

## Case Study Series on Malaria in Conflicts and Emergencies



Case Study Series  
on Malaria in Conflicts  
and Emergencies

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**Recommended Citation**

Malaria Elimination Initiative. (2019). *Case Study Series on Malaria in Conflicts and Emergencies*. San Francisco: The Global Health Group, University of California, San Francisco.

Produced in the United States of America. First Edition, November 2019.

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Cover photo © Cpl. Alicia R. Giron  
Haitian citizens walk through the flooded streets of Port-au-Prince, Haiti, November 6, 2010, after Hurricane Tomas hit the country.

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The Malaria Elimination Initiative (MEI) at the University of California San Francisco (UCSF) Global Health Group believes a malaria-free world is possible within a generation. As a forward-thinking partner to malaria-eliminating countries and regions, the MEI generates evidence, develops new tools and approaches, disseminates experiences, and builds consensus to shrink the malaria map. With support from the MEI's highly-skilled team, countries around the world are actively working to eliminate malaria – a goal that nearly 30 countries will achieve by 2020.

[shrinkingthemalariamap.org](http://shrinkingthemalariamap.org)

## Contributors and Acknowledgements

This report was authored by Gretchen Newby, with support from Kelly Harvard, Ingrid Chen, and Kayla Escobar of the Global Health Group at the University of California, San Francisco (UCSF) and Suguni Loku Galappaththy of the University of Missouri, and oversight and guidance from Charlotte Rasmussen and Carlota Gui of the Global Malaria Programme (GMP) at WHO.

The following individuals reviewed drafts of the report and provided important assistance and feedback: Allison Phillips, Jennifer Wegbreit, and Chris White of the UCSF Global Health Group; Kim Lindblade and Pascal Ringwald of GMP; members of WHO's Strategic Advisory Group on malaria eradication; and attendees of the Fourth Meeting of the WHO Strategic Advisory Group on malaria eradication, Geneva, Switzerland, 28-29 November 2018.

The author acknowledges with thanks the several key informants who gave their time and invaluable insight during data collection and draft review.

The author is responsible for any errors or omissions.

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# Introduction

In recent years, in light of remarkable progress in reducing malaria morbidity and mortality and the achievement of elimination in several countries, the malaria community has begun to discuss setting a goal for eradicating global malaria transmission within the next few decades.<sup>1–3</sup> In 2016, the World Health Organization's (WHO) Global Malaria Programme convened a Strategic Advisory Group on malaria eradication (SAGme) to evaluate the feasibility of this ambitious goal, as well as identify the major challenges, potential strategies, and expected costs of an eradication campaign.<sup>4</sup> The SAGme has developed a series of work packages to analyze the various biological, technical, financial, socioeconomic, political, and environmental factors that underpin malaria transmission, one of which is an assessment of the potential factors that could threaten or delay eradication. Identified potential threats include crossover of zoonotic malaria, environmental changes, natural disasters, and conflict.

Complex emergencies—encompassing both natural and man-made disasters, including violent conflict—are increasing in number and intensity as a result of rapid population growth, high population mobility, erratic weather due to climate change, and numerous sociopolitical factors.<sup>5</sup> The top risks identified in the Global Risks Report for 2019 included extreme weather events, natural disasters, and failure of climate-change mitigation and adaptation.<sup>6</sup> Emergencies such as these have a tremendous impact on population health, leading to increased rates of morbidity and mortality from a range of infectious and noncommunicable diseases and disrupting the delivery of normal health services. In malaria-endemic countries, complex emergencies can drive the movement of displaced, non-immune populations into high transmission areas with poor quality or absent housing, increasing the likelihood of exposure

to malaria infection. Conversely, populations from high transmission areas may move into areas that are relatively malaria-free but still receptive to transmission, and the arrival of an infectious reservoir can trigger localized outbreaks. Other factors that may lead to intensified malaria transmission in these settings include lack of access to effective case management and prevention interventions, poor nutrition, and overcrowding.<sup>7,8</sup> In addition, countries and global donors are under increasing pressure to divert money away from routine health programs and comprehensive health systems strengthening efforts which undermines their ability to respond to and recover from crises.<sup>9</sup> Progress toward malaria elimination and eventual global eradication will rely, in part, on national malaria programs and other stakeholders in the malaria community recognizing these potential risks and being prepared to implement strategies that alleviate the effects of complex emergencies.

As part of the Threats to Eradication work package, the University of California, San Francisco (UCSF) Global Health Group conducted a series of short case studies investigating malaria control and elimination efforts in conflict and emergency settings, both past and current, drawing out challenges, successes, and lessons learned. Malaria control and elimination activities were examined in the context of diverse emergency settings to identify a range of learnings: violent conflict, focusing on Afghanistan; natural disasters, focusing on the 2010 earthquake in Haiti; and other health emergencies, focusing on the 2014–15 Ebola outbreak in Sierra Leone. The goal of the case study series was to identify best practices that can be incorporated into future strategies as malaria programs and stakeholders set out to mitigate potential risks and drive progress toward national, regional, and global elimination and eradication goals.

## Methods

A short-list of potential focus countries was developed for each complex emergency category identified above, based on emergency situations that have unfolded over the past two decades. More recent events from the last 5–10 years were prioritized to ensure that malaria program activities reflect contemporary strategies and interventions. Countries were also selected such that diverse geographies and transmission settings were represented. Countries were removed from the shortlist if there was a dearth of available evidence on the complex emergency of interest and/or the malaria situation and program activities. Some emergency settings – for example, the war in Yemen, the displacement of Rohingya refugees to Bangladesh, or the collapse of the economy and health services in Venezuela – were removed because of the acute nature of the crises, likely resulting in a lack of access to timely data and/or unavailability of key informants.

Once focus countries were selected, the case study series utilized a mixed-methods approach, including a literature review, data extraction, and key informant interviews. As a first step, a semi-structured questionnaire was developed for each case study with questions addressing the following broad topics: brief history of malaria epidemiology and control efforts prior to the conflict/emergency; description of the conflict/emergency and its impact on the population; effects of conflict/emergency on malaria morbidity and mortality trends; description of how immediate malaria activities changed as a result of the acute conflict/emergency and why; description of the longer-term impact of conflict/emergency on malaria activities, if applicable; identification of major challenges, solutions, failures, and successes; and summary of lessons learned.

Next, a literature review was conducted, including peer-reviewed journal articles, web resources, malaria program reports and strategy documents, policy reports and documents from local and global

stakeholders, and other relevant published and grey literature. The review focused on malaria control in the context of complex emergencies as a general topic, historical and current country-specific malaria situations, and the conflicts and emergencies of interest. Using the questionnaires as a guide, data were extracted from the materials gathered through the literature review and summarized by topic.

Following data extraction, key informant interviews with WHO country representatives, malaria program managers, other staff from the Ministry of Health and WHO, and/or representatives from other partner organizations such as UNICEF were conducted by telephone to fill in remaining information gaps and to provide context and expert insight into the data gleaned from the literature review. Key informant input was merged and summarized across interviews in order to preserve anonymity.

Finally, a review of the series of ten case study reports on malaria elimination, launched jointly in 2012 by the UCSF Global Health Group and WHO's Global Malaria Programme, was conducted to extract relevant lessons from countries in the malaria elimination or prevention of re-establishment (POR) programmatic phase and supplement the learnings derived from this research. The previous case studies used similar, but more extensive, data collection methods relative to those described above and documented a wide range of activities and experiences over the history of the malaria programs. For the purposes of this research, only the content related to the complex emergencies the countries faced during their elimination/POR campaigns was extracted and summarized. Because the reports were published in 2015 and earlier, brief literature reviews were then conducted to determine the current situations in selected countries with regard to the complex emergencies described in the case studies. In addition, for Turkey and Turkmenistan, national malaria program managers provided updates via email.

## Results

### Malaria in the Context of Violent Conflict: Afghanistan

Afghanistan has been embroiled in violent conflict for decades, beginning with the 1979 Soviet invasion and decade-long occupation, the rise and fall of both the mujahideen government (1992–1996) and the Taliban regime (1996–2001) during a period of civil war, the US- and NATO-led combat operations (2001–2014), and the ongoing fighting by NATO and Afghan militaries against anti-government groups. The malaria burden as well as malaria program structure, operations, and strategies have all fluctuated dramatically as the nature of the conflict and its impact on the health system and affected populations have evolved over time.

#### Malaria trends and control efforts prior to conflict

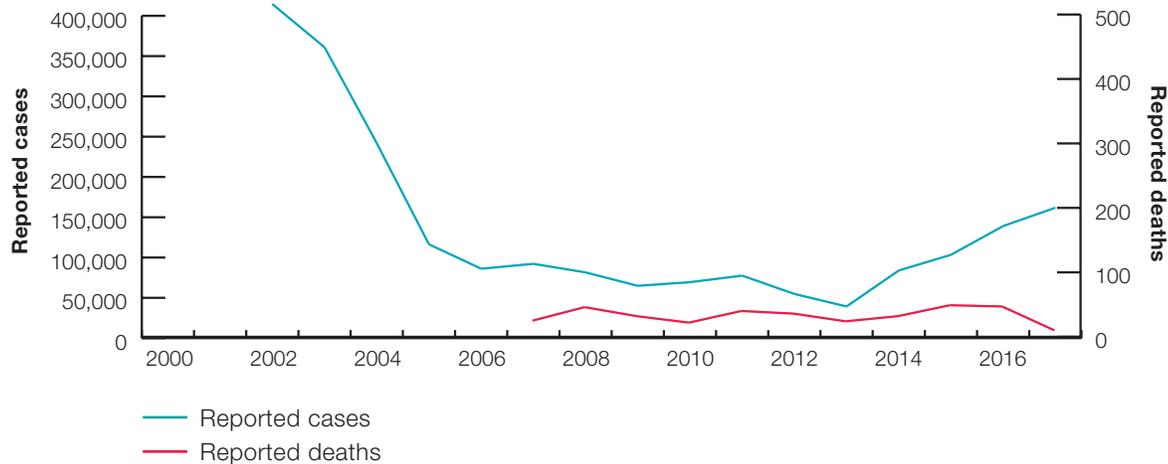
Historically, Afghanistan has had low malaria prevalence, even in the more endemic areas of the country.<sup>10</sup> Most of the terrain is mountainous (in the north and east) or desert (in the south and west), and incidence of malaria is determined by elevation, annual rainfall and snow-melt, and manmade factors such as irrigation systems and rice farming.<sup>11,12</sup> Transmission is seasonal, occurring between April and November, with *Plasmodium vivax* responsible for the majority of annual infections. *P. falciparum* is at the edge of its ecological range in Afghanistan; thus, transmission is unstable and subject to fluctuation based on environmental conditions.<sup>13,14</sup> Primary vectors include *Anopheles superpictus* (found in the Hindu Kush valleys in the east and responsible for most *P. falciparum* transmission), *An. hyrcanus* and *An. pulcherrimus* (found in the rice-growing areas of the north and responsible for most *P. vivax* transmission) and *An. stephensi* and *An. culicifacies* (found in the east and south).<sup>15,16</sup>

The first organized malaria control operations in Afghanistan were launched by the government in 1948. A campaign of indoor residual spraying (IRS) with DDT was scaled up nationwide by 1952, allowing agricultural development in many parts of the country that had previously been uninhabitable.<sup>10,17</sup> The National Institute for Malaria and Parasitology was established in 1954 and went on to oversee Afghanistan's elimination activities under the WHO's Global Malaria Eradication Programme (GMEP) beginning in 1956, which consisted primarily of IRS in rural areas and larval control in urban centers.<sup>10</sup> Financial and technical support for the bulk of the elimination campaign was provided by WHO and

UNICEF, and the USSR collaborated with the program to conduct field trials of mass drug administration (MDA) in the northern parts of the country.<sup>10,18</sup> Although these efforts were collectively successful in reducing malaria incidence, the goal of elimination in Afghanistan was ultimately deemed infeasible due to increasing insecticide resistance among the main vectors and a high degree of population mobility which made the targeting of interventions difficult. The malaria program transitioned to control activities in 1973, with a focus on increasing access to diagnosis and treatment through the expansion of community health posts, and maintenance of IRS.<sup>10</sup> The latter proved difficult to achieve due to periodic insecticide shortages throughout the 1970s, which led to focal outbreaks. During this period, 40,000–80,000 malaria cases were reported annually with an annual parasite index (API) of 2.5–5.0 per 1,000 population; 99% of infections were due to *P. vivax*.<sup>10,17</sup>

#### Description of conflict and its impact on malaria trends and control efforts: 1979–2013

In 1979, the USSR invaded Afghanistan and occupied the country for a decade, causing significant violence, societal upheaval, and the movement of an estimated one-third of the population into neighboring countries, mainly Pakistan and Iran. By the end of the occupation in 1989, Afghanistan's health infrastructure had been largely destroyed, numerous health staff had emigrated out of the country, and the malaria program had collapsed.<sup>10,17</sup> In the absence of consistent implementation of control measures and the proliferation of breeding sites in abandoned agricultural areas, the API rose to as high as 100 per 1,000 population in the late 1980s and early 1990s. *P. falciparum* accounted for nearly 20% of the malaria burden as a result of the mass return to the eastern provinces of Afghan refugees who had been infected while residing in camps in Pakistan.<sup>10,17,19</sup> A network of international and local NGOs began delivering malaria services throughout the 1980s and 1990s but implementation was patchy and sporadic. The main interventions were insecticide-treated nets and health education, selected because they did not require government input and were easily accepted by communities.<sup>17,20</sup> Reporting during this period of civil war was inconsistent and highly fragmented, so the impact of the limited malaria control interventions is unknown.<sup>10</sup> However, by the early 2000s, WHO estimated Afghanistan's malaria burden to be around 3 million cases per year.<sup>13</sup>

