Annual Report 2018

Anti Malaria Campaign

Ministry of Health - Sri Lanka

ANNUAL REPORT 2018

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2018

Acknowledgement

The Annual Report 2018, compiles data from the AMC headquarters and all districts to provide a progress of activities conducted to sustain the prevention of re-introduction phase of malaria in Sri Lanka in 2018. AMC gratefully appreciates the leadership provided by the Director AMC in 2018, Dr. Hemantha Herath and his team in conducting the activities and providing the data and Dr. Prasad Ranaweera, Act. Director AMC at the time of compilation of the data for the Annual report 2018.

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1. Introduction

Sri Lanka maintains zero indigenous malaria cases since 2012. The WHO certification of malaria elimination was received in 2016, thus Sri Lanka entered into the prevention of re-introduction phase of malaria. However, the risk of re-introduction of malaria remains high due to increased travel to and from malaria endemic countries which allows in bringing the malaria parasite to the country. Sri Lanka being a tropical country, the malaria vector remains in several regions of the country making transmission from the imported malaria cases more possible. In 2018, following 6 years of zero indigenous cases, on 26th December 2018 the first introduced case was reported in Monaragala District with other 47 imported cases.

Vision

A malaria-free Sri Lanka

Mission

Plan and implement a comprehensive programme to sustain intensive surveillance, comprehensive case management, outbreak preparedness, and rapid response for prevention of re-introduction and re-establishment of malaria in Sri Lanka.

Goal

To maintain malaria-free status

Objectives of the Anti-Malaria Campaign

1. To prevent re-introduction and re-establishment of malaria in Sri Lanka
2. To maintain zero mortality due to malaria in Sri Lanka

Strategies

In order to achieve the above objectives, the following strategies are adopted:

1. Universal access to malaria diagnosis and treatment,
2. Surveillance and response,
3. Malaria prevention,
4. Information, education and communication, and advocacy, and
5. Fostering partnerships

Under the overarching cross cutting themes of

1. Quality assurance,
2. Monitoring and evaluation,
3. Capacity building,
4. Improved programme management, and
5. Research and innovation through operational research

2. Epidemiology

Sri Lanka successfully sustained its malaria free status for the third consecutive year since the WHO certification of malaria elimination in 2016. Over the past four years Sri Lanka had received approximately 50 imported malaria cases in each year. On 26th December 2018, the first introduced malaria case was reported from Colombo District.

2.1 Malaria cases by species since 2012

Sri Lanka has been maintaining zero indigenous cases since 2012. Table 1 provides a categorization by the type of species among the imported cases.

Table 1: Categorization of malaria cases from 2012 – 2018

Year	Total cases	*P. vivax*		*P. falciparum*		*P. ovale*		*P. malariae*		*P. knowlesi*		*Mixed*	
	No	No	%	No	%	No.	%	No	%	No	%	No	%
2012	93	45	48.3%	42	45.2%	2	2.2%	0	0.0%	0	0.0%	4	4.3%
2013	95	52	54.7%	42	44.2%	1	1.0%	0	0.0%	0	0.0%		
2014	49	28	57.1%	20	40.8%	0	0.0%	1	2.0%	0	0.0%		
2015	36	17	47.2%	17	47.2%	2	5.5%	0	0.0%	0	0.0%		
2016	41	16	39.0%	18	43.9%	5	12.3%	1	2.4%	1	2.4%		
2017	57	27	47.4%	26	45.6%	3	5.3%	1	1.8%	0	0.0%		
2018	48*	30	62.5%	15	31.3%	3	6.3%	0	0.0%	0	0.0%		

**Including the introduced case – P. vivax*

P. vivax had been the predominant type of species in the last two years. In 2018, 62.5% (n=30) cases were *P. vivax* with 31.3% (n = 15) being *P. falciparum*. Out of these cases, three cases were relapses and four were categorized as severe malaria cases. A separate discussion on the introduced case will be given at the end of this chapter.

2.2 Categorization of malaria cases by country of origin

In 2018, majority of the cases (58.3%) were imported from the countries in the African continent. Thirty-five-point three percent of travellers to and from India were imported cases (Figure 1).

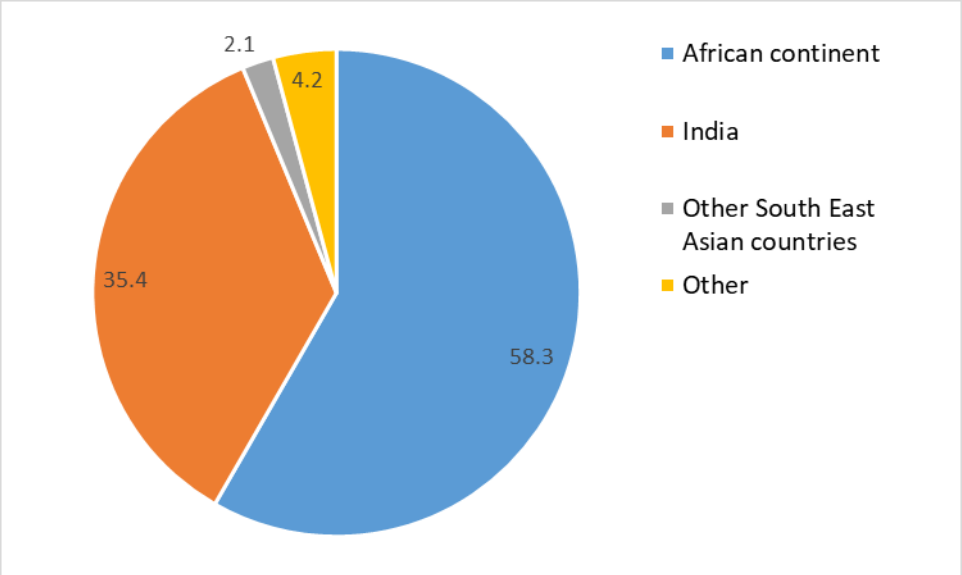

Figure 3 Proportion of imported malaria cases by country categories in 2018.

The type of species by the country of origin is given in detail in Table 2. Almost all cases reported from India (n= 16/17) are *P. vivax*. From the countries in the African continent, approximately half the cases were *P. falciparum*.

Table 2. Type of species of imported malaria by country of origin in 2018

Country of origin	**Species**			**Total**
	Pf	***Pv***	***Po***	
Afghanistan	0	1	0	1
Cameroon	1	0	0	1
Central Africa	0	0	1	1
Djibouti Island	0	1	0	1
Ethiopia	1	3	0	4
Ghana	1	0	0	1
India	0	16	1	17
Kenya	1	0	0	1
Madagascar	1	4	0	5
Malawi/Bangladesh	1	0	0	1
Mozambique	0	0	1	1
Sierra Leone	1	0	0	1
Soloman Islands	0	1	0	1
Sudan	5	2	0	7
South Sudan, Uganda	1	0	0	1
Uganda	1	1	0	2
West Africa	1	0	0	1
Total	**15**	**29**	**3**	**47**

2.3 Malaria cases by the risk category and nationality in 2018

Majority of the cases (68.8%) were reported from Sri Lankans who have travelled to malaria endemic countries and returned. Seventy nine percent (n=15) of these travellers have travelled for the purpose of occupation.

Table 3. Malaria cases by the risk category and nationality in 2018

Nationality	Occupation	Business	Forces	Tourist/ Pilgrims	Total	
					No.	Percent
Afghan	-	-	-	1	1	2.1%
American	-	-	-	1	1	2.1%
British	-	-	-	2	2	4.2%
Camaroon	1	-	-	-	1	2.1%
Ethiopian	1	-	-	-	1	2.1%
Indian	1	-	-	-	8	16.7%
Sudanese	1	-	-	-	1	2.1%
Sri Lankan	15	9	7	2	33	68.8%
Total	19	9	7	6	48	100.0%

2.4 Distribution of malaria cases by districts

Figure 2 provides the distribution of malaria cases as reported by districts in 2018 with data of 2017 provided for comparison. In both years, most cases were reported from Colombo District, followed by Rathnapura and Gampaha districts.

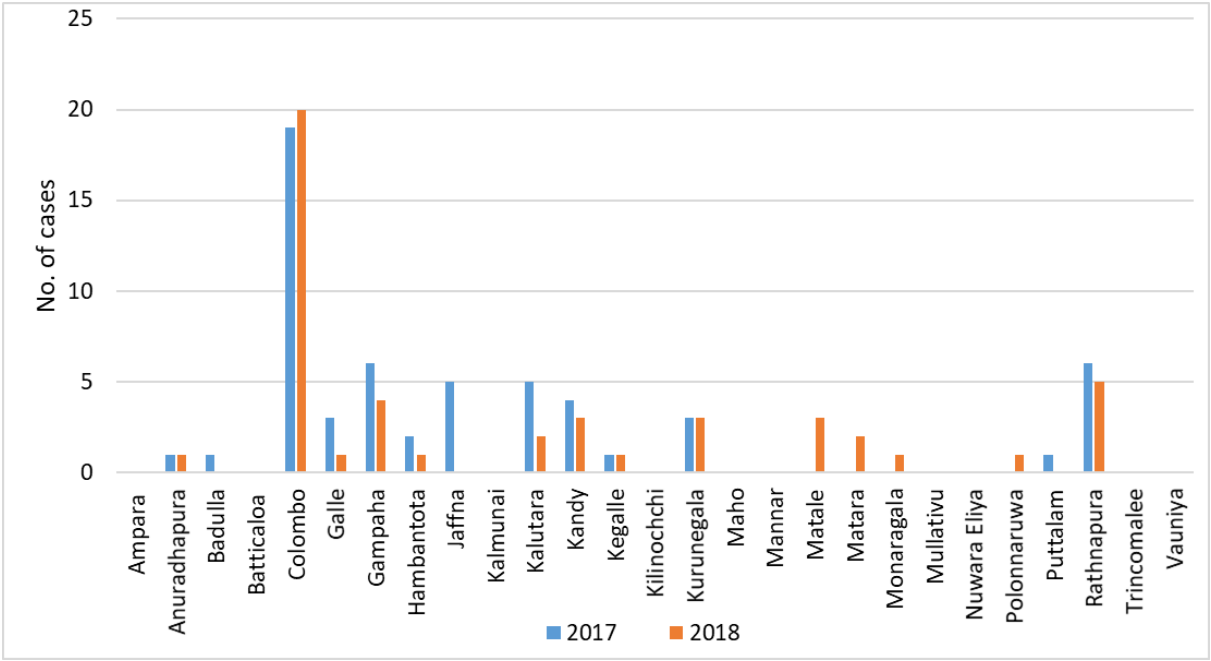

Figure 2. Distribution of Malaria cases by districts in 2017 and 2018

2.5 Malaria cases by sex and age group in 2018

Most cases are reported in males (91.7%). All the cases were reported from people under 40 years, out of them, most cases were reported in the age category 11 – 20 years.

