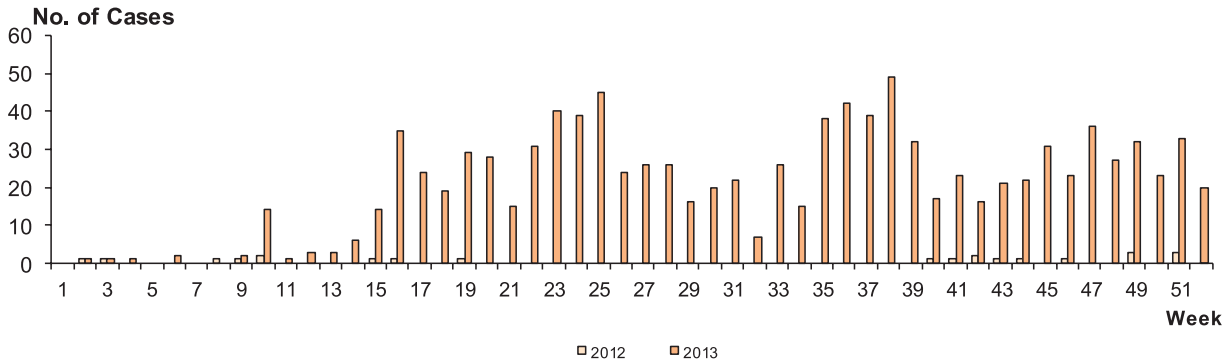
II
VECTOR-BORNE DISEASES

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 1,059 laboratory-confirmed cases of chikungunya fever were reported in 2013, compared to 22 cases in 2012 (Figure 2.1). Out of the 1,059 cases, 48 were imported cases, involving 19 Singapore residents and 29 foreigners including work permit holders. The remaining 1,011 cases were indigenous cases. No deaths due to chikungunya were reported in 2013.

Figure 2.1
E-weekly distribution of Chikungunya fever cases, 2012 – 2013



The incidence rate among indigenous cases was highest in the 35 – 44 years age group with a male to female ratio of 1.4:1 (Table 2.1). Among the three major ethnic groups, Chinese had the highest incidence followed by Indians and Malays. Foreigners comprised 66.7% of the indigenous cases (Table 2.2).

Table 2.1
Age-gender distribution and age-specific incidence rate of indigenous chikungunya fever cases^, 2013

Age (Yrs)	Male	Female	Total (%)	Incidence rate per 100,000 population*
0 - 4	2	2	4 (0.4)	1.8
5 – 14	21	9	30 (3.0)	6.3
15 – 24	70	12	82 (8.1)	10.5
25 – 34	227	67	294 (29.1)	24.1
35 – 44	172	122	294 (29.1)	30.8
45 – 54	88	53	141 (13.9)	19.1
55+	99	67	166 (16.4)	16.6
Total	**679**	**332**	**1,011 (100.0)**	**18.7**

^Cases acquired locally among Singaporeans, permanent and temporary residents.
*Rates are based on 2013 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^, 2013

	Male	Female	Total (%)	Incidence rate per 100,000 population*
Singapore Resident				
Chinese	160	108	268 (26.5)	9.4
Malay	17	2	19 (1.9)	3.7
Indian	12	4	16 (1.6)	4.5
Others	19	15	34 (3.3)	26.9
Foreigner	471	203	674 (66.7)	43.4
Total	**679**	**332**	**1,011 (100.0)**	**18.7**

^Cases acquired locally among Singaporeans, permanent and temporary residents.
*Rates are based on 2013 estimated mid-year population.
(Source: Singapore Department of Statistics)

There were 48 (4.5%) 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. 18 (37.5%), 15 (31.3%) and 7 (14.6%) had travelled to India, Indonesia and Philippines respectively (Table 2.3).

Table 2.3
Imported chikungunya fever cases, 2009 – 2013

	Year				
	2009	2010	2011	2012	2013
Southeast Asia					
Thailand	2	0	0	0	2
Myanmar	2	0	0	0	0
Malaysia	26	2	4	0	5
Indonesia	4	6	1	5	15
Philippines	0	1	0	2	7
South Asia					
Bangladesh	0	0	0	0	1
India	30	11	3	12	18
Maldives	2	0	0	0	0
Other Regions	0	0	1	0	0
Total	**66**	**20**	**9**	**19**	**48**

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*, 2013

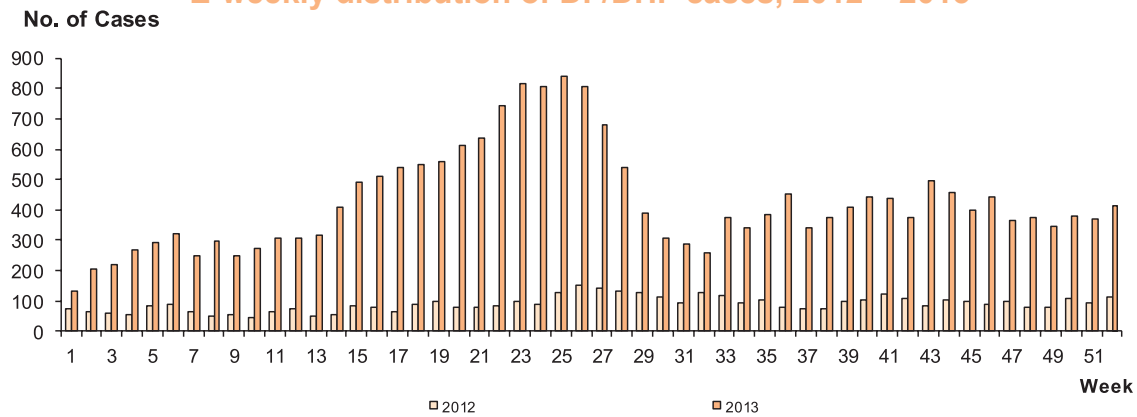
(Source: National Environment Agency)

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 22,170 laboratory confirmed cases of DF/DHF [comprising 22,077 cases of dengue fever (DF) and 93 cases of dengue haemorrhagic fever (DHF)] were reported in 2013, more than four times of the 4,632 dengue fever cases reported in 2012. Of these, 13,592 were Singapore residents, with 78 imported and 13,514 indigenous cases. The remaining 8,578 cases were foreigners, of which 8,349 cases were infected locally and 229 cases acquired the infection overseas. Majority of those who acquired the infection overseas were foreigners who came to Singapore for medical treatment. The incidence increased from E-week 2 and peaked in E-week 25, and decreased from E-weeks 26 to 32, after-which the incidence fluctuated for the rest of the year. (Figure 2.3).

Figure 2.3
E-weekly distribution of DF/DHF cases, 2012 – 2013



The incidence rate among indigenous cases was highest in the age group of 15-24 with a male to female ratio of 1.9:1 (Table 2.4). Among the three major ethnic groups, Chinese had the highest incidence rate, followed by Malays and Indians. Foreigners comprised 38.2% of the indigenous cases (Table 2.5).