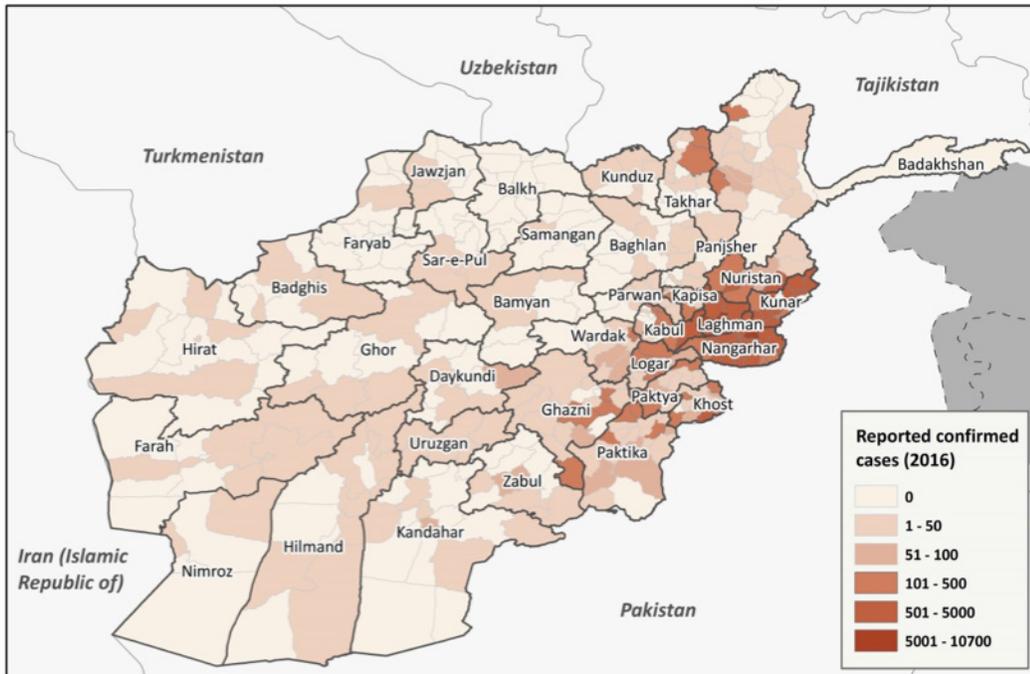
**Figure 1. Reported malaria cases and deaths in Afghanistan, 2002–2017<sup>25</sup>**

After the fall of the Taliban in 2001, NGOs and international aid organizations provided health care services while the new Afghan government rebuilt. Under the new national health system, vertical disease programs were abandoned due to ongoing instability; instead, malaria activities were integrated into primary care services.<sup>10,21</sup> In 2002, the Ministry of Public Health (MoPH) began rollout of a basic package of health services designed to efficiently deliver essential interventions – including malaria diagnosis and treatment – through regional and provincial hospitals down to the community health post level, even in areas with poor infrastructure and limited accessibility.<sup>22</sup> Artemisinin-based combination therapy (ACT) was introduced in 2003 and free distribution of long-lasting insecticide-treated nets (LLINs) began in 2005, supported through Global Fund grants.<sup>13,23</sup> Also in 2005, the basic package of health services expanded to include laboratory and diagnostic services at different levels of the health system, contributing to the overall strengthening of malaria case management. Reporting improved considerably with the establishment of a national health management information system and a disease early warning system to monitor morbidity and mortality of priority diseases, including malaria.<sup>13,24</sup> The expansion and strengthening of health services during this period had a positive impact on the malaria situation, despite ongoing conflict: between 2002 and 2013, reported malaria cases declined by more than 90% (Figure 1).<sup>25</sup> Key informants noted that additional drivers of the steep decline were likely climate change, economic development, and population movement into urban centers.

### Description of conflict and its impact on malaria trends and control efforts: 2014–present day

Despite significant case reduction across provinces in the north, northeast, and west, an overall increase in reported malaria cases was observed beginning in 2014, centered in the three highest transmission provinces in the eastern part of the country near the Pakistan border (Kunar, Laghman, Nangarhar) (Figures 1 and 2). While these provinces are affected by ongoing conflict, historically they have reported the most *P. falciparum* transmission due to the more tropical climate and hospitable environment for vectors.<sup>16,23</sup> Key informants believe the case increase in 2014 to be a result of several factors, including improved diagnosis and reporting due to the rollout of rapid diagnostic tests (RDTs) that year, and a delay in scheduled LLIN replacement because of localized conflict. However, since 2014 there has been an increase in the number of RDTs performed, and test positivity rate rose from 12% in 2014 to 17% in 2016, indicating that transmission may also be on the rise. The trends observed in 2014 continued over the next two years: in 2015, 80% of all confirmed cases were reported in Kunar, Laghman, and Nangarhar, and that figure grew to 85% in 2016 (Figure 2).<sup>23,26</sup> Key informants noted that neighboring provinces such as Khost, Paktika, and Paktya are also high-risk due to both security issues and environments conducive to vector breeding. As of 2017, 27% of Afghanistan's 35.5 million population live in areas of high transmission (>1 case per 1,000), 50% live in areas of low transmission (0–1 case per 1,000), and 23% live in malaria-free areas. *P. vivax* accounts for about 95% of all cases.<sup>25</sup>

**Figure 2. Reported confirmed cases in Afghanistan in 2016, by district<sup>23</sup>**



Malaria services are currently delivered by a network of healthcare providers. Government health workers deploy malaria interventions in stable, conflict-free areas through all levels of the health system, and in areas where anti-government sentiments are strong, these services are contracted out to NGOs. HealthNet International and Bangladesh Rural Advancement Committee are two such organizations with extensive ties in the Afghan communities they serve, and both have been primary or sub-recipients of Global Fund grants since 2005.<sup>13</sup> The National Malaria and Leishmaniasis Control Programme (NMLCP) at the MoPH provides oversight and strategic plans, develops policy and guidelines, and coordinates surveillance and monitoring and evaluation activities. Other main partners are United Nations Development Programme, the primary recipient for current Global Fund grants, and the country and regional offices of WHO, which provide technical guidance and analytical support.<sup>13</sup>

The NMLCP and its partners are working toward a national malaria elimination goal of 2030 using a phased approach, with immediate priority given to reducing all malaria transmission in high burden provinces and eliminating *P. falciparum* transmission in low burden provinces.<sup>27</sup> According to key informants and the 2018–2022 National Strategic Plan, the primary malaria control interventions in Afghanistan include prompt case management using RDTs and ACT with the

addition of primaquine when G6PD testing is available. Increasing staff capacity for case management and reporting has been a priority of the program in recent years, particularly at the community level. LLINs are the only vector control intervention, although IRS is being considered for use in outbreak settings and in provinces targeted for malaria elimination. Malaria education and community engagement is extensive, and mainly delivered through mosques and local leaders. Facilitators are recruited from within communities to help garner trust during data gathering for surveillance and to ensure community participation in malaria case management and prevention activities.<sup>21</sup> Afghanistan also collaborates with its neighbors through participation in interregional malaria meetings facilitated by WHO-EMRO and WHO-EURO, and through malaria networks and binational agreements. The NMLCP exchanges information with Tajikistan and Turkmenistan on malaria prevention and control activities in border areas in order to reduce the risk of importation into both countries, which are now malaria-free.<sup>28,29</sup> The NMLCP has also formed a network with the malaria programs in Iran and Pakistan to coordinate data exchange and synchronize border interventions. The three countries participate in annual meetings but have not yet conducted any joint activities.<sup>30</sup>

## Challenges, successes, and lessons learned

Key informants identified several major challenges for the malaria program going forward, foremost among them the ongoing violence which has escalated in frequency and become increasingly complex in the last few years. Because conflict in Afghanistan is sporadic and occurs throughout the country, it does not have a direct impact on malaria transmission. There are indirect effects, however, particularly when services are disrupted and health workers or facilities are specifically targeted for attack. In 2017, 164 health facilities were forced to close due to local conflict, affecting 3 million beneficiaries, and the number of health workers has decreased over time as a result of fear and inadequate compensation.<sup>31</sup> A related challenge is the repatriation of Afghan refugees from Europe, Iran, and Pakistan, estimated to be 1 million people per year in both 2016 and 2017.<sup>32</sup> In many parts of the country, infrastructure is still being rebuilt and ongoing violence has produced large numbers of internally displaced people – over 630,000 in 2016.<sup>33</sup> Thus, the health system lacks capacity to accommodate a high volume of incoming refugees, and if large numbers move into endemic areas, there is a strong likelihood of malaria outbreaks.<sup>34</sup> Capacity building, along with staff training, motivation, and retention are high priorities under the current National Strategic Plan.<sup>27</sup>

Additional challenges are inadequate resources and heavy reliance on global donors for funding. Budget limitations prevent full coverage of RDTs outside of the highest burden provinces and clinical diagnosis is still common in some areas, leading to overuse of malaria drugs and incomplete and/or inaccurate reporting of the malaria burden.<sup>14</sup> Similarly, key informants note that full coverage with LLINs cannot be achieved outside of the highest burden provinces, and there is no funding or capacity available to monitor LLIN usage or support IRS implementation. Increased domestic funding would allow the NMLCP to avoid the inefficiencies of the Global Fund grant structure and provide more flexibility in terms of choosing interventions and achieving desired coverage.

In the last fifteen years, the MoPH has significantly strengthened its capacity with the support of donors and partner organizations. Malaria service delivery, surveillance and reporting, laboratory and operational research capacity, and linkages with the community have all greatly improved as a result.<sup>14,24</sup> According to key informants, maintaining flexibility and adapting strategies to suit local circumstances is essential for success, particularly in unstable areas where the security situation constantly fluctuates. Another success factor is building trust within local communities through transparency, accountability, and regular engagement with local political and religious leaders. In areas where

government cannot operate, this relationship-building must be carried out by NGOs, and hiring health workers from local communities helps inspire confidence and ensures familiarity with local customs and social norms. Finally, strong collaboration and regular communication across all stakeholders—provincial- and national-level malaria program staff, NGOs, development councils, military and other government ministries, local leaders—were identified as critical for success, particularly in conflict areas.

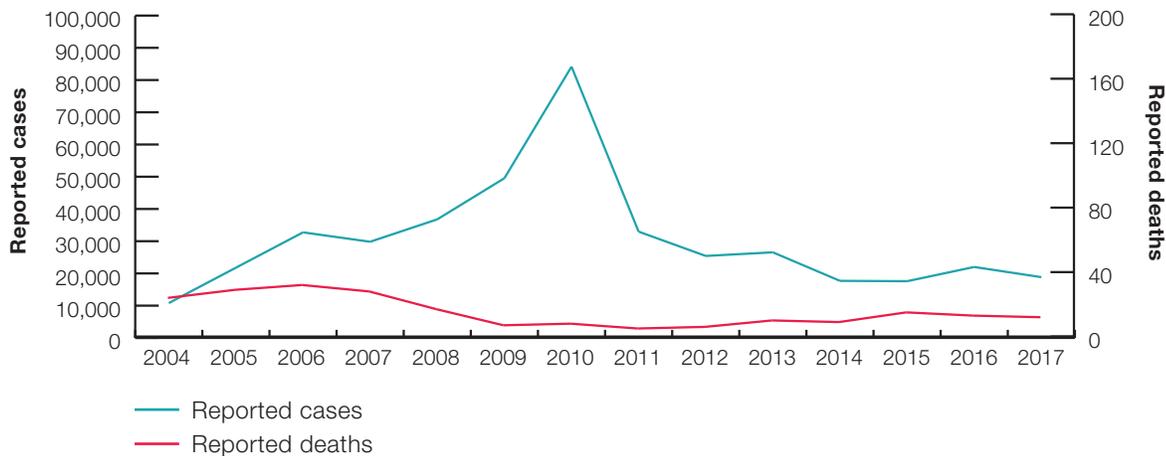
## Malaria in the Context of Natural Disasters: Haiti

On January 12, 2010, a magnitude 7.0 earthquake struck Haiti with an epicenter on the southern peninsula near the capital city, Port-au-Prince. The earthquake was devastating, causing considerable morbidity, mortality, and population displacement, and further straining the capacity of an already weak health system. In the intervening years, Haiti's recovery has been hampered by outbreaks of cholera, chikungunya, and Zika, as well as additional natural disasters, most notably Hurricane Matthew in 2016. Despite ongoing challenges, Haiti continues to work hard to end malaria transmission in 2020.