Table 4. Malaria cases by sex and age group in 2018

Age	Gender		Total
	Female	Male	N (%)
	N (%)	N (%)	
0-10	0 (0.0%)	1 (2.1%)	1 (2.1%)
11-20	2 (4.2%)	27 (56.3%)	29 (60.4%)
21-30	1 (2.1%)	12 (25.0%)	13 (27.1%)
31-40	1 (2.1%)	4 (4.2%)	5 (10.4%)
Total	4 (8.3%)	44 (91.7%)	48 (100.0%)

2.6 Delay in diagnosis of malaria

Thirty-seven cases (77.1%) were diagnosed within 7 days of onset of symptoms of malaria.

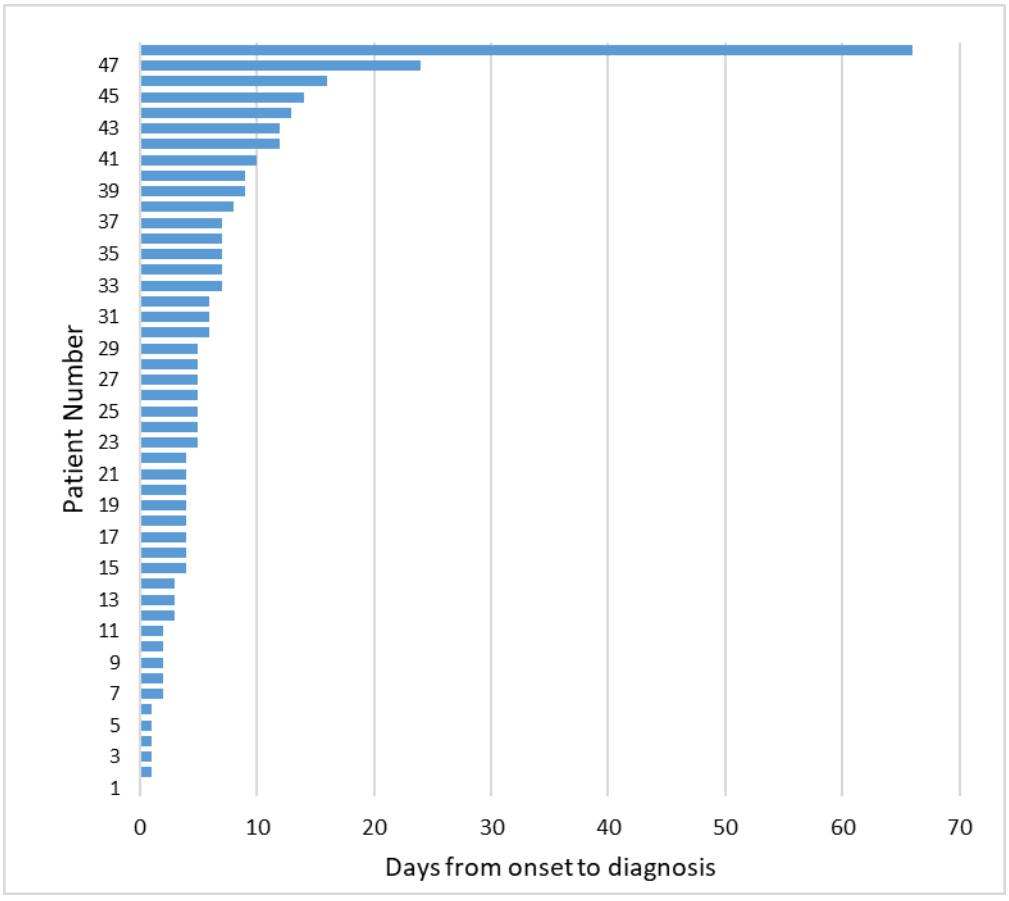

Figure 4 Days of delay in diagnosis of malaria from the onset of symptoms in 2018

2.7 Mortality from malaria

No deaths due to malaria cases were reported since 2008.

2.8 Status of drug resistance and drug policy

Parasitaemia of diagnosed malaria patients were assessed daily to detect the efficacy of treatment. All p. vivax cases were treated with Choloroquine for 3 days followed by Primaquine for 14 days. All uncomplicated *P. falciparum* cases were treated with artemisinin-based combination therapy (ACT) followed by a stat dose of Primaquine. Four severe cases were treated with IV Artesunate, followed by a stat dose of Primaquine. No patients were detected with drug resistance in 2018.

2.9 Chemoprophylaxis

Chemoprohylaxis is provided by AMC Headquarters, Regional Malaria Officers and certain identified MOH regions. Prophylactic drugs used were chloroquine, mefloquine and doxycycline.

Introduced malaria case

An introduced case is a malaria case acquired by mosquito transmission from an imported case in an area where malaria is not a regular occurrence.

The introduced case:

A Sri Lankan male, who has never been abroad, but has visited a construction site (The same construction site where the imported case was resident) in Monaragala and stayed overnight 12 days prior to developing fever. He had a past history of malaria and has had three blood transfusions in 2000. Following a mis diagnosis as a lower respiratory track infection, he was later diagnosed with *P.vivax* malaria at Colombo South Teaching Hospital. He was treated with chloroquine for 3 days and primaquine for 14 days to achieve radical cure. Around his resident in Colombo district, no adult Anopheline were detected.

Probable origin of the introduced case:

A skilled labourer, an Indian national who was employed at a construction site in Monaragala district in Uva province was diagnosed with *P. vivax* infection in December 2018. He was diagnosed by the government hospital after developing fever for 5 days one month after arriving in Sri Lanka. The diagnosis was confirmed by microscopy and RDT. Treatment was initiated with Chloroquine for 3 days and the patient was free of parasitaemia on the third day of initiating treatment. Primaquine for 14 days given for radical cure.

Response to the introduced case:

Parasitological surveillance: Contact screening of the workers at the construction site was initiated within 48 hours. Parasitological screening was conducted in residents of all houses within a radius of 1 km. Nearly 1190 people were screened. None were found positive for malaria. Reactive surveillance was also conducted in the regions where these contacts have visited. Ampara RMO region screened 1584 individuals from around the residencies of the construction site workers from Ampara. None were positive.

Entomological surveillance and vector control: Entomological surveillance was initiated within 48 hours. High densities of *Anopheles culicifacies*, were found in and around the construction site. Vector control measures were implemented immediately with indoor residual spraying (IRS), larviciding, fogging and distribution of long-lasting impregnated bed nets (LLINs) to residents at the construction site and the residents in the 1 km vicinity. Surveillance and vector control continued for 2 months.

Laboratory confirmation of the link between the two cases: Genetic analyses of P. vivax strains obtained from both these cases was conducted. It showed an identical match at five polymorphic gene loci, suggesting a strong molecular epidemiological link.

Health education and awareness: An awareness campaign was conducted using the public address system in and around the construction site. House to house visits conducted informing to test for malaria if they developed fever. Public and private healthcare workers were educated to test for malaria in febrile patients. A circular was issued by the DGHS, recommending to test for malaria in all fever patients in the districts of Monaragala, Ampara, and Colombo. An SMS to alert to physicians nation-wide was sent.

Mass drug administration: Due to high susceptibility and vulnerability of the region surrounding the construction site in Monaragala, a treatment course with Choloroquine and primaquine was given to all 30 Indian labour migrant group.

Reference: Karunasena, V.M., Marasinghe, M., Koo, C. et al. The first introduced malaria case reported from Sri Lanka after elimination: implications for preventing the re-introduction of malaria in recently eliminated countries. Malar J 18, 210 (2019).
https://doi.org/10.1186/s12936-019-2843-6

3. Parasitological Surveillance

The parasitological surveillance in the country is implemented mainly through screening of individuals attending to medical institutions and field level screening done based on the vulnerability and receptivity. Screening done at medical institutions is categorized as Passive Case Detection (PCD) which included medical institutions without a Public Health Laboratory Technician (PHLT)/ Public Health Field Officer (PHFO); Activated Passive Case Detection (APCD) which includes medical institution where there is either a PHLT and/or a PHFO. Active Case Detection (ACD) is carried out in the form of screening high risk groups as Proactive Case Detection or as Reactive Case Detection as a response to a malaria case detected. This is done mainly by conducting mobile malaria clinics at village/field level. Microscopy is the main diagnostic method while Rapid Diagnostic tests (RDTs) are also being used as a supplementary tool.

3.1 Screening of suspected malaria patients

In 2018, a total of 1,129,070 blood smears were examined by the Public Health Laboratory Technicians attached to Anti Malaria Campaign. The proportions of blood smears screened under PCD, ACD and by screening blood donors and the number of positives by different methods are given in Figure 4.

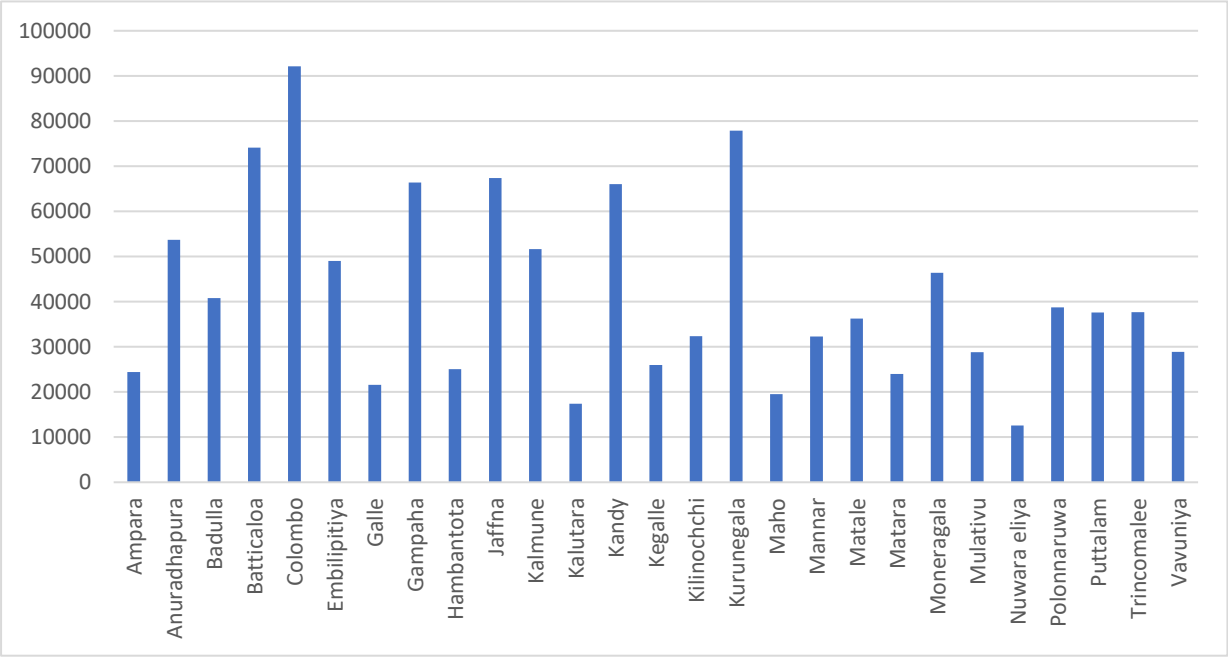

Figure 4: Total number of blood smears examined during the year 2018

3.2 Provision of laboratory items

The Central laboratory, Anti Malaria Campaign Head quarters (AMC HQ) distributed series of laboratory items required for malaria microscopy to regional malaria laboratories to ensure quality assured and quality-controlled malaria microscopy services throughout the country. As a cost cutting measure Giemsa powder, Methanol and ethanol are obtained from the MSD, and the Giemsa stock solution is prepared at the Central Parasitology Laboratory. Prepared stock solution is subjected to quality check according to the Standard operating procedures for malaria microscopy before distribution. Details of items issued are given in table 5.