Table 2.4
Age-gender distribution and age-specific incidence rates of indigenous^ DF/DHF cases, 2013

Age (Yrs)	Male	Female	Total	(%)	Incidence rate per 100,000 population*
0 - 4	83	74	157	(0.7%)	70.1
5 – 14	733	524	1,257	(5.7%)	262.0
15 – 24	2,697	1,421	4,118	(18.8%)	527.2
25 – 34	4,135	1,772	5,907	(27.0%)	483.8
35 – 44	3,065	1,487	4,552	(20.8%)	476.4
45 – 54	1,751	1,138	2,889	(13.2%)	392.2
55+	1,504	1,479	2,983	(13.6%)	297.9
Total	**13,968**	**7,895**	**21,863**	**(100.0%)**	**404.9**

^Cases acquired locally among Singaporeans, permanent and temporary residents.
*Rates are based on 2013 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 2.5
Ethnic-gender distribution and ethnic-specific incidence rates of indigenous^ DF/DHF cases, 2013

	Male	Female	Total	(%)	Incidence rate per 100,000 population*
Singapore Resident					
Chinese	5,682	4,644	10,326	(47.2%)	361.8
Malay	1,021	699	1,720	(7.9%)	335.4
Indian	408	278	686	(3.1%)	195.1
Others	451	331	782	(3.6%)	618.2
Foreigner	6,406	1,943	8,349	(38.2%)	537.1
Total	**13,968**	**7,895**	**21,863**	**(100.0%)**	**404.9**

^Cases acquired locally among Singaporeans, permanent and temporary residents.
*Rates are based on 2013 estimated mid-year population.
(Source: Singapore Department of Statistics)

There were 78(0.4%) 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 (79.5%) were from Southeast Asian countries: 35 from Malaysia, 16 from Indonesia, 5 from Thailand, 3 from Philippines, 2 from Myanmar, 1 from Vietnam and the rest are from other regions (Table 2.6).

Table 2.6
Imported DF/DHF cases, 2008 – 2013

	Year					
	2008	**2009**	**2010**	**2011**	**2012**	**2013**
Southeast Asia						
Brunei	0	1	0	0	0	0
Cambodia	4	3	0	2	4	0
East Timor	1	1	1	1	3	0
Indonesia	40	19	42	17	25	16
Laos	0	1	0	0	0	0
Malaysia	42	32	34	7	17	35
Myanmar	1	1	0	0	0	2
Philippines	4	3	9	6	4	3
Thailand	15	2	11	8	10	5
Viet Nam	8	4	6	3	1	1
South Asia						
Bangladesh	2	0	0	0	0	0
China	0	0	0	0	2	3
India	13	9	26	8	9	5
Maldives	1	0	0	0	4	1
Nepal	0	1	0	0	0	0
Pakistan	0	0	0	0	0	0
Sri Lanka	1	0	1	0	1	0
Other Regions	11	6	6	2	4	7
Total	**143**	**83**	**136**	**54**	**84**	**78**

Residents in Housing & Development Board (HDB) flats, condominiums and compound houses constituted 85.4%, 8.1% and 4.2% of the cases respectively. Compared to previous year, the incidence rate of residents of compound houses (6,845.0 per 100,000) was more than five times of residents in HDB flats (1,222.5 per 100,000). (Table 2.7).

Table 2.7
Incidence rates of reported indigenous DF/DHF cases by housing type for Singapore residents, 2013

Housing Type	No.	%	Incidence rate per 100,000 population*
Compound houses (including shophouses)	568	6.3	6845.0
HDB Flats	11539	85.4	1222.5
Condominiums	1098	6.0	852.1
Others	309	2.3	476.1
Total	**13514**	**100.0**	**1179.3**

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

A total of 1,475 clusters involving 10,256 epidemiologically linked cases were identified in 2013, of which 188 clusters (12.8%) had 10 or more cases. Areas with more than 50 cases are listed in Table 2.9. The median number of cases in these 188 clusters was 17 (range 10 to 233) and the median duration of transmission was 27 days (range 2 to 142) (Table 2.8). The number of clusters increased almost five times more compared to the previous year.

Table 2.8
Dengue clusters identified, 1990 – 2013

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	4,632	328	1,403 (30.9)	21 (6.4)	3	6
2013	22,170	1,475	10,256 (46.3)	188 (12.8)	17	27

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

Table 2.9
Dengue clusters identified, 2013 (50 or more cases)

S/No.	LOCALITY	No. of cases	Month
1	Tampines Ave 5 (Blk858,860,860B,861) / Tampines St 71 (Blk707,724,725,731,732,734) / Tampines St 82 (Blk830,832,836,840,842,856,856B) / Tampines St 83 (Blk833,835,839,841,843,847,849,851,853,855,857,862,863B,864,867A,868,885) / Tampines St 84 (Blk871,871A,872,874,882,883)	233	Mar - Jul
2	Bedok Nth Rd (Blk 705, 706, 707, 708) / Bedok Reservoir Rd (Blk 701, 702, 703, 704, 705, 709, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 740) / Construction Site @ Bedok Reservoir Rd / Construction Site @ Bedok Reservoir Cres	158	Sep - Nov
3	Tampines St 12 (Blk 158, 161, 162, 163, 164, 166) / Tampines St 21 (Blk 245, 246, 247, 248, 249, 250, 251, 253, 254, 266, 267, 268, 269, 270, 271) / Tampines St 22 (Blk 272, 273, 274, 275,277)	141	Feb - May
4	Tamp Ctr 1 / Tampines St 21(Blk 236, 238, 239, 240, 243, 244) / Tampines St 41 (Blk 401, 402, 404, 405, 406, 407, 408, 410, 415, 411,418, 419, 421, 422, 423, 424, 426,428,429,430) / Tampines St 43 (Blk 433,434)	134	Mar - Jul
5	Pasir Ris Dr 4 (232,233,234,477,478,479,480,481,482,483,484,485,486,487) / Pasir Ris Dr 6 (453,469,470,472,473,474,475,476,477) / Pasir Ris St 21 (225.226.227,229,230,236,235,237,238,239,241) / Pasir Ris St 41 (463,464)	134	Jun - Aug
6	Yishun Ave 6 (Blk 283, 286, 288) / Yishun Ave 9 (Blk 245,246,247,248,249,250,255) / Yishun Ring Rd (Blk 225,237,244,252,253,254,255,256,257) / Yishun St 21 (Blk 222,227) / Yishun St 22 (Blk 258,260,263,262,264,265,269,270,271,272,273,274,275,276,277 ,279,291,293)	128	Apr - Jul
7	Jurong West St 74 (Blk 759, 760, 761, 764, 765, 766) / Westwood Ave, Walk, Rd, Cres, Ter, Dr, Walk	112	May - Aug
8	Construction Site @ Orchard Rd (near Somerset MRT Stn) / Orchard Rd / Emerald Hill Rd / Saunder	107	Oct - Dec
9	Tampines St 71 (Blk 710, 712, 713, 714, 715, 716, 726, 728, 730, 731, 733, 734, 735) / Tampines St 72 (Blk 717, 718, 719, 720, 722, 723, 735, 736, 737, 738, 740, 741) / Tampines St 73	105	Aug - Nov
10	Pasir Ris Dr 1 (Blk 531, 533, 534, 535, 536) / Construction Site @ Pasir Ris St 51 / Pasir Ris St 51 (Blk 537, 538, 540, 541, 543, 547, 552, 553, 555, 557, 558, 560, 561, 562, 564, 565, 566, 567, 568, 569)	102	May - Jul
11	Joo Chiat Ln, Pl, Rd, Ter / Lor 101, 102, 104, 105, 106 Changi / Changi Rd / Langsat Rd / Everitt Rd, Rd Nth / Geylang Serai (Blk 3A) / Sims Ave (Blk 826, 830, 832, 838, 840, 842, 846)/Tembeling Rd	99	Apr - May
12	Choa Chu Kang St 51 (Blk 515, 517, 523, 525, 526, 527, 528, 529, 531) / Choa Chu Kang St 52 (Blk 540, 541, 542, 543, 544, 545, 547, 548, 549, 550, 551, 552)	94	May - Aug
13	Construction Site @ Yishun Ind St 1 / Yishun St 23	92	Apr - May
14	Choa Chu Kang St 53 (Blk 701, 702, 703, 704, 705, 706, 707, 708) / Choa Chu Kang Nth 5 (Blk 751, 753, 754, 755, 756, 757, 758, 759, 761)/ Choa Chu Kang Dr (Blk 784, 785, 786)/Choa Chu Kang Nth 6 (Blk 787, 633, 634, 788, 792)/ Choa Chu Kang Nth 6	88	Apr - Jul
15	Ava Rd / Balestier Rd / Jln Ampas / Jln Kemaman / Kim Keat Cl, Ln, Rd / Lor Ampas / Lor Limau (Blk 76, 77) / Lor Limau / Mandalay Rd / Minbu Rd / Pegu Rd / Prome Rd / Whampoa Dr (Blk 82)	84	Nov - Jan 14

