



Vector
Control

2017

Annual Report

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LIST OF ABBREVIATIONS

All acronyms and abbreviations that appear in the report should be listed here, particularly jargon related to the relevant technical area/health region/facility. Sample below:

ULV	Ultra Low Volume
IRS	Indoor Residual Spraying
E.U.	European Union
EMMIE	Elimination of Malaria in Meso America and the Island of Hispaniola
AMI/RAVREDA	Amazon Malaria Initiative
USAID	United States Agency for International Development
NHI	National Health Insurance
PAHO	Pan American Health Organization
CHW	Community Health Worker
VC	Voluntary Collaborator
ABER	Annual Blood Examination Rate
API	Annual Parasitic Index
WHO	World Health Organization
COMBI	Communication for Behavioral Impact
IEC	Information, Education and Communication
BTB	Belize Tourist Board
BTIA	Belize Tourism Industry Association
DFID	Department for International Development
INDRE	Institute for Epidemiologic Diagnosis and Reference (Mexico)

1. INTRODUCTION

BACKGROUND

Under the Environmental Health Unit, the Vector Control Program has the responsibility for implementing surveillance, prevention and control measures to protect the population against vector borne diseases, particularly Malaria, Dengue, Chikungunya and Zika. It executes, on an ongoing basis, a series of mosquito vector control activities within areas with transmission of afore mentioned diseases. The program is also responsible for the development and dissemination of Information, Education and Communication (IEC) to the public.

VISION, MISSION AND OBJECTIVES

To reduce the social and economic impacts of vector borne diseases in Belize by implementing prevention and control measures based on the principles of integrated vector management.

Objectives:

- To conduct active and passive surveillance of vector borne diseases
- To implement various interventions to reduce human-vector contact
- To conduct Public Awareness and Education of major vector borne diseases
- To achieve a 20% reduction in the incidence of Dengue by 2020
- To eliminate autochthonous transmission of Malaria by 2020

SITUATIONAL ANALYSIS

MALARIA SITUATION

Between 2014 and 2016, the introduction of the EMMIE - entitled “Elimination of Malaria in Mesoamerica and the Island of Hispaniola” project resulted in an overall revamping of the vector control program, significantly impacting malaria transmission and strengthening district programs to ensure sustainability. The program is now moving towards elimination and is currently going through a re-orientation process to enhance its surveillance strategies through risk stratification, timely interventions using a combination of IRS and LLIN, vector surveillance, improved diagnosis, and treatment and follow up of patients. This change in approach will be a major challenge but with the continuation of technical and financial support by various external entities, this should facilitate the process. Belize maintains one of the lowest malaria incidence rate in the region at .02 per 1000 population and a total of 9 cases were confirmed in 2017. Of the 9 cases confirmed, 7 cases were classified as local from 3 foci (Trio Village, Silk Grass Village and Benque Viejo del Carmen).

The ministry was notified in December 2017 that the cash reward pay out from the Global Fund through the EMMIE project was approved and the transfer of USD \$800,000.00 should be completed shortly. This reward will be used to continue financing Belize's malaria elimination effort, as counterpart funds through the Regional Malaria Elimination Initiative (RMEI) being led by the Inter-American Development Bank (IDB), the Bill & Melinda Gates Foundation and the Carlos Slim Foundation.

The National Malaria Elimination Action Plan 2015 – 2020 will continue to give direction with respect to areas of priority where resources must be placed. This acceleration will take a concerted effort to sustain the momentum brought about by external funding and technical support, and in the light of new and emerging vector borne diseases which are of great public health concern, the ministry must continue to prioritize the malaria elimination effort and use the recent program success as both motivation and to lobby for support. Further analysis is necessary to determine the adequate number of human resources needed to efficiently and effectively carry out the required interventions in the various health regions. This is important and key if 2020 is to be a realistic timeline for malaria elimination, in a time when Dengue and Zika continue to be on the rise.

Belize's commitment to malaria elimination is reflected in their National Malaria Elimination Plan 2015-2020 which is guided by the following global and regional plans:

- WHO - Global Technical Strategy for Malaria - 2016 – 2030
- PAHO - Plan of Action for Malaria Elimination 2016-2020
- AMEXCID - MesoAmerican Master Plan for Malaria Elimination
- Strategic Plan for Malaria Elimination in Central America and the Island of Hispaniola - 2015 - 2020

The current focus is on border areas and communities with highly mobile populations, especially to endemic regions. This includes workers in the sugar cane, citrus, banana and tourism industries which not only have a high population of immigrant workers, but a mobile one as well.

Between 2007 and 2016, *Plasmodium vivax* account for 100% of detected cases, however, in August 2017 two mixed infections (*p. vivax* and *p. falciparum*) were detected in Silk Grass Village in Southern Belize. The mother and son duo maintains there was no recent travel history outside the country and failure to establish a travel pattern or detect prior or new cases within the locality, have resulted in both cases classified as local. Microscopists have continued to receive yearly refresher trainings to ensure they are competent to detect mixed infections or possible *p. falciparum* infections.

