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Summary
2016 Program Review
RIVER BLINDNESS ELIMINATION PROGRAMS
Ethiopia, Nigeria, OEPA, Sudan, and Uganda
27-29 March 2017
The Carter Center
Atlanta, GA

September 2017

Donors to The Carter Center River Blindness Elimination, Lymphatic Filariasis Elimination, and Schistosomiasis/Soil Transmitted Helminths Control Programs*

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And to many others, our sincere gratitude.

*We appreciate the support of the donors listed here, whose funding was utilized in 2016 for the activities described in these proceedings.

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ACRONYMS

APOC	African Program for Onchocerciasis Control
ATO	Annual Treatment Objective
BCC	Behavior Change Communication
CBM	Christoffel Blindenmission
CDC	Centers for Disease Control and Prevention
CDD	Community Directed Distributors
CDTI	Community-Directed Treatment with Ivermectin
CS	Community Supervisors
DDT	Dichlorodiphenyltrichloroethane
DEC	Diethylcarbamazine
DRC	Democratic Republic of Congo
EOEEAC	Ethiopia Onchocerciasis Elimination Expert Advisory Committee
ELISA	Enzyme-linked immunosorbent assay
EPHI	Ethiopia Public Health Institute
FMOH	Federal Ministry of Health
GSK	GlaxoSmithKline
HAD	Health Development Army
HEWs	Health Extension Workers
IACO	InterAmerican Conference on Onchocerciasis
IRB	Institutional Review Board
IVT	International Verification Team
KAP	Knowledge Attitude & Perceptions
KDR	Knockdown Resistance
KGaA	E-Merck
LCIF	Lions Clubs International Foundation
LF	Lymphatic Filariasis
LGA	Local Government Areas
LLIN	Long Lasting Insecticidal (bed) Net
MDA	Mass Drug Administration
MDP	Mectizan® Donation Program
MEC	Mectizan® Expert Committee
Mectizan®	Ivermectin (Merck & Co., Inc., product name)
MIS	Malaria Indicator Survey
MITOSATH	Mission to Save The Helpless
MOA	Memorandum of Agreement
MOH	Ministry of Health
NOEC	The Nigerian Onchocerciasis Elimination Committee
NGDO	Non-Governmental Development Organization

ACRONYMS (Continued)

NTDs	Neglected Tropical Diseases
OEPA	Onchocerciasis Elimination Program for the Americas
PAHO	Pan American Health Organization
PATH	Program for Appropriate Technology in Health
PCC	Program Coordinating Committee of OEPA
PCR	Polymerase Chain Reaction
PTS	Post-Treatment Surveillance
RB	River Blindness
RBF	River Blindness Foundation
RBEP	River Blindness Elimination Program
REMO	Rapid Epidemiological Mapping of Onchocerciasis
RSS	Republic of South Sudan
RTI	Research Triangle Institute
SAE	Severe Adverse Events
SIZs	Special Intervention Zones
SOPs	Standard Field Operating Procedures
STH	Soil Transmitted Helminths
TAS	Treatment Assessment Survey
TCC	The Carter Center
TDA	Triple Drug Administration
TDR	Tropical Disease Research
UOEEAC	Ugandan Onchocerciasis Elimination Expert Advisory Committee
USAID	United States Agency for International Development
USF	University of Southern Florida
UTG	Ultimate Treatment Goal
WHO	World Health Organization

Figure ES1

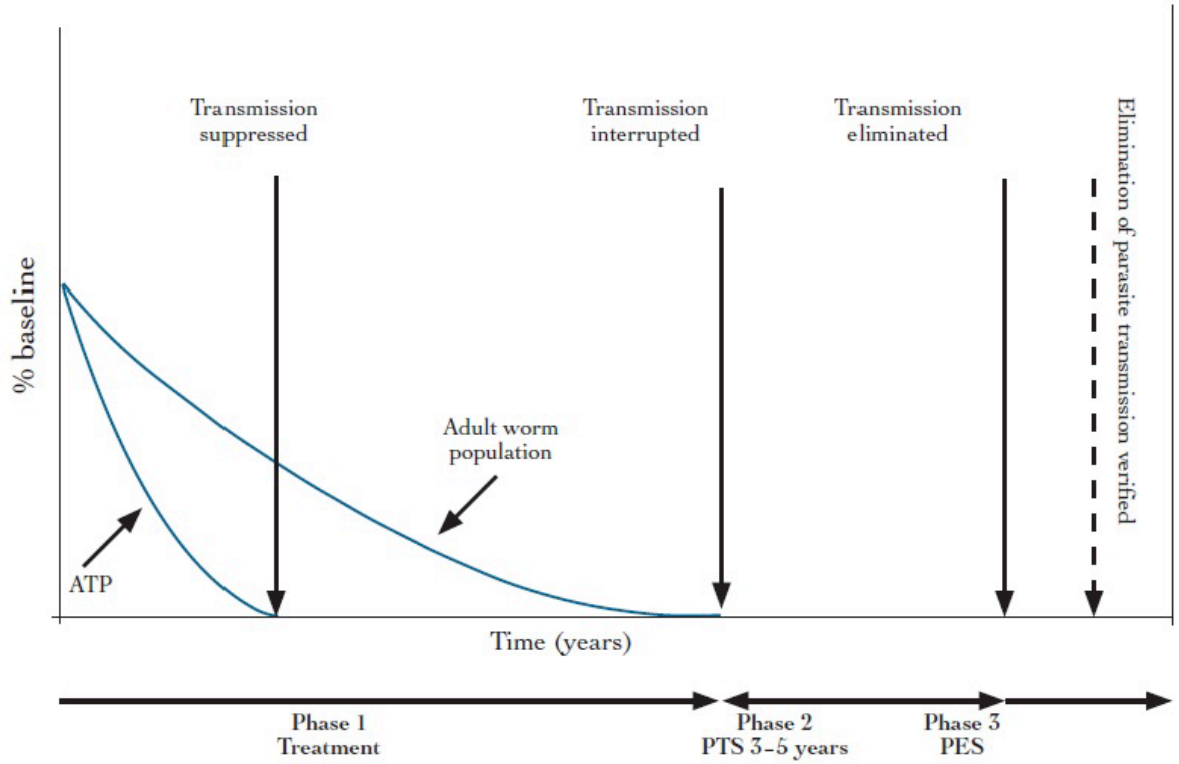
2016 River Blindness Elimination Program Review Participants

Figure ES2

The River Blindness Band (RBB) debut at the 21st RBEP Review! (2017)

Figure ES3

Phases of the Elimination of Onchocerciasis (2016 WHO Guidelines*)



ATP, annual transmission potential; PES, post-elimination surveillance; PTS, post-treatment surveillance

*WHO (2016). Guidelines for stopping mass drug administration and verifying elimination of human onchocerciasis: criteria and procedures (document WHO/HTM/NTD/PCT/2016.1). Geneva, World Health Organization. http://www.who.int/onchocerciasis/resources/9789241510011/en/

Figure ES4

2016 Mectizan® Mass Treatment Figures for Carter Center RBEP- Assisted Areas in Africa, Latin America (OEPA) & Sudan

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL	% UTG	% ALL RBP TX
NIGERIA	***UTG=**	**20,216,060**			**UTG (villages)=**	**18,784**									
Treatments	0	0	0	0	0	806,922	2,579,375	6,484,770	3,002,147	3,233,261	1,271,198	1,314,110	**18,691,783**	**92%**	**50%**
Villages treated	0	0	0	0	0	1,059	3,337	8,392	3,875	1,079	1,293	667	**19,702**	**105%**	**40%**
UGANDA ELIM	****UTG(2)=**	**3,951,740**			**UTG (villages)=**	**3,736**									
Treatments	0	0	0	296,252	1,464,586	76,413	0	0	0	453,950	1,370,947	36,171	**3,698,319**	**94%**	**10%**
Villages treated	0	0	0	879	2,510	347	0	0	0	0	0	0	**3,736**	**100%**	**8%**
OEPA	****UTG(2)=**	**7,232**			**UTG (villages)=**	**56**									
Treatments	3,037	0	0	0	0	3,276	0	0	0	0	0		**6,313**	**87%**	**0%**
Villages treated	56	0	0	0	0	0	0	0	0	0	0		**56**	**100%**	**0%**
OEPA	****UTG(4)=**	**82,540**			**UTG (villages)=**	**459**									
Treatments	0	0	15,598	0	0	13,801	0	0	15,175	0	0	15,695	**60,269**	**73%**	**0%**
Villages treated	0	0	186	0	0	34	0	0	0	0	0	0	**220**	**48%**	**0%**
ETHIOPIA	***UTG=**				**UTG (villages)=**										
Treatments															
Villages treated															
ETHIOPIA ELIM	****UTG(2)=**	**18,024,571**			**UTG (villages)=**	**50,892**									
Treatments	0	0	0	1,522,144	1,781,406	5,100,858	0	0	0	381,492	3,921,955	1,759,785	**14,467,640**	**80%**	**39%**
Villages treated	0	0	0	0	8,812	28,463	9,263	0	0	0	0	4,354	**25,446**	**50%**	**52%**
SUDAN	*****ATO=**	**23,427**			**UTG (villages)=**	**20**									
Treatments	0	0	0	0	0	35,564	27,000	0	0	0	0	0	**62,564**	**267%**	**0%**
Villages treated	0	0	0	0	0	15	9	0	0	0	0	0	**24**	**120%**	**0%**
SUDAN ELIM	****UTG(2)=**	**246,180**			**UTG (villages)=**	**153**									
Treatments	0	0	0	0	0	0	0	107,070	0	0	0	0	**107,070**	**43%**	**0%**
Villages treated	0	0	0	0	0	0	0	0	153	0	0	0	**153**	**100%**	**0%**
TOTALS	***UTG=**	**42,551,750**			**UTG (villages)=**	**74,100**									
Treatments	**3,037.00**	**-**	**15,598**	**1,818,396**	**3,245,992**	**6,036,834**	**2,606,375**	**6,591,840**	**3,017,322**	**4,068,703**	**6,564,100**	**3,125,761**	**37,093,958**	**87%**	
Villages treated	**56.00**	**-**	**186**	**879**	**11,322**	**29,918**	**12,609**	**8,392**	**4,028**	**1,079**	**1,293**	**5,021**	**49,337**	**67%**	

Cumulative RBEP-Assisted Treatments (1996 - 2016) = 278,023,299

2016 Mass Treatments	37,093,958
2016 Passive Treatments	118,589
2016 TOTAL TREATMENTS	**37,212,547**

*UTG: Ultimate Treatment Goal (all the treatment-eligible population in a program area, i.e. healthy persons >5 years of age)

**OEPA's UTG 2 and UTG 4 are the UTG times 2 or 4. OEPA treatments are semiannual or quarterly

***ATO: Annual Treatment Objective – used because the population is unknown

Figure ES5

RBEP-Assisted Programs: Ivermectin Treatments 1996–2016 and 2017 Target

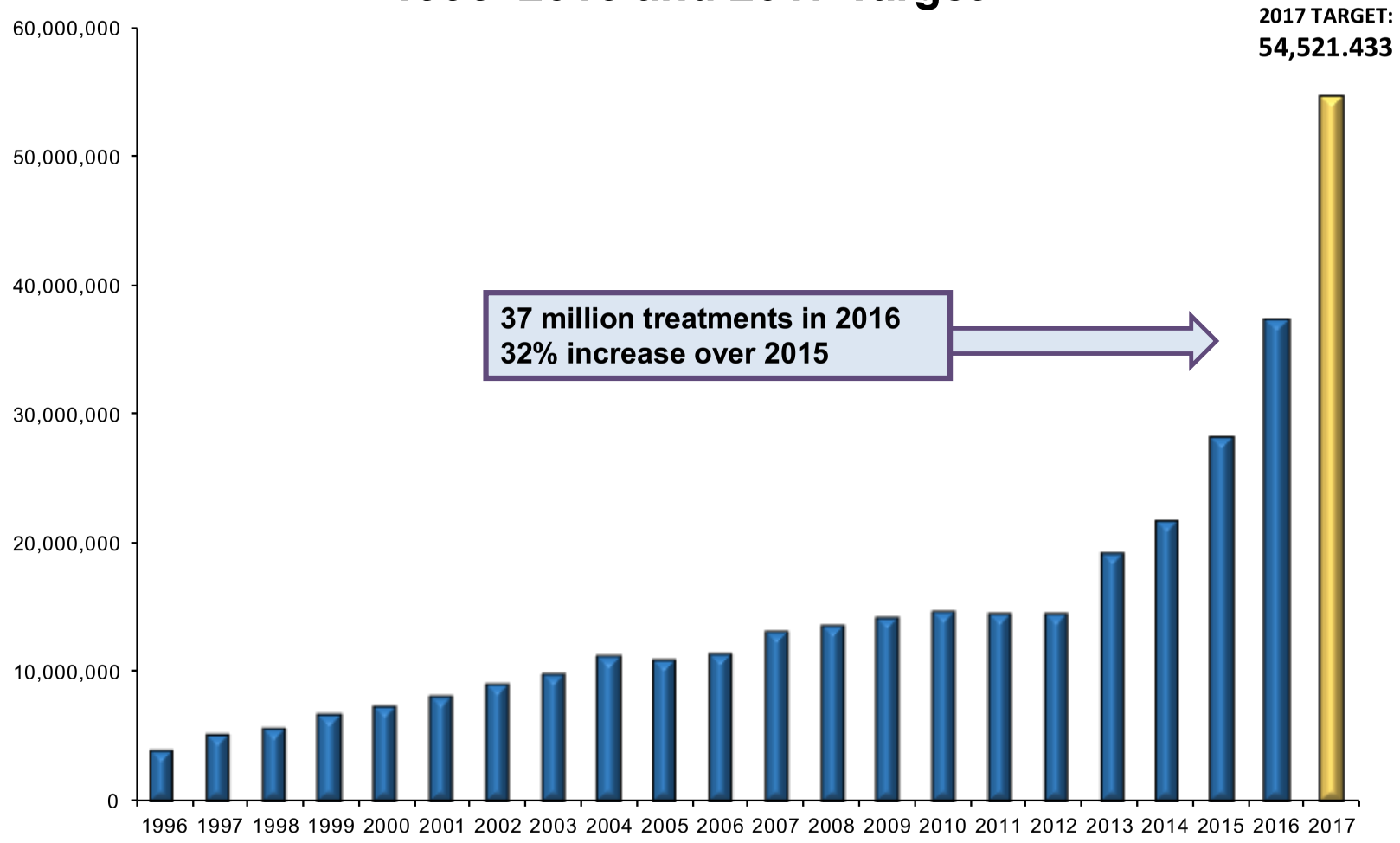
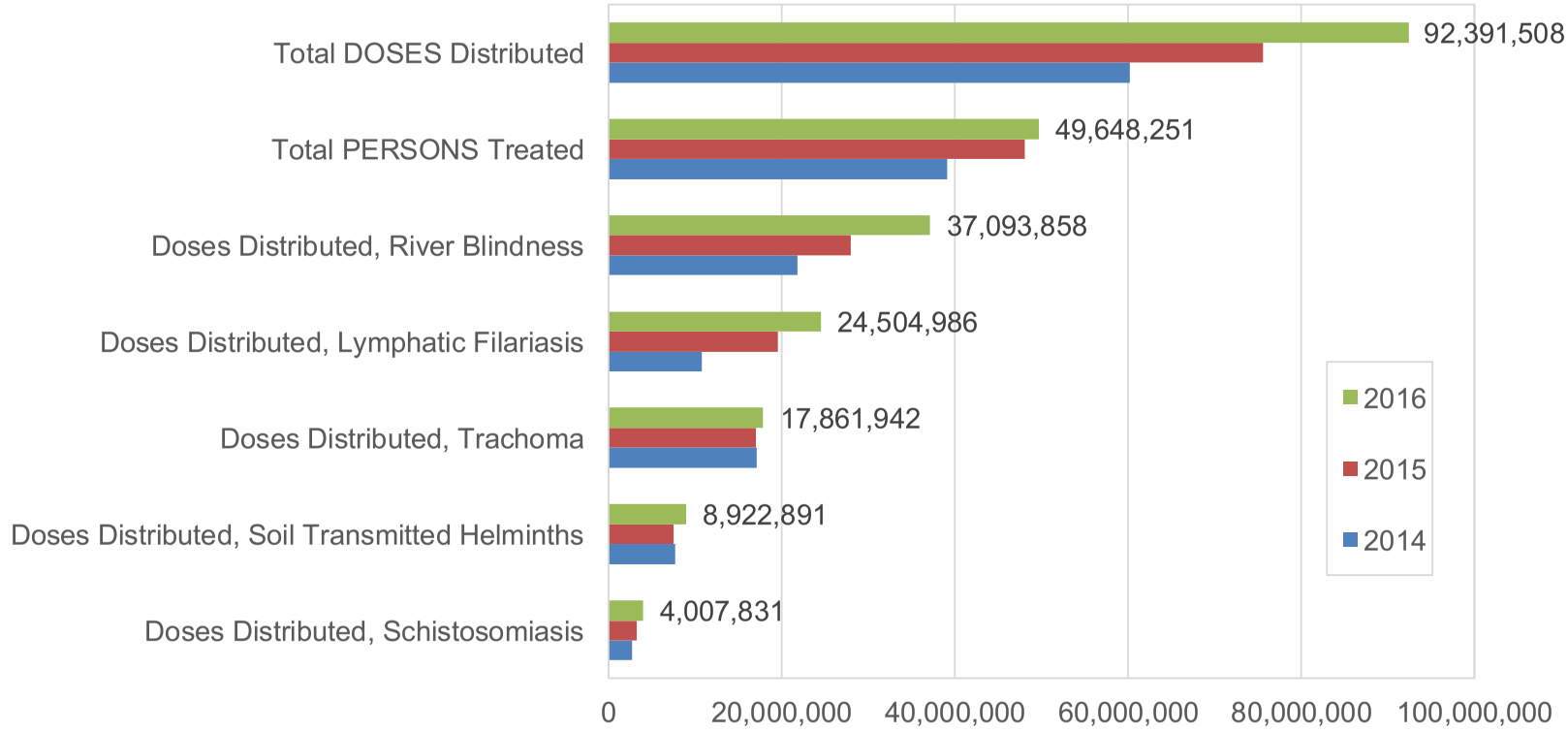


Figure ES6

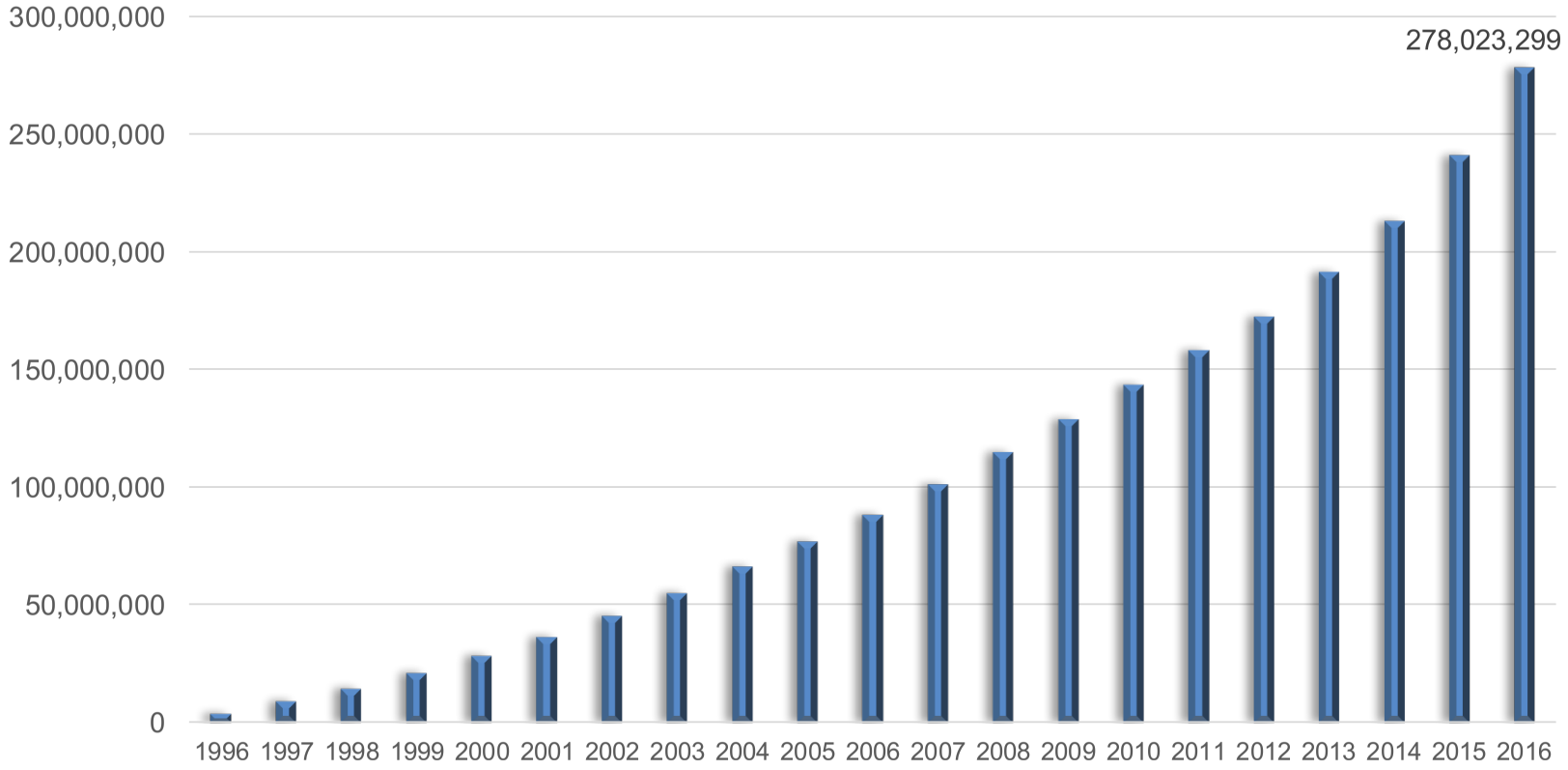
Carter Center-Supported Treatment Doses, and Persons Treated, for Neglected Tropical Diseases 2014 – 2016*



* The Carter Center is grateful for our Ministry of Health partners and the many donors and pharmaceutical companies who have made financial and in-kind contributions to make these treatments possible.

Figure ES7

277 Million Cumulative Mectizan® Doses (Treatments) for RB Delivered by Carter Center RBEP-Assisted Programs, 1996 – 2016



RB = River Blindness, RBEP = River Blindness Elimination Program

Figure ES8

Carter Center-Assisted Programs: 1996 – 2016 Mectizan® Treatments by Program

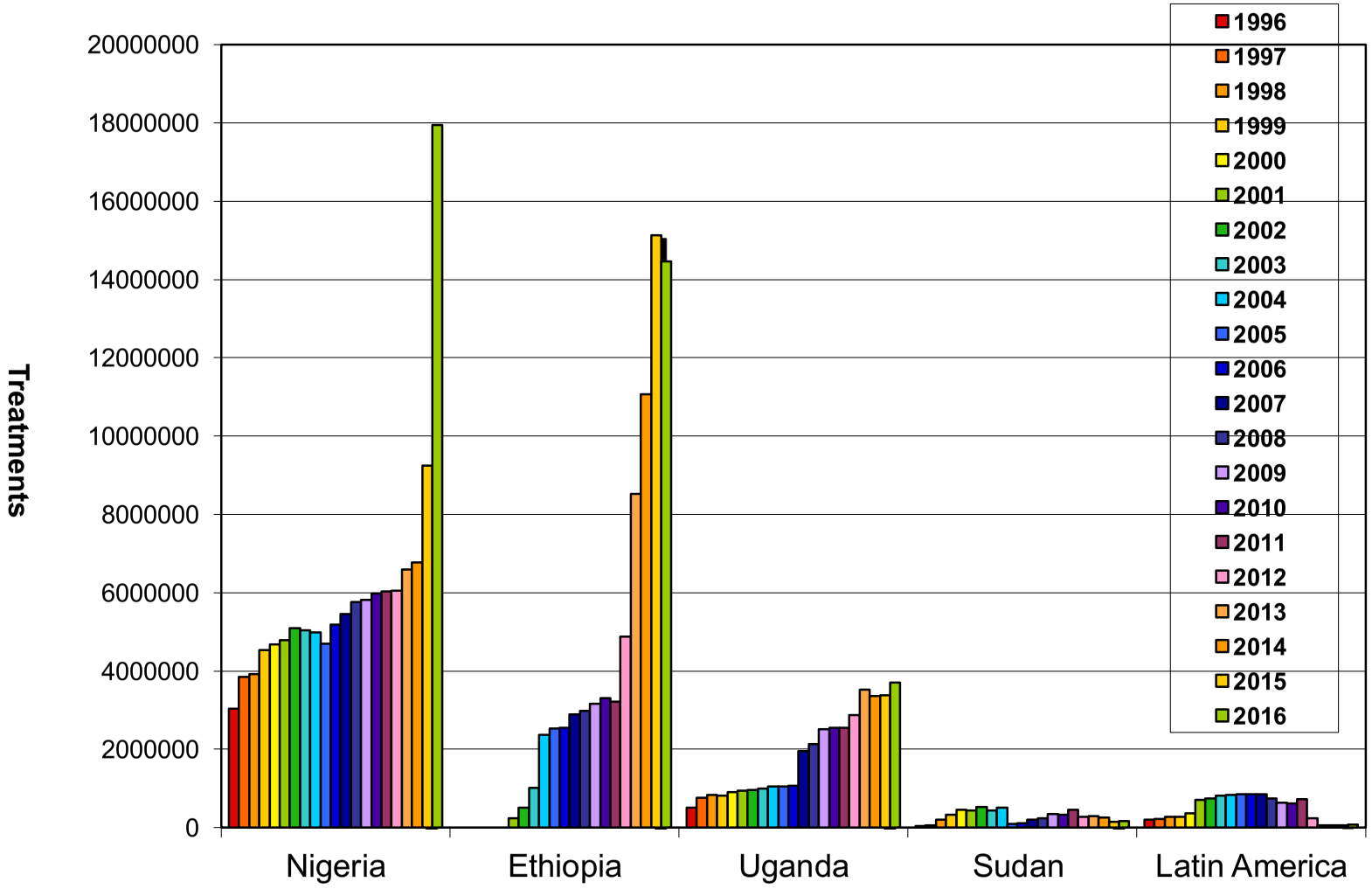
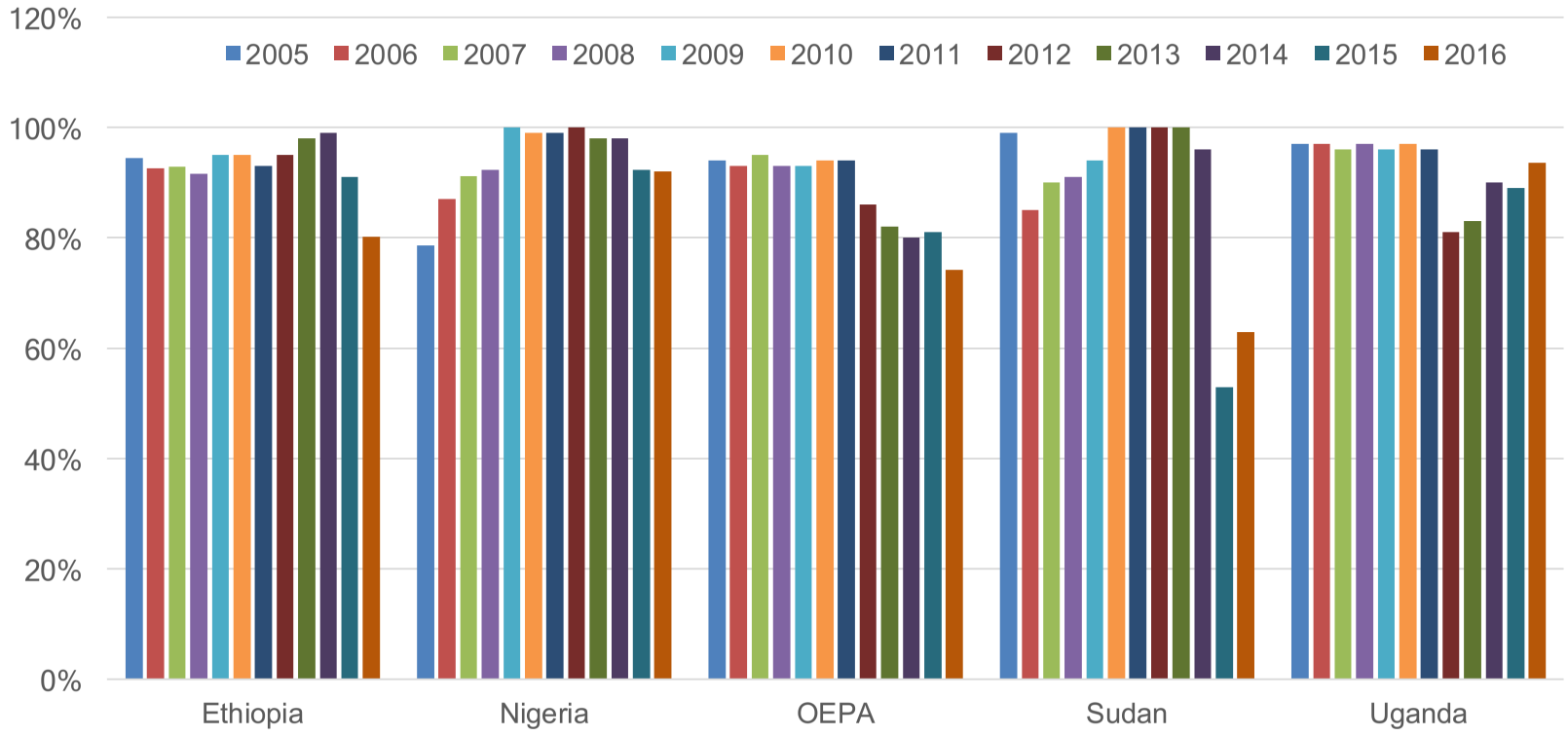


Figure ES9

River Blindness Program: Reported Treatment Coverage (eligible population) by Project: UTG, UTG(2), or UTG(4) 2005 – 2016*



* Decreasing coverage in OEPA, Sudan and Uganda are the result of these programs' focus on their final transmission zones, which are of most difficult access.

