exercise (ISRE) for mosquito breeding in these Focus Areas is usually conducted from Jan-April, ahead of the historically warmer months (typically from June to October) when cases traditionally peaks. Mosquito breeding habitats are identified and eliminated both in homes and other premises as well as outdoor areas so that the mosquito population is suppressed during this period. In 2009, a containment strategy was devised to conduct intensive surveillance in areas with emerging Den-3 and Den-4 serotypes. This was to prevent the new serotypes from gaining a foothold in Singapore.

In 2009, NEA inspected some 4.3 million premises, and carried out over 90,000 ground surveys. In addition, more than 2,200 ovitraps were placed around Singapore for *Aedes* monitoring (*Figure 2.7*). The distribution of dengue cases was more closely associated with *Aedes aegypti* than *Aedes albopictus* (*Figure 2.8*). (Note: *Aedes aegypti* and *Aedes albopictus* are now known as *Stegomyia aegypti* and *Stegomyia albopictus* respectively.). The overall *Aedes* premises index was about 0.35%, with the highest percentage detected in compound houses (*Figure 2.9*). The top five breeding habitats for *Ae. aegypti* were domestic containers (29%), ornamental containers (13%), flower pot plate/tray (10%), discarded receptacles (3%), and canvas/plastic sheets (2%) (*Figure 2.10*). In the case of *Ae. albopictus*, the most common breeding habitats were discarded receptacles (13%), Domestic containers (11%), flower pot plate/tray (10%), canvas/plastic sheets (8%), and ornamental containers (5%) (*Figure 2.11*).

In addition to vector surveillance, Singapore's experience has also shown that effective control and prevention of dengue transmission requires a collective effort from all stakeholders due to the multitude of social, economic, and environmental factors involved. The Inter-Agency Dengue Task Force (IADTF) is the demonstration of the inter-sectoral collaboration at the highest level in Singapore.

The IADTF is made up of representatives from 26 public, private and professional organizations. Its key mission is to ensure that an effective mosquito control programme is put in place among the partners. The IADTF can tap the resources of all the three sectors. The IADTF also helps to resolve inter-agency issues and responsibilities relevant to mosquito control and to enhance the communication and coordination among partners on dengue control efforts.
In 2009, NEA together with other land agencies, Town Councils and their pest control operators carried out ISREs successfully that helped to curb the surge in dengue cases experienced during the traditional warmer months.

Since Sept 2005, NEA had assisted Town Councils to implement dedicated mosquito control programmes to reduce the number of breeding found in TC-maintained areas. Apart from providing technical specifications for dengue control works, NEA also trained officers in these 15 TCs to be Estate Environmental Officers so that they can supervise the performance of the dedicated pest control operators. Since the implementation of this programme, the reduction of *Aedes* breeding found in these estates had reduced from 19% in 2005 to about 4.2% in 2009.

Nevertheless, for source reduction to be effective, we need the cooperation of all in the community to play their part in keeping their premises free from mosquito breeding. Community participation and adoption of mosquito preventive steps at individual and household levels are crucial to prevent and control dengue transmission in Singapore effectively. The NEA adopts a two-pronged communication approach that incorporates both national level publicity programmes and target-group specific programmes for dengue outreach.

The national level programme addresses the general public through an aggressive communications strategy via the local media. Both publicity and advertising is used to communicate the message quickly and in a sustained manner. It helps to heighten public awareness during critical periods and keep the subject at the top of the public's mind.

Target-group specific programmes zoom in to engage different segments of the population in preventing dengue. To demarcate various target groups, the use of demographic (i.e. by age or place of residence) and ethnographic (i.e. by cultural trait or interest) segmentation were employed. Target groups include school children and their parents, homeowners, foreign workers, outbound travellers and plant lovers, etc. For each of the target group, five key mosquito breeding habitats or steps are highlighted for them to take action.

The NEA adopts a 3P (People-Public-Private Sectors) strategy in her planning and implementation of these programmes as the 3P partners understand the respective target groups better and would thus be able to provide valuable advices on the means of outreach. Some partners also have established networks, which are important in achieving maximum outreach. Some of the key partners include grassroots organizations, educational institutions and commercial organizations.

Research is also an integral part of Singapore's *Aedes* surveillance and control programme to establish an evidence-based *Aedes* control strategy. Through a network of general practitioners all over the island, NEA's Environmental Health Institute (EHI)'s active laboratory surveillance system has enabled us to detect the rapid switch in dengue serotype that forewarned us of any impending outbreak. In the event of an emergence of serotype not common in Singapore, the surveillance system determines the location to guide intensive vector control operation to prevent the spread of the new serotype.

These are made possible by the development of new diagnostic tools at EHI. A rapid cost effective PCR test developed at EHI has allowed high throughput analyses to facilitate the dengue virus surveillance.