S/No.	LOCALITY	No. of cases	Month
16	Construction Site @ Boon Lay Way / Corporation Rd, Rise, Walk / Lakepoint Dr / Lakeside Dr	82	May - Jul
17	Jurong West St 52 (Blk 514, 515, 516, 517, 517A, 517C, 517D, 517E, 518, 520, 521) / Corporation Rd	82	May - Jul
18	Geylang Rd / Guillemard Rd / Lor 4, 6, 8, 14, 16, 18, 20, 22 Geylang	80	Nov - Jan 14
19	Berwick Dr / Bishops Pl / Bridport Ave / Cowdray Ave / Farleigh Ave / Huddington Ave / Portchester Ave / Kingswear Ave / Hemsley Ave / Tavistock Ave / S'goon Gdn Way	79	Mar - May
20	Da Silva Ln / Flower Rd / Glasgow Rd / Highland Cl, Rd, Walk / Kovan Rd / Lowland Rd / Palm Grove Ave / Phillips Ave / Richards Ave, Pl / Rosyth Rd / Simon Pl / Teow Hock Ave / Upp Serangoon Rd	74	Sep - Dec
21	Parry Ter / Park Villas Green, Rise, Ter / Poh Huat Cres, Dr, Rd, Rd West, Ter / Construction Site @ Terrasse Ln / Robey Cres / Limbok Ter	72	Jan - Feb
22	Bartley Rd / Eden Grove / Jln Labu Ayer / Jln Labu Manis / Jln Labu Merah / Lor Gambir / Serangoon Ave 1 (Blk 401, 402, 403, 405, 406, 407) / Sunshine Ter / Upp Sgn Rd	72	Nov - Jan 14
23	Jurong East St 21 (Blk 201, 202, 203, 204, 205, 206, 207, 208, 287A, 287B, 287C, 287D, 288A, 288C, 288D) / Toh Guan Rd (Blk 285A, 285B, 286A, 286C, 286D)	71	Sep - Oct
24	Compassvale Bow (Blk 266A) / Compassvale Link (Blk 267A) / Construction Site @ Sengkang East Ave / Construction Site @ Rivervale Link / Rivervale Walk (Blk 101, 102, 103, 109, 110)	69	Aug - Sep
25	Changi Rd / Jln Eunos / Kampong Eunos / Lor 110 Changi / Lor Sarina / Lor G, H Telok Kurau / Telok Kurau Rd/Lor Marzuki/ Sims Ave East	68	May - Jun
26	Lor 2 Toa Payoh (Blk 86) / Lor 3 Toa Payoh / Lor 4 Toa Payoh (Blk 56, 58, 60, 80, 80A, 81A, 81B, 82, 82A, 82B, 85, 85B) / Lor 5 Toa Payoh (Blk 48, 49, 50, 53, 54, 55, 57, 61) / Lor 6 Toa Payoh (Blk 47, 51) / Toa Payoh Central (Blk 79B, 79D, 79E)	67	Sep - Oct
27	Construction Site @ Tampines Ave 8 (Blk 868C) /.St 71 (Blk 704,7 24,725,727,729,730,731,732) /St 82 (Blk 850) /St 83 (Blk 853,855, 857,865,866,867,867A,868,869)/ St 84 (Blk 871,871A,872,874)/ Tampines Central (Blk 518A)	66	Feb - May
28	Corporation Rd / Construction Site @ Lakeside Dr / Lakeside Dr	66	Dec - Jan 14
29	Hougang St 51 (Blk 533, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 566, 567) / Hougang St 52 (Blk 534, 537, 538, 539, 699A) / Hougang Ave 6 (Blk 531) / Hougang Ave 8 (Blk 544, 545, 699)	65	Jan - Mar
30	Jln Belibas / Jln Chegar / Jln Chempah / Jln Hari Raya / Jln Keli / Jln Khamis / Jln Ikan Merah / Jln Isnin / Jln Minggu / Jln Pintau / Jln Sembilang / Jln Terubok / Shunfu Rd (Blk 311, 314, 315, 317) / Sin Ming Rd (Blk 23, 24, 25)	65	Aug - Dec
31	Hougang Ave 8 (Blk 626, 628, 629, 631, 632, 633, 634, 635, 636, 637, 638, 639, 641, 642, 647, 648)	60	Jan - Feb
32	Construction Site @ Pasir Ris Link	57	Jun - Jul
33	Construction Site @ Canberra Dr / Yishun Ave 7 (Blk 170, 172, 173, 175) / Yishun Ring Rd (Blk 165, 166, 167) / Yishun St 11 (Blk 122, 123, 125, 127, 128, 130)	57	Oct - Jan 14
34	Yishun Central (Blk 304, 306, 320, 321, 322, 323, 324, 325) / Yishun Ring Rd (Blk 308, 326, 327, 328, 329, 330, 331, 332)	52	May - Aug

Dengue Deaths

A total of eight fatal cases were reported in 2013. Of these, seven fatal cases were classified as indigenous infections among local residents. The remaining fatal case was a non-resident foreigner seeking treatment in Singapore who had acquired the infection overseas.

Laboratory Surveillance

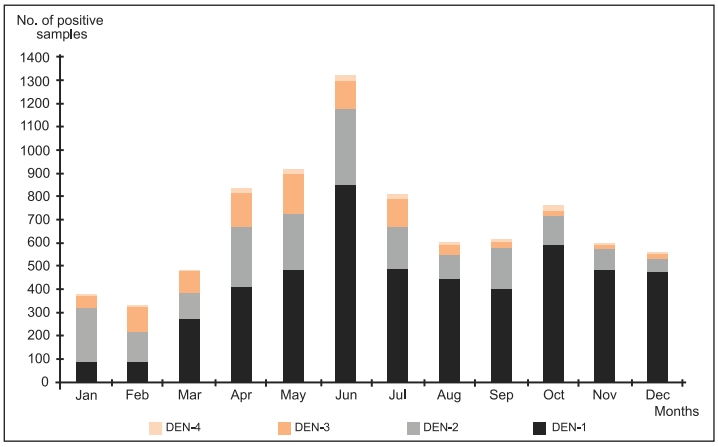
All reported cases of DF/DHF were confirmed by one or more laboratory tests; viz. anti-dengue IgM antibody, enzyme linked immunosorbent assay (ELISA), and polymerase chain reaction (PCR).