### Malaria trends and control efforts prior to earthquake

Haiti and its neighbor, Dominican Republic, make up the island of Hispaniola, the only remaining malaria-endemic area in the Caribbean. While half of the island's 21.8 million population resides in Haiti, the country accounted for 98% of Hispaniola's 19,000 reported malaria cases in 2017.<sup>25,35</sup> Malaria is extremely heterogeneous in Haiti as a result of both the natural environment and human activity, with small pockets of intense transmission scattered throughout otherwise low incidence areas.<sup>36,37</sup> The climate is tropical with two rainfall peaks per year; transmission is highest in May and November, corresponding with these peaks. The primary vector is *An albimanus*; *An pseudopunctipennis* is a secondary vector of minimal importance. Nearly all malaria cases are caused by *P. falciparum*, with sporadic cases of *P. malariae* reported.<sup>38</sup> The entire country is considered to be at risk, but the most vulnerable groups include remote populations living in poverty, particularly children under five years of age, and migrant farmers.<sup>37</sup>

Prior to the GMEP era, efforts to control malaria in Haiti centered on oiling, drainage, and filling of mosquito breeding sites.<sup>36</sup> Haiti's first organized malaria program, the Service National d'Eradication de la Malaria, was formed in 1958. By 1962, with financial and technical support from WHO-PAHO, USAID, and UNICEF, the program had replaced larval control in favor of IRS

**Figure 3. Reported malaria cases and deaths in Haiti, 2004–2017<sup>25</sup>**

with DDT, MDA with chloroquine, and community-level active case detection.<sup>36,39</sup> These interventions were very effective in reducing the malaria burden and elimination seemed within reach: slide positivity rate in 1962 was 6.5% and only 0.1% by 1966. However, budget constraints led to the cessation of IRS and MDA in areas that had greatly reduced but not yet eliminated malaria, and subsequent rainy seasons brought about frequent outbreaks.<sup>39</sup> After the conclusion of GMEP in 1969 and withdrawal of funding by USAID, interventions were carried out inconsistently and Haiti experienced a resurgence in cases. The national malaria program eventually closed in 1988 amidst a global financial crisis and domestic political instability, and for several years thereafter, malaria interventions were limited to epidemic response only.<sup>36,40</sup>

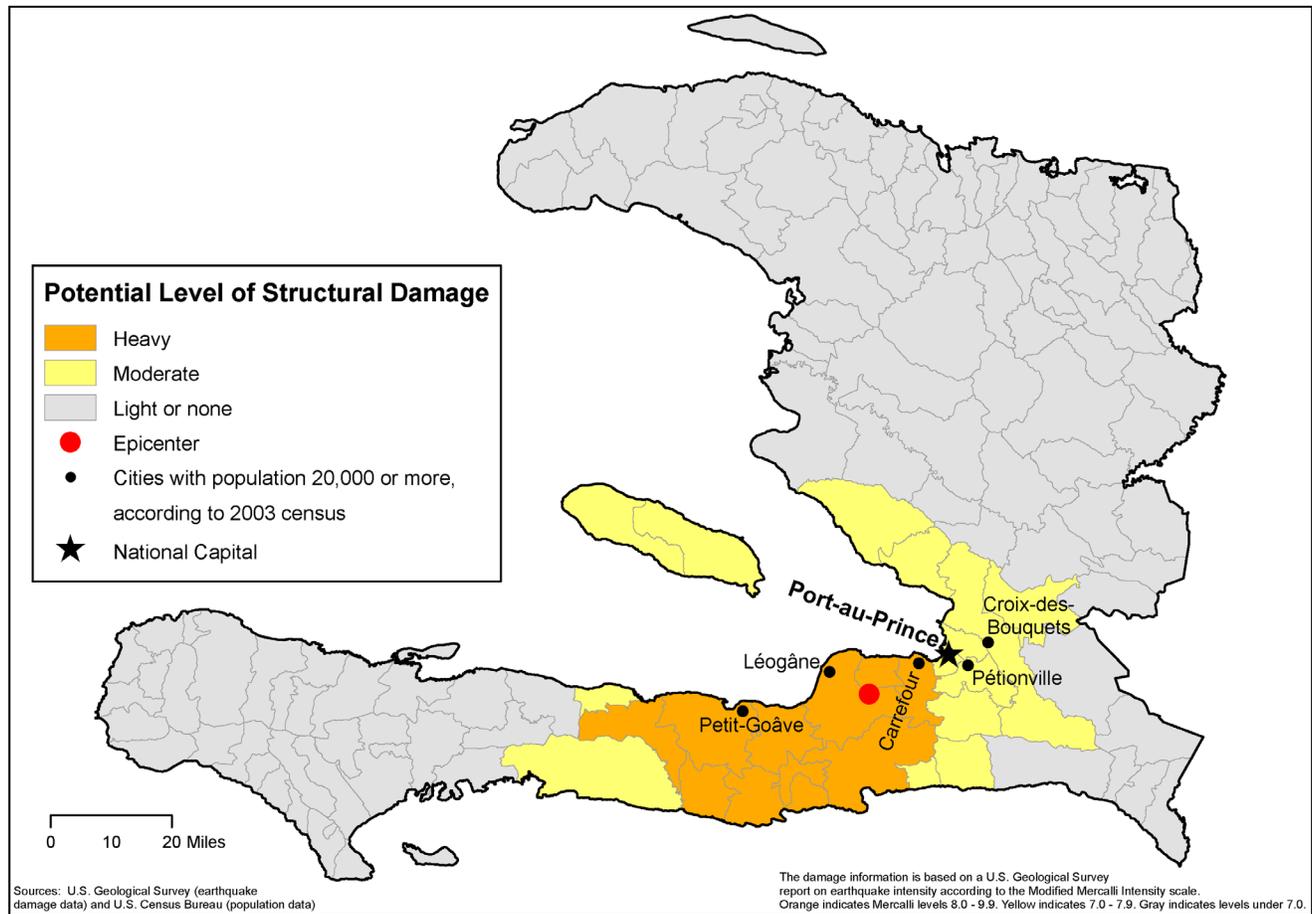
Concerted control efforts resumed in 2005 with the launch of the Program National de la Contrôle de la Malaria (PNCM), supported by a Round 3 grant from the Global Fund. Initial priorities during the period 2004–2009 included strengthening case management and reporting, LLIN distribution, and collaborating with Dominican Republic to plan and conduct joint malaria control activities.<sup>38,41</sup> Over the course of the Round 3 grant, reported cases increased three-fold as a result of improved testing and surveillance (Figure 3). However, underreporting persisted and was believed to be significant, and annual cases were likely closer to 200,000 during this period.<sup>25,42</sup> A malaria survey conducted in 2007 estimated *P. falciparum* prevalence to range from 1.5% to 15.7% across Haiti's ten departments.<sup>43</sup> In 2009, based on recent improvements in malaria program operations as well as the success of a cross-border pilot project supported by the Carter Center, the Haiti PNCM and its counterpart in Dominican Republic launched a binational plan to eliminate malaria from Hispaniola. The plan emphasized data-sharing and the harmonization of policies and strategies, with a goal elimination date of 2020.<sup>41,42</sup>

### Description of earthquake and its impact on malaria trends and control efforts

The earthquake struck Haiti at 4:53pm on January 12, 2010 with an epicenter located close to densely-populated urban areas, including Carrefour, Léogâne, Petit-Goâve, and Port-au-Prince (Figure 4). These cities suffered severe infrastructure damage. In the capital, the presidential palace and several government buildings were destroyed, including those which housed the Ministère de la Santé Publique et de la Population (MSPP) and the UN Stabilization Mission. Several seaports as well as the Port-au-Prince airport were damaged, leading to initial delays in the arrival of aid workers and emergency supplies.<sup>44,45</sup> An estimated 230,000 people were killed, more than 300,000 were injured, and in Port-au-Prince alone, more than 1 million people were left homeless. Large-scale population displacement occurred in the immediate aftermath of the earthquake, as 1.5 million people were displaced into temporary shelters and many others left urban centers to live with relatives in rural areas.<sup>44,46</sup>

The direct impact of the earthquake on malaria incidence is difficult to quantify. Most of the displaced population were living outside or in temporary shelters that offered negligible protection from mosquitos in the several months after the earthquake, potentially exposing them to more infectious bites.<sup>47,48</sup> The number of malaria cases reported in 2010 increased by 70% compared to 2009 (Figure 3), but key informants and others believe this to be a result of the same malaria patients being tested and reported more than once by the numerous NGOs providing humanitarian aid in temporary camps. In addition, surveillance and reporting prior to the earthquake was still being scaled up so cases during the period 2004–2009 were likely underreported. Data prior to and just after the earthquake is thought to be of poor quality overall.<sup>40,49</sup>

Figure 4. Impact of 2010 Haiti Earthquake<sup>45</sup>



The earthquake's impact on health system operations was more apparent. The PNCM was headquartered in the destroyed MSPP building, and there was extensive damage to laboratories and healthcare facilities that rendered them inoperable. In addition, many government staff and healthcare workers were killed or displaced.<sup>47,50</sup> Prior to the earthquake, the public health system in Haiti had very limited capacity due to chronic underfunding and inadequate staffing, so the human resource and infrastructure losses were crippling.<sup>44,51</sup> However, according to key informants, the PNCM was able to maintain operations after the earthquake despite major challenges, both in the earthquake-affected areas and beyond.

One of the first actions taken by the PNCM was obtaining emergency approval of RDT use for malaria diagnosis for 90 days immediately after the earthquake. This was necessary because microscopy was the only approved diagnostic method under national case management policy, and infrastructure and capacity for microscopy were limited post-earthquake. Mobile malaria teams were trained to use RDTs and were able to access the displaced population quickly, helping ensure prompt treatment for positive cases.<sup>41,47</sup> Later in 2010, in collaboration with CDC, the PNCM conducted a field

trial comparing performance of RDTs with microscopy to determine whether RDTs were sensitive enough for routine use in Haiti's low transmission epidemiological setting, and address concerns over sustainability and logistics. Based on the field trial results, three types of RDTs were approved for use throughout the recovery period and were later incorporated into national policy in 2012, although RDT data (number of tests performed and number of confirmed positives) were not consistently reported until 2014.<sup>25,41</sup>

Relatedly, another immediate priority for the PNCM was improvement of case reporting and surveillance. Several thousand NGOs had been operating in Haiti before the earthquake and more came in the aftermath to provide emergency services. As a result, data capture was inconsistent, with considerable gaps, duplication, and a lack of coordination with the MSPP and across organizations.<sup>41,46</sup> PAHO, CDC, and USAID supported the MSPP in establishing a National Sentinel Surveillance System to improve data capture and facilitate detection of and response to disease outbreaks. Initially, only suspected cases of malaria were reported but confirmed cases were included as the system expanded and diagnostic capacity improved.<sup>47,52</sup>

As the acute earthquake response shifted into a recovery and reconstruction phase, the PNCM refocused on strengthening routine malaria program operations—including increasing coverage with LLINs, minimizing delays in diagnosis and treatment, conducting community education and engagement activities, and implementing operational research—in preparation for elimination by 2020, the goal declared just before the earthquake.<sup>53</sup> Over the next few years, solid progress was made with the financial support of Global Fund and USAID and technical support from PAHO, CDC, and UNICEF. The rollout of RDTs facilitated accurate diagnosis and reduced presumptive treatment, while the expansion of the new surveillance system improved data quality and timeliness of reporting.<sup>49</sup> Several research studies were conducted to build the evidence base and guide the selection of elimination strategies, including an evaluation of LLIN effectiveness, a pilot of community-based active case detection, and a mapping exercise to determine the degree of case clustering and improve case investigation and response.<sup>36,41,48</sup> In addition, an insectary was established for vector behavior studies and insecticide resistance monitoring, and laboratory capacity was increased to include molecular testing and drug resistance monitoring.<sup>38,41</sup>

Throughout the earthquake recovery period, the PNCM remained committed to achieving elimination. In 2013, the MSPP signed on with eight other countries as a participant of the regional initiative for the Elimination of Malaria in Mesoamerica and the Island of Hispaniola. MalariaZero—a consortium of research organizations, academic institutions, technical experts, and funders—formed in 2015 to support the malaria programs of Haiti and Dominican Republic in achieving the 2020 goal. In 2016, the Haiti PNCM launched a 2016–2022 Plan Strategique National d'Elimination de la Malaria outlining strategic priorities for reducing transmission to zero by 2020 and sustaining elimination through 2022: continued expansion of RDTs and vector control, including antilarval measures; increasing human resource capacity, particularly at the local level through the hiring and training of 1,500 community health workers (CHWs); and strengthening surveillance through implementation of DHIS2 and building capacity for monitoring and evaluation.<sup>37,38,54</sup> Malaria burden remains stable and low: annual surveys since the earthquake indicate national prevalence rates of less than 1%, and 70% of Haiti's municipalities are classified as low endemicity (API of <1 case per 1,000 population).<sup>37,55</sup> Cases have been on the decline since the earthquake, although there was an increase in 2016 before decreasing again in 2017 (Figure 3). Key informants believe the increase is largely due to improved testing and reporting. However, given that the total positivity rate increased while the number of tests conducted remained the same compared to 2015, it may also reflect a rise in transmission after Hurricane Matthew struck in October

2016, causing extensive flooding and population displacement in areas with high malaria burden.<sup>41</sup>

