- Chikungunya Fever
- Dengue Fever/Dengue Haemorrhagic Fever (DF/DHF)
- Malaria

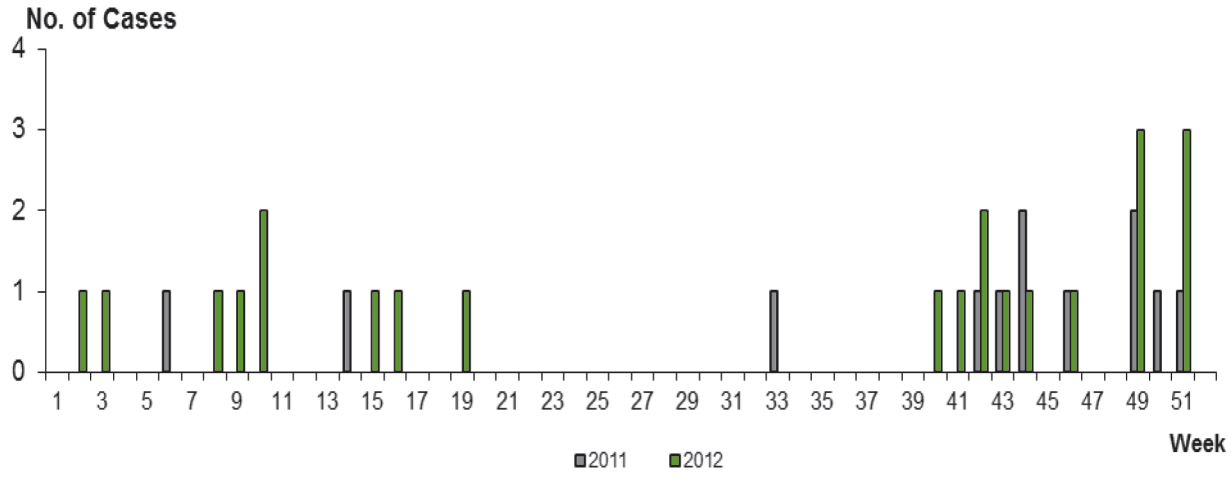
II
VECTOR-BORNE DISEASES

CHIKUNGUNYA FEVER

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

A total of 22 laboratory-confirmed cases of chikungunya fever were reported in 2012, compared to 12 cases in 2011 (Figure 2.1). Out of the 22 cases, 19 were imported cases, involving 6 Singapore residents and 13 foreign work permit holders. The remaining 3 were indigenous cases. No deaths due to chikungunya were reported in 2012.

Figure 2.1
E-weekly distribution of chikungunya fever cases, 2011 – 2012



2 of the 3 indigenous cases were in the 15-24 year age group (Table 2.1). All three indigenous cases involved foreign work permit holders (Table 2.2).

Table 2.1
Age-gender distribution and age-specific incidence rate of indigenous chikungunya fever cases^, 2012

Age (Yrs)	Male	Female	Total (%)	Incidence rate per 100,000 population*
0 – 4	0	0	0	0.0
5 – 14	0	0	0	0.0
15 – 24	1	1	2 (66.7)	0.3
25 – 34	0	0	0	0.0
35 – 44	1	0	1 (33.3)	0.1
45 – 54	0	0	0	0.0
55+	0	0	0	0.0
Total	**2**	**1**	**3 (100.0)**	**0.1**

^Cases acquired locally among Singaporeans, permanent and temporary residents.
***Rates are based on 2012 estimated mid-year population.**
(Source: Singapore Department of Statistics)

Table 2.2
Ethnic-gender distribution and ethnic-specific incidence rate of indigenous chikungunya fever cases^, 2012

	Male	Female	Total (%)	Incidence rate per 100,000 population*
Singapore Resident				
Chinese	0	0	0	0
Malay	0	0	0	0
Indian	0	0	0	0
Others	0	0	0	0
Foreigner	2	1	3 (100.0)	0.2
Total	**2**	**1**	**3 (100.0)**	**0.1**

^Cases acquired locally among Singaporeans, permanent and temporary residents.
***Rates are based on 2012 estimated mid-year population.**
(Source: Singapore Department of Statistics)

There were 19 (86.4%) imported cases, defined as residents and non-residents with a history of travel to chikungunya-endemic countries within twelve days prior to the onset of illness. 12 (63.2%), 5 (26.3%) and 2 (10.5%) cases were from India, Indonesia and the Philippines respectively (Table 2.3).

Table 2.3
Imported chikungunya fever cases, 2008 – 2012

	Year				
	2008	2009	2010	2011	2012
Southeast Asia					
Cambodia	1	0	0	0	0
Thailand	0	2	0	0	0
Myanmar	0	2	0	0	0
Malaysia	166	26	2	4	0
Indonesia	6	4	6	1	5
Philippines	0	0	1	0	2
South Asia					
India	4	30	11	3	12
Sri Lanka	2	0	0	0	0
Maldives	0	2	0	0	0
Other Regions	2	0	0	1	0
Total	**181**	**66**	**20**	**9**	**19**

The geographical distribution of indigenous chikungunya fever cases and *Aedes albopictus* is as follows (Figure 2.2).

Figure 2.2
Geographical distribution of indigenous chikungunya fever cases and Aedes albopictus, 2012

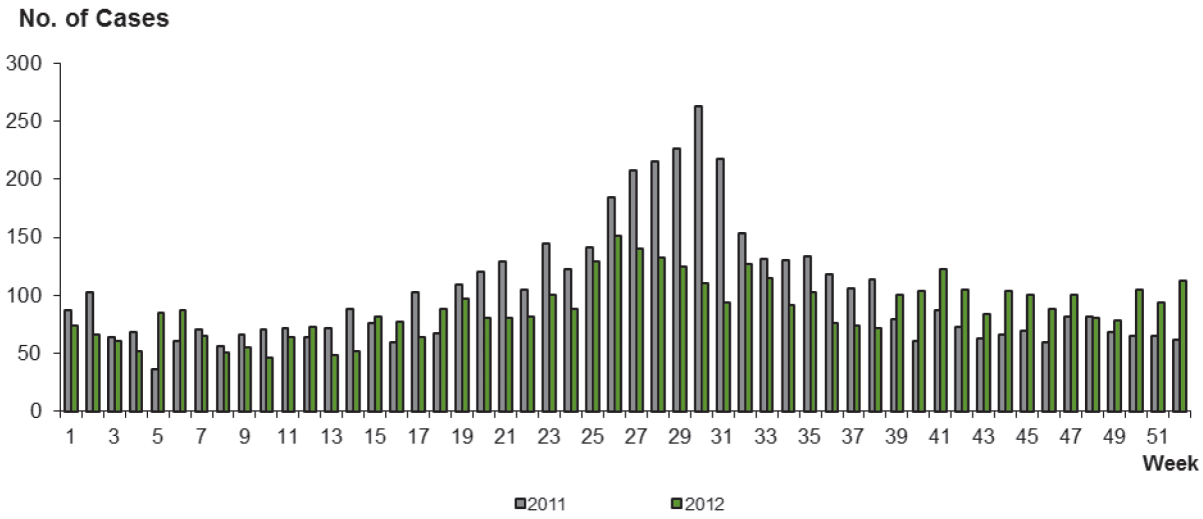
(Source: National Environment Agency)

DENGUE FEVER/DENGUE HAEMORRHAGIC FEVER (DF/DHF)

Dengue fever is an acute febrile viral disease characterised by a sudden onset of fever, headache, myalgia, arthralgia, retro-orbital pain and rash. Early generalised erythema may occur in some cases. The infectious agents are flaviviruses comprising four serotypes (dengue virus-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 4,632 laboratory confirmed cases of DF/DHF [comprising 4,602 cases of DF and 30 cases of DHF] were reported in 2012, a decrease of 13.1% from the 5,330 DF/DHF cases reported in 2011. Of these, 2,945 were Singapore residents with 84 imported and 2,861 indigenous cases. The remaining 1,687 cases were foreigners, of whom 1,508 cases were infected locally and 179 cases acquired the infection overseas. The majority of the foreigners who had acquired the infection overseas were those who came to Singapore for medical treatment. The incidence of dengue remained 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, 2011 – 2012



The incidence rate among indigenous cases was highest in the 35 – 44 years age group, with an overall male to female ratio of 1.7:1 (Table 2.4). Among the three major ethnic groups, Chinese had the highest incidence rate, followed by Malays and Indians. Foreigners comprised 34.5% of the indigenous cases (Table 2.5).