Long Lasting Insecticide Treated Bed nets (LLIN's) are now used in combination with IRS in areas with transmission, this combination of interventions along with supervision of treatment has produced great results. In 2018 the plan is to improve on both passive and active surveillance, re-distribute bed nets, cut down on the turn around time from the time a slide is taken to treatment administered, continue with supervised treatment, and conduct micro planning for foci under surveillance.

DENGUE

Since the introduction of Dengue in Belize in 1978, the disease have changed its characteristics of being an urban disease to now affecting many rural communities on an annual basis during the rainy season which runs from June to November. There are a relatively low number of cases during the dry season which is from January to end of May; this is followed by a sharp increase in the middle of June extending to the middle of October. Between October and December, there is a gradual decrease in the number of cases. Over time many rural communities have grown significantly and can be classified as being "urban like", meaning that many of the contributing factors which exit in an urban setting also exits in the rural setting.

The country has two main vectors, with the *aedes aegypti* as the primary vector and *aedes albopictus* as a secondary vector. The latter is found predominantly in rural communities and in limited distribution as opposed to the primary vector which is found in most areas.

Dengue remained concentrated mostly in Corozal, Orange Walk and Cayo districts. Although not reflected within the tables below, there was significant testing done through an arbovirus prevalence study carried out in collaboration with Mexico. Through the Belize-Mexico project, samples sent were tested by PCR for the three primary arboviruses in the region, namely Dengue, Zika and Chikungunya. Of 1457 persons tested for dengue, only 28 were positive. It was a striking contrast to what was being reported locally through rapid diagnostic testing, particularly in first and second quarter of 2017 where the positivity rate was extremely high. There was clearly an issue with the RDT which was eventually pulled from government medical facilities. The discrepancy in results by RDT's and ELISA/PCR can be established in the table below whereby "confirmed" dengue is classified as ELISA NS1 and PCR and "probable" is for IgM RDT. Dengue serotype 2 was the only serotype confirmed in country for 2017. Dengue transmission tends to be restricted to same communities in the various districts, eg. in Cayo, Benque Viejo del Carmen, San Martin, Salvapan, Las Flores, Armenia, Cotton Tree and Maya Mopan continue to be problematic. Factors contributing to transmission include poor drainage, storage of water in drums, and tires.

- Three indices are commonly used to record *Ae. aegypti* and *Ae. albopictus* density levels:
 1. **The House (premises) Index (HI) or *Aedes* Index:**
 - Percentage of houses or premises positive for *Aedes* larvae
 2. **Container Index (CI):**
 - percentage of water-holding containers positive for *Aedes* larvae.
 3. **Breteau Index (BI):**
 - number of positive containers per 100 houses in a specific location.

The primary entomological indicators monitored include house, container and brateau indices, of which the two most important are house and brateau. The goal is to keep these indicators below 5% and in the case of house and container indices, very low transmission should take place below 1%. These figures vary greatly by region, but the correlation is made whereby district like Corozal which had significant number of cases of both Zika and Dengue, also had a House Index of 5 and brateau of 8. Likewise, the Cayo district had many areas with house and container indices at 4 and 10

respectively. It is clear that much more needs to be done to reduce the number of water holding containers which serve as breeding sites. This can be improved through increased and effective communication with householders.

A study published in journal Emerging Infectious Diseases entitled *Aedes aegypti* Larval Indices and Risk for Dengue Epidemics highlighted "The house index (HI, percentage of houses positive for larvae) and the Breteau index (BI, number of positive containers per 100 houses) have become the most widely used indices, but their critical threshold has never been determined for dengue fever transmission. Since $HI \leq 1\%$ or $BI \leq 5$ was proposed to prevent yellow fever transmission, these values have also been applied to dengue transmission but without much evidence. The Pan American Health Organization described 3 levels of risk for dengue transmission: low ($HI < 0.1\%$), medium ($HI 0.1\% - 5\%$), and high ($HI > 5\%$), but these values need to be verified. The vector density, below which dengue transmission does not occur, continues to be a topic of much debate and conflicting empiric evidence. For example, dengue outbreaks occurred in Singapore when the national overall HI was $< 1\%$. In contrast, researchers from Fortaleza, Brazil, found that dengue outbreaks never occurred when HI was $< 1\%$."

Indices	High risk of transmission	Low risk of transmission
House index	> 10%	< 1%
Breteau index	> 50	< 5

A master's thesis study entitled "A Comprehensive Needs Assessment to Identify Priority Program Targets for Mosquito Vector Control and Related

Diseases in Belmopan, Belize" done by a Duke Kunshan University student – Mary Schooler in the Belmopan area during the past year used a KAP study to look at the effectiveness of the vector control program on addressing the needs of residents. Some of the interesting findings include that television, radio, hospital and ministry of health house visits (through inspections) were the primary source of information on the common mosquito borne diseases.