Table 5: Laboratory items issued during the year 2018

District/RMO region	Glass Slides	Lancets	Methanol (L)	Giemsa (L)	RDT Kits	Anisol (L)	Isopropyl alcohol/Ethanol
Ampara	7200	19000	5	7	-	2.5	2.5
Anuradhapura	-	-	7.5	2	-	2.5	2.5
Badulla	-	-	10	4.5	-	2.5	2.5
Batticaloa	43000	42000	17.5	10	-	-	7.5
Hambantota	23000	29000	5	5	-		
Jaffna	12200	10000	2.5	2		2.5	2.5
Kalmunei	15800	10000	2.5	4		-	2.5
Kandy	10800	10000	2.5	6			2.5
Kegalle	17200	16000					-
Kilinochchi	10000						
Kurunegala	20000	36000	5	2.5	250		5
Maho	5000	9000	2.5	2.5	400	2.5	
Mannar	7200	10000	2.5	2		-	-
Matale	15000	10000	5	4.5	-	2.5	5
Monaragala	10800	10000	-	4.5	-	-	2.5
Mulativu	14400	16000	2.5	1	-	5	2.5
Polonnaruwa	-	-	10	10		-	2.5
Puttalam	12200	10000	2.5	5.5		-	2.5
Rathnapura	-	-	2.5	2	-	-	2.5
Trincomalee	17200	19000	-	2		-	-
Vavuniya	12200	19000	4.5	3		1	-
Total	253200	275000	89.5	80	650	21	45

3.6 Activities related to quality assurance of malaria microscopy

With the aim of improving quality of malaria microscopy services in the country, 14 two-day in-service training programs were conducted for Public Health Laboratory Technicians (PHLTs) and Medical Laboratory Technologists (MLTs). For Private sector laboratory technicians, two one-day training programs were conducted. Trainings were provided on the proper preparation and collection of blood smears and microscopical diagnosis of malaria. The Standard Operating Procedures for malaria microscopy and RDTs were also distributed.

Table 6. Details of in-service training programs

Category	Number of programs conducted	Number train	Number of District represented
PHLT	13	161	26
Private sector	2	43	05

3.7 Special parasitological surveillance activities carried out by the Anti Malaria Campaign

During the year 2018, the Anti Malaria Campaign conducted special screening programmes at the Bandaranaike International Airport to screen military personnel returning from UN peace keeping missions and special groups returning from malaria endemic countries when informed by IOM and UNHCR.

4. Entomological Surveillance

Entomological surveillance play a key role in the efforts made to prevent malaria re-introduction in Sri Lanka. In 2018 entomological surveillance activities have been carried out according to the revised guidelines for entomological surveillance 2017 and in accordance with the National Strategic Plan 2018-2022. The main objectives of entomological surveillance were to assess the receptivity to prevent forward transmission by taking appropriate timely actions within the circumscribed locality when a malaria case is reported and to assess the receptivity of a focus through entomological investigations if the vulnerable groups or individuals have been identified.

These entomological investigations are mainly classified in to two categories as spot surveys and sentinel surveys. Spot surveys were carried out as reactive spots when a malaria patient was reported and as proactive spots when vulnerability of a certain area is increased.

Fixed site entomological monitoring has been carried out at monthly basis in foci where both the receptivity and vulnerability was high as extended routine sentinel monitoring. Routine sentinel monitoring has been carried out in foci where vulnerability and /or receptivity was moderate to high on quarterly basis.

Special entomological surveys were carried out in areas found with invasive container breeding *Anopheles stephensi* and in urban areas with high human mobility and transportation hubs are present with the view of investigating the distribution of *Anopheles stephensi* in Sri Lanka.

Forty-four (44) entomological teams have been engaged in the above entomological surveillance activities during 2018 through the 28 regions island wide. A total of 4628 days was spent by the central and regional entomological teams in 2018 and the total number of days spent for entomological activities are given in Figure 5.

The entomological days carried out by the regions were funded by the Global Fund and government funds in 2018. Two semi-annual review programs were conducted in 2018 for entomological surveillance with the participation of all regional staff and technical staff of AMC HQ. Figure 6 shows the distribution of locations of extended routine sentinel sites in Sri Lanka in 2018.

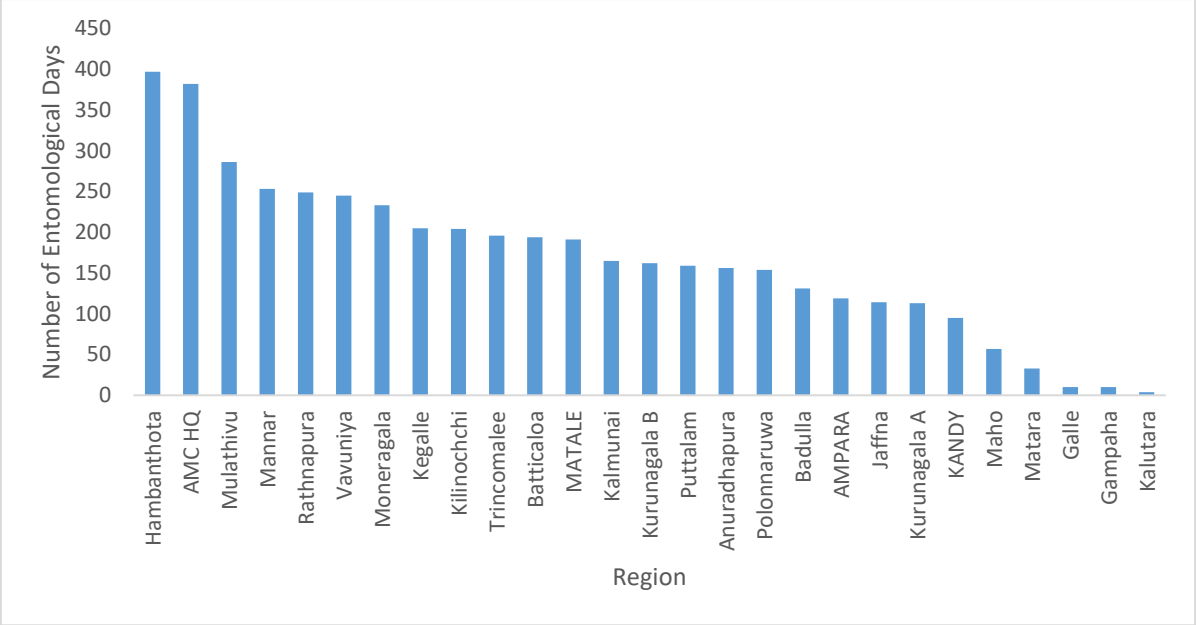

Figure 5. Total number of entomological surveillance days spent by each region in 2018

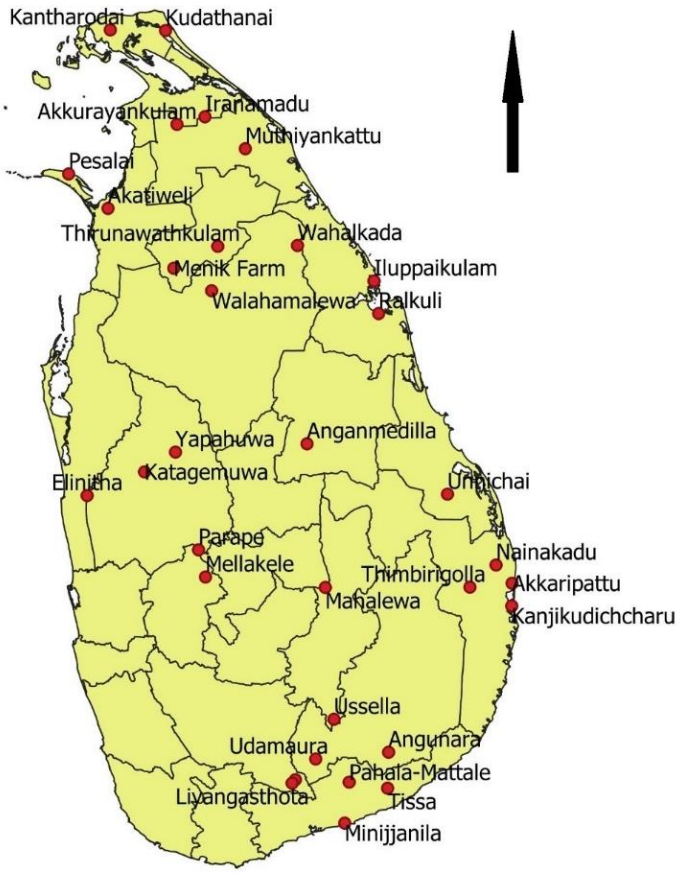

Figure 6: Extended routine sentinel sites in different RMO regions in 2018

4.1 Entomological techniques

4.1.1 Larval surveys

Larval surveys were conducted in all sentinel sites, proactive and reactive spot surveys to monitor larval densities and breeding site preferences of malaria vector mosquitoes. Further larval surveys have been conducted as pre and post intervention larval surveys in areas where invasive *Anopheles stephensi* has been found.

Figure 7. shows the total work output of larval surveys in total number of dips taken by entomological teams attached to RMO regions and AMC HQ in 26 RDHS areas.