## Challenges, successes, and lessons learned

Most of the challenges faced by the Haiti PNCM in the aftermath of the 2010 earthquake were a result of chronic weaknesses in the larger health system that were exacerbated by the ensuing damage and disruption. Many of these problems persist today, despite improvements in recent years.<sup>53</sup> The health sector is underfunded, with insufficient numbers of trained health workers. Access to healthcare is difficult for a large percentage of the population because of the distance to health facilities and high costs associated with obtaining care. Since quality of care is often inadequate, the population has poor health-seeking behavior and there is considerable distrust of the public health system.<sup>35,55,56</sup> Relatedly, key informants report that there is a lack of government ownership over the health system and Haiti has become over-reliant on external donors and NGOs to both fund and provide health services.<sup>53</sup>

As the recovery and reconstruction phase began post-earthquake, the MSPP was able to identify longer term health priorities and devise a strategy for addressing them with the financial and technical support of PAHO, CDC, USAID, the Global Fund, and other partners. The massive influx of donor funding allowed for the rebuilding of public health infrastructure with a focus on filling pre-existing gaps and strengthening capacities in human resources, laboratory facilities, and surveillance.<sup>41,51,57</sup> According to key informants, many of the emergency funds were not earmarked for specific activities which allowed the MSPP and its partners a greater degree of flexibility and the ability to prioritize improvements that would help ensure the sustainability and resilience of Haiti's health system. The devastation of the earthquake notwithstanding, the recovery period presented the PNCM and its partners with the resources and the opportunity to reestablish momentum toward malaria elimination in a more efficient and effective manner than before.<sup>41</sup>

One of the most essential lessons learned by the PNCM since the earthquake was the importance of maintaining commitment to and focus on the malaria elimination goal that had initially been set in 2009, despite numerous obstacles and setbacks. Once recovery began, the PNCM was able to identify program weaknesses and set rebuilding priorities with external partners that would facilitate progress toward elimination.<sup>41</sup> Key informants note that in the aftermath of the earthquake, malaria was not the most important health problem and other diseases and health concerns were given higher priority. However, the PNCM identified opportunities to integrate malaria elimination activities with other disease control efforts to improve

efficiency and take advantage of the funding and expertise that existed in other programs.<sup>41,58</sup> Another important lesson was the need for engagement and establishing trust among communities to improve malaria knowledge and health-seeking behavior, both in the context of an emergency such as the earthquake and for routine health needs.<sup>59</sup> According to key informants, strengthening community-level health delivery and employing more CHWs to provide local care among rural and remote populations will go a long way toward building trust and improving perceptions of the public health system.

## Malaria in the Context of Other Health Emergencies: Sierra Leone

The first outbreak of Ebola virus disease (EVD) to occur in West Africa began in December 2013 in Guinea, and quickly became an epidemic that spread throughout the country and into neighboring Liberia and Sierra Leone. Over the two years of the epidemic, Sierra Leone experienced the most cases and deaths of the three countries, in part due to eroded health infrastructure and a severe shortage of health workers – a legacy of the country's 11-year civil war that ended in 2002. The impact of the Ebola epidemic on the malaria program was considerable, with both negative and positive ramifications.

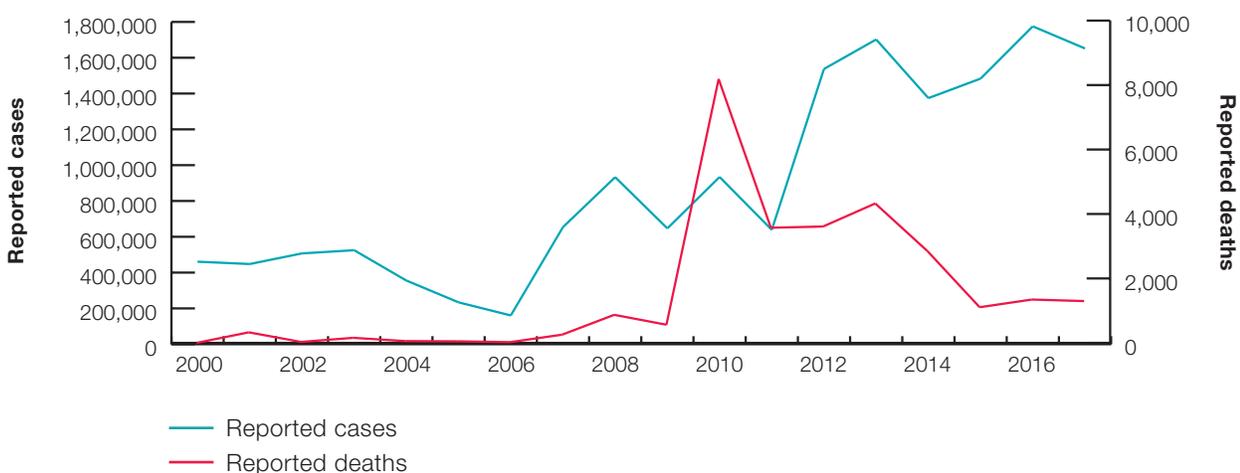
### Malaria trends and control efforts prior to outbreak

Sierra Leone has historically been highly endemic for malaria. Transmission is stable and occurs year-round in all parts of the country, with peaks in May and October at the beginning and end of the rainy season. The entire population is considered at risk, and malaria

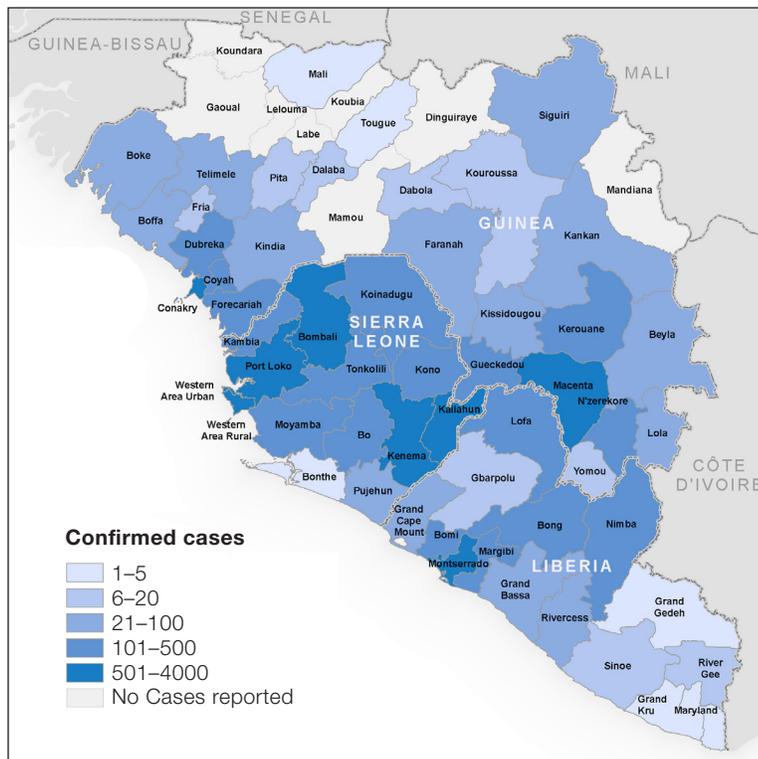
is the leading cause of morbidity and mortality in children under five years of age. *P. falciparum* causes 95% of all cases; *P. malariae* and *P. ovale* infections also occur. Primary vectors are *An gambiae* s.l. and *An funestus*.<sup>60–62</sup>

Organized efforts to control malaria transmission in Sierra Leone began in the early 20th century, with the use of window screens, netting, and removal or oiling of breeding sites. A field lab established in the capital city of Freetown by the British in 1920 oversaw extensive entomological, parasitological, and clinical research studies, but the lab was closed in 1945 when the national government took over malaria control.<sup>63</sup> From 1945 through the 1980s, IRS and MDA with chloroquine were implemented only sporadically and the malaria burden remained high: prevalence of *P. falciparum* infection among children was 61% in 1989. All malaria control efforts were disrupted when Sierra Leone's civil war began in 1991, and although the National Malaria Control Programme (NMCP) was established in 1994, coordinated control activities under a national strategic plan were not implemented until 2004, two years after the civil war ended.<sup>63,64</sup> Over the next ten years and with the support of WHO, Global Fund, and several implementing partners, the NMCP rolled out a comprehensive control program that included IRS, LLINs, and a case management strategy centered on the use of ACT, RDTs, and trained CHWs.<sup>60,64</sup> During this period, despite better coverage with preventive interventions particularly in high-risk districts, reported cases increased as a result of expanded access to parasitological diagnosis and more consistent surveillance and reporting (Figure 5).<sup>25,65</sup> By 2013, nearly two-thirds of households owned an LLIN, over 6,000 CHWs had been trained in malaria diagnosis and treatment, and more than 85% of suspected malaria cases detected in the public sector were tested.<sup>64,66</sup>

**Figure 5. Reported malaria cases and deaths in Sierra Leone, 2000–2017<sup>25</sup>**



**Figure 6. Total confirmed Ebola cases in West Africa 2013–2016, by district<sup>72</sup>**



### Description of outbreak and its impact on malaria trends and control efforts

The first EVD case in West Africa was identified in Guéckédou, Guinea, near the forested border region with eastern Sierra Leone and northwestern Liberia. The case occurred in December 2013 but was not reported until March 2014.<sup>67,68</sup> On May 25th, 2014, the first EVD case in Sierra Leone was confirmed in Kailahun district in the same border region. EVD then spread rapidly throughout the country: the Government of Sierra Leone declared a state of emergency in Kailahun in June, in neighboring Kenema district in July, and nationwide on July 30, 2014.<sup>69,70</sup> Transmission peaked in October, with approximately 500 total cases reported per week across the country's 14 districts (Figure 6), although actual EVD caseloads were presumed to be considerably higher due to underreporting.<sup>70,71</sup>

The outbreak started just as malaria transmission was peaking, and according to key informants, the malaria program had no external guidance on whether or how to continue operations and none of the staff had prior experience with EVD. A mass distribution of more than 300,000 LLINs had been scheduled for June 2014 and this was carried out as planned in all districts except Kailahun.<sup>64</sup> Although not quantifiable, key informants believe the increased coverage with LLINs likely prevented additional malaria cases and deaths in the covered areas during the EVD outbreak. However, all other malaria operations were halted along with routine

healthcare activities, primarily because fear of EVD kept both patients and health workers from attending clinics, most of which quickly closed.<sup>66,73</sup> This had a considerable impact on the malaria situation: although reported malaria cases declined in 2014–15 versus 2013 (Figure 5), it is estimated that lack of access to case management services during the outbreak led to an 88% increase in untreated malaria cases (~1.3 million cases) and 1,755 additional malaria deaths among children under age five. These increases went undetected and unreported as a result of the breakdown in services.<sup>74,75</sup>

Mounting a coordinated response and obtaining emergency funding was initially slow, according to key informants. The Government of Sierra Leone established an Emergency Operations Centre in July, and international organizations such as Médecins Sans Frontières (MSF) and UNICEF soon began setting up triage centers and treatment units, and recruiting and training community members to assist in containment operations.<sup>67,69,70</sup> Because the early symptoms of EVD were nonspecific and very similar to those of malaria and other febrile illnesses, it was estimated that one-third of patients admitted to treatment units between June and September did not actually have EVD.<sup>67,68</sup> In order to reduce the risk of exposing these people to EVD-positive patients in the treatment units and alleviate the overall patient burden, guidelines were issued by WHO in September 2014 to presumptively treat all patients meeting the EVD case definition with

antimalarials (a 3-day course of artesunate-amodiaquine [AS-AQ], according to national treatment guidelines at the time) and antibiotics while waiting for test results. Only those positive for EVD were admitted to the treatment units.<sup>66,76,77</sup> Many fever patients were too scared to present to EVD treatment units, so CHWs were also instructed to provide presumptive treatment with AS-AQ at the community level to anyone meeting the EVD case definition.<sup>73,76</sup>

Another control measure recommended by WHO in November 2014 was MDA, and as malaria cases and deaths increased and EVD treatment units were overwhelmed with patients, the NMCP worked with MSF, UNICEF, and Global Fund to carry out two rounds of MDA in December 2014 and January 2015.<sup>61,66,76</sup> A population of approximately 3 million people age six months or older in 8 of 14 highly malaria endemic districts were targeted for treatment with AS-AQ in both rounds, with the goal of rapidly reducing the malaria burden and the number of febrile patients treated as suspected EVD patients.<sup>61,66</sup> Prior to the MDA campaigns, intensive social mobilization and advocacy was carried out to ensure maximum participation. At least 60% effective coverage of the target population with full treatment was achieved despite stockouts of drugs in some areas, and the number of suspected and inpatient malaria cases and Ebola hotline calls all decreased in the weeks following the rounds of MDA.<sup>66</sup>

After peaking in October 2014, the number of new EVD cases slowly began to decline. By the time the outbreak was declared over by WHO in November 2015, Sierra Leone had recorded more than 8,700 confirmed cases—over two times the number reported in Guinea or Liberia—and nearly 3,600 confirmed deaths due to EVD.<sup>69,71</sup> According to key informants, the population subgroups worst affected were medical staff and traditional healers. More than 350 of the country's health-care workers had been infected and two-thirds died, the equivalent of 20% of the total healthcare workforce which had already been operating at very low capacity since the civil war. Prior to the outbreak, Sierra Leone had one of the highest patient-to-physician ratios in the world at 50,000 to 1, and the loss of so many health-care workers to EVD was devastating.<sup>78,79</sup> In July 2015, the President of Sierra Leone introduced a recovery plan in collaboration with WHO, focusing on building human resource capacity and a resilient health system in addition to strengthening surveillance, disease prevention, outbreak preparedness and rapid response, community engagement, and overall health management. The primary goals of the recovery plan were to rebuild community confidence in the health system and restore access to essential health services.<sup>71,79</sup> According to key informants, malaria patients resumed their regular use of health facilities for diagnosis and treatment in late 2015/early 2016, an indication that the recovery plan was having a positive impact.