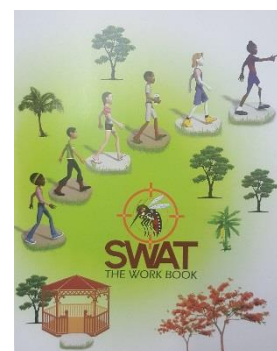
The survey showed that while house visits are effective, the persons at home during normal working hours tend to have less education and in some instances are illiterate, thereby highlighting the need to target workplaces more often and also look at targeting high risk areas during the weekends. There needs to be more community engagement including community meetings, health fairs and clean up campaigns. To build on the integrated approach for vector control, the ministry in the past had invested in the training of vector control, public health and health educators in COMBI – communication for behavioral impact. Although costly and with finances limited, the approach can be taken in communities which are a problem every year.

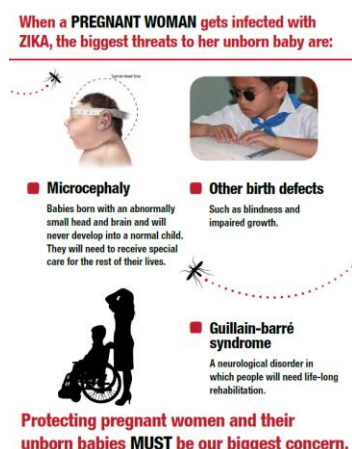
ZIKA

The areas which had confirmed transmission of Zika were the same as dengue. The ministry through the vector control and MCH program continued its intervention in distributing a combination on insecticide treated bed nets, insect repellent (DEET), and educational materials to pregnant women who accepted these items.

Testing was done at a significant levels as the ministry entered into a study with Mexico and PAHO to look at the prevalence of Dengue, Zika and Chikungunya countrywide. A total of 1457 persons were tested with results showing 28 dengue, 332 Zika, 0 Chikungunya positive. This study clearly established Zika as the primary arboviral disease in 2017, this was somewhat expected due to the susceptible population with Zika having been introduced in 2016. Excluding the issues aforementioned regarding dengue RDT's early in the year, it is evident that areas with usual high transmission such as Belize City, saw minimal number of cases.

The development of new educational materials, increased in public events such as health fairs and the observance of mosquito awareness week in May, certainly kept to the forefront both dengue and zika. In collaboration with HECOPAB, discussion were had to include some content on mosquito borne diseases and prevention thereof, in the HFLE – health and family life education curriculum prepared for primary schools by the ministry of education. Plans are underway for the introduction of Zika workbooks and a board games (SWAT) in selected primary schools located in areas with significant transmission.





2. OPERATIONAL OVERVIEW

KEY ACHIEVEMENTS

1. Belize has one of the lowest malaria incidence rate in the region at .02 per 1000 population: 9 cases in 2017 with 7 cases classified as local from 3 foci (Trio Village, Silk Grass Village and Benque Viejo del Carmen)
2. Cash reward payout from the Global Fund through the Malaria project entitled "Elimination of Malaria in Mesoamerica and the Island of Hispaniola" approved and pending the transfer of USD \$800,000.00
3. Training of 5 senior officers in Malaria Elimination
4. Observance of Malaria Day in the Americas in Trio Village
5. Observance of Mosquito Awareness Week countrywide
6. Exemplary performance in PAHO's external quality assurance program for Malaria Microscopy
7. Refresher training of 13 malaria microscopists and laboratory technicians
8. Completion of Zoning exercise w/ GIS Technician to streamline reporting on aedes inspections and to conduct risk stratification for optimal use of resources
9. Insecticide Resistance Monitoring Program implemented and collection of baseline data completed
10. MOH in collaboration with the University of Notre Dame and the Mayo Clinic's Program in Underserved Global Health has outlined a three-tiered project to reduce mosquito-borne infectious disease, expand the diagnostic capacity of vector-borne infections and increase public health education and awareness of these infections. IMPACTS Project – Integrated Mayo Program for Arboviral Community Education, Training and Surveillance - <http://fightingfor.nd.edu/2017/fighting-mosquito-borne-diseases/>
11. Public Health England £10,000 investment in strengthening aedes surveillance to impact the transmission of Zika. Country visit was completed in November 2017 and the plan is to evaluate various traps for aedes

surveillance and to pilot the implementation of a mobile based platform aedes surveillance system using Andriod tablets and GIS. System to be piloted in Corozal, Orange Walk and Cayo districts by mid-2018.

12. Vector control needs assessment conducted by the Caribbean Public Health Agency (CARPHA) in November 2017. European Union has committed €655,000 to help Caribbean States reduce the spread and impact of Zika and other mosquito borne diseases in the Region. The activities will be implemented by the Caribbean Public Health Agency (CARPHA) under the leadership of the Caribbean Forum for ACP States (CARIFORUM). MOH received 1 desktop and 1 Garmin GPS in December 2017
13. The specific objective is to support CARPHA's activities to strengthen health systems to effectively monitor, prevent and control Zika and other mosquito-borne diseases in the Caribbean region, ultimately to contribute to improving public health of the Caribbean population.
14. Member of regional network for monitoring of insecticide resistance – COMISCA
15. Member of regional network for entomology – COMISCA

MAJOR ACTIVITIES AND OUTPUTS

- Malaria continues to be the strong point of the program and the country is still on course for Malaria elimination in the near future. The combination of Indoor Residual Spraying combined with adequate distribution of insecticide treated bed nets and supervised treatment resulted in 7 local cases from 3 localities.
- 67,967 premises inspected both urban and rural areas – application of various larvicides and fogging operations
- Establishment of baseline for insecticide resistance in all 6 districts
- ##### number of villages covered by indoor residual spraying, number of houses and population covered
- New partnerships established with the University of Notre Dame and the Mayo Clinic. IMPACTS Project – Integrated Mayo Program for Arboviral Community Education, Training and Surveillance. Also Public Health England technical and financial support (£10,000).