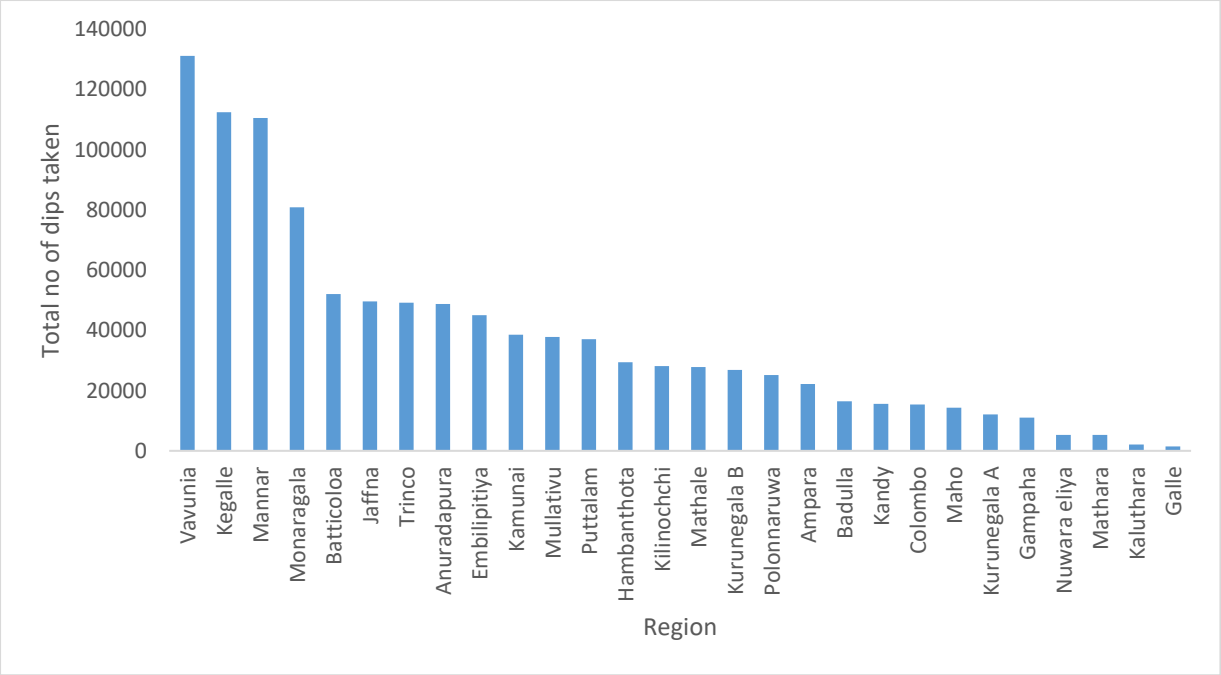

Figure 7: Total Number of dips taken by the regions in 2018

4.1.1.1 Breeding Habitats of malaria vectors

Figure 8 shows the results of larval surveys carried out in all RMO regions showing breeding habitat preferences of major malaria vector and secondary vectors. Larval surveys during 2018 indicate that the highest density of *An. culcifacies* was found in riverbed pools. Other breeding sites contributing to *An.culicifacies* breeding are borrow pits, quarry pits, wells, rain water collections, water storage devices, irrigation canals, river and stream margins, gem pits and tank margins. Highest density of *An. subpictus* was recorded from the lagoon margins while *An. varuna* highest densities were recorded from river margins. *An. annularis* was found from tank margins.

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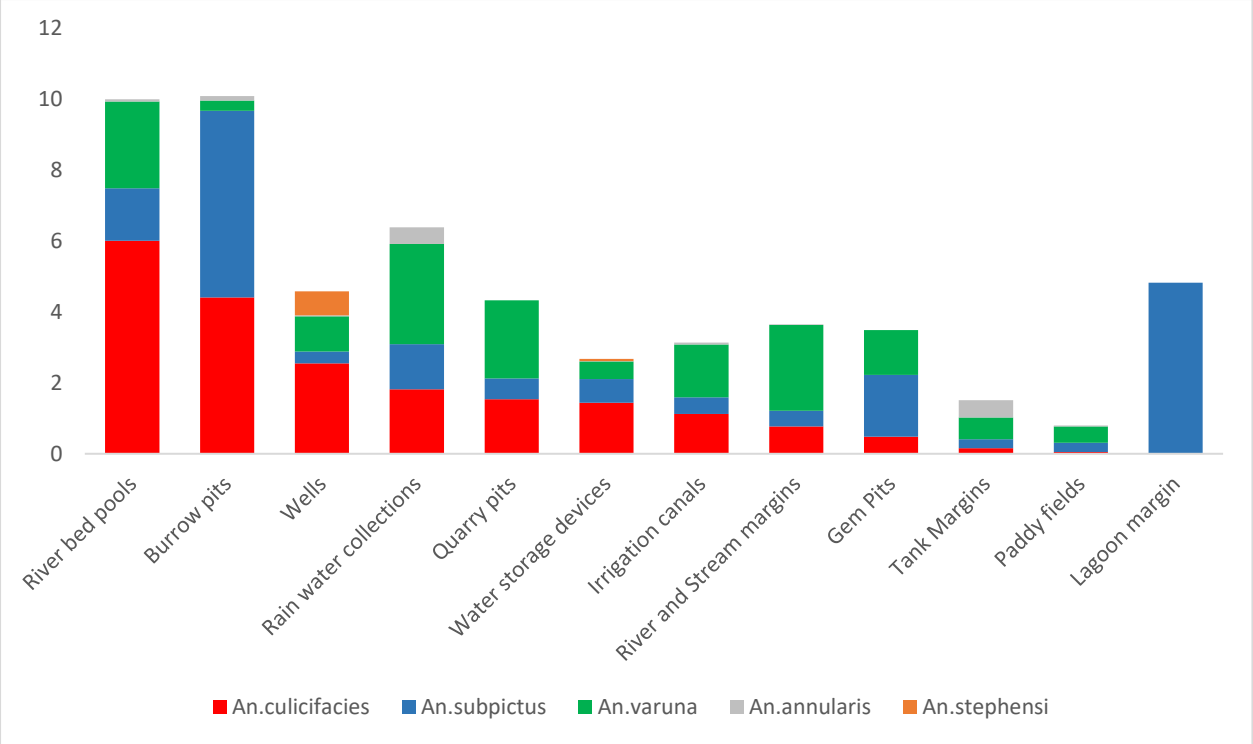

Figure 8: Relative density of major malaria vector larvae and secondary vector larvae in different breeding habitats

4.1.1.2 Larval Densities of malaria vectors

Comparison of larval densities of major vector and the secondary vectors by the districts is shown by figure 9. Trincomalee District of Eastern Province has recorded the highest densities of *An. culicifacies* larvae in 2018.

Highest densities of *An. subpictus* was recorded from Kalmunai while highest density *of Anopheles varuna* was recorded from Maho from the 2018 larval surveys. Further, *An. annularis* highest density was reported from Maho region. *An. stephensi* highest density was recorded from Mannar in 2018.

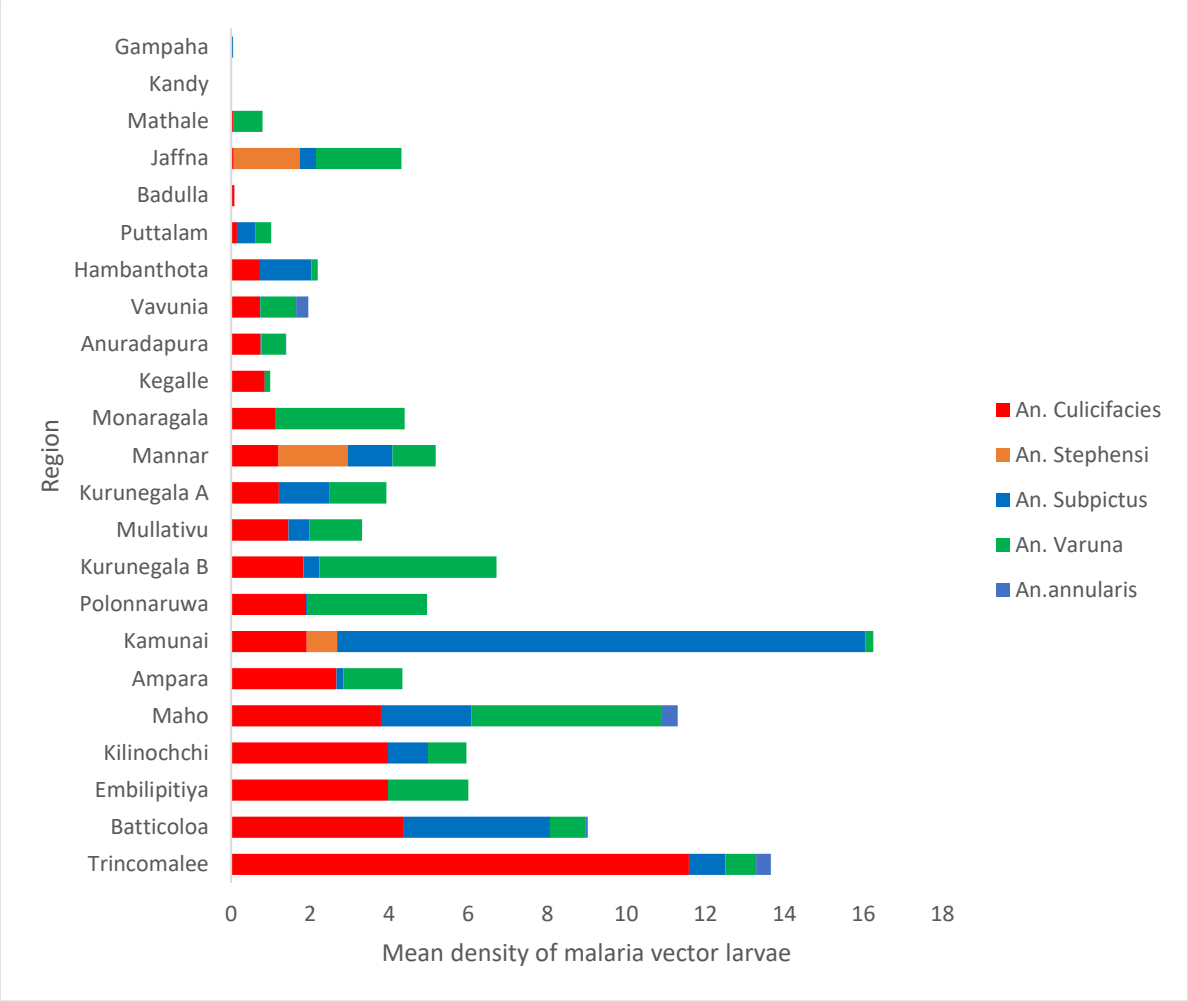

Figure 9. Mean densities of malaria vector larvae in each region in 2018

4.1.1.3 Larval surveys for *Anopheles stephensi*

An. stephensi was found for the first time in Sri Lanka from larval surveys carried out in Mannar district in 2016. Afterwards it has been found from other four districts of the country Vavuniya (September 2017), Jaffna, Kilinochchi and Mullaitivu (October 2017). Special larval surveys were continued in these districts as pre-intervention and post intervention surveys with the vigorous vector control interventions carried out for elimination of *An. stephensi*.

In June 2018, *An. stephensi* was first detected from Akkarapaththu MOH area of Kalmunai, Eastern province of Sri Lanka. Hence, special pre and post larval surveys and control programmes were conducted in Kalmunai district targeting elimination of *An. stephensi*. The predominant breeding sites of *An. stephensi* was identified as domestic wells while some were abandoned without any use. Other identified breeding sites were cemented tanks (ground level, overhead level and underground), water storage barrels. Abandoned boats and small size water storage containers were also found with very low incidence.