Table 2.4
Age-gender distribution and age-specific incidence rate of indigenous DF/DHF cases^, 2012

Age (Yrs)	Male	Female	Total (%)	Incidence rate per 100,000 population*
0 – 4	19	19	38 (0.9)	17.0
5 – 14	126	82	208 (4.8)	42.8
15 – 24	487	236	723 (16.5)	91.0
25 – 34	724	367	1,091 (25.0)	91.7
35 – 44	626	287	913 (20.9)	97.5
45 – 54	332	231	563 (12.9)	77.3
55+	411	422	833 (19.0)	87.2
Total	**2,725**	**1,644**	**4,369 (100.0)**	**82.2**

^Cases acquired locally among Singaporeans, permanent and temporary residents.
***Rates are based on 2012 estimated mid-year population.**
(Source: Singapore Department of Statistics)

Table 2.5
Ethnic-gender distribution and ethnic-specific incidence rate of indigenous DF/DHF cases^, 2012

	Male	Female	Total (%)	Incidence rate per 100,000 population*
Singapore Resident				
Chinese	1,230	999	2,229 (51.0)	78.7
Malay	178	124	302 (7.0)	59.3
Indian	102	83	185 (4.2)	52.7
Others	89	56	145 (3.3)	115.4
Foreigner	1,126	382	1,508 (34.5)	100.9
Total	2,725	1,644	4,369 (100.0)	82.2

^Cases acquired locally among Singaporeans, permanent and temporary residents.
*Rates are based on 2012 estimated mid-year population.
(Source: Singapore Department of Statistics)

There were 84 (1.8%) imported cases, defined as local residents with a history of travel to endemic areas within seven days prior to the onset of illness. The majority of these cases (76.2%) had travelled to Southeast Asian countries: 25 to Indonesia, 17 to Malaysia, 10 to Thailand, 4 to Philippines, 4 to Cambodia, 3 to East Timor, 1 to Vietnam (Table 2.6).

Table 2.6
Imported DF/DHF cases, 2008 – 2012

	Year				
	2008	2009	2010	2011	2012
Southeast Asia					
Brunei	0	1	0	0	0
Cambodia	4	3	0	2	4
East Timor	1	1	1	1	3
Indonesia	40	19	42	17	25
Laos	0	1	0	0	0
Malaysia	42	32	34	7	17
Myanmar	1	1	0	0	0
Philippines	4	3	9	6	4
Thailand	15	2	11	8	10
Viet Nam	8	4	6	3	1
South Asia					
Bangladesh	2	0	0	0	0
China	0	0	0	0	2
India	13	9	26	8	9
Maldives	1	0	0	0	4
Nepal	0	1	0	0	0
Pakistan	0	0	0	0	0
Sri Lanka	1	0	1	0	1
Other Regions	11	6	6	2	4
Total	**143**	**83**	**136**	**54**	**84**

Residents in Housing & Development Board (HDB) flats, compound houses and condominiums constituted 69.6%, 18.6% and 9.9% of the cases respectively. The incidence rate of residents of compound houses (160.1 per 100,000) was three times more as compared to residents living in HDB flats (58.1 per 100,000) (Table 2.7).

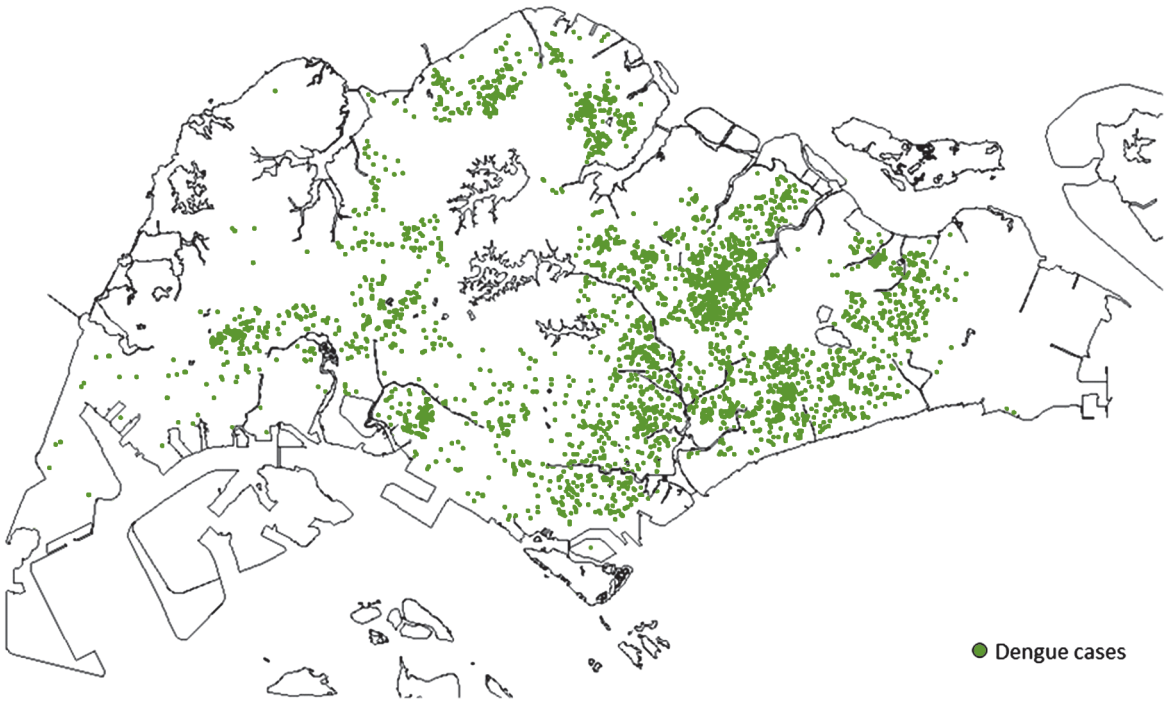
Table 2.7
Incidence rates of reported indigenous DF/DHF cases by housing type for Singapore residents, 2012

Housing Type	No.	%	Incidence rate per 100,000 population*
Compound houses (including shophouses)	533	18.6	160.1
HDB Flats	1,992	69.6	58.1
Condominiums	284	9.9	55.1
Others	52	1.8	156.7
Total	2,861	100.0	66.4

*Rates are based on census of population 2010.
(Source: Singapore Department of Statistics)

Though cases were concentrated in the 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 DF/DHF cases, 2012



A total of 328 clusters involving 1,403 epidemiologically linked cases were identified. The median number of cases in each cluster was 3 (range 2 to 123) and the median duration of transmission was 6 days (range 1 to 59) (Table 2.8). The number of clusters decreased by 24.2% compared to the previous year.

Table 2.8
Dengue clusters identified, 1990 – 2012

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	4,187	392	1,456 (34.8)	17 (4.3)	3	7
2010	4,978	406	1,858 (37.3)	29 (7.1)	3	7
2011	5,099	433	1,904 (37.3)	32 (7.4)	3	7
2012	4,369	328	1,403 (30.9)	21 (6.4)	3	6

***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 328 clusters identified, there were 21 clusters (6.4%) which had 10 or more cases. They were in the areas listed in Table 2.9. The median number of cases in these 21 clusters was 23 (range 10 to 123) and the median duration of transmission was 23 days (range 10 to 59).