WORKSHOPS ATTENDED/FACILITATED

Workshop	Key objectives	Venue	Date	Sponsor	Participants
3rd Meeting of EMMIE- Elimination of Malaria in Meso-America and the Island of Hispaniola	<ul style="list-style-type: none"> • Review the progress and challenges faced through the first phase of the EMMIE project which seeks to eliminate Malaria in the region by 2020 • Review the methodology for verification of data and the financing model by the Global Fund • Discuss the roles and functions of 	San Jose - Costa Rica	1 – 3 February 2017	COMISCA	Kim Bautista Gerhaldine Morazan

	stakeholders in the implementation of the EMMIE project <ul style="list-style-type: none"> Finalize the activities for the next year in the regional plan of action for malaria in Mesoamerica 				
Getting to Zero by 2020 – A network of Countries	<ul style="list-style-type: none"> To review progress made and current status of malaria elimination in the 21 countries To establish a network of 21 countries to share experiences, challenges/bottlenecks faced by countries and possible solutions To establish an online system for tracking malaria cases and other parameters To develop consensus on methods and tools for information sharing and response 	Geneva - Switzerland	16 – 17 March 2017	WHO	Kim Bautista Lorna Perez
1st Regional Meeting of Entomological Surveillance Monitoring Network for COMISA Member States	<ul style="list-style-type: none"> Development of Terms of Reference for network Present and Analyze the baseline results for insecticide resistance monitoring in member countries Prepare a work plan for 2017/2018 for network 	Guatemala City - Guatemala	22 – 23 May 2017	Universidad del Valle de Guatemala	Kim Bautista
Workshop for the conformation of a regional network for the surveillance and management of the resistance of insecticides	<ul style="list-style-type: none"> Present and compile the progress in conducting susceptibility and resistance testing of aedes and anopheles vectors to insecticides used in public health Present and discuss the technical and organizational guidelines for the 	Rio de Janeiro - Brazil	8 – 10 August 2017	PAHO	Kim Bautista

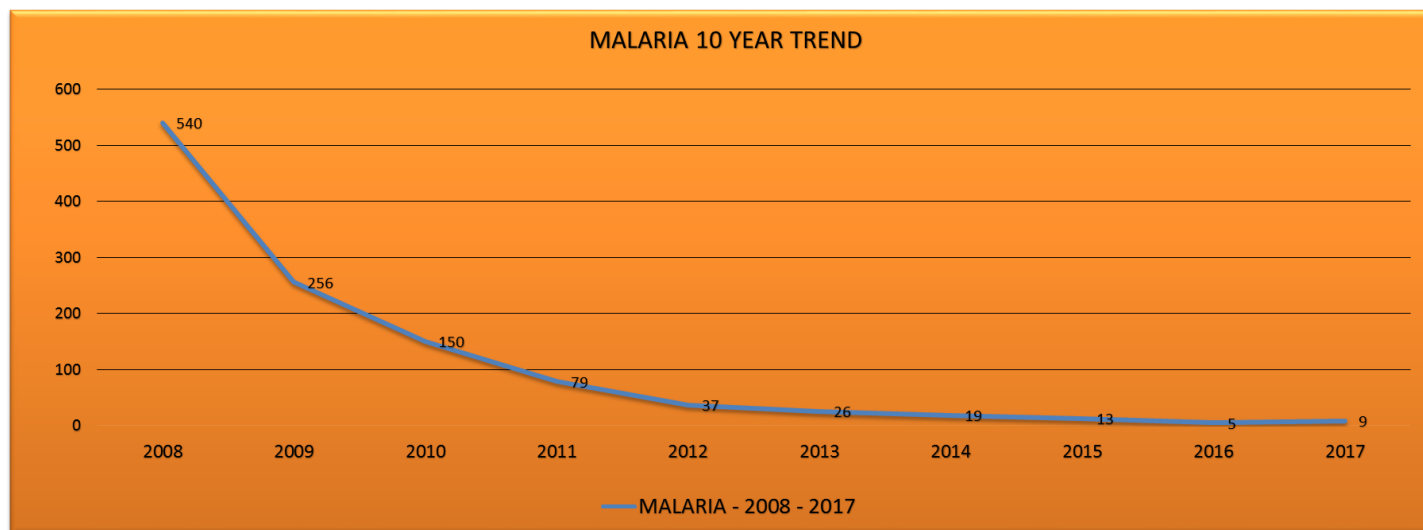
used in public health	<p>creation of a regional network for the surveillance and management of resistance of vector s to insecticides used in public health</p> <ul style="list-style-type: none"> • Establish the structure of the regional network • Develop national plans for the surveillance and management of the resistance to insecticides used in public health • Establish work plan and follow up schedule to the process of structuring the network 				
RCM Plenary Meeting	<ul style="list-style-type: none"> • To carry out the agreements from the COMISCA and RCM resolutions • To Establish mechanism of work of the RCM in order to join them with the COMISCA executive • Approve Malaria Elimination concept note for submission to Global Fund and IDB 	Antigua – Guatemala	2 – 3 September 2017	RCM	Kim Bautista Antonio Coyoc