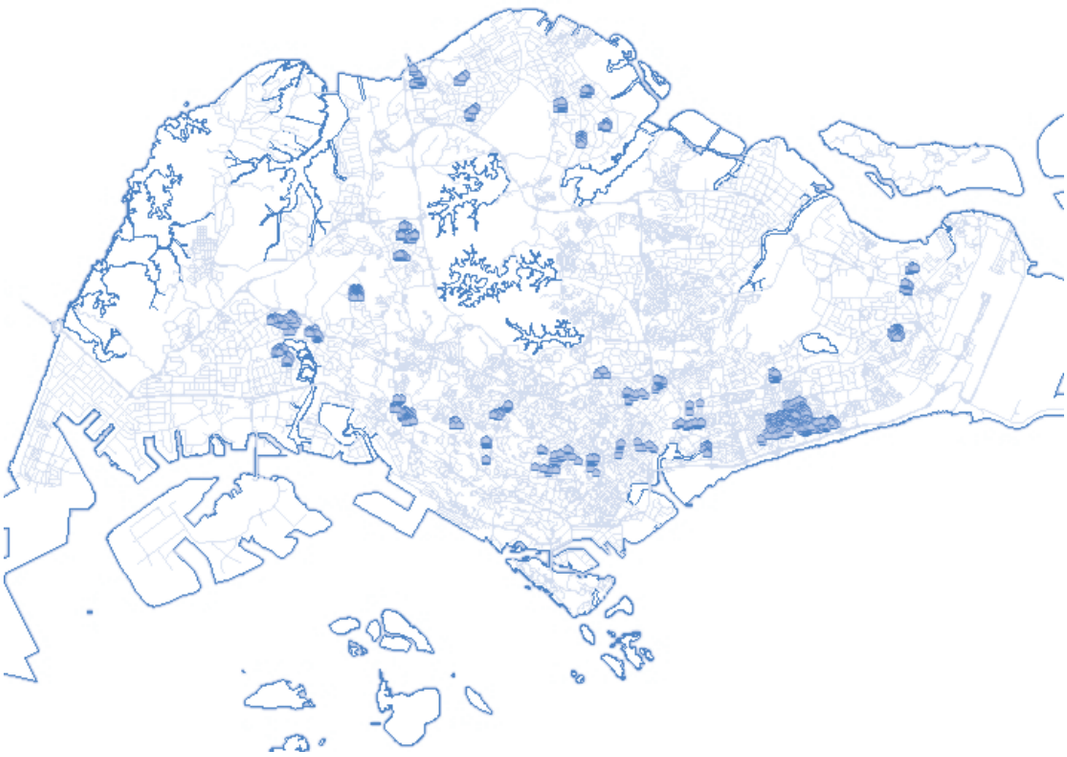
The epidemiology of Dengue is a complex interplay of many factors such as the mosquito population, the virus type, the human immunity and human behaviour. Research has shown that the geographical expansion of dengue's primary vector *Aedes aegypti* has contributed to recent outbreaks in Singapore. Through blood analysis of residents, EHI also seeks to understand the immunity level of the human population in different areas of the island. Such data, collected from various projects, on population of the primary vector, immunity of human host and circulating dengue serotype, is being used to identify areas for focused mosquito control.

To ensure efficacy of mosquito control, insecticides

commonly used by NEA and pest management companies are evaluated and monitored at EHI, to ensure that local mosquitoes do not develop resistance to the insecticides use. Through collaborations with commercial companies, NEA also supports the development of new product in the market.