Table 2.9
Dengue clusters identified, 2012 (10 or more cases)

S/No.	Location	No. of cases	Month
1	Lor K, L, M, N Telok Kurau / Telok Kurau Rd / East Coast Rd / Dunbar Rd, Walk / Kurau Gr, Pl / Construction site @ St Patrick's Rd / St Patrick's Rd / Jln Tenggiri / Coldstream Ave	123	Dec – Feb 13
2	Woodlands Ave 4 (Blk 610, 612, 614, 615, 616) / Woodlands Dr 50 (Blk 895A, 896A, 896B, 897A, 897B, 897C, 898A, 898B, 899A, 899B, 899C) / Woodlands Ring Rd (Blk 609)	57	Dec – Feb 13
3	Ang Mo Kio Ave 5 (Blk 537, 538) / Ang Mo Kio Ave 10 (Blk 531, 534, 536, 539, 540, 541, 542, 543, 544, 545, 546, 547, 549, 550, 552, 553, 554, 556)	55	Apr – Jun
4	Construction site at Ang Mo Kio Ave 5	48	Apr - May
5	Jln Rahmat / Jln Yasin / Lor Marican / Lor Marzuki / Lor Melayu / Lor Mydin / Lor Sarina	40	Jun – Jul
6	Da Silva Ln / Florence Rd / Jln Arif / Kang Choo Bin Rd / Kovan Rd / Lowland Rd / Poh Huat Dr, Rd / Robey Cres / Simon Ln, Pl	40	Jun – Jul
7	Elias Green, Ter / Pasir Ris Gr	37	Jul – Aug
8	Clementi Ave 1 (Blk 402, 403, 404, 405, 407, 408, 409, 421) / Clementi Ave 2 (Blk 365) / Clementi Ave 3 (Blk 457, 459, 461) / Commonwealth Ave West (Blk 411, 413)	30	Sep – Nov
9	Ang Mo Kio Ave 2-5 (Blk 602, 603, 605, 606, 608, 609, 611) / Serenade Walk / Yio Chu Kang Gdns / Yio Chu Kang Rd	29	Feb – Mar
10	Aroozoo Ln / Construction site @ Hougang St 11 / Hougang St 11 (Blk 154, 155, 161) / Jln Geneng / Surin Ave	24	Nov
11	Mimosa Cres / Mimosa Rd / Nim Rd / Stralton Dr	23	Oct – Nov
12	Yishun Ave 11 (Blk 349, 350, 350A, 351) / Yishun Ring Rd (Blk 353, 354, 355, 356, 357)	22	Apr – May
13	Aida St / Bedok South Rd / Carmen St, Ter / Dafne St / Dido St / Ernani St / Fidelio St / Figaro St / Jln Tua Kong / Jln Ulu Siglap / Lakme St, Ter / Lorong Abu Talib / Rienzi St / Tosca St, Ter / Tua Kong Green, Pl, Ter, Walk / Woo Mon Chew Rd	18	Jan – Feb
14	Hougang Ave 5 (Blk 324, 328) / Hougang Ave 7 (Blk 31, 37, 337, 339, 341, 346, 351, 355)	18	Sep – Oct
15	Jln Geneng / Kampong Sireh / Surin Ave / Surin Rd / Construction site @ Hougang St 11 / Hougang St 11 (Blk 155) / Upper Serangoon Rd	18	Oct
16	Lor 4 Toa Payoh (Blk 58, 81A, 81B) / Lor 5 Toa Payoh (Blk 50, 53, 55, 58, 59)	15	Jun – Jul
17	Kang Choo Bin Rd / Da Silva Ln / Poh Huat Dr, Rd / Simon Pl	14	Jun
18	Clementi Ave 1 (Blk 401, 402, 404, 406, 422) / Clementi Ave 3 (Blk 456, 459, 460, 461)	13	Nov
19	Mimosa Cres / Mimosa Rd / Nim Rd	11	Nov
20	Yishun Ave 9 (Blk 245, 247, 249, 250) / Yishun Ring Rd (Blk 253, 254)	10	Jun – Jul
21	Hougang Ave 6 (Blk 429, 430, 520, 525, 527, 529, 533)	10	Aug

Dengue Deaths

A total of two fatal cases were reported in 2012. One was an indigenous infection involving a local resident while the other case is a local resident who contracted the infection overseas.

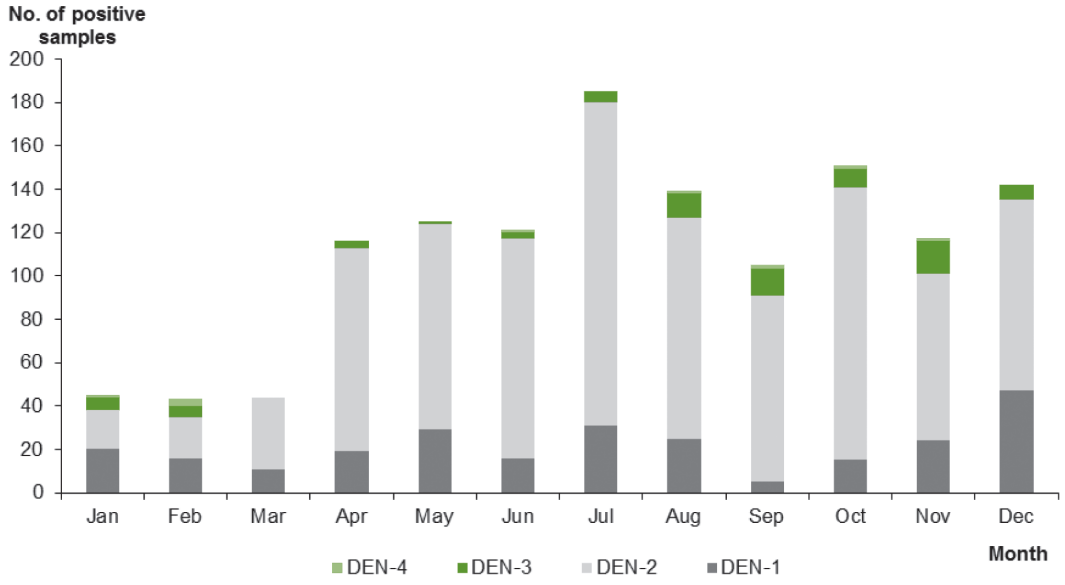
Laboratory Surveillance

A total of 1,333 blood samples obtained from both inpatients and outpatients tested positive for dengue virus by PCR at the Singapore General Hospital Department of Pathology, Environmental Health Institute, Tan Tock Seng Hospital Department of Pathology and Laboratory Medicine, National University Hospital Laboratory, Changi General Hospital, KK Women's and Children's Hospital Laboratory and Khoo Teck Puat Hospital Laboratory.

All four dengue serotypes were detected, comprising DENV1 (19.4%), DENV2 (74.1%), DENV3 (5.7%) and DENV4 (0.8%) (Figure 2.5 & 2.6).