Figure ES10

Community-Directed Distributors (CDDs) Trained, 2004 – 2016 and 2017 Projections

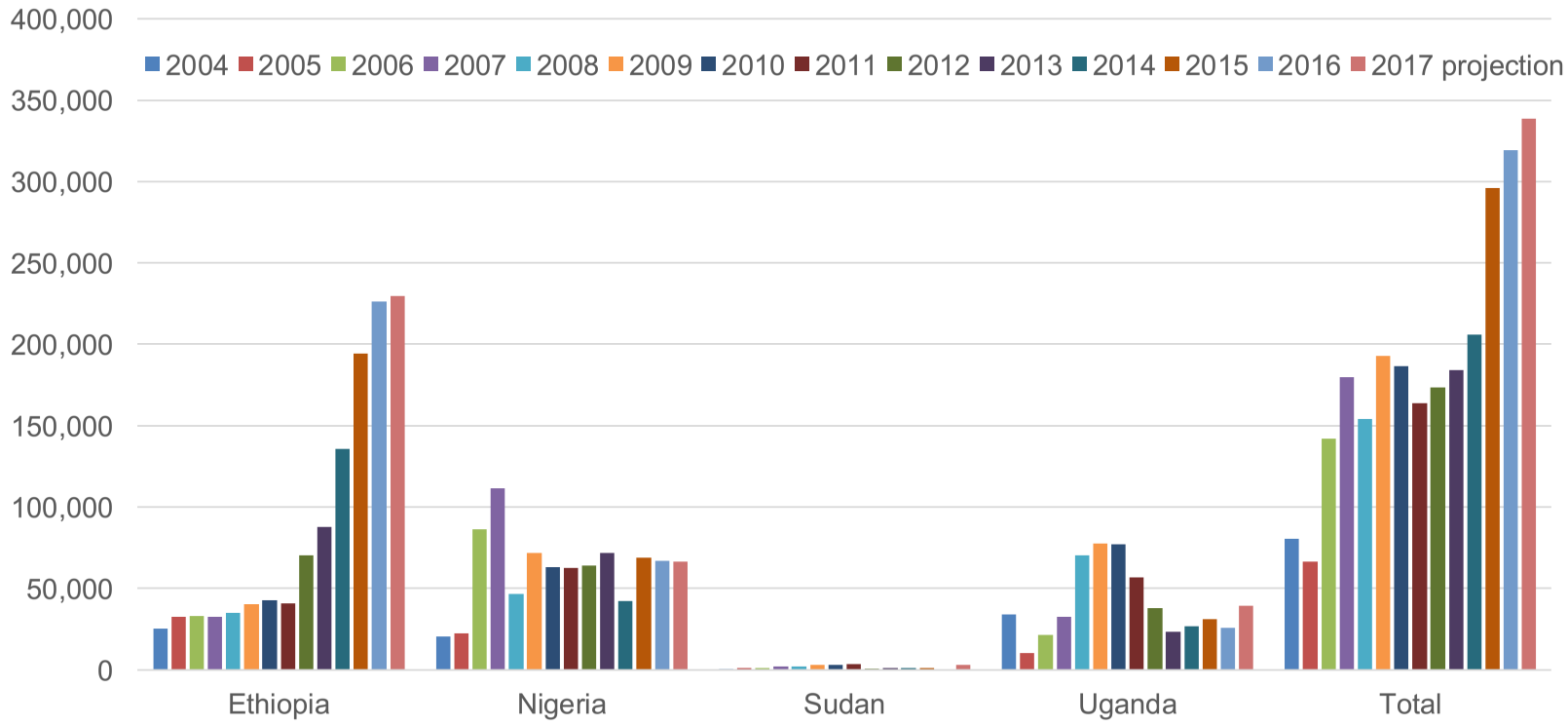
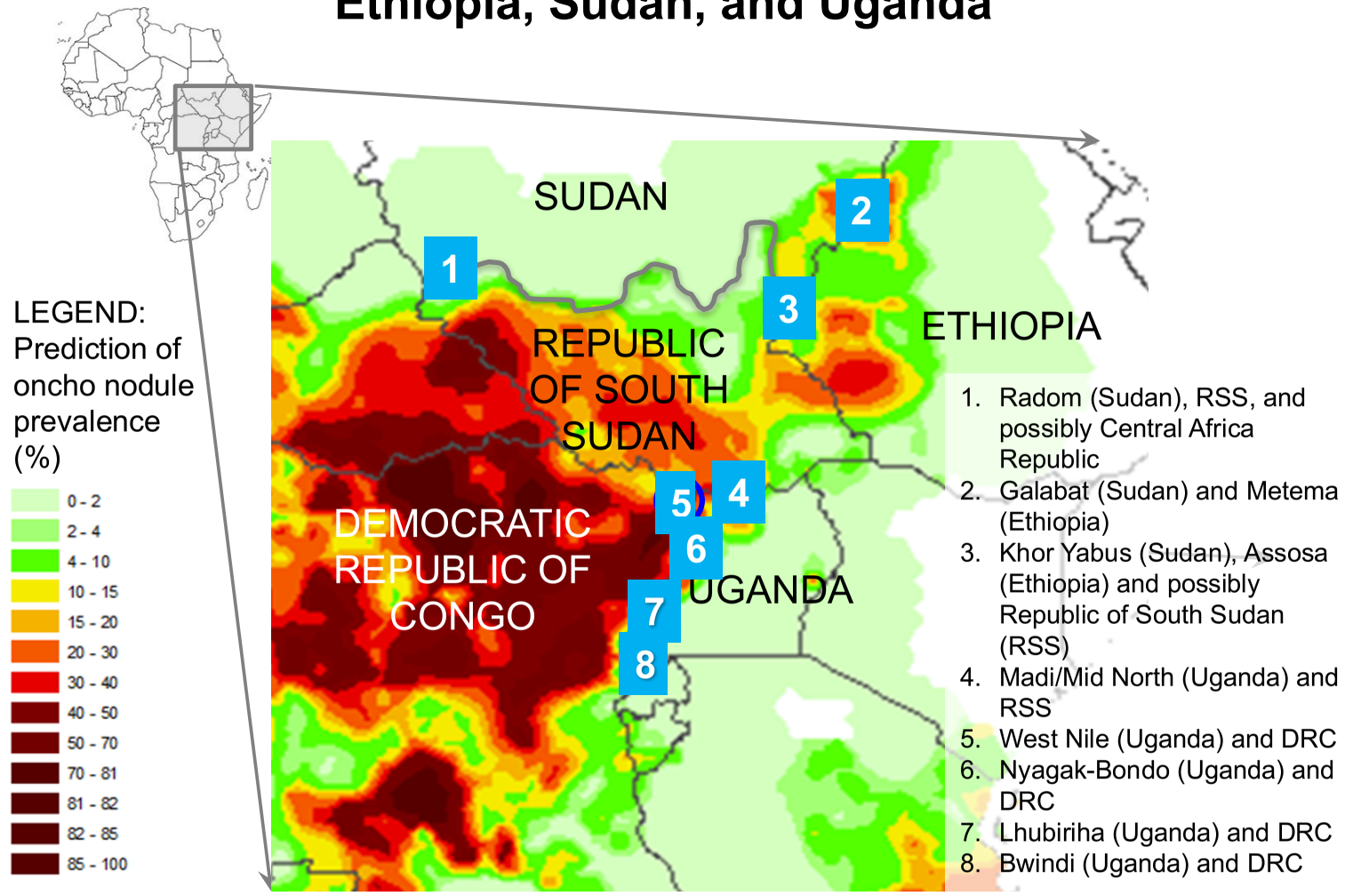


Figure ES11

Carter Center-Assisted Special Intervention Zones in Ethiopia, Sudan, and Uganda



REMO map source: APOC

Figure ES12

Ethiopia: Training of Community Directed Drug Distributors: 2001 – 2016 and Percentage Female

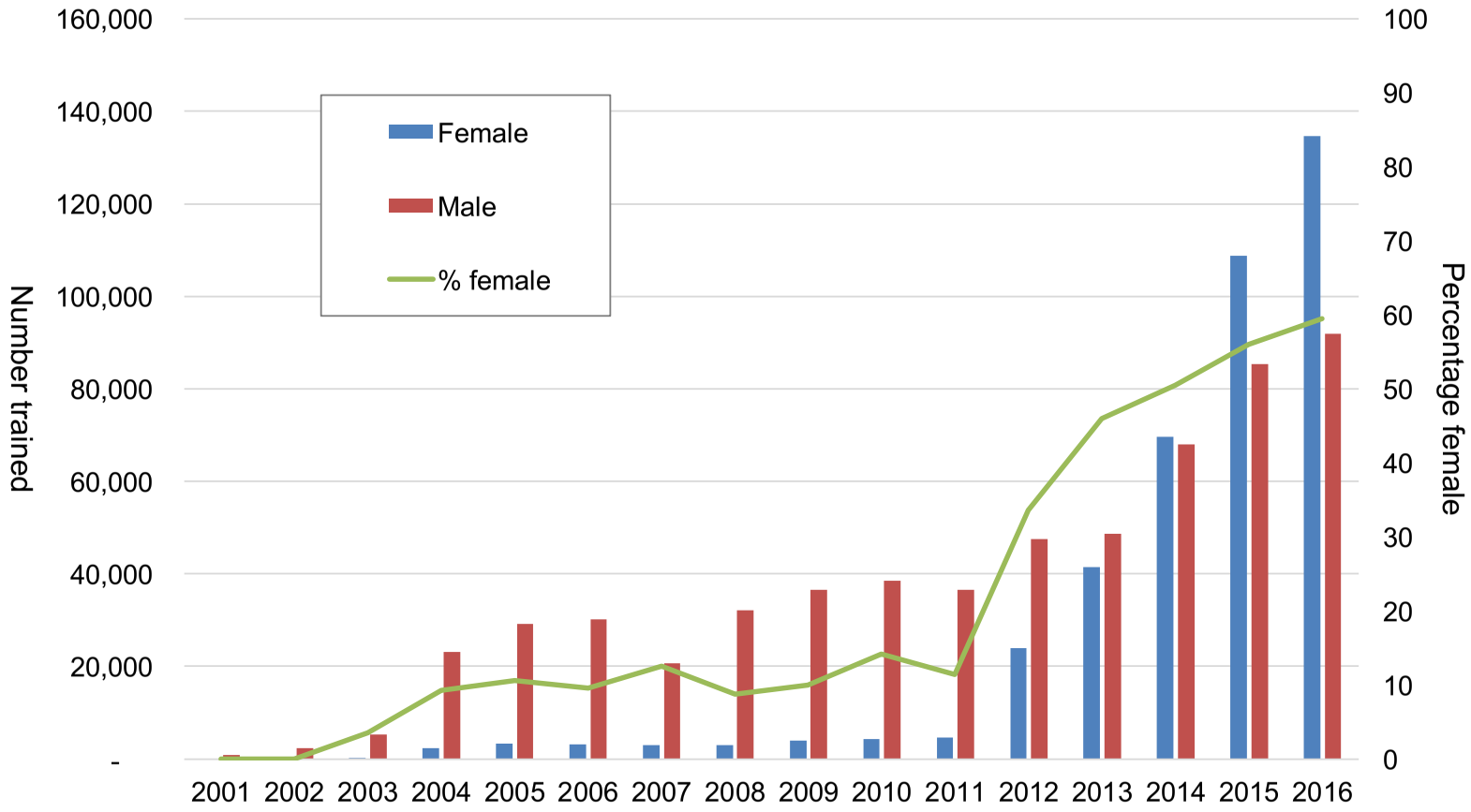


Figure ES13

Nigeria: Carter Center Assisted River Blindness (RB), Lymphatic Filariasis (LF), Soil Transmitted Helminths (STH) and Schistosomiasis (SCH) Treatments 2012 – 2016 and 2017 Targets

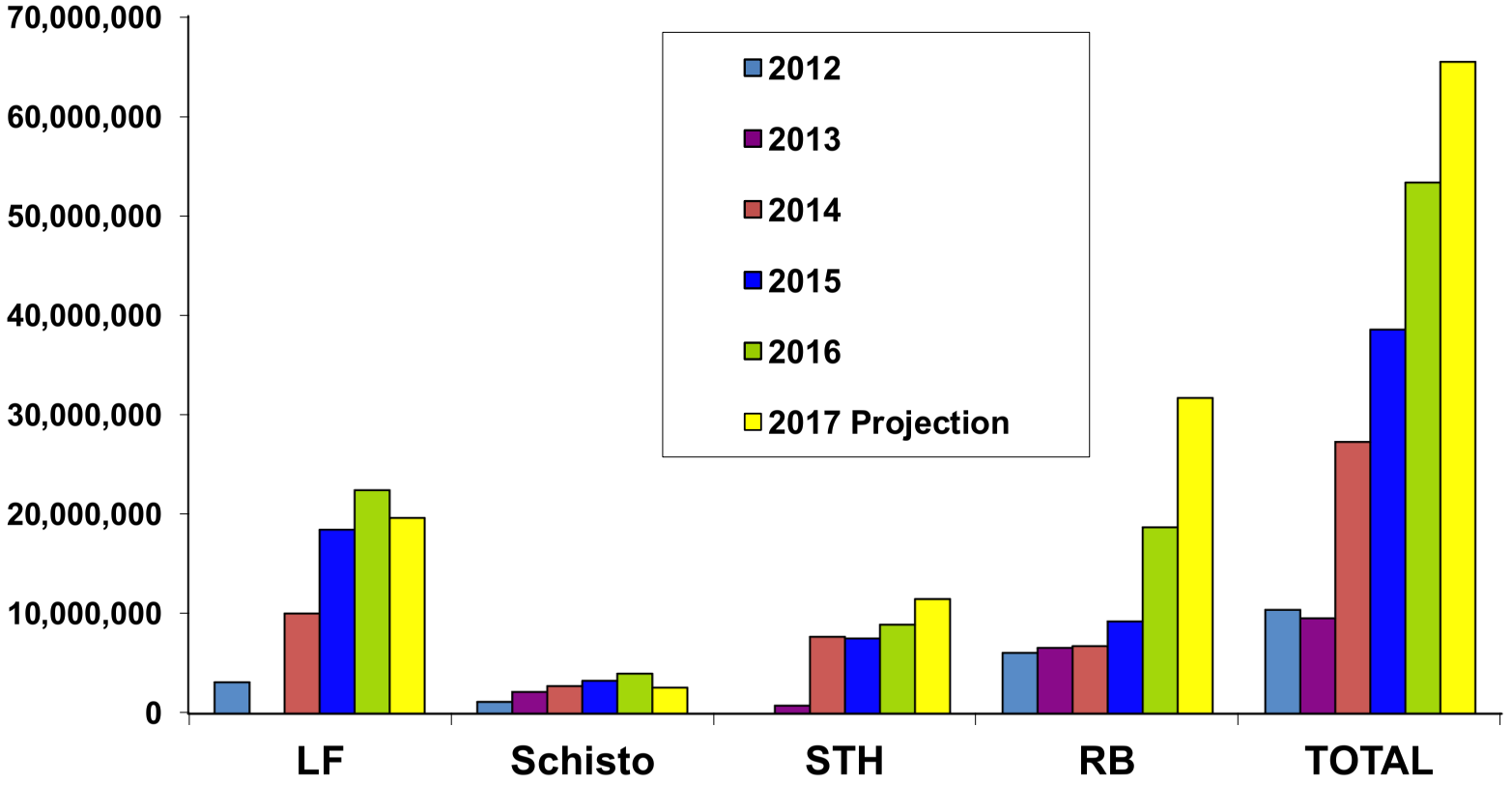
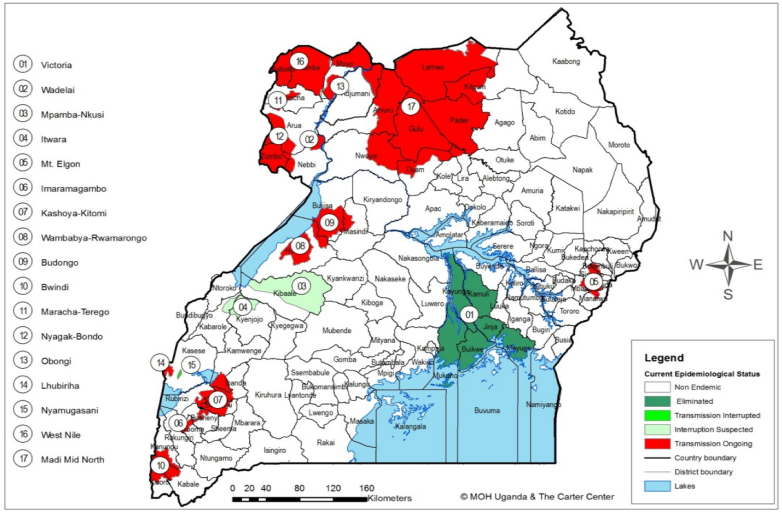


Figure ES14

Uganda: Progress in Eliminating Onchocerciasis Transmission

2007



2016

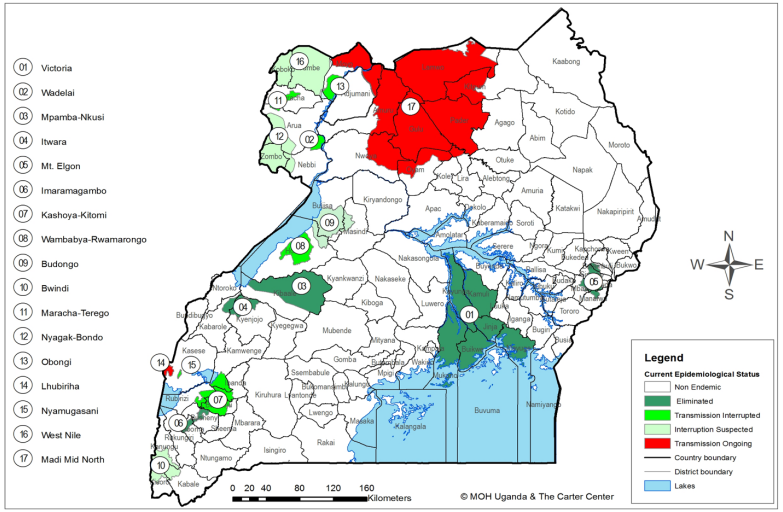


Figure ES15

Uganda Progress in Eliminating Onchocerciasis Transmission (Change in Endemic Status in Foci) 2007-2016

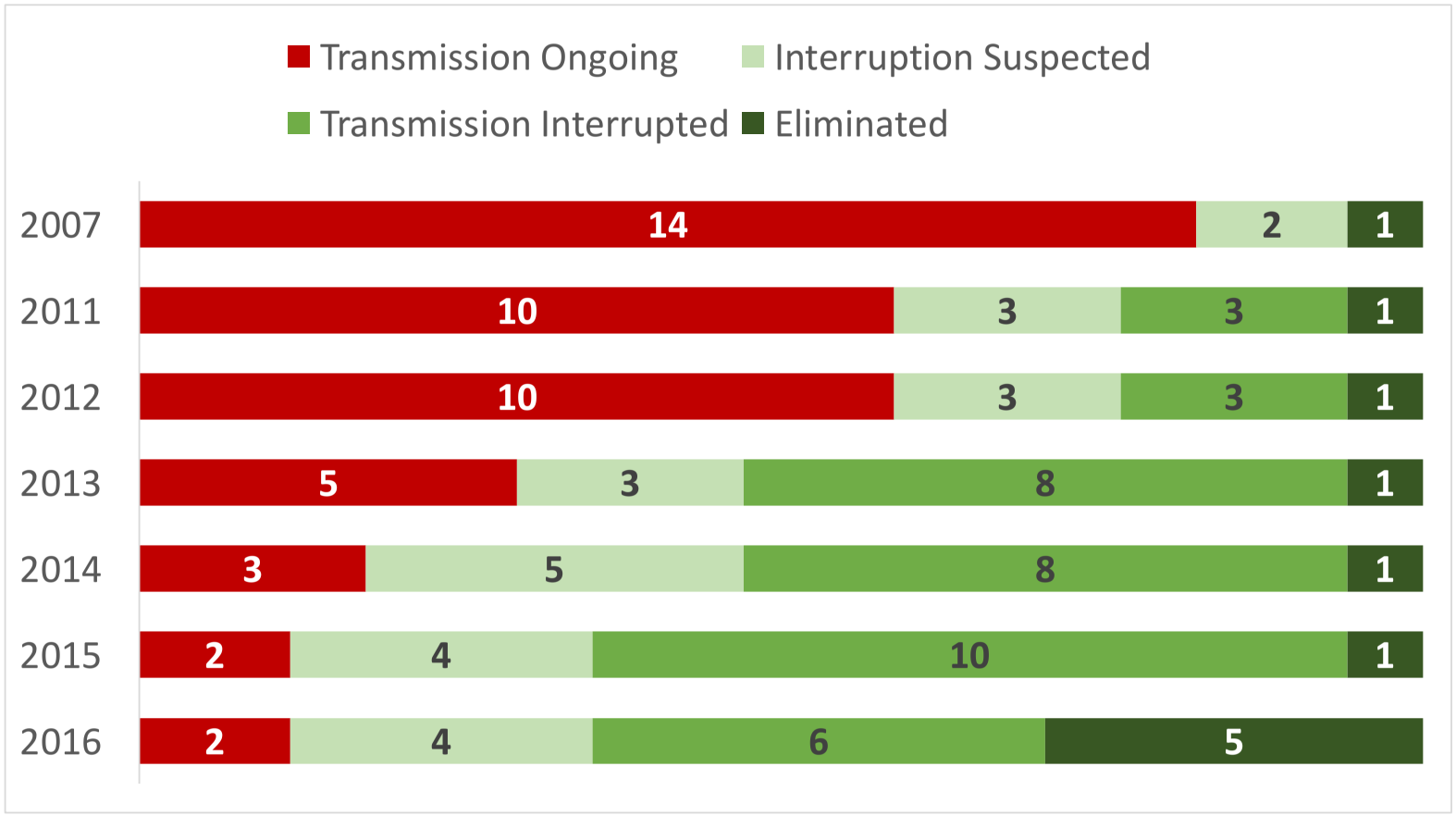
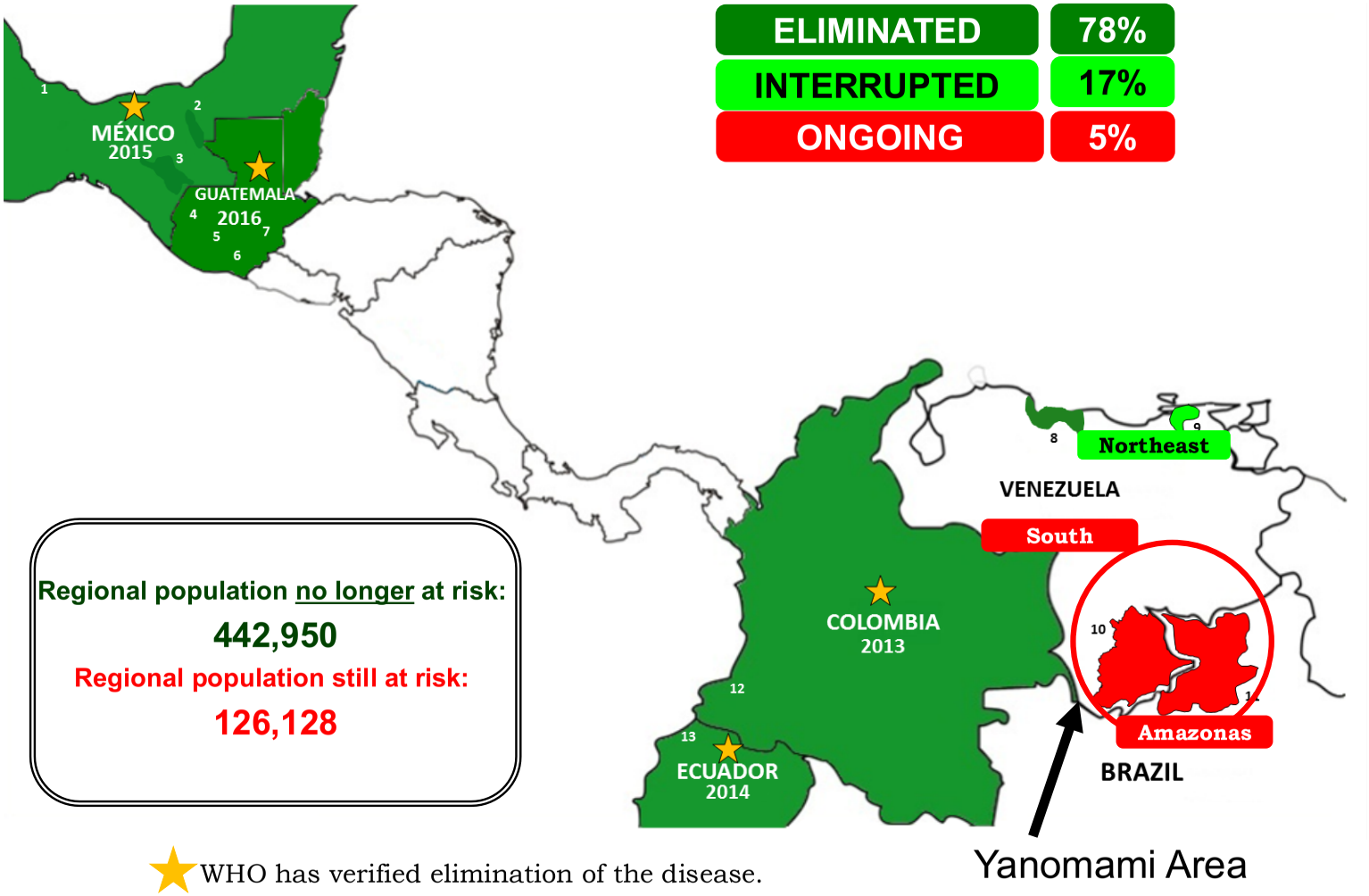


Figure ES16

Onchocerciasis in the Americas (April 2017)



Small numbers represent positions of the original 13 foci

ABSTRACT

The Carter Center River Blindness Elimination Program (RBEP) held its 21st annual Review, March 27-29, 2017 at its Atlanta headquarters (meeting photos, Figure ES1 – ES2). The Review focused on the 2016 RBEP achievements, challenges, and operational research and provided recommendations for 2017 activities in each RBEP assisted country. In addition to Carter Center headquarters and field staff, ministry of health officials from the countries we assist, and other key partners and donors, the meeting had several high-level attendees: President Jimmy Carter; First Lady Rosalynn Carter; the Honorable Minister of Health for Nigeria, Professor Isaac Adewole; Undersecretary of Health for Sudan, Dr. Isameldin Mohammed; Uganda Minister of State for Health, Honorable Dr. Joyce Kaducu Moriku; World Laureate Lion, Honorable Dr. Tebebe Berhan; and Director of Communicable Diseases, African Regional Office of the World Health Organization (WHO) Dr. Magda Robalo.

The goal of the RBEP is to eliminate river blindness (RB) transmission everywhere it assists ministries of health (MOHs) in 10 countries.[1] The approach to RB elimination is defined by WHO guidelines, which provide three milestones (shown by the vertical lines in Figure ES3): 1) transmission suppressed; 2) transmission interrupted; and 3) transmission eliminated. The strategy for elimination in RBEP programs is mass drug administration (MDA) with ivermectin (Mectizan®, donated by Merck), together with health education, preferably given twice per year (six monthly). RBEP assisted efforts in the Americas have resulted in WHO-verified national elimination of onchocerciasis from Colombia (in 2013), Ecuador (2014), Mexico (2015), and in 2016, Guatemala. The Abu Hamad focus in Sudan was the first focus in Africa to complete the WHO elimination guidelines, and four foci in Uganda have followed. The 2016 Review continued to highlight challenges in cross-border transmission areas that we have termed 'Special Intervention Zones' (SIZs).

In 2016, The Carter Center assisted in a total of 37,093,958 mass ivermectin treatments for river blindness (onchocerciasis) in 6 countries, a 32% increase from 2015 and 87 percent of the 2016 treatment target (Figures ES4 and ES5). These treatments represented about 40% of the 92 million MDA treatments assisted by The Carter Center for neglected tropical diseases (NTDs). Figure ES6 shows the last three years of treatments by disease, and estimated number of persons treated.

RBEP's cumulative treatments since 1996 have now reached 278 million (Figure ES7). A goal of 54 million treatments has been set for 2017, an increase of 49% over 2016. Figures ES8 and ES9 show our assisted annual treatments and annual coverage geographically. RBEP aims to exceed 90% reported treatment coverage of the eligible population (which excludes children under five years of age) in each treatment round, except in the Americas, where the goal is 85% or more.

[1] Brazil, Colombia, Ecuador, Ethiopia, Guatemala, Mexico, Nigeria, Sudan, Uganda and Venezuela.

Record treatment numbers were reported for 2016 Carter Center-assisted MDA activities in several other Neglected Tropical Disease (NTD) efforts in addition to river blindness, including lymphatic filariasis (LF) in Ethiopia and Nigeria (24,504,989 treatments, 93% of the target), and schistosomiasis (SCH) and soil-transmitted helminthiasis (STH) in Nigeria (4,007,831 and 8,922,891 treatments, for 81% and 77% of the targets, respectively). Donated medicines for these treatments were provided by Merck, GSK, E-Merck, Johnson and Johnson, and Pfizer.

Our work would not be possible without a grassroots network of community-directed drug distributors who provide the treatments, with health education. A combined 319,166 community workers were trained in 2016, all of whom were trained and mentored by health personnel working with the national health care services in all affected districts with support from The Carter Center and ministries of health (Figure ES10).

EXECUTIVE SUMMARY OF THE 21ST PROGRAM REVIEW

Dr. Frank Richards, director of The Carter Center's River Blindness, Lymphatic Filariasis, and Schistosomiasis Programs, co-chaired the meeting with the RBEP field office leaders: Dr. Nabil Aziz (Country Representative, Sudan), Ms. Peace Habomugisha (Country Representative, Uganda), Dr. Emmanuel Miri (Country Representative, Nigeria), Dr. Mauricio Sauerbrey (Director, Onchocerciasis Elimination Program for the Americas-OEPA), and Dr. Zerihun Tadesse (Country Representative, Ethiopia). In addition to Carter Center field and headquarters staff, attendees included representatives from: the ministries of health of Ethiopia, Nigeria, Sudan, and Uganda; Emory Eye Center; Emory University; The END Fund; Bill & Melinda Gates Foundation; Global Health Institute: Health and Development International; Institut für Evolution und Evaluation; Institute for Health Metrics & Evaluation; Lions Clubs International Foundation; Liverpool John Moores University; Mectizan Donation Program; PATH; Rabin Martin; RTI International; Sightsavers; St. Patrick's Episcopal Church; Task Force for Global Health; University of Georgia; University of Notre Dame; University of South Florida; U.S. Agency for International Development (USAID); U.S. Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO). Key findings and country reports follow. (See Annexes 1 – 8 for background on the diseases, a program achievement timeline, a complete participant list, contact list, publications, and the Review agenda).

Binationally coordinated 'Special Intervention Zones' (SIZs) for cross-border onchocerciasis transmission areas have become an important focus for all RBEP country offices. Transmission must be simultaneously tackled on all sides of the SIZ if the elimination initiative is to be successful. One side cannot be left behind, and engaging both sides involves not only technical activities, but political and diplomatic engagement as well. SIZ issues are relevant both in the Americas and in Africa. The 'final' inch to achieving regional elimination in the Americas is the Yanomami Area SIZ that straddles the border between Brazil and Venezuela. In Africa, the SIZs currently addressed are: 1) the Radom focus of Sudan, another very unstable SIZ that extends into Republic of South Sudan (RSS) and possibly Central Africa Republic; 2) the adjacent Galabat (Sudan) and Metema (Ethiopia) transmission zones, both of which are close to reaching an agreement for coordinated stopping of Mass Drug Administration (MDA); 3) Sudan's Khor Yabus focus which is shared between Ethiopia, RSS, and Sudan; 4) the Madi/Mid North focus of Uganda, which extends into RSS; and four Ugandan foci that extend into DRC 5) West Nile, 6) Nyagak-Bondo, 7) Lhubiriha and 8) Bwindi (See Figure ES11 for a map of these areas). All RBEP international SIZs in the Americas and Africa will require considerable diplomatic and programmatic work to intensify interventions. We also consider internal borders to be SIZs. For example, in Nigeria, there are important state cross-border transmission zone between 1) Edo state (Carter Center supported) and Ondo state (supported by an NGO called Mission to Save the Helpless-MITOSATH) and 2) Plateau state (Carter Center supported) and Kaduna state (supported by SightSavers).

Ethiopia
In 2016 Ethiopia conducted twice-per-year treatments for river blindness in all Carter-Center assisted areas in aggressive pursuit of the national policy of onchocerciasis elimination by 2020 (Figure ES5). In 2016, Ethiopia delivered a total of 14,467,640 Mectizan® treatments, compared to 15,134,578 in 2015. The decline was due to changes in integrated training procedures required by the Federal Ministry of Health in some of the zones assisted by The Carter Center, which delayed MDA in late 2016. The treatment target for Ethiopia in 2017 is 18,377,466. Over 226,529 community drug distributors were trained, approximately 32,000 more than in 2015, and about 60% were female (Figure ES12). The Ethiopia Onchocerciasis Elimination Expert Advisory Committee (EOEEAC) was unable to meet in 2016 but was able to hold its third meeting in Atlanta on March 30, 2017, immediately following the RBEP review. The Carter Center's work in Ethiopia is based on a longstanding partnership with the Federal Ministry of Health, The Lions Clubs International Foundation SightFirst Program and the Lions Clubs of Ethiopia. The program also received support in 2016 from the Cargill Foundation. Additionally, Ethiopia continued treatments for lymphatic filariasis (LF), reaching 1.1 million treatments in a program supported by GSK. Treatment projections for LF in 2017 are 1.5 million.

Nigeria
Thanks to NTD funding from USAID's ENVISION project, led by RTI International, and funding from Cargill Foundation, Izumi Foundation and other generous donors, the program assisted 54 million treatments for river blindness, LF, SCH and STH in Nigeria in 2016 (Figure ES13).

RBEP assisted 18,691,783 Mectizan® treatments for river blindness in nine Nigerian states in 2016. Most treatments in Nigeria were given once per year, with the exception of a few districts (or LGAs) in Edo state where twice per year was given. An exciting expansion of twice-per-year treatments for the majority of Carter Center assisted areas in the seven southern states is planned for 2017. The RB treatment target for 2017 is 31.7 million, a significant leap due to this move to twice-per-year. The Nigeria Onchocerciasis Elimination Committee (NOEC) met twice in 2016 with the support of The Carter Center and completed work on a national 'Onchocerciasis Elimination Plan' that was signed by the Honorable Minister of Health. The NOEC will meet at least twice in 2017.

The LF Elimination Program assisted 22,421,697 treatments in the seven southern Nigerian states in 2016. The program focused on treatment strategies in *Loa loa* areas where Mectizan® was not recommended due to the risk of severe adverse events (SAEs). In such areas, the WHO-recommended twice-per-year monotherapy of albendazole (donated by GSK) was provided to 4.5 million persons (9 million treatments). However, an important 2016 study led by The Carter Center, using the new 'LoaScope,' found no hyperparasitemia from *Loa loa* (the major risk factor for central nervous system SAEs) in RBEP assisted states. Based on that study, the Federal Ministry of Health and the Mectizan® Expert Committee approved that the standard LF MDA regimen of once-per-year ivermectin plus albendazole could be given in 2017. The treatment target for LF in 2017 therefore decreased compared to 2016, to 18.8 million. In central Nigeria, where The Carter Center assists Plateau and Nasarawa states, LF treatments stopped in 2013.

In 2016 The Carter Center conducted post-treatment surveillance (PTS) research studies in potential hot spots of ongoing transmission in 2016 with support from the Task Force for Global Health, and demonstrated that there had been no resurgence of LF transmission. We expect results of a 2017 TAS 3 survey will confirm that we have indeed stopped transmission in those two states.

The Carter Center assisted in 4,007,831 praziquantel treatments for schistosomiasis in our nine assisted states in Nigeria in 2016. Praziquantel is donated by Merck KGaA (E-Merck of Germany) to The Carter Center through the WHO. Our target in 2017 is 2,599,967 (a 35% decrease due to the WHO MDA rotation schedule). Treatments in 2016 for STH were 8,922,891 with a 2017 target of 11 million (a 23% increase). The medicines used for STH treatment are donated by GSK (albendazole) or Johnson & Johnson (mebendazole).

Uganda

The Uganda program administered 3.6 million Mectizan® treatments in 2016, where all treatments are given under the twice-per-year strategy. Currently, onchocerciasis elimination in Uganda is supported by The Carter Center, the United States Agency for International Development (USAID) ENVISION project led by RTI International, and Sightsavers, under the coordination of the Ministry of Health. In 2017, Uganda has a target of 4 million treatments. At its 2016 meeting, the Ugandan Onchocerciasis Elimination Expert Advisory Committee (UOEEAC) reviewed PTS data for four foci (Imaramagambo, Itwara, Mpamba-Nkusi, and Mt. Elgon) and concluded that they had eliminated transmission. This translates into approximately 800,000 residents of those areas being no longer being at risk for onchocerciasis. Only two of the original 17 Ugandan onchocerciasis transmission foci (Lhubiriha and Madi-MidNorth) continue to have active RB transmission. Figures ES14 – ES15 show Uganda's progress towards elimination.

Sudan

In 2015, Abu Hamad was the first focus in Sudan to eliminate river blindness transmission as defined by WHO Geneva elimination guidelines. Continuing this successful trajectory, Sudan reported interruption of transmission of onchocerciasis in Galabat District of Gedarif State in 2016. The Galabat onchocerciasis-endemic area borders the Metema endemic zone of North Gondar (Amhara) Ethiopia. Sudan and Ethiopia are working together to eliminate transmission in this cross-border focus. Sudan aims to give about 300,000 treatments in 2017.

