ROLL BACK MALARIA PARTNERSHIP

PROGRESS & IMPACT SERIES

Number 8 · October 2011

Eliminating Malaria: Learning From the Past, Looking Ahead

World Health Organization

PATH
A catalyst for global health

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ACRONYMS AND ABBREVIATIONS

ACT	*Artemisinin-based combination therapy*
ACTED	*Agency for Technical Cooperation and Development*
AFRO	*WHO Regional Office for Africa*
AMRO	*WHO Regional Office for the Americas*
CDC	*US Centers for Disease Control and Prevention*
DDT	*dichloro-diphenyl-trichloroethane*
ECHO	*Humanitarian AID Department of the European Commission*
E8	*Elimination Eight*
EMRO	*WHO Regional Office for the Eastern Mediterranean*
EURO	*WHO Regional Office for Europe*
FIND	*Foundation for Innovative New Diagnostics*
GIS	*geographical information system*
Global Fund	*The Global Fund to Fight AIDS, Tuberculosis and Malaria*
GMAP	*Global Malaria Action Plan*
GMEP	*Global Malaria Eradication Programme*
GMP	*Global Malaria Programme*
IRS	*indoor residual spraying*
ITN	*insecticide-treated mosquito net*
LLIN	*long-lasting insecticide-treated mosquito net*
MDGs	*Millennium Development Goals*
MMC	*Malaria Mobile Clinic*
MOH	*Ministry of Health*
NGO	*nongovernmental organization*
NMCP	*National Malaria Control Programme*
NPMC	*National Programme on Malaria Control*
PAHO	*Pan American Health Organization*
PATH	*Program for Appropriate Technology in Health*
RBM	*Roll Back Malaria Partnership*
RDT	*rapid diagnostic test*
SADC	*Southern African Development Community*
SEARO	*WHO Regional Office for South-East Asia*
TDR	*Special Programme for Research and Training in Tropical Diseases*
UNDP	*United Nations Development Programme*
UNICEF	*United Nations Children's Fund*
USAID	*United States Agency for International Development*
US-PMI	*United States President's Malaria Initiative*
WHO	*World Health Organization*
WPRO	*WHO Regional Office for the Western Pacific*

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FOREWORD

The vision of eliminating malaria from individual countries and ultimately eradicating malaria from the world has captivated scientists and public health professionals for nearly a century. During the first half of the 20th century, the discovery and deployment of measures to control mosquito vectors and to diagnose and treat malaria infections resulted in dramatic declines in the malaria burden in many settings. Much of this progress was undone during World War II as a result of catastrophic infrastructure loss and massive population displacements.

In 1955, less than a decade after its founding, the World Health Organization (WHO) launched the Global Malaria Eradication Programme (GMEP). While its ambitious goal was never met, the GMEP achieved the elimination of malaria from 37 of the 143 malaria-endemic countries, and two continents: Europe and Australia. However, the slow progress in some settings (especially in Africa), the dramatic resurgences in other settings where tremendous progress had been made and the development of *Plasmodium* resistance to chloroquine and *Anopheles* mosquito resistance to the insecticide dichloro-diphenyl-trichloroethane (DDT), resulted in the *de facto* abandonment of the programme in 1972.

The nearly three decades that followed were certainly dark for malaria control efforts. Resurgences occurred in many settings, undoing the progress made in eliminating malaria. The primary lesson learned was powerful, but simple: achieving and maintaining malaria elimination can *only* occur when countries make sustained commitments to the required health systems and human capacity.

The last decade has witnessed the re-birth of hope in the fight against malaria. Unprecedented increases in funding have resulted in the massive scale-up of new tools, such as long-lasting insecticide-treated nets, rapid diagnostic tests, and artemisinin-based combination therapies, and sharp reductions in the malaria burden in every WHO Region. Importantly, these investments have been matched in many settings, especially outside of Africa, with rapid socioeconomic development that has changed housing and the wider environment, and thus the intrinsic risk of malaria, in many countries. In the WHO European Region, this progress re-ignited aspirations to eliminate malaria, resulting in the signing of the Tashkent declaration in 2005—a pledge by all malaria-affected countries in the Region to eliminate malaria by 2015.

In 2007, the Bill & Melinda Gates Foundation renewed the call for malaria eradication, stating that anything less was morally unacceptable—a position immediately echoed by the Director General of WHO, Dr Margaret Chan. This visionary call has sparked investment, innovation and impatient optimism. Around the world, a variety of malaria elimination initiatives have been launched. Since 2007, three new countries have been added to the WHO register of areas where malaria elimination has been achieved, the first such additions in 20 years. Yet we cannot underestimate the challenges on the road to malaria elimination and eradication, nor can we forget the tremendous public health successes that have and will continue to accrue en route to these goals.

There are still 781 000 deaths from malaria annually, completely unacceptable for a disease

that is entirely preventable and treatable. In 2011, with the highly effective tools we have available, no one should die from malaria. Scaling up these tools is estimated to have saved an estimated 1.1 million lives in Africa since 2000, with the vast majority of those occurring in the past five years when scale-up of interventions began in earnest. If we truly achieve universal access to and utilization of today's tools—while investing in the people and systems required to implement them as well as in the research required to develop tomorrow's transformative tools—then the country and regional goals of malaria elimination, and the global goal of eradicating this ancient scourge, *will* become a reality.

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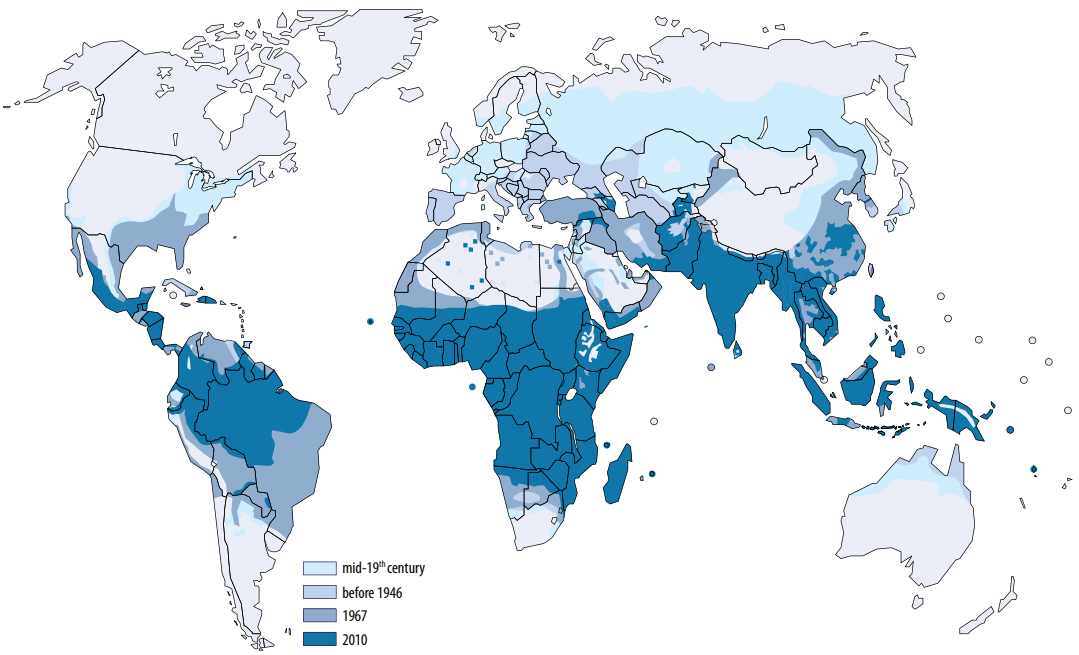
EXECUTIVE SUMMARY

Recognition of malaria illness and efforts to prevent and treat it have existed for thousands of years. The earliest prevention methods involved avoiding living in marshy areas, managing the environment through means such as draining wetlands, and eventual improvements in housing conditions that limited human contact with mosquitoes.

Some of the earliest treatment interventions—such as quinine and *Artemisia*—still play a critical role today in efforts to stop the disease. When the malaria parasite and its mode of transmission by mosquitoes was discovered at the end of the 19th century, it launched a half-century of advances in entomology and malaria control using chemical and environmental methods (Figure E.1).

Figure E.1
World distribution of malaria, mid-19th century to 2010

Malaria risk areas in the world have diminished dramatically since the mid-19th century.



Note: This composite map does not claim to be complete. It is intended to illustrate where malaria transmission existed over the years.

Source: Mendis K, et al (*1*) and WHO Global Malaria Programme.

The end of World War I in 1919 led to a period of concentrated effort to stop malaria, which was ravaging many countries. Success in malaria control was uneven, however, and by the 1920s the link between development and global health became clear. A range of efforts focused on mosquito control, diagnosis by microscopy and quinine treatment led to malaria elimination in nearly all of western Europe by the mid-1930s. The discovery of DDT in 1939 and its application through indoor residual spraying (IRS) brought about dramatic success in the Balkans, Mexico and Latin America, Greece, the Middle-East, Taiwan and Sri Lanka. This progress, paired with the discovery of chloroquine as an effective antimalarial, set the stage for renewed global ambitions to tackle the disease.

The massive population displacements and destruction of infrastructure caused by World War II resulted in major malaria resurgences in countries that had achieved earlier success, as well as significant importation of malaria by troops returning from malarious areas. The Global Malaria Eradication Programme (GMEP) was launched by the World Health Organization (WHO) in 1955. The GMEP aimed to implement intensive IRS in combination with case detection and treatment to rapidly reduce malaria transmission in all endemic areas where the intensity of transmission was low to moderate. For sub-Saharan Africa, the WHO African Regional Committee determined that the requirements for effective IRS could not yet be met, and that there was not enough evidence to assume that surveillance would ever be adequate in the region in light of the intensity of transmission.

The GMEP campaign freed 37 of the 143 malaria-endemic countries from malaria by 1978, including 27 in Europe and the Americas. But slower-than-hoped-for progress and increasing resistance to drugs and insecticides led to waning confidence—and ultimately reduced investment—in the programme. Some of the countries that had achieved remarkable progress during this time experienced malaria resurgences with, in some cases, soaring mortality rates.

During the mid-1970s to the late 1990s, some countries experienced sustained setbacks that made it impossible to gain a foothold against malaria. But others that had been highly committed to the GMEP effort (mainly those at the edge of malaria's range and those that had secured consistent funding) were able to continue their successful paths; a number of countries (Australia, Bahrain, Egypt, Greece, Kuwait, Libya, the Maldives, Tunisia, the United Arab Emirates and one territory [Hong Kong]) became malaria-free during this time, resulting in complete elimination of malaria from two continents: Europe and Australia.

This era also marked the development of new tools that remain critical to success today. The development of insecticide-treated mosquito nets (ITNs) was a major improvement upon the previous class of nets that served as personal protection only. Deployment of ITNs (and more recently, long-lasting insecticide-treated nets [LLINs]) for personal protection and vector control has had a major impact on malaria control efforts in the last decade. The global introduction of artemisinin-based combination therapies (ACTs) transformed malaria treatment by early 2000. The third tool in this new arsenal was the rapid malaria diagnostic test (RDT), which made it conceivable to obtain reliable diagnostic test results even in the most remote areas, where microscopy was not available.

The RBM decade: 2000–2010

The first Roll Back Malaria decade, from 2000–2010, marked the latter-day transformation of malaria control efforts. With new tools in hand, this period was characterized by dramatic increases in national, regional and global commitment and corresponding increases in financing and technical capacity that allowed countries to accelerate their efforts. Many countries that

rapidly scaled up malaria control interventions quickly reduced transmission and are now well-positioned to launch elimination efforts. Other countries with long-standing moderate to low transmission levels intensified their focus on eliminating malaria.

Regional progress in the past decade has been dramatic

Summary of progress in the European Region

Ten out of 53 countries in the European Region were affected by malaria in 2000. As of 2010, locally acquired malaria cases were reported in only five countries: Azerbaijan, Kyrgyzstan, Tajikistan, Turkey and Uzbekistan. Kazakhstan reported its last locally acquired malaria case in 2001, as did Turkmenistan in 2004, Armenia in 2005 and Georgia in 2009. Turkmenistan was certified malaria-free by WHO in 2010, and certification of Armenia is ongoing as of September 2011. The temporary reintroduction of malaria transmission in the Russian Federation has been controlled.

Summary of progress in the Eastern Mediterranean Region

Twelve out of 22 countries in the Eastern Mediterranean Region reported local malaria transmission in 2000. During the subsequent decade, six countries continued or embarked on nationwide elimination programmes (Islamic Republic of Iran, Iraq, Morocco, Oman, Saudi Arabia and Syria), with a resulting 10-fold reduction in malaria cases, while two others (Sudan and Yemen) developed sub-national malaria-free initiatives. The United Arab Emirates (last local case in 1997) and Morocco (last local case in 2004) were certified malaria-free in 2007 and 2010, respectively.

Summary of progress in the Region of the Americas

Local malaria transmission occurred in 23 out of 47 countries in the Region of the Americas during the RBM decade. Of these 23, four have progressed to the pre-elimination phase (Argentina, El Salvador, Paraguay and Mexico) and two initiated an elimination programme at the sub-national level (Dominican Republic and Haiti). Two other countries (Bahamas and Jamaica) suffered a temporary reintroduction of malaria transmission in 2006 that has since been controlled.

Summary of progress in the South-East Asia Region

With the exception of the Maldives, which is preventing reintroduction following its successful elimination efforts in the 1980s, all countries of the Region were affected by malaria during the last decade. Two countries are progressing with nationwide elimination (Sri Lanka and Democratic People's Republic of Korea); Indonesia has adopted a sub-national elimination strategy for Java and Bali; and Bhutan and Thailand, where large areas with no malaria transmission are found, have expressed their intention to proceed with elimination.

Summary of progress in the Western Pacific Region

Malaria is still endemic in 10 of the 37 countries of the Region. Malaysia and the Republic of Korea are implementing nationwide malaria elimination programmes. Sub-national elimination is ongoing in China, the Philippines, the Solomon Islands and Vanuatu. Cambodia, China, Viet Nam and the Lao People's Democratic Republic have included elimination in their national strategies. In 2010, China made a government commitment to eliminate malaria.

Summary of progress in the African Region

All but four of the 46 African Region countries still have ongoing malaria transmission. Lesotho, Mauritius and the Seychelles are not endemic for malaria, and Algeria is in the elimination phase. Cape Verde entered the pre-elimination phase in 2010.

Four countries of southern Africa (Botswana, Namibia, South Africa and Swaziland) share a

common goal of eliminating malaria by 2015. They were joined by their four northern neighbours (Angola, Mozambique, Zambia and Zimbabwe) in 2009, to form the sub-regional malaria elimination initiative known as the Elimination Eight (E8). Another four countries in Africa (Gambia, Rwanda, São Tomé and Principe, and Madagascar) have secured Global Fund grants to prepare for elimination.

Countries are progressing towards malaria elimination at varying rates

Countries preventing malaria reintroduction

By 2010, four previously endemic countries had interrupted malaria transmission and were implementing intensive programmes to prevent reintroduction. Three non-endemic countries experienced outbreaks in recent years and have controlled the situation. Two countries were certified malaria-free in 2010 and continue their vigilance efforts. Many other once-endemic countries continue to prevent re-establishment of transmission.

Countries in malaria elimination phase

In 2010, ten countries were implementing nationwide malaria elimination programmes; the majority of these countries had previously halted malaria transmission in the 1950s and 1960s. Most countries reduced their annual number of reported local cases 100-fold or more from 1998–2010, and none have reported malaria deaths due to local transmission since 1998.

Countries that have eliminated malaria—or have nearly done so—have had the advantages of political and socioeconomic stability, passionate leadership, qualified staffing, and national commitment and investments that have made it possible to deploy a range of interventions and adapt them to needs over time. Strong surveillance and information systems and community-level empowerment are key components of the elimination programmes.

Countries in malaria pre-elimination phase

In 2010, nine countries were in the pre-elimination phase and increasing their emphasis on the quality of surveillance, reporting and information systems. Five of these countries had already nearly eliminated malaria during the 1950s and 1960s. Nearly all of the confirmed malaria cases in the pre-elimination countries in 2010 were reported from just four countries. With the exception of Sri Lanka, no pre-elimination country reported a death from malaria during the decade; Sri Lanka reported two local malaria deaths in 2004 and none since then.

Control-phase countries with low burden moving to pre-elimination

Ten countries are currently moving from control to pre-elimination phase. They are building the systems to detect and contain the remaining foci of transmission in their countries in order to progress to elimination.

Control-phase countries with higher transmission

In countries with persistently high transmission rates, markedly reducing human–mosquito contact, improving access to diagnosis and treatment and reducing the prevalence of parasites in humans are critical to achieve the dramatic reductions in transmission that are required to consider moving towards elimination. Many countries recently have demonstrated that achieving high coverage with current interventions has a dramatic impact on disease burden and on transmission reduction. Improved tools and socioeconomic conditions will come with time, and even though new tools are much needed—particularly to speed the path towards elimination in the high-transmission countries—progress through scaling up current effective interventions remains central to the programme work.

The challenges to global success in eliminating malaria are daunting and many—for example, history has demonstrated that progress is fragile and can easily be lost. The long-term cost benefit of elimination still needs to be sufficiently documented, to facilitate the required policy and financing commitments. Success is accumulating, however, and the evidence base guiding local, national, regional and global action is growing quickly. Future investment

in new malaria control tools and in socioeconomic development that will support both malaria control and communities broadly will be essential. In this most recent decade, we have witnessed unprecedented political and financial investment—ensuring the stability and durability of this commitment and generosity from endemic countries, donor governments, the private sector, charitable foundations and civil society will foster continued impact against the malaria burden. With strong human capacity, continued investment, evidence-based programming and continued partnership, achieving the ambitious RBM 2015 targets, including elimination in at least 8 to 10 countries and the WHO European Region is within our grasp (Box 1).

Box 1: Global Malaria Action Plan Objectives

(approved by RBM Partnership Board, 2011)

Objective 1. Reduce global malaria deaths to near zero by end-2015.

Objective 2. Reduce global malaria cases by 75% by-end 2015 (from 2000 levels).

Objective 3. Eliminate malaria by end-2015 in at least 8 to 10 new countries (since 2008), including the entire World Health Organization European Region.

Source: Roll Back Malaria. (http://www.rbm.who.int/gmap/gmap2011update.pdf) (*2*).

KEY MESSAGES

- Eliminating malaria by the end of 2015 in at least eight to ten new countries, including the entire WHO European Region, is one of the RBM Partnership's three objectives.

  » The malaria community is back on track helping countries progress to elimination. Since 2007, three countries have been certified by WHO as malaria-free. Sixteen countries and territories were certified by WHO as malaria-free during the 17 years of the Global Malaria Eradication Programme (1955 to 1972), and seven countries and one territory were certified in the period 1973-1987. After this, certification was abandoned for a period of twenty years.

- Further progress in malaria elimination is occurring in most regions in the world.

  » Seven countries are in the phase of preventing reintroduction and some may soon be ready for certification. Ten countries currently are in the elimination phase and nine countries are in the pre-elimination phase.

- Successful malaria elimination programmes are built on strong national leadership, commitment to high-quality staffing and programme delivery, national stability (political and socio-economic), sound technical approaches that address local malaria biology and evolve with changing epidemiology, and effective surveillance systems that can rapidly detect and contain transmission.

- Malaria elimination can be fragile and, once achieved, needs to be sustained through continued effort. Concomitant investments to improve socioeconomic conditions and housing in the at-risk areas, as well as raising awareness regarding key malaria elimination activities among community and business leaders, health workers and the wider public, will be critical to achieving and sustaining success.

- Many countries in the control phase have substantially reduced malaria morbidity and mortality and some have established or expanded malaria-free areas—progress that will require ongoing support for eventual transition to nationwide pre-elimination and elimination.

- Countries with intense malaria transmission will require new tools and strategies to speed their advance to elimination; maintaining investment for research and development and strengthening public-private partnerships' capacity to pursue long-term elimination objectives are essential. However, extraordinary progress is possible with existing tools and we must act now, while planning for the availability of new tools.

- In addition to national commitment, sustained and predictable technical and financial support will be required from regional and global partners for malaria elimination efforts in many settings. Investments in malaria control need to increase substantially over existing levels.

- Tremendous public health successes can be achieved on the way to malaria elimination, through its focus on the systematic building of local and community empowerment for health, quality health service-delivery mechanisms that reach the most peripheral areas, surveillance systems for timely detection and containment of disease transmission, and a new generation of results-oriented public health leadership.


FUNDAÇÃO DE VIGILÂNCIA EM SAÚDE
MALÁRIA
AMAZONAS

INTRODUCTION

Malaria elimination and eradication was recently revived as the ultimate goal for the global malaria effort. During the first global effort to address malaria, the World Health Organization's (WHO's) Global Malaria Eradication Programme (GMEP, 1955–1972) led to the elimination of malaria in 37 of the 143 malaria-endemic countries; in the subsequent 40 years, 17 countries eliminated malaria. Between 2007 and 2010, 3 countries were certified as malaria-free by WHO. The hope for continued progress in malaria elimination is built on diverse opportunities: the parasite-vector-human biology allows for many points of attack; malaria control programmes have recently demonstrated considerable success built on sufficient funding and growing human and technical capacity; and with the recent certification of three countries as malaria-free, many others (especially in but not limited to the European Region) can envision a path to elimination.

Experience has been the most valuable teacher in aiding our understanding of how to halt malaria. The long and complex history of humanity's attempts to prevent and treat the disease offers important direction and guidance in developing a modern-day approach to eliminating malaria. This is particularly true as the first decade of renewed and intensified efforts to stop the disease comes to a close. While global aspirations are more visionary than ever before, there are clear opportunities to ground our actions in the considerable body of evidence and experience from past efforts.

Communities have grappled with malaria for millennia, with early documentation of malaria fever and use of medicinal plants for treatment dating back thousands of years. But the conditions remained wholly accommodating for efficient malaria transmission in most of the world well into the early 20th century—at that time, the best defences against the disease were the good fortunes of not living in a transmission area or having a strong immune system.

The advent of new medicines and vector control methods in the early part of the 20th century inspired growing confidence at the national and global levels that malaria elimination—and even eradication—were in reach (Box 2). While many countries and territories succeeded in eliminating malaria during the life of the WHO's Global Malaria Eradication Programme (GMEP) (*3,4*), the slow pace of progress in some areas, emerging drug resistance and waning commitments overshadowed the successes. Financing dropped off, and many countries that had succeeded in reducing or eliminating malaria transmission experienced devastating disease resurgences that were deadly to those with low immunity who could not access treatment in time.

But the story of malaria elimination does not end there.

Box 2: Definitions of programmatic stages of malaria intervention

Malaria control: Reduction of the malaria disease burden to a level at which it is no longer a public health problem.

Malaria pre-elimination: A time during which well-functioning malaria control programmes are further oriented to increase coverage of good-quality laboratory and clinical services and strengthen reporting and surveillance systems, followed by programme adjustments to halt transmission nationwide. As an indication, transition to pre-elimination can be considered when the slide positivity rate among fever cases is less than 5% throughout the year.

Malaria elimination: The interruption of local mosquito-borne malaria transmission; reduction to zero of the incidence of infection caused by human malaria parasites in a defined geographical area as a result of deliberate efforts; continued measures to prevent re-establishment of transmission are required. As an indication, transition to elimination can be considered when the programme reorientation (the pre-elimination phase) has been achieved and health facility data show that there is less than 1 malaria case per 1000 population at risk per year.