A total of 8,203 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 (61.8%), DENV2 (24.6%), DENV3 (11.6%) and DENV4 (2.0%) (Figures 2.4 & 2.5).

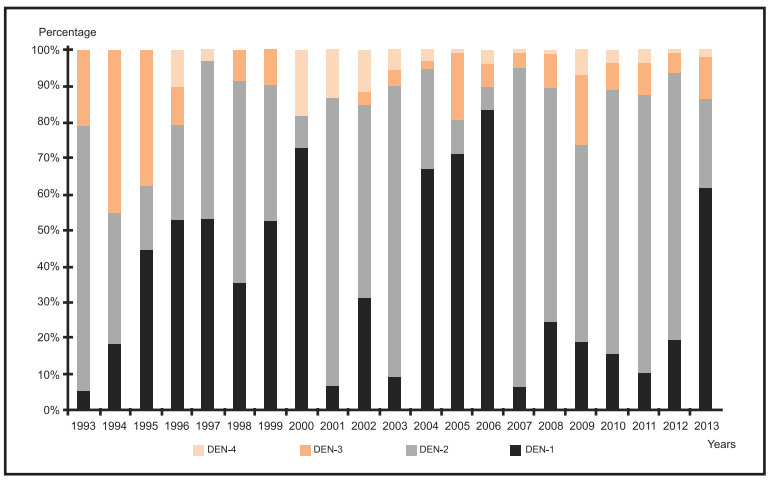
DENV2 was the predominant circulating serotype from 2007 to 2012. DENV1 was found to be the predominant circulating serotype in 2013 (Figure 2.5).

Figure 2.4
Surveillance of dengue virus serotypes, 2013



(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 2.5
Surveillance of dengue virus serotypes, 1993 – 2013



(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 mosquito vectors surveillance and control

Suppressing the Aedes mosquito vector population is the key to dengue control in the absence of an effective vaccine. The National Environment Agency (NEA) adopts an evidence-based approach for the surveillance and control of Aedes vectors.

Surveillance builds on the current regime of inspecting premises for mosquito breeding. It is complemented by adult mosquito sentinel surveillance using Gravitraps, which capture gravid mosquitoes. Vector surveillance is integrated with epidemiological surveillance and laboratory-based virus surveillance, to generate risk maps that are used to guide vector control efforts, and to communicate risk to the community.

Source reduction by the community is central to Singapore's dengue vector control efforts. NEA actively engages the community to do their part to prevent mosquito breeding in their premises. Through the Inter-Agency Dengue Taskforce, NEA coordinates source reduction efforts in partnership with stakeholders in the public, private and people sectors. Since 2006, this has been augmented by Intensive Source Reduction Exercise (ISRE) that takes place at the start of the year. This systematic searching and destroying of potential breeding habitats in outdoor areas helps to reduce the vector population to a low level before the onset of the peak season for dengue transmission, which typically falls between May and October.

To control the vector population in clusters, NEA carries out space and residual spraying of insecticides to kill adult mosquitoes, complemented by searching and destroying of mosquito breeding sources. Apart from surveillance, Gravitraps are also used to supplement these measures and to monitor the extent of control efforts.

A total of 22,170 cases were reported in 2013. This was 50% higher than the previously largest epidemic in 2005. Against the backdrop of the low population immunity and the continued presence of Aedes mosquito vectors, the increase in cases was associated with the switch of predominant serotype from DENV-2 to DENV-1 and the emergence of a new strain of DENV-1 virus with apparently greater fitness. DENV-1 was the predominant virus serotype in 2013.

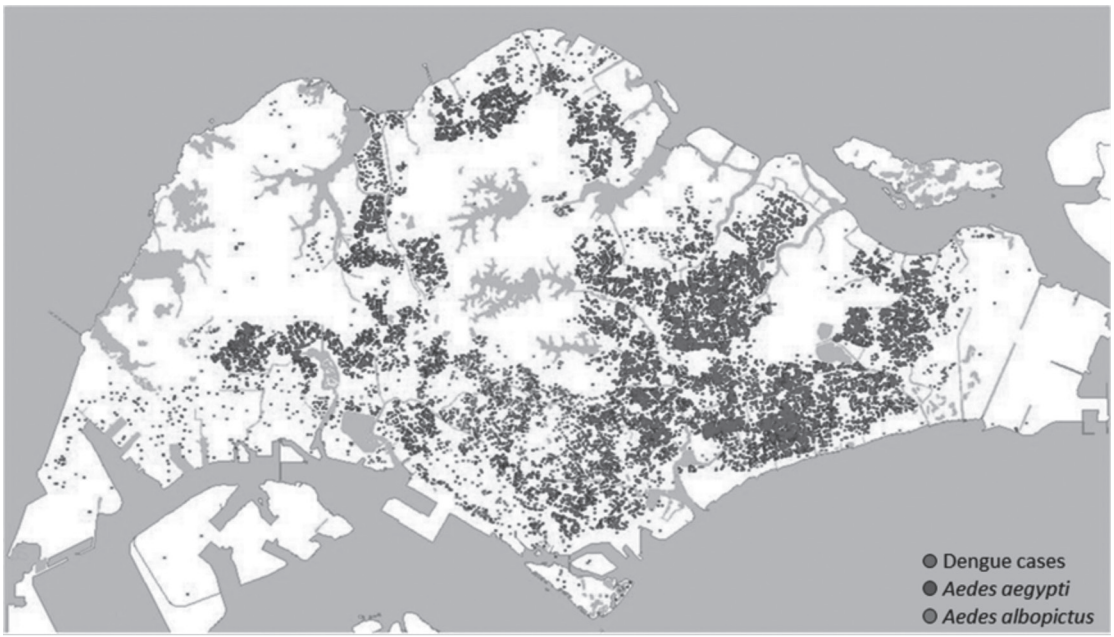
In the absence of an effective vaccine, Singapore's dengue control programme focuses on controlling the Aedes mosquito vector. To this end, NEA piloted a sentinel surveillance system whereby 2,900 gravitraps were deployed in HDB housing estates at 34 locations around Singapore to monitor the Aedes mosquito population. The map (Figure 2.6) shows the distribution of the 34 sentinel sites. Another 1,300 gravitraps were also rolled out in two constituencies – Bukit Panjang and Clementi. Data provides information on mosquito population and distribution, which could serve as basis for guiding operational deployment.

In 2013, NEA inspected some 6 million premises and surveyed over 112,000 outdoor areas. These include residential premises, as well as construction sites, schools and factories. The distribution of dengue cases and Aedes mosquito breeding are shown in Figure 2.7 (Note: Aedes aegypti and Aedes albopictus are now known as Stegomyia aegypti and Stegomyia albopictus, respectively). The overall Aedes House Index (HI) was 0.30%, with compound houses showing the highest HI among the residential premises (Figure 2.8). The top breeding habitats for Ae. aegypti were domestic containers (32.9%), ornamental containers (10.9%), flower pot plate/tray (9.7%), puddle/ground depression (2.8%), and discarded receptacles (2.4%) (Figure 2.9). As for Ae. albopictus, the most common breeding habitats were discarded receptacles (13.2%), domestic containers (10.1%), flower pot plate/tray (9.7%), canvas/plastic sheets (6.2%), and plants such as hardened soil and plant axils) (3.9%) (Figure 2.10).