The Americas

In 2016 Guatemala became the fourth country in the Americas to receive official verification from the WHO to have eliminated river blindness; it follows Colombia (verified in 2013), Ecuador (2014) and Mexico (2015). See Figure ES16 for a map of the region. The Onchocerciasis Elimination Program for the Americas (OEPA) now focuses on strengthening its partnership with Brazil and Venezuela so as to finish the fight in the last active transmission zone in the region of the Americas. This is a shared cross-border SIZ in the Amazon rainforest. The 50,000 indigenous residents of the area, called the

Yanomami, live in small, migratory communities that are difficult to locate and sometimes dangerous to reach. An ambitious strategy of providing Mectizan® four times per year is being used for the most afflicted villages. In addition, the Venezuelan Ministry of Health is recovering unused and overgrown landing strips in the jungle to allow fixed wing aircraft to land closer to the most inaccessible villages in need of treatment. About 83,000 treatments are planned in the Yanomami Area in 2017.

2017 GENERAL RECOMMENDATIONS FOR THE CARTER CENTER RIVER BLINDNESS ELIMINATION PROGRAM

In collaboration with the host governments, RBEP helps to interrupt onchocerciasis transmission in Carter Center-assisted River Blindness Elimination Program (TCC/RBEP) assisted areas in Africa. Recommendations for the broader program include working to:

- Help empower national onchocerciasis committees to review their data and make decisions related to enhancing interventions, expanding treatment, stopping interventions, and entering into post-treatment surveillance, guided by (but not restricted to) WHO guidelines.
- Conduct new assessments to help delimit the precise borders of African onchocerciasis transmission zones ('*foci*') that are targeted for elimination in TCC/RBEP assisted areas.
- Further define areas of active onchocerciasis transmission, including within the so-called 'hypoendemic' onchocerciasis areas that have traditionally not been targeted for ivermectin treatment under previous WHO/APOC disease control policy.
- Enhance interventions (two or four-times-per-year ivermectin treatment, vector control, etc.) where transmission persists or in new foci where treatments have never been given.
- Where active onchocerciasis transmission spans borders, work with authorities on both sides of internal or international boundaries to establish 'Special Intervention Zones' (SIZs) and the needed collaboration on both sides to stop transmission.
- Monitor the impact of interventions using sensitive tools.
- Encourage the concerned Ministries of Health and local authorities to evaluate and treat cross-border foci in a coordinated manner.
- Encourage the Ministries of Health to revise complex village rollup forms that must be completed by CDDs and health workers that require recording treatment data by gender and age groups.
- Improve collaboration and transparency among stakeholders to reduce drug supply delays and over and under supply inaccuracies.
- Have programs collect more information, to share at the next review, on communities with low coverage.
- Conduct treatment coverage surveys by the Carter Center field offices, in consultation with HQ.
- Submit drug applications to WHO and MDP as early as possible; timely drugs are critical, particularly for twice-per-year treatment areas. Programs in Africa should work with Ministries of Health to target an April 30 submission rather than August 31, to receive drugs on time. Drug inventories submitted with applications can be interim, but must be included. Assist the national programs with submissions. Keep TCC/RBEP headquarters informed on the process.
- In African programs, seek to increase training, supervision, involvement of kinship groups, and gender balance among CDDs and community supervisors. Work

toward a target ratio of at least 1 CDD:100 people, 1 community supervisor:5 CDDs and 1 community supervisor per village.

- The Carter Center website will house key documents from Elimination Committees (Ethiopia, Nigeria, Uganda), once they are published.
- WHO should consider convening an international expert *ad hoc* technical committee dealing with establishing best practices for cross-border issues in onchocerciasis elimination, using experience gained in Sudan/Ethiopia, Uganda/DRC and OEPA (Brazil/Venezuela).
- Maintain laboratory support by TCC/RBEP for serology, entomology, and parasitology (including PCR testing in vectors and skin snips) led by University of South Florida (USF) (Dr. Thomas Unnasch). In consultation with USF, field laboratories should send samples and/or data to USF for quality control purposes. Reagent and supply orders from these labs will be reviewed by Dr. Unnasch or his staff before TCC will purchase.
- Monitor government and partner financial contributions for elimination efforts in RBEP-assisted areas through national mechanisms.
- Complete or renew the Emory IRB certification if Carter Center is to be involved with research programs.
- Evaluate technological solutions for improving accuracy and speed of village level and district level data aggregation and reporting.

River Blindness (RB), Lymphatic Filariasis (LF), Schistosomiasis (SCH) and Soil Transmitted Helminthiasis (STH) propose to assist ministries of health to provide 88,892,858 treatments in 2017.

2017 Treatment and Training Objectives:

UTG = Ultimate Treatment Goal
UTG(2) = Twice-per-year UTG
UTG(4) = Four-times-per-year UTG

River Blindness	
Quarterly UTG(4)	63,628
Semiannual UTG(2)	37,350,608
Annual UTG	17,107,197
Total RB Treatments	**54,521,433**

Lymphatic Filariasis	
Annual UTG	20,277,861
Total LF Treatments	**20,277,861**

Schistosomiasis	
Annual SCH UTG	2,599,967
Total STH Treatments	**2,599,967**

Soil Transmitted Helminthiasis	
Annual STH UTG	9,338,404
Semiannual STH UTG(2)	2,155,193
Total STH Treatments	**11,493,597**

Training Objectives	
CDDs	338,866
Community Supervisors	99,407

ONCHOCERCIASIS ELIMINATION PROGRAM FOR THE AMERICAS (OEPA)

Summary: The Onchocerciasis Elimination Program for the Americas (OEPA) is a Carter Center-led program that serves as the vanguard of the regional initiative working to eliminate transmission of onchocerciasis from the Americas through distribution of Mectizan® (ivermectin). The OEPA strategy is based on mass drug administration (MDA) of Mectizan® twice or four times per year, with a target of ≥85% coverage of the population eligible for treatment. About 11.6 million ivermectin treatments have been given in the Americas during the period 1989-2016, eliminating transmission in 10 of 13 foci in the six initially endemic countries (Figure ES16 and Figure O1). In 2016, Guatemala became the fourth country to be verified by the World Health Organization (WHO) as having eliminated onchocerciasis (after Colombia in 2013, Ecuador in 2014 and Mexico in 2015).

Background: Ninety-five percent of ivermectin treatments in the region have been halted, and the regional focus called the Yanomami Area is now on the only remaining active transmission zone, on the border between Venezuela and Brazil. The Northeast Focus of Venezuela stopped MDA but has not completed its post treatment surveillance (PTS) activities, so its population of 95,567 is still categorized as 'at risk' (Figure O2).

In addition to The Carter Center, the OEPA coalition includes ministries of health (MOHs) of the six currently or formerly endemic countries in the Americas (Brazil, Colombia, Ecuador, Guatemala, Mexico, and Venezuela), the Pan American Health Organization/WHO (PAHO/WHO), the United States Agency for International Development (USAID), the Carlos Slim Foundation, the Lions Clubs International Foundation (LCIF) and local Lions Clubs, the Bill & Melinda Gates Foundation, Merck and the Mectizan® Donation Program (MDP), the U.S. Centers for Disease Control and Prevention (CDC), and several U.S. and Latin American universities. A Program Coordinating Committee (PCC) serves as the steering body for OEPA, which is based in Guatemala City, Guatemala. Technical and financial assistance to the six countries flows through the OEPA office.

The OEPA initiative was launched by the River Blindness Foundation (RBF) in 1993 in response to the 1991 Resolution XIV of the 35th PAHO Assembly that called for the elimination of onchocerciasis morbidity from the Americas by the year 2007. With the closure of the RBF in 1996, The Carter Center assumed administrative responsibilities for OEPA. In 2008, PAHO renewed the call to eliminate onchocerciasis (Resolution CD48.R12) throughout the region. A 2009 PAHO Resolution (CD49.R19), called for the elimination or drastic reduction of 12 neglected tropical disease (NTDs) in the Americas, includes onchocerciasis as an elimination target. A 2016 PAHO Resolution (CD55.R9) on NTDs calls for regional elimination of onchocerciasis by 2022.

In 2001, the WHO established a set of guidelines to assist onchocerciasis programs to determine whether interruption of transmission had occurred and MDA with Mectizan® could be stopped. These guidelines were revised in 2016 (See Executive Summary and Figure ES3). Once all transmission zones (foci) in a country reach the elimination stage,

final country verification can be requested from an independent international verification team (IVT) working under the auspices of the WHO. IVT activities involve a country visit.

The 'Yanomami Area' Special Intervention Zone (SIZ) is the remaining active onchocerciasis transmission zone in the Americas and the only area that will be under treatment in 2016. It is shared by Brazil and Venezuela (Figure O3). A total of 66,582 Mectizan® treatments were given in the Yanomami Area in 2016.

Guatemala:

Onchocerciasis was first reported in the Americas in 1915 in Guatemala by the renowned Guatemalan physician and researcher Dr. Rodolfo Robles Valverde. Among his multiple contributions to the study of onchocerciasis, Dr. Robles was the first to associate onchocerciasis infection with its ocular manifestations. In his honor, the disease is known in Guatemala as Robles Disease. The Guatemalan Onchocerciasis Control Program was launched in 1935, five years after the launching of the Mexican Onchocerciasis Control Program. There were four Guatemalan transmission foci: Santa Rosa, Escuintla Guatemala, Huehuetenango and a large 'Central focus' that included parts of the Departments of Suchitepéquez, Sololá and Chimaltenango. The Central focus was the largest among all 13 foci in the American continent. The total population at risk of onchocerciasis in Guatemala (using 2011 figures) was estimated to be 229,535 individuals, making Guatemala the most endemic country in the Americas, with 42% of the total regional at-risk population. During the first 54 years, the Guatemalan Onchocerciasis Control Program strategy focused on surgical removal of nodules, some vector control activities and sporadic treatment of cases with diethylcarbamazine.

Ivermectin treatments were launched on a pilot basis in Guatemala in the late 1980's in studies (sponsored by WHO TDR) of the impact of semiannual mass drug administration (MDA) on onchocerciasis transmission. The successful results from these studies formed the scientific rationale for establishing the regional elimination strategy based on twice-per-year treatments in all endemic communities. By 2000, all four Guatemalan foci were implementing six-monthly MDA in all endemic communities. The first focus to achieve success was the Santa Rosa focus in 2006 after 18 MDA rounds (1996-2006), with 13 rounds (72%) having coverage ≥85%. Santa Rosa was the first to successfully complete the three-year PTS phase in 2010. By 2007, the Escuintla-Guatemala focus had completed 21 MDA rounds (1995-2007), 13 (62%) of which had coverage ≥85%, and also successfully completed PTS in 2010. The Huehuetenango focus completed 22 MDA rounds (1996-2008), with 17 (77%) ≥85% and successfully completed PTS in 2011. The Central focus had the most intense onchocerciasis transmission and required the greatest number of MDA rounds (28 from 1996-2011) with 22 (79%) ≥85% coverage. The Central focus successfully completed PTS in 2014.

On March 20, 2015, Guatemala filed a formal application to WHO for verification of onchocerciasis elimination after the Ministry of Health of Guatemala and the PCC concluded that the country had eliminated onchocerciasis transmission. The application included a comprehensive country dossier describing the history and achievements of the national program. In response to Guatemala's request, an International Verification

Team (IVT) visited the country from May 30 to June 10, 2016 to extensively review the program and the supportive evidence for elimination in accordance with WHO guidelines. The IVT delivered its report to the PAHO's country representative on June 10.

On July 20, 2016, based on internal review of the IVT's report and recommendations, the Director General issued an official letter to Guatemala congratulating the country on the elimination of onchocerciasis transmission. The Guatemalan Minister of Health announced the WHO verification at the 55th Directing Council PAHO meeting in Washington DC on September 29, 2016. Guatemala is now the fourth country to be verified as having eliminated onchocerciasis.

(*This section was extracted from the following publication: Progress towards eliminating onchocerciasis in the WHO Region of the Americas: verification of elimination of transmission in Guatemala.* Wkly Epidemiol Rec. *2016; 91:501-5.)*

Venezuela/Brazil:

Two national foci, the Venezuelan South Focus and the Brazilian Amazonas Focus, comprise the Yanomami Area. The epidemiological map of the Yanomami Area and tables and details of Venezuela and Brazil treatment figures are provided in Figures O3 – O6. Communities having the highest baseline infection prevalence of microfilariae in skin have been targeted to receive four-times-per-year ivermectin treatment in an effort to hasten the elimination of the disease, but overall treatment coverage under this approach has not made the goal of $\geq$85% (although coverage within communities varies). A total of 60,269 treatments were provided under four-times-per-year treatment strategy in 2016; 6,313 twice-per-year treatments were given in less highly endemic communities.

The 26th Annual InterAmerican Conference on Onchocerciasis (IACO'16) in Guatemala City

The 26th InterAmerican Conference on Onchocerciasis (IACO), convened December 7 – 8, 2016 in Guatemala City. Guatemalan President Jimmy Morales attended the inaugural ceremony where he and Dr. Lucrecia Hernández Mack (Guatemalan Minister of Health) received a commemorative plaque of the country's victory over onchocerciasis from Dr. Carissa Ettiene, Director of the PanAmerican Health Organization (Figure O7). In his acceptance speech President Morales recognized the many partners who contributed to this achievement. In particular, he commended the many health workers in the audience, whom he referred to as angels; those who brought medicine to the communities in need year after year until the disease was no more. Ambassador (ret.) Mary Ann Peters, CEO of The Carter Center, and Mr. José Bastos, Merck's Latin America Regional President, also spoke at the inaugural event. One hundred and one years have passed since the disease was discovered in the country by Guatemalan physician Dr. Rodolfo Robles. His grandson (who shares his name) was a guest of honor and accepted a plaque from Minister Hernández in his grandfathers' honor (Figure O8).

2017 RECOMMENDATIONS FOR THE ONCHOCERCIASIS ELIMINATION PROGRAM FOR THE AMERICAS (OEPA)

By the end of 2017, identify, and make progress in the epidemiological assessment of, all new Yanomami communities in the South Venezuela Focus (Yanomami Area). This should include 1) completion of the UGA remote sensing studies to identify suspected villages and sharing of coordinates with Venezuela; 2) a fly over (or site visit) of all suspected villages newly identified; 3) if suspected sites are confirmed to be inhabited villages then an epidemiological assessment visit is required; and 4) if the village is confirmed to be onchocerciasis endemic, Mectizan treatment (preferably 4x per year) launched immediately.

Maintain the implementation of four-times-per-year treatment, prioritizing hyper-endemic areas. High treatment coverage (>85%) in each of four treatment rounds should be considered high priority in communities 'scored' by a series of factors such as: year when treatment began, the number of rounds with any treatment coverage, the number of rounds with>85% treatment coverage, and the number of consecutive rounds of >85% coverage, baseline endemicity, and the efficiency of the vector in the area. Brazil should return to twice per year treatment schedules in low priority areas.

Promote the highest level of political support from Venezuela and Brazil for the elimination of onchocerciasis from the Yanomami Area, including support for the 2014 binational memorandum of agreement (MOA) which calls for an annual bi-national plan of operations and an annual meeting of the binational steering committee.

Advocate for and support a 2017 meeting of the Brazil-Venezuela bi-national committee, with OEPA representation. Continue to propose cross-border activities, including flights from Brazil into Venezuela (especially for the Siapa valley).

Launch programmatic activities in the Siapa river valley in Venezuela.

Solve transportation issues in hard-to-reach communities on the border of Venezuela and Brazil. Continue supporting efforts to recover old landing strips in Venezuela.

Continue to invite all six OEPA country representatives to IACO regardless of verification of elimination status.

Encourage the Lions Clubs International Foundation to support the attendance of a Lions representative from each of the six countries to IACO.

Complete PTS in 2017 in the Northeast focus of Venezuela.

Encourage Colombia and Ecuador to publish the results supporting declaration of elimination of transmission of onchocerciasis in peer reviewed journals.

Where possible, train Yanomami indigenes to take part in treatment activities, including distribution.

2017 Treatment Objectives:

River Blindness	
UTG(2)	19,396
UTG(4)	63,628

Figure O1

Mectizan® Treatment in the Americas 1989-2016 (by treatment approach), and projection 2017-2019

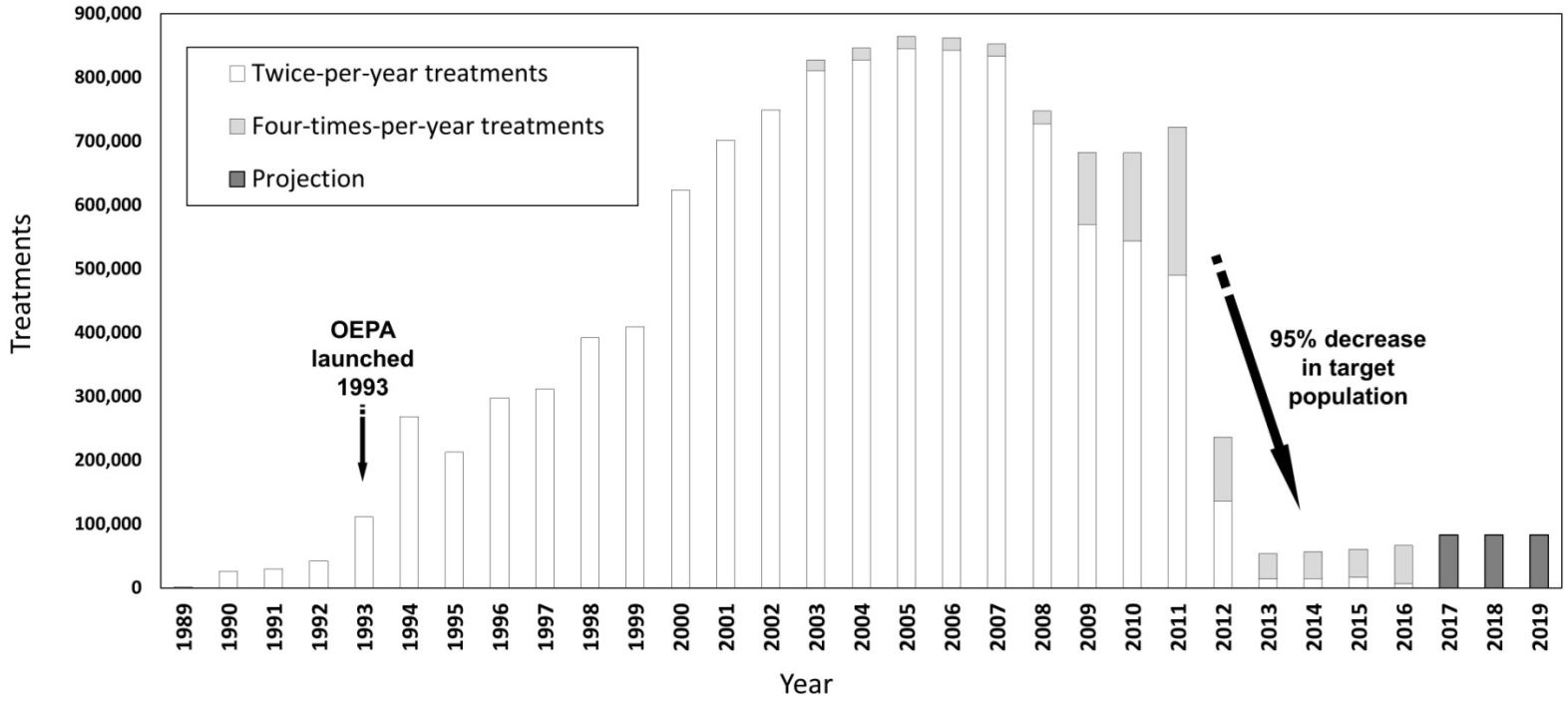


Figure O2

Onchocerciasis in the Americas: Population at risk, no longer at risk, under Post-treatment Surveillance (PTS), eligible for treatment and transmission status by focus in the Americas

Focus	Treatment Approach	# of Communities	Population at Risk	Population no longer at risk	Population under PTS	Population Eligible for Treatment	Status of Transmission
Lopez de Micay - COL		1		1,366			Eliminated in 2010 Verified in 2013
Esmerald as - EC		119		25,863			Eliminated in 2012 Verified in 2014
North Chiapas - MX		13		7,125			Eliminated in 2010, 2011 and 2014, Verified in 2015
Oxaca - MX		98		44,919			
South Chiapas - MX*		559		117,825			
Escuintla - GU		117		62,590			Eliminated in 2010, 2010, 2011, and 2014, Verified in 2016
Santa Rosa - GU		37		12,208			
Huehuetenango - GU		43		30,239			
Central - GUA		321		126,430			
Northcentral - VZ		45		14,385			Eliminated in 2013
Northeast - VZ		465	95,567		95,567		Interrupted in 2012
South-VZ	2x/year	66	4,248			3,744	ONGOING
	4x/year	236	10,838			9,273	
	Focus' total	302	15,086			13,017	
Amazonas-BZ	2x/year	117	7,209			5,954	ONGOING
	4x/year	122	8,266			6,634	
	Focus' total	239	15,475			12,588	
Regional total		2,359	126,128	442,950	95,567	25,605	

Figure O3

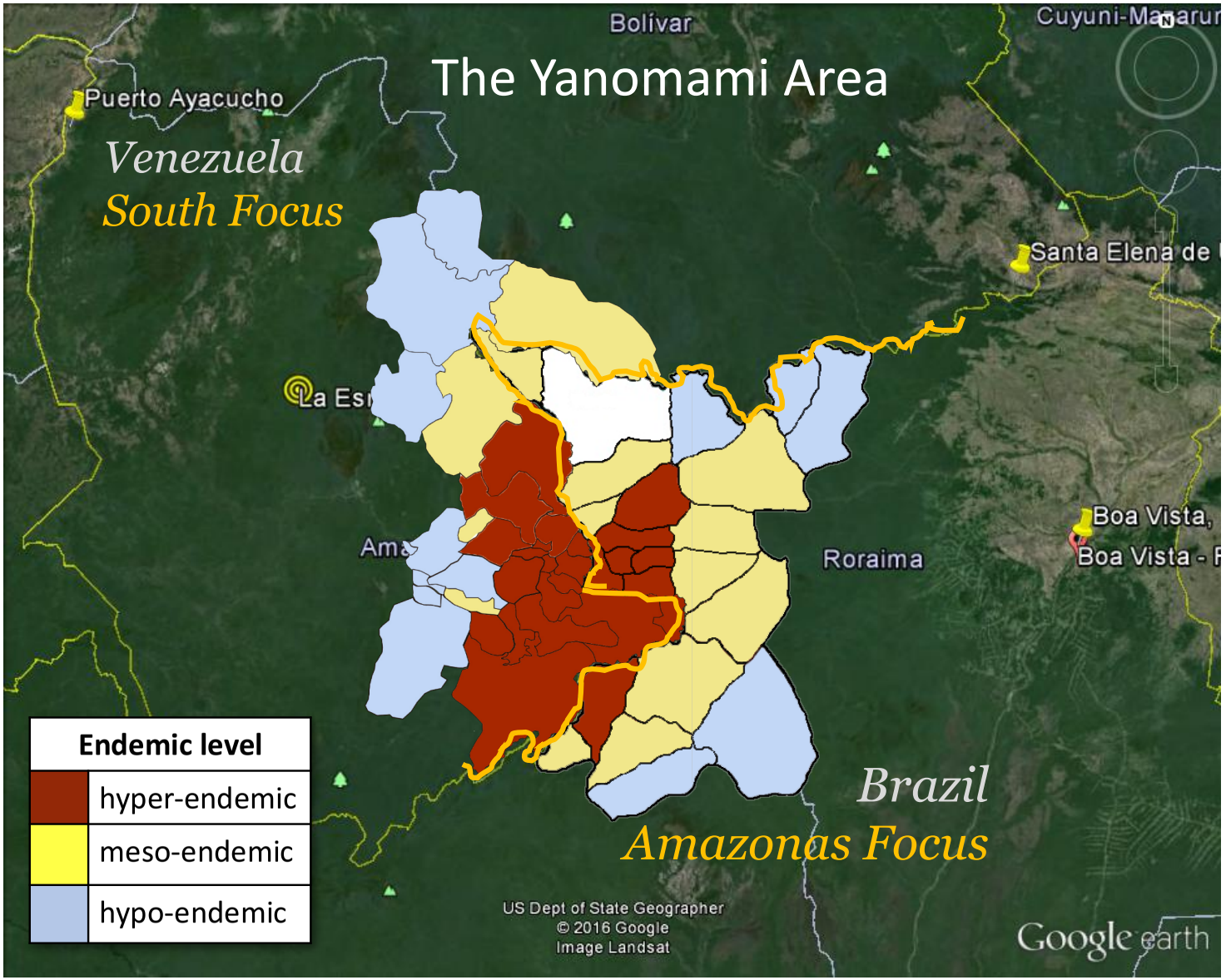

The Yanomami Area
Bolivar
Puerto Ayacucho
Venezuela
South Focus
Santa Elena de
Roraima
Boa Vista,
Brazil
Amazonas Focus
Endemic level
hyper-endemic
meso-endemic
hypo-endemic
US Dept of State Geographer
© 2016 Google
Image Landsat
Google earth

Figure O4

Twice and Four times per Year Treatment in the Yanomami Area

Twice per Year

Focus	Comm Treated 2x	Meso Comm	Hypo Comm	Popn @ Risk 2x	Eligible for Treatment	Treatment RD 1	COV RD 1 %	Treatment RD 2	COV RD 2 %	UTG2	Treated UTG2	COV UTG2 %
Amazonas-BRA	0			0	0	NA		NA		-		
South-VEN	56		56	4,110	3,616	3,037	84%	3,276	91%	7,232	6,313	87%
Total	**56**	**0**	**56**	**4,110**	**3,616**	**3,037**	84%	**3,276**	91%	**7,232**	**6,313**	87%

Four Times per Year

Focus	Comm Treated 4x	Hyper Comm	Meso Comm	Hypo Comm	POP @ Risk 4x	Eligible for Treatment	Eligible for Treatment w/o EEP POP RD 2	Treated RD 1	COV RD 1 %	Treated RD 2	COV RD 2 %	Treated RD 3	COV RD 3 %	Treated RD 4	COV RD 4 %	UTG4	Treated UTG4	COV UTG4 %
Amazonas-BRA	239	105	64	70	15,323	**12,532**	10,148	9,525	76%	7,880	78%	9,501	76%	8,986	72%	47,744	**35,892**	75%
South-VEN	220	186	34	0	10,102	8,699		6,073	70%	5,921	68%	5,674	65%	6,709	77%	34,796	**24,377**	70%
Total	**459**	**291**	**98**	**70**	**25,425**	**21,231**	**10,148**	**15,598**	74%	**13,801**	73%	**15,175**	72%	**15,695**	74%	82,540	**60,269**	**73%**

Figure O5

4x/Year Treatment Coverage, South Focus, Venezuela 2009-2016

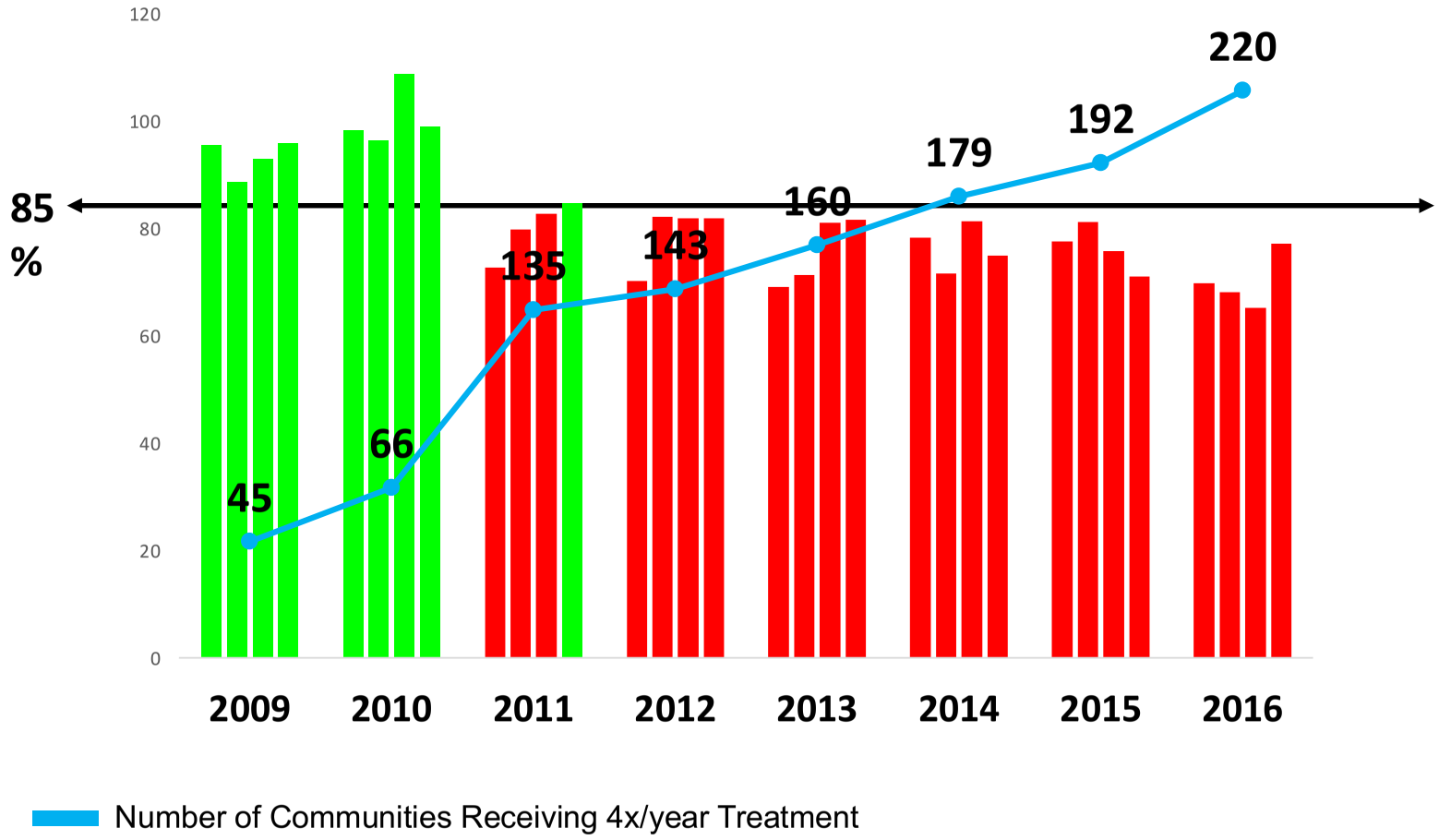


Figure O6

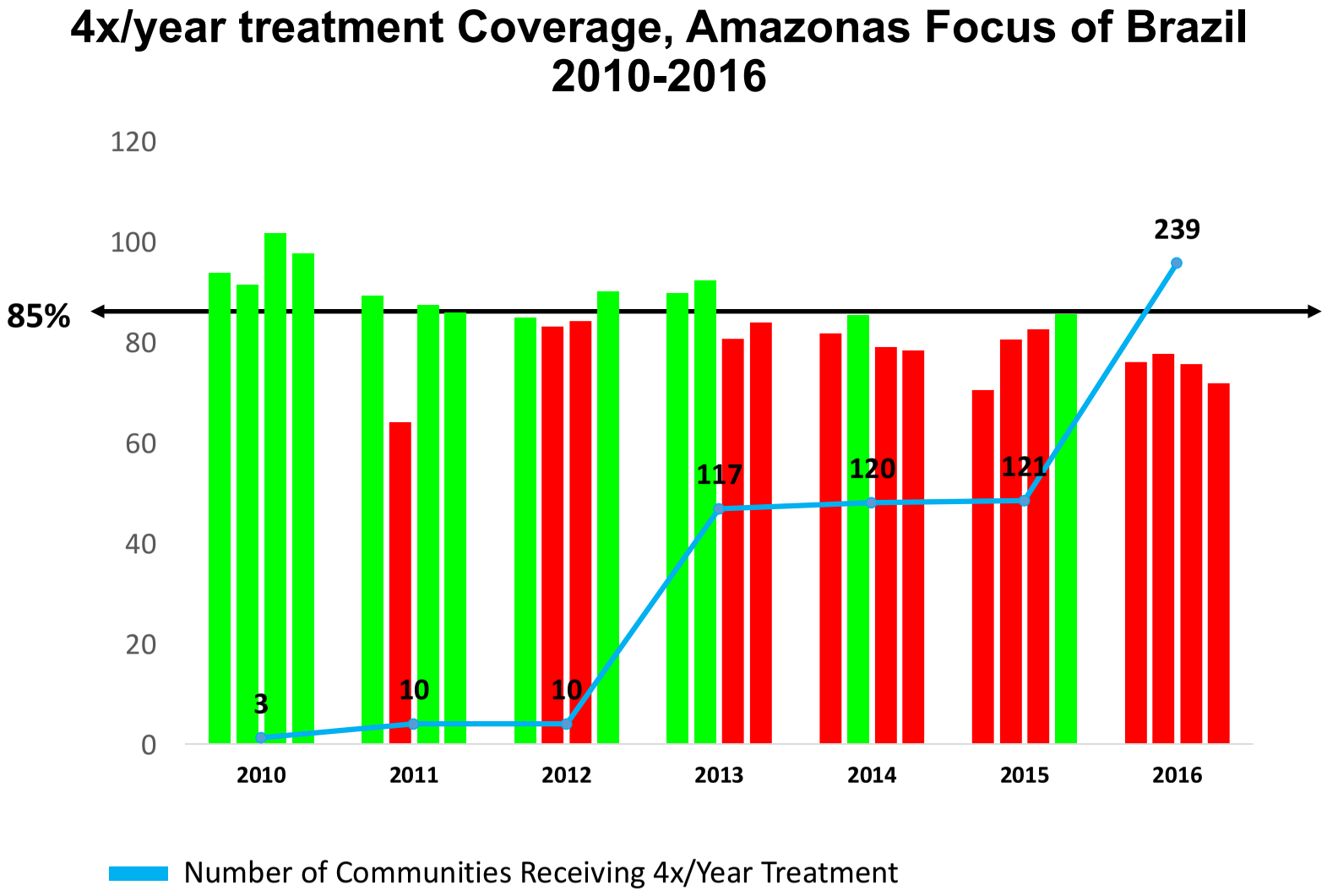

4x/year treatment Coverage, Amazonas Focus of Brazil 2010-2016
120
100
80
60
40
20
0
85%
239
117
120
121
3
10
10
2010
2011
2012
2013
2014
2015
2016
Number of Communities Receiving 4x/Year Treatment

Figure O7

At IACO 2016, President Morales and Minister Hernández receive a plaque from PAHO Director Etienne verifying the end of river blindness in Guatemala.