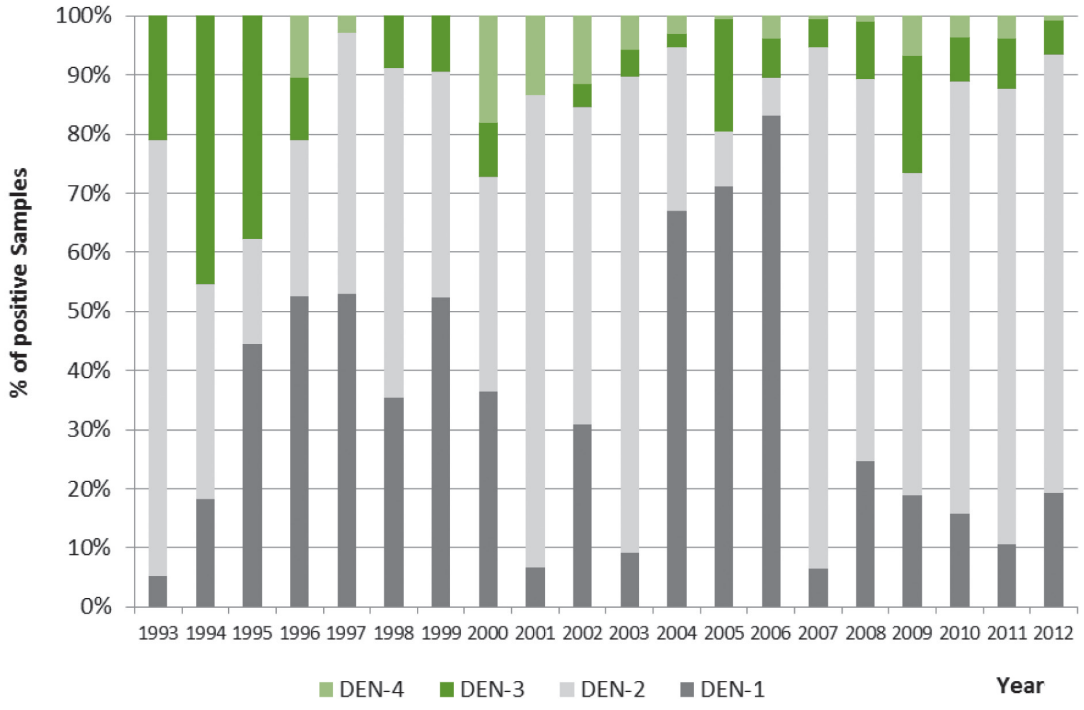
DENV2 remained the predominant circulating serotype since 2007 (Figure 2.6).

Figure 2.5
Surveillance of dengue virus serotypes, 2012



(Source: Singapore General Hospital Department of Pathology, Environmental Health Institute, Tan Tock Seng Hospital Department of Pathology and Laboratory Medicine, National University Hospital Laboratory, Changi General Hospital, KK Women's and Children's Hospital Laboratory and Khoo Teck Puat Hospital Laboratory)

Figure 2.6
Surveillance of dengue virus serotypes, 1993 – 2012



(Source: Singapore General Hospital Department of Pathology, Environmental Health Institute, Tan Tock Seng Hospital Department of Pathology and Laboratory Medicine, National University Hospital Laboratory, Changi General Hospital, KK Women's and Children's Hospital Laboratory and Khoo Teck Puat Hospital Laboratory)

Aedes Surveillance and Control

The NEA adopts an integrated evidence-based approach to dengue control, which consists of Vector Surveillance and Control, Laboratory Surveillance and Research and Risk assessment, supported by Community Outreach and Mobilization together with Legislation and Enforcement. With this approach, NEA has successfully bucked the trend of dengue transmission for the past 5 years and avoided the outbreak which was expected to have occurred in 2011 and 2012.

As the key thrust of this approach is pre-emptive source reduction, NEA has in place a preventive surveillance programme to carry out vector control operations island-wide to detect and destroy mosquito breeding habitats. Since Nov 2011, NEA also embarked on a new engagement plan that further enhances its existing dengue control operations by incorporating deeper education and outreach efforts into routine inspection visits by vector control officers. These educational visits were conducted to create greater awareness on dengue and the potential mosquito breeding spots in their homes.

Another key measure of NEA's dengue control strategy is the annual Intensive Source Reduction Exercise (ISRE) which is carried out in phases throughout the year targeting different premise types. NEA has also developed a set of Focus Areas for 2012, where focus will be placed on inspection of areas with past records of high numbers of *Aedes aegypti* mosquito breeding sites, low herd immunity to DENV2 virus serotype, high number of foreign workers and migrant workers and concentration of construction activities.

NEA also leads the Inter-Agency Dengue Taskforce that coordinates source reduction efforts undertaken by the community, government agencies and the private sector. In 2012, NEA together with other land agencies, Town Councils and their pest control operators carried out ISREs successfully and managed to mitigate the increase in dengue cases.

In 2012, NEA continues to adopt a containment strategy to prevent a non-predominant serotype from gaining predominance. Intensive surveillance is carried out in areas with emerging DENV 1, DENV 3 and DENV 4 serotypes, to prevent the new serotypes from gaining a foothold in Singapore.

In 2012, NEA inspected some 5.88 million premises (including residential and all other types of premises such as schools, factories, shop houses etc), and carried out over 112,000 ground surveys (in ground and Town Council maintained areas). In addition, more than 1,800 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 0.28%, with the highest percentage detected in compound houses (Figure 2.9). The top five breeding habitats for *Aedes aegypti* were domestic containers (31.8%), ornamental containers (10.8%), flower pot plate/tray (10.8%), discarded receptacles (2.4%), and HDB corridor scupper/gully (2.1%) (Figure 2.10). In the case of *Aedes albopictus*, the most common breeding habitats were discarded receptacles (15.0%), flower pot plate/tray (9.7%), domestic containers (9.4%), canvas/ plastic sheets (5.7%), and ornamental containers (3.5%) (Figure 2.11). Since the implementation of a dedicated mosquito control programme in Town Councils in 2005, Aedes breeding detected in these estates had reduced from 17% in 2005 to about 3.9% in 2012.

Given the multiple causative factors for dengue infections, research is necessary to better understand these factors, so as to prevent infection and curtail disease transmission. The Environmental Health Institute (EHI) of NEA has embarked on numerous research projects that study how factors such as population immunity, virus serotypes, fitness of different dengue virus strains and weather (ambient temperature) influence dengue transmission. Many of the research outcomes have successfully supported vector control operations.

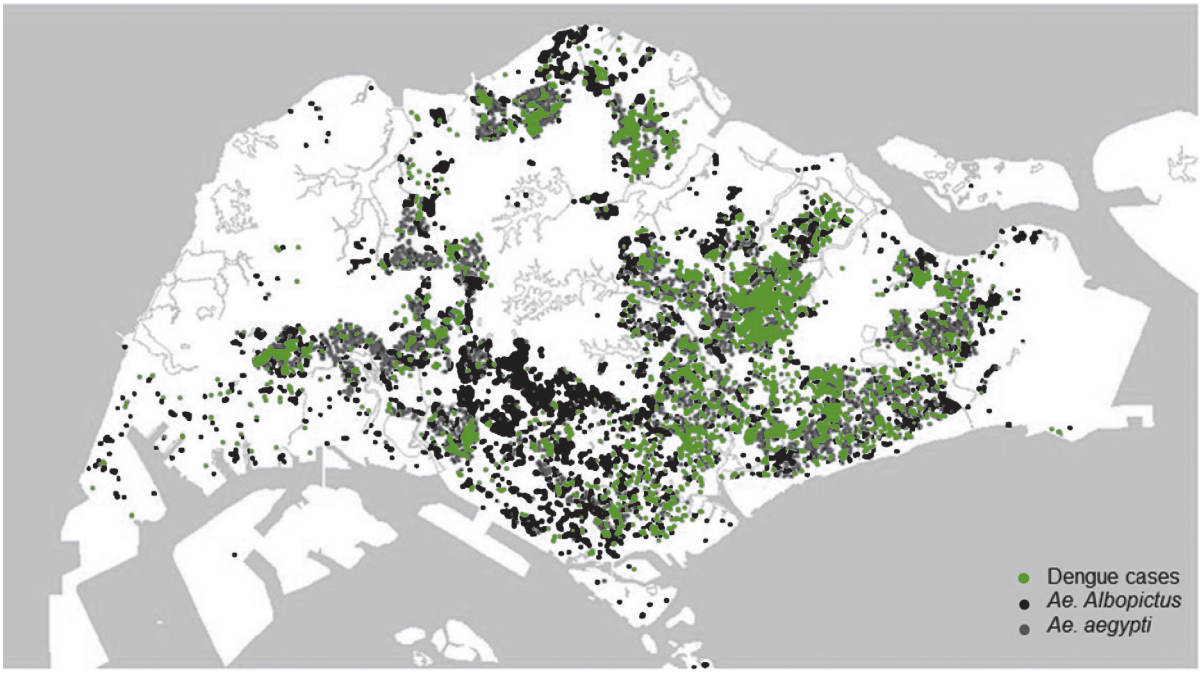
While the integrated evidence-based approach in *Aedes* surveillance and control has helped to reduce dengue transmission in Singapore in recent years, Singapore will continue to remain both vulnerable and receptive to dengue as there is a mounting pressure for a switch in virus serotype. In addition, dengue incidences follow a natural cycle of 5-7 years, with increasing incidences and intensity year on year, before collapsing at the end of the cycle. With the extensive dengue control operations, NEA successfully bucked the trend of dengue transmission, and avoided the outbreak which