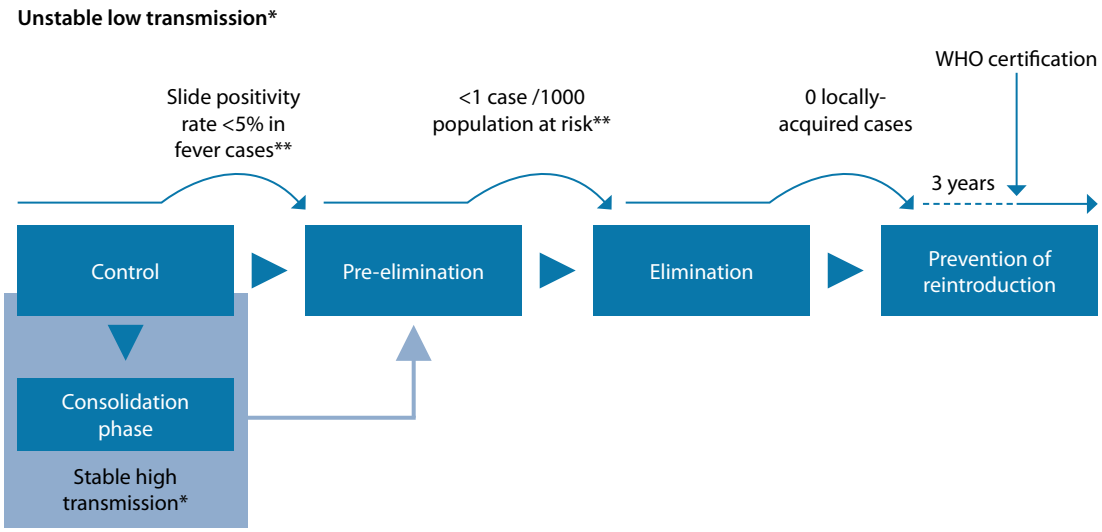
Prevention of reintroduction: Following the elimination of locally-transmitted malaria, the continued deployment of appropriate malaria transmission prevention with emphasis on vigilance to identify any imported cases, clear those infections, and stop any possibility of resumed local transmission. This transition can be considered when elimination is achieved and should build on the activities that succeeded in eliminating malaria.

Malaria eradication: The permanent reduction to zero of the worldwide incidence of infection caused by human malaria parasites as a result of deliberate efforts. Intervention measures are no longer needed once eradication has been achieved.

Scores of countries were fully committed to the malaria elimination targets during the GMEP era in the 1950s and 1960s, and their efforts and experiences continue to critically inform the direction that malaria elimination is taking today. Some countries succeeded in eliminating malaria even after the major GMEP efforts ceased. Others sustained their commitment to controlling malaria and were finally able to achieve elimination decades later. The experiences documented here come from countries with diverse political, socio-economic, programmatic and epidemiological landscapes and can provide valuable insights for current planning and action in a wide range of settings.

A remarkable surge in funding, commitment and action to rapidly reduce malaria transmission in endemic countries has occurred in the last decade. The 2007 call for malaria eradication from Bill and Melinda Gates sent shockwaves through the malaria control world; the position was immediately affirmed by WHO's Director-General Margaret Chan. One year later, the Roll Back Malaria Partnership set the target that in a mere seven years, by 2015, at least eight then-endemic countries would have interrupted local malaria transmission and freed their lands and people from the risks of malaria. Stopping malaria is now a top global health priority with clearly defined markers of progress (Figure 1.1).

Figure 1.1
Phases of malaria control through prevention of reintroduction



*Countries with unstable, low transmission typically progress from the control phase to pre-elimination. Countries with stable high transmission may progress from the consolidation phase to pre-elimination.

**Milestones are indicative only.

Source: Malaria Elimination: A Field Manual for Low and Moderate Endemic Countries, WHO, 2007.

The unanticipated challenges of implementing the GMEP global eradication strategy, and the tragic results of its cessation remain sobering lessons today for those considering or committed to malaria elimination. The long-term challenge of eliminating malaria in poor, disrupted, ill-equipped and transmission-heavy countries is daunting. But the circumstances for success are firmly in place for many countries now and so it is fitting to set our sights high. An entirely new arsenal of tools exists today that are critical to elimination success, and better ones are in the development pipeline. In the last four years, three countries have been certified by WHO as having eliminated malaria and many more countries are on the pathway to elimination or pre-elimination (Table 1.1).

While the parasite–human–vector biology may seem complex, it allows for many points of attack (see Box 3), there is a wealth of experience to draw from, and many countries are poised for elimination success. The time is ideal for the national, regional and global malaria community to reflect on lessons from the past, join together to attain new goals in stopping malaria, and plan for the many new challenges and successes that lie ahead.

Table 1.1.

Malaria programme status from malaria control to elimination among 194 WHO Member States and 4 territories, by WHO region.

Among 194 WHO member states and 4 territories, 90 are malaria-free and 7 additional countries have recently halted malaria transmission and are preventing reintroduction; 101 countries and territories have ongoing transmission; and approximately one-half of all 'control countries' are in Africa south of the Sahara.

Malaria Category	African Region	Americas Region	Eastern Mediterranean Region	European Region	South-East Asia Region	Western Pacific Region	Total
Malaria-free	4	13	9	45	1	18	90
(WHO-certified)*	(2)	(6)	(2)	(16)	–	(4)	(30)
Prevention of reintroduction	–	2	3	2	–	–	7
Elimination phase	1	–	2	6	–	1	10
Pre-elimination phase	1	4	1	–	2	1	9
Control phase	42	17	7	–	8	8	82
Total	**48**	**36**	**22**	**53**	**11**	**28**	**198**

*The WHO-certified category is a subset of the malaria-free category.

Note: For definitions of malaria control category, see page 18 in the report. The four included territories are Mayotte and French Guiana with transmission and Réunion and Taiwan which have been certified malaria-free by WHO.

Source: World Health Organization.

Box 3: Malaria biology as it relates to elimination

Malaria is an ancient disease that is caused by a single-celled parasite that lives and multiplies inside the red blood cells of warm-blooded animals, including humans. Malaria parasites can remain there until medicines kill the parasites, host immunity removes them, or the host itself dies.

To guarantee the long-term survival of its species, the malaria parasite must transfer from one warm-blooded host to the next; for this transfer process and for completing its life cycle it uses mosquitoes. The parasite enters the mosquito through blood that a mosquito ingests; after the necessary transformations, including sexual replication, the parasite is transferred to other humans through the saliva of a mosquito's bite.

Mosquitoes are cold-blooded insects that are only as warm as the surrounding temperature; to develop, the malaria parasite needs a temperature that is consistently above 14–16 degrees Celsius, depending on the species. In general, the warmer the ambient temperatures, the faster the parasite can develop inside the mosquito, and the more likely it can be ready in time for transfer back into a warm-blooded host during the mosquito's next blood meal, and before the mosquito dies.

The malaria parasite's success at moving between animals and mosquitoes has enabled it to develop special bonds with many different warm-blooded hosts, ranging from mice to birds to humans. All malaria vectors belong to the genus *Anopheles*; within this genus there are at least 400 different species of *Anopheles*, including at least 60 that can transfer malaria parasites from human to human, of which about 25 are vectors of major importance in the modern world (*3*,*5*). *Anopheles* mosquitoes bite almost without exception between dusk and dawn.

Four malaria parasite species naturally occur in humans: *Plasmodium (P.) falciparum, P. vivax, P. malariae* and *P. ovale*. Some other species occasionally infect humans but have not yet mastered the full cycle of transfer from humans to mosquitoes and back to humans. An example is *P. knowlesi*, which occurs in forested areas of South-East Asia.

Human malaria parasites thrive in warm humid climates where accessible, unprotected hosts and vector mosquitoes abound in close vicinity, and ambient temperatures ensure quick development and transfer between hosts. In such areas, many malaria parasites will be able to multiply and perpetuate the transmission cycle.

Conditions for maintaining the transmission cycle are more marginal in temperate climates, where place and time are critical because the parasite may have only a short summer season for onward transmission. The *P. vivax* parasite has developed ingenious mechanisms for surviving such marginal climatic conditions: it can remain dormant until the next transmission season and reside undetected in the liver of a human host in a form known as a hypnozoite (*6*). The *P. malariae* parasite has evolved

another mechanism for long-term undetected survival in the human host: it can maintain—for many years—very low levels of infection that rarely cause clinical disease.

The malaria transmission cycle can be broken when an infected person takes medication that kills the parasites before they are picked up by a mosquito; when the ambient temperature is too low, and thus parasite development in the mosquito is too slow, and the mosquito dies before transmitting the malaria parasite; or when there are simply no mosquitoes around to transmit the parasite to the next host. Similarly, transmission will not succeed if the infected mosquito dies prematurely; if it cannot find another host to bite—for instance, when humans fully protect themselves from mosquito bites; or if it injects the parasite into an incompatible host (e.g. a human malaria parasite that ends up in a cow).

Over the millennia of its evolution, the parasite has mastered its fragile interplay with humans, mosquitoes and ambient temperatures, allowing it to survive and be transmitted in almost all parts of the world where humans and *Anopheles* mosquitoes have co-existed. At the height of its global distribution, it reached as far north as the Arctic Circle, and an estimated 90% of the world's population lived in malarious areas.

The geographic spread of malaria has been on the decline since mid-1800s due in part to humans' durable impact on the environment and overall improvements in living standards. Malaria-specific efforts also contributed to the decline: the discovery of medicines to kill parasites and insecticides to kill vector mosquitoes, the Global Malaria Eradication Programme's efforts of the 1950s and 1960s, and the advent of good diagnostic testing. When closely examined, today's elimination successes are actually built on decades of continued investment by ministries of health of endemic countries and other stakeholders, supported in recent years by a well-funded global movement to control and eliminate malaria.

In areas where humans have broken the cycle of parasite transmission, we can speak of malaria elimination. Our victory over malaria is most secure in marginal transmission areas where malaria disappeared following gradual and durable changes in the environment and living conditions. Our victory over malaria is less secure in areas where the natural conditions for transmission are robust and persistent, or in areas where negligence or sudden destruction of infrastructure due to war or natural disaster creates the potential for reintroduction. In these latter areas, malaria transmission may easily take hold again, and more effort is needed to keep it at bay. Many experts agree that achieving and maintaining a 'malaria-free' status in areas that combine an abundance of efficient vectors, freely accessible human hosts and optimal ambient temperatures would require additional, novel control tools—'tomorrow's tools' (*7, 8*).

PROGRESS TOWARDS ELIMINATION BEFORE THE GLOBAL MALARIA ERADICATION PROGRAMME[1]

While malaria has been a global scourge for thousands of years, the discovery of the parasite and its vector transmission in the late 1800s and the gradual development of methods for prevention, detection and treatment allowed malaria control and elimination in some countries to progress rapidly. In the first half of the 20th century, while two world wars disrupted health systems and fostered malaria spread, the tools developed then (insecticides and methods for applying them and drugs and regimens for treatment and prevention) formed the backbone of many of our current malaria control efforts.

Countries and territories where malaria never existed or disappeared without specific measures (*9*)[2]

Americas: Barbados, Canada, Chile

Asia: Mongolia

Europe: Austria, Belgium, Czech Republic, Denmark, Finland, Germany, Gibraltar, Iceland, Ireland, Malta, Monaco, Norway, San Marino, Slovakia, Sweden, Switzerland, United Kingdom

Oceania: American Samoa, Cocos (Keeling) Islands, Cook Islands, Fiji and Pitcairn, French Polynesia, Gilbert and Ellice Islands, Guam, Nauru, New Caledonia, New Zealand, Niue, Norfolk Islands, Pacific Islands (Trust Territories), Tokelau Islands, Tonga, Western Samoa

Note: Countries listed as published in *Supplementary list for areas where malaria never existed or disappeared without specific measures* (WHO, 1973).

[1] For the broad lines of this chapter as well as many of the specific examples, the author gratefully acknowledges the 1999 historical WHO publication 'Malaria control, achievements, problems and strategies' by Dr J. Nájera (*6*).

[2] Malaria never invaded the distant Pacific islands east of the longitude of Vanuatu (the Buxton line) because they are naturally free of *Anopheles* mosquitoes. In all other countries, the historical presence of malaria at some point in time cannot be excluded. One island in Vanuatu, named Futuna, is located east of the Buxton line, and so never had malaria. This island is part of the Tafea Province, which is the designated 'malaria elimination province' in Vanuatu, which includes the following islands: Tanna, Erromango, Aniwa, Futuna and Aneytium. Malaria was successfully eliminated from Aneytium in the early 1990s. See section on Vanuatu on page 61.

The early days of malaria prevention

Early insights into the relationship between malaria and the existence of unhealthy, marshy areas gave the disease its name (from the Italian *mala* [bad] and *aria* [air]). With this realization came the earliest malaria prevention strategy for those who had a choice: avoiding settlement in the unhealthy, marshy areas, or withdrawing from them during the warmer summer months. This avoidance approach (site selection) has been practiced by civilizations throughout the ages, and records of its use for new settlements and military camps exist as far back as Roman times. A realization of the local nature of malaria (or 'marsh ague', as it became known) led the wealthier classes in England to avoid settlement in afflicted areas near the mouth of the river Thames as early as the 18th century (*10*).

The realization of the focal nature of epidemic malaria—together with the growing importance of agriculture—led to the earliest efforts in temperate areas to eliminate malaria by influencing the natural environment where it occurred. Environmental sanitation was most often carried out for economic reasons—draining wetlands and marshes yielded fertile agricultural lands—but also had important health implications. One account of environmental sanitation for health reasons in Sicily (Italy) dates back to the 5th century BC (*4*). Early accounts of the regulation of agriculture for eliminating malaria exist for 14th century Spain, when the King of Aragon prohibited the cultivation of rice near the city in order to control fever outbreaks.

A lasting effect on malaria transmission was brought about by the gradually increasing affluence in temperate rural areas: people started to improve housing conditions, and as a by-product reduced their contact with vector mosquitoes.

All of these activities had an important cumulative impact in some parts of the world. In the second half of the 19th century, large areas of northern and central Europe and North America became malaria-free, mainly as a by-product of changes in agricultural land use and improved living conditions (*1*).

It was not until the end of the 19th century that the malaria parasite was discovered by Charles Laveran in 1880, and its mode of transmission by mosquito vectors was discovered by Ronald Ross in 1887. These discoveries heralded a 50-year period of great advances in entomology and malaria control using environmental control methods that targeted the mosquito vectors. These control methods required a thorough knowledge of local vector species, habitats and

behaviours, and were often only applicable in well-defined geographic areas with common epidemiological characteristics. A drawback of environmental control methods was that they were costly and labour intensive. In most tropical areas, this limited their use to the vicinity of settlements and rural areas of economic importance, leaving the population in the periphery unprotected (*11*).

Local environmental control measures were designed to eliminate ('sanitize') the species-specific breeding sites of the main mosquito vector in a given area, without necessarily affecting other mosquito species. It required detailed understanding of the local anophelene ecology and malaria epidemiology. This sophisticated approach to reducing the incidence of malaria by exploiting the habits of one species of *Anopheles*, which became known as 'species sanitation,' was developed in Malaysia and later successfully used in Indonesia and the Netherlands (*12*).

The early days of malaria treatment

The search for treatment for the fevers caused by malaria infection has persisted for millennia. Early Sumerian (6000–5500 BC) and Vedi (1600 BC) scripts described malaria fevers, and Chinese texts (Nei Ching, 2700 BC) describe medicinal plants for treating them. The two most potent herbal cures, discovered centuries ago by people in South America and China are still used today: extracts of quinine bark (*Cinchona*, also called Peruvian bark) and the wormwood plant (*Artemisia annua*, also known as Qinghaosu). The role of these traditional medicines in malaria elimination was for a long time limited to the areas where they were grown. From the 17th century onwards, demand for quinine expanded to European and American markets, leading to the plunder of the natural forests where the trees grew, and eventually the establishment of large Cinchona plantations in Java, Indonesia (then called the Netherlands Indies) (*13*). The chemical isolation of quinine in 1820 by two French pharmacists initiated modern malaria chemotherapy.[3] Quinine, and 'quininization' chemoprophylaxis campaigns, would become a key element of the early attempts to eliminate malaria from Italy.

Many currently and formerly malarious countries can trace the origins of their national malaria control efforts and state hygiene institutions to the scientific studies on malaria and its vectors in the early part of the 20th century. The tools against malaria at the time included antimalarial treatment, bed nets, sanitary and environmental methods for vector control, prevention of human-vector contact, and chemoprophylaxis.

Early movement towards a global approach to malaria control

World War I (1914–1919) led to the creation of the intergovernmental League of Nations in 1919, in which countries would settle disputes in a peaceful manner rather than by waging wars. The League of Nations' Malaria Commission was established in 1924 (*14*) in large part due to recognition that the aftermath of WWI left many countries with uncontrolled and severe forms of malaria. The labour-intensive and local nature of *Anopheles* control, and the lack of universally applicable methods for it, led to a realization in the late 1920s that the only globally practical requirements for malaria control were the need for health improvement and socioeconomic development, which could be promoted by strengthening health services. Through a range of concerted efforts, most

[3] The worldwide use of *Artemisia annua* (Qinghaosu) started much later, in the 1980s. It is currently the treatment of choice as part of artemisinin-based combination therapy (ACT).

northern countries in western Europe practically eliminated malaria before World War II through the use of focal mosquito control and by making microscopic diagnosis and quinine treatment widely available (*1*).

The discovery of the long-lasting insecticidal properties of dichloro-diphenyl-trichloroethane (DDT) in 1939 revolutionized the practice of spraying against malaria. Until then the role of indoor spraying in malaria control had been minimal due to the non-residual nature of the insecticides, and the consequent need to spray very frequently (weekly for the first-generation pyrethrum extracts[4]) to obtain the desired effect. DDT, a contact insecticide, required only two or three applications on the indoor surfaces per year, and resulted in greatly reduced transmission of malaria. Thus the modern technique of indoor residual spraying (IRS) was developed. Early dramatic successes with IRS using DDT were obtained in the Balkans, Mexico and Latin America, Greece, the Middle-East, Taiwan and Sri Lanka.[5] In the 1940s, as part of the WWII United States Army drug development programme, chloroquine became available as the first synthetic antimalarial medicine with an acceptable tolerability and safety profile that could be mass-produced. Together, these new tools provided a promising arsenal for launching a new era of efforts to halt malaria.

[4] Natural insecticide made from the dried flower heads of Chrysanthemum (*C. cinerariifolium* and *C. coccineum*).

[5] DDT was enthusiastically adopted for use in agriculture and forestry, which resulted in extensive and sometimes uncontrolled outdoor use of DDT. At present, the use of DDT is tightly regulated under the Stockholm Convention on persistent organic pollutants (POPs) .

PROGRESS TOWARDS ELIMINATION DURING THE PERIOD OF THE GLOBAL MALARIA ERADICATION PROGRAMME

Soon after the establishment of WHO, the GMEP was launched in 1955 and led to malaria elimination in many countries. This included the formal certification of malaria elimination in 20 countries in Europe, Asia, the Americas and two islands in Africa between 1960 and the mid-1970s. Despite this success, the prevalence of malaria in the more challenging places and weaknesses in the tools (including vector resistance to insecticides and parasite resistance to drugs) led to the abandonment of the GMEP.

Countries and territories where malaria was eliminated over the period 1955–1972 (*15*)

Africa: Mauritius*, la Réunion*

Americas: Cuba*, Dominica*, Grenada and Carriacou*, Jamaica*, Saint Lucia*, Trinidad and Tobago*, United States of America and its outlying areas of Puerto Rico and the Virgin Islands*, Venezuela (northern part only)*

Asia: Brunei Darussalam*, Jordan, Lebanon, Palestine, Qatar, Singapore*, Taiwan*

Europe: Bulgaria*, Cyprus*, Hungary*, Italy*, Netherlands*, Poland*, Portugal*, Romania*, Spain*, former Soviet Union (with exception of Azerbaijan and Tajikistan), former Yugoslavia (Bosnia and Herzegovina, Croatia, Kosovo, Republic of Macedonia, Montenegro, Serbia, Slovenia)*

*Countries/areas that have completed WHO certification as malaria-free.

The massive destruction, population displacement and worldwide migration flows caused by World War II (1939–1945) left their mark on malaria control. Countries in temperate areas that had nearly eliminated malaria before the war had to cope with renewed epidemics in areas with damaged systems for health care, agriculture and water management. Other countries had to deal with massive importation of malaria parasites by returning troops. The Rockefeller Foundation, whose malariologists favoured aggressive vector control using DDT, provided extensive technical and

financial support during this time for malaria control in Europe and North America.

The horrors of WWII led to the founding of the United Nations on 24 October 1945, followed in 1948 by the launch of its specialized agency for health, the World Health Organization (WHO). Malaria was an early topic of attention for the WHO Interim Commission, and the first session of its malaria expert committee was held in April 1947 (*16*). With the war over and post-war reconstruction ongoing, there was a general air of optimism about tackling critical public health issues, including malaria.

By the early 1950s, the first reports of *Anopheles* resistance to DDT appeared, followed by *P. falciparum* resistance to chloroquine, and with them came a sense of urgency: What if these effective control methods were soon to be rendered useless? These circumstances offered a potentially narrow remaining window of opportunity to undertake an all-out effort to eradicate malaria. Fierce debates took place among experts, pitting the advocates for malaria transmission control (mainly through IRS with DDT) against the proponents of the general health improvement approach. As one proponent of transmission control put it: 'If people are continuously falling over the edge of a cliff, it is cheaper to build a fence around the top than a hospital at the foot.'(*4*)

The transmission control group carried the debate and, in 1955, WHO launched the Global Malaria Eradication Programme (GMEP). It was anticipated that rigorous use of IRS with DDT or other insecticides, in combination with malaria case detection and treatment, would promptly bring malaria down to such low levels that the remaining few cases could be dealt with by surveillance, with global eradication as the ultimate goal. The WHO Regional Committees endorsed this approach, with the exception of the African Regional Committee, which determined that preparations required for effective IRS could not yet be met and that there was not enough evidence to assume that surveillance would ever be adequate in the region in light of the intensity of transmission (*1*). The second African Malaria Conference, held in Lagos in November 1955, considered that 'the physical, economic and developmental difficulties in Africa, combined with the high endemicity and prolonged transmission, justify the temporary exclusion of African south of the Sahara from the general proposals on the eradication of malaria made by the eighth World Health Assembly' (*17*). Thus the GMEP became a campaign to interrupt transmission in all endemic areas outside of sub-Saharan Africa where the intensities of transmission were low to moderate (*18*).

The GMEP strategy was an effort of unprecedented magnitude—it launched an all-out war on malaria that focused on applying a single approach uniformly to the target areas. The operations were carried out by a cadre of specially trained personnel deployed to even the remotest corners of countries to map and spray all houses and structures, perform census counts, do mass blood surveys, distribute chloroquine and carry out general surveillance activities (*18*). Entomologists with specialized knowledge of the various vector species and their behaviours were no longer needed. Vector control staff measured the effects of IRS on vector densities and longevity. A Malaria Eradication Special Account was created in 1956 to sustain the global eradication efforts, and over the next seven years, 44 countries contributed a total of US$ 20.33 million to it (approximately US$ 146 million in 2011 dollars), with the United States contributing over 85% of the total.[6] At the height of its efforts in 1969, 1.4 billion people (almost 40% of the 3.6 billion

[6] US$ 1 million in 1969 had the same buying power as US$ 6.17 million in 2011.

world population at the time) were covered by GMEP activities (*4*, *19*).