Figure O8

At IACO 2016, Guatemalan physician, Dr. Rodolfo Robles', grandson of the same name, receives a plaque from Minister Hernández, in honor of his grandfather's work with onchocerciasis.

UGANDA

Summary: Uganda has classified 10 of its 17 foci (including Victoria Nile, which was eliminated in the early 1970's), as either 'transmission interrupted,' transmission suspected interrupted' or 'transmission eliminated,'(Figures U1 and ES14**).** This translates into about 1.7 million treatments for onchocerciasis no longer being required in Uganda in Mpamba-Nkusi, Itwara, Mt. Elgon, Imaramagambo, Wadelai, Kashoya-Kitomi, Wambabya-Rwamarongo, Maracha-Terego, Obongi and Nyamugasani foci. Transmission is ongoing in the small Lhubiriha focus and massive Madi-MidNorth focus. Both of these areas neared their targeted treatment coverage for 2016, which showed remarkable improvement over 2015.

New for 2016 is the classification of four foci as having eliminated onchocerciasis after completing post treatment surveillance. As a result, over 800,000 persons are now free of the infection.

Background: Onchocerciasis was initially endemic in 37 of the 112 districts in Uganda (Figure U1). The first Ugandan onchocerciasis transmission zone ('focus') to successfully eliminate the disease was Victoria, which used DDT to treat river systems in the 1970s. Onchocerciasis control using annual mass treatment with Mectizan® began in 1991. The original Ministry of Health ivermectin program received financial support from The River Blindness Foundation (RBF), GTZ/Bernhard Nocht Institute for Tropical Medicine, Hamburg, AVSI, CBM, and Sightsavers. In 1996, The Carter Center (TCC) assumed the activities of RBF. In 1997, the African Program for Onchocerciasis Control (APOC) began supporting some Ugandan efforts and introduced the community-directed approach to Mectizan® distribution. APOC also supported successful vector elimination efforts in two foci (Itwara and Mpamba-Nkusi) that used ground larviciding with temephos (Abate®) together with annual Mectizan® distribution. In 2006, The Lions-Carter Center partnership helped launch semi-annual treatments (every six months) to eliminate onchocerciasis from the Wadelai focus, with support from Merck (funding being administered through the NGDO Coalition for Onchocerciasis Control). Wadelai's success was confirmed in 2010, but annual treatment with Mectizan and albendazole had to continue as the Nebbi district was also endemic for LF**.** Since then, other onchocerciasis foci with LF co-endemicity have interrupted onchocerciasis transmission, but the post treatment surveillance (PTS) period can't truly commence until LF transmission has been interrupted and treatments (albendazole plus ivermectin) stopped.

The Uganda Ministry of Health (MOH) announced a nationwide elimination policy in 2007 that was to be based on twice-per-year treatment (where necessary) and (where feasible) vector elimination/control using ground-based larviciding, in addition to health education in the affected communities. The flexible elimination policy, which aimed for nationwide elimination of onchocerciasis by the year 2020, was immediately applauded and supported technically and financially by the Lions-Carter Center partnership and Sightsavers.

Currently, onchocerciasis elimination in Uganda is supported by The Carter Center, the United States Agency for International Development (USAID) ENVISION project led by RTI International, and Sightsavers, under the coordination of the Ministry of Health. The Carter Center River Blindness Elimination Program (RBEP) assists in all 37 of the onchocerciasis endemic districts[1], and in epidemiological and entomological cross-border transmission assessment surveys. Since 2007, The Carter Center has supported technical services, vector elimination activities and community-directed treatment with ivermectin (CDTI) activities.

Lions have supported the Uganda effort through the Lions Clubs International Foundation (LCIF) SightFirst program for many years. LCIF's final grant to the program ended in 2016, but the Ugandan Lions Clubs remain active participants and advocates for the national river blindness elimination activities, including engaging and mobilizing members of parliament, district and other relevant government officials. The Carter Center's Country Representative in Uganda, Ms. Peace Habomugisha, is a Lions Club member.

Uganda Laboratory Activity: In support of the elimination effort, The Carter Center has continued to fund equipment and reagents for the MOH laboratory that provides state-of-the-art diagnostic support to the elimination program. The laboratory is located at the MOH Vector Control Division in Kampala and provides polymerase chain reaction (PCR) testing for black flies and skin snips, and serologic enzyme-linked immunosorbent assay (ELISA) testing for OV16 antibodies. Technical backup and reference lab support is provided by Dr. Thomas Unnasch's laboratory at the University of South Florida in Tampa, Florida. In 2016, the lab analyzed 102,156 blood spots for OV16 antibodies. It also analyzed 4,117 skin snips and 135,950 *Simulium* flies by PCR.

Expert Advisory Committee for National Onchocerciasis Elimination: To ensure that the elimination decisions are supported with the best scientific and technical advice, the Uganda MOH established the Ugandan Onchocerciasis Elimination Expert Advisory Committee (UOEEAC). The UOEEAC responsibilities are to: 1) review programmatic activity reports from each elimination-targeted focus in Uganda annually; 2) advise the MOH on focus-specific monitoring and evaluation activities, and recommend halting of interventions when appropriate in accord with international and national guidelines; and 3) make any other recommendations to the MOH on activities needed to reach the national 2020 elimination goal. In addition to MOH and institutional representatives, the UOEEAC includes several members-at-large who are recognized for their international expertise in onchocerciasis. One of these, Prof. Thomas Unnasch of the University of

[1] 36 oncho endemic districts: Bushenyi, Kabale, Kanungu, Kasese, Kisoro, Rubirizi, Buhweju, Kamwenge, Ibanda, and Mitooma (in southwest Uganda); Buliisa, Hoima, Kabarole, Kibale, Kyenjojo, and Masindi (in western Uganda); Adjumani, Arua, Koboko, Maracha, Moyo, Nebbi, Yumbe, and Zombo (in the West Nile region bordering the Democratic Republic of the Congo); Amuru, Gulu, Kitgum, Lamwo, Lira, Nwoya, Oyam and Pader districts (in the Mid North focus); and Bududa, Manafwa, Mbale, and Sironko (in the Mount Elgon focus in the east, bordering Kenya).

South Florida, is also the chair of the committee. Mr. Tom Lakwo (National Coordinator for the onchocerciasis elimination program, MOH) and Ms. Peace Habomugisha (The Carter Center country representative) both serve as committee secretaries. The World Health Organization (WHO) Uganda representative attends these meetings as an observer, to avoid any conflict of interest since WHO will coordinate the future international verification team visit.

The MOH and UOEEAC have designated 6 foci where onchocerciasis transmission has been interrupted (Figure U1 for corresponding numbers of foci): 1. Wadelai (2010); 2. Maracha-Terego (2012); 3. Kashoya-Kitomi (2013) 4. Wambabya-Rwamarongo (2013), 5. Obongi (2014), and 6. Nyamugasni (2015) (Figure U2).

At the UOEEAC's ninth session (August 2-4, 2016) the committee was advised that the LF program had passed the TAS1 assessments and LF treatments would be stopped. The UOEEAC recommended commencement of a three-year onchocerciasis Post Treatment Surveillance (PTS) in an integrated manner with the PTS TAS2 LF assessment.

Also at the UOEEAC 2016 session, it was noted that four foci that had been earlier classified as interrupted (Imaramagambo, Itwara, Mpamba-Nkusi, and Mt. Elgon) had successfully completed their third year Post Treatment Surveillance (PTS) evaluations that included both entomological and Ov16 serological assessments among children under 10 years of age. These four foci have now been declared eliminated by the MOH and the over 800,000 Ugandans living in these four foci to be no longer at risk of onchocerciasis.

Uganda has three foci (Bwindi, Nyagak-Bondo and West Nile), where interruption of transmission is suspected, but there is uncertainty due to possible transmission across the shared international borders with DRC (Figure ES11). Interventions cannot be halted unless the RB transmission status across the border is known. UOEEAC recommended that the Ministry of Health work alongside DRC to conduct joint cross-border assessments. DRC cross-border assessments were conducted in 2016 and the UOEEAC will receive a report of those findings in 2017. If this model is successful, it will offer a way forward in other foci with possible ongoing cross-border transmission such as Lhubiriha and (with DRC) Madi-Mid North.

Treatments: The Carter Center-assisted treatments achieved 88% of the 2016 treatment target of 3,894,298. All the treatments were delivered on a semiannual basis. The Carter Center assisted 3,430,406 treatments in Bwindi, Luhbirhia, Madi-Midnorth and Nyagak Bondo foci, while Sightsavers assisted the remaining 267,913 in the Budongo focus (Figures U3 and U4). In 2016, the Uganda RBEP assisted in 3,698,319 MDA treatments and 118,566 passive and visitor treatments, totaling 3,816,885 treatments. The Uganda RBEP reached 100% of the 3,736 villages targeted for treatment. "Rwot Kweri" is a neighborhood-based approach in northern Uganda allowed all districts in Madi Mid North to reach or exceed the desired treatment coverage of 90% of the UTG with the exception of one of the districts (Lamwo) which attained 87% UTG coverage (Figure U5).

Training and Health Education: Uganda trained or retrained 25,748 Community-Directed Distributors (CDDs) and 8,729 Community-Directed Health Supervisors (CDHSs) in 2016. The reduction of the total number of CDDs from 31,419 in 2015 to 25,748 in 2016 is an indication of progress towards interruption of transmission and a reduction in the number of foci where onchocerciasis treatment is needed.

Of those trained in 2016, 45% of the CDDs and 30% of the CDHSs were female. The current ratio of CDDs to population served is 1 CDD to 92 persons served, and the supervisor-to-CDD ratio was 1:3.

Financial Contribution: Figure U6 shows APOC (which closed in 2015), Carter Center with its major donors (LCIF, and USAID's ENVISION Project), and government (district and national) financial contributions to onchocerciasis control/elimination in areas assisted by the RBEP. Other partners contributions are not shown. Starting in 2007, The Carter Center dramatically increased its funding with the launching of the new national elimination policy. The national government contribution has been disappointing and reduced from US $51,195 in 2014 to US $7,143 in 2016.

Sustainability and Integration: The RBEP-assisted CDTI program actively co-implements with the national lymphatic filariasis elimination effort in districts with both onchocerciasis and LF. There were 1,365,651 treatments (for 90% coverage) in those districts in 2016, 15% more than in 2015.

2017 RECOMMENDATIONS FOR THE CARTER CENTER RBEP, UGANDA

Intensify training of new Community Directed Distributors (CDDs) in the Madi/Mid-North Focus.

Provide financial and administrative support for the 2017 Uganda Onchocerciasis Elimination Expert Advisory Committee (UOEEAC) meeting.

Continue to conduct, under Uganda MOH leadership, joint cross-border activities with DRC and RSS in Special Intervention Zones (SIZ), and to provide a report of such activities at the 2017 UOEEAC and program review.

Complete final post treatment surveillance (PTS) evaluations in the Kashoya-Kitomi, Wambababya and Victoria Nile foci, and report results at the 2017 UOEEAC.

Continue to publish Uganda country experience with onchocerciasis elimination.

Publish the 2016 Knowledge Attitude and Perceptions (KAP) survey conducted in three PTS foci (Kashoya-Kitomi, Mt. Elgon, and Imaramagambo). Continue to study what the CDDs in these foci are involved in now that onchocerciasis interventions were halted.

Continue feasibility pilot studies of vector control of *S. damnosum* in the Madi/Mid-North focus. Utilize findings for Dr. Tom Unnasch's vegetation clearing study to determine if communities will do this work in a sustainable way.

Continue vector control with river larviciding in Madi/Mid-North.

For 2017, the Ugandan program has selected a target ratio of 1 CDD:50 people (this is towards the ultimate radio of 1:34), 1 CS:5 CDDs and 1 CS per village.

2017 Treatment and Training Objectives:

River Blindness	
Semiannual UTG(2):	4,070,215
Passive (TX in Towns)	218,704

Training Objectives	
CDDs	39,47
CSs	9,129
HWs	186
Parish	1,237

Figure U1

Uganda's Progress towards Elimination of Onchocerciasis: 2016

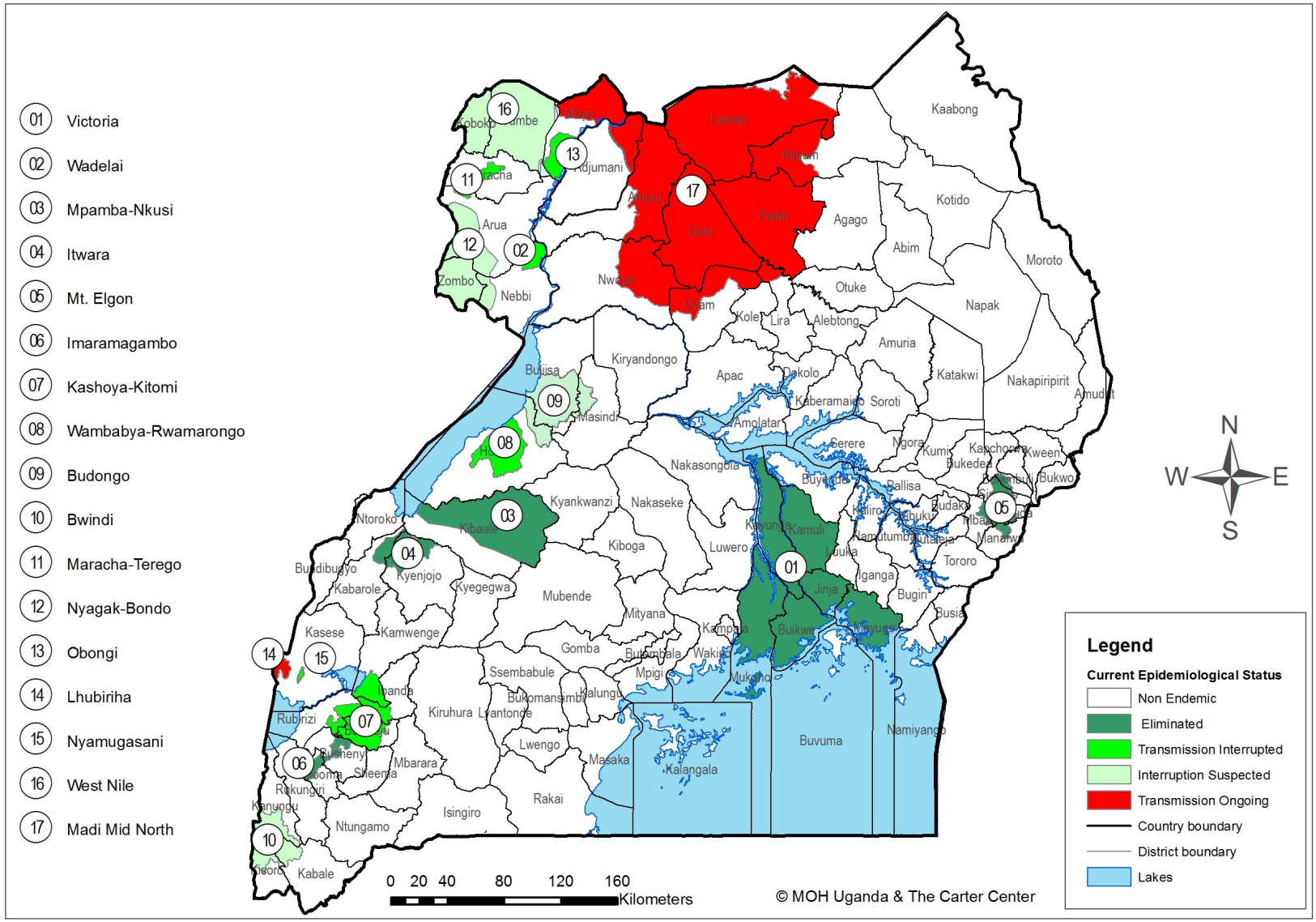


Figure U2

Foci Under Transmission Eliminated or Transmission Interrupted: Treatments Stopped (2011-2016)

Focus	District	Year Transmission Eliminated	Total Population	UTG1	UTG2	Projected Population	No. Treatments stopped	No. Communities	PTS Status
Itwara	Kabarole	2011	32,875	27,482		39,045	33,188	49	
	Kyenjojo	2011	68,398	54,837		81,235	69,050	83	
Mt. Elgon	Manafwa	2011	40,604	33,698	67,396	48,225	81,982	98	
	Mbale	2011	50,253	40,781	81,562	59,685	101,464	131	
	Sironko	2011	76,375	64,396	128,792	90,710	154,206	179	
	Bududa	2011	161,630	139,656	279,312	191,966	326,342	412	
Mpamba-Nkusi	Kibale	2012	194,045	160,062	320,124	222,671	378,541	330	
Imaramagambo	Bushenyi	2012	112,633	95,738		129,249	109,862	212	
Wadelai/*	Nebbi	2010	17,979	14,727	29,454	22,101	37,571	34	No PTS
Maracha-Terego*	Maracha-Terego	2012	120,121	108,098		137,842	117,165	307	No PTS
Kashoya-Kitomi	Buhweju	2013	60,255	49,512	99,024	66,806	113,570	97	PTS
	Rubirizi	2013	77,250	63,676	127,352	85,648	145,602	170	PTS
	Ibanda	2013	26,144	21,805	43,610	28,986	49,277	60	PTS
	Kamwenge	2013	45,626	37,173	74,346	50,586	85,997	58	PTS
Wambabya-Rwamarongo	Hoima	2013	75,733	62,654	125,308	83,967	142,743	70	PTS
Obongi / Moyo**	Moyo	2014	37,539	30,848		40,213	34,181	61	PTS
Nyamugasani	Kasese	2015	11,368	10,237		11,766	10,001	7	PTS
Total			**1,208,828**	**1,015,380**	**1,376,280**	**1,390,699**	**1,990,742**	**2,358**	

Eliminated | Transmission interrupted

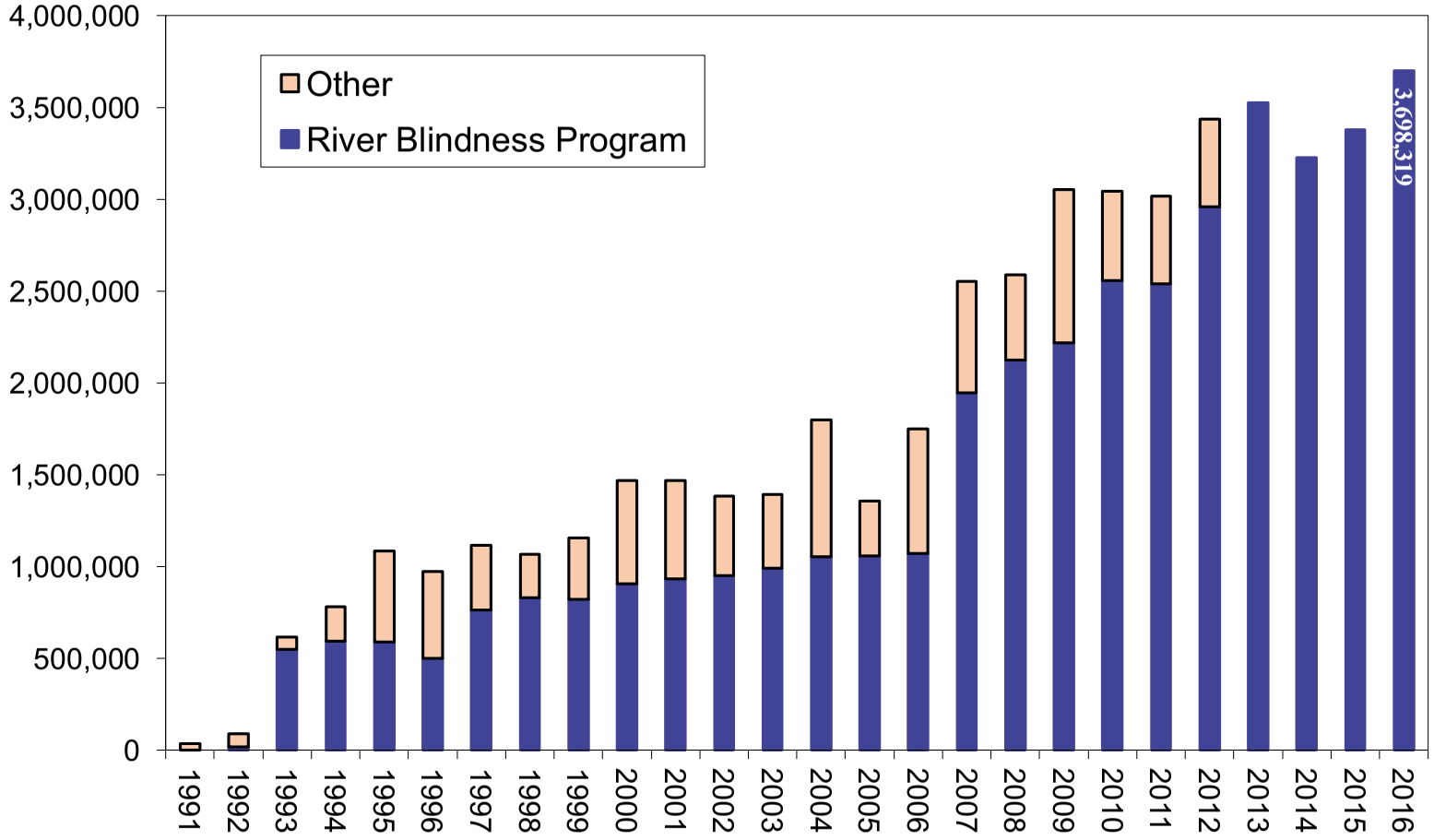
*There is no PTS in Wadelai & Maracha-Terego foci due to co-endemicity with LF

**PTS has begun in Obongi focus because LF TAS1 was conducted and passed in 2015

*** Victoria focus is not listed in the table

Figure U3

Uganda: Carter Center-Assisted Treatments and Total Mectizan® RB Treatments Provided, 1991-2016



*Treatments in 1992-1995 assisted by River Blindness Foundation.

Figure U4

Uganda - Transmission Interruption Suspected: Semiannual Treatments 2016

Focus	District	Transmission Suspected	Total Population	UTG 1	UTG 2	Population Treated		Population Treated Cumulative	% Treatment Coverage Cumulative	Active Villages UTG	LF Endemicity
						Rd1	Rd2				
Bwindi	Kabale	2013	32,313	25,748	51,456	24,401	25,301	49,702	96.6	59	No LF
	Kanungu	2013	62,297	50,440	100,880	47,797	48,652	96,449	95.6	107	No LF
	Kisoro	2013	39,829	32,122	64,244	29,705	30,628	60,333	93.9	45	No LF
Nyagak-Bondo	Nebbi	2014	137,416	112,042	224,084	110,255	103,102	213,357	95.2	168	LF
	Zombo	2014	244,755	202,106	404,212	197,121	194,423	391,544	96.9	625	LF
	Arua	2014	180,868	153,701	307,402	136,984	141,909	278,893	90.7	325	LF
Budongo (Supported by Carter Center & Sightsavers)	Hoima	2014	80,115	66,293	132,586	62,888	65,413	128,301	96.8	70	No LF
	Buliisa	2014	33,375	28,850	57,700	28,295	28,340	56,635	98.2	54	No LF
	Masindi	2014	52,428	42,855	85,710	41,743	41,234	82,977	96.8	60	No LF
West Nile	Yumbe	2013	304,070	258,459	NA	NA	NA	NA	NA	248	LF
	Koboko	2013	177251	150663	NA	NA	NA	NA	NA	394	LF
Total			**1,344,717**	**1,123,280**	**1,428,274**	**679,189**	**679,002**	**1,358,191**	**86.1**	**2,155**	

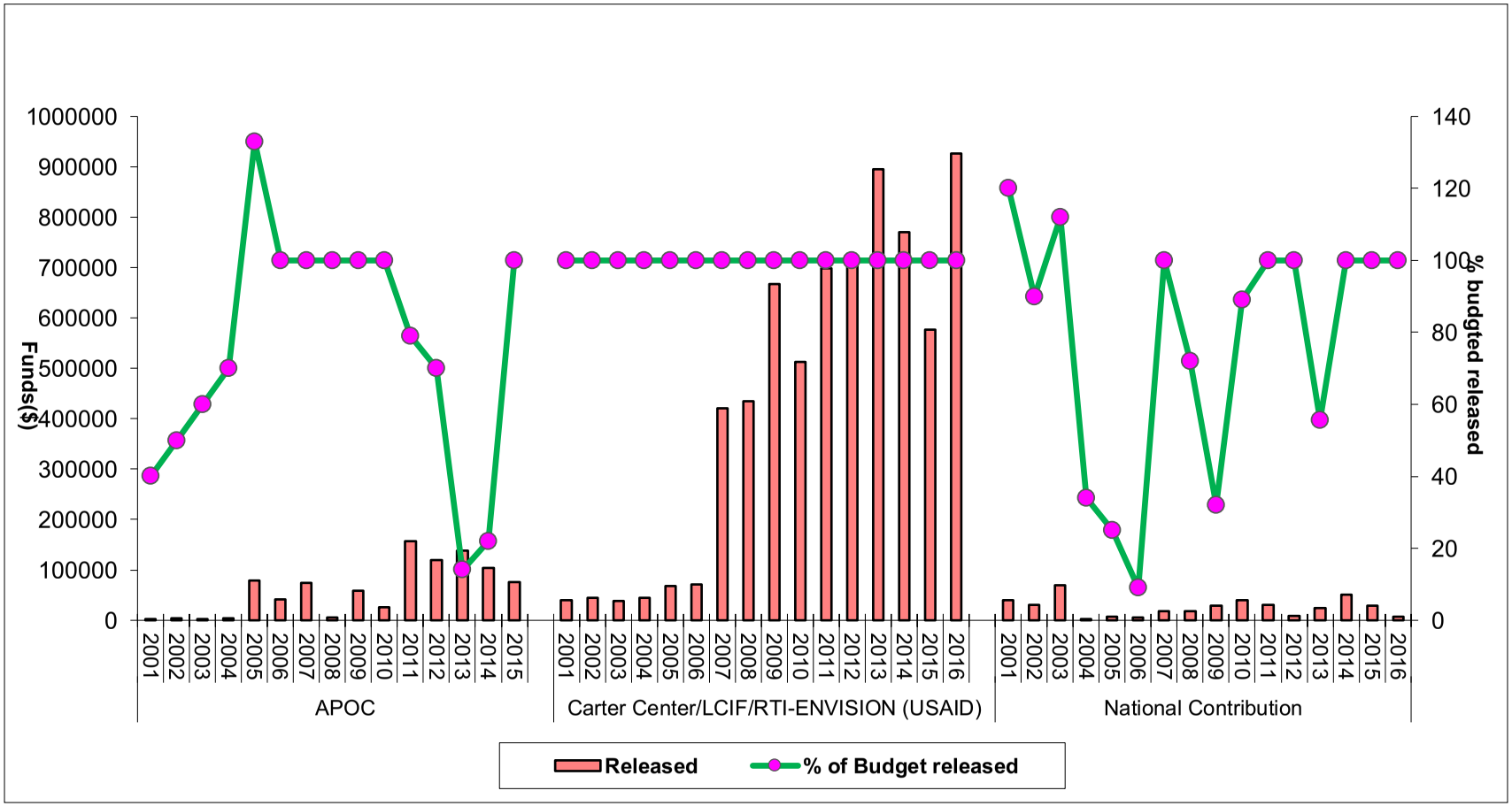
Figure U5

Uganda: Transmission Ongoing- Semiannual Treatments 2016

Focus	District	Total Population	UTG 1	UTG 2	Population Treated		Populaton Treated Cumulative	% Treatment Coverage Cumulative	Active Villages UTG	LF Endemicity
					Rd1	Rd2				
Lhubilia	Kasese	131,113	108,309	216,618	105,728	102,880	208,608	96.3	124	No LF
Madi-MidNorth	Adjumani	27,756	22,921	45,842	21,760	21,797	43,557	95.0	43	No LF
	Moyo	88,086	76,897	153,794	73,628	74,069	147,697	96.0	165	No LF
	Gulu	332,570	285,320	570,640	260,590	266,914	527,504	92.4	232	LF
	Amuru	231,476	185,440	370,880	173,181	169,863	343,044	92.5	67	LF
	Pader	189,153	162,531	325,062	143,963	148,530	292,493	90.0	617	LF
	Kitgum	104,626	87,982	175,964	81,524	84,293	165,817	94.2	234	LF
	Lamwo	148,545	125,930	251,860	105,057	114,953	220,010	87.4	427	LF
	Lira	70,981	59,588	119,176	56,009	57,103	113,112	94.9	225	No LF
	Oyam	23,147	19,830	39,660	18,625	18,969	37,594	94.8	35	LF
	Nwoya	149,467	126,965	253,930	117,997	122,695	240,692	94.8	54	No LF
Total		**1,496,920**	**1,261,713**	**2,523,426**	**1,158,062**	**1,182,066**	**2,340,128**	**92.7**	**2,223**	

Figure U6

Uganda: Financial Contributions in US Dollars (2001-2016)



The APOC and government contributions are reported by our Carter Center country representatives based on their best possible determinations from information available in country through the National Onchocerciasis Task Force and other local sources. Capital equipment replacement provided by APOC and government salaries are not considered.

SUDAN

Summary: Sudan had four known river blindness foci: Abu Hamad (River Nile state), Galabat (Gedaref state), Radom (South Darfur state), and Khor Yabus (Figure S1). In 2015, Abu Hamad focus was declared eliminated by the Federal Ministry of Health (FMOH). Galabat's transmission status was determined that same year to be interrupted. Galabat is now known to be part of the larger cross-border focus with Ethiopia known as the Galabat/Metema focus. Annual Mectizan® treatments will continue in Galabat in spite of declaring transmission interrupted, as the Metema sub-focus in Ethiopia has not satisfied WHO guidelines to stop Mass Drug Administration (MDA), as has Galabat. The civil conflict in South Darfur rendered treatments in Radom difficult, although security there is improving. Conflict in Blue Nile prevents assessment of Khor Yabus focus, where the current status of onchocerciasis is unknown. No treatments in Khor Yabus have ever been provided.

During the program review, there was discussion of a possible fifth focus in Sudan in Blue Nile State (Geissan District) bordering Ethiopia.

Background: The Republic of Sudan was the first African country to declare a nationwide onchocerciasis elimination policy, in December 2006. The RBEP has supported Sudan in this effort technically, although in recent years all programmatic support is provided by Sudan itself (an example for the rest of Africa to emulate).

In moving from a control to elimination strategy, Mectizan® treatments were increased in 2007 from annual to semiannual in order to accelerate elimination in the isolated desert focus of Abu Hamad in the River Nile state. Successful interruption of transmission was declared in Abu Hamad in 2012, when semi-annual treatment with Mectizan® ceased. A three-year Post Treatment Surveillance (PTS) was successfully completed in 2015. In October 2015, a national program review was held with the support of The Carter Center to review, in particular, the entomological and serological data collected in the Abu Hamad transmission zone. To date, Abu Hamad is the only African focus that has been eliminated under WHO guidelines and has had its findings published in the peer reviewed literature (Zarroug et al, 2016).

Semiannual treatment was launched in Galabat in the Gedaref State from 2011-2014. In 2015, assessments indicated that transmission had been interrupted and MDA could stop. However, Mectizan® treatments have been continued because the cross-border focus of Metema (in Ethiopia) has not satisfied the WHO guidelines for stopping MDA. Therefore, the Sudan FMOH has reduced treatment frequency from semi-annual to annual (Figure S2). The program is expected to halt Mectizan® treatments here as soon as the Metema region in Ethiopia is also able to do the same.

Mectizan® treatments in Radom focus of South Darfur remained a control strategy with annual treatment, but due to improved security, the program accessed more communities and treated a total of 62,587 people compared to 43,764 treated in 2015. (Figure ES3). In 2016, the program collected 3,282 blood spots for OV16 analysis in 19 communities

and a total of 2,000 *Simulium damnosum* flies, all of which are awaiting analysis in the Khartoum lab.

The recent epidemiological status of the Khor Yabus focus in Blue Nile state is still unknown. Plans to reach this area for OV16 surveys in 2016 could not be carried out due to the security situation there.

Radom and Blue Nile are on international borders. Assessments are needed there to determine if there is ongoing transmission, and if so, if these are areas where Special Intervention Zones (SIZs) need to be established with Ethiopia, South Sudan and the Central African Republic (Figure S1).

Treatments: A total of 169,657 treatments were delivered by the Sudan program in 2016 in Galabat (107,070) in one round (Figure S2) and Radom (62,587) in one round (Figure S3). Due to civil conflict, a proper census of the affected population in Radom has not been performed to date, so an ultimate treatment goal cannot be determined. Accordingly, an annual treatment objective (ATO) based on the Mectizan® drug order request is used as the denominator.

Training and Health Education: During 2016, the program trained a total of 100 community-directed distributors (CDDs) of whom 100% were male. The trained CDDs were from the Galabat focus (Figure S4).

Mectizan®: During 2016, 403,000 tablets were distributed in the Galabat and Radom foci with an average of 2.1 tablets per person. No severe adverse effects were reported. The program began in 2016 with a balance of 403,000 tablets.

Sustainability and Integration: Since 2007 the program has involved kinship/family groups in all foci in mobilization and health education, selection and training of CDDs, and distribution of Mectizan®. This policy has improved training figures and has reportedly also reduced demand for monetary incentives.