Breeding site preference of *Anopheles stephensi*

An. stephensi was observed breeding in domestic wells and water storage items in the areas where it has been found. Domestic wells are continuing to be the most preferred breeding site. Figure 10 shows the breeding site preference of *An. stephensi.*

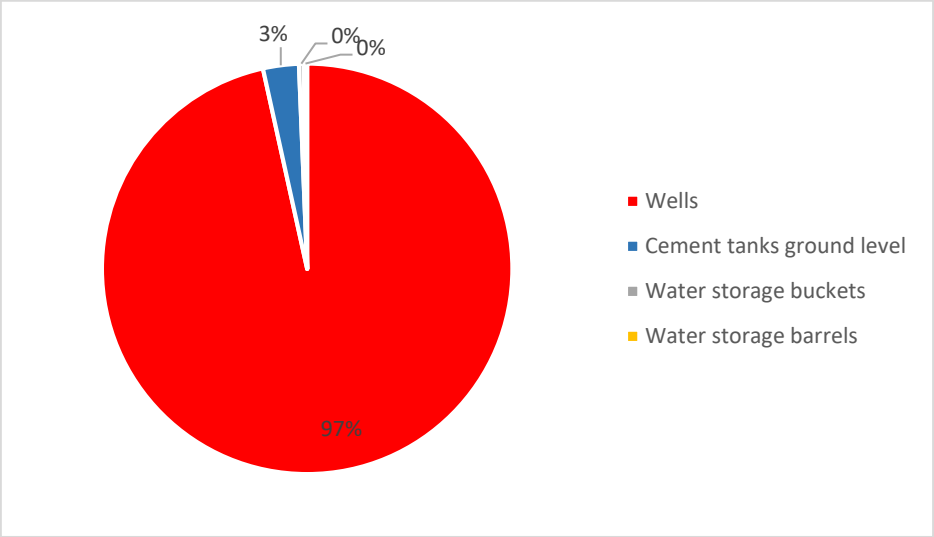

Figure 10. Breeding site preference of *Anopheles stephensi* in 2018

4.1.2 Cattle Baited Cadjan Hut Collections

Results of cattle baited hut technique is often used as an indicator for prevalence of indoor biting and resting vector populations. Figure 11 shows the total work output of cattle baited hut collections in different regions of Sri Lanka in 2018. Highest number of cattle baited cadjan hut collections were carried out in Hambanthota district followed by Vavuniya and Mulathivu districts.

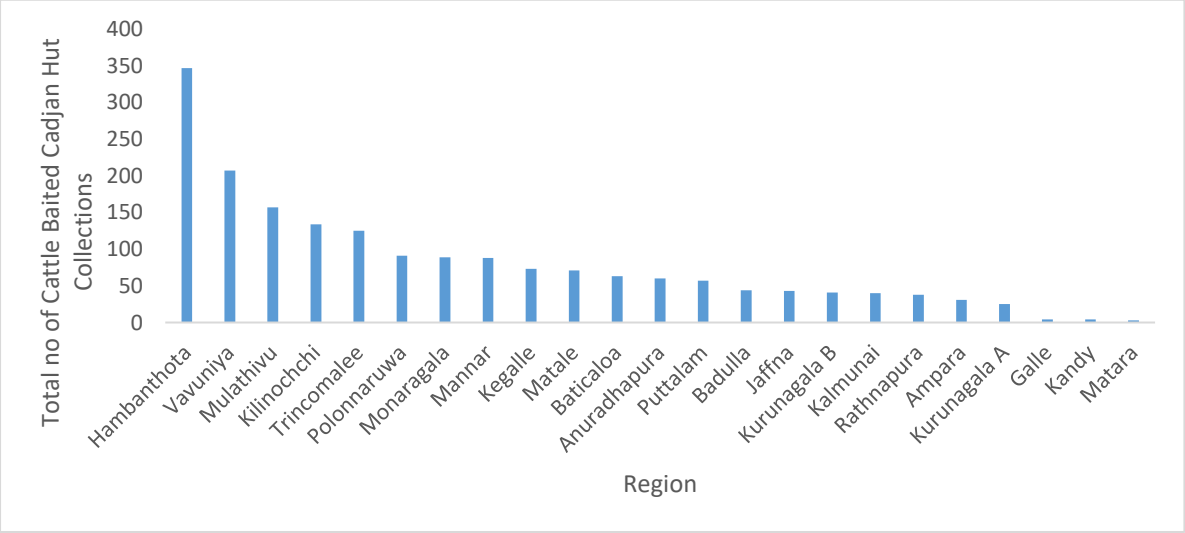

Figure 11. Total number of Cattle baited cadjan hut collections carried out in 2018 by districts

Highest densities of *An. culcifacies* was found in Polonnaruwa District during 2018 followed by Rathnapura District. Highest densities of *An. subpictus* was found in Kalmunai District followed by Mannar District. *An. annularis*was found only from four Districts namely, Hambanthota, Trincomalee, Vavuniya and Mulathivu. *An. varuna* highest density was from Polonnaruwa district.

A very low density of *An. stephensi* density was reported from Mannar District from Cattle baited cadjan hut collections. Figure 12 shows the malaria vector densities in Cattle baited cadjan hut collections reported by different regions in 2018.

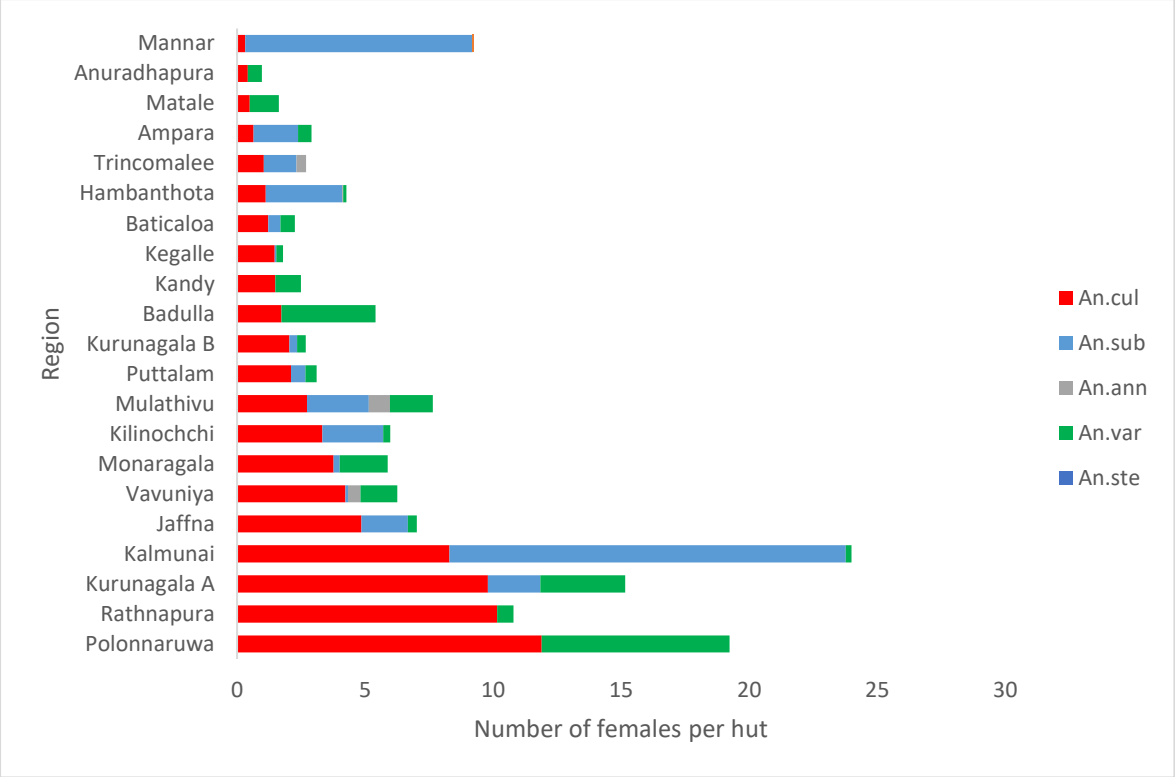

Figure 12. Mean densities of malaria vector adults collected from cattle baited cadjan huts by each region in 2018

4.1.3 Cattle Baited Trap Net Collections

Results of cattle baited net trap technique is often used as an indicator for prevalence of outdoor biting and resting vector populations. Figure 13 shows the total work output of cattle baited net trap collections in different regions of Sri Lanka in 2018. Highest number of cattle baited net trap collections were carried out in Hambanthota district followed by Kalmunai and Vavuniya districts.

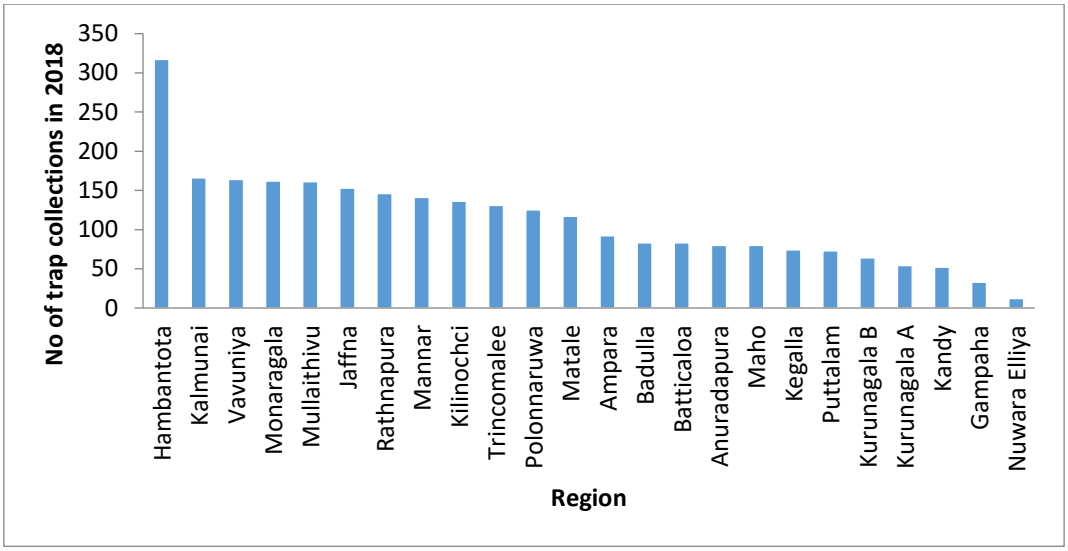

Figure 13. Total number of Cattle baited net trap collections carried out by regions in 2018

Highest densities of *An. culcifacies* was found in Batticaloa region during 2018 followed by Mulathivu region. Highest densities of *An. subpictus* was found in Hambanthota District followed by Trincomalee District. *An. annularis* highest density was from Trincomalee region and *An. varuna* highest density was from Monaragala region.

Mannar and Jaffna Districts reported very low densities of *An. stephensi* from Cattle baited net trap collections. Figure 14 shows the malaria vector densities in Cattle baited trap net collections reported by different regions in 2018.