Figure 2.6
Distribution of sentinel sites, 2013

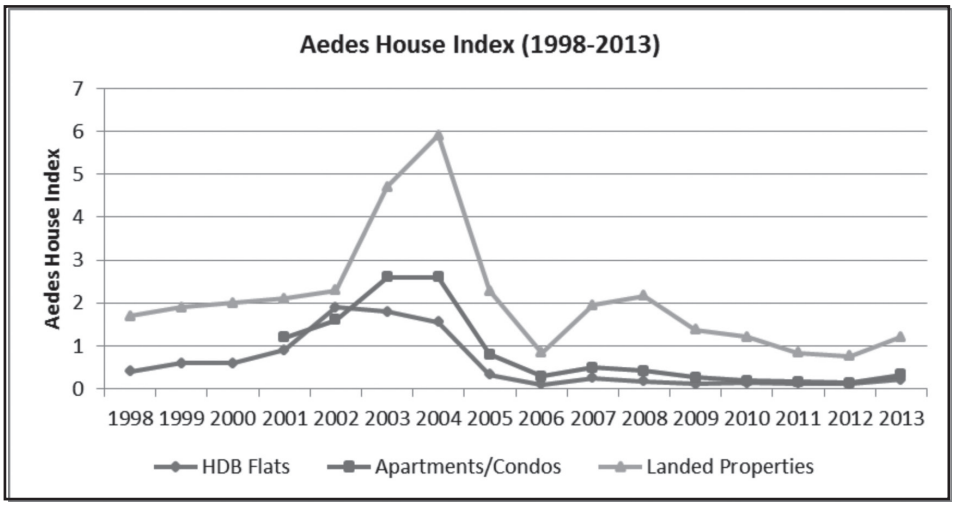
(Source: National Environment Agency)

Figure 2.7
Geographical distribution of *Ae. albopictus*, *Ae. aegypti* and dengue cases



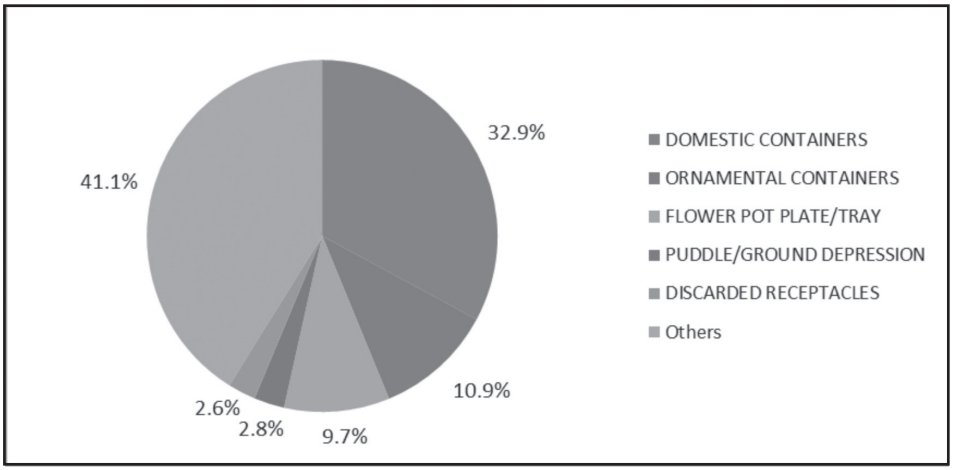
(Source: National Environment Agency)

Figure 2.8
Percentage of premises breeding *Aedes* mosquitoes, 1998-2013



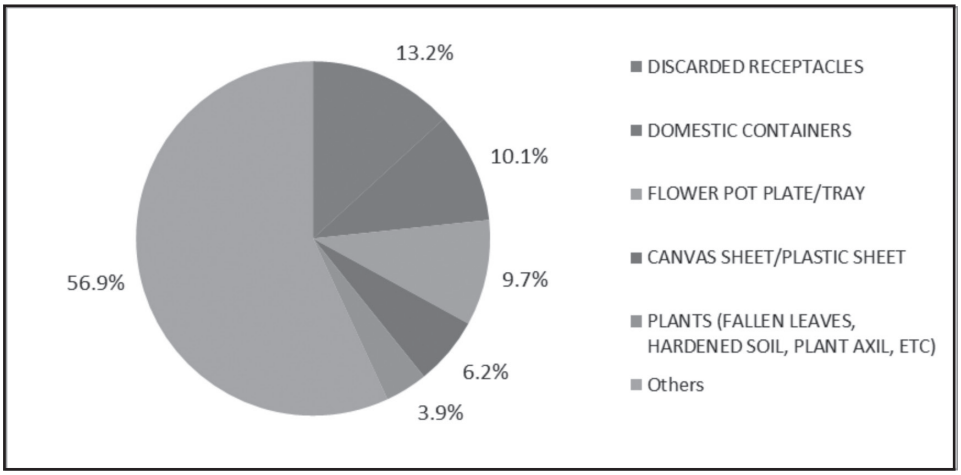
(Source: National Environment Agency)

Figure 2.9
Distribution (%) of *Aedes aegypti* by top 5 breeding habitats, 2013



(Source: National Environment Agency)

Figure 2.10
Distribution (%) of *Aedes albopictus* by top 5 breeding habitats, 2013



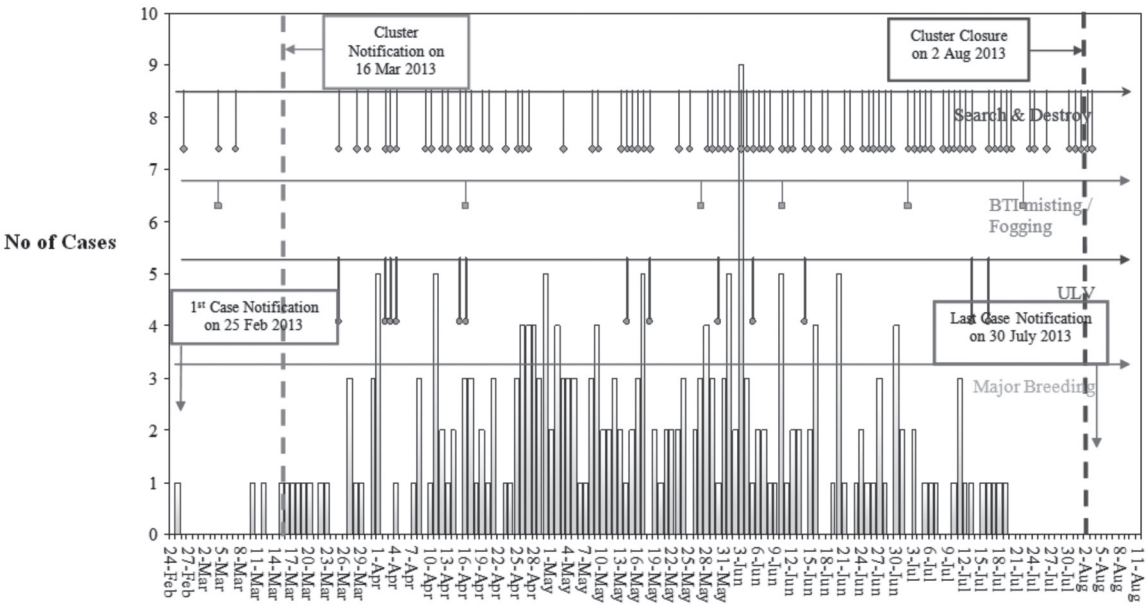
(Source: National Environment Agency)

There were 1,475 clusters in 2013. The two largest clusters were in Tampines Ave 5, Ave 8, St 71, St 81, St 82, St 83, St 84, and Bedok Reservoir Road (Blk 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 740) / Construction Site) with 233 and 158 cases, respectively.