The GMEP rapidly achieved impact in areas with enabling circumstances: low and seasonal transmission, a fair level of overall development, good infrastructure, and mosquito vector species that maintained a natural tendency to rest on surfaces that could be sprayed with insecticide (*1*).

In Africa, several eradication pilot projects were initiated in the 1950s and 1960s, using IRS alone or in combination with other control methods such as mass drug administration in different epidemiological conditions.[7] Eradication was achieved on the islands of Mauritius[8] and la Réunion, where malaria disappeared using the standardized approach. The results in other areas in Africa were less definitive, ranging from a good entomological and parasitological response in areas with seasonal, unstable malaria to a very poor response in African savannah areas with year-round transmission (*20*). In 1969, the Government of Nigeria, together with WHO, embarked on a landmark study that would become known as the Garki project, to study the epidemiology of malaria and the impact of IRS and mass drug administration interventions in these intense transmission savannah areas, and to construct and test a mathematical model of malaria transmission as a planning tool. It proved that the interventions could bring about a marked reduction in parasite prevalence; however, transmission was not interrupted in the relatively short period under consideration (*20*).

As a result of the GMEP campaign, 37 of the 143 countries that were endemic in 1950 were free from malaria by 1978, including 27 in Europe and the Americas (*21*). Many other countries greatly reduced their malaria burdens. In India, the number of malaria cases declined from an estimated 110 million in 1955 to less than a million reported cases in 1968, and reported malaria mortality dropped to zero. Sri Lanka reduced the incidence of malaria from an estimated 2.8 million cases in 1946 to a reported 18 cases in 1966 (*1*).

As countries increasingly freed themselves from malaria under the GMEP, it became important to know where malaria still existed, to manage the dangers of possible re-importation of the parasite. For this purpose, the World Health Assembly (the decision-making body of WHO) requested WHO to establish an official register listing areas where malaria eradication has been achieved, after inspection and certification by a WHO evaluation team. Countries were entered in the register upon their request and after due international certification that the country had fulfilled the necessary criteria (see Annex 1 for WHO malaria elimination certification procedures).

It soon became evident that the feared resistance to DDT and chloroquine were by no means the only obstacles to eradicating malaria.[9] The

[7] Tropical forest: southern Cameroon, Liberia; lowland savanna: northern Cameroon, northern Nigeria (Sokoto), Senegal, Upper Volta; degraded forest: Benin, Togo (Palimé); high plateau: Uganda, Madagascar; oceanic islands: Mauritius, Réunion; southern limits of tropical Africa: South Africa, Swaziland, Southern Rhodesia (see http://whqlibdoc.who.int/publications/9241560614_(chp1).pdf).

[8] WHO certified the malaria-free status of Mauritius in 1973. In 1974, Mauritius' history of malaria was documented in the article 'Malaria in Mauritius–As Dead as the Dodo' (see http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1749438/pdf/bullnyacadmed00177-0023.pdf). However, the malaria mosquito (*Anopheles gambiae*) still existed on the island, and in 1975–1976 after the passage of cyclone Gervaise there was a resurgence of the disease following the reintroduction of the malaria parasite (*Plasmodium vivax*) by workers from malaria-endemic countries who came to rehabilitate the island infrastructure destroyed by the cyclone. This renewed transmission would take until 1996 to fully control again. Since then, Mauritius has maintained an active programme for prevention of reintroduction.

[9] In 2011, mosquitoes are still sensitive to DDT in certain malaria-endemic areas, and chloroquine largely maintains its efficacy against the *P. falciparum* malaria parasites of Central America and Hispaniola.

strategy itself was inadequate in areas where mosquitoes tended to bite and rest outdoors or otherwise avoided contact with the insecticide. The strategy also was inadequate in highly endemic parts of tropical Africa, and in remote 'problem areas' with an overall lack of development (*22*).

In the 1960s, public support for the GMEP campaign waned, and the 19th World Health Assembly in 1966 voiced its concern that 'the advance towards malaria eradication had been slower than hoped for.' The erosion of confidence in malaria eradication translated into a declining funding base for activities. Resurgences of malaria, largely due to faltering parasite and vector surveillance and control, started to occur in areas that had only recently been cleared, including a *P. vivax* malaria epidemic that spread over Sri Lanka in 1967, resulting in more than one million cases reported in 1968–1969, just a few years after its model achievements of 1966 (*23*). As stated by Nájera (*4*): 'A contrast became increasingly obvious between the near-absence of resurgences in countries which had achieved malaria elimination as a result of control programmes with a long history, begun before 1955, and the high frequency with which [resurgences] followed after the apparent success of the newly established vertical programmes'.[10]

By 1969, it was clear that the world would not reach the global malaria eradication target in the near future, and the World Health Assembly recommend that WHO change its approach to 'malaria control with the ultimate aim of malaria eradication', while still maintaining its support for malaria eradication programmes (*24*). The main sponsors of the GMEP (WHO, the Pan American Health Organization [PAHO], the United Nations Children's Fund [UNICEF] and the United States Agency for International Development [USAID]) subsequently evaluated the ongoing GMEP country projects to assess the likelihood of success with or without additional resources, and they developed new terminology: malaria eradication projects, malaria pre-eradication projects and malaria eradication pilot projects. The malaria eradication projects soon dwindled and increasingly more malaria pre-eradication projects and malaria eradication pilot projects were established (*1*). Within a few years, however, global interest in malaria eradication ceased, and the focus for malaria shifted to finding new tools that might provide a new malaria eradication opportunity.

[10] A vertical programme, as opposed to an integrated horizontal programme, is a disease-specific programme that has its own hierarchy, structure and services from central down to village levels, and that functions rather independently from the general health services.

PROGRESS TOWARDS ELIMINATION FROM 1973 TO THE LATE 1990s

Although some countries, particularly a number of countries in the Eastern Mediterranean Region and North Africa, progressed to eliminate malaria, the 1970s through the 1990s were characterized by an emphasis on malaria science (such as that to address parasite and vector resistance) and limited financial support for malaria control programmes. By 1992 at the Amsterdam Ministerial Conference, a revised global malaria strategy emphasized malaria control; and the new tools (insecticide-treated mosquito nets [ITNs], artemisinin-based combination therapy [ACT], and rapid diagnostic tests [RDTs]) were under evaluation and poised for forming the basis of an evolving malaria control strategy.

Countries and territories where malaria was eliminated over the period 1973–1999

Europe: Greece

Eastern Mediterranean: Bahrain, Egypt, Kuwait, Libya, Tunisia, United Arab Emirates*

Asia: Hong Kong, Maldives

Oceania: Australia*

*Countries that have completed WHO certification as malaria-free.

In 1973 the global oil crisis occurred and stock markets crashed globally, heralding the end to the general post-WWII economic boom. The Cold War would continue for another 20 years, and conflicts resulted in battle fronts in Africa, Asia, Central Asia and Central and South America. In the mid-1970s, WHO, joined later by the United Nations Development Programme (UNDP), the World Bank and UNICEF, founded the Special Programme for Research and Training in Tropical Diseases (TDR), which developed specialized work streams for malaria medicines, field epidemiological research and immunological research, including the search for a malaria vaccine. During these years, while funding for malaria control was dwindling and attention was focused elsewhere, malaria made a dramatic resurgence in many areas where the GMEP had been almost successful in eliminating malaria and population immunity was lowered. These so-called 'post-eradication' or 'rebound' epidemics following the discontinuation, weakening or loss of effect of vector-control

programmes took a particularly high toll on the Indian subcontinent (Sri Lanka [1968], India and Pakistan [1976–1977]), and in Turkey (1977) and the Madagascar highlands (1988) (*23, 25, 26*). Elsewhere, epidemics followed natural disasters that destroyed housing and infrastructure and increased opportunities for mosquito breeding; examples included cyclone Gervaise in Mauritius in 1975, and cyclones Ida and Namu in the Solomon Islands in 1972 and 1986 respectively (*27–30*).

When *P. falciparum* malaria epidemics affect non-immune populations, dramatic mortality can occur among people of all age groups. People fell sick and died within days in areas with erratic access to health care. The rebound epidemics defined the global perception of malaria as a disease where a controlled, stable equilibrium, coupled with access to health care for all who fell sick, might be preferable to a substantial reduction of transmission that could perhaps not be maintained. Malaria thus became one of many health problems affecting poor, rural populations—best approached through a broader primary health care strategy that emphasized the development of health services. In 1978, the International Conference on Primary Health Care adopted the Alma Ata Declaration, and the World Health Assembly adopted a new malaria control strategy to reduce malaria mortality using an epidemiological approach, with the ultimate objective of eliminating the disease whenever feasible. The tactical variants of this strategy, for use in situations of diminishing transmission severity, were: 1) reduction and prevention of mortality due to malaria, 2) reduction and prevention of mortality and morbidity particularly in high-risk groups, 3) reduction of prevalence and endemicity of malaria and 4) countrywide malaria control aimed ultimately at eradication (*31*, *32*).

While setbacks were being faced in many countries, progress was made in others, mainly at the edge of malaria's range in situations where continued programme funding had been available. Thus, Australia reported its last case of local transmission on the Torres Straits Islands in 1973. A year later the last European pocket of malaria transmission was cleared up in Macedonia, Greece, and after millennia of struggle, the continent of Europe was finally free of indigenous malaria—a milestone that was marked in 1975 with little fanfare (*15, 33, 34*). The achievement has proved stable, despite an overall steady influx of imported malaria cases and periods of considerable socioeconomic destruction and conflict in the Balkans. The single largest renewed outbreak of local transmission in the region occurred in Bulgaria in 1995–1996, when locally acquired 18 locally acquired cases of *P. vivax* malaria were reported—a situation that was swiftly controlled (*35*). By the mid-1970s, the GMEP had thus, in retrospect, achieved complete elimination of malaria from two entire continents: Europe and Australia.

The Government of Tunisia chose to continue the intensive malaria eradication campaign that it had started in 1967, and successfully eliminated malaria from the country; the last three locally acquired cases of malaria were recorded in 1979 (*34*). In view of the desert environment, larviciding was an important focal component of the strategy. Bahrain and Kuwait also reported their last local cases in 1979. Another country that quietly progressed on the path towards malaria elimination was the Maldives, a group of 1190 islands, of which 196 were inhabited by a total population of approximately 320 000 people (*36*), located 700 km south-west of Sri Lanka. The Maldives already had a low level of *P. vivax* malaria transmission (1105 cases in 1975, reduced to 52 in 1980) (*23*). Elimination of malaria was achieved in 1984 through the complete elimi-

nation of the mosquito vector from the islands (*37*). The continued absence of malaria transmission is very important for tourism in the Maldives, and vigilance for parasites and vectors is being carefully maintained. With these two eradication successes, and the certification of Australia (1981), Singapore (1982) and Brunei Darussalam (1987), which had achieved malaria elimination many years before, the era of the GMEP came to an end.

Over the course of the 1980s, the world malaria situation deteriorated with the spread of resistance to chloroquine and other antimalarial drugs, increasing occurrence of epidemics, and overall operational constraints and reduced financing. In *P. falciparum*–endemic areas outside Africa, the percentage of malaria cases due to *P. falciparum* (as opposed to *P. vivax*) increased from 15% in the early 1970s to 36% in 1988 (*4*). Toward the end of the 1980s in Africa, resources for mounting an effective response to control malaria were very limited despite the fact that more than 80% of all malaria disease episodes and an estimated 800 000 child deaths were occurring there each year (*38*).

The fall of the Berlin Wall in 1989 and the breakup of the Soviet Union in 1991 ushered in a new era of determination. Attention was drawn back to public health, and there was hope that the 'peace dividend' that might become available due to decreased defense spending could be applied to the fight against malaria. A revised *Global Malaria Control Strategy* was adopted by high-level government officials from 102 WHO Member States at a Ministerial Conference in Amsterdam in 1992, and an action plan was developed for its implementation (*39*). In hindsight we now know that it would be another decade before the Global Fund to Fight AIDS, Tuberculosis and Malaria would be established as one of the most critical steps to ensuring that essential financial resources would be made available to implement recommended strategies. The end of the Soviet occupation of Afghanistan, when malaria-infected soldiers returned home to receptive areas, and the collapse of the Soviet Union resulted in the reintroduction of *P. vivax* malaria into Central Asia, Armenia, Georgia, and even the surroundings of Moscow, which had all been free from the disease since the 1960s. A reappearance of *P. falciparum* malaria in Tajikistan was first noted in the mid-1990s. The main reasons behind this resurgence and spread of malaria over the WHO European Region are understood to have been the disruption of historical ties between the countries of the former Soviet Union, socioeconomic instability, uncontrolled population movements, deterioration of health infrastructures and services, and shortages of basic supplies (*40*). At the peak of this epidemic in 1995–1996, the countries of the WHO European Region together reported over 90 000 locally-acquired malaria cases annually, mainly in Azerbaijan, Tajikistan and Turkey.

In the 1990s, global malaria control finally turned its attention to the needs of the world's most affected populations and countries—those in Africa. The initiatives included the Global Malaria Control Strategy, developed during international consultations and interregional conferences during 1991–1992 and ratified in October 1992, WHO's Programme for the Accelerated Implementation of Malaria Control in Africa (1997) (*41*) and the commitment of WHO, UNICEF, UNDP and the World Bank to 'Roll Back Malaria' (1998).

New tools that transformed malaria control

The 1990s saw three important tools being added to malaria control that would come into use in a significant way in the decade that followed: insecticide-treated bed nets (ITNs),

artemisinin-based combination therapy (ACT) and rapid diagnostic tests (RDTs) for malaria.

Insecticide-treated nets

The classic bed nets that had been used previously were a personal protection method—the net protected the person sleeping under it but had little impact on malaria transmission overall. The development of insecticide-treated nets lifted this technology to an entirely new level: the ITN not only protected the person sleeping under it, but could also kill the mosquitoes that landed on it. Large-scale trials in intense transmission areas proved that if enough people diligently used ITNs, they could greatly reduce overall malaria transmission, and contribute to saving lives in a very cost-effective way (*42*). Despite the massive impact of ITNs (and later, long-lasting insecticide-treated nets, or LLINs) on malaria control, their role today in malaria elimination has been limited as they have been more widely deployed in high-transmission settings. However, there is evidence that when deployed on a mass scale, ITNs do result in a large-scale impact on transmission (*43*). While the greatest protection is obtained by sleeping under an ITN, sleeping in a house where an ITN is deployed, or even in a house without an ITN that is close to a house with one, provides some degree of protection (*44*). One challenge for elimination is that the less malaria there is, the lower the personal motivation may be to sleep under a bed net.

Artemisinin-based combination therapies

In China, artemisinin (Qinghaosu) was isolated from the *Artemisia annua* plant in 1972 and included in the national pharmacopeia in 1977, after which it was widely produced and played a role in the progressive elimination of malaria in the country (*45*). Large-scale use of free artemisinin, like the 'quininization' campaigns in early 20th century Italy, also played an important role in the progress made by Viet Nam in the mid 1990s, when it greatly reduced its malaria burden (*46*). ACTs were introduced on the world stage in the late 1990s—these were effective three-day therapies that replaced increasingly inefficacious chloroquine and sulfadoxine-pyrimethamine (Fansidar) as treatment for *P. falciparum* malaria (*47*). ACTs quickly became the universal treatment of choice for *P. falciparum* malaria (*48*). ACTs were successfully used in malaria elimination in Tajikistan, where the last case of *P. falciparum* occurred in 2008. For the elimination of *P. vivax*, which was until now invariably the last remaining parasite species in elimination countries, chloroquine plus primaquine (to kill the dormant liver stage of the parasite) remains the treatment of choice (*48*). However, there is increasing evidence of chloroquine-resistant *P. vivax*, and the role of ACTs in the treatment of this species may increase in coming years (*49*).

Rapid diagnostic tests

Rapid diagnostic tests, introduced for malaria in the 1990s, have extended access to rapid and reliable malaria diagnostic testing even in the most peripheral areas where microscopy is generally not available. Their use in malaria control accelerated in the second half of the 2000s when the reliability and stability of the available products improved, and WHO, together with TDR, the Foundation for Innovative New Diagnostics (FIND) and the US Centers for Disease Control and Prevention (CDC), introduced routine product testing of RDTs for malaria. These tests made it possible for WHO to recommend universal diagnostic testing in 2010: all suspected malaria fevers should receive a diagnostic test, with antimalarial treatment reserved for confirmed infections (*49*). In elimination programmes, quality-assured microscopy is still critically important because the blood slides give a lasting record that provides more detailed information than current RDTs, such as the parasite density and the presence of gametocytes.

Elimination progress in the 1990s

In the discourse on malaria control of the 1990s, the least-affected countries–where elimination of malaria would be feasible–were rarely mentioned (*19*). This neglect was highlighted by the 1993 report of the International Task Force on Disease Eradication, which identified potentially eradicable diseases and mentioned malaria in merely an historical context (*50*).

This did not deter Oman from taking up the challenge of malaria elimination in 1990. In a country with a desert climate, where mosquito breeding possibilities were mostly limited to human-made water bodies, and where the standard of living of the population was increasing so that human-mosquito contact was diminishing, why should there still be malaria? A full-scale malaria eradication programme was started in Sharquiya Region in 1991 and expanded gradually to other regions over three years. The backbone of the programme was conscientious mapping of the transmission areas, reported malaria cases and larval breeding sites, and close supervision of the field operations. The latter consisted chiefly of total coverage of all the potential breeding places of the *Anopheles* vector with weekly larviciding based on accurate, periodically updated maps (*19*). Special attention was paid to training and retraining staff, to management and supervision, to surveillance and information systems and to the execution of anti-vector measures (mainly larviciding) in an efficient and timely manner. An Inter-ministerial Committee was established to guide and oversee the programme. The programme manager was constantly available for malaria case investigation as needed, and the Minister of Health expected weekly programme updates. It would take Oman until 2004 to fully interrupt transmission. Subsequent outbreaks due to reintroduction of *P. vivax* and *P. falciparum* parasites from the Indian subcontinent continue to preclude Oman's certification as a malaria-free country (*51*).

The successes of Bahrain, Kuwait and Tunisia in the early 1980s and the efforts of Oman in the early 1990s inspired other countries in the WHO Eastern Mediterranean Region. In 1997, the four North African countries in the Region and Algeria set an eradication target for malaria for the North African subregion (*52*); Egypt reported its last indigenous malaria case that same year. The WHO Malaria Expert Committee noted in 1997: 'In a number of countries, the incidence of malaria has been brought down to such low levels that total interruption of transmission may be a feasible objective (e.g. Algeria, Egypt, Morocco, Oman and United Arab Emirates). For such countries, interventions could be planned to achieve complete interruption of transmission based on the principles of eradication' (*47*). The United Arab Emirates, Oman's northern neighbour, achieved interruption of transmission in 1998, and would become the first country since the 1980s to complete the official certification procedures in 2007 (*53*).

CHAPTER V

PROGRESS TOWARDS ELIMINATION DURING THE RBM DECADE 2000–2010

During the Roll Back Malaria decade from 2000 to 2010, countries demonstrated much success in malaria control and a global emphasis on progression to elimination emerged, with three countries becoming WHO-certified from 2007 to 2010 as having eliminated malaria. Progress has occurred in every WHO Region of the world and the WHO European Region is poised to eliminate malaria from all of its nations in the coming five years.

Countries and territories where malaria was eliminated over the period 2000–2010[11]

Eastern Mediterranean: Morocco,* Syria, Iraq

Europe and Central Asia: Armenia, Georgia, Kazakhstan, Turkmenistan*

*Countries that have completed WHO certification as malaria-free.

With the advent of RBM in 1998, strategies for addressing malaria were clarified and mechanisms established to improve coordination between partners in endemic countries and at international level. Vigorous advocacy efforts gave renewed visibility to malaria. The four main strategies for achieving the goal of the RBM decade were: 1) prompt access to effective treatment; 2) malaria prevention through vector control, particularly the use of ITNs; 3) prevention and management of malaria in pregnancy; and 4) prevention of and effective response to malaria in epidemics and complex emergencies (*54*). The resolution 'was born out of the growing consensus that malaria, one of the deadliest and economically most devastating of all tropical diseases, could be effectively controlled with the tools and strategies currently available' (*54*). Although RBM was a global initiative, its main focus

[11] In addition, some countries re-eliminated malaria subsequent to reintroduction of transmission: Bahamas, Jamaica and the Russian Federation.

was Africa, where the vast majority of cases and deaths occur.

Building upon a decade of major United Nations conferences and summits, world leaders came together in September 2000 at United Nations Headquarters in New York to adopt the United Nations Millennium Declaration. This indicated their national commitment to a new global partnership to reduce extreme poverty, setting out a series of time-bound targets, with a deadline of 2015, which became known as the Millennium Development Goals (MDG) (*55*). Target 6C of the MDGs spoke specifically to malaria: to have halted by 2015 and begun to reverse the incidence of malaria and other major diseases (*55*). A year later, the United Nations General Assembly proclaimed the period 2001–2010 the Decade to Roll Back Malaria in Developing Countries, particularly in Africa, with the goal of halving the world's malaria burden by 2010. In April 2002, the Global Fund approved its first round of grants for large-scale malaria prevention and treatment programmes. While the Global Fund today has funded several malaria elimination proposals, this was not its focus earlier in the decade. But the resources provided then did help countries to significantly reduce their burden, setting the stage for them to consider embarking on elimination.

Progress in malaria elimination by WHO region

Progress in expanding malaria control programmes and reducing cases and deaths has been achieved both inside and outside of Africa (*35*, *56*). There have also been considerable advances in eliminating malaria in several parts of the world. Following is a summary of country progress in malaria elimination based on WHO region.

WHO European Region

Among the 53 countries of the European Region, 45 are now malaria-free; the remaining 8 countries are either in the elimination or prevention of reintroduction categories.

Source: WHO/Global Malaria Programme.

The WHO European Region comprises 53 countries and covers the continent of Europe as well as Israel, Turkey and the 15 countries of the former Soviet Union.[12] Ten countries were affected by malaria during the RBM decade 2000–2010: Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Russian Federation, Tajikistan, Turkey, Turkmenistan and Uzbekistan.

The ministers of health from all malaria-affected countries in the Region endorsed the 2005 Tashkent Declaration: The Move from Malaria Control to Elimination in the European Region (*57*), which supported and facilitated their decisions to undertake a new elimination effort (Box 4). The ultimate goal of the new strategy, developed in 2006, is to interrupt malaria transmission by 2015 and eliminate the disease within the Region. In areas and countries where malaria had been eliminated, priority is given to maintaining the malaria-free status. In the remaining affected countries of the Region, malaria shows a markedly focal distribution. Here, malaria elimination activities focus on disease management, vector control, capacity building, disease surveillance, operational research, community mobilization, intersectoral collaboration and cross-border collaboration within the Region and between the European and Eastern Mediterranean Regional Offices.

[12] Full listing: Albania, Andorra, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Luxembourg, Malta, Monaco, Montenegro, Netherlands, Norway, Poland, Portugal, Republic of Moldova, Romania, Russian Federation, San Marino, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Tajikistan, The former Yugoslav Republic of Macedonia, Turkey, Turkmenistan, Ukraine, United Kingdom of Great Britain and Northern Ireland, Uzbekistan.