was expected to have occurred in 2011 and 2012. Other challenges include low herd immunity in our population due to previous years of successful dengue control and disease transmission occurs easily even with a low mosquito population. The increase in migrants from countries non-endemic to dengue, and who therefore have little or no immunity against the disease, will also pose a challenge in suppressing the local transmission of the disease. The emergence of a more virulent strain of dengue virus could also be an important factor which could lead to dengue outbreaks.

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

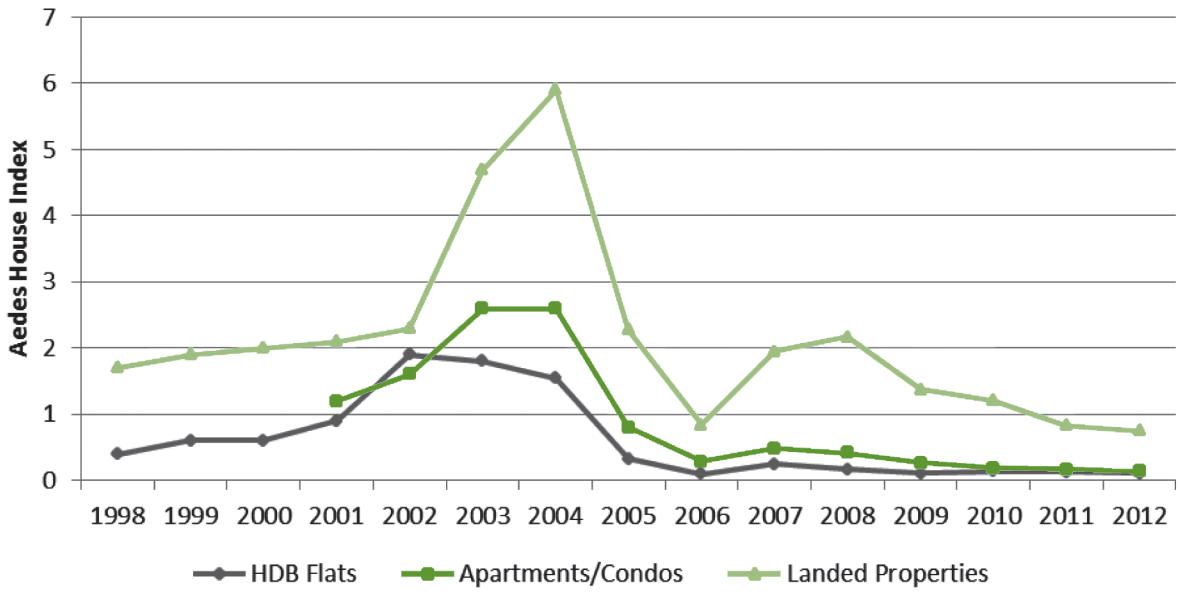
(Source: National Environment Agency)

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



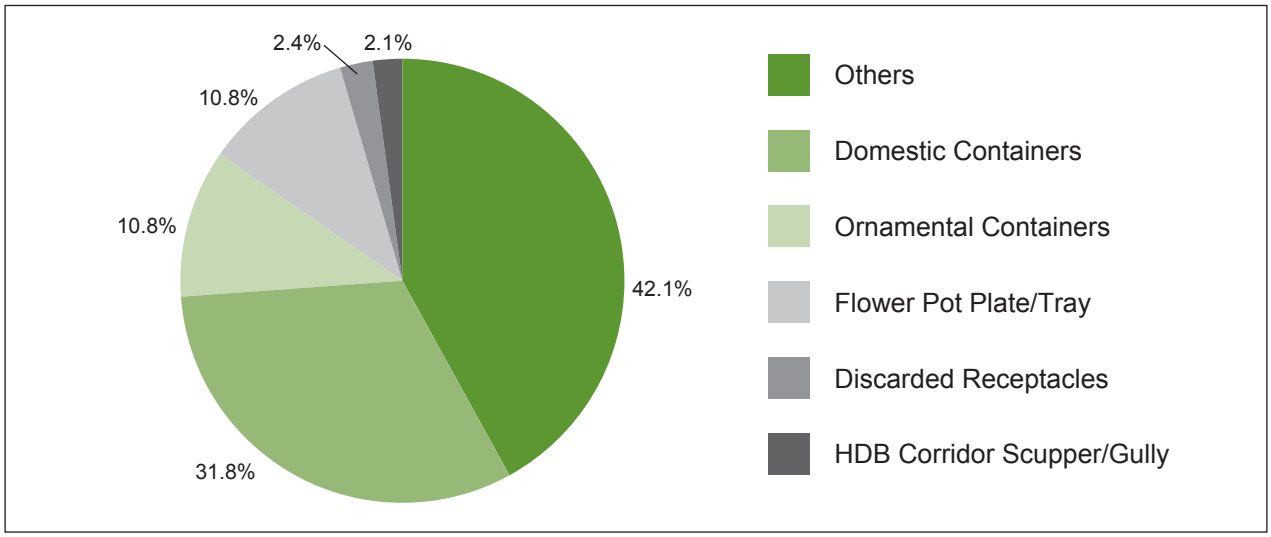
(Source: National Environment Agency)

Figure 2.9
Percentage of premises breeding *Aedes* mosquitoes, 1998-2012



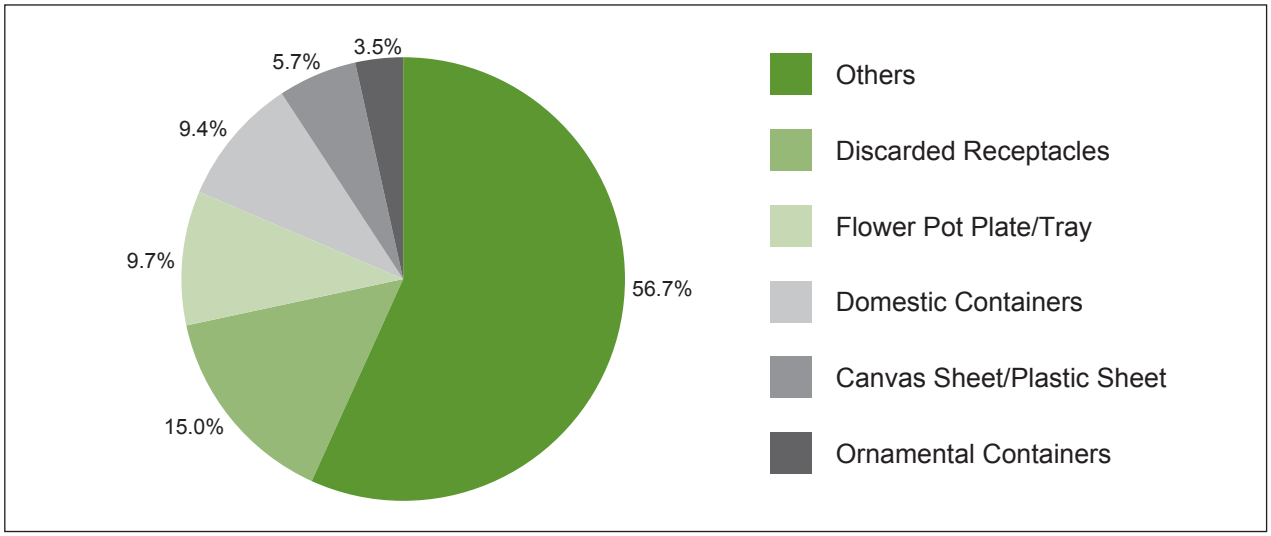
(Source: National Environment Agency)