Outbreak of Dengue Fever at Tampines Ave 5, Ave 8, St 71, St 81, St 82, St 83, St 84

On 25 February 2013, the Ministry of Health was notified of a Dengue case residing in Blk 860 Tampines Ave 5. Within two weeks, two additional cases were reported in the vicinity. Epidemiological investigation and vector control were carried out. A total of 233 cases were reported in the outbreak, with onset dates spanning 25 February 2013 and 19 July 2013. The epidemic curve is shown in Figure 2.11.

Figure 2.11
Time distribution of 233 DF/DHF cases in Tampines Ave 5, Ave 8, St 71, St 81, St 82, St 83, St 84

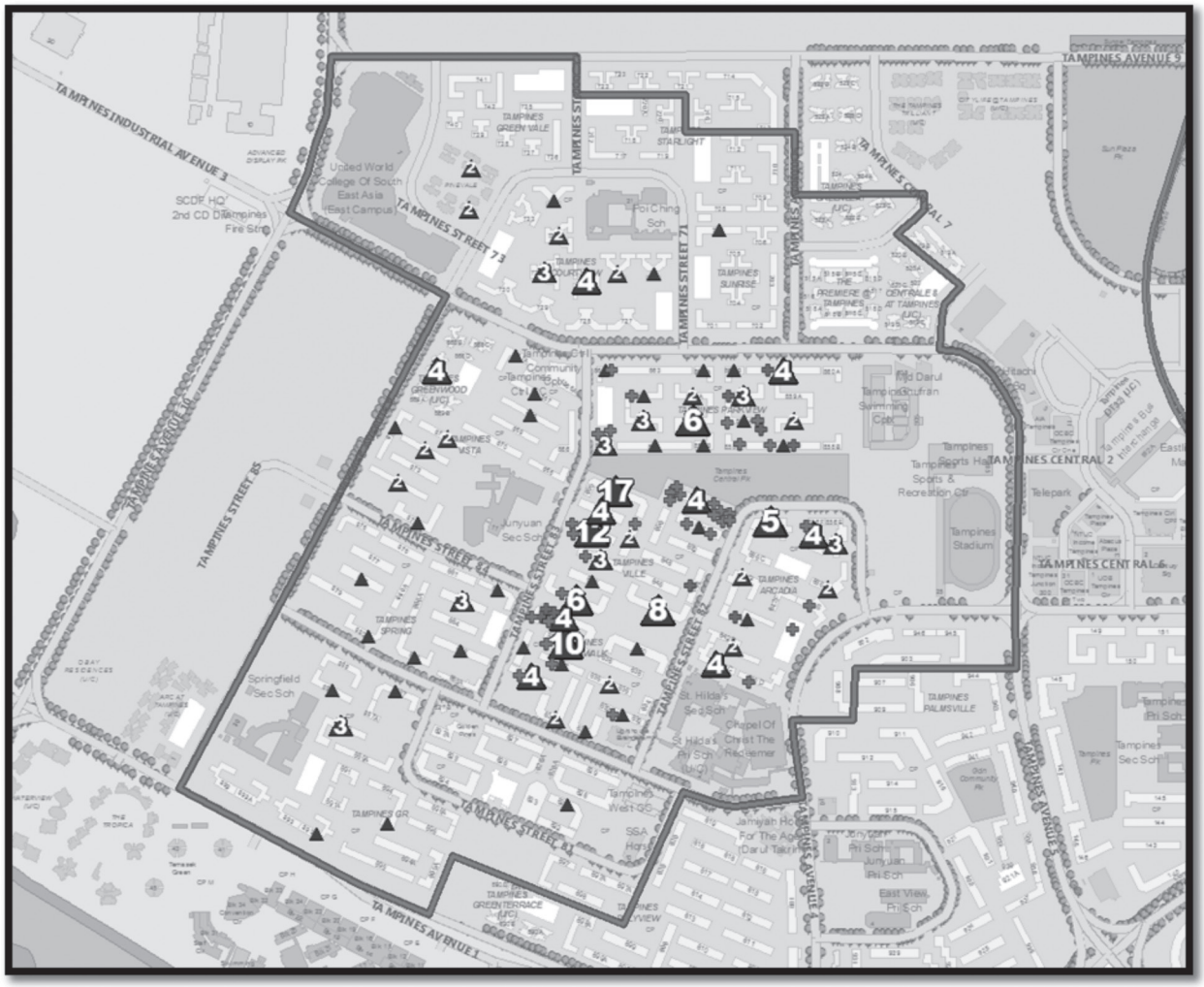


(Source: National Environment Agency)

Of the 233 cases, 209 (89.7%) were Singapore residents. Majority of the cases (68.2%) were in the 15-50 years age group. The female to male ratio was 1:1.3. Based on the reported occupations, the cases comprised 44 students, 26 housewives, 8 workers in construction-related trade, 7 unemployed, 6 retirees, 3 domestic helpers and 71 working adults. Information was not available for 68 cases.

Figure 2.12 shows the geographical distribution of cases in the cluster. 83 mosquito breeding habitats were identified and destroyed. 32.5% of the breeding habitats found in the cluster were domestic containers (containers and pails), and 16.9% were ornamental containers (flower vase and pots). 73.5% of the breeding habitats were detected in residential premises, with the remainder on outdoor grounds. Aedes aegypti accounted for 76% of the breeding. There were three profuse breeding – one in a plastic pail within residential premises (400pH), and two in concrete gutters in outdoor areas (200pH and 300pH, respectively).

Figure 2.12
Geographical distribution of 233 DF/DHF cases in Tampines Ave 5, Ave 8, St 71, St 81, St 82, St 83, St 84