2017 RECOMMENDATIONS FOR THE CARTER CENTER RBEP, SUDAN

Galabat Focus in Gedaref State

Continue treatments in the cross-border Special Intervention Zone (SIZ) with North Gondar until completion of the Ethiopian entomological and epidemiological surveys.

Encourage publication of experience of bi-national collaboration in assessment of cross-border focus.

Blue Nile State and Radom in South Darfur State

Continue annual treatment in Radom as security allows.

As security allows, conduct baseline serological (OV 16) surveys in Khor Yabus and Geissan (adjacent to Asossa and Metekel in Ethiopia) to establish if transmission is occurring there. Priority should be given to assessments in Khor Yabus since this is a known focus in Sudan.

If Khor Yabus and/or Geissan are shown to be endemic for onchocerciasis, then consideration should be given to whether a SIZ is needed between Sudan, Ethiopia and South Sudan. This decision should involve discussions with Carter Center HQ.

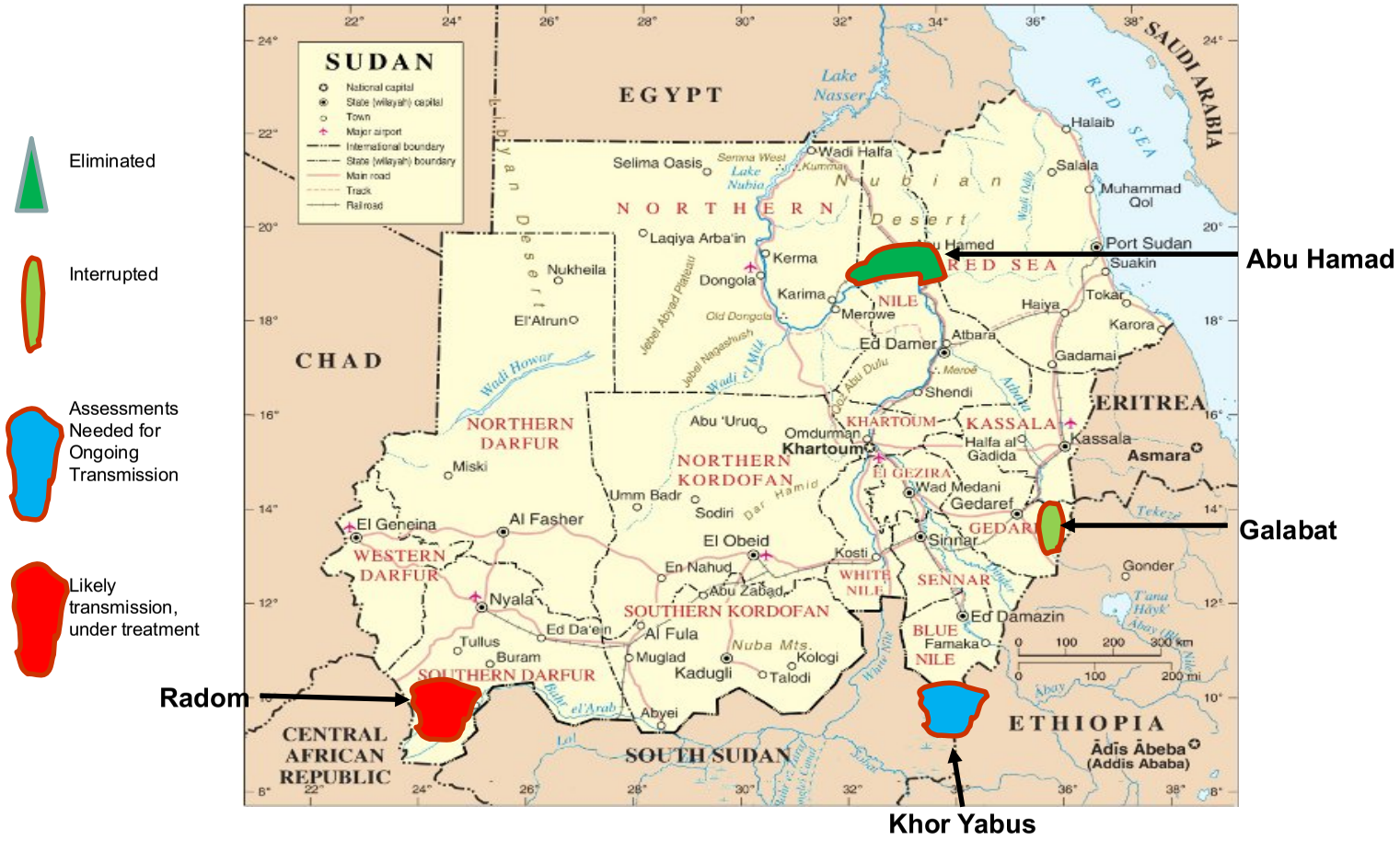
2017 Treatment and Training Objectives:

River Blindness	
Annual UTG	62,576
Semiannual UTG(2):	246,180

Training Objectives	
CDDs	3,088
CSs	309

Figure S1

Map of Sudan Onchocerciasis Program Areas

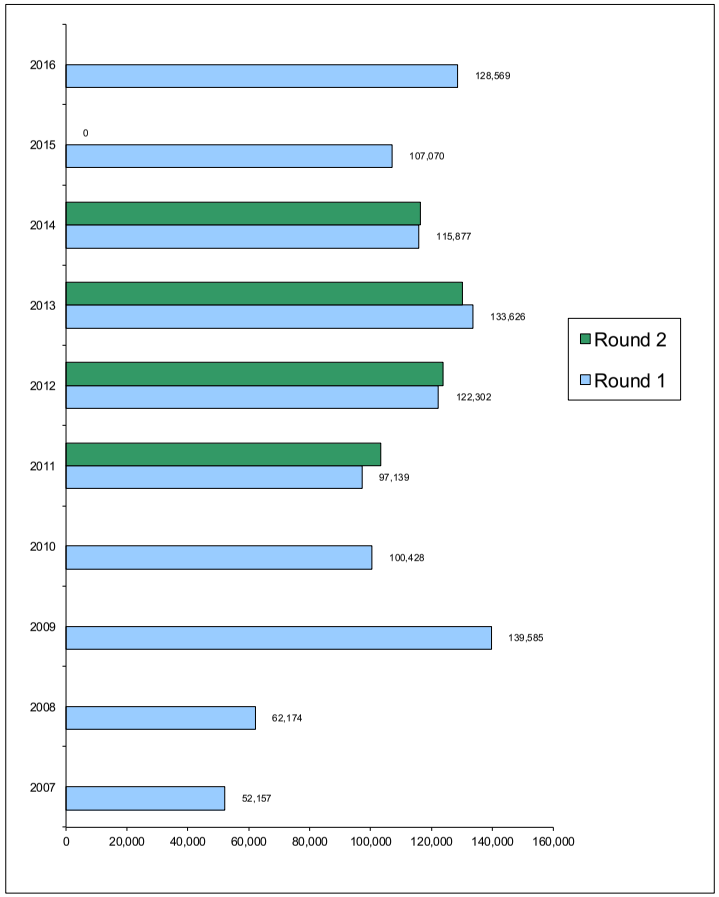


Note: Galabat has cross border transmission with Ethiopia. Status in previously recognized Foci of Radom and Khor Yabus is unknown at this time.

Figure S2

Galabat Treatments

Number of Treatments



% UTG Coverage

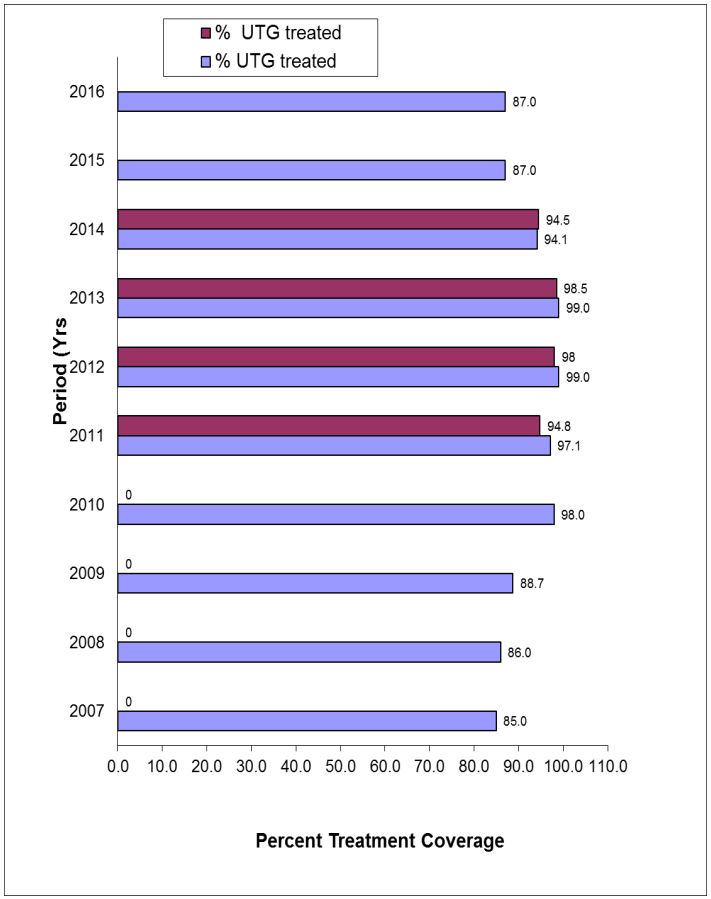


Figure S3

Radom Treatments

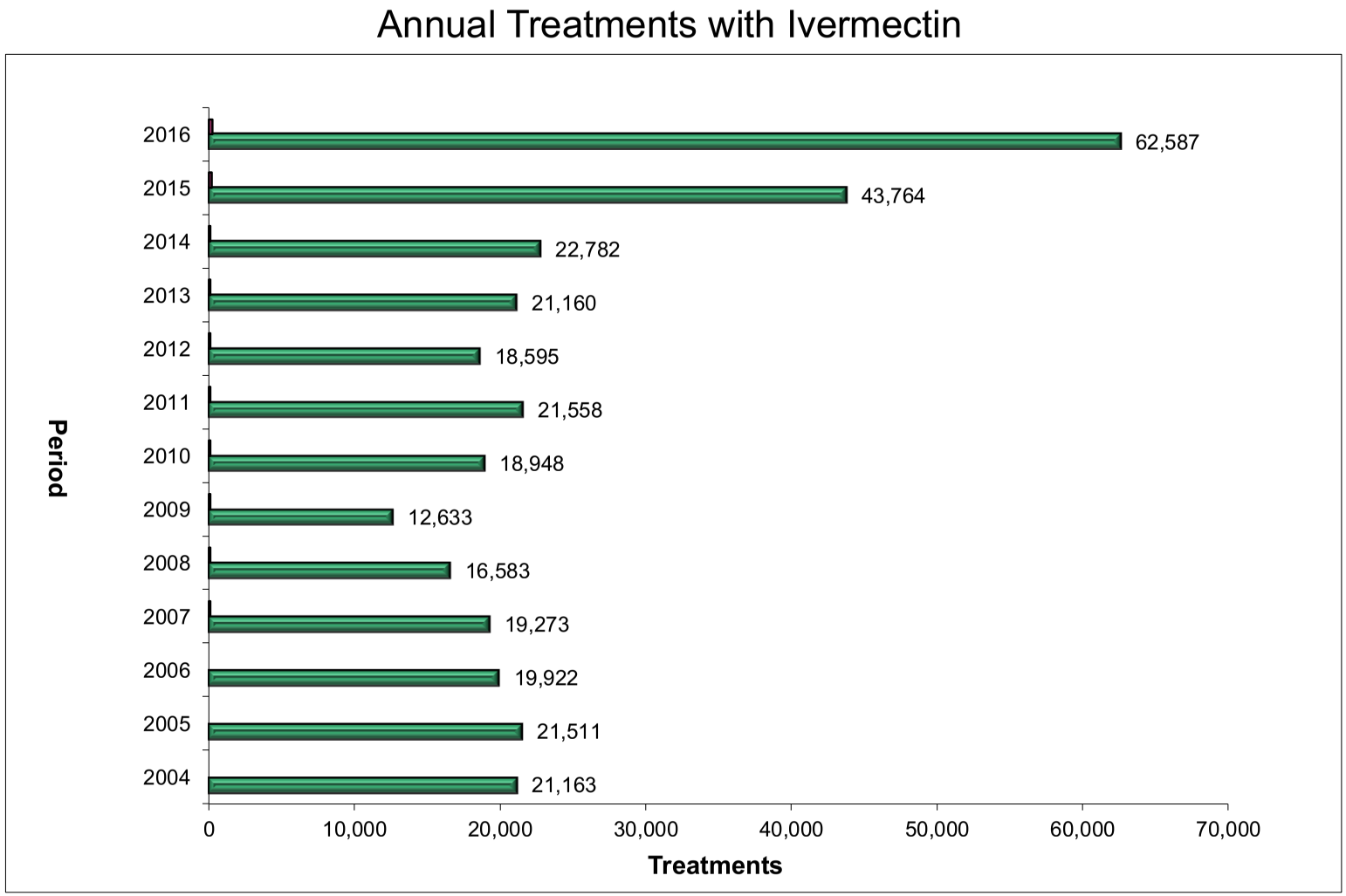


Figure S4

Number of CDDs Trained in Galabat and Radom Foci by Gender 2012 - 2016

Area	2013					2014					2015					**2016**				
	Total CDDs	Male CDDs	% Male	Female CDDs	% Female	Total CDDs	Male CDDs	% Male	Female CDDs	% Female	Total CDDs	Male CDDs	% Male	Female CDDs	% Female	Total CDDs	Male CDDs	% Male	Female CDDs	% Female
Galabat	**824**	510	61.89	314	38.11	**859**	528	61.47	331	38.53	**876**	539	61.53	337	38.47	**964**	593	61.53	371	38.47
Gorisha	**319**	170	53.29	149	46.71	**335**	176	52.54	159	47.46	**343**	180	52.48	163	47.52	**377**	198	52.48	179	47.52
Radom	**100**	100	0.00	0	0.00	**100**	100	100	0	0.00	**100**	100	100	0	0.00	**100**	100	100.00	0	0.00

NIGERIA

Summary: The River Blindness Elimination Program (RBEP) seeks to interrupt transmission of onchocerciasis in the nine states it assists in Nigeria (Abia, Anambra, Delta, Ebonyi, Edo, Enugu, Imo, Nasarawa, and Plateau) (Figure N1) by 2022, in accord with the Federal Ministry of Health's new plan for onchocerciasis elimination. In 2016, 18,691,783 Mectizan® mass treatments (with health education) for onchocerciasis were distributed (Figures N2 – N3) with assistance from The Carter Center (TCC). This was approximately 50% of all RB treatments in Nigeria (N4). The total includes 1,467,428 treatments (7%) given on the twice-per-year schedule in the special intervention zone of Edo state's border with Ondo; the first place that twice-per-year MDA for RB has been used programmatically in Nigeria. Twice per year treatment began in Edo in 2015.

The Carter Center and its ministry of health partners successfully interrupted lymphatic filariasis (LF) transmission in Plateau and Nasarawa in 2012 with MDA/health education and long lasting insecticidal bed nets (LLIN). In 2013 the two states stopped nearly four million albendazole-Mectizan® treatments (Figure N4). The seven southern RBEP assisted states launched their own LF programs in 2014, and quickly scaled up treatments (Figures N4 - N6). In the south, the Nigeria program also pioneered twice-per-year MDA (using albendazole alone) for LF in the country, starting with Imo state in 2015 and expanding to six of the seven states in 2016 (Figure N6). TCC's LF program saw 22,421,697 LF treatments in 2016, about a third of the total for the whole country.

The Carter Center has also been a leader in developing coordinated LF and malaria activities. In 2013 the Federal Ministry of Health adopted this as national policy and published the guidelines for coimplementation, with Carter-Center assistance. We continue to advocate for this coimplementation approach in areas where we work.

In 2016 TCC assisted in providing 4,007,831 praziquantel treatments with health education for schistosomiasis in the nine states we assist in Nigeria (Figure N7). The oscillation of treatments is due to the WHO recommended alternating year treatment strategy in many Local Government Areas (LGAs) (Figure 8). This was about 43% of all schistosomiasis treatments given throughout Nigeria.

The Carter Center further expanded treatments for soil-transmitted helminths (STH) to 8,922,891 in 2016. Of these, 1,703,087 (19%) were twice-per-year treatments. This builds on major increases that began in 2014, when the seven southern states[1] began treatment for STH with mebendazole and albendazole (Figures N9 - N11).

The 2016 activities in Nigeria are thanks in large part to TCC's partnership with USAID's ENVISION project, led by RTI International, along with other key partners, such as the Sir Emeka Offor Foundation, the Margaret A. Cargill Foundation, and the Izumi Foundation. Of course, these programs would not be possible without donated products and coordination from many different partners (including Merck, GSK, The Task Force for

[1] Abia, Anambra, Delta, Ebonyi, Edo, Enugu, and Imo are collectively referred to in this document as 'southeast.'

Global Health, Merck KGaA (E-Merck), the World Health Organization, Johnson & Johnson, and Clarke Mosquito Company).

River Blindness in Nigeria

***Background*:** Nigeria is home to about 40% of the global population at risk for onchocerciasis, making it the most endemic country in the world. The country's onchocerciasis program is the largest Mectizan® distribution program globally, and reported record (provisional) treatments in 2016 of over 48 million (Figure N3). In 2013, the Federal Ministry of Health (FMOH) of Nigeria released a new master plan for neglected tropical diseases (NTDs) that articulated a new national policy of onchocerciasis elimination. New guidelines were issued by the Nigeria National Onchocerciasis Elimination Committee (NOEC) in 2017. The Carter Center supports the NOEC meetings.

The RBEP in Nigeria is headquartered in Jos, Plateau state, with supporting sub-offices in Benin City, Enugu, Lagos, and Owerri. Active in nine states (Figure N1) since 1996, the TCC RBEP enjoyed LCIF support from 1999 to 2008, and core APOC support from 2000 to 2005. It currently receives funding from the Margaret A. Cargill Foundation and USAID's ENVISION project, led by RTI International.

Treatments: In 2016, the TCC-assisted RBEP program in Nigeria provided health education and Mectizan® treatments to nearly 18 million people (Figures N2 and N3), for 93% of the treatment target. No severe adverse events (SAEs) were reported following Mectizan® treatments in RBEP-assisted states in Nigeria in 2016. Particularly close monitoring for adverse reactions is carried out in the south because of the presence of *Loa loa* in that part of the country. *Loa loa* parasites release large numbers of microfilariae into the blood stream and death of these microfilariae after treatment with Mectizan® can, in rare cases, provoke severe adverse central nervous system events (CNS SAEs). Globally, almost all Loa associated CNS SAEs have occurred in Cameroon and DRC; only one has been reported in Nigeria where Mectizan treatment has been ongoing in Loa endemic areas since 1993.

TCC-assisted treatments for LF, schistosomiasis, and STH are discussed in the Integrated Programs sections below.

Training and Health Education: In the nine states assisted by TCC there were 74,748 professional and lay health personnel involved in Mectizan® distribution in 2016: 66,889 CDDs and 7,859 community supervisors. The ratio of CDDs to persons served increased in 2016 to an average 559 to 1 (the RBEP goal is to have one CDD per 100 persons). Just under half (49.1%) of CDDs were female. One community supervisor managed about nine CDDs, up slightly from six in 2015. The program is working to boost CDD participation and retention.

Financial Contributions: For the past three years, major funding from USAID's ENVISION project, led by RTI International, has led to a marked increase in treatments, particularly for LF and STH. Financial contributions to the integrated programs are

discussed in more detail in their sections below. Unfortunately, the Nigeria RBEP-assisted areas have had chronically insufficient government contributions to the programs at national, state, and local levels (Figure N12).

The Integrated Programs in Nigeria

Background: TCC-assisted programs in Nigeria pioneered the concept of using the RB mass treatment logistical system to 'piggy-back' launching of LF elimination and SCH control activities by sharing costs and infrastructure across several programs (Hopkins 2001). The integrated RB program began in 1999 with onchocerciasis and urinary schistosomiasis interventions, expanding to include LF in 2000, trachoma in 2001, malaria in 2003, and STH in 2014. Background information on LF, SCH and STH is provided in Annexes 7 and 8. Our studies on integration showed it offered broader services with lower costs and higher efficiency among disease programs that use similar community-based strategies. The Carter Center also pioneered 'triple drug administration' (TDA)--simultaneous administration of ivermectin, albendazole, and praziquantel--demonstrating that TDA is safe, feasible, and gave enormous savings (40%) compared with giving two separate treatment rounds (ivermectin and albendazole separated from praziquantel) (Eigege et al. 2013, Evans et al. 2011).

Lymphatic Filariasis: The goal of the LF program is to interrupt LF transmission with MDA/health education, and distribution and use of LLIN. The TCC LF program in Plateau and Nasarawa was the first to be launched in Nigeria, in 2000. An in-depth history of the TCC effort in those states was published by Richards et al. (2011). When the program began, LF was widespread in Plateau and Nasarawa states, and mass treatment and health education was required in all cities and villages in the 30 LGAs of the two states. MDA started in 2000 and achieved scale in 2003. In 2008, a survey for LF prevalence demonstrated that 10 of the 30 LGAs had achieved the elimination threshold (based on LF antigenemia prevalence) (King et al. 2012). In surveys conducted in 2012 (Eigege et al. 2017) using the newly released WHO Transmission Assessment Survey (TAS) it was determined that MDA for LF could be stopped throughout both states, and approximately 4 million treatments were halted at the end of 2012. Entomological assessments demonstrated that transmission was halted when LLIN were distributed (Eigege et al. 2013). All the 30 LGAs entered a period of post-treatment surveillance (PTS), beginning in 2013. In 2014 and 2016, PTS TAS surveys confirmed that transmission remained interrupted in four LGAs that stopped LF MDA in 2010, while TAS surveys conducted in 2015 confirmed transmission interruption in the other 26 LGAs three years after halting MDA. Final "TAS-3" surveys are planned for 2017 in the 26 LGAs to confirm elimination of LF across Plateau and Nasarawa.

In the seven TCC-assisted states in the southeast, LF MDA was launched in 2014 with support from USAID's ENVISION project, led by RTI International. Following the 'piggy-back' approach, the program began in LGAs with an existing river blindness program (Figure N4). It has grown rapidly to reach 22,326,437 treatments in 2016, expanding into LGAs without river blindness. A particular challenge to this expansion has been the current WHO strategy for LF programs in *Loa loa* areas (which includes southeast)

Nigeria that avoids the use of Mectizan® due to its associated risk of CNS SAEs. The WHO strategy calls for once, but preferably twice, per-year MDA with albendazole alone, together with LLINs. The FMOH and Carter Center began to target twice-per-year albendazole-only treatments in these areas in 2015, but late drug arrival precluded the second round. However, in 2016 the program successfully delivered about 9 million twice-per-year treatments to over 4 million people. After two years of the provisional albendazole-alone monotherapy (together with LLIN) due to *Loa loa* concerns, The Carter Center, in partnership with the Federal and local governments of Nigeria, conducted a large survey in 2016 and determined that levels of *Loa loa* were not sufficient in our supported areas to preclude Mectizan treatment. After our results were reviewed by the Mectizan Expert Committee (MEC), we were given approval by the FMOH and the MEC to begin supporting annual ivermectin and albendazole for LF throughout the Carter Center assisted states, and do away with the more expensive twice per year albendazole-only approach. A publication on this work is in preparation.

Fighting Malaria and Lymphatic Filariasis with LLINs: In Nigeria, LF is transmitted by the same mosquitoes that transmit malaria (*Anopheles gambiae* and *An funestus*). LLINs, one of the most important prevention tools for malaria, have been shown to also be useful as an adjunct to MDA in the LF elimination program. Between 2009 and 2013, all nine TCC-supported states received LLINs as part of the nationwide mass distribution of nets that aimed to provide two nets to every household. TCC has assisted with the distribution of 11.5 million LLINs in Nigeria since 2004.

In Plateau and Nasarawa, rates of LF-infected mosquitoes have been determined by dissection since the launching of the program (Richards et al., 2011). By the end of 2011, the year after mass LLIN distribution—the number of infected mosquitoes fell to 0% for the first time ever (Eigege et al., 2013). It is very likely that the effect of the LLINs was synergistic with MDA and helped to interrupt LF transmission completely. Additional results from a Bill and Melinda Gates Foundation funded TCC study in two states in the southeast (Imo and Ebonyi) showed that even in the absence of MDA, LLIN could interrupt LF transmission if used for sufficient time (Richards et al., 2013). A project in Kanke LGA Plateau State launched in 2013 with support from GSK demonstrated that using CDDs to distrute LLINs coupled with regular education and monitoring increased both LLIN ownership (currently defined by FMOH as access to at least one net per two household residents) from 57.6% to 69.0% between 2012 and 2015, and net use from 68.3% to 79.2% over the same period, including surpassing the ministry target of 80% use among children under five years (83.6%) and pregnant women (88.6%) in 2015.

Preliminary results were presented from a malaria indicator survey (MIS) that was conducted in 2015 in Abia and Plateau states to evaluate the impact of mass net distribution since 2010. LLIN ownership ($\geq$1 net per 2 persons) increased significantly in both states: in Abia from 1.4% in 2010 to 37.3% in 2015 ($p<0.001$) and in Plateau from 6.3% to 50.0% ($p<0.001$). However, coverage in both states remains below the national target of 80%. Reported net use the previous night in all individuals increased significantly in Abia from 3.4% to 24.2% ($p<0.001$) and in Plateau from 14.7% to 65.6% ($p<0.001$). Net use in children under 5 and pregnant women was 3-4 times higher in 2015 compared

to 2010, but failed to reach the 80% goal in either state. Age-adjusted microscopy-diagnosed Plasmodium prevalence significantly decreased in Abia from 36.1% (95% CI: 32.3-40.1) in 2010 to 26.4% (95% CI: 20.1-31.5) in 2015. In Plateau, a non-significant increase from 36.6% (95% CI: 31.3-42.3) to 43.4% (95% CI: 39.9-46.9) occurred. Over the same period, anemia in children 10 years and younger also significantly declined in Abia from 74.7% (95% CI: 72.1-81.0) to 58.3% (95% CI: 53.9-62.6), with a non-significant reduction observed in Plateau from 57.1% (95% CI: 50.6-63.4) to 52.5% (95% CI: 44.6-60.2).

Schistosomiasis/STH Control: The SCH program launched in Plateau and Nasarawa states in 1999 with a focus on *Schistosoma haematobium* infections (see Annex 8). The program initally remained limited for a number of factors, most importantly the lack of donated praziquantel (Richards at al. 2006, Gutman et al 2008, Gutman et al 2009). With the advent in 2008 of donation of praziquantel through the World Health Organization (WHO) by Merck KGaA (E-Merck), Germany, and new support from USAID's ENVISION project, led by RTI International, and the Izumi Foundation, SCH/STH treatments have been able to expand to all endemic areas in the nine states we assist (Figure N7). In 2016, we assisted in providing 4,007,831 praziquantel treatments (Figures N7 and N8). Double (Mectizan and praziquantel, mebendazole and praziquantel, or albendazole and praziquantel) or triple (ivermectin, albendazole and praziquantel) drug administration is used wherever RB and LF MDA programs are also active, but only after one round of stand-alone treatment (i.e., drug administration staggered by at least two weeks) has occurred.

In accordance with WHO guidelines and the FMOH's direction, adults and children were treated for schistosomiasis in LGAs that had average prevalence of greater than 50%, and school-aged children alone were treated where LGA prevalence exceeded 10%. Areas where prevalence is lower than 10% do not receive every year. In Plateau and Nasarawa states, where average LGA schistosomiasis prevalence did not exceed 50%, treatment was offered to all school-aged children.

Again, in accordance with WHO guidelines, only school children are targeted for STH treatment in all nine TCC-assisted states. Treatments occur twice-per-year in the most highly endemic areas (Figures N9 and N10). In 2016, 8,922,891 million treatments were given. Of these, 1,703,087 (19%) were given on the semi-annual scheme.

In Plateau and Nasarawa, where LF MDA has halted, and the schistosomiasis/STH program is only targeting school-aged children, our efforts are shifting from the community-based LF-CDD model toward a new school-based model. The implications of the transition from the Ministry of Health toward the Ministry of Education are being studied.

2017 RECOMMENDATIONS FOR THE CARTER CENTER RBEP, NIGERIA

Overarching for the three programs:
Establish specialized teams to undertake rolling treatment coverage surveys, in close consultation with headquarters. These teams should verify that the "community census" is complete of all existing communities in the Southeast states we support.

Launch the Jos lab's service as one of the national NTD support labs of Nigeria.

Whenever possible, we should have purposeful sampling in sentinel villages (as appropriate) in any population-based survey activities of LF, RB, SCH, and STH.

Continue providing awards in each state to the best CDD, village leader and community supervisor.

Conduct a CDD attrition study to determine causes and how large a role is played by the complicated forms that now must be filled.

Improve community mobilization so that communities support CDDs. Improve CDD numbers.

Instate the data quality committees in each state and at Jos headquarters to improve data management.

Lymphatic Filariasis/Malaria:
LF Malaria FMOH guidelines: Work to scale up and operationalize these guidelines in TCC assisted areas, especially with regard to LLIN use, care, and resupply.

Expand behavior change communications (BCC) for bednets that include LF prevention messages into additional LGAs in Southeast Nigeria.

Papers to be published: 1) CDD net monitoring from Kanke LGA; 2) the 2015 malaria indicator survey in Plateau and Abia; and 3) the post MDA LF TAS surveys in Plateau and Nasarawa.

Complete the analysis of specimens (Wb123 and Ov-16) from the research, funded by Task Force for Global Health, on post MDA surveillance in suspected LF transmission hotspots. Based on the epidemiological findings of hot spots, follow-up with entomological and epidemiological assessments as indicated.

Continue entomological collections in LF sentinel villages, but store (rather than dissect) specimens for later molecular testing for kdr genes.

As a result of the study that showed no high-density *Loa loa* microfilaremia (despite high RAPLOA findings) switch LF MDA strategy in SE Nigeria from guidelines recommended for *L. loa* areas (twice- per- year albendazole monotherapy) to once per year ivermectin

and albendazole. Publish findings of the study in peer reviewed literature.

Establish LF sentinel village activities in the Southeast.

Conduct TAS3 in 26 LGAs in Plateau and Nasarawa.

Pre-TAS studies should use only filarial antigen testing, not nocturnal microfilaremia testing.

Onchocerciasis:
Provide financial and administrative support for the 2017 NOEC meeting.

Complete surveys and lab work [being conducted under the new guidelines of the Nigeria National Onchocerciasis Elimination Committee (NOEC)] needed for halting MDA for RB in Plateau and Nasarawa states. Have some results available in time for the December 2017 NOEC meeting so that a decision to halt MDA in 2018 might be made.

Sign an agreement with SightSavers to analyze their samples for stop MDA surveys in Kaduna (a Special Intervention Zone (SIZ) state bordering TCC assisted states of Plateau and Nasarawa). Also assist SightSavers in analyzing samples from other states they assist, but these with lesser priority than Kaduna.

Expand twice-per-year treatment (obtaining good coverage in all rounds) in southeast/south-south assisted areas, wherever drugs are being made available by FMOH.

Encourage FMOH, WHO, and partner NGDOs to consider state cross-border foci as SIZs. One of these is the Edo-Ondo SIZ, where we will work in collaboration with MITOSATH and surveyed treatment coverage in 2016 has been very poor. A KAP survey should be conducted in the Edo/Ondo border LGAs to learn more to improve treatment coverage, and to enable the TCC team to understand the cultural differences and their influence on disease and health-seeking behaviors.

Monitor onchocerciasis sentinel village activities in the Southeast, and continue to collect and test vector flies.

Assess the remaining (few) hypoendemic onchocerciasis local government areas in Southeast that are not yet slated for ivermectin treatment either for RB or LF.

Expand the use of black fly traps in selected fly collection sites. In consultation with HQ, calibrate black fly collection on traps with nearby collections on human attractants.

Schistosomiasis (SCH) and soil transmitted helminthiasis (STH):
Consider publication of the analysis of maximum values versus averages for STH and schistosomiasis based on the FMOH approved final data set from the 2014 USAID supported integrated mapping for schistosomiasis, STH, trachoma, and *Loa loa* in TCC-assisted states.

Compare and publish the costs and effectiveness of three treatment approaches to reach school aged children: 1) teacher MDA, 2) CDD MDA and 3) combination MDA (teacher and CDD).

Improve training of teachers and track teachers who have been trained (attrition).

Conduct community mobilization and health education to mitigate fear of adverse events that led some schools to reject schistosomiasis and STH treatments.