In 2016, the NMCP launched a new malaria strategic plan with a focus on intervention scale-up and capacity-building. Case management with artemether-lumefantrine as the new first-line drug, intermittent preventive treatment for infants and pregnant women, IRS, mass distribution of LLINs, and intensified surveillance and monitoring and evaluation are the main interventions under the plan.<sup>61,65</sup> According to key informants, the NMCP is also prioritizing aggressive outreach to private hospitals to ensure they follow case management guidelines and report malaria cases to the public sector, as well as the development of a large network of more than 10,000 CHWs to improve community-level case management. Early success in these two areas led to an increase in the number of malaria cases reported in 2016 (Figure 5), and although malaria burden remains high—40% prevalence among children under five years in 2016—treatment seeking for febrile children is up to 71%, and 88% of positive cases detected in the public sector received treatment.<sup>80</sup>

## Challenges, successes, and lessons learned

The Sierra Leone malaria program faced many challenges during the EVD outbreak, most of which could be attributed to conditions that existed well before 2014. The health sector is chronically underfunded, health services are expensive, and there is an insufficient number of skilled health workers.<sup>62</sup> According to key informants, the NMCP is heavily dependent on external donors to fund malaria control activities and on international organizations to provide technical and operational support. Other persistent challenges over the past several years include high staff turnover, a weak supply chain, and gaps in coverage in more remote areas of the country. Key informants identified additional challenges that came to light during the EVD outbreak: community knowledge of malaria is good, but compliance with prevention and control interventions is poor, particularly usage of LLINs, adherence to drug regimens, and treatment-seeking behavior. Overall, it was estimated that outpatient attendance at health facilities dropped to just 10% during the outbreak, and patients with malaria symptoms were more likely to seek treatment through the private, informal health sector rather than attend public facilities.<sup>76,80</sup>

Once the outbreak was contained, the Government of Sierra Leone committed to strengthening the health system and improving capacity and preparedness.<sup>79</sup> According to key informants, a major goal is to ensure that local health staff have the expertise and resources to immediately respond to any emergencies that may arise without having to wait for external partners to come to their aid. While these reforms are taking place health system-wide and are not specific to the NMCP, key informants noted that malaria operations will benefit. Emergency planning is included in the current

malaria strategic plan and NMCP staff are being trained in emergency response alongside other health workers.

Numerous lessons were learned from the EVD outbreak, both malaria-specific and generalizable to the broader health system. According to key informants, the primary lessons for the malaria program center on creating strong partnerships and establishing trust and good communication with communities. Coordination and joint-planning between national and subnational NMCP staff and across local and international partners are important for both routine operations and emergency response. Strong community participation, regular engagement, and effective education are all essential, not only to improve the malaria situation but to ensure better trust and compliance with malaria interventions in the event of future health emergencies. In addition, in accordance with WHO recommendations on the use of MDA in complex emergencies, time-limited MDA was shown to be a highly effective strategy for reducing morbidity and mortality in the absence of routine health services, as well as easing pressure on the Ebola treatment units by freeing up beds and resources for actual EVD patients.<sup>68,81</sup>

During the outbreak, major drivers of EVD transmission were ongoing high-risk practices such as traditional burial ceremonies and refusals to seek treatment due to fear and distrust of the outbreak response carried out by the Government of Sierra Leone and external partners. Much of this fear and distrust arose from confusing, inconsistent, and even condescending messaging in the early days of the outbreak, as well as

forcible removal of infected patients from their homes and culturally insensitive burial practices.<sup>82,83</sup> While a top-down, command-and-control approach may be necessary to respond to and contain an outbreak, ensuring community buy-in requires a thorough understanding of cultural norms and the relationship dynamics between government and different population subgroups. Communities should be given the opportunity to participate in the response, and communication should be open, frequent, respectful, and tailored to different groups. Identifying community leaders and partnering with them to disseminate information and dispel myths and rumors can further establish trust.<sup>69,82,83</sup>

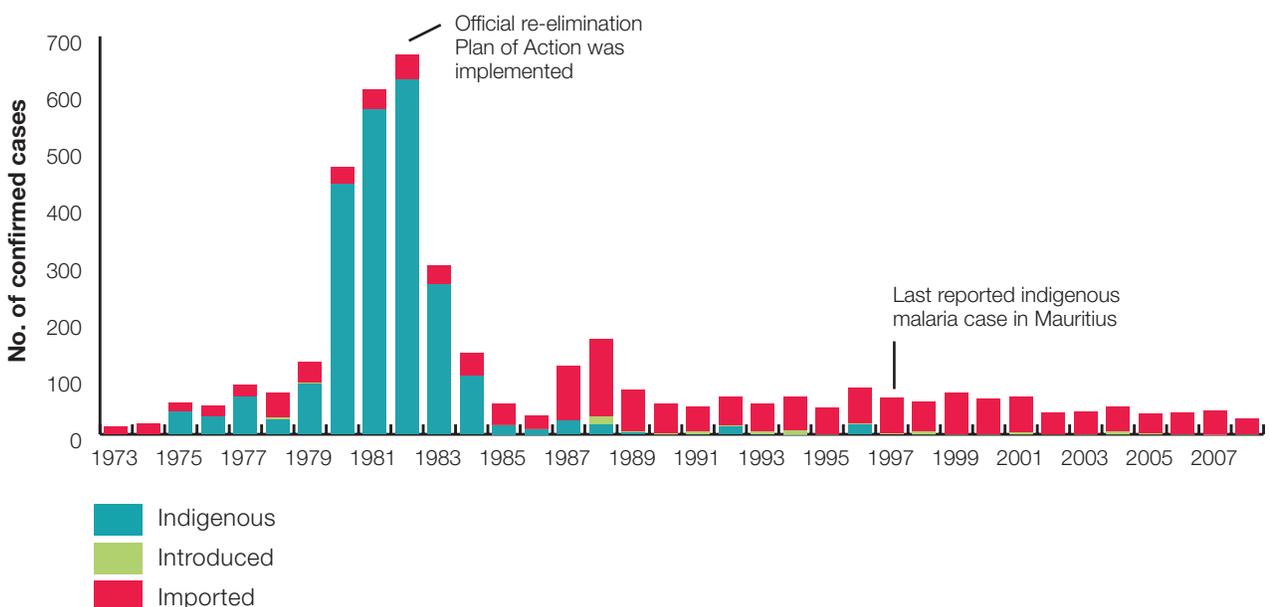
## Malaria Elimination Case Study Series

Five of the ten malaria elimination case studies provided details on the occurrence of complex emergencies and their effect on elimination and POR efforts: Mauritius, Sri Lanka, Turkmenistan, Turkey, and Bhutan. For the latter three countries, the emergencies took place in neighboring countries but had significant impact on local malaria situations and required specific interventions beyond routine national elimination strategies.

### Mauritius: natural disasters

Malaria was initially eliminated on the island of Mauritius in 1969 during the GMPE, and the country received WHO certification of its malaria-free status in 1973.

**Figure 7. Number of malaria cases reported in Mauritius, by origin of infection, 1973–2008<sup>84</sup>**



Mauritius remained both receptive and vulnerable to malaria transmission, however. The POR strategies put into place after certification consisted primarily of vector control and passenger screening at ports of entry as well as prophylaxis for travelers. Despite these efforts, Mauritius experienced a resurgence beginning in 1975 in the aftermath of Cyclone Gervaise. The storm caused extensive damage, creating many new breeding sites for the primary vector, *An arabiensis*, and numerous migrant workers from malaria endemic areas arrived to assist with reconstruction, reintroducing the malaria parasite. The first new cases detected on the island since 1968 were identified in an area where the visiting laborers were living. The situation worsened after another destructive cyclone hit in 1979, and by 1982, 623 cases were reported and all districts had active transmission foci (Figure 7).<sup>84</sup>

In response to the epidemic, the previously-disbanded Malaria Control Unit was reestablished to oversee intensified epidemiological and entomological surveillance, case management, vector control, and environmental management. In 1981, the Government of Mauritius updated its Prevention of Malaria Act to emphasize health education and community participation in malaria elimination activities, particularly larval source management on private property. The country's second elimination campaign was formally launched in 1982, and the resurgence was contained by 1989. After small outbreaks of *P. vivax* in 1992 and 1996, the last local case of malaria was reported in 1997 (Figure 7).<sup>84</sup>

A WHO-led analysis in 1980 revealed several factors that likely contributed to the resurgence in Mauritius, beyond the devastation caused by the cyclones. The POR program had not devoted adequate human or financial resources to surveillance, vector control, or larval source reduction, possibly because malaria activities had been integrated into general health services after certification; new breeding sites were identified on flat rooftops that allowed water to pool during the rainy season; community members were not participating in environmental management per the original Prevention of Malaria Act; and IRS was not as effective, perhaps due to growing resistance to DDT. In addition, the number of tourists and migrant workers visiting the island grew significantly beginning in the 1970s, many of whom came from malaria endemic areas in India and mainland Africa.<sup>84</sup>

Although cyclones and heavy rains are still an annual reality for Mauritius, the country was able to eliminate a second time and maintain POR over the past two decades by focusing program resources on reducing receptivity and vulnerability. Island-wide larval source management and vector control are conducted routinely, rapid response teams are equipped to detect and respond to every imported case, and incoming passengers are screened at ports of entry with a thermal fever

scanner and parasitological tests. Preventing the return of malaria remains a high priority for the Government of Mauritius to this day, and efficiencies have been gained by combining malaria surveillance and response efforts with those of other vector-borne diseases such as dengue, chikungunya, and Zika.<sup>84,85</sup>

### Sri Lanka: local conflict

In 2016, Sri Lanka was certified malaria-free by WHO after maintaining three consecutive years of zero transmission.<sup>86</sup> This remarkable accomplishment was even more striking in light of the separatist war that was fought in the north and east parts of the island nation from 1983 to 2009, causing significant loss of life, population displacement, and disruption of government services. Sri Lanka had nearly eliminated malaria during the GMEP, reporting only 17 cases in 1963. Unfortunately, elimination activities and funding were scaled back prematurely and the country experienced major resurgences within a few years (Figure 8). Sri Lanka shifted back to a policy of control after the GMEP ended.<sup>87</sup>

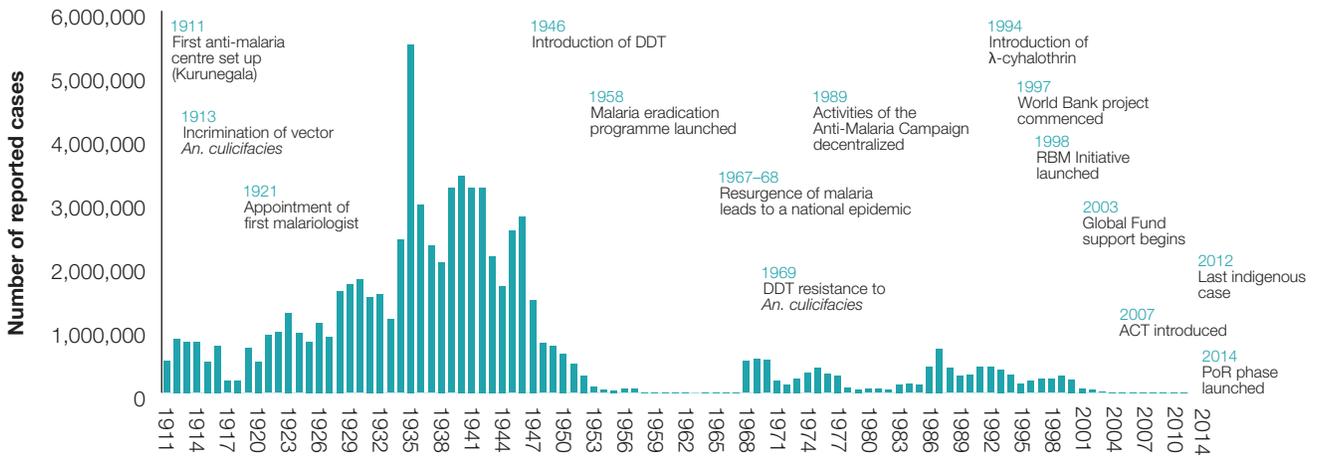
After the start of the separatist war in 1983, malaria program staff in the conflict areas continued to perform their duties when the security situation allowed it. Despite the instability, the malaria program remained intact and staff were able to work with separatist forces to some degree, coordinating mobile malaria clinics and carrying out IRS in the conflict areas whenever possible. Because the separatists were severely impacted by malaria, they had incentive to support the work of the local malaria program staff by facilitating access to the affected populations. However, instability caused consistent disruptions in the provision of diagnosis, treatment, and prevention interventions, and this led to a relatively steady increase in malaria cases in the conflict areas throughout the 1980s and 1990s. When Global Fund support began in 2003, a key component of every grant was the scale-up of intervention coverage in conflict areas. To accomplish this, the malaria program collaborated with local organizations to carry out community education, advocacy, and net distribution campaigns at a grassroots level, and conduct intensified surveillance through the recruitment and training of local staff in the affected districts. Over the next five years, the work of the malaria program and its partners brought cases in the conflict districts down to 272 from a peak of 154,465 in 1999 (Figure 9).<sup>87</sup>