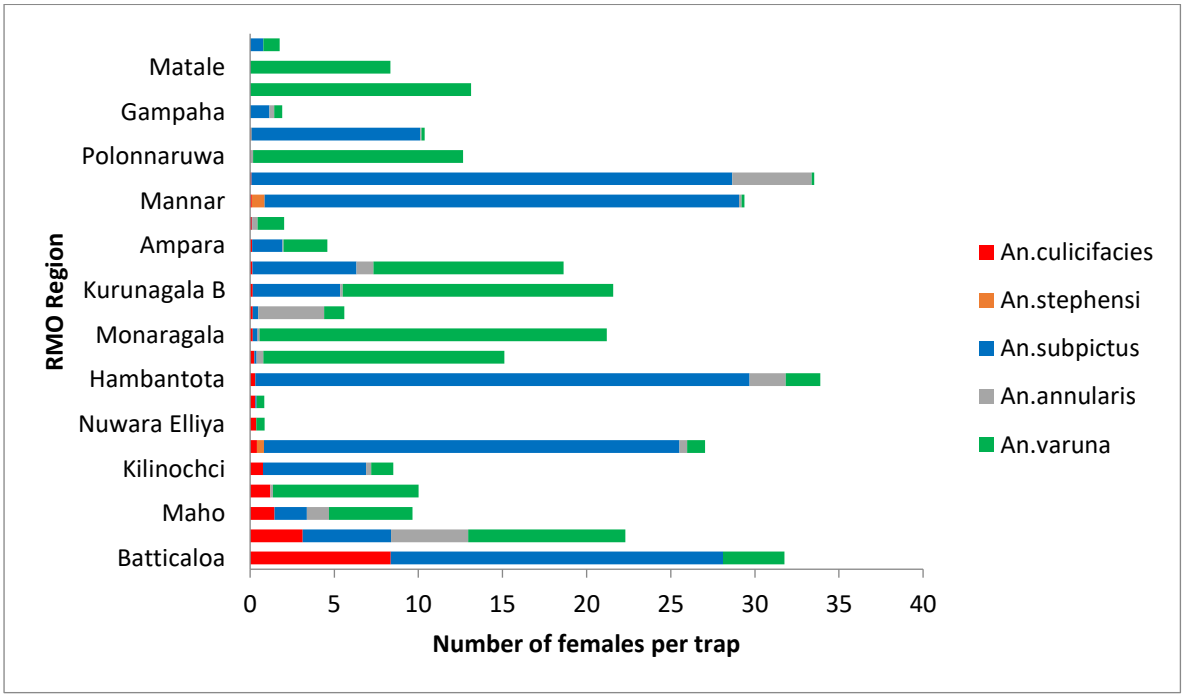

Figure 14. Mean densities of malaria vector adults collected from cattle baited net trap by each region in 2018.

4.1.4 Indoor Hand collections

Hand collection of indoor resting *Anopheles* mosquitoes was performed in many of the RMO regions. This technique provides useful information such as seasonality of indoor resting of vectors and their resting sites inside human dwellings.

Highest number of houses inspected for indoor resting mosquitoes was done in Hambanthota region followed by Baticaloa, Trincomalee and Maho regions (Figure 15). Major malaria vector *Anopheles culicifacies* was recorded in very low densities in some of the regions. Highest indoor resting habit of *An. culicifacies* was found in Baticaloa and Trincomalee Districts of Northern Province. Highest indoor resting density of secondary vector *An. subpictus* was found in Mannar region of Northern Province in 2018 (Figure 16).

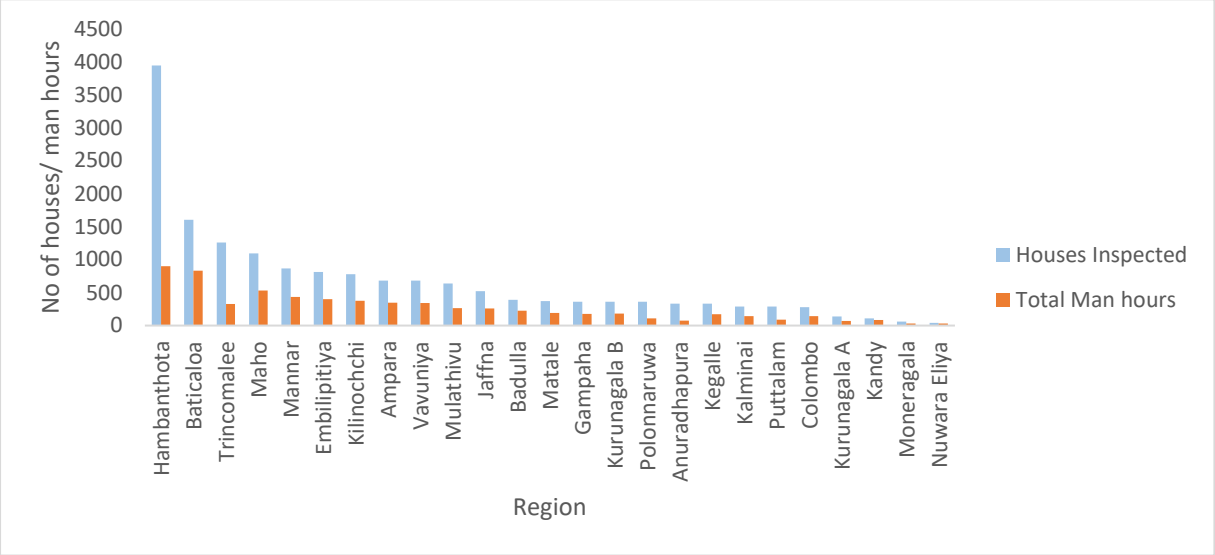

Figure 15. Total number of houses inspected, and man hours spent for indoor hand collections for malaria vectors by regions in 2018.

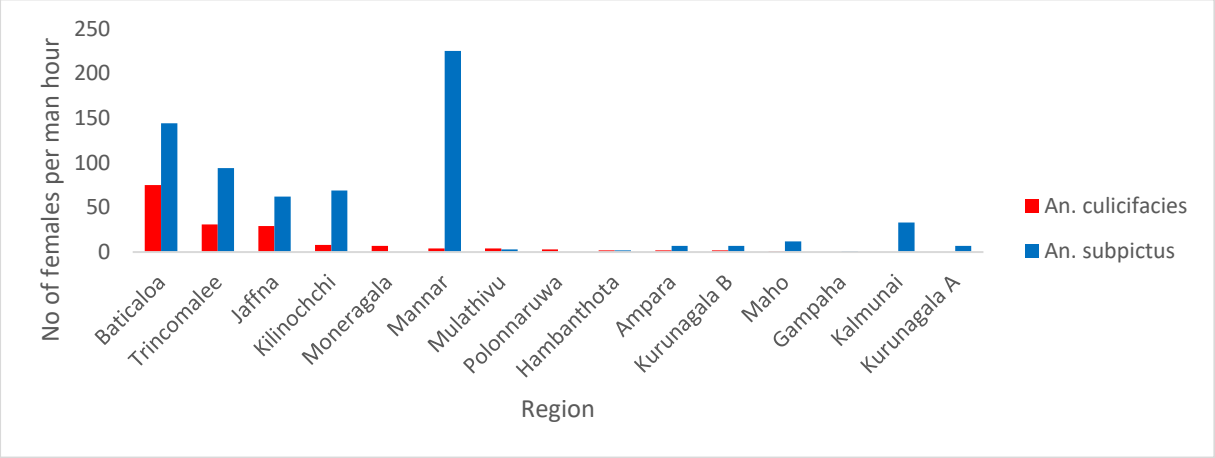

Figure 16. Mean density of *An. culicifacies* and *An. subpictus* indoor resting densities

4.1.5 Human landing catches

Human landing catches serves as a good indicator of assessing the risk of malaria transmission in the malaria elimination phase as there is no indigenous transmission. Results of partial night (6.00 p.m.to 9.00 p.m) human landing catches in different regions in 2018 are as follows.

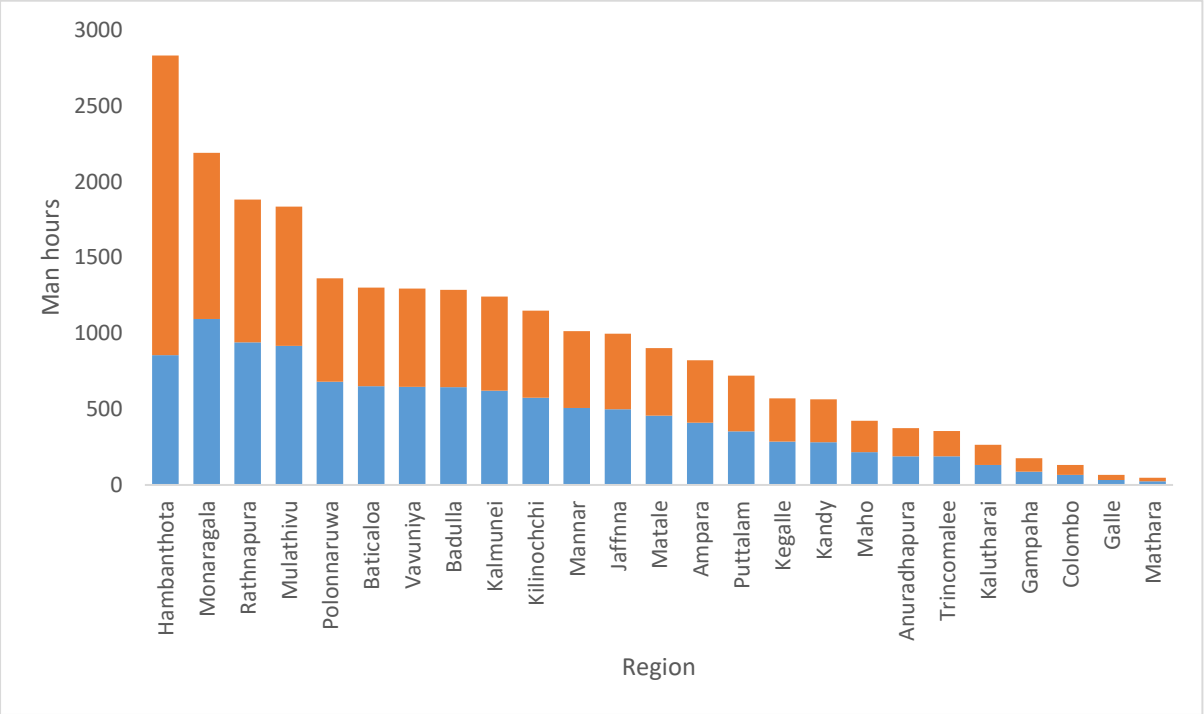

Figure 17: Total man hours spent in different regions in human landing catches in 2018

Figure 17 shows the total work output of human landing catches spent in man hours in different regions. Monaragala, Rathnapura, Mulathivu and Hambanthota regions have spent the highest total man hours indoor and outdoor.

4.2 Biting Preferences of Malaria Vectors

Despite the malaria eliminated situation in the country the human landing catches were continued to assess the risk of malaria transmission. *Anopheles culicifacies*, the primary malaria vector was found more abundantly (56%), followed by *Anopheles subpictus* (16%), *Anopheles varuna* (9%) and *Anopheles tessallatus* (5%) (Figure 18).