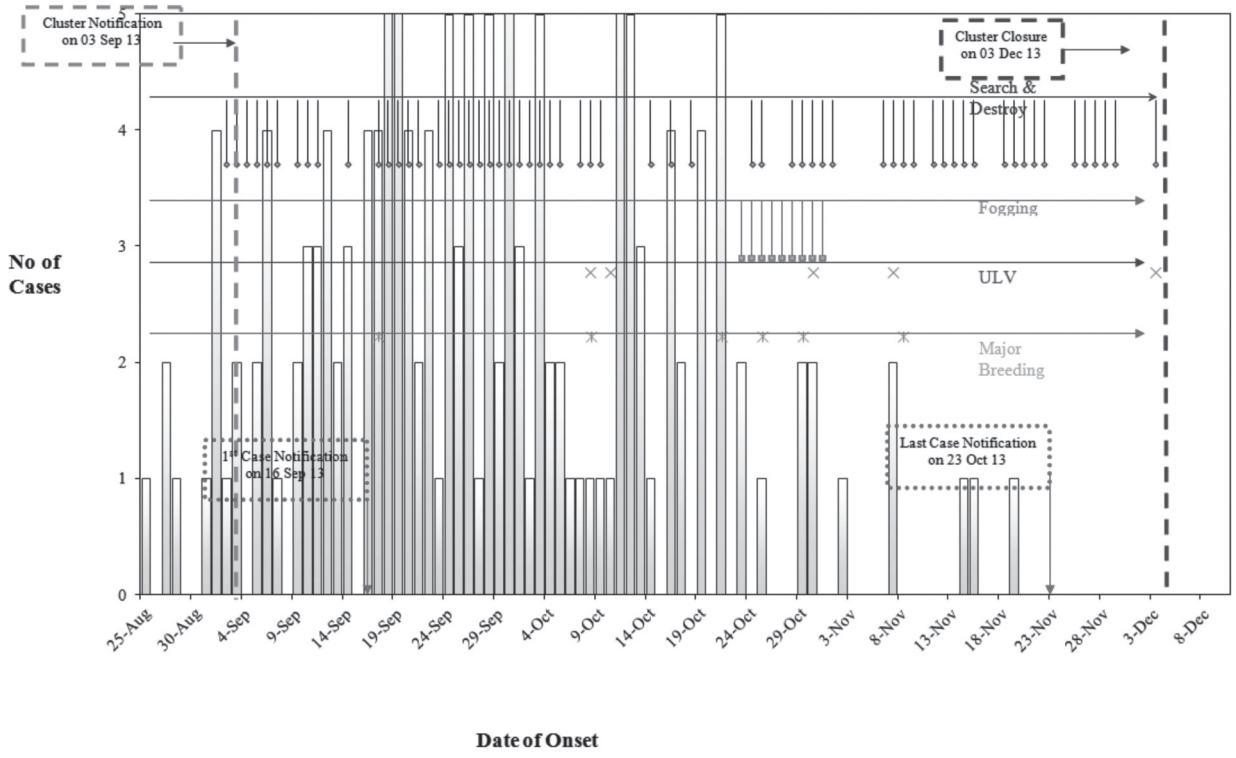


(Source: National Environment Agency)

Outbreak of Dengue Fever at Bedok Reservoir Road (Blk 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 740) / Construction Site)

On 29 August 2013, the Ministry of Health was notified of a Dengue case residing in Bedok Reservoir Road. Another case was reported in the same area in the next few days. Epidemiological investigation and vector control were carried out. A total of 158 cases were reported in the outbreak, with onset dates spanning 25 August 2013 and 15 November 2013. The epidemic curve is shown in Figure 2.13.

Figure 2.13
Time distribution of 158 DF/DHF cases in Bedok Reservoir Road (Blk 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 740) / Construction Site)

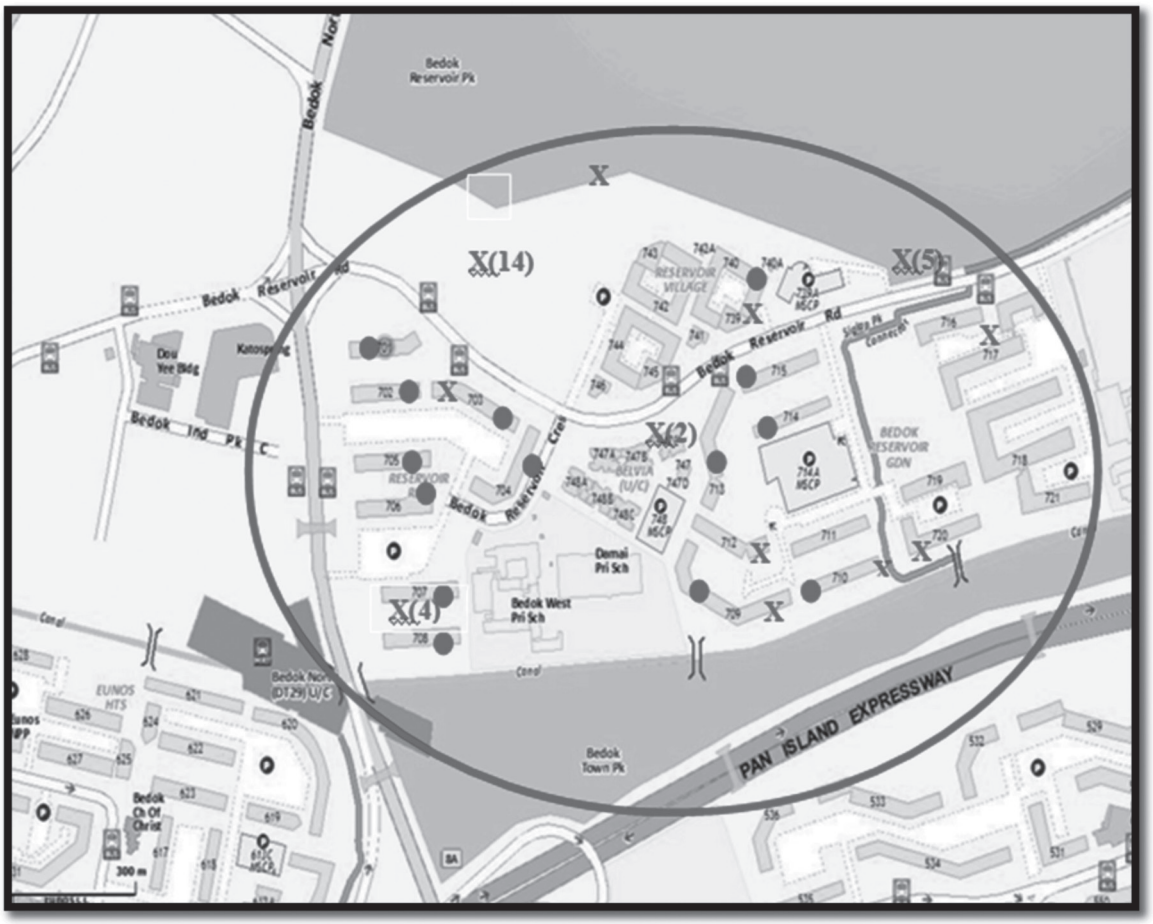


(Source: National Environment Agency)

Of these 158 cases, 100 (63.3%) were non-Singapore residents. Majority of the cases (82.3%) were in the 15-50 years age group. The female to male ratio was 1:2.2. Based on the reported occupations, the cases comprised 23 workers in construction-related trade, 19 students, 3 retirees, 2 housewives and 22 working adults. Information was not available for 89 cases.

Figure 2.14 shows the geographical distribution of cases in the cluster. 38 mosquito breeding habitats were identified and destroyed during the vector control operation in the cluster. 39.5% of the breeding habitats found in the cluster were found in construction sites (drain holes, unattended construction materials), 34.2% of the habitats were found in outdoor areas (drains, tree holes and lighting covers) and 26.3% in residential premises (domestic containers, flower pots/vases and hardened soil). Aedes aegypti accounted for 70% of the breeding habitat.

Figure 2.14
Geographical distribution of 158 DF/DHF cases in Bedok Reservoir Road (Blk 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 740) / Construction Site)



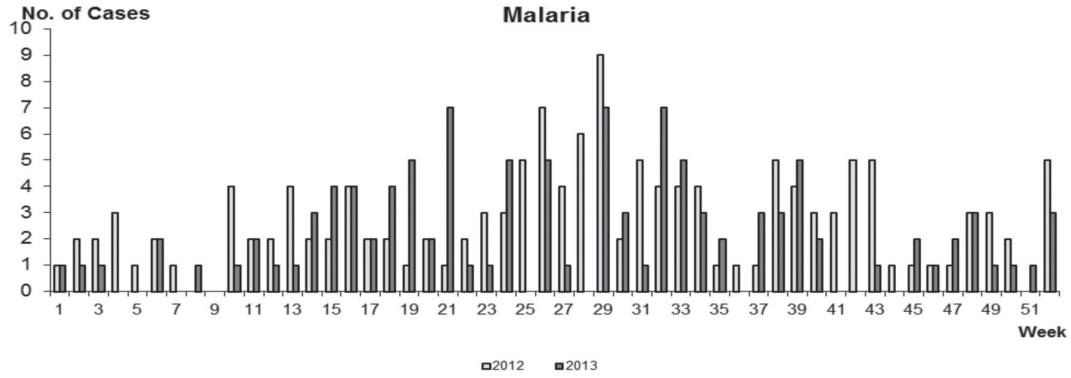
(Source: National Environment Agency)

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 2013, a total of 111 laboratory-confirmed cases were reported, a decrease of 22% compared to the 143 cases reported in 2012 (Figure 2.15). 110 cases were imported.