2017 Treatment and Training Objectives: NIGERIA

River Blindness	
Annual UTG:	17,044,621
Semiannual UTG:	14,637,351

Lymphatic Filariasis	
Annual UTG:	19,634,468

Soil-Transmitted Helminths:	
Annual UTG:	9,338,404
Semiannual UTG:	2,155,193

Schistosomiasis:	
Annual UTG:	2,599,967

Training Objectives:	
CDDs:	66,408
CSs:	13,644
Teachers:	11,195

Figure N1

Nigeria: Carter Center-Assisted States

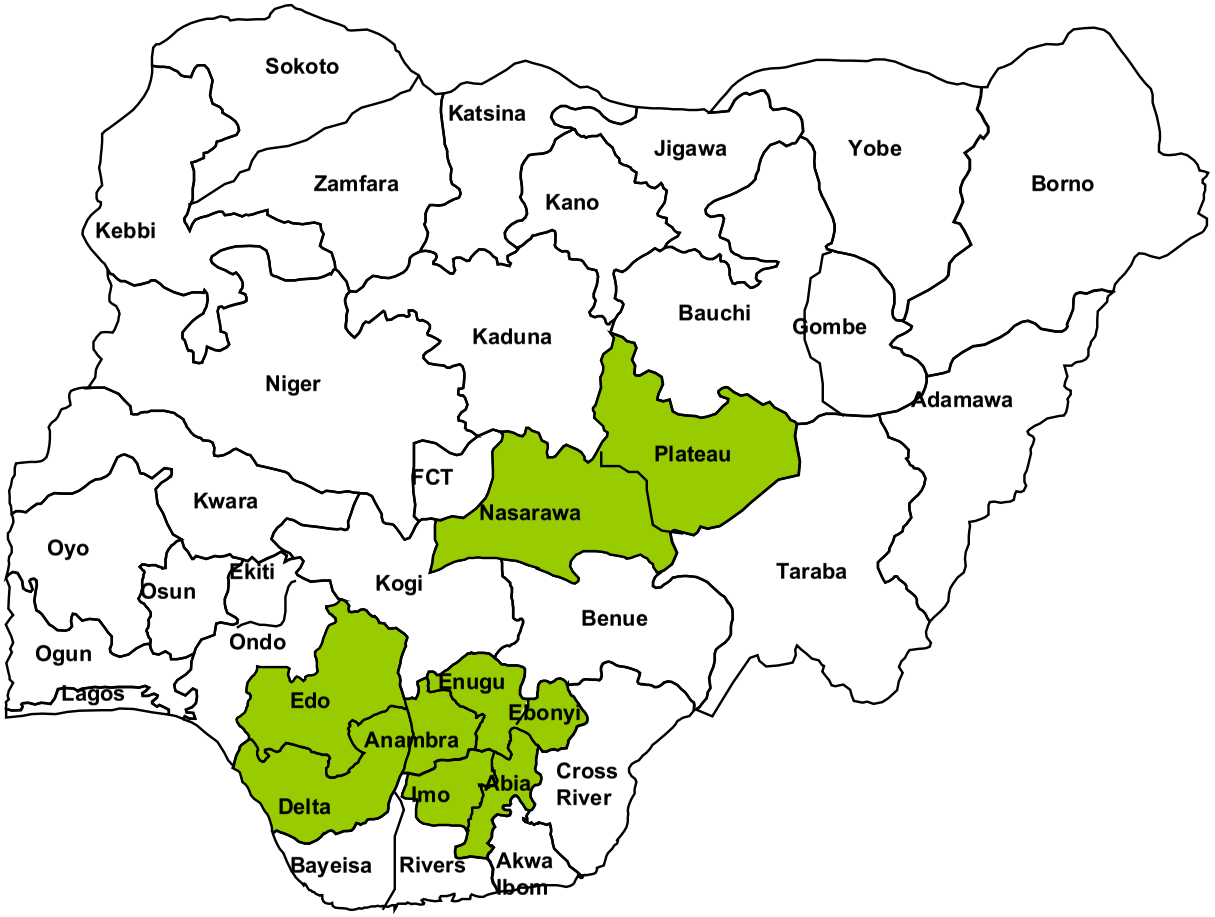


Figure N2

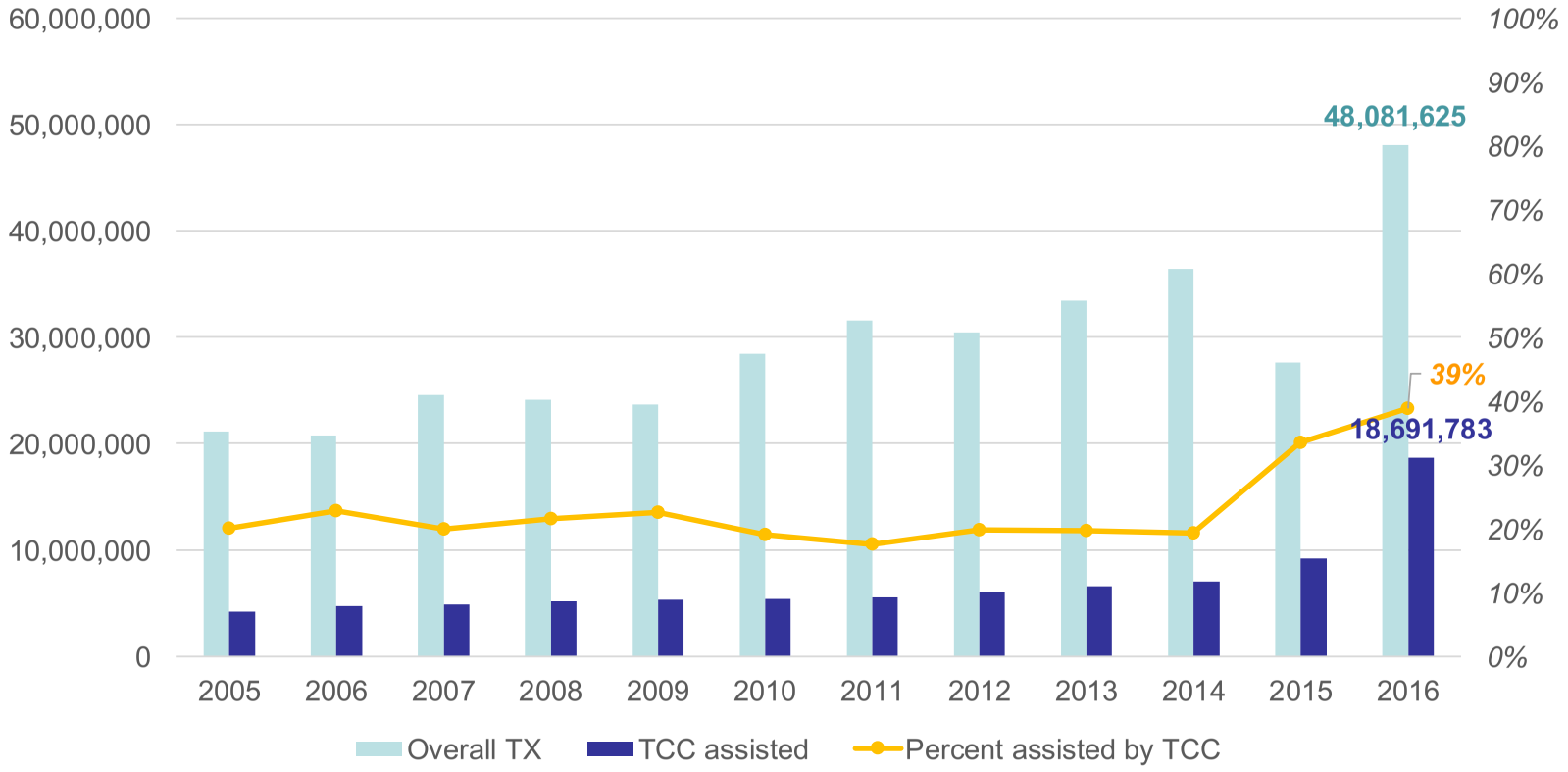
Nigeria: Carter Center-Assisted Areas
2016 River Blindness Treatments

State	Total Popn.	Ultimate TX Goal (UTG)	Popn. Treated	% of Popn. Treated	% of UTG Treated	Villages Treated	Villages UTG	% Villages Covered
Enugu	4,169,617	*3,335,693*	3,018,927	61%	91%	4,634	4,634	100%
Anambra	4,323,872	*3,459,096*	3,414,823	72%	99%	1,674	1,717	97%
Ebonyi	2,135,653	*1,708,523*	1,681,362	61%	98%	1,904	2,061	92%
Edo	1,137,804	*1,950,590*	1,666,669	81%	85%	749	833	90%
Delta	1,573,699	*1,258,958*	1,156,583	73%	92%	885	885	100%
Imo	3,541,001	*2,832,799*	2,634,580	73%	93%	3,372	3,646	92%
Abia	2,328,435	*1,862,748*	1,737,319	74%	93%	2,657	2,829	94%
Plateau	1,046,869	*837,495*	793,787	75.8%	95%	559	573	97.6%
Nasarawa	1,507,868	*1,206,296*	1,120,305	74.3%	93%	581	590	98.5%
TOTAL	**21,764,818**	**18,452,198**	**18,691,783***	**85%**	**92%**	**17,015**	**17,768**	**96%**

** Table does not include 1,467,428 semi-annual treatments given in Edo state (83% of the goal).*

Figure N3

Nigeria: Carter Center-Assisted Treatments and Total Mectizan® Treatments Provided 1992-2016*



* Treatments in TCC areas from 1992-1995 were assisted by RBF. The 2016 national figure is provisional.

Figure N4

Nigeria: Carter Center-Assisted Lymphatic Filariasis Treatments (with Mectizan® and Albendazole) 2000-2016, and 2017 Target

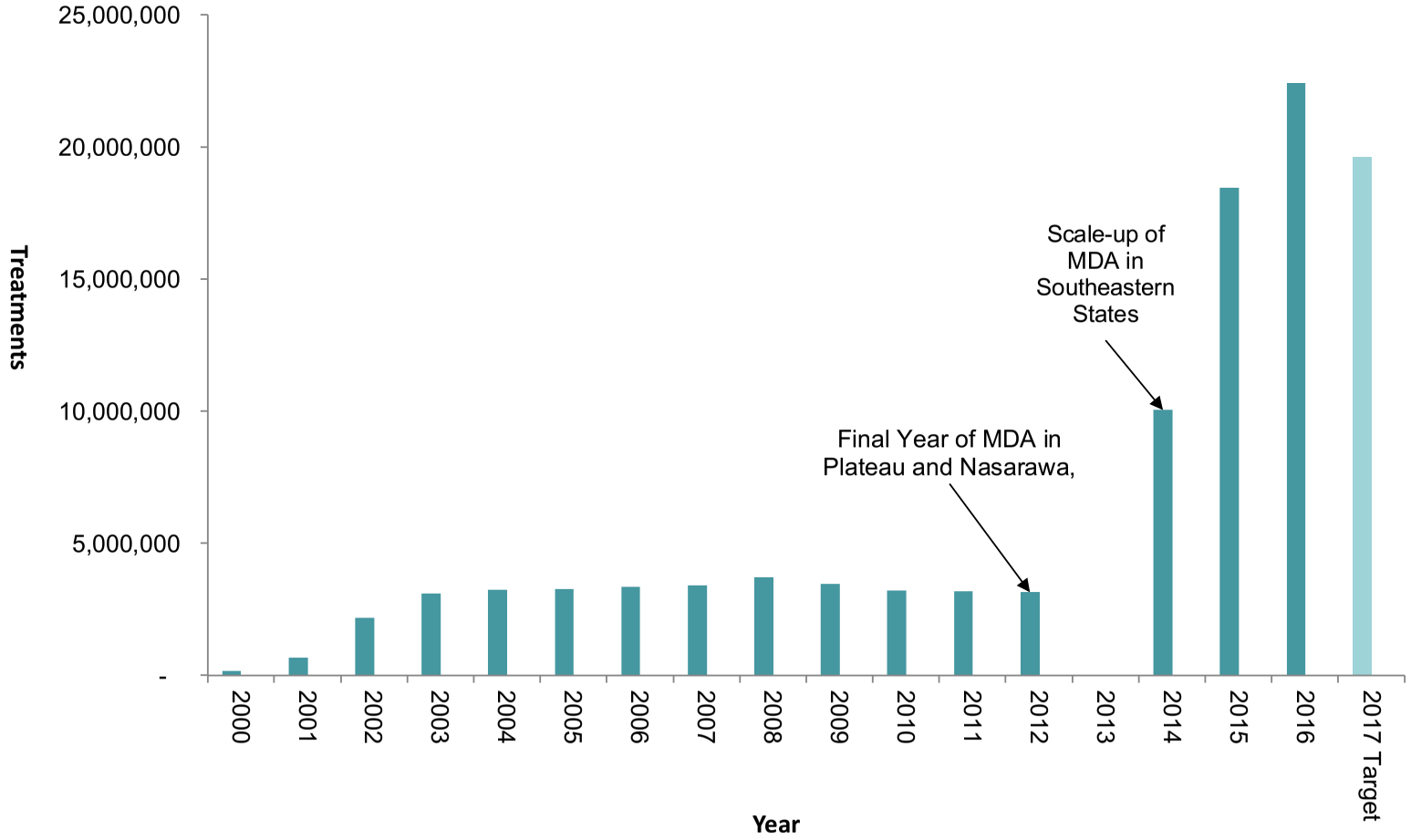


Figure N5

Nigeria: Carter Center-Assisted Areas
2016 Annual Lymphatic Filariasis Treatments

State	Total Popn	UTG	Popn Treated	Total Popn TX %	Popn TX % of UTG	Villages Treated	Villages UTG	% of Villages Covered
Enugu	3,507,000	2,805,603	2,594,776	74%	92%	3,960	3960	100%
Anambra	4,323,873	3,459,096	3,414,823	79%	99%	2,680	2680	100%
Ebonyi	1,507,193	1,205,755	1,186,433	79%	98%	1,507	1507	100%
Edo	1,326,842	1,061,474	892,854	67%	84%	1120	1120	100%
Delta	1,191,045	952,836	885,618	74%	93%	752	752	100%
Imo	3,541,001	2,832,799	2,634,580	74%	93%	3,646	3646	100%
Abia	2,328,435	1,862,747	1,737,319	75%	93%	2,829	2829	100%
TOTAL	**17,725,389**	**14,180,310**	**13,346,403**	**75%**	**94%**	**16,521**	**16,494**	**100%**

Figure N6

Nigeria: Carter Center-Assisted Areas
2016 Semi-Annual Lymphatic Filariasis Treatments

State	Popn Treated R1	Popn Treated R2	Popn Treated (R1+R2)	UTG(1)	UTG(2) (R1+R2)	% UTG(1) Treated	% UTG(2) Treated	Total Popn	% total popn Treated R1	% total popn Treated R2	Villages R1	Villages R2	Villages UTG	Vill. % UTG R1	Vill. % UTG R2
Anambra	802,673	914,102	1,716,775	823,586	1,647,172	97%	104%	1,029,482	78%	89%	953	963	963	99%	100%
Ebonyi	355,636	352,062	707,698	356,437	712,874	100%	99%	445,546	80%	79%	786	786	786	100%	100%
Edo	86,233	90,595	176,828	96,851	193,702	89%	91%	121,064	71%	75%	67	67	67	100%	100%
Delta	868,661	1,309,097	2,177,758	1,462,132	2,924,264	59%	74%	1,827,665	48%	72%	640	715	956	67%	75%
Imo	1,140,498	1,135,486	2,275,984	1,196,802	2,393,604	95%	95%	1,496,003	76%	76%	1,659	1,679	1679	99%	100%
Abia	998,661	1,021,590	2,020,251	1,039,458	2,078,916	96%	97%	1,299,323	77%	79%	1005	1,009	1009	100%	100%
TOTAL	**4,252,362**	**4,822,932**	**9,075,294**	**4,975,266**	**9,950,532**	**85%**	**91%**	**6,219,083**	**68%**	**78%**	**5,110**	**5,219**	**5,460**	**94%**	**96%**

Figure N7

Nigeria: 2016 Carter Center-Assisted Schistosomiasis Treatments

State	Population treated	Ultimate TX Goal (UTG)	% UTG treated	Total population	% Total population treated	Villages/ schools treated	Villages/ schools UTG	% Villages/ schools treated
Enugu	78,682	145,870	54%	520,965	15%	582	637	91%
Anambra	258,204	707,547	36%	2,526,951	10%	551	1,536	36%
Ebonyi	285,266	367,631	78%	1,312,967	22%	834	1,848	45%
Edo	144,356	146,275	99%	522,410	28%	432	432	100%
Delta	52,133	61,247	85%	218,739	24%	199	199	100%
Imo	1,004,163	1,079,483	93%	3,855,297	26%	3,609	4,397	82%
Abia	273,014	331,569	82%	1,184,175	23%	1848	1,848	100%
Plateau *(schools)*	910,682	992,587	92%	3,308,620	28%	2,984	3,185	94%
Plateau *(communities)*	299,485	314,061	95%	1,046,869	29%	549	573	96%
Nasarawa *(schools)*	280,330	313,561	89%	1,045,202	27%	851	891	96%
Nasarawa *(communities)*	421,516	462,361	93%	1,507,869	28%	584	589	99%
TOTAL	**4,007,831**	**4,922,192**	**81%**	**17,050,064**	**24%**	**13,023**	**16,135**	**81%**

All treatments were school-based unless otherwise indicated.

Figure N8

Scale up of Carter Center-Assisted Schistosomiasis Treatments in Nigeria and 2017 Target

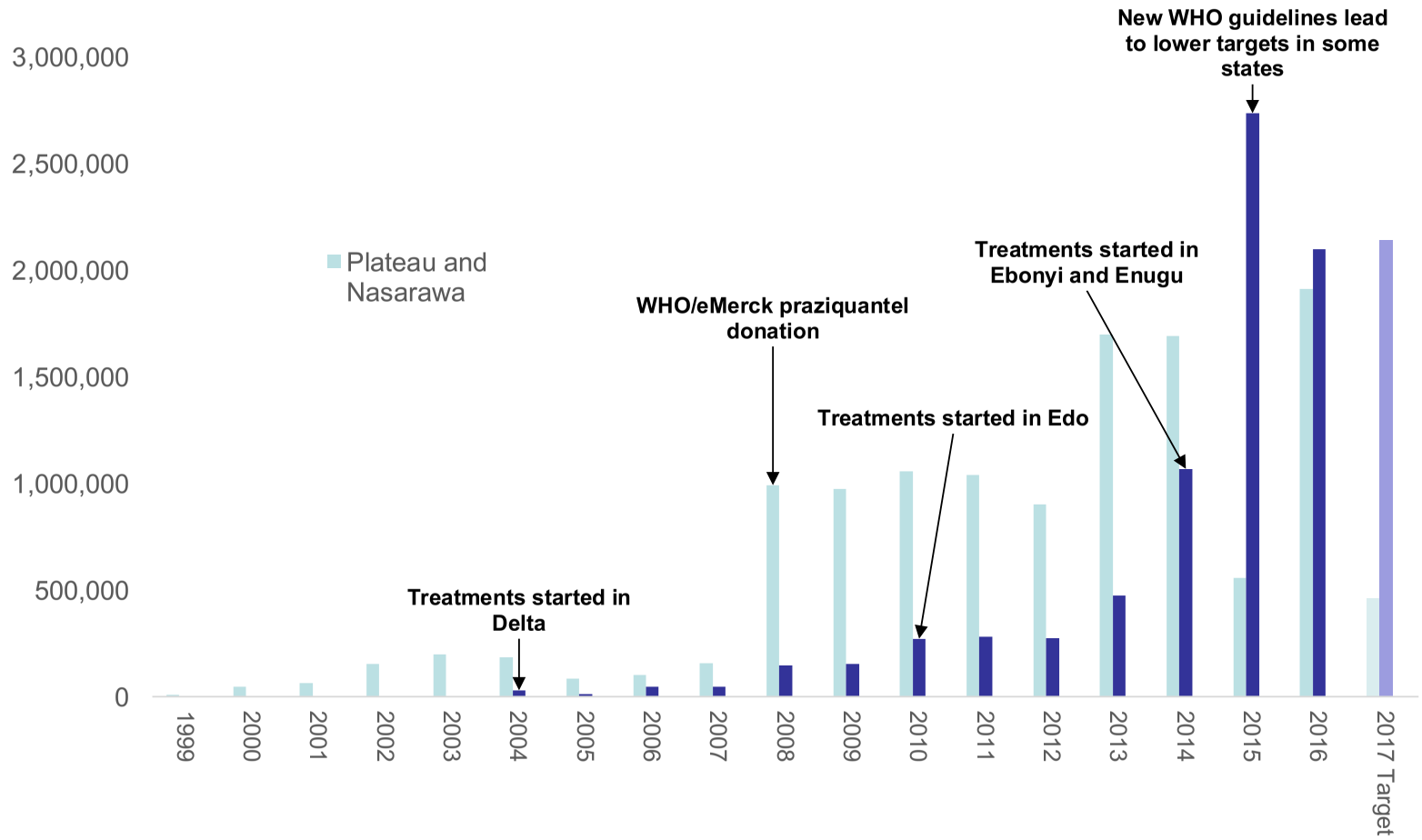


Figure N9

Nigeria: 2016 Carter Center-Assisted Annual and 1st Round Soil-Transmitted Helminthiasis Treatments

Name of State	No. of LGAs treating ANNUALLY	Popn treated	UTG	% UTG treated	Total Popn for	% of total popn treated	Villages/schools treated	Villages/Schools UTG	Villages/School % of UTG
Enugu	10	572,469	699,758	81.8%	2,499,137	22.9%	2,363	2,363	100.0%
Anambra	12	644,804	817,897	78.8%	2,921,062	22.1%	1,078	1,078	100.0%
Ebonyi	10	597,531	606,336	98.5%	2,165,484	27.6%	938	1,220	76.9%
Edo	18	961,311	1,208,972	79.5%	4,317,756	22.3%	1,073	1,085	98.9%
Delta	25	715,885	1,468,960	48.7%	5,246,287	13.6%	591	591	100.0%
Imo	25	1,050,078	1,286,240	81.6%	4,593,714	22.9%	4,022	4,223	95.2%
Abia	16	765,713	937,051	81.7%	3,346,611	22.9%	3,209	3,237	99.1%
Plateau	17	1,210,167	1,306,647	92.6%	4,355,489	27.8%	3833	3983	96.2%
Nasarawa	13	701,846	765,921	91.6%	2,553,071	27.5%	1484	1544	96.1%
TOTAL	**146**	**7,219,804**	**9,097,782**	**79.4%**	**31,998,611**	**22.6%**	**18,591**	**19,324**	**96%**

Figure N10

Nigeria: 2016 Carter Center-Assisted 2nd Round Soil-Transmitted Helminthiasis Treatments

Name of State	No. of LGAs treating Semi-annually	Popn treated Rd2 2016	UTG 2016	% UTG(2) Treated	Total Popn	% of total popn treated Round 2	Villages treated in Round 2	Villages UTG for Round 2	Villages % UTG for Round 2
Enugu	1	32,575	47,930	68.0%	171,177	19%	101	112	90%
Anambra	*NO TWICE-PER-YEAR TREATMENT*								
Ebonyi	3	149,626	176,704	84.7%	631,087	24%	143	1,179	12%
Edo	8	478,632	521,903	91.7%	1,863,939	26%	1379	1,379	100%
Delta	19	744,113	1,468,960	50.7%	4,093,520	18%	1395	2038	68%
Imo	3	151,783	159,695	95.0%	570,340	27%	614	750	82%
Abia	3	146,358	159,475	91.8%	569,554	26%	346	350	99%
TOTAL	**37**	**1,703,087**	**2,534,667**	**67.2%**	**7,899,617**	**22%**	**3,978**	**5,808**	**68%**

Figure N11

Soil Transmitted Helminthiasis Treatments, 2013 – 2016, and 2017 Target

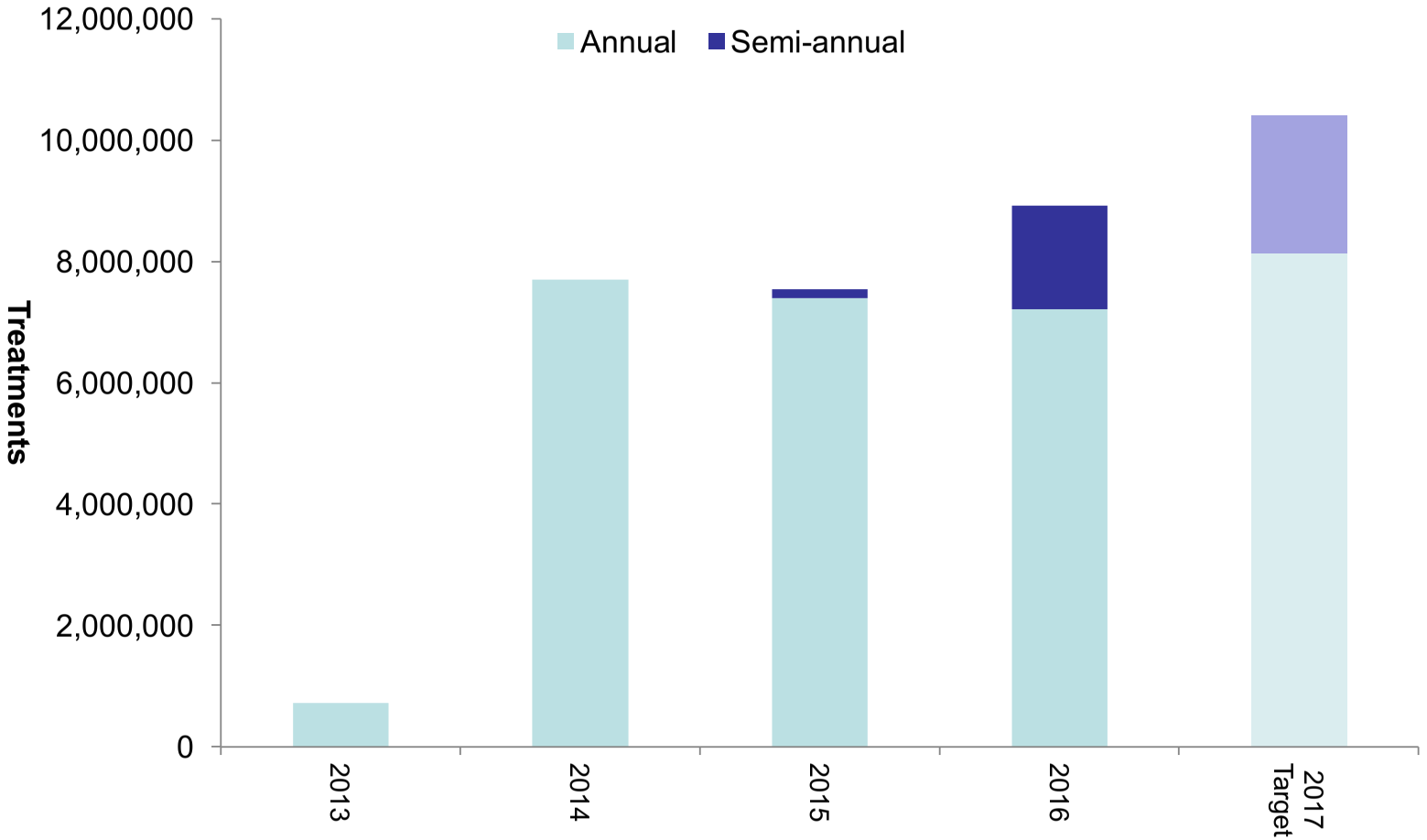
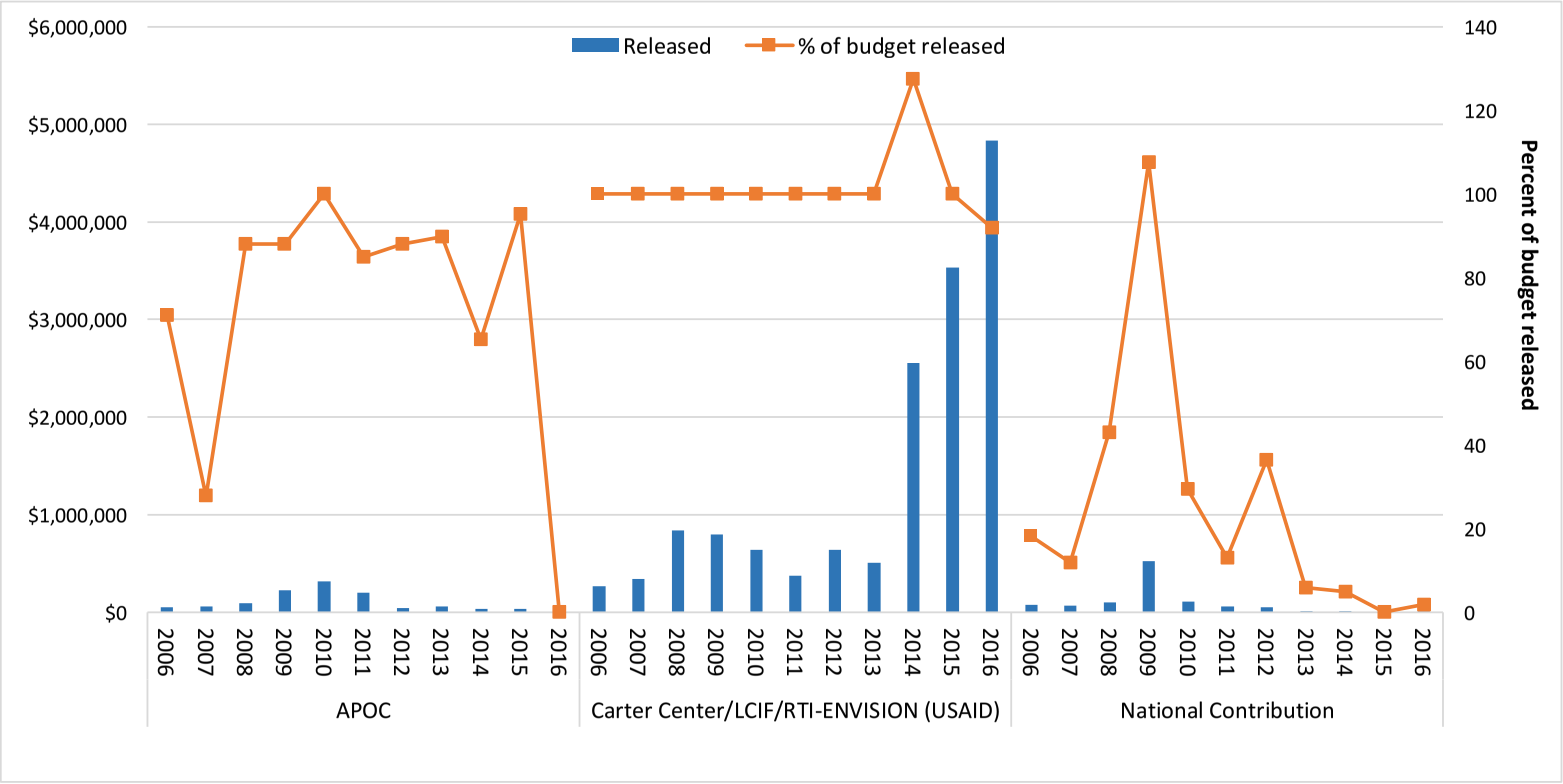


Figure N12

Nigeria: Financial Contribution* to RBEP by Individual Partners in US Dollars (2006 – 2016)



** The APOC and government contributions are reported by our Carter Center country representatives based on their best possible determinations from information available in country through the national program and other local sources. Capital equipment replacement provided by APOC and government salaries are not considered.*

ETHIOPIA

Summary: In 2016 RBEP assisted five regions in Ethiopia (Amhara, Benshangul Gumuz, Gambella, Oromia, and SNNPR, see Figure E1). The program provided 14,467,640 river blindness treatments under the twice-per-year approach, which was less than the 15,134,758 provided in 2015 (Figure E2). This was due to the Federal Ministry of Health's (FMoH's) directive to delay treatments in selected zones in order to pilot special integrated training for Neglected Tropical Disease (NTD) Health Extension Workers. Ethiopia also continued its work toward eliminating lymphatic filariasis, reaching 2,083,289 treatments in 2016 in a program supported by GSK (Figure E6). With the reorientation of the Ethiopian onchocerciasis program to an elimination strategy in 2012, there are now outstanding challenges to refine onchocerciasis mapping in areas formally deemed hypo-endemic as well as such areas deemed ecologically conducive for onchocerciasis transmission in the eastern part of Ethiopia.

Cross-border coordination between Ethiopia and Sudan in the Special Intervention Zone of Galabat and Metema continue, with Sudan agreeing to continue treating Galabat until Ethiopia is able to stop MDA across the border in Metema and West Armachio districts (see also the Sudan report). Staff from both ministries will keep each other informed as new results come in.

Background: Ethiopia is the second-most populous country in Africa with a population of about 104 million. Rapid Epidemiological Mapping of Onchocerciasis (REMO) was conducted in Ethiopia in 2001 with support from the African Programme for Onchocerciasis. REMO identified and initially targeted 10 areas for treatment, primarily in the western part of the country, where the overall prevalence of onchocerciasis was estimated to be more than 40% (≥20% nodule rate).

Key program partners in Ethiopia include the Federal Ministry of Health, The Lions Clubs International Foundation SightFirst Program and the Lions Clubs of Ethiopia. Locally, members of the Lions Clubs District 411-A, under the leadership of the Honorable World Laureate Dr. Tebebe Y. Berhan, continue to play a key role in both the River Blindness and Trachoma Control Programs in the Lions-Carter Center SightFirst project areas of Ethiopia. Other sources of funding include the Margaret A. Cargill Philanthropies.

The Ethiopia Onchocerciasis Elimination Expert Advisory Committee (EOEEAC): With the declaration of an elimination strategy in 2012, the EOEEAC was launched to provide recommendations to the FMOH to reach nationwide interruption of onchocerciasis transmission by 2020, with WHO verification as a goal shortly thereafter. The committee is composed of national and international experts. Dr. Mark Eberhard (former director of parasitic diseases at the CDC) serves as the Chair with support from co-secretaries Mr. Biruck Kebede (FMOH NTD Coordinator) and Dr. Zerihun Tadesse (Ethiopia Country Representative of The Carter Center). Due to political challenges in Ethiopia in 2016 the EOEEAC was unable to hold its third meeting, but committee members were able to work by email to produce draft Standard Field Operating Procedures (SOPs), which provide approaches for mapping, entomological, and

epidemiological assessments. These were approved by the FMOH. An abbreviated EOEEAC meeting was held the day after the RB Program Review (March 30, 2017), and the committee plans to have a full meeting in Addis Ababa in October 2017.

Treatments: The total number of treatments provided in 2016 was 14,467,640, which were all delivered semi-annually (Figure E2). Overall, treatments were 80% of the UTG(2), lower than the 91% reached in 2015 due to the aforementioned FMOH-mandated integrated training that prevented the achievement of good coverage in the second round. Geographic coverage was 100% of targeted villages in the first round and 62% in round 2 (Figure E3). Carter Center-assisted treatments represented 62% of all ivermectin treatments given in Ethiopia in 2016.

Training and Health Education: Training was provided to 226,733 community-directed distributors (CDDs) in 2016, an increase of 32,598 (17%) over 2015 (Figure E4). The percent of female CDDs was 59% in 2016, continuing the trend of increasing female participation that began in 2012 (Figure ES11). Overall, the population per CDD reduced from 52 in 2015 to 47 in 2016. All zones except Mezheng and Itang in Gambella reached ratios of better than the target of 1 CDD per 100 population.