MAJOR CHALLENGES

The following are the major challenges for the reporting period:

1. Limited staff to adequately address dengue/chik-v and malaria surveillance and prevention measures
2. Poor supervision and accountability for field officers – poor productivity is a major issue crippling the program
3. Urgent need to fill critical vacancies in 2 district supervisors in Orange Walk and Belize districts.
4. Appointment of officers who have been performing exceptionally well for over 15 to 20 years. Many of officers are demoralized with numerous personnel only recently hired having been appointed
5. Regional management teams continue take away transportation from the program, thereby limiting response time and mobility of officers. Commitment from the regions seem to come in a responsive manner as opposed to being proactive.
6. Regional teams must involve stakeholders in the public and private sector, particularly for dengue prevention – the Ministry of Health cannot do it alone but the regions must convince stakeholders of the vital role they play

3. STATISTICAL ANALYSIS



2015 Malaria by District and Species					2016 Malaria by District and Species					2017 Malaria by District and Species				
District	SPECIES				District	SPECIES				District	SPECIES			
	FALCIP	VIVAX	MIXED	Total		FALCIP	VIVAX	MIXED	Total		FALCIP	VIVAX	MIXED	Total
Corozal	0	5	0	5	Corozal	0	0	0	0	Corozal	0	0	0	0
Orange Walk	0	4	0	4	Orange Walk	0	0	0	0	Orange Walk	0	0	0	0
Belize	0	1	0	1	Belize	0	0	0	0	Belize	1	1	0	2
Cayo	0	1	0	1	Cayo	0	0	0	0	Cayo	0	1	0	1
Stann Creek	0	2	0	2	Stann Creek	0	4	0	4	Stann Creek	0	4	2	6
Toledo	0	0	0	0	Toledo	0	1	0	1	Toledo	0	0	0	0
Total	0	13	0	13	Total	0	5	0	5	Total	0	6	2	9

- Mixed cases are *p. vivax* and *p. falciparum*

2017 Indoor Residual Spraying			
	# of communities sprayed	# houses sprayed By IRS	Population Protected By IRS
Corozal	9	2380	8,794
Orange Walk	9	2145	8,463
Belize	0	0	0
Cayo	9	3133	9,299
Stann Creek	10	1128	6,176
Toledo	16	859	4,734
Total	53	9,645	37,466

2017 Active and Passive Case Detection			
	Active	Passive	Total
Corozal	3171	668	3839
Orange Walk	3790	456	4246
Belize	296	5295	5591
Cayo	414	1171	1585
Stann Creek	993	1922	2915
Toledo	770	1990	2760
Total	9434	11502	20936

DISTRICT	YEAR 2015					YEAR 2016					YEAR 2017				
	# Cases	Slides	Pop	API	ABER	# Cases	Slides	Pop	API	ABER	# Cases	Slides	Pop	API	ABER
Corozal	5	6053	44613	0.11	13.6	0	3839	46472	0.00	8.3	0	2812	46472	0.00	6.1
Orange Walk	4	5145	48744	0.08	10.6	0	4246	50208	0.00	8.5	0	3355	50208	0.00	6.7
Belize	1	5544	107494	0.01	5.2	0	5591	113878	0.00	4.9	2	8916	113878	0.02	7.8
Cayo	1	3529	85243	0.01	4.1	0	1585	90579	0.00	1.7	1	5472	90579	0.01	6.0
Stann Creek	2	3758	38728	0.05	9.7	4	2915	41032	0.10	7.1	6	4259	41032	0.15	10.4
Toledo	0	2338	34077	0.00	6.9	1	2760	35800	0.03	7.7	0	2181	35800	0.00	6.1
Country Total	13	26367	358899	0.04	7.3	5	20936	377968	0.01	5.5	9	26995	377968	0.02	7.1
ABER		7.3					5.5					7.1			

2017 Local Cases

Stann Creek District –

- Trio Village – 4 cases
- Silk Grass Village – 2 cases

Cayo District –

- Benque Viejo del Carmen Town – 1 case

2017 Imported Cases

Belize District - Belize City

- 1 case from Gabon - Africa
- 1 case from Puerto Cabezas – Nicaragua

DENGUE

LABORATORY RESULTS: 15.4% POSITIVITY RATE

LABORATORY RESULTS FROM MEXICO: 1457 TESTED BY PCR W/ 28 POSITIVE- 1.9% POSITIVITY RATE

2017 Dengue					
District	Confirmed	Probable	Clinical	Tested	Grand Total
Corozal	15	154	147	639	955
Orange Walk	3	55	31	259	348
Belize	6	45	26	621	698
Cayo	4	34	41	294	373
Stann Creek	15	15	15	279	324
Toledo	4	9	7	245	265
Unknown	0	0	1	2	3
Total	47	312	268	2339	2966