Box 4: Basic principles of managing malaria elimination programmes in the WHO European Region

Individuals with clinically suspected malaria are identified through active and passive case detection. Parasitological diagnostic confirmation by microscopy is always recommended before treatment is started. In areas where malaria is unstable and there is no significant immunity, the objective of malaria treatment is to obtain a parasitological and radical cure (i.e. to clear parasites from the blood and liver). All parasitologically confirmed cases of *P. vivax* are treated with chloroquine (CQ) and primaquine (PQ), and both drugs are usually given concurrently, i.e. CQ with PQ during the first three days and PQ alone for the next eleven days. Artemisinin-based combination therapies (ACTs) are recommended for the treatment of uncomplicated locally transmitted and imported *P. falciparum*. Malaria patients are usually treated on an out-patient basis, and only patients with evidence of severe (life-threatening) malaria need to be admitted to hospital.

Indoor residual spraying (IRS), as the principal tool for transmission control, is applied on a strict total coverage of all residual and new foci of malaria, with a view to interrupting transmission as soon as possible all over the target area, and preventing its re-establishment. Use of larvivorous Gambusia fish can be promoted in areas where mosquito breeding sites are few and well defined, including in rice-growing areas. Insecticide-treated materials, such as nets and screens, are used for personal and community protection in some malaria settings, particularly against outdoor-resting *Anopheles* species in Central Asian countries.

When the number of malaria cases becomes low, a central question is whether or not malaria transmission is still taking place in a given area. Hence, all cases reported are subject to epidemiological investigation. The result of the investigation is an epidemiological diagnosis of each malaria case in terms of its place, time and source—in particular, whether a case was imported from another country, locally acquired or a relapse. The case investigation forms the basis of classifying each malaria transmission focus as to whether or not there is active transmission. The status of every focus is periodically reviewed and reclassified. The identification and monitoring of the status of malaria foci is central to the interruption of malaria transmission and/or prevention of its reintroduction.

Particular emphasis is given to situations where there is a risk of spread of malaria between neighbouring countries and regions. For instance, a majority of countries in the WHO European and Eastern Mediterranean Regions have similar epidemiological situations and problems concerning malaria. Therefore, close cross-border cooperation is being promoted through the organization of border meetings and international trainings, the regular exchange of relevant information and technical documents of mutual interest, the development of joint project proposals and visits of national malaria programme counterparts and WHO staff.

Attention is also given to operational research. For instance, the identification and geographical distribution of *Anopheles* mosquitoes, prevalence of sibling species and their roles in malaria transmission, taxonomy, biology and ecology of malaria vectors are of particular interest in the WHO European Region.

Source: WHO/EURO.

In addition to high-level political commitment within affected countries, the Regional elimination effort has also received continued technical support from WHO and financial assistance from the Global Fund from 2003 onwards, with a total of 11 grants for five countries (Azerbaijan, Georgia, Kyrgyzstan, Tajikistan, Uzbekistan). Several countries, including Bulgaria, Italy, the Russian Federation and the United States of America, have shared their expertise and provided training opportunities, covering areas such as parasitology, entomology, vector control, malaria diagnosis, disease management, laboratory quality assurance, epidemic prevention and control, stratification and mapping. The national reference laboratory for parasitic diseases in Sofia, Bulgaria, became a WHO/EURO regional reference laboratory for malaria diagnosis and external quality control.

There has been a substantial reduction in the number of reported malaria cases in the WHO European Region as a result of intensive antimalaria interventions. After 15 years of country and regional efforts, the 1990s malaria epidemics in the former Soviet Republics and Turkey are very nearly under control, with cases declining from 90 712 probable and confirmed cases in 1995 to 32 394 cases in 2000 and only 176 confirmed cases in 2010. As of 2010, locally acquired malaria cases were reported in 5 out of the 53 Member States of the Region: Azerbaijan, Kyrgyzstan, Tajikistan, Turkey and Uzbekistan. No locally acquired *P. falciparum* cases have been reported since 2008 when just 2 cases were reported in Tajikistan. Kazakhstan reported its last locally acquired malaria case in 2001; Georgia reported its last in 2009. Turkmenistan, which reported its last case in 2004, was certified free of malaria by the Director-General of WHO in October 2010. Armenia reported its last case in 2005 and was, as of September 2011, in the process of certification. Turkey had reported no new malaria infections in 2010[13] and only 9 relapses of *P. vivax* malaria, and is continuing its efforts in the hope of certification in the near future.

[13] Renewed disease caused by the persistent liver forms of *P. vivax* following incomplete treatment.

Country examples in the European Region

Tajikistan

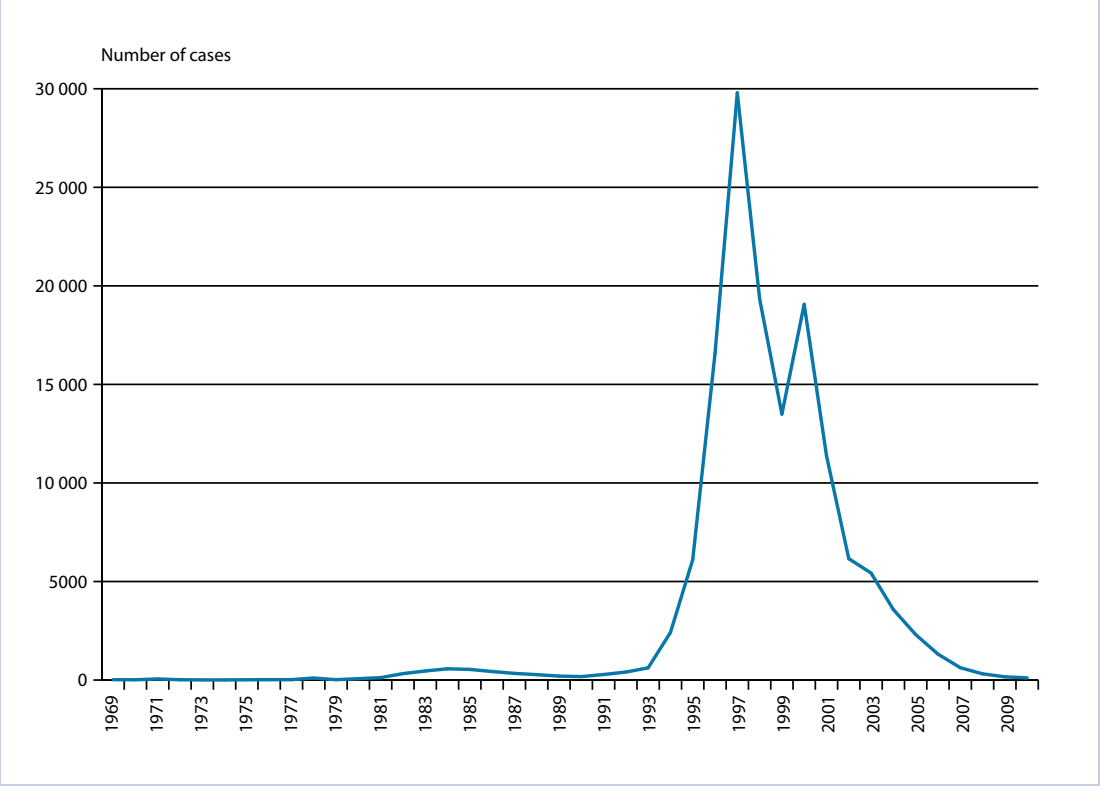
By the end of the 1960s, malaria was nearly eradicated in Tajikistan but residual foci remained in the southern parts of the country bordering Afghanistan, where transmission of the *P. vivax* parasite persisted and sporadic cases of the disease were reported each year.

After national independence in 1991, malaria expanded to epidemic proportions once again, reaching a peak in 1997, when nearly 30 000 cases were linked to armed conflict, mass population movement across malaria endemic zones—particularly Afghanistan—and the disruption of public health care services and vector control activities. In addition, lack of irrigation system maintenance and marked changes in agricultural practices—particularly the increase in the cultivation of rice—led to an increase in vector breeding grounds. The resurgence included local transmission of both *P. vivax* and *P. falciparum* in the country (Figures 5.1A and 5.1B).

Figure 5.1
Malaria cases in Tajikistan (1969–2010)

Following independence, a weakened malaria control programme, and population movement internally and from neighbouring countries (especially Afghanistan), malaria resurged in the late 1990s and early 2000s; resumption of control work and concerted efforts to achieve elimination have led to elimination of P. falciparum *(by 2009) and essential decrease of* P. vivax *transmission (111 cases in 2010).*

A. *Plasmodium vivax* cases

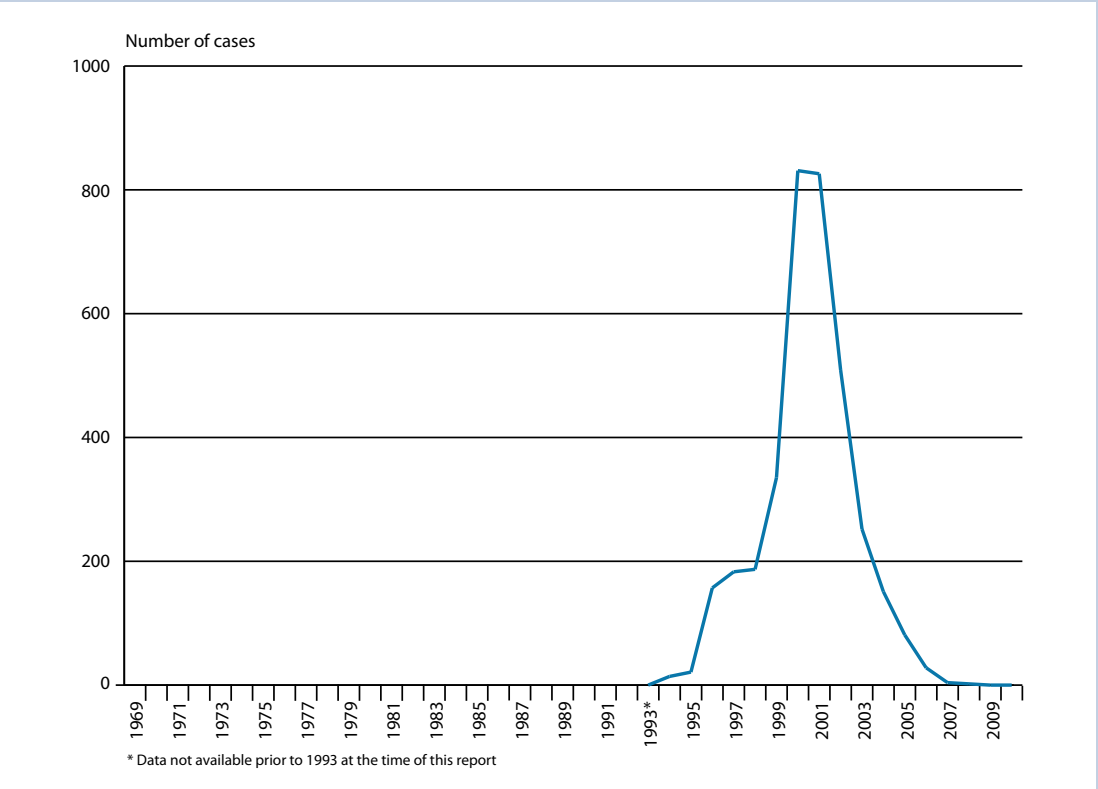


In this difficult situation, the Ministry of Health (MOH), together with the WHO Regional Office for Europe (WHO/EURO), developed the National Programme on Malaria Control (NPMC) aimed to reinforce antimalaria activities. The human and financial resources invested by the Government were limited; fortunately, external technical support and financing for the NPMC were provided by many international, nongovernmental and other organizations. Support included:

- Essential technical assistance, as well as some financial support, provided by the WHO European Region for strategy and policy formulation, activity planning and staff training. WHO financial contributions over the period 1998–2005 were US$ 890 000.
- Support beginning in 1997 from the Swiss Agency for Development and Cooperation to sponsor the Programme of Malaria Prevention, with the NGO Agency for Technical Cooperation and Development (ACTED) implementing the programme in the Khatlon region of the country. ITNs and basic education on malaria prevention were provided to 9000 families in four districts: Vakhsh, Kolkhosobad, Bokhtar and Pyanj. Total Swiss contributions from 1997–2005 were US$ 1 704 200.
- An effort to roll back malaria in Central Asia, with particular emphasis on Tajikistan and Kyrgyzstan, was conducted in 2003–2004. USAID contributed US$ 564 000 to the effort; other main donors were the Humanitarian Aid department of the European Commission (ECHO) (1999–2004, US$ 700 000), UNICEF

Figure 5.1

B. *Plasmodium falciparum* cases



Notes: P. falciparum is no longer present in Tajikistan.

Source: CISID, Tajikistan National Malaria Programme.

(US$ 100 000 in 1999; US$ 200 000 in 2004) and the British NGO Merlin UK (1998–2001; US$ 256 000).

- Activities have been reinforced since 2006 by substantial funding for malaria control through the Global Fund. The substantial financial support (US$ 5 383 510 from Round 5 and US$ 7 171 889 from Round 8) contributed to further improvement of the malaria situation in the country.

Assistance from partners enabled the NPMC to upgrade the national malaria surveillance system and conduct a full range of antimalarial activities directed at early detection and radical treatment of all malaria cases; reinforcement of the MOH's malaria control capabilities; mass drug administration with primaquine; information, education and communication on malaria prevention, and promotion of community participation; and vector control through targeted IRS, ITN distribution and biological control (treating water bodies with the larvivorous Gambusia fish).

Joint activities by the Tajikistan MOH and other partners have resulted in a considerable decline in the number of malaria cases, which have fallen from 3588 cases in 2004 to 111 cases (all *P. vivax*) in 2010, and no registered epidemics. The transmission of *P. falciparum* has been interrupted.

Turkmenistan

P. falciparum, *P. vivax* and *P. malariae* have long been endemic to Turkmenistan; areas of malaria receptivity were the foothills, plains, irrigation areas and along canals and other human-made water management systems. Large-scale antimalaria activities implemented in the middle of the century enabled the country to eliminate malaria by 1960. But from 1960–1980, sporadic imported and introduced cases of *P. vivax* were reported in Turkmenistan, and during the 1980s there was an increase in imported malaria originating from across the border in Afghanistan.

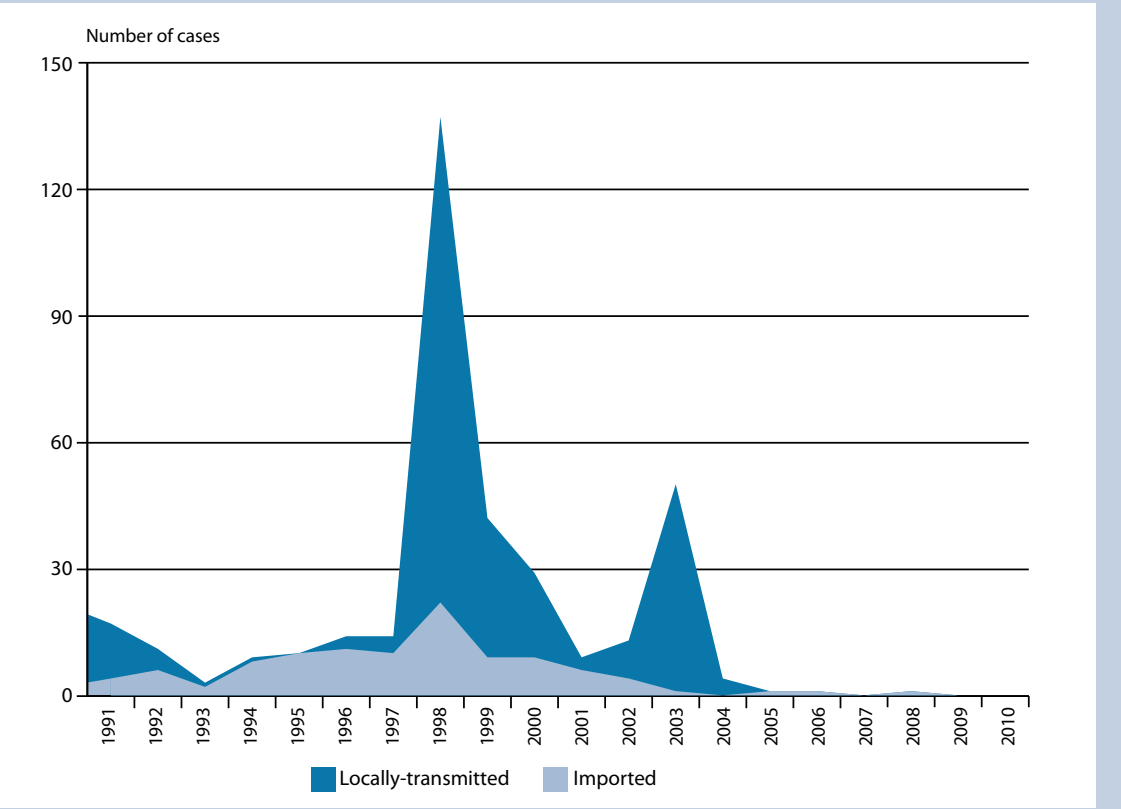
Renewed malaria transmission in 1998

After national independence in the 1990s, the malaria situation in Turkmenistan deteriorated owing to neglect of control efforts and increased movement of populations (Figure 5.2). In 1998, 108 cases of malaria (nearly 80% of all cases) were detected in Gushgi (now Serhetabad) District of Mary Province. The outbreak occurred in a military training camp located near the border with Afghanistan. It was assumed that the malaria infections were caused by infected mosquitoes from across the border, an area where highly endemic settlements were located. In 1999, asymptomatic demobilized military personnel carried the infection to the eastern part of the country in the Dashkovuz and Lebap Provinces. The MOH mobilized the Sanitary Epidemiological Service and general health facilities to take urgent measures and strengthen the epidemiological surveillance and control of malaria in the area, with technical assistance from WHO; this led to the containment of the outbreak.

Figure 5.2

Imported and locally transmitted malaria cases in Turkmenistan

Through a combination of weakened malaria surveillance activities and population movement internally and with neighbouring countries, malaria outbreaks occurred in 1998 and 2003; since that time, concerted emphasis on malaria surveillance and control brought both locally transmitted and imported cases to zero.



Note: Turkmenistan was certified by WHO as malaria-free in 2010. The total number of cases shown by the figure is the sum of imported cases and locally transmitted cases.
Source: CISID, Turkmenistan National Malaria Programme.

In 2003, a second malaria outbreak involving 48 cases occurred in Mary Province. In 2002–2003, a large number of oil and gas workers had been regularly travelling between the two vulnerable border districts and highly receptive Yoloten Etrap. This led to an outbreak in Yoloten, which exported a few secondary cases to other parts of Mary Province. Based on experience with the outbreak in the 1990s, the country responded quickly with malaria control activities and the proliferation of malaria cases throughout the province was rapidly halted.

Interventions for containing the outbreaks

The surveillance and control methods used were:

- intensive case detection (daily house-to-house visits with temperature-taking);
- a mass blood survey carried out among 602 oil and gas workers and 2566 villagers;
- epidemiological investigation of all cases and foci;

- radical treatment of patients detected;
- indoor residual spraying (IRS);
- larviciding of 96 hectares of water bodies;
- seasonal prophylaxis with chloroquine of 3000 military personnel in units stationed in the active malaria foci, approximately 6000 residents of active focal areas, 610 oil and gas workers and residents of affected areas;
- inter-seasonal prophylaxis with primaquine of the population in affected areas;
- trainings for laboratory technicians and other personnel engaged in programme implementation (such as specialists from defence and border guards) and
- awareness-raising sessions.

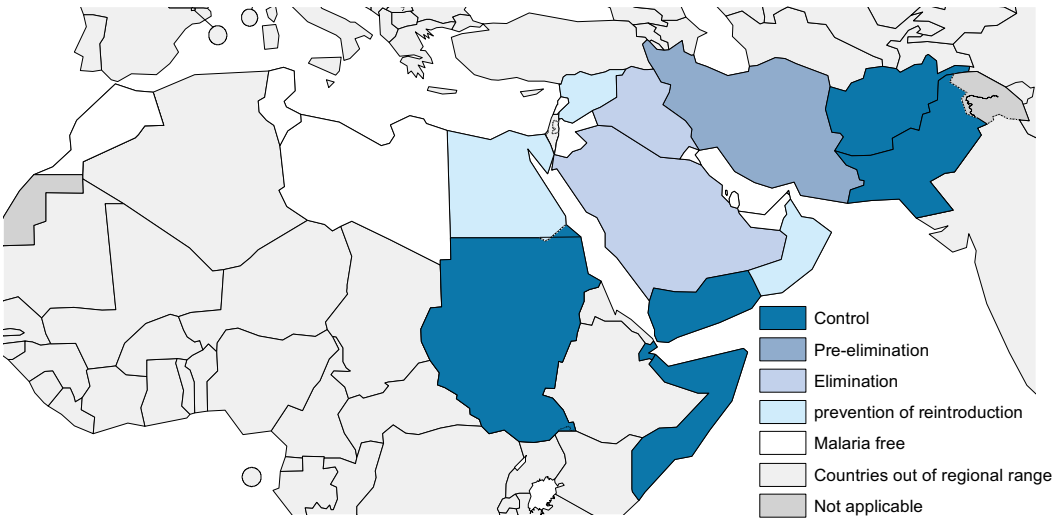
These activities resulted in containment of the outbreaks.

Turkmenistan learned from experience that intensive surveillance is required even in a situation of low transmission. Thus, after the outbreaks in 1998, malaria interventions continued and a high level of vigilance was maintained. The last locally transmitted cases in Turkmenistan were registered in 2004; in 2010 the country was certified by WHO as free of malaria.

Turkmenistan offers an example of how correct contemporary and scientifically-based strategies and policies can be applied to achieve malaria elimination or to prevent or address transmission reintroduction. The country has demonstrated how enormous effort, strong political commitment and sufficient and durable national funding can lead to success in eliminating malaria.

WHO Eastern Mediterranean Region

Among the 22 countries of the Eastern Mediterranean Region, 9 have eliminated malaria while 6 are now in the elimination, pre-elimination or prevention of reintroduction categories. Seven countries are still in the control phase.



Source: WHO/Global Malaria Programme.

The WHO Eastern Mediterranean Region comprises 22 countries and covers parts of Northern Africa, the Middle East and Asia.[14] Twelve countries were affected by local malaria transmission during the RBM decade of 2000–2010: Afghanistan, Djibouti, the Islamic Republic of Iran, Iraq, Morocco, Oman, Pakistan, Saudi Arabia, Somalia, Sudan, Syrian Arab Republic and Yemen. Of these, six countries moved forward with nationwide elimination programmes (Iran, Iraq, Morocco, Oman, Saudi Arabia, Syria), while two others (Sudan and Yemen) developed subnational malaria-free initiatives.

The Eastern Mediterranean Region placed an early focus on inter-country support, quality assurance of malaria microscopy (58) and new guidance materials to move forward on elimination. A technical consultation on Elimination of residual malaria foci and prevention of reintroduction of malaria was held in Rabat, Morocco, in 2002, resulting in the first WHO guidelines on malaria elimination in 40 years.

There has been a greater than 10-fold reduction in the number of locally transmitted malaria cases reported by the elimination countries of the WHO Eastern Mediterranean Region as a result of the intensive antimalaria interventions: locally acquired cases dropped from 22 234 in 2001 in Iran, Iraq, Morocco, Oman, Saudi Arabia and Syria to 1908 local cases in 2010. (*59*). Egypt and the United Arab Emirates had already reported their last locally acquired malaria cases in 1997. The United Arab Emirates were certified free of malaria by the Director-General of WHO in January 2007 (*53*). Morocco reported its last local malaria case in 2004 and was certified free of malaria in May 2010.