A total of 68,245 community supervisors (CS) were trained in 2016, overseeing an average of 3 CDDs each, an even better ratio than the 1:5 ratio seen in 2015. The proportion of community supervisors who are women increased significantly, from 48% in 2015 to 60% in 2016.

According to the terminology of the Ethiopian health system, CDDs are referred to as members of the Health Development Army (HDA) and CSs are grouped with Health Extension Workers (HEWs).

Financial Contribution: Carter Center 2016 contributions (that include key funding from the Lions Clubs International Foundation, the Margaret A. Cargill Foundation, and individual donors to The Carter Center) continued to increase in support of an expanding Ethiopian RB elimination effort. The figure shown for the government investment in the program dramatically decreased because dedicated RB funding could not be determined; only salary figures for dedicated personnel were reported (Figure E5).

Lymphatic Filariasis (LF): The LF program in Ethiopia began in 2008 with GSK support, integrating LF with RB treatments (Shiferaw *et al*. 2011). The current Carter Center policy is to assist the FMOH LF program as it is able in those zones where RB is also endemic. Thus, as the RB program expands eastward with mapping activities into new, co-endemic areas, the LF program will likewise continue to grow in scope. The LF efforts began in Gambella region and have expanded to LF/RB co-endemic zones in SNNPR, Beneshangul-Gumuz, and Amhara regions, increasing the UTG nearly tenfold. There were 2,083,289 treatments in 2016 (Figure E6).

Other Integration Activities: In the North Gondar zone (Amhara region) the RB-LF integrated program works with Carter Center-assisted trachoma control activities.

2017 RECOMMENDATIONS FOR THE CARTER CENTER RBEP, ETHIOPIA

Onchocerciasis

Seek a binational decision with Sudan in 2017 for halting MDA in the cross-border Special Intervention Zone (SIZ) between Galabat and North Gondar by completing new entomological surveys (heads and bodies) in the one site in Metema where there were positive flies (2 head pools). Have some results available in time for the October 2017 EOEEAC meeting.

Prioritize field entomology collections and laboratory PCR assessments to those areas where skin snip and Ov-16 serology results are at or near thresholds established by the FMOH/EOEEAC guidelines. Have some results available in time for the October 2017 EOEEAC meeting.

In consultation with HQ, conduct impact assessments (using the assessment protocol).

As resources allow and in consultation with HQ, use the mapping protocol to assess all districts in potential eastern expansion zones. If treatments are needed in any new area these should be twice per year.

Once proper authorization/responsibilities are obtained from the FMOH, pilot Abate®-based ground larviciding in 1-2 sites, with close consultation with FMOH, EPHI and the EOEEAC. Ideally the pilot areas chosen will be *S. ethiopiense* areas refractory to several years of Mectizan® MDA.

Provide financial and administrative support for the 2017 EOEEAC meeting.

Encourage EOEEAC to issue a press release following each meeting.

Lymphatic Filariasis

Discuss with FMOH to consider communicating LF TAS results from North Gondar (Metema and Quarra) to the RPRG for comment/approval to stop MDA. It is suggested that the FMOH consult with the AFRO RPRG for guidance on when and where to conduct pre-TAS and TAS surveys.

In consultation with HQ, conduct monitoring in sentinel villages using the LF sentinel village protocol.

Pre-TAS studies should use only filarial antigen testing and not nocturnal mf assessments.

2017 Treatment and Training Objectives:

River Blindness	
Semiannual UTG(2):	18,421,949

Lymphatic Filariasis	
Annual UTG:	1,517,035

Training Objectives	
CDDs:	229,895
CSs:	76,325

Figure E1

Map of RB & LF Areas Assisted by The Carter Center

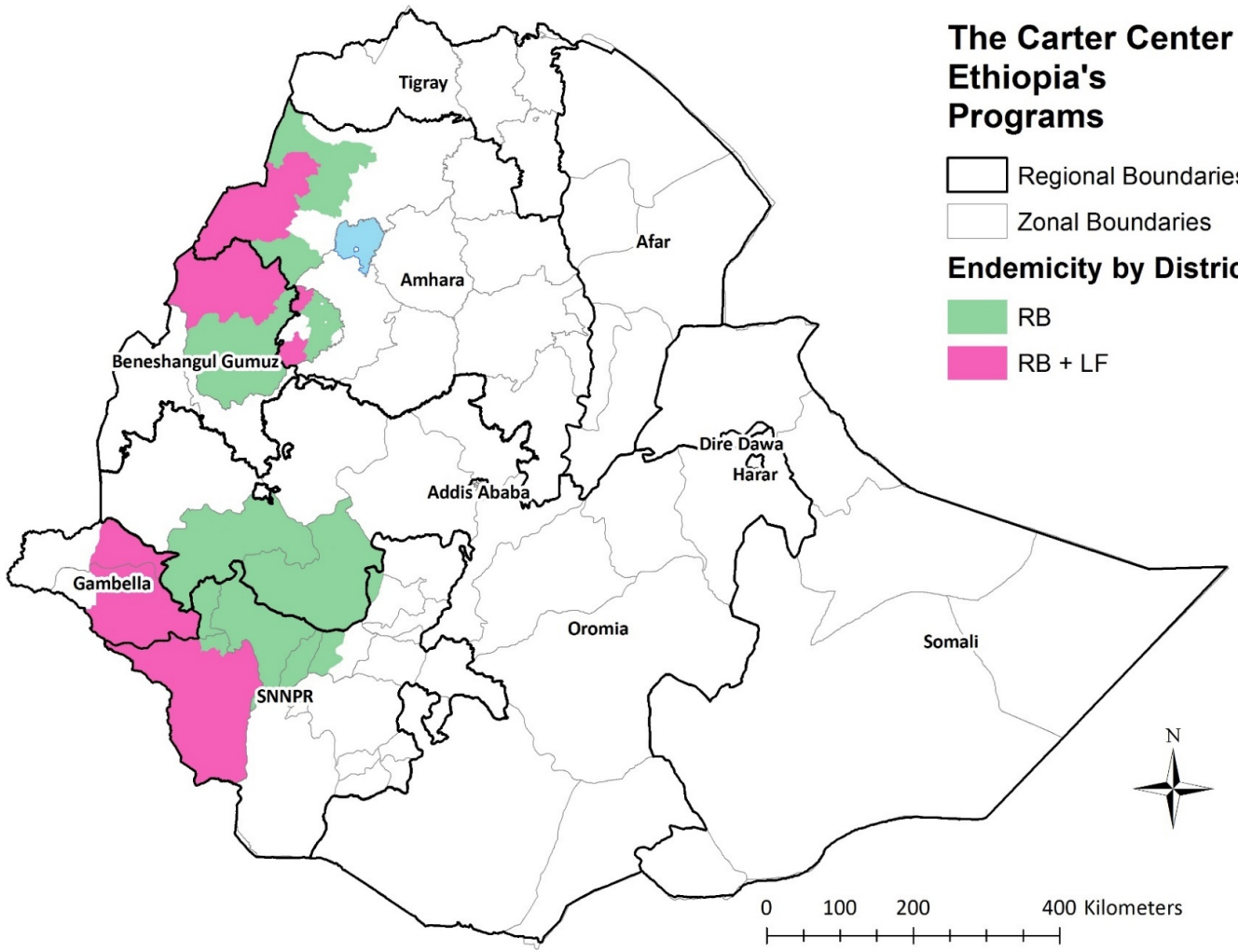


Figure E2

Ethiopia: History of TCC-Supported Mectizan® Treatments by Treatment Regimen

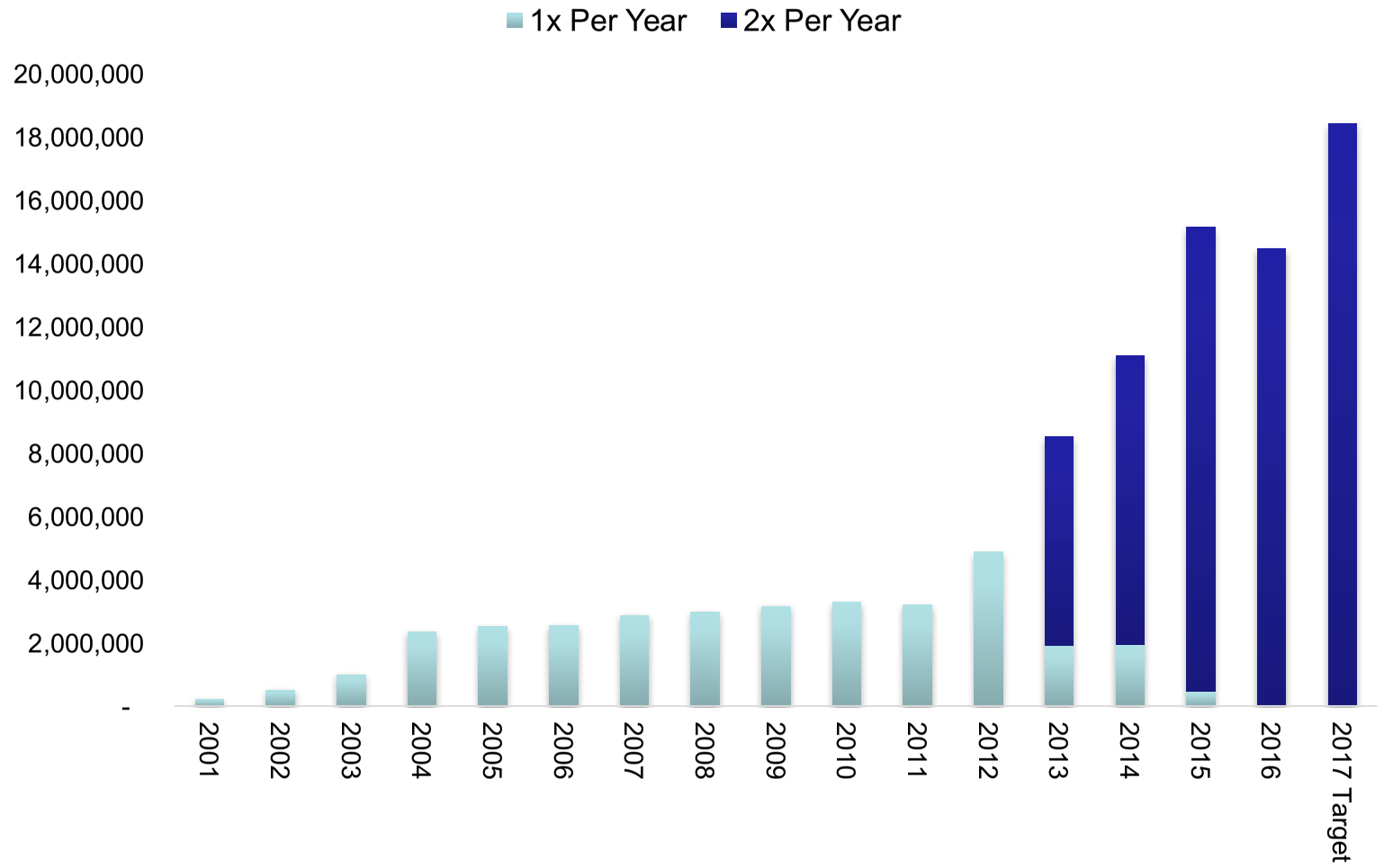


Figure E3

Ethiopia: 2016 Carter Center-Assisted Semi-Annual River Blindness Treatments

Region	Zone	No. of Districts	Total Pop.	UTG 2	No. treated R1	Percent (%) UTG 1	No. Treated R2	No. Treated UTG 1 & 2	Percent (%) UTG 2	No. of Commun-ities	Percent (%) of Communities Treated
SNNPR	Kaffa	11	1,151,228	1,934,063	966,277	100%	*Delayed*	966,277	50%	4,718	100
	Sheka	5	229,013	384,742	196,341	102%	198,282	394,623	103%	1,325	100
	Bench Maji	10	841,433	1,413,607	699,007	99%	*Delayed*	699,007	49%	3,028	100
	Dawuro	6	521,138	875,512	435,990	100%	*Delayed*	435,990	50%	2,029	100
	Konta	1	124,163	208,594	102,906	99%	*Delayed*	102,906	49%	499	100
	Yem	1	86,475	145,278	68,304	94%	*Delayed*	68,304	47%	523	100
Amhara	North Gondar	8	998,521	1,677,515	820,188	98%	867,150	1,687,338	101%	6,294	100
	Awi	11	1,090,439	1,831,938	909,889	99%	972,495	1,882,384	103%	5,270	100
Oromia	Illubabor	24	1,627,161	2,733,630	1,361,543	100%	*Delayed*	1,361,543	50%	8,345	100
	Jimma	19	3,414,507	5,736,372	2,843,967	99%	2,906,209	5,750,176	100%	15,768	100
Beneshanghul Gumuz	Metekel	7	397,037	667,022	343,452	103%	359,527	702,979	105%	2,545	100
Gambella	Agnuwa	7	115,318	193,734	93,922	97%	106,658	200,580	104%	260	100
	Mezheng	2	84,364	141,732	69,842	99%	64,524	134,366	95%	198	100
	Itang	1	48,114	80,832	39,557	98%	41,610	81,167	100%	90	100
Total	**14**	**113**	**10,728,911**	**18,024,571**	**8,951,185**	**99%**	**5,516,455**	**14,467,640**	**80%**	**50,892**	**100**

Figure E4

Ethiopia: Community Directed Distributors (CDDs) and Community Supervisors (CSs) Trained (2005 – 2016) in Carter Center-Assisted Areas

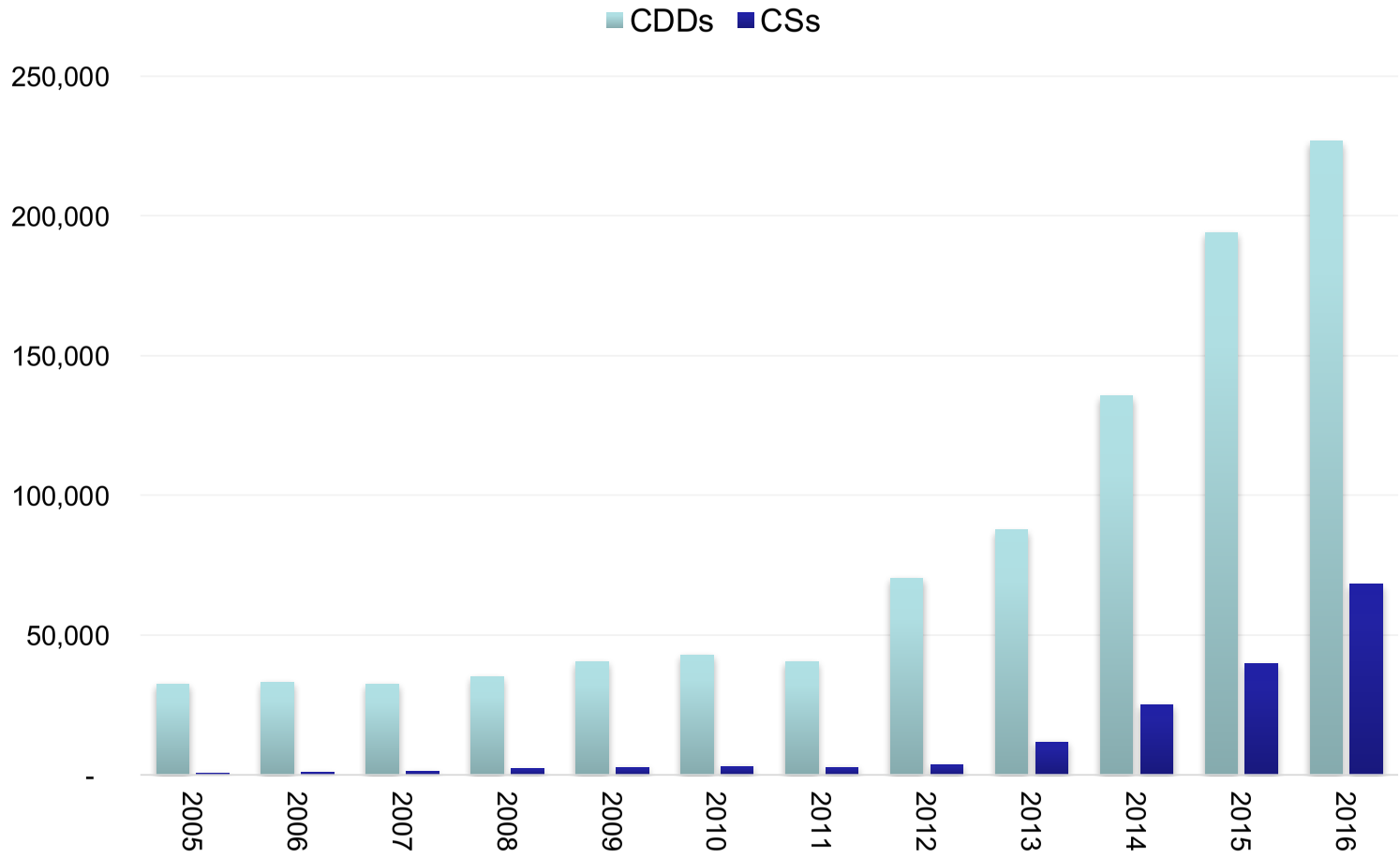
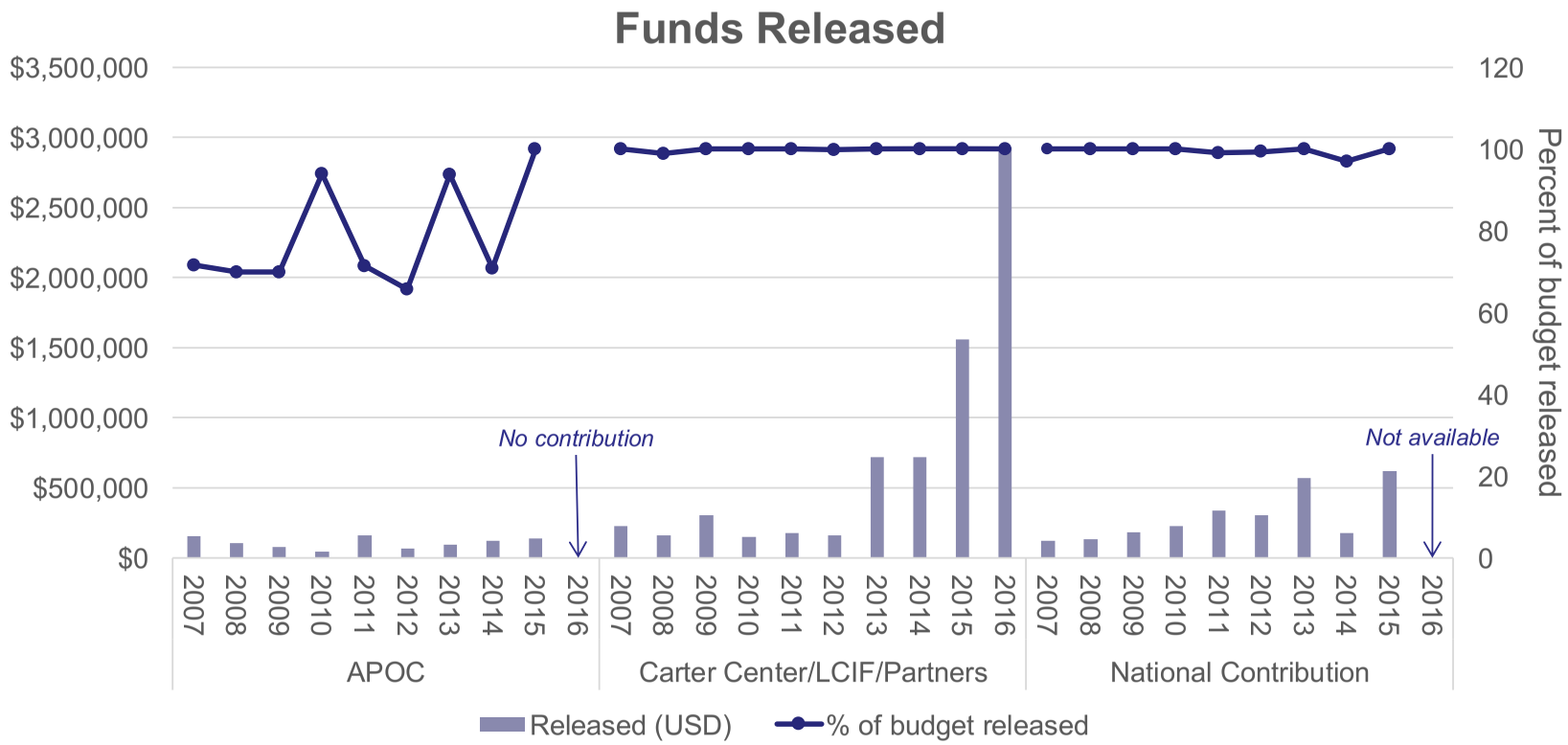


Figure E5

Ethiopia: Financial Contribution by Different Partners (US$) 2004 – 2016



1. The APOC and government contributions are reported by our Carter Center country representatives based on their best possible determinations from information available in country through the National Onchocerciasis Task Force and other local sources. Capital equipment replacement provided by APOC and government salaries are not considered.

2. Actual Cash contribution by Government to program implementation is not available. The graphic above only shows Staff salaries.

Figure E6

Ethiopia: Carter Center-Assisted Lymphatic Filariasis Treatments in 2016

Region	Zone	No. of Districts	No. of Communities	Total Population	Eligible Population	No. Treated	% Treated (UTG)	No. of Commu-nities Treated	% of Commu-nities Treated
SNNPR	Bench Maji	9	2,430	644,830	541,657	534,543	99%	2,430	100%
	Dawuro	1	321	75,280	63,235	63,684	101%	321	100%
Amhara	North Gondar	3	1,765	262,413	220,427	442,953	201%	1,765	100%
	Awi	3	1,265	251,851	211,555	648,972	307%	1,265	100%
Beneshangul Gumuz	Metekel	2	459	88,400	74,256	170,183	229%	459	100%
Gambella	Agnuwa	4	238	68,034	57,149	77,263	135%	238	100%
	Mezheng	2	198	84,364	70,866	64,524	91%	198	100%
	Itang	1	90	48,114	40,416	81,167	201%	90	100%
Total		**25**	**6,766**	**1,523,286**	**1,279,561**	**2,083,289**	**163%**	**6,766**	**100%**

Note: Albendazole was offered twice in 2016 in 10 districts. This has to do with changes by FMOH using the Ethiopian Calendar.

ANNEX 1: BACKGROUND

Human onchocerciasis, an infection caused by the parasitic worm *Onchocerca volvulus,* causes chronic skin disease and severe itching, as well as eye lesions that can progress to visual loss or complete blindness. The worms live in fibrous 'nodules' that often can be felt just under the skin. Onchocerciasis is transmitted by small black flies that breed in rapidly flowing rivers and streams, thus leading to the common name for the disease, "river blindness." The World Health Organization (WHO) estimates that approximately 37.2 million people are infected and 770,000 are blinded or severely visually impaired in 31 endemic countries. Approximately 123 million people live in endemic areas worldwide and are therefore at risk of infection; more than 99% of those at risk are in Africa. Periodic mass treatment with the oral tablet Mectizan® (ivermectin, donated by Merck) prevents eye and skin disease caused by *O. volvulus* and may also be used to reduce or even interrupt transmission of the disease depending on the duration and frequency of treatment, the efficiency of the vector, and the geographic extent of the distribution programs.

The Carter Center River Blindness Elimination Program (RBEP) is dedicated to safe and sustainable mass distribution of Mectizan® with health education to eliminate onchocerciasis. The distinction between control and elimination is important. In the control approach, Mectizan® is distributed only in areas where the morbidity from the infection is greatest (meso- and hyperendemic areas) in a manner in which MDA will likely need to continue indefinitely because onchocerciasis transmission persists and people continue to get new infections ('open system'); sustainability of control programs is vital. In the elimination approach, Mectizan® treatment is used more intensively to 'close the system' so that transmission can eventually be broken. At a point when the residual parasites in the human population are unable to recover, the MDA can be stopped because there is no animal or environmental reservoir of infection. Before 2013, the elimination of onchocerciasis was the program goal in the Americas, Uganda and Sudan. By 2013, national onchocerciasis transmission elimination had become the stated goal of all the governments where RBEP assists. At that time, RBEP set a new goal to stop transmission in all its assisted areas. Of note, we also advocate for our programs to cooperate and integrate when possible, with the national Lymphatic Filariasis (LF) programs of these countries (in Africa), which also use MDA with Mectizan®.

A historical barrier to treatment in some parts of Nigeria where The Carter Center works has been co-endemicity of a parasite called *Loa loa*; ivermectin treatment in a person with high *Loa loa* parasite loads (>30,000 *Loa loa* microfilaria per ml blood) can result in serious adverse reactions, with complications that can lead to coma or death. In partnership with the federal and local governments of Nigeria, The Carter Center conducted a large survey in Nigeria in 2016 using a recently developed technology called the 'LoaScope' and determined that microfilaria levels of *Loa loa* were not sufficient in our supported areas to preclude treatment (of over 10,000 persons examined with the LoaScope, the highest count observed was under 12,000 per ml blood). Our results were reviewed by the Mectizan Expert Committee and the Federal Ministry of Health of Nigeria which gave their permission to use ivermectin treatment in *Loa loa* areas that are

ivermectin-naïve and hypoendemic for onchocerciasis. A publication on this work is forthcoming.

A major focus of The Carter Center in order to achieve impact on RB is reaching the best possible treatment coverage, monitored through routine monthly reports by assisted programs, periodic coverage surveys, and impact on RB transmission indicators. Annex 3 is a discussion of this reporting process and treatment indices used by the program and in this report. Important coverage terms include the **Ultimate Treatment Goal** (**UTG**), which is the number of treatment-eligible people living in a program area (persons >5 years of age); the **UTG(2) and UTG(4)**, used by elimination programs in areas where semiannual or quarterly treatments are required to break transmission; and **full coverage**, which is defined as >90% achievement of the UTG, UTG(2), or UTG(4) (85% for OEPA).

Mectizan® tablets are distributed in Africa at the community level by grassroots community volunteers known as Community Directed Distributors (CDDs), through a process known as Community Directed Treatment with Ivermectin (CDTI); CDTI was perfected by the Tropical Disease Research program of WHO and was broadly introduced into the African Programme for Onchocerciasis Control's (APOC's) supported project areas throughout Africa in the late 1990's. In some areas, The Carter Center's RBEP focuses on "kinship/neighborhood-enhanced CDTI," an approach that seeks to train more CDDs than is done in classic CDTI, and which TCC developed and pioneered in Uganda. In kinship-enhanced CDTI, CDDs serve within their own kinships or neighborhoods within every community where decisions and activities about treatments are handled. A similar approach is used in Ethiopia; the Health Development Army (HDA) system is based in communities' Health Development Units, with five households of about 30 people served by at least one CDD from the HDA. This strategy seeks to increase the active participation of members of affected communities by: 1) training as many inhabitants of endemic villages as possible to serve as distributors; 2) encouraging the involvement of women; 3) reducing the demand for financial or other "incentives"; and 4) allowing community members to choose their own distributors and the time and location of treatments. Monitoring indices of the kinship approach include 1) community selection of CDDs in every kinship/neighborhood zone in the community; 2) sustained treatment coverage of at least 90% of treatment-eligible persons; 3) increasing involvement of women as CDDs; and 4) the presence of at least two community-selected supervisors in every community. The ratio of CDD per population that our programs have pursued historically has been at least 1 CDD per 100 persons to be treated. Ethiopia, using its Health Development Army, has moved towards supporting a ratio of 1 CDD per 30 persons. Uganda is steadily increasing its concentration of CDDs with an ultimate goal of 1:34 persons.

The CDDs and community supervisors are often also highly engaged in other community-based health interventions, such as water provision and sanitation, malaria control, immunization, and integrated NTD control efforts.

ANNEX 2: A Timeline of the River Blindness Campaign at the Carter Center

- **1996:** The Carter Center assumed activities of the River Blindness Foundation and began assisting RB programs in the Americas, Nigeria, Cameroon, Sudan and Uganda. (Ethiopia started in 2001.)
- **1998:** Richards, with other TCC authors (Miri and Sauerbrey) writes about opportunities for RB elimination in a special edition of the Bulletin of WHO entitled "Global Disease Elimination and Eradication as Public Health Strategies". He also writes about the history of the launching of the OEPA initiative (Bull PAHO).
- **2000:** OEPA needed a 'definition of success' endorsed by WHO; with a push from President Carter, WHO agreed to hold an important meeting to establish certification criteria for onchocerciasis elimination (WHO 2001), which had great utility for programs in the Americas and Uganda. Richards, writing in *Lancet*, notes the importance of the LF program in advancing the RB elimination agenda.
- **2002:** The Carter Center and WHO (with Gates Foundation support) co-hosted the Conference on RB Eradicability that concluded RB can be eliminated in the Americas but not yet throughout Africa with current tools (ivermectin alone). The challenge was noted of the parasite *Loa loa*, which occurs in some areas that have RB: ivermectin given to a person having *Loa loa* infection can result in severe nervous system reactions, including coma. (Dadzie 2003)
- **2003:** Richards coauthors a paper on mass treatment decision-making in *Loa loa* areas where onchocerciasis occurs. (Addis 2003)
- **2005:** Paper published by Hopkins, Richards, and Katabarwa ("Whither Onchocerciasis Control in Africa?") challenges feasibility of indefinite RB control in Africa without continued external support; calls for governments to do more to fund their programs; and calls for further research into RB elimination in Africa. (Hopkins 2005)
- **2006:** TCC agrees to assist Sudan in elimination efforts in the Abu Hamad focus on the River Nile. (Higazi 2011, 2013)
- **2007:** TCC's ITFDE reviews RB eradicability and notes evidence that ivermectin alone may interrupt transmission in Africa, but that the challenge of *Loa loa* is not resolved. (WHO 2007). TCC/RBP agrees to assist Uganda in its new goal of national RB elimination.
- **2008:** The Carter Center provided technical and financial assistance to help establish a national onchocerciasis expert advisory committee in Uganda.
- **2009:** A key WHO/TDR study by Diawara (2009) that was conducted in Senegal and Mali with Gates Foundation support (derived as an outcome of the 2002 Conference on Eradicability) proves RB elimination is possible with 17 years of ivermectin alone under some conditions in Africa. Gates, MDP, TCC and APOC all call for "Shrinking the Map" in Africa (WHO 2009). Rakers (TCC/RBP) reports that RB programs in Nigeria would collapse without external support, questioning the 'sustainability' theory (*Lancet* 2009).
- **2010:** TCC reports considerable success in RB elimination efforts in the Americas (series of *Weekly Epidemiological Record* articles) and parts of Africa. However, Katabarwa (TCC/RBP) notes a need to expand treatment into the so-called

hypoendemic areas excluded by APOC's treatment strategies. He also challenges the Diawara report by noting failures of once-per-year treatment with ivermectin alone for 17 years in TCC-assisted North Province, Cameroon; TCC calls for twice-per-year treatment in these areas (Katabarwa 2011). At an international conference TCC reports an analysis of the impact of annual ivermectin and albendazole (for lymphatic filariasis) on onchocerciasis transmission elimination in many areas of Plateau and Nasarawa States of Nigeria.

- **2011:** TCC's International Task Force for Disease Eradication reviews the RB and LF elimination efforts in Africa, applauds the move by APOC from RB control to elimination, and calls for better coordination of RB and LF interventions as well as with malaria bed net distribution efforts (*Weekly Epidemiological Record* 2011). An expert committee (with Frank Richards, the TCC RBP Director, as a member), meeting under the auspices of the World Bank, recommends an elimination goal for ten African countries by 2020, including Nigeria, Uganda, and Ethiopia. In late 2012, the World Bank/APOC governing board recommends onchocerciasis elimination now be APOCs goal.
- **2012:** Sudan announces interruption of transmission in Abu Hamad focus (Higazi 2013). TCC's River Blindness Program obtained Board of Trustees' approval for an eight-year plan to interrupt RB transmission everywhere we assist, by 2020. WHO sends verification team to Colombia to determine if the country has eliminated onchocerciasis.
- **2013:** The name of TCC's River Blindness Program was changed to The Carter Center's River Blindness Elimination Program (RBEP) to reflect the paradigm shift to focusing efforts on eliminating RB transmission everywhere we work. Colombia is the first country in the world verified by WHO to be free of onchocerciasis. Ecuador applies to WHO for verification of elimination.
- **2014:** WHO verifies that Ecuador has eliminated onchocerciasis. ITFDE reviews RB/LF in Africa again (*WER* 2014). The Carter Center provided technical and financial assistance to help establish a national onchocerciasis expert advisory committee in Ethiopia.
- **2015:** WHO verifies that Mexico has eliminated onchocerciasis and Guatemala requests verification. The Carter Center provided technical and financial assistance to help establish a national onchocerciasis expert advisory committee in Nigeria. Sudan announces that transmission has been eliminated in Abu Hamad focus.
- **2016:** WHO verifies that Guatemala has eliminated onchocerciasis transmission. Uganda declares river blindness transmission eliminated in four foci. Carter Center celebrates its ½ billionth treatment for NTDs. Nigeria Onchocerciasis Expert Committee (NOEC) releases plan of action for elimination of river blindness in Nigeria, and Carter Center is selected as a semi-finalist in the MacArthur 100&Change grant competition with a proposal to support the NOEC plan.

ANNEX 3: The Carter Center RBEP Reporting Processes

At-risk Villages (ARVS): An epidemiological mapping exercise was a prerequisite to identifying at-risk villages (ARVS) for mass Mectizan® treatment programs. The assessment techniques used in the mapping exercise in Africa varied from those used in the Americas. An overview of the two approaches follows.