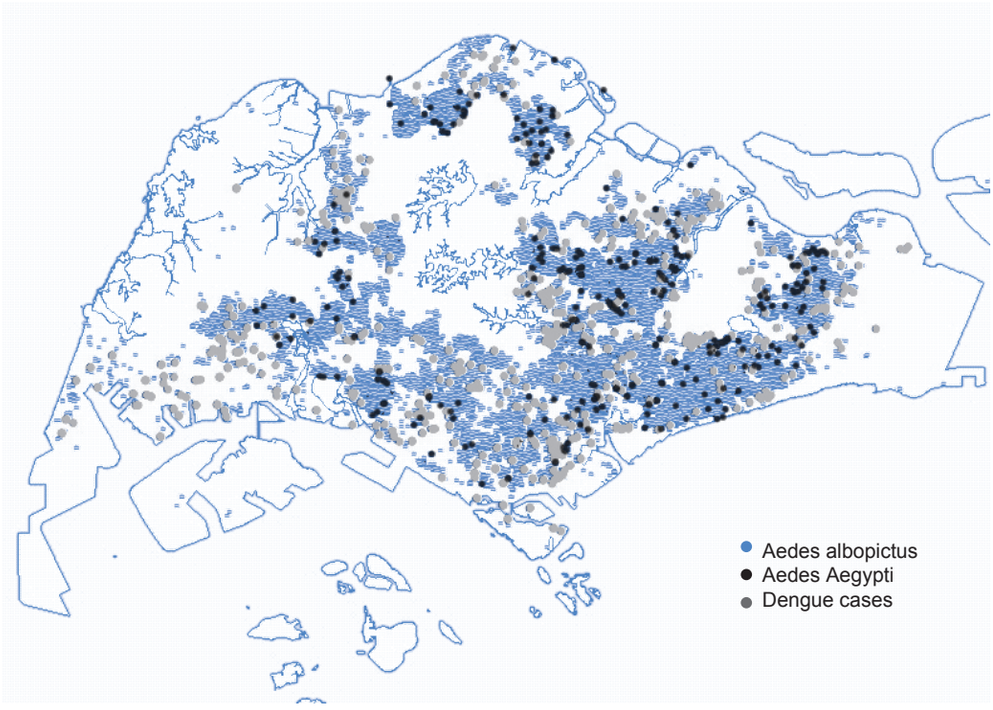
This integrated evidence-based approach in *Aedes* surveillance and control help to reduce dengue transmission in Singapore.

Figure 2.7
Locations of 2,288 ovitraps used for *Aedes* surveillance



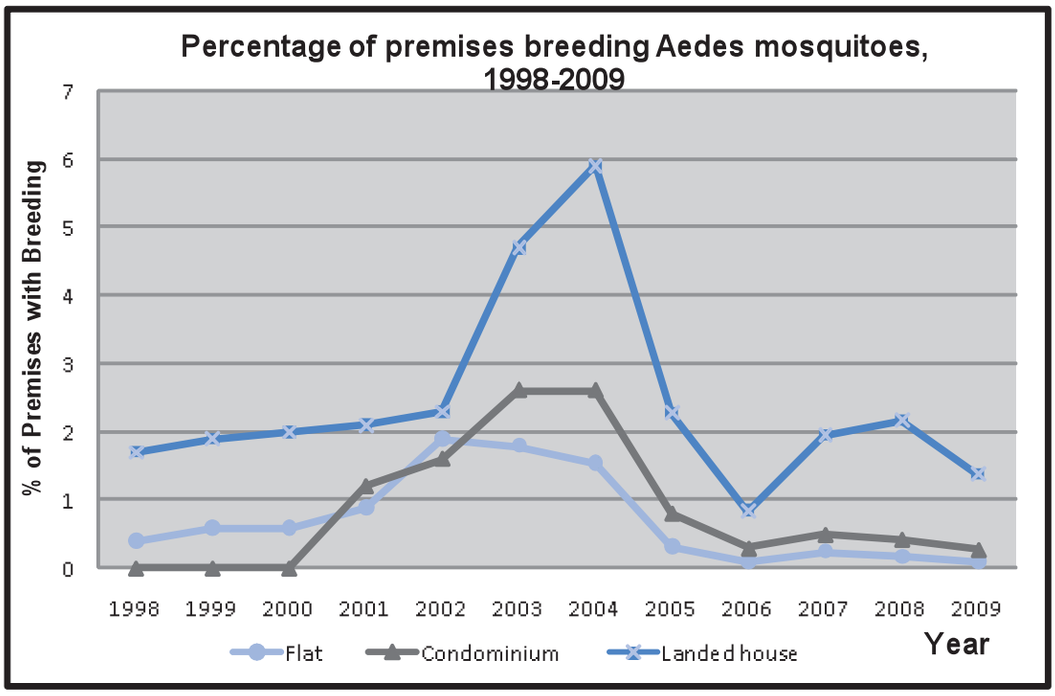
(Source: National Environment Agency)

Figure 2.8
Geographical distribution of *Aedes albopictus*, *Aedes aegypti* and dengue cases, 2009