[14] Full listing: Afghanistan, Bahrain, Djibouti, Egypt, Islamic Republic of Iran, Iraq, Jordan, Kuwait, Lebanon, Libyan Arab Jamahiriya, Morocco, Oman, Pakistan, Palestine, Qatar, Saudi Arabia, Somalia, Sudan, Syrian Arab Republic, Tunisia, United Arab Emirates, Yemen.

Country examples in the Eastern Mediterranean Region

Yemen

The Government of Yemen, the country on the Arabian Peninsula that is most affected by malaria, decided in 2002 to eliminate malaria from Socotra Island, an important tourist destination. The main elements of the malaria elimination campaign for the estimated 90 000 inhabitants on the 3600 km^2 island were reduction of human–vector contact by the use of indoor residual house spraying, insecticide-treated mosquito nets, larviciding and biological control measures, including the use of larvivorous fish. Vector control staff were intensively supervised. Emphasis was also placed on early and correct diagnosis followed by prompt and correct treatment; medical doctors and laboratory technicians were trained and home management was undertaken by community health workers. Surveillance was strengthened to monitor the incidence of malaria, climatic changes, the occurrence of any outbreak, and the vector density and bionomics. Community participation, health education and intersectoral collaboration were promoted through strong political commitment, and technical support was provided by WHO and the Government of Oman (*60*).

As a result of these efforts, the last four locally acquired malaria cases on Socotra were reported in 2005. On mainland Yemen, malaria cases declined 7-fold since the late 1990s, from nearly 1.4 million suspected cases in 1997 to 198 963 cases in 2010, mainly *P. falciparum*. Over this period, the country benefited from two substantial Global Fund grants (in total US$ 20 million), as well as sub-regional support for its malaria control programme.

Saudi Arabia

Saudi Arabia made the decision in 2004 to eliminate malaria nationwide. Two years later, the Gulf Cooperation Council, with Saudi Arabia in the lead and technical support from WHO/EMRO, initiated the Arabian Peninsula Malaria Free Initiative (target date 2015), in which six countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates) agreed to jointly support malaria elimination in Yemen with US$ 17 million, of which Saudi Arabia would pay 50% (*61*). The strategy emphasizes strengthened case management and quality laboratory confirmation of all cases; vector control (consisting mainly of IRS, use of ITNs, larviciding of breeding sites mapped by a geographical information system [GIS] and space spraying as needed); improved surveillance, with the introduction of active case detection, epidemiological investigation of all cases and updating of malaria foci accordingly; and cross-border initiatives including the establishment of special malaria units for free diagnosis and treatment at the Yemeni border. Enabling approaches included strong political commitment, increased intersectoral cooperation and improvement of living standards.

The number of reported locally transmitted malaria cases in Saudi Arabia dropped from 4736 in 1998 to 29 in 2010, with 4657 and 1912 imported cases in 1998 and 2010, respectively. Most of the imported malaria cases in Saudi Arabia are detected by the special malaria units established along the border with Yemen. In recent years, surveillance and cross-border collaborative activities have been intensified; the programme distributed nearly 581 000 LLINs from 2008–2010, targeting populations at risk in focal areas. In addition, focal IRS was carried out, protecting nearly 2.5 million people at risk in 2010. ACT and other antimalarial treatments are available through public health services, free of charge for all who need them. The Government is the principal source

of funding for the malaria programme, providing an average of US$ 26.5 million every year (2005–2010) (*34*). In 2010, all local cases were due to *P. falciparum* (*60*).

Iraq

In 2005, the Government of Iraq committed to eliminating malaria. The country had already greatly reduced its malaria burden in the 1960s during the implementation of the Global Malaria Eradication Programme, when the reported numbers fell from 320 926 cases and 760 deaths in 1955 to 2234 cases in 1962. *P. falciparum* was eliminated in 1987. The destruction and population movements caused by the first Gulf war resulted in a malaria epidemic, with over 98 000 cases reported annually in 1994 and 1995; however, by 2005, an intensive control programme had brought locally transmitted cases down to only 44, all in the northern governorates. WHO's Regional Office for the Eastern Mediterranean sponsored a meeting in Jordan to develop the strategy for malaria elimination in Iraq, which would be based on improvement of malaria detection and case management combined with vector control through IRS, chemical and biological larval control, and use of ITNs. Despite ongoing security concerns, Iraq achieved zero reported local cases four years later in 2009 (*35*), opening up the possibility of sub-regional elimination in the Turkey–Iraq–Syria triangle.

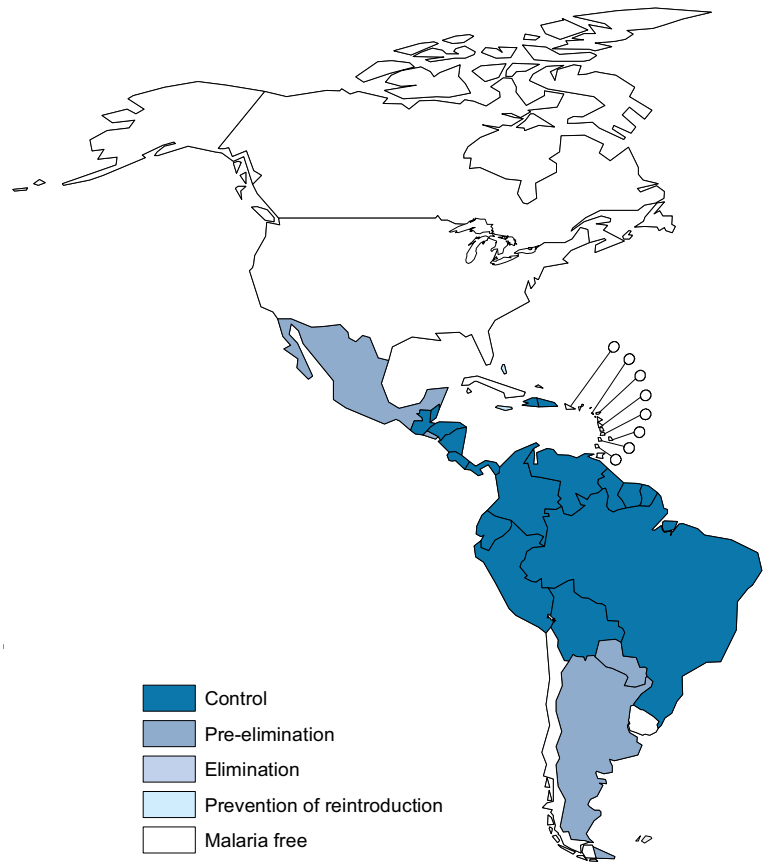
Islamic Republic of Iran

The Government of Iran decided in 2005 to proceed with elimination of malaria, despite its still relatively high burden; local cases were reduced from 14 396 in 2005 to 1847 in 2010, mainly due to *P. vivax*. The country spent the first two years following its announcement of the intent to eliminate malaria in a preparatory phase, strengthening the programme's infrastructure and logistics capacity and its human resources for planning and implementation of malaria control. As in Saudi Arabia, the remaining endemic areas in Iran pose challenges because these areas have more efficient vectors and a longer transmission season than the rest of the country, and are less well developed socioeconomically, with lower health system coverage. In addition, the areas most affected have borders with countries with high burdens of malaria across which there is a high level of population movement (*36*).

Source: WHO/EMRO.

WHO Region of the Americas

Among the 36 WHO member countries of the Region of the Americas, 13 are malaria-free while 6 are either in the pre-elimination or prevention of reintroduction categories. Seventeen countries are still in the control phase.



Source: WHO/Global Malaria Programme.

The WHO Region of the Americas comprises 47 countries and territories, covering North and South America.[15] Twenty-three countries reported local malaria transmission during the RBM decade of 2000–2010: Argentina, Bahamas, Belize, Bolivia, Brazil, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname and Venezuela. Of these, four countries moved forward with further nationwide malaria elimination (Argentina, El Salvador, Mexico, Paraguay) and two initiated an elimination programme at the sub-national level (Dominican Republic, Haiti), while two others suffered a temporary reintroduction of malaria transmission in 2006 that has since been controlled (Bahamas, Jamaica).

In the Americas, the RBM decade has seen decline in malaria cases of 50% or more in 13 of the 21 endemic countries and five others with reductions of less than 50%, with a shift towards a predominance of *P. vivax* as opposed to *P. falciparum* in the second half of the decade, reflecting the more rapid effect of control measures on *P. falciparum*. Three countries (Dominican Republic, Haiti, Venezuela) reported a relative increase in cases between 2000 and 2009, but the trend has already shifted downward for two of them (Dominican Republic, Venezuela) since 2005. As of 2010, four countries were in the WHO pre-elimination phase (Argentina, El Salvador, Mexico, Paraguay) and are introducing an increased emphasis on the quality of surveillance, reporting and information systems. Five countries and one territory now in the control phase (Belize, Costa Rica, French Guiana, Nicaragua, Panama, Suriname) report considerably fewer than 1000 cases per year. Many of these countries already incorporate elimination approaches in their control programmes (such as individual case notification), and this process is being strengthened and expanded aiming at nationwide elimination programmes in the near future.

The national control and elimination efforts are boosted by regional projects in the Amazon region (RAVREDA and the Amazon Malaria Initiative) (*62*) and the Central American region (the Salud Mesoamérica 2015 Initiative) (*63*), aimed at improving the lives of marginalized populations in which malaria flourished, to the benefit of the entire population of the region. Thirteen countries in the region have likewise benefitted from financial support for malaria efforts from the Global Fund. On Hispaniola, the last endemic area of the Caribbean, an island-wide elimination effort called the Hispaniola Initiative has been launched together with RBM partners (*64*).

There has been a substantial reduction in the number of locally transmitted malaria cases reported by the countries of the WHO Region of the Americas as a result of the intensive antimalaria interventions: from 1 181 138 cases in 2000 to 514 931 cases in 2010, with 9 of the 21 malaria-affected countries now reporting 1000 cases or fewer annually, and the 2 higher burden elimination countries (Mexico, Paraguay) reporting a combined total of 1253 cases in 2010 versus 15 428 cases in 2000. Political and financial support for malaria elimination is increasing with subregional elimination initiatives supported by WHO and RBM partners. However, financial support has yet to reach key countries such as Argentina and Paraguay.

[15] Full listing: Anguilla, Antigua and Barbuda, Argentina, Aruba, Bahamas, Barbados, Belize, Bermuda, Bolivia, Brazil, British Virgin Islands, Canada, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, Montserrat, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos Islands, Uruguay, Venezuela, Unites States of America.

Country examples in the Region of the Americas

Hispaniola

In 2000, the Dominican Republic and Haiti made a joint proposal to eliminate malaria from Hispaniola, the last endemic island of the Caribbean (*64*, *65*). The International Task Force on Disease Eradication, changing its stance from its 1993 report, agreed in 2006 that elimination on the island would be 'technically feasible, medically desirable, and economically beneficial' (*64*). In September 2008, the Dominican Republic and Haiti received support from the Carter Center for a bi-national programme to accelerate the elimination of malaria and lymphatic filariasis (which is also transmitted by mosquitoes). They developed a standard protocol and procedures for case management, including free diagnosis and treatment of malaria; added primaquine anti-gametocyte treatment of *P. falciparum* malaria; and intensified surveillance and use of microscopy to confirm diagnosis of malaria. The Carter Center provided supplies such as ITNs, microscopes, computers, transport, salaries for staff and technical assistance. The initiative started in two border towns on the Dajabón River. The efforts to eliminate malaria in Hispaniola are gradually getting back on track after the devastation of the 2010 Haiti earthquake.

Jamaica and the Bahamas

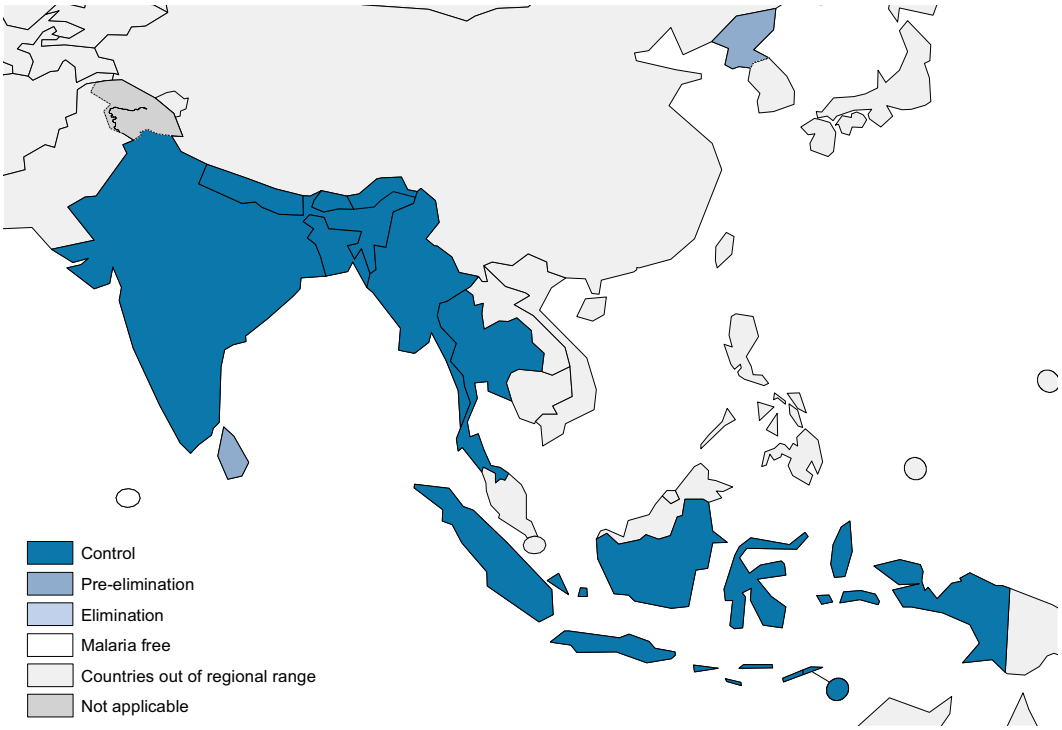
The reintroduction of malaria in Jamaica and the Bahamas in 2006, which took several years to control (*66*), was a stark reminder of the mutual benefits of regional elimination.

After four decades of malaria elimination, Jamaica (certified malaria-free in 1966) had an outbreak of *P. falciparum*: 406 confirmed cases between September 2006 and December 2009 with a peak of the epidemic in December 2006 (*67*). In the Bahamas a total of 19 malaria cases were identified on the island of Great Exuma between May and June 2006. A parasite prevalence survey was conducted on Great Exuma in a community of immigrants from Haiti, from which anecdotal reports of illness had been received. Of 159 persons who consented to testing, 29 adults were determined to be infected with *P. falciparum* (*68*). Both countries successfully mounted a prompt and effective response, including intensification of surveillance efforts, in coordination with PAHO/WHO and other international agencies, and currently continue to be well prepared in preventing and managing potential outbreaks. In these countries, as in many other islands of the Caribbean, the simultaneous presence of suitable vectors, imported malaria parasites and susceptible human hosts continues to pose a risk of renewed transmission, challenging the health services (*69*).

Source: WHO/AMRO.

WHO South-East Asia Region

Among the 11 countries of the South-East Asia Region, only 1 has eliminated malaria and 2 are in the pre-elimination category. The remaining 8 countries are still in the control phase.



Source: WHO/Global Malaria Programme.

The WHO Region for South-East Asia comprises 11 countries: Bangladesh, Bhutan, the Democratic People's Republic of Korea, India, Indonesia, Maldives, Myanmar, Nepal, Sri Lanka, Thailand and Timor-Leste. With the exception of the Maldives, which maintains a strong prevention of reintroduction programme following its successful malaria elimination efforts in the 1980s, all the South-East Asian Region countries were affected by malaria during the RBM decade of 2000–2010.

Two countries in the South-East Asian Region are progressing with nationwide elimination: Sri Lanka and DPR Korea. Indonesia has adopted a sub-national elimination strategy for Java and Bali, where locally acquired cases have declined from 101 852 to 4913 annually over the period 2000–2010. Bhutan and Thailand have large areas with no malaria transmission, have expressed their intention to proceed with elimination, and have joined the other South-East Asian Region elimination countries in the Asia Pacific Malaria Elimination Network (APMEN).

The number of malaria cases reported by the countries of the WHO South-East Asian Region has remained relatively stable over the RBM decade, mainly due to continuing high reported malaria burdens in India, Indonesia and Myanmar. There were 5 203 976 probable and confirmed cases reported in 2000, and 4 988 599 in 2010. Sri Lanka showed a large decline in local cases, from 210 039 in 2000 to only 684 local cases in 2010, only 6 of which were *P. falciparum*. DPR Korea reduced its locally acquired cases from a peak of 143 674 cases in 2001 to 13 520 local cases in 2010. Political and financial support for malaria elimination is increasing with sub-regional elimination initiatives supported by RBM partners.

Country examples in the South-East Asia Region

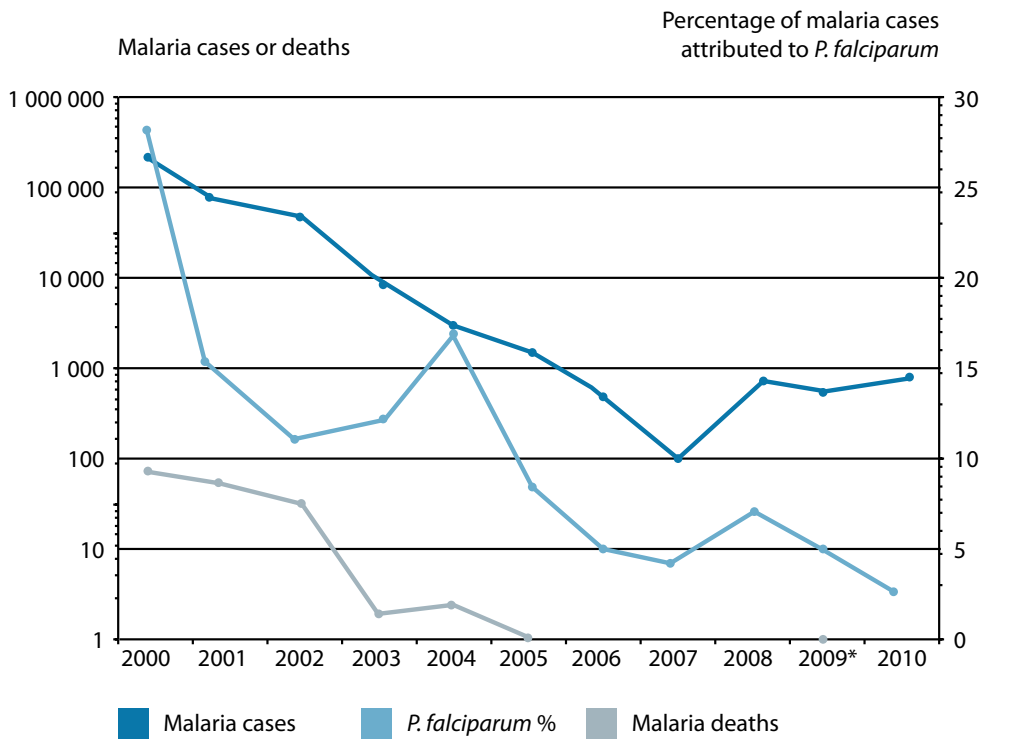
Sri Lanka

In Sri Lanka, which is currently in the pre-elimination phase, the number of confirmed malaria cases decreased from 210 000 in 2000 to 684 in 2010 and the proportion of cases due to *P. falciparum* dropped from 28% to 2%; the number of reported deaths fell from 77 in 2000 to zero in 2010 (Figure 5.3). A key initial strategy to carry out blood surveys and reduce the number of malaria cases has been the use of Malaria Mobile Clinics (MMCs) comprising at least three health personnel and a 4-wheel-drive vehicle to make services available to populations that do not have access to health facilities. Populations were informed one or two days before an MMC reached an area; if attendance was low, health personnel visited people in their houses in order to obtain blood films and increase the yield of the survey. Blood surveys were also conducted as part of active case detection among asymptomatic persons in localities where a positive case has been diagnosed. The early detection and prompt treatment of malaria among symptomatic cases by MMCs, and reduction of the parasite reservoir among asymptomatic cases, have contributed to rapid reduction of the parasite reservoir. Diagnosis was initially confirmed by trained microscopists, but microscopy was supplemented with RDTs when MMCs travelled to areas lacking trained microscopists. IRS has been the principal method of vector control, protecting an average of 50% of the population at risk during 2001–2004. Two groups of insecticides are used simultaneously in different areas and periodically rotated in order to reduce the risk of insecticide resistance developing. ITNs were introduced as a complementary measure for populations at high risk. The country is currently reorienting itself towards a nationwide elimination approach.

Figure 5.3

Trends in malaria cases (and proportion due to *P. falciparum*) and malaria deaths in Sri Lanka, 2000–2010

During the decade cases dropped from 210 000 to 684 (a 30-fold reduction), the proportion of cases due to P. falciparum *dropped from 28% to 2%, and deaths fell to zero by 2005.*



*No deaths reported from 2005 to 2010 except for one instance in a malaria case imported from Africa in 2009.

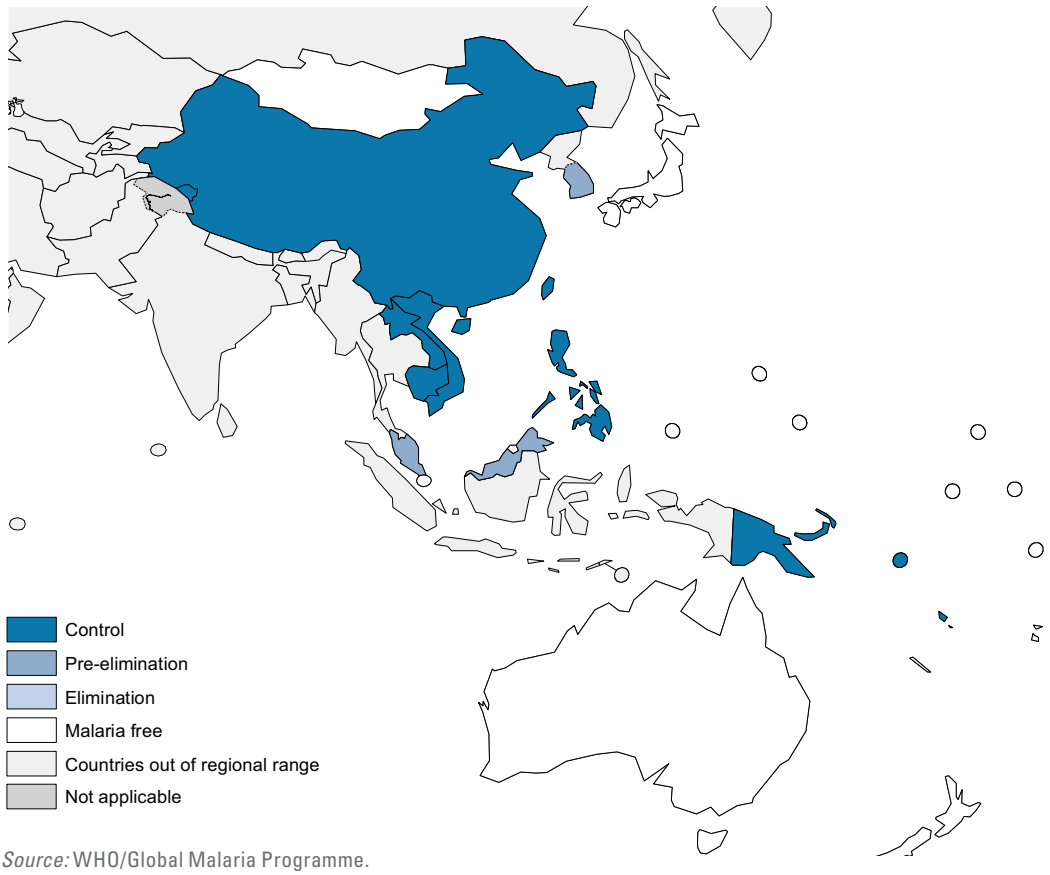
Democratic People's Republic of Korea

In DPR Korea, which currently is in the malaria pre-elimination phase, *P. vivax* malaria re-emerged in 1998 as a main public health problem. A substantial increase in malaria incidence was seen in all seven provinces and two municipalities. The three southern provinces (North Hwanghae, South Hwanghae, Kangwon), which border the Republic of Korea, are at high risk. The country is implementing early diagnosis, prompt treatment, use of LLINs, IRS and, starting in 2010, promoting insecticide-treated clothing to protect farmers and labourers who work at night. Primaquine is used for mass chemoprophylaxis. To raise awareness in the population, leaflets with malaria information are distributed and malaria posters are widely displayed. The total reported malaria cases were reduced from 143 674 in 2001 to 13 520 cases in 2010.