In much of Africa, a staged village sampling scheme called Rapid Epidemiological Mapping of Onchocerciasis (REMO) was executed with assistance from WHO to define endemic "zones" that should capture most or all villages having onchocercal nodule rates ≥20% in adults (which roughly corresponds to a microfilariae in skin prevalence ≥40%) for mass treatment. The mapping strategy is based on studies that have shown that most ocular and dermal morbidity from onchocerciasis occurs in villages where the nodule prevalence exceeds 20%. In the first stage of REMO, survey villages were selected based on a review of large-scale maps of areas that appear to be environmentally able to support black fly breeding and, therefore, transmission of *O. volvulus*. In the second stage, the survey villages are visited by field teams and a convenience sample of 30-50 adults were examined (by palpation) for characteristic onchocercal nodules. The mean nodule prevalence for each village sample were mapped (often using geographic information systems) and the map was used to define endemic zones called 'community directed treatment with ivermectin (CDTI) treatment zones.' These zones typically are defined by sample villages having nodule prevalence of ≥20%. All villages within the CDTI treatment zone were initially offered mass Mectizan® treatment annually. The approach of REMO excludes some areas from CDTI, where there was onchocerciasis but nodules rates were under 20% (the so-called "hypoendemic areas").

As the policy in Africa continues to shift towards elimination (all Carter Center-supported countries have an elimination policy), more and more countries are adopting twice-per-year treatments in some or all endemic areas to accelerate elimination. In addition, the role of hypoendemic areas in *O. volvulus* transmission is being critically re-examined. The River Blindness Elimination Program (RBEP) contributes to this area of investigation in our assisted areas (see Katabarwa, *Trop Med Int Health*. 2010). Based on evidence we have collected, we firmly believe that transmission occurs in some hypoendemic areas and that they must therefore be promptly reassessed and if necessary treated with CDTI under the elimination approach.

Any areas not yet mapped in the countries we support (and some of those where the mapping is outdated) have launched new field exercises based on the mapping guidelines of that country's national onchocerciasis elimination committee (typically serology in children). Generally, Ov16 testing is used, with seroprevalence > 1% in children ≥ 5 years <10 years as the indication for launching mass drug administration.

In the Americas, the goal from the start has been to eliminate both morbidity and transmission from *O. volvulus* and, as a result, all villages where transmission can occur are considered "at-risk" and are offered mass Mectizan® treatment activities every three or six months. A broader net was cast for mass treatment, and the concept of excluding

hypoendemic villages never existed. For the Americas, where the endemic foci are characteristically smaller and more defined than in Africa, every village in known or suspected endemic areas has a rapid epidemiological assessment of 50 adults, who have both nodule examinations and superficial skin biopsies to identify *O. volvulus* microfilaria in skin. Villages in which one or more persons are positive (sample prevalence ≥2%) are considered "at-risk" and are recommended for the mass treatment campaign. Thus, the cutoff prevalence for treatment was much lower for the Americas compared to Africa until recently, when elimination in Africa became the focus.

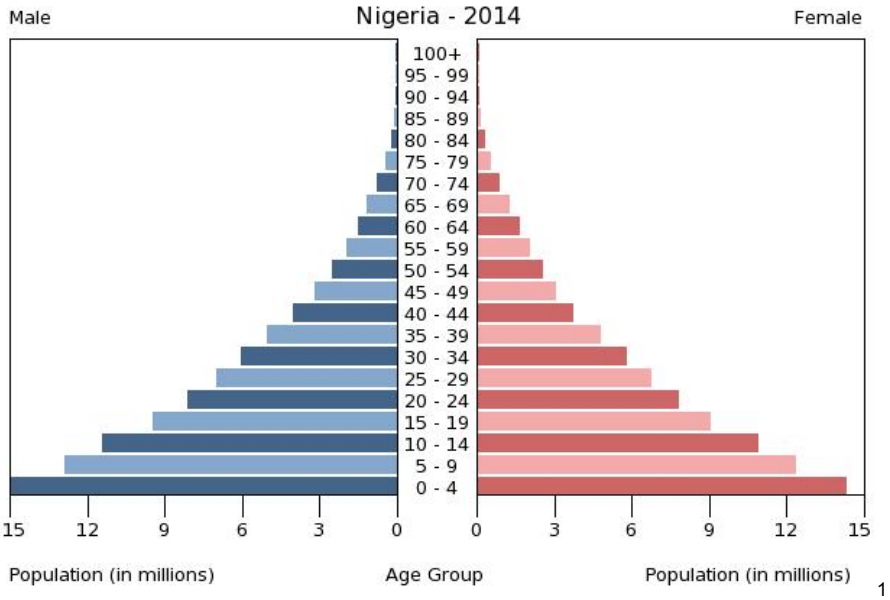
Data Reporting: The Carter Center program offices report monthly to The Carter Center headquarters in Atlanta. These reports include: 1) numbers of villages and persons treated during the previous month (reporting of treatments are updated quarterly for the Americas); 2) the status of the Mectizan® tablet supply; 3) training and health education activities; 4) epidemiological assessment, research, and program monitoring activities; and 5) administrative issues. Standardized tables and graphs are used across programs. The treatment data that are reported originate from village level records prepared during mass treatment activities carried out by village distributors (Africa) or national Ministry of Health (MOH) personnel (Americas). The accuracy of these reports is routinely confirmed with random spot checks performed primarily by Carter Center and MOH personnel, supplemented by a standardized monitoring questionnaire administered by The Carter Center and MOH staff. Summary reports of numbers of villages and persons treated are compiled at the district level and forwarded (whenever possible through MOH surveillance and reporting channels) to both headquarters of the national onchocerciasis programs and the national Carter Center offices. In the Americas, the MOHs in the six countries report treatments quarterly to the OEPA office in Guatemala City, which then provides a combined regional report to The Carter Center and to the Program Coordination Committee (PCC), InterAmerican Conference on Onchocerciasis (IACO) and the Pan American Health Organization (PAHO)/World Health Organization (WHO) in its regular meetings; OEPA updates are provided annually in WHO's *Weekly Epidemiological Record (WER)* articles (See Annex 9 for references to these publications). African MOHs report their annual results directly to WHO.

The data from monthly reports are supplemented with additional information at the annual Carter Center River Blindness Elimination Program Review held during the first quarter of the following year. At these reviews, all Carter Center program directors and other partners convene to finalize treatment figures for the previous year and establish new treatment objectives for the coming year. Data on Mectizan® treatments provided by other programs/partners operating in other parts of the countries where The Carter Center assists also are discussed (if these data are available), as well as results from research initiatives. The Carter Center reports its final treatment figures to the Mectizan Donation Program (MDP), Merck, and the NGDO Onchocerciasis Coordination office at the WHO, Geneva.

RBEP Treatment Indices: Treatments are reported as numbers of persons and number of at-risk villages (ARVS) treated for the month by district, focus, region, state or zone, depending on the geographical stratification of the country. Cumulative treatment figures

for the year are compared to Ultimate Treatment Goals (UTGs), i.e. the eligible at-risk population that is targeted. Treatment coverage is calculated with treatments as the numerator and UTG as the denominator. UTG figures typically increase by about five percent annually to account for normal population growth.

The eligible populations of at-risk villages (ARVS) targeted for active mass distribution receive community-wide Mectizan® treatment. The eligible at-risk population includes all persons living in ARVS who are eligible to receive Mectizan® (i.e., who are either ≥5 years of age, ≥15 kg in weight, or ≥90 cm in height, and who are in good health). Although RBEP mass treatment activities exclude pregnant women, these women should be treated later during the treatment year (treatment may be given one week or more after parturition) and therefore all adult women are included in the UTG calculation. In practice, the UTG is established by ARV census from the most recent treatment rounds. The UTG is expected to be the same figure used in the annual request for tablets submitted to the Mectizan Donation Program. WHO uses total population as their treatment denominator, so RBEP routinely reports both coverage of eligible population (UTG) and coverage of total population ("therapeutic coverage") to satisfy those program's needs. The rationale for RBEP's focus on the UTG denominator has been published (Richards et al., *American Journal of Tropical Medicine and Hygiene* 2001; 65:108-14). In general, total population coverage is 18-20% less than UTG (eligible) population coverage, in accord with population pyramids in areas being served, where approximately 20% of the population is under 5 years of age or otherwise (sick or pregnant) ineligible for Mectizan® treatment (see example below, Nigeria).



[1]

The UTG(2) and UTG(4) denominators are used by elimination programs where semiannual or quarterly treatments are delivered: the values are twice or four times the

[1] Source: CIA Factbook. https://www.cia.gov/library/publications/the-world-factbook/geos/ni.html.

UTG, and represent treatments targeted for the year, not persons. Full coverage in once-per-year treatment areas is defined as 90% achievement of the UTG. Full coverage for elimination programs is 90% of the UTG(2) in African projects, or 85% of the UTG(2) or UTG(4) for OEPA. The differences in full coverage thresholds result from different recommendations by the African and American expert committees.

In Uganda, passive treatments with Mectizan® (outside of the mass drug administration structure) are provided when patients present themselves in clinics within towns of endemic districts where large sections of the population are highly mobile, and often from non-endemic areas.

Annex 4: List of Program Review Participants (*attendees of all 21 reviews)

The Carter Center Atlanta
Ms. Marsha Base
Dr. Stephen Blount
Ms. Kelly Callahan
Ms. Kenya Casey
Mr. Yohannes Dawd
Ms. Erika Dillingham
Ms. Emily Griswold
Ms. Shakia Guest
Ms. Madelle Hatch
Mr. Andrew Heacox
Ms. Lauri Hudson-Davis
Dr. Moses Katabarwa*
Ms. Nicole Kruse
Dr. Scott Nash
Ms. Anne Nguyen
Dr. Gregory Noland
Amb. Mary Ann Peters
Ms. Lindsay Rakers
Ms. Faith Randolph
Ms. Julia Rankine
Dr. Frank Richards*
Dr. Ernesto Ruiz-Tiben
Ms. Angelia Sanders
Ms. Lauren Shewmaker
Ms. Janet Shin
Dr. Dean Sienko
Mr. Randall Slaven
Ms. Emily Staub
Mr. Marc Tewari
Mr. Craig Withers

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Mr. Firdaweke Bekele – Ethiopia
Dr. Luccene Desir – Dominican Republic
Dr. Abel Eigege – Nigeria
Mr. Yemane Elill - Ethiopia
Dr. Emmanuel Emukah – Nigeria
Dr. Tekola Endeshaw – Ethiopia
Ms. Peace Habomugisha – Uganda
Dr. Cephas Ityonzughul – Nigeria
Ms. Annet Khainza - Uganda
Mr. Aderajew Mohamed – Ethiopia
Dr. Emmanuel Miri – Nigeria*
Mr. Adamu Sallau – Nigeria
Dr. Mauricio Sauerbrey – Guatemala
Dr. Zerihun Tadesse – Ethiopia
Mr. Abate Tilahun – Ethiopia
Mr. Makoy Samuel Yibi - Sudan

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Dr. Barbara Marston
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Hon. Prof. Isaac Adewole – Nigeria
Ms. Ifeoma Anagbogu – Nigeria
Mr. Kadu Merido Burika – Ethiopia
Mr. Sindew Feleke - Ethiopia
Mr. Bizuayehu Gashaw - Ethiopia
Mr. Biruck Kebede – Ethiopia
Mr. Thomson Lakwo – Uganda
Hon. Dr. Joyce Moriku – Uganda
Dr. Evelyn Ngige – Nigeria
Dr. Edridah Tukahebwa – Uganda
Dr. Tsigereda Wolde - Ethiopia
Mr. Asam Zroug – Sudan

University and NGDO Personnel and Special Guests
Ms. Fanny Adjarho – Consulate General - Nigeria
Dr. Sergio Bernardes – University of Georgia
Ms. Gloria Chukwurah – FMOH Nigeria
Mr. Daniel Cohn – RTI International
Dr. Elizabeth Cromwell – IHME
Ms. Amy Doherty – RTI International
Dr. Mark Eberhard
Dr. Elizabeth Elhassan – Sightsavers
Dr. Darin Evans – U.S. Agency for International Development
Ms. Tina Flores – Rabin Martin
Dr. Mike French – RTI International
Rev. Dick Game – St. Patrick's Episcopal Church
Dr. Katherine Gass - Task Force for Global Health
Ms. Elizabeth Heilmann – Emory University
Dr. Rafe Henderson
Dr. Rubina Imtiaz – Task Force for Global Health
Mr. Warren Lancaster – The END Fund
Ms. Joni Lawrence - Task Force for Global Health
Dr. Deborah McFarland – Emory University
Prof. Edwin Michael – University of Notre Dame
Dr. Imran Morhasen-Bello – FMOH Nigeria
Mr. Aryc Mosher – USAID
Dr. Johnson Ngorok - Sightsavers
Prof. B.E.B. Nwoke – Imo State University Owerri

Annex 4: List of Program Review Participants (Continued)

University and NGDO Personnel and Special Guests (Continued)

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Dr. Kisito Ogoussan - Task Force for Global Health
Dr. Eric Ottesen - Task Force for Global Health
Mr. Roger Peck – PATH
Ms. Sonia Pelletreau – Children's Investment Fund Foundation
Prof. Rory Post – Liverpool John Moores University
Dr. Alfons Renz – Inst. Für Evolution und Ökologie
Dr. Magda Robalo – WHO (AFRO
Dr. David Ross – Task Force for Global Health
Ms. Hassatu Sarika – NAFDAC
Dr. Anders Seim – HDI
Mr. Oumer Shafi – Emory University
Dr. Yao Sodahlon – Task Force for Global Health
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Ms. Jamie Tallant – The End Fund
Ms. Wangeci Thuo – RTI International
Dr. Thomas Unnasch - University of South Florida
Mr. Paul Weiss – Emory University
Ms. Leslie Weston – Bill & Melinda Gates Foundation

ANNEX 5

Twenty-First Annual Carter Center River Blindness Elimination
Program Review Agenda
Monday, March 27 - Wednesday, March 29, 2017
The Carter Center, Atlanta GA

Day 1: Monday, March 27, 2017		
8:00	*Shuttle Pickup at Hotel*	
8:30-9:00	*Continental Breakfast*	
9:00-9:40	Welcome Overview and Introduction	Dr. Dean Sienko Dr. Frank Richards
Morning Session Chair: Dr. Mauricio Sauerbrey		
9:40-10:10 10:10-10:25	Nigeria: Treatments - Southeast/Plateau & Nasarawa States *Discussion*	Dr. Abel Eigege
10:25-10:55	*Coffee Break*	
10:55-11:15 11:15-11:25	Nigeria: Coverage Surveys - 2017 and Twice-Per-Year *Discussion*	Ms. Emily Griswold
11:25-11:55 11:55-12:10	Nigeria: Impact, Training, Integration & Community Ownership *Discussion*	Dr. Emmanuel Miri
12:10-1:40	*Lunch*	
Afternoon Session 1 Chair: Ms. Peace Habomugisha		
1:40-2:00 2:00-2:10	Nigeria: Diagnostic Studies - Wb123, ICT and Ov16 *Discussion*	Dr. Gregory Noland
2:10-2:30 2:30-2:40	Nigeria: MIS Survey Update *Discussion*	Ms. Elizabeth Heilmann
2:40-3:00 3:00-3:10	Nigeria: RB Treatments in Hypoendemic Areas in the SE *Discussion*	Ms. Lindsay Rakers
3:10-3:40	*Coffee Break*	
Afternoon Session 2 Chair: Emmanuel Miri		
3:40-4:10 4:10-4:25	Ethiopia: Treatments and Impact *Discussion*	Mr. Aderajew Mohammed
4:25-4:55 4:55-5:10	Ethiopia: Training, Integration & Community Ownership *Discussion*	Dr. Zerihun Tadesse
5:10-5:40 5:40-5:55	Ethiopia: Proposed New Initiatives -Triple-Drug Administration & Quarterly Ivermectin Treatment *Discussion*	Mr. Biruck Kebede
5:55	*Session Adjourned*	
6:00	*Shuttle Departs for Hotel*	
6:30	***Atlantic Station Shopping Trip - Pickup from Hotel***	

Twenty-First Annual Carter Center River Blindness Elimination
Program Review Agenda
Monday, March 27 - Wednesday, March 29, 2017
The Carter Center, Atlanta GA

Day 2: Tuesday, March 28, 2017		
8:00	*Shuttle Pickup at Hotel*	
8:30-9:00	*Continental Breakfast*	
Morning Session Chair: Dr. Zerihun Tadesse		
9:00-9:30 9:30-9:45	Uganda: Treatments and Impact *Discussion*	Mr. Thomson Lakwo
9:45-10:15 10:15-10:30	Uganda: Training, Integration & Community Ownership *Discussion*	Ms. Peace Habomugisha
10:30-11:00	*Coffee Break*	
11:00-11:20 11:20-11:30	Uganda: Onchocerchiasis Elimination Expert Advisory Committee *Discussion*	Dr. Thomas Unnasch
11:30-11:50 11:50-12:00	Sudan: Treatment and Plan for Khor Yabus *Discussion*	Dr. Nabil Aziz
12:00-1:30	*Lunch*	
Afternoon Session Chair: Dr. Nabil Aziz		
1:30-2:00 2:00-2:15	ESPEN *Discussion*	Dr. Magda Robalo
2:15-3:00 3:00-3:15	OEPA Overview 2016 *Discussion*	Dr. Mauricio Sauerbrey
3:15-3:45	*Coffee Break*	
3:45-4:15 4:15-4:30	Freedom From Infection *Discussion*	Prof. Edwin Michael
4:30-4:50 4:50-5:05	Uganda: Onchocerca Ochengi and its Impact on Monitoring Onchocerciasis Elimination *Discussion*	Dr. Moses Katabarwa
5:05-5:25 5:25-5:40	Mectizan Donation Program: Update *Discussion*	Dr. Yao Sodahlon
5:40	*Session Adjourned*	
5:45-7:45	***Reception: The Carter Center "Jimmy Carter Museum & Lobby"***	
7:45	*Shuttle Departs for Hotel*	

Twenty-First Annual Carter Center River Blindness Elimination
Program Review Agenda
Monday, March 27 - Wednesday, March 29, 2017
The Carter Center, Atlanta GA

Day 3: Wednesday, March 29, 2017		
8:45	*Shuttle Pickup at Hotel*	
9:15-9:45	*Continental Breakfast*	
9:45-10:00	*Group Photo*	
10:00-10:25 10:25-10:30	Introduction: Day's Proceedings Recognition of Nigeria's 500 Million Treatment Celebration	Dr. Frank Richards Amb. Mary Ann Peters
10:30-10:50 10:50-11:00	Nigeria: Loa Loa Study *Discussion*	Dr. Emmanuel Emukah
11:00-11:30	*Coffee Break*	
11:30-11:50 11:50-12:00	Nigeria Onchocerciasis Elimination Committee (NOEC) *Discussion*	B.E.B. Nwoke
12:00-12:20 12:20-12:30	Nigeria: MacArthur Grant Application *Discussion*	Dr. Frank Richards
12:30-2:00	*Lunch*	
2:00-2:20 2:20-2:30	Challenges of Coordinating RB/LF Stop-MDA Decisions *Discussion*	Dr. Gregory Noland
2:30-2:50 2:50-3:00	OEPA: UGA Mapping in the Siapa Valley *Discussion*	Dr. Sergio Bernardes
3:00-3:15	*Coffee Break*	
3:15-3:35 3:35-3:45	The Synergistic History: Uganda & OEPA Programs *Discussion*	Ms. Lauri Hudson-Davis
3:45-4:00	President Carter Comments	
4:00-4:20 4:20-4:30	Uganda: Community Control of Simulium Damnosum *Discussion*	Dr. Thomas Unnasch
4:30-5:00	Summary and Closure of the Twenty-First Session	Dr. Frank Richards
5:00	***2017 Carter Center River Blindness Program Review Adjourned***	
5:05	*Shuttle Departs for Hotel*	

ANNEX 6: River Blindness Elimination Program Review Contact List

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ANNEX 6: River Blindness Elimination Program Review Contact List

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ANNEX 7: The Lymphatic Filariasis (LF) Elimination Program

LF in Africa is caused by *Wuchereria bancrofti*, a filarial worm that is transmitted in rural and urban areas by *Anopheline* and *Culex sp*. mosquitoes, respectively. The adult worms live in the lymphatic vessels and cause dysfunction, often leading to poor drainage of lymphatic fluid. Clinical consequences include collection of lymph that results in swelling of limbs and genital organs (lymphoedema, "elephantiasis" and hydrocele), and painful recurrent bacterial infections ('attacks' of acute adenolymphangitis). The female worms release microfilariae, which are tiny embryonic worms that circulate in blood at night, when the mosquito vectors bite. Microfilariae are picked up by mosquitoes, develop over several days into infectious larvae, and are then able to be transmitted to another person when the mosquitoes bite again. Microfilariae are killed by annual single-dose combination therapy, with either Mectizan® (donated by Merck) and albendazole (donated by GSK/The Task Force for Global Health), or diethylcarbamazine (DEC) and albendazole (in areas where there is no onchocerciasis and/or *Loa loa* infection). Annual mass drug administration (MDA) prevents mosquitoes from becoming infected, and when given for a period of time (estimated to be five to six years), can interrupt transmission of *W. bancrofti* (which has no animal reservoir). In 2013, the WHO issued a 'provisional strategy' for *Loa loa* areas that includes the dual approach of albendazole monotherapy via MDA once or twice-per-year, together with long-lasting insecticidal (bed) nets (LLIN).

Nigerians suffer in disproportionate numbers from LF. Disease mapping of the country confirms that Nigeria is third globally behind India and Indonesia in the human suffering from this parasite. With 761 out of 774 LGAs of 36 States and the Federal Capital Territory mapped, 574 LGAs (75%) are endemic and over 100 million Nigerians are at risk. In Plateau and Nasarawa states, The Carter Center, working with the Federal Ministry of Health (FMOH) of Nigeria and with the state and local government ministries, assisted in establishing an LF elimination program. The effort is based on a strategy of health education (HE) and annual drug combination therapy with albendazole and Mectizan®. The manufacturers of the drugs have global donation programs for LF: GSK donates albendazole and Merck donates Mectizan®. After years of high treatment coverage, LF transmission was broken in the two states, and they are now under post-treatment surveillance for five years. Recent TAS surveys suggest that the PTS period has been successful and that LF has been eliminated as a public health problem.

Through a grant from the Bill & Melinda Gates Foundation, The Carter Center also conducted field research on the use of LLINs alone to combat LF in Imo and Ebonyi states, which are areas where LF MDA with Mectizan® was not currently possible due to the presence of *Loa loa*. Results showed that the LLINs had significant impact on mosquito infection (Richards et al., *Am J T Med Hyg* 2013). Thanks to the Global Fund Round 8, in the early 2010s, LLINs were mass distributed for malaria prevention, two per household, in the majority of Nigeria; this supplemented health education and drug combination therapy as one more way to fight LF. The national malaria and lymphatic filariasis programs are actively involved in The Carter Center-assisted program, and The Carter Center has assisted (in differing degrees) in the mass distribution of LLINs in all nine states where we work. Due in part to strong Carter Center advocacy, Nigeria

launched its FMOH Guidelines for Malaria-Lymphatic Filariasis Co-implementation in Nigeria in June 2013. We continue to work on this important synergy in Carter Center assisted states, although the Center's Malaria Program closed in 2014.

LF treatments in Nigeria expanded to the seven states we assist in the southeast in 2014, as part of the USAID ENVISION project, led by RTI International. Treatments started in 2014 in areas with an existing river blindness program, and in 2015 expanded to address all LF-endemic areas in the nine states. After two years of the provisional albendazole-alone monotherapy (together with LLIN) due to *Loa loa* concerns, The Carter Center, in partnership with the Federal and local governments of Nigeria, conducted a large survey in 2016 and determined that levels of *Loa loa* were not sufficient in our supported areas to preclude treatment. After our results were reviewed by the Mectizan Expert Committee, we can now begin supporting annual ivermectin and albendazole in those areas and do away with the less-efficient, albendazole-only approach. A publication on this work is forthcoming.

The LF program in Ethiopia was launched in 2008, starting with LF surveys for antigenemia conducted in several zones in western Ethiopia in areas where MDA for RB was ongoing (results reported in Shiferaw et al. *Trans Royal Soc Trop Med Hyg* 2011). With GSK support, The Carter Center assisted in the launching of a Ministry of Health LF elimination pilot program in 2009 that provided roughly 75,000 treatments annually. Now the program is delivering over one million treatments each year. Although LF mapping for Ethiopia has been completed, the Federal Ministry of Health identified the need for further surveys (Rebollo et al., *PLoS Negl Trop Dis* 2015). The Ethiopian Malaria Program completed the mass distribution of LLINs throughout the malaria endemic areas of Ethiopia (which, in our assisted areas, occurred in 2007 and 2010). The Carter Center has supported (again in differing degrees) this distribution in those regions we assist. These LLINs undoubtedly had impact on LF transmission.

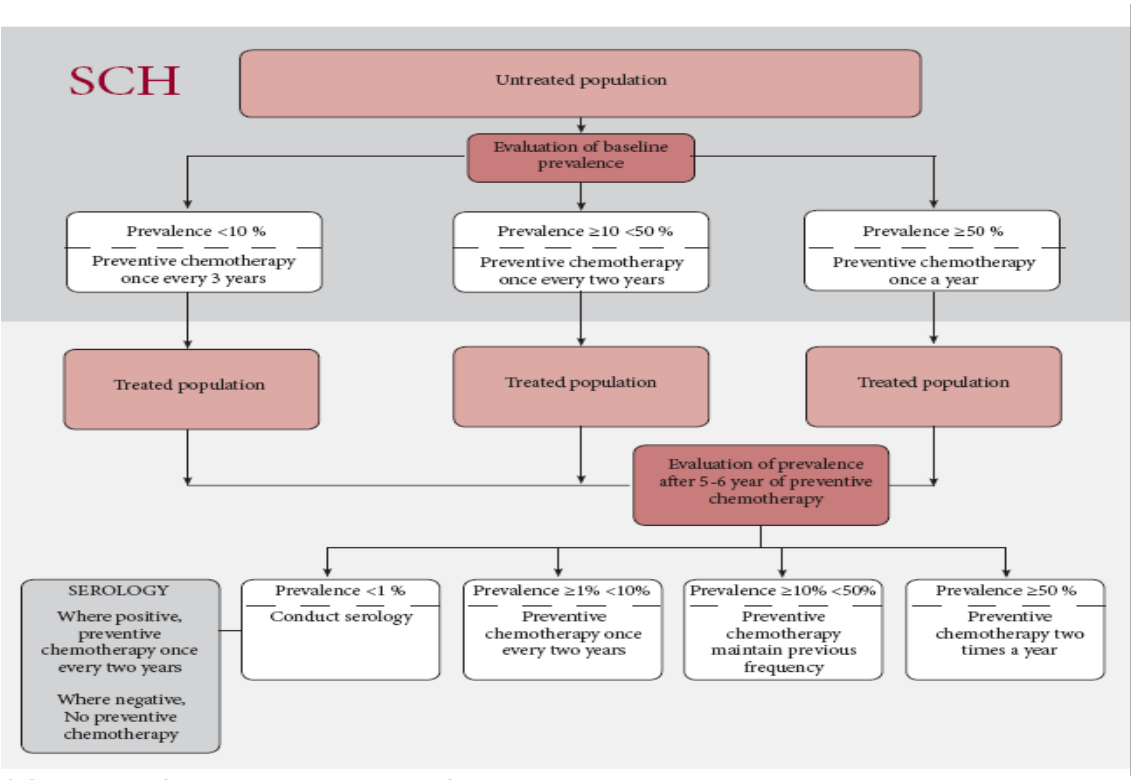
ANNEX 8: The Schistosomiasis/Soil Transmitted Helminthiasis Control Program

SCHISTOSOMIASIS

Schistosomiasis (SCH) is acquired from contact with infected fresh water. Cercariae, released from infected snails, penetrate the skin and develop into adult worms that reside in venules of the intestines (*Schistosoma mansoni*) or bladder and genitals (*S. haematobium*). It is important to note that SCH is actually two different infections with different geographical distributions, human epidemiology, and disease patterns (morbidity). In both conditions, female worms lay thousands of eggs that exit the body in feces (*S. mansoni*) or urine (*S. haematobium*). If the eggs gain access to fresh water, they hatch and release miracidae, which swim in search of certain types of snails (*S. mansoni* infects *Biomphalaria species*; *S. haematobium* infects *Bulinus species*) that they penetrate and infect. In the snails, a miracidium transforms and multiplies, resulting in a single snail releasing thousands of cercariae, thus continuing the lifecycle. Disease from schistosomiasis comes from the inflammation caused by the eggs deposited into human tissues by the adult female worms. These eggs cause inflammation, organ damage, bleeding, and anemia. Although all age groups are infected, school-aged children (ages five to 14) have the greatest number of adult worms, and act as the main disseminators of this infection by passing large numbers of eggs in their urine and feces. MDA with the safe and effective oral medicine praziquantel can significantly reduce schistosomiasis morbidity. Praziquantel kills the adult worms and so reduces the number of eggs that accumulate in tissues, and as a result reduces the disease (morbidity) associated with schistosomiasis. However, all age groups would need to be treated to have the greatest impact on transmission.

SCH programs are for morbidity control; transmission is unlikely to be interrupted until open defecation and urination (and reduction of release of raw sewage into fresh water) is halted through deployment and use of sanitary systems. MDA with praziquantel under current WHO guidelines will have little to no impact on infected snails (which live for many months), or developing (pre-adult) worms in humans. In other words, persons treated are not cured of their developing infections, or become reinfected within days of receiving praziquantel treatment.

The current WHO guidelines for schistosomiasis treatment (below) focuses on providing treatment to school aged children:



SOIL-TRANSMITTED HELMINTHS

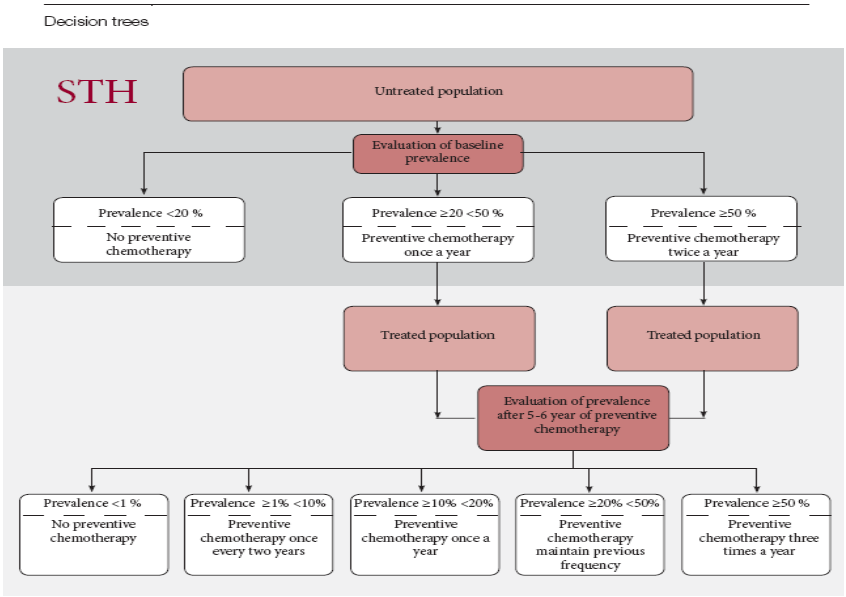
Soil-Transmitted Helminthiasis (STH) is caused by a group of four different intestinal worms that infect humans. STH are among the most common infections worldwide and heavy infections lead to developmental delay, malnutrition, intestinal obstruction, and anemia (depending on the infecting species). The causal agents in humans are the following intestinal lumen dwelling nematodes: *Ascaris lumbricoides* (roundworm), *Trichuris trichiura* (whipworm), or *Ancylostoma duodenale* and *Necator americanus* (hookworms).

Transmission of soil transmitted helminths occurs through feces. Eggs from the adult females are passed into the environment in feces, where they become infective within days (hookworm and whipworm) or weeks (roundworm). Once in the environment, infective eggs are passed to humans either by ingestion of fecally contaminated food or water (*Ascaris* and *Trichuris*) or through penetration of skin by larvae (*Ancylostoma* and *Necator*). The infective eggs of the whipworm hatch, mature, mate, and lay eggs in the intestines within 70-90 days. Both the roundworm, once hatched, and hookworm will migrate through the circulatory system until they reach the lungs. From there, they pass through the trachea and mouth where they are ingested, traveling from there to the intestines. They then mature, mate, and release eggs within 6-8 weeks.

Heavy infections result in blood loss leading to increased risk of anemia and hypoproteinemia which, in children, can lead to poor physical and developmental growth causing stunting and decreased mental acuity. In adults, this may reduce productivity. In

some cases, pulmonary complications can occur caused by the migration of roundworm or hookworm larvae through the lungs and in the case of *Ascaris,* bowel obstructions can occasionally lead to death. Hookworms have their highest prevalence in adults, but the current WHO guidelines (below) focus on STH control through MDA targeted at school aged children. STH programs are for morbidity control; transmission will not be interrupted until open defecation is halted through deployment and use of sanitary systems.

It is notable that the different species of worms have different sensitivities and cure rates from the MDA regimens provided: 1) albendazole is superior to mebendazole, and ascaris is most sensitive to treatment, while trichuris is least sensitive.



The challenges in implementing schistosomiasis and STH programs in TCC Nigeria programs have included: 1) complex WHO guidelines (shown above); 2) unclear global goals (control versus elimination, the latter requiring a major sanitation infrastructure investment); 3) alternating year treatment schedules for schistosomiasis (including treatment programs every third year); 4) twice-per-year treatment programs for STH; 5) focus on ministry of education partners ('school-based') rather than ministry of health, which is more experienced at MDA activities and an effective and long term partner of the integrated RBEP; 6) focus on teachers (in schools) rather than community distributors (house to house); 7) exclusion of potentially infected preschool children, unenrolled children, and adults (in most cases); 8) algorithms with thresholds statistically indistinguishable from one another; 9) mapping based on averages results in exclusion of communities that need interventions; 10) difficult calculations of coverage due to challenges with denominator determinations; 11) difficulty in justifying the closure of a long-standing infrastructure (community-based interventions) that work well, to start a new approach (school-based), and 12) loss of high quality STH control resulting from communitywide LF MDA with the most potent STH treatment (ivermectin and albendazole) when LF programs that pass TAS assessments cease treatment.

Annex 9: Publications by Year Authored or Coauthored by RBEP Personnel

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