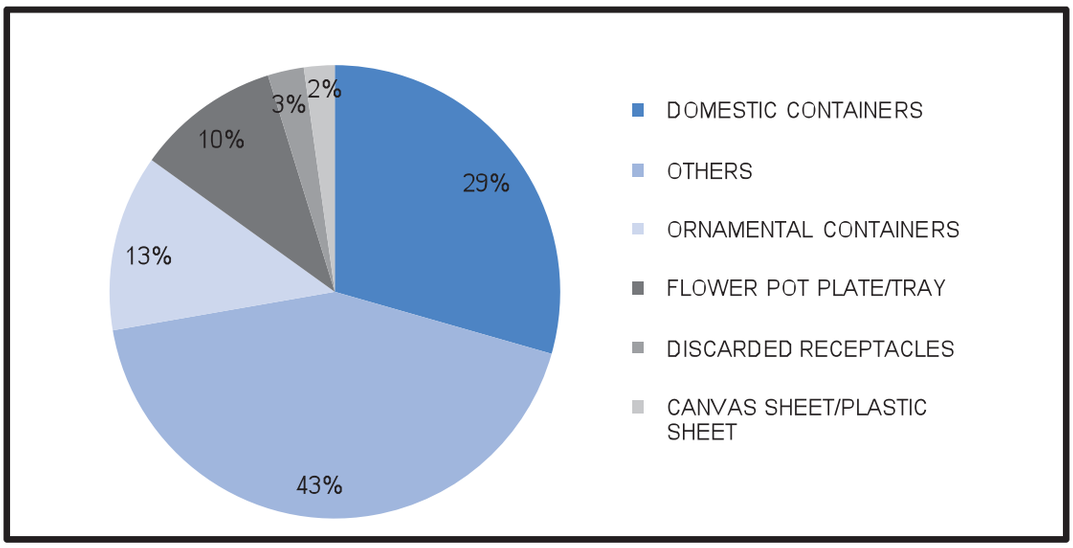
(Source: National Environment Agency)

Figure 2.9
Percentage of premises breeding *Aedes* mosquitoes, 1998 – 2009



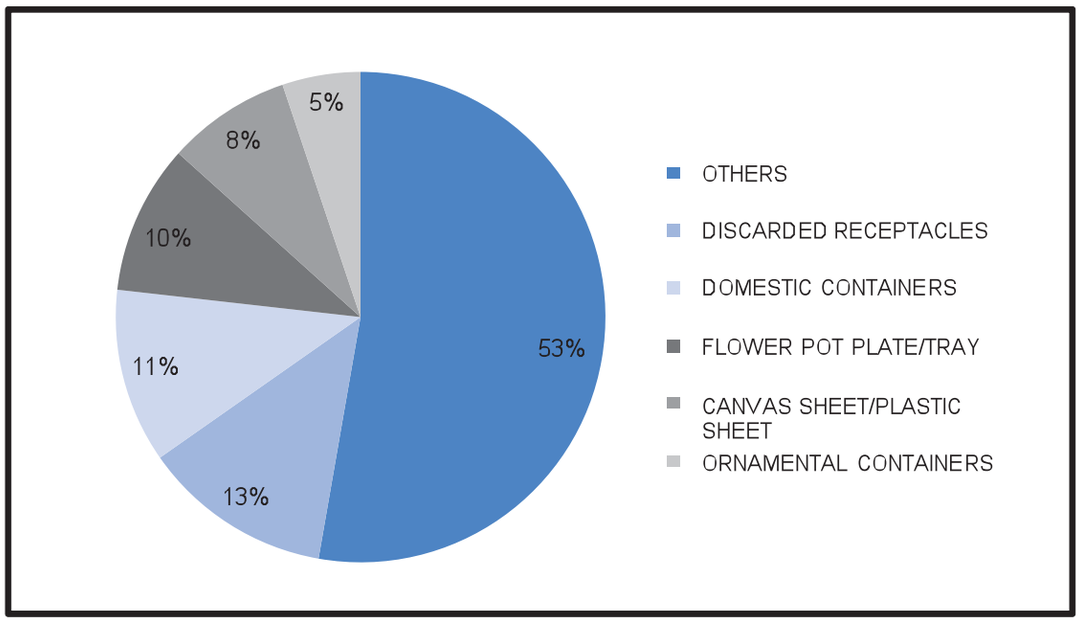
(Source: National Environment Agency)

Figure 2.10
Distribution of *Aedes aegpyti* by top five breeding habitats, 2009



(Source: National Environment Agency)

Figure 2.11
Distribution of *Aedes albopictus* by top five breeding habitats, 2009