Figure 2.10
Distribution (%) of *Aedes aegypti* by top 5 breeding habitats, 2012



(Source: National Environment Agency)

Figure 2.11
Distribution (%) of *Aedes albopictus* by top 5 breeding habitats, 2012



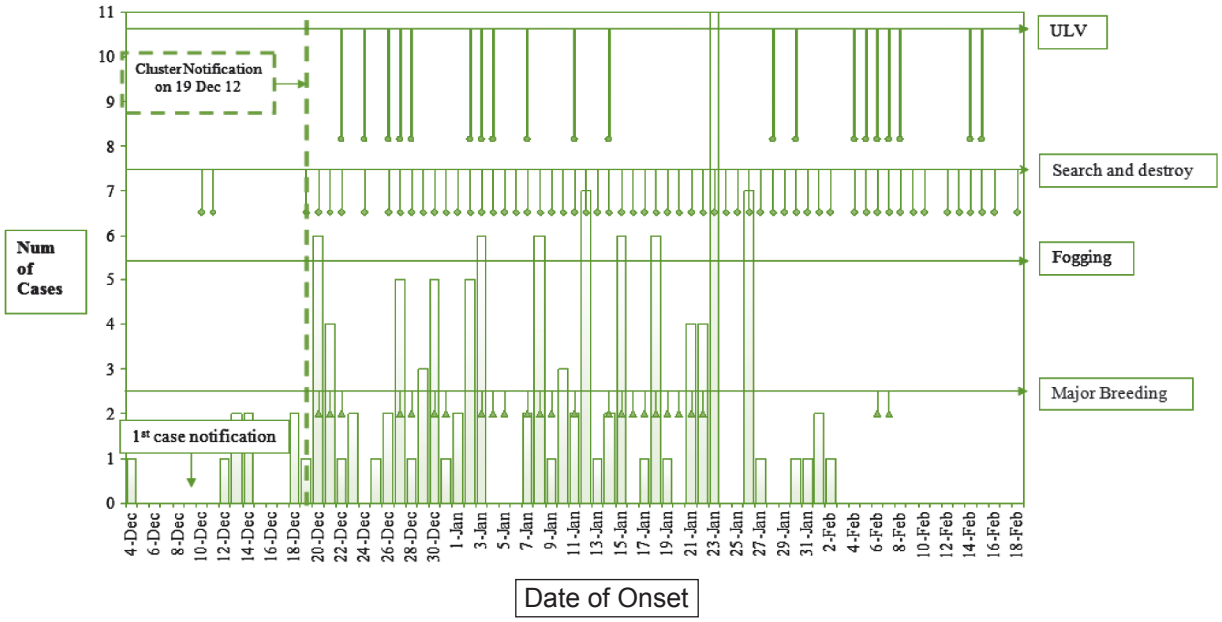
(Source: National Environment Agency)

The two largest clusters in 2012 were in Lor K, L, M, N Telok Kurau / Telok Kurau Rd / East Coast Rd / Dunbar Rd, Walk / Kurau Gr, Pl / Construction site @ St Patrick's Rd / St Patrick's Rd / Jln Tenggiri / Coldstream Ave and Woodlands Ave 4 (Blk 610, 612, 614, 615, 616) / Woodlands Dr 50 (Blk 895A, 896A, 896B, 897A, 897B, 897C, 898A, 898B, 899A, 899B, 899C) / Woodlands Ring Rd (Blk 609) with a total of 123 cases and 57 cases respectively.

Outbreak of Dengue fever at Lor K, L, M, N Telok Kurau / Telok Kurau Rd / East Coast Rd / Dunbar Rd, Walk / Kurau Gr, Pl / Construction site @ St Patrick's Rd / St Patrick's Rd / Jln Tenggiri / Coldstream Ave

On 9 Dec 2012, the Ministry of Health was notified of a case of dengue fever residing in Lorong N Telok Kurau area. Within one week, another case in the same area was reported. As soon as the cluster was identified, epidemiological investigations and vector control were carried out. A total of 123 serologically confirmed cases were identified in the outbreak. All the cases had onset dates between 4 Dec 2012 and 2 Feb 2013. The epidemic curve is shown in Figure 2.12.

Figure 2.12
Time distribution of 123 DF/DHF cases in Lor K, L, M, N Telok Kurau / Telok Kurau Rd / East Coast Rd / Dunbar Rd, Walk / Kurau Gr, Pl / Construction site @ St Patrick's Rd / St Patrick's Rd / Jln Tenggiri / Coldstream Ave, Dec 2012 – Feb 2013



(Source: National Environment Agency)

A breakdown by occupation showed that the cases comprised 35 working adults, 30 students, 19 housewives, 2 domestic helpers, 6 retirees and 2 unemployed (Note that 29 of the cases were not tagged with occupation). The majority of the cases were in the 35 - 44 years age group (28.5%). The female to male ratio was 1:1.

Of these 123 cases, 35% were non-Singaporeans. Figure 2.13 shows the geographical distribution of cases in the cluster. A total of 90 mosquito breeding habitats were identified and destroyed during the vector control operations within the cluster. About 17.7% of the total breeding habitats found in the cluster were ornamental containers (flower vase, pots etc), 10.0% were flower pot plate/tray and 8.8% were domestic containers (container, pails etc). 93.3% of the breeding sites were detected in homes. The two largest breeding sites of about 200 larvae each, detected in a sump pit and a closed perimeter drain in two construction sites, could have contributed to the spread of dengue cases in the area. Overall, *Aedes aegypti* and *Aedes albopictus* accounted for 44.1% and 42.2% of the breedings respectively.

The majority (89.5%) of the samples serotyped in the cluster was DENV1. The rapid spread of dengue in the area was attributed to the high indoor breeding detected and the presence of DENV1, which most residents were not immune to.

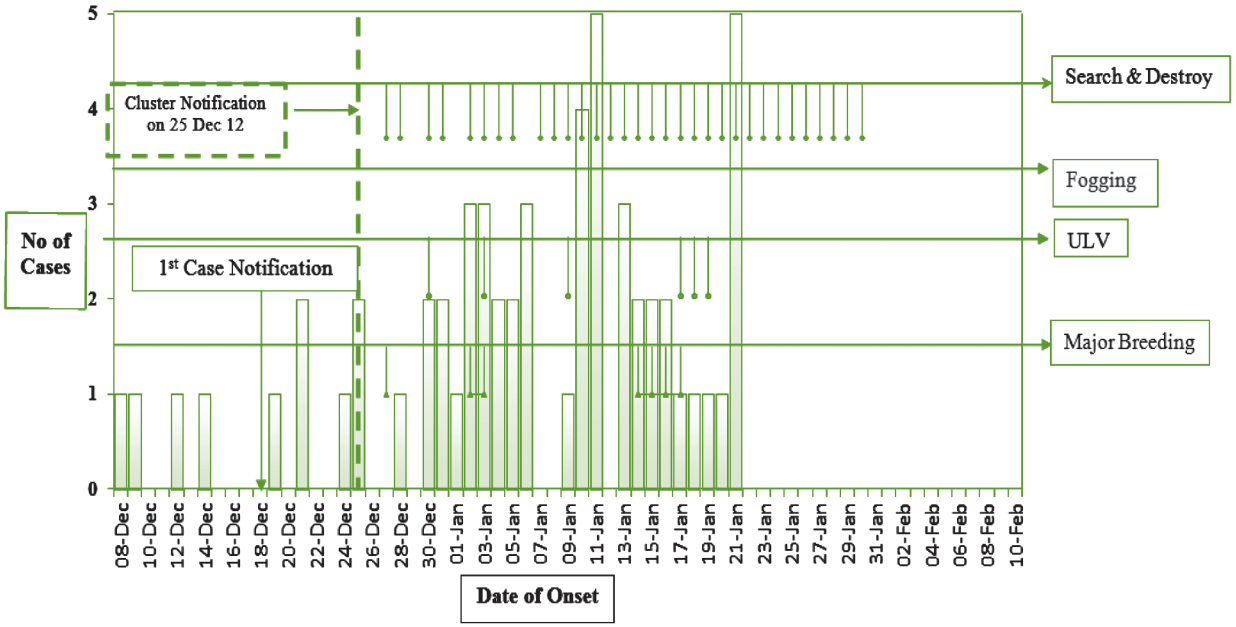
Figure 2.13
Geographical distribution of 123 DF/DHF cases in Lor K, L, M, N Telok Kurau / Telok Kurau Rd / East Coast Rd / Dunbar Rd, Walk / Kurau Gr, Pl / Construction site @ St Patrick's Rd / St Patrick's Rd / Jln Tenggiri / Coldstream Ave, Dec 2012 – Feb 2013