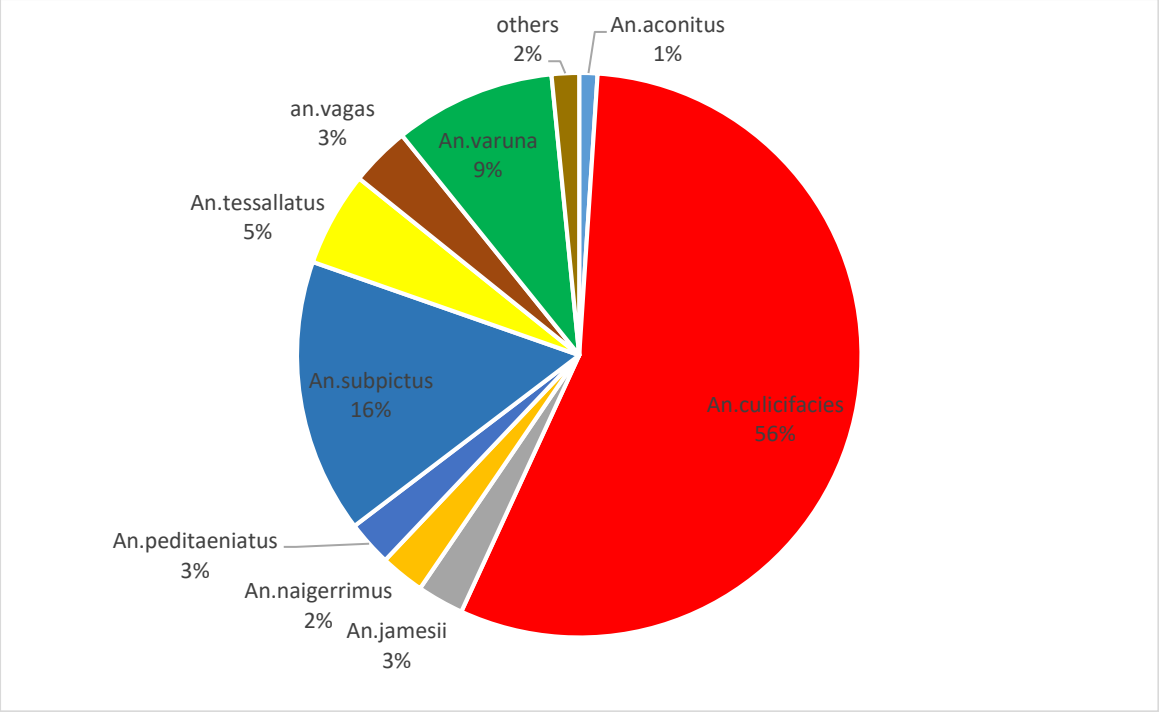

Figure 18: Percentage of human biting preferences of *Anopheles* species caught in human landing catches in all regions in 2018

4.3 Insecticide resistance in malaria vectors in 2018

Resistance to insecticides was tested in main malaria vector *An. culicifacies* and other secondary and potential vectors in 56 sites in 47 MOH areas during 2018. The WHO tube bioassays were conducted for diagnostic concentration of insecticides which are in use or with potential use for malaria vector control. *An. culicifacies* showed confirmed resistance to DDT 4% in Thamankaduwa (mortality, 28%) and to Permethrin 0.75% in Oddusudan (mortality, 89%) and in Chilaw (mortality, 67%). Possible resistance to three other pyrethroids was also evident in four districts (Table 7).

Table 7: Insecticide resistance status of *An. culicifacies* in 2018

RMO Region	MOH	Insecticide	Resistance Status
Polonnaruwa	Thamankaduwa	DDT 4%	Confirmed
Mullaitivu	Oddusudan	Permethrin 0.75%	resistance*
Puttalam	Chilaw		
Jaffna	Maruthankerny	Deltamethrin 0.05%	Possible resistance
Kalmunai	Thirukkovil		
Trincomalee	Uppuweli	Cyfluthrin 0.15%	
Vavuniya	Cheddikulam	Lambda cyhalothrin 0.05%	
Ampara	Damana	Deltamethrin 0.05%	Susceptible
Embilipitiya	Embilipitiya		
Hambantota	Sooriyawewa	Lambda cyhalothrin 0.05%	
Kurunegala	Wariyapola		
Kurunegala	Wariyapola	Permethrin 0.75%	
Moneragala	Buttala	Cyfluthrin 0.15%	
Moneragala	Buttala	Permethrin 0.75%	
Moneragala	Siyabalanduwa	Lambda cyhalothrin 0.05%	
Polonnaruwa	Thamankaduwa	Cyfluthrin 0.15%	
Puttalam	Arachchikattuwa	Lambda cyhalothrin 0.05%	
Puttalam	Karuwalagaswewa		
Trincomalee	Uppuweli	Deltamethrin 0.05%	
Trincomalee	Uppuweli	Permethrin 0.75%	
Vavuniya	Cheddikulam	Deltamethrin 0.05%	
Vavuniya	Cheddikulam	Etofenprox 0.5%	
Vavuniya	Manikfarm	Lambda cyhalothrin 0.05%	

*Confirmed Resistance:<90% mortality, Possible Resistance: 90-97% mortality, Susceptible: 98-100% mortality

Secondary malaria vector *An. subpictus* showed confirmed resistance to DDT 4%, Etofenprox 0.5%, Lambda cyhalothrin 0.05%, Cyfluthrin 0.15% in four locations and possible resistance to other pyrethroids (Table 8).

Table 8: Insecticide resistance status of *An. subpictus* in 2018

RMO Rigion	MOH	Insecticide	Resistance Status
Hambantota	Hambantota	DDT 4%	Confirmed
Jaffna	Jaffna	Etofenprox 0.5%	resistance*
Killinochchi	Kandawalai	Lambda cyhalothrin 0.05%	
Mannar	Mannar	Cyfluthrin 0.15%	
Ampara	Uhana	Deltamethrin 0.05%	Possible resistance
Hambantota	Hambantota	Cyfluthrin 0.15%	
Hambantota	Mirijjawila	Deltamethrin 0.05%	
Hambantota	Mirijjawila	Lambda cyhalothrin 0.05%	
Jaffna	Jaffna	Etofenprox 0.5%	
Jaffna	Uduvil	Lambdacyhalothrin 0.05%	
Mannar	Adampan		
Mannar	Mannar	DDT 4%	
Mannar	Mannar	Deltamethrin 0.05%	
Trincomalee	Muthur	Permethrin 0.75%	
Trincomalee	Uppuweli	Deltamethrin 0.05%	
Batticaloa	Kiran	Deltamethrin 0.05%	Susceptible
Batticaloa	Arayampatay	Etofenprox 0.5%	
Hambantota	Tissa		
Kilinochchi	Palai	Deltamethrin 0.05%	
Kilinochchi	Kandawalai	Propoxur 0.1%	
Mannar	Mannar		
Trincomalee	Uppuweli	Permethrin 0.75%	
Trincomalee	Muthur		
Trincomalee	Muthur		

**Confirmed Resistance: <90% mortality, Possible Resistance: 90-97% mortality, Susceptible: 98-100% mortality*

Invasive potential malaria vector *An. stephensi* in Jaffna MOH area has shown confirmed resistance to Etofenprox 0.5% and possible resistance to Deltamethrin 0.05%. *An. varuna* and *An. vagus* have also tested possibly resistant to some pyrethroids in seven locations (Table 9).

Table 9: Reported insecticide resistance in other Anophelines

RMO Region	MOH	Insecticide	Mosquito species	Resistance Status
Jaffna	Jaffna	Etofenprox 0.5%	*An. stephensi*	Confirmed resistance
Jaffna	Jaffna	Deltamethrin 0.05%	*An. stephensi*	Possible resistance
Mullaitivu	Oddusudan	Deltamethrin 0.05%	*An. varuna*	
Ampara	Uhana	Deltamethrin 0.05%	An. vagus	
Embilipitiya	Godakawela	DDT 4%		
Matale	Ambagahakorale	Etofenprox 0.5%		
Vavuniya	Manikfarm	Cyfluthrin 0.15%		
Vavuniya	Cheddikulam	Cyfluthrin 0.15%		
Vavuniya	Vavuniya North	Cyfluthrin 0.15%	*An. annularis*	Susceptible
Ampara	Damana	Deltamethrin 0.05%	*An. varuna*	
Embilipitiya	Embilipitiya	Deltamethrin 0.05%		
Kandy	Hasalaka	Permethrin 0.75%		
Kandy	Wattegama	Cyfluthrin 0.15%		
Kurunegala	Gokarella	Permethrin 0.75%		
Matale	Laggala Pallegama	Deltamethrin 0.05%		
Matale	Wilgamuwa	Cyfluthrin 0.15%		
Matale	Laggala Pallegama	Deltamethrin 0.05%		
Mullathivu	Mullathivu	Permethrin 0.75%		
Vavunya	Cheddikulam	Lambda cyhalothrin 0.05%		

5. Vector Control

5.1 Core vector control activities

The core vector control methods used in AMC are Indoor Residual Spraying (IRS) and use of Long-lasting insecticidal nets (LLIN).

Table 10: Total number of premises/houses and the population protected by application of IRS in 2018

RMO Region	Premises/ Houses	Population protected
Ampara	86	1158
Anuradhapura	152	586
Badulla	0	0
Batticaloa	106	492
Rathnapura	344	1032
Hambanthota	37	141
Jaffna	0	0
Kalmunai	65	260
Kandy	100	371
Kegalle	0	0
Kilinochchi	0	0
Kurunegala A	694	1401
Kurunegala B	1963	4830
Maho	104	1072
Mannar	687	2292
Matale	0	0
Monaragala	310	1099
Mullathiu	0	2
Polonnaruwa	161	639
Puttalum	274	1059
Trincomalee	0	0
Vauniya	192	666
TOTAL	**5275**	**17373**

A total of 5275 premises/houses were sprayed with IRS, and 17373 population was protected. Kurunegala B had the highest number of premises sprayed and population protected (1963 premises and 4830 population protected). In Mannar, a total of 2292 population was protected with 687 premises/houses sprayed with IRS. IRS spray activities conduced in Moneragala district was for the introduced case in December.

The type of Long Lasting Insecticidal Nets (LLIN) used in the Anti Malaria Campaign in 2018 is PermaNet 2.0. Insecticide contained in PermaNet 2.0 is deltamethrin. The Table 2 gives the distribution of LLIN by regions in 2018.

Table 11. Long Lasting Insecticidal Net (LLIN) distribution by regions in 2018

RMO Region	No. distributed
Ampara	1620
Anuradhapura	1670
Badulla	710
Batticaloa	967
Rathnapura	2757
Hambanthota	360
Jaffna	1960
Kalmunai	1724
Kandy	1343
Kegalle	394
Kilinochchi	1049
Kurunegala A	0
Kurunegala B	641
Maho	84
Mannar	1407
Matale	1872
Monaragala	1122
Mullathiu	1359
Polonnaruwa	310
Puttalum	1192
Trincomalee	431
Vauniya	894
TOTAL	**23866**

A total of 23866 LLIN were distributed in 2018 in the entire country. LLIN is distributed as part of reactive vector control activities as well as for vulnerable population in the presence of high receptivity. Highest number of LLIN were distributed in Rathnapura district.