Even after the war came to an end in 2009, government health capacity in the former conflict areas was limited and infrastructure had been heavily damaged. Local organizations continued to support the work of the malaria program as it began its transition to pre-elimination. Under the new strategy, Sri Lanka set a phased elimination goal, aiming to disrupt *P. falciparum* transmission by the end of 2012, followed by disruption of

*P. vivax* transmission by the end of 2014. However, improved capacity in the former conflict areas and intensified elimination strategies throughout the country led to the successful disruption of all malaria

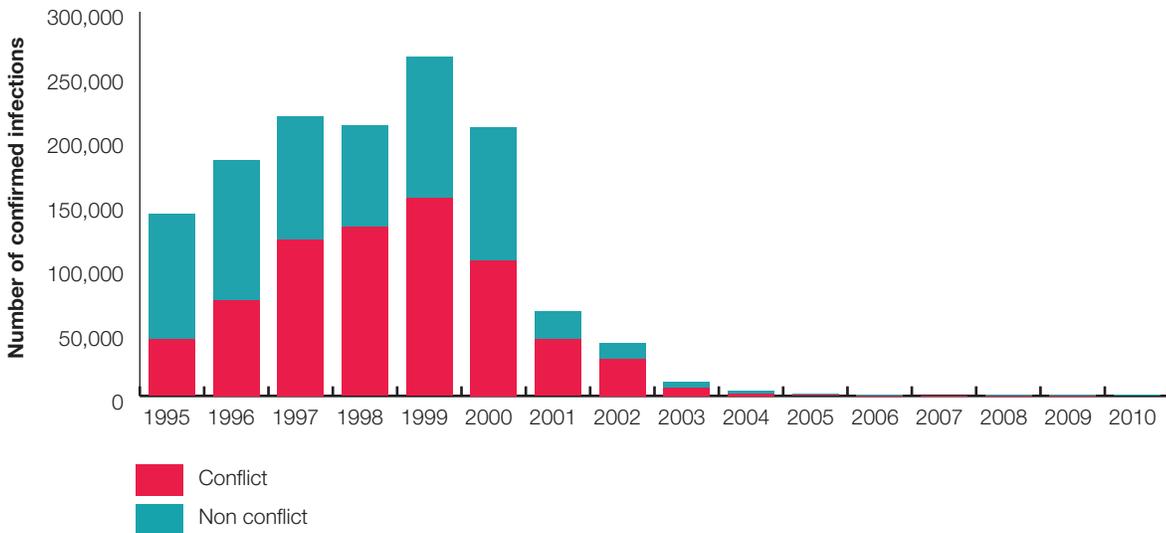
transmission in 2012: the last local cases of *P. falciparum* and *P. vivax* were reported in September and October 2012, respectively.<sup>88</sup>

**Figure 8. Historical timeline of malaria control in Sri Lanka, 1911–2014<sup>88</sup>**



ACT, artemisinin-based combined therapies; PoR, prevention of re-introduction

**Figure 9. Numbers of cases of malaria in conflict and non-conflict districts of Sri Lanka 1995–2010<sup>87</sup>**



## Turkmenistan: conflict in neighboring countries

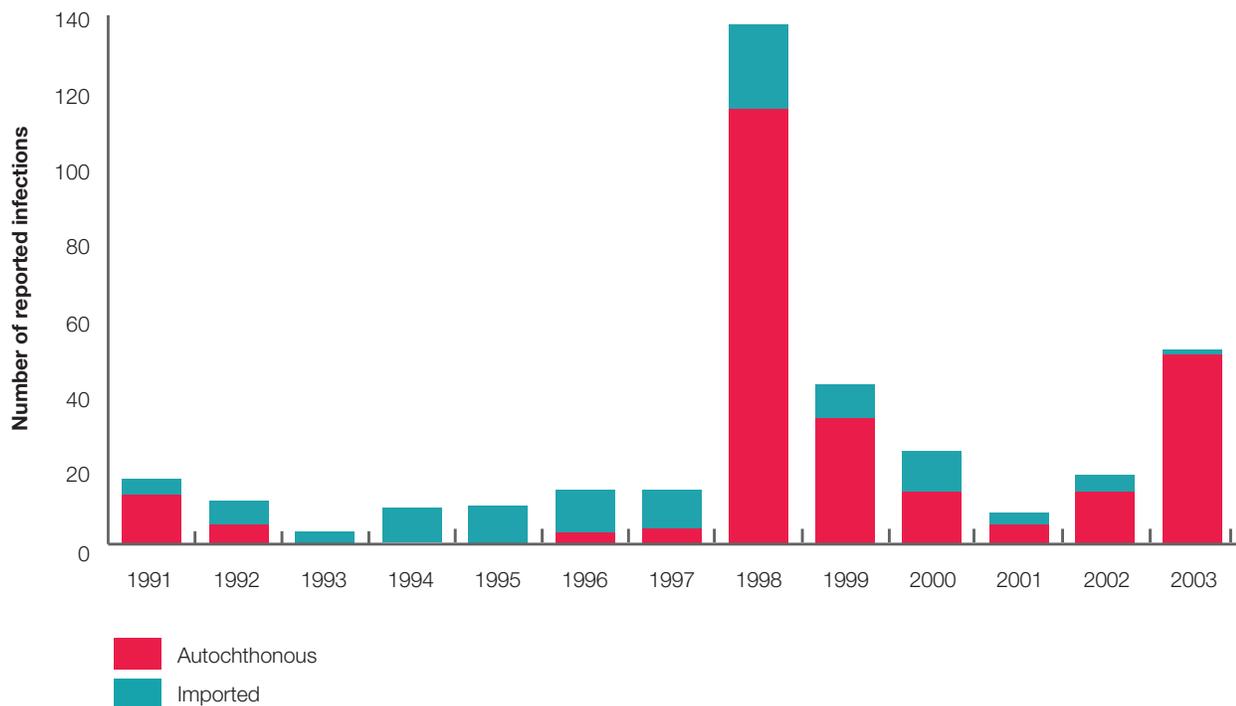
Turkmenistan first achieved malaria elimination in 1961 during the GMEP when it was a part of the USSR. Sporadic cases, both local and imported, were recorded over the next thirty years, but a rigorous surveillance and response strategy ensured that ongoing transmission was prevented. Most of the cases occurred near the southern border with Afghanistan, where receptivity was high: the climate in much of Turkmenistan is arid, but the border areas are characterized by foothills, oases, and manmade water bodies (e.g., irrigation canals, rice farms) conducive to mosquito breeding. Mosquitoes infected in Afghanistan were also able to transport malaria into Turkmenistan, heightening the risk for those living and working near the border – primarily gas and oil workers and soldiers stationed at border camps. Beginning in the 1980s, vulnerability in these areas increased as a result of troops returning from Afghanistan with malaria infections acquired during deployment. The situation worsened after the collapse of the USSR and Turkmenistan's subsequent independence in 1991, as returning military personnel continued to import cases but the malaria program's capacity to respond was severely diminished. The number of Afghan civilians crossing into Turkmenistan to escape unrest also increased at this time. After decades of negligible local malaria transmission, two successive

outbreaks occurred, the first in 1998–1999 and the second in 2002–2003 (Figure 10).<sup>28</sup>

With the support of WHO-EURO, the malaria program contained the outbreaks and focused on rebuilding the capacity lost after independence, filling open positions, implementing rigorous malaria control protocols, and stockpiling drugs, insecticides, and lab materials that had previously been in short supply. This momentum led to the adoption of an elimination strategy and Turkmenistan's endorsement of the Tashkent Declaration, a document signed in 2005 by nine malaria-endemic countries in the European region committing to a shared goal of national and regional malaria elimination by 2015. In fact, Turkmenistan had already achieved this goal: the last local cases were reported in 2004, and the country was certified malaria-free in 2010.<sup>28</sup>

In addition to strengthening surveillance, case management, and epidemic preparedness, a key component of Turkmenistan's elimination strategy was cooperation with neighboring Afghanistan, Iran, and Uzbekistan, including information sharing, coordination of joint malaria control activities, and participation in several cross-border meetings organized by WHO-EURO from 1999–2009. The POR strategy launched in 2010 called for sanitary quarantine points at the border with Afghanistan, where visitors are screened for fever, provided with health education on malaria and other

**Figure 10. Reported malaria cases in Turkmenistan, 1991–2010<sup>28</sup>**



diseases, and registered in the health system for follow-up within destination districts. Although receptivity at the southern border remains high, Turkmenistan's POR activities have successfully reduced vulnerability to importation from Afghanistan and prevented local transmission for more than a decade. In 2016, Turkmenistan affirmed its commitment to remaining malaria-free as a signatory of the Ashgabat Statement on preventing the re-establishment of malaria transmission in the WHO European Region.<sup>28,89</sup>

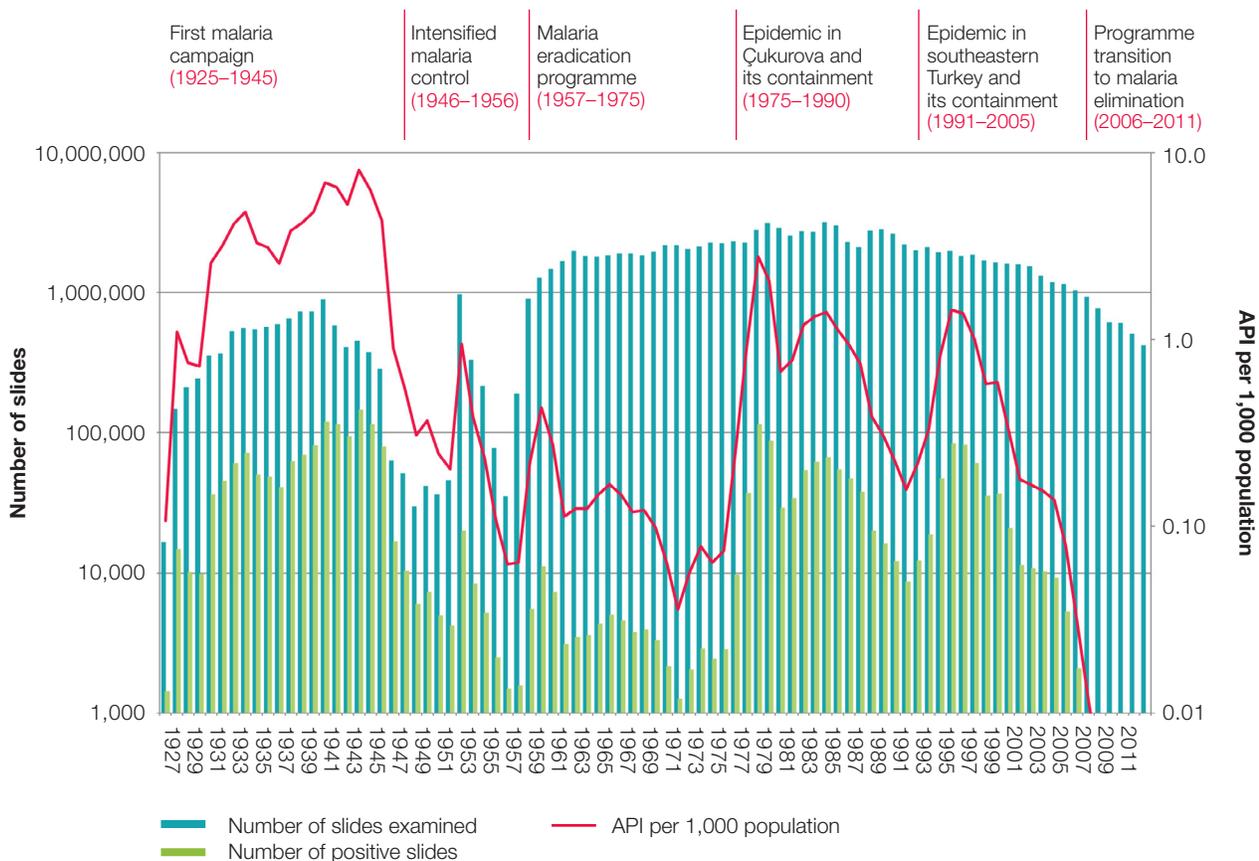
### Turkey: conflict in neighboring countries