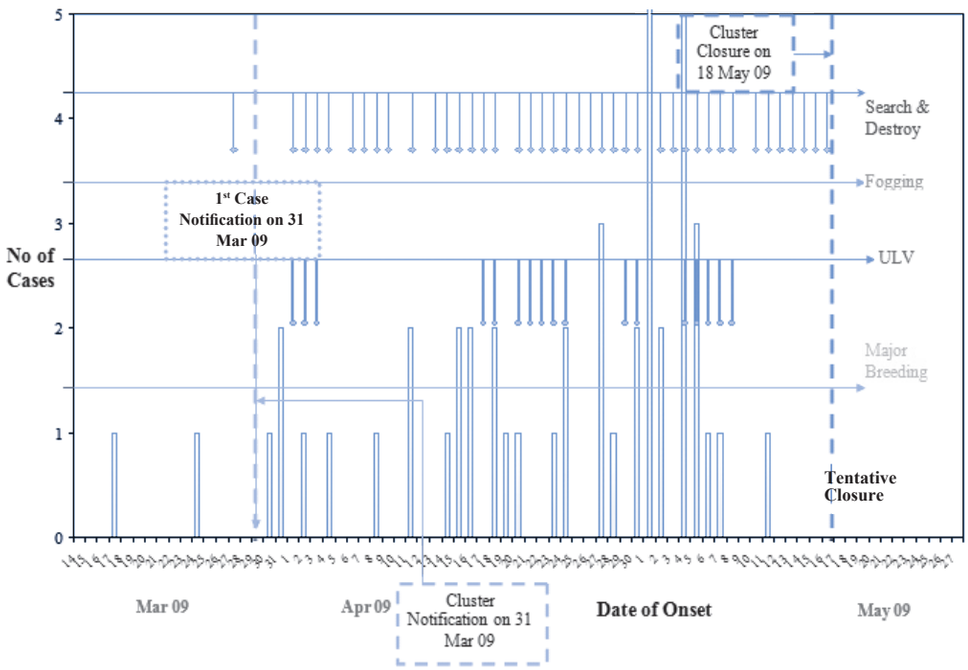


(Source: National Environment Agency)

Outbreak of Dengue fever at West Coast Drive

On 31 Mar 2009, the Ministry of Health was notified of a case of dengue fever residing in West Coast Drive. Within one week, another case among residents in the same area was reported. As soon as the cluster was identified, epidemiological investigations and vector control were carried out. A total of 42 serologically confirmed cases were identified in the outbreak. All of them had onset spacing of illness all between 17 Mar 2009 and 04 May 2009. The epidemic curve is shown in Figure 2.12.

Figure 2.12
Time distribution of 42 DF/DHF cases in West Coast Dr (Blk 95, 113A) / West Coast Lane / West Coast Pl / West Coast Ter, March – May 2009



A breakdown by occupation showed that the cases comprised of 18 working adults, 7 students, 1 housewife, 4 retirees and 1 unemployed (Note that 11 of the cases were not tagged with occupation). The majority of the cases were in the 15-34 years age group (50%). The female to male ratio was 1:3.

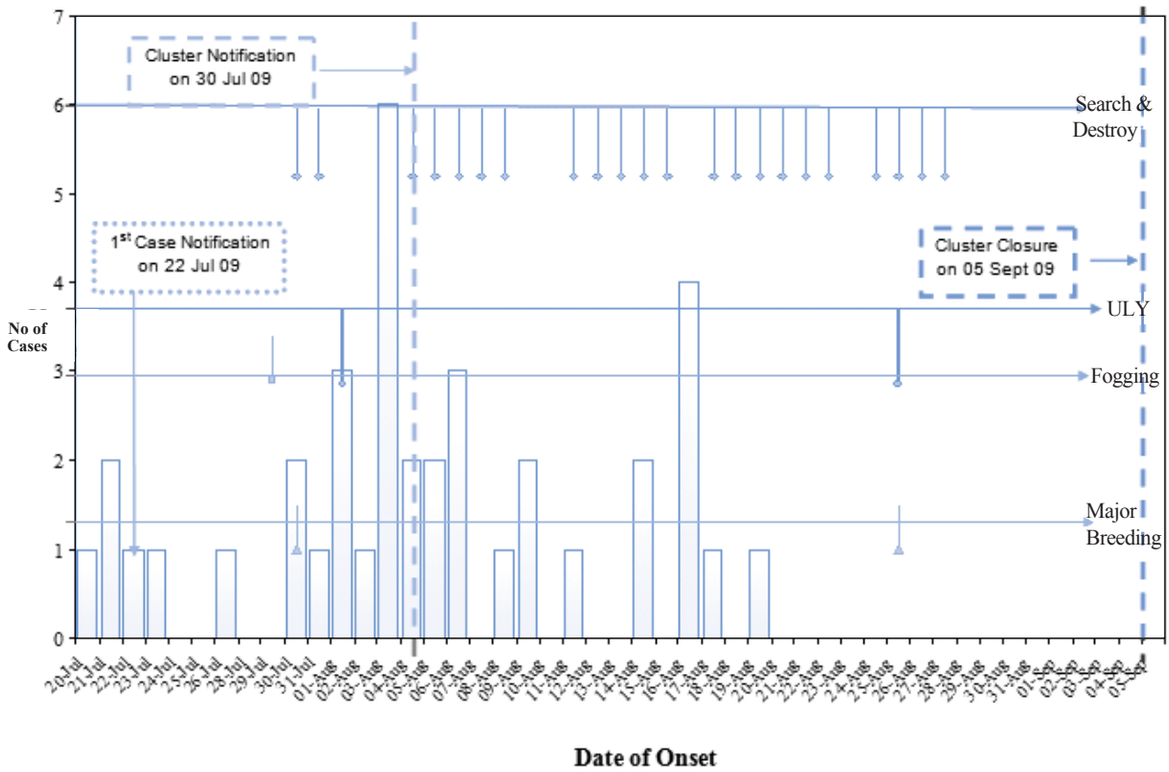
Of these 42 cases, 16.7% were non-Singaporean cases. All of the cases were clustered by residential/workplace addresses within a 150-metre radius from the initial focus of transmission (Figure 2.13). As part of vector control operations, a total of 72 mosquito breeding habitats were identified and destroyed. 40.3% of the breeding habitats were found in domestic containers (containers, pails etc) and 26.4% were found in ornamental containers (flower vase, pots etc). It was noted that most of the breeding habitats were detected in residential premises. *Aedes aegypti* and *Aedes albopictus* accounted for 60% and 36% of the breeding respectively. 4% of culex breeding was also detected.