Figure 2.15
E-weekly distribution of reported malaria cases, 2012-2013



The incidence rate was highest in the 15 - 24 years age group, with an overall male to female ratio of 7.8:1 (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^, 2013

Age (Yrs)	Male	Female	Total (%)	Incidence rate per 100,000 population*
0 - 4	0	0	0 (0.0)	0.0
5 – 14	0	1	1 (1.2)	0.2
15 – 24	27	1	28 (31.8)	3.6
25 – 34	35	4	39 (44.3)	3.2
35 – 44	10	2	12 (13.6)	1.3
45 – 54	3	0	3 (3.4)	0.4
55+	3	2	5 (5.7)	0.5
Total	**78**	**10**	**88 (100.0)**	**1.6**

^Excluding 9 foreigners seeking medical treatment in Singapore and 14 tourists.
*Rates are based on 2013 estimated mid-year population.
(Source: Singapore Department of Statistics)

Table 2.11
Ethnic-gender distribution and ethnic-specific incidence rate of reported malaria cases^, 2013

	Male	Female	Total (%)	Incidence rate per 100,000 population*
Singapore Resident				
Chinese	4	1	5 (5.7)	0.2
Malay	2	0	2 (2.2)	0.4
Indian	4	1	5 (5.7)	1.4
Others	5	0	5 (5.7)	4.0
Foreigner	63	8	71 (80.7)	4.6
Total	**80**	**18**	**88 (100.0)**	**1.6**

^ Excluding 9 foreigners seeking medical treatment in Singapore and 14 tourists.
*Rates are based on 2013 estimated mid-year population.
(Source: Singapore Department of Statistics)

Malaria parasite species

The distribution of the cases by parasite species was *P. vivax (75.7%)*, *P. falciparum (18.9%)*, *P. knowlesi (3.6%)* and *P. ovale (1.8%)* (Table 2.12).

Table 2.12
Classification of reported malaria cases by parasite species, 2013

Classification	Parasite species					Total (%)
	P.v.	P.f.	P.o.	P.m.	P.k.	
Imported**	84	21	2	0	3	110 (99.1)
Introduced	0	0	0	0	0	0 (0.0)
Indigenous	0	0	0	0	1	1 (0.9)
Cryptic	0	0	0	0	0	0 (0.0)
Induced	0	0	0	0	0	0 (0.0)
Total	**84**	**21**	**2**	**0**	**4**	**111 (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 (71.8%) and Indonesia (8.2%). *P. vivax* accounted for 91.1% and 44.4% of the infections acquired in India and Indonesia respectively and *P. falciparum* accounted for 75.0% and 44.4% 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, 2013

Classification	Parasite species					Total (%)
	P.v.	P.f.	P.o.	P.m.	P.k.	
Southeast Asia						
Brunei Darussalam	0	0	0	0	1	1 (0.9)
Indonesia	4	4	1	0	0	9 (8.2)
Malaysia	0	0	0	0	1	1 (0.9)
Myanmar	2	0	0	0	0	2 (1.8)
Thailand	1	0	0	0	1	2 (1.8)
South Asia						
India	72	7	0	0	0	79 (71.8)
Pakistan	1	0	0	0	0	1 (0.9)
Africa						
Angola	0	1	0	0	0	1 (0.9)
Cameroon	1	0	0	0	0	1 (0.9)
Ghana	0	1	0	0	0	1 (0.9)
Guinea	0	1	0	0	0	1 (0.9)
Libya	0	0	1	0	0	1 (0.9)
Mali	0	1	0	0	0	1 (0.9)
Niger	0	1	0	0	0	1 (0.9)
Nigeria	0	2	0	0	0	2 (1.8)
South Africa	1	0	0	0	0	1 (0.9)
Tanzania	0	1	0	0	0	1 (0.9)
Uganda	0	1	0	0	0	1 (0.9)

Other countries						
British Indian Ocean Territory	0	1	0	0	0	1 (0.9)
Papua New Guinea	2	0	0	0	0	2 (1.8)
Total	**84**	**21**	**2**	**0**	**3**	**110 (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, 2013

Interval in weeks	Parasite species					Total (%)
	P.v.	P.f.	P.o.	P.m.	P.k.	
<2	32	18	0	0	2	52 (47.3)
2 – 3	11	3	0	0	1	15 (13.7)
4 – 5	3	0	1	0	0	4 (3.6)
6 - 7	6	0	0	0	0	6 (5.5)
8 – 9	5	0	0	0	0	5 (4.6)
10 – 11	5	0	0	0	0	5 (4.6)
12 – 13	2	0	0	0	0	2 (1.8)
14 – 15	2	0	0	0	0	2 (1.8)
16 – 17	0	0	1	0	0	1 (0.9)
18 – 19	3	0	0	0	0	3 (2.7)
20 – 23	4	0	0	0	0	4 (3.6)
24 – 27	2	0	0	0	0	2 (1.8)
28 – 31	1	0	0	0	0	1 (0.9)
32 – 35	2	0	0	0	0	2 (1.8)
36 – 39	2	0	0	0	0	2 (1.8)
40+	4	0	0	0	0	4 (3.6)
Total	**84**	**21**	**2**	**0**	**3**	**110 (100.0)**

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

The 110 imported cases comprised 16 Singapore residents (14.6%), 58 work permit/employment pass holders (52.7%), 2 student pass holders (1.8%), 11 foreigners residing in Singapore (10.0%), 9 foreigners seeking medical treatment in Singapore (8.2%) and 14 tourists (12.7%) (Table 2.15).

Table 2.15
Classification of imported malaria cases by population group, 2012-2013

Classification	2012		2013	
	Cases	%	Cases	%
Local Residents				
Singapore residents	29	20.3	16	14.6
Work permit/Employment pass holders	61	42.6	58	52.7
Student pass holders	3	2.1	2	1.8
Other foreigners	5	3.5	11	10.0
Foreigners seeking medical treatment	21	14.7	9	8.2
Tourists	24	16.8	14	12.7
Total	**143**	**100.0**	**110**	**100.0**

The majority of Singapore residents who contracted malaria whilst travelling overseas were on holiday. All of the cases 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, 2009-2013

	2009	2010	2011	2012	2013
Purpose of Travel					
Social visits/holidays	14	26	10	24	10
Business	5	6	4	1	3
Military service	0	0	1	1	0
Volunteer/Missionary work	1	0	0	1	2
Employment	2	3	1	2	1
Total	**22**	**35**	**16**	**29**	**16**

Table 2.17
History of chemoprophylaxis for Singapore residents who contracted malaria overseas, 2009 - 2013

	2009	2010	2011	2012	2013
Chemoprophylaxis					
Took complete chemoprophylaxis	0	0	0	1	0
No chemoprophylaxis	22	35	15	27	16
Irregular/incomplete chemoprophylaxis	0	0	1	1	0
Total	**22**	**35**	**16**	**29**	**16**