(Source: National Environment Agency)

Outbreak of Dengue fever at Woodlands Ave 4 (Blk 610, 612, 614, 615, 616) / Woodlands Dr 50 (Blk 895A, 896A, 896B, 897A, 897B, 897C, 898A, 898B, 899A, 899B, 899C) / Woodlands Ring Rd (Blk 609)

On 18 Dec 2012, the Ministry of Health was notified of a case of dengue fever residing at 899A Woodlands Drive 50. Within one week, another 2 cases within the vicinity were reported. As soon as the cluster was identified, epidemiological investigations and vector control were carried out. A total of 57 serologically confirmed cases were identified in the outbreak. All the cases had onset dates between 8 Dec 2012 and 21 Jan 2013. The epidemic curve is shown in Figure 2.14.

Figure 2.14
Time distribution of 57 DF/DHF cases in Woodlands Ave 4 (Blk 610, 612, 614, 615, 616) / Woodlands Dr 50 (Blk 895A, 896A, 896B, 897A, 897B, 897C, 898A, 898B, 899A, 899B, 899C) / Woodlands Ring Rd (Blk 609), Dec 2012 – Feb 2013



(Source: National Environment Agency)

A breakdown by occupation showed that the cases comprised 24 working adults, 13 students, 9 housewives, 2 retirees and 2 unemployed (Note that 7 of the cases were not tagged with occupation). The majority of the cases were in the 35 - 44 years age group (29.8%). The female to male ratio was 1:1.4.

Of these 57 cases, 53 were Singaporeans. Figure 2.15 shows the geographical distribution of cases in the cluster. A total of 81 mosquito breeding habitats were identified and destroyed. About 22.2% of the total breeding habitats found in the cluster were domestic containers (container, pails etc) and 12.3% were ornamental containers (flower vase, pots etc). 77.8% of the breeding habitats were detected in residential premises, while ground and Town council breeding constituted 22.2% of the total breeding. Two profuse breeding sites of 100ph each, detected in two water tanks, could have contributed to the spread of dengue cases in the area. Overall, *Aedes aegypti* and *Aedes albopictus* accounted for 80.0% and 17.3% of the breeding respectively.

Figure 2.15
Geographical distribution of 57 DF/DHF cases in Woodlands Ave 4 (Blk 610, 612, 614, 615, 616) / Woodlands Dr 50 (Blk 895A, 896A, 896B, 897A, 897B, 897C, 898A, 898B, 899A, 899B, 899C) / Woodlands Ring Rd (Blk 609), Dec 2012 – Feb 2013

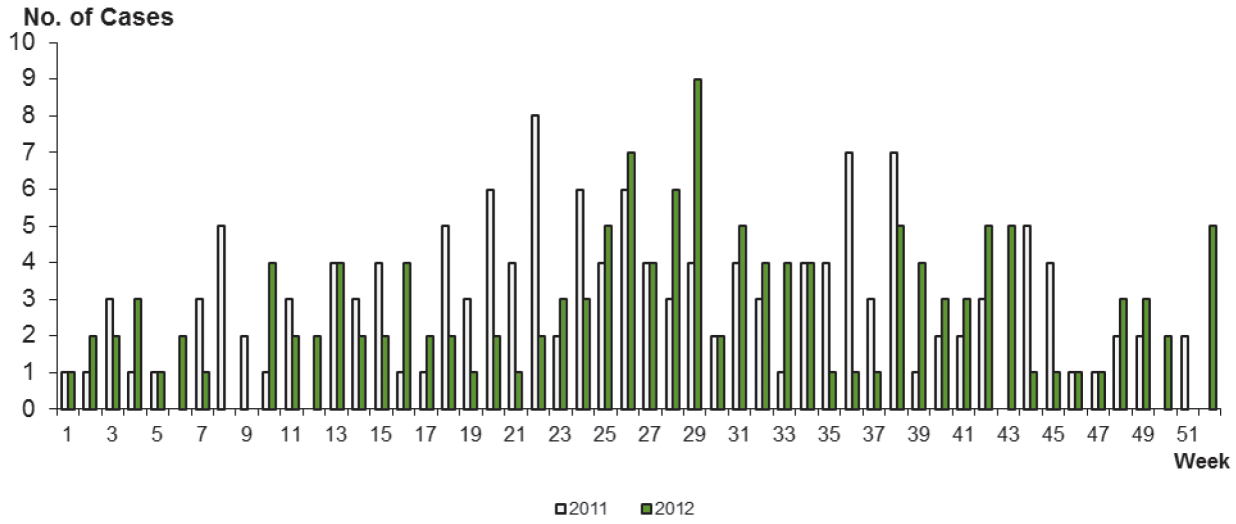
(Source: National Environment Agency)

MALARIA

Malaria is a disease caused by a protozoan parasite, *Plasmodium*. The disease is transmitted via the bite of an infective female *Anopheles* mosquito. There are four species that cause disease in humans, namely *P. vivax, P.malariae, P. falciparum and P. ovale*. In recent years, *P. knowlesi* – a species that causes malaria among monkeys and occurs in certain forested areas of South-East Asia – has also caused several human cases of malaria. Symptoms of malaria include fever, headache, chills and vomiting.

In 2012, a total of 143 laboratory-confirmed cases were reported, a decrease of 4% compared to the 149 cases reported in 2011 (Figure 2.16). All the cases were imported.

Figure 2.16
E-weekly distribution of reported malaria cases, 2011-2012



The incidence rate was highest in the 25 - 34 years age group, with an overall male to female ratio of 4.4:1 (Table 2.10). Among the three major ethnic groups, Indians had the highest incidence rate, followed by Malays and Chinese (Table 2.11).

Table 2.10
Age-gender distribution and age-specific incidence rate of reported malaria cases^, 2012

Age (Yrs)	Male	Female	Total (%)	Incidence rate per 100,000 population*
0 – 4	0	0	0 (0.0)	0.0
5 – 14	1	1	2 (2.0)	0.4
15 – 24	21	5	26 (26.5)	3.3
25 – 34	42	3	45 (46.0)	3.8
35 – 44	5	4	9 (9.2)	1.0
45 – 54	8	2	10 (10.2)	1.4
55+	3	3	6 (6.1)	0.6
Total	**80**	**18**	**98 (100.0)**	**1.8**

^Excluding 21 foreigners seeking medical treatment in Singapore and 24 tourists.
***Rates are based on 2012 estimated mid-year population.**
(Source: Singapore Department of Statistics)

Table 2.11
Ethnic-gender distribution and ethnic-specific incidence rate of reported malaria cases^, 2012

	Male	Female	Total (%)	Incidence rate per 100,000 population*
Singapore Resident				
Chinese	9	2	11 (11.2)	0.4
Malay	3	2	5 (5.1)	1.0
Indian	6	2	8 (8.2)	2.3
Others	3	2	5 (5.1)	4.0
Foreigner	59	10	69 (70.4)	4.6
Total	**80**	**18**	**98 (100.0)**	**1.8**

^ Excluding 21 foreigners seeking medical treatment in Singapore and 24 tourists.
***Rates are based on 2012 estimated mid-year population.**
(Source: Singapore Department of Statistics)

Malaria parasite species

The distribution of the cases by parasite species was *P. vivax* (74.8%), *P. falciparum* (18.9%), *P. ovale* (2.8%), *P. malariae* (2.1%), *P. knowlesi* (0.7%) and mixed infection (0.7%) (Table 2.12).