Figure 2.13
Geographical distribution of 42 DF/DHF cases in West Coast Dr (Blk 95, 113A) / West Coast Lane / West Coast Pl / West Coast Ter, March – May 2009

Outbreak of Dengue fever at Chay Yan Street

On 22 Jul 2009, the Ministry of Health was notified of a case of dengue fever residing in Chay Yan Street. Within one week, another case among residents in the same area was reported. As soon as the cluster was identified, epidemiological investigations and vector control were carried out. A total of 36 serologically confirmed cases were identified in the outbreak. All of them had onset spacing of illness all between 20 Jul 2009 and 19 Aug 2009. The epidemic curve is shown in Figure 2.14.

Figure 2.14
Time distribution of 36 DF/DHF cases in Chay Yan Street/Yong Siak St/Guan Chuan St/ Moh Guan Ter/Kim Tian Rd, July – August 2009



A breakdown by occupation showed that the cases comprised of 21 working adults, 2 students, 3 housewife, 2 retirees and 1 unemployed (Note that 7 of the cases were not tagged with occupation). The majority of the cases were in the >35 years age group (61.1%). The female to male ratio was 1:6.

Of these 36 cases, 72.2% were non-Singaporean cases. All of the cases were clustered by residential/ workplace addresses within a 150-metre radius from the initial focus of transmission (Figure 2.15). A total of 9 mosquito breeding habitats were identified and destroyed. Profuse breeding (999ph) was detected in a double slab deck in the construction site at Chay Yan St. This profuse breeding was the key source of the outbreak of the cluster.

Aedes aegypti and Aedes albopictus accounted for 22% and 56% of the breeding respectively. 22% of culex breeding was also detected.

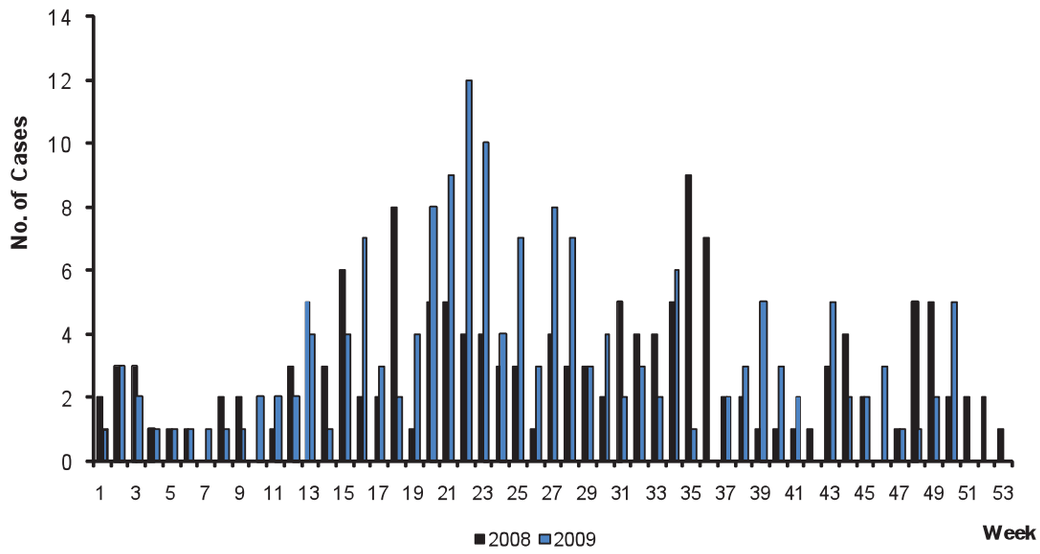
Figure 2.15
Geographical distribution of 36 DF/DHF cases in Chay Yan Street/Yong Siak St/Guan Chuan St/ Moh Guan Ter/Kim Tian Rd, July – August 2009

MALARIA

Malaria is a parasitic disease characterised by fever and chills. Most serious malarial infections may present with cough, diarrhoea, respiratory distress and headache. The infectious agent is a protozoan parasite, *Plasmodium*, and there are four different species namely, *P. vivax, P.malariae, P. faciparum* and *P. ovale*. The mode of transmission is via a bite of an infective female Anopheles mosquito.