5.2 Supplementary vector control methods

Use of temephos and larvirous fish introduction are two common supplementary method carried out by AMC as Larval source management (LSM). Both these methods are used for *An. Stephensi* control and elimination activities as well.

5.3 Use of space spraying

Space spraying is not advocated by AMC as a main vector control method. It has a limited role in reactive vector control. Whenever, space spraying is applied, the decision to apply, extent and the timing of space spraying is decided through discussions between RMO and the AMC – HQ.

5.4 Reactive vector control activities

In 2018, 47 imported cases and one introduced case was detected in Sri Lanka. Since the elimination of malaria in 2012, this is the first time an introduced case was reported. Vector control carried out at the site of the local transmission of the introduced case included IRS application, distribution of LLIN, larviciding and space spraying. Sustained vector control activities were continued for 8 weeks.

For the 47 imported cases and one introduced case, based on night stay of each individual, 69 reactive spot surveys were conducted. Of the 69 sites where reactive spot surveys were conducted, only 16 sites required vector control activities. IRS application and LLIN distribution was conducted in 3 sites each. Temephos application, fish introduction and space spraying were done in 6,5 and 10 sites respectively. Certain sites required more than one vector control method. The Table 12 gives the type of vector control activity conducted in each of these 16 sites.

Table 12: Reactive vector control activities conducted in 2019 in Sri Lanka by MOH area by activity

RMO Region	MOH area	Vecto control activities conducted				
		IRS	LLIN	Temephos	Larvivorous fish introduction	Space spraying
Gampaha	Minuwangoda				√	
Gampaha	Negombo					√
Kegalle	Ruwanwella				√	
Matale	Naula			√	√	
Galle	Bope Poddala					√
Anuradhapura	Nachchaduwa				√	
Kalutara	Madurawa			√		√
Kalutara	Madurawa			√		√
Rathnapura	Kuruwita				√	
Monaragala	Siyambalanduwa	√	√	√		√
Kalmunai	Potuvil	√	√			√
Matara	Kakunadura					
Colombo	Homagama			√		√
Colombo	Homagama					√
Monaragala	Siyambalanduwa	√	√	√		√
Galle	Hikkaduwa					√

6 Monitoring and Evaluation

6.1 Monthly programme review meetings

Monthly programme review meetings were started in 2009 and continued over the years with the participation of Regional Malaria officers, technical officers of the Anti-Malaria campaign, Tri forces, police, technical support group members and other relevant stakeholders as necessary. In 2018, 24 RMO regional officers participated in these review meetings. Out of these two regions (Colombo and Gampaha regional malaria offices) were newly established in 2018. These review meetings were conducted once a month to review the programmes and surveillance activities carried out in the previous month. Knowledge was shared and recommendations were provided by discussions among AMC technical staff and the regional malaria officers.

Reviewed activities of the RMO regions include;

1. Parasitological surveillance data: Active case detection conducted in hospitals in the regions, ante natal clinics, blood banks and passive case detection with fever surveillance data is monitored. Conducting malaria mobile clinics to screen for malaria positive blood smears in the highly vulnerable and receptive areas is a high priority activity to sustain the malaria free status.
2. Entomological surveillance data: Routine and reactive entomological surveillance techniques are assessed. Insecticide resistance monitoring, vector control measures, the reasons for conducting these measures.
3. Control and elimination programme for *An. stephensi* is assessed in the three regions (Jaffna, Kalmunai and Mannar).
4. Logistics and drug stocks and maintenance data.
5. Case Management: Case histories, case management and follow up were discussed.

6.2 Technical Support Group

The Director General of Health Services has appointed a Technical Support Group (TSG), for the purpose of providing carefully considered evidence based strategic and technical advice and recommendations to the Anti- Malaria Campaign (AMC) for the prevention of reintroduction of malaria in Sri Lanka. The TSG comprises of 17 expert members who represents the fields of public health, parasitology, entomology, pharmacology, clinical medicine and the Ministry of Health as DDG Public Health Services 1, a representative from health education bureau and regional director of

Colombo district to provide the administrative and technical guidance representing the region with the highest incidence of imported cases. Two regional malaria officers and the technical staff of AMC headquarters are also comprising the group. The TSG meeting is chaired by the Director General of Health Services. The TSG is convened once in every two months.

6.3 Case Review Committee meeting

Five of the TSG expert members also comprise the Case review committee (CRC) along with the AMC technical staff. The CRC reviews information of all malaria cases in detail and confirms the diagnosis, review the origin of infections, confirms the classification whether it is imported, locally acquired or an introduced case or an indigenous case. The details of treatment are reviewed and follow up procedures discussed. Following classification of cases, the national malaria case register is signed by a CRC member. These meetings are held once a month chaired by the Director AMC. In 2018, 12 CRC meetings were held. These committees also collaborate closely with the AMC and provide technical guidance and feedback for many related activities, programmes and in guideline development.

6.4 Information management system

Case data section of the Digital Health Information System 2 (DHIS 2) was completed in 2018. The first training to the Regional Malaria Officers were given by the Anti Malaria Campaign. The online data entry of case histories, and management was initiated in 2018. All malaria cases, reactive surveillance data, sites where mobile screening clinics were conducted are mapped using GIS.

6.4 Semi Annual Entomology Reviews:

Reviewing and evaluation of entomological surveillance activities carried out in district levels should be done at least on semi-annual basis at national level for planning purposes and forecasting of malaria outbreaks. In 2018, two reviews were conducted with the participation of AMC Directorate, technical staff of AMC HQ, Regional Malaria Officers, Regional Entomologists and Health Entomology Officers.

6.5 Supervision visits

Supervision visit ensure that quality of services provided are according to the AMC guidelines and allows to take necessary action if needed early in the course. Supervisions are conducted by the technical teams of AMC and review the activities related to case management, parasitological surveillance, case surveillance, logistic management, private sector collaborations, quality assurance processes, documentations and drug and commodity storage and distribution among many other things. These visits are conducted by AMC HQ and RMOs, to review the activities at the hospital level and field level.

7. Infrastructure and Human Resources

7.1 Human Resources at the Anti Malaria Campaign

The approved cadre for human resources and the in -position number as at 31 December 2018 are given in detail in Table

Table 12. Cadre information and human resources in position at AMC as at 31 December 2018

Designation	Approved cadre as at 31.12.2016	In position as at 31.12.2018
Director	1	1
Deputy Director	1	0
Consultant Community Physician (Medical Consultant)	3	2
PGIM Trainee		2
Medical Officer	8	5
Accountant	1	0
Entomologist	4	3
Parasitologist	1	1
RMO / AMO (Registered/Assistant Medical Officer)	1	0
Special Grade Health Entomological Officer	1	0
Special Grade PHLT	2	0
Health Entomology Officer	6	7
Medical Laboratory Technologist	3	1
Public Health Inspector	2	3
Public Health Laboratory Technician	22	16
Health Education Officer	1	0
Medical Record Assistant	1	0
Planning and Programme Assistant	1	0
Public Health Field Officer	10	9
Public Management Assistant	17	6
Medical Supplies Assistant	3	0
Development Officer	5	6
Development Assistant	4	2
Management Assistant	0	5
ICT Officer	1	0

ICT Assistant	2	1
Telephone Operator	0	2
Cinema Operator	1	1
Health Driver	19	11
Health Laboratory Aide	3	2
KKS	1	2
Lift Operator	2	2
Saukya Karya Sahayaka (Junior)	20	13
Saukya Karya Sahayaka (Ordinary)	25	22
Spray Machine Operator	19	5
Saukya Karya Sahayaka (Junior) Casual	0	8
Pharmacist	1	0
Technical Officer (Civil)	1	0
Generator Operator	1	0
Plumber/ Pump Machine Operator	1	0
Total	195	138

7.3 Vehicles in position

Adequate number of vehicles in good condition is an important factor in effective programme to prevent re-introduction of malaria. The table 18 shows the available number of vehicles in AMC headquarters In 2018.

Table 13. Vehicles in position at AMC in 2018

Serial No	Vehicle No	Type of Vehicle	Working Condition
1	WP PE 8966	CAB	Running
2	WP GP 2558	VAN	Running
3	WP GP 2556	VAN	Running
4	WP 42-9399	Motor Lorry	Running
5	WP LC-0249	Motor Lorry	Running
6	WP NA 3117	VAN	Running
7	WP NB 4568	VAN	Running
8	WP NB 4567	VAN	Running

9	WP PE 8975	CAB	Running
10	WP KK 6977	JEEP	Running
11	WP JL 8129	CAB	Not Running
12	WP PE 8974	CAB	Running
13	WP PE 8972	CAB	Running
14	WP PE 2025	CAB	Running
15	WP AAD 0185	Three wheel	Running
16	WP WF 5034	Motor Bicycle	Not Running

8. Funding

The government of Sri Lanka (GoSL) allocates funds for the Anti Malaria Campaign through the Ministry of Health, Nutrition and Indigenous Medicine. In 2106, The GoSL allocated Rs. 30 million as capital expenditure to AMC headquarters. The recurrent expenditure borne by the GoSL for AMC headquarters for year 2018 was Rs. 114.14 million. The recurrent expenditure of the regional malaria office staff are borne by the respective Ministries of Provincial Councils.

The Global Fund to fight AIDS, Tuberculosis and Malaria (GFATM) is a collaborative partner and a major funding source for the AMC. Year 2018 was the final year, the AMC received funding support through the New Funding Model grant which extended from 2016 – 2018. The GFATM budgetary allocation of Rs. 183.48 million comprised of 78.8% of the total capital budgetary allocations of the AMC in year 2018.

Following elimination of malaria in Sri Lanka in 2016, the New Funding Model supported the programme to sustain the malaria free status. The Prevention of Re-introduction phase of the AMC was designed under four modules; case management, vector control, health information systems and monitoring and evaluation and programme management. The activities were planned to achieve; a) improvements by clinical/communities, program development, provincial support, b) infrastructure development & strengthening, c) advocacy, d) health Education, e) community participation, f) national level program strengthening and f) monitoring and evaluation.

Table 14. Key performance indicators were identified

Indicator	Target Expected %	Expenditure target %
Proportion of confirmed malaria cases that received first line antimalarial treatment at public health sector facilities	100 %	100 %
Proportion of malaria cases that received first line treatment at private sector facilities	100 %	100 %
Percentage of confirmed cases fully investigated and classified	100 %	100 %

The World Health organization (WHO) is also a technical and funding partner for AMC. The WHO supported the activities of AMC by providing a capital allocation of Rs. 1.89 million in financial assistance to conduct 10 programmes for capacity building for clinical management n four provinces, by financially supporting participation at an International training on clinical management of malaria and by financing participation of two technical officers for regional training mosquito taxonomy.