Source: WHO/SEARO.

WHO Western Pacific Region

Among the 28 countries of the Western Pacific Region, 18 are now malaria-free while 2 are in the elimination or pre-elimination categories. The remaining 8 countries are still in the control phase.



Source: WHO/Global Malaria Programme.

The WHO Western Pacific Region comprises 37 countries and areas in Asia and the Pacific.[16] Malaria is still endemic in 10 countries of the Western Pacific Region (Cambodia, China, Lao People's Democratic Republic, Malaysia, Papua New Guinea, Philippines, Republic of Korea, Solomon Islands, Vanuatu and Viet Nam), associated with poverty and retarding progress towards economic well-being among the affected communities. In the past decade, national health authorities in several of these endemic countries have made considerable progress in reducing malaria morbidity and mortality. Resistance to chloroquine and other commonly available anti-malarial drugs is a major issue in malaria control in the region, as it is worldwide. The problem is most critical in the countries of the Mekong sub-region, where it is aggravated by the increasing proliferation of low-quality and counterfeit drugs, and widespread irrational drug use in the private sector (*70*).

[16] Full listing: American Samoa (USA); Australia; Brunei Darussalam; Cambodia; China; Cook Islands; Fiji; French Polynesia (France); Guam (USA); Hong Kong (China); Japan; Kiribati; Lao People's Democratic Republic; Macao (China); Malaysia; Marshall Islands; Micronesia, Federated States of; Mongolia; New Caledonia (France); New Zealand; Niue; Northern Mariana Islands, Commonwealth of the (USA); Palau; Papua New Guinea; Philippines; Pitcairn Islands (UK); Republic of Korea; Samoa; Singapore; Solomon Islands; Tokelau (an Associate Member in New Zealand); Tonga; Tuvalu; Vanuatu; Viet Nam; Wallis and Futuna (France). The following Member States are responsible for areas in the Western Pacific Region: China (Hong Kong and Macao); France (French Polynesia, New Caledonia and Wallis and Futuna); United Kingdom of Great Britain and Northern Ireland (Pitcairn Islands); and the United States of America (American Samoa, Guam and Commonwealth of the Northern Mariana Islands).

The Western Pacific Region adopted a Regional Action Plan for Malaria Control and Elimination in the Western Pacific (2010–2015) in 2009 (*71*), and 9 of the 10 endemic countries (highly endemic Papua New Guinea being the exception) joined the Asia Pacific Malaria Elimination Network (APMEN), also founded in 2009. Malaysia and the Republic of Korea are implementing nationwide malaria elimination programmes; Malaysia's National Malaria Elimination Strategic Plan 2010–2020 is in line with the Regional Action Plan and aims to achieve malaria-free certification by 2020. Sub-national elimination programmes are ongoing in China, the Philippines, the Solomon Islands and Vanuatu. Cambodia, China, Viet Nam and the Lao People's Democratic Republic have recently updated their national strategies to include elimination goals. In 2010, China made a government commitment to eliminate malaria, set up a national expert committee and issued the Malaria Elimination Action Plan (2010–2020). Cambodia has embarked on an ambitious country-wide elimination strategy that will build on the success of the ongoing project for containment of drug-resistant malaria along the Cambodia-Thailand border. The further progress and success will hinge on controlling uncoordinated, unplanned, or uncontrolled populations moving in and out of forest areas with malaria risk.

The number of malaria cases reported by the countries of Western Pacific Region declined from 2 354 847 in 2001 to 1 728 453 in 2010; the burden in the elimination countries was reduced by nearly half, dropping from a combined total of 14 845 in 2000 to 8422 local cases in 2010. Political and financial support for malaria elimination is increasing with sub-regional elimination initiatives supported by RBM and bilateral donor partners.

Country examples in the Western Pacific Region

The 1990s saw major progress in malaria control in some areas and disappointments in others. From the mid-1980s to the mid-1990s, there was a resurgence of malaria in some countries of the Region, attributable to economic, demographic and ecological factors. The opening up of remote areas for agriculture, mining, timber exploitation and other economic activities played a key role. The highly mobile populations associated with those activities contributed to nearly optimal conditions for malaria transmission in rural areas. At the same time, a degree of social stabilization and economic progress in countries like Lao People's Democratic Republic and Cambodia led to increased case reporting.

The epidemiology of malaria is also modulated by population movements, among ethnic minority people and others notably due to economic and political factors that may result in internal migration or resettlement, or due to natural disasters such as climate change or floods. Economic corridors are currently being developed across the Greater Mekong Subregion at an accelerated pace. They will increase trade and connectivity between populations across borders and thereby increase the complexity of the malaria transmission and its control.

Republic of Korea

Malaria was eliminated from the Republic of Korea during the 1970s. In 1993, however, *P. vivax* malaria re-emerged in the country. From the 21 cases diagnosed in 1993, the number of reported cases increased to 4142 cases in 2000. In 2000, the malaria situation began to improve and, in 2001, the Government launched a 10-year programme aimed at eliminating malaria from the Republic of Korea by 2010 by enhancing the system for case detection and treatment, reinforcing the vector control effort and strengthening collaboration between civilian and military sectors. In 2003, only 1107 cases were reported and in 2004, rates fell to a low of 826. In 2009, 1317 cases were reported, the majority of the increase being attributed to military personnel. In 2010, 1772 cases were reported.

Due to the increase in the number of malaria cases, the target year for achievement of malaria elimination was revised to 2015. The reported confirmed malaria cases were concentrated along the border between the Democratic People's Republic of Korea and the Republic of Korea in the demilitarized zone (DMZ), with civilians constituting 62% and veterans and soldiers 38%. Surveillance activities (malaria and vectors) around the borderline showed increasing vector density and malaria vulnerability in nine army bases in malaria epidemic areas near the DMZ. All malaria cases in the country are caused by *P. vivax* and no mortality has been reported. The main vector is *Anopheles sinensis*, which is highly exophilic and difficult to control by either house spraying or insecticide-treated mosquito nets. The Government has recommitted to attain its revised 2015 malaria elimination goals through strengthened surveillance, containment of transmission and reduction of importation focusing on industrial complexes.

Solomon Islands

The Solomon Islands initiated a progressive elimination strategy with major funding from the Australian Agency for International Development as part of the Pacific Malaria Initiative, which also includes Vanuatu. Two low-prevalence provinces were selected for malaria elimination by 2014. In Temotu and Isabel Provinces of the Solomon Islands, malaria elimination programmes commenced in 2008 with commitment from the MOH and support from technical and donor partners. With high coverage of LLINs and IRS, aggressive case-based surveillance through application of GIS technology and strengthened case management, reported cases

per year in Isabel Province dropped from 359 in 2004 to 19 in 2010, and in Temotu Province from 909 cases in 2005 to 49 in 2010. Critical success factors include strong commitment of government, availability and flexibility of resources from government and partners, strong technical and operational support, strengthened logistics capacity and functional coordination mechanisms. However, harmonizing operational plans at national and provincial levels and accessing remote and scattered populations remain daunting challenges.

Vanuatu

Vanuatu has achieved a substantial decline in malaria over the past 20 years as a result of concerted malaria control efforts. The success has inspired Vanuatu's current Malaria Action Plan 2008–2014, which aims to reduce the country's malaria burden below public health importance and to eliminate malaria in Tafea Province. The Government's vision is to go for stepwise countrywide malaria elimination in the years to come, province by province, inspired by Vanuatu's successful and sustained achievement to date of malaria elimination on Aneytium Island. This success occurred in the early 1990s as a result of a comprehensive package of interventions that included introduction of ITNs to achieve 100% coverage, deployment of primaquine mass treatment against *P. vivax*, and strong community involvement. The current malaria elimination strategy being implemented on the remaining malaria-endemic islands in Tafea Province involves the use of LLINs, IRS in houses within a 2 km radius from the coast line, larviciding in active breeding sites, case-based surveillance supported by GIS mapping and use of a new rapid SMS reporting system, and case investigation of all confirmed cases. Cases of both *P. falciparum* and *P. vivax* are effectively managed by use of RDTs and ACTs in all health facilities down to community level, supported by direct observed treatment and monthly case follow-up by malaria elimination officers. In addition, use of supervised primaquine treatment against *P. vivax* relapses is emphasized, supported by glucose-6-phosphate dehydrogenase (G6PD) deficiency testing in selected health facilities.

This combined strategy has already resulted in a steady decline in the number of confirmed malaria cases in Tafea Province (population size of 33 000), from 1006 cases in 2007 to 69 in 2010 and fewer than 10 locally acquired cases in the first half of 2011. The next steps will involve focal screening and treatment (FSAT) operations, guided by GIS-based case surveillance systems highlighting closely related cases and risk factors for transmission. Strong community participation is being promoted by involving chiefs, community groups and rural health workers to raise awareness; engaging the Tafea Malaria Elimination Stakeholder Committee; and working closely with primary schools. As with the neighbouring Solomon Islands, building logistical and human resource capacity, ensuring high political commitment, obtaining strong technical and financial support from partners, and establishing effective coordination and an integrated health systems approach at the national and provincial levels will be critical factors to successful malaria elimination in Vanuatu.

Philippines

The vision of the 2011–2016 Medium Term Plan of the Philippines Malaria Control Programme is a malaria-free Philippines. Government funding for its malaria disease-free elimination zone initiatives has increased to Php 169 million (approximately US$ 4 million) in 2008. This vision requires a rapid acceleration in the reduction of malaria cases in every endemic locality in the country until it reaches the elimination level of less than 1 malaria case per 1000 population nationwide. In addition to the rapid reduction in malaria cases, the vision requires equal vigilance in the country's efforts to sustain the status of

those localities that have already been declared malaria-free by preventing the resurgence of the disease or infection. The goal therefore is to accelerate the transition of the different provinces and cities from the control phase to the elimination phase, and to sustain the malaria-free status of already malaria-free declared provinces and zones. Four objectives—which are consistent with the country's four pillars of health sector reform—have been identified as critical to attaining these goals:

1) ensure universal access to reliable diagnosis, highly effective and appropriate treatment and preventive measures;

2) capacitate local government units to own, manage and sustain the malaria programme in their respective localities;

3) sustain financing of antimalaria efforts at all levels of operations; and

4) ensure a functioning quality assurance system for malaria operations.

Success is contingent on a range of requirements, including: institutionalizing area stratification, zoning and planning towards elimination; enhancing malaria surveillance, response, monitoring and evaluation; and securing stable government and nongovernment financial assistance in support of malaria elimination. At the sub-national level, elimination hubs are responsible for overseeing and sustaining the malaria-free status of their respective provinces and cities. The elimination hubs will be managed by a team of local malaria personnel and other provincial or city health staff with expertise in malaria surveillance and response, an entomologist, a medical doctor trained in malaria case management and treatment, the existing malaria programme coordinator and an individual in charge of health promotion. The number of elimination hubs to be established will vary depending on the endemic population size, geographical spread and location of endemic barangays (lowest level government administrative unit) and client accessibility to these hubs. Though early diagnosis and prompt management and treatment of cases will not be the prominent interventions to be carried out in these areas, the elimination hub will implement a mix of interventions to prevent the reintroduction of the disease, which requires local government commitment, policy support and resources. Key activities within the hubs include:

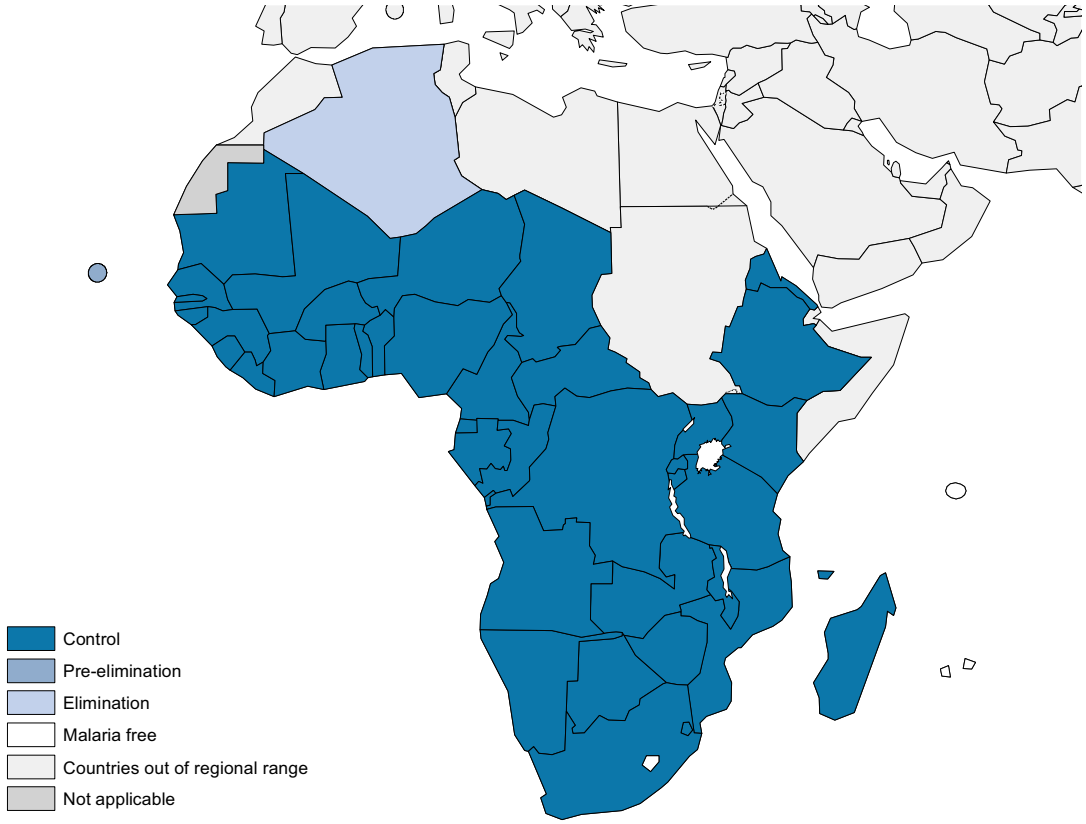
- intensified malaria disease surveillance;
- proactive vector surveillance;
- establishment of response mechanisms in case there is an outbreak or epidemic (e.g. stockpiling of antimalarial drugs, insecticides and laboratory reagents);
- measures to modify the vector environment;
- focused and intentional health promotion to prevent complacency among community members;
- technical updating of knowledge and skills of service providers; and
- institutionalizing appropriate policies and local ordinances to support and sustain malaria-free status in each area.

Developing a functional referral system is essential to ensuring that clients will have access to necessary services. The strategy requires that all declared malaria-free areas should be able to establish their respective elimination hubs by 2013. Provinces and cities that are currently classified as epidemic-risk and malaria-prone are also expected to do the same.

Source: WHO/WPRO.

WHO African Region

Among the 46 WHO member countries and two territories (Réunion and Mayotte) of the African Region, only 4 have eliminated malaria and 2 are in the elimination or pre-elimination categories. The remaining 42 are in the control phase.



Source: WHO/Global Malaria Programme.

The WHO African Region comprises 46 countries[17] and includes Algeria and most of Africa south of the Sahara, including islands in the Atlantic and Indian Oceans. In 2010, locally acquired malaria cases were reported all but 4 Member States of the Region. Lesotho, Mauritius and the Seychelles are not endemic for malaria. Algeria is in the elimination phase, reporting 196 cases in 2008 of which only 3 were locally acquired; in 2009 all 94 reported cases were imported. Cape Verde has been in the malaria pre-elimination phase since 2010. Since 2007, a number of African countries have announced their intent to eliminate malaria, including the Southern African Development Community (SADC) countries, which joined the sub-regional malaria elimination initiative in southern Africa known as the Elimination Eight (E8). The WHO African Region adopted a resolution in 2009 to accelerate control towards malaria elimination (*72*).

The number of reported confirmed malaria cases in Cape Verde has decreased from 144 in

[17] Full listing: Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Cote d'Ivoire, Democratic Republic of Congo, Equatorial Guinea, Ethiopia, Eritrea, Gabon, Gambia, Ghana, Guinea, Guinée-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome & Principe, Senegal, Seychelles, Sierra Leone, South Africa, Swaziland, Togo, Uganda, United Republic of Tanzania, Zambia, Zimbabwe.

2000 to 46 in 2010, and the country has recently succeeded in securing a Global Fund grant to support its transition from malaria control to a nationwide pre-elimination programme.

As of 2010 the total numbers of reported cases in Botswana, South Africa and Swaziland were relatively low (12 196, 7558 and 1722, respectively), raising prospects that malaria could be eliminated from the southern tip of Africa in the not too distant future. The E8 platform to increase collaboration among the eight southern African countries to achieve their common goal of eventual elimination of malaria in the region, and elimination by 2015 in four countries—Botswana, Namibia, South Africa and Swaziland—was officially adopted at a SADC Ministers of Health meeting in Maputo, Mozambique, in April 2008; and the initiative was launched in March 2009. The E8 includes the four elimination target countries, along with their northern neighbours—Angola, Mozambique, Zambia and Zimbabwe. The E8 efforts, and an active 'shrinking the map' approach that gradually reduces the transmission zone, coincide with several ongoing trans-border initiatives, including the trans-border Lubombo Spatial Development Initiative (LSDI) (*73*) and the Trans-Zambezi Malaria Initiative (TZMI) (*74*). History shows that as people's living conditions improve over the decades, malaria will slowly, steadily and surely recede. Nonetheless, great progress in reducing malaria transmission and saving lives is already occurring, and programme preparations are being made for a future drive towards elimination. Another four countries in Africa (Gambia [116 353 confirmed cases in 2010], Rwanda [698 745 confirmed cases in 2009], Sao Tome and Principe [2740 confirmed cases in 2010] and Madagascar [202 450 confirmed cases in 2010]) aspire to eliminate malaria and have secured Global Fund grants to support their acceleration towards elimination programme preparation.

Country examples in the Africa Region

Cape Verde

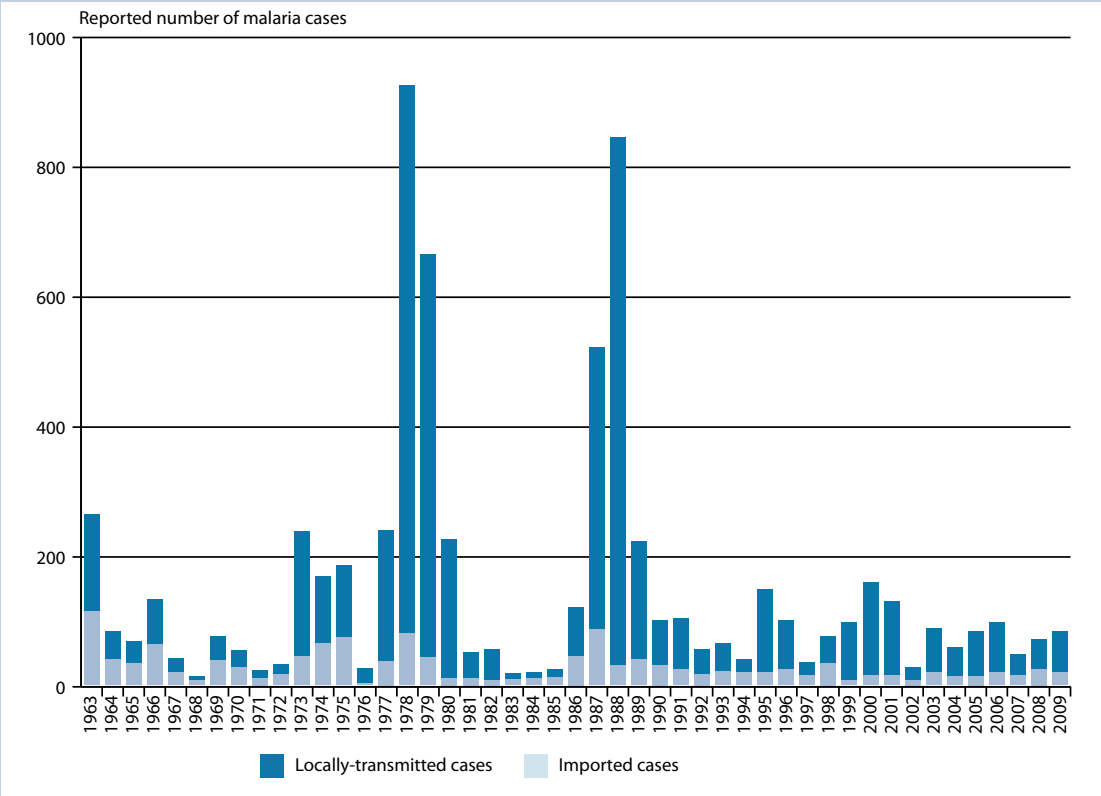
Cape Verde is a lower-middle income country consisting of a group of 10 islands off the coast of Senegal, currently inhabited by just over half a million people. It has a very dry, Sahelian climate with irregular annual rainfall usually between 200 and 500 mm. Portuguese seafarers discovered the islands in 1460, at which time they were uninhabited. When humans subsequently colonized the islands, they brought *P. falciparum* malaria parasites with them. Over the centuries, deadly malaria epidemics followed periods of heavy or prolonged rains without fail, resulting in more than 10 000 malaria cases and 200 malaria deaths annually in the 1940s (*75*). Cape Verde embarked on Global Malaria Eradication Programme (GMEP) efforts early in the 1950s, and used IRS with DDT to achieve the complete removal of the local malaria vector, An. arabiensis, from all islands except the largest most populous island, Santiago, home to the capital Praia. Local transmission was interrupted between 1967 and 1972. Systematic control activities were abandoned too early (1969) and the vector gradually recolonized the country, resulting in renewed transmission on the island of Santiago from 1973 onwards and a major epidemic in 1977–80. Again the vector was attacked with large-scale, focal IRS operations on Santiago Island and transmission was halted a second time in 1983. Efforts were again stopped too early and transmission resumed years later. Since then, low-level malaria transmission continued on Santiago and, since 2003, on the island of Boa Vista as well.