2017 Dengue					
Age-group	Confirmed	Probable	Clinical	Tested	Grand Total
<1	2	10	4	85	101
1-4	2	18	15	208	243
5 -9	3	22	14	235	274
10-14	4	19	21	188	232
15-19	3	40	28	245	316
20-24	5	29	29	225	288
25-29	5	29	31	243	308
30-34	4	31	29	212	276
35-39	2	24	31	158	215
40-44	5	25	28	122	180
45-49	5	14	11	146	176
50-54	4	15	12	88	119
55-59	1	13	5	70	89
60-64	1	8	5	45	59
65+	1	15	5	69	90
Dk/Ns	0	0	0	0	0
Total	47	312	268	2339	2966

2017 Dengue					
Sex	Confirmed	Probable	Clinical	Tested	Grand Total
Female	30	178	157	1303	1668
Male	17	134	111	1036	1298
Indeterminant	0	0	0	0	0
Total	47	312	268	2339	2966

ZIKA 2017

2017 Zika				
District	Confirmed	Clinical	Tested	Grand Total
Corozal	197	61	346	604
Orange Walk	81	36	168	285
Belize	15	112	169	296
Cayo	10	58	184	252
Stann Creek	17	33	128	178
Toledo	0	39	80	119
Unknown	0	0	2	2
Total	320	339	1077	1736

2017 Zika				
Age-group	Confirmed	Clinical	Tested	Grand Total
<1	6	13	36	55
1-4	6	5	81	92
5-9	25	12	80	117
10-14	35	6	92	133
15-19	34	67	120	221
20-24	42	86	118	246
25-29	36	77	121	234
30-34	40	40	109	189
35-39	39	13	67	119
40-44	20	7	68	95
45-49	12	5	68	85
50-54	10	2	42	54
55-59	8	3	32	43
60-64	2	1	22	25
65+	5	2	21	28
Dk/Ns	0	0	0	0
Total	320	339	1077	1736

2017 Zika				
Sex	Confirmed	Clinical	Tested	Grand Total
Female	223	301	600	1124
Male	97	38	477	612
Indeterminate	0	0	0	0
Total	320	339	1077	1736

4. FINANCIAL ANALYSIS

The budget approved for the fiscal period 2017/2018 is \$813,628 of which 42% has been executed through the end of 2017. There are still payments to be made for the most costly inputs, particularly pesticides procured through tender which is paid under Materials and Supplies. There is a significant sum of unspent funds under travel and subsistence as the rates had changed and these funds are used mostly for temporary hired workers conducting indoor residual spraying which is schedule for February 2018 in Corozal, Orange Walk, Cayo, Toledo and Stann Creek. After payments for fuel, tender supplies, and purchase of additional spares are done we should have an execution of greater than 80%.

Item	Description	Approved	Adjusted Budget	Release	Encumbrance	Expense	Available	Reserved	Unspent	% Spent
230	Personal Emoluments	\$176,512	\$176,512	\$161,810	\$0	\$109,377	\$52,433	\$14,702	\$67,135	62
231	Travel & Subsistence	\$108,098	\$108,098	\$99,088	\$739	\$39,155	\$59,194	\$9,010	\$68,943	36
340	Material & Supplies	\$377,158	\$377,158	\$345,730	\$8,340	\$111,104	\$266,285	\$31,428	\$266,054	29
341	Operating Cost	\$122,260	\$122,260	\$112,068	\$450	\$54,867	\$56,751	\$10,192	\$67,393	45
342	Maintenance Costs	\$25,600	\$25,600	\$23,474	\$4,623	\$8,781	\$10,070	\$2,126	\$16,820	34
343	Training	\$4,000	\$4,000	\$3,663	\$30	\$30	\$3,221	\$337	\$3,970	1
	Total	\$813,628	\$813,628	\$745,833	\$14,566	\$345,361	\$407,954	\$67,795	\$490,315	42

5. SWOT ANALYSIS

STRENGTHS

- The program saw the training of vector control supervisors in various areas including malaria elimination, aedes vector surveillance, and insecticide resistance monitoring.
- The malaria program continues to be very strong with the continued aid of the network of voluntary collaborators and community health workers. This network is the backbone of the passive surveillance system and has been responsible for over 90% of positive Malaria cases detected.
- The vector control program, although understaffed, has a number of experienced, dedicated staff with the majority of which have received the necessary training to carry out core functions required.
- The program has significant assets at its disposal with respect to a fleet of reliable vehicles, equipment and all the necessary inputs – this has allowed district program to respond timely and appropriately to outbreaks.
- The malaria program continues to be supported technically by regional experts and now with the hiring of a technical advisor for malaria at the PAHO country office.
- With the injection of funds into the region for malaria elimination, it presents an opportunity for the country to access much need external funding to accelerate its efforts towards elimination.
- The vector control program also receives on a continuous basis technical support from the Belize Vector and Ecology Center, specifically in the areas of monitoring insecticide resistance, aedes surveillance, vector identification and various research.