Malaria transmission in Turkey has been impacted by conflict several times in recent history. Large scale population movement after the 1912–1913 Balkan Wars and the return of troops after World War I (1914–1918) helped maintain epidemic-level transmission throughout the country. Turkey's first antimalarial campaign was launched in 1925, in part to address the post-war malaria burden. Cases spiked during World War II (1939–1945) when many malaria program staff were recruited into the army, disrupting control activities and leading to several local outbreaks (Figure 11). Control operations were intensified after the war and the introduction of IRS with DDT brought cases down dramatically, facilitating the establishment of a national elimination

campaign in 1957 under the GMEP. By 1970, transmission was very low and confined to a handful of historically endemic foci in the southeast of the country. These foci were characterized by a high density of vectors and breeding areas as a result of irrigation schemes, early development of insecticide resistance, and frequent population movement.<sup>90</sup>

During the 1970s and 1980s, much of the population movement in the endemic southeastern provinces was a result of seasonal laborers, both local and foreign, seeking work on the many irrigation projects underway. However, political instability in neighboring Iran, Iraq, and Syria throughout this period led many people to cross into Turkey to escape violent conflict, bringing imported malaria cases with them. An influx of refugees fleeing the Gulf War in Iraq in 1990–1991 compounded the ongoing problem, as did a *P. vivax* epidemic in Iraq in 1993. High rates of importation as well as understaffing and inadequate coverage of vector control and surveillance interventions in these receptive and vulnerable areas in the southeast led to a malaria epidemic that lasted from 1993–1996 (Figure 11). The malaria program responded with an aggressive containment campaign that included active case detection, health education and promotion, and MDA among migrant

Figure 11. A century of malaria control in Turkey<sup>90</sup>



workers and refugees, as well as intensified larval and vector control in the affected areas. Although it took several years to fully contain the epidemic, the situation had improved dramatically by 2005 when Turkey endorsed the Tashkent Declaration, committing to the WHO-EURO regional goal of malaria elimination by 2015.<sup>90</sup>

Despite numerous challenges, Turkey successfully achieved elimination ahead of the 2015 goal; the last locally acquired *P. vivax* cases were reported in 2012. A critical factor for achieving elimination was managing importation from migrants and refugees, as the regional instability among Turkey's neighbors persisted after the epidemic in the mid-1990s. Throughout the elimination phase, these populations were targeted with the same interventions used to control the epidemic. In addition, provincial malaria program staff worked with the Ministry of Interior Affairs to identify and coordinate access to immigrants and refugees.<sup>90</sup>

While Turkey has benefitted from a decline in malaria risk from its immediate neighbors (Iraq and Syria became malaria free in 2009 and 2005, respectively; Iran reported just 57 local cases in 2017),<sup>91,92</sup> it continues to face importation threats from other countries, namely Pakistan and, to a lesser degree, Afghanistan. The malaria program has developed national guidelines for surveillance and management of imported cases and

continues to train health workers in malaria prevention and control. Community awareness, active case detection, and vector control activities are also conducted in areas of high risk, particularly where large populations of refugees reside. Because many European countries face similar importation threats from a growing international refugee population, WHO-EURO developed a framework to guide and coordinate POR activities, including screening at entry points, provision of free malaria control and prevention services to immigrants and refugees, and intercountry and interregional communication and collaboration facilitated by WHO-EURO.<sup>93</sup> Turkey committed to maintaining these POR activities when it signed the Ashgabat Statement in 2016.<sup>89</sup>

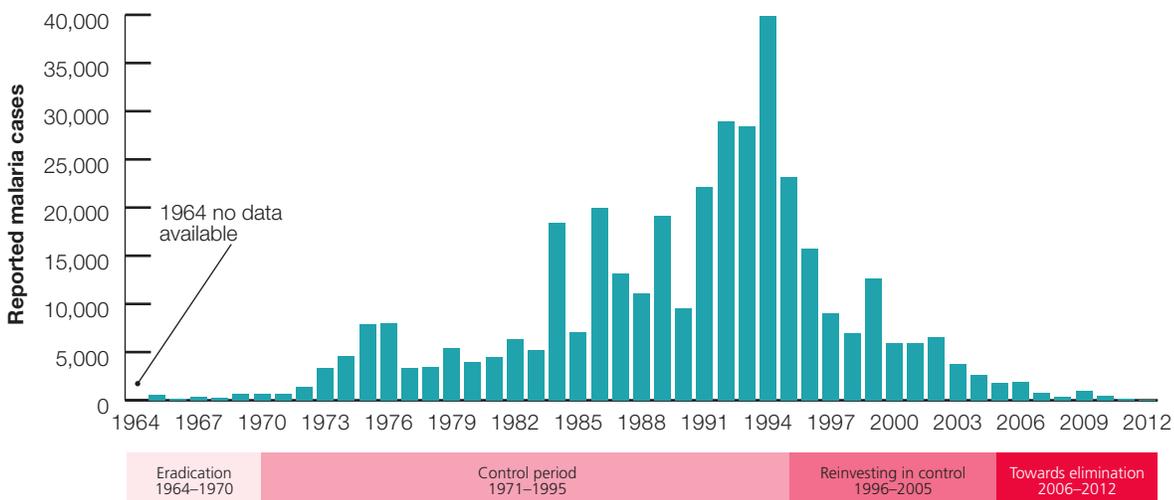
### Bhutan: conflict in neighboring countries

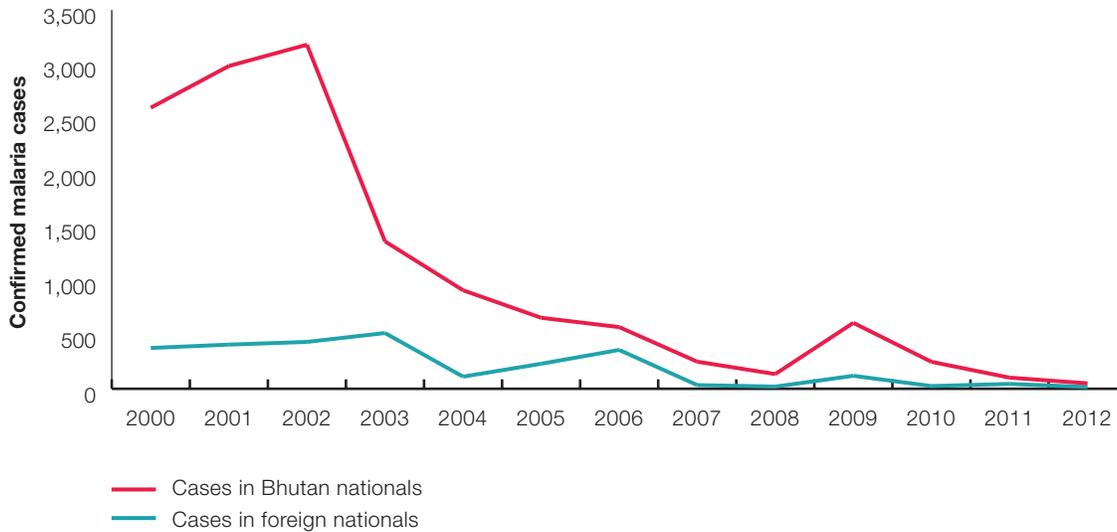
Bhutan's malaria program was first launched in 1964, and throughout the initial two decades of the program, emphasis was placed on building surveillance capacity, improving access to case management through expansion of health facilities, and conducting annual IRS with DDT. During this period, reported cases were relatively low but increased dramatically in the 1980s (Figure 12).<sup>94</sup>

While many factors likely contributed to this trend, an increase in travel by migrant workers between the Indian state of Assam and Bhutan was also documented

**Figure 12. Reported malaria cases in Bhutan, 1965–2012, with program phases<sup>94</sup>**

*Note: Through 1994, all reported cases are shown; from 1995 on, only indigenous cases are shown.*



**Figure 13. Confirmed malaria cases in Sarpang District, 2000–2012<sup>94</sup>**

during the 1980s. The seven Bhutanese districts with the highest malaria burden border the Indian states of Assam, Arunachal Pradesh, Sikkim, and West Bengal; Assam is the largest Indian border state and is highly endemic. The border area is porous and much of it is remote and heavily forested, making it difficult to monitor crossings. Further, Assam is prone to political instability, and the local populations are impoverished and highly mobile. Lack of access to government services leads many Assamese to cross into Bhutan for health care.<sup>94</sup>

These challenges were compounded in the 1990s during an armed insurgency between the Government of India and Assamese separatist groups. The separatists crossed over into the Sarpang District of Bhutan and set up illegal camps, leading to local instability and preventing the district malaria program from providing regular IRS and active surveillance interventions to local beneficiaries. As a result of the situation in Sarpang and other factors, malaria cases in Bhutan subsequently spiked, reaching a high of nearly 40,000 indigenous and imported cases in 1994 (Figure 12). Increasing access to Sarpang and other hard-to-reach populations with case management and prevention interventions became a programmatic priority in the late 1990s and early 2000s, facilitated by an expansion of village health workers and community engagement activities. The

separatists remained in Sarpang until they were forcibly removed by the Bhutan military in 2003, and cases in the district sharply declined in the years that followed (Figure 13).<sup>94</sup>

Bhutan's malaria burden has decreased dramatically since the peak in 1994. The country is very close to achieving its elimination goal, yet managing malaria at the Assam border region still poses considerable challenges for the program. Assamese continue to cross into Bhutan seeking employment and government services, and unrest in Assam has spilled over into Bhutan repeatedly since 2003. Enlisting the help of nongovernmental organizations, private companies, and community groups to provide malaria services along both sides of the border has been recommended as a way to supplement program activities and access hard-to-reach areas that may pose security risks to government malaria workers. The India-Bhutan Friendship Association supports cross-border coordination through the distribution of LLINs and other prevention measures in border villages.<sup>95</sup> In addition, aggressive scale-up of malaria interventions among transient border populations is a priority under India's new National Framework for Malaria Elimination, which has potential to alleviate some of the pressure on Bhutan's border districts.<sup>96</sup> Despite the remaining challenges, Bhutan reported just 11 indigenous cases in 2017.<sup>95</sup>

# Discussion

**Figure 14. Summary of case study challenges and lessons learned**

Case study location	Elimination goal/ program phase	Type of complex emergency	Biggest challenges	Primary lessons learned
Afghanistan	Phased elimination by 2030	Violent conflict	<ul style="list-style-type: none"> <li>Government access is restricted</li> <li>Ongoing violence reduces health capacity</li> <li>Heavy reliance on external donors</li> </ul>	<ul style="list-style-type: none"> <li>Flexibility and adaptation to changing circumstances</li> <li>Community engagement and building trust</li> <li>Communication/collaboration across all stakeholders</li> </ul>
Haiti	Zero transmission by 2020, sustained through 2022	Natural disaster (earthquake)	<ul style="list-style-type: none"> <li>Chronic health system weaknesses</li> <li>Underuse/lack of trust in health system</li> <li>Heavy reliance on external donors</li> </ul>	<ul style="list-style-type: none"> <li>Maintain vision, commitment to elimination</li> <li>Rebuilding presents opportunities</li> <li>Community engagement and building trust</li> </ul>
Sierra Leone	Control	Health emergency (Ebola outbreak)	<ul style="list-style-type: none"> <li>Chronic health system weaknesses</li> <li>Fear, lack of trust in health system</li> <li>Heavy reliance on external donors</li> </ul>	<ul style="list-style-type: none"> <li>Community engagement and building trust</li> <li>Communication/collaboration across all stakeholders</li> <li>MDA can be effective in emergency settings</li> </ul>

Common themes emerged across the case studies despite the diversity of settings, the nature of the complex emergencies faced, and malaria program structures and phases (Figure 14).

The malaria programs in Afghanistan, Haiti, and Sierra Leone experienced similar challenges and identified common lessons learned, in addition to those that were unique to the complex emergencies examined in the respective case studies. Challenges included heavy reliance on external funding, a lack of access to health services among populations, and chronic health system weaknesses. Lessons learned included the importance of community engagement and the need for communication and collaboration across all malaria program stakeholders.

## Common Challenges

Afghanistan, Haiti, and Sierra Leone all have low income economies and a history of political instability. While external funding is necessary to support health system operations under these circumstances, an unfortunate and unintended consequence is that over-reliance on external assistance has limited government ownership over program performance and decision-making. Key informants from the three countries identified this as an ongoing limitation, while acknowledging that external support has been essential for building program capacity and improving the coverage and quality of malaria interventions during and after

the complex emergencies they faced. In Haiti, malaria program staff were able to participate in the post-earthquake rebuilding process, identifying gaps and priorities in collaboration with external partners and funders. However, key informants expressed concern over the sustainability of some of the infrastructure and capacity improvements, particularly as post-earthquake recovery funds run out. Similarly, after the Ebola outbreak in Sierra Leone, the malaria program launched a new strategic plan that identified and sought to address some of the significant gaps that had exacerbated the effects of the outbreak. Yet, the program must rely almost entirely on the Global Fund to finance implementation of the strategic plan. In Afghanistan, the malaria program has outlined plans to expand some activities in order to improve coverage in high burden districts and facilitate a shift to elimination in low burden districts, but these changes are not yet possible under the current grant.