At present, malaria risk is naturally low, linked to the very dry climate. Cape Verde has no rivers, very little annual rainfall, and almost no opportunities for mosquito breeding. Over the 12-year period of 1996–2007 only 798 malaria cases were reported, of which 608 (76%) were locally acquired. Only two of the nine inhabited islands report cases: Santiago with 35 locally acquired cases reported in 2009, and Boa Vista with 10 locally acquired cases reported in 2009. Together these islands account for 58% of the population. Overall, Cape Verde has experienced considerable fluctuations in malaria incidence rates in recent decades (Figure 5.4).

Figure 5.4

Reported annual malaria cases (*P. falciparum*) in Cape Verde, 1963–2009

Cape Verde has experienced several episodes of high importation of malaria (1973–1980) and outbreaks of local transmission after heavy rains (1978–1980 and 1987–1988). Recent years are characterized by few cases (fewer than 50 cases of local malaria transmission annually since 2007) and the country of islands is seeking to eliminate transmission in the coming years.



Note: The total number of cases shown by the graphic is the sum of imported cases and locally transmitted cases.

Source: Cape Verde National Malaria Control Programme.

In late 2008, the Government of Cape Verde decided to explore the possibility of eliminating malaria by 2020. Shortages of funding and of trained human resources for health and malaria control were severe constraints for the programme, so the Government asked WHO for support to develop a Global Fund proposal for malaria elimination. In order to prepare a solid proposal, one of the first steps taken was the launch of a thorough analysis. The annual blood examination rate (the percentage of people tested for malaria) jumped from roughly 1-2% in 2000–2008 to 4% in 2009. The last entomological surveys found the vector *An. arabiensis* on Santiago and Boa Vista as expected but also on five other islands that had not reported local cases: Santo Antão, São Vicente, São Nicolau, Maïo and Fogo. Only two islands have no apparent vectors and no malaria cases: Brava and Sal, which are outlying in the east and west of the country.

Having characterized the epidemiological status of the national landscape, the next step was an assessment of existing MOH/NMCP operational and financial capacities and the exploration

of potential additional national and external resources. Built on this thorough foundation, a successful funding proposal for malaria elimination was submitted for Round 10 of the Global Fund, and five-year funding worth US$ 1 383 725 was secured to complement the increasing national spending commitment (approximately US$ 415 000 annually) that will fund the largest part of the elimination programme.

Cape Verde's National Strategic Plan 2009-2013 was directed to 1) Expand capacity for quality assured diagnostic testing to all health facilities; 2) Provide early and efficacious treatment to all infected patients; 3) Report, investigate, classify and monitor all detected cases and foci; 4) Implement IRS and localize and control breeding sites in active foci, and; 5) Reduce the risk of dissemination of parasites and vectors.

Key activities include:

- Case detection: testing of patients with fever who have travelled to areas with malaria transmission; deployment of RDTs starting in 2009.
- Reporting: microscopically-confirmed cases.
- Case and focus investigation.
- Disease management: policy shift from chloroquine to ACTs for treatment of *P. falciparum* malaria.
- Vector control: larval control (temephos insecticide or larvivorous fishes [*Gambusia affinis*]) in known anthropogenic breeding sites; occasional single annual round of IRS with Deltamethrin.

Swaziland

When Swaziland launched its NMCP in 1946, malaria was highly endemic throughout the country. Consistent IRS efforts began in 1949, which enabled the country to maintain low incidence throughout the 1950s and 1960s. With the implementation of focal spraying efforts and active surveillance activities, coupled with the scale up of malaria control interventions in neighbouring countries under the WHO GMEP, malaria incidence reached its lowest level in 1969 with only 46 cases reported, of which 36 were determined to have been imported. Funding cutbacks led to small malaria epidemics throughout the 1970s and 1980s. By the mid-1990s, malaria had re-emerged as a serious public health threat in Swaziland, with incidence returning to its highest level since 1947 due to a combination of above-average rainfall, parasitic resistance to the drug options of chloroquine and Fansidar, and instability in the health system exacerbated by the emerging HIV epidemic. The launch of a successful regional collaboration with Mozambique and South Africa in 1999, the Lubombo Spatial Development Initiative, led to a significant reduction in parasite prevalence in Mozambique, which contributed to a gradual reduction in Swaziland's malaria incidence throughout the 2000s (Figure 5.5). In 2002, the country expanded bednet and IRS coverage among at-risk populations with the support of a Global Fund Round 2 grant. As a result of these gains, the SADC and the African Union identified Swaziland as a candidate for malaria elimination by 2015, a goal that has since been adopted by the country.

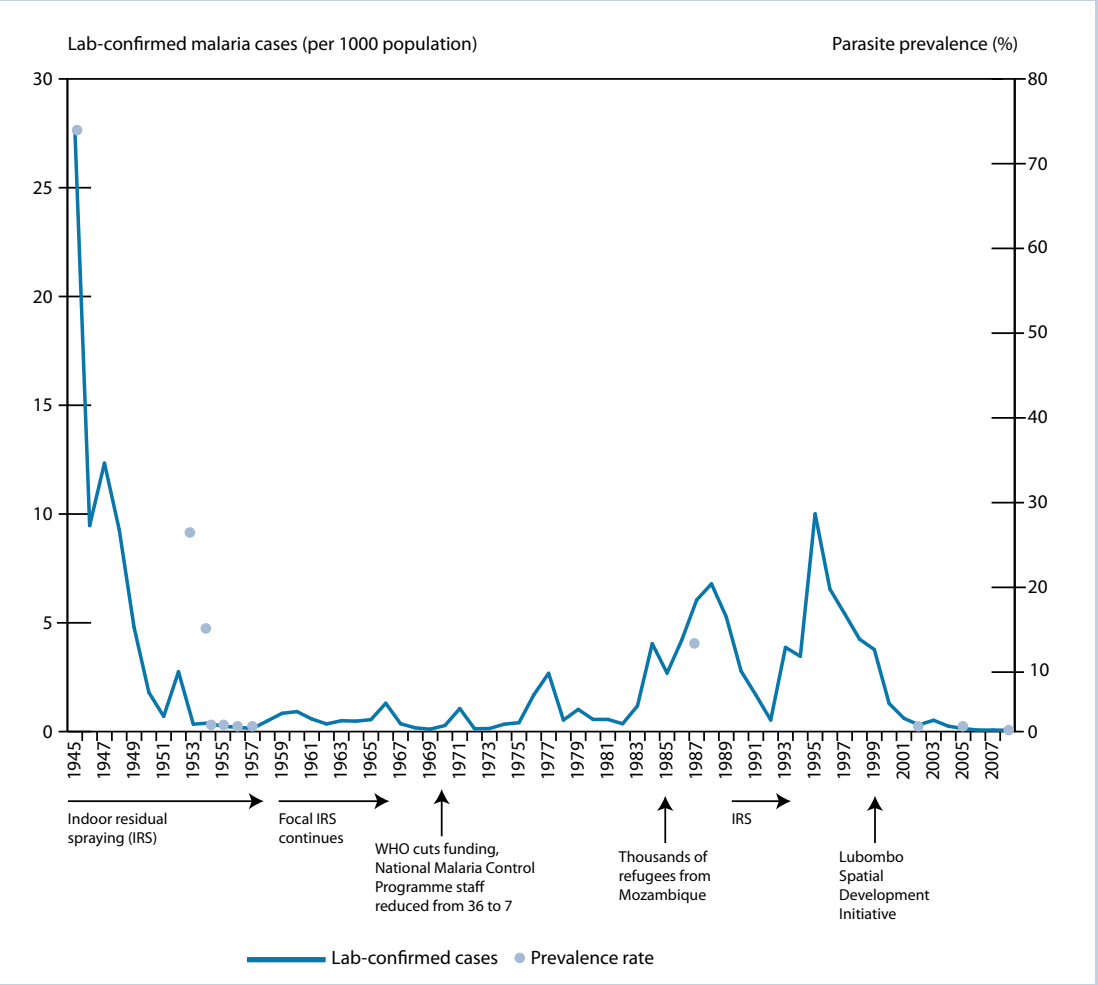
In 2008, Swaziland mobilized resources from a Global Fund Round 8 grant to pursue elimination. The country developed a revised strategic plan to transition from control to elimination, focusing on four major intervention areas: 1) definitive diagnosis and prompt, effective treatment; 2) integrated vector management, particularly in combining the use of IRS and LLINs; 3) a strong epidemiological and entomological surveillance system and 4) a comprehensive information, education, and communication campaign. Since the elimination campaign launch in 2008, Swaziland has developed new diagnosis and treatment guidelines for malaria; rolled out RDTs

and ACTs to all health facilities in the country; strengthened surveillance systems through the development of GIS capabilities, developed a functional immediate case notification system and active surveillance programme; conducted a national prevalence survey highlighting a very low burden of malaria in the country (0.2% prevalence); distributed over 100 000 LLINs in the malaria at-risk region; and developed a comprehensive health promotion programme encouraging personal protection measures and treatment seeking behaviour. With less than 500 confirmed cases reported during the last transmission season (2010–2011), Swaziland continues to progress towards its goal of malaria elimination by 2015.

Figure 5.5

Malaria incidence in Swaziland, 1948–2008

Following decades of good malaria control and few cases from the 1950s to the early 1980s, Swaziland experienced a resurgence of malaria linked to funding cuts and an influx of Mozambican refugees. With renewed financing under the Lubombo Spatial Development Initiative (LSDI), control has resumed and elimination is now the goal.



Source: WHO/AFRO and Swaziland MOH.

Progress in malaria elimination by WHO epidemiological category

Countries preventing the reintroduction of malaria

By 2010, six previously endemic countries had interrupted malaria transmission and were implementing intensive programmes to prevent its reintroduction: Armenia, Egypt, Georgia, Iraq, Oman and the Syrian Arab Republic. Morocco and Turkmenistan were certified malaria-free in 2010; they also continue their vigilance efforts. The three non-endemic countries that during the RBM decade experienced outbreaks of locally acquired malaria subsequent to importation of parasites have managed to control the situation again: Bahamas, Jamaica (*67*) and the Russian Federation. No deaths were reported in these outbreaks. Many other previously endemic countries, such as Australia, Jordan, Lebanon, Singapore, Tunisia, the United Arab Emirates and the United States of America, have eliminated malaria and continue to successfully prevent re-establishment of transmission.

Countries eliminating malaria

In 2010, ten countries were implementing nationwide malaria elimination programmes: Algeria, Azerbaijan, Georgia, Iraq, Kyrgyzstan, the Republic of Korea, Saudi Arabia, Tajikistan, Turkey and Uzbekistan. Only one country in the elimination phase has remaining foci of active *P. falciparum* transmission: Saudi Arabia. All others have only *P. vivax*. Tajikistan eliminated *P. falciparum* in 2009. A majority of these countries had already eliminated malaria once before, during the 1950s and 1960s. These include countries in the WHO European Region located in the Caucasus and Central Asia. During the period

1998–2010, the annual number of reported local cases was reduced 100-fold or more in nearly all the countries. The exception was the Republic of Korea, which showed a more sustained transmission pattern. Together, the ten elimination countries reported just 1950 locally acquired malaria infections in 2010, and 2023 imported cases. Almost 90% of the local cases were reported by the Republic of Korea. None of the elimination countries has reported deaths due to local malaria transmission since 1998, but imported *P. falciparum* malaria in travellers continues to result in occasional deaths.

Countries in the pre-elimination phase

As of 2010, nine countries were in the pre-elimination programme phase and are increasing their emphasis on the quality of surveillance, reporting and information systems: Argentina, Cape Verde, Democratic People's Republic of Korea, El Salvador, Islamic Republic of Iran, Malaysia, Mexico, Paraguay and Sri Lanka. Of the nine pre-elimination countries, five (Argentina, Cape Verde, Democratic People's Republic of Korea, Paraguay and Sri Lanka) had already nearly eliminated malaria once before, during the 1950s and 1960s. The nine pre-elimination countries reported a total of 25 138 confirmed malaria cases in the last year for which data are available, with 97% reported from just four countries: Iran, DPR Korea, Malaysia and Mexico. With the exception of Sri Lanka, none of the pre-elimination countries has reported deaths from malaria during the past decade. In Sri Lanka, local malaria deaths decreased from 115 in 1998 to 2 in 2004; no deaths from malaria have been reported since then.

Control-phase countries with low malaria burdens moving to pre-elimination

As of 2010, Bhutan (with 487 local cases) and five countries in the Americas report fewer than 1000 cases per year: Belize (150), Costa Rica (114), Nicaragua (692), Panama (418) and Suriname (550). A next group of countries with relatively low numbers of reported cases is the Dominican Republic (2582), Sao Tome and Principe (2740), Swaziland (1722) and South Africa (7558). Many of these countries already incorporate elimination approaches (such as case notification) in their control programmes and are strengthening and expanding these efforts with the goal of implementing nationwide elimination in the near future. In some of the countries, difficulties with achieving and maintaining elimination can be expected due to high rates of migration across borders with neighbouring countries.

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CHAPTER VI

FUTURE OPPORTUNITIES TO ELIMINATE MALARIA

There is reason for excitement as many countries and the entire WHO European Region are on a path to malaria elimination. At the same time, it is understood that the recent progress in malaria control scale-up is fragile and the broader public health community must continue to support successful programmes such as malaria control and its ultimate elimination so gains are not lost. The coming years—characterized by economic uncertainties and with the looming MDGs of 2015—will test our resolve to forge ahead with progressive malaria control and elimination in a fragile public health environment.

Malaria elimination is the progressive interruption of the chain of transmission by completely blocking the transfer of *Plasmodium* parasites from and to humans and mosquitoes in a defined geographical area. The prospects are both exciting and daunting in the countries that have not yet achieved malaria elimination.

There are many reasons for excitement. Among WHO Member States, 90 countries are malaria-free (30 were WHO-certified after intensive efforts) and there are many countries already working within declared phases of elimination (10 countries), pre-elimination (9 countries) or prevention of reintroduction (7 countries). Among countries laboring in the malaria control phase (82 countries), many have seen substantial and rapid progress in markedly reducing the intensity of malaria transmission such that portions of their country are malaria-free; these countries are increasing in number and successes are accumulating.

Countries that are successful in achieving or nearly achieving malaria-free status have undertaken major efforts to do so. They have benefitted greatly from political and socioeconomic stability and national commitment and they have typically invested their own national financial resources into a concerted elimination effort. These countries have confident, passionate leadership and sufficient staffing for the programme and have deployed a variety of interventions that have evolved with and addressed the changing malaria epidemiology that occurs with reduced burden. They all use existing tools to break the chain of transmission. They have uniformly established strong information and surveillance systems that can detect infection and transmission foci and ensure a timely and comprehensive response that quickly contains transmission; it is this same surveillance system that will enable them to know that they have no more malaria transmission. Progress towards achieving nationwide malaria-free status typically occurred in

a step-wise fashion, with countries accruing a growing number of malaria-free areas, resulting in ever fewer foci of transmission that were ultimately contained and stopped.

Perhaps those elimination successes were in the countries with fewest mitigating circumstances, and those that have not yet eliminated malaria do not yet have the fully enabling environment to achieve elimination, or they have different and more difficult challenges. However, it is also notable that most malaria-endemic nations have made substantial progress during the last decade, with demonstrated improvements in intervention coverage and reductions in morbidity and mortality. This has been achieved by markedly reducing the intensity of transmission through the use of effective interventions, particularly those directed at the mosquito vectors (LLINs, IRS and others), but also with prompt diagnosis and effective treatment of malaria cases to reduce the prevalence of parasites in humans and their likelihood of being transmitted on to mosquitoes. As a consequence, many countries in the control phase have achieved very low malaria burdens in some areas and envision a shift to elimination on the horizon.

While enthusiasm is warranted, nations and the global community would be remiss to not look carefully at and address directly the challenges and barriers to progress towards elimination—in fact, it is this continual and critical examination informing and leading to action that will accelerate progress.

Some of the challenges are simply the counterpoint to the requirements for success: political and socioeconomic instability; lack of true national commitment including commitment of human and financial resources; insufficient leadership; or inadequate infrastructure and systems (especially surveillance that reaches and involves local communities that are best situated to promptly identify and help contain transmission foci). For the countries in elimination or pre-elimination phases that are verging on stopping transmission, many of these challenges can be overcome—as they have been by other countries that succeeded in elimination—through sufficient local and national technical capacity, funding and leadership.

In a number of the countries in the control phase, the intensity of malaria transmission is still simply too high to begin elimination efforts; in addition to very favorable climatic conditions, these areas have too much human–mosquito contact and too many malaria parasites in both humans and mosquitoes such that the transmission cycle seems unbreakable. Despite recent progress in the last decade, many countries and communities still have inadequate coverage of interventions to break the intensive contact between humans, mosquitoes and parasites. Doing so will require the full application of existing interventions as well as the introduction of additional or new interventions once they are available. At least for the moment, these countries should focus first on the full application of and universal access to existing interventions to benchmark how much progress can be made. Continued socioeconomic improvements (including better housing to reduce human–mosquito contact) and better malaria control tools will come with time. While programmes should anticipate such potential opportunities, they should act now to reduce malaria transmission with proven effective interventions, rather than waiting for 'better' options.

There are additional national and global threats to progress in malaria elimination. Some would say that elimination will be too expensive amidst other pressing health problems and that the inherent uncertainty in its success will threaten national commitment and global support. There are data to suggest that programmes aimed at eliminating malaria will temporarily cost more than programmes

that merely aim to control the disease (*76*), and potential costs savings upon completion of the elimination effort have not been well documented. Better documentation of the long-term benefit of elimination will enhance national commitment, future investment and ultimate success.

Until malaria has been eradicated worldwide, there is always the threat that imported malaria might reintroduce transmission locally. This certainly has happened in many countries and is a risk requiring attention based on knowledge of travel patterns and malaria risk in the ares where travellers come from, and an assessment of the receptivity to renewed transmission in the areas where the settle. The risk of importation–and the levels of vigilance required to respond to it–should be considered carefully as elimination progresses. Addressing malaria in mobile populations has proven to be quite challenging.

Accelerating and creating durable success in malaria elimination will require new tools in many settings. As noted above, one critical tool is a solid operational surveillance system that can detect infection and transmission and contain its spread; this tool or intervention approach will be critical for all programmes and the requisite knowledge, skills, and technologies can be established and strengthened today. For other new tools, such as new insecticides, drugs, diagnostics and vaccines, the priorities and possible time lines have been well delineated in recent publications (*22*), and hopefully many will become available and further strengthen the intervention packages. Tools specifically directed against transmission are highly prioritized as they will be critical for progress in elimination and will simultaneously contribute importantly to reduced illness and death from malaria.

Country experiences have shown that malaria elimination requires a durable investment that usually builds on a foundation of decades of sustained control efforts. Socioeconomic stability, improvements in living standards, responsive health services and strong central oversight of the programme are key ingredients of success. It is fair to say that today's successful malaria elimination programmes have had passionately dedicated programme managers who kept a close watch on the quality of every aspect of the field operations. Most successful malaria elimination programmes have been funded primarily from state budgets and were carried out as a national effort under the Ministry of Health, with support from the Cabinet and multidisciplinary oversight committees. The high-level government support and financing ensures that effective interventions can be launched when needed—for instance to respond immediately when a malaria outbreak occurs among army personnel, border patrols or in agricultural or building projects.

The most basic requirements for elimination will include strengthening the same systems that are needed for addressing many other health problems in the affected countries. One cornerstone of elimination programmes must be health intelligence capable of detecting all infections and transmission foci and documenting the progress in containment. Another cornerstone must be the capacity to reach the most difficult parts of the country and collaborate with local communities. Even if nationwide malaria-free status is a distant vision, countries may find that the gradual adoption of elimination approaches in control programmes can improve equitable access to quality health services as malaria control interventions reach the most peripheral areas and disadvantaged populations. At the country level, there are opportunities for tremendous public health successes as progress is made towards malaria elimination.

The road to eliminating malaria has proved fragile. A number of countries have achieved elimination or near-elimination only to see some political or socioeconomic disruption, population movement or natural disaster lead to a return of transmission with the attendant outbreaks and morbidity and mortality. Thus, the systems developed for malaria elimination must endure beyond elimination to ensure sustained success. Fortunately, the improvements in environmental and living conditions as well as the health systems required for elimination are the same ones needed for preventing the return of transmission.

The transition from malaria control to elimination has consistently taken time—there may be few opportunities for shortcuts that still lead to durable success. With nearly 100 countries still requiring elimination to ultimately achieve malaria eradication, progress at a rate of one additional malaria-free country per year would take a century. Is there some way that elimination of transmission can be accelerated? For the many countries in the elimination phase, can the global community help them progress rapidly to achieve malaria-free status? For the countries in pre-elimination, can we similarly help speed their progress? For the countries battling malaria in the control phase, can progress to pre-elimination be facilitated? It is the experience and the confidence that will come with this progress that will catalyze further success.

In 2011, we can now say that the first RBM decade has laid a foundation for long-term success. Countries are sharing experiences and learning from each other about what works. Malaria elimination case studies are being developed to document experiences and speed the uptake of best practices. While new tools and technologies are incorporated in the malaria elimination efforts as they come along, countries are already achieving remarkable successes with the tools we have today. With strong human capacity, continued investment and rational programmes, and by continuing to join forces, the world will achieve the newly updated RBM elimination targets for 2015, eliminating malaria from at least eight to ten countries including the entire WHO European Region (*77*).

The RBM decade began and ended amidst economic crises of global proportions. Nevertheless, steady and unprecedented financial investment, commitment and generosity from endemic country and donor governments, the private sector, charitable foundations and civil society have resulted in the largest impact on the worldwide malaria disease burden ever (*35*, *56*). Never before in the history of malaria control have we had the opportunities, possibilities and resources of today. Most importantly, never before have we stood so united in our fight against malaria. In addition to its global successes in malaria control (*56*), the RBM decade concluded with a strong revival of the malaria elimination agenda (*8*, *22*, *78–81*) and real hope that one day, perhaps 40 years from now, our children and grandchildren can live in a world without malaria (*78*).

'I dare you to come along with us.'[18]

[18] Quote from WHO Director-General Dr Margaret Chan at the Bill & Melinda Gates Foundation's 2007 Seattle Malaria Forum.

REFERENCES

1. Mendis K, Rietveld A, Warsame M, Bosman A, Greenwood B, Wernsdorfer WH. From malaria control to eradication: the WHO perspective. *Tropical Medicine and International Health*, 2009, 14(7):802–809 (http://onlinelibrary.wiley.com/doi/10.1111/j.1365-3156.2009.02287.x/pdf).

2. Roll Back Malaria. (http://www.rbm.who.int/gmap/gmap2011update.pdf).

3. Pampana E. *A textbook of malaria eradication*. Oxford University Press, London, 1963.

4. Nájera JA. *Malaria control: achievements, problems and strategies*. Geneva, WHO, 1999 (WHO/CDS/RBM/99.10) (http://whqlibdoc.who.int/hq/1999/WHO_MAL_99.1087.pdf). Also available in *Parassitologia*. 2001, 43(1-2):1-89.

5. Kiszewski A, Mellinger A, Spielman A, Malaney P, Sachs SE, Sachs J. A global index representing the stability of malaria transmission. Am J Trop Med Hyg 2004 70:486-498.dellher

6. Lysenko AJA, Beljaev AE. An analysis of the geographical distribution of *Plasmodium ovale*. *Bulletin of the World Health Organization*, 1969, 40:383–394 (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2554635/pdf/bullwho00224-0052.pdf).