WEAKNESSES

- All vector control district units are overburdened with a heavy workload and this human resource crisis needs to be addressed as the staffing profile has not grown over the years to keep up with a booming population. If we are to adequately monitor aedes infestation levels in all target areas and reach out to the public with educational messages, there has to be an increase in staff.
- Some regions continue to deal with the issue of poor productivity by field officers and there is a need to improve the enforcement of effective performance appraisal and job performance agreement in order to hold officers accountable.
- Transportation within the regions for hospital support services needs to be addressed in order to avoid the constant taking away of vector control assigned vehicles which result in slow response and demoralized officers.
- There is an urgent need for adequate storage facilities for equipment and pesticides, currently being housed inside some offices which is a serious health risk.
- The need to engage community health workers and malaria voluntary collaborators to ensure their involvement in the passive surveillance system is critical. Some regions like the Central Health Region have all but abandon this approach to the point where officers are not visiting on a weekly basis for slide collection and fever case surveys as in other regions.
- Monitoring of fever cases for malaria needs to be improved at our health facilities, as we continue to miss cases that are detected in the private sector. In some instances tests are ordered and not done and in most situations the test is not ordered.

OPPORTUNITIES

- The relationship with the Belize Vector and Ecology Center in Orange Walk and the University of Notre Dame professors who manage this institution must be further exploited in conducting critical operational research including susceptibility testing in areas where IRS is conducted and insecticide resistance testing. Other areas of support could include improving the system for vector surveillance to assist in stratification, planning, better overall program management.
- Although Zika is quickly fading into the lime light, the opportunity is still there to bring to the forefront the urgent need for aedes control, the opportunity must be seized to build relationships with stakeholder government ministries and the private sector, as well as foreign entities. The importance of fighting this vector collectively must be sold and there must be persistent follow up.
- Establish a National Technical Group for Dengue to ensure an integrated approach to vector control is being implemented and to Integrated Vector Management committee with stakeholders such as other government ministries responsible for drainage and infrastructure, housing, sanitation, and waste disposal, to address some of the contributing factors to the spread of dengue and chikungunya
- Look at new technology beyond malaria microscopy, in order to be able to detect “sub microscopic” parasite levels and to support screening of asymptomatic patients in serologic surveys. Such tools are necessary for countries going through the pre-elimination phase and gearing towards elimination.
- There is a need to train more vector control personnel in the core concepts of field epidemiology. The opportunity is there with the FETP program but this must be prioritized by the ministry to ensure this critical group is included.

THREATS

- The addition of Zika to the portfolio of the program and the far reaching implications of this disease have resulted in the program having to be selective in its prevention strategies. The current financial climate in country will bring about additional challenges in the coming years.
- There must be a human resource succession plan to ensure that the retirement of experienced officers in critical roles do not leave the program at a disadvantage. It is critical to ensure district programs are led by well-rounded persons in all aspects of vector control.
- Natural disasters for the most part results in the outbreaks of mosquito vector borne diseases and that was the case in 2016 with Hurricane Earl and high rainfall activity in 2017 resulting in the increase of breeding sites as a result of flooding, disruption of field activities and spraying cycles etc. As a program we need to be prepared annually for such eventuality as external assistance is extremely slow to come or non-existent.
- The overall lack of proper supervision and the poor work ethics of young staff results in poor surveillance and overall poor program performance in some regions. The lack of discipline in some districts must be addressed immediately, particularly in Stann Creek, Belize City, and Corozal.

6. RECOMMENDATIONS

LOGICAL FRAMEWORK				
	Intervention logic	Objectively verifiable indicators of achievement	Sources and means of verification	Assumptions
Overall objectives Belize elimination of autochthonous transmission of Malaria by 2020 Reduction of 30% in Dengue cases by 2020 Reduce the incidence of Zika and Chikunguna	<i>To reduce the social and economic impacts of major vector borne diseases</i>	<i>% reduction of laboratory confirmed cases vs. 2017 baseline</i>	<i>BHIS Reports</i>	<i>Adequate funding for execution of planned activities</i> <i>No unforeseen natural disaster</i>
Specific objective 20% reduction in Malaria cases 10% reduction in dengue cases 10% reduction in Zika cases	<i>Global Fund/Elimination Target</i> <i>Strategic Plan Target</i>	<i>Baseline of 7 in 2017</i> <i>Baseline of 359 laboratory cases in 2017</i> <i>Baseline of 320 laboratory cases in 2017</i>	<i>BHIS Reports</i>	<i>Adequate funding for execution of planned activities</i> <i>No unforeseen natural disaster</i>

There are several areas which are priority for Malaria at this time, including the following:

- Creating the post of district supervisor for Orange Walk
- Creating the post of microscopist for Orange Walk as there is only 1 microscopist in Corozal servicing both districts and this officer is pulling double duty
- Hiring of additional staff Malaria surveillance for the Independence catchment area
- Maintain minimum of 80% coverage for villages selected for bed net distribution
- Monitor the quality and use of bed nets distributed
- Maintain minimum of 80% coverage for Indoor Residual Spraying (IRS) spraying in localities which have produced malaria over the past 3 years.
- Ensure malaria evaluators visit CHW's and VC's on a weekly basis, as recent checks have malaria slides remain for weeks at a time and are not picked up. VC's and CHW's also need to be more active.
- Development of a work plan for execution of cash reward component of Global Fund project

There are several areas which are priority for Dengue and Zika at this time, including the following:

- Review of an efficient and effective system for the surveillance of aedes infestation levels, either through the use of ovi traps or random premises inspection, both with the support of a mobile based platform with GIS.
- San Pedro does not have any officers and we need to establish a minimum of 2 officers fulltime on the island
- Ensure the use of COMBI – communication for behavioral impact as a tool to address behaviors which are risk factors that increase the probability for dengue transmission/outbreaks
- Supervision at the level of district supervisor is weak and must improve. Vector control officers are entrusted to work mostly unsupervised and this leads to poor execution of duties.
- Administration at the regions, starting with deputy and regional health managers need to ensure there is better execution of vector control programs, starting with proper reporting, planning sessions, and regular meetings to update on the progress of work plans. Operational plans are developed but not followed and there is little to no periodic update and review of these plans.
- Evaluation of larvicides – temephos, spinosad and methoprene
- Expand monitoring of insecticide resistance based on results of 2017 baseline

7. CONCLUSION

Malaria remains the strong area within the vector control program and the confirmation of the awarding of USD \$800,000, in combination with the annual recurrent budget, should accelerate our plan towards elimination. The reintroduction of *p. falciparum* was unexpected but with the continuous support to the network of microscopists and the the expected improved passive surveillance at both the community and health facility level, it is not expected to materialize to anything significant. The drastic reduction in malaria cases should not be reason for complacency. Frequent traveling of Belizean nationals to malaria endemic areas as well as the constant increase of immigrant workers in the agriculture and tourism industry pose a constant threat for the reintroduction of the plasmodium parasite into malaria free areas. The expansion of the sugar cane industry into the Cayo district is a primary example of the potential for reintroduction into malaria free areas. The influx of workers from neighbouring Guatemala into this newly established industry in the Cayo district which had not reported a local case of Malaria since 2012 is a cause for concern. There is also the issue of the daily entry of hundreds of students from neighboring Guatemala which is a viable threat. Another key concern is the possible re-emergence of Malaria in the Corozal and Orange Walk districts, particularly communities in close proximity to the Mexican villages on their side of the Rio Hondo where there is active transmission. The northern districts have not reported a Malaria case in two consecutive years. The program continues to go through a process of re-orientation whereby plans and strategies must shift from the mind-set of controlling malaria to eliminating malaria.

With respect to vector borne diseases transmitted by the *aedes aegypti* and *aedes albopictus*, there are so many external factors which contribute to transmission and in this aspect it is critical that regional management teams forge the relationships necessary to reduce their incidence and impact. It will take a concerted effort to make successful, meaningful gains in controlling the aedes vector. These efforts, together with other actions based on the principles of integrated vector control is the new path which the program must undertake. The support of Public Health England to strengthen vector surveillance and the Mayo Clinic funded Zika project are certainly expected to improve the Dengue and Zika prevention programs, similarly to how the Global Fund reenergized the malaria program. The working relationship with HECOPAB is something that the program expects to continue to build on in 2018. The use of mass media, social media and increase public presence will enable the program to target those populations most vulnerable. The relationship with the Ministry of Education and HECOPAB to introduce Zika activity workbooks and the SWAT Zika board game in primary schools in 2018 is a testament to the renewed approach the ministry is taking.

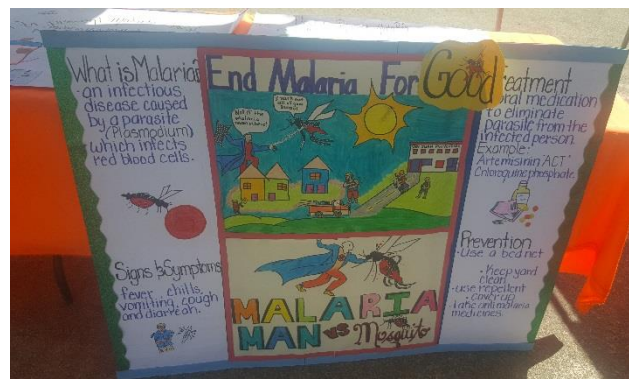
Aedes aegypti



Aedes albopictus



PARTICIPATION IN REGIONAL AND LOCAL EVENTS TO SENSITIZE PUBLIC ON VECTOR BORNE DISEASES



CARPHA/PUBLIC HEALTH ENGLAND COUNTRY VISIT



MICROSCOPY TRAINING