Table 2.12
Classification of reported malaria cases by parasite species, 2012

Classification	Parasite species						Total (%)
	P.v.	P.f.	P.o.	P.m.	P.k.	Mixed (P.v. + P.f.)	
Imported**	107	27	4	3	1	1	143 (100.0)
Introduced	0	0	0	0	0	0	0 (0.0)
Indigenous	0	0	0	0	0	0	0 (0.0)
Cryptic	0	0	0	0	0	0	0 (0.0)
Induced	0	0	0	0	0	0	0 (0.0)
Total	**107**	**27**	**4**	**3**	**1**	**1**	**143 (100.0)**

P.v. - *Plasmodium vivax* P.f. - *Plasmodium falciparum* P.o. - *Plasmodium ovale*
P.m. - *Plasmodium malariae* P.k. - *Plasmodium knowlesi*

****Including relapsed cases that were imported.**

Imported malaria cases

The majority of cases who had acquired malaria overseas were infected in India (52.4%) and Indonesia (20.3%). *P. vivax* accounted for 97.3% and 55.2% of the infections acquired in India and Indonesia respectively and *P. falciparum* accounted for 64.7% and 37.9% of the infections acquired in the African region and Indonesia respectively (Table 2.13).

Table 2.13
Imported malaria cases by country of origin and by parasite species, 2012

Classification	Parasite species						Total (%)
	P.v.	P.f.	P.o.	P.m.	P.k.	Mixed (P.v. + P.f.)	
Southeast Asia							
Indonesia	16	11	1	0	0	1	29 (20.3)
Malaysia	2	1	0	0	1	0	4 (2.8)
Myanmar	8	0	0	0	0	0	8 (5.6)
Thailand	2	0	0	1	0	0	3 (2.1)
South Asia							
Bangladesh	1	0	0	0	0	0	1 (0.7)
China	0	1	0	0	0	0	1 (0.7)
India	73	2	0	0	0	0	75 (52.4)
Pakistan	2	0	0	0	0	0	2 (1.4)
Africa							
Angola	0	1	0	0	0	0	1 (0.7)
Central African Republic	0	1	1	0	0	0	2 (1.4)
Congo	0	1	0	1	0	0	2 (1.4)
Ghana	0	2	0	0	0	0	2 (1.4)
Liberia	0	2	0	0	0	0	2 (1.4)
Mozambique	0	1	0	0	0	0	1 (0.7)
Nigeria	1	2	1	0	0	0	4 (2.8)
Sierra Leone	0	1	0	0	0	0	1 (0.7)
Uganda	0	0	1	1	0	0	2 (1.4)
Other countries							
Papua New Guinea	2	1	0	0	0	0	3 (2.1)
Total	**107**	**27**	**4**	**3**	**1**	**1**	**143 (100.0)**

P.v. - *Plasmodium vivax* P.f. - *Plasmodium falciparum* P.o. - *Plasmodium ovale*
P.m. - *Plasmodium malariae* P.k. - *Plasmodium knowlesi*

Most of the cases (69.9%) had onset of fever within three weeks of entry into Singapore (Table 2.14). For *P. vivax* malaria, 31.8% of cases did not develop symptoms until more than six weeks after entry.

Table 2.14
Imported malaria cases by interval between period of entry and onset of illness and by parasite species, 2012

Interval in weeks	Parasite species						Total (%)
	P.v.	P.f.	P.o.	P.m.	P.k.	Mixed (P.v. + P.f.)	
<2	48	23	1	2	1	1	76 (53.1)
2 – 3	19	4	1	0	0	0	24 (16.8)
4 – 5	6	0	1	0	0	0	7 (4.9)
6 - 7	6	0	0	0	0	0	6 (4.2)
8 – 9	5	0	0	1	0	0	6 (4.2)
10 – 11	2	0	0	0	0	0	2 (1.4)
12 – 13	1	0	0	0	0	0	1 (0.7)
14 – 15	3	0	0	0	0	0	3 (2.1)
16 – 17	2	0	0	0	0	0	2 (1.4)
18 – 19	3	0	0	0	0	0	3 (2.1)
20 – 23	1	0	0	0	0	0	1 (0.7)
24 – 27	2	0	0	0	0	0	2 (1.4)
28 – 31	1	0	0	0	0	0	1 (0.7)
32 – 35	5	0	0	0	0	0	5 (3.5)
36 – 39	1	0	0	0	0	0	1 (0.7)
40+	2	0	1	0	0	0	3 (2.1)
Total	**107**	**27**	**4**	**3**	**1**	**1**	**143 (100.0)**

P.v. - *Plasmodium vivax* P.f. - *Plasmodium falciparum* P.o. - *Plasmodium ovale*
P.m. - *Plasmodium malariae* P.k. - *Plasmodium knowlesi*

The 143 imported cases comprised 29 Singapore residents (20.3%), 61 work permit/employment pass holders (42.6%), 3 student pass holders (2.1%), 5 foreigners residing in Singapore (3.5%), 21 foreigners seeking medical treatment in Singapore (14.7%) and 24 tourists (16.8%) (Table 2.15).

Table 2.15
Classification of imported malaria cases by population group, 2011-2012

Classification	2011		2012	
	Cases	%	Cases	%
Local Residents				
Singapore residents	16	10.8	29	20.3
Work permit/Employment pass holders	69	46.6	61	42.6
Student pass holders	2	1.4	3	2.1
Other foreigners	4	2.7	5	3.5
Foreigners seeking medical treatment	33	22.3	21	14.7
Tourists	24	16.2	24	16.8
Total	148	100.0	143	100.0

The majority of Singapore residents who contracted malaria whilst travelling overseas were on holiday. Most of the cases (96.6%) admitted that they did not take/ complete chemoprophylaxis (Table 2.16 and 2.17).

Table 2.16
Purpose of travel for Singapore residents who contracted malaria overseas, 2008-2012

	2008	2009	2010	2011	2012
Purpose of Travel					
Social visits/holidays	18	14	26	10	24
Business	3	5	6	4	1
Military service	0	0	0	1	1
Volunteer/Missionary work	0	1	0	0	1
Employment	4	2	3	1	2
Total	**25**	**22**	**35**	**16**	**29**

Table 2.17
History of chemoprophylaxis for Singapore residents who contracted malaria overseas, 2008 - 2012

	2008	2009	2010	2011	2012
Chemoprophylaxis					
Took complete chemoprophylaxis	0	0	0	0	1
No chemoprophylaxis	25	22	35	15	27
Irregular/incomplete chemoprophylaxis	0	0	0	1	1
Total	**25**	**22**	**35**	**16**	**29**

Blood film and PCR examination for malaria parasites

A total of 406 blood samples were collected during epidemiological investigations and examined for malaria parasites using Polymerase Chain Reaction (PCR) test. No blood samples were found positive for malaria parasite (Table 2.18).

Table 2.18
Malaria Surveillance, 2012

Locality	No. of blood samples examined by PCR	No. positive for malaria parasite
Ubi Road 1	18	0
Yishun Ave 7	185	0
Sentosa	167	0
Tagore Drive	36	0
Total	**406**	**0**