7. WHO Global Malaria Programme. Q&A on malaria elimination and eradication. World Health Organization, Geneva, November 2010 (http://www.who.int/malaria/elimination/WHOGMP_elimination_qa.pdf).

8. Feachem RGA, The Malaria Elimination Group. *Shrinking the malaria map—a guide on malaria elimination for policy makers*. San Francisco, Global Health Group, UCSF Global Health Sciences, 2009 (http://www.malariaeliminationgroup.org/sites/default/files/fileuploads/AGuideonMalariaEliminationforPolicyMakers.pdf).

9. WHO. Status of malaria eradication during the year 1972. *Weekly Epidemiological Record*, 1973, 48 (34):329–340 (supplementary list published on page 335) (http://whqlibdoc.who.int/wer/WHO_WER_1973/WER1973_48_329-344%20(N%C2%B034).pdf).

10. Dobson MJ. History of malaria in England. J Roy Soc Med, 1989, 82(Suppl 17):3-7. (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1291929/pdf/jrsocmed00141-0007.pdf)

11. Slooff R. [A century of (or eternal) care: worldwide steps and missteps in the control of malaria]. In: [*100 years of malaria control: lessons and perspectives*], Nieuwsbrief Maatschappij voor Wetenschappelijk Onderzoek in de Tropen (TREUB Maatschappij), No. 7, December 1998 (article in Dutch).

12. Swellengrebel NH. How the malaria service in Indonesia came into being, 1898–1948. *Journal of Hygiene*, 1950, 48:146–157 (http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=4664412).

13. Kager PA. [Prevention and treatment – from old to new and back]. In: [*100 years of malaria control: lessons and perspectives*], Nieuwsbrief Maatschappij voor Wetenschappelijk Onderzoek in de Tropen (TREUB Maatschappij), No. 7, December 1998 (article in Dutch).

14. The League of Nations malaria documents are available at http://www.who.int/library/collections/historical/en/index4.html. This site contains 282 documents, in PDF format, published by the Malaria Commission between the years of 1924–1932.

15. Sergiev V, Baranova A, Majori G, Ejov M. *Malaria in the European Region of the World Health Organization*, 1970–2000. Geneva, WHO, 2007; and also WHO *Weekly Epidemiological Record*, 2010, 85:461–472. (http://www.who.int/wer/2010/wer8547.pdf).

16. WHO Interim Commission. *Expert Committee on Malaria - report on the first session*. Geneva, WHO, 1947 (WHO.IC/79; WHO.IC/Mal./4) (http://whqlibdoc.who.int/malaria/WHO_IC_MAL_4.pdf).

17. *Report of the second African Malaria Conference*. Geneva, WHO, 1956 (WHO/MAL/160, Lagos Conf./32) (http://whqlibdoc.who.int/malaria/WHO_Mal_160.pdf). Quote from page 48.

18. *Expert Committee on Malaria - sixth report*. Geneva, WHO, 1956 (WHO/Mal/180) (http://whqlibdoc.who.int/malaria/WHO_Mal_180.pdf).

19. *Informal consultation on malaria elimination: setting up the WHO agenda, Tunis, 25–26 February 2006*. Geneva, WHO, 2006 (WHO/HTM/MAL/2006.1114) (http://whqlibdoc.who.int/hq/2006/WHO_HTM_MAL_2006.1114_eng.pdf).

20. Molineaux L, Gramiccia G. *The Garki Project*. Geneva, WHO, 1980:15–21 (http://whqlibdoc.who.int/publications/9241560614_(chp1).pdf).

21. Wernsdorfer WH. The importance of malaria in the world. In: Kreier JP, ed: *Malaria*. New York, Academic Press, 1980:1–93.

22. Nájera JA, González-Silva M, Alonso PL. Some lessons for the future from the Global Malaria Eradication Programme (1955–1969). In: *MalERA, a research agenda for malaria eradication. PLoS Medicine*, 2011, 8(1):84–90 (http://www.ploscollections.org/downloads/plos_medicine_malERA2011_collection.pdf).

23. Malaria, 1962–1981. *World Health Statistics Annual, 1983*, Geneva, WHO, 1983:791–795.

24. WHO Expert Committee on Malaria, 15th report. *WHO Technical Report Series*, no. 467. Geneva, WHO, 1971:42 (http://whqlibdoc.who.int/trs/WHO_TRS_467.pdf).

25. WHO. Emergency antimalarial operations in Madagascar. *Weekly Epidemiological Record*, 1988, 63(47):362–363 (http://whqlibdoc.who.int/wer/WHO_WER_1988/WER1988_63_357-364%20(N%C2%B047).pdf).

26. Nájera JA, Kouznetsov RL, Delacollete C. Malaria epidemics detection and control forecasting and prevention. Geneva, Roll Back Malaria (RBM), [1998] (WHO/MAL/98.1084) (http://www.rollbackmalaria.org/docs/najera_epidemics/naj3.htm).

27. WHO. Malaria: Mauritius. *Weekly Epidemiological Record*, 1975, 50(34):303 (http://whqlibdoc.who.int/wer/WHO_WER_1975/WER1975_50_297-304%20(N%C2%B034).pdf).

28. Madeley J. Malaria in the Solomons. *World Health*, 1988, June:14–15.

29. Communicable Diseases Control Unit (CDCU) of Mauritius Ministry of Health, UNICEF. Malaria in Mauritius. Beau Bassin, CDCU and UNICEF, 2008 (http://www.gov.mu/portal/goc/moh/file/mal-history.pdf).

30. WHO. Malaria: British Solomon Islands Protectorate. *Weekly Epidemiological Record*, 1975, 50(42):356–357 (http://whqlibdoc.who.int/wer/WHO_WER_1975/WER1975_50_353-360%20(N%C2%B042).pdf).

31. WHO Expert Committee on Malaria, 17th report. *WHO Technical Report Series*, no. 640. Geneva, WHO, 1979 (http://whqlibdoc.who.int/trs/WHO_TRS_640.pdf).

32. *Malaria control strategy*. Report by the Director-General. Document A31/19. Geneva, WHO, 1978.

33. WHO. Information on the world malaria situation. *Weekly Epidemiological Record*, 1977, 52:21-36. (http://whqlibdoc.who.int/wer/WHO_WER_1977/WER1977_52_21-36%20(N%C2%B03).pdf).

34. Bruce-Chwatt LJ, de Zulueta J. *The rise and fall of malaria in Europe: A historico-epidemiological study*. Oxford, Oxford University Press, 1980.

35. *World malaria report 2010*. Geneva, WHO, 2010. (http://www.who.int/malaria/world_malaria_report_2010/worldmalariareport2010.pdf).

36. WHO country overview: Maldives (http://www.who.int/countries/mdv/en/); and United Nations Population Fund (UNFPA). *Final country programme document for Maldives*. New York, United Nations Development Programme and UNFPA, 2010 (http://countryoffice.unfpa.org/maldives/drive/final_cpd5_maldives_feb2011.pdf).

37. WHO Regional Office for South-East Asia. Malaria situation in SEAR countries: Maldives (http://www.searo.who.int/en/Section10/Section21/Section340_4023.htm).

38. WHO. World malaria situation 1990 (part I). *Weekly Epidemiological Record*, 1992, 67(22):161–167 (http://whqlibdoc.who.int/wer/WHO_WER_1992/WER1992_67_161-168%20(N%C2%B022).pdf).

39. WHO. Ministerial conference on malaria, Amsterdam. *Weekly Epidemiological Record*, 1992, 67(47):349–350 (http://whqlibdoc.who.int/wer/WHO_WER_1992/WER1992_67_349-356%20(N%C2%B047).pdf); and *A global strategy for malaria control*. Geneva, WHO, 1993 (http://whqlibdoc.who.int/publications/9241561610.pdf).

40. *Epidemiological surveillance of malaria in countries of central and eastern Europe and selected newly independent states*. Copenhagen, WHO Regional Office for Europe, 1992 (EUR/02/5037191) (http://www.euro.who.int/__data/assets/pdf_file/0006/98781/E77302.pdf).

41. *Project for the accelerated implementation of malaria control in Africa (1997–1998)*. Geneva, RBM Partnership/WHO, 2000 (WHO/CDS/RBM/2000.27) (http://whqlibdoc.who.int/hq/2000/WHO_CDS_RBM_2000.27.pdf).

42. Wiseman V, Hawley WA, ter Kuile FO, Phillips-Howard PA, Vulule JM, Nahlen BL, Mills AJ. The cost-effectiveness of permethrin-treated bed nets in an area of intense malaria transmission in western Kenya. *American Journal of Tropical Medicine and Hygiene*, 2003, 68(4 Suppl):161–167 (http://www.ajtmh.org/content/68/4_suppl/161.long).

43. Lindblade KA, Eisele TP, Gimnig JE, Alaii JA, Odhiambo F, ter Kuile FO, Hawley WA, Wannemuehler KA, Phillips-Howard PA, Rosen DH, Nahlen BL, Terlouw DJ, Adazu K, Vulule JM, Slutsker L. Sustainability of reductions in malaria transmission and infant mortality in western Kenya with use of insecticide-treated bednets: 4 to 6 years of follow-up. JAMA, 2004, 291(21):2571-80.

44. Hawley WA, Phillips-Howard PA, ter Kuile FO, Terlouw DJ, Vulule JM, Ombok M, Nahlen BL, Gimnig JE, Kariuki SK, Kolczak MS, Hightower AW. Community-wide effects of permethrin-treated bed nets on child mortality and malaria morbidity in western Kenya. Am J Trop Med Hyg, 2003, 68(4 Suppl):121-7.

45. UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases (TDR). *The development of artemisinin and its derivatives: report of a meeting of the scientific working group on the chemotherapy of malaria, Geneva, 6–7 October, 1986* (TDR/CHEMAL/ART/86.3) (http://whqlibdoc.who.int/hq/1985-86/TDR_CHEMAL_ART_86.3.pdf).

46. Ettling MB. *The control of malaria in Viet Nam from 1980 to 2000: what went right?* Manila, WHO Regional Office for the Western Pacific, 2002 (http://www.wpro.who.int/internet/resources.ashx/MVP/Ettling-VTN+finalrepSept02.pdf).

47. WHO Expert Committee on Malaria, 20th report. *WHO Technical Report Series*, no. 892. Geneva, WHO, 2000:23,60 (http://whqlibdoc.who.int/trs/WHO_TRS_892.pdf).

48. *Guidelines for the treatment of malaria*, 2nd ed. Geneva, WHO, 2010 (http://whqlibdoc.who.int/publications/2010/9789241547925_eng.pdf).

49. *Global report on antimalarial drug efficacy and drug resistance: 2000–2010*. Geneva, WHO, 2011 (http://whqlibdoc.who.int/publications/2010/9789241500470_eng.pdf).

50. US Centers for Disease Control (CDC). Recommendations of the International Task Force for Disease Eradication. *Morbidity and Mortality Weekly Report*, 1993, 42: No. RR-16 (http://www.cdc.gov/mmwr/PDF/rr/rr4216.pdf).

51. Country list: yellow fever vaccination requirements and recommendations. In: *International Travel and Health 2011*. Geneva, WHO, 2011 (http://www.who.int/ith/chapters/ith2011countrylist.pdf).

52. *Malaria coordination meeting in North Africa, Tunis, Tunisia, 26–28 May 1997*. Cairo, WHO Regional Office for the Eastern Mediterranean, 1997 [URL not available].

53. WHO. Meeting of the International Task Force for Disease Eradication – 12 May 2006. *Weekly Epidemiological Record, 2007*, 82(4):25–32 (http://www.who.int/wer/2007/wer8204.pdf).

54. United Nations (UN) General Assembly 2002, 57th Session. *2001–2010: Decade to roll back malaria in developing countries, particularly in Africa*. New York, UN, 2002 (http://www.undemocracy.com/A-57-123.pdf).

55. UN Millennium Development Goals: Goal 6: Combat HIV/AIDS, malaria and other diseases (http://www.un.org/millenniumgoals/aids.shtml).

56. *RBM progress and impact series: A decade of partnership and results*. Geneva, RBM Partnership/WHO, 2011 http://rollbackmalaria.org/ProgressImpactSeries/report8.html).

57. *The Tashkent Declaration: 'The move from malaria control to elimination' in the WHO European Region*. Copenhagen, WHO Regional Office for Europe, 2006 (http://www.euro.who.int/__data/assets/pdf_file/0005/98753/E89355.pdf).

58. *Intercountry workshop on quality assurance of laboratory diagnosis for malaria, Tehran, Islamic Republic of Iran, 2–5 Sept 2001*. Cairo, WHO Regional Office for the Eastern Mediterranean (EMRO), 2001 (WHO-EM/MAL/269/E/L) (http://www.emro.who.int/rbm/Publications/iran0901.pdf).

59. WHO/EMRO: Malaria control and elimination: Epidemiological situation page (http://www.emro.who.int/rbm/epidemiology-2000.htm).

60. *Second intercountry meeting of national malaria programme managers, Muscat, Oman, 24–28 March 2002*. Cairo, WHO/EMRO, 2002 (http://www.emro.who.int/rbm/publications/mal280.pdf).

61. Meleigy M. The quest to be free of malaria. *Bulletin of the World Health Organization, 2007*, 85(7):507–508 (http://www.who.int/bulletin/volumes/85/7/07-020707.pdf).

62. Pan American Health Organization (PAHO) web site: Amazon Network for the Surveillance of Antimalarial Drug Resistance (RAVREDA) / Amazon Malaria Initiative (AMI) page (http://www.paho.org/english/ad/dpc/cd/ravreda-ami.htm).

63. Salud Mesoamerica 2015 web site (http://www.iadb.org/en/salud-mesoamerica-2015/salud-mesoamerica-2015-home,1904.html).

64. The Carter Center web site: The Hispaniola Initiative page (http://www.cartercenter.org/health/hispaniola-initiative/index.html).

65. Roll Back Malaria in Meso America: Report of the meeting held in the Dominican Republic with the participation of Central American countries, Mexico, Haiti, and the Dominican Republic. San Pedro de Macorís, 20–24 November 2000. Washington, DC, PAHO, 2000 (http://www.paho.org/English/AD/DPC/CD/rbm-mesoamerica.Htm).

66. WHO. Outbreak news, malaria, Bahamas. *Weekly Epidemiological Record*, 2006, 81(25):241 (http://www.who.int/wer/2006/wer8125.pdf).

67. Webster-Kerr K, Figueroa PJ, Weir PL, Lewis-Bell K, Baker E, Horner-Bryce J, Lewis-Fuller E, Bullock Ducasse M, Carter KH, Campbell-Forrester S. Success in controlling a major outbreak of malaria because of Plasmodium falciparum in Jamaica. *Tropical Medicine and International Health*, 2011, 16(3):298–306 (http://www.ncbi.nlm.nih.gov/pubmed/21143708).

68. CDC. Malaria – Great Exuma, Bahamas, May-June 2006. MMWR 2006, 55(37):1013-1016. (http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5537a1.htm)

69. Rawlins SC, Hinds A, Rawlins JM. Malaria and its vectors in the Caribbean: the continuing challenge of the disease forty-five years after eradication from the islands. *West Indian Medical Journal*, 2008, 57(5) Mona (http://caribbean.scielo.org/scielo.php?script=sci_arttext&pid=S0043-31442008000500008&lng=pt&nrm=iso).

70. WHO Western Pacific Region: Malaria page (http://www.wpro.who.int/health_topics/malaria/general_info.htm).

71. WHO Western Pacific Region: Regional Action plan for Malaria Control and Elimination in the Western Pacific (2010–2015) page (http://www.wpro.who.int/rcm/en/archives/rc60/rc_resolutions/WPR_RC60_R5.htm).

72. Sambo LG, Ki-Zerbo G, Kirigia JM. Malaria control in the African Region: perceptions and viewpoints on proceedings of the Africa Leaders Malaria Alliance (ALMA). *BMC Proceedings*, 2011, 5(Suppl 5):S3 (http://www.biomedcentral.com/content/pdf/1753-6561-5-S5-S3.pdf).

73. Lubombo Spatial Development Initiative (LSDI) web site (http://www.malaria.org.za/lsdi/Lubombo_SDI/lubombo_sdi.html).

74. Trans-Zambezi Malaria Initiative. (http://www.sadc.int/shdsp/sarn/).

75. Sabot O, Cohen JM, Hsiang MS, Kahn JG, Basu S, Tang L, Zheng B, Gao Q, Zou L, Tatarsky A, Aboobakar S, Usas J, Barrett S, Cohen JL, Jamison DT, Feachem RG. Costs and financial feasibility of malaria elimination. *Lancet*, 2010, 376(9752):1604–1615 (http://www.ncbi.nlm.nih.gov/pubmed/21035839).

76. Da Monteiro MC. [Malaria in Cape Verde Islands]. *Anais do Instituto de Medicina Tropical (Lisb)*, 1952, 9(2):461–484 (http://www.ncbi.nlm.nih.gov/pubmed/13058133). (article in Portuguese)

77. *Refined/Updated GMAP [Global Malaria Action Plan] objectives, targets, milestones and priorities beyond 2011*. Geneva, RBM Partnership Board, June 2011 (http://rollbackmalaria.org/gmap/gmap2011update.pdf).

78. Bill & Melinda Gates Foundation. Bill Gates – Malaria Forum Keynote Address, 17 October 2007 (http://www.gatesfoundation.org/speeches-commentary/Pages/bill-gates-malaria-forum.aspx).

79. *Global malaria control and elimination: report of a technical review*. Geneva, WHO, 2008 (http://whqlibdoc.who.int/publications/2008/9789241596756_eng.pdf).

80. *Progress against malaria: Winning the fight against a deadline disease* [progress sheet]. Seattle, Bill & Melinda Gates Foundation, 2009 (http://www.gatesfoundation.org/livingproofproject/Documents/progress-against-malaria.pdf).

81. Sachs JD, Chambers RG. The new global war on malaria. In: *Realizing the right to health, Vol. 3*, Clapham A, Robinson M, eds. Zurich, ruffer & rub, 2009:305–320 (http://www.earthinstitute.columbia.edu/sitefiles/file/about/director/2009/The%20New%20Global%20War%20on%20Malaria_chapter%20in%20Realizing%20the%20Right%20to%20Health_2009.pdf).

ANNEX. WHO certification of malaria elimination

Countries request certification as an acknowledgement of a significant operational achievement, and for economic reasons such as tourism, foreign investment, etc. WHO certification of a malaria-free status is only initiated at the request of the country itself. There is no obligation or international binding agreement for countries to request it.

The authority of WHO to certify a country's achievement of malaria eradication/elimination is derived from resolution WHA 13.55 by the World Health Assembly (1960), which 'Requests the Director-General to establish an official register listing areas where malaria eradication has been achieved, after inspection and certification by a WHO evaluation team'.

The guiding principles for WHO's certification procedures are set out in the various reports of the WHO Expert Committees on Malaria, as detailed in this Annex. Current Standard Operating Procedures for the certification process are available on the WHO Global Malaria Programme website at http://www. who.int/malaria.

The 1960 meeting of the WHO Expert Committee gave guidance on the methodology of inspection and certification (8th report, TRS 205, pages 34-36). Unified procedures for certification were further deliberated by the 10th Expert Committee in 1963 (TRS 272, pages 34-37). Its report formed the basis for the Notes on the methodology for certification, registration and follow-up of areas where malaria eradication has been achieved that the WHO Director-General circulated to all governments and regional directors in 1966.

In 1973, the 16th Expert Committee reviewed the certification issue. Its report (TRS 549) provides the guiding principles for the current WHO criteria for achievement of malaria eradication/elimination. In 1980, in view of the by then irregular schedule of the WHO Expert Committee meetings, WHO decided to amend the certification procedures, so that countries could be added to the Register in-between expert committee meetings. The 18th Expert committee endorsed the amended procedure in 1985 (TRS 735).

The ordinary certification procedure was complemented by a simplified procedure for countries where malaria never existed or disappeared spontaneously a long time ago (as opposed to being eradicated with specific measures). These countries were entered on a 'supplementary list'.

General

Malaria elimination is the interruption of mosquito-borne malaria transmission in a given area. An area in which elimination has been carried out and where the re-establishment of malaria transmission is unlikely is considered malaria-free. When a country has zero locally acquired malaria cases for at least 3 consecutive years, it can request WHO to certify its malaria-free status. Such certification requires proving beyond reasonable doubt that the chain of transmission of human malaria by mosquitoes has been interrupted in the entire country. For practical reasons, WHO will only certify countries (Member States) as malaria-free, although it is of course possible for a particular area within a country to be malaria-free, even though transmission takes place in other parts of the country. Note that

elimination is a process, while malaria-free refers to a state.

For certification, a defensible, plausible argument must be made based on the available evidence, that, 1) beyond reasonable doubt, malaria transmission has not occurred in the country after a given point in time, and 2) a surveillance and response system that would detect and rapidly interrupt any local transmission is in place in the country. The burden of proof of malaria-free status falls on the health authorities of the country requesting certification. WHO grants certification based on an assessment of the current situation and the likelihood that the country can maintain malaria-free status.

Principles and procedures

1. Certification is for a country as a whole and for all four human malaria species;[19]

2. Certification has to be requested by the government of the country;

3. During a first assessment mission, WHO/HQ, regional office and country staff, together with the national health authorities assess again the chances of certification and if the claim is considered plausible, they jointly prepare a plan of action for the certification procedures, taking into account the status of certification preparedness and available documentation in-country;

4. The country prepares the required documentation and a national report that lays out the evidence for the durable absence of transmission in the entire territory;

5. Inspection and evaluation are carried out by an independent assessment team, organized by WHO;

6. The assessment report of the inspection team is reviewed by the WHO Expert Advisory Panel on Malaria, which submits a recommendation to the WHO Director-General on whether or not malaria-free status should be certified on the basis of the available evidence;

7. The decision on whether or not to grant certification rests with the WHO Director-General;

8. WHO publishes certification in the Weekly Epidemiological Record.

Follow-up of certification

Certified countries continue reporting on an annual basis to WHO on the maintenance of their malaria-free status.

Outbreaks of malaria in a normally or recently malaria-free country must be reported to WHO immediately, so that WHO can provide assistance if needed, can alert international travellers visiting the affected areas, and can alert neighbouring countries, especially those seeking to eliminate malaria. When there is a falciparum malaria outbreak in a 'malaria-free' country, WHO will provide a timely travel alert on the International travel and health website www.who.int/ith, as well as a 'Note to travelers' in the first possible Weekly Epidemiological Record.

An indication of the re-establishment of transmission would the occurrence of three or more malaria infections that can be linked in space and time to mosquito-borne transmission in the same geographical focus within the country, for two consecutive years for *P. falciparum*,

[19] *P. knowlesi* and other zoonoses are at present not included among these 4 human malaria species, even though they can cause serious disease. The current exclusion for certification should be re-evaluated when there is proof of human-to-mosquito-to-human transmission of the zoonosis.

and for three consecutive years for *P. vivax*. WHO reports such instances in the annual updates of its publication International travel and health. Countries in which transmission has been re-established are no longer considered malaria-free.

The key documents to be prepared by the national government for the certification evaluation team are listed in Annex 11 of the document 'Malaria elimination, a field manual for low and moderate endemic countries' (WHO, 2007) and can be accessed online at: http://www.who.int/malaria/docs/elimination/MalariaElimination_BD.pdf

Source: WHO Global Malaria Programme.

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