The access issues identified by the three countries have different causes but similar effects. In Afghanistan, geopolitical circumstances dictate access, whether a result of sporadic violent attacks that disrupt delivery of health services or because territory is under the control of anti-government groups. In Haiti and Sierra Leone, there is a significant lack of trust in the public health system among the respective populations, and people are much more likely to attend private clinics and/or faith-based healers. This was made worse during the Ebola outbreak in Sierra Leone when poor

communication from the government served to amplify fears. All three countries also have physical access challenges, in that remote and rural populations live a considerable distance from the nearest health facility. Regardless of cause, lack of access means that vulnerable populations do not receive prompt diagnosis or treatment for malaria and cases are not reported into the surveillance system, undermining the ability of the malaria programs to manage and target cases with appropriate interventions.

Both Haiti and Sierra Leone have weak health systems that are chronically underfunded and understaffed. The earthquake and the Ebola outbreak put a spotlight on these systemic problems, particularly since both complex emergencies had direct and devastating effects on health infrastructure and healthcare workers. In the years since the emergencies, efforts by the respective governments and their partners have helped strengthen the health systems, but it will be many years before they can operate at full capacity. In the meantime, health system weaknesses invariably impact the quality of malaria program operations in Haiti and Sierra Leone, even with the support of external funders and partners, and they underscore the issue of sustainability and government ownership. In contrast, Afghanistan's health system is still nascent and is operating relatively effectively in much of the country, although inadequate staffing—particularly female healthcare workers—remains a challenge. However, in areas that are inaccessible to the government, the systemic problems and their negative impact on malaria program operations are similar to those in Haiti and Sierra Leone.

## Common Lessons Learned

All three countries recognized how essential community engagement was during their respective complex emergencies, as well as its role in improving routine malaria program operations. Establishing trust within communities through educational activities, outreach, and community-level service delivery were identified in the literature and by key informants as solutions to the access issues and some of the health system weaknesses described above. In Haiti and Sierra Leone, providing consistent access to quality care through the use of trained community health workers may help alleviate the long-term problem of distrust in the public health system. In Afghanistan, where tribal loyalties are extremely strong and there is a general suspicion of outsiders even in areas where the government can operate safely, recruiting health workers from local communities to provide education and distribute malaria control and prevention interventions improves trust and acceptance.

The other primary lesson learned in all three countries was the importance of establishing partnerships and strong communication across all stakeholders. In

Afghanistan, this network of partners was key to filling gaps where the national government could not operate, and played a key role in facilitating communication and engagement with communities, particularly those impacted by episodes of violent conflict. In Sierra Leone, collaboration proved necessary for joint planning of Ebola control operations, particularly as different external organizations took responsibility for various aspects of the outbreak response and the need for clear and consistent messaging to the public grew. In Haiti, it was the lack of coordination across the large number of NGOs operating in routine health service delivery and earthquake response that illustrated the importance of establishing collaborative relationships and clear lines of communication among partners.

## Lessons from Elimination/POR Countries

Common themes were also apparent when comparing the three country case studies with the five countries featured in the Malaria Elimination Case Study Series, and important lessons on achieving elimination and maintaining POR can be derived from the latter and applied to the former.

### Island importation risk

Like Haiti, Mauritius is an island nation prone to natural disasters, particularly cyclones. The resurgence of malaria in Mauritius in the 1970s was the result of a failure to manage importation at its borders and an overall lack of commitment to maintaining POR activities after it was declared malaria-free. Haiti has already suffered from a cholera epidemic introduced by UN peacekeepers after the 2010 earthquake, so the dangers of imported diseases are known.<sup>97</sup> As Haiti approaches elimination and begins to outline plans for the POR phase, the lessons from Mauritius on the importance of remaining vigilant, maintaining border screening and surveillance, and retaining staff capacity for vector control and case management are particularly relevant.

### Eliminating in conflict zones

While the dynamics of the violent conflict in Sri Lanka differed significantly from that in Afghanistan, the two malaria programs faced similar challenges and identified many common success factors. Sri Lanka had to adapt its strategy and approach to malaria control in conflict areas based on constantly fluctuating security situations, implementing whatever interventions could be safely deployed, and recruiting other organizations with established local presence to fill gaps. The program also benefitted greatly from regular communication with other stakeholders, including the separatists, to coordinate activities and establish trust. Although Sri Lanka waited until its conflict came to an end before officially

launching a national elimination program, Afghanistan's conflict is protracted without a clear end in sight; thus, the program is moving forward with phased, district-level elimination despite the ongoing challenges. Promisingly, the Sri Lanka experience shows that significant reductions in malaria burden can be achieved in conflict zones even when operations are periodically disrupted.

### Regional support for elimination/POR

The experiences of Turkmenistan and Turkey highlight the importance of regional-level support and coordination, as well as the essential role of the WHO regional offices in facilitating cross-border and cross-region collaboration. Both countries benefitted from technical support on regional elimination and POR strategies from WHO-EURO, and both have successfully dealt with the constant threat of importation from neighboring countries in the WHO-EMRO region experiencing political instability and violent conflict. Afghanistan and Haiti are already participating in regional-level coordination through various mechanisms and networks, and these relationships will continue to be important as both countries approach elimination. Haiti will not face significant importation threats from Dominican Republic since the latter is likely to achieve elimination first, but maintaining vigilance at ports of entry and along national borders will require ongoing communication and coordination between the two countries. Afghanistan is surrounded by countries that have either already eliminated (China, Tajikistan, Turkmenistan, Uzbekistan) or will very soon (Iran),<sup>25,98</sup> but its border with Pakistan remains a hotspot of both malaria transmission and violent conflict. While political circumstances may make direct collaboration between the two nations' malaria programs difficult, WHO-EMRO and the Asia Pacific Leaders Malaria Alliance<sup>99</sup> can facilitate cross-border coordination and push both countries toward their mutual 2030 elimination goal.

### Cross-border, multi-stakeholder collaboration

Bhutan is impacted by political instability in neighboring India, although the lessons from Bhutan's experience are slightly different than those of Turkmenistan and Turkey. Bhutan relied on the use of village health workers and community engagement to improve access in areas that were restricted due to the presence of armed Assamese separatists, aligning with lessons learned from Afghanistan, Haiti, and Sierra Leone on the importance of strengthening community-level health service delivery. In addition, Bhutan is engaging in cross-border collaboration with India with the support of an NGO with ties to communities on both sides of the border, similar to the approaches utilized in conflict settings by both Afghanistan and Sri Lanka.

## Conclusions

It is well-established that there is no one-size-fits-all approach in malaria elimination/eradication, and the experiences of one malaria program should not dictate the strategies of another. However, the themes, challenges, and lessons learned revealed in this case study series can be broadly applied to countries targeting elimination over the next few decades, many of which will inevitably face complex emergencies of one type or another. Evidence from the eight country experiences reviewed here shows that complex emergencies can create barriers, complicate operations, and exacerbate existing challenges faced by malaria programs. These outcomes can, in turn, lead to increases in local malaria cases and deaths, causing considerable setbacks for countries working towards time-bound malaria elimination goals. However, the scale and scope of the impact will differ depending on several variables, including the extent of the existing malaria burden or whether the emergency is acute or chronic.

The potential for a complex emergency to alter the trajectory and timeline for elimination is greater the closer a country is to its goal. For example, in Sierra Leone, malaria morbidity and mortality significantly increased during the Ebola epidemic, but because the program was already many years away from considering an elimination goal, its overall trajectory toward elimination likely remains the same. If instead the epidemic occurred while Sierra Leone was actively working to clear its last remaining transmission foci, the disruption of health services and lack of access to affected populations would have been more likely to delay achievement of the elimination goal. A related contributing factor is the political visibility of malaria elimination relative to other health, economic, and societal concerns during the post-emergency phase. Getting a country back on track toward an elimination goal in the aftermath of an emergency may not be a top priority from a funding or advocacy perspective, further undermining the elimination trajectory and timeline.

Acute versus chronic emergencies pose unique sets of threats and opportunities for malaria elimination and eradication. Acute crises such as the earthquake in Haiti may cause immediate morbidity and mortality and temporary disruption of services as a response is mounted, but the influx of new technical partners and financial resources can facilitate health system improvements that would not have been previously possible. Further, countries with a strong health system are better equipped to withstand acute crises and the impact on the malaria situation will likely be minimal and short-lived. Conversely, a chronic emergency such as the protracted conflict in Afghanistan can generate lasting damage to essential infrastructure and lead to donor fatigue, weakening both the malaria program and the larger health system. However, facing chronic

barriers can push stakeholders to be resilient, creative, and flexible in identifying solutions to ongoing and new problems.

While avoiding complex emergencies is impossible, assessing risks, developing contingency and preparedness plans, and implementing mitigation strategies can help lessen the impact on population health. Yet, many of these activities are not within the purview of national malaria programs and require inputs and commitments from ministries of health, central governments, and regional and global bodies. The following broad lessons, aimed at both the larger malaria community as well as national malaria programs, can be gleaned based on the findings of this case study series. It is important to note that many of the suggested guidelines, policies, platforms, and so forth mentioned below already exist in some form or another. However, they have not yet been applied to malaria eradication; thus, they may need to be reconsidered and possibly revised in the context of a global malaria eradication goal.

### Lessons for the global malaria community

1. Global malaria stakeholders must actively participate in broader discussions on disaster risk reduction and response, communicating the potential risks of malaria resurgence in the event of a complex emergency and advocating for the inclusion of malaria resurgence prevention and response strategies in global and regional emergency preparedness plans.<sup>100</sup>
2. Guidelines and policies for regional- and national-level disaster preparedness and resilience must be generated in collaboration with representatives from relevant fields (such as climate change, population movement, refugees and internally displaced persons, etc), and malaria stakeholders must be trained in the development and implementation of emergency response plans and strategies. In addition, guidelines and policies must be tailored to suit local contexts to ensure better country participation and ownership over emergency response.<sup>7</sup>
3. Platforms for regional and cross-border collaboration that can be leveraged in the event of a complex emergency should be developed and supported, and existing collaborative bodies should participate in emergency planning and preparedness for individual member countries and the region as a whole.<sup>101–105</sup>
4. When countries require external technical, operational, or financial assistance during or after a complex emergency, partners must work with local malaria stakeholders to develop a long-term capacity-building and sustainability plan with adequate transitional support before exiting.<sup>106</sup>
5. Regional and global funding mechanisms for malaria control and elimination should include funds that can be quickly reprogrammed to support programs during emergencies, particularly when acute emergency funding sources 107–109 are allocated toward other health priorities.
6. Countries must receive ongoing support in identifying and leveraging more domestic resources for the health sector that can fund routine health services, including malaria operations, as well as emergency response.<sup>110</sup>
7. The provision of technical and financial support for health system strengthening must continue so that health systems – and malaria programs, by extension – can better withstand the impacts of complex emergencies with minimal service disruption.<sup>111</sup>
8. Relevant lessons should be derived from other disease control and eradication programs that operate in complex emergency settings, particularly polio and Guinea worm. Transmission of both diseases is now confined to areas characterized by protracted conflict with sporadic flare-ups of violence, fragmented health services, and poor access to local communities.<sup>112,113</sup> There is potential for successful strategies and existing infrastructure to be repurposed for malaria elimination and eradication efforts.

### Lessons for national malaria programs

1. Regularly engaging with the community is essential for building trust – before, throughout, and after complex emergencies. Engagement activities must extend to all members of the affected population, particularly those who have been displaced as a result of the emergency.<sup>114</sup> Good communication and an understanding of and respect for local customs and social dynamics will foster strong relationships. Maintaining an active local presence via community health workers assures the community that the public health system is invested in their wellbeing, which improves health-seeking behavior, cooperation, and participation in both routine health interventions and activities and interventions deployed in emergency settings.<sup>115</sup>
2. Identifying key partners, establishing mechanisms for communication and collaboration, and developing emergency preparedness plans together can improve coordination in the event of a complex emergency.<sup>7</sup> Partnerships should exist across all levels of the malaria program (national, district, community-level), across relevant ministries, with private sector/civil society/religious organizations, and with local and international NGOs. Mapping key strengths and identifying roles for each partner in advance of a complex emergency can help the malaria program fill gaps in terms of access and

area of expertise. These activities and collaborative mechanisms can be overseen by national malaria elimination advisory committees.<sup>116</sup>

3. A longer-term focus on malaria programmatic goals should be maintained, even if immediate operations are disrupted by an acute emergency. Achieving elimination and maintaining POR requires unwavering commitment and continued investment of human and financial resources to manage importation and conduct real-time surveillance. Complex emergencies may cause setbacks and timelines may have to be adjusted, but recovery periods can present new opportunities for partnerships and funding and can facilitate rapid progress toward malaria elimination goals. Securing strong political

commitment and visibility for elimination early on can also help get the malaria program back on track toward its goal post-emergency.<sup>117</sup>

At the 4th SAGme meeting convened in Geneva in November 2018, members of the Threats to Eradication work package reviewed the evidence generated by the case study series and concluded that complex emergencies are inevitable and will likely cause disruptions in progress toward elimination and eradication, but they should not be deterrents in the pursuit of a global malaria eradication goal. The impact of complex emergencies can be minimized if the steps highlighted above are taken by malaria stakeholders operating at subnational, national, regional, and global levels.<sup>118</sup>

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