In 2009, a total of 172 laboratory-confirmed cases were reported, an increase of 13.2% compared to the 152 cases reported in 2008 (Figure 2.16). 16.8% of the cases were reportedly acquired - locally, an increase of 16.1% compared to the previous year. There were six cases of simian malaria involving five locals and one foreigner. There were five local residents of which three acquired their infection while trekking in Malaysia at separate occasions while two were infected during their separate jungle trainings at Brunei. A total of 53 local residents affected, 27 were classified as imported and 26 classified as indigenous. The remaining were 75 foreigners worked in Singapore, 23 foreigners seeking medical treatment in Singapore, three student pass holders and 18 tourists.

Figure 2.16
E-weekly distribution of reported malaria cases, 2008-2009



Among the 131 reported cases of malaria, the age-specific incidence rate was highest in the 15-24 years age group. The male to female ratio was 9.4:1 (Table 2.14). Among the three major ethnic groups, the incidence rate was highest for Malays, followed by Indians and Chinese (Table 2.15).

Table 2.14
Age-gender distribution and age-specific incidence rates of reported malaria cases, 2009 ^

Age Group	Male	Female	Total (%)	Incidence rate per 100,000 population*
0 – 4	0	0	0 (0.0)	0.0
5 – 14	0	2	2 (1.5)	0.4
15 – 24	35	7	42 (32.1)	5.3
25 – 34	42	2	44 (33.6)	4.1
35 – 44	21	1	22 (16.8)	2.5
45 – 54	15	0	15 (11.4)	2.2
55+	5	1	6 (4.6)	0.7
Total	**118**	**13**	**131 (100.0)**	**2.6**

^Excluding 23 foreigners seeking medical treatment in Singapore and 18 tourists.
*Rates are based on 2009 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 2.15
Ethnic-gender distribution and ethnic-specific incidence rates of reported malaria cases^, 2009

	Male	Female	Total (%)	Incidence rate per 100,000 population*
Singapore Resident				
Chinese	14	2	16 (12.2)	0.6
Malay	5	1	6 (4.6)	1.2
Indian	2	1	3 (2.3)	0.9
Others	3	2	5 (3.8)	4.2
Foreigner	91	10	101 (77.1)	8.1
Total	**115**	**16**	**131 (100.0)**	**2.6**

^Excluding 23 foreigners seeking medical treatment in Singapore and 18 tourists.
*Rates are based on 2009 estimated mid-year population.
(Source: Singapore Department of Statistics)

Malaria parasite species

The distribution of the cases by parasite species was *P. vivax* (77.8%), *P. falciparum* (20.5%), *P. malariae* (0.6%) and mixed infection (1.2%). (Table 2.16).

Table 2.16
Classification of reported malaria cases by parasite species, 2009 *

Classification	Parasite species				Total (%)
	P.v.	P.f.	P.m.	Mixed (P.v. & P.k.)	
Imported**	100	34	1	2	137 (82.5)
Introduced	0	0	0	0	0 (0.0)
Indigenous	29	0	0	0	29 (17.5)
Cryptic	0	0	0	0	0 (0.0)
Induced	0	0	0	0	0 (0.0)
Total	**129**	**34**	**1**	**2**	**166 (100.0)**

P.v. - *Plasmodium vivax* P.m. - *Plasmodium malariae* P.f. - *Plasmodium falciparum*

*Exclude six simian malaria cases involving Singaporeans
**Including relapsed and induced cases that were imported.

Overseas-acquired malaria

The majority of the malaria cases acquired overseas were infected in India (59.2%) and Indonesia (21.2%). *P. vivax* accounted for 92.6% and 87.5% of the infections acquired in India and Malaysia respectively and *P. falciparum* accounted for 77.8% and 65.5% of the infections acquired in African region and Indonesia respectively. (Table 2.17).

Table 2.17
Imported malaria cases by country of origin and by parasite species, 2009

Countries	P.v.	P.f.	P.m.	Mixed (P.v. + P.k.)	Total	%
Southeast Asia						
Indonesia	10	19	0	0	29	21.2
Malaysia	7	1	0	0	8	5.9
Myanmar	2	3	0	0	5	3.7
Thailand	1	0	0	0	1	0.7
South Asia						
Bangadeshi	2	0	0	0	2	1.5
India	75	4	0	2	81	59.2
Pakistan	1	0	0	0	1	0.7
Other Asian countries						
Papua New Guinea	1	0	0	0	1	0.7
Africa						
Algeria	1	0	0	0	1	0.7
Cameroon	0	1	0	0	1	0.7
Cote D'Ivoire	0	1	0	0	1	0.7
Mozambique	0	0	1	0	1	0.7
Nigeria	0	3	0		3	2.2
Rwanda	0	1	0	0	1	0.7
Tanzania	0	1	0	0	1	0.7
Total	**100**	**34**	**1**	**2**	**137**	**100.0**

P.v. - *Plasmodium vivax* P.m. - *Plasmodium malariae* P.f. - *Plasmodium falciparum*

Most of the cases (69.9%) had onset of fever within three weeks of entry into Singapore (Table 2.18). For *P. vivax* malaria, 24.9% did not develop symptoms until more than six weeks after entry.

Table 2.18
Imported malaria cases by interval between period of entry and onset of illness and by parasite species, 2009

Interval in weeks	Parasite species				
	P.v.	P.f.	P.m.	Mixed (P.v. & P.k.)	Total (%)
<2	49	32	1	2	84 (61.8)
2 – 3	11	0	0	0	11 (8.1)
4 – 5	6	1	0	0	7 (5.2)
6 – 7	1	0	0	0	1 (0.7)
8 – 9	1	0	0	0	1 (0.7)
10 – 11	4	0	0	0	4 (2.9)
12 – 13	3	0	0	0	3 (2.2)
14 – 15	4	0	0	0	4 (2.9)
16 – 17	2	0	0	0	2 (1.5)
18 – 19	2	0	0	0	2 (1.5)
20 – 23	5	0	0	0	5 (3.7)
24 – 27	3	0	0	0	3 (2.2)
28 – 31	2	0	0	0	2 (1.5)
32 – 35	1	0	0	0	1 (0.7)
36 – 39	1	0	0	0	1 (0.7)
40+	5	0	0	0	5 (3.7)
Total	**100**	**33**	**1**	**2**	**136 (100.0)**

P.v. - *Plasmodium vivax* P.f. - *Plasmodium falciparum* P.m. - *Plasmodium malariae*

Excluding one asymptomatic case

The overseas-acquired cases comprised 22 Singapore residents (16.0 %), 69 work permit/employment pass holders (50.4%), three student pass holders (2.2 %), 23 foreigners seeking medical treatment in Singapore (16.8 %) and 18 tourists (13.1 %) (Table 2.17).

Table 2.17
Classification of imported malaria cases by population group, 2008-2009

Classification	2008		2009	
	Cases	%	Cases	%
Local Residents				
Singapore residents	25	16.6	22	16.0
Work permit/Employment pass holders	71	47.0	69	50.4
Student pass holders	7	4.6	3	2.2
Other foreigners	0	0.0	2	1.5
Foreigners seeking medical treatment	34	22.5	23	16.8
Tourists	14	9.3	18	13.1
Total	**148**	**100.0**	**137**	**100.0**

The majority of Singapore residents who contracted malaria whilst travelling overseas were on business trips or holidays. All admitted that they did not take chemoprophylaxis (Table 2.18 and 2.19).

Table 2.18
Purpose of travel for Singapore residents who contracted malaria overseas, 2005-2009

	2005	2006	2007	2008	2009
Purpose of Travel					
Social visits/holidays	35	44	23	18	14
Business	11	5	3	3	5
Military service	0	1	0	0	0
Volunteer/Missionary work	0	0	0	0	1
Employment	0	5	2	4	2
Total	**46**	**55**	**28**	**25**	**22**

Table 2.19
History of chemoprophylaxis for Singapore residents who contracted malaria overseas, 2005 - 2009

	2005	2006	2007	2008	2009
Chemoprophylaxis					
Took complete chemoprophylaxis	0	0	0	0	0
No chemoprophylaxis	45	51	28	25	22
Irregular/incomplete chemoprophylaxis	1	4	0	0	0
Total	**46**	**55**	**28**	**25**	**22**

Blood film examination for malaria parasites

A total of 1217 blood films were collected during routine epidemiological investigations and examined for malaria parasites. Of these, three was tested positive for malaria parasite which are all P. vivax (Table 2.20).

Table 2.20
Malaria Surveillance, 2009

Locality	No. of blood films examined	No. positive for malaria parasite
Jalan Gali Batu	165	0
Jurong Island	743	2
Marina Bay	69	0
Punggol	143	0
Sembawang	97	1
Total	**1